

**A REVIEW OF ACHIEVABLE EFFICIENCIES AND
ASSOCIATED ISSUES UNDER OUTPUT AND
PERFORMANCE BASED CONTRACTS**

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1. INTRODUCTION

Since 1991 a mix of Output and Performance based roading maintenance has been in place on New Zealand's State Highway and Territorial Local Authority roading networks. A variety of contract delivery methods have been developed over this period. This paper discusses direct roading network management experience with a variety of State Highway and Territorial Local Authority networks.

The paper discusses the currently employed delivery methods namely the Conventional, Hybrid and Performance Specified Maintenance Contract (PSMC) contract methods and examines the efficiencies, which have been realised in terms of both reactive maintenance expenditure and the outcomes achieved on the ground with respect to network condition as it is currently measured for two specific examples.

Further to the issues of expenditure, achievement and condition other factors associated with the choice of delivery type, which are of direct relevance to roading network owners, are discussed. These factors include contract period, industry trends, funding and the ongoing ownership and maintenance of roading network information assets.

Currently Transit New Zealand's procurement strategy is to apportion approximately one third of the State Highway network maintenance to each of the three delivery models outlined in this paper. The Authors suggest that careful comparison of performance for each model type is essential over an extended period of time before it will be possible to determine which, if any, has a significant advantage in terms of cost efficiency and outcome performance, as they consider that value can be gained under all model types.

2. CONTRACT TYPES

We will not discuss the various types of contract in detail as that subject is discussed in several other presented papers. A brief description is as follows:

(a) Performance Specified Maintenance Contracts

Relationships in this model are shown in Figure 1. This contract type is outcome based.

This delivery model has, in New Zealand, been developed around a 10-year lump sum contract structure. This long-term contract tenure has provided the contractor/consultant consortium with a level of security concerning contract resourcing. The client also has security in knowing what the long term financial commitments will be. Auditing for Performance Compliance over this length of tenure becomes crucial to its success, as the client needs to know how the asset condition and service delivery is being maintained over the length of the tenure.

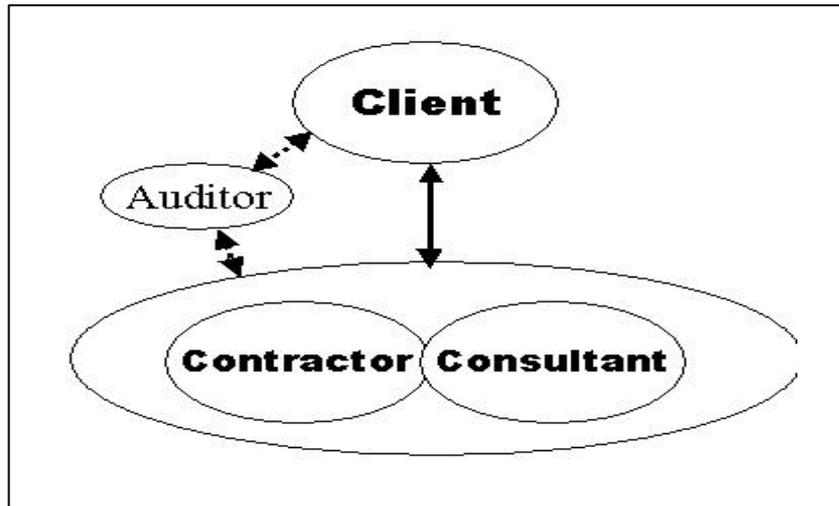


Figure 1: The PSMC Model

(b) The Hybrid Model

Relationships and Entities are shown in Figure 2 This contract type is a mixture of Outcome and Output based.

In New Zealand the development of the hybrid model has been considered as a stepping stone to the PSMC model and may be most suited to network areas where suppliers required time to develop the alliances and experience necessary to successfully tender under the PSMC model. This model has been let with a 5-year tenure (2+1+1+1), with performance review targets required to be met for annual roll over.

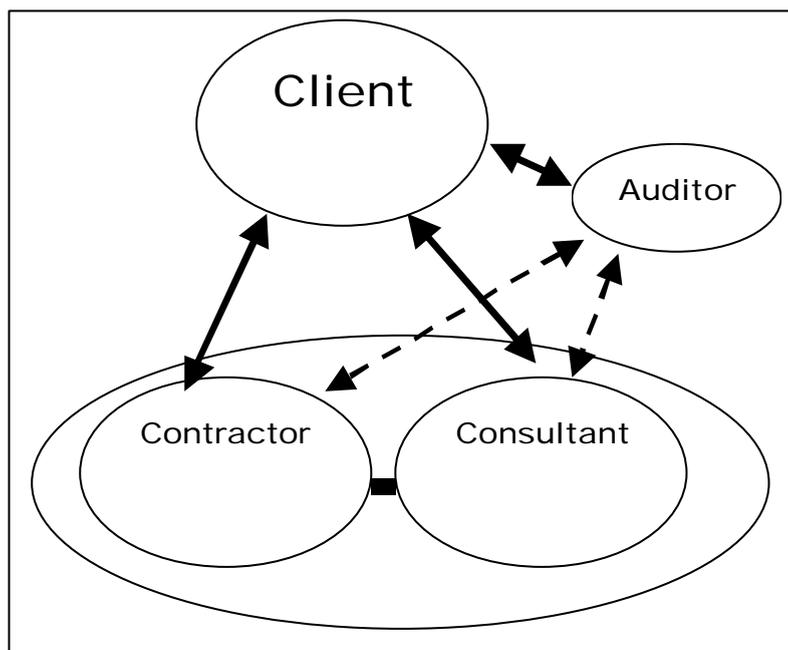


Figure 2: The Hybrid Model

(c) The Conventional Model

Relationships in this model are shown in [Figure 3](#). While this figure only shows one Contractor, this delivery model in reality requires many separate contracts and contractors to be managed by the Consultant. The contract style can range from input to output to outcome based.

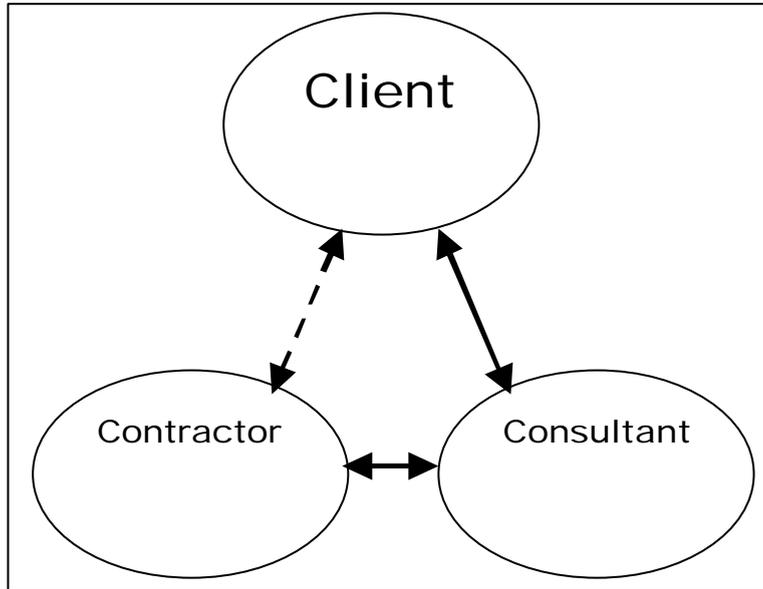


Figure 3: The Conventional Model

This model relies on the Consultant developing and maintaining a successful contractual relation with both the Client and the Contractor (s). These contracts have in the past been typically 1 to 3 years in duration, but in more recent years, tenures of up to 5 years have become more common, usually incorporating a provision for rolling over the contract for extra years (e.g. 2+1+1+1) based on performance.

The full range of these models is most evident in Transit New Zealand’s (TNZ) networks but developments are also taking place to implement PSMC and Hybrid type contracts in Local Authority Networks.

3. MEASURES OF PERFORMANCE – COST EFFICIENCIES

Historical information on cost efficiencies from the perspective of Road Controlling Authorities (RCA’s) is available for networks within NZ where comprehensive detailed expenditure over five or more years is available. Anything less than five years is really too short to both identify trends and have some confidence that trends are well established. This means that in reality the only delivery type where this information currently exists is the conventional model. An example of information we have on contract cost efficiencies as a measure of performance is shown in [Figure 4](#), which shows the cumulative annual costs of reactive unplanned pavement maintenance on the 550 km TNZ Hawke’s Bay network for each year of a nine-year period.

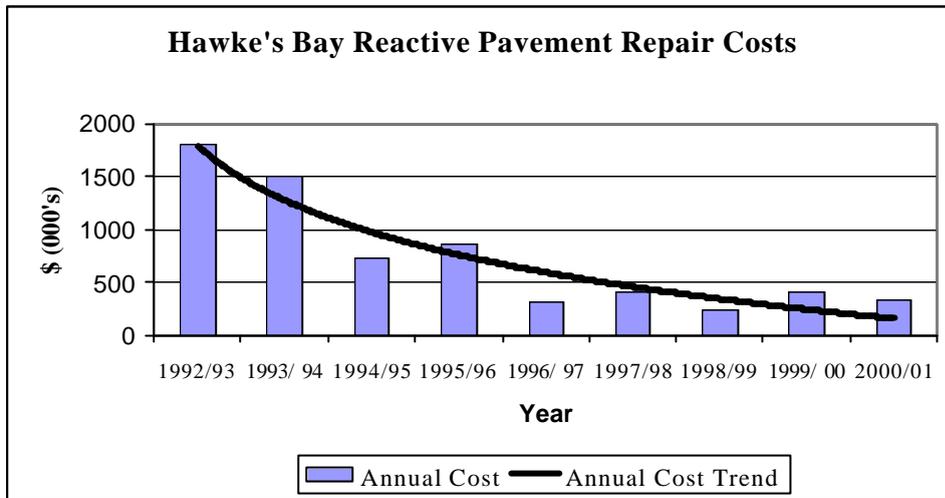


Figure 4: Reactive Maintenance Cost Trends

Costs (and quantities) have reduced dramatically over the period shown from a high of approximately \$1.8 million (50,000m²/yr) in 1992/93 to a current stable annual figure of approximately \$0.4 million (4,000m²/yr).

A number of factors have combined to produce this outcome however, from the perspective of the authors who have been participants in the network management process over this period, the key success factors are:

- A balance of differing objectives and perspectives from actively involved participants i.e. Consultant and contractor. This brought a healthy tension to the network management process.
- The access on a daily, weekly and monthly basis to detailed audited, network achievement data. Review and feedback of this data into the management of the network resulted in very significant savings in unplanned reactive expenditure.

While cost data is either unavailable or too limited in its extent to enable such information over time to be observed for Hybrid or PSMC contracts, it is also more relevant in these delivery methods to the network service suppliers than it is to the network owner.

Under a lump sum method of payment the opportunity for cost efficiencies (leaving aside the issue of "extras" under the contract) is really decided up front at the time the contract is signed. There are however, factors a Road Controlling Authority (RCA) can, and should, consider with respect to overall cost over the period of the contract.

Delivery models that return to the market place on a relatively frequent basis (3 to 5 years) have the ability to test the effect of competitive pricing arising from advances in technology and management systems.

The following is an example that compares the Net Present Value (NPV) over a ten year period at 10% Internal Rate of Return (IRR) of a nominal \$1000 contract that is re-tendered at a three yearly interval (Conventional Model), with a range of possible

price reductions for each tendering round ranging from 15% to 30%. These price reductions have been typical of those experienced in recent years.

The three yearly tender options are also compared with a contract fixed over ten years at the same IRR but at 80% (i.e. 20% initial price reduction) of the original \$1000 contract value (PSMC Model).

An illustration of the cost issues is given in [Figure 5](#).

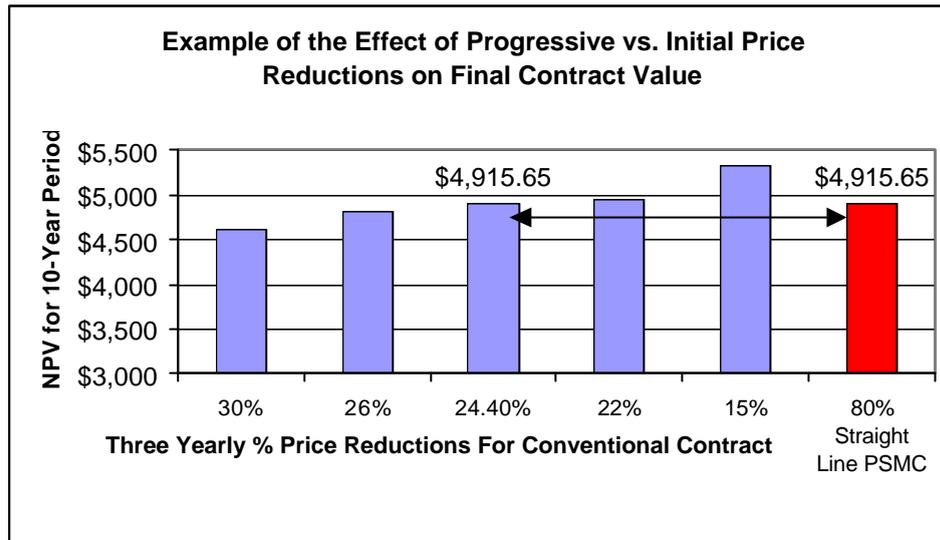


Figure 5: NPV values – Three years vs Ten years

The graph shows the sensitivity of the three yearly price reductions compared with that for a fixed ten-year contract that starts with an initial value of 80% of the conventional contract. This analysis suggests that if three yearly retendering realises approximately 24% saving then this is equivalent to an initial 20% saving for a fixed ten-year contract in terms of NPV.

Based on the above result, a consideration on the outcome with respect to cost is the likely result of the revisit to the market place every three years (NB while some non PSMC contracts are five years in duration this is usually subject to RCA extensions after two or three years). In considering industry trends in pricing since 1991 once again we only have the Conventional model to call upon in looking at these. For the Hawke’s Bay TNZ contract area the trend since 1991 is shown in [Figure 6](#).

In this graph the figures shown are for the highway pavement maintenance contract costs corrected for inflation. Some cyclic or corridor costs are not included. The lump sum price for the PSMC model also includes area wide pavement treatments, while prices for these items are currently re-tendered annually for the other two models.

Based on a period of time with three re-tendering rounds, the average reduction for each round in let contract price is between 25% and 30% for highway maintenance contracts in Hawke’s Bay.

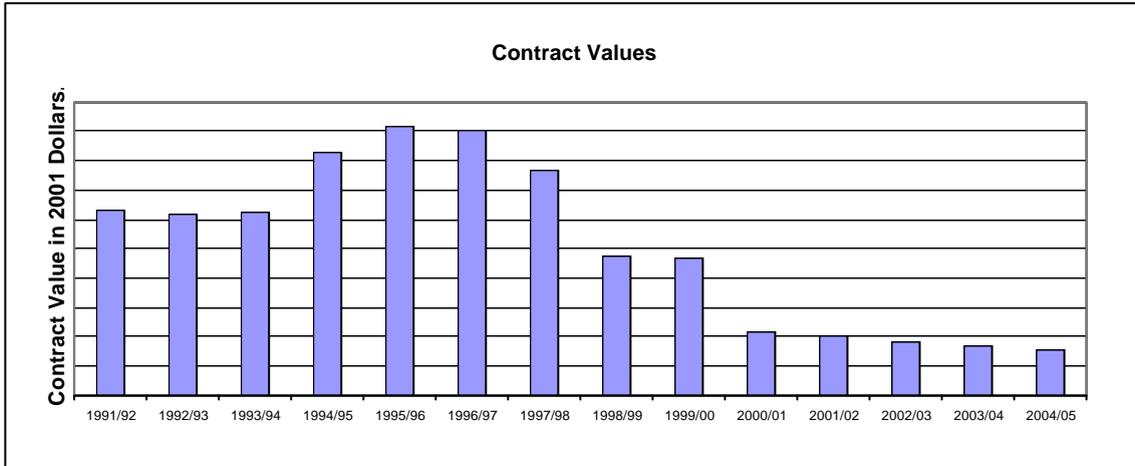


Figure 6: Hawke's Bay Pavement Maintenance Costs over Ten Years

The other factors to be considered in a longer-term contract from the point of view of the service supplier are:

(a) Security of Tenure

This is a major benefit to a supplier to securing a PSMC. The contract supplies a guaranteed level of revenue over an extended period.

(b) Flexibility in Resourcing

The PSMC and, to a certain extent five year contracts, provide the supplier with a greatly improved flexibility in utilisation of operational resources. This flexibility translates in improved efficiency for the supplier.

(c) Competition

A successful tenderer for a PSMC particularly is in a strong position to compete with other suppliers in future tenders.

(d) Intellectual Property

Knowledge of the asset gained over an extended period of management is a significant advantage in future tendering.

Factors to be considered from the point of view of the RCA are:

(e) Intellectual Property

Is the owner becoming separated from a detailed understanding of their asset? Specific provision needs to be put in place to ensure that information related to the maintenance of the asset is supplied to the owner from the service provider frequently and in detail. It is far easier under an output based type of contract to obtain detailed specific asset maintenance data as a default option as it is usually required for payments. Specific provision needs to be made for

information supply under the Hybrid/PSMC models, which may be more difficult to enforce.

(f) Funding Commitment

The authors have had two dramatically different views expressed to them by roading network owners on the issue of funding commitment. These views from two Territorial Local Authorities (TLAs) were:

- “we would never consider entering into a long term PSMC as such an arrangement would restrict our ability to manage our funds”

and

- “the main reason why we would enter into a long term PSMC is to secure, on a long term basis, funds dedicated to maintaining our roading network”.

These two views well illustrate the range of the issues involved in funding a long-term lump sum contract. Individual RCAs will lie somewhere in this range.

(g) Involvement and Ownership

Long term Hybrid or PSMC needs to be set up and actively managed by a RCA if the potential problem of having a lack of knowledge and involvement is to be avoided. The default situation can easily occur where, on a monthly basis, little detailed information is routinely available. As a result, under a PSMC an RCA may well find that their inputs increase as they seek to overcome this.

4. NETWORK PERFORMANCE OUTCOMES

Condition measures of a roading network’s current status are being increasingly used by network owners and managers to monitor the outcomes of the management process and, for long term performance based contracts, such measures are crucial for RCAs in determining the outcome on their asset, of the management process. In this case we are referring to “hard” measures i.e. independently collected data which is accepted as being:

- Subject to industry standard calibration
- Auditable
- Repeatable

High Speed data (HSD) particularly goes closest to meeting the above criteria. Visual Condition Rating data would be next in terms of repeatable consistency but it is subject to more variation than HSD. As with the cost data only conventional data is available over time for both these types of data.

Historically the most commonly nationally applied measure in New Zealand has been that of roughness. As the electronic records of high speed surveys have become readily available however new performance measures have been considered.

Examples of measures currently used are:

(a) Skid Resistance (High Speed Data)

1. The extent of the network which has survey deficiencies that are below the nationally set intervention level.
2. The mean Skid Resistance Coefficient level, and the mean intervention level.

(b) Surfacing Performance (Analysed from Database Surfacing Records)

The current performance measure for surfacing life is Remaining Service Life (RSL) but this only represents the estimated surfacing life remaining on the pavement. Actual surfacing age may prove to be a better measure in the future.

(c) Pavement Structural condition (Analysed from Falling Weight Deflectometer and Pavement Database records)

1. Network representative structural number
2. Network percentage below minimal structural number.

(d) Roughness (High Speed Data)

1. Mean Roughness in NAASRA Counts
2. Network percentage with readings above 130 NAARSA Counts

(e) Rutting (High Speed Data)

1. Extent of Rutting >30 mm in m/km
2. Extent of Network with any rutting

(f) Texture (High Speed Data)

1. Mean texture depth
2. Network percentage with a texture depth less than 0.9mm

Illustrated graphs with comparable scales for some of the measures a), d) and f) are shown in the following figures for the North Canterbury (pre and post 1999 hybrid contract) and for Hawke's Bay (conventional) Transit New Zealand regions. The trends shown on these graphs indicate that desirable performances have been achieved, both before and after the introduction of the hybrid in North Canterbury (1999) and over the last 5 years for Hawke's Bay.

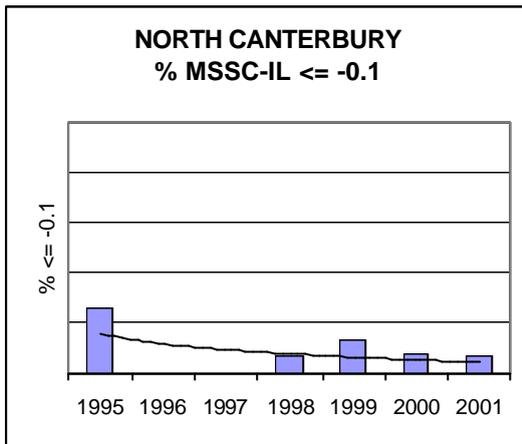


Figure 7:
North Canterbury Skid Resistance below threshold

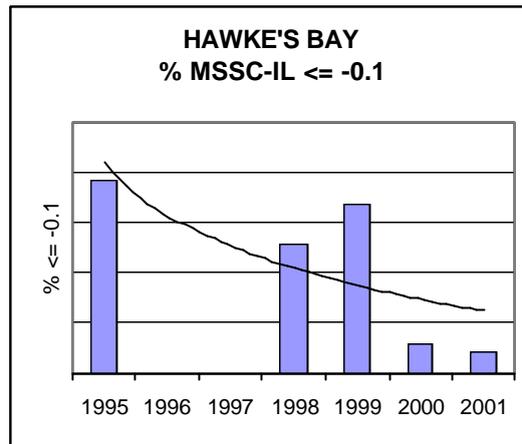


Figure 8:
Hawke's Bay Skid Resistance below threshold

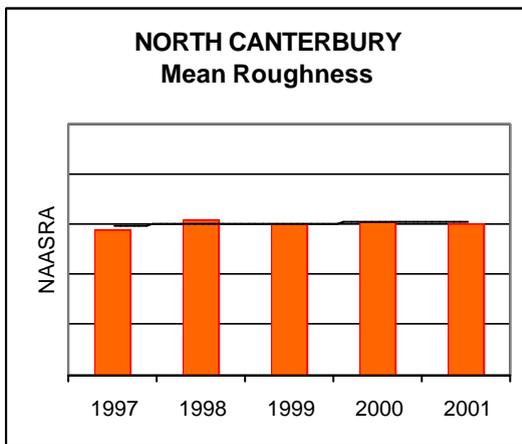


Figure 9:
North Canterbury Mean Roughness

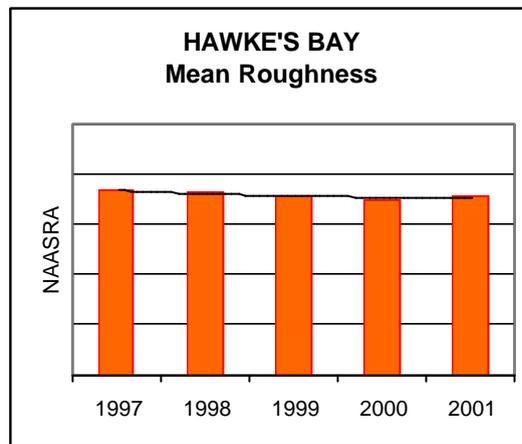


Figure 10:
Hawke's Bay Mean Roughness

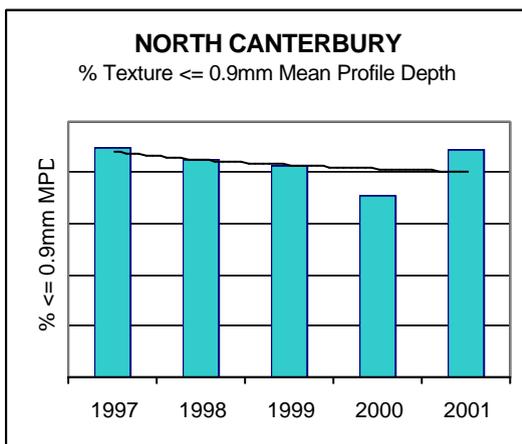


Figure 11:
North Canterbury Texture below 0.9mm MPD

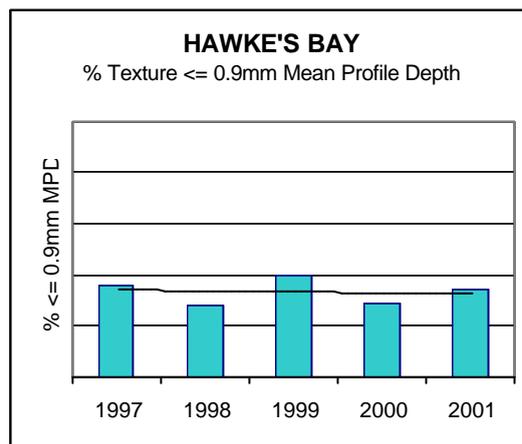


Figure 12:
Hawke's Bay Texture below 0.9mm MPD

Network managers (either client, consultant or contractor) can develop more detailed measures for their local areas.

One further example of the type of hard measure that is applicable for all delivery models is shown in Figure 13.

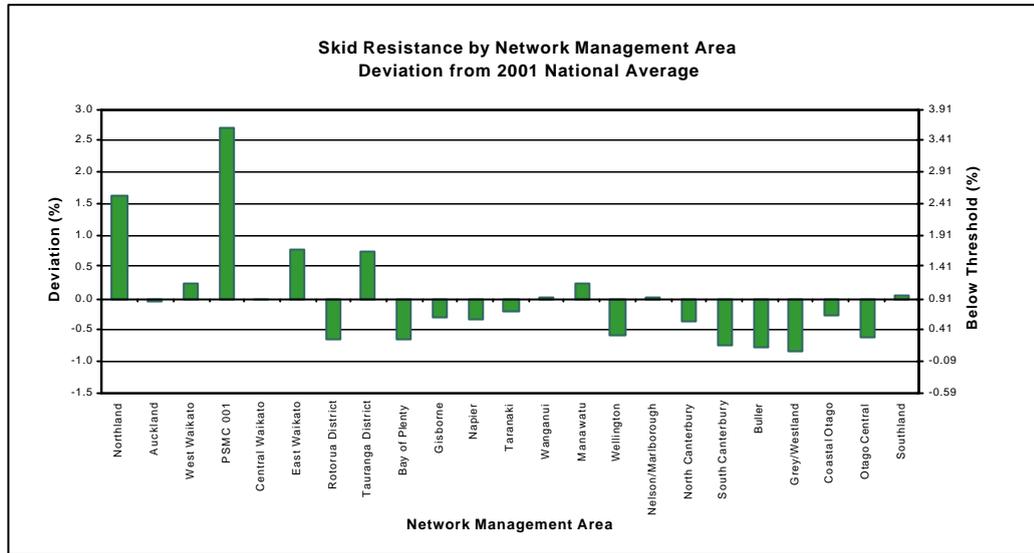


Figure 13: Transit New Zealand Network Area 2001 Skid Resistance Survey.

While useful long term comparative data is not yet available for the PSMC areas, and the information from the hybrid contracts is limited, Figures 7 to 12 suggest that trends over time, at least for two networks compared in this paper, are similar. For these and other roading networks (including those with PSMC) time will provide a better measure, in terms of hard published performance outcomes, of the reflection of network condition. The challenge will be to obtain meaningful measures that have wide industry acceptance and creditability.

5. WHAT ARE THE CRITICAL FACTORS?

The following factors are considered to be critical to the achievement of the desired outcomes, and are arguably generic across all delivery models:

- **Tenure.**

Contract tenure that is long enough to permit the Contractor/Consultant to develop and retain the technical skills/resources necessary to ensure consistent delivery. However, if this duration is too long, or is not subject to a degree of tension through on going performance review, then there is the risk that, over time, local competition may be lost. This would result in loss of future competitive pricing and output quality.

- **Data Acquisition and Analysis.**

The acquisition and analysis of all of the available network data to determine when the most cost effective treatment is required to ensure network condition is maintained within the prescribed parameters. This requires a detailed

understanding of asset management at the level at which these decisions are being made, as well as a strong systems based approach to support asset management personnel.

- **Strategies.**

The development of strategies to promote efficient maintenance expenditure. For example under the conventional model the following strategies have proven to be very successful:

- reactive repairs (to treat failed areas only, not those judged about to fail)
- differing response times (e.g. within 2 weeks for crack seals, 4 weeks for pavement failures, or 8 weeks for non-urgent work)
- differing life expectancies of repairs (e.g. 1 year for areas that are due for rehabilitation or realignment, 10 years for normal repairs)
- differing risk allocation if repairs fail (e.g. low cost, high risk repairs have more client risk than high cost, low risk type repairs)
- differing response times for pre-programmed repairs (e.g. potholes, minor crack seals, pavement repairs, blocked water channels).

- **Monitoring**

The ability to track and monitor the effectiveness of the strategies selected and report on trends and exceptions to the client through matching advanced systems and personnel skills.

- **Achievements.**

- Consistent long-term achievement of the specified Key Performance Measures by the contracted parties.
- Maintenance of the specified network Key Performance Indicators, with truly optimised maintenance expenditure patterns.

- **Ownership.**

Network “ownership” at all levels. All parties must understand what the objectives are and are committed to achieving them.

- **Skills.**

Personnel who are technically skilled at the contract management level and, just as importantly, at the construction level. It will not be possible to achieve the required outcomes if the technical and analytical decisions fail to be transformed into high quality workmanship in the field.

- **Innovation.**

A continuing emphasis on innovation at all levels. If advances are to be achieved in terms of output efficiency and quality, then there needs to be a consistent examination of contract models used and work methods employed. This requires inputs both from the Client, Consultant and the Contractor. The recent development of contracts that permit an involvement by the Contractor in the final area type treatment selection have demonstrated benefits to all

parties. This style of contract has enabled the Contractor to demonstrate and incorporate innovation under conventional style contracts, to the benefit of the client, but without necessarily assuming the higher level of risk associated with full performance based contracts.

- **Communication.**

The development of contractual relationships (both internal and external) that maintain open and honest communication between all parties. Unless this is achieved, it probable that any delivery model will struggle to attain the required outcomes.

6. CONCLUSIONS

The conventional model has demonstrated both cost efficiencies and improvement in outcomes over time.

During the 2000 tendering round similar percentage reductions in tender prices were achieved with both the hybrid and conventional models discussed in this paper. This along with the comparable performances of these two models suggests that either delivery model can achieve the desired outcomes so long as they include the critical factors outlined previously.

The initial savings in price being achieved for the 10-year tenure PSMC models will appear attractive to respective RCA's. However given the demonstrated advantages of also returning to the market place on a 3 to 5 year interval, this initial saving needs to be critically examined against the outcomes achieved and any perceived loss of funding flexibility.

Meaningful comparisons between the three delivery models is currently limited by the relatively short period of time the hybrid and the PSMC type models have been in existence. For future valid comparisons of performance achievements to be made, it is essential that "hard" measures be used that are directly comparable between delivery model types. These measures need to be agreed upon and implemented as soon as possible following contract commencement.

Concern has been expressed from the Contracting industry over the potential for contracts with periods of tenure (e.g. 5 to 10 years) to adversely affect the viability of local small contractors who are unsuccessful in either tendering directly, or as subcontractors. The affect of these contracts in terms of reduced local or regional competitive pricing over time needs to be carefully monitored.

Before there is any significant adjustment to the current Transit New Zealand maintenance procurement strategy, this paper recommends that careful comparison of performance for each model type is required over an extended period of time. Only once this has been completed and the outcomes evaluated will it be possible to determine which, if any, has a significant advantage.

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Tony Porter; Opus International Consultants, *Trends in the Procurement Models for Highway Maintenance*, Transportation Research Board, Washington DC, January 2001