Bristol City and South Gloucestershire Councils

A403 Condition modelling for Challenge Bid

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W.D.M. Limited Technical and Advisory Report Quality Check

The following report has been checked and inspected to ensure that the contents meet the specification and that the presentation matches the standards set by the Company in their quality procedures.

Document Control

Version Number	Produced By	Authorised By	Date	Comments
1.0	MS	MS	29-01-2015	First draft for review
1.1	MS	MS	2-02-2015	Minor corrections to text following client review.
2.0	MS	MS	03-02-2015	Addition of do minimum scenario
3.0	JM	MS	04-02-2015	Addition of do minimum £350,000 scenario
4.0	JM	MS	05-02-2015	Increased deterioration for do minimum £350,000 scenario
5.0	MS	MS	06-02-2015	Clarification of 'do minimum' scenario

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1. INTRODUCTION

Bristol City Council and South Gloucestershire Councils have commissioned WDM limited to undertake lifecycle modelling on the A403 from the A4 junction at Avonmouth to junction 1 on the M49 at Aust. The objective of the modelling is to assess the predicted cost of maintenance over a 25 year period (2015 – 2040) with 3 different scenarios:

- The Lifecycle costs for a scheme funded by the challenge bid in 2015/16
- The costs of achieving the same level of service through an annual investment strategy
- The implications of a 'worst first' strategy based on current funding allocations.

This has been done by using a deterministic deterioration model developed for use for the Scottish Local authorities. The model has been used to calculate backlog and steady state costs for the 32 Scottish local authorities since 2009[1]. The output is reported to Audit Scotland, and has been used in the Scottish National Maintenance Review in 2012[2].

1.1 A403

The A403 runs in a general northerly direction from the A4 adjacent to junction 18 of the M5 to junction 1 of the M49 at Aust. The road is in both Bristol City Council and South Gloucestershire Council. Both authorities utilise a hosted WDM PMS from which data has been extracted to populate the model.

1.2 Condition data

The model uses the current condition data collected form SCANNER/ SCRIM and Deflectograph surveys as set out below.

SCANNER	Full survey in 2013 and 2014
SCRIM	Full survey collected in 2014
Deflectograph	South Gloucestershire: last survey 2004 Bristol: Nothing available since 1996

Deflectograph data is generally considered valid for up to 7 years after survey dates. In this case there is no Deflectograph data that meets this criterion, and the model therefore uses just the SCANNER and SCRIM data.

This may mean the forecast underestimates the treatment costs for lengths suffering significant structural failures, as treatments will be identified based on surface condition only.

1.3 Model parameters

The available data has been used at 10m lengths for the purpose of modelling. The data was summarised to include:

[1] Maintaining Scotland's roads. Audit Scotland. May 2013

[2] Economic, environmental and Social Impacts of Changes in Maintenance Spend on Local Roads in Scotland. TRL 2012.
http://www.transportscotland.gov.uk/consultations/j235737-00.htm

- SCRIM - SCRIM difference, SCRIM coefficient and investigatory level
- SCANNER – rut depth, 3 and 10m profile, cracking % and texture depth.

The model was built to report the NI130 – 01, and this was then managed in the model to provide a realistic maintenance strategy.

The current condition on the prescribed network is:

SCANNER RCI > 100 5.6%

SCRIM below IL 15.4%

2. DETERIORATION MODELLING

In order to predict the need for treatment, the consequence of investment and the effects of deterioration models were developed. This model enabled the assessment of cost associated with different investment strategies.

2.1. Carriageway deterioration (SCANNER)

The modelling uses individual parameter scores as a means to identify treatments and future condition predictions. In order to support this analysis WDM® provided results from detailed studies undertaken on condition data from Scotland and Cornwall to assess deterioration trends on their respective networks.

These studies considered data from up to 10 years worth of surveys on the respective networks and assessed the change in condition over time. Based on the results of these studies deterioration rates for rutting, 3 and 10m profile, texture depth and SCRIM have been derived and applied in the models. Cracking data has only been collected since 2004 and there have been developments in the algorithms used to process the data. It has therefore not been possible to derive relationships for cracking data and an empirical relationship has been applied. Table 1 provides the deterioration rates used for the parameters in the carriageway deterioration modelling.

Parameter	**Annual deterioration rate**
Rutting	+0.30mm
3m profile	+0.2mm^2
10m profile	+1.0mm^2
Texture depth	-0.03mm
Cracking	+10% (if WTRC = 0 +0.03% in first year)
SCRIM	-0.006

Table 1: Deterioration rates

2.2. Treatments

The deterioration model includes the identification of treatments for each 10m sub section of road in the model. The treatments used in modelling are based on the SCANNER defects present. Figure 1 illustrates the application of treatment through the model. This considers the SCANNER defects present in terms of:

- below lower threshold: green
- between lower and upper threshold: amber
- above upper threshold: red

The treatments are applied in the order shown in figure 1, which ensures the lowest cost treatment is applied. If a site is SCRIM deficient a surface dressing treatment would be applied using the model, unless the SCANNER data indicated a more substantial treatment was required.

A treatment is derived for every 10m length in the model for each of the 25 years modelled, based on the predicted condition.

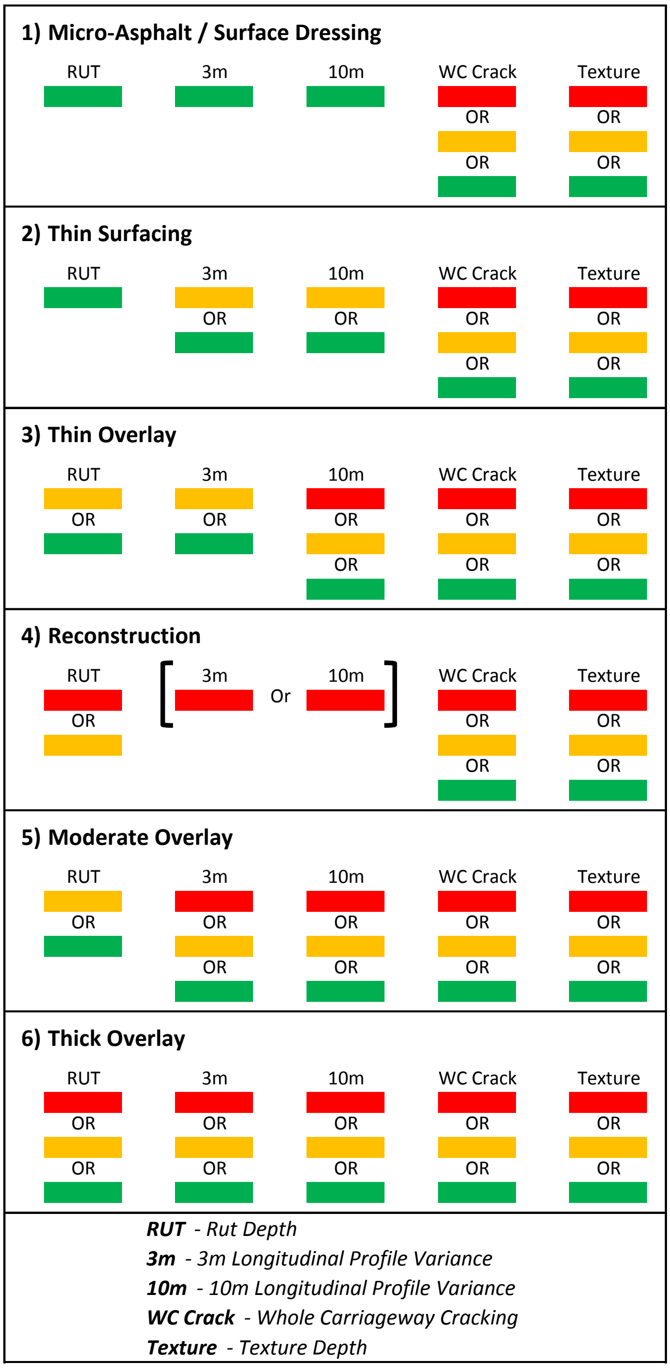

Figure 1: Model treatments using SCANNER defects.

The default SCRIM treatment is a surface dressing, unless the SCANNER data suggests a more significant treatment is required.

2.3. Reset Values

Following treatment reset values are applied to the SCANNER data. The reset values have been derived from the Cornwall study which considered approximately 30 schemes treated in 2008, and surveyed in 2009.

Figure 2 illustrates the theory used in determining reset values.

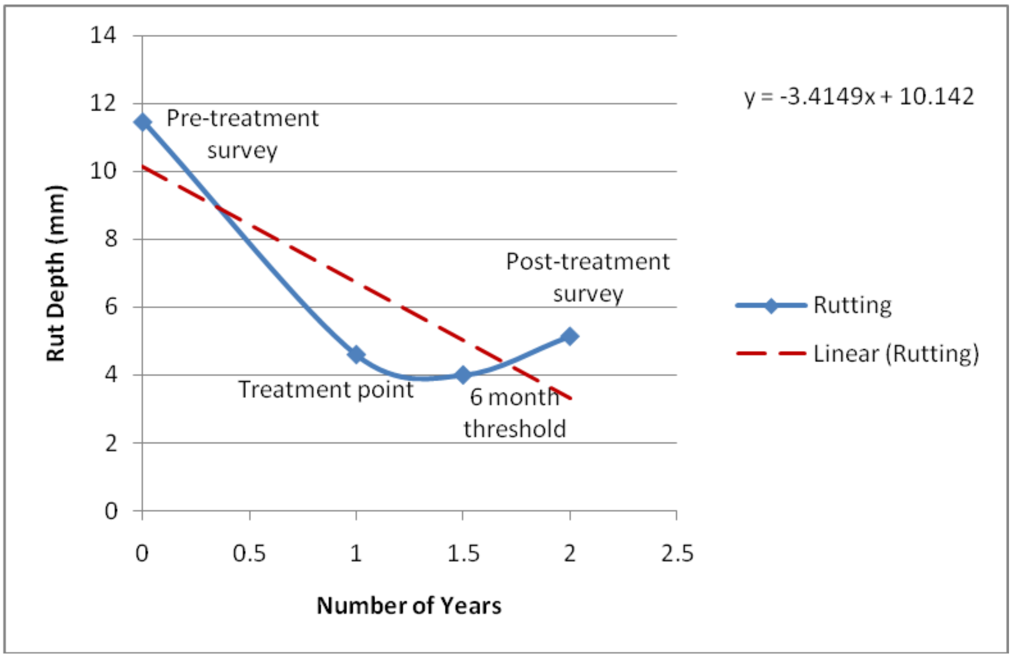

Figure 2: The calculation of reset values (rutting)

Using this methodology the reset values used in the deterioration modelling are shown in table 2.

Parameter	**Reset value (surface dressing/ microasphalt)**	**Reset value (other treatments)**
Rutting	n/a	2mm
3m profile	n/a	0.4mm^2
10m profile	n/a	2.2mm^2
Texture depth	1.0mm	1.0mm
Cracking	0%	0%
SCRIM	0.08 above IL	0.08 above IL

Table 2: Reset values

The reset values applied to the surfacing, overlay and reconstruction options are the same. Applying the treatment matrix in figure 3 the extent of the treatment applied is derived from the condition data, with more extensive defects requiring more significant treatment options.

2.4. Assigning treatments within model

In order to determine whether a 10m sub section requires treatment the following process is applied.

1. Assess starting condition based on survey by converting Raw data to equivalent RCI
2. Apply deterioration to Raw data and assess resulting scores after deterioration period
3. Identify 10m lengths that require treatment based on condition
4. Determine type of treatment required using treatment matrix
5. Apply reset values to treated lengths
6. Aggregate all 10m treatment lengths and apply a factor to consider effectiveness
7. Calculate condition after treatment
8. Reassess condition after treatment and deterioration for subsequent period

2.4.1. Calculating Treatment costs

For those 10m lengths that have been identified for treatment, a cost to treat the Monitoring Length in accordance with the treatment matrix in figure 1, and treatment priority in 2.4 is calculated. A treatment is identified for every 10m length, and treatment cost calculated, with an allowance for effectiveness in the cost calculation; that is an adjustment to account for how the works would be delivered on the road. An effectiveness of 40% has been applied, so for every scheme 40% of the length is considered to address identified defects.

Treatment costs used in the modelling are based on an analysis of rates undertaken by BCC/ SGC on projects completed in 2014/15. All costs detailed in this report are in 2014/15 prices.

The calculated costs represent an optimal treatment strategy to address the defects present. In undertaking the works the BCC/ SGC will need to consider how to turn a series of 10m treatments into an engineering solution that balances the practical site constraints with the need to improve condition.

3. MODELLING SCENARIOS

The modelling has been run on 2 different scenarios:

1. Maintenance strategy to achieve same level of service as challenge bid, with annual investment
2. Do something. Challenge bid funding treats entire length of scheme in 2015/16.
3. Do minimum. Maintenance regime on worst first basis.

3.1. Annual investment to achieve level of service

The ‘do nothing’ scenario has included a programme of structural maintenance in the first 5 years to remove the existing red and high amber lengths, and then applies treatments to sustain this condition for the subsequent 25 years.

The output from the analysis is shown in Appendix 1, which details the treatment lengths, and costs. This shows a total cost over 25 years of £9.86m. In the period from 2015 – 2020 there is a significant investment on structural treatments, primarily to address the high rutting areas on the road. After 2020 the treatments are thin surfacing/

overlay treatments, with a significant length of surface treatments to manage the skidding resistance on the road.

3.2. Do something

The 'do something' model applies treatment to the whole length of the A403 in 2015/16 as detailed in the Challenge bid application. This brings about a significant improvement in condition. The only subsequent treatments identified is surface treatment is 2025 – 2030 which is to address the SCRIM deficiency and to act as a preventative treatment to arrest more significant deterioration.

The output from the analysis is shown in Appendix 2, which details the treatment lengths, and costs. This shows a total cost over 25 years of £1.37m.

3.3. Do minimum

The 'do minimum' model applies treatment on a 'worst first' based on an annual budget allocation of £350k. This is prioritised to lengths with structural defects. The budget is allocated so £300k per year is spent on structural work, and the remaining £50k on addressing SCRIM deficiency. The deterioration per year for each parameter in the model has been increased to the upper range of those observed from the studies referred to in 2.1 for this scenario to account for the large proportion of HGV vehicles using this route. It is considered that on the 'do minimum' scenario the limitations on addressing all of the carriageway defects may result in some less than optimal treatment solutions, which will result in more rapid deterioration.

The output from the analysis is shown in Appendix 3, which details the treatment lengths, and costs and resulting Indicators. This shows the indicators increasing fairly slowly until 2025, and then as the investment is no longer able 'to hold' condition the indicators begin to increase rapidly, with a national indicator of 45.8% and SCRIM deficiency of 57.3% predicted in 2040.

4.0 CONCLUSION

The modelling exercise has compared the predicted cost of a regular programme of maintenance based on road condition for 25 years against a maintenance scheme funded by the Challenge Bid that involves treating the whole length of the A403. The modelling enables an assessment of the potential benefits in early intervention. A third scenario looks at a maintenance regime where a fixed funding of £60k per year is invested on a worst first basis to assess the predicted change in condition over 25 years with this strategy.

The modelling reports all costs in terms of 2014/15 prices, and doesn't consider the following:

- An increase in routine maintenance under the 'do nothing' during the period 2020 -2030.
- Delay costs during roadworks during the works.
- Other user costs.

The results indicate that the 'annual investment' scenario involves £9.86m of maintenance work (2014/15 prices) over the 25 year period. For the do something after the initial investment (not included in the costs reported) there is a further £1.37m identified in 2025 – 30.

The ‘do minimum’ shows an increase in National Indicator from 5.6% to 45.8% and SCRIM deficiency from 31.1% to 57.3%.

5.0 GLOSSARY

MSSC	Mean Summer SCRIM coefficient. A methodology to seasonally adjust SCRIM data. For more information see HD28/04
Investigatory Level	A SCRIM value which is used to identify sites that exhibit a greater risk of skidding resistance concerns.
130 – 01 and 130 - 02	National Indicators used by English highway authorities to report road condition
PMS	Pavement management System. A computer system designed to store road condition data, and enable interrogation of data using map and other reporting methods.
RCI	Road Condition Indices. A weighted road condition indices used for national reporting.
SCANNER	Surface Condition Assessment for the National NEtwork of Roads. A survey vehicle and methodology used on the UK's local road network. For more detail see www.pcis.org.uk
SCRIM	Sideways force Coefficient Routine Investigation Machine. A survey vehicle that measures skidding resistance.
UKPMS	UK Pavement Management System. An accredited system for undertaking visual surveys and storage of all condition surveys. For more details see www.pcis.org.uk

6.0 APPENDIX 1: ANNUAL INVESTMENT STRATEGY MODELLING OUTPUT

Year	Maintenance Cost	Surface Treatment		Thin Surfacing		Thin In/Overlay		Reconstruction		Thick Overlay 100mm	
		Length	Cost	Length	Cost	Length	Cost	Length	Cost	Length	Cost
2015 - 2020	£3,058,150	5.11	£262,246	1.24	£268,704	5.35	£1,625,063	0.05	£48,938	1.44	£853,200
2020 - 2025	£1,385,289	15.52	£397,062	0.78	£150,552	3.13	£832,275	0.00	£0	0.00	£5,400
2025- 2030	£1,608,312	9.91	£508,332	0.71	£152,280	3.12	£947,700	0.00	£0	0.00	£0
2030 - 3035	£2,603,956	6.65	£299,182	1.00	£445,824	3.22	£1,858,950	0.00	£0	0.00	£0
2035 - 2040	£1,201,192	6.02	£400,345	0.83	£381,672	2.38	£419,175	0.00	£0	0.00	£0

7.0 APPENDIX 2: DO SOMETHING MODELLING OUTPUT

Year	Maintenance Cost	Surface Treatment		Thin Surfacing		Thin In/Overlay		Reconstruction		Thick Overlay 100mm	
		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

8.0 APPENDIX 3: DO MINIMUM MODELLING OUTPUT

Year	Maintenance Cost	NI	SCRIM	Surface Treatment Length	Surface Treatment Cost	Thin Surfacing Length	Thin Surfacing Cost	Thin In/Overlay Length	Thin In/Overlay Cost	Reconstruction Length	Reconstruction Cost	Thick Overlay 100mm Length	Thick Overlay 100mm Cost
2015 - 2020	£1,750,000	4.4%	28.3%	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	9.0%	34.4%	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	25.4%	49.2%	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	46.6%	53.6%	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	45.8%	57.3%	3.86	£247,587	0.01	£2,700	2.48	£942,764	0.01	£12,234	0.63	£523,125