IDS

Status of Asset Analytics in New Zealand

November 2016

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EXECUTIVE SUMMARY

This report assesses the status of long-term road asset analytics for renewals and maintenance planning for local authority Road Controlling Authorities in New Zealand. To achieve this, it has:

- considered the extent to which local councils in New Zealand are undertaking modelling of the road networks;
- summarised the trends emerging from the latest analyses with particular emphasis on the learnings from the recently completed RATA analysis;
- summarised the data confidence aspects related to asset planning and analysis;
- considered the risk for the sector and for road investment over the medium to long term.

The introduction of the One Network Road Classification (ONRC) has seen the modelling approach become increasingly attractive to councils. Analyses and case studies have proven that the robustness of the model, if calibrated and used in conjunction with robust data, stands beyond questioning. Optimisation analysis has demonstrated a 15 to 25% efficiency gain. Furthermore, the analysis allows councils to develop a roadmap towards achieving certain levels of service expectations on respective ONRC classes.

The RATA Analysis demonstrated that using the same model setting for a group of councils creates a real opportunity for a true long-term benchmarking of maintenance investment.

The report concludes by recommending a number of actions including;

1. There is a need for leadership and driving a step change in data collection. The suggestion is that this could be best facilitated by NZTA and would lead to significant savings in the collection process itself as well as substantial savings in the physical programs of approximately half of the local authorities' roading programmes resulting from the quality of the modelling it will enable. (The savings generated by centrally facilitated high-speed data collection contract when compared to each authority running its own contract, would be sufficient to fund a nationwide optimisation model.)
2. Region wide or amalgamated analysis needs to be promoted and encouraged.
3. IDS should be supported in assisting modelling outcomes to be considered at the executive level of councils. Reports and approach should be adjusted to facilitate this change.

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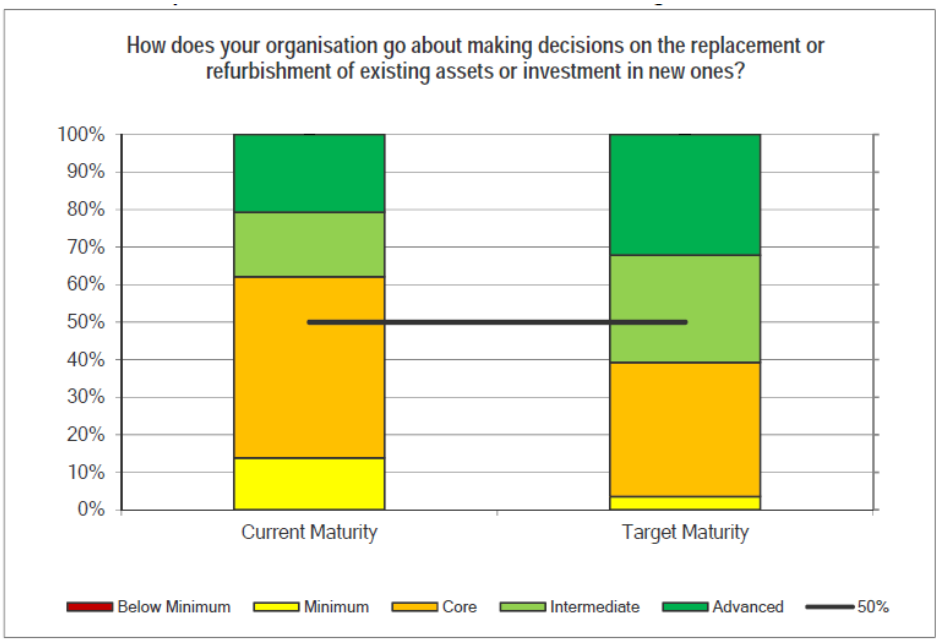
1. Introduction

1.1 Background

New Zealand road controlling authorities made a step change in road asset analytics during 1999 with the adoption of pavement deterioration modelling technology that was built into the dTIMS tool. Although most local councils in New Zealand have bought into the dTIMS project, not all of them have been using the tool for asset analytics. During 2011, it was estimated that approximately one-third of councils could be classified as power users, one-third have completed some modelling and another third of councils never did any modelling. In discussions with the non-modelling councils, the main perceived barrier for not undertaking analytics was that they believed their data was not fulfilling the required robustness for undertaking modelling. An interesting trend in the industry was that those councils who did undertake some modelling were the only ones that also focused on getting better data of their road networks.

A significant step change took place following the work of the 2012 Road Maintenance Task Force. The Better Asset Management, Planning and Delivery report (Waugh, 2012)[1] in particular referred to the advanced asset analysis. This document was one of the inputs into the improvement strategies that were developed by the Road Efficiency Group (REG). There was a realisation within this group that many of the required tools for asset management existed, but there was no doubt that the use of the available tools had to be improved upon. Figure 1 shows the self-assessment of councils related to their decision processes, a noticeable improvement need was identified by the councils themselves.



[1] Waugh, R. And Holland, G. (2012). Better Asset Management, Planning and Delivery. Road Maintenance Task Force Report Number 64-130-1002. New Zealand Transportation Agency. Wellington.

Figure 1: Councils' Self-Assessment on Decision Making (Waugh, 2012)[2]

*"Managers generally believe they are doing a good job and establish one plan for the future. Models should be used to investigate options rather than support one option. More testing and sensitivity analysis along with a feedback loop on the effectiveness and efficiency of the programmes should be utilised." (*Waugh, 2012)

1.2 A Step-Change in the Sector

The REG group has embarked on an ambitious journey to improve road management practices. The first focus area was the establishment of the One Network Road Classification system (ONRC). There was also a significant emphasis in getting the true value form the dTIMS modelling process. It is fair to say that historically the system was not used to its full capability. In most cases councils only modelled historical investment levels without tensioning the true investment need of the road renewal and maintenance programme.

IDS is specifically adapted to the directives from REG including:

- A changed focus of the IDS analysis is to tension the lowest sustainable investment for road networks. Two examples of this type of analysis are the analysis undertaken for Central Otago (Refer to Appendix A) and the determination of the base quantity rates for the NZTA Network Outcome Contracts (NOC);
- The ONRC project offered significant opportunities for IDS as it set the basis for meaningful analysis related to:
  - Investigating the affordability of ONRC target service levels;
  - Determining a road map on the investment plan toward closing the GAP between current and desired service level targets set for the respective ONRC road classes;
- IDS also underwent a significant internal adjustment in order to deliver more relevant services to the industry. The first focus shift went away from "selling software or a solution" to selling modelling services. Secondly, where the consultants were the client interface of the past, all services were consolidated under the bureau service with IDS being responsible for the direct client interface.

This report will cover the results that could be attributed to some of the changes.

1.3 Objectives of this Project

The overall aim of this project is to determine the status of long-term road asset analytics for renewals and maintenance planning for Road Controlling Authorities in New Zealand. In order to achieve this aim the following objectives have to be addressed:

[2] Waugh, R. And Holland, G. (2012). Better Asset Management, Planning and Delivery. Road Maintenance Task Force Report Number 64-130-1002. New Zealand Transportation Agency. Wellington.

- To understand the extent to which local councils in New Zealand are undertaking modelling of their road networks;
- To summarise the trends that are emerging from the latest analysis, with particular emphasis on the learnings from the recently completed RATA analysis;
- A summary of the data confidence aspects related to asset planning and analysis;
- Summary and risk for the sector and for road investment over the medium to long-term.

2. A Review of the Modelling that are Taking Place

2.1 Modelling Taking Place

Figure 2 summarises the dTIMS modelling status amongst local councils (excluding the state highways). The figure shows that more than a half of councils have undertaken modelling during the past couple of years, notably increasing the active modelling status compared to the status in 2012. An additional 12% of councils have undertaken modelling some years back and it is anticipated that most of these will undertake modelling during the coming year. There is also an expectation to model some of the councils (36%) that have not undertaken any modelling before. It should also be noted that the portion of councils modelled represents 83% of the VKT's travelled on council roads.

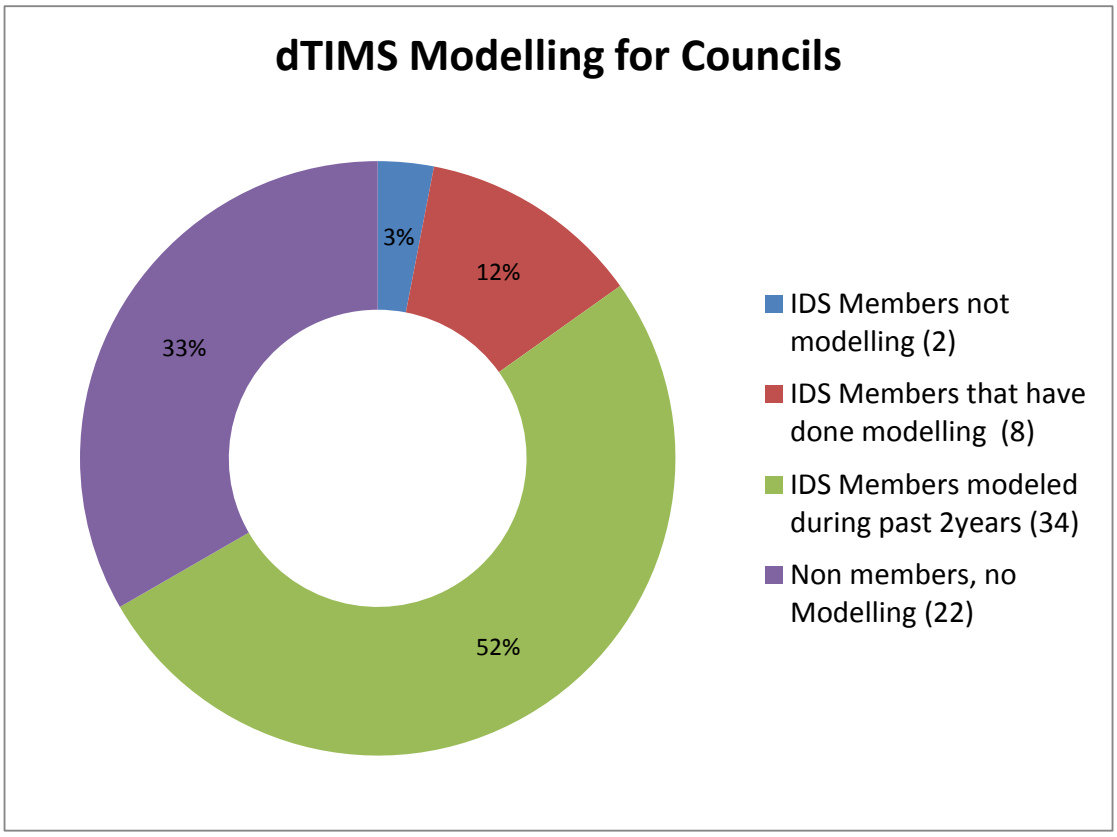


Figure 2: Summary of dTIMS Modelling Status at Local Councils (Total 66)

2.2 Does it Make Sense to Model the Small Councils?

For a number of years Central Otago did not undertake any modelling on the basis of it a) being a very small sealed road network; and b) doubts existed on the available data being good enough for modelling. Their network also had some of the smoothest ride performance and nationally one of the lowest cost per KM for maintenance. At a macro level there were no indications that would suggest an urgent need to review their process.

As being highlighted by this case study (Appendix A), an annual planning surplus of $300,000 has been realised on a sealed network of only 400km. The $300,000 per year planning surplus was realised with a total data collections and modelling investment of approximately $140,000. Note that care must be taken not to see the $300, 000 as real savings since operation processes ensure that only roads and surfaces that have failed will be renewed. It does explain one of the main criticisms against local councils of over-forecasting the real investment need to maintain road networks (Refer to Figure 3).

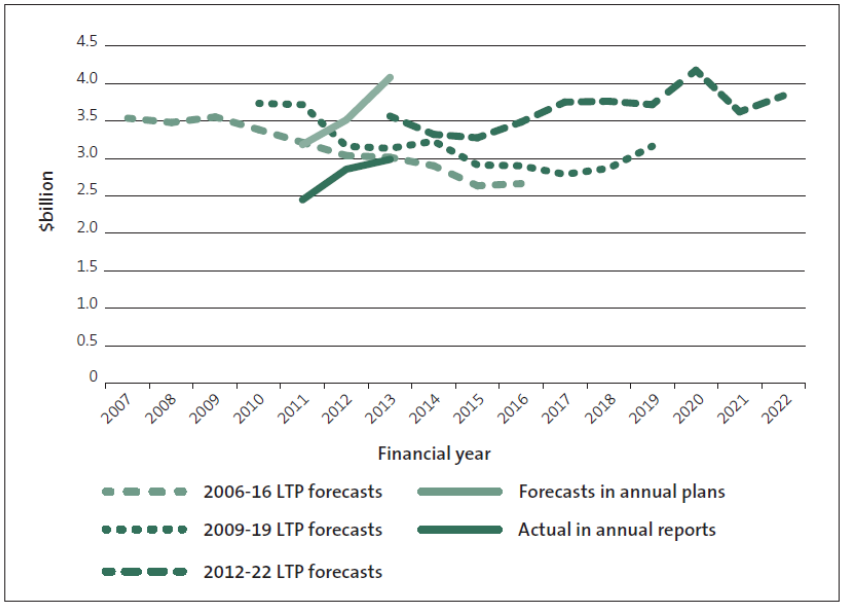


Figure 3: Differences between LTP Forecasted and Actual Expenditure (OAG, 2014) [3]

It is therefore evident that even small sealed road networks are worth modelling.

2.3 Trends Emerging from the Modelling

The number of modelling analyses undertaken for local councils is encouraging, in particular for those councils who had not undertaken modelling on their networks before. Figure 4and Figure 5 shows the councils that have been modelled using the respective service providers. Of the latest modelling undertaken, a total of five (excluding RATA) started modelling to the ONRC classification. Some general trends from the analysis are:

- All the analysis have undertaken data reviews and included future improvements plans. A common issue with the data items included inappropriate section lengths and;
- A limited number of analyses tensioned the minimum preservation levels as was undertaken in the NZTA and RATA analyses (See Section 3);

[3] Office of the Auditor-General. (2014). Water and roads: Funding and management challenges. Presented to the House of Representatives under section 20 of the Public Audit Act 2001.

As one would expect the overall maintenance quantities are normally higher in comparison to the RATA analysis – this is a function of the questions/objectives for the analyses.

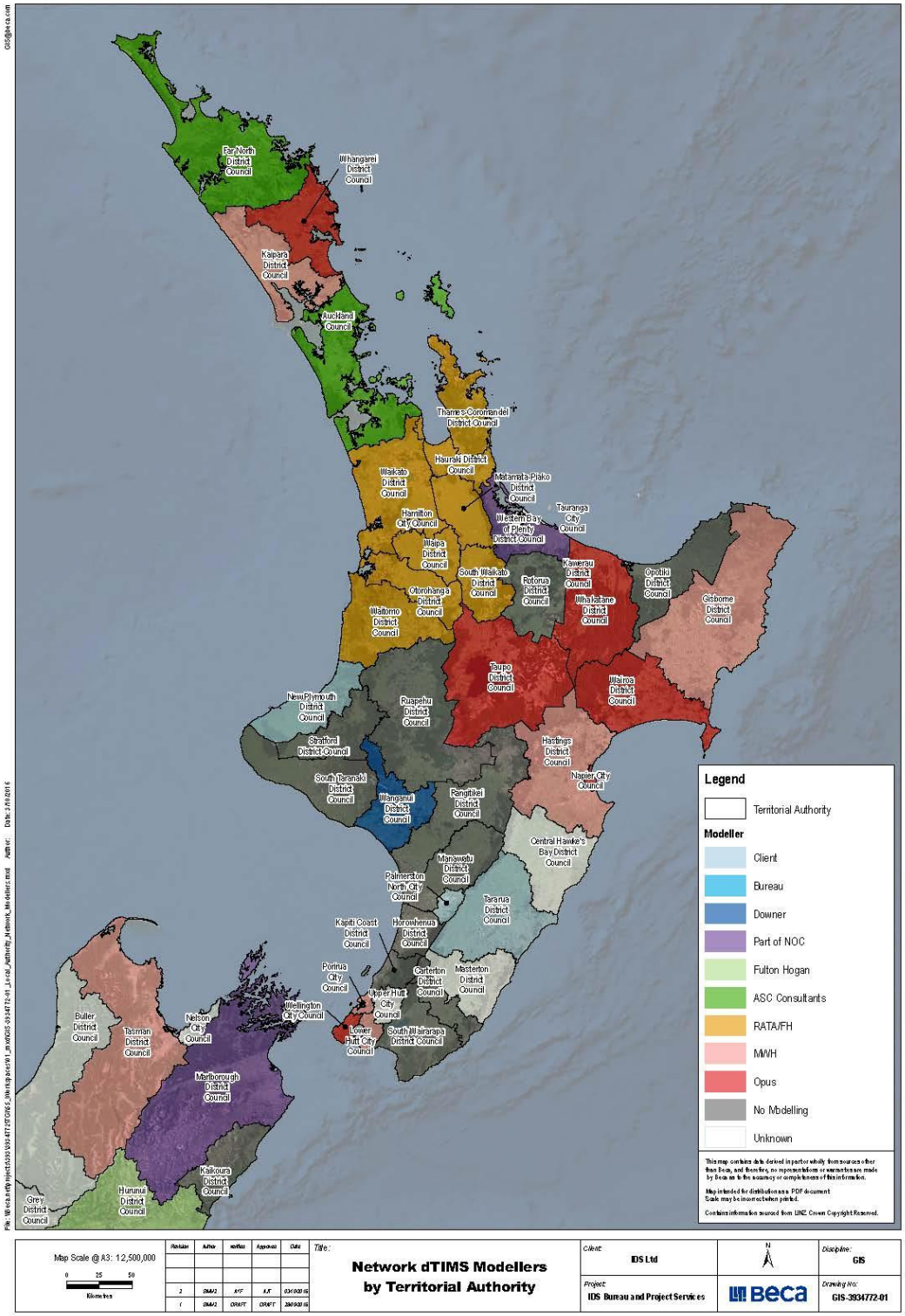


Figure 4: Councils' dTIMS Modelling Status North Island

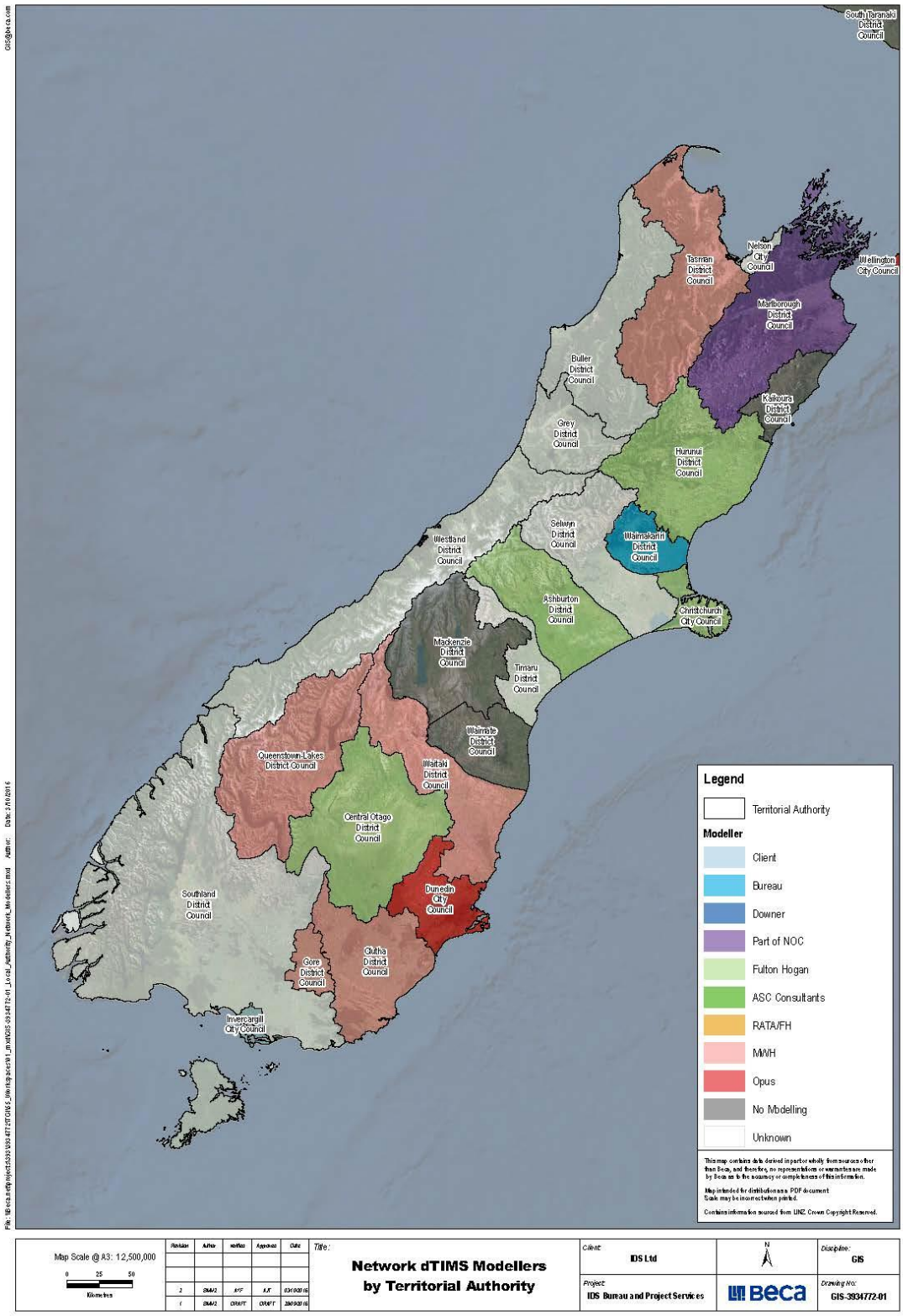


Figure 5: Councils' dTIMS Modelling Status South Island

3. Learnings from the RATA Analysis

3.1 Analysis Process

Figure 6 shows the framework for the originally proposed analysis for RATA.

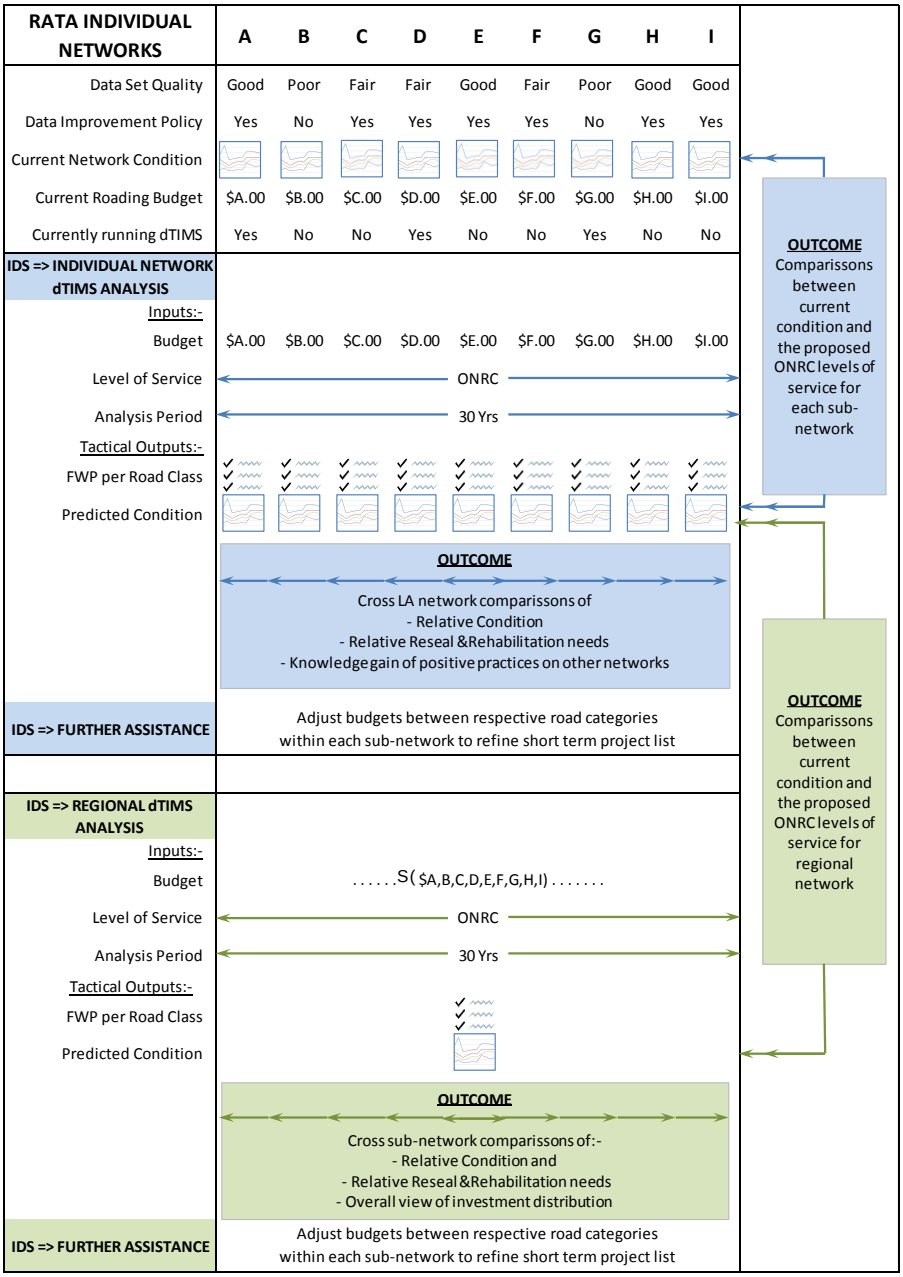


Figure 6: Original Proposal for the Rata Analysis

A two-stage analysis was proposed including:

- A network specific analysis that considers each network in isolation. Although the same intervention setting and models were applied to each network, the network were analysed to individual budget level and in an isolated analysis process;
- The second analysis stage would be a combined analysis with an over-all combined analysis. For this analysis, the model network boundaries, optimising the programme to maximise the over-all return. A good example of this analysis approach included the NZTA state highway and Auckland Transport analysis.

Only the first analysis stage was completed since much more work went into the system customisation than originally anticipated. Also from a RATA perspective little value was perceived from a region wide analysis as this was a theoretical exercise only, a combined budget between the councils is unlikely for the foreseeable future.

The subsequent section will demonstrate the value from the analysis obtained from RATA in terms of benchmarking the programmes. Obviously a true investment benchmark between the councils would be more effective using a combined analysis when the programme is optimised across the region.

3.2 Observations from the Rata Analysis

3.2.1 Data Quality

As with many networks that have not been modelled before, a significant effort went into the data validation and clean-up. Table 1 shows the outcome following the initial data validation.

Table 1: Missing Information for Networks (Note the percentage indicate the proportion missing information)

		Hauraki DC		Hamilton CC		Matamata Piako DC		Otorohanga DC		South Waikato DC		Thames Coromandel DC		Waikato DC		Waipa DC		Waitomo DC	
Network Length (km)		507.8		635.5		925.2		530.2		498.0		463.3		1,793.2		1,013.6		459.3	
Number of TL Sections (Count)		1,160		3,702		1,660		1,090		1,176		1,947		3,246		1,788		854	
Parameter		**Num**	**% Total**	**Num**	**% Total**	**Num**	**% Total**	**Num**	**% Total**	**Num**	**% Total**	**Num**	**% Total**	**Num**	**% Total**	**Num**	**% Total**	**Num**	**% Total**
Traffic	Missing	0	0.0%	136	3.7%	0	0.0%	1	0.1%	0	0.0%	2	0.1%	109	3.4%	26	1.5%	17	2.0%
Traffic Composition	Missing	0	0.0%	415	11.2%	2	0.1%	1	0.1%	36	3.1%	353	18.1%	262	8.1%	571	31.9%	88	10.3%
	Incorrect	1,114	96.0%	3,278	88.5%	1,450	87.3%	101	9.3%	985	83.8%	1,585	81.4%	2,654	81.8%	1,095	61.2%	760	89.0%
Surface Details	Missing	0	0.0%	21	0.6%	4	0.2%	33	3.0%	1	0.1%	5	0.3%	5	0.2%	17	1.0%	2	0.2%
	Incorrect	11	0.9%	12	0.3%	20	1.2%	21	1.9%	6	0.5%	11	0.6%	2	0.1%	19	1.1%	16	1.9%
Road Condition	Visual	21	1.8%	131	3.5%	8	0.5%	0	0.0%	3	0.3%	130	6.7%	125	3.9%	98	5.5%	2	0.2%
	Roughness	43	3.7%	39	1.1%	23	1.4%	24	2.2%	8	0.7%	36	1.8%	110	3.4%	66	3.7%	83	9.7%
Pavement Details		1,024	88.3%	85	2.3%	946	57.0%	107	9.8%	83	7.1%	1,341	68.9%	198	6.1%	908	50.8%	64	7.5%
Pavement Strength	SNP	724	62.4%	1,386	37.4%	1,660	100.0%	1,090	100.0%	1,176	100.0%	1,947	100.0%	2,912	89.7%	1,788	100.0%	854	100.0%
	Deflection	910	78.4%	3,016	81.5%	1,144	68.9%	1,090	100.0%	970	82.5%	1,636	84.0%	2,740	84.4%	1,735	97.0%	735	86.1%
ONRC Classification		1,160	100.0%	783	21.2%	1,660	100.0%	453	41.6%	593	50.4%	1,033	53.1%	2,341	72.1%	438	24.5%	15	1.8%
Maintenance Activities		Yes		Yes		Yes		No		Yes		Yes		Yes		Yes		Yes	

Observations were:

- The traffic data was of greatest concern; especially the composition data had significant errors and missing values. The traffic data is as important as the condition data as it directly influences the outcome of the deterioration model;
- The only condition data was the roughness and visual data which, in general, is a weak starting position for the modelling. Neither roughness nor visual data gives a good indication of pavement strength in the absence of SNP data; and,
- Of the modelled councils, a certain percentage of existing Falling Weight Deflectometer surveys data has existed (between 5 to 15 %). Councils that have not performed modelling before did not have much pavement strength data at all.

Prior to the analysis, councils had an opportunity to improve their data as much as possible.

3.2.2 Optimisation Process

Initial modelling results suggested that roughness was not a primary driver for the rehabilitation programmes. In the end, maintenance cost and surface conditions were the only two parameters that drove the analysis process. The consumer choice theory optimisation process was used in the RATA analysis. This optimisation process is used since it best simulates the desire to get close to target performance levels for the respective ONRC classes. According to this method, the optimisation maximises achieving the stated targets for the ONRC classes, and in cases where insufficient funds are provided, priority is given to higher order roads.

Table 2: Target Level of Service used for the Optimisation

Variable (Mean / Sum)	One Network Road Classification (ONRC)				
	Arterial	**Primary Collector**	**Secondary Collector**	**Access**	**Low Volume**
Maintenance Cost ($/km) Targets					
Rural (Mtc Cost Target)	750	1000	1500	2000	4000
Urban (Mtc Cost Target)	1000	1500	2000	3000	5000
Condition Index (CI) Targets					
Rural (CI Target)	0.5	1	1	1.5	3
Urban (CI Target)	0.5	1.5	1.5	2.5	4
Residual Surface Life Targets					
Rural (Res Life Target)	-2	-2	-2	-4	-5
Urban (Res Life Target)	-3	-3	-3	-4	-5

The optimisation is repeated for different budget levels in order to establish the minimum preservation investment level for a network. Figure 7 shows an example of a modelling process that determine the appropriate long-term surface condition,

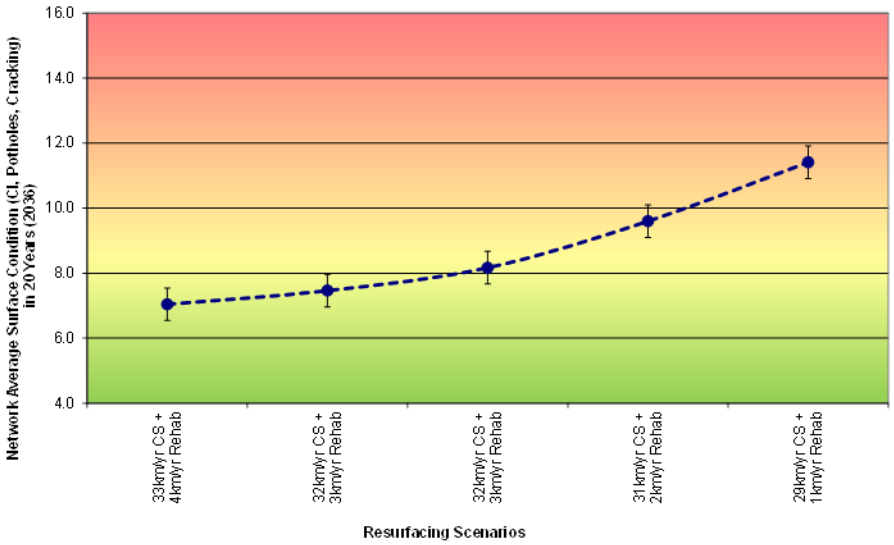


Figure 7: Example of Modelling Scenarios Analysis

3.2.3 Findings from the Analysis

Everything else being equal in terms of the settings for the analysis, it was interesting to observe the significant variation in the analysis outcomes between the councils networks. **Note that the current FWP was used as an indication of the accepted investment level.** Figure 8 shows an example of the optimisation results for two networks. In both cases the long-term surfacing condition is indicated for five budget levels. The plot on the left shows a network that overall has a strong surfacing performance and is relatively insensitive to changes in the budget level. The plot on the right shows a network where the over-all surface condition is poorer in comparison and it is also more sensitive if the budget level is reduced. Concluding from these two graphs, one can assume the network presented by the plot on the left shows an opportunity for reduced investment. In contrast, the network on the right will be significantly impacted by a reduction in maintenance investment.

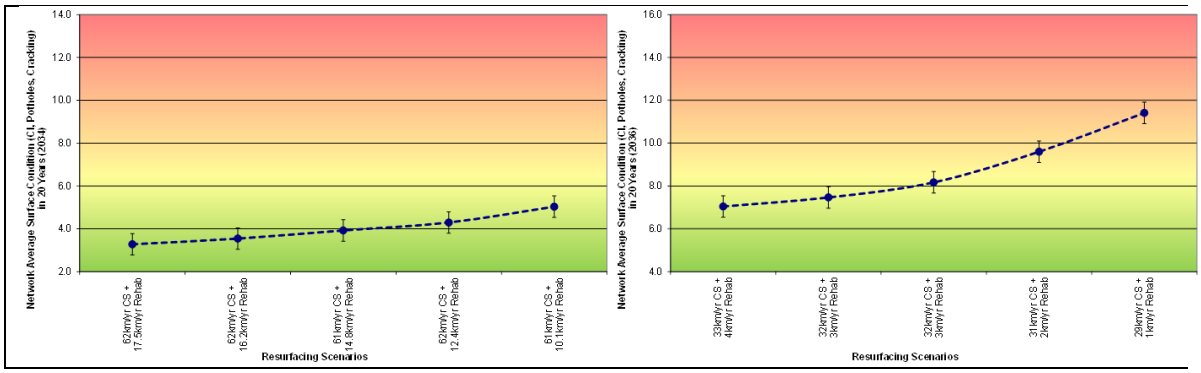


Figure 8: Sensitivity of Two Networks for Varying Budget Levels

An over-all summary of the modeling outcomes for the RATA region is presented in Table 3. This table shows the network modelling status from the past, the data confidence and the maintenance investment recommendation. The last two columns present and intuitive assessment whether a lower investment could be considered.

Table 3: Difference in Outcome for the Respective Networks

Council	Active Modelling Before	Data Confidence	Percentile			Could lower investment be considered	
			Pavement	Surface	TAC	Pavement	Surface
A	None	Med-low	0.40	6.80	-	No	No
B	Some	Med-high	0.60	6.40	-	No	No
C	Active	High	0.70	4.70	1.20	No	No
D	Active	Med-high	0.70	6.00	-	No	yes
E	None	Med-high	0.90	6.00	-	No	yes
F	Active	Med-high	0.90	8.10	0.10	No	Yes
G	Some	Med-high	1.10	7.10	-	No	No
H	None	Medium	1.10	8.10	0.10	Yes	Yes
I	Some	Medium	1.30	5.10	0.10	Yes	No

Observations from the table include:

- There is no correlation between the previous modelling status and the outcome of this rounds' analysis. The only exception suggest that previous modelling did encourage better data quality; and,
- The recommended long-term quantity of maintenance is closely related to the current status of the network. Therefore, if sufficient maintenance investment was maintained in the past, the current need would not be that great.

It was hoped that councils who have undertaken modelling on their networks before would have used more appropriate investment levels, however this was not the case considering that in the past, the model was never used to determine the minimum investment levels. In contrast however, the modeling run for all the councils using the same analysis settings was extremely helpful to determine the appropriateness of current funding levels. It is also worth mentioning that non-license holders from RATA have now committed to undertake regular modeling in the future.

4. Summary and Discussion

It should be appreciated that the modelling system that was developed for New Zealand could be classified as one of the worlds most advanced. In particular, our ability to model to the treatment length level is a unique approach. In addition, few countries have achieved the robustness with deterioration models to the same extend that New Zealand has. There are also few countries that validate the results to the same extend as we do in New Zealand. For example, each forecast made on the State Highway has been validated by a team of asset integrators. The dTIMS system is the most widely used pavement management system in the world and the robustness of our model is acknowledged by the international dTIMS experts.

Unfortunately, the robustness of our model approach is not matched in other areas in particular:

- Our data collection practices is simply stuck in the stone ages, when compared to other countries; and,
- It is only in isolated cases where the true value of the systems is realised at a strategic investment level.

Collectively, our vision should be for the modelling process to reach a level of robustness where the modelling results could become central to the funding conversation between the NTZA and the council. The subsequent sections focus on the improvement areas in more detail.

4.1 Value of Modelling Analysis

The IDS system has now been in use in New Zealand for 17 years. During this time the validation and improvement of the model has resulted into the most valuable asset for the asset management (AM) sector. Analyses and case studies have proven that:

- The robustness of the model, if calibrated and used in conjunction with robust data stands beyond questioning;
- Optimisation analysis (apart from its strategic/information value), demonstrated a 15 to 25% efficiency gain. This means that a better LoS could be achieved for similar investment levels, or a similar LoS could be achieved with reduced funding; and,
- The power of the system has come to its own when councils starts undertaking the ONRC gap analysis that allows them to develop a road map towards achieving certain LoS expectations on respective ONRC classes.

Table 4 summarises the value of the modelling system on its ability to address the OAG's perspective of AM essentials.

Table 4: The Value from Modelling Analysis (Based on OAG, 2010)

AM Essential	*Does the modelling addresses this issue?*	*Comments*
Integrated with other planning, considering funding sources and available finance	Not yet	The system has the capability of cross asset analysis that are currently not being used in NZ
Reliant on good quality data and well operated data systems	Not yet	See Section 4.2
Clear levels of service	✓✓✓	The recently completed ONRC analysis showed the value of connecting LoS with investment needs
Comprehensive lifecycle asset management strategies	✓✓✓	This is what the system was designed to do
Clear service delivery arrangements	Not applicable	
Demand needs understood	✓✓✓	dTIMS has recently been used in the HPMV analysis
Risks recognised and managed	✓✓	We have risk based model included to the system, but could be utilised better
Financial forecasts are complete and inform choices	✓✓✓	E.g. the analysis completed for the NZTA State Highways
Planned and monitored improvements	✓✓✓	Through sensitivity and impact analysis that informed data improvement strategies.

Legend ✓✓✓ The system is ideal with addressing this AM essential
✓✓ The system somewhat addresses this essential, but could be improved
✓ The system partly addresses this essential

IDS has realised that a significant short-coming in the industry is that the modelling analytic is not appropriately applied at a strategic asset planning level. There are a number of initiatives that aims at addressing this issue. REG could also play an instrumental part in assisting with this initiative.

4.2 Data Issues

From a strategic viewpoint, addressing the data is one of the main issues for REG to take account of. Some considerations are:

- **The value of data collection is not understood/appreciated.** – Data collection costs are normally but a fraction of the asset management process, yet councils in New Zealand still follows a minimalistic policy. Roughness survey and visual assessment is simply not sufficient for undertaking condition reporting, benchmarking or robust asset planning. To get more value from condition assessments will require a slight increase in survey cost with a significant return in value from the data;
- **Pavement performance indicators are needed**. With roughness being a weak indicator of pavement performance, either rutting or FWD surveys are required to give an indication of pavement needs. In not undertaking these surveys there is a significant risk of over-or-under investing on pavement renewals. For example the recently completed FWD surveys on the Wellington network has returned more than its value when compared to the cost of undertaking it. A University of Auckland study

showed that by increasing FWD coverage on the network from 5% to a 66% a planning surplus of $4million was realised for the first ten years of the FWP;

- Many councils claim that rutting is not a maintenance driver from them thus not needing rutting surveys. This claim is fundamentally flawed since we use rutting as a failure criteria for the AUSTROADS pavement design method. Even though few roads fail in rutting, **rutting is still one of the core parameters that indicate pavement health.** The NZTA has undertaken some sensitivity analysis that demonstrated an 2mm average increase on rutting on the state highways will result in a 20-30% increase in routine maintenance costs;
- **Appropriate road length sectioning will yield significant efficiency gains.** All of the analyses that have been undertaken on the local council network suggest that improvements are needed to achieve more homogeneous treatment lengths. There are also a number of comments that simply states the treatment length to be too long. This improvement perhaps is the most important aspect to address. (Appendix B shows a review of the impact of treatment length on reporting and maintenance decisions.)

4.3 The Value of Region-wide / Amalgamated Network Analysis

The NZTA state highway, Auckland Transport and RATA analyses have proven the value of regional-wide analysis. Whether a true regional analyses (one budget for all) or a stratified analysis (each having their own budget) is undertaken, the value of a comparative analysis is significant. Using the same model setting allows for a true long-term benchmarking of maintenance investment. This also include a comparison in long-term LoS achieve per ONRC class. The value of the result became especially valuable in the discussion between councils in assessing the outcomes.

4.4 Recommended Actions

The recommended actions for improving the asset analytic and planning are:

- To take leadership in driving a step change in data collection. Working with individual councils during the past 17 years did not result in significant changes. Although councils who have undertaken modelling have substantial better quality data compared to the rest, there still needs to be quantum shift in the approach to data collection. The value of NZTA co-ordinating a country wide High Speed Data collection process will yield significant outcomes from a funding perspective;
- It would be appropriate for the NZTA to commission High Speed Data collection nationwide. This would immediately advise a number of data collection inconsistencies, provide a snapshot of the network as a whole, and endorse improve management outcomes nationwide. Given that it cost the average council in the order of $10,000 to prepare, advertise and let a contract of this nature, savings of $500, 0000 would be achieved through a centrally managed data. These savings in turn could be used to fund a comprehensive national analysis;

- Outcomes from this report suggest that councils that are not doing any modelling probably have significantly limited data, thus the robustness of long-term maintenance planning is questionable. This should be of major concern to the funder;
- Region wide or ambulated analyses need to be encouraged/promoted; and,
- IDS should be supported in assisting modelling outcomes to be considered at executive level of councils. Therefore the reports and approach should be adjusted to facilitate this change.

Appendix A: CODC Case Study

Appendix B: The impact of Treatment Length –Ontario Study