PUNJAB STATE ROAD SECTOR PROJECT CONSULTANCY SERVICES AND PROJECT PREPARATORY STUDIES FOR PACKAGE II (PHASE II)

Preliminary Report on Contract Format for Output and Performance Based Contracts for Roads.

OPUS

PUNJAB STATE ROAD SECTOR PROJECT LOAN # 4843-IN

Consultancy Services and Project Preparatory Studies for Package II (Phase II)

Preliminary Report on Contract Format for Output and Performance Based Contracts for Roads.

Technical Proposal Discussion Offer Item 4 Concerning Task A2: Financial Model to be used for Payment.

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1 Executive Summary

All of the current Output and Performance based Road Contracts (OPRC) that Opus International Group are aware of have utilised underpinned quantities as the basis for managing the risk of unintended pavement asset consumption. This concept is also provided for within the World Bank's Sample Bidding Documents for OPRC.

The preservation of pavement residual condition (life) is seen as one of the most critical outcomes of any performance based contract as the Client must be confident that he is not going to be presented with a significant and unexpected bow wave of pavement investment required at the end of the contract period. However this is one of the most difficult parameters to establish with a high level of confidence, and the current theoretical approaches still contain a significant number of uncertainties.

The underpinned quantity approach has provided a practical way of managing the uncertainties that currently exist over the ability to adequately define and measure end of pavement life condition parameters. These uncertainties may exist as a result of one or more of the following:

- data limitations
- the impact of risk transfer to the contractor and associated contract pricing considerations
- the impact external factors such as environmental, spatial or temporal effects that are difficult to quantify at the time of tender.

The fundamental difference between the way the Hybrid model and the PSMC model apply the philosophy of underpinned quantities is the extent to which the risk of pavement consumption is transferred from the Client to the Contractor. The extent of this transfer under the PSMC model requires a significant increase in the level of work required at the time of tender by both the Tenderers and the Client compared to the Hybrid. Consequently the cost of tendering is significantly higher for the PSMC model.

In determining and specifying the quantity of underpinned quantities in the Hybrid, the Client retains the risk associated with the validity of this assessment along with the ownership and control of the network residual condition over the long term (10+ years). This then reduces the level of data accuracy and the extent of modelling analysis required, which only has to be undertaken by the Consultant in this model. Further flexibility is provided through the Contract Management Board being able to agree a variation to the quantities if it can be shown that the quantities determined through the initial modelling were inadequate. Equally the specified quantities to be reduced with the inclusion of appropriate clauses within the contract documents.

With the full transfer of this risk to the Contractor under the PSMC model, it then becomes his responsibility to define the quantum of these underpinned quantities and the timing of their implementation. This quantum can then be valued during the tender evaluation process, although this valuation process requires further extensive modelling by the Client or their Consultant.

All models permit trade offs to occur between various work categories. This mechanism enables the year upon year variability that occurs between these work categories (resurfacing, rehabilitation etc) to be accommodated while maintaining the integrity of the contract Lump Sum value. This mechanism therefore allows good asset management decisions to be made with respect to the long term needs of the network.

Careful consideration needs to be given to the way these underpinned quantities are defined in either model to enable a fair basis for valuing the trade offs between treatments to be established and operated over the duration of the contact.

This process should require Tenderers to include in the price schedule the unit rates for all of the expected resurfacing and pavement treatments along with a mechanism for applying some price tension during this phase in preference to a reliance on post award negotiation.

Financial models that specify only a cost profile, without defining the nature of the works to be undertaken, run the risk of the Contractor scheduling low cost, short duration treatments that may achieve and maintain specified condition measures over the duration of the contract, but will leave a potential legacy of a large backlog and a large future pavement investment that will have to be subsequently addressed.

There will still be a number of considerations from other Task outputs that may influence the final contract format with respect to controlling the risk of pavement asset consumption with this Punjab OPRC pilot. These will be:

- Establishing the current level of knowledge and understanding over the way the pavements on the network perform and establishing the level of investment necessary through the OPRC model to ensure that the residual life that exists at the commencement is preserved through to the end of the contract

- The need to limit the reliance placed up initial data availability and modelling interpretation while still permitting a 10 year contract duration

- The potential need to limit the level of risk transfer to a relatively inexperienced (with OPRC) contracting industry over the aspect long term pavement condition and asset consumption in an effort to attract as many viable Tenderers as possible

- The need for the contract to be flexible and to allow for as much Contractor driven innovation as possible, including the responsibility for the design of all pavements (to defined minimum design life requirements) and resurfacing along with the location and final annual quantity of rehabilitated pavements to be completed

- The level of uncertainty associated with the behaviour of the pavement asset under a new maintenance regime along with the impact of the quantity of improvement work (both rehabilitation and upgradation) to be completed within the Punjab OPRC pilot.

- The development of compliance mechanisms to ensure all the risk of rework associated with the design and/or construction quality remains with the Contractor

- The development of a pricing mechanism at a detailed treatment option level for all applicable maintenance treatments to be undertaken on the network's pavements. This should be price tensioned at the time of tender and will then form the basis of a trade off mechanism permitting the Contractor (with the Client's agreement) to adjust the annual quantities in line with the actual assessed needs of the network.

The final report on the Contract Format will then also be subject to the outputs from the following Tasks before a final recommendation can be made under Task A6 and included in Interim Report 1:

- Task A1-Definition of Service Level Classification
- Task A2-Financial Model to be used for Payment
- Task A3-Legal Framework and EIA and SIA Frameworks
- Task A4-Confirmation of Contracting Capacity to Undertake and Manage the Works
- Task B1-Checking Suitability of Pre-Selected Road Sections
- Task A5-Overseas Study Tour.
- Discussion and agreement with the PRBDB.

2 Introduction

Clarification was sought by the Punjab Roads and Bridges Development Board (PRBDB) concerning a section within the Technical Proposal methodology submitted by Opus International Group (Opus) for the Punjab State Road Sector Project Loan # 4843 –IN Consultancy Services and Project Preparatory Studies for Package II (Phase II).

Specifically this related to the development of the Financial Model to be used for Payment under Task A2. The RFP for this component required the following:

Task: A2: Financial Model to be used for payment

19. Based upon the service level classification established under A.1 above, the Consultant will carry out a detailed analysis which will lead to an estimate of the likely medium- and long-term cost of assuring each of the predefined service levels. In order to reach that result, he will need to identify all physical works and other activities (managerial, self-control, etc.) a Contractor will most likely have to carry out for each service level class, as well as the frequency of those activities and the interventions as well as *the quality of a road at the time handing over to the Client at the end of the contract.* A cost recovery model in at least 3 alternatives will be developed as to define the most suitable and optimized method of payment for the contracting entity, as well as to define "the best value for money" the Client will pay to the contracting entity. The cost estimate will be based on **conceptual designs** for each road which will include the typical cross sections and other typical geometric design parameters and be based upon the basic field surveys (traffic counts and forecasting, topographical and soils/materials).

The Opus Technical Proposal referred to their experience with a range of existing performance based contracts for roads, and these were summarised within Section 3 B of the submission relating to the Consultant's experience.

Of initial concern to the PRBDB was the intention within the Opus submission to use the concept of "underpinned quantities" of pavement rehabilitation and surfacing to ensure that over the duration of the Output and Performance based Road Contract (OPRC), there would be sufficient investment made by the Contractor(s) to prevent any significant risk of not maintaining residual pavement life over the duration of the contract. One of the prime objectives of any OPRC is to ensure that the network's pavements still have at least the same level of residual life left at the end of the contract period as they had at the start.

If this is not achieved, then there is a very real risk that the client will be faced with a significant cost in addressing deteriorating pavements and a reduction in service levels soon after the end of the contract.

The term "Underpinned Quantities" identifies a defined quantity of surfacing and pavement rehabilitation work, usually clearly specified as a minimum of m^2, to be completed within each of the financial years over the contract term. However the actual location, design and detailed programme for the work remain the responsibility of the Contractor. A degree of flexibility in the completion of these quantities is usually provided by the Contract Management Board permitting an agreed variation to these annual quantities (typically ± 10%) so long as the total specified quantity is completed during the term of the contract.

The PRBDB expressed concern that the concept of setting these "underpinned quantities" may result in the following adverse or unintended outcomes:

- The risk of the incorrectly identifying the quantities, either too little or too much, would be retained by the Client, where as, in their opinion, the intent of the OPRC contract was the transfer of this risk to the Contracting Industry.

- Specifying the quantities would limit or remove any incentive for the contracting industry to identify innovative practices and that they would simply target the quantities and associated treatments specified.

The PRDBD expressed a preference in developing the financial models that did not specify underpinned quantities, but rather placed emphasis on the development of methods of payment (expenditure profiles) and Key Performance Measures (KPM's) that would ensure Contractor investment would be sufficient to limit the risk of pavement asset consumption.

While Opus was aware of these concerns and preferences of the PRBDB, we were also aware of the following issues:

- That all of the existing OPRC's known to Opus had utilised the principal of "underpinned quantities" in preference to other methodologies to protect against the risk of asset consumption. This is the situation with the projects listed in the Technical Proposal Table 3.4 and identified within the draft itinerary for the overseas tour outlined under Task A5. Table 3.4 has been included under Appendix B.

Task A5: Overseas Study Tour

22. The Consultant shall arrange a study tour for five PRBDB/PWD staff to an appropriate country/counties to study a range of maintenance contracts that include performance based elements. ….. The tour shall be undertaken prior to completion of the "Contract Format Report" required at the completion of Task A6.

- That the measurement of residual life is in practice difficult and it is not a precise science, an aspect that has again encouraged road controlling authorities to move to the use of underpinned quantities as a simple means of ensuring adequate investment occurs

- That under a Performance Based contract it is "easy" to expend money for little gain, and the Contractor will always be seeking ways of minimising inputs and maximising profit within the LS profile

- The anticipated quantity of upgradation works to be included in the Punjab OPRC pilot differentiates this from the other projects listed, and the financial models to be presented to the PRBDB are also required to ensure there is a balance between the improvement works and other maintenance activities that will continue beyond the time that the improvement work is complete.

Opus does not wish to un-necessary constrain the options to be examined under Task A2, nor that required under Task A6: Development of Contract Format. Section 25 which required specific attention to be given to this aspect as follows:

> **Task A6: Development of contract format.**
>
> 25. **End of contract residual road condition.** To ensure that the road is returned in a fit condition for service that will not require major capital maintenance immediately following the end of the contract, the Consultant shall specify separate residual life for each element of the project road. The Consultant shall review, as part of this assignment, the impact of the contract on asset value up to the end of the contract and should advise the Client on the inclusion of additional measures during the contract period to achieve the minimum required asset value at the end of the contract.

As a consequence, Opus has offered, in addition to it's Technical Proposal, the preparation of a report summarising the how the protection of the end of contract residual road condition has been developed and implemented within a number of existing performance based contracts.

The objectives of this report are therefore three fold:

- To provide the members of the Government of Punjab (POG), Public Works Department (PWD), and the PRBDB a level of background information on the performance based contracts, included some of those in the overseas study tour, thereby enabling them to ask more focussed questions relating to this particular component during the tour.
- Briefly outline the other currently available means of determining residual pavement condition (life).
- To enable a better understanding of the practical application of the concept of "underpinned quantities" as one option for the management of the residual road condition.

3 Summary of Existing Output and Performance Based Road Contracts

The following road maintenance contracts have been considered in the preparation of this report:

Contract Name	Network Type	Network Length	Contract Duration	Control of Residual Pavement Condition
North Canterbury State Highway Hybrid (NZ)	Highly trafficked urban and lower trafficked rural State Highways	757km	5 years	Client Specified Underpinned Quantities
Marlborough Roads Hybrid (NZ)	Medium trafficked urban and lower trafficked State Highways and low to very low trafficked (sealed and unsealed) Local Authority (LA) roads.	260km State Highway 1530km LA Roads	5 years	Client Specified Underpinned Quantities
Western Bay of Plenty (WBoP) Performance Based Contract (PBC01) (NZ)	Highly trafficked rural State Highways and medium to lowly trafficked (sealed and unsealed) LA roads.	150km State Highway 1042km of LA Roads	10 years	Contractor Nominated Underpinned Quantities
East Waikato State Highway Hybrid (NZ)	Highly trafficked urban and lower trafficked rural State Highways	544km	5 years	Client Specified Underpinned Quantities
North Sydney Road Transport Authority (RTA) Network Maintenance Contract (Australia)	Very highly trafficked high speed urban motorways, major urban arterials, secondary roads and lower trafficked minor roads.	115km urban motorways 238km Major Arterials 220km Urban Arterials 75km of Minor Roads	10 years	Contractor Nominated Underpinned Quantities
South West Waikato State Highway PSMC 001 (NZ)	Highly trafficked to lowly trafficked rural State Highways	450km	10 Years	Contractor Nominated Underpinned Quantities
MAC Road Maintenance Contracts (UK)	Very highly trafficked to highly trafficked motorway networks	Various	7 Years	Underpinned Quantities
Public Private Partnerships for Road Network Development and Long Term Maintenance (Canada – B.C)	Very highly trafficked to highly trafficked motorway networks	Various	10 Years +	Underpinned Quantities

Table 3.1: Summary of Existing Performance Based Models

The following table summarises the respective risks carried by the Client and the Contractor under the Hybrid and PSMC Models.

Residual Pavement Life Management Component	Hybrid Model	PSMC Model
Determination of underpinned quantities (m^2 / km)	Client	Contractor
General Programme timing for underpinned quantity investment	Client	Contractor
Specific Location of works required to meet KPI's	Contractor	Contractor
Specific timetable for underpinned quantity investment	Contractor	Contractor
Responsibility for achieving annual programme output (m^3)	Contractor	Contractor
Specification of minimum pavement and surfacing design life	Client	Client
Detailed design including the quantity of materials required	Contractor	Contractor
Construction quality and serviceability	Contractor	Contractor

Table 3.2: Summary of Residual Pavement Life Risk Ownership

4 Current Methodologies for the Prediction of Remaining Pavement Life.

The methodologies in use to predict when a pavement would need rehabilitation or to calculate remaining pavement life can be broadly classified under the four following approaches:

4.1 Theoretical Approach

This is very detailed and includes methodologies based on the theory of elasticity and the finite element method. The methodologies require data such as deflection, layer thicknesses, material characteristics, etc. Given detailed data, tools based on theory of elasticity or finite element method can be used to estimate pavement strength (structural number) and remaining life. Where layer thickness and material data is not available, the data is assumed and the analyst follows an iterative trial and error process using finite element or theory of elasticity tool until the predicted and observed deflection bowls match.

If this path is followed, a high level of technical and research expertise is required, along with a significant amount of in-field verification. The level of information and analysis required makes this approach suitable at a project level, but the uncertainties associated with pavement structure and history across an entire network significantly reduce the level of its predictive accuracy.

4.2 Mechanistic-empirical Approach

This includes methodologies such as Austroads Pavement Design Guide which gives pavement “life” in terms of total traffic. This guide states that the pavement has reached a terminal level of distress after a number of Equivalent Standard Axles (ESA) passes.

The sensitivity of the time to structural failure to small changes in granular thickness can be seen if the number of passes of design traffic is considered in terms of years. For a typical pavement on a subgrade CBR of 10, a change in thickness of the granular layers from 256 to 276 mm will increase the design traffic from 9×10^5 to 18×10^5 ESA (i.e. a doubling in life).

Neglecting traffic growth this suggests that, if the design traffic occurred over 25 years, then the increase in life associated with an increase in granular thickness of 20 mm would be from 25 to 50 years. It is obvious that the sensitivity of the mechanistic design guide to very small changes in granular thickness makes it unsuitable as a tool for predicting remaining life over an entire network.

4.3 Empirical Approach

This entails models developed using time series data relating deflection to pavement life. Such models are network specific and usually not transferable. For instance, we see higher deflection for pavements in Central Waikato Region of New Zealand because of volcanic subgrades than in other parts of the country. A recent research study recommended increasing the estimated structural number (SNP) by 1 for Central Waikato network to reflect the in field performance of these subgrades. The adoption of this approach was initially considered by the Road Transport Authority in Sydney after extensive research to validate the relationships had been undertaken, but was not subsequently included in the contract (refer Section 4).

4.4 Pavement performance modelling systems

Such models as the Highway Development and Management Tool (HDM-4) predict pavement condition (roughness, rutting, cracking, etc.) over time as a function of inputs such as the initial conditions, traffic levels, pavement strength, maintenance and environmental conditions. These systems can then also be used to predict the age at which rehabilitation due to structural distress needs to be performed.

It is important to note however, that the accuracy of predictions is strongly linked to data availability and reliability (construction and maintenance records, pavement strength, traffic, etc.) and the specific model calibration and adaptation to the unique attributes of the network. This again takes time and initial predictive accuracy is likely to be limited, until these aspects improve.

The initial model development by Opus will initially place a higher degree of reliance on our international experience and will take a more conservative approach to mitigate the risks brought about by data limitations and other uncertainties. This approach would be in contrast to the situation where Tenderers (under a PSMC approach) typically adopt an approach of minimising quantities while still maintaining an acceptable level of credibility.

5 Applied Methodologies for the Protection of Residual Road Condition at the End of the Contract Period.

As a consequence of the uncertainties outlined in Section 4, both the Hybrid and the Performance Specified Maintenance Contract (PSMC) model development has to date used the concept of underpinned quantities. This is to ensure adequate pavement and surfacing investment will be made by the Contactor over the duration of the contract to minimise the risk of pavement asset consumption. It is important to recognise however that there may be situations (e.g. the creation or renew pavement assets, or where routine maintenance activities have increased condition measures well above the required targets) where consumption is quite appropriate and should be permitted.

There is currently considerable research being undertaken into both the definition of what constitutes the end of pavement life condition and the methods for the accurate prediction of when it will occur[1]. However even with the most recent OPRC model (North Sydney Road Transport Authority Network), which was well supported with condition data and inventory information, there was still an insufficient level of confidence to move away from the underpinned quantity approach.

During the development of this replacement OPRC, the RTA had been working on a methodology and a tool to predict remaining pavement life for a number of years. This tool essentially works on Falling Weight Deflect-o-meter (FWD) data to predict the residual pavement life.

Despite this research they had still taken the underpinned quantity approach, although the definition of the quantities has been left to the Tenderers in this model. However it is still considered advantageous to develop and implement a deflection based residual life model to verify the residual life being achieved by pavement improvement works completed under these performance based contacts. This will be especially important with the Punjab OPRC Pilot given the large percentage of the network that is expected to undergo upgradation and rehabilitation work, as any quality assurance failure during construction that adversely impacts upon the required pavement design life could have a serious outcome on the overall pavement residual life of the network, potentially stretching well beyond the term of the OPRC.

One of the less recognised advantages of having the underpinned quantities of work defined in the contract is that it also forces the development of a balanced programme over the full duration of the contract, and limits the opportunity for the contractor to simply “polish” the condition measures near the end of the contract. Having this balanced programme of work physically completed during the term of the contract then ensures that the balance is retained post contract as the lifecycle of this initial investment ends and further renewal or maintenance works are required.

5.1 Typical New Zealand State Highway Hybrid Contract Structure.

The Hybrid model description (within the New Zealand context) refers to road maintenance contracts that lie on the spectrum between conventional input based contracts and the PSMC model. It’s initial development and implementation was seen as a transitional step for the contracting industry, enabling them to move from the conventional model and to gain experience

[1] Refer References 1,2,3, and 4

with managing performance based contracts in preparation of more wide spread adoption of the PSMC concept.

However the Hybrid concept continues to be retained for a number of New Zealand State Highway networks where it has proved to be a successful network maintenance model and it has continued to evolve to a point where it now lies much closer to the PSMC model.

Both the Hybrid and PSMC models typically require the establishment of a Contract Management Board. This Board normally comprises of senior management personnel from both the Contractor's and Client organisation, who would meet at regular intervals to review performance, and who would have the authority to agree necessary actions to address any issues threatening the successful outcome of the contract.

The general intent of such a Board is to provide a mechanism for resolving issues and disputes before they escalate into the formal dispute procedures of mediation or arbitration. To be effective the Board should therefore comprise of representatives from each organisation who are well aware of the historical background and objectives of the OPRC pilot model.

Within the Hybrid contract, the Contractor (within a fixed Lump Sum (LS) payment financial model), takes responsibility for the development and operation of the routine maintenance activities along with a rolling 5 year Forward Work Programme (FWP).

The Client (through their Consultant) continues to carry the risk for the FWP for the years beyond year 5. The risk of long term asset consumption is managed by the Client through the setting of "underpinned quantities" defined as annual quantities of resurfacing and pavement rehabilitation, and typically expressed in m^2 per year, which the Contractor must allow for within his Lump Sum price.

A degree of flexibility in the completion of these quantities is usually provided by the Contract Management Board permitting an agreed variation to these annual quantities (typically ± 10%) so long as the total specified quantity is completed during the term of the contract. The UK MAC model is essentially a hybrid and these currently have contract durations of 7 years.

The Contractor remains responsible for all of the pavement rehabilitation designs and for ensuring these will meet minimum design life expectations. These are demonstrated using conventional pavement design methods and construction quality control records.

Within the New Zealand context, the Hybrid models typically have durations up to 5 years, but this is only as a result of the current legislative requirements for Government funding which limit this model type to this maximum duration. There is no technical reason why longer (e.g. 10 year) Hybrid contract durations could not be developed if required.

5.2 Determination of the Underpinned Quantities - Hybrid

Because the management of the risk of loosing residual pavement life is retained by the Client under this model, the Tenderers are not required to undertake any significant pavement deterioration modelling as part of the tendering process, as these quantities are derived by the Client and their Consultant in advance of the contract being tendered. This is undertaken through a combination of reviewing the existing 10 year FWP quantities, pavement deterioration modelling to verify the adequacy of the proposed work programme over the (longer term) 10 year horizon to meet existing Level of Service targets. Inputs are sought from the networks maintenance practitioners who are experienced with the specific needs of the network during this process.

One of the advantages of the development of the underpinned quantities within the Hybrid is that this work is undertaken within the concept of "what is best for the network and the client within his budget constraints", and avoids the pressure to minimise these quantities that might otherwise be necessary to win the contract.

This has the advantage of limiting the need for extensive and detailed pavement modelling that would otherwise be necessary to verify the level of investment required to maintain the condition of the asset through to the end of the contract period. Consequently the Hybrid model is also less demanding on modelling data accuracy, hence more suited to networks where data limitations exist, and/or where the cost associated with additional data collection would not be warranted.

The retention of this risk also results in a considerable saving to the Tenderers from them not having to undertake extensive modelling and verification themselves and also means the Tenderers will not price to take on the higher level of risk associated with any perceived potential liability that might arise from the limitations of their model predictions. In addition it also enables less experienced contractors to tender for the work, thereby maximising the level of competitive pricing.

Under a 5 year duration model, the risk of any significant under investment is unlikely to be realised within the term of the contract, as the contract period is less than the average surfacing lifecycle in New Zealand (approximately 7.5 years).

5.3 Management of the Annual Underpinned Quantities - Hybrid.

To provide flexibility to the Contractor in managing the year upon year variance in actual resurfacing and rehabilitation work needed the actual quantities required to be completed will vary year upon year, usually within a specified tolerance (typically ±10%) of the average annual quantity.

To maintain the integrity of the Lump Sum, these variances are then managed through a process of agreed trade offs between various treatments within any given year. For example, an agreed quantity of rehabilitation could be substituted for a quantity of resurfacing to a similar value. To ensure a fair trade off is accomplished, the respective unit rates for the rehabilitation and surfacing treatments are provided by the Contractor at the time of tender.

5.4 Performance Specified Maintenance Contracts (PSMC or PBC).

In contrast to the Hybrid, the PSMC model fully transfers the management of the risk of long term asset consumption to the Contractor, again under a fixed LS financial payment model. To gain the benefit of this transfer, these contracts have all been of 10 years duration, with a few extended beyond this date to align the time of their replacement with other factors.

An outcome of this risk transfer process is the need for all Tenderers to undertake extensive pavement deterioration modelling to ensure their price (inclusive of all future work over the 10 year duration) is sufficient to meet all of the required condition measures. In addition the Client (through his Consultant) must also be able to verify the Contractor's models are appropriate during the tender evaluation phase, and consequently this requires further independent model development and analysis.

The reliance the Contractor has to place on deterioration modelling required to predict the quantities of rehabilitation and resurfacing places a greater demand on data integrity and accuracy, if the risk to both the Contractor and the Client of under scoping this is aspect is to be minimised. This typically requires a time series of data points sufficient to enable the modelling to be accurate enough for the Tenderers and the Client to have confidence in quantities being included in the contract price.

Through this process, all of the Tenderers will be making an assessment of the level of risk they will be carrying in an effort to reduce the overall quantities and thereby submit the lowest tendered price. Consequently the competitive pricing environment will tend to favour the Tenderer who takes the highest risk and allows for the minimum quantity of pavement investment. There have been instances where this has resulted in a significant under-investment on some networks which has resulted in penalties being applied to the Contractor, but has also left the Client having to take back and manage a network in deteriorated condition.

While physical inputs are still used as the basis of protecting against pavement asset consumption, unlike the Hybrid model, these quantities are determined by each Tenderer from their own modelling and assessment of the networks needs. The quantities offered up by each Tenderer are then evaluated by the Client's bid team. These quantities will be those determined by the Tenderer as being necessary to complete over the full term of the contract, and will not be necessary fixed annually, so the timing of the investment is also the responsibility of the Contractor.

Independent modelling of the Tenderers FWP is necessary to determine if the completion of the tendered underpinned quantity will be sufficient to ensure the condition measures and residual pavement life criteria will be achieved at the end of the contract period. This will further increase the overall of cost of the tendering process in comparison to the Hybrid where this risk is retained by the Client.

To counter the risk of Tenderers taking on too much risk and under scoping these quantities, some evaluation procedures will allow Tenderers to earn an increased score if higher underpinned quantities are identified in the FWP. Subject to the weighting of the non price scores within method of tender evaluation, this might then result in the selection of a Contractor who has not submit the lowest price.

However with an increased level of modelling input, it may also be possible to earn similar marks during the evaluation phase by showing that lower underpinned quantities are also able to achieve the required condition measures (e.g. roughness) if completed at an earlier phase of the FWP. This will then allow the Tenderer to reduce his LS price.

5.5 Management of the Annual Underpinned Quantities – PSMC

The 10 year duration of these contracts mean that the Contractor requires some flexibility with the timing of this work, however it is generally expected that his submitted tender programme will be adhered to unless there is a well supported argument put forward for this to be varied. To ensure that the Contractor does carry out the work submitted in his tendered FWP, many contracts make the completion of these tendered quantities a contractual requirement. As a consequence any variance will have to be agreed to by the Contract Management Board.

Trading of the tendered underpinned quantities is also necessary within the PSMC model in similar fashion to the Hybrid. However the typically longer duration of this model means that much more care is required in allowing this trading to occur, especially if there is a risk of this happening too early in the contract. For example, if one Network Performance Measure such as texture falls below its target late in the contract and the Contractor has traded away too much of the resurfacing quantity at an earlier time, then there will be problems for the Contractor and the Client who will be reluctant to agree to increase the quantity of resurfacing that then has to be paid for as a variation to the LS. This is also a risk with the longer duration (7 to 10 year) Hybrid, however these longer duration contracts offer the potential for the Tenderers to submit lower unit rates for these quantities as a result of the greater time available to them to depreciate equipment values and spread overhead costs.

5.6 Specific Risks Related to the Management of the Residual Pavement Condition

Within either model, the way the underpinned quantities are specified will be important, as there needs to be a simple and transparent mechanism established to enable the trade off between scheduled treatments to occur.

To date these quantities have been based either upon m^2 or on lane-km unit rates. The problem with using lane-km as the unit rate is the large variations in pavement widths that can exist especially in urban areas (as a result of dual lanes, turn bays, traffic islands and medians etc) which adversely affect the lane-km areas assumed by the Tenderers.

Moving to a m^2 unit rate has therefore reduced this risk to the Contractor and limits the incentive for them to complete work only on those lane-km sections that had small surface areas in an effort to reduce their overall cost profile. However this then creates more of a problem in determining appropriate pricing for each specified treatment.

These models have, to date, not normally included any price tension mechanism on the unit rate prices associated with the various treatments specified, with the adopted approach being for these to be negotiated post contract award. Consequently there has been a tendency for some Contractors to manipulate these rates to their advantage, e.g. offering up a low rate for treatments that will be infrequently used and high rates for those treatments that are expected to be used extensively. The advantages of such a mechanism will be equally applicable to either the Hybrid or the PSMC model.

The specification of each resurfacing or pavement rehabilitation treatment type needs to also carefully define what it will provide. For example simply specifying a treatment as Thin Asphaltic Surfacing will be inadequate, as the Contractor will typically then supply the treatment with the lowest possible cost (i.e. minimum standard), and if anything more substantial is then required by the Consultant or Client, perhaps as a result of minimum design life or lifecycle considerations beyond the contract duration, then the Client will have to pay for this as a variation to the LS.

Another aspect that needs to be carefully considered in either model is the correct determination of operational service levels. It is generally considered undesirable to have the annual investment into the networks surfacing and pavement assets being driven by routine maintenance needs. If the required performance measures are set well above the current standard, then this could induce a backlog of work and drive short lifecycle preservation treatments by the Contractor. Essentially this would amount to the utilisation of annual underpinned quantities to address the operational backlog that had been created by these artificially high performance standards. The risk of this needs to be considered at the earliest phase of contract development, especially if the level of knowledge surrounding current operational condition of the network is limited.

The single biggest difference between the networks that the models described previously and the Punjab network OPRC pilot is the quantity of the identified upgradation and probable rehabilitation works that are expected to be undertaken over the duration of the contract. In practice these existing contracts would typically be undertaking rehabilitation work on approximately 5% of the network length per year. In contrast, the Punjab OPRC may be requiring the Contractor(s) (and subject to timing on the FWP) to complete upgradation works on a significant percentage of the network within the first 2 to 3 years of the contract as well as a high percentage also being rehabilitated each year.

The financial models developed will need to ensure the Contractor(s) don’t front load their FWP with large amounts of (profitable) rehabilitation work and then neglect the on-going routine maintenance requirements over the latter phase of the contract. Consequently it may be advantageous for the Client to apply a greater level of control over this aspect through the setting of annual quantities along with the use of Performance Bonds and other compliance assurance measures.

Finally a disadvantage (with all OPRC’s) is that the Client has to relinquish control over the programme of work, as any instruction to complete work as an alternative to, or outside of the Contractor’s programme, has the potential for the contactor abdicating his responsibility for meeting a NPM.

6 Summary Discussion

The final report on the Contract Format will still be subject to the outputs from the following Tasks before a final recommendation can be made under Task A6 and included in Interim Report 1:

- Task A1-Definition of Service Level Classification
- Task A2-Financial Model to be used for Payment
- Task A3-Legal Framework and EIA and SIA Frameworks
- Task A4-Confirmation of Contracting Capacity to Undertake and Manage the Works
- Task B1-Checking Suitability of Pre-Selected Road Sections
- Task A5-Overseas Study Tour.
- Discussion and agreement with the PRBDB.

6.1 Managing the End of Contract Residual Road Condition

All of the OPRC's currently in operation and known to Opus utilise underpinned quantities as the basis for managing the risk of pavement asset consumption.

While further research into alternative ways of measuring and managing this risk will be on-going, there is presently still insufficient confidence over the use of condition measures or pavement strength assessment tools as the only mechanism for ensuring unintended consumption has not occurred.

The fundamental difference between the way the Hybrid model and the PSMC model apply the philosophy of underpinned quantities is the extent of risk transfer to the Contractor that occurs and the overall cost of the tendering process.

While the Hybrid model in the New Zealand context has been limited by legislation to a maximum duration of 5 years, there is no technical reason why contract durations of 7 years (e.g. the UK MAC) or even up to 10 years could not be considered.

In determining and specifying the quantity of underpinned quantities in the Hybrid, the Client retains the risk associated with the validity of this assessment and therefore the ownership of the network residual condition over the long term. This reduces the level of data required and the extent of modelling analysis, which has to be undertaken only by the Consultant.

With the transfer of this risk to the Contractor under the PSMC model, it then becomes his responsibility to define the quantum of these underpinned quantities and the timing of their implementation. This significantly increases the reliance on data availability and accuracy. The quantity and validity of the underpinned quantities has to then be determined by the Client during the tender evaluation process.

Careful consideration needs to be given to the way these underpinned quantities are defined in either model to enable a fair basis for trade offs between treatments to be established and operated over the duration of the contact. This process should require Tenderers to include in the price schedule the unit rates for all of the expected resurfacing and pavement treatments along with a mechanism for applying some price tension during this phase in preference to a reliance post award negotiation.

There specific risks under either model, essentially as a result of the Contractor attempting to minimise his costs or maximise potential additional revenue. The risk of this can be significantly reduced by:

- ensuring a fair and transparent mechanism is in place for any trade offs between work categories
- appropriate unit rates for specified treatments are established and with as much price tension during tendering as possible
- the establishment of appropriate operational service levels
- establishing a high level of trust between both parties
- the establishment and effective operation of a Contract Management Board capable of resolving issues or potential disputes expeditiously.

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Piet Venter:	In^{3}Roads Team Leader for the Western Bay of Plenty PBC01 Contract - Tauranga.
Graham Barrow:	Opus International Consultants Regional Network Management Coordinator - Paeroa.
Rick Jarvis:	Opus International Consultants Principal Infrastructure and Asset Manager - Sydney
Dr Riaz Ul-Islam:	Opus International Consultants Senior Asset Management Engineer - Sydney

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9 Appendix A Copies of Reference Papers 1,2,3, 4.

10 Appendix B Task A5: Table 3.4 – Indicative Draft Itinerary to Overseas Study Tour

Visit	Location	Activity	Comment
1	Auckland, New Zealand	Overview of performance-based maintenance contracts for Transit New Zealand. Visit to the Auckland Harbour Bridge which is being managed by a consortium including Opus under a 10yr OPRC.	Because performance-based maintenance contracts have been in-place for some time in New Zealand, the delegation will benefit from the practical aspects from these contracts, particularly in the area of data management and predictive modelling
2	Western Bay of Plenty (Tauranga), New Zealand	A combined local road network and state highway network 10 yr contract, with focussed levels of service for different portions of the network	A predominantly rural OPRC, with a diverse range of traffic demands and predominantly agricultural roadside activities.
3	Hamilton, New Zealand	Review of a "Hybrid" style contract	Under the Hybrid approach, the contractor has both output and outcome based components of work. This is similar to the scope of many pilot trials of OPRC.
4	Sydney, Australia	Review of the long-term performance specified maintenance (OPRC) contract for the North Sydney road network	The 10-year, North Sydney OPRC (the first in the world) has just been concluded and delegates will have the opportunity to discuss with representatives of the client organisation the details, benefits and weaknesses of the contract. In addition Opus has been recently commissioned by the RTA to draft the replacement contract document and the outcomes from this will also be available for discussion.
5	Bunbury/Perth, Western Australia	Overview of term network contract development and implementation for the State road network and the move from full in-house maintenance to full outsourcing in a short timeframe.	These WA term maintenance contracts vary from the contracts in New Zealand in that the regions covered are highly diverse in terms of the environment and the availability of resources to meet the needs of the contracts (Note: How the contract forms were developed will be relevant to the Punjab Project)
Optional sites not included in the Opus Team's bid scope but for which arrangements could be made:			
6	Victoria, Canada	Review of maintenance performance measures adopted in recent Public Private Partnership projects in British Columbia.	The performance parameters and their application to recently initiated PPP projects represent latest best practice in long-term maintenance management.
7	Other World Bank Projects	We would seek guidance from the World Bank on any other applicable projects.	The most recent OPRC related projects would be sought in preference to older ones.

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