transport

Department:
Transport
REPUBLIC OF SOUTH AFRICA

TENDER NO.: DoT/08/2006/IP & IC

National Transport Master Plan

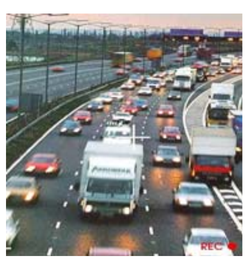
NATMAP 2050

You pay for good transport whether you've got it or not

MODELLING REPORT

October 2009

REFERENCE NO : MOD/PH3/OCT09

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1 INTRODUCTION

The purpose of the model was to provide assistance to the Department of Transport with regard to strategic decisions. Focus of the model is therefore on the movement of persons and goods within South Africa as well as between South Africa and neighbouring countries including countries outside Africa.

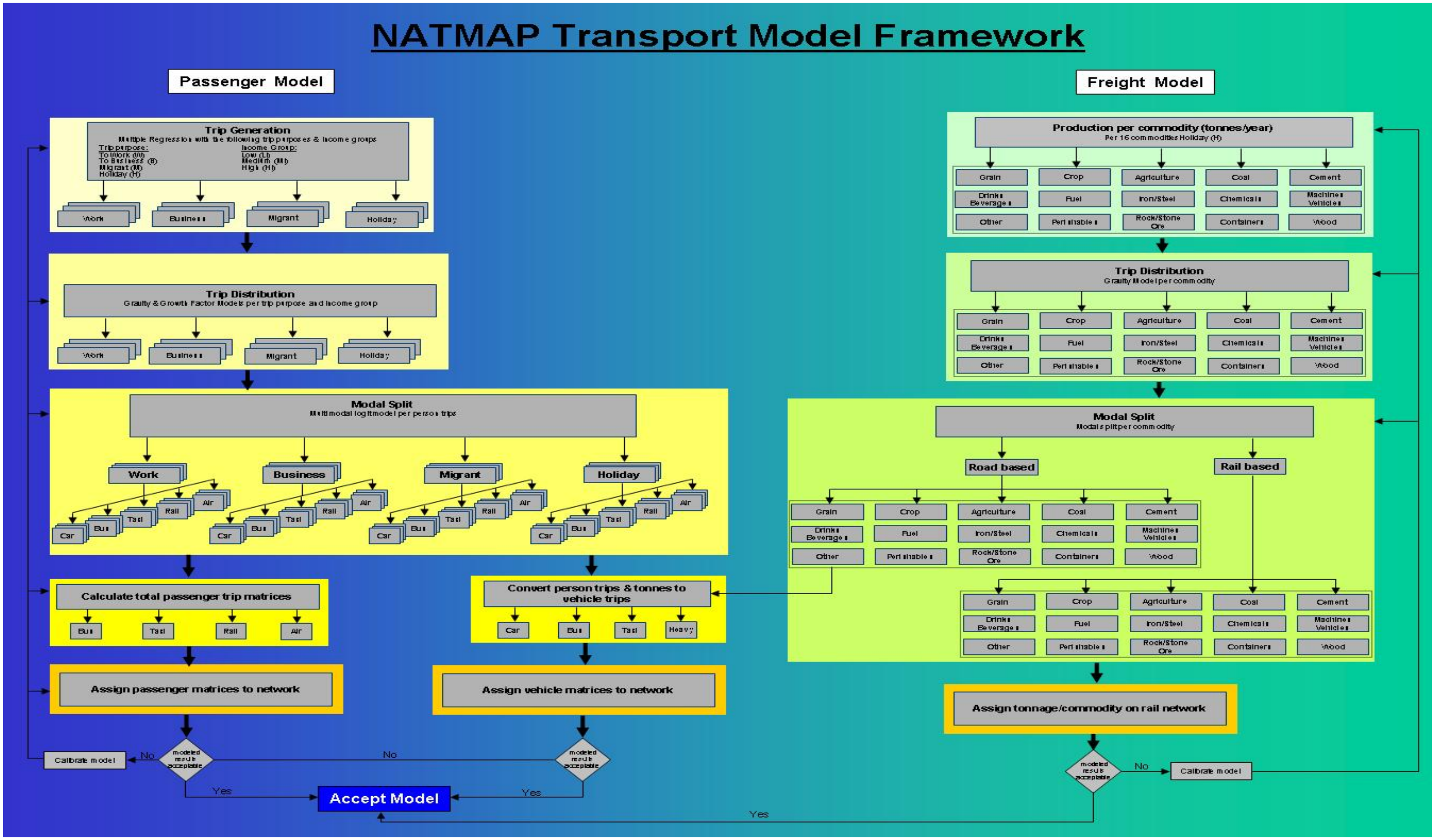
The majority of the road and rail network represented in the model is outside of urban areas where the Average Daily Traffic (ADT) is more applicable than the peak hour traffic. For this reason the model represents the ADT on the roads. Peak hour traffic volumes can be derived from the modelled ADT volumes if needed.

The modelled results were transferred to spreadsheets and database files to be imported into the GIS where the data and results of each model step can be displayed on the GIS. Model input data and modelling results is thus part of the NATMAP data base. Both network and zones is based on WGS84 co-ordinate system.

This model followed the standard four step modelling process consisting of trip generation, trip distribution, modal split and assignment of vehicles on the representing road network. The model framework is displayed diagrammatically in Figure 1.1 and a detail discussion on each step of the model follows. The specifications of this model are based on the information received with regard to the data obtained and the status of development as indicated by the results displayed in the document.

This report focuses on the development of the model. Modelled results are displayed and discussed in detail in the individual provincial reports. Summaries of the modelled results for the target years are, however given in this report for comparison purposes. Each step of modelling process for both the passenger and freight models are discussed and the methodology is explained in this report.

Figure 1.1: Natmap Transport Model Framework



2 ZONE SYSTEM

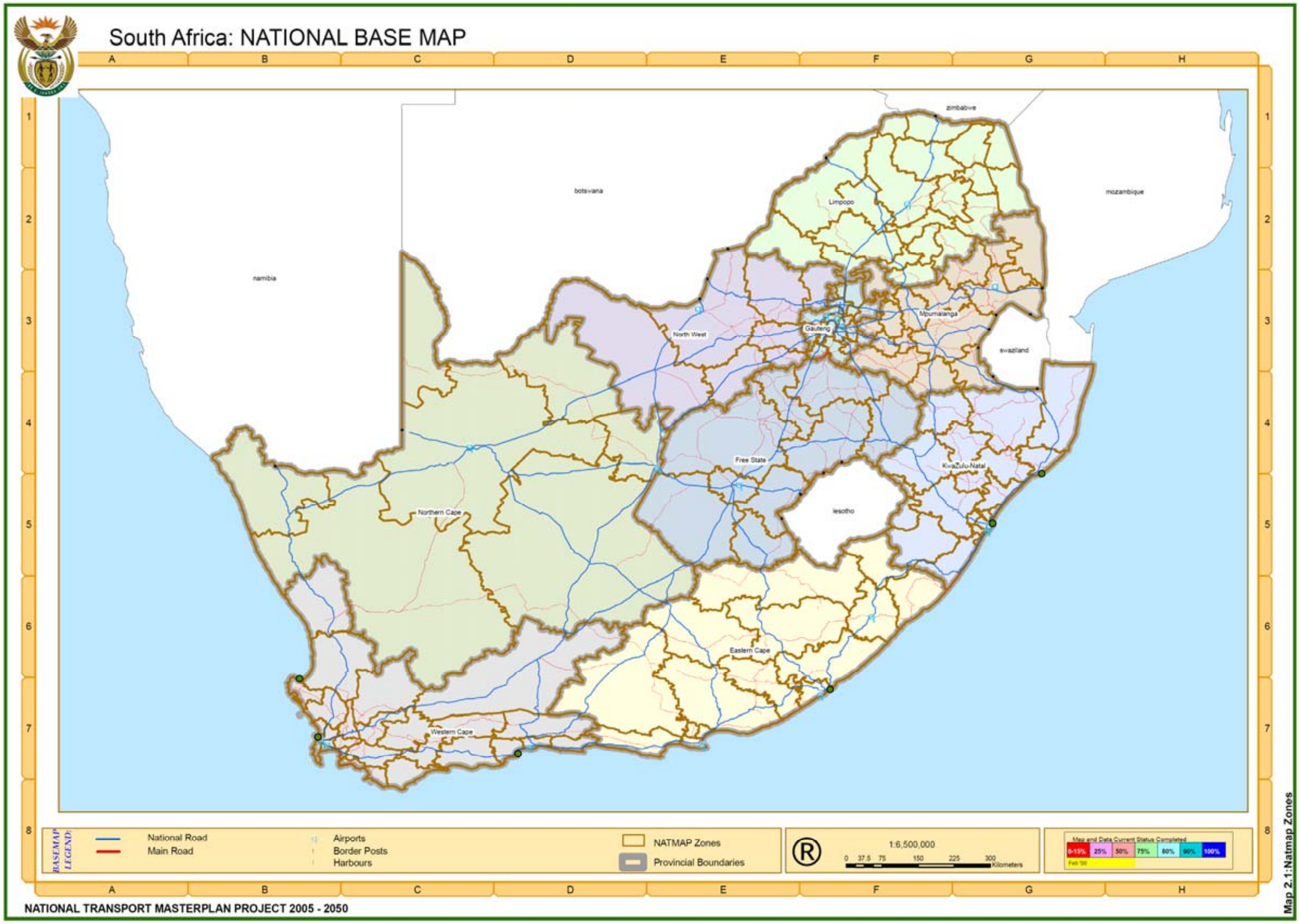
The sizes of zones were linked to the population density and economic activity in the applicable areas. Areas with low population densities or economic activity justify zones based on district boundaries. Zones representing those areas with higher population densities and economic activities were based on local municipality boundaries. Metropolitan areas have the highest population densities and economic activity and therefore needs an even finer zoning system. Metropolitan areas were therefore subdivided into smaller areas and are closely compatible with the NHTS TAZ boundaries and metropolitan zoning system to reflect the higher densities and activities prevalent in these regions. Existing as well as future land uses and infrastructure requirements were taken into account when defining the zone system.

Each zone is represented by a separate polygon. Zones connect like a puzzle with no islands inbetween. A total of 142 internal zones represent the whole of the Republic of South Africa (Figure 2.1). The most prominent town in a zone represents that zone and is therefore the centroid of that particular zone, metropolitan areas being the exception.

External zones were created based on road and rail links that cross the borders of the Republic of South Africa at the point of crossing. One external zone was created for air and see traffic and therefore represent all of the countries linked to import and export via sea or air.

A five digit numbering system was used for zone numbers. The first digit represents the province (as per NHTS provincial numbering system), the second and third digits represent the district municipality (random sequential in each province) and the forth and fifth digits represents the zone number (random sequential in each DM). A summary of the internal zones are given Annexure A.

Figure 2.1: Internal zones



3 NETWORK

The network level of detail is appropriate for a coarse strategic model at a national scale and therefore consists mainly of national and higher order provincial roads and only those municipal roads providing links to activity nodes of strategic significance to the country as a whole. It is important to ensure that all zones are linked to one another via the represented network. The road network was coded as two-way links with the following parameters:

- Hourly capacity
- Number of lanes
- Length (the actual length of the road represented by the link)
- Speed – The speed to be coded will depend on whether speed data are available or not. The speed limits are to be used as the speed of the link where no speed data are available. The average speeds recorded are to be used for those links where speed data are to be used. A distinction should be made between the average speed for light and heavy vehicles.
- Percentage heavy vehicles
- Modes applicable

Mountain passes are represented in terms of distance and speed in the network. The actual distance of the pass and the average speed of vehicles in the pass were coded. The same applies for tunnels.

The rail network is represented in the model and the parameters specified previously apply with the only exception being the usage of the rail line. A distinction was made between commuter and freight usage. Passenger trips were assigned to that section of the rail network covered by Shosholoza Meyl, as well as additional commuter lines in the metropolitan areas.

Air and sea routes are represented by two-way links and coded as such and the parameters mentioned previously are applicable to these links as well. The network is shown in Figures 3.1 to 3.3.

Links were classified according to the road type and area adjacent to the road. Both capacities and speeds were allocated to the different link types.

Available information on speeds and volumes was obtained for a large number of representative locations across South Africa. It was hoped that this information could be used to calibrate the speed-flow equations used in the model assignment. However, with only a few exceptions in the more dense metropolitan areas, particularly the N1 Ben Schoeman freeway in Gauteng, none of the roads where speed/flow data was available exhibited a sufficient range in daily volumes to determine the nature of the speed/flow curve at volumes closer to the road's capacity. Indeed, most surveyed roads had traffic volumes that rarely exceeded the B or C Level of Service mark.

Because no suitable data was available for speed versus flow on typical South African national and strategic roads, it was decided that generic speed flow relationships commonly used in existing South African provincial and metropolitan models would be used. The lack of suitable and detailed data on speed/flow relationships indicates that more work needs to be undertaken to obtain this information in order to improve the calibration of the network speed flow relationships.

A summary of the road types are given in Table 3.1. A fixed speed is applied to rail, air and see modes. Provision was made for two types of centroid connectors. One type for road based modes and the second for rail based modes.

Table 3.1: Summary of link types

Road Type	Area Type	Link Code	Free flow speed	Capacity	Power
Freeway	Rural	11	120 km/h	4000	4.92
	Urban	12	120 km/h	6000	4.38
	Pass	13	100 km/h	3600	4.1
Dual-carriageway	Rural	21	120 km/h	4000	2.36
	Urban	22	120 km/h	4000	2.64
Other major roads	Rural	31	80 km/h	3800	2.22
	Urban	32	60 km/h	1800	0.82
	Pass	33	70 km/h	1700	4.15
Centroid connectors	Road	51	60 km/h		
	Rail	52	60 km/h		
	See	53	45 km/h		
Rail	Rural	61	60 km/h		
	Urban	62	60 km/h		
Air link	Rural	71	700 km/h		
See link	Rural	81	45 km/h		

For the air network transfer links were coded at all modelled airport nodes with appropriate transfer costs, reflecting time to transfer between road and aeroplane at the departure end and a suitable penalty at the destination end, applied to these links. Air passenger trips were therefore able to access airports via the road network, enabling a more realistic spread of air passenger trips between the national modelled zones.

The Base Year network was checked for the following errors:

- Links with incorrect specification of length/number of lanes/speed-flow equations/modes allowed
- Links with inconsistent attributes in the opposite direction
- Dead end links
- Missing links

The model was initially coded using the SATURN transportation modelling suite since the speed-flow relationships in the model are more readily coded as speed-flow curves in SATURN as against the volume-delay functions required in EMME. However, after difficulties encountered using SATURN (which is primarily an urban congestion based model rather than a strategic-level one) on such a large-scale modelled area the entire network was switched to EMME and the SATURN speed-flow curves converted to volume-delay functions. These are shown in Table 3.2. Note that the final modelled capacity volumes (shown as typical hourly capacities) were adjusted to more accurately reflect all-day volumes.

Volau and volad refer to assigned EMME demand (volau) plus any additional demand (volad, usually zero in the current model). Values el1 and el2 refer to toll link penalties and additional link lengths respectively (the latter necessary since the maximum link length in EMME is 999.99km and a few air links exceeded this value).

Table 3.2: Volume Delay Functions in Base EMME Model

Road	Area	EMME code	Function
Freeway	Rural	11	((length*60/120+el1 *(1+.34*((volau+volad)/(lanes*(4000)*.725))^4.9)))
Freeway	Urban	12	((length*60/120+el1 *(1+.34*((volau+volad)/(lanes*(6000)*.725))^4.9)))
Freeway	Pass	13	((length*60/100+el1 *(1+.34*((volau+volad)/(lanes*(3600)*.725))^4.9)))
Dual-carriageway	Rural	21	((length*60/120+el1 *(1+.30*((volau+volad)/(lanes*(4000)*.720))^5.0)))
Dual-carriageway	Urban	22	((length*60/120+el1 *(1+.30*((volau+volad)/(lanes*(4000)*.720))^5.0)))
Other major	Rural	31	((length*60/80+el1 *(1+.25*((volau+volad)/(lanes*(3800)*.570))^2.5)))
Other major	Urban	32	((length*60/80+el1 *(1+.25*((volau+volad)/(lanes*(1800)*.570))^2.5)))
Other major	Pass	33	((length*60/70+el1 *(1+.25*((volau+volad)/(lanes*(1700)*.570))^2.5)))
Centroid connectors	Road	51	((length*60/52+el1 *(1+.30*((volau+volad)/(lanes*(9999)*.720))^5.0)))
Centroid connectors	Rail	52	((length*60/90+el1 *(1+.30*((volau+volad)/(lanes*(9999)*.720))^5.0)))
Centroid connectors	Sea	53	((length*60/52+el1 *(1+.30*((volau+volad)/(lanes*(9999)*.720))^5.0)))
Rail	Rural	61	((length*60/60))
Rail	Urban	62	((length*60/60))
Air	-	71	((length+el2)*60)/450)
Sea	-	81	((length*60/40+el1 *(1+.15*((volau+volad)/(lanes*(9999)*.75))^4.0)))

Figure 3.1: Model road network

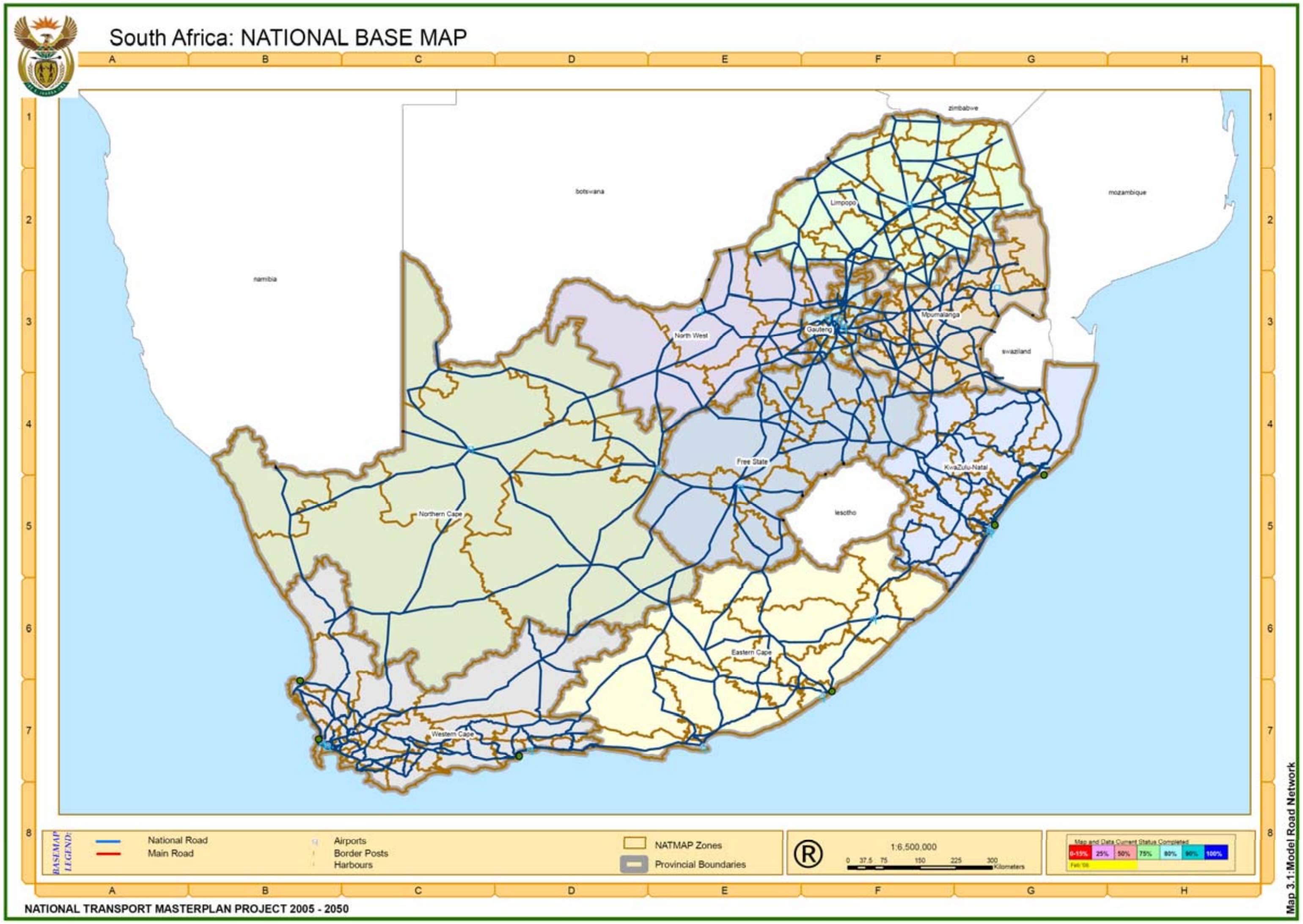


Figure 3.2: Model Rail Network

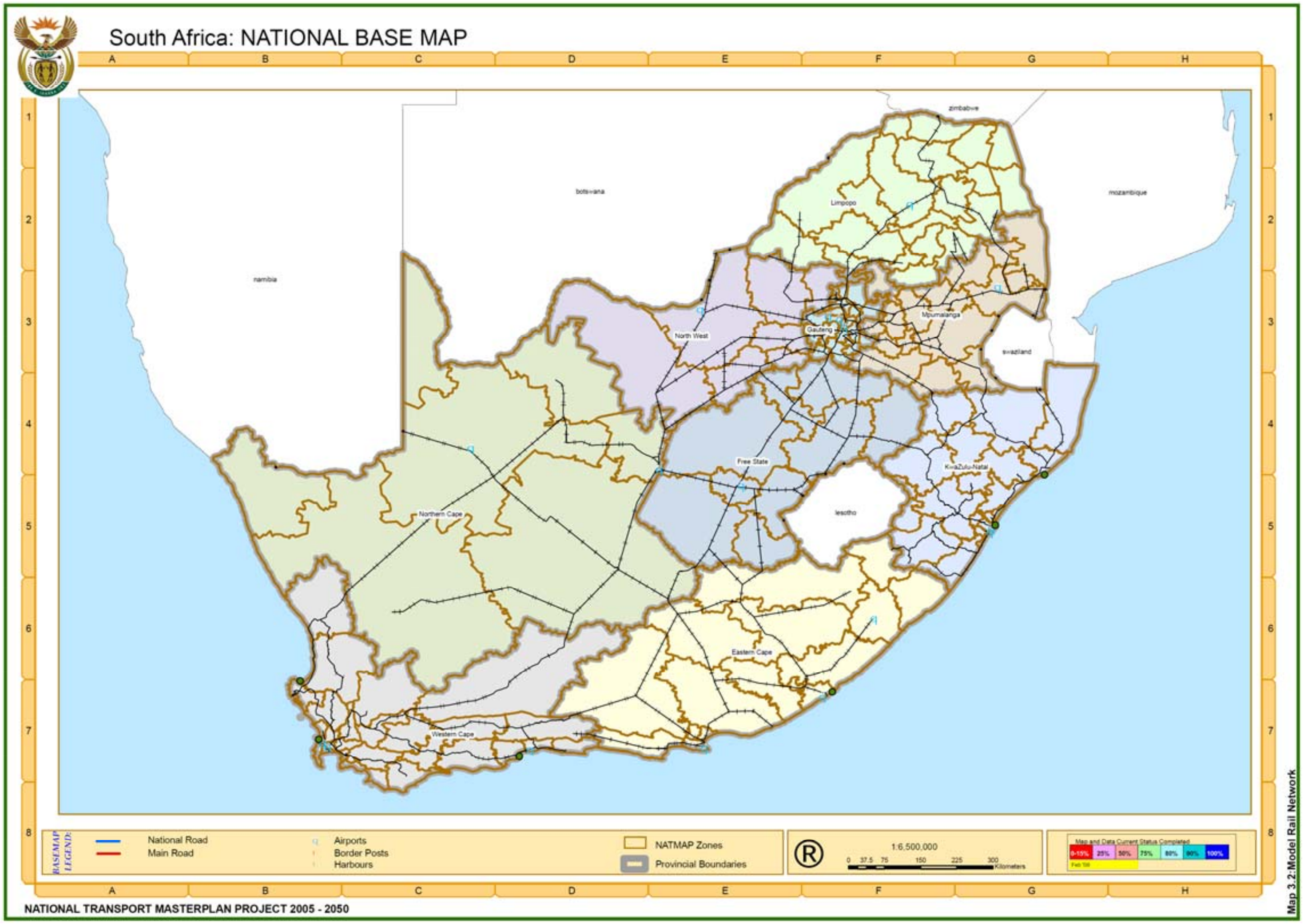
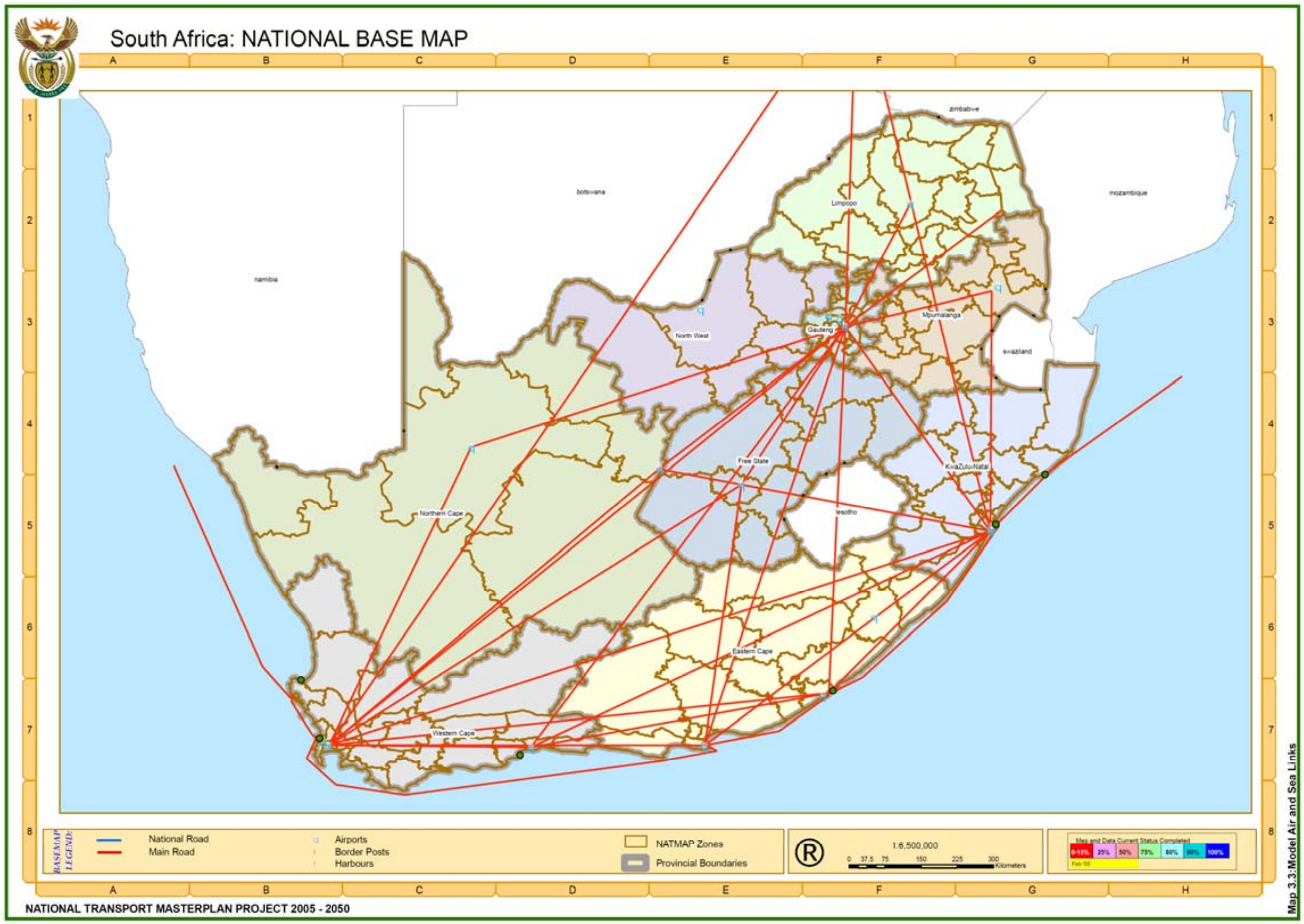


Figure 3.3: Model air and sea links



4 TRIP GENERATION & ATTRACTION

Trip production is where the number of trips produced and attracted is determined. The result of a trip distribution model is a table of number of trips produced and attracted by zone.

4.1 PASSENGER MODEL

4.1.1 Introduction

Trip generation is the first step in the demand modelling process. It involves forecasting the number of person trips that will start or end in a traffic zone. Trip generation are calculated by using information from the land use part of the study as inputs.

The trip generation model is a spreadsheet model where regression equations were used to calculate the number of trips generated for each trip purpose.

To estimate the regression equations for passenger trips multiple linear regression analyses was carried out for each trip purpose and income group in order to develop the equations needed for the estimation of trip attractions and trip productions. The regression analysis compared the trips from the National Household Travel Survey (NHTS).

The following typical multiple linear regression equation was used::

$$Y = b_0 + b_1 X_1 + b_2 X_2 + ... + b_n X_n$$

Where: Y = number of trips generated in a zone, the dependant variable

$b_{0,}$ b_1 ..... , b_n are regression coefficients obtained from the analysis

$X_{1,}$ $X_{2,}$ ..... , X_n are independent variables.

Linear regression produces the slope of a line that best fits a single set of data. Multiple linear regression is the analysis of more than one set of data, which often produces a more realistic projection.

The following trip purposes for passengers were modelled:

- to work;
- to business
- to 'other' home (migrant trips); and
- to holiday.

Separate regression equations were estimated for each trip purpose and each of the three income groups. The income groups used in this model are:

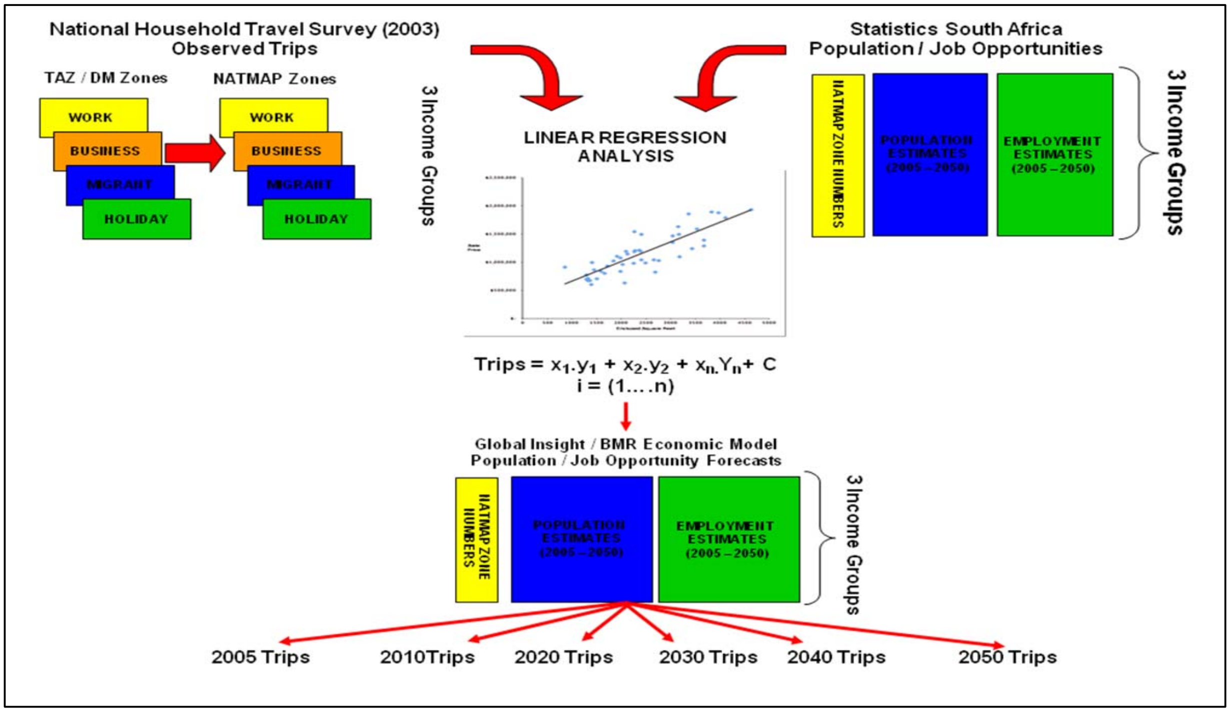
- Low Income Group (<R3000 per month
- Income Group (more than R6000 per month).
- Middle Income Group (between R3000 and R6000 per month)

High

4.1.2 Methodology

The methodology followed to produce trip generation results is shown in **Figure 4.1**.

Figure 4.1: Methodology



The trip generation process for the base year included the following tasks:

- Conversion of NHTS origins and destinations from TAZ zone level to NATMAP zone level
- Development of a Socio Economic Database
- Multiple Linear Regression Analysis
- Calculate Productions and Attractions
- Balance Trips

The trip generation process for estimating future demand is somewhat simpler and includes the following steps:

- Develop Socio Economic Database for future scenarios
- Calculate productions and attractions by applying the equations developed during the base year process with the data projections for future scenarios
- Balance trips

Each step will be described in more detail in the subsequent sections.

4.1.2.1 National Home Travel Survey origins and destinations to be converted from Transport Area Zone level to Natmap zone level

All National Home Travel Survey (NHTS) data had to be converted to the NATMAP zoning system. The sizes of NATMAP zones were to be linked to the population density and economic activity in the applicable area. Areas with low population densities or economic activity justified zones based on district boundaries. Zones representing those areas with higher population densities and economic activities were based on local municipality boundaries. Metropolitan areas have the highest population densities and economic activity and therefore needed a finer zoning system.

The NHTS captured all origins on Transport Area Zone (TAZ) level, which is the smallest zone in the NHTS. All origin data was converted to NATMAP zone level. Work Trip destinations were captured on TAZ level while business, migrant and holiday trips were captured in district level. All destination data was converted to NATMAP zone level.

In several instances this process was complicated by boundary changes that took place since the NTHS in 2003. Boundary changes did not only occur on municipal and district level but also provincial level.

4.1.2.2 Develop Socio Economic Database

An extensive and detailed demographic and socio-economic database was developed for the development of the Transport Model by the Land Use Working Group members from each consortium.

The database consisted of 3 sets of data in 5 year intervals from 2005 to 2050 per NATMAP zone:

- Population with the following data fields:
- Population by income group
- Households by income group
- Economically active population with the following data fields
- Employed
- Unemployed
- Total
- Employment by main industry (at place of work) with the following data fields:
- Agriculture and hunting
- Forestry and logging
- Fishing, operation of fish farms
- Mining of coal and lignite
- Mining of gold and uranium ore
- Mining of metal ores
- Other mining and quarrying
- Food, beverages and tobacco products
- Textiles, clothing and leather goods
- Wood and wood products
- Fuel, petroleum, chemical and rubber products
- Other non-metallic mineral products
- Metal products, machinery and household appliances
- Electrical machinery and apparatus
- Electronic, sound/vision, medical & other appliances
- Transport equipment
- Furniture and other items NEC and recycling
- Electricity, gas, steam and hot water supply
- Collection, purification and distribution of water
- Construction
- Wholesale and commission trade
- Retail trade and repairs of goods

- Sale and repairs of motor vehicles, sale of fuel
- Hotels and restaurants
- Land and Water transport
- Air transport and transport supporting activities
- Post and telecommunication
- Finance and Insurance
- Real estate activities
- Other business activities
- Public administration and defence activities
- Education
- Health and social work
- Other service activities
- Informal
- Domestic
- Unemployed

4.1.2.3 Multiple Linear Regression Analysis

The multiple regression analysis compared the trips from the NHTS with the base year data in the socio-economic database. Analyses were carried out for each trip purpose per income group as shown in ***Table 4-1***.

Table 4.1: Trip Purpose And Income Group For Regression Analysis

Trip Purpose	**Income Group**
Work Trips	Low-income (R1 – R3,000)
	Middle-income (R3,001 – R6,000)
	High-income (>R6,000)
Business Trips	Low-income (R1 – R3,000)
	Middle-income (R3,001 – R6,000)
	High-income (>R6,000)
Migrant Trips	Low-income (R1 – R3,000)
	Middle-income (R3,001 – R6,000)
	High-income (>R6,000)
Holiday Trips	Low-income (R1 – R3,000)
	Middle-income (R3,001 – R6,000)
	High-income (>R6,000)

The process commenced with as many variables as possible. Thereafter variables that do not contribute significantly to the overall R-square will be eliminated.

The significance of each variable was tested. If Ho (the null hypothesis) was rejected in the t-test, the variable is significant. With a confidence level of 95 per cent, the t-value should be larger than 2 for the variable to be significant. Thus if the t-statistic value for a specific variable is smaller than 2, the variable was excluded from the equation.

Independent variables whose inclusion did not appear to be logical (e.g. the number of unemployed workers who will probably not affect the number of high-income work trips) was also eliminated.

The effect of combining some variables (e.g. combine retail, office, industrial etc. workers to form total workers) was also be tested to ascertain i.e. if the total number of formal workers did not yield a higher level of significance than other combinations of the different employment sectors.

Business, migrant and holiday trips were analysed on district level because:

- Small sample size at NATMAP level
- Attractions were captured per DM

Regression analysis of migrant trip attractions yielded poor results. A more detailed analysis was required. Metropolitan and non-metropolitan areas were analysed separately and agricultural and non-agricultural areas were analysed separately. This resulted in a significant improvement in the R-square values for migrant trip attractions.

The results of the regression analyses were expressed in the form of equations. Multiple linear regression equations of the following general form:

$$Y = b_0 + b_1 X_1 + b_2 X_2 + ... + b_n X_n$$

Where: Y = number of trips generated in a zone, the dependant variable

$b_0, b_1, ..., b_n$ are regression coefficients obtained from the analysis

$X_1, X_2, ..., X_n$ are independent variables.

4.1.2.4 Calculate Productions and Attractions

The equations were applied to the database to calculate the total trip productions and attractions for each zone per trip purpose and income group. The results of this step are shown in trip end tables for each trip purpose per income group with the following format:

Zone	Productions	Attractions
101301	100	25
101302	50	200
101303	150	75
…	…	…

The end product of the trip generation phase was a table of trip ends for each trip purpose per income group. The trip ends are the number of trips that are produced in or attracted to each zone. These trip productions and attractions will be used as the first step of the trip distribution process.

4.1.2.5 Balance Trips

The equations above do not guarantee that the total number of productions will be equal to the total number of attractions. For trip distribution it is however imperative that the productions equal the attractions. It is not possible to have a distribution matrix where the sum of all rows (productions) is different from the sum of all columns (attractions). Therefore the productions and attractions of each trip purpose had to be balanced.

In this specific study the attractions were scaled to match the productions since the production data from the NHTS was deemed to be more reliable since only the last trip's destination was recorded in the NHTS.

4.1.3 Trip Generation Results

4.1.3.1 Regression Results

The results from the regression analyses for Trip Production and Trip Attraction are presented in Table 4.2 and Table 4.3 respectively. The quality of calibration is also indicated, 1 indicates a very good quality, thus, the closer to 1 the better the calibration.

Table 4.2: Trip Production Regression Equations

	Y	R^2	Equation
Work trips	Low	0.85	Y = (2.697 x low income EA persons)
Work trips	Mid	0.89	Y = (2.165 x mid income EA persons)
Work trips	High	0.80	Y = (1.086 x Employed persons)
Business trips	Low	0.43	Y = (0.0602 x Emoloyed persons)
Business trips	Mid	0.62	Y = (0.090 x Employed persons)
Business trips	High	0.68	Y = (0.433 x High income EA persons)
Migrant trips	Low	0.73	Y = (1.615 x Transport, storage and communication job opportunities)
Migrant trips	Mid	0.81	Y = (0.114 x fincance, ensurance, real estate and business services job opportunities)
Migrant trips	High	0.88	Y = (0,055 x mining and quarrying job opportunities) + (0.064 x fincance, ensurance, real estate and business services job opportunities)
Holiday trips	Low	0.70	Y = (1.000 x low income households)
Holiday trips	Mid	0.66	Y = (0.912 x mid income households)
Holiday trips	High	0.76	Y = (1.533 x high income households)

Table 4.3: Trip Attraction Regression Equations

	Y	R^2	Equation

	Y	R^2	Equation
Work trips	Low	0.84	y = (0.941 x total informal job opportunities)+(1.873 * domestic job opportunities) + (0.109 * total formal job opportunities)
Work trips	Mid	0.74	Y = 0.182 x total formal job opportunities
Work trips	High	0.71	Y = 0.268 x total formal job opportunities
Business trips	Low	0.75	Y = 0.003 x total EA persons
Business trips	Mid	0.83	Y = 0.006 x total jobs)
Business trips	High	0.86	Y = 0.019 x total jobs)
Migrant trips (to Metro)	Low	0.610	Y = 0.016 x low income households
Migrant trips (to Non-Metro)	Low	0.73	Y = 0.054 x low income households
Migrant trips (to Agricultural areas)	Mid	0.66	Y = 0.041 x mid income households
Migrant trips (to Non-Agricultural areas)	Mid	0.39	Y = 0.01 x low income households
Migrant trips (to Metro)	High	0.77	Y = 0.008 x high income households
Migrant trips (to Non-Metro)	High	0.28	Y = 0.02 x high income households
Holiday trips	Low	0.81	Y = (0.260 x low income households)
Holiday trips	Mid	0.80	Y = (0.946 x Hotel&Restaurant job opportunities)
Holiday trips	High	0.74	Y = (1.996 x Hotel&Restaurant job opportunities)

4.1.3.2 Base Year Results

The base year trip generation results are summarised in Tables 4.4 to 4.5. Refer to ***Annexure B*** for full base year trip generation results. Table 4.4 shows the work trip productions and attractions per week per province. These are total person trips.

Table 4.4: Work Trip Productions And Attractions (Total Person Trips Per Week) Per Province

	Productions	Attractions

Province	Low income	Middle income	High income	Low income	Middle income	High income
Eastern Cape	3 191 353	847 670	970 122	2 397 506	697 704	921 907
Free State	2 096 254	478 409	714 358	1 997 067	486 413	642 719
Gauteng	6 030 128	3 345 258	4 368 090	8 580 611	3 563 879	4 709 110
Gauteng	5 698 290	1 349 475	2 001 163	5 153 437	1 364 097	1 802 441
KwaZulu Natal	2 871 947	686 567	892 488	2 471 355	587 461	776 237
Mpumalanga	2 525 696	668 857	953 770	2 298 123	625 910	827 042
North West	2 820 572	760 854	943 046	1 827 546	708 408	936 050
Northern Cape	558 519	174 685	232 537	474 526	196 977	260 275
Western Cape	2 441 669	1 400 468	1 757 634	3 034 256	1 481 392	1 957 429
TOTAL	**28 234 428**	**9 712 241**	**12 833 209**	**28 234 428**	**9 712 241**	**12 833 209**

A total 50 780 000 work trips were generated for an average work week. More than half of these are low income work trips. Only Gauteng and the Western Cape have more trip attractions than productions i.e. work trips flowing into the province.

Table 4.5 shows total business trip productions and attractions per month by each province. These are total person trips.

Table 4.5: Business Trip Productions And Attractions (Total Person Trips Per Month) Per Province

	Productions			**Attractions**		
Province	**Low income**	**Middle income**	**High income**	**Low income**	**Middle income**	**High income**
Eastern Cape	53 777	80 397	120 655	69 152	76 401	127 972
Free State	39 599	59 201	54 254	41 918	53 264	89 217
Gauteng	242 135	361 996	845 559	213 926	390 258	653 681
Gauteng	110 930	165 842	237 055	122 510	149 374	250 200
KwaZulu Natal	49 473	73 963	87 522	59 103	64 329	107 751
Mpumalanga	52 870	79 042	94 109	54 502	68 539	114 803
North West	52 276	78 153	91 632	60 026	77 573	129 935
Northern Cape	12 890	19 271	23 221	12 738	21 570	36 129
Western Cape	97 431	145 660	227 398	77 505	162 218	271 714
TOTAL	**711 380**	**1 063 526**	**1 781 402**	**711 380**	**1 063 526**	**1 781 402**

Three and a half million business trips were generated per month. Half of these business trips were generated by the high income group. The highest number business trips are generated in Gauteng, forty one per cent of all business trips start in Gauteng. Most business trips end in Gauteng (35%), followed by KwaZulu Natal (15%) and Western Cape (14%). The Northern Cape produces and attracts the fewest business trips.

Table 4.6 shows total migrant trip productions and attractions per month by each province. These are total person trips. In this study migrant workers were defined as workers who use public transport to visit another home in another district, at least once a month.

Table 4.6: Migrant Trip Productions And Attractions (Total Person Trips Per Month) Per Province

	Productions			Attractions		
Province	**Low income**	**Middle income**	**High income**	**Low income**	**Middle income**	**High income**
Eastern Cape	32 638	5 929	3 414	144 187	10 447	12 740
Free State	38 322	3 160	4 271	71 208	11 038	5 902
Gauteng	363 987	81 981	48 907	69 817	14 877	30 643
Gauteng	121 058	18 979	11 167	150 761	26 290	15 638
KwaZulu Natal	25 614	3 345	5 718	109 700	25 309	9 780
Mpumalanga	38 401	4 277	6 637	77 254	26 014	8 862
North West	36 506	4 386	12 802	73 617	9 455	7 775
Northern Cape	13 307	1 204	1 907	20 531	5 283	2 788
Western Cape	90 842	22 409	12 778	43 599	16 958	13 473
TOTAL	**760 674**	**145 670**	**107 601**	**760 674**	**145 670**	**107 601**

Just over one million persons trips were generated per month for migrant trips. Seventy five per cent of migrant trips were made by the low income group. Gauteng produced nearly fifty per cent of all migrant trips. The biggest attractors for migrant trips are KwaZulu Natal (19%) and Eastern Cape (17%).

Table 4.7 shows total holiday trip productions and attractions per year by each province. These are total person trips.

Fourteen million person trips were generated in the base year. Seven and a half million of these trips were made by the low income group. Gauteng produced the most holiday trips in a year (20%). KwaZulu Natal is the biggest attractor of holiday trips, attracting almost thirty per cent of all holiday trips.

KwaZulu Natal, Western Cape and North West attracts more holiday trips than it produces, creating an inflow to these provinces.

Table 4.7: Holiday Trip Productions And Attractions (Total Person Trips Per Year) Per Province

	Productions			Attractions		
Province	**Low income**	**Middle income**	**High income**	**Low income**	**Middle income**	**High income**
Eastern Cape	1 243 276	331 554	373 852	1 243 276	174 681	251 168
Free State	568 980	145 946	137 467	568 980	42 795	61 534
Gauteng	1 238 273	759 617	1 563 360	1 238 273	780 651	1 122 472
Gauteng	1 569 905	398 392	554 068	1 569 905	928 367	1 334 868
KwaZulu Natal	876 554	224 349	227 794	876 554	45 594	65 558
Mpumalanga	617 297	179 687	206 426	617 297	94 702	136 169
North West	588 229	180 663	181 112	588 229	159 638	229 538
Northern Cape	164 049	57 776	64 934	164 049	26 915	38 701
Western Cape	619 157	402 167	544 687	619 157	426 807	613 692
TOTAL	**7 485 721**	**2 680 151**	**3 853 700**	**7 485 721**	**2 680 151**	**3 853 700**

4.1.3.3 Target Year Results

Trip generation results are currently being prepared for:

- Middle growth scenario:
- 2010
- 2020
- 2030
- 2040
- 2050
- High growth scenario:
- 2030
- 2050
- Low growth scenario:
- 2030
- 2050

The results are summarised in Tables 4.8 to Table 4.16

Table 4.8: Trip Generation Results: Middle Scenario 2010

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5,153,652	272,189	46,947	1,981,148	4,365,762	291,735	187,993	1,762,842
Free State	3,279,323	154,346	48,980	853,586	3,048,313	185,980	99,894	698,068
Gauteng	15,055,394	1,638,713	585,454	4,170,123	18,434,474	1,418,032	145,333	3,657,532
KwaZulu Natal	9,278,925	535,749	172,960	2,550,950	8,416,974	548,435	209,212	4,414,476
Limpopo	4,583,618	191,104	41,505	2,181,539	3,888,756	244,017	177,121	1,058,387
Mpumalanga	4,288,691	239,364	56,438	1,050,789	3,818,663	250,115	131,223	922,331
North West	4,518,916	228,768	58,446	982,516	3,478,566	270,513	104,898	1,076,549
Northern Cape	1,027,096	58,029	18,189	301,201	947,447	73,098	33,439	247,959
Western Cape	6,264,671	531,757	150,197	1,712,847	7,051,332	568,093	90,003	1,946,555
TOTAL	**53,450,285**	**3,850,020**	**1,179,116**	**15,784,699**	**53,450,285**	**3,850,020**	**1,179,116**	**15,784,699**

Table 4.9: Trip Generation Results: Middle Scenario 2020

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5 244 668	315 868	58 872	2 025 855	4 913 847	345 982	231 244	1 758 529
Free State	3 305 938	168 432	59 798	851 789	3 076 171	208 520	125 373	695 676
Gauteng	17 750 115	2 091 948	772 837	4 531 778	21 007 258	1 799 537	192 415	3 760 830
KwaZulu Natal	9 909 831	601 763	222 000	2 642 227	9 085 359	662 271	272 177	4 455 503
Limpopo	4 829 070	260 003	54 208	1 580 767	4 155 533	287 672	218 807	1 148 413
Mpumalanga	4 605 788	277 207	71 753	1 166 918	4 088 294	296 011	182 425	979 441
North West	4 572 803	258 746	71 352	1 047 621	3 614 364	305 857	137 846	1 097 076
Northern Cape	1 126 437	67 888	22 838	331 002	1 006 815	86 303	45 073	257 817
Western Cape	7 532 981	658 932	197 203	1 974 481	7 929 990	708 632	125 501	1 999 154
TOTAL	**58 877 630**	**4 700 786**	**1 530 861**	**16 152 438**	**58 877 630**	**4 700 786**	**1 530 861**	**16 152 438**

Table 4.10: Trip Generation Results: Middle Scenario 2030

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5 383 993	368 526	75 560	1 844 497	5 308 708	403 567	259 900	1 744 552
Free State	3 451 651	190 843	75 727	865 316	3 173 540	236 519	160 111	718 161
Gauteng	20193 515	2 507 169	982 352	5 388 495	23 510 51	2 144 080	282 711	4 190 949
KwaZulu Natal	10 647 52	677 375	285 369	2 815 228	9 855 469	783 183	348 452	4 964 728
Limpopo	4 962 777	299 841	68 875	1 735 090	4 409 291	330 887	269 713	1 253 925
Mpumalanga	4 964 816	322 864	91 134	1 313 067	4 375 245	343 248	227 489	1 095 119
North West	4 760 341	297 895	88 909	1 133 866	3 847 998	346 219	166 888	1 205 452
Northern Cape	1 246 600	80 686	29 482	359 905	1 102 495	101 312	56 252	279 075
Western Cape	8 957 485	799 398	257 545	2 271 427	8 985 634	855 581	183 437	2 274 929
TOTAL	**64 569 31**	**5 544 596**	**1 954 952**	**17 726 91**	**64 569 31**	**5 544 596**	**1 954 952**	**17 726 91**

Table 4.11: Trip Generation Results: Middle Scenario 2040

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5 542 329	409 565	89 558	1 850 303	5 671 080	447 154	286 924	1 820 215
Free State	3 607 065	208 228	88 806	848 388	3 265 065	258 458	176 399	723 829
Gauteng	22 512 821	2 835 386	1 147 382	6 355 996	25 601 321	2 409 894	374 942	4 677 264
KwaZulu Natal	11 218 036	738 856	338 680	2 941 856	10 552 446	875 500	405 712	5 485 210
Limpopo	5 017 505	326 526	80 218	1 834 211	4 609 259	359 004	317 188	1 337 239
Mpumalanga	5 251 449	357 641	107 000	1 431 245	4 628 905	378 582	249 720	1 207 393
North West	5 001 672	328 836	103 708	1 189 024	4 068 921	379 414	194 236	1 304 889
Northern Cape	1 324 493	89 270	34 793	409 991	1 181 348	111 791	71 471	315 025
Western Cape	10 220 312	921 021	313 394	2 565 977	10 117 338	995 534	226 948	2 555 928
TOTAL	**69 695 682**	**6 215 331**	**2 303 539**	**19 426 992**	**69 695 682**	**6 215 331**	**2 303 539**	**19 426 992**

Table 4.12: Trip Generation Results: Middle Scenario 2050

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5 597 477	406 934	91 254	1 785 205	5 193 822	446 979	274 908	1 835 283
Free State	3 621 771	204 188	89 563	790 973	3 303 297	255 251	163 244	703 899
Gauteng	24 102 726	2 884 380	1 183 351	7 270 455	27 260 926	2 479 832	430 875	5 185 697
KwaZulu Natal	11 452 293	750 774	346 472	2 991 118	11 085 185	883 749	406 842	5 798 843
Limpopo	5 005 593	321 033	80 325	1 836 894	4 732 911	352 912	315 223	1 369 336
Mpumalanga	5 331 303	354 675	107 949	1 494 990	4 793 696	375 507	259 498	1 287 088
North West	5 082 609	324 273	104 676	1 197 914	4 173 001	377 013	194 418	1 360 242
Northern Cape	1 369 521	88 548	35 649	440 152	1 227 173	112 696	69 113	341 921
Western Cape	10 803 715	956 866	322 377	2 840 869	10 596 997	1 007 734	247 496	2 766 261
TOTAL	**72 367 008**	**6 291 672**	**2 361 617**	**20 648 570**	**72 367 008**	**6 291 672**	**2 361 617**	**20 648 570**

Table 4.13: Trip Generation Results: High Scenario 2030

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	4 701 976	480 429	83 249	5 711 975	4 716 046	446 077	355 266	2 857 629
Free State	3 192 969	228 198	82 591	756 092	3 031 104	258 209	148 489	693 711
Gauteng	23 890 678	3 125 692	1 243 380	6 866 601	27 672 190	2 716 665	377 661	7 775 622
KwaZulu Natal	10 798 127	709 422	317 622	2 978 846	9 892 017	876 143	433 168	3 342 643
Limpopo	4 812 004	316 689	75 117	1 540 327	4 232 833	360 449	310 674	1 248 057
Mpumalanga	5 057 930	350 612	100 821	1 291 394	4 327 703	383 157	249 964	1 379 515
North West	4 663 861	315 668	96 072	931 283	3 760 524	376 217	162 688	1 547 620
Northern Cape	1 297 614	89 334	32 588	362 997	1 124 827	113 342	63 575	355 804
Western Cape	9 807 555	892 737	288 902	2 614 995	9 465 470	978 522	218 859	3 853 911
TOTAL	**68 222 714**	**6 508 780**	**2 320 342**	**23 054 511**	**68 222 714**	**6 508 780**	**2 320 342**	**23 054 511**

Table 4.14: Trip Generation Results: High Scenario 2050

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5 437 172	424 690	96 118	5 442 259	5 127 960	450 990	490 505	3 432 196
Free State	2 991 838	216 049	91 010	443 937	3 008 688	245 634	86 908	544 508
Gauteng	31 625 240	3 312 230	1 503 175	9 639 053	34 421 042	3 005 828	603 199	9 821 752
KwaZulu Natal	11 686 905	784 476	373 307	3 209 879	11 348 007	920 198	458 859	3 704 958
Limpopo	4 614 952	319 332	82 113	1 143 411	4 391 953	344 850	205 366	1 035 945
Mpumalanga	5 328 582	373 094	114 129	1 346 607	4 736 985	384 335	237 778	1 493 724
North West	4 823 536	328 615	107 901	708 802	3 994 871	373 695	118 813	1 522 443
Northern Cape	1 459 069	93 184	38 068	1 639 869	1 268 441	117 487	262 384	1 056 903
Western Cape	11 727 384	1 060 122	349 474	3 609 144	11 396 730	1 068 776	291 485	4 570 532
TOTAL	**79 694 677**	**6 911 793**	**2 755 295**	**27 182 961**	**79 694 677**	**6 911 793**	**2 755 295**	**27 182 961**

Table 4.15: Trip Generation Results: Low Scenario 2030

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5 591 827	313 218	60 186	2 272 347	4 428 850	325 231	221 750	2 131 435
Free State	3 178 825	182 603	59 562	880 169	2 996 707	185 682	119 033	715 297
Gauteng	15 288 471	1 690 811	762 835	4 569 311	20 102 597	1 578 423	198 591	4 768 179
KwaZulu Natal	10 244 773	604 837	224 447	2 978 841	9 221 430	612 874	287 924	2 845 123
Limpopo	5 231 064	262 883	54 942	1 877 513	4 306 500	269 721	223 532	1 430 080
Mpumalanga	4 808 041	270 883	71 609	1 276 089	4 110 774	268 897	173 854	1 191 343
North West	4 533 789	242 909	70 339	1 099 375	3 483 270	271 097	125 874	1 348 920
Northern Cape	1 170 626	64 795	23 211	325 619	977 671	78 779	41 076	296 041
Western Cape	7 324 845	600 150	200 222	1 996 742	7 744 463	642 386	135 720	2 549 588
TOTAL	**57 372 262**	**4 233 090**	**1 527 353**	**17 276 006**	**57 372 262**	**4 233 090**	**1 527 353**	**17 276 006**

Table 4.16: Trip Generation Results: Low Scenario 2050

	Productions				Attractions			
Province	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Eastern Cape	5 710 459	323 332	65 995	2 531 172	4 691 687	327 187	232 998	2 406 395
Free State	3 291 559	184 104	64 018	884 211	3 035 276	182 194	119 737	754 307
Gauteng	16 488 369	1 641 307	838 003	5 000 473	21 175 890	1 622 473	229 741	5 222 678
KwaZulu Natal	10 789 732	643 776	245 902	3 437 785	9 945 593	625 838	308 395	3 279 858
Limpopo	5 319 752	271 817	58 494	2 396 630	4 629 353	264 744	271 840	1 852 038
Mpumalanga	5 090 269	280 873	76 854	1 512 591	4 372 643	267 092	181 024	1 404 605
North West	4 638 032	243 334	75 081	1 199 498	3 574 305	265 581	130 562	1 487 981
Northern Cape	1 221 945	64 422	25 327	424 377	1 006 871	78 237	47 149	374 067
Western Cape	8 189 160	648 821	224 959	2 151 422	8 307 658	668 441	153 189	2 756 230
TOTAL	**60 739 278**	**4 301 786**	**1 674 633**	**19 538 158**	**60 739 278**	**4 301 786**	**1 674 633**	**19 538 158**

4.1.3.4 Data Problems and Shortcomings

During the trip generation process some problems were encountered with the available data. These problems are listed in **Annexure C**.

4.2 FREIGHT MODEL

4.2.1 Introduction

Trip generation for the freight model is based on the tonnage of freight moved between town/districts, thus ignoring urban distribution tonnage and much of the short hauled freight movement with the emphasis being placed on the main commodity groupings and major national corridor and parallel provincial routes. The estimates for overall annual road freight tonnes moved in South Africa is approximately 1.4 billion tonnes (CSIR) whereas NATMAP has focused on approximately 400 million tonnes of long distance cargo [181 million on road and 182 on rail] on the main corridors. It is noteworthy that StatsSA reports approximately 568.5 million tonnes p.a. of land freight with no indication of the proportions by corridor or mode (P7162 – Feb 2009)

4.2.2 Methodology

A comprehensive model of the freight transport systems of the country has been created from the available data, covering ports, road corridors, rail corridors, pipeline transport and air cargo. The information has been gleaned from a variety of sources:

- **Rail freight data** was obtained from Transnet, covering all movements for the financial year 2005.

- **Road freight data** has been collated from the various provincial databanks [2005-2007] and then adapted and updated with industry information, press reports, road count information and import-export data.
- **Ports information** has been obtained from Transnet National Ports Authority [TNPA] for all commodity movements through all ports, from 2003 -2008.
- **Pipeline data** was obtained from Transnet for 2006 and has been adapted from press reports of later developments.
- **Air Cargo information** has been obtained from ACSA and various sources.

The information has been integrated into a model of the freight system of the country in which the origins and destinations of cargo movements are defined into a national matrix of 145 zones that cover the whole country and include transport to and from neighbouring states. A system of 15 major commodity groups has been used for the land transport modes in order to make the model manageable and to provide comparability between the modes. Production and attraction derived from the data sources indicated above were correlated with land use data, population data and published sources of information. The commodities and the total tonnages produced and attracted are tabled in Table 4.17.

Table 4.17: Total tonnage transported by commodity for the base year 2005

Commodity	**Production**	**Attraction**
Grain	18 644 830	18 803 803
Crop	6 015 974	6 021 161
Agriculture	5 581 609	6 005 470
Coal	76 990 351	101 644 975
Cement	11 646 619	12 116 113
Drink/Beverages	3 293 113	3 133 105
Fuel	15 579 314	15 647 622
Iron/Steel	11 853 666	9 674 504
Chemicals	3 892 092	3 987 463
Machines/Vehicles	3 908 411	3 955 287
Other	27 706 865	27 658 327
Perishables	7 162 556	7 165 748
Rock/Stone	45 664 203	43 004 065
Containers	25 673 507	24 489 775
Wood	9 492 432	10 907 171
Total	273 105 543	294 214 589

Coal is the commodity produced the most in terms of tonnage followed by rock/stone emphasising the importance of commodities in the South African economy.

4.2.3 Target Year Results

Estimates for future production and attractions were calculated for the middle scenario only due to a time constraint resulted as a result of negotiations with Transnet to obtain input from their model. The expected growth per commodity transported over long distances was done for the target years 2010, 2020, 2030, 2040 and 2050. The expected growth in production per commodity is tabulated in Table 4.16 and the expected growth in attraction in Table 4.17. An increase in the growth rate is expected up to 2020, a decrease in growth rate up to 2030, in increase up to 2040 and a decrease in the expected growth rate up to 2050. A detail explanation is of the expected growth per commodity and the factors impacting on the growth is discussed in the Phase 3 report, Chapter 6.

Table 4.18: Expected growth in freight production (2005 – 2050)

	2005		2010		2020		2030		2040		205 0	
Commodity	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth
Grain	18644830	-	19787601	6	23752062	20	29930251	26	33401891	11	39426451	18
Crop	6015974	-	5793607	-4	6108594	5	8209440	34	9407346	14	9446558	0
Agriculture	5581609	-	5508224	-2	6101541	10	7057014	15	8565181	21	9713471	13
Coal	76990352	-	87038588	13	122075829	40	135541661	11	146418730	8	158824050	8
Cement	11646619	-	11575201	-1	14110105	21	18442804	30	21404908	16	28461564	32
Drink/Beverages	3293113	-	4776210	45	4705394	-2	5429531	15	7788587	43	9382142	20
Fuel	15579314	-	19618208	25	20873251	6	28183265	35	34184637	21	41443327	21
Iron/Steel	11853666	-	12203032	2	15788495	29	18317153	16	20180021	10	21893523	8
Chemicals	3892092	-	3684435	-6	4662237	26	5741519	23	6941775	20	8839766	27
Machines/Vehicles	3908411	-	4369287	11	6323246	44	7840015	23	9292941	18	11187222	20
Other	27706865	-	31301673	12	56286355	79	64153325	13	99649841	55	111541923	11
Perishables	7162556	-	7770934	8	9614743	23	12921410	34	17365295	34	23337504	34
Rock/Stone	45664203	-	47498232	4	60936626	28	75236367	23	83792497	11	88629891	5
Containers	25673507	-	31685599	23	38815698	22	51363538	32	70615616	37	103038645	45
Wood	9492432	-	11444472	20	12931473	12	14478591	11	15670433	8	17050629	8
Total	273105543	-	304055303	11	403085649	32	482845884	19	584679699	21	682216666	16

Table 4.19: Expected growth in freight attraction (2005 – 2050)

	2005		2010		2020		2030		2040		205 0	
Commodity	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth	Tonnage	% growth
Grain	18803803	-	19746659	5	24007139	21	30284824	26	33730123	11	39855542	18
Crop	6021161	-	5802813	-4	6125057	5	8231565	34	9429901	14	9483691	0
Agriculture	6005470	-	6663874	10	7321006	9	8450174	15	10275871	21	11751132	14
Coal	101644975	-	115126077	13	160954822	39	176880375	9	190574879	7	203678999	6
Cement	12116113	-	12070903	-1	14738315	22	19181476	30	22086699	15	29315933	32
Drink/Beverages	3133105	-	4574063	45	4514219	-2	5208133	15	7477517	43	9020275	20
Fuel	15647622	-	19775297	26	21116062	6	28517322	35	34581800	21	41914061	21
Iron/Steel	9674504	-	10065434	4	13017063	29	15434631	18	17059631	10	18658992	9
Chemicals	3987463	-	3637174	-9	4795353	31	5881772	22	7073174	20	8980274	26
Machines/Vehicles	3955287	-	4480641	13	6547592	46	8139444	24	9649675	18	11594396	20
Other	27658327	-	31279103	13	56163009	79	63989889	13	99366377	55	111146165	11
Perishables	7165748	-	8034783	12	9941195	23	13360135	34	17954904	34	24129890	34
Rock/Stone	43004065	-	44828056	4	57485214	28	70923599	23	79023266	11	83606631	5
Containers	24489775	-	30514159	24	37343857	22	49797036	33	69012865	38	101431061	46
Wood	10907171	-	12860763	17	14111349	9	15971395	13	17004312	6	18271073	7
Total	**294214589**	**-**	**329459799**	**11**	**438181252**	**32**	**520251770**	**18**	**624300994**	**19**	**722838115**	**15**

5 TRIP DISTRIBUTION

Trip distribution is where the origin-destination pattern of travel is determined. The result of a trip distribution model is a trip matrix.

5.1 PASSENGER MODEL

The number of person trip ends occurring within the study area was forecast during the Trip Generation step of the traditional four-step modelling approach as follows:

- Work trips per week
- Business trips per month
- Migrant trips per month
- Holiday trips per annum

Multiple linear regression analyses were carried out to develop equations for estimating trip productions and trip attractions by traffic zone for each trip purpose per income group.

Although trip productions and attractions provide an idea of the level of trip making, they give no insight into the pattern of trip making within a particular study area. The second step in the modelling process, i.e. Trip Distribution, involves the distribution of trips between origin zones and destination zones. It is customary to represent the trip patterns in a study area by means of origin-destination (O-D) trip matrices.

This report discusses the type of Trip Distribution model chosen, the methodology followed in developing the model, the calibration and validation of the model, and the results obtained for the future year scenarios.

5.1.1 Model Description

Different types of trip distribution models have been developed over the years to distribute trips among origin-destination (O-D) pairs. Models range from the simpler (e.g. growth-factor models), which are suitable for short-term studies where no major changes are envisaged in the accessibility provided by the network, to the more complex (e.g. synthetic models), which respond better to changes in network cost and are therefore suitable for longer-term strategic studies.

As opposed to growth-factor models, which apply growth rates to observed trip matrices to estimate future trip patterns, synthetic models estimate trips for each cell in the matrix without directly using the observed trip pattern. They make assumptions about group trip making behaviour and the way this is influenced by external factors (i.e. total trip ends and travel distance). The best known of the synthetic models is the Gravity Distribution model.

The Gravity Distribution model was used in this study. Both growth factor and synthetic models are discussed in short. Due to the shortcomings of growth factor models that are particularly relevant to this study, the Gravity Distribution model was used in this study.

5.1.1.1 Growth Factor Models

Growth-factor models are simple to understand and make direct use of observed trip matrices and forecasts of trip end growth. They preserve the observations as much as is consistent with the information available on growth rates. The future year trip matrix can be derived from the base year trip matrix so that its row and column totals match the future trip ends. The simplest model for doing this is the Furness distribution model. This operates as shown below where a cell of the matrix is the number of trips from one origin zone to one destination zone as follows:

- The base year matrix cells for one row are multiplied by the growth for that zone and all rows are done in turn. The matrix so obtained will have its origin trip ends matching the future year origin trip ends which are what we wanted to achieve, however the column totals will not in general match the future year destination trip end so:

- The matrix cells for each column are multiplied by the ratio of the future year destination trip end to the column total achieved in 1 above so that the resulting matrix will have its column total matching its future year destination trip end.

- However its row total will not generally match its future year origin trip end so steps 1 and 2 are repeated successively until the row and column total are both close to the future year origin and destination trip ends. The process stops when they are close enough (e.g. to within a few trips). This method is often used for the external to external movements or for forecasting goods vehicles and freight.

Growth factor models have some shortcomings that are specifically applicable in this study:

- They are suitable for short-term studies where no major changes are envisaged in the accessibility provided by the network. Since this model has a 50 year horizon, this is a major concern.
- The methods are heavily based on the accuracy of the base-year trip matrix (from the travel survey). The accuracy of individual cell entries is never very high especially in this case where a very small sample was used to estimate the base-year matrices.
- If parts in the base-year matrix are unobserved, they will remain so in the forecasts.
- They are of limited use in the analysis of policy options involving new links or modes.

5.1.2 Synthetic models

Synthetic models estimate trips for each cell in the matrix without directly using the observed trip pattern. They make assumptions about group trip making behaviour and the way this is influenced by external factors (i.e. total trip ends and travel distance).

5.1.2.1 Gravity model

The gravity distribution is the best known synthetic model, originally generated from an analogy with Newton’s gravitational law. Gravity models estimate trips for each cell in the matrix without directly using the observed trip pattern. It is a mathematical model for calculating the trip distribution. It is based on the assumption that the trips made in a planning area are directly proportional to:

- the relevant origin and destination demand in all zones and

- the functional values of the utility function between the zones.

The Gravity model works with distribution parameters, i.e. with values within the utility function, which map the reaction of road users to distance and time relations.

The model can be expressed mathematically as follows:

$$T_{ij} = \alpha P_i A_j f(C_{ij})$$

Where	T_{ij}	=	number of trips between origin i and destination j
	α	=	proportionality factor
	P_i	=	total number of trip productions at zone i
	A_j	=	total number of trip attractions at zone j
	$f(C_{ij})$	=	deterrence function

The deterrence function represents the disincentive to travel as distance (time) or cost increases. A deterrence function estimated from the calibrated base year is assumed to capture underlying travel behaviour and to be stable in future to allow its use in forecasting. The deterrence function used in this study can be expressed as follows:

$$f(C_{ij}) = \alpha x^{C_{ij}} e^{(cC_{ij})}$$

Where	Cij	= value for the utility or cost between zones, e.g. distance from zone i to zone j
	a, b, c	= calibration parameters, calculated during the gravity model calibration

5.1.2.2 Intervening Opportunities Model

The basic idea behind this model is that trip making is not explicitly related to distance but to the relative accessibility of opportunities for satisfying the objective of the trip. However this model is not often used in practice, probably for the following reasons:

- The theoretical basis is less well known;
- The idea of matrices ranked by distance from origin is more difficult to handle in practice; and
- Mainly because the theoretical and practical advantages of this function over the gravity model are not overwhelming

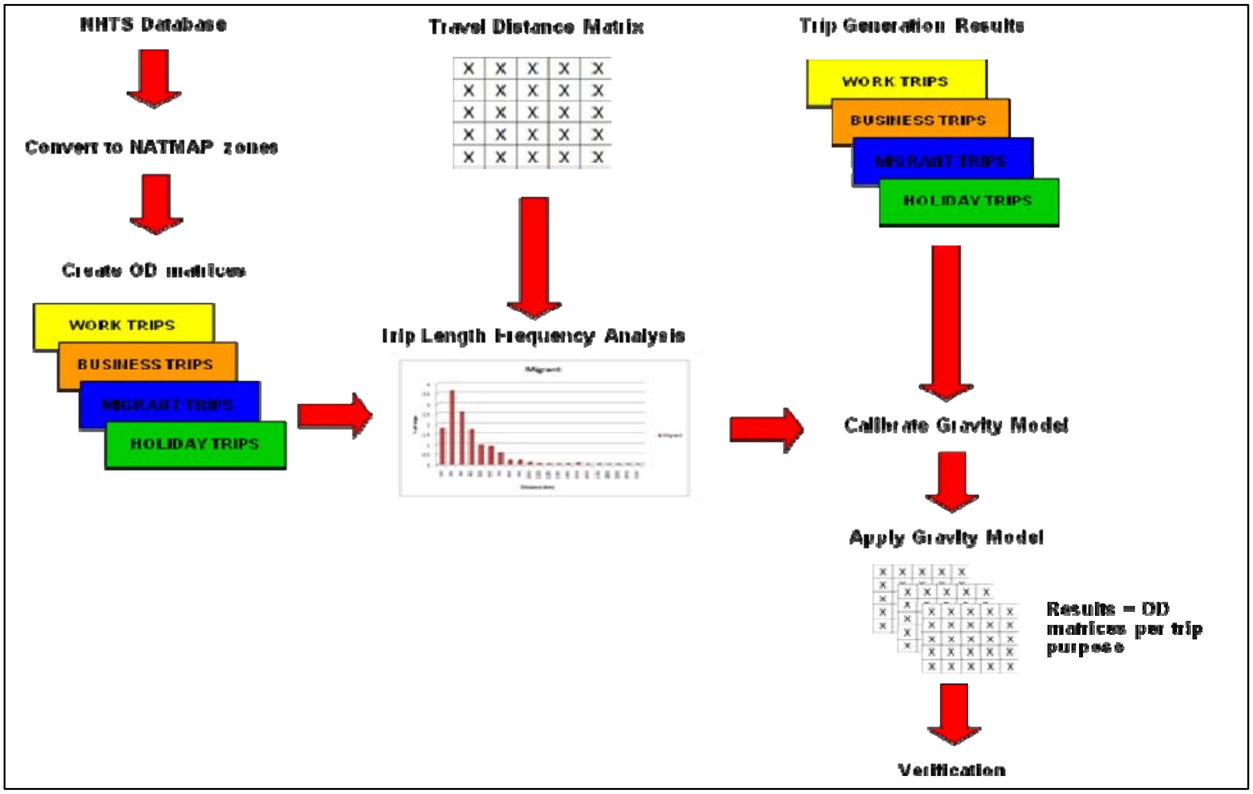
5.1.3 Methodology

The estimation of a gravity model essentially involves the estimation of the deterrence function. **Figure 5.1** shows the methodology diagrammatically. Input data include:

- Observed trip matrices
- Distance matrix
- Trip generation results

The observed trip matrices are classified in distance classes to obtain trip length frequency distributions (TLFDs). These TLFDs together with the trip ends (trip generation results) are then used in the estimation of the deterrence function (also gravity model calibration). The resulting parameters and trip ends are then applied to the distance matrix to obtain the resulting OD matrices per income group and trip purpose. Each step is described in more detail in the following sections.

Figure 5.1: Trip Distribution Methodology



5.1.4. Input Data

5.1.4.1 Observed Trip Matrices

Observed trip matrices were created from the travel survey database for each trip purpose and income group. This process involved the conversion of travel survey origins and destinations to NATMAP origins and destinations the 12 trip purpose and income combinations:

The travel survey only captured the last destination of a specific trip purpose. In the trip generation process total trips was generated. In order to create observed trip matrices for all trips one had to assume that for instance all business trips made by a person had the same destinations as his last business trip. This is not very accurate. Thus only the last trip was used, i.e. the observed trip matrices only contained trips where a destination was captured.

5.1.4.2 Distance Matrix

A distance matrix was generated from the full road network. Intra-zonal distance (the diagonal) was assumed to be equal to half the distance to the nearest neighbouring zone.

Two trip purposes had specific definitions according the travel survey, which affected trip distribution:

- Business trips are longer than <u>200km</u>.
- Migrant trips are public transport trips to another home in <u>another district</u>.

To apply these restrictions, the following adjustments were made to the distance matrix for trip distribution of these trip purposes:

- All distances shorter than 200km = 9999

- All intra-district distances = 9999

5.1.4.3 Trip Generation Results

The number of person trip ends occurring within the study area was forecast during the Trip Generation step of the traditional four-step modelling approach as follows:

- Work trips per week per income group
- Business trips per month per income group
- Migrant trips per month per income group
- Holiday trips per annum per income group

5.1.5 Trip Length Frequency Analysis

The observed trip matrices were classified in distance classes to obtain trip length frequency distributions. The following section briefly describes the trip length frequency of each trip purpose combined with income category.

5.1.5.1 Work Trips

Figure 4-2 shows the trip length frequency distributions for work trips. This is a typical trip length distribution often found in modelling of urban areas. There are few short trips followed by a larger number of medium trips and as distance increases the number of trips decreases with very few long distance trips.

More than 70 per cent of all work trips are 40 kilometres or shorter. Less than 7 per cent are longer than 80 kilometres.

The graphs reveal slightly different characteristics between the three income groups. On average the work trips made by the lower income group is slightly longer (42km) than the middle (38km) and high (35km) income groups. Only 25 per cent of the low income group travels 20 kilometres or less to work, whereas almost 40 per cent of the high income group travels 20 kilometres or less to work.

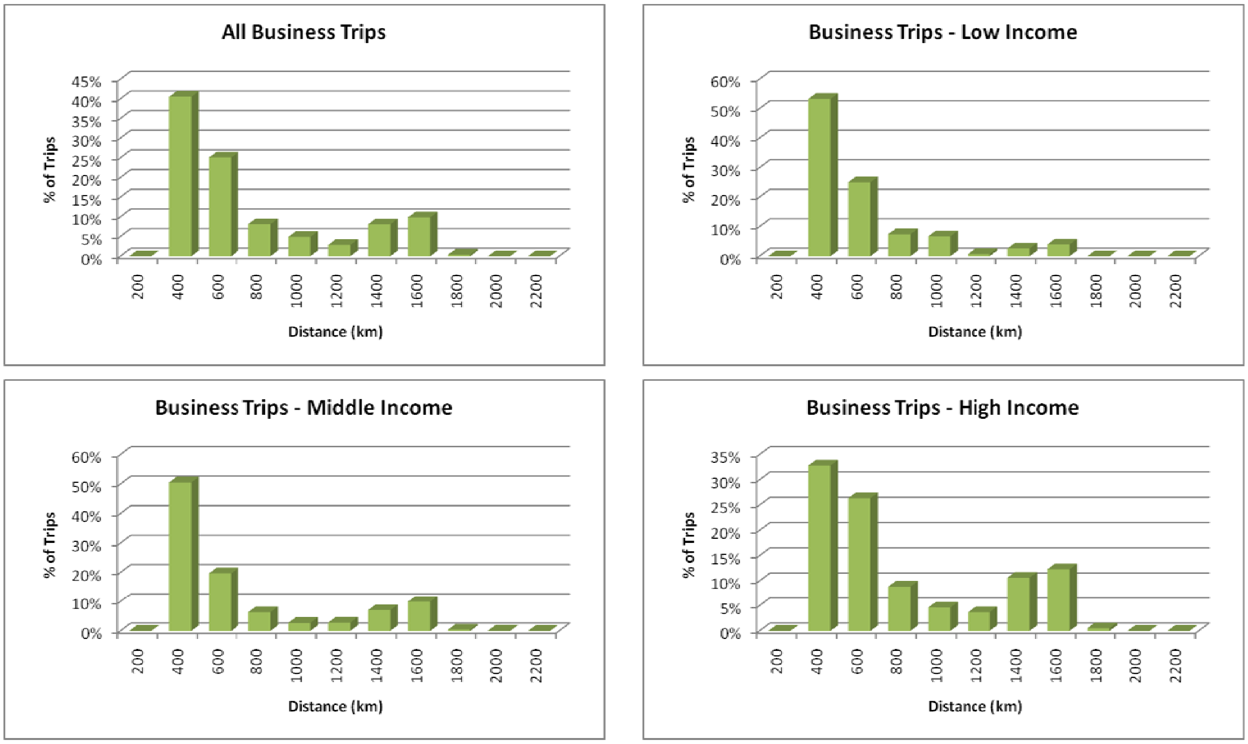
Figure 5.2: Trip Length Frequency Distributions For Work Trips

Different types of trip distribution models have been developed over the years to distribute trips among origin-destination (O-D) pairs. The two models that will be applied here are a synthetic (or gravity) model and growth factor model.

5. 1.5.2 Business Trips

The trip length frequency distribution of business trips (Figure 4-3) shows that there are no short trips; this is due to the definition of business trips in the travel survey which recorded only business trips longer than 200km. There are many intermediate trips, few long trips and a larger number of long distance trips.

Figure 5.3: Trip Length Frequency Distributions For Business Trips



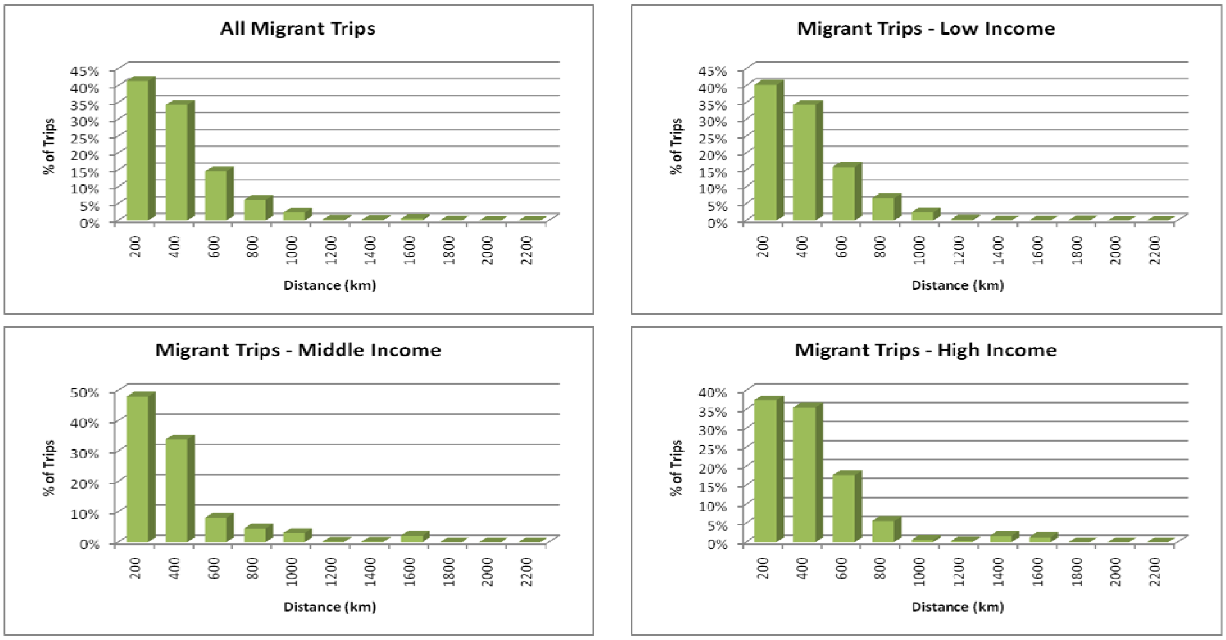
Low income business trips are mainly intermediate trips with 78 per cent of trips being between 200 and 600 kilometres with very few (7%) longer than 1,000 kilometres. A large number of middle income business trips are also between 200 and 600 kilometres (70%), but 20 per cent are longer than 1000 kilometres. Fewer high income business trips are between 200 and 600 kilometres (60%). A large number (30%) are longer than 1,000 kilometres.

The difference in average trip length is quite significant with 490 kilometres for the low income group and 710 kilometres for the high income group.

5. 1.5.3 Migrant Trips

The trip length frequency distributions for migrant trips are similar for the three income groups. There are a high number of shorter trips, fewer intermediate trips and even less long distance trips. The average trip lengths for low, middle and high income groups are 296, 287 and 326 kilometres respectively.

Figure 5.4: Trip Length Frequency Distributions For Migrant Trips



5.1.5.4 Holiday Trips

On average the holiday trips follows a typical trip length pattern where there are many shorter trips, fewer intermediate trips and even fewer shorter trips. There are however differences in the trip distribution characteristics of the three income groups. The trip length frequency distributions for the different income groups for holiday trips are shown in Figure 4-5.

Low income holiday trips are mainly shorter trips with 70 per cent of trips being shorter than 400 kilometres with very few (4%) longer than 1,000 kilometres. A large number of middle income holiday trips are shorter and intermediate trips with 60 per cent shorter than 400km and 33 per cent between 400km and 1,000km. Fewer high income holiday trips are shorter than 400 kilometres (41%). A large number (15%) are longer than 1000 kilometres.

The difference in average trip length is quite significant with 336 kilometres for the low income group and 564 kilometres for the high income group.

Figure 5.5: Trip Length Frequency Distributions For Holiday Trips

5.1.6 Calibrate Gravity Model

Before using a gravity distribution model it is necessary to calibrate it; this just makes sure that that its parameters are such that the model comes as close as possible to reproducing the base-year trip pattern (Ortuzar & Willumsen, 1990).

Calibration is, however a very different process from validation of a model. The parameters are calibrated during the estimation of the gravity model as part of the direct effort to satisfy the constraints.

The validation task is different. In this case one wants to make sure the model is appropriate for the decisions likely to be tested with it.

The distribution parameters were determined in Muuli+ where the Kalibri function was used to adjust the utility function to a given trip length distribution. The function requires as input a skim matrix (travel time / distance / generalised cost), in this case a distance matrix, zone productions and attractions and the trip length frequency distributions for each trip purpose and income combination.

The deterrence function used in this study can be expressed as follows:

$$f(C_{ij}) = \alpha x^{C_{ij}} e^{(cC_{ij})}$$

Where Cij = value for the utility or cost between zones, e.g. distance from zone i to zone j

a, b, c = calibration parameters, calculated during the gravity model calibration

Table 5.1 shows the results of the gravity model calibration. The quality of calibration is also indicated, 1 indicates a very good quality, thus, the closer to 1 the better the calibration.

Table 5.1: Results Of Gravity Model Calibration

Trip Purpose	Income Group	Gravity Parameters			Quality of calibration
		a	b	c	
Work	Low	6.4266	0.7333	0.0383	0.69
Work	Mid	1.0809	0.0095	0.0475	0.83
Work	High	5.0901	0.6665	0.0370	0.81
Business	Low	1.3234	0.0000	0.0032	0.46
Business	Mid	0.6285	0.0000	0.0018	0.54
Business	High	0.3075	0.0000	0.0008	0.77
Migrant	Low	0.8522	0.0000	0.0041	0.85
Migrant	Mid	0.7251	0.0000	0.0035	0.28
Migrant	High	0.5567	0.0000	0.0025	0.87
Holiday	Low	4.9705	0.4344	0.0023	0.72
Holiday	Mid	0.3789	0.0000	0.0018	0.75
Holiday	High	0.0075	0.6455	0.0020	0.74

During the calibration process, attraction balancing factors are also determined. These factors are required so that the boundary conditions of the distribution model can be observed. These factors are listed in Annexure D.

5.1.7 Apply Gravity Model

The gravity model was applied for each trip purpose and income combination, using the parameters determined during the calibration process. The result is 12 full origin destination matrices.

Initial results indicated high intrazonal trips in Soweto, Mabopane, Temba and Centurion. When compared with traffic counts and rail census data, this did not appear to be correct. Upon investigation it was found that the land use information in these areas resulted in these high number of intrazonal trips. As a result of a possible over estimation of job opportunities in Soweto, Mabopane, Temba and Centurion, major adjustments to the gravity parameters were required to obtain fewer intrazonal trips in these zones. The adjustment of gravity parameters was however discarded as an option since it would affect trip distribution of the entire country. Due to the local nature of the problem, it was decided to apply a adjustment factors to work tips in the zones in question to reduce intrazonal trips. The adjustment factors are listed in **Table 5.2**. These factors were also applied to all future work trip matrices.

Table 5.2: Adjustment Factors

Traffic Zone Number	Name	Factor for intrazonal trips	Factor for interzonal trips
70104	Soweto	0.186	2.470
70301	Mabopane	0.215	1.684
70302	Temba	0.438	1.166
70304	Centurion	0.837	1.051

Tables 5.3 to 5.7 summarises the results in aggregated matrices. Matrices were aggregated to provincial level and show the totals for low, middle and high income groups. A summary is as follows:

- Table 5.3: The greater majority of work trips do not cross provincial boundaries (96%). In fact most work trips start and end within the same district (80%). Sixty per cent of those crossing provincial borders enter Gauteng. The largest movements across borders are from North West to Gauteng and Mpumalanga to Gauteng.

- Table 5.4: Only four per cent of business trips start and end in the same province. One should however take note that only business trips longer than 200km were considered due to data restrictions in the NHTS. The biggest flow of business trips across borders is from Gauteng to KwaZulu Natal, it constitutes 11 per cent of all business trips, followed by the movement from Gauteng to the Western Cape (9%).

- Table 5.5: Almost a third of migrant trips start and end in the same province. The biggest migrant movement across borders is from Gauteng to Limpopo with 10 per cent of all migrant trips and Gauteng to Mpumalanga with 8% of all migrant trips.

- Table 5.6: Almost forty per cent of all holiday trips have their origin and destination within the same province. The biggest movement across provincial borders is from Gauteng to KwaZulu Natal with more than a million person trips annually, followed by almost half a million trips from the Eastern Cape to KwaZulu Natal.

- Table 5.7 shows the average total person trips per day. Different factors are applied to each trip purpose to translate it from trips per week / trips per month / trips per annum to trips per day. Al base year matrices by trip purpose and income groups are added together. Only six per cent of the average total person trips per day cross provincial boundaries

Table 5.3: Total Work Trips (Total Person Trips Per Week) Matrix Aggregated To Provincial Level

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpumalanga	Limpopo
Totals	**50 779 882**	**5 601 839**	**4 974 857**	**935 871**	**3 262 932**	**9 069 075**	**3 959 194**	**14 725 202**	**3 923 772**	**4 327 140**
Western Cape	**5 599 770**	5 597 755	132	1 883	0	0	0	0	0	0
Eastern Cape	**5 009 144**	207	4 936 532	359	28 976	43 071	0	0	0	0
Northern Cape	**965 740**	3 876	750	922 617	23 466	0	15 029	2	0	0
Free State	**3 289 023**	0	16 664	1 869	3 056 015	51 617	13 598	148 071	1 186	4
KwaZulu Natal	**9 048 928**	0	20 779	0	50 965	8 955 877	1	303	21 004	0
North West	**4 524 471**	0	0	9 144	19 863	0	3 827 521	662 253	931	4 758
Gauteng	**13 743 475**	0	0	0	83 133	4	69 642	13 518 597	70 230	1 869
Mpumalanga	**4 148 323**	0	0	0	501	18 504	2 796	326 962	3 678 302	121 258
Limpopo	**4 451 006**	0	0	0	14	2	30 607	69 014	152 119	4 199 251

Table 5.4: Total Business Trips (Total Person Trips Per Month) Matrix Aggregated To Provincial Level

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpumalang a	Limpopo
Totals	**3 556 336**	**551 751**	**290 663**	**76 833**	**205 739**	**598 913**	**265 428**	**1 025 448**	**261 173**	**280 389**
Western Cape	**470 496**	54 656	61 239	14 039	18 083	32 739	36 311	225 250	18 031	10 149
Eastern Cape	**254 833**	55 843	19 214	3 183	8 660	29 797	15 946	107 816	9 420	4 954
Northern Cape	**55 385**	11 812	2 727	847	1 766	3 218	4 793	26 856	2 121	1 247
Free State	**153 055**	15 058	7 653	1 832	3 739	16 939	15 333	76 252	10 363	5 886
KwaZulu Natal	**513 830**	33 944	29 986	3 923	18 580	27 035	39 804	310 876	33 034	16 648
North West	**222 060**	33 126	14 055	5 076	15 829	36 548	10 182	55 915	31 409	19 920
Gauteng	**1 449 690**	317 844	141 768	43 834	121 595	404 074	89 515	560	134 181	196 320
Mpumalanga	**226 021**	19 557	9 513	2 687	11 592	33 437	34 694	90 240	7 362	16 939
Limpopo	**210 966**	9 913	4 508	1 411	5 896	15 127	18 850	131 684	15 252	8 325

Table 5.5: Total Migrant Trips (Total Person Trips Per Month) Matrix Aggregated To Provincial Level

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpumalanga	Limpopo
Totals	**1 013 971**	**72 992**	**146 928**	**27 698**	**90 398**	**185 059**	**91 288**	**127 769**	**116 765**	**155 073**
Western Cape	**126 035**	63 941	35 793	9 935	5 985	3 674	2 612	2 056	942	1 097
Eastern Cape	**41 983**	2 629	27 925	1 007	2 358	5 646	618	788	539	473
Northern Cape	**16 419**	1 440	3 921	1 574	3 019	1 336	2 432	1 254	618	824
Free State	**45 756**	660	10 310	2 328	6 481	8 392	4 878	5 633	3 268	3 806
KwaZulu Natal	**151 211**	633	32 854	1 103	10 303	76 103	3 868	7 645	10 504	8 198
North West	**53 695**	656	3 791	1 998	6 163	6 028	7 243	12 300	6 262	9 255
Gauteng	**494 877**	2 691	28 783	8 981	51 370	71 127	63 500	85 788	80 770	101 868
Mpumalanga	**49 318**	192	2 536	477	3 228	9 520	3 673	7 664	6 847	15 180
Limpopo	**34 677**	151	1 016	295	1 493	3 232	2 464	4 641	7 015	14 371

Table 5.6: Total Holiday Trips (Total Person Trips Per Year) Matrix Aggregated To Provincial Level

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpumalanga	Limpopo
Totals	**14 019 596**	**1 554 099**	**1 637 401**	**209 836**	**661 650**	**3 898 446**	**989 539**	**3 245 071**	**849 421**	**974 133**
Western Cape	**1 566 016**	945 668	145 178	30 638	26 539	175 894	43 865	170 415	17 090	10 729
Eastern Cape	**1 948 684**	178 360	852 478	30 266	84 642	471 171	60 304	200 480	39 360	31 624
Northern Cape	**286 760**	42 531	34 243	25 621	26 056	47 685	32 081	58 227	9 971	10 344
Free State	**852 393**	35 857	85 864	23 661	134 182	205 540	76 448	204 970	44 092	41 780
KwaZulu Natal	**2 522 368**	70 976	242 345	18 722	109 695	1 327 008	104 164	426 115	128 428	94 915
North West	**950 004**	34 692	44 507	23 973	62 423	170 088	186 121	300 284	59 862	68 052
Gauteng	**3 561 257**	199 672	158 386	38 271	135 916	1 030 791	317 608	1 278 224	222 054	180 334
Mpumalanga	**1 003 413**	22 417	36 871	8 247	39 114	239 469	72 395	274 634	171 050	139 217
Limpopo	**1 328 700**	23 926	37 529	10 436	43 080	230 800	96 554	331 723	157 513	397 139

Table 5.7: Average Total Person Trips Per Day Aggregated to Provincial Level

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**9 003 586**	**998 816**	**882 339**	**166 738**	**579 191**	**1 610 359**	**704 187**	**2 596 421**	**696 731**	**768 803**
Western Cape	**997 195**	973 174	4 882	1 511	1 179	2 156	1 910	10 918	919	546
Eastern Cape	**882 631**	3 213	855 629	337	5 734	10 346	927	5 543	566	336
Northern Cape	**170 594**	1 394	529	159 253	4 337	340	3 011	1 452	153	124
Free State	**578 549**	821	3 934	578	527 737	10 627	3 483	29 856	952	561
KwaZulu Natal	**1 597 647**	1 784	7 136	282	10 416	1 552 494	2 293	15 864	5 975	1 402
North West	**795 362**	1 648	942	1 968	4 607	2 424	661 228	118 141	2 056	2 348
Gauteng	**2 468 622**	15 284	8 275	2 533	23 847	24 673	22 368	2 333 946	23 115	14 580
Mpumalanga	**730 636**	969	655	168	875	5 821	2 444	626	635 312	22 765
Limpopo	**782 349**	528	357	107	460	1 477	6 522	19 076	27 683	726 140

5.1.8 Model Validation

In model validation one wants to make sure the model is appropriate for the decisions likely to be tested with it.

A general strategy for validating a model would be to check whether it can reproduce a known state of the system with sufficient accuracy. As the future is unknown, this task is sometimes attempted by trying to estimate some well-documented state in the past, say a matrix from an earlier study. However, it is seldom the case that such a case is well documented and in this case there are no earlier studies. Therefore less demanding validation tests incorporating data not used during the estimation are often employed, for example to check whether the number of trips across important screenlines or along main roads is well reproduced (Ortuzar & Willumsen, 1990). This will be however only be done after modal split and assignment, during the validation process.

Although not scientific, the trip distribution results are compared with the travel survey results for some validation in Annexure E. One should bear in mind that the travel survey matrices are based on a very small sample, therefore it is very likely trips between some OD pairs are overestimated and others underestimated or even omitted.

5.1.9 Target Year Results

Trip matrices are currently being prepared for:

- Middle growth scenario:
- 2010
- 2020
- 2030
- 2040
- 2050
- High growth scenario:
- 2030
- 2050
- Low growth scenario:
- 2030
- 2050

The results are summarised at provincial level in the **Tables 5.8** to **5.16**. These tables are average total person trips per day aggregated to provincial level. Full matrices per zone are available for each trip purpose and income group in the database. In total there are 120 separate OD matrices.

Table 5.8: Middle Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2010

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**9 447 047**	**1 118 395**	**909 428**	**177 562**	**576 715**	**1 654 676**	**698 443**	**2 802 304**	**715 816**	**793 706**
Western Cape	**1 116 163**	1 089 282	5 477	1 669	1 260	2 313	2 007	12 578	987	589
Eastern Cape	**908 662**	3 558	880 802	347	5 562	10 559	919	5 994	577	344
Northern Cape	**181 415**	1 475	552	169 506	4 556	348	3 126	1 564	157	130
Free State	**577 088**	840	3 944	598	524 414	10 751	3 405	31 590	964	582
KwaZulu Natal	**1 639 387**	1 853	7 251	287	10 498	1 592 505	2 267	17 037	6 194	1 496
North West	**795 020**	1 720	955	2 047	4 412	2 452	652 796	126 039	2 127	2 471
Gauteng	**2 666 452**	18 111	9 382	2 826	24 660	27 749	24 158	2 518 332	24 340	16 894
Mpumalanga	**755 909**	1 047	686	173	899	5 902	2 520	67 673	653 285	23 725
Limpopo	**806 951**	509	379	111	455	2 097	7 244	21 497	27 185	747 475

Table 5.9: Middle Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2020

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**10,343,384**	**1,346,791**	**932,585**	**195,661**	**573,342**	**1,778,339**	**699,892**	**3,208,919**	**766,860**	**840,996**
Western Cape	1,343,561	1,310,562	6,615	2,005	1,473	2,753	2,316	15,962	1,173	703
Eastern Cape	927,033	4,268	896,346	393	5,121	11,856	984	7,042	641	380
Northern Cape	199,291	1,663	620	186,128	4,880	402	3,388	1,876	182	152
Free State	582,816	930	4,099	676	522,054	14,486	3,509	35,373	1,040	649
KwaZulu Natal	1,753,704	1,956	10,833	314	7,531	1,704,889	2,339	19,086	5,027	1,728
North West	806,462	1,970	1,061	2,214	4,193	2,774	648,243	140,794	2,413	2,800
Gauteng	3,065,798	23,597	11,826	3,607	26,600	35,250	28,313	2,886,712	28,766	21,127
Mpumalanga	813,342	1,207	775	197	982	4,148	2,755	78,693	699,457	25,129
Limpopo	851,376	637	410	124	509	1,781	8,045	23,379	28,162	788,329

Table 5.10: Middle Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2030

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**11 369 656**	**1 603 028**	**962 101**	**217 467**	**597 618**	**1 917 456**	**724 595**	**3 655 323**	**824 205**	**867 864**
Western Cape	**1 599 212**	1 559 623	7 753	2 436	1 769	3 337	2 691	19 378	1 387	838
Eastern Cape	**953 746**	5 117	921 329	435	4 924	11 699	1 067	8 039	714	423
Northern Cape	**220 982**	1 953	691	206 379	5 242	478	3 600	2 242	216	182
Free State	**609 739**	1 076	4 378	782	542 713	15 291	3 772	39 803	1 174	750
KwaZulu Natal	**1 887 831**	2 238	11 493	359	8 091	1 833 659	2 564	21 831	5 618	1 979
North West	**841 639**	2 287	1 176	2 376	4 254	3 209	665 200	157 178	2 775	3 183
Gauteng	**3 500 515**	28 589	13 953	4 329	28 939	42 953	33 164	3 289 656	33 687	25 245
Mpumalanga	**878 634**	1 410	877	229	1 115	4 793	3 097	89 350	752 041	25 723
Limpopo	**877 357**	735	451	142	570	2 038	9 439	27 846	26 594	809 543

Table 5.11: Middle Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2040

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**12 327 103**	**1 830 553**	**994 271**	**232 099**	**623 005**	**2 025 157**	**756 918**	**4 115 670**	**870 786**	**878 644**
Western Cape	**1 825 908**	1 780 453	8 811	2 908	1 995	3 846	3 055	22 323	1 569	950
Eastern Cape	**983 591**	5 952	949 656	494	4 816	11 501	1 148	8 807	763	454
Northern Cape	**235 188**	2 211	756	219 555	5 505	540	3 676	2 501	239	204
Free State	**637 889**	1 208	4 656	890	565 412	15 985	4 022	43 636	1 260	819
KwaZulu Natal	**1 991 746**	2 518	12 126	410	8 483	1 933 137	2 777	24 104	6 005	2 185
North West	**885 502**	2 593	1 272	2 488	4 381	3 538	690 754	173 955	3 042	3 480
Gauteng	**3 947 759**	33 208	15 562	4 939	30 616	49 126	37 497	3 711 253	37 099	28 458
Mpumalanga	**930 707**	1 594	952	257	1 198	5 284	3 357	96 734	796 017	25 313
Limpopo	**888 813**	816	479	158	599	2 201	10 632	32 356	24 791	816 781

Table 5.12: Middle Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2050

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**12 798 547**	**1 933 223**	**1 003 790**	**239 856**	**622 954**	**2 067 552**	**762 532**	**4 411 350**	**882 492**	**874 798**
Western Cape	**1 929 309**	1 882 351	8 845	2 934	1 970	4 007	3 115	23 533	1 597	957
Eastern Cape	**992 879**	6 034	959 348	495	4 642	11 242	1 115	8 818	745	439
Northern Cape	**243 040**	2 268	751	227 191	5 629	551	3 652	2 554	241	204
Free State	**640 116**	1 182	4 595	909	565 964	16 141	3 986	45 311	1 239	789
KwaZulu Natal	**2 033 177**	2 539	11 957	414	8 411	1 973 796	2 773	24 982	6 126	2 179
North West	**899 316**	2 556	1 229	2 488	4 271	3 504	695 061	183 752	3 015	3 438
Gauteng	**4 229 637**	33 944	15 689	5 014	30 360	50 876	38 732	3 988 419	38 068	28 535
Mpumalanga	**944 556**	1 560	921	255	1 146	5 288	3 304	100 038	807 519	24 525
Limpopo	**886 519**	787	456	155	562	2 147	10 795	33 943	23 941	813 733

Table 5.13: High Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2030

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**12 144 809**	**1 762 659**	**856 664**	**232 296**	**551 815**	**1 946 644**	**695 999**	**4 418 031**	**833 708**	**846 994**
Western Cape	**1 752 451**	1 706 633	10 849	2 356	1 614	3 000	2 689	23 049	1 427	834
Eastern Cape	**852 251**	8 882	812 655	571	3 823	8 832	1 666	14 237	1 043	542
Northern Cape	**230 327**	2 097	799	220 111	1 507	428	2 311	2 660	227	186
Free State	**566 873**	1 258	4 406	561	498 731	11 730	3 685	44 494	1 246	760
KwaZulu Natal	**1 917 128**	2 430	7 557	384	10 213	1 859 288	2 545	25 377	7 380	1 954
North West	**825 596**	2 461	1 283	2 439	4 109	3 110	634 883	171 281	2 871	3 159
Gauteng	**4 251 942**	36 574	17 739	5 482	30 195	51 374	35 504	4 007 225	36 731	31 118
Mpumalanga	**896 351**	1 573	910	249	1 107	7 276	3 146	99 465	757 712	24 914
Limpopo	**851 890**	751	467	142	516	1 606	9 570	30 243	25 069	783 526

Table 5.14: High Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2050

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**14 205 476**	**2 101 437**	**987 317**	**270 134**	**510 048**	**2 109 905**	**701 663**	**5 858 308**	**863 439**	**803 226**
Western Cape	**2 096 660**	2 041 342	11 551	4 827	1 556	3 501	2 953	28 467	1 593	870
Eastern Cape	**976 298**	8 497	938 354	1 078	3 959	9 627	1 315	12 207	846	414
Northern Cape	**262 091**	2 853	1 342	249 104	1 348	647	2 485	3 814	303	196
Free State	**531 168**	1 176	4 328	1 127	461 151	11 297	3 268	47 222	1 071	528
KwaZulu Natal	**2 077 009**	2 726	9 082	886	8 728	2 014 530	2 489	29 620	7 347	1 602
North West	**853 656**	2 626	1 343	3 051	3 633	3 221	634 587	199 505	2 849	2 841
Gauteng	**5 646 511**	39 789	19 793	9 336	28 316	57 687	41 214	5 383 292	38 309	28 774
Mpumalanga	**944 811**	1 698	1 051	450	960	7 845	3 095	118 106	789 431	22 175
Limpopo	**817 271**	730	474	273	396	1 551	10 256	36 074	21 690	745 827

Table 5.15: Low Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2030

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**10 153 636**	**1 307 203**	**989 452**	**205 621**	**549 998**	**1 823 824**	**689 594**	**2 877 031**	**803 266**	**907 646**
Western Cape	**1 305 173**	1 274 875	6 594	1 897	1 342	2 263	2 087	14 374	1 074	668
Eastern Cape	**987 502**	4 588	957 956	395	5 032	10 509	994	6 966	655	406
Northern Cape	**206 770**	1 666	652	197 068	1 328	338	3 593	1 779	183	164
Free State	**561 618**	1 051	4 160	445	502 914	11 557	3 520	36 173	1 097	702
KwaZulu Natal	**1 812 629**	2 200	7 759	330	10 440	1 760 838	2 479	19 965	6 806	1 812
North West	**799 102**	1 869	1 036	2 186	4 009	2 492	635 818	146 490	2 333	2 868
Gauteng	**2 710 962**	19 092	10 058	2 976	23 453	27 971	29 954	2 549 302	28 736	19 421
Mpumalanga	**848 216**	1 184	784	193	955	6 318	2 742	76 900	732 406	26 732
Limpopo	**921 664**	677	452	132	526	1 540	8 406	25 082	29 976	854 873

Table 5.16 Low Scenario: Average Total Person Trips per Day Aggregated to Provincial Level for 2050

	Totals	Western Cape	Eastern Cape	Northern Cape	Free State	KwaZulu Natal	North West	Gauteng	Mpuma-langa	Limpopo
Totals	**12 347 567**	**1 596 096**	**1 212 496**	**258 063**	**683 835**	**2 200 845**	**818 270**	**3 351 513**	**1 027 025**	**1 199 424**
Western Cape	**1 672 608**	1 545 994	60 344	18 457	8 992	8 046	5 664	19 732	2 614	2 766
Eastern Cape	**1 072 357**	11 016	1 020 208	1 916	8 046	17 729	1 813	8 813	1 529	1 287
Northern Cape	**240 133**	3 983	6 093	208 496	4 924	2 512	7 104	4 028	1 208	1 786
Free State	**642 413**	1 979	16 562	3 864	526 373	23 743	9 679	47 308	5 802	7 105
KwaZulu Natal	**2 145 219**	3 796	51 399	2 110	25 502	1 975 102	7 859	38 519	24 222	16 711
North West	**889 216**	2 630	5 122	4 862	10 398	10 474	648 215	178 159	10 987	18 368
Gauteng	**3 719 316**	24 338	47 329	16 908	92 531	136 204	117 820	2 927 972	153 508	202 706
Mpumalanga	**971 548**	1 445	3 725	864	4 659	20 495	7 401	91 371	789 750	51 838
Limpopo	**994 756**	915	1 714	587	2 411	6 541	12 714	35 611	37 405	896 858

5.1.10 Data Problems and Short Comings

During the trip generation process some problems were encountered with the available data. These problems are listed in **Annexure C**.

5.2 FREIGHT MODEL

5.2.1 Introduction

The next step after the freight production and attraction was the distribution of tonnage between the different zones in the model, resulting in the freight matrices. This step was more complicated and time consuming, compared to the trip distribution of the passenger model due to the absence of data to calibrate the model against.

5.2.2 Methodology

The gravity model is not the most applicable distribution model for all freight commodities, but was chosen to keep consistency in the model and avoiding complicated and time consuming distribution modelling for freight. The methodology followed was due to the lack of data to calibrate the model against. Distances were chosen as the dominant parameter and not travel time as was the case with passenger distribution. This was followed by a sensitivity analysis for each commodity based on distance. The process then consists of an iterative process of adjusting the average distance and calibration parameters until satisfactory distributions were obtained.

5.2.3 Calibration Results

The iterative process explained above resulted in various possible combinations that satisfy the criteria described. The most applicable solution was chosen based on the knowledge of the Freight - and Modelling Working Groups. Results of the calibration exercise are given in Table 5.17.

Table 5.17: Calibrated detergence parameter

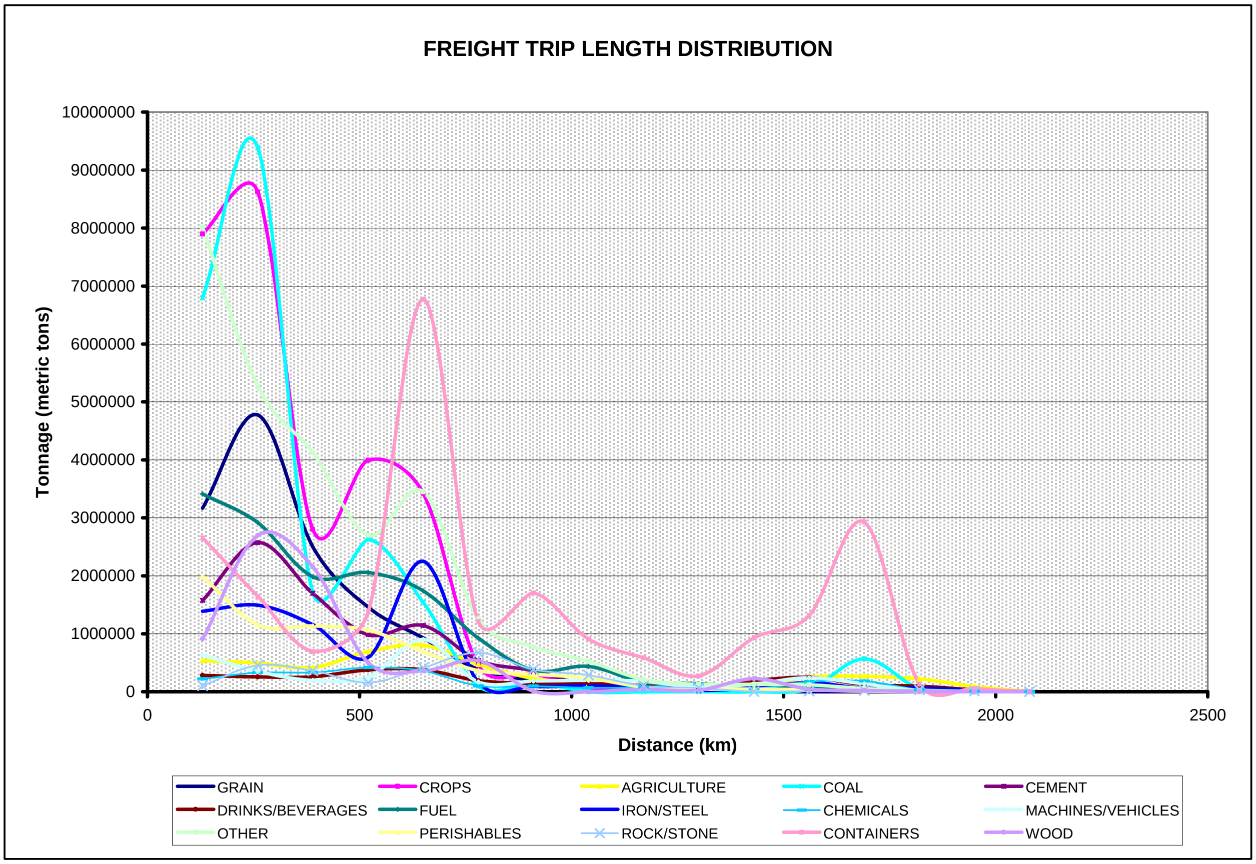
Commodity	β
Grain	-7
Crop	-5
Agriculture	0
Coal	0
Cement	-3
Drink/Beverages	0
Fuel	-3
Iron/Steel	0
Chemicals	0
Machines/Vehicles	0
Other	-3

Perishables	-3
Rock/Stone	0
Containers	0
Wood	-5

The final test for the distribution was to compare the measured volumes in term of total tonnage with the modelled tonnage on the main freight corridors. A R^2 of 0.986 were achieved and considered acceptable for this model.

The distribution pattern of each commodity modelled is displayed in Figure 5.6. It is clear that there is a significant difference in trip length distribution between the various commodities and that the majority of commodities are transported over distances less than 500 km. There are however commodities transported over longer distances such as containers and coal. The unexpected distribution patterns are attributed to the combination of the locations of resources and markets.

Figure 5.6: Trip length distribution by commodity



5.2.4 Apply Freight Distribution Model

Results of the distribution model as applied on the target years' production and attraction is tabulated Tables 5.18 – 5.22. These tables contain the proportion of trip within and between provinces.

Table 5.18: Expected proportions of trips per province for 2010

	W-Cape	E-Cape	N-Cape	Free State	KZN	Northwest	Gauteng	Mpumalanga	Limpopo	Total
W-Cape	0.057	0.006	0.005	0.002	0.015	0.001	0.007	0.002	0.000	**0.057**
E-Cape	0.006	0.005	0.002	0.002	0.010	0.000	0.005	0.001	0.000	**0.006**
N-Cape	0.077	0.010	0.002	0.006	0.012	0.002	0.017	0.014	0.000	**0.077**
Free State	0.007	0.004	0.002	0.004	0.007	0.002	0.015	0.005	0.001	**0.007**
KZN	0.020	0.013	0.003	0.009	0.110	0.003	0.046	0.023	0.003	**0.020**
Northwest	0.004	0.002	0.002	0.002	0.004	0.003	0.018	0.005	0.001	**0.004**
Gauteng	0.009	0.004	0.004	0.006	0.035	0.004	0.041	0.013	0.002	**0.009**
Mpumalanga	0.011	0.003	0.003	0.003	0.069	0.005	0.047	0.073	0.003	**0.011**
Limpopo	0.018	0.002	0.001	0.002	0.020	0.001	0.015	0.015	0.002	**0.018**
Total	**0.057**	**0.006**	**0.005**	**0.002**	**0.015**	**0.001**	**0.007**	**0.002**	**0.000**	**0.057**

Table 5.19: Expected proportions of trips per province for 2020

	W-Cape	E-Cape	N-Cape	Free State	KZN	Northwest	Gauteng	Mpumalanga	Limpopo	Total
W-Cape	0.057	0.006	0.005	0.002	0.014	0.001	0.006	0.002	0.000	**0.093**
E-Cape	0.006	0.006	0.001	0.002	0.010	0.000	0.005	0.001	0.000	**0.032**
N-Cape	0.076	0.009	0.002	0.006	0.012	0.002	0.016	0.014	0.000	**0.136**
Free State	0.006	0.003	0.002	0.003	0.005	0.002	0.014	0.005	0.001	**0.041**
KZN	0.019	0.014	0.003	0.009	0.113	0.003	0.051	0.025	0.003	**0.241**
Northwest	0.004	0.002	0.001	0.002	0.004	0.003	0.015	0.005	0.001	**0.036**
Gauteng	0.009	0.004	0.004	0.006	0.035	0.004	0.045	0.014	0.002	**0.123**
Mpumalanga	0.011	0.002	0.002	0.003	0.072	0.005	0.048	0.078	0.003	**0.225**
Limpopo	0.018	0.002	0.001	0.002	0.019	0.001	0.014	0.015	0.001	**0.072**
Total	**0.205**	**0.048**	**0.022**	**0.035**	**0.282**	**0.021**	**0.215**	**0.159**	**0.013**	**1.000**

Table 5.20: Expected proportions of trips per province for 2030

	W-Cape	E-Cape	N-Cape	Free State	KZN	Northwest	Gauteng	Mpumalanga	Limpopo	Total
W-Cape	0.054	0.006	0.005	0.002	0.014	0.001	0.006	0.002	0.000	**0.090**
E-Cape	0.007	0.006	0.001	0.002	0.010	0.000	0.006	0.002	0.000	**0.034**
N-Cape	0.073	0.008	0.002	0.006	0.011	0.002	0.016	0.013	0.000	**0.130**
Free State	0.006	0.003	0.002	0.003	0.004	0.002	0.013	0.005	0.001	**0.037**
KZN	0.019	0.014	0.003	0.009	0.103	0.003	0.050	0.025	0.003	**0.229**
Northwest	0.004	0.002	0.001	0.002	0.003	0.002	0.014	0.004	0.001	**0.034**
Gauteng	0.008	0.004	0.004	0.006	0.034	0.003	0.042	0.013	0.002	**0.116**
Mpumalanga	0.009	0.002	0.002	0.002	0.047	0.004	0.041	0.072	0.003	**0.183**
Limpopo	0.018	0.002	0.001	0.002	0.091	0.002	0.016	0.015	0.001	**0.147**
Total	**0.198**	**0.046**	**0.021**	**0.033**	**0.316**	**0.020**	**0.204**	**0.151**	**0.013**	**1.000**

Table 5.21: Expected proportions of trips per province for 2040

	W-Cape	E-Cape	N-Cape	Free State	KZN	Northwest	Gauteng	Mpumalanga	Limpopo	Total
W-Cape	0.056	0.006	0.005	0.002	0.015	0.001	0.006	0.002	0.000	**0.093**
E-Cape	0.007	0.006	0.001	0.002	0.011	0.000	0.006	0.002	0.000	**0.035**
N-Cape	0.064	0.007	0.001	0.005	0.010	0.002	0.014	0.012	0.000	**0.116**
Free State	0.005	0.003	0.002	0.003	0.004	0.002	0.012	0.004	0.001	**0.036**
KZN	0.020	0.015	0.003	0.010	0.104	0.003	0.052	0.026	0.004	**0.237**
Northwest	0.004	0.002	0.001	0.002	0.003	0.002	0.013	0.004	0.001	**0.032**
Gauteng	0.008	0.004	0.004	0.006	0.035	0.004	0.045	0.014	0.003	**0.124**
Mpumalanga	0.007	0.002	0.002	0.002	0.031	0.003	0.033	0.047	0.002	**0.130**

Limpopo	0.017	0.002	0.001	0.001	0.124	0.002	0.021	0.030	0.002	**0.199**
Total	**0.187**	**0.046**	**0.020**	**0.033**	**0.337**	**0.019**	**0.202**	**0.141**	**0.013**	**1.000**

Table 5.22: Expected proportions of trips per province for 2050

	W-Cape	E-Cape	N-Cape	Free State	KZN	Northwest	Gauteng	Mpumalanga	Limpopo	Total
W-Cape	0.052	0.006	0.004	0.002	0.017	0.001	0.008	0.002	0.001	**0.093**
E-Cape	0.008	0.006	0.002	0.002	0.015	0.001	0.009	0.002	0.000	**0.045**
N-Cape	0.053	0.006	0.001	0.004	0.008	0.001	0.012	0.010	0.000	**0.098**
Free State	0.004	0.002	0.002	0.002	0.004	0.002	0.011	0.004	0.001	**0.031**
KZN	0.023	0.015	0.004	0.010	0.100	0.004	0.058	0.026	0.004	**0.244**
Northwest	0.003	0.001	0.001	0.002	0.003	0.002	0.012	0.004	0.001	**0.029**
Gauteng	0.012	0.006	0.004	0.007	0.045	0.004	0.049	0.015	0.003	**0.145**
Mpumalanga	0.006	0.002	0.001	0.002	0.019	0.003	0.027	0.033	0.002	**0.096**
Limpopo	0.015	0.002	0.001	0.001	0.136	0.002	0.022	0.039	0.002	**0.219**
Total	**0.177**	**0.045**	**0.020**	**0.034**	**0.347**	**0.020**	**0.208**	**0.136**	**0.013**	**1.000**

6 MODAL SPLIT

Modal split in this model was done after the trip distribution phase

6.1 PASSENGER MODEL

6.1.1 Introduction

Modal choice models are probably one of the most important models in transport planning due to the key role played by public transport, especially with regard to policy making. It is well known that public transport has specific benefits such improved use of energy by passenger, less pollution per passenger and better utilization of road space. These benefits of public transport are thus the reason for public transport's importance as a mode and therefore the importance in transport planning and transport modeling. It is thus clear that an efficient public transport system is a paramount contributor to the efficient functioning of a city.

Mode choice models which are sensitive to those attributes of travel that influence individual choice of mode is therefore of utmost important in the planning and design of public transport in cities. Factors influencing the choice of mode can be grouped into three groups:

- Characteristics of the trip maker
- Characteristics of the journey
- Characteristic of the transport facility

Modal split models, particular in the USA were pre-distribution models. These models are based on personal characteristics that were thought to be the most important determinants of model choice. Mode choice was therefore applied immediately after trip generation. Very accurate choice models could be built over the short run, but were insensitive to policy decisions. The Europeans on the other hand developed post-distribution models almost from the beginning. These models are applied after the trip distribution and therefore have the advantage of taking into account journey characteristics. The first of these models included only one or two characteristics of the journey. The well known S-shape curve seemed to represent behaviour better.

Other more sophisticated models were developed over time. These models are known as the discrete choice models. These models aggregate models postulate that:

The probability of individuals choosing a given option is a function of their socioeconomic characteristics and the relative attractiveness of the option.

The concept of *utility* was developed to represent the attractiveness of the alternatives. The observed utility is usually defined as a linear combination of variables where each variable represents an attribute of the option or of the traveler. The value of an alternative's utility must be contrasted with those of other alternative options and transferred into a probability value between 0 and 1. A variety of mathematical transformations exist which are:

- Logit models
    - o Multinomial logit model
    - o Hierarchical logit model

- Probit models
    - o Multinomial probit model

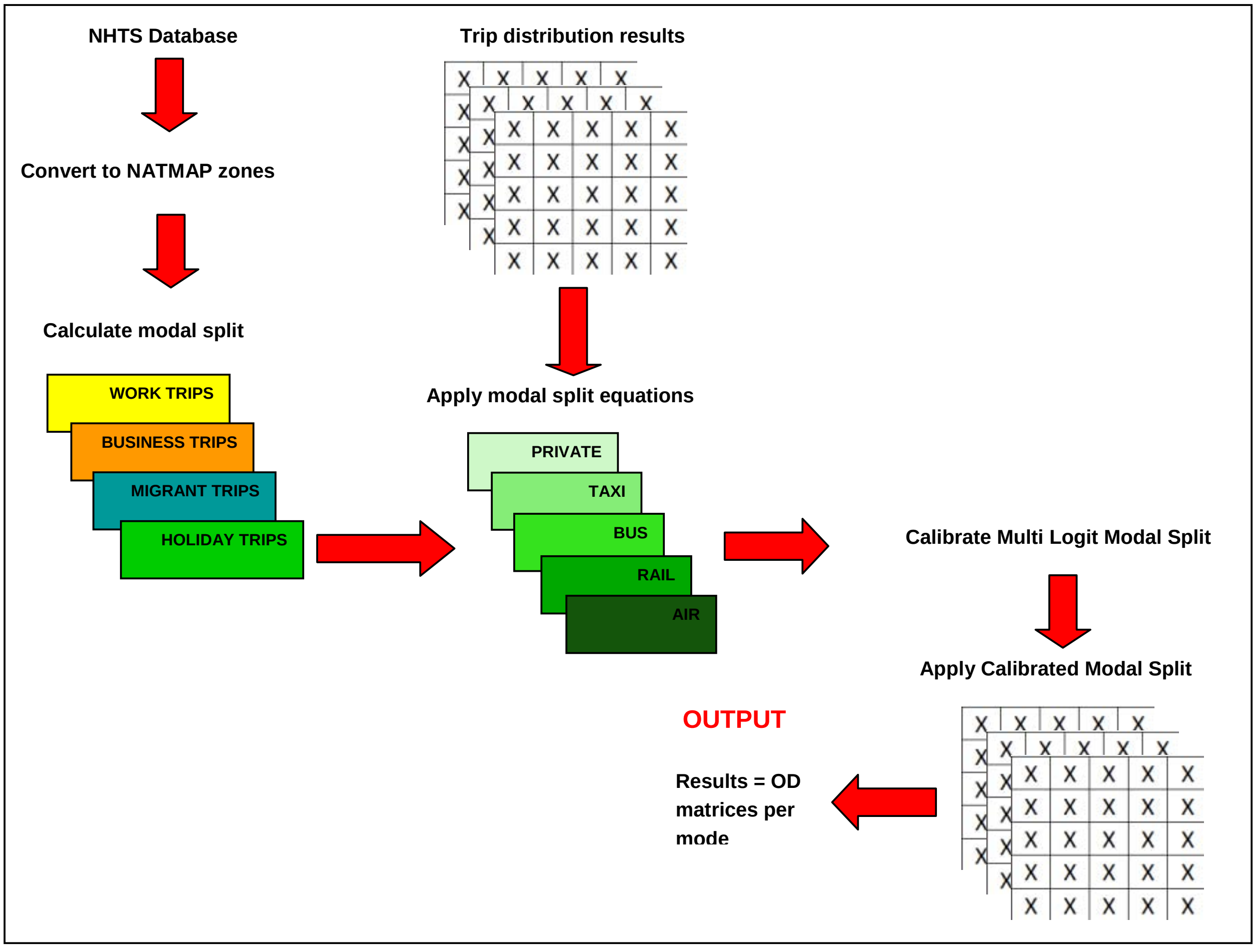
Useful properties of the discrete choice models were summarized by Spear (1977). These properties are:

- These models are based on theories of individual behaviour and do not constitute physical analogies of any kind and are stable or transferable in time and space.
- These models are estimated using individual data and this has the following implications:
    - o Are more efficient compared to conventional models in terms of information usage.
    - o Inherent variability in the information can be utilized.
    - o Disaggregate demand models can be applied at any aggregation level.
    - o These models are less likely to suffer from biases due to correlation between aggregate units.
- Disaggregate models are probabilistic.
- The utility function, in principle, allows any number and specification of the explanatory variables thus allowing for flexible representation of the policy variables considered relevant for the study.

6.1.2 Methodology

A multi modal logit model was developed based on a combination of data previously obtained for stated and revealed preference surveys as well as the NHTS. The utility functions were then calibrated and applied in the model. The modal split proportions were obtained from the NHTS data. The methodology is set out in Figure 6.1. The calibrated modal split model was applied to the results of the trip distribution phase to calculate the number of person trips between each origin-destination pair per mode. The modes identified for the passenger model are private vehicles, minibus taxis, bus, rail and air. This was done for each trip purpose and income group separately.

Figure 6.1:	Modal Split methodology



6.1.3 Preparation of NHTS data

The main source of travel data was the NHTS (2003). The data is quite dated but in light of the timeline of the Masterplan (2005 – 2050) it was deemed suitable.

The NHTS data was split into TAZs specific to the purpose of that particular survey. The data therefore first had to be converted to the NATMAP zones. This process proved cumbersome, especially in the cases where the NATMAP zones did not follow the same boundaries as the TAZs. In these cases the NHTS land-use and employment data was apportioned to the NATMAP zones in terms of population rather than land area.

All trips across NATMAP zone boundaries were singled out and these are the trips used in the model. These are longer distance trips which effectively rule out non-motorised modes of transport.

Trips were grouped according to province, zone, trip purpose, income group, and mode. The four trip purposes used for the study are, as identified in the modelling specifications: work, business, migrant and holiday trips. Certain trip purposes disqualify certain modes, e.g. migrant trips by definition are undertaken by some form of public transport, therefore the private car mode is not applicable to this trip purposes.

Certain zones, such as the Kruger National Park in Limpopo Province, do not currently generate trips but it is foreseen that they may do so in future. In these cases the incumbent modal split patterns in surrounding zones of similar land-use and socio-economic characteristics, were amalgamated and applied to those zones.

There was quite a large amount of inconclusive data, where trip modes were given as other or unspecified. In these cases exact modes used to achieve the given trip purpose could not be extracted.

The modal split was determined separately for each zone, trip purpose and income level. Table 6.1 shows the total modal split for each trip purpose and income level, with the zones combined. The modal split for each zone is presented in Annexure F.

Table 6.1: Modal Split by Income Group and Trip Purpose (source: NHTS, 2003)

		Trip Purpose							
		Number of trips				Proportion			
Income Group	**Mode**	**Work**	**Business**	**Migrant**	**Holiday**	**Work**	**Business**	**Migrant**	**Holiday**
Low	Rail	4361	15	59	616	0.043	0.017	0.031	0.043
	Bus	7078	40	295	2488	0.070	0.045	0.156	0.174
	Taxi	34865	148	1450	7588	0.346	0.167	0.766	0.531
	Car	12446	442	0	3194	0.123	0.498	0.000	0.223
	Truck	5942	0	0	0	0.059	0.000	0.000	0.000
	Air	0	30	9	96	0.000	0.034	0.005	0.007
	NMT	35637	0	0	0	0.353	0.000	0.000	0.000
	Other	494	174	49	256	0.005	0.196	0.026	0.018
	Unspecified	0	38	31	63	0.000	0.043	0.016	0.004
	Total	**100823**	**887**	**1893**	**14301**	**1**	**1**	**1**	**1**
Middle	Rail	1642	8	5	119	0.046	0.012	0.010	0.013
	Bus	3260	23	67	1428	0.091	0.034	0.139	0.156
	Taxi	9115	37	360	2732	0.254	0.055	0.748	0.298
	Car	14486	502	0	4657	0.404	0.751	0.000	0.508
	Truck	458	0	0	0	0.013	0.000	0.000	0.000
	Air	0	41	8	175	0.000	0.061	0.017	0.019
	NMT	6588	0	0	0	0.184	0.000	0.000	0.000
	Other	337	54	34	34	0.009	0.081	0.071	0.004
	Unspecified	0	3	7	26	0.000	0.004	0.015	0.003
	Total	**35886**	**668**	**481**	**9171**	**1**	**1**	**1**	**1**
High	Rail	1800	8	14	127	0.014	0.004	0.047	0.011
	Bus	3353	33	26	345	0.026	0.015	0.087	0.031
	Taxi	8074	32	167	557	0.062	0.014	0.560	0.050
	Car	104662	1674	0	9329	0.806	0.739	0.000	0.833
	Truck	566	0	0	0	0.004	0.000	0.000	0.000
	Air	0	461	12	782	0.000	0.203	0.040	0.070
	NMT	6399	0	0	0	0.049	0.000	0.000	0.000
	Other	5026	51	79	38	0.039	0.023	0.265	0.003
	Unspecified	0	7	0	27	0.000	0.003	0.000	0.002
	Total	**129880**	**2266**	**298**	**11205**	**1**	**1**	**1**	**1**

NMT is the abreviation used for non motorised transport

6.1.4 Modal Split Model

Revealed and stated preference surveys done in Cape Town, Durban and Gauteng were used to develop the utility functions used in the multimodal logit model. For the purpose of policy testing and the coarseness of the NATMAP model it was decided to reduce the explanatory variables to two, ie travel time and cost. The general form of the utility functions developed for the modal split is as follows:

$$U = t_c \times \text{traveltime} + c_c \times \text{cost} + \text{Constant}$$

Where U = Utility

T_c = Coefficient for travel time

C_c = Coefficient for travel cost

Results of the utility functions are displayed in Table 6.2.

Table 6.2: Coefficients of the utility functions

Income Group	Utility per mode	Business		Holiday/Migrant		Work	
		Time coefficient (min)	Cost coefficient (R/trip)	Time coefficient (min)	Cost coefficient (R/trip)	Time coefficient (min)	Cost coefficient (R/trip)
High Income	U_{car}	-0.240	-0.160	-0.120	-0.144	-0.120	-0.180
	U_{taxi}	-0.230	-0.345	-0.110	-0.220	-0.110	-0.330
	U_{bus}	-0.230	-0.345	-0.110	-0.220	-0.110	-0.335
	U_{train}	-0.230	-0.345	-0.110	-0.220	-0.110	-0.335
	U_{air}	-0.260	-0.104	-0.150	-0.129	na	na
Middle Income	U_{car}	-0.090	-0.108	-0.070	-0.120	-0.070	-0.140
	U_{taxi}	-0.070	-0.210	-0.050	-0.250	-0.050	-0.250
	U_{bus}	-0.070	-0.210	-0.050	-0.250	-0.050	-0.259
	U_{train}	-0.070	-0.210	-0.050	-0.250	-0.050	-0.259
	U_{air}	-0.120	-0.080	-0.090	-0.154	na	na
Low Income	U_{car}	-0.070	-0.120	-0.050	-0.120	-0.050	-0.150
	U_{taxi}	-0.050	-0.250	-0.040	-0.400	-0.040	-0.600
	U_{bus}	-0.050	-0.250	-0.040	-0.400	-0.040	-0.600
	U_{train}	-0.050	-0.250	-0.040	-0.400	-0.040	-0.600
	U_{air}	-0.090	-0.154	-0.050	na	na	na

The utility functions were calibrated against the modal split obtained from the NHTS data and acceptable results were obtained. The modal split for the different income groups and trip purposes are tabled in Table 6.4. The general pattern is that the proportion of private vehicle trips are higher for the high income group compared to the low and middle income group, except for business trips. The latter is attributed to the fact that mode choice for business trip are not as dependant on personal income compared to the other trip purposes. Interesting observation is that the low and middle income groups favor public transport modes for all trip purposes except business trips. An exceptional high portion of migrant trips by the middle and high income groups occur. There are low income households choosing to fly when holiday trips are made.

Table 6.4: 2005 modal split per income group and trip purpose

Mode	Work			Business			Migrant			Holiday		
	LI	MI	HI	LI	MI	HI	LI	MI	HI	LI	MI	HI
Private	0.20	0.45	0.75	0.57	0.53	0.59	0.00	0.00	0.00	0.20	0.53	0.61
Taxi	0.56	0.36	0.15	0.16	0.03	0.03	0.75	0.72	0.61	0.49	0.20	0.04
Bus	0.11	0.10	0.06	0.11	0.08	0.03	0.20	0.15	0.20	0.24	0.16	0.07
Rail	0.13	0.09	0.04	0.03	0.02	0.01	0.06	0.01	0.06	0.06	0.02	0.01
Air	0.00	0.00	0.00	0.13	0.35	0.33	0.00	0.12	0.12	0.01	0.08	0.27

Note: LI = Low income group

MI = Middle income group

HI = High income group

6.1.5Apply the Modal Split Model

Based on the middle land use scenario developed for the various target years it can be expected that the private vehicle will increase its share from 40% in 2005 to 47% in 2050. Both minibus taxis and bus is expected to have a reduction in share, while rail will gain marginally and air is expected to stay at 1%. The low scenario benefits bus and rail compared to the middle and high scenarios.

Table 6.5: Expected modal split for each target year

Mode	2005	2010-middle	2020-middle	2030-low	2030-middle	2030-high	2040-middle	2050-low	2050-middle	2050-high
Private	0.40	0.42	0.44	0.42	0.45	0.45	0.46	0.42	0.47	0.46
Taxi	0.40	0.39	0.36	0.38	0.35	0.35	0.34	0.38	0.34	0.35
Bus	0.10	0.10	0.10	0.10	0.09	0.09	0.09	0.10	0.09	0.09
Rail	0.08	0.09	0.09	0.08	0.09	0.09	0.09	0.08	0.09	0.09
Air	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01

6.2 FREIGHT MODEL

6.2.1 Modal Split Model

Modal split for the freight model focused on two modes only: Road based and rail based transport. Tonnage of freight transported by air is so insignificant compared to the total tonnage transported within a year that it was excluded from the modal split. Modal split for freight is much more complicated compared to passengers and the data needed to develop a sophisticated freight modal split model was not available. The base year modal split was calculated by means of the tonnage transported by road (based on the method explained earlier in this report) and the tonnage transported by rail according to available Transnet data. The modal split per commodity based on the tonnage transported is given in Table 6.6. 55% of the freight transported over longer distances is by road and 45% by rail. Bulk commodities are favored by rail such as coal and rock/stone. All the other commodities are favored by road. Cement, Iron/steel, chemicals and wood are commodities where rail has a recognizable proportion of the split.

Table 6.6: Modal split between road and rail in 2005

Commodity	Proportion road based	Proportion rail based
Grain	0.78	0.22
Crop	0.98	0.02
Agriculture	0.83	0.17
Coal	0.26	0.74
Cement	0.78	0.22
Drink/Beverages	0.91	0.09
Fuel	0.92	0.08
Iron/Steel	0.72	0.28
Chemicals	0.66	0.34
Machines/Vehicles	0.94	0.06
Other	0.97	0.03
Perishables	1.00	0.00
Rock/Stone	0.07	0.93
Containers	0.93	0.07
Wood	0.74	0.26
Average	0.55	0.45

6.2.2 Apply the Modal Split Model

It is expected that rail's contribution to freight transport will reduce over time based on the current trend. This trend is reflected in the model. It is however possible to force certain commodities to rail in order to be able to determine the impact of a shift from road to rail or vice versa. Table 6.7 is a summary of the expected modal split by commodity for each target year. It is expected that the contribution of rail will reduce from 45% in 2005 to 33% by 2050.

Table 6.7: Expected freight modal split for each target year (middle scenario)

Commodity	2005		2010		2020		2030		2040		2050	
	Road	**Rail**	**Road**	**Rail**	**Road**	**Rail**	**Road**	**Rail**	**Road**	**Rail**	**Road**	**Rail**
Grain	0.78	0.22	0.76	0.24	0.83	0.17	0.82	0.18	0.84	0.16	0.83	0.17
Crop	0.98	0.02	0.98	0.02	0.98	0.02	0.98	0.02	0.98	0.02	0.97	0.03
Agriculture	0.83	0.17	0.84	0.16	0.85	0.15	0.86	0.14	0.86	0.14	0.83	0.17
Coal	0.26	0.74	0.25	0.75	0.26	0.74	0.29	0.71	0.30	0.70	0.33	0.67
Cement	0.78	0.22	0.76	0.24	0.76	0.24	0.78	0.22	0.82	0.18	0.83	0.17
Drink/Beverages	0.91	0.09	0.97	0.03	0.98	0.02	0.98	0.02	0.98	0.02	1.00	0.00
Fuel	0.92	0.08	0.93	0.07	0.93	0.07	0.93	0.07	0.93	0.07	0.94	0.06
Iron/Steel	0.72	0.28	0.72	0.28	0.73	0.27	0.76	0.24	0.77	0.23	0.78	0.22
Chemicals	0.66	0.34	0.69	0.31	0.65	0.35	0.71	0.29	0.79	0.21	0.83	0.17
Machines/Vehicles	0.94	0.06	0.96	0.04	0.90	0.10	0.88	0.12	0.88	0.12	0.89	0.11
Other	0.97	0.03	0.96	0.04	0.96	0.04	0.95	0.05	0.95	0.05	0.94	0.06
Perishables	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Rock/Stone	0.07	0.93	0.11	0.89	0.10	0.90	0.09	0.91	0.09	0.91	0.10	0.90
Containers	0.93	0.07	0.95	0.05	0.94	0.06	0.95	0.05	0.96	0.04	0.97	0.03
Wood	0.74	0.26	0.79	0.21	0.81	0.19	0.80	0.20	0.82	0.18	0.84	0.16
Average	**0.55**	**0.45**	**0.57**	**0.43**	**0.57**	**0.43**	**0.59**	**0.41**	**0.63**	**0.37**	**0.67**	**0.33**

7 ASSIGNMENT

7.1 PASSENGER TRANSPORT ASSIGNMENT

7.1.1 Assignment Methodology

The final stage in the four-step approach is the assignment of the trip demand onto the road, rail, air and sea networks.

For private road-based assignments person trips from the previous stages were converted to vehicles. Passenger trips were retained for assignment to buses, minibus-taxis, trains and aeroplanes.

The assignment approach used was a straightforward user equilibrium assignment, using minimum time plus toll penalties (as a component of time) as calculated from the volume-delay functions, to be able to take into consideration the distribution of values of time in the case of toll roads. Although technically an equilibrium assignment, the coarseness of the modelled network, together with an all-day assignment period, led to convergence being achieved within 2 iterations, thus making the process, for all practical purposes, similar to an all-or-nothing assignment. For a more detailed explanation of the assignment method used in the model, refer to Annexure G.

The coarseness of the network and zone system, together with the assignment of all day (ADT) demand, meant that the base year 2005 model is characterised by relatively little or no congestion, especially when the demand is aggregated over an all day period. This was borne out in the assignment stage by the extremely quick convergence of the assignment process, rarely requiring more than two iterations to reach equilibrium.

The costs were based on the free-flow speeds as determined during the creation of the model network. Speeds were adjusted to match averages from observed data where available and speed flow curves fine-tuned to calibrate as well as possible to observed data where there was any. Network sections where specific conditions likely to affect travelling speeds occur – such as road sections with hazardous alignments and/or gradients, routes with high volumes of heavy vehicles, or toll fees – were modelled as part of the network definition.

As discussed in Section 3, data relating travelling speed to flow was obtained from a variety of sources but in very few cases outside of urban areas were the observed volumes on these links anywhere near big enough to indicate the full definition of the speed flow curve for that particular link. To reiterate the point from Section 3: **the lack of suitable and detailed data on speed/flow relationships indicates that more work needs to be undertaken to obtain this information in order to improve the calibration of the network speed flow relationships.**

Links with tolls were tested with a range of time penalties between 5 and 30 minutes in order to best model toll road usage. Link counts available from toll roads on all major freeways in inter-provincial and non-metropolitan locations were used to calibrate the penalty value. Due to the coarse nature of the model network and the large zone sizes, and relative lack of alternative route choices, it was found that the assigned routeings were relatively insensitive to toll penalty values.

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For private road-based trips the person data obtained from the previous modelling stages was converted to a single nationwide average of 1.25 persons per vehicle. While this figure is lower than available observed values, which range from between 1.6 and 2.4 depending on the survey used (the value from the 2002 Gauteng Household Interview Survey indicated a provincial-wide average of 1.6, while for the City of Johannesburg metropolitan area alone, this figure was as high as 2.4), a lower factor was considered valid since available factors invariably reflect occupancies in metropolitan areas and also a lower factor was required in order to improve the comparison between counted volumes and modelled, in the absence of other validation data. **More work needs to be undertaken to obtain a more relevant indication of average occupancies at the national level.**

Prior to assignment, public transport passenger volumes were also converted to average vehicles. Minibus-taxi passengers were factored by 15 per vehicle while bus passengers were factored by 80. These factors reflect urban commuter values more than longer distance ones but are adequate for the purposes of strategic national-level route assignment where road congestion for these modes is generally not a significant influence on route choice.

7.1.2 Validation & Matrix Adjustment

7.1.2.1 Private Road-Based Trips

Due to the nature of the national model, traditional validation procedures (Annexure H) at the assignment stage – comparing observed link counts to modelled volumes - are of limited worth, especially given the general lack of comprehensive count data nationally where counts correlate closely enough to modelled zone boundaries to make a valid comparison viable. This problem is compounded by the mismatch between full counts, especially in metropolitan areas which contain a high percentage of short-distance peak period commuter travel, and the partial component of daily trips in the model. It is, therefore, not possible to make a direct comparison between counted trips and modelled trips at such a strategic level.

Also, the coarse level of the network means that route choice is relatively limited in the model, especially at the strategic level of trip making where many trip lengths are greater than one hour.

This problem is even further compounded by the influence of zone connector placement, particularly in metropolitan areas, since adjusting the precise location of a zone connector can have a marked influence on the modelled volume at any given point. Comparing modelled volumes to observed on this basis, then, is in these areas to a great extent arbitrary.

It was decided that as a rough rule, modelled volumes should mainly be less than counted. To what degree lower was impossible to determine without a much more detailed and extensive understanding of trip purposes on these counted links. However, even this rough rule cannot be strictly adhered to since the coarseness of the model network and the arbitrary positioning and number per zone of zone centroid connectors can sometimes result in modelled volumes actually being greater than counted since there are simply fewer roads available for the traffic to use.

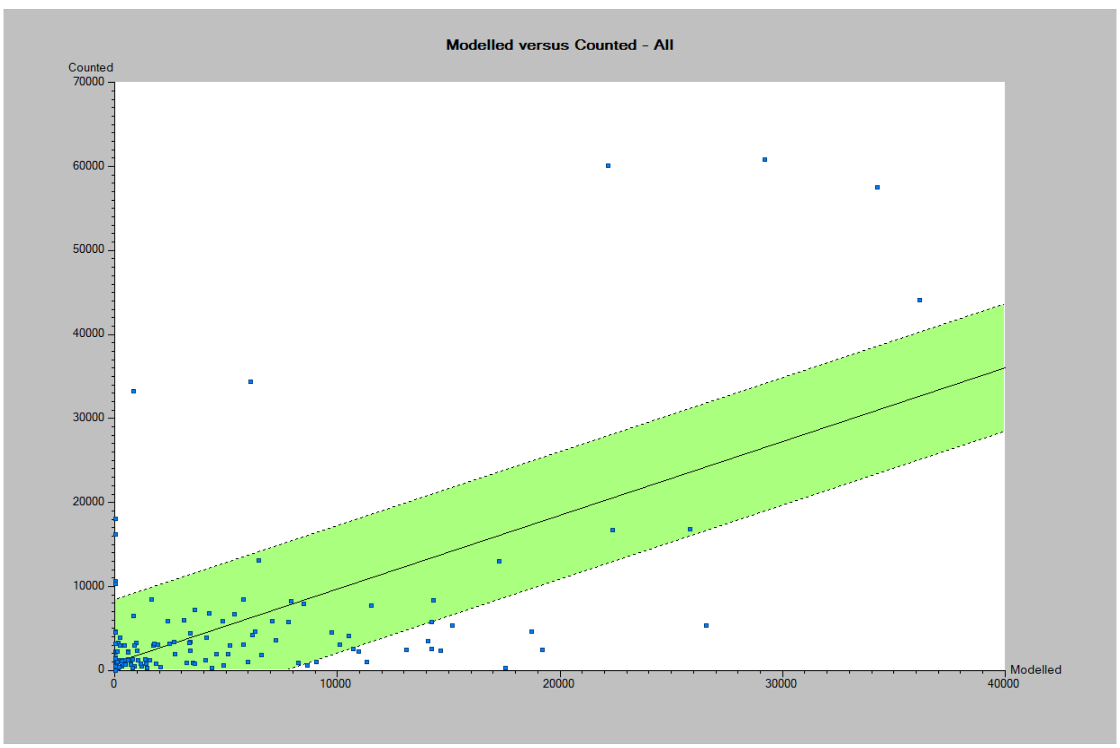
However, given these limiting factors, a judicious choice of available counted data was used, the main source being the SANRAL 2007 Yearbook. Counts were chosen based on their location, favouring counts available on provincial borders and where possible modelled zone borders. These count locations are likely to be those that can be expected to correlate the closest with the level of detail in the model.

All counts at toll roads were also used, even though in some cases the mix of short distance commuter/metropolitan trips and longer distance non-peak commuter trips were likely to comprise an unknown percentage of the total count. Counts in metropolitan areas, as well as any other counts showing a large annual daily flow (which were mostly all in metropolitan areas anyway, containing high proportions of short-distance, commuter trips were omitted from the analysis.

Due to the general lack of suitable count locations – given that the vast majority of count programmes focus primarily on metropolitan and built up areas or on national highways - this approach resulted in an insufficient number of counts for validation purposes, notably on the non SANRAL links. **It is therefore recommended that additional counted data be obtained, particularly on non-metropolitan, non SANRAL governed, roads.**

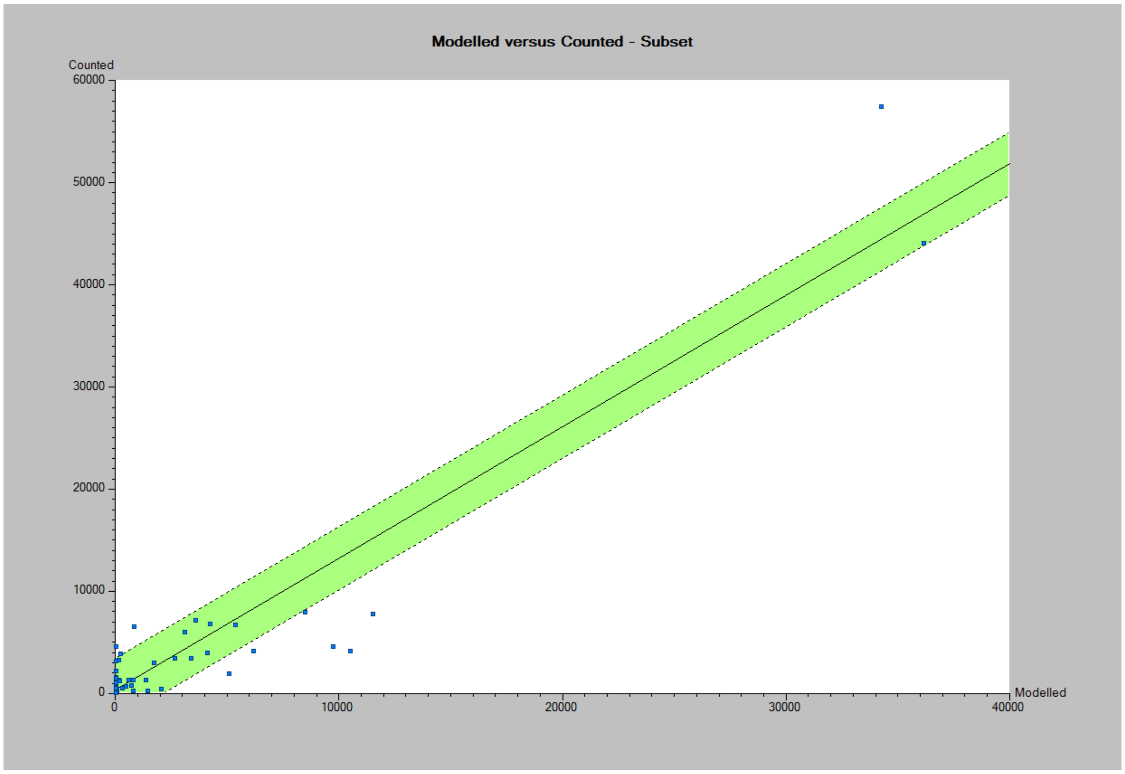
Observed and modelled demands were compared and the degree of correlation is shown in Figures 7.1 and 7.2. Figure 7.1 shows the comparison of all observed (mainly SANRAL) counts while Figure 7.2 shows the comparison with only those counts located such that internal zonal trips modelled would be at a minimum. The R^2 values are 0.40 and 0.89 respectively.

Figure 7.1: Base Year Private Road Vehicles Comparison – all counts



Figure

7.2: Base Year Private Road Vehicles Comparison – Zone Boundry Counts



Assumptions made in earlier stages were revisited and corrections made in order to improve the initial accuracy of modelled volumes. The correlation data was fed back to the first stage of the four-step model – trip generation – and various adjustments were applied at this stage and equations tweaked in order to address validation issues identified in the current stage. Subsequent stages of trip distribution and modal split were likewise revisited with a view to attaining a better validation.

As discussed in previous sections a major problem with initial assignments was that the model was substantially overestimating intra-zonal demand based on the available data, predominantly the National Household Survey. Refinements to this element of the model resulted in significantly improved assignments. However, this does draw attention to the general problem of developing a national-scale model using the currently available survey data, much of which was not designed with model development in mind.

As explained, due to the fact that the model contains only partial volumes because of zone size and the nature of the model, it is not feasible to aim for an accurate validation against observed link counts.

As can be seen from Figure 7.2, when using those counts that correspond with zone boundaries, or are reasonably close, this reduces the number of available counts significantly. **So as recommended above, it is essential that additional count data nationwide be obtained in order to improve the validation process and to gain greater confidence in the results**.

7.2.2 Air Trips

For air trips, assigned volumes were compared with available data from ACSA. The observed versus modelled air passenger trips are shown in Table 7.1.

Table 7.1: Comparison Of Observed & Modelled Air Passenger Trips

Domestic Daily Passengers	Departures		Arrivals	
	Counted	NatMap	Counted	NatMap
Bloemfontein	583	1813	579	272
Cape Town	9478	8224	9386	5425
Durban	6549	8229	6550	8964
East London	896	1083	1023	2470
George	887	435	879	667
Johannesburg	15191	18028	15367	13548
Port Elizabeth	2052	1364	2066	2378
Total	**35636**	**39176**	**35850**	**34624**

7.1.2.3 Minibus-taxi & Bus Trips

Public transport trips on minibus-taxi, bus and rail were not validated since there was little reliable count data available, especially outside of metropolitan areas. **More data for these modes needs to be obtained in order to carry out validation of these modes.** However, as with the road-based private trips, given the coarseness of the model network/zones, it became essential that the bulk of the validation of these trips be carried out during the earlier modelling stages.

7.1.2.4 Rail Trips

Validation of rail passenger volumes was complicated by the need to validate inter-provincial, long distance trips using Shosholoza-Meyl-related observed data and at the same time to ensure the larger commuter demand was accurately modelled in the metropolitan areas. Table 7.2 sows the comparison of modelled versus counted demand for long distance travellers only.

Note that since the rail network is connected directly to zones and all rail demand has access solely to the rail network, and in turn that network has been reduced to reflect Shosholoza_Meyl network only (with additional commuter network in the metropolitan areas) such that route choice is effectively non-existent, validation of this component of the model reflects earlier, non-assignment, stages of the process.

Comparison of Shosholoza-Meyl, long-distance rail passenger trips is shown in Table 7.2. Total arrivals and departures at zones containing the major metropolitan termini is shown in Table 7.3. Again the coarseness of the network and the large zones mean that in some areas the bulk of rail commuter trips occurs entirely within that zone (e.g. Bloemfontein) and therefore the total volume is equal or similar to the long-distance, non-commuter volume. On this basis these centres have been omitted. To overcome this, smaller zones will be needed in and around these metropolitan areas.

Table 7.2: Long Distance Rail Trips- Adt

Location	From – Observed(Modelled)	To – Observed(Modelled)
Cape Town	212(103)	197(42)
Durban	286(160)	250(160)
Johannesburg	1956(2553)	1622(1800)
Bloemfontein	163(18)	114(111)
Port Elizabeth	252(96)	218(67)
East London	94(74)	96(40)
Kimberley	15(31)	41(58)
Messina	97(5)	195(58)
Komatipoort	326(306)	693(662)

Table 7.3: Total Rail Trips At Major Centres- Adt

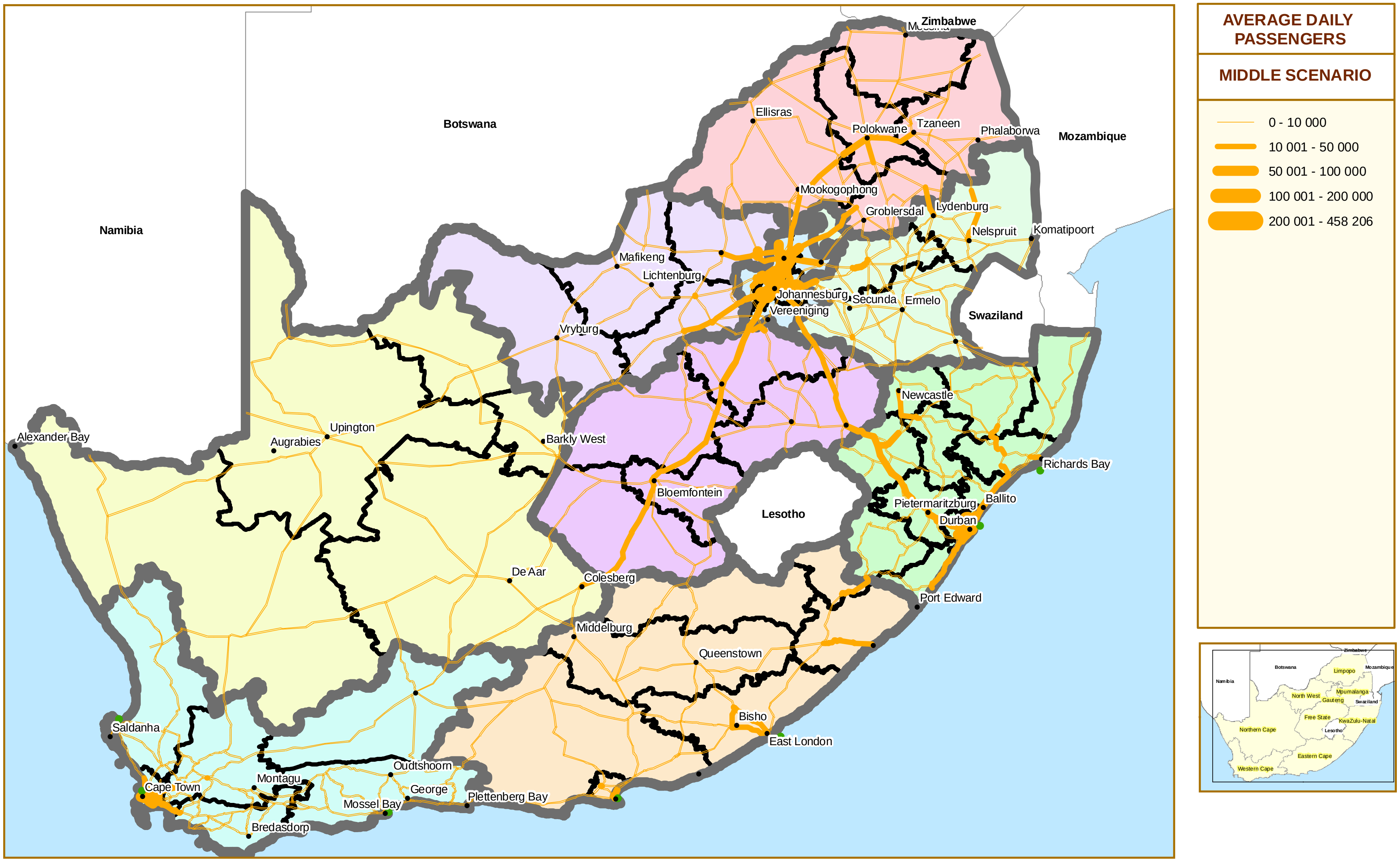
Location	From	To
Cape Town	57,083	57,083
Durban	5,747	5,747
Johannesburg	80,781	80,642

7.1.3 Assignments

The results for the five modes assigned – road-based private, taxi, bus, rail and air – are shown in Figures 7.3 to 7.5 All volumes are Annual Average Daily (ADT) volumes. Table 7.4 shows the total assigned volumes for each mode, excluding intra-zonal demand. Note that all modes were assigned as if they were using the private road network. At this stage no public transport services or routes exist in the model and so the assignment does not depend on the location of services.

Similarly, no boarding or transfer penalties have been applied except in the case of air passenger trips where transfer penalties have been implemented in order to obtain more realistic estimates of total trip time.

Western Cape Province: ROAD PASSENGER VOLUMES (2005)



BASEMAP LEGEND:

Border Posts | Airports | District Municipal Boundary
Harbours | Towns | Provincial Boundaries

1:9,000,000

0 37.5 75 150 225 300 Kilometers

Map and Data Current Status Completed

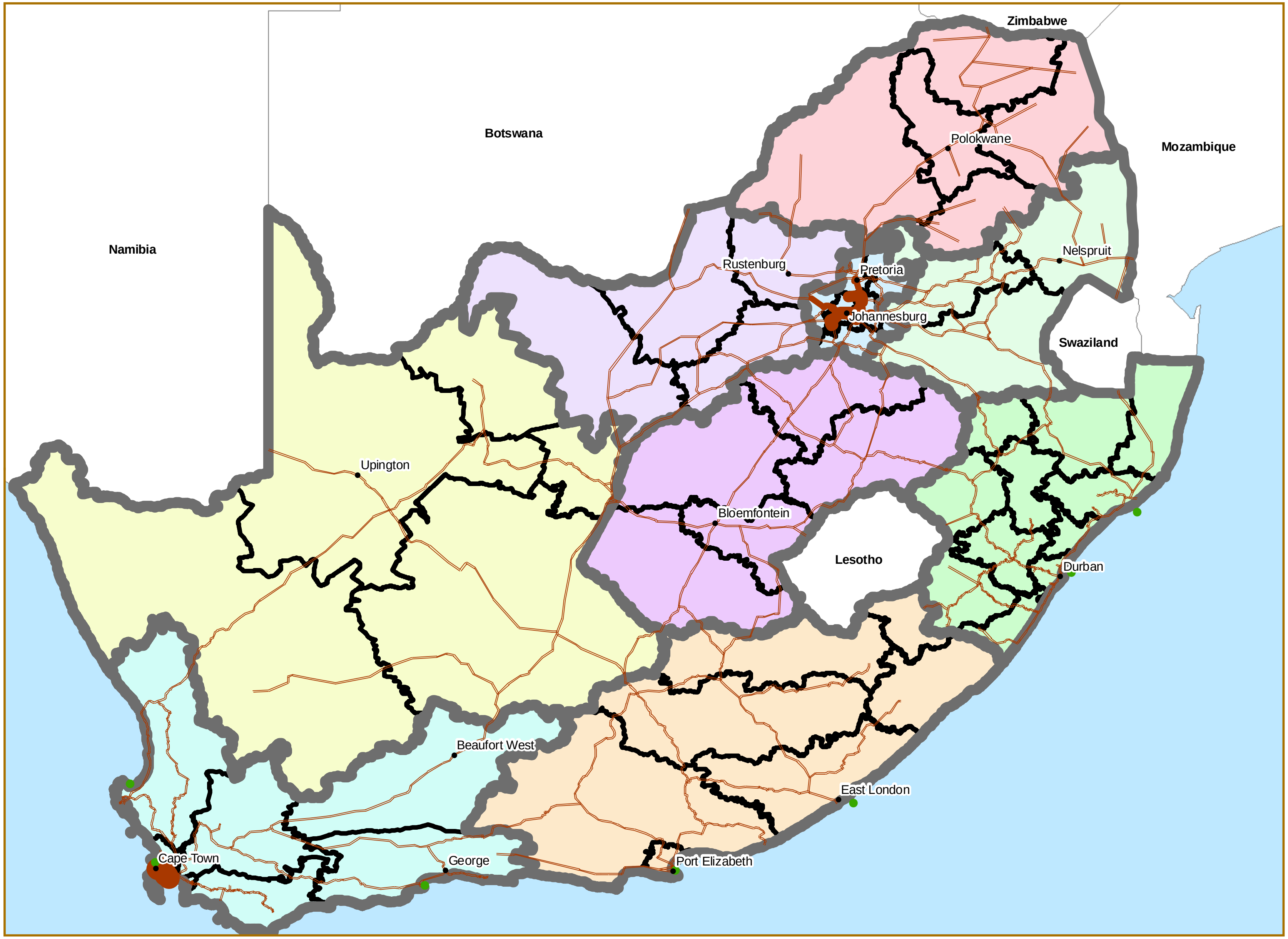
0-15% | 25% | 50% | 75% | 80% | 90% | 100%

February '09

MAP 7.3 Road Passenger Volumes (Average Passengers/Day)-2005

NATIONAL TRANSPORT MASTERPLAN 2050

National: RAIL PASSENGER VOLUMES (2005)



AVERAGE DAILY PASSENGERS

MIDDLE SCENARIO

- 0 - 5 000
- 5 001 - 10 000
- 10 001 - 30 000
- 30 001 - 50 000
- 50 001 - 155 526

BASEMAP LEGEND:

- Border Posts
- Harbours
- Airports
- Towns
- District Municipal Boundary
- Provincial Boundaries

1:9,000,000

0 37.5 75 150 225 300 Kilometers

Map and Data Current Status Completed

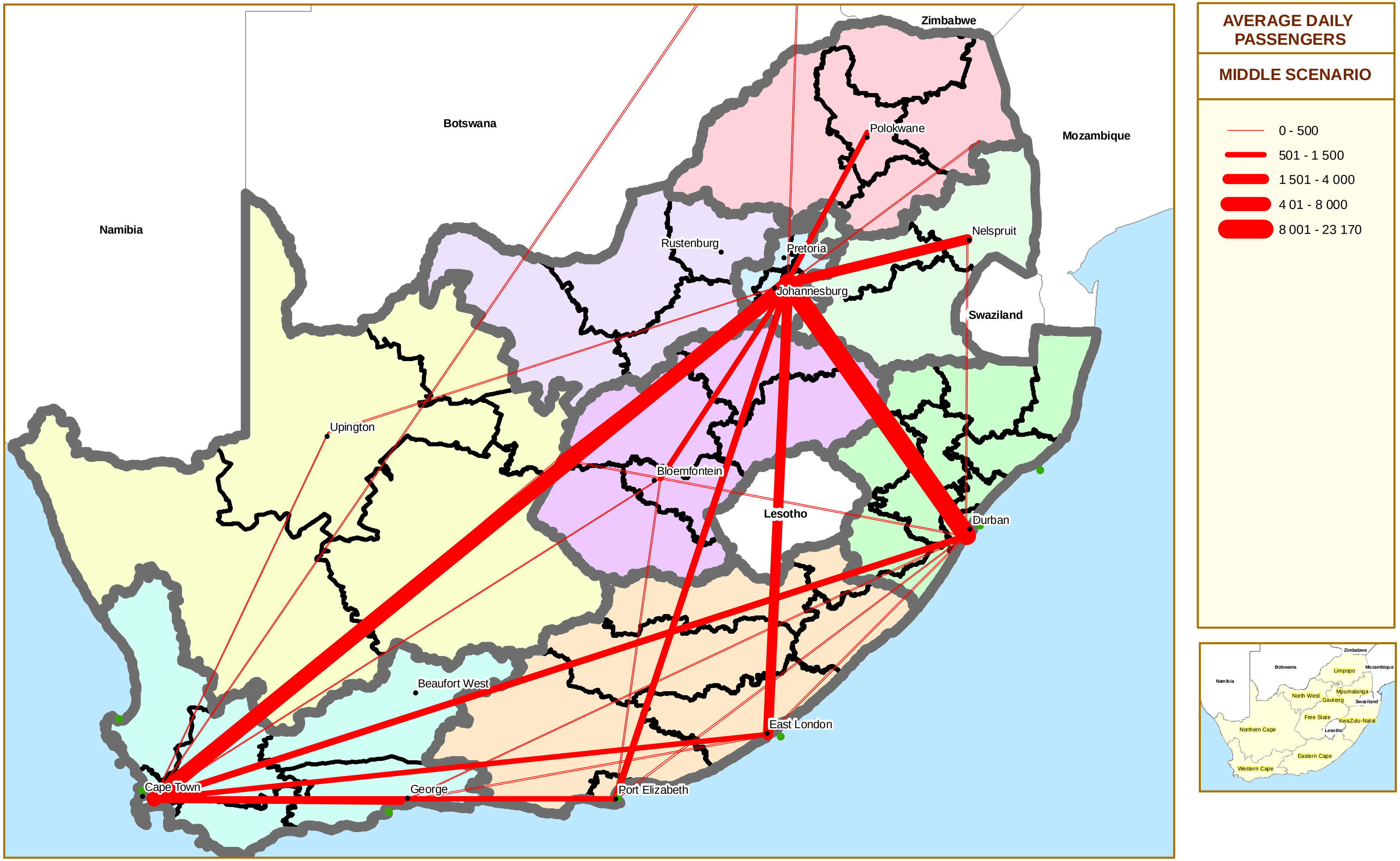
0-15%	25%	50%	75%	80%	90%	100%

February '09

FIGURE 7.4 Rail Passenger Volumes (Average Passengers/Day)-2005

NATIONAL TRANSPORT MASTERPLAN 2050

National: AIR PASSENGER VOLUMES (2005)



BASEMAP LEGEND:

Border Posts
Harbours
Airports
Towns
District Municipal Boundary
Provincial Boundaries

1:9,000,000

0 37.5 75 150 225 300 Kilometers

Map and Data Current Status Completed

0-15% | 25% | 50% | 75% | 80% | 90% | 100%

February '09

FIGURE 7.5 Air Passenger Volumes (Average Passengers/Day)-2005

Table 7.4: Total Assigned Base Year Demand

Mode	Total ADT (persons)
Road-based private	1,487,218
Minibus-taxi	1,452,002
Bus	361,356
Rail	289,212
Air	64,250
Total:	3,654,038

The modelled Trip Length Frequency Distributions (TLFD) of assigned trips is shown per mode in Figures 7.6 to 7.10. The average trip lengths/costs per mode are shown in Table 7.5:

Table 7.5: Average Trip Times Base Year Assignment

Mode	Average Weighted Trip Cost (Hours)
Road-based private	1.13
Minibus-taxi	0.82
Bus	1.24
Rail	1.00
Air	4.12

Figure 7.6: 2005 Private Trip Distribution (Hours)

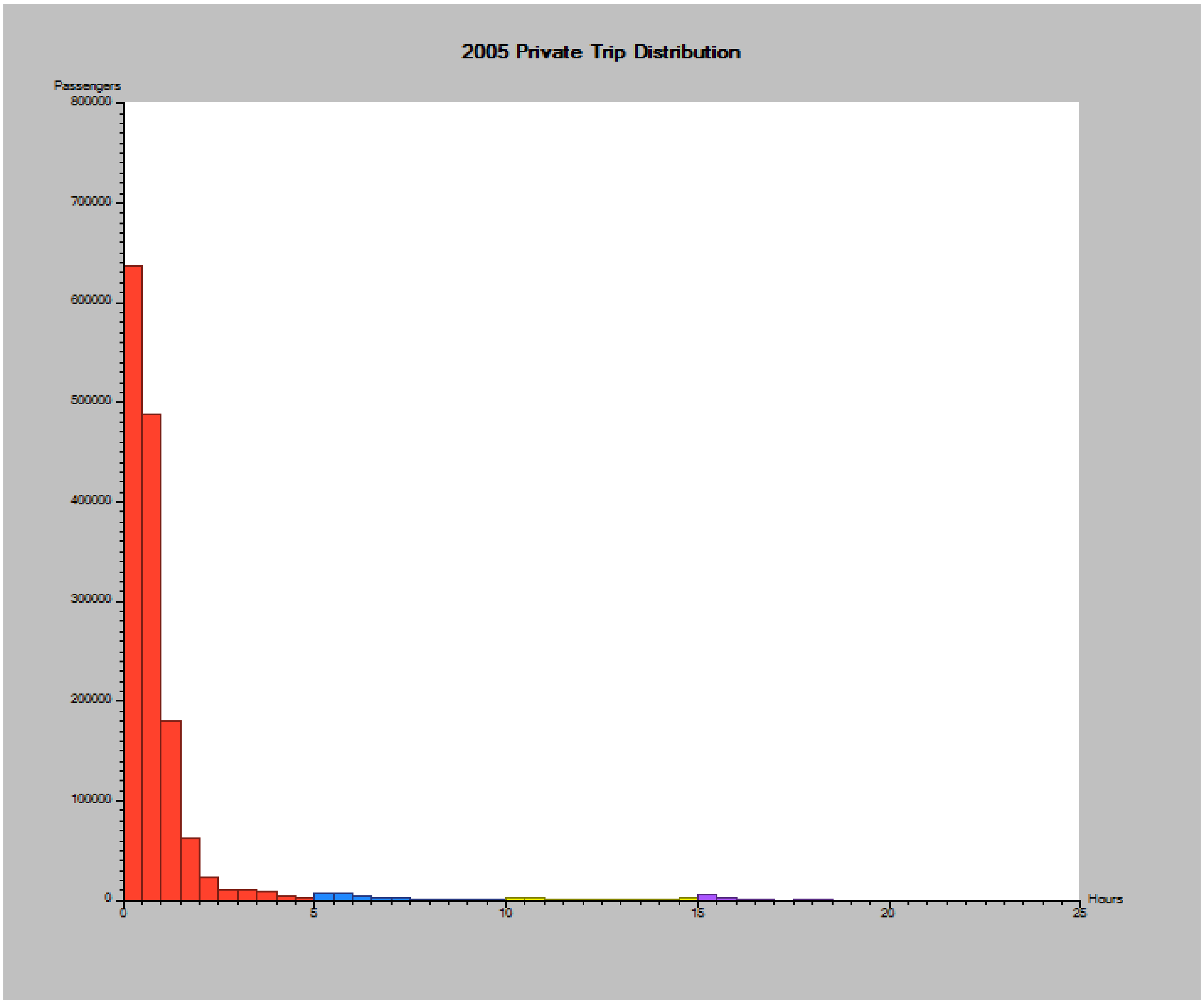


Figure 7.7: 2005 Minibus-Taxi Trip Distribution (Hours)

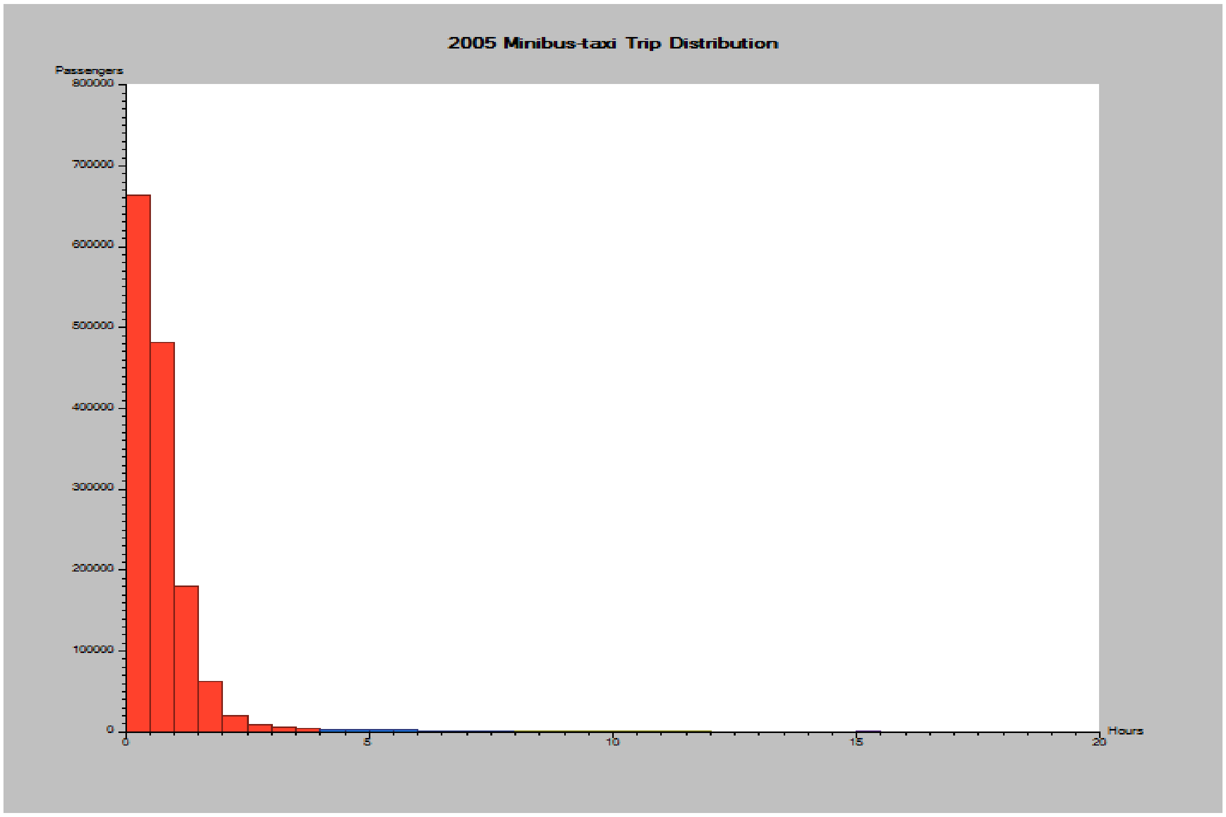


Figure 7.8: 2005 Bus Trip Distribution (Hours)

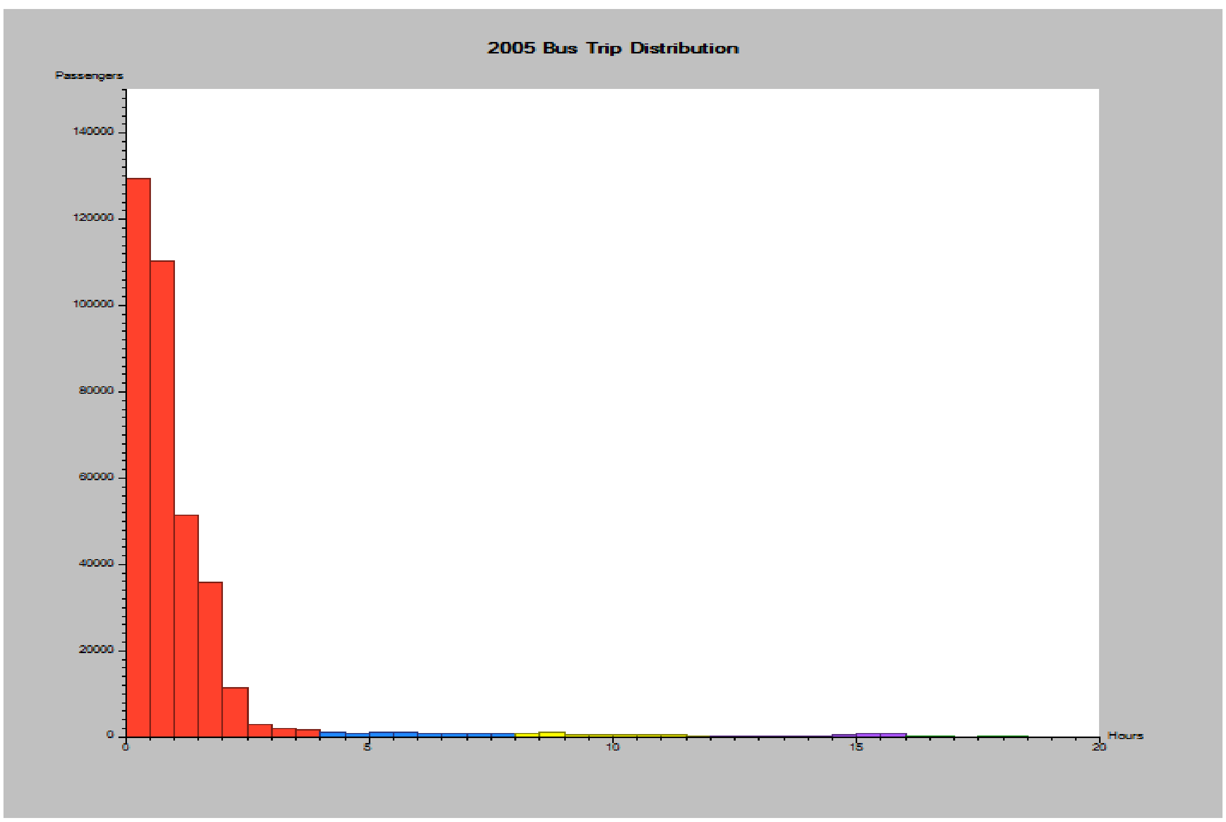


Figure 7.9: 2005 Rail Trip Distribution (Hours)

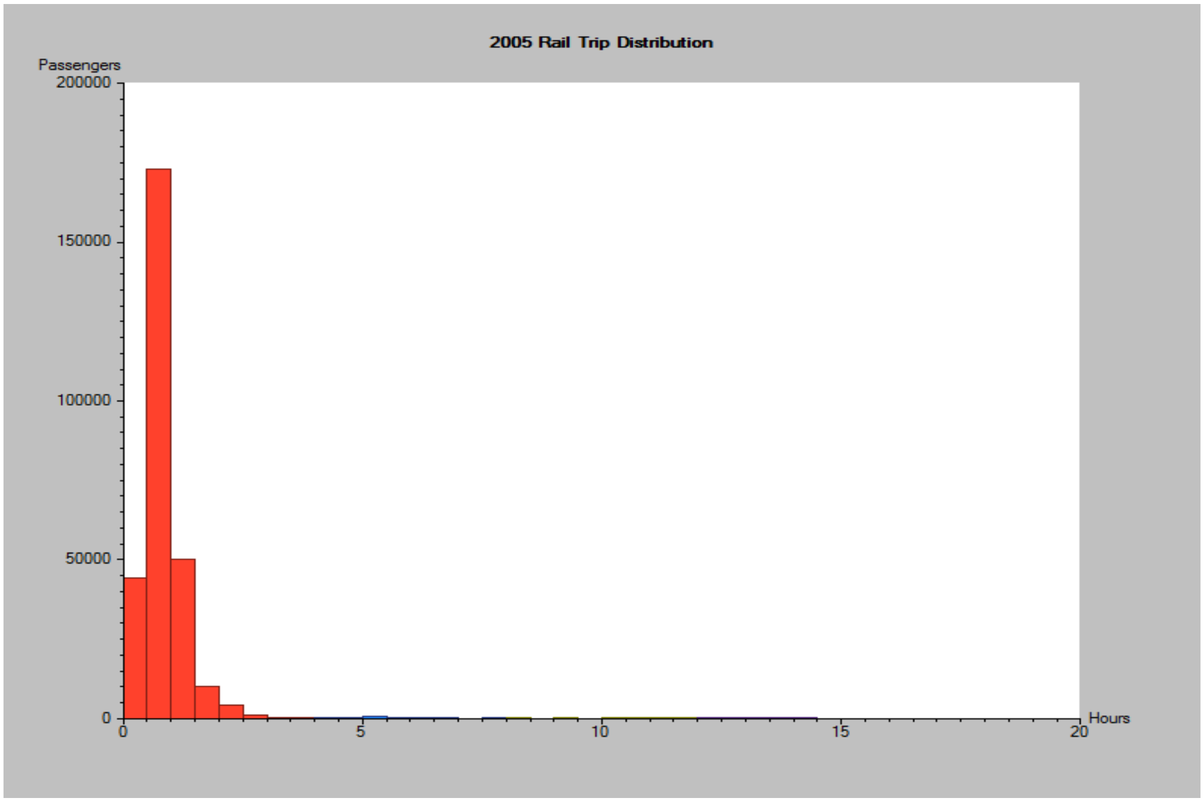
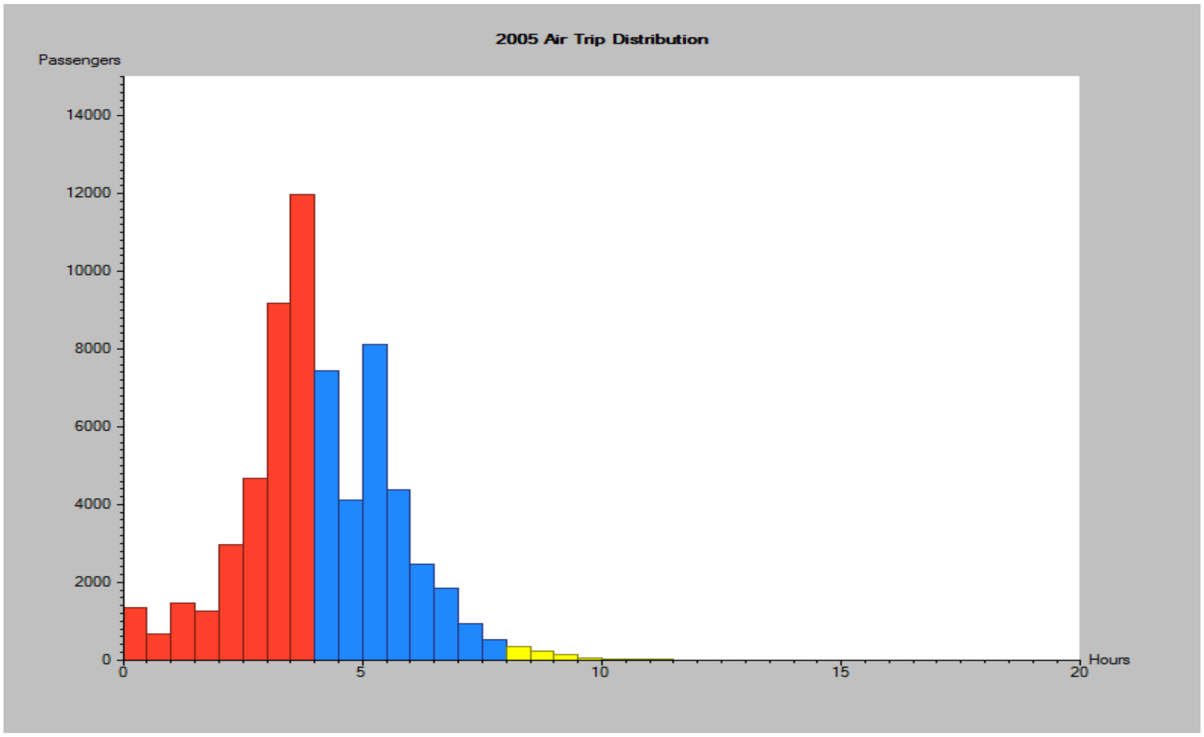


Figure 7.10: 2005 Air Trip Distribution (Hours)



7.1.4 Background Trips

Since the private road-based vehicle assigned volumes in the Natmap model are partial flows due to the large zone sizes and the fact that intra-zonal demand is not assigned onto the road network, it was necessary to develop a method to estimate the missing volumes for the purposes of analysis of future road bottlenecks and related capacity issues.

The problem of partial assigned volumes due to zone size and the coarse-level network is mainly of importance on roads of national importance in the metropolitan areas. While modelled volumes on the major corridors located outside metropolitan areas are also to some degree partial the number of intra-zonal trips in these areas not assigned to the road network is relatively small, and so for the purposes of this exercise the focus was entirely on the metropolitan areas.

Since the zoning system was large and the road network coarse even in the metropolitan areas, Base Year and future year estimation of background volumes it was clear that future year estimates of total road usage would have to be achieved using both traffic counts and land use and population data as the basis. Therefore, the approach adopted was to utilise the estimates of total road volumes, including for future year scenarios calculated growth rates (based on projected zonal changes in population and employment) as part of the FONA exercise.

The FONA approach uses Base Year traffic counts as a primary input and so this ensured that traffic counts could be used as a basis from which to estimate future modelled full road volumes. For future year estimates, where Base Year traffic counts are not applicable, the FONA model was supplied with EMME model zonal growth factors. These zonal factors were then applied to the FONA link volumes and estimates of future year total link volumes obtained. These link volumes were re-input directly into the EMME model as static volumes. I.e., they were not assigned in Origin-Destination (OD) matrix form to the road network.

The EMME model growth factors were estimated directly from the land use, population and employment data, the same data used to determine future year scenario trip ends used to develop the EMME future year OD matrices. Applying these factors in the FONA model in order to obtain future year full volumes on the EMME network ensured that distortions that would arise from using the modelled network and zoning system in a standard assignment exercise would be avoided. In other words, using data based on land use, population, and employment minimised the potential distortion that would occur by estimating background volumes based on the modelled network and zone size.

7.1.5 Expected Future Volumes

The expected future road, rail and air volumes are depicted in Figure 7.11 – 7.17

National: ROAD PASSENGERS VOLUMES (2030)

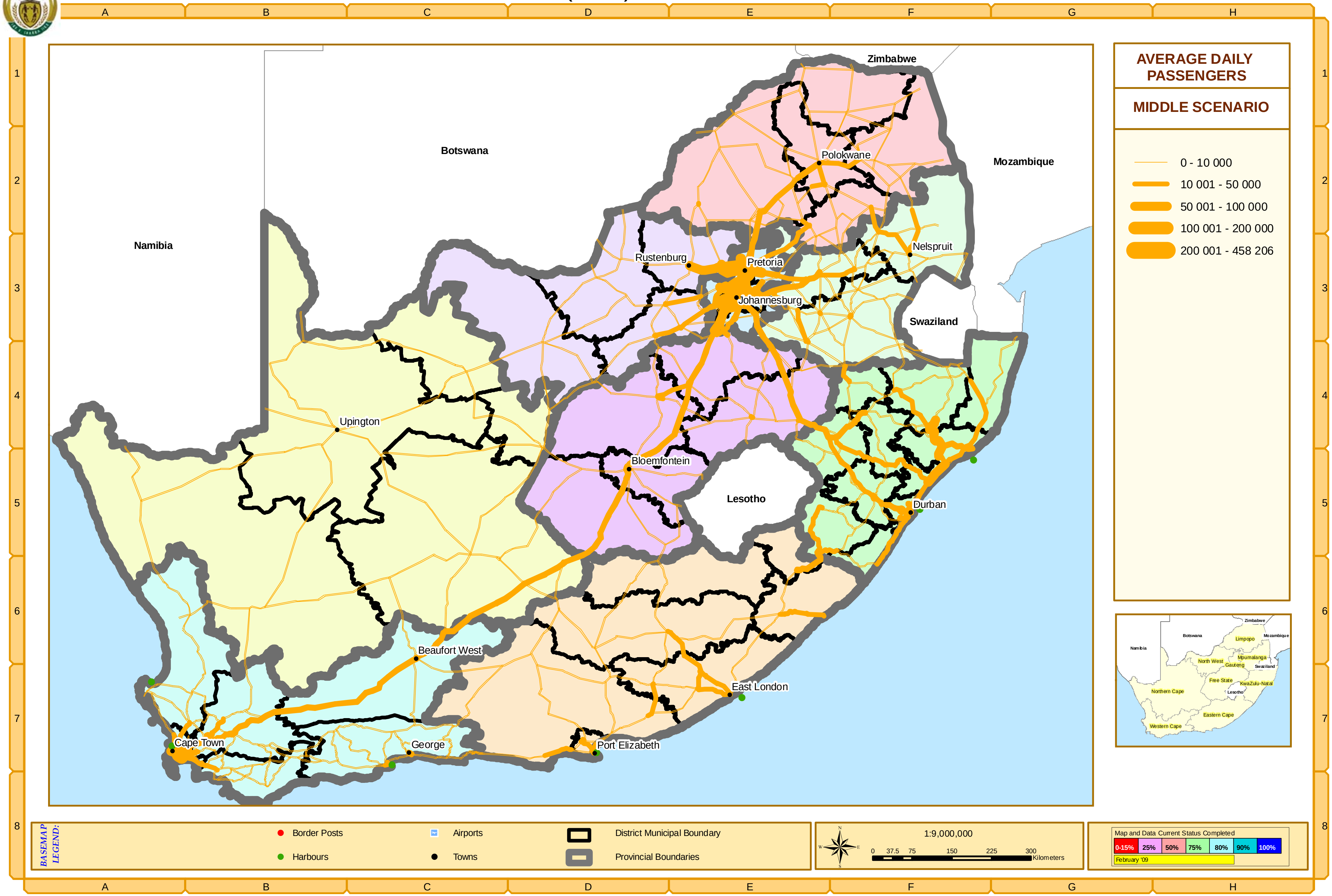


FIGURE 7.11 Road Passenger Volumes (Average Passengers/Day)-2030

NATIONAL TRANSPORT MASTERPLAN 2050

National: ROAD PASSENGER VOLUMES (2050)

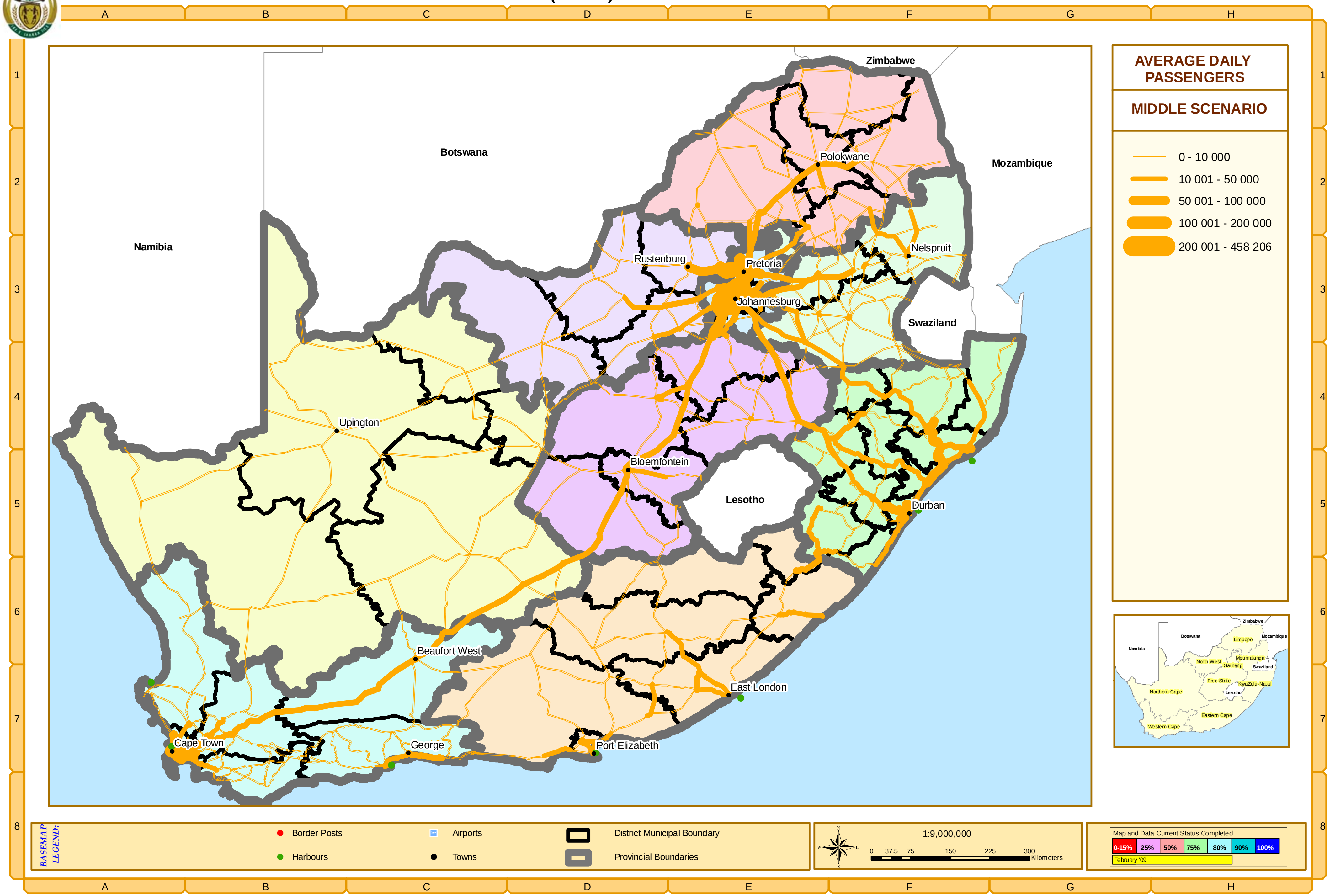


FIGURE 7.12 Road Passenger Volumes (Average Passengers/Day)-2050

National: RAIL PASSENGER VOLUMES (2030)

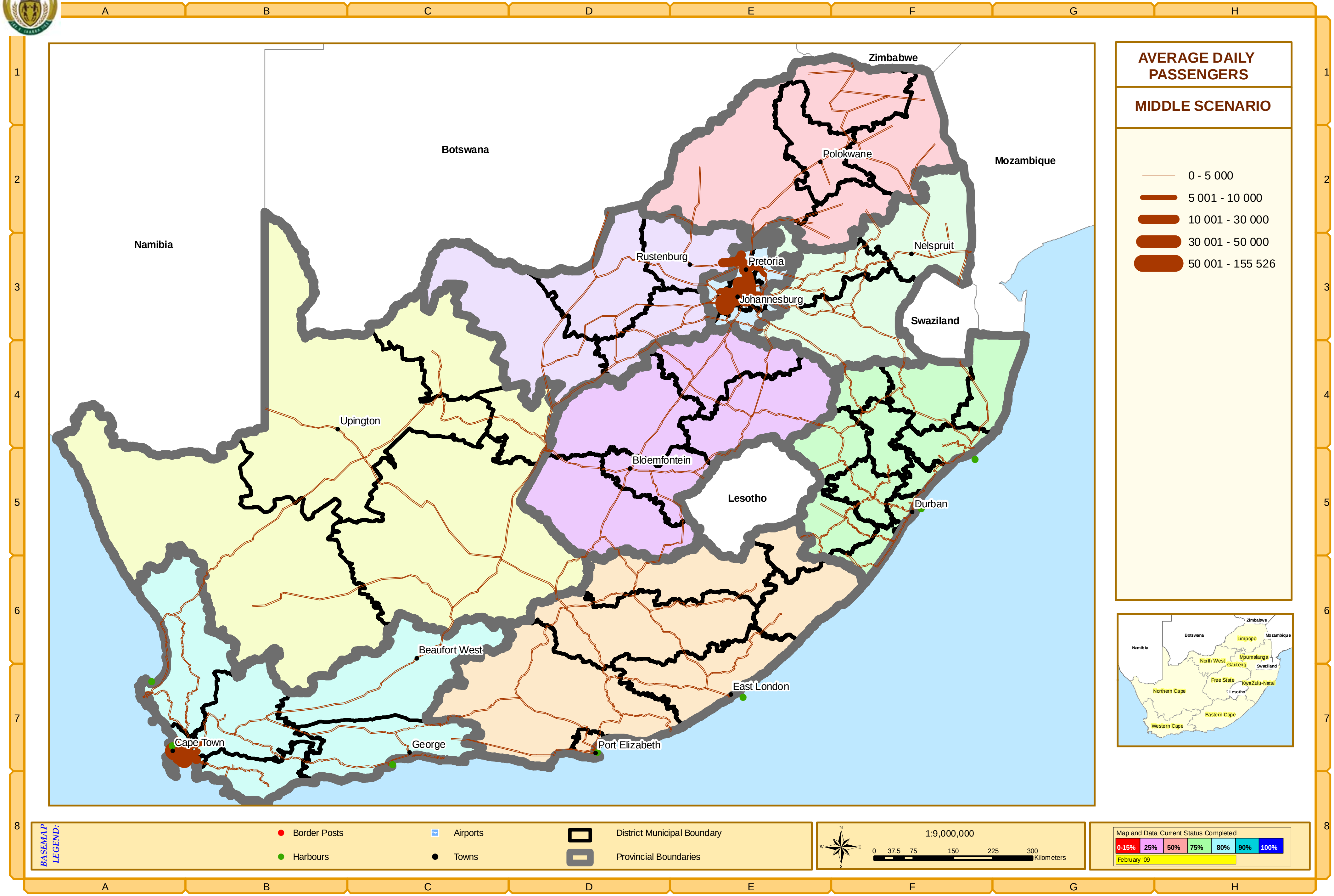
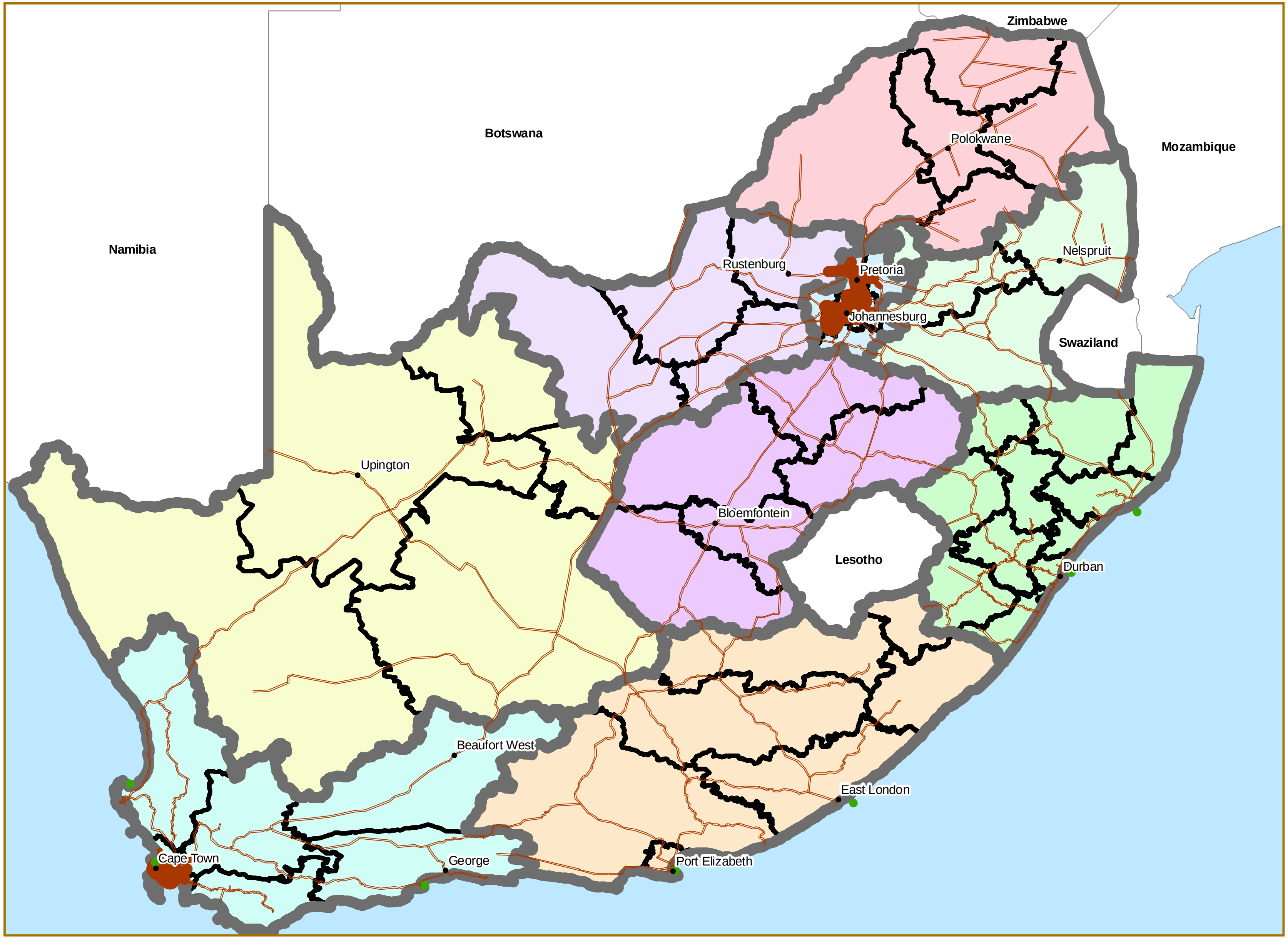


FIGURE 7.13 Rail Passenger Volumes (Average Passengers/Day)-2030

National: RAIL PASSENGER VOLUMES (2050)



AVERAGE DAILY PASSENGERS

MIDDLE SCENARIO

- 0 - 5 000
- 5 001 - 10 000
- 10 001 - 30 000
- 30 001 - 50 000
- 50 001 - 155 526

BASEMAP LEGEND:

- Border Posts
- Harbours
- Airports
- Towns
- District Municipal Boundary
- Provincial Boundaries

1:9,000,000

0 37.5 75 150 225 300 Kilometers

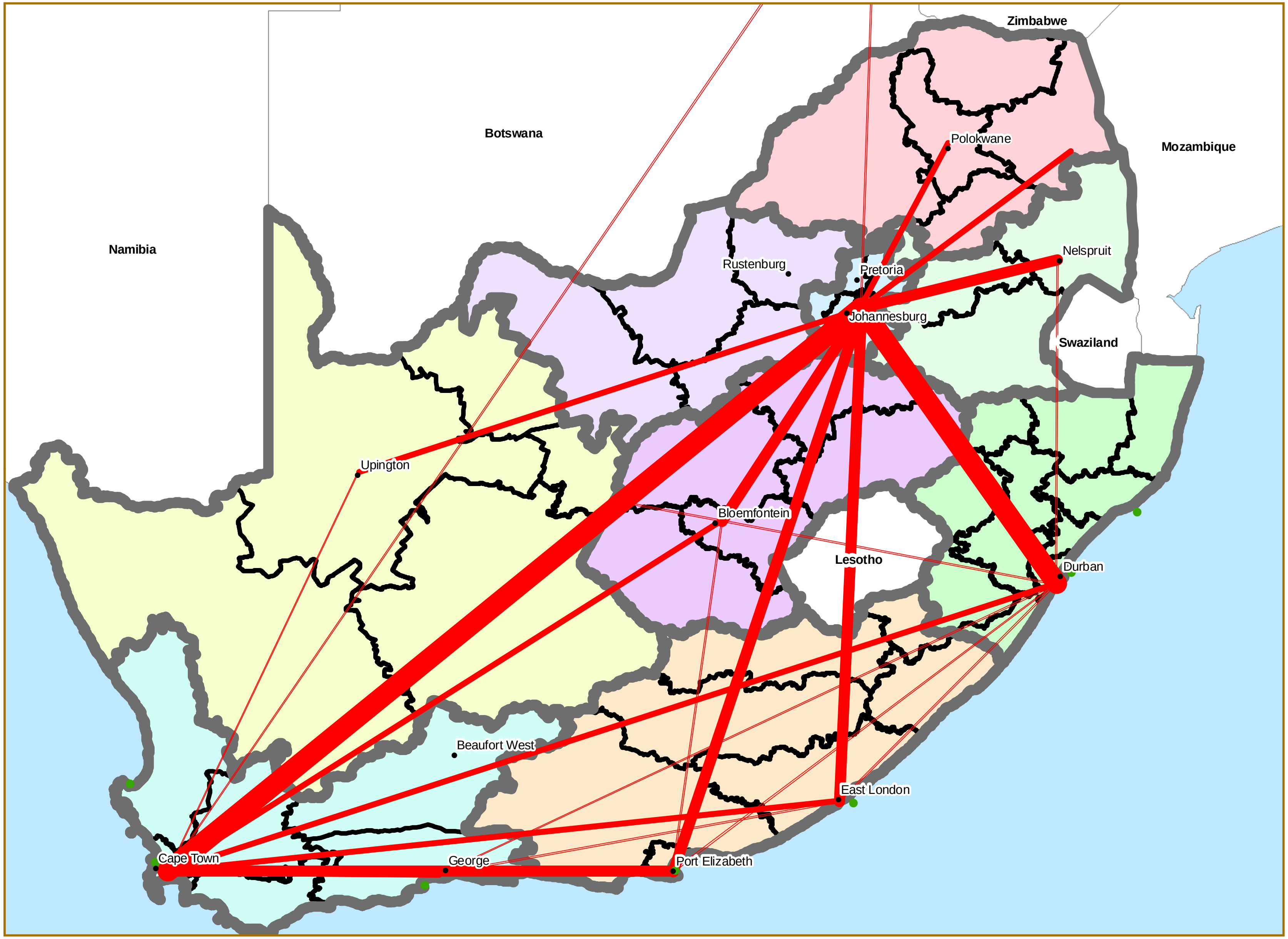
Map and Data Current Status Completed

0-15%	25%	50%	75%	80%	90%	100%

February '09

FIGURE 7.14 Rail Passenger Volumes (Average Passengers/Day)-2050

National: AIR PASSENGER VOLUMES (2030)



AVERAGE DAILY PASSENGERS

MIDDLE SCENARIO

- 0 - 500
- 501 - 1 500
- 1 501 - 4 000
- 4 01 - 8 000
- 8 001 - 23 170

BASEMAP LEGEND:

- Border Posts
- Harbours
- Airports
- Towns
- District Municipal Boundary
- Provincial Boundaries

1:9,000,000

0 37.5 75 150 225 300 Kilometers

Map and Data Current Status Completed

0-15%	25%	50%	75%	80%	90%	100%

February '09

NATIONAL TRANSPORT MASTERPLAN 2050

FIGURE 7.15 Air Passenger Volumes (Average Passengers/Day)-2030

National: AIR PASSENGER VOLUMES (2050)

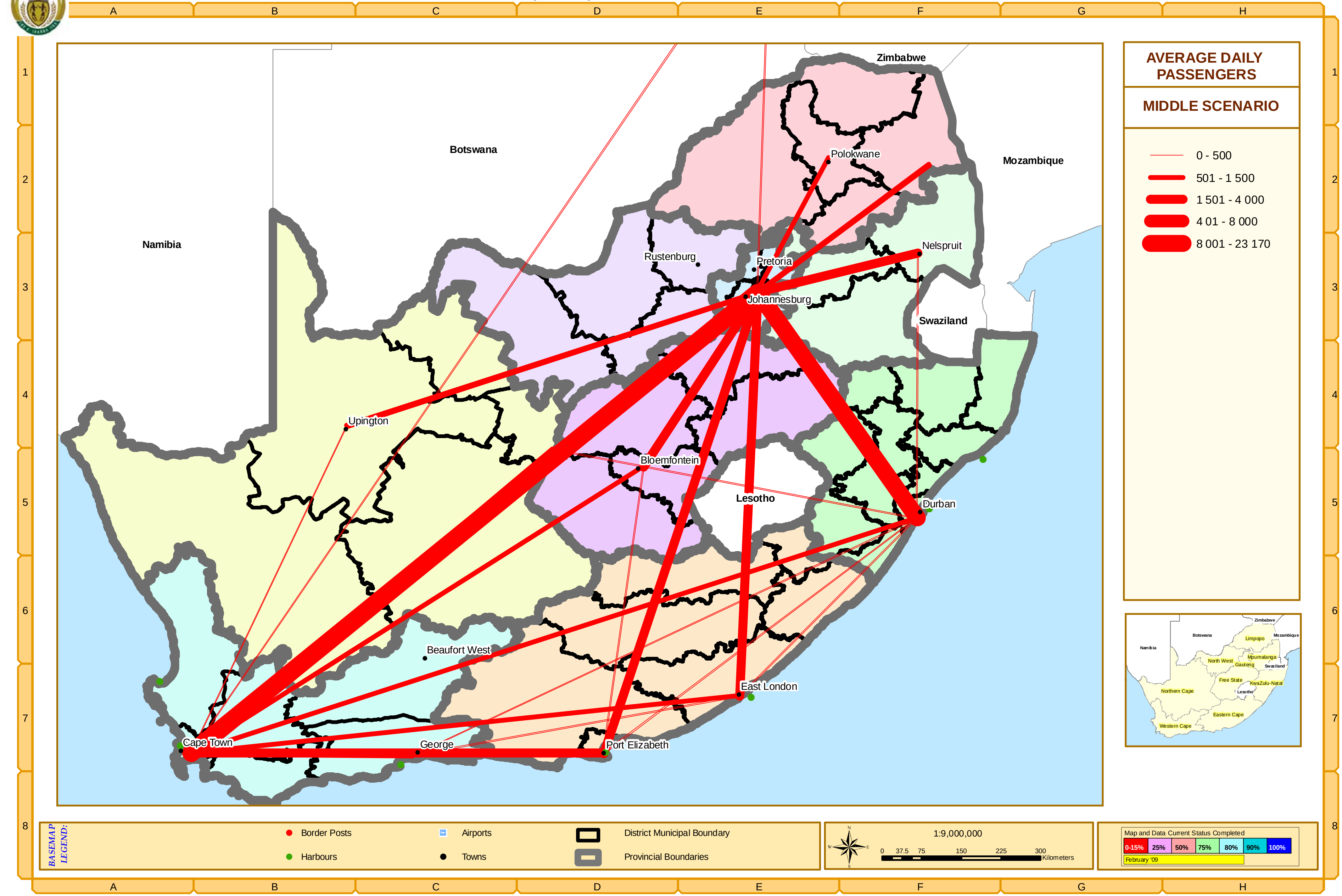


FIGURE 7.16 Air Passenger Volumes (Average Passengers/Day)-2050

7.2 FREIGHT ASSIGNMENT

Transport companies aim to keep the dead kilometres (kilometres travelled without generating income) to an absolutely minimum and simultaneously aim to keep the travel distance from point A to B also to a minimum in order to prohibit the incurrence of additional cost. For this reason the all or nothing assignment technique was chosen for the freight assignment (for both road and rail transport). This assignment technique explains the volumes on the majority of corridors. It was found that the average tonnage per vehicle is 14 and was used for the conversion from total tonnage to vehicles. Figures 7.17 and 7.18 display the average daily vehicle volumes on the roads and average daily tonnage by rail for 2005 (Base Year).

The target year 2030 and 2050 were chosen to give an indication of the expected average daily vehicle volumes and average daily tonnage transported by rail. These are displayed in Figures 7.19 to 7.22.

National: ROAD FREIGHT VOLUMES (2005)

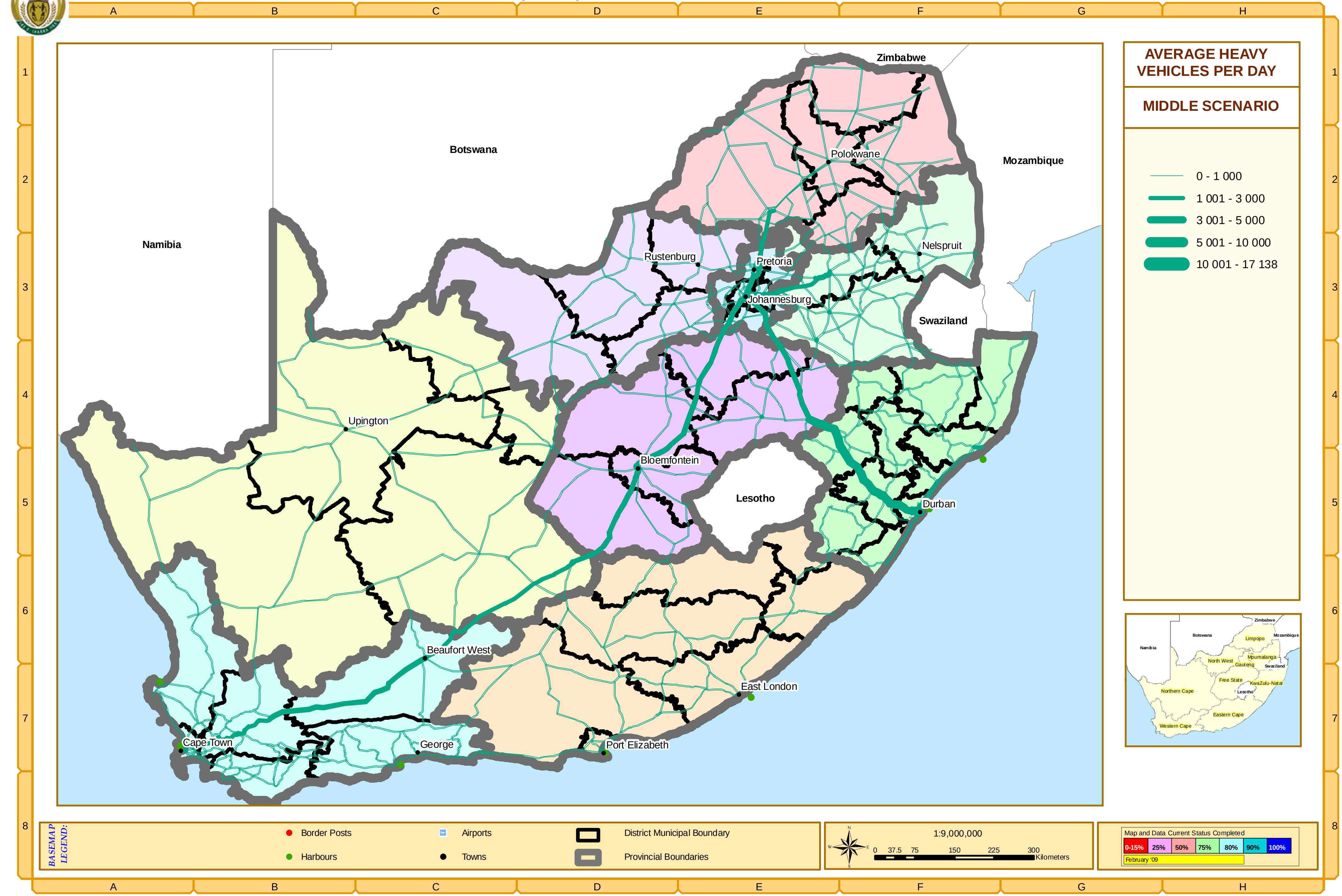


FIGURE 7.17 Road Freight Volumes (Average Daily Heavy Vehicles)-2005

National: RAIL FREIGHT VOLUMES (2005)

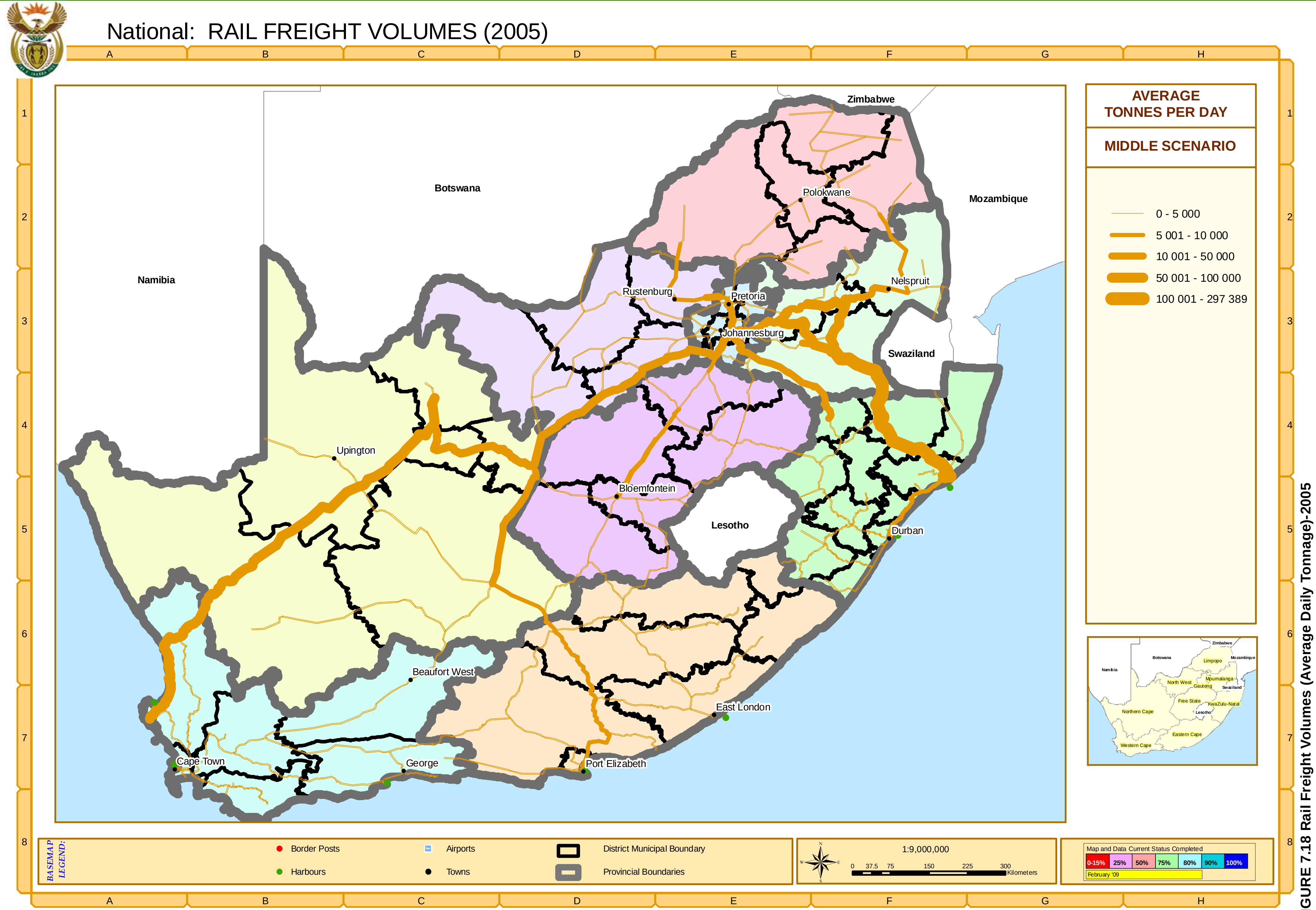


FIGURE 7.18 Rail Freight Volumes (Average Daily Tonnage)-2005

National: ROAD FREIGHT VOLUMES (2030)

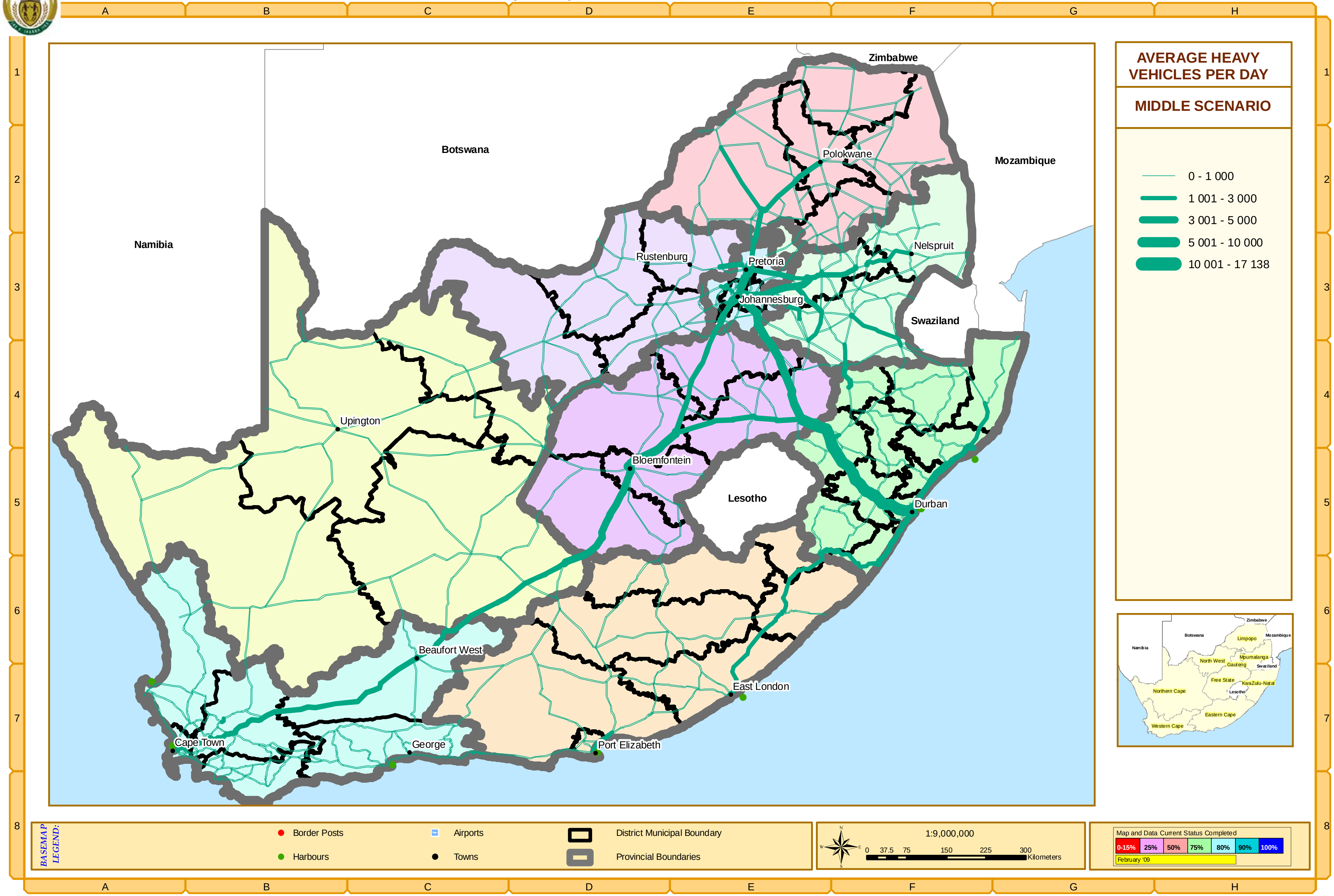


FIGURE 7.19 Road Freight Volumes (Average Daily Heavy Vehicles)-2030

National: ROAD FREIGHT VOLUMES (2050)

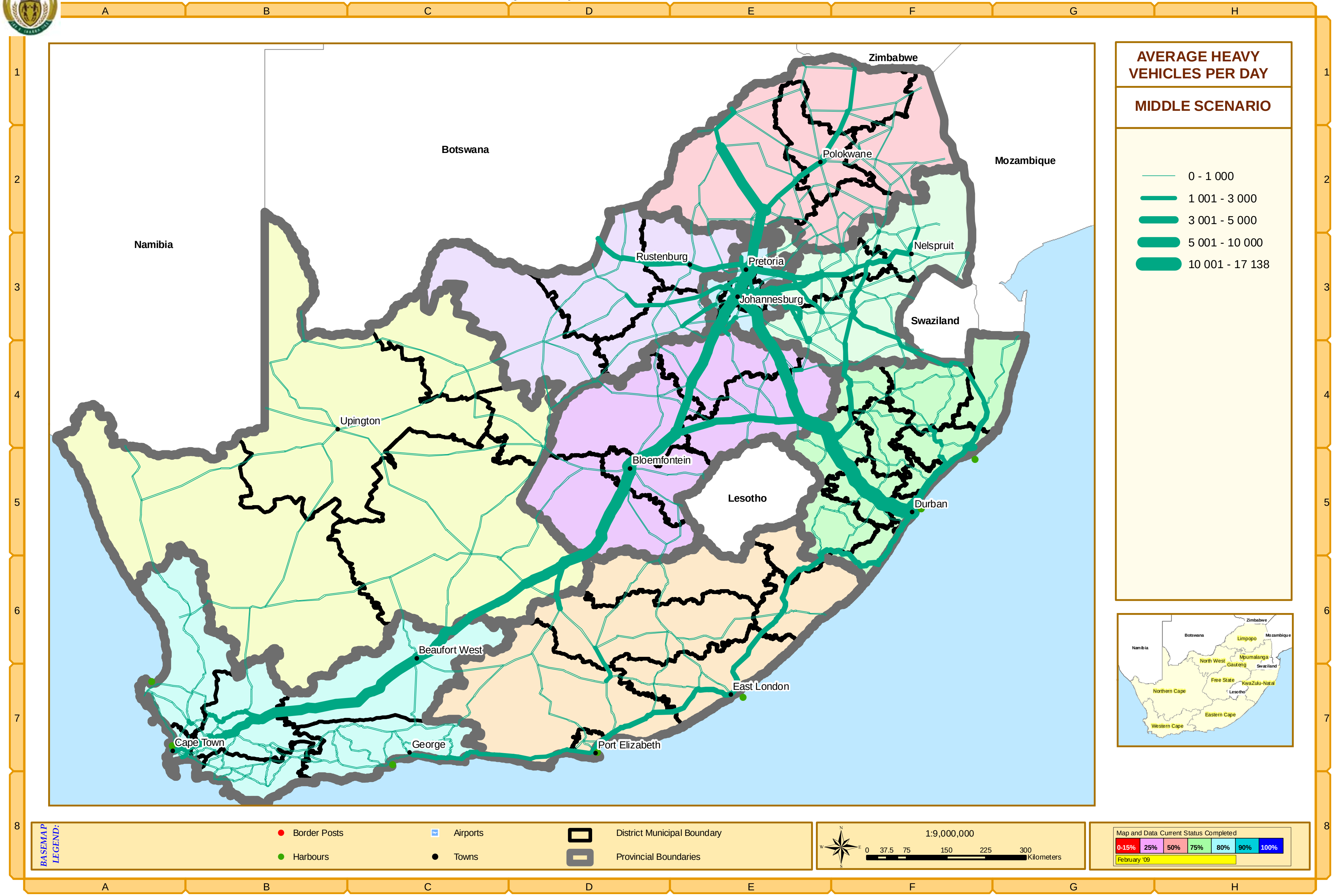
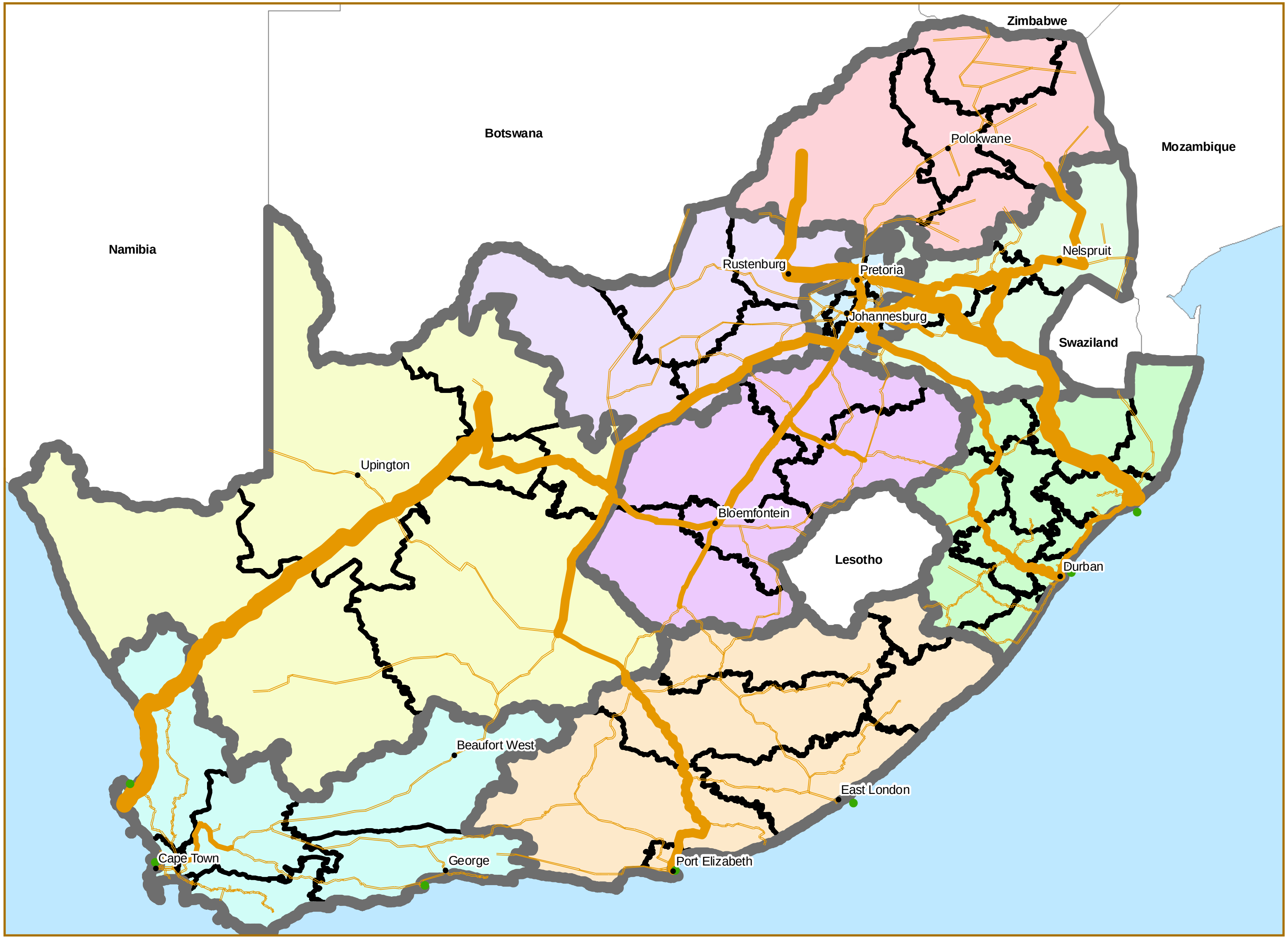


FIGURE 7.20 Road Freight Volumes (Average Daily Heavy Vehicles)-2050

National: RAIL FREIGHT VOLUMES (2030)



AVERAGE TONNES PER DAY

MIDDLE SCENARIO

- 0 - 5 000
- 5 001 - 10 000
- 10 001 - 50 000
- 50 001 - 100 000
- 100 001 - 297 389

BASEMAP LEGEND:

Border Posts, Harbours, Airports, Towns, District Municipal Boundary, Provincial Boundaries

1:9,000,000

0 37.5 75 150 225 300 Kilometers

Map and Data Current Status Completed

0-15% 25% 50% 75% 80% 90% 100%

February '09

FIGURE 7.21 Rail Freight Volumes (Average Daily Tonnage)-2030

National: RAIL FREIGHT VOLUMES (2050)

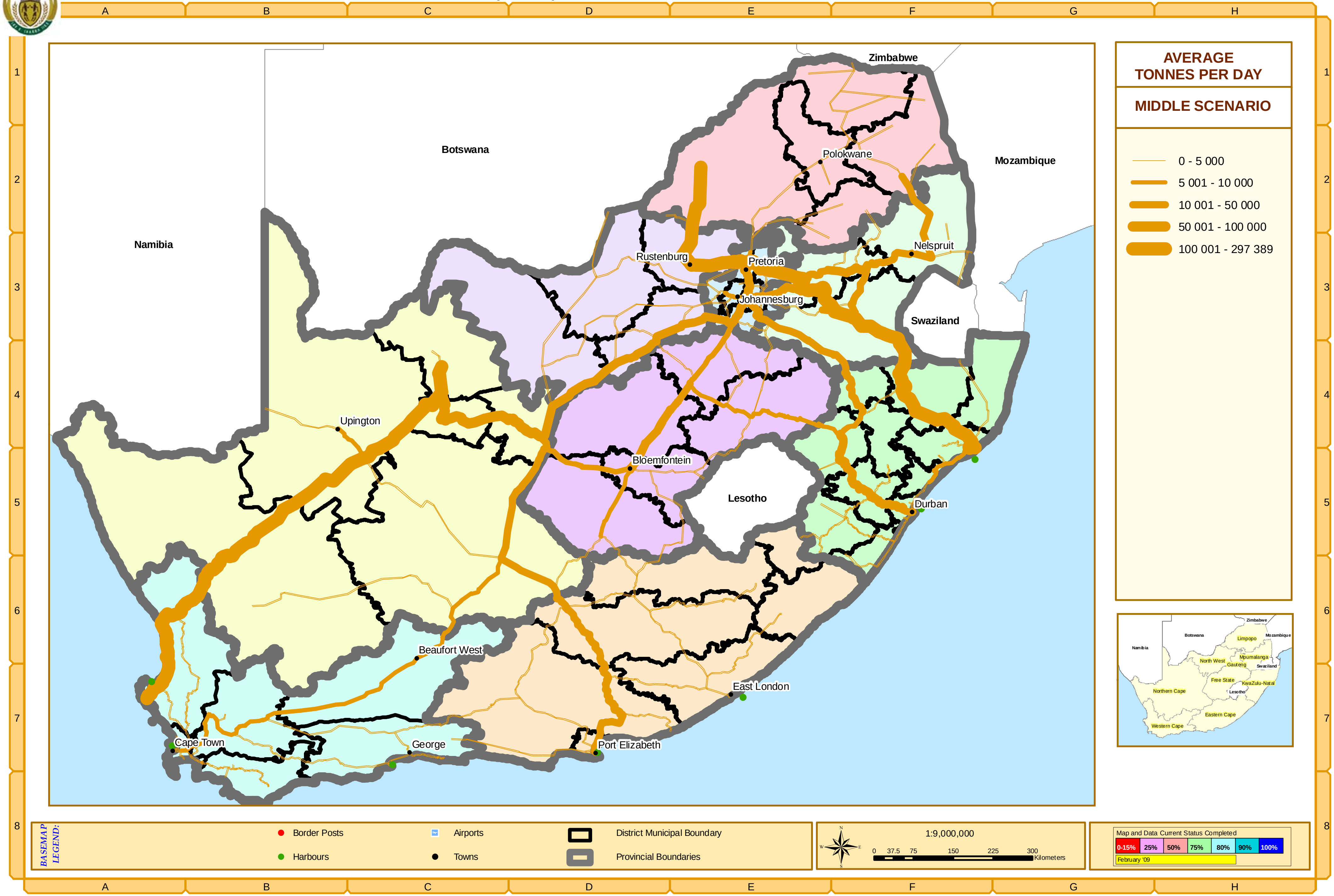


FIGURE 7.22 Rail Freight Volumes (Average Daily Tonnage)-2050

ANNEXURE A: INTERNAL ZONES

ZONE	DM	PROV	LM_MM	CENTROID	AREA (ha)
10101	City of Cape Town Metropolitan Municipality	Western Cape	City of Cape Town Metropolitan Municipality	Koeberg	46875
10102	City of Cape Town Metropolitan Municipality	Western Cape	City of Cape Town Metropolitan Municipality	Somerset West	33316
10103	City of Cape Town Metropolitan Municipality	Western Cape	City of Cape Town Metropolitan Municipality	Mitchell's Plain	23758
10104	City of Cape Town Metropolitan Municipality	Western Cape	City of Cape Town Metropolitan Municipality	Cape Town	47228
10105	City of Cape Town Metropolitan Municipality	Western Cape	City of Cape Town Metropolitan Municipality	Milnerton	8372
10106	City of Cape Town Metropolitan Municipality	Western Cape	City of Cape Town Metropolitan Municipality	Parow	28781
10107	City of Cape Town Metropolitan Municipality	Western Cape	City of Cape Town Metropolitan Municipality	Durbanville	59332
10201	West Coast District Municipality	Western Cape	Matzikama Local Municipality	Vredendal	1310512
10202	West Coast District municipality	Western Cape	Cederberg Local Municipality	Citrusdal	1251867
10203	West Coast District municipality	Western Cape	Saldanha Bay Local Municipality	Saldanha	203294
10204	West Coast District municipality	Western Cape	Swartland Local Municipality	Malmesbury	372161
10301	Cape Winelands District Municipality	Western Cape	Witzenberg Local Municipality	Ceres	1105731
10302	Cape Winelands District Municipality	Western Cape	Drakenstein Local Municipality	Paarl	154861
10303	Cape Winelands District Municipality	Western Cape	Stellenbosch Local Municipality	Stellenbosch	84298
10304	Cape Winelands District Municipality	Western Cape	Breede Valley Local Municipality	Worcester	301407
10305	Cape Winelands District Municipality	Western Cape	Breede River/Winelands Local Municipality	Robertson	598484
10401	Overberg District Municipality	Western Cape	Theewaterskloof Local Municipality	Caledon	326854
10402	Overberg District Municipality	Western Cape	Overstrand Local Municipality	Hermanus	171875
10403	Overberg District Municipality	Western Cape	Cape Agulhas Local Municipality (including Overber	Bredasdorp	346455
10404	Overberg District Municipality	Western Cape	Swellendam Local Municipality	Swellendam	301242
10501	Eden District Municipality	Western Cape	Kannaland Local Municipality	Ladismith	477183
10502	Eden District Municipality	Western Cape	Hessequa Local Municipality (Langeberg)	Riversdale	575204
10503	Eden District Municipality	Western Cape	Mossel Bay Local Municipality	Mossel Bay	201227
10504	Eden District Municipality	Western Cape	George Local Municipality	George	107370
10505	Eden District Municipality	Western Cape	Oudtshoorn Local Municipality	Oudtshoorn	771612
10506	Eden District Municipality	Western Cape	Knysna Local Municipality	Knysna	205145
10601	Central Karoo District Municipality	Western Cape	Beaufort West Local Municipality	Beaufort West	3892430
20101	Nelson Mandela Metropolitan Municipality	Eastern Cape	Nelson Mandela Metropolitan Municipality	Port Elizabeth	80458
20102	Nelson Mandela Metropolitan Municipality	Eastern Cape	Nelson Mandela Metropolitan Municipality	Coega	55628
20103	Nelson Mandela Metropolitan Municipality	Eastern Cape	Nelson Mandela Metropolitan Municipality	Uitenhage	59734
20201	Cacadu District Municipality	Eastern Cape	Camdeboo Local Municipality	Graaff-Reinet	3249665
20202	Cacadu District Municipality	Eastern Cape	Makana Local Municipality	Grahamstown	1976565
20203	Cacadu DistrictMunicipality	Eastern Cape	Kouga Local Municipality	Humansdorp	599422
20301	Amatole DistrictMunicipality	Eastern Cape	Amahlathi Local Municipality	Stutterheim	1237798
20302	Amatole DistrictMunicipality	Eastern Cape	Buffalo City Local Municipality	East london	206487
20303	Amatole DistrictMunicipality	Eastern Cape	Buffalo City Local Municipality	King WilliamsTown	46608
20304	Amatole District Municipality	Eastern Cape	Nkonkobe Local Municipality	Fort Beaufort	870342
20401	Chris Hani District Municipality	Eastern Cape	Inxuba Yethemba Local Municipality	Cradock	1775479
20402	Chris Hani District Municipality	Eastern Cape	Lukanji Local Municipality	Queenstown	1896985
20501	Ukhahlamba District Municipality	Eastern Cape	Maletswai Local Municipality	Aliwal North	2569214
20601	O.R.Tambo District Municipality	Eastern Cape	Port St Johns Local Municipality	Port Saint Johns	767577
20602	O.R.Tambo District Municipality	Eastern Cape	King Sabata Dalindyebo Local Municipality	Umtata	835427
20701	Alfred Nzo District Municipality	Eastern Cape	Umzimvubu Local Municipality	Mount Frere	688215
30101	Namakwa District Municipality	Northern Cape	Nama Khoi Local Municipality	Springbok	2495762
30102	Namakwa District Municipality	Northern Cape	Hantam Local Municipality	Calvinia	10284287
30201	Pixley ka Seme District Municipality	Northern Cape	Emthanjeni Local Municipality	De Aar	10282015
30301	Siyanda District Municipality	Northern Cape	Mier Local Municipality	Twee Rivieren	1996654
30302	Siyanda District Municipality	Northern Cape	//Khara Hais Local Municipality	Upington	8294064
30401	Frances Baard District Municipality	Northern Cape	Sol Plaatjie Local Municipality	Kimberley	1352057
30501	Kgalagadi District Municipality	Northern Cape	Ga-Segonyana Local Municipality	Kuruman	2730950

40101	Xhariep District Municipality	Free State	Kopanong Local Municipality	Springfontein	2547915
40102	Motheo District Municipality	Free State	Lukanji Local Municipality	Rouxville	878200
40301	Motheo District Municipality	Free State	Mangaung Local Municipality	Bloemfontein	466210
40302	Motheo District Municipality	Free State	Mangaung Local Municipality	Thaba Nchu	934482
40401	Lejweleputswa District Municipality	Free State	Matjhabeng Local Municipality	W elkom	3194193
40501	Thabo Mofutsanyane District Municipality	Free State	Dihlabeng Local Municipality	Bethlehem	1634963
40502	Thabo Mofutsanyane District Municipality	Free State	Maluti a Phofung Local Municipality	Harrismith	1208133
40601	Northern Free State District Municipality	Free State	Moqhaka Local Municipality	Maokeng	793470
40602	Northern Free State District Municipality	Free State	Metsimaholo Local Municipality	Sasolburg	1340532
50101	eThekwini Metropolitan Municipality	Kwazulu Natal	eThekwini Metropolitan Municipality	Kwa Mashu	34051
50102	eThekwini Metropolitan Municipality	Kwazulu Natal	eThekwini Metropolitan Municipality	Hammarsdale	51828
50103	eThekwini Metropolitan Municipality	Kwazulu Natal	eThekwini Metropolitan Municipality	Pinetown	41433
50104	eThekwini Metropolitan Municipality	Kwazulu Natal	eThekwini Metropolitan Municipality	Umhlanga	37346
50105	eThekwini Metropolitan Municipality	Kwazulu Natal	eThekwini Metropolitan Municipality	Durban CBD	15800
50106	eThekwini Metropolitan Municipality	Kwazulu Natal	eThekwini Metropolitan Municipality	Amanzimtoti	19275
50107	eThekwini Metropolitan Municipality	Kwazulu Natal	eThekwini Metropolitan Municipality	Umlazi	37076
50201	Ugu District Municipality	Kwazulu Natal	Hibiscus Coast Local Municipality	Port Shepstone	507243
50301	UMgungundlovu District Municipality	Kwazulu Natal	The Msunduzi Local Municipality	Edendale	898974
50401	Uthukela District Municipality	Kwazulu Natal	Emnambithi-Ladysmith Local Municipality	Ladysmith	1052172
50402	Uthukela District Municipality	Kwazulu Natal	KZNDMA23	Cathedral Peak	86360
50501	Umzinyathi District Municipality	Kwazulu Natal	Endumeni Local Municipality	Dundee	612020
50502	Umzinyathi District Municipality	Kwazulu Natal	Umvoti Local Municipality	Greytown	253241
50601	Amajuba District Municipality	Kwazulu Natal	Newcastle Local Municipality	Newcastle	695285
50701	Zululand District Municipality	Kwazulu Natal	Ulundi Local Municipality	Ulundi	1494248
50801	Umkhanyakude District Municipality	Kwazulu Natal	Jozini Local Municipality	Mkuze	1403533
50901	Uthungulu District Municipality	Kwazulu Natal	uMhlathuze Local Municipality	Richard's Bay	312030
50902	Uthungulu District Municipality	Kwazulu Natal	uMlalazi Local Municipality	Eshowe	517381
51001	iLembe District Municipality	Kwazulu Natal	KwaDukuza Local Municipality	Stanger	324430
51101	Sisonke District Municipality	Kwazulu Natal	Kwa Sani Local Municipality (inc Mkhomazi)	Underberg	243313
51102	Sisonke District Municipality	Kwazulu Natal	Greater Kokstad Local Municipality	Kokstad	874946
60101	Bojanala District Municipality	North West	Local Municipality of Madibeng	Brits	522759
60102	Bojanala District Municipality	North West	Rustenburg Local Municipality	Rustenburg	1313020
60201	Central District Municipality	North West	Mafikeng Local Municipality	Mafikeng	2789380
60301	Bophirima District Municipality	North West	Naledi Local Municipality	Vryburg	4402905
60401	Southern District Municipality	North West	Ventersdorp Local Municipality	Ventersdorp	540117
60402	Southern District Municipality	North West	Potchefstroom Local Municipality	Potchefstroom	267712
60403	Southern District Municipality	North West	Matlosana Local Municipality	Klerksdorp	820866
70101	City of Johannesburg Metropolitan Municipality	Gauteng	City of Johannesburg Metropolitan Municipality	Midrand	43055
70102	City of Johannesburg Metropolitan Municipality	Gauteng	City of Johannesburg Metropolitan Municipality	Roodepoort	21448
70103	City of Johannesburg Metropolitan Municipality	Gauteng	City of Johannesburg Metropolitan Municipality	Johannesburg CBD	52459
70104	City of Johannesburg Metropolitan Municipality	Gauteng	City of Johannesburg Metropolitan Municipality	Soweto	47706
70201	Ekurhuleni Metropolitan Municipality	Gauteng	Ekurhuleni Metropolitan Municipality	Kempton Park	27201
70202	Ekurhuleni Metropolitan Municipality	Gauteng	Ekurhuleni Metropolitan Municipality	Bapsfontein	30146
70203	Ekurhuleni Metropolitan Municipality	Gauteng	Ekurhuleni Metropolitan Municipality	Germiston	58015
70204	Ekurhuleni Metropolitan Municipality	Gauteng	Ekurhuleni Metropolitan Municipality	Benoni	77418
70301	City of Tshwane Metropolitan Municipality	Gauteng	City of Tshwane Metropolitan Municipality	Mabopane	48273
70302	City of Tshwane Metropolitan Municipality	Gauteng	City of Tshwane Metropolitan Municipality	Temba	46150
70303	City of Tshwane Metropolitan Municipality	Gauteng	City of Tshwane Metropolitan Municipality	Pretoria	76188
70304	City of Tshwane Metropolitan Municipality	Gauteng	City of Tshwane Metropolitan Municipality	Centurion	49382
70401	Sedibeng District Municipality	Gauteng	Emfuleni Local Municipality	Vanderbijl Park	96919
70402	Sedibeng District Municipality	Gauteng	Midvaal Local Municipality	Meyerton	173057
70403	Sedibeng District Municipality	Gauteng	Lesedi Local Municipality	Heidelberg	149186

70501	Metsweding District Municipality	Gauteng	Nokeng tsa Taemane Local Municipality	Cullinan	196951
70502	Metsweding District Municipality	Gauteng	Kungwini Local Municipality	Bronkhorstspruit	173405
70503	Metsweding District Municipality	Gauteng	Kungwini Local Municipality	Olympus	45829
70601	West Rand District Municipality	Gauteng	Mogale City Local Municipality	Krugersdorp	134698
70602	West Rand District Municipality	Gauteng	Randfontein Local Municipality	Randfontein	47721
70603	West Rand District Municipality	Gauteng	Westonaria Local Municipality	Westonaria	63886
80101	Gert Sibande District Municipality	Mpumalanga	Msukaligwa Local Municipality	Ermelo	1165663
80102	Gert Sibande District Municipality	Mpumalanga	Mkhondo Local Municipality	Piet Retief	492055
80103	Gert Sibande District Municipality	Mpumalanga	Pixley Ka Seme Local Municipality	Amersfoort	525794
80104	Gert Sibande District Municipality	Mpumalanga	Lekwa Local Municipality	Standerton	723186
80105	Gert Sibande District Municipality	Mpumalanga	Govan Mbeki Local Municipality	Bethal	124741
80106	Gert Sibande District Municipality	Mpumalanga	Govan Mbeki Local Municipality	Secunda	171904
80201	Nkangala District Municipality	Mpumalanga	Delmas Local Municipality	Delmas	157250
80202	Nkangala District Municipality	Mpumalanga	Emalahleni Local Municipality	Witbank	268872
80203	Nkangala District Municipality	Mpumalanga	Steve Tshwete Local Municipality	Middelburg	399575
80204	Nkangala District Municipality	Mpumalanga	Highlands Local Municipality	Belfast	476739
80205	Nkangala District Municipality	Mpumalanga	Dr JS Moroka Local Municipality	Siyabuswa	381572
80301	Ehlanzeni District Municipality	Mpumalanga	Thaba Chweu Local Municipality	Lydenburg	576430
80302	Ehlanzeni District Municipality	Mpumalanga	Mbombela Local Municipality	N elspruit	848206
80303	Ehlanzeni District Municipality	Mpumalanga	Bushbuckridge Local Municipality	Bosbokrand	261439
80304	Ehlanzeni District Municipality	Mpumalanga	MPDMA32	Skukuza	938167
80305	Ehlanzeni District Municipality	Mpumalanga	MPDMA32	Malelane Gate	193132
90101	Mopani District Municipality	Limpopo	Greater Giyani Local Municipality	Giyani	300990
90102	Mopani District Municipality	Limpopo	Greater Tzaneen Local Municipality	Tzaneen	516938
90103	Mopani District Municipality	Limpopo	Maruleng Local Municipality	Phalaborwa	630201
90201	Vhembe District Municipality	Limpopo	Musina Local Municipality	Musina	542550
90202	Vhembe District Municipality	Limpopo	Musina Local Municipality	Venetia Diamond Mine	219620
90203	Vhembe District Municipality	Limpopo	Thulamela Local Municipality	Thohoyandou	529005
90204	Vhembe District Municipality	Limpopo	Makhado Local Municipality	Makhado	857629
90301	Capricorn District Municipality	Limpopo	Polokwane Local Municipality	Polokwane	1359172
90302	Capricorn District Municipality	Limpopo	Lepele-Nkumpi Local Municipality	Lebowakgomo	348436
90401	Waterberg District Municipality	Limpopo	Thabazimbi Local Municipality	Thabazimbi	987629
90402	Waterberg District Municipality	Limpopo	Lephalale Local Municipality	Ellisras	1964500
90403	Waterberg District Municipality	Limpopo	Mookgopong Local Municipality	Naboomspruit	1053453
90404	Waterberg District Municipality	Limpopo	Bela-Bela Local Municipality	Bela Bela	338749
90405	Waterberg District Municipality	Limpopo	Mogalakwena Local Municipality	Mokopane	618625
90501	Greater Sekhukhune District Municipality	Limpopo	Greater Marble Hall Local Municipality	Marble hall	191676
90502	Greater Sekhukhune District Municipality	Limpopo	Elias Motsoaledi Local Municipality	Groblersdal	373147
90503	Greater Sekhukhune District Municipality	Limpopo	Makhuduthamaga Local Municipality	Jjane Furse Hospital	322254
90504	Greater Sekhukhune District Municipality	Limpopo	Greater Tubatse Local Municipality	Burgersfort	463333
90601	Mopani District Municipality	Limpopo	NPDMA33	Kruger National Shingwedzi	451893
90602	Mopani District Municipality	Limpopo	NPDMA33	Kruger National Letaba	570273

ANNEXURE B: BASE DATA TRIP GENERATION RESULTS

		Production Side												Attraction Side											
		Work trips			Business trips			Migrant trips			Holiday trips			Work trips			Business trips			Migrant trips			Holiday trips		
	NATMAP ZONE	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)	LOW (up to R3000)	MEDIUM (R3001-R6000)	HIGH (R6000+)
NAME	**Unit**	**Total person trips per week**	**Total person trips per week**	**Total person trips per week**	**Total person trips per month**	**Total person trips per month**	**Total person trips per month**	**Total person trips per month**	**Total person trips per month**	**Total person trips per month**	**Total person trips per year**	**Total person trips per year**	**Total person trips per year**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**	**Total of last trip**
TOTAL TRIPS	**ALL**	**28,234,428**	**9,712,241**	**#########**	**711,380**	**1,063,526**	**1,781,402**	**760,674**	**145,670**	**107,601**	**7,485,721**	**2,680,151**	**3,853,700**	**4,486,366**	**1,629,013**	**2,398,767**	**76,268**	**53,704**	**170,062**	**328,383**	**81,559**	**32,698**	**1,947,261**	**377,833**	**797,204**
Koeberg	10101	11,515	44,676	35,934	1,992	2,978	4,622	601	186	131	2,837	12,511	10,877	8,406	4,283	6,306	142	141	447	45	116	57	738	380	802
Somerset West	10102	6,775	90,648	84,575	4,688	7,009	17,042	8,419	557	313	1,669	25,384	40,108	19,831	6,989	10,292	335	230	730	27	278	209	434	1,141	2,407
Mitchell's Plain	10103	1,206,940	318,530	382,607	21,209	31,708	7,963	8,419	1,856	1,042	297,339	89,197	18,742	37,109	25,214	37,128	2,452	831	2,632	4,760	978	98	77,347	3,803	8,025
Cape Town	10104	11,853	72,949	154,324	8,555	12,789	46,941	27,235	11,691	6,563	2,920	20,428	110,477	110,645	63,412	93,376	586	2,091	6,620	47	224	577	760	23,960	50,555
Milnerton	10105	11,241	8,482	43,905	2,434	3,639	14,546	4,860	1,113	625	2,769	2,375	34,234	19,740	8,183	12,050	167	270	854	44	26	179	720	2,282	4,815
Parow	10106	308,585	384,384	377,058	20,901	31,248	44,418	20,406	2,227	1,250	76,022	107,638	104,538	89,526	48,044	70,746	1,578	1,584	5,016	1,217	1,180	546	19,776	4,564	9,630
Durbanville	10107	5,053	2,366	71,126	3,943	5,894	27,951	997	928	548	1,245	662	65,784	28,324	8,150	12,002	270	269	851	20	7	343	324	1,902	4,012
Vredendal	10201	36,411	15,161	21,448	1,189	1,777	1,693	860	96	151	9,922	4,696	4,409	5,830	3,073	4,525	98	101	321	536	407	58	2,581	352	743
Citrusdal	10202	58,326	20,274	31,394	1,740	2,602	1,804	547	116	68	16,799	6,637	4,963	7,248	4,688	6,904	141	155	489	908	689	65	4,370	651	1,373
Saldanha	102	33,7	25,6	30,8	1,70	2,55	4,11	3,02	201	118	8,04	6,97	9,38	7,54	4,69	6,91	135	155	490	435	76	122	2,09	1,40	2,97

	03	10	98	19	8	4	5	8			8	4	6	9	8	8							3	9	4
Malmesbury	10204	41,109	19,817	27,141	1,505	2,249	2,273	682	121	71	10,810	5,923	5,711	6,323	3,555	5,234	119	117	371	584	443	75	2,812	407	858
Ceres	10301	55,741	28,370	37,552	2,082	3,112	3,150	578	112	63	12,213	7,065	6,592	7,780	5,776	8,506	164	190	603	660	501	86	3,177	657	1,387
Paarl	10302	84,638	60,635	71,001	3,936	5,884	10,781	2,060	502	284	18,914	15,402	23,016	16,702	9,042	13,315	337	298	944	1,022	776	300	4,920	2,150	4,536
Stellenbosch	10303	64,363	31,919	41,974	2,327	3,479	4,587	1,024	462	260	17,839	10,056	12,145	11,746	7,047	10,377	197	232	736	964	110	158	4,640	1,807	3,813
Worcester	10304	79,749	44,371	53,300	2,955	4,417	5,774	1,862	267	153	18,298	11,572	12,657	12,255	7,701	11,340	254	254	804	989	751	165	4,760	1,044	2,202
Robertson	10305	50,275	21,832	27,908	1,547	2,313	2,049	536	84	48	13,812	6,818	5,376	7,463	3,675	5,412	134	121	384	746	567	70	3,593	937	1,978
Caledon	10401	70,548	23,028	36,743	2,037	3,045	2,015	1,077	157	94	19,544	7,251	5,332	8,039	5,356	7,887	166	177	559	1,056	802	70	5,084	694	1,464
Hermanus	10402	34,020	17,623	21,832	1,210	1,809	1,667	393	169	96	13,073	7,698	6,122	7,912	2,798	4,120	98	92	292	706	84	80	3,401	1,365	2,880
Bredasdorp	10403	12,120	8,554	10,344	573	857	1,008	387	53	30	3,665	2,940	2,911	3,515	1,278	1,881	43	42	133	198	150	38	953	326	688
Swellendam	10404	16,232	7,431	10,362	574	859	862	203	29	20	4,608	2,398	2,338	3,109	1,397	2,058	46	46	146	249	189	30	1,199	323	681
Ladismith	10501	12,908	5,179	7,065	392	585	474	146	23	15	3,746	1,709	1,314	2,376	1,051	1,548	33	35	110	202	154	17	974	134	283
Riversdale	10502	18,635	12,894	15,319	849	1,270	1,446	391	67	40	6,072	4,775	4,502	5,251	1,935	2,849	65	64	202	328	249	59	1,579	376	794
Mossel Bay	10503	30,691	24,939	29,598	1,641	2,453	4,298	1,322	308	177	8,753	8,084	11,711	9,635	3,773	5,556	131	124	394	473	89	153	2,277	1,555	3,282
George	10504	58,200	45,116	51,942	2,879	4,305	7,072	2,377	600	338	15,803	13,925	18,346	15,422	7,168	10,555	235	236	748	854	153	239	4,111	2,627	5,544
Oudtshoorn	10505	50,491	24,418	27,443	1,521	2,274	2,768	476	107	67	11,949	6,568	6,259	9,597	3,320	4,889	146	109	347	646	72	82	3,108	940	1,983
Knysna	10506	42,825	27,516	38,512	2,135	3,192	4,575	925	313	177	12,668	9,252	12,928	13,689	5,033	7,411	157	166	525	684	101	169	3,295	3,944	8,321
Beaufort West	10601	28,716	13,657	16,407	910	1,360	1,503	1,030	65	37	7,820	4,227	3,910	7,111	1,832	2,697	82	60	191	422	321	51	2,034	438	925
Port Elizabeth	20101	321,327	166,945	173,200	9,601	14,354	33,369	10,020	1,666	954	76,428	45,135	75,823	60,433	22,398	32,982	1,093	738	2,338	1,223	495	396	19,881	3,364	7,098
Coega	20102	103,478	53,762	55,776	3,092	4,622	10,746	3,227	537	307	24,612	14,535	24,418	19,462	7,213	10,621	352	238	753	394	159	127	6,402	1,083	2,286
Uitenhage	201	119,	62,2	64,5	3,58	5,35	12,4	3,73	621	356	28,4	16,8	28,2	22,5	8,35	12,2	408	275	872	456	185	148	7,41	1,25	2,64

	03	816	51	82	0	2	43	6			99	30	73	34	2	98							3	4	7
Graaff-Reinet	20201	40,959	13,417	16,447	912	1,363	1,397	284	38	21	10,534	3,922	3,433	8,882	1,458	2,147	98	48	152	569	432	45	2,740	181	382
Grahamstown	20202	121,727	43,957	51,517	2,856	4,269	5,053	732	232	134	33,306	13,671	13,208	21,359	5,966	8,785	308	197	623	1,799	1,366	172	8,664	1,055	2,227
Humansdorp	20203	66,299	32,310	38,724	2,147	3,209	3,241	786	154	90	17,405	9,642	8,128	13,156	4,626	6,811	188	152	483	940	714	106	4,528	742	1,565
Stutterheim	20301	361,718	55,026	72,133	3,999	5,978	4,019	1,380	277	161	145,309	25,126	15,423	29,707	8,516	12,539	675	281	889	7,851	276	201	37,799	2,261	4,771
East london	20302	410,316	161,176	175,188	9,711	14,518	25,532	6,152	1,231	702	110,223	49,214	65,524	61,447	23,112	34,033	1,142	762	2,413	5,955	540	855	28,672	8,575	18,093
King WilliamsTown	20303	102,579	40,294	43,797	2,428	3,630	6,383	1,538	308	176	110,223	49,214	65,524	15,362	5,778	8,508	286	190	603	5,955	540	855	28,672	2,144	4,523
Fort Beaufort	20304	156,502	34,174	31,829	1,764	2,638	2,639	229	68	39	41,153	10,215	6,630	10,839	3,776	5,560	320	124	394	2,223	112	86	10,705	1,187	2,504
Cradock	20401	54,807	15,919	17,809	987	1,476	1,484	341	42	38	16,327	5,390	4,223	7,622	2,004	2,951	124	66	209	882	59	55	4,247	234	494
Queenstown	20402	351,917	54,131	71,775	3,979	5,948	4,543	1,899	233	131	137,579	24,055	16,968	33,329	7,719	11,366	664	254	806	7,433	264	221	35,788	392	826
Aliwal North	20501	155,425	22,929	30,975	1,717	2,567	2,172	365	69	41	72,404	12,141	9,666	15,953	3,616	5,324	293	119	377	3,912	133	126	18,834	127	268
Port Saint Johns	20601	279,484	28,272	33,830	1,875	2,804	2,190	500	60	38	151,560	17,427	11,344	15,302	3,179	4,681	487	105	332	8,188	191	148	39,425	1,129	2,382
Umtata	20602	373,756	47,381	71,417	3,959	5,919	4,416	1,326	365	209	178,592	25,735	20,158	35,360	7,502	11,046	683	247	783	9,649	282	263	46,457	859	1,812
Mount Frere	20701	171,243	15,725	21,123	1,171	1,750	1,028	123	27	17	89,120	9,302	5,110	10,211	1,812	2,668	293	60	189	4,815	102	67	23,183	38	80
Springbok	30101	29,025	10,941	13,972	775	1,158	1,692	500	55	235	8,234	3,528	4,585	4,292	2,139	3,150	79	71	223	445	39	60	2,142	248	522
Calvinia	30102	33,615	10,679	16,102	893	1,334	1,439	449	41	87	9,754	3,522	3,988	4,750	2,004	2,951	83	66	209	527	400	52	2,537	177	373
De Aar	30201	91,649	31,319	37,609	2,085	3,117	3,225	1,622	114	67	26,810	10,414	9,012	14,247	4,819	7,096	224	159	503	1,448	1,100	118	6,974	714	1,507
Twee Rivieren	30301	6,094	1,257	2,740	152	227	83	60	8	11	1,341	314	174	448	205	302	12	7	21	72	55	2	349	16	35
Upington	30302	96,481	40,989	50,392	2,793	4,176	5,740	2,302	259	563	25,916	12,515	14,730	15,255	7,986	11,759	272	263	834	1,400	1,063	192	6,742	653	1,378
Kimberley	30401	204,086	56,167	80,012	4,435	6,631	6,442	7,210	612	560	60,399	18,894	18,214	27,292	11,809	17,389	466	389	1,233	3,263	207	238	15,712	1,644	3,469

Kuruman	30501	97,570	23,332	31,709	1,758	2,628	4,600	1,163	116	384	31,596	8,588	14,231	9,117	4,076	6,002	230	134	426	1,707	94	186	8,219	342	721
Springfontein	40101	77,076	17,493	25,283	1,402	2,095	1,465	871	46	99	24,383	6,290	4,426	11,270	2,894	4,262	160	95	302	1,317	1,000	58	6,343	58	122
Rouxville	40102	24,920	6,337	9,155	507	759	454	271	11	7	7,732	2,235	1,345	4,564	941	1,385	53	31	98	418	317	18	2,011	78	164
Bloemfontein	40301	618,234	93,121	199,655	11,067	16,546	6,193	15,418	1,525	873	169,870	29,083	16,256	89,819	22,591	33,265	1,146	745	2,358	9,178	319	212	44,188	2,968	6,263
Thaba Nchu	40302	54,827	14,442	20,055	1,112	1,662	1,767	736	31	18	16,907	5,062	5,207	9,053	2,325	3,424	124	77	243	913	694	68	4,398	57	121
W elkom	40401	534,075	149,467	175,985	9,755	14,584	19,456	6,568	517	2,603	116,734	37,134	40,626	74,719	21,859	32,188	1,248	721	2,282	6,307	407	530	30,366	960	2,025
Bethlehem	40501	237,309	47,636	86,735	4,808	7,188	4,934	3,849	248	143	70,552	16,098	14,012	38,680	10,107	14,883	486	333	1,055	3,812	2,894	183	18,353	444	937
Harrismith	40502	284,569	52,903	68,895	3,819	5,709	4,771	2,878	179	103	86,684	18,317	13,884	34,028	6,085	8,960	564	201	635	4,683	201	181	22,549	341	720
Maokeng	40601	83,621	37,842	45,147	2,503	3,741	4,802	3,290	207	192	24,563	12,635	13,475	19,838	5,242	7,719	238	173	547	1,327	139	176	6,389	387	816
Sasolburg	40602	181,623	59,168	83,450	4,626	6,916	10,412	4,441	396	234	51,555	19,091	28,235	35,358	9,542	14,050	475	315	996	2,785	209	368	13,411	740	1,561
Kwa Mashu	50101	767,976	172,775	220,852	12,242	18,303	11,486	7,994	269	152	171,713	43,911	24,535	31,283	9,713	14,303	1,564	320	1,014	2,749	481	128	44,668	1,608	3,393
Hammarsdale	50102	209,639	25,977	52,775	2,925	4,374	1,613	746	134	88	46,873	6,602	3,445	7,734	2,972	4,377	374	98	310	750	1,923	18	12,193	804	1,697
Pinetown	50103	419,839	160,487	261,554	14,499	21,676	60,985	10,438	1,344	755	93,872	40,788	130,266	119,322	29,059	42,791	1,483	958	3,034	1,503	447	680	24,419	24,124	50,900
Umhlanga	50104	161,223	79,090	158,692	8,797	13,151	30,198	10,438	134	77	36,048	20,101	64,504	61,424	15,515	22,846	664	511	1,620	577	220	337	9,377	8,041	16,967
Durban CBD	50105	135,911	109,102	172,000	9,534	14,254	34,289	29,911	11,292	6,340	30,389	27,728	73,243	161,139	61,605	90,715	720	2,031	6,431	486	304	382	7,905	41,010	86,530
Amanzimtoti	50106	160,680	29,311	46,342	2,569	3,840	3,874	10,438	134	76	35,927	7,449	8,274	15,765	5,786	8,520	328	191	604	575	82	43	9,346	4,021	8,483
Umlazi	50107	466,133	73,789	124,242	6,887	10,296	5,668	12,458	134	77	104,223	18,753	12,108	18,729	6,377	9,391	880	210	666	1,668	206	63	27,112	804	1,697
Port Shepstone	50201	359,071	83,941	113,951	6,317	9,443	9,786	3,317	642	395	111,706	29,683	29,085	53,475	10,594	15,600	778	349	1,106	6,035	325	379	29,058	6,582	13,887
Edendale	50301	574,533	181,882	219,203	12,151	18,166	30,768	8,927	1,931	1,101	139,998	50,377	71,623	95,054	24,150	35,562	1,472	796	2,521	7,564	552	934	36,418	12,080	25,487
Ladysmith	504	354,	60,1	84,6	4,69	7,01	5,44	4,69	464	265	109,	21,1	16,1	37,1	8,49	12,5	688	280	886	5,94	232	210	28,6	4,94	10,4

	01	796	62	78	4	8	5	2			981	98	24	90	0	02				2			09	0	24
Cathedral Peak	50402	6,368	523	1,058	59	88	33	18	3	2	2,604	243	130	395	115	170	11	4	12	141	3	2	677	222	468
Dundee	50501	152,444	15,879	19,883	1,102	1,648	1,367	507	42	29	66,595	7,885	5,704	8,312	1,812	2,669	268	60	189	3,598	86	74	17,323	850	1,793
Greytown	50502	43,183	9,161	12,675	703	1,050	739	194	39	23	17,571	4,237	2,872	4,308	1,368	2,015	88	45	143	949	721	37	4,571	446	940
Newcastle	50601	316,905	69,392	106,067	5,880	8,790	10,360	4,199	614	406	72,115	17,949	22,522	48,475	10,377	15,280	694	342	1,083	3,896	197	294	18,759	6,413	13,531
Ulundi	50701	367,806	46,276	65,081	3,608	5,393	3,906	1,699	209	196	120,294	17,203	12,205	27,002	6,551	9,647	667	216	684	6,499	189	159	31,292	2,977	6,281
Mkuze	50801	227,418	25,428	40,706	2,256	3,373	1,736	770	103	75	89,045	11,317	6,494	15,754	4,260	6,273	400	140	445	4,811	124	85	23,163	1,493	3,150
Richard's Bay	50901	234,851	75,469	98,710	5,472	8,180	13,481	9,869	880	748	65,363	23,875	35,843	39,051	12,420	18,288	612	409	1,297	3,531	262	468	17,003	7,151	15,088
Eshowe	50902	185,294	29,776	37,866	2,099	3,138	2,764	811	121	81	54,322	9,922	7,741	14,979	3,723	5,483	355	123	389	2,935	109	101	14,131	1,245	2,628
Stanger	51001	324,614	76,754	116,381	6,451	9,645	6,889	3,012	423	243	102,128	27,448	20,704	39,878	9,716	14,306	687	320	1,014	5,518	4,189	270	26,567	4,570	9,641
Underberg	51101	11,274	2,355	4,876	270	404	241	89	9	5	3,201	760	654	2,846	447	659	23	15	47	173	131	9	833	8	17
Kokstad	51102	218,333	21,947	43,569	2,415	3,611	1,427	534	57	35	95,937	10,962	5,992	16,748	3,745	5,514	378	123	391	5,183	3,935	78	24,956	1,489	3,141
Brits	60101	372,252	123,711	154,176	8,546	12,777	12,140	5,513	463	684	94,155	35,567	29,333	37,679	13,449	19,804	893	443	1,404	5,087	390	383	24,493	4,276	9,022
Rustenburg	60102	541,302	227,908	281,881	15,625	23,360	32,852	11,506	1,339	6,997	110,415	52,843	64,017	72,750	42,025	61,883	1,527	1,385	4,387	5,965	579	835	28,722	11,394	24,041
Mafikeng	60201	702,642	133,571	156,625	8,682	12,980	14,176	6,414	850	595	147,965	31,972	28,520	55,990	19,022	28,011	1,420	627	1,986	7,994	351	372	38,490	2,618	5,525
Vryburg	60301	329,166	56,795	76,450	4,238	6,336	5,230	2,165	251	210	85,221	16,714	12,936	29,415	8,741	12,871	641	288	913	4,604	3,496	169	22,169	924	1,950
Ventersdorp	60401	217,749	64,046	88,846	4,925	7,363	7,896	2,749	405	2,160	40,026	13,382	13,866	26,607	12,223	17,999	514	403	1,276	2,162	147	181	10,412	674	1,423
Potchefstroom	60402	89,922	45,609	51,277	2,842	4,249	9,207	2,365	353	217	16,846	9,712	16,477	19,324	6,259	9,217	303	206	653	910	106	215	4,382	968	2,043
Klerksdorp	60403	567,540	109,213	133,790	7,416	11,088	10,131	5,794	725	1,938	93,600	20,473	15,962	48,626	17,100	25,180	1,137	564	1,785	5,057	224	208	24,348	1,649	3,480
Midrand	70101	213,893	129,431	184,551	10,230	15,294	35,633	15,005	4,174	2,416	36,239	24,926	57,674	55,427	25,584	37,673	886	843	2,671	580	273	301	9,427	5,422	11,439
Roodepoo	701	118,	71,9	102,	5,68	8,49	19,7	8,33	2,31	1,34	20,1	13,8	32,0	30,7	14,2	20,9	492	469	1,48	322	152	167	5,23	3,01	6,35

rt	02	830	06	528	3	7	96	6	9	2	33	48	41	93	13	29			4				7	2	5
Johannesburg CBD	70103	1,116,999	675,916	963,766	53,424	79,870	186,083	78,359	21,796	12,617	189,246	130,167	301,185	289,452	133,604	196,736	4,624	4,405	13,948	3,029	1,427	1,572	49,229	28,313	59,739
Soweto	70104	926,872	560,866	799,721	44,331	66,275	154,409	65,021	18,086	10,469	157,034	108,011	249,919	240,184	110,863	163,249	3,837	3,655	11,574	2,514	1,184	1,304	40,849	23,494	49,570
Kempton Park	70201	380,402	196,464	199,645	11,067	16,545	35,997	20,405	2,945	1,777	83,742	49,161	75,705	60,227	27,509	40,508	1,260	907	2,872	1,341	539	395	21,784	3,325	7,015
Bapsfontein	70202	17,291	8,930	9,075	503	752	1,636	927	134	81	3,806	2,235	3,441	2,738	1,250	1,841	57	41	131	61	25	18	990	151	319
Germiston	70203	691,639	357,207	362,990	20,122	30,082	65,449	37,100	5,354	3,230	152,259	89,384	137,645	109,504	50,017	73,651	2,290	1,649	5,222	2,437	980	718	39,607	6,045	12,754
Benoni	70204	639,766	330,417	335,766	18,612	27,826	60,541	34,317	4,952	2,988	140,840	82,680	127,321	101,292	46,266	68,127	2,119	1,525	4,830	2,255	907	664	36,637	5,591	11,797
Mabopane	70301	162,195	111,234	177,459	9,837	14,707	39,865	14,194	3,168	1,794	31,847	24,826	74,778	57,654	24,036	35,394	814	792	2,509	510	272	390	8,284	5,023	10,598
Temba	70302	19,082	13,086	20,877	1,157	1,730	4,690	1,670	373	211	3,747	2,921	8,797	6,783	2,828	4,164	96	93	295	60	32	46	975	591	1,247
Pretoria	70303	620,157	425,305	678,518	37,612	56,231	152,424	54,270	12,114	6,860	121,768	94,922	285,914	220,440	91,903	135,329	3,114	3,030	9,594	1,949	1,041	1,492	31,675	19,205	40,522
Centurion	70304	133,572	91,604	146,142	8,101	12,111	32,830	11,689	2,609	1,478	26,227	20,445	61,582	47,479	19,794	29,148	671	653	2,066	420	224	321	6,822	4,137	8,728
Vanderbijl Park	70401	398,353	134,656	105,556	5,851	8,748	16,771	4,999	901	509	116,345	44,703	46,795	46,345	12,460	18,347	995	411	1,301	6,286	490	611	30,265	1,242	2,620
Meyerton	70402	62,068	13,997	33,720	1,869	2,794	4,235	2,413	363	205	17,328	4,442	11,295	13,231	4,325	6,369	157	143	452	936	49	147	4,507	484	1,022
Heidelberg	70403	30,502	10,679	11,500	637	953	2,010	781	108	62	11,362	4,522	7,151	4,669	1,357	1,998	84	45	142	614	50	93	2,955	110	231
Cullinan	70501	9,518	6,516	6,273	348	520	1,511	266	45	69	6,385	4,968	9,681	2,561	714	1,051	40	24	75	345	54	126	1,661	79	167
Bronkhorstspruit	70502	88,244	27,960	31,390	1,740	2,601	2,742	2,213	418	263	25,983	9,358	7,714	11,839	3,989	5,874	208	132	416	1,404	103	101	6,759	416	877
Olympus	70503	19,082	13,086	20,877	1,157	1,730	4,690	1,670	373	211	3,747	2,921	8,797	6,783	2,828	4,164	96	93	295	202	32	115	975	591	1,247
Krugersdorp	70601	227,833	98,193	115,822	6,420	9,598	16,463	7,988	1,382	894	54,500	26,699	37,623	36,464	15,888	23,395	671	524	1,659	2,944	293	491	14,177	2,351	4,959
Randfontein	70602	71,200	36,457	30,115	1,669	2,496	4,679	1,545	264	518	20,355	11,847	12,779	9,917	3,975	5,854	216	131	415	1,100	130	167	5,295	307	648
Westonaria	70603	82,631	31,346	31,798	1,763	2,635	3,105	819	101	913	15,382	6,633	5,522	9,651	4,359	6,418	209	144	455	831	73	72	4,001	165	348

Ermelo	80101	214,158	48,433	66,056	3,662	5,474	5,104	3,587	265	371	58,741	15,100	13,375	26,147	7,200	10,602	454	237	752	3,174	2,410	174	15,280	604	1,275
Piet Retief	80102	107,421	14,267	29,468	1,634	2,442	1,346	928	84	132	26,600	4,016	3,183	9,957	3,688	5,431	198	122	385	1,437	1,091	42	6,919	118	249
Amersfoort	80103	45,163	11,277	16,887	936	1,399	1,378	677	57	47	14,564	4,134	4,245	6,947	1,675	2,467	101	55	175	787	597	55	3,789	63	132
Standerton	80104	128,879	35,486	48,526	2,690	4,021	3,898	1,393	148	504	27,833	8,711	8,042	15,459	6,063	8,927	293	200	633	1,504	1,142	105	7,240	423	893
Bethal	80105	36,065	16,789	21,042	1,166	1,744	3,766	959	95	279	7,314	3,870	7,296	7,452	2,792	4,111	119	92	291	395	42	95	1,903	226	477
Secunda	80106	120,740	56,208	70,444	3,905	5,838	12,607	3,210	318	935	24,487	12,958	24,427	24,947	9,347	13,763	399	308	976	1,323	142	319	6,370	757	1,597
Delmas	80201	57,368	19,517	22,170	1,229	1,837	2,694	1,434	101	165	10,016	3,873	4,493	9,092	2,667	3,927	146	88	278	541	411	59	2,605	149	315
Witbank	80202	175,358	94,302	110,476	6,124	9,156	19,345	6,920	738	1,447	39,317	24,033	41,436	36,132	15,286	22,510	613	504	1,596	2,124	264	541	10,228	1,364	2,879
Middelburg	80203	91,084	42,186	65,479	3,630	5,426	11,700	2,756	417	887	19,611	10,324	24,066	23,129	9,181	13,519	321	303	958	1,060	113	314	5,101	1,090	2,299
Belfast	80204	33,553	14,085	18,430	1,022	1,527	1,315	1,267	54	213	8,470	4,041	3,172	8,206	2,033	2,993	88	67	212	458	44	41	2,203	475	1,002
Siyabuswa	80205	404,307	77,040	76,178	4,223	6,313	5,217	909	110	83	88,046	19,070	10,853	15,333	3,325	4,896	790	110	347	4,757	209	142	22,903	78	165
Lydenburg	80301	89,501	24,047	39,374	2,183	3,263	1,827	1,322	144	433	24,865	7,594	4,849	18,652	5,230	7,701	194	172	546	1,343	1,020	63	6,468	1,105	2,332
N elspruit	80302	760,068	170,521	312,915	17,346	25,932	19,421	11,780	1,582	1,044	165,469	42,197	40,392	138,246	31,984	47,098	1,622	1,054	3,339	8,940	6,788	527	43,043	6,320	13,334
Bosbokrand	80303	256,739	43,572	54,759	3,035	4,538	3,866	1,013	122	71	100,002	19,291	14,387	22,988	3,665	5,397	497	121	383	5,403	212	188	26,014	284	599
Skukuza	80304	5,027	1,070	1,488	82	123	593	235	38	26	1,863	451	2,100	2,356	805	1,186	7	27	84	101	76	27	485	280	591
Malelane Gate	80305	265	56	78	4	6	31	12	2	1	98	24	111	124	42	62	0	1	4	5	4	1	26	15	31
Giyani	90101	151,839	29,410	40,883	2,266	3,388	3,462	1,111	190	116	42,561	9,370	9,269	18,822	4,243	6,248	312	140	443	2,299	103	121	11,071	230	486
Tzaneen	90102	355,062	61,403	94,014	5,211	7,791	6,147	1,928	295	231	120,905	23,766	19,997	44,572	9,560	14,077	697	315	998	6,532	4,960	261	31,451	558	1,178
Phalaborwa	90103	164,696	46,841	65,113	3,609	5,396	6,755	1,695	244	992	42,090	13,607	16,492	23,269	8,372	12,328	393	276	874	2,274	149	215	10,949	374	790
Musina	90201	28,266	3,890	9,843	546	816	439	313	31	36	6,549	1,024	971	3,944	1,213	1,785	53	40	127	354	269	13	1,704	44	92

Venetia Diamond Mine	90202	297,855	52,112	60,211	3,338	4,990	5,641	1,190	219	148	119,241	23,714	21,574	28,542	6,236	9,183	590	206	651	6,442	260	281	31,018	261	551
Thohoyandou	90203	297,149	60,524	77,692	4,307	6,439	6,696	1,924	269	177	86,376	19,998	18,594	37,803	8,106	11,936	614	267	846	4,667	3,543	243	22,469	465	981
Makhado	90204	14,133	1,945	4,921	273	408	219	157	16	18	3,274	512	485	1,972	606	893	27	20	63	177	134	6	852	22	46
Polokwane	90301	562,266	145,245	194,476	10,780	16,117	18,124	9,637	1,169	675	155,708	45,720	47,947	103,095	18,913	27,850	1,270	624	1,974	8,412	501	626	40,504	1,795	3,788
Lebowakgomo	90302	127,472	34,595	30,842	1,710	2,556	4,204	555	73	48	32,015	9,876	10,086	13,951	3,267	4,811	292	108	341	1,730	108	132	8,328	163	344
Thabazimbi	90401	65,543	34,161	59,516	3,299	4,932	7,707	1,672	132	1,928	8,589	5,088	9,648	14,048	8,680	12,782	232	286	906	464	56	126	2,234	193	408
Ellisras	90402	88,901	17,118	32,225	1,786	2,671	2,266	379	72	382	24,135	5,282	5,876	12,818	4,052	5,967	184	134	423	1,304	58	77	6,278	88	185
Naboomspruit	90403	62,390	23,182	37,670	2,088	3,122	4,007	1,013	185	160	18,743	7,916	11,500	18,747	3,613	5,321	172	119	377	1,013	769	150	4,876	248	523
Bela Bela	90404	30,580	20,063	23,223	1,287	1,925	4,278	1,173	150	90	5,783	4,312	7,728	11,261	2,374	3,496	122	78	248	312	237	101	1,504	894	1,886
Mokopane	90405	198,250	74,073	87,167	4,832	7,224	9,817	980	105	157	41,368	17,569	19,569	28,333	10,904	16,057	522	359	1,138	2,235	193	255	10,761	382	807
Marble hall	90501	56,663	11,342	12,914	716	1,070	967	402	45	49	24,712	5,623	4,028	5,545	1,414	2,082	114	47	148	1,335	1,014	53	6,428	60	126
Groblersdal	90502	127,244	29,808	14,345	795	1,189	2,720	228	21	118	52,799	14,059	10,784	6,179	1,585	2,334	269	52	165	2,853	154	141	13,735	132	279
Jjane Furse Hospital	90503	124,705	23,547	24,750	1,372	2,051	2,433	642	75	69	38,201	8,199	7,119	11,668	2,582	3,803	251	85	270	2,064	1,567	93	9,937	122	258
Burgersfort	90504	117,749	16,809	21,581	1,196	1,788	1,362	576	48	308	53,407	8,666	5,902	7,652	2,677	3,942	218	88	279	2,885	95	77	13,893	387	816
Kruger National Shingwedzi	90601	592	250	552	31	46	140	19	3	7	49	24	112	235	68	100	3	2	7	3	0	1	13	4	9
Kruger National Letaba	90602	592	250	552	31	46	140	19	3	7	49	24	112	235	68	100	3	2	7	3	0	1	13	4	9

ANNEXURE C: DATA PROBLEMS AND SHORT COMMINGS

C. DATA PROBLEMS AND SHORTCOMINGS

C.1 Introduction

The working document summarises data problems and shortcomings in the modelling process. It includes problems at network building stage, the trip generation process and the trip distribution process. Problems affecting modal split and assignment are not listed here.

These data problems and shortcomings resulted in the following:

- Data correction was often time consuming due sheer volume of data and to the fact that was often corrected manually.
- The quality NATMAP model was affected
- Model verification was very difficult.

C.2 Network

C.2.1 Link Network

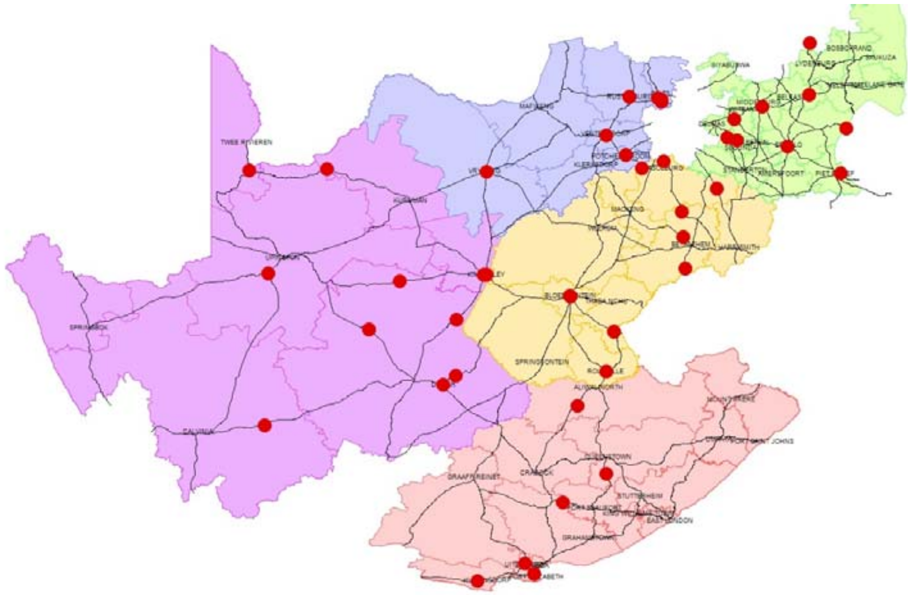
The network was imported from the GIS centreline layers received from the various provinces and SANRAL.

The most common problems with the GIS network were:

- It looks like link is complete, but when zoom in there is a small gap
- It looks like intersection, but nodes are on top of each other

The only way to solve these network errors was to manually check the network. A unit matrix was assigned to the network and every time the assignment could not be completed a manual check had to be performed on the shortest path search between the zones in the error message. Once assignment was possible all 'empty' had to be manually checked. This process had to be repeated for the rail network.

Figure 0-1: Location of Network Corrections


TWEE RIVIEREN
SPRINGBOK
CALVINIA
MAFIKENG
BOSBOKRAND
SIYABUSWA
LYDENBURG
BELFAST
STANDERTON
AMERSFOORT
KLERKSDORP
SPRINGFONTEIN
ALIWAL NORTH
MOUNT FRERE
PORT SAINT JOHNS
GRAAFF-REINET
STUTTERHEIM
EAST LONDON

C.2.2 Attribute data

Attribute data such as speed limit, average speed, capacity and cross section data etc was not available on all model links. The GIS team went through an extensive exercise to capture as much data as available. Where no data was available assumptions had to be made using the type of road as an indicator. Please note that these are only GIS problems related to the modelling, refer to GIS reports for other problems or shortcomings.

C.2.3 Mountain passes

No data was available for mountain passes. The mountain passes had to be coded manually using road maps of South Africa.

C.3 Trip Generation

The NHTS was never designed for modelling purposes resulting in data problems and shortcomings affecting the quality of the NATMAP model. Nevertheless it is a rich source of travel information and without the data in the NHTS the modelling process would have been an almost impossible task.

With that in mind the following data shortcomings were identified in the NHTS regarding trip generation:

- Missing income data
- Attraction data
- Converting TAZ zone data to NATMAP zone data
- When trips took place was not recorded

C.3.1 Missing income data

Various records in the NHTS database did not indicate income. This is a common problem with sensitive questions. In South Africa as a whole there were about 6% with missing income data, but in some provinces the occurrence was higher. The Western Cape for instance 16% of records had missing income data. All trip data had to be allocated to the low, middle or high income group. If the missing income records were ignored, it would have lead to a serious undercount of trips in some areas. If it were allocated to for instance the high income group (because it is often the high income group who does not want to complete the income question), it could skew the results.

A solution to the problem was to allocate these records to income groups based on other income related variables such as car ownership etc.

C.3.2 Attraction data

Only the destination of last trip was captured in NHTS. To get total trips attracted an assumption had to be made. The assumption was made that all trips for a specific trip purpose made by a person had the same destination as the last trip. This obviously severely affected the quality of the attraction data. Thus in the balancing of trip productions and attractions the attractions were scaled towards the productions.

C.3.3 Converting TAZ zone data to NATMAP zone data

In the trip generation phase there were problems with preparing the data in the required format:

- NHTS Origins to be converted from TAZ zone level to NATMAP zone level
- NHTS Destinations to be converted from TAZ and District zone level to NATMAP zone
  Level

Owing to the splitting of some TAZ zones (mainly due to boundary changes) proportional allocation tables were created. This resulted in Many-to-Many relational queries in MS Access which resulted double counting of trips.

To solve this problem the following was done:

- The origins and destinations of zones were summed to a unique list of TAZs and DMs
- The Unique TAZ / DM list was exported to Excel
- The DM zones were allocated to TAZ zones manually
- A proportional TAZ – NATMAP table were created manually
- Origin and Destination pivot tables for NATMAP zones were prepared separately
- A vlookup function was used to get NATMAP origin and destination trip totals into the trip generation spreadsheet that was used in the regression analysis.

C.3.4 When trips took place was not recorded

The NHTS did not record in enough detail when business, migrant and holiday trips took place. It was therefore not possible to generate trips for specific periods such as:

- Average weekday
- Peak holiday period
- Peak migrant trip period

As a result the trip generation results included all trips. This meant that a factor had to be applied to each trip purpose before assignment to scale the total number of trips to for instance an average weekday.

C.4 Trip Distribution

The NHTS was never designed for modelling purposes resulting in data problems and shortcomings affecting the quality of the NATMAP model. Nevertheless it is a rich source of travel information and without the data in the NHTS the modelling process would have been an almost impossible task.

With that in mind the following data shortcomings were identified in the NHTS regarding trip distribution:

- Attraction data: Only the destination of last trip was captured in NHTS
- Very small sample size for some trip purposes
- NHTS recorded only business trips longer than 200km
- Growth factor / Furness models not option due to large number of empty cells

C.4.1 Attraction Data

Only the destination of last trip was captured in NHTS. To get total trips attracted an assumption had to be made. In the trip generation phase the assumption was made that all trips for a specific trip purpose made by a person had the same destination as the last trip. However in the trip distribution phase it was decided that 'Last trip' matrices must be used in trip length frequency analysis in the trip distribution process.

C.4.2 Very small sample size for some trip purposes

The very small sample size in some zones for some trip purposes resulted in OD relations with high frequency that skews the results when the weight is applied e.g. in the NHTS 11,500 out of 84,000 middle income migrant trips were from Johannesburg to Pretoria. Upon investigation it was revealed that only 6 respondents reported such a trip, when the weight was applied it equalled 11,500.

Some of these 'outliers' that were identified manually were manually removed in the trip distribution analysis to prevent it from influencing the trip distribution results.

Data was also analysed on district level for those trip purposes. This improved results significantly.

Due to problem with small sample sizes and the fact that only the destination of the last trip was captured it was not possible to verify trip distribution results between OD pairs.

C.4.3 NHTS recorded only business trips longer than 200km

The NHTS recorded only business trips longer than 200km. This presented 2 problems:

- In reality there are many business trips shorter than 200km, but these were excluded from the study due to lack of information on such trips
- Although only business trips shorter than 200km were recorded, a number of business trips were recorded with distances shorter than 200km

C.5 RECOMMENDATIONS

It is recommended that in future a modelling exercise of this magnitude should not only rely on secondary data, but it should also include and extensive data collection phase where data is collected with the data requirements for a strategic national model in mind.

Specific recommendations regarding specific problems and shortcomings are listed below.

C.5.1 Network

9.1.1 Link Network

GIS centreline data must be captured with more care and should be verified by the various authorities.

C.5.2 Attribute data

Surveys should be undertaken to fill in the gaps in the data.

C.5.3 Mountain passes

Surveys should be undertaken to capture data concerning mountain passes.

C.6 Trip Generation

Conduct a travel survey with specific attention to modelling requirements.

C.6.1 Missing income data

It is inevitable that some respondents would not want to answer questions regarding income. It is recommended that it be treated as was done in this study.

C.6.2 Attraction data

The destination of all trips must be captured.

C.6.3 Converting TAZ zone data to NATMAP zone data

This is a problem for which there is no recommendation because one cannot plan for municipal / district / provincial boundary changes made by government.

C.6.4 When trips took place was not recorded

All trip data must be recorded in as much detail as possible, including when such trips took place. This is especially important for lower frequency trips such as holiday, migrant and business trips.

C.7. TRIP DISTRIBUTION

Conduct a travel survey with specific attention to modelling requirements.

C.7.1 Attraction Data

The destination of all trips must be captured.

C.7.2 Very small sample size for some trip purposes

It is inevitable that some trip purposes will have small sample sizes in a national survey. The capture of all trip destinations would however significantly improve the sample size for all trip purposes.

C.7.3 NHTS recorded only business trips longer than 200km

All trips must be recorded. No limitations in terms of distance. If however there are such limitations, all data captured must adhere to those limitations.

ANNEXURE D: BALANCING FACTORS

Gravity Parameters

		a	b	c	Quality
Work	LOW	6.4266	-0.7333	-0.0383	0.69
Work	MID	1.0809	-0.0095	-0.0475	0.83
Work	HIGH	5.0901	-0.6665	-0.0370	0.81
Business	LOW	1.3234	0.0000	-0.0032	0.46
Business	MID	0.6285	0.0000	-0.0018	0.54
Business	HIGH	0.3075	0.0000	-0.0008	0.77
Migrant	LOW	0.8522	0.0000	-0.0041	0.85
Migrant	MID	0.7251	0.0000	-0.0035	0.28
Migrant	HIGH	0.5567	0.0000	-0.0025	0.87
Holiday	LOW	4.9705	-0.4344	-0.0023	0.72
Holiday	MID	0.3789	0.0000	-0.0018	0.75
Holiday	HIGH	0.0075	0.6455	-0.0020	0.74

Balancing Factor for Attraction

Zone	Work	Work	Work	Business	Business	Business	Migrant	Migrant	Migrant	Holiday	Holiday	Holiday
	LOW	MID	HIGH	LOW	MID	HIGH	LOW	MID	HIGH	LOW	MID	HIGH
10101	3.935	1.959	2.262	4.414	2.605	1.386	2.400	4.037	4.706	1.170	1.258	1.597
1010	3.238	1.254	1.477	3.558	2.287	1.284	2.168	3.544	4.084	1.120	1.200	1.510

2												
10103	0.463	0.946	0.893	4.585	2.440	1.300	2.235	3.716	4.249	1.128	1.217	1.526
10104	1.459	1.049	1.153	4.568	2.575	1.359	2.273	3.828	4.438	1.134	1.229	1.570
10105	1.352	0.939	1.048	4.486	2.502	1.330	2.268	3.787	4.357	1.133	1.223	1.549
10106	1.363	0.921	0.950	4.557	2.433	1.299	2.233	3.712	4.245	1.125	1.214	1.524
10107	1.419	1.073	1.199	4.586	2.441	1.300	2.235	3.716	4.250	1.128	1.217	1.526
10201	1.029	1.244	1.169	0.423	0.859	0.864	0.840	1.142	1.222	2.095	1.495	1.296
10202	0.962	1.578	1.433	2.297	1.998	1.221	0.417	0.608	0.826	1.171	1.259	1.492
10203	2.091	1.511	1.803	2.877	2.429	1.471	0.401	0.612	0.852	1.250	1.320	1.658
10204	3.262	2.933	3.165	4.241	2.307	1.259	0.387	0.591	0.813	1.123	1.205	1.492
10301	1.498	1.604	1.721	3.819	2.123	1.194	0.384	0.605	0.819	1.084	1.161	1.421
10302	1.187	1.142	1.100	3.867	2.176	1.211	0.386	0.608	0.822	1.100	1.179	1.443
10303	1.222	1.057	1.308	4.340	2.312	1.258	0.388	0.612	0.829	1.106	1.193	1.485
10304	1.069	1.117	1.230	3.098	2.034	1.180	0.390	0.605	0.818	1.075	1.152	1.409
10305	1.134	1.280	1.338	2.536	1.945	1.172	0.388	0.598	0.811	1.071	1.133	1.388
10401	0.799	1.222	1.063	3.112	2.369	1.340	0.382	0.588	0.821	1.142	1.222	1.560
10402	1.350	1.390	1.309	3.096	2.243	1.278	0.382	0.588	0.816	1.144	1.214	1.513
10403	2.197	1.476	1.578	1.152	1.580	1.080	0.496	0.836	1.043	1.139	1.212	1.409
10404	1.442	1.296	1.288	0.487	0.941	0.910	0.639	0.950	1.123	1.606	1.272	1.260
10501	1.971	1.696	1.755	0.398	0.786	0.812	0.782	1.051	1.159	1.667	1.259	1.162
10502	2.052	1.156	1.308	0.412	0.835	0.855	0.760	1.054	1.183	1.632	1.278	1.217
10503	1.866	0.930	1.021	0.390	0.762	0.797	0.757	1.000	1.121	1.555	1.204	1.129
10504	1.411	0.794	0.904	0.544	0.819	0.781	1.206	1.513	1.480	1.764	1.265	1.089
1050	1.305	0.920	1.035	0.538	0.820	0.780	1.183	1.504	1.468	1.794	1.274	1.091

5												
10506	2.002	1.129	1.087	0.585	0.833	0.781	1.325	1.542	1.493	1.725	1.269	1.082
10601	1.722	0.849	1.000	0.564	0.736	0.702	1.254	1.440	1.322	1.932	1.263	0.975
20101	1.039	0.707	0.886	0.921	0.939	0.808	2.244	2.206	1.895	1.437	1.254	1.091
20102	1.344	0.896	1.145	0.889	0.891	0.775	2.174	2.085	1.786	1.407	1.224	1.051
20103	1.245	0.833	1.053	0.913	0.934	0.807	2.232	2.199	1.875	1.428	1.247	1.088
20201	1.422	0.689	0.831	0.679	0.710	0.663	1.604	1.569	1.406	1.536	1.163	0.922
20202	1.007	0.838	0.975	1.171	0.930	0.763	1.555	1.563	1.618	1.042	1.148	1.029
20203	1.765	1.284	1.408	0.903	0.952	0.819	1.516	1.614	1.674	1.495	1.272	1.112
20301	0.471	0.785	0.790	1.016	0.850	0.720	2.332	2.140	1.821	1.111	1.180	0.998
20302	0.969	0.866	1.073	0.983	0.844	0.718	2.055	1.909	1.721	1.002	1.155	0.991
20303	0.671	0.717	0.837	1.002	0.849	0.721	2.257	2.117	1.818	1.093	1.174	0.999
20304	0.577	0.803	1.053	1.172	0.908	0.752	1.786	1.777	1.716	1.012	1.134	1.015
20401	1.160	0.985	1.231	0.852	0.759	0.674	1.945	1.760	1.562	1.317	1.181	0.943
20402	0.656	0.950	0.976	0.843	0.725	0.652	1.568	1.438	1.405	0.958	1.058	0.906
20501	0.633	0.871	0.840	0.780	0.658	0.612	1.753	1.556	1.366	1.226	1.124	0.879
20601	0.404	0.800	0.846	1.161	0.892	0.728	2.814	2.423	2.116	1.261	1.373	1.064
20602	0.526	0.848	0.769	0.920	0.779	0.684	1.721	1.573	1.563	1.003	1.174	0.968
20701	0.422	0.840	0.781	0.876	0.731	0.646	1.670	1.523	1.517	1.012	1.175	0.936
30101	0.935	1.170	1.216	0.711	0.957	0.826	1.641	1.989	1.699	3.143	1.772	1.248
30102	0.909	1.144	1.029	0.405	0.761	0.772	0.772	1.067	1.134	1.936	1.356	1.132
30201	0.997	0.943	1.063	0.681	0.667	0.631	1.574	1.584	1.316	1.582	1.158	0.870
30301	1.365	6.570	7.836	1.875	1.098	0.783	5.828	4.797	2.749	4.147	2.080	1.256
3030	1.001	1.166	1.256	0.860	0.778	0.683	2.091	2.103	1.569	2.225	1.433	0.987

2												
30401	0.906	1.296	1.213	0.655	0.582	0.569	1.334	1.310	1.121	1.294	1.074	0.812
30501	0.625	1.067	1.056	0.797	0.642	0.594	1.731	1.593	1.318	1.709	1.263	0.892
40101	1.099	1.158	1.102	0.642	0.585	0.571	1.312	1.272	1.151	1.328	1.059	0.807
40102	1.231	1.206	1.115	0.746	0.636	0.596	1.469	1.387	1.283	1.112	1.078	0.857
40301	0.847	1.284	0.825	0.551	0.526	0.541	1.144	1.054	0.987	1.054	0.963	0.788
40302	1.668	1.896	1.528	0.714	0.600	0.575	1.672	1.477	1.246	1.349	1.100	0.831
40401	0.876	0.843	0.949	0.483	0.483	0.516	0.845	0.828	0.877	0.976	0.920	0.791
40501	1.096	1.268	0.959	0.458	0.472	0.512	0.800	0.781	0.845	0.926	0.905	0.800
40502	0.709	0.726	0.703	0.452	0.468	0.509	0.818	0.788	0.861	0.895	0.913	0.806
40601	1.784	1.241	1.429	0.636	0.639	0.723	0.684	0.631	0.727	0.895	0.869	0.842
40602	1.878	2.000	2.025	1.163	1.130	1.482	0.539	0.516	0.664	0.833	0.843	0.934
50101	0.707	1.085	0.879	1.043	0.771	0.679	1.834	1.722	1.574	0.969	1.123	0.946
50102	1.219	1.414	1.387	0.907	0.712	0.648	1.709	1.564	1.467	0.910	1.062	0.906
50103	1.182	1.101	0.985	0.942	0.726	0.656	1.672	1.577	1.472	0.934	1.080	0.917
50104	1.280	1.114	0.998	1.047	0.772	0.678	1.839	1.729	1.570	0.984	1.124	0.944
50105	0.933	0.902	0.764	1.006	0.756	0.671	1.786	1.679	1.535	0.951	1.103	0.935
50106	1.221	1.513	1.396	1.013	0.761	0.672	1.970	1.758	1.596	0.984	1.121	0.940
50107	0.783	1.634	1.154	1.035	0.770	0.676	2.002	1.778	1.616	1.004	1.143	0.949
50201	1.206	1.144	1.166	1.294	0.885	0.728	1.189	1.230	1.371	0.974	1.193	0.998
50301	0.938	0.894	0.861	0.861	0.693	0.641	0.952	0.971	1.101	0.842	1.025	0.892
50401	0.616	0.773	0.738	0.488	0.492	0.523	0.841	0.806	0.895	0.893	0.929	0.821
50402	4.236	8.840	7.961	0.682	0.599	0.584	1.253	1.209	1.160	1.117	1.096	0.872
5050	0.624	1.116	1.103	0.534	0.523	0.544	0.884	0.856	0.932	0.895	0.969	0.847

1												
50502	2.237	2.759	2.673	0.861	0.693	0.643	0.919	0.947	1.071	0.870	1.042	0.900
50601	0.827	0.838	0.734	0.483	0.492	0.525	0.841	0.812	0.905	0.948	0.957	0.841
50701	0.494	0.903	0.859	0.752	0.632	0.605	1.298	1.270	1.291	1.138	1.167	0.905
50801	0.470	1.064	0.904	0.722	0.616	0.609	1.271	1.266	1.259	1.213	1.179	0.910
50901	1.057	1.023	1.043	1.081	0.784	0.712	1.264	1.178	1.349	1.129	1.235	0.989
50902	0.623	0.963	0.954	0.952	0.725	0.674	1.051	1.047	1.210	0.992	1.133	0.935
51001	1.203	1.456	1.287	1.044	0.767	0.686	0.979	1.023	1.176	0.939	1.115	0.947
51101	3.411	3.342	2.574	0.800	0.667	0.633	1.172	1.020	1.149	1.066	1.101	0.900
51102	0.467	0.932	0.662	0.898	0.732	0.652	1.634	1.512	1.461	1.042	1.162	0.935
60101	1.693	1.828	1.936	1.495	1.398	1.749	0.568	0.541	0.724	0.852	0.869	0.998
60102	0.904	1.127	1.190	1.515	1.358	1.650	0.576	0.544	0.730	0.870	0.873	0.982
60201	0.497	0.843	0.946	0.577	0.544	0.548	1.027	0.946	0.900	1.241	1.054	0.867
60301	0.566	0.929	0.919	0.601	0.546	0.549	1.194	1.084	1.003	1.299	1.092	0.843
60401	0.947	1.282	1.302	1.469	1.347	1.638	0.545	0.531	0.685	0.819	0.849	0.958
60402	1.002	1.183	1.361	1.298	1.215	1.479	0.548	0.536	0.680	0.796	0.842	0.942
60403	0.591	0.949	1.023	0.899	0.860	0.944	0.633	0.600	0.725	0.891	0.872	0.893
70101	1.614	1.013	1.145	1.508	1.464	1.902	0.738	0.920	0.926	0.761	0.818	0.970
70102	1.956	1.354	1.521	1.477	1.434	1.876	0.740	0.922	0.926	0.773	0.821	0.965
70103	1.041	0.775	0.808	1.416	1.403	1.855	0.718	0.900	0.906	0.743	0.807	0.953
70104	1.326	1.020	0.986	1.418	1.395	1.846	0.725	0.906	0.911	0.769	0.816	0.956
70201	1.357	1.065	1.259	1.508	1.459	1.891	0.624	0.582	0.693	0.775	0.824	0.971
70202	3.328	2.246	3.070	1.465	1.417	1.863	0.633	0.587	0.703	0.813	0.840	0.979
7020	1.172	0.995	1.146	1.507	1.452	1.888	0.622	0.582	0.692	0.785	0.827	0.971

3												
70204	1.078	1.018	1.145	1.482	1.432	1.878	0.628	0.585	0.699	0.798	0.835	0.979
70301	2.465	1.665	1.378	1.619	1.493	1.869	0.644	0.641	0.745	0.820	0.856	1.003
70302	6.823	3.407	3.864	1.561	1.462	1.858	0.643	0.641	0.748	0.806	0.851	1.005
70303	1.387	0.966	0.839	1.614	1.515	1.945	0.631	0.633	0.735	0.789	0.838	0.992
70304	1.589	1.048	0.910	1.557	1.484	1.923	0.621	0.615	0.717	0.786	0.834	0.986
70401	1.153	1.195	1.809	1.144	1.117	1.473	0.541	0.520	0.667	0.845	0.844	0.933
70402	3.168	2.881	3.075	1.220	1.215	1.622	0.520	0.511	0.649	0.789	0.820	0.939
70403	6.145	4.316	6.132	1.266	1.244	1.675	0.536	0.522	0.673	0.826	0.847	0.972
70501	10.236	5.171	6.700	1.561	1.448	1.833	0.545	0.532	0.671	0.832	0.862	1.005
70502	1.699	2.112	2.101	1.494	1.440	1.855	0.526	0.514	0.646	0.782	0.840	0.993
70503	3.444	2.599	2.624	1.495	1.425	1.843	0.536	0.527	0.662	0.800	0.844	0.991
70601	1.629	1.767	1.699	1.522	1.441	1.830	0.535	0.518	0.654	0.813	0.843	0.981
70602	2.055	1.820	2.212	1.442	1.387	1.788	0.523	0.511	0.643	0.791	0.828	0.959
70603	1.941	2.248	2.453	1.263	1.236	1.628	0.532	0.515	0.664	0.806	0.833	0.951
80101	0.764	0.924	0.878	0.568	0.570	0.608	0.778	0.789	0.865	0.881	0.919	0.876
80102	0.688	1.669	1.112	0.507	0.504	0.541	0.926	0.847	0.970	1.014	0.999	0.863
80103	1.235	1.325	1.247	0.493	0.501	0.539	0.890	0.860	0.908	0.939	0.948	0.852
80104	1.009	1.149	1.163	0.825	0.829	0.971	0.610	0.579	0.733	0.831	0.876	0.924
80105	1.344	1.237	1.318	1.040	1.036	1.348	0.567	0.538	0.707	0.835	0.866	0.959
80106	1.238	1.115	1.175	1.086	1.077	1.400	0.561	0.535	0.699	0.849	0.867	0.962
80201	4.783	3.465	4.800	1.273	1.257	1.683	0.539	0.519	0.685	0.810	0.842	0.975
80202	1.209	0.986	1.018	1.293	1.277	1.643	0.535	0.517	0.681	0.747	0.837	0.982
8020	1.306	1.072	1.031	1.267	1.237	1.580	0.543	0.524	0.695	0.752	0.845	0.982

3												
80204	1.959	1.574	1.692	0.567	0.558	0.594	0.864	0.851	0.921	0.924	0.963	0.893
80205	0.250	0.311	0.386	0.889	0.842	0.960	0.699	0.651	0.803	0.905	0.930	0.966
80301	1.096	1.312	1.129	0.587	0.556	0.581	1.007	0.964	0.995	0.914	1.002	0.915
80302	1.009	0.990	0.735	0.591	0.553	0.576	1.086	1.000	1.047	1.076	1.055	0.912
80303	0.760	0.797	0.865	0.892	0.695	0.652	1.925	1.727	1.446	1.245	1.281	0.980
80304	6.309	6.547	6.239	0.860	0.677	0.640	1.860	1.685	1.431	1.356	1.276	0.973
80305	8.899	7.129	5.804	0.661	0.584	0.585	1.337	1.220	1.224	1.250	1.148	0.927
90101	0.893	0.975	0.938	0.946	0.720	0.666	1.869	1.747	1.546	1.262	1.331	1.014
90102	0.830	0.916	0.800	0.710	0.613	0.602	1.345	1.238	1.248	1.154	1.168	0.958
90103	0.965	1.060	1.020	0.956	0.726	0.665	1.700	1.619	1.469	1.191	1.292	0.997
90201	0.887	1.841	0.971	0.985	0.737	0.674	2.156	1.890	1.615	1.618	1.456	1.037
90202	0.604	0.732	0.815	1.504	0.957	0.765	3.969	3.243	2.347	2.090	1.851	1.202
90203	0.807	0.804	0.826	1.311	0.867	0.738	3.256	2.754	2.087	1.914	1.690	1.126
90204	2.544	3.671	2.424	0.948	0.720	0.666	2.086	1.852	1.570	1.571	1.416	1.023
90301	0.873	0.660	0.669	0.587	0.551	0.571	1.072	0.983	1.006	0.991	1.044	0.925
90302	1.397	1.072	1.556	0.579	0.545	0.568	1.085	0.992	1.021	1.060	1.057	0.920
90401	1.697	1.730	1.393	0.669	0.636	0.676	0.866	0.820	0.892	1.164	1.013	0.919
90402	0.939	1.475	1.054	0.574	0.540	0.563	1.166	1.040	1.098	1.364	1.126	0.928
90403	1.801	1.050	0.928	0.675	0.643	0.713	0.846	0.799	0.920	1.021	0.992	0.941
90404	3.024	1.572	1.673	1.524	1.381	1.673	0.563	0.541	0.707	0.843	0.883	1.013
90405	1.079	0.857	0.941	0.564	0.539	0.569	1.017	0.959	1.022	1.002	1.024	0.913
90501	0.483	0.473	0.700	0.672	0.648	0.715	0.790	0.767	0.852	0.949	0.958	0.929
9050	0.518	0.530	1.354	0.575	0.545	0.575	1.006	0.959	0.992	1.068	1.038	0.915

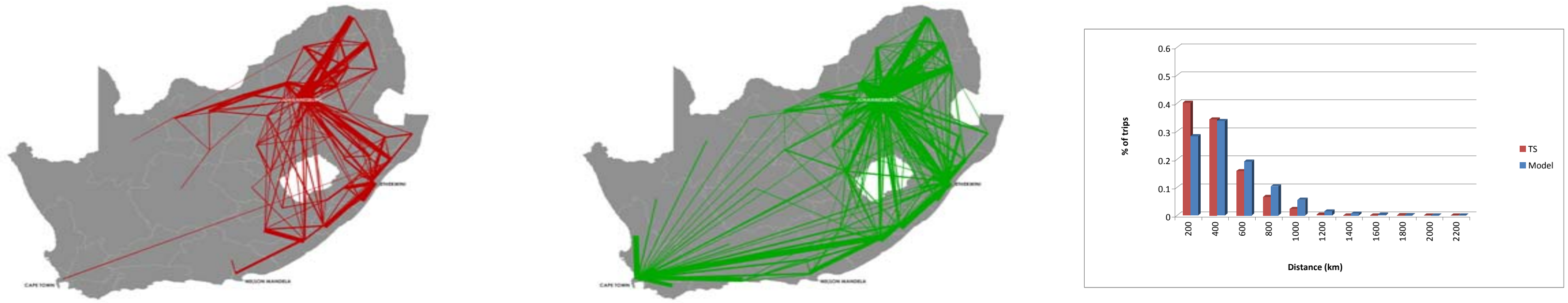
2												
90503	0.592	0.650	0.936	0.573	0.540	0.567	1.046	0.979	1.014	1.136	1.072	0.917
90504	0.686	1.175	1.216	0.610	0.570	0.587	0.955	0.933	0.970	0.916	1.016	0.926
90601	10.777	7.623	5.915	1.138	0.802	0.709	2.463	0.000	1.829	1.794	1.604	1.089
90602	6.326	6.355	5.361	0.991	0.737	0.674	2.121	0.000	1.622	1.744	1.493	1.038
99001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
99012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

ANNEXURE E : COMPARISON BETWEEN TS AND TRIP DISTRIBUTION RESULTS

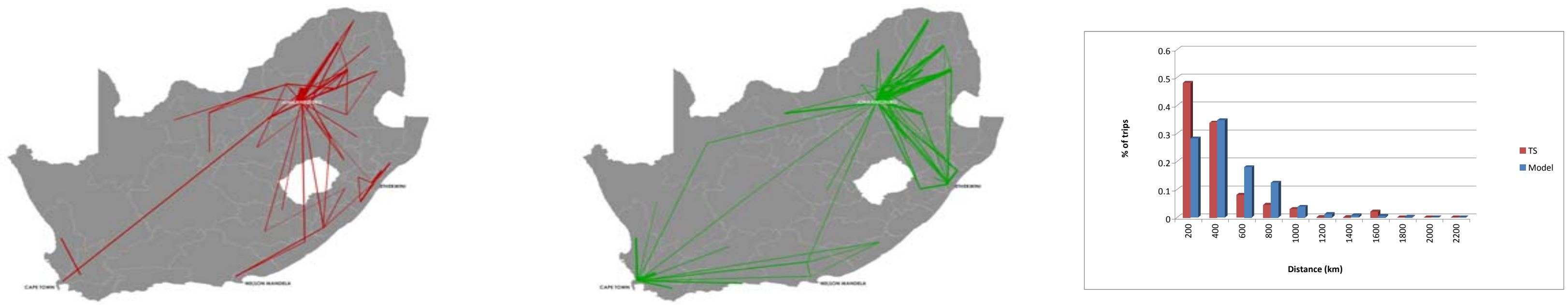
Migrant trips

TS | MODEL

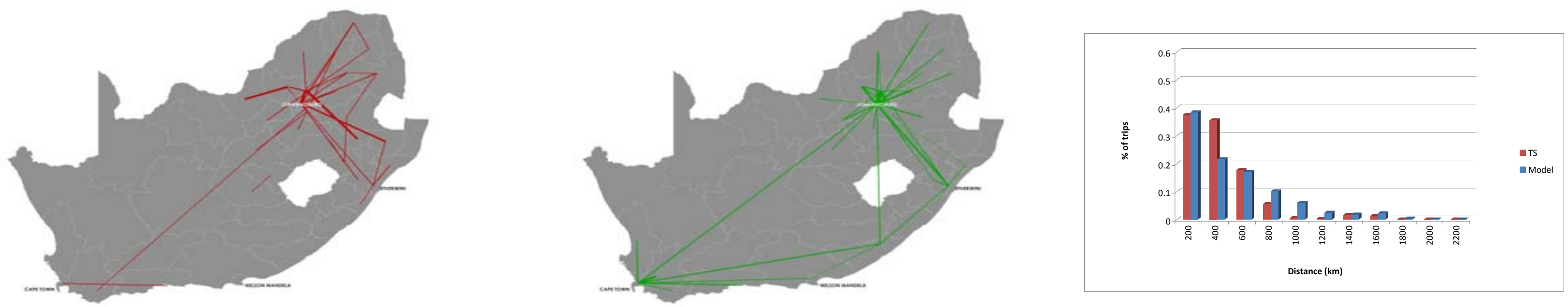
LOW



Middle



High



ANNEXURE F : MODAL SPLIT PER ZONE

Zone	1. Train	2. Bus	3. Taxi	4. Car	5. Truck	6. NMT	7. Other	Total	1. Train	2. Bus	3. Taxi	4. Car	5. Truck	6. NMT	7. Other	Total	1. Train	2. Bus	3. Taxi	4. Car	5. Truck	6. NMT	7. Other	Total
10101	0.000	0.099	0.547	0.159	0.000	0.194	0.000	**1.000**	0.032	0.064	0.477	0.321	0.000	0.103	0.000	**1.000**	0.014	0.073	0.019	0.863	0.000	0.028	0.000	**1.000**
10102	0.120	0.000	0.331	0.282	0.023	0.242	0.000	**1.000**	0.067	0.000	0.243	0.542	0.000	0.147	0.000	**1.000**	0.019	0.000	0.058	0.873	0.008	0.040	0.000	**1.000**
10103	0.363	0.155	0.230	0.165	0.020	0.061	0.002	**1.000**	0.264	0.146	0.203	0.318	0.003	0.046	0.016	**1.000**	0.154	0.116	0.107	0.584	0.000	0.032	0.003	**1.000**
10104	0.259	0.008	0.214	0.243	0.012	0.259	0.000	**1.000**	0.068	0.090	0.183	0.533	0.011	0.112	0.000	**1.000**	0.065	0.011	0.045	0.814	0.003	0.059	0.000	**1.000**
10105	0.035	0.092	0.522	0.155	0.002	0.191	0.000	**1.000**	0.033	0.065	0.474	0.322	0.000	0.103	0.000	**1.000**	0.015	0.072	0.023	0.860	0.000	0.028	0.000	**1.000**
10106	0.289	0.071	0.262	0.212	0.010	0.152	0.000	**1.000**	0.204	0.074	0.178	0.408	0.005	0.128	0.000	**1.000**	0.128	0.040	0.080	0.704	0.004	0.040	0.000	**1.000**
10107	0.289	0.071	0.262	0.212	0.010	0.152	0.000	**1.000**	0.000	0.031	0.007	0.872	0.000	0.087	0.000	**1.000**	0.007	0.025	0.000	0.958	0.003	0.004	0.000	**1.000**
10201	0.000	0.000	0.006	0.206	0.024	0.755	0.006	**1.000**	0.000	0.000	0.168	0.352	0.000	0.480	0.000	**1.000**	0.000	0.000	0.149	0.701	0.000	0.149	0.000	**1.000**
10202	0.000	0.000	0.006	0.206	0.024	0.755	0.006	**1.000**	0.000	0.000	0.012	0.477	0.000	0.510	0.000	**1.000**	0.000	0.000	0.000	0.687	0.000	0.312	0.000	**1.000**
10203	0.000	0.041	0.056	0.339	0.000	0.561	0.000	**1.000**	0.000	0.015	0.064	0.644	0.000	0.256	0.018	**1.000**	0.000	0.055	0.000	0.814	0.000	0.100	0.030	**1.000**
10204	0.033	0.047	0.085	0.142	0.000	0.690	0.000	**1.000**	0.000	0.042	0.331	0.191	0.000	0.434	0.000	**1.000**	0.000	0.000	0.000	0.717	0.101	0.181	0.000	**1.000**
10301	0.000	0.010	0.118	0.114	0.158	0.597	0.000	**1.000**	0.000	0.015	0.025	0.310	0.047	0.601	0.000	**1.000**	0.000	0.000	0.000	0.428	0.071	0.357	0.142	**1.000**
10302	0.111	0.000	0.161	0.109	0.121	0.477	0.018	**1.000**	0.065	0.000	0.160	0.208	0.065	0.430	0.069	**1.000**	0.021	0.000	0.119	0.570	0.051	0.208	0.029	**1.000**
10303	0.149	0.000	0.125	0.239	0.065	0.421	0.000	**1.000**	0.184	0.000	0.211	0.172	0.074	0.342	0.014	**1.000**	0.152	0.000	0.069	0.672	0.026	0.078	0.000	**1.000**
10304	0.000	0.000	0.066	0.219	0.038	0.651	0.023	**1.000**	0.000	0.000	0.059	0.452	0.000	0.471	0.015	**1.000**	0.000	0.000	0.000	0.895	0.000	0.104	0.000	**1.000**
10305	0.000	0.000	0.045	0.163	0.034	0.746	0.010	**1.000**	0.000	0.000	0.195	0.390	0.093	0.297	0.023	**1.000**	0.000	0.000	0.101	0.673	0.073	0.149	0.001	**1.000**
10401	0.000	0.016	0.034	0.194	0.140	0.605	0.008	**1.000**	0.000	0.019	0.078	0.425	0.078	0.397	0.000	**1.000**	0.000	0.000	0.000	0.854	0.000	0.145	0.000	**1.000**
10402	0.000	0.000	0.360	0.150	0.000	0.488	0.000	**1.000**	0.000	0.000	0.000	0.454	0.000	0.545	0.000	**1.000**	0.000	0.000	0.000	0.692	0.000	0.307	0.000	**1.000**
10403	0.000	0.000	0.020	0.303	0.016	0.659	0.000	**1.000**	0.000	0.000	0.000	0.586	0.000	0.413	0.000	**1.000**	0.000	0.000	0.000	0.621	0.000	0.378	0.000	**1.000**
10404	0.000	0.000	0.016	0.305	0.016	0.661	0.000	**1.000**	0.000	0.000	0.000	0.588	0.000	0.411	0.000	**1.000**	0.000	0.000	0.000	0.619	0.000	0.380	0.000	**1.000**
10501	0.000	0.012	0.012	0.162	0.036	0.776	0.000	**1.000**	0.000	0.034	0.000	0.395	0.058	0.511	0.000	**1.000**	0.000	0.000	0.000	0.884	0.000	0.115	0.000	**1.000**
10502	0.000	0.012	0.012	0.162	0.036	0.776	0.000	**1.000**	0.000	0.034	0.000	0.395	0.058	0.511	0.000	**1.000**	0.000	0.000	0.000	0.884	0.000	0.115	0.000	**1.000**
10503	0.000	0.089	0.297	0.268	0.000	0.344	0.000	**1.000**	0.000	0.069	0.166	0.534	0.000	0.229	0.000	**1.000**	0.000	0.000	0.156	0.843	0.000	0.000	0.000	**1.000**
10504	0.000	0.000	0.526	0.190	0.000	0.283	0.000	**1.000**	0.000	0.059	0.250	0.470	0.000	0.220	0.000	**1.000**	0.000	0.000	0.105	0.809	0.000	0.084	0.000	**1.000**
10505	0.000	0.000	0.210	0.250	0.023	0.505	0.009	**1.000**	0.000	0.000	0.242	0.561	0.050	0.144	0.000	**1.000**	0.000	0.000	0.151	0.726	0.000	0.122	0.000	**1.000**
10506	0.000	0.000	0.297	0.215	0.049	0.437	0.000	**1.000**	0.000	0.000	0.253	0.483	0.187	0.075	0.000	**1.000**	0.000	0.000	0.000	0.861	0.000	0.138	0.000	**1.000**
10601	0.000	0.000	0.047	0.255	0.023	0.649	0.023	**1.000**	0.000	0.000	0.000	0.729	0.000	0.270	0.000	**1.000**	0.000	0.000	0.000	0.660	0.000	0.340	0.000	**1.000**
20101	0.004	0.152	0.356	0.203	0.028	0.253	0.000	**1.000**	0.025	0.102	0.310	0.417	0.000	0.136	0.007	**1.000**	0.000	0.031	0.081	0.857	0.005	0.023	0.000	**1.000**
20102	0.000	0.414	0.368	0.150	0.012	0.055	0.000	**1.000**	0.000	0.218	0.422	0.359	0.000	0.000	0.000	**1.000**	0.000	0.045	0.135	0.819	0.000	0.000	0.000	**1.000**
20103	0.071	0.082	0.552	0.177	0.010	0.105	0.000	**1.000**	0.063	0.048	0.203	0.595	0.000	0.088	0.000	**1.000**	0.012	0.012	0.112	0.862	0.000	0.000	0.000	**1.000**
20201	0.000	0.000	0.051	0.123	0.000	0.825	0.000	**1.000**	0.000	0.000	0.086	0.362	0.086	0.465	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20202	0.004	0.019	0.152	0.156	0.024	0.626	0.013	**1.000**	0.000	0.051	0.125	0.343	0.074	0.387	0.017	**1.000**	0.000	0.000	0.032	0.690	0.000	0.210	0.065	**1.000**
20203	0.000	0.052	0.072	0.291	0.028	0.554	0.000	**1.000**	0.000	0.000	0.000	0.561	0.000	0.438	0.000	**1.000**	0.000	0.000	0.000	0.809	0.000	0.190	0.000	**1.000**
20301	0.000	0.022	0.283	0.083	0.032	0.578	0.000	**1.000**	0.000	0.000	0.385	0.299	0.000	0.314	0.000	**1.000**	0.000	0.000	0.359	0.372	0.000	0.267	0.000	**1.000**
20302	0.157	0.030	0.521	0.147	0.005	0.132	0.004	**1.000**	0.102	0.036	0.513	0.261	0.000	0.072	0.013	**1.000**	0.000	0.011	0.156	0.777	0.000	0.044	0.011	**1.000**
20303	0.000	0.040	0.351	0.052	0.000	0.555	0.000	**1.000**	0.000	0.063	0.421	0.352	0.031	0.131	0.000	**1.000**	0.000	0.066	0.190	0.676	0.000	0.066	0.000	**1.000**
20304	0.000	0.061	0.092	0.212	0.073	0.542	0.017	**1.000**	0.000	0.070	0.338	0.352	0.000	0.239	0.000	**1.000**	0.000	0.000	0.000	0.870	0.000	0.129	0.000	**1.000**
20401	0.000	0.016	0.303	0.106	0.000	0.573	0.000	**1.000**	0.000	0.000	0.082	0.504	0.000	0.348	0.064	**1.000**	0.000	0.000	0.000	0.860	0.000	0.140	0.000	**1.000**
20402	0.000	0.032	0.208	0.096	0.020	0.642	0.000	**1.000**	0.000	0.000	0.200	0.369	0.014	0.415	0.000	**1.000**	0.000	0.000	0.111	0.582	0.000	0.305	0.000	**1.000**
20501	0.000	0.000	0.119	0.073	0.012	0.795	0.000	**1.000**	0.000	0.106	0.236	0.427	0.000	0.229	0.000	**1.000**	0.000	0.000	0.131	0.703	0.000	0.165	0.000	**1.000**
20601	0.000	0.026	0.256	0.111	0.000	0.606	0.000	**1.000**	0.000	0.000	0.496	0.183	0.000	0.320	0.000	**1.000**	0.000	0.000	0.401	0.303	0.000	0.294	0.000	**1.000**
20602	0.000	0.006	0.342	0.159	0.000	0.467	0.024	**1.000**	0.000	0.000	0.355	0.387	0.000	0.257	0.000	**1.000**	0.000	0.000	0.400	0.523	0.000	0.076	0.000	**1.000**
20701	0.000	0.065	0.300	0.083	0.000	0.530	0.020	**1.000**	0.000	0.000	0.234	0.000	0.000	0.687	0.078	**1.000**	0.000	0.065	0.526	0.065	0.000	0.342	0.000	**1.000**
30101	0.000	0.242	0.058	0.143	0.000	0.555	0.000	**1.000**	0.000	0.306	0.000	0.408	0.000	0.285	0.000	**1.000**	0.000	0.178	0.089	0.505	0.000	0.226	0.000	**1.000**
30102	0.000	0.020	0.000	0.025	0.041	0.912	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	0.913	0.086	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
30201	0.000	0.009	0.076	0.076	0.048	0.788	0.000	**1.000**	0.000	0.032	0.023	0.497	0.000	0.447	0.000	**1.000**	0.000	0.000	0.043	0.550	0.000	0.406	0.000	**1.000**
30301	0.000	0.048	0.144	0.309	0.014	0.483	0.000	**1.000**	0.000	0.131	0.315	0.421	0.000	0.131	0.000	**1.000**	0.000	0.000	0.000	0.954	0.000	0.045	0.000	**1.000**
30302	0.000	0.009	0.126	0.146	0.090	0.614	0.012	**1.000**	0.000	0.023	0.272	0.347	0.026	0.329	0.000	**1.000**	0.000	0.035	0.000	0.847	0.000	0.080	0.035	**1.000**
30401	0.000	0.029	0.182	0.220	0.029	0.521	0.015	**1.000**	0.000	0.040	0.233	0.479	0.022	0.208	0.015	**1.000**	0.000	0.009	0.132	0.793	0.006	0.037	0.020	**1.000**
30501	0.000	0.167	0.198	0.219	0.000	0.413	0.000	**1.000**	0.000	0.200	0.066	0.366	0.000	0.366	0.000	**1.000**	0.000	0.230	0.086	0.593	0.000	0.089	0.000	**1.000**
40101	0.000	0.000	0.029	0.052	0.008	0.908	0.000	**1.000**	0.000	0.000	0.000	0.375	0.000	0.562	0.062	**1.000**	0.000	0.062	0.000	0.937	0.000	0.000	0.000	**1.000**
40102	0.000	0.000	0.013	0.094	0.024	0.867	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.658	0.000	0.341	0.000	0.000	0.000	**1.000**
40301	0.000	0.084	0.371	0.131	0.043	0.369	0.000	**1.000**	0.000	0.069	0.403	0.368	0.007	0.137	0.012	**1.000**	0.000	0.062	0.000	0.937	0.000	0.000	0.000	**1.000**
40302	0.000	0.234	0.175	0.070	0.009	0.509	0.000	**1.000**	0.000	0.208	0.248	0.140	0.000	0.402	0.000	**1.000**	0.000	0.658	0.000	0.341	0.000	0.000	0.000	**1.000**
40401	0.000	0.019	0.226	0.136	0.023	0.570	0.023	**1.000**	0.000	0.013	0.288	0.360	0.013	0.256	0.066	**1.000**	0.000	0.138	0.000	0.702	0.159	0.000	0.000	**1.000**
40501	0.000	0.008	0.097	0.089	0.046	0.752	0.005	**1.000**	0.000	0.000	0.100	0.625	0.000	0.275	0.000	**1.000**	0.000	0.000	0.000	0.714	0.000	0.000	0.285	**1.000**
40502	0.000	0.033	0.304	0.100	0.033	0.523	0.003	**1.000**	0.000	0.125	0.318	0.318	0.085	0.153	0.000	**1.000**	0.000	0.269	0.000	0.730	0.000	0.000	0.000	**1.000**

40601	0.000	0.019	0.331	0.096	0.117	0.435	0.000	**1.000**	0.000	0.000	0.122	0.673	0.000	0.204	0.000	**1.000**	0.000	0.000	0.000	0.500	0.000	0.000	0.500	**1.000**
40602	0.000	0.000	0.180	0.181	0.046	0.591	0.000	**1.000**	0.000	0.075	0.198	0.503	0.000	0.222	0.000	**1.000**	0.000	0.000	0.000	0.861	0.138	0.000	0.000	**1.000**
50101	0.010	0.004	0.681	0.000	0.233	0.069	0.000	**1.000**	0.035	0.238	0.285	0.404	0.022	0.014	0.000	**1.000**	0.026	0.144	0.119	0.679	0.000	0.030	0.000	**1.000**
50102	0.000	0.024	0.670	0.000	0.306	0.000	0.000	**1.000**	0.000	0.052	0.600	0.242	0.000	0.105	0.000	**1.000**	0.000	0.047	0.119	0.833	0.000	0.000	0.000	**1.000**
50103	0.003	0.002	0.666	0.009	0.262	0.055	0.000	**1.000**	0.001	0.150	0.380	0.419	0.008	0.039	0.001	**1.000**	0.002	0.034	0.072	0.878	0.000	0.010	0.000	**1.000**
50104	0.061	0.000	0.514	0.004	0.265	0.152	0.000	**1.000**	0.041	0.235	0.173	0.502	0.009	0.036	0.000	**1.000**	0.010	0.029	0.029	0.893	0.000	0.002	0.034	**1.000**
50105	0.005	0.019	0.515	0.000	0.227	0.232	0.000	**1.000**	0.001	0.170	0.174	0.584	0.004	0.060	0.005	**1.000**	0.000	0.074	0.044	0.820	0.004	0.048	0.008	**1.000**
50106	0.000	0.040	0.609	0.000	0.324	0.024	0.000	**1.000**	0.062	0.007	0.478	0.382	0.000	0.069	0.000	**1.000**	0.048	0.065	0.117	0.736	0.026	0.005	0.000	**1.000**
50107	0.000	0.012	0.771	0.000	0.197	0.018	0.000	**1.000**	0.085	0.372	0.363	0.179	0.000	0.000	0.000	**1.000**	0.000	0.341	0.094	0.564	0.000	0.000	0.000	**1.000**
50201	0.000	0.033	0.799	0.000	0.162	0.000	0.003	**1.000**	0.034	0.107	0.308	0.410	0.026	0.113	0.000	**1.000**	0.000	0.012	0.144	0.698	0.000	0.118	0.025	**1.000**
50301	0.000	0.012	0.800	0.003	0.176	0.003	0.004	**1.000**	0.000	0.056	0.375	0.376	0.042	0.143	0.005	**1.000**	0.000	0.005	0.215	0.670	0.013	0.094	0.000	**1.000**
50401	0.008	0.023	0.787	0.000	0.157	0.022	0.000	**1.000**	0.000	0.127	0.468	0.367	0.000	0.037	0.000	**1.000**	0.000	0.000	0.241	0.635	0.019	0.088	0.015	**1.000**
50402	0.000	0.080	0.826	0.000	0.093	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.500	0.250	0.000	0.250	0.000	**1.000**
50501	0.010	0.056	0.671	0.000	0.249	0.010	0.000	**1.000**	0.000	0.035	0.268	0.512	0.000	0.183	0.000	**1.000**	0.000	0.062	0.020	0.815	0.031	0.066	0.002	**1.000**
50502	0.033	0.033	0.808	0.000	0.089	0.033	0.000	**1.000**	0.000	0.000	0.283	0.264	0.000	0.358	0.094	**1.000**	0.000	0.000	0.081	0.918	0.000	0.000	0.000	**1.000**
50601	0.007	0.013	0.695	0.000	0.200	0.083	0.000	**1.000**	0.000	0.044	0.104	0.576	0.000	0.170	0.104	**1.000**	0.000	0.000	0.154	0.759	0.000	0.059	0.027	**1.000**
50701	0.000	0.019	0.821	0.000	0.131	0.026	0.000	**1.000**	0.000	0.063	0.411	0.214	0.000	0.310	0.000	**1.000**	0.037	0.037	0.200	0.524	0.000	0.155	0.042	**1.000**
50801	0.000	0.037	0.882	0.000	0.080	0.000	0.000	**1.000**	0.000	0.034	0.387	0.156	0.000	0.387	0.034	**1.000**	0.000	0.000	0.255	0.608	0.000	0.135	0.000	**1.000**
50901	0.000	0.006	0.769	0.000	0.224	0.000	0.000	**1.000**	0.000	0.437	0.178	0.269	0.062	0.034	0.017	**1.000**	0.000	0.172	0.126	0.575	0.013	0.072	0.039	**1.000**
50902	0.000	0.010	0.925	0.000	0.064	0.000	0.000	**1.000**	0.000	0.000	0.300	0.111	0.000	0.588	0.000	**1.000**	0.000	0.109	0.000	0.484	0.000	0.406	0.000	**1.000**
51001	0.000	0.017	0.783	0.006	0.175	0.013	0.003	**1.000**	0.031	0.094	0.290	0.303	0.015	0.264	0.000	**1.000**	0.000	0.059	0.093	0.668	0.000	0.155	0.023	**1.000**
51101	0.000	0.000	0.768	0.000	0.231	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	0.500	0.250	0.000	0.250	0.000	**1.000**
51102	0.000	0.025	0.862	0.000	0.112	0.000	0.000	**1.000**	0.000	0.000	0.406	0.225	0.000	0.367	0.000	**1.000**	0.000	0.061	0.185	0.629	0.000	0.061	0.061	**1.000**
60101	0.044	0.264	0.180	0.151	0.031	0.322	0.004	**1.000**	0.095	0.278	0.160	0.345	0.012	0.107	0.000	**1.000**	0.095	0.278	0.160	0.345	0.012	0.107	0.000	**1.000**
60102	0.000	0.133	0.195	0.294	0.014	0.359	0.003	**1.000**	0.000	0.136	0.239	0.379	0.018	0.218	0.007	**1.000**	0.000	0.136	0.239	0.379	0.018	0.218	0.007	**1.000**
60201	0.000	0.080	0.126	0.098	0.021	0.671	0.001	**1.000**	0.000	0.100	0.270	0.417	0.000	0.195	0.014	**1.000**	0.000	0.100	0.270	0.417	0.000	0.195	0.014	**1.000**
60301	0.000	0.014	0.164	0.117	0.018	0.684	0.000	**1.000**	0.000	0.035	0.185	0.189	0.071	0.517	0.000	**1.000**	0.000	0.035	0.185	0.189	0.071	0.517	0.000	**1.000**
60401	0.003	0.267	0.078	0.070	0.000	0.565	0.014	**1.000**	0.043	0.084	0.262	0.307	0.000	0.301	0.000	**1.000**	0.022	0.029	0.073	0.736	0.000	0.137	0.000	**1.000**
60402	0.000	0.000	0.387	0.172	0.040	0.400	0.000	**1.000**	0.000	0.000	0.652	0.213	0.060	0.073	0.000	**1.000**	0.000	0.000	0.652	0.213	0.060	0.073	0.000	**1.000**
60403	0.000	0.006	0.355	0.148	0.017	0.471	0.000	**1.000**	0.000	0.028	0.209	0.508	0.000	0.253	0.000	**1.000**	0.000	0.028	0.209	0.508	0.000	0.253	0.000	**1.000**
70101	0.334	0.000	0.398	0.100	0.000	0.161	0.004	**1.000**	0.079	0.000	0.521	0.381	0.000	0.018	0.000	**1.000**	0.000	0.000	0.083	0.882	0.005	0.000	0.028	**1.000**
70102	0.062	0.000	0.413	0.116	0.041	0.359	0.006	**1.000**	0.013	0.027	0.439	0.464	0.022	0.000	0.032	**1.000**	0.012	0.021	0.028	0.865	0.000	0.000	0.071	**1.000**
70103	0.094	0.039	0.452	0.146	0.003	0.255	0.007	**1.000**	0.028	0.036	0.358	0.449	0.000	0.116	0.011	**1.000**	0.007	0.017	0.087	0.880	0.002	0.000	0.003	**1.000**
70104	0.195	0.054	0.416	0.144	0.000	0.179	0.009	**1.000**	0.108	0.098	0.504	0.231	0.002	0.044	0.010	**1.000**	0.089	0.076	0.286	0.547	0.000	0.000	0.000	**1.000**
70201	0.075	0.005	0.614	0.126	0.003	0.174	0.000	**1.000**	0.160	0.000	0.152	0.665	0.000	0.022	0.000	**1.000**	0.028	0.000	0.048	0.903	0.000	0.000	0.019	**1.000**
70202	0.000	0.000	0.000	0.416	0.000	0.583	0.000	**1.000**	0.113	0.000	0.159	0.500	0.000	0.227	0.000	**1.000**	0.000	0.000	0.155	0.844	0.000	0.000	0.000	**1.000**
70203	0.100	0.019	0.551	0.152	0.023	0.146	0.006	**1.000**	0.055	0.017	0.356	0.429	0.015	0.096	0.029	**1.000**	0.006	0.004	0.039	0.939	0.000	0.000	0.010	**1.000**
70204	0.053	0.003	0.432	0.237	0.004	0.254	0.012	**1.000**	0.063	0.009	0.230	0.580	0.004	0.095	0.014	**1.000**	0.051	0.005	0.097	0.841	0.000	0.000	0.003	**1.000**
70301	0.341	0.199	0.313	0.084	0.000	0.061	0.000	**1.000**	0.206	0.213	0.388	0.174	0.000	0.000	0.016	**1.000**	0.001	0.095	0.380	0.522	0.000	0.000	0.000	**1.000**
70302	0.063	0.304	0.158	0.229	0.031	0.210	0.000	**1.000**	0.000	0.162	0.031	0.663	0.000	0.101	0.041	**1.000**	0.009	0.048	0.060	0.881	0.000	0.000	0.000	**1.000**
70303	0.143	0.173	0.411	0.124	0.006	0.137	0.003	**1.000**	0.091	0.143	0.288	0.387	0.000	0.078	0.008	**1.000**	0.018	0.066	0.086	0.823	0.002	0.000	0.002	**1.000**
70304	0.000	0.000	0.256	0.256	0.000	0.426	0.060	**1.000**	0.020	0.024	0.390	0.410	0.000	0.154	0.000	**1.000**	0.005	0.000	0.041	0.934	0.000	0.000	0.017	**1.000**
70401	0.105	0.157	0.274	0.194	0.000	0.264	0.003	**1.000**	0.030	0.239	0.167	0.462	0.006	0.075	0.017	**1.000**	0.000	0.000	0.102	0.885	0.000	0.000	0.010	**1.000**
70402	0.086	0.000	0.021	0.224	0.021	0.625	0.021	**1.000**	0.000	0.000	0.043	0.385	0.000	0.570	0.000	**1.000**	0.000	0.000	0.000	0.999	0.000	0.000	0.000	**1.000**
70403	0.000	0.000	0.733	0.086	0.016	0.123	0.040	**1.000**	0.000	0.000	0.595	0.355	0.000	0.049	0.000	**1.000**	0.000	0.000	0.160	0.838	0.000	0.001	0.000	**1.000**
70501	0.050	0.194	0.300	0.050	0.101	0.300	0.000	**1.000**	0.000	0.105	0.273	0.547	0.073	0.000	0.000	**1.000**	0.000	0.053	0.000	0.945	0.000	0.000	0.000	**1.000**
70502	0.000	0.084	0.438	0.088	0.000	0.388	0.000	**1.000**	0.000	0.184	0.397	0.383	0.000	0.034	0.000	**1.000**	0.000	0.098	0.098	0.803	0.000	0.000	0.000	**1.000**
70503	0.000	0.084	0.438	0.088	0.000	0.388	0.000	**1.000**	0.000	0.184	0.397	0.383	0.000	0.034	0.000	**1.000**	0.000	0.098	0.098	0.803	0.000	0.000	0.000	**1.000**
70601	0.083	0.032	0.543	0.127	0.016	0.182	0.017	**1.000**	0.139	0.000	0.323	0.387	0.000	0.095	0.053	**1.000**	0.047	0.026	0.122	0.706	0.000	0.000	0.096	**1.000**
70602	0.006	0.458	0.030	0.064	0.000	0.439	0.000	**1.000**	0.158	0.158	0.317	0.079	0.000	0.285	0.000	**1.000**	0.009	0.008	0.030	0.892	0.001	0.000	0.058	**1.000**
70603	0.000	0.086	0.213	0.070	0.000	0.576	0.052	**1.000**	0.140	0.000	0.112	0.475	0.000	0.271	0.000	**1.000**	0.145	0.052	0.000	0.800	0.000	0.001	0.000	**1.000**
80101	0.000	0.015	0.121	0.313	0.080	0.468	0.000	**1.000**	0.000	0.048	0.159	0.516	0.000	0.275	0.000	**1.000**	0.000	0.000	0.283	0.554	0.000	0.162	0.000	**1.000**
80102	0.000	0.077	0.189	0.157	0.048	0.516	0.009	**1.000**	0.000	0.113	0.113	0.545	0.000	0.227	0.000	**1.000**	0.000	0.370	0.222	0.185	0.000	0.222	0.000	**1.000**
80103	0.000	0.017	0.182	0.182	0.000	0.604	0.012	**1.000**	0.000	0.000	0.227	0.303	0.000	0.393	0.075	**1.000**	0.000	0.000	0.000	0.901	0.098	0.000	0.000	**1.000**
80104	0.000	0.072	0.239	0.147	0.047	0.492	0.000	**1.000**	0.000	0.028	0.355	0.437	0.000	0.177	0.000	**1.000**	0.000	0.050	0.050	0.636	0.000	0.262	0.000	**1.000**
80105	0.000	0.004	0.399	0.223	0.128	0.244	0.000	**1.000**	0.000	0.091	0.275	0.440	0.000	0.192	0.000	**1.000**	0.000	0.000	0.039	0.960	0.000	0.000	0.000	**1.000**
80106	0.000	0.035	0.464	0.257	0.000	0.242	0.000	**1.000**	0.000	0.225	0.193	0.516	0.000	0.064	0.000	**1.000**	0.000	0.011	0.086	0.843	0.000	0.058	0.000	**1.000**
80201	0.011	0.028	0.244	0.223	0.065	0.427	0.000	**1.000**	0.000	0.000	0.040	0.727	0.040	0.190	0.000	**1.000**	0.000	0.000	0.000	0.803	0.000	0.196	0.000	**1.000**
80202	0.000	0.077	0.333	0.215	0.057	0.306	0.009	**1.000**	0.000	0.098	0.251	0.508	0.000	0.141	0.000	**1.000**	0.000	0.047	0.071	0.816	0.014	0.038	0.011	**1.000**

80203	0.000	0.025	0.368	0.263	0.012	0.330	0.000	**1.000**	0.000	0.000	0.311	0.500	0.000	0.188	0.000	**1.000**	0.000	0.024	0.068	0.858	0.000	0.024	0.024	**1.000**
80204	0.000	0.042	0.072	0.179	0.000	0.705	0.000	**1.000**	0.000	0.376	0.000	0.419	0.000	0.204	0.000	**1.000**	0.000	0.388	0.048	0.456	0.000	0.106	0.000	**1.000**
80205	0.005	0.518	0.129	0.029	0.038	0.264	0.013	**1.000**	0.000	0.475	0.129	0.188	0.000	0.206	0.000	**1.000**	0.000	0.259	0.000	0.462	0.000	0.185	0.092	**1.000**
80301	0.000	0.025	0.063	0.079	0.239	0.591	0.000	**1.000**	0.000	0.000	0.075	0.560	0.000	0.363	0.000	**1.000**	0.000	0.134	0.144	0.528	0.000	0.192	0.000	**1.000**
80302	0.000	0.266	0.138	0.124	0.080	0.384	0.005	**1.000**	0.000	0.200	0.109	0.449	0.000	0.239	0.000	**1.000**	0.000	0.033	0.082	0.795	0.000	0.088	0.000	**1.000**
80303	0.000	0.063	0.194	0.126	0.018	0.578	0.018	**1.000**	0.000	0.063	0.194	0.126	0.018	0.578	0.018	**1.000**	0.000	0.063	0.194	0.126	0.018	0.578	0.018	**1.000**
80304	0.000	0.164	0.166	0.125	0.049	0.481	0.012	**1.000**	0.000	0.132	0.151	0.288	0.009	0.409	0.009	**1.000**	0.000	0.048	0.138	0.461	0.009	0.333	0.009	**1.000**
80305	0.000	0.048	0.138	0.461	0.009	0.333	0.009	**1.000**	0.000	0.048	0.138	0.461	0.009	0.333	0.009	**1.000**	0.000	0.048	0.138	0.461	0.009	0.333	0.009	**1.000**
90101	0.000	0.205	0.225	0.117	0.025	0.426	0.000	**1.000**	0.000	0.471	0.207	0.094	0.000	0.226	0.000	**1.000**	0.000	0.205	0.225	0.117	0.025	0.426	0.000	**1.000**
90102	0.000	0.136	0.162	0.126	0.064	0.510	0.000	**1.000**	0.000	0.000	0.402	0.390	0.000	0.207	0.000	**1.000**	0.000	0.136	0.162	0.126	0.064	0.510	0.000	**1.000**
90103	0.000	0.201	0.178	0.187	0.007	0.425	0.000	**1.000**	0.000	0.287	0.241	0.413	0.000	0.057	0.000	**1.000**	0.000	0.201	0.178	0.187	0.007	0.425	0.000	**1.000**
90201	0.000	0.046	0.272	0.092	0.000	0.588	0.000	**1.000**	0.000	0.275	0.293	0.086	0.086	0.258	0.000	**1.000**	0.000	0.046	0.272	0.092	0.000	0.588	0.000	**1.000**
90202	0.000	0.096	0.237	0.032	0.000	0.633	0.000	**1.000**	0.000	0.266	0.354	0.122	0.010	0.203	0.043	**1.000**	0.000	0.096	0.237	0.032	0.000	0.633	0.000	**1.000**
90203	0.000	0.306	0.063	0.077	0.049	0.502	0.000	**1.000**	0.000	0.166	0.151	0.401	0.000	0.280	0.000	**1.000**	0.000	0.306	0.063	0.077	0.049	0.502	0.000	**1.000**
90204	0.000	0.046	0.272	0.092	0.000	0.588	0.000	**1.000**	0.000	0.275	0.293	0.086	0.086	0.258	0.000	**1.000**	0.000	0.046	0.272	0.092	0.000	0.588	0.000	**1.000**
90301	0.000	0.141	0.261	0.101	0.028	0.467	0.000	**1.000**	0.000	0.074	0.262	0.436	0.000	0.208	0.020	**1.000**	0.000	0.141	0.261	0.101	0.028	0.467	0.000	**1.000**
90302	0.000	0.085	0.027	0.139	0.112	0.635	0.000	**1.000**	0.000	0.208	0.333	0.104	0.041	0.312	0.000	**1.000**	0.000	0.085	0.027	0.139	0.112	0.635	0.000	**1.000**
90401	0.000	0.000	0.052	0.221	0.000	0.725	0.000	**1.000**	0.000	0.000	0.045	0.844	0.000	0.110	0.000	**1.000**	0.000	0.000	0.052	0.221	0.000	0.725	0.000	**1.000**
90402	0.000	0.163	0.055	0.023	0.143	0.613	0.000	**1.000**	0.000	0.432	0.000	0.000	0.000	0.567	0.000	**1.000**	0.000	0.163	0.055	0.023	0.143	0.613	0.000	**1.000**
90403	0.000	0.000	0.069	0.083	0.033	0.813	0.000	**1.000**	0.000	0.000	0.078	0.486	0.000	0.434	0.000	**1.000**	0.000	0.000	0.069	0.083	0.033	0.813	0.000	**1.000**
90404	0.000	0.021	0.076	0.233	0.050	0.618	0.000	**1.000**	0.000	0.090	0.530	0.090	0.000	0.287	0.000	**1.000**	0.000	0.021	0.076	0.233	0.050	0.618	0.000	**1.000**
90405	0.000	0.074	0.328	0.050	0.000	0.546	0.000	**1.000**	0.000	0.000	0.489	0.163	0.054	0.293	0.000	**1.000**	0.000	0.074	0.328	0.050	0.000	0.546	0.000	**1.000**
90501	0.000	0.137	0.258	0.060	0.050	0.492	0.000	**1.000**	0.000	0.149	0.104	0.432	0.000	0.313	0.000	**1.000**	0.000	0.137	0.258	0.060	0.050	0.492	0.000	**1.000**
90502	0.000	0.000	0.053	0.160	0.026	0.721	0.037	**1.000**	0.000	0.000	0.300	0.200	0.000	0.500	0.000	**1.000**	0.000	0.000	0.053	0.160	0.026	0.721	0.037	**1.000**
90503	0.000	0.304	0.226	0.049	0.000	0.418	0.000	**1.000**	0.000	0.000	0.189	0.396	0.000	0.413	0.000	**1.000**	0.000	0.304	0.226	0.049	0.000	0.418	0.000	**1.000**
90504	0.000	0.106	0.199	0.078	0.138	0.476	0.000	**1.000**	0.000	0.240	0.000	0.300	0.000	0.460	0.000	**1.000**	0.000	0.106	0.199	0.078	0.138	0.476	0.000	**1.000**

	LOW INCOME BUSINESS TRIP MODAL SPLIT PROPORTIONS								MIDDLE INCOME BUSINESS TRIP MODAL SPLIT PROPORTIONS								HIGH INCOME BUSINESS TRIP MODAL SPLIT PROPORTIONS							
Zone	**1. Train**	**2. Bus**	**3. Taxi**	**4. Car**	**5. Truck**	**6. NMT**	**7. Other**	**Total**	**1. Train**	**2. Bus**	**3. Taxi**	**4. Car**	**5. Truck**	**6. NMT**	**7. Other**	**Total**	**1. Train**	**2. Bus**	**3. Taxi**	**4. Car**	**5. Truck**	**6. NMT**	**7. Other**	**Total**
10101	0.000	0.000	0.000	0.002	0.997	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.636	0.363	0.000	0.000	**1.000**
10102	0.000	0.000	0.000	0.002	0.997	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.785	0.214	0.000	0.000	**1.000**
10103	0.000	0.000	0.000	0.002	0.997	0.000	0.000	**1.000**	0.000	0.000	0.000	0.502	0.497	0.000	0.000	**1.000**	0.055	0.055	0.000	0.227	0.551	0.110	0.000	**1.000**
10104	0.000	0.000	0.000	0.498	0.501	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.898	0.101	0.000	0.000	**1.000**
10105	0.000	0.500	0.000	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.636	0.363	0.000	0.000	**1.000**
10106	0.000	0.500	0.000	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.367	0.632	0.000	0.000	**1.000**	0.000	0.056	0.000	0.391	0.533	0.018	0.000	**1.000**
10107	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.997	0.002	0.000	0.000	**1.000**	0.000	0.000	0.000	0.791	0.208	0.000	0.000	**1.000**
10201	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10202	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.099	0.600	0.299	0.000	**1.000**
10203	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10204	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**
10301	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.166	0.833	0.000	0.000	**1.000**
10302	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.166	0.833	0.000	0.000	**1.000**
10303	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
10304	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10305	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10401	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10402	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10403	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10404	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10501	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.333	0.666	0.000	0.000	**1.000**
10502	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.333	0.666	0.000	0.000	**1.000**
10503	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.750	0.250	0.000	0.000	**1.000**
10504	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.200	0.800	0.000	0.000	**1.000**
10505	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10506	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10601	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
20101	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.024	0.975	0.000	0.000	**1.000**
20102	0.000	0.500	0.000	0.000	0.000	0.500	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
20103	0.000	0.000	0.000	0.000	0.500	0.500	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.200	0.800	0.000	0.000	**1.000**
20201	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.454	0.000	0.545	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.800	0.000	0.200	**1.000**
20202	0.000	0.000	0.000	0.000	0.800	0.200	0.000	**1.000**	0.000	0.000	0.454	0.000	0.545	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
20203	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.454	0.000	0.545	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
20301	0.000	0.000	0.333	0.000	0.666	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	0.909	0.000	0.090	0.000	0.000	**1.000**
20302	0.000	0.090	0.090	0.000	0.454	0.363	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.033	0.000	0.066	0.900	0.000	0.000	**1.000**
20303	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.222	0.000	0.000	0.777	0.000	0.000	**1.000**	0.000	0.000	0.000	0.166	0.833	0.000	0.000	**1.000**
20304	0.000	0.000	0.285	0.000	0.428	0.285	0.000	**1.000**	0.000	0.000	0.333	0.000	0.666	0.000	0.000	**1.000**	0.000	0.250	0.000	0.000	0.750	0.000	0.000	**1.000**
20401	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.400	0.200	0.000	0.400	0.000	0.000	**1.000**
20402	0.000	0.000	0.190	0.000	0.047	0.761	0.000	**1.000**	0.000	0.125	0.125	0.125	0.000	0.625	0.000	**1.000**	0.000	0.400	0.200	0.000	0.400	0.000	0.000	**1.000**
20501	0.000	0.032	0.064	0.000	0.258	0.645	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
20601	0.000	0.333	0.222	0.000	0.444	0.000	0.000	**1.000**	0.000	0.000	0.545	0.000	0.454	0.000	0.000	**1.000**	0.000	0.142	0.000	0.000	0.857	0.000	0.000	**1.000**
20602	0.000	0.090	0.363	0.000	0.545	0.000	0.000	**1.000**	0.000	0.000	0.333	0.166	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.150	0.850	0.000	0.000	**1.000**
20701	0.000	0.666	0.333	0.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
30101	0.000	0.000	0.000	0.200	0.600	0.200	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.038	0.961	0.000	0.000	**1.000**
30102	0.000	0.000	0.000	0.200	0.600	0.200	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.038	0.961	0.000	0.000	**1.000**
30201	0.000	0.000	0.000	0.000	0.333	0.666	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.075	0.100	0.500	0.325	0.000	**1.000**
30301	0.000	0.000	0.000	0.200	0.600	0.200	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.833	0.166	0.000	0.000	**1.000**
30302	0.000	0.000	0.000	0.200	0.600	0.200	0.000	**1.000**	0.000	0.030	0.000	0.121	0.363	0.484	0.000	**1.000**	0.000	0.000	0.000	0.064	0.935	0.000	0.000	**1.000**
30401	0.065	0.000	0.000	0.000	0.852	0.065	0.016	**1.000**	0.129	0.096	0.129	0.000	0.645	0.000	0.000	**1.000**	0.000	0.000	0.000	0.121	0.784	0.094	0.000	**1.000**
30501	0.000	0.000	0.500	0.000	0.500	0.000	0.000	**1.000**	0.129	0.096	0.129	0.000	0.645	0.000	0.000	**1.000**	0.000	0.000	0.000	0.105	0.894	0.000	0.000	**1.000**
40101	0.000	0.000	0.000	0.000	0.909	0.090	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
40102	0.000	0.000	0.000	0.000	0.909	0.090	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
40301	0.129	0.259	0.129	0.000	0.259	0.220	0.000	**1.000**	0.000	0.066	0.000	0.000	0.933	0.000	0.000	**1.000**	0.000	0.024	0.000	0.282	0.680	0.012	0.000	**1.000**

40302	0.000	0.158	0.000	0.000	0.793	0.047	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.172	0.000	0.086	0.741	0.000	0.000	**1.000**
40401	0.000	0.000	0.333	0.000	0.666	0.000	0.000	**1.000**	0.000	0.166	0.166	0.000	0.166	0.500	0.000	**1.000**	0.000	0.129	0.010	0.000	0.860	0.000	0.000	**1.000**
40501	0.000	0.000	0.500	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.166	0.000	0.833	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
40502	0.000	0.000	0.307	0.000	0.538	0.153	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.062	0.000	0.937	0.000	0.000	**1.000**
40601	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.111	0.888	0.000	0.000	**1.000**
40602	0.000	0.000	0.000	0.000	0.500	0.500	0.000	**1.000**	0.000	0.000	0.333	0.000	0.333	0.333	0.000	**1.000**	0.000	0.052	0.000	0.000	0.947	0.000	0.000	**1.000**
50101	0.503	0.000	0.496	0.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.747	0.252	0.000	0.000	**1.000**
50102	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.400	0.600	0.000	0.000	**1.000**
50103	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.116	0.731	0.000	0.035	0.116	0.000	0.000	**1.000**	0.000	0.000	0.000	0.226	0.773	0.000	0.000	**1.000**
50104	0.000	0.000	0.000	0.679	0.135	0.184	0.000	**1.000**	0.000	0.000	0.000	0.131	0.744	0.124	0.000	**1.000**	0.000	0.000	0.000	0.510	0.489	0.000	0.000	**1.000**
50105	0.000	0.000	0.291	0.698	0.002	0.007	0.000	**1.000**	0.095	0.095	0.000	0.006	0.802	0.000	0.000	**1.000**	0.000	0.019	0.000	0.289	0.690	0.000	0.000	**1.000**
50106	0.000	0.000	0.291	0.698	0.002	0.007	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.510	0.489	0.000	0.000	**1.000**
50107	0.000	0.000	0.291	0.698	0.002	0.007	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.510	0.489	0.000	0.000	**1.000**
50201	0.000	0.000	0.000	0.000	0.333	0.666	0.000	**1.000**	0.000	0.000	0.000	0.832	0.166	0.000	0.000	**1.000**	0.000	0.076	0.000	0.307	0.615	0.000	0.000	**1.000**
50301	0.000	0.035	0.285	0.000	0.250	0.428	0.000	**1.000**	0.000	0.000	0.000	0.832	0.166	0.000	0.000	**1.000**	0.000	0.021	0.000	0.297	0.680	0.000	0.000	**1.000**
50401	0.000	0.500	0.000	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50402	0.000	0.500	0.000	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50501	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.166	0.000	0.833	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50502	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.166	0.000	0.833	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50601	0.000	0.200	0.000	0.000	0.600	0.200	0.000	**1.000**	0.000	0.000	0.166	0.000	0.833	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50701	0.000	0.066	0.400	0.000	0.533	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.154	0.000	0.845	0.000	0.000	**1.000**
50801	0.047	0.000	0.283	0.047	0.273	0.000	0.349	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.250	0.750	0.000	**1.000**
50901	0.000	0.666	0.000	0.000	0.333	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.250	0.750	0.000	**1.000**
50902	0.000	0.666	0.000	0.000	0.333	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
51001	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.250	0.750	0.000	0.000	**1.000**
51101	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.250	0.750	0.000	0.000	**1.000**
51102	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
60101	0.500	0.000	0.500	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.307	0.692	0.000	0.000	**1.000**
60102	0.500	0.000	0.500	0.000	0.000	0.000	0.000	**1.000**	0.000	0.500	0.000	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.153	0.000	0.846	0.000	0.000	**1.000**
60201	0.500	0.000	0.500	0.000	0.000	0.000	0.000	**1.000**	0.142	0.000	0.000	0.000	0.714	0.142	0.000	**1.000**	0.000	0.000	0.025	0.102	0.846	0.025	0.000	**1.000**
60301	0.500	0.000	0.500	0.000	0.000	0.000	0.000	**1.000**	0.142	0.000	0.000	0.000	0.714	0.142	0.000	**1.000**	0.000	0.100	0.100	0.000	0.800	0.000	0.000	**1.000**
60401	0.500	0.000	0.500	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.058	0.000	0.941	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
60402	0.500	0.000	0.500	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.058	0.000	0.941	0.000	0.000	**1.000**	0.000	0.000	0.000	0.125	0.875	0.000	0.000	**1.000**
60403	0.500	0.000	0.500	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.058	0.000	0.941	0.000	0.000	**1.000**	0.000	0.000	0.000	0.066	0.933	0.000	0.000	**1.000**
70101	0.000	0.333	0.000	0.000	0.666	0.000	0.000	**1.000**	0.000	0.000	0.000	0.250	0.750	0.000	0.000	**1.000**	0.000	0.000	0.000	0.511	0.488	0.000	0.000	**1.000**
70102	0.000	0.000	0.722	0.000	0.277	0.000	0.000	**1.000**	0.000	0.000	0.000	0.250	0.750	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70103	0.000	0.000	0.073	0.048	0.878	0.000	0.000	**1.000**	0.000	0.000	0.000	0.500	0.500	0.000	0.000	**1.000**	0.000	0.000	0.009	0.617	0.372	0.000	0.000	**1.000**
70104	0.185	0.000	0.074	0.000	0.740	0.000	0.000	**1.000**	0.000	0.000	0.000	0.500	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70201	0.000	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**	0.000	0.500	0.000	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.201	0.791	0.000	0.007	**1.000**
70202	0.000	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**	0.000	0.500	0.000	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.444	0.416	0.000	0.138	**1.000**
70203	0.000	0.000	0.250	0.250	0.500	0.000	0.000	**1.000**	0.444	0.222	0.000	0.000	0.111	0.000	0.222	**1.000**	0.000	0.000	0.058	0.029	0.911	0.000	0.000	**1.000**
70204	0.000	0.000	0.200	0.000	0.600	0.200	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.245	0.621	0.088	0.044	**1.000**
70301	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.196	0.000	0.803	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70302	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70303	0.000	0.869	0.000	0.000	0.130	0.000	0.000	**1.000**	0.000	0.109	0.000	0.054	0.836	0.000	0.000	**1.000**	0.000	0.010	0.000	0.221	0.673	0.094	0.000	**1.000**
70304	0.000	0.869	0.000	0.000	0.130	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.500	0.500	0.000	0.000	**1.000**
70401	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.100	0.000	0.000	0.700	0.000	0.200	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70402	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.100	0.000	0.000	0.700	0.000	0.200	**1.000**	0.000	0.166	0.000	0.500	0.333	0.000	0.000	**1.000**
70403	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.100	0.000	0.000	0.700	0.000	0.200	**1.000**	0.000	0.166	0.000	0.500	0.333	0.000	0.000	**1.000**
70501	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.109	0.000	0.054	0.836	0.000	0.000	**1.000**	0.000	0.000	0.000	0.636	0.363	0.000	0.000	**1.000**
70502	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.109	0.000	0.054	0.836	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70503	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.109	0.000	0.054	0.836	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70601	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.100	0.800	0.000	0.100	**1.000**
70602	0.000	0.000	0.000	0.250	0.000	0.750	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70603	0.000	0.000	0.000	0.250	0.000	0.750	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**0.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80101	0.000	0.000	0.545	0.000	0.454	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80102	0.000	0.000	0.200	0.000	0.200	0.600	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80103	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80104	0.000	0.000	0.150	0.000	0.400	0.450	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**

80105	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80106	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80201	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80202	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80203	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.090	0.000	0.909	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80204	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.090	0.000	0.909	0.000	0.000	**1.000**	0.000	0.000	0.000	0.500	0.500	0.000	0.000	**1.000**
80205	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80301	0.000	0.083	0.500	0.000	0.416	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.080	0.919	0.000	0.000	**1.000**
80302	0.000	0.083	0.500	0.000	0.416	0.000	0.000	**1.000**	0.000	0.000	0.052	0.052	0.684	0.210	0.000	**1.000**	0.000	0.000	0.000	0.080	0.919	0.000	0.000	**1.000**
80303	0.000	0.083	0.500	0.000	0.416	0.000	0.000	**1.000**	0.000	0.000	0.052	0.052	0.684	0.210	0.000	**1.000**	1.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.000**
80304	0.001	0.041	0.231	0.000	0.645	0.080	0.000	**1.000**	0.001	0.023	0.113	0.035	0.699	0.126	0.000	**1.000**	0.067	0.004	0.002	0.125	0.799	0.000	0.000	**1.000**
80305	0.001	0.041	0.231	0.000	0.645	0.080	0.000	**1.000**	0.001	0.023	0.113	0.035	0.699	0.126	0.000	**1.000**	0.067	0.004	0.002	0.125	0.799	0.000	0.000	**1.000**
90101	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.142	0.000	0.000	0.857	0.000	0.000	**1.000**
90102	0.000	0.500	0.000	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90103	0.000	0.500	0.000	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90201	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.500	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90202	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.675	0.162	0.000	0.162	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90203	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90204	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.500	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90301	0.022	0.022	0.181	0.000	0.681	0.090	0.000	**1.000**	0.027	0.027	0.027	0.000	0.916	0.000	0.000	**1.000**	0.018	0.000	0.018	0.056	0.906	0.000	0.000	**1.000**
90302	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.018	0.000	0.018	0.056	0.906	0.000	0.000	**1.000**
90401	0.000	0.000	0.000	0.000	0.434	0.565	0.000	**1.000**	0.000	0.000	0.000	0.000	0.625	0.375	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90402	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	1.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.000**
90403	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90404	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90405	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90501	0.000	0.000	0.500	0.000	0.000	0.500	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.017	0.000	0.011	0.041	0.928	0.000	0.000	**1.000**
90502	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.017	0.000	0.011	0.041	0.928	0.000	0.000	**1.000**
90504	0.009	0.018	0.091	0.000	0.596	0.284	0.000	**1.000**	0.010	0.020	0.031	0.010	0.791	0.135	0.000	**1.000**	0.017	0.000	0.011	0.041	0.928	0.000	0.000	**1.000**

	LOW INCOME MIGRANT TRIP MODAL SPLIT PROPORTIONS							MIDDLE INCOME MIGRANT TRIP MODAL SPLIT PROPORTIONS							HIGH INCOME MIGRANT TRIP MODAL SPLIT PROPORTIONS						
Zone	**1. Train**	**2. Bus**	**3. Taxi**	**4. Aircraft**	**5. Other**	**9. Unspecified**	**Total**	**1. Train**	**2. Bus**	**3. Taxi**	**4. Aircraft**	**5. Other**	**9. Unspecified**	**Total**	**1. Train**	**2. Bus**	**3. Taxi**	**4. Aircraft**	**5. Other**	**9. Unspecified**	**Total**
10101	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10102	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10103	0.496	0.000	0.496	0.000	0.000	0.007	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10104	0.000	0.000	0.501	0.000	0.000	0.498	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10105	0.000	0.000	0.501	0.000	0.000	0.498	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10106	0.571	0.285	0.143	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10107	0.571	0.285	0.143	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10201	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10202	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10203	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10204	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10301	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10302	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10303	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10304	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10305	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10401	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10402	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10403	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10404	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10501	0.000	0.500	0.000	0.000	0.000	0.500	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
10502	0.000	0.500	0.000	0.000	0.000	0.500	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
10503	0.000	0.500	0.000	0.000	0.000	0.500	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
10504	0.000	0.500	0.000	0.000	0.000	0.500	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
10505	0.000	0.500	0.000	0.000	0.000	0.500	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
10506	0.000	0.500	0.000	0.000	0.000	0.500	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
10601	0.000	0.500	0.000	0.000	0.000	0.500	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
20101	0.000	0.000	0.923	0.000	0.076	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20102	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.666	0.000	0.000	0.333	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20103	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.666	0.000	0.000	0.333	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20201	0.200	0.200	0.600	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20202	0.200	0.200	0.600	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20203	0.200	0.200	0.600	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20301	0.000	0.444	0.444	0.000	0.111	0.000	**1.000**	0.000	0.800	0.200	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20302	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.800	0.200	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20303	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.800	0.200	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20304	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20401	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**
20402	0.000	0.090	0.909	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**
20501	0.000	0.090	0.909	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**
20601	0.000	0.062	0.937	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
20602	0.000	0.111	0.888	0.000	0.000	0.000	**1.000**	0.000	0.153	0.846	0.000	0.000	0.000	**1.000**	0.000	0.000	0.571	0.071	0.357	0.000	**1.000**
20701	0.000	0.600	0.400	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
30101	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.181	0.000	0.000	0.000	0.818	0.000	**1.000**
30102	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.181	0.000	0.000	0.000	0.818	0.000	**1.000**
30201	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.181	0.000	0.000	0.000	0.818	0.000	**1.000**
30301	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.181	0.000	0.000	0.000	0.818	0.000	**1.000**
30302	0.000	0.066	0.133	0.000	0.800	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.181	0.000	0.000	0.000	0.818	0.000	**1.000**
30401	0.000	0.142	0.785	0.000	0.071	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.111	0.000	0.000	0.111	0.777	0.000	**1.000**
30501	0.000	0.142	0.785	0.000	0.071	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.111	0.000	0.000	0.111	0.777	0.000	**1.000**
40101	0.375	0.000	0.500	0.000	0.125	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
40102	0.000	0.000	0.500	0.000	0.500	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
40301	0.000	0.666	0.086	0.000	0.246	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**
40302	0.000	0.075	0.670	0.000	0.253	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**

40401	0.030	0.212	0.757	0.000	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
40501	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
40502	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
40601	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**
40602	0.000	0.047	0.952	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**
50101	0.064	0.175	0.694	0.000	0.000	0.064	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.498	0.501	0.000	0.000	0.000	**1.000**
50102	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.600	0.000	0.400	0.000	**1.000**	0.000	0.498	0.501	0.000	0.000	0.000	**1.000**
50103	0.000	0.232	0.670	0.064	0.032	0.000	**1.000**	0.000	0.000	0.997	0.000	0.002	0.000	**1.000**	0.000	0.498	0.501	0.000	0.000	0.000	**1.000**
50104	0.000	0.680	0.319	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50105	0.000	0.088	0.911	0.000	0.000	0.000	**1.000**	0.000	0.092	0.438	0.000	0.469	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
50106	0.000	0.000	0.999	0.000	0.000	0.000	**1.000**	0.000	0.000	0.999	0.000	0.000	0.000	**1.000**	0.000	0.000	0.250	0.000	0.750	0.000	**1.000**
50107	0.000	0.083	0.916	0.000	0.000	0.000	**1.000**	0.000	0.000	0.833	0.000	0.166	0.000	**1.000**	0.000	0.000	0.250	0.000	0.750	0.000	**1.000**
50201	0.000	0.114	0.686	0.000	0.142	0.057	**1.000**	0.000	0.142	0.857	0.000	0.000	0.000	**1.000**	0.000	0.000	0.996	0.000	0.003	0.000	**1.000**
50301	0.000	0.024	0.831	0.000	0.000	0.144	**1.000**	0.000	0.043	0.738	0.000	0.000	0.217	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**
50401	0.000	0.095	0.904	0.000	0.000	0.000	**1.000**	0.000	0.250	0.625	0.000	0.125	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
50402	0.000	0.095	0.904	0.000	0.000	0.000	**1.000**	0.000	0.250	0.625	0.000	0.125	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
50501	0.000	0.706	0.293	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
50502	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
50601	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.666	0.000	0.333	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
50701	0.000	0.279	0.689	0.000	0.000	0.031	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
50801	0.000	0.250	0.750	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.909	0.090	0.000	0.000	**1.000**
50901	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
50902	0.000	0.222	0.777	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
51001	0.000	0.405	0.594	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
51101	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
51102	0.000	0.091	0.886	0.000	0.022	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
60101	0.000	0.066	0.933	0.000	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
60102	0.000	0.197	0.739	0.000	0.062	0.000	**1.000**	0.000	0.296	0.592	0.000	0.111	0.000	**1.000**	0.000	0.000	0.545	0.000	0.454	0.000	**1.000**
60201	0.666	0.000	0.166	0.000	0.166	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.833	0.166	0.000	0.000	0.000	0.000	**1.000**
60301	0.000	0.000	0.666	0.000	0.333	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
60401	0.000	0.458	0.504	0.000	0.000	0.037	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
60402	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
60403	0.000	0.066	0.866	0.000	0.066	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70101	0.023	0.127	0.837	0.000	0.011	0.000	**1.000**	0.000	0.000	0.925	0.000	0.074	0.000	**1.000**	0.454	0.000	0.272	0.000	0.272	0.000	**1.000**
70102	0.135	0.084	0.610	0.000	0.169	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**
70103	0.032	0.111	0.837	0.009	0.004	0.004	**1.000**	0.031	0.265	0.687	0.000	0.015	0.000	**1.000**	0.000	0.000	0.500	0.000	0.500	0.000	**1.000**
70104	0.104	0.213	0.658	0.000	0.023	0.000	**1.000**	0.000	0.061	0.887	0.000	0.000	0.051	**1.000**	0.000	0.176	0.823	0.000	0.000	0.000	**1.000**
70201	0.248	0.101	0.649	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	0.000	0.172	0.827	0.000	**1.000**
70202	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	**1.000**	0.000	0.000	0.000	0.172	0.827	0.000	**1.000**
70203	0.087	0.058	0.824	0.000	0.029	0.000	**1.000**	0.000	0.000	0.100	0.600	0.300	0.000	**1.000**	0.000	0.000	0.000	0.172	0.827	0.000	**1.000**
70204	0.058	0.192	0.748	0.000	0.000	0.000	**1.000**	0.000	0.250	0.562	0.000	0.187	0.000	**1.000**	0.000	0.000	0.000	0.172	0.827	0.000	**1.000**
70301	0.000	0.178	0.285	0.000	0.000	0.535	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.043	0.956	0.000	0.000	0.000	**1.000**
70302	0.454	0.000	0.545	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**
70303	0.013	0.443	0.530	0.013	0.000	0.000	**1.000**	0.090	0.227	0.409	0.090	0.181	0.000	**1.000**	0.000	0.243	0.332	0.038	0.386	0.000	**1.000**
70304	0.035	0.285	0.678	0.000	0.000	0.000	**1.000**	0.000	0.000	0.923	0.076	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**
70401	0.000	0.071	0.928	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70402	0.000	0.200	0.800	0.000	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70403	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70501	0.000	0.615	0.307	0.000	0.076	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70502	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70503	0.000	0.333	0.666	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70601	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.500	0.000	0.000	0.500	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70602	0.111	0.555	0.333	0.000	0.000	0.000	**1.000**	0.000	0.500	0.000	0.000	0.500	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
70603	0.000	0.454	0.500	0.000	0.000	0.045	**1.000**	0.000	0.500	0.000	0.000	0.500	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**
80101	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80102	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80103	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80104	0.000	0.000	0.250	0.000	0.750	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80105	0.000	0.000	0.250	0.000	0.750	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**

80106	0.000	0.000	0.250	0.000	0.750	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	**1.000**
80201	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.111	0.555	0.000	0.333	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80202	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.111	0.555	0.000	0.333	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80203	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80204	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80205	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80301	0.000	0.066	0.933	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.111	0.888	0.000	0.000	0.000	**1.000**
80302	0.000	0.000	0.964	0.000	0.035	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
80303	0.126	0.141	0.629	0.000	0.062	0.039	**1.000**	0.015	0.112	0.727	0.055	0.083	0.006	**1.000**	0.024	0.194	0.526	0.157	0.095	0.000	**1.000**
80304	0.126	0.141	0.629	0.000	0.062	0.039	**1.000**	0.015	0.112	0.727	0.055	0.083	0.006	**1.000**	0.024	0.194	0.526	0.157	0.095	0.000	**1.000**
80305	0.000	0.000	0.964	0.000	0.035	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90101	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90102	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90103	0.000	0.111	0.888	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90201	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.500	0.000	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90202	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.500	0.000	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90203	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.500	0.000	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90204	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.500	0.000	0.500	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90301	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90302	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90401	0.000	0.277	0.722	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**
90402	0.000	0.277	0.722	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**
90403	0.000	0.000	0.909	0.000	0.000	0.090	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**
90404	0.040	0.040	0.880	0.000	0.040	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**
90405	0.040	0.040	0.880	0.000	0.040	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**
90501	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**
90502	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**
90503	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**
90504	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	**1.000**	0.000	0.400	0.600	0.000	0.000	0.000	**1.000**

	LOW INCOME HOLIDAT TRIP MODAL SPLIT PROPORTIONS								MIDDLE INCOME HOLIDAY TRIP MODAL SPLIT PROPORTIONS								HIGH INCOME HOLIDAY TRIP MODAL SPLIT PROPORTIONS							
Zone	**1. Train**	**2. Bus**	**3. Taxi**	**4. Car**	**5. Truck**	**6. NMT**	**7. Other**	**Total**	**1. Train**	**2. Bus**	**3. Taxi**	**4. Car**	**5. Truck**	**6. NMT**	**7. Other**	**Total**	**1. Train**	**2. Bus**	**3. Taxi**	**4. Car**	**5. Truck**	**6. NMT**	**7. Other**	**Total**
10101	0.400	0.000	0.000	0.000	0.600	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.021	0.000	0.031	0.947	0.000	0.000	**1.000**
10102	0.093	0.406	0.187	0.062	0.250	0.000	0.000	**1.000**	0.181	0.030	0.000	0.060	0.727	0.000	0.000	**1.000**	0.000	0.021	0.000	0.021	0.957	0.000	0.000	**1.000**
10103	0.094	0.063	0.300	0.002	0.538	0.000	0.000	**1.000**	0.000	0.085	0.101	0.017	0.726	0.068	0.000	**1.000**	0.000	0.004	0.004	0.064	0.922	0.004	0.000	**1.000**
10104	0.007	0.042	0.056	0.343	0.520	0.028	0.000	**1.000**	0.016	0.029	0.008	0.069	0.874	0.000	0.000	**1.000**	0.000	0.018	0.000	0.152	0.829	0.000	0.000	**1.000**
10105	0.400	0.000	0.000	0.007	0.592	0.000	0.000	**1.000**	0.000	0.061	0.000	0.010	0.928	0.000	0.000	**1.000**	0.000	0.020	0.000	0.031	0.947	0.000	0.000	**1.000**
10106	0.061	0.027	0.179	0.009	0.721	0.000	0.000	**1.000**	0.026	0.066	0.215	0.015	0.657	0.000	0.017	**1.000**	0.003	0.039	0.000	0.009	0.941	0.005	0.000	**1.000**
10107	0.018	0.054	0.000	0.000	0.927	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.005	0.000	0.000	0.122	0.866	0.000	0.005	**1.000**
10201	0.000	0.117	0.176	0.000	0.705	0.000	0.000	**1.000**	0.000	0.000	0.172	0.000	0.827	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10202	0.000	0.000	0.399	0.019	0.565	0.009	0.004	**1.000**	0.000	0.000	0.297	0.000	0.702	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10203	0.000	0.000	0.000	0.000	0.999	0.000	0.000	**1.000**	0.000	0.000	0.001	0.000	0.998	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10204	0.000	0.000	0.000	0.500	0.500	0.000	0.000	**1.000**	0.000	0.000	0.166	0.166	0.666	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10301	0.250	0.000	0.000	0.000	0.750	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10302	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.333	0.190	0.000	0.476	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10303	0.000	0.147	0.132	0.088	0.632	0.000	0.000	**1.000**	0.000	0.333	0.190	0.000	0.476	0.000	0.000	**1.000**	0.000	0.041	0.027	0.602	0.328	0.000	0.000	**1.000**
10304	0.230	0.000	0.407	0.000	0.238	0.123	0.000	**1.000**	0.010	0.000	0.076	0.000	0.913	0.000	0.000	**1.000**	0.000	0.007	0.034	0.000	0.958	0.000	0.000	**1.000**
10305	0.004	0.000	0.000	0.000	0.920	0.075	0.000	**1.000**	0.000	0.000	0.000	0.000	0.751	0.000	0.248	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10401	0.000	0.303	0.090	0.000	0.606	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10402	1.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.428	0.571	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10403	0.000	0.072	0.054	0.000	0.690	0.181	0.000	**1.000**	0.000	0.000	0.000	0.131	0.861	0.007	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10404	0.000	0.072	0.054	0.000	0.690	0.181	0.000	**1.000**	0.000	0.000	0.000	0.133	0.866	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10501	0.000	0.500	0.272	0.000	0.227	0.000	0.000	**1.000**	0.000	0.031	0.031	0.000	0.937	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10502	0.000	0.500	0.272	0.000	0.227	0.000	0.000	**1.000**	0.000	0.031	0.031	0.000	0.937	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10503	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.025	0.000	0.975	0.000	0.000	**1.000**
10504	0.000	0.108	0.351	0.000	0.540	0.000	0.000	**1.000**	0.090	0.090	0.000	0.000	0.818	0.000	0.000	**1.000**	0.000	0.005	0.000	0.069	0.924	0.000	0.000	**1.000**
10505	0.015	0.000	0.050	0.000	0.923	0.009	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.059	0.000	0.940	0.000	0.000	**1.000**
10506	0.000	0.000	0.058	0.000	0.705	0.235	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
10601	0.119	0.000	0.047	0.000	0.833	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
20101	0.085	0.085	0.376	0.025	0.427	0.000	0.000	**1.000**	0.045	0.102	0.340	0.068	0.443	0.000	0.000	**1.000**	0.009	0.022	0.006	0.016	0.919	0.025	0.000	**1.000**
20102	0.058	0.071	0.766	0.000	0.103	0.000	0.000	**1.000**	0.000	0.031	0.156	0.000	0.812	0.000	0.000	**1.000**	0.010	0.000	0.139	0.096	0.752	0.000	0.000	**1.000**
20103	0.047	0.079	0.761	0.000	0.111	0.000	0.000	**1.000**	0.000	0.333	0.666	0.000	0.000	0.000	0.000	**1.000**	0.083	0.166	0.000	0.000	0.527	0.222	0.000	**1.000**
20201	0.000	0.000	0.437	0.000	0.562	0.000	0.000	**1.000**	0.200	0.000	0.000	0.000	0.800	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
20202	0.090	0.060	0.610	0.000	0.240	0.000	0.000	**1.000**	0.000	0.025	0.200	0.000	0.775	0.000	0.000	**1.000**	0.000	0.000	0.139	0.000	0.860	0.000	0.000	**1.000**
20203	0.000	0.250	0.750	0.000	0.000	0.000	0.000	**1.000**	0.000	0.025	0.200	0.000	0.775	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**
20301	0.018	0.412	0.495	0.000	0.045	0.027	0.000	**1.000**	0.000	0.600	0.266	0.066	0.066	0.000	0.000	**1.000**	0.076	0.038	0.846	0.000	0.038	0.000	0.000	**1.000**
20302	0.062	0.125	0.562	0.000	0.250	0.000	0.000	**1.000**	0.055	0.000	0.722	0.111	0.111	0.000	0.000	**1.000**	0.000	0.171	0.114	0.114	0.571	0.000	0.028	**1.000**
20303	0.000	0.144	0.644	0.013	0.197	0.000	0.000	**1.000**	0.000	0.142	0.400	0.000	0.457	0.000	0.000	**1.000**	0.000	0.176	0.156	0.019	0.647	0.000	0.000	**1.000**
20304	0.009	0.099	0.498	0.000	0.315	0.078	0.000	**1.000**	0.000	0.055	0.333	0.000	0.611	0.000	0.000	**1.000**	0.025	0.153	0.000	0.000	0.820	0.000	0.000	**1.000**
20401	0.156	0.039	0.490	0.000	0.196	0.058	0.058	**1.000**	0.000	0.000	0.230	0.000	0.769	0.000	0.000	**1.000**	0.000	0.333	0.000	0.000	0.666	0.000	0.000	**1.000**
20402	0.083	0.258	0.568	0.000	0.071	0.017	0.000	**1.000**	0.000	0.202	0.380	0.071	0.345	0.000	0.000	**1.000**	0.053	0.214	0.339	0.000	0.392	0.000	0.000	**1.000**
20501	0.036	0.386	0.484	0.006	0.085	0.000	0.000	**1.000**	0.000	0.617	0.058	0.000	0.235	0.000	0.088	**1.000**	0.000	0.142	0.000	0.000	0.857	0.000	0.000	**1.000**
20601	0.000	0.261	0.615	0.000	0.069	0.053	0.000	**1.000**	0.000	0.458	0.041	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.750	0.000	0.250	0.000	0.000	**1.000**
20602	0.000	0.314	0.568	0.000	0.089	0.027	0.000	**1.000**	0.000	0.327	0.072	0.000	0.600	0.000	0.000	**1.000**	0.000	0.193	0.322	0.048	0.435	0.000	0.000	**1.000**
20701	0.000	0.516	0.431	0.019	0.019	0.013	0.000	**1.000**	0.000	0.583	0.416	0.000	0.000	0.000	0.000	**1.000**	0.000	0.096	0.536	0.024	0.342	0.000	0.000	**1.000**
30101	0.000	0.090	0.666	0.000	0.242	0.000	0.000	**1.000**	0.000	0.000	0.333	0.000	0.666	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
30102	0.000	0.000	0.666	0.000	0.333	0.000	0.000	**1.000**	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
30201	0.401	0.009	0.009	0.000	0.457	0.121	0.000	**1.000**	0.114	0.200	0.042	0.000	0.642	0.000	0.000	**1.000**	0.089	0.000	0.017	0.000	0.892	0.000	0.000	**1.000**
30301	0.000	0.085	0.485	0.000	0.428	0.000	0.000	**1.000**	1.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
30302	0.000	0.116	0.241	0.000	0.426	0.214	0.000	**1.000**	0.010	0.000	0.494	0.000	0.412	0.082	0.000	**1.000**	0.000	0.000	0.000	0.000	0.953	0.046	0.000	**1.000**
30401	0.254	0.031	0.323	0.000	0.386	0.003	0.000	**1.000**	0.254	0.049	0.260	0.000	0.434	0.000	0.000	**1.000**	0.077	0.000	0.064	0.018	0.839	0.000	0.000	**1.000**
30501	0.026	0.078	0.631	0.000	0.263	0.000	0.000	**1.000**	0.000	0.000	0.470	0.000	0.529	0.000	0.000	**1.000**	0.000	0.080	0.240	0.000	0.680	0.000	0.000	**1.000**
40101	0.108	0.000	0.608	0.000	0.217	0.065	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.041	0.000	0.000	0.916	0.041	0.000	**1.000**
40102	0.018	0.000	0.504	0.000	0.467	0.009	0.000	**1.000**	0.000	0.260	0.000	0.000	0.739	0.000	0.000	**1.000**	0.000	0.041	0.000	0.000	0.916	0.041	0.000	**1.000**
40301	0.020	0.177	0.354	0.030	0.416	0.000	0.000	**1.000**	0.157	0.041	0.078	0.000	0.721	0.000	0.000	**1.000**	0.072	0.050	0.046	0.086	0.731	0.011	0.000	**1.000**

40302	0.051	0.186	0.658	0.006	0.096	0.000	0.000	**1.000**	0.025	0.007	0.636	0.000	0.330	0.000	0.000	**1.000**	0.090	0.039	0.015	0.018	0.837	0.000	0.000	**1.000**
40401	0.030	0.058	0.479	0.000	0.369	0.061	0.000	**1.000**	0.000	0.000	0.164	0.000	0.835	0.000	0.000	**1.000**	0.000	0.002	0.046	0.016	0.930	0.004	0.000	**1.000**
40501	0.000	0.070	0.709	0.000	0.211	0.008	0.000	**1.000**	0.000	0.040	0.680	0.000	0.280	0.000	0.000	**1.000**	0.000	0.000	0.200	0.000	0.800	0.000	0.000	**1.000**
40502	0.000	0.182	0.701	0.000	0.115	0.000	0.000	**1.000**	0.000	0.148	0.296	0.000	0.555	0.000	0.000	**1.000**	0.000	0.000	0.090	0.000	0.909	0.000	0.000	**1.000**
40601	0.285	0.037	0.548	0.000	0.105	0.022	0.000	**1.000**	0.230	0.076	0.000	0.000	0.692	0.000	0.000	**1.000**	0.333	0.000	0.000	0.000	0.666	0.000	0.000	**1.000**
40602	0.040	0.188	0.586	0.000	0.180	0.004	0.000	**1.000**	0.050	0.100	0.433	0.000	0.416	0.000	0.000	**1.000**	0.000	0.016	0.100	0.000	0.883	0.000	0.000	**1.000**
50101	0.417	0.027	0.427	0.000	0.100	0.000	0.027	**1.000**	0.000	0.000	0.077	0.000	0.922	0.000	0.000	**1.000**	0.000	0.048	0.000	0.000	0.951	0.000	0.000	**1.000**
50102	0.587	0.027	0.385	0.000	0.000	0.000	0.000	**1.000**	0.000	0.500	0.500	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.090	0.818	0.000	0.090	**1.000**
50103	0.000	0.118	0.462	0.020	0.397	0.000	0.000	**1.000**	0.000	0.051	0.007	0.021	0.920	0.000	0.000	**1.000**	0.014	0.018	0.000	0.118	0.844	0.005	0.000	**1.000**
50104	0.026	0.176	0.260	0.070	0.466	0.000	0.000	**1.000**	0.000	0.104	0.051	0.401	0.442	0.000	0.000	**1.000**	0.000	0.021	0.001	0.288	0.688	0.000	0.000	**1.000**
50105	0.000	0.195	0.494	0.037	0.272	0.000	0.000	**1.000**	0.007	0.101	0.204	0.041	0.645	0.000	0.000	**1.000**	0.000	0.032	0.000	0.114	0.833	0.019	0.000	**1.000**
50106	0.000	0.000	0.000	0.000	0.999	0.000	0.000	**1.000**	0.006	0.000	0.000	0.425	0.567	0.000	0.000	**1.000**	0.000	0.000	0.000	0.351	0.648	0.000	0.000	**1.000**
50107	0.000	0.333	0.166	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.500	0.250	0.250	0.000	0.000	**1.000**	0.000	0.000	0.000	0.750	0.250	0.000	0.000	**1.000**
50201	0.019	0.135	0.553	0.000	0.194	0.000	0.097	**1.000**	0.000	0.062	0.416	0.000	0.520	0.000	0.000	**1.000**	0.000	0.000	0.221	0.001	0.777	0.000	0.000	**1.000**
50301	0.002	0.087	0.723	0.000	0.175	0.009	0.000	**1.000**	0.011	0.005	0.148	0.059	0.773	0.000	0.000	**1.000**	0.000	0.000	0.006	0.059	0.933	0.000	0.000	**1.000**
50401	0.000	0.067	0.796	0.008	0.093	0.034	0.000	**1.000**	0.000	0.031	0.452	0.000	0.515	0.000	0.000	**1.000**	0.000	0.058	0.367	0.000	0.573	0.000	0.000	**1.000**
50402	0.000	0.000	0.965	0.000	0.022	0.011	0.000	**1.000**	0.000	0.031	0.452	0.000	0.515	0.000	0.000	**1.000**	0.000	0.058	0.367	0.000	0.573	0.000	0.000	**1.000**
50501	0.000	0.078	0.448	0.000	0.473	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50502	0.000	0.000	0.500	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
50601	0.000	0.234	0.297	0.170	0.127	0.000	0.170	**1.000**	0.000	0.000	0.108	0.000	0.891	0.000	0.000	**1.000**	0.067	0.000	0.000	0.000	0.887	0.000	0.044	**1.000**
50701	0.000	0.094	0.833	0.000	0.071	0.000	0.000	**1.000**	0.000	0.000	0.754	0.000	0.245	0.000	0.000	**1.000**	0.000	0.000	0.029	0.000	0.970	0.000	0.000	**1.000**
50801	0.000	0.141	0.818	0.000	0.040	0.000	0.000	**1.000**	0.000	0.000	0.454	0.000	0.545	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	0.769	0.000	0.230	**1.000**
50901	0.000	0.051	0.896	0.000	0.051	0.000	0.000	**1.000**	0.000	0.000	0.454	0.000	0.545	0.000	0.000	**1.000**	0.000	0.181	0.227	0.000	0.590	0.000	0.000	**1.000**
50902	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.454	0.000	0.545	0.000	0.000	**1.000**	0.000	0.181	0.227	0.000	0.590	0.000	0.000	**1.000**
51001	0.030	0.297	0.445	0.000	0.226	0.000	0.000	**1.000**	0.000	0.090	0.096	0.271	0.542	0.000	0.000	**1.000**	0.000	0.000	0.097	0.024	0.878	0.000	0.000	**1.000**
51101	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.027	0.972	0.000	0.000	**1.000**
51102	0.000	0.285	0.714	0.000	0.000	0.000	0.000	**1.000**	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.027	0.972	0.000	0.000	**1.000**
60101	0.085	0.085	0.106	0.000	0.723	0.000	0.000	**1.000**	0.312	0.187	0.250	0.000	0.250	0.000	0.000	**1.000**	0.057	0.038	0.000	0.288	0.615	0.000	0.000	**1.000**
60102	0.006	0.269	0.553	0.003	0.164	0.000	0.003	**1.000**	0.000	0.050	0.522	0.018	0.408	0.000	0.000	**1.000**	0.000	0.032	0.225	0.064	0.677	0.000	0.000	**1.000**
60201	0.015	0.123	0.503	0.000	0.207	0.138	0.011	**1.000**	0.000	0.075	0.242	0.000	0.681	0.000	0.000	**1.000**	0.012	0.012	0.160	0.074	0.740	0.000	0.000	**1.000**
60301	0.127	0.107	0.644	0.000	0.107	0.013	0.000	**1.000**	0.238	0.000	0.142	0.000	0.619	0.000	0.000	**1.000**	0.098	0.000	0.196	0.058	0.627	0.000	0.019	**1.000**
60401	0.000	0.456	0.528	0.000	0.014	0.000	0.000	**1.000**	0.000	0.200	0.200	0.000	0.600	0.000	0.000	**1.000**	0.000	0.370	0.355	0.000	0.274	0.000	0.000	**1.000**
60402	0.050	0.100	0.550	0.100	0.100	0.100	0.000	**1.000**	0.000	0.375	0.541	0.000	0.083	0.000	0.000	**1.000**	0.000	0.000	0.047	0.000	0.952	0.000	0.000	**1.000**
60403	0.047	0.161	0.442	0.000	0.347	0.000	0.000	**1.000**	0.000	0.000	0.227	0.045	0.727	0.000	0.000	**1.000**	0.000	0.007	0.030	0.015	0.946	0.000	0.000	**1.000**
70101	0.000	0.138	0.676	0.046	0.138	0.000	0.000	**1.000**	0.000	0.407	0.250	0.000	0.342	0.000	0.000	**1.000**	0.000	0.027	0.000	0.088	0.879	0.004	0.000	**1.000**
70102	0.000	0.000	0.750	0.000	0.250	0.000	0.000	**1.000**	0.000	0.036	0.000	0.000	0.963	0.000	0.000	**1.000**	0.012	0.006	0.000	0.464	0.516	0.000	0.000	**1.000**
70103	0.017	0.295	0.422	0.000	0.215	0.004	0.044	**1.000**	0.000	0.198	0.258	0.026	0.516	0.000	0.000	**1.000**	0.003	0.025	0.007	0.212	0.750	0.000	0.000	**1.000**
70104	0.087	0.027	0.796	0.000	0.089	0.000	0.000	**1.000**	0.000	0.626	0.149	0.000	0.223	0.000	0.000	**1.000**	0.008	0.014	0.071	0.305	0.600	0.000	0.000	**1.000**
70201	0.027	0.403	0.401	0.000	0.167	0.000	0.000	**1.000**	0.000	0.197	0.363	0.000	0.439	0.000	0.000	**1.000**	0.000	0.049	0.000	0.012	0.937	0.000	0.000	**1.000**
70202	0.000	0.095	0.761	0.047	0.095	0.000	0.000	**1.000**	0.000	0.250	0.062	0.000	0.687	0.000	0.000	**1.000**	0.000	0.000	0.000	0.217	0.782	0.000	0.000	**1.000**
70203	0.046	0.178	0.677	0.003	0.093	0.000	0.000	**1.000**	0.042	0.057	0.114	0.000	0.757	0.000	0.028	**1.000**	0.000	0.100	0.056	0.068	0.774	0.000	0.000	**1.000**
70204	0.062	0.293	0.333	0.066	0.244	0.000	0.000	**1.000**	0.117	0.132	0.059	0.000	0.690	0.000	0.000	**1.000**	0.000	0.016	0.044	0.072	0.867	0.000	0.000	**1.000**
70301	0.017	0.536	0.207	0.000	0.238	0.000	0.000	**1.000**	0.000	0.105	0.051	0.525	0.303	0.000	0.015	**1.000**	0.008	0.016	0.000	0.034	0.924	0.000	0.016	**1.000**
70302	0.000	0.212	0.696	0.000	0.025	0.000	0.064	**1.000**	0.000	0.689	0.206	0.000	0.103	0.000	0.000	**1.000**	0.000	0.054	0.000	0.048	0.896	0.000	0.000	**1.000**
70303	0.147	0.416	0.273	0.024	0.137	0.000	0.000	**1.000**	0.000	0.235	0.120	0.117	0.525	0.000	0.000	**1.000**	0.000	0.023	0.000	0.102	0.865	0.000	0.008	**1.000**
70304	0.000	0.000	1.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.400	0.600	0.000	0.000	**1.000**	0.061	0.035	0.000	0.091	0.811	0.000	0.000	**1.000**
70401	0.200	0.189	0.265	0.022	0.289	0.000	0.033	**1.000**	0.129	0.155	0.155	0.000	0.560	0.000	0.000	**1.000**	0.051	0.025	0.038	0.000	0.885	0.000	0.000	**1.000**
70402	0.000	0.272	0.727	0.000	0.000	0.000	0.000	**1.000**	0.000	0.260	0.043	0.000	0.695	0.000	0.000	**1.000**	0.000	0.044	0.000	0.000	0.822	0.000	0.133	**1.000**
70403	0.000	0.529	0.000	0.000	0.470	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.076	0.923	0.000	0.000	**1.000**
70501	0.136	0.250	0.454	0.000	0.159	0.000	0.000	**1.000**	0.000	0.333	0.000	0.000	0.666	0.000	0.000	**1.000**	0.000	0.153	0.000	0.000	0.846	0.000	0.000	**1.000**
70502	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.333	0.000	0.000	0.666	0.000	0.000	**1.000**	0.000	0.272	0.000	0.000	0.727	0.000	0.000	**1.000**
70503	0.000	1.000	0.000	0.000	0.000	0.000	0.000	**1.000**	0.000	0.333	0.000	0.000	0.666	0.000	0.000	**1.000**	0.000	0.272	0.000	0.000	0.727	0.000	0.000	**1.000**
70601	0.027	0.055	0.805	0.000	0.111	0.000	0.000	**1.000**	0.000	0.000	0.384	0.000	0.615	0.000	0.000	**1.000**	0.000	0.000	0.153	0.000	0.846	0.000	0.000	**1.000**
70602	0.000	0.000	0.088	0.000	0.911	0.000	0.000	**1.000**	0.000	0.000	0.384	0.000	0.615	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
70603	0.000	0.502	0.453	0.000	0.043	0.000	0.000	**1.000**	0.000	0.174	0.174	0.000	0.651	0.000	0.000	**1.000**	0.000	0.115	0.115	0.000	0.769	0.000	0.000	**1.000**
80101	0.000	0.177	0.691	0.000	0.122	0.009	0.000	**1.000**	0.000	0.010	0.420	0.000	0.570	0.000	0.000	**1.000**	0.000	0.017	0.293	0.000	0.682	0.000	0.005	**1.000**
80102	0.000	0.022	0.883	0.000	0.089	0.004	0.000	**1.000**	0.000	0.000	0.322	0.000	0.677	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80103	0.000	0.000	0.500	0.000	0.500	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80104	0.000	0.054	0.454	0.000	0.490	0.000	0.000	**1.000**	0.000	0.111	0.666	0.111	0.111	0.000	0.000	**1.000**	0.000	0.000	0.142	0.000	0.857	0.000	0.000	**1.000**

80105	0.000	0.013	0.569	0.000	0.416	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.105	0.000	0.000	0.000	0.894	0.000	0.000	**1.000**
80106	0.000	0.010	0.563	0.000	0.395	0.000	0.030	**1.000**	0.000	0.000	0.097	0.000	0.756	0.000	0.146	**1.000**	0.000	0.000	0.031	0.000	0.968	0.000	0.000	**1.000**
80201	0.060	0.040	0.660	0.000	0.240	0.000	0.000	**1.000**	0.000	0.000	0.230	0.000	0.769	0.000	0.000	**1.000**	0.000	0.000	0.100	0.900	0.000	0.000	0.000	**1.000**
80202	0.019	0.049	0.627	0.000	0.303	0.000	0.000	**1.000**	0.000	0.000	0.071	0.000	0.928	0.000	0.000	**1.000**	0.028	0.000	0.000	0.000	0.971	0.000	0.000	**1.000**
80203	0.000	0.000	0.897	0.000	0.102	0.000	0.000	**1.000**	0.000	0.000	0.488	0.000	0.511	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80204	0.000	0.062	0.296	0.000	0.640	0.000	0.000	**1.000**	0.000	0.000	0.125	0.000	0.875	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80205	0.000	0.392	0.540	0.000	0.067	0.000	0.000	**1.000**	0.000	0.052	0.368	0.157	0.421	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
80301	0.000	0.257	0.642	0.000	0.100	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.000	0.083	0.416	0.000	0.500	0.000	0.000	**1.000**
80302	0.050	0.196	0.532	0.000	0.220	0.000	0.000	**1.000**	0.000	0.051	0.155	0.000	0.793	0.000	0.000	**1.000**	0.000	0.008	0.070	0.008	0.904	0.008	0.000	**1.000**
80303	0.000	0.000	0.625	0.000	0.375	0.000	0.000	**1.000**	0.000	0.000	0.500	0.000	0.500	0.000	0.000	**1.000**	0.000	0.800	0.000	0.000	0.200	0.000	0.000	**1.000**
80304	0.049	0.158	0.460	0.012	0.298	0.014	0.004	**1.000**	0.024	0.123	0.228	0.027	0.584	0.005	0.004	**1.000**	0.011	0.053	0.098	0.051	0.777	0.003	0.004	**1.000**
80305	0.049	0.158	0.460	0.012	0.298	0.014	0.004	**1.000**	0.024	0.123	0.228	0.027	0.584	0.005	0.004	**1.000**	0.011	0.053	0.098	0.051	0.777	0.003	0.004	**1.000**
90101	0.000	0.376	0.435	0.000	0.164	0.023	0.000	**1.000**	0.000	0.320	0.336	0.000	0.328	0.016	0.000	**1.000**	0.000	0.000	0.076	0.000	0.923	0.000	0.000	**1.000**
90102	0.000	0.421	0.500	0.000	0.052	0.026	0.000	**1.000**	0.000	0.440	0.128	0.000	0.426	0.003	0.000	**1.000**	0.000	0.033	0.233	0.000	0.733	0.000	0.000	**1.000**
90103	0.000	0.447	0.342	0.000	0.200	0.009	0.000	**1.000**	0.000	0.069	0.063	0.002	0.863	0.001	0.000	**1.000**	0.000	0.000	0.222	0.055	0.722	0.000	0.000	**1.000**
90201	0.032	0.253	0.478	0.000	0.173	0.009	0.051	**1.000**	0.026	0.232	0.498	0.000	0.194	0.007	0.041	**1.000**	0.000	0.156	0.625	0.000	0.218	0.000	0.000	**1.000**
90202	0.005	0.408	0.445	0.000	0.096	0.036	0.008	**1.000**	0.002	0.218	0.693	0.000	0.063	0.018	0.003	**1.000**	0.000	0.276	0.604	0.000	0.119	0.000	0.000	**1.000**
90203	0.006	0.522	0.341	0.000	0.112	0.016	0.000	**1.000**	0.004	0.435	0.297	0.000	0.250	0.012	0.000	**1.000**	0.000	0.092	0.092	0.000	0.814	0.000	0.000	**1.000**
90204	0.032	0.253	0.478	0.000	0.173	0.009	0.051	**1.000**	0.026	0.232	0.498	0.000	0.194	0.007	0.041	**1.000**	0.000	0.156	0.625	0.000	0.218	0.000	0.000	**1.000**
90301	0.008	0.138	0.748	0.000	0.104	0.000	0.000	**1.000**	0.005	0.078	0.331	0.023	0.561	0.000	0.000	**1.000**	0.000	0.010	0.013	0.047	0.929	0.000	0.000	**1.000**
90302	0.000	0.133	0.800	0.000	0.066	0.000	0.000	**1.000**	0.000	0.152	0.794	0.000	0.052	0.000	0.000	**1.000**	0.000	0.076	0.923	0.000	0.000	0.000	0.000	**1.000**
90401	0.000	0.250	0.416	0.000	0.333	0.000	0.000	**1.000**	0.000	0.134	0.414	0.000	0.451	0.000	0.000	**1.000**	0.000	0.028	0.257	0.000	0.714	0.000	0.000	**1.000**
90402	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**	0.090	0.090	0.030	0.000	0.787	0.000	0.000	**1.000**	0.096	0.096	0.032	0.000	0.774	0.000	0.000	**1.000**
90403	0.000	0.000	0.811	0.000	0.188	0.000	0.000	**1.000**	0.000	0.000	0.690	0.000	0.310	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90404	0.000	0.000	0.517	0.000	0.482	0.000	0.000	**1.000**	0.000	0.000	0.322	0.000	0.677	0.000	0.000	**1.000**	0.000	0.000	0.222	0.000	0.777	0.000	0.000	**1.000**
90405	0.000	0.400	0.000	0.000	0.600	0.000	0.000	**1.000**	0.000	0.014	0.000	0.000	0.985	0.000	0.000	**1.000**	0.000	0.000	0.000	0.000	1.000	0.000	0.000	**1.000**
90501	0.000	0.136	0.795	0.000	0.068	0.000	0.000	**1.000**	0.000	0.056	0.877	0.037	0.028	0.000	0.000	**1.000**	0.000	0.090	0.363	0.000	0.545	0.000	0.000	**1.000**
90502	0.000	0.005	0.882	0.000	0.112	0.000	0.000	**1.000**	0.000	0.015	0.871	0.000	0.113	0.000	0.000	**1.000**	0.000	0.045	0.348	0.133	0.472	0.000	0.000	**1.000**
90503	0.000	0.068	0.731	0.000	0.200	0.000	0.000	**1.000**	0.000	0.541	0.353	0.000	0.104	0.000	0.000	**1.000**	0.000	0.000	0.333	0.266	0.400	0.000	0.000	**1.000**
90504	0.000	0.217	0.652	0.000	0.130	0.000	0.000	**1.000**	0.000	0.144	0.480	0.038	0.336	0.000	0.000	**1.000**	0.000	0.045	0.348	0.133	0.472	0.000	0.000	**1.000**

ANNEXURE G : ASSIGNMENT PROCEDURES

As explained in Section 7.1 the assignment technique used in the Base Year modelling was what is known as an All-or-Nothing (AoN) assignment. This is one of the simplest assignment methods and assigns all trips between any given origin and destination pair along one and only one path. In other words trips that have a common origin and destination all travel on identical routes with no spread of trips across other routes.

While this is the simplest assignment method in common use this is not to say that it is any less accurate than more complicated techniques such as capacity-constraint assignments or equilibrium assignments. For a model of this coarseness and over such a large area, and focusing exclusively on longer-distance, strategic-level movements between urban and provincial areas rather than within them, such an AoN technique is perfectly adequate. The method, as used in the model is explained here.

ALL-OR-NOTHING ASSIGNMENT.

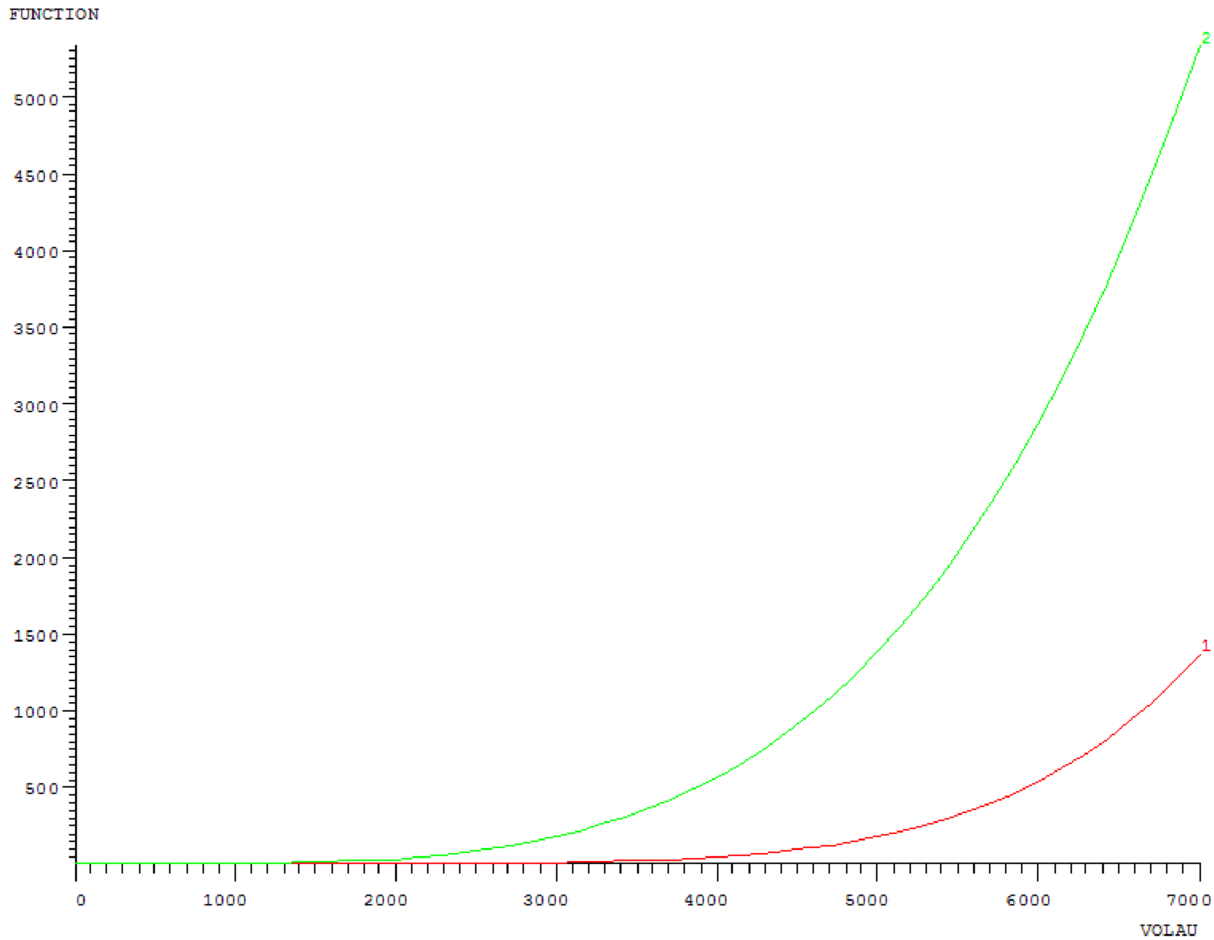
Strictly speaking the assignment procedure implemented in the Natmap model is an equilibrium assignment. This technique is a standard one used in models where both route choice is substantial and the modelled period exhibits high degrees of congestion. Since neither of these elements feature in the Natmap model the end result is for all practical purposes the same as an all-or-nothing assignment with little or no route choice between identical OD pairs. The number of iterations in any given assignment was rarely greater than 2.

The all-or-nothing method assumes that there are no congestion effects in the model. Since the Natmap assignment is an all-day assignment on high-capacity inter-provincial routes, and that the large zone sizes and national scale of the model means that a lot of traffic is going to be intra-zonal (that is, the trips start and end within a single traffic zone and therefore do not access the modelled network at all and therefore do not appear on it as part of the assigned volumes). Because of these factors – (a) assigning over an all day period where peaks in traffic demand will be removed, (b) large zones leading to high percentages of intra-zonal trips and therefore partial demand assigned to the network, and also (c) the strategic nature of the modelled network meaning there is little practical route choice or alternative routes, given that alternative routes are likely to be very different in their costs - it is clear that most assigned volumes in the model are to varying degrees partial ones over an all-day period and therefore congestion is mostly non-existent, so consequently there does not exist of a point of equilibrium as traffic reroutes in order that no single trip can change paths and reduce its travel time or cost.

In the assignment method all trip-makers consider the same attributes for route choice and perceive and weigh them in the same way – travel time plus any toll costs (converted to value of time, one value used for all travellers). The costs therefore are crucial in determining the eventual paths chosen and thus the assigned demand along these paths on the model network.

The costs were calculated using the Volume-Delay Functions (VDFs) described in Section 3. A typical set of VDFs is shown in Figure D.1. It can be seen that as the volume on the link increases this has the effect of increasing the travel cost (in this case time).

Figure D.1 TYPICAL VOLUME-DELAY CURVES - EMME



Different road types behave differently to increases in traffic depending on their basic characteristics. Hence the modelled classification shown in Tables 3.1 and 3.2, showing roads classified by type (freeway/dual-carriageway/major/etc) and location (urban/rural/mountain pass/etc.). Thus a high-capacity inter-urban freeway will be able to maintain high travelling speeds and Levels of Service (LoS) A to B even as the demand gets relatively close the that road's limiting capacity, while a lower-capacity single lane road where all traffic is affected by the speed of cars in front and in urban areas road sections between intersections as well as frontage and on-street parking and more pedestrians means that not only will capacity be reached at much lower demand levels than for higher-capacity roads but travel speeds can be affected even if the demand is far short of the limiting capacity, with LoS D or worse being experienced at only 50% of the actual saturation point. Figure D.1 indicates two typical curves for in one instance a high-capacity freeway (curve 1) and a minor arterial (curve 2).

The resultant assigned demand (as shown in Figures 7.? To 7.?) meet the generally accepted objectives expected of models of this nature, namely:

- Good aggregate network measures of total link flows, total passenger demand by mode;
- Zone-to-zone travels costs (times) for any given level of demand
- Reasonable link flows and, where applicable, identification of heavily congested links.

ANNEXURE H : VALIDATION STANDARDS

H. VALIDATION STANDARDS

H.1 Concept

Concept:

Model quality control standards should be developed early in the project to provide clear and unambiguous targets for the modelling team to aim towards during calibration and validation. These will be established by senior transport planning professionals not directly involved in the day to day model development. The modelling team members will interact with this group during the development process to ensure that the model meets the defined standards.

This form of audit control during the model development, testing and approval processes creates a platform where the model can be used with confidence to support the strategic master plan development.

Current model validation procedures in South Africa (when applied) generally try and meet the standards first defined in the UK Department of Transport's design manual for roads and bridges (the DMRB). These guidelines (which pertain to peak hour volumes) are summarised in Table H.1 below.

TABLE H.1: ASSIGNMENT VALIDATION CRITERIA AND ERROR RANGES, AS PER DMRB

Criteria and Measures	Acceptability Guidelines
Assigned Hourly flows compared with observed flows	
Individual flows within 15% for flows 700-2,700 vph	)
Individual flows within 100 vph for flows< 700 vph	) > 85% of the cases
Individual flows within 400 vph for flows > 2700 vph	)
Total Screen line flows (normally > 5 links) to be within 5%	All or nearly all screen lines
GEH statistic:	
Individual flows: GEH < 5	> 85% of cases
Screen line totals: GEH < 4	All or nearly all screen lines
Modelled journey times compared with observed times	
Times within 15% (or 1 minute, if higher)	> 85% of the routes.
Correlation analysis, modelled vs observed values	
Correlation coefficient , R	0.95 (R-squared > 0.903)
Slope of the best fit regression line	between 0.9 and 1.10

In table H.1, the GEH statistic is defined as:

$$GEH = \sqrt{(M - C)^2 / (0.5(M + C))}$$

Where M = the modelled flow

C = the observed flow

The letters GEH are the initials of Geoff Havers, formerly of Greater London Council, who first suggested the use of this statistic to Professor Dirck van Vliet, the author of Saturn. To quote verbatim from the Saturn manual:

The reason for introducing such a statistic is the inability of either the absolute difference or the relative difference to cope over a wide range of flows. For example an absolute difference of 100 pcu/h may be considered a big difference if the flows are of the order of 100 pcu/h, but would be totally unimportant for flows of the order of several thousand pcu/h. Equally a 10% error in 100 pcu/h would not be important, whereas a 10% error in, say, 3000 pcu/h might mean the difference between building an extra lane or not.

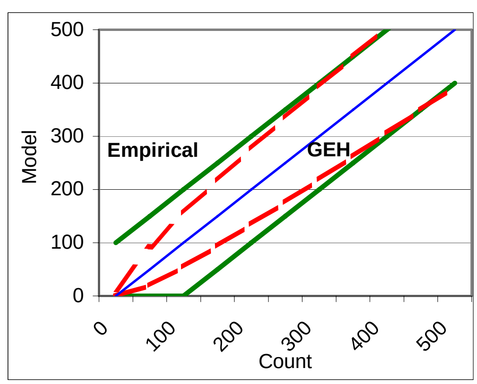
Generally speaking the GEH parameter is less sensitive to such problems since a modeller would probably feel that an error of 20 in 100 would be roughly as bad as an error of 90 in 2,000, and both would have a GEH statistic of, roughly, 2.

In the experience of most traffic and transportation modellers, these standards are extraordinarily high and, without question, impossible to attain during conventional urban traffic modelling. In particular, when the usual 4-step process of trip generation, trip distribution, modal split and assignment is followed, there is invariably a very poor correlation between final model volumes and traffic counts.

On analysis of the DMRB standard, some ambiguities become obvious. These relate to overlaps between the GEH parameter and the empirical guidelines, at either end of the comparison scale. The effect is illustrated in Table H.2, where the GEH test narrows the tolerance considerably at counts below 400.

TABLE H.2: AMBIGUITIES IN THE DMRB VALIDATION GUIDELINES

	Empirical Limits		GEH<5 Limit	
Count	Lower	Upper	Lower	Upper
0	0	100	0	12
50	0	150	20	92
100	0	200	55	156
150	50	250	94	217
200	100	300	135	277
250	150	350	176	335
300	200	400	219	393
350	250	450	262	450
400	300	500	306	506
450	350	550	350	562
500	400	600	394	618



For example, a model volume of 120 creates an ambiguity when measured against the DMRB standard. When compared to a corresponding count of 50, it fails the GEH test but passes the empirical test, as shown shaded in Table H.2. Similarly, for counts greater than about 1200 vph, the GEH test is a tighter restriction than the 15% empirical test, in all cases. For a count of say 2000 vph, the GEH limits are between 1782 and 2230, whereas the 15% limits lie between 1700 and 2300. Further, for screen-line totals, only one measure should be used. The 5% limit is a better guideline.

Consider this: for ADT volumes in the order of 45,000 vehicles per day, a tolerance of 5% equates to an equivalent GEH of 10.52. Conversely, a GEH of 4 implies a tolerance of **2.36**%, which is clearly absurd. It does not make sense to apply several similar validation tests, when any particular comparison can fail one test, but pass another.

These ambiguities can be avoided by adopting simplifications that do not affect the stringency of the standard. Modified criteria are proposed in Table H.3. These tests would apply to ADT trips (vehicles or passengers).

TABLE H.3: SIMPLIFIED VALIDATION CRITERIA

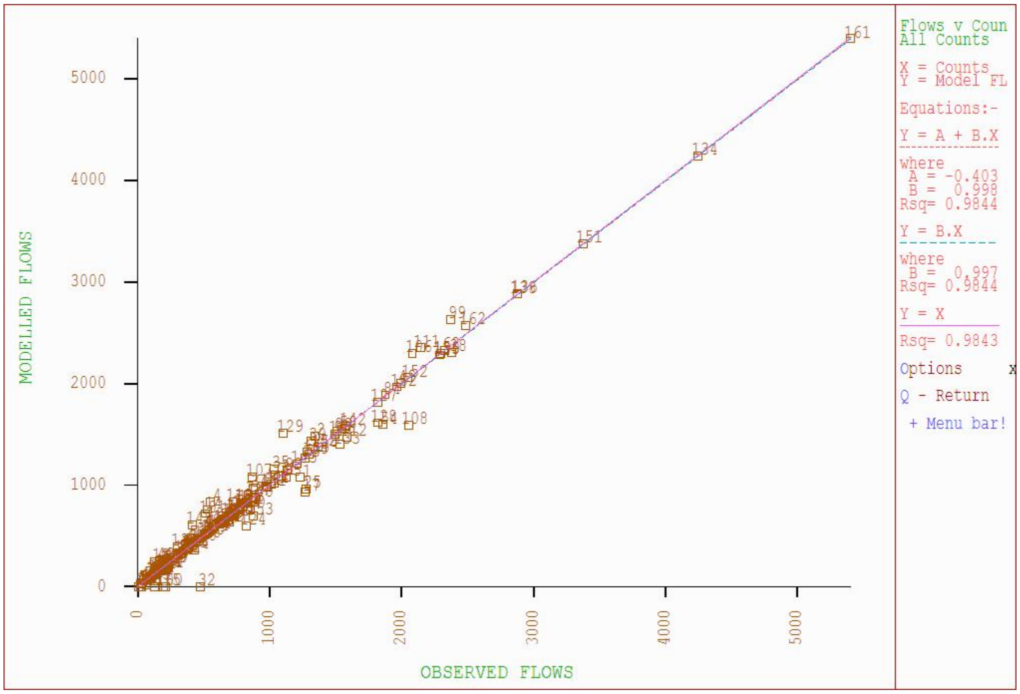
Criteria and Measures	Acceptability Guidelines
Assigned trips compared with observed trips	
Within 100 test	
For counts <= 700	> 85% of the cases
GEH < =5 test	
For counts between 700 and 6000	> 85% of cases
Within 15% Test	
For counts > 6000	> 85% of cases
Correlation analysis, modelled vs observed values	
Correlation coefficient , R	0.95 (R-squared > 0.903)
Slope of the best fit regression line	between 0.9 and 1.10

It should also be noted that the DMRB standard is normally applied in toll projects when the financiers of the capital construction insist upon formal and detailed traffic audits. Model accuracy is thus closely aligned to the *risk of capital loans*. In such cases, the following additional restrictions apply:

- Land-use considerations are not taken into account for future traffic projections.
- Only growth rates are applied to the base year OD matrices, to estimate future traffic demand. These growth rates are applied to base year trip matrices that, although derived from the 4-step process, have been adjusted to match the counts as closely as possible, using appropriate matrix adjustment techniques.

Figure H.1 reflects the typical correlation that can be obtained within Saturn, when using the SATME2 matrix adjustment processes.

FIGURE H.1: MATRIX ADJUSTMENT & ASSIGNMENT VALIDATION WITHIN SATURN




```
FLOW > 700: MODELLED WITHIN 15% OF OBSERVED = 88.43%
FLOW < 700: MODELLED WITHIN 100 OF OBSERVED = 90.53%
ALL LINKS - GEH STATISTIC < 5.0             = 85.98%
```

As mentioned in section 7.2, matrix adjustment techniques will be used mainly as an intermediate assignment step to improve the initial estimates of trips ends, distribution patterns and modal split, within iterative loops of the 4-step process. Ideally, the trip distribution model would generate the final trip matrices, without any adjustment being required during the very last iteration. If assignment results still do not meet the validation criteria, a final adjustment may be unavoidable. In such cases, the aim would be to minimise changes to matrices produced directly by the trip distribution model.

H.2 Observations

The DMRB standards appear to have been derived using an empirical approach not supported by scientific research. For example, the arbitrary GEH limit of 5, when it first appeared in Saturn manuals more than twenty years ago, was no more than the expression of an opinion by Professor Van Vliet, Saturn's author. The GEH statistic was conceived almost thirty years ago, within the context of the static models in use at the time. It is questionable whether such arbitrary measures should continue to serve as the definitive standard for international best practice. To quote the Saturn manual verbatim:

Thus, as a rule of thumb, in comparing assigned volumes with observed volumes, a GEH parameter of 5 or less would indicate an acceptable fit to a traffic modeller, whether it was a difference of 325 to 4,000 or 120 in 500, while links with GEH parameters greater than 10 would probably require closer attention. It needs to be noted that the GEH statistic is an "intuitive" and "empirical engineering" measure, not necessarily a measure that a professional statistician would recognise or deign to use.

Taking this into consideration, there is a case to be made for developing more appropriate standards for strategic models. This notion is explored below.

"Model realism tests" will be done additional to the assignment validation. These tests are based on sensitivity tests to determine the overall model elasticity to parameters used in the model to ensure that the model is neither insensitive nor too sensitive.

H.3 Proposed Revised Validation Standards

There is a clear need for the definition of revised standards that are commensurate with the following:

- The probabilistic nature of transport demand.
- The statistical variations associated with traffic counts against which the model performance is being measured.
- The intended use of the model.
- The financial risk associated with inaccurate modelling estimates.

As a first step towards defining such a revised framework, we propose the following adjustments:

- Remove the overlapping ambiguities contained in the DMRB, as already done in table 3.
- Remove the journey time comparisons. These are not critical for strategic, being more applicable to toll road diversions and freeway analyses.
- Allow the removal of conflicting counts which matrix adjustment processes are unable to resolve.
- Modify the values of the acceptability criteria and/or the limits of the acceptability tests. These should be determined using appropriate statistical analysis and quality control techniques as opposed to imposing arbitrary, empirical limits.

The aim is to develop a standard approach for model validation that is based upon scientific/engineering standards and is reasonably easy to achieve by competent modellers. The following approach is suggested, as a first stage:

- Determine the mean and standard deviations of the traffic counts, where these are available (generally the case, for example permanent CTO count stations located country wide, daily air travel passenger statistics collected over continuous periods, etc.)

- Determine the probability distribution of the counts at each location or route. It is expected that these would be normally distributed around the mean, for a large number of observations, at each location. (For fewer than 10 observations, Student's t-distribution may be more appropriate). These hypotheses should nevertheless be tested properly, using the correct statistical analyses.

- Once the probability distributions are known, the 90%, 95% and 99% confidence intervals can be calculated, for each count location. This defines the ranges within which traffic counts are expected to vary, for different levels of certainty.

- The desired degree of confidence must then be linked to the degree of risk associated with the project.

- Reality thus dictates the limits of model performance. For example, if the chosen level of certainty is 95%, then one would expect 95% of the counts to fall within plus or 1.96 standard deviations of the mean value, across an extended observation period at the same location. The same requirement would then be expected of the model, i.e. 95% of the model volumes must fall within the same range.