Extract from Wellington Transport Strategy Model (WTSM) Functional Design

1. Major Issues

1.1 Introduction

Within the context of a model of this general type, the aforementioned issues and requirements raise some major issues which we shall need to consider in the context of the functional specification:

- model scale and more detailed modelling,
- commercial vehicle data collection and modelling,
- public transport data collection,
- weekend data collection and modelling,
- growth forecasting/demographic forecasting,
- road pricing and tolling,
- parking.

1.2 Model scale and more detailed modelling

Despite the merits of much more detailed modelling outlined in Table 1.1, we have concluded that the substantial additional time and resources involved in setting up and running a disaggregated, intersection-based model system would make it impractical, and we are aware of no precedent at a city region scale.

Conceptually, a 2-level modelling hierarchy is therefore envisaged, in which the strategic model links to lower level more detailed roading models (and possibly public transport models).

Nonetheless, in specific areas, the detail of the model will be reviewed and enhanced:

- an enlarged demand segmentation will be explored to reflect the objectives (Table 1.2),
- the zone system will be reviewed but a large scale change in detail is not envisaged; the review will cover:
  - compatibility with more detailed models' zone systems and other data sources,
  - more detailed representation in areas of sensitivity such as: Wellington and the sub-regional CBDs; developing areas; for access to Central Station and the rail network; for access to important bottlenecks on the highway network; representation of key turning movements;
- the structure of the networks will be reviewed, focusing on the rail network (station representation) and the highway network; in the latter, the representation of key bottlenecks and the connection of zone centroids to CBDs road networks will be reviewed; possible refinements include greater network detail and expansion of key intersections to identify turning movements and allocate them a capacity; full modelling of some intersections is also conceivable but not preferred.

The outcome of these refinements will be improved model precision in areas of significance.

- **Table 1-1 Characteristics of Increased Modelling Detail**

Characteristics of a more detailed model
More: ❑ zones ❑ detailed breakdown of the transport networks ❑ information attached to the transport networks (intersections, park-&-ride), large car parks ❑ segmentation of demand to reflect behavioural differences
Advantages
1. Road network: explicit representation of queues, bottleneck effects, turning movements etc 2. Parking: may enable parking locations and ultimate destination to be distinguished. 3. Park-&-ride: could enable the access modes to/from public transport to be distinguished 4. Better reflection of variations in demand sensitivity 5. Generally a less coarse model representation
Disadvantages
1. Model set-up time increases substantially as much more network detail must be supplied. 2. Model run time may increase substantially (50 fold) due to extra zones and network, time taken to converge networks and to balance supply with the more detailed demands. 3. The sparse zonal data may affect calibration

- **Table 1-2 Expanded Segmentation**

Choice/personal travel:
HB work
HB education
HB shop
HB social
NHB other
Captive/personal travel
Business travel by car/public transport
Travel by commercial vehicle (sub-segmentation to be determined)

Note: We shall also consider a further refinement of the choice category for commuters, to reflect variations in car availability within this segment.

1.3 Commercial vehicle data collection and modelling

With the objective of establishing a basic commercial vehicle model cost-effectively, our preferred approach is as follows:

- a commercial vehicle model would be developed comprising current year matrix, growth factors and an multi-user assignment procedure in which commercial vehicle paths would be differentiated (at this stage, the multi-user assignment procedure is an option to be reviewed)[1];
- the choice of vehicle types (eg lights, mediums and heavies) remains to be resolved;
- the base matrix will be devised using a combination of surveyed or otherwise obtained trip rate data for special generators (such as ports, industrial areas and airports), sample surveys of commercial vehicle usage and a 'prior' trip matrix (the current WSTM matrix or one developed from a synthetic modelling approach); this matrix will be scaled using matrix estimation techniques on restricted O/D pairs to match classified vehicle counts;
- growth trends will be related to employment distributions and historic trends (such as are available);
- outcomes of the Transfund research project will be used where feasible.

1.4 Public transport data collection

It is our judgement that the reliability of the public transport matrix needs to be improved, and that this could be assisted by supplementary data collection:

- the census journey to work data provides the most cost-effective basis for improving both model estimation and the public transport trip matrix, for those trips which are usually of most concern (commuting trips); if it is used for estimation, then there will be constraints on the proposed car availability segmentation;
- we will consider the cost-effectiveness of supplementary rail and bus surveys. Possible options to be considered further (based on cost and value to the technical design) are:
  - specific surveys of school travel via the schools (likely to account for most of the non-commuting peak period trips); such data could improve the travel matrix[2];
  - the collection of extra public transport trip data in the household surveys for example by using more than 1 travel day for such trips; statistically this may no be helpful for repeated trips (such as work and education) but may be useful for off peak travel;

[1] We need to be sure that the volume of commercial vehicle traffic justifies the additional complexity.
[2] It seems unlikely that conventionally structured models of education trip mode choice reflect the nature of this behaviour with any reliability, given the prevalence of car escorts and pooling, both sub-modes being typically difficult to model.

- intercept surveys might efficiently be undertaken at the central railway station; however, a major intercept survey programme would only realistically be justified if a model along the lines of the Auckland Public Transport Model was envisaged (at a lower level in the modelling hierarchy).

It would be helpful to obtain ETM information at some level of aggregation from the operators, to be used for model validation and overall matrix tuning. Such data is not however readily related to the OD matrix. While it would be theoretically feasible to consider mapping OD characteristics onto detailed ETM data using relationships in the household survey and linking this to bus routes in the network, the risks and costs of such a novel exercise may be high. Despite the risks, we shall explore this option further because of its potential cost-effectiveness.

We understand that WRC is currently undertaking a public transport passenger survey, the data from which may make unnecessary further intercept surveys and/or may improve the feasibility of the ETM-based alternative approach. This will be investigated further in the technical design.

1.5 Weekend data collection and modelling

The major issue with which we are faced is that we would need to collect weekend data from most of the surveyed households in order to achieve similar statistical reliability. Our proposed options are as follows:

1. a road traffic bottleneck data base: this would be based on obtaining current traffic volume counts at various weekend times for key major route bottlenecks, attaching them to the network and linking this to a simple growth factoring process so that projections of delay build up could be made[3];

2. a road traffic matrix: using weekend traffic counts for the weekend peak period(s), an attempt could be made to estimate the weekend car trip matrices using matrix estimation techniques in conjunction with the weekday non-work matrices as prior estimates; it is possible that the collection of some limited travel data for the weekend could be considered as an add-on to the household survey to improve this estimation process; the road matrix would be combined with the road network and assignment to provide a basic traffic model;

3. a similar approach to public transport travel could be considered, supplemented by ETM data, but because there would be a much smaller trip sample the reliability would be poor;

4. a full modelling approach would probably involve the following concepts:

[3] This would provide a data of traffic performance across the network at weekends, focused perhaps on key bottlenecks, which could readily be maintained/updated. In the Netherlands for example, there is a national 'bottleneck model' which projects forward current traffic counts at identified sites and forecasts and build up of delays at these sites. Such 'monitoring' would enable WRC to be seen to understand the issues and problems and provide a basis for deciding whether weekend-specific projects might be needed. At that point, project-specific data collection at the weekend would be justified.

- the non-work trip purposes would be segmented into weekday and weekend travel, and separate models (trip end, mode choice and distribution) developed from an extended household survey;
- using counts and ETM data, the resulting vehcile and PT matrices would be scaled to reproduce observed weekend travel patterns;
- some sort of time period factor model would be required to generate weekend peaks (Saturday morning, Sunday evening?).

While we shall investigate the more comprehensive option 4, our current view is that the first two options will prove to be the most cost-effective, the more attractive second option providing a matrix-based model of road traffic[4].

1.6 Growth forecasting/Demographic forecasting

The process of demographic forecasting is to be reviewed. There are two parts to this, the technical procedure and the process by which local authorities reach agreement. No change in functionality is anticipated.

The performance of the model in growth forecasting is an issue and the components of the update which will contribute to improvements in this area are as follows:

- the review of the demographic forecasts and the documentation to be provided by Mera);
- a review of historic trends in major corridors (extending that already done by WRC) seeking clear evidence on actual growth by time period;
- subsequent analysis of the census to identify changes in population and car ownership which may partially account for the growth;
- refinements to the car ownership model which will affect traffic growth forecasts;
- refinements to the non-work trip end models and, specifically, consideration of the influence of income growth on discretionary travel (trips and trip kms).

1.7 Road pricing and tolling

There are two different issues to consider: the effects on demand of area-wide road user charging and the impacts of tolls on individual routes such as Transmission Gully.

Both options rely on road users' willingness to pay for time savings which is represented in modelling systems by the value of time. We shall need to review the value in the context of research on Transmission Gully and that being undertaken by Transfund. Neither covers commercial vehicle response to tolls, for which a separate research exercise would be required (or some basis sought from international experience).

In order of probable importance, tolls will affect routing through the road network, the time of travel (in the case of peak surcharges), and the mode and destination of the

[4] Like the interpeak it seems unlikely that there are major interactions between public and private transport use at the weekends, and any such interactions might, if necessary, be handled using simplified elasticity techniques.

trip. Provided that time of travel choice is included, the WSTM should be able to provide a realistic forecast of the effects of area-wide charges.

Further modelling refinement is likely to be needed for tolls on new roads, and it is as yet unclear whether such more sophisticated approaches should be left to the project models. Specific requirements and outcomes may be as follows:

- incorporate multi-user techniques to forecast the differential response of cars and commercial vehicles;

- for specific roading projects such as Transmission Gully, consider representing the choice between the tolled road and the alternative(s) in a multinomial choice structure in which the probability of choosing the tolled road is calculated for each cell of the trip matrix; this would be the standard approach for a private sector roads funder, and might be designed as a non-standard extension to the modelling procedures;

- consider whether the person-type segmentation in the model could be developed to improve the representation of tolling behaviour, for example by classifying demands into different income groups (as has been done in the UK) or by distinguishing commercial/business travel, and requiring an extension to the multi-user assignment capability.

1.8 Parking

We propose the following approach to the assessment of parking within the model framework:

- the household survey would be designed to obtain parking information (type, duration, cost and possibly location);

- for Wellington CBD and, possibly, the regional CBDs, estimates of overall long term parking supply by type would be sought;

- a model of average long term CBD parking costs related to the distribution of use of parking by type and price would be established; this would be included in the cost of car use in the model; in the model applications it would be feasible to adjust this cost to reflect the effects of parking supply constraints in the CBD on car commuting;

- using distributions of short term parking by type and time, model output included forecasts of the demand for short term spaces.

2. Other Issues

Other issues raised in the Statement of Requirements are addressed below.

2.1 General

The study area will be reviewed and amended as necessary to meet the requirements.

Guidance on interfaces with project models will be provided and the necessary technical linkages established (based on compatible zone systems and the capability to provide matrix and network data). A key issue to consider is whether and how the existing city roading models should be updated and interfaces with WTSM to provide a comprehensive modelling system.

The peak spreading model will be reviewed in the light of available experience in NZ and Australia and the latest European research and thought will be given to collecting relevant data in the survey programme.

2.2 Car Ownership

This model is to be reviewed. The major area is the credibility of the forecast trend, and this may be important for growth forecasting. Cross-sectional car ownership models are not necessarily a reliable basis for projection and it has become common to develop independent means of projecting region-wide growth – we shall review this further in the technical design.

Other detailed areas are: refinement to identify 3+ car owning households, the value of the accessibility terms, the influence of car prices and the representation of family and work structures. An improved fit at zonal level may be obtained by fitting the model to the census data.

2.3 Trip Ends

The technical task will be to consider the extent to which the policy and scenario priorities can be reflected in the model. To provide a basis for improvements the household surveys will need to cover family and work structures and types of retail destination (and this would need to be reflected in the land use/planning data). The proverbial issue of the effects of income will be revisited.

We believe that external trip ends are a problem with the current base model and future forecasts. We will therefore investigate the importance of trip patterns for the external trip ends as this will have an influence on project like Transmission Gully which provide for significant amounts of external trips; this will also be a survey issue.

2.4 Mode Choice/Distribution

The collection of additional public transport data and the application of matrix estimation techniques should assist in addressing the mode choice and distribution issues. Internationally there exist car pooling model specifications, but the most attractive of these involve a considerable re-specification of the model. Our proposal would be to explore these model structures for commuting and education trips where car polling is of most importance – the additional household data requirement would be to identify the travel purposes of car occupants in the survey, so that commuting and education travel groups can be isolated. We also intend to tune the car trip matrices to independent counts to improve the flow representation.

2.5 Road Assignment/Networks

Most of the issues have been addressed in Chapter 3. Of the priorities, only HOV lanes would require further model refinement. The proposed implementation of a HOV lane on SH1 through Mana may require this refinement included in the model. The benefits of this would need to be reviewed with WRC and its stateholders. Geometry, layout and capacity data will be collected to improve the representation and, in addition, consideration will be given to free/flow speed surveys.

2.6 Public Transport Assignment/Networks

The principal new issues are those related to patronage funding and ATR project appraisals.

Regarding patronage funding, the requirement would appear to be that the model should reliably represent (i) current passenger trips and kms on the network, (ii) the changes in these in future and (iii) the changes in response to public transport projects.

If, as proposed, the public transport matrices can be developed on enhanced data and adjusted to ETM count data then item (i) will be satisfied.

There are difficulties with (ii) and (iii). We would expect that the Council would be mainly interested in short term 1-5 year changes in public transport patronage over time, which models of this strategic type are not designed for. While it would be expected that the model should be able to address major changes in public transport infrastructure, its reliability for small changes or individual projects is less certain. This same issue affects ATR project appraisals.

This raises the question of what modification would be required to address these issues.

Short term trend forecasting relies on time series analysis. If a detailed historic trend was available then a short term forecasting process could be derived, but it is our understanding that historic data on public transport patronage is not readily available

ATR appraisals range from small scale quality improvements to major rail infrastructure investments in, say, light rail. As a general rule, some sort of project model will be required for any of these appraisals, and the question is to what extent would WSTM form the basis of this model or provide information to this project model? To take some examples:

- major rail improvements might be appropriately evaluated using this model as a basis, probably with enhanced detail and possibly with additional OD data collection;
- the impacts of area-wide service improvements in services on patronage might be forecast reliably; but the same could not be said of individual bus service changes;
- the development of improved linkages to the central station are best done outside the model, the benefits being very localised.

2.7 Model Output

We suggest that a standard set of model outputs for evaluation should be agreed and, so far as possible hard-coded. For some such as noise and emissions this will require post-processing.