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Transport
Roads & Maritime
Services

ROADS AND MARITIME SERVICES

TRIP GENERATION SURVEYS

BUSINESS PARKS AND INDUSTRIAL ESTATES

ANALYSIS REPORT



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1 INTRODUCTION

1.1 Study Brief / Outcomes

The former Roads and Traffic Authority (RTA) published its Guide to Traffic Generating Developments (“*Guide*”) in the mid-1990s. This document drew on the results of a number of trip generation and parking demand surveys covering a range of land uses. These surveys had been progressively conducted since 1979. Since the original publication of the *Guide*, there have been numerous changes to single dwelling residential subdivisions including lot sizes and major development in areas not adequately served by public transport. Industrial estates and business parks have changed as well over the last 40 years, with improved access to private vehicles.

TEF Consulting in association with Gennaoui Consulting (the consultants) were appointed to undertake a detailed trip generation analysis of industrial estates and business parks. The study includes surveys of traffic characteristics relating to vehicle and person trips.

The collected information was then compared to equivalent data in overseas traffic generation databases. This assessment helped to identify if alternative source of trip generation databases could have relevance to Australian conditions.

1.2 Industrial Estates and Business Parks

A Business Park can be defined as an area which include a mixture of office, retail and wholesale stores; warehousing, manufacturing light industrial and scientific research establishments.

A mix of manufacturing and warehousing would be the major land uses in an Industrial Park, which is also differentiated from a Business Park by a larger site, larger lot sizes and extensive internal road network.

1.3 Approach

The approach to this trip generation study is described below:

- The Consultants have been originally provided with a list of 10 survey sites. A list of required attributes and other criteria for the area selection is provided in the Brief. These attributes and criteria are hereby acknowledged.
- The Consultants have assessed the suitability of the sites for the Study and have found that two of the provided sites were not suitable as being very recently developed and containing only 3 or 4 businesses with most of the lots being vacant.
- The Consultants identified a number of alternative sites in the areas close to the rejected sites and from these three sites were selected. The **total number of sites** for the Study has thus become **11**.
- The consultants then undertook a detailed assessments of all selected sites to identify the actual number and size of businesses, ancillary land uses such as petrol stations and retail stores and accessibility to public transport.
- The Consultants then arranged traffic counts on a weekday at all sites. The surveys were undertaken on an either a Tuesday, Wednesday or Thursday. The survey data included vehicle counts and person counts entering and exiting each site. A questionnaire survey was carried out in every business to determine the floor areas, number of employees, daily and seasonal fluctuations of demand and travel/parking arrangements.
- Automatic traffic counters were placed on adjacent major roads to determine the network morning and evening peak hour periods on the survey day and weekly traffic variations.
- The Consultants studied the data using linear and non-linear regression analysis and considered the generated data as a function of the key variable, the floor area of the businesses.

- The Consultants then compared the generation rates established with information from other databases from Australia and overseas.
- The Consultants prepared a report to summarise the findings of the survey and data analysis.
- The reporting is presented in two documents. The first, this report, contains the analysis covering all of the calculations and comparisons. The second report contains the raw data from the surveys and other data such as survey area plans and tabulated vehicle-trip and person-trip data.

The analysis process is captured in the flowchart in Figure 1.1.

1.4 Report Structure

This analysis report has the following structure:

- **Chapter 1: Introduction** – This contains the background to the study, approach and report structure;
- **Chapter 2: Survey methodology** – This contains a description of the survey and survey area selection process;
- **Chapter 3: Survey analysis** – This section analyses the survey results using linear and non-linear regression;
- **Chapter 4: Comparison of survey results with overseas databases** – This section compares the NSW survey results with other country's databases such as TRICS (United Kingdom), NZTDB (New Zealand) and ITE (United States) and assesses the validity of comparing the different databases
- **Chapter 5 : Summary**

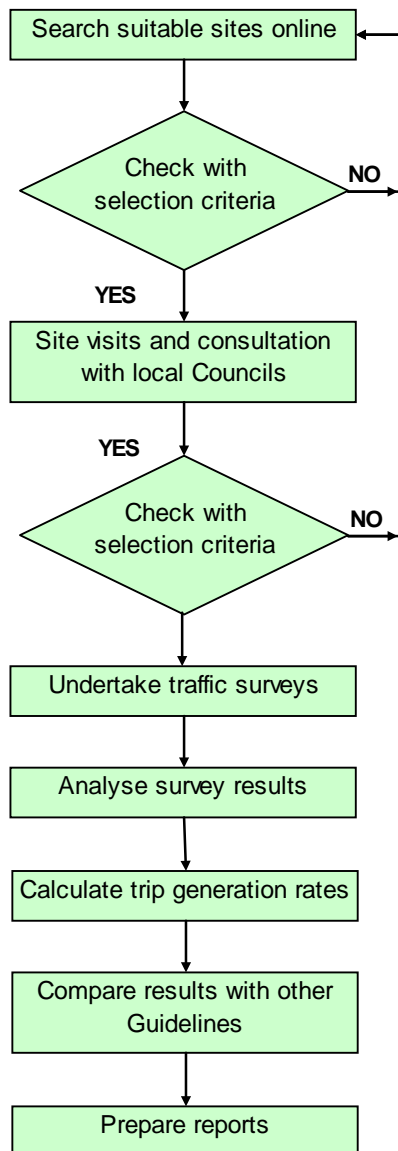


Figure 1.1 Study Approach

2 SURVEY METHODOLOGY

2.1 Selection of survey sites

The survey areas were specified in the RMS Brief and were all adopted for this assessment except two sites, one in Dubbo and one in the Hunter district, which proved not to be suitable and replaced with another site in Dubbo and two sites in the Hunter.

2.2 Survey site Selection Methodology

Refinement of the survey sites

- Consultation with the RMS
- Detailed examination of cadastral maps and aerial photographs
- Identification of survey site characteristics
 - Survey site boundaries
 - Identification of access points
 - Determination of floor area by type of establishments
 - Public transport availability
- Initial survey planning to check suitability in terms of ease of observations
- Confirmation of four (4) survey sites within the Sydney Area (Sites 1 to 4), and seven (7) survey sites in NSW regional centres (non-Sydney, Sites 5 to 11).
 - Survey area visits and collection of specific details
 - Questionnaire survey of all establishments within each site
 - Photographic and video records of access locations

The details of the selected survey areas are summarised in **Table 2.1**. The locations of the survey areas are shown on **Figures 2.1** and **2.2**.

Table 2.1 Details of the selected survey sites.

Traffic results summary												
Survey area ID	Sydney areas				Non-Sydney areas							
	Site 1 Erskine Park Industrial Estate, Erskine	Site 2 Helensburgh Business Park, Helensburgh	Site 3 Wonderland Business Park, Eastern Creek	Site 4 Riverwood Business Park, Riverwood	Site 5 Tuggerah Business Park, Tuggerah	Site 6 Central Business Park, Albion Park Rail	Site 7 Anambah Business Park, Rutherford	Site 8 Freeway Business Park, Beresfield	Site 9 Shearwater Business Park, Taylors Beach	Site 10 Port Stephens Industrial Estate, Taylors	Site 11 Johnson Street Business Park, Dubbo	
Date of survey	29/03/2012	28/03/2012	27/03/2012	28/03/2012	1/05/2012	8/05/2012	2/05/2012	1/05/2012	2/05/2012	2/05/2012	10/05/2012	
Day of survey	Thursday	Wednesday	Tuesday	Wednesday	Tuesday	Tuesday	Wednesday	Tuesday	Wednesday	Wednesday	Thursday	
Duration of survey	06:00-19:00	07:00-19:00	07:00-19:00	07:00-19:00	07:00-19:00	07:00-19:00	06:00-19:00	07:00-19:00	06:00-19:00	06:00-19:00	06:00-19:00	
Surrounding area characteristics:												
Surrounding landuse (eg residential, commercial, open space, etc)	Commercial	Residential	Residential	Residential	Commercial	Residential	Open space	Commercial	Open space	Open space	Residential	
Indicative Public Transport Accessibility Score	2	2	4	8	48	10	0	0.5	0.5	0.5	0	
Principal adjacent road - AM peak period (weekday)	8.00 to 9.00 am	8.30 to 9.30 am	7.30 to 8.30 am	8.15 to 9.15 am	8.00 to 9.00 am	8.00 to 9.00 am	8.00 to 9.00 am	7.00 to 8.00 am	8.00 to 9.00 am	8.00 to 9.00 am	8.00 to 9.00 am	
Principal adjacent road - PM peak period (weekday)	3.30 to 4.30 pm	4.30 to 5.30 pm	4.15 to 5.15 pm	5.00 to 6.00 pm	3.00 to 4.00 pm	4.00 to 5.00 pm	4.00 to 5.00 pm	5.00 to 6.00 pm	4.00 to 5.00 pm	4.00 to 5.00 pm	3.00 to 4.00 pm	
Principal adjacent road – daily peak period (weekdays)	1.00 to 2.00 pm	11.00 am to 12.00 pm	12.15 to 1.15 pm	1.15 to 2.15 pm	11.00 am to 12.00 pm	11.00 am to 12.00 pm	2.00 to 3.00 pm	12.00 to 1.00 pm	11.00 am to 12.00 pm	11.00 am to 12.00 pm	10.0 to 11.00 am	
Estate characteristics:												
Year opened	2003	2011	2007	2004	2006	2000-2005	2008-2010	2005	2003-2005	2001-2005	Late 1980s	
Total site area (hectares)	326.9	0.6	114.6	4.7	52.2	14.6	17.5	32.5	10.3	5.9	6.3	
No. of units/lots (including vacant units/lots)	38	21	26	16	229	79	18	58	93	42	14	
No. of occupied units/lots	36	13	22	16	184	66	18	52	44	27	14	
Predominant business types within estate:												
no. of factories	5	0	0	0	6	0	1	5	0	0	1	
no. of factories/warehouses	2	0	0	0	2	0	0	2	0	0	0	
no. of warehouses	27	0	20	15	41	13	5	23	5	3	11	
no. of offices	1	9	0	1	93	4	3	7	7	1	1	
no. of retailers	0	0	0	0	16	25	1	2	12	6	0	
no. of workshops	1	0	0	0	0	9	3	7	6	1	0	
no. of manufacturers	0	3	2	0	2	0	0	2	2	10	0	
no. of others commercial businesses	0	1	0	0	23	15	5	2	12	5	1	
Gross Floor Area in estate m ² (occupied)	693,605	1,605	406,600	29,983	136,737	42,899	29,766	89,291	16,022	19,881	14,419	
No. of employees	incomplete data from businesses			231	incomplete data from businesses			182	incomplete data from businesses			
Person Trips:												
Peak 1-hour person-trips	1294	29	927	173	1458	519	204	575	285	97	149	
Time of peak 1-hour person-trips	14:45-15:45	14:45-15:45	14:00-15:00	08:15-09:15	16:30-17:30	16:15-17:15	15:00-16:00	07:00-08:00	16:15-17:15	15:00-16:00	16:15-17:15	
Peak person-trips per business	35.9	2.2	42.1	10.8	8	7.9	11.3	11.1	6.5	3.6	10.6	
Peak person-trips per hectare	4	49.4	8.1	37.0	28	35.6	11.6	17.7	27.7	16.5	23.6	
Peak person-trips per 100 m ² of GFA	0.187	1.807	0.228	0.577	1.066	1.210	0.685	0.644	1.779	0.488	1.033	
Peak person-trips per employee	incomplete data from businesses			0.749	incomplete data from businesses			1.121	incomplete data from businesses			
Total daily person-trips	14056	168	9929	1410	12066	4205	2064	6399	2389	975	1316	
Total daily person-trips per business	390.4	13.0	451.3	88	65.6	63.7	114.6	123.1	54.3	36.1	94.0	
Total daily person-trips per hectare	43.0	287.0	86.6	301.5	231.4	288.7	117.6	197.1	232.0	165.5	208.8	
Total daily person-trips per 100 m ² of GFA	2.026	10.492	2.442	4.703	8.824	9.802	6.933	7.167	14.910	4.904	9.129	
Total daily person-trips per employee	incomplete data from businesses			6.105	incomplete data from businesses			11.339	incomplete data from businesses			
Person-trips during adjacent road AM peak	976	24	789	173	1408	270	123	575	176	93	120	
Person-trips during adjacent road PM peak	1073	7	858	94	1060	478	160	396	258	54	136	
Vehicle Trips:												
Peak 1-hour vehicle-trips	1128	24	820	129	1256	418	173	504	209	78	116	
Time of peak 1-hour vehicle-trips	14:45-15:45	14:45-15:45	08:00-09:00	08:15-09:15	08:00-09:00	16:15-17:15	15:00-16:00	07:15-08:15	16:15-17:15	15:00-16:00	15:00-16:00	
Peak vehicle-trips per business	31	1.8	37.3	8.1	6.8	6.3	9.6	9.7	4.8	2.9	8.3	
Peak vehicle-trips per hectare	3.5	40.9	7.2	27.6	24.1	28.7	9.9	15.5	20.3	13.2	18.4	
Peak vehicle-trips per 100 m ² of GFA	0.163	1.495	0.202	0.430	0.919	0.974	0.581	0.564	1.304	0.392	0.805	
Peak vehicle-trips per employee	incomplete data from businesses			0.558	incomplete data from businesses			0.951	incomplete data from businesses			
Total daily vehicle-trips	13125	168	9384	1116	10383	4619	1793	5876	1921	751	1246	
Total daily vehicle-trips per business	364.6	12.9	426.5	69.75	56.4	70.0	99.6	113.0	43.7	27.8	89.0	
Total daily vehicle-trips per hectare	40.1	286.3	81.9	238.6	199.1	317.2	102.2	181.0	186.5	127.5	197.7	
Total daily vehicle-trips per 100 m ² of GFA	1.892	10.467	2.308	3.722	7.593	10.767	6.024	6.581	11.990	3.777	8.642	
Total daily vehicle-trips per employee	incomplete data from businesses			4.83	incomplete data from businesses			9.85	incomplete data from businesses			
Vehicle-trips in adjacent road AM peak (Average)	1165	126	2749	1608	2594	1131	112	1645	670	670	315	
Vehicle-trips in adjacent road PM peak (Average)	972	149	2593	1613	2844	1281	150	1789	805	805	341	
Vehicle-trips during adjacent road AM peak	929	19	724	129	1256	246	111	495	147	64	108	
Vehicle-trips during adjacent road PM peak	965	5	714	69	794	382	127	354	187	42	116	
Average vehicle occupancy	1.10	1.10	1.12	1.16	1.17	1.16	1.17	1.17	1.26	1.19	1.15	
% of total trips by principal mode:												
% Car (as driver)	62.5%	81.9%	63.2%	68.8%	79.1%	78.5%	70.0%	69.1%	74.3%	71.1%	66.1%	
% Car (as passenger)	8.0%	8.3%	8.3%	12.3%	11.2%	13.4%	13.4%	9.6%	19.5%	14.1%	10.9%	
% Commercial Vehicles	28.3%	4.2%	25.9%	12.6%	4.9%	6.2%	15.5%	18.3%	4.3%	8.9%	21.8%	
% Bus	0.8%	0.0%	2.1%	0.5%	3.2%	0.0%	0.0%	2.2%	0.0%	0.0%	0.2%	
% Cycle	0.1%	0.0%	0.3%	0.1%	0.3%	0.6%	0.2%	0.4%	0.8%	1.3%	0.1%	
% Motorbike	0.1%	0.0%	0.0%	0.0%	0.3%	0.4%	0.0%	0.3%	0.9%	3.8%	0.2%	
% On foot	0.1%	5.6%	0.2%	5.7%	1.1%	0.8%	0.6%	0.0%	0.3%	0.9%	0.4%	
% Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.4%	

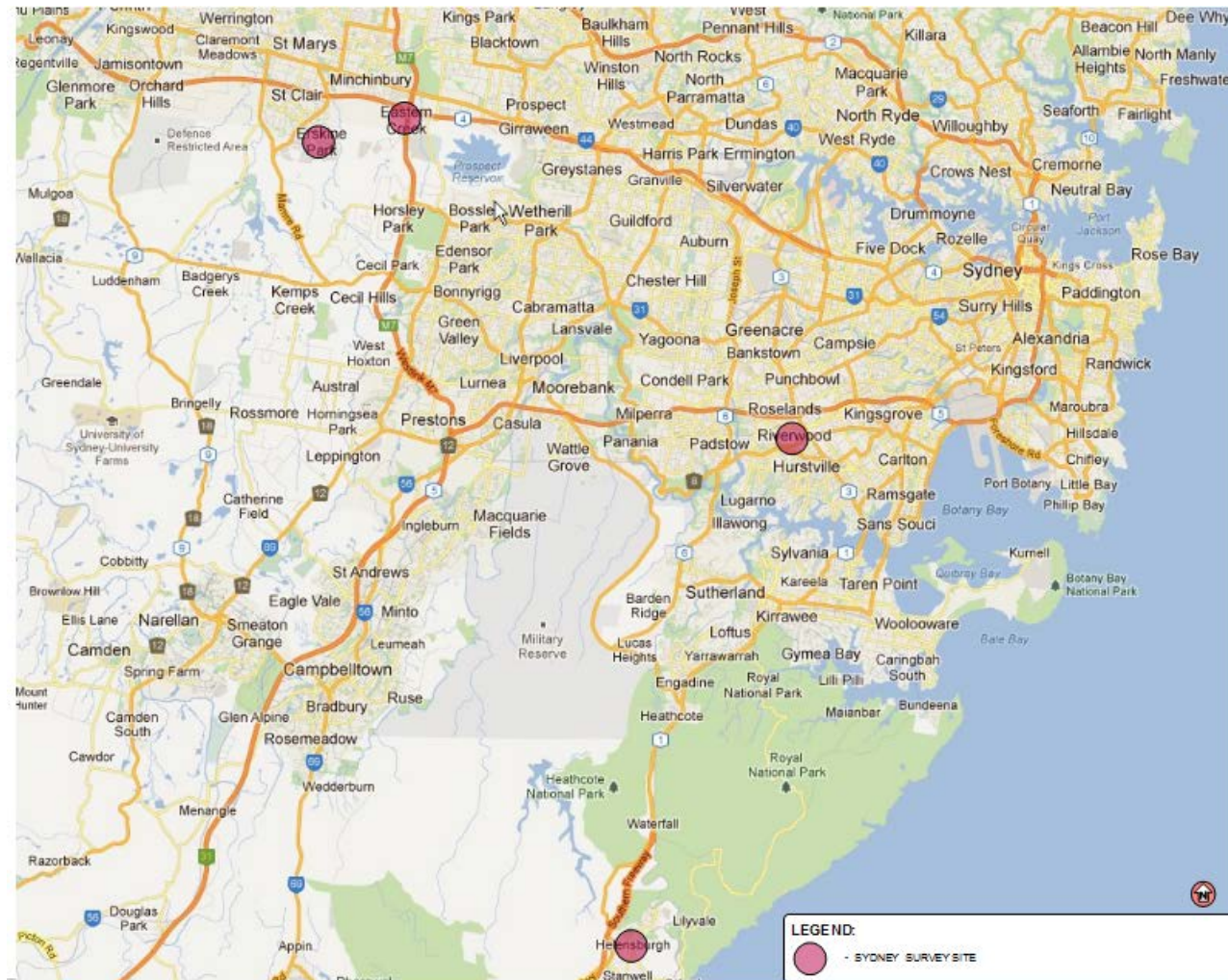


Figure 2.1 Survey site locations - Sydney

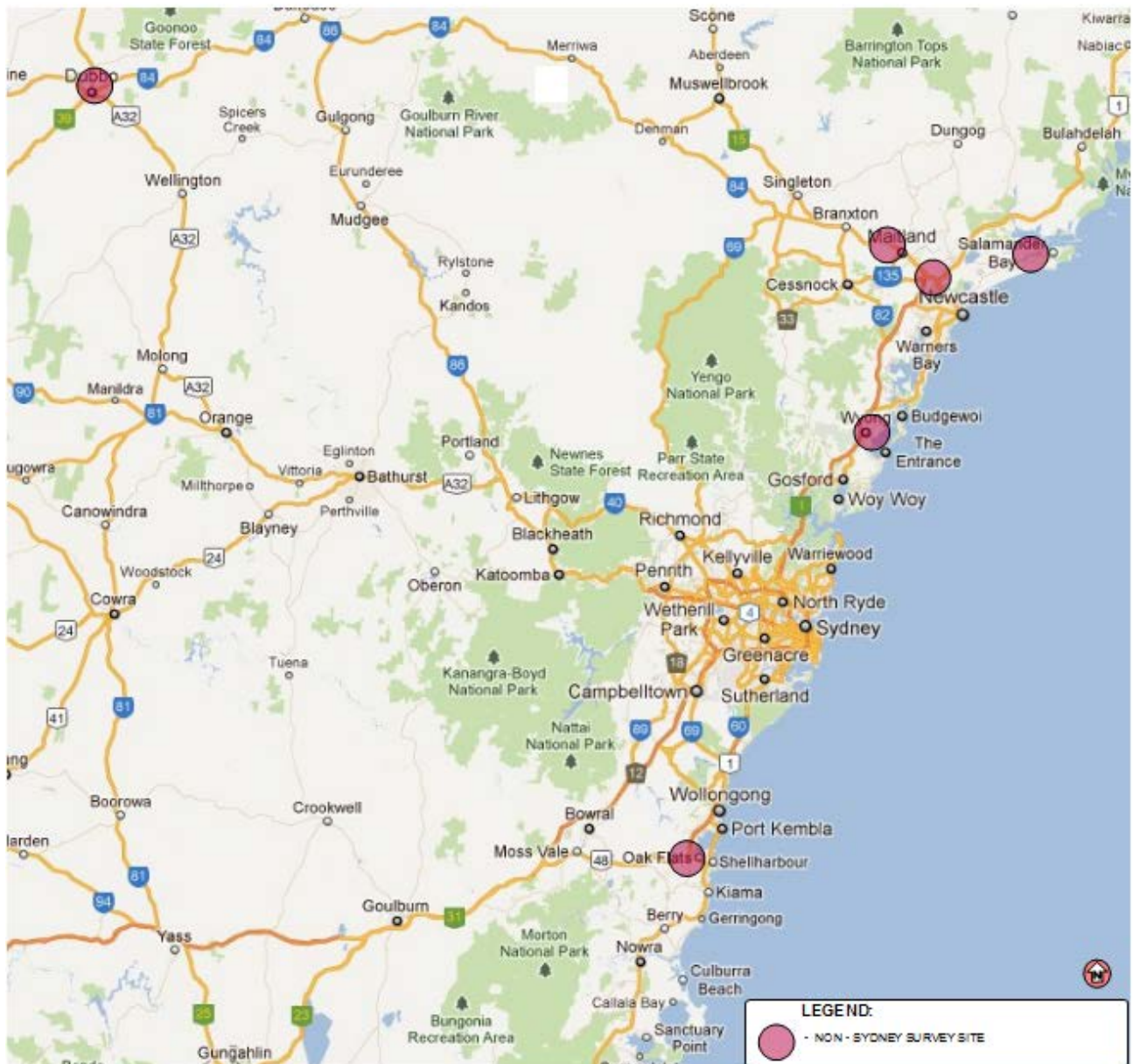


Figure 2.2 Survey site locations – Regional centres

2.2.1 Survey site selection and survey conduct issues

- Two of the survey sites contained establishments which were not considered to be part of the business park / industrial estate (bulky goods stores and a petrol station with significant demand from passing traffic). Trip generation to these establishments had to be identified and extracted from the overall site trip generation.
- All businesses were approached with requests for information in a form of a questionnaire survey; however many businesses chose not to participate. This impacted in particular on the information about the total number of employees for the estates which thus could not be identified for all sites but two.
- In the early hours of the morning, mainly between 6 am and 7 am, traffic observers had some difficulties identifying vehicle occupancies due to dark conditions and headlight glare at some locations.

2.3 Survey Process

Conduct of surveys

Survey period	April – May 2012
	Outside school holidays and public holidays
Day of the week	Tuesday, Wednesday or Thursday
	One survey day for each of the survey sites
Survey times	Generally 7.00 am to 7.00 pm with a number of sites surveyed between 6.00 am to 7.00 pm (where some businesses were identified to start earlier)

Data Recorded by traffic surveyors

- Weather on the survey day
- Number of vehicles (*cars, commercial vehicles, separated into rigid and articulated vehicles, and buses*) entering and leaving the survey site
- Occupancy for each type of vehicle
- Number of pedestrians / motorcyclists / cyclists entering and leaving the survey site
- Questionnaire surveys of businesses
- Hourly traffic volumes on the adjacent major road were also collected to determine main road peak hours using automatic traffic counters.

3 SURVEY ANALYSIS

3.1 Survey Output Requirements

The data was analysed with the key parameters needing to be established being

- Weekday survey site peak hourly generation AM & PM
- Weekday hourly generation in adjacent network AM & PM peak
- Weekday daily trip generation

3.2 Average Trip Rates for Business Parks and Industrial Estates

The trip generation calculation that was to be performed would depend upon the variable that was interrogated, in this case the total floor area by type of land use.

The summary of the survey data for each of the surveyed areas is shown in Table 3.1. Average trip generation rates for sites in the Sydney area are summarised in Table 3.2 together with those for non-Sydney area. The detailed results are contained in a separate “Data Report”.

Table 3.1 Traffic survey results summary.

Site ID	Sydney areas				Non-Sydney areas							
	Site 1 Erskine Park Industrial Estate, Erskine Park	Site 2 Helensburgh Business Park, Helensburgh	Site 3 Wonderland Business Park, Eastern Creek	Site 4 Riverwood Business Park, Riverwood	Site 5 Tuggerah Business Park, Tuggerah	Site 6 Central Business Park, Albion Park Rail	Site 7 Anambah Business Park, Rutherford	Site 8 Freeway Business Park, Beresfield	Site 9 Shearwater Business Park, Taylors Beach	Site 10 Port Stephens Industrial Estate, Taylors Beach	Site 11 Johnson Street Business Park, Dubbo	
Gross Floor Area in estate m ²	693,605	1,605	406,600	29,983	136,737	42,899	29,766	89,291	16,022	19,881	14,419	
Person-based trips												
Site AM peak hour	1148	28	885	173	1416	294	168	575	244	94	120	
Trips per 100 m ² of GFA	0.17	1.74	0.22	0.58	1.04	0.69	0.56	0.64	1.52	0.47	0.83	
Site PM peak hour	1294	29	927	157	1458	519	204	555	285	97	149	
Trips per 100 m ² of GFA	0.19	1.81	0.23	0.52	1.07	1.21	0.69	0.62	1.78	0.49	1.03	
Vehicle network AM peak hour	976	24	743	173	1408	270	123	575	176	93	120	
Trips per 100 m ² of GFA	0.14	1.50	0.18	0.58	1.03	0.63	0.41	0.64	1.10	0.47	0.83	
Vehicle network PM peak hour	1073	7	822	94	1060	477	160	396	258	54	136	
Trips per 100 m ² of GFA	0.15	0.44	0.20	0.31	0.78	1.11	0.54	0.44	1.61	0.27	0.94	
Daily total person trips:												
During Survey Times	0600 to 1900	0700 to 1900	0700 to 1900	0700 to 1900	0700 to 1900	700 to 1900	0600 to 1900	0700 to 1900	0600 to 1900	0600 to 1900	0600 to 1900	
24 hours	11750	144	7654	1344	10796	3590	1898	5210	2253	931	1227	
Trips per 100 m ² of GFA (24hrs)	14056	168	9929	1410	12066	4205	2064	6399	2389	975	1316	
	2.03	10.49	2.44	4.70	8.82	9.80	6.93	7.17	14.91	4.90	9.13	
Vehicle-based trips												
Site AM peak hour	1046	21	820	129	1256	268	145	504	193	64	108	
Trips per 100 m ² of GFA	0.15	1.31	0.20	0.43	0.92	0.62	0.49	0.56	1.20	0.32	0.75	
Site PM peak hour	1128	24	763	123	1,222	418	173	481	209	78	116	
Trips per 100 m ² of GFA	0.16	1.50	0.19	0.41	0.89	0.97	0.58	0.54	1.30	0.39	0.80	
Network AM peak hour	929	19	679	129	1256	246	111	495	147	64	108	
Trips per 100 m ² of GFA	0.13	1.18	0.17	0.43	0.92	0.57	0.37	0.55	0.92	0.32	0.75	
Network PM peak hour	965	5	703	69	794	382	127	354	187	42	116	
Trips per 100 m ² of GFA	0.14	0.31	0.17	0.23	0.58	0.89	0.43	0.40	1.17	0.21	0.80	
Daily total vehicle trips												
During Survey Times	0600 to 1900	0700 to 1900	0700 to 1900	0700 to 1900	0700 to 1900	700 to 1900	0600 to 1900	0700 to 1900	0600 to 1900	0600 to 1900	0600 to 1900	
24 hours	11036	146	7327	1059	9271	2822	1640	4831	1813	714	1,164	
Trips per 100 m ² of GFA (24hrs)	13125	168	9384	1116	10383	3351	1793	5876	1921	751	1,246	
	1.89	10.47	2.31	3.72	7.59	7.81	6.02	6.58	11.99	3.78	8.64	

Table 3.2 Trips rate summary.

Site ID	Sydney areas				Non-Sydney areas				All survey sites				Avg Non-Sydney / Sydney %
	Site 1 to Site 4				Site 5 to Site 11				Site 1 to Site 11				
Trips per 100 m ² of GFA	Min	Max	Avg	St Dev	Min	Max	Avg	St Dev	Min	Max	Avg	St Dev	
Person-based trips													
Site AM peak hour	0.17	1.74	0.68	0.74	0.47	1.52	0.82	0.36	0.17	1.74	0.77	0.50	122%
Site PM peak hour	0.19	1.81	0.69	0.76	0.49	1.78	0.98	0.44	0.19	1.81	0.88	0.56	143%
Vehicle network AM peak hour	0.14	1.50	0.60	0.63	0.41	1.10	0.73	0.27	0.14	1.50	0.68	0.41	122%
Vehicle network PM peak hour	0.15	0.52	0.32	0.19	0.27	1.61	0.83	0.45	0.15	1.61	0.65	0.44	259%
Daily total person trips	2.03	10.49	4.92	3.90	4.90	14.91	8.81	3.16	2.03	14.91	7.39	3.79	179%
Vehicle-based trips													
Site AM peak hour	0.15	1.31	0.52	0.54	0.32	1.20	0.70	0.29	0.15	1.31	0.63	0.38	133%
Site PM peak hour	0.16	1.50	0.56	0.63	0.39	1.30	0.78	0.31	0.16	1.50	0.70	0.43	139%
Network AM peak hour	0.13	1.18	0.48	0.49	0.32	0.92	0.63	0.24	0.13	1.18	0.57	0.34	132%
Network PM peak hour	0.14	0.41	0.25	0.13	0.21	1.17	0.66	0.32	0.14	1.17	0.51	0.33	263%
Daily total vehicle trips	1.89	10.47	4.60	3.99	3.78	11.99	7.49	2.53	1.89	11.99	6.44	3.28	163%

A review of the data reveals a number of observations

- The surveys were undertaken in estates with floor space varying from as low as 1,605 m² to over 690,000 m².
- The morning survey site peak hour trip generation rate varied from 0.15 to 1.31 vehicle trips per 100 m² GFA with an average of 0.63 trips per 100 m² GFA and standard deviation of 0.38.
- The afternoon survey site peak hour trip generation rate varied from 0.16 to 1.50 vehicle trips per 100 m² GFA with an average of 0.70 trips per 100 m² GFA and standard deviation of 0.43.
- The daily trip rate varied from 1.89 to 11.99 vehicle trips per 100 m² GFA with an average of 6.44 trips per 100 m² GFA and standard deviation of 3.28.
- The non-Sydney survey sites had higher average trip rates than the Sydney survey sites.
- Slightly higher trips rates were observed during the site PM peak than during AM peak.

A summary of the daily trip rates is shown below.

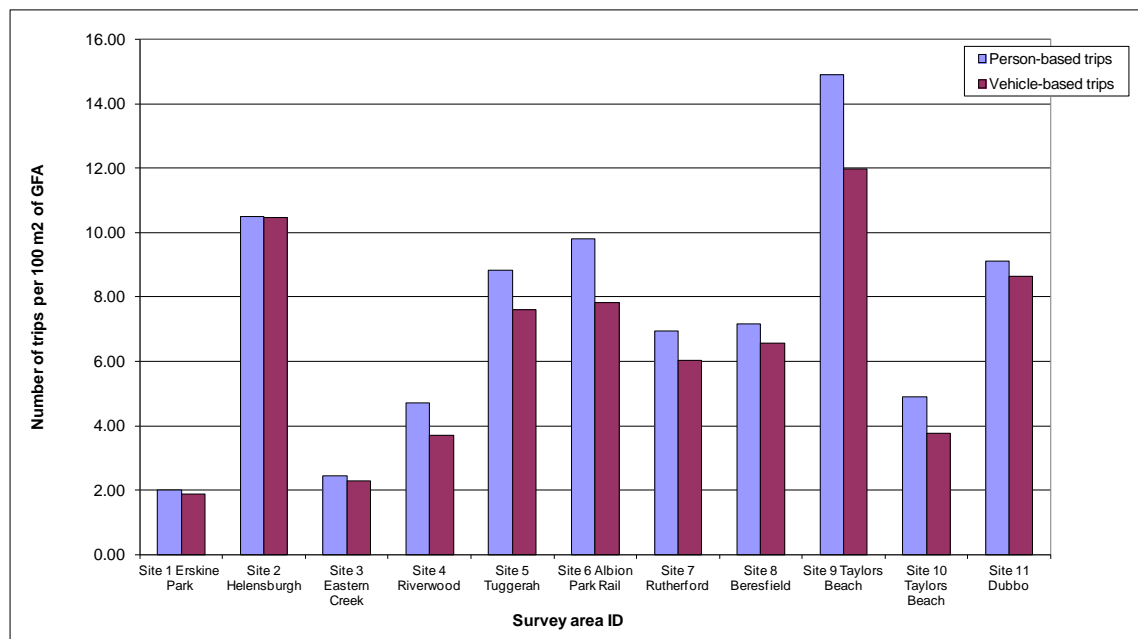


Figure 3.1 Daily trip rates.

The results of the analyses for both peak hour and daily trips rates indicate high values of standard deviation in all cases, for both person and vehicle trips. The base data is therefore regarded as wide-spread and average rates are not recommended to be used for predicting the trip generation because of wide prediction intervals around the mean estimated values.

3.3 Regression analysis

As agreed in the project brief, the data has been analysed to determine the most consistent measure of trip generation, using a simple linear regression approach.

The coefficient of determination (R^2) has been used to provide a measure of the usefulness of the regression equation. It measures the proportion of variation in Y (trip behaviour) that is explained by the independent variable X (such as gross floor area) in the regression model. The values vary from 0 to 1 with higher values representing a higher degree of correlation. In this study, R^2 above 0.8 are considered to provide the desired level of correlation. In other words, at least 80% of the variation in trip behaviour can be explained by the variability in the independent variable in the acceptable level.

A number of simple linear regression models did not fit the data at an acceptable level, returning low R^2 . For this reason, non-linear regression models were trialled as well.

3.3.1 Relationship between the number of trips and Gross Floor Area (m²)

The overall Gross Floor Area (GFA, m²) was used as the key independent variable for this regression analysis. The total number of trips in the AM, PM and for the Daily periods are plotted against the GFA. 'Person' trips and 'vehicle' trips are plotted separately.

3.3.1.1 Linear regression analysis

3.3.1.1.1 Survey site Peak Hour (AM & PM) ALL SITES

- For the person trips, R² is 0.51 for AM and 0.54 for PM
- For the vehicle trips, R² is 0.53 for AM and 0.56 for PM
- R² for peak hour for all estates is low and indicates little correlation between the number of trips and the overall gross floor area, if a linear function is used.

All sites – Linear type:

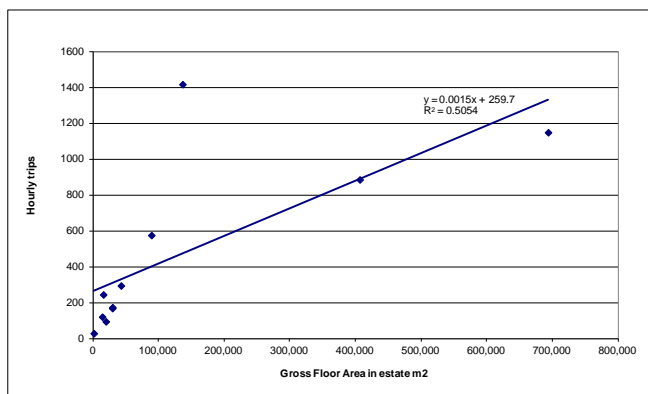


Figure 3-2 Person Trips – Survey site AM Peak Hour – All sites – Linear type

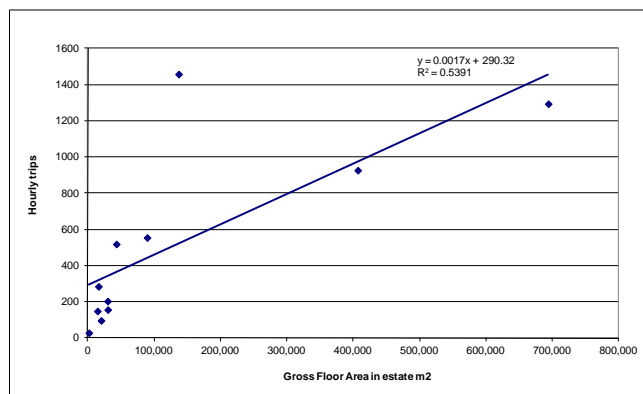


Figure 3-3 Person Trips – Survey site PM Peak Hour – All sites – Linear type

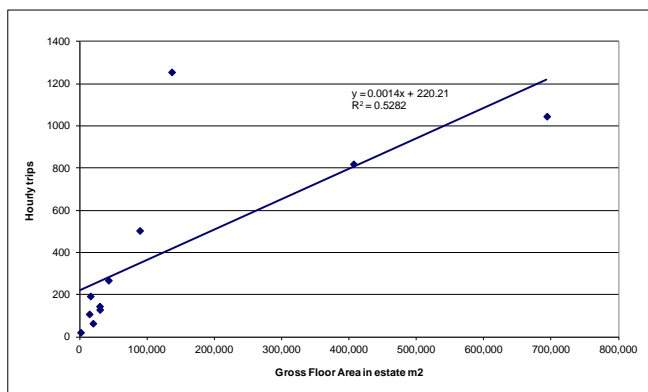


Figure 3-4 Vehicle Trips – Survey site AM Peak Hour – All sites – Linear type

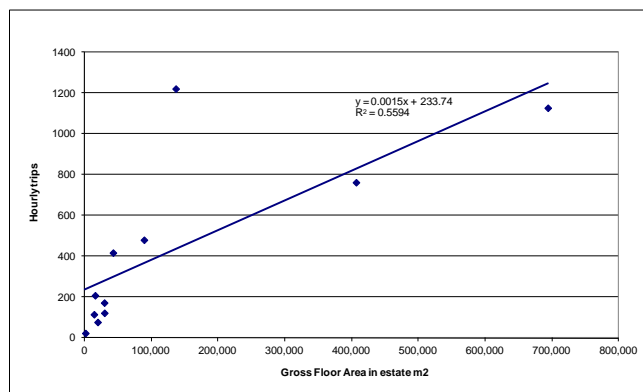


Figure 3-5 Vehicle Trips – Survey site PM Peak Hour – All sites – Linear type

3.3.1.1.2 Survey site Peak Hour (AM & PM) for sites less than 200,000 m² GFA

An inspection of the scatter plots for all sites indicated that there could be a good linear relationship fit for sites with an area less than 200,000 m² GFA. Therefore a separate analysis for sites with an area less than 200,000 m² GFA with their trip generation was then carried out. The results are shown in Figures 3.6 to 3.9.

- For the person trips, R² is 0.92 for AM and 0.89 for PM
- For the vehicle trips, R² is 0.92 for AM and 0.91 for PM
- R² for estates with up to 200,000 m² GFA peak hour is high and indicates very high correlation between the number of person and vehicle trips, and the overall gross floor area.

GFA under 200,000 m²

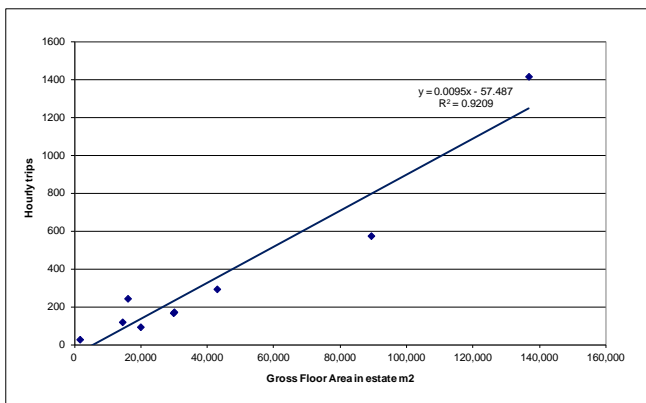


Figure 3-6 Person Trips – Survey site AM Peak Hour – GFA under 200,000 m²

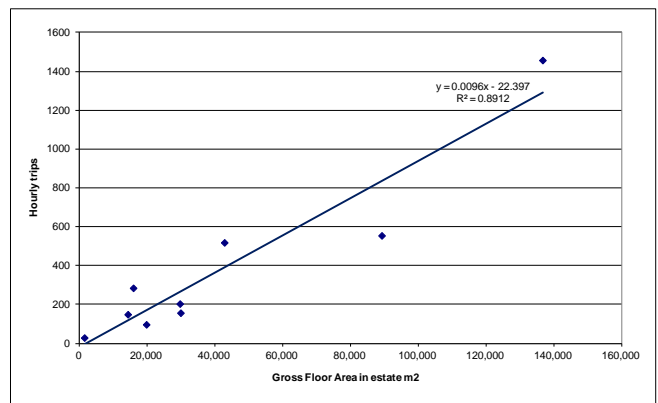


Figure 3-7 Person Trips – Survey site PM Peak Hour – GFA under 200,000 m²

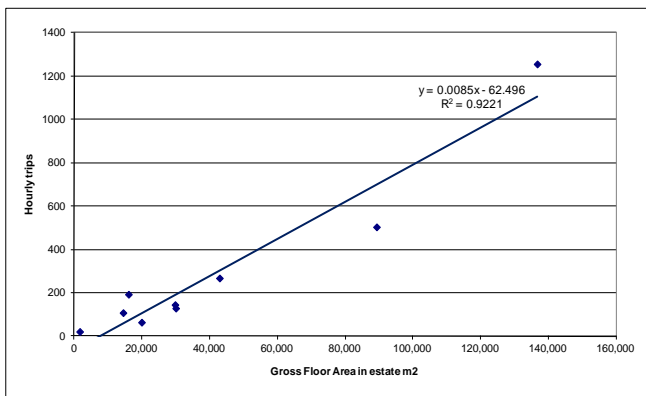


Figure 3-8 Vehicle Trips – Survey site AM Peak Hour – GFA under 200,000 m²

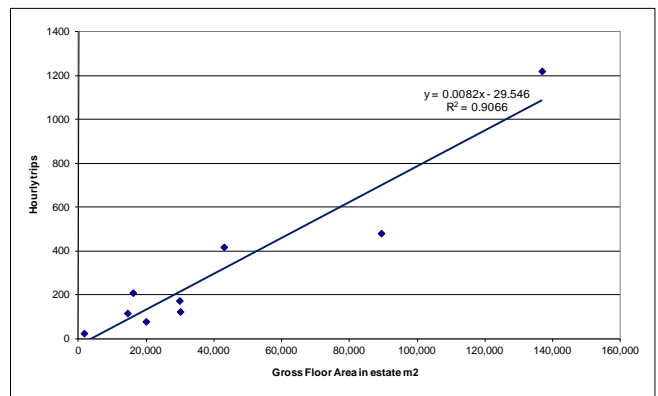


Figure 3-9 Vehicle Trips – Survey site PM Peak Hour – GFA under 200,000 m²

3.3.1.1.3 Road Network Peak Hour (AM & PM) ALL SITES

- For the person trips, R^2 is 0.40 for AM and 0.59 for PM
- For the vehicle trips, R^2 is 0.44 for AM and 0.68 for PM

R^2 for peak hour for all estates is very low and indicates little correlation between the number of trips and the overall gross floor area.

All sites – Linear type:

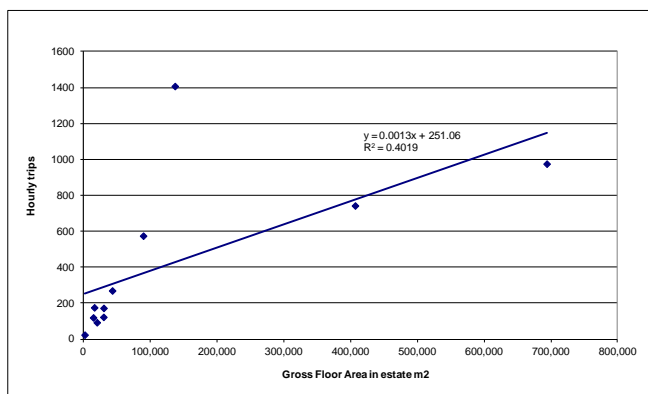


Figure 3-10 Person Trips – Network AM Peak – All sites – Linear type

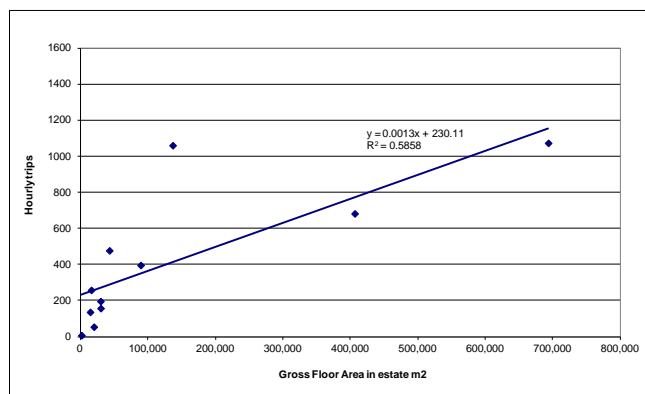


Figure 3-11 Person Trips – Network PM Peak – All sites – Linear type

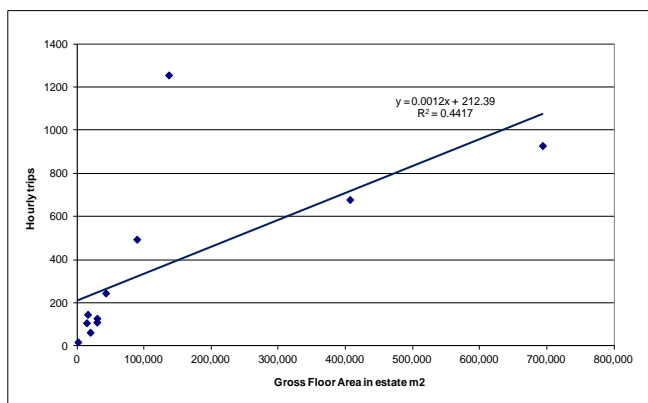


Figure 3-12 Vehicle Trips – Network AM Peak – All sites – Linear type

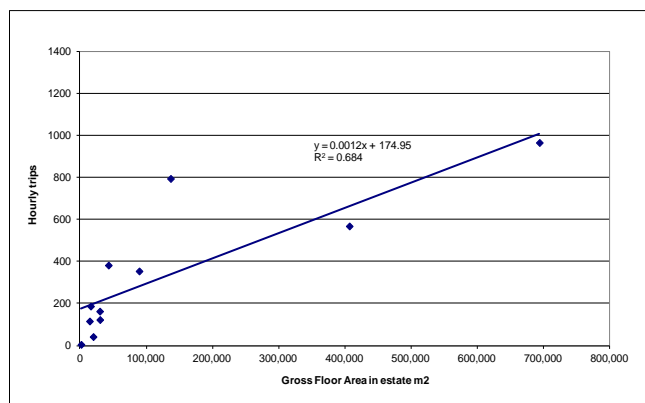


Figure 3-13 Vehicle Trips – Network PM Peak – All sites – Linear type

3.3.1.1.4 Road Network Peak Hour (AM & PM) for Sites less than 200,000 m² GFA

The relationship for sites with an area less than 200,000 m² GFA with their trip generation was then carried out and is shown in Figures 3.14 to 3.17.

- For the person trips, R² is 0.93 for AM and 0.85 for PM
- For the vehicle trips, R² is 0.92 for AM and 0.88 for PM

R² for estates with up to 200,000 m² GFA peak hour is high and indicates very high correlation between the number of person and vehicle trips, and the overall gross floor area. This is similar to the results obtained for the Survey Sites Peak.

GFA under 200,000 m²

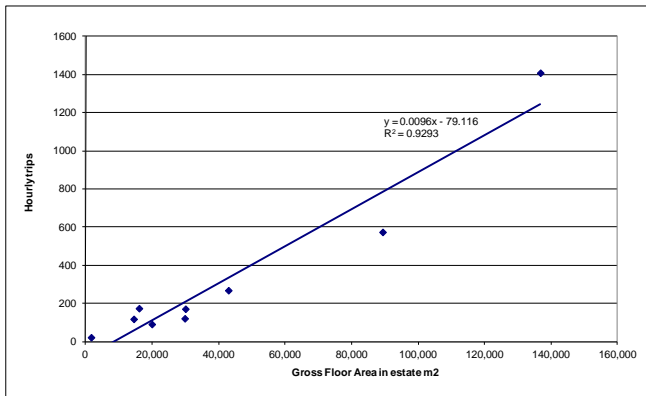


Figure 3-14 Person Trips – Network AM Peak – GFA under 200,000 m²

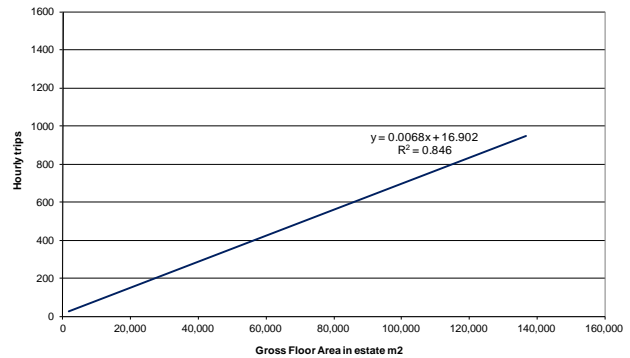


Figure 3-15 Person Trips – Network PM Peak – All sites – GFA under 200,000 m²

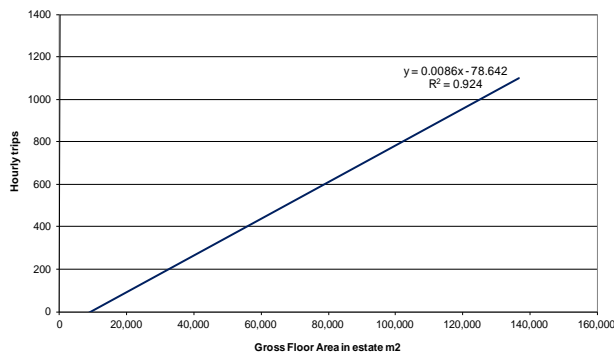


Figure 3-16 Vehicle Trips – Network AM Peak – GFA under 200,000 m²

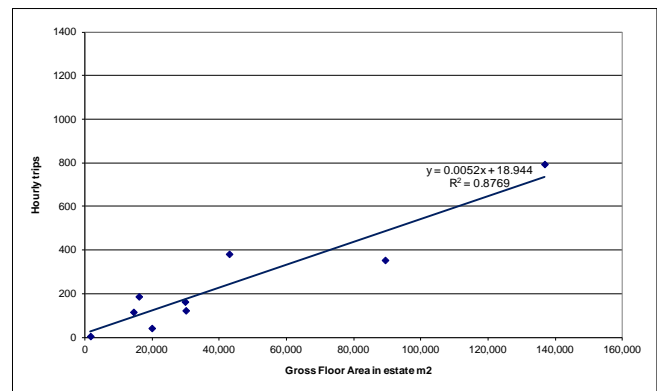


Figure 3-17 Vehicle Trips – Network PM Peak – All sites – GFA under 200,000 m²

3.3.1.1.5 Daily Total Trips ALL SITES

- For the person trips, R^2 is 0.70
- For the vehicle trips, R^2 is 0.73
- R^2 for daily total trips indicates for all estates some correlation between the number of person and vehicle trips and the overall gross floor area. The correlation coefficients are however below the preferred 0.80 level suggested for this study.

All sites – Linear type:

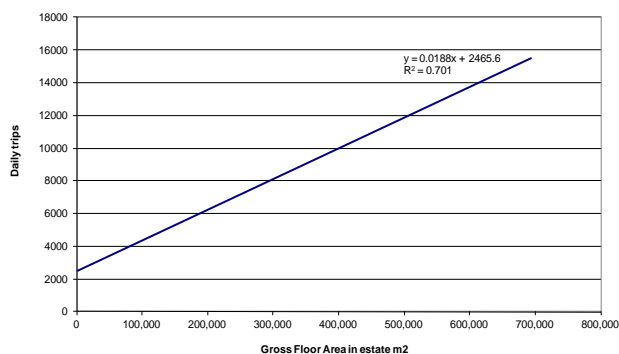


Figure 3-18 Person Trips – Daily – All sites – Linear type

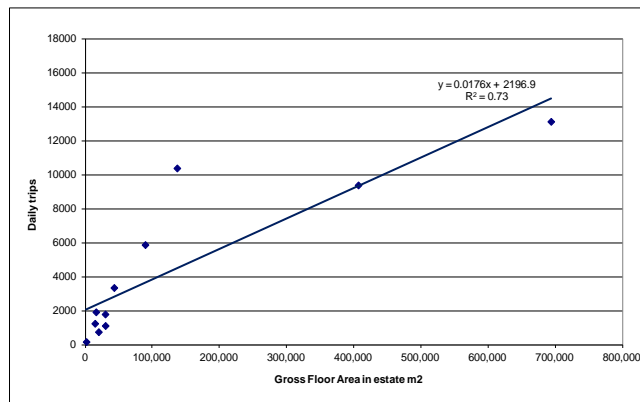


Figure 3-19 Vehicle Trips – Daily – All sites – Linear type

3.3.1.1.6 Daily Total Trips for Sites with less than 200,000 m² GFA

The relationship for sites with an area less than 200,000 m² GFA with their daily trip generation was then carried out and is shown in Figures 3.20 and 3.21.

- For the person trips, R^2 is 0.96
- For the vehicle trips, R^2 is 0.94

R^2 for estates with up to 200,000 m² GFA daily trips is high and indicates very high correlation between the number of person and vehicle trips and the overall gross floor area.

GFA under 200,000 m²

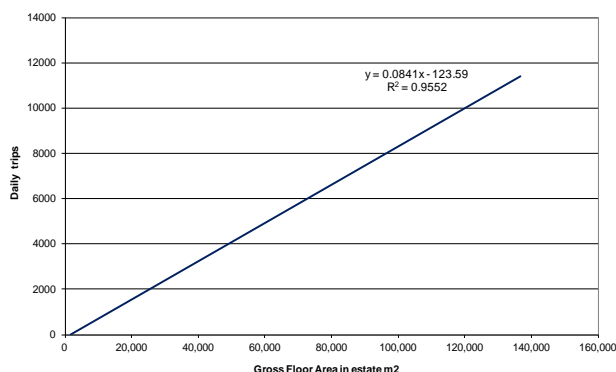


Figure 3-20 Person Trips – Daily – GFA under 200,000 m²

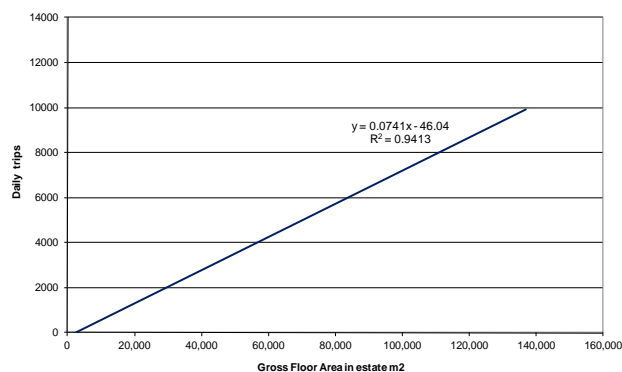


Figure 3-21 Vehicle Trips – Daily – GFA under 200,000 m²

3.3.1.2 Non-linear regression analysis

A review of graphs illustrating linear regression analysis (Section 3.3.1.1) has indicated a likelihood that there could be a non-linear relationship between GFA and the number of trips when all surveyed sites are analysed. A non-linear regression analysis was thus carried out. The results are detailed below.

3.3.1.2.1 Survey site Peak Hour (AM & PM) ALL SITES

The logarithmic relationship for all estates with their trip generation shown in Figures 3.22 to 3.25 was analysed with the following outputs:

- For the person trips, R^2 is 0.67 for AM and 0.69 for PM
- For the vehicle trips, R^2 is 0.68 for AM and 0.70 for PM

R^2 for peak hour for all estates is lower than desired, however it indicates some correlation between the number of trips and the overall gross floor area.

The graphs represented in Figures 3.22 to 3.25 indicated that all sites except Tuggerah were very close to the line of best fit. A closer inspection of the types of land uses within the survey sites indicated that offices accounted for over 40 percent of all businesses in the Tuggerah Estate. Offices are likely to generate higher number of trips than industrial establishments. All other developments (except the smallest site in Helensburgh with only 1,605 m² GFA) had the office component below 10% of the total GFA.

All sites: Logarithmic type

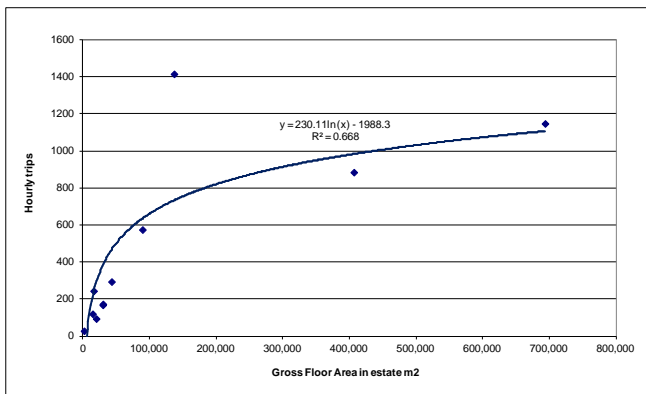


Figure 3-22 Person Trips – Survey site AM Peak Hour – All sites - Logarithmic type

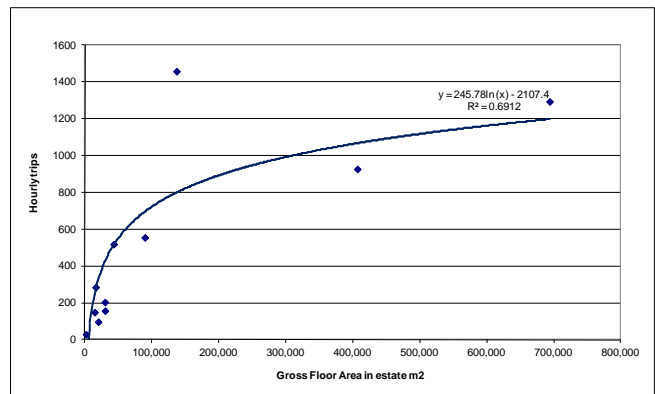


Figure 3-23 Person Trips – Survey site PM Peak Hour – All sites - Logarithmic type

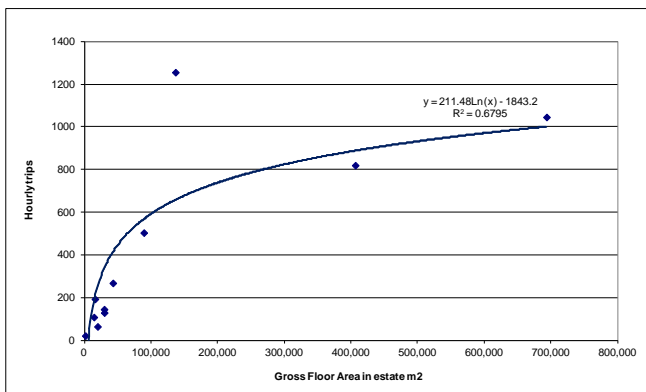


Figure 3-24 Vehicle Trips – Survey site AM Peak Hour – All sites - Logarithmic type

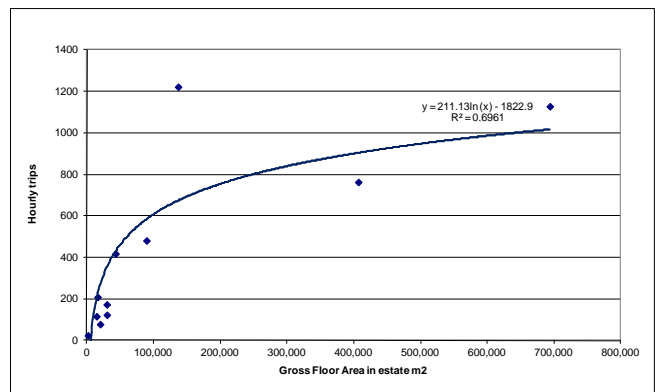


Figure 3-25 Vehicle Trips – Survey site PM Peak Hour – All sites - Logarithmic type

3.3.1.2.2 Survey site Peak Hour (AM & PM) without the Tuggerah site

The removal of the Tuggerah site from the analysis results in a much better logarithmic relationship with an R^2 over 0.80 as shown in Figures 3.26 to 3.29 and summarised below.

- For the person trips, R^2 is 0.84 for AM and 0.82 for PM
- For the vehicle trips, R^2 is 0.83 for AM and 0.82 for PM

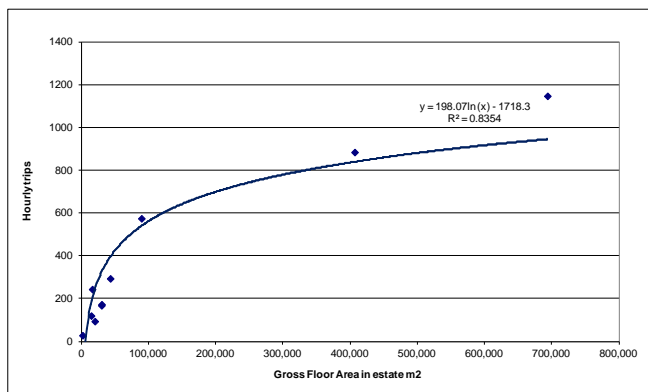


Figure 3-26 Person Trips – Survey site AM Peak Hour – Logarithmic type without Tuggerah

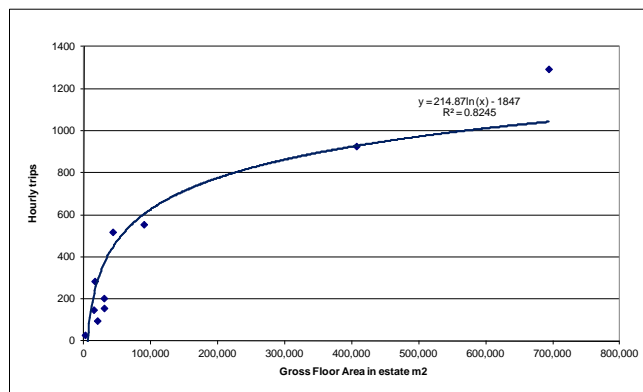


Figure 3-27 Person Trips – Survey site PM Peak Hour – Logarithmic type without Tuggerah

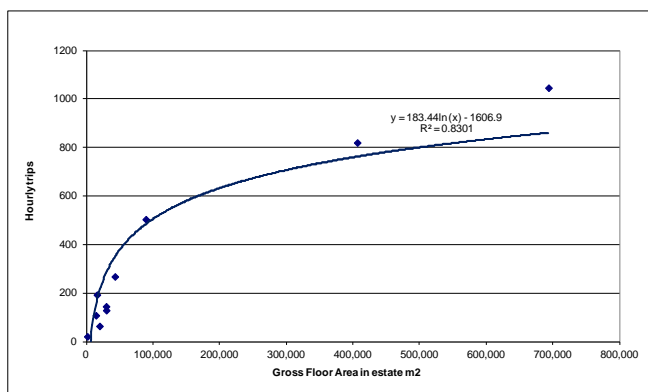


Figure 3-28 Vehicle Trips – Survey site AM Peak Hour – Logarithmic type without Tuggerah

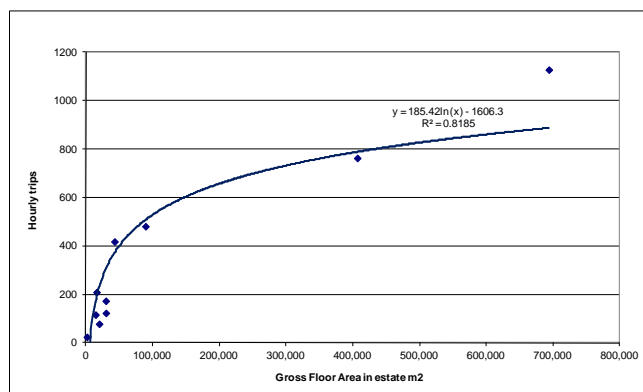


Figure 3-29 Vehicle Trips – Survey site PM Peak Hour – Logarithmic type without Tuggerah

3.3.1.2.3 Road Network Peak Hour (AM & PM) ALL SITES

The logarithmic relationship for all estates with their trip generation shown in Figures 3.30 to 3.33 was then analysed with the following outputs:

- For the person trips, R^2 is 0.60 for AM and 0.72 for PM
- For the vehicle trips, R^2 is 0.62 for AM and 0.76 for PM

R^2 for peak hour for all estates is low and indicates some correlation between the number of trips and the overall gross floor area during the afternoon peak. Again, similarly to the results from the site peak hour analysis, the Tuggerah site stood out from the line of best fit. It was prudent to re-run the regression analysis without this site (refer to Section 3.3.1.2.4).

All sites: Logarithmic type

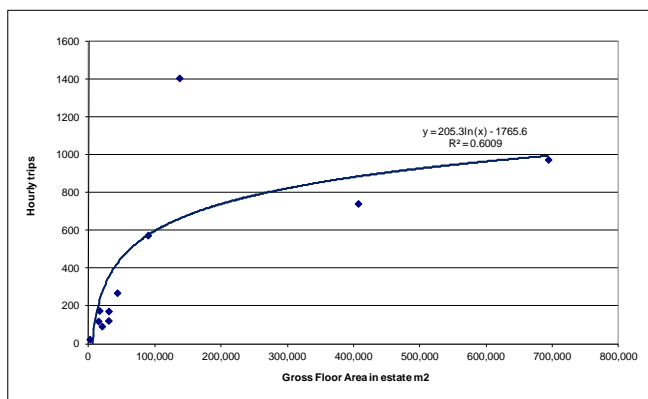


Figure 3-30 Person Trips – Network AM Peak – All sites
– Logarithmic type

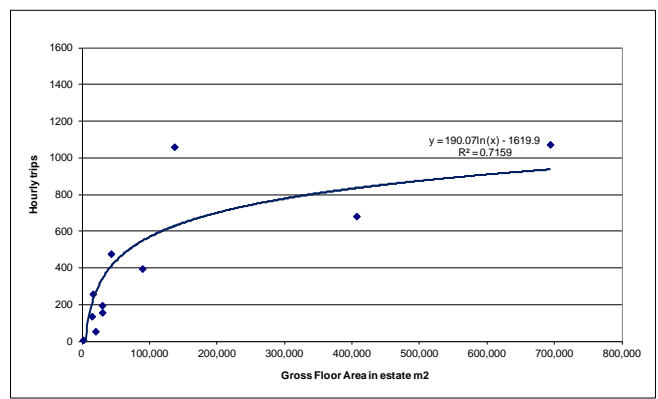


Figure 3-31 Person Trips – Network PM Peak – All sites
– Logarithmic type

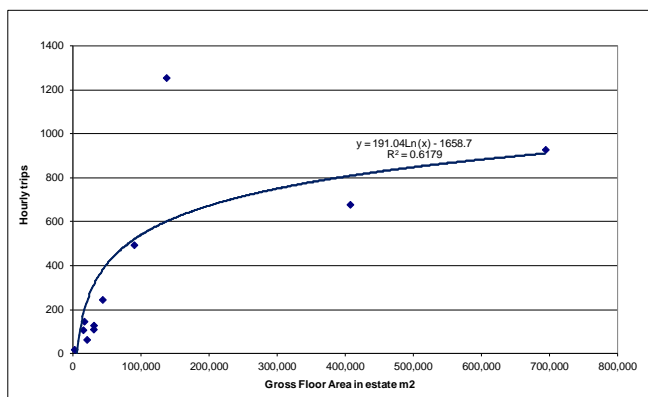


Figure 3-32 Vehicle Trips – Network AM Peak – All sites
– Logarithmic type

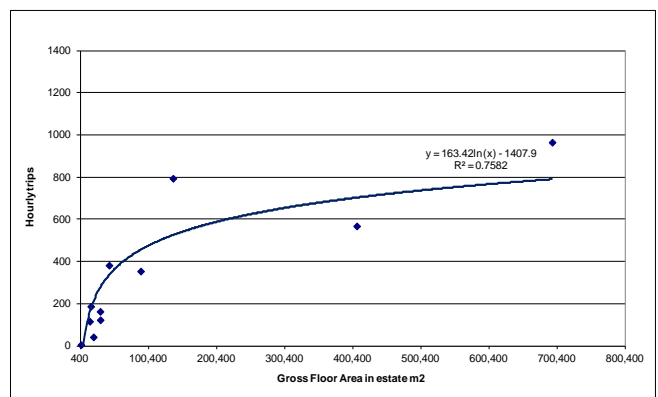


Figure 3-33 Vehicle Trips – Network PM Peak – All sites
– Logarithmic type

3.3.1.2.4 Road Network Peak Hour (AM & PM) without the Tuggerah site

The removal of the Tuggerah Site (136,737 m² GFA) from the analysis results in much better logarithmic relationship with an R² higher than 0.80 as shown in Figures 3.34 to 3.37 and summarised below.

- For the person trips, R² is 0.84 for AM and 0.80 for PM
- For the vehicle trips, R² is 0.83 for AM and 0.79 for PM

Logarithmic type without Tuggerah

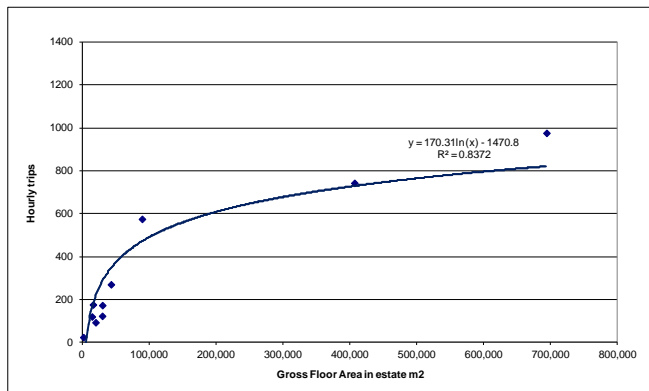


Figure 3-34 Person Trips – Network AM Peak – Logarithmic type

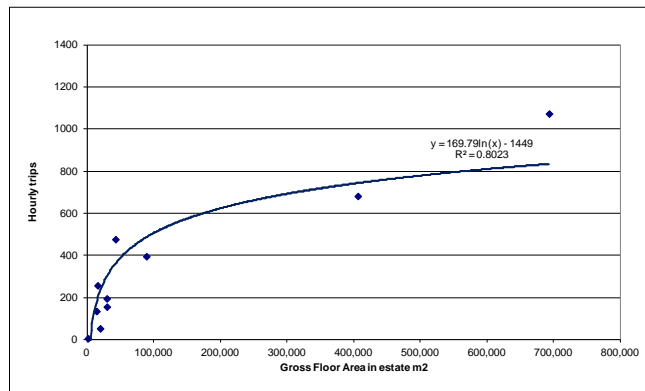


Figure 3-35 Person Trips – Network PM Peak – Logarithmic type

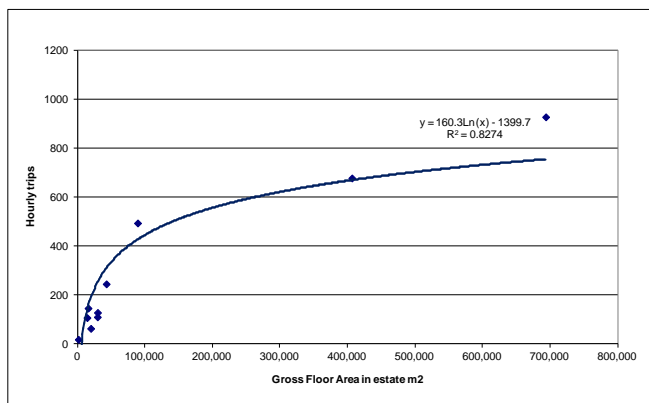


Figure 3-36 Vehicle Trips – Network AM Peak - Logarithmic type

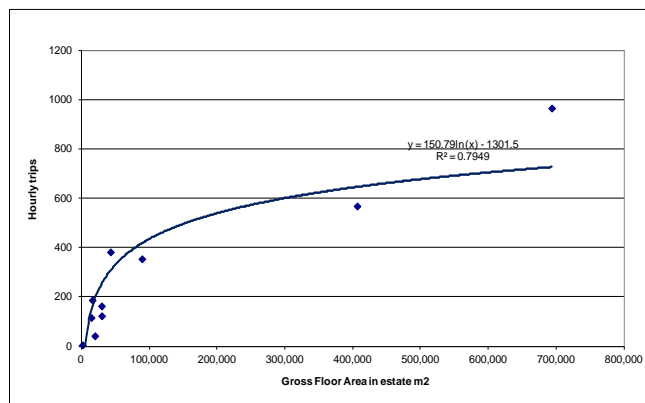


Figure 3-37 Vehicle Trips – Network PM Peak - Logarithmic type

3.3.1.2.5 Daily Total Trips

The logarithmic relationship for all estates with their trip generation shown in Figures 3.38 and 3.39 was then analysed with the following outputs:

- For the person trips, R^2 is 0.79
- For the vehicle trips, R^2 is 0.80

R^2 for peak hour for all estates is reasonable and indicates some correlation between the number of trips and the overall gross floor area. However the removal of the Tuggerah Site from the analysis results in a slightly better logarithmic relationship with an R^2 over 0.80 as shown in Figures 3.40 and 3.41 and summarised below.

- For the person trips, R^2 is 0.83
- For the vehicle trips, R^2 is 0.82

All sites: Logarithmic type

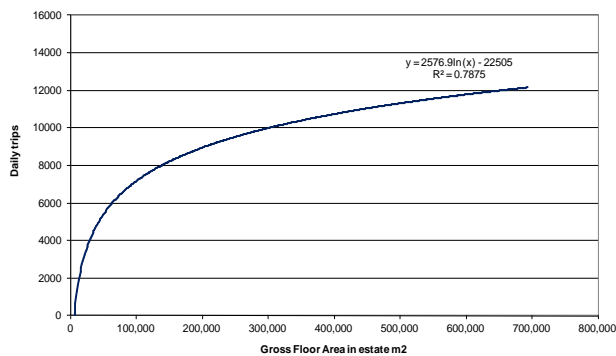


Figure 3-38 Person Trips – Daily trips – All sites – Logarithmic type

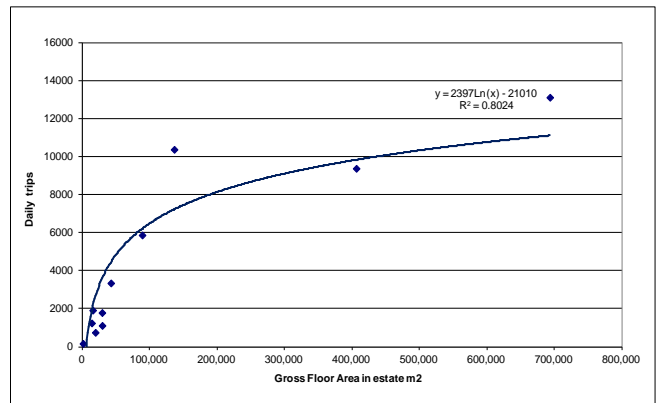


Figure 3-39 Vehicle Trips – Daily trips – All sites – Logarithmic type

Logarithmic type without Tuggerah

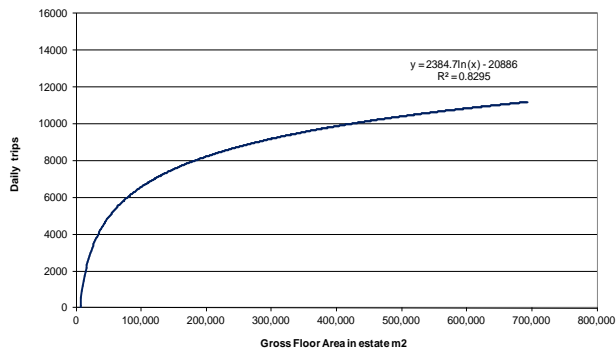


Figure 3-40 Person Trips – Daily trips – All sites – Logarithmic type without Tuggerah

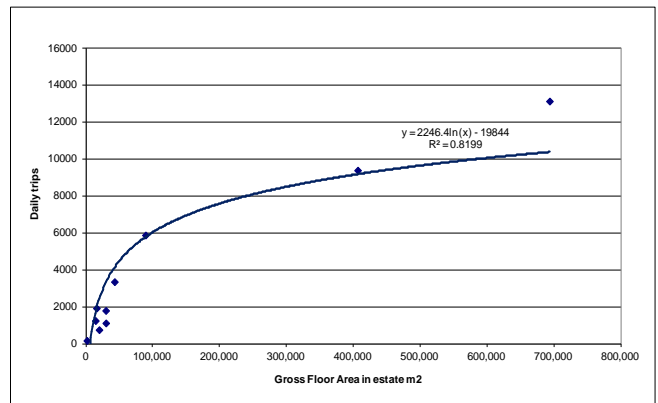


Figure 3-41 Vehicle Trips – Daily trips – All sites – Logarithmic type without Tuggerah

3.3.1.3 Commercial Vehicles - Relationship between the number of trips and Gross floor area (m²)

3.3.1.3.1 Survey area Peak Hour (AM & PM) ALL SITES

- For the commercial vehicle trips, R^2 is 0.91 for AM and 0.97 for PM

R^2 for all estates peak hour is high and indicates very high correlation between the number of commercial vehicle trips and the overall gross floor area.

All sites:

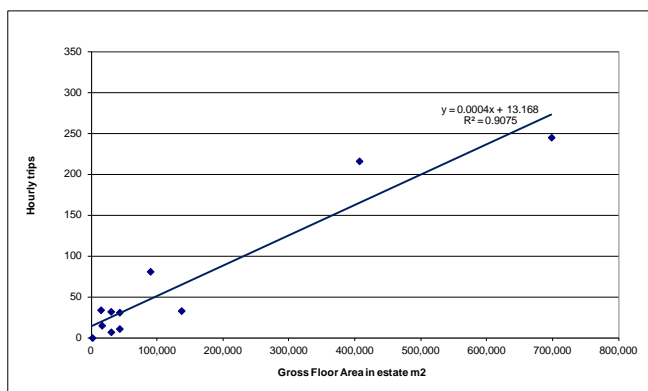


Figure 3-42 Commercial Vehicle Trips – Survey site AM Peak Hour – All sites – Linear type

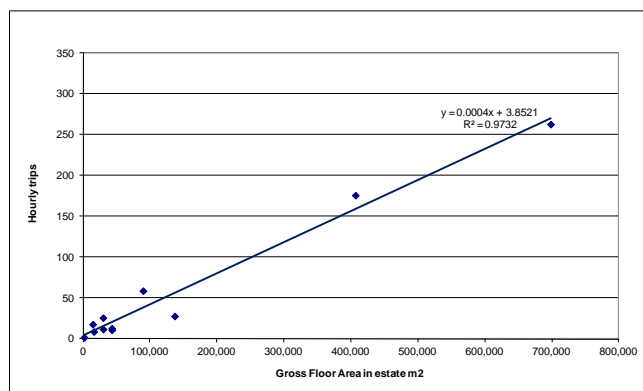


Figure 3-43 Commercial Vehicle Trips – Survey site PM Peak Hour – All sites – Linear type

An inspection of the graph indicates that estates to 200,000 m² GFA are all grouped together near the bottom-left end of the trend line. This may indicate that the good fit of the trend line could be because the lower GFA sites form, in effect, a single point near the origin of coordinates, thus resulting in the trend line effectively fitting between the three points only. A closer look at the sites with up to 200,000 m² GFA revealed that, indeed, unlike in case of person-based and total vehicle trips, there is no correlation between the number of commercial vehicle trips and GFA (refer to Figures 3.44 and 3.45).

3.3.1.3.2 Survey area Peak Hour (AM & PM) for Sites less than 200,000 m² GFA

- For the commercial vehicle trips, R^2 is 0.31 for AM and 0.42 for PM

R^2 for estates with up to 200,000 m² GFA peak hour is very low and indicates lack of correlation between the number of commercial vehicle trips and the overall gross floor area.

The result of the analysis indicates that estimation of the number of commercial trips may only be carried out, with caution, for larger estates (400,000 to 700,000 m² GFA), based on relationships included in Figures 3.42 and 3.43.

GFA under 200,000 m²

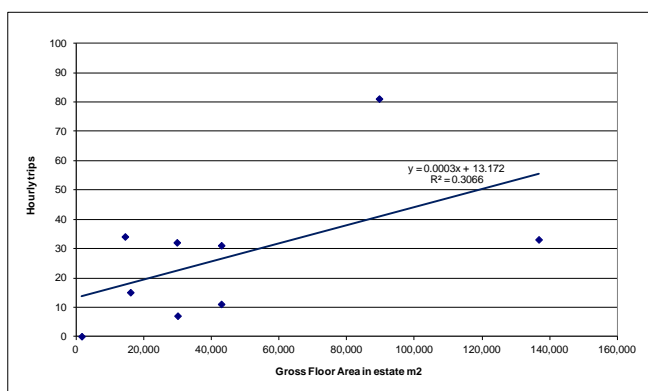


Figure 3-44 Commercial Vehicle Trips – Survey site AM Peak Hour – GFA under 200,000 m² – Linear type

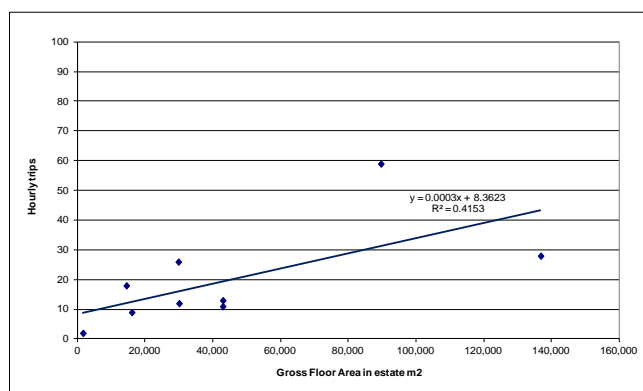


Figure 3-45 Commercial Vehicle Trips – Survey site PM Peak Hour – GFA under 200,000 m² – Linear type

3.3.1.3.3 Daily Total Trips

- All Sites -For commercial vehicle trips, R^2 is 0.98 (refer to Figure 3.46)

R^2 for daily vehicle trips is high and indicates very high correlation between the number of commercial vehicle trips and the overall gross floor area. However, a visual inspection of the scatter plot reveals a similar situation to that with the peak hour analysis described above.

A separate analysis of the sites with GFA up to 200,000 m² shows that the level of correlation between the GFA and the number of commercial vehicle trips is very low with R^2 equal to 0.51 (refer to Figure 3.47). Similarly to peak hour trips, the number of daily trips may be estimated based on the relationship shown in Figure 3.46 for the larger sites only (400,000 to 700,000 m² GFA).

All sites – Linear type:

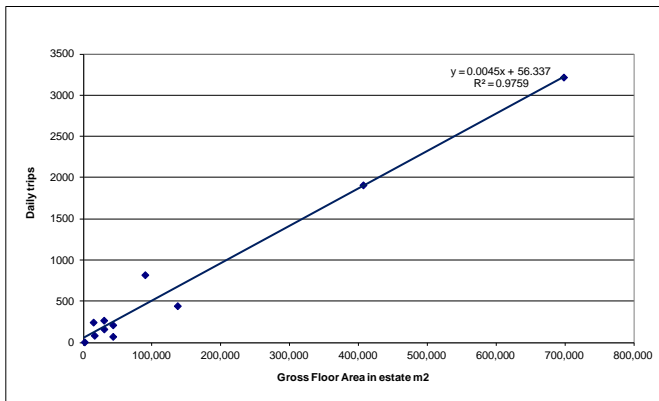


Figure 3-46 Commercial Vehicle Trips – Daily – All sites – Linear type

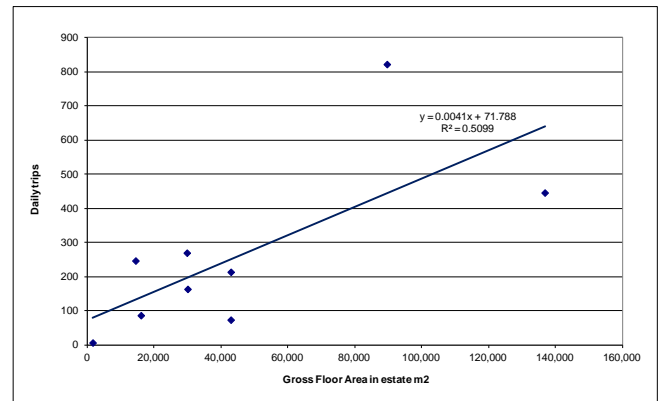


Figure 3-47 Commercial Vehicle Trips – Daily – GFA under 200,000 m² – Linear type

3.3.2 Relationship between trip rates and overall gross floor area of a business/industrial park

The relationship between the trip rates (number of trips per 100 m² GFA) and the gross floor area of business/industrial parks was also analysed. 'Person' trips and 'vehicle' trips are plotted separately.

3.3.2.1.1 Survey area Peak Hour

- For the person trips, R^2 is 0.33 for AM and 0.36 for PM
- For the vehicle trips, R^2 is 0.33 for AM and 0.36 for PM
- R^2 for the survey area peak hour is very low and indicates practically no correlation between the gross floor area and the number of person and vehicle trips per 100 m² GFA.
- Refer to (Figures 3.48 to 3.51)

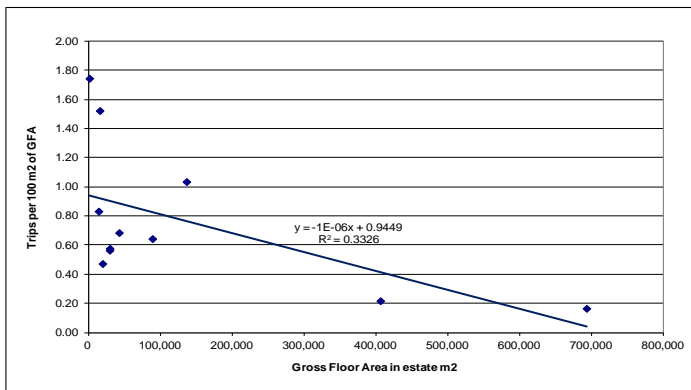


Figure 3-48 Person trip rates – Survey site AM Peak Hour

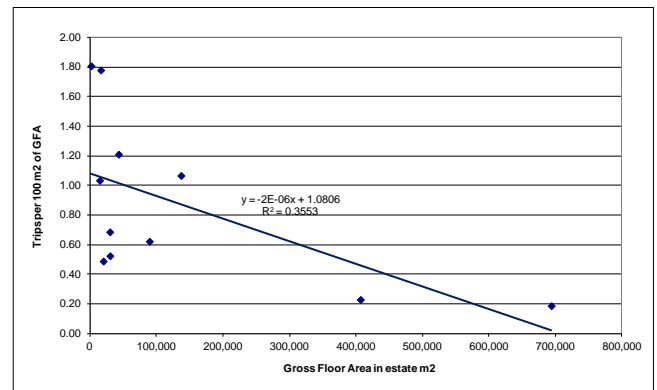


Figure 3-49 Person trip rates – Survey site PM Peak Hour

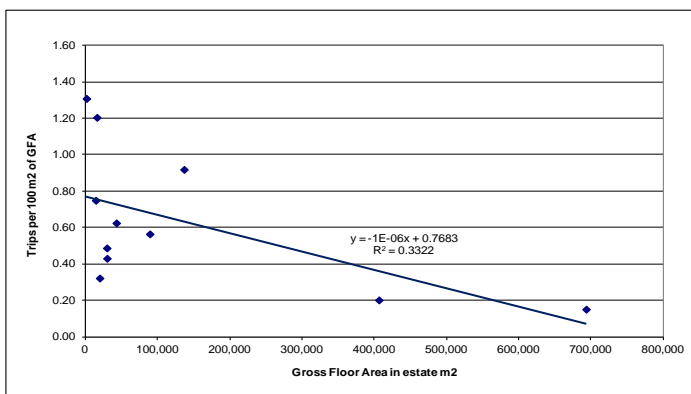


Figure 3-50 Vehicle trip rates – Survey site AM Peak Hour

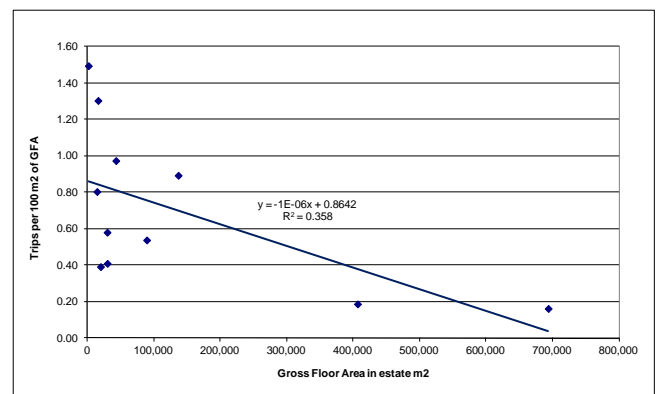


Figure 3-51 Vehicle trip rates – Survey site PM Peak Hour

3.3.2.1.2 Daily Total Trips

- For the person trips, R^2 is 0.43; for the vehicle trips, R^2 is 0.42
- R^2 for the survey area peak hour is very low and indicates practically no correlation between the gross floor area and the number of person and vehicle trips per 100 m² GFA
- Refer to Figures 3.48 to 3.51)

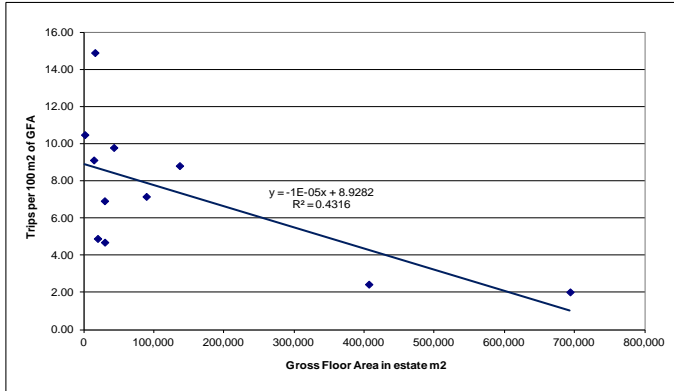


Figure 3-52 Person Trip rates – Daily

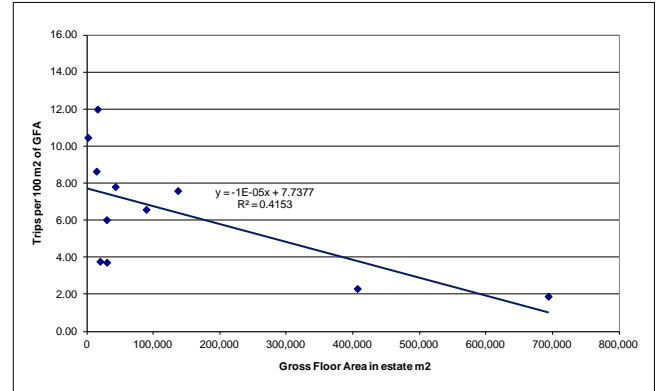


Figure 3-53 Vehicle Trip rates – Daily

3.3.2.1.3 Road Network Peak

- For the person trips, R^2 is 0.37 for AM and 0.27 for PM (Figures 3.54 and 3.55);
- For the vehicle trips, R^2 is 0.35 for AM and 0.28 for PM (Figures 3.56 and 3.57);
- R^2 for the survey area peak hour is very low and indicates practically no correlation between the gross floor area and the number of person and vehicle trips per 100 m² GFA.

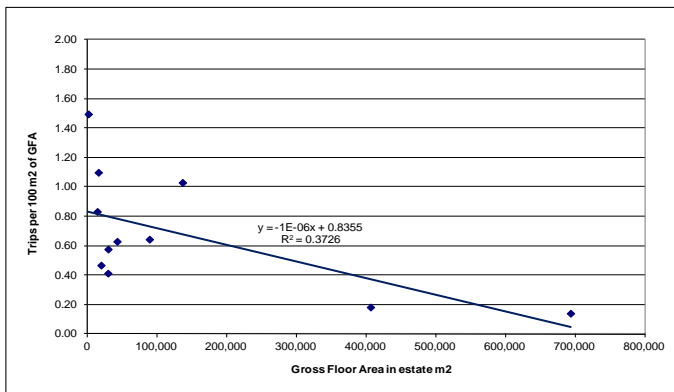


Figure 3-54 Person trip rates – Network AM Peak

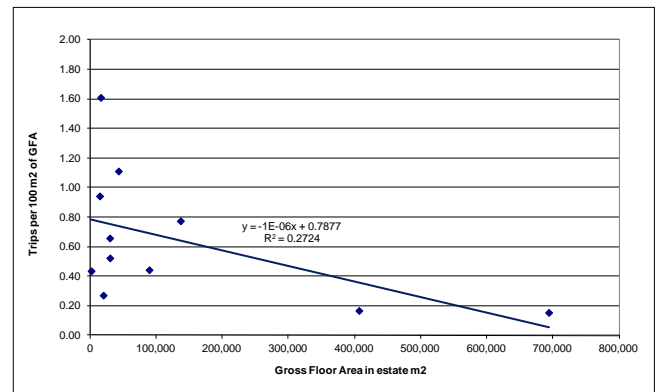


Figure 3-55 Person trip rates – Network PM Peak

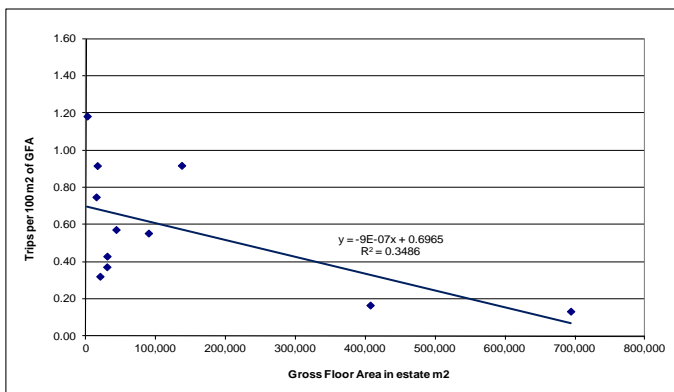


Figure 3-56 Vehicle trip rates – Network AM Peak

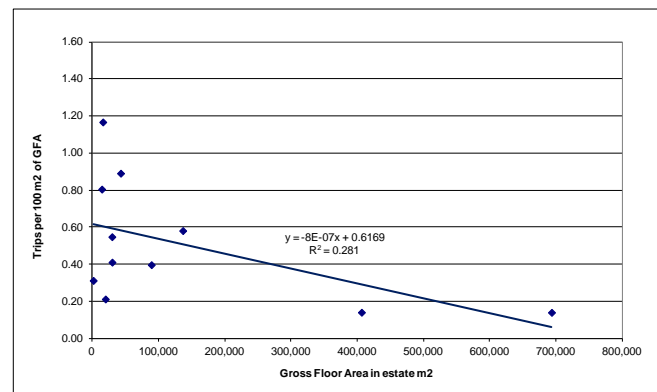


Figure 3-57 Vehicle trip rates – Network PM Peak

3.3.3 Trip rates and Accessibility Score

The trip rates in the following periods are plotted against the Accessibility Score. 'Person' trip rates and 'vehicle' trip rates are plotted separately.

3.3.3.1.1 Survey site Peak Hour

- For the person trips, R^2 is 0.02 for AM and 0.01 for PM
- For the vehicle trips, R^2 is 0.04 for AM and 0.02 for PM
- R^2 for the survey area peak hour is negligible and indicates absolutely no correlation between the Accessibility Score and the trip rates.
- Refer to Figures 3.58 to 3.61)

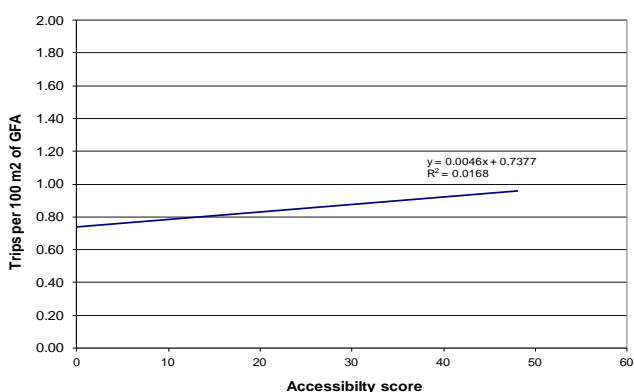


Figure 3-58 Person trip rates – survey site AM peak hour

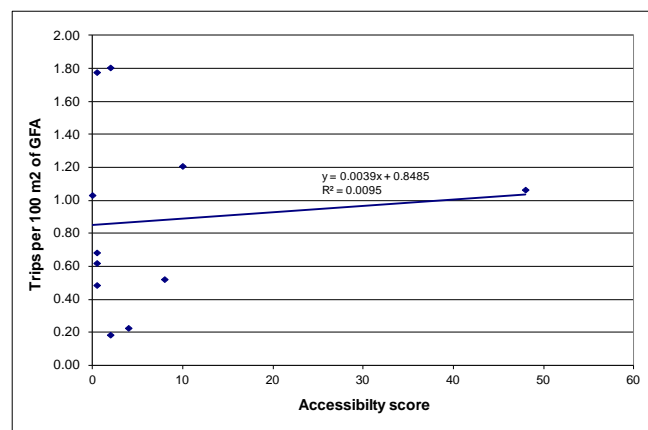


Figure 3-59 Person trip rates – survey site PM peak hour

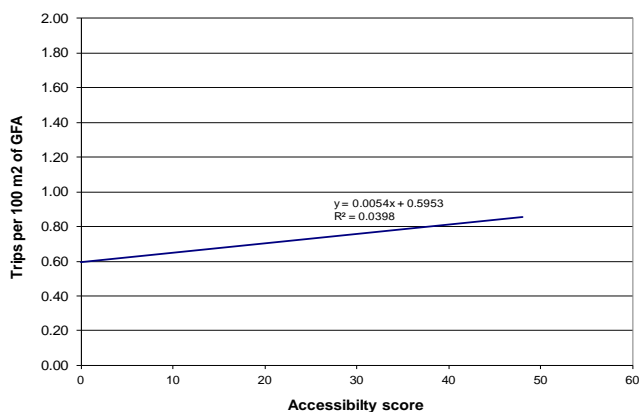


Figure 3-60 Vehicle trip rates – survey site AM peak hour

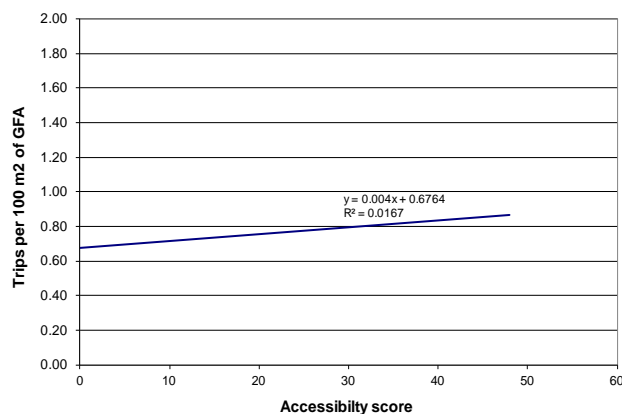


Figure 3-61 Vehicle trip rates – survey site PM peak hour

3.3.3.1.2 Daily Total Trips

- For the person trips, R^2 is 0.01
- For the vehicle trips, R^2 is 0.00
- R^2 for daily total trips is low and indicates practically no correlation between the Accessibility Score and the trip rates.

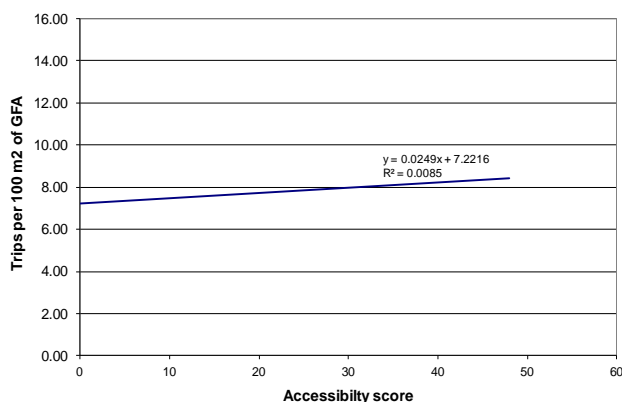


Figure 3-62 Person trip rates – daily

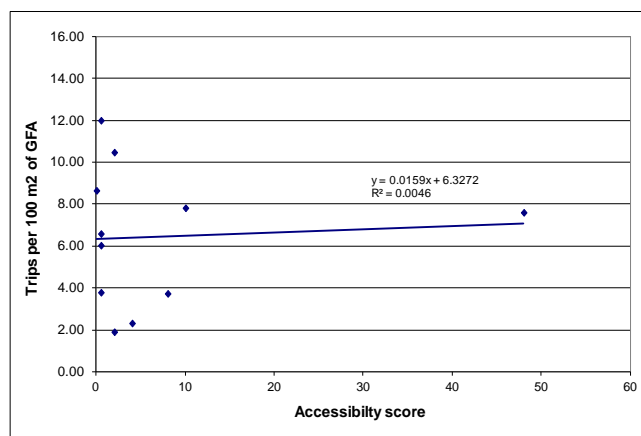


Figure 3-63 Vehicle trip rates – daily

3.3.4 Conclusions about Linear and Logarithmic Regression analysis

In general, the trip generation for business and industrial parks has a very good correlation ($R^2 > 0.8$) with the total gross floor areas of the estate. The assessment highlighted the following facts:

- Average trip rates should not be utilised for planning purposes.
- The site Accessibility Score has no effect on the trip rates of an estate.
- Good linear relationships between trip generation and gross floor area were established for business/industrial parks up to 200,000 m² GFA.
- Good logarithmic relationships between trip generation and gross floor area were established for business/industrial parks where office/commercial establishments do not exceed 10% of the total floor area of the estate.

Relationships which could be used to estimate the person and all vehicle trip generation of Business/Industrial parks are summarised in the following tables:

- Table 3.3 - Estates with total gross floor areas up to 200,000 m²
- Table 3.4 - Estates with office establishments up to 10% of total GFA of the estate

For estates up to 200,000 m² and with office/commercial component area not exceeding 10% of total estate, the relationships in Table 3.3 would provide better correlation.

No suitable relationship was established to estimate the trip generation of estates exceeding 200,000 m² where the gross floor area of office/commercial establishments exceeds 10% of the total floor area. In this situation it is suggested that the following approach be adopted:

- Determine the trip generation of the office/commercial component of the estate using the latest RMS trip generation for such developments
- Determine the trip generation of the remaining area of the estate using the appropriate relationship included in either Table 3.3 or 3.4.

Table 3.3 Peak Trip Generation Relationships for Estates up to 200,000 m² GFA

Survey Area	Period	R ²	Relationship
Estate Peak Hours			
Person Trips	AM	0.92	$Y = 0.0095x - 57$
	PM	0.89	$Y = 0.0096x - 22$
	Daily	0.96	$Y = 0.0841x - 124$
All Vehicle Trips	AM	0.92	$Y = 0.0085x - 62$
	PM	0.91	$Y = 0.0082x - 30$
	Daily	0.94	$Y = 0.0741x - 46$
Road Network Peak Hours			
Person Trips	AM	0.93	$Y = 0.0096x - 79$
	PM	0.85	$Y = 0.0068x + 17$
Vehicle Trips	AM	0.92	$Y = 0.0086x - 79$
	PM	0.88	$Y = 0.0052x + 19$

Where Y = Number of trips x = Total Gross Floor Area, m²

Table 3.4 Peak Trip Generation Relationships for Estates with up to 10% of Office/Commercial Areas

Survey Area	Period	R ²	Relationship
Estate Peak Hours			
Person Trips	AM	0.84	$Y = 198.07 \ln(x) - 1718$
	PM	0.82	$Y = 214.87 \ln(x) - 1847$
	Daily	0.83	$Y = 2384.7 \ln(x) - 20886$
Vehicle Trips	AM	0.83	$Y = 183.44 \ln(x) - 1607$
	PM	0.82	$Y = 185.42 \ln(x) - 1606$
	Daily	0.82	$Y = 2246.4 \ln(x) - 19844$
Road Network Peak Hours			
Person Trips	AM	0.84	$Y = 170.31 \ln(x) - 1471$
	PM	0.80	$Y = 169.79 \ln(x) - 1449$
Vehicle Trips	AM	0.83	$Y = 160.3 \ln(x) - 1400$
	PM	0.79	$Y = 150.79 \ln(x) - 1302$

Where Y = Number of trips x = Total Gross Floor Area, m²

3.4 Trip distribution by direction of travel

The results of the trip distribution analysis are summarised in Tables 3.5 and 3.6.

Table 3.5 Directional trip distribution.

Site ID	Sydney areas				Non-Sydney areas																
	Site 1 Erskine Park Industrial Estate, Erskine Park	Site 2 Helensburgh Business Park, Helensburgh	Site 3 Wonderland Business Park, Eastern Creek	Site 4 Riverwood Business Park, Riverwood	Site 5 Tuggerah Business Park, Tuggerah	Site 6 Central Business Park, Albion Park Rail	Site 7 Anambah Business Park, Rutherford	Site 8 Freeway Business Park, Beresfield	Site 9 Shearwater Business Park, Taylors Beach	Site 10 Port Stephens Industrial Estate, Taylors Beach	Site 11 Johnson Street Business Park, Dubbo										
	Number of trips per m ² of GFA																				
Person-based trips																					
Site AM peak hour	1148		28		885		173		1416		294		168		575		244		94		120
incoming trips	882		22		676		137		1155		202		101		389		148		48		61
% incoming / total trips	76.8%		78.6%		76.4%		79.2%		81.6%		68.7%		60.1%		67.7%		60.7%		51.1%		50.8%
outgoing trips	266		6		209		36		261		92		67		186		96		46		59
% outgoing / total trips	23.2%		21.4%		23.6%		20.8%		18.4%		31.3%		39.9%		32.3%		39.3%		48.9%		49.2%
Site PM peak hour	1294		29		927		157		1458		519		204		555		285		97		149
incoming trips	355		11		321		32		354		237		76		159		130		35		52
% incoming / total trips	27.4%		37.9%		34.6%		20.4%		24.3%		45.7%		37.3%		28.6%		45.6%		36.1%		34.9%
outgoing trips	939		18		606		125		1104		282		128		396		155		62		97
% outgoing / total trips	72.6%		62.1%		65.4%		79.6%		75.7%		54.3%		62.7%		71.4%		54.4%		63.9%		65.1%
Vehicle-based trips																					
Site AM peak hour	1046		21		820		129		1256		268		145		504		193		64		108
incoming trips	795		16		623		97		1052		187		89		361		111		38		54
% incoming / total trips	76.0%		76.2%		76.0%		75.2%		83.8%		69.8%		61.4%		71.6%		57.5%		59.4%		50.0%
outgoing trips	251		5		197		32		204		81		56		143		82		26		54
% outgoing / total trips	24.0%		23.8%		24.0%		24.8%		16.2%		30.2%		38.6%		28.4%		42.5%		40.6%		50.0%
Site PM peak hour	1128		24		763		123		1222		418		173		481		209		78		116
incoming trips	329		9		286		27		262		180		60		105		82		26		57
% incoming / total trips	29.2%		37.5%		37.5%		22.0%		21.4%		43.1%		34.7%		21.8%		39.2%		33.3%		49.1%
outgoing trips	799		15		477		96		960		238		113		376		127		52		59
% outgoing / total trips	70.8%		62.5%		62.5%		78.0%		78.6%		56.9%		65.3%		78.2%		60.8%		66.7%		50.9%

Table 3.6 Directional trip distribution summary.

Site ID	Sydney areas					Non-Sydney areas					All Sites				
	Site 1 to Site 4					Site 5 to Site 11					Site 1 to Site 11				
	Min	Max	Avg	St Dev	85th % - le	Min	Max	Avg	St Dev	85th % - le	Min	Max	Avg	St Dev	85th % - le
Proportion of trips															
% incoming / total trips AM peak	76%	79%	78%	1%	79%	51%	82%	63%	11%	70%	51%	82%	68%	11%	79%
% outgoing / total trips AM Peak	21%	24%	22%	1%	23%	18%	49%	37%	11%	49%	18%	49%	32%	11%	44%
% incoming / total trips PM peak	20%	38%	30%	8%	36%	24%	46%	36%	8%	46%	20%	46%	34%	8%	42%
% outgoing / total trips PM Peak	62%	80%	70%	8%	76%	54%	76%	64%	8%	72%	54%	80%	66%	8%	74%
Vehicle-based trips															
% incoming / total trips AM peak	75%	76%	76%	0%	76%	50%	84%	65%	11%	73%	50%	84%	69%	10%	76%
% outgoing / total trips AM Peak	24%	25%	24%	0%	24%	16%	50%	35%	11%	43%	16%	50%	31%	10%	42%
% incoming / total trips PM peak	22%	38%	32%	7%	37%	21%	49%	35%	10%	44%	21%	49%	34%	9%	41%
% outgoing / total trips PM Peak	63%	78%	68%	7%	75%	51%	79%	65%	10%	78%	51%	79%	66%	9%	78%

The average distributions of person and vehicular trips are summarised in Table 3.7.

Table 3.7 Overall Average Directional trip distribution.

	Sydney Sites		Non Sydney Sites		All Sites	
Location	Arrivals	Departures	Arrivals	Departures	Arrivals	Departures
Person Trips						
AM Peak	78%	22%	63%	37%	68%	32%
PM Peak	30%	70%	36%	64%	34%	66%
Vehicle Based Trips						
AM Peak	76%	24%	65%	35%	69%	31%
PM Peak	32%	68%	35%	65%	34%	66%

This information is also graphically presented in Figures 3.64 to 3.67.

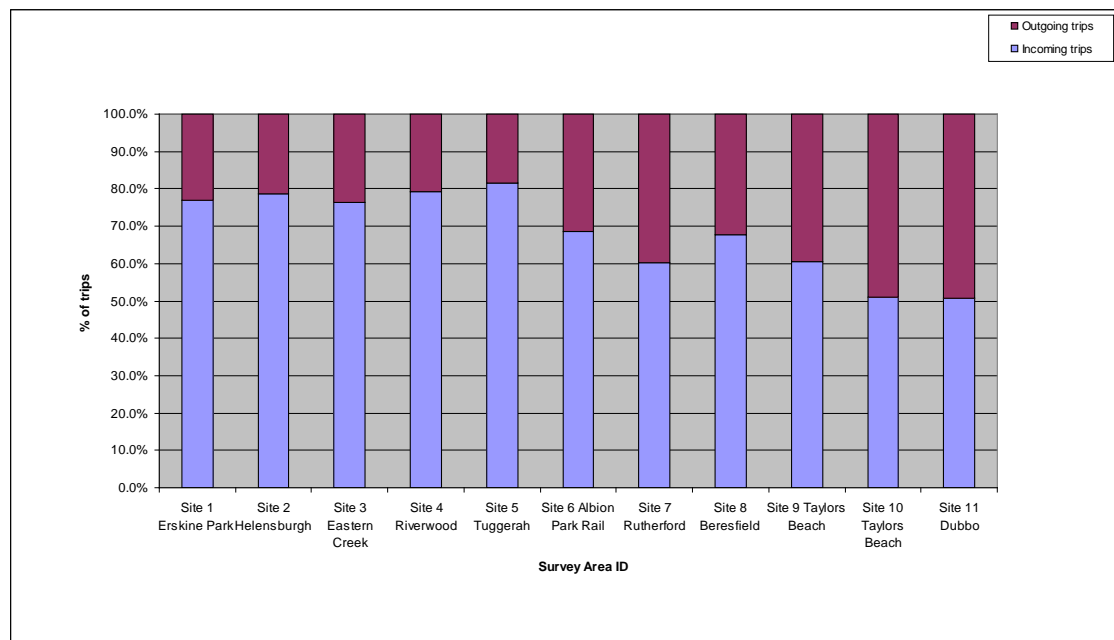


Figure 3.64 Person-based trip distribution – AM Peak

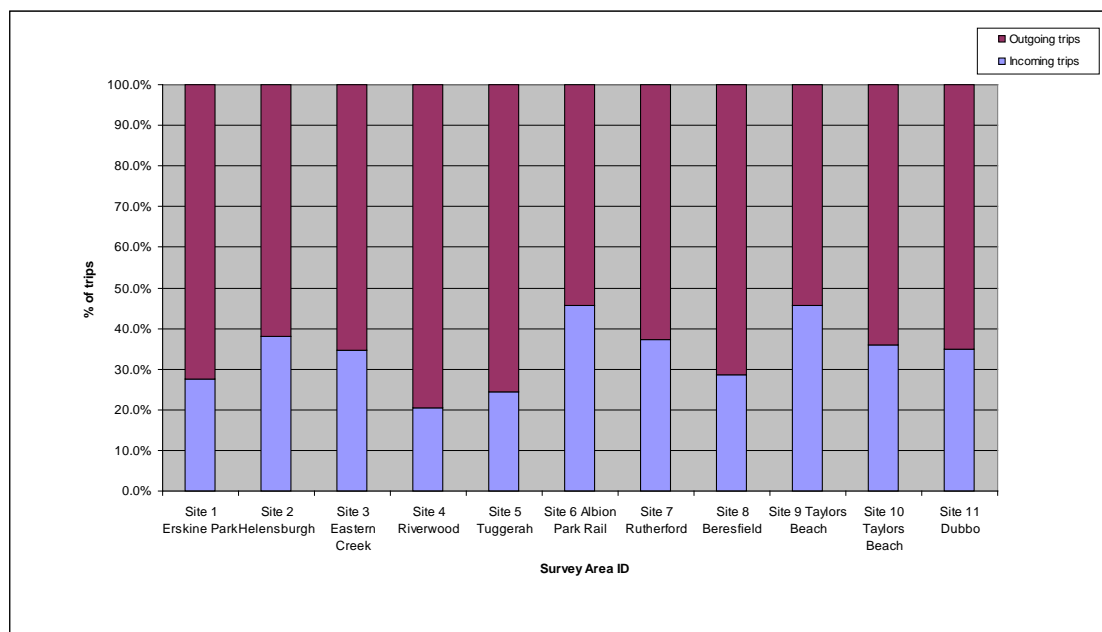


Figure 3.65 Person-based trip distribution – PM Peak

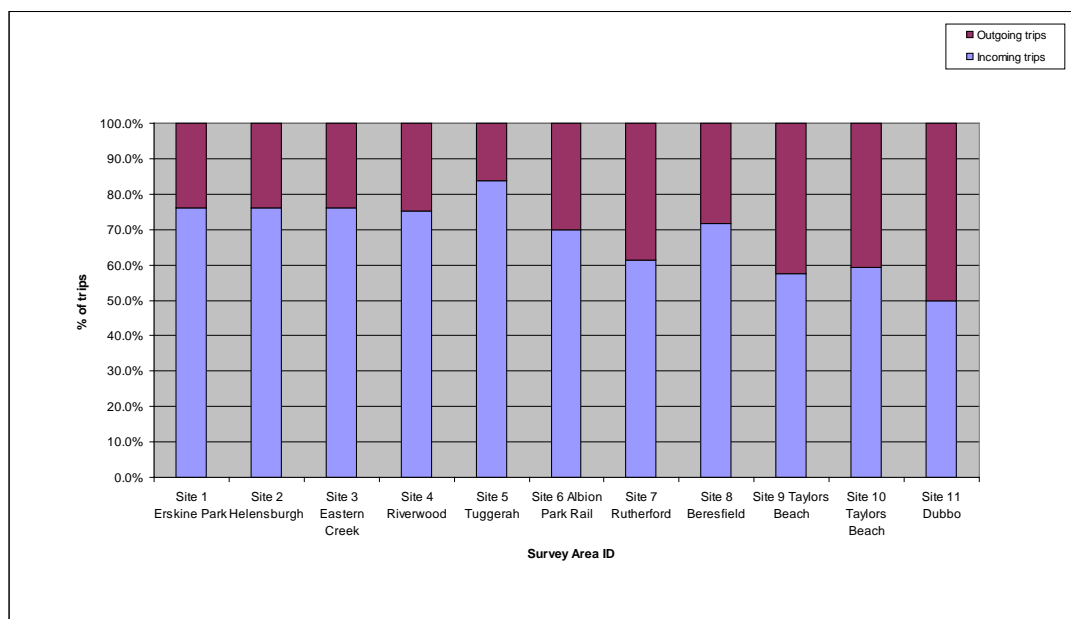


Figure 3.66 Vehicle-based trip distribution – AM Peak

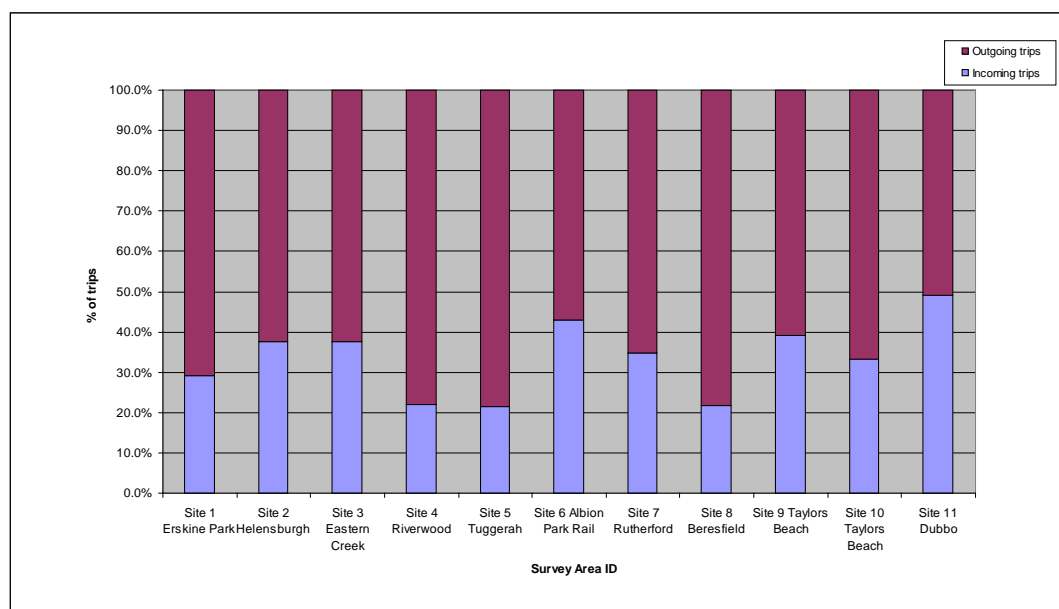


Figure 3.67 Vehicle-based trip distribution – PM Peak

3.5 Modes of travel

Modes of travel were calculated for daily person-based trips. The results are presented in Table 3.8.

Table 3.8 Daily modes of travel.

Site ID	Sydney areas					Non-Sydney areas								Average	Average all sites
	Site 1 Erskine Park Industrial Estate, Erskine Park	Site 2 Helensburgh Business Park, Helensburgh	Site 3 Wonderland Business Park, Eastern Creek	Site 4 Riverwood Business Park, Riverwood	Average	Site 5 Tuggerah Business Park, Tuggerah	Site 6 Central Business Park, Albion Park Rail	Site 7 Anambah Business Park, Rutherford	Site 8 Freeway Business Park, Beresfield	Site 9 Shearwater Business Park, Taylors Beach	Site 10 Port Stephens Industrial Estate, Taylors Beach	Site 11 Johnson Street Business Park, Dubbo			
Travel mode															
Car driver	62.5%	81.9%	63.2%	68.8%	69.1%	79.1%	78.6%	70.0%	69.1%	74.3%	71.1%	66.1%	72.6%	71.3%	
Car passenger	8.0%	8.3%	8.3%	12.3%	9.2%	11.2%	13.5%	13.4%	9.6%	19.5%	14.1%	10.9%	13.2%	11.7%	
Bus	0.8%	0.0%	2.1%	0.5%	0.9%	3.2%	0.0%	0.0%	2.2%	0.0%	0.0%	0.2%	0.8%	0.8%	
Commercial vehicle	28.3%	4.2%	25.9%	12.6%	17.8%	4.9%	6.2%	15.5%	18.3%	4.3%	8.9%	21.8%	11.4%	13.7%	
Bicycle	0.1%	0.0%	0.3%	0.1%	0.1%	0.3%	0.5%	0.2%	0.4%	0.8%	1.3%	0.1%	0.5%	0.4%	
Motorbike	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%	0.4%	0.0%	0.3%	0.9%	3.8%	0.2%	0.8%	0.5%	
Walk	0.1%	5.6%	0.2%	5.7%	2.9%	1.1%	0.8%	0.6%	0.0%	0.3%	0.9%	0.4%	0.6%	1.4%	
Other	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.4%	0.1%	0.1%	
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

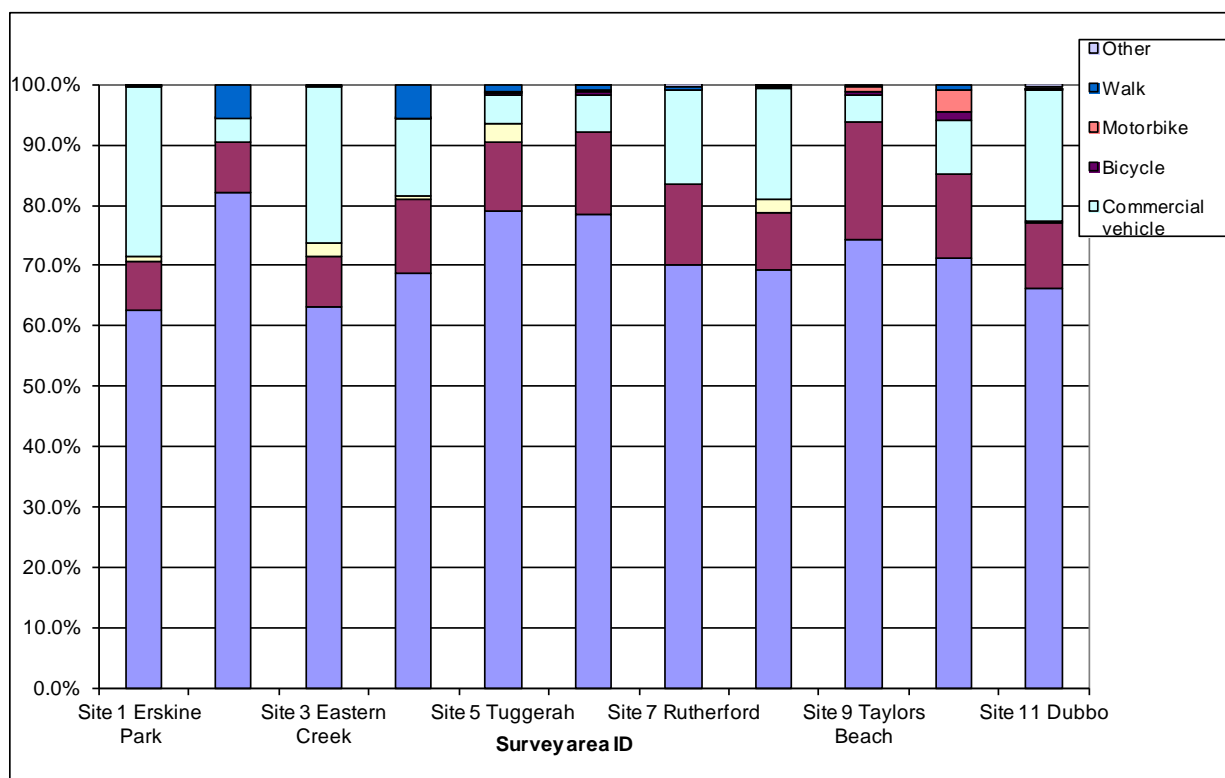


Figure 3.68 Daily modes of travel

3.6 Car occupancy

Car occupancy was calculated for peak hour and daily vehicle-based trips. The results are presented in Tables 3.9 and 3.10.

Table 3.9 Car occupancy results.

Site ID	Sydney areas				Non-Sydney areas						
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11
Car Occupancy											
Site AM peak hour	1.10	1.14	1.08	1.20	1.08	1.08	1.18	1.08	1.25	1.34	1.11
Site PM peak hour	1.18	1.23	1.23	1.22	1.14	1.23	1.20	1.14	1.36	1.21	1.14
Daily total vehicle trips	1.10	1.10	1.13	1.18	1.14	1.17	1.19	1.17	1.26	1.20	1.17

Table 3.10 Car occupancy summary.

Site ID	Sydney areas				Non-Sydney areas				All survey sites				Avg Non-Sydney / Sydney %
	Site 1 to Site 4				Site 5 to Site 11				Site 1 to Site 11				
Car occupancy	Min	Max	Avg	St Dev	Min	Max	Avg	St Dev	Min	Max	Avg	St Dev	
Site AM peak hour	1.08	1.20	1.13	0.05	1.08	1.34	1.16	0.10	1.08	1.34	1.15	0.09	
Site PM peak hour	1.18	1.23	1.21	0.02	1.14	1.36	1.20	0.08	1.14	1.36	1.21	0.06	
Daily total vehicle trips	1.10	1.18	1.13	0.04	1.14	1.26	1.19	0.04	1.10	1.26	1.16	0.05	

3.7 Special survey

Two of the business parks were also a subject of a special survey which included counts of vehicle movements into and out of each individual business in the estate, in order to gain an insight into the extent of multiple trip-making within the estate. The aim of the special survey was to clarify whether there was a disparity between the number of trips entering the precinct compared with the number of trips which might be expected based on a business-by-business estimate. Additional observers were set up within the special survey sites on the same day as the main survey. Each observer carried out manual classification counts of vehicles and pedestrians separately for a number of individual businesses (including vehicles parked outside where their occupants then entered the business grounds or building). All businesses within special survey sites were individually observed.

Site 8 Freeway Business Park, Beresfield

This is one of the larger sites with approximately 90,000 m² of GFA.

- Surrounding land uses: industrial/warehouse/commercial developments to the east; vacant lands in all other directions.
- Road environment: located at the roundabout where F3 Freeway ends and continues as Weakleys Drive.
- Public transport regime: infrequent bus services along John Renshaw Drive (Newcastle to Cessnock via Kurri Kurri).

Survey results for the early morning were incomplete due to observation difficulties and were excluded from the analysis. For the comparable survey times the results of the survey indicated the following:

Total number of vehicular trips from individual businesses combined is greater than that counted at the site entry by 4%.

Total number of person trips from individual businesses combined is greater than that counted at the site entry by 5%.

The very low differences between the added counts for individual businesses and the counts at the site entry and exit are believed to be due to the nature and the scale of the businesses on Site 8. Most of the businesses are large scale industrial and warehousing operations (including heavy machinery hire). Customers of these businesses arrive for a specific pre-arranged purpose and have no need to visit any other businesses on site. The nature of businesses on site is also very diverse and therefore it is unlikely that suppliers of goods or materials would deliver to different businesses by the same trip. Combined trips would thus likely to be limited to waste collection, office supplies and couriers.

Site 9 Shearwater Business Park, Taylors Beach

This is one of the smaller sites with approximately 16,000 m² of GFA.

- Surrounding land uses: holiday parks and vacant lands to the south; a bulky goods store (Bunnings) and small business/industrial/warehousing park immediately to the north; vacant lands further to the north in all other directions.
- Road environment: Port Stephens Drive runs along the eastern boundary, connecting Pacific Highway and holiday townships (Nelson Bay, Salamander Bay).
- Public transport regime: infrequent bus services along Port Stephens Drive. The results of the survey indicate the following:

Total number of vehicular trips from individual businesses combined is greater than that counted at the site entry by 7%.

Total number of person trips from individual businesses combined is greater than that counted at the site entry by 12%. The greater difference in percentage for person trips is believed to be due to persons who drove to a specific business, parked their car and then walked to other business outlets.

The greater difference between the main and special survey results, compared with that for Site 8, is believed to be due to smaller size industry/warehousing businesses on Site 9. Also, a number of businesses had retail outlets for general public. Customers of some businesses were observed visiting the outlets of the neighbouring businesses.

4 COMPARISON OF NSW FINDINGS WITH OTHER NATIONAL & OVERSEAS DATABASES

4.1 Introduction

A number of Australian and overseas guidance documents and traffic generation databases have been examined to determine whether they are comparable to the results established from this study. These are examined below.

4.2 Australian Documents

4.2.1 National Documents

Austroroads has a document titled “The Guide to Traffic Management Part 12 – Traffic Impact of Developments”. This document provides guidance for planners and engineers associated with the design, development and management of a variety of land use developments. The aim is to ensure consistency in the assessment and treatment of traffic impacts, including addressing the needs of all road users and the effect upon the broader community. Part 12 presents the land use and transport planning context for traffic impact assessment, including travel demand, safety, parking and access management issues. It provides guidance on the need and criteria for impact assessments, and a detailed procedure for identifying and assessing the traffic impacts, and mitigating their effects. Assessment of safety, infrastructure and environmental effects is also covered. Examples are given of checklists, report structures, traffic generation rates and case study projects.

4.2.2 State Documents

Most of the Australian states produce a document(s) which shows how to undertake traffic / transport impact assessments. Most of these documents refer to sources of traffic generation data. The documents, and other anecdotal information, are discussed below for each of the states.

Table 4.1 Sources of Trip Generation Rate Information

NSW	The RTA “Guide to Traffic Generating Developments” is generally used. The latest version of the document was published in 2002 but much of its data is around 20 years old and more. A number of consultancies use their own data collection efforts to argue variations to the RTA Guide (both up and down) but invariably use the RTA guide as the starting point.
Queensland	Queensland use the RTA guidelines as well as the Dept of Transport and Main Roads Road Planning Queensland use the RTA guidelines as well as the Dept of Transport and Main Roads Road Planning and Design Manual. A number of Councils generally use the trip generation rates specified in the Queensland Department of Transport and Main Roads (TMR) Road Planning and Design Manual Chapter 3 Appendix 3A. For industrial land uses, sources including RTA and QT are quoted.
Victoria	The RTA Guide to Traffic Generating Developments is used extensively and some documents refer to a Victorian document “Guidelines for Transport Impact Assessment Reports for major land use and development proposals (2006)” often referred to as “The Transport Impact Assessment Report (TIAR) Guidelines”. To a lesser extent, the Institute of Transportation Engineers (ITE) Trip Generation, 8th Edition publication is also used. Again, consultancies tend to use their own data collection efforts to assemble traffic generation figures.

South Australia	It appears that traffic assessments generally use the RTA Guide to Traffic Generating Developments
Western Australia	Transport Assessment Guidelines for Developments were issued in 2006 for trial and evaluation. The document is divided into 5 volumes with the final volume giving more detailed considerations. The document was endorsed by the Western Australia Planning Commission Transport Committee as a “working” document for voluntary trial and evaluation. Transport officers within the Dept for Planning and Infrastructure are using the guidelines to assist them in assessing the transport implications of land use development proposals and officers within local government are being encouraged to do the same.
Australian Capital Territory	The ACT generally uses the RTA Guide to Traffic Generating Developments.
Northern Territory	Unknown
Tasmania	Tasmania generally uses the RTA guidelines when assessing traffic generating developments. This only varies when contemporary and relevant traffic count data that supports using other figures is available.

Each of the key Australian documents is described below

NSW

The RTA Guide (2002) includes both traffic generation and parking impact information for a wide range of land uses. Even so, some of the uses range across a broad spectrum of developments. The Guide includes trip generation for business parks, factories and warehousing. The Guide defines a trip as a one way vehicular movement from one point to another excluding the return journey; therefore, a return trip to / from a land use is counted as two trips.

The document is widely used in NSW although its validity is sometimes called into question, particularly at Land and Environment Court cases, when developers often submit their own traffic count data. This situation is in compliance with the Guide which states that “surveys of existing developments similar to the proposal can also be undertaken and comparisons may be drawn”. NSW is currently in the process of updating the data for some of the more critical land uses such as residential, bulky goods, offices and shopping centres.

Queensland

Council generally adopts (or 'accepts' in terms of development traffic impact reports) the trip generation rates specified in the Queensland Department of Transport and Main Roads (TMR) Road Planning and Design Manual Chapter 3 Appendix 3A. For industrial and warehousing land uses, the document refers to the RTA Guide (2002). The document suggests for light industrial developments a peak trip generation rate of 0.9 trips/hour/100m² and 9.0 trips/day/100m².

Victoria

The Guidelines for Preparation of Transport Impact Assessment Report document (which is part of the VicRoads Toolkit for managing access to Arterial Roads and Freeways) discusses the provision of traffic generation information but gives no indication as to where such trip generation information might be obtained.

VicRoads runs a model that is calibrated against current volumes. There are different trip generation rates, for different trip purposes, for different age groups, for different household types, for different car ownership levels. The model is calibrated such that the traffic volumes, and public transport patronage rates, match observed values on screen lines across the network. No other information could be obtained from VicRoads.

Western Australia

The DPI (now DoP and DoT) issued the Transport Assessment Guidelines for Developments in 2006. The guidelines suggest the adoption of the following generation rates published in the RTA guidelines (2002) for industrial developments.

	Daily Trips	AM Peak	PM Peak
Trips per 100m ²		1.00	1.00
Directional Distribution IN/OUT		80%/20%	20%/80%

South Australia

The 1987 South Australia document *Land use traffic generation guidelines* states that the ‘trip rates’ used in the document are appropriate for the 1980’s and “*care should be taken in applying them after 1980*”. It does however contain simplistic trip generation rates for a large number of land uses. It appears that more recently traffic assessments generally use the RTA Guide to Traffic Generating Developments.

4.3 Other Countries

4.3.1 New Zealand

4.3.2 The New Zealand Trips and Parking Database Bureau is now known as the Trips Database Bureau (TDB). The Bureau was formed in New Zealand in 2002 using an initial database of around 500 survey sites, increasing to about 700 sites. The Bureau continues to collect surveys of trip rates, parking demand and travel information relative to different land uses from across the country. In addition to developing the trips and parking database, the Bureau also undertakes government sponsored transportation research on travel profiles, trip generation and transportation assessment guidelines. Members of the Bureau include New Zealand organisations such as Transit NZ, RMS, consultants and councils and recently some Australian councils and consultants. NSW RMS is also a member of TDB.

4.3.3 USA

The Institution of Transportation Engineers (ITE) “Trip Generation” book consists of two data volumes with land use descriptions, trip generation rates, equations and data plots. Data is included from more than 4,800 sites and 162 land uses. The most recent (8th) edition was published in 2008. The USA document is produced in book format only which means it is not possible to select the most appropriate site data and it encourages the use of average values. Furthermore, some of the source data dates from the 1960s and it is not possible to extract data for recent surveys only.

4.3.4 UK

TRICS (Trip Rate Information Computer Systems) is the UK national standard trip generation database and is used as an integral and essential part of the Transport Assessment process. The system is marketed and managed by JMP Consultants Limited on behalf of the TRICS® Consortium of 6 County Councils: Surrey, Kent, East Sussex, West Sussex, Hampshire and Dorset. JMP regularly ask for input from consultants and local authorities with regard to the additional land uses that require additional information. It contains transport generation data for a wide variety of development types, across all regions of the UK and Ireland. The current annual data collection programme consists of multi-modal surveys across all regions, supplemented by a number of traffic surveys. The database uses a flexible system of filtering, to allow users to interrogate trip rates for sites (including a very specialised range of land use categories) which meet their own compatibility criteria. Also, individual trip rates for a given time period for a number of surveys can be calculated and ranked, displaying the worst and best case scenarios.

Nevertheless, with the wide range of data, it is often the case that developers and development control officers fail to agree on the most relevant site data which in turn often leads to disagreements and this often forms the basis of planning appeals (which are the UK equivalent of Land & Environment Courts).

4.4 Industrial & Business parks Vehicle Trip Generation - International Databases

The following databases have been examined:

- RTA Guide to Traffic Generating Developments (2002)
- New Zealand Trips Database Bureau (NZTDB)
- United States Institute of Transportation Engineers (ITE)
- Trip Rate Information Computer Systems (TRICS) UK

4.4.1 RTA Guide to Traffic Generating Developments

The RTA Guide (2002) trip generation rates and parking requirements for single use factory, warehouse developments, industrial and business parks are included in **Table 4.2**.

Table 4.2 RTA Trip Generation Rates (Weekdays)

Type	Daily Trip	Peak Hourly Trip		Parking
Business Parks		Option A	1.1 / 100 m ² GLFA	1.5 spaces per 100m ² of total GLA
		Option B	1.2 / 100 m ² GLFA of office/showroom + 1.0 / 100 m ² GLFA of factory/warehouse	1.8 spaces per 100m ² GLFA of office/ showroom plus 1.2 spaces per 100m ² GLFA of factory / warehouse area
Factory	5.0 / 100 m ² GFA		1.00/ 100 m ² GFA	1.3/100m ² GFA
Warehouse	4.0 / 100 m ² GFA		0.5 / 100 m ² GFA	1/300 m ² GFA
Industrial Estate *				
Trip rate	2.30/ employee		0.31/ employee	
% Heavy vehicles	12% of all vehicles		7% of all vehicles	

*based on 1000 employees in a wide range of factory types, calculated using the data presented in Table 3.4 of the RTA Guide (2002).

4.4.2 New Zealand Trips Database Bureau (NZTDB)

The surveys available in the New Zealand database for industrial type development are normally for the morning and afternoon peak hours and weekday daily trips. The available published survey results were analysis and summarised in **Table 4.3**.

Table 4.3 Trip Generation Rates of Industrial land Use (NZTDB) (Weekdays)

Type of Land Use	Trip Generation rates			Parking Demand
Industrial Estate	Daily Trips	AM Peak	PM Peak	Space /100 m ² GFA
Trips per 100 m ² GFA	9.1	0.84	0.91	
Directional Distribution	50%/50%	65%/35%	36%/64%	
Warehouses				
Trips per 100 m ² GFA	4.4	1.07	1.01	0.86
Trips per employee	5.17	1.14	0.83	
Directional Distribution	50%/50%	67%/33%	46%/54%	
Manufacturing				
Trips per 100 m ² GFA	14.1	1.88	2.08	0.65
Trips per employee	17.55	1.16	1.53	
Directional Distribution	50%/50%	60%/40%	53%/47%	

4.4.3 US Institute of Transportation Engineers (ITE)

The Institute of Transportation Engineers (ITE) Trip Generation Manual (8th Edition 2008) include trip generations for business park (referred to as N^o 770) and industrial parks (referred to as N^o 130). Trip generation rates based on employees and gross floor area are provided.

Business Parks

The information contained in the ITE manual is summarised in **Table 4.4**. The ITE defines a business park as an area which include a mixture of office, retail and wholesale stores; warehousing, manufacturing light industrial and scientific research establishments.

Table 4.4 Vehicle Trip Generation of Business Park– ITE (2008) *

	Period	Trips/ employees	Range	%Arr / %Dep
WEEKDAY TRIP GENERATION				
	Daily	4.04	3.25-8.19	50% / 50%
Network Peak Hour	AM	0.45	0.30–0.95	85% / 15%
	PM	0.39	0.24-1.01	22% / 78%
WEEKEND				
Saturday	Daily	0.71	0.48-1.37	50% / 50%
Sunday	Daily	0.36	0.17-1.02	50% / 50%
	Period	Trips / 100 m ² GFA	Range	%Arr / %Dep
WEEKDAY TRIP GENERATION				
	Daily	4.19	5.56-27.96	50%/50%
Network Peak Hour	AM	0.47	0.65-2.90	84%/16%
	PM	0.42	0.55-2.97	23%/77%
WEEKEND				
Saturday	Daily	0.84	1.10-5.30	50%/50%
Sunday	Daily	0.42	0.74-2.28	50%/50%

*The sites were surveyed from 1980's to the 1990's

** Generator peak hours coincided with network peak hours

Industrial Parks

The information contained in the ITE manual is summarised in **Table 4.5**. The ITE defines industrial parks as areas characterised by a mix of manufacturing and warehousing.

Table 4.5 Vehicle Trips Generation of Industrial Park– ITE (2008) *

	Period	Trips/ employee	Range	%Arr / %Dep
WEEKDAY TRIP GENERATION				
	Daily	3.34	1.24-8.80	50%/50%
Network Peak Hour	AM	0.47	0.28-1.13	86%/14%
	PM	0.46	0.26-1.36	20%/80%
WEEKEND				
Saturday	Daily	1.14	0.35-11.03	50%/50%
	Peak	0.14	0.07-.031	32%/68%
Sunday	Daily	0.34	0.05-1.26	50%/50%
	Peak	0.03	0.02-0.14	46%/54%
	Period	Trips / 100 m ² GFA	Range	%Arr / %Dep
WEEKDAY TRIP GENERATION				
	Daily	2.28	0.91-36.97	50%/50%
Network Peak Hour	AM	0.28	0.12-2.28	82%/18%
	PM	0.28	0.13-2.85	21%/79%
Saturday	Daily	0.82	0.18-43.00	50%/50%
	Peak	0.11	0.31-0.60	32%/68%
Sunday	Daily	0.24	0.07-2.49	50%/50%
	Peak	0.02	0.05-0.28	46%/54%

*The sites were surveyed from late 1960's to the mid 1980's

Other relevant information published in the ITE document pertaining to Industrial Parks are summarised in Table 4.6.

Table 4.6 Other Relevant Information

	Rate	Range
Average weekday transit trip ends	0.03 per employee	
	0.02 per 100 m ² GFA	
Truck trips	8% of all vehicles	1 to 22 percent
Vehicle occupancy	1.37 persons/car	1.2 to 1.8

4.4.4 Trip Rate Information Computer Systems (TRICS)

The TRICS data base included trip information for both Business Parks and Industrial Estate. Some 33 business parks with gross floor areas between 1000 m² and 120,000 m² were filtered for weekday trip generations. Similarly, some 32 industrial parks with gross floor areas between 500 m² and 120,000 m² were also filtered for weekdays. Survey data from 2004 to 2010 were selected. A summary of the information extracted from the database is summarised in Table 4.7.

Table 4.7 Summary of TRICS Analysis for Business Parks and Industrial Estates (Weekdays)

	Trip Generation Rates/ 100m ² GFA				
	Daily Trips	AM peak Hour		PM peak Hour	
		Arr	Dep	Arr	Dep
Business Park	10.12	1.33	0.25	0.24	1.07
Industrial Estate	6.32	0.44	0.21	0.22	0.40
Business & Industrial	8.02	0.95	0.25	0.25	0.79

4.4.5 Comparison of Databases - Vehicle Trip Generation

Business Parks

A comparison of trip rates for Business Parks between these databases is summarised in Table 4.8 based when available on floor area and/or number of employees.

Table 4.8 Business Parks Summary Trip Generation Rates (Trips/100 m² GFA)

Source	Weekdays			Saturday	Sunday
	AM Peak	PM Peak	Daily	Daily	Daily
RTA Guide 2002	1.1				
Trips/100 m ² GFA					
NZTDB	Not available				
ITE					
Trips / employee	0.45	0.39	4.04	0.71	0.36
Trips/100 m ² GFA	0.47	0.42	4.19	0.84	0.42
TRICS					
Trips/100 m ² GFA	1.58	1.31	10.12		
STUDY RESULTS					
All Sites	Reliable simple trip generation rates could not be established. However, trip generation can be determined using the regression analysis formulae included in Tables 3.3 and 3.4.				
Sydney Metropolitan					
Regional					

It should be noted that the result of this current study do not include *internal* trips to other establishments within the surveyed Business/Industrial Parks.

The trip rates obtained in the present study varied significantly between the sites and therefore single values could not be established for peak hour and daily traffic. It is noted, however, that average values for trip rates obtained in this Study (noting significant standard deviation and confidence intervals) were generally between ITE and TRICS values.

The use of information from any of the above databases would not be appropriate in NSW.

Industrial Parks

A comparison of trip rates for Industrial Parks between the databases is summarised in **Table 4.9** based when available on floor area and/or number of employees.

It should be noted that the result of this current study do not include *internal* trips to other establishments within the surveyed Industrial Park.

Table 4.9 Industrial Parks Summary Trip Generation Rates

SOURCE	WEEKDAYS			SATURDAYS		SUNDAYS	
	AM Peak	PM Peak	Daily	Peak	Daily	Peak	Daily
RTA Guide							
Trips /employee	0.31	0.31	2.30				
NZTDB							
Trips / 100 m ² GFA	0.84	0.91	9.1				
ITE							
Trips /employee	0.43	0.45	3.34	0.14	1.14	0.03	0.34
Trips / 100 m ² GFA	0.27	0.28	2.28	0.11	0.82	0.02	0.24
TRICS							
Trips / 100 m ² GFA	0.65	0.62	6.32				
STUDY RESULTS							
All Sites	Reliable simple trip generation rates could not be established. Refer to regression analysis formulae included in Tables 3.3 and 3.4						
Sydney Metropolitan							
Regional							

The trip rates obtained in the present study varied significantly between the sites and therefore single values could not be established for peak hour and daily traffic. It is noted, however, that average values for trip rates obtained in this Study (noting significant standard deviation and confidence intervals) were generally closer to TRICS values. NZTDB values are much greater and ITE values are substantially lower than those obtained in the present Study.

The use of information from any of the above databases would not be appropriate in NSW.

5

SUMMARY

The current RTA Guide includes limited information in relation to Business Parks and Industrial Parks. Since the original publication of the *Guide to Traffic Generating Developments*, there has been a proliferation of Business and Industrial Parks in areas not well served by public transport.

Traffic generation data in the RTA 2002 Guide contains data that was collected prior to the document's initial issue in 1993, and that does not reflect current traffic patterns.

Five (5) urban and six (6) regional sites were selected in consultation with RMS project manager.

Some issues were encountered in selecting the sites and conducting the surveys. For example an estate may have included a traffic generator not compatible with its use or by its own nature attracted through traffic not destined to the area eg a service station. Traffic generated by this land use was then discounted from the total observed trips in the corresponding estate. In the early hours of the morning, mainly between 6 am and 7 am, traffic observers had some difficulties identifying vehicle occupancies due to dark conditions and headlight glare at some locations.

Surveys of trips generation were carried out in February-May 2012, outside school holidays. Traffic counts (all travel modes and vehicle occupancy) were undertaken at each entry and exit of each survey area generally between 7 am and 7 pm on Tuesday, Wednesday or Thursday.

A review of the data reveals a number of observations

- The surveys were undertaken in estates with floor space varying from as low as 1,605 m² to over 690,000 m².
- Slightly higher trips rates were observed during the site PM peak than during AM peak.
- The non-Sydney survey sites had higher average trip rates than the Sydney survey sites.

The results of the analyses for both peak hour and daily trips rates indicated high values of standard deviation in all cases, for both person and vehicle trips. The base data was therefore regarded as wide-spread. The average rates are thus not recommended to be used for predicting the trip generation because of wide prediction intervals around the mean estimated values.

The trip generation rates were then analysed in terms of their dependency on the GFA and the Accessibility Score. The regression analysis did not reveal any correlation between the above variables.

The regression analysis showed that the number of trips generated by the estates had a linear (for some cases) and non-linear dependency on GFA.

Linear relationships showed good level of correlation for estates with up to 200,000 m² GFA, leaving the two largest sites (Erskine Park and Wonderland) outside of the equation. Non-linear regression model, on the other hand, enabled inclusion of these two sites. However, non-linear dependencies also had an exclusion - the Tuggerah site which had a much higher (over 40 percent of all businesses) proportion of offices. All other developments (except the smallest site in Helensburgh with only 1,605 m² GFA) had the office component below 10% of the total GFA. Offices are likely to generate higher number of trips than industrial establishments which resulted in the higher trip rate for the Tuggerah site overall.

In summary, the analysis of data highlighted the following facts:

- Average trip rates should not be utilised for planning purposes.
- The analysis showed no dependency of the trip rates from the survey site Accessibility Score.
- A good linear relationship was established for business/industrial parks up to 200,000 m² GFA.

- Good logarithmic relationships exist for business/industrial parks where office/commercial establishments do not exceed 10% of all floor area.

Relationships which could be used to estimate the trip generation of Business/Industrial parks are shown in Tables 5.1 and 5.2.

Table 5.1 Peak Trip Generation Relationships for Estates up to 200,000 m² GFA

Survey Area	Period	R ²	Relationship
Estate Peak Hours			
Person Trips	AM	0.92	$Y = 0.0095x - 57$
	PM	0.89	$Y = 0.0096x - 22$
	Daily	0.96	$Y = 0.0841x - 124$
All Vehicle Trips	AM	0.92	$Y = 0.0085x - 62$
	PM	0.91	$Y = 0.0082x - 30$
	Daily	0.94	$Y = 0.0741x - 46$
Road Network Peak Hours			
Person Trips	AM	0.93	$Y = 0.0096x - 79$
	PM	0.85	$Y = 0.0068x + 17$
Vehicle Trips	AM	0.92	$Y = 0.0086x - 79$
	PM	0.88	$Y = 0.0052x + 19$

Table 5.1 Peak Trip Generation Relationships for Estates with up to 10% of Office/Commercial Areas

Survey Area	Period	R ²	Relationship
Estate Peak Hours			
Person Trips	AM	0.84	$Y = 198.07 \ln(x) - 1718$
	PM	0.82	$Y = 214.87 \ln(x) - 1847$
	Daily	0.83	$Y = 2384.7 \ln(x) - 20886$
Vehicle Trips	AM	0.83	$Y = 183.44 \ln(x) - 1607$
	PM	0.82	$Y = 185.42 \ln(x) - 1606$
	Daily	0.82	$Y = 2246.4 \ln(x) - 19844$
Road Network Peak Hours			
Person Trips	AM	0.84	$Y = 170.31 \ln(x) - 1471$
	PM	0.80	$Y = 169.79 \ln(x) - 1449$
Vehicle Trips	AM	0.83	$Y = 160.3 \ln(x) - 1400$
	PM	0.79	$Y = 150.79 \ln(x) - 1302$

Where Y = Number of trips x = Total Gross Floor Area, m²

In terms of car occupancy, regional sites showed similar car occupancy rates to those within the Sydney Metropolitan Area, with a greater standard deviation from the mean value.

The survey results confirmed that private car is by far the main mode of travel in all areas, with the regional sites having generally a slightly higher proportion of car use than that at the Sydney Metropolitan Area sites.

A special survey designed to gauge the extent of multiple trip-making within the estates was conducted at two survey sites. The results revealed little differences between the number of trips into and out of the sites' main entries and the sums of trips to individual businesses. This result is believed to be due to the nature of individual businesses (manufacturing and warehousing) which attract mostly single-purpose trips by customers and suppliers. Combined trips are likely to be limited to waste collection, office supplies and couriers.

Existence of retail outlets at a number of individual neighbouring businesses within the estate was observed to generate additional person-based trips (on foot) between the outlets.

A review of existing traffic generation guides and databases, suggests that throughout Australia:

- The RTA “Guide to Traffic Generating Developments” seems to be the main source of traffic generation data, with some States (QLD, VIC and WA) complementing its use by their own guidelines.
- The ITE books are used but in a very limited way.
- Many practitioners use the RTA Guide as a starting point but then do their own surveys to establish traffic generation characteristics at similar sites / land uses.

In summary, although other documents are used, and many companies seem to undertake their own surveys to establish the traffic generating capabilities of a particular site, the RTA Guide seems to be the first point of reference.

International guides are available such as

- The New Zealand Trips Database Bureau.
- The Institution of Transportation Engineers (ITE) “Trip Generation” book.
- UK - TRICS is the UK national standard trip generation database and is used as an integral and essential part of the Transport Assessment process.

The above guides offer a range of trip generation rates for both peak hour and daily traffic for business parks and industrial parks. The results of the analysis have shown that, although the trip generation rates obtained in the present Study fall generally within the ranges of values derived from the international Guides, they cannot be reliably used for estimation of future traffic generation from business parks & industrial estates. Rather, it is recommended that trip generation relationships based on linear and non-linear formulae established for a number of specific cases be used. Conversely, none of the trip generation rates derived from the analysis of international guides can be recommended for use in NSW.

APPENDIX

International data summaries

BUSINESS PARK AM PEAK

RANK ORDER for Land Use 02 - EMPLOYMENT/B - BUSINESS PARK													
Ranking Type: TOTALS Time Range: 08:00-09:00													
**85th Percentile = no. 6													
Rank	Site Ref	Description	Area	GFA	Day	Date	Arrivals	Departures	Totals	Travel Plan	Arrivals	Departures	Totals
30	TW-02-B-0	BUSINESS PARK, NEWCASTLE	TYNE & WEAR	975	Tuesday	3/05/2005	0.513	0.103	0.616		5.00175	1.00425	6.006
32	HO-02-B-0	BUSINESS PARK, HOUNSLOW	HOUNSLOW	1200	Wednesday	16/06/2010	0.333	0.167	0.5		4.00	2.00	6.00
24	SH-02-B-0	BUSINESS CENTRE, TELFORD	SHROPSHIRE	1300	Tuesday	16/06/2009	0.846	0.077	0.923		11.00	1.00	12.00
17	DC-02-B-0	BUSINESS PARK, POOLE	DORSET	1570	Thursday	17/07/2008	1.529	0.127	1.656		24.01	1.99	26.00
1	NO-02-B-0	BUSINESS PARK, SCUNTHORPE	NORTH LINCOLNSHIRE	1574	Thursday	22/09/2005	3.494	0.254	3.748		55.00	4.00	58.99
9	NT-02-B-0	BUSINESS PARK, NOTTINGHAM	NOTTINGHAMSHIRE	2321	Thursday	17/05/2007	1.81	0.474	2.284		42.01	11.00	53.01
7	SF-02-B-0	BUSINESS PK, BURY ST EDMUNDS	SUFFOLK	2480	Wednesday	10/05/2006	2.218	0.161	2.379		55.01	3.99	59.00
33	CF-02-B-0	BUSINESS/TECH. UNITS, CARDIFF	CARDIFF	2587	Friday	20/10/2006	0.155	0.077	0.232		4.01	1.99	6.00
3	WL-02-B-0	BUSINESS PK,WOOTTON BASSETT	WILTSHIRE	2600	Monday	2/10/2006	2.423	0.385	2.808		63.00	10.01	73.01
22	DL-02-B-0	OFFICE PARK, DUBLIN	DUBLIN	2920	Tuesday	11/05/2010	0.788	0.24	1.028		23.01	7.01	30.02
16	LC-02-B-0	BUSINESS PARK, PRESTON	LANCASHIRE	3450	Tuesday	18/10/2011	0.696	0.145	0.841		24.01	5.00	29.01
13	WO-02-B-0	BUSINESS PARK, REDDITCH	WORCESTERSHIRE	3525	Tuesday	2/05/2006	1.39	0.397	1.787		49.00	13.99	62.99
20	GM-02-B-0	BUSINESS PARK, SALE	GREATER MANCHESTER	3985	Tuesday	18/10/2011	1.33	0.05	1.38		53.00	1.99	54.99
12	LN-02-B-0	BUSINESS PARK, LINCOLN	LINCOLNSHIRE	4460	Tuesday	17/05/2005	1.457	0.583	2.04		64.98	26.00	90.98
27	KI-02-B-0	BUSINESS PARK, KINGSTON	KINGSTON	5250	Monday	19/04/2004	0.667	0.152	0.819		35.02	7.98	43.00
23	DL-02-B-0	BUSINESS PARK, DUBLIN	DUBLIN	5985	Wednesday	12/05/2010	0.952	0.033	0.985		56.98	1.98	58.95
14	EB-02-B-0	BUSINESS PARK, EDINBURGH	CITY OF EDINBURGH	6675	Tuesday	1/05/2007	1.573	0.18	1.753		105.00	12.02	117.01
6 **	NF-02-B-0	BUSINESS PARK, NORWICH	NORFOLK	7400	Thursday	17/05/2007	2.162	0.243	2.405		159.99	17.98	177.97
5	DN-02-B-0	BUSINESS PARK, LETTERKENNY	DONEGAL	7951	Wednesday	30/09/2009	2.327	0.138	2.465		185.02	10.97	195.99
10	SH-02-B-0	BUSINESS PARK, TELFORD	SHROPSHIRE	9500	Monday	22/06/2009	1.958	0.242	2.2		186.01	22.99	209.00
8	CF-02-B-0	BUSINESS PARK, CARDIFF	CARDIFF	9520	Monday	18/10/2010	2.132	0.189	2.321	Yes	202.97	17.99	220.96
2	CF-02-B-0	BUSINESS PARK, CARDIFF	CARDIFF	12000	Wednesday	18/10/2006	2.775	0.367	3.142		333.00	44.04	377.04
15	BU-02-B-0	BUSINESS PARK, HIGH WYCOMBE	BUCKINGHAMSHIRE	13300	Thursday	8/07/2004	1.571	0.18	1.751		208.94	23.94	232.88
4	SH-02-B-0	BUSINESS PARK, SHREWSBURY	SHROPSHIRE	17197	Tuesday	14/06/2005	2.058	0.57	2.628		353.91	98.02	451.94
25	HE-02-B-0	BUSINESS PARK, NR HEREFORD	HEREFORDSHIRE	18808	Tuesday	13/09/2011	0.776	0.128	0.904		145.95	24.07	170.02
29	WT-02-B-0	BUSINESS/TECH. PARK, ATHLONE	WESTMEATH	22150	Tuesday	19/06/2007	0.519	0.144	0.663		114.96	31.90	146.85
18	HF-02-B-0	BUSINESS PARK, HATFIELD	HERTFORDSHIRE	26000	Monday	7/07/2008	1.485	0.119	1.604		386.10	30.94	417.04
31	TW-02-B-0	BUSINESS PARK,NORTH SHIELDS	TYNE & WEAR	27142	Friday	10/10/2008	0.501	0.103	0.604		135.98	27.96	163.94
21	WM-02-B-0	BUSINESS PARK, COVENTRY	WEST MIDLANDS	30042	Friday	10/02/2006	0.809	0.273	1.082		243.04	82.01	325.05
19	TW-02-B-0	BUSINESS PARK, NEWCASTLE	TYNE & WEAR	38853	Thursday	11/12/2008	1.264	0.245	1.509		491.10	95.19	586.29
28 **	GA-02-B-0	BUSINESS PARK, GALWAY	GALWAY	46175	Wednesday	20/09/2006	0.628	0.132	0.76		289.98	60.95	350.93
11	TW-02-B-0	BUSINESS PARK, SUNDERLAND	TYNE & WEAR	77513	Thursday	9/10/2008	1.773	0.267	2.04	Yes	1374.31	206.96	1581.27
16	HC-02-B-0	BUSINESS PARK, BASINGSTOKE	HAMPSHIRE	121275	Thursday	22/11/2007	1.375	0.366	1.741	Yes	1667.53	443.87	2111.40

BUSINESS PARK PM PEAK

RANK ORDER for Land Use 02 - EMPLOYMENT/B - BUSINESS PARK														
Ranking Type: TOTALS Time Range: 16:30-17:30														
**85th Percentile = no. 6														
Rank	Site Ref	Description	Area	GFA	Day	Date	Arrivals	Departures	Totals	Travel Plan	Arrivals	Departures	Totals	
21	TW-02-B-0	BUSINESS PARK, NEWCAST	TYNE & WEAR	975	Tuesday	3/05/2005	0.308	0.821	1.129		3.00	8.00	11.01	
23	HO-02-B-0	BUSINESS PARK, HOUNSLO	HOUNSLOW	1200	Wednesda	16/06/2010	0.333	0.667	1		4.00	8.00	12.00	
27	SH-02-B-0	BUSINESS CENTRE, TELFOR	SHROPSHIRE	1300	Tuesday	16/06/2009	0.077	0.692	0.769		1.00	9.00	10.00	
10	DC-02-B-0	BUSINESS PARK, POOLE	DORSET	1570	Thursday	17/07/2008	0.637	1.083	1.72		10.00	17.00	27.00	
8	NO-02-B-0	BUSINESS PARK, SCUNTHO	NORTH LINCOLNSHIR	1574	Thursday	22/09/2005	0.191	1.652	1.843		3.01	26.00	29.01	
3	NT-02-B-0	BUSINESS PARK, NOTTINGH	NOTTINGHAMSHIRE	2321	Thursday	17/05/2007	0.517	1.68	2.197		12.00	38.99	50.99	
13	SF-02-B-01	BUSINESS PK, BURY ST EDN	SUFFOLK	2480	Wednesda	10/05/2006	0.242	1.29	1.532		6.00	31.99	37.99	
31	CF-02-B-02	BUSINESS/TECH. UNITS, CA	CARDIFF	2587	Friday	20/10/2006	0.116	0.387	0.503		3.00	10.01	13.01	
6 **	WL-02-B-0	BUSINESS PK,WOOTTON BA	WILTSHIRE	2600	Monday	2/10/2006	0.115	1.962	2.077		2.99	51.01	54.00	
9	DL-02-B-03	OFFICE PARK, DUBLIN	DUBLIN	2920	Tuesday	11/05/2010	0.651	1.096	1.747		19.01	32.00	51.01	
26	LC-02-B-03	BUSINESS PARK, PRESTON	LANCASHIRE	3450	Tuesday	18/10/2011	0.058	0.812	0.87		2.00	28.01	30.02	
19	WO-02-B-0	BUSINESS PARK, REDDITCH	WORCESTERSHIRE	3525	Tuesday	2/05/2006	0.284	0.965	1.249		10.01	34.02	44.03	
17	GM-02-B-0	BUSINESS PARK, SALE	GREATER MANCHEST	3985	Tuesday	18/10/2011	0.176	1.205	1.381		7.01	48.02	55.03	
16	LN-02-B-01	BUSINESS PARK, LINCOLN	LINCOLNSHIRE	4460	Tuesday	17/05/2005	0.404	1.031	1.435		18.02	45.98	64.00	
33	KI-02-B-01	BUSINESS PARK, KINGSTON	KINGSTON	5250	Monday	19/04/2004	0.114	0.362	0.476		5.99	19.01	24.99	
24	DL-02-B-02	BUSINESS PARK, DUBLIN	DUBLIN	5985	Wednesda	12/05/2010	0.067	0.902	0.969		4.01	53.98	57.99	
18	EB-02-B-03	BUSINESS PARK, EDINBURG	CITY OF EDINBURGH	6675	Tuesday	1/05/2007	0.255	1.079	1.334		17.02	72.02	89.04	
15	NF-02-B-02	BUSINESS PARK, NORWICH	NORFOLK	7400	Thursday	17/05/2007	0.243	1.203	1.446		17.98	89.02	107.00	
2	DN-02-B-0	BUSINESS PARK, LETTERKE	DONEGAL	7951	Wednesda	30/09/2009	0.39	2.05	2.44		31.01	163.00	194.00	
11	SH-02-B-02	BUSINESS PARK, TELFORD	SHROPSHIRE	9500	Monday	22/06/2009	0.274	1.421	1.695		26.03	135.00	161.03	
7	CF-02-B-03	BUSINESS PARK, CARDIFF	CARDIFF	9520	Monday	18/10/2010	0.095	1.838	1.933	Yes	9.04	174.98	184.02	
1	CF-02-B-01	BUSINESS PARK, CARDIFF	CARDIFF	12000	Wednesda	18/10/2006	0.283	2.183	2.466		33.96	261.96	295.92	
12	BU-02-B-0	BUSINESS PARK, HIGH WYC	BUCKINGHAMSHIRE	13300	Thursday	8/07/2004	0.211	1.421	1.632		28.06	188.99	217.06	
4	SH-02-B-01	BUSINESS PARK, SHREWSB	SHROPSHIRE	17197	Tuesday	14/06/2005	0.57	1.611	2.181		98.02	277.04	375.07	
29	HE-02-B-01	BUSINESS PARK, NR HEREF	HEREFORDSHIRE	18808	Tuesday	13/09/2011	0.106	0.601	0.707		19.94	113.04	132.97	
25	WT-02-B-0	BUSINESS/TECH. PARK, AT	WESTMEATH	22150	Tuesday	19/06/2007	0.248	0.691	0.939		54.93	153.06	207.99	
14	HF-02-B-01	BUSINESS PARK, HATFIELD	HERTFORDSHIRE	26000	Monday	7/07/2008	0.219	1.277	1.496		56.94	332.02	388.96	
32	TW-02-B-0	BUSINESS PARK,NORTH SH	TYNE & WEAR	27142	Friday	10/10/2008	0.074	0.409	0.483		20.09	111.01	131.10	
30	WM-02-B-0	BUSINESS PARK, COVENTRY	WEST MIDLANDS	30042	Friday	10/02/2006	0.113	0.496	0.609		33.95	149.01	182.96	
20	TW-02-B-0	BUSINESS PARK, NEWCAST	TYNE & WEAR	38853	Thursday	11/12/2008	0.201	0.947	1.148		78.09	367.94	446.03	
28 **	GA-02-B-0	BUSINESS PARK, GALWAY	GALWAY	46175	Wednesda	20/09/2006	0.136	0.583	0.719		62.80	269.20	332.00	
5	TW-02-B-0	BUSINESS PARK, SUNDERL	TYNE & WEAR	77513	Thursday	9/10/2008	0.446	1.722	2.168	Yes	345.71	1334.77	1680.48	
22	HC-02-B-0	BUSINESS PARK, BASINGST	HAMPSHIRE	121275	Thursday	22/11/2007	0.192	0.899	1.091	Yes	232.85	1090.26	1323.11	

BUSINESS PARK WEEKDAY DAILY TRIPS

TRIP RATE for Land Use 02 - EMPLOYMENT/B - BUSINESS PARK								
Calculation Factor: 100 sqm								
Count Type: VEHICLES								
		ARRIVALS			DEPARTURES			TOTALS
	No.	Ave.	Trip	No.	Ave.	Trip	No.	Ave.
Time Range	Days	GFA	Rate	Days	GFA	Rate	Days	GFA
06:30-07:00	0	0	0	0	0	0	0	0
07:00-07:30	33	16293	0.153	33	16293	0.041	33	16293
07:30-08:00	33	16293	0.385	33	16293	0.078	33	16293
08:00-08:30	33	16293	0.574	33	16293	0.116	33	16293
08:30-09:00	33	16293	0.756	33	16293	0.136	33	16293
09:00-09:30	33	16293	0.482	33	16293	0.119	33	16293
09:30-10:00	33	16293	0.258	33	16293	0.115	33	16293
10:00-10:30	33	16293	0.166	33	16293	0.113	33	16293
10:30-11:00	33	16293	0.123	33	16293	0.111	33	16293
11:00-11:30	33	16293	0.119	33	16293	0.118	33	16293
11:30-12:00	33	16293	0.141	33	16293	0.139	33	16293
12:00-12:30	33	16293	0.151	33	16293	0.273	33	16293
12:30-13:00	33	16293	0.213	33	16293	0.227	33	16293
13:00-13:30	33	16293	0.244	33	16293	0.258	33	16293
13:30-14:00	33	16293	0.248	33	16293	0.173	33	16293
14:00-14:30	33	16293	0.147	33	16293	0.172	33	16293
14:30-15:00	33	16293	0.137	33	16293	0.161	33	16293
15:00-15:30	33	16293	0.122	33	16293	0.185	33	16293
15:30-16:00	33	16293	0.129	33	16293	0.204	33	16293
16:00-16:30	33	16293	0.113	33	16293	0.332	33	16293
16:30-17:00	33	16293	0.13	33	16293	0.44	33	16293
17:00-17:30	33	16293	0.107	33	16293	0.628	33	16293
17:30-18:00	33	16293	0.086	33	16293	0.482	33	16293
18:00-18:30	33	16293	0.062	33	16293	0.27	33	16293
18:30-19:00	33	16293	0.047	33	16293	0.136	33	16293
19:00-19:30	0	0	0	0	0	0	0	0

INDUSTRIAL ESTATES AM PEAK

RANK ORDER for Land Use 02 - EMPLOYMENT/D - INDUSTRIAL ESTATE													
Ranking Type: TOTALS Time Range: 08:00-09:00													
**85th Percentile = no. 6													
Rank	Site Ref	Description	Area	GFA	Day	Date	Arrivals	Departures	Totals	Travel Plan	Arrivals	Departures	Totals
1	EA-02-D-02	INDUSTRIAL EST., KILMARNOCK	EAST AYRSHIRE	552	Wednesday	11/06/2008	2.899	2.174	5.073		16.00	12.00	28.00
2	NY-02-D-02	INDUSTRIAL ESTATE, SHERBURN	NORTH YORKSHIRE	1197	Tuesday	19/04/2005	2.005	1.003	3.008		24.00	12.01	36.01
4	HE-02-D-02	BUSINESS PARK, HEREFORD	HEREFORDSHIRE	1758	Monday	17/10/2011	1.422	0.455	1.877		25.00	8.00	33.00
6 **	CA-02-D-02	IND. ESTATE, CAMBRIDGE	CAMBRIDGESHIRE	2063	Monday	19/10/2009	0.921	0.873	1.794		19.00	18.01	37.01
31	MS-02-D-02	INDUSTRIAL ESTATE, ST HELENS	MERSEYSIDE	2430	Tuesday	18/10/2005	0.165	0.123	0.288		4.01	2.99	7.00
21	WY-02-D-02	INDUSTRIAL ESTATE, LEEDS	WEST YORKSHIRE	4225	Tuesday	19/04/2005	0.544	0.189	0.733		22.98	7.99	30.97
16	CA-02-D-02	IND. ESTATE, PETERBOROUGH	CAMBRIDGESHIRE	4300	Tuesday	13/05/2008	0.535	0.442	0.977		23.01	19.01	42.01
5	CA-02-D-03	IND. ESTATE, PETERBOROUGH	CAMBRIDGESHIRE	4425	Thursday	22/10/2009	1.288	0.52	1.808		56.99	23.01	80.00
14	LC-02-D-04	INDUSTRIAL ESTATE, GARSTANG	LANCASHIRE	4555	Friday	16/06/2006	0.549	0.461	1.01		25.01	21.00	46.01
10	MS-02-D-02	INDUSTRIAL EST., LIVERPOOL	MERSEYSIDE	4800	Thursday	9/09/2010	0.813	0.667	1.479		39.02	32.02	71.04
8	WH-02-D-02	INDUSTRIAL ESTATE, BALHAM	WANDSWORTH	5125	Friday	13/05/2005	1.034	0.624	1.658		52.99	31.98	84.97
19	LN-02-D-02	INDUSTRIAL ESTATE, GRANTHAM	LINCOLNSHIRE	5347	Thursday	12/05/2005	0.561	0.299	0.86		30.00	15.99	45.98
9	BR-02-D-03	INDUSTRIAL ESTATE, BRISTOL	BRISTOL CITY	6000	Tuesday	20/10/2009	1.3	0.35	1.65		78.00	21.00	99.00
13	BR-02-D-02	INDUSTRIAL ESTATE, BRISTOL	BRISTOL CITY	6000	Thursday	19/11/2009	0.833	0.233	1.066		49.98	13.98	63.96
15	CW-02-D-02	INDUSTRIAL ESTATE, CAMBORNE	CORNWALL	6515	Friday	21/09/2007	0.66	0.322	0.982		43.00	20.98	63.98
7	WL-02-D-02	IND. ESTATE, WOOTTON BASSETT	WILTSHIRE	7050	Tuesday	3/10/2006	1.234	0.553	1.787		87.00	38.99	125.98
11	ES-02-D-05	IND. ESTATE, EASTBOURNE	EAST SUSSEX	7525	Monday	30/11/2009	0.837	0.372	1.209		62.98	27.99	90.98
3	NB-02-D-02	INDUSTRIAL ESTATE, HEXHAM	NORTHUMBERLAND	10525	Monday	23/05/2005	1.511	0.903	2.414		159.03	95.04	254.07
25	AR-02-D-02	INDUSTRIAL ESTATE, ARMAGH	ARMAGH	11548	Tuesday	8/06/2010	0.433	0.121	0.554		50.00	13.97	63.98
22	DH-02-D-02	INDUSTRIAL ESTATE,NR CONSETT	DURHAM	12025	Wednesday	27/04/2005	0.491	0.125	0.616		59.04	15.03	74.07
23	CB-02-D-03	INDUSTRIAL ESTATE, BRAMPTON	CUMBRIA	13700	Thursday	23/06/2005	0.409	0.161	0.57		56.03	22.06	78.09
24	CB-02-D-04	INDUSTRIAL ESTATE, BRAMPTON	CUMBRIA	17708	Wednesday	16/12/2009	0.367	0.203	0.57		64.99	35.95	100.94
32	WY-02-D-02	INDUSTRIAL EST., HUDDERSFIELD	WEST YORKSHIRE	20824	Monday	11/09/2006	0.221	0.048	0.269		46.02	10.00	56.02
17	CH-02-D-02	INDUSTRIAL EST., NORTHWICH	CHESHIRE	22000	Friday	15/06/2007	0.677	0.223	0.9		148.94	49.06	198.00
28	TW-02-D-02	INDUSTRIAL ESTATE, N. SHIELDS	TYNE & WEAR	23000	Thursday	19/10/2006	0.252	0.191	0.443		57.96	43.93	101.89
27 **	NT-02-D-02	IND. ESTATE, SUTTON-IN-ASHFLD	NOTTINGHAMSHIRE	26400	Friday	30/06/2006	0.295	0.163	0.458		77.88	43.03	120.91
20	EX-02-D-02	INDUSTRIAL ESTATE, LOUGHTON	ESSEX	27687	Thursday	22/11/2007	0.65	0.116	0.766		179.97	32.12	212.08
12	HI-02-D-03	IND. EST./BUS.PK., FT. WILLIAM	HIGHLAND	35000	Monday	18/05/2009	0.777	0.414	1.191		271.95	144.90	416.85
18	CW-02-D-02	IND. ESTATE, NEAR PENZANCE	CORNWALL	36500	Monday	3/10/2011	0.529	0.359	0.888		193.09	131.04	324.12
30	DS-02-D-02	IND. ESTATE,SOUTH NORMANTON	DERBYSHIRE	92286	Tuesday	15/06/2004	0.218	0.094	0.312		201.18	86.75	287.93
26	SF-02-D-02	INDUSTRIAL ESTATE, IPSWICH	SUFFOLK	102000	Tuesday	22/05/2007	0.309	0.184	0.493		315.18	187.68	502.86
29	DL-02-D-02	INDUSTRIAL ESTATE, DUBLIN	DUBLIN	120000	Tuesday	26/06/2007	0.234	0.087	0.321		280.80	104.40	385.20

INDUSTRIAL ESTATES PM PEAK

RANK ORDER for Land Use 02 - EMPLOYMENT/D - INDUSTRIAL ESTATE													
Ranking Type: TOTALS Time Range: 16:00-17:00													
**85th Percentile = no. 6													
Rank	Site Ref	Description	Area	GFA	Day	Date	Arrivals	Departures	Totals	Travel Plan	Arrivals	Departures	Totals
1	EA-02-D-02	INDUSTRIAL EST., KILMARNOC	EAST AYRSHIRE	552	Wednesday	11/06/2008	2.174	1.812	3.986		12.00	10.00	22.00
5	NY-02-D-01	INDUSTRIAL ESTATE, SHERBURNE	NORTH YORKSHIRE	1197	Tuesday	19/04/2005	1.003	1.253	2.256		12.01	15.00	27.00
3	HE-02-D-01	BUSINESS PARK, HEREFORD	HEREFORDSHIRE	1758	Monday	17/10/2011	0.569	2.105	2.674		10.00	37.01	47.01
2	CA-02-D-02	IND. ESTATE, CAMBRIDGE	CAMBRIDGESHIRE	2063	Monday	19/10/2009	1.212	1.551	2.763		25.00	32.00	57.00
12	MS-02-D-01	INDUSTRIAL ESTATE, ST HELEN	MERSEYSIDE	2430	Tuesday	18/10/2005	0.453	0.658	1.111		11.01	15.99	27.00
17	WY-02-D-01	INDUSTRIAL ESTATE, LEEDS	WEST YORKSHIRE	4225	Tuesday	19/04/2005	0.308	0.568	0.876		13.01	24.00	37.01
10	CA-02-D-01	IND. ESTATE, PETERBOROUGH	CAMBRIDGESHIRE	4300	Tuesday	13/05/2008	0.442	0.698	1.14		19.01	30.01	49.02
6 **	CA-02-D-03	IND. ESTATE, PETERBOROUGH	CAMBRIDGESHIRE	4425	Thursday	22/10/2009	0.497	0.927	1.424		21.99	41.02	63.01
14	LC-02-D-04	INDUSTRIAL ESTATE, GARSTAN	LANCASHIRE	4555	Friday	16/06/2006	0.351	0.703	1.054		15.99	32.02	48.01
22	MS-02-D-01	INDUSTRIAL EST., LIVERPOOL	MERSEYSIDE	4800	Thursday	9/09/2010	0.208	0.458	0.666		9.98	21.98	31.97
9	WH-02-D-01	INDUSTRIAL ESTATE, BALHAM	WANDSWORTH	5125	Friday	13/05/2005	0.624	0.663	1.287		31.98	33.98	65.96
23	LN-02-D-01	INDUSTRIAL ESTATE, GRANTHAM	LINCOLNSHIRE	5347	Thursday	12/05/2005	0.374	0.224	0.598		20.00	11.98	31.98
11	BR-02-D-03	INDUSTRIAL ESTATE, BRISTOL	BRISTOL CITY	6000	Tuesday	20/10/2009	0.317	0.817	1.134		19.02	49.02	68.04
18	BR-02-D-02	INDUSTRIAL ESTATE, BRISTOL	BRISTOL CITY	6000	Thursday	19/11/2009	0.217	0.633	0.85		13.02	37.98	51.00
7	CW-02-D-01	INDUSTRIAL ESTATE, CAMBORNE	CORNWALL	6515	Friday	21/09/2007	0.645	0.691	1.336		42.02	45.02	87.04
8	WL-02-D-01	IND. ESTATE, WOOTTON BASSETT	WILTSHIRE	7050	Tuesday	3/10/2006	0.525	0.78	1.305		37.01	54.99	92.00
15	ES-02-D-05	IND. ESTATE, EASTBOURNE	EAST SUSSEX	7525	Monday	30/11/2009	0.346	0.611	0.957		26.04	45.98	72.01
4	NB-02-D-01	INDUSTRIAL ESTATE, HEXHAM	NORTHUMBERLAND	10525	Monday	23/05/2005	1.036	1.501	2.537		109.04	157.98	267.02
29	AR-02-D-01	INDUSTRIAL ESTATE, ARMAGH	ARMAGH	11548	Tuesday	8/06/2010	0.13	0.286	0.416		15.01	33.03	48.04
16	DH-02-D-01	INDUSTRIAL ESTATE, NR CONSIDER	DURHAM	12025	Wednesday	27/04/2005	0.166	0.79	0.956		19.96	95.00	114.96
30	CB-02-D-03	INDUSTRIAL ESTATE, BRAMPTON	CUMBRIA	13700	Thursday	23/06/2005	0.175	0.19	0.365		23.98	26.03	50.01
24	CB-02-D-04	INDUSTRIAL ESTATE, BRAMPTON	CUMBRIA	17708	Wednesday	16/12/2009	0.232	0.361	0.593		41.08	63.93	105.01
26	WY-02-D-01	INDUSTRIAL EST., HUDDERSFIELD	WEST YORKSHIRE	20824	Monday	11/09/2006	0.144	0.37	0.514		29.99	77.05	107.04
21	CH-02-D-02	INDUSTRIAL EST., NORTHWICH	CHESHIRE	22000	Friday	15/06/2007	0.236	0.468	0.704		51.92	102.96	154.88
25	TW-02-D-01	INDUSTRIAL ESTATE, N. SHIELDS	TYNE & WEAR	23000	Thursday	19/10/2006	0.139	0.383	0.522		31.97	88.09	120.06
28	NT-02-D-01	IND. ESTATE, SUTTON-IN-ASHFORD	NOTTINGHAMSHIRE	26400	Friday	30/06/2006	0.144	0.28	0.424		38.02	73.92	111.94
19	EX-02-D-01	INDUSTRIAL ESTATE, LOUGHTON	ESSEX	27687	Thursday	22/11/2007	0.188	0.643	0.831		52.05	178.03	230.08
13	HI-02-D-03	IND. EST./BUS.PK., FT. WILLIAM	HIGHLAND	35000	Monday	18/05/2009	0.494	0.594	1.088		172.90	207.90	380.80
20	CW-02-D-01	IND. ESTATE, NEAR PENZANCE	CORNWALL	36500	Monday	3/10/2011	0.31	0.499	0.809		113.15	182.14	295.29
32	DS-02-D-01	IND. ESTATE, SOUTH NORMAN	DERBYSHIRE	92286	Tuesday	15/06/2004	0.088	0.177	0.265		81.21	163.35	244.56
27 **	SF-02-D-02	INDUSTRIAL ESTATE, IPSWICH	SUFFOLK	102000	Tuesday	22/05/2007	0.18	0.287	0.467		183.60	292.74	476.34
31	DL-02-D-03	INDUSTRIAL ESTATE, DUBLIN	DUBLIN	120000	Tuesday	26/06/2007	0.118	0.246	0.364		141.60	295.20	436.80

Site No.	Land Use Group	Land Use Activity (Primary)	Land Use Activity (Description)	Date of Survey	Time of Survey	Day of Survey	GFA (m ²)	Site Area (m ²)	Employees	Parking Spaces Provided On-site	Other Parking Spaces Available On-street and Off-site	MAX ON-SITE PARKING DEMAND	MAX OFF-SITE PARKING DEMAND	(at time)	PEAK TOTAL PARKING DEMAND RATES			TRIP GENERATION RATES								
															GFA (spaces/ 100m ² GFA)	SITE AREA (spaces/ 100m ² SA)	EMPLOYEES (spaces/emp)	GFA (IN+OUT) (vph or vpd/100m ² GFA)			SITE AREA (IN+OUT) (vph or vpd/100m ² SA)			EMPLOYEES (IN+OUT) (vph or vpd/Emp)		
																		AM	PM	DAILY	AM	PM	DAILY	AM	PM	DAILY
7	Industry	Storage					26153		132	180		202		1030	0.77		1.53	0.60	0.17	2.47				1.19	0.33	4.89
11	Industry	Manufacturing		14/04/1992	0800-1600	Tuesday	1617	4906	30	40		34		1000	2.10	0.69	1.13	3.28	2.91	27.03	1.08	0.96	8.91	1.77	1.57	14.57
13	Industry	Manufacturing		26/03/1993	0800-1600	Friday	2956		44	91		112		1545	3.79		2.55	1.12	6.02	38.94				0.75	4.05	26.16
14	Industry	Storage		24/06/1992	0800-1600	Wednesday	3550	4243	120	82		52		0945	1.46	1.23	0.43	3.66	3.04	22.14	3.06	2.55	18.52	1.08	0.90	6.55
81	Industry	Storage		18/01/1993	0900-1700	Monday	3410		79	112		68		1500	1.99		0.86		3.81	31.03					1.65	13.39
86	Industry	Manufacturing		25/01/1994	0900-1600	Tuesday	4127		36	17		17		1415	0.41		0.47		1.33	8.31					1.53	9.53
115	Industry	Storage		28/08/1998	24hr	Friday	79600	206000										1.19	1.34	13.31	0.46	0.52	5.14			
150	Industry	Manufacturing		6/05/1998	0745-0845, 1630-1730	Wednesday		625000													0.29	0.29				
359	Industry	Contractor		18/06/1995			11000	22600		480	20	500			4.55	2.21		2.64	2.36		1.28	1.15				
448	Industry	Manufacturing		3/04/1995	0.5	Mon	62000	250000		700		264		12:00	0.43	0.11										
449	Industry	Manufacturing		3/04/1995	0.5	Mon	9600	20000		130		108		12:00	1.13	0.54										
452	Industry	Manufacturing		3/04/1995	0.5	Mon	25000	48000		92		92	44	12:00	0.54	0.28										
486	Industry	Industrial Park	Light/Medium	27/10/2004	7:00-8:00 12:00-1:00	see notes		171,000													0.16	0.14				
487	Industry	Industrial Park	Medium/Heavy	25/10/2004	9:00-10:00 4:00-5:00	see notes		77,000													0.26	0.29				
507	Industry	Storage		28/01/2005	8:00-17:30	Friday	4700	10000		100		8		9:00	0.17	0.08		0.34	0.30	1.74	0.16	0.14	0.82			
508	Industry	Storage		23/04/2005	unknown	Saturday	4700	10000		100		9		10:00	0.19	0.09		0.28			0.13					
550	Industry	Storage		13/09/2007	16:00-17:00	Thursday	10062	23490		160	35								0.93			0.40				
551	Industry	Storage		28/09/2007	14:15-17:00	Friday	10062	23489		159	35			1520					0.67			0.29				
552	Industry	Manufacturing		19/09/2007	15:00-17:30	Wednesday	4960	9799		40	6	31		15:51	0.63	0.32				1.07			0.54			
553	Industry	Commercial		19/09/2007	15:00-17:30	Wednesday	7400	10249		101	19	85		15:33	1.15	0.83				2.97			2.15			
554	Industry	Contractor		17/09/2007	14:30-16:30	Monday	1093	1188	2	6	2	5		15:58	0.46	0.42	2.50		0.09			0.08			0.50	
555	Industry	Contractor		17/09/2007	14:30-16:30	Monday	160	1832	8	4	1	3		15:05	1.88	0.16	0.38		1.88			0.16			0.38	
556	Industry	Manufacturing		17/09/2007	14:30-16:30	Monday	240	827	8	1	1	1		15:30	0.42	0.12	0.13		0.42			0.12			0.13	
558	Industry	Manufacturing		17/09/2007	14:30-16:30	Monday	301	560	15	6	3	8		15:10	2.66	1.43	0.53		1.33			0.71			0.27	
559	Industry	Contractor		17/09/2007	14:30-16:30	Monday	100	877	2	12	2	10		15:50	10.00	1.14	5.00		6.00			0.68			3.00	
560	Industry	Contractor		17/09/2007	14:30-16:30	Monday	1093	1188	5	11	2	10		15:00	0.91	0.84	2.00		0.46			0.42			1.00	
561	Industry	Contractor		17/09/2007	14:30-16:30	Monday	3160	7713	8	48	5	25		15:10	0.79	0.32	3.13		0.73			0.30			2.88	
562	Industry	Storage		20/09/2007	14:30-17:30	Thursday	792	1589	8	8	3	4		15:15	0.51	0.25	0.50		1.01			0.50			1.00	

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															GFA (spaces/ 100m2 GFA)	SITE AREA (spaces/ 100m2 SA)	EMPLOYEES (spaces/emp)	GFA (IN+OUT) (vph or vpd/100m2 GFA)			SITE AREA (IN+OUT) (vph or vpd/100m2 SA)			EMPLOYEES (IN+OUT) (vph or vpd/Emp)		
																		AM	PM	DAILY	AM	PM	DAILY	AM	PM	DAILY
563	Industry	Storage		20/09/2007	14:30-17:30	Thursday	1416	2139	11	10	5	5		15:50	0.35	0.23	0.45		0.71			0.47			0.91	
564	Industry	Storage		20/09/2007	14:30-17:30	Thursday	646	1700	14	20	5	7		14:45	1.08	0.41	0.50		2.32			0.88			1.07	
565	Industry	Storage		20/09/2007	14:30-17:30	Thursday	1174	1201	11	28	5	4		15:55	0.34	0.33	0.36		0.85			0.83			0.91	
566	Industry	Contractor		20/09/2007	14:30-17:30	Thursday	158	2381	6	12	5	2		16:21	1.27	0.08	0.33		8.23			0.55			2.17	
567	Industry	Manufacturing		20/09/2007	14:30-17:30	Thursday	1570	2839	16	12	9	10		14:50	0.64	0.35	0.63		1.34			0.74			1.31	
568	Industry	Storage		20/09/2007	14:30-17:30	Thursday	6677	8970	25	36	8	19		15:20	0.28	0.21	0.76		0.58			0.43			1.56	
569	Industry			21/09/2007	14:00-16:15	Friday	19800	50900	454	283	30	200		17:00	1.01	0.39	0.44		0.51			0.20			0.22	
570	Industry	Storage		14/09/2007	14:20-16:50	Friday	900	2245	15-20	16	up to 30	15		14:36	1.67	0.67			0.67			0.27				
571	Industry	Storage		14/09/2007	14:20-16:50	Friday	900	2245	25-35	30	up to 30	18		15:14	2.00	0.80			0.89			0.36				
572	Industry	Commercial		14/09/2007	14:20-16:50	Friday	860	1800	10-15	12	up to 30	6		14:20	0.70	0.33			0.58			0.28				
573	Industry	Manufacturing		14/09/2007	14:20-16:50	Friday	1250	4821	05-15	20	up to 30	9		15:59	0.72	0.19			0.24			0.06				
574	Industry	Manufacturing		14/09/2007	14:20-16:50	Friday	1050	1887	15-25	19	up to 30	10		15:59	0.95	0.53			0.67			0.37				
575	Industry	Manufacturing & Commercial		14/09/2007	14:20-16:50	Friday	2020	3976	20-35	25	up to 30	19		15:31	0.94	0.48			1.04			0.53				
576	Industry	Storage & Office & Electrician		14/09/2007	14:20-16:50	Friday	1800	3962	25-40	33	up to 30	14		16:09	0.78	0.35			1.06			0.48				
578	Industry	Transport		14/09/2007	14:20-16:50	Friday	420	880	05-15	5	up to 30	4		14:59	0.95	0.45			2.38			1.14				
579	Industry	Manufacturing		14/09/2007	14:20-16:50	Friday	420	1015	5-10	8	up to 30	8		15:48	1.90	0.79			2.86			1.18				
580	Industry	Storage		14/09/2007	14:20-16:50	Friday	1330	2962		6				14:32					0.30			0.14				
581	Industry	Manufacturing		14/09/2007	14:20-16:50	Friday	800	1889	05-15	7	up to 30	1		14:35	0.13	0.05			0.75			0.32				
582	Industry	Storage		14/09/2007	14:20-16:50	Friday	30	68		1	up to 30	1		15:51	3.33	1.47			6.67			2.94				
583	Industry	Storage		27/09/2007	14:00-17:30	Thursday	1306	2325			15								0.15			0.09				
584	Industry	Storage		27/09/2007	14:00-17:30	Thursday	800	2245			6								0.13			0.04				
586	Industry	Storage		27/09/2007	14:00-17:30	Thursday	860	4821			9								0.23			0.04				
587	Industry	Commercial		27/09/2007	14:00-17:30	Thursday	1170	1887			32								0.17			0.11				
588	Industry	Manufacturing		27/09/2007	14:00-17:30	Thursday	1050	3967			15								0.48			0.13				
590	Industry	Storage		27/09/2007	14:00-17:30	Thursday	1810	1288			41								0.66			0.93				
592	Industry	Commercial		27/09/2007	14:00-17:30	Thursday	420	1015			8								0.95			0.39				
593	Industry	Manufacturing		27/09/2007	14:00-17:30	Thursday	420	2963			8								2.62			0.37				
594	Industry	Storage		27/09/2007	14:00-17:30	Thursday	1463	1669											0.27			0.24				
649	Industry	Storage		2/04/2009	7:00-18:00	Thursday		112100														0.09	0.65			
657	Industry	Industrial Park	Medium/Heavy	Week beginning 13-06-05			71,000	237,000											0.51	0.43	5.58	0.15	0.13	1.67		
658	Industry	Industrial Park	Light/Medium	Week beginning 9-06-05			42,100	127,000											1.04	1.30	11.05	0.34	0.43	3.66		
659	Industry	Industrial Park	Medium/Heavy	Week beginning 13-06-05			76,100	588,000											1.04	1.14	11.19	0.13	0.15	1.45		
671	Industry	Storage		20/09/2007	05:00-18:00	Thursday	6,650												1.17	0.47						
672	Industry			12/02/2008	14:00-15:00	Tuesday	20,570		202	195		131		14:20	0.64		0.65		0.55						0.56	