

## The Influence of Trends in Heavy Vehicle Travel on Road Trauma in the Light Vehicle Fleet.

Delaney, A. & Newstead, S.  
*Monash University Accident Research Centre*

### ABSTRACT

Increased travel by heavy vehicles (rigid trucks, articulated trucks and buses) has been identified as one of the key components of total growth in vehicle travel over the next ten years. This paper examines the effect of anticipated growth in heavy vehicle travel on the light passenger vehicle fleet by measuring changes in road trauma levels as measured by the number of light vehicle driver fatalities and serious injuries resulting from collisions with heavy vehicles. Using data sourced primarily from the BTRE, the ABS and NSW Police reported crash database, a model to project relevant future trends in road trauma is developed to reflect three key elements of the road trauma chain: exposure, crash risk and injury outcome given crash involvement. In addition to the specific results presented in this study, the model developed may be used to assess the likely impact of proposed policy changes on heavy vehicle related road trauma. Future heavy vehicle related road trauma trends are projected based on two scenarios of future crash risk. The results demonstrate the sensitivity of heavy vehicle related road trauma to crash risk and highlight the importance of continuing to reduce heavy vehicle crash rates to offset projected growth in heavy vehicle travel and deliver reductions in heavy vehicle related road trauma. A potential remedy to predicted increases in heavy vehicle related trauma is explored and demonstrates the application of the model as a policy evaluation tool.

### INTRODUCTION

Increased travel by heavy vehicles has been identified as one of the key components of total growth in vehicle travel over the next ten years. Given the obvious incompatibility between heavy vehicles and the light passenger vehicle fleet in crash situations, the anticipated rise in heavy vehicle travel raises questions about the likely impact on road trauma levels should the anticipated increases be realised. This study aims to examine the effect of anticipated growth in heavy vehicle travel on the light passenger vehicle fleet by measuring changes in road trauma levels as measured by the number of light vehicle driver fatalities and serious injuries resulting from collisions with heavy vehicles. The influence of heavy vehicle travel on other road users such as passengers of light passenger vehicles, pedestrians, bicyclists, motorcyclists or heavy vehicle occupants themselves is not considered.

The factors that influence light passenger vehicle road trauma associated with heavy vehicle travel include: growth in heavy vehicle transport and the area of that growth (i.e. metropolitan or non-metropolitan), the relative seriousness of outcomes in passenger vehicle collisions with the three heavy vehicle types, differences between crash outcomes in metropolitan and non-metropolitan areas and changes in heavy vehicle crash rates due to improved safety of both vehicle and non-vehicle infrastructure. The influence of each of these factors is considered in the model used to estimate light passenger vehicle road trauma levels.

### DATA

Reflecting the detail available in the data for analysis, heavy vehicles were defined in three classes: articulated trucks, rigid trucks and buses. Data detailing the nature and extent of travel undertaken by these vehicle types and the frequency of crashes in which they are involved are derived from three sources. The Bureau of Transport and Regional Economics (BTRE) provided MUARC with updated estimates of national vehicle kilometres travelled by commercial vehicles (including buses) separately for metropolitan and non-metropolitan areas for the period 1990 to 2004 (BTRE, 2005).

For the period 2005 to 2020 forecasts of travel by each of the heavy vehicles types produced by the BTRE were provided both in aggregate and according to the area of travel (i.e. metropolitan vs. non-metropolitan travel). Details of the forecasting methods and changes to estimated growth in total annual vehicle kilometres are provided in BTRE (2002) and BTRE (2005).

The Australian Bureau of Statistics (ABS) Surveys of Motor Vehicle Use provided data detailing the extent of travel undertaken by articulated and rigid trucks for the years 1998 to 2003. Average annual vehicle kilometres travelled by vehicle type and average annual tonne kilometres by vehicle type were relevant to this study. These data were used to calculate the average load carried by articulated and rigid trucks. NSW Police reported crash data covering crashes resulting in death, serious injury, injury or a vehicle being towed away (i.e. all reportable crashes) between 1990 and 2003 were used in conjunction with vehicle information supplied by NSW RTA to estimate the frequency of collisions between light passenger vehicles and articulated trucks, rigid trucks or buses. The data also generates the distribution of heavy vehicle crashes by the opposing light passenger vehicle market group. Full details of the data used are provided in Newstead et al (2005). This data was also used in associated work to produce revised estimates of the crashworthiness of passenger vehicles by market group in collisions with each heavy vehicle type (Delaney et al., 2006). These aggressivity estimates measure the risk of death or serious injury to a driver of a light passenger vehicle from a given market group when colliding with a given heavy vehicle type. These estimates were produced for all crashes, for crashes occurring in metropolitan areas only and for crashes occurring in non-metropolitan areas only.

Finally, monthly distillate fuel sales data for the period 1991 to 2004 provided for each State and Territory by the Federal Department of Industry, Science and Resources was used to scale NSW crash data to generate estimates of national heavy vehicle crashes.

## MODEL INPUTS

Historical trends in heavy vehicle travel and crashes were important inputs into the model of total road trauma. Figure 1 below plots total national vehicle kilometres travelled (VKT) over the period 1990 to 2004 using data supplied by the BTRE. In the early 1990s, there was a period of decline in total annual travel by both rigid trucks and buses, most likely associated with the economic recession at the time. Travel by articulated trucks remained stable over this period. Over the next decade, travel across all heavy vehicle classes increased steadily although the rate of growth varied across vehicle types. This upward trend in heavy vehicle travel represents an increase in exposure to crash risk.

Figure 1. Total national vehicle kilometres travelled (billion km)

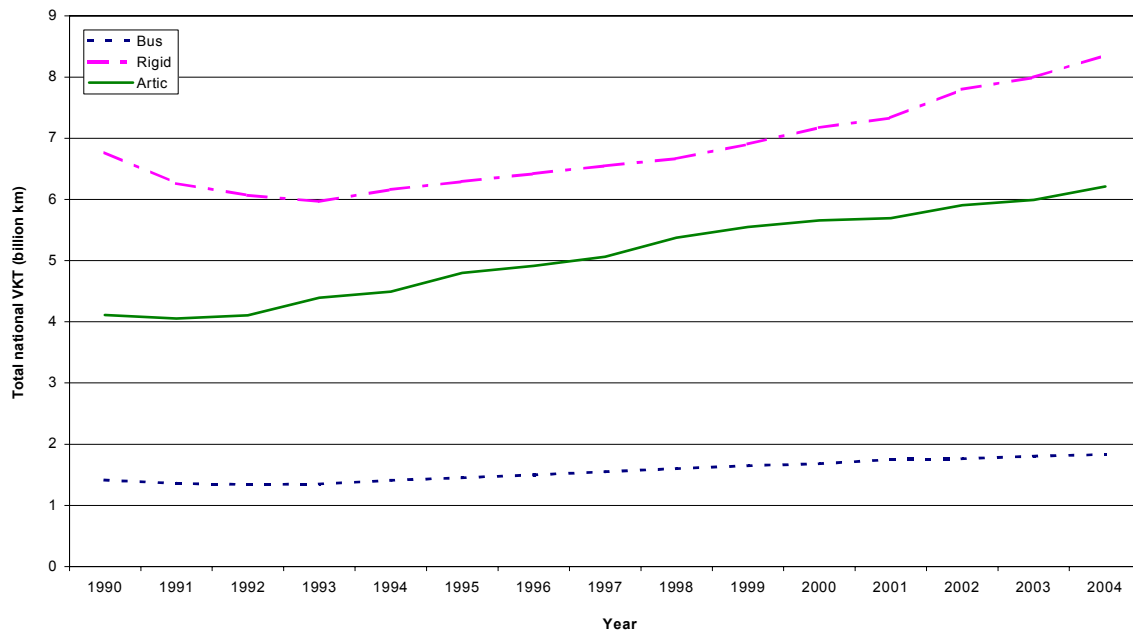
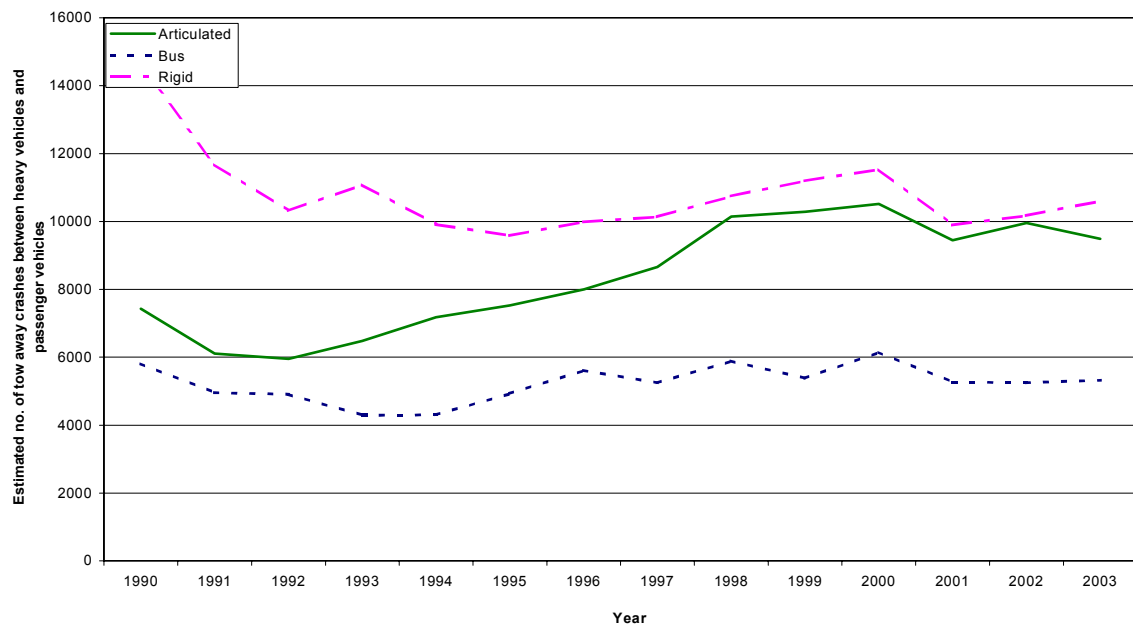


Figure 2 below plots the estimated number of reportable crashes between heavy and light passenger vehicles occurring nationally over the period 1990 to 2003. The data presented is derived from NSW Police reported crash data and scaled to represent the national situation. It is necessary to use NSW data as it is the only available data that classifies heavy vehicles into the categories of interest and provides a consistent time series of data on both injury and non-injury crashes over an extended time period.

Figure 2. Estimated national number of reportable crashes between heavy vehicles and passenger vehicles.



Estimates of vehicle kilometres travelled and heavy vehicle to light passenger vehicle crash frequency are also available by the region of travel/crash. These data are used to estimate average total, metropolitan and non-metropolitan crash rates for the period 1998 to 2003 for articulated trucks, buses and rigid trucks presented in Table 1 below.

Table 1. Average heavy vehicle crash rates per million vehicle kilometres travelled in metropolitan and non-metropolitan areas (1998-2003)

Heavy Vehicle Type	Metropolitan Crash Rate (a)	Non-metropolitan Crash Rate (b)	Relative Difference (a)/(b)	Total (c)
Articulated Trucks	5.76	0.87	6.62	1.75
Buses	6.57	0.52	12.63	3.26
Rigid Trucks	2.04	0.74	2.76	1.47

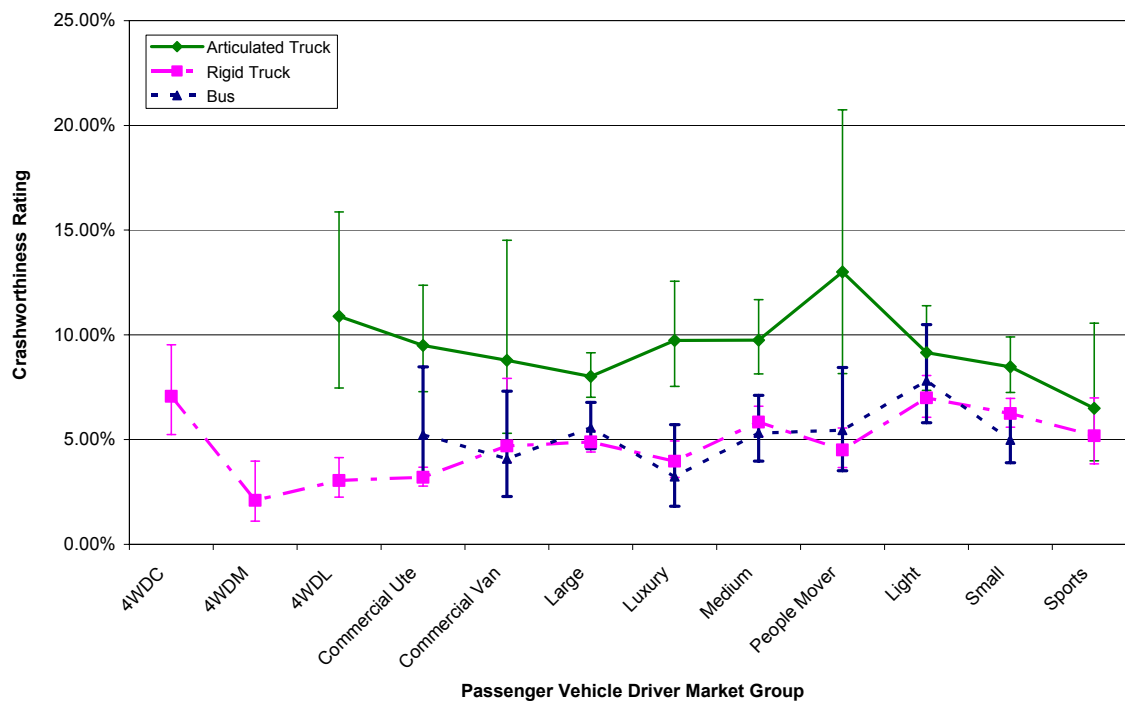
The greatest disparity between metropolitan and non-metropolitan crash rates exists for buses, followed by articulated trucks and rigid trucks. In metropolitan areas, buses have the highest crash rate followed by articulated trucks and rigid trucks whereas in non-metropolitan areas rigid trucks have the highest estimated crash rate followed by articulated trucks and buses. As these crash rates refer to collisions with light passenger vehicles only, potential explanations for the variations in the crash rates include differences in exposure to the light passenger vehicle fleet. Whilst this and other causes are not considered in detail in this study, investigation of these issues may act to validate the estimated heavy vehicle crash rates.

#### *Crashworthiness*

The risk of death or serious injury to light passenger vehicle drivers in collisions with heavy vehicles (vehicle crashworthiness) will also influence the safety impact of future growth in heavy vehicle travel. Crashworthiness of light passenger vehicles in collisions with heavy vehicles by light vehicle market group and heavy vehicle class have been estimated by Newstead et al., 2004 using crash data to the end of 2002. These crashworthiness ratings have been updated for this study based on police reported crash data to the end of 2003. Figure 3 charts the estimated crashworthiness rating of light passenger vehicles by market group in collisions with each of the three heavy vehicle types. The crashworthiness estimates represent the risk of death or serious injury to a light passenger vehicle driver in a collision with the given heavy vehicle type. Ninety-five percent confidence limits are also given on each rating. Ratings were not estimated for some combinations due to insufficient crash data although this was not considered a problem for the study since crashes involving these vehicle combinations are relatively rare.

The risk to passenger vehicle drivers differs by both passenger vehicle market groups and the type of heavy vehicle involved. Articulated trucks, pose the greatest risk of death or serious injury to drivers of all passenger vehicle types for which estimates could be obtained. However, for crashes involving articulated trucks, statistically significant differences in the risk to drivers of the various passenger vehicle market groups could not be identified. It is noted that, as far as possible, these estimates of crashworthiness have been adjusted for factors other than vehicle type that may influence injury outcome. These factors include the speed zone of the crash location which is intended to act as a proxy for the crash location (metropolitan/non-metropolitan). The use of proxy measures offers the only opportunity to account for potential differences by crash location. However, this approach has not been validated. Drivers of passenger vehicles colliding with rigid trucks and buses experience a similar rate of death and serious injury, however, the risk does differ according to the market group of the passenger vehicle. At particular risk are drivers of compact 4WDs, light passenger cars and small passenger cars. At significantly lower risk in collisions with rigid trucks are drivers of medium or large 4WDs and commercial utilities.

Figure 3. Crashworthiness by light passenger vehicle market group and heavy vehicle collision partner.



## METHOD

### *Estimating a base level of road trauma*

Using data from 1998 to 2003 the following three stages were used to determine the base level of road trauma related to heavy vehicle travel. The same approach was adopted to estimate road trauma levels in metropolitan and non-metropolitan areas respectively using data specific to these areas.

First, the total crash numbers involving each type of heavy vehicle on a national basis were estimated according to Equation 1.

$$\text{No. of national heavy vehicle crashes}_j = \text{NSW heavy vehicle crashes}_j / 0.292 \quad \dots \text{Eqn 1.}$$

where  $j$  is the heavy vehicle type.

National data on the number of reportable crashes involving heavy vehicles were not available. Therefore, NSW Police reported crash data, merged with vehicle identification data, was used to provide total reported crashes involving heavy vehicles in NSW over the relevant period. National distillate fuel sales data were used as a proxy for vehicle travel to determine the average proportion of national travel represented by NSW (29.2%). The NSW crash numbers were adjusted upwards using this proportion to provide estimates of national reportable crashes occurring between 1998 and 2003. Adopting this approach assumed that heavy vehicle exposure does not differ significantly across Australian States and Territories.

The second stage determined the distribution of heavy vehicle crashes by the passenger vehicle collision partner and estimated the number of light vehicle driver casualties involved in each collision type. The distribution of heavy vehicle crashes by the light passenger vehicle collision partner was calculated as the average proportion of all heavy vehicle to light passenger vehicle collisions occurring in each heavy vehicle crash configuration (e.g. rigid truck vs large passenger car) for the period 1998 to 2003 derived from the NSW heavy vehicle crash data. Total crashes involving the relevant heavy vehicle type were then multiplied by these proportions to estimate the number of drivers involved in each collision type in each year.

The final stage used estimates of crashworthiness by heavy vehicle and light passenger vehicle market group to calculate fatalities and serious injuries resulting from heavy vehicle crashes. This process is described in Equation 2 below. Where crashworthiness estimates were not able to be estimated due to insufficient data, raw data on the number of fatalities and serious injuries per 100 crash involvements were used as a proxy for crashworthiness. Again, this was not expected to affect model robustness given the relatively small number of crashes with these configurations.

$\text{No. of fatalities and serious injuries}_i = CWR_i \times \text{No. of involved drivers}_i$ <p>where <math>i</math> is the crash configuration.</p>	...Eqn 2.
---	-----------

### Forecasting levels of road trauma

The BTRE provided forecasts of increases in heavy vehicle travel but not heavy vehicle crashes. However, using data from previous years it was possible to calculate annual heavy vehicle crash rates and apply these to forecasted travel to estimate the number of future crashes involving each heavy vehicle type. The crash rate per million vehicle kilometres travelled for each year between 1998 and 2003 was calculated according to Equation 3.

$\text{Crash rate}_j (\text{per million vkt}) = \text{No. of national heavy vehicle crashes}_j \div \text{Million vkt}_j$ <p>where <math>j</math> is the heavy vehicle type</p>	...Eqn 3.
---	-----------

Equation 3 was used to calculate an individual crash rate for each year of the period 1998 to 2003. In applying a crash rate to future heavy vehicle travel a decision had to be made about which crash rate to use. Two alternatives are presented in this paper. The first used crash rates for the period 1998 to 2003 to forecast crash rates for 2004 to 2010 using a linear trend. The second assumed that the crash rate remains stable at the 2003 levels over the period 2004 to 2010. This produced two alternative forecasts of heavy vehicle crash numbers generated by multiplying the crash rate by forecast vehicle kilometres travelled. Having estimated the number of each heavy vehicle crash type for 2004 to 2010, steps two and three detailed above were applied to each of the years in the forecast period. The same approach was also adopted to estimate future road trauma levels in metropolitan and non-metropolitan areas respectively using data specific to these areas.

## RESULTS

### *Forecast heavy vehicle travel*

Data from the BTRE was used to provide information on the forecast level of vehicle travel for the period 2004 to 2010. Figure 4 below plots estimated vehicle kilometres travelled by each of the three heavy vehicle types across all areas. Historical data from 1998 to 2003 is included in each of the charts to provide some context for the forecasts.

Figure 4. *BTRE national forecast of billion vehicle kilometres travelled (2004-2010) by heavy vehicles.*

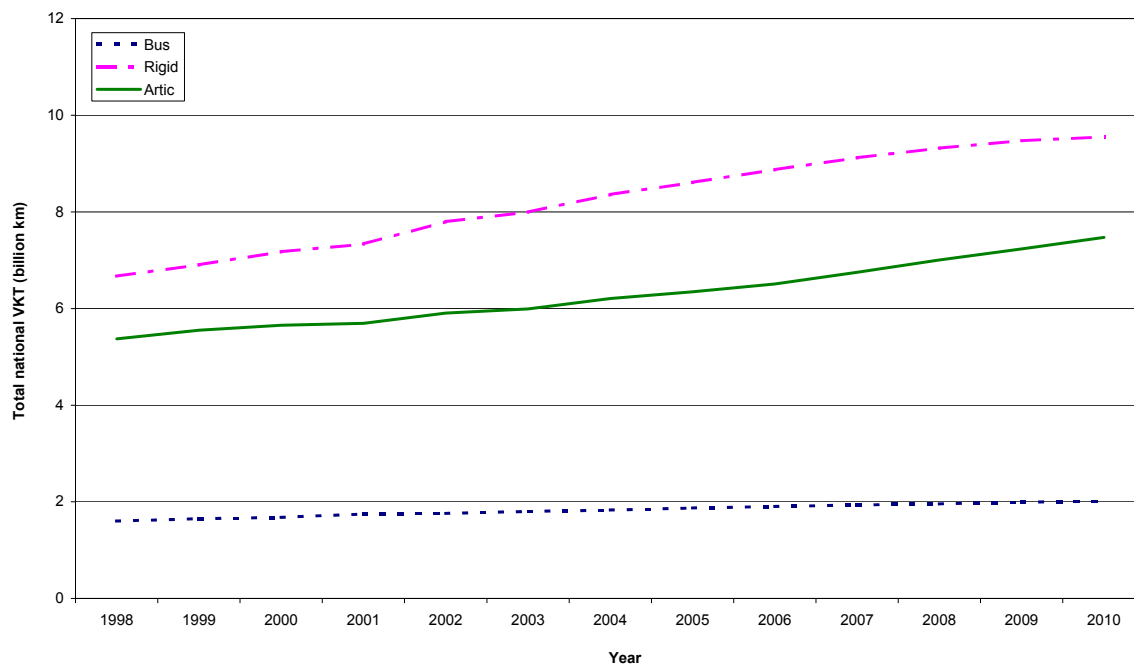


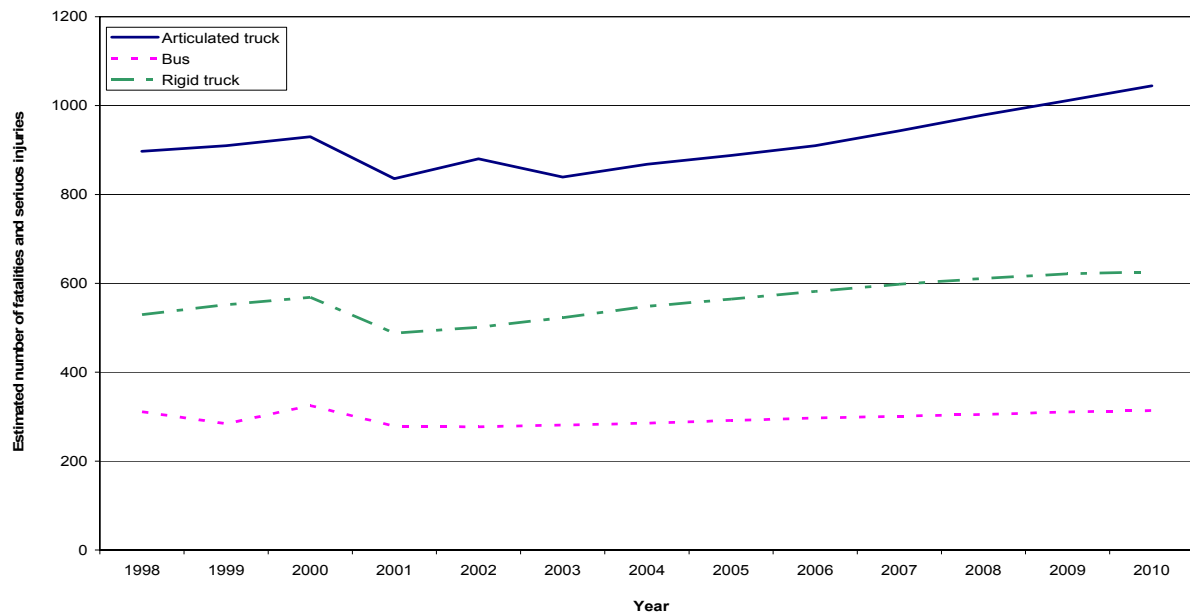
Figure 4 shows that there is expected to be substantial growth in rigid and articulated travel and modest growth in bus travel over the forecast period. Although not shown here, rigid trucks are expected to experience the most travel with the majority of travel being completed in metropolitan areas. Further, growth in rigid truck travel is expected to be greatest in metropolitan areas. In contrast, articulated truck travel is predicted to increase most in non-metropolitan areas.

#### *Forecast road trauma levels*

Two scenarios for forecasting future road trauma levels were investigated. The first applies the 2003 crash rate to future years whilst the second assumes a linear trend in crash rates over the forecast period. The resulting estimates of road trauma differ according to the crash rates applied and when viewed together provide a range of potential future road trauma levels. Figures 5 and 6 plot estimated national fatalities and serious injuries resulting from collisions between heavy vehicles and passenger vehicles between 1998 and 2010.

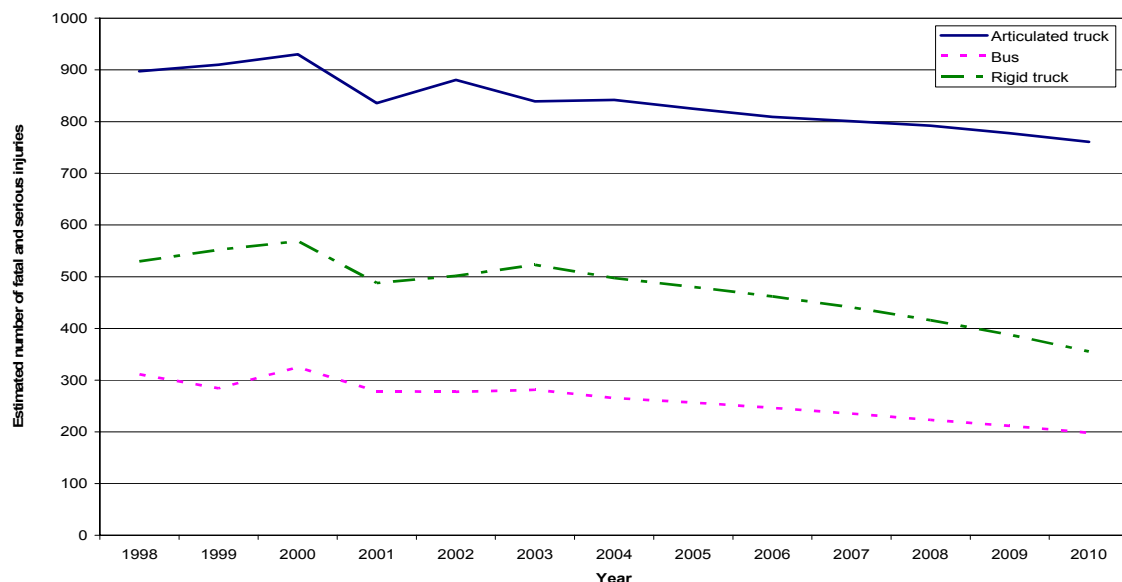
When assuming stable crash rates from 2003 onwards, there is evidence of substantial increases in fatal and serious injuries resulting from light passenger vehicle collisions with each heavy vehicle type. The greatest increase is generated by articulated truck travel. Although rigid trucks are forecast to travel more vehicle kilometres over the forecast period and the crash rates of the two vehicle types do not differ greatly, the severity of crashes involving articulated trucks is approximately twice that of crashes involving rigid trucks. Therefore, the higher severity associated with articulated truck crashes appears to be the primary contributor to the higher number of fatalities and serious injuries associated with articulated truck travel. However, it is also noted that forecast percentage growth in vehicle travel is greater for articulated trucks than rigid trucks particularly in non-metropolitan areas.

Figure 5. *Estimated number of fatalities and serious injuries resulting from collisions between heavy vehicles and light passenger vehicles: 2003 crash rate maintained.*



Under the alternative scenario, where crash rates for the three heavy vehicle types are projected to decline according to a linear trend over the forecast period, fatal and serious injuries resulting from passenger vehicle collisions with each heavy vehicle type declines slowly over the forecast period. Under this scenario, increases in heavy vehicle travel are more than offset by declining crash rates and fatal and serious injuries resulting from collisions with heavy vehicles will decrease over time despite increases in vehicle kilometres travelled.

Figure 6. *Estimated number of fatalities and serious injuries resulting from collisions between heavy vehicles and light passenger vehicles: Linear forecast of crash rates.*



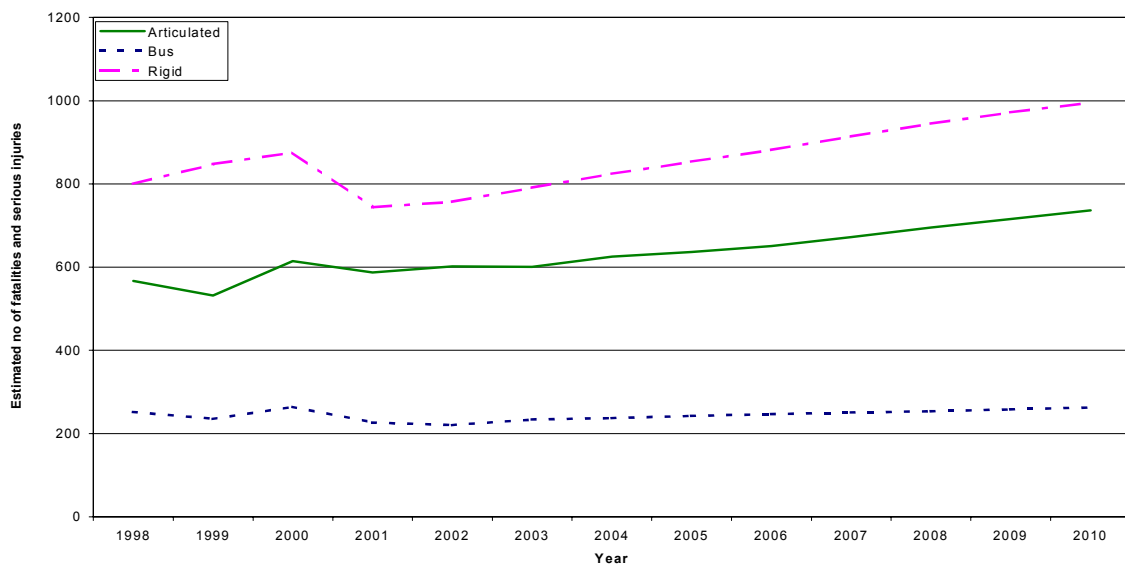
#### *Restricted Articulated Truck Travel*

Given the relatively high crash rate experienced by articulated trucks in metropolitan areas and the relatively high severity of crashes involving articulated trucks, the impact of removing articulated trucks from the metropolitan area was considered.



The workload of articulated trucks in metropolitan areas was transferred to rigid trucks through use of relative tonne-kilometre estimates for the two heavy vehicle classes derived from the SMVU data. The results are presented for the two crash rate scenarios in Figures 7 and 8 following. It is noted that estimated bus related casualties presented below differ from those presented in Figures 5 and 6 as they are sums of independently estimated metropolitan and non-metropolitan fatalities and serious injuries. The variation in values between these estimates and those presented above and estimated across all regions is due to estimation error.

*Figure 7. Estimated number of fatalities and serious injuries resulting from collisions between heavy vehicles and light passenger vehicles where articulated truck travel is restricted to non-metropolitan areas: 2003 crash rates maintained.*



*Figure 8. Estimated number of fatalities and serious injuries resulting from collisions between heavy vehicles and light passenger vehicles where articulated truck travel is restricted to non-metropolitan areas; Linear forecast of crash rates.*



To quantify the potential benefits of restricting articulated truck travel to non-metropolitan areas, the percentage difference between the crash rate forecasts presented for combined metropolitan and non-metropolitan travel with no restriction on articulated truck travel and those presented with restriction were compared. The results for the two travel forecast scenarios are presented in Table 2.

*Table 2. Estimated percentage crash savings due to the removal of articulated trucks from metropolitan roads: 1998-2010 (negative savings indicate a net crash increase).*

<b>Year</b>	<b>2003 Crash Rate</b>	<b>Linear Forecast of Crash Rate</b>
1998	3.63%	3.63%
1999	3.44%	3.44%
2000	-0.32%	-0.32%
2001	-1.19%	-1.19%
2002	2.65%	2.65%
2003	-1.58%	-1.58%
2004	-1.59%	-2.50%
2005	-1.59%	-3.97%
2006	-1.60%	-5.72%
2007	-1.61%	-7.87%
2008	-1.63%	-10.56%
2009	-1.64%	-13.94%
2010	-1.65%	-18.36%

## DISCUSSION

This study has attempted to quantify the effects of projected growth in heavy vehicle travel on the future levels of road trauma amongst drivers of light passenger vehicles by examining each of three critical components of the road trauma chain: exposure to risk, crash risk per unit exposure and injury outcome per crash event. Therefore it is useful to consider each specific analysis input as well as how the specific form of each relates to the analysis outcome.

The first relevant analysis input considered is the measure of heavy vehicle exposure in terms of total kilometres travelled. The BTRE estimates used for this study are the nationally recognised government estimates of past and predicted future heavy vehicle travel and hence appeared the best estimates for use in this study. However many unexpected things can alter demand for travel and any error in predicted heavy vehicle travel trends will translate proportionately to error in the estimates of future road trauma. Whilst the modelling framework considered here has not considered the possible impacts of departures from the projected exposure curve, it could easily be adapted to do so. The second important determinant of heavy vehicle related road trauma included as in the model developed is the estimated crash risk per heavy vehicle kilometre travelled. As noted, historical crash risk trends have been derived based on crash data from New South Wales inflated to national values using the estimates of the proportion of all crashes in Australia occurring in New South Wales. The use of New South Wales data was necessary as it was the only state database with consistent and reliable reporting of tow-away and higher severity crashes where truck involved crashes are identified explicitly in the database. Using New South Wales as the basis for determining and projecting crash risk makes a number of assumptions. Key amongst these is that crash trends in New South Wales are representative of the national average and will remain so in the future in both relative and proportionate terms.

The above two inputs combine to generate estimated crash rate.

The influence of crash rates on predicted levels of heavy vehicle road trauma is evident in the diverging estimates presented under the two crash rate scenarios. Across all travel areas, where crash rates are assumed to remain constant at 2003 levels, heavy vehicle road trauma levels are predicted to increase. Under the alternative scenario, where crash rates are forecast to follow a downward linear trend over the forecast period, two inputs to predicted road trauma levels vary: crash rates and heavy vehicle travel. Given that across all travel areas, road trauma levels are predicted to fall, it is clear that the expected rise in vehicle travel is more than offset by the reductions in crash rates under this scenario. It is noted that the forecast decline in crash rates ranges between 27% for articulated trucks and 38% for rigid trucks over the period 2003 to 2010 across all travel areas.

The example discussed above illustrates the importance of the input variables and the interactions between them in determining the predicted level of heavy vehicle related road trauma. Therefore, in considering the scenario that is likely to most accurately represent future outcomes the reliability of the input variables is relevant. In terms of heavy vehicle crash rates, it is perhaps unlikely that either of the scenarios presented in this report will be reflected over the coming years. Continuing efforts aimed at improving heavy vehicle safety make it unlikely that there will be no reduction in heavy vehicle crash rates over the next five years. At the same time, it would require substantial effort and investment to reduce heavy vehicle crash rates by the levels estimated under the alternative scenario. Nevertheless, the results of the two scenarios examined present the possible boundaries of changes in total heavy vehicle related road trauma resulting from future growth in heavy vehicle travel. The actual level achieved will, in part, be influenced by the level of crash rate reductions achieved across all heavy vehicle classes.

The final critical input to the model of heavy vehicle related road trauma is the estimated crashworthiness of the light vehicle fleet by market group as a function of the heavy vehicle collision partner. The estimates used in the model, whilst labelled crashworthiness, are a function both of the crashworthiness of the light passenger vehicle class and the aggressivity of each heavy vehicle class. The models predicting total road trauma have not accounted for change in either crashworthiness of the light vehicle fleet or aggressivity of heavy vehicles over time. Instead they have assumed crashworthiness and aggressivity remain static. Whilst it is likely that the aggressivity of heavy vehicles will show little improvement in the future based on historical trends, it is likely that the crashworthiness of the vehicle fleet will continue to improve leading to reductions in deaths and serious injuries not reflected in the modelling presented. It is also noted that the crashworthiness estimates used in the models developed here relate only to driver injury outcome.

One scenario examined in this study as a possible solution to predictions of increases in heavy related fatalities and serious injuries is the removal of articulated trucks from metropolitan areas. In metropolitan areas articulated trucks experience particularly high crash rates and result in particularly severe outcomes. Under this proposed solution rigid trucks would be substituted to carry the load previously carried by articulated trucks. Regardless of the crash rate scenario applied, this potential solution does not result in a reduction of heavy vehicle related road trauma. Indeed, road trauma could be expected to increase were articulated trucks to be replaced with rigid trucks in metropolitan areas. This outcome results from the increase in the number of rigid trucks required to complete the work of the articulated trucks no longer travelling in metropolitan areas. Despite the lower frequency and severity of rigid truck crashes in metropolitan areas compared to articulated truck crashes, the additional vehicle kilometres travelled required by rigid trucks to carry the same load negates any overall benefits to be obtained by switching vehicle types. This result suggests that replacing rigid trucks with fewer articulated trucks in metropolitan areas would serve to reduce the road toll. However, this may not be generally possible as articulated trucks do not offer the same manoeuvrability and general utility of rigid trucks in many circumstances where rigid trucks currently operate. It may also not be possible to arrange all freight logistics to be served by the higher capacity articulated trucks.

Although only the one scenario has been considered for heavy vehicle fleet composition, the model developed in the study could be used to examine many others. The only real substitution in heavy

vehicle composition that is practical, however, is the distribution between rigid and articulated trucks. As shown by the scenario considered, current practice within the constraints of practicality is probably not too far from the optimum.

From the general results in the study, it would seem the most viable ways of reducing heavy vehicle related road trauma are to reduce either the heavy vehicle exposure, crash risk or both and to continue to improve light vehicle crashworthiness and reduce heavy vehicle aggressivity.

## LIMITATIONS AND ASSUMPTIONS

The analysis undertaken in this study is subject to a number of assumptions and qualifications. First, definitions of heavy vehicle types and metropolitan and non-metropolitan regions in NSW may vary between data sources. Detailed information on the definitions used in the relevant data sets is not available.

Second, distinct forecasts of future heavy vehicle crash rates are considered. Both of these scenarios estimate changes in heavy vehicle crash rates as a function of changes in heavy vehicle usage only. Changes in the usage of light passenger vehicles and the influence of such changes on heavy vehicle crash rates are not considered. Future work in this area would benefit from estimating future changes in light passenger vehicle travel, preferably by market group, and considering the combined influence of these changes and estimated changes in heavy vehicle travel on heavy vehicle crash rates for the three classes of heavy vehicle identified in this study. Third, the model considers the influence of heavy vehicle travel on light passenger vehicle drivers only. Consideration is not given to the influence of growth in heavy vehicle travel on other road users such as pedestrians, bicyclists, motorcyclists or heavy vehicle occupants themselves. Whilst the effects of heavy vehicle travel on these road users warrants investigation it was beyond the scope of this study.

The final limitation to be noted related to the data used to estimate heavy vehicle crash rates. As stated previously, crash rates are estimated using national estimates of heavy vehicle exposure and NSW crash data scaled to represent the national situation using national fuel sales data. This approach was adopted primarily on the basis of the available data, in particular the distinction between heavy vehicle types in the NSW crash data. However, by scaling NSW crash data to represent the national situation and calculated national crash rates, it is assumed that heavy vehicle exposure does not differ significantly across Australian States and Territories. The validity of this assumption has not been tested. An alternative to adopting this approach would be to obtain heavy vehicle exposure data for metropolitan and non-metropolitan areas of NSW and calculate crash rates for NSW only. National estimates of heavy vehicle road trauma could then be estimated based on the assumption that national heavy vehicle crash rates mirror those experienced in NSW. The relative merit of this alternative approach should be considered in future work in this area.

## REFERENCES

BTRE (2002) *Greenhouse Gas Emissions from Transport: Australian trends to 2020* Report 107, Australian Government Department of Transport and Regional Services, Canberra, Australia.

BTRE (2005) *Greenhouse Gas Emissions from Australian Transport: Base Case Projections to 2020*, Australian Government Department of Transport and Regional Services, Canberra, Australia.

Delaney A. and Newstead S. (2006) *The influence of trends in heavy vehicle travel on total road trauma in the light vehicle fleet*. Draft Report, Monash University Accident Research Centre, Melbourne, Australia.

Newstead S., Watson L., Delaney A. and Cameron M. (2004) *Crashworthiness and aggressivity of the Australian light vehicle fleet by major crash type* Report 227, Monash University Accident Research Centre, Melbourne, Australia.

Newstead, S., Cameron, M. and Watson, L. (2005) *Vehicle safety ratings estimated from police reported crash data: 2005 Update* Report 241, Monash University Accident Research Centre, Melbourne, Australia.