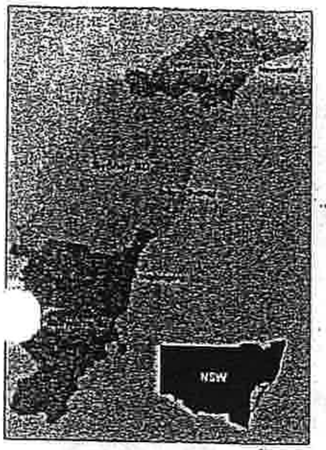
Appendix A TDC Input Data

Travel Zone Population Forecasts

About the population forecasts



The Transport Data Centre (TDC) produces population forecasts at the small area level as inputs to other modelling processes, in particular TDC's Strategic Travel Model. These forecasts are compatible with, but should be differentiated from, the official population projections which are produced by the NSW Department of Planning and subscribed to by the NSW Government.

This data is available by travel zone (TZ)[1] across the entire Greater Metropolitan Area (shown mapped at the left) by age and sex at five-yearly intervals from the 2001 base year till 2031.

The *July 2007 Population Forecasts* is the latest set of TDC travel zone population forecasts. These forecasts are a revision of the *November 2006 TZ Population Forecasts*. While the major inputs are unchanged, the release of 2001 Estimated Resident Population at the Collector's District (CD) level by the Australian Bureau of Statistics provided more reliable small area data for the base year.

Methodology

Key Inputs to the *July 2007 Population Forecasts*:

- ABS 2001 Estimated Resident Population by CD
- *November 2006 TDC TZ Population Forecasts*
- Official NSW *2005 SLA Population Projections* (NSW Dept Planning)[2]
- 2004 Metropolitan Development Program (NSW Dept Planning, refer to Figure 2)

The population projections are distributed across the travel zones within each SLA using a dwelling stock model. This model produces dwelling numbers within each travel zone and then converts these to population counts based on assumptions about:

- Household size
- Dwelling commencements in established areas and lot releases in greenfield areas for both multi-unit and detached dwellings. See Greenfield map over.
- Vacancy and replacement rates
- Occupancy rates

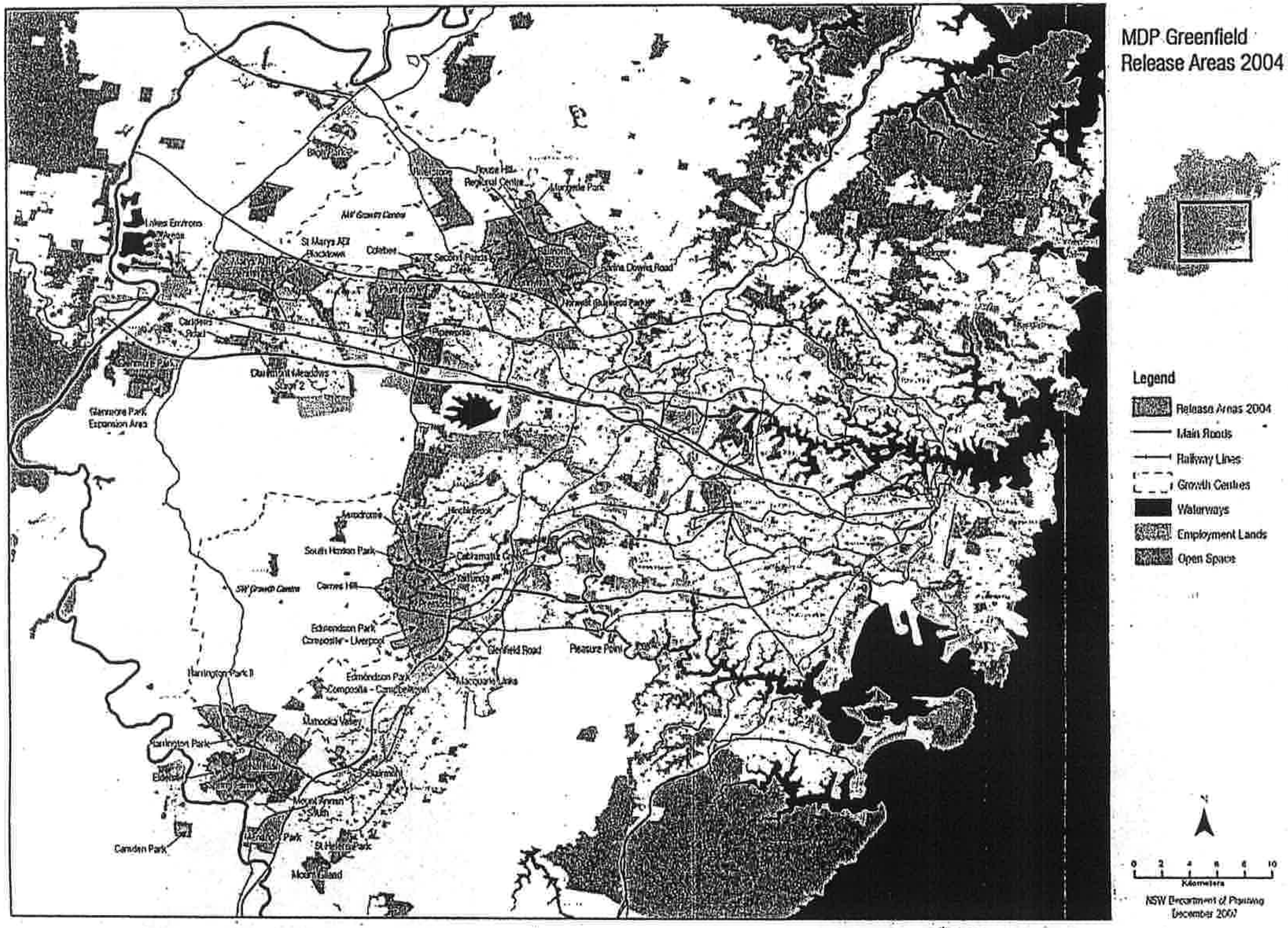
The model adjusts dwelling demand in each Statistical Local Area iteratively until the totals match the official SLA population projections by which they are constrained.

Level 7
Sydney NSW 2001

[1] As the geographic basis for TDC's data collection and modelling, travel zones provide a level of analysis between Census Collection District (CD) and Statistical Local Area (SLA) as defined by the Australian Bureau of Statistics. This dataset uses the 2001 travel zone system.

[2] See http://www.planning.nsw.gov.au/programservices/population.asp

Figure 2


MDP Greenfield
Release Areas 2004
Legend
Release Areas 2004
Main Roads
Railway Lines
Growth Centres
Waterways
Employment Lands
Open Space
Kilometres
NSW Department of Planning
December 2007
Camden Park
Glenmore Park
Expansion Area
South Horton Park
Carnes Hill
Edmondson Park
Pleasure Point
Glenfield Road
Macquarie Links
Cabramatta Creek
Rouse Hill
Regional Centre
Box Hill
St Marys ADI
Blacktown
Colebee
Santa Downs Road
Norwest Business Park
Harrington Park
Mount Annan
St Helens Park
Camden Lakeside
Aerodrome

Travel Zone Employment Forecasts

About the employment forecasts

Employment forecasts at travel zone level are estimated using the Transport Data Centre (TDC) Small Area Employment Forecasting Model (SAEFM). Forecasts to 2031 at five-yearly intervals (corresponding to Census years) from the 2001 base year are available for each travel zone (TZ) in the Greater Metropolitan Area (GMA, Figure 1). These future year small area employment estimates are designed to be used as an input to the TDC Strategic Travel Model (STM) and other strategic modelling processes.

Figure 1
Greater Metropolitan Area

Methodology

The November 2006 employment forecasts are based on revised inputs and a number of methodological enhancements to the forecasting process used in the previously released September 2004 TZ Employment Forecasts. Revised inputs are:

- 2005 Official Population Projections for NSW[1]
- 2004 Metropolitan Development Program
- TDC's 2006 Small Area (TZ) Population Forecasts
- 2001 JTW data
- updated labour force participation and unemployment rate projections[2]
- updated industry trend curves

The official NSW Population Projections are used as the basis for estimating the future workforce by applying projected labour force participation and unemployment rates to the projected population. The resulting projections of the workforce within the GMA are used as control totals for subsequent forecasts of employment at lower geographical levels.

CAUTION

Forecasts are only as good as the assumptions and inputs used.

TDC makes these forecasts available to those wishing to undertake similar strategic modelling exercises, on the understanding that users will test the validity of the TZ forecasts against the most current local knowledge.

This is even more essential if the forecasts are used for less strategic analysis at finer geographic levels.

Control totals must be kept constant if any adjustments are made.

Total forecast GMA employment for each year is disaggregated by industry and small area using three review modules which focus on industry of employment, broad sub-regions within the GMA and then specific job nodes.

The Industry Review module distributes GMA employment at each five-yearly period by 27 Industry categories using trend curves derived from a study of economic and industry trends and forecasts.

The Regional Review module specifies the share that each sub-region has of the total number of jobs in each industry at each five-yearly period. There are 20 Sub-regions used in the 2006 SAEFM which are listed in *Table 1* over the page.

The Job Node Review module forecasts the share each job node has of total jobs in each Industry by Sub-region at each five-yearly period. There were 94 Job Nodes specified in the 2006 SAEFM.

Trend forecasts may not adequately capture the employment impact of planned developments. Adjustments to historical trends for areas thought likely to be affected are made in the 'New Developments' module based on a detailed analysis of the most current information available at the time. *Table 2* (over) lists the locations considered and the final decision.

As total jobs for each year is always kept constant, any change in employment in one location requires redistribution from elsewhere.

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1 see http://www.planning.nsw.gov.au/programservices/population_projections.asp#local

2 TDC commissioned the National Institute of Labour Studies (NILS) to provide updated projections of GMA labour force participation and unemployment rates up to 2031.

Note: SAEFM employment estimates are often different from Journey to Work (JTW) employment counts for the equivalent Census year. The Census undercounts the population (and therefore workers) and gives less accurate counts of labour force participation than the official estimates derived from the ABS Labour Force Survey (LFS). SAEFM uses JTW employment distribution at the TZ level, but total employment is factored up to match total Labour Force. For an explanation of the difference between Census and LFS estimates follow this link to the ABS website:

http://www.abs.gov.au/Ausstats/ABS@.nsf/Latestproducts/00D58320BB5387A4CA25729E0008A884?opendocument

Table 1: Sub-regions

Sub-regions		
CBD	Central North West	Central Coast
CBD North	Central South West	Newcastle & Lake Macquarie
Inner West	Central West	Other Lower Hunter
Inner East	Outer North	Outer South
Inner North	Outer North West	Wollongong
Inner South	Outer South West	Illawarra South
Inner South West	Outer West	

Table 2: New Development Areas

New Development Areas			
TZ	Locality	TZ	Locality
4	Millers Point	416	Huntingwood
6	Sydney - King St Wharf	424	Seven Hills North
28	Sydney Art Gallery/Motor Museum	534	Frenchs Forest South
29	Pyrmont	584	Smeaton Grange
79	Green Square	626	Nelson
85	Redfern West - Redfern Station	627	Box Hill
86	Eveleigh	664	Catherine Field
137	Port Botany	666	Leppington
139	Banksmeadow	667	Leppington West
140	Botany	670	Prestons
146	Domestic Terminal	672	Cecil Park South
147	International Terminal	679	Willmot
210	Rhodes	680	Marsden Park South
252	Arncliffe	682	Llandilo
326	Homebush Bay	714	Liverpool
335	Greystanes	716	Newington
346	Smithfield	717	Oran Park
347	Wetherill Park	720	Macarthur Square
358	Wattle Grove	739	Eastern Creek
366	Edmondson Park	741	Erskine Park South
367	Cecil Hills	743	Schofields South
378	Bow Bowing	746	Schofields East
379	Ingleburn	751	Rouse Hill South
383	Mount Vernon	753	Castle Hill Showground
405	Marayong	754	Norwest Business Park
408	Whalan	784	Macquarie Park North
		821	Horsley Park North

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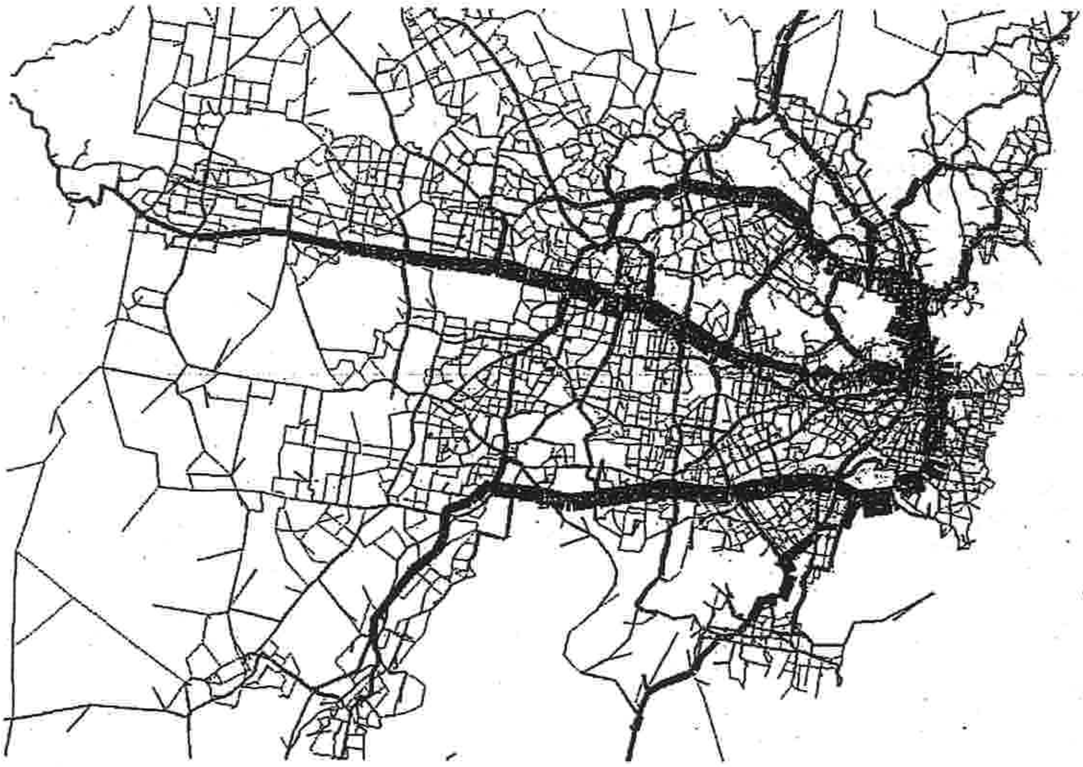
Strategic Travel Model (STM)
Modelling future travel patterns



Transport Data Centre
January 2008

CONTENTS

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What is the STM?

The Strategic Travel Model is a world class tool, operated by the Transport Data Centre (TDC), for projecting travel patterns in Sydney, Newcastle and Wollongong under different land use, transport and pricing scenarios. It can be used to test alternative settlement, employment and transport policies, to identify likely future capacity constraints, or to determine potential usage levels of proposed new transport infrastructure or services.

Scope

The STM produces travel forecasts for:

- The Greater Metropolitan Area (GMA) (figure 1)
- 5 yearly intervals from 2006 to 2031
- Car, Train, Bus (Car Passenger, Bike, Walk and Taxi also modelled, but not currently reported)
- Work and non-work (7 non work purpose models implemented and currently being validated)
- 24 hour, average weekday (non-school holiday) travel
- am/pm peak and interpeak travel (factored from 24 hour travel)

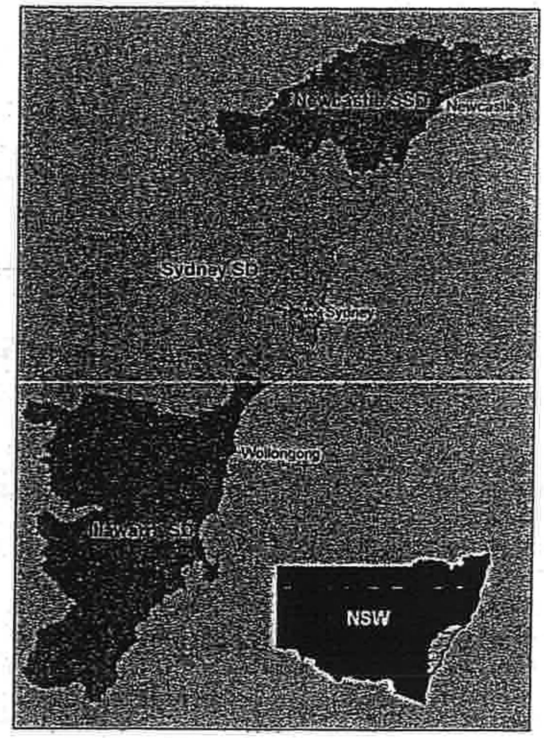

Figure 1: Geographic extent of Strategic Travel Model (STM) – called the Greater Metropolitan Area (GMA)

How does the STM work?

The STM, built largely in the Emme transport modelling software, is a series of models and processes that attempt to replicate, in a simplified manner, people's travel choices and behaviour under a given scenario. The STM combines our understanding of travel behaviour with likely population and employment size and distribution, and likely road and public transport networks and services to estimate future travel under different strategic land use and transport scenarios (Figure 2).

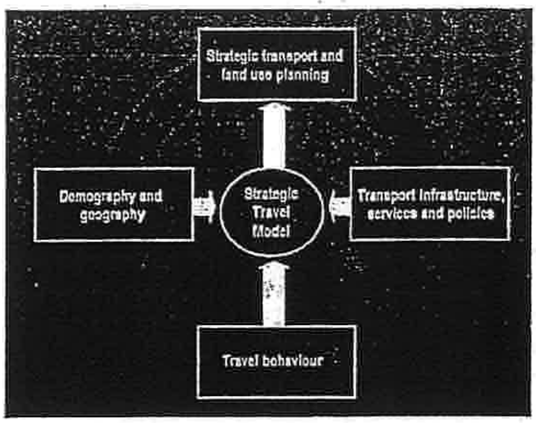

Figure 2: STM Framework

STM Inputs

The STM's basic geography is the travel zone. All input data, mostly sourced from the TDC, is at travel zone level. There are 1,129 travel zones in the STM, which produces estimates of travel to and from each travel zone from and to every other travel zone, as well as travel within zones (see Figure 3). This travel is then assigned within the model to the transport network.

Figure 3: TDC Travel Zones

Population

The STM uses detailed current demographics to synthesise households of different types. This allows for very powerful forecasting of the travel behaviour of different market segments. The TDC uses its population projections to grow these different household types across the GMA.

Household Travel Survey (HTS)

The Household Travel Survey, running continuously since 1997, collects comprehensive information on the daily travel patterns of residents of the GMA. Data from the HTS forms the basis of most of the behavioural models and other factors in the STM:

- estimation of the travel behaviour characteristics of the population in terms of amount of trip making, travel mode choice (eg. car, train, bus, walk) and destination choice, which can then be used to predict future mode and destination distributions;
- estimation of license holding and car ownership models as these are important factors of the mode choice behaviour
- estimation of trip purpose factors (work, education, shopping, etc.), trip length distributions and the like for the non-commute matrix estimates;
- estimation of time of day trip factors for modelling peak/off-peak period travel.

A state of the art travel model such as the STM would not be possible without a rich, high quality data source such as the Household Travel Survey.

Journey to Work (JTW)

The five-yearly Census provides the STM with origin and destination by mode for base year travel to work patterns. This data set thus provides the starting point (currently in 2001) for the work travel matrix. The JTW data is also used to validate the work model parameters, estimated using Household Travel Survey data only.

Employment

Current year employment is known from the JTW census data. Workplaces are one of the key travel destinations. It is therefore important to know where workplaces are likely to be located in the future, and how their distribution may change. TDC's Employment Projections are used in the STM to identify the location of future employment, and are an important component of the commute travel model.

Commercial Transport Study (CTS)

The CTS covers freight movements by professional drivers that are not in the scope of the HTS. Freight movements are not modelled in the STM, but input as a fixed OD matrix. Future year freight matrices are currently grown based on projected growth in employment by industry and zone. Once the freight matrix is added to the passenger matrix, they are jointly assigned to the road network. The additional freight traffic affects travel times, which are then fed back into the next iteration of the model, affecting trip generation, mode, destination and route choice for non-freight movements.

Parking Survey

A Parking Survey was conducted by the TDC into the cost of parking in different destination zones. The cost of parking is included in the mode and destination choice models.

Road network (current and future)

The Roads and Traffic Authority and the TDC work jointly to develop a current and future year representation of the GMA road network in the STM. The road network does not include all roads, but does in include all arterial, major and important local roads that connect travel zones (see cover page for road network).

Each road is comprised of "links" between intersections or changes in road type. Each link is characterised by its number of lanes and its road type, which is reflected in a curve called a "volume delay function" (Figure 4). This shows how the speed on each length of road is affected by the amount of traffic on the road. As the amount of traffic increases, the time taken to travel the length of the link increases, that is, the speed slows. In Figure 4, the time it takes to travel the link is on the vertical axis, while the number of cars per hour is on the horizontal axis. Each road type has a different shape, depending on its characteristics. The curves approximate delay at intersections as well as on the link itself.

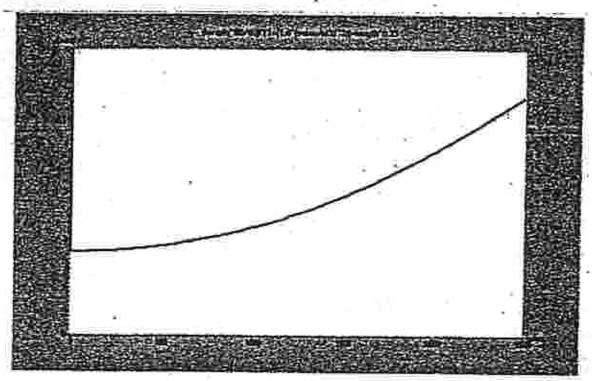

Figure 4: Volume/Delay Function

A current road network is used when modelling current year travel patterns, while future likely road networks, jointly developed by the RTA and TDC, are used when estimating future travel. It is possible to add, remove or alter road characteristics, and test the impact on travel patterns.

Rail network (current and future)

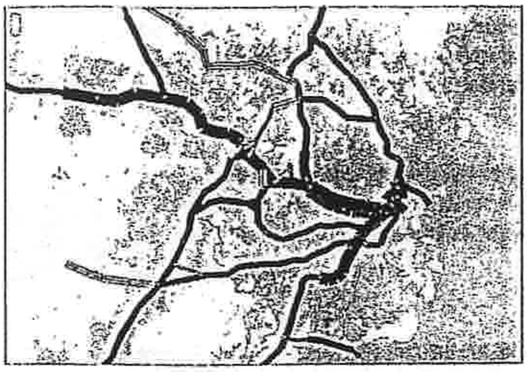

Figure 5: Current and possible STM rail networks

Railcorp and the TDC work jointly to develop current and future year representations of passenger rail operations in the GMA for input to the STM. Figure 5 shows in blue the current rail network (thickness of lines represents number of tracks) and in yellow some of the proposed future projects that have been included in the network for scenario testing.

The rail network is defined by

- route
- station location
- travel time between stations pairs
- frequency of service at stations (headways)
- stopping patterns
- fares between station pairs.

The STM currently operates a peak hour network only. It is theoretically possible to have different networks for different times of day, but these are cumbersome to define for future years. This is an area of ongoing investigation by the TDC, and may be implemented with more sophisticated peak spreading functionality over the coming years.

Bus network (current and future)

The TDC has developed current year bus networks based on actual bus routes, stops and timetables as captured for the 131 500 Transport Info Line. Given the number and complexity of bus routes, developing future year networks is problematic.

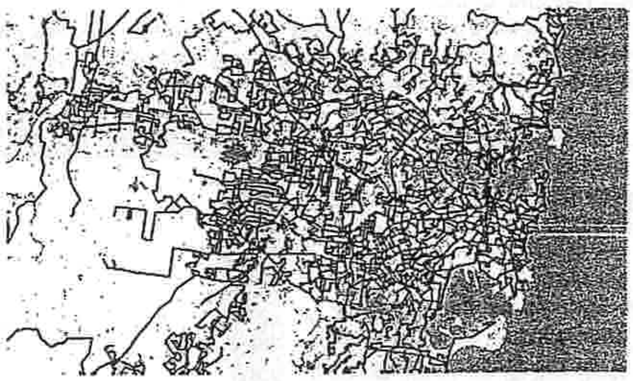

Figure 6: Current STM Bus Network

The approach most frequently used when applying the STM is to improve the frequency of existing services over time in line with population growth, and manually code in new bus services to newly developing fringe areas.

An alternative approach (currently being used for State Plan modelling) is to code the Strategic Bus Networks developed and gradually being implemented by the Ministry of Transport into the STM, and increase their speed and/or frequency in future years. These networks represent a paradigm shift in the provision of integrated and cross-regional bus services. .

Deleted: in

Bus networks are similar to rail networks, in that they are characterised by route, stop, frequency of service, stopping pattern and cost between OD pairs.

STM Model Structure and Processes

The STM currently contains a series of demographic and behavioural models which collectively produce estimates of home to work travel. Non-work travel is then estimated using a sophisticated factoring process, while freight movements are added from the Commercial Transport Study. Behavioural models for non-work travel have been implemented and are being validated, for use in 2008.

Traditionally, transport models were developed to predict the number of "trips". A trip is any travel form from a given origin to a destination (eg. home-to-work, or work-to-home). Later, it was recognised that the travel mode of the return-to-home trip is mostly determined by the mode used for the home-to-work trip, therefore these two trips are better modelled by a unit called a "tour". The STM uses person tours to model work-related travel.

A work tour is any travel from home that eventually returns to home and at some point during the journey goes to the main or secondary place of work. For example, while most employed people will only have one work tour on a working day, those who return home for lunch will have two tours. The HTS indicates that in 92% of cases, the outward and return leg of a work tour are symmetrical in terms of mode, so for modelling purposes, symmetry is assumed. Non-work tours are currently generated by a series of factors calculated from the HTS data.

The STM is implemented in two sections.

The first section is the **Population Model.** It segments the population into groups based on socio-demographics that influence travel choices, as well as on the basis of car ownership and licence holding. These segments are grown into the future based on population, employment and other projections and trends. This segmentation occurs at the model wide level and the travel zone level. The model structure is shown in Figure 7.

The second section is the **Travel Model.** This is implemented in EMME transport modelling software. It is comprised of a series of work travel models, of travel frequency, mode and destination choice, calibration, factoring of non-work travel, addition of freight movements, and assignment of travel to the road and public transport networks. The model structure in shown in Figure 8.

Strategic Travel Model
Population Model

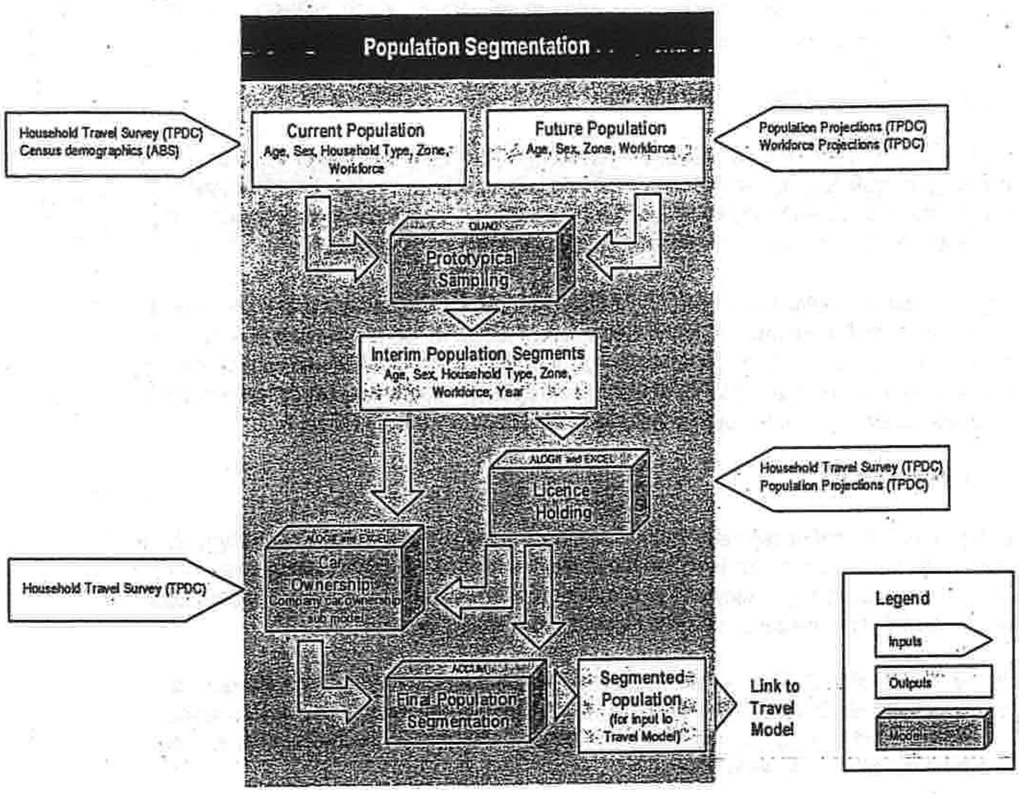

Figure 7: STM Population Model

POPULATION MODEL

Prototypical Sampling (1)

Current and Future Population Segments

In order to estimate future travel pattens, it is necessary to understand the future size, distribution and composition of the population. Since detailed socio-economic population forecasts for each travel zone in the model area are not available, the STM uses a simplifying approach called Prototypical Sampling. This represents a balance between a detailed base year description of the population which we have from the most recent Census and HTS data, and a future year sketch of key characteristics that we have available in the form of population projections by age and sex, workforce and employment projections.

Licence Holding (2)

A further characteristic of the population that can affect mode choice is whether on not a person has a driver's licence. Without a licence, they are unlikely to drive a car, so this choice can be removed from their mode choice set. The STM has a licence holding model, which further segments the population into those with and without a licence. Historical data was used to investigate trends in licence holding by age and gender, and develop a model of likely change in licence holding over the projection period of the model. These model results are then combined with cohort projections to produce estimates of likely licence holding. Figure 8 shows, as an example the changes in female licence holding over time from the Household Travel Surveys. This data has been used to estimate the models.

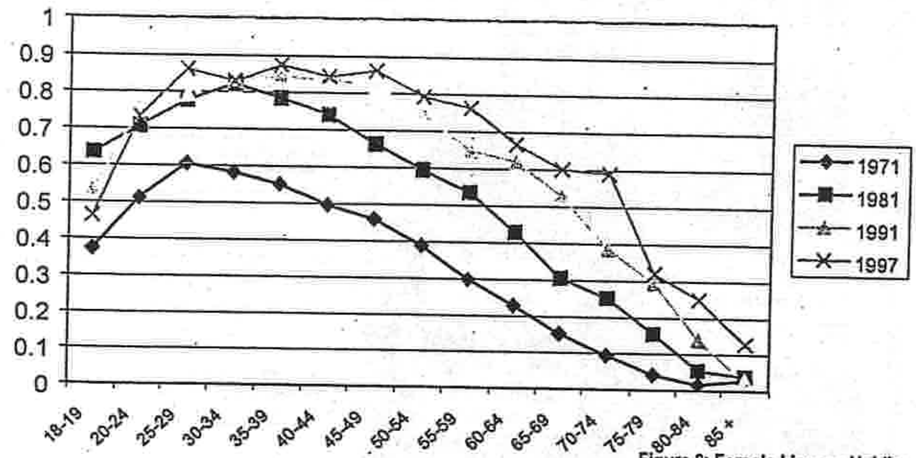

Figure 8: Female Licence Holding by Age

The licence holding model also considers the number of adults (of driving age) in the household, and predicts the likelihood of each of them holding a licence conditional upon other adults having licences. The main variables in the licence holding model are household income, size and structure.

Car Ownership (3)

Another characteristic of the population which effects how much they travel and by what mode is the number of cars owned by the household. The Population Model further segments the above population on the basis of car ownership. A key component in this model is licence holding probability from the licence holding model.

Company and private car ownership are not independent. Therefore, the car ownership model is split into two components. Company car ownership is modelled first. The number of company cars owned is a function of household income and structure (including age of the head of the household), licence holding and ease of parking/parking cost a home end.

This is then followed by a second, total car ownership model, which predicts the probability of each household owning a number of cars, conditional upon the results of the company car ownership model. The key variables in this model are similar to the company car model, though they also include variables on employment status and accessibility.

Outputs (4)

The result of this process is, for each forecast year in the home-based work model, is 128 weighted population segments for the mode-destination choice model and 384 segments for the travel frequency model, distributed among all travel zones. The segmented population data by travel zone, and the corresponding travel behavioural parameters are entered into the EMME in matrix format and used as the basis for further processing in the travel model.

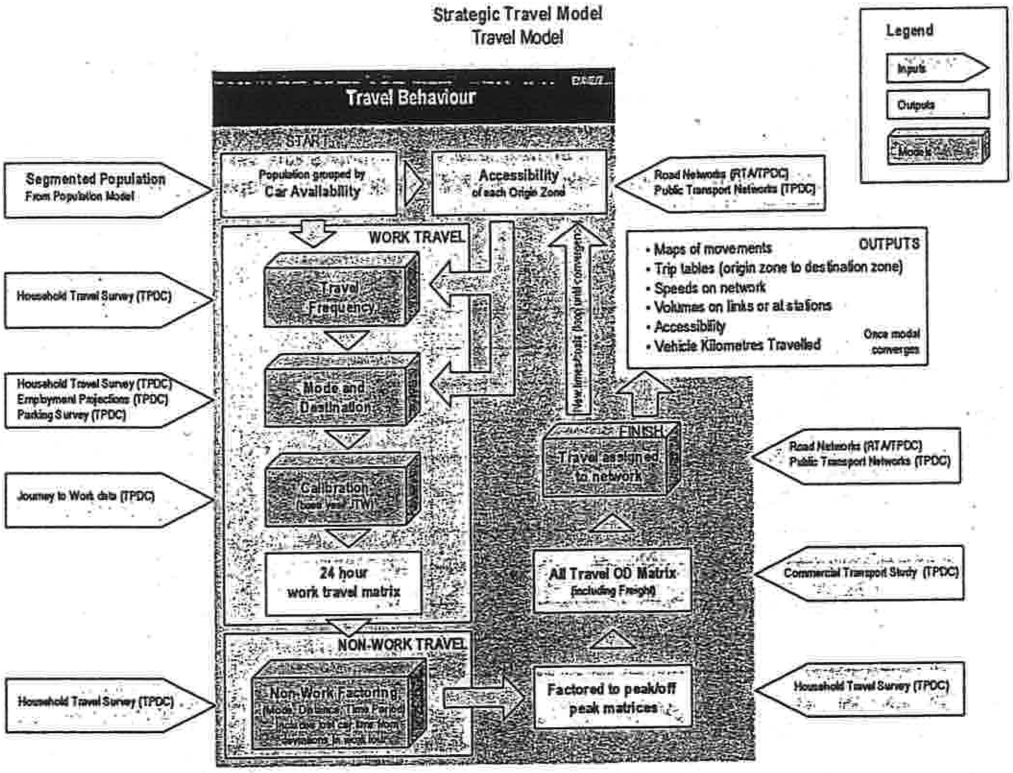

Figure 9: STM Travel Model

TRAVEL MODEL

Travel models usually consist of a four step process to produce estimates of travel:

- Trip generation (number of trips from each zone)
- Trip distribution (destination of trips from each zone to every other zone)
- Mode split (share of different modes for travel from each OD zone pair)
- Trip assignment (route chosen for travel between each OD zone pair)

As shown in Figure 9, at present, the STM largely broadly follows the 4 step approach for estimating work travel, with some additional refinements and processes to incorporate non work and freight components of travel.

The STM uses the detailed outputs of the population model to segment the population by their car availability. Car availability, combined with an accessibility measure generated from the transport networks and HTS, are input to the Travel Frequency model.

Travel Frequency (work)

The Travel Frequency model predicts the number of work "tours" on an ordinary working day (excludes weekends and public holidays).

The frequency that individuals travel is modelled in two linked "disaggregate" (that is, based on individuals, not averages) models. One model predicts the probability that an employed person will travel to work on a particular day (the survey day). The main variables explaining this probability are sourced from the HTS, the Population Model outputs, or the transport networks:

- Age

- Licence holding
- Income
- Industry
- Gender
- Company car
- Car availability
- Accessibility
- Labourforce status

The second model uses a subset of these variables to predict the probability that an individual will make more than one trip to their workplace on a given day.

The output of this model is the number of tours originating from every travel zone.

Mode and Destination Choice (work)

This step distributes the tours from each travel zone to their most likely destinations and assigns the most likely mix of travel modes by each population segment (separately) between each zone pair.

Mode and destination choice are modelled simultaneously in the STM, not because the decisions about the destination of travel and the mode of travel are thought to be taken simultaneously (the order is unimportant from a modelling viewpoint), but for model efficiency only.

Mode alternatives
The STM allows 7 possible ways to travel from one zone to another:

- Car driver
- Car passenger
- Train/Ferry
- Bus
- Bike
- Walk
- Taxi

Not all modes are available for travel between each zone pair. For example:

- Car driver is available to individuals with a licence and a car available for their use (the probability is lowered if there are fewer cars than licences in the household).
- Car passenger is available to all individuals (the probability is higher if there is a car and another licence holder in the household)
- Taxi and bike is available to all individuals
- Walk is available for journeys less than 20 kilometres.
- Train, bus and taxi are not considered available for tours within zones

Destination alternatives
Of the 1,129 zones, only zones which contain employment are considered as potential destinations for work tours.

Model variables
The utility, or attractiveness, of each mode for a given origin-destination pair, is represented by:

- *Car driver* – operating costs, tolls, parking costs, travel time
- *Car passenger* – travel time
- *Train/Ferry* - fare, in vehicle time, access/egress time, access/egress cost, wait time, transfers
- *Bus* – fare, in vehicle time, access/egress time, wait time, transfers

The socio-economic status of an individual also has a large impact on their choice of mode – different segments may have different perceptions of modes and different values of time, so these models were applied to the different socio-economic segments output from the Population Model. The socio-economic variables with the most impact on mode choice are:

- *Gender (males more likely to drive/ride)*
- *Income (higher incomes more likely to use train)*
- *Age (young less likely to be car drivers)*
- *Company car ownership (more likely to drive car)*

The value of in vehicle time in the models generally varies in the range $10-12 an hour, with access time valued at twice that level, and wait time higher again. These values are also dependent on population segment, with higher income segments having higher values of time.

The model output is a 3 dimensional table of origin zone by destination zone by mode for a 24 hour period in a given forecast year.

Base Year Calibration (home-based work)

Calibration is the process of ensuring that the model in its base year predicts known base year travel patterns. Therefore, the 24 hour home-based work tour matrices, by mode, can be checked against known journey to work travel patterns as revealed by the Census. After adjusting the Census Journey to Work data to match the scope of the home-based work tours from the HTS, it is possible to check (validate) the model results against the Census reality. A good model should (and the STM does) predict the base year travel pattern well, but it is still advisable to calibrate (or factor) the model results to exactly match the base year Census Journey to Work travel patterns. This gives the most accurate starting point for any projections.

Non-Work factoring

As the behavioural models in the STM currently relate to work travel, a factoring process is used to produce non-work travel matrices. These factors are based on revealed travel of the different population segments in the Household Travel Survey. They account for travel for non-work purposes, by time of day and mode, and include an allowance for non-work deviations that occur on the work tour. The result of this factoring, which is by mode, trip length and time of day, is a matrix of total personal travel.

This is currently the single most significant limitation of the STM, and is being addressed with the implementation of a series on non-work models. Whilst these models are being finalised, the TDC has implemented an improved factoring process which accounts for the geographic distribution of non-work trips revealed in the Household Travel Survey.

Time Period factoring

Household Travel Survey data is then used to factor the 24 hour matrix into different times of the day. Factors are provided for the 2 hour am peak (7-9am), 6 hour interpeak (9am-3pm), 3 hour evening peak (3-6pm) and evening/night. Tours are allocated to time periods based on the mid-point of the inward or outward tour leg.

Currently the STM does not explicitly allow for "peak spreading", or different departure time choices when faced with congestion or other conditions that may lead to a change in the timing of travel. TDC is working with the University of South Australia on a peak spreading addition to the STM. This limitation may lead to overstatement of future road congestion, and overstatement of public transport use in future year model runs, if not specifically addressed by the modeller.

Addition of freight matrix

The final step to producing an estimate of total travel in the GMR is the addition of freight travel to the personal travel matrix developed. The CTS is a matrix of road freight movements developed separately by the TDC in the

CUBE-Trips software. For future year estimates, the freight matrix is grown using factors based on zonal employment growth by industry, sourced from TDC's employment projections. This is probably a conservative assumption, and the TDC is investigating more sophisticated methods for projecting commercial travel movements.

Assignment to Networks

The complete matrix of movements from one zone to another by mode is then assigned to the most appropriate route on the networks of each of the modes. It is then possible to examine flows on particular links in the networks. There are several different assumptions that can be made about which route people choose to travel between an origin and destination.

The most commonly used assumption is that people attempt to minimise their *perceived* "generalised travel costs", representing a combination of travel times, distance and additional costs (tolls, fares), taking into account the changing traffic conditions in the network. STM uses an "equilibrium" assignment process that is based on this assumption: the process will ensure that the route with the lowest cost is used, but in congestion and with multiple routes, that all possible alternative routes used between each origin-destination pair will be used to the extent that they have an equal cost.

Iterations and Outputs

The times and costs of travel that result from the assignment of travel are then fed back into the accessibility calculations for each area, and the various travel models are re-run with these new network costs. In this way, the predicted travel reflects the actual conditions facing travellers on the network.

The model "iterates" or runs several times with revised times and costs until there is limited change in the outputs. At this point, the model is deemed to have "converged" on the "right" solution, and final outputs can be produced. The range of outputs from the STM is very large, and includes, but is not limited to:

- travel demand by mode in the form of Origin-Destination matrices
- traffic volumes by road section and by time period
- travel times/speeds by road section and by time period
- travel times between Origins and Destinations by mode and time period
- rail and bus patronage by line and time period
- rail station entry and exit passenger totals

Uses of the STM

Strategic Models

The STM is a "strategic" travel model. "Strategic" in this usage means that it is able to examine the impact of significant proposed changes to land use or transport within the GMA. Being based on travel zones, which in many cases approximate the size of a whole suburb, the input data and therefore outputs contain many averages which mean that the STM is not the right tool for studies of small parts of the GMA, or non-major links in the transport network.

The STM is best suited to examining the effect of significant new residential or employment land releases, major new arterial road links, new rail links, or significantly altered bus servicing strategies. It can also investigate system wide parking, tolling or other strategies. It can provide detailed outputs on the likely usage of different transport modes.

It does not provide feedback to land use changes – this must be handled outside the model, by giving the model different land use inputs.

Some examples of recent projects or scenarios examined by the STM include:

- Parramatta Rail Link (and Epping to Chatswood Rail Link)
- North West Rail Link
- South West Rail Link
- M7
- M4 East
- Increased petrol prices
- No new public transport investment
- Strong CBD employment growth
- Strong employment growth in western Sydney
- Greater levels of urban consolidation
- Greater levels of greenfields development
- Unsworth strategic bus networks

It is essential that the STM is only applied for strategic purposes. Using it for very detailed work for which it is not the best tool potentially undermines the credibility of the model for the strategic projects which it handles very well. It is important to maintain the credibility of the model such that the Government can be confident in any decisions informed by model outputs.

Microsimulation Models

For detailed local area studies, control totals from the STM may be appropriate, but these should be input into micro-simulation or similar detailed level software which is able to represent local data, include transport networks and intersections, in more detail than the STM. Microsimulation software such as Paramics, Aimsun, and Vissim are used to develop this category of models for defined local areas. For example, the RTA has developed Paramics models for many key centres, including the CBD, in Sydney.

The TDC is developing its own microsimulation modelling capability in Aimsun as a means of improving the accuracy of the STM. It plans to link the STM with Aimsun such that STM results can be better calibrated, and STM networks can be improved.

There are also some strategic questions, such as to how (or if) the CBD road system can operate effectively with increased numbers of buses (or light rail) which cannot be answered by a strategic model. This is largely because Strategic Models don't explicitly model intersection delays, and the capacity constraints imposed by intersections. Micro-simulation models allow you to this.

How good is the STM?

The STM performs literally billions of calculations to produce trip matrices for a single output year. It is therefore able to model the working of the entire metropolitan transport system at a relatively high degree of detail, and perform far more calculations and processes than are possible within a spreadsheet. It is a leading edge, extremely powerful tool for scenario modelling possible futures for the GMA. However, it is important that all users understand that the STM is a major simplification of reality and real world decision-making processes. Some of these simplifications bias the STM results in known directions. The TDC is working to alleviate some of the major limitations, but in its current form, users of the STM should be aware of, and correct for if necessary, the following major model limitations.

Non-work travel (factoring process)

A major limitation of the STM is that it currently operates a very sophisticated model for estimating work travel, but is yet to utilise a range of non-work models that have been developed. Currently, non-work travel in the STM is estimated using a factoring process based on work travel. The factoring process does account to some degree for trip length and destination differences in non-work travel, and produces reasonable results at the metropolitan scale. However, area specific analysis of the impact of the factoring process shows an overestimation of non-work trips to large employment centres. In this short term, it is possible to calibrate the results using geographic specific factors derived from the Household Travel Survey.

Time of day of travel (and peak spreading)

Another significant limitation of the STM presently, in terms of the accuracy of its forecasts of peak period travel on different parts of the network, is the way in which 24 hour travel is factored to different times of day.

A time of day factoring process is used. This factoring process does not respond to congestion. That is, while people in the model can choose to respond to congestion by changing mode of travel, location of travel, or decide not to travel, they cannot make their most likely choice, which is to alter the time at which they travel (ie travel outside or on the shoulder of the peak). There is plenty of evidence of the peak spreading phenomenon in the HTS data and RTA traffic counts.

The implications of not accounting for peak spreading in the model are higher predicted traffic volumes in peak hour where there is sufficient capacity, and higher than predicted switching to public transport where there is insufficient peak hour capacity.

The TDC is currently working with the University of South Australia on a methodology to incorporate peak spreading within the STM. This may involve the development of peak and off-peak transport networks (the STM currently operates with a peak hour network only).

Currently, professional judgment can be applied to alter mode-specific time period factors to account for peak spreading.

Validation and Calibration

The behavioural models of the STM, and the metropolitan wide results of the STM have undergone extensive validation, and produce acceptable results. The TDC does not currently utilise any calibration techniques (other than pivoting off the JTW data) to refine the STM's sub-regional estimates. This means that there may be some variation between modelled results and on the ground results for the base year. For this reason the TDC recommends using STM growth factors applied to known base year numbers, rather than predicted STM volumes. A benefit of this approach is that the limitations of the STM are very transparent, not being hidden by extensive calibration

The TDC is currently working on a process of base year validation of the STM to against RTA traffic counts and public transport patronage figures. It is hoped that this will lead to model improvements, but it can also provide a useful calibrated base year upon which to grow travel forecasts.

Capacity constraint on public transport

Currently, rail capacity constraints are not implemented in the STM. No equivalent to volume delay functions on roads are currently applied to deter passengers from catching the train once conditions are crowded. This current formulation of the model is useful for determining the potential demand for rail, allowing RailCorp to respond with additional capacity, but may tend to overestimate rail patronage on some crowded corridors, especially in future years. It is possible to capacity constrain rail within the STM, but this is not currently implemented.

Like rail, there are currently no capacity constraints on the bus system. This assumes, probably more reasonably than for rail, that bus operators will respond to capacity issues with the provision of extra buses/services to meet capacity requirements. Bus is a flexible enough mode for this to be a reasonable assumption.

A further limitation is that service times of buses are not currently affected by traffic congestion. Again, it is assumed that the bus operator timetables account for the effects of congestion at particular times of day.

Access to rail stations

Currently in the STM, car access from a zone to a rail station is limited to station(s) that have a bus service from that zone. Thus, in areas where a person may in reality choose to drive to a nearby station not serviced by their local bus, but which offers parking or more frequent services, this choice is not available in the STM. The TDC is currently undertaking a project Halcrow to address this limitation of the STM.

Zone centroids as approximations

The STM being a simplification of reality, instead of all 5 million GMA residents being modelling individually, they are segmented into socio-demographic groupings and geographic groupings. The geographic groupings, called travel zones, mean that each population segment in an area is given some average characteristics in terms of their accessibility to the public transport system. Each zone is represented by a single, "average" point in the zone which averages the access of all those in a zone. Averages such as this can potentially hide important differences in travel between those who live close to or far away from the public transport system.

The best way to address this issue is to use smaller geographical areas. In 2008 the TDC will implement a smaller zoning system, consisting of 2,600 travel zones in the GMA rather than 1,129, leading to a significant reduction in the potential errors associated with average zonal access characteristics.

Transport Data Centre
January 2008

Appendix B Network Statistics By Road Class

2016 AM Peak

Base

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	1755326	1432170	267532	257043
Arterial	7898980	4003181	467107	246887
Sub-Arterial	3879678	1384578	182685	64968
Local	583483	129731	14256	4170
Total	14117477	6948657	911580	573059
Avg Speed		29.5		37.7

Option F - MSE Toll NS Link Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	1672739	1454686	256034	263964
Arterial	7790206	3990909	454221	242925
Sub-Arterial	3835570	1375490	158161	62584
Local	580811	129342	14149	4136
Total	13879326	6950330	882565	574528
Avg Speed		30.0		38.1

Option G - MSE No Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	1740037	1480258	265410	266151
Arterial	7736280	3977822	451858	242012
Sub-Arterial	3811213	1370271	157395	63409
Local	579349	129218	14068	4134
Total	13874879	6957570	888731	575706
Avg Speed		30.1		38.5

Option H - MSE Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	1678654	1457701	256671	264421
Arterial	7777682	3988073	453617	242573
Sub-Arterial	3832480	1374411	157881	63545
Local	580490	128209	14112	4127
Total	13869266	6949393	882181	574666
Avg Speed		30.1		39.1

Option I - MSE Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	1677236	1449925	255847	263001
Arterial	7828829	3994026	457515	243454
Sub-Arterial	3848862	1378428	158814	64105
Local	581254	129362	14191	4165
Total	13932281	6951741	887266	574726
Avg Speed		29.9		38.9

Option J - MSE No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	1745682	1470881	264610	264744
Arterial	7790678	3984585	456114	243046
Sub-Arterial	3822846	1373846	156572	63845
Local	578568	128986	14097	4136
Total	13937775	6958304	893393	575771
Avg Speed		30.0		38.7

2016 Annual (millions)

AM1 to Daily Factor 3000

Base

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	5266	4297	803	771
Arterial	23697	12010	1401	741
Sub-Arterial	11638	4154	488	195
Local	1750	389	43	13
Total	42352	20849	2725	1719
Avg Speed		29.5		37.7

Option F - MSE Toll NS Link Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	5018	4364	768	792
Arterial	23371	11972	1363	729
Sub-Arterial	11507	4126	474	191
Local	1742	388	42	12
Total	41638	20851	2648	1724
Avg Speed		30.0		39.1

Option G - MSE No Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	5244	4441	796	798
Arterial	23209	11933	1356	726
Sub-Arterial	11434	4111	472	190
Local	1738	388	42	12
Total	41625	20873	2666	1727
Avg Speed		30.1		38.9

Option H - MSE Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	5036	4373	770	793
Arterial	23333	11964	1361	728
Sub-Arterial	11497	4123	474	191
Local	1741	388	42	12
Total	41606	20848	2647	1724
Avg Speed		30.1		39.1

Option I - MSE Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	5032	4350	768	789
Arterial	23480	11982	1373	730
Sub-Arterial	11541	4135	479	192
Local	1744	388	43	12
Total	41797	20855	2662	1724
Avg Speed		29.9		38.9

Option J - MSE No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	5237	4413	794	794
Arterial	23372	11954	1368	729
Sub-Arterial	11469	4122	476	192
Local	1736	387	42	12
Total	41813	20875	2680	1727
Avg Speed		30.0		38.7

2016 Annual Change

Option F - MSE Toll NS Link Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-248	68	-34	21
Arterial	-326	-37	-38	-12
Sub-Arterial	-132	-27	-14	-4
Local	-8	-1	0	0
Total	-714	2	-87	4
Avg Speed		1		1

Option G - MSE No Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-22	144	-6	27
Arterial	-488	-76	-46	-15
Sub-Arterial	-205	-43	-16	-5
Local	-12	-2	-1	0
Total	-729	24	-69	8
Avg Speed		1		1

Option H - MSE Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-230	77	-33	22
Arterial	-364	-45	-41	-13
Sub-Arterial	-142	-30	-14	-4
Local	-9	-2	0	0
Total	-746	-1	-88	5
Avg Speed		1		1

Option I - MSE Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-234	53	-35	18
Arterial	-218	-27	-29	-10
Sub-Arterial	-98	-18	-9	-3
Local	-7	-1	0	0
Total	-556	6	-73	5
Avg Speed		0		1

Option J - MSE No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-29	116	-9	23
Arterial	-325	-56	-33	-12
Sub-Arterial	-170	-32	-12	-3
Local	-15	-2	0	0
Total	-539	26	-55	8
Avg Speed		0		1

2026 AM Peak

Base

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	2246426	1568627	416658	350280
Arterial	10128806	4566661	673917	320125
Sub-Arterial	5027486	1605381	235934	85577
Local	727201	156034	21648	5700
Total	18129959	7896713	1348158	761682
Avg Speed		26.1		33.9

Option F - MSE Toll NS Link Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	2152503	1597429	404164	358583
Arterial	9957851	4548500	853096	314213
Sub-Arterial	4961688	1594106	228770	83555
Local	723048	155511	21360	5684
Total	17795059	7895555	1307390	763036
Avg Speed		26.6		35.0

Option G - MSE No Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	2240862	1617257	417483	361032
Arterial	9902107	4537502	650636	312531
Sub-Arterial	4938860	1588808	227832	83446
Local	722780	155628	21437	5684
Total	17804708	7899195	1317878	763693
Avg Speed		26.8		34.8

Option H - MSE Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	2154826	1600158	404470	360088
Arterial	9943138	4546444	852042	313917
Sub-Arterial	4959158	1593106	228753	83559
Local	722683	155481	21252	5640
Total	17779803	7895271	1306516	763204
Avg Speed		26.6		35.0

Option I - MSE Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	2161173	1591327	403662	358240
Arterial	10010717	4553047	858145	315114
Sub-Arterial	4976103	1597113	230894	84177
Local	722534	155318	21387	5649
Total	17870527	7896805	1314088	763181
Avg Speed		26.5		34.8

Option J - MSE No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	2244888	1609028	416351	358640
Arterial	9873467	4544884	656739	314783
Sub-Arterial	4954112	1592907	230451	84151
Local	722570	155465	21460	5658
Total	17795038	7901283	1325001	763532
Avg Speed		26.5		34.8

2026 Annual (millions)

AM1 to Daily Factor 3000

Base

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	6739	4706	1250	1051
Arterial	30387	13700	2022	960
Sub-Arterial	15082	4816	708	257
Local	2182	468	65	17
Total	54390	23690	4044	2285
Avg Speed		26.1		33.9

Option F - MSE Toll NS Link Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	6458	4792	1212	1079
Arterial	29874	13646	1959	943
Sub-Arterial	14885	4782	686	251
Local	2169	467	64	17
Total	53385	23687	3922	2289
Avg Speed		26.6		35.0

Option G - MSE No Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	6723	4852	1252	1083
Arterial	29706	13613	1953	941
Sub-Arterial	14817	4766	684	250
Local	2168	467	64	17
Total	53414	23698	3953	2291
Avg Speed		26.8		34.8

Option H - MSE Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	6464	4800	1213	1080
Arterial	29829	13639	1956	942
Sub-Arterial	14877	4780	686	251
Local	2168	466	64	17
Total	53339	23686	3920	2290
Avg Speed		26.6		35.0

Option I - MSE Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	6484	4774	1211	1075
Arterial	30032	13659	1574	945
Sub-Arterial	14928	4791	693	253
Local	2168	466	64	17
Total	53612	23690	3942	2290
Avg Speed		26.5		34.8

Option J - MSE No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	6735	4824	1249	1077
Arterial	29620	13635	1970	944
Sub-Arterial	14862	4779	691	252
Local	2168	466	64	17
Total	53685	23704	3975	2291
Avg Speed		26.5		34.8

2026 Annual Change

Option F - MSE Toll NS Link Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-282	86	-37	28
Arterial	-513	-54	-62	-18
Sub-Arterial	-197	-34	-21	-6
Local	-12	-2	-1	0
Total	-1005	-3	-122	4
Avg Speed		0		1

Option G - MSE No Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-16	146	2	32
Arterial	-680	-87	-69	-20
Sub-Arterial	-266	-50	-24	-8
Local	-13	-1	-1	0
Total	-976	7	-91	6
Avg Speed		0		1

Option H - MSE Toll NS Link No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-275	95	-37	29
Arterial	-557	-61	-66	-18
Sub-Arterial	-205	-37	-22	-6
Local	-14	-2	-1	0
Total	-1051	-4	-125	5
Avg Speed		1		1

Option I - MSE Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-256	68	-39	24
Arterial	-355	-41	-47	-15
Sub-Arterial	-154	-25	-15	-4
Local	-14	-2	-1	0
Total	-778	0	-102	4
Avg Speed		0		1

Option J - MSE No Toll

Road Class	Car VMT	Car VKT	Truck VMT	Truck VKT
Freeway	-5	118	-1	26
Arterial	-466	-65	-52	-16
Sub-Arterial	-220	-37	-16	-4
Local	-14	-2	-1	0
Total	-705	14	-69	6
Avg Speed		0		1