IPAG

Irish Pavement Asset Group

Pavement Asset Management Guidance Section 6: Pavement Asset Management Strategies

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Document Information

Title	Pavement Asset Management Guidance, Section 6: Pavement Asset Management Strategies
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Description	This section recommends how pavement asset management strategies should be developed. It provides guidance on how asset data should be used to support identification of potential sites for treatment, analysis of the options for treatment, the creation of a short-term programme of schemes and long-term projections of funding needs.

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6 Pavement Asset Management Strategies

This section recommends how pavement asset management strategies should be developed. It provides guidance on how asset data should be used to support identification of potential sites for treatment, analysis of the options for treatment, the creation of a short-term programme of schemes and long-term projections of funding needs.

6.0 Pavement Asset Management

Application of asset management principles to the management of pavements requires a structured approach. That approach should be based upon documented strategies. Strategies should enable road authorities to target expenditure to achieve specific targets for condition and repair of defects.

Recording and monitoring of strategies is essential, if the strategies are to be successful in enabling the best possible value for money to be achieved from available budgets. It is recommended that road authorities document their approach to pavement management, based around the following key steps. Each of these steps creates or uses data that the pavement management system should support.

Details of the tasks, for each step, are given in the following sections. This process runs concurrently to the delivery of routine and reactive maintenance. Road authorities should review their routine and reactive maintenance costs, and numbers & types of defects in order to determine an appropriate balance between routine / reactive repairs and planned maintenance.

Measuring Performance

Performance should be reported using a set of performance measures. The following are suggested as a set of statistics that road authorities may choose from, to establish appropriate ways of measuring and reporting performance:

- The percentage of roads requiring maintenance by condition band and road category;
- The length of road requiring maintenance by condition band and road category;
- The number of defects (by type and road category / class (see *Section 4: Routine Maintenance Management*);
- Compliance with specified defect repair / make safe response times (see *Section 4*);

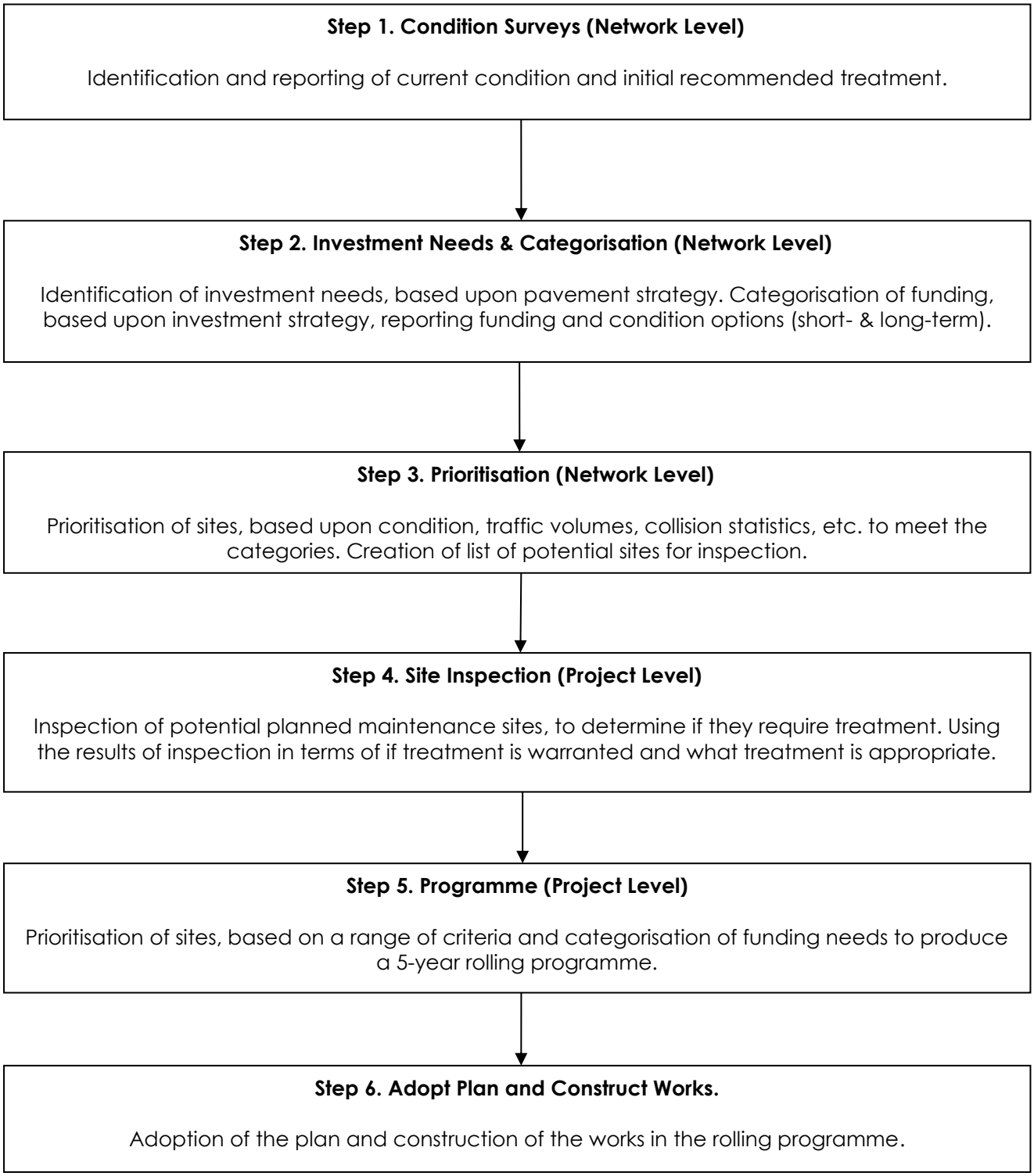
The terms "road category" and "road class" are interchangeable for the purpose of this section.

Recommendation: Road authorities should establish performance measures for road condition.

Pavement Asset Management Process – Overview

The overall process recommended is illustrated below. It is expected that this process will be repeated annually, following completion of condition surveys, using the following steps. The process involves a combination of network level and project level activities.

Figure 6.1: Pavement Asset Management Process Overview



6.1 Step 1 – Condition Surveys (Network Level)

Section 5: Condition Surveying and Rating of this guidance provides advice upon the regime, method and type of condition surveys recommended by IPAG. Condition surveys undertaken in accordance with the methods set out will result in the identification of an initial recommended treatment for every length of road identified as potentially requiring treatment. The data held in the pavement management system (PMS) should be used to assist with the identification of potential schemes by reporting the following information.

Condition Data: To identify sites where the measured condition values exceed the specified investigation level for the relevant category of road. The level of detail used for this exercise will vary, depending upon the class of road. For roads where machine-collected condition data is available, reports showing road segments where the measured values exceed the specified values will be produced.

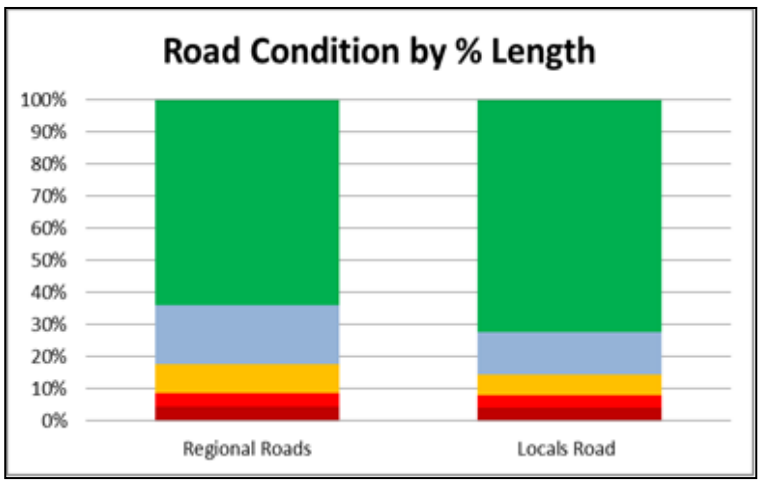
Reporting Current Condition

Condition survey results should be reviewed annually, to determine the current condition of the pavement asset and how it is changing over time. As a minimum, it is recommended that road authorities report the length of asset in each condition band, as illustrated below.

Table 6.1: Percentage of Road by Length in Condition Bands

Condition Band	1, 2	3, 4	5, 6	7, 8	9, 10
Potential Treatment / Road Category	Road Reconstruction	Structural Overlay	Surface Restoration	Resealing and Restoration of Skid Resistance	Routine Maintenance
Regional Roads	4.3%	4.3%	9.2%	18.3%	63.9%
Local Roads	4.0%	4.0%	6.6%	13.2%	72.2%

Graph 6.1



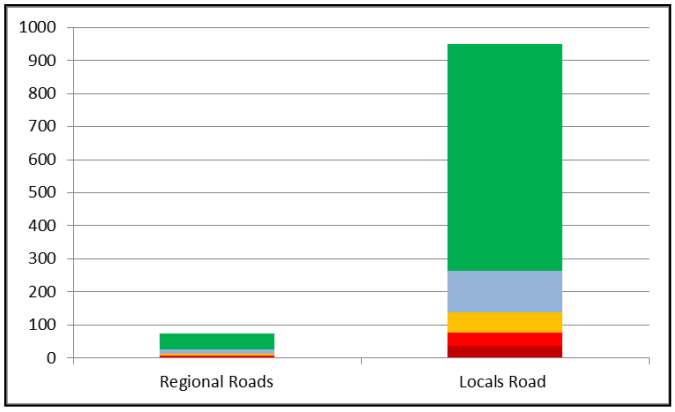
Graphically presenting the results as shown can help to illustrate the split of condition and the variance in condition between regional and local roads.

Using percentages can, however, mask the scale. It is therefore recommended that results are also reported in km length as shown below.

Table 6.2: Road by Length (km) in Condition Bands

Condition Band	1, 2	3, 4	5, 6	7, 8	9, 10
Potential Treatment / Road Category	Road Reconstruction	Structural Overlay	Surface Restoration	Resealing and Restoration of Skid Resistance	Routine Maintenance
Regional Roads	3	3	7	14	47
Local Roads	38	38	63	125	686

Graph 6.2: Length of Road Requiring Treatment



Showing the lengths of road requiring treatment as shown is useful where certain road classes have vastly greater lengths than others, as in this example.

The proportion of roads requiring treatment may be similar, the actual length for which treatment should be considered may be substantially more for local roads.

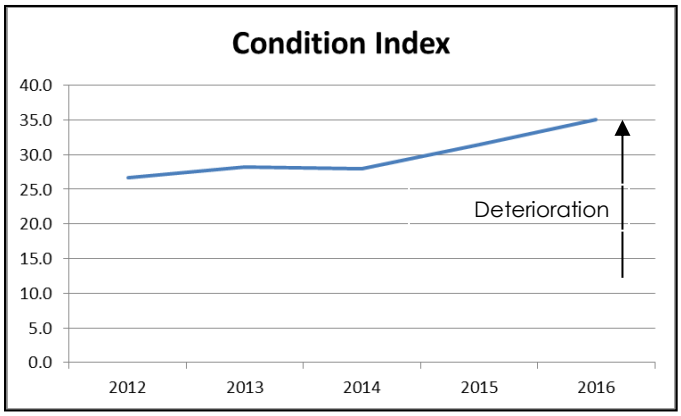
Reporting Changes in Condition

When condition data is available, reporting should be undertaken of the change in condition over time. This should again report the length of road in each condition band and illustrate if condition is improving or deteriorating, as a result of the level of maintenance undertaken. The recording and monitoring of condition will enable more informed decisions about which roads require increased maintenance. As the reliability of condition measurement improves and the quantity of condition data held grows, the ability to predict future condition will improve.

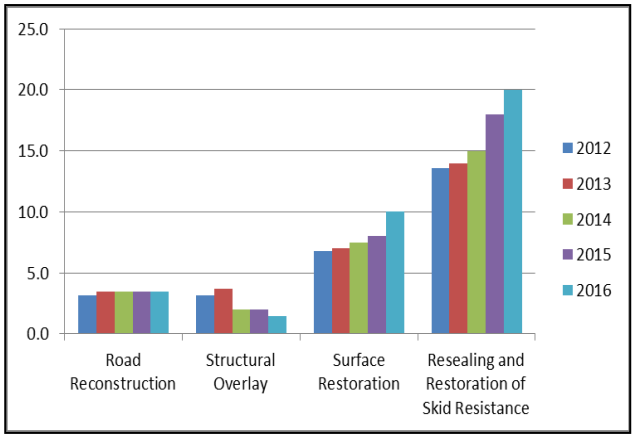
Graph 6.3

By reporting the total length of road requiring consideration for treatment (Condition Bands 1 to 8 inclusive), an indication of overall condition and how it is changing can be shown.

In this example, the length of road where treatment should be considered is increasing, illustrating deteriorating condition over time.



Graph 6.4: Length of Road Where Treatment Should be Considered



Breaking down the results by condition band illustrates the relative need for structural or surface treatments.

In this example, the need for structural treatment is decreasing, whereas the need for Surface Restoration & Resealing and Restoration of Skid Resistance is growing year-on-year. This information should be used to inform future budget allocations between treatment types.

Maintenance "Backlog"

The reporting of a maintenance "backlog" enables the condition information to be interpreted to report the effect of changing condition in financial terms. It is recommended that two backlog figures are computed as follows:

1. **Headline Backlog:** this records the estimated cost of fully treating all roads that are in a condition where a maintenance treatment has been recommended from the condition survey results.
2. **Maintenance Backlog:** this records the estimated cost of treating the length of roads that exceed the national recommended targets for each road category.

Example Backlog Calculations

Table 6.3: Headline Backlog: Local Primary Roads

Condition Band	1, 2	3, 4	5, 6	7, 8
Potential Treatment	**Road Reconstruction**	**Structural Overlay**	**Surface Restoration**	**Resealing and Restoration of Skid Resistance**
Length (km)	38.00	38.00	62.70	125.40
Average Width (m)	5	5	5	5
Area (m^2)	190,000	190,000	313,500	627,000
Unit Treatment Rate (€/m^2)	€25.00	€15.00	€10.00	€4.50
Headline Backlog: Breakdown	€4,750,000	€2,850,000	€3,135,000	€2,821,500
Headline Backlog: Local Roads	**€13,556,500**			

The headline backlog figure includes for the treatment of all segments of road where condition surveys indicate a potential need for treatment. It is a theoretical figure. It will however, when monitored and reported overtime, show the effect of changes in condition in monetary terms.

Table 6.4: Maintenance Backlog: Local Roads

Potential Treatment	Road Reconstruction (1, 2)	Structural Overlay (3, 4)	Surface Restoration (5, 6)	Resealing and Restoration of Skid Resistance (7, 8)
Local Roads %	4%	4%	7%	13%
National Target Condition Standard %	2%	2%	5%	10%
Maintenance Backlog %	2%	2%	2%	3%
Maintenance Backlog (km)	19.00	19.00	15.20	30.40
Average Width (m)	7	7	7	7
Area (m^2)	133,000	133,000	106,400	212,800
Unit Treatment Rate (€/m^2)	€21.50	€11.00	€4.50	€4.50
Headline Backlog: Breakdown	€2,859,500	€1,463,000	€478,800	€957,600
Headline Backlog: Local Roads	**€5,758,900**			

The national target condition standards represent a standard of condition that is desirable. The standards recognise that it would be impractical and unaffordable to manage the road network to a condition where there were no segments of road requiring maintenance. The headline backlog figure is therefore a reporting tool that illustrates a changing level. The maintenance backlog represents the estimated investment required to improve condition such that it meets the national target condition standards for each road category.

Recommendation: Road authorities should report annually upon the condition of their pavement assets.

The report should include the results of any additional condition testing undertaken by the road authority, for example any skid-resistance testing results.

Using Machine-collected Condition Data

Where machine-collected condition data is available in addition to visual road condition rating (for example on regional roads) these figures may also be reported. Machine-collected condition data provides the potential to examine particular types of defects. The table below provides some example investigation levels that road authorities may use to interrogate machine-collected condition data.

For some roads, it may be appropriate and informative to report the length of road exceeding these investigatory levels. Some, however, may not be appropriate. For example, there may be local roads that are inherently rough due to their history as an evolved road (never designed) or due to topography. For such roads the use of IRI as a trigger for potential treatment may be inappropriate. The machine-collected condition data does, however, provide a rich source of useful information, if analysed with local needs in mind.

Table 6.5: Condition Data Proposed Investigation Levels by Road Type

	Regional Roads	Local Primary Roads	Local Secondary Roads	Local Tertiary Roads
Visual Condition Score	6 or below	6 or below	4 or below	4 or below
PCI	>80	>80	>100	>100
Rutting	>10mm	>10mm	>20mm	>20mm
Roughness (IRI)	>3.5 IRI	>3.5 IRI	>4.0 IRI	>4.0 IRI
Texture	<0.40mm	<0.40mm	<0.35mm	<0.35mm

For further details on how condition is measured and reported see *Section 5: Condition Surveying and Rating*.

Machine-collected condition data is collected and summarised for each 10-metre sector along the road. It is necessary to summarise data into sensible lengths, in order to assist with scheme identification. This can be done:

1. By segment length – where fixed lengths are established within the system and the data is processed to produce average values for each segment.
2. Using fixed lengths – e.g. fixed 200-metre subdivisions. Fixed lengths enable comparison between lengths without the comparison being distorted by short lengths with very high values.
3. Using variable treatment lengths – these are produced by the system (PMS), identifying where condition data indicates that the length of road is homogeneous and it may be appropriate for treatment as an individual length.
4. Using the surface layer record – use the actual lengths of specific surfacing where the inventory data is sufficiently reliable to enable it.

There is no single way to process the data for this purpose. The PMS software needs to be flexible enough to be able to process reports, based on at least the above ways of summarising it.

Recommendation: Road authorities should use all available data to investigate and report condition.

Using Other Asset Data

Inventory Data / Expected Service Life: This can be used to identify sites where the surfacing is approaching the end of its expected life (where surfacing age data is known). This will require the road authority to establish a list of the average expected service life of each typical material type by road category. The table in *Appendix 6.a* gives default values that can be used where data is not available. Once sufficient age data is populated into the PMS (a minimum of 5 years' data), a report should be generated each year, high-lighting those sites that have reached or exceeded their expected service lives.

Early Life Failures: A further separate report should be generated when this data is available. This will identify where sites are programmed for treatment as a result of visual inspection and condition survey, but have not reached near their ESL.

Inspection Data: Should be interrogated to produce a list of sites, where a large number of defects have been identified from routine and reactive inspections. For example, road segments with >20 no. unrepaired defects on them. It may be appropriate to report as a number of defects per km to take into account the different lengths of road segments.

Routine and Reactive Repair Records: These should be interrogated to produce a list of sites, where records show that a large number of pothole and patch repairs has been undertaken and the sites have not been resurfaced subsequently. If cost records are kept in the routine maintenance records, then the routine repair cost per km can be used.

Customer Contacts: Should be interrogated to identify those sites, where a higher than normal quantity of customer complaints have been received, e.g. sites where >x no. of customer contacts have been received with the last 3 years.

Claims Data: Should be interrogated to identify those sites where a higher level of third party claims (such as public liability claims) than normal has been received.

In order to carry out this analysis, it will be necessary to determine what constitutes a potential site in terms of length. As a starting point, it is recommended that data is analysed on road segments. The data for all road segments should be collated. With an asset management system, this process may be able to be undertaken within the system. For road authorities without an asset management system, the data may need to be collated from a range of sources and compiled into a spreadsheet to enable it to be combined and analysed. A list of potential schemes should be created from this data, by combining the results in a spreadsheet, to create a list sufficient to enable a 3-year rolling programme to be derived from it.

Recommendation: Road authorities should establish a list of potential schemes, by analysing data from the PMS and other relevant data sources.

6.2 Step 2 – Investment Need and Categorisation (Network Level)

Investment Need

The backlog figures above provide a means of reporting overall "needs". Each road authority needs to consider its needs, in the context of local priorities and the condition of their roads. It may be unaffordable or undesirable to target meeting the national condition standards for some or all road classes. Road authorities should consider the condition of their roads as indicated by condition survey and determine their own target condition standard for each road class. In doing so, it will be necessary to consider

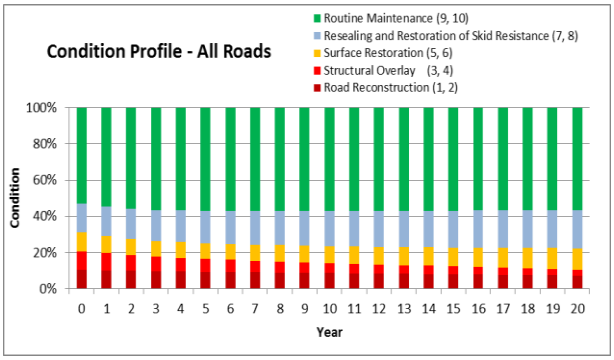
- What is an acceptable condition standard for each road category?
- What is an acceptable split in condition for each road category, i.e. roads requiring structural treatment, as opposed to those requiring surface treatment only at present?
- What is the cost of maintaining current condition (steady state)? This is useful starting point for consideration of appropriate condition standards.

Recommendation: Condition targets should be established for regional and local roads.

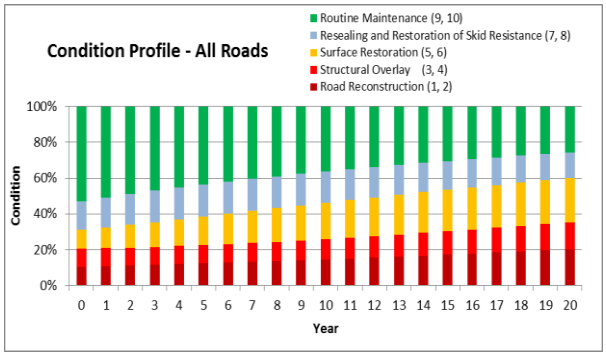
Long-term Cost Predictions

To enable informed decisions to be made about what level of condition is affordable for each category of road, long-term (>10 years) cost projections should be prepared. Over time, these can be informed by predictions of deterioration, based upon actual measured condition. Prior to the availability of reliable deterioration rates, predictions can be based upon life-cycle assumptions, i.e. the average expected life of each category of road. These can be used to predict rates of deterioration. Mitigation of deterioration can then be estimated, by using the generic cost of treatment and using it to compute the area that particular budget levels can afford. This principle has been used to create a condition / cost projection spreadsheet that has been made available in conjunction with this guidance. The spreadsheet enables initial assessment of long-term condition to be predicted. The spreadsheet uses assumed levels of deterioration and should be used in context, as a means of producing initial approximate figures only. Although it is only suitable for testing purposes at present, it will however, be a useful tool for comparing different investment options, i.e. looking at the predicted effect of increasing or decreasing funding on different categories of road and / or different types of treatment. Eventually, the PMS should be able to produce predictions, based upon starting condition, predicted rates of deterioration and unit treatment costs.

Graph 6.5



Graph 6.6



The example above illustrates the predicted effect of two different budgets upon condition. *Graph 6.5* is based upon a substantially higher budget than *Graph 6.6*. In this instance, the budget level used in *Graph 6.5* is sufficient to improve condition over time. *Graph 6.6*, however, with a much lower level budget, shows progressive deterioration. Predictive modelling of this type can be used to enable road authorities to choose between road categories, when allocating budgets and to target investment at the category of roads in most need of maintenance.

Categorisation

Achievement of target condition is best obtained by targeting investment at road categories and treatments that are aligned to the condition targets. This means increasing the funding level allocated to a particular treatment (e.g. Surface Restoration) on a particular road category in order to effect an improvement in condition. In doing so, the strategy adopted will need to recognise the sources of funding and any constraints placed upon the use of that funding. The following cost categories are currently used:

Restoration Improvement

- Surface Restoration (Condition rating 5 & 6)
    - Local roads schemes
    - Regional roads schemes
- Road Reconstruction (Condition rating 4 or less)
    - Local roads schemes
    - Regional roads schemes

Restoration Maintenance

- Surface Dressing (Condition rating 7 or 8)
    - Local roads schemes
    - Regional roads schemes

Budget Consideration – Example

In the example below, the road authority has chosen to establish targets, based upon a combined condition of red and amber condition road (Condition Rating 1 to 6 inclusive).

Table 6.6

Road category / classification	Current Condition (PSCI)	Target Condition (PSCI)	Budget adjustment required
Local Primary and Secondary Roads	38%	40%	Budget
Local Tertiary Roads	60%	50%	Increased budget should be considered
Regional Roads	25%	30%	Minor reduction in budget may be required to fund increases in other road category budgets

Setting and adjusting target condition is an integral part of an asset management approach. Future budgets should generally be established, based upon a consideration of current condition and the prediction of the future condition, based on anticipated funding levels. The ability to accurately predict future condition is limited, by the small amount of repeatable condition information initially available to most road authorities. However, this should not prevent road authorities from starting to apply the principles of this guidance, using the available data with appropriate caution.

Treatment Costs

The activities above rely upon access to unit treatment costs. To ensure that these can be relied upon, quantities of standard treatments laid per year, together with the total cost of the treatments, should be recorded against the table shown below. This will enable computation of unit costs, for each of the generic treatments for budget planning, life-cycle cost analysis and cost benchmarking.

Table 6.7: Pavement Treatments / Works Types with Examples

PSCI Rating	Generic Treatment	Description	Quantity	Cost	Unit Rate
8 7	**Resealing and Restoration of Skid Resistance**				
	Surface Dressing				
	Thin Overlay (30-50mm)	Clause 942 / SMA (40mm)			
6 5	**Surface Restoration** Carry out localised repairs and treat with surface treatment or thin overlay Works can include combinations of: *Pothole Repair (PR); Edge Repair (ER); Drainage Works (D) and Surfacing*				
	Surface Restoration	Extensive patching and shaping and surface dressing			
		Asphaltic concrete			
		Clause 910 / 30% HRA			
	Granular Overlay (50-150mm)	150mm Clause 804 / 806 double surface dressing			
		150mm stabilised wetmix double surface dressing			
4 3	**Structural Rehabilitation** Structural Overlay / Inlay (Urban)				
	Structural Overlay (150mm+)	Local excavate & rebuild, Clause 806 overlay & double surface dressing			
	Bituminous Overlay	100mm DBM surface dressing			
		100mm DBM + 40mm HRA / SMA			
	Thin Inlay (30-50mm)	Clause 942 / SMA (40mm)			
		Asphaltic concrete			
		Clause 910 / 30% HRA			
	Granular Inlay (50-150mm)	150mm Clause 804 / 806 double surface dressing			
		150mm stabilised wetmix double surface dressing			
	Bituminous Inlay	100mm DBM surface dressing			
		100mm DBM + 40mm HRA / SMA			
	Structural Inlay (150mm+)				
2 1	**Road Reconstruction**				
	Fully Reconstructed				

Recommendation: Road authorities should establish, and annually update, a set of unit treatment costs (based on actual treatment costs from the preceding year).

6.3 Step 3 – Prioritisation

A documented method of scheme prioritisation enables schemes to be put into an order that can be justified. Scheme prioritisation should use the data as used in *Step 1* for scheme identification. This will enable road authorities to prioritise their programme, based upon criteria that are considered to be of value locally, by identifying and weighting the criteria that are important locally. So for example, a road authority with a heavy reliance on public transport, may wish to prioritise the maintenance of bus lanes to a higher standard than other roads / lanes. This can be achieved from using bus lanes as part of the prioritisation method and weighting their contribution to the overall ranking / prioritisation score accordingly.

Proposed schemes identified from Step 1 should be allocated against the appropriate category, as shown in *Section 6.2* above. Schemes should then be put in a priority order, within each cost category, using an appropriate local prioritisation method. The table below shows criteria that such a method may be based upon. *Appendix 6.b* below gives a simplified example that shows how such prioritisation can be applied.

Table 6.8: Example Scheme Identification Scoring System Criteria

	Criteria	**Score**
Condition (from visual survey):	- Lower condition rating in band (1, 3, 5 or 7) - Higher condition rating in band (2, 4, 6 or 8)	5 4
Condition (skid resistance – roads subject to SCRIM testing):	- Percentage of site exceeds intervention criteria	3
Condition (from machine-based condition survey):	- PCI >100 - PCI >80 - PCI >60	5 4 3
Site is on:	- Regional road - Local Primary or Local Secondary road - Local Tertiary road	5 4 2
Traffic Volume & Type:	- e.g. AADT - Percentage HCV	

Table 6.8: Example Scheme Identification Scoring System Criteria		
	Criteria	**Score**
Strategic Importance:	For example: - Strategic – major employer or strategic industry - Regionally important service or local industry - Local community, social inclusion or shops - Agricultural - Local access - Forestry - Airports	Add 1 for each factor
Inventory (where age and surface type known):	- Exceeds average expected service life	1
Defects: From routine maintenance records	- Number of Category 1 defects in last year	5
Collision History	- Number and type of collisions in the last 3 years	3
Repairs	- Routine and reactive cost per km in last 3 years	3
Customer Contacts	- Number of service requests in the last 3 years	2
Third Party Claims	- Number of claims received in last 3 years	3
Site is on a bus lane		
Requests for works from elected members received		
Is the site within a construction or development area?		Remove from programme
Are statutory undertakers' works required?		

Recommendation: Road authorities should document and apply a method of scheme prioritisation.

6.4 Step 4 – Site Inspection (Project Level)

Each potential scheme site should be visited by an appropriately experienced technician or engineer. The inspection shall be used to:

- Reject any schemes where site inspection shows that treatment is not currently required.
- Determine a proposed treatment, based upon observation.
- Determine if testing or coring is required.

It is recommended that for each site the following data is recorded:

Table 6.9: Site Inspection Data Requirements

Data from Records to Inform Inspection			
Prior to inspection, the following items can be provided from the PMS and other records			
Road Number			
Street / Road Name			
Road Segment(s)			
Length of Scheme	Note: if the full length does not warrant treatment or if the scheme should comprise a series of adjacent segments.		
Surface Type	Record current surface material type		
Defects	Record the quantity of defects		
Vehicle Survey Data	Texture		
	Longitudinal profile		
Visual Survey	Condition band		
Skid Resistance	SCRIM value		
Proposed Treatment from PMS		Generic treatment proposed, e.g. surface dressing, re-sealing.	
Data to be Collected from Site Inspection			
The following items should be collected during site inspection			
Photographs	Photographs should be taken to show / record: – Defects, e.g. potholes and cracking – Patches – Surface type(s) – Access ways / crossings – Traffic-calming assets – Drainage facilities, e.g. gullies – Road markings		
	Quantity (estimated visually)	Extent (% of the site affected)	
Cracking	____ m^2		
Rutting, >10mm	____ m		
Potholes no.	____ no. ____ no. repaired.		
Patches	____ m^2		
Edge Break	____ m		
Site Validation of Condition Rating Data			
What is the condition of the drainage?		e.g. working, partially blocked, unknown, other	
Are works required to upgrade drainage?		*	
Are works required to adjacent:			
– Kerbs?			
– Footways?			
– Verges?			
– Public lighting?			
What environment is the road in?		Urban, industrial, residential, outside hospital, school, etc.	
What traffic management will be required?		Lane closures, full closure	
How many accesses are affected?		Number of accesses	
Length of road with footway and / or kerb.		Dimensions of adjacent footways and kerbs	
Are there any traffic-calming assets?		Number, size and type of features	
Are there road markings and road studs present?		Ensure they are photographed	
Treatment proposed, based on site inspection		Generic treatment	
Is it on a bus route?		Can the bus be diverted if necessary?	
Will the work have to be carried out at night?			
Comment on reasons if treatment differs between that recommended from the PMS and that recommended following site inspection, e.g. "Defects are too extensive to allow surface dressing, resurfacing is required".			

** Where drainage condition rating has been undertaken, reference should be made to the rating records for the site.*

Engineers and technicians who undertake these inspections should be trained in pavement management. They need to be able to discern an appropriate treatment for the defects they observe on site and the extent of deterioration. The selection of a proposed treatment at this stage shall be considered as provisional. It is recommended that actual treatments are determined after carrying out life-cycle cost analysis on the available treatment options, as described in *Appendix* 6.c.

Recommendation: Road authorities should inspect potential schemes and determine a recommended treatment from site inspection.

6.5 Step 5 – Programme (Project Level)

A similar process to Step 3 will apply to Step 5.

6.6 Step 6 – Publish Plan and Construct Works

Once the list of schemes has been prioritised and proposed treatments allocated, a short-term programme should be produced. It is recommended that a rolling programme of at least 3 years is created and then updated annually. A 3-year programme will enable sites to be identified, and where appropriate, embargoed from routine repairs, i.e. sites where resurfacing is planned are not patched in the years leading up to the scheme, with any required patching being incorporated into the scheme, at lower costs.

The programme comprising of the sites, their proposed treatments and the predicted year of treatment shall be stored in the PMS.

The programme should be aligned to condition targets. The targets should be published in an appropriate plan document.

Recommendation: Road authorities should produce a 3-year rolling programme for all work types.

Recommendation: Road authorities should produce a plan stating what their condition targets are for each road class and over what period of time those targets are expected to be achieved.

Appendix 6.a: Default Expected Service Life (ESL) of Treatments

There are many factors that can affect the service life of a road pavement. Other than the design and structural make-up of the road, factors such as traffic and drainage can also be important. The gathering of data to support the tracking of pavement performance and to benchmark pavement service lives is critical and should be logged in a Pavement Management System. Where such data does not exist, standard 'text book' default values can be set, based on road type / surface type, etc. These should be used where better quality local data, on expected lives, does not exist. The ESLs should be used to aid identification of sites potentially requiring treatment and to assist with the development of rolling programmes and long-term condition / cost predictions.

Table 6.10:

Average Expected Service Life by Road Surface and Treatment Type (Years)

Road Type		Regional		Local	
Treatment	**Surface Type**	**Urban**	**Rural**	**Urban**	**Rural**
Re-sealing and restoration of skid resistance	Surface dressing				
Re-sealing and restoration of skid resistance	Overlay – thin surfacing				
Re-sealing and restoration of skid resistance	Hot rolled asphalt (HRA)				
Surface Restoration					
Structural Overlay					
Road Reconstruction					

Appendix 6.b: Example Prioritisation

The road authority has decided to prioritise sites, based upon the following criteria:

Table 6.11

Visual Condition	Score	Road Category / Class	Score	Traffic Volume (AADT) up to	Score	HCV%	Score	Customer Contact	Score
1	10	LP	3	250	1	1%	1	No contacts	0
2	10	LS	3	1,000	3	5%	3	Contacts	1
3	8	LT	1	5,000	5	10%	5		
4	8	R	5						
5	6								
6	6								
7	4								
8	4								
9	0								
10	0								

Each potential site has data entered as shown below. The scoring is then added up to produce a priority score.

Image 6.1

Scheme/Site Number	PRIORITY SCORE	Visual Condition Score	SCORE	Road Category (R, LP/LS, LT)	SCORE	Traffic Volume, AADT	SCORE	%HGV	SCORE	Customer Contacts	SCORE
1	21	1	10	R	5	5000	5	1%	1	0	0
2	15	1	10	LT	1	250	1	5%	3	0	0
3	21	1	10	R	5	5000	5	1%	1	0	0
4	15	1	10	LS	3	500	1	1%	1	0	0
5	24	1	10	R	5	1000	3	10%	5	1	1
6	20	3	8	R	5	5000	5	1%	1	2	1
7	12	5	6	LT	1	250	1	5%	3	10	1
8	14	6	6	LS	3	1000	3	1%	1	25	1
9	7	7	4	LT	1	250	1	1%	1	0	0
10	17	2	10	LT	1	250	1	10%	5	0	0
11	11	4	8	LT	1	250	1	1%	1	0	0
12	20	5	6	R	5	5000	5	5%	3	1	1
13	18	6	6	R	5	5000	5	1%	1	2	1
14	16	8	4	R	5	5000	5	1%	1	10	1
15	22	2	10	LS	3	1000	3	10%	5	25	1
16	16	4	8	LP	3	1000	3	1%	1	2	1

The results can then be put in overall priority order, based upon their priority score.

Image 6.2

Scheme/Site Number	PRIORITY SCORE	Visual Condition Score	SCORE	Road Category (R, LP/LS, LT)	SCORE	Traffic Volume, AADT	SCORE	%HGV	SCORE	Customer Contacts	SCORE
5	24	1	10	R	5	1000	3	10%	5	1	1
15	22	2	10	LS	3	1000	3	10%	5	25	1
1	21	1	10	R	5	5000	5	1%	1	0	0
3	21	1	10	R	5	5000	5	1%	1	0	0
6	20	3	8	R	5	5000	5	1%	1	2	1
12	20	5	6	R	5	5000	5	5%	3	1	1
13	18	6	6	R	5	5000	5	1%	1	2	1
20	18	8	4	R	5	1000	3	10%	5	2	1
10	17	2	10	LT	1	250	1	10%	5	0	0
14	16	8	4	R	5	5000	5	1%	1	10	1
16	16	4	8	LP	3	1000	3	1%	1	2	1
2	15	1	10	LT	1	250	1	5%	3	0	0
4	15	1	10	LS	3	500	1	1%	1	0	0
17	15	5	6	LP	3	1000	3	5%	3	0	0
8	14	6	6	LS	3	1000	3	1%	1	25	1
19	14	7	4	R	5	1000	3	1%	1	6	1
7	12	5	6	LT	1	250	1	5%	3	10	1
11	11	4	8	LT	1	250	1	1%	1	0	0
18	10	6	6	LT	1	250	1	1%	1	10	1
9	7	7	4	LT	1	250	1	1%	1	0	0

By filtering the results by road category, a prioritised list for each road category can be produced, as shown in the example below for regional roads.

Image 6.3

Scheme/Site Number	PRIORITY SCORE	Visual Condition Score	SCORE	Road Category (R, LP/LS, LT)	SCORE	Traffic Volume, AADT	SCORE	%HGV	SCORE	Customer Contacts	SCORE
5	24	1	10	R	5	1000	3	10%	5	1	1
1	21	1	10	R	5	5000	5	1%	1	0	0
3	21	1	10	R	5	5000	5	1%	1	0	0
6	20	3	8	R	5	5000	5	1%	1	2	1
12	20	5	6	R	5	5000	5	5%	3	1	1
13	18	6	6	R	5	5000	5	1%	1	2	1
20	18	8	4	R	5	1000	3	10%	5	2	1
14	16	8	4	R	5	5000	5	1%	1	10	1
19	14	7	4	R	5	1000	3	1%	1	6	1

Adding an additional filter, based upon the condition score, can enable prioritised lists of schemes for each type of work to be presented, in this case for roads in condition bands 5 and 6 (Surface Restoration schemes).

Image 6.4

Scheme/Site Number	PRIORITY SCORE	Visual Condition Score	SCORE	Road Category (R, LP/LS, LT)	SCORE	Traffic Volume, AADT	SCORE	%HGV	SCORE	Customer Contacts	SCORE
12	20	5	6	R	5	5000	5	5%	3	1	1
13	18	6	6	R	5	5000	5	1%	1	2	1

This process can be used to create prioritised lists by road category and proposed treatment.

Appendix 6.c: Cost Categories

Cost Categorisation

To ensure that costs can be benchmarked and peer comparison can be used to determine whether value for money is being achieved, a consistent cost coding is recommended. All pavement expenditure should be recorded against one of the following cost categories.

Table 6.12: Cost Categories

Cost Category	Definition	Example	Grant Category
Planned Maintenance – preventative	Planned maintenance activities that are designed to ensure that more expensive future repairs will not be needed.	Appropriately timed roadway dressing.	Restoration Maintenance (Surface Dressing) (Condition rating 7 or 8).
Planned Maintenance – corrective	Planned maintenance activities that correct the condition of the asset and would not cost significantly more if delayed.	Resurfacing of residential streets.	Restoration Improvement (Road Reconstruction) Condition bands 4 or less & Surface Restoration (Condition rating 5 & 6).
Routine Cyclic Maintenance	Scheduled works consisting of activities that are based on a prescribed time interval.	Roadway drainage gully emptying.	
Routine – reactive repairs (emergency)	Reactive repair of potentially dangerous defects identified from inspection or customer complaint / notification.	Category 1 defect repair to roadway.	
Routine – reactive repairs (non-emergency)	Other less urgent minor repairs.	Category 2 & 3 defect repair to roadway.	
Routine – Inspection and Survey	Cost of specialist inspection and surveys.	Roadway condition surveys.	

Table 6.12: Cost Categories

Cost Category	Definition	Example	Grant Category
Overhead	Internal costs associated with the management of the asset. Note: it is accepted that these costs may not be available at an asset group level.	Salaries & associated costs of staff engaged in managing the asset.	
Loss	Money expended that is effectively "lost" to the road authority from which no benefit to the asset or user is gained.	Pay-out of third party claims.	
Improvements	Works that add new infrastructure to the asset.	Road safety schemes, e.g. junction improvements.	

Recording costs at a cost category level will enable per km costs for each network to be compared and will aid subsequent evaluation, as to whether the split between reactive and planned maintenance is being managed well.

Recommendation: Expenditure on roadways should be recorded against the categories shown in Table 6.12 to enable per km costs to be reported.

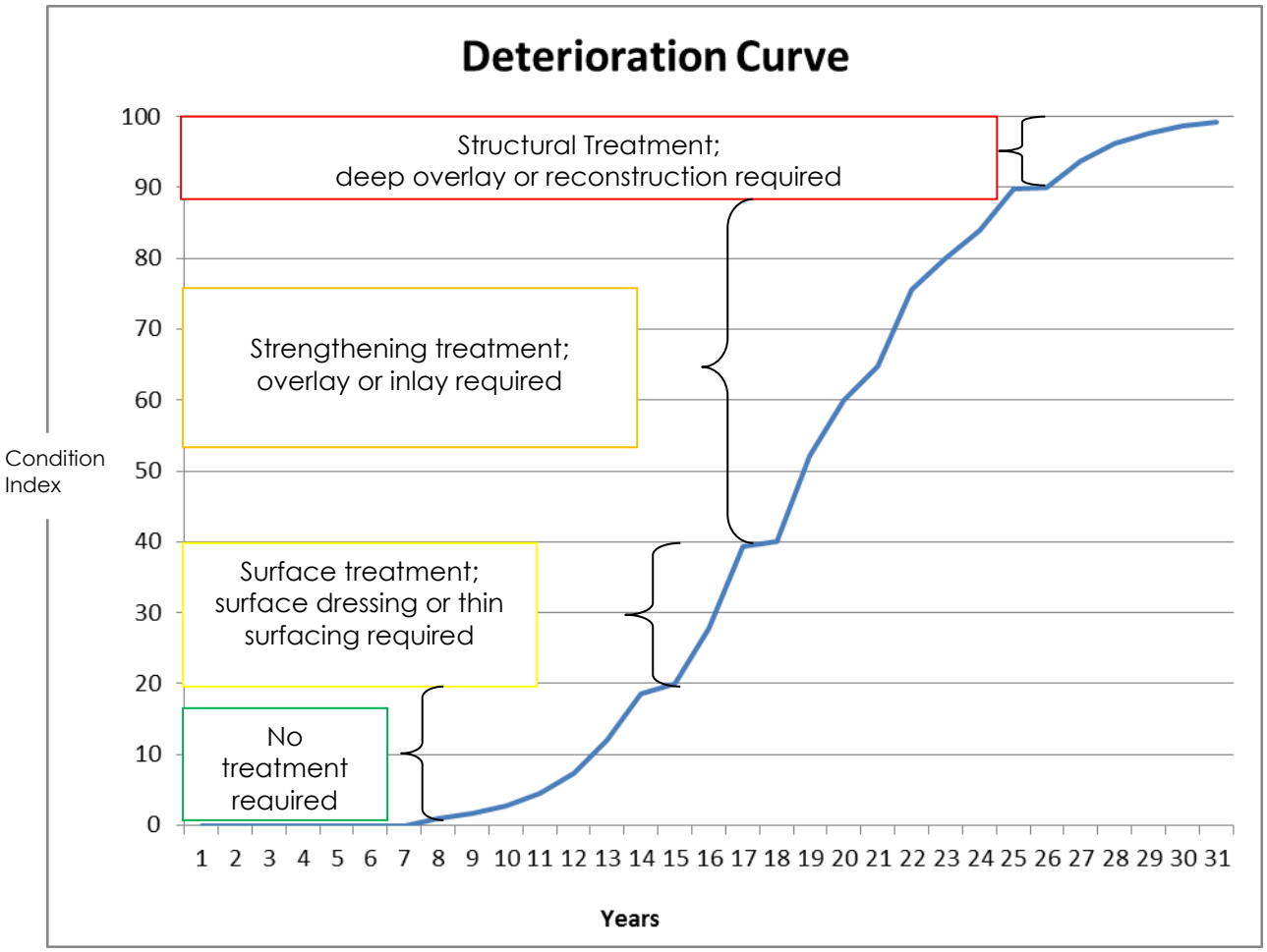
Appendix 6.d: Life-cycle Cost Analysis

Life-cycle cost analysis (LCA) is a method of determining the minimum whole-life cost (WLC) of maintaining an asset. It can be applied at a network level, to determine the level of budget that should be allocated to low-cost preventative treatments. It can also be applied at a project level or for a particular site to determine which, out of a range of acceptable treatments, is the minimum whole-life cost treatment.

Preventative Maintenance

LCA will identify the schemes where the minimal WLC option is being adopted. For rural networks this is likely to be largely surface dressing treatments. The application of treatments at a time in the pavement's deterioration, when it can prevent the need for more expensive and intrusive treatment, is known as preventative maintenance. It is recommended that road authorities specifically budget for preventative maintenance, such that a priority can be made of preventing more extensive deterioration, before expenditure is incurred on the repair of already heavily-deteriorated roads.

The curve below illustrates the way in which roadways deteriorate.



Graph 6.7

1. Initially, roadway pavements deteriorate very little, as illustrated by the flatness of the curve in the first years. During this period no treatment is required.
2. Initial deterioration then occurs in the surface layers. During this period, the surface can be restored using a surface treatment, surface dressing or a thin surfacing. These treatments are comparatively cheap. Therefore, this period of deterioration offers an opportunity for cost-effective pavement maintenance, via the use of these treatments, as a strategy to prevent more deep-seated & expensive treatments to restore the road and prevent further deterioration from occurring.
3. If a preventative treatment is not applied, deterioration continues and increases, causing deeper distresses in the pavement. Pavements in this middle level of deterioration become unsuitable for surface treatments. Surface treatments could be applied, but would have a very limited life, much shorter than their normal expected life. Pavements in the middle levels of deterioration are usually restored using resurfacing treatments of inlays or overlays.
4. If a resurfacing treatment is not applied and further deterioration occurs, structural damage to the pavement can occur, requiring more extensive treatments to be required, comprising of deep overlays or inlays or in some circumstances reconstruction.

Deterioration curves following this pattern of deterioration have been used on the cost projection models used in this report.

Corrective Maintenance

Sites that are not the minimum WLC option for which no alternative treatment are available should be classified as corrective maintenance.

Project Level Application

To ensure that the whole-life costs of the treatments proposed are taken into account, it is recommended that a life-cycle cost analysis (LCA) is applied for the sites that are programmed for treatment in the next 3 years. LCA is applied when a scheme has been validated via site inspection and it is the intention of the road authority to undertake works at the site. The purpose of LCA is to determine the lowest life-cycle cost (i.e. most cost-effective) means to deliver the scheme. LCA enables the road authority to make sure that the selection of a treatment and the timing of the treatment are not based solely on the lowest initial costs, but also consider all the future costs (appropriately discounted) over the project's usable life.

The process for LCA is as follows:

1 Establish alternatives: what treatments are realistically viable at this site?

2 Determine the timing and pattern of subsequent treatments that follow the initial treatment.

3 Estimate the costs using a schedule of standard / average treatment costs.

4 Compute life-cycle costs using a simple spreadsheet (or alternatively within the PMS).

5 Analyse the results based upon a net present value (NPV) / cost.

6 Identify which treatment provides the minimum whole-life cost (WLC) option.

There may be valid reasons why the minimum WLC treatment is not chosen, but with this analysis available, this decision can be made as an informed one rather than a guess.

Image 6.5

OPTION APPRAISAL

	1		2		3		4	
Desription								
	PV	**£26,198,951**	**PV**	**£22,009,245**	**PV**	**£16,146,894**	**PV**	**£23,265,000**
Year	Treatment	In Year Cost	Treatment	In Year Cost	Treatment	In Year Cost	Treatment	In Year Cost
1	RCN	£24,675,000	OL	£10,575,000	sd	£2,115,000	mil	£8,460,000
2	Nil	£0	nil	£0	nil	£0	ol	£10,575,000
3	Nil	£0	nil	£0	nil	£0	nil	£0
4	Nil	£0	nil	£0	nil	£0	nil	£0
5	Nil	£0	nil	£0	nil	£0	nil	£0
6	Nil	£0	nil	£0	ol	£10,575,000	nil	£0
7	Nil	£0	nil	£0	nil	£0	nil	£0
8	Nil	£0	nil	£0	nil	£0	nil	£0
9	Nil	£0	nil	£0	nil	£0	nil	£0
10	Nil	£0	nil	£0	nil	£0	sd	£2,115,000
11	Nil	£0	nil	£0	nil	£0	nil	£0
12	sd	£2,115,000	ol	£10,575,000	nil	£0	nil	£0
13	nil	£0	nil	£0	nil	£0	nil	£0
14	nil	£0	nil	£0	nil	£0	nil	£0
15	nil	£0	nil	£0	nil	£0	nil	£0
16	nil	£0	nil	£0	nil	£0	nil	£0
17	nil	£0	nil	£0	nil	£0	nil	£0
18	nil	£0	nil	£0	nil	£0	nil	£0
19	nil	£0	nil	£0	ol	£10,575,000	sd	£2,115,000
20	nil	£0	nil	£0	nil	£0	nil	£0
21	nil	£0	nil	£0	nil	£0	nil	£0
22	nil	£0	nil	£0	nil	£0	nil	£0
23	sd	£2,115,000	ol	£10,575,000	nil	£0	nil	£0
24	nil	£0	nil	£0	nil	£0	nil	£0
25	nil	£0	nil	£0	nil	£0	nil	£0

In the example above, four viable treatments for the site in question have been analysed, Reconstruction (RCN), overlay (OL), inlay (mill) and surface dressing (SD). Each has been assumed to be applied in Year 1, following which the predicted pattern of treatments required to keep the road in an acceptable condition have been identified. In the case of the reconstructions, a surface dressing has been programmed after 11 years and then again in Year 23. A 25-year analysis period has been used.

The future costs have been discounted to provide a net present value or a net present cost. Discounting is necessary in order to take into account the time value of money, i.e. that €100,000 spent now does not have the same value as €100,000 planned to be spent in 10-years' time.

Recommendation: The treatment of all schemes should be determined taking into account the results of life-cycle cost analysis of the viable treatment options.

Appendix 6.e: Instructions for Roadway Cost Projection Spreadsheet*

* Note: This spreadsheet has been issued for testing purposes and should not be used in reporting of data or results.

1. Introduction

This appendix provides instructions on how to use the Roadway Cost Projection Spreadsheet that is available from the Local Government Management Agency / Road Management Office.

2. How The Model Works

The roadway model predicts future condition, based upon the effect of budgets inputted into the spreadsheet using the following steps:

a. The starting condition is entered using data from the data survey. The condition has been divided into five condition bands, based on treatment types – Road Reconstruction (life fully utilised), Structural Overlay (80% of life utilised), Surface Restoration (60% of life utilised), Resealing and Restoration of Skid Resistance (40% of life utilised) and Routine Maintenance (20% of live utilised).

b. The deterioration curve issued in *TN46 – Part 1, Financial Information to support Asset Management, Guidance notes for UKPMS Developers for 2010/11 Carriageways* has been used to determine the duration that each road category is predicted to spend in each condition band. The following steps are followed to identify the correct time periods.

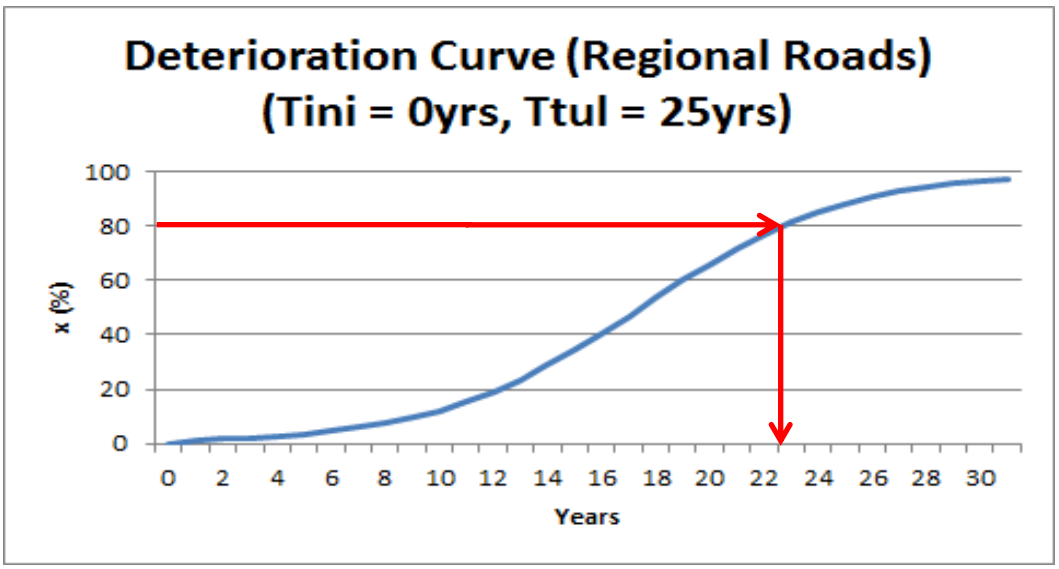
   i. Identify values of T_{INI} (time when deterioration commences) and T_{TUL} (time when pavement is unserviceable and needs replacement) have been identified for each different road classes as follows:

Table 6.13

Road Category	T_{INI} (years)	T_{TUL} (years)
Regional Roads	0	25
Local Primary Roads	0	30
Local Secondary Roads	0	30
Local Tertiary Roads	0	40

The figures in Table 6.13 above are for illustrative purposes only and do not represent the true T_{TUL} values for a road. In most cases, the period would be much shorter.

   ii. A deterioration curve is then created using the formulas provided in TN46. The curve for Regional Roads is shown below:



Graph 6.8

iii. The age when the asset reaches the specific treatment type, e.g. Structural Overlay is then identified using the curve above. A horizontal line is projected from the vertical axis to the curve. The time is identified by projecting a line down to the horizontal axis. The example above is for the Structural Overlay category which has a condition band of 80%. The chart shows that this condition band will be reached in Year 22.

iv. The individual duration that the asset remains in each specific treatment type is calculated by taking the differences between the ages identified in the above curve.

c. The duration that any particular class of road spends in each condition category is then used to determine how much road will deteriorate from one condition into another in a year. For example, if a road class is predicted to spend 10 years at the Surface Restoration level then each year 10% of the area in Surface Restoration will be transferred into the next worse condition category, in this example Structural Overlay.

d. Each year, the deteriorated condition is predicted by taking away the amount of roadway that is predicted to deteriorate into the next worse condition and adding the amount of roadway that has been predicted to deteriorate from the next better condition, i.e.

$$Y1\ Surface\ Restoration\ quantity = Y0\ Surface\ Restoration\ quantity - The\ quantity\ predicted\ to\ deteriorate\ from\ SR\ to\ SO + The\ quantity\ predicted\ to\ deteriorate\ from\ RRSR\ to\ SR$$

** SR = Surface Restoration; SO = Structural Overlay; RRSR = Resealing and Restoration of Skid Resistance*

e. The curve from TN46 has been used for the deterioration of the surfacing, i.e. as the basis of deterioration from Routine Maintenance condition to Structural Overlay condition. This curve is understood to be based entirely on surface readings and as such, reflects surface condition only. This model presumes that treatment of Road Reconstruction condition roads includes surface and base and as such an additional logic has been applied to determine the predicted deterioration, from Structural Overlay condition to Road Reconstruction condition.

f. To predict the deterioration between Structural Overlay condition and Road Reconstruction condition, the difference in the expected service lives of the surface and the pavement structure has been taken as the time it takes to move from Structural Overlay condition to Road Reconstruction condition. The assumed expected service lives of the pavements structure has been taken as:

Table 6.14

Road Category		ESL of Pavement (Structurally) (years)	ESL of Surface Layers (years)
Regional Roads	Urban	60	25
	Rural	40	25
Local Primary Roads	Urban	40	30
	Rural	50	30
Local Secondary Roads	Urban	50	30
	Rural	50	30
Local Tertiary Roads	Urban	60	40
	Rural	60	40

g. So if (ESL) surface = 10 years and (ESL) pavement (structure) = 20 years then the time taken to move between conditions is 10 years and 1/10th of the quantity in Structural Overlay condition is deteriorated into Road Reconstruction condition each year.

Budgets & Treatment

h. Budgets are entered against four generic treatments. Unit rates are included for each generic treatment, based upon the average cost of the treatment that the road authority would most frequently apply to treat a road in that condition.

i. The budgets for each treatment and road class are divided by the appropriate unit rate, to determine the area of treatment that the budget can buy.

j. The amount treated is deducted from the appropriate quantity, to produce a predicted post-treatment condition. All treatments reset the condition to green.

3. Input Instructions

3.1 Open the worksheet labelled "Input – Inventory & Condition".

Inventory

a. Enter the length (in metres) of the road in each road category into cells C4-C11.

b. Enter the average width (in metres) of each road category into cells D4-D11. If widths are not known, then standard / default roadway widths should be used as below:

Table 6.15

Road Category	Urban / Rural	Default Roadway Width (m)
Regional Roads	Urban	8.0
	Rural	8.0
Local Primary Roads	Urban	7.0
	Rural	7.0
Local Secondary Roads	Urban	7.0
	Rural	7.0
Local Tertiary Roads	Urban	6.0
	Rural	6.0

Condition

c. Enter the percentage of each road category in each of the following condition bands.

Table 6.16

Condition Band	Condition Rating*	Enter percentage into:
Road Reconstruction	1 - 2	Cells F4 to F11
Structural Overlay	3 - 4	Cells H4 to H11
Surface Restoration	5 - 6	Cells J4 to J11
Resealing and Restoration of Skid Resistance	7 - 8	Cells L4 to L11
Routine Maintenance	9 - 10	Cells N4 to N11

* Refer to Page 26, *Flexible Roads Manual: Pavement Surface Evaluation and Rating on Irish Roads (Department of Transport, Tourism And Sport)*.

Treatment Costs

3.2 Open the worksheet labelled "Input_Treatments". The purpose of this sheet is to enable generic unit costs to be created for the four condition bands (Road Reconstruction, Structural Overlay, Surface Restoration & Resealing and Restoration of Skid Resistance) of each category of road. This should be done by considering the current practice for each category of road and each generic treatment. The generic treatment types used in this process are:

- Surface Dressing
- Surface Restoration
- Thin Overlay (30-50mm)
- Granular Overlay (50-150mm)
- Recycling
- Bituminous Overlay
- Structural Overlay (150mm+)
- Thin Inlay (30-50mm)
- Granular Inlay (50-150mm)
- Bituminous Inlay
- Structural Inlay (150mm+)
- Fully Reconstructed

a. For each Road Category enter a local description of what constitutes each treatment type into the following cells:

Table 6.17

Road Category	Treatment Type	Description of Treatment
Regional Roads	Cells A5 to A25	Cells B5 to B25
Local Primary Roads	Cells A31 to H51	Cells B31 to B51
Local Secondary Roads	Cells A57 to A77	Cells B57 to B77
Local Tertiary Roads	Cells A83 to L103	Cells B83 to B103

b. Enter the actual average unit treatment rate for each treatment into the following cells:

Table 6.18

Road Category	Average Unit Treatment Rate
Regional Roads	Cells C5 to C25
Local Primary Roads	Cells C31 to C51
Local Secondary Roads	Cells C57 to C77
Local Tertiary Roads	Cells C83 to C103

The treatment rates should be an average rate, based preferably on a number of typical schemes. The rates should include for overheads such as traffic management costs, design of treatments, supervision, etc.

c. The percentage of schemes for a particular treatment and a particular condition band are entered into the following cells (for further description see example below):

Table 6.19

Road Category	Percentage of Schemes using Treatment for particular Condition Band
Regional Roads	Cells D5 to K25
Local Primary Roads	Cells D31 to K51
Local Secondary Roads	Cells D57 to K77
Local Tertiary Roads	Cells D83 to K103

Example of this process: For Regional Roads (Urban), if the 'Structural Overlay' treatment used would be a 'Recycling' treatment' 8 times out of 10, then enter 80% into cell E12. If a 'Bituminous Overlay (100mm DBM surface dressing)' treatment would then be applied in the other two schemes then enter 20% into cell E13. This will then use the rates already entered into cells C12 and C13 to generate an average unit rate for 'Structural Overlay' treatment of Regional Roads (Urban) which will appear in cell E26. This process should be repeated for each road category and condition band (Road Reconstruction, Structural Overlay, Surface Restoration & Resealing and Restoration of Skid Resistance).

Budgets

3.3 Open the worksheet labelled "Budgets". There are two options available:

Option 1: Fixed Annual Budgets: To enter an identical budget for Years 1 to 20:

For each condition band and road category enter the annual budget into the following cells:

Table 6.20

Road Reconstruction Treatment (1, 2)	Structural Overlay Treatment (3, 4)	Surface Restoration Treatment (5, 6)	Resealing and Restoration of Skid Resistance Treatment (7, 8)
Cells C6 to C13	Cells D6 to D13	Cells E6 to E13	Cells F6 to F13

If you use this option, Cells C6 to F13 will be copied into the annual budget profiles for Year 2 (cells C18 to F25) to Year 20 (cells C234 to F241).

Option 2: Varied Annual Budgets: To enter different budgets for Years 1 to 20:

Note: using this option overwrites the cells for Years 2-20. They will no longer read from Year 1.

a. Enter the annual budgets for each condition band on each Road Category for each year in the cells specified below. An option may be to enter specific budgets for, say the first 3-5 years and then enter a fixed budget for the remainder of the analysis period.

Budget Cell References				
Year	**Road Reconstruction Treatment (1, 2)**	**Structural Overlay Treatment (3, 4)**	**Surface Restoration Treatment (5, 6)**	**Resealing and Restoration of Skid Resistance Treatment (7, 8)**
1	Cells C6 to C13	Cells D6 to D13	Cells E6 to E13	Cells F6 to F13
2	Cells C18 to C25	Cells D18 to D25	Cells E18 to E25	Cells F18 to F25
3	Cells C30 to C37	Cells D30 to D37	Cells E30 to E37	Cells F30 to F37
4	Cells C42 to C49	Cells D42 to D49	Cells E42 to E49	Cells F42 to F49
5	Cells C54 to C61	Cells D54 to D61	Cells E54 to E61	Cells F54 to F61
6	Cells C66 to C73	Cells D66 to D73	Cells E66 to E73	Cells F66 to F73
7	Cells C78 to C85	Cells D78 to D85	Cells E78 to E85	Cells F78 to F85
8	Cells C90 to C97	Cells D90 to D97	Cells E90 to E97	Cells F90 to F97
9	Cells C102 to C109	Cells D102 to D109	Cells E102 to E109	Cells F102 to F109
10	Cells C114 to C121	Cells D114 to D121	Cells E114 to E121	Cells F114 to F121
11	Cells C126 to C133	Cells D126 to D133	Cells E126 to E133	Cells F126 to F133
12	Cells C138 to C145	Cells D138 to D145	Cells E138 to E145	Cells F138 to F145
13	Cells C150 to C157	Cells D150 to D157	Cells E150 to E157	Cells F150 to F157
14	Cells C162 to C169	Cells D162 to D169	Cells E162 to E169	Cells F162 to F169
15	Cells C174 to C181	Cells D174 to D181	Cells E174 to E181	Cells F174 to F181
16	Cells C186 to C193	Cells D186 to D193	Cells E186 to E193	Cells F186 to F193
17	Cells C198 to C205	Cells D198 to D205	Cells E198 to E205	Cells F198 to F205
18	Cells C210 to C217	Cells D210 to D217	Cells E210 to E217	Cells F210 to F217
19	Cells C222 to C229	Cells D222 to D229	Cells E222 to E229	Cells F222 to F229
20	Cells C234 to C241	Cells D234 to D241	Cells E234 to E241	Cells F234 to F241

b. To the right-hand side of the screen, a results graph is displayed showing the projected condition for the budget entered over a 20-year period.

c. The purpose of this is to allow users to iterate budget options to match the projected condition profile required, e.g. users can test the predicted results from a range of budget scenarios, by changing the budgets on this worksheet and examining the results. To store different scenarios the sheets should simply be saved with a new file name.

4. Output

a. Open the worksheet labelled "Summary Condition". This sheet contains tabulated results as shown below.

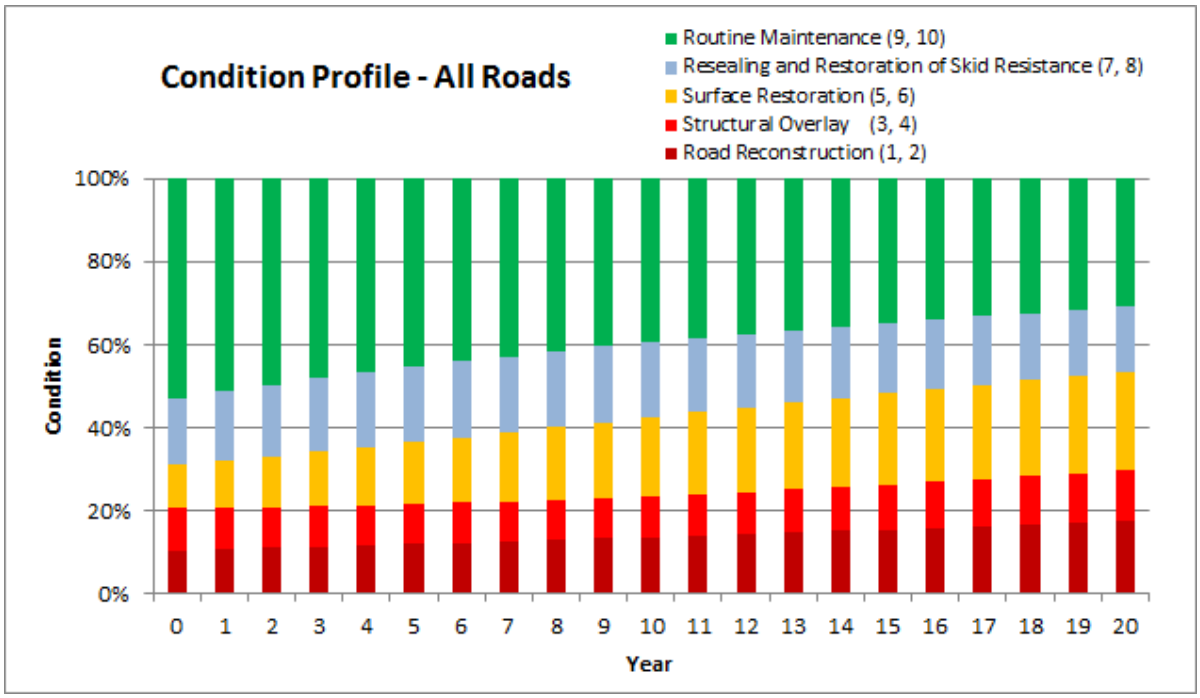
Image 6.6

Regional Roads (Urban)					
Year	Road Reconstruction (1, 2)	Structural Overlay (3, 4)	Surface Restoration (5, 6)	Resealing and Restoration of Skid Resistance (7, 8)	Routine Maintenance (9, 10)
0	4.30	4.30	9.17	18.33	63.90
1	4.10	3.89	9.87	19.65	62.50
2	3.89	3.48	10.77	20.68	61.18
3	3.69	3.07	11.81	21.48	59.95
4	3.48	2.66	12.98	22.09	58.79
5	3.28	2.26	14.23	22.53	57.71
6	3.07	1.85	15.55	22.84	56.69
7	2.87	1.47	16.88	23.04	55.74
8	2.66	1.19	18.14	23.15	54.85
9	2.46	0.99	19.34	23.19	54.02
10	2.26	0.87	20.47	23.17	53.23
11	2.05	0.83	21.52	23.10	52.50
12	1.85	0.86	22.49	23.00	51.81
13	1.64	0.95	23.37	22.87	51.17
14	1.44	1.10	24.18	22.72	50.56
15	1.23	1.30	24.92	22.55	50.00
16	1.03	1.55	25.58	22.37	49.47
17	0.82	1.85	26.17	22.18	48.97
18	0.62	2.19	26.69	22.00	48.51
19	0.42	2.56	27.15	21.80	48.07
20	0.21	2.96	27.55	21.61	47.66

The tables are not protected and as such, care should be taken to not overwrite the results. Having the tables free from protection means that users can copy them to other spreadsheets, if they want make further use of them. This can be useful, when comparing different budget scenarios together with each other.

b. Open the worksheet labelled "Output".

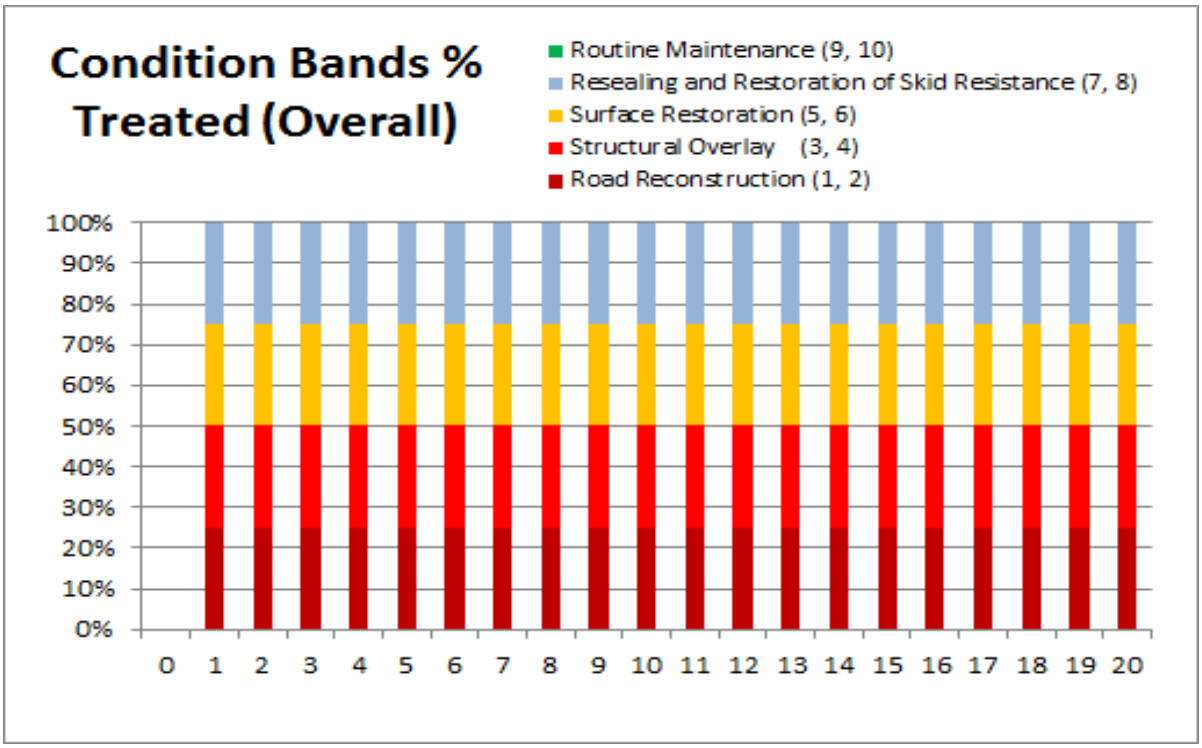
Graph 6.9



Condition Profile – All Roads

This chart provides the combined roads condition profile associated with the provided budget.

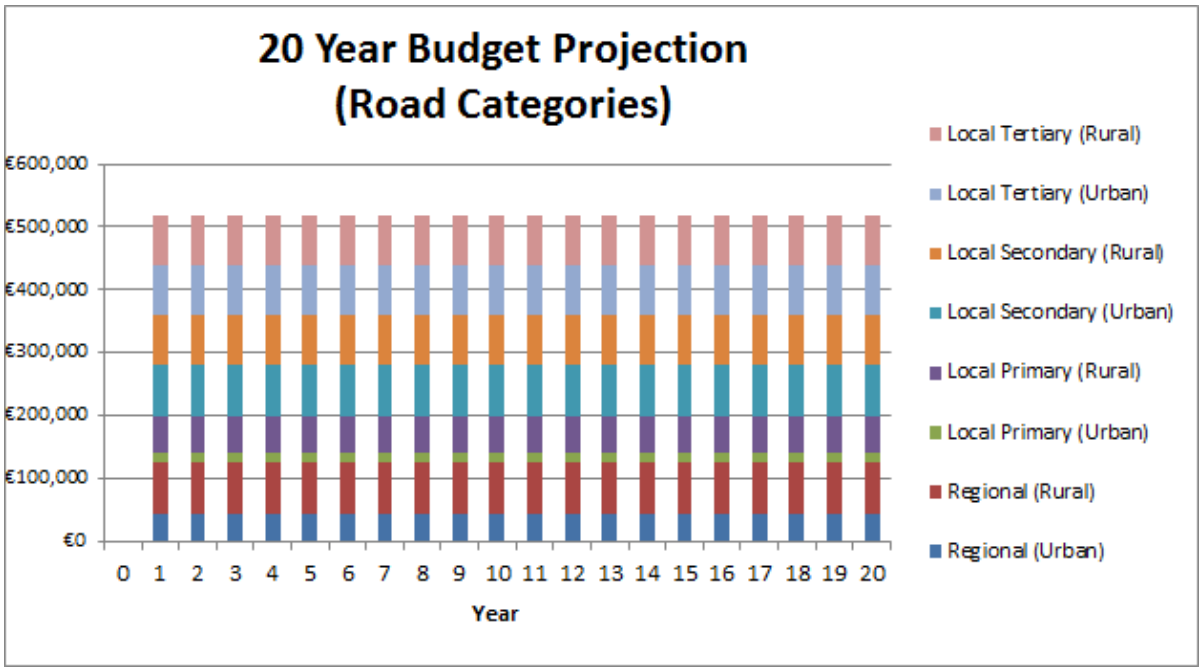
Graph 6.10



Condition Bands % Treated (Overall)

This chart provides a budget distribution by condition band.

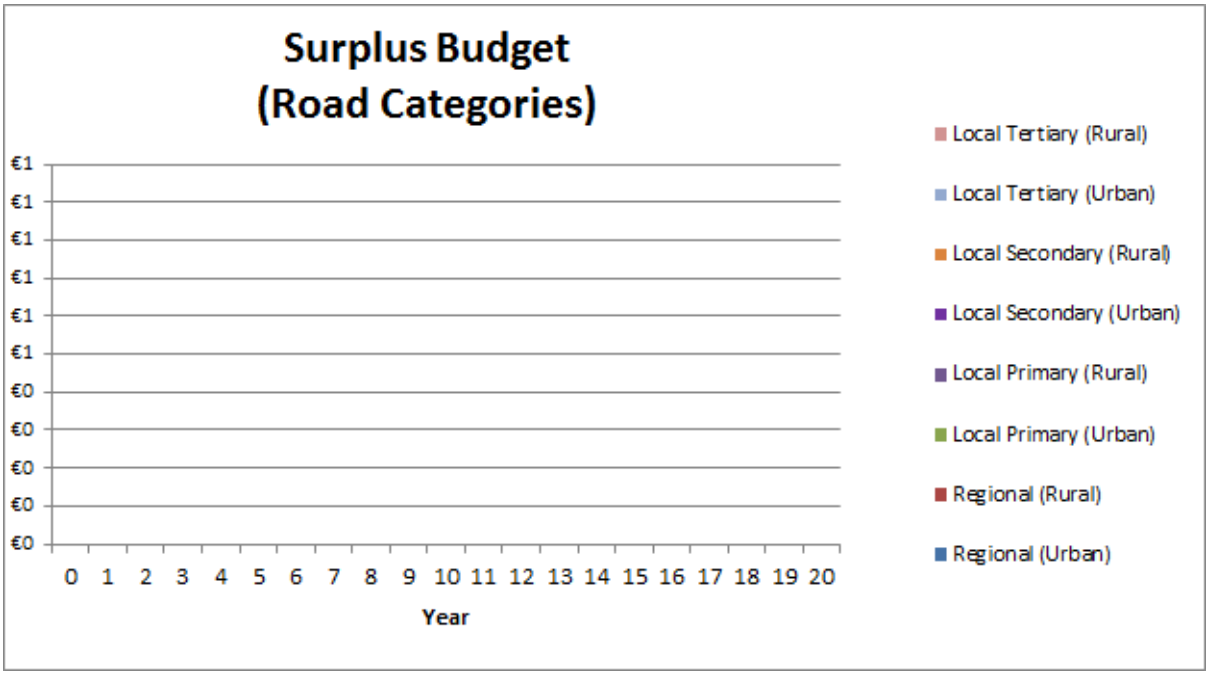
Graph 6.11



20 Year Budget Projection (Road Categories)

This chart provides a budget distribution by road category.

Graph 6.12



Surplus Budget (Road Categories)

Within this cost projection process, it is possible to insert 'surplus' budget where there is insufficient road to treat. This chart shows the year and road category where 'surplus' budget occurs. The user can then re-allocate the 'surplus' budget.