IDS

2016 NZ Transport Agency Strategic Maintenance Investment Model

July 2016

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IDS
NZTA Strategic Maintenance Investment Model

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1. EXECUTIVE SUMMARY

1.1 Introduction

This business case recommends NZTA's preferred option for the pavement and renewals and maintenance for the 2018-2021 National Land Transport Programme (NLTP). A team of New Zealand's most experienced pavement management modelling specialists have been brought together to improve the way NZTA determines the sustainable long term sustainable customer needs for state highways (SH) pavement renewals and maintenance.

1.1.1 Modelling Process

Modelling is required to determine the quantity of renewal work required. The outcomes of the modelling are used in the National Outcome Contracts with road contractors to set the level of work required, assist in understanding the modes of failure and identifying sites requiring treatment. The final cost of planned works are agreed with road contractors, so costs presented in this business case are based on average national planning rates. Negotiations with contractors will determine the final cost of planned works, so costs presented in this business case are based on the average of the previous national rates.

The process to model the level of state highway investment was to:

- Assess the minimum sustainable investment profile for the respective road classes on the SH network
- Quantify the condition outcomes in data and chart form. Recommend the preferred sustainable investment and the consequences, in terms of condition outcomes, of not investing at that level
- Run scenarios either side of the minimum preservation need profile to assess associated risks with adopted investment profile
- Assess the minimum funding to sustain safety from slippery road surfaces over the NLTP period. Identify the portion of safety need that mitigated by preservation treatments, ensuring no double dipping
- Forecast predicted performance in terms of condition outcomes for the 'optimal' scenario
- Validate and challenge the model outputs by:
    - Developing and running a 2nd model, built on entirely different framework, and comparing the outcomes
    - perform retrospective analysis on a sample network
    - comparing to 'birthday' analysis
    - Asset Integrators completing small sample validation in the field

1.2 Pavement Modelling

For the purposes of this business case the term “renewals” refers to asphaltic concrete and chip seal surfacing, rehabilitation and heavy maintenance work intended to extend the life of the pavement. “Maintenance” is defined as reactive maintenance only and is characterised by short term actions such as potholes and patching.

1.2.1 Current State

New Zealand has a good quality state highway network. However, there has been an over investment in maintaining the quality of state highway pavements. The 2013 network modelling recommended the quantity of pavement at about two thirds of previous levels. The lower levels modelled were equivalent to levels of renewal on the Australian highway networks.

The historical trends over the past 10 years show some rutting deterioration on some specific networks, but the performance of the different ONRC classes of road are generally similar.

1.2.2 Desired State

What is acceptable?

NZTA requires a network that fulfils the customer level of service expectations over the long term at the least sustainable cost. Rutting of the road surface as shown in the photos below, is used as the indicator that the pavement surface is reaching the end of its useful life.


A number of factors are known to lead to pavement end of life including but not limited to:

- Construction quality
- Saturation of pavement material
- Strength of pavement
- Traffic/loading exceeding design
-

A pavement that has reached its end of life will exhibit any number of visible defects that in technical terminology are:

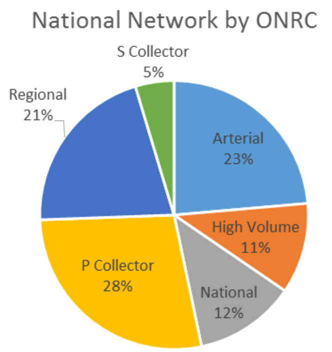
- Rutting/deformations
- Shoving
- Flushing
- Roughness
- Cracking/potholes/pumping
- Extensive maintenance patches

NZTA has introduced the One Road Network Classification (ONRC) in order to differentiate the level of service between different types of road. Targeted investment is required in order to obtain the desired performance differentiation between ONRC classes. This has been agreed by the Road Efficient Group (REG) and local government bodies.
The different classifications of road are designed for different performance levels. Many of the customer level of service measures specified in NZTA One Road Network Classification have not yet been translated into technical measures. In future, measures other than rutting may be able to be used to indicate the end of pavement life.
For modelling purposes the classes of roads in the ONRC have been grouped as follows, with rut target levels lower (i.e. less rutting) for higher class roads:

ONRC groups				
Group	**ONRC class**	**Modelling Outcome**	**Percentage of Network Length**	**Rutting Target**
High	National High Volume and National	Maintain condition profile	23%	4mm (Nat HV 3mm)
Medium	Regional and Arterial	Deteriorate slightly	44%	5mm
Low	Primary and secondary Collectors	Deteriorate significantly	33%	6mm

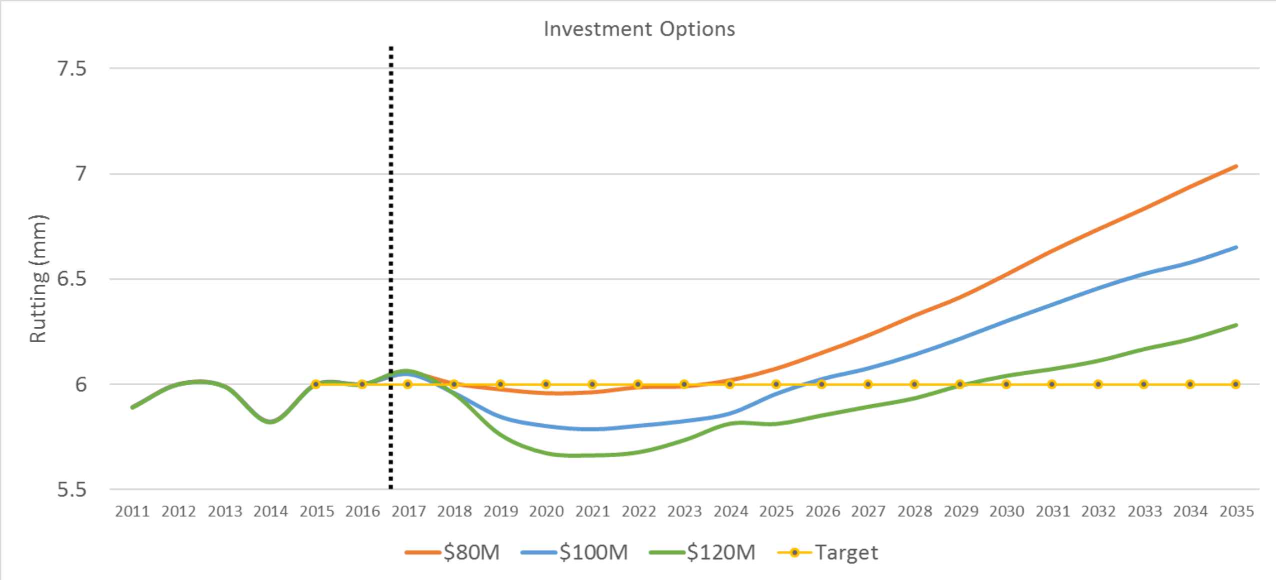
The total length of the state highway network is 23,085 lane Km. A summary of the network is presented in the table and figure below:

ONRC	%	Lane km
High Volume	11%	2,522
National	12%	2,811
Regional	21%	4,828
Arterial	23%	5,451
P Collector	28%	6,399
S Collector	5%	1,074
Grand Total	**100%**	**23,085**



1.3 Outcomes

The 2016 modelling was undertaken at numerous budget levels to determine the least cost sustainable long term investment required to prevent the pavements from reaching the tipping point beyond which is considered unsustainable and would require large investment to reinstate the pavement. In modelling terms, the tipping point is the point at which deterioration accelerates to an unacceptable level or at an unacceptable rate.
Three investment levels are shown to demonstrate the impact on levels of rutting across the network:
1. $80m per annum
2. $100m per annum
3. $120m per annum

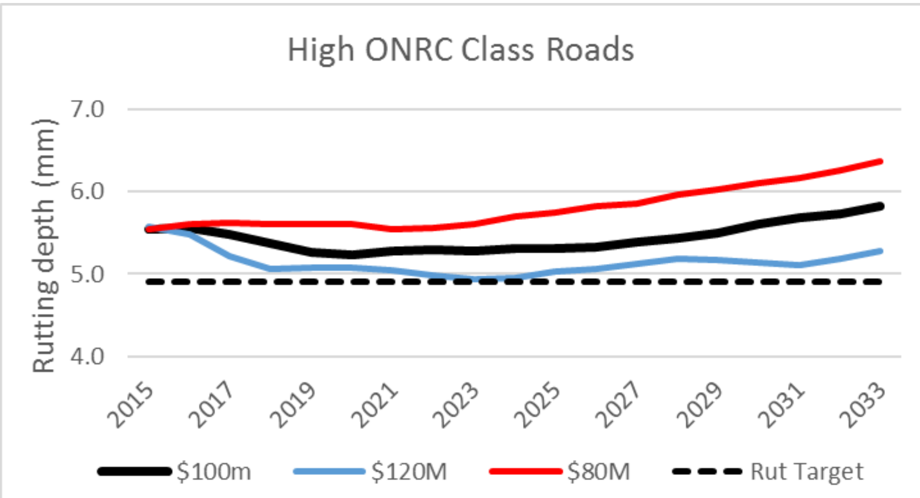


Each of the three investment options maintains the network at average target levels over the short term. From year 2024, rutting starts to accelerate, and it is expected that increased levels of investment will be required. It is estimated that the level of extra investment to maintain the current target level from 2024 will be approximately $30m-$50m per annum, but this will be confirmed closer to the time.

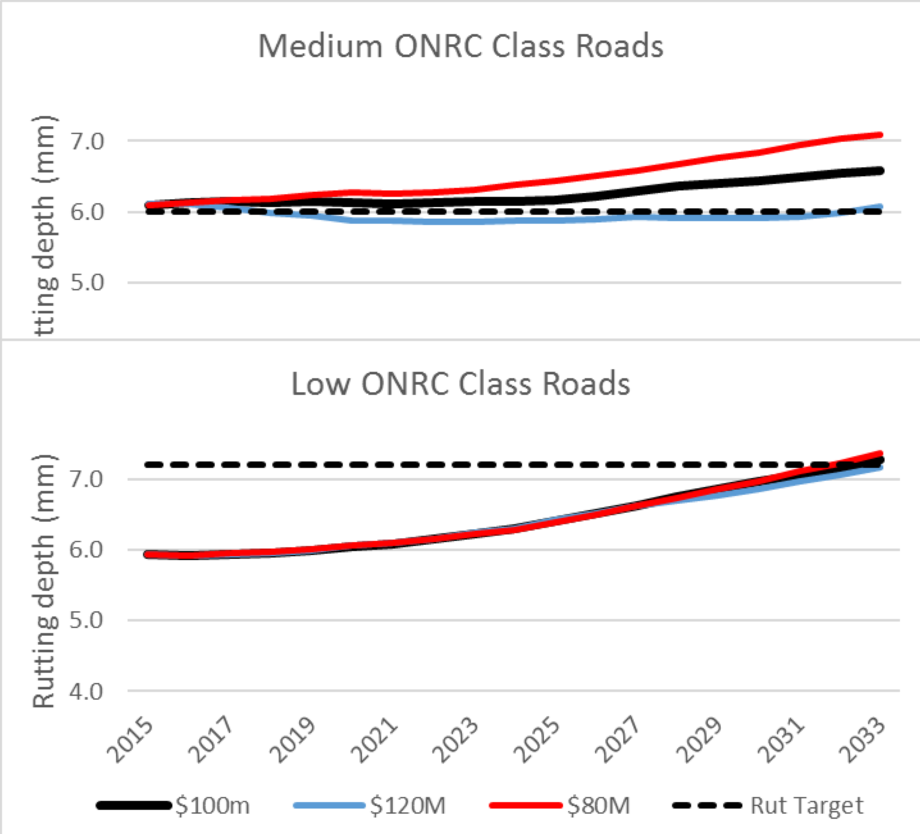
The reason that the rutting exceeds the target from 2018-2024 is that lower ONRC class roads are in better condition than is targeted. The impact on classes of roads is shown in the next section.

The recommended level of investment for renewals is $100m per annum, until approximately 2024. From that point, it is recommended to budget up to $150m per annum. Although, the $80m level of investment meets short to medium term average target levels, it will not maintain key high ONRC class roads at acceptable levels.

1.4 Impact of Investment Options on ONRC classes of roads



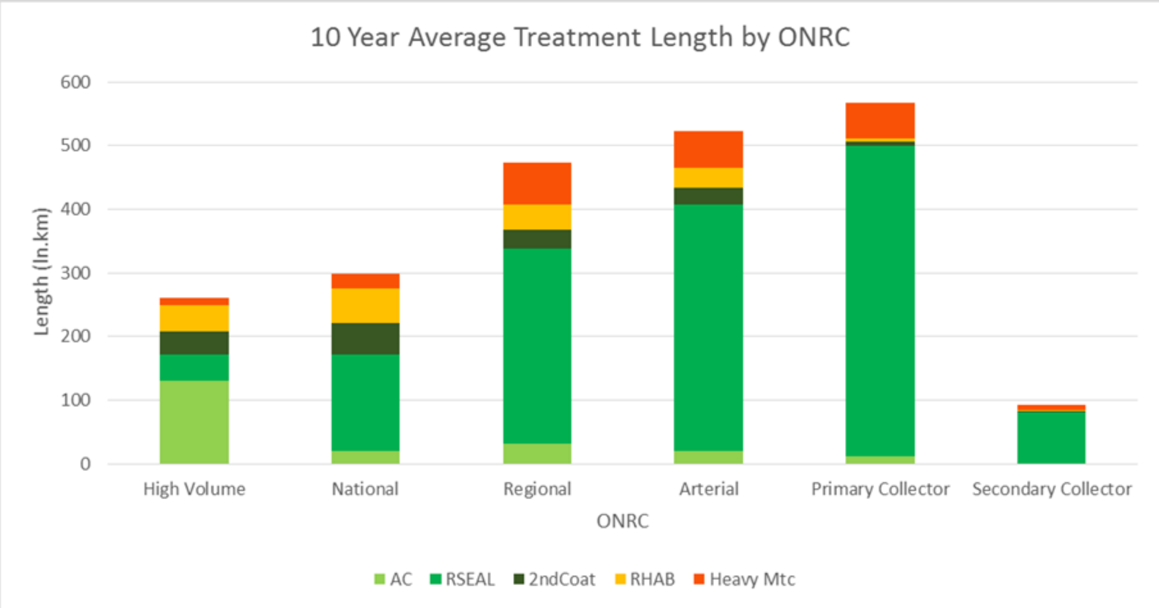
High ONRC class roads are currently worse (higher) than target levels. The $80m investment option does not improve the condition of these roads, and would result in three times more roads reaching the end of life than the recommended option. The $100m option improves the performance towards the target, while the $120m enables these roads to reach the target.



Medium ONRC class roads are currently at target levels. The $80m investment option results in a faster rate of deterioration than the $100m option. The $120m option enables these roads to stay at or below the target.

Low volume roads are currently at better (lower) levels of rutting than the target. The overall level of investment does not impact significantly on the performance of the roads as a higher proportion of the budget is spent on High ONRC Class Roads.

1.4.1 Treatment types



The investment model selects the most economic treatment type over the long term. The high volume roads are predominantly constructed and treated with asphaltic concrete. Reseals are the most common treatment for other classes of road.

When compared to network length, high ONRC class routes are given double the renewal funding as a percentage and low class routes given half. This aligns with expectation, where high cost renewal funding is spent on high class routes. The investment in renewal assigns 43% to the national routes, equalling that to the arterial and regional routes. Arterial and regional routes account for 51% of the routine maintenance cost.

1.4.2 Maintenance

The modelling team has been investigating methods to determine the optimum quantity of maintenance required. The current budgets for maintenance are $30m per annum and it is recommended to hold those levels until an accurate maintenance model can be developed.

1.4.3 Recommendation for Pavement Renewal and Maintenance

The recommended outcome is a budget of $100m over the next 6-7 years and then $130m-$150m from 2024, with routine maintenance at $30m per annum. This level of budget will enable 1856 lane km to be renewed per annum (8.1% of the total network).

The reason is that this level maintains the network at an acceptable level of service for the short-medium term, and achieves the aims of a higher level of service for the higher ONRC road classifications.

1.5 Safety

Safety is a key priority for NZTA. Despite substantial progress over the last 30 years, New Zealand still lags behind many other countries in road safety. Every year, around 300 people are killed, 2700 hospitalised, and a further 10,000 injured on New Zealand's roads at a social cost of around $3.5 billion.

Slightly over half of all fatalities and around 37 per cent of serious injuries occur on the state highway network, at an approximate cost of $1 billion each year. A proportion of the current pavement renewal work improves the safety of the network, and over the last three years the number of wet road crashes on the state highway network has continued to decrease by about 5% from 2,526in 2014 to 2,391 in 2016.

NZTA has developed a new model to quantify how much of the renewal work is driven by safety needs and how much more is required in order to maintain a safe network.

The modelling has provided answers to the following questions:

- What is the surface driven safety need on the network?
- How much of this safety need is actually treated by asset preservation prior to manifesting as a safety concern? *This is limited to surface driven safety only*.
- What is the predicted network skid resistance profile following the combined asset preservation and surface safety program?

1.6 What is acceptable?

Currently NZTA policy is to improve sites with a high traffic volume, low skid resistance, low road surface texture and a history of 2 or more wet weather crashes over the past 5 years. The safety modelling uses the same policy intervention thresholds for skid resistance and road surface texture to determine the annual safety related pavement rehabilitation need, and focuses on high risk sites as per the table below:

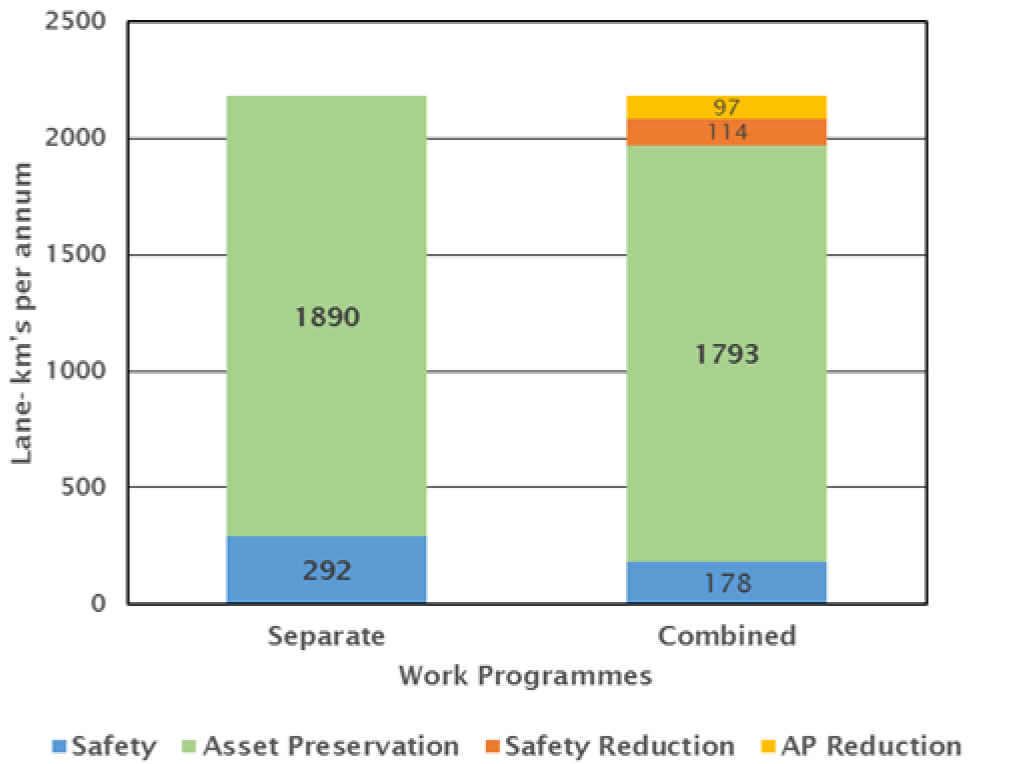
Risk	NZTA Policy Site Category	Skid Site Description
High	1	Approaches to: a. Railway level crossings b. Traffic signals c. Pedestrian crossings d. Stop and Give Way controlled intersections (where state highway traffic is required to stop or give way) e. Roundabouts One lane bridges:

		a. Approaches and bridge deck
	2	a. Urban curves < 250 m radius b. Rural curves < 250 m radius c. Rural curves 250 m – 400 m radius d. Down gradients > 10% e. On ramps with ramp metering
Medium	3a	State highway approach to a local road junction
	3b and 3c	Down gradients 5% - 10% Motorway junction area including on/off ramps
	3d	Roundabouts, circular section only
Low	4	Undivided carriageways (even-free)
	5	Divided carriageways (event-free)

As chip seal surfaces age, the exposed surface becomes smoother and can reach a condition described as flushed. Flushing can lead to a dramatic lowering of the skid resistance available to vehicles because the tyre rubber is supported on the low skid resistant bitumen. The photo below shows how a flushed section of state highway looks.

1.6.1 Outcomes

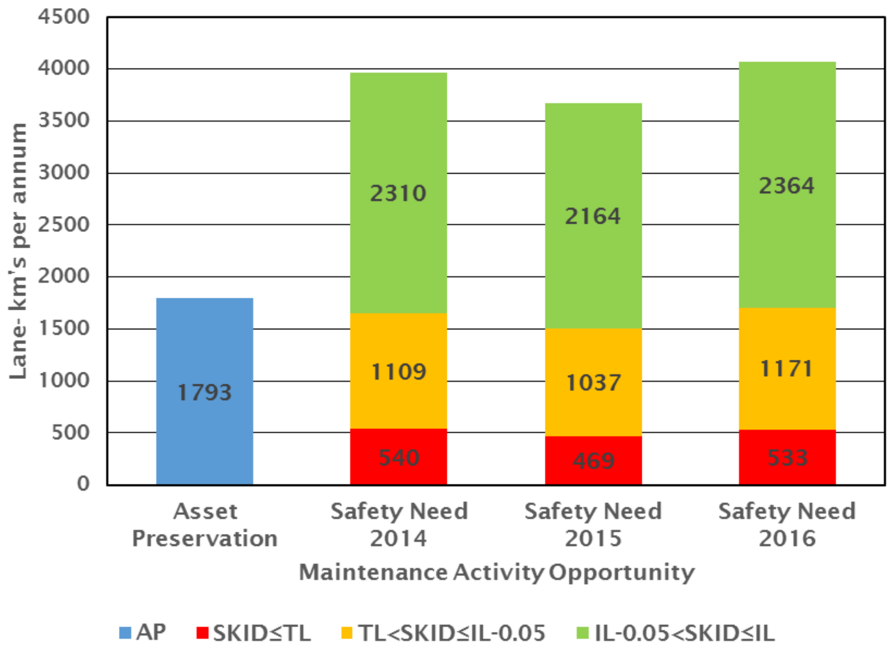
When the safety programme is considered alongside the asset preservation programme, there are some treatment lengths that would be treated both for safety and asset preservation reasons. The combined programme is shown below:



The asset preservation need was modelled separately from the safety need. However, there are asset preservation treatments that also improve the safety risk. The estimated cost saving through combining the asset preservation and safety programmes is around $5.2 million per annum.

The estimated benefit of treating the high risk sites is $30.5m at a cost of $5.95m, which results in a benefit cost ratio over 5 (see page 38 of the Opus Research Report, “Incorporating Safety Management Modelling in NZ:dTIMS”, May 2016).

An analysis of historical safety needs showed that over the past 3 years about 3,370 lane km’s per year or about 15% of the state highway network is medium risk (in technical terms, lies between the skid resistance investigatory and threshold levels) and may deteriorate into high risk. The graph below, shows that about a third of this length (1,106 lane km) is very close to becoming high risk (reaching the threshold level). Maintenance treatment of this 1,106 lane km was shown to have a benefit cost ratio of 1, which is fiscally neutral with every $1 spent on resurfacing yielding $1 in crash cost saving. However, by identifying lengths of state highway where lower skid resistance and texture are contributing to wet road crashes, treatment can be very cost effective resulting in benefit cost ratio’s in excess of 4.



1.7 Recommendation

The outcome of the modelling is a total length of safety need over the 10-year period of 292 lane km per annum ($7.4m pa). This is equivalent to 1.2% of the total network lane length per annum.

The recommendation is for 178 lane km per annum ($5.95m pa) to be treated solely for safety needs, as some of the safety need sites are improved through already budgeted asset preservation treatments. This is significantly less that the historical safety need of about 500 lane km per annum and results from the contribution from asset preservation treatment and the Transport Agency's expectation that as the industry gains more experience with safety management of road surfaces, better use of available aggregates will occur leading to longer seal lives.

2. Introduction

A network modelling run has been on the State Highways since 2000. These analyses have been used to inform the asset management planning process of the NZ Transport Agency (NZTA) with respect to long-term investment for surfaces and road pavements. This report documents that analysis completed for the 2016/17 planning round.

2.1 Questions this Report Addresses

The pavement performance analysis for the NZTA SH network for NLTP 2017/26 has answered five questions:

- Base Need: What is the base asset need, the minimum investment level required to preserve the asset? This element of the analysis is a re-evaluation of the Base Renewal Preservation Quantities established from the 2012/13 SH analysis, reviewing where we are three years down the track;
- Future Condition: What is the predicted condition assessment under the optimal 'Base Need' scenario as well as the Contractors Baseline Plan? This will highlight any potential investment and funding risk as a result of the adopted/planned investment profile and maintenance regime;
- Model Validity – are the results real? Compare the stochastic and deterministic model outputs. In a perfect world the results would align at both network and regional level. Assess differences to validate and/or challenge the deterministic model outputs. Perform a retrospective analysis on each key model independently, and a full sample network analysis. Perform a birthday analysis as a sensibility check on outputs. Asset integrators to perform sample validation in field.

The importance of the analysis was stressed as it must provide robust, evidence based justification for the 2017/26 NLTP Surface and Pavements submission. The work includes provision to complete the pavement and surfacing renewal analysis within dTIMS, over the national state highway network.

2.2 Objectives and Scope

The over-all purpose of the analysis described in this report was to provide the NZ Transport Agency (NZTA) with forecasted results on strategic investment scenarios for the2017/26 round of the National Land-Transport Plan. In order to achieve this purpose specific objectives were to:

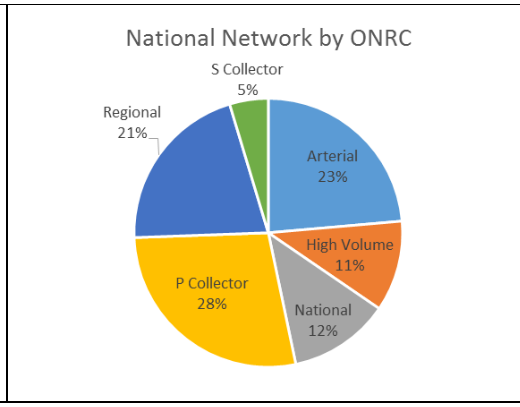
- Re-evaluate the minimum sustainable/preservation investment profile for the respective road classes on the SH network;
- Quantify the condition outcomes in relation to ONRC classification. Recommend the preferred sustainable programme and the consequences, in terms of condition outcomes, of not investing at that level;
- Run scenarios either side of the minimum preservation need profile to better understand the associated risks with adopted investment profile;
- Assess the minimum funding to sustain safety over the NLTP period driven by polishing and flushing (safety related);

- Validate and challenge the model outputs by:
    - comparing with stochastic model using identical input parameters and assessing and describing differences;
    - perform retrospective asset preservation analysis on a sample network;
    - comparing to 'birthday' analysis; and,
    - Asset Integrators to complete small sample validation in the field.

The scope of the analyses included the full state highway network only excluding surfaces on bridge deck and tunnels, concrete and unsealed roads. In total the network length analysed included a total of 23,085 lane Km. Note that this analysis also exclude any network expansion or future maintenance needs on this part of the network. A summary of the network is presented in Figure 2.1.

Figure 2.1: A Summary of Network Length per ONRC Class

ONRC	%	Lane km
High Volume	11%	2,522
National	12%	2,811
Regional	21%	4,828
Arterial	24%	5,451
P Collector	28%	6,399
S Collector	5%	1,074
Grand Total	**100%**	**23,085**



The analyses completed for this report included:

- Base need analysis – establishing the lowest sustainable investment levels (tipping point analyses)
- Analyses outcomes with constraint and unconstraint routine maintenance cost;
- Integrated analysis incorporating the safety projects (SCRIM)
- Establish a long-term sustainable investment strategy – increasing budget for later years
- Sensitivity analyses:
    - Influence of unit rate fluctuations across regions
    - Impact of capping routine maintenance at different levels
- Validation of analysis including:
    - Comparing model to the stochastic modelling;
    - Model calibration;
    - Retrospective analyses; and,
    - Comparing maintenance quantities to other existing programmes.

The analyses completed are also graphically presented in Figure 2.2. The figure also illustrates the number of tested investment levels (budget scenarios) completed as part of the respective analyses rounds.

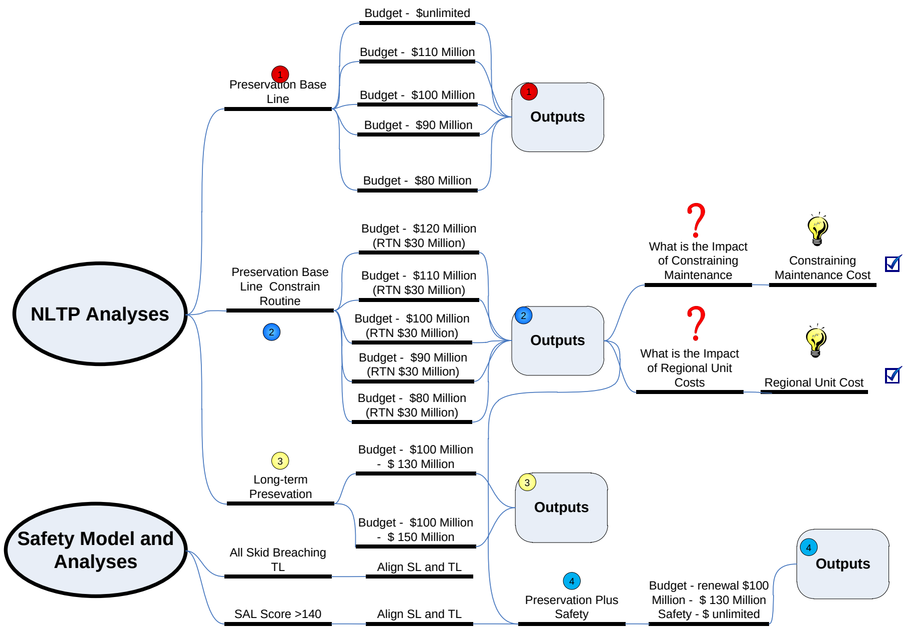


Figure 2.2: Full analyses completed for the NLTP

2.3 Context of the Analysis compared to the 2013 analyses.

With the flexibility of dTIMS software it is entirely possible to change the analysis approach to answer very specific questions. In addition to that, the modelling resources in New Zealand keeps the IDS set-up updated to the latest knowledge and experience form other analysis. The analyses completed for this report often gets benchmarked back to analyses competed during 2013. The comparison is valid but the reader also needs to be aware of the distinct differences between these two analyses rounds. A summary of the comparison between these two analyses are presented in Figure 2.3.

Figure 2.3: Comparing the 2013 and 2016 Analyses Rounds

	2013 Analyses	2016 Analyses
Main Purpose for the analyses	Base Preservation for NOC quantities	Long-term base presentation for input into the NLTP
AC Model	✓	✓✓
KPI – Rutting and SCI	✓	✓
75th Percentile as marker	✓	✓
Incorporating ONRC	✓	✓✓
Do Something	✓	✓✓
Incorporating Safety	×	✓
Routine Maintenance Cost	✓	✓✓
Validation	✓	✓✓

Note: × = not considered
✓ = considered in basic form
✓✓ = significant consideration and or development

Therefore the significant area of development and enhancements for the 2016 NLTP analyses include:

- New templates included development of Stochastic model for roads with Markov Chain model framework;
- New models added to the analyses included a new crack initiation model for asphalt surfaces, texture model, skid model and a revised roughness model;
- A new optimisation technique was adopted in order to cater specifically for the ONRC classification (refer to Section 4.2);
- Although being part of previous analyses, a separate treatment category was created for a heavy maintenance option (Do-Something);
- Incorporating safety models into the over-all investment planning (Refer to Section 4.3.3);
- With the heavy maintenance option, an ability to split routine maintenance costs and pre-seal repairs allowed for more targeted reporting for the respective maintenance categories; and,
- Given the amount of significant enhancements to the model it resulted in a strong need and focus around the validation for the modelling results.

3. Current Performance of the Network

3.1 Summary of Key Points for this Section

- The optimisation analysis uses rutting and surface condition as indicators for asset preservation, while outcomes reported to the ONRC are measures such as roughness;
- Past trends indicate a stable pavement performance and declining surface condition;
- Current trends suggest appropriate treatment selection processes, however trends need to be monitored as a delay in pavement condition response is expected;
- Specific trends that need monitoring are:
    - The over-all texture and skid trends in relation to the re-surfacing preservation quantities;
    - Surface condition of National road class needs to be monitored further;
    - Rutting performance for some specific low-volume regions; and,
    - Currently the surface performance of the primary and secondary collectors is noticeably better compared to the performance of regional and arterial roads. Targeted investment is required in order to obtain the desired performance differentiation between ONRC classes.

3.2 Data Quality Statement

The State Highway data is of a high quality, particularly from a modelling perspective. It is further recognised that the NZTA has spent a considerable effort in improving the base data for the state highways. A summary of the main data items and associated quality and issues are summarised in Figure 3.1, while more details are provided in Appendix A.

Figure 3.1: State Highway Data Quality

Data Item	Rating	Comment
Inventory including ONRC	✓✓✓	
Pavement Strength	✓✓	The new traffic speed deflectometer data has been incorporated to the model (Refer to Appendix A)
Surfaces	✓✓✓	
Traffic	✓✓	Better information is needed on traffic mix and growth
HSD Condition	✓✓✓	
Treatment Length	✓	
Defect Condition	✓	Scanning laser information to be incorporated in the future.
Routine Maintenance Cost	✓✓	Better quality routine maintenance cost information is required –NZTA already focuses on this.

Legend:

- ✓✓✓ Data items is completely appropriate for modelling
- ✓✓ Data item is appropriate for modelling, future enhancements may be considered
- ✓ Know issues with data items and special mitigation was adopted for model

3.3 Selection of Performance Measures: How the ONRC Relates to this Report

3.3.1 ONRC in Context to the State Highway Analyses

One of the primary objectives for setting up the ONRC was for a nationally transparent road classification system that would result in efficiency gains for the industry. In terms of the long-term maintenance modelling there are two impacts that results from the ONRC implementation including:

- Not all the roads are to be treated the same – in the past most comparisons between the optimised programme and the SH field developed projects suggested that field decisions tend to treat roads equally when it comes to deciding on treatments. Now the ONRC forces engineers to think “different Level of Service (LoS)” of different road classes in the same way the model optimises the investment across the road classes;
- There are now clear target LoS expectations (from a road user perspective) for the respective road classes. Using this same approach the level of service expectations could be extrapolated to other technical measures.

It is important to realise though that the ONRC target LoS qualify the outcome or user expectations for roads. Many of the customer LoS measures are difficult to translate to technical measures. In addition to that, the way that measures are being defined cannot be directly used for the purpose of maintenance planning. For example, outcome measures often specify the maximum value for some measures such as roughness. Using these definitions would be unpractical from an asset preservation perspective.

Note

The optimisation model uses preservations performance measures in order to deliver the ONRC outcome measures in the most long-term cost effective manner.

The next section lists the optimisation preservation measures that have been used for this analysis. The outcomes are then presented in relation to the ONRC measures.

3.3.2 Pavement and Surface Preservation Measures

The pavement preservation measures used for the optimisation of different investment levels, while ensuring long-term sustainability were:

- **Rutting** – rutting is a direct measure of pavement performance and residual pavement life. This project has also revealed a strong relationship between rutting and routine maintenance cost. Although less effective on asphalt surface roads, rutting is an excellent indication of structural health for chip sealed roads;
- **Over-all Surface Condition (SII)** – SII is used in the dTIMS model and it has two components: Surface Condition (measured defects in the surface) and Age. The second component considers the age beyond the expected surface life. Therefore, SII will show an increase as the surface ages, even if it is not demonstrating any visible fault. As expected the SII is strongly driven by the occurrence of cracking.

In terms of the statistical reporting the 75th percentile point is used as a marker to indicate when the bulk of the network is deteriorating or improving. This measure has been proven as the most effective statistical indicator to monitor the long-term sustainability of road performance (Henning et al., 2016)[1]

3.4 Past Performance of the State Highway Network

A summary of the trend monitoring on the State Highways is presented in Figure 3.2, a full trend report is presented in Appendix B.

[1] Henning, T.F.P., Roux, D.C. Beca, E. Fraser, D. (2016) Keeping Good Roads Good – An Investment Strategy for Road Networks under Constraint Funding Conditions. 2016 ARRB Conference, Melbourne (To be Published)

Figure 3.2: Summary of Network Trends

Condition Item	Observed Trends	Comments
Condition Index	—	Stable across the network
Roughness	—	Stable across the network
Rutting	—	Over-all stable but some regions are seeing increased rutting (Northland, Gisborne, South Canterbury, Nelson, Wellington)
Surface Age	↑	By programme design the surface age is increasing
Surface Condition (SCI)	↑	Slight deterioration of the surface mainly due to texture. There is a noticeable surface deterioration for the national road classification
Texture	↓	Slight reduction in texture –back to 2014 levels
Skid	↓	Slight reduction of skid on the over-all network with indications of a slight improvement during the last couple of years.

Observations from the table are:

- On a national level the pavement condition has been fairly stable, whereas the surface condition has deteriorated slightly;
- The surface index that has changed the most significantly was the texture;
- The surface condition has deteriorated most significantly on the National road classification (Refer to Figure 3.3). There is also an imbalance in the performance of the respective ONRC classes; in particular, the primary and secondary collectors are performing better compared to the regional and national network. This may have resulted from past maintenance practices that did not differentiate between different roads;
- There were some regions where a notable rutting progression was observed and these regions should be monitored to ensure sustainable performance of these networks (Northland, Gisborne, S Cant, Nelson, Wellington);
- The T-10 Skid intervention is successful in holding the intervention levels stable, indication are that this may be increasing in future (see comments below).

The trend analysis resulted in an expected outcome given the maintenance philosophy applied on the NOC contracts. There was a deliberate focus on obtaining longer surface lives (i.e. reduced surface quantities) plus the rehabilitation treatments are also constraint to a minimum sustainable level. The maintenance regime stems from an objective to find efficiencies in the operations of maintenance planning, specifically focused on appropriate investment for respective road classes.

The observed trends are suggesting the desired outcome of deferring surface treatment slightly. The slight reduction is surface condition, while holding the current pavement condition also suggested that the specific treatment selection process yielded a desirable outcome, **confirming value from applying the "right treatment, in the right location at the right time**".

Note

Although desirable outcomes were obtained from the trend analysis, it should be kept in mind that it has only been three years since the adoption of the NOC contracts. There is an expected delay of up to 6 years before road conditions will react to a changing maintenance regime. Therefore, the full impact of the changed maintenance regime of the NOC contracts may not be noticeable yet.

Figure 3.3 shows the historical surface condition index (SCI) for the respective ONRC classes. Observations from this figure are:

- While there is a noticeable improvement of the SCI condition of the high volume roads, the remaining national road system is deteriorating. Half of this road class consist of asphalt, therefore it is safe to assume that part of the deterioration is attributed by the reduction in surface texture on the chip seals and general poorer performance of the asphalt surfaces.

Definition

Surface Condition Index (SCI) is a composite index that defines the over-all surface condition on the basis of a weighted summation of all surface defects. SCI is normally used to determine historical performance of surfaces and an age component that consider surface age past expected life.

Surface Integrity Index (SII) is a composite index used for determining surfacing needs in the IDS dTIMS template. In essence it is exactly the same as the SCI but it also includes ravelling as a factor which is not included by the SCI.

Given the fundamental similarities between the indices, they are not comparable on a one-to-one basis.

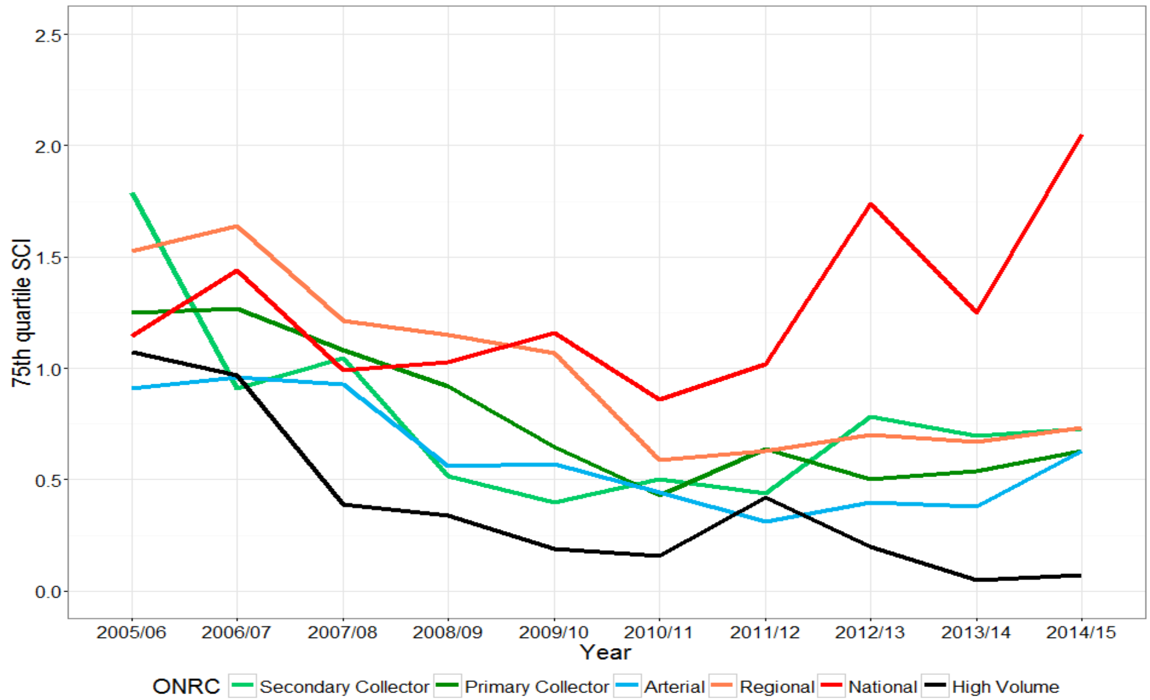
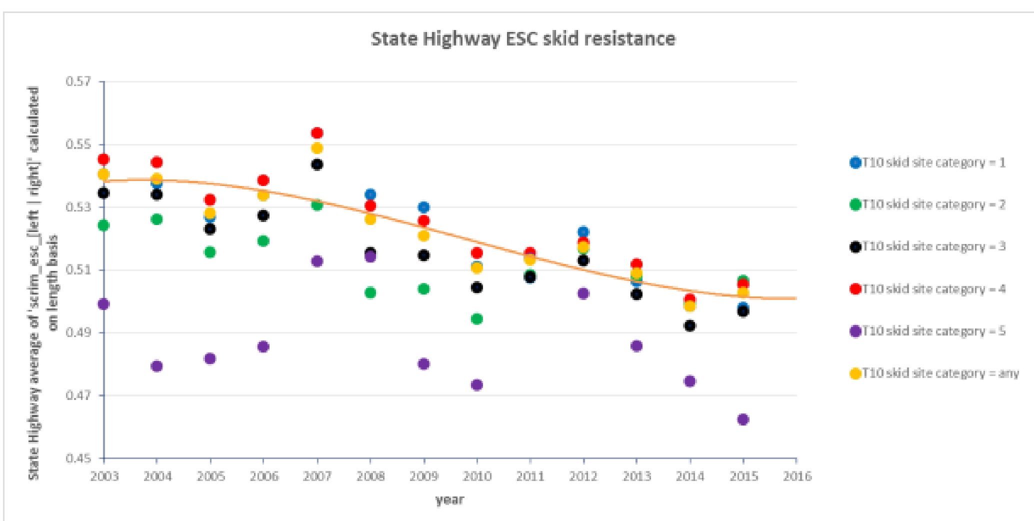


Figure 3.3: Historical Performance of the 75% Percentile Surfacing Condition
Note: Lower SCI indicates a better condition

The texture and skid trend is of particular importance to note (refer to Figure 3.4). The right-hand plot shows the average mean profile depth for the slow lanes, while the left-hand plots shows the skid resistance for the corresponding lanes. Both these indices show declining trends particularly noted over the last five years. Note that the trend on the exception measures such as the texture < 0.5 mm does not completely indicate this declining trend, with the exception for the past year.



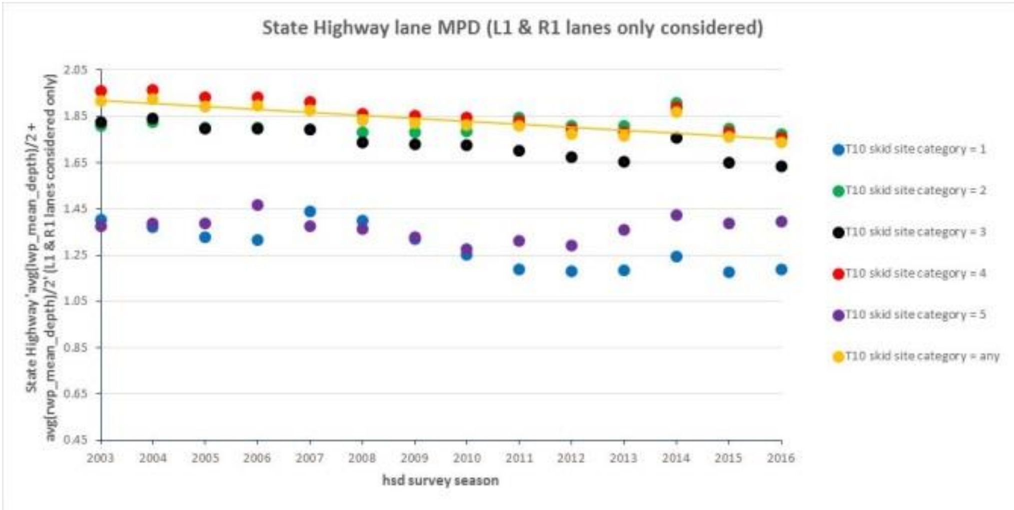


Figure 3.4: Trends for Texture and Skid on the State Highways

Figure 3.5 illustrate the changes on the State Highways surfaces when the full distribution is considered. Skid and texture are controlled at the worse end of the distribution. Traditionally the over-all trends of skid and texture were coincidently controlled through the re-surfacing preservation programme, which at present time is being constraint. As a result of the reduced surfacing quantities the over-all condition of surfaces are deteriorating (distribution shifting right – see red line). This will result in a future increase in surfacing needs from a safety perspective.

An important consideration for this analysis is to understand the interrelationship between the surfaces quantities from a preservations perspective and from a safety consideration.

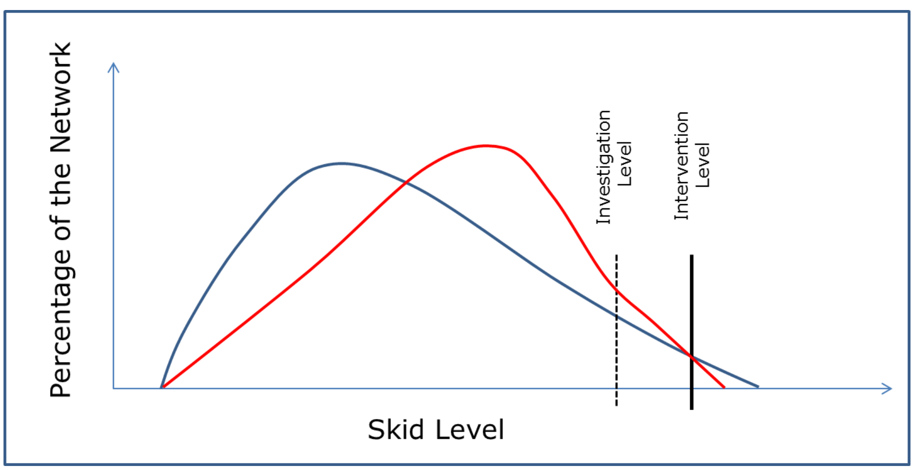


Figure 3.5: Full Condition Distribution Trends for Surfaces

Note: Blue line represent past condition distribution
Red line represents deteriorated state after some time

4. Over-all Investment Signals

4.1 Summary of Key Points for this Section

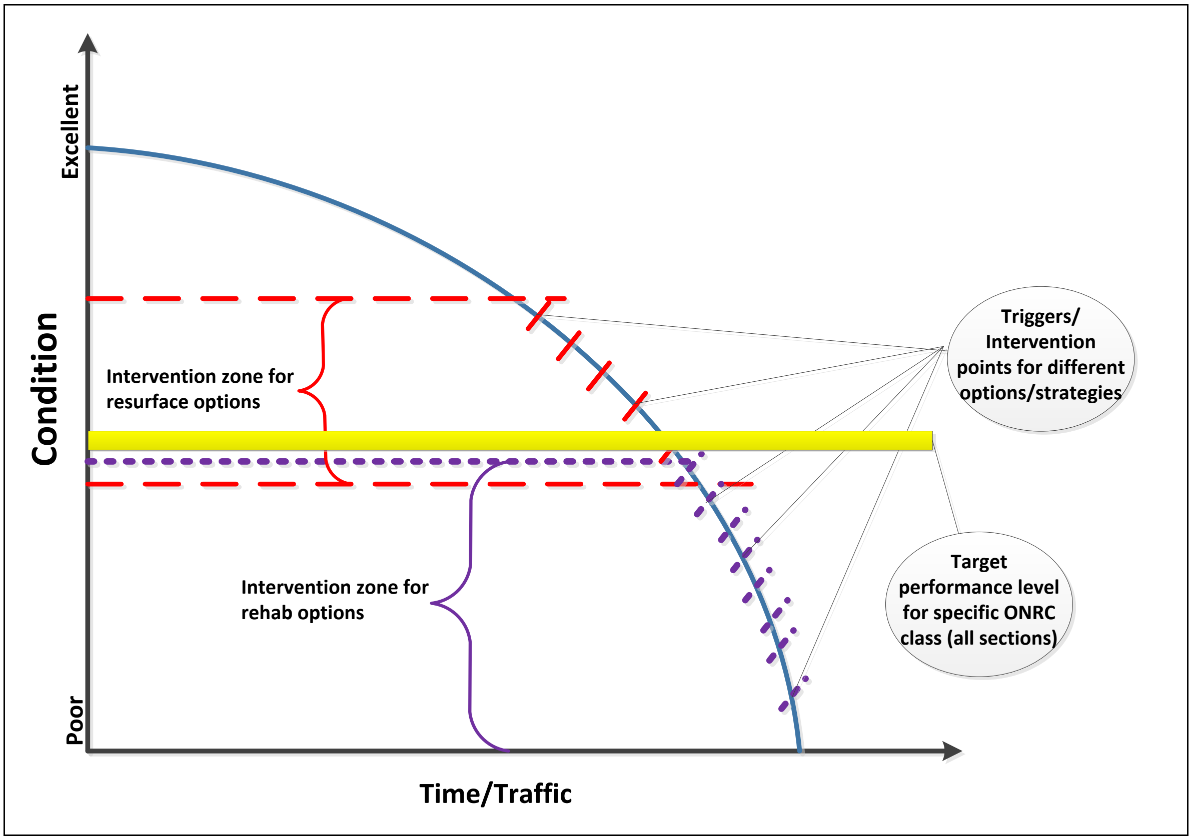
- The recommended short-medium term investment for the state highway network is $100 million;
- This investment level is only sustainable up to year eight to ten. It appears that there is currently still some "condition capacity" remaining on the network. However, after some time an increased funding level would be required to maintain the network at sustainable levels;
- A lower investment level was proven to be un-sustainable as it was unable to maintain all the ONRC classes at an acceptable condition performance. The rate of the deterioration for national strategic roads was of particular concern;
- An increased budget is required in order to ensure a long-term sustainable performance of the state highway network. This appropriate increased budget level seems to be in the order of $150 million if applied from years 11 onwards. Obviously a lower budget would be required if applied from an earlier date.

4.2 Optimisation and Defining the Target Performance

The 2016 analysis described in this report has made a significant advancement in terms of the optimisation process that targets the ONRC outcomes. Optimisations used on prior analysis maximised the long-term pavement condition that was weighted by traffic volume. Obviously the traffic weighting is not completely appropriate for the ONRC plus a more definitive outcome is targeted considering the ONRC. Appendix C provides a full description of the philosophy followed in setting the ONRC target and the optimisation technique. Subsequent paragraphs provide a brief summary of the process.

Definition - Trigger Levels and Performance Target

For the optimisation a number of trigger/intervention points are being used in order to create a number of life-cycle options. The model will then decide for each road section what the best options is to choose given the budget constraints. The given budget level will then ultimately result in the over-all performance level for each ONRC class.



Previous optimisation methodology attempted to maximise condition (where condition was a composite condition index weighted by traffic) given a fixed level of investment. There was no ability, other than traffic, to focus effort on different classifications. The new optimisation methodology attempts to attain target condition levels which can be set for each key variable and each classification. This allows much more flexibility to direct funds where require during optimisation. The optimisation method uses a financial concept of varying outcomes termed “Consumer Choice and Utility”. With this method the optimisation aims at getting as close to the desired outcomes as possible for the given budget constraint. The utility function ensures the model seeks to achieve targets for higher class routes before achieving targets on lower class routes by weighting the utility for each respective road class.

Figure 4.1 Demonstrates the assigned Targets for the key variable ‘rutting,’ while **Error! Reference source not found.** provide the measures used and the target values for the respective measures.

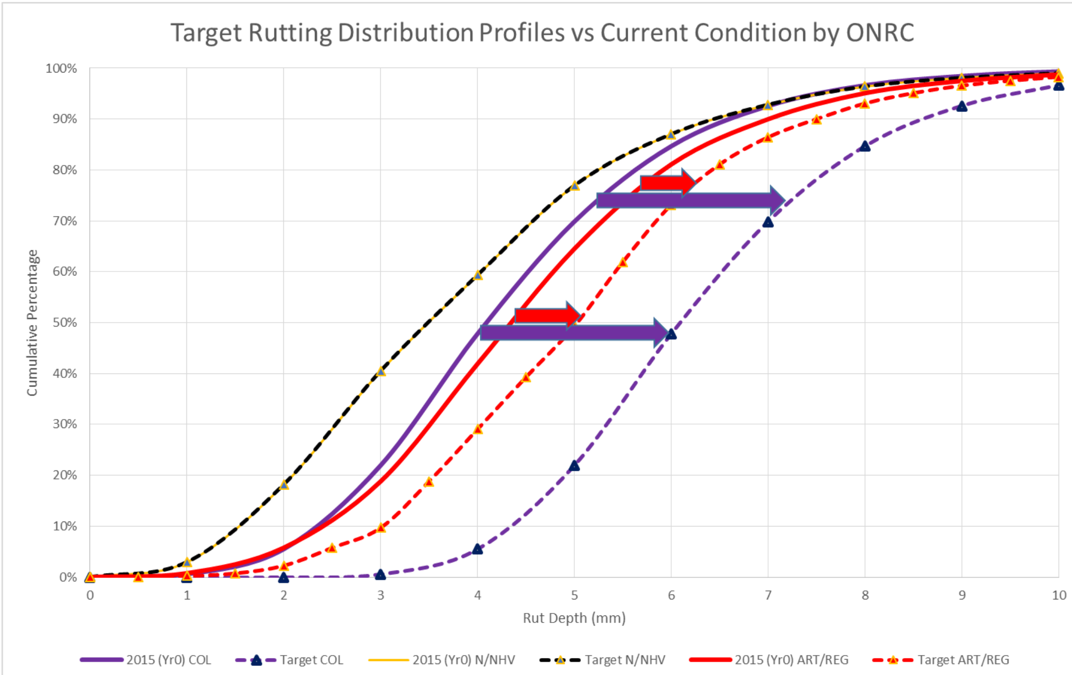


Figure 4.1: Target Performance for the 2016 ONRC Analysis

The figure shows the current rut distribution (solid lines) relative to the proposed desired rut level (dotted lines). It is interesting to note that the current rut performance of primary and secondary collectors is better when compared to the higher order roads (arterial and regional). The proposed target values have a median (50th percentile) range of 3.5 mm for National Roads to 6.0 mmm for Collectors.

Target values were set to align with ONRC philosophy whereby high class offer a higher level of service than low class. The high class roads are expected to maintain current condition levels while low class are expected to deteriorate toward a lower target condition level than currently performing.

The target values for each of the measures are presented in Table 4.1. Note that a consistent residual life for the surfaces was adopted for all road groupings. Some allowance for differentiating surface conditions are allowed for in the crack percentage.

Table 4.1: Measures and Target Values per ONRC Class

	ONRC Classification					
Variable (Mean)	**2nd Col**	**1st Col**	**Art**	**Reg**	**Nat**	**Nat HV**
Rut (mm)	6	6	5	5	4	3
Rough (IRI) (rural/urban)	3.07/3.45	3.07/3.45	2.69/3.07	2.69/3.07	2.31/2.69	1.94/2.31
Crack (%)	3.5	3	2.5	2	1.5	1.5
Res Life (yrs)	-2	-2	-2	-2	-2	-2

4.3 Minimum Base Investment Levels

Note

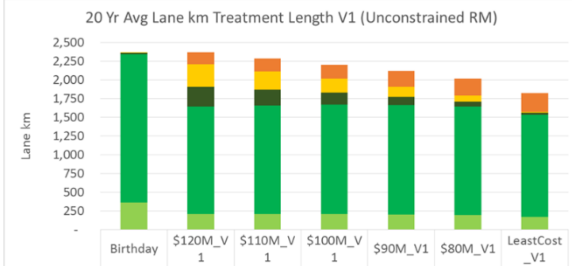
The over-all objective of the analyses was to undertake the minimum intervention that will achieve a long-term sustainable performance of the network, or apply an intervention if that proved to be the long-term lowest cost option.

The base investment levels have been undertaken in three stages (Refer to Figure 2.2). The findings from each of these stages are discussed in subsequent sections.

4.3.1 Minimum Base Level for a Consistent Budget Level

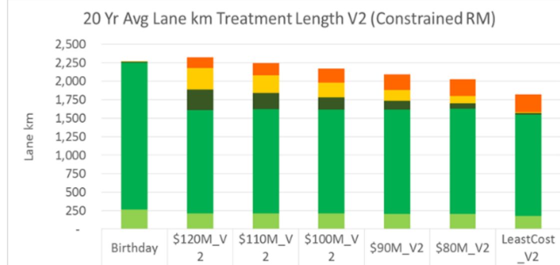
The forecasted quantities and consequential performance for the consistent budget level are compared in Table 4.2. A more complete set of results for this analysis round is presented in Appendix D.

Table 4.2 Comparing Outcomes for Long-term Consistent Budget Levels



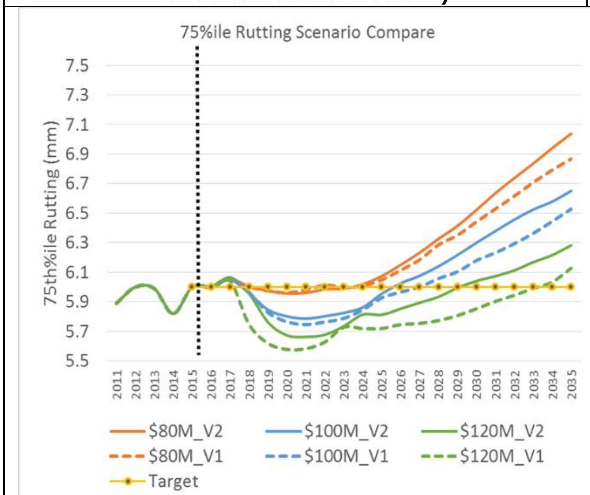
	Birthday	$120M_V1	$110M_V1	$100M_V1	$90M_V1	$80M_V1	LeastCost_V1
Heavy Mtc	-	157	173	189	212	224	251
RHAB	6	303	243	185	130	84	13
2ndCoat	18	260	211	160	109	64	23
CS	1,984	1,439	1,450	1,461	1,460	1,444	1,366
AC	359	206	208	207	204	197	169

Forecasted Maintenenance Quantities (Routine Maintenance Unconstraint)

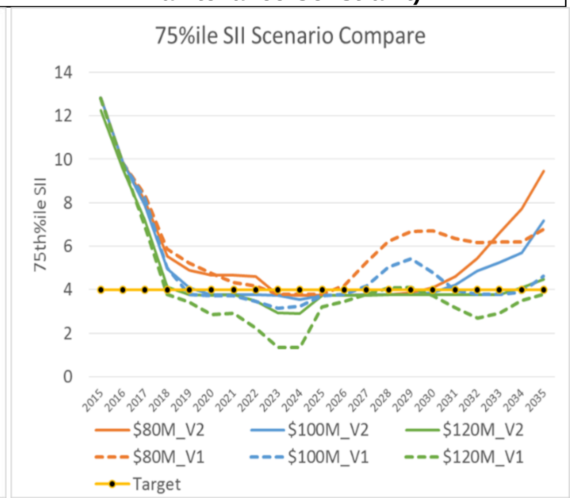


	Birthday	$120M_V2	$110M_V2	$100M_V2	$90M_V2	$80M_V2	LeastCost_V2
Heavy Mtc	-	142	166	193	211	226	240
RHAB	6	296	237	198	147	98	13
2ndCoat	18	280	223	166	117	76	23
CS	1,983	1,392	1,409	1,405	1,408	1,423	1,366
AC	266	214	212	208	207	205	181

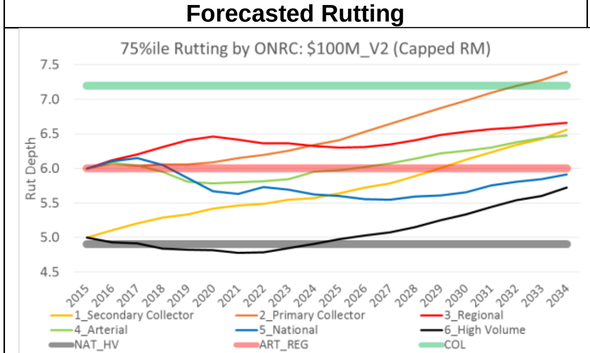
Forecasted Maintenenance Quantities (Routine Maintenance Constraint)



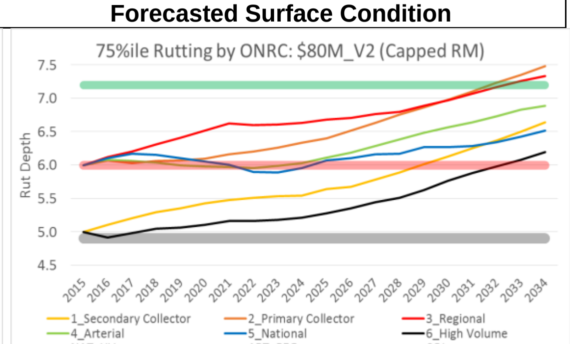
Forecasted Rutting



Forecasted Surface Condition



Forecasted Rutting Per ONRC ($100 million)



Forecasted Rutting Per ONRC ($80 million)

Legend:

Very High - $ 110 Million
Normal - $100 million
Low – $90 million
Very Low - $80 million

V1: Unconstraint Routine Maintenance
V2: Constraint Routine Maintenance

Definition

Least Cost is strategy used by the analysis in order to compare any scenario against. It represents the minimum life-cycle cost strategy that can be undertaken on a road sections. Note that this investment level does not necessarily maintain the LoS.

Note

A significant reduction in the SII for the initial three years is observed for all budget levels. The model fundamentally aims to improve surface condition and will initially focus on rectifying any outlier, very old and second coat seals.

Further observations from Table 4.2 are:

Impact on renewal quantities:

- The impact of constraining the routine maintenance on renewal quantities is negligible – Refer to Section 6.2;
- Varying budget levels have the most noticeable impact on both rehabilitation and the heavy maintenance treatment types, while the impact on resurface and AC surface is minor;

Impact on Key Performance Measures

- The long-term pavement performance quantified by the 75th percentile rutting is most significantly influenced by constraining the routine maintenance cost. For all budget levels the unconstraint routine maintenance costs results in a notable better pavement performance;
- Although the over-all long-term surface performance would be similar for the unconstraint versus constraint routine maintenance costs, there is a stronger cyclic variation in the surface performance for the unconstraint routine maintenance costs;
- None of the modelled budget scenarios are able to arrest the long-term condition beyond eight to ten years of the analyses period.

Impact on ONRC Groupings

- The $100 million investment scenario is sufficient to hold the medium-term pavement performance for national, arterial and regional road classes, while the two collector network are allowed to deteriorate to a worse performing state;
- The $80 million investment scenario is not able to hold any of the road classes to its current performance.

Meaning of the results:

The analyses discussed in this section were aiming at finding a minimum sustainable investment level. That means the minimum investment that will hold the over-all condition of the state highways preventing any rapid deterioration, while still applying the minimum whole of life cost. The analyses also targeted specific LoS outcomes for each ONRC class.

The results have indicated that a budget level of approximately $100 million would be considered as minimum sustainable investment level. This budget level however, is not sustainable beyond the medium-term. The figures showed that this budget level is able to maintain the condition only up to year eight to ten. After this period the road network goes into an accelerated deterioration. This outcome was not too dissimilar with the findings form the 2013 analysis that has also suggested a level of "condition capacity" on the state highways, especially for the lower order roads. This "condition capacity" means that with little maintenance, the network could still function at an acceptable LoS. However, after some time, the "condition capacity" is consumed and an elevated funding level would be required to maintain the network condition at a sustainable level for the longer term.

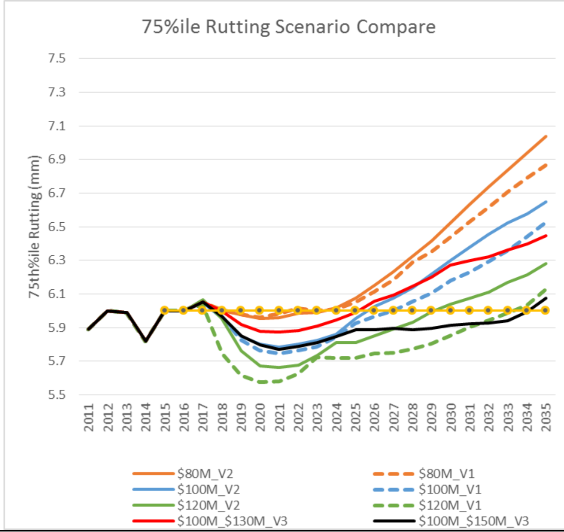
The next question then is if any lower budget could be adopted for the medium term, especially since full network graphs indicated this potential. When considering the forecasted performance of the individual ONRC classes at lower investment level, the answer is "no". A $100 million budget yields the desired stable condition outcome of the higher order roads, while letting some of the lower order road deteriorate slightly. At lower investment levels, the higher order roads immediately start deteriorating, thus indicating and inappropriate maintenance strategy. Therefore the $100 million investment is recommended for the short and medium term investment level. The next session describes analysis that considered the funding requirement in the long term.

4.3.2 Minimum Base Level for a Varied Medium and Long-term Budget

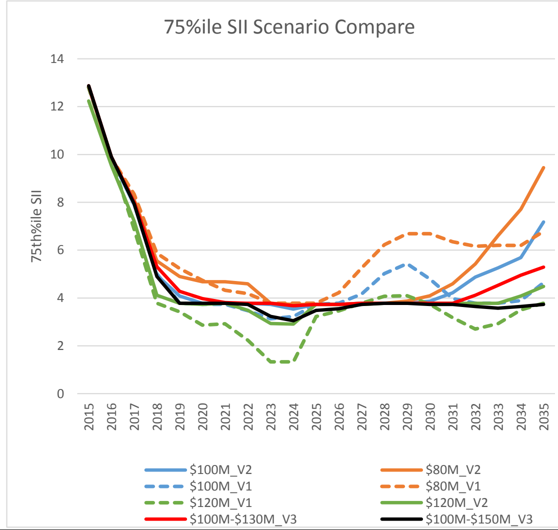
Figure 2.2 shows the second stage of the analysis to involve investigating the long-term investment requirements given the medium term investment of $100 million. The emphasis of the analysis was not so much on finding the exact long-term investment levels but more so to determine that it would be possible to arrest further deterioration of the state highways given the impact of the $100 million up to year eight to ten. Two long-term funding options of $130 and $150 million were investigated. For the sake of the analysis it was assumed this increased funding level to commence at year 11.

The forecasted outcome from this analysis round is presented in Table 4.3, while more comprehensive analysis and observations are presented in Appendix E.

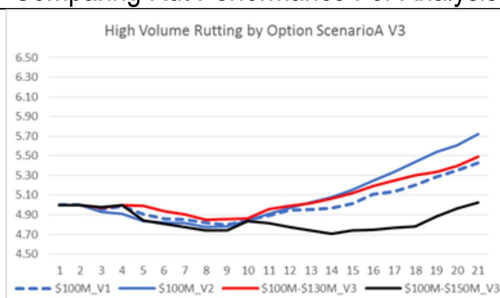
Table 4.3: Comparing Outcomes for Split Budget levels between Medium and Long-term



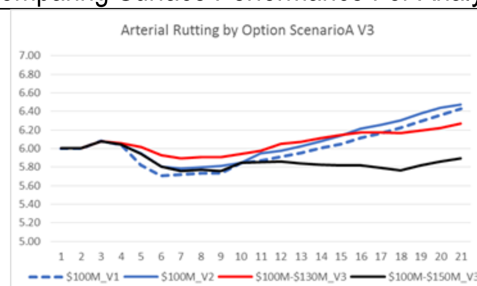
Comparing Rut Performance For Analysis



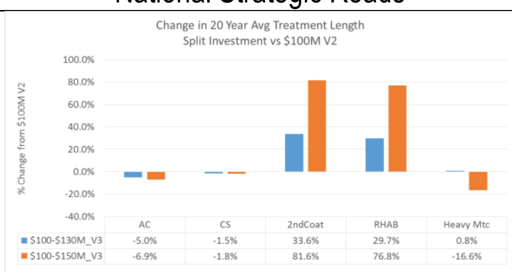
Comparing Surface Performance For Analysis



Relative Rut Performance for High Volume National Strategic Roads

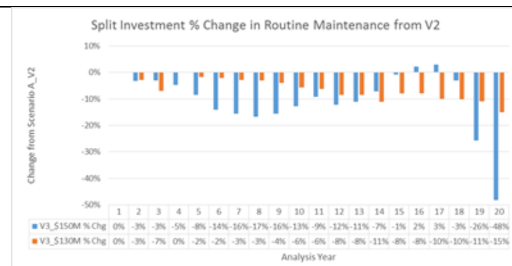


Relative Rut Performance for Arterial Roads



	AC	CS	2ndCoat	RHAB	Heavy Mtc
$100-$130M_V3	-5.0%	-1.5%	33.6%	29.7%	0.8%
$100-$150M_V3	-6.9%	-1.8%	81.6%	76.8%	-16.6%

Response in Renewal Length Due to Elevated Long-term Investment



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
V3_$150M % Chg	0%	-3%	-3%	-5%	-8%	-14%	-16%	-17%	-16%	-13%	-9%	-12%	-11%	-7%	-1%	2%	3%	-3%	-26%	-48%
V3_$130M % Chg	0%	-3%	-7%	0%	-2%	-2%	-3%	-3%	-4%	-6%	-6%	-8%	-8%	-11%	-8%	-8%	-10%	-10%	-11%	-15%

Response in Routine Maintenance Cost Due to Elevated Long-term Investment

Observations from the figures are:

- On a network level the $150million elevated budget after year 10 arrested the long-term deterioration for both the pavement and surface condition;
- The $130million elevated budget after year 10 only holds the surface condition, while the pavement condition as indicated by rutting still goes into an accelerated deterioration;
- Similar outcomes to the national trends were achieved on the ONRC classes. Both the high volume and arterial roans confirmed the requirement of a $150 million long-term to hold the pavement condition. Further result in Appendix E indicates that a condition

improvement is observed for both long-term investment options for the national strategic and regional roads. Both the collector road keep deteriorating for both funding options;

- Both the renewal program and routine maintenance cost quantities differ for the first 10 years when a consistent and split budget approach is compared; and,
- With the "promise" of more money during the long-term, the model delays both asphalt and rehabilitation during the initial years of the analysis period. Naturally this leads into an increase of heavy maintenance. This observation is completely expected due to the impact of the discount rate.

Note

The discount rate causes the economic model to defer more expensive treatments such as rehabilitation for as long as possible. This phenomenon is aggravated by adopting an increased budget during later years of the analysis – the higher budget level plus impact of discount (cheaper money later) has a double impact on the timing selection of more expensive treatments.

The Meaning of the Observations

The analysis outcome confirmed that an increased long-term investment would be able to maintain the minimum preservation for the long-term. The outcome confirms the theory that during the short to medium term there are still some "condition capacity" in the state highway system that gets depleted by year eight to ten.

Should the recovery investment start at year 11, a budget of $150 million would be able to maintain the sustainable performance of the state highway network. It should be noted that the recovery budget may be implemented earlier, say at year six to eight, which will result in a reduction of the actual annual recovery investment level. This aspect should be investigated during later year's analysis.

From an asset management perspective it was interesting to note that the availably of inflated budgets after year 10 had an impact on the modeling decision for the first 10 years. The result showed an increase in rehabilitation and less heavy maintenance. However, for the NLTP it is recommended to use the programme that was developed assuming a constant investment level of $100 million. Obviously this will require the NZTA to review the programme on a regular cycle, adjusting the investment when needed.

4.3.3 Safety Analysis

The objective of this model development is to allow the effect of different investment levels on network skid resistance levels and the associated impact on casualty crashes to be quantified. This in turn will enable the portion of the NLTP that is safety works related to be quantified and also the funding level required to achieve a specified safety outcome in terms of percentage change in casualty crashes. This can be summarised as:

- What is the surface driven Safety need on the network?
- How much of this Safety need is actually treated by Asset Preservation prior to manifesting as a Safety concern? *This is limited to surface driven safety only*.

- What is the predicted network skid resistance profile following the combined Asset Preservation and surface Safety program?
- What is the impact on casualty crash numbers

Safety modelling includes predicting both SCRIM (micro texture) and Texture (macro texture) 20 years into the future for every Skid Assessment Length (SAL). Annual Safety Need is determined as the predicted length of network breaching the NZTA T10 threshold levels (as generated outside of dTIMS). The total length of Safety Need over the 10 year period: 2015 to 2024 is 2,920 lane km. This accounts for 1.2% of the total network lane length per annum.

Once the safety projects were determined it was entered into dTIMS as a dedicated programme. The optimisation then took account of these works and rationalised it to the optimal preservation programme. Therefore, where sections were scheduled for a resurface or rehabilitation within a year of the safety works, it was combined into one project. Appendix F provides more information on the safety and preservation programme integrations, this includes a flowchart indicating the programme rationalisation.

The outcome from the analysis is graphically presented in Figure 4.2. The figure shows that individually the safety and preservation resurfacing quantities amount to 292 ln.Km and 1,890 ln.Km per annum respectively. For the rationalised programme, only 178 ln.Km is undertaken for safety only considerations and 114 ln.Km is treated for both safety and asset preservation.

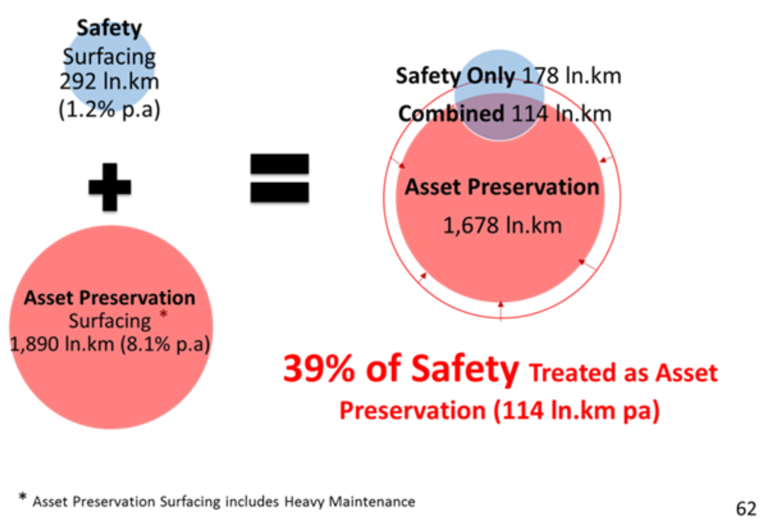


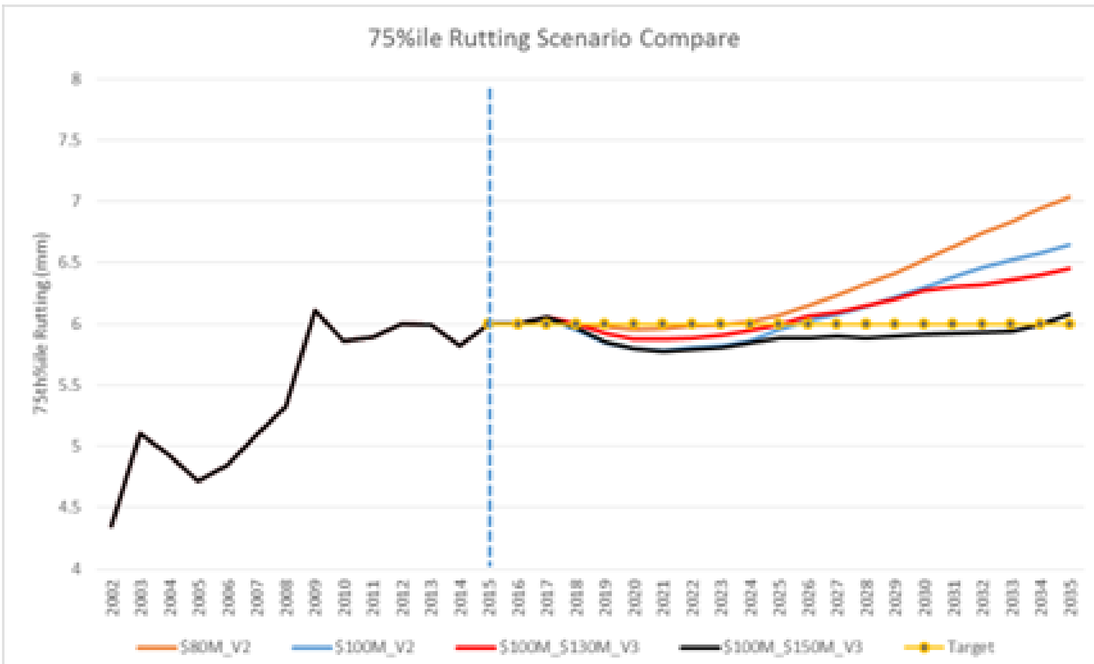
Figure 4.2: Outcome from the Safety and Preservation Integration

A surprising outcome was that due to incorporating the safety programme, the asset preservation only programme has reduced to 1,678 ln.km thus freeing up some planning money to be spent on different treatments. On average there is $5 million freed up from integrating the safety and preservation programme.

4.4 Forecasted Performance

4.4.1 Rutting

Figure 4.3 illustrate the 75th percentile rutting performance of the network for the respective analyses. The left-hand plot shows the performance outcome for the entire network as an outcome from four funding scenarios. The right hand plot depicts the same outcomes but instead of just considering the 75th percentile, it displays the full distribution for 2002, 2005, 2015, 2015 and 2015.



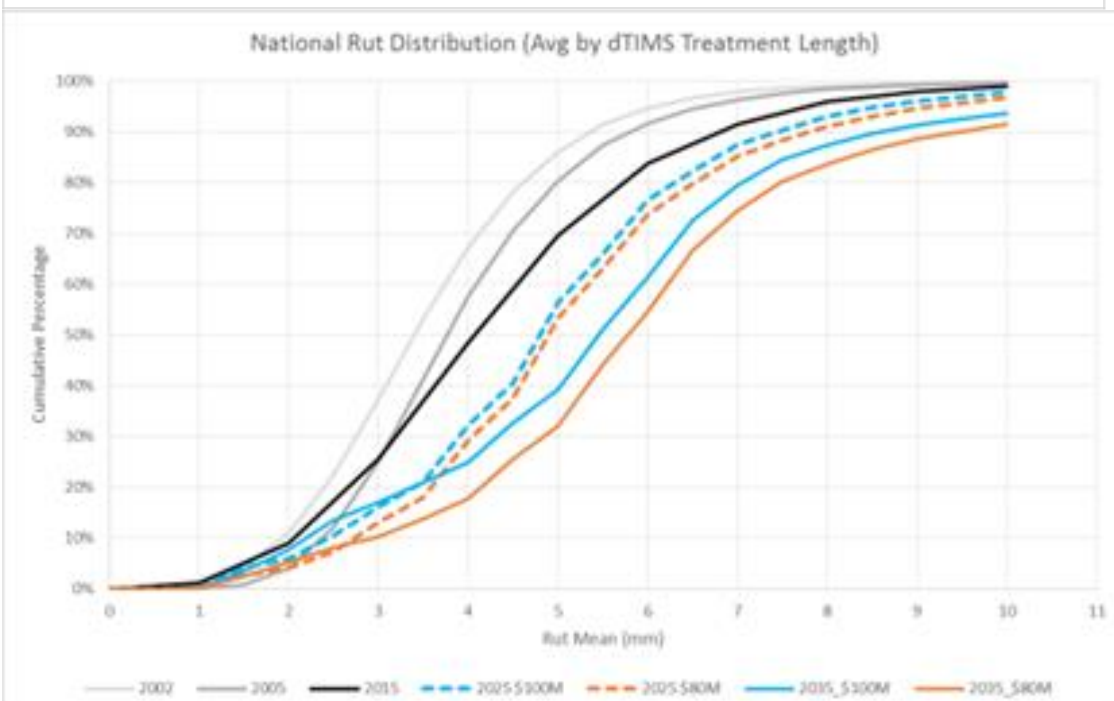


Figure 4.3: Forecasted Rut Progression

Observations from the figures are:

75th Percentile trends

- The historical rutting performance of the state highway network suggested a historical increase in rut value. The reader should be aware though that the rut measurement technology has slightly changed over time. For example, the laser configuration on the High-Speed data equipment has changed leading up to 2009. Rutting has been static over the past 5 years with 75%ile rutting sitting around 6mm.;
- It is obvious that the only long-term sustainable investment strategy is a $100million up to year 8 followed by a $150million.

Full distribution Outcomes;

- The full distribution supports the earlier observations and confirms that both the constant investment levels of $80 and $100 million would be insufficient to maintain the long-term target level of service;
- The full distributions also shows that the distribution widens as the average condition worsen. That means that the percentage over the assumed ONRC threshold increases as the over-all condition shifts. This point is being investigated further in Table 4.4.

Table 4.4 shows the outcome from the forecasted analyses implication on typical network intervention and Operational Performance Measure (OPM) levels used for the Network Outcome Contracts (NOC). The results are presented for the three ONRC groupings.

Table 4.4: Outcome of Rut Progression in Relation to Exceeding Levels

	High Class (Nat & NHV)		Medium Class (Art & Reg)		Low Class (Col)	
SCENARIO	%>20mm	%>10mm	%>20mm	%>10mm	%>20mm	%>10mm
Current (2015)	0.6%	11.1%	0.7%	11.2%	0.9%	10.2%
Calc. 2015 (Mean)	0.6%	11.1%	0.7%	11.2%	0.9%	10.2%
Predicted ($80M Yr10)	1.0%	14.7%	1.0%	15.8%	1.4%	16.1%
Predicted ($80M Yr20)	1.3%	20.8%	1.7%	22.4%	2.2%	23.0%
Predicted ($100M Yr10)	0.9%	12.8%	1.0%	15.8%	1.4%	16.1%
Predicted ($100M Yr20)	1.1%	17.3%	1.3%	19.0%	2.2%	23.0%
Current OPM Level	1.0%	na	1.5%	na	2.0%	na
Target	**0.6%**	**11.1%**	**1.0%**	**15.8%**	**2.2%**	**23.0%**

Note: The red highlight cell indicates where the criteria are exceeded.

The results show the high class road exceeding both the percentages above 10 and 20 mm from year 10 onwards for both the $80 and $100 million investment levels. The same outcome is achieved for the long-term (20 years) performance of the medium class roads. These observations support earlier recommendations that neither the $80 million or $100 million investment levels meets the stated performance levels, however the $100m million closest yields the desired outcome. It also confirms the $100million investment strategy is only appropriate for the medium term (say up to year 6).

4.4.2 Roughness

Figure 4.4 and Figure 4.5 illustrate the forecasted roughness for the $100million constant funding scenario. The full distribution change for the roughness is illustrated for the Arterials and Regional roads as an example, while Figure 4.5 shows the roughness performance in relation to the target performance levels for the ONRC classes.

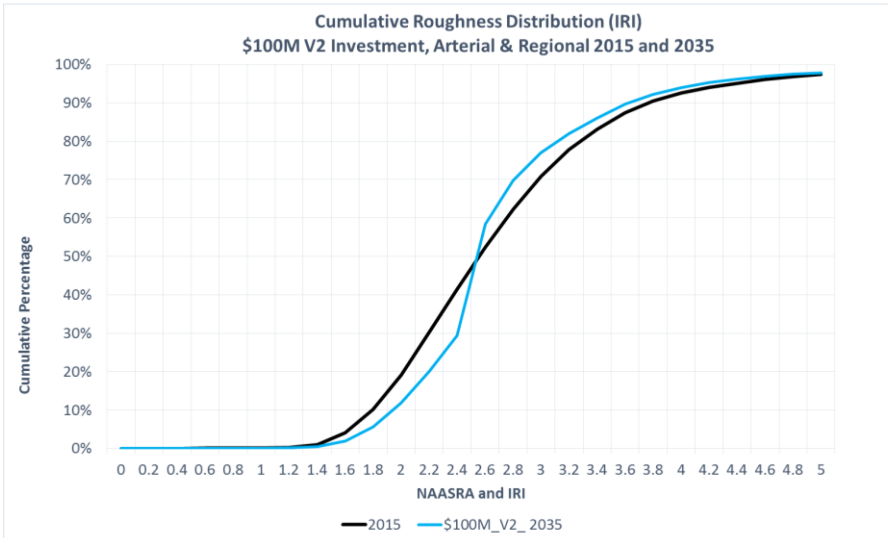


Figure 4.4: Forecasted Roughness Distribution for Arterial and Regional Roads

The observations for the figure are:

- The over-all distribution resulted in a very similar outcome compared to the current roughness value (i.e. the 50th percentile remains the same); and,
- There is an over-all decrease in the range of the distribution – i.e. more values aggregate closer to the mean roughness. Experience has indicated the well maintained networks normally have a narrower distribution (Henning et al, 2016)[2].

The comparison to the ONRC target values (Figure 4.5) indicates the 20 year outcome of the $100 million constant investment strategy will result the roughness performance being almost an exact match to the ONRC target values (Both the average and maximum roughness). However, as indicated in the previous section the same investment strategy will result in unsustainable pavement performance from a rutting perspective. This finding confirms the reasoning for using separate sustainable performance measures not covered by ONRC (refer to Section 3.3)

[2] Henning, T.F.P., Roux, D.C. Beca, E. and Fraser, D. (2016). Keeping Good Roads Good – An Investment Strategy for Road Networks under Constraint Funding Conditions. 2016 ARRB Conference, Melbourne. (To be Published)

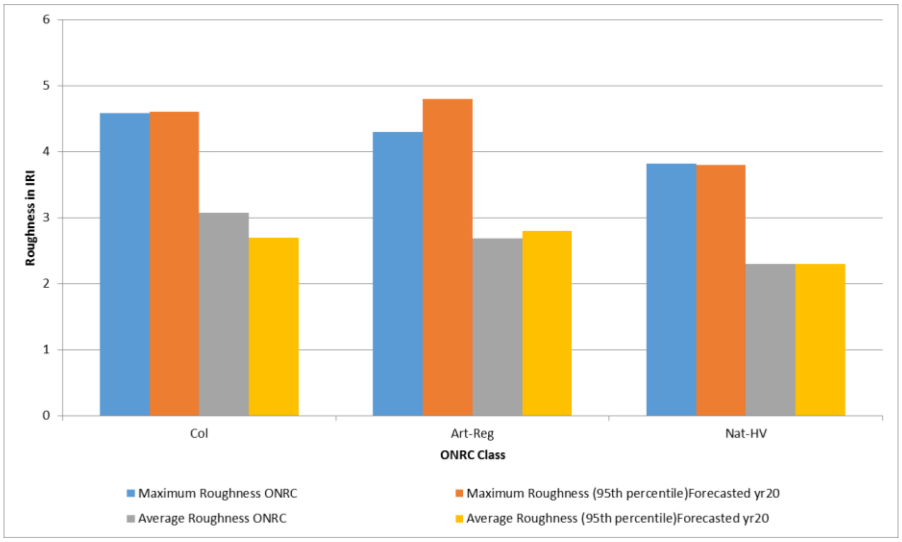


Figure 4.5: ONRC Target Roughness Levels Compared with the Forecasted Roughness (Year 20)

Note: the forecasted 95th percentile values were calculated on the basis of treatment length averages, which is slightly different to the ONRC measures that is calculated on the rough roughness data.

4.5 Investment Risk Assessment

The entire analyses approach incorporated risk considerations and various risk mitigation measures, some example include:

- Risk around data quality – The data processing process includes a significant validation routine and has identify the main areas of concern (Refer to Section 3.2);
- The robustness of the system and confidence in forecasts – not stone was left unturned to validate the outcomes (Refer to Section 7);
- Sensitivity analyses were undertaken to understand the impact of variables that was identified as having an impact on the analysis outcomes (Refer to Section 6): and,
- A significant portion of this analyses process investigate the performance risk resulting from different investment strategies.

It is therefore believed that the analyses consider most of the risk aspects that form part of the analyses scope. The items the NZTA need to investigate further or perhaps monitor on an on-going base are:

- The issues associated with asphalt surface performance need to be better understood. It is believed that improved diagnostic processes may assist in preventing asphalt surfacing in locations where sub-optimal performance could be expected. The two main urban centres of Auckland and Wellington were separated out with treatment lengths modelled by lane. AC model predictions in these areas were far superior to other Urban AC areas. The migration to lane Treatment Length management nationwide should be considered for improved maintenance programming.;
- The impact of increased truck load (e.g. HPMV, 50t Max and Super Single Tires). There has been numerous studies completed for the NZTA on this aspect, but these findings could not be incorporated to the analysis. It has to be allowed for in the NLTP context; and,

- Target levels for the respective ONRC classes. Much work has been completed to ensure the ONRC targets for the analysis was within expected ranges and there is strong confidence that they are at the right levels. The one risk aspect to consider though is the levels on the lowest road spectrum i.e. Primary and Secondary Collector. The next paragraph expands on this perceived risk.

The rutting model for New Zealand has been developed on the bases of the LTPP data. This analysis project included a significant validation of the model accuracy including the rutting model that was found to have an extremely strong correlation to the actual performance of the network (See Section 7).

In the model development it was recognised that there is a distinct difference in performance between weaker (lower order roads) to that of high strength roads used on higher class roads. (Refer to Figure 4.6.) In this figure the solid line represents the deterioration rate of lower volume roads, while the broken line represents the deterioration rate of higher volume roads. It is evident form the figure that the low volume roads hardly deteriorate with time, until one day when something may change (say water ingress or extra traffic loading). At this point the rutting increases to an accelerated state that results in a failed pavement within a short time (months).

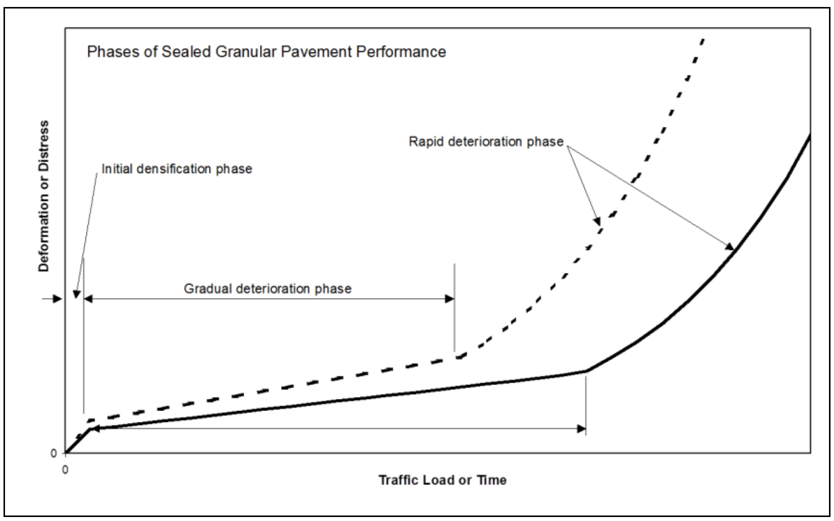


Figure 4.6: Expected Pavement Performance (Henning et al., 2009)[3]

The meaning of these trends in the wider context of this report is that there is a risk of allowing the lower volume roads (collectors) to deteriorate beyond the point of accelerated rutting. Addressing these roads mostly through a heavy maintenance strategy may not be sufficient to keep these roads in the functional performance level that is desirable. It is expected that a lower performance of these road would be associated with significant failures and not just a reduction in some specific performance measures.

[3] Henning, T., Dunn, R., Costello, S., & Parkman, C. (2009). A new approach for modelling rutting on the New Zealand State Highways. ROAD & TRANSPORT RESEARCH, 18(1), 3-18

5. Investment Assessment on Regional and ONRC Level

The subsequent section summarised the maintenance quantities obtained for the respective regions and ONRC classes. The quantities are also compared to the existing programmes in order to establish: a) confidence in the outcomes; and, b) highlight potential risk areas in current programmes.

Note

The analyses described in this report were undertaken independently from the known quantities referenced in this section. There was therefore no attempt during the analyses to mirror expected outputs or quantities.

5.1 Comparing the Model with Base Line Quantities on Regional Level

The national level maintenance quantity comparison is presented in Table 5.1

Table 5.1: Comparing Modelling Quantities with Other Existing Programmes

Average Annual Lane km Lengths (9 year excl. 2015/16)				
Scenario	**AC**	**CS**	**RHAB**	**HEAVY MTC**
2016 Recommended Investment ($100M V2)	210	1,512	164	207
Contractor Baseline (FWP)	195	1,525	135	
Base Preservation Renewal Qtys (BPRQ)	274	1,521	160	
2013 Outcomes (SMO18) (2 lanes per CL)	188	1,506	301	

Notes:

The $100 million V2 (constant investment) are used for the comparison, realising the need for the increased budget for the long-term. For the sake of the comparison the impact of potential future funding increases as ignored;

Contractors Baseline FWP – 2015/16 and 2016/17 programmes from RAPT selected sites and remaining years based on NZTA supplied specimen programmes;

Base Preservation Renewal Quantities – NZTA's accepted base level of renewals going into the NOC contracts (2013)

SMO 18 was the Delphi modified modelling results from the 2013 analysis (See Section 2.3)

Observations form the table are:

- There is a remarkably high comparison for both the surfacing and the AC surfacing quantities, thus giving high confidence in the forecasted needs. In particular the high level of correlation between the 2016 analysis and the 2013 BPRQ (NZTA Field validated programme) is encouraging. The same level of confidence did not existed for the 2013 analyses;
- There is a high correlation between the 2016 forecasted rehabilitation needs and the 2013 BPRQ, again giving confidence to the validity of the outcomes;
- The SMO 18 (2013) analysis suggesting double the quantity of rehabilitation compared to the 2016 analysis. This difference can be explained by the following three factors:
    - 2013 were centreline and these figures have been adjusted to lane km (factor of 2 multiplication);
    - The 2013 analysis does not have the heavy maintenance as an option. The addition of this treatment type allows for treating of poor condition sections where a rehabilitation is not an affordable option; and,
    - The 2013 analysis constrained both the routine maintenance and the pre-reseal repairs, therefore some sections allowed to deteriorate significantly to a point where rehabilitation becomes the only option (See Section 6.2).

The comparisons to regional programmes are presented in Table 5.2. A further discussion on performance outcomes are presented in Appendix G. Key observations from the comparisons are:

- Chip Seal quantities generally match within +/-20% (this equates to give or take 2 years for a 10 year surfacing cycle). Exceptions are West Waikato, Northland and East Waikato which recommend higher RHAB quantities as offset to chip seals;
- The model forecast has high RHAB quantities. Central Waikato, Central Otago, East Waikato, Northland and West Waikato North predict at least double the quantity specified in the FWP.
- AC quantities in the high AC regions match within 15%. Refer to comments on future AC need due to high quantity of recent AC surfaced RONS (Section 3.4).
- Auckland Alliance has significant differences between SMO18, BPRQ and FWP quantities. The 2016 Recommended quantities align well with FWP Surfacing but does not pick the RHAB quantities.
- Wellington aligns well with FWP (within 15%) and better with BPRQ (within 10%)
- Marlborough FWP appears incomplete

Table 5.2: Comparing Forecasted Quantities to Existing Programmes

	Stats					2016 Recommended				Cycle		SMO18			BPRQ			Contractor FWP			Compare SMO18			Compare BPRQ			Compare FWP		
Region	**%HC**	**%MC**	**%LC**	**%AC**	**%CS**	**AC**	**CS**	**RH**	**DS**	**AC**	**CS**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**
AUCK ALLIANCE	97%	3%	0%	99%	1%	78.5	0.6	1.2	1.3	11.6	15.3	96	8	6	144	12	9	75.3	0.0	4.9	-18%	-93%	-79%	-46%	-95%	-86%	4%	0%	-75%
(NOC) BOP EAST	0%	57%	43%	5%	95%	3.0	92.0	9.6	20.4	18.9	11.9	2	82	12	5.3	79.8	9	5.3	79.9	5.9	50%	12%	-20%	-43%	15%	7%	-44%	15%	64%
(NOC) BOP WEST	46%	46%	9%	41%	59%	9.2	26.0	4.7	7.1	23.1	11.5	6	30	12	15.3	25.1	3.6	9.3	23.4	4.4	53%	-13%	-61%	-40%	4%	30%	-1%	11%	6%
(NOC) CENTRAL WAIKATO	33%	32%	35%	2%	98%	1.6	112.3	33.0	24.0	22.2	13.5	2	110	18	3.5	119.1	11	2.9	112.6	10.1	-18%	2%	83%	-53%	-6%	200%	-44%	0%	228%
COASTAL OTAGO	25%	32%	43%	8%	92%	8.3	109.1	9.9	13.6	13.3	12.1	6	98	16	4.6	97.1	7.2	6.8	110.7	2.9	38%	11%	-38%	80%	12%	38%	21%	-1%	246%
(NOC) EAST WAIKATO	6%	64%	30%	13%	87%	10.9	76.9	12.3	17.0	13.3	12.9	6	62	16	11.7	96.9	4.7	11.0	99.6	4.7	81%	24%	-23%	-7%	-21%	162%	-1%	-23%	160%
(NOC) TAIRAWHITI ROADS NORTHERN	0%	1%	99%	0%	100%	0.1	30.4	2.2	2.8	4.5	12.7	0	54	12	0.5	51.7	13.1	0.0	34.7	7.9	0%	-3%	-48%	-42%	1%	-53%	UNL	-12%	-72%
(NOC) TAIRAWHITI ROADS WESTERN	0%	97%	3%	1%	99%	0.2	21.8	4.0	2.2	10.6	12.4							0.4	23.4	3.1							-40%	-7%	29%
(NOC) MANAWATU-WHANGANUI	46%	34%	21%	4%	96%	4.2	89.6	8.6	7.7	11.3	14.3	2	94	15	2.3	88.8	8.7	3.3	92.8	7.4	112%	-5%	-43%	85%	1%	-2%	30%	-3%	15%
(EC) MARLBOROUGH	35%	33%	32%	3%	97%	3.1	33.8	4.9	3.8	5.6	15.0	2	40	8	2	40	8	0.2	2.8	0.7	57%	-16%	-38%	57%	-16%	-38%	UNL	UNL	UNL
MILFORD	0%	90%	10%	1%	99%	0.0	33.9	0.5	1.2	UNL	11.6	0	24	2	**0.3**	**16**	**0.1**	0.3	28.7	1.2	0%	41%	-75%	-100%	112%	407%	-100%	18%	-56%
NAPIER	23%	54%	23%	2%	98%	1.7	82.0	4.2	7.9	13.1	12.0	2	82	20	1.8	87.8	6.1	2.0	89.0	5.9	-14%	0%	-79%	-4%	-7%	-31%	-15%	-8%	-29%
NELSON	0%	61%	39%	5%	95%	5.9	52.8	1.6	6.0	7.1	14.1	2	58	8	9.1	55.1	1.7	4.0	61.8	1.5	195%	-9%	-80%	-35%	-4%	-4%	48%	-15%	12%
(NOC) NORTHLAND	16%	16%	69%	8%	92%	11.2	89.2	16.4	25.8	13.3	18.6	12	122	30	**9.8**	**104.6**	**7**	10.4	104.7	6.3	-7%	-27%	-45%	14%	-15%	134%	7%	-15%	160%
NTH CANTERBURY	50%	33%	17%	10%	90%	10.7	104.3	9.5	7.4	15.4	14.0	8	102	28	8	102	28	8.0	102.0	28.0	34%	2%	-66%	34%	2%	-66%	34%	2%	-66%
OTAGO CENTRAL	0%	82%	18%	2%	98%	1.6	73.7	3.1	7.2	14.0	13.1	0	72	4	0.7	61.7	3.2	1.0	67.5	2.8	0%	2%	-22%	126%	19%	-2%	55%	9%	13%
(NOC) SOUTH CANTERBURY	32%	39%	29%	3%	97%	2.1	84.1	4.7	4.1	14.8	13.3	2	74	12	**3.2**	**87.3**	8.2	2.7	92.5	11.5	4%	14%	-61%	-35%	-4%	-43%	-21%	-9%	-59%
SOUTHLAND	0%	53%	47%	3%	97%	6.3	81.9	5.8	13.1	5.3	14.6	2	66	12	**2.9**	**85.4**	5.7	3.7	69.6	3.8	217%	24%	-52%	118%	-4%	2%	71%	18%	54%
(NOC) TARANAKI	0%	53%	47%	4%	96%	2.5	86.9	9.8	15.1	16.2	11.9	2	72	21	3.7	62.6	10.4	4.6	81.2	9.5	23%	21%	-53%	-34%	39%	-6%	-46%	7%	3%
(NOC) WELLINGTON	62%	32%	5%	51%	49%	35.0	23.7	4.0	4.4	9.8	13.7	20	36	8	33.2	23.9	3.7	30.2	24.1	3.5	75%	-34%	-50%	5%	-1%	8%	16%	-1%	14%
(NOC) WEST COAST	0%	70%	30%	2%	98%	2.1	145.6	1.7	8.0	12.6	11.8	2	126	10	1.2	142.3	0.9	1.5	139.7	1.1	4%	16%	-83%	74%	2%	89%	35%	4%	56%
WEST WAIKATO NORTH	57%	33%	9%	35%	65%	11.2	20.7	9.1	3.3	19.7	19.6	8	52	19	**8.6**	**33**	**3.2**	10.2	34.4	2.5	40%	-60%	-52%	30%	-37%	186%	9%	-40%	268%
(EC) WEST WAIKATO SOUTH	0%	61%	39%	3%	97%	0.9	41.0	3.2	3.9	25.1	17.7	6	42	12	**1.8**	**49.2**	7.7	2.1	49.5	5.3	-84%	-2%	-73%	-48%	-17%	-58%	-55%	-17%	-40%
Grand Total	**% of each Region in ONRC**					**210.3**	**1512.4**	**164.2**	**207.3**	**Cycle**		**188**	**1506**	**301**	**273.5**	**1521.4**	**160.2**	**195.3**	**1525**	**134.7**	**12%**	**0%**	**-45%**	**-23%**	**-1%**	**2%**	**8%**	**-1%**	**22%**
	Group and AC/CS Surface					***excl 15/16***				**(Yrs)**		***include all***			***excl 14/15 & 15/16***			***excl 14/15 & 15/16***			**% differnce between 2016 Recommended and Scenarios**								

All quantities are ln.km. AC= Thin AC Surface, CS= Chipseal Surface, RH=Rehabilitation (all pavement), DS= Do Something (Heavy Maintenance with Surfacing - 2016 Recommended only)

Auckland and Wellington were modelled by Lane Treatment Lengths (TLs), all others modelled by Centreline TLs.

%HC = percentage in High Class, %MC = percentage in Middle Class, %LC = percentage in Low Class Collectors

%AC= percentage of length (ln km) surfaced in AC, %CS = percentage of length (ln km) surfaced in CS

Cycle = Average age of surface based on length of that surface type by region (AC or CS based on the 2016 Recommended quantities)

5.2 Comparing Modelled Quantities with ONRC Investment Levels

Figure 5.1and Figure 5.2 illustrate the relative investment split for the respective ONRC classes. Figure 5.1 compares the treatment lengths (10 year) and the investment cost (20 year) for the ONRC classes.

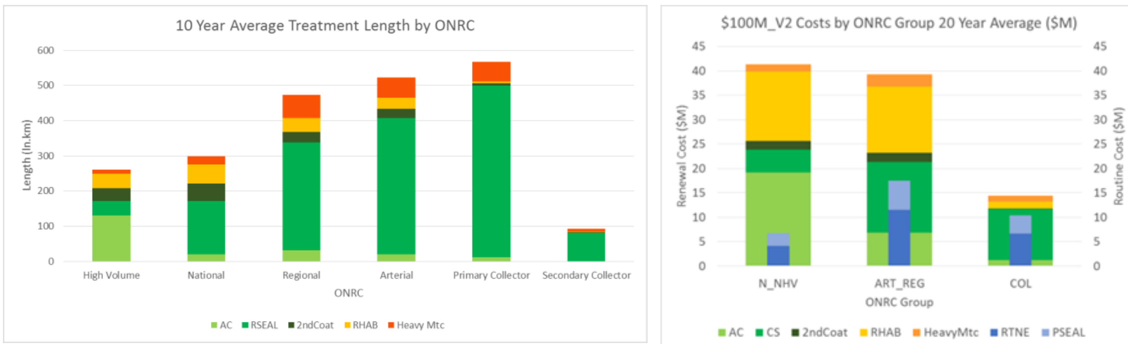


Figure 5.1: Comparing the Investment Split between ONRC Classes

Observations from the Figure are:

- As expected most of the rehabilitation investment are focused on the higher order roads;
- Likewise, the chip seals resurfacing quantities are predominantly applied on the lower order roads. And,
- Arterial and Regional roads have a similar over-all investment to the national route system with more significant focus on resurfacing and heavy maintenance.

The normalised comparisons are presented in Figure 5.2.

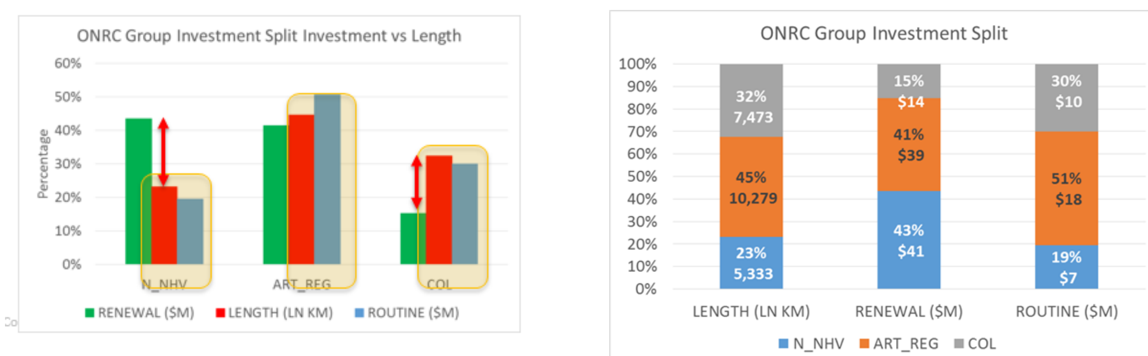


Figure 5.2: Relative Spending for ONRC Classes

When compared to network length, High Class routes are given double the renewal funding as a percentage and Low Class routes given half. This aligns with expectation, where high cost renewal funding is spent on high class routes. The investment in renewal assigns 43 % in the national routes, equalling that to the arterial and regional routes. Arterial and regional routes account for 51% of the routine maintenance cost.

6. Sensitivities of Input Assumptions

Sensitivity analyses were undertaken on two items that were highlighted as potential unknown elements during the analysis process. The subsequent sections summarised the findings from these analyses, while Appendix H and Appendix I go into these areas in more detail.

6.1 Impact of Unit Rate Variations across Regions

Much consideration was given to the method of determining the appropriate unit rate for the analysis. Two considerations were pertinent:

- Should the analyses be undertaken on the bases of a regional specific unit rate or should a national rate be used; and,
- What would be a represented unit rate should a national consistent rate be used for the analyses.

6.1.1 Should a single or regional specific rate being used?

The modelling approach optimises the entire state highway in a single data-set. This means that it maximises the benefits (resulting from a treatment) at the specific cost for that treatment. Therefore if two roads say road (a) and road (b), located in two different regions are exactly in the same condition, but the cost to resurface road (a) is double that of road (b), road b will be prioritised before road a because the ratio in benefit/cost is higher.

In this analysis, it was decided to have a common rate across the entire network. Once the recommended investment strategy has been determined the forward works programme is finalised. The regional unit rates are then applied to the works programme in order to determine its specific cost. The motivation for this analysis approach was:

- The purpose of the NLTP analysis is to determine the over-all asset management needs from the network. Therefore all roads should be analysed on equal bases within its ONRC class and in context of its current condition and expected performance; and,
- Unit rate differences are recognised but it is realised that it is only valid for a single contract term and therefore will differ many times during the analysis period;

6.1.2 Determining the appropriate rate for the analysis

The unit rates used for the 2016 analyses were based on a number of considerations including:

- An average of unit rates supplied form the NTZA;
- Considering the unit rates used during the 2013 analyses; and,
- The full distribution of unit rates received from the NOC contracts.

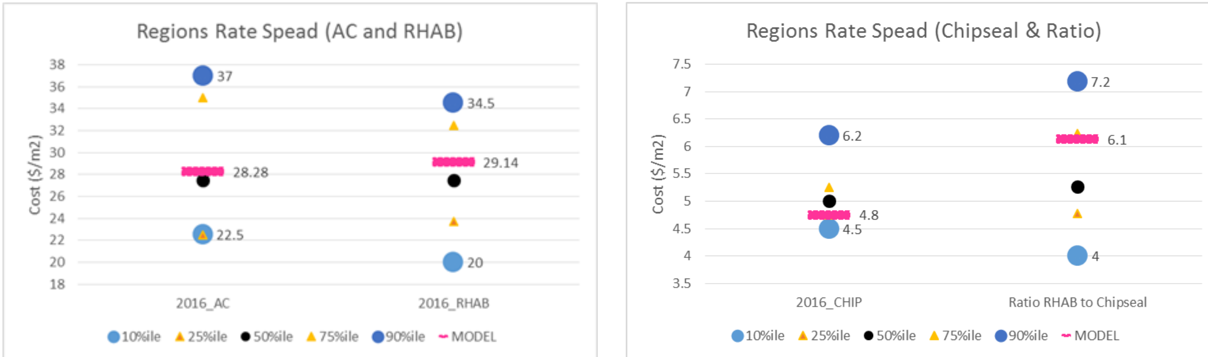


Figure 6.1: Variation in Regional Unit Rates

Table 6.1 summarise the difference in using regional rates versus a national rate across the state highways. Although the variances in Figure 6.1 suggest that the national rates are a good mid-point to use, the outcome in the table does suggest a stronger emphasis on resurface treatments to the expense of rehabilitation and AC resurfacing. Subsequent sections investigate the sensitivity in more detail. The chart to the far right examines how the relative cost of rehabilitation and resurfacing vary across the country. If the relative cost remains the same, while strategies will cost different amounts in different regions, the overall optimal strategy will likely still be the same. Based on Regional Rates, RHAB varies between 4 and 7.2 times more expensive than chipseal. Based on Model rates, RHAB is 6.1 times more expensive than chipseal. It is noted that the Optimal Strategy would be affected if Regional Rates were indeed used, although the absolute impact of this has not been tested. The relative cost of RHAB to AC has been examined and is deemed negligible across the regions.

Table 6.1: Variance in Forecasted Maintenance Quantities Using National versus Regional Rates

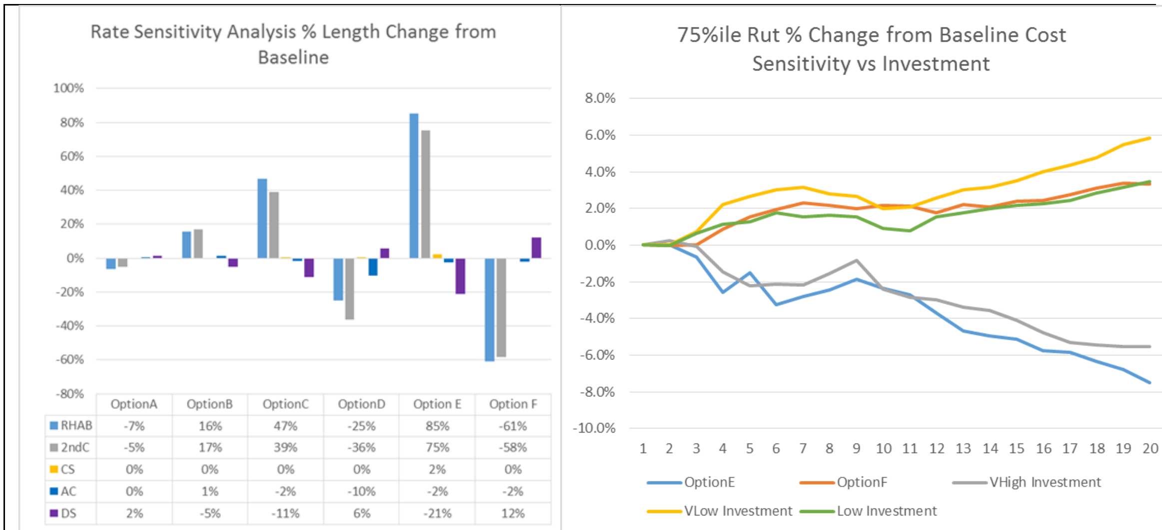
Treatment	Regional Rates ($M)	National Rates ($M)	% Change
RHAB	29.10	31.74	-8.3%
AC	28.39	29.49	-3.7%
RSEAL	37.50	35.78	4.8%
RENEWAL	**94.99**	**97.01**	-2.1%
RTNE	22.30	22.30	0.0%
PSEAL	12.35	12.35	0.0%
ROUTINE	**34.65**	**34.65**	0.0%

6.1.3 Outcome form Sensitivity Analyses

The sensitivity analysis methodology invested different permutations for unit rate combinations:

- Option A — Max RHAB other remained on national rate;
- Option B — Max RHAB Min SURF
- Option C — Min RHAB other remain on national rate
- Option D — Min RHAB Max SURF
- Option E — Min RHAB Min Surf
- Option F — Max RHAB Max Surf

The outcome of the sensitivity Analyses are depicted in Figure 6.2. The figure shows both the impact of unit rate on the renewal treatment lengths and the impact on the long-term performance. Note that the same budget was used for all the analyses.



	OptionA	OptionB	OptionC	OptionD	Option E	Option F
RHAB	-7%	16%	47%	-25%	85%	-61%
2ndC	-5%	17%	39%	-36%	75%	-58%
CS	0%	0%	0%	0%	2%	0%
AC	0%	1%	-2%	-10%	-2%	-2%
DS	2%	-5%	-11%	6%	-21%	12%

Impact of Unit Rate on Maintenance Quantities	Impact of Unit Rate on Long-term Performance (Rutting)

Figure 6.2: Outcome from the Sensitivity Analyses

Observations are:

- This setup is sensitive to the variations in renewal treatment rates that we see in the Regional spread. Based on condition outcomes, the model suggests:
    - Lowest Region rates used nationally with 'baseline' investment offers similar condition outcomes to Model Rates with 'Very High ($120M pa)' investment.
    - Highest Region rates used nationally with 'baseline' investment offers similar condition outcomes to Model Rates with 'Low ($90M pa)' investment.
- This chart shows the percentage change in 75%ile rutting between the tested scenarios and the 'Baseline' Investment (where Model Rates were used). This compares the Highest and Lowest Region rate sensitivity analysis (10% sample) and the Very High and Low & Very Low Investment analysis (100% network run). This shows the Lowest Region rates and Very High Investment both offer up to 8% improvement in 75%ile rutting by year 20 and conversely Highest Region rates and the Low Investment analysis perform similarly offering approx. 3% poorer (increase) in 75%ile rutting by year 20.

Note

Confidence was established that the recommended approach of using national rates during the optimisations analyses, then applying regional rates to the final outcomes is the appropriate strategy of dealing with regional rate differences.

6.2 Impact of Routine Maintenance Costs on Pro-active Investment

The report earlier indicated that routine maintenance cost models currently uses defect forecast in order to estimate the works costs. Although this approach has proven that the trends of routine maintenance cost over time is fairly robust, yet certainty on the absolute dollar value for routine maintenance cost still need some improvement. It was therefore important to gain an understanding of the impact of routine maintenance on the renewal programmes if it is constrained at different levels.

The methodology that was used for the analyses investigated the following analyses scenarios:

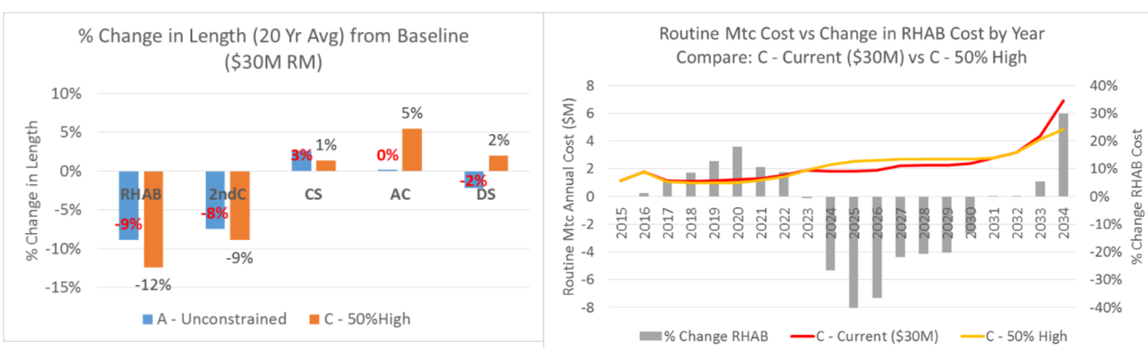
- **Option A:** Uncapped routine maintenance budget (traditional)
- **Option B:** Fixed Routine Maintenance and Preseal Repair Investment: Fixed at the sample equivalent to $30M investment ($3M pa). *NOTE: Model outcomes are sub-optimal*
- **Option C:** Fixed Routine Maintenance Investment (allowing Preseal repairs to remain unconstraint). Five scenarios tested starting at the sample equivalent to $30M investment minus Preseal allocation **(Normal = Baseline)** and testing +/-20% and +/-50%.

50%High	20%High	Normal	20%Low	50%Low
2,700,000	2,160,000	1,800,000	1,440,000	900,000

Note: In years where least cost is higher than the fixed level, the model is provided least cost investment.

- **Option D:** Identical to B but disregarding the model generated Least Cost requirements. *NOTE: Model outcomes are sub-optimal*

Note that for the analysis was undertaken for a 10% random sample on the state highways. Option C most closely represents the approach used during the full analyses. The 'current' Routine Maintenance Investment, provided by NZTA is $30M pa (including both routine and preseal repairs). This has been used in the modelling and benchmark for this sensitivity analysis. Figure 6.3 depicts some of the results from the sensitivity analysis.



Impact on Maintenance Quantities Long-term Impact on Rehabilitation Costs

Figure 6.3: Outcome from Sensitivity Analyses on Routine Maintenance Cost Impact on the Porgamme

A summary of the findings were:

- The routine maintenance investment is sensitive to the Renewal Investment level. At $100M renewal investment, the 'balance' is good over 7-10 year horizon. Beyond 7-10yrs, renewal investment is insufficient and increasing routine by up to 50% begins to have an impact.

- Routine Maintenance is not sensitive to changes in the first 7-10 under the 2016 Recommended Investment level of $100M.
- This setup is sensitive to changes up to 50% above the 'current' routine maintenance investment of $30M when renewal investment is insufficient, which begins to occur around 7-10 years.
- This setup is not sensitive to changes up to 50% below the 'current' routine maintenance investment of $30M.
- When routine maintenance is fixed at 'current' levels, traditional optimisation is not possible due to insufficient funds being available in every year.
- When the model is allowed to perform sub-optimal optimisation (neither renewals nor routine maintenance budget are adhered to), the total cost over the analysis period increases. In this scenario, the routine maintenance reduces slightly, RHAB increases significantly, PRESEAL decreases slightly.
- When fixed at 50% above 'current', the routine maintenance budget:
  - Matches Least Cost for 7-10 at levels below $30M equivalent
  - Only just exceeds Least Cost between years 7 – 15
  - Matches Least cost between years 15 – 20 where least cost exceeds $30M equivalent.
  - Rutting outcomes are better on the sub-optimal options (B and D) due to higher RHAB quantities.

Note

The results of the sensitivity analysis provide expected outcomes that correlate with real observations in the field. This is:

1) When an appropriate renewal investment is applied on the network a base-line routine maintenance cost is needed. By providing high routine maintenance cost does not have a material impact on the renewal treatments nor would the amount of routine maintenance increase;
2) At unsustainable investment level on renewals the renewal quantities is directly impacted by the allowable routine maintenance budget, with a particular impact on the amount of rehabilitation. Increased routine, reduced rehabilitation quantities and vice versa.

Another outcome of the sensitivity analyses confirmed the appropriate maintenance philosophy adopted for the modelling. For any deviation in budget or routine maintenance cost, the model will protect preservations treatment (resurfacing) in the first instance. Fluctuations in available funding mostly impact on the amount of rehabilitation.

7. Validation of Outcomes

7.1 The Importance of the Validation

The analyses documented in this report are important for the following two reasons:

- It validates results from the 2013 analysis plus it highlights any potential risk areas for the accepted NOC contractual quantities;
- It is a vital input into the NLTP submission. The NZTA needs confidence that the appropriate funding levels are targeted.

7.2 Validation Methodology and Outcomes

The most significant validation process ever has been undertaken on this year's results. Individual components and joined interactions were tested form various perspectives (Refer to Figure 7.1).

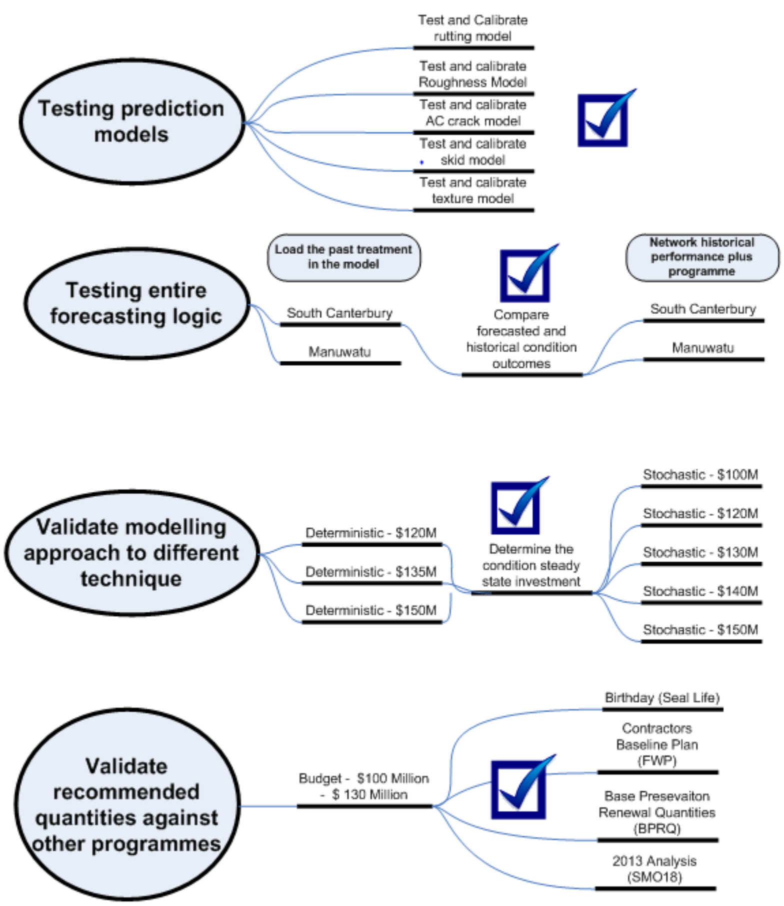


Figure 7.1: Validation of Modelling Outcomes

- Two performance forecasting model tests were undertaken by "rolling back" the data five years and then compared the predicted versus actual performance of the current data:

- All new and significant models were re-calibrated on the bases of the latest state highway data;
- Three networks were used where the maintenance programme for the past five years were simulated in dTIMS, followed by a comparison of results at current date;
- The forecasted prorgramme was compared to current maintenance quantities in past and current forward works programmes (Refer to Section 5.1);
- Lastly the modelling approach was compared to a completely different modelling philosophy (Stochastic model) to ensure the modelling result could line up.

Detail outcome of the modelling validation is presented in Appendix J; to **Appendix L**. An unprecedented level of validation on the forecasting model confirmed that the NZTA can have full confidence in the outcomes presented in this report.

8. Conclusions and Recommendations

8.1 Conclusions

This analysis has been completed as the main input in to the NLTP. Specific conclusions are:

Objective	Conclusions
Re-evaluate the minimum sustainable/preservation investment profile for the respective road classes on the SH network	An analysis was completed that only address road pavement when it needs the investment, or if any other strategy proves to be cheaper in the long-run.
Quantify the condition outcomes in relation to ONRC classification	This has been successfully achieved through the implementation of a new optimisation approach. It was established that the recommended funding level will achieve the defined performance targets for the ONRC classes.
Run scenarios either side of the minimum preservation need profile to better understand the associated risks with adopted investment profile	Despite the confidence in the recommended investment profile, there is an inherent risk that the targeted performance of the regional and local collector roads may be set too low. These road classes need to be monitored closely in order to understand the feasibility of the defined performance targets.
Assess the minimum funding to sustain safety over the NLTP period driven by polishing and flushing (safety related)	Safety analyses were successfully integrated to the safety programme with the preservation programme. Through this analysis a combined investment profile was established. A further understanding resulted from the analysis regarding the mutual gain from both programmes “being” aware of the maintenance treatments of the other programmes.
Validate and challenge the model outputs	A significantly comprehensive validation has confirmed that the NZTA could have full confidence in the outcome of the analyses.

8.2 Recommendations

8.2.1 Investment

The recommended medium-term (years 7 to 10) investment level is $100 million per annum. All analyses outcomes have indicated a need to increase the funding level after 2023. An increased budget between $130 million to a $150 million would be required for the long-term. The exact investment level will depend on the timing when an increased budget is initiated.

The investment split between the treatment categories is depicted in Table 8.1. This table also shows how the recommended quantities compare to the current programmes. It shows a relative good comparison in resurfacing quantities but the shortfall in contractor's baseline rehabilitation is evident.

Table 8.1: Recommended Maintenance Quantities

Average Annual Lane km Lengths (9 year excl. 2015/16)				
Scenario	**AC**	**CS**	**RHAB**	**HEAVY MTC**
2016 Recommended Investment ($100M V2)	210	1,512	164	207
Contractor Baseline (FWP)	195	1,525	135	
Base Preservation Renewal Qtys (BPRQ)	274	1,521	160	
2013 Outcomes (SMO18) (2 lanes per CL)	188	1,506	301	

8.2.2 Performance

The current performance has indicated that the adopted maintenance strategy for the NZTA is effectively achieving the objective of gaining more life from the surfacing without significantly compromising on the performance. The analyses suggested a continuation of this strategy and the recommended budget level will manage the network at recommended levels based on classification, holding high class roads and allowing lower class roads to deteriorate to lower levels. The analysis has also established that the regional and local collector roads' performance exceed that of the arterial roads, thus indicating capacity for performance reductions without significant consequences.

A lower budget level could not be adopted since it causes an immediate reduction in the performance of the national route system, where the target performance indicates a similar performance level to its current situation.

8.2.3 Safety

The Recommended quantity for resurfacing resulting from the preservation considerations amounts to 8.1% on annum. The corresponding surfacing needs if analysed in isolation is 1.2% per annum. The analysis has indicated that 39% of the required safety work would be addressed through the preservation treatments. The efficiency gain from the joined analysis of these two programme has released $5 million per annum that could be planned for other purposes.

8.2.4 Further work

Further work is required in order to address the concerns regarding the performance of asphalt surfaces. This part of the network is in a worse condition when compared to the chip seals. There will be an increase need for asphalt surfaces in the future thus warranting the investment into the enhancement of its performance.

There is a further step towards giving wider access of the modelling result to the NTZA. This will be addressed as part of the implementation of dTIMS Version 9 in New Zealand.

Appendix A: Data Quality and Pavement Strength

MWH®

BUILDING A BETTER WORLD

MEMORANDUM

TO: Elke Beca

DATE: 06 March 2016

CC:

REF:

FROM: Hassan Salarpour

MWH New Zealand Ltd

SUBJECT: National State Highway dTIMS modelling- Preparing data for dTIMS analysis

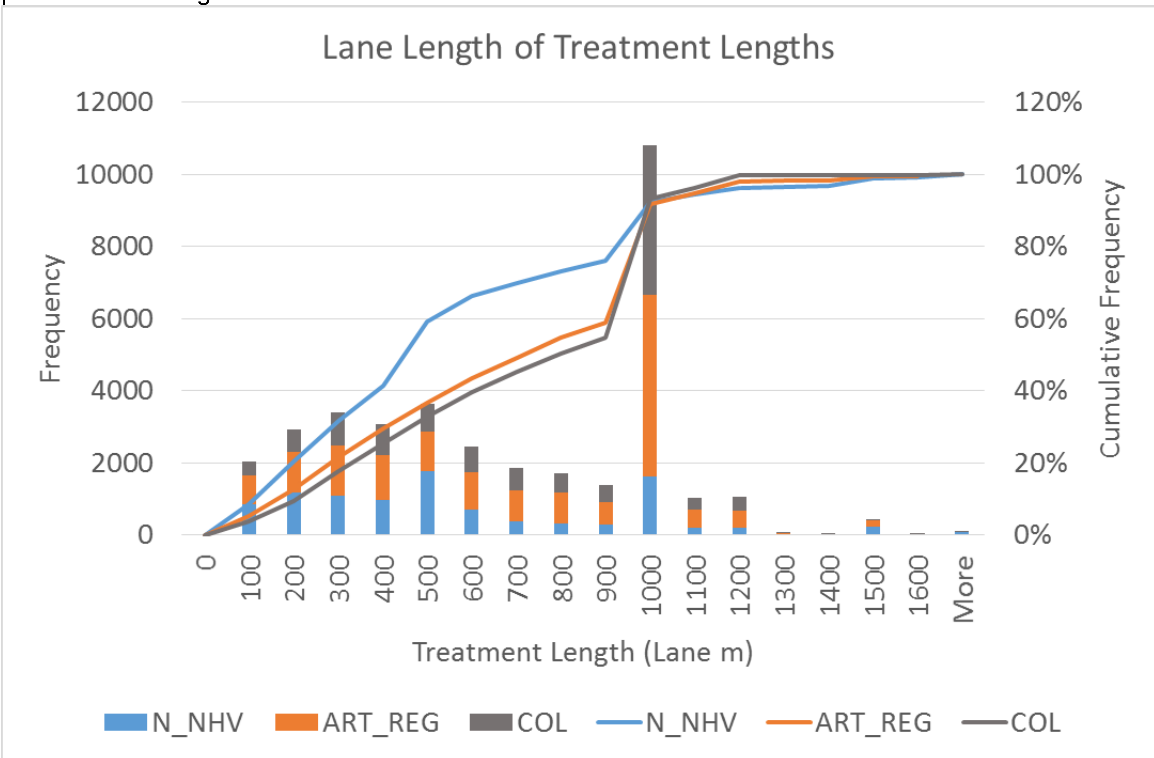
1- Background

The data required for the National State highway dTIMS analysis were provided by NZTA and based on 500m length rule.

The initial list of Treatment Lengths (TL) included 34569 TLs. This increased to 36223 TLs following splitting selected multilane TLs in Wellington and Auckland regions to two or more TLs.

2- Treatment Length Segmentation

Evidence suggests that treatment length management is still not adequate. A significant portion of the SH network contains long length TLs. Similar to the 2013 national modelling analysis, TLs have been split when exceeding 500m length. A summary of the final TL lane length, split by ONRC group is provided in the figure below.



3- Data Issue

There were a number of records from the RAMM data tables that did not contain the required data. Table 1 shows a summary of the missing data in the dataset and the criticality of data (based on initial data set).

The most significant issues found were the lack of **structural capacity** data. Lower priority data items that were missing were **surface information and pavement thickness and construction dates**.

A lesser number of errors were found with **traffic**, **rutting and roughness**. These data types are used in the models and have an important role in the deterioration modelling.

Table 1 Data errors found

Importance	Field	No. of TLs
Low Priority	Flushing	331
	Thickness of top surface	3330
	Thickness of old surfaces	3347
	Pothole and patching (area)	411
	Pothole (number)	411
	Surface Friction Coefficient def.	411
	Shoving (length) (HSD)	460
	Shoving (length of TL) (HSD)	460
	Shoving (by rating)	460
	Pavement Width	80
Required	AADT	307
	Percentage of Buses	644
	Percentage of HCV1	644
	Percentage of HCV2	644
	Percentage of Light commercial	644
	Percentage of Medium commercial	644
	Percentage of Cars	644
	CHIP (size/grade)	242
	Alligator cracking	411
	Pavement average thickness	9200
	Pavement construction date	7129
	SNP	26951
	Surface construction date	242
	Surface type	242
	Surface type function	240
	Surface width	80
Required if HSD present	IRI	911
	Average rut depth	460
	Texture	331
Required if NO HSD present	NAASRA	911

	Rut depth >30 mm (length)	411
Required if RAMM SurfLife is to be used in Model	Surface Expected Life	380
Required if Rating Data Present	Inspected area	412
	Inspected length	412
	Number of wheel path inspected	412
Grand Total		**63249**

4- Data preparation

The RAMM data was imported into the IDS dTIMS interface and prepared to be appropriate for the analysis.

Data preparation process was undertaken on the initial data set of 34569 TLs. The prepared data for Wellington and Auckland regions were then split into more TLs for the selected multilane sections.

The following sections describe the adopted data preparation methodologies:

SNP:

The pavement strength data was collected by Geosolve using TSD survey and utilised to calculate SNP values. These data were then adopted as SNP values for TLs with missing SNP data (26951 TLs).

Surface Layer:

The missing surface layers were estimated based on other related information such as number of surface layers, surface type and the average surface thickness for various surface types.

Pavement Construction Date:

The missing pavement construction dates were estimated based on other available information such as number of surface layers, surface type and the achieved surface lives for various surface types and chip sizes.

Roughness and Rutting:

The missing roughness and rutting data was updated using the provided HSD data by NZTA.

Other Missing Data:

The remaining missing records from the data set were completed using a combination of the following two methods:

- Using additional data tables such as surface structure and traffic data; and
- Estimating values from similar sections based on various relevant criteria.

Most of the missing data has been completed by estimation. In this method, all variables deemed to affect the missing data field have been identified, and all sections have been categorised based on similar properties. The average of each category has been allocated to the missing data field within that category.

Lane split for Wellington and Auckland regions:

IDS was tasked by NZTA to split some of the multilane TLs in Wellington and Auckland regions into two or more TLs based on their lane numbers. This exercise required changes to road name, TL and MC Cost tables.

The following describes the approach undertaken in this regard:

- New Road IDs was created by adding the lane position and number to original road name.
- The full width TLs was replaced with two or more TLs based on the number of lanes and the above new Road IDs.
- The other required information for these new TLs was divided into two groups as below:
    - Inventory data: This includes data that does not change on annual basis and remains unchanged for a period a time. The inventory data of the lane split TLs were the same as original TLs except the changes in surface width and number of lanes.
    - Condition data: The condition data included the data collected by both rating and HSD surveys. The rating data was proportionally distributed among the new TLs based on the lane width. The provided HSD data however, included the individual lanes data and was directly applied to these New TLs.
- The associated historical maintenance costs of these TLs were also distributed among the new TLs based on the lane width.

5- Historical maintenance costs and pre-seal costs

The recorded maintenance costs usually include the routine and reactive maintenance actions and also the pre-seal activities. While the changes in the routine and reactive maintenance actions is mainly related to the network pavement and surface performance, the cost of pre-seal activities is directly linked to the reseal quantities. The higher reseal quantities results in higher overall pre-seal activities cost.

Separating the pre-seal and other maintenance activities has never been as easy task. For the purpose of this analysis, it is assumed that the recorded maintenance activities within a year prior to the reseal date are pre-seal activities.

This assumption was then applied to the available maintenance and reseal records in the last 5 years and used in calculating the annual pre-seal cost on the network and for each region.

Table 2 shows the average percentage of pre-seal costs of the total maintenance costs in different regions.

Table 2 Average Pre-seal cost % (of total maintenance costs) in regions (2011-12, 2012-13, 2013-14)

Region	Pre-seal %	Region	Pre-seal %
North Island	25%	(NOC) TARANAKI	37%
South Island	30%	(NOC) WELLINGTON	30%
(EC) MARLBOROUGH	16%	(NOC) WEST COAST	33%
(EC) WEST WAIKATO SOUTH	23%	AUCK ALLIANCE	8%
(NOC) BOP EAST	23%	COASTAL OTAGO	36%
(NOC) BOP WEST	14%	MILFORD	48%
(NOC) CENTRAL WAIKATO	20%	NAPIER	19%

(NOC) EAST WAIKATO	34%	NELSON	24%
(NOC) MANAWATU-WHANGANUI	35%	NTH CANTERBURY	22%
(NOC) NORTHLAND	22%	OTAGO CENTRAL	41%
(NOC) SOUTH CANTERBURY	31%	SOUTHLAND	23%
(NOC) TAIRAWHITI ROADS NORTHERN	31%	WEST WAIKATO NORTH	40%
(NOC) TAIRAWHITI ROADS WESTERN	34%		

The extent and the average unit rates of pre-seal activities are also other important factors in dTIMS analysis.
A task was defined to calculate the average historical pre-seal cost $/m^2$ and estimate the extent of pre-seal in different regions.
Maintenance costs and quantities are the two main inputs of any recorded maintenance activity in RAMM. For the purpose of this study, it was decided to select the recorded maintenance **quantities** as the base data in estimating the pre-seal extent and then utilise the recorded **costs** to calculate the pre-seal unit rate that results in similar pre-seal extent to those calculated based on quantities.

The following describes the methodology in more detail:

1) Calculating the extent of pre-seal for each TL using TL area from *TL table* and the estimated pre-seal quantities from *MC Cost table*. (note: The selected quantity unit for this exercise is m^2)
2) Plotting the pre-seal extent distribution based on the percentage of TL area
3) Using the pre-seal cost (cost_amount_rci) from MC Cost *table* to find pre-seal cost $/\mathrm{m}^2$ value that result in similar pre-seal extent distribution to the first distribution based on pre-seal quantities.

It must be noted that the recorded maintenance quantities are the base inputs in this study and are assumed to be accurate.
Table 3 demonstrates an example of the adopted method.

Table 3 Estimating Pre-seal extent and unit rate

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost $/m^2$		
		$\$21.5/m^2$	$\$29/m^2$	$\$14/m^2$
0.1	0.6%	0.5%	0.4%	0.7%
0.2	0.9%	0.9%	0.7%	1.4%
0.3	1.3%	1.3%	0.9%	2.0%
0.4	1.7%	1.7%	1.3%	2.6%
0.5	2.3%	2.2%	1.6%	3.4%
0.6	3.1%	2.9%	2.2%	4.5%
0.7	4.2%	4.2%	3.1%	6.4%
0.8	6.2%	6.3%	4.7%	9.7%
0.9	11.2%	11.8%	8.7%	18.1%
0.95	20.6%	20.7%	15.4%	31.8%
Average	5.0%	5.0%	3.9%	7.1%

As seen in the table, pre-seal extent varies between 0.6% and 20.6% of the TL area with the average pre-seal extent of 5% of the TL area. This is the extent estimated based on maintenance **quantities**.

More pre-seal distributions are also estimated based on the recorded maintenance **costs** and some assumed pre-seal unit rates. It can be seen in the table that the pre-seal unit rate of \$21.5 $/m^2$ results in similar pre-seal extent distribution as that calculated based on quantity. Hence, it can be assumed that this is the historical average pre-seal unit rate for this dataset.

Topic: Structural Number (SNP) – Calculation, Compare One Pager

Date: 28 March 2016

Author: Elke Beca

Objective

Provide an overview of the key variable: SNP

Structural Number (SNP) is a key variable used in multiple of pavement deterioration models.

SNP Methods

Structural number is value that may be derived from various methods to provide an indication of a pavement strength. While evidence suggests that aggregating inputs to arrive at an overall strength value may not be a suitable absolute parameter. As a relative measure, for use in performance modelling, the structural number is still the best indicator we have available and continues to be included in our IDS NZ dTIMS setup.

Two common methods for calculating SNP have been tested prior to this analysis. Both of these methods are documented in the NZTA research report 281 (pg 35-38).

Equation 4.5: Calculating using pavement layer thickness and moduli

$$SNP = 0.0394 \sum_{i=1}^{n\_layer} a_i h_i + SNSG \qquad \text{Equation 4.5}$$

$$a_i = a_g \left(\frac{E_i}{E_g} \right)^{0.333} \qquad \text{Equation 4.6}$$

$$SNSG = 3.51 \log_{10} CBR - 0.85 (\log_{10} CBR)^2 - 1.43 \qquad \text{Equation 4.7}$$

where:

SNP	=	pavement structural number (Equation 4.5);
a_i	=	layer coefficient for the i'th pavement layer above the subgrade as defined by Equation 4.6;
n_layer	=	number of pavement layers above the subgrade
h_i	=	thickness of the i'th pavement layer
a_g	=	the layer coefficient of standard material (from the AASHO Road Test) as listed in Table 4.4
E_i	=	resilient modulus of the i'th pavement layer
E_g	=	resilient modulus of the standard material (from AASHO Road Test) as listed in Table 4.4
$SNSG$	=	structural number contribution from the subgrade (Equation 4.7)
CBR	=	subgrade California Bearing Ratio (%)

Equation 4.9: Using Falling Weight Deflectometer deflection data (RAMM)

Transit New Zealand equation:

$$SNP = 4.47 + 0.463 \log_e (d_0) + 0.063 \log_e (d_0 - d_{900})^{2.2} - 0.031 \log_e (d_0 - d_{1500})^3$$

Equation 4.9

Where: d values are bowl deflection values from the Falling Weight Deflectometre surveys (FWD)

d0 = disp0
d900 = disp6
d1500 = disp8

Historically in NZ dTIMS modelling (where pavement thickness and materials are not known), the SNP has been calculated *Equation 4.9*.

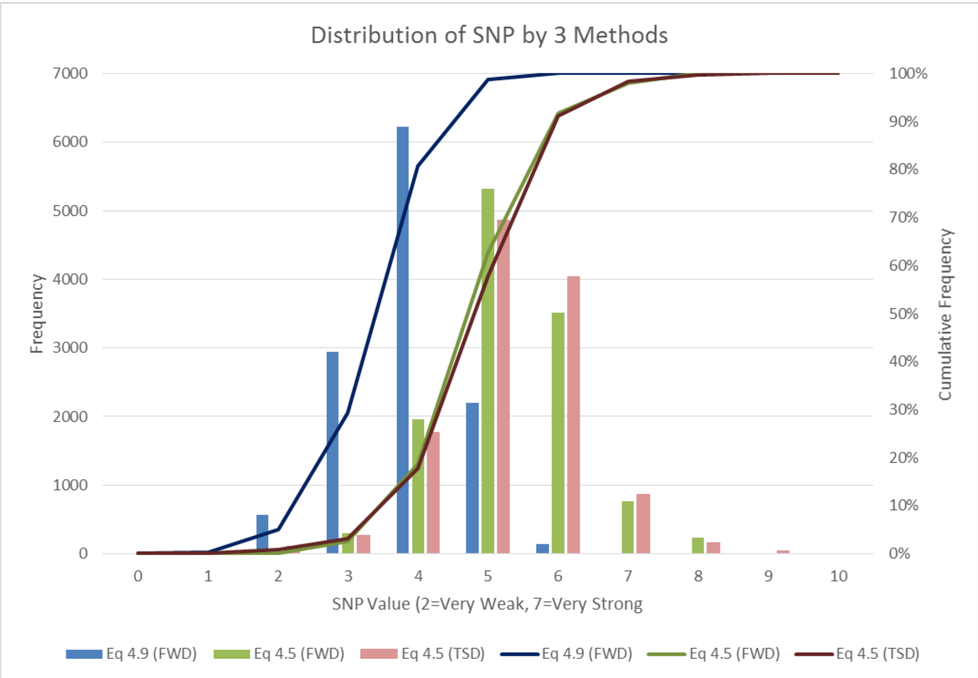
In 2015 the traffic speed deflectometer (TSD) vehicle surveyed approximately 45% of the NZ SH network (~710,000 equivalent test points covering ~5,100 cl.km of network), gathering continuous deflection data. At the time of this analysis, no formal research had been completed to confirm how the TSD should be interpreted and/or the alignment of TSD with FWD, however, comprehensive analysis carried out by Geosolve suggests the two may be aligned.

Historical FWD testing provides coverage of approximately 75% of the SH network (~82,000 test points covering ~ 8,500 cl.km).

SNP Compare

Three methods have been compared:

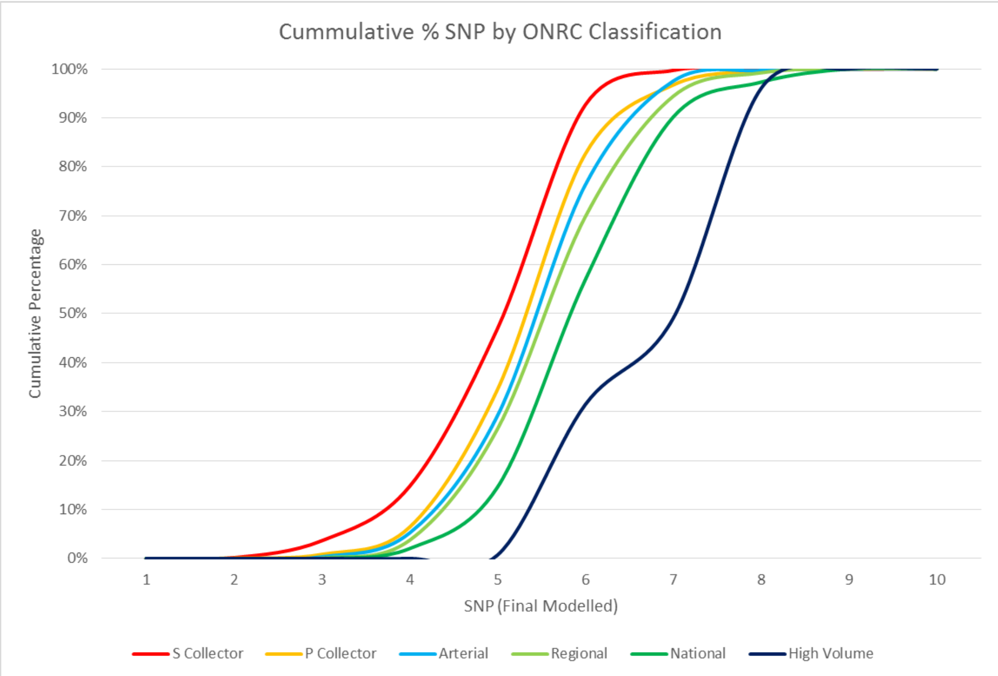
- Equation 4.9
- Equation 4.5 (FWD only)
- Equation 4.5 (TSD tethered to FWD where available)



This summary shows that Equation 4.9 provides a SNP profile approximately 1.5SNP weaker than Equation 4.5. What is very promising is that the Equation 4.5 SNP profile using FWD and TSD align very well.

For the 2016 analysis, Geosolve have calculated SNP using *Equation 4.5* using data gathered during historical FWD surveys and where available, utilising TSD tethered to these FWD surveys. This provides coverage to around 75% of the network. For the remaining ~25%, SNP data was infilled using Road averages and where no FWD was available for a Road, using Region averages.

The following chart shows the final SNP split by ONRC classification. The results appear as intuitively expected with higher class roads demonstrating higher strength. The High Volume routes are typically Expressways and Motorways where it is expected pavements will be built to carry loads.



Prediction Model

No prediction model for structural number currently exists. This variable is fixed throughout the pavement life and reset when the pavement is renewed.

Topic: Data Requirements

One Pager

Date: 25 November 2015

Author: Elke Beca

1. Objective

Delivery of an exemplary NLTP Analysis is dependent upon access to quality, accurate and timely data. This summarises our current data position.

2. Complete

- Copy of National RAMM database has been created including the following:
  - TL cut to 500m (max 600m) based on 2013 script
  - Access to TSD and SCANNER Crack datasets
  - Latest FWD surveys (no updates will be included)
  - Dec 2014 HSD (no updates will be included)
  - 2013 Rating data (last RAMM Rating)
  - Latest renewal updates (no updates will be included)
  - FWP (expect an update of this table)
  - Maintenance Costs (no updates will be included)
- Hassan Salarpour, Elke Beca, Dean Silvester and Gemma Mathieson have access to the RAMM database.

3. Outstanding – Yet to Complete

- Meta data for TSD and SCANNER Crack datasets. Any supporting information on how this data aligns with existing parameters or confidence levels.
  - Martin Gribble is tasking Geosolve to establish a correlation between TSD and FWD **(needs follow-up with urgency from NZTA with defined timeframe) Action GH to follow up with MG**
  - Theuns Henning is involved in SCANNER crack alignment with RAMM rating on LTPP sites **(needs follow-up with urgency from NZTA with defined timeframe) Action TH EB provide data**
- Contractor base preservation FWP **(NZTA to liaise with contractors and set a date when NOMAD must be updated (in December), we will then take a final cut of FWP)** Spreadsheet consistent format (Chch, Nth Canterbury & AMA) Action GH. Internal specimen program).
  - Specimen program (excl. Chch, Nth Canterbury & AMA), Central Otago next week
  - LDM will get AMA program
  - RB has 3yr prog for Chch & Nth Canterbury (15/16)

    - Treatment Codes not consistent
    - Wellington/AMA and Dunedin (specimen program whole or partially by lane) – FWP by lane
- Agreement to model by State Highway Classification rather than ONRC. If the latter NZTA to provide list by Road ID.
    - EB Jeremy Hughes (Company X) or RSL directly to ask how to write SQL script to relate ONRC to data within database.
- Treatment costs by NOC
    - EB Action to Pradeep.
- Base Preservation Renewal Quantities by NOC. If available maintenance lump sum quantities to assist in calibration the maintenance cost model
    - EB Action Karen Kiriona for this there will be gaps (how do we fill these). Ask for Gordon's spreadsheet and all of the section 6 tables from contracts have been awarded.
    - GH unsure how we get lump sum per NOC (need to specify what it is we are looking for). EB liaise with Pradeep.
- AMA & Wellington Urban AC NLTP Requirements: Due to the nature of these networks, it is requested that the NLTP requirements be assessed directly by their respective network teams. These requirements will be compared with model outputs with the most appropriate assessment used in the submission. **(NZTA to liaise with these networks and the independent results provided back to analysis team by Jan 2016)**
    - Dave Robertson – Wellington
    - Paul Geck – AMA
- ACTION: EB – what to do on lanes? **Lane km outputs.** One Pager. Explain data and what we will be doing and what the result is.
- NLTP Analysis: 30yrstrategic investment plan (not a detailed program) but investment profile. **One pager DS** Concerns over run time

Topic: NLTP Analysis Data Segmentation

One Pager

Date: 2 December 2015

Author: Elke Beca

1. Recommendation

Model by centreline TL's with exception of AMA and Wellington which will be modelled by lane. TLs will be 600m (maximum). Report analysis outputs by lanekm.

2. Objective

Define the base network segmentation process for the NLTP modelling analysis. Define the reporting units.

3. Methodology

The 2013 national modelling project highlighted a weakness in the management and ongoing maintenance of treatment lengths within the RAMM database. An excess of long treatment lengths, which are not suitable for modelling purposes, were identified in the database.

- A script was developed to cut each treatment length at 500m or up to 600m if the treatment length was between 500 and 600m. This has been applied to the 2015 dataset.

A number of areas are managing their networks by lane rather than centerline. RAMM is limited to managing treatment lengths and surfaces by centerline rather than lane.

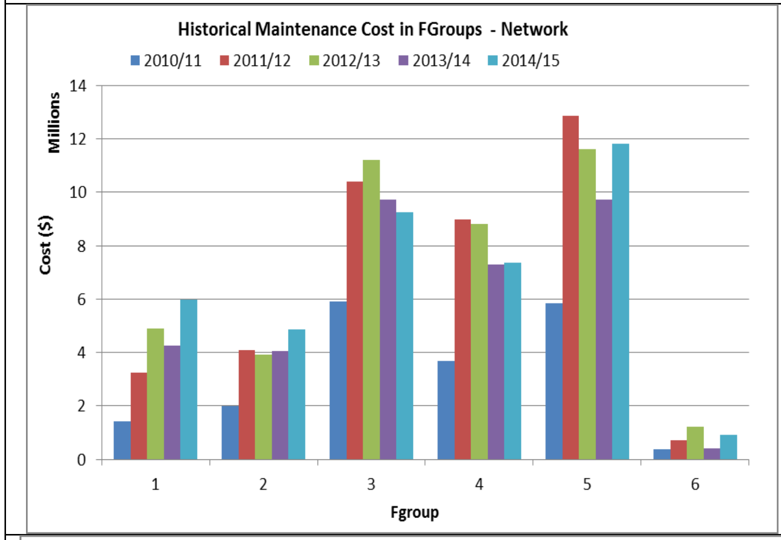
The following will apply to the 2015 modelling analysis:

- As a rule all treatment lengths will be modelled by centerline with two exceptions:
    - AMA and Wellington Urban, where a lane specific Forward Work Programme (FWP) has been provided, will have lane treatment lengths manually added to the dTIMS input file.
    - Lane treatment lengths will be copies of the centerline TL with the following updates: surface details (if available by lane), width, number of lanes FWP and high speed data (if available),
    - Maintenance costs on lane TL will be allocated correctly if possible or divided by number of new lane TLs.
- Analysis reported outputs will be in lane km calculated at treatment length level by multiplying the model output length by number of lanes (recorded by treatment length). *Note: all cost calculations within the model are by area so will not be impacted.*
- It is understood the number of lanes field is not always a whole number and this is acceptable.

Historical Maintenance and Pre-seal costs:

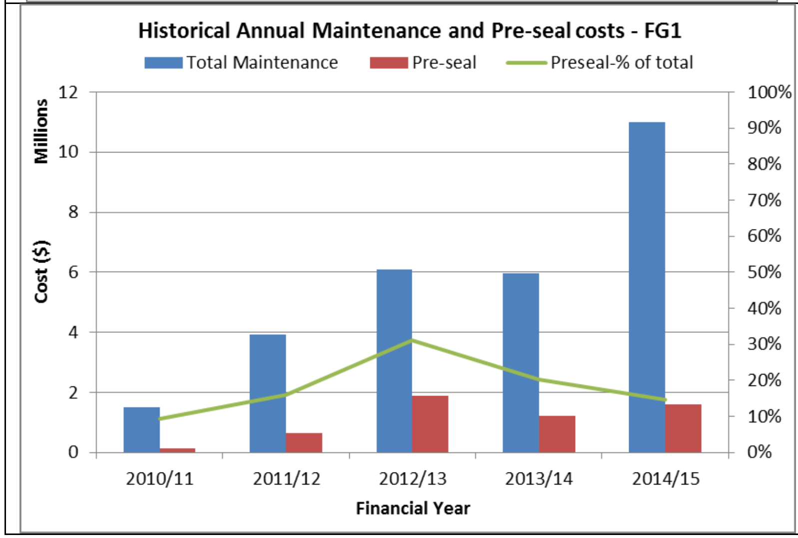
For the purpose of this analysis, it is assumed that the recorded maintenance activities within a year prior to the reseal date are pre-seal activities. This assumption was then applied to the available maintenance and reseal records in the last five years.

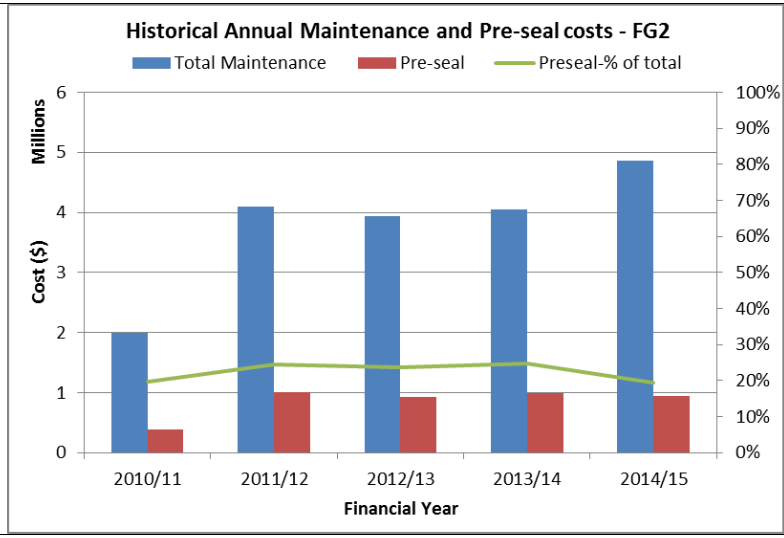
Network

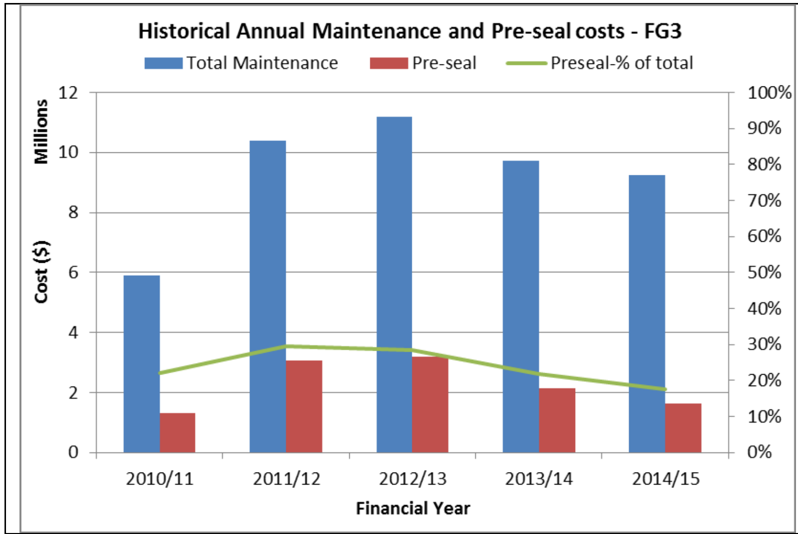


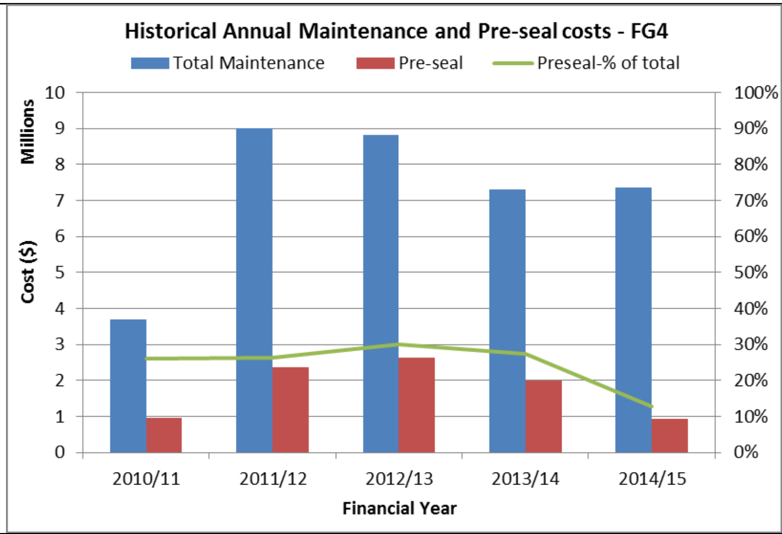
Pre-seal % (of total maintenance costs)	FGroups						Network
	1	2	3	4	5	6	
2010/11	9%	20%	22%	26%	24%	17%	22%
2011/12	16%	25%	30%	26%	24%	26%	25%
2012/13	31%	24%	29%	30%	25%	46%	28%
2013/14	20%	25%	22%	27%	30%	53%	25%
2014/15	15%	20%	18%	13%	14%	25%	16%

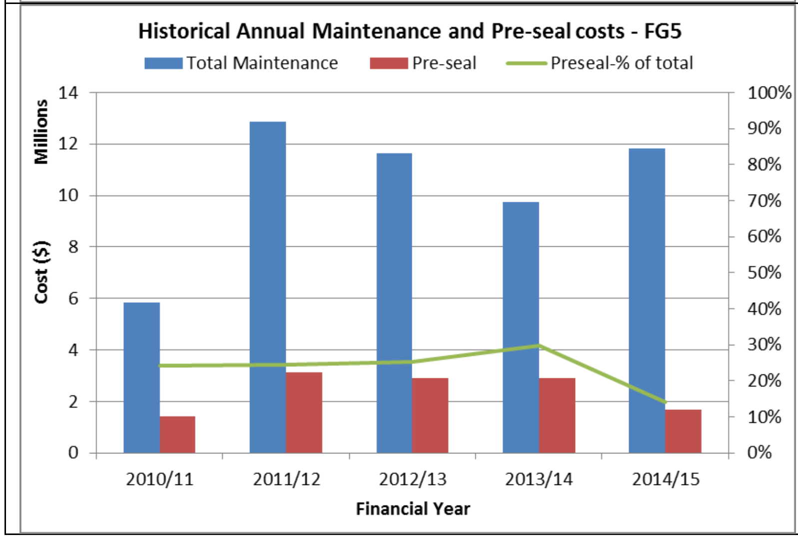
Note: 2014/15 pre-seal data must be ignored as not all the reseal projects in 2015/16 financial year are completed or loaded into RAMM.

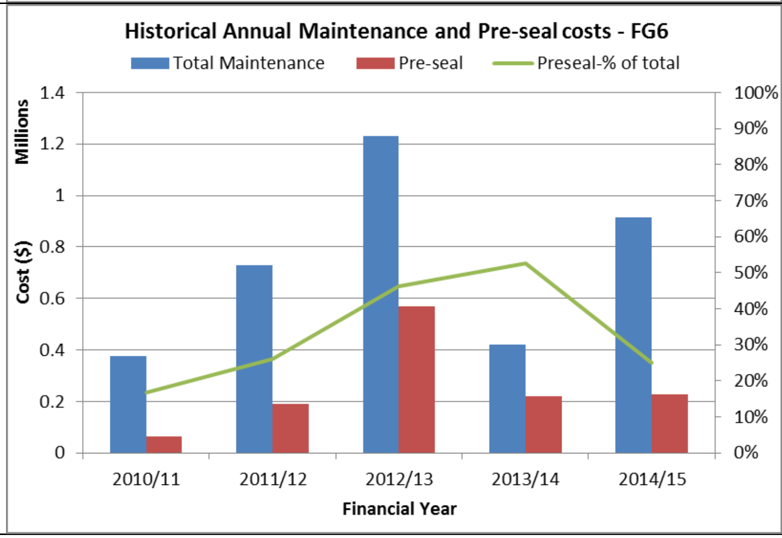




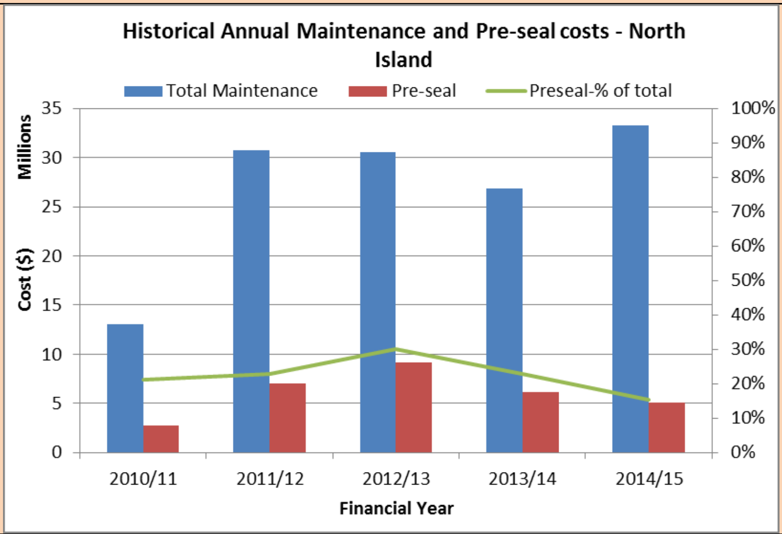

Historical Annual Maintenance and Pre-seal costs - FG3
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
0
2
4
6
8
10
12
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year


Historical Annual Maintenance and Pre-seal costs - FG4
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
0
1
2
3
4
5
6
7
8
9
10
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year


Historical Annual Maintenance and Pre-seal costs - FG5
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
0
2
4
6
8
10
12
14
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

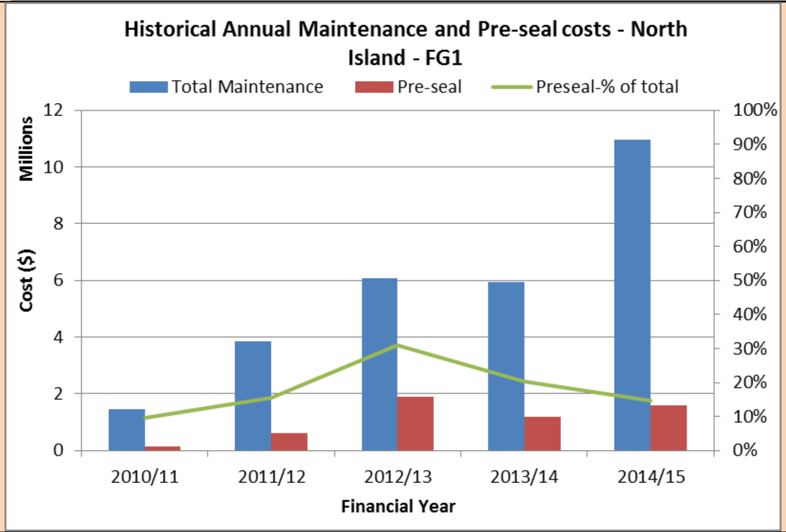

Historical Annual Maintenance and Pre-seal costs - FG6
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

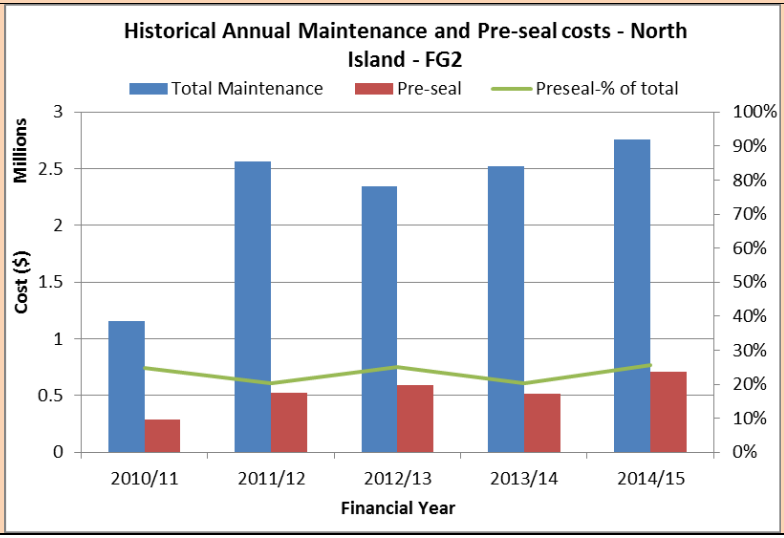
North Island

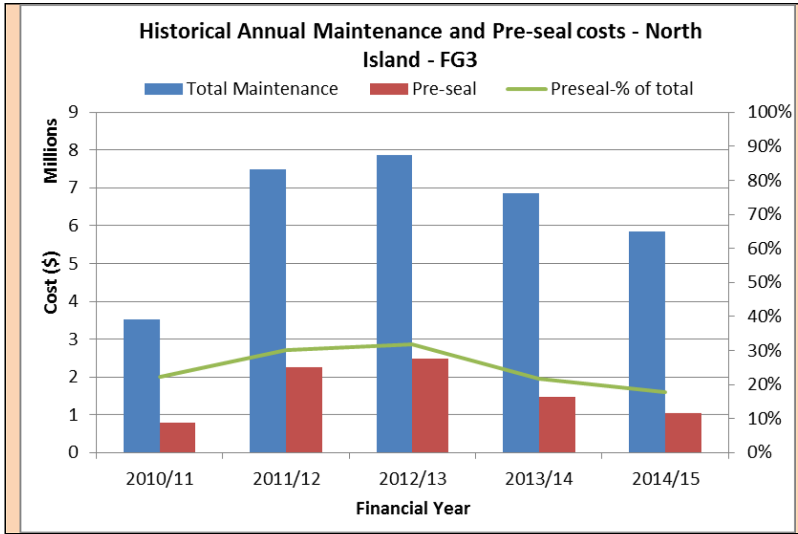


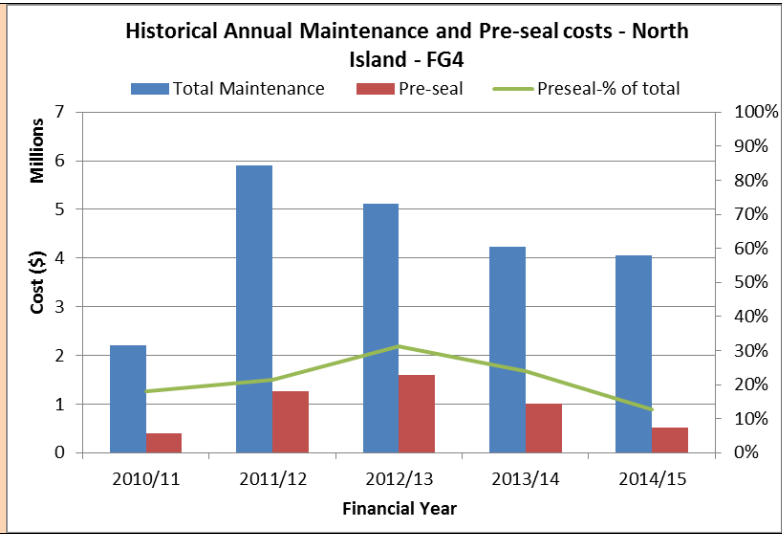
Pre-seal % (of total maintenance costs)	FGroups						Network
	1	2	3	4	5	6	
2010/11	10%	25%	22%	18%	25%	21%	21%
2011/12	16%	20%	30%	22%	22%	26%	23%
2012/13	31%	25%	32%	31%	28%	41%	30%
2013/14	20%	20%	22%	24%	26%	0%	23%
2014/15	15%	26%	18%	13%	13%	0%	15%

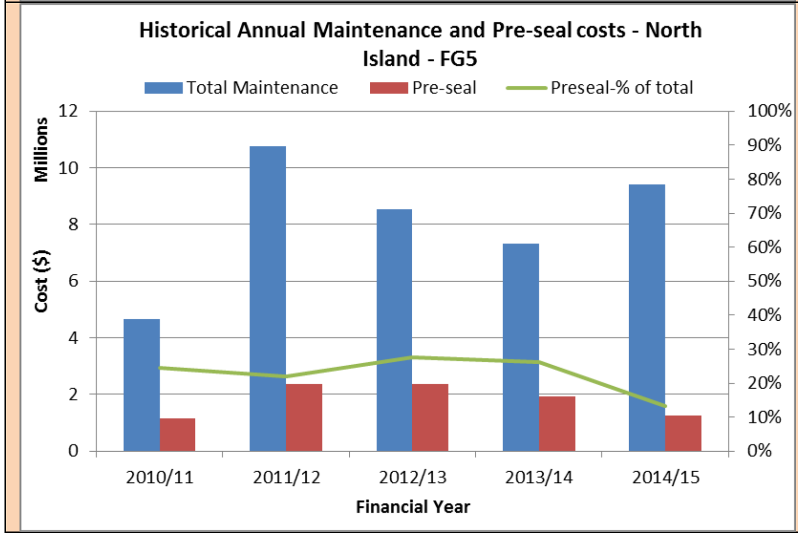
Note: 2014/15 pre-seal data must be ignored as not all the reseal projects in 2015/16 financial year are completed or loaded into RAMM.

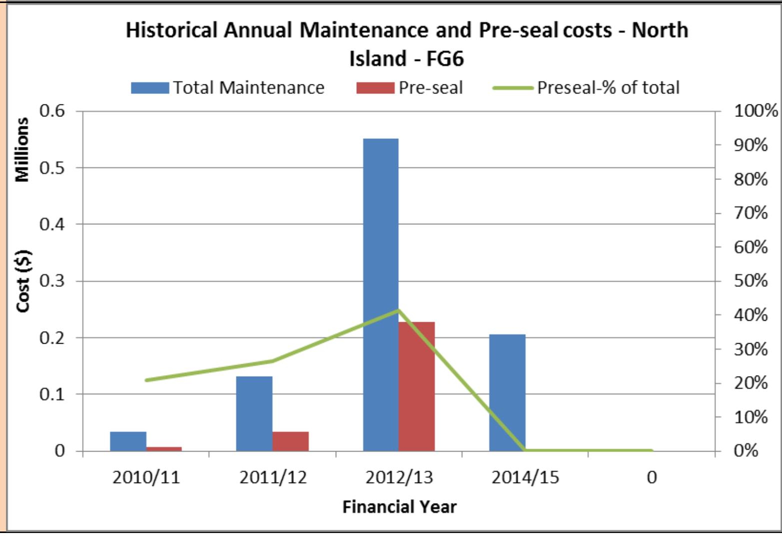




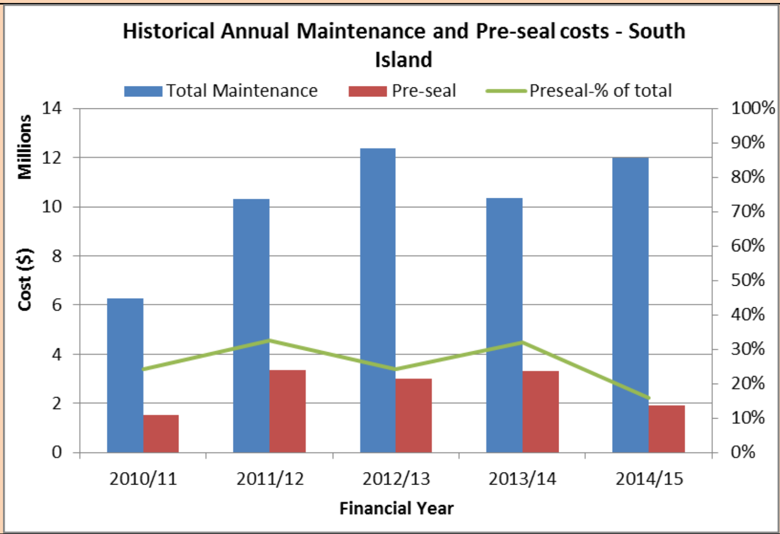

Historical Annual Maintenance and Pre-seal costs - North Island - FG3
Total Maintenance
Pre-seal
Preseal-% of total
Cost ($)
Millions
0
1
2
3
4
5
6
7
8
9
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year


Historical Annual Maintenance and Pre-seal costs - North Island - FG4
Total Maintenance
Pre-seal
Preseal-% of total
Cost ($)
Millions
0
1
2
3
4
5
6
7
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year


Historical Annual Maintenance and Pre-seal costs - North Island - FG5
Total Maintenance
Pre-seal
Preseal-% of total
Cost ($)
Millions
0
2
4
6
8
10
12
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

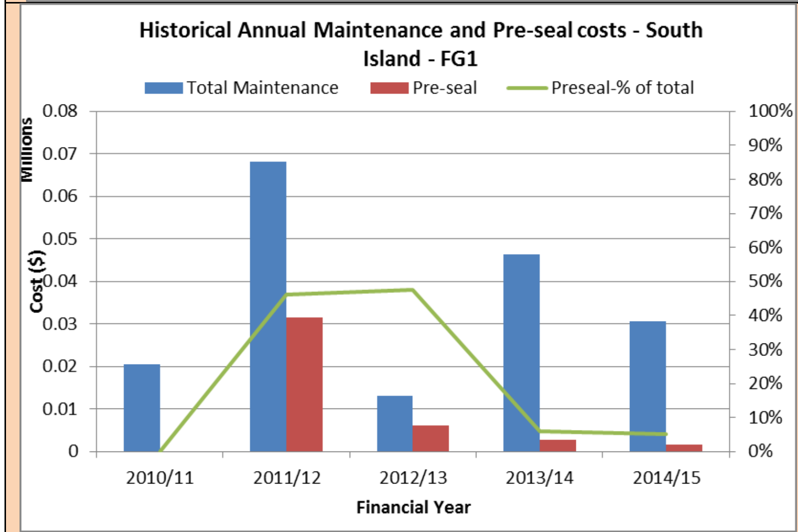

Historical Annual Maintenance and Pre-seal costs - North Island - FG6
Total Maintenance
Pre-seal
Preseal-% of total
Cost ($)
Millions
0
0.1
0.2
0.3
0.4
0.5
0.6
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2010/11
2011/12
2012/13
2014/15
0
Financial Year

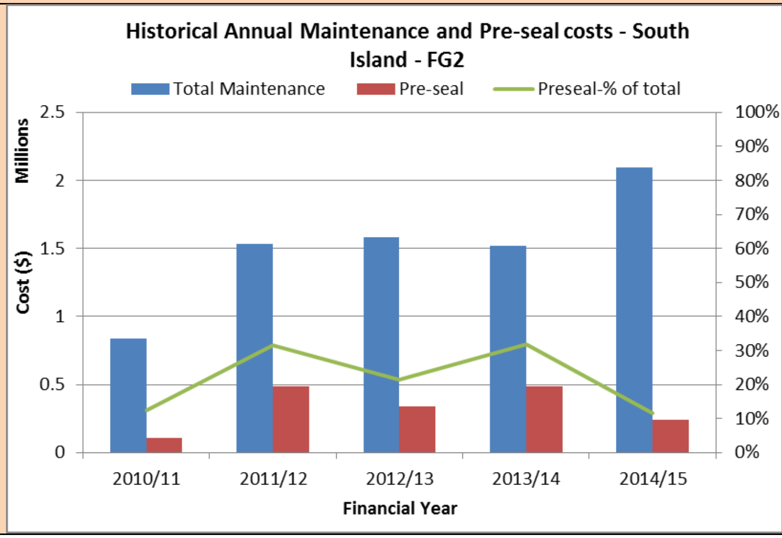
South Island

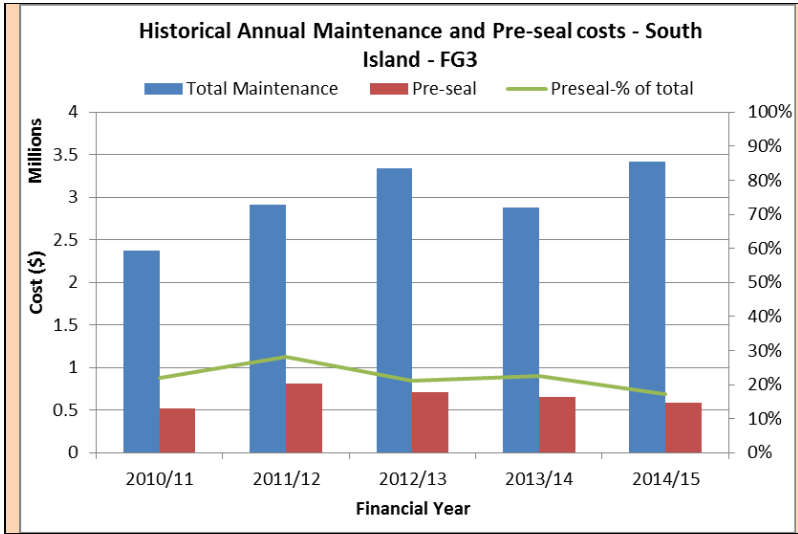


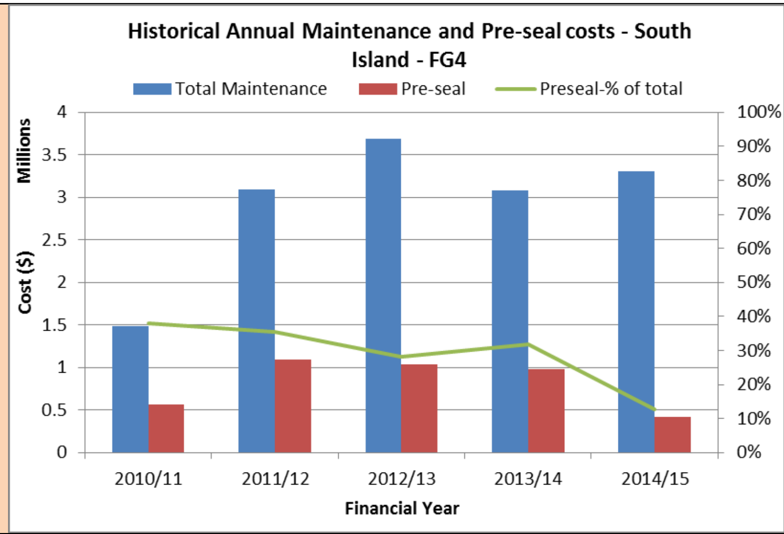
Pre-seal % (of total maintenance costs)	FGroups						Network
	1	2	3	4	5	6	
2010/11	0%	13%	22%	38%	23%	17%	24%
2011/12	46%	32%	28%	35%	37%	26%	33%
2012/13	47%	21%	21%	28%	18%	50%	24%
2013/14	6%	32%	23%	32%	41%	53%	32%
2014/15	5%	12%	17%	13%	18%	32%	16%

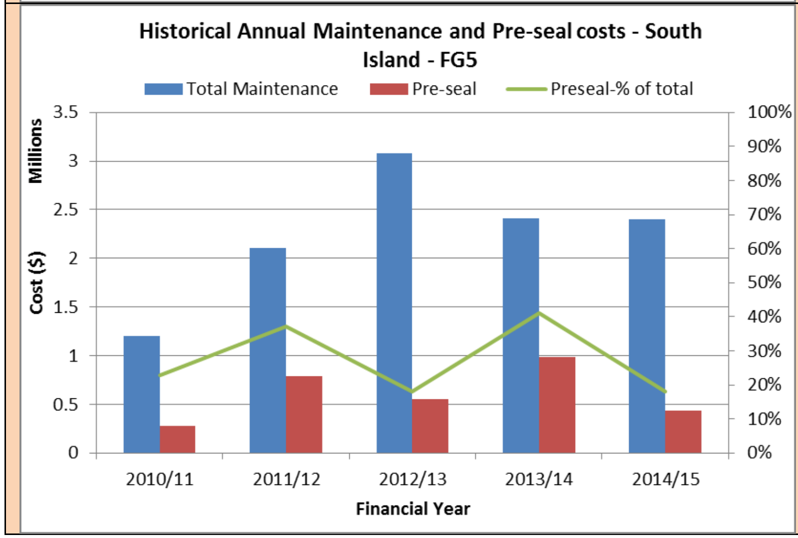
Note: 2014/15 pre-seal data must be ignored as not all the reseal projects in 2015/16 financial year are completed or loaded into RAMM.

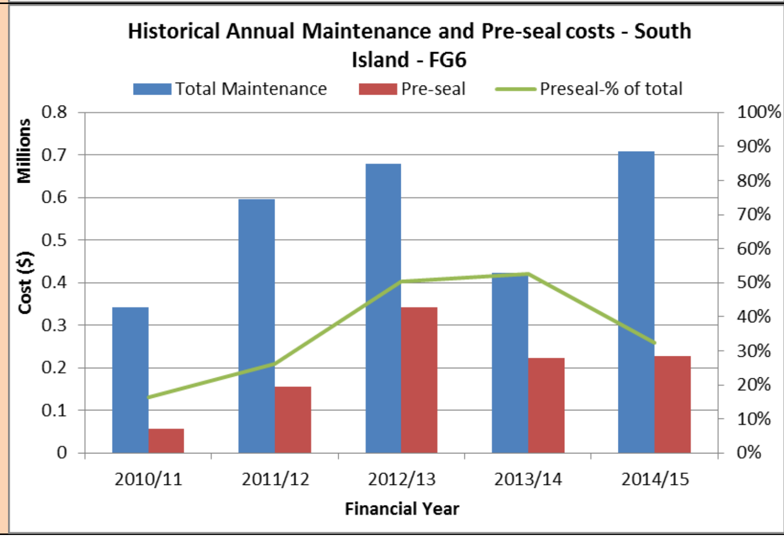




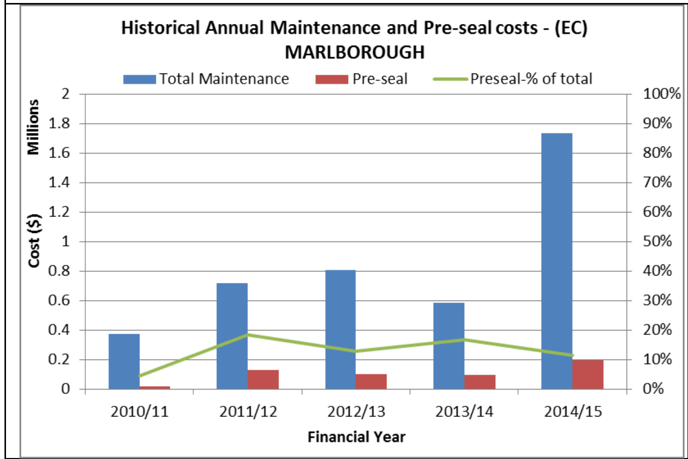

Historical Annual Maintenance and Pre-seal costs - South Island - FG3
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
4
3.5
3
2.5
2
1.5
1
0.5
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year


Historical Annual Maintenance and Pre-seal costs - South Island - FG4
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
4
3.5
3
2.5
2
1.5
1
0.5
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

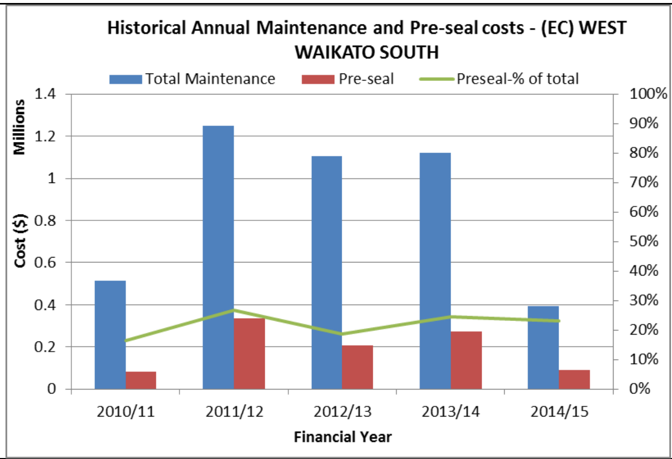

Historical Annual Maintenance and Pre-seal costs - South Island - FG5
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
3.5
3
2.5
2
1.5
1
0.5
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year


Historical Annual Maintenance and Pre-seal costs - South Island - FG6
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

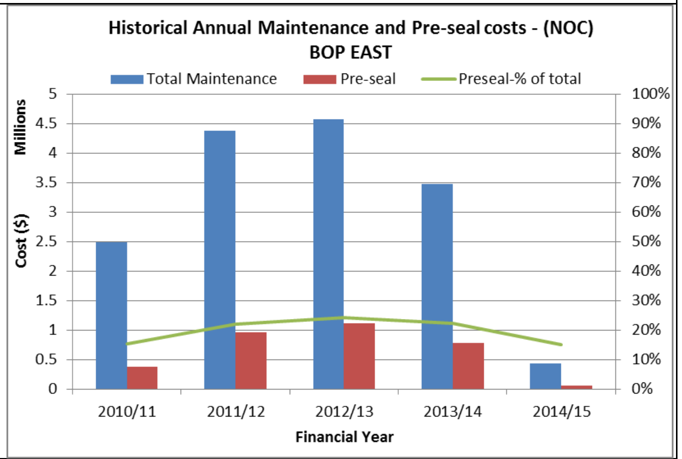
Regions



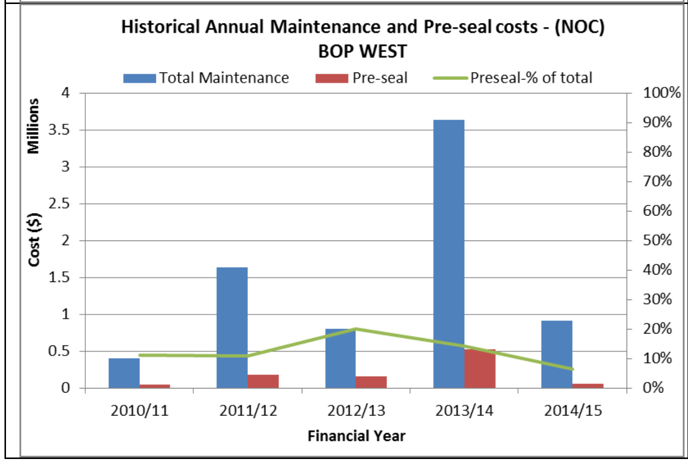
Historical Annual Maintenance and Pre-seal costs - (EC) MARLBOROUGH
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
Financial Year
2010/11
2011/12
2012/13
2013/14
2014/15



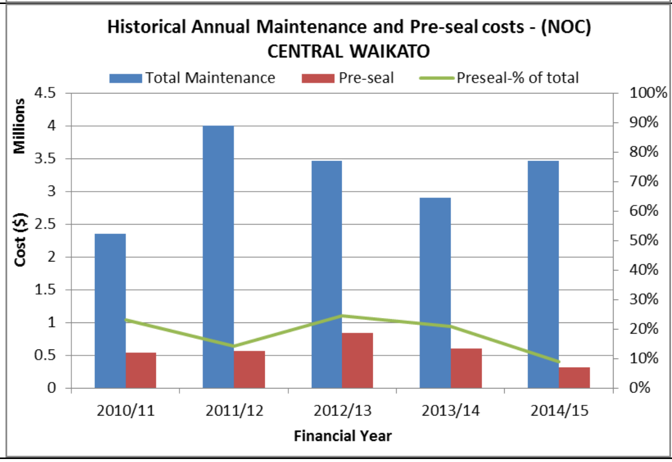
Historical Annual Maintenance and Pre-seal costs - (EC) WEST WAIKATO SOUTH
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
Financial Year
2010/11
2011/12
2012/13
2013/14
2014/15



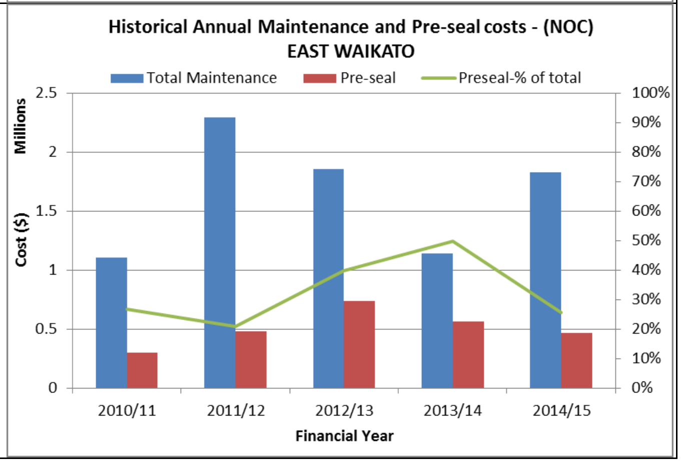
Historical Annual Maintenance and Pre-seal costs - (NOC) BOP EAST
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
Financial Year
2010/11
2011/12
2012/13
2013/14
2014/15



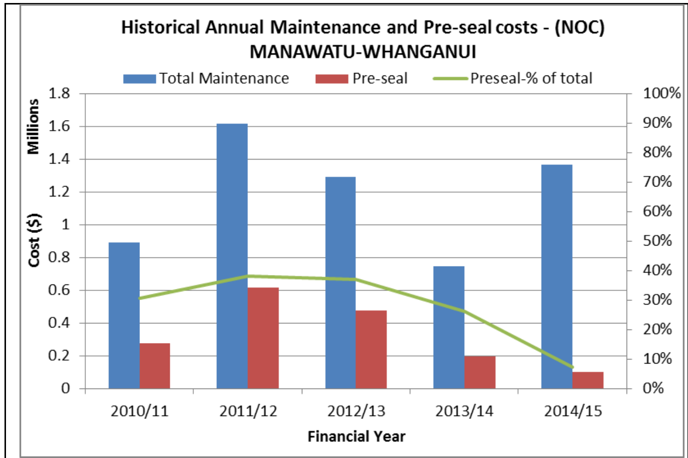
Historical Annual Maintenance and Pre-seal costs - (NOC) BOP WEST
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
Financial Year
2010/11
2011/12
2012/13
2013/14
2014/15

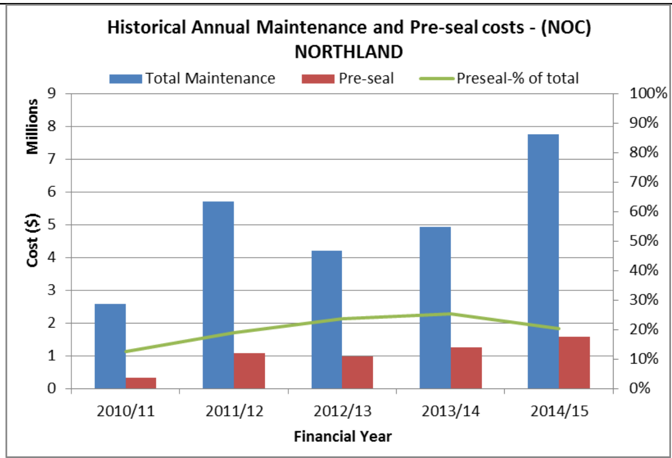


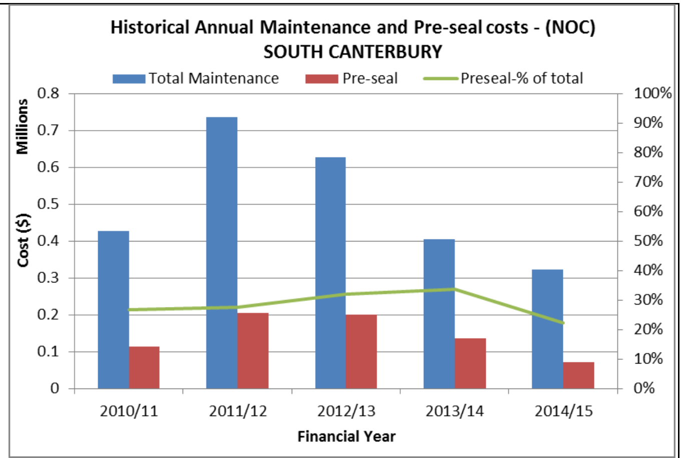
Historical Annual Maintenance and Pre-seal costs - (NOC) CENTRAL WAIKATO
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
Financial Year
2010/11
2011/12
2012/13
2013/14
2014/15

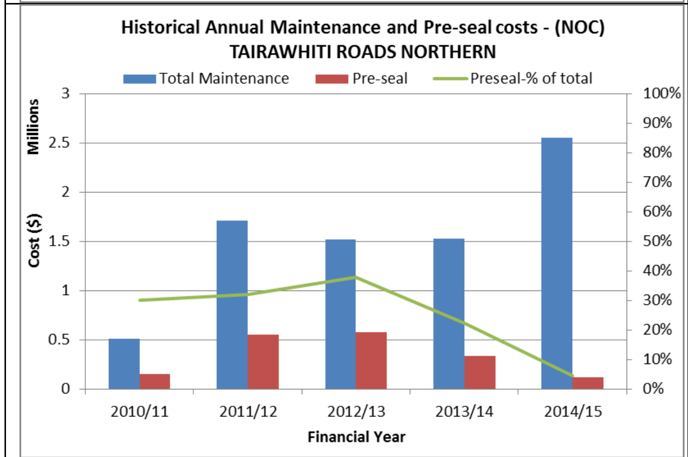


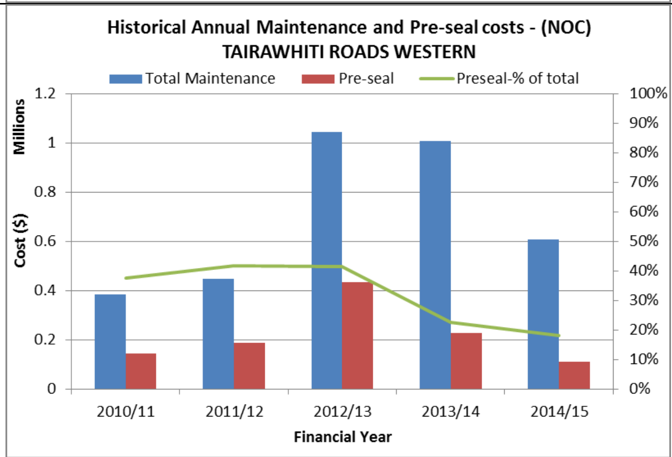
Historical Annual Maintenance and Pre-seal costs - (NOC) EAST WAIKATO
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
Financial Year
2010/11
2011/12
2012/13
2013/14
2014/15

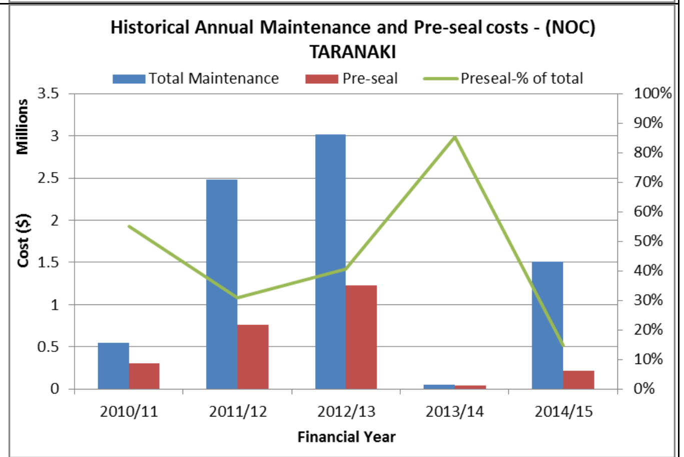

Historical Annual Maintenance and Pre-seal costs - (NOC)
MANAWATU-WHANGANUI
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

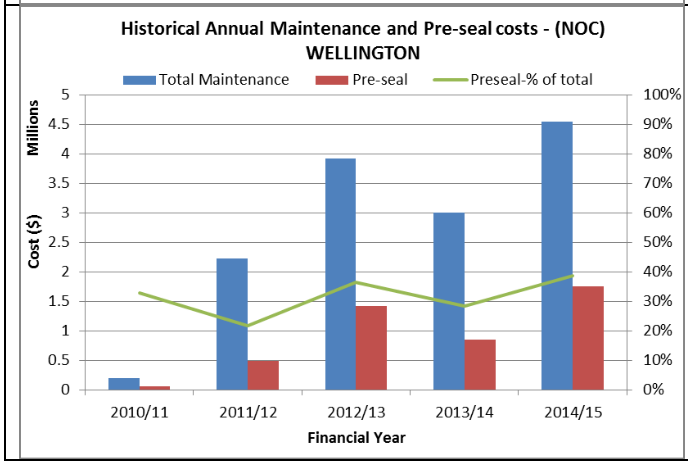

Historical Annual Maintenance and Pre-seal costs - (NOC)
NORTHLAND
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

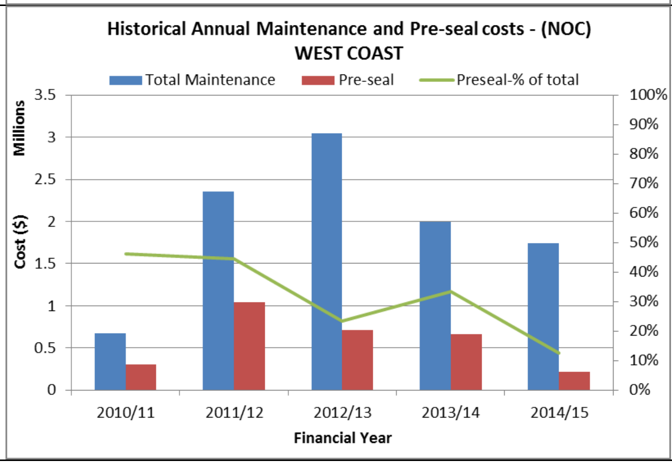

Historical Annual Maintenance and Pre-seal costs - (NOC)
SOUTH CANTERBURY
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

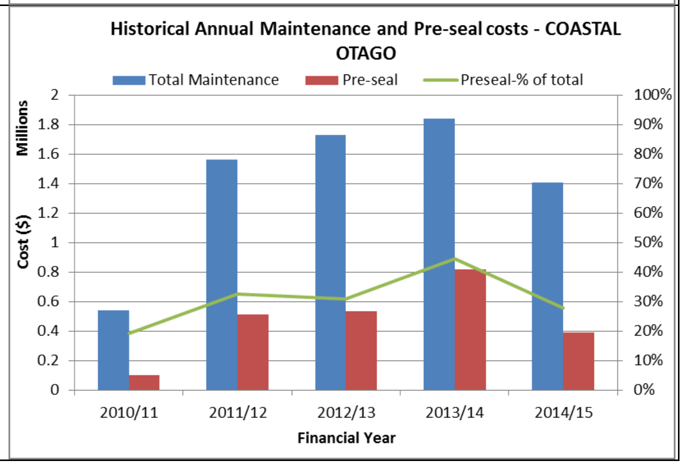

Historical Annual Maintenance and Pre-seal costs - (NOC)
TAIRAWHITI ROADS NORTHERN
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

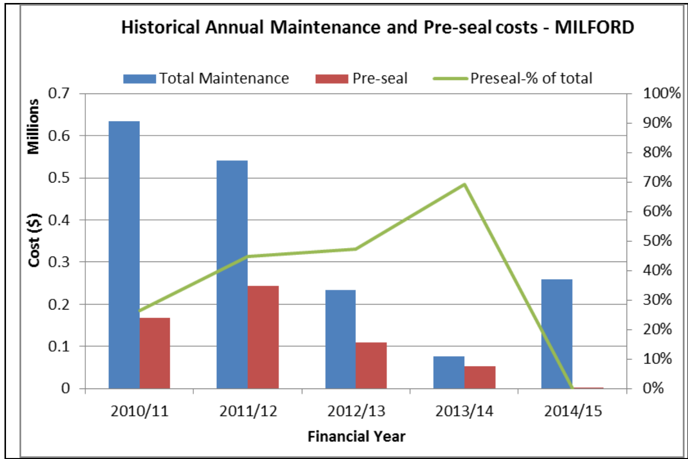

Historical Annual Maintenance and Pre-seal costs - (NOC)
TAIRAWHITI ROADS WESTERN
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

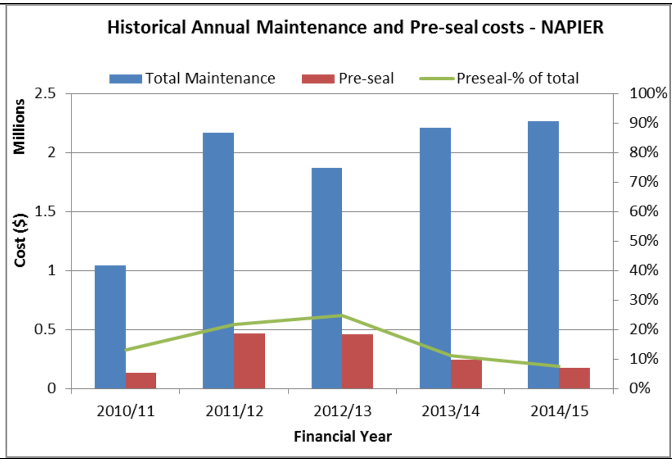

Historical Annual Maintenance and Pre-seal costs - (NOC)
TARANAKI
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

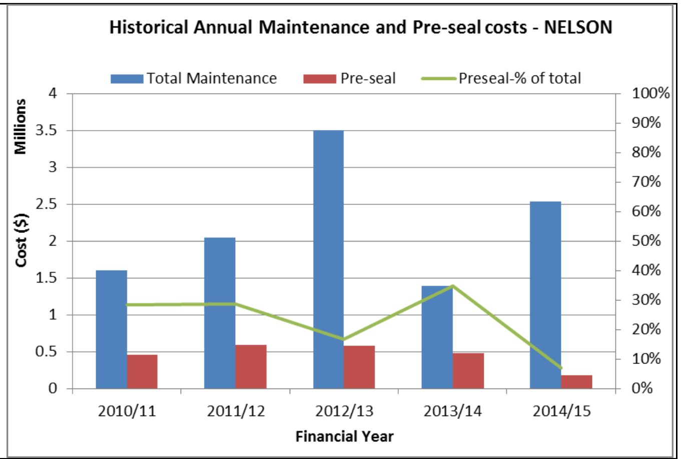

Historical Annual Maintenance and Pre-seal costs - (NOC)
WELLINGTON
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

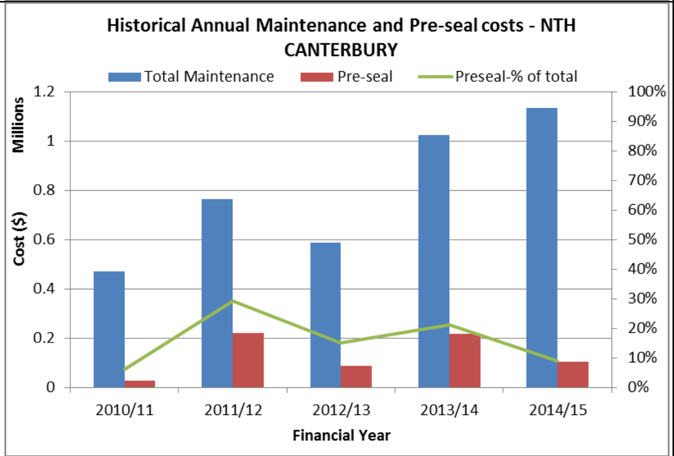

Historical Annual Maintenance and Pre-seal costs - (NOC)
WEST COAST
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

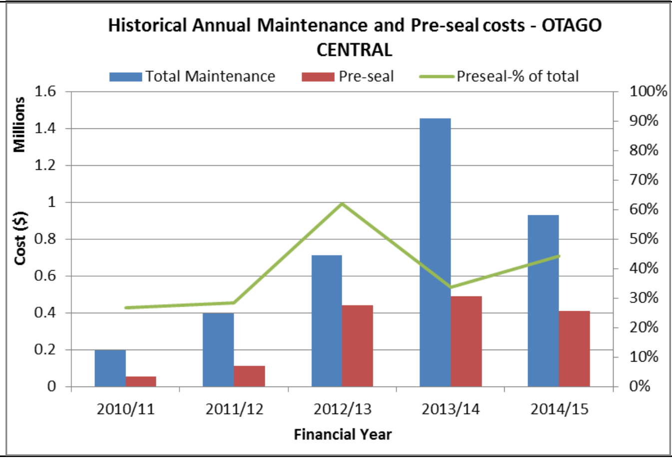

Historical Annual Maintenance and Pre-seal costs - COASTAL
OTAGO
Total Maintenance
Pre-seal
Preseal-% of total
Millions
Cost ($)
2010/11
2011/12
2012/13
2013/14
2014/15
Financial Year

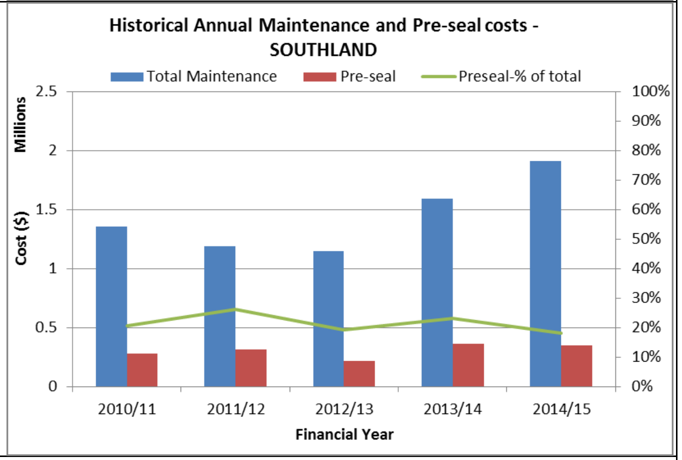


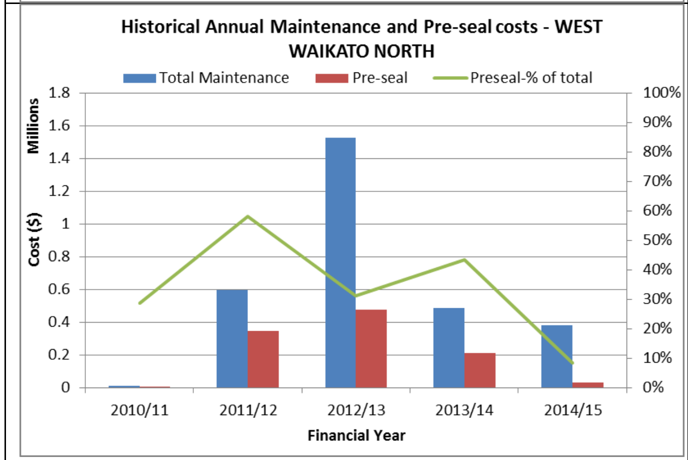












Average Pre-seal cost % (of total maintenance costs) in regions (2011-12, 2012-13, 2013-14)

Region	Preseal %	Region	Preseal %
North Island	25%	(NOC) TARANAKI	37%
South Island	30%	(NOC) WELLINGTON	30%
(EC) MARLBOROUGH	16%	(NOC) WEST COAST	33%
(EC) WEST WAIKATO SOUTH	23%	AUCK ALLIANCE	8%
(NOC) BOP EAST	23%	COASTAL OTAGO	36%
(NOC) BOP WEST	14%	MILFORD	48%
(NOC) CENTRAL WAIKATO	20%	NAPIER	19%
(NOC) EAST WAIKATO	34%	NELSON	24%
(NOC) MANAWATU-WHANGANUI	35%	NTH CANTERBURY	22%

	(NOC) NORTHLAND	22%		OTAGO CENTRAL	41%
	(NOC) SOUTH CANTERBURY	31%		SOUTHLAND	23%
	(NOC) TAIRAWHITI ROADS NORTHERN	31%		WEST WAIKATO NORTH	40%
	(NOC) TAIRAWHITI ROADS WESTERN	34%			

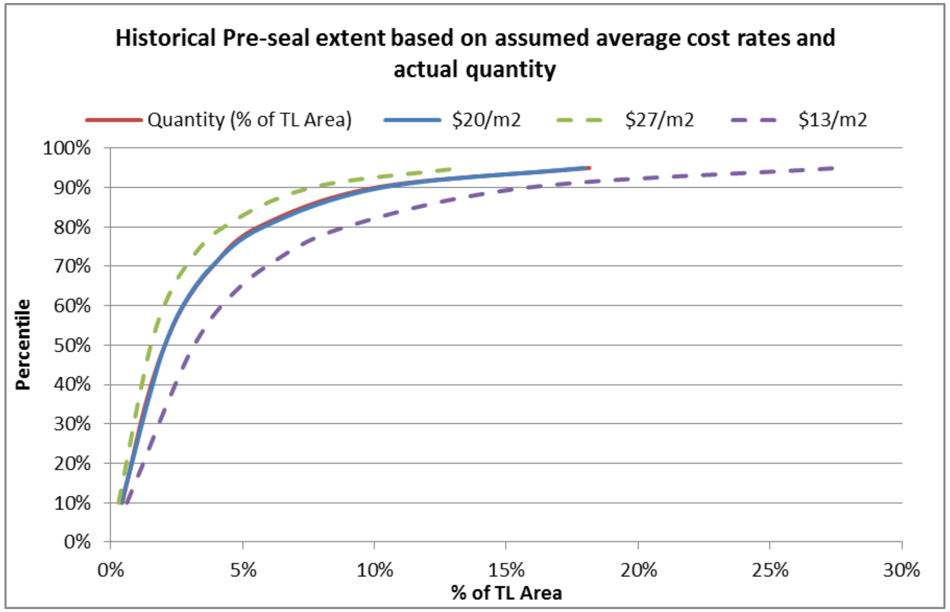
Pre-seal extent and estimated costs:

The task was to calculate the average historical pre-seal cost $/m^2$ and then find the common extent of pre-seal areas in different regions.

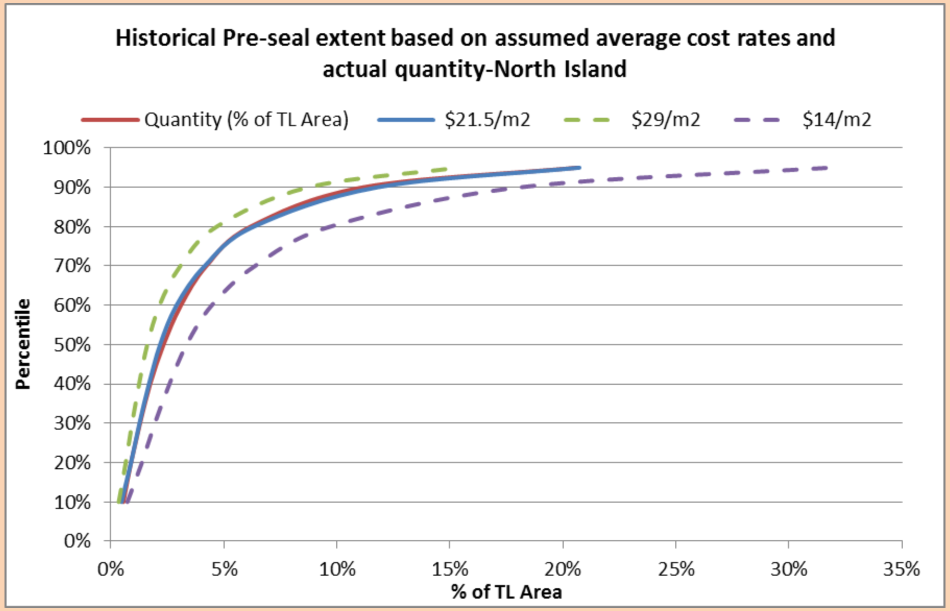
Here is the method and findings:

1. Calculating the extent of pre-seal for each TL using TL area from *TL table* and the estimated pre-seal quantities from *pre-seal table*. (note: The selected quantity unit for this exercise is m^2)
2. Plotting the pre-seal extent distribution based on the percentage of TL area
3. Using the pre-seal cost (cost_amount_rci) from *pre-seal table* to find pre-seal cost $/\mathrm{m}^2$ value that result in similar pre-seal extent distribution to the first distribution based on pre-seal quantities.

Note: The recorded maintenance quantities are the base inputs in this analysis and are assumed to be accurate.

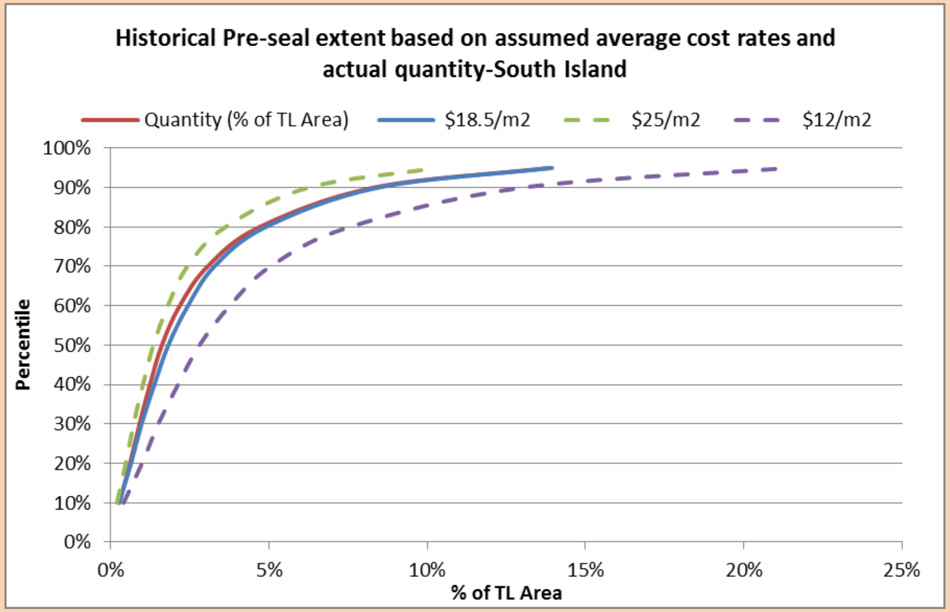
Region	Tabular format					Graph
	Percentile	Pre-seal extent distribution				
		Based on Quantities	Based on Cost (amount)			
		Quantity (% of TL Area)	Pre-seal cost /m^2			
			$16/m2	$22/m2	$10/m2	
Network	0.1	0.4%	0.5%	0.4%	0.8%	
	0.2	0.8%	1.0%	0.7%	1.6%	
	0.3	1.1%	1.5%	1.1%	2.4%	
	0.4	1.5%	2.0%	1.4%	3.2%	
	0.5	2.1%	2.6%	1.9%	4.1%	
	0.6	2.8%	3.4%	2.5%	5.5%	
	0.7	3.9%	4.8%	3.5%	7.7%	
	0.8	5.6%	7.2%	5.3%	11.6%	
	0.9	10.0%	12.8%	9.3%	20.5%	
	0.95	18.2%	22.5%	16.3%	35.9%	
	Average	4.6%	5.5%	4.2%	8.1%	

	No. of TLs	4552			
North Island	Percentile	Pre-seal extent distribution			
		Based on Quantities	Based on Cost (amount)		
			Pre-seal cost /m^2		
		Quantity (% of TL Area)	$21.5/m2	$29/m2	$14/m2
	0.1	0.6%	0.5%	0.4%	0.7%
	0.2	0.9%	0.9%	0.7%	1.4%
	0.3	1.3%	1.3%	0.9%	2.0%
	0.4	1.7%	1.7%	1.3%	2.6%
	0.5	2.3%	2.2%	1.6%	3.4%
	0.6	3.1%	2.9%	2.2%	4.5%
	0.7	4.2%	4.2%	3.1%	6.4%
	0.8	6.2%	6.3%	4.7%	9.7%
	0.9	11.2%	11.8%	8.7%	18.1%
	0.95	20.6%	20.7%	15.4%	31.8%
	Average	5.0%	5.0%	3.9%	7.1%
	No. of TLs	2943			

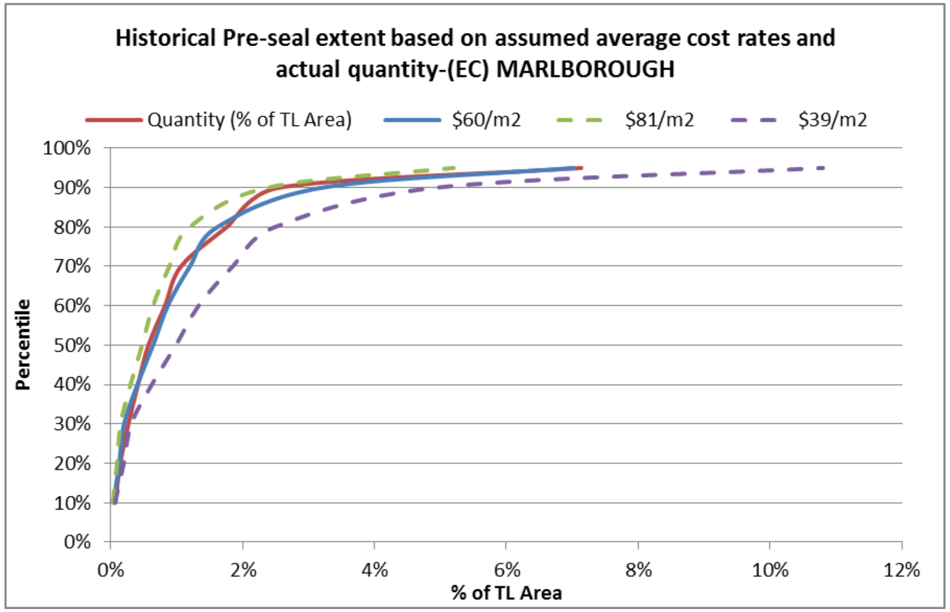


The average cost per m2 differs by $3 between the two islands. The average extent of pre-seal repair is also different being 5.0% of TL area in the north island and 3.8% in the south island.

South Island	Percentile	Pre-seal extent distribution			
		Based on Quantities	Based on Cost (amount)		
			Pre-seal cost /m^2		
		Quantity (% of TL Area)	$18.5/m2	$25/m2	$12/m2
	0.1	0.3%	0.3%	0.2%	0.4%
	0.2	0.6%	0.6%	0.5%	1.0%
	0.3	0.9%	1.0%	0.7%	1.5%
	0.4	1.2%	1.4%	1.0%	2.1%
	0.5	1.6%	1.8%	1.3%	2.8%
	0.6	2.2%	2.4%	1.8%	3.8%
	0.7	3.1%	3.3%	2.4%	5.1%
	0.8	4.7%	4.9%	3.6%	7.6%
	0.9	8.3%	8.4%	6.3%	13.0%
	0.95	13.9%	13.9%	10.3%	21.5%
	Average	3.8%	3.8%	2.8%	5.6%
	No. of TLs	1640			

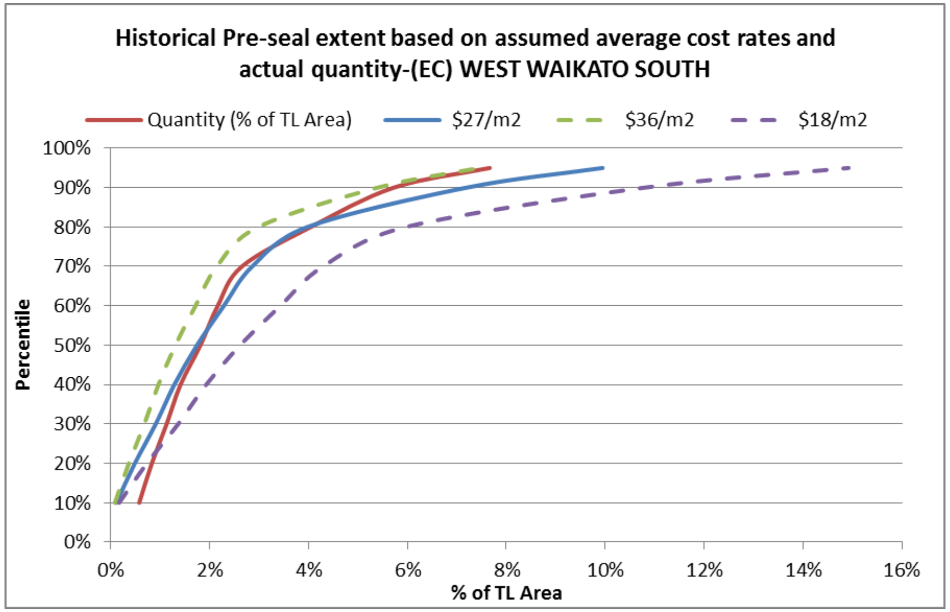


MARLBOROUGH	Percentile	Pre-seal extent distribution			
		Based on Quantities	Based on Cost (amount)		
			Pre-seal cost /m^2		
		Quantity (% of TL Area)	$60/m2	$81/m2	$39/m2
	0.1	0.1%	0.0%	0.0%	0.1%
	0.2	0.1%	0.1%	0.1%	0.2%
	0.3	0.3%	0.2%	0.1%	0.3%
	0.4	0.4%	0.4%	0.3%	0.6%
	0.5	0.6%	0.6%	0.5%	1.0%
	0.6	0.8%	0.9%	0.6%	1.3%
	0.7	1.1%	1.2%	0.9%	1.8%
	0.8	1.8%	1.6%	1.2%	2.5%
	0.9	2.6%	3.2%	2.4%	4.9%
	0.95	7.1%	7.0%	5.2%	10.8%
	Average	1.9%	1.8%	1.4%	2.8%
	No. of TLs	74			



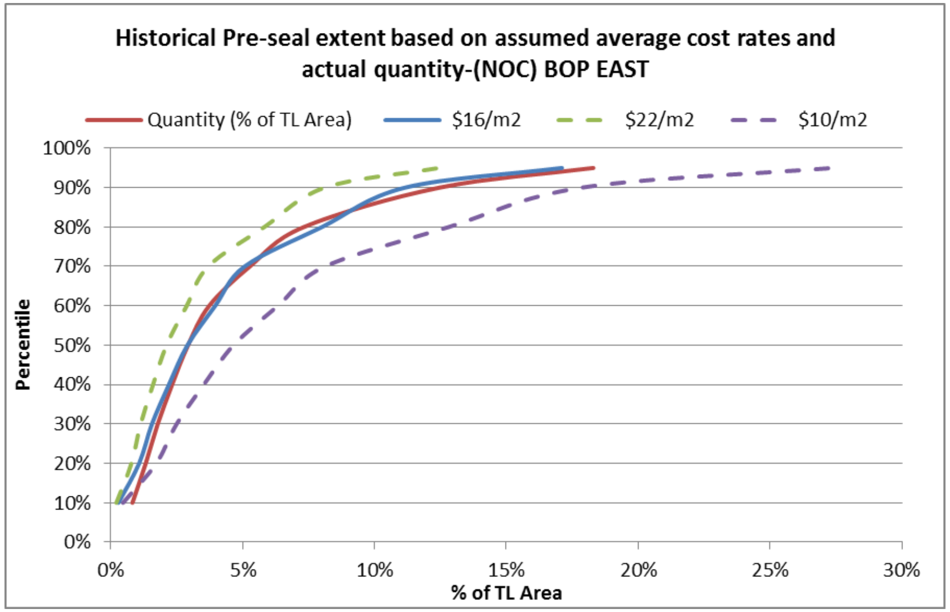
WEST WAIKATO SOUTH

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$27/m2	$36/m2	$18/m2
0.1	0.6%	0.1%	0.1%	0.2%
0.2	0.8%	0.5%	0.4%	0.7%
0.3	1.1%	0.9%	0.7%	1.4%
0.4	1.4%	1.3%	1.0%	1.9%
0.5	1.8%	1.7%	1.3%	2.6%
0.6	2.2%	2.3%	1.7%	3.4%
0.7	2.7%	2.9%	2.1%	4.3%
0.8	4.0%	4.0%	3.0%	6.0%
0.9	5.7%	7.2%	5.4%	10.8%
0.95	7.7%	9.9%	7.5%	14.9%
Average	3.3%	3.1%	2.4%	4.7%
No. of TLs	186			



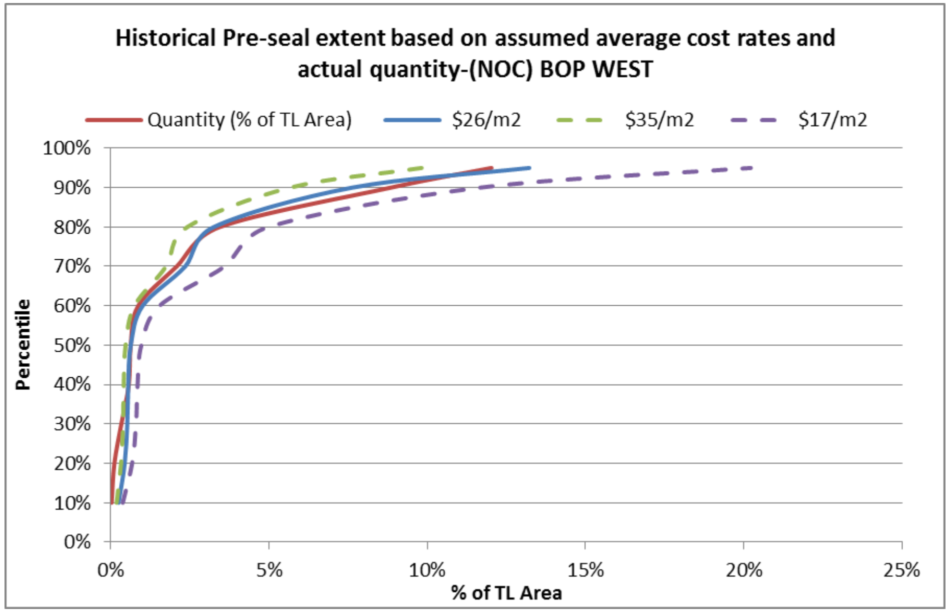
BOP EAST

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$16/m2	$22/m2	$10/m2
0.1	0.8%	0.3%	0.2%	0.5%
0.2	1.3%	1.1%	0.8%	1.7%
0.3	1.8%	1.6%	1.1%	2.5%
0.4	2.3%	2.2%	1.6%	3.5%
0.5	2.9%	2.9%	2.1%	4.7%
0.6	3.7%	4.0%	2.9%	6.3%
0.7	5.3%	5.1%	3.7%	8.1%
0.8	7.3%	8.0%	5.8%	12.8%
0.9	12.5%	11.2%	8.1%	17.9%
0.95	18.3%	17.1%	12.4%	27.4%
Average	5.3%	5.4%	3.9%	8.0%
No. of TLs	330			



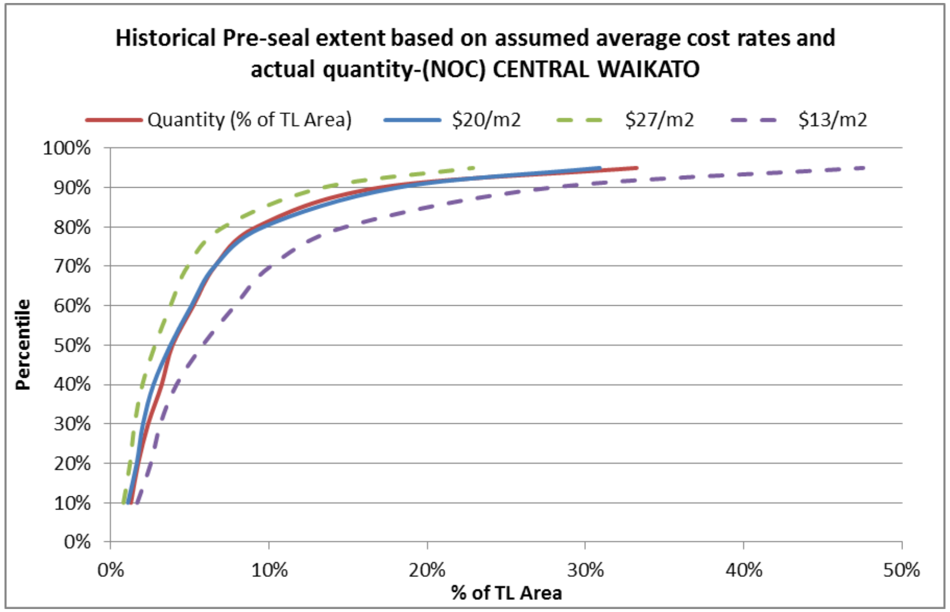
BOP WEST

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$26/m2	$35/m2	$17/m2
0.1	0.0%	0.2%	0.2%	0.4%
0.2	0.1%	0.4%	0.3%	0.7%
0.3	0.3%	0.5%	0.4%	0.8%
0.4	0.6%	0.6%	0.4%	0.8%
0.5	0.6%	0.6%	0.5%	1.0%
0.6	0.9%	1.0%	0.8%	1.5%
0.7	2.1%	2.4%	1.8%	3.6%
0.8	3.4%	3.3%	2.4%	5.0%
0.9	8.9%	7.6%	5.7%	11.7%
0.95	12.0%	13.2%	9.8%	20.2%
Average	2.7%	2.7%	2.0%	4.1%
No. of TLs	20			



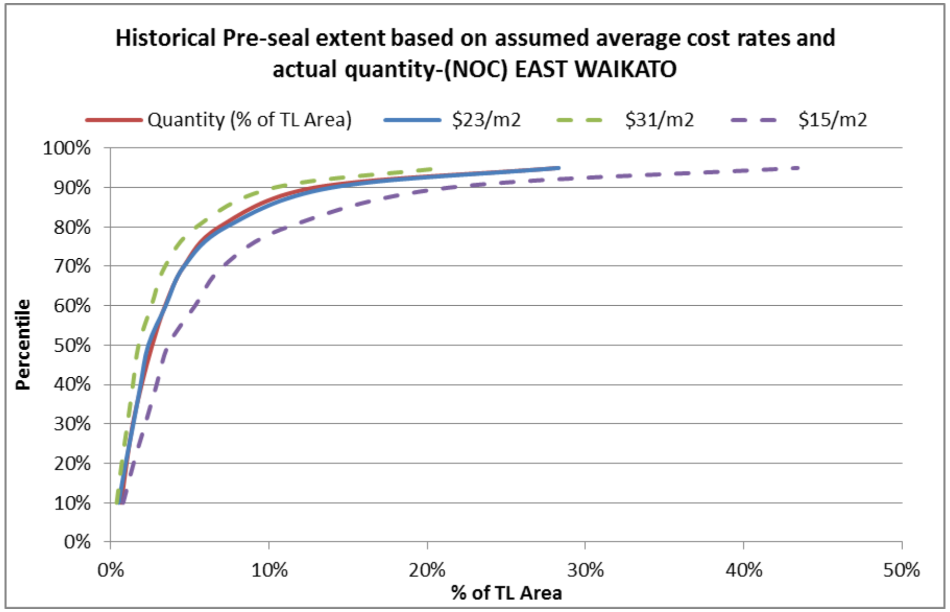
CENTRAL WAIKATO

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$20/m2	$27/m2	$13/m2
0.1	1.3%	1.1%	0.8%	1.7%
0.2	1.7%	1.6%	1.2%	2.5%
0.3	2.4%	2.0%	1.5%	3.1%
0.4	3.2%	2.7%	2.0%	4.2%
0.5	3.9%	3.8%	2.8%	5.8%
0.6	5.2%	5.1%	3.8%	7.8%
0.7	6.6%	6.6%	4.9%	10.1%
0.8	9.2%	9.6%	7.1%	14.8%
0.9	17.0%	18.1%	13.4%	27.9%
0.95	33.2%	30.9%	22.9%	47.6%
Average	7.8%	7.1%	6.0%	10.3%
No. of TLs	222			



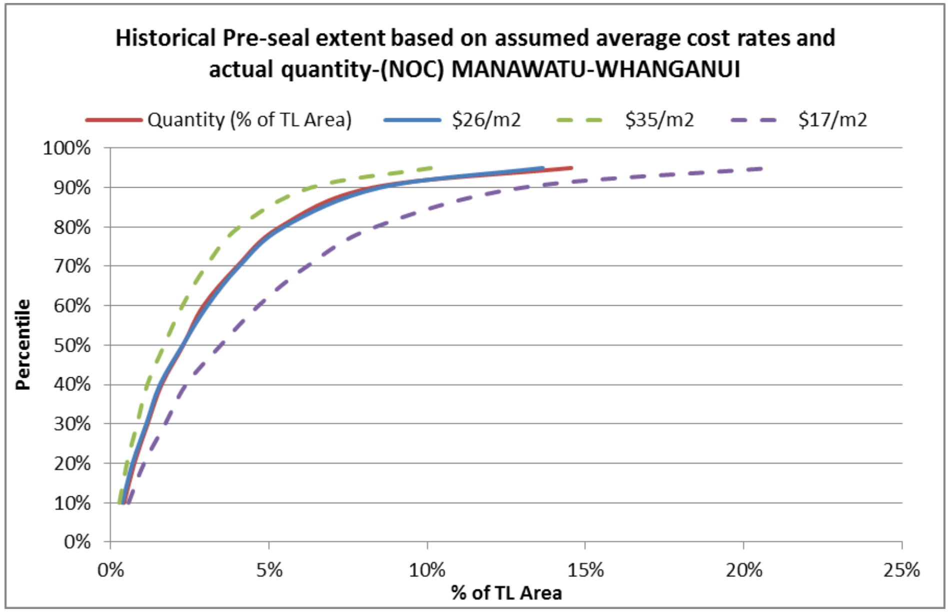
EAST WAIKATO

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$23/m2	$31/m2	$15/m2
0.1	0.7%	0.5%	0.4%	0.8%
0.2	1.0%	0.9%	0.7%	1.4%
0.3	1.4%	1.4%	1.1%	2.2%
0.4	2.0%	1.9%	1.4%	2.9%
0.5	2.6%	2.4%	1.8%	3.6%
0.6	3.4%	3.5%	2.6%	5.3%
0.7	4.6%	4.6%	3.4%	7.1%
0.8	6.9%	7.3%	5.4%	11.2%
0.9	12.9%	14.0%	10.4%	21.4%
0.95	28.3%	28.3%	21.0%	43.4%
Average	6.3%	6.2%	5.2%	7.2%
No. of TLs	287			



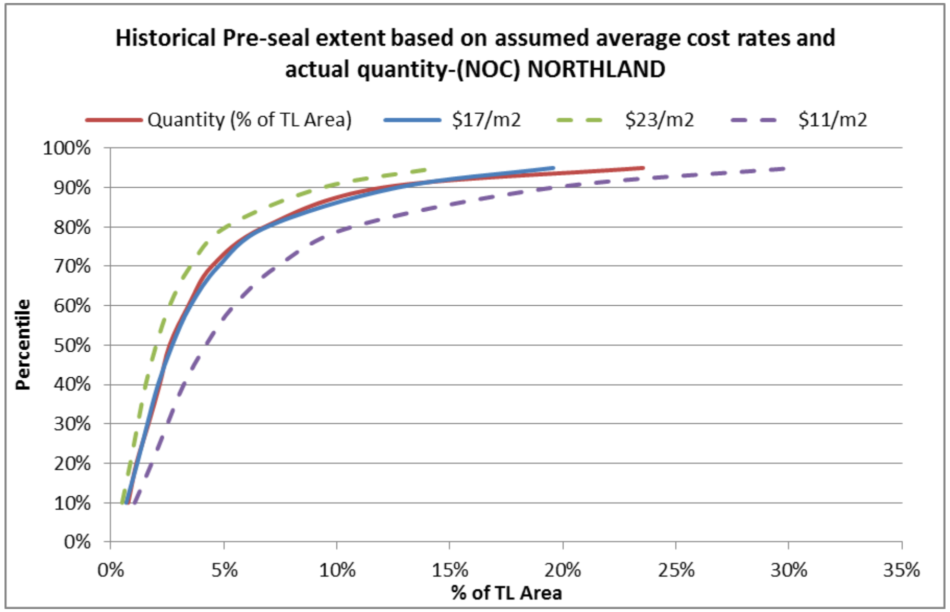
MANAWATU-WHANGANUI

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$26/m2	$35/m2	$17/m2
0.1	0.4%	0.4%	0.3%	0.6%
0.2	0.7%	0.7%	0.5%	1.1%
0.3	1.2%	1.1%	0.8%	1.7%
0.4	1.6%	1.6%	1.2%	2.4%
0.5	2.3%	2.3%	1.7%	3.5%
0.6	2.9%	3.1%	2.3%	4.7%
0.7	4.0%	4.1%	3.0%	6.2%
0.8	5.3%	5.5%	4.1%	8.4%
0.9	8.3%	8.5%	6.3%	13.0%
0.95	14.6%	13.7%	10.1%	20.9%
Average	4.3%	4.3%	3.5%	6.6%
No. of TLs	264			



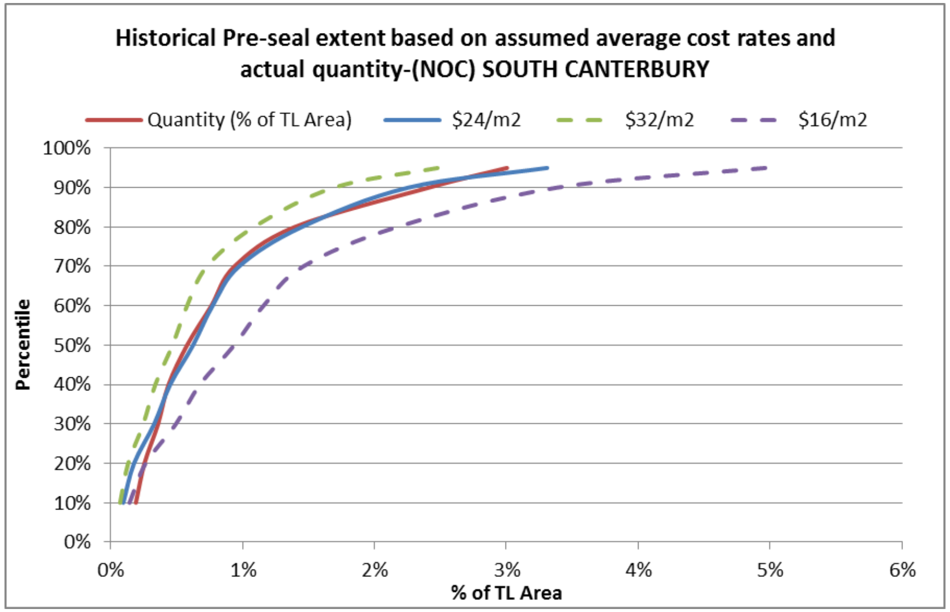
NORTHLAND

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$17/m2	$23/m2	$11/m2
0.1	0.8%	0.7%	0.5%	1.1%
0.2	1.1%	1.2%	0.9%	1.8%
0.3	1.7%	1.6%	1.2%	2.5%
0.4	2.2%	2.1%	1.5%	3.2%
0.5	2.6%	2.7%	2.0%	4.2%
0.6	3.4%	3.5%	2.6%	5.4%
0.7	4.5%	4.8%	3.5%	7.4%
0.8	6.8%	6.9%	5.1%	10.7%
0.9	12.0%	12.7%	9.4%	19.6%
0.95	23.5%	19.6%	14.5%	30.3%
Average	5.7%	5.4%	4.0%	8.1%
No. of TLs	499			



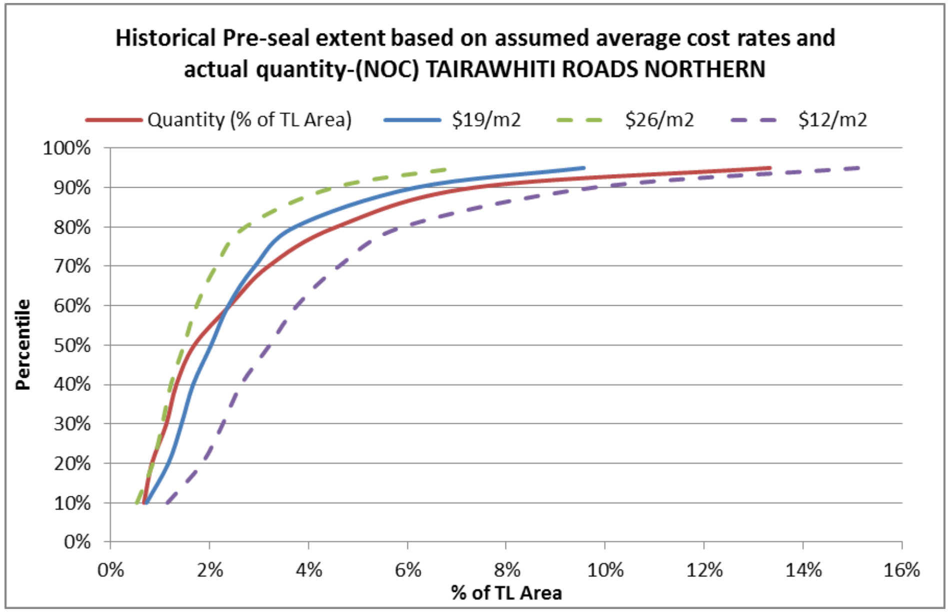
SOUTH CANTERBURY

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$24/m2	$32/m2	$16/m2
0.1	0.2%	0.1%	0.1%	0.1%
0.2	0.3%	0.2%	0.1%	0.3%
0.3	0.4%	0.3%	0.2%	0.5%
0.4	0.4%	0.5%	0.3%	0.7%
0.5	0.6%	0.6%	0.5%	0.9%
0.6	0.8%	0.8%	0.6%	1.2%
0.7	0.9%	1.0%	0.7%	1.5%
0.8	1.4%	1.4%	1.1%	2.2%
0.9	2.4%	2.3%	1.7%	3.4%
0.95	3.0%	3.3%	2.5%	5.0%
Average	1.2%	1.2%	0.9%	1.8%
No. of TLs	104			



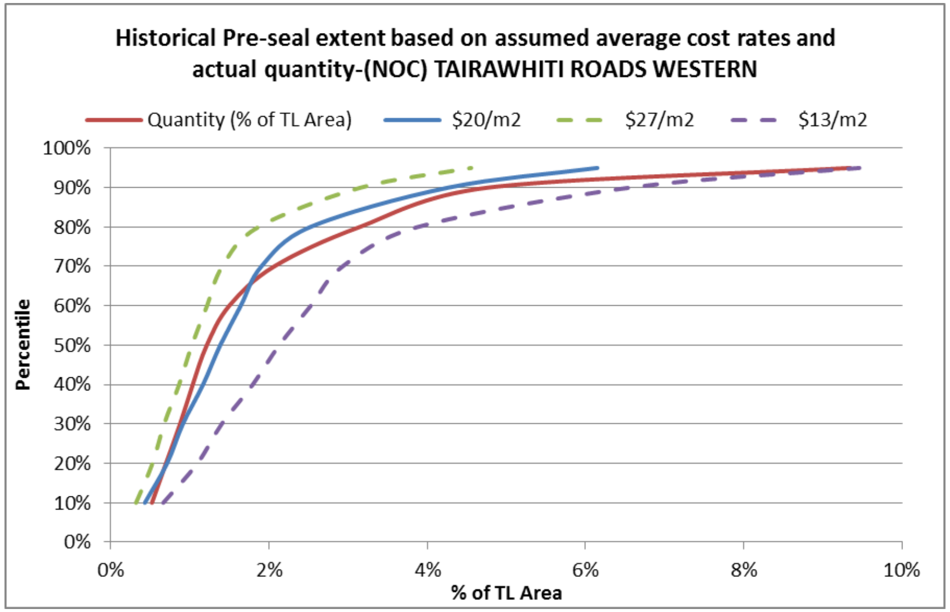
TAIRAWHITI ROADS NORTHERN

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$19/m2	$26/m2	$12/m2
0.1	0.7%	0.7%	0.5%	1.1%
0.2	0.8%	1.2%	0.9%	1.8%
0.3	1.1%	1.4%	1.0%	2.3%
0.4	1.3%	1.7%	1.2%	2.6%
0.5	1.7%	2.0%	1.5%	3.2%
0.6	2.4%	2.4%	1.7%	3.8%
0.7	3.2%	2.9%	2.1%	4.6%
0.8	4.6%	3.7%	2.7%	5.9%
0.9	7.3%	6.2%	4.5%	9.8%
0.95	13.3%	9.6%	7.0%	15.1%
Average	4.0%	3.1%	2.6%	4.9%
No. of TLs	261			



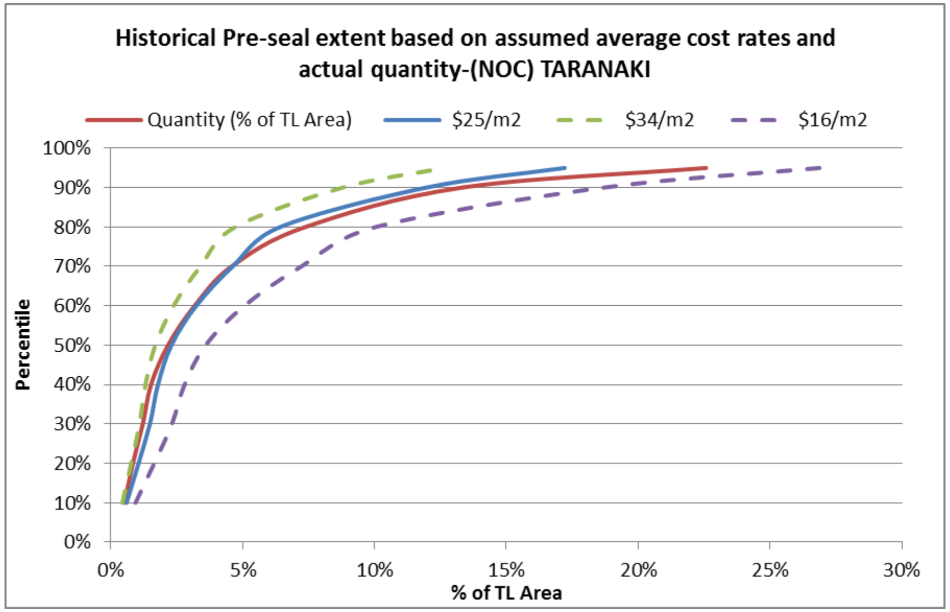
TAIRAWHITI ROADS WESTERN

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$20/m2	$27/m2	$13/m2
0.1	0.5%	0.4%	0.3%	0.7%
0.2	0.7%	0.7%	0.5%	1.1%
0.3	0.9%	0.9%	0.7%	1.4%
0.4	1.0%	1.2%	0.9%	1.8%
0.5	1.2%	1.4%	1.0%	2.1%
0.6	1.5%	1.6%	1.2%	2.5%
0.7	2.1%	1.9%	1.4%	2.9%
0.8	3.1%	2.5%	1.9%	3.9%
0.9	4.8%	4.3%	3.2%	6.6%
0.95	9.3%	6.2%	4.6%	9.5%
Average	2.3%	3.0%	2.2%	3.7%
No. of TLs	144			



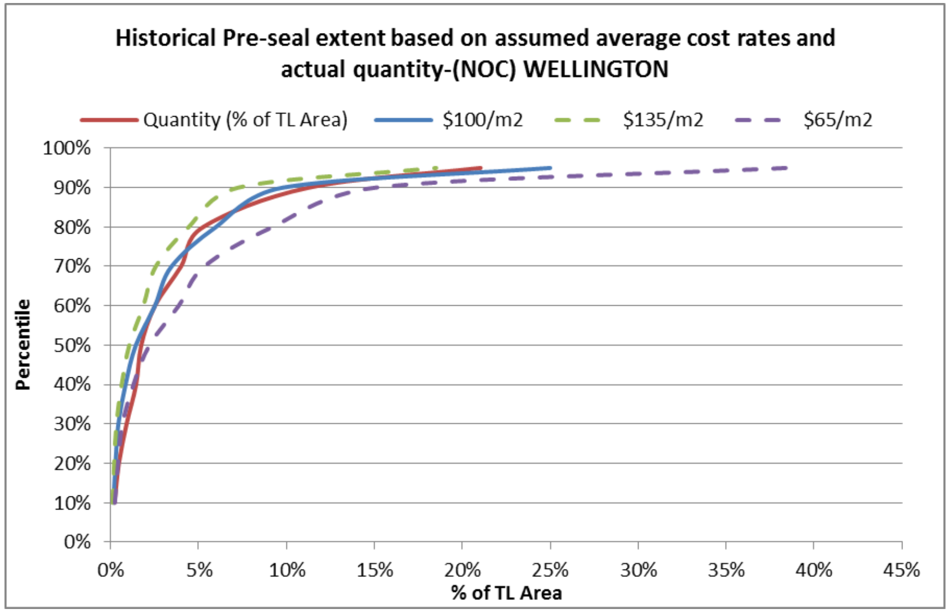
TARANAKI

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$25/m2	$34/m2	$16/m2
0.1	0.5%	0.6%	0.4%	0.9%
0.2	0.8%	1.1%	0.8%	1.6%
0.3	1.2%	1.5%	1.1%	2.3%
0.4	1.5%	1.8%	1.3%	2.8%
0.5	2.2%	2.3%	1.7%	3.6%
0.6	3.2%	3.2%	2.4%	5.1%
0.7	4.6%	4.6%	3.4%	7.2%
0.8	7.4%	6.4%	4.7%	10.0%
0.9	13.3%	12.0%	8.8%	18.7%
0.95	22.6%	17.2%	12.7%	26.9%
Average	4.9%	5.4%	4.0%	7.9%
No. of TLs	215			



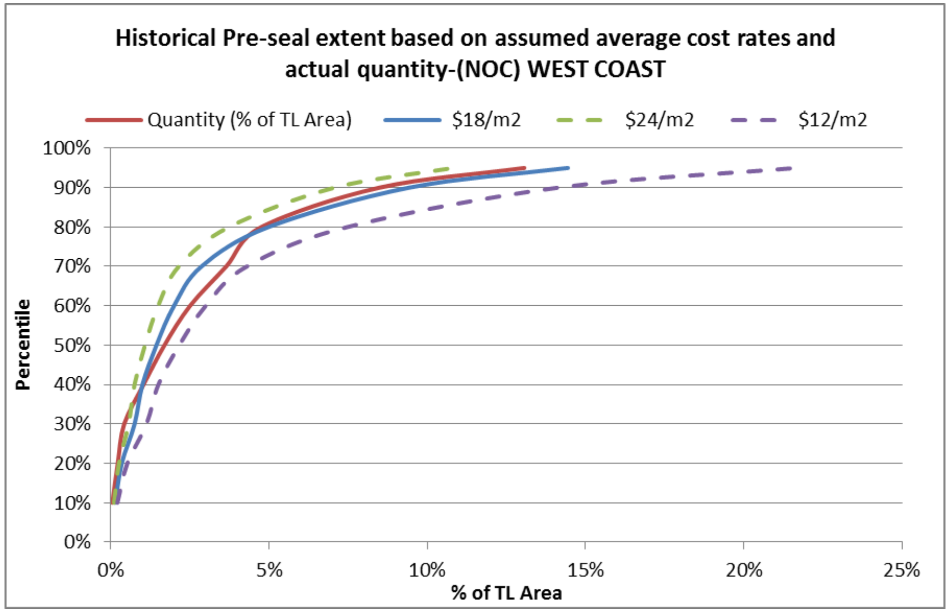
WELLINGTON

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
	Quantity (% of TL Area)	Pre-seal cost /m^2		
		$110/m2	$149/m2	$72/m2
0.1	0.2%	0.2%	0.1%	0.3%
0.2	0.6%	0.3%	0.2%	0.4%
0.3	1.1%	0.7%	0.5%	1.0%
0.4	1.5%	1.2%	0.9%	1.8%
0.5	1.9%	2.1%	1.5%	3.1%
0.6	2.7%	2.7%	2.0%	4.2%
0.7	4.0%	3.5%	2.6%	5.3%
0.8	5.3%	5.4%	4.0%	8.3%
0.9	11.1%	10.2%	7.6%	15.6%
0.95	20.3%	24.2%	17.9%	37.0%
Average	4.1%	4.4%	3.3%	6.8%
No. of TLs	140			



WEST COAST

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$18/m2	$24/m2	$12/m2
0.1	0.1%	0.1%	0.1%	0.2%
0.2	0.2%	0.3%	0.3%	0.5%
0.3	0.4%	0.8%	0.6%	1.1%
0.4	1.0%	1.0%	0.8%	1.5%
0.5	1.7%	1.4%	1.1%	2.2%
0.6	2.5%	2.0%	1.5%	3.0%
0.7	3.7%	2.9%	2.2%	4.3%
0.8	4.8%	5.0%	3.7%	7.5%
0.9	8.5%	9.4%	7.1%	14.2%
0.95	13.1%	14.4%	10.8%	21.7%
Average	3.9%	4.2%	3.2%	5.4%
No. of TLs	141			



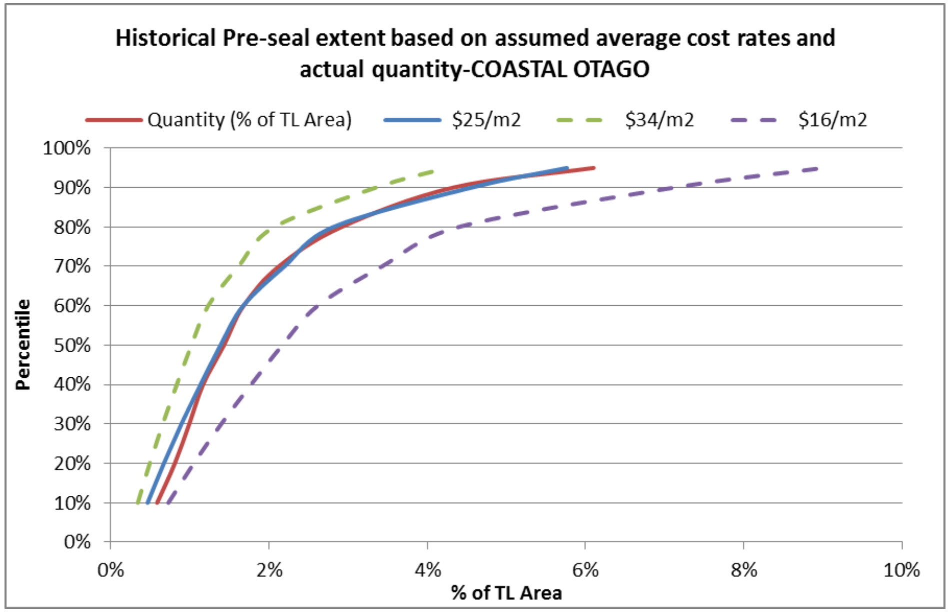
AUCK ALLIANCE

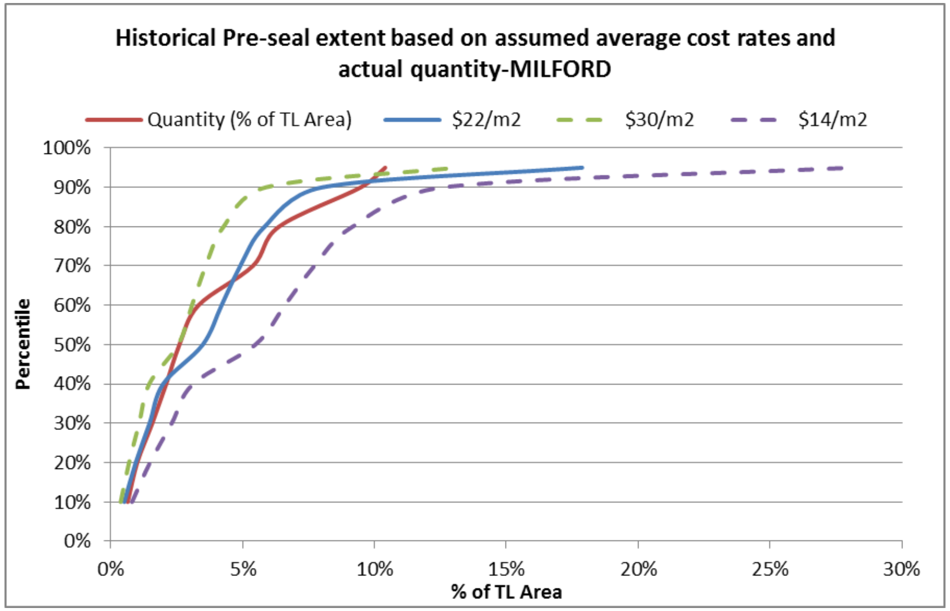
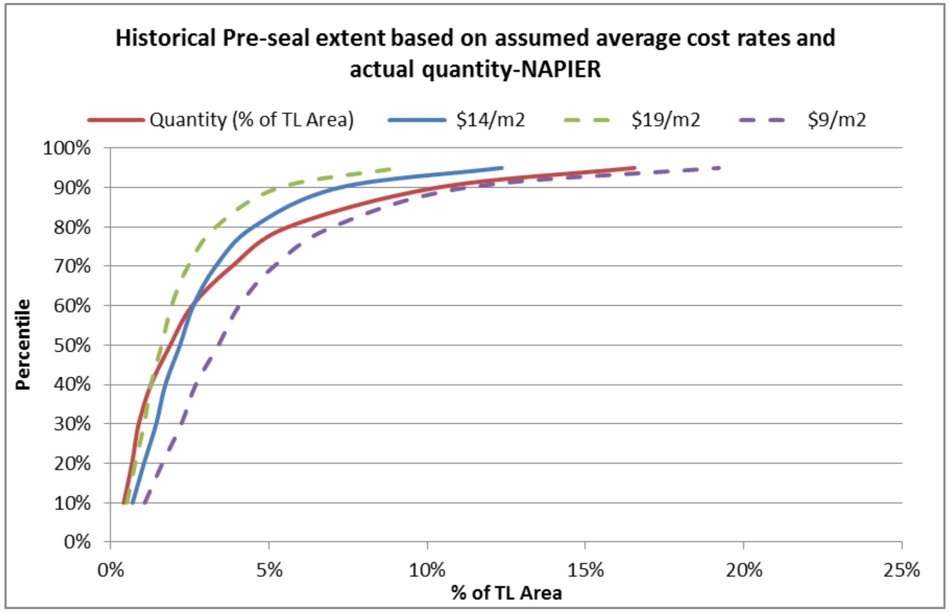
Not enough records

Not enough records

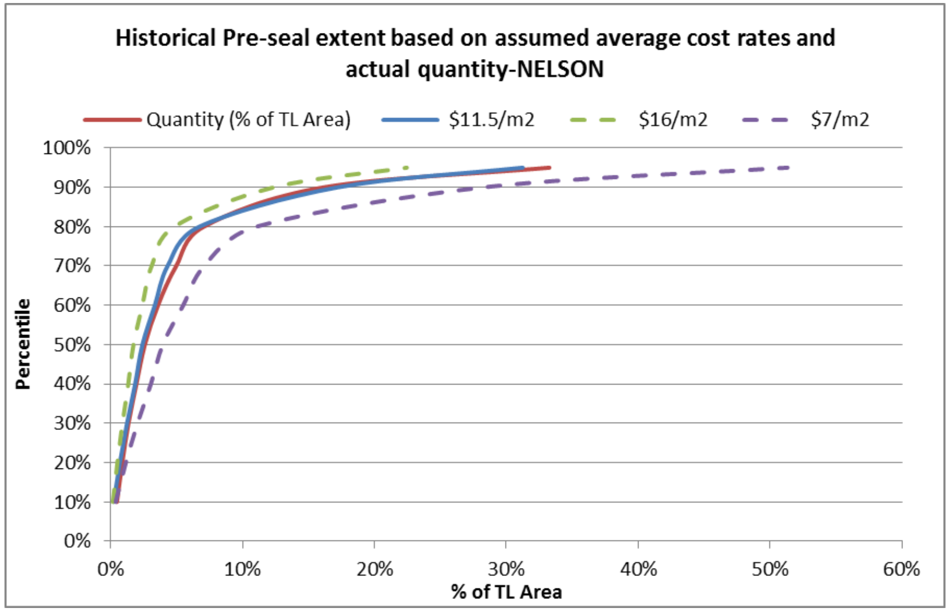
COASTAL OTAGO

Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$25/m2	$34/m2	$16/m2
0.1	0.6%	0.5%	0.3%	0.7%
0.2	0.8%	0.7%	0.5%	1.0%
0.3	1.0%	0.9%	0.7%	1.4%
0.4	1.2%	1.1%	0.8%	1.8%
0.5	1.4%	1.4%	1.0%	2.2%
0.6	1.7%	1.7%	1.2%	2.6%
0.7	2.1%	2.2%	1.6%	3.4%
0.8	2.9%	2.8%	2.1%	4.4%
0.9	4.3%	4.6%	3.4%	7.1%
0.95	6.1%	5.8%	4.2%	9.0%
Average	2.2%	2.1%	1.5%	3.3%

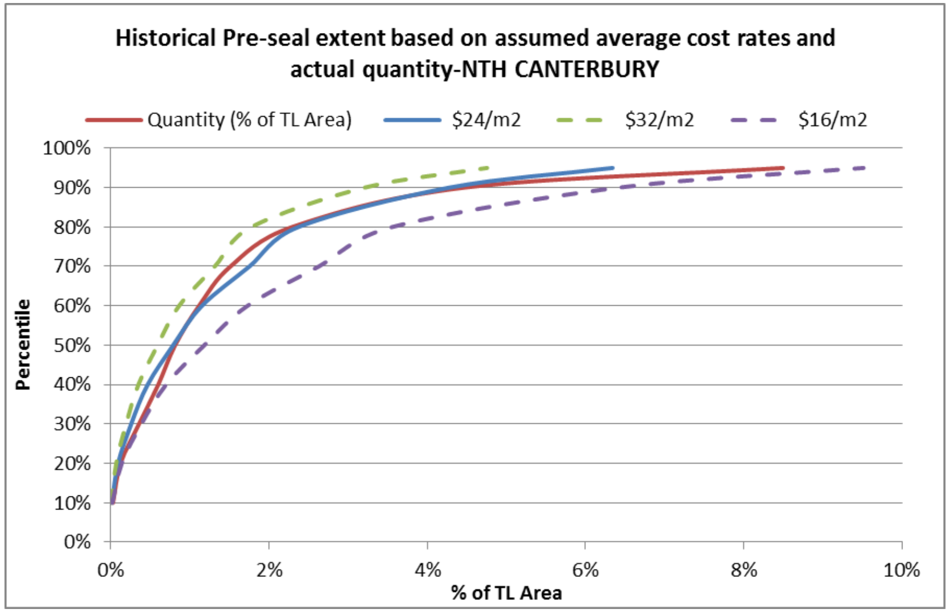


	No. of TLs	398				
MILFORD	Percentile	Pre-seal extent distribution				
		Based on Quantities	Based on Cost (amount)			
			Pre-seal cost /m^2			
		Quantity (% of TL Area)	$22/m2	$30/m2	$14/m2	
	0.1	0.6%	0.5%	0.4%	0.8%	
	0.2	1.0%	0.9%	0.7%	1.5%	
	0.3	1.6%	1.5%	1.1%	2.3%	
	0.4	2.1%	2.0%	1.5%	3.1%	
	0.5	2.6%	3.5%	2.6%	5.5%	
	0.6	3.3%	4.2%	3.1%	6.6%	
	0.7	5.4%	4.9%	3.6%	7.7%	
	0.8	6.4%	5.8%	4.3%	9.2%	
	0.9	9.5%	8.0%	5.9%	12.6%	
	0.95	10.4%	17.9%	13.1%	28.1%	
	Average	4.7%	4.6%	3.4%	7.3%	
	No. of TLs	59				
NAPIER	Percentile	Pre-seal extent distribution				
		Based on Quantities	Based on Cost (amount)			
			Pre-seal cost /m^2			
		Quantity (% of TL Area)	$14/m2	$19/m2	$9/m2	
	0.1	0.4%	0.7%	0.5%	1.1%	
	0.2	0.7%	1.0%	0.8%	1.6%	
	0.3	0.9%	1.4%	1.1%	2.2%	
	0.4	1.3%	1.7%	1.3%	2.7%	
	0.5	1.9%	2.2%	1.6%	3.4%	
	0.6	2.6%	2.6%	1.9%	4.1%	
	0.7	3.8%	3.3%	2.4%	5.2%	
	0.8	5.6%	4.5%	3.3%	7.0%	
	0.9	10.3%	7.2%	5.3%	11.2%	
	0.95	16.6%	12.4%	9.1%	19.2%	
	Average	4.2%	4.1%	3.0%	5.5%	

	No. of TLs	260			
NELSON	Percentile	Pre-seal extent distribution			
		Based on Quantities	Based on Cost (amount)		
			Pre-seal cost /m^2		
		Quantity (% of TL Area)	$11.5/m2	$16/m2	$7/m2
	0.1	0.5%	0.2%	0.2%	0.4%
	0.2	0.9%	0.7%	0.5%	1.1%
	0.3	1.3%	1.2%	0.9%	2.0%
	0.4	1.9%	1.9%	1.3%	3.0%
	0.5	2.6%	2.4%	1.7%	3.9%
	0.6	3.6%	3.3%	2.4%	5.5%
	0.7	5.0%	4.3%	3.1%	7.1%
	0.8	7.1%	6.7%	4.8%	11.1%
	0.9	16.2%	17.2%	12.4%	28.3%
	0.95	33.3%	31.2%	22.5%	51.3%
	Average	6.5%	6.3%	4.5%	9.5%



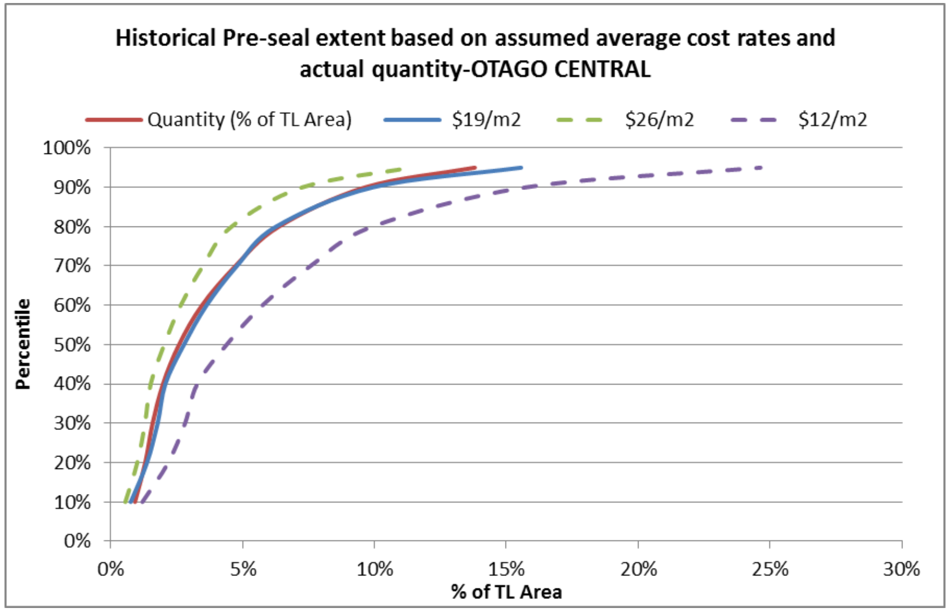
	No. of TLs	269			
NTH CANTERBURY	Percentile	Pre-seal extent distribution			
		Based on Quantities	Based on Cost (amount)		
			Pre-seal cost /m^2		
		Quantity (% of TL Area)	$24/m2	$32/m2	$16/m2
	0.1	0.0%	0.0%	0.0%	0.0%
	0.2	0.1%	0.1%	0.1%	0.1%
	0.3	0.4%	0.3%	0.2%	0.4%
	0.4	0.6%	0.5%	0.4%	0.7%
	0.5	0.8%	0.8%	0.6%	1.2%
	0.6	1.1%	1.2%	0.9%	1.7%
	0.7	1.5%	1.8%	1.3%	2.6%
	0.8	2.3%	2.4%	1.8%	3.6%
	0.9	4.5%	4.3%	3.2%	6.4%
	0.95	8.5%	6.3%	4.8%	9.5%
	Average	1.9%	1.9%	1.4%	2.8%



No. of TLs	208

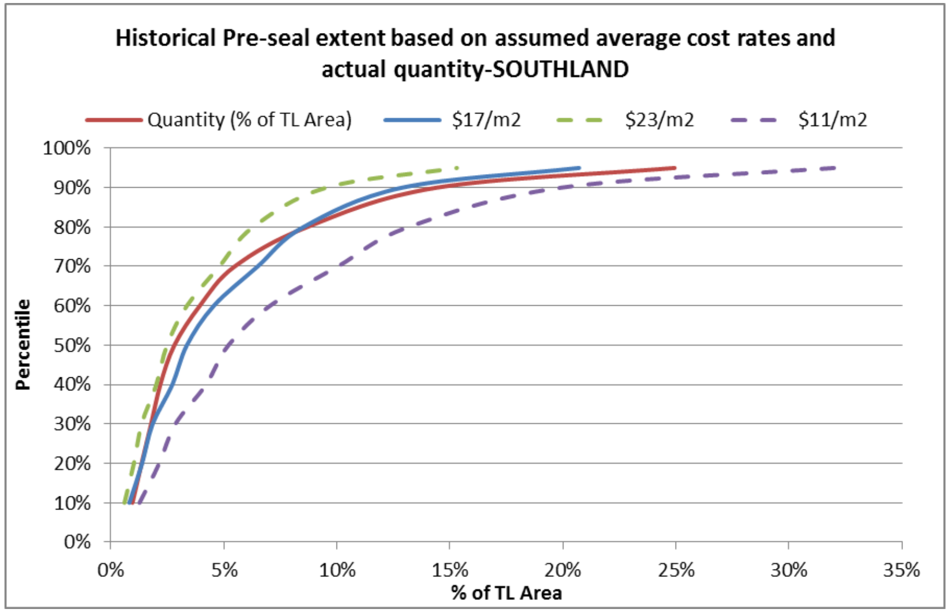
OTAGO CENTRAL

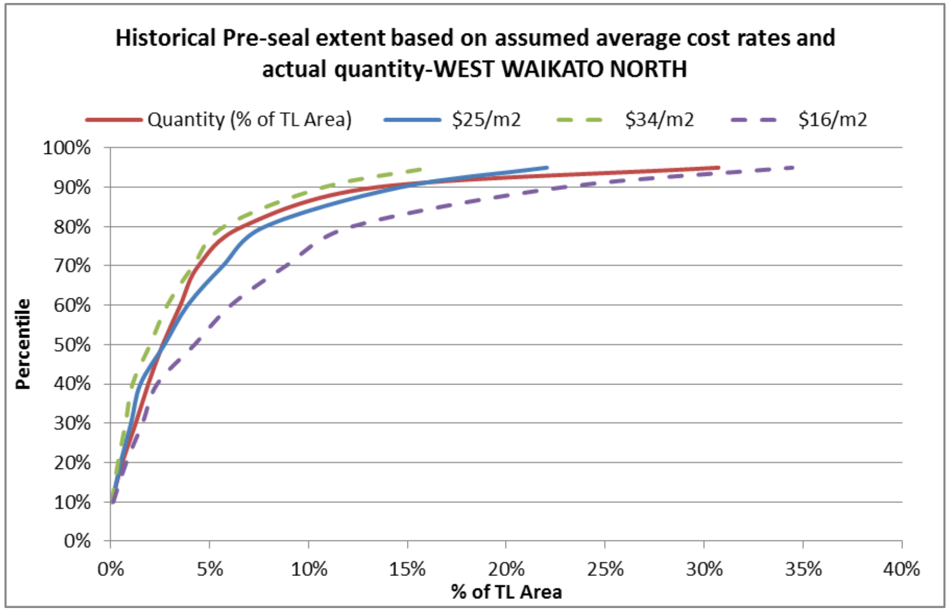
Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$19/m2	$26/m2	$12/m2
0.1	0.9%	0.8%	0.6%	1.2%
0.2	1.3%	1.4%	1.0%	2.2%
0.3	1.6%	1.8%	1.3%	2.8%
0.4	2.0%	2.1%	1.5%	3.3%
0.5	2.6%	2.8%	2.0%	4.4%
0.6	3.5%	3.6%	2.7%	5.8%
0.7	4.7%	4.8%	3.5%	7.6%
0.8	6.4%	6.3%	4.6%	9.9%
0.9	9.7%	10.0%	7.3%	15.8%
0.95	13.8%	15.6%	11.4%	24.6%
Average	4.9%	4.8%	3.5%	7.6%
No. of TLs	199			



SOUTHLAND

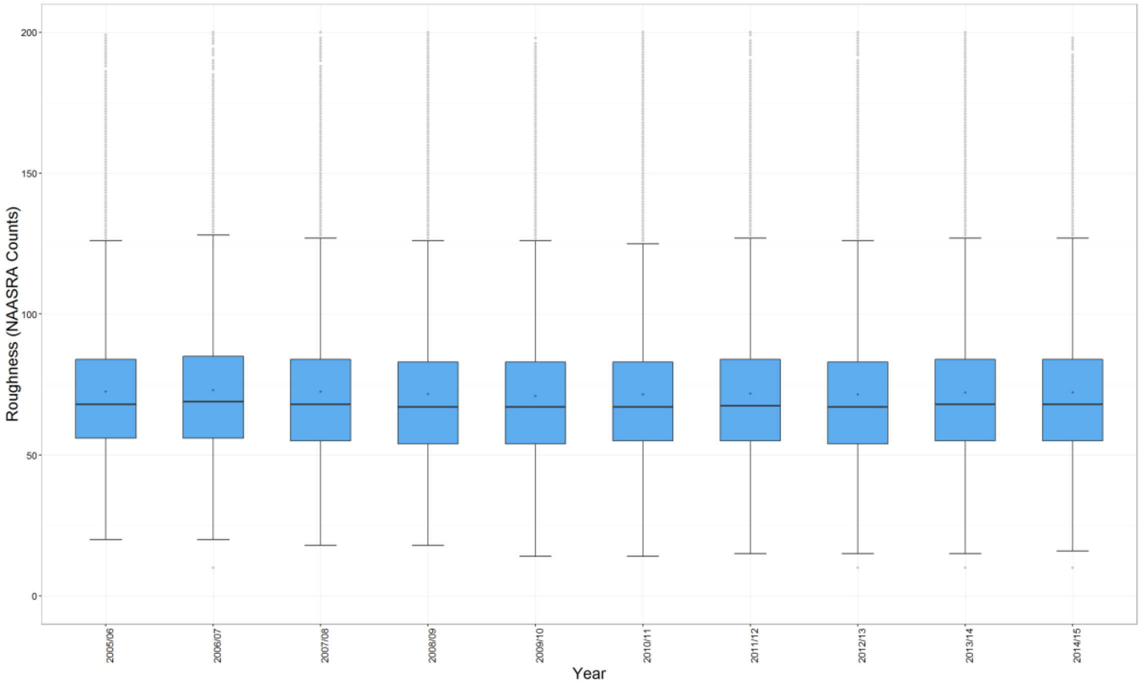
Percentile	Pre-seal extent distribution			
	Based on Quantities	Based on Cost (amount)		
		Pre-seal cost /m^2		
	Quantity (% of TL Area)	$17/m2	$23/m2	$11/m2
0.1	1.0%	0.8%	0.6%	1.3%
0.2	1.4%	1.4%	1.0%	2.1%
0.3	1.8%	1.9%	1.4%	2.9%
0.4	2.2%	2.7%	2.0%	4.2%
0.5	2.8%	3.4%	2.5%	5.2%
0.6	3.9%	4.6%	3.4%	7.0%
0.7	5.5%	6.5%	4.8%	10.0%
0.8	8.7%	8.5%	6.3%	13.2%
0.9	14.4%	12.9%	9.5%	19.9%
0.95	24.9%	20.7%	15.3%	32.0%
Average	5.8%	5.7%	4.2%	8.4%



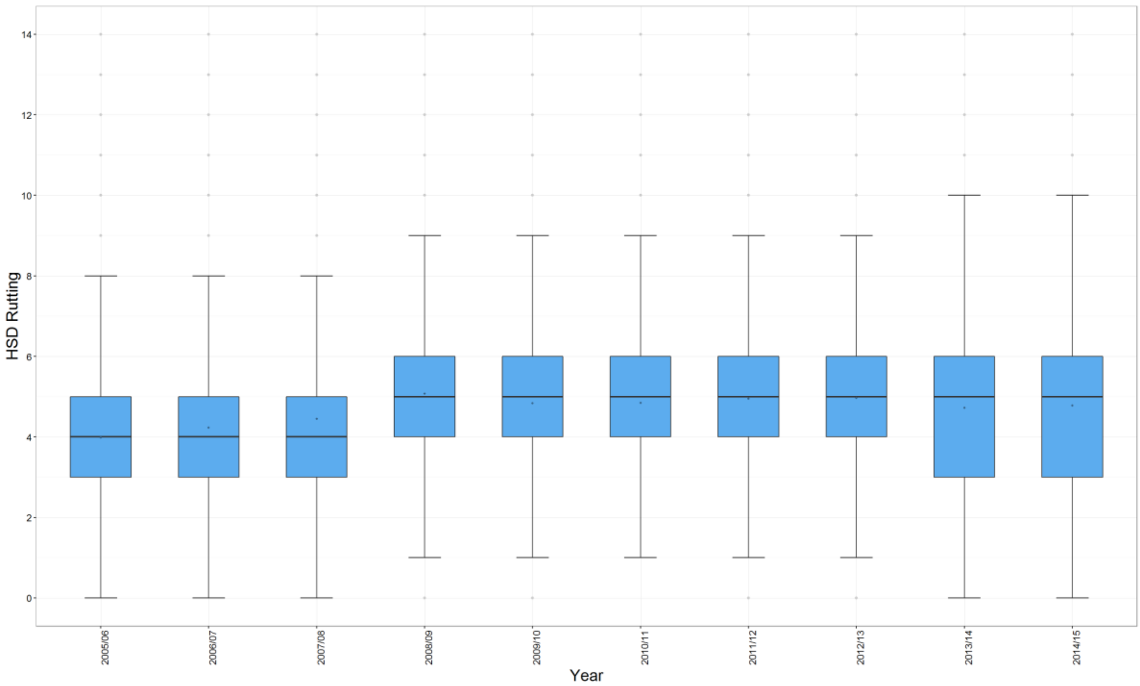
	No. of TLs	188				
WEST WAIKATO NORTH	Percentile	Pre-seal extent distribution				
		Based on Quantities	Based on Cost (amount)			
			Pre-seal cost /m^2			
		Quantity (% of TL Area)	$25/m2	$34/m2	$16/m2	
	0.1	0.1%	0.1%	0.1%	0.1%	
	0.2	0.6%	0.5%	0.4%	0.8%	
	0.3	1.3%	1.0%	0.8%	1.6%	
	0.4	1.9%	1.5%	1.1%	2.3%	
	0.5	2.6%	2.7%	2.0%	4.2%	
	0.6	3.5%	3.9%	2.9%	6.1%	
	0.7	4.4%	5.7%	4.2%	8.9%	
	0.8	6.7%	7.8%	5.7%	12.2%	
	0.9	13.4%	14.6%	10.8%	22.9%	
	0.95	30.7%	22.1%	16.2%	34.5%	
	Average	6.4%	5.7%	4.9%	7.7%	
	No. of TLs	111				

Appendix B: Historical Trends

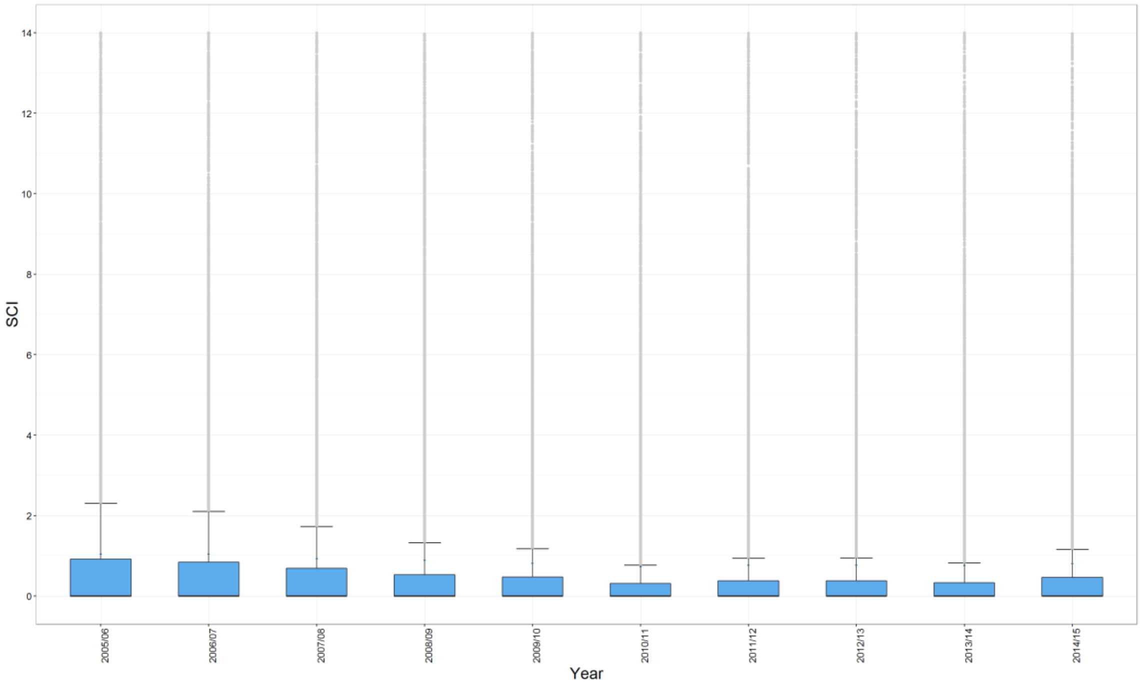
"National Roughness"



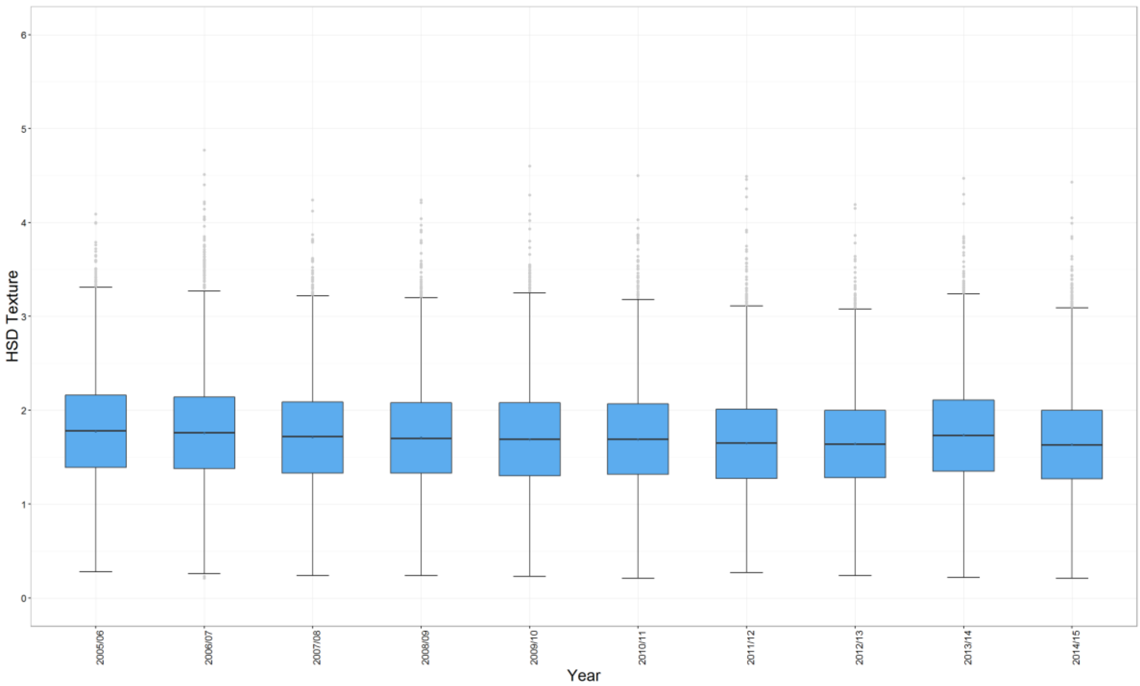
"National HSD Rutting"



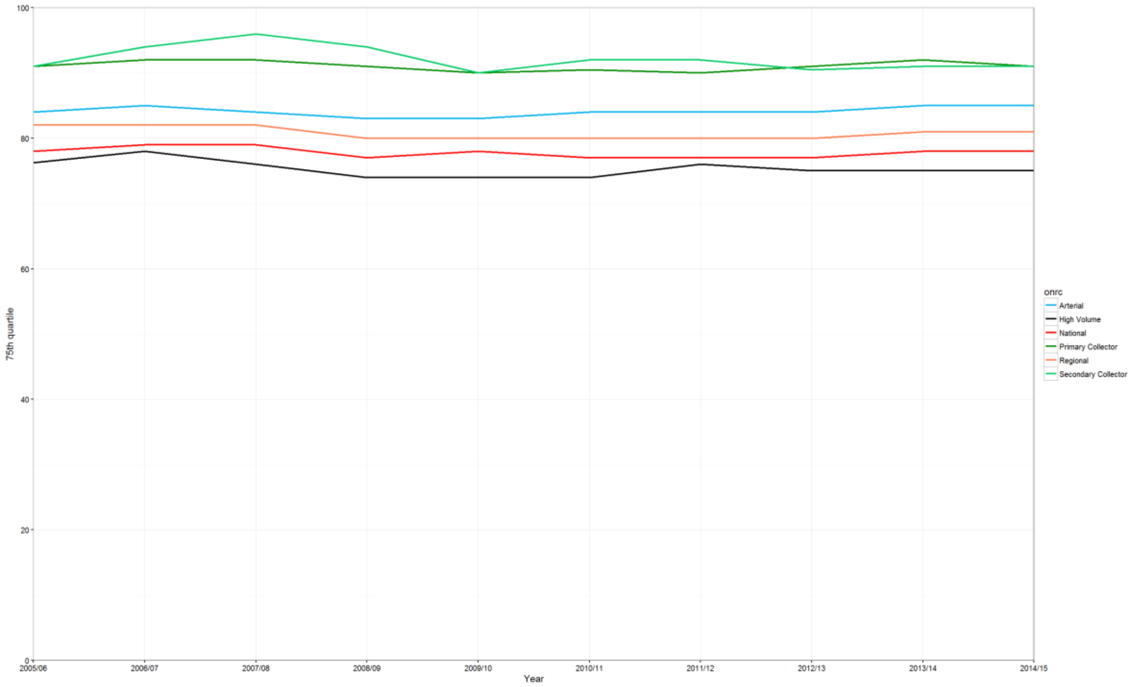
```
"National SCI_CI"
```



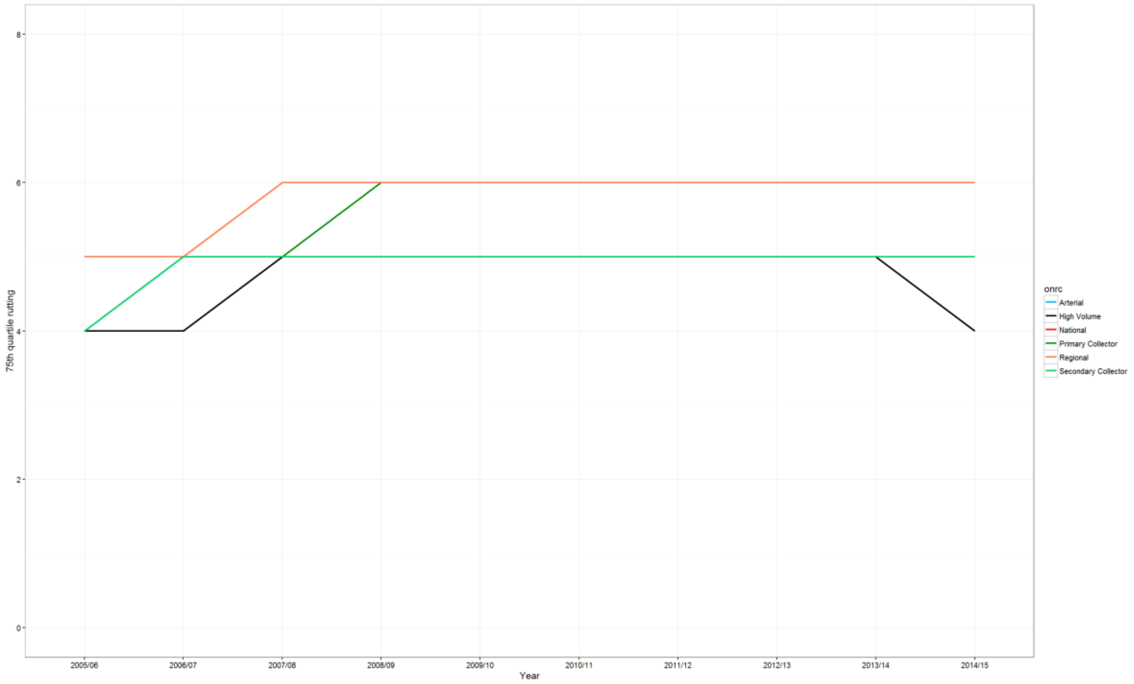

```
"National Texture"
```



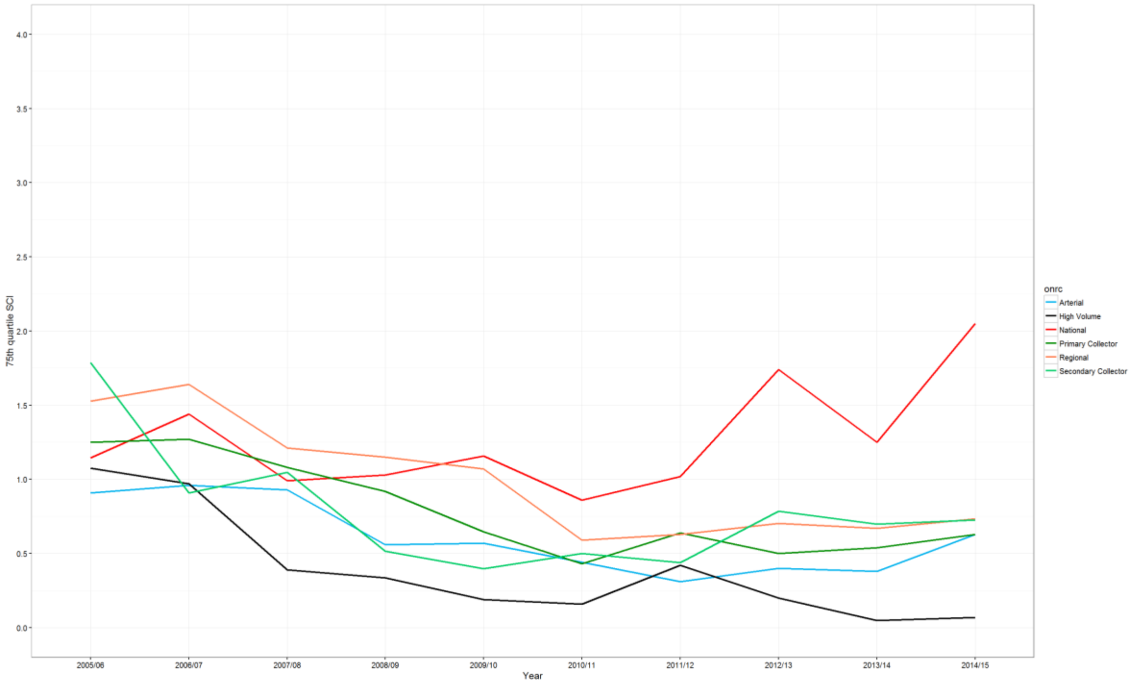
"75th %ile Roughness by ONRC"



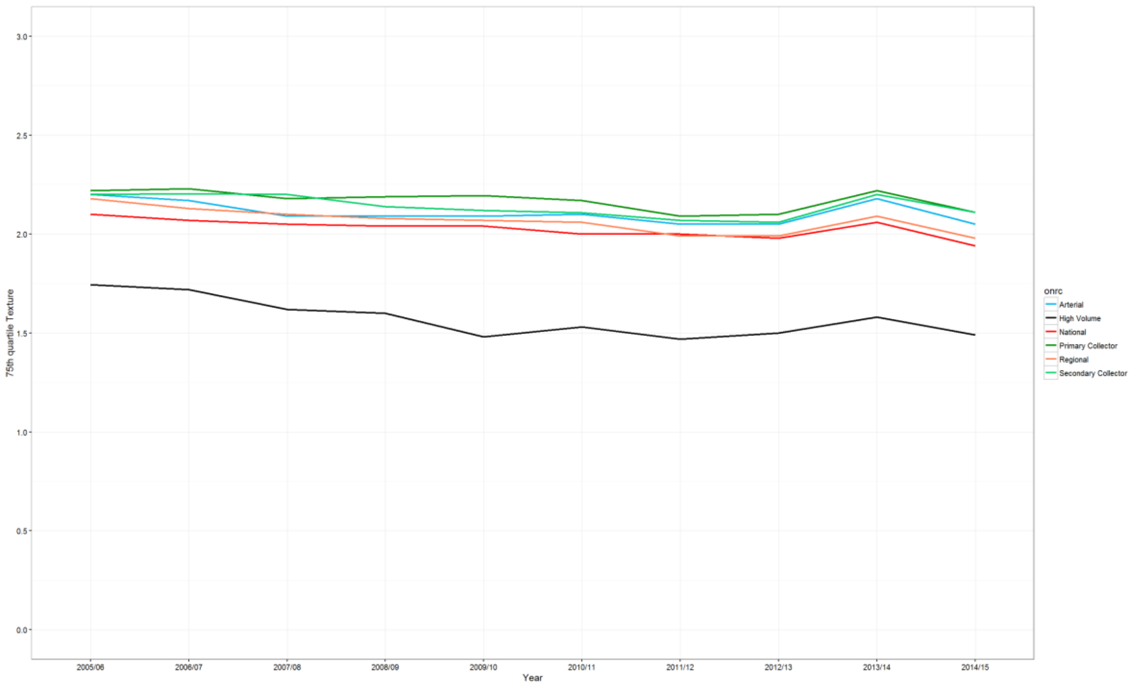
"75th %ile Rutting by ONRC"



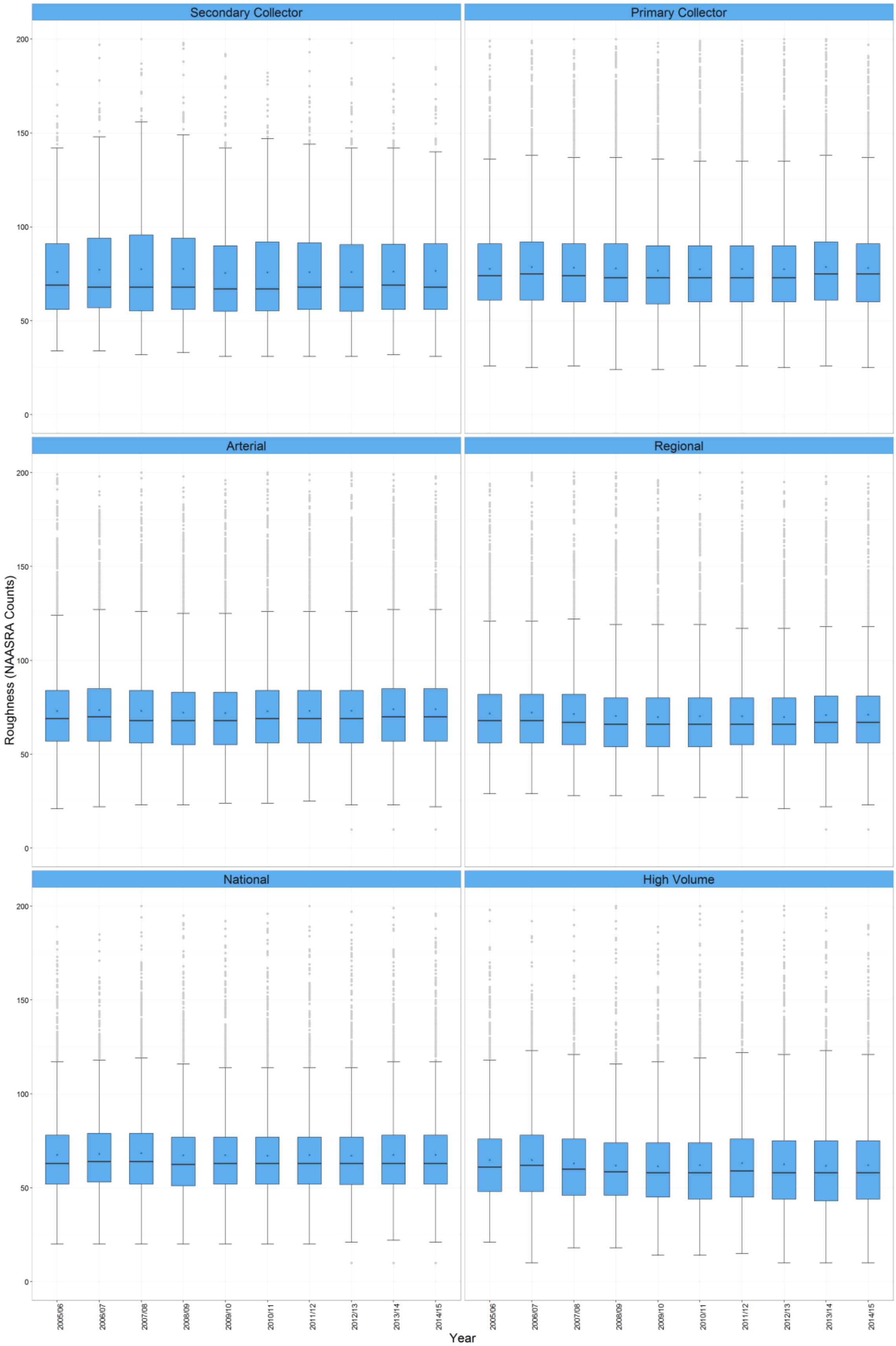
```
"75th %ile SCI by ONRC"
```



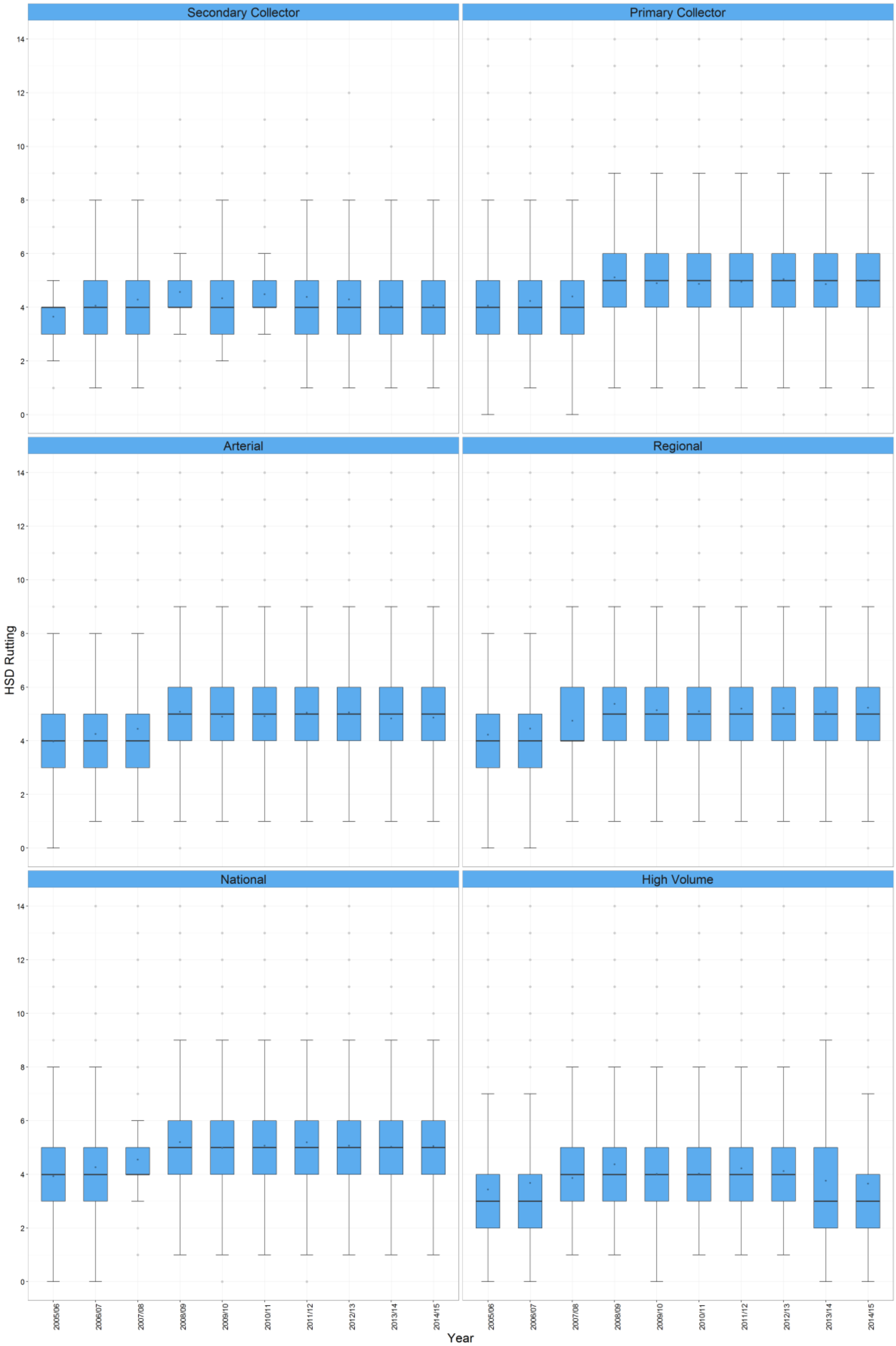

```
%ile Texture by ONRC"
```



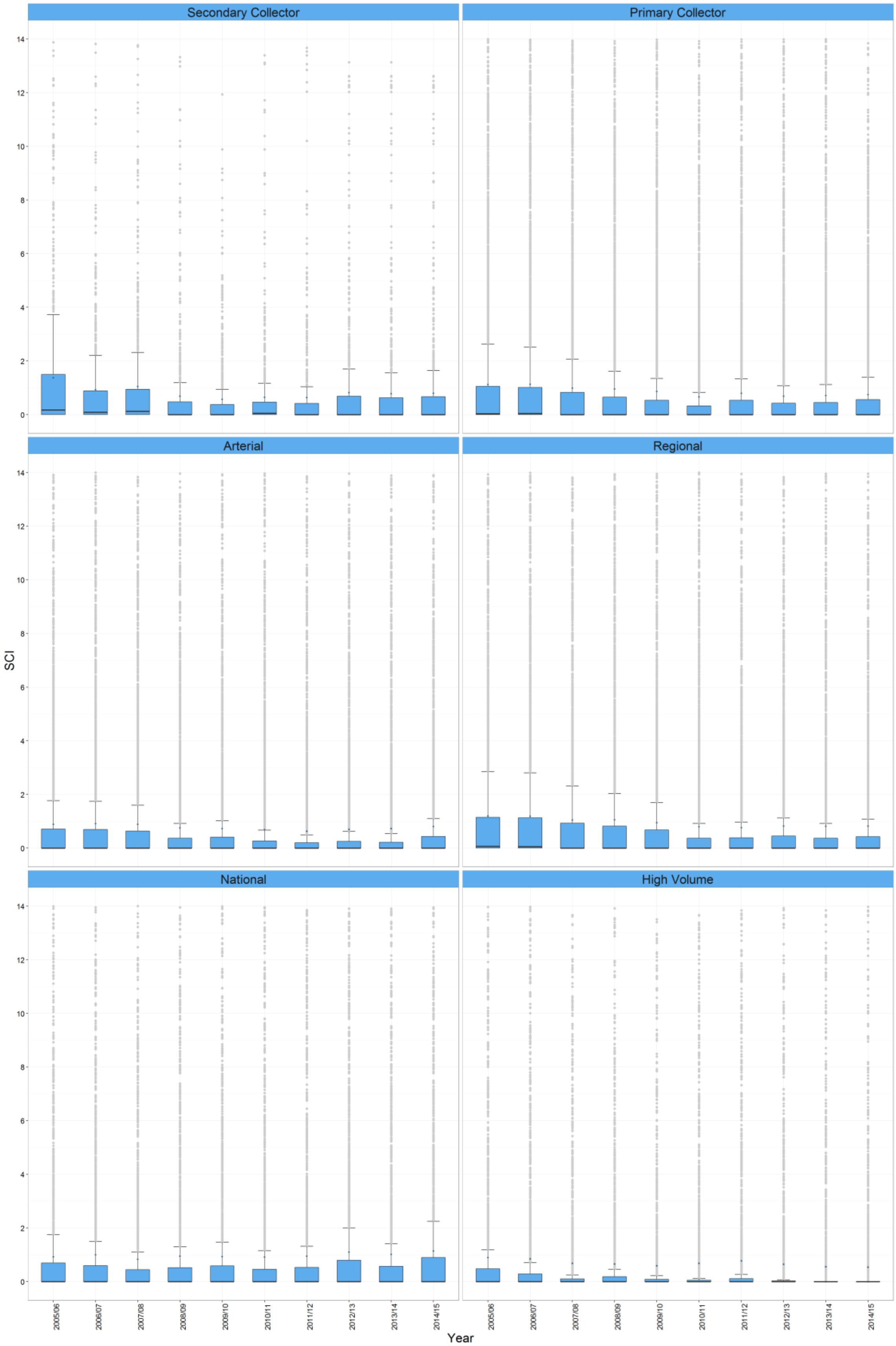
"Roughness by ONRC"



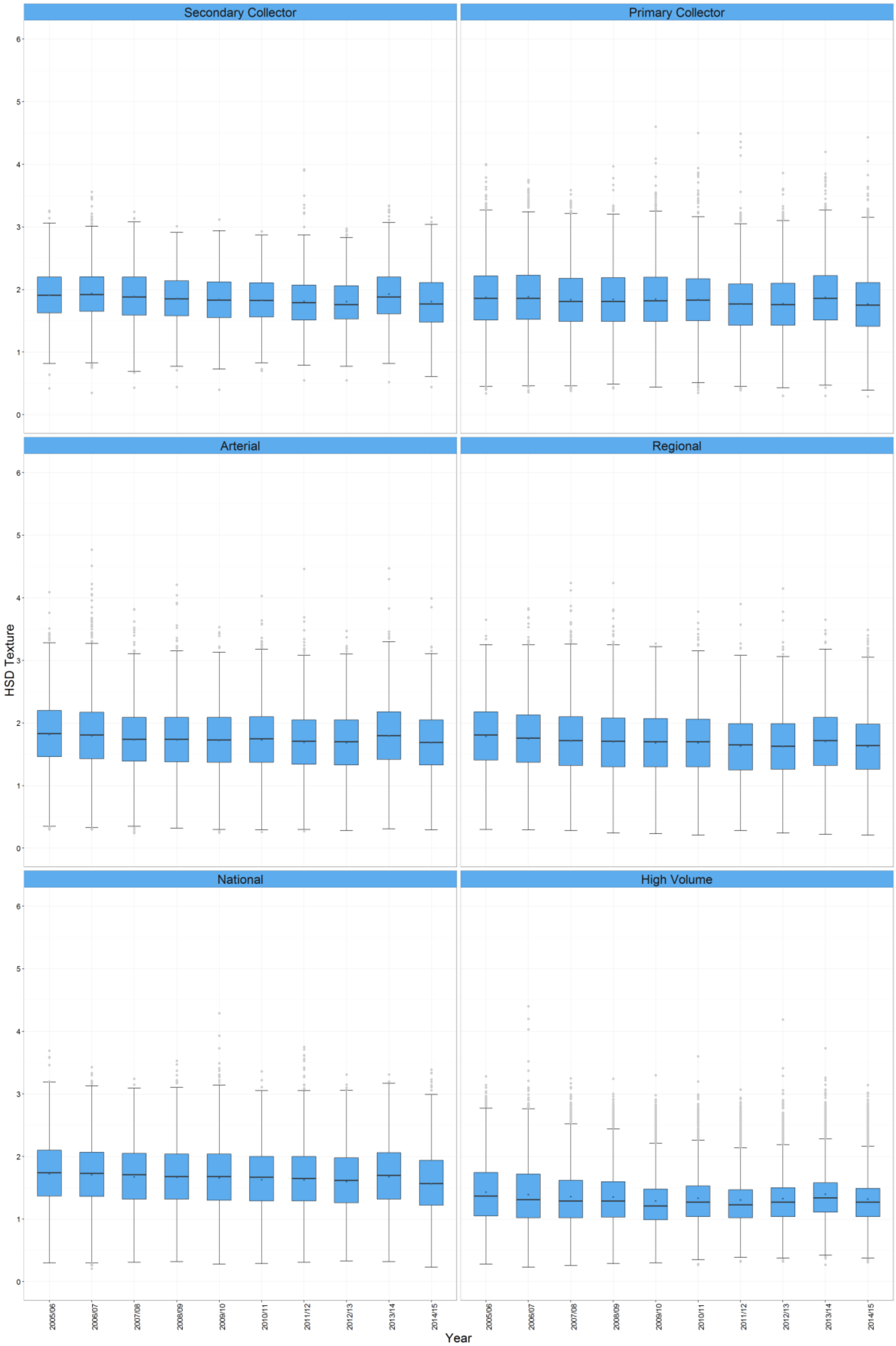
"Rutting by ONRC"



```
"SCI by ONRC"
```


Secondary Collector
Primary Collector
Arterial
Regional
National
High Volume
SCI
Year
0
2
4
6
8
10
12
14
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15

"Texture by ONRC"



Appendix C: ONRC Target Values – What do they mean?

Topic: ONRC Target Values – What do they mean?

One Pager

Date: 16 March 2016

Author: Elke Beca

Objective

The objective function adopted in this NLTP modelling analysis enables identification of 'level of service' **targets** for each key variable for each ONRC classification. The function also includes a **weighting factor** whereby the further from the target you get (varying by classification), the higher the pain. The model will then **seek these targets**, moving closer to them the more money we provide. Focus is placed on the rutting indicator.

Expectations – Tipping-Point

The following over-arching objectives have been built into the model. The 'tipping point' or base need investment corresponds to the point where these targets are *just* met. Exceeding these targets represents over investment, failing to reach these targets means under investment.

- **High Class** routes should **maintain** their **current condition profiles** (rutting as key indicator)
- **Middle Class** routes allowed to **deteriorate slightly**
- **Low Class** routes are currently over performing and allowed to **deteriorate significantly**.

Targets

The following targets have been assigned to meet the expectations listed above. These targets are based on averages and varying by road classification. For roughness (IRI) the targets also vary by rural/urban. Residual life is static across all road classes given the expected life is already adjusted for class.

	ONRC Classification					
Variable (Mean)	**2nd Col**	**1st Col**	**Art**	**Reg**	**Nat**	**Nat HV**
Rut (mm)	6	6	5	5	4	3
Rough (IRI)	3.07/3.45	3.07/3.45	2.69/3.07	2.69/3.07	2.31/2.69	1.94/2.31
Crack (%)	3.5	3	2.5	2	1.5	1.5
Res Life (yrs)	-2	-2	-2	-2	-2	-2

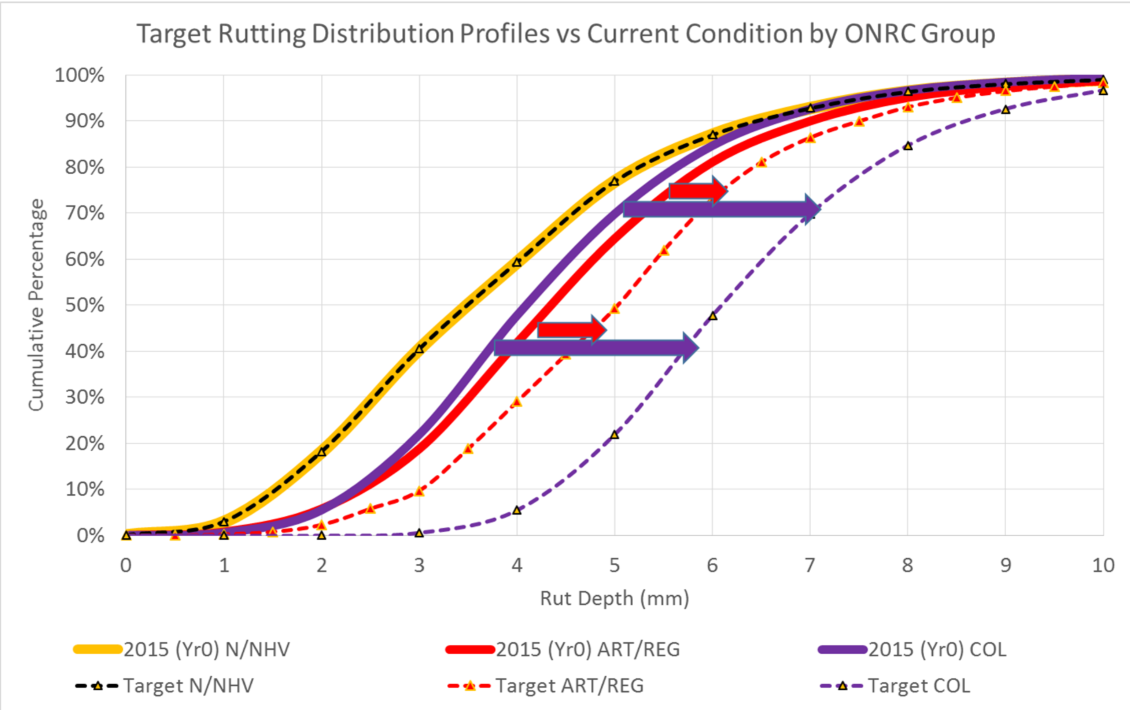
The targets have been further summarized into 3 ONRC Group

- **NATIONAL_HV:** National and National High Volume
- **ART_REG:** Arterial and Regional
- **COLLECTORS:** Primary & Secondary Collectors

	ONRC Group		
Variable	**NATIONAL_HV**	**ART_REG**	**COLLECTOR**
Rut (mm)	3.5	5	6
Rough (IRI)	2.31/2.69	2.69/3.07	3.07/3.45
Rough (NAASRA)	*60/70*	*70/80*	*80/90*
Crack (%)	1.5	2.5	3.5
Residual Life (yrs)	-2	-2	-2

The **target base need rutting profiles** (dotted lines) by ONRC group compared to **current condition profiles** (solid lines) are shown in the following chart.

- High class routes are targeted to maintain the current profile (yellow and black lines on top of each other).
- Mid class routes should deteriorate slightly (red lines and arrow show movement of 50%ile and 75%ile)
- Low class routes should deteriorate significantly (purple lines and arrow show movement of 50%ile and 75%ile)

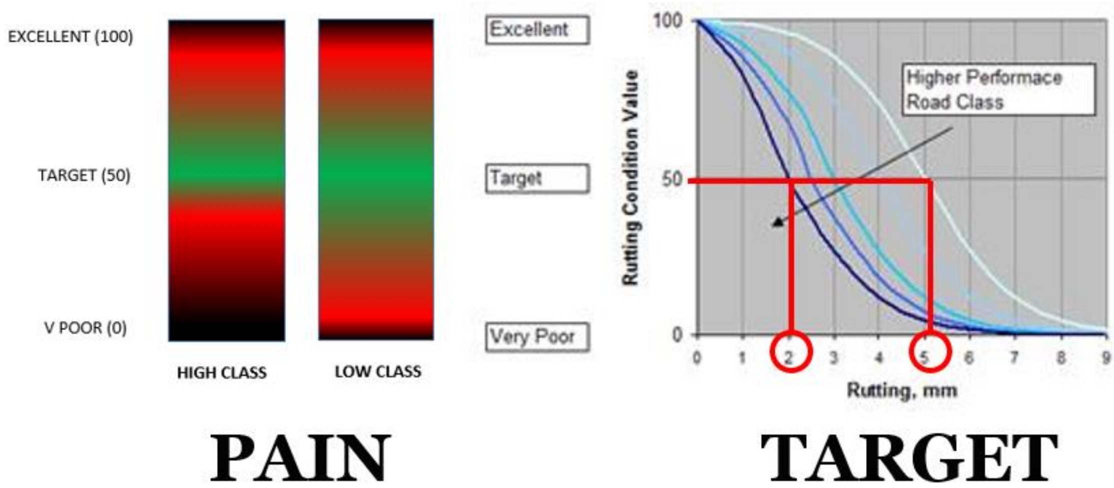


Pain (Utility Function)

The utility function is used to specify the impact of not achieving the target. This enables us to prioritise further by classification, it is essentially a second dial to ensure we are sending investment based on classification not just condition. Moving a high class length 1 unit from the target is 10 times more 'painful' than moving a low class length 1 unit from the target. This means the model will seek to achieve targets for higher class routes before achieving targets on lower class routes.

	ONRC Classification					
Variable	**SC**	**PC**	**Art**	**Reg**	**Nat**	**Nat HV**
Utility	10	10	50	50	100	100

The objective functionality is shown graphically below (not to scale). The 'target' diagram shows normalised rutting curves, whereby a high class road with a rut depth of 2mm is equivalent to a low class road with rut depth of 5mm. The 'pain' chart shows that on low class you can move quite far from the target and stay in low pain (green), whereas you quickly move into red pain zone on high class roads.



This objective function allows us to optimally distribute investment based on ONRC classification and has proven to function very effectively.

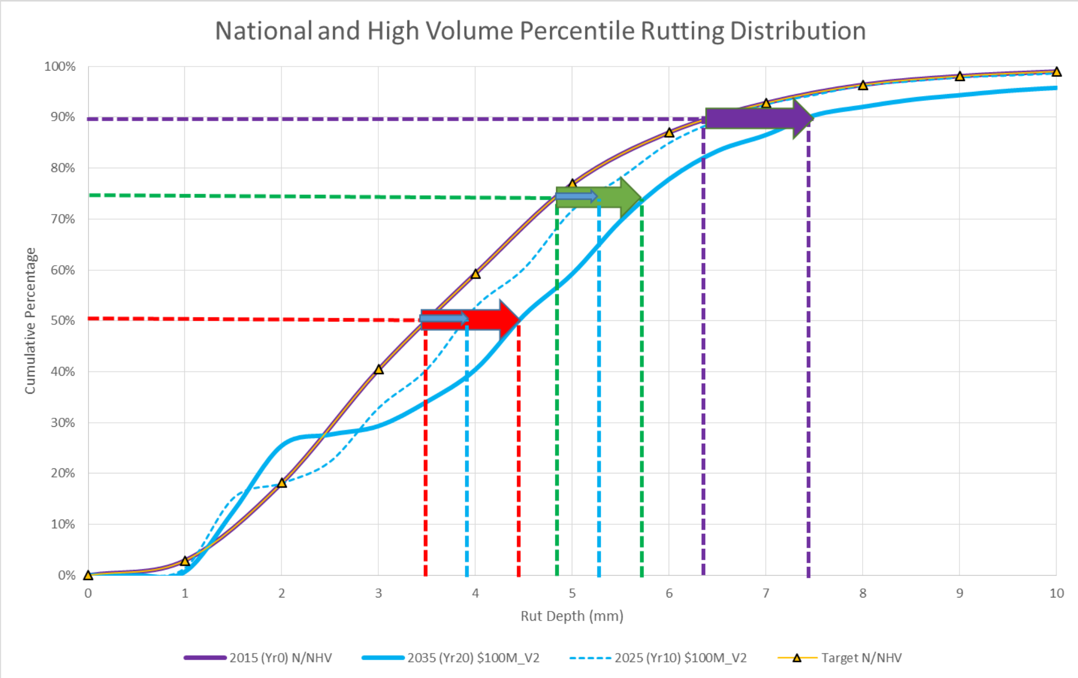
Base Need Investment (Tipping Point)

The recommended base investment over the short to mid-term is $100M pa increasing after 8 to 10 years to somewhere between $130M and $150M.

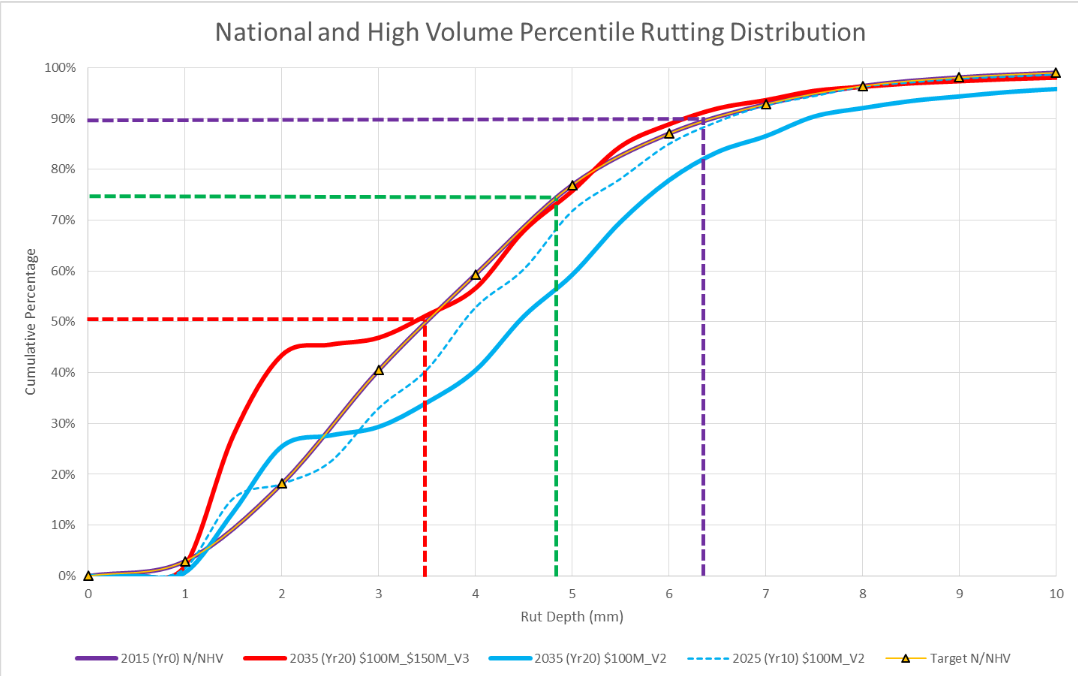
How has this level of investment been chosen?

The 'tipping point' or base need investment corresponds to the point where these targets are *just* met.

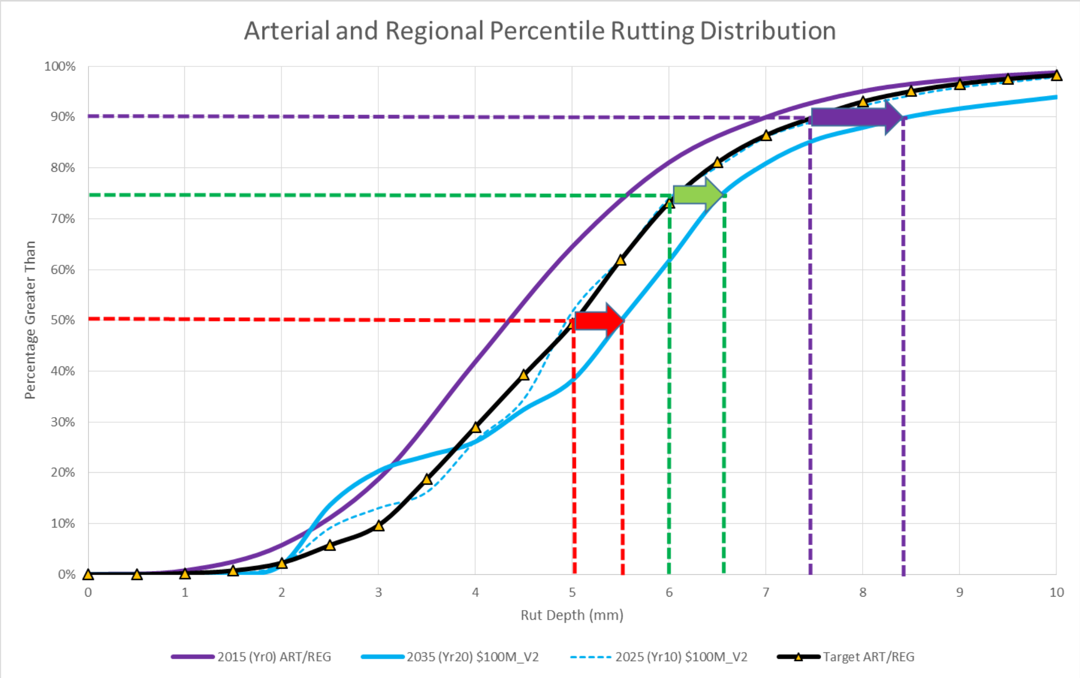
High class roads: *Target* is to maintain the current condition profile. Observing the predicted performance of rutting against the targets at year 10, the $100M investment will *just about achieve the target*. The blue dotted line shows the profile at year 10 which sits just to the right (poorer condition) of the target profile line. By year 20, with $100M investment, the profile has shifted significantly further to the right. This indicates $100M over long term is insufficient.



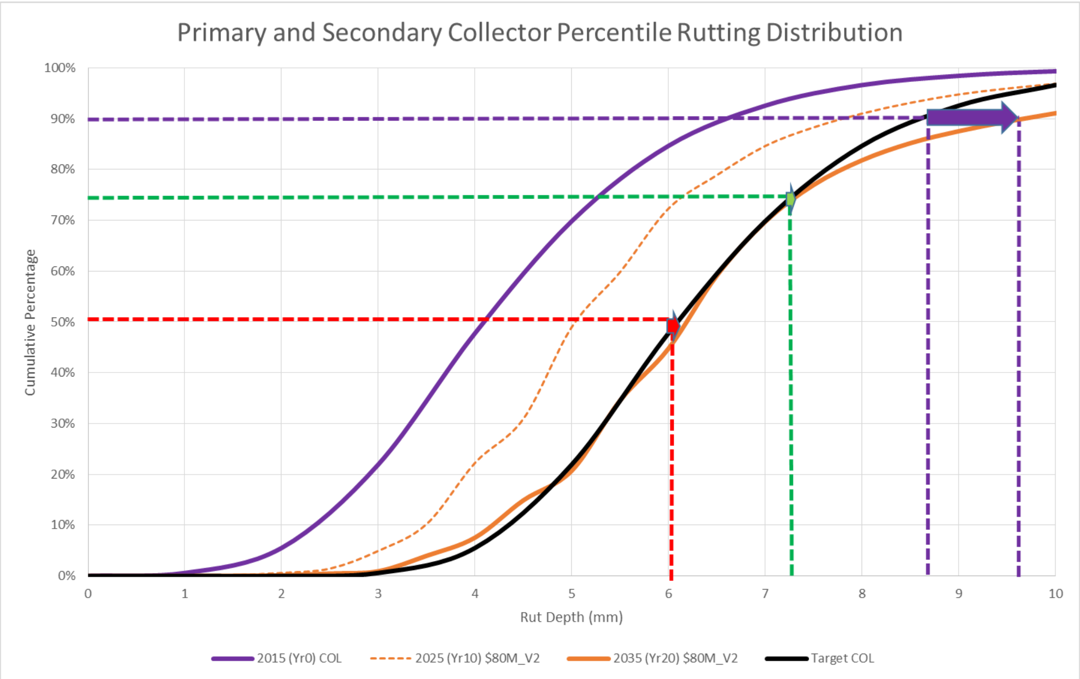
Increasing the investment to $150M pa from year 10 (2025) onward is sufficient to maintain the high class target over the full 20 year period. This investment option is shown by the red line which merges with the target and 2015 lines.



Medium class roads: *Target* is to relax current condition profile slightly. This target is easier to meet because some deterioration from current levels is allowed. Over the 10 year period, this target is achievable with $100M investment. The dotted blue line sits alongside the black target line. Again the $100M investment is insufficient to maintain this class over the 20 year period, shown by the blue line shifting to the right.



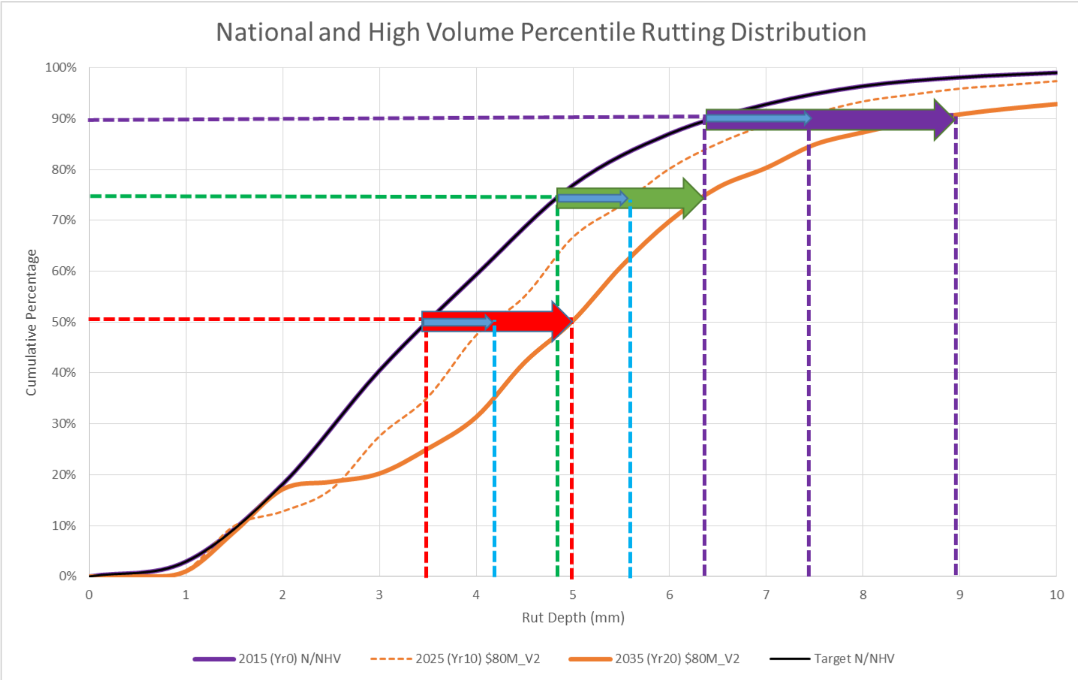
Low class roads: *Target* is to relax current condition profile signficantly. After 10 years, the profile is shifting from the current (purple) toward the lower target (black) but does not reach it until year 20. Due to relatively good current condition this class is left to deteriorate. Has the target been set too low?



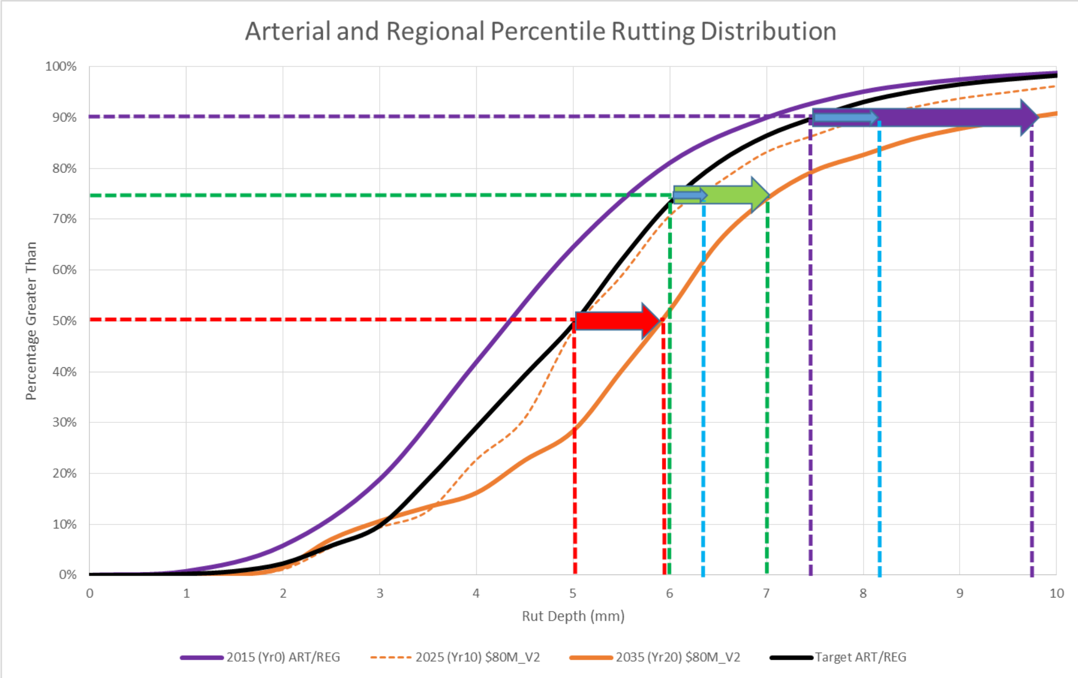
<u>What happens if we go lower?</u>

Capping the investment to $80M over a 20 year period would result in high and class roads deteriorating **well below targets**, low class roads will deteriorate to target level. Over a 10 year period neither high nor medium class roads are predicted to achieve their targets: *Note, observe shift from black line (target) to dotted orange line ($80M investment at year 10) and solid orange line ($80M investment at year 20).*

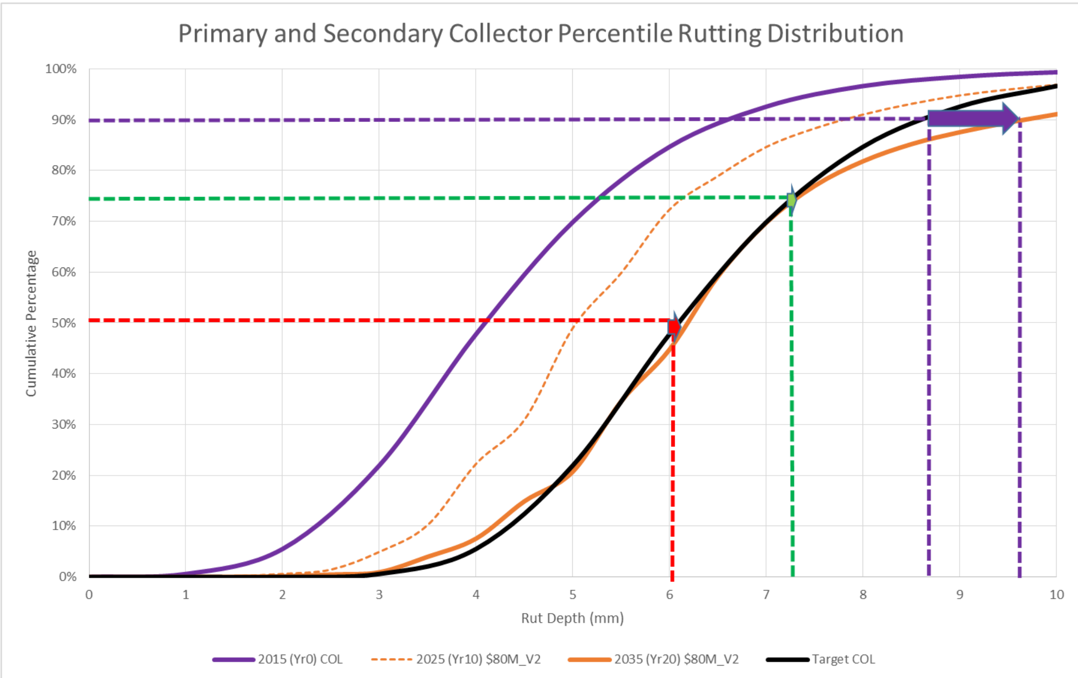
High class roads: *Target* is to maintain the current condition profile.
***Impact* is the condition profile will deteriorate by over a quarter over 20 yrs.**
Over three quarters of the network will sit in worse than the current average condition. 25% of the network would look like the worst 10% currently. Even after 10 years the deterioration is significant (orange dotted line).



Medium class roads: *Target* is to relax current condition profile slightly.
Impact is the condition profile will sit nearly 25% below target. This means half of the network will be in a poorer condition state than the targeted worse 25% after 20 years. At 10 years, an investment of $80M is sufficient to manage the average condition but the 75th percentile and more pronounced, the 90th percentiles are starting to move rapidly away from the target.



Low class roads: *Target* is to relax current condition profile signficantly. *Impact* is the target will be met. This class has achieved the target because the target has been set at a considerably low threshold. We expect these low class roads to deteriorate.



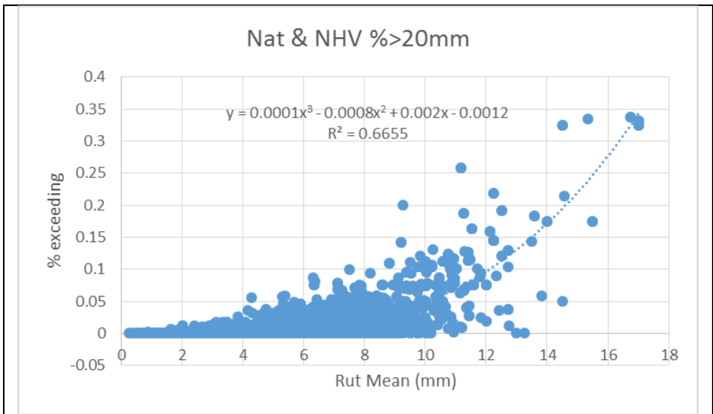
Rutting Indicator Translated

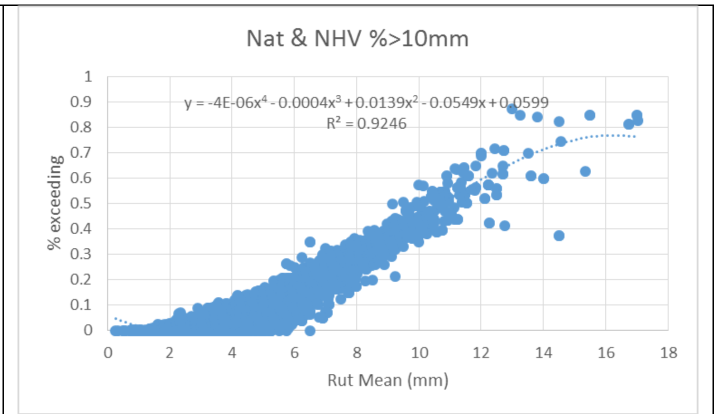
In day to day network operation, we think of rutting as a safety indicator, an operational performance measure and in some cases an indicator of pavement deterioration when progression begins to accelerate. Rutting is not often considered at a network level and a shift in mean rut depth or 75%ile rut depth is more or less meaningless to a practitioner. To translate some of the trends described in the earlier sections, we have determined a relationship between average rut depth (which is used in the modelling) and typical exceedance thresholds based on 2015 data. These relationships have been used to predict the % exceedance values based on the mean values generated by the dTIMS modelling for the various scenarios.

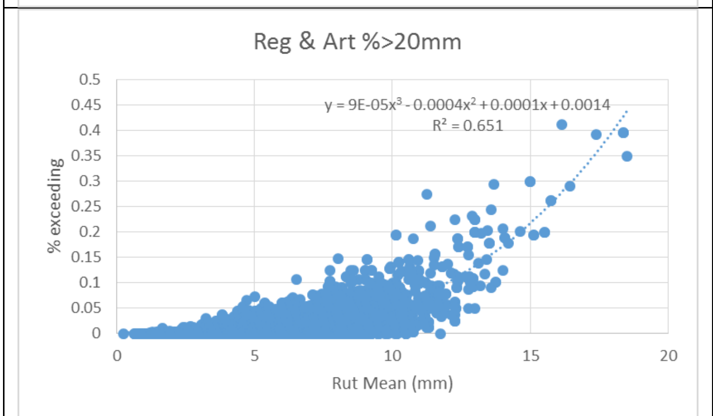
	High Class (Nat & NHV)		Medium Class (Art & Reg)		Low Class (Col)	
SCENARIO	%>20mm	%>10mm	%>20mm	%>10mm	%>20mm	%>10mm
Current (2015)	0.6%	11.1%	0.7%	11.2%	0.9%	10.2%
Calc. 2015 (Mean)	0.6%	11.1%	0.7%	11.2%	0.9%	10.2%
Predicted ($80M Yr10)	1.0%	14.7%	1.0%	15.8%	1.4%	16.1%
Predicted ($80M Yr20)	1.3%	20.8%	1.7%	22.4%	2.2%	23.0%
Predicted ($100M Yr10)	0.9%	12.8%	1.0%	15.8%	1.4%	16.1%
Predicted ($100M Yr20)	1.1%	17.3%	1.3%	19.0%	2.2%	23.0%
Current OPM Level	1.0%	na	1.5%	na	2.0%	na
Target	**0.6%**	**11.1%**	**1.0%**	**15.8%**	**2.2%**	**23.0%**

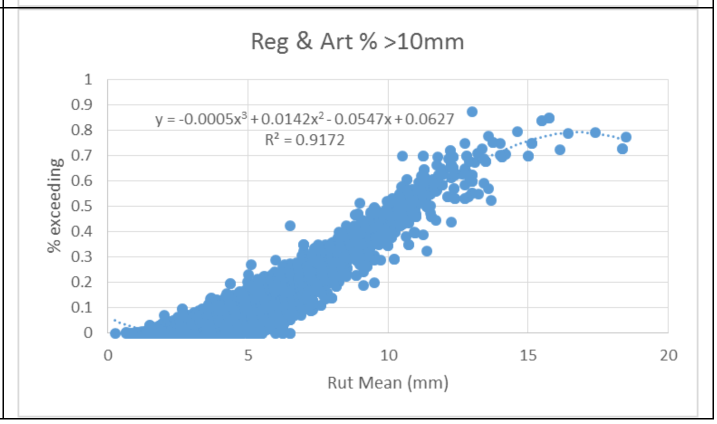
Red highlights are where predicted values exceed targets. The low class roads, due to residual capacity remain within target range. High class roads struggle to meet targets.

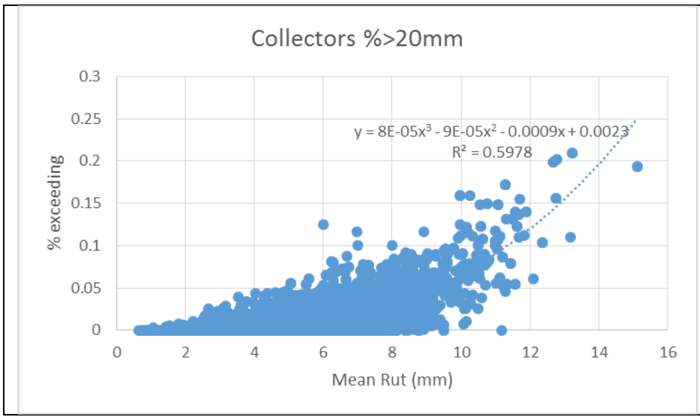
The following charts show the inferred relationship between mean rut depth and % exceeding 10mm and 20mm for each grouped class.

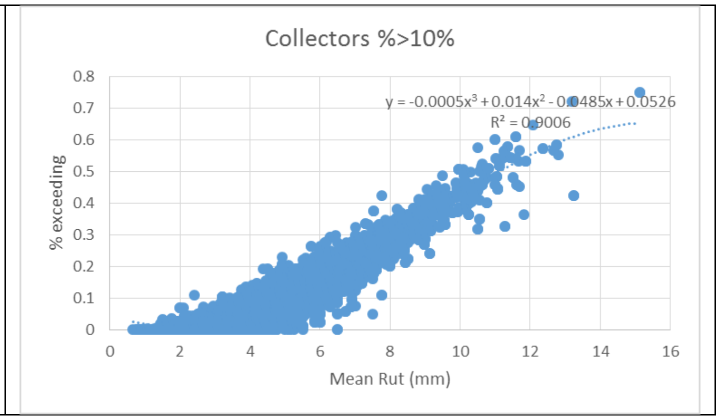






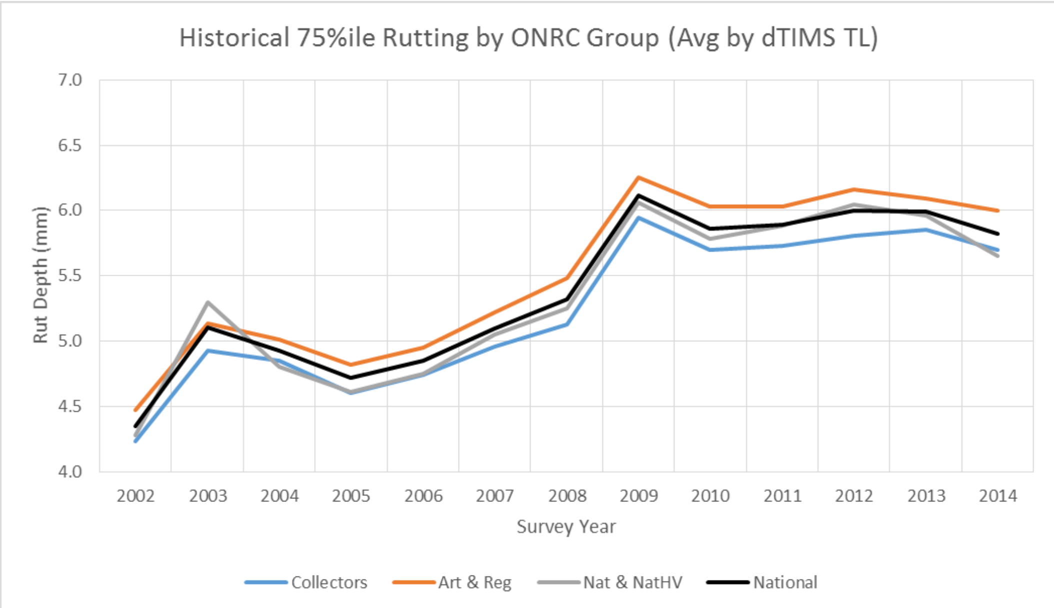




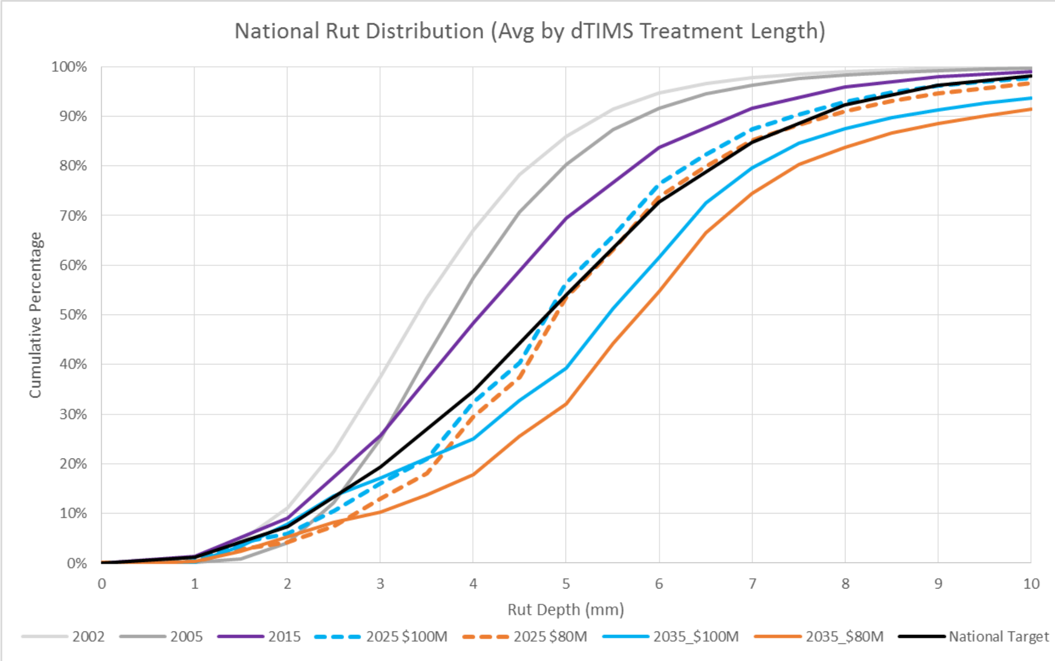


Historical Rutting Trends

Historical data suggests that the national rutting profile has been shifting to the left (deteriorating), however this trend stabilised around 2009 and has been static since this time. All road classification have been performing similarly when comparing the 75th percentile.

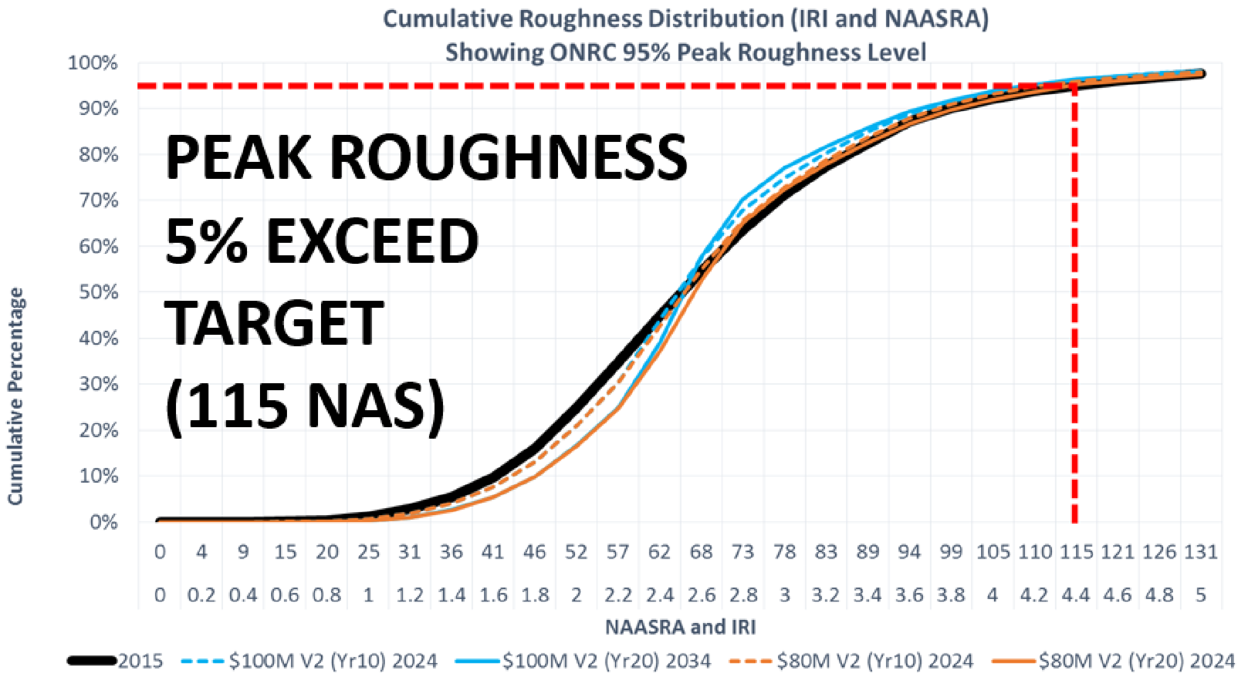


The following chart combines historical distributions, current performance, our target and predicted scenarios both 10 and 20 years in future. The shift between the purple line (current) and black line (target) represents the shift we 'expect' to see under the base need investment scenario at a national level (most of this shift is in the collector class routes). *NOTE: to enable comparison with future projections, historical data has been averaged over the dTIMS treatment lengths and these values have been plotted.*

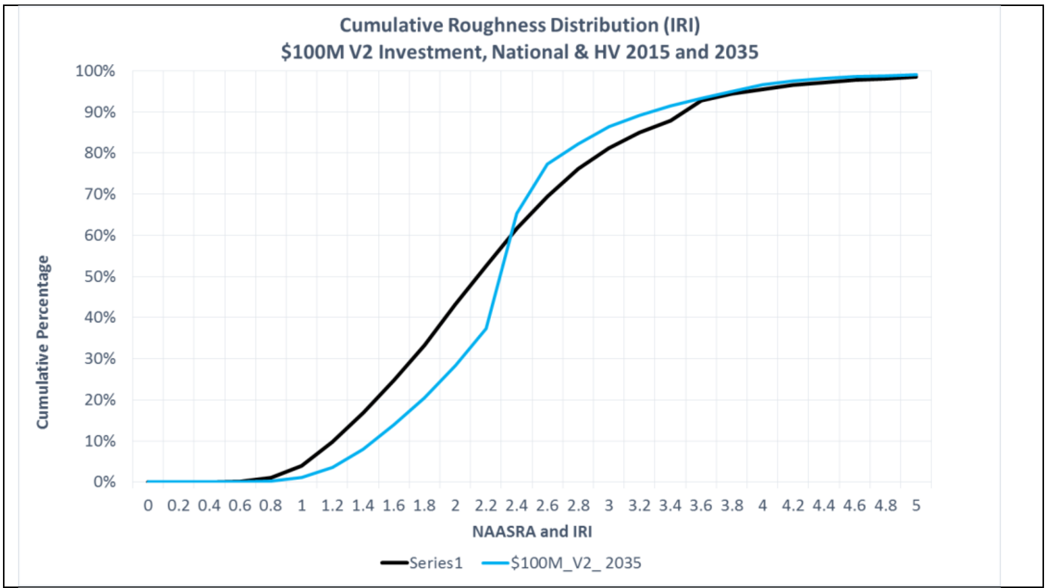


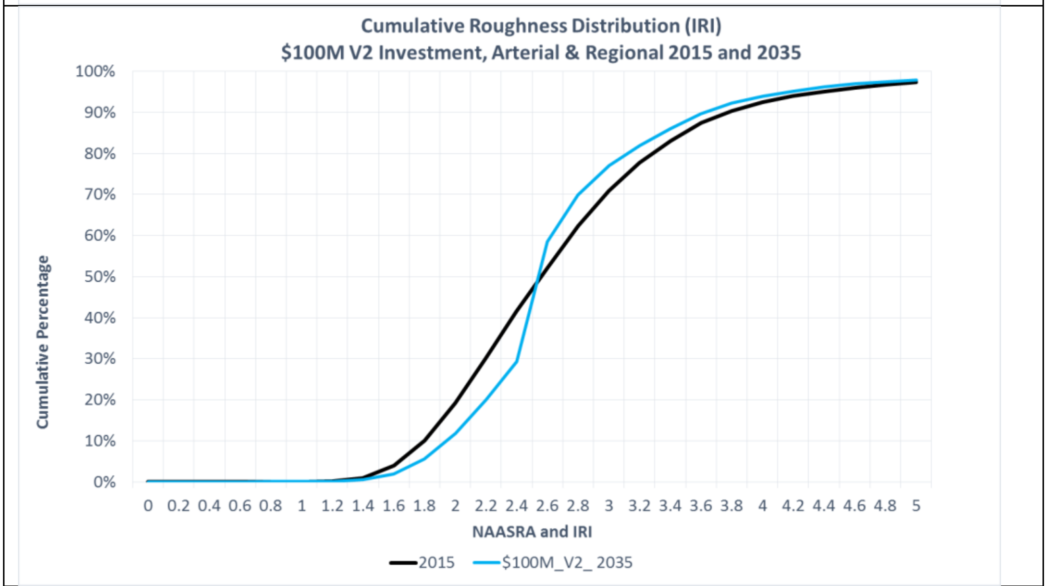
Roughness Trends

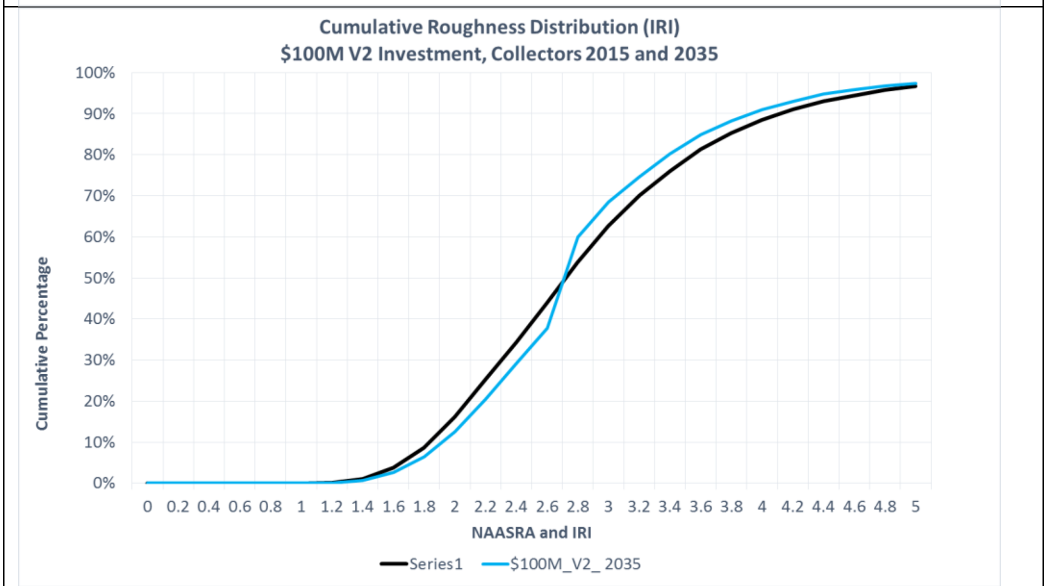
Roughness is modelled as IRI and is not a 'driving' variable, in that it very rarely is triggering treatments. It is however an important reporting measure and forms a link to the ONRC customer measures. The ONRC has a peak roughness limit for each class, with an allowable target of 5% exceedance. The chart below shows the cumulative distribution chart for roughness today (2015) and 10yrs and 20yrs predicted under both $80M V2 and $100M V2 scenarios. This chart suggests that profiles do not change significantly with investment, and under both investment options, the ONRC targets of 5% roughness exceedance are met.\



The following set of charts shows the cumulative distribution charts for roughness split by ONRC at year 20 (2035) for $100M V2 investment.


Cumulative Roughness Distribution (IRI)
$100M V2 Investment, National & HV 2015 and 2035
Cumulative Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 4.6 4.8 5
NAASRA and IRI
Series1
$100M_V2_ 2035


Cumulative Roughness Distribution (IRI)
$100M V2 Investment, Arterial & Regional 2015 and 2035
Cumulative Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 4.6 4.8 5
NAASRA and IRI
2015
$100M_V2_ 2035


Cumulative Roughness Distribution (IRI)
$100M V2 Investment, Collectors 2015 and 2035
Cumulative Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2 4.4 4.6 4.8 5
NAASRA and IRI
Series1
$100M_V2_ 2035

Topic: Significance of Rutting

One Pager

Date: 23 June 2016

Author: Elke Beca

Summary

A pavement will reach end of serviceable life through many failure modes manifested through a range of measurable and un-measurable defects. Using the NZ IDS template, this analysis has predicted the future timing of pavement and surfacing end of life and the optimal allocation of investment to renew pavements, ensuring the overall quantum of pavements in a state of 'end of life' do not exceed target levels (differentiated by classification). Rutting is the proxy used to represent pavement end of life condition for this analysis.

This one-pager examines why the rutting indicator is suitable as a proxy for overall pavement condition and how the targets have been set.

Pavement End of Life

A number of factors are known to lead to pavement end of life including but not limited to:

- Construction quality
- Saturation of pavement material
- Strength of pavement
- Traffic/loading exceeding design

A pavement that has reached its end of life will exhibit any number of visible defects including but not limited to:

- Rutting/deformations
- Shoving
- Flushing
- Roughness
- Cracking/potholes/pumping
- Extensive maintenance patches

In relation to the list of defects above, the NZ IDS framework includes prediction models for Rutting, Roughness and Cracking. The cracking model is made up of 'surface' variables and largely used in the framework for predicting surface performance or surface 'end of life'. The roughness model is simplistic with a purpose of producing a reported outcome, rather than for use in decision making. Of these three models, the rutting model is the strongest in predicting pavement performance because it includes three of the four identified factors; Strength and Loading and can be calibrated to take into account site specific issues such as Construction Quality (which if present will be evident in historical data). **Rutting is deemed a 'proxy' for overall pavement condition when predicting into the future.** Research completed by Opus Research supports this finding. This research looked at a number of measures including Rutting, Roughness, PCI Index, RHAB Probability Index and Maintenance Costs immediately prior to pavement renewal compared to the extent of the same measures over the full network. Rutting was proven to be the best indicator of RHAB Need[1].

Recommendations and technical discussions in this analysis are based on the performance of the rutting indicator.

The following figures depict pavements that have reached End of Life.






[1] Patrick. J, Beca, E, McLean. J, Jamieson. N; Development of a Stochastic Model for Network Cost Forecasting

Targets

To illustrate the impact of investment levels using Rutting as key indicator, suggest 1% of the network is currently at end of life. These numbers are supported by the annual RAPT review which identified approximately 0.8% rehabilitation candidates in 16/17 (which are known to be low), the NOC base preservation levels and the rut exceedance levels (refer 2016_03_24ONRCTargetValues.docx one pager). Under the targets set by the analysis, this 1% is expected to remain static for High Class roads, increase by about 40% (to 1.4% network) for Medium Class and increase by 4 times (to 4% network) on Low Class roads.

Currently all road classes are performing similarly with similar quantity at End of Life. The rules adopted with this analysis to align with ONRC principals are:

- High Class will be maintained,
- Medium class will deteriorate so that for every 2 current end of life pavements we will see three in the future,
- Low class will deteriorate significantly such that for every 1 current end of life we will see 4 in the future.

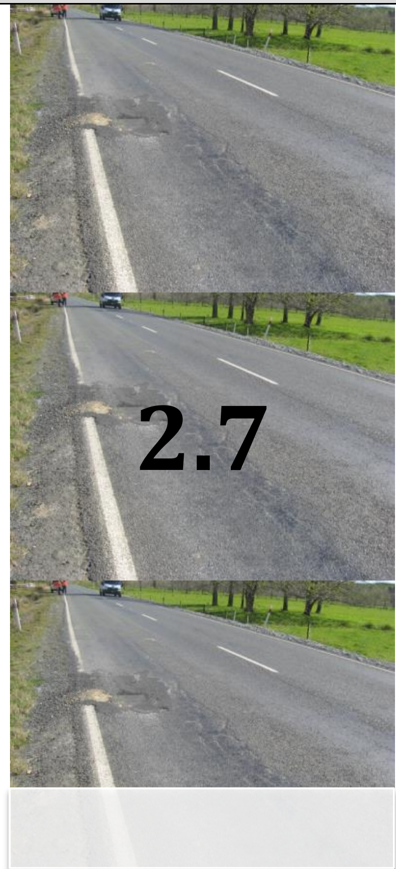
The investment scenarios and the expected number of sites at End of Life are shown below. NOTE: Current is set = 1 for all Classes to demonstrate relativity.

Number of Sites at End of Life				
Class	**Current**	**Target**	**Future $80M**	**Future $100M**
High	1	1	2.7	1.4
Medium	1	1.5	3.6	1.8
Low	1	4	4	4

As funding is restricted, investment will be prioritised toward High Class routes. Medium term (10 year) investment risk of under investing with $80M pa is:

- We will see almost 3 times as many End of Life pavements on National Strategic and HV routes.
- We will see over 3 times as many End of Life pavements on Arterial and Regional routes (we expect to see 1.5 times as many).
- Expect to see up to 4 times as many Collector routes as End of Life (while maybe ok in short term is not sustainable).

This is visually depicted in the following table.

Classification Group	Current	10 Year Targets	10 Year $80M Investment	10 Year $100M Investment
High Class (National & High Volume)	 1	 1	 2.7	 1.4

Classification Group	Current	10 Year Targets	10 Year $80M Investment	10 Year $100M Investment
Middle Class (Arterial & Regional)	 1	 1.5	 3.6	 1.8

Classification Group	Current	10 Year Targets	10 Year $80M Investment	10 Year $100M Investment
Low Class (Collectors)	 1	 4	 4	 4

TO	NLTP Development Technical Committee
FROM	Theuns Henning Chief Executive, Infrastructure Decision Support and Dean Silvester
DATE	15 October 2015
SUBJECT	**Defining the objective for NLTP Analysis**

1 Purpose of the Memorandum

The purpose of this memorandum is to propose the optimisation methodology that will be used during the 15/16 State Highway NLTP analysis. This methodology was developed on the basis of the One Network Road Classification (ONRC) System and the experience gained from previous analysis.

2 Introduction

2.1 Background

The analysis objective for New Zealand dTIMS setup is to optimise the whole of life cost across the entire network to an acceptable level of service for the travelling public. Translating this statement into the system definition, the object function is to maximise the pavement and surface condition for the minimum over-all long-term investment across the network.
Figure 1 shows a Condition Time Curve which illustrates the benefit that can be gained by conducting some treatment as opposed to the do-minimum strategy.

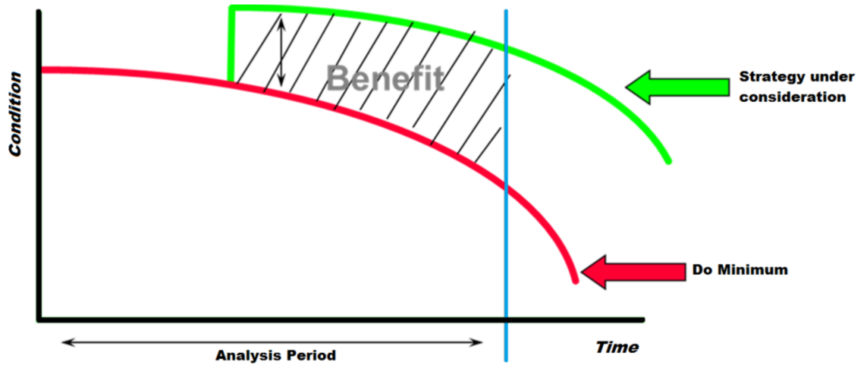


Figure 1: Condition Time Curve

For each life-cycle strategy, the over-all costs are recorded, together with the total benefit area for the analysis period. These two values (life-cycle costs and life-cycle benefits) are then recorded for the Efficiency frontier, as illustrated in Figure 2.

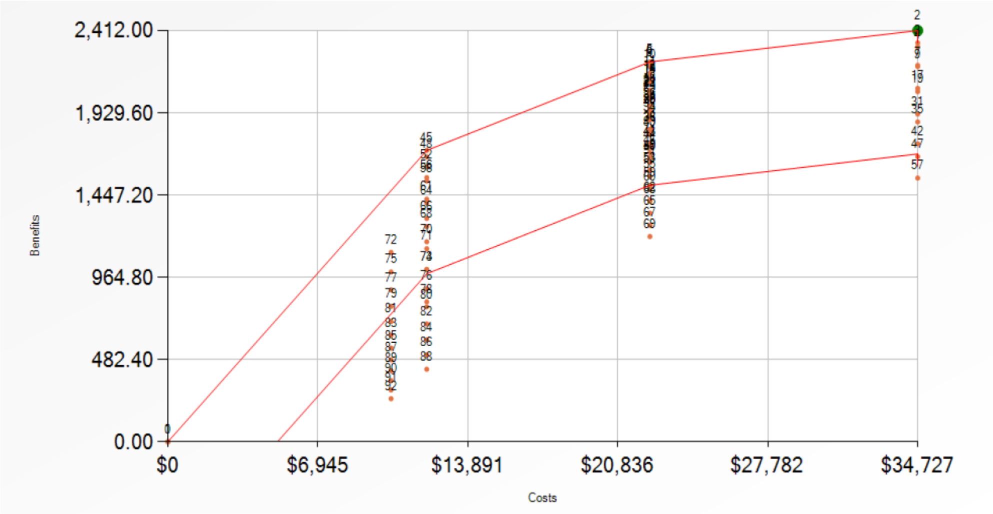


Figure 2: Efficiency Frontier Used for Optimisation

The efficiency frontier itself connects the "best performing" strategies i.e. the highest return for a given investment. The software will generate an efficiency frontier for each road section and each will contain the life-cycle strategies generated for these sections. During the optimisation the user will specify a budget scenario to be analysed. For this budget, the software will maximise the overall return (i.e. incremental benefit cost ratio) for each road section. Therefore, for the particular example in Figure 2 an unlimited budget will allow the section of Strategy 2. However, with reduced budget levels a cheaper LCC strategy has to be selected, accepting that it will yield reduced benefits.

2.2 Problem Statement

Given the relatively low traffic volumes of NZ roads optimisation based on a Total Transportation costs was found to be less relevant. Instead the NZ dTIMS system has been using the condition time curve, thus optimise the return on investment on the basis of returns in Level of Service (LOS) The LOS was defined as an over-all condition or Pavement Condition Index (PCI). Therefore, when testing strategies to meet funding criteria such as positive NPV, the system will maximise condition across the network for the available budget.

Provision was made to weight road sections according to the traffic volume therefore favouring more expensive treatment on higher volume roads. The One Network Classification (NOC) and the Network Outcome Contracts have resulted in a different requirement from the optimisation process. Both these initiatives results in a more strategized approach to road maintenance planning whereby:

- Lower volume roads will only receive treatments that will allow a minimum required LOS, whiles minimising the risk for failure. From a modelling perspective this means that the lowest LCC strategy will be applied to these roads; and,
- Higher volume roads still have an element of maximising the LOS but under more constraint funding conditions compared to the past.

A further issue of using the traffic volume weighting is the significant overlap of traffic volume range contained within different road classes. The traffic distribution of a particular road class may not be readily distinguishable from that of another road class and higher objective weighting is possible for roads in lower order classes.

The above requirements resulted in the need for dTIMS to be analysing maintenance investment with a different objective function for respective road classes.

3 Proposed Enhancements

3.1 Classification Based Objective

The obvious solution to the stated problem is to employ multi-objective optimisation, yet that capability does not currently reside in pavement management software. However, there is a way of taking a multi-objective approach into a single-objective environment.

By normalising different objectives to a common scale and ranking strategies with a utility function it could be analysed as a single-objective function. It allows for two separate objectives to be interchangeable.

The principles involved in the proposed objective provide a rational framework from which to build different objectives for respective road classes. Figures 3 and 4 illustrate the difference in approach between the current objective and the proposed enhancement.

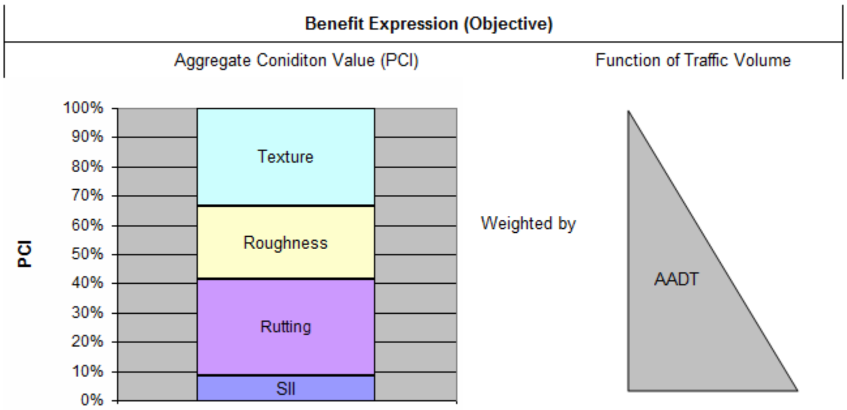


Figure 3: Current Objective Function

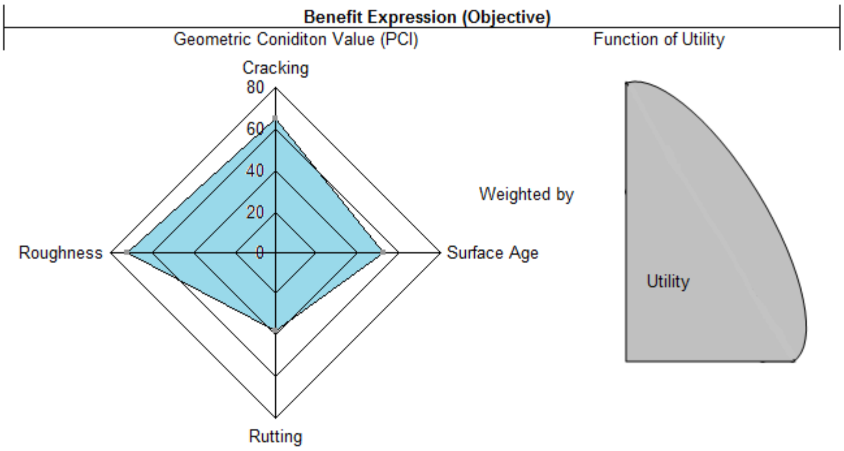


Figure 4: Proposed Objective Function

Figure 4 shows the indicators Cracking, Surface Age, Rutting and Roughness. The final indicators used will be discussed with NZTA.

The normalisation of condition indicators puts the different conditions on the same scale, ranging from excellent to poor. The critical point is the middle or target value. This target point determines the contribution of the condition to the overall utility of a treatment strategy.

It is possible that a condition value could have a different relationship to the forecast condition depending on the road class; this would normally apply for the LOS type indicators (rather than safety or preservation, which would have a more common target across the road classes). Figure 5 illustrates how the mean rut depth (mm) might be rated depending on the road class. In Figure 5 it takes less rutting to be considered poor condition when the order of road class increases (higher performance road class vs lower performance road class).

The target values for the different condition indicators and road classes needs to be agreed with NZTA.

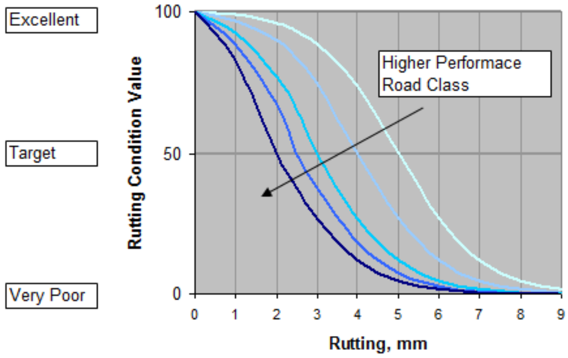


Figure 5: Rutting condition value compared with mean rut depth for different road classes

The utility function ensures that, in the over-all outcomes, the maximum combined impact of the condition indicators are achieved for the respective road classes.

The utility function will be of the Cobb - Douglass form:

$u = x^a y^{(1-a)}$

Where x is the cardinal version of the condition parameter (rutting transformed to 0 - 100 scale) and *y* and *a* (alpha) are constants that are established for the section's road class. These constants will determine the relative (ordinal) preference of the strategy, both in respect to the value of the condition parameter itself and the road class to which it belongs.

The Cobb - Douglass function is chosen because it exhibits a diminishing marginal rate of substitution (MRS). The diminishing rate is important because it acknowledges the willingness to make trade-offs increases when there are increasing values of *x*.

To illustrate, a strategy that has a strong alpha value (representing a road section within a high service-level class) and a strong x value (good rutting) will have a relatively strong MRS compared with a strategy that has a weak alpha value (representing a section within a low service-level class) and strong x value. There is less willingness to trade the high service-level class strategy than there is to trade the low service-level class strategy. This is manifest in a higher MRS for the high-service level road.

High Perf (strong alpha value)

X	Utiltiy	MRS
100	75	0.7
90	70	0.8
80	66	0.9
70	61	1.0
60	56	1.2
50	50	1.4
40	44	1.8
30	37	2.3
20	29	3.5
10	20	7.0
0	0	∞

Low Perf (weak aplha value)

X	Utility	MRS
100	81	0.5
90	78	0.6
80	74	0.6
70	70	0.7
60	66	0.8
50	61	1.0
40	55	1.2
30	49	1.7
20	42	2.5
10	31	5.0
0	0	∞

Figure 6: Condition values (X), Utility and MRS for two different road classes

In the law of diminishing returns the strategy with the lowest marginal rate will be traded for the strategy with the higher marginal rate. The network Utility is maximised when MRS is equal for each strategy. Otherwise spending will be decreased on the strategy with the lower MRS and increased on the strategy with the higher MRS.

The MRS provides a consistent framework for valuing the relative importance of different condition values for different road classes (at different funding levels). The MRS provides a pricing mechanism. This mechanism enables consistent, reliable assessment of appropriate constants to use for each parameter for each road class.

The strength of the pricing mechanism will be discussed with NZTA. The utility parameters ultimately used will depend on the willingness to differentiate LOS between road classes for the decided budget outcome.

The proposed enhancement provides the Objective Function with the following properties:

- Contains rational objective weightings
- Incorporates simple and flexible criteria
- Provides proportionate allocation of resource to acheive the desired service levels and/or maintain appropriate service levels for different road classes (project level outcomes).
- Provides proportionate resource allocation to different road classes so that condition levels are appropriate and proportionate to the accepted risk and consuption profile of the network. (network level outcomes).
- Rationally addressess asset consumption if funding is not a constraint
- Extracts value from existing seals and programmed treatments
- Expresses the objective terms in a common unit of measure
- Applies the principle of optimising;
    - nothing other than consumption for roads that are low hierarchy (TTC, LOS, LCC, Risk low importance)
    - LOS, LCC and Risk for roads that are medium hierarchy (TTC low importance, consumption is implicitly important)
    - TTC for roads with high hierarchy (LOS, LCC, Risk and consumption are implicitly important)

3.2 Objectives for the NLTP Analysis

Within the context of the NOC stratified approach there are two objective functions that apply to the respective road classes. For the higher volume roads the objective would be the maximise the performance for the allowed budget, while the objective for the lower volume roads would be solely to reduce the LCC cost, while still adhering to a minimum LOS (Refer to Figure 7).

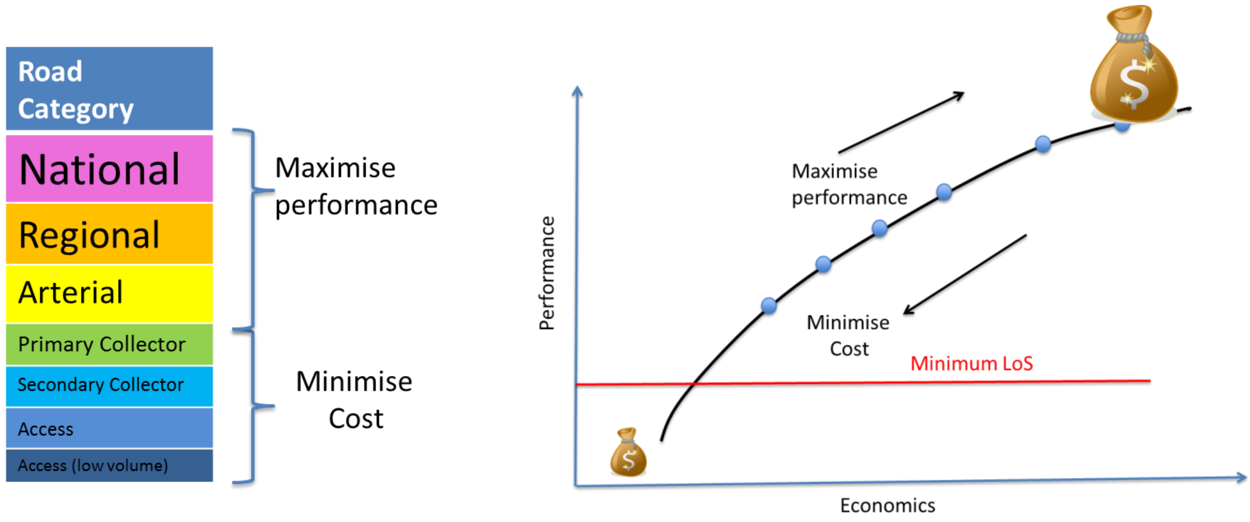


Figure 7: Objectives for the NLTP Analysis

In terms of applying these objective functions to the State Highway analysis, the following process will be followed:

1) The condition indicators used are to be determined, these will encapsulate multiple objectives of LOS, safety and asset preservation.
2) The target values for the different condition indicators and road classes needs to be agreed with NZTA.
3) The utility parameters will depend on the willingness to differentiate the LOS between road classes for a given budget level. A key aspect is determining the minimum LOS accepted for the low performance road classes as well as the risk appetite in terms of long-term preservation outcomes (condition tipping point).

At this stage it is uncertain how the optimisation will assign the total budget to the two respective road class groupings.

Topic: 30 Year Analysis

One Pager

Date: 10 December 2015

Author: Dean Silvester

1. Recommendation

For the Pavement & Surfacing NLTP analysis, run with current NZdTIMS best practice; 20 to 24 year analysis reported to 10 or 12 years. If projections to 30 years are required, these will be forecast using the 10 year dTIMS outputs with risks and limitations documented.

2. Issue

At the 26 November workshop, NZTA expressed an assumption that the analysis and optimisation period is over 30 year period. Treasury expectation will be 30 years.

An issue is that additional length of time increases modelling requirements. High level projections could be used instead of the dTIMS model for distant future forecasts.

3. Projected Run Time

At this stage it is anticipated that two analysis runs will be done. This is required to accommodate the needs of the Safety Model.

A test set has shown that, on average, there is 8 times the number of strategies generated when doubling the analysis period.

On this basis, the projected single run time is two weeks to get basic outputs[1]. The time to complete two runs is at least four weeks.

4. Further Technical Issues

NZdTIMS has been used to forecast future network trends for the next decade or so. There is no precedent or experience of extreme future forecasts.

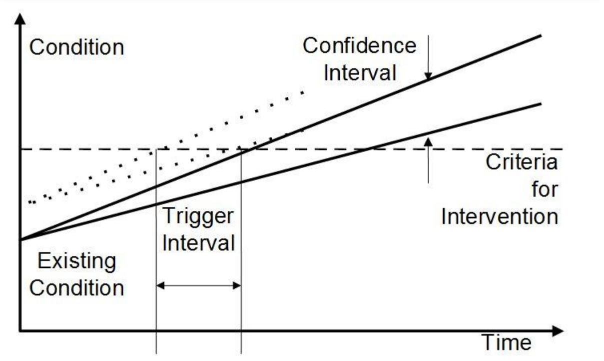
Some performance models have known limitations. In particular:

- Strength is not deteriorated. The SNP value is currently accepted to be stable over a 10 year period. This will not actually be the case over an extended period of time.
- Current traffic growth parameters. A projection to 40 years in the future (required period to produce a 30 year optimisation) shows an average of doubling the present day traffic volume for each treatment length. Traffic will have serious impact to rates of deterioration in the latter half of the 30 year forecast.

[1] For strategy generation and optimising three budget scenarios and Least Cost, an allowance for SQL data summarisation for subsequent reporting queries. Assumes there is continuous and reasonable speed processing without down time (active 24/7). Does not include allowance for the larger data requirements of individual strategies (double time period size). Does not include an allowance for cross-asset optimisation – the run time for cross-asset optimisation cannot be predicted at this stage.

The above are key sub-models to many of the performance models.

Prediction of treatment is based on the mean rate of deterioration. The confidence interval will spread (much) wider as the prediction of deterioration goes further into the future.



The Safety Model inputs will also erode over an extended time period. Even so, the Safety Model intervention periods may not be appropriate for the distant future.

5. Risks

The dTIMS software licence is now remote. There is increased risk of lost connectivity during the duration of a run. Weeks of time could be lost and it may not even be possible to maintain a continuous connection during the duration of two full runs.

The projected run time is a span established from a single test and prior experience with established practice and utilising desktop software. It should be considered as a best case scenario.

Traffic growth projections could be erroneous.

Strength projections will be erroneous.

While distant future outcomes should have little to no effect on optimisation, it is possible that the near future (next 12 years) will be a sub-optimal solution.

It is not possible to validate the outcomes. Previously stated methods of validation are not adequate.

Appendix D: Additional Model Outputs (Consistent budget for 20 years)

Topic: Scenario A Outputs, Network Base Need

One Pager

Date: 19 February 2016

Author: Elke Beca

Objective

The object of the Scenario A analysis was to determine the base sustainable level of investment required to maintain the network and to demonstrate the impacts of funding over and under this level. Two models have been run:

- **Scenario A V1:** Constrained renewal investment, unconstrained (uncapped) routine maintenance investment. The unconstrained routine maintenance ensures poor routes, or the 'tail' of the distribution are always maintained. Five renewal investment options were investigated ranging from $70M to $105M
- **Scenario A V2:** Constrained renewal investment, constrained (capped) routine maintenance investment. The routine maintenance constraint has been fixed at approximately $30M (based on numbers proved by NZTA best estimate of the lump sum funding). The same five investment options as V1 are used. *NOTE: Sensitivity of the Routine Maintenance was tested on 5 options using a 10% network sample. Outcomes suggested the model is relatively insensitive to the range of current +/-50%.*

Capped Routine Maintenance Investment

An initial 10% run was completed to test the impact of a constrained routine maintenance budget. The routine maintenance budget is made up of two components: Routine and Preseal Repairs.

Findings demonstrated:

- Traditional optimisation was not possible due to insufficient funds (allowable funds lower than least cost). This was overcome by allowing model to borrow money from the renewal budgets.
- The Preseal component of the budget was sacrificed when the budget was constrained, essentially disallowing reseals (because there were insufficient funds to complete preseal repairs. This resulted in an increase in RHAB, a decrease in RSEAL and a rapid deterioration in condition profiles.

Note: It is presumed the 2013 analysis took the approach above, thus resulting in extreme condition profiles, high RHAB and low RSEAL quantities.

The solution taken by team was to split the Routine and Preseal budgets and only constrain the Routine part of the budget. The model was allowed the least cost funding as a minimum in each year (allowing traditional optimisation practice). This meant the routine budget was increased (above the $30M) in 4 years of the 20 year analysis.

Scenario A Outcome Commentary

The key findings from the two model runs are as follows:

SURFACING

- Chipseal quantities (excluding 2nd coats) are more or less static across all investment levels
- AC quantities increase slightly as investment increases
- When routine maintenance budget is capped (preseal budget unconstrained) the quantity of surfacing decreases very slightly (<2%).

PAVEMENT

- Rehabilitation quantities increase significantly as investment increases
- Do something quantities decrease as investment increases (investment in full renewal treatments)
- Rehabilitation and do something quantities both increase moderately when routine maintenance budget is constrained.

COSTS

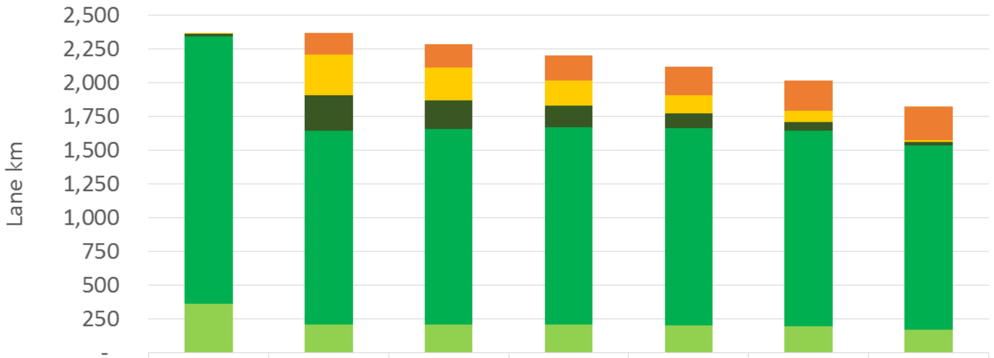
- Renewal budgets (single budget includes chipseal, AC and rehabilitation) are fixed at different levels of investment ranging between $70M and $110M.
- Preseal cost is static across all investment levels and both models (capped and uncapped)
- Routine maintenance cost decreases as investment increases (when uncapped)

CONDTION

- Optimisation is driving the condition of each key variable (Rutting, Roughness, Cracking (SII) and Residual Life) to a target value which differs for each Classification.
- The ‘tipping point’ we are seeking may be demonstrated when we see these target conditions are no longer able to be met.
- Low classification routes are currently in better than acceptable condition so show fairly static deterioration across all investment scenarios (their target condition is significantly worse than current condition).
- At the normal investment level ($100M) the high and medium classification routes are converging on their target condition.
- The Very Low investment level ($80M) shows the condition of all classes dropping beyond target (rutting) condition.

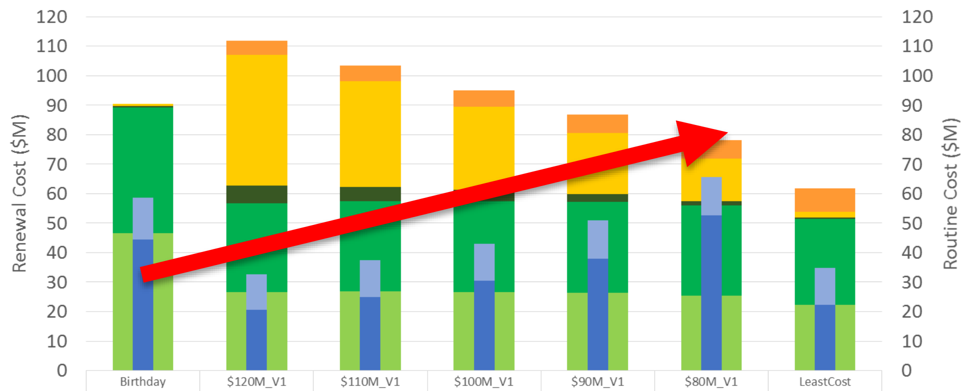
Scenario A V1: Uncapped Routine Maintenance

20 Yr Avg Lane km Treatment Length V1 (Unconstrained RM)



	Birthday	$120M_V1	$110M_V1	$100M_V1	$90M_V1	$80M_V1	LeastCost_V1
Heavy Mtc	-	157	173	189	212	224	251
RHAB	6	303	243	185	130	84	13
2ndCoat	18	260	211	160	109	64	23
CS	1,984	1,439	1,450	1,461	1,460	1,444	1,366
AC	359	206	208	207	204	197	169

20 Yr Avg Cost ($M) V1 (Unconstrained RM)

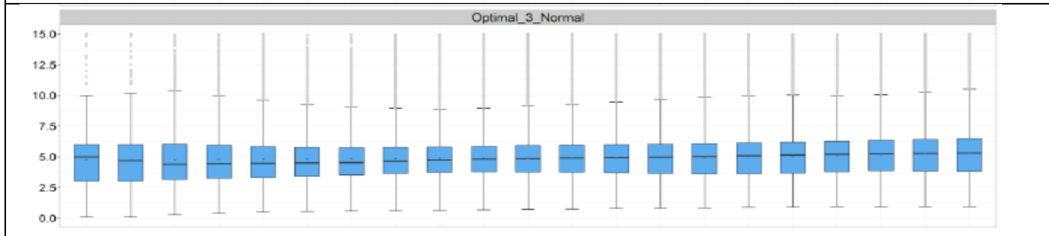


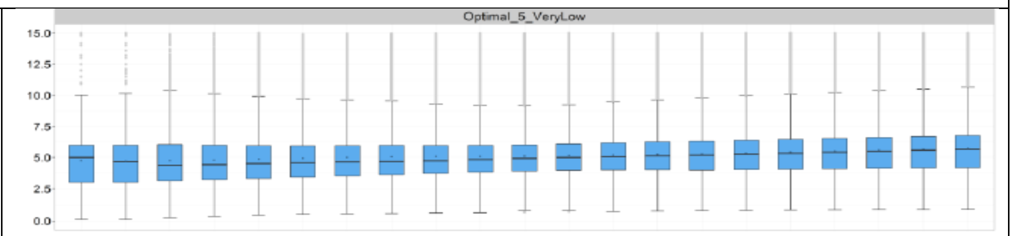
	Birthday	$120M_V1	$110M_V1	$100M_V1	$90M_V1	$80M_V1	LeastCost
HeavyMtc	0.0	4.7	5.2	5.7	6.3	6.4	8.0
RHAB	0.8	44.3	35.9	28.2	20.8	14.3	1.9
2ndCoat	0.4	6.0	4.9	3.7	2.5	1.5	0.5
CS	42.5	30.2	30.5	30.8	30.9	30.7	29.1
AC	46.7	26.5	26.9	26.7	26.3	25.4	22.4
PSEAL	14.3	12.1	12.4	12.7	13.0	13.1	12.6
RTNE	44.4	20.5	25.0	30.4	38.0	52.6	22.3

Investment Scenario

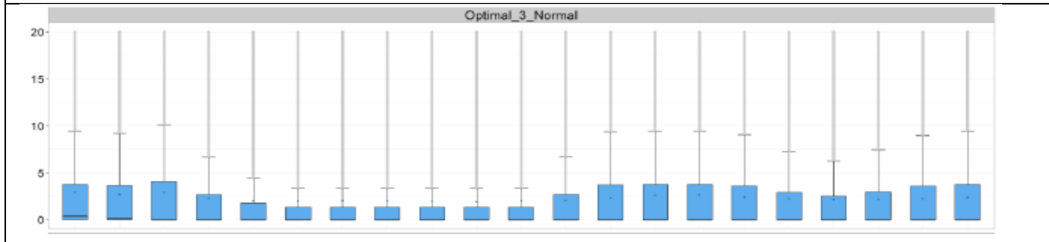
AC CS 2ndCoat RHAB HeavyMtc RTNE PSEAL

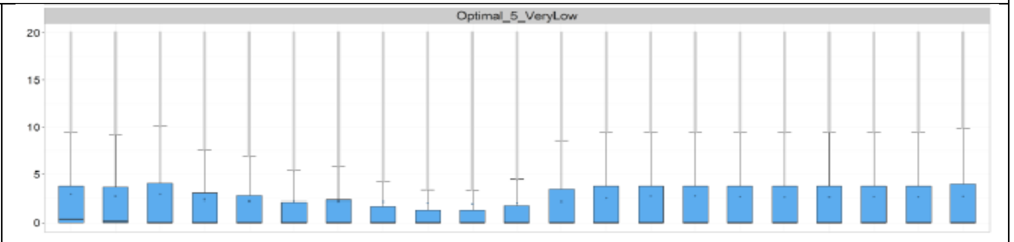
Rutting Profile Normal Investment ($100M) Unconstrained Routine Maintenance



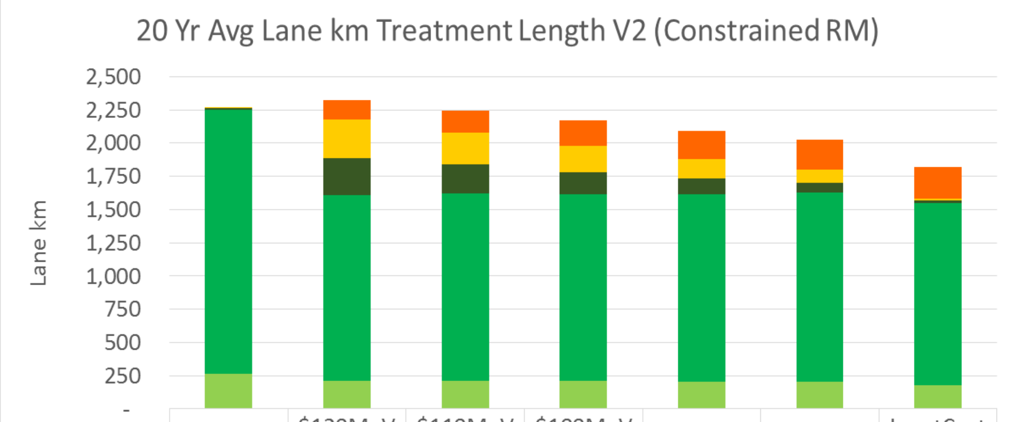


SII Profile Normal Investment ($100M) Unconstrained Routine Maintenance

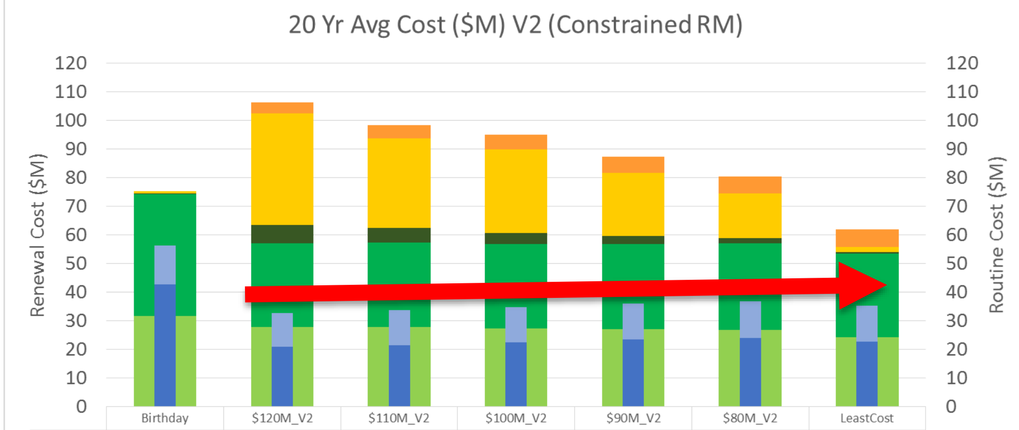




Scenario A V2: Capped Routine Maintenance



	Birthday	$120M_V2	$110M_V2	$100M_V2	$90M_V2	$80M_V2	LeastCost_V2
Heavy Mtc	-	142	166	193	211	226	240
RHAB	6	296	237	198	147	98	13
2ndCoat	18	280	223	166	117	76	23
CS	1,983	1,392	1,409	1,405	1,408	1,423	1,366
AC	266	214	212	208	207	205	181

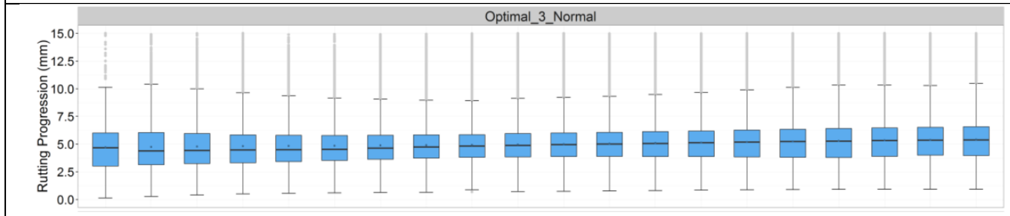


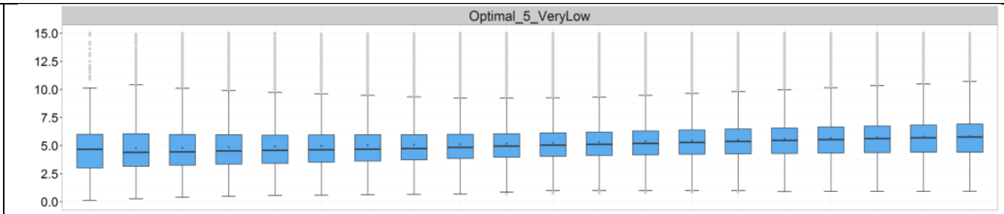
	Birthday	$120M_V2	$110M_V2	$100M_V2	$90M_V2	$80M_V2	LeastCost
HeavyMtc	0.00	4.02	4.63	5.27	5.66	6.05	6.23
RHAB	0.71	38.94	31.21	29.10	22.11	15.67	1.88
2ndCoat	0.40	6.43	5.15	3.83	2.71	1.77	0.54
CS	42.53	29.23	29.65	29.64	29.78	30.18	29.10
AC	31.59	27.75	27.67	27.15	26.96	26.74	24.25
PSEAL	13.55	11.77	12.14	12.35	12.57	12.82	12.57
RTNE	42.70	20.96	21.42	22.30	23.37	24.03	22.61

Investment Scenario

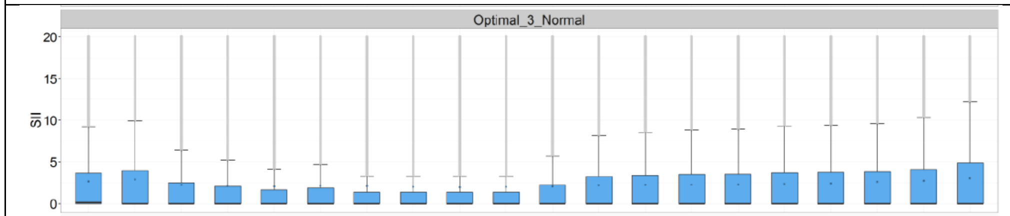
AC CS 2ndCoat RHAB HeavyMtc RTNE PSEAL

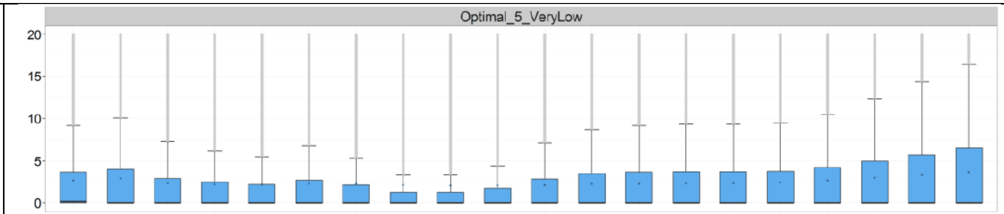
Rutting Profile Normal Investment ($100M) Constrained Routine Maintenance ($30M)



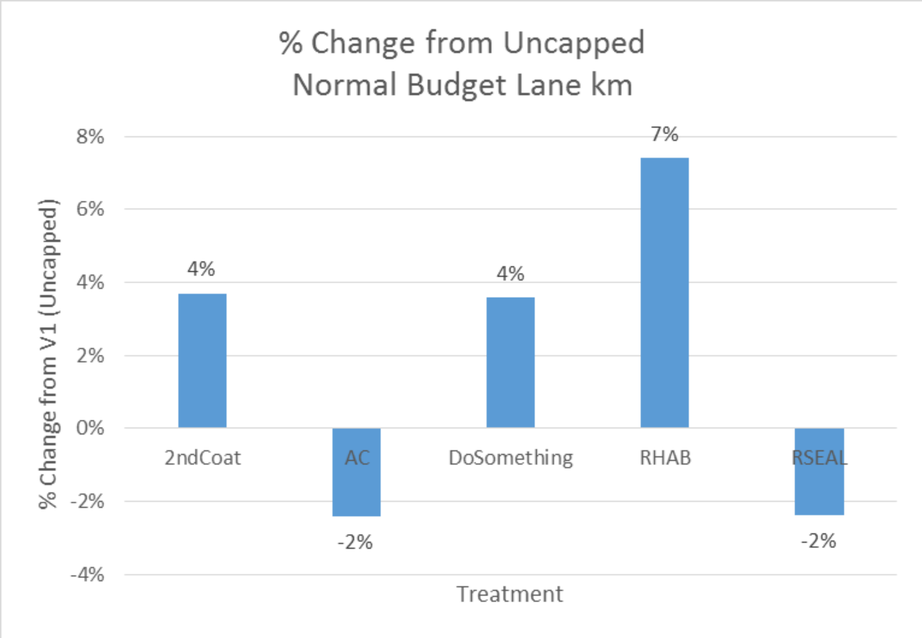


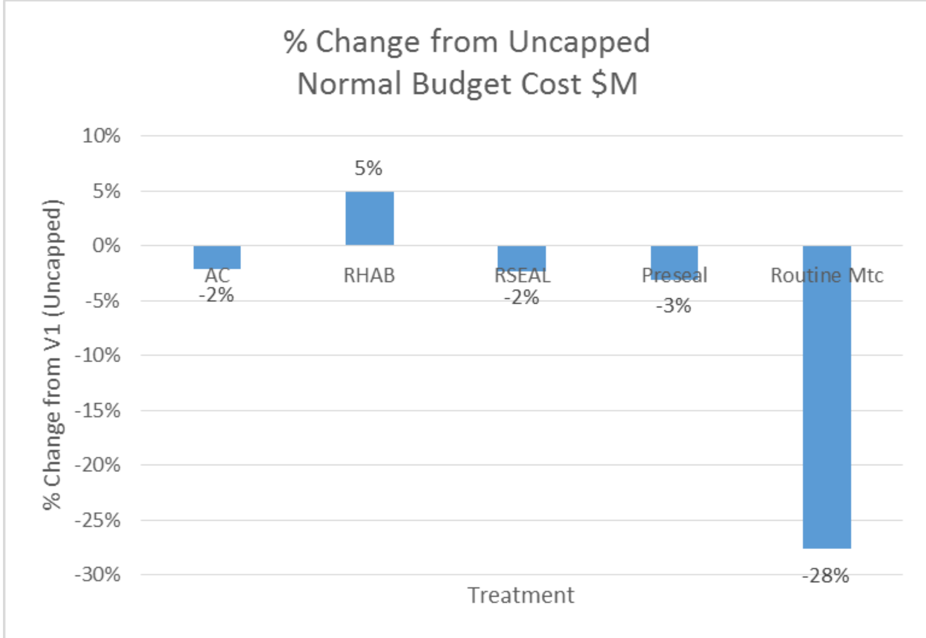
SII Profile Normal Investment ($100M) Constrained Routine Maintenance ($30M)

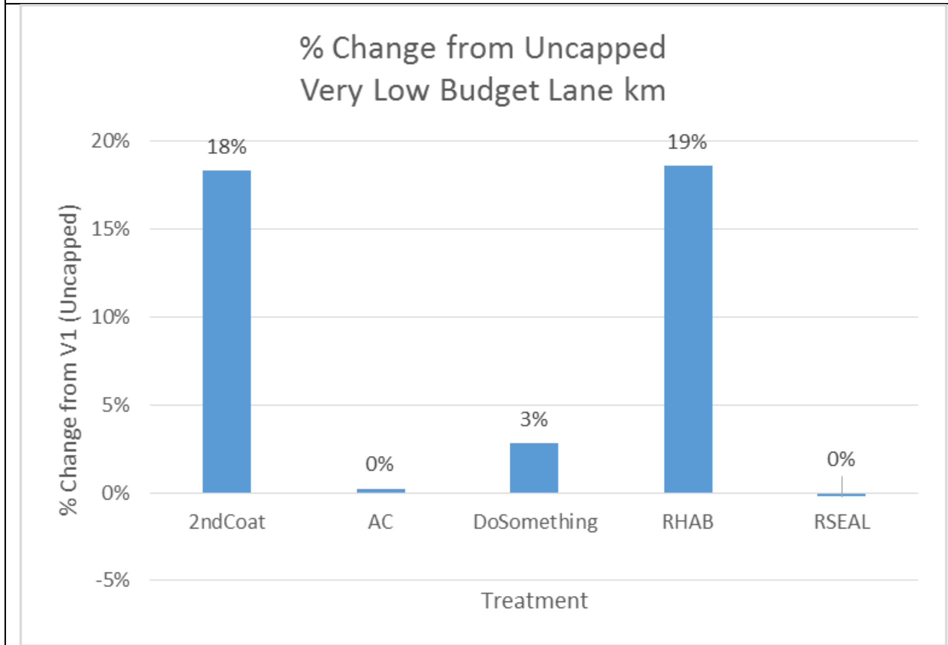


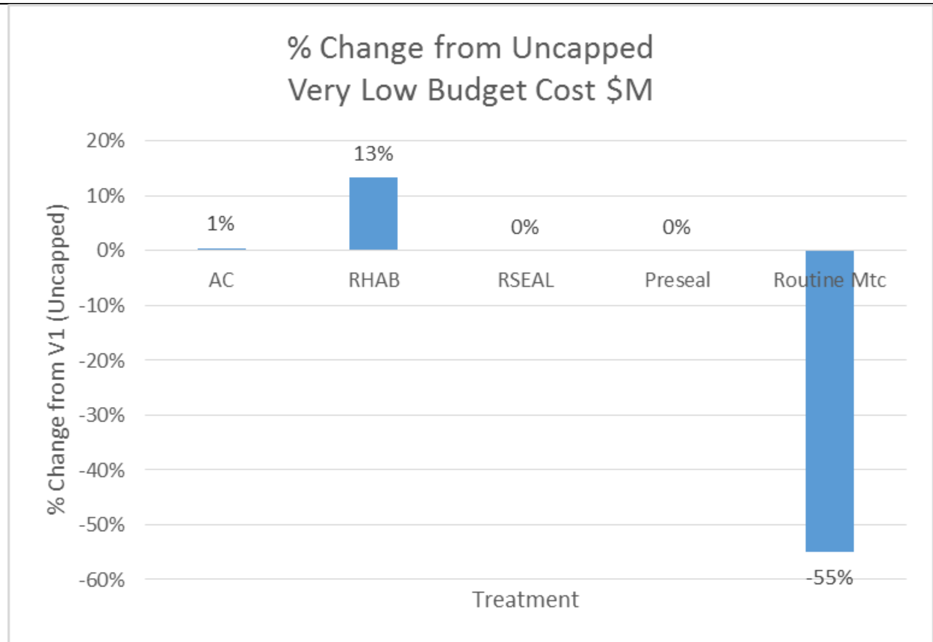


Compare V1 (Uncapped) with V2 (Capped): Cost and Length

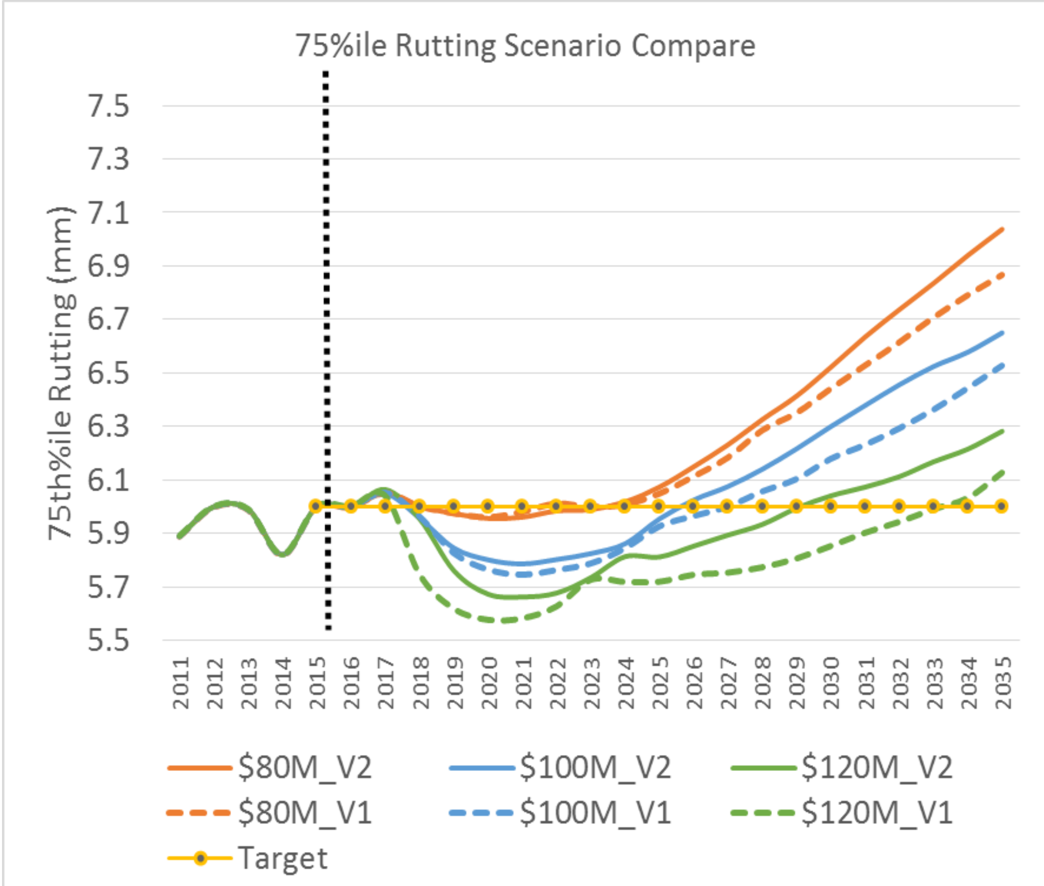


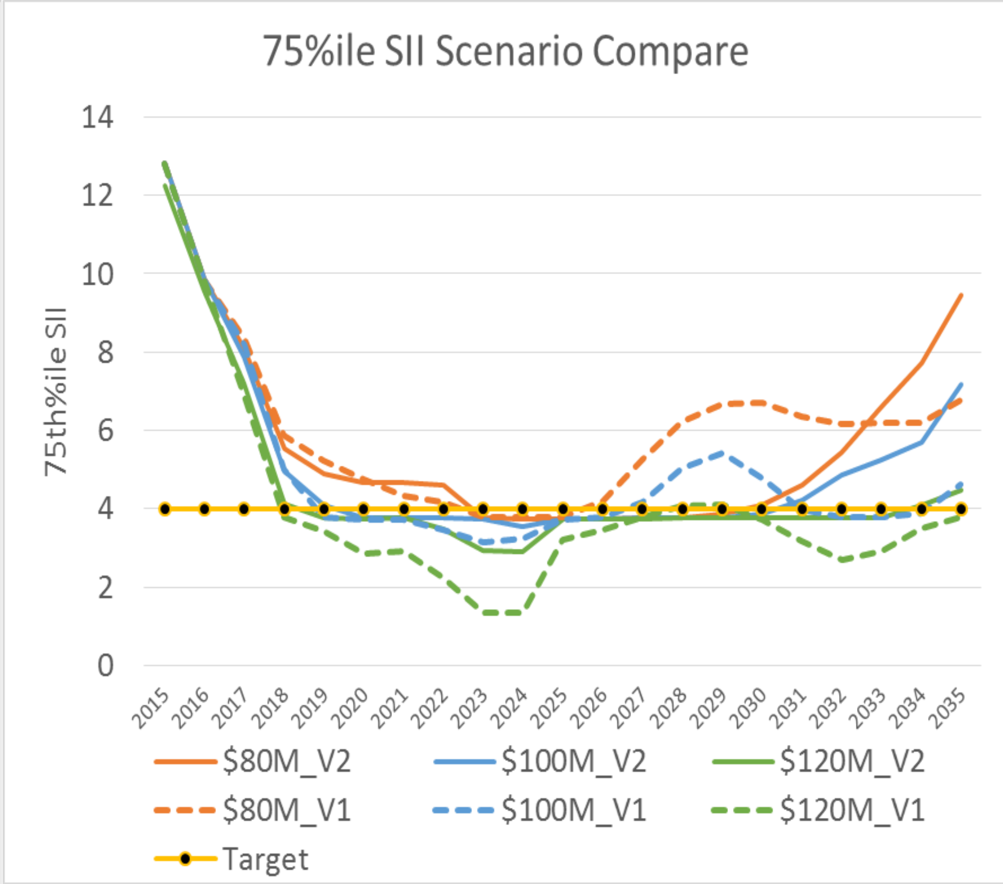






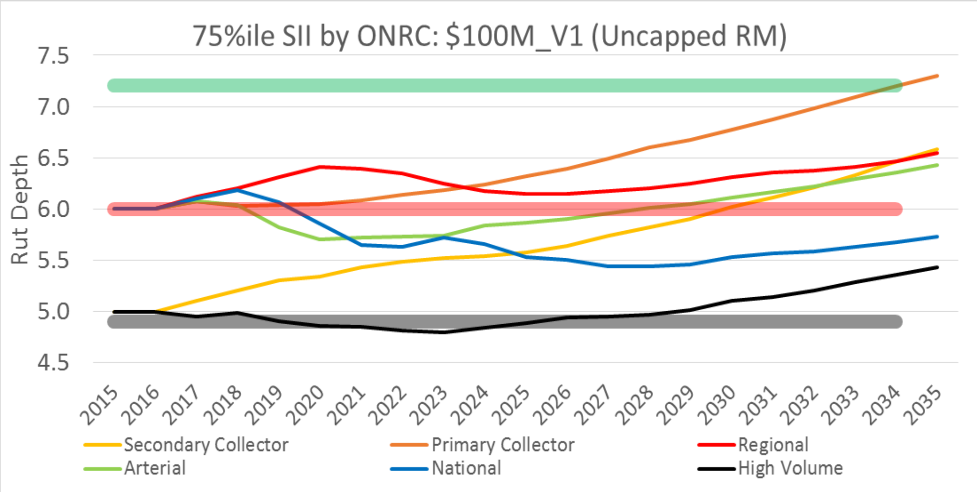
Compare V1 (Uncapped) with V2 (Capped): Condition 75%iles

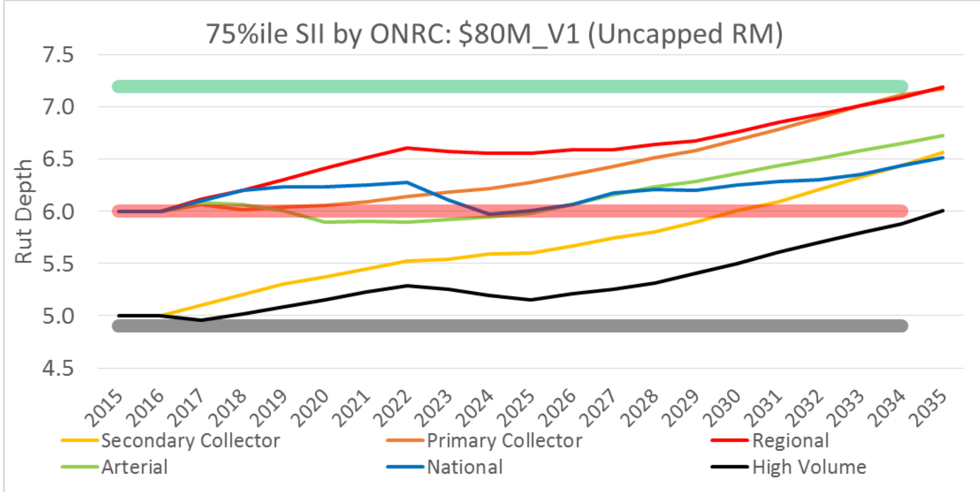




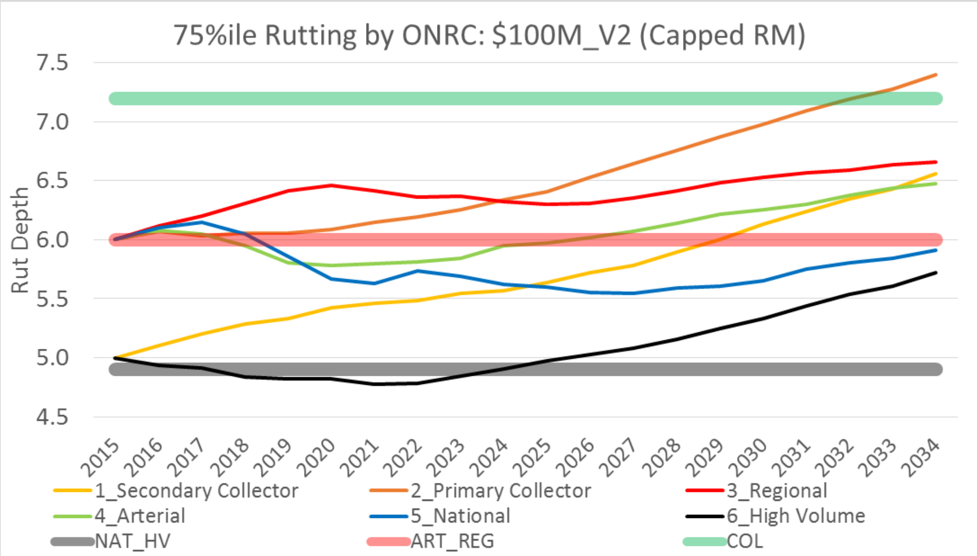
Compare V1 (Uncapped) with V2 (Capped): Rutting Condition 75%iles Split by ONRC

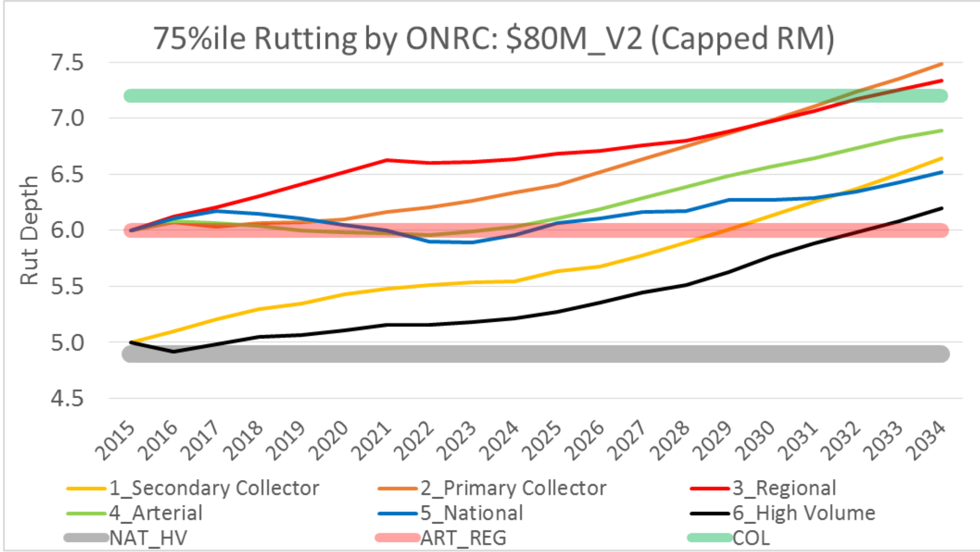
Rutting 75%ile V1 Unconstrained Routine Maintenance





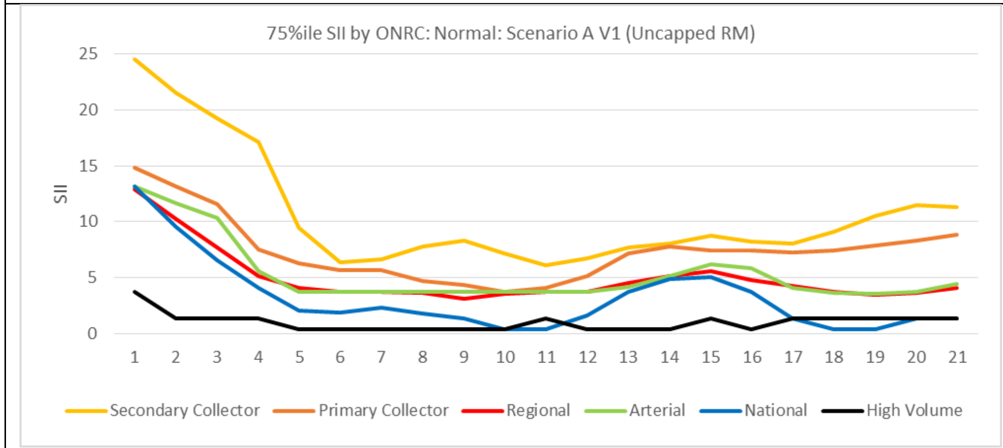
Rutting 75%ile V2 Constrained Routine Maintenance ($30M)

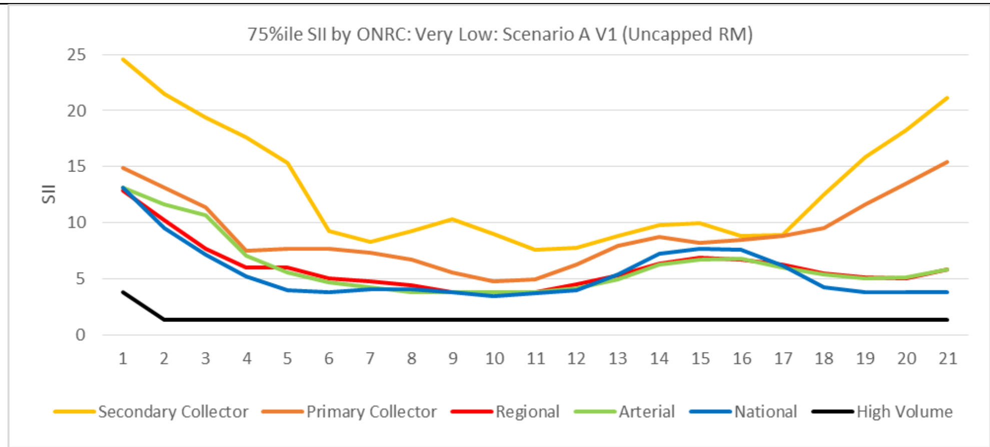




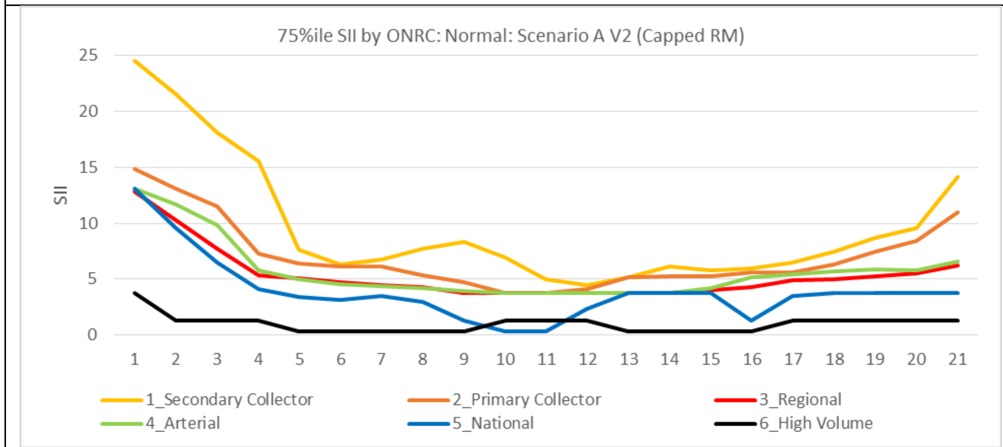
Compare V1 (Uncapped) with V2 (Capped): SII Condition 75%iles Split by ONRC

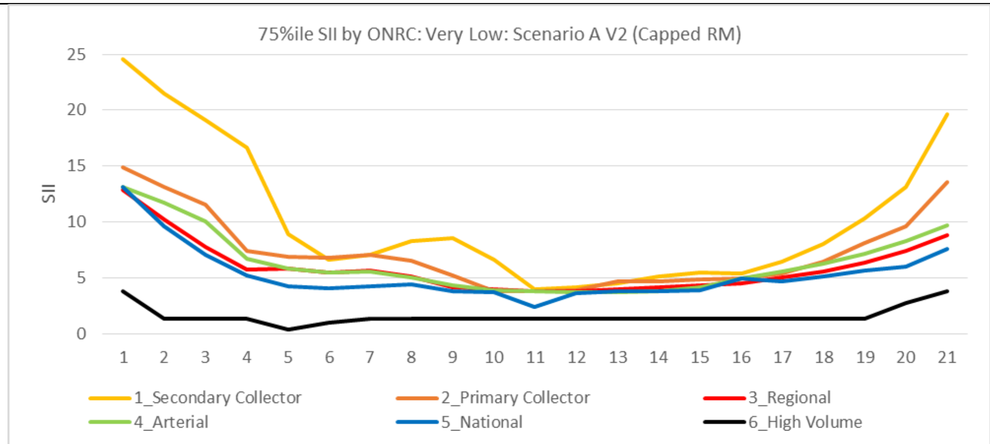
SII 75%ile V1 Unconstrained Routine Maintenance





SII 75%ile V2 Constrained Routine Maintenance ($30M)





Topic: Base Renewal Need Summary

One Pager

Date: 25 February 2016

Author: Elke Beca

Summary

Three one pagers have been prepared to summarise:

- #1: Base Need Tipping Point Analysis
- #2: Routine Maintenance Capped Investment Sensitivity
- #3: Renewal Rate Sensitivity

This memo provides the overall recommendations from these sub-tasks

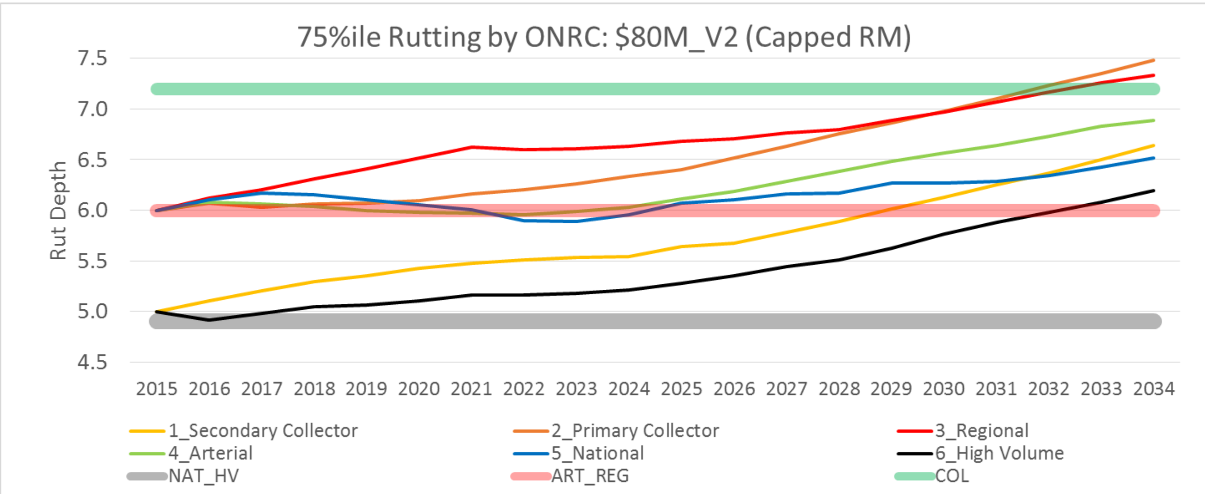
Overall we are happy with outcomes to date and sensitivity analyses support our recommendations.

Recommendations/Findings

Tipping Point

The recommended Base Sustainable Investment level over the next 10 years is $100M pa with Routine Maintenance Investment capped at the current 'relative' level of $30M pa. This is referred to as *'Scenario A V2 Normal'* scenario in supplementary #1.

Condition outcomes at this investment show stability in moderate and high class routes over the next 8-10 years. Beyond the 8-10 year window, this investment is unable to hold deterioration in the very high class (made up predominately high cost AC surfacing). Low class routes are expected to deteriorate, allowing investment to be focused on the higher volume routes.

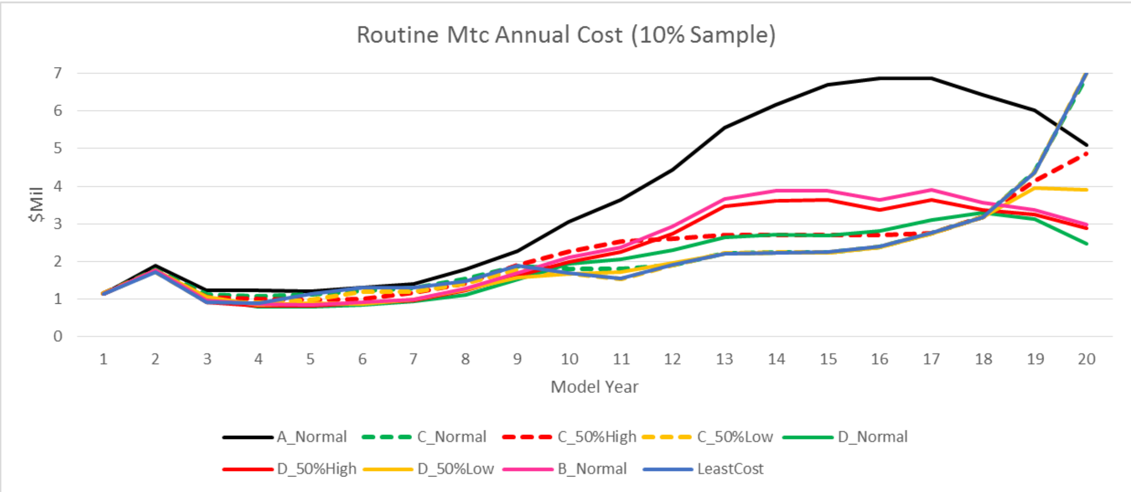


<u>Routine Maintenance Sensitivity</u>

The current setup is **insensitive** to changes up to 50% above and below current levels <u>over the next 10 years</u> when tested with a fixed $100pa renewal investment. It appears the network retains residual life and routine maintenance does not exceed minimum levels. Beyond 10 years, the $100pa renewal investment is insufficient, shown by accelerated condition deterioration of high class routes and accelerating routine maintenance.

The model essentially determines the routine maintenance level that will offer the least overall network cost (Least Cost). When the renewal investment is sufficient, the model will only spend this Least Cost amount. When renewal investment is insufficient, the model will start compensating by spending routine maintenance (shown by black 'A_Normal' uncapped RM line in chart below that accelerates after year 8-10).

This sensitivity analysis supports the recommendation that renewal investment of $100M (C_Normal in chart below) is sufficient in the 10yr period but insufficient beyond, once the residual 'good' condition of the network is consumed. Providing a routine maintenance investment 50% higher (C_50%High in chart below) provides only marginal benefit over the least cost requirement.

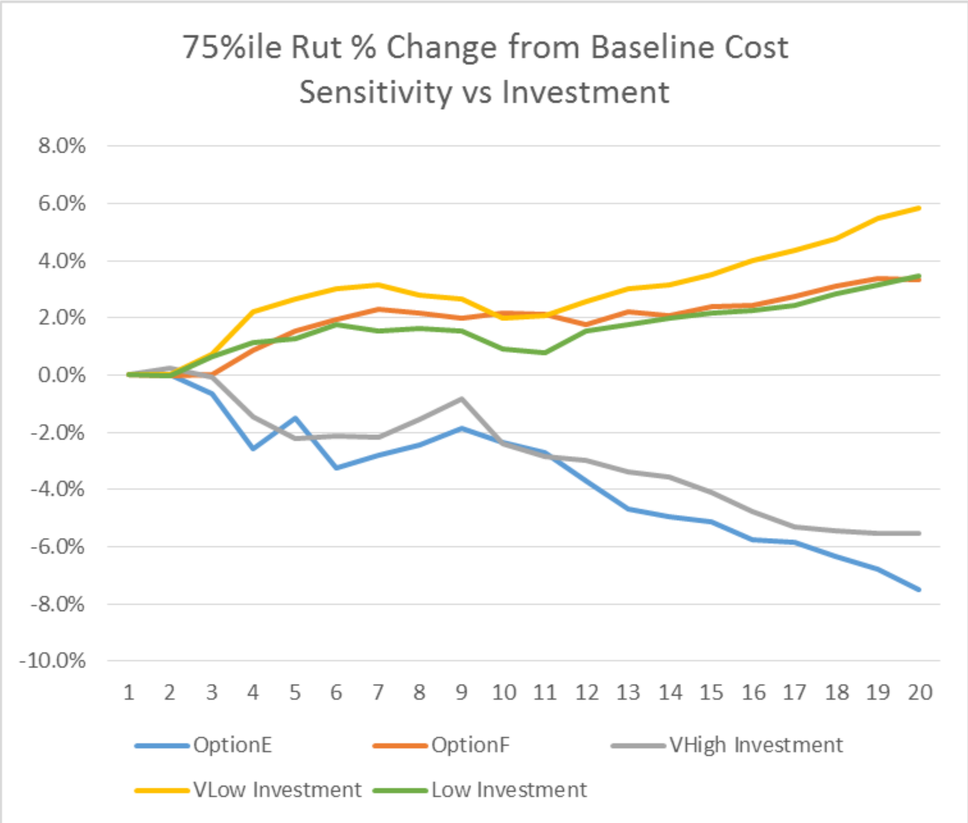


Inaccuracies of up to 50% in the current $30M routine maintenance investment level are not expected to significantly impact the overall model accuracy.

Renewal Rate Sensitivity

Overall, this setup is highly sensitive to renewal rates.

- AC surfacing and RHAB are very sensitive to rate fluctuations
- Chipseal surfacing is insensitive to rate fluctuations.
- Reducing rates to Lowest regional rates (nationally fix rates at lowest value) has same effect on pavement condition as increasing the Renewal Investment from $100M to $120M (VHigh Investment).
- Increasing rates to Highest regional rates (nationally fix rates at highest value) has same effect on pavement condition as decreasing the Renewal Investment from $100M to $90M (Low Investment).



National rates used in the modelling sit close to the median of the Region range so we have confidence the risk of inaccuracies dues to rates have been reduced but not eliminated.

Appendix E: Additional Model Outputs (Split Investment between Medium and Long-term)

Topic: Split Investment Scenarios (Scenario A V3)

One Pager

Date: 10 March 2016 (UPDATED 6 April 2016)

Author: Elke Beca

Objective

Observations from the Routine Maintenance sensitivity analysis indicated the 'tipping point' may be a function of both investment and timing of investment. This analysis investigates the impact of a split investment, initialising at the previously recommended 'base need investment' of $100M and testing two scenarios increasing funding beyond year 10:

- **$100M - $130M V3:** Renewal budget fixed at $100M pa through year 10 then increased to $130M through year 20. Capped routine maintenance budget ($30M or least cost)
- **$100M - $150M V3:** Renewal budget fixed at $100M pa through year 10 then increased to $150M through year 20. Capped routine maintenance budget ($30M or least cost)

Note: In years where least cost is higher than the fixed level, the model is provided least cost investment.

Summary Findings

- The recommended option to meet defined targets over the long term is $100M - $150M V3.
- The pavement indicator (75%ile rutting) begins to show accelerated deterioration beyond year 10 with $100M flat line investment over 20 years.
- This accelerated deterioration is halted with a split investment $100M - $150M V3. This equates to an average of $125M pa over the 20 years.
- Target values for each ONRC group are met with the $150M split investment option. No other option meet target values across all groups.
- The impact to Routine Maintenance investment is not significant with the $150M split investment. This is because all options cap the routine maintenance at least cost (and cannot be reduced further).
- In the first 5 years, high cost treatment (AC and RHAB) are delayed when long term budget is increased.

Supporting Outputs: Condition

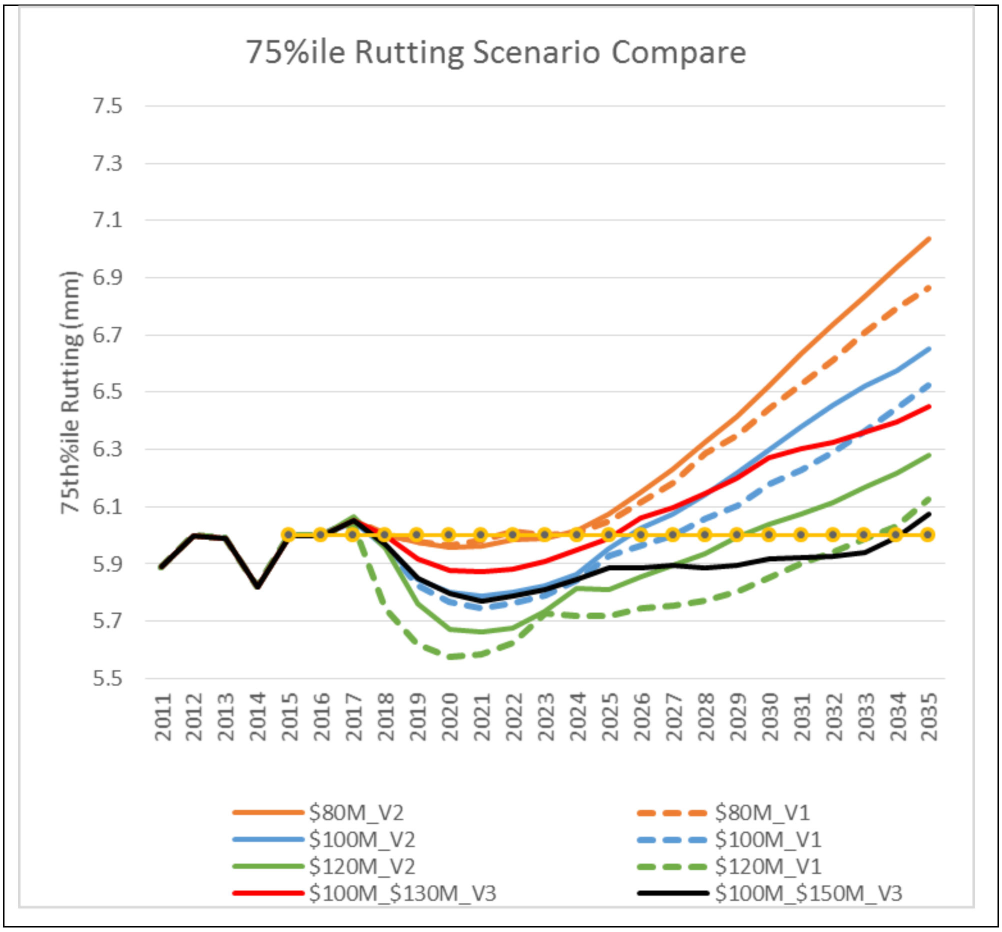
Scenario outputs are compared with previous analysis to assess the impact. The two previous analysis include:

- V1: Fixed $100M renewal budget and Uncapped routine maintenance budget
- V2: Fixed $100M renewal budget and Capped routine maintenance budget ($30M or least cost)

The following charts show the 75%ile condition outputs for rutting and SII. In summary this shows.

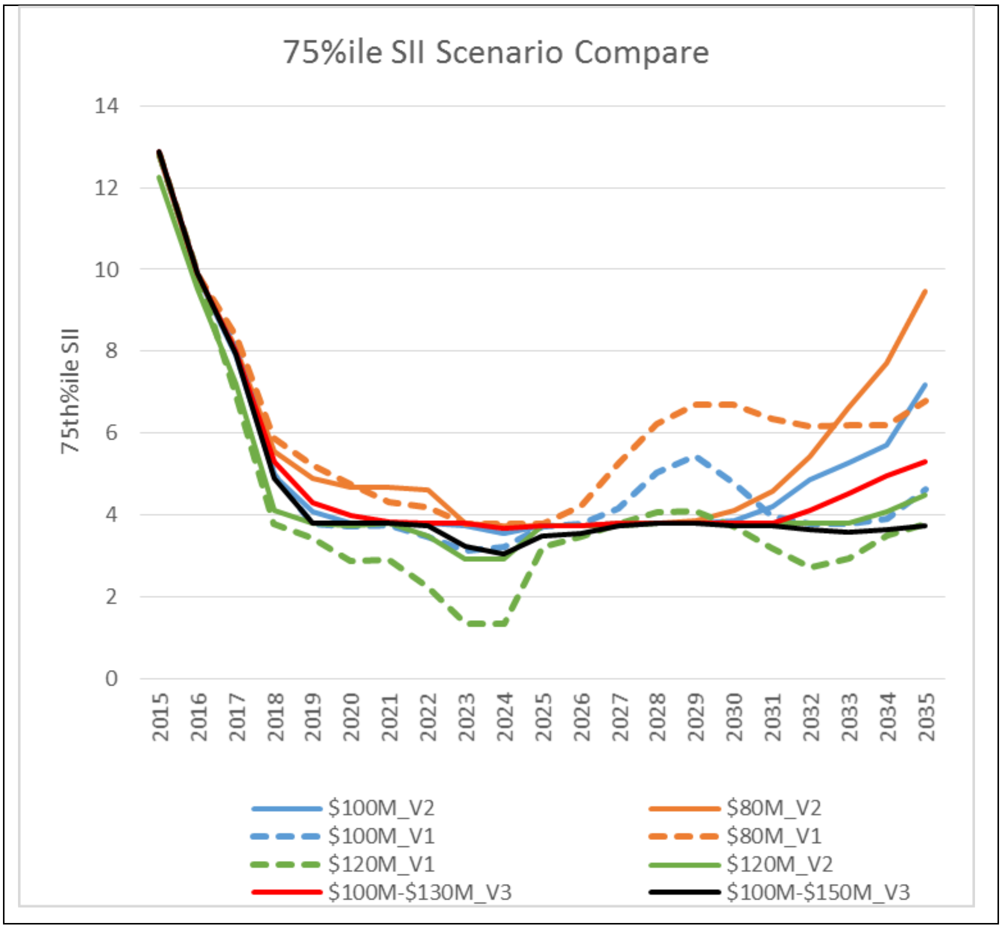
<u>Rutting 75%ile</u>

- *Flat line renewal investment:* Deterioration increases beyond year 8-10 and increases further when Routine Maintenance is constrained (dotted vs solid).
- *Pavement condition impact to change in renewal investment:* Capping the routine maintenance has the same impact as increasing renewal investment by ~$10M (half of the $20M shown in chart).
- *Split investment $130M:* Applying a recovery investment of $130M from year 10 – 20 has limited impact on accelerated deterioration.
- *Split investment $150M:* Applying a recovery investment of $150M from year 10 – 20 halts the accelerated deterioration.



SII 75%ile

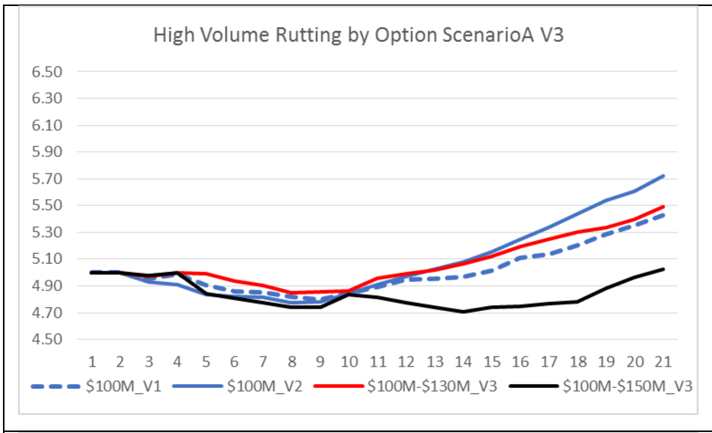
- *Flat line renewal investment:* Deterioration is not significant under any investment scenario. As investment is reduced the pavement renewal is sacrificed (shown in previous chart) while reseal quantities are maintained more or less static.
- *Split investment:* Manages the slight deterioration evident after year 15.

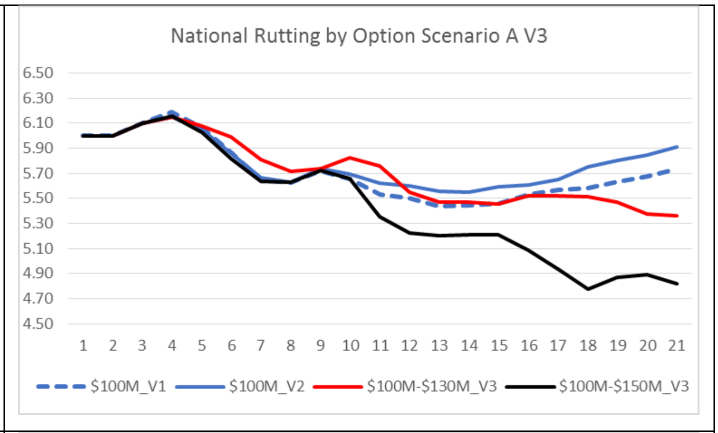


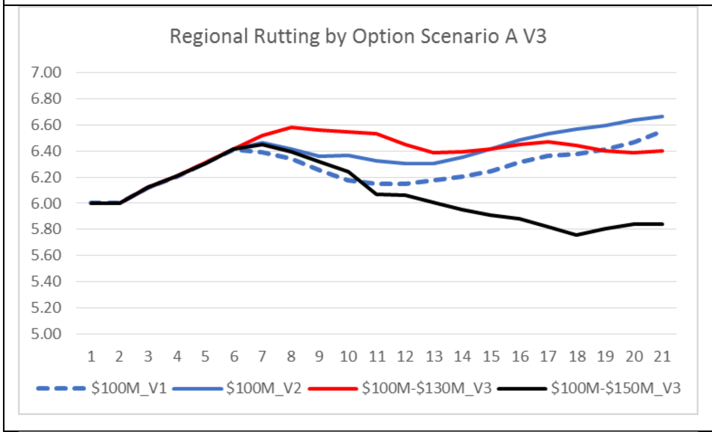
The following charts show 75%ile Rutting for the four scenarios split by ONRC.

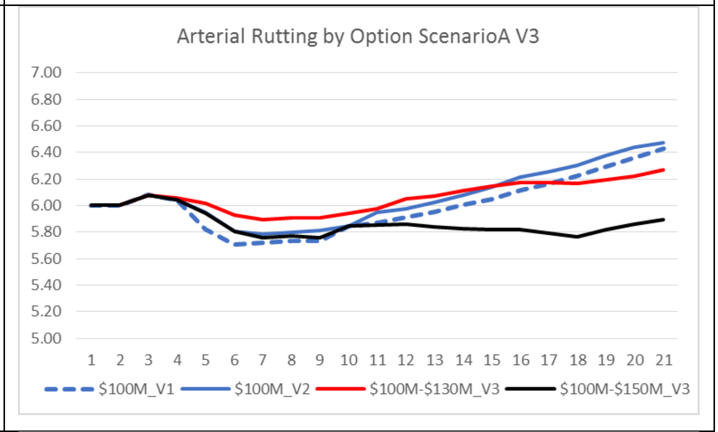
Split Investment $150M

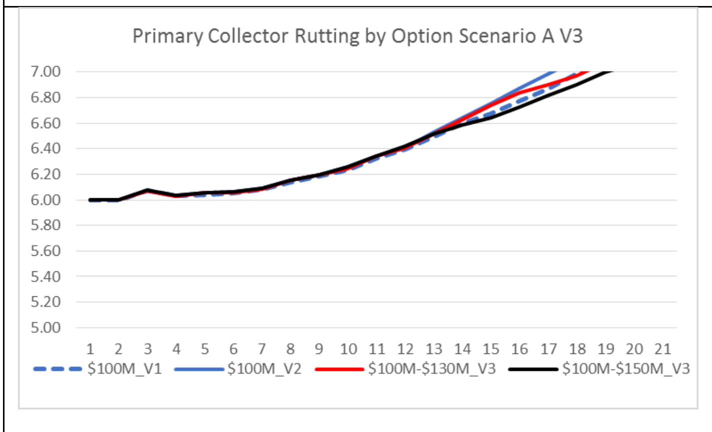
- High class roads are maintained or improved to meet the 'sweet spot target' with 75%ile rutting of 5mm. No other scenarios reach this target.
- Middle class roads are maintained or improved to meet the 'sweet spot target' with 75%ile rutting of 6mm. No other scenarios reach this target.
- Low class roads are left to deteriorate – regardless of investment toward the target of 7mm. This suggests, given the targets set for these low classes, there is sufficient capacity remaining in the pavement to permit deterioration. It is expected the following 20 year period would see a need for increased investment to maintain once the targets are reached. Note: The lines do start to diverge after year 12 on Primary Collectors suggesting they are reaching target toward the end of the period.

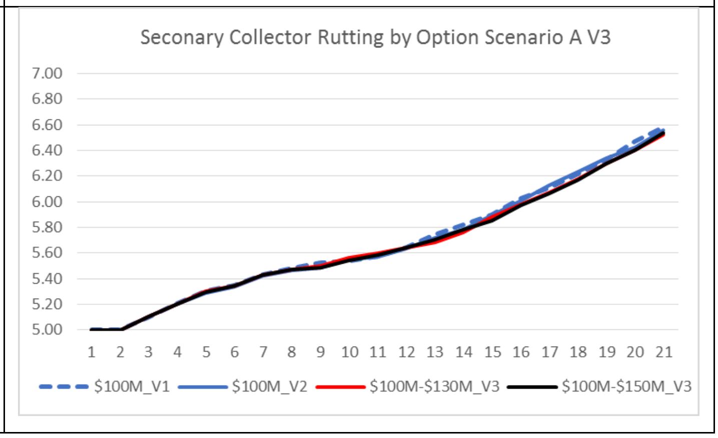








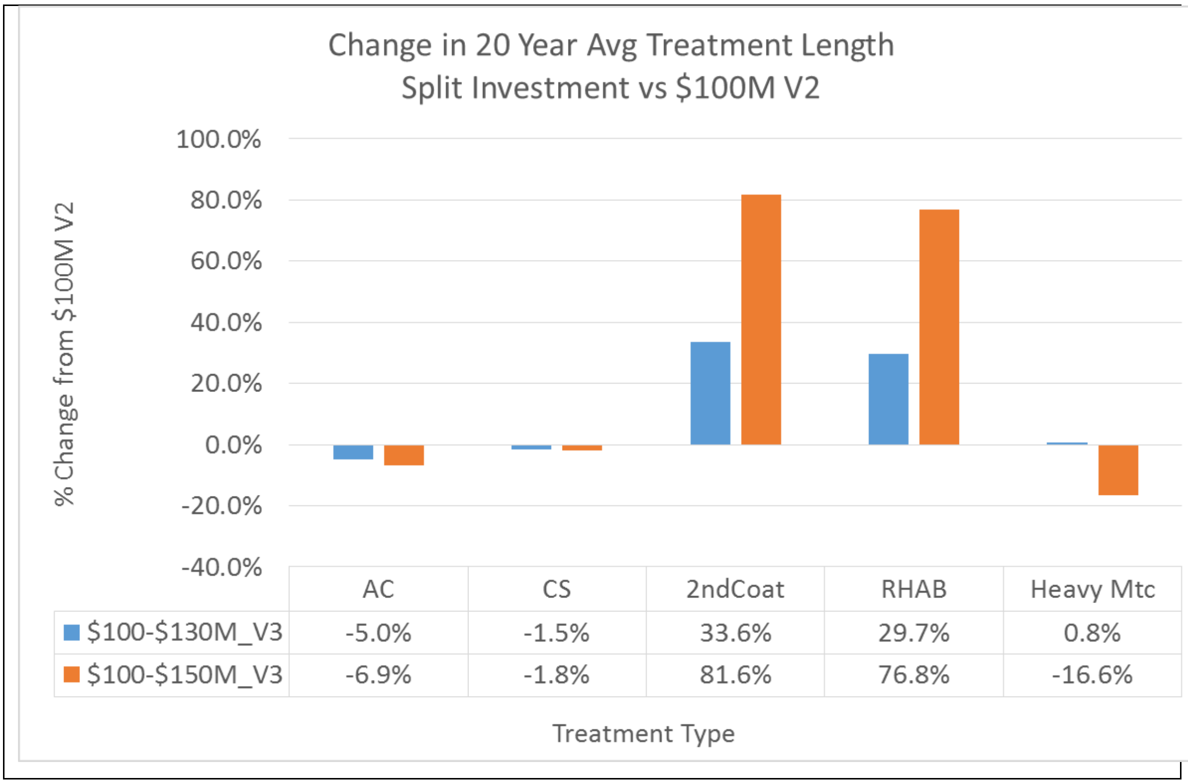




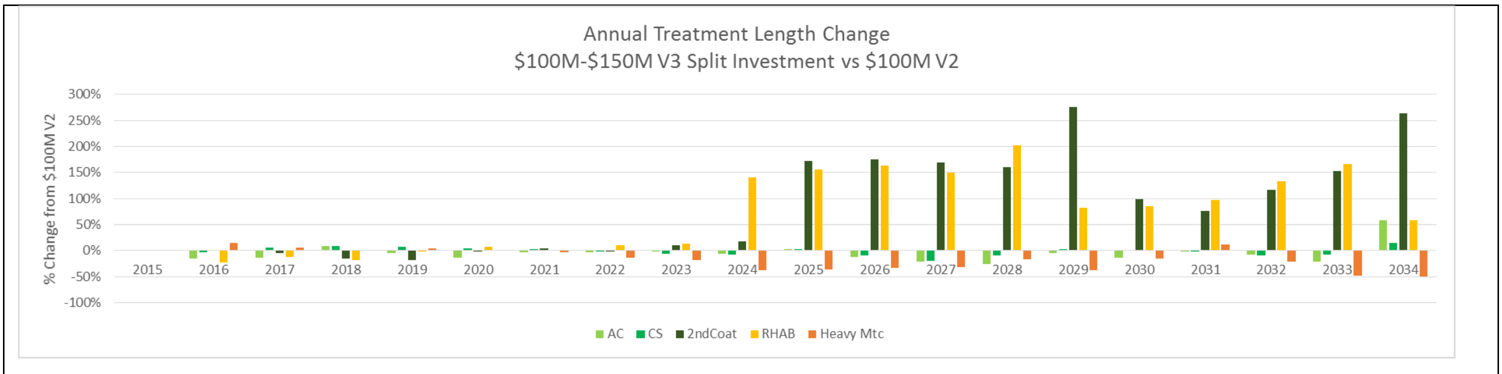
Supporting Outputs: Length

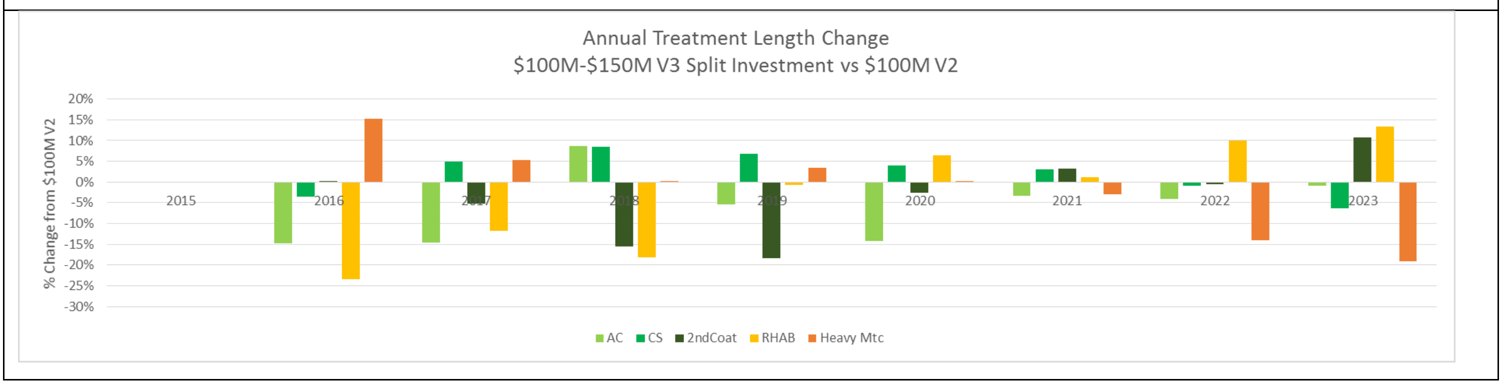
What is the impact on treatment length by increasing renewal investment beyond year 10? *Compared to flat line $100M pa Renewal investment with $30M capped Routine Maintenance ($100M V2). Note: the investment for the first 10 years is identical under each of these scenarios.*

Over 20 years the RHAB quantities (and 2nd Coats) are most significantly impacted. The chart below shows the annual average RHAB length (over 20 years) increases by nearly 80% when investment is increased to $150M after 10 years. Surfacing reduces slightly with the increased investment. As expected, Heavy Mtc. reduces as more RHAB is completed.



The two following charts show the annual % change by treatment type. The top chart shows the full 20 years, with a sharp jump after year 10 as expected. The second chart shows the first 10 years (where investment is identical). High cost treatment (RHAB yellow and AC light green) are delayed (reduced qty in first 5 years shown by negative bars) when long term investment is available. 2nd Coats have increased higher (proportionally) than RHAB suggesting more CS RHAB are occurring with increased investment than AC RHAB.





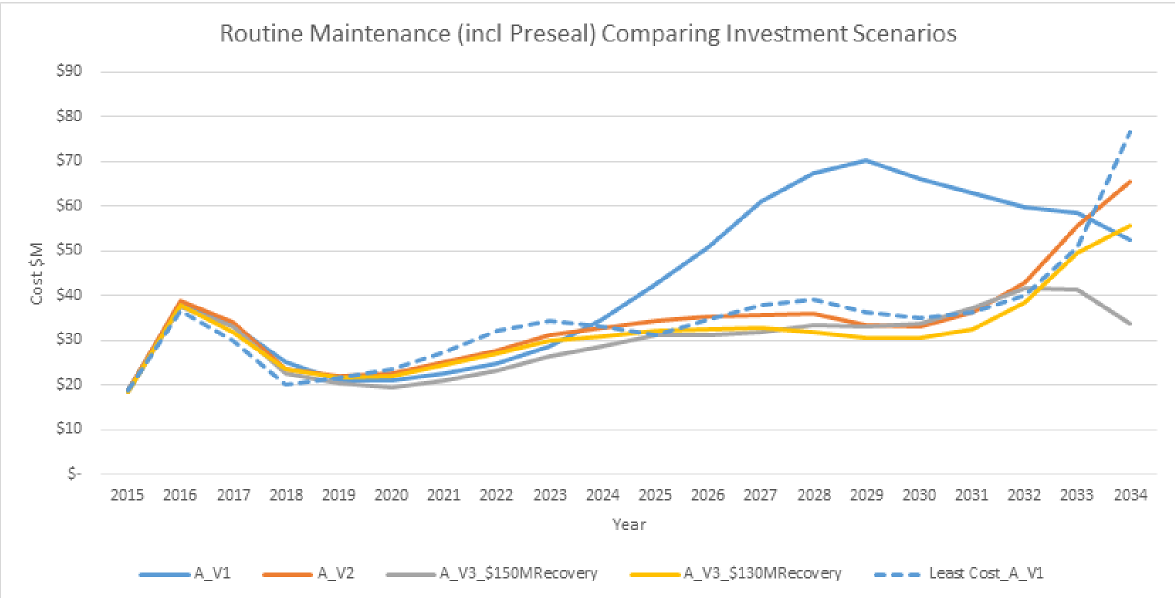
Supporting Outputs: Cost

What is the impact on investments (both renewal and routine maintenance) by increasing renewal investment beyond year 10? *Compared to flat line $100M pa Renewal investment with $30M capped Routine Maintenance.*

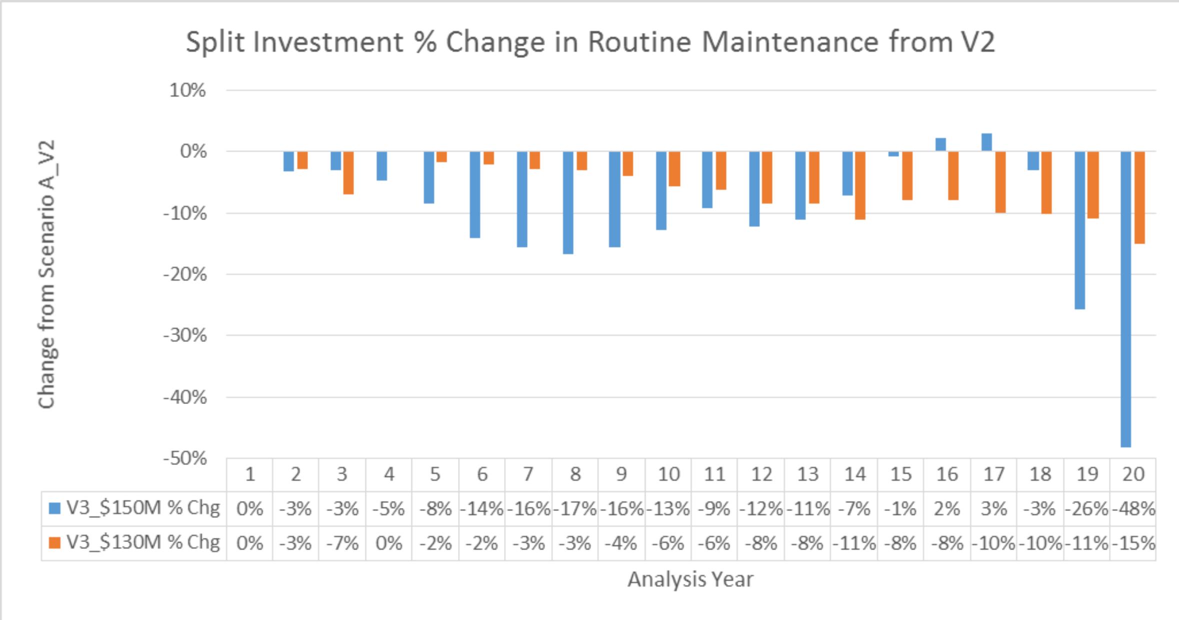
- *Routine Maintenance: MINIMAL Impact.* With $150M increase, routine maintenance decreases by 13% over the 20 year period. This is halved to 7% with $130M increase.
- *Total Investment (Renewal + Routine Maintenance):* With $150M increase, total investment increases by 23% (nearly one quarter). This reduces to 9% with $130M increase.

The following chart demonstrates the impact of split investment on routine maintenance.

- As observed in the routine maintenance sensitivity analysis, when routine maintenance is unconstrained, it begins to accelerate rapidly from year 8 – 10.
- All constrained models, including the split investment scenarios result in a similar routine maintenance investment. This level of investment also aligns closely with the least cost. All begin to diverge in the last couple years of the analysis period.



This chart shows the same data as annual change from the $100M V2 as a percentage.



Analysis Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
V3_$150M % Chg	0%	-3%	-3%	-5%	-8%	-14%	-16%	-17%	-16%	-13%	-9%	-12%	-11%	-7%	-1%	2%	3%	-3%	-26%	-48%
V3_$130M % Chg	0%	-3%	-7%	0%	-2%	-2%	-3%	-3%	-4%	-6%	-6%	-8%	-8%	-11%	-8%	-8%	-10%	-10%	-11%	-15%

Appendix F: Incorporating Safety Into the dTIMS Model

Topic: Safety Logic into dTIMS

One Pager

Date: 25 November 2015 (Updated 9/12/2015)

Author: Elke Beca

1. Objective

The safety model implementation has two phases:

1. Generation of safety program **Completed outside of dTIMS using Machine Learning techniques**
2. Alignment of safety and asset preservation programs including investment and condition profiles. **Completed in dTIMS**

This summary outlines 2. The alignment of the safety and asset preservation programs within dTIMS. For details of 1. Safety program generation please refer to the summary provided by Peter Cenek.

2. Methodology

Input Data: The safety program (output from MATLAB) which is aggregated by Skid Investigation Lengths (SALs) will be loaded as a lookup file within dTIMS. The table will specify:

- YFI: the year that each SAL requires the next safety treatment,
- TINT: the fixed interval between safety interventions,
- SAL_Score: The SAL score at time of safety treatment (NOTE: all values fixed except texture and skid contributions).
- Flushing: Flag where texture<TL and ESC<0.40 used to indicate potential unstable seals.

The treatment length (TL) that the ach SAL belongs to as well as the % of the treatment length that has a safety treatment planned in the 'same' year (+/- 1 year) will be calculated prior to loading into dTIMS.

Logic: The Safety program will be treated as a comitted program with two treatment options triggered by the % of treatment length that requires treatment. *Note, final details will be confirmed once coding begins*:

- ***Maintenance***: Small sections where % TL < defined threshold.
    - Area only treated
    - New Major treatment used
    - Cost allocated to Safety budget
    - No condition resets
    - A variable is carried which reduces the next asset preservation treatment (cost) by SAL area –we recognise that small SAL section is not resealed again.
    - Recurs at fixed interval defined by the lookup table

Note: With this treatment the cost is capture but length is not (this is a proxy for all types of minor safety treatments including scabbling, waterblasting or small reseal)

- ***Reseal***: Large sections where % TL > defined threshold
    - Full TL treated

- Used same Major Treatment as asset preservation to capture length but different cost ancillary
- Cost allocated to Safety budget (same rates as reseal)
- Full condition resets (same as reseal)
- Recurs at fixed interval defined by the lookup table

Strategy Generation: Occurs as per normal, but at each iteration, in addition to asset preservation triggers there is a check to determine whether a safety treatment is required and triggered as required. If asset preservation occurs prior to safety, the next safety treatment will be reset according to fixed interval in lookup table.

Optimization: No impact

Coding:
The coding logic works on the premise that at the start of analysis each TL can be flagged as either eligible for full Safety Treatment or NOT. This status will not change through the analysis period.

dTAG_TL: Add columns based on Safety model outputs.

- YFI – holds the min year of next safety intervention (regardless whether full treatment or not)
- TINT – holds the safety cycle of the SAL selected above (have to pick one – maybe run with average or min? For sections that flag full TL treatment this will be the fixed number, for maintenance only this will not end up being used.)
- TL - % of the TL that has SAL's breaching in same year (+/- 1yr) – Dean to calculate this. Note we have to base this on the YFI value and it will be FIXED throughout analysis period.

dTAG_SAL: New table added into setup holding all safety model outputs.

Expressions:

- ASTreat_INI_nSE_SafetyTL (Numeric) – holds the critical threshold level (eg: 50% or 60% decides whether full Safety or Mtc only done)
- ASTreat_TRG_bAF_Safety_Full (Boolean) – this checks whether a full Safety Treatment will occur or just a maintenance area. dTAG_TL->TL > ASTreat_INI_nSE_SafetyTL

Variables:

- SVnTRG_Safety_YR (Dynamic Variable) – this is the year that the next safety treatment will occur (unless asset preservation occurs first).
  - Initialize: dTAG_TL->YFI – Base Year
  - Reset: from ancRHAB/AC/CS whenever a major treatment occurs (reset will have filter on it depending on whether full or mtc safety eligible length).

Treatments:
FULL TL SAFETY TREATEMENT: Use majCS or majAC for the new full TL Safety Treatment.

- majTRT (CS or AC) trigger expression: allow majTRT to trigger if YR= SVnTRG_Safety_YR and ASTreat_TRG_bAF_Safety_Full=TRUE
- Create new ancillary for majCS and majAC
    - ancCS/AC_Safety: Costs filter checks YR= SVnTRG_Safety_YR, if true same cost expression as for ancCS. No resets. Budget Category = SAFTEY
    - ancCS/AC: Make adjustment to cost filter (opposite above – so one or other will have cost each time). This is the only ancillary with resets.
    - ancCS/AC/RHAB: add reset with filter if ASTreat_TRG_bAF_Safety_Full = TRUE:
        - SVnTRG_Safety_YR=YR+ dTAG TL->TINT otherwise
        - SVnTRG_Safety_YR=lookup on SAL table and find the next safety maintenance treatment year.

The costs will be separated by ancillaries with Safety cost going to SAFETY budget. The length will NOT be separated but can be done at reporting stage.

MAINTENANCE SAFETY TREATMENT: You will ONLY ever enter this loop if the treatment length TL field is < the defined threshold.

dTAG_SAL: New table added into setup holding all safety model outputs. Include new column which holds area of each SAL.

Expressions: (all from FULL SAFETY TREATMENT plus what is needed to initialize variables and trigger statements)

Variables:

- DVnCND_SafetyMtcArea (Dynamic Variable) – This is the area of next SAL on each TL (< threshold) used to calculate the cost of the safety maintenance treatment.
- DVnCND_UsedSafetyMtcArea (Dynamic Variable) - This dynamic variable holds the total area of SALs that have been treated since the last full surface or pavement renewal (so that cost can be deducted from the next full renewal)

Treatments:
MAINTENANCE SAFETY TREATEMENT:
New Maj and Anc treatments.

- majMTC_SAFETY trigger expression: allow to trigger if YR= SVnTRG_Safety_YR and ASTreat_TRG_bAF_Safety_Full=FALSE
- Create two new ancillary
    - ancCS_MtcSafety: Costs filter checks chipseal=TRUE. Cost= DVnCND_SafetyMtcArea * CSRate. Budget Category = SAFTEY
    - ancAC_MtcSafety: Costs filter checks chipseal=FALSE. Cost= DVnCND_SafetyMtcArea * ACRate. Budget Category = SAFTEY
    - Resets for both anc are (although to save model time put reset against the MAJ treatment so it is done once, then just use ancillaries to calculate the cost based on a filter):
        - SVnTRG_Safety_YR=find the YEAR the next SAL in the TL fails safety. Unsure exactly how this will be coded but will look

at all SALs in the TL and find min(if(SAL->YFI – Base Year > YR, SAL->YFI – Base Year, YR + SAL->TINT))

- DVnCND_UsedSafetyMtcArea = DVnCND_SafetyMtcArea + DVnCND_UsedSafetyMtcArea. This will be reset = 0 when the next full treatment is done
- DVnCND_SafetyMtcArea = Lookup in the SAL table the area of the next section that will be treated under maintenance. (unsure how this will be coded.. Will be a DAL function you can use I'm sure☺)

- ancCS/AC/RHAB/ACSafety & CSSafety:
  - Reduce area used to calculate cost by DVnCND_UsedSafetyMtcArea (this is so we don't pay to seal over the maintenance areas we've already done – not sure how we will work out lengths at end – will need to think through)

  Add Reset:
  - DVnCND_UsedSafetyMtcArea =0

The costs will be separated by ancillaries with Safety cost going to SAFETY budget. The length will NOT be separated (the MAJ treatment will hold the full TL length) but can be done at reporting stage (I think).

Communication Record

To:	Luca de Marco	Date:	24/11/2015
Copy to:	Kym Neaylon	Time:	
Recorded by:	Peter Cenek & Elke Beca	File No:	5-29E54.00
Subject:	SCRIM Skid Model Testing Results	Proj No:	
Type:		Page 1 of 3	

SUMMARY: Model predicted current ESC was compared against the 2014-15 (current) ESC for 5292 valid SAL records from the BoP West network. The starting value of skid resistance assumed in the modelling is the actual Yr_2 value for each SAL. However, if a surface is less than 2 years old, the predicted current ESC will be the previous seal surface's YR_2 ESC value if the same aggregate source has been used in the reseal or from statistically derived YR_2 ESC values taken from NZTA Research Report 470. During the course of testing, a data issue has been identified, where almost 1000 SALs (nearly 1/5) have a current ESC higher than their Yr_2 ESC which is counter intuitive. This may be due to lane sealing that has not been picked up in the TL surfacing records or removal of binder from pre-coated chips. Further investigation will be needed to establish the cause of what is causing skid resistance to increase over time. Therefore, in order to perform valid comparisons between predicted and actual ESC values, the BoP West dataset had to be cleaned of SAL's having entries that were considered to have anomalous entries. The cleaning involved applying the following conditions:

- Assume any road over 20 months with the 2 year being no more than 5 months (month values of 0-5 and 19-23) from the 2 year mark as being 2 years old.
- Assume any ESC measurements without a survey date was taken on 28th Nov 2014.
- Remove any SAL where there is no seal date.
- Remove any SAL where the ESC value increases.
- Exclude all SAL's where the surface is younger than 20 months.
- Excluded all SAL's where the surface is older than 16 years.

Application of these conditions reduced the number of SAL's available for analysis from 5292 to 2048, corresponding to 39% of the total available. The model fit results are summarised as follows:

Skid Value	Actual	Predicted
ESC≤TL	1.76% (36)	2.39% (49)
TL<ESC≤IL	15.28% (313)	18.85% (386)
ESC≤IL	17.04% (349)	21.24% (435)

Regarding ESC≤TL, the model correctly predicts 23 out of 36 SAL's giving a success rate of 64%. However, 26 (49-23 = 26) are false positives representing 53%. These results suggest the proposed skid model is more than adequate for its intended purpose of generating reseal dates.

MODELLING METHODOLOGY:

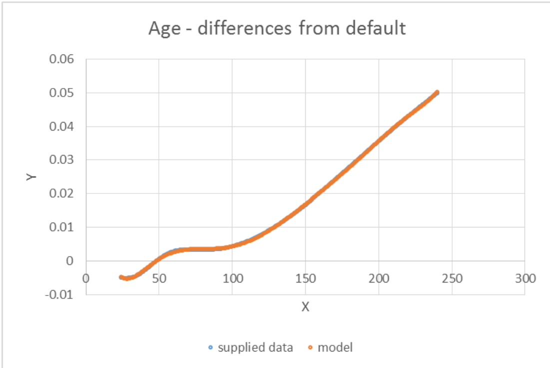
- Extract texture (ESC) data from RAMM, averaged by lane and summarised by SAL (skid investigation length). **Extract one record per SAL for each year since the date of last reseal**. This results in a lane average ESC per year per SAL.

- Determine the year 2 (Yr_2) texture value per SAL. This is the first record post reseal, which may be up to 12 months post reseal depending on time of reseal and HSD collection.
- Apply the time dependent component of the skid model given in NZTA Research Report 470. Curve fit software was applied to obtain equations for surface age (months) and surface age × ADT effects. ADT in this case is the lane ADT not the carriageway ADT as SAL's are lane based. The resulting ESC model is:

$$ESC = ESC_{Year2} + fn1(AGE) + fn2\,(AGE \times ADT),$$

where: $fn1 = a \times AGE^{8} + b \times AGE^{7} + c \times AGE^{6} + d \times AGE^{5} + e \times AGE^{4} + f \times AGE^{3} + g \times AGE^{2} + h \times AGE + i$

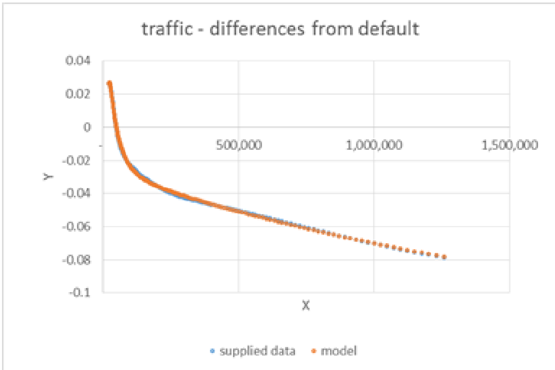
a	3.02E-18
b	-3.41E-15
c	1.62E-12
d	-4.20E-10
e	6.40E-08
f	-5.76E-06
g	2.92E-04
h	-7.28E-03
i	6.32E-02



and:

$$fn2 = a + b/\ln(AGE \times AADT) + c/\ln(AGE \times AADT)^{2} + d/\ln(AGE \times AADT)^{3} + e/\ln(AGE \times AADT)^{4} + f/\ln(AGE \times AADT)^{5}$$

a	66.24
b	-4396.06
c	114403.94
d	-1466054.60
e	9273525.00
f	-23194384.21



YEAR 2 VALUES OF ESC:

The average Yr_2 has been calculated for the most common aggregate types in use on the BOP West network. These are summarised in the table below. This shows that the Yr_2 value for high stress sites (i.e. horizontal radius of curvature < 400m) sites to be very similar to the value derived for all sites.

Furthermore, the BoP West dataset Yr_2 values agree reasonably well with Yr_2 values derived from statistical modelling work undertaken by Dr Davies to identify best performing aggregate sources on high crash risk curves (i.e. curves < 400 m horizontal radius). This finding indicates that if there is insufficient historical ESC data for a SAL to calculate the SAL specific Yr_2 value, Dr Davies Yr_2 estimates can be used instead with reasonable confidence.

Source	All	S.D.	<400m R	S.D.	Statistical Analysis	
					All	<400m R
ALLIED ASH	0.55	0.06	0.55	0.08		
BALDWINS	0.46	0.03	0.47	0.03		
KATIKATI	0.59	0.04	0.59	0.04		0.40
LEACHES	0.51	0.03	0.49	0.04	0.51	0.45
POPLAR LANE	0.56	0.06	0.57	0.08		
SWAPS	0.51	0.06	0.51	0.09	0.52	0.48
TAOTAOROA	0.49	0.06	0.53	0.04	0.53	0.50
TIROHIA	0.50	0.04	0.49	0.03	0.54	0.49
WAIOEKA	0.54	0.05	0.50	0.03		
WAITAWHETA	0.53	0.05	0.52	0.05	0.56	0.53
WHITEHALL	0.51	0.04	0.50	0.04		
WORKS	0.55	0.05	0.54	0.08		

Communication Record

To:	Luca de Marco	Date:	23/11/2015
Copy to:	Kym Neaylon	Time:	
Recorded by:	Peter Cenek & Elke Beca	File No:	5-29E54.00
Subject:	Texture Loss Model Testing Results	Proj No:	
Type:		Page 1 of 1	

SUMMARY: Two model forms for texture loss were investigated, these being the HDM4 model, which employs logarithmic deterioration and a simple linear deterioration model. When applied to BoP West data, the HDM4 model is more accurate between 0-5 years with the linear model more accurate when the surface age reaches 5+ years. For the HDM4 model the average absolute texture error is below 0.1mm when the surface age is less than 6 years. When the surface age is less than 3 years old, the HDM4 model has only 10% of the SAL's with a texture error greater than 0.5, while the linear model has 20%. When the surface age is greater than 10 years, the HDM4 model becomes more inaccurate than the linear model. At this point the HDM4 model has 20% of SAL's with an error greater than 1.0mm while the linear model only has 9%. This is expected due to the logarithmic form of the HDM4 model.

Overall the HDM4 model is slightly more accurate and so is recommended for estimating texture loss, within the NZ-dTIMS framework. Based on all model observations for BoP West, 50% show an absolute error greater than 0.3mm and only 10% show an absolute error of greater than 0.8mm.

MODELLING METHODOLOGY:

- Extract texture (MPD) data from RAMM, averaged by lane and summarised by SAL (skid investigation length). **Extract one record per SAL for each year since the date of last reseal**. This results in a lane average MPD per year per SAL
- Determine the year zero (Yr_o) texture value per SAL. This is the first record post reseal, which may be up to 12 months post reseal depending on time of reseal and HSD collection.
- Apply the HDM4 texture deterioration model (annual incremental form) to calculate MPD texture as follows:

  Current Texture - (a_o* LOG10((Surf_Age + 1.0) / Surf_Age))

  where:

  - Current Texture (starts at Yr_o)
  - a_o =Texture Slope = value based on surface type (chipseal or AC) and chipsize as follows:

Chip Grade	2	3	4	5	6	AC
a_o	0.85	0.85	0.8	0.5	0.5	0.1

- Predict texture from Yr_o through to current based on HDM4. Calculate ratio of observed to predicted MPD texture each year. Note Yr_o ratio will always be = 1.
- Calculate the average ratio (excluding Yro) for each SAL. This becomes the SAL scaling factor to improve fit of the HDM4 texture model. Where no data is available, the scaling factor = 1.

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Communication Record

To:	Luca de Marco	Date:	25/11/2015
Copy to:	Kym Neaylon	Time:	
Recorded by:	Peter Cenek & Elke Beca	File No:	5-29E54.00
Subject:	Revised Flushing Model	Proj No:	
Type:		Page 1 of 1	

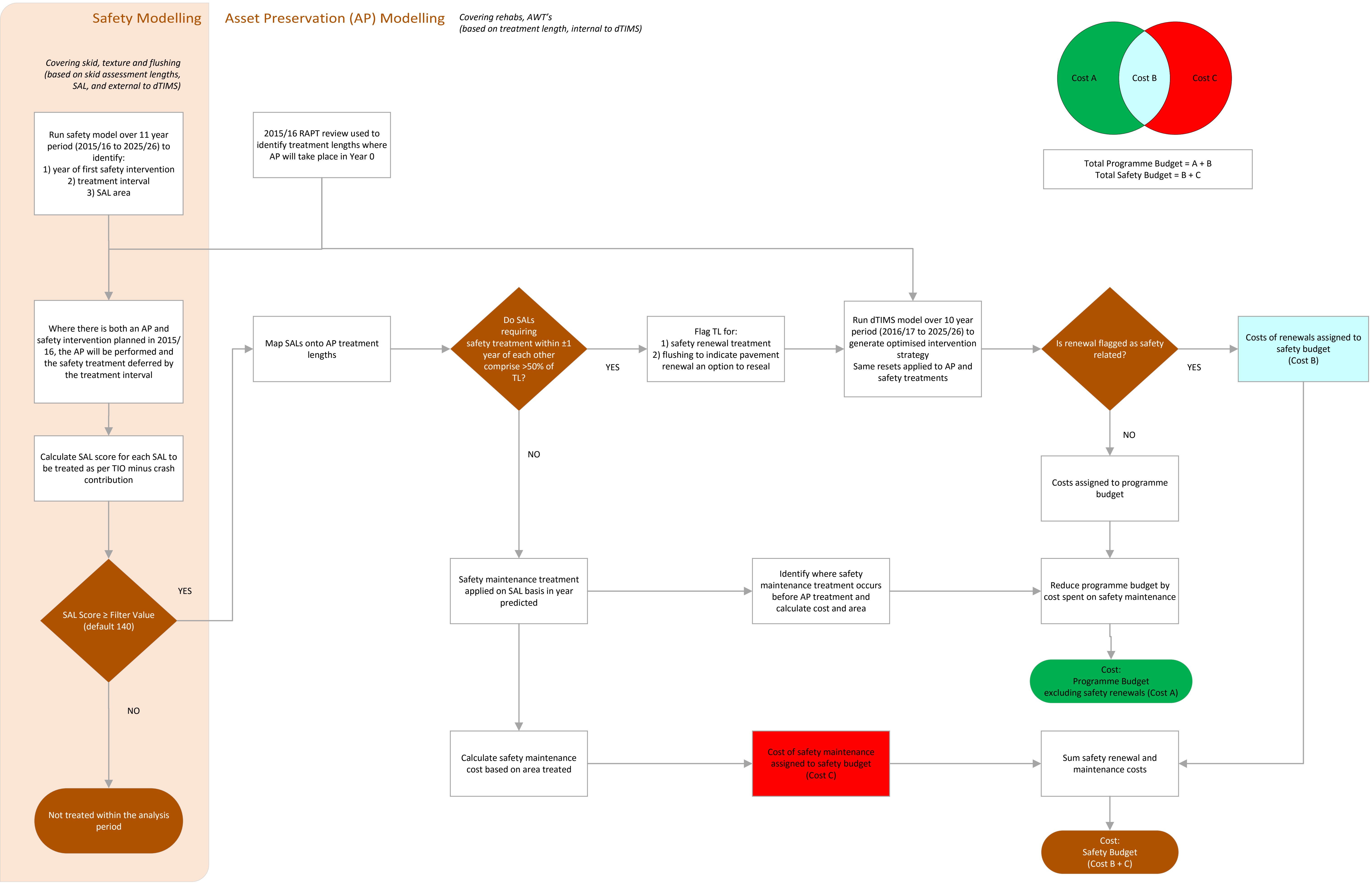
Application of the University of Auckland's flushing initiation model to the BoP West network showed it to give an unacceptably high number of false positives. To put this in context, BoP West typically has about 1-2% of treatment lengths requiring pavement recycling/rehabilitation due to layer instability, whereas the model was predicting around 10% for a modelled flushing probability setting of 80%. This increases to a very high 40% if the modelled flushing probability is relaxed to 50%. (Refer Theuns summary paper for results of different model probability settings). Therefore, the project team has unanimously decided not to proceed with including the University of Auckland's flushing initiation and progression models in NZ-dTIMS.

Instead the proposed SCRIM skid and texture models will be used outside of dTIMS to establish if there are any occurrences when SAL predicted values of 0.35ESC and 0.7mm MPD occur within one year of each other, this being NZTA' s definition of flushing.

Each SAL meeting this flushing condition will be "flagged" as will treatment lengths in which the percentage length flushed will also be recorded. Routines inside dTIMS will be written to recognise treatment lengths where and when flushing is predicted to occur so optimisation of asset rehabilitation works with regards to type and timing can take place.

Testing is currently taking place to determine if this proposed methodology can correctly predict the BoP West SAL's that actually displayed flushing in 2014 before being incorporated in the MatLab routine being used to identify "safety" related maintenance works.

SAFETY MODELLING IN dTIMS



Topic: Safety Analysis Outputs

One Pager

Date: 24 March 2016 (UPDATED 8 April 2016)

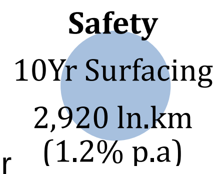
Author: Elke Beca & Peter Cenek

Objective

The objective of this model development is to allow the effect of different investment levels on network skid resistance levels and the associated impact on casualty crashes to be quantified. This in turn will enable the portion of the NLTP that is safety works related to be quantified and also the funding level required to achieve a specified safety outcome in terms of percentage change in casualty crashes. This can be summarised as:

- What is the surface driven Safety need on the network?
- How much of this Safety need is actually treated by Asset Preservation prior to manifesting as a Safety concern? *This is limited to surface driven safety only*.
- What is the predicted network skid resistance profile following the combined Asset Preservation and surface Safety program?
- What is the impact on casualty crash numbers

Network Safety Need



Safety modelling includes predicting both SCRIM (micro texture) and Texture (macro texture) 20 years into the future for every Skid Assessment Length (SAL). Annual Safety Need is determined as the predicted length of network breaching the NZTA T10 threshold levels (as generated outside of dTIMS). The total length of Safety Need over the 10 year period: 2015 to 2024 is 2,920 lane km. This accounts for 1.2% of the total network lane length per annum. *Note: Technical details of the Safety modelling may be found in the appendices.*

Network Asset Preservation Need

The recommended base asset preservation investment is $100M pa for the mid-term. The predicted treatment type and length profile corresponding to this $100M investment scenario (as generated by dTIMS) is termed the Asset Preservation Need. The total length of Asset Preservation Surface Need over the 10 year period: 2015 to 2024 is 18,900 lane km. This accounts for 8.1% of the total network lane length per annum. *Note: Asset Preservation Surfacing includes AC, Chipseal and Do Something treatments.*

Network Combined Need

The Combined Need is a scenario run in dTIMS which includes the Safety program, loaded as an input, matched with the fixed $100M recommended Asset Preservation investment. dTIMS generates treatment options in the same way as a straight asset preservation model, the difference being, where a safety treatment is required it will be included in all treatment options on that segment (either before or after the asset preservation treatment depending on condition and timing).

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Optimisation occurs normally with the Safety treatments allowed an unlimited budget and Asset Preservation capped at $100M pa. The unlimited Safety budget ensures that all safety treatments will be funded. *Note: Details of the Safety dTIMS modelling is provided in separate One Pager in the appendices with the flow chart showing generation of treatment options appended to this summary.*

The modelling suggests that under a combined scenario, **<u>over the 10 year period: 2015 to 2024</u>**,

- ***Hidden Benefit:*** Asset Preservation Surfacing (excluding Safety) reduces by 970ln.km due to more pavement work allowed (less surfacing) when Safety Investment is considered.
- ***Tangible Benefit:*** The Combined or shared quantity between Asset Preservation and Safety is 1140 ln.km.
- **39% (1,140 ln.km) of the Safety Need will be treated under Asset Preservation (combined).**
- **Asset Preservation surfacing reduces by 11.2% (970 ln.km + 1140 ln.km).**
- **Combined (Shared) Asset Preservation and Safety amounts to 1,140 ln.km**

The following table summarises the surface length under the three base scenarios described. Surfacing includes AC, Chipseal and Heavy Mtc. quantities.

Predicted Surface Need (Length Lane km)						
Base Scenario	**10 Yr Sum**	**10 Yr Avg**	**% Network**	**20 Yr Sum**	**20 Yr Avg**	**% Network**
Safety Only	2,920	292	1.2%	6,870	344	1.5%
AP Only	18,900	1,890	8.1%	36,120	1,806	7.7%
Combined AP	17,930	1,793	7.7%	35,090	1,755	7.5%
Combined Safety	1,780	178	0.8%	3,870	194	0.8%
Combined Safety Reduction	***1,140***	***114***	***39.0%***	***3,000***	***150***	***43.7%***
Combined AP Reduction	***2,110***	***211***	***11.2%***	***4,030***	***202***	***11.2%***

Note: 10 and 20 Yr Sum are rounded to the nearest 10 lane.km

Impact on Cost

The proposed cost benefit of combining the Asset Preservation and Safety programmes is around $5.2 Million per annum.

	Surface Costs ($M)		
Scenario	**AP Surface**	**Safety Surface**	**Total**
Treated Separately (10 year sum)	$ 646.4	$ 74.3	$ 720.7
Treated Combined (10 year sum)	$ 609.1	$ 59.5	$ 668.6
Proposed Benefit of Combining Programmes (10 year sum)	*$ 37.3*	*$ 14.8*	*$ 52.1*
Proposed Benefit of Combining Programmes (Annual)	***$ 3.7***	***$ 1.5***	***$ 5.2***

Note: AP = Asset Preservation

Cost information for Safety Surface programme Treated Separately (modelled outside of dTIMS) has been calculated using the dTIMS surface rates (CS: $4.74/m2 and AC: $28.28/m2) with an assumed lane width (not available in

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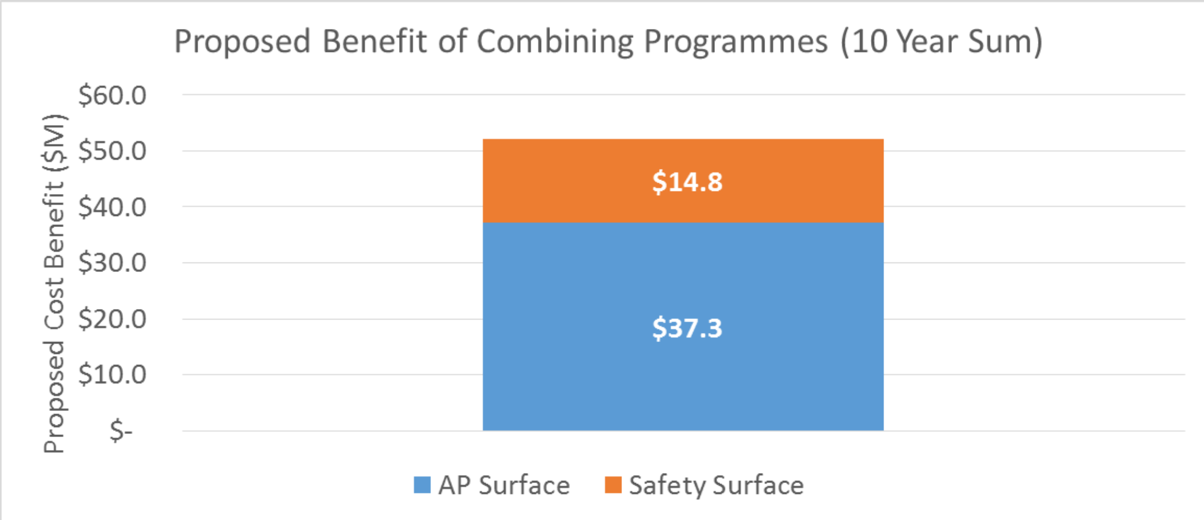
RAMM) of 4m for AC and 3.5m. All other costs have been extracted from the various dTIMS analyses. Approximately 18% of the Safety Surfaces are AC.

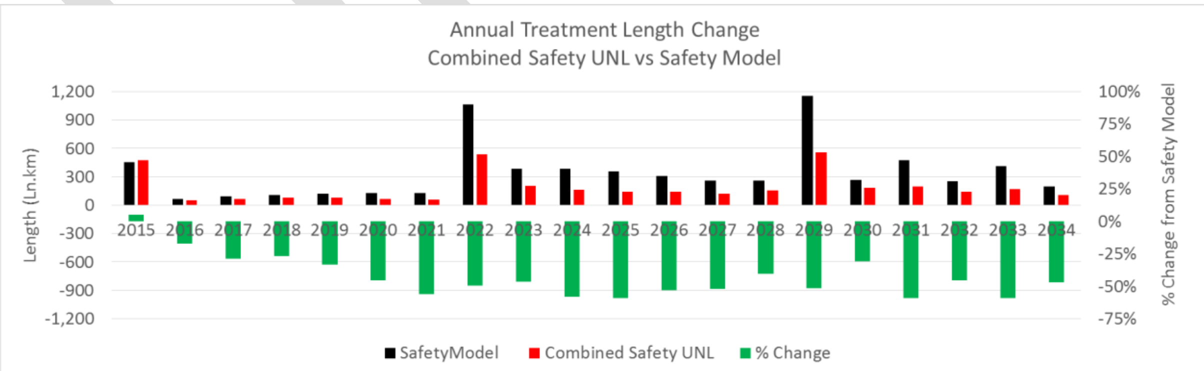


Impact on Treatment Length

How do the Safety quantities change?

The Safety Modelling predicts that under the Unlimited scenario (all SAL with either SCRIM or Texture dropping below Threshold Level), a total length of 2920 lane km will require treatment in the next 10 years. This quantity reduces to 1780 lane km when combined with the Asset Preservation model (Combined Safety UNL). The chart below shows the Safety Model annual predicted lengths (black bars) matched with the Combined Safety UNL predicted lengths (red bars). The cyclic nature (peaks in 2015, 2022 and 2029) are due to a constraint put on the Safety Model saying a safety surface **MUST LAST 7 YEARS MINIMUM.**

The green bars on the secondary axis show the % reduction in Safety each year due to combined treatment selection.



How do the Asset Preservation quantities change?

Due to the small percentage of annual safety (1.2% of network by ln.km), the impact on the total asset preservation programme is relatively small. The following charts shows the comparison of predicted length by treatment type between the

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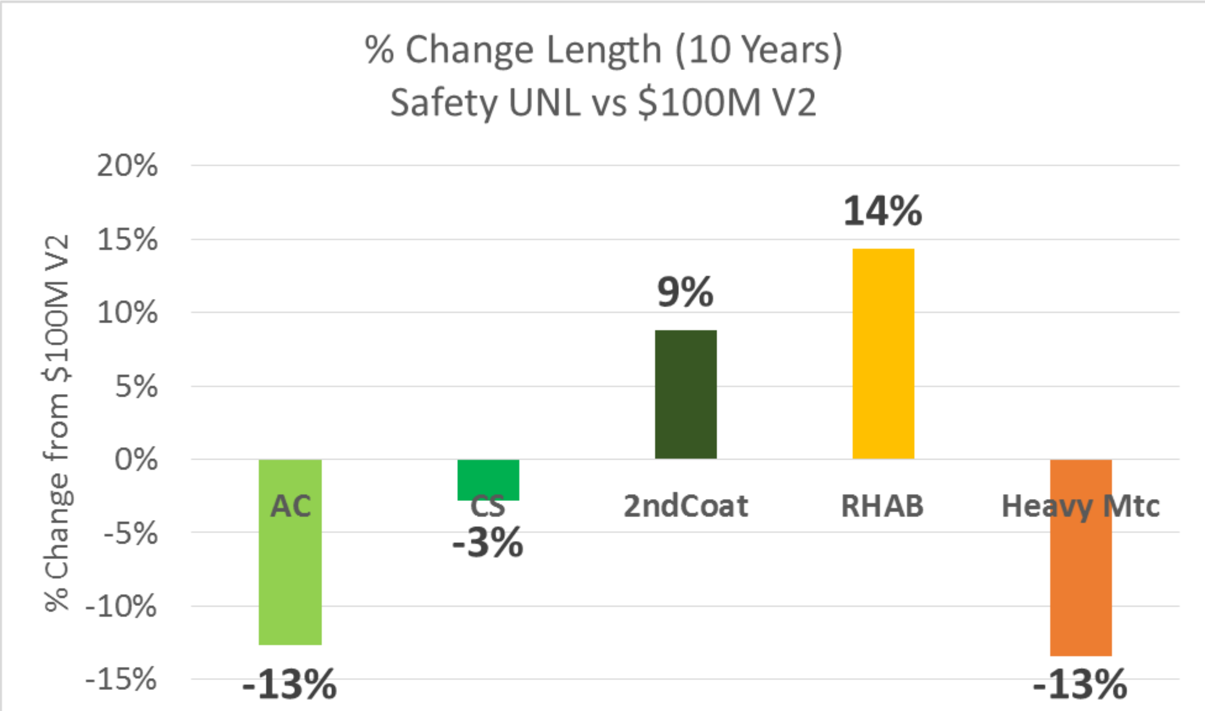
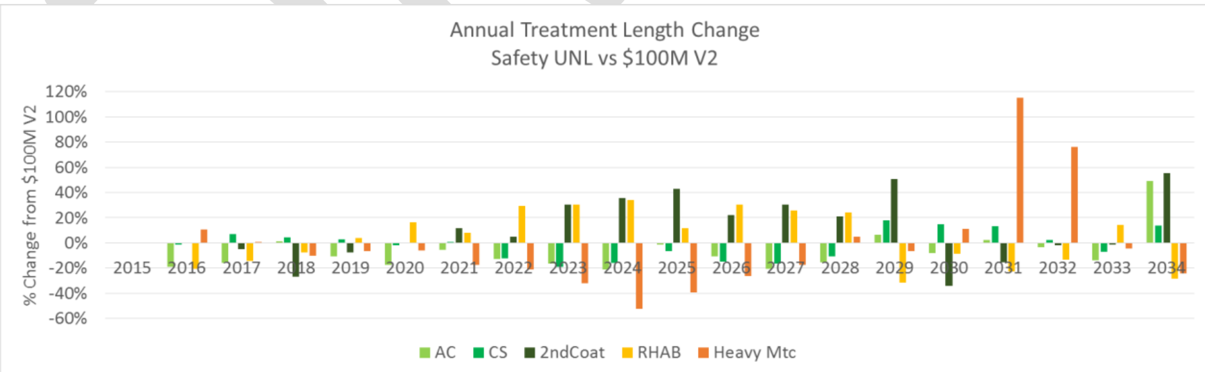
Recommended Investment Scenario ($100M V2) and the Combined Safety UNL which includes Safety. Both scenarios include:

- Fixed annual renewal budget of $100M and $30M routine maintenance
- Combined Safety UNL also allowed unlimited Safety budget

When Safety is funded through a separate budget, the Asset Preservation model reacts by increasing spending on RHAB and reducing Heavy Mtc. The drop in AC and CS quantities link directly to sections funded by Safety.

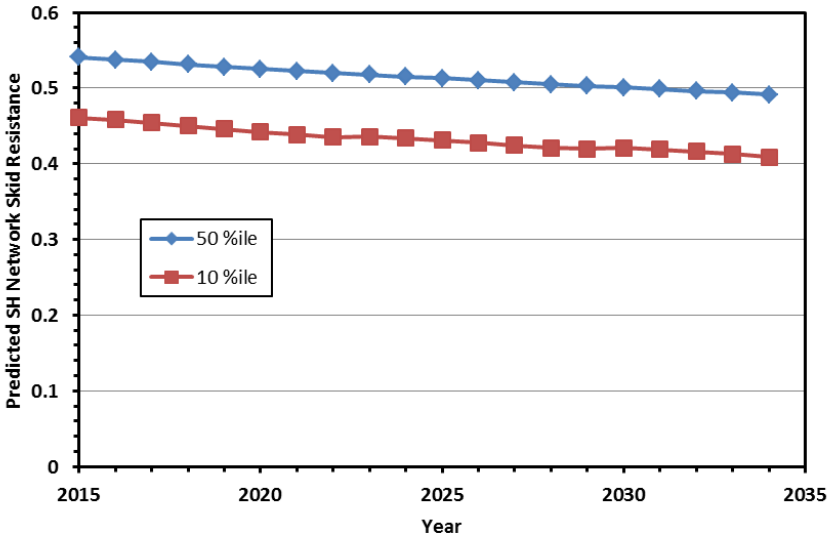


The following chart shows the annual length difference. The first 5 years have little change. The middle 10 years show vast tradeoff between Heavy Mtc and RHAB. The final 5 years show a reversal in the tradeoff with more Heavy Mtc.



Impact on Condition

For skid resistance, the modelling shows that the SH network skid resistance level continues to decline over the 20 year analysis period (refer plot below). This is because the amount of safety surfacing works is insufficient to keep up with the yearly degradation of skid resistance due to trafficking, which is presently about 0.0026 ESC per annum.



For texture, the modelling shows that the SH network texture level will decline to about 1.5mm MPD in year 2021 at a rate of 0.03 mm MPD per annum after which it fluctuates about this level (refer plot below). It will also be noted that the 10 percentile value stabilises around 0.8mm, which is just above the T10 threshold value of 0.7 mm MPD for chipseal surfaces.

The impact of including $100 million per annum asset preservation works is negligible. This is because a large percentage of the asset preservation works involve bituminous mix treatment lengths, which display significantly lower skid loss and texture loss rates than chipseal road surfaces, which dominate the state highway network. Therefore, renewal of bituminous surfaces has very little effect on arresting the deterioration rates of the network averaged skid and texture levels.

However, the modelling shows that if all the asset preservation works were to take place predominately on chipseal surfaces, then there would be an improvement in the safety condition of the network, particularly in relation to texture.

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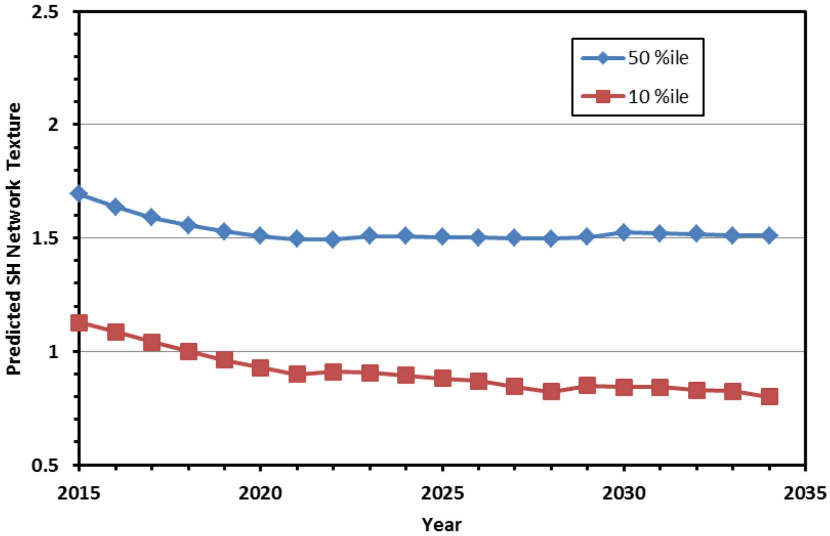


The modelling also indicated that:

- To maintain skid and texture at the 2015 50 percentile levels, 9% and 20% respectively of the network must be resurfaced per annum.
- To maintain skid and texture at 2015 10 percentile levels, between 1.4% and 1.7% of the network must be resurfaced per annum.

Impact on Crash Numbers

Analysis of the 2014, 2015 and 2016 SAL tables in RAMM has shown:

- % of SH network with breached TL/TLM is relatively stable over the 3 year period.
- There is a disproportionate amount of wet crashes on SAL's with breached TL/TLM (ratio %crashes/%length of network = 2.7)
- The percentage of all wet crashes on SAL's with TL/TLM breaches = 7.5%.

The number of wet injury crashes occurring on the SH network is 769 per annum based on the 5 year period 2011- 2015. Assuming the social cost of a wet injury crash is $697, 500 (from EEM), treatment of all TL/TLM breaches will result in a saving of 57.7 wet injury crashes (7.5% of 769) amounting to a social cost saving of $40.2 million.

The cost of treating TL/TLM breaches is estimated to be $7.42 million per annum (1.2% of the entire SH network) giving a benefit cost of 5.4.

Communication Record

To:	Luca de Marco	Date:	12/7/2016
Copy to:	Elke Beca, David Jeffery	Time:	
Recorded by:	Peter Cenek	File No:	5-29E54.00
Subject:	Safety into NZ-dTIMS – Overview - Updated	Proj No:	
Type:		Page 1 of 3	

To ensure a safe road surface is provided for users of the state highway network, skid resistance and texture are managed to specified levels that have been set with the objective of equalising the personal risk across the state highway network of having a skidding related crash. This level is referred to as the investigatory level. Therefore, skid resistance and texture values above the investigatory level are deemed to be satisfactory. Those below prompt the need for investigation to determine whether increasing either the skid resistance or texture will be beneficial in reducing wet crashes. However, if the skid resistance or texture fall by a certain amount below the investigatory value, a maintenance intervention is triggered on the grounds that a wet crash is highly likely requiring urgent action. This level is referred to as the threshold level.

Modelling of skid resistance and texture condition over the 10 year period 2015 to 2024 indicates that approximately 292 lane-km per annum of the state highway network will breach the skid resistance and texture threshold values. This corresponds to 1.2% of the state highway network. An economic analysis shows maintenance treatment of such road sections to be very cost effective, resulting in $4 of crash cost savings for every $1 spent on resurfacing the road.

The annual safety budget, based on a resurfacing need of 292 lane-km, is estimated to be $7.4 million. By comparison, the annual asset preservation budget is estimated to be $64.6 million based on a resurfacing need of 1890 lane-km.

When safety treatment needs are combined with asset preservation treatment needs, the amount of resurfacing required under both work streams reduce.

With reference to Figure1, the modelling forecasts that over the 10 year analysis period, the safety treatment need is reduced by some 39% on account that resurfacing under asset preservation addresses some of the length of state highway that breaches skid resistance and texture. On a per annum basis, this corresponds to 114 lane-km's, amounting to a reduction of $1.5 million in the forecast safety budget.

Conversely, as a result of safety addressing some of the surfacing required under asset preservation, more funding can be diverted to pavement related work. This results in a 97 lane-km reduction in the forecast annual asset preservation resurfacing need from 1,890 lane-km to 1,793 lane-km, which corresponds to a 5.1% reduction. The associated reduction in asset preservation resurfacing cost is $3.7 million per annum.

The total reduction in resurfacing achieved by considering safety and asset preservation together, rather than in isolation amounts to 211 lane-km per annum. This equates to a 9.7% reduction in resurfacing length from 2182 lane-km's to 1971 lane-km's per annum, yielding a combined cost saving of $5.2 million per annum.

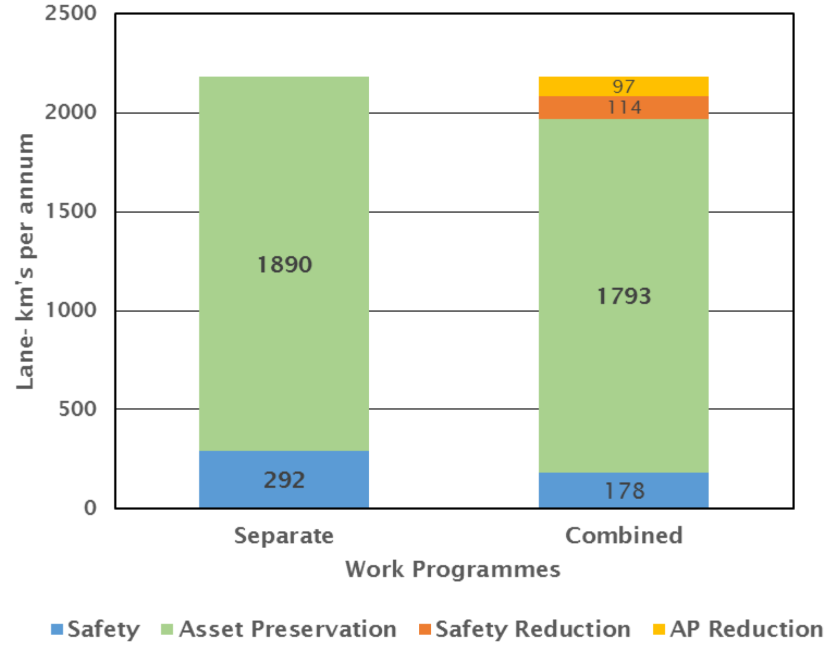


Figure 1: Forecast annual work quantities

An analysis of historical safety needs showed that over the past 3 years about 3,370 lane-km's per year or about 15% of the state highway network lies between the skid resistance investigatory and threshold levels. With reference to Figure 2 below, about a third of this length i.e. 1,106 lane-km is very close to breaching the threshold level. Maintenance treatment of this 1,106 lane-km was shown to be on average fiscally neutral with every $1 spent on resurfacing yielding $1 in crash cost saving. However, by identifying lengths of state highway where lower skid resistance and texture are contributing to wet road crashes, treatment can be very cost effective resulting in benefit cost ratio's in excess of 4.

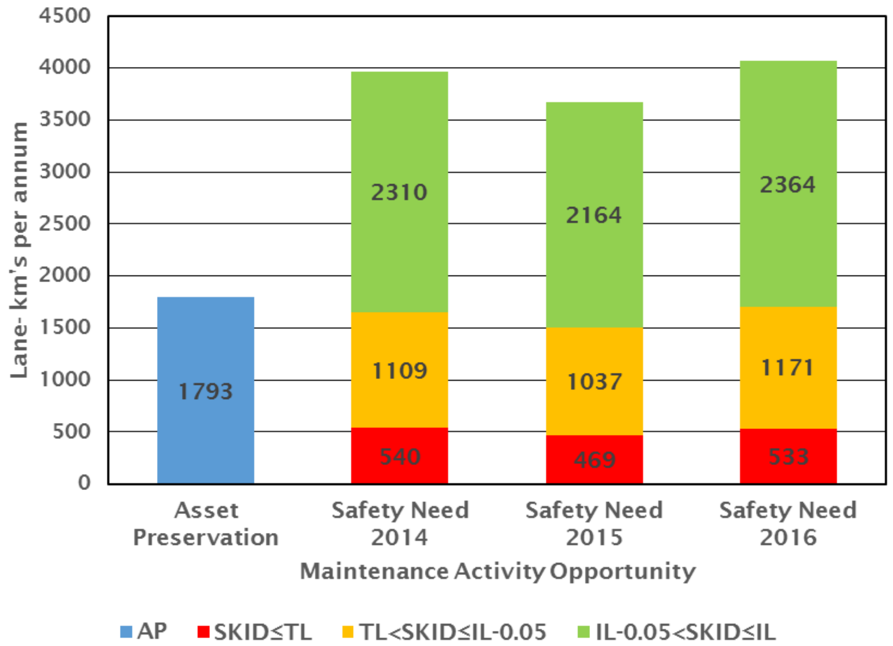


Figure 2: Historical distribution of safety need and how it relates to forecast asset preservation need

With reference to Figure 3, it can be seen that the majority of the safety need comprises low skid resistance levels in high wet crash risk locations such as intersections, tight curves and steep downhill grades.

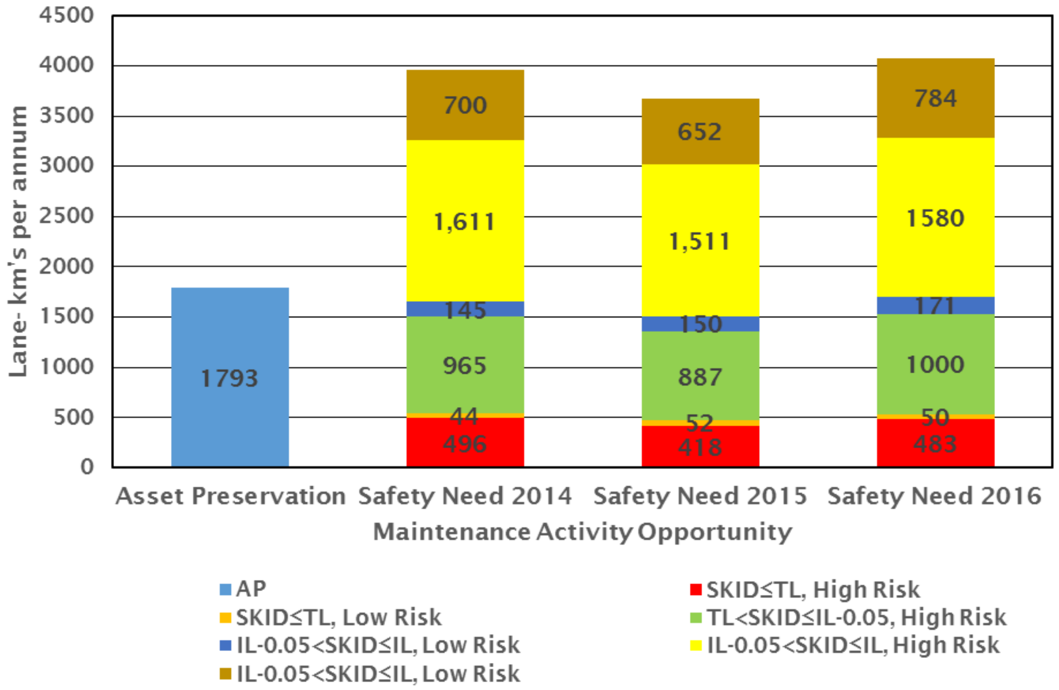


Figure 3: Historical make-up of safety need

Figures 2 and 3 show that there is considerable opportunity for asset preservation surfacing to contribute to safety by:

1. Impacting on the amount of state highway that is close to breaching skid resistance and texture thresholds, thereby allowing safety works to remain at manageable levels
2. Reducing crashes wherever asset preservation surfacing coincides with sections of state highway with a history of surfacing related crashes.

The 10 year modelling highlights that a key impact of surfacing works performed under asset preservation is to even out the annual amount of surfacing required under safety as it erodes the length of state highway that has values of skid resistance and macrotexture that fall between the investigatory and threshold values.

Appendix G: Comparing Forecasted Programme to Existing Programmes

Topic: How Do the Results Compare?

One Pager

Date: 25 March 2016

Author: Elke Beca

Objective

Over the past 2-3 years, the NZ Roading industry has seen a paradigm shift in the way road maintenance is procured and delivered, in order to meet government objectives and policy. In 2013 an extensive project was undertaken including dTIMS modelling, field validation and Delphi workshopping to arrive at target treatment quantities by Region.

This one pager provides a summary of the treatment quantities by Region, from this NLTP analysis' recommended base need investment ($100M pa for 10 years with Routine Maintenance capped at $30M pa). The 9* year average quantities are compared to:

- SMO18 quantities (2013 results)
- Base Preservation Renewal Quantities
- Contractors Baseline Plan Quantities (NZTA provided spreadsheets updated with 15/16 and 16/17 RAPT reviews)
- Commentary around ONRC is also provided

** Note: 2014/15 where applicable and 15/16 quantities have been excluded from all averages.*

Summary

The 9 year averages for each treatment type are provided below.

- 2016 Recommended Investment quantities align most closely with BPRQ
- Average CS quantities align *very closely* across all scenarios
- AC and RHAB quantities both have significant ranges
- Contractors Baseline (FWP) is has lower than expected AC and RHAB quantity (expect alignment with BPRQs).

The 2016 recommended 'Heavy Maintenance' quantities highlight the expected quantum of pavement need on the network which will need to be addressed over the short-mid term.

Average Lane km Lengths (9 Yr excl 2015/16)				
Scenario	**AC**	**CS**	**RHAB**	**Heavy Mtc**
2016 Recommended Investment ($100M)	210	1,512	164	207
Contractor Baseline (FWP)	195	1,525	135	
Base Preservation Renewal Qtys (BPRQ)	274	1,521	160	
2013 Outcomes (SMO18) (2 lanes per CL)	188	1,506	301	

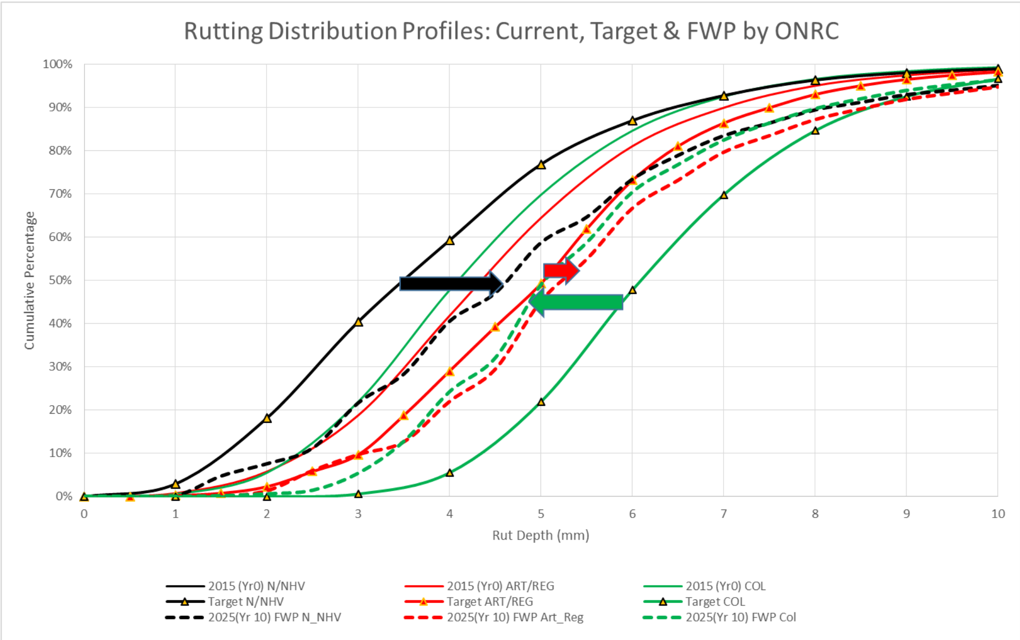
Contractors Baseline Plan (FWP)

The contractors' baseline plan as provided by the Transport Agency has been modelled. A full 10 year plan from 2015/16 has been modelled.

- Where the contractors plan is unavailable (either full or part) the contract Specimen Program values have been used.
- Treatments have all been summarised into AC, CS or RHAB.
- 2015/16 and 2016/17 have been updated to match the RAPT 0 and -1 lengths. Any treatments not selected during RAPT have been pushed to 2017/18

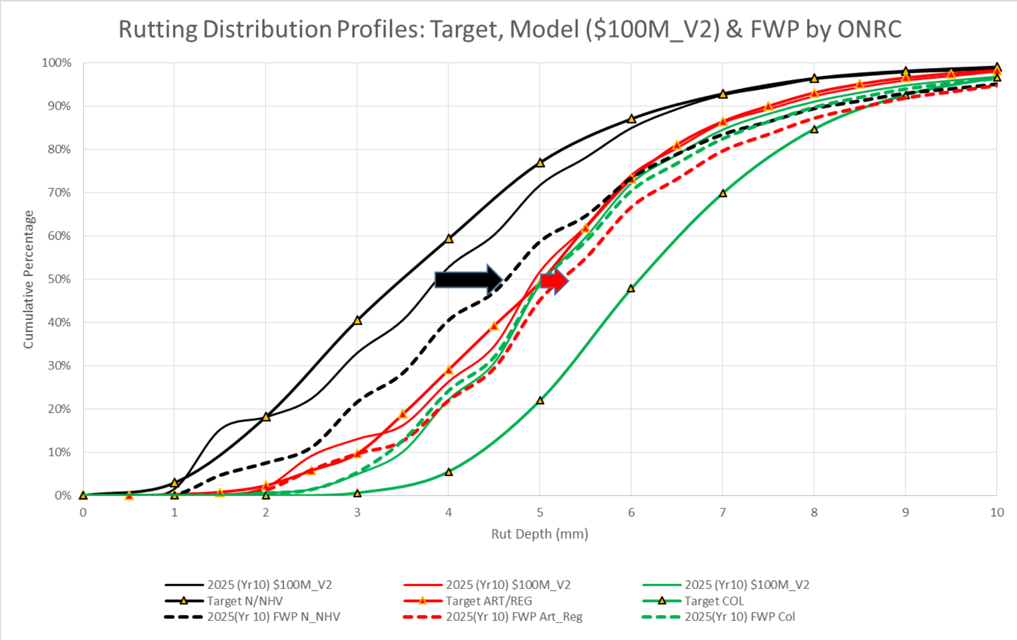
The following chart shows the rutting profile based on the FWP (dotted lines), projected to year 10 and split by ONRC Group*. The FWP is compared to current profile (2015 thin solid lines) and the Target profiles (solid lines with triangles).

- Collectors (green) are predicted to perform as expected (deteriorating toward target). Note they are predicted to still be in better condition than middle class after 10 years.
- Middle class (red) are predicted to deteriorate beyond the target (red arrow shows distance past target).
- National and High Volume are predicted to deteriorate substantially (black arrow) past target.
- The profiles of all classes merge around 75%, which means the worst 25% of each class is predicted to look about the same condition after 10 years, based on the FWP.



ONRC Group: N_NHV = National and High Volume, Art_Reg= Arterial and Regional, Col = Primary and Secondary Collectors

The following chart is identical except FWP is compared to Year 10 of the recommended Model scenario ($100M_V2).

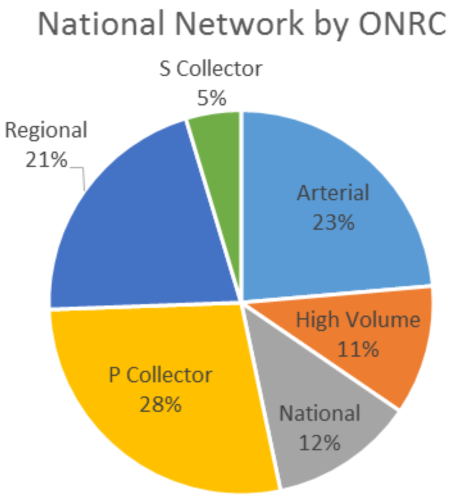


Overall general comment; it would appear the Contractors Baseline Plan (FWP) quantities are too low across AC and RHAB treatments. The increased in investment/quantities should have focus around ONRC by prioritising the higher class roads.

Network Statistics

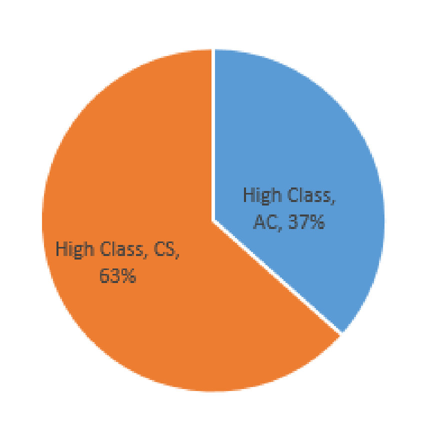
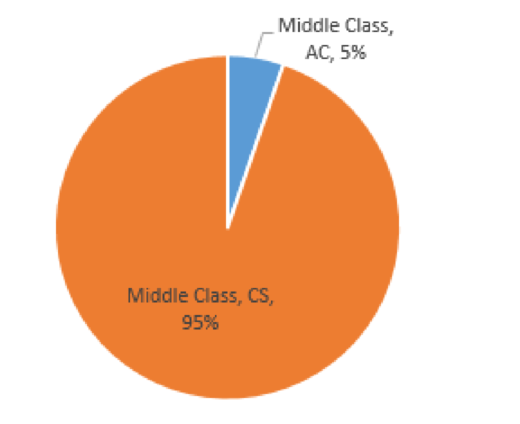
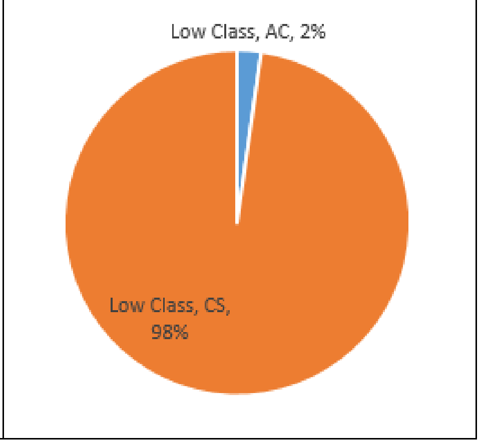
To assist in assessing the 2016 Recommended outputs against the existing quantities, an overview of the network statistics by ONRC and Region is provided.

Total Modelled Length: 23,082 lane km (340 ln km of Concrete excluded)



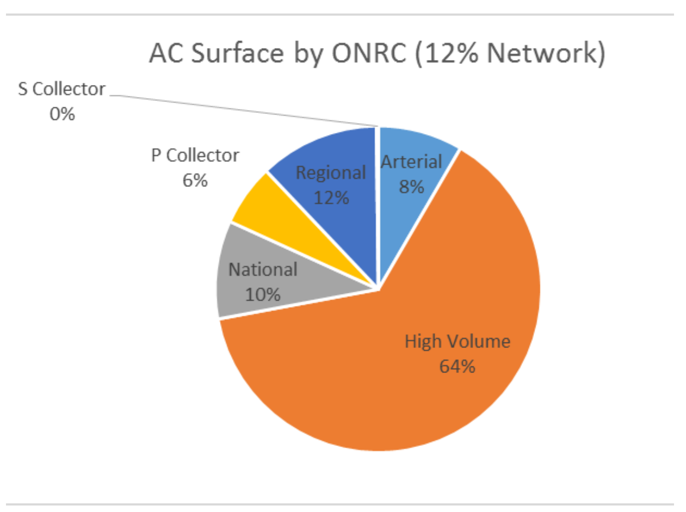
ONRC	%	Lane km
High Volume	11%	2,522
National	12%	2,811
Regional	21%	4,828
Arterial	24%	5,451
P Collector	28%	6,399
S Collector	5%	1,074
Grand Total	**100%**	**23,085**

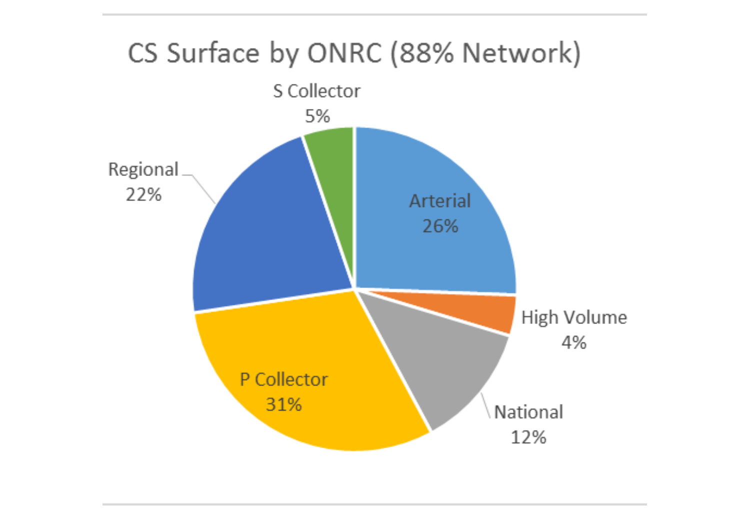
A quarter of the network is High Class, and just under half of the network is Middle Class. Nearly 40% of the High Class is AC surfaced. The other classes have minimal amounts of AC surfacing.

High Class	Middle Class	Low Class
		

AC Surfacing: 2,657 lane km (12% of total network by Length)

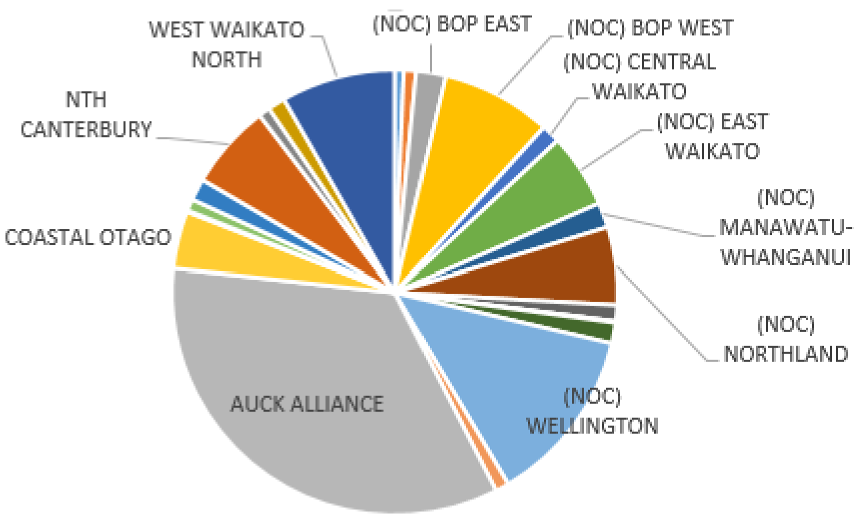
CS Surfacing: 20,425 lane km (88% of total network by Length)





Four Regions have significant quantities of AC Surfacing (>200ln km):

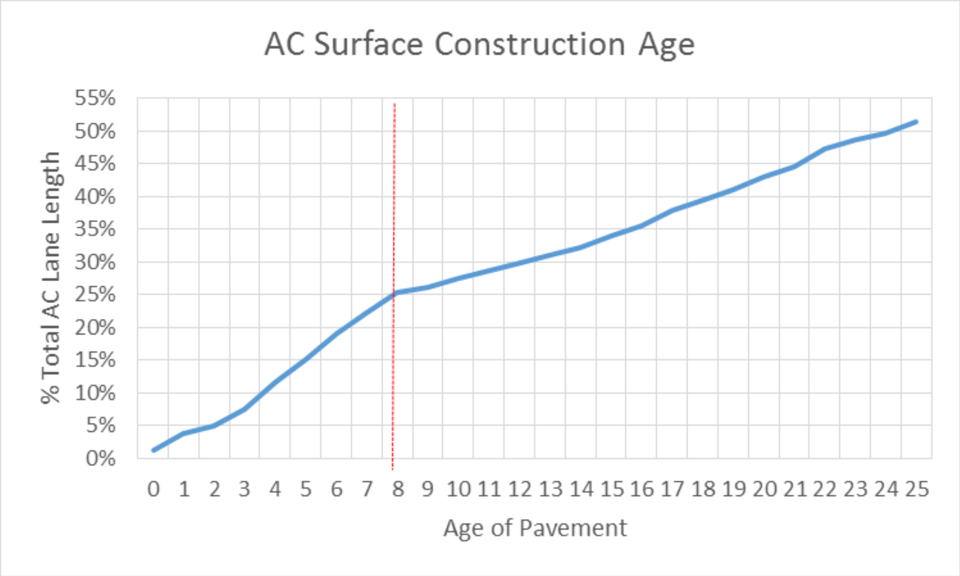
Auckland Alliance, BOP West, West Waikato North and Wellington



Lane TLs were modelled for both Wellington and Auckland. The comparison table will show that the return cycles for AC on these networks were around 10-12 years as expected. In contrast BOPWest and West Waikato North had AC return cycles 20-23 years which is far too long for high class urban environments.

It is recommended that all high AC urban centres (eg. Tauranga/Hamilton) be modelled by lane TL in future to allow the AC model to function adequately. *Note: 20% of West Waikato and almost 40% of BOP West AC is new capital AC, constructed since 2012. If these quantities are removed (they will not require renewal in 10 year period) the return cycles are 16 and 14 years respectively.*

This highlights a major looming concern; the high volume of capital projects that are being surfaced in AC. A number of these projects have occurred in the past 4 – 8 years with 25% of AC surfaces constructed in past 8 years (refer chart below). Note the change in slope pre-2008 and post 2008 (8 years).



Regional Comparison

General commentary on the 2016 Recommended quantities compared the Contractors Baseline Plan (FWP):

- **CS quantities generally match within +/-20%.** Exceptions are West Waikato North and East Waikato which recommend higher RHAB quantities to replace CS.
- **RHAB quantities area generally over predicting**. Central Waikato, Central Otago, East Waikato, Northland and West Waikato North predict at least double the quantity specified in the FWP.
- **AC quantities in the high AC regions match within 15%**. Refer to comments on future AC need due to high quantity of recent AC surfaced RONS.
- **Auckland Alliance** has significant differences between SMO18, BPRQ and FWP quantities. The 2016 Recommended quantities align well with FWP Surfacing but does not pick the RHAB quantities.
- **Wellington** aligns well with FWP (within 15%) and better with BPRQ (within 10%)
- **Marlborough** FWP appears incomplete

	Stats					2016 Recommended				Cycle		SMO18			BPRQ			Contractor FWP			Compare SMO18			Compare BPRQ			Compare FWP		
Region	**%HC**	**%MC**	**%LC**	**%AC**	**%CS**	**AC**	**CS**	**RH**	**DS**	**AC**	**CS**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**	**AC**	**CS**	**RH**
AUCK ALLIANCE	97%	3%	0%	99%	1%	78.5	0.6	1.2	1.3	11.6	15.3	96	8	6	144	12	9	75.3	0.0	4.9	-18%	-93%	-79%	-46%	-95%	-86%	4%	0%	-75%
(NOC) BOP EAST	0%	57%	43%	5%	95%	3.0	92.0	9.6	20.4	18.9	11.9	2	82	12	5.3	79.8	9	5.3	79.9	5.9	50%	12%	-20%	-43%	15%	7%	-44%	15%	64%
(NOC) BOP WEST	46%	46%	9%	41%	59%	9.2	26.0	4.7	7.1	23.1	11.5	6	30	12	15.3	25.1	3.6	9.3	23.4	4.4	53%	-13%	-61%	-40%	4%	30%	-1%	11%	6%
(NOC) CENTRAL WAIKATO	33%	32%	35%	2%	98%	1.6	112.3	33.0	24.0	22.2	13.5	2	110	18	3.5	119.1	11	2.9	112.6	10.1	-18%	2%	83%	-53%	-6%	200%	-44%	0%	228%
COASTAL OTAGO	25%	32%	43%	8%	92%	8.3	109.1	9.9	13.6	13.3	12.1	6	98	16	4.6	97.1	7.2	6.8	110.7	2.9	38%	11%	-38%	80%	12%	38%	21%	-1%	246%
(NOC) EAST WAIKATO	6%	64%	30%	13%	87%	10.9	76.9	12.3	17.0	13.3	12.9	6	62	16	11.7	96.9	4.7	11.0	99.6	4.7	81%	24%	-23%	-7%	-21%	162%	-1%	-23%	160%
(NOC) TAIRAWHITI ROADS NORTHERN	0%	1%	99%	0%	100%	0.1	30.4	2.2	2.8	4.5	12.7	0	54	12	0.5	51.7	13.1	0.0	34.7	7.9	0%	-3%	-48%	-42%	1%	-53%	UNL	-12%	-72%
(NOC) TAIRAWHITI ROADS WESTERN	0%	97%	3%	1%	99%	0.2	21.8	4.0	2.2	10.6	12.4							0.4	23.4	3.1							-40%	-7%	29%
(NOC) MANAWATU-WHANGANUI	46%	34%	21%	4%	96%	4.2	89.6	8.6	7.7	11.3	14.3	2	94	15	2.3	88.8	8.7	3.3	92.8	7.4	112%	-5%	-43%	85%	1%	-2%	30%	-3%	15%
(EC) MARLBOROUGH	35%	33%	32%	3%	97%	3.1	33.8	4.9	3.8	5.6	15.0	2	40	8	2	40	8	0.2	2.8	0.7	57%	-16%	-38%	57%	-16%	-38%	UNL	UNL	UNL
MILFORD	0%	90%	10%	1%	99%	0.0	33.9	0.5	1.2	UNL	11.6	0	24	2	**0.3**	**16**	**0.1**	0.3	28.7	1.2	0%	41%	-75%	-100%	112%	407%	-100%	18%	-56%
NAPIER	23%	54%	23%	2%	98%	1.7	82.0	4.2	7.9	13.1	12.0	2	82	20	1.8	87.8	6.1	2.0	89.0	5.9	-14%	0%	-79%	-4%	-7%	-31%	-15%	-8%	-29%
NELSON	0%	61%	39%	5%	95%	5.9	52.8	1.6	6.0	7.1	14.1	2	58	8	9.1	55.1	1.7	4.0	61.8	1.5	195%	-9%	-80%	-35%	-4%	-4%	48%	-15%	12%
(NOC) NORTHLAND	16%	16%	69%	8%	92%	11.2	89.2	16.4	25.8	13.3	18.6	12	122	30	**9.8**	**104.6**	**7**	10.4	104.7	6.3	-7%	-27%	-45%	14%	-15%	134%	7%	-15%	160%
NTH CANTERBURY	50%	33%	17%	10%	90%	10.7	104.3	9.5	7.4	15.4	14.0	8	102	28	8	102	28	8.0	102.0	28.0	34%	2%	-66%	34%	2%	-66%	34%	2%	-66%
OTAGO CENTRAL	0%	82%	18%	2%	98%	1.6	73.7	3.1	7.2	14.0	13.1	0	72	4	0.7	61.7	3.2	1.0	67.5	2.8	0%	2%	-22%	126%	19%	-2%	55%	9%	13%
(NOC) SOUTH CANTERBURY	32%	39%	29%	3%	97%	2.1	84.1	4.7	4.1	14.8	13.3	2	74	12	**3.2**	**87.3**	8.2	2.7	92.5	11.5	4%	14%	-61%	-35%	-4%	-43%	-21%	-9%	-59%
SOUTHLAND	0%	53%	47%	3%	97%	6.3	81.9	5.8	13.1	5.3	14.6	2	66	12	**2.9**	**85.4**	5.7	3.7	69.6	3.8	217%	24%	-52%	118%	-4%	2%	71%	18%	54%
(NOC) TARANAKI	0%	53%	47%	4%	96%	2.5	86.9	9.8	15.1	16.2	11.9	2	72	21	3.7	62.6	10.4	4.6	81.2	9.5	23%	21%	-53%	-34%	39%	-6%	-46%	7%	3%
(NOC) WELLINGTON	62%	32%	5%	51%	49%	35.0	23.7	4.0	4.4	9.8	13.7	20	36	8	33.2	23.9	3.7	30.2	24.1	3.5	75%	-34%	-50%	5%	-1%	8%	16%	-1%	14%
(NOC) WEST COAST	0%	70%	30%	2%	98%	2.1	145.6	1.7	8.0	12.6	11.8	2	126	10	1.2	142.3	0.9	1.5	139.7	1.1	4%	16%	-83%	74%	2%	89%	35%	4%	56%
WEST WAIKATO NORTH	57%	33%	9%	35%	65%	11.2	20.7	9.1	3.3	19.7	19.6	8	52	19	**8.6**	**33**	**3.2**	10.2	34.4	2.5	40%	-60%	-52%	30%	-37%	186%	9%	-40%	268%
(EC) WEST WAIKATO SOUTH	0%	61%	39%	3%	97%	0.9	41.0	3.2	3.9	25.1	17.7	6	42	12	**1.8**	**49.2**	7.7	2.1	49.5	5.3	-84%	-2%	-73%	-48%	-17%	-58%	-55%	-17%	-40%
Grand Total	**% of each Region in ONRC Group and AC/CS Surface**					**210.3**	**1512.4**	**164.2**	**207.3**	**Cycle (Yrs)**		**188**	**1506**	**301**	**273.5**	**1521.4**	**160.2**	**195.3**	**1525**	**134.7**	**12%**	**0%**	**-45%**	**-23%**	**-1%**	**2%**	**8%**	**-1%**	**22%**
						excl 15/16						***include all***			***excl 14/15 & 15/16***			***excl 14/15 & 15/16***			**% differnce between 2016 Recommended and Scenarios**								

All quantities are ln.km. AC= Thin AC Surface, CS= Chipseal Surface, RH=Rehabilitation (all pavement), DS= Do Something (Heavy Maintenance with Surfacing - 2016 Recommended only)

Auckland and Wellington were modelled by Lane Treatment Lengths (TLs), all others modelled by Centreline TLs.

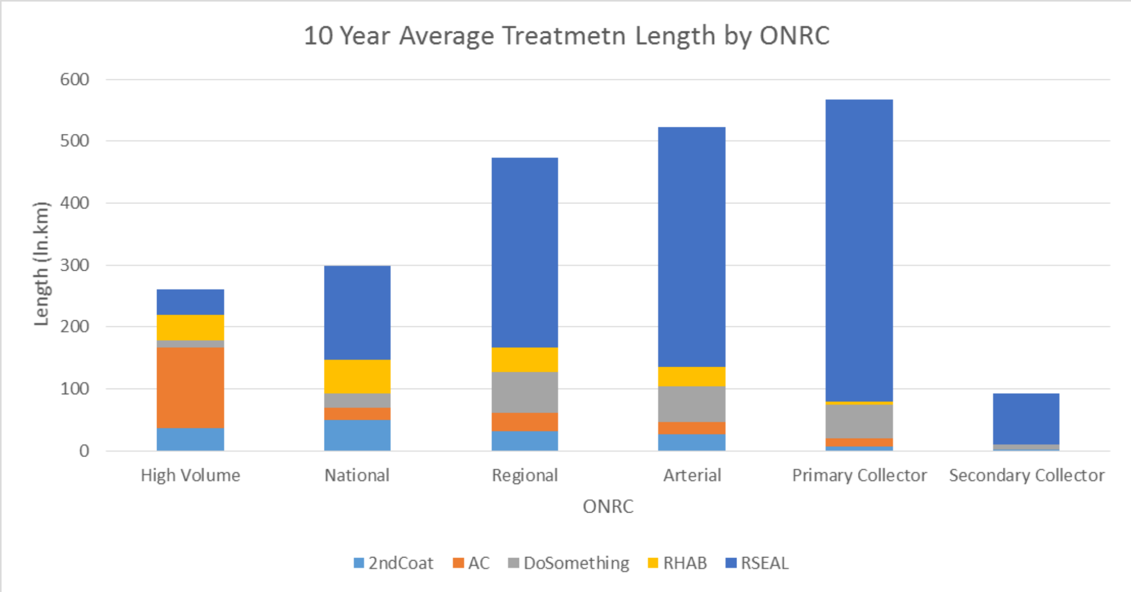
%HC = percentage in High Class, %MC = percentage in Middle Class, %LC = percentage in Low Class Collectors

%AC= percentage of length (ln km) surfaced in AC, %CS = percentage of length (ln km) surfaced in CS

Cycle = Average age of surface based on length of that surface type by region (AC or CS based on the 2016 Recommended quantities)

ONRC Comparison

The following table shows the 10 year average treatment type and length by ONRC based on the 2016 Recommended investment scenario. This shows a gradual decrease in pavement treatments as class decreases.



For ease of reporting, we have grouped the ONRC classes into 3 groups:

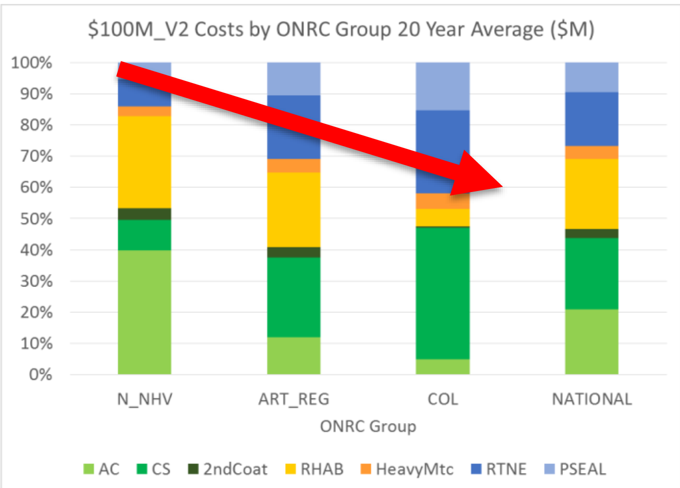
– NATIONAL_HV: National and National High Volume

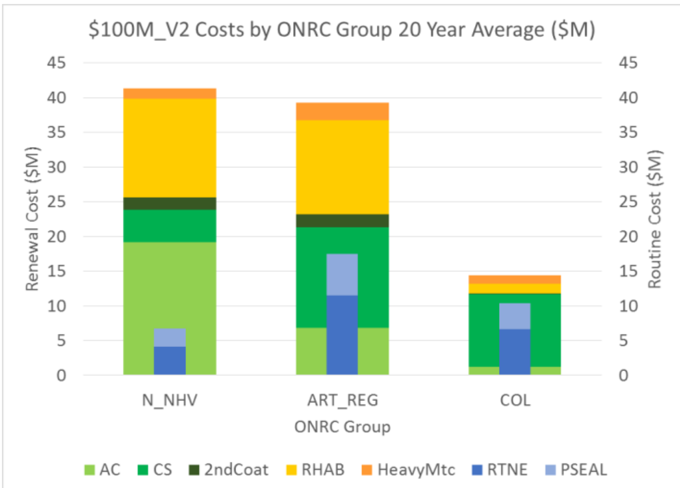
– ART_REG: Arterial and Regional

– COLLECTORS: Primary & Secondary Collectors

The two following charts show the maintenance cost split by ONRC group and treatment type, both as actual cost value and as ratio.

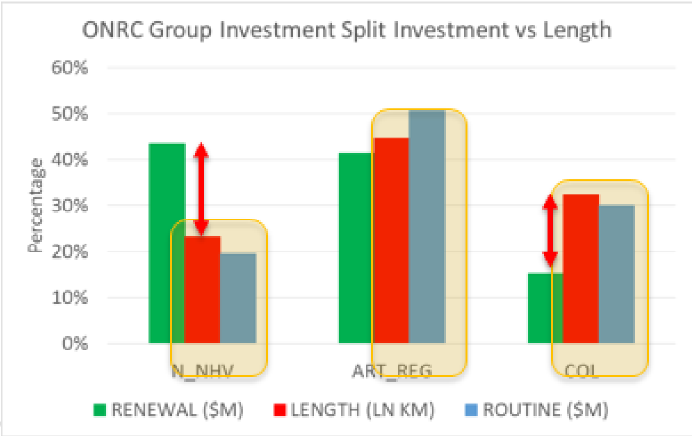
These show a decrease in RHAB as class decreases and a corresponding increase in routine maintenance. At a national level, roughly ¼ cost sits in routine mtc, ¼ in AC, ¼ in Chipseal and final ¼ in RHAB.

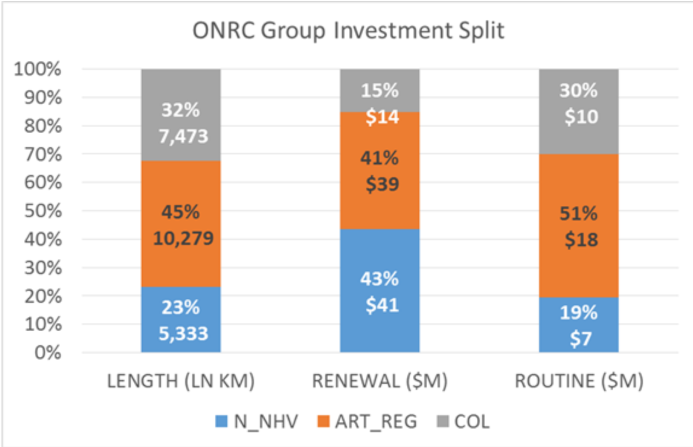




This information may be viewed in a couple different manners:

When compared to network length, High Class routes are given double the renewal funding as a percentage and Low Class routes given half. This aligns with expectation, where high cost renewal funding is spent on high class routes.





Appendix H: Sensitivity Analyses on Unit Rate Variations

Topic: NLTP Treatment Rates

One Pager

Date: 09 February 2016

Author: Elke Beca

Objective

A key objective of the NLTP Pavement & Surfacing analysis is to re-evaluate the **minimum sustainable/preservation investment profile** for the respective road classes on the SH network. To determine the investment profile we must have confidence in the treatment rates used within the model.

Discussion

Treatment rates play a vital role in performance modelling with model outcomes exceptionally sensitive to rate changes. Using our NZ modelling setup, two key processes happen during analysis.

1. Option Generation: Treatment options are generated for each treatment length over a 20 year period (may be a couple hundred treatment combinations for each TL over the period). Each option has a <u>net present cost</u> and benefit
2. Optimisation: All treatment options are ranked by net present benefit/cost with **one** option selected for each treatment length. Selection is constrained by total annual investment.

In our setup we have four renewal treatments each with a defined cost rate: Chipseal Surface, Asphalt Surface, Granular Pavement Renewal and Structural Asphalt. The cost rates can take two forms:

- National Treatment Rates (4 treatment rates used in the modelling)
- Area Specific (NOC Area) Treatment Rates (4 x 23 = 92 treatment rates used in the modelling)

This discussion looks at pros and cons of using National Treatment Rates vs Area Specific (NOC Area) Treatment Rates to calculate the <u>cost.</u>

<u>National Treatment Rates</u>

PROS:

- Enables optimisation to seek the true asset preservation need based on condition indicators, irrespective of economic impacts. Every renewal treatment type has same rate regardless of location.
- Aligns with ONRC objective that a road of the same classification will offer the same level of service regardless of where it is physically located in the country.
- Data available, has been provided by NZTA and used in the analysis to date

CONS:

- Economic realities of treatment cost differentiation by area not carried through into optimisation.

- NZTA have not provided Area Specific Rates but have confirmed there is large variation in rates by area, some up to 100% variation.

Area Specific Treatment Rates

PROS:

- Reflects the economic reality that some areas offer more affordable treatments than others. This is due to access to resources, traffic management requirements etc. Enables optimisation to seek the true economic benefits
- Final investment profile will reflect economic reality.

CONS:

- Areas will be advantaged/disadvantaged due to relatively lower/higher treatment costs than others.
- ONRC objectives may not be achieved due to cost differences making it un-economic to treat in some areas.
- Data not yet available, once obtained will lead to significant re-work
- Added complexity in modelling coding 88 extra treatment rates

EXAMPLE: A granular pavement in Northland = \$30/m2 and in Southland = \$20m2, the national rate is \$30/m2. If a treatment length in the same ONRC class in Northland and Southland have exact same net present benefit (condition) the following will occur during optimisation:

- <u>National Treatment Rate:</u> Both will be treated equally and will both be selected if funding available.
- <u>Area Specific Treatment Rate:</u> The Southland TL will be selected before the Northland TL as it is cheaper for the same benefit. The Northland option may never be selected despite offering the same condition benefit. From an ONRC perspective, the Northland road user experience will likely differ from the Southland road despite being in the same class.

Recommendation

Due to time constraints, in the short term we are progressing with the analysis using National Rates.

We recommend running the optimization using National Rates, so that treatments are selected based on NEED rather than ECONOMICS. We will determine the minimum sustainable profile based on NEED, thus aligning with ONRC objective. At the reporting stage we will import Area Specific Rates to calculate the <u>actual investment</u> required to fund the minimum sustainable profile.

Topic: Renewal Rate Sensitivity

One Pager

Date: 24 February 2016 (Updated 22/03/2016)

Author: Elke Beca

Objective

Renewal treatment rates by Region have been supplied but are only used for reporting purposes. The objective of this sensitivity analysis is to test the impact the range of rates may have on overall results if they were used within the model. Six unit rate combinations were investigated using a 10% sample of the full NZ State Highway network dataset with a fixed equivalent $100m pa Renewal Investment and fixed equivalent $30M pa Routine Maintenance Investment (referred to at the 'Baseline Investment'):

Name	Description	AC Surf	CS Surf	RHAB	RHAB AC	SAC - fixed
Option A	Max RHAB other remain	29.1	4.7	35.0	57.7	76.7
Option B	Max RHAB Min SURF	22.5	4.5	35.0	51.8	76.7
Option C	Min RHAB other remain	29.1	4.7	20.0	38.3	76.7
Option D	Min RHAB Max SURF	37.0	6.2	20.0	38.3	76.7
Option E	Min RHAB Min Surf	22.5	4.5	20.0	38.3	76.7
Option F	Max RHAB Max Surf	37.0	6.2	35.0	64.8	76.7

NOTE: The Max and Min values were taken as the Region specific 90%ile (Max) and 10%ile (Min) values.

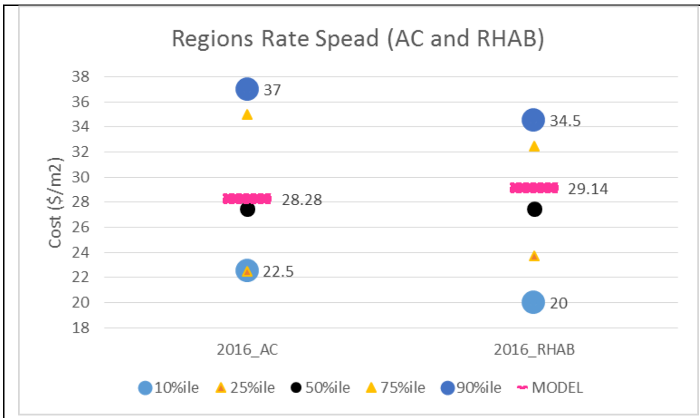
Regional Rate Range

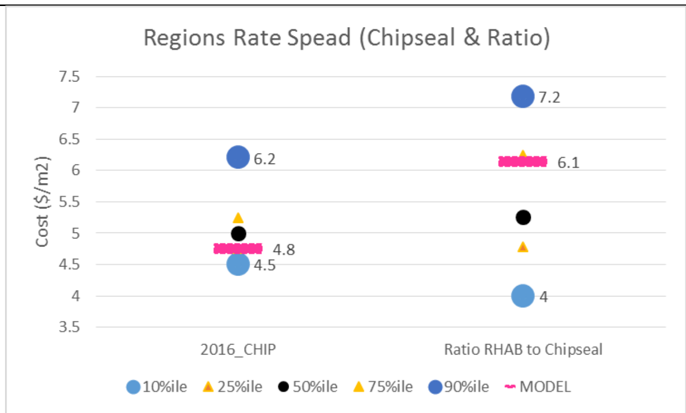
RHAB pavement rates are relatively evenly spread with a range of around $15/m2 between highest to lowest. The rate used in modelling is slightly above the median value.

AC surface have very wide 25%ile to 75%ile spread, the modelling rate sits marginally below the median value. Total spread is approx. $15/m2 between highest and lowest.

Chipseal surface rates have narrow range with 75% of regions sitting between $4.5 and $5.25 /m2. The rate used in modelling sits at the 25%ile.

A recommendation from the Peer Review was to examine how the relative cost of rehabilitation and resurfacing vary across the country. If the relative cost remains the same, while strategies will cost different amounts in different regions, the overall optimal strategy will likely still be the same. Based on Regional Rates, RHAB varies between 4 and 7.2 times more expensive than chipseal. Based on Model rates, RHAB is 6.1 times more expensive than chipseal. Clearly there is quite a lot of variation, and the model rates sit slightly higher than average (refer right hand graph below). It is noted that the Optimal Strategy would be affected if Regional Rates were indeed used, although the absolute impact of this has not been tested. The relative cost of RHAB to AC has been examined and is deemed negligible across the regions.

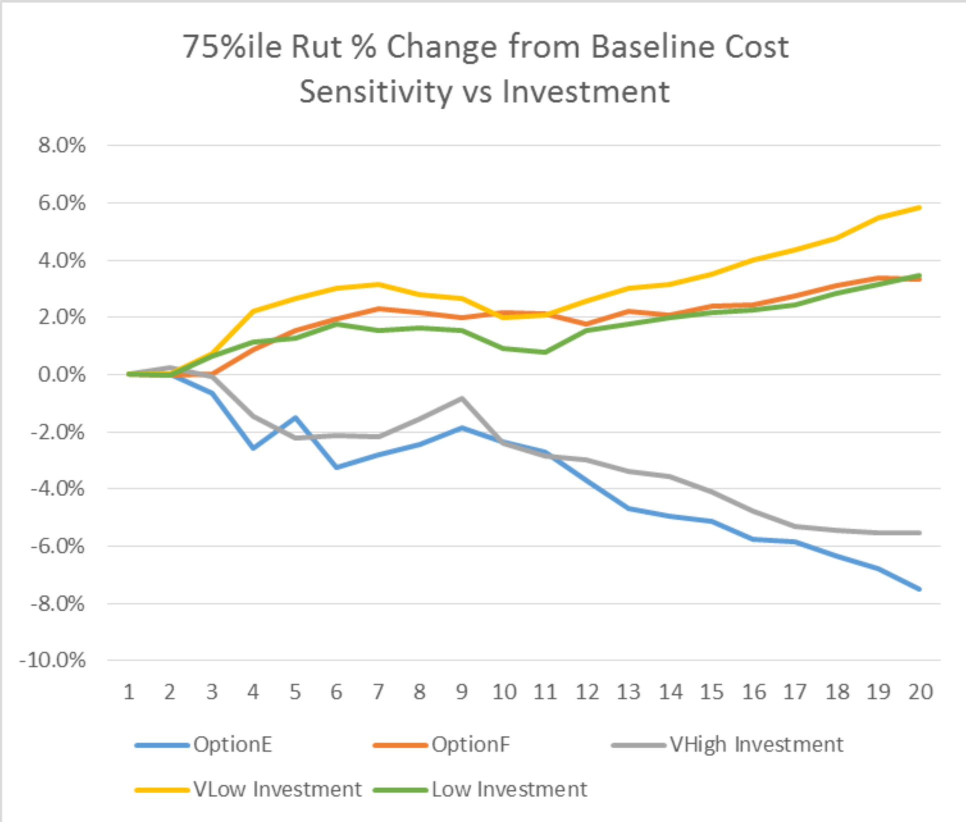




Summary Findings

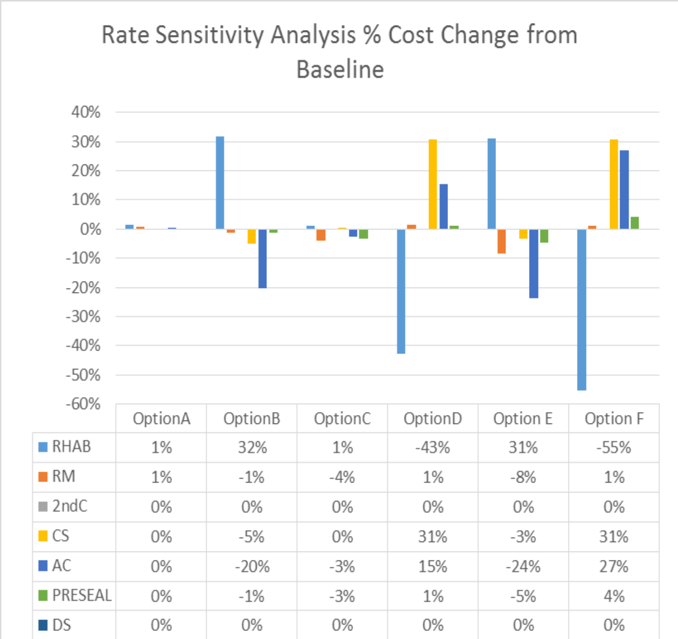
- ***This setup is sensitive to the variations in renewal treatment rates that we see in the Regional spread. Based on condition outcomes, the model suggests:***
    - ***Lowest Region rates used nationally with 'baseline' investment offers similar condition outcomes to Model Rates with 'Very High' investment.***
    - ***Highest Region rates used nationally with 'baseline' investment offers similar condition outcomes to Model Rates with 'Low' investment.***

This chart shows the percentage change in 75%ile rutting between the tested scenarios and the 'Baseline' Investment (where Model Rates were used). This compares the Highest and Lowest Region rate sensitivity analysis (10% sample) and the Very High and Low & Very Low Investment analysis (100% network run). This shows the Lowest Region rates and Very High Investment both offer up to 8% improvement in 75%ile rutting by year 20 and conversely Highest Region rates and the Low Investment analysis perform similarly offering approx. 3% poorer (increase) in 75%ile rutting by year 20.

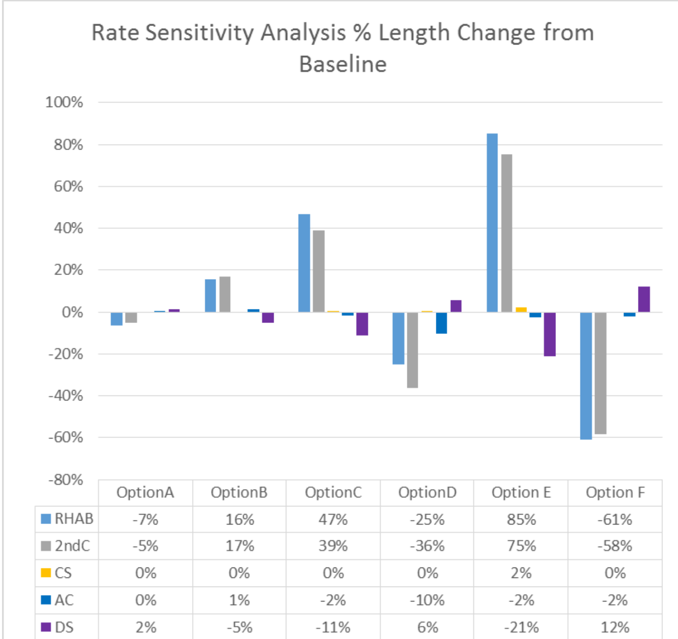


- Model Rates currently sit at or very near median Region rates. We are confident they provide an accurate representation and are not over or under inflated.
- RHAB quantities are most impacted by rate fluctuations. Chipseal quantities are almost exclusively unaffected by rate fluctuations.
- The range of relative cost of RHAB to Chipseal is quite high across the regions and it is noted that this does impact on the selection of optimal strategies.

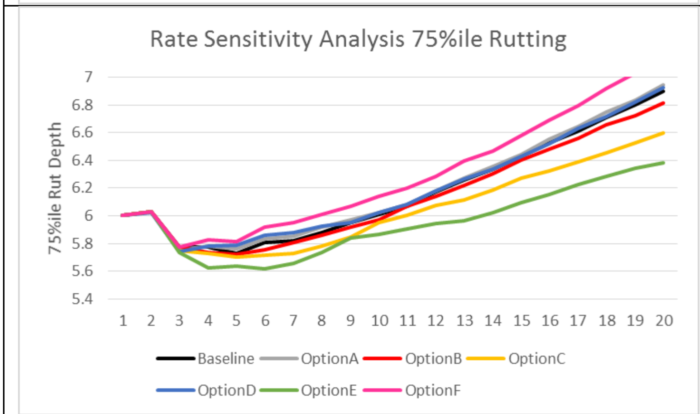
Supporting Outputs

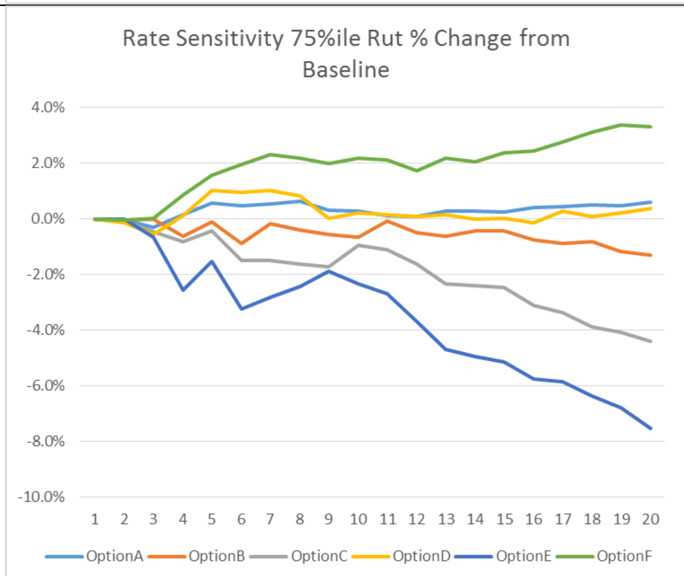


	OptionA	OptionB	OptionC	OptionD	Option E	Option F
RHAB	1%	32%	1%	-43%	31%	-55%
RM	1%	-1%	-4%	1%	-8%	1%
2ndC	0%	0%	0%	0%	0%	0%
CS	0%	-5%	0%	31%	-3%	31%
AC	0%	-20%	-3%	15%	-24%	27%
PRESEAL	0%	-1%	-3%	1%	-5%	4%
DS	0%	0%	0%	0%	0%	0%



	OptionA	OptionB	OptionC	OptionD	Option E	Option F
RHAB	-7%	16%	47%	-25%	85%	-61%
2ndC	-5%	17%	39%	-36%	75%	-58%
CS	0%	0%	0%	0%	2%	0%
AC	0%	1%	-2%	-10%	-2%	-2%
DS	2%	-5%	-11%	6%	-21%	12%





Cost Rates Summary

Three different sets of rates have been used in this analysis.

1. **Economic Rates:** These are the costs used to calculate the net present cost to be used in optimisation. Ie. These costs are used in the trade off process of selecting the most optimal strategies. All surfacing economic costs are the same, ensuring that all sections with the same asset preservation need (taking classification into account) will be weighted equally.
2. **Financial Rates (Model):** These are the costs used to draw down from the fixed budgets during optimisation. These costs accurately reflect treatment type but national average values are used.

3. **Regional Rates (Reporting):** These rates are applied during reporting to each selected strategy to calculate the ‘actual’ investment required. These are region specific rates.

The following table shows the net impact of the Regional Rates vs the Financial Rates (National Rates) when applied to the $100M fixed investment scenario (20 yr average figures). Overall, moving to regional rates has reduced the investment slightly (approximately 2% reduction). All final reporting is done with Regional Rates.

Treatment	**Regional Rates ($M)**	**National Rates ($M)**	**% Change**
RHAB	29.10	31.74	-8.3%
AC	28.39	29.49	-3.7%
RSEAL	37.50	35.78	4.8%
RENEWAL	**94.99**	**97.01**	-2.1%
RTNE	22.30	22.30	0.0%
PSEAL	12.35	12.35	0.0%
ROUTINE	**34.65**	**34.65**	0.0%

Cost Rates Appendix

Economic Rates ($/m2)

FGroup	Desc	EcoAC	EcoCS	EcoRHAB_AC	EcoRHAB_CS
1	Secondary Col_R	4.74	4.74	29.14	29.14
2	Primary Col_R	4.74	4.74	29.14	29.14
3	Arterial_R	4.74	4.74	29.14	29.14
4	Regional_R	4.74	4.74	29.14	29.14
5	National_R	4.74	4.74	29.14	29.14
6	National HV_R	4.74	4.74	29.14	29.14
7	Secondary Col_U	28.28	4.74	76.68	29.14
8	Primary Col_U	28.28	4.74	76.68	29.14
9	Arterial_U	28.28	4.74	76.68	29.14
10	Regional_U	28.28	4.74	76.68	29.14
11	National_U	28.28	4.74	76.68	29.14
12	National HV_U	28.28	4.74	76.68	29.14

Financial Rates ($/m2)

FGroup	Desc	AC_Surf	CS_Surf	RHAB_CS	RHAB_AC_SAC	RHAB_AC_Gran
1	Secondary Col_R	28.28	4.74	29.14	52.68	52.68
2	Primary Col_R	28.28	4.74	29.14	52.68	52.68
3	Arterial_R	28.28	4.74	29.14	52.68	52.68
4	Regional_R	28.28	4.74	29.14	52.68	52.68
5	National_R	28.6	4.74	32.34	55.88	55.88
6	National HV_R	28.6	4.74	32.34	55.88	55.88
7	Secondary Col_U	28.28	4.74	29.14	76.68	52.68
8	Primary Col_U	28.28	4.74	29.14	76.68	52.68
9	Arterial_U	28.28	4.74	29.14	76.68	52.68
10	Regional_U	28.28	4.74	29.14	76.68	52.68
11	National_U	28.6	4.74	32.34	79.88	55.88
12	National HV_U	28.6	4.74	32.34	79.88	55.88

Regional Rates and Relative Cost ($/m2)

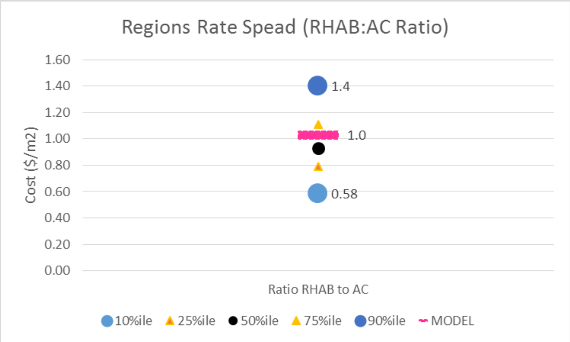
Region	**RHAB**	**CS_Surf**	**AC_Surf**	**Ratio RHAB to Chipseal**	**Ratio RHAB to AC**
(EC) MARLBOROUGH	20	5	50	6.36	1.40
(EC) WEST WAIKATO SOUTH	25	4.5	22.5	7.00	1.40
(NOC) BOP EAST	20	4.5	25	6.11	0.92
(NOC) BOP WEST	32.5	6.75	35	7.33	1.10
(NOC) CENTRAL WAIKATO	32.5	4.5	22.5	5.56	1.11
(NOC) EAST WAIKATO	27.5	4.5	30	4.81	0.93
(NOC) MANAWATU-WHANGANUI	30	5	37.5	4.44	0.80
(NOC) NORTHLAND	35	5.5	25	7.22	1.44

(NOC) SOUTH CANTERBURY	20	6	27.5	5.20	0.93
(NOC) TAIRAWHITI ROADS NORTHERN	32.5	6.25	35	6.84	0.93
(NOC) TAIRAWHITI ROADS WESTERN	32.5	4.75	35	3.68	0.64
(NOC) TARANAKI	20	5	35	4.00	0.57
(NOC) WELLINGTON	50	6.25	22.5	6.00	0.80
(NOC) WEST COAST	25	5	45	8.00	2.22
AUCK ALLIANCE	35	5	25	5.00	0.92
COASTAL OTAGO	22.5	4.75	22.5	4.00	0.40
MILFORD	25	4.75	22.5	5.00	0.56
NAPIER	17.5	4.75	27.5	5.50	0.79
NELSON	27.5	5.5	30	3.33	0.73
NTH CANTERBURY	27.5	5	35	5.26	1.11
OTAGO CENTRAL	25	4.75	22.5	4.74	1.00
SOUTHLAND	25	4.75	22.5	5.26	1.11
WEST WAIKATO NORTH	27.5	3.75	25	5.26	1.11
MODEL RATES	**28.3**	**4.8**	**29.1**	**6.1**	**1.0**

Summary Stats on Regional Rates and Relative Cost ($/m2)

Area/Region	AC	CHIP	RHAB	Ratio RHAB to Chipseal	Ratio RHAB to AC
10%ile	22.5	4.5	20	4	0.6
25%ile	22.5	4.75	23.75	4.8	0.8
50%ile	27.5	5	27.5	5.3	0.9
75%ile	35	5.25	32.5	6.2	1.1
90%ile	37	6.2	34.5	7.2	1.4
MODEL	28.3	4.8	29.1	6.1	1.0

Graph showing RHAB to AC ratio – indicating insignificant variation across the country.



Appendix I: Sensitivity Analysis on Routine Maintenance Cost

Topic: Routine Maintenance Sensitivity

One Pager

Date: 19 February 2016 (Updated 6 April 2016)

Author: Elke Beca

Objective

Provide a summary of the sensitivity analysis performed around the Routine Maintenance Investment in the NLTP Pavement & Surfacing analysis. Four routine maintenance options were investigated using a 10% sample of the full NZ State Highway network dataset including:

- **Option A:** Uncapped routine maintenance budget (traditional)
- **Option B:** Fixed Routine Maintenance and Preseal Repair Investment: Fixed at the sample equivalent to $30M pa investment ($3M pa). *NOTE: Model outcomes are sub-optimal*
- **Option C:** Fixed Routine Maintenance Investment (allowing Preseal repairs to remain unconstrained). Five scenarios tested starting at the sample equivalent to $30M pa investment minus Preseal allocation **(Normal = Baseline)** and testing +/-20% and +/-50%.

50%High	20%High	Normal	20%Low	50%Low
2,700,000	2,160,000	1,800,000	1,440,000	900,000

Note: In years where least cost is higher than the fixed level, the model is provided least cost investment.

- **Option D:** Identical to B but disregarding the model generated Least Cost requirements. *NOTE: Model outcomes are sub-optimal*

Summary Findings

The 'current' Routine Maintenance Investment, provided by NZTA is $30M pa (including both routine and preseal repairs). This has been used in the modelling and benchmark for this sensitivity analysis.

- ***The routine maintenance investment is sensitive to the Renewal Investment level. At $100M renewal investment, the 'balance' is good over 7-10 year horizon. Beyond 7-10yrs, renewal investment is insufficient and increasing routine by up to 50% begins to have an impact.***
- ***Routine Maintenance is not sensitive to changes in the first 7-10 under the 2016 Recommended Investment level of $100M.***
- ***This setup is sensitive to changes up to 50% above the 'current' routine maintenance investment of $30M when renewal investment is insufficient, which begins to occur around 7-10 years.***
- ***This setup is not sensitive to changes up to 50% below the 'current' routine maintenance investment of $30M.***
- When routine maintenance is fixed at 'current' levels, traditional optimisation is not possible due to insufficient funds being available in every year.

- When the model is allowed to perform sub-optimal optimisation (neither renewals nor routine maintenance budget are adhered to), the total cost over the analysis period increases. In this scenario, the routine maintenance reduces slightly, RHAB increases significantly, PRESEAL decreases slightly.
- When fixed at 50% above ‘current’, the routine maintenance budget:
    - Matches Least Cost for 7-10 at levels below $30M equivalent
    - Only just exceeds Least Cost between years 7 – 15
    - Matches Least cost between years 15 – 20 where least cost exceeds $30M equivalent.
- Rutting outcomes are better on the sub-optimal options (B and D) due to higher RHAB quantities.

Option A

This is the option used to run Scenario A V1 over the full network. A control run was completed to determine the output when the routine maintenance budget is left unconstrained.

Option B

The routine maintenance budget is made up of two components: Routine and Preseal Repairs.

Findings demonstrated:

- Traditional optimisation was not possible due to insufficient funds (allowable funds lower than least cost). This was overcome by allowing routine maintenance budget to borrow money from the renewal budgets.
- The Preseal component of the budget was sacrificed when the budget was constrained, essentially disallowing reseals (because there were insufficient funds to complete preseal repairs. This resulted in an increase in RHAB, a decrease in RSEAL and a rapid deterioration in condition profiles.

Note: It is presumed the 2013 analysis took the approach above, thus resulting in extreme condition profiles, high RHAB and low RSEAL quantities.

The solution taken by team was to split the Routine and Preseal budgets and only constrain the Routine part of the budget.

Option C

This is the option used to run Scenario A V2 over the full network. The Routine Maintenance and Preseal budgets are split in the model with only the Routine Maintenance being fixed. Sensitivity analysis looked at plus and minus 20% and 50% of the sample equivalent of a $30M budget, minus the preseal repair amount (equivalent to $12M).

Findings demonstrated:

- 20yr avg routine maintenance dropped by approx. 40% compared to Option A (unconstrained). Preseal repairs unaffected.
- The 'current' level of routine maintenance is just sufficient (in most years) to meet least cost, therefore, all scenarios below 'current' are identical. This is because the fixed budgets must be increased most years to meet Least Cost.
- Increasing routine maintenance by 50% (and leaving unconstrained) results in a decrease in RHAB quantity of around 10%. It is suggested the 'tail end' of the condition distribution can be treated with routine maintenance under these scenarios rather than relying on pavement renewal.

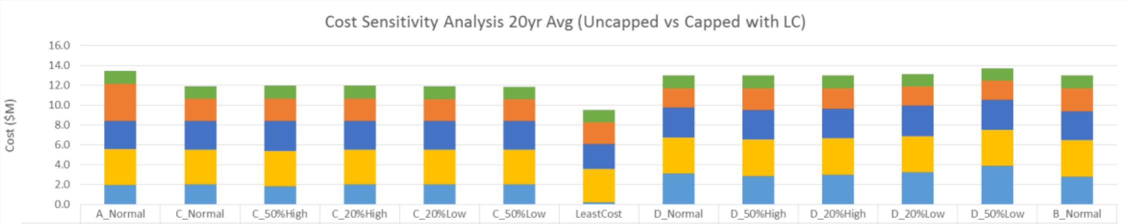
Option D

The Routine Maintenance and Preseal budgets are split in the model with only the Routine Maintenance being fixed. The budgets are NOT increased to meet Least Cost. Sensitivity analysis looked at plus and minus 20% and 50% of the sample equivalent of a $30M budget, minus the preseal repair amount (equivalent to $12M)

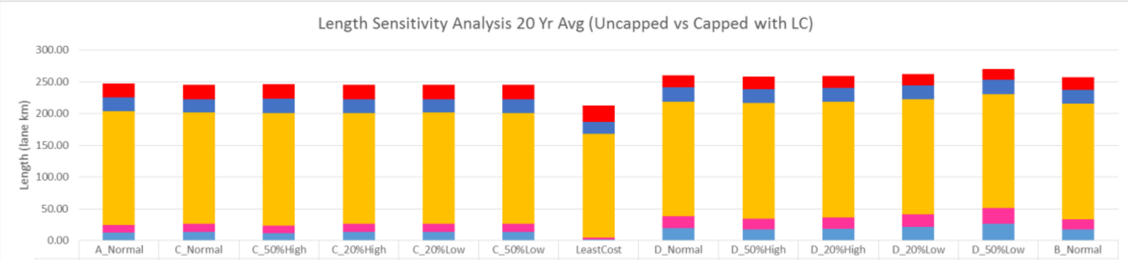
Findings demonstrated:

- 20yr avg routine maintenance dropped by 40% to 47% compared to Option A (unconstrained). Preseal repairs unaffected.
- All scenarios (+/-20% and +/-50%) result in near identical outputs. This is because the fixed budgets must be increased most years to meet Least Cost. This means, it is cheaper overall to spend more on

Supporting Outputs

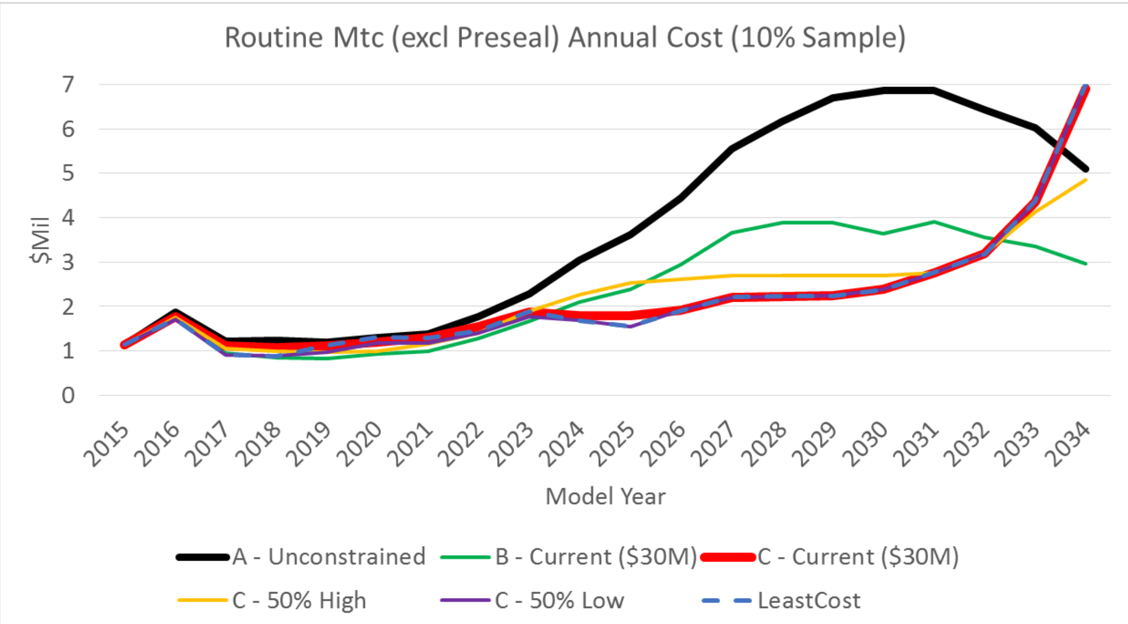


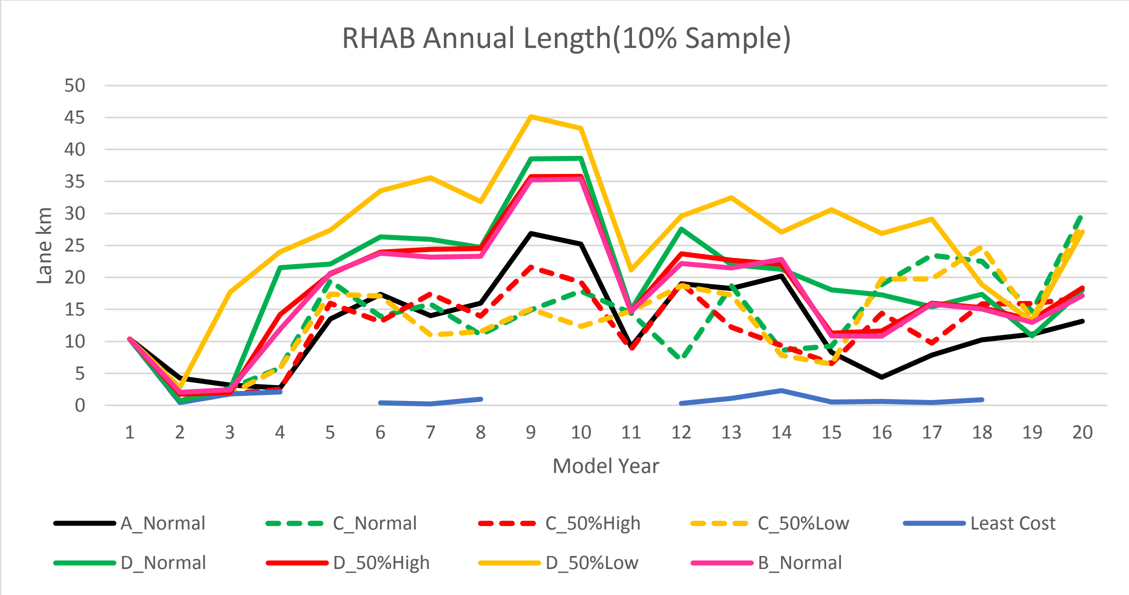
	A_Normal	C_Normal	C_50%High	C_20%High	C_20%Low	C_50%Low	LeastCost	D_Normal	D_50%High	D_20%High	D_20%Low	D_50%Low	B_Normal
PRESEAL	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.2	1.2	1.3
RM	3.7	2.2	2.2	2.2	2.2	2.1	2.2	2.0	2.2	2.1	2.0	1.9	2.3
DS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AC	2.9	2.9	3.1	2.9	2.9	2.9	2.5	3.0	2.9	2.9	3.0	3.0	2.9
CS	3.6	3.5	3.6	3.5	3.5	3.5	3.3	3.6	3.7	3.7	3.6	3.6	3.7
2ndC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RHAB	2.0	2.0	1.8	2.0	2.0	2.0	0.2	3.1	2.9	3.0	3.3	3.9	2.8



	A_Normal	C_Normal	C_50%High	C_20%High	C_20%Low	C_50%Low	LeastCost	D_Normal	D_50%High	D_20%High	D_20%Low	D_50%Low	B_Normal
DS	22.03	22.53	22.98	22.87	22.49	22.55	25.83	18.74	19.86	19.32	17.65	16.34	19.71
AC	21.52	21.48	22.65	21.57	21.47	21.52	18.59	22.26	21.98	21.96	22.51	22.57	21.80
CS	178.78	174.19	176.50	173.56	174.09	174.33	163.78	180.63	181.51	181.83	180.00	179.08	181.55
2ndC	12.08	13.06	11.90	12.95	13.15	12.85	2.84	18.34	16.69	17.42	20.37	25.32	16.26
RHAB	12.76	14.00	12.26	14.06	13.97	13.71	1.59	19.71	18.10	18.89	21.56	26.39	17.60

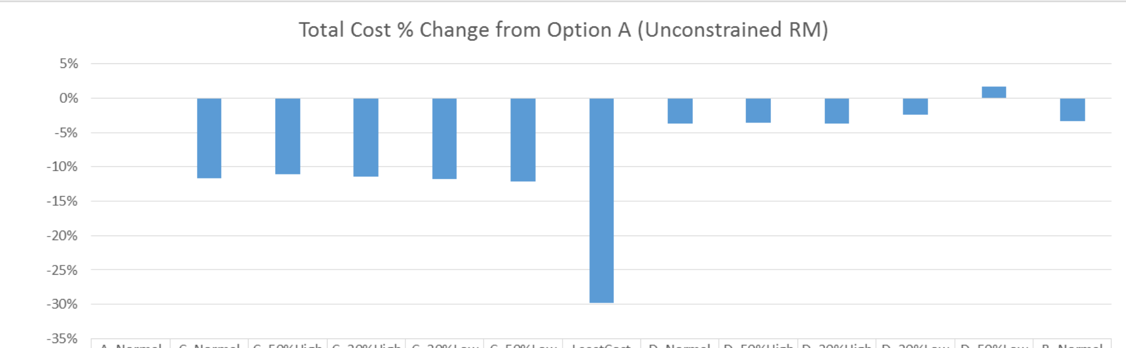
RHAB 2ndC CS AC DS



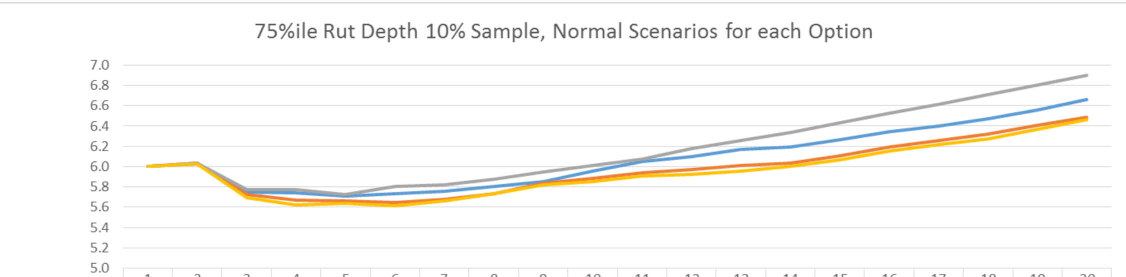


Cost: % Change from Option A (Uncapped RM Budget)													
Treatment	A_Normal	C_Normal	C_50%High	C_20%High	C_20%Low	C_50%Low	LeastCost	D_Normal	D_50%High	D_20%High	D_20%Low	D_50%Low	B_Normal
RHAB	0.0	3%	-7%	3%	3%	3%	-88%	59%	48%	55%	67%	100%	44%
RM	0.0	-41%	-40%	-40%	-41%	-43%	-42%	-47%	-40%	-44%	-47%	-48%	-37%
2ndC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
CS	0.0	-2%	-1%	-3%	-2%	-2%	-8%	1%	1%	2%	1%	0%	1%
AC	0.0	1%	6%	1%	1%	1%	-12%	4%	2%	2%	6%	6%	1%
PRESEAL	0.0	-4%	0%	-3%	-4%	-4%	-3%	-4%	-2%	-3%	-5%	-8%	-2%
DS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0

Length: % Change from Option A (Uncapped RM Budget)													
Treatment	A_Normal	C_Normal	C_50%High	C_20%High	C_20%Low	C_50%Low	LeastCost	D_Normal	D_50%High	D_20%High	D_20%Low	D_50%Low	B_Normal
RHAB	0	10%	-4%	10%	9%	7%	-88%	54%	42%	48%	69%	107%	38%
2ndC	0	8%	-2%	7%	9%	6%	-76%	52%	38%	44%	69%	110%	35%
CS	0	-3%	-1%	-3%	-3%	-2%	-8%	1%	2%	2%	1%	0%	2%
AC	0	0%	5%	0%	0%	0%	-14%	3%	2%	2%	5%	5%	1%
DS	0	2%	4%	4%	2%	2%	17%	-15%	-10%	-12%	-20%	-26%	-11%



	A_Normal	C_Normal	C_50%High	C_20%High	C_20%Low	C_50%Low	LeastCost	D_Normal	D_50%High	D_20%High	D_20%Low	D_50%Low	B_Normal
Series1	0	-12%	-11%	-11%	-12%	-12%	-30%	-4%	-4%	-4%	-2%	2%	-3%

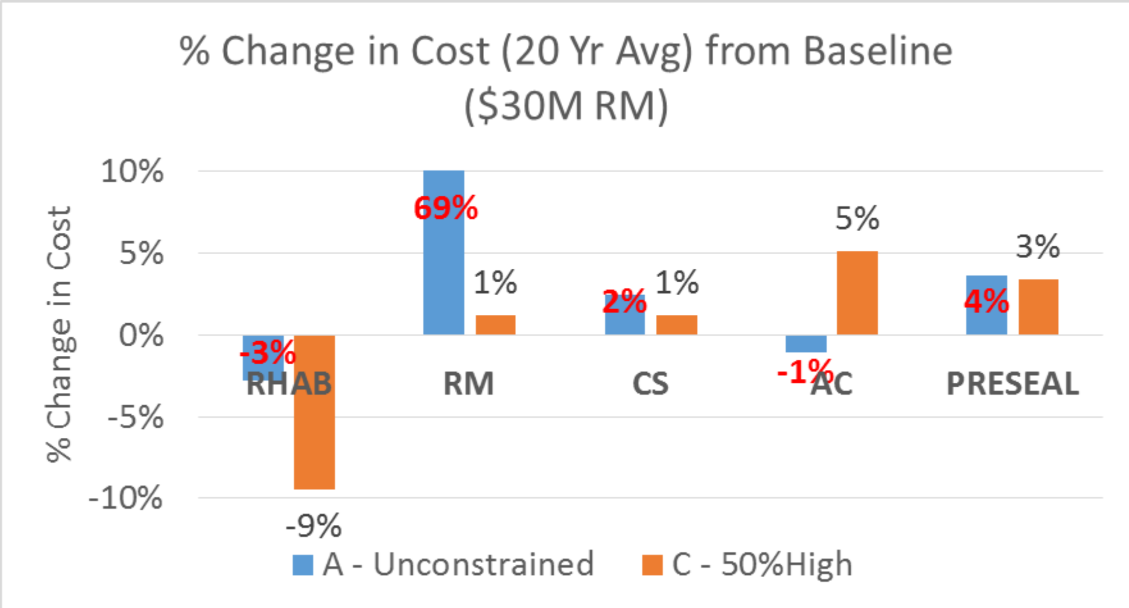


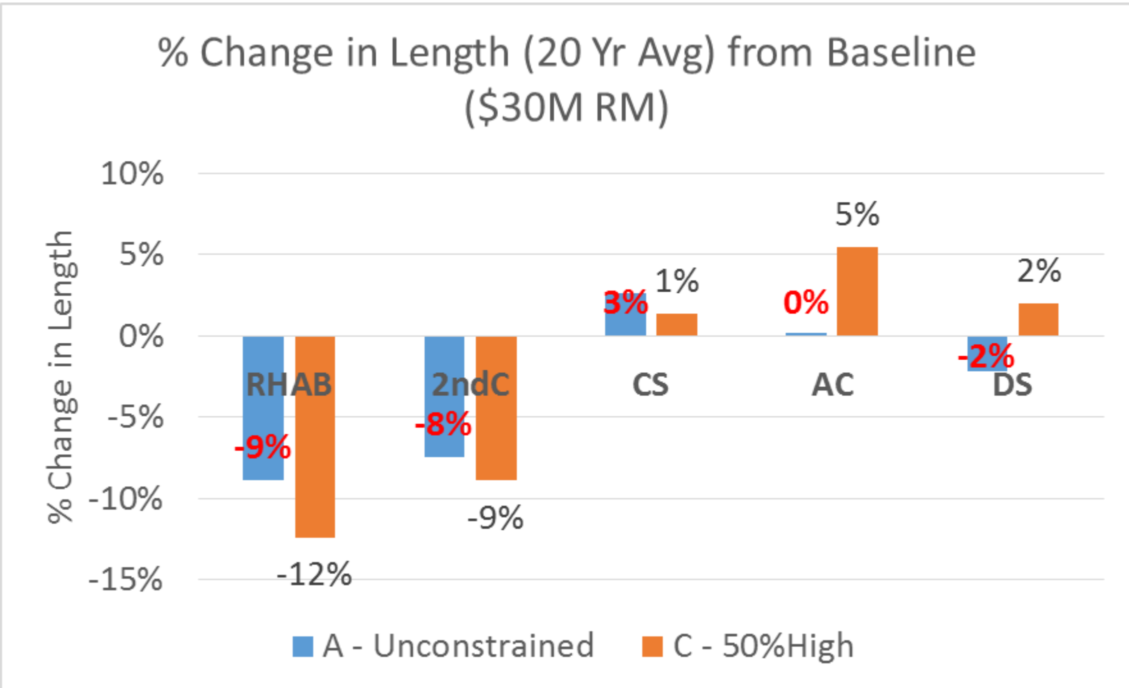
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
OptionA	6.00	6.03	5.75	5.74	5.71	5.73	5.76	5.80	5.85	5.96	6.05	6.10	6.17	6.19	6.27	6.34	6.40	6.47	6.56	6.66
OptionB	6.00	6.03	5.73	5.67	5.67	5.64	5.68	5.74	5.84	5.88	5.94	5.97	6.01	6.03	6.11	6.19	6.26	6.32	6.41	6.49
OptionC	6.00	6.03	5.77	5.77	5.73	5.80	5.82	5.88	5.95	6.01	6.07	6.17	6.26	6.33	6.43	6.53	6.61	6.71	6.80	6.90
OptionD	6.00	6.03	5.69	5.62	5.64	5.62	5.66	5.74	5.82	5.85	5.91	5.92	5.96	6.00	6.06	6.16	6.21	6.28	6.37	6.46

The following table and charts assess the % change in length and cost comparing all options with the Current equivalent C - $30M option.

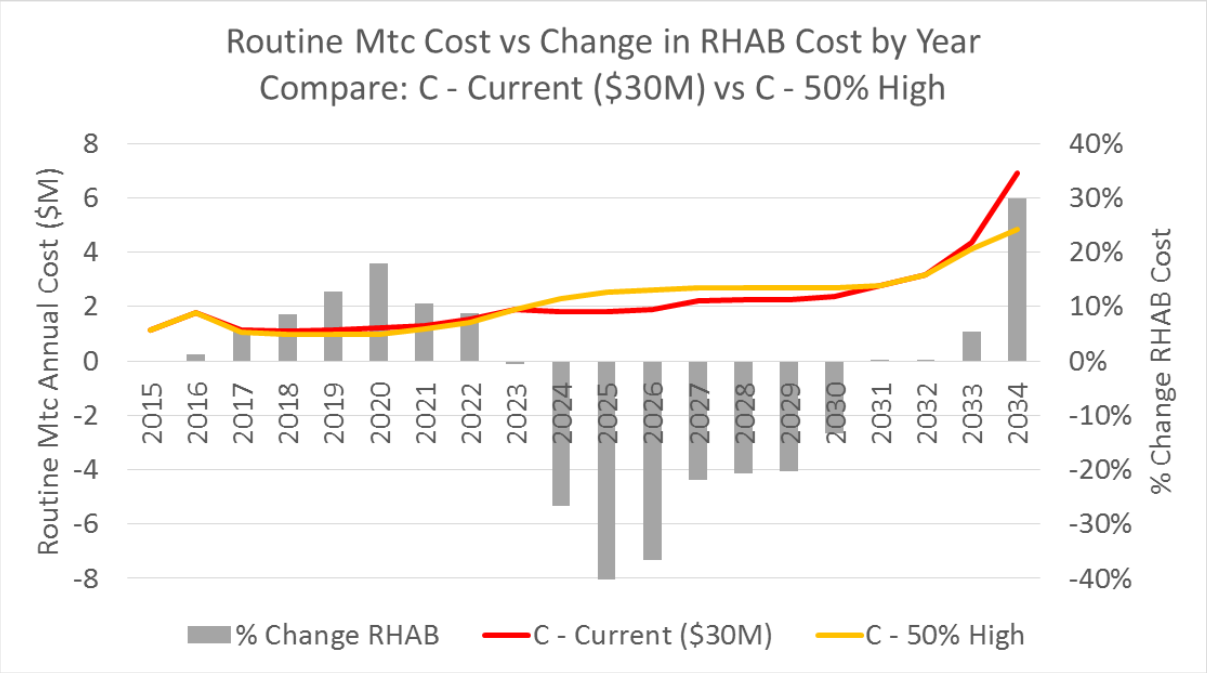
Length: % Change from Option C (Current Budget)													
Treatment	A - Unconstrain	C_Normal	C - 50%High	C_20%High	C_20%Low	C_50%Low	LeastCost	D_Normal	D_50%High	D_20%High	D_20%Low	D_50%Low	B_Normal
RHAB	-9%	0%	-12%	0%	0%	-2%	-89%	41%	29%	35%	54%	88%	26%
2ndC	-8%	0%	-9%	-1%	1%	-2%	-78%	40%	28%	33%	56%	94%	24%
CS	3%	0%	1%	0%	0%	0%	-6%	4%	4%	4%	3%	3%	4%
AC	0%	0%	5%	0%	0%	0%	-13%	4%	2%	2%	5%	5%	2%
DS	-2%	0%	2%	2%	0%	0%	15%	-17%	-12%	-14%	-22%	-27%	-13%

Cost: % Change from Option A (Current Budget)													
Treatment	A_Normal	C_Normal	C_50%High	C_20%High	C_20%Low	C_50%Low	LeastCost	D_Normal	D_50%High	D_20%High	D_20%Low	D_50%Low	B_Normal
RHAB	-3%	0%	-9%	0%	0%	0%	-88%	55%	44%	50%	62%	94%	40%
RM	69%	0%	1%	1%	-1%	-3%	-1%	-11%	1%	-6%	-11%	-12%	6%
CS	2%	0%	1%	0%	0%	0%	-6%	3%	4%	4%	3%	2%	4%
AC	-1%	0%	5%	0%	0%	0%	-13%	3%	1%	1%	4%	5%	0%
PRESEAL	4%	0%	3%	0%	0%	-1%	0%	0%	1%	1%	-1%	-5%	1%

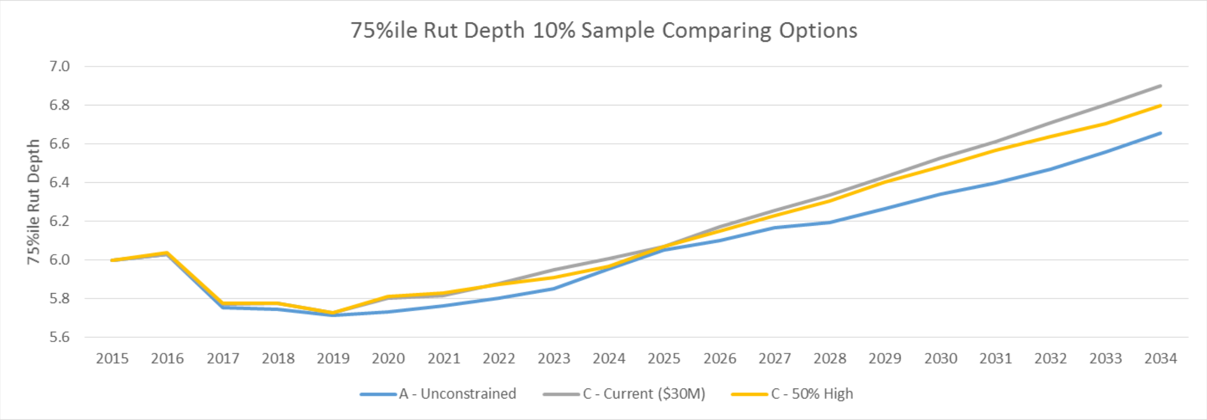




Between 9 and 15 years the 50% increase in Routine Maintenance has an impact when Renewal Investment is constrained. RHAB are brought forward and the total quantity of RHAB reduces by 10% compared to the ‘Current’ scenario.



When RM investment is increased by 50% the condition outcomes slightly improve compared to the ‘current’ $30M investment.



Appendix J: Calibration of Forecasting Models

Topic: Roughness – Current, Model, Calibration, Retrospective Analysis

One Pager

Date: 21 March 2016

Author: Elke Beca

Objective

Provide an overview of the key variable: Roughness

Roughness is no longer viewed as a key indicator of pavement deterioration, however, it is one of the more important customer measures, reported as ride comfort and has been included in this analysis.

Summary

The selected roughness model performs very well. The retrospective analysis results suggest that up to 10% of the treatment lengths may have roughness over-predicted by 1 NAASRA per year, balanced by 15% of treatment lengths which under predict by 1 NAASRA per year. Over 75% of the treatment lengths demonstrate prediction accuracy after 5 years **within** the +/-1 NAASRA per year window.

Prediction Model

Over the past 4 years, IDS have migrated from the HDM4 roughness model (which significantly over predicted) to the interim Jooste Model, which is a calibrated, linear progression model based on pavement age, and finally to the Cenek model, a calibrated progression model based on loading and strength.

The Cenek model was developed in the early 90's, as part of research study[1] which provides capability to fully calibrate at treatment length level, offering an improved roughness projection. The model was slightly modified to align with the existing traffic loading code within the IDS Roading template. Cenek Model B has been adopted.

A summary of each model form is provided (selected model in red box).

Jooste Model:

New IRI = current_IRI + 0.004 + Pave_Age * 0.046/ CriticalPaveAge

Where:

pave age (yrs) = round((today-layer_date)/365,0) and CriticalPaveAge=60

Cenek Model A: Original Formula

New IRI = Previous IRI + (m*Previous Model IRI+ ((0.2175*(1.0+ SNP)^-4.99)*EDA*(1.0+m)))*EXP(m)

Where:

[1] Central Laboratories Report 91-29301 "Prediction of Road Roughness Progression" by P.D.Cenek and J.E. Patrick, February 1991.

M = Environmental constant to be calculated as per $m = \frac{\left\{\left(\frac{IRI_2}{IRI_1}\right) - 1\right\}}{t}$

$$\text{EDA/lane/day} = 0.7x\ [\text{AADT/Total no. of lanes}]\ x\ [\%\text{HCV}/100] \quad (2.6)$$

And

where AADT = average annual daily traffic volume
%HCV = percent heavy vehicles

Cenek Model B: Modified to use Existing dTIMS Traffic Coding

New IRI = Previous IRI + (m*Previous Model IRI+ ((0.2175*(1.0+ SNP)^-4.99)*ESA*(1.0+m)))*EXP(m)

Where:

M = Environmental constant to be calculated as per $m = \frac{\left\{\left(\frac{IRI_2}{IRI_1}\right) - 1\right\}}{t}$

And

ESA = (AADT_MCV * 0.35 + AADT_HCV1 * 0.83 + AADT_HCV2 * 1.86 + AADT_Bus * 0.5) / tl_lanes

Where: AADT_XXX = pc_XXX/100*traffic_adt_est

Calibration

Cenek Model B includes a calibration (Environmental) factor 'm'. This value was determined for each TL based on the formula $m = \frac{\left\{\left(\frac{IRI_2}{IRI_1}\right) - 1\right\}}{t}$ and provided as a dTIMS model input. Due to the inclusion of loading (a growth variable), the roughness progression is not linear. The following charts show the actual observed annual roughness progression compared to the model generated annual roughness progression in the first year (2015) as a box and whisker illustration. The actual rate of progression is taken as a 5 year average slope (or since the last pavement renewal).

NOTE: Approximately 40% of treatment lengths currently demonstrate a negative rate of roughness progression eg. they are getting smoother, as shown by the negative bars in the actual chart.

Retrospective Analysis

To test the predictive accuracy of each model, the clock was 'rolled back' 5 years. 2010 data was plugged into the model as starting value. The model was then run forward and the 2015 results compared with actual 2015 values. Note, all 3 model options were tested to compare performance.

Method

- Unload 5 years roughness data (summarised to Treatment Length level) from RAMM. This unload includes the other variables required with exception of SNP which is supplied separately

- Assign SNP to each TL
- Calculate m for Cenek Models (single value for each TL based on first 2 years)
- Calculate the predicted IRI for each model over the 5 years (or since last pavement renewal whichever later) for each TL.
- Plot the results of 3 models and actual 2015 (Dec 2014).

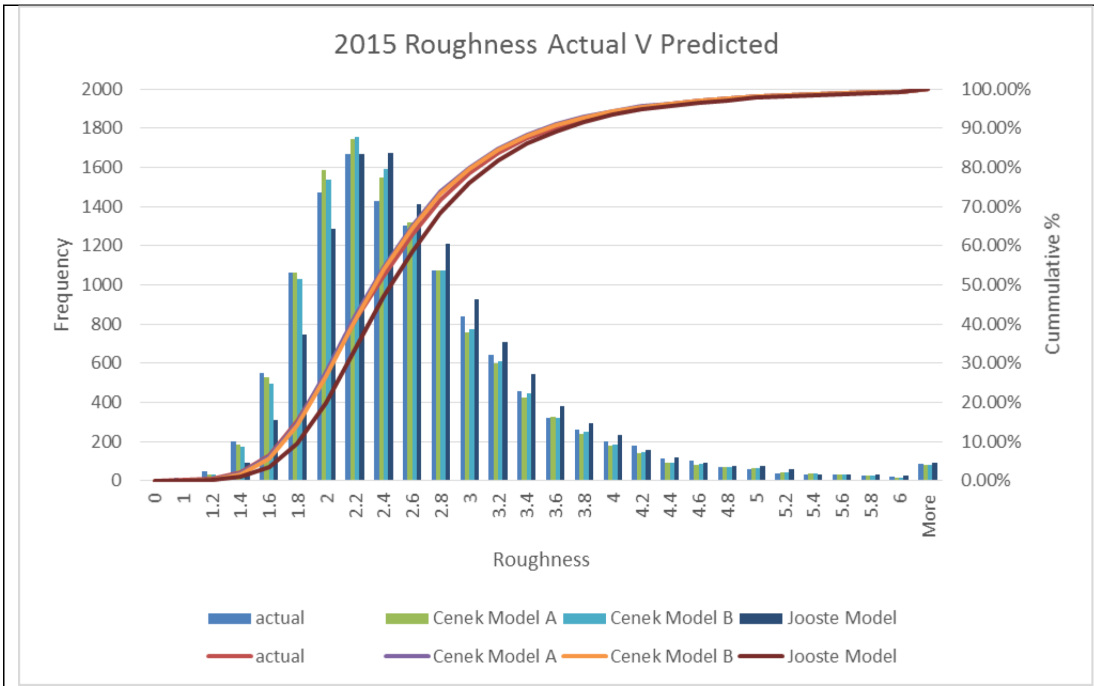
Outputs

Both Cenek Models perform similarly, therefore, Model B will be used which reduces the amount of recoding required in the IDS template.

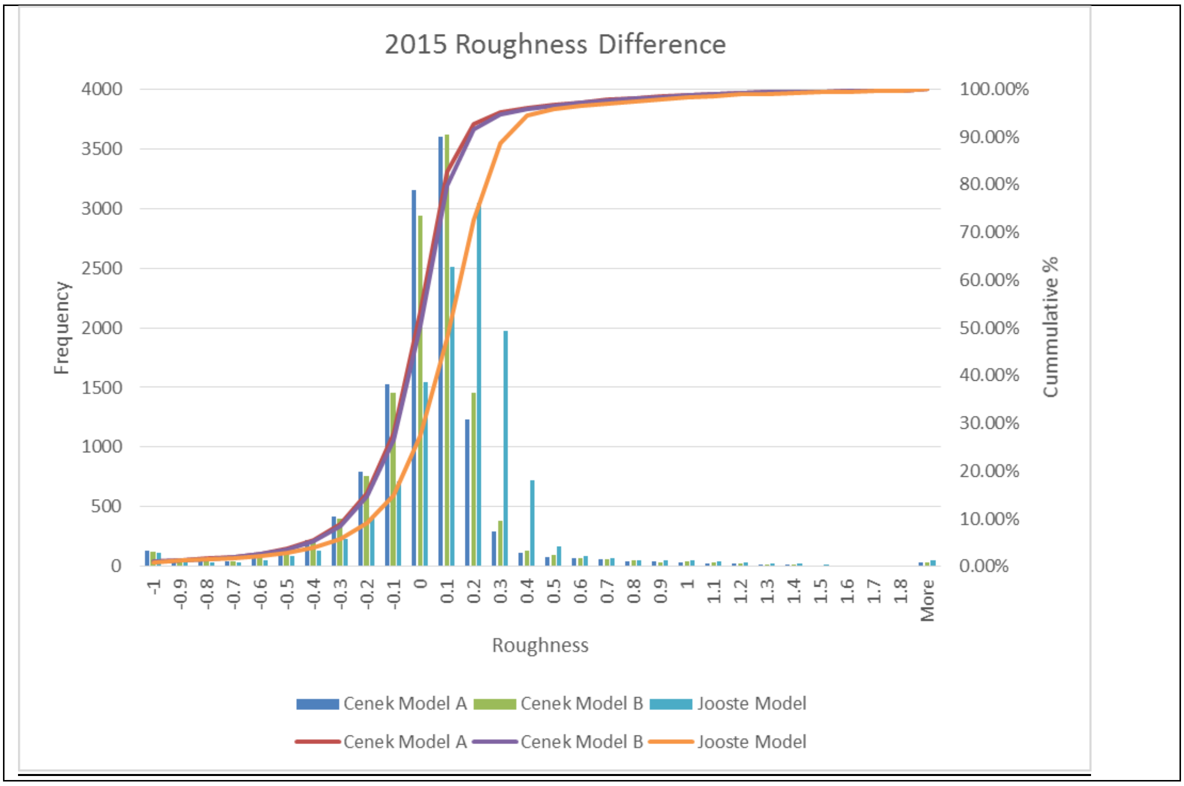
The following table shows the predicted % changes from actual after 5 years

Model	<-0.2IRI	<-0.1IRI	>0.1IRI	>0.2IRI	Comment
Cenek	14.5%	25%	20%	8.5%	Symmetric, slightly under predicting
Jooste	9%	15%	52%	27.5%	Shift to Right

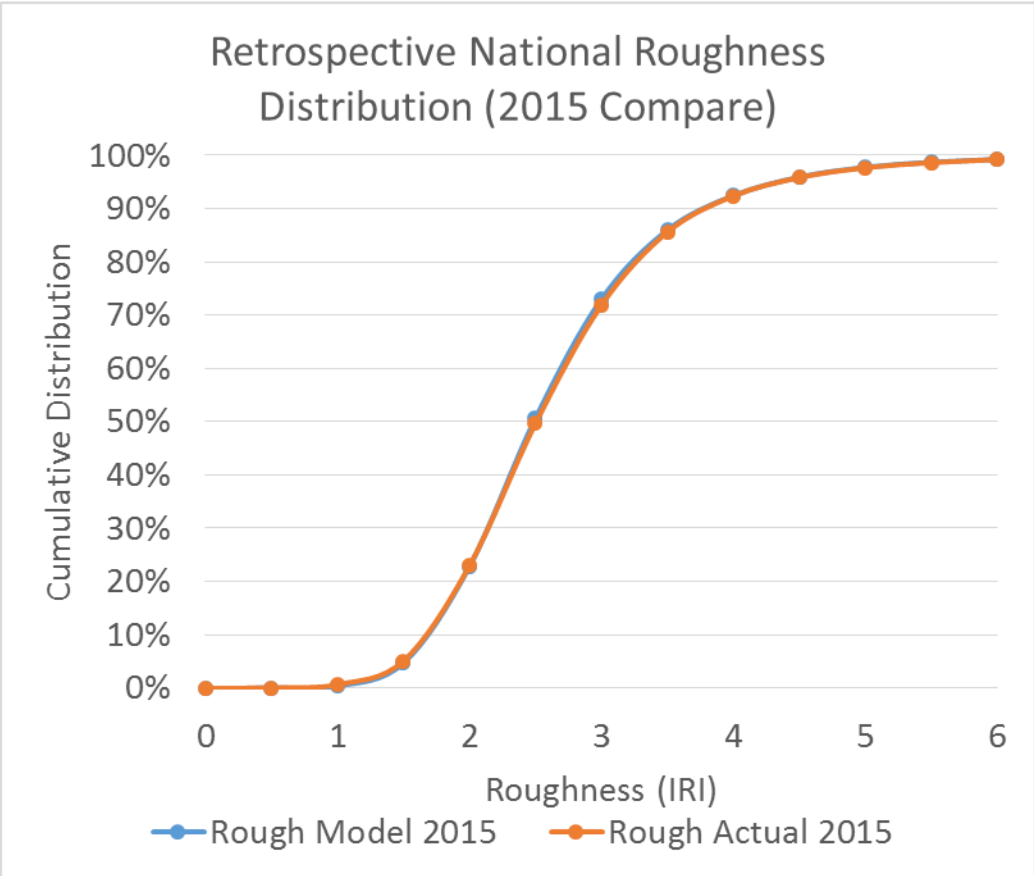
This analysis using the Cenek Model suggest that after 5 years, it is expected <10% of the predicted roughness values will be more than 0.2IRI (~5 NAASRA) over predicted, balanced by <15% which will be under predicted by the same amount.

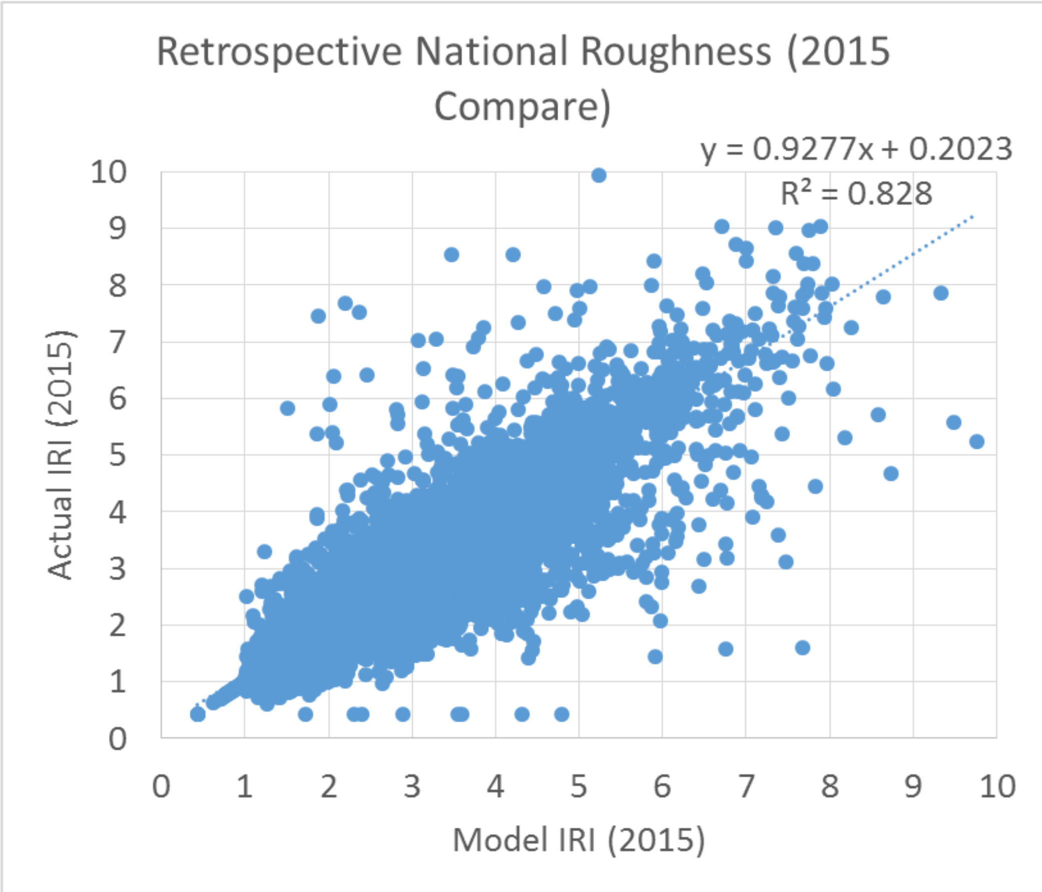


The Jooste Model is over predicting roughness, shown by the shift to right compared to actual and Cenek models. The Cenek models show near symmetrical deviation about zero (accurate prediction) with slight under prediction overall.



The following charts show the direct comparison between 2015 predicted and actual values for the selected Model. The first chart shows cumulative distribution which demonstrate accuracy at a network level, the second compares at a treatment length level. Both show excellent alignment.




Retrospective National Roughness (2015 Compare)
y = 0.9277x + 0.2023
R² = 0.828
Actual IRI (2015)
Model IRI (2015)
0
1
2
3
4
5
6
7
8
9
10

Topic: Rutting – Model, Calibration, Retrospective Analysis One Pager

Date: 22 March 2016

Author: Elke Beca

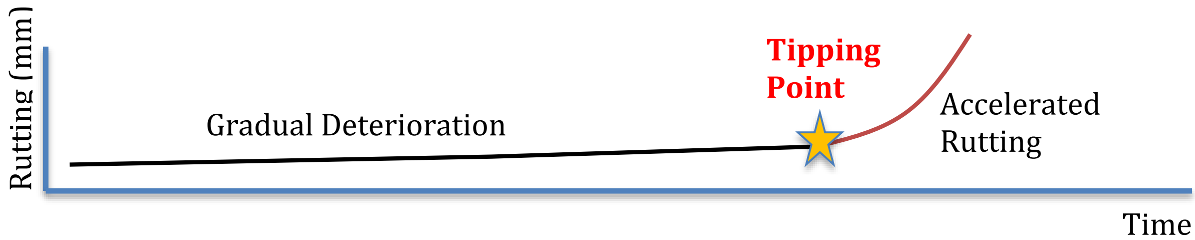
Objective

Provide an overview of the key variable: Rutting

Rutting is a key indicator of pavement deterioration, and in this analysis is the primary variable used to predict pavement deterioration.

Prediction Model

In 2008, a New Zealand specific calibrated model was developed based on LTPP data. The model has two stages, gradual deterioration and accelerated rutting, as shown in the chart below. A probabilistic model was also developed to predict the time of the 'tipping point' when gradual deterioration begins to accelerate.



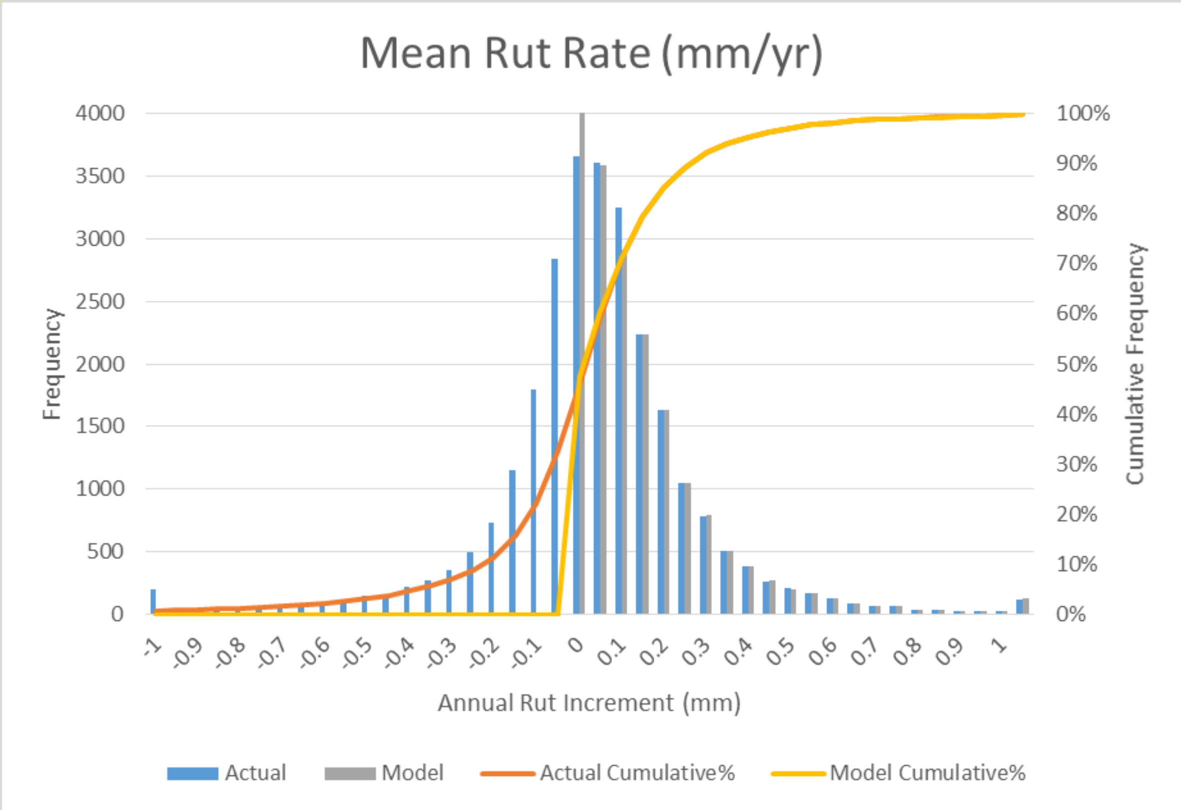
Both progression and probabilistic tipping point models are dependant on pavement strength (SNP) and loading.

Calibration

This model has been calibrated at a treatment length level.

The following charts show the actual observed annual rutting progression compared to the model generated annual rutting progression in the first year (2015) as a cumulative distribution chart. The actual rate of progression is taken as a 5 year average slope (or since the last pavement renewal).

NOTE: Approximately 40% of treatment lengths currently demonstrate a negative rate of rutting progression eg. rutting is reducing, as shown by the bars to the left of 0 in chart. Where actual rut progression is negative, a default calibration resulting in a rate of ~0mm/year has been assigned.



This demonstrates that the model has been calibrated effectively for all sections that are showing deterioration (60% of sections).

Retrospective Analysis

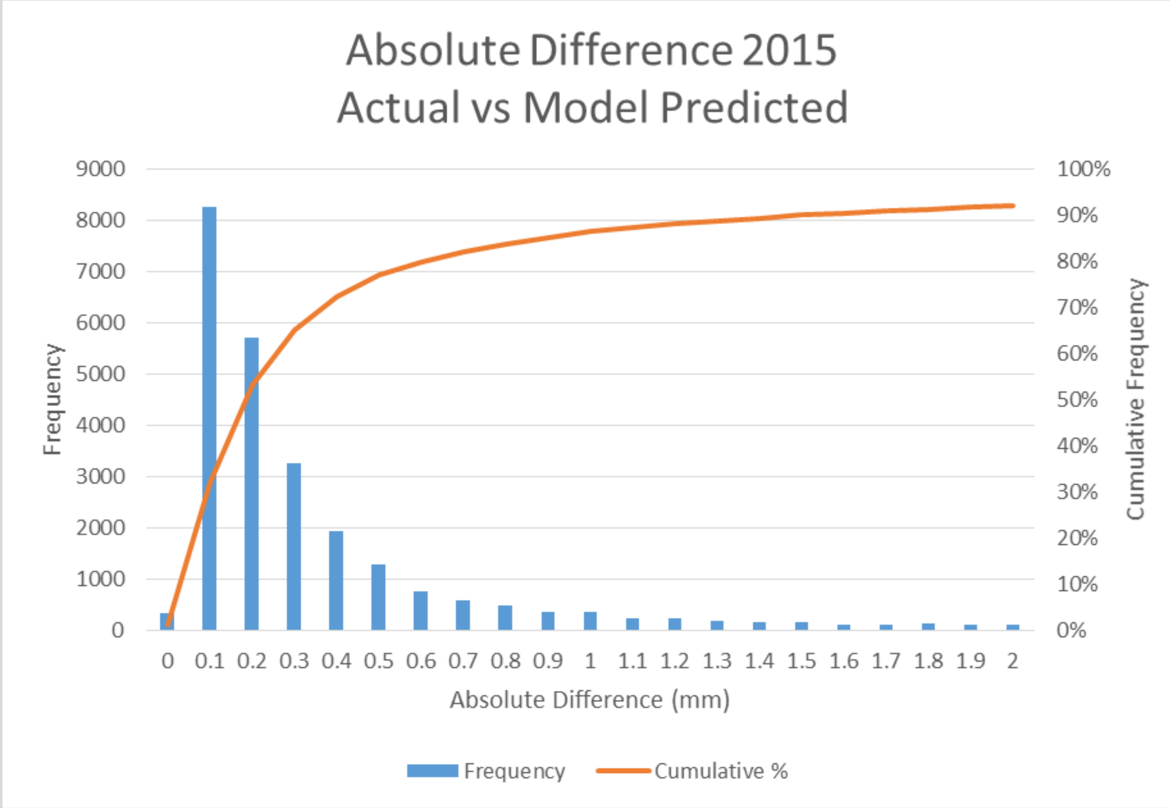
To test the predictive accuracy of each model, the clock was 'rolled back' 5 years. 2010 data was plugged into the model as starting value. The model was then run forward and the 2015 results compared with actual 2015 values.

Method

- Unload 5 years rutting data (summarised to Treatment Length level) from RAMM. This unload includes the other variables required with exception of SNP which is supplied separately
- Assign SNP to each TL
- Calculate CF for rutting model based on rate of progression
- Start at 2010 and calculate the predicted rut mean for each year over the 5 years (or since last pavement renewal whichever later) for each TL.
- Plot the results against actual 2015.

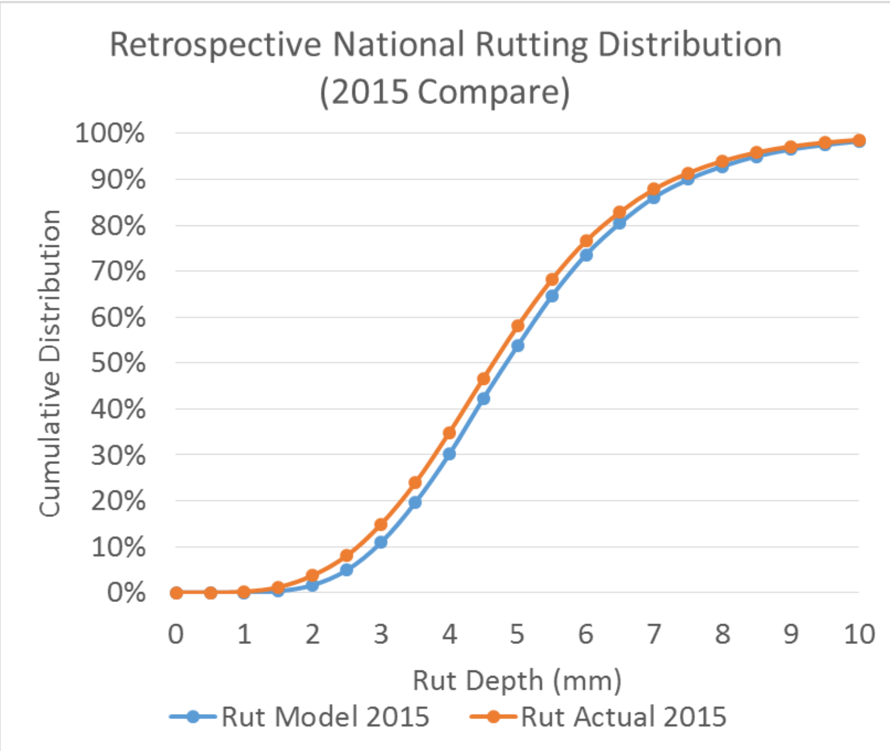
Outputs

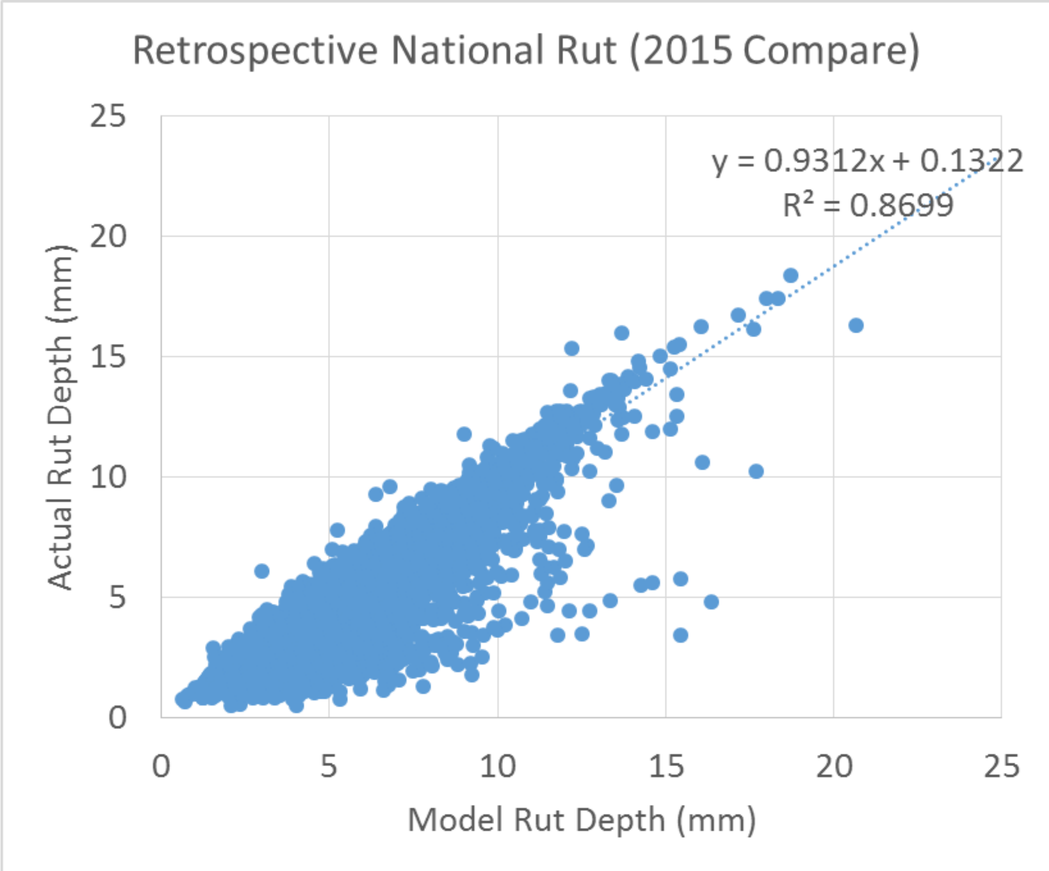
The 5 year retrospective analysis shows the ~10% of treatment lengths will have a 0.2mm error per year (>1mm difference over 5 years). Approximately 60% of the treatment lengths are expected to have an error < 0.05mm per year.



This chart shows the absolute difference between actual and model predicted after 5 years.

The following charts show the direct comparison between 2015 predicted and actual rut mean depth values. The first chart shows cumulative distribution which demonstrate accuracy at a network level, the second compares at a treatment length level. Both show excellent alignment.





Retrospective National Rut (2015 Compare)
y = 0.9312x + 0.1322
R² = 0.8699
Actual Rut Depth (mm)
Model Rut Depth (mm)
0
5
10
15
20
25
0
5
10
15
20
25

Appendix K: Retrospective Analyses on Networks with Given Historical Progamme

Topic: Retrospective Analysis

One Pager

Date: 20 April 2016

Author: Elke Beca

Summary

To assist in understanding "Have we got it right?" an analysis of three sample network sections have been completed, where the full RAMM dataset is rolled back 5 years to test the model logic. The three sample areas include:

- Southland SH1
- Manawatu SH1
- Taranaki SH3

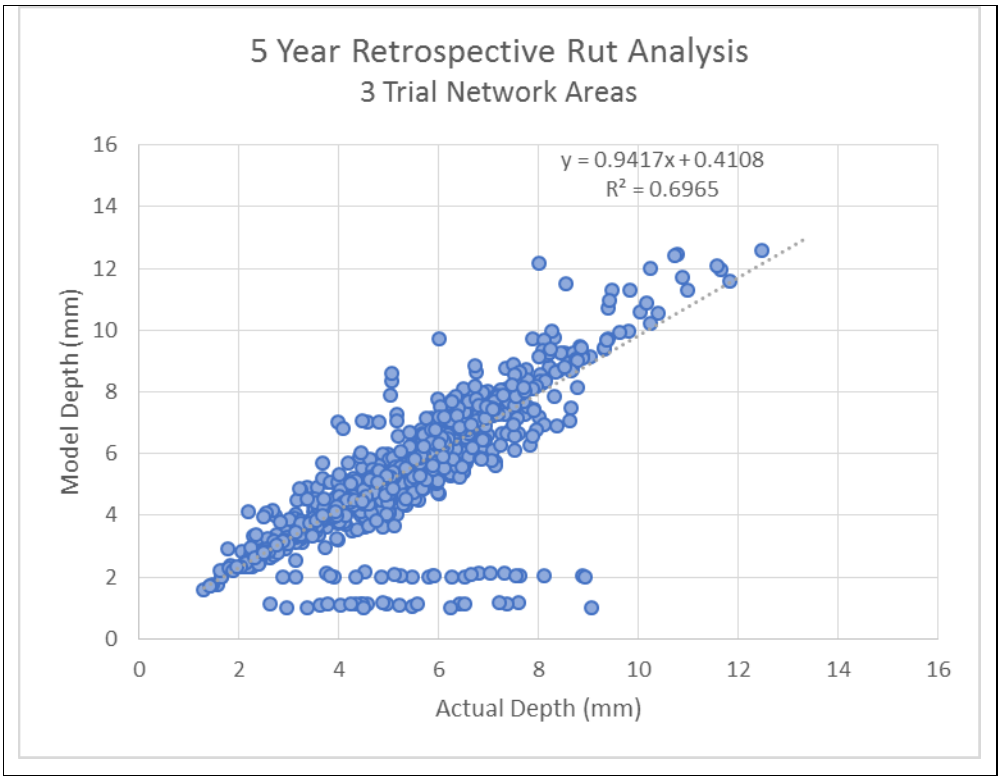
Methodology

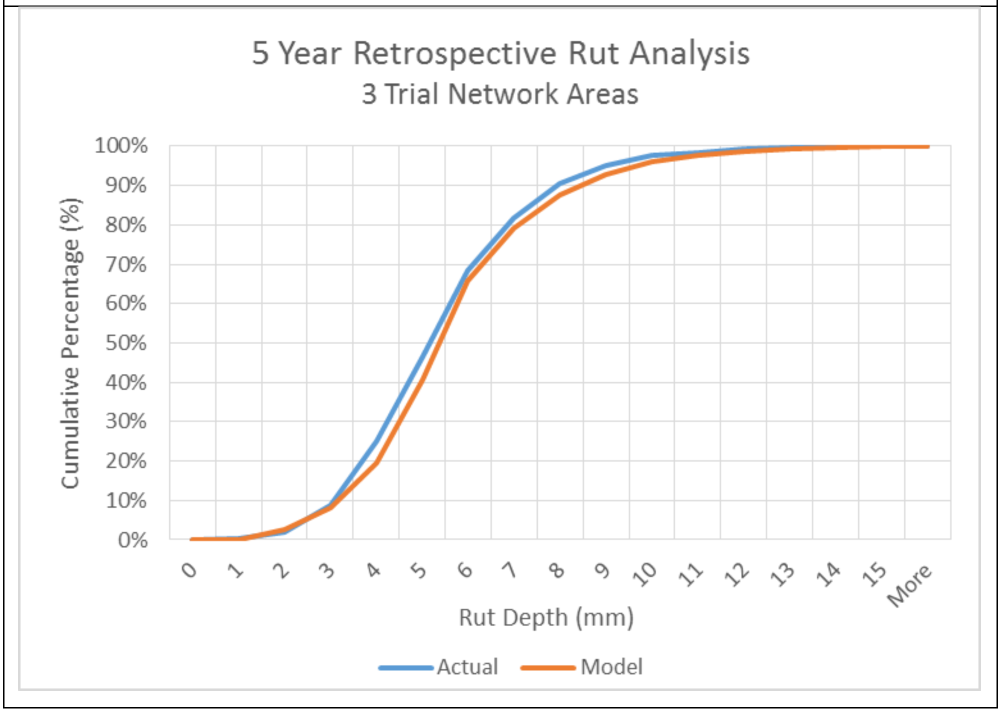
- Extract data from RAMM to re-create the Treatment Length table as at June 2010, with the actual TL segmentation based on 2016 segments.
- Establish the timing of all renewal treatments by TL, which have occurred between June 2010 and Dec 2015. Lock each treatment in as a 'fixed' renewal treatment in the dTIMS model.
- Run the Specified Model in dTIMS. This will model the specified FWP and predict the various condition parameters.
- Extract the Actual Dec 2015 rutting and roughness values from RAMM
- Compare the Actual variables against the Model generated 2015 values both at network level and TL level.

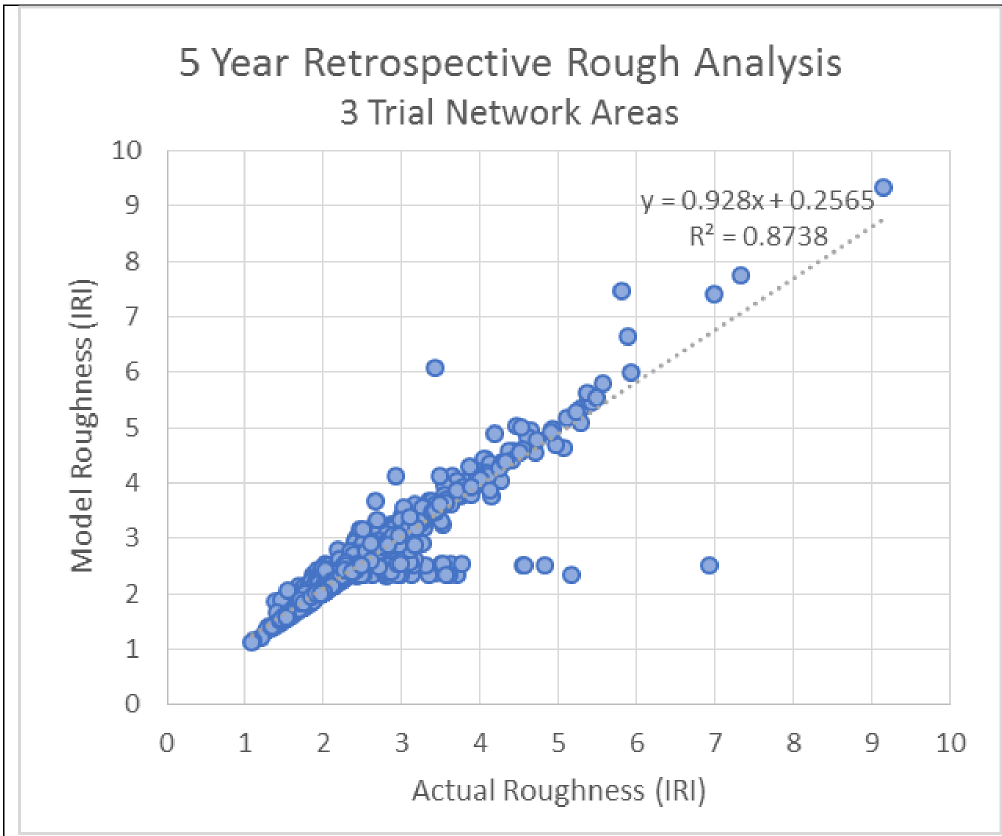
Outcomes

The following charts show the 2015 Model predicted values vs the 2015 Actual values for both rutting and roughness. The first chart shows the project level correlation between the Actual and Model, while the 2nd chart shows the network level alignment.

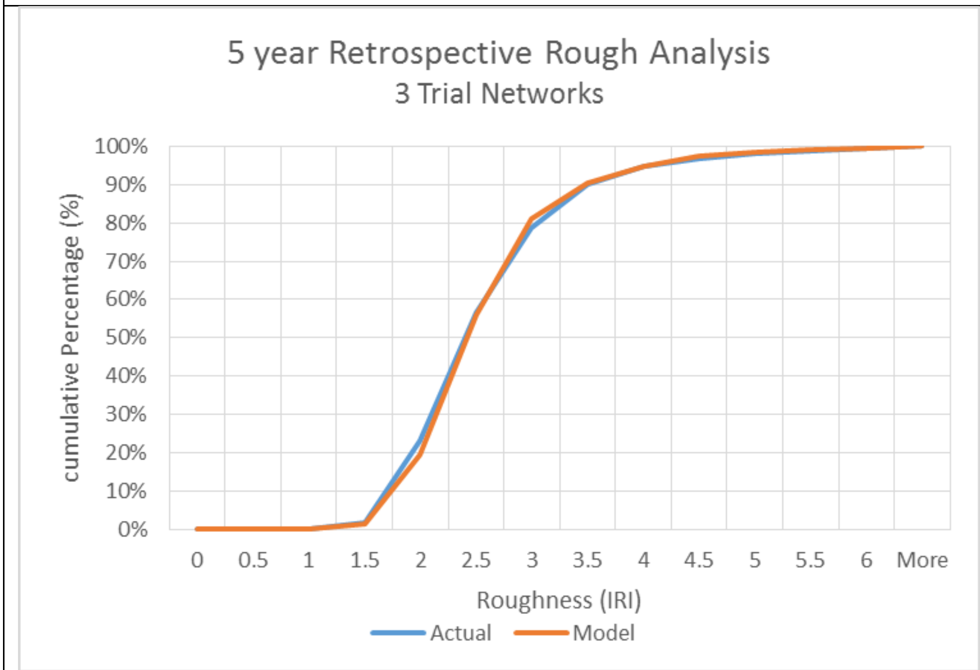
- Project level correlation: R squared values for both condition variables are good for Treatment Length level alignment, with roughness showing slightly higher level of correlation than rutting. The outliers shown as horizontal lines represent the treatment resets. These have raised some concerns given the apparent mis-alignment. The data in this sample suggests that some sites have reset with rutting as bad as 8mm depth following pavement renewal with roughness in order of 3.5IRI (90 NAASRA), whereas the model resets for rutting and roughness are fixed by class (between 1mm and 3mm for rutting and 2.3 and 2.5 IRI for roughness).
- Network level correlation: The charts show excellent correlation for both condition variables, providing significant confidence that network level outputs will be accurate.


5 Year Retrospective Rut Analysis
3 Trial Network Areas
y = 0.9417x + 0.4108
R² = 0.6965
Model Depth (mm)
Actual Depth (mm)
0
2
4
6
8
10
12
14
16


5 Year Retrospective Rut Analysis
3 Trial Network Areas
Cumulative Percentage (%)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 More
Rut Depth (mm)
Actual
Model



5 Year Retrospective Rough Analysis
3 Trial Network Areas
y = 0.928x + 0.2565
R² = 0.8738
Model Roughness (IRI)
Actual Roughness (IRI)
0 1 2 3 4 5 6 7 8 9 10



5 year Retrospective Rough Analysis
3 Trial Networks
cumulative Percentage (%)
100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0%
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 More
Roughness (IRI)
Actual
Model

Appendix L: Comparing the Deterministic Model to the Stochastic Model

Topic: Stochastic Model

One Pager

Date: 21 March 2016 (UPDATED 4 April 2016)

Author: Elke Beca & Evan Ou Yang

Objective

Historically in NZ we have adopted a single view of the pavement performance world. That view has been established through IDS as the NZ IDS dTIMS Roading template. This IDS template is based on deterministic principals and offers a detail perspective of pavement deterioration by looking at each condition variable separately, applying treatments and aggregating to identify the overall investment needed. How do we know it's right?

To test and challenge the outputs from the well-established NZ IDS dTIMS Roading template, a new template, based on probabilistic principals has been developed. This new Stochastic (probabilistic) template offers a different view of the same world.

The objective statement for this development:

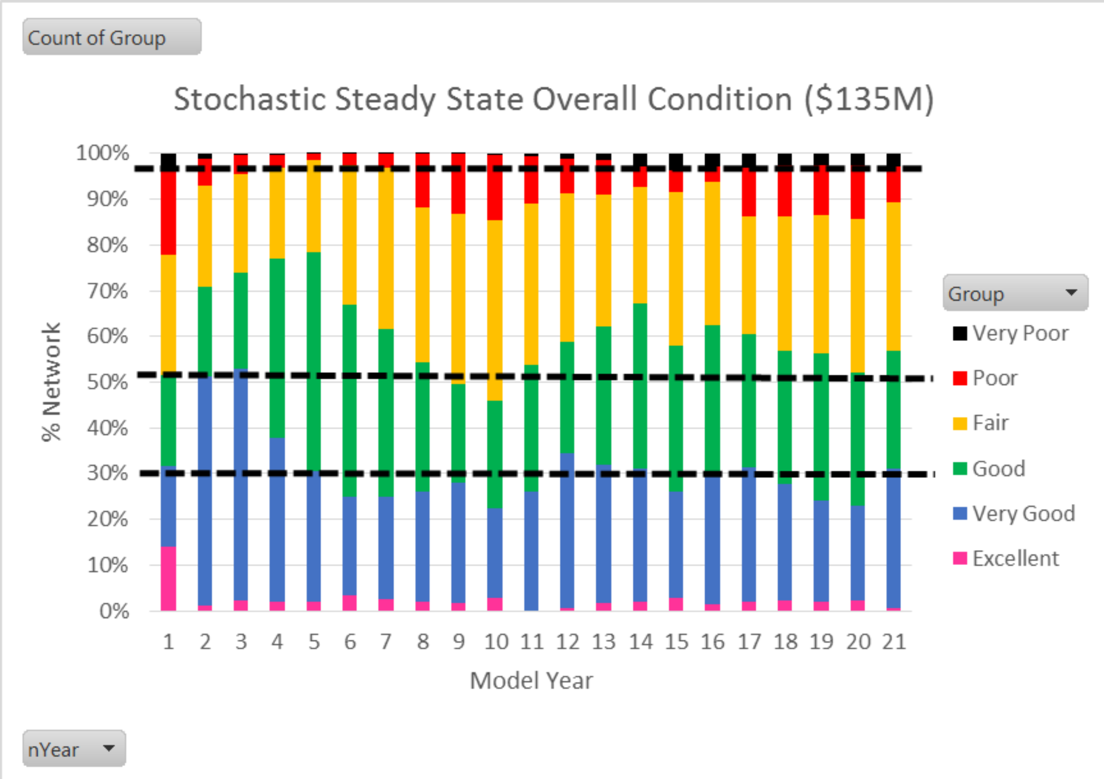
To quantify the **steady state profile** for pavement and surface assets (excluding safety considerations) and corresponding investment, using a stochastic approach. Logic coded into dTIMS enabling parallel analysis from both stochastic and deterministic approaches using identical input data. Analysis outputs will validate or challenge the existing deterministic modelling setup.

Summary Findings

Both the **Deterministic Model** (with Objective Function modified to allow Steady State) and the **Stochastic Model** suggest an **Investment level of between $130M to $140M** will **sustain Steady State condition** on the NZ State Highway network over the mid- long term (20 years).

Both models are indicating similar Investment Levels providing confidence that the Deterministic Model is valid and outcomes are supported.

The steady state investment profile based on the IDS Pavement and Surfacing Stochastic Model is approximated between $130M and $140M. This is the point where the current average condition index is maintained at year 20 (2035). Due to the inherent function of the Markov Chain models, a very definite cycle is apparent.



Template Development and Customisation

<u>Model Logic</u>

The deterioration models (Transition Probability Matrices – TPMs) used in this analysis have been adopted directly from the 2014 NZTA Stochastic Pavement & Surfacing project.

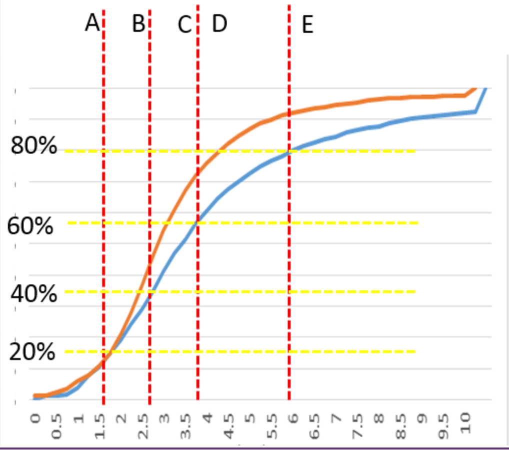
The template has been customised to align with existing NZ logic (as coded in the IDS NZ dTIMS Roading Template). It has incorporated the Transition Probability Matrices (TPM) of two different indices (Surface Index: SI & Pavement Index: PI), each consists four different asset groups based on traffic loading, resulting a total of eight separate TPMs. In summary:

Model 1: Surface Index – Based on *Texture* and *Default Age/Current Age*. Models generated using 5 years of historical texture trend data from RAMM (2010 through 2014) and modified default lives standardised nationally for *Default Age*.

- Asset Groups: Four asset groups (separate models) based on traffic volumes (matched with SH Classification) for chipseal surfaced pavements and a separate group for AC surfaced pavement.
- Condition Bands (A=Excellent, E=Very Poor)

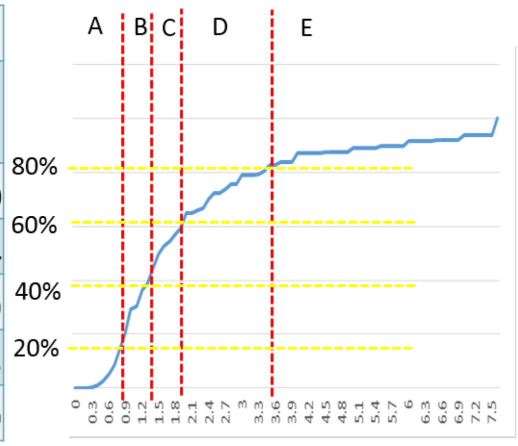
Chipseal Condition Bands

Condition Bands		
Code	Lower (>=)	Upper (<)
A	5.75	20
B	3.75	5.75
C	2.75	3.75
D	1.75	2.75
E	0	1.75

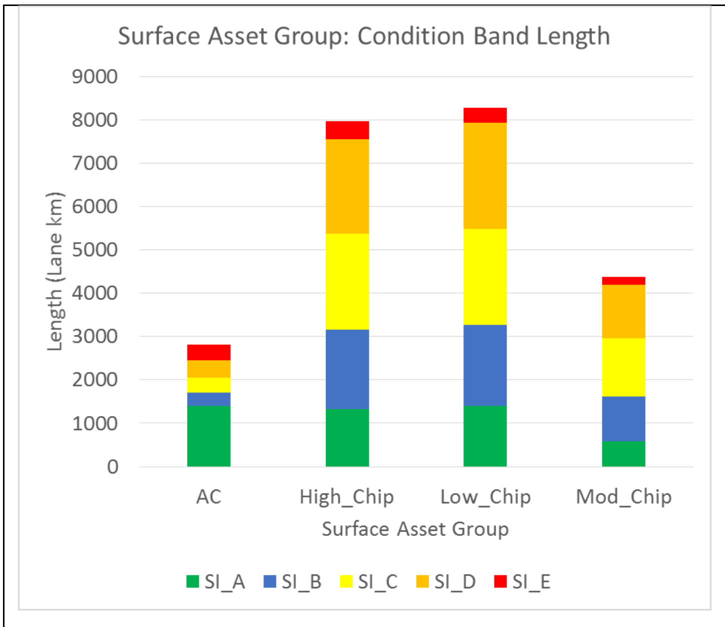


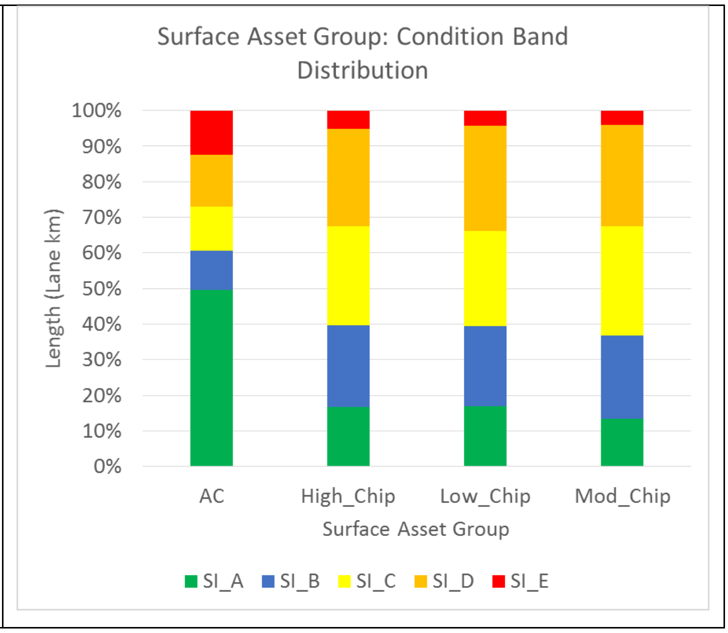
AC Condition Bands

Condition Bands		
Code	Lower (>=)	Upper (<)
A	3.4	20
B	1.9	3.4
C	1.3	1.9
D	0.9	1.3
E	0	0.9



The 2015 distribution of the condition bands by asset groups, based on the modelled data is shown below.

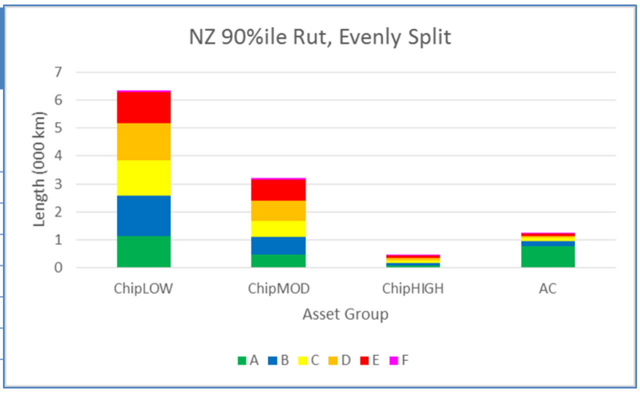




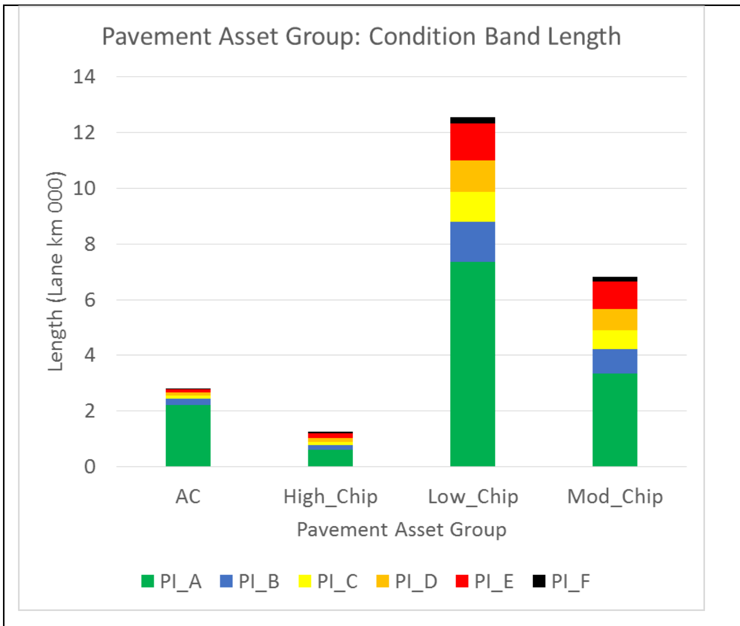
Model 2: Pavement Index – Based on *90th Percentile Rutting*. Models generated using 5 years of historical trend data from RAMM (2010 through 2014).

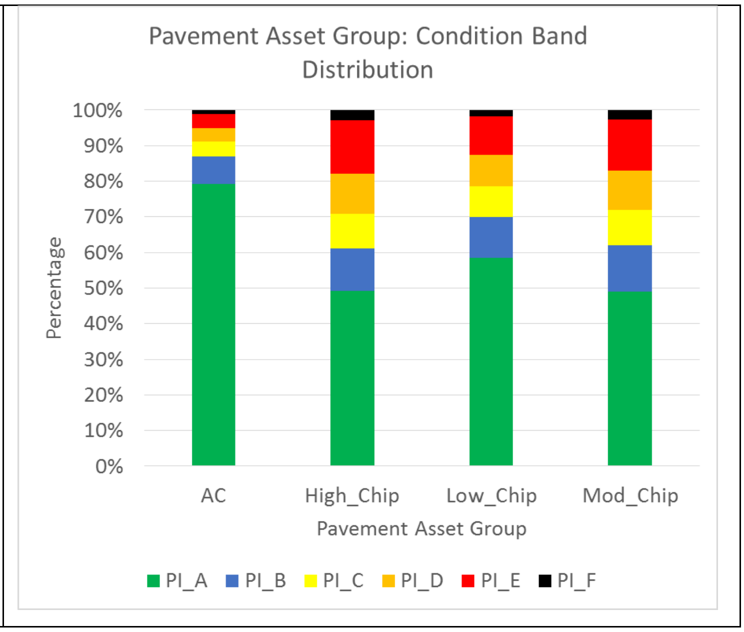
- Asset Groups: Four asset groups (separate models) based on ESA (Equivalent Standard Axles) for chipseal surfaced pavements and a separate group for AC surfaced pavement.
- Condition Bands (A=Excellent, F=Very Poor): Set roughly equally distributed with a single Very Poor band set at 15mm rut depth.

Condition Band	Range of 90%ile Rutting (mm)		Overall SH Network	
	Lower (>=)	Upper (<)	%	km
A	0	4.8	20	2400
B	4.8	6.2	22	2640
C	6.2	7.4	18	2160
D	7.4	9.2	21	2520
E	9.2	15	18	2160
F	15	50	1	120
	Total		100	12000



When regenerated on the 2015 Deterministic Treatment Lengths, the distribution using the same condition bands changed quite significantly. Rather than the even spread established with the original research, approximately 40% to 80% of each asset group is in Condition Band A. The following chart shows the modelled distributions in 2015.





dTIMS Template

The base stochastic template has been coded in dTIMS9.

Treatments

Similar to the existing Roading Template, the stochastic model offers three major treatment options with associated ancillary treatments:

- Chipseal Surface – 3 chipseal asset groups triggered by SI

    - ancCS
- Asphaltic Surface – 1 AC asset group triggered by SI
    - ancAC
- Rehabilitation – 4 asset groups triggered by PI
    - ancCS_RHAB (chipseal rehab)
    - ancAC_RHAB (AC rehab)
- 2nd Coat applied following pavement renewals, 2 years wait time

Treatments draw on a single Budget Category (PROGRAMME)

<u>Treatment Interventions</u>

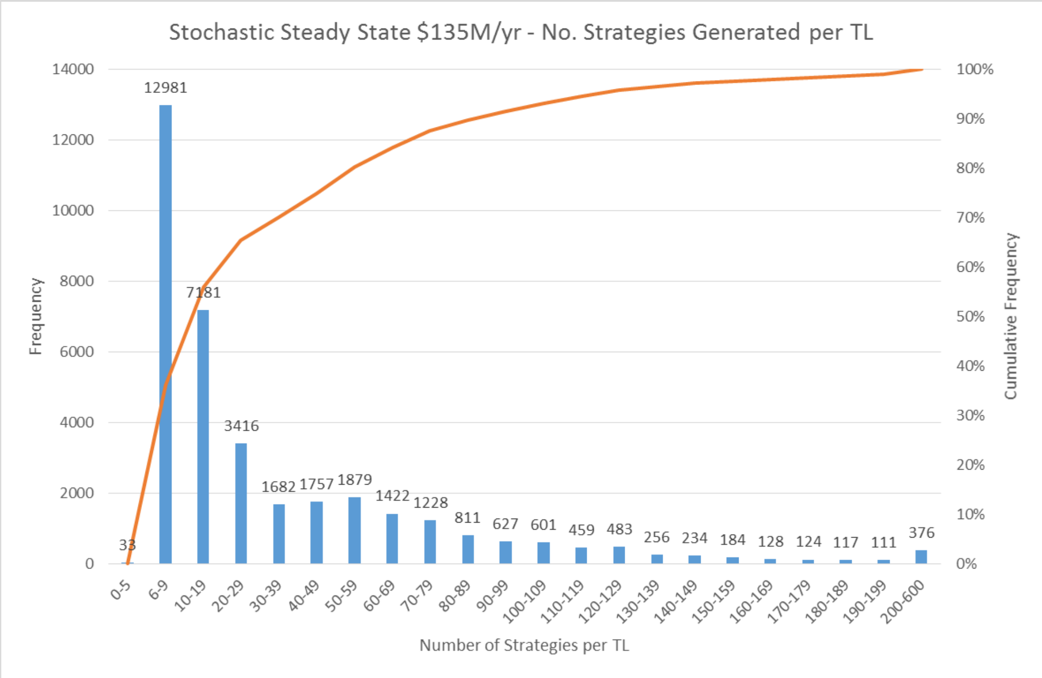
This determines when a treatment length becomes eligible for a treatment based on its condition, they are set based on the indices (PI & SI) as well as different types of treatment applied.

Intervention levels have been set to ensure a suitable number of 'treatment options' are available for each treatment length for the optimisation.

Treatment	Intervention
AC Surfacing	When: • Surface asset group IS 'AC' • Treatment year is great than 'committed year' • SI Condition band D + SI Condition band E > 92%
CS Surfacing	When: • Surface asset group IS NOT 'AC' • Treatment year is great than 'committed year' • SI Condition band D + SI Condition band E > 50%
Rehabilitation	When: • Treatment year is great than 'committed year' • PI Condition band E + PI Condition band F > 43% *Eg. When 43% of treatment length has 90%ile rutting > 9.2mm*

The following chart shows the number of treatment options (or strategies) generated for each treatment length based on these intervention levels.

- Only 33 TLs have 5 or fewer options (we want to minimise the number with < 5 options to ensure Optimisation has ability to work)
- Approximately 55% of the TLs have between 5 and 20 options
- Approximately 20% of the TLs have over 50 options (due to processing time we attempt to minimise the number exceeding this level).



Resets

This sets the condition profile of a treatment length after a treatment is carried out. The reset is configured so everything is set back to 100% Band A.

Treatment Rates

The following rates are utilised for treatments in the model (single national rate). These match the deterministic model rates:

Treatment	**National Rate ($/m^2)**
CS Rehabilitation (ancCS_RHAB)	$29.14
AC Rehabilitation (ancAC_RHAB)	$76.68
AC Surfacing (ancAC)	$28.28
CS Surfacing (ancCS) and 2nd Coat	$4.74

Optimisation

The objective function is to maximise the Overall Condition Index (OCI) for a fixed annual investment. The index has a range 0 – 100 with 0=Very Poor and 100 = Excellent. The selected overall condition index has a weighting of 20% on PI and 80% on SI. The expression of the index is shown below:

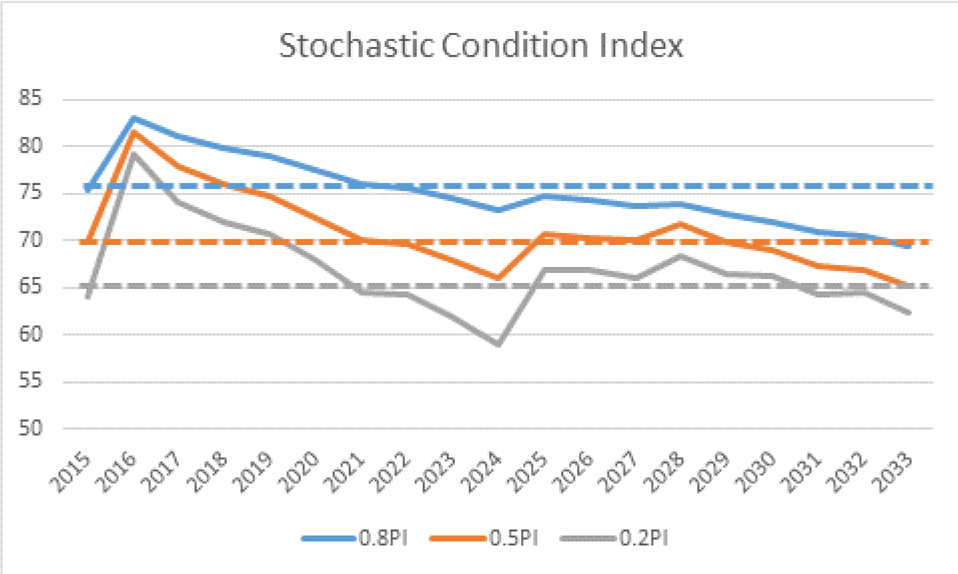
$$OCI = 0.2 * (100.0 * PI\_A + 80.0 * API\_B + 60.0 * PI\_C + 40.0 * PI\_D + 20.0 * PI\_E + 0.0 * PI\_F) +$$

$$0.8 * (100.0 * SI\_A + 75.0 * SI\_B + 50.0 * SI\_C + 25.0 * SI\_D + 0.0 * SI\_E)$$

The weightings within the brackets increase as condition improves, therefore if an entire TL is in condition band F the index = 0

The weighting of SI vs PI in overall condition index has quite a significant impact on model outcomes. The following chart shows the impact on the predicted Overall Condition index with three variations:

- 0.8PI: 80% Pavement / 20% Surface
- 0.5PI: 50% Pavement / 50% Surface and;
- 0.2PI: 20%Pavement / 80% Surface

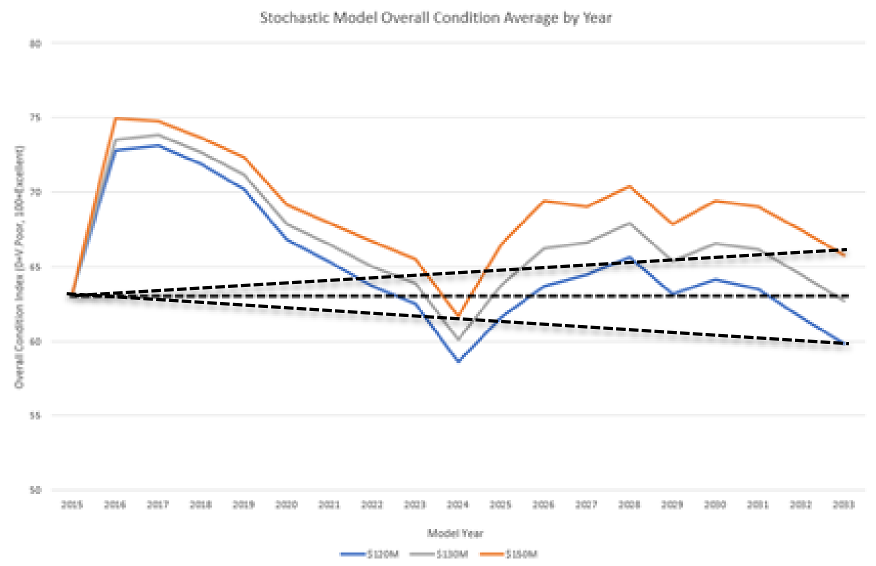


The index of 20%PI and 80%SI has been *'arbitrarily'* selected as this aligns more closely with reality, where surfacing typically accounts for around three quarters of the annual investment and pavement less than one quarter.

Outcome Commentary

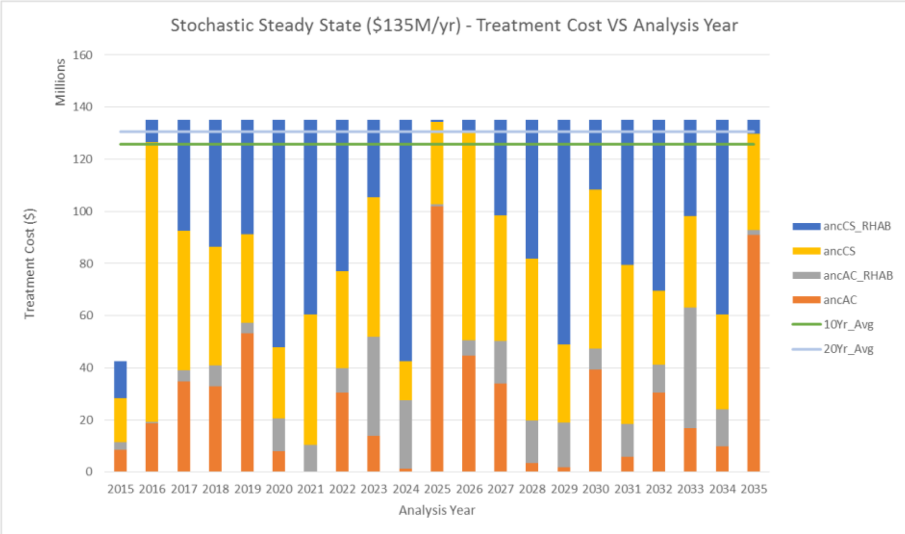
<u>Investment Scenarios</u>

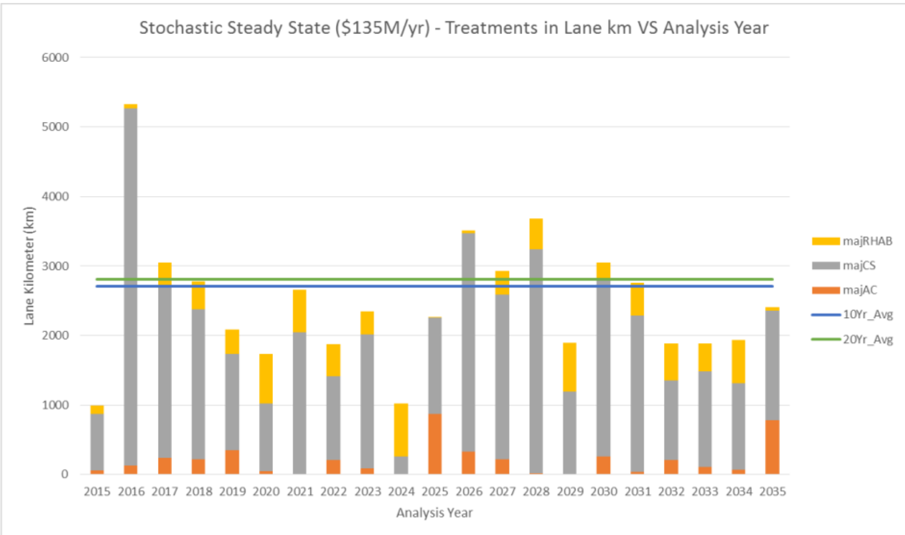
Five investment scenarios, $120M, $130, $135, $140 and $150M, have been tested to identify Steady State. The following chart shows the Overall Condition Index projections based on the $120M, $135M and $150M investment scenarios. An investment level just over $130M is identified as steady state.



Stochastic Steady State ($135M/yr)

The two diagrams below illustrate the length of treatment in lane km and cost versus analysis year. 10yr and 20yr averages are indicated as horizontal lines for each case respectively.





Condition Indices

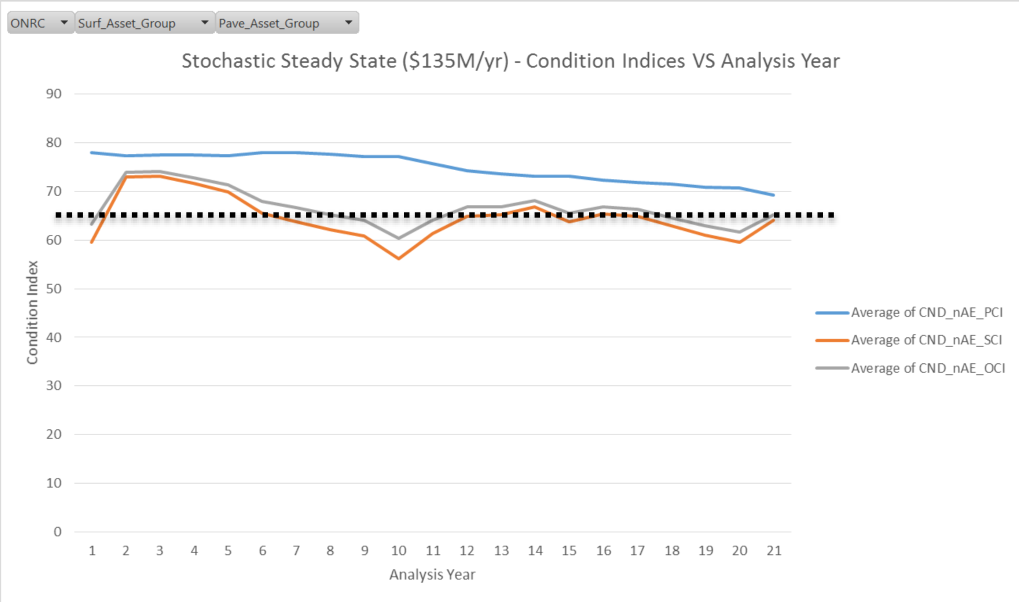
The following set of charts show the performance in terms of Condition Index under the proposed 'Steady State Investment Level' of $135M pa.

- Blue line = Pavement Index (PI)
- Orange line = Surface Index (SI)
- Grey line = Overall Condition Index (OCI)

Steady state is defined as point where the grey line is 'stable' over the mid term (20 years) over the full network (all asset groups combined).

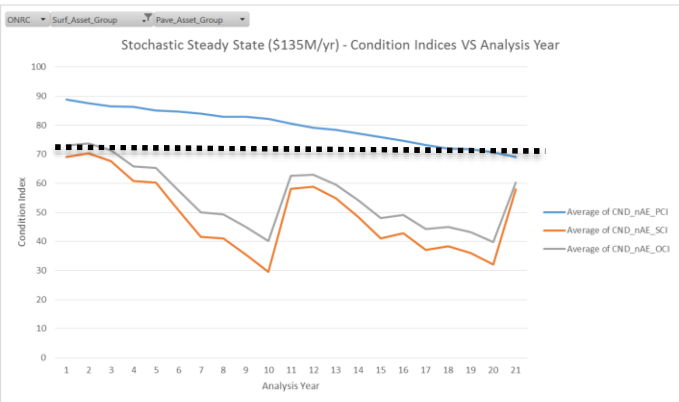
Overall – All Asset Groups

Over the full network the Overall Condition Index is maintained at $135M pa investment level (black dotted line).

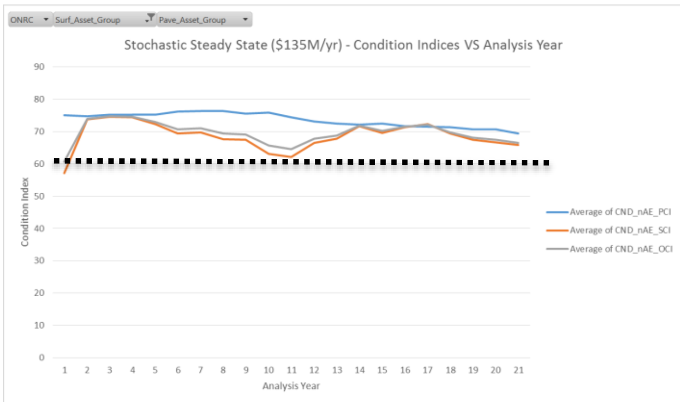


The following set of charts show the performance of the 8 individual Asset Groups (each having a different rate of deterioration and different model (TPM)), however for both Pavement and Surface the 3 chipseal groups have been combined.

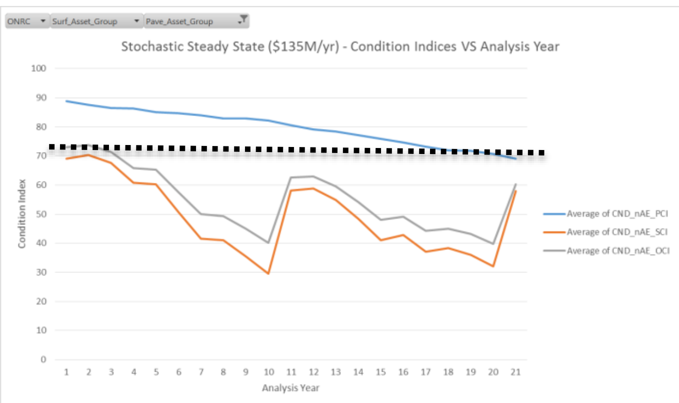
Surface: AC ONLY



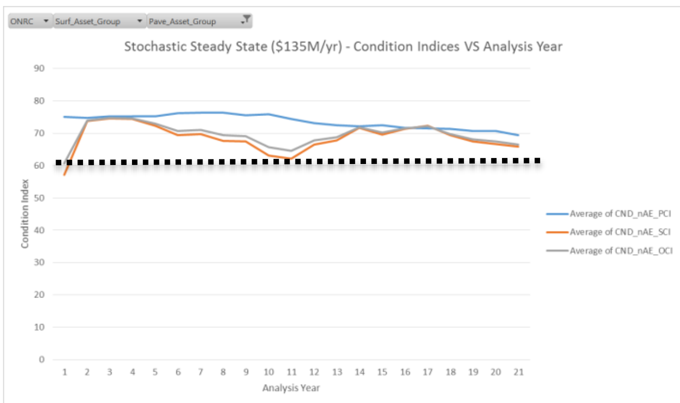
Surface: Chipseal (Low, Mod, High) ONLY



Pavement: AC ONLY



Pavement: Chipseal (Low, Mod, High) ONLY



The two AC groups on the left are not maintaining condition (grey line drops below black dotted line), although recall that AC makes up only 12% of the total network lane km length.

The 6 chipseal groups, represented by the two charts on the right show that the bulk of the network is slightly over delivering (grey lines above black dotted lines) with an investment of $135M pa.

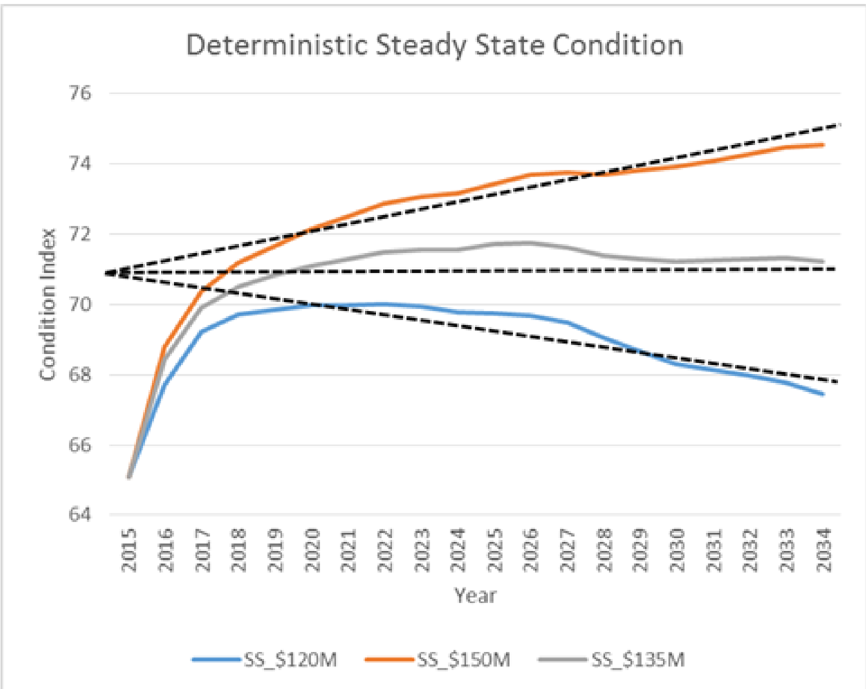
Comparison with Deterministic Steady State

The deterministic model required re-configuring to allow a steady state analysis. For the primary NLTP analysis, the Objective Function had been adopted to find the base need considering ONRC, whereby low class routes were permitted to deteriorate beyond current conditions. The model actively sought these lower targets and therefore was unable to find steady state. The objective function was modified to allow all road classes to be treated equally. Targets were set based on current condition. This enabled the model to seek steady state based on current condition.

Five investment scenarios, ranging from $120M to $150M, have been tested to identify Steady State. The following chart shows the Overall Condition Index projections based on the $120M, $135M and $150M investment scenarios. When viewing this chart recall: The Overall Condition Index is made up of four variables:

- Rutting; Roughness; Cracking and; Residual Life

It is apparent that initially the model is tackling an observed 'backlog' which boosts the Overall Condition Index in the first 2 years. Steady State has been identified where the profile stabilises over the 3 to 20 year period. The black dotted lines show the trends of each of the three tested scenarios with the $120M clearly showing a deteriorating trend and the $150M showing a continuous improving trend.



Appendix M: dTIMS Setup

Note: Light yellow highlighting is new to the template, dark yellow are changes made to the existing template.

Attributes:

Att Key	Name	Desc	Pers	Type	Width	Sdefault	N min	N max	N default	D min	D max	Ddefault	N decimals
54	aadt_est	TL: Traffic, Estimate [RAMM->traffic_adt_est]	dTAG_TL	Double	10		0	999999	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
55	aadt_pct_bus	TL: Traffic, Percentage of Buses (0-100%) [RAMM->pc_bus]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
56	aadt_pct_hcv1	TL: Traffic, Percentage of Heavy Commercial Vehicles Type 1 (0-100%) [RAMM->pc_hcv_i]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
57	aadt_pct_hcv2	TL: Traffic, Percentage of Heavy Commercial Vehicles Type 2 (0-100%) [RAMM->pc_hcv_ii]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
58	aadt_pct_lcv	TL: Traffic, Percentage of Light Commercial Vehicles (0-100%) [RAMM->pc_lcv]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
59	aadt_pct_mcv	TL: Traffic, Percentage of Medium Commercial Vehicles (0-100%) [RAMM->pc_mcv]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
60	aadt_pct_pc	TL: Traffic, Percentage of Passenger Cars (0-100%) [RAMM->pc_car]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
92	can_rehab	TL: TL, Rehabilitation is allowed (User Defined)	dTAG_TL	Boolean	1		0	1	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
61	chip	TL: Surface, Grade of Surfacing Aggregate or Thickness of AC [RAMM->first_chip_size]	dTAG_TL	Integer	10		0	40	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
62	com_cost	TL: Committed Treatment Cost	dTAG_TL	Double	10		0	1000000	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
63	com_trt	TL: Committed Treatment Name	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
64	com_trt_is_proj	TL: The TL FWP contains a 'PROJ'	dTAG_TL	Boolean	1		0	1	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
65	com_use_anc	TL: Committed Treatment - Use Ancillary Treatments	dTAG_TL	Boolean	1		0	1	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
66	com_use_sub	TL: Committed Treatment - Use Subsequent Treatments	dTAG_TL	Boolean	1		0	1	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
247	com_year	TL: Committed Treatment Year	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-00	02-Jan-00	0
68	crk_alligator	TL: Condition, Cracking, Alligator Cracking (Wheelpath (m)) [RAMM->Alligator]	dTAG_TL	Double	10		0	5000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
69	crk_alligator_prev	TL: Condition, Cracking, Previous Alligator Cracking (Wheelpath (m)) [RAMM->prev_crack_length]	dTAG_TL	Double	10		0	5000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
70	def_bb	TL: Pavement, Peak FWD Deflection (mm) [RAMM->????], Benkelman Beam	dTAG_TL	Double	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
71	def_fwd	TL: Pavement, Peak FWD Deflection (mm) [RAMM->????], Falling Weight Deflectometer	dTAG_TL	Double	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
243	fgroup	TL: Functional Group, Performance Model (User Defined)	dTAG_TL	Integer	25		0	20	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
77	flush	TL: Condition, Flushing, Length of wheelpath (m) (m) [RAMM->Flushing]	dTAG_TL	Double	10		0	9000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
73	group_desc	F Group Description User Defined	dTAG_TL	Text	50	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
79	hnew	TL: Surface, Thickness of top surface (mm) (Interface)	dTAG_TL	Integer	10		0	250	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
80	hold	TL: Surface, Thickness of all Surfacings excluding top surface (mm) (Interface)	dTAG_TL	Integer	10		0	999	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
81	hole_patch	TL: Condition, Pothole Patches, Number of Pothole Patches in the inspection area (No.) [RAMM->patches]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
82	holes	TL: Condition, Potholes, Number of Potholes in the inspection area (no,) [RAMM->holes]	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
83	insp_area	TL: Condition, Inspection, Area of TL inspected (m^2) [RAMM->insp_area]	dTAG_TL	Double	10		0	90000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
84	insp_length	TL: Condition, Inspection, Length of TL Inspected (m) [RAMM->insp_length]	dTAG_TL	Double	10		0	10000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
86	iri	TL: Condition, Roughness, International Roughness Index (m/km) [RAMM->hsd_iri_avg]	dTAG_TL	Double	10		0	12	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
283	Island	TL: TL, North or South Island - unit rates lookup	dTAG_TL	Text	7	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
287	KIRI	TL: TL based roughness calibration	dTAG_TL	Double	10		0	10	-1	03-Jan-00	01-Jan-99	02-Jan-00	5
286	KRut	TL: TL based rutting calibration	dTAG_TL	Double	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	5

88	lanes	TL: TL, Number of Lanes (For Traffic Loading) [RAMM->tl_lanes]	dTAG_TL	Integer	10		0	10	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
279	LU_SAL_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
277	LU_SAL_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
278	LU_SAL_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
280	LU_SAL2_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
281	LU_SAL2_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
282	LU_SAL2_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
289	LU_SAL3_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
303	LU_SAL3_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
304	LU_SAL3_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
290	LU_SAL4_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
297	LU_SAL4_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
305	LU_SAL4_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
291	LU_SAL5_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
298	LU_SAL5_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
306	LU_SAL5_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
292	LU_SAL6_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
299	LU_SAL6_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
307	LU_SAL6_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
293	LU_SAL7_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
300	LU_SAL7_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
308	LU_SAL7_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
294	LU_SAL8_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
301	LU_SAL8_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
309	LU_SAL8_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
295	LU_SAL9_Area	TL: LU_SAL_Area	dTAG_TL	Double	10		0	20000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
302	LU_SAL9_INT	TL: LU_SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
310	LU_SAL9_YFI	TL: LU_SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
89	mcost_pa	TL: MCOST, Annual Pavement Related Costs since Rehab/Recon, $ (Use Batch Transformation to Populate)	dTAG_TL	Double	10		0	1000000	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
90	mcost_su	TL: Maintenance Cost, Annual Surface Related Costs since Rehab/Recon, $ (Use Batch Transformation to Populate)	dTAG_TL	Double	10		0	1000000	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
91	naasra	TL: Condition, Roughness, NAASRA [RAMM->naasra_avg]	dTAG_TL	Integer	10		0	600	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
246	naasra_s	TL: Condition, Rutting, Standard Deviation of 20m mean values (mm) [RAMM->hsd_rutting_stddev]	dTAG_TL	Double	10		0	600	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
94	pave_avgthickness	TL: RAMM->avg_pave_depth	dTAG_TL	Double	10		1	1000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
95	pave_date	TL: Pavement, Date Pavement Constructed/Rehabilitated [RAMM->layer_date]	dTAG_TL	Date	10		0	0	-1	03-Jan-00	28-Dec-15	02-Jan-00	0
96	ravelling	TL: Condition, Ravelling, Area (m²) [RAMM->scabbing]	dTAG_TL	Double	10		0	10000	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
285	RegionDesc	TL: SH Region	dTAG_TL	Text	50	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
284	RegionNo	TL: SH RegionNo	dTAG_TL	Integer	25		0	50	-1	03-Jan-00	01-Jan-99	02-Jan-00	0

99	rut_30	TL: Condition, Rutting, Length of wheelpath (m) rated > 30mm [RAMM->hsd_rutting_30]	dTAG_TL	Double	10		0	500	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
100	rutm	TL: Condition, Rutting, Mean Depth (mm) [RAMM->hsd_rutting_avg]	dTAG_TL	Double	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
101	ruts	TL: Condition, Rutting, Standard Deviation of 20m mean values (mm) [RAMM->hsd_rutting_stddev]	dTAG_TL	Double	10		0	20	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
276	SAL_Flush	TL: SAL is flushing	dTAG_TL	Boolean	1		0	1	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
275	SAL_INT	TL: SAL_INT	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
274	SAL_YFI	TL: SAL_YFI	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
106	snp	TL: Pavement, Structural Number [RAMM->????]	dTAG_TL	Double	10		0	15	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
107	spectrt_yr01	TL: Specified Treatment YR1, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
108	spectrt_yr02	TL: Specified Treatment YR2, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
109	spectrt_yr03	TL: Specified Treatment YR3, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
110	spectrt_yr04	TL: Specified Treatment YR4, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
111	spectrt_yr05	TL: Specified Treatment YR5, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
112	spectrt_yr06	TL: Specified Treatment YR6, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
113	spectrt_yr07	TL: Specified Treatment YR7, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
114	spectrt_yr08	TL: Specified Treatment YR8, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
115	spectrt_yr09	TL: Specified Treatment YR9, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
116	spectrt_yr10	TL: Specified Treatment YR10, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
117	spectrt_yr11	TL: Specified Treatment YR11, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
118	spectrt_yr12	TL: Specified Treatment YR12, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
119	spectrt_yr13	TL: Specified Treatment YR13, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
120	spectrt_yr14	TL: Specified Treatment YR14, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
121	spectrt_yr15	TL: Specified Treatment YR15, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
122	spectrt_yr16	TL: Specified Treatment YR16, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
123	spectrt_yr17	TL: Specified Treatment YR17, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
124	spectrt_yr18	TL: Specified Treatment YR18, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
125	spectrt_yr19	TL: Specified Treatment YR19, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
126	spectrt_yr20	TL: Specified Treatment YR20, majOPT_RHAB, majOPT_AC, majOPT_RSEAL	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
127	surf_date	TL: Surface, Date Top Surface Applied [RAMM->surface_date]	dTAG_TL	Date	10		0	0	-1	03-Jan-00	28-Dec-15	02-Jan-00	0
128	surf_expectedlife	TL: Surface, Expected Life	dTAG_TL	Integer	10		0	60	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
129	surf_num	TL: Surface, Number of surface layers since last pavement construction	dTAG_TL	Integer	10		0	10	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
132	texture	TL: Condition, Texture Depth, Average Surface texture depth (mm) [RAMM->hsd_texture_avg]	dTAG_TL	Double	10		0	10000	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
288	TrafficGrowthRegion	TL: Old Traffic Growth Regions	dTAG_TL	Text	50	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
134	treat_length_id	TL: RAMM treatment length ID [RAMM->treatment_length!treat_length_id]	dTAG_TL	Double	10		0	999999999	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
135	type_base	TL: Pavement, Base Type (Stabilised 'S' or Unstabilised 'U') [RAMM->????]	dTAG_TL	Text	10	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
136	type_pave	TL: Pavement, Type (RAMM Codes T,C,S,B) [RAMM->pavement_type]	dTAG_TL	Text	10	Null	0	0	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
137	type_surf	TL: Surface, Type (RAMM COAT1, TWO1, etc) [RAMM->surface_material]	dTAG_TL	Text	10	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0

138	type_surf_function	TL: Surface, Function, 1, 2, R	dTAG_TL	Text	10	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
139	urb_rural	TL: TL, Urban or Rural Designation (U or R) [RAMM->urban_rural]	dTAG_TL	Text	5	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
273	user_filter	User Defined Filter	dTAG_TL	Text	50	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
142	width_surf	TL: Surface, Width (m) [RAMM->tl_width]	dTAG_TL	Double	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
143	z_av_boolean	TL: dTIMS Analysis Variable	dTAG_TL	Boolean	1		0	1	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
144	z_av_date	TL: dTIMS Analysis Variable	dTAG_TL	Date	10		0	0	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
145	z_av_double_0_1	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	1	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
146	z_av_double_0_10	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	10	-1	03-Jan-00	01-Jan-99	02-Jan-00	2
147	z_av_double_0_100	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
148	z_av_double_0_1e3	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	1000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
149	z_av_double_0_1e4	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	10000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
150	z_av_double_0_1e5	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	100000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
151	z_av_double_0_1e6	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	100000 0	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
152	z_av_double_0_1e7	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	100000 00	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
153	z_av_double_0_1e8	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		0	100000 000	-1	03-Jan-00	01-Jan-99	02-Jan-00	1
154	z_av_double_100ne g_100	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		-100	100	-101	03-Jan-00	01-Jan-99	02-Jan-00	1
155	z_av_double_10neg _1e5	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		-10	100000	-11	03-Jan-00	01-Jan-99	02-Jan-00	1
156	z_av_double_1e6ne g_1e6	TL: dTIMS Analysis Variable	dTAG_TL	Double	10		- 1000 000	100000 0	- 100000 1	03-Jan-00	01-Jan-99	02-Jan-00	1
157	z_av_integer_0_10 0	TL: dTIMS Analysis Variable	dTAG_TL	Integer	10		0	100	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
158	z_av_integer_0_20	TL: dTIMS Analysis Variable	dTAG_TL	Integer	10		0	20	-1	03-Jan-00	01-Jan-99	02-Jan-00	0
159	z_av_string_10	TL: dTIMS Analysis Variable	dTAG_TL	Text	10	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
160	z_av_string_100	TL: dTIMS Analysis Variable	dTAG_TL	Text	100	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0
161	z_av_string_25	TL: dTIMS Analysis Variable	dTAG_TL	Text	25	Null	0	0	0	03-Jan-00	01-Jan-99	02-Jan-00	0

Analysis Variables:

Var Key	Name	Desc	PropAtt	Slope	InitFrom	Order	Filter	CurveExp
146	AVbTRG_OPT_SUB_Pinch	Annual | Was last surface pinched?	dTAG_TL->z_av_boolean	Up	Gen_CON_bSF_Never	0	(none)	AS_Opt_TRG_bAF_RHAB_Pinch2
150	AVbTRG_OPT_SUB_Pinch_SAL	Annual | Was last surface pinched due to SAL flushing?	dTAG_TL->z_av_boolean	Up	Gen_CON_bSF_Never	0	(none)	AS_Opt_TRG_bAF_RHAB_Pinch3
27	AVnCND_Crack_ACA	Annual | Condition: Crack Progression, Area of 'All' cracking (0-100)	dTAG_TL->z_av_double_0_100	Up	Crack_INI_nSE_ACA_Convert	0	(none)	Crack_CND_nAE_ACA
39	AVnCND_CrackIniProb	Annual | Condition: Crack Initiation, Probability of crack initiation	dTAG_TL->z_av_double_0_100	Up	CrackIniProb_INI_nSE	0	Surf_CND_bAF_Type_AC_True	CrackIniProb_CND_nAE_AC
						1	(none)	CrackIniProb_CND_nAE_CS
33	AVnCND_Deflection	Annual | Pavement: Deflection, Peak deflection (mm)	dTAG_TL->def_fwd	Down	Deflection_INI_nSE_Convert	0	(none)	Deflection_CND_nAE
58	AVnCND_Flushing	Annual | Condition: Flushing, Area of flushing (0-100)	dTAG_TL->z_av_double_0_100	Up	Flushing_INI_nSE_Convert	0	(none)	Flushing_CND_nAE
121	AVnCND_FlushIniProb	Annual | Condition: Flush Initiation, Probability of flush initiation	dTAG_TL->z_av_double_0_100	Up	FlushIniProb_INI_nSE	0	Surf_CND_bAF_Type_AC_True	Gen_CON_nSE_0
						1	(none)	FlushIniProb_CND_nAE
71	AVnCND_IRI	Annual | Roughness condition (IRI)	dTAG_TL->z_av_double_0_100	Up	IRI_INI_nSE_Convert	0	(none)	IRI_CND_nAE
87	AVnCND_IRI_Exceedence	Annual | Condition: IRI Threshold Exceedence	dTAG_TL->z_av_double_0_100	Up	IRI_CND_nAE_Exceedence	0	(none)	IRI_CND_nAE_Exceedence
77	AVnCND_MaintCostkm	Annual | Condition: Maintenance Cost ($/km not $/project length)	dTAG_TL->z_av_double_0_1e5	Up	MaintCostkm_INI_nSE	0	(none)	MaintCostkm_CND_nAE
127	AVnCND_OBJ_Crack_ACA	Annual | Condition: Crack Progression, Area of 'All' cracking (0-100)	dTAG_TL->z_av_double_0_100	Down	OBJ_CND_nAE_Crack_ACA	0	(none)	OBJ_CND_nAE_Crack_ACA
128	AVnCND_OBJ_Flushing	Annual | Condition: Flushing, Area of flushing (0-100)	dTAG_TL->z_av_double_0_100	Down	OBJ_CND_nAE_Flushing	0	(none)	OBJ_CND_nAE_Flushing
125	AVnCND_OBJ_IRI	Annual | Roughness condition (IRI)	dTAG_TL->z_av_double_0_100	Down	OBJ_CND_nAE_IRI	0	(none)	OBJ_CND_nAE_IRI
129	AVnCND_OBJ_PCI	Annual | Objective Function condition	dTAG_TL->z_av_double_0_100	Down	OBJ_CND_nAE_PCI	0	(none)	OBJ_CND_nAE_PCI
157	AVnCND_OBJ_ResSurfLife	Annual | Condition: RSL	dTAG_TL->z_av_double_0_100	Down	OBJ_CND_nAE_ResSurfLife	0	(none)	OBJ_CND_nAE_ResSurfLife
126	AVnCND_OBJ_Rut	Annual | Condition: Rutting, average rutting in mm	dTAG_TL->z_av_double_0_100	Down	OBJ_CND_nAE_Rut	0	(none)	OBJ_CND_nAE_Rut
138	AVnCND_OBJ_Utility	Annual | Objective Function condition	dTAG_TL->z_av_double_0_100	Down	OBJ_CND_nAE_Utility	0	(none)	OBJ_CND_nAE_Utility
57	AVnCND_Patch	Annual | Condition: Patches, Area of patching (0-100)	dTAG_TL->z_av_double_0_100	Up	Patch_INI_nSE_Convert			
1	AVnCND_Pave_Age	Annual | Pavement: Age (yrs)	dTAG_TL->z_av_integer_0_100	Up	Pave_INI_nSE_Age_Convert	0	(none)	Pave_CND_nAE_Age
73	AVnCND_PCI	Annual | Condition: Pavement Condition Index , PCI	dTAG_TL->z_av_double_0_100	Down	PCI_CND_nAE	0	(none)	PCI_CND_nAE
56	AVnCND_Pot	Annual | Analysis: Condition, SII, Potholes	dTAG_TL->z_av_double_0_100	Up	Pot_INI_nSE_Convert			
80	AVnCND_Ravelling	Annual | Condition: Ravelling	dTAG_TL->z_av_double_0_1e5	Up	dTAG_TL->ravelling	0	(none)	Ravelling_CND_nAE
68	AVnCND_Rut	Annual | Condition: Rutting, average rutting in mm	dTAG_TL->z_av_double_0_100	Up	Rut_INI_nSE_Convert	0	(none)	Rut_CND_nAE
89	AVnCND_Rut_Exceedence	Annual | Condition: Rutting Threshold Exceedence	dTAG_TL->z_av_double_0_100	Up	Rut_CND_nAE_Exceedence	0	(none)	Rut_CND_nAE_Exceedence

43	AVnCND_RutAccelProb	Annual | Condition: Rut Progression, Probability of accelerated rutting	dTAG_TL->z_av_double_0_100	Up	RutAccelProb_CND_nAE	0	(none)	RutAccelProb_CND_nAE
63	AVnCND_SII	Annual | Condition: Surface Integrity Index	dTAG_TL->z_av_double_0_100	Up	SII_CND_nAE	0	(none)	SII_CND_nAE
62	AVnCND_SII_AI	Annual | Condition: Surface Integrity Index, Age Index	dTAG_TL->z_av_double_0_100	Up	SII_CND_nAE_AI	0	(none)	SII_CND_nAE_AI
64	AVnCND_SII_CI	Annual | Condition: Surface Integrity Index, Condition Index	dTAG_TL->z_av_double_0_100	Up	SII_CND_nAE_CI	0	(none)	SII_CND_nAE_CI
29	AVnCND_SNP	Annual | Pavement: Structural Number	dTAG_TL->snp	Up	dTAG_TL->snp	0	(none)	SNP_CND_nAE
2	AVnCND_Surf_Age	Annual | Surface: Age (yrs)	dTAG_TL->z_av_integer_0_100	Up	Surf_INI_nSE_Age_Convert	0	(none)	Surf_CND_nAE_Age
61	AVnCND_SurfLife_Residual	Annual | Condition: Surface, Residual Surface Life	dTAG_TL->z_av_double_100neg_100	Down	SurfLife_CND_nAE_Residual	0	(none)	SurfLife_CND_nAE_Residual
40	AVnCND_Texture	Annual | Condition: Texture, Mean depth in mm	dTAG_TL->z_av_double_0_10	Down	Texture_INI_nSE_Convert	0	(none)	Texture_CND_nAE
21	AVnCND_Traffic_AADT	Annual | Traffic: AADT, Total	dTAG_TL->z_av_double_0_1e6	Up	dTAG_TL->aadt_est	0	(none)	Traffic_CND_nAE_AADT
15	AVnCND_Traffic_AADT_Bus	Annual | Traffic: AADT, Bus	dTAG_TL->z_av_double_0_1e5	Up	Traffic_INI_nSE_AADT_BUS_Convert	0	(none)	Traffic_CND_nAE_AADT_Bus
16	AVnCND_Traffic_AADT_HCV1	Annual | Traffic: AADT, HCV1	dTAG_TL->z_av_double_0_1e5	Up	Traffic_INI_nSE_AADT_HCV1_Convert	0	(none)	Traffic_CND_nAE_AADT_HCV1
17	AVnCND_Traffic_AADT_HCV2	Annual | Traffic: AADT, HCV2	dTAG_TL->z_av_double_0_1e5	Up	Traffic_INI_nSE_AADT_HCV2_Convert	0	(none)	Traffic_CND_nAE_AADT_HCV2
18	AVnCND_Traffic_AADT_LCV	Annual | Traffic: AADT, LCV	dTAG_TL->z_av_double_0_1e5	Up	Traffic_INI_nSE_AADT_LCV_Convert	0	(none)	Traffic_CND_nAE_AADT_LCV
19	AVnCND_Traffic_AADT_MCV	Annual | Traffic: AADT, MCV	dTAG_TL->z_av_double_0_1e5	Up	Traffic_INI_nSE_AADT_MCV_Convert	0	(none)	Traffic_CND_nAE_AADT_MCV
20	AVnCND_Traffic_AADT_PC	Annual | Traffic: AADT, Passenger cars	dTAG_TL->z_av_double_0_1e5	Up	Traffic_INI_nSE_AADT_PC_Convert	0	(none)	Traffic_CND_nAE_AADT_PC
34	AVnCND_Traffic_ESA	Annual | Traffic: Loading, (ESA/ Lane/ day)	dTAG_TL->z_av_double_0_1e5	Up	Traffic_CND_nAE_ESA	0	(none)	Traffic_CND_nAE_ESA
59	AVnCND_Traffic_NELV	Annual | Traffic: Light Vehicles, per year	dTAG_TL->z_av_double_0_1e6	Up	Traffic_CND_nAE_NELV	0	(none)	Traffic_CND_nAE_NELV
52	AVnECO_AnnualCost	Annual | Economics: Strategy Cost, Annual	dTAG_TL->z_av_double_0_1e6	Up	Gen_CON_nSE_0	0	(none)	ECO_nAE_AnnualCost
162	AVnECO_AnnualEcoCost	Annual | Economics: Strategy Cost, Annual	dTAG_TL->z_av_double_0_1e6	Up	Gen_CON_nSE_0	0	(none)	ECO_nAE_AnnualEcoCost
97	AVnTRG_Treat_Count	Annual | Counts the min treatments in one year to avoid two mins in one year	dTAG_TL->z_av_integer_0_20	Up	Gen_CON_nSE_0	0	(none)	Gen_CON_nSE_0
53	CVnECO_Opt_PV_Benefit	Compilation | Economics: Optimal Model, Benefits	dTAG_TL->z_av_double_0_1e8	Down		0	(none)	ECO_nCE_Opt_PV_Benefit
54	CVnECO_PV_Cost	Compilation | Economics: Total Strategy, PV of Cost per km	dTAG_TL->z_av_double_0_1e8	Down		0	(none)	ECO_nCE_PV_Cost
147	DVbCND_SAL_Flush	Dynamic | Surface: Is SAL Flush?	dTAG_TL->z_av_boolean	Up	dTAG_TL->SAL_Flush			
35	DVbCND_Surf_TwoCoat	Dynamic | Surface: Is two coat surface?	dTAG_TL->z_av_boolean	Up	Surf_INI_bSF_TwoCoat_True			
159	DVbTRG_OPT_SUB_DoSomething	Dynamic | Optimal Analysis Subsequent Treatment Trigger for DoSomething	dTAG_TL->z_av_boolean	Up	Gen_CON_bSF_Always			
25	DVnCAL_Crack_HDM	Dynamic | Cracking: HDM4 factor (HDM4 Part C Table C2.20)	dTAG_TL->z_av_double_0_10	Up	Crack_INI_nDE_HDM_Cal			
28	DVnCAL_CrackIniProb_KPI	Dynamic | Calibration factor for Crack Inititation Probability	dTAG_TL->z_av_double_0_10	Up	CrackIniProb_INI_nDE_KPI_Cal			
72	DVnCAL_CrackIniProb_Thresh	Dynamic | Threshold at which cracking will start	dTAG_TL->z_av_double_0_100	Up	CrackIniProb_INI_nDE_Thresh			
36	DVnCND_Crack_PCA	Dynamic | Condition: Crack Initialisation, Previous area of 'All' cracking (0-100)	dTAG_TL->z_av_double_0_100	Up	Crack_INI_nSE_PCA_Convert			
88	DVnCND_IRI_StDev	Dynamic | Standard Deviation of HSD Roughness	dTAG_TL->z_av_double_0_100	Up	IRI_INI_nSE_StDev_Convert			
78	DVnCND_MaintCostkm_ActualScaling	Dynamic | Condition: Maint. Cost, Adjustment factor to reflect actual project level costs	dTAG_TL->z_av_double_0_100	Up	MaintCostkm_INI_nSE_ActualScaling			

42	DVnCND_Pave_Depth	Dynamic | Pavement: Total Thickness	dTAG_TL->pave_avgthickness	Up	dTAG_TL->pave_avgthickness			
90	DVnCND_Rut_StDev	Dynamic | Standard Deviation of HSD Rutting	dTAG_TL->z_av_double_0_100	Up	Rut_INI_nSE_StDev_Convert			
32	DVnCND_Surf_Chip	Dynamic | Surface: Aggregate Grade	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->chip			
38	DVnCND_Surf_Hnew	Dynamic | Surface: Depth of top most surface (mm)	dTAG_TL->z_av_integer_0_100	Up	Surf_INI_nSE_HNew_Convert			
37	DVnCND_Surf_Hold	Dynamic | Surface: Depth of all old surfaces, excluding top most surface (mm)	dTAG_TL->hold	Up	Surf_INI_nSE_HOld_Convert			
30	DVnCND_Surf_Num	Dynamic | Surface: Number of layers	dTAG_TL->z_av_integer_0_20	Up	dTAG_TL->surf_num			
116	DVnCND_Surf_OGPA	Dynamic | Surface: OGPA = 1, not OGPA = 0	dTAG_TL->z_av_integer_0_20	Up	Ravelling_INI_nSE_Surf_OGPA			
60	DVnCND_SurfLife	Dynamic | Condition: Surface, Expected Life (yrs)	dTAG_TL->z_av_double_0_100	Down	SurfLife_INI_nSE			
41	DVnCND_Texture_Slope	Dynamic | Condition: Texture, Rate of Change	dTAG_TL->z_av_double_0_10	Down	Texture_INI_nDE_Slope			
153	DVnTRG_OPT_SafetyArea_Maint	Dynamic | DVnTRG_OPT_SafetyArea_Maint	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
154	DVnTRG_OPT_SafetyArea_Maint2	Dynamic | DVnTRG_OPT_SafetyArea_Maint2	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
163	DVnTRG_OPT_SafetyArea_Maint3	Dynamic | DVnTRG_OPT_SafetyArea_Maint3	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
164	DVnTRG_OPT_SafetyArea_Maint4	Dynamic | DVnTRG_OPT_SafetyArea_Maint4	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
165	DVnTRG_OPT_SafetyArea_Maint5	Dynamic | DVnTRG_OPT_SafetyArea_Maint5	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
166	DVnTRG_OPT_SafetyArea_Maint6	Dynamic | DVnTRG_OPT_SafetyArea_Maint6	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
167	DVnTRG_OPT_SafetyArea_Maint7	Dynamic | DVnTRG_OPT_SafetyArea_Maint7	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
168	DVnTRG_OPT_SafetyArea_Maint8	Dynamic | DVnTRG_OPT_SafetyArea_Maint8	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
169	DVnTRG_OPT_SafetyArea_Maint9	Dynamic | DVnTRG_OPT_SafetyArea_Maint9	dTAG_TL->z_av_double_0_1e4	Up	Gen_CON_nSE_0			
140	DVnTRG_OPT_SafetyYr	Dynamic | DVnTRG_OPT_SafetyYr	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->SAL_YFI			
151	DVnTRG_OPT_SafetyYr_Maint	Dynamic | DVnTRG_OPT_SafetyYr_Maint	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL_YFI			
155	DVnTRG_OPT_SafetyYr_Maint2	Dynamic | DVnTRG_OPT_SafetyYr_Maint2	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL2_YFI			
175	DVnTRG_OPT_SafetyYr_Maint3	Dynamic | DVnTRG_OPT_SafetyYr_Maint3	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL3_YFI			
176	DVnTRG_OPT_SafetyYr_Maint4	Dynamic | DVnTRG_OPT_SafetyYr_Maint4	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL4_YFI			
170	DVnTRG_OPT_SafetyYr_Maint5	Dynamic | DVnTRG_OPT_SafetyYr_Maint5	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL5_YFI			
171	DVnTRG_OPT_SafetyYr_Maint6	Dynamic | DVnTRG_OPT_SafetyYr_Maint6	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL6_YFI			
172	DVnTRG_OPT_SafetyYr_Maint7	Dynamic | DVnTRG_OPT_SafetyYr_Maint7	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL7_YFI			
173	DVnTRG_OPT_SafetyYr_Maint8	Dynamic | DVnTRG_OPT_SafetyYr_Maint8	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL8_YFI			
174	DVnTRG_OPT_SafetyYr_Maint9	Dynamic | DVnTRG_OPT_SafetyYr_Maint9	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL9_YFI			
95	DVnTRG_OPT_SUB_AC_ACA	Dynamic | Optimal Analysis Subsequent Treatment Trigger for AC cracking	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_0			
92	DVnTRG_OPT_SUB_AC_Ravelling	Dynamic | Optimal Analysis Subsequent Treatment Trigger for ravelling	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_0			

91	DVnTRG_OPT_SUB_CS_ACA	Dynamic | Optimal Analysis Subsequent Treatment Trigger for CS cracking	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_0			
124	DVnTRG_OPT_SUB_CS_Flushing	Dynamic | Optimal Analysis Subsequent Treatment Trigger for flushing	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_0			
143	DVnTRG_OPT_SUB_Pinch_ACA	Dynamic | Optimal Analysis Pinching Parameters	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_0			
148	DVnTRG_OPT_SUB_Pinch_SAL_SurfAge	Dynamic | Optimal Analysis Pinching Parameters	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_100			
149	DVnTRG_OPT_SUB_Pinch_SAL_SurfLife	Dynamic | Optimal Analysis Pinching Parameters	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_100			
145	DVnTRG_OPT_SUB_Pinch_SurfAge	Dynamic | Optimal Analysis Pinching Parameters	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_100			
144	DVnTRG_OPT_SUB_Pinch_SurfLife	Dynamic | Optimal Analysis Pinching Parameters	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_100			
93	DVnTRG_OPT_SUB_RHAB_IRI	Dynamic | Optimal Analysis Subsequent Treatment Trigger for roughness	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_0			
94	DVnTRG_OPT_SUB_RHAB_Rut	Dynamic | Optimal Analysis Subsequent Treatment Trigger for rutting	dTAG_TL->z_av_double_0_100	Up	Gen_CON_nSE_0			
22	DVtCND_Pave_TypePave	Dynamic | Pavement: Type, HDM-4 4 character code for the pavement classification (combination of base and surf)	dTAG_TL->type_pave	Up	Pave_INI_tDE_TypePave			
100	DVtCND_Surf_Function	Dynamic | Specify the surface function for 2nd Coat application	dTAG_TL->z_av_string_10	Up	dTAG_TL->type_surf_function			
23	DVtCND_Surf_Type	Dynamic | Surface: Type, HDM-4 2 character surface code	dTAG_TL->type_surf	Up	Surf_INI_tSE_Type			
161	SVbCON_TFC_Island	Dynamic | Surface: Is North Island?	dTAG_TL->z_av_boolean	Up	ASTreat_INI_bSE_NorthIsland			
26	SVnCAL_Crack_KCP	Dynamic | Calibration factor for Crack Progression	dTAG_TL->z_av_double_0_100	Up	Crack_INI_nSE_KCP_Cal			
105	SVnCAL_Flushing	Dynamic | Calibration factor for Flushing	dTAG_TL->z_av_double_0_100	Up	Flushing_INI_nSE_Cal			
119	SVnCAL_FlushIniProb	Dynamic | Calibration factor for Flush Inititation Probability	dTAG_TL->z_av_double_0_10	Up	FlushIniProb_INI_nSE_Cal			
120	SVnCAL_FlushIniProb_Thresh	Dynamic | Threshold at which flushing will start	dTAG_TL->z_av_double_0_100	Up	FlushIniProb_INI_nSE_Thresh			
106	SVnCAL_IRI_KGE	Dynamic | Environmental Factor influences IRI progression	dTAG_TL->z_av_double_0_1	Up	IRI_INI_nSE_KGE_Cal			
75	SVnCAL_MaintCostkm_Calib	Dynamic | Maintenance cost calibration factor	dTAG_TL->z_av_double_0_100	Up	MaintCostkm_INI_nSE_Calib_Cal			
76	SVnCAL_MaintCostkm_CCI	Dynamic | Costruction Cost Index at a date 3 yrs before basedate	dTAG_TL->z_av_double_0_100	Up	MaintCostkm_INI_nSE_CCI_Cal			
131	SVnCAL_OBJ_Crack_ACA	Dynamic | Target lookup to calculate Crack ACA object function	dTAG_TL->z_av_double_0_100	Up	OBJ_INI_nSE_ACA_Cal			
132	SVnCAL_OBJ_Flushing	Dynamic | Target lookup to calculate Flushing object function	dTAG_TL->z_av_double_0_100	Up	OBJ_INI_nSE_Flushing_Cal			
134	SVnCAL_OBJ_IRI	Dynamic | Target lookup to calculate Roughness object function	dTAG_TL->z_av_double_0_100	Up	OBJ_INI_nSE_IRI_Cal			
158	SVnCAL_OBJ_ResSurfLife	Dynamic | Target lookup to calculate RSL object function	dTAG_TL->z_av_double_100neg_100	Up	OBJ_INI_nSE_ResSurfLife_Cal			
133	SVnCAL_OBJ_Rut	Dynamic | Target lookup to calculate Rutting object function	dTAG_TL->z_av_double_0_100	Up	OBJ_INI_nSE_Rut_Cal			
136	SVnCAL_OBJ_Utility_Alpha	Dynamic | Utility Alpha Function lookup	dTAG_TL->z_av_double_0_1	Up	OBJ_INI_nSE_Utility_Alpha_Cal			
139	SVnCAL_OBJ_Utility_X	Dynamic | Utility X Function lookup	dTAG_TL->z_av_double_0_100	Up	OBJ_INI_nSE_Utility_X_Cal			
135	SVnCAL_OBJ_Utility_Y	Dynamic | Utility Y Function lookup	dTAG_TL->z_av_double_0_100	Up	OBJ_INI_nSE_Utility_Y_Cal			
79	SVnCAL_Ravelling	Dynamic | Calibration factor for Ravelling	dTAG_TL->z_av_double_0_100	Up	Ravelling_INI_nSE_Cal			
101	SVnCAL_Rut_KRP	Dynamic | Calibration factor for Rut Progression	dTAG_TL->z_av_double_0_100	Up	Rut_INI_nSE_KRP_Cal			
67	SVnCAL_RutAccelProb_Thresh	Dynamic | Threshold at which accelerated rutting starts	dTAG_TL->z_av_double_0_100	Up	RutAccelProb_INI_nSE_Thresh			

44	SVnCON_AC_Req_AADTLimit	Dynamic | Asphalt Traffic limit	dTAG_TL->z_av_double_0_1e5	Up	ASTreat_INI_nSE_AC_Req_AADTLimit		
108	SVnCON_IRI_Exceedence_Thresh	Dynamic | Threshold lookup to calculate IRI exceedence	dTAG_TL->z_av_double_0_100	Up	IRI_INI_nSE_Exceedence_Thresh		
55	SVnCON_OPT_DSC_WaitTime	Dynamic | Wait time period before upper trigger limit is enforced	dTAG_TL->z_av_double_0_100	Up	AS_Opt_INI_nSE_DSC_WaitTime		
107	SVnCON_Rut_Exceedence_Thresh	Dynamic | Threshold lookup to calculate Rut exceedence	dTAG_TL->z_av_double_0_100	Up	Rut_INI_nSE_Exceedence_Thresh		
14	SVnCON_Traffic_Growth	Annual | Traffic: AADT, Growth Rate	dTAG_TL->z_av_double_0_10	Up	Traffic_INI_nSE_Growth		
96	SVnTRG_2ndCoat_WaitTime	Dynamic | Number of years for before 2nd Coat treatments should be applied	dTAG_TL->z_av_integer_0_100	Up	ASTreat_INI_nSE_2ndCoat_WaitTime		
102	SVnTRG_AC_ACA_LWR	Dynamic | Trigger Lower Limit for ACA (All cracking Area)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_AC_ACA_LWR		
103	SVnTRG_AC_ACA_UPR	Dynamic | Trigger for ACA (All cracking Area)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_AC_ACA_UPR		
82	SVnTRG_AC_Ravelling_LWR	Dynamic | Trigger Lower Limit for Ravelling	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_AC_Ravelling_LWR		
81	SVnTRG_AC_Ravelling_UPR	Dynamic | Trigger for Ravelling	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_AC_Ravelling_UPR		
46	SVnTRG_CS_ACA_LWR	Dynamic | Trigger Lower Limit for ACA (All cracking Area)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_CS_ACA_LWR		
45	SVnTRG_CS_ACA_UPR	Dynamic | Trigger for ACA (All cracking Area)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_CS_ACA_UPR		
122	SVnTRG_CS_Flushing_LWR	Dynamic | Trigger Lower Limit for Flushing	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_CS_Flushing_LWR		
123	SVnTRG_CS_Flushing_UPR	Dynamic | Trigger for Flushing	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_CS_Flushing_UPR		
160	SVnTRG_DoSomething_PSealCost	Dynamic | RTNE Cost/km when DoSomething is triggered	dTAG_TL->z_av_double_0_1e6	Up	ASTreat_INI_nSE_DoSomething_PSealCost		
141	SVnTRG_OPT_SafetyInt	Dynamic | SVnTRG_OPT_SafetyInt	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->SAL_INT		
152	SVnTRG_OPT_SafetyInt_Maint	Dynamic | SVnTRG_OPT_SafetyInt_Maint	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL_INT		
156	SVnTRG_OPT_SafetyInt_Maint2	Dynamic | SVnTRG_OPT_SafetyInt_Maint2	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL2_INT		
177	SVnTRG_OPT_SafetyInt_Maint3	Dynamic | SVnTRG_OPT_SafetyInt_Maint3	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL3_INT		
178	SVnTRG_OPT_SafetyInt_Maint4	Dynamic | SVnTRG_OPT_SafetyInt_Maint4	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL4_INT		
179	SVnTRG_OPT_SafetyInt_Maint5	Dynamic | SVnTRG_OPT_SafetyInt_Maint5	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL5_INT		
180	SVnTRG_OPT_SafetyInt_Maint6	Dynamic | SVnTRG_OPT_SafetyInt_Maint6	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL6_INT		
181	SVnTRG_OPT_SafetyInt_Maint7	Dynamic | SVnTRG_OPT_SafetyInt_Maint7	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL7_INT		
182	SVnTRG_OPT_SafetyInt_Maint8	Dynamic | SVnTRG_OPT_SafetyInt_Maint8	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL8_INT		
183	SVnTRG_OPT_SafetyInt_Maint9	Dynamic | SVnTRG_OPT_SafetyInt_Maint9	dTAG_TL->z_av_integer_0_100	Up	dTAG_TL->LU_SAL9_INT		
109	SVnTRG_PercentSurfLife	Dynamic | Trigger upper limit for Percent Life Exceedence	dTAG_TL->z_av_double_0_1e3	Up	ASTreat_INI_nSE_PercentSurfLife		
113	SVnTRG_PSEAL_ACA_Thresh	Dynamic | Preseal lookup trigger for all cracking area (ACA)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_PSEAL_ACA_Thresh		
115	SVnTRG_PSEAL_IRI_Exceedance_Thresh	Dynamic | Preseal lookup trigger for roughness exceedence	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_PSEAL_IRI_Exceedence_Thresh		
112	SVnTRG_PSEAL_MaxExtent	Dynamic | Preseal lookup maximum % of TL treated, set lookup to 0 if no preseal repairs	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_PSEAL_MaxExtent		
114	SVnTRG_PSEAL_Rut_Exceedance_Thresh	Dynamic | Preseal lookup trigger for rutting exceedence	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_PSEAL_Rut_Exceedence_Thresh		

70	SVnTRG_RHAB_IRI_LWR	Dynamic | Trigger Lower Limit tolerance for Roughness (IRI)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_RHAB_IRI_LWR			
69	SVnTRG_RHAB_IRI_UPR	Dynamic | Trigger for Roughness (IRI)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_RHAB_IRI_UPR			
66	SVnTRG_RHAB_Rut_LWR	Dynamic | Trigger Lower Limit for Rutting (mm)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_RHAB_Rut_LWR			
65	SVnTRG_RHAB_Rut_UPR	Dynamic | Trigger for Rutting (mm)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_RHAB_Rut_UPR			
110	SVnTRG_RTNE_ACA_LWR	Dynamic | Trigger Maint lower limit for ACA (All Cracking Area)	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_RTNE_Crack_LWR			
111	SVnTRG_RTNE_Interval	Dynamic | Allowable Maint interval years	dTAG_TL->z_av_double_0_100	Up	ASTreat_INI_nSE_RTNE_Interval			
24	SVtCND_Pave_TypeBase	Dynamic | Pavement: Type, HDM-4 2 character base code	dTAG_TL->type_base	Up	Pave_INI_tSE_TypeBase_Convert			
13	SVtCON_Traffic_Growth_Category	Annual | Traffic: TL road category based on U/R and traffic (EEM)	dTAG_TL->z_av_string_10	Up	Traffic_INI_tSE_Growth_Category_Convert			

Expressions:

Type: B = boolean, D= double, T=Text

Name	Desc	Type	TheExpression
A_CON_bSF_FilterSet	Analysis Filter for All Valid Treatment Lengths	B	dTAG_TL->user_filter = 'Y'
AS_BDay_TRG_bAF_AC	Analysis: Birthday, Trigger-Based Model, AC	B	(dTAG_TL->com_trt = 'majAC' And YR = dTAG_TL->com_year) Or (YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And ASTreat_TRG_bAF_AC_Permitted And (DVnCND_SurfLife - AVnCND_Surf_Age)<=0.0)
AS_BDay_TRG_bAF_CS	Analysis: Birthday, Trigger-Based Model, CS	B	(dTAG_TL->com_trt = 'majCS' And YR = dTAG_TL->com_year) Or (YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And NOT ASTreat_TRG_bAF_AC_Permitted And (DVnCND_SurfLife - AVnCND_Surf_Age)<=0.0)
AS_BDay_TRG_bAF_RHAB	Analysis: Birthday, Trigger-Based Model, committed Rehab	B	dTAG_TL->com_trt = 'majRHAB' And YR = dTAG_TL->com_year
AS_Opt_DSC_bAF	Analysis: Discard, Discard unwanted strategies, Optimal Model Only	B	AS_Opt_DSC_bAF_AC_ACA Or AS_Opt_DSC_bAF_CS_ACA
AS_Opt_DSC_bAF_AC_ACA	Analysis: Discard, Discard unwanted strategies, Optimal Model Only, ACA (All Cracking Area) AC	B	Surf_CND_bAF_Type_AC_True And DAL_DCG_GETMAX(AVnCND_Crack_ACA,SVnCON_OPT_DSC_WaitTime,20.0) > SVnTRG_AC_ACA_UPR*Crack_RES_nDE_ACA_RTNE_Factor
AS_Opt_DSC_bAF_CS_ACA	Analysis: Discard, Discard unwanted strategies, Optimal Model Only, ACA (All Cracking Area) CS	B	NOT Surf_CND_bAF_Type_AC_True And DAL_DCG_GETMAX(AVnCND_Crack_ACA,SVnCON_OPT_DSC_WaitTime,20.0) > SVnTRG_CS_ACA_UPR*Crack_RES_nDE_ACA_RTNE_Factor
AS_Opt_INI_nSE_DSC_WaitTime	Waitime period before the upper trigger limit is enforced	D	XTAB(FGroup_Parameters,'FTrg_Discard_WaitTime',dTAG_TL->fgroup,99.0) + dTAG_TL->com_year
AS_Opt_RES_nDE_SUB_AC_ACA	Subsequent Trigger Reset for AC Cracking	D	IF(YR > dTAG_TL->com_year And DVnTRG_OPT_SUB_AC_ACA = 0.0, ROUND(MIN(MAX(SVnTRG_AC_ACA_LWR, AVnCND_Crack_ACA), SVnTRG_AC_ACA_LWR + (SVnTRG_AC_ACA_UPR - SVnTRG_AC_ACA_LWR)/2.0)*(1.0 - MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0)) + MIN(MAX(SVnTRG_AC_ACA_LWR, AVnCND_Crack_ACA), MIN(SVnTRG_AC_ACA_UPR, AVnCND_Crack_ACA))*MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0), 1.0), DVnTRG_OPT_SUB_AC_ACA)
AS_Opt_RES_nDE_SUB_AC_Ravelling	Subsequent Trigger Reset for AC Ravelling	D	IF(YR > dTAG_TL->com_year And DVnTRG_OPT_SUB_AC_Ravelling = 0.0, ROUND(MIN(MAX(SVnTRG_AC_Ravelling_LWR, AVnCND_Ravelling), SVnTRG_AC_Ravelling_LWR + (SVnTRG_AC_Ravelling_UPR - SVnTRG_AC_Ravelling_LWR)/2.0)*(1.0 - MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0)) + MIN(MAX(SVnTRG_AC_Ravelling_LWR, AVnCND_Ravelling), MIN(SVnTRG_AC_Ravelling_UPR, AVnCND_Ravelling))*MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0), 1.0), DVnTRG_OPT_SUB_AC_Ravelling)
AS_Opt_RES_nDE_SUB_CS_ACA	Subsequent Trigger Reset for CS Cracking	D	IF(YR > dTAG_TL->com_year And DVnTRG_OPT_SUB_CS_ACA = 0.0, ROUND(MIN(MAX(SVnTRG_CS_ACA_LWR, AVnCND_Crack_ACA), SVnTRG_CS_ACA_LWR + (SVnTRG_CS_ACA_UPR - SVnTRG_CS_ACA_LWR)/2.0)*(1.0 - MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0)) + MIN(MAX(SVnTRG_CS_ACA_LWR, AVnCND_Crack_ACA), MIN(SVnTRG_CS_ACA_UPR, AVnCND_Crack_ACA))*MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0), 1.0), DVnTRG_OPT_SUB_CS_ACA)
AS_Opt_RES_nDE_SUB_CS_Flushing	Subsequent Trigger Reset for CS Flushing	D	IF(YR > dTAG_TL->com_year And DVnTRG_OPT_SUB_CS_Flushing = 0.0, ROUND(MIN(MAX(SVnTRG_CS_Flushing_LWR, AVnCND_Flushing), SVnTRG_CS_Flushing_LWR + (SVnTRG_CS_Flushing_UPR - SVnTRG_CS_Flushing_LWR)/2.0)*(1.0 - MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0)) + MIN(MAX(SVnTRG_CS_Flushing_LWR, AVnCND_Flushing), MIN(SVnTRG_CS_Flushing_UPR, AVnCND_Flushing))*MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0), 1.0), DVnTRG_OPT_SUB_CS_Flushing)
AS_Opt_RES_nDE_SUB_RHAB_IRI	Subsequent Trigger Reset for RHAB Roughness	D	IF(YR > dTAG_TL->com_year And DVnTRG_OPT_SUB_RHAB_IRI = 0.0, ROUND(MIN(MAX(SVnTRG_RHAB_IRI_LWR, AVnCND_IRI), SVnTRG_RHAB_IRI_LWR + (SVnTRG_RHAB_IRI_UPR -

			SVnTRG_RHAB_IRI_LWR)/2.0)*(1.0 - MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0)) + MIN(MAX(SVnTRG_RHAB_IRI_LWR, AVnCND_IRI), MIN(SVnTRG_RHAB_IRI_UPR, AVnCND_IRI))*MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0), 1.0), DVnTRG_OPT_SUB_RHAB_IRI)
AS_Opt_RES_nDE_SUB_RHAB_Rut	Subsequent Trigger Reset for RHAB Rutting	D	IF(YR > dTAG_TL->com_year And DVnTRG_OPT_SUB_RHAB_Rut = 0.0, ROUND(MIN(MAX(SVnTRG_RHAB_Rut_LWR, AVnCND_Rut), SVnTRG_RHAB_Rut_LWR + (SVnTRG_RHAB_Rut_UPR - SVnTRG_RHAB_Rut_LWR)/2.0)*(1.0 - MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0)) + MIN(MAX(SVnTRG_RHAB_Rut_LWR, AVnCND_Rut), MIN(SVnTRG_RHAB_Rut_UPR, AVnCND_Rut))*MIN(YR/SVnCON_OPT_DSC_WaitTime, 1.0), 1.0), DVnTRG_OPT_SUB_RHAB_Rut)
AS_Opt_TRG_bAF_AC	Analysis: Trigger, majAC	B	YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And YR <= DVnTRG_OPT_SafetyYr And ASTreat_TRG_bAF_AC_Permitted And (AS_Opt_TRG_bAF_AC_Safety Or AS_Opt_TRG_bAF_AC_ACA Or AS_Opt_TRG_bAF_AC_Ravelling Or AS_Opt_TRG_bAF_AC_PercentSurfLife)
AS_Opt_TRG_bAF_AC_ACA	majAC treatment ACA trigger used in Optimal Analysis	B	IF(DVnTRG_OPT_SUB_AC_ACA>0.0,AVnCND_Crack_ACA>=DVnTRG_OPT_SUB_AC_ACA And AVnCND_Crack_ACA<(DVnTRG_OPT_SUB_AC_ACA+5.5),IF(YR < SVnCON_OPT_DSC_WaitTime,AVnCND_Crack_ACA>=SVnTRG_AC_ACA_LWR,AVnCND_Crack_ACA>=SVnTRG_AC_ACA_LWR And AVnCND_Crack_ACA<SVnTRG_AC_ACA_UPR))
AS_Opt_TRG_bAF_AC_PercentSurfLife	Catchall treatment trigger for surfaces	B	AVnCND_Surf_Age >= 0.01*SVnTRG_PercentSurfLife*DVnCND_SurfLife And AVnCND_Crack_ACA < SVnTRG_AC_ACA_LWR
AS_Opt_TRG_bAF_AC_Ravelling	majAC treatment Ravelling trigger used in Optimal Analysis	B	IF(DVnTRG_OPT_SUB_AC_Ravelling>0.0,AVnCND_Ravelling>=DVnTRG_OPT_SUB_AC_Ravelling,IF(YR < SVnCON_OPT_DSC_WaitTime,AVnCND_Ravelling>=SVnTRG_AC_Ravelling_LWR,AVnCND_Ravelling>=SVnTRG_AC_Ravelling_LWR And AVnCND_Ravelling<SVnTRG_AC_Ravelling_UPR))
AS_Opt_TRG_bAF_AC_Safety	Analysis: Trigger, majAC Safety	B	YR = DVnTRG_OPT_SafetyYr
AS_Opt_TRG_bAF_AC_SafetyNot	Analysis: Trigger, majAC Safety	B	YR <> DVnTRG_OPT_SafetyYr
AS_Opt_TRG_bAF_CS	Analysis: Trigger, majCS	B	YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And YR <= DVnTRG_OPT_SafetyYr And NOT ASTreat_TRG_bAF_AC_Permitted And (AS_Opt_TRG_bAF_CS_Safety Or AS_Opt_TRG_bAF_CS_ACA Or AS_Opt_TRG_bAF_CS_PercentSurfLife)
AS_Opt_TRG_bAF_CS_ACA	majCS treatment ACA trigger used in Optimal Analysis	B	IF(DVnTRG_OPT_SUB_CS_ACA>0.0,AVnCND_Crack_ACA>=DVnTRG_OPT_SUB_CS_ACA And AVnCND_Crack_ACA<(DVnTRG_OPT_SUB_CS_ACA+2.5),IF(YR < SVnCON_OPT_DSC_WaitTime,AVnCND_Crack_ACA>=SVnTRG_CS_ACA_LWR,AVnCND_Crack_ACA>=SVnTRG_CS_ACA_LWR And AVnCND_Crack_ACA<SVnTRG_CS_ACA_UPR))
AS_Opt_TRG_bAF_CS_Flushing	NO DEPENDENCIES majCS treatment Flushing trigger used in Optimal Analysis	B	IF(DVnTRG_OPT_SUB_CS_Flushing>0.0,AVnCND_Surf_Age > 2.0 And AVnCND_Flushing>=DVnTRG_OPT_SUB_CS_Flushing,IF(YR < SVnCON_OPT_DSC_WaitTime,AVnCND_Flushing>=SVnTRG_CS_Flushing_LWR,AVnCND_Flushing>=SVnTRG_CS_Flushing_LWR And AVnCND_Flushing<SVnTRG_CS_Flushing_UPR))
AS_Opt_TRG_bAF_CS_PercentSurfLife	Catchall treatment trigger for surfaces	B	AVnCND_Surf_Age >= 0.01*SVnTRG_PercentSurfLife*DVnCND_SurfLife And AVnCND_Crack_ACA < SVnTRG_CS_ACA_LWR
AS_Opt_TRG_bAF_CS_Safety	Analysis: Trigger, majCS Safety	B	YR = DVnTRG_OPT_SafetyYr
AS_Opt_TRG_bAF_CS_SafetyNot	Analysis: Trigger, majCS Safety	B	YR <> DVnTRG_OPT_SafetyYr
AS_Opt_TRG_bAF_DoSomething	Treatment Trigger for DoSomething	B	dTAG_TL->can_rehab And DVbTRG_OPT_SUB_DoSomething And (AS_Opt_TRG_bAF_RHAB_Pinch3 Or (MaintCostkm_CND_nAE>=SVnTRG_DoSomething_PSealCost And (AS_Opt_TRG_bAF_RHAB_Rut Or AS_Opt_TRG_bAF_RHAB_IRI)))
AS_Opt_TRG_bAF_RHAB	Treatment Trigger for RHAB used in Optimal Analysis	B	YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And YR <= DVnTRG_OPT_SafetyYr And dTAG_TL->can_rehab And AVnCND_Surf_Age > 3.0 And (AS_Opt_TRG_bAF_RHAB_Rut Or AS_Opt_TRG_bAF_RHAB_IRI Or AS_Opt_TRG_bAF_RHAB_Pinch2 Or AS_Opt_TRG_bAF_RHAB_Pinch3)
AS_Opt_TRG_bAF_RHAB_IRI	majRHAB treatment Roughness trigger used in Optimal Analysis	B	IF(DVnTRG_OPT_SUB_RHAB_IRI>0.0,AVnCND_IRI>=DVnTRG_OPT_SUB_RHAB_IRI,IF(YR < 15.0,AVnCND_IRI>=SVnTRG_RHAB_IRI_LWR,AVnCND_Crack_ACA > 0.0 And AVnCND_IRI>=SVnTRG_RHAB_IRI_LWR And AVnCND_IRI<SVnTRG_RHAB_IRI_UPR))

AS_Opt_TRG_bAF_RHAB_Pinch1	majRHAB treatment Surface Life pinched	B	YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0))
AS_Opt_TRG_bAF_RHAB_Pinch2	majRHAB treatment Surface Life pinched	B	DVnTRG_OPT_SUB_Pinch_SurfAge < 5.0 And (DVnTRG_OPT_SUB_Pinch_SurfAge/DVnTRG_OPT_SUB_Pinch_SurfLife) < 0.67 And IF(ASTreat_TRG_bAF_AC_Permitted,DVnTRG_OPT_SUB_Pinch_ACA>=SVnTRG_AC_ACA_LWR,DVnTRG_OPT_SUB_Pinch_ACA>=SVnTRG_CS_ACA_LWR)
AS_Opt_TRG_bAF_RHAB_Pinch3	majRHAB treatment Surface Life pinched	B	RTRIM(DVtCND_Surf_Type) = 'CS' And DVnCND_Surf_Num > 4.0 And (DVbCND_SAL_Flush Or (DVnTRG_OPT_SUB_Pinch_SAL_SurfAge < 5.0 And (DVnTRG_OPT_SUB_Pinch_SAL_SurfAge/DVnTRG_OPT_SUB_Pinch_SAL_SurfLife) < 0.67))
AS_Opt_TRG_bAF_RHAB_Rut	majRHAB treatment RutAccelProb trigger used in Optimal Analysis	B	IF(DVnTRG_OPT_SUB_RHAB_Rut>0.0,AVnCND_Rut>=DVnTRG_OPT_SUB_RHAB_Rut,IF(YR < 15.0,AVnCND_Rut>=SVnTRG_RHAB_Rut_LWR,AVnCND_Crack_ACA > 0.0 And AVnCND_Rut>=SVnTRG_RHAB_Rut_LWR And AVnCND_Rut<SVnTRG_RHAB_Rut_UPR))
AS_Spec_TRG_bAF_AC	Analysis: Trigger, Specified Model, Specific Treatment, AC	B	AS_Spec_TRG_tAE_Master = 'specAC'
AS_Spec_TRG_bAF_CS	Analysis: Trigger, Specified Model, Specific Treatment, RSEAL	B	AS_Spec_TRG_tAE_Master = 'specCS'
AS_Spec_TRG_bAF_RHAB	Analysis: Trigger, Specified Model, Specific Treatment, RHAB	B	AS_Spec_TRG_tAE_Master = 'specRHAB'
AS_Spec_TRG_tAE_Master	Analysis: Trigger, Specified Model, Master Trigger Expression	T	RTRIM(IF(YR <= 5.0,AS_Spec_TRG_tSE_Treat_YR01_05,IF(YR <= 10.0,AS_Spec_TRG_tSE_Treat_YR06_10,IF(YR <= 15.0,AS_Spec_TRG_tSE_Treat_YR11_15,AS_Spec_TRG_tSE_Treat_YR16_20))))
AS_Spec_TRG_tSE_Treat_YR01_05	Analysis: Trigger, Specified Model, Trigger Expression Years 1 to 5	T	IF(YR = 1.0,dTAG_TL->spectrt_yr01,IF(YR = 2.0,dTAG_TL->spectrt_yr02,IF(YR = 3.0,dTAG_TL->spectrt_yr03,IF(YR = 4.0,dTAG_TL->spectrt_yr04,IF(YR = 5.0,dTAG_TL->spectrt_yr05,'')))))
AS_Spec_TRG_tSE_Treat_YR06_10	Analysis: Trigger, Specified Model, Trigger Expression, Years 6 to 10	T	IF(YR = 6.0,dTAG_TL->spectrt_yr06,IF(YR = 7.0,dTAG_TL->spectrt_yr07,IF(YR = 8.0,dTAG_TL->spectrt_yr08,IF(YR = 9.0,dTAG_TL->spectrt_yr09,IF(YR = 10.0,dTAG_TL->spectrt_yr10,'')))))
AS_Spec_TRG_tSE_Treat_YR11_15	Analysis: Trigger, Specified Model, Trigger Expression, Years 11 to 15	T	IF(YR = 11.0,dTAG_TL->spectrt_yr11,IF(YR = 12.0,dTAG_TL->spectrt_yr12,IF(YR = 13.0,dTAG_TL->spectrt_yr13,IF(YR = 14.0,dTAG_TL->spectrt_yr14,IF(YR = 15.0,dTAG_TL->spectrt_yr15,'')))))
AS_Spec_TRG_tSE_Treat_YR16_20	Analysis: Trigger, Specified Model, Trigger Expression, Years 16 to 20	T	IF(YR = 16.0,dTAG_TL->spectrt_yr16,IF(YR = 17.0,dTAG_TL->spectrt_yr17,IF(YR = 18.0,dTAG_TL->spectrt_yr18,IF(YR = 19.0,dTAG_TL->spectrt_yr19,IF(YR = 20.0,dTAG_TL->spectrt_yr20,'')))))
AS_Trig_TRG_bAF_AC	Analysis: Trigger, Trigger-Based Model, minAC	B	(dTAG_TL->com_trt = 'majAC' And YR = dTAG_TL->com_year) Or (YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And ASTreat_TRG_bAF_AC_Permitted And (AS_Trig_TRG_bAF_AC_ACA Or AS_Trig_TRG_bAF_AC_Ravelling Or AS_Opt_TRG_bAF_AC_PercentSurfLife))
AS_Trig_TRG_bAF_AC_ACA	minAC treatment ACA trigger used in Trigger Analysis	B	AVnCND_Crack_ACA>=SVnTRG_AC_ACA_UPR
AS_Trig_TRG_bAF_AC_Ravelling	minAC treatment Ravelling trigger used in Trigger Analysis	B	AVnCND_Ravelling>=SVnTRG_AC_Ravelling_UPR
AS_Trig_TRG_bAF_CS	Analysis: Trigger, Trigger-Based Model, minCS	B	(dTAG_TL->com_trt = 'majCS' And YR = dTAG_TL->com_year) Or (YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And NOT ASTreat_TRG_bAF_AC_Permitted And (AS_Trig_TRG_bAF_CS_ACA Or AS_Trig_TRG_bAF_CS_Flushing Or AS_Opt_TRG_bAF_CS_PercentSurfLife))
AS_Trig_TRG_bAF_CS_ACA	minCS treatment ACA trigger used in Trigger Analysis	B	AVnCND_Crack_ACA>=SVnTRG_CS_ACA_UPR
AS_Trig_TRG_bAF_CS_Flushing	minCS treatment Flushing trigger used in Trigger Analysis	B	AVnCND_Flushing>=SVnTRG_CS_Flushing_UPR
AS_Trig_TRG_bAF_RHAB	Treatment Trigger for RHAB used in Trigger Analysis	B	(dTAG_TL->com_trt = 'majRHAB' And YR = dTAG_TL->com_year) Or (YR > MAX(dTAG_TL->com_year,XTAB(FGroup_Parameters,'FPol_CommittedYears',dTAG_TL->fgroup,-1.0)) And dTAG_TL->can_rehab And (AS_Trig_TRG_bAF_RHAB_Rut Or AS_Trig_TRG_bAF_RHAB_IRI))

AS_Trig_TRG_bAF_RHAB_IRI	minRHAB treatment Roughness trigger used in Trigger Analysis	B	AVnCND_IRI>=SVnTRG_RHAB_IRI_UPR
AS_Trig_TRG_bAF_RHAB_Rut	minRHAB treatment Rut trigger used in Trigger Analysis	B	AVnCND_Rut>=SVnTRG_RHAB_Rut_UPR
ASTreat_INI_bSE_NorthIsland	TFC is North Island Rate else South Island Rate	B	dTAG_TL->Island = 'NI' Or dTAG_TL->Island = 'NI_Mway'
ASTreat_INI_nSE_2ndCoat_WaitTime	Lookup number of years after rehab treatment to apply 2nd Coat	D	XTAB(FGroup_Parameters,'FPol_2ndCoat_WaitTime',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_AC_ACA_LWR	Lookup trigger lower limit for ACA (All Cracking Area)	D	XTAB(Traffic_Parameters,'TTrg_AC_ACA_Lower',dTAG_TL->aadt_est,1000.0)
ASTreat_INI_nSE_AC_ACA_UPR	Lookup trigger for ACA (All Cracking Area)	D	XTAB(Traffic_Parameters,'TTrg_AC_ACA_Upper',dTAG_TL->aadt_est,1000.0)
ASTreat_INI_nSE_AC_Ravelling_LWR	Lookup trigger lower limit for Ravelling	D	XTAB(FGroup_Parameters,'FTrg_AC_Ravelling_Lower',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_AC_Ravelling_UPR	Lookup trigger for Ravelling	D	XTAB(FGroup_Parameters,'FTrg_AC_Ravelling_Upper',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_AC_Req_AADTLimit	Policy lookup traffic threshold to apply AC	D	XTAB(FGroup_Parameters,'FPol_AC_Traffic_Threshold',dTAG_TL->fgroup,99999.0)
ASTreat_INI_nSE_CS_ACA_LWR	Lookup trigger lower limit for ACA (All Cracking Area)	D	XTAB(Traffic_Parameters,'TTrg_CS_ACA_Lower',dTAG_TL->aadt_est,1000.0)
ASTreat_INI_nSE_CS_ACA_UPR	Lookup trigger for ACA (All Cracking Area)	D	XTAB(Traffic_Parameters,'TTrg_CS_ACA_Upper',dTAG_TL->aadt_est,1000.0)
ASTreat_INI_nSE_CS_Flushing_LWR	Lookup trigger lower limit for Flushing	D	XTAB(FGroup_Parameters,'FTrg_CS_Flushing_Lower',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_CS_Flushing_UPR	Lookup trigger for Flushing	D	XTAB(FGroup_Parameters,'FTrg_CS_Flushing_Upper',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_DoSomething_PSealCost	Lookup RTNE Cost /km, when DoSomething is triggered	D	XTAB(FGroup_Parameters,'FTrg_DoSomething_RTNECost',dTAG_TL->fgroup,99000.0)
ASTreat_INI_nSE_PercentSurfLife	Lookup trigger upper limit for Percent Life Exceedence	D	XTAB(FGroup_Parameters,'FTrg_Surf_PCT_LifeExceedence',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_PSEAL_ACA_Thresh	Preseal lookup trigger for all cracking area (ACA)	D	XTAB(FGroup_Parameters,'FTrg_PSEAL_ACA',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_PSEAL_IRI_Exceedence_Thresh	Preseal lookup trigger for roughness exceedence	D	XTAB(FGroup_Parameters,'FTrg_PSEAL_IRI_Exceedence',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_PSEAL_MaxExtent	Preseal lookup maximum % of TL treated, set lookup to 0 if no preseal repairs	D	XTAB(FGroup_Parameters,'FTrg_PSEAL_MaxExtent',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_PSEAL_Rut_Exceedence_Thresh	Preseal lookup trigger for rutting exceedence	D	XTAB(FGroup_Parameters,'FTrg_PSEAL_Rut_Exceedence',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_RHAB_IRI_LWR	Lower limit for optimal condition range	D	XTAB(FGroup_Parameters,'FTrg_RHAB_IRI_Lower',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_RHAB_IRI_UPR	Roughness trigger limit for trigger analysis, and upper	D	XTAB(FGroup_Parameters,'FTrg_RHAB_IRI_Upper',dTAG_TL->fgroup,99.0)

	for optimal condition range		
ASTreat_INI_nSE_RHAB_Rut_LWR	Lower limit for optimal condition range	D	XTAB(FGroup_Parameters,'FTrg_RHAB_Rut_Lower',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_RHAB_Rut_UPR	Rutting trigger limit for trigger analysis, and upper for optimal condition range	D	XTAB(FGroup_Parameters,'FTrg_RHAB_Rut_Upper',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_RTNE_Crack_LWR	Lookup trigger Maint lower limit for ACA (All Cracking Area)	D	XTAB(FGroup_Parameters,'FMaint_Cracking_Threshold',dTAG_TL->fgroup,99.0)
ASTreat_INI_nSE_RTNE_Interval	Lookup allowable Maint interval years	D	XTAB(FGroup_Parameters,'FMaint_Interval',dTAG_TL->fgroup,99.0)
ASTreat_RES_nDE_Count	Analysis: Treatment counter	D	AVnTRG_Treat_Count + 1.0
ASTreat_TEC_nDE_ancAC	Analysis: Area, ancAC	D	XTAB(FGroup_Parameters,'FUnitRate_EcoAC',dTAG_TL->fgroup,0.0)*((GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf)-(DVnTRG_OPT_SafetyArea_Maint+DVnTRG_OPT_SafetyArea_Maint2+DVnTRG_OPT_SafetyArea_Maint3+DVnTRG_OPT_SafetyArea_Maint4+DVnTRG_OPT_SafetyArea_Maint5+DVnTRG_OPT_SafetyArea_Maint6+DVnTRG_OPT_SafetyArea_Maint7+DVnTRG_OPT_SafetyArea_Maint8+DVnTRG_OPT_SafetyArea_Maint9))
ASTreat_TEC_nDE_ancCS	Analysis: Area, ancCS	D	XTAB(FGroup_Parameters,'FUnitRate_EcoCS',dTAG_TL->fgroup,0.0)*((GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf)-(DVnTRG_OPT_SafetyArea_Maint+DVnTRG_OPT_SafetyArea_Maint2+DVnTRG_OPT_SafetyArea_Maint3+DVnTRG_OPT_SafetyArea_Maint4+DVnTRG_OPT_SafetyArea_Maint5+DVnTRG_OPT_SafetyArea_Maint6+DVnTRG_OPT_SafetyArea_Maint7+DVnTRG_OPT_SafetyArea_Maint8+DVnTRG_OPT_SafetyArea_Maint9))
ASTreat_TEC_nDE_ancRHAB	Analysis: Area, ancRHAB	D	IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_EcoRHAB_AC',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_EcoRHAB_CS',dTAG_TL->fgroup,0.0)) * GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf
ASTreat_TEC_nDE_ancRHAB_AC	Analysis: Area, ancRHAB	D	XTAB(FGroup_Parameters,'FUnitRate_EcoRHAB_AC',dTAG_TL->fgroup,0.0) * GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf
ASTreat_TEC_nDE_ancRHAB_CS	Analysis: Area, ancRHAB	D	XTAB(FGroup_Parameters,'FUnitRate_EcoRHAB_CS',dTAG_TL->fgroup,0.0) * GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf
ASTreat_TEC_nDE_RTNE_Safety	Analysis: Area, RTNE Safety	D	IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_EcoAC',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_EcoCS',dTAG_TL->fgroup,0.0))*dTAG_TL->LU_SAL_Area
ASTreat_TEC_nDE_RTNE_Safety2	Analysis: Area, RTNE Safety	D	IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_EcoAC',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_EcoCS',dTAG_TL->fgroup,0.0))*dTAG_TL->LU_SAL2_Area
ASTreat_TEC_nDE_RTNE_Safety3	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL3_Area
ASTreat_TEC_nDE_RTNE_Safety4	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL4_Area
ASTreat_TEC_nDE_RTNE_Safety5	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL5_Area
ASTreat_TEC_nDE_RTNE_Safety6	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL-

			>fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL6_Area
ASTreat_TEC_nDE_RTNE_Safety7	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL7_Area
ASTreat_TEC_nDE_RTNE_Safety8	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL8_Area
ASTreat_TEC_nDE_RTNE_Safety9	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL9_Area
ASTreat_TFC_bDF_IsComCost	Analysis: Committed treatment has a user defined cost, Treatment has a financial cost defined in dTAG TL. Filter required for Min & Spec Treatments only	B	dTAG_TL->com_cost > 0.0 And YR = dTAG_TL->com_year
ASTreat_TFC_bDF_IsProj	Analysis: Committed treatment is Proj, Treat ancillaries have no financial cost	B	dTAG_TL->com_trt_is_proj And YR = dTAG_TL->com_year
ASTreat_TFC_nDE_AC	Analysis: Cost, majAC	D	0
ASTreat_TFC_nDE_ancAC	Analysis: Cost, ancAC	D	IF(SVbCON_TFC_Island,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0))*((GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf)-(DVnTRG_OPT_SafetyArea_Maint+DVnTRG_OPT_SafetyArea_Maint2+DVnTRG_OPT_SafetyArea_Maint3+DVnTRG_OPT_SafetyArea_Maint4+DVnTRG_OPT_SafetyArea_Maint5+DVnTRG_OPT_SafetyArea_Maint6+DVnTRG_OPT_SafetyArea_Maint7+DVnTRG_OPT_SafetyArea_Maint8+DVnTRG_OPT_SafetyArea_Maint9))
ASTreat_TFC_nDE_ancCS	Analysis: Cost, ancCS	D	IF(SVbCON_TFC_Island,XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0))*((GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf)-(DVnTRG_OPT_SafetyArea_Maint+DVnTRG_OPT_SafetyArea_Maint2+DVnTRG_OPT_SafetyArea_Maint3+DVnTRG_OPT_SafetyArea_Maint4+DVnTRG_OPT_SafetyArea_Maint5+DVnTRG_OPT_SafetyArea_Maint6+DVnTRG_OPT_SafetyArea_Maint7+DVnTRG_OPT_SafetyArea_Maint8+DVnTRG_OPT_SafetyArea_Maint9))
ASTreat_TFC_nDE_ancPSEAL	Analysis: Cost, ancPSEAL	D	0.01 * GET_LENGTH(dTAG_TL) * (dTAG_TL->width_surf * (MIN(Crack_CND_nDE_ACA_PreSeal,SVnTRG_PSEAL_MaxExtent) * XTAB(FGroup_Parameters,'FUnitRate_ancPSEAL_ACA',dTAG_TL->fgroup,0.0) + MIN(IRI_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal-Rut_CND_nDE_PreSealExceedence,0.0)) * XTAB(FGroup_Parameters,'FUnitRate_ancPSEAL_IRI',dTAG_TL->fgroup,0.0)) + dTAG_TL->lanes * 2.0 * MIN(Rut_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal,0.0)) * XTAB(FGroup_Parameters,'FUnitRate_ancPSEAL_Rut',dTAG_TL->fgroup,0.0))
ASTreat_TFC_nDE_ancRHAB_AC	Analysis: Cost, ancRHAB	D	IF(RTRIM(SVtCND_Pave_TypeBase)='AP',IF(SVbCON_TFC_Island,XTAB(FGroup_Parameters,'FUnitRate_ancRHAB_ACS_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancRHAB_ACS_S',dTAG_TL->fgroup,0.0)),IF(SVbCON_TFC_Island,XTAB(FGroup_Parameters,'FUnitRate_ancRHAB_ACG_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancRHAB_ACG_S',dTAG_TL->fgroup,0.0)))*GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf
ASTreat_TFC_nDE_ancRHAB_CS	Analysis: Cost, ancRHAB	D	IF(SVbCON_TFC_Island,XTAB(FGroup_Parameters,'FUnitRate_ancRHAB_CS_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancRHAB_CS_S',dTAG_TL->fgroup,0.0))*GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf
ASTreat_TFC_nDE_Com	Analysis: Cost, Committed treatment with user defined cost	D	dTAG_TL->com_cost

ASTreat_TFC_nDE_CS	Analysis: Cost, majCS	D	0
ASTreat_TFC_nDE_RHAB	Analysis: Cost, majRHAB	D	0
ASTreat_TFC_nDE_RTNE	Treatment Financial Cost for routine maintenance	D	AVnCND_MaintCostkm * GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf / 8000.0
ASTreat_TFC_nDE_RTNE_Safety	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL_Area
ASTreat_TFC_nDE_RTNE_Safety2	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL2_Area
ASTreat_TFC_nDE_RTNE_Safety3	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL3_Area
ASTreat_TFC_nDE_RTNE_Safety4	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL4_Area
ASTreat_TFC_nDE_RTNE_Safety5	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL5_Area
ASTreat_TFC_nDE_RTNE_Safety6	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL6_Area
ASTreat_TFC_nDE_RTNE_Safety7	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL7_Area
ASTreat_TFC_nDE_RTNE_Safety8	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL8_Area
ASTreat_TFC_nDE_RTNE_Safety9	Treatment Financial Cost for Safety routine maintenance	D	IF(SVbCON_TFC_Island,IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_N',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_N',dTAG_TL->fgroup,0.0)),IF(ASTreat_TRG_bAF_AC_Permitted,XTAB(FGroup_Parameters,'FUnitRate_ancAC_S',dTAG_TL->fgroup,0.0),XTAB(FGroup_Parameters,'FUnitRate_ancCS_S',dTAG_TL->fgroup,0.0)))*dTAG_TL->LU_SAL9_Area
ASTreat_TRG_bAF_2ndCoat	Analysis: Trigger, min2ndCoat	B	YR > dTAG_TL->com_year And RTRIM(DVtCND_Surf_Type) = 'CS' And SVnTRG_2ndCoat_WaitTime > 0.0 And DVtCND_Surf_Function = '1' And AVnCND_Pave_Age >= SVnTRG_2ndCoat_WaitTime
ASTreat_TRG_bAF_AC_Permitted	Analysis: Surface, Asphalt surfacing Permitted.	B	Surf_CND_bAF_Type_AC_True Or (AVnCND_Traffic_AADT >= SVnCON_AC_Req_AADTLimit)

ASTreat_TRG_bAF_RTNE	Routine maintenance treatment trigger	B	AVnCND_Crack_ACA > SVnTRG_RTNE_ACA_LWR Or AVnCND_Rut > SVnTRG_PSEAL_Rut_Exceedance_Thresh
ASTreat_TRG_bAF_RTNE_Safety	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint
ASTreat_TRG_bAF_RTNE_Safety2	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint2
ASTreat_TRG_bAF_RTNE_Safety3	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint3
ASTreat_TRG_bAF_RTNE_Safety4	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint4
ASTreat_TRG_bAF_RTNE_Safety5	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint5
ASTreat_TRG_bAF_RTNE_Safety6	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint6
ASTreat_TRG_bAF_RTNE_Safety7	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint7
ASTreat_TRG_bAF_RTNE_Safety8	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint8
ASTreat_TRG_bAF_RTNE_Safety9	Safety maintenance treatment trigger	B	YR = DVnTRG_OPT_SafetyYr_Maint9
ASTreat_TRG_bDF_Permit_ancAC_RHAB	Analysis: Trigger, ancAC_RHAB	B	ASTreat_TRG_bAF_AC_Permitted
ASTreat_TRG_bDF_Permit_ancCS_RHAB	Analysis: Trigger, ancCS_RHAB	B	NOT ASTreat_TRG_bAF_AC_Permitted
Crack_CND_nAE_ACA	Analysis: Condition, Crack Progression, 'All', Cracking Annual Increment (0-100)	D	IF(CrackIniProb_CND_bAF_GT_Thresh Or AVnCND_Crack_ACA > 0.0, SVnCAL_Crack_KCP * DVnCAL_Crack_HDM * MIN(MAX(AVnCND_Crack_ACA,0.1), 100.0 - AVnCND_Crack_ACA)**0.5, AVnCND_Crack_ACA)
Crack_CND_nAE_ACA_Current	Analysis: Area of All Cracking	D	AVnCND_Crack_ACA
Crack_CND_nDE_ACA_PreSeal	Analysis: Condition, 'All' Cracking, treated by Preseal Repairs	D	IF(AVnCND_Crack_ACA>=SVnTRG_PSEAL_ACA_Thresh,AVnCND_Crack_ACA,0.0)
Crack_INI_nDE_HDM_Cal	Analysis: Condition, Crack Progression, 'All', Constant Lookup	D	VAL(XTAB(HDM4_Constants,RTRIM(DVtCND_Pave_TypePave),'Value1','99.0'))
Crack_INI_nSE_ACA_Convert	Analysis: Condition, Crack Initialisation, Initialise RAMM Cracking	D	IF(dTAG_TL->insp_length <= 0.0,0.0,0.0004 * (dTAG_TL->crk_alligator * 50.0 / dTAG_TL->insp_length) ** 2.0 + 0.28 * dTAG_TL->crk_alligator * (50.0 / dTAG_TL->insp_length))
Crack_INI_nSE_KCP_Cal	Analysis: Calibration, Initialise Crack Progression	D	XTAB(Traffic_Parameters,'TCal_Crack_KCP',dTAG_TL->aadt_est,1000.0)
Crack_INI_nSE_PCA_Convert	Analysis: Condition, Crack Progression, 'All' Initialise Previous 'All' Cracking	D	IF(dTAG_TL->insp_length <= 0.0,0.0,0.0004 * (dTAG_TL->crk_alligator_prev * (50.0 / dTAG_TL->insp_length)) ** 2.0 + (0.28 * dTAG_TL->crk_alligator_prev * 50.0 / dTAG_TL->insp_length))
Crack_RES_bDF_ACA_RTNE	Filter to disable repair reset when seal is very old, ramps the crack progression	B	AVnCND_Surf_Age < 0.01*SVnTRG_PercentSurfLife*DVnCND_SurfLife

Crack_RES_nDE_ACA_RTNE	Routine Maintenance condition reset to cracking	D	AVnCND_Crack_ACA*Crack_RES_nDE_ACA_RTNE_Factor
Crack_RES_nDE_ACA_RTNE_Factor	Routine Maintenance factor reset to cracking	D	0.6
Crack_RES_nDE_PCA	Analysis: Reset, Condition, Crack Initialisation, Previous Area of All Cracking	D	AVnCND_Crack_ACA
CrackIniProb_CND_bAF_GT_Thresh	Test if cracking has started	B	IF(Surf_CND_bAF_Type_AC_True, CrackIniProb_CND_nAE_AC, CrackIniProb_CND_nAE_CS) > DVnCAL_CrackIniProb_Thresh
CrackIniProb_CND_nAE_AC	Analysis: Condition, Cracking Initiation, Probability of cracking, Asphalt	D	100.0/(1.0+EXP(-0.21612*(AVnCND_Surf_Age)+(3.91537-0.53103*IF(DVnCND_Crack_PCA<0.5,0.0,1.0)-0.55157*LOG10(DVnCND_Surf_Hnew+DVnCND_Surf_Hold)-0.04097*(LOG10(AVnCND_Traffic_ESA*365.0/1000000.0)*AVnCND_SNP))/DVnCAL_CrackIniProb_KPI))
CrackIniProb_CND_nAE_CS	Analysis: Condition, Cracking Initiation, Probability of cracking, NOT Asphalt	D	100.0/(1.0+EXP(-0.141*AVnCND_Surf_Age+(IF(DVnCND_Crack_PCA<0.5,4.5,4.1)-0.455*LOG(MAX(1.0,AVnCND_Traffic_AADT))-0.275*LOG(MAX(1.0,DVnCND_Surf_Hnew+DVnCND_Surf_Hold))+0.655*AVnCND_SNP)/DVnCAL_CrackIniProb_KPI))
CrackIniProb_INI_nDE_KPI_Cal	Analysis: Condition, Crack Initiation Probability, Calibration Factor	D	XTAB(Traffic_Parameters,'TCal_CrackIniProb_KPI_' + RTRIM(DVtCND_Surf_Type) + RTRIM(dTAG_TL->urb_rural),dTAG_TL->aadt_est,1000.0)
CrackIniProb_INI_nDE_Thresh	Threshold lookup for when cracking would start	D	XTAB(FGroup_Parameters,'FThresh_CrackINIProb_' + RTRIM(DVtCND_Surf_Type),dTAG_TL->fgroup,99.0)
CrackIniProb_INI_nSE	Analysis: Condition, Cracking Initiation, Probability of cracking, Initialisation	D	IF(Surf_CND_bAF_Type_AC_True, CrackIniProb_CND_nAE_AC, CrackIniProb_CND_nAE_CS)
Deflection_CND_nAE	Analysis: Pavement Deflection, Peak deflection (mm)	D	MIN(2.5,1.0033*AVnCND_Deflection)
Deflection_INI_nSE_Convert	Maximum deflection initialisation	D	IF(dTAG_TL->def_fwd <= 0.0,IF(dTAG_TL->def_bb <= 0.0,3.5 / AVnCND_SNP ** 1.6,dTAG_TL->def_bb / 0.7),dTAG_TL->def_fwd)
Deflection_RES_nDE	Deflection condition reset	D	MIN(AVnCND_Deflection,XTAB(FGroup_Parameters,'FRes_Deflection',dTAG_TL->fgroup,99.0))
ECO_nAE_AnnualCost	Analysis: Economics, Cost, Scenario cost at given year	D	GST_COST_F
ECO_nAE_AnnualEcoCost	Analysis: Economics, Cost, Scenario cost at given year	D	GST_COST_E
ECO_nCE_Opt_PV_Benefit	Analysis: Economics, Benefit, PV of PCI difference with do nothing	D	GET4CAV_PVDIFF(AVnCND_OBJ_Utility,0,AVnCND_Traffic_AADT,0)
ECO_nCE_PV_Cost	Analysis: Economics, Present Value of Scenario Costs by Length. Here it has to be $/KM for Optimisation	D	GET4CAV_PV(AVnECO_AnnualEcoCost) / (GET_LENGTH(dTAG_TL) * dTAG_TL->width_surf)
Flushing_CND_nAE	Analysis: Condition, Flushing, Area (0-100)	D	IF(FlushIniProb_CND_bAF_GT_Thresh,MIN(100.0,MAX(AVnCND_Flushing,(AVnCND_Flushing+SVnCAL_Flushing*(0.416*AVnCND_Surf_Age+0.04*(DVnCND_Surf_Hnew+DVnCND_Surf_Hold)+0.11*AVnCND_Rut+0.17*DVnCND_Surf_Chip)**2.0)/2.0)),AVnCND_Flushing*1.1)
Flushing_INI_nSE_Cal	Initialise Flushing calibration variable	D	XTAB(Traffic_Parameters,'TCal_Flushing',dTAG_TL->aadt_est,1000.0)
Flushing_INI_nSE_Convert	Analysis: Condition, Flushing, Initialise	D	IF(Surf_CND_bAF_Type_AC_True,0.0,IF(dTAG_TL->insp_area <= 0.0,0.0,100.0 * dTAG_TL->flush / dTAG_TL->insp_area))

FlushIniProb_CND_bAF_GT_Thresh	Test if Flushing has started	B	IF(Surf_CND_bAF_Type_AC_True,FALSE,FlushIniProb_CND_nAE > SVnCAL_FlushIniProb_Thresh)
FlushIniProb_CND_nAE	Analysis: Condition, Flushing Initiation, Probability of flushing	D	100.0/(1.0+EXP(-0.293*AVnCND_Surf_Age+(2.913-0.046*(DVnCND_Surf_Hnew+DVnCND_Surf_Hold))/SVnCAL_FlushIniProb))
FlushIniProb_INI_nSE	Analysis: Condition, Flush Initiation, Probability of flushing, Initialisation	D	IF(Surf_CND_bAF_Type_AC_True,0.0,FlushIniProb_CND_nAE)
FlushIniProb_INI_nSE_Cal	Analysis: Condition, Flush Initiation Probability, Calibration Factor	D	XTAB(Traffic_Parameters,'TCal_FlushIniProb',dTAG_TL->aadt_est,1000.0)
FlushIniProb_INI_nSE_Thresh	Threshold lookup for when flushing would start	D	XTAB(FGroup_Parameters,'FThresh_FlushINIProb',dTAG_TL->fgroup,99.0)
Gen_CON_bSF_Always	General: Always True	B	TRUE
Gen_CON_bSF_Never	General: Always False	B	FALSE
Gen_CON_nSE_0	General: 0	D	0
Gen_CON_nSE_100	General: 100	D	100
IRI_CND_nAE	Annual roughness progression	D	AVnCND_IRI+(SVnCAL_IRI_KGE*AVnCND_IRI+((0.2175*(1.0+AVnCND_SNP)**-4.99)*0.4*AVnCND_Traffic_ESA*(1.0+SVnCAL_IRI_KGE)))*EXP(SVnCAL_IRI_KGE)
IRI_CND_nAE_Exceedence	Analysis: Condition, IRI Exceedence, % greater than threshold	D	(1.0 - IF(IRI_CND_nAE_Exceedence_Variance < -6.0,0.0,IF(IRI_CND_nAE_Exceedence_Variance > 6.0,1.0,IF(IRI_CND_nAE_Exceedence_Variance < 0.0,1.0 - IRI_CND_nAE_Exceedence_N,IRI_CND_nAE_Exceedence_N))))*100.0
IRI_CND_nAE_Exceedence_B	Analysis: Condition, IRI Exceedence, Constant b	D	0.3989423 * EXP(-1.0 * IRI_CND_nAE_Exceedence_Variance ** 2.0 / 2.0)
IRI_CND_nAE_Exceedence_N	Analysis: Condition, IRI Exceedence, Constant n	D	1.0 - IRI_CND_nAE_Exceedence_B * ((((1.330274429 * IRI_CND_nAE_Exceedence_T - 1.821255978) * IRI_CND_nAE_Exceedence_T + 1.781477937) * IRI_CND_nAE_Exceedence_T + -0.356563782) * IRI_CND_nAE_Exceedence_T + 0.31938153) * IRI_CND_nAE_Exceedence_T
IRI_CND_nAE_Exceedence_T	Analysis: Condition, IRI Exceedence, constant t	D	1.0 / (1.0 + ABS(IRI_CND_nAE_Exceedence_Variance) * 0.2316419)
IRI_CND_nAE_Exceedence_Variance	Analysis: Condition, Roughness Variance	D	(SVnCON_IRI_Exceedence_Thresh - AVnCND_IRI)/DVnCND_IRI_StDev
IRI_CND_nDE_PreSealExceedence	Analysis: Condition, IRI Preseal Repair Exceedence, % greater than threshold	D	(1.0 - IF(IRI_CND_nDE_PreSealExceedence_Variance < -6.0,0.0,IF(IRI_CND_nDE_PreSealExceedence_Variance > 6.0,1.0,IF(IRI_CND_nDE_PreSealExceedence_Variance < 0.0,1.0 - IRI_CND_nDE_PreSealExceedence_N,IRI_CND_nDE_PreSealExceedence_N))))*100.0
IRI_CND_nDE_PreSealExceedence_B	Analysis: Condition, IRI Preseal Repair Exceedence, Constant b	D	0.3989423 * EXP(-1.0 * IRI_CND_nDE_PreSealExceedence_Variance ** 2.0 / 2.0)
IRI_CND_nDE_PreSealExceedence_N	Analysis: Condition, IRI Preseal Repair Exceedence, Constant n	D	1.0 - IRI_CND_nDE_PreSealExceedence_B * ((((1.330274429 * IRI_CND_nDE_PreSealExceedence_T - 1.821255978) * IRI_CND_nDE_PreSealExceedence_T + 1.781477937) * IRI_CND_nDE_PreSealExceedence_T + -0.356563782) * IRI_CND_nDE_PreSealExceedence_T + 0.31938153) * IRI_CND_nDE_PreSealExceedence_T
IRI_CND_nDE_PreSealExceedence_T	Analysis: Condition, IRI Preseal Repair Exceedence, constant t	D	1.0 / (1.0 + ABS(IRI_CND_nDE_PreSealExceedence_Variance) * 0.2316419)
IRI_CND_nDE_PreSealExceedence_Variance	Analysis: Condition, Roughness Preseal Repair Variance	D	(SVnTRG_PSEAL_IRI_Exceedance_Thresh - AVnCND_IRI)/DVnCND_IRI_StDev

IRI_INI_nSE_Convert	Initialise RAMM Roughness	D	IF(dTAG_TL->iri <= 0.0,(MAX(0.0,dTAG_TL->naasra) + 1.27) / 26.49,dTAG_TL->iri)
IRI_INI_nSE_Exceedence_Thresh	Initialise threshold lookup to calculate IRI exceedence	D	XTAB(FGroup_Parameters,'FThresh_IRI_Exceedence',dTAG_TL->fgroup,99.0)
IRI_INI_nSE_KGE_Cal	Initialise IRI calibration variable	D	dTAG_TL->KIRI
IRI_INI_nSE_StDev_Convert	Analysis: Condition, Roughness Standard Deviation, Initialisation. IF HSD Data present use that, otherwise use Rating Data - Not Used	D	IF(dTAG_TL->naasra_s <= 0.0,(0.21 * IRI_INI_nSE_Convert + 0.69),(dTAG_TL->naasra_s + 1.27)/26.49)
IRI_RES_nDE	RHAB treatment reset for IRI	D	MIN(AVnCND_IRI,XTAB(FGroup_Parameters,'FRes_IRI',dTAG_TL->fgroup,99.0))
IRI_RES_nDE_KGE_Cal	Reset IRI calibration variable after Rehab	D	MIN(SVnCAL_IRI_KGE,XTAB(Traffic_Parameters,'TCal_IRI_KGE_' + RTRIM(dTAG_TL->urb_rural),dTAG_TL->aadt_est,0.1))
IRI_RES_nDE_PreSeal	Preseal Repair reset for IRI	D	MAX(IRI_RES_nDE, AVnCND_IRI + DVnCND_IRI_StDev * (-0.0000045362 * MIN(IRI_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal-Rut_CND_nDE_PreSealExceedence,0.0)) ** 3.0 + 0.00004718 * MIN(IRI_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal-Rut_CND_nDE_PreSealExceedence,0.0)) ** 2.0 - 0.025346 * MIN(IRI_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal-Rut_CND_nDE_PreSealExceedence,0.0))))
IRI_RES_nDE_StDev	Reset for Roughness Standard Deviation	D	MIN(DVnCND_IRI_StDev, 0.21 * AVnCND_IRI + 0.69)
MaintCostkm_CND_nAE	Analysis: Condition, Maintenance Costs, ($/km/yr)	D	DVnCND_MaintCostkm_ActualScaling * MaintCostkm_CND_nAE_Base
MaintCostkm_CND_nAE_Base	Analysis: Condition, Maintenance Costs, $/km/yr (Cost Adjustment Factor from June 03 to present)	D	(EXP(0.6*LOG(MAX(1.0,AVnCND_IRI))+1.0*LOG(MAX(0.1,AVnCND_Crack_ACA))+0.5*LOG(MAX(1.0,AVnCND_Rut))+0.25*LOG(MAX(1.0,AVnCND_Pave_Age))+5.5)+MaintCostkm_CND_nAE_Holes)*SVnCAL_MaintCostkm_CCI*SVnCAL_MaintCostkm_Calib
MaintCostkm_CND_nAE_Holes	Analysis: Condition, Maintenance Costs, LTNZ Method, Number of Potholes	D	(AVnCND_Pot/ 100.0 * dTAG_TL->width_surf * 1000.0) / 0.05
MaintCostkm_INI_nSE	Analysis: Condition, Maintenance Costs, Initialise ($/km)	D	MaintCostkm_CND_nAE
MaintCostkm_INI_nSE_Actual_Convert	Analysis: Condition, Maintenance Costs, Actual Costs per km	D	(dTAG_TL->mcost_pa + dTAG_TL->mcost_su) / (GET_LENGTH(dTAG_TL) / 1000.0) / (dTAG_TL->width_surf / 8.0)
MaintCostkm_INI_nSE_ActualScaling	Analysis: Condition, Maintenance Costs, Adjustment factor so model costs are same as actual costs	D	MIN(MAX(MaintCostkm_INI_nSE_Actual_Convert / MaintCostkm_CND_nAE_Base,1.0),10.0)
MaintCostkm_INI_nSE_Calib_Cal	Initialise MCost calibration variable	D	XTAB(Traffic_Parameters,'TCal_MCost_Calib',dTAG_TL->aadt_est,1000.0)
MaintCostkm_INI_nSE_CCI_Cal	Initialise Construction Cost Index Variable	D	XTAB(Traffic_Parameters,'TCal_MCost_CCI',dTAG_TL->aadt_est,1000.0)
MaintCostkm_RES_nDE_ActualScaling	Reset for Actual Maint Cost scaling	D	1
OBJ_CND_nAE_Crack_ACA	Analysis: Condition, Crack Progression, 'All', Cracking	D	IF((100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Crack_ACA-AVnCND_Crack_ACA))))>50.0,(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Crack_ACA-AVnCND_Crack_ACA))))*100.0/(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Crack_ACA-

	Annual Increment (0-100)		Gen_CON_nSE_0)))),100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Crack_ACA-AVnCND_Crack_ACA))))
OBJ_CND_nAE_Flushing	CHANGE TO RSL Analysis: Condition, Flushing, Area (0-100)	D	IF((100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Flushing-AVnCND_Flushing))))>50.0,(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Flushing-AVnCND_Flushing))))*100.0/(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Flushing-Gen_CON_nSE_0)))),100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Flushing-AVnCND_Flushing))))
OBJ_CND_nAE_IRI	Annual roughness progression	D	IF((100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_IRI-AVnCND_IRI))))>50.0,(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_IRI-AVnCND_IRI))))*100.0/(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_IRI-Gen_CON_nSE_0)))),100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_IRI-AVnCND_IRI))))
OBJ_CND_nAE_PCI	Annual Objective Function Condition	D	(AVnCND_OBJ_Crack_ACA*AVnCND_OBJ_ResSurfLife*(AVnCND_OBJ_IRI*AVnCND_OBJ_Rut)**0.5)**(1.0/3.0)
OBJ_CND_nAE_ResSurfLife	Analysis: Condition, RSL	D	MIN(100.0,IF((100.0-(100.0/(1.0+EXP(0.5*AVnCND_SurfLife_Residual-0.5*SVnCAL_OBJ_ResSurfLife))))>50.0,(100.0-(100.0/(1.0+EXP(0.5*AVnCND_SurfLife_Residual-0.5*SVnCAL_OBJ_ResSurfLife))))*100.0/(100.0-(100.0/(1.0+EXP(2.0)))),100.0-(100.0/(1.0+EXP(0.5*AVnCND_SurfLife_Residual-0.5*SVnCAL_OBJ_ResSurfLife)))))
OBJ_CND_nAE_Rut	Rutting condition	D	IF((100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Rut-AVnCND_Rut))))>50.0,(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Rut-AVnCND_Rut))))*100.0/(100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Rut-Gen_CON_nSE_0)))),100.0-(100.0/(1.0+EXP(SVnCAL_OBJ_Rut-AVnCND_Rut))))
OBJ_CND_nAE_Utility	Analysis: Economics, Objective Utility	D	MIN(100.0,MAX(0.0,(AVnCND_OBJ_PCI**SVnCAL_OBJ_Utility_Alpha)*(SVnCAL_OBJ_Utility_Y**(1.0-SVnCAL_OBJ_Utility_Alpha))))
OBJ_INI_nSE_ACA_Cal	Initialise target lookup to calculate Crack ACA object function	D	XTAB(FGroup_Parameters,'FCal_OBJ_ACA',dTAG_TL->fgroup,99.0)
OBJ_INI_nSE_Flushing_Cal	CHANGE TO RSL Initialise target lookup to calculate Flushing object function	D	XTAB(FGroup_Parameters,'FCal_OBJ_Flushing',dTAG_TL->fgroup,99.0)
OBJ_INI_nSE_IRI_Cal	Initialise target lookup to calculate Roughness object function	D	XTAB(FGroup_Parameters,'FCal_OBJ_IRI',dTAG_TL->fgroup,99.0)
OBJ_INI_nSE_ResSurfLife_Cal	Initialise target lookup to calculate RSL object function	D	XTAB(FGroup_Parameters,'FCal_OBJ_ResSurfLife',dTAG_TL->fgroup,99.0)
OBJ_INI_nSE_Rut_Cal	Initialise target lookup to calculate Rutting object function	D	XTAB(FGroup_Parameters,'FCal_OBJ_Rut',dTAG_TL->fgroup,99.0)
OBJ_INI_nSE_Utility_Alpha_Cal	Initialise Utility function Alpha lookup	D	(SVnCAL_OBJ_Utility_X/SVnCAL_OBJ_Utility_Y)/(1.0+SVnCAL_OBJ_Utility_X/SVnCAL_OBJ_Utility_Y)
OBJ_INI_nSE_Utility_X_Cal	Initialise Utility function X lookup	D	XTAB(FGroup_Parameters,'FCal_OBJ_Utility',dTAG_TL->fgroup,50.0)
OBJ_INI_nSE_Utility_Y_Cal	Initialise Utility function Y lookup	D	50
Patch_CND_nAE	Analysis: Condition, Patches, Area (0-100)	D	AVnCND_Patch
Patch_INI_nSE_Convert	Analysis: Condition, Patches, Convert RAMM Patches	D	IF(dTAG_TL->insp_area <= 0.0,0.0,100.0 * 0.125 * dTAG_TL->hole_patch / dTAG_TL->insp_area)
Pave_CND_nAE_Age	Analysis: Pavement, Age (years)	D	AVnCND_Pave_Age + 1.0
Pave_INI_nSE_Age_Convert	Analysis: Pavement, Age, Initialise (yrs)	D	ROUND((365.0 + (((VAL(RIGHT(XTAB(Local_Setup,'BASEDATE','Value','01/01/1900'),4.0))-1.0)*365.0 + VAL(BEFORATNUM('/',AFTERATNUM('/',(XTAB(Local_Setup,'BASEDATE','Value','01/01/1900')))))*30.0 + VAL(LEFT(XTAB(Local_Setup,'BASEDATE','Value','01/01/1900'),2.0)))) - ((YEAR(dTAG_TL->pave_date)-1.0)*365.0 + MONTH(dTAG_TL->pave_date)*30.0 + DAY(dTAG_TL->pave_date)))/365.0,0.0)

Pave_INI_tDE_TypePave	Analysis: Pavement, Initialise, Type	T	RTRIM(DVtCND_Surf_Type) + RTRIM(SVtCND_Pave_TypeBase)
Pave_INI_tSE_TypeBase_Convert	Analysis: Pavement, Initialise, Base	T	RTRIM(XTAB(HDM4_Constants,RTRIM(dTAG_TL->type_pave),'Value1','ZZ'))
Pave_RES_nDE_Depth	Reset for Pavement depth	D	XTAB(FGroup_Parameters,'FRes_Pave_AvgThickness',dTAG_TL->fgroup,99.0)
PCI_CND_nAE	Analysis; Condition, PCI, 2008 Version	D	MAX(0.0, 100.0 - AVnCND_SII - 4.0 * AVnCND_Rut - 3.0 *AVnCND_IRI - 4.0 * (IF(Surf_CND_bAF_Type_AC_True, 3.0 ,5.0) - AVnCND_Ture))
Pot_CND_nAE	Analysis: Condition, SII, Potholes for 2008 PCI Expression	D	AVnCND_Pot
Pot_INI_nSE_Convert	Analysis: Condition, Potholes, Initialise, Convert RAMM Holes	D	IF(dTAG_TL->insp_area <= 0.0,0.0,100.0 * 0.05 * dTAG_TL->holes / dTAG_TL->insp_area)
Ravelling_CND_nAE	Ravelling model	D	MAX(AVnCND_Ravelling,DVnCND_Surf_OGPA/(1.0+EXP(-0.237*AVnCND_Surf_Age+(2.801-0.02955*AVnCND_SNP-0.139*LOG(365.0*Traffic_CND_nAE_ESA/1000000.0)-1.359*IF(AVnCND_Crack_ACA>0.3,1.0,0.0))/SVnCAL_Ravelling)))
Ravelling_INI_nSE_Cal	Initialise Ravelling calibration variable	D	XTAB(Traffic_Parameters,'TCal_Ravelling',dTAG_TL->aadt_est,1000.0)
Ravelling_INI_nSE_Surf_OGPA	Initialise surface type is OGPA only for Ravelling progression	D	IF(LEFT(dTAG_TL->type_surf,2.0) = 'OG',1.0,0.0)
Rut_CND_nAE	Rutting condition	D	AVnCND_Rut+IF(RutAccelProb_CND_bAF_GT_Thresh,1.4,1.0)*SVnCAL_Rut_KRP*0.1*LOG10(MAX(10.0,AVnCND_Traffic_ESA*365.0))/AVnCND_SNP
Rut_CND_nAE_Exceedence	Analysis: Condition, Rut Exceedence, % greater than threshold	D	(1.0 - IF(Rut_CND_nAE_Exceedence_Variance < -6.0,0.0,IF(Rut_CND_nAE_Exceedence_Variance > 6.0,1.0,IF(Rut_CND_nAE_Exceedence_Variance < 0.0,1.0 - Rut_CND_nAE_Exceedence_N,Rut_CND_nAE_Exceedence_N))))*100.0
Rut_CND_nAE_Exceedence_B	Analysis: Condition, Rut Exceedence, Constant b	D	0.3989423 * EXP(-1.0 * Rut_CND_nAE_Exceedence_Variance ** 2.0 / 2.0)
Rut_CND_nAE_Exceedence_N	Analysis: Condition, Rut Exceedence, Constant n	D	1.0 - Rut_CND_nAE_Exceedence_B * ((((1.330274429 * Rut_CND_nAE_Exceedence_T - 1.821255978) * Rut_CND_nAE_Exceedence_T + 1.781477937) * Rut_CND_nAE_Exceedence_T + -0.356563782) * Rut_CND_nAE_Exceedence_T + 0.31938153) * Rut_CND_nAE_Exceedence_T
Rut_CND_nAE_Exceedence_T	Analysis: Condition, Rut Exceedence, constant t	D	1.0 / (1.0 + ABS(Rut_CND_nAE_Exceedence_Variance) * 0.2316419)
Rut_CND_nAE_Exceedence_Variance	Analysis: Condition, Rutting Variance	D	(SVnCON_Rut_Exceedence_Thresh - AVnCND_Rut)/DVnCND_Rut_StDev
Rut_CND_nDE_PreSealExceedence	Analysis: Condition, Rut Preseal Repair Exceedence, % greater than threshold	D	(1.0 - IF(Rut_CND_nDE_PreSealExceedence_Variance < -6.0,0.0,IF(Rut_CND_nDE_PreSealExceedence_Variance > 6.0,1.0,IF(Rut_CND_nDE_PreSealExceedence_Variance < 0.0,1.0 - Rut_CND_nDE_PreSealExceedence_N,Rut_CND_nDE_PreSealExceedence_N))))*100.0
Rut_CND_nDE_PreSealExceedence_B	Analysis: Condition, Rut Preseal Repair Exceedence, Constant b	D	0.3989423 * EXP(-1.0 * Rut_CND_nDE_PreSealExceedence_Variance ** 2.0 / 2.0)
Rut_CND_nDE_PreSealExceedence_N	Analysis: Condition, Rut Preseal Repair Exceedence, Constant n	D	1.0 - Rut_CND_nDE_PreSealExceedence_B * ((((1.330274429 * Rut_CND_nDE_PreSealExceedence_T - 1.821255978) * Rut_CND_nDE_PreSealExceedence_T + 1.781477937) * Rut_CND_nDE_PreSealExceedence_T + -0.356563782) * Rut_CND_nDE_PreSealExceedence_T + 0.31938153) * Rut_CND_nDE_PreSealExceedence_T
Rut_CND_nDE_PreSealExceedence_T	Analysis: Condition, Rut Preseal Repair Exceedence, constant t	D	1.0 / (1.0 + ABS(Rut_CND_nDE_PreSealExceedence_Variance) * 0.2316419)
Rut_CND_nDE_PreSealExceedence_Variance	Analysis: Condition, Rutting Preseal Repair Variance	D	(SVnTRG_PSEAL_Rut_Exceedance_Thresh - AVnCND_Rut)/DVnCND_Rut_StDev

Rut_INI_nSE_Convert	Initialise RAMM Rutting, Use HSD data is available otherwise use Rating data	D	IF(dTAG_TL->rutm >0.0,dTAG_TL->rutm,IF(dTAG_TL->rut_30>0.0,((0.3666 * MAX(0.0,dTAG_TL->rut_30) / 2.0 * 50.0 / dTAG_TL->insp_length) + 8.4),Rut_RES_nDE+AVnCND_Pave_Age*IF(DVnCND_Pave_Depth<150.0,0.6,0.3)))
Rut_INI_nSE_Exceedence_Thresh	Initialise threshold lookup to calculate Rut exceedence	D	XTAB(FGroup_Parameters,'FThresh_Rut_Exceedence',dTAG_TL->fgroup,99.0)
Rut_INI_nSE_KRP_Cal	Initialise Rut depth progression calibration variable	D	dTAG_TL->KRut
Rut_INI_nSE_StDev_Convert	Analysis: Condition, Rut Standard Deviation, Initialisation. IF HSD Data present use that, otherwise use Rating Data - Not Used	D	IF(dTAG_TL->ruts <= 0.0,(0.21 * Rut_INI_nSE_Convert + 0.69),dTAG_TL->ruts)
Rut_RES_nDE	RHAB treatment reset for rutting	D	MIN(AVnCND_Rut,XTAB(FGroup_Parameters,'FRes_Rut',dTAG_TL->fgroup,99.0))
Rut_RES_nDE_KRP_Cal	Reset Rut depth progression calibration variable after Rehab	D	MIN(SVnCAL_Rut_KRP,XTAB(Traffic_Parameters,'TCal_Rut_KRP_' + RTRIM(dTAG_TL->urb_rural),dTAG_TL->aadt_est,1000.0))
Rut_RES_nDE_PreSeal	Preseal Repair reset for rutting	D	MAX(Rut_RES_nDE, AVnCND_Rut + DVnCND_Rut_StDev * (-0.0000045362 * MIN(Rut_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal,0.0)) ** 3.0 + 0.00004718 * MIN(Rut_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal,0.0)) ** 2.0 - 0.025346 * MIN(Rut_CND_nDE_PreSealExceedence,MAX(SVnTRG_PSEAL_MaxExtent-Crack_CND_nDE_ACA_PreSeal,0.0))))
Rut_RES_nDE_StDev	Reset for Rutting Standard Deviation	D	MIN(DVnCND_Rut_StDev, 0.21 * AVnCND_Rut + 0.69)
RutAccelProb_CND_bAF_GT_Thresh	Test if rutting is in accelatered phase	B	AVnCND_RutAccelProb>SVnCAL_RutAccelProb_Thresh
RutAccelProb_CND_nAE	Analysis: Initialisation, Rut Progression, Probability of accelerated rutting	D	100.0 / (1.0 + EXP(-7.568/1000000.0 * AVnCND_Traffic_ESA * 365.0 + 2.434 * AVnCND_SNP - IF(DVnCND_Pave_Depth < 150.0 And AVnCND_SNP < 2.5,4.426,0.4744)))
RutAccelProb_INI_nSE_Thresh	Threshold lookup for when accelaratedrutting would start	D	XTAB(FGroup_Parameters,'FThresh_RutAccelProb',dTAG_TL->fgroup,99.0)
Safety_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr	B	(DVnTRG_OPT_SafetyYr + SVnTRG_OPT_SafetyInt)<100.0
Safety_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr	D	YR + SVnTRG_OPT_SafetyInt
SafetyMaint_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint + SVnTRG_OPT_SafetyInt_Maint)<100.0
SafetyMaint_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint) And (DVnTRG_OPT_SafetyYr_Maint + SVnTRG_OPT_SafetyInt_Maint)<100.0
SafetyMaint_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL_Area
SafetyMaint_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint
SafetyMaint2_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint2 + SVnTRG_OPT_SafetyInt_Maint2)<100.0
SafetyMaint2_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr	B	(DVnTRG_OPT_SafetyArea_Maint2 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint2) And (DVnTRG_OPT_SafetyYr_Maint2 + SVnTRG_OPT_SafetyInt_Maint2)<100.0

	_Maint if Major treatment		
SafetyMaint2_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL2_Area
SafetyMaint2_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint2
SafetyMaint3_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint3 + SVnTRG_OPT_SafetyInt_Maint3)<100.0
SafetyMaint3_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint3 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint3) And (DVnTRG_OPT_SafetyYr_Maint3 + SVnTRG_OPT_SafetyInt_Maint3)<100.0
SafetyMaint3_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL3_Area
SafetyMaint3_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint3
SafetyMaint4_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint4 + SVnTRG_OPT_SafetyInt_Maint4)<100.0
SafetyMaint4_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint4 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint4) And (DVnTRG_OPT_SafetyYr_Maint4 + SVnTRG_OPT_SafetyInt_Maint4)<100.0
SafetyMaint4_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL4_Area
SafetyMaint4_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint4
SafetyMaint5_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint5 + SVnTRG_OPT_SafetyInt_Maint5)<100.0
SafetyMaint5_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint5 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint5) And (DVnTRG_OPT_SafetyYr_Maint5 + SVnTRG_OPT_SafetyInt_Maint5)<100.0
SafetyMaint5_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL5_Area
SafetyMaint5_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint5
SafetyMaint6_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint6 + SVnTRG_OPT_SafetyInt_Maint6)<100.0
SafetyMaint6_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint6 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint6) And (DVnTRG_OPT_SafetyYr_Maint6 + SVnTRG_OPT_SafetyInt_Maint6)<100.0
SafetyMaint6_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL6_Area
SafetyMaint6_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint6
SafetyMaint7_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint7 + SVnTRG_OPT_SafetyInt_Maint7)<100.0
SafetyMaint7_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint7 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint7) And (DVnTRG_OPT_SafetyYr_Maint7 + SVnTRG_OPT_SafetyInt_Maint7)<100.0

SafetyMaint7_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL7_Area
SafetyMaint7_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint7
SafetyMaint8_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint8 + SVnTRG_OPT_SafetyInt_Maint8)<100.0
SafetyMaint8_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint8 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint8) And (DVnTRG_OPT_SafetyYr_Maint8 + SVnTRG_OPT_SafetyInt_Maint8)<100.0
SafetyMaint8_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL8_Area
SafetyMaint8_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint8
SafetyMaint9_RES_bDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	B	(DVnTRG_OPT_SafetyYr_Maint9 + SVnTRG_OPT_SafetyInt_Maint9)<100.0
SafetyMaint9_RES_bDE_SafetyYr_Maj	Analysis: Reset, TRG_OPT_SafetyYr_Maint if Major treatment	B	(DVnTRG_OPT_SafetyArea_Maint9 = 0.0 Or YR = DVnTRG_OPT_SafetyYr_Maint9) And (DVnTRG_OPT_SafetyYr_Maint9 + SVnTRG_OPT_SafetyInt_Maint9)<100.0
SafetyMaint9_RES_nDE_SafetyArea	Analysis: Reset, TRG_OPT_SafetyArea	D	dTAG_TL->LU_SAL9_Area
SafetyMaint9_RES_nDE_SafetyYr	Analysis: Reset, TRG_OPT_SafetyYr_Maint	D	YR + SVnTRG_OPT_SafetyInt_Maint9
SII_CND_nAE	Analysis: Condition, Surface Integrity Index (0-100)	D	MIN(100.0,AVnCND_SII_CI + AVnCND_SII_AI)
SII_CND_nAE_AI	Analysis; Condition, SII, Age Index, (reviewed in 2008)	D	IF(SurfLife_CND_nAE_Residual>0.0,0.0,0.74*(SurfLife_CND_nAE_Residual)**2.0 - 0.2293*SurfLife_CND_nAE_Residual+0.3637)
SII_CND_nAE_CI	Analysis; Condition, SII, Condition Index, (reviewed in 2008)	D	4.0 * AVnCND_Crack_ACA + 80.0 * (AVnCND_Pot + AVnCND_Patch) + 1.2 * AVnCND_Flushing
SNP_CND_nAE	Analysis: Pavement Structural Number	D	MAX(0.5,0.99*AVnCND_SNP)
SNP_RES_nDE	SNP condition reset	D	MAX(AVnCND_SNP,XTAB(FGroup_Parameters,'FRes_SNP',dTAG_TL->fgroup,99.0))
Surf_CND_bAF_Type_AC_True	Analysis: Surface, Surface Type is asphalt	B	RTRIM(DVtCND_Surf_Type) = 'AC'
Surf_CND_nAE_Age	Analysis: Surface, Age (years)	D	AVnCND_Surf_Age + 1.0
Surf_CND_nAE_AgeCurrent	Analysis: Surface, Age (years)	D	AVnCND_Surf_Age
Surf_INI_bSF_TwoCoat_True	Analysis: Condition, Surface Life, Initialise, ST, Is Two Coat surfacing?	B	XTAB(HDM4_Constants,RTRIM(dTAG_TL->type_surf),'Value2','FALSE') = 'TRUE'
Surf_INI_nSE_Age_Convert	Analysis: Surface, Age, Initialise (yrs)	D	ROUND((365.0 + (((VAL(RIGHT(XTAB(Local_Setup,'BASEDATE','Value','01/01/1900'),4.0))-1.0)*365.0 + VAL(BEFORATNUM('/',AFTERATNUM('/',(XTAB(Local_Setup,'BASEDATE','Value','01/01/1900')))))*30.0 + VAL(LEFT(XTAB(Local_Setup,'BASEDATE','Value','01/01/1900'),2.0)))) - ((YEAR(dTAG_TL->surf_date)-1.0)*365.0 + MONTH(dTAG_TL->surf_date)*30.0 + DAY(dTAG_TL->surf_date)))/365.0,0.0)

Surf_INI_nSE_HNew_Convert	Analysis: Surface, Initialisation, HNEW	D	IF(dTAG_TL->hnew <= 0.0,IF(Surf_CND_bAF_Type_AC_True,20.0,7.0),dTAG_TL->hnew)
Surf_INI_nSE_HOld_Convert	Analysis: Surface, Initialise HOLD, assumes 7mm per seal, Average seal life 7 years, excludes latest surface	D	IF(dTAG_TL->hold <= 0.0,IF(RTRIM(dTAG_TL->type_surf_function) = '1',0.0,IF(RTRIM(dTAG_TL->type_surf_function) = '2',7.0,7.0 * (INT(Pave_INI_nSE_Age_Convert / (7.0 * SurfLife_CAL_nDE_Factor))))),dTAG_TL->hold)
Surf_INI_tSE_Type	Analysis: Surface, Initialise, Type	T	RTRIM(XTAB(HDM4_Constants,RTRIM(dTAG_TL->type_surf) ,'Value1','ZZ'))
Surf_RES_bDE_TwoCoat	Chipseal Reseals are TwoCoat, Always True	B	TRUE
Surf_RES_bDF_TwoCoat	Chipseal Reseals are TwoCoat filter	B	AVnCND_Traffic_AADT >= XTAB(FGroup_Parameters,'FPol_2CHIP_Traffic_Threshold',dTAG_TL->fgroup,99999.0)
Surf_RES_nDE_Chip_AC	Analysis: User Defined, Reset, Chip AC	D	15
Surf_RES_nDE_Chip_CS	Analysis: User Defined, Reset, Chip	D	IF(DVbCND_Surf_TwoCoat,XTAB(Surface_Parameters,'FollowingChipGrade_2CHIP',DVnCND_Surf_Chip,3.0),XTAB(Surface_Parameters,'FollowingChipGrade_1CHIP',DVnCND_Surf_Chip,3.0))
Surf_RES_nDE_Hnew	Analysis: Reset, Surface, Thickness	D	IF(Surf_CND_bAF_Type_AC_True,XTAB(FGroup_Parameters,'FRes_AC_Hnew',dTAG_TL->fgroup,99.0),XTAB(Surface_Parameters,'ALD',DVnCND_Surf_Chip,99.0))
Surf_RES_nDE_Hold	Analysis: Reset, Surface, Thickness, Increase	D	IF(AVnCND_Pave_Age = 0.0,0.0,DVnCND_Surf_Hold + DVnCND_Surf_Hnew)
Surf_RES_nDE_Num	Analysis: Reset, Number of surfaces, Surface, Reseal	D	IF(AVnCND_Pave_Age=0.0,1.0,DVnCND_Surf_Num + 1.0)
Surf_RES_tDE_Function	Reset the type_surf_function based on the last treatment	T	IF(AVnCND_Pave_Age=0.0,'1','R')
Surf_RES_tDE_Type_AC	Surf type reset for AC treatments	T	'AC'
Surf_RES_tDE_Type_CS	Surf type reset for CS treatments	T	'CS'
SurfLife_CAL_nDE_Factor	Analysis: User Defined, Surfacing Life, Adjustment Factor to amend P/17 expected surface lives to reflect local performance	D	IF(Surf_CND_bAF_Type_AC_True,IF(DVnCND_Surf_OGPA=1.0,XTAB(Surface_Parameters,'SurfLifeFactor_OG',1.0,99.0),XTAB(Surface_Parameters,'SurfLifeFactor_AC',1.0,99.0)),IF(DVbCND_Surf_TwoCoat,XTAB(Surface_Parameters,'P17_SurfLifeFactor_2CHIP',DVnCND_Surf_Chip,99.0),XTAB(Surface_Parameters,'P17_SurfLifeFactor_1CHIP',DVnCND_Surf_Chip,99.0)))
SurfLife_CND_bDF_CS1Coat_GT_G5_True	Analysis: Condition, Surface Life, Filter, ST, ALD >= 4.75 or NELV < 300	B	SurfLife_CND_nDE_Chip_ALD >= 4.75 Or AVnCND_Traffic_NELV < 300.0
SurfLife_CND_bDF_CS1Coat_LT_G5_True	Analysis: Condition, Surface Life, Filter, ST, ALD < 4.75 and NELV >= 300	B	SurfLife_CND_nDE_Chip_ALD < 4.75 And AVnCND_Traffic_NELV >= 300.0
SurfLife_CND_bDF_CS2Coat_GT_7K_True	Analysis: Condition, Surface Life, Filter, ST, Two Coat >= 7000 NELV	B	DVbCND_Surf_TwoCoat And AVnCND_Traffic_NELV >= 7000.0
SurfLife_CND_bDF_CS2Coat_LT_7K_True	Analysis: Condition, Surface Life, Filter, ST, Two Coat < 7000 NELV	B	DVbCND_Surf_TwoCoat And AVnCND_Traffic_NELV < 7000.0
SurfLife_CND_nAE	Analysis: Condition, Surface Life	D	DVnCND_SurfLife

SurfLife_CND_nAE_Residual	Analysis: Condition, Surface Life, Residual Surface Life	D	DVnCND_SurfLife - AVnCND_Surf_Age
SurfLife_CND_nDE_AC	Analysis: Condition, Surface Life, AM	D	ROUND(SurfLife_CAL_nDE_Factor * MAX(1.0,28.3 - 4.4 * LOG10(MAX(1.0,AVnCND_Traffic_AADT))),0.0)
SurfLife_CND_nDE_Chip_ALD	Analysis: Condition, Surface Life, ST, Aggregate Average Least Dimension	D	XTAB(Surface_Parameters,'ALD',DVnCND_Surf_Chip,99.0)
SurfLife_CND_nDE_CS1Coat_GT_G5	Analysis: Condition, Surface Life, ST, ALD >= 4.75 or NELV < 300	D	MAX(3.0,ROUND(SurfLife_CAL_nDE_Factor * MAX(1.0,9.948 + SurfLife_CND_nDE_Chip_ALD - 2.824 * LOG10(MAX(1.0,AVnCND_Traffic_NELV/dTAG_TL->lanes))),0.0))
SurfLife_CND_nDE_CS1Coat_LT_G5	Analysis: Condition, Surface Life, ST, ALD < 4.75 and NELV >= 300	D	MAX(3.0,ROUND(SurfLife_CAL_nDE_Factor * MAX(1.0,9.948 + SurfLife_CND_nDE_Chip_ALD - 2.824 * LOG10(MAX(1.0,AVnCND_Traffic_NELV/dTAG_TL->lanes)) - (4.35 - 1.4 * LOG10(MAX(1.0,AVnCND_Traffic_NELV/dTAG_TL->lanes)))),0.0))
SurfLife_CND_nDE_CS2Coat_GT_7K	Analysis: Condition, Surface Life, ST, Two Coat, NELV >=7000	D	MAX(3.0,ROUND(SurfLife_CAL_nDE_Factor * MAX(1.0,26.84 + SurfLife_CND_nDE_Chip_ALD - 6.64 * LOG10(MAX(1.0,AVnCND_Traffic_NELV/dTAG_TL->lanes))),0.0))
SurfLife_CND_nDE_CS2Coat_LT_7K	Analysis: Condition, Surface Life, ST, Two Coat < 7000 NELV	D	MAX(3.0,ROUND(SurfLife_CAL_nDE_Factor * MAX(1.0,11.915 + SurfLife_CND_nDE_Chip_ALD - 2.8 * LOG10(MAX(1.0,AVnCND_Traffic_NELV/dTAG_TL->lanes))),0.0))
SurfLife_INI_bSF_UseRAMM_True	Analysis: User Defined, Use RAMM Surface Life values (True) or use dTIMS CT (P/17) (False) for SURFLIFE initialisation	B	RTRIM(XTAB(Local_Setup,'UseRAMMExpectedSurfaceLife','Value','TRUE')) = 'TRUE'
SurfLife_INI_nSE	Analysis: Condition, Surface Life, Initialisation - Analysis variable can't be used for initialisation	D	IF(SurfLife_INI_bSF_UseRAMM_True,dTAG_TL->surf_expectedlife,IF(Surf_CND_bAF_Type_AC_True,SurfLife_CND_nDE_AC,IF(SurfLife_CND_bDF_CS2Coat_GT_7K_True,SurfLife_CND_nDE_CS2Coat_GT_7K,IF(SurfLife_CND_bDF_CS2Coat_LT_7K_True,SurfLife_CND_nDE_CS2Coat_LT_7K,IF(SurfLife_CND_bDF_CS1Coat_GT_G5_True,SurfLife_CND_nDE_CS1Coat_GT_G5,SurfLife_CND_nDE_CS1Coat_LT_G5)))))
Ture_CND_nAE	Analysis: Condition, Ture (mm)	D	AVnCND_Ture - (DVnCND_Ture_Slope * LOG10((AVnCND_Surf_Age + 1.0) / AVnCND_Surf_Age))
Ture_INI_nDE_Slope	Analysis: Set Ture, Rate of change of mean depth	D	XTAB(Surface_Parameters,'SLOPE_' + RTRIM(DVtCND_Surf_Type),DVnCND_Surf_Chip,-99.0)
Ture_INI_nSE_Convert	Analysis: Condition, Ture, Mean, Initialise	D	IF(dTAG_TL->Ture <= 0.0,Ture_RES_nDE - LOG10(AVnCND_Surf_Age + 1.0) * Ture_INI_nDE_Slope,dTAG_TL->Ture)
Ture_RES_nDE	Analysis: Reset, Condition, Ture, Mean Ture depth (mm)	D	XTAB(Surface_Parameters,'RESET_' + RTRIM(DVtCND_Surf_Type),DVnCND_Surf_Chip,-99.0)
Traffic_CND_nAE_AADT	Analysis: Traffic, AADT - Total (Average Annual Daily Traffic)	D	AVnCND_Traffic_AADT_Bus+ AVnCND_Traffic_AADT_HCV1 + AVnCND_Traffic_AADT_HCV2+ AVnCND_Traffic_AADT_LCV+ AVnCND_Traffic_AADT_MCV+ AVnCND_Traffic_AADT_PC
Traffic_CND_nAE_AADT_Bus	Analysis: Traffic, AADT - Bus	D	(1.0 + SVnCON_Traffic_Growth * (YR - 1.0) / 100.0) * Traffic_INI_nSE_AADT_BUS_Convert
Traffic_CND_nAE_AADT_HCV1	Analysis: Traffic, AADT - Heavy Commercial Veh. Type I	D	(1.0 + SVnCON_Traffic_Growth * (YR - 1.0) / 100.0) * Traffic_INI_nSE_AADT_HCV1_Convert
Traffic_CND_nAE_AADT_HCV2	Analysis: Traffic, AADT - Heavy Commercial Veh. Type II	D	(1.0 + SVnCON_Traffic_Growth * (YR - 1.0) / 100.0) * Traffic_INI_nSE_AADT_HCV2_Convert
Traffic_CND_nAE_AADT_LCV	Analysis: Traffic, AADT - Light Commercial Veh.	D	(1.0 + SVnCON_Traffic_Growth * (YR - 1.0) / 100.0) * Traffic_INI_nSE_AADT_LCV_Convert
Traffic_CND_nAE_AADT_MCV	Analysis: Traffic, AADT - Medium Commercial Veh.	D	(1.0 + SVnCON_Traffic_Growth * (YR - 1.0) / 100.0) * Traffic_INI_nSE_AADT_MCV_Convert

Traffic_CND_nAE_AADT_PC	Analysis: Traffic, AADT - Car	D	(1.0 + SVnCON_Traffic_Growth * (YR - 1.0) / 100.0) * Traffic_INI_nSE_AADT_PC_Convert
Traffic_CND_nAE_ESA	Analysis: Daily Equivalent Standard Axles	D	(AVnCND_Traffic_AADT_MCV * 0.35 + AVnCND_Traffic_AADT_HCV1 * 0.83 + AVnCND_Traffic_AADT_HCV2 * 1.86 + AVnCND_Traffic_AADT_Bus * 0.5) / dTAG_TL->lanes
Traffic_CND_nAE_NELV	Analysis: Traffic, Net Equivalent Light Vehicles	D	(AVnCND_Traffic_AADT_PC + AVnCND_Traffic_AADT_LCV) + 10.0 * (AVnCND_Traffic_AADT_MCV + AVnCND_Traffic_AADT_HCV1 + AVnCND_Traffic_AADT_HCV2 + AVnCND_Traffic_AADT_Bus)
Traffic_INI_nSE_AADT_BUS_Convert	Analysis: Traffic, Initialise AADT - Bus	D	dTAG_TL->aadt_est * dTAG_TL->aadt_pct_bus / 100.0
Traffic_INI_nSE_AADT_HCV1_Convert	Analysis: Traffic, Initialise AADT - Heavy Commercial Veh. Type I	D	dTAG_TL->aadt_est * dTAG_TL->aadt_pct_hcv1 / 100.0
Traffic_INI_nSE_AADT_HCV2_Convert	Analysis: Traffic, Initialise AADT - Heavy Commercial Veh. Type II	D	dTAG_TL->aadt_est * dTAG_TL->aadt_pct_hcv2 / 100.0
Traffic_INI_nSE_AADT_LCV_Convert	Analysis: Traffic, Initialise AADT - Light Commercial Veh.	D	dTAG_TL->aadt_est * dTAG_TL->aadt_pct_lcv / 100.0
Traffic_INI_nSE_AADT_MCV_Convert	Analysis: Traffic, Initialise AADT - Medium Commercial Veh.	D	dTAG_TL->aadt_est * dTAG_TL->aadt_pct_mcv / 100.0
Traffic_INI_nSE_AADT_PC_Convert	Analysis: Traffic, Initialise AADT - Car	D	dTAG_TL->aadt_est * dTAG_TL->aadt_pct_pc / 100.0
Traffic_INI_nSE_Growth	Analysis: Traffic, Growth	D	XTAB(Traffic_Growth_Factors,Traffic_INI_tSE_Growth_Region,SVtCON_Traffic_Growth_Category,99.0)
Traffic_INI_tSE_Growth_Category_Convert	Analysis: Traffic, Growth, whether road is Arterial, Strategic or Other for Traffic Growth - as per Transfund PEM - Table A2.2.2	T	RTRIM(dTAG_TL->urb_rural) + IF((RTRIM(dTAG_TL->urb_rural) = 'U' And dTAG_TL->aadt_est > 7000.0),'A',IF((RTRIM(dTAG_TL->urb_rural) = 'R' And dTAG_TL->aadt_est > 2500.0),'S','O'))
Traffic_INI_tSE_Growth_Region	Analysis: User Defined, Region for Traffic Growth - As per Transfund PEM Table A2.4	T	RTRIM(dTAG_TL->TrafficGrowthRegion)

Treatments:

Trt Key	Name	Type	Int YR	AfterInit	IsInit	PersName	TrigFilt	Over Ride	Template	BudCat	Ancilliary	Order	Ancillary		
											Cost	Order	Filter	FCosExp	ECosExp
											Resets	Order	VarName	ResetFilt	ResetExp
											Subs	Order	Subsequent		
18	ancAC	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_AC_SafetyNot	FALSE	Maintenance Only	PROGRAMME	Ancilliary				
18	ancAC										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
18	ancAC										Cost	1	(none)	ASTreat_TFC_nDE_ancAC	ASTreat_TEC_nDE_ancAC
18	ancAC										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
18	ancAC										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
18	ancAC										Resets	2	AVnCND_Surf_Age	(none)	Gen_CON_nSE_0
18	ancAC										Resets	3	DVtCND_Surf_Function	(none)	Surf_RES_tDE_Function
18	ancAC										Resets	4	DVtCND_Surf_Type	(none)	Surf_RES_tDE_Type_AC
18	ancAC										Resets	5	DVnCND_Surf_Chip	(none)	Surf_RES_nDE_Chip_AC
18	ancAC										Resets	6	DVnCND_Surf_Hnew	(none)	Surf_RES_nDE_Hnew
18	ancAC										Resets	7	DVtCND_Pave_TypePave	(none)	Pave_INI_tDE_TypePave
18	ancAC										Resets	8	DVnCAL_Crack_HDM	(none)	Crack_INI_nDE_HDM_Cal
18	ancAC										Resets	9	DVnCAL_CrackIniProb_KPI	(none)	CrackIniProb_INI_nDE_KPI_Cal
18	ancAC										Resets	10	DVnCAL_CrackIniProb_Thresh	(none)	CrackIniProb_INI_nDE_Thresh
18	ancAC										Resets	11	DVnCND_SurfLife	(none)	SurfLife_CND_nDE_AC
18	ancAC										Resets	12	AVnCND_SurfLife_Residual	(none)	SurfLife_CND_nAE_Residual
18	ancAC										Resets	13	AVnCND_OBJ_ResSurfLife	(none)	OBJ_CND_nAE_ResSurfLife
18	ancAC										Resets	14	DVnCND_Crack_PCA	(none)	Gen_CON_nSE_0
18	ancAC										Resets	15	AVnCND_Crack_ACA	(none)	Gen_CON_nSE_0
18	ancAC										Resets	16	AVnCND_OBJ_Crack_ACA	(none)	OBJ_CND_nAE_Crack_ACA
18	ancAC										Resets	17	AVnCND_Flushing	(none)	Gen_CON_nSE_0
18	ancAC										Resets	18	AVnCND_OBJ_Flushing	(none)	OBJ_CND_nAE_Flushing
18	ancAC										Resets	19	AVnCND_Patch	(none)	Gen_CON_nSE_0
18	ancAC										Resets	20	AVnCND_Pot	(none)	Gen_CON_nSE_0

18	ancAC										Resets	21	AVnCND_Ravelling	(none)	Gen_CON_nSE_0
18	ancAC										Resets	22	DVnCND_Texture_Slope	(none)	Texture_INI_nDE_Slope
18	ancAC										Resets	23	AVnCND_Texture	(none)	Texture_RES_nDE
18	ancAC										Resets	24	AVnCND_SII_AI	(none)	Gen_CON_nSE_0
18	ancAC										Resets	25	AVnCND_SII_CI	(none)	Gen_CON_nSE_0
18	ancAC										Resets	26	AVnCND_SII	(none)	Gen_CON_nSE_0
18	ancAC										Resets	27	AVnCND_CrackIniProb	(none)	CrackIniProb_CND_nAE_AC
18	ancAC										Resets	28	AVnCND_FlushIniProb	(none)	Gen_CON_nSE_0
18	ancAC										Resets	29	AVnCND_MaintCostkm	(none)	MaintCostkm_CND_nAE
18	ancAC										Resets	30	AVnCND_PCI	(none)	PCI_CND_nAE
18	ancAC										Resets	31	AVnCND_OBJ_PCI	(none)	OBJ_CND_nAE_PCI
18	ancAC										Resets	32	AVnCND_OBJ_Utility	(none)	OBJ_CND_nAE_Utility
18	ancAC										Subs				
1	ancAC_RHAB	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bDF_Permit_ancAC_RHAB	FALSE	Maintenance Only	PROGRAMME	Ancilliary				
1	ancAC_RHAB										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualCost
1	ancAC_RHAB										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
1	ancAC_RHAB										Resets	2	AVnCND_Surf_Age	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	3	DVtCND_Surf_Function	(none)	Surf_RES_tDE_Function
1	ancAC_RHAB										Resets	4	DVtCND_Surf_Type	(none)	Surf_RES_tDE_Type_AC
1	ancAC_RHAB										Resets	5	DVnCND_Surf_Chip	(none)	Surf_RES_nDE_Chip_AC
1	ancAC_RHAB										Resets	6	DVnCND_Surf_Num	(none)	Surf_RES_nDE_Num
1	ancAC_RHAB										Resets	7	DVnCND_Surf_Hnew	(none)	Surf_RES_nDE_Hnew
1	ancAC_RHAB										Resets	8	DVnCND_Surf_Hold	(none)	Surf_RES_nDE_Hold
1	ancAC_RHAB										Resets	9	DVtCND_Pave_TypePave	(none)	Pave_INI_tDE_TypePave
1	ancAC_RHAB										Resets	10	DVnCAL_Crack_HDM	(none)	Crack_INI_nDE_HDM_Cal
1	ancAC_RHAB										Resets	11	DVnCAL_CrackIniProb_KPI	(none)	CrackIniProb_INI_nDE_KPI_Cal
1	ancAC_RHAB										Resets	12	DVnCAL_CrackIniProb_Thresh	(none)	CrackIniProb_INI_nDE_Thresh
1	ancAC_RHAB										Resets	13	DVnCND_SurfLife	(none)	SurfLife_CND_nDE_AC

1	ancAC_RHAB										Resets	14	AVnCND_SurfLife_Residual	(none)	SurfLife_CND_nAE_Residual
1	ancAC_RHAB										Resets	15	AVnCND_OBJ_ResSurfLife	(none)	OBJ_CND_nAE_ResSurfLife
1	ancAC_RHAB										Resets	16	DVnCND_Crack_PCA	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	17	AVnCND_Crack_ACA	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	18	AVnCND_OBJ_Crack_ACA	(none)	OBJ_CND_nAE_Crack_ACA
1	ancAC_RHAB										Resets	19	AVnCND_Flushing	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	20	AVnCND_OBJ_Flushing	(none)	OBJ_CND_nAE_Flushing
1	ancAC_RHAB										Resets	21	AVnCND_Patch	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	22	AVnCND_Pot	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	23	AVnCND_Ravelling	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	24	DVnCND_Texture_Slope	(none)	Texture_INI_nDE_Slope
1	ancAC_RHAB										Resets	25	AVnCND_Texture	(none)	Texture_RES_nDE
1	ancAC_RHAB										Resets	26	AVnCND_SII_AI	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	27	AVnCND_SII_CI	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	28	AVnCND_SII	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	29	AVnCND_CrackIniProb	(none)	CrackIniProb_CND_nAE_AC
1	ancAC_RHAB										Resets	30	AVnCND_FlushIniProb	(none)	Gen_CON_nSE_0
1	ancAC_RHAB										Resets	31	AVnCND_MaintCostkm	(none)	MaintCostkm_CND_nAE
1	ancAC_RHAB										Resets	32	AVnCND_PCI	(none)	PCI_CND_nAE
1	ancAC_RHAB										Resets	33	AVnCND_OBJ_PCI	(none)	OBJ_CND_nAE_PCI
1	ancAC_RHAB										Resets	34	AVnCND_OBJ_Utility	(none)	OBJ_CND_nAE_Utility
1	ancAC_RHAB										Subs				
28	ancAC_Safety	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_AC_Safety	FALSE	Maintenance Only	SAFETY	Ancilliary				
28	ancAC_Safety										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
28	ancAC_Safety										Cost	1	(none)	ASTreat_TFC_nDE_ancAC	ASTreat_TEC_nDE_ancAC
28	ancAC_Safety										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
28	ancAC_Safety										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
28	ancAC_Safety										Resets	2	AVnCND_Surf_Age	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	3	DVtCND_Surf_Function	(none)	Surf_RES_tDE_Function
28	ancAC_Safety										Resets	4	DVtCND_Surf_Type	(none)	Surf_RES_tDE_Type_AC

28	ancAC_Safety										Resets	5	DVnCND_Surf_Chip	(none)	Surf_RES_nDE_Chip_AC
28	ancAC_Safety										Resets	6	DVnCND_Surf_Hnew	(none)	Surf_RES_nDE_Hnew
28	ancAC_Safety										Resets	7	DVtCND_Pave_TypePave	(none)	Pave_INI_tDE_TypePave
28	ancAC_Safety										Resets	8	DVnCAL_Crack_HDM	(none)	Crack_INI_nDE_HDM_Cal
28	ancAC_Safety										Resets	9	DVnCAL_CrackIniProb_KPI	(none)	CrackIniProb_INI_nDE_KPI_Cal
28	ancAC_Safety										Resets	10	DVnCAL_CrackIniProb_Thresh	(none)	CrackIniProb_INI_nDE_Thresh
28	ancAC_Safety										Resets	11	DVnCND_SurfLife	(none)	SurfLife_CND_nDE_AC
28	ancAC_Safety										Resets	12	AVnCND_SurfLife_Residual	(none)	SurfLife_CND_nAE_Residual
28	ancAC_Safety										Resets	13	AVnCND_OBJ_ResSurfLife	(none)	OBJ_CND_nAE_ResSurfLife
28	ancAC_Safety										Resets	14	DVnCND_Crack_PCA	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	15	AVnCND_Crack_ACA	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	16	AVnCND_OBJ_Crack_ACA	(none)	OBJ_CND_nAE_Crack_ACA
28	ancAC_Safety										Resets	17	AVnCND_Flushing	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	18	AVnCND_OBJ_Flushing	(none)	OBJ_CND_nAE_Flushing
28	ancAC_Safety										Resets	19	AVnCND_Patch	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	20	AVnCND_Pot	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	21	AVnCND_Ravelling	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	22	DVnCND_Texture_Slope	(none)	Texture_INI_nDE_Slope
28	ancAC_Safety										Resets	23	AVnCND_Texture	(none)	Texture_RES_nDE
28	ancAC_Safety										Resets	24	AVnCND_SII_AI	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	25	AVnCND_SII_CI	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	26	AVnCND_SII	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	27	AVnCND_CrackIniProb	(none)	CrackIniProb_CND_nAE_AC
28	ancAC_Safety										Resets	28	AVnCND_FlushIniProb	(none)	Gen_CON_nSE_0
28	ancAC_Safety										Resets	29	AVnCND_MaintCostkm	(none)	MaintCostkm_CND_nAE
28	ancAC_Safety										Resets	30	AVnCND_PCI	(none)	PCI_CND_nAE
28	ancAC_Safety										Resets	31	AVnCND_OBJ_PCI	(none)	OBJ_CND_nAE_PCI
28	ancAC_Safety										Resets	32	AVnCND_OBJ_Utility	(none)	OBJ_CND_nAE_Utility
28	ancAC_Safety										Subs				
17	ancCS	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_CS_SafetyNot	FALSE	Maintenance Only	PROGRAMME	Ancilliary				

17	ancCS										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
17	ancCS										Cost	1	(none)	ASTreat_TFC_nDE_ancCS	ASTreat_TEC_nDE_ancCS
17	ancCS										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
17	ancCS										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
17	ancCS										Resets	2	AVnCND_Surf_Age	(none)	Gen_CON_nSE_0
17	ancCS										Resets	3	DVtCND_Surf_Function	(none)	Surf_RES_tDE_Function
17	ancCS										Resets	4	DVtCND_Surf_Type	(none)	Surf_RES_tDE_Type_CS
17	ancCS										Resets	5	DVbCND_Surf_TwoCoat	Surf_RES_bDF_TwoCoat	Surf_RES_bDE_TwoCoat
17	ancCS										Resets	6	DVnCND_Surf_Chip	(none)	Surf_RES_nDE_Chip_CS
17	ancCS										Resets	7	DVnCND_Surf_OGPA	(none)	Gen_CON_nSE_0
17	ancCS										Resets	8	DVnCND_Surf_Num	(none)	Surf_RES_nDE_Num
17	ancCS										Resets	9	DVnCND_Surf_Hold	(none)	Surf_RES_nDE_Hold
17	ancCS										Resets	10	DVnCND_Surf_Hnew	(none)	Surf_RES_nDE_Hnew
17	ancCS										Resets	11	DVtCND_Pave_TypePave	(none)	Pave_INI_tDE_TypePave
17	ancCS										Resets	12	DVnCAL_Crack_HDM	(none)	Crack_INI_nDE_HDM_Cal
17	ancCS										Resets	13	DVnCAL_CrackIniProb_KPI	(none)	CrackIniProb_INI_nDE_KPI_Cal
17	ancCS										Resets	14	DVnCAL_CrackIniProb_Thresh	(none)	CrackIniProb_INI_nDE_Thresh
17	ancCS										Resets	15	DVnCND_SurfLife	SurfLife_CND_bDF_CS2Coat_GT_7K_True	SurfLife_CND_nDE_CS2Coat_GT_7K
17	ancCS										Resets	16	DVnCND_SurfLife	SurfLife_CND_bDF_CS2Coat_LT_7K_True	SurfLife_CND_nDE_CS2Coat_LT_7K
17	ancCS										Resets	17	DVnCND_SurfLife	SurfLife_CND_bDF_CS1Coat_GT_G5_True	SurfLife_CND_nDE_CS1Coat_GT_G5
17	ancCS										Resets	18	DVnCND_SurfLife	SurfLife_CND_bDF_CS1Coat_LT_G5_True	SurfLife_CND_nDE_CS1Coat_LT_G5
17	ancCS										Resets	19	AVnCND_SurfLife_Residual	(none)	SurfLife_CND_nAE_Residual
17	ancCS										Resets	20	AVnCND_OBJ_ResSurfLife	(none)	OBJ_CND_nAE_ResSurfLife
17	ancCS										Resets	21	DVnCND_Crack_PCA	(none)	Gen_CON_nSE_0
17	ancCS										Resets	22	AVnCND_Crack_ACA	(none)	Gen_CON_nSE_0

17	ancCS										Resets	23	AVnCND_OBJ_Crack_ACA	(none)	OBJ_CND_nAE_Crack_ACA
17	ancCS										Resets	24	AVnCND_Flushing	(none)	Gen_CON_nSE_0
17	ancCS										Resets	25	AVnCND_OBJ_Flushing	(none)	OBJ_CND_nAE_Flushing
17	ancCS										Resets	26	AVnCND_Patch	(none)	Gen_CON_nSE_0
17	ancCS										Resets	27	AVnCND_Pot	(none)	Gen_CON_nSE_0
17	ancCS										Resets	28	AVnCND_Ravelling	(none)	Gen_CON_nSE_0
17	ancCS										Resets	29	DVnCND_Texture_Slope	(none)	Texture_INI_nDE_Slope
17	ancCS										Resets	30	AVnCND_Texture	(none)	Texture_RES_nDE
17	ancCS										Resets	31	AVnCND_SII_AI	(none)	Gen_CON_nSE_0
17	ancCS										Resets	32	AVnCND_SII_CI	(none)	Gen_CON_nSE_0
17	ancCS										Resets	33	AVnCND_SII	(none)	Gen_CON_nSE_0
17	ancCS										Resets	34	AVnCND_CrackIniProb	(none)	CrackIniProb_CND_nAE_CS
17	ancCS										Resets	35	AVnCND_FlushIniProb	(none)	FlushIniProb_CND_nAE
17	ancCS										Resets	36	AVnCND_MaintCostkm	(none)	MaintCostkm_CND_nAE
17	ancCS										Resets	37	AVnCND_PCI	(none)	PCI_CND_nAE
17	ancCS										Resets	38	AVnCND_OBJ_PCI	(none)	OBJ_CND_nAE_PCI
17	ancCS										Resets	39	AVnCND_OBJ_Utility	(none)	OBJ_CND_nAE_Utility
17	ancCS										Subs				
7	ancCS_RHAB	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bDF_Permit_ancCS_RHAB	FALSE	Maintenance Only	PROGRAMME	Ancilliary				
7	ancCS_RHAB										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
7	ancCS_RHAB										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
7	ancCS_RHAB										Resets	2	AVnCND_Surf_Age	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	3	DVtCND_Surf_Function	(none)	Surf_RES_tDE_Function
7	ancCS_RHAB										Resets	4	DVtCND_Surf_Type	(none)	Surf_RES_tDE_Type_CS
7	ancCS_RHAB										Resets	5	DVbCND_Surf_TwoCoat	Surf_RES_bDF_TwoCoat	Surf_RES_bDE_TwoCoat
7	ancCS_RHAB										Resets	6	DVnCND_Surf_Chip	(none)	Surf_RES_nDE_Chip_CS
7	ancCS_RHAB										Resets	7	DVnCND_Surf_OGPA	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	8	DVnCND_Surf_Num	(none)	Surf_RES_nDE_Num
7	ancCS_RHAB										Resets	9	DVnCND_Surf_Hold	(none)	Surf_RES_nDE_Hold

7	ancCS_RHAB										Resets	10	DVnCND_Surf_Hnew	(none)	Surf_RES_nDE_Hnew
7	ancCS_RHAB										Resets	11	DVtCND_Pave_TypePave	(none)	Pave_INI_tDE_TypePave
7	ancCS_RHAB										Resets	12	DVnCAL_Crack_HDM	(none)	Crack_INI_nDE_HDM_Cal
7	ancCS_RHAB										Resets	13	DVnCAL_CrackIniProb_KPI	(none)	CrackIniProb_INI_nDE_KPI_Cal
7	ancCS_RHAB										Resets	14	DVnCAL_CrackIniProb_Thresh	(none)	CrackIniProb_INI_nDE_Thresh
7	ancCS_RHAB										Resets	15	DVnCND_SurfLife	SurfLife_CND_bDF_CS2Coat_GT_7K_True	SurfLife_CND_nDE_CS2Coat_GT_7K
7	ancCS_RHAB										Resets	16	DVnCND_SurfLife	SurfLife_CND_bDF_CS2Coat_LT_7K_True	SurfLife_CND_nDE_CS2Coat_LT_7K
7	ancCS_RHAB										Resets	17	DVnCND_SurfLife	SurfLife_CND_bDF_CS1Coat_GT_G5_True	SurfLife_CND_nDE_CS1Coat_GT_G5
7	ancCS_RHAB										Resets	18	DVnCND_SurfLife	SurfLife_CND_bDF_CS1Coat_LT_G5_True	SurfLife_CND_nDE_CS1Coat_LT_G5
7	ancCS_RHAB										Resets	19	AVnCND_SurfLife_Residual	(none)	SurfLife_CND_nAE_Residual
7	ancCS_RHAB										Resets	20	AVnCND_OBJ_ResSurfLife	(none)	OBJ_CND_nAE_ResSurfLife
7	ancCS_RHAB										Resets	21	DVnCND_Crack_PCA	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	22	AVnCND_Crack_ACA	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	23	AVnCND_OBJ_Crack_ACA	(none)	OBJ_CND_nAE_Crack_ACA
7	ancCS_RHAB										Resets	24	AVnCND_Flushing	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	25	AVnCND_OBJ_Flushing	(none)	OBJ_CND_nAE_Flushing
7	ancCS_RHAB										Resets	26	AVnCND_Patch	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	27	AVnCND_Pot	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	28	AVnCND_Ravelling	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	29	DVnCND_Texture_Slope	(none)	Texture_INI_nDE_Slope
7	ancCS_RHAB										Resets	30	AVnCND_Texture	(none)	Texture_RES_nDE
7	ancCS_RHAB										Resets	31	AVnCND_SII_AI	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	32	AVnCND_SII_CI	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	33	AVnCND_SII	(none)	Gen_CON_nSE_0
7	ancCS_RHAB										Resets	34	AVnCND_CrackIniProb	(none)	CrackIniProb_CND_nAE_CS
7	ancCS_RHAB										Resets	35	AVnCND_FlushIniProb	(none)	FlushIniProb_CND_nAE

7	ancCS_RHAB										Resets	36	AVnCND_MaintCostkm	(none)	MaintCostkm_CND_nAE
7	ancCS_RHAB										Resets	37	AVnCND_PCI	(none)	PCI_CND_nAE
7	ancCS_RHAB										Resets	38	AVnCND_OBJ_PCI	(none)	OBJ_CND_nAE_PCI
7	ancCS_RHAB										Resets	39	AVnCND_OBJ_Utility	(none)	OBJ_CND_nAE_Utility
7	ancCS_RHAB										Subs				
29	ancCS_Safety	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_CS_Safety	FALSE	Maintenance Only	SAFETY	Ancilliary				
29	ancCS_Safety										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
29	ancCS_Safety										Cost	1	(none)	ASTreat_TFC_nDE_ancCS	ASTreat_TEC_nDE_ancCS
29	ancCS_Safety										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
29	ancCS_Safety										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
29	ancCS_Safety										Resets	2	AVnCND_Surf_Age	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	3	DVtCND_Surf_Function	(none)	Surf_RES_tDE_Function
29	ancCS_Safety										Resets	4	DVtCND_Surf_Type	(none)	Surf_RES_tDE_Type_CS
29	ancCS_Safety										Resets	5	DVbCND_Surf_TwoCoat	Surf_RES_bDF_TwoCoat	Surf_RES_bDE_TwoCoat
29	ancCS_Safety										Resets	6	DVnCND_Surf_Chip	(none)	Surf_RES_nDE_Chip_CS
29	ancCS_Safety										Resets	7	DVnCND_Surf_OGPA	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	8	DVnCND_Surf_Num	(none)	Surf_RES_nDE_Num
29	ancCS_Safety										Resets	9	DVnCND_Surf_Hold	(none)	Surf_RES_nDE_Hold
29	ancCS_Safety										Resets	10	DVnCND_Surf_Hnew	(none)	Surf_RES_nDE_Hnew
29	ancCS_Safety										Resets	11	DVtCND_Pave_TypePave	(none)	Pave_INI_tDE_TypePave
29	ancCS_Safety										Resets	12	DVnCAL_Crack_HDM	(none)	Crack_INI_nDE_HDM_Cal
29	ancCS_Safety										Resets	13	DVnCAL_CrackIniProb_KPI	(none)	CrackIniProb_INI_nDE_KPI_Cal
29	ancCS_Safety										Resets	14	DVnCAL_CrackIniProb_Thresh	(none)	CrackIniProb_INI_nDE_Thresh
29	ancCS_Safety										Resets	15	DVnCND_SurfLife	SurfLife_CND_bDF_CS2Coat_GT_7K_True	SurfLife_CND_nDE_CS2Coat_GT_7K
29	ancCS_Safety										Resets	16	DVnCND_SurfLife	SurfLife_CND_bDF_CS2Coat_LT_7K_True	SurfLife_CND_nDE_CS2Coat_LT_7K
29	ancCS_Safety										Resets	17	DVnCND_SurfLife	SurfLife_CND_bDF_CS1Coat_GT_G5_True	SurfLife_CND_nDE_CS1Coat_GT_G5

29	ancCS_Safety										Resets	18	DVnCND_SurfLife	SurfLife_CND_bDF_CS1Coat_LT_G5_True	SurfLife_CND_nDE_CS1Coat_LT_G5
29	ancCS_Safety										Resets	19	AVnCND_SurfLife_Residual	(none)	SurfLife_CND_nAE_Residual
29	ancCS_Safety										Resets	20	AVnCND_OBJ_ResSurfLife	(none)	OBJ_CND_nAE_ResSurfLife
29	ancCS_Safety										Resets	21	DVnCND_Crack_PCA	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	22	AVnCND_Crack_ACA	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	23	AVnCND_OBJ_Crack_ACA	(none)	OBJ_CND_nAE_Crack_ACA
29	ancCS_Safety										Resets	24	AVnCND_Flushing	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	25	AVnCND_OBJ_Flushing	(none)	OBJ_CND_nAE_Flushing
29	ancCS_Safety										Resets	26	AVnCND_Patch	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	27	AVnCND_Pot	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	28	AVnCND_Ravelling	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	29	DVnCND_Texture_Slope	(none)	Texture_INI_nDE_Slope
29	ancCS_Safety										Resets	30	AVnCND_Texture	(none)	Texture_RES_nDE
29	ancCS_Safety										Resets	31	AVnCND_SII_AI	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	32	AVnCND_SII_CI	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	33	AVnCND_SII	(none)	Gen_CON_nSE_0
29	ancCS_Safety										Resets	34	AVnCND_CrackIniProb	(none)	CrackIniProb_CND_nAE_CS
29	ancCS_Safety										Resets	35	AVnCND_FlushIniProb	(none)	FlushIniProb_CND_nAE
29	ancCS_Safety										Resets	36	AVnCND_MaintCostkm	(none)	MaintCostkm_CND_nAE
29	ancCS_Safety										Resets	37	AVnCND_PCI	(none)	PCI_CND_nAE
29	ancCS_Safety										Resets	38	AVnCND_OBJ_PCI	(none)	OBJ_CND_nAE_PCI
29	ancCS_Safety										Resets	39	AVnCND_OBJ_Utility	(none)	OBJ_CND_nAE_Utility
29	ancCS_Safety										Subs				
37	ancDoSomething	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_DoSomething	FALSE	Maintenance Only	ROUTINE	Ancilliary				
37	ancDoSomething										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
37	ancDoSomething										Resets	0	DVbTRG_OPT_SUB_DoSomething	(none)	Gen_CON_bSF_Never
37	ancDoSomething										Subs				
25	ancPSEAL	Ancillary	1	FALSE	FALSE	dTAG_TL	Gen_CON_bSF_Always	FALSE	Maintenance Only	ROUTINE	Ancilliary				
25	ancPSEAL										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0

25	ancPSEAL										Cost	1	(none)	ASTreat_TFC_nDE_ancPSEAL	ASTreat_TFC_nDE_ancPSEAL
25	ancPSEAL										Resets	0	AVnCND_IRI	(none)	IRI_RES_nDE_PreSeal
25	ancPSEAL										Resets	1	AVnCND_OBJ_IRI	(none)	OBJ_CND_nAE_IRI
25	ancPSEAL										Resets	2	DVnCND_IRI_StDev	(none)	IRI_RES_nDE_StDev
25	ancPSEAL										Resets	3	AVnCND_IRI_Exceedence	(none)	IRI_CND_nAE_Exceedence
25	ancPSEAL										Resets	4	AVnCND_Rut	(none)	Rut_RES_nDE_PreSeal
25	ancPSEAL										Resets	5	AVnCND_OBJ_Rut	(none)	OBJ_CND_nAE_Rut
25	ancPSEAL										Resets	6	DVnCND_Rut_StDev	(none)	Rut_RES_nDE_StDev
25	ancPSEAL										Resets	7	AVnCND_Rut_Exceedence	(none)	Rut_CND_nAE_Exceedence
25	ancPSEAL										Subs				
4	ancRHAB	Ancillary	1	FALSE	FALSE	dTAG_TL	Gen_CON_bSF_Always	FALSE	Maintenance Only	PROGRAMME	Ancilliary				
4	ancRHAB										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
4	ancRHAB										Cost	1	ASTreat_TRG_bAF_AC_Permitted	ASTreat_TFC_nDE_ancRHAB_AC	ASTreat_TEC_nDE_ancRHAB_AC
4	ancRHAB										Cost	2	(none)	ASTreat_TFC_nDE_ancRHAB_CS	ASTreat_TEC_nDE_ancRHAB_CS
4	ancRHAB										Resets	0	AVnCND_Pave_Age	(none)	Gen_CON_nSE_0
4	ancRHAB										Resets	1	DVnCND_Pave_Depth	(none)	Pave_RES_nDE_Depth
4	ancRHAB										Resets	2	AVnCND_SNP	(none)	SNP_RES_nDE
4	ancRHAB										Resets	3	AVnCND_Deflection	(none)	Deflection_RES_nDE
4	ancRHAB										Resets	4	DVnCND_MaintCostkm_ActualScaling	(none)	MaintCostkm_RES_nDE_ActualScaling
4	ancRHAB										Resets	5	SVnCAL_IRI_KGE	(none)	IRI_RES_nDE_KGE_Cal
4	ancRHAB										Resets	6	AVnCND_IRI	(none)	IRI_RES_nDE
4	ancRHAB										Resets	7	AVnCND_OBJ_IRI	(none)	OBJ_CND_nAE_IRI
4	ancRHAB										Resets	8	DVnCND_IRI_StDev	(none)	IRI_RES_nDE_StDev
4	ancRHAB										Resets	9	AVnCND_IRI_Exceedence	(none)	IRI_CND_nAE_Exceedence
4	ancRHAB										Resets	10	SVnCAL_Rut_KRP	(none)	Rut_RES_nDE_KRP_Cal
4	ancRHAB										Resets	11	AVnCND_Rut	(none)	Rut_RES_nDE
4	ancRHAB										Resets	12	AVnCND_OBJ_Rut	(none)	OBJ_CND_nAE_Rut
4	ancRHAB										Resets	13	DVnCND_Rut_StDev	(none)	Rut_RES_nDE_StDev

4	ancRHAB										Resets	14	AVnCND_Rut_Exceedence	(none)	Rut_CND_nAE_Exceedence
4	ancRHAB										Resets	15	AVnCND_RutAccelProb	(none)	RutAccelProb_CND_nAE
4	ancRHAB										Subs				
34	ancRoutineSafety	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety	FALSE	Maintenance Only	SAFETY	Ancilliary				
34	ancRoutineSafety										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
34	ancRoutineSafety										Cost	1	(none)	ASTreat_TFC_nDE_RTNE_Safety	ASTreat_TEC_nDE_RTNE_Safety
34	ancRoutineSafety										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
34	ancRoutineSafety										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
34	ancRoutineSafety										Subs				
36	ancRoutineSafety2	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety2	FALSE	Maintenance Only	SAFETY	Ancilliary				
36	ancRoutineSafety2										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
36	ancRoutineSafety2										Cost	1	(none)	ASTreat_TFC_nDE_RTNE_Safety2	ASTreat_TEC_nDE_RTNE_Safety2
36	ancRoutineSafety2										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
36	ancRoutineSafety2										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
36	ancRoutineSafety2										Subs				
38	ancRoutineSafety3	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety3	FALSE	Maintenance Only	SAFETY	Ancilliary				
38	ancRoutineSafety3										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
38	ancRoutineSafety3										Cost	1	(none)	ASTreat_TFC_nDE_RTNE_Safety3	ASTreat_TEC_nDE_RTNE_Safety3
38	ancRoutineSafety3										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
38	ancRoutineSafety3										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
38	ancRoutineSafety3										Subs				
39	ancRoutineSafety4	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety4	FALSE	Maintenance Only	SAFETY	Ancilliary				
39	ancRoutineSafety4										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
39	ancRoutineSafety4										Cost	1	(none)	ASTreat_TFC_nDE_RTNE_Safety4	ASTreat_TEC_nDE_RTNE_Safety4
39	ancRoutineSafety4										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
39	ancRoutineSafety4										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost

39	ancRoutineSafety4										Subs					
40	ancRoutineSafety5	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety5	FALSE	Maintenance Only	SAFETY	Ancilliary					
40	ancRoutineSafety5										Cost		0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
40	ancRoutineSafety5										Cost		1	(none)	ASTreat_TFC_nDE_RTNE_Safety5	ASTreat_TEC_nDE_RTNE_Safety5
40	ancRoutineSafety5										Resets		0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
40	ancRoutineSafety5										Resets		1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
40	ancRoutineSafety5										Subs					
41	ancRoutineSafety6	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety6	FALSE	Maintenance Only	SAFETY	Ancilliary					
41	ancRoutineSafety6										Cost		0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
41	ancRoutineSafety6										Cost		1	(none)	ASTreat_TFC_nDE_RTNE_Safety6	ASTreat_TEC_nDE_RTNE_Safety6
41	ancRoutineSafety6										Resets		0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
41	ancRoutineSafety6										Resets		1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
41	ancRoutineSafety6										Subs					
42	ancRoutineSafety7	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety7	FALSE	Maintenance Only	SAFETY	Ancilliary					
42	ancRoutineSafety7										Cost		0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
42	ancRoutineSafety7										Cost		1	(none)	ASTreat_TFC_nDE_RTNE_Safety7	ASTreat_TEC_nDE_RTNE_Safety7
42	ancRoutineSafety7										Resets		0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
42	ancRoutineSafety7										Resets		1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
42	ancRoutineSafety7										Subs					
43	ancRoutineSafety8	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety8	FALSE	Maintenance Only	SAFETY	Ancilliary					
43	ancRoutineSafety8										Cost		0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
43	ancRoutineSafety8										Cost		1	(none)	ASTreat_TFC_nDE_RTNE_Safety8	ASTreat_TEC_nDE_RTNE_Safety8
43	ancRoutineSafety8										Resets		0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
43	ancRoutineSafety8										Resets		1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
43	ancRoutineSafety8										Subs					
44	ancRoutineSafety9	Ancillary	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety9	FALSE	Maintenance Only	SAFETY	Ancilliary					

44	ancRoutineSafety9										Cost	0	ASTreat_TFC_bDF_IsProj	Gen_CON_nSE_0	Gen_CON_nSE_0
44	ancRoutineSafety9										Cost	1	(none)	ASTreat_TFC_nDE_RTNE_Safety9	ASTreat_TEC_nDE_RTNE_Safety9
44	ancRoutineSafety9										Resets	0	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
44	ancRoutineSafety9										Resets	1	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
44	ancRoutineSafety9										Subs				
10	ancSUBS_ResetAC	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_AC_SafetyNot	FALSE	Maintenance Only	ROUTINE	Ancilliary				
10	ancSUBS_ResetAC										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
10	ancSUBS_ResetAC										Resets	0	DVnTRG_OPT_SUB_Pinch_SurfAge	AS_Opt_TRG_bAF_RHAB_Pinch1	Surf_CND_nAE_AgeCurrent
10	ancSUBS_ResetAC										Resets	1	DVnTRG_OPT_SUB_Pinch_SurfLife	AS_Opt_TRG_bAF_RHAB_Pinch1	SurfLife_CND_nAE
10	ancSUBS_ResetAC										Resets	2	DVnTRG_OPT_SUB_Pinch_ACA	AS_Opt_TRG_bAF_RHAB_Pinch1	Crack_CND_nAE_ACA_Current
10	ancSUBS_ResetAC										Resets	3	AVbTRG_OPT_SUB_Pinch	(none)	AS_Opt_TRG_bAF_RHAB_Pinch2
10	ancSUBS_ResetAC										Resets	4	DVnTRG_OPT_SUB_Pinch_SAL_SurfAge	AS_Opt_TRG_bAF_RHAB_Pinch1	Surf_CND_nAE_AgeCurrent
10	ancSUBS_ResetAC										Resets	5	DVnTRG_OPT_SUB_Pinch_SAL_SurfLife	AS_Opt_TRG_bAF_RHAB_Pinch1	SurfLife_CND_nAE
10	ancSUBS_ResetAC										Resets	6	AVbTRG_OPT_SUB_Pinch_SAL	(none)	AS_Opt_TRG_bAF_RHAB_Pinch3
10	ancSUBS_ResetAC										Resets	7	DVnTRG_OPT_SUB_AC_ACA	AS_Opt_TRG_bAF_AC_ACA	AS_Opt_RES_nDE_SUB_AC_ACA
10	ancSUBS_ResetAC										Resets	8	DVnTRG_OPT_SUB_AC_Ravelling	AS_Opt_TRG_bAF_AC_Ravelling	AS_Opt_RES_nDE_SUB_AC_Ravelling
10	ancSUBS_ResetAC										Resets	9	DVnTRG_OPT_SUB_CS_ACA	(none)	Gen_CON_nSE_0
10	ancSUBS_ResetAC										Resets	10	DVnTRG_OPT_SUB_CS_Flushing	(none)	Gen_CON_nSE_0
10	ancSUBS_ResetAC										Subs				
31	ancSUBS_ResetAC_Safety	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_AC_Safety	FALSE	Maintenance Only	ROUTINE	Ancilliary				
31	ancSUBS_ResetAC_Safety										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
31	ancSUBS_ResetAC_Safety										Resets	0	DVnTRG_OPT_SUB_Pinch_SAL_SurfAge	AS_Opt_TRG_bAF_RHAB_Pinch1	Surf_CND_nAE_AgeCurrent
31	ancSUBS_ResetAC_Safety										Resets	1	DVnTRG_OPT_SUB_Pinch_SAL_SurfLife	AS_Opt_TRG_bAF_RHAB_Pinch1	SurfLife_CND_nAE

31	ancSUBS_ResetAC_Safety										Resets	2	AVbTRG_OPT_SUB_Pinch_SAL	(none)	AS_Opt_TRG_bAF_RHAB_Pinch3
31	ancSUBS_ResetAC_Safety										Subs				
23	ancSUBS_ResetCS	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_CS_SafetyNot	FALSE	Maintenance Only	ROUTINE	Ancilliary				
23	ancSUBS_ResetCS										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
23	ancSUBS_ResetCS										Resets	0	DVnTRG_OPT_SUB_Pinch_SurfAge	AS_Opt_TRG_bAF_RHAB_Pinch1	Surf_CND_nAE_AgeCurrent
23	ancSUBS_ResetCS										Resets	1	DVnTRG_OPT_SUB_Pinch_SurfLife	AS_Opt_TRG_bAF_RHAB_Pinch1	SurfLife_CND_nAE
23	ancSUBS_ResetCS										Resets	2	DVnTRG_OPT_SUB_Pinch_ACA	AS_Opt_TRG_bAF_RHAB_Pinch1	Crack_CND_nAE_ACA_Current
23	ancSUBS_ResetCS										Resets	3	AVbTRG_OPT_SUB_Pinch	(none)	AS_Opt_TRG_bAF_RHAB_Pinch2
23	ancSUBS_ResetCS										Resets	4	DVnTRG_OPT_SUB_Pinch_SAL_SurfAge	AS_Opt_TRG_bAF_RHAB_Pinch1	Surf_CND_nAE_AgeCurrent
23	ancSUBS_ResetCS										Resets	5	DVnTRG_OPT_SUB_Pinch_SAL_SurfLife	AS_Opt_TRG_bAF_RHAB_Pinch1	SurfLife_CND_nAE
23	ancSUBS_ResetCS										Resets	6	AVbTRG_OPT_SUB_Pinch_SAL	(none)	AS_Opt_TRG_bAF_RHAB_Pinch3
23	ancSUBS_ResetCS										Resets	7	DVnTRG_OPT_SUB_CS_ACA	AS_Opt_TRG_bAF_CS_ACA	AS_Opt_RES_nDE_SUB_CS_ACA
23	ancSUBS_ResetCS										Resets	8	DVnTRG_OPT_SUB_CS_Flushing	AS_Opt_TRG_bAF_CS_Flushing	AS_Opt_RES_nDE_SUB_CS_Flushing
23	ancSUBS_ResetCS										Resets	9	DVnTRG_OPT_SUB_AC_ACA	(none)	Gen_CON_nSE_0
23	ancSUBS_ResetCS										Resets	10	DVnTRG_OPT_SUB_AC_Ravelling	(none)	Gen_CON_nSE_0
23	ancSUBS_ResetCS										Subs				
32	ancSUBS_ResetCS_Safety	Ancillary	1	FALSE	FALSE	dTAG_TL	AS_Opt_TRG_bAF_CS_Safety	FALSE	Maintenance Only	ROUTINE	Ancilliary				
32	ancSUBS_ResetCS_Safety										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
32	ancSUBS_ResetCS_Safety										Resets	0	DVnTRG_OPT_SUB_Pinch_SAL_SurfAge	AS_Opt_TRG_bAF_RHAB_Pinch1	Surf_CND_nAE_AgeCurrent
32	ancSUBS_ResetCS_Safety										Resets	1	DVnTRG_OPT_SUB_Pinch_SAL_SurfLife	AS_Opt_TRG_bAF_RHAB_Pinch1	SurfLife_CND_nAE
32	ancSUBS_ResetCS_Safety										Resets	2	AVbTRG_OPT_SUB_Pinch_SAL	(none)	AS_Opt_TRG_bAF_RHAB_Pinch3
32	ancSUBS_ResetCS_Safety										Subs				
24	ancSUBS_ResetRHAB	Ancillary	1	FALSE	FALSE	dTAG_TL	Gen_CON_bSF_Always	FALSE	Maintenance Only	ROUTINE	Ancilliary				
24	ancSUBS_ResetRHAB										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0

24	ancSUBS_ResetRHAB										Resets	0	DVnTRG_OPT_SUB_Pinch_SurfAge	(none)	Gen_CON_nSE_100
24	ancSUBS_ResetRHAB										Resets	1	DVnTRG_OPT_SUB_Pinch_SurfLife	(none)	Gen_CON_nSE_100
24	ancSUBS_ResetRHAB										Resets	2	DVnTRG_OPT_SUB_Pinch_ACA	(none)	Gen_CON_nSE_0
24	ancSUBS_ResetRHAB										Resets	3	AVbTRG_OPT_SUB_Pinch	(none)	Gen_CON_bSF_Never
24	ancSUBS_ResetRHAB										Resets	4	DVnTRG_OPT_SUB_Pinch_SAL_SurfAge	(none)	Gen_CON_nSE_100
24	ancSUBS_ResetRHAB										Resets	5	DVnTRG_OPT_SUB_Pinch_SAL_SurfLife	(none)	Gen_CON_nSE_100
24	ancSUBS_ResetRHAB										Resets	6	AVbTRG_OPT_SUB_Pinch_SAL	(none)	Gen_CON_bSF_Never
24	ancSUBS_ResetRHAB										Resets	7	DVnTRG_OPT_SUB_RHAB_IRI	AS_Opt_TRG_bAF_RHAB_IRI	AS_Opt_RES_nDE_SUB_RHAB_IRI
24	ancSUBS_ResetRHAB										Resets	8	DVnTRG_OPT_SUB_RHAB_Rut	AS_Opt_TRG_bAF_RHAB_Rut	AS_Opt_RES_nDE_SUB_RHAB_Rut
24	ancSUBS_ResetRHAB										Resets	9	DVnTRG_OPT_SUB_AC_ACA	(none)	Gen_CON_nSE_0
24	ancSUBS_ResetRHAB										Resets	10	DVnTRG_OPT_SUB_AC_Ravelling	(none)	Gen_CON_nSE_0
24	ancSUBS_ResetRHAB										Resets	11	DVnTRG_OPT_SUB_CS_ACA	(none)	Gen_CON_nSE_0
24	ancSUBS_ResetRHAB										Resets	12	DVnTRG_OPT_SUB_CS_Flushing	(none)	Gen_CON_nSE_0
24	ancSUBS_ResetRHAB										Subs				
3	majAC	Major	1	FALSE	TRUE	dTAG_TL	AS_Opt_TRG_bAF_AC	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancDoSomething		
3	majAC										Ancilliary	1	ancSUBS_ResetAC		
3	majAC										Ancilliary	2	ancSUBS_ResetAC_Safety		
3	majAC										Ancilliary	3	ancPSEAL		
3	majAC										Ancilliary	4	ancAC		
3	majAC										Ancilliary	5	ancAC_Safety		
3	majAC										Ancilliary	6	ancRoutineSafety		
3	majAC										Ancilliary	7	ancRoutineSafety2		
3	majAC										Ancilliary	8	ancRoutineSafety3		
3	majAC										Ancilliary	9	ancRoutineSafety4		
3	majAC										Ancilliary	10	ancRoutineSafety5		
3	majAC										Ancilliary	11	ancRoutineSafety6		
3	majAC										Ancilliary	12	ancRoutineSafety7		
3	majAC										Ancilliary	13	ancRoutineSafety8		

3	majAC										Ancilliary	14	ancRoutineSafety9		
3	majAC										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
3	majAC										Resets	0	DVnTRG_OPT_SafetyYr	Safety_RES_bDE_SafetyYr	Safety_RES_nDE_SafetyYr
3	majAC										Resets	1	DVnTRG_OPT_SafetyYr_Maint	SafetyMaint_RES_bDE_SafetyYr_Maj	SafetyMaint_RES_nDE_SafetyYr
3	majAC										Resets	2	DVnTRG_OPT_SafetyArea_Maint	(none)	Gen_CON_nSE_0
3	majAC										Resets	3	DVnTRG_OPT_SafetyYr_Maint2	SafetyMaint2_RES_bDE_SafetyYr_Maj	SafetyMaint2_RES_nDE_SafetyYr
3	majAC										Resets	4	DVnTRG_OPT_SafetyArea_Maint2	(none)	Gen_CON_nSE_0
3	majAC										Resets	5	DVnTRG_OPT_SafetyYr_Maint3	SafetyMaint3_RES_bDE_SafetyYr_Maj	SafetyMaint3_RES_nDE_SafetyYr
3	majAC										Resets	6	DVnTRG_OPT_SafetyArea_Maint3	(none)	Gen_CON_nSE_0
3	majAC										Resets	7	DVnTRG_OPT_SafetyYr_Maint4	SafetyMaint4_RES_bDE_SafetyYr_Maj	SafetyMaint4_RES_nDE_SafetyYr
3	majAC										Resets	8	DVnTRG_OPT_SafetyArea_Maint4	(none)	Gen_CON_nSE_0
3	majAC										Resets	9	DVnTRG_OPT_SafetyYr_Maint5	SafetyMaint5_RES_bDE_SafetyYr_Maj	SafetyMaint5_RES_nDE_SafetyYr
3	majAC										Resets	10	DVnTRG_OPT_SafetyArea_Maint5	(none)	Gen_CON_nSE_0
3	majAC										Resets	11	DVnTRG_OPT_SafetyYr_Maint6	SafetyMaint6_RES_bDE_SafetyYr_Maj	SafetyMaint6_RES_nDE_SafetyYr
3	majAC										Resets	12	DVnTRG_OPT_SafetyArea_Maint6	(none)	Gen_CON_nSE_0
3	majAC										Resets	13	DVnTRG_OPT_SafetyYr_Maint7	SafetyMaint7_RES_bDE_SafetyYr_Maj	SafetyMaint7_RES_nDE_SafetyYr
3	majAC										Resets	14	DVnTRG_OPT_SafetyArea_Maint7	(none)	Gen_CON_nSE_0
3	majAC										Resets	15	DVnTRG_OPT_SafetyYr_Maint8	SafetyMaint8_RES_bDE_SafetyYr_Maj	SafetyMaint8_RES_nDE_SafetyYr
3	majAC										Resets	16	DVnTRG_OPT_SafetyArea_Maint8	(none)	Gen_CON_nSE_0
3	majAC										Resets	17	DVnTRG_OPT_SafetyYr_Maint9	SafetyMaint9_RES_bDE_SafetyYr_Maj	SafetyMaint9_RES_nDE_SafetyYr
3	majAC										Resets	18	DVnTRG_OPT_SafetyArea_Maint9	(none)	Gen_CON_nSE_0
3	majAC										Subs	0	majAC		
3	majAC										Subs	1	majRHAB		
3	majAC										Subs	2	majCS		
9	majCS	Major	1	FALSE	TRUE	dTAG_TL	AS_Opt_TRG_bAF_CS	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancDoSomething		

9	majCS										Ancilliary	1	ancSUBS_ResetCS		
9	majCS										Ancilliary	2	ancSUBS_ResetCS_Safety		
9	majCS										Ancilliary	3	ancPSEAL		
9	majCS										Ancilliary	4	ancCS		
9	majCS										Ancilliary	5	ancCS_Safety		
9	majCS										Ancilliary	6	ancRoutineSafety		
9	majCS										Ancilliary	7	ancRoutineSafety2		
9	majCS										Ancilliary	8	ancRoutineSafety3		
9	majCS										Ancilliary	9	ancRoutineSafety4		
9	majCS										Ancilliary	10	ancRoutineSafety5		
9	majCS										Ancilliary	11	ancRoutineSafety6		
9	majCS										Ancilliary	12	ancRoutineSafety7		
9	majCS										Ancilliary	13	ancRoutineSafety8		
9	majCS										Ancilliary	14	ancRoutineSafety9		
9	majCS										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
9	majCS										Resets	0	DVnTRG_OPT_SafetyYr	Safety_RES_bDE_SafetyYr	Safety_RES_nDE_SafetyYr
9	majCS										Resets	1	DVnTRG_OPT_SafetyYr_Maint	SafetyMaint_RES_bDE_SafetyYr_Maj	SafetyMaint_RES_nDE_SafetyYr
9	majCS										Resets	2	DVnTRG_OPT_SafetyArea_Maint	(none)	Gen_CON_nSE_0
9	majCS										Resets	3	DVnTRG_OPT_SafetyYr_Maint2	SafetyMaint2_RES_bDE_SafetyYr_Maj	SafetyMaint2_RES_nDE_SafetyYr
9	majCS										Resets	4	DVnTRG_OPT_SafetyArea_Maint2	(none)	Gen_CON_nSE_0
9	majCS										Resets	5	DVnTRG_OPT_SafetyYr_Maint3	SafetyMaint3_RES_bDE_SafetyYr_Maj	SafetyMaint3_RES_nDE_SafetyYr
9	majCS										Resets	6	DVnTRG_OPT_SafetyArea_Maint3	(none)	Gen_CON_nSE_0
9	majCS										Resets	7	DVnTRG_OPT_SafetyYr_Maint4	SafetyMaint4_RES_bDE_SafetyYr_Maj	SafetyMaint4_RES_nDE_SafetyYr
9	majCS										Resets	8	DVnTRG_OPT_SafetyArea_Maint4	(none)	Gen_CON_nSE_0
9	majCS										Resets	9	DVnTRG_OPT_SafetyYr_Maint5	SafetyMaint5_RES_bDE_SafetyYr_Maj	SafetyMaint5_RES_nDE_SafetyYr
9	majCS										Resets	10	DVnTRG_OPT_SafetyArea_Maint5	(none)	Gen_CON_nSE_0
9	majCS										Resets	11	DVnTRG_OPT_SafetyYr_Maint6	SafetyMaint6_RES_bDE_SafetyYr_Maj	SafetyMaint6_RES_nDE_SafetyYr
9	majCS										Resets	12	DVnTRG_OPT_SafetyArea_Maint6	(none)	Gen_CON_nSE_0

9	majCS										Resets	13	DVnTRG_OPT_SafetyYr_Maint7	SafetyMaint7_RES_bDE_SafetyYr_Maj	SafetyMaint7_RES_nDE_SafetyYr
9	majCS										Resets	14	DVnTRG_OPT_SafetyArea_Maint7	(none)	Gen_CON_nSE_0
9	majCS										Resets	15	DVnTRG_OPT_SafetyYr_Maint8	SafetyMaint8_RES_bDE_SafetyYr_Maj	SafetyMaint8_RES_nDE_SafetyYr
9	majCS										Resets	16	DVnTRG_OPT_SafetyArea_Maint8	(none)	Gen_CON_nSE_0
9	majCS										Resets	17	DVnTRG_OPT_SafetyYr_Maint9	SafetyMaint9_RES_bDE_SafetyYr_Maj	SafetyMaint9_RES_nDE_SafetyYr
9	majCS										Resets	18	DVnTRG_OPT_SafetyArea_Maint9	(none)	Gen_CON_nSE_0
9	majCS										Subs	0	majRHAB		
9	majCS										Subs	1	majAC		
9	majCS										Subs	2	majCS		
6	majRHAB	Major	1	FALSE	TRUE	dTAG_TL	AS_Opt_TRG_bAF_RHAB	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancSUBS_ResetRHAB		
6	majRHAB										Ancilliary	1	ancRHAB		
6	majRHAB										Ancilliary	2	ancAC_RHAB		
6	majRHAB										Ancilliary	3	ancCS_RHAB		
6	majRHAB										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
6	majRHAB										Resets	0	DVnTRG_OPT_SafetyYr	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	1	DVbCND_SAL_Flush	(none)	Gen_CON_bSF_Never
6	majRHAB										Resets	2	DVnTRG_OPT_SafetyYr_Maint	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	3	DVnTRG_OPT_SafetyArea_Maint	(none)	Gen_CON_nSE_0
6	majRHAB										Resets	4	DVnTRG_OPT_SafetyYr_Maint2	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	5	DVnTRG_OPT_SafetyArea_Maint2	(none)	Gen_CON_nSE_0
6	majRHAB										Resets	6	DVnTRG_OPT_SafetyYr_Maint3	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	7	DVnTRG_OPT_SafetyArea_Maint3	(none)	Gen_CON_nSE_0
6	majRHAB										Resets	8	DVnTRG_OPT_SafetyYr_Maint4	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	9	DVnTRG_OPT_SafetyArea_Maint4	(none)	Gen_CON_nSE_0
6	majRHAB										Resets	10	DVnTRG_OPT_SafetyYr_Maint5	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	11	DVnTRG_OPT_SafetyArea_Maint5	(none)	Gen_CON_nSE_0
6	majRHAB										Resets	12	DVnTRG_OPT_SafetyYr_Maint6	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	13	DVnTRG_OPT_SafetyArea_Maint6	(none)	Gen_CON_nSE_0

6	majRHAB										Resets	14	DVnTRG_OPT_SafetyYr_Maint7	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	15	DVnTRG_OPT_SafetyArea_Maint7	(none)	Gen_CON_nSE_0
6	majRHAB										Resets	16	DVnTRG_OPT_SafetyYr_Maint8	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	17	DVnTRG_OPT_SafetyArea_Maint8	(none)	Gen_CON_nSE_0
6	majRHAB										Resets	18	DVnTRG_OPT_SafetyYr_Maint9	(none)	Gen_CON_nSE_100
6	majRHAB										Resets	19	DVnTRG_OPT_SafetyArea_Maint9	(none)	Gen_CON_nSE_0
6	majRHAB										Subs	0	majRHAB		
6	majRHAB										Subs	1	majAC		
6	majRHAB										Subs	2	majCS		
12	min2ndCoat	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_2ndCoat	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancCS		
12	min2ndCoat										Cost	0	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
12	min2ndCoat										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
12	min2ndCoat										Resets	1	DVnTRG_OPT_SafetyYr	Safety_RES_bDE_SafetyYr	Safety_RES_nDE_SafetyYr
12	min2ndCoat										Resets	2	DVnTRG_OPT_SafetyYr_Maint	SafetyMaint_RES_bDE_SafetyYr_Maj	SafetyMaint_RES_nDE_SafetyYr
12	min2ndCoat										Resets	3	DVnTRG_OPT_SafetyArea_Maint	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	4	DVnTRG_OPT_SafetyYr_Maint2	SafetyMaint2_RES_bDE_SafetyYr_Maj	SafetyMaint2_RES_nDE_SafetyYr
12	min2ndCoat										Resets	5	DVnTRG_OPT_SafetyArea_Maint2	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	6	DVnTRG_OPT_SafetyYr_Maint3	SafetyMaint3_RES_bDE_SafetyYr_Maj	SafetyMaint3_RES_nDE_SafetyYr
12	min2ndCoat										Resets	7	DVnTRG_OPT_SafetyArea_Maint3	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	8	DVnTRG_OPT_SafetyYr_Maint4	SafetyMaint4_RES_bDE_SafetyYr_Maj	SafetyMaint4_RES_nDE_SafetyYr
12	min2ndCoat										Resets	9	DVnTRG_OPT_SafetyArea_Maint4	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	10	DVnTRG_OPT_SafetyYr_Maint5	SafetyMaint5_RES_bDE_SafetyYr_Maj	SafetyMaint5_RES_nDE_SafetyYr
12	min2ndCoat										Resets	11	DVnTRG_OPT_SafetyArea_Maint5	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	12	DVnTRG_OPT_SafetyYr_Maint6	SafetyMaint6_RES_bDE_SafetyYr_Maj	SafetyMaint6_RES_nDE_SafetyYr
12	min2ndCoat										Resets	13	DVnTRG_OPT_SafetyArea_Maint6	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	14	DVnTRG_OPT_SafetyYr_Maint7	SafetyMaint7_RES_bDE_SafetyYr_Maj	SafetyMaint7_RES_nDE_SafetyYr

12	min2ndCoat										Resets	15	DVnTRG_OPT_SafetyArea_Maint7	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	16	DVnTRG_OPT_SafetyYr_Maint8	SafetyMaint8_RES_bDE_SafetyYr_Maj	SafetyMaint8_RES_nDE_SafetyYr
12	min2ndCoat										Resets	17	DVnTRG_OPT_SafetyArea_Maint8	(none)	Gen_CON_nSE_0
12	min2ndCoat										Resets	18	DVnTRG_OPT_SafetyYr_Maint9	SafetyMaint9_RES_bDE_SafetyYr_Maj	SafetyMaint9_RES_nDE_SafetyYr
12	min2ndCoat										Resets	19	DVnTRG_OPT_SafetyArea_Maint9	(none)	Gen_CON_nSE_0
12	min2ndCoat										Subs				
2	minAC	Minor	1	FALSE	FALSE	dTAG_TL	AS_Trig_TRG_bAF_AC	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancPSEAL		
2	minAC										Ancilliary	1	ancAC		
2	minAC										Ancilliary	2	ancAC_Safety		
2	minAC										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancAC
2	minAC										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
2	minAC										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
2	minAC										Subs				
19	minACBD	Minor	1	FALSE	FALSE	dTAG_TL	AS_BDay_TRG_bAF_AC	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancPSEAL		
19	minACBD										Ancilliary	1	ancAC		
19	minACBD										Ancilliary	2	ancAC_Safety		
19	minACBD										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancAC
19	minACBD										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
19	minACBD										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
19	minACBD										Subs				
8	minCS	Minor	1	FALSE	FALSE	dTAG_TL	AS_Trig_TRG_bAF_CS	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancPSEAL		
8	minCS										Ancilliary	1	ancCS		
8	minCS										Ancilliary	2	ancCS_Safety		
8	minCS										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancCS
8	minCS										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
8	minCS										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
8	minCS										Subs				
20	minCSBD	Minor	1	FALSE	FALSE	dTAG_TL	AS_BDay_TRG_bAF_CS	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancPSEAL		
20	minCSBD										Ancilliary	1	ancCS		

20	minCSBD										Ancilliary	2	ancCS_Safety		
20	minCSBD										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancCS
20	minCSBD										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
20	minCSBD										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
20	minCSBD										Subs				
5	minRHAB	Minor	1	FALSE	FALSE	dTAG_TL	AS_Trig_TRG_bAF_RHAB	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancRHAB		
5	minRHAB										Ancilliary	1	ancAC_RHAB		
5	minRHAB										Ancilliary	2	ancCS_RHAB		
5	minRHAB										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancRHAB
5	minRHAB										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
5	minRHAB										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
5	minRHAB										Subs				
21	minRHABBDcom	Minor	1	FALSE	FALSE	dTAG_TL	AS_BDay_TRG_bAF_RHAB	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancRHAB		
21	minRHABBDcom										Ancilliary	1	ancAC_RHAB		
21	minRHABBDcom										Ancilliary	2	ancCS_RHAB		
21	minRHABBDcom										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancRHAB
21	minRHABBDcom										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
21	minRHABBDcom										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
21	minRHABBDcom										Subs				
11	minRoutine	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE	FALSE	Maintenance Only	ROUTINE	Ancilliary				
11	minRoutine										Cost	0	(none)	ASTreat_TFC_nDE_RTNE	ASTreat_TFC_nDE_RTNE
11	minRoutine										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
11	minRoutine										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
11	minRoutine										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
11	minRoutine										Resets	3	AVnCND_Crack_ACA	Crack_RES_bDF_ACA_RTNE	Crack_RES_nDE_ACA_RTNE
11	minRoutine										Resets	4	AVnCND_OBJ_Crack_ACA	(none)	OBJ_CND_nAE_Crack_ACA
11	minRoutine										Resets	5	AVnCND_PCI	(none)	PCI_CND_nAE
11	minRoutine										Resets	6	AVnCND_OBJ_PCI	(none)	OBJ_CND_nAE_PCI
11	minRoutine										Resets	7	AVnCND_OBJ_Utility	(none)	OBJ_CND_nAE_Utility

11	minRoutine										Subs				
33	minRoutineSafety	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety	FALSE	Maintenance Only	SAFETY	Ancilliary				
33	minRoutineSafety										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety	ASTreat_TEC_nDE_RTNE_Safety
33	minRoutineSafety										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
33	minRoutineSafety										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
33	minRoutineSafety										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
33	minRoutineSafety										Resets	3	DVnTRG_OPT_SafetyYr_Maint	SafetyMaint_RES_bDE_SafetyYr	SafetyMaint_RES_nDE_SafetyYr
33	minRoutineSafety										Resets	4	DVnTRG_OPT_SafetyArea_Maint	(none)	SafetyMaint_RES_nDE_SafetyArea
33	minRoutineSafety										Resets	5	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
33	minRoutineSafety										Subs				
35	minRoutineSafety2	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety2	FALSE	Maintenance Only	SAFETY	Ancilliary				
35	minRoutineSafety2										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety2	ASTreat_TEC_nDE_RTNE_Safety2
35	minRoutineSafety2										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
35	minRoutineSafety2										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
35	minRoutineSafety2										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
35	minRoutineSafety2										Resets	3	DVnTRG_OPT_SafetyYr_Maint2	SafetyMaint2_RES_bDE_SafetyYr	SafetyMaint2_RES_nDE_SafetyYr
35	minRoutineSafety2										Resets	4	DVnTRG_OPT_SafetyArea_Maint2	(none)	SafetyMaint2_RES_nDE_SafetyArea
35	minRoutineSafety2										Subs				
45	minRoutineSafety3	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety3	FALSE	Maintenance Only	SAFETY	Ancilliary				
45	minRoutineSafety3										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety3	ASTreat_TEC_nDE_RTNE_Safety3
45	minRoutineSafety3										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
45	minRoutineSafety3										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
45	minRoutineSafety3										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
45	minRoutineSafety3										Resets	3	DVnTRG_OPT_SafetyYr_Maint3	SafetyMaint3_RES_bDE_SafetyYr	SafetyMaint3_RES_nDE_SafetyYr
45	minRoutineSafety3										Resets	4	DVnTRG_OPT_SafetyArea_Maint3	(none)	SafetyMaint3_RES_nDE_SafetyArea

45	minRoutineSafety3										Subs				
46	minRoutineSafety4	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety4	FALSE	Maintenance Only	SAFETY	Ancilliary				
46	minRoutineSafety4										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety4	ASTreat_TEC_nDE_RTNE_Safety4
46	minRoutineSafety4										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
46	minRoutineSafety4										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
46	minRoutineSafety4										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
46	minRoutineSafety4										Resets	3	DVnTRG_OPT_SafetyYr_Maint4	SafetyMaint4_RES_bDE_SafetyYr	SafetyMaint4_RES_nDE_SafetyYr
46	minRoutineSafety4										Resets	4	DVnTRG_OPT_SafetyArea_Maint4	(none)	SafetyMaint4_RES_nDE_SafetyArea
46	minRoutineSafety4										Subs				
47	minRoutineSafety5	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety5	FALSE	Maintenance Only	SAFETY	Ancilliary				
47	minRoutineSafety5										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety5	ASTreat_TEC_nDE_RTNE_Safety5
47	minRoutineSafety5										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
47	minRoutineSafety5										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
47	minRoutineSafety5										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
47	minRoutineSafety5										Resets	3	DVnTRG_OPT_SafetyYr_Maint5	SafetyMaint5_RES_bDE_SafetyYr	SafetyMaint5_RES_nDE_SafetyYr
47	minRoutineSafety5										Resets	4	DVnTRG_OPT_SafetyArea_Maint5	(none)	SafetyMaint5_RES_nDE_SafetyArea
47	minRoutineSafety5										Subs				
48	minRoutineSafety6	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety6	FALSE	Maintenance Only	SAFETY	Ancilliary				
48	minRoutineSafety6										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety6	ASTreat_TEC_nDE_RTNE_Safety6
48	minRoutineSafety6										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
48	minRoutineSafety6										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
48	minRoutineSafety6										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
48	minRoutineSafety6										Resets	3	DVnTRG_OPT_SafetyYr_Maint6	SafetyMaint6_RES_bDE_SafetyYr	SafetyMaint6_RES_nDE_SafetyYr
48	minRoutineSafety6										Resets	4	DVnTRG_OPT_SafetyArea_Maint6	(none)	SafetyMaint6_RES_nDE_SafetyArea
48	minRoutineSafety6										Subs				

49	minRoutineSafety7	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety7	FALSE	Maintenance Only	SAFETY	Ancilliary				
49	minRoutineSafety7										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety7	ASTreat_TEC_nDE_RTNE_Safety7
49	minRoutineSafety7										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
49	minRoutineSafety7										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
49	minRoutineSafety7										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
49	minRoutineSafety7										Resets	3	DVnTRG_OPT_SafetyYr_Maint7	SafetyMaint7_RES_bDE_SafetyYr	SafetyMaint7_RES_nDE_SafetyYr
49	minRoutineSafety7										Resets	4	DVnTRG_OPT_SafetyArea_Maint7	(none)	SafetyMaint7_RES_nDE_SafetyArea
49	minRoutineSafety7										Subs				
50	minRoutineSafety8	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety8	FALSE	Maintenance Only	SAFETY	Ancilliary				
50	minRoutineSafety8										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety8	ASTreat_TEC_nDE_RTNE_Safety8
50	minRoutineSafety8										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
50	minRoutineSafety8										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
50	minRoutineSafety8										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
50	minRoutineSafety8										Resets	3	DVnTRG_OPT_SafetyYr_Maint8	SafetyMaint8_RES_bDE_SafetyYr	SafetyMaint8_RES_nDE_SafetyYr
50	minRoutineSafety8										Resets	4	DVnTRG_OPT_SafetyArea_Maint8	(none)	SafetyMaint8_RES_nDE_SafetyArea
50	minRoutineSafety8										Subs				
51	minRoutineSafety9	Minor	1	FALSE	FALSE	dTAG_TL	ASTreat_TRG_bAF_RTNE_Safety9	FALSE	Maintenance Only	SAFETY	Ancilliary				
51	minRoutineSafety9										Cost	0	(none)	ASTreat_TFC_nDE_RTNE_Safety9	ASTreat_TEC_nDE_RTNE_Safety9
51	minRoutineSafety9										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
51	minRoutineSafety9										Resets	1	AVnECO_AnnualEcoCost	(none)	ECO_nAE_AnnualEcoCost
51	minRoutineSafety9										Resets	2	AVnECO_AnnualCost	(none)	ECO_nAE_AnnualCost
51	minRoutineSafety9										Resets	3	DVnTRG_OPT_SafetyYr_Maint9	SafetyMaint9_RES_bDE_SafetyYr	SafetyMaint9_RES_nDE_SafetyYr
51	minRoutineSafety9										Resets	4	DVnTRG_OPT_SafetyArea_Maint9	(none)	SafetyMaint9_RES_nDE_SafetyArea
51	minRoutineSafety9										Subs				
13	specAC	Minor	1	FALSE	FALSE	dTAG_TL	AS_Spec_TRG_bAF_AC	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancPSEAL		

13	specAC										Ancilliary	1	ancAC		
13	specAC										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancAC
13	specAC										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
13	specAC										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
13	specAC										Subs				
14	specCS	Minor	1	FALSE	FALSE	dTAG_TL	AS_Spec_TRG_bAF_CS	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancPSEAL		
14	specCS										Ancilliary	1	ancCS		
14	specCS										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancCS
14	specCS										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
14	specCS										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
14	specCS										Subs				
15	specRHAB	Minor	1	FALSE	FALSE	dTAG_TL	AS_Spec_TRG_bAF_RHAB	FALSE	Maintenance Only	PROGRAMME	Ancilliary	0	ancRHAB		
15	specRHAB										Ancilliary	1	ancAC_RHAB		
15	specRHAB										Ancilliary	2	ancCS_RHAB		
15	specRHAB										Cost	0	ASTreat_TFC_bDF_IsComCost	ASTreat_TFC_nDE_Com	ASTreat_TEC_nDE_ancRHAB
15	specRHAB										Cost	1	(none)	Gen_CON_nSE_0	Gen_CON_nSE_0
15	specRHAB										Resets	0	AVnTRG_Treat_Count	(none)	ASTreat_RES_nDE_Count
15	specRHAB										Subs				

Budgets - CS and Rural Set

YR		VH	H	N	L	VL	LC
1	2015	999,999,999	999,999,999	999,999,999	999,999,999	999,999,999	41,198,344
2	2016	104,000,000	94,500,000	85,000,000	83,500,000	83,500,000	83,426,990
3	2017	104,000,000	94,500,000	85,000,000	73,644,444	70,500,000	70,462,602
4	2018	104,000,000	94,500,000	85,000,000	73,644,444	57,960,000	36,779,563
5	2019	104,000,000	94,500,000	85,000,000	73,644,444	57,960,000	43,073,259
6	2020	104,000,000	94,500,000	85,000,000	73,644,444	57,960,000	44,915,491
7	2021	104,000,000	94,500,000	85,000,000	73,644,444	57,960,000	55,635,241
8	2022	104,000,000	94,500,000	85,000,000	77,400,000	77,400,000	77,367,753
9	2023	104,000,000	94,500,000	85,000,000	82,300,000	82,300,000	82,292,085
10	2024	104,000,000	94,500,000	85,000,000	73,644,444	66,300,000	66,219,965
11	2025	104,000,000	94,500,000	85,000,000	73,644,444	57,960,000	49,128,732
12	2026	104,000,000	94,500,000	85,000,000	73,644,444	61,300,000	61,215,289
13	2027	104,000,000	94,500,000	85,000,000	73,644,444	60,900,000	60,844,352
14	2028	104,000,000	94,500,000	85,000,000	75,500,000	68,600,000	68,592,194
15	2029	104,000,000	94,500,000	85,000,000	75,500,000	66,000,000	46,786,039
16	2030	104,000,000	94,500,000	85,000,000	75,500,000	66,000,000	46,818,989
17	2031	104,000,000	94,500,000	85,000,000	75,500,000	66,000,000	40,106,883
18	2032	104,000,000	94,500,000	85,000,000	75,500,000	66,000,000	30,843,962
19	2033	104,000,000	94,500,000	85,000,000	75,500,000	66,000,000	21,050,862
20	2034	104,000,000	94,500,000	85,000,000	75,500,000	66,000,000	13,779,682
AVERAGE		104,000,000	94,500,000	85,000,000	75,500,000	66,000,000	60,946,777

Budgets – Urban AC Set

YR		VH	H	N	L	VL	LC
1	2015	999,999,999	999,999,999	999,999,999	999,999,999	999,999,999	5,543,765
2	2016	31,770,000	31,770,000	31,770,000	31,770,000	31,770,000	31,766,171
3	2017	14,566,364	14,020,909	13,475,455	13,300,000	13,300,000	13,298,756
4	2018	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	10,619,754
5	2019	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	10,010,232
6	2020	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	6,743,096
7	2021	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	6,538,220
8	2022	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	7,613,888
9	2023	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	8,009,126
10	2024	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	6,709,938
11	2025	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	3,144,200
12	2026	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	4,889,549
13	2027	14,566,364	14,020,909	13,475,455	12,893,000	12,293,000	6,631,844
14	2028	20,690,000	20,690,000	20,690,000	20,690,000	20,690,000	20,683,319
15	2029	16,000,000	15,500,000	15,000,000	14,500,000	14,120,000	14,110,654
16	2030	16,000,000	15,500,000	15,000,000	14,500,000	14,000,000	13,049,931
17	2031	16,000,000	15,500,000	15,000,000	14,500,000	14,000,000	5,767,630
18	2032	16,000,000	15,500,000	15,000,000	14,500,000	14,000,000	3,056,798
19	2033	16,000,000	15,500,000	15,000,000	14,500,000	14,000,000	1,387,192
20	2034	16,000,000	15,500,000	15,000,000	14,500,000	14,000,000	268,568
AVERAGE		16,000,000	15,500,000	15,000,000	14,500,000	14,000,000	9,664,564

FGroup Parameters – CS and rural AC set

		RURAL						URBAN					
	ONRC Desc	Low Vol	Access	Sec Col	Prim Col	Arterial	Regional	Low Vol	Access	Sec Col	Prim Col	Arterial	Regional
	New Desc		RDH	RCH	RSH	NSH	NSHVH		RDH	RCH	RSH	NSH	NSHVH
	-1	1	2	3	4	5	6	7	8	9	10	11	12
NULL	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
*****POLICY*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FPOL_AC_TRAFFIC_THRESHOLD	-1	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999
FPOL_2CHIP_TRAFFIC_THRESHOLD	-1	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
FPOL_COMMITTEDYEARS	-1	1	1	1	1	1	1	1	1	1	1	1	1
FPOL_2NDCOAT_WAITTIME	-1	2	2	1	1	1	1	2	2	1	1	1	1
*****CALIBRATION FACTORS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FCAL_OBJ_UTILITY	-1	10	10	50	50	100	100	10	10	50	50	100	100
FCAL_OBJ_ACA	-1	3.5	3	2.5	2	1.5	1.5	3.5	3	2.5	2	1.5	1.5
FCAL_OBJ_FLUSHING	-1	7	6	5	4	3	3	7	6	5	4	3	3
FCAL_OBJ_RESSURFLIFE	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
FCAL_OBJ_RUT	-1	6	6	5	5	4	3	6	6	5	5	4	3
FCAL_OBJ_IRI	-1	3.07	3.07	2.69	2.69	2.31	1.94	3.45	3.45	3.07	3.07	2.69	2.31
*****THRESHOLDS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FTHRESH_CRACKINIPROB_AC	-1	50	50	50	50	50	50	50	50	50	50	50	50
FTHRESH_CRACKINIPROB_CS	-1	50	50	50	50	50	50	50	50	50	50	50	50
FTHRESH_FLUSHINIPROB	-1	50	50	50	50	50	50	50	50	50	50	50	50
FTHRESH_RUTACCELPROB	-1	1	1	1	1	1	1	10	10	10	10	10	10
FTHRESH_RUT_EXCEEDENCE	-1	6	6	5	5	4	4	6	6	5	5	4	4
FTHRESH_IRI_EXCEEDENCE	-1	4.58	4.58	4.2	4.2	4.2	4.2	5.33	5.33	4.96	4.96	4.58	4.58
*****UNIT RATES*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FUNITRATE_ANCPSEAL_ACA	-1	25	25	25	25	25	25	25	25	25	25	25	25
FUNITRATE_ANCPSEAL_RUT	-1	20	20	20	20	20	20	20	20	20	20	20	20
FUNITRATE_ANCPSEAL_IRI	-1	10	10	10	10	10	10	10	10	10	10	10	10
FUNITRATE_ECOAC	-1	4.74	4.74	4.74	4.74	4.74	4.74	28.28	28.28	28.28	28.28	28.28	28.28
FUNITRATE_ECOCS	-1	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74
FUNITRATE_ECORHAB_AC	-1	29.14	29.14	29.14	29.14	29.14	29.14	76.68	76.68	76.68	76.68	76.68	76.68
FUNITRATE_ECORHAB_CS	-1	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14
FUNITRATE_ANCAC_N	-1	28.28	28.28	28.28	28.28	28.6	28.6	28.28	28.28	28.28	28.28	28.6	28.6

FUNITRATE_ANCCS_N	-1	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74
FUNITRATE_ANCRHAB_ACS_N	-1	52.68	52.68	52.68	52.68	55.88	55.88	76.68	76.68	76.68	76.68	79.88	79.88
FUNITRATE_ANCRHAB_ACG_N	-1	52.68	52.68	52.68	52.68	55.88	55.88	52.68	52.68	52.68	52.68	55.88	55.88
FUNITRATE_ANCRHAB_CS_N	-1	29.14	29.14	29.14	29.14	32.34	32.34	29.14	29.14	29.14	29.14	32.34	32.34
FUNITRATE_ANCAC_S	-1	28.28	28.28	28.28	28.28	28.6	28.6	28.28	28.28	28.28	28.28	28.6	28.6
FUNITRATE_ANCCS_S	-1	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74
FUNITRATE_ANCRHAB_ACS_S	-1	52.68	52.68	52.68	52.68	55.88	55.88	76.68	76.68	76.68	76.68	79.88	79.88
FUNITRATE_ANCRHAB_ACG_S	-1	52.68	52.68	52.68	52.68	55.88	55.88	52.68	52.68	52.68	52.68	55.88	55.88
FUNITRATE_ANCRHAB_CS_S	-1	29.14	29.14	29.14	29.14	32.34	32.34	29.14	29.14	29.14	29.14	32.34	32.34
*****ROUTINE MAINTENANCE*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FMAINT_CRACKING_THRESHOLD	-1	0.5	0.5	0.25	0.25	0.1	0.1	0.5	0.5	0.25	0.25	0.1	0.1
FMAINT_INTERVAL	-1	1	1	1	1	1	1	1	1	1	1	1	1
*****PRESEAL REPAIRS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FTRG_PSEAL_MAXEXTENT	-1	15	15	15	15	15	15	15	15	15	15	15	15
FTRG_PSEAL_ACA	-1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
FTRG_PSEAL_RUT_EXCEEDENCE	-1	10	10	9	9	8	8	10	10	9	9	8	8
FTRG_PSEAL_IRI_EXCEEDENCE	-1	3.45	3.45	3.07	3.07	2.69	2.69	3.82	3.82	3.45	3.45	3.07	3.07
*****TRIGGERS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FTRG_DOSOMETHING_RTNECOST	-1	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
FTRG_SURF_PCT_LIFEEXCEEDENCE	-1	150	150	150	150	150	150	150	150	150	150	150	150
FTRG_CS_FLUSHING_UPPER	-1	16	16	13	13	10	10	18	18	15	15	12	12
FTRG_CS_FLUSHING_LOWER	-1	10	10	8	8	6	6	12	12	10	10	8	8
FTRG_AC_RAVELLING_UPPER	-1	10	10	10	10	10	10	10	10	10	10	10	10
FTRG_AC_RAVELLING_LOWER	-1	5	5	5	5	5	5	5	5	5	5	5	5
FTRG_RHAB_RUT_UPPER	-1	10	10	9	9	8	8	10	10	9	9	8	8
FTRG_RHAB_RUT_LOWER	-1	7	7	6	6	5	5	7	7	6	6	5	5
FTRG_RHAB_IRI_UPPER	-1	5.33	5.33	4.96	4.96	4.58	4.58	5.71	5.71	5.71	5.71	4.96	4.96
FTRG_RHAB_IRI_LOWER	-1	4.2	4.2	3.82	3.82	3.45	3.45	4.96	4.96	4.58	4.58	4.2	4.2
FTRG_DISCARD_WAITTIME	-1	5	5	4	4	3	3	6	6	5	5	4	4
*****RESETS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FRES_AC_HNEW	-1	30	30	40	40	40	40	30	30	40	40	40	40
FRES_PAVE_AVGTHICKNESS	-1	300	300	350	350	400	400	300	300	350	350	400	400
FRES_SNP	-1	4	4	4.5	4.5	5.5	5.5	4	4	4.5	4.5	5.5	5.5
FRES_DEFLECTION	-1	0.7	0.7	0.6	0.6	0.5	0.5	0.7	0.7	0.6	0.6	0.5	0.5
FRES_IRI	-1	2.69	2.69	2.5	2.5	2.31	2.31	2.69	2.69	2.5	2.5	2.31	2.31
FRES_RUT	-1	3	3	2	2	1	1	3	3	2	2	1	1

FGroup Parameters – Urban AC set

		RURAL						URBAN					
	ONRC Desc	Low Vol	Access	Sec Col	Prim Col	Arterial	Regional	Low Vol	Access	Sec Col	Prim Col	Arterial	Regional
	New Desc		RDH	RCH	RSH	NSH	NSHVH		RDH	RCH	RSH	NSH	NSHVH
	-1	1	2	3	4	5	6	7	8	9	10	11	12
NULL	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
*****POLICY*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FPOL_AC_TRAFFIC_ THRESHOLD	-1	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999	99999
FPOL_2CHIP_TRAFFIC_THRESHOLD	-1	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
FPOL_COMMITTEDYEARS	-1	1	1	1	1	1	1	1	1	1	1	1	1
FPOL_2NDCOAT_WAITTIME	-1	2	2	1	1	1	1	2	2	1	1	1	1
*****CALIBRATION FACTORS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FCAL_OBJ_UTILITY	-1	10	10	50	50	100	100	10	10	50	50	100	100
FCAL_OBJ_ACA	-1	3.5	3	2.5	2	1.5	1.5	3.5	3	2.5	2	1.5	1.5
FCAL_OBJ_FLUSHING	-1	7	6	5	4	3	3	7	6	5	4	3	3
FCAL_OBJ_RESSURFLIFE	-1	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
FCAL_OBJ_RUT	-1	6	6	5	5	4	3	6	6	5	5	4	3
FCAL_OBJ_IRI	-1	3.07	3.07	2.69	2.69	2.31	1.94	3.45	3.45	3.07	3.07	2.69	2.31
*****THRESHOLDS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FTHRESH_CRACKINIPROB_AC	-1	50	50	50	50	50	50	50	50	50	50	50	50
FTHRESH_CRACKINIPROB_CS	-1	50	50	50	50	50	50	50	50	50	50	50	50
FTHRESH_FLUSHINIPROB	-1	50	50	50	50	50	50	50	50	50	50	50	50
FTHRESH_RUTACCELPROB	-1	1	1	1	1	1	1	10	10	10	10	10	10
FTHRESH_RUT_EXCEEDENCE	-1	6	6	5	5	4	4	6	6	5	5	4	4
FTHRESH_IRI_EXCEEDENCE	-1	4.58	4.58	4.2	4.2	4.2	4.2	5.33	5.33	4.96	4.96	4.58	4.58
*****UNIT RATES*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FUNITRATE_ANCPSEAL_ACA	-1	25	25	25	25	25	25	25	25	25	25	25	25
FUNITRATE_ANCPSEAL_RUT	-1	20	20	20	20	20	20	20	20	20	20	20	20
FUNITRATE_ANCPSEAL_IRI	-1	10	10	10	10	10	10	10	10	10	10	10	10
FUNITRATE_ECOAC	-1	4.74	4.74	4.74	4.74	4.74	4.74	28.28	28.28	28.28	28.28	28.28	28.28
FUNITRATE_ECOCS	-1	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74
FUNITRATE_ECORHAB_AC	-1	29.14	29.14	29.14	29.14	29.14	29.14	76.68	76.68	76.68	76.68	76.68	76.68
FUNITRATE_ECORHAB_CS	-1	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14	29.14
FUNITRATE_ANCAC_N	-1	28.28	28.28	28.28	28.28	28.6	28.6	28.28	28.28	28.28	28.28	28.6	28.6

FUNITRATE_ANCCS_N	-1	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74
FUNITRATE_ANCRHAB_ACS_N	-1	52.68	52.68	52.68	52.68	55.88	55.88	76.68	76.68	76.68	76.68	79.88	79.88
FUNITRATE_ANCRHAB_ACG_N	-1	52.68	52.68	52.68	52.68	55.88	55.88	52.68	52.68	52.68	52.68	55.88	55.88
FUNITRATE_ANCRHAB_CS_N	-1	29.14	29.14	29.14	29.14	32.34	32.34	29.14	29.14	29.14	29.14	32.34	32.34
FUNITRATE_ANCAC_S	-1	28.28	28.28	28.28	28.28	28.6	28.6	28.28	28.28	28.28	28.28	28.6	28.6
FUNITRATE_ANCCS_S	-1	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74	4.74
FUNITRATE_ANCRHAB_ACS_S	-1	52.68	52.68	52.68	52.68	55.88	55.88	76.68	76.68	76.68	76.68	79.88	79.88
FUNITRATE_ANCRHAB_ACG_S	-1	52.68	52.68	52.68	52.68	55.88	55.88	52.68	52.68	52.68	52.68	55.88	55.88
FUNITRATE_ANCRHAB_CS_S	-1	29.14	29.14	29.14	29.14	32.34	32.34	29.14	29.14	29.14	29.14	32.34	32.34
*****ROUTINE MAINTENANCE*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FMAINT_CRACKING_THRESHOLD	-1	0.5	0.5	0.25	0.25	0.1	0.1	0.5	0.5	0.25	0.25	0.1	0.1
FMAINT_INTERVAL	-1	1	1	1	1	1	1	1	1	1	1	1	1
*****PRESEAL REPAIRS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FTRG_PSEAL_MAXEXTENT	-1	15	15	15	15	15	15	15	15	15	15	15	15
FTRG_PSEAL_ACA	-1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
FTRG_PSEAL_RUT_EXCEEDENCE	-1	6	6	5	5	4	4	6	6	5	5	4	4
FTRG_PSEAL_IRI_EXCEEDENCE	-1	3.45	3.45	3.07	3.07	2.69	2.69	3.82	3.82	3.45	3.45	3.07	3.07
*****TRIGGERS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FTRG_DOSOMETHING_RTNECOST	-1	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
FTRG_SURF_PCT_LIFEEXCEEDENCE	-1	150	150	150	150	150	150	150	150	150	150	150	150
FTRG_CS_FLUSHING_UPPER	-1	16	16	13	13	10	10	18	18	15	15	12	12
FTRG_CS_FLUSHING_LOWER	-1	10	10	8	8	6	6	12	12	10	10	8	8
FTRG_AC_RAVELLING_UPPER	-1	10	10	10	10	10	10	10	10	10	10	10	10
FTRG_AC_RAVELLING_LOWER	-1	5	5	5	5	5	5	5	5	5	5	5	5
FTRG_RHAB_RUT_UPPER	-1	10	10	9	9	8	8	10	10	9	9	8	8
FTRG_RHAB_RUT_LOWER	-1	7	7	6	6	5	5	7	7	6	6	5	5
FTRG_RHAB_IRI_UPPER	-1	5.33	5.33	4.96	4.96	4.58	4.58	5.71	5.71	5.71	5.71	4.96	4.96
FTRG_RHAB_IRI_LOWER	-1	4.2	4.2	3.82	3.82	3.45	3.45	4.96	4.96	4.58	4.58	4.2	4.2
FTRG_DISCARD_WAITTIME	-1	5	5	4	4	3	3	6	6	5	5	4	4
*****RESETS*****	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
FRES_AC_HNEW	-1	30	30	40	40	40	40	30	30	40	40	40	40
FRES_PAVE_AVGTHICKNESS	-1	300	300	350	350	400	400	300	300	350	350	400	400
FRES_SNP	-1	4	4	4.5	4.5	5.5	5.5	4	4	4.5	4.5	5.5	5.5
FRES_DEFLECTION	-1	0.7	0.7	0.6	0.6	0.5	0.5	0.7	0.7	0.6	0.6	0.5	0.5
FRES_IRI	-1	2.69	2.69	2.5	2.5	2.31	2.31	2.69	2.69	2.5	2.5	2.31	2.31
FRES_RUT	-1	3	3	2	2	1	1	3	3	2	2	1	1

HDM4 Constants:

	NULL	VALUE1	VALUE2
NULL	NULL	NULL	Null
*****PAVEMENT CODES*****	NULL	PaveType	Null
CSGB	NULL	2.95	Null
CSSB	NULL	3.35	Null
CSAP	NULL	2.95	Null
ACGB	NULL	3.87	Null
ACSB	NULL	3.87	Null
ACAP	NULL	1.96	Null
*****BASE CODES*****	NULL	BaseType	Null
T	NULL	GB	Null
S	NULL	AP	Null
U	NULL	GB	Null
B	NULL	AP	Null
C	NULL	AP	Null
*****SURFACE CODES*****	NULL	SurfType	IS2CHIP
2CHIP	NULL	CS	TRUE
3CHIP	NULL	CS	TRUE
B/S	NULL	CS	TRUE
BOLID	NULL	CS	TRUE
COMB	NULL	CS	TRUE
LOCK	NULL	CS	TRUE
OTHER	NULL	CS	TRUE
SLRY	NULL	CS	TRUE
1CHIP	NULL	CS	FALSE
BAU	NULL	CS	FALSE
METAL	NULL	CS	FALSE
PRS	NULL	CS	FALSE
PSEAL	NULL	CS	FALSE
PSKID	NULL	CS	FALSE
RACK	NULL	CS	FALSE
RCHIP	NULL	CS	FALSE
RSEAL	NULL	CS	FALSE
TEXT	NULL	CS	FALSE
VFILL	NULL	CS	FALSE
CONC	NULL	CONC	FALSE
INBLK	NULL	CONC	FALSE
AC	NULL	AC	FALSE
BBM	NULL	AC	FALSE
CAPE	NULL	AC	FALSE
FC	NULL	AC	FALSE
GRAC	NULL	AC	FALSE
GRIPF	NULL	AC	FALSE
HSOGP	NULL	AC	FALSE
OGEM	NULL	AC	FALSE
OGPA	NULL	AC	FALSE
OGPAH	NULL	AC	FALSE
SMA	NULL	AC	FALSE
UTA	NULL	AC	FALSE

Local Setup:

	NULL	VALUE
NULL	Null	Null
BASEDATE	Start date of analysis financial year (dd/mm/yyyy)	28/12/2015
USE RAMMEXPECTED SURFACELIFE	(Boolean) Use the RAMM provided surface expected life (Other P/17 calculation)	TRUE
TRAFFICGROWTHREGION	Set the traffic growth region, must be as in Traffic Growth Factors Cross Tab	AT
NUMBEROFFGROUPS	Number of active F Groups used	12

Surface Parameters:

	-1	0-3	3-4	4-5	5-6	6-7	7-99
NULL	-1	-1	-1	-1	-1	-1	-1
*****TEXTURE*****	-1	-1	-1	-1	-1	-1	-1
SLOPE_CS	-1	0.85	0.85	0.8	0.5	0.5	0.15
SLOPE_AC	-1	0.1	0.1	0.1	0.1	0.1	0.1
RESET_CS	-1	3	2.8	2.6	2	1.6	1.4
RESET_AC	-1	1	1	1	1	1	1
ALD	-1	10	8.75	6.75	4.75	3.25	3.25
*****CHIP ROTATION*****	-1	-1	-1	-1	-1	-1	-1
FOLLOWINGCHIPGRADE_1CHIP	-1	4	5	3	2	3	3
FOLLOWINGCHIPGRADE_2CHIP	-1	2	3	4	3	4	3
*****SURFACE LIFE*****	-1	-1	-1	-1	-1	-1	-1
P17_SURFLIFEFACTOR_1CHIP	-1	1.3	1.2	1.2	1	0.75	1
P17_SURFLIFEFACTOR_2CHIP	-1	1	1	1	1	1	1
SURFLIFEFACTOR_AC	-1	0.92	-1	-1	-1	-1	-1
SURFLIFEFACTOR_OG	-1	0.8	-1	-1	-1	-1	-1

Traffic Growth Factors

	NULL	UA	UO	RS	RO
NULL	-1	-1	-1	-1	-1
AUCKLAND CITY	-1	1.5	1.5	1.5	1.5
NORTH SHORE CITY	-1	3	2	2	2
WAITAKERE CITY	-1	3	2	3	2
MANUKAU CITY	-1	3	2	3	2
WAIKATO	-1	2	1	3	2.5
BAY OF PLENTY	-1	2.5	2	2.5	2.5
GISBORNE	-1	1	1	1	1
HAWKES BAY	-1	1.5	1.5	2	1
TARANAKI	-1	1.5	1	1.5	0.5
MANAWATU-WANGANUI	-1	2	1.5	2	1.5
WELLINGTON	-1	2	2	2	2
NELSON-MARLBOROUGH	-1	2.5	2	2.5	2.5
CANTERBURY	-1	2	2	3	2.5
WEST COAST	-1	2	2	2	2
OTAGO	-1	1.5	1.5	2	1.5
SOUTHLAND	-1	1	1	1	1
NORTHLAND	-1	3	2	3	2.5
AT	-1	3	2	3	2
AUCKLAND	-1	2.6	1.9	2.5	2.5
USER DEFINED 3	-1	-1	-1	-1	-1

Traffic Parameters

	-1	0-500	500-2000	2000-5000	5000-10000	10000-99000
NULL	-1	-1	-1	-1	-1	-1
*****CALIBRATION FACTORS*****	-1	-1	-1	-1	-1	-1
TCAL_CRACK_KCP	-1	1	1	1	1	1
TCAL_CRACKINIPROB_KPI_ACU	-1	1	1.05	1.25	1.4	1.45
TCAL_CRACKINIPROB_KPI_ACR	-1	0.95	1.05	1.2	1.2	1.2
TCAL_CRACKINIPROB_KPI_CSU	-1	2	2	1.65	1.45	1.45
TCAL_CRACKINIPROB_KPI_CSR	-1	2	2	1.65	1.45	1.45
TCAL_FLUSHING	-1	0.2	0.2	0.2	0.2	0.2
TCAL_FLUSHINIPROB	-1	0.55	0.55	0.55	0.55	0.55
TCAL_IRI_KGE_U	-1	5.00E-05	0.00015	0.00025	0.00035	0.00045
TCAL_IRI_KGE_R	-1	0.0002	0.0002	0.0002	0.0002	0.0002
TCAL_MCOST_CALIB	-1	0.6	0.9	1.2	1.5	1.8
TCAL_MCOST_CCI	-1	1	1	1	1	1
TCAL_RAVELLING	-1	1	1	1	1	1
TCAL_RUT_KRP_U	-1	0.3	0.35	0.4	0.5	0.6
TCAL_RUT_KRP_R	-1	0.3	0.35	0.4	0.5	0.6
*****TRIGGERS*****	-1	-1	-1	-1	-1	-1
TTRG_AC_ACA_UPPER	-1	14.5	8.5	8	8	7.1
TTRG_AC_ACA_LOWER	-1	3	2	1.5	1.5	1
TTRG_CS_ACA_UPPER	-1	8.5	5	5	5	5
TTRG_CS_ACA_LOWER	-1	3	2	2	2	2

Topic: Do Something

One Pager

Date: 25 November 2015

Author: Elke Beca

1. Objective

Validation of the 2013 NZTA National dTIMS modelling outcomes showed:

- ~98% alignment of resurfacing quantities
- ~60% alignment of pavement quantities (model quantities higher than validation)

The 40% differential between model and validation was thought to be what is now loosely termed ‘do something’. There is uncertainty and disagreement in the industry as to what the ‘do something’ treatment is. The NZTA have arrived at a definition of ‘do something’ which we will adopt for modelling purposes (authors interpretation).

Do Something = Heavy Maintenance followed by Resurfacing, typically on pavement sections < 100m length or >100m length where NPV better than full renewal.

We propose the ‘do something’ is modelling using the existing pre-reseal model within dTIMS, heavily calibrated to align as closely to reality as possible.

NOTE: For model purposes we will not consider the funding source (lump sum or measure & value) or contractual constraints (length comes out of fixed renewal quantities or not) relating to the ‘do something’ option.

2. Methodology

From a modelling perspective, the do something is just a “pre-reseal repair with a reseal over it” where a pavement renewal is unaffordable (no different to a reseal treatment except repairs required will be higher). The ‘heavy maintenance’ component of this treatment will come out of a separate budget (constrained or unconstrained) and the reseal out of the constrained programme budget. This can be modelled with our current setup with minor changes.

Two Options:

1. No coding changes, do somethings will simply increase the reseal quantity and budget and the pre-reseal budget will increase when investment decreases and pavement renewals become unaffordable. We can track differential budgets to understand the impact of investment on ‘do something’ vs full renewal ***(Risk: Inability to determine which surfaces are where a renewal is simply not affordable and the only option vs legitimate surfaces.)***
2. Separate do something treatment (pre-reseal repairs from separate heavy maintenance budget followed by reseal treatment which comes out of the programme budget) – this treatment will have higher benefits than a straight reseal but lower than a pavement renewal. The do something treatment will be triggered only where area requiring pre-reseal treatment exceeds a

defined threshold. This option enables us to track where ‘do something’ treatments occur and their cost without impacting the reseal quantities.

The identified risks:

- Inability to calibrate pre-reseal model due to uncertainty of data in RAMM
- Identifying the threshold where a reseal becomes a do something. A rehab will default to a do something based on budget.
- Ensuring the benefit distribution between reseal, do something and pavement renewal is correct so the right balance is found.
- Doesn’t directly align with industry or NZTA definition or triggering of do something

Option 2 was selected for the 2016 NLTP analysis run.

Appendix N: Output Charts

Note: This has been generated as a separate, standalone document due to large size