Whole Life Costing for Option Appraisal of Maintenance Schemes for Local Highway Authorities

June 2011

Contents

1. Introduction

1.1 Purpose of this Guidance Note

The purpose of this Guidance Note is to provide local highway authorities with a consistent process for undertaking whole life costing in order to evaluate different maintenance options for specific schemes. The outcomes from this process will enable informed investment decisions to be made. These decisions will support the delivery of value-for-money objectives.

This Guidance Note provides an introduction to the key concepts of whole life costing. The input and output parameters are described and advice is provided on the interpretation of the results. A worked example in Section 4 provides an illustration of a typical analysis.

1.2 Relationship to other guidance

This Guidance Note supports *Well-maintained Highways* [1] and the other UKRLG Codes of Practice [2], [3], [4].

Well-maintained Highways describes sustainability as a core objective of highways maintenance, together with safety, serviceability and customer service. The sustainability core objective comprises economic, social and environmental components. In the economic context, a sustainable approach would require that the costs of providing, operating, maintaining and disposing of an asset are minimised. Whole life costing enables these costs to be evaluated.

Additional sources of information are referenced in Section 6.

1.3 Objective of whole life costing

Whole life costing seeks to determine the total cost of ownership of an asset. It involves a structured approach to identify the direct and indirect costs that may occur during its lifecycle. It provides a basis for comparing alternative maintenance intervention strategies in order to identify the most economically advantageous option over a defined period.

1.4 Importance of whole life costing

Any money spent on highway maintenance should be treated as an investment and therefore be subject to a rigorous assessment process - similar to those adopted for assessing new construction schemes.

Historically, maintenance decisions have been based upon short-term, subjective criterion. These typically ignore the downstream costs of operating and maintaining the asset. Furthermore, they fail to optimise the timing of maintenance interventions to deliver maximum value.

A whole life cost approach ensures that consideration is given to the maintenance requirements throughout the asset’s lifecycle. Alternative intervention strategies can be evaluated in terms of future cost profiles and asset performance. This ensures that the most beneficial treatments are applied at the most opportune time in order to maximise value.

The adoption of a whole life cost approach enables informed maintenance decisions to be made.

1.5 Basic principles of whole life costing

Whole life costing involves the evaluation of treatment costs for a range of maintenance options over a consistent analysis period. All costs (and any benefits) are then discounted back to a common reference point. Typically this is the current works year. The discounting process reflects the ‘time value of money’ and enables options to be assessed on a comparable basis. The option with the lowest total discounted cost indicates the most advantageous investment.

1.6 Benefits of adopting whole life costing

The benefits of adopting a whole life costing approach are:

- It provides a mechanism to evaluate competing maintenance options over a defined period of time.
- It ensures an increased awareness of the life cycle costs of different maintenance options.
- It enables the demonstration (to decision-makers) of the long-term performance and economic implications of alternative treatment strategies and funding levels.

By basing investment decisions on a whole life costing approach, local highway authority engineers can demonstrate long term value for money benefits. This should be documented within the authority’s Transport Asset Management Plan (TAMP) – or equivalent.

1.7 Context of this Guidance Note

The intended readership for this Guidance Note is local highway authority engineers, including those dealing with highway asset management and highway maintenance. In most instances, the local road network is an established asset with little investment in the way of new road schemes. As such, there is little opportunity to influence the initial design or construction aspects which will impact upon the long-term maintenance and operation of the asset. Therefore this Guidance Note does not address new-build considerations.

This Guidance Note considers whole life costing undertaken on individual maintenance schemes or for the replacement of individual assets that may be considered necessary by local highway authority engineers. Whole life costing may also be included in life cycle planning to analyse investment decisions across an entire network. This is known as a Network Level Analysis, and is not addressed in this Guidance Note. It is underpinned by the same general principles but involves large amounts of data and sophisticated approaches to deterioration modelling.

At scheme level, whole life costing may be used as one of the criteria upon which maintenance decisions are made. However, it is not the only factor. *Well-maintained Highways* [1] describes how whole life costing may be incorporated into a value management process that considers a range of issues and influences to arrive at a prioritised programme of schemes that is aligned with the authority's objectives and which deliver value for money. This is shown in Figure 1.

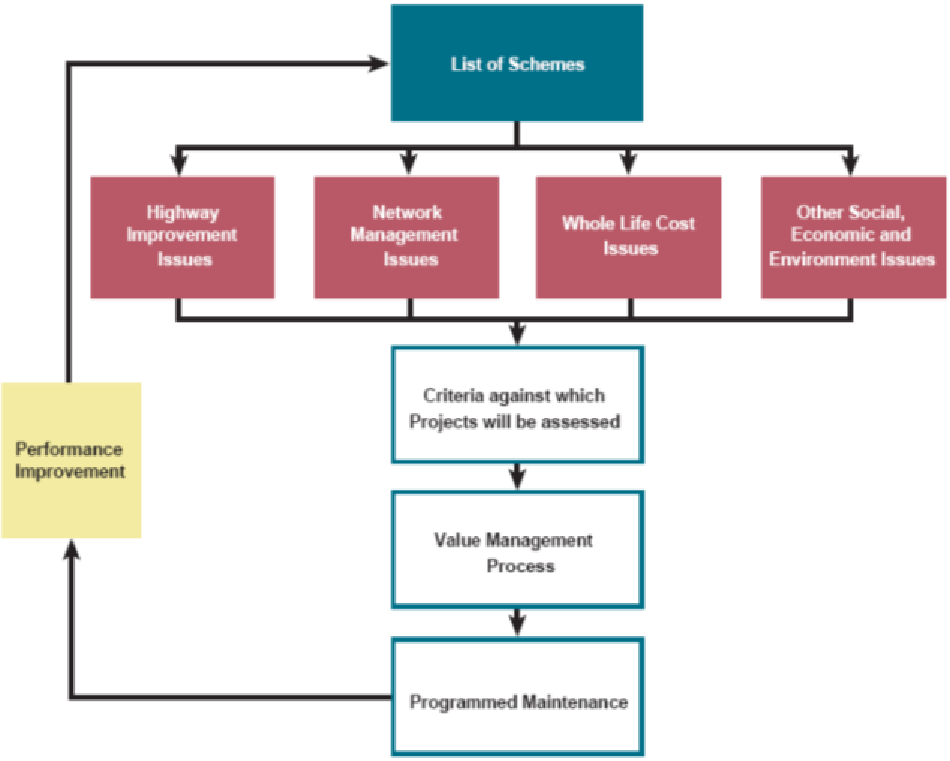


Figure 1 – Whole life costing in the context of the value management process (Source: Well-maintained Highways [1])

1.8 Limitations of this guidance

The input parameters required to undertake whole life costing need to be tailored to reflect local practices. Whilst this Guidance Note provides indicative design lives and analysis periods for a range of asset types, these will need to be adapted to reflect local factors such as:

- Material types
- Specifications
- Local environment
- Usage (traffic levels/network hierarchy etc)
- Construction practices and workmanship

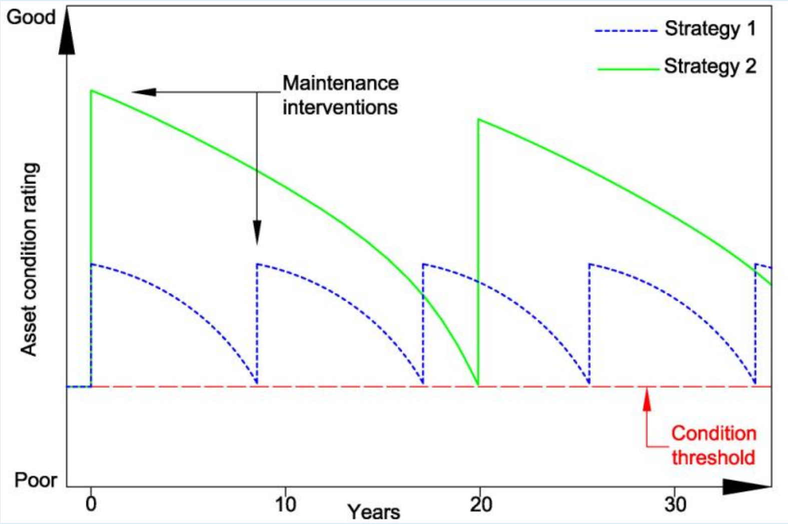
Whole life costing relies on accurate estimation of works costs. The unit rates needed to arrive at these works costs cannot be defined on a national basis - and so none are provided in this Guidance Note. Local highway authority engineers will need to derive their own unit rates. These may be obtained from their local service providers of from other relevant sources, such as local benchmarking clubs.

Once the above inputs have been locally established they must be applied consistently throughout the whole life costing process. Failure to do so will prevent meaningful comparisons between competing schemes or treatment options.

2. Key Parameters

The input and output parameters involved in whole life costing are described in the following sections. Industry accepted definitions are provided for the key terms.

2.1 Input Parameters

Asset inventory	This is the number, size and/or dimension of the asset that is to be analysed. For a pavement maintenance scheme this will be the length and width of the treatment area.
Analysis period	This is the duration over which the maintenance costs are to be evaluated. It should extend over at least one full lifecycle of the asset/treatment under consideration. Suggested typical ranges of analysis periods for various highway asset types are provided in Appendix A. This is not exhaustive and provides a limited number of examples only. Once an analysis period has been selected, it must be consistently applied across all maintenance options that are under consideration. Failure to do so will prevent meaningful comparisons between the whole life costing results.
Maintenance strategies	Having determined the analysis period, the engineer needs to consider a range of treatment strategies that could be employed to maintain the asset above a particular condition threshold or level of service. Different treatment types will deteriorate, over time, at different rates. Maintenance will then be required to restore the asset condition above the intervention level. The following schematic illustrates two different maintenance strategies.  **Strategy 1:** Small-scale, superficial maintenance works, typically funded through revenue funds, only to minimise short-term expenditure and avoid large-scale traffic management disruption. This strategy would require frequent intervention and the asset would deteriorate over time and eventually require substantial works. **Strategy 2:** Undertake major maintenance at the earliest opportunity to provide a long-term solution that will preserve the asset and minimise future routine maintenance costs. This will typically require capital investment.

Treatment options	Treatment options need to be prescribed to deliver the various maintenance strategies. These could range from small-scale superficial works to wholesale replacement or reconstruction. A range of materials options or specification types should be considered. For a pavement maintenance scheme this will be likely to include a range of treatment depths.
Asset or treatment lifecycle	The lifecycle of an asset or treatment will determine the timing of future maintenance interventions. The use of realistic, achievable lifecycles is of prime importance in whole life costing. They should be determined locally and be based on a number of factors including: • Performance history • Material type • Specification (including construction practices and workmanship) • Local environment • Demand (such as traffic levels and energy consumption and therefore not necessarily applicable to all assets) Typical ranges of asset lifecycles are provided in Appendix A. These are based upon practical experience – but could be amended to suit local practices or performance histories. The list of assets in Appendix A is not exhaustive and provides a limited number of examples only. If the highway authority has a TAMP containing lifecycle plans then these should be used as the first source of reference.
Unit rates	This is the cost per unit measure (number/length/area/volume) to maintain an asset or part of an asset. It could, for example, be the price per m^2 to apply a particular resurfacing treatment to a carriageway or the cost to replace a single lighting column. It is important that the engineer appreciates what is included in a particular rate and is aware of any assumptions that were used in deriving its value. For example, the item coverage (contained in the Method of Measurement) should be checked to determine whether uplifts for unsocial or restricted working hours have been applied or whether traffic management costs have been included within the unit rates. This is considered to be essential to arrive at an accurate works cost (see below).
Works cost	This is the direct cost of undertaking planned maintenance activities on site. Unit rates are used to estimate the works cost. The cost of site establishment, traffic management and preliminaries should be included.

Routine maintenance costs	These are the (direct) ongoing costs of maintaining an asset in a safe and serviceable condition. It excludes cyclic activities such as sweeping and cleansing (since these are normally constant factors that will not vary according to treatment strategies or type). Routine maintenance costs need to be factored into whole life costing calculations if competing maintenance strategies are likely to result in significantly different ongoing costs. This is illustrated in the assessment of the following strategies for maintaining a pavement that is nearing the end of its structural life: **Strategy X:** Reconstruct the pavement in Year 1 to deliver a long-term solution that will require minimal routine maintenance. **Strategy Y:** Defer the reconstruction works until Year 5. During years 1 to 4 the pavement will require ongoing maintenance in the form of regular pothole and patch repairs. These routine maintenance activities need to be reflected in the whole life costing.
Indirect costs	These are costs incurred by road users, the public and industry during the asset's lifetime. They are not borne by the local highway authority so they are termed 'indirect'. They typically include: • User delay costs - due to traffic management requirements when undertaking works on site. The Highways Agency's computer programme: *'**QU**eues **A**nd **D**elays at **RO**adworks'* (QUADRO) [5] provides a methodology for assessing these effects. Alternatives also exist. • Vehicle operating costs – these include factors such as fuel consumption and vehicle wear and tear. The '*Highway Design and Maintenance Standard Model – HDM4*' [6] provides a methodology for assessing these effects. Alternatives also exist. • Accident costs – these reflect the fact that accident rates can increase in areas where roadworks /diversion routes are in operation. • In the future it may become appropriate to also consider carbon costs. However, at this point in time there is not an agreed methodology for doing so. A whole life costing exercise which involves direct costs only will reflect the 'real' costs to the highway authority. Additionally including indirect costs in the exercise will influence the outcome and could result in the selection of a maintenance option that may offer benefits to the wider economy but at the detriment of the highway authority's budget. The use of indirect costs in the evaluation of whole life costs should therefore be determined as part of a highway authority's asset management strategy and should be applied to ensure that it delivers the organisation's overarching objectives.

Residual value

This is the value associated with the asset condition at the end of the analysis period.

If the end of an asset's lifecycle coincides with the end of the analysis period then it can be deemed to have no residual life. Conversely, if an asset received major maintenance immediately before the end of the analysis period then it will continue to be serviceable and can be classified as having residual life.

Determining the residual value will depend upon:

- The asset's condition.
- The amount of residual life.
- The scrap or salvage value that may be realised when the asset it disposed of.

Methodologies for calculating residual value differ according to asset type.

Whereas the direct and indirect costs included in the whole life costing process are expenditures, residual value is instead regarded as a benefit (or income) when calculating Net Present Value. This is outlined in Section 3.

Discount rates

Discounting is a technique used to compare costs (and benefits) that occur at different times throughout the analysis period. It works by adjusting these future costs (and benefits) to their present-day values. This enables competing maintenance options to be compared on a common basis.

Discounting is fully explained in the HM Treasury's publication: *The Green Book* [7] (and guidance on evaluation is provided in *The Magenta Book* [8]). Examples are provided later in this Guidance Note.

The discount rate is the input parameter that is used to convert all future costs (and benefits) back to their present-day values. *The Green Book* recommends the use of declining, long-term discount rates as follows:

Years	0 to 30	31 to 75	76 to 125
Discount rate	3.5%	3.0%	2.5%

If for example, an analysis period of 60 years was selected, the user would apply a discount rate of 3.5% for the first 30 years and a rate of 3.0% for the remaining 30 years.

Once a discount rate has been selected, it must be consistently applied across all maintenance options that are under consideration. Failure to do so will prevent meaningful comparisons between the whole life costing results.

2.2 Output parameters

Cost profile

The intervention strategies, timings and (direct and indirect) costs determined in Section 2.1 will enable the production of a profile showing future expenditure in each year of the analysis period.

By analysing cost profiles across a programme of works it is possible to identify instances in the future where major works on several schemes may coincide in a single year. These may pose future funding issues (as well as creating network management and workload issues). Alternative maintenance strategies can then be considered to alleviate peak demands.

Discounted works cost	This is the present-day cost of all future maintenance requirements. It provides a basis for comparing alternative maintenance options. It provides an indication of the level of investment that will be required to meet future expenditure. [The discounting process is described in Section 3 of this Guidance Note].
Discounted residual value	This is the present-day value of the asset at the end of the analysis period. [The discounting process is described in Section 3 of this Guidance Note].
Net Present Value (NPV)	This is the whole life cost of maintaining the asset throughout the analysis period. It is the sum of the discounted costs minus the discounted residual value.

3. Process

The following steps provide a framework for undertaking whole life costing to evaluate a range of different maintenance options for an individual site. They utilise the key parameters that were previously defined in Section 2 of this Guidance Note.

(STEP 0)
Identify maintenance requirement

This Guidance Notice starts from the premise that a site has already been identified as potentially being in need of maintenance.

Methods of identification could include safety or service inspections, defect histories, customer complaints or local network knowledge. Guidance is provided in *Well-maintained Highways*[1].

In the case of pavements, a site could also be identified from a highway authority's UKPMS[9] system as being either 'Red' or 'Amber' in terms of condition.

STEP 1
Formulate alternative maintenance strategies

Typically the following range of maintenance strategies should be considered:

- **'Do Nothing'**. This, commonly used, strategy title is a misnomer. Highway authorities have a duty of maintenance and so a literal interpretation is inappropriate. Under a 'Do Nothing' strategy the highway authority would undertake reactive repairs to safety defects only. These are likely to be superficial repairs and would possibly be temporary in nature. The repairs would not arrest the decline of the asset and frequent re-visits are likely to be required. In the short term, routine maintenance costs are likely to be high due to the ongoing liability to repair Category 1 defects (as defined in *Well-maintained Highways*[1]). There is also an increased risk of personal injury accidents (resulting from road users' interface with the defective asset) and the resulting legal consequences.
- **'Do Minimum'.** This approach seeks to do the minimal amount of routine maintenance work to keep the asset safe and serviceable. Works will normally be restricted to the repair of Category 1 defects. However, the works effort will be slightly enhanced in comparison to the 'Do Nothing' as repairs will normally be permanent in nature – although they will add no value to the asset. In the context of a pavement scheme a 'Do Minimum' approach might be limited to the permanent repair of potholes only. These would be undertaken on an isolated basis or may extend to small patches.
- **'Do Something'** – this is likely to involve capital expenditure by an authority rather than routine expenditure. It may include wholesale replacement or major repair of an asset to a level that will enhance its long term durability and minimise future routine maintenance. A pro-active approach may also be adopted which means that repair takes place before the condition intervention level is reached. In the context of a pavement scheme this could see the treatment of a section of pavement classified as being in the 'Amber' condition category (as defined by UKPMS).

Continued…

STEP 1 **(Continued)**	It is recommended that more than one ‘Do Something’ strategy is evaluated in order to explore the range of available treatment types. For the ‘Do Something’ strategies the required timing of the initial maintenance intervention requires consideration. Options may include: • Undertaking capital maintenance at the soonest opportunity. • Deferring the capital maintenance for a few years whilst holding the condition in a safe and serviceable state by undertaking routine maintenance only. If the latter (deferred) option is selected then the additional routine maintenance costs need to be included in the whole life costing. The recent defect history for the site will provide an evidence-base for estimating these costs. In the context of a pavement scheme, the above factors could be realised in the following way: • A pavement nearing the end of its serviceable life may exhibit surface defects such as potholes. These could be Category 1 defects. • If the initial treatment is deferred then there will be an ongoing (possibly increasing) requirement to re-visit the site during the period of deferment to carry out repairs to these defects. The costs of these repairs need to be included in the whole life cost analysis. • If the initial treatment is deferred then more deterioration may occur to the pavement structure. This may result in a more extensive treatment eventually being required - compared to the treatment that would otherwise have been implemented if the site was addressed earlier. By considering a range of treatment strategies and permutations on the type and timing of the initial intervention an optimum whole life cost can be determined from the following steps.
STEP 2 **Predict future performance and the required timing of maintenance interventions**	For each maintenance strategy formulated in STEP 1 appropriate treatments and lifecycles should be determined (as described in Section 2.1).
STEP 3 **Determine costs over the analysis period**	Annual costs should be determined for each intervention of each maintenance strategy. These should be based on the approaches described in Section 2.1 for: • Direct (Works) Costs • Indirect Costs • Residual Value The Worked Example in Section 4 illustrates how these costs should be presented.

STEP 4
Calculate Whole Life Costs on the basis of NPV

The costs determined in STEP 3 are converted to their present-day values using Equations 1 to 3 (respectively).

$$\text{Discounted Works Cost} = \frac{\text{Works Cost}}{(1+r)^{n}} \qquad \textbf{Equation 1}$$

$$\text{Discounted Indirect Cost} = \frac{\text{Indirect Cost}}{(1+r)^{n}} \qquad \textbf{Equation 2}$$

$$\text{Discounted Residual Value} = \frac{\text{Residual Value}}{(1+r)^{n}} \qquad \textbf{Equation 3}$$

Where:

r = Discount Rate expressed in decimal form (i.e. 3.5% ≡ 0.035)

n = Year in which the cost or benefit occurs (current year = Year 0).

The Net Present Value (NPV) of a particular option is then determined by considering all of the costs (and benefits) for a particular maintenance strategy throughout the analysis period – as shown in Equation 4.

$$\text{NPV} = \sum \text{Discounted Works Costs} + \sum \text{Discounted Indirect Costs} - \text{Discounted Residual Value}$$

Equation 4

STEP 5
Initial assessment of results

The maintenance strategy with the lowest NPV is generally regarded as the most economically beneficial option.

However, whole life costing is only one factor when selecting a preferred maintenance option. Other factors such as engineering judgement, network operations, buildability, affordability and risk management also require consideration.

STEP 6
Undertake sensitivity analysis

On significant or complex maintenance schemes it may be appropriate to undertake a sensitivity analysis in order to test the effects of certain assumptions used in the previous steps. Such schemes could include:

- Those with a value that represents a substantial (or unusually high) proportion of the highway authority’s capital maintenance budget.
- Works to a part of the network that is likely to undergo development which could affect future usage. For example, a pavement rehabilitation scheme near to where a planned shopping centre is to be built or a new bypass is to be tied-in – both of which could potentially affect future traffic loading (which would have an influence on the long-term performance of the asset).
- Those involving innovative treatment types that have not previously been applied on the local network and are therefore considered to involve a degree of risk.

The following input parameters can be subject to particular uncertainty:

- Unit rates.
- The required timings of individual maintenance interventions.

Continued…

STEP 6 **(Continued)**	By varying these input parameters across the full range of values that could perceivably be experienced and then repeating the above steps it is possible to assess the potential economic uncertainty. When undertaking this process only one input parameter should be varied at a time. The outcomes will reveal: • Whether the selection of a preferred option (based on lowest NPV) is affected. • The likely variability in the resulting whole life cost of the preferred option. This variability represents a risk and should be managed accordingly. On small to medium scale sites with commonplace maintenance requirements it is unlikely that sensitivity analyses will provide significant benefits – once the highway authority has developed a set of reliable, proven input parameters. All assumptions made and input parameters selected should be documented.
STEP 7 **Arrive at a preferred option**	The initial assessment of results (undertaken in STEP 5) should be revisited when the outcome of (any) sensitivity analysis are available. A final preferred option will then emerge.

4. Worked Example

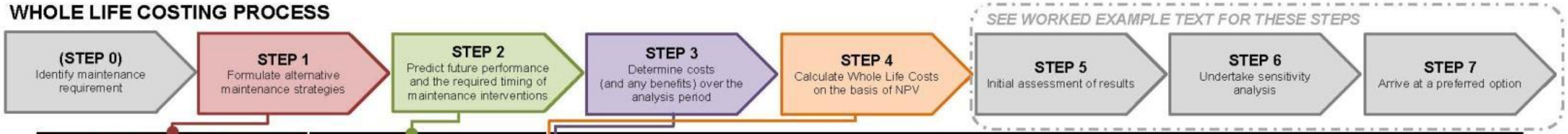
A worked example is provided below to demonstrate the whole life costing process.

The worked example considers a generic asset type in need of maintenance. A 25 year analysis period and a discount rate of 3.5% have been assumed. Only the (direct) works costs have been considered.

The worked example shows a typical format for presenting a whole life costing analysis. A tabulated (spreadsheet) approach serves to illustrate the maintenance and cost profiles for competing options. It also facilitates subsequent amendments as part of any sensitivity analysis.

The ‘Do Something (1)’ option is seen to have the lowest NPV over the analysis period and therefore emerges as the preferred option.

WHOLE LIFE COSTING PROCESS



Maintenance Strategy		Performance Prediction	Works Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Title	Description																											
'Do Nothing'	Reactive, 'make-safe', temporary repairs only - that require re-visiting on a regular basis. Asset condition deteriorates rapidly and the eventual scope of the capital maintenance intervention is increased.	Asset becomes life-expired in 5 years time. Over the initial 4 years there is an increasing requirement to undertake Category 1 (temporary) repairs. In the 5th year the asset is replaced/reconstructed to deliver a 40 year design life.	Intervention type	Cat 1 repairs	Cat 1 repairs	Cat 1 repairs	Cat 1 repairs	Recon / Replace																				
			Works Cost	£1,000	£2,000	£4,000	£8,000	£50,000																				
			Discounted Works Cost	£1,000	£1,932	£3,734	£7,215	£43,570																				
			Residual Value																									-£25,000
			Discounted Residual Value																									-£10,950
			Net Present Value	£46,502																								
'Do Minimum'	Maintenance limited to essential, permanent repairs to keep the asset safe and serviceable. Asset condition deteriorates and the eventual scope of the capital maintenance intervention is increased.	Asset becomes life-expired in 10 years time. Over the initial 9 years there is an increasing requirement to undertake Category 1 (permanent) repairs. In the 10th year the asset is replaced/reconstructed to deliver a 40 year design life.	Intervention type	Cat 1 repairs		Cat 1 repairs		Cat 1 repairs		Cat 1 repairs		Cat 1 repairs	Recon / Replace															
			Works Cost	£500		£1,000		£1,500		£2,000		£2,500	£50,000															
			Discounted Works Cost	£500		£934		£1,307		£1,627		£1,899	£36,685															
			Residual Value																									-£31,250
			Discounted Residual Value																									-£13,688
			Net Present Value	£29,264																								
'Do Something (1)'	Capital maintenance. Permanent treatment Type 'X' (Medium-term solution).	The asset receives a major maintenance treatment (Type 'X') in Year 0 (i.e. the current works year). The treatment is designed to deliver a 25 year design life.	Intervention type	Major Maint.																								
			Works Cost	£20,000																								
			Discounted Works Cost	£20,000																								
			Residual Value																									£0
			Discounted Residual Value																									£0
			Net Present Value	£20,000																								
'Do Something (2)'	Capital maintenance. Permanent treatment Type 'Y' (Long-term solution).	The asset receives a major maintenance treatment (Type 'Y') in Year 0 (i.e. the current works year). The treatment is designed to deliver a 40 year design life.	Intervention type	Major Maint.																								
			Works Cost	£30,000																								
			Discounted Works Cost	£30,000																								
			Residual Value																									-£11,250
			Discounted Residual Value																									-£4,928
			Net Present Value	£25,073																								

SAMPLE CALCULATION:
Works Cost = Unit Rate * Works Quantity

SAMPLE CALCULATION:
Discounted Works Cost = $\frac{\text{Works Cost}}{(1+r)^n} = \frac{£50{,}000}{(1+0.035)^4} = \frac{£50{,}000}{1.147579}$

SAMPLE CALCULATION:
Residual Value - the asset was renewed 15 years ago at a cost of £50k.
At the end of the Analysis Period it still has 25 years of its 40 year design lfe remaining.
If the value of the asset decreases linearly over time then the Residual Value is 25/40 * £50,000.
[**NOTE**: Residual value calculation methodologies vary according to asset type]

SAMPLE CALCULATION:
Discounted Residual Value = $\frac{\text{Residual Value}}{(1+r)^n} = \frac{£31{,}250}{(1+0.035)^{24}} = \frac{£31{,}250}{2.28333}$

SAMPLE CALCULATION:
Net Present Value = $\sum$ Discounted Works Cost(s) + $\sum$ Discounted Residual Value(s) = £30,000 + (4,928)

NOTES:
1) This worked example considers an asset on the Secondary network – where its usage is predicted to be light.
2) Routine maintenance activities are not considered beyond the first major intervention. However, local highway authorities may decide to include the cost of routine maintenance, in accordance with their policies.

5. Bibliography

1. **UK Roads Liaison Group**. *Well-maintained Highways – Code of Practice for Highway Maintenance Management.* 2005*.* [Plus associated Complementary Guidance as published on UKRLG website]

2. **UK Roads Liaison Group**. *Well-lit Hghways – Code of Practice for Highway Lighting Management*. 2004. [Plus associated Complementary Guidance as published on UKRLG website]

3. **UK Roads Liaison Group**. *Management of Highway Structures – A Code of Practice*. 2005. [Plus associated Complementary Guidance as published on UKRLG website]

4. **UK Roads Liaison Group**. *Management of electronic traffic equipment – A Code of practice*. 2010.

5. **Highways Agency.** *QUADRO Manual*. Design Manual for Roads and Bridges. Volume 14. 2006.

6. **Bennett, C.R and Greenwood, I.** *Modelling road user and environmental effects in HDM-4*. ISBN 2-84060-103-7. 2007.

7. **HM Treasury**. *The Green Book: Appraisal and evaluation in central government*. 2003.

8 **HM Treasury.** *The Magenta Book: Guidance for Evaluation.* 2011

9. **UKPMS.** *UKPMS User Manual*. www.pcis.org.uk. 2005.

6. Additional Sources of Information

UK Roads Board. *Highway Asset Management Quick Start Guidance Note: Life cycle planning.* 2009*.*

> The above reference identifies that….'effective lifecycle planning is about making the right investment at the right time to ensure that the asset delivers the requisite level of service over its full expected life, at the minimum cost'. Whole Life Costing contributes to the achievement of this aim. Refer to www.ukroadsliaisongroup.org.

London Bridges Engineering Group (LoBEG). *Good Practice Guide: Lifecycle Planning for Highway Structures*. Version 1. 2009.

> The above reference describes a step-by-step approach for structure specific lifecycle planning and Whole Life Costing. LoBEG have also developed an accompanying proof-of-concept model to enable asset managers to undertake lifecycle planning for individual structures. Refer to www.lobeg.com.

Chartered Institute of Public Finance and Accountancy (CIPFA). *Code of Practice on Transport Infrastructure Assets: Guidance to Support Asset Management, Financial Management and Reporting.* 2010.

> The above reference promotes (inter alia) a whole-life cost-based approach to highways maintenance underpinned by life cycle planning.

Appendix A - Typical Highway Asset Lifecycles and Analysis Periods

Typical ranges of asset lifecycles are provided below. They are based upon practical experience and are consistent with the CIPFA *Code of Practice on Transport Infrastructure Assets,* but can be amended to suit local practices or performance histories. Currently a number of projects are underway nationally to help identify typical lifecycles for particular assets or treatments. In general these asset or treatment specific guides will be more detailed and may be preferred to the values provided here. The intention is that in due course this Guidance Note will be updated to reflect any specific guides as they become available. It should be noted that the list of assets is not exhaustive.

Asset Group	**Asset Types / Components**	**Typical Lifecycle (Years)**	**Typical Analysis Period (Years)**
Pavements	Structure	“Indefinite” [NOTE A]	25 - 60
	Surface Course	10-25	
	Surface treatment	5-10	
Structures	Structure	“Indefinite” [NOTE A]	120
	Bearings	30 - 50	
	Joints	5 – 25	
	Waterproofing	20 – 35	
Street Lighting	Columns	25 – 40	25 - 60
	Ducting	25 - 50	
	Cables	35 – 45	
	Photocell	10 – 15	
	Luminaries	15 – 25	
	Feeder pillar	20 – 40	
Traffic Signals	Poles	25 – 35	25 - 60
	Heads	15 – 25	
	Cabinets	20 – 40	
	Controllers	3 – 7	
Drainage	Ironwork	“Indefinite” [NOTE A]	25 - 60
	Pipes	“Indefinite” [NOTE A]	
	Culverts	“Indefinite” [NOTE A]	
Ancillaries	Kerbs	“Indefinite” [NOTE A]	25 - 60
	Road Restraint Systems	15 – 25	
	Road markings	3 – 7	
	Road studs	10 – 20	

Asset Group	Asset Types / Components	Typical Lifecycle (Years)	Typical Analysis Period (Years)
			Continued…
Ancillaries (Continued)	Traffic sign face	10 – 20	25 - 60
	Traffic sign post	10 – 20	
	Chambers	50	
	Ironwork	20 – 30	
Street Furniture	Bins	15 - 20	25 - 60
	Seats and planters	50	
	Guardrail	20 - 30	

NOTE A:
These asset components are defined in the CIPFA *Code of Practice on Transport Infrastructure Assets* (referenced in Section 6 of this Guidance Note) as ‘indefinite’ life assets. In practice this means that they will not typically require complete replacement or renewal within a lifecycle of 60 years or less – although there are exceptions to this as set out in the CIPFA Code. For Whole Life Costing purposes, it is unlikely that allowance for replacement of these items will be required within a typical lifecycle unless there are unusual circumstances relating to the scheme in question (very poor ground conditions for instance) that will impact on the expected life of these assets.