# DfT Maintenance Challenge Fund

# A403 Value for Money Assessment

PREPARED FOR: Bristol City Council / South Gloucestershire Council

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## 1. Introduction

CH2M HILL have been appointed to undertake the Economic Case Value for Money (VfM) assessment for the A403 Local Highways Maintenance Challenge Fund submission on behalf of Bristol City Council (BCC) and South Gloucestershire Council (SGC).

This note sets out the Value for Money assessment undertaken.

## 2. Scheme

### 2.1. Scheme Overview

The A403 links Avonmouth Port and the Avonmouth and Severnside Enterprise Area to the Strategic Road Network of M4, M48, M49 and M5. As well as providing a critical business link the road provides access to the local communities of Aust, Severn Beach and Avonmouth. Since opening over 50 years ago the A403 has exceeded its design life and is no longer able to support the traffic loads and demands. Expected traffic growth will accelerate deterioration rapidly. Localised repairs have been carried out but major maintenance is unaffordable if a balanced asset management programme is to be delivered across the network. The industrial nature of the area served by the A403 exposes the road to greater stress than a standard "A" road due to the higher than normal percentage of Heavy Goods Vehicles using the route is 27% compared to national average on all roads of 5%.

The scheme consists of maintenance and enhancement of the A403 Corridor from Avonmouth Port to the M48 at Aust, to support economic development within the Avonmouth & Severnside Enterprise Area. The scheme will provide enhanced facilities for sustainable transport modes whilst extending the life of the existing carriageway, footways, drainage and cycleway. The scheme supports development of the Avonmouth/Severnside Enterprise Area and Avonmouth Deep Water Container Port by improving the condition of the A403 for all forms of transport ahead of these major economic investments.

### 2.2. Scheme Rationale

The condition of this road has been assessed annually as part of the annual condition assessment of the principal road network. Without Challenge Fund investment, the existing maintenance regime of high cost reactive maintenance with localised reconstruction would continue. The road will be managed in a declining condition resulting in lane closures and traffic delays and disruption. As the condition declines, vehicle

operating costs and accident risk will increase. Lane closures will severely disrupt the capacity of the joining road network affecting businesses with the Avonmouth and Severnside Area. The poor standard of the road could potentially become a deterrent to businesses considering locating to the Enterprise Area, meaning that the aspirations for the economic growth of the area is constrained and the objectives of the Strategic Economic Plan are put at risk.

This reactive maintenance is estimated at £350,000 per year in line with previous annual level of maintenance works undertaken on the route.

With Challenge Fund investment, the scheme will:

- Extend the life of the carriageway and other transport assets reducing future revenue and capital maintenance costs;
- Improve surface condition, reducing accidents and vehicle running costs;
- Enhance public transport facilities to meet the needs of operators and users;
- Provide a safer, healthier environment for pedestrians, cyclists and vulnerable road users through environmental enhancement and reduce verge maintenance requirements;
- Reduce energy costs by upgrading the street lighting;
- Reduce road noise and vehicle pollution benefiting local communities.

If funding is granted, the works will be constructed in two years and benefits could start in 2017 and last for 25 years before another round of resurfacing/maintenance works is needed. Benefits from revised layout would yield ongoing cycling and safety benefits. Below is a list of benefits that have been monetised:

- Accident benefits from improved resurfacing and improved vehicle turning arrangements over 25 years
- Cycle accident benefits from the introduction of a cycle way over 60 years
- Vehicle speed and operating cost benefits from resurfacing works over 25 years
- Energy saving from improved lighting
- Physical activity benefits from increased cycling levels.

It is expected that traffic disruption resulting from reactive ongoing maintenance without Challenge Fund investment will have a greater overall impact than disruption resulting from the planned works required for scheme implementation. This is due to:

- greater number of maintenance interventions in do minimum scenario due to reactive nature of works with limited funding in any given year
- works undertaken later in do minimum scenario would impact greater numbers of vehicles due to increased traffic levels associated with significant planned growth in the Avonmouth area in future years.

It is therefore expected that further scheme benefits would result from reduced traffic disruption due to scheme maintenance works although these impacts have not been monetised.

## 2.3. Scheme Costs

Scheme investment costs are provide in Table 2.1

| Year | Cost |
|---|---|
| 2015 | £9,666,559 |
| 2016 | £4,363,761 |
| **Total** | **£14,030,320** |

Table 2.1 Scheme Costs (Nominal Terms)

10% of the investment costs is assumed to be funded by the local authority.

The scheme is also estimated to result in savings from street lighting maintenance and energy costs. These include:

- Ongoing maintenance costs
- Energy costs
- Replacement of non-galvanised lighting columns.

Details of estimated 20 year savings are provided in Appendix A. These are discounted to £147,492 (2010 values and prices).

If Challenge Fund investment is not obtained reactive maintenance is estimated by BCC / SGC at £350,000 per year in line with previous annual level of maintenance works undertaken on the route.

# 3. Scheme Benefits Assessment

## 3.1. Pavement Condition Impacts

To provide information on the forecast condition of the pavement on the A403, BCC/SGC commissioned WDM Ltd to carry out lifecycle modelling of the route over a 25 year period.

Pavement Condition Forecasting

This is based on existing pavement condition data and uses a deterministic deterioration model to assess the state of the pavement in each year under the Do-Minimum (DM) and Do-Something (DS) maintenance scenarios.

The DM scenario assumes that the historic spend on the A403 of circa £350,000 per annum is maintained over the 25 year period with treatment applied on a 'worst first' basis in a managed decline of the pavement.

The forecast pavement condition results for the DM and DS scenarios are shown in Appendix B and C, respectively. The DM forecast shows that, after an initial improvement, the pavement begins to deteriorate with nearly 46 per cent of the route within the worst Red Scanner category, that is, with a Road Condition Index (RCI) of 100 or more. The DS forecast, on the other hand, shows that the pavement is brought entirely within the Green Scanner category, with an RCI of less than 40 after the first year.

Forecast Traffic Flows

The estimation of the impact of pavement condition on vehicle operating costs (VOC) and travel time required an estimate of future traffic volumes along the A403. BCC and SGC supplied automatic traffic counter (ATC) data for their respective sections for this purpose. Table 3.1 shows the two-way Annual Average Daily Traffic (AADT) and year of count within each local authority area. Based on the observed growth between SGC counts between 2009 and 2014, these volumes were growthed at 2.6 per cent per annum to bring them to current 2015 levels and to forecast traffic throughout the 25 assessment period.

| Authority (Year) | All | Cars | LGVs | HGVs | PSVs |
|---|---|---|---|---|---|
| BCC (2008) | 12689 | 5911 | 2894 | 3379 | 22 |
| SGC (2014) | 9463 | 5682 | 874 | 2673 | 19 |

Table 3.1: Base Two-Way AADT Values

Pavement Condition and Operating Costs

The impact of pavement condition VOC has been estimated using a relationships published in a study by Transport Scotland and TRL ('Economic, Environmental and Social Impacts of Changes in Maintenance Spend on the Scottish Trunk Road Network', 2012). Table 14.9 of that report provides calculated changes in the VOC for various vehicle types (cars, LGsV, HGVs and PSV) for increasing values of International Roughness

Index (IRI) based on output from the HDM-4 model. The relative change calculated from this table is shown in Table 3.2.

| Vehicle Type | IRI = 1 | IRI = 4 | IRI =7 | IRI=9.5 |
|---|---|---|---|---|
| Car | 0.00% | 3.55% | 13.79% | 22.36% |
| LGV | 0.00% | 4.35% | 21.45% | 36.99% |
| HGV | 0.00% | 6.71% | 21.55% | 33.09% |
| PSV | 0.00% | 9.48% | 31.91% | 48.33% |

Table 3.2: Increase in VOC with Increases in IRI

The pavement forecast condition for the DM and DS scenarios from WDM gave the proportion of the route falling within three categories: Red (RCI > 100), Amber (RCI 40-100), and Green (RCI < 40). However, to calculate the impact on VOC, a single RCI value was needed. Thus, an RCI value within each category was assumed as follows: Red = 150, Amber = 80 and Green = 10. These values were converted initially into 3 metre longitudinal profile variance (LPV3m) value and then into IRI using the following formula taken from the Transport Scotland (2012) study:

(1) $$LPV3m = A \times RCI + B$$

where: *A* is a coefficient for single all purpose trunk roads of 0.0397

*B* is a coefficient for single all purpose trunk roads of 0.3085

(2) $$IRI = \sqrt[1.8507]{LPV3m/0.2117}$$

Using these formulae, the IRI values within each Scanner category were calculated as follows: Red = 6.5, Amber = 4.88 and Green = 2.56. The impact on VOC for each vehicle type (car, LGV, HGV and PSV) was then estimated by interpolating between the values in Table 2. Table 3.3 shows the resulting VOC adjustments by vehicle type used to estimate the impact of pavement condition on VOC.

| Vehicle Type | Red | Amber | Green |
|---|---|---|---|
| Car | 17.40% | 9.39% | 1.23% |
| LGV | 27.99% | 14.10% | 1.51% |
| HGV | 26.41% | 15.17% | 2.33% |
| PSV | 38.82% | 22.27% | 3.29% |

Table 3.3: VOC Adjustments by Scanner Category by Vehicle Type

The values of VOC by vehicle type in forecast each year were taken from the Transport Analysis Guidance (TAG) data book (November 2014). TAG provides forecast fuel, both work (Table A 1.3.12) and non-work (Table A 1.3.13), and non-fuel resource operating costs (Table A 1.3.14). The fuel cost element was calculated based on an assumed mean speed of 48 kilometres per hour and split for cars and LGV between work and non-work time based on weighted average based on the proportion of travel in work and non-work time in data book Table A 1.3.4. The non-fuel resource was calculated based on an assumed mean speed of 48 kilometres per hour with the cost assumed to be fixed throughout the assessment period.

The vehicle kilometres for each vehicle type within each Scanner category were calculated by multiplying the forecast two way AADT by type in each year by the length of the route (in kilometres) within each category for that year from the WDM Ltd DM and DS pavement condition forecast. The VOC within each

category, by each vehicle type, was then calculated by multiplying the vehicle kilometres by the forecast VOC (in Table 4) increased by the relevant VOC adjustment factor for the category (in Table 3). These were then summed to give an overall VOC over the 25 year assessment period to give an overall estimate of daily VOC for each maintenance scenario.

## Pavement Condition and Travel Time

The impact of pavement condition on travel time is based on a study by TRL ('The Effect on Traffic Speeds of Resurfacing a Road', by Cooper, Jordan and Young, 1980), which showed that average speed increased when a new surface was provided for a road pavement. The Transport Scotland study (2012), by assuming the reverse, namely that speeds reduce as pavement condition deteriorates, provides estimated reductions in speed for various vehicle types based on increasing values of 3mLPV. This is shown in Table 3.4.

| Type | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| Car | 0 | 0.22 | 0.44 | 0.67 | 0.89 | 1.11 | 1.33 | 1.56 | 1.78 | 2 |
| LGV | 0 | 0.26 | 0.51 | 0.77 | 1.02 | 1.28 | 1.53 | 1.79 | 2.04 | 2.3 |
| HGV | 0 | 0.26 | 0.51 | 0.77 | 1.03 | 1.28 | 1.53 | 1.79 | 2.05 | 2.30 |
| PSV | 0 | 0.22 | 0.44 | 0.67 | 0.89 | 1.11 | 1.33 | 1.56 | 1.78 | 2 |

Table 3.4: Reductions in Speed by LPV3m by Type

The assumed values within each Scanner category were converted to LPV3m using equation (1). This gave LPV3m values within each category as follows: Red = 6.76, Amber = 3.98 and Green = 1.21. The impact on mean speed for each vehicle type (car, LGV, HGV and PSV) was then estimated by interpolating between the values in Table 3.4. Table 3.5 shows the resulting mean speed reduction by vehicle type.

| Vehicle Type | Red | Amber | Green |
|---|---|---|---|
| Car | 2 | 1.40 | 0.27 |
| LGV | 2.3 | 1.61 | 0.31 |
| HGV | 2.60 | 1.82 | 0.35 |
| PSV | 2.00 | 1.40 | 0.27 |

Table 3.5: Mean Speed Adjustments by Scanner Category by Vehicle Type

The values in Table 3.5 were used to create an adjusted mean speed within each Scanner category. The total vehicle hours by type were then estimated by dividing the length of the route within each category (in kilometres) from the WDM Ltd DM and DS pavement condition forecast by the adjusted mean speed (in kilometres per hour) to give the travel time in hours for a single vehicle. This was multiplied by the forecast AADT for that vehicle type to give total vehicle hours.

The vehicle hours in each year were then monetised using average type/all-week values of time (VOT) in pounds per hour from TAG (Table A 1.3.5) growthed in line with forecast values of time set out in TAG Table A 1.3.6. The costs in each year were then summed to give a yearly cost which was totalled over the 25 year assessment period to give an overall estimate of daily travel time costs for each maintenance scenario.

## Net Economic Benefit of Scheme

The methodology set out above was carried out for the DM and DS maintenance scenarios based on the WDM Ltd pavement forecast data for the A403. The separate VOC and travel time components were separately calculated and summed to give costs within each of the 25 assessment years (from 2015 to 2040). The daily benefit was calculated by the net difference between the DM and DS scenarios. A 3.5 per cent discount factor was applied to future benefits and the benefits were annualised using a factor of 365.

The calculations were carried out separately for the BCC and SGC sections with the relevant route length and AADT forecast used to estimate the economic impacts of forecast pavement condition. This assumed the same distribution of forecast pavement condition within each local authority area. The estimated net benefit of the DS scenario on the BCC section was nearly £13 million (2010 prices), with an estimated net benefit of the DS scenario on the SGC section of £11 million (2010 prices). A total benefit of circa £24 million (2010 prices), with around 75% resulting from the reduced VOC.

## 3.2. Accident Benefits

Methodology

Accident reduction benefits have been calculated using 2010 base prices abstracted from WebTAG. These unit base year prices are shown in Table 3.6.

| Severity | Insurance £ | Damage to Property £ | Police Cost £ | Casualty Cost £ | Total Rates £ |
|---|---|---|---|---|---|
| | Administration | Urban | Urban | | |
| **Fatal** | 301 | 7,842 | 17,012 | 1,640,134 | 1,665,289 |
| **Serious** | 187 | 4,203 | 1,878 | 184,305 | 190,574 |
| **Slight** | 114 | 2,479 | 486 | 14,208 | 17,287 |

Table 3.6: Accident cost rates

Annual Rates of Growth of Accident Values abstracted from WebTAG (COBALT 2) have been used as the growth rates of accident reduction benefits. Accident reduction benefits resulting from resurfacing have been discounted for 25 years using a discount rate of 3.5%, while accident reduction benefits resulting from a new cycle route have been discounted for 60 years (discount rate for 30 years: 3.5%, for 60 years: 3%).

Current Accident Rates

Annual accident rates have been calculated based on a recent five year reporting period (2009 to 2014) for the BCC section and four year reporting period (2009 to 2013) for the SGC section as shown in Table 3.7.

| | BCC (5 years accidents) | | SGC (4 years accidents) | | Total | |
|---|---|---|---|---|---|---|
| **Severity** | **Total** | **Total/year** | **Total** | **Total/year** | **Total** | **Total/year** |
| **Fatal** | 2 | 0.4 | 1 | 0.25 | 3 | 0.65 |
| **Serious** | 1 | 0.2 | 1 | 0.25 | 2 | 0.45 |
| **Slight** | 27 | 5.4 | 6 | 1.5 | 33 | 6.9 |
| **Total** | 30 | 6 | 8 | 2 | 38 | 8 |

Table 3.7: Annual accident rates

Assumptions

The nature of improvement works have some differences between the BCC and SGC sections of the A403, consequently different accident reduction assumptions have been used.
A review of accident data has been undertaken by BCC to identify the proportions of accidents that would be expected to reduce with improved road surface as follows:

- A reduction of 50% of cycle accidents on BCC section of the A403 (1 fatal and 2 serious cycle accidents) as a result of the introduction of a new cycle route on this section. The benefits from this reduction is assessed over 60 years.
- In the BCC section, a reduction of 40% is assumed to the number of accidents directly targeted by the new road layout (8.64 out of 30 accidents). The number of accidents directly targeted is calculated as follows:

- The total number of vehicle manoeuvres recorded in the accident records was 59
- The number of manoeuvres that would be assisted by the revised layout (accidents involving right turns, changing lanes, overtaking) was 19, equating to 32% of the total number of manoeuvres recorded.
- The total number of targeted accidents is calculated as the 32% of the total (non-cycling) accidents, which equates to 8.64 accidents.

- A 20% reduction is assumed on the accidents not directly influenced by targeted action but expected to be affected by overall design on BCC section of the A403.

A conservative reduction rate of 10% is assumed on the SGC section of the A403.

Predicted Reductions in Accidents

Table3.8 shows the current and the predicted number of accidents based on the assumptions listed above (combining accident data for BCC and SGC).

| Severity | Total current Accidents | Total/year DM | Total/year DS | Predicted Annual Reduction |
|---|---|---|---|---|
| **Fatal** | 3 | 0.65 | 0.47 | 0.18 |
| **Serious** | 2 | 0.45 | 0.37 | 0.08 |
| **Slight** | 33 | 6.9 | 5.23 | 1.67 |
| **Total** | 38 | 8 | 6.07 | 1.93 |

Table 3.8: Annual accident rates

The monetised accident reduction benefits in the opening year (2018) is: £ 279,270. The discounted accident reduction benefits is £8.7 million.

## 3.3. Physical Activity Benefits

Health benefits have been identified using the HEAT assessment tool to reflect reduced mortality as a result of changes in cycling behavior. Further details are provided in Appendix E.

# 4. Cost Benefit Analysis and Conclusion

Scheme costs and benefits have been used to undertake a cost benefit analysis in accordance with WebTAG. Annual inflation of 15% has been applied to scheme costs incurred in the second year of implementation, as a conservative assumption. 44% optimism bias has been included as a conservative assumption.

Scheme costs are summarised as follows:

| **Public Accounts** | **(£'000)** |
|---|---|
| Investment costs | 17,805 |
| Operating costs (maintenance) | - 8,803 |
| Operating costs (street lighting) | - 147 |
| **Broad Transport Budget** | **8,854** |
| **Wider Public Finances** | **0** |

2010 values and prices

The cost benefit analysis is summarised as follows:

| **Analysis of Monetised Costs and Benefits** | **(£'000)** |
|---|---|
| Physical Activity | 3,430 |
| Accidents | 8,674 |
| Economic Efficiency | 24,144 |
| Wider Public Finances | - |
| Present Value of Benefits | 36,248 |
| Present Value of Costs | 8,854 |
| **Net Present Value (NPV)** | **27,394** |
| **Benefit to Cost Ratio (BCR)** | **4.09** |

2010 values and prices

Full AMCB and Public Accounts tables are provide in Appendix D.

With a number of conservative assumptions made, the assessment indicates the scheme represents very high value for money with a BCR of 4.09.

# Appendix A

# Street Lighting Cost Savings

# Avonmouth Scheme (20 Year Costs)

**Miantenance Costs Per 3 Years Lanterns**

| item | Description | Cost | Qty | Total |
|---|---|---|---|---|
| A | Lamp Change Group A Lantern | £16.14 | 142 | £2,291.88 |
| B | Cost of Lamp | £20.00 | 142 | £2,840.00 |
| | 3 Years | | | **£5,131.88** |
| | 20 Years | | | **£34,178.32** |

**Energy Savings Per Lantern (Subject to Dimming Profiles)**

| item | Description | Cost | Qty | Total |
|---|---|---|---|---|
| A | Energy Saving per Lamp per year | £22.20 | 142 | £3,152.40 |
| | 20 Years | | | **£63,048.00** |

**Cost of Having to replace non galvanised lighting Columns**

| item | Description | Cost | Qty | Total |
|---|---|---|---|---|
| A | Replace Non Galvanised Lighting Columns and lanterns as both are at the end of their design life, inc WPD wortks, conventional lanterns | £1,800.00 | 96 | £172,800.00 |

**Total Estimated 20 Year Savings** **£270,026.32**

# Appendix B

# DM Forecast Pavement Condition

| Yearly Maintenance Allocation | | | | | | | | | | | | Indicator - Current Year | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | SCANNER | | | | | | | | | | SCRIM DEFICIENCY | | | | | |
| | | Surface Treatment | | Thin Surfacing | | Thin Overlay 50mm | | Reconstruction | | Thick Overlay 100mm | | Red | | Amber | | Green | | Total | | <=0 | | 0.01 to 0.05 | | >0.05 | | Total | |
| Year | Maintenance Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost | km | % | km | % | km | % | km | % | km | % | km | % | km | % | km | % |
| 2015 | £350,000 | 0.777 | £49,825 | 0.010 | £2,700 | 0.122 | £46,322 | 0.050 | £61,172 | 0.260 | £183,938 | 1.482 | 5.6% | 5.011 | 18.8% | 20.197 | 75.7% | 26.69 | 100.0% | 8.26 | 31.1% | 4.079 | 15.4% | 14.186 | 53.5% | 26.525 | 100.0% |
| 2016 | £350,000 | 0.779 | £49,953 | 0.000 | £0 | 0.394 | £149,597 | 0.000 | £0 | 0.200 | £145,125 | 1.41 | 5.3% | 4.791 | 18.0% | 20.489 | 76.8% | 26.69 | 100.0% | 8.112 | 30.5% | 4.26 | 16.0% | 14.183 | 53.4% | 26.555 | 100.0% |
| 2017 | £350,000 | 0.778 | £49,889 | 0.077 | £20,790 | 0.340 | £129,094 | 0.000 | £0 | 0.190 | £145,125 | 1.23 | 4.6% | 4.807 | 18.0% | 20.653 | 77.4% | 26.69 | 100.0% | 7.909 | 29.8% | 4.135 | 15.6% | 14.531 | 54.7% | 26.575 | 100.0% |
| 2018 | £350,000 | 0.770 | £49,376 | 0.040 | £10,800 | 0.430 | £163,266 | 0.000 | £0 | 0.170 | £121,500 | 1.23 | 4.6% | 5.024 | 18.8% | 20.436 | 76.6% | 26.69 | 100.0% | 7.569 | 28.5% | 5.22 | 19.6% | 13.806 | 51.9% | 26.595 | 100.0% |
| 2019 | £350,000 | 0.770 | £49,376 | 0.060 | £16,200 | 0.430 | £163,266 | 0.000 | £0 | 0.150 | £118,125 | 1.15 | 4.3% | 5.374 | 20.1% | 20.166 | 75.6% | 26.69 | 100.0% | 7.099 | 26.7% | 6.599 | 24.8% | 12.907 | 48.5% | 26.605 | 100.0% |
| 2020 | £350,000 | 0.770 | £49,376 | 0.050 | £13,500 | 0.524 | £198,956 | 0.000 | £0 | 0.110 | £82,688 | 1.18 | 4.4% | 5.514 | 20.7% | 19.996 | 74.9% | 26.69 | 100.0% | 7.539 | 28.3% | 7.862 | 29.6% | 11.204 | 42.1% | 26.605 | 100.0% |
| 2021 | £350,000 | 0.770 | £49,376 | 0.129 | £34,830 | 0.435 | £165,164 | 0.000 | £0 | 0.130 | £99,563 | 1.26 | 4.7% | 5.78 | 21.7% | 19.65 | 73.6% | 26.69 | 100.0% | 7.545 | 28.4% | 8.977 | 33.7% | 10.083 | 37.9% | 26.605 | 100.0% |
| 2022 | £350,000 | 0.772 | £49,505 | 0.110 | £29,700 | 0.580 | £220,219 | 0.000 | £0 | 0.065 | £49,781 | 1.365 | 5.1% | 5.91 | 22.1% | 19.415 | 72.7% | 26.69 | 100.0% | 7.355 | 27.6% | 10.157 | 38.1% | 9.118 | 34.2% | 26.63 | 100.0% |
| 2023 | £350,000 | 0.774 | £49,633 | 0.037 | £9,990 | 0.500 | £189,844 | 0.000 | £0 | 0.120 | £99,563 | 1.44 | 5.4% | 6.2 | 23.2% | 19.05 | 71.4% | 26.69 | 100.0% | 7.9 | 29.7% | 10.715 | 40.2% | 8.015 | 30.1% | 26.63 | 100.0% |
| 2024 | £350,000 | 0.777 | £49,825 | 0.033 | £8,910 | 0.630 | £239,203 | 0.000 | £0 | 0.060 | £47,250 | 1.87 | 7.0% | 6.17 | 23.1% | 18.65 | 69.9% | 26.69 | 100.0% | 8.72 | 32.7% | 10.698 | 40.2% | 7.212 | 27.1% | 26.63 | 100.0% |
| 2025 | £350,000 | 0.775 | £49,697 | 0.020 | £5,400 | 0.710 | £269,578 | 0.000 | £0 | 0.030 | £23,625 | 2.39 | 9.0% | 6.28 | 23.5% | 18.02 | 67.5% | 26.69 | 100.0% | 9.159 | 34.4% | 10.653 | 40.0% | 6.818 | 25.6% | 26.63 | 100.0% |
| 2026 | £350,000 | 0.770 | £49,376 | 0.000 | £0 | 0.590 | £224,016 | 0.000 | £0 | 0.090 | £70,875 | 2.95 | 11.1% | 6.43 | 24.1% | 17.31 | 64.9% | 26.69 | 100.0% | 10.219 | 38.4% | 10.025 | 37.6% | 6.386 | 24.0% | 26.63 | 100.0% |
| 2027 | £350,000 | 0.774 | £49,633 | 0.030 | £8,100 | 0.680 | £258,188 | 0.000 | £0 | 0.040 | £30,375 | 3.65 | 13.7% | 7.08 | 26.5% | 15.96 | 59.8% | 26.69 | 100.0% | 10.949 | 41.1% | 9.756 | 36.6% | 5.945 | 22.3% | 26.65 | 100.0% |
| 2028 | £350,000 | 0.777 | £49,825 | 0.012 | £3,240 | 0.735 | £279,070 | 0.000 | £0 | 0.020 | £15,188 | 4.55 | 17.0% | 7.419 | 27.8% | 14.721 | 55.2% | 26.69 | 100.0% | 11.609 | 43.5% | 9.642 | 36.2% | 5.409 | 20.3% | 26.66 | 100.0% |
| 2029 | £350,000 | 0.777 | £49,825 | 0.000 | £0 | 0.690 | £261,984 | 0.000 | £0 | 0.050 | £37,125 | 5.69 | 21.3% | 7.379 | 27.6% | 13.621 | 51.0% | 26.69 | 100.0% | 12.369 | 46.4% | 9.143 | 34.3% | 5.158 | 19.3% | 26.67 | 100.0% |
| 2030 | £350,000 | 0.775 | £49,697 | 0.000 | £0 | 0.590 | £224,016 | 0.000 | £0 | 0.090 | £72,563 | 6.78 | 25.4% | 7.139 | 26.7% | 12.771 | 47.8% | 26.69 | 100.0% | 13.119 | 49.2% | 8.406 | 31.5% | 5.145 | 19.3% | 26.67 | 100.0% |
| 2031 | £350,000 | 0.777 | £49,825 | 0.004 | £1,080 | 0.680 | £258,188 | 0.000 | £0 | 0.050 | £38,813 | 7.999 | 30.0% | 6.54 | 24.5% | 12.151 | 45.5% | 26.69 | 100.0% | 13.539 | 50.8% | 8.125 | 30.5% | 5.006 | 18.8% | 26.67 | 100.0% |
| 2032 | £350,000 | 0.773 | £49,569 | 0.010 | £2,700 | 0.650 | £246,797 | 0.000 | £0 | 0.060 | £48,938 | 9.269 | 34.7% | 5.48 | 20.5% | 11.941 | 44.7% | 26.69 | 100.0% | 13.739 | 51.5% | 8.288 | 31.1% | 4.643 | 17.4% | 26.67 | 100.0% |
| 2033 | £350,000 | 0.770 | £49,376 | 0.000 | £0 | 0.590 | £224,016 | 0.000 | £0 | 0.090 | £74,250 | 10.479 | 39.3% | 4.09 | 15.3% | 12.121 | 45.4% | 26.69 | 100.0% | 13.966 | 52.4% | 8.095 | 30.4% | 4.609 | 17.3% | 26.67 | 100.0% |
| 2034 | £350,000 | 0.770 | £49,376 | 0.009 | £2,430 | 0.520 | £197,438 | 0.000 | £0 | 0.120 | £99,563 | 11.659 | 43.7% | 2.66 | 10.0% | 12.371 | 46.4% | 26.69 | 100.0% | 14.186 | 53.2% | 7.98 | 29.9% | 4.504 | 16.9% | 26.67 | 100.0% |
| 2035 | £350,000 | 0.777 | £49,825 | 0.000 | £0 | 0.559 | £212,245 | 0.000 | £0 | 0.100 | £82,688 | 12.429 | 46.6% | 1.73 | 6.5% | 12.531 | 47.0% | 26.69 | 100.0% | 14.289 | 53.6% | 7.979 | 29.9% | 4.402 | 16.5% | 26.67 | 100.0% |
| 2036 | £350,000 | 0.770 | £49,376 | 0.010 | £2,700 | 0.550 | £208,828 | 0.000 | £0 | 0.100 | £81,000 | 12.47 | 46.7% | 1.63 | 6.1% | 12.59 | 47.2% | 26.69 | 100.0% | 14.464 | 54.2% | 7.901 | 29.6% | 4.305 | 16.1% | 26.67 | 100.0% |
| 2037 | £350,000 | 0.770 | £49,376 | 0.000 | £0 | 0.520 | £197,438 | 0.000 | £0 | 0.120 | £101,250 | 12.33 | 46.2% | 1.92 | 7.2% | 12.44 | 46.6% | 26.69 | 100.0% | 14.839 | 55.6% | 7.546 | 28.3% | 4.285 | 16.1% | 26.67 | 100.0% |
| 2038 | £350,000 | 0.774 | £49,633 | 0.000 | £0 | 0.394 | £149,597 | 0.010 | £12,234 | 0.160 | £133,313 | 12.19 | 45.7% | 2.294 | 8.6% | 12.206 | 45.7% | 26.69 | 100.0% | 14.966 | 56.1% | 7.428 | 27.9% | 4.276 | 16.0% | 26.67 | 100.0% |
| 2039 | £350,000 | 0.770 | £49,376 | 0.000 | £0 | 0.460 | £174,656 | 0.000 | £0 | 0.150 | £124,875 | 12.24 | 45.9% | 2.445 | 9.2% | 12.005 | 45.0% | 26.69 | 100.0% | 15.167 | 56.9% | 7.325 | 27.5% | 4.178 | 15.7% | 26.67 | 100.0% |
| 2040 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 12.23 | 45.8% | 2.692 | 10.1% | 11.768 | 44.1% | 26.69 | 100.0% | 15.294 | 57.3% | 7.248 | 27.2% | 4.128 | 15.5% | 26.67 | 100.0% |

| Yearly Maintenance Allocation | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Surface Treatment | | Thin Surfacing | | Thin Overlay 50mm | | Reconstruction | | Thick Overlay 100mm | |
| Year | Maintenance Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost |
| 2015 - 2020 | £1,750,000 | 3.87 | £248,420 | 0.19 | £50,490 | 1.72 | £651,544 | 0.05 | £61,172 | 0.97 | £713,813 |
| 2020 2025 | £1,750,000 | 3.86 | £247,715 | 0.36 | £96,930 | 2.67 | £1,013,386 | 0.00 | £0 | 0.49 | £378,844 |
| 2025- 2030 | £1,750,000 | 3.87 | £248,356 | 0.06 | £16,740 | 3.41 | £1,292,836 | 0.00 | £0 | 0.23 | £177,188 |
| 2030 - 3035 | £1,750,000 | 3.87 | £247,843 | 0.02 | £6,210 | 3.03 | £1,150,453 | 0.00 | £0 | 0.41 | £334,125 |
| 2035 - 2040 | £1,750,000 | 3.86 | £247,587 | 0.01 | £2,700 | 2.48 | £942,764 | 0.01 | £12,234 | 0.63 | £523,125 |

# Appendix C

# DS Forecast Pavement Condition

| | Yearly Maintenance Allocation | | | | | | | | | | | Indicator - Current Year | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Thick Overlay | | SCANNER | | | | | | | | | | SCRIM DEFICIENCY | | | | | |
| | | Surface Treatment | | Thin Surfacing | | Thin Overlay 50mm | | Reconstruction | | 100mm | | Red | | Amber | | Green | | Total | | <=0 | | 0.01 to 0.05 | | >0.05 | | Total | |
| Year | Maintenance Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost | km | % | km | % | km | % | km | % | km | % | km | % | km | % | km | % |
| 2015 | | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 26.690 | ######### | 1.482 | 5.6% | 5.011 | 18.8% | 20.197 | 75.7% | 26.69 | 100.0% | 8.26 | 31.1% | 4.079 | 15.4% | 14.186 | 53.5% | 26.525 | 100.0% |
| 2016 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2017 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2018 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2019 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2020 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2021 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2022 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2023 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2024 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2025 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2026 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2027 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2028 | £809,924 | 15.788 | £809,924 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2029 | £558,760 | 10.892 | £558,760 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 10.902 | 40.8% | 15.788 | 59.2% | 26.69 | 100.0% |
| 2030 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2031 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2032 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2033 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% |
| 2034 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 15.788 | 59.2% | 10.902 | 40.8% | 26.69 | 100.0% |
| 2035 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2036 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2037 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2038 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2039 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% | 0 | 0.0% | 26.69 | 100.0% |
| 2040 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0.000 | £0 | 0 | 0.0% | 0 | 0.0% | 26.69 | 100.0% | 26.69 | 100.0% | 0 | 0.0% | 10.442 | 39.1% | 16.248 | 60.9% | 26.69 | 100.0% |

| | Yearly Maintenance Allocation | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Thick Overlay | |
| | | Surface Treatment | | Thin Surfacing | | Thin Overlay 50mm | | Reconstruction | | 100mm | |
| Year | Maintenance Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost | Length | Cost |
| 2015 - 2020 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 |
| 2020 - 2025 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 |
| 2025- 2030 | £1,368,684 | 26.68 | £1,368,684 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 |
| 2030 - 3035 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 |
| 2035 - 2040 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 | 0.00 | £0 |

# Appendix D
# Appraisal Tables

## Public Accounts (PA) Table

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | **TOTAL** | | **INFRASTRUCTURE** | | | |
| Revenue | | | | | | |
| Operating Costs | -8,950 | | -8,950 | | | |
| Investment Costs | 1,780 | | 1,780 | | | |
| Developer and Other Contributions | | | | | | |
| Grant/Subsidy Payments | | | | | | |
| **NET IMPACT** | -7,170 | *(7)* | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | | | | | | |
| Operating costs | 0 | | 0 | | | |
| Investment Costs | 16,024 | | 16,024 | | | |
| Developer and Other Contributions | | | | | | |
| Grant/Subsidy Payments | | | | | | |
| **NET IMPACT** | 16,024 | *(8)* | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | | *(9)* | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 8,854 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted present values in 2010 prices and values.

## Analysis of Monetised Costs and Benefits

| | | |
|---|---|---|
| Noise | | *(12)* |
| Local Air Quality | | *(13)* |
| Greenhouse Gases | | *(14)* |
| Journey Quality | | *(15)* |
| Physical Activity | 3,430 | *(16)* |
| Accidents | 8,674 | *(17)* |
| Economic Efficiency: Consumer Users (Commuting) | 13,198 | *(1a)* |
| Economic Efficiency: Consumer Users (Other) | | *(1b)* |
| Economic Efficiency: Business Users and Providers | 10,946 | *(5)* |
| Wider Public Finances (Indirect Taxation Revenues) | | *- (11) - sign changed from PA table, as PA table represents costs, not benefits* |
| Present Value of Benefits (see notes) (PVB) | 36,248 | *(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)* |
| Broad Transport Budget | 8,854 | *(10)* |
| Present Value of Costs (see notes) (PVC) | 8,854 | *(PVC) = (10)* |
| OVERALL IMPACTS | | |
| **Net Present Value (NPV)** | 27,394 | NPV=PVB-PVC |
| **Benefit to Cost Ratio (BCR)** | 4.09 | BCR=PVB/PVC |

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

# Appendix E

# HEAT Assessment

# HEAT estimate

*26 January 2015 - 16:47* (v2.3)

## Reduced mortality as a result of changes in cycling behaviour

The average amount of cycling per person per year has **increased** between your pre and post data.
This change results in **a decreased** in the average mortality risk for your population of cyclists of: **4 %**

The number of individuals cycling has **increased** between your pre and post data.
There are now **387 additional** individuals regularly cycling, compared to the baseline.

Taking this into account, the number of deaths per year that are prevented by this change in cycling is: **0.17**

## Financial savings as a result of cycling

*Currency: GBP, rounded to 1000*

| | |
|---|---|
| The value of statistical life applied is: **1,654,000 GBP** | |
| The annual benefit of this level of cycling, per year, is: | **212,000 GBP** |
| The total benefits accumulated over **30** years are: | **6,361,000 GBP** |
| When future benefits are discounted by **3.50 %** per year: | |
| **the current value of the average annual benefit, averaged across 30 years is:** | **114,000 GBP** |
| **the current value of the total benefits accumulated over 30 years is:** | **3,430,000 GBP** |

## Benefit–Cost Ratio

| | |
|---|---|
| **The total costs of:** | **1,500,000 GBP** |
| Should produce a total saving over **30** years of: | **3,430,000 GBP** |
| assuming **5** year build up of benefits, **10** years build up of uptake, and discounting of **3.5 % per year** | |
| The benefit to cost ratio is therefore: | **2.29:1** |

**Please bear in mind that HEAT does not calculate risk reductions for individual persons but an average across the population under study. The results should not be misunderstood to represent individual risk reductions. Also note that the VSL not assign a value to the life of one particular person but refers to an average value of a "statistical life".**

**It is important to remember that many of the variables used within this HEAT calculation are estimates and therefore liable to some degree of error.**

You are reminded that the HEAT tools provide you with an approximation of the level of health benefits. **To get a better sense for the possible range of the results, you are strongly advised to rerun the model**, entering slightly different values for variables where you have provided a "best guess", such as entering high and low estimates for such variables.