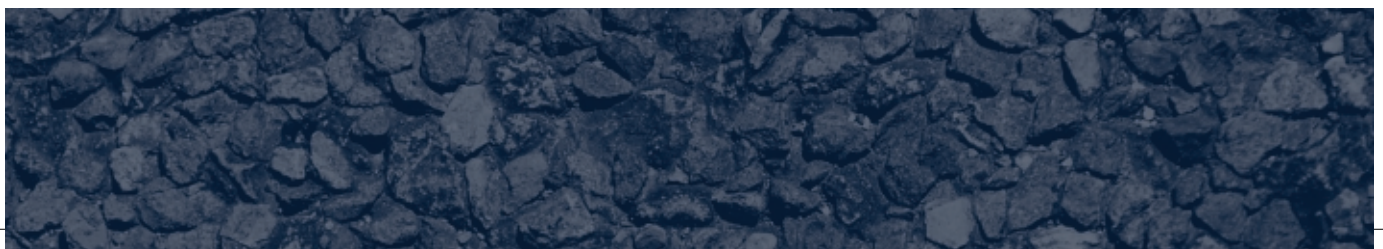
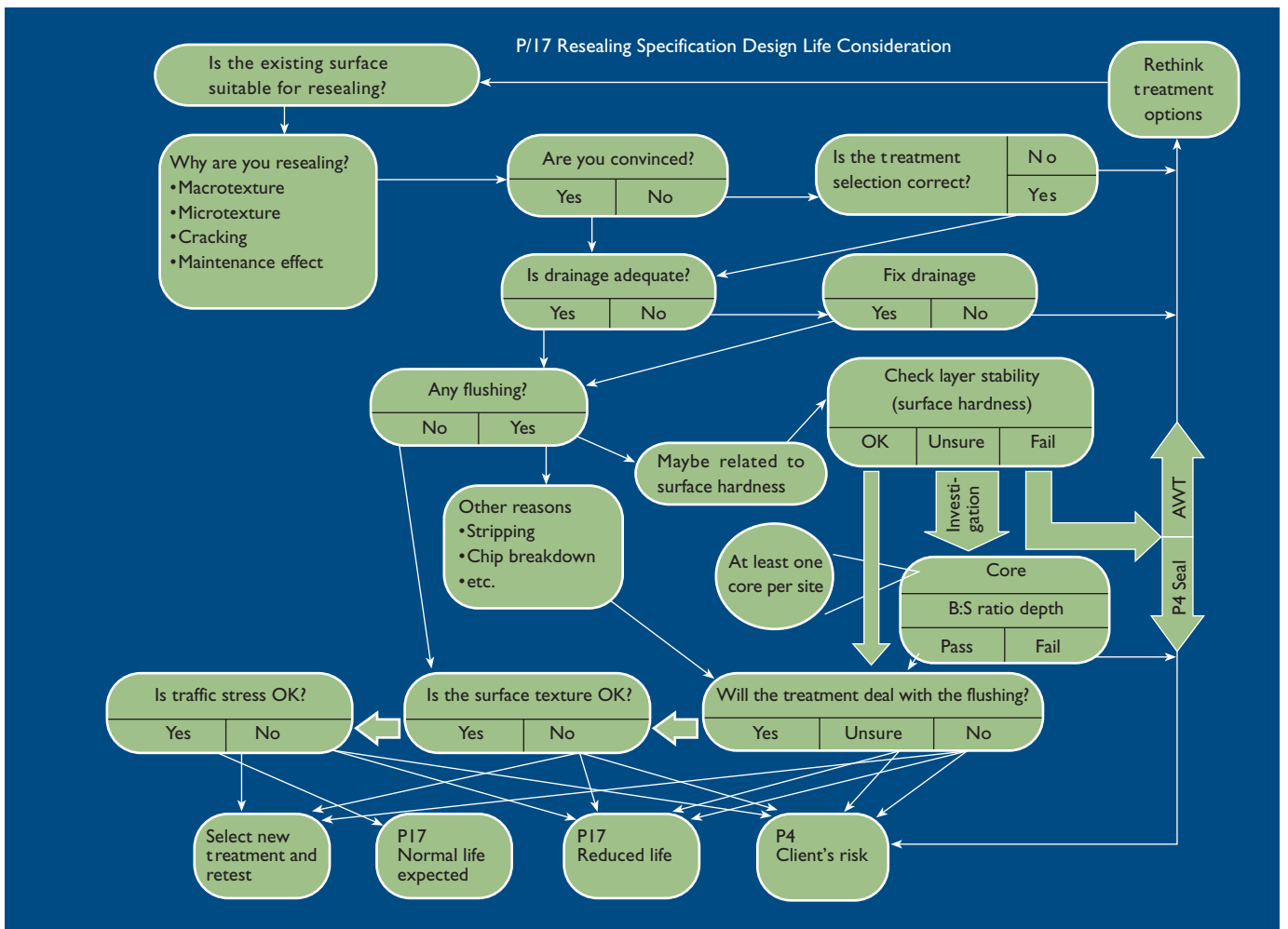


CHAPTER FIVE

Road Asset Management



Chapter 5 Road Asset Management

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Previous page: This flow chart is used to identify sections of pavement that are to be resurfaced in accordance with TNZ P/17:2002 *Performance-based specification for bituminous chipseals*.

Chapter 5 Road Asset Management

5.1 Road Asset Management Principles

5.1.1 Introduction

Management of the road asset involves the application of engineering, financial and management practices to optimise the level-of-service outcome in return for the most cost-effective financial input. The function of the asset manager is to optimise investment and outcomes within the constraints of finance, service level, resources, etc. Taking only the pavement and surfacing assets into consideration, the optimisation is applied using a life-cycle management approach.

The objective is simply to apply the right treatment at the right time to achieve the desired level of service.

In practice the asset manager is operating in a financially restricted environment, and the constraints require the minimisation of whole-of-life costs while maintaining service levels above well-established minimum technical standards and customer values.

The key asset management principles evolving from this asset management function that are relevant to chipsealing operations are discussed in this section. The intent is to highlight the factors that should be understood at an overview level. Developing the full knowledge necessary to apply asset management principles will require reference to other documentation (e.g. NAMS 1996). An understanding of these principles affects all players involved in the delivery of the end result and, for chipsealing treatments, the different expectations and levels of involvement are as follows:

- The *asset manager* must be fully aware of the purpose, life expectancies and outcomes of all sealing options in resolving which will be applied in the Forward Works Programme (discussed in Section 5.1.2.5) to achieve the financial and service level objectives.
- The *seal designer* must be aware of the objectives and intent of the scheduled chipseal treatments in order to produce the most appropriate design. To meet the objectives, both the designer and the asset manager must target the same life expectations, service level outcomes and costs.

- The *construction team* must understand the importance of the construction standards and deliver the work at those expected required standards. The construction standards are to be specified because they are an implicit component of the service level.

The general concepts relating to road asset management, of inputs, process, outputs and implementation, are shown in Figure 5-1. The components are discussed in sequence below.

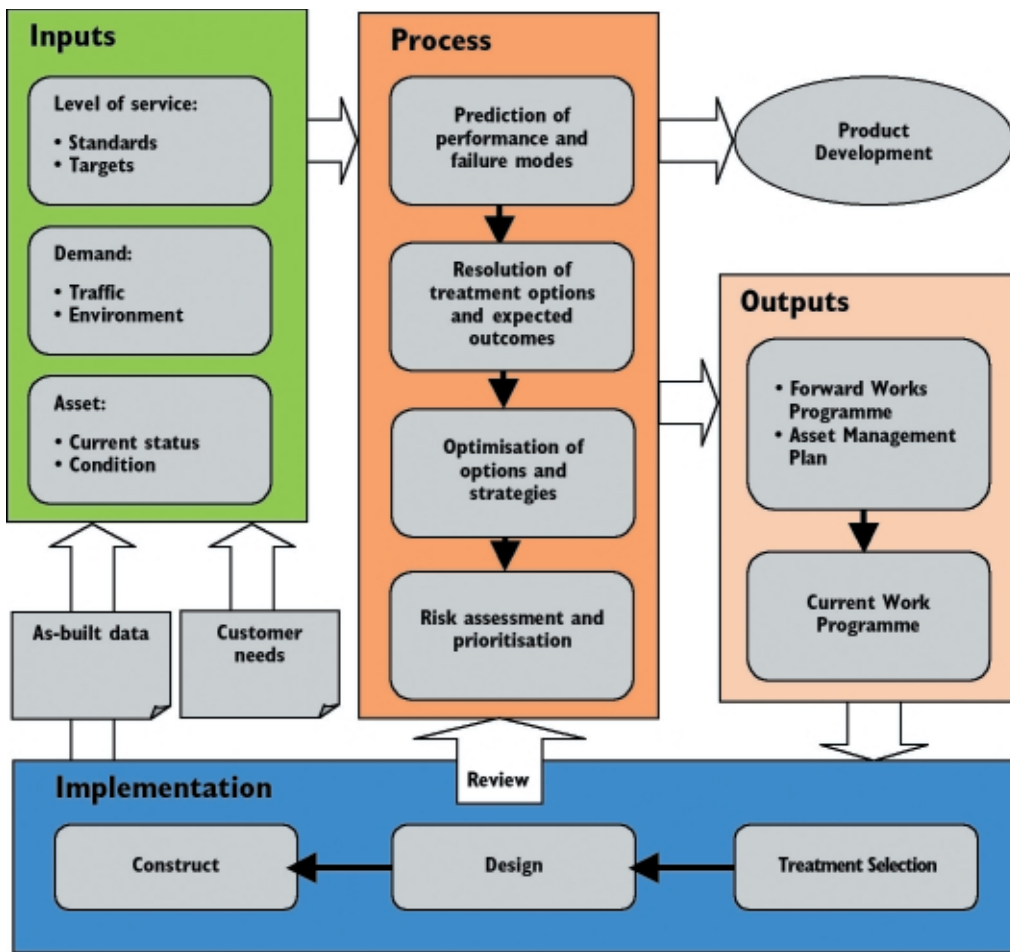


Figure 5-1 Applying the asset management process.

5.1.2 Applying the Asset Management Process

5.1.2.1 Treatment Lengths

Current best practice is for programmes to be developed based on needs, assessed at a treatment length level. A treatment length is defined as a uniformly performing section of pavement that is performing differently to the sections on either side of it. In many cases treatment lengths are synonymous with the lengths that will be scheduled for resealing.

There are exceptions to this:

- When a treatment has to be applied in a reactive manner to deal with a specific failure, such treatments may well be applied only to part of a treatment length.
- When sealing to improve skid resistance in reaction to results of the annual SCRIM survey. The original treatment length may then be split into two separate treatment lengths.

5.1.2.2 Life Cycle Asset Management

Life Cycle asset management is the concept of planning and analysis of all needs, requirements and activities that will be necessary to achieve the full life of the asset, from the current status to replacement, and is commonly referred to as a 'cradle to grave' analysis. There is much debate surrounding when the life cycle of a pavement ends. One idea is that indefinite extension of life can be achieved through the application of maintenance treatments. For this discussion the key issues are:

- A resealing treatment does not start a new life cycle.
- Typically the treatment that initiates a new life cycle will be one that renews the structural capacity of the asset.

The selection of treatments is based on consideration of all treatment options or strategies that are possible over the full life of the asset.

5.1.2.3 Inputs

The following details the inputs for asset management (see box for 'Inputs' on Figure 5-1).

Level of Service

Service levels should be regarded as the outcome that the asset provides for the end user (e.g. the asset of the pavement and the service level of its desired roughness). Service levels can be applied as fixed standards (not to be exceeded) or desirable targets. If established as desirable targets, the term 'investigatory' is frequently used which means a level at which the justification for treatment or correction should be considered.

Examples of service levels that are common in considering chipsealing requirements include:

| Level of Service Outcome | Action | Example |
|--------------------------|---------------------|-----------------|
| Fixed Standards | Not to be exceeded | Texture depth |
| Desirable Targets | Investigatory level | Skid resistance |

Construction agencies should also regard construction standards in terms of levels of service. For example, where a resurfacing is necessary to correct a texture deficiency, the level of service achieved from the treatment (the output) is calculated from (or is a function of) the texture achieved through the construction and the construction standard.

The construction standards establish the expected new service level. For example, one key service level expectation that is rated very highly by the public, and is implemented through construction standards, relates to the presence of loose sealing chip. This is a construction outcome, and the service level is achieved through the seal design and the road-sweeping requirements in the construction specification.

Demand on Asset

Once the level of service is set and the construction has achieved it, the next thing to consider is the demands that are placed on the asset causing it to deteriorate over time. As outlined in Chapters 3 and 4, the two great influences on chipseals over their life time are traffic and the environment.

Asset Condition

Next we consider the current condition of the asset. Obviously not all assets (e.g. roads) in a road network will have the same ability to meet the required level of service. The current status of some will be close to the 'as-built' condition, meeting or exceeding the required level of service. The condition of other assets will be at various stages of deterioration and at or below the required level of service.

5.1.2.4 Process

The following details the process for asset management (see box for 'Process' on Figure 5-1).

Prediction of Performance and Failure Modes

After the condition of each treatment length is known, this information can be fed into models that are assigned to predict the performance and failure modes of the asset, under the influences of the demands of traffic and environment and in terms of the levels of service.

Resolution of Treatment Options and Expected Outcomes

Part of the outcome of the model is resolution of treatment options and expected outcomes. These are combined in terms of life cycle costs.

Optimisation of Options and Strategies

The next step is optimisation of options and strategies, including the complicated decision of choosing a factor on which to base the optimisation process. Common options include optimisation based on:

- Asset condition or performance (service level).
- Total transportation costs (takes into account the costs to the agency, i.e. the RCA, to retain service level and user benefits).
- Agency costs against fixed service level (net present value analysis).

The key issue for the seal designer is that the optimisation process will provide recommended treatments (i.e. outputs), the timing of which is based on life expectancies and service level requirements. These expectations should be carried into the design stage and the designer must discuss options with the asset manager should the following matters arise:

- If the detailed design is not expected to achieve the life expectations or service levels because of constraints that possibly have not been fully understood at the planning stage (e.g. unexpected widespread pavement faults).
- If more economic options become apparent at the detailed design stage. Discussion is necessary to ensure alignment with the longer term planning considerations and assumptions (e.g. a longer chipseal life could be achieved with a different chipseal type).
- If the scheduled treatment and objectives are unrealistic (e.g. demands from high-stress areas within longer treatment lengths that had not been noticed at time of initial inspection).

The asset manager may resolve to apply a non-chipsealing treatment, e.g. asphaltic concrete, if the sealing objectives cannot be met.

Risk Assessment and Prioritisation

Risk assessment and prioritisation are important considerations in the asset management process.

As a pavement approaches the end of its life, seal designers and asset managers must be very conscious of the marginal benefit of applying “just one last reseal” rather than an area-wide pavement treatment. This applies especially for pavements that are nearing the ends of their lives because either thick and unstable seal layers have accumulated or excessive pavement deterioration has occurred.

- Where unstable surfacings exist and where one further reseal is applied, it often proves to be a catalyst for rapid flushing and bleeding (and a significant increase in surfacing repair costs) that dramatically shortens the life the reseal.
- Where the pavement itself is deteriorating, the life of the reseal is not achieved as the surface is compromised through excessive pavement repairs.
- The extent of these repairs will result in either an area-wide pavement treatment, or a full pavement rehabilitation treatment becoming necessary well before the economic life of the seal has been achieved.

Seal designers must be aware of the expected life of the new reseal, taking all these considerations into account. They must avoid the temptation of designing high cost-low risk treatments (for example two-coat seals, or the use of expensive polymer modified binders) based on the assumption that the increased cost of the treatment will be recovered through an increased seal life. In the two situations outlined above, this assumption often proves to be unrealistic, resulting in a need for rehabilitation to be brought forward before the end of life of the seal is reached.

5.1.2.5 Outputs

Forward Works Programme

The principal output of the asset management function which affects sealing operations is the Forward Works Programme. The Forward Works Programme details the specific maintenance treatments that are required for each treatment length on the network, which were obtained as outputs from the whole-of-life optimisation. It should be sufficiently detailed to convey to the seal designer the objectives of the current reseal programme covering issues such as:

- The reason for scheduling the reseal. What is the objective or specific service level output that it is designed to correct? Is it triggered by cracking, skid resistance, texture improvement, etc.?
- The service level that is expected following treatment. If the objective of the seal is to improve skid resistance, the design will possibly be different to that selected if the intent is to control maintenance costs for a short period before reconstruction (e.g. if a holding seal is applied, it will need to be recorded and depreciated over a shorter life).

- The expected design life.
- The next treatment proposed.

The development of a Forward Works Programme is a requirement of current best practice applying to infrastructure asset management and now is a legislative requirement (see Section 5.2.4). Typically the minimum programme covers the forward ten years but twenty-year programmes are becoming common.

The Asset Management Plan is another output, which is not covered here.

Current Work Programme

The Current Work Programme is extracted from the Forward Works Programme. In selecting a particular type of surfacing for a road, the five main factors to be considered are: initial cost, maintenance cost, vehicle operating cost, safety, and attractiveness to the community at large.

5

5.1.2.6 Implementation

As shown in the box for 'Implementation' in Figure 5-1, the next steps in the cycle of applying the asset management process are to:

- complete the treatment selection process (i.e. choosing which type of chipseal to use), and to finalise the Current Work Programme;
- carry out seal design; and
- undertake the construction.

5.1.2.7 Product Development

The item 'Product Development' on Figure 5-1 indicates that the industry is developing new products to more efficiently meet the asset management objectives. These products are based on analysis of the performance of seals currently specified, and how well they meet the objectives of the asset management process.

5.2 Pavement Management Principles

5.2.1 Systems for Treatment Selection

The principal objective of any Pavement Management System (PMS) is to enable the asset manager to optimise the level of maintenance expenditure required to achieve the level of service specified by the Road Controlling Authority (RCA). This objective can be achieved through an understanding of how the pavement and surfacing of any given roading asset is performing at a particular point in time. Through this understanding, the asset manager is able to maximise the level of service being provided to the road user while minimising the whole-of-life cost to the RCA.

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With the significant advancement that has occurred with the application of computerised database technology, quick and efficient analysis of the immense amount of data collected about the condition of roads is now possible. These analytical techniques enable the asset manager to produce Exception Reports.

Exception Reports, as the name suggests, report the assets which are performing below the required level of service and are therefore 'exceptions' to an otherwise compliant network. Exception Reports greatly assist in identifying pavement sections that are performing poorly but have not yet fallen below the required level of service. These sections can then be programmed for treatment just before the level of service falls below the prescribed level. Their usefulness in relation to layer instability is discussed in Section 6.5.6, and layer instability analysis is covered in Section 6.5.5.

The principal repository of this information for most roading networks in New Zealand is the RAMM (Road Assessment and Maintenance Management) database, which can summarise all the inventory and condition information useful to the asset manager.

5.2.2 Inventory of Assets and Condition Data

The inventory of physical assets and the condition of these (both current and historical) is a key feature of any asset management system. Such inventories not only form the basis for inputs that will drive the optimisation process, but also provide data to the seal designer who uses it to select the most appropriate design and identify any risks associated with alternatives. It is imperative that, soon after chipsealing operations, the accurate as-built data of the newly sealed roads or pavement sections are fed back into the inventory.

Through relatively simple manipulation of the condition data, Exception Reports can be provided which indicate how sections of pavement are performing in terms of accumulated maintenance costs, roughness, rutting, texture, skid resistance (from high speed data capture surveys), cracking (from RAMM rating surveys), and accident data. By analysing data from previous surveys a trend analysis can predict when a pre-defined threshold level of service may be passed, enabling treatment to be programmed in a timely manner.

Although the information drawn from RAMM is exceedingly useful for the development of a robust and stable Forward Works Programme, the programme is always historical and limited to describing the current, or at best probable, condition of the pavement and surfacing within the next one to two years. RAMM outputs cannot predict the condition of the asset in five, ten or twenty years from now, and this is the information that is required by RCAs for the robust financial management of their networks and the development of long-term Asset Management Plans.

5.2.3 Intelligent Treatment Identification Systems

Significant advances have been made in the field of pavement deterioration modelling which has the capability of selecting future treatments based upon deterioration models. The first of these is the Treatment Selection Algorithm, a computer program within RAMM, developed to directly utilise the condition information maintained within the RAMM database. This program is capable of selecting the next pavement treatment, subject to prescribed economic constraints but is currently limited in its ability to be easily calibrated to match the actual performance of pavements over the range of climatic, geographic and traffic loading conditions that exist across New Zealand. The Treatment Selection Algorithm does not have any medium- or long-term predictive capability. Its principal function is to assist with identifying short-term needs based on current surface condition.

More recently, significant effort has gone into the development of predictive pavement deterioration models using sophisticated stand-alone software (e.g. dTIMS¹), which is able to produce treatment selections that are well aligned with the treatments selected by experienced asset managers. These predictive modelling tools use historical performance data to predict the decline of current condition to produce medium- to long-term forecasts of intervention needs and, by analysing an extensive array of options, to make firm recommendations on optimal strategies. With access to accurate inventory and condition data held in the RAMM database, along with a programme of on-going calibration, these

¹ dTIMS – Deighton's Total Infrastructure Management System software program, used for predictive modelling.

models are now capable of accurately selecting economically optimised treatments for Forward Works Programmes extending out to twenty years from the present. Figure 5-2 shows an example of predicted network requirements for the next 20 years.

However all the systems described above are only tools developed to assist the asset manager. They serve to complement but are never likely to entirely replace the engineering judgement that is required at the end to facilitate the most appropriate treatment selection for a length of pavement.

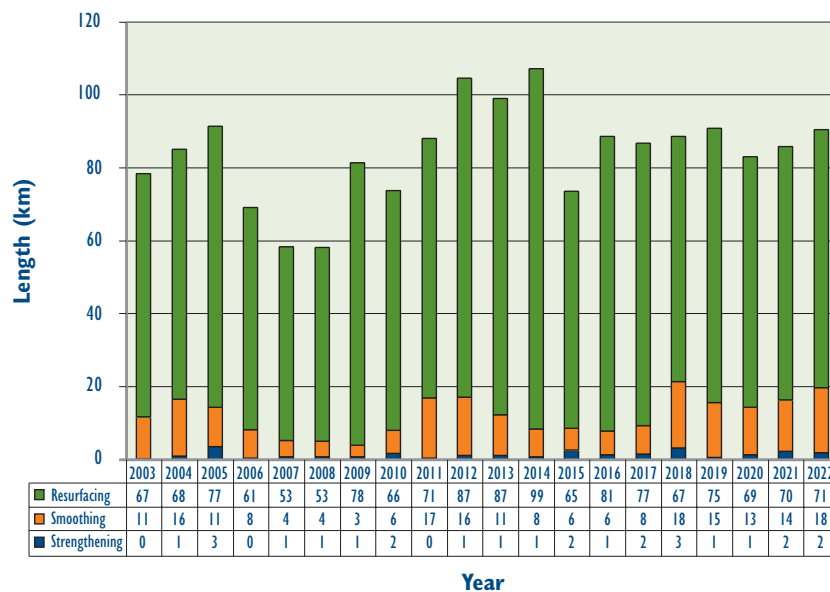


Figure 5-2 Model prediction of network work requirements for the next 20 years (i.e. 2003-2022) for one Transit NZ region (Hawke's Bay).

Definitions:

Resurfacing: Reseals and thin asphaltic surfacings (km)

Smoothing: Pavement treatments to reduce roughness (usually asphaltic concrete) (km)

Strengthening: Pavement treatments to increase strength (usually rehabilitation by overlays, stabilisation, or reconstruction) (km)

5.2.4 The Forward Works Programme

The outputs from the pavement deterioration model must be captured in a proposed programme, as mentioned in Section 5.1.2.5. Most asset management systems require the management of a ten-year Forward Works Programme for maintenance activities and indeed this is a requirement of the Local Government Act and for documentation required by Transfund New Zealand² that will be used to support funding requests.

² Transfund New Zealand is now Land Transport New Zealand, from 2004.

The software application known as NOMAD³, and available as part of the RAMM software, provides an electronic method of storing and maintaining the Forward Works Programme.

The intent is that the programme should be reviewed on an ongoing basis and at least annually, using the tools provided by the pavement deterioration model as an input to assist the practitioner to find the most optimal programme. Following the review process, a commitment should be made to adopting the programme.

5.2.5 Reactive and Proactive Maintenance

The asset management principles will typically result in most treatments being applied in a proactive manner, as a 'stitch in time'. An experienced practitioner will be needed to carry out some form of needs-assessment or review against expected pre-treatment service level, and make adjustments (advancement or deferral of works) based on actual performance. The objective is to minimise the extent of reactive (unplanned) maintenance resulting from unpredicted performance.

Pavement deterioration models generally cannot be told about upcoming major capital works, e.g. a road realignment. They may predict work needed on a treatment length that is soon to go out of service, so such items need to be identified and data fed in so the programme can be adjusted.

5.2.6 Risk Assessment and Management

Risk assessment and risk management are essential road asset management considerations. The outcomes of the Forward Works Programme need to be reviewed in terms of risk, and equally, risk should be considered at the individual treatment level. It may be entirely appropriate to review individual treatments or indeed the entire whole-of-life strategy for a treatment length, based on risk disclosed at the design or construction stage that was not appreciated at the planning stage.

Therefore maintaining open dialogue is essential between design, construction and asset management teams if unforeseen or underestimated risk potential becomes apparent. For example, unexpected soft pavements or other factors may be found that can affect long-term pavement and surfacing performance.

³ NOMAD – National Optimisation of Maintenance Allocation by Decade

5.2.7 Impact of the Committed Programme

Once future treatments have been selected for a given section of road, these will then define what strategies should be applied by the contractors responsible for the routine maintenance of the pavement and surfacing.

These maintenance intervention strategies prescribe in detail how the maintenance contractor should be scheduling the reactive repairs in response to either the next programmed treatment or, in some cases, in response to the most recently completed treatment. These strategies are developed by the asset manager to ensure that the most cost-effective reactive treatment is applied and that the routine maintenance work does not conflict with the obligations of other contractors working on that part of the roading network.

5

As an example of such a strategy, treatment lengths of road programmed for resealing in the coming financial year are identified with a code that defines that they are within one year of a reseal. The maintenance contractor is thus alerted to pay specific attention to the pre-reseal and drainage needs of this section of pavement for at least a year (and in some cases longer) in advance of constructing the reseal.

This approach ensures that the section of pavement to be resealed will be presented to the resealing contractor in the best possible condition, and should either eliminate, or at least significantly reduce, the extent of pre-reseal repairs that might otherwise be required immediately in advance of the reseal. This in turn will maximise the efficiency of the resealing programme by minimising unscheduled delays, and a better surface will result as the pre-seal repairs will have had time to 'settle down' before the reseal.

The flow chart on the Chapter 5 frontispiece was developed to identify sections of pavement that are to be resurfaced in accordance with TNZ P/17:2002, *Performance-based specification for bituminous reseals*. This is an 'end result' specification that requires the new reseal to meet or exceed a prescribed level of texture 12 months after construction. According to this specification the resealing contractor also carries the responsibility for maintaining the new seal for a 12-month period after construction. With this contractual obligation in place, a pavement maintenance contractor would not intervene for either premature flushing or chip loss during this 12-month maintenance period, as the liability

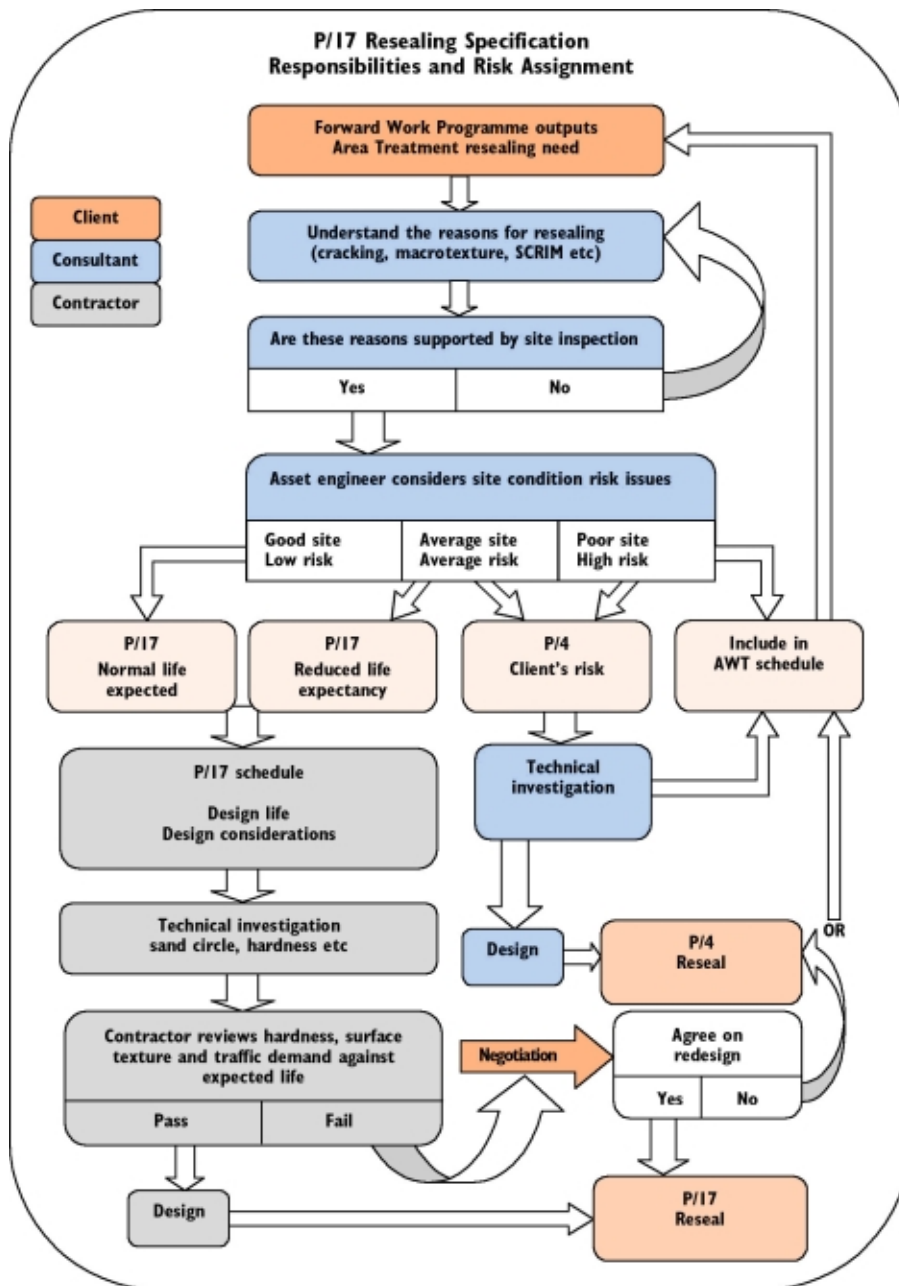


Figure 5-3 Flow chart showing resealing specification responsibilities and risk assignment, based on TNZ P/17 specification.

for such remedial work lies with the resealing contractor. Any such intervention could compromise planned maintenance by the resealing contractor as well as the assessment of texture achieved at the end of the 12-month maintenance period.

Other strategies may involve deferring routine maintenance work on lengths programmed for short-term pavement treatment works. The level of service on such lengths may be allowed to deteriorate in the time leading up to the planned treatments, providing of course that traffic safety is not compromised.

The primary objective that needs to be achieved through the development of these strategies, and the maintenance contractors' alignment with them, is an assurance that the lowest whole-of-life maintenance options are always being applied. Achieving this objective ensures that an economic balance between the reactive and proactive approaches to the management of the pavement is being maintained at the network level.

5

5.3 Life Cycle Impacts on Seal Design

5.3.1 Selection of Economic Seal Design

To select an appropriate surface for a site, a balance is required between not only the engineering needs for extending the life of seals and appropriate treatments and the associated costs, but also for safety reasons, skid resistance requirements, vehicle operating costs, community, environmental and aesthetic requirements (Section 6.10). Skid resistance considerations are discussed in Section 4.9 where the need for higher macrotexture levels in high speed environments is discussed. Other safety considerations include spray suppression and roadmarking contrast in wet weather. Many of these factors are discussed in the Austroads *Guide to the selection of road surfacings* (2000).

A range of other considerations also needs to be taken into account before the final surfacing is selected.

If the decision is to be based solely on the cost to the RCA, then the ratio of expected life from an alternative treatment to the expected life of a chipseal, as shown in Figure 5-4, can be used. In this figure the net present value (NPV) of the increased costs of a number of alternative surfacings have been discounted at 10%. Comparing a chipseal with an expected life of 6 years to an alternative treatment with an expected life of 20 years, it shows that the ratio of the cost of the alternative must not be more than twice that of the seal, or the treatment will not be economic.

In New Zealand, a dense asphaltic concrete surfacing will typically be 4 to 5 times the cost of a chipseal and will last 10 to 15 years. Figure 5-4 shows that this alternative surfacing would be economic only if the chipseal life was less than 2 years, a situation which can occur on high stress areas where a chipseal can fail rapidly.

From an RCA perspective, the extra cost of an alternative surfacing needs to be balanced against the benefits that will be given to the road users. The RCA needs to determine the conditions under which the road users will be prepared to pay extra for a more expensive treatment.

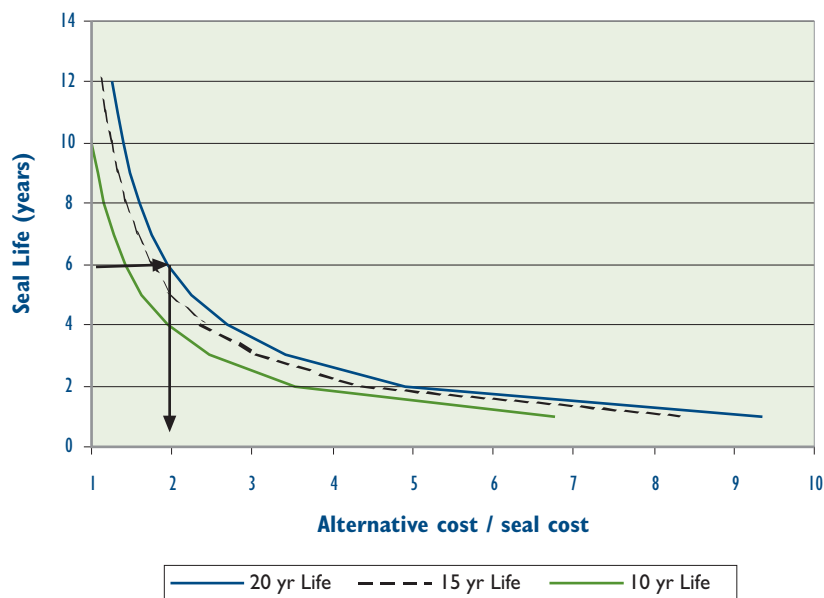


Figure 5-4 Ratio of the cost of the alternative treatment to that of a chipseal (based on a net discounted value of 10%).

The seal designer must apply engineering judgement and consider all these factors when selecting the next treatment, while also considering the economics of the treatment options. The designer must also be aware of the potential impact the next treatment will have on the overall pavement life cycle, and should always aim to maximise the time before the next major investment in the pavement becomes necessary.

5.3.2 Pavement Lives

The expected lives of the proposed resurfacing treatment need to be understood by the seal designer. While tables of default lifetimes exist, more recent studies undertaken on

the performance of a wide range of seal types have enabled the design life of a reseal to be calculated as follows.

For single coat seals:

$$Y_d = 4.916 + 1.68 ALD - (1.03 + 0.219 ALD) \log_{10} elv \quad \text{Equation 5-1}$$

For multicoat seals:

$$Y_d = 14.87 + ALD - 3.719 \log_{10} elv \quad \text{Equation 5-2}$$

where: Y_d = Design Life (years)
 elv = equivalent light vehicles/lane/day (v/l/d)
 ALD = average least dimension (mm) of the sealing chip used

For multicoat seals the larger chip ALD is to be used. To calculate elv , the following equation can be used.

$$elv = \frac{AADT}{\text{No. of lanes}} \times \frac{(1 + 9 (HCV))}{100} \quad \text{Equation 5-3}$$

where: $AADT$ = annual average daily traffic on the section of road
 HCV = percentage of heavy commercial vehicles

The above equations are useful for predicting the life of the seal based on the parameters of chip ALD and traffic loading. Where traffic loading is very low (less than 50 v/l/d) the design values may indicate an unrealistically long seal life. Other factors will influence the actual life that will be achieved. In particular they are the stresses applied to the seal on tight bends, steep gradients and intersections; the condition of the existing surface and pavement to be sealed over; the loss of skid resistance; and the stability of the existing surface layers.

Taking all these other factors into account along with an understanding of how long the existing surface has lasted (compared to its design life 'Yd') will enable the seal designer to determine the expected life of the new reseal.

By evaluating the expected life and construction cost for each of the applicable resurfacing options, the designer can then compare and select the lowest cost option by calculating the present value costs for each one. Where the actual or predicted growth in maintenance costs is also known over time for the treatment length under consideration, these costs should be discounted and included in the total present value sum.

A worked example is given opposite.

Worked Example:

Site Conditions:

AADT (annual average daily traffic): 2500
 HCV (heavy commercial vehicles): 8%
 Number of lanes: 2
 elv (equivalent light vehicles): 2150
 Site length: 1000 m

Age of existing surface at the time of resealing: 6 years
 Design life of existing surface (Yd): 8 years
 Declining seal cycle life: evident
 Reason for sealing: existing surface flush
 Drainage: no problems evident

| Technically Feasible Resealing Option | ALD (mm) | Cost per km NZ\$ | Design Life Yd (yr) | Reduced Design Life (yr) |
|---------------------------------------|----------|------------------|---------------------|--------------------------|
| Grade 3 single coat seal | 8.75 | 35,000 | 9.8 | 7 |
| Grade 2/4 two coat | 10.75 | 60,000 | 13.2 | 10 |

The reduced design life for each option is assessed as $0.75 \times Yd$ to reflect that the last surface lasted only 75% of its design life.

Further reductions may be appropriate if the stability of the existing surface is doubtful or if the stresses from traffic loading are likely to lead to chip polishing and the loss of skid resistance.

Using the Reduced Design Life, a Present Value factor (for a 10% per annum discount rate) can be chosen.

| Resealing Option | Resealing Present Value Factor | Present Value of Future Reseal Costs NZ\$/km |
|--------------------------|--------------------------------|--|
| Grade 3 single coat seal | 0.5131 | NZ\$35,000 \times 0.5131 = \$17,960 |
| Grade 2/4 two coat | 0.3855 | NZ\$60,000 \times 0.3855 = \$23,130 |

The Grade 3 single coat seal is therefore the lowest cost option, assuming that the future cost of the next treatment will be equivalent to the current cost for each option.

Figure 5-5 shows a typical pavement life cycle, beginning with a new pavement construction. Over time the condition of the new pavement and surfacing declines as a result of traffic and environmental factors.

As the condition of the pavement declines and cost of routine reactive maintenance increases, a point is reached where the lowest whole-of-life cost (typically in terms of a 25-year economic view) is achieved by undertaking a full-width (of road) Area-Wide Pavement Treatment (AWPT) in preference to continuing with reactive patch repairs. The timing of these area-wide treatments is tested using a Present Value analysis to compare the Present Value costs of continuing with the reactive repairs with the Present Value costs of the area-wide treatment. Where the investment in the pavement through the AWPT shows a Net Present Value (NPV) saving compared to continued reactive maintenance, then this will result in the lowest whole-of-life pavement cost being achieved.

One or more AWPT may be undertaken before the pavement condition and accumulated maintenance costs reach a point where a complete rebuild or replacement of the pavement becomes necessary. This full rebuild is usually justified through a Benefit/Cost analysis which considers the savings achieved by avoiding the high cost of the on-going maintenance necessary to maintain an acceptable level of service, as well as the costs to the road user arising from increasing pavement roughness.

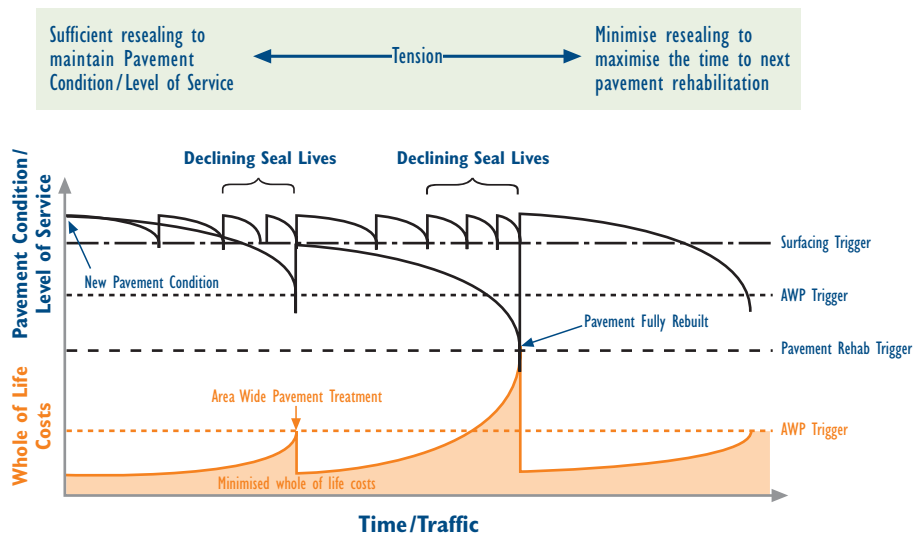


Figure 5-5 The pavement surfacing life cycle.

Typically the AWPT or full pavement rebuild destroys all the existing seal layers, and a new surfacing life cycle thus begins at this point.

Resealing should be programmed when the condition of the pavement surface falls below prescribed limits for texture, skid resistance or a lack of adequate pavement waterproofing (e.g. when surface cracking becomes evident).

5.3.3 End of Pavement-Life Cycle Considerations

Testing the resealing economics becomes increasingly important as the life of each subsequent reseal becomes shorter, and the instability of the existing surface increases. See discussion on shortening seal lives and layer instability in Section 4.7.4.2.

The last reseal in advance of an expected AWPT or pavement rehabilitation will only be economic if the seal designer is confident that, by applying this reseal, the next pavement treatment will be deferred long enough to ensure the Present Value savings of this deferral will exceed the Present Value costs of the reseal.

5

Example: Reseal versus Area-wide Pavement Treatment

If the average cost of a reseal is *\$38,000 per km, and the cost of the next AWPT is estimated to be \$150,000 per km, then for this example, pavement treatment would have to be deferred by at least 4 years for this reseal to be economic.

Using the Present Worth factor (Transfund NZ 1997) at a 10% Discount Rate at year 4 of 0.6830, then $(\$150,000 - (0.6830 \times \$150,000)) = \$47,550$ per km.

This means that, by deferring this pavement investment for 4 years, a Present Value saving is made that exceeds the Present Value cost of the reseal.

The 4-year life of the reseal is not likely to be achieved because of a history of shortened seal lives on the site caused by rapid flushing, the development of shallow shears through surface instability, or accelerated deterioration of the underlying pavement. Therefore the lowest whole-of-life option is to bring forward the AWPT in place of the reseal treatment.

* \$ are NZ\$.

5.3.4 Unscheduled Resurfacing Needs

In certain conditions, a road may need urgent action to improve safety. For example, a road that is severely flushed will have insufficient macrotexture in the wheelpaths for an open road speed (>70km/h) environment. In warm weather, the binder bleeds and both the macrotexture and the microtexture of the surfacing chip are masked by bitumen. This can result in a very slippery surface in damp conditions, and in hot weather the excess bitumen can adhere to tyres, allowing 'chunks' of the surface to be plucked out and carried or tracked on.

In such situations consideration of life cycle efficiencies is obviously overridden by the need to restore safety. However, asset managers must avoid adopting a quick fix solution which may turn out to be totally inadequate in the medium to long term. For example, covering the surface with a reseal to restore the skid resistance may provide short-term restoration of texture and skid resistance, but this has been proven in many cases to cause premature flushing and so make the long-term skid resistance worse.

Repair of unexpected chip loss from new seals which may occur after the first frost of winter, as well as other unscheduled repairs, are covered in Chapters 7 and 12.

5.3.5 Timing of Resurfacing

Programming of reseals is subject to many variables, e.g. time of year and seasonal constraints, completion of preparation works, economic constraints and environmental constraints. Resealing too frequently can waste large amounts of money but also can result in unstable and unsafe road surfaces. On the other hand, delaying too long may result in serious skid-resistance deficiencies and extensive pavement damage, both of which are even more expensive to rectify.

5.4 References

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