# Western Highway Upgrade: Review of Economic Appraisal and Road Crash History

William McDougall 19 November 2020

## 1 Background

I, William McDougall, am an independent transport planner and engineer with over 40 years' experience in appraisal processes for major projects and strategy planning, including economic appraisal for transport projects and road safety analyses.

I am an experienced expert witness in transport planning matters. I have acted as such for various clients during EES hearings for Melbourne Metro Rail Tunnel, West Gate Tunnel and North East Link in recent years.

I have prepared this report as an independent expert witness.

My summary CV is given at the end of this report.

### 1.1 This review

This review is in two parts following:

- Section 2 discusses the economic appraisal for the Western Highway upgrade project, contained in the 2012 EES documentation; and
- Section 3 analyses the road safety record of the Western Highway as a whole, also focussing on the Beaufort to Buangor and Buangor to Ararat sections.

Data and other sources used for the analyses are referenced throughout the document.

# 2 Economic appraisal review

This review is based on available material describing the economic benefits of upgrading Western Highway west of Beaufort (the Beaufort-Stawell duplication), particularly the following reports prepared for the EES:

- Technical Appendix D: Western Highway Project – Section 2: Beaufort to Ararat: Traffic and Transport Impact Assessment Report (GHD, 2012).
- Technical Appendix P: Western Highway Project – Section 2: Beaufort to Ararat: Economic Impact Assessment Report (GHD, 2012).

## 2.1 Overall justification

General justification for the project looks open to question. There seems to have been a strategic decision that Western Highway needs duplicating from Beaufort to Stawell, without clear evidence of the need. It is undersood that the project first appeared in Auslink (a Commonwealth Government national road funding process, now defunct) and then in the 2008 Victorian Transport Plan. It is unknown if there was a cost-benefit analysis done for Auslink.

The Grattan Institute report *'Roads to riches: better transport investment'* says a lot about rural road projects, including the Geelong to Colac upgrade of Princes Highway. This project stands out amongst the ones they looked at for its high cost (and cost blow-outs) and apparent lack of justification. The Western Highway Upgrade is not mentioned, but parallels can be drawn.

## 2.2 Traffic flow and growth

Traffic flow (from counts done in the first week of March 2012) was 6,000 to 6,100 vehicles an average day, with 31-34% heavy vehicles. Traffic in March is typically about 4% above the annual average, so AADT (annual average daily traffic) would be 5,800 vehicles.

Traffic was projected to grow at 1.59% a year.

According to more recent VicRoads traffic data, the traffic flow between Beaufort and Ararat has been estimated as shown in Table 1.

***Table 1: VicRoads traffic estimates for Western Highway Beaufort to Ararat***

| 2-way daily traffic flow | 2007 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|
| All vehicles (AADT) | 5,000 | 6,000 | 5,500 | 5,600 | 5,800 |
| Commercial vehicles | 1,590 | 1,620 | 1,460 | 1,480 | 1,580 |

*Source: VicRoads website, November 2020*

The long-run (2007-2017) annual growth rate in these figures is 1.5% a year, slightly lower than was assumed in 2012, but the traffic flow has also been fluctuating from one year to the next. Commercial vehicle volumes have also fluctuated but are more or less the same in 2007 and 2017.

Traffic growth is now open to question, post-COVID-19; 2020 will show much lower traffic levels, and it remains to be seen how quickly traffic returns to pre-COVID levels, and what the long-term growth prospects are as well.

## 2.3 Road user benefits

The cost-benefit analysis quantifies a range of road user benefits for 30 years after the road opens to traffic:

- Vehicle operating cost savings
- Travel time savings
- Crash cost savings
- Externality savings

A residual value is calculated at the end of 30 years, and the total is discounted to present values (using a discount rate of 4.4%) for comparison with the construction and maintenance cost. This gives a measure of the economic worth of the project, which is given as 0.5 to 0.6 (actually 0.54 to 0.55) for the three options assessed.

The GHD report asserts that 'such BCRs are common for rural highway upgrades because of the high cost involved for long corridors' without providing any evidence. This is a contentious statement. It could be worth exploring other rural highway project cost-benefit analyses, to compare them.

It appears that the traffic conditions with and without the project were estimated for 2025 (i.e. year 8 of the 30-year project period, with 2018 as year 1). The annual benefits were calculated in this year and then extrapolated assuming a constant growth rate of 1.5-1.6% per annum.

## 2.4 Discount rate

The economic appraisal used a discount rate of 4.4%, whereas Victorian Treasury recommends 7% (and has done for some time, despite arguments that it is too high).

If the cost-benefit analysis was calculated using 7% (with no other changes), the overall effect would be to reduce the GHD benefit-cost ratio from 0.55 to about 0.37. Present value of costs would go down by 5%, and benefits by 38%.

## 2.5 Costs

The present value costs are overestimated, because:

- GHD escalated the capital cost values year-by-year through the construction period before discounting them to 2012. The correct method is to express all future-year costs (and benefits) in 2012 dollars, then discount them using the chosen discount rate (they used 4.4%) – this reduces the present value of capital costs (and the residual value) by about 10%.
- The maintenance costs could be less, because of no longer needing to maintain parts of the old road, but this has not been estimated herein.

## 2.6 Benefits

### *2.6.1 General*

All the benefits appear to have been calculated for an average day in the year 2025 only (the eighth year after opening), then annualised and spread out across the 30-year evaluation period. No attempt has apparently been made to recalculate the benefits in another year further into the 30-year project life, which is a better approach – traffic growth can obviously affect the results. If this had been done, the project benefits might have increased somewhat (because the existing road would have been more affected by extra traffic growth than the new one).

The annualisation factor is unknown. If the traffic flow was converted to AADT (annual average daily traffic), which is the usual convention, then a factor of 365 would apply.

### *2.6.2 Vehicle operating costs (VOC) saving*

This is the largest benefit item (50% of total benefits).

The VOC calculation relies on estimating vehicle travel speeds and road surface condition (roughness). The speeds depend on quite a few factors, including the grades and curves along the route but also the surface roughness.

The surface roughness comes into play again when estimating the vehicle operating cost, because it affects fuel consumption, tyre and suspension wear and other running costs.

The formula used is from Austroads report AP-R264-05 (2005). That might have been valid in 2012, but the methods have since changed and are given in ATAP (Australian Transport Assessment & Planning) Guidelines. A comparable calculation using the ATAP guidance would probably give similar results, however.

Although the new road increases the vehicle-km travelled, the better-quality road results in lower VOC unit rates. The net effect is a vehicle operating cost saving.

The main factor affecting the VOC rate is the assumed surface roughness. The new road is assumed to have half the roughness value of the old road. The implicit assumptions are that the new road will be built and then maintained to a much better quality than the existing road, and that, in the no-project case, the existing road surface would never be improved (for example, by resurfacing it at suitable intervals).

This is highly optimistic and produces very large vehicle operating cost savings. No evidence is given to support the assumed halving of the roughness value as a starting point, and on top of that it is much more likely that the new road's surface condition would deteriorate over time, so its VOC unit rate would increase over time. If the net effect is to gradually reduce the annual VOC saving to zero by year 30, it would reduce the present value of VOC savings by about 40%.

The VOC calculations produce unusually large benefits depending almost entirely on the surface condition assumption. Because of this, further research should have been done to establish a more realistic starting-point roughness value, and a way of allowing for future traffic growth and surface quality (and thus VOC), based on assumed maintenance levels, for both the project and no-project cases.

### *2.6.3 Travel time saving*

Travel time savings make up 27% of total benefits.

They are calculated by estimating travel times over the old and new roads, and applying values of travel time saving (VTTS, for different vehicle types and purposes) to them.

GHD used VTTS as shown in Table 2. The latest published values from ATAP Guidance, deflated to 2012 dollars, are given for comparison.

***Table 2: Values of travel time saving used in GHD appraisal compared to latest figures***

| Vehicle type | Value of travel time saving ($/hour) | |
|---|---|---|
| | GHD value | Latest ATAP equivalent |
| Articulated trucks | $48.38 | $44.26 |
| Rigid trucks | $34.00 | $32.34 |
| Light commercial vehicle | $35.04 | $30.76 |
| Cars undertaking business travel | $55.99 | $61.22 |
| Cars undertaking private travel | $22.89 | $24.68 |

Because some values of time have increased, and others have decreased, using the latest values would not change the present value of travel time savings significantly.

### *2.6.4 Crash cost savings*

Crash cost savings make up 5% of benefits.

They are calculated by assuming that the new road will be 30% safer than the old one. The rationale for this is that, in 2012, VicRoads had a road safety strategy which was aiming for a 30% reduction in road crashes.

This is illogical and erroneous; if that strategy had been successful, then there would have been a 30% reduction in crashes across the entire network[1].

The correct way of estimating crash savings is to extract statistics by road type and compare the difference between the existing 2-lane road and the proposed 4-lane divided road, with the latter based on evidence of similar types of road elsewhere. Any future trends in road safety (for example, due to network-wide initiatives) could then be applied to both the project and no-project cases.

Further research would be needed to establish this more precisely, but a more reasonable assumption at the time could have been that the new road would be 10% safer than the old one (as opposed to 30% assumed by GHD), and that the entire network would see a 30% reduction in crashes by 2025. If so, the project crash benefits would go down by 53%.

A detailed review of the Western Highway's crash history is documented in Section 3.

### *2.6.5 Externalities*

The externality values used in the 2012 cost-benefit analysis have not changed much since then. They cover greenhouse gas emissions, noise and air pollution from the project, which were assessed as being very small.

### *2.6.6 Overall effects*

Table 3 summarises the overall effects of the changes discussed above, for route Option 1 (which was the route finally chosen, following the EES panel recommendations). The effect would be to

[1] The data in Table 5 on page 12 herein shows that the state-wide crash rate went down by only 10% from 2012 to 2019. This makes a 30% reduction by 2025 highly optimistic in any case, albeit with the benefit of hindsight.

reduce the benefit-cost ratio from 0.54 to 0.47. If the discount rate had been 7% instead of 4.4%, the benefit-cost ratio would be 0.32.

The effect on the cost-benefit analysis for Options 2 and 3 has not been calculated herein, but they would be proportionally similar.

***Table 3: Effect of revised assumptions on benefit-cost ratio***

| Item | GHD Option 1 | Adjusted results using revised assumptions | |
|---|---|---|---|
| | | 4.4% discount rate (as GHD original) | 7% discount rate (Vic Treasury spec) |
| Vehicle operating cost savings | $87M | $54M | $40M |
| Travel time savings | $46M | $50M | $33M |
| Crash cost savings | $9M | $6M | $4M |
| Externalities* | $0M* | $0M* | $0M* |
| Residual value | $32M | $29M | $13M |
| **Present value of benefits** | **$174M** | **$139M** | **$89M** |
| Capital cost | $314M | $283M | $268M |
| Maintenance cost | $9M | $9M | $6M |
| **Present value of costs** | **$323M** | **$292M** | **$274M** |
| **Benefit cost ratio** | **0.54** | **0.47** | **0.32** |
| **Net present value** | **-$149M** | **-$154M** | **-$185M** |

** Externalities are very small (less than $100,000 in present value terms), so are rounded off to zero in the above.*

### *2.6.7 Other issues*

In addition to the user benefits, the appraisal quantified:

- construction employment and flow-on effects;
- effects on businesses and industries downstream from the project;
- values of freight and connectivity, and
- impacts on the grain harvest.

No allowance was made (beyond land acquisition costs) for effects like land severance, loss of habitat, loss of vegetation/biomass and the social/cultural value of land and items lost.

The latest (ATAP) guidance says the following:

*'If, after using the default values, some externalities are of sufficient magnitude to make a significant difference to the summary results of the CBA, then - as part of a detailed CBA - consider undertaking modelling or survey work to identify externalities specific to the impacts of the initiative being appraised.*

*The first step will be to estimate the quantities of the externalities in physical terms for the Base and Project Cases.*

*The second step is to value the externalities. When valuing an externality, the aim is to find out how much the affected people are willing to pay to avoid the externality, or how much they are*

*willing to accept to put up with it. Techniques to do this include hedonic pricing, stated preference surveys, and estimation of mitigation costs or damage and avoidance costs.'*

*Source: ATAP T2 Cost Benefit Analysis, May 2018*

Given the significant concerns raised by stakeholders, in particular relative to the cultural significance of trees affected by the road upgrade, it could be argued that efforts should have been made to value them in economic terms using the above principles.

Even with the optimistic and erroneous assumptions discussed herein, the project does not return a positive economic benefit (its costs are substantially higher than its benefits). If its impact on cultural values was recognised and properly accounted for, it would necessarily reflect the strength of the community's concerns (because the method of valuation involves consulting affected people). It is reasonable to expect that this would produce further large disbenefits, thus worsening the already poor economic performance of the project.

# 3 Road crash history analysis

## 3.1 Summary findings

This section provides an analysis of 20 years of road crash data for the Western Highway and Freeway, from the Deer Park Bypass to the South Australian border, with a focus on the Beaufort-Buangor-Ararat sections.

Key findings from the analysis are summarised as follows:

- Overall, the 5-year rolling average crash rate (injury accidents per million vehicle-kilometres) for the Western Freeway/Highway route is low, at 27% of the Victorian average.
- The Buangor to Ararat section has a crash rate half that of the Victorian average, and 60% of that for Regional Victoria.
- From 2000 to 2019, there were 13 fatalities on the Highway between Beaufort and Ararat. However, only three of these occurred between Buangor and Ararat. The rest were on the Beaufort to Buangor section, including three lives lost after it was upgraded to a dual carriageway in April 2016.
- The three lives lost between Buangor and Ararat were in two separate head-on crashes in 2002, about 0.5km south-east of Ararat. There have been no road deaths on the Buangor to Ararat section for 18 years.
- The low crash severity means that the human costs per crash on the Buangor to Ararat section are among the lowest on the Western Highway.
- Compared to the Highway section as a whole, the Buangor to Ararat section has a higher proportion of single-vehicle crashes and crashes with fixed objects. Heavy commercial vehicles are involved in a lower proportion of crashes, despite the high truck numbers in the traffic flow.

If the safety of the Buangor to Ararat section is a high priority (and the data suggests that is questionable), it could be improved substantially by low-cost solutions such as lowering the speed limit, installing wire rope safety barriers and upgrading the road markings. It is a straight and relatively flat section of road. An 80km/h speed limit would increase travel times over the 16.8km section by only 2.5 minutes.

Subject to further research, there are probably several examples of regional roads, with similar traffic volumes to the Buangor-Ararat section of Western Highway, where speed reductions and safety barrier treatments have been implemented in recent years; it is an important element of the State Government's road safety strategy.

## 3.2 Data used

### *3.2.1 Crash data*

Road crash data files were downloaded from VicRoads' website on 29 October 2020. There are two sets of data; one for 2000-2005 and the other for 2006-2020.

The data files were combined to produce continuous data from 1 January 2000 to 26 September 2020. Because of their incompleteness and the effects of COVID-19, 2020 results have been ignored, leaving the full 20 years from 2000 to 2019 for analysis.

The incidents recorded in this dataset are personal injury accidents (PIAs); incidents involving property damage only are not included (the vast majority of these are not reported to the police and are thus unknown).

VicRoads' *Crashstats User Guide (2013)* states that:

*The CrashStats database contains statistics of road traffic accidents which were reported to the police and which met the following conditions:*

- *That the accident occurred from the calendar year 1987 onwards.*
- *That the accident resulted in:*
  - *The death of any person within thirty days of the accident.*
  - *Personal injury as identified by the police officers completing the accident report.*
- *That the accident occurred on any road, street, thoroughfare, footpath, railway level crossing, or any place open to the public.*
- *That the accident involved one or more road vehicles which, at the time of the accident were in motion, including motor cars, station wagons, utilities, panel vans, motor cycles, trucks, buses, trams and railway vehicles, pedal cyclists and ridden animals.*

### *3.2.2 Traffic data*

Traffic flow data was downloaded from VicRoads' website on 29 October 2020. It is a spreadsheet containing summary traffic flows for all state-controlled roads in Victoria. The spreadsheet contains annual average daily traffic (AADT) flows and commercial vehicle traffic flows for 2007, 2014, 2015, 2016 and 2017. Interpolations were made for intervening years, as well as extrapolations for previous and later years to provide yearly estimates for 2001 to 2019 (to match the available full calendar years in the crash data).

Crash and traffic data for the Western Highway and Western Freeway were extracted from these datasets and reviewed. In particular, crash location coordinates and road chainages were carefully checked to ensure that they were correct and internally consistent.

## 3.3 Analysis

The route was divided up into 38 segments, between major intersections on the Freeway and between towns and through major towns separately along the Highway. These segments were then summarised into longer sections for simplification, as shown in Table 4. The summary sections maintained the detail of the segments from Beaufort to Ararat, the focus of this review.

Analysis comprised several different components:

1. **Traffic flow** data was reviewed and summarised along the route.
2. **Crash rates** (crashes per vehicle-km) was calculated to explore their distribution.
3. **Crash severity** was explored by analysing human consequences (fatalities and injuries).
4. **Crash causation** factors were analysed to explore any notable patterns.

At the end of this note, conclusions are drawn from the analysis findings.

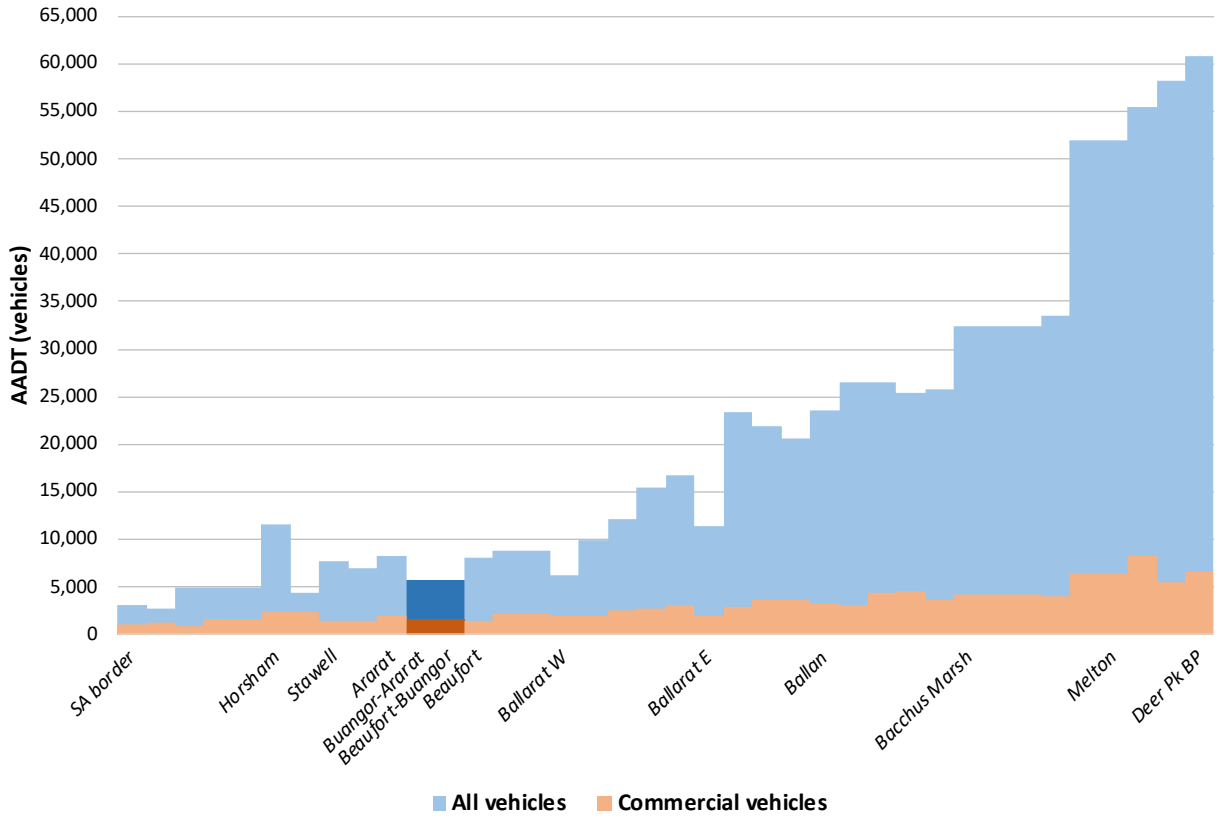
### *Table 4: Western Freeway/Highway – segments for crash analysis*

| Road | Segments No | From | To | Length (km) | Summary sections From | To | Length (km) |
|---|---|---|---|---|---|---|---|
| **Western Fwy** | 1 | Deer Park Bypass | Hopkins Rd | 4.0 | | | |
| | 2 | Hopkins Rd | Leakes Rd | 5.0 | | | |
| | 3 | Leakes Rd | Melton Hwy | 5.3 | | | |
| | 4 | Melton Hwy | Coburns Rd | 3.3 | | | |
| | 5 | Coburns Rd | Hopetoun Park Rd | 5.9 | | | |
| | 6 | Hopetoun Park Rd | Bacchus Marsh Rd | 1.9 | | | |
| | 7 | Bacchus Marsh Rd | Gisborne Rd | 4.9 | | | |
| | 8 | Gisborne Rd | Halletts Way | 1.4 | | | |
| | 9 | Halletts Way | Bacchus Marsh Rd | 0.7 | | | |
| | 10 | Bacchus Marsh Rd | Mortons Rd | 2.6 | | | |
| | 11 | Mortons Rd | Pentland Hills Rd | 2.9 | | | |
| | 12 | Pentland Hills Rd | Greendale-Myrniong Rd | 6.4 | Deer Park Bypass | Freeway end | 128.4 |
| | 13 | Greendale-Myrniong Rd | Old Melbourne Rd | 5.7 | | | |
| | 14 | Old Melbourne Rd | Ballan-Daylesford Rd | 5.2 | | | |
| | 15 | Ballan-Daylesford Rd | Moorabool W Rd | 9.7 | | | |
| | 16 | Moorabool W Rd | Forbes Rd | 13.2 | | | |
| | 17 | Forbes Rd | Ballarat-Burrumbeet Rd | 3.5 | | | |
| | 18 | Ballarat-Burrumbeet Rd | Daylesford Rd | 1.7 | | | |
| | 19 | Daylesford Rd | Midland Hwy | 6.7 | | | |
| | 20 | Midland Hwy | Gillies Street | 1.6 | | | |
| | 21 | Gillies Street | Learmonth Rd | 2.2 | | | |
| | 22 | Learmonth Rd | Sunraysia Hwy | 2.7 | | | |
| | 23 | Sunraysia Hwy | Remembrance Dr | 10.1 | | | |
| | 24 | Remembrance Dr | Freeway end | 21.6 | | | |
| **Western Hwy** | 25 | Freeway end | Beaufort E 60 sign | 3.7 | Freeway end | Beaufort W 60 sign | 7.1 |
| | 26 | Beaufort E 60 sign | Beaufort W 60 sign | 3.4 | | | |
| | **27** | **Beaufort W 60 sign** | **Buangor (2016 upgrade)** | **23.0** | **Beaufort W 60 sign** | **Buangor (2016 upgrade)** | **23.0** |
| | **28** | **Buangor (2016 upgrade)** | **Ararat E 80 sign** | **16.9** | **Buangor (2016 upgrade)** | **Ararat E 80 sign** | **16.9** |
| | 29 | Ararat E 80 sign | Ararat W 80 sign | 6.1 | Ararat E 80 sign | Ararat W 80 sign | 6.1 |
| | 30 | Ararat W 80 sign | Stawell E 80 sign | 23.8 | Ararat W 80 sign | Stawell E 80 sign | 23.8 |
| | 31 | Stawell E 80 sign | Stawell W 80 sign | 3.8 | | | |
| | 32 | Stawell W 80 sign | Horsham E 80 sign | 67.5 | | | |
| | 33 | Horsham E 80 sign | Horsham W 80 sign | 4.5 | | | |
| | 34 | Horsham W 80 sign | Pimpinio | 8.5 | Stawell E 80 sign | SA border | 205.2 |
| | 35 | Pimpinio | Dimboola | 19.1 | | | |
| | 36 | Dimboola | Nhill | 37.9 | | | |
| | 37 | Nhill | Kaniva | 39.5 | | | |
| | 38 | Kaniva | SA border | 24.4 | | | |
| **Total length (km)** | | | | **410.4** | | | **410.4** |

## 3.4 Traffic flow

Estimated daily 2019 annual average daily traffic (AADT) flows on each segment along the route are shown in Figure 1 (total traffic and commercial vehicles).

***Figure 1: 2019 average daily traffic***




This clearly shows how the traffic levels reduce considerably west of Melbourne, and again west of Ballarat. It also shows that commercial vehicle traffic levels do not go down by the same amount as all traffic. The proportion of commercial vehicles in the traffic increases steadily, from about 10% at Deer Park Bypass to just under 30% at Buangor, and over 35% at the SA border.

Local traffic adds noticeably to through traffic in Ararat, Stawell and Horsham.

## 3.5 Crash rates

The usual measure of the road crash rate is the number of PIAs per million vehicle-kilometres (PIA/Mvkm). This enables comparison of the overall safety performance of different road segments with varying traffic levels and lengths, over suitable time periods.

Crash rates have been calculated for every year from 2001 to 2019. From this, rolling 5-year averages were calculated for each summary road segment, from 2005-2019.

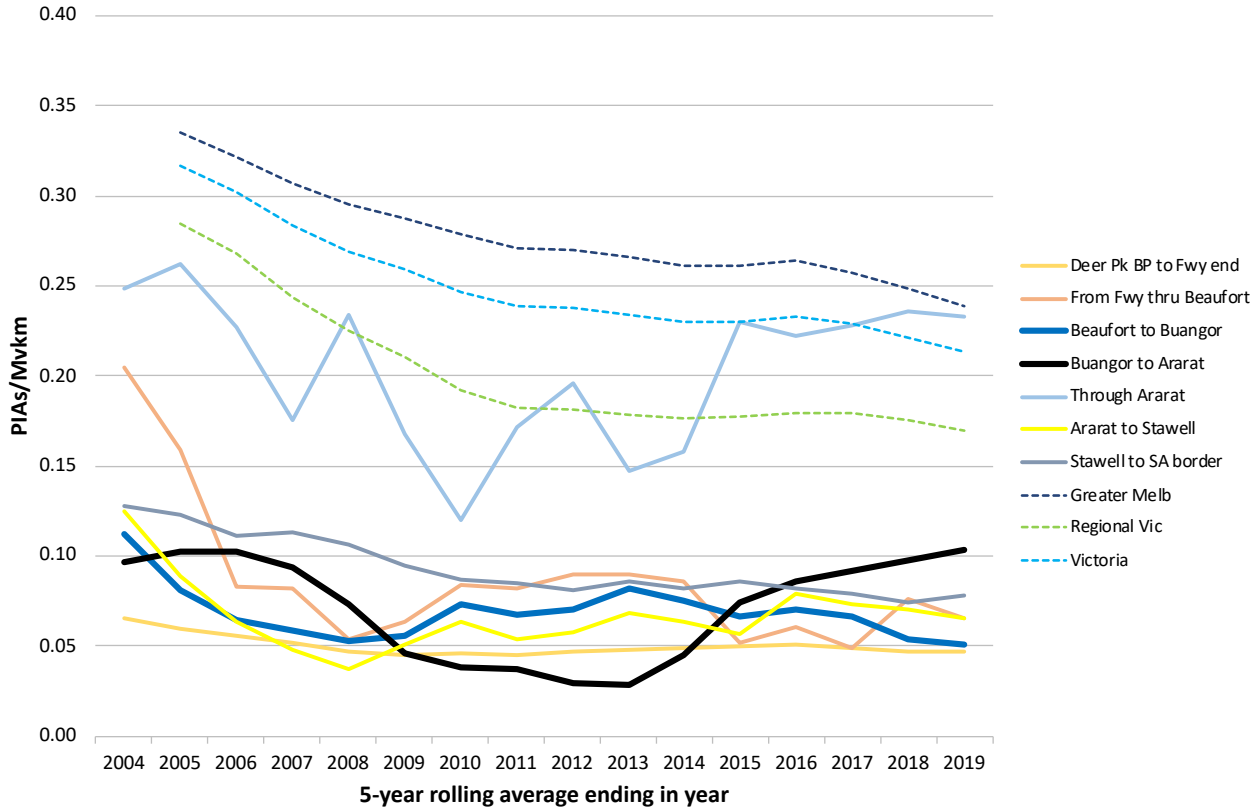
Overall rolling 5-year averages for Greater Melbourne and Victoria were also calculated for comparison, using total annual vehicle-km travelled from *Australian Infrastructure Statistics Yearbook 2019* by the Bureau of Infrastructure and Transport Research Economics (BITRE).

Results are shown in Table 5 and Figure 2.

### *Table 5: Crash rates*

| Road | Summary sections | Length (km) | 5-year rolling average PIA/Mvkm | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| **Western Fwy** | Deer Pk BP to Fwy end | 128 | 0.07 | 0.06 | 0.06 | 0.05 | 0.05 | 0.04 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Western Hwy** | From Fwy thru Beaufort | 7 | 0.20 | 0.16 | 0.08 | 0.08 | 0.05 | 0.06 | 0.08 | 0.08 | 0.09 | 0.09 | 0.09 | 0.05 | 0.06 | 0.05 | 0.08 | 0.07 |
| | **Beaufort to Buangor** | **23** | **0.11** | **0.08** | **0.06** | **0.06** | **0.05** | **0.06** | **0.07** | **0.07** | **0.07** | **0.08** | **0.07** | **0.07** | **0.07** | **0.07** | **0.05** | **0.05** |
| | **Buangor to Ararat** | **17** | **0.10** | **0.10** | **0.10** | **0.09** | **0.07** | **0.05** | **0.04** | **0.04** | **0.03** | **0.03** | **0.04** | **0.07** | **0.09** | **0.09** | **0.10** | **0.10** |
| | Through Ararat | 6 | 0.25 | 0.26 | 0.23 | 0.18 | 0.23 | 0.17 | 0.12 | 0.17 | 0.20 | 0.15 | 0.16 | 0.23 | 0.22 | 0.23 | 0.24 | 0.23 |
| | Ararat to Stawell | 24 | 0.13 | 0.09 | 0.06 | 0.05 | 0.04 | 0.05 | 0.06 | 0.05 | 0.06 | 0.07 | 0.06 | 0.06 | 0.08 | 0.07 | 0.07 | 0.07 |
| | Stawell to SA border | 205 | 0.13 | 0.12 | 0.11 | 0.11 | 0.11 | 0.09 | 0.09 | 0.08 | 0.08 | 0.09 | 0.08 | 0.09 | 0.08 | 0.08 | 0.07 | 0.08 |
| **Total** | | 410 | 0.09 | 0.08 | 0.07 | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| **For comparison** | Greater Melb | | | 0.33 | 0.32 | 0.31 | 0.29 | 0.29 | 0.28 | 0.27 | 0.27 | 0.27 | 0.26 | 0.26 | 0.26 | 0.26 | 0.25 | 0.24 |
| | Regional Vic | | | 0.28 | 0.27 | 0.24 | 0.23 | 0.21 | 0.19 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | 0.17 |
| | Victoria | | | 0.32 | 0.30 | 0.28 | 0.27 | 0.26 | 0.25 | 0.24 | 0.24 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 | 0.22 | 0.21 |

### *Figure 2: Crash rates*




Firstly, it is important to note that, despite using a 5-year rolling average, the shortest sections in the analysis (from the end of the Freeway through to the west side of Ararat) have much more year-to-year variability than the longer sections. This is a common feature of crash analysis and emphasises the inherent underlying randomness of crash events, as well as their low occurrence relative to traffic flow.

As can be seen, the Western Freeway/Highway (apart from the section through Ararat) has significantly lower crash rates than the averages for Greater Melbourne and Regional Victoria as a whole.

The section through Ararat has the highest average crash rate (0.23 PIAs/Mvkm) in the 5 years up to 2019, and the Buangor to Ararat section has the second highest (0.10). Both sections have also seen increases in average crash occurrences since 2013 or earlier.

It is also noteworthy that the Buangor to Ararat section had very low crash rates through the early 2010s – lower than any of the other sections.

## 3.6 Crash severity

Table 6 to Table 9 list the number of crashes, fatalities and personal injuries (serious and other) for every year from 2000 to 2019.

### *Table 6: Total injury crashes*

| Road | Summary sections | Personal injury accidents (PIAs) | | | | | | | | | | | | | | | | | | | | 20yr total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
| **Western Fwy** | Deer Pk BP to Fwy end | 57 | 54 | 45 | 50 | 44 | 39 | 43 | 31 | 35 | 39 | 50 | 45 | 49 | 47 | 47 | 66 | 59 | 40 | 42 | 58 | 940 |
| **Western Hwy** | From Fwy thru Beaufort | 4 | 6 | 1 | 2 | 1 | 1 | 1 | 1 | 0 | 2 | 3 | 1 | 2 | 0 | 2 | 0 | 2 | 1 | 3 | 1 | 34 |
| | **Beaufort to Buangor** | **6** | **6** | **3** | **3** | **4** | **0** | **3** | **2** | **2** | **5** | **4** | **2** | **3** | **5** | **4** | **2** | **3** | **2** | **2** | **3** | **64** |
| | **Buangor to Ararat** | **1** | **1** | **4** | **4** | **4** | **2** | **1** | **3** | **1** | **0** | **1** | **1** | **2** | **1** | **3** | **6** | **3** | **3** | **2** | **4** | **47** |
| | Through Ararat | 2 | 3 | 4 | 1 | 5 | 3 | 1 | 1 | 5 | 1 | 0 | 5 | 3 | 2 | 2 | 6 | 5 | 4 | 3 | 2 | 58 |
| | Ararat to Stawell | 9 | 7 | 5 | 4 | 0 | 2 | 2 | 2 | 2 | 3 | 5 | 0 | 3 | 5 | 2 | 4 | 6 | 2 | 5 | 1 | 69 |
| | Stawell to SA border | 32 | 40 | 21 | 28 | 34 | 27 | 27 | 23 | 21 | 20 | 19 | 25 | 20 | 28 | 16 | 26 | 23 | 18 | 25 | 25 | 498 |
| **Total** | | 111 | 117 | 83 | 92 | 92 | 74 | 78 | 63 | 66 | 70 | 82 | 79 | 82 | 88 | 76 | 110 | 101 | 70 | 82 | 94 | 1710 |

### *Table 7: Fatalities*

| Road | Summary sections | Fatalities | | | | | | | | | | | | | | | | | | | | 20yr total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
| **Western Fwy** | Deer Pk BP to Fwy end | 3 | 3 | 6 | 2 | 5 | 3 | 4 | 3 | 1 | 1 | 2 | 4 | 1 | 4 | 1 | 2 | 7 | 1 | 0 | 4 | 57 |
| **Western Hwy** | From Fwy thru Beaufort | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | **Beaufort to Buangor** | **0** | **2** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **4** | **0** | **0** | **0** | **0** | **0** | **1** | **2** | **1** | **0** | **10** |
| | **Buangor to Ararat** | **0** | **0** | **3** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **3** |
| | Through Ararat | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 |
| | Ararat to Stawell | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 9 |
| | Stawell to SA border | 8 | 2 | 1 | 8 | 7 | 2 | 3 | 1 | 2 | 1 | 1 | 3 | 0 | 3 | 1 | 2 | 1 | 0 | 0 | 2 | 48 |
| **Total** | | 13 | 8 | 13 | 10 | 13 | 5 | 7 | 4 | 3 | 2 | 7 | 7 | 1 | 10 | 2 | 5 | 9 | 3 | 1 | 8 | 131 |

### *Table 8: Serious person-injuries*

| Road | Summary sections | Serious person-injuries | | | | | | | | | | | | | | | | | | | | 20yr total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
| **Western Fwy** | Deer Pk BP to Fwy end | 37 | 28 | 28 | 26 | 21 | 25 | 26 | 31 | 23 | 29 | 30 | 35 | 28 | 28 | 19 | 29 | 34 | 15 | 16 | 20 | 528 |
| **Western Hwy** | From Fwy thru Beaufort | 5 | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 4 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 20 |
| | **Beaufort to Buangor** | **3** | **5** | **4** | **5** | **2** | **0** | **4** | **1** | **4** | **5** | **3** | **1** | **1** | **5** | **4** | **1** | **3** | **0** | **0** | **2** | **53** |
| | **Buangor to Ararat** | **0** | **0** | **5** | **2** | **2** | **1** | **1** | **2** | **1** | **0** | **0** | **1** | **1** | **0** | **0** | **8** | **0** | **2** | **0** | **3** | **29** |
| | Through Ararat | 1 | 3 | 4 | 0 | 2 | 2 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 1 | 1 | 3 | 0 | 24 |
| | Ararat to Stawell | 10 | 11 | 2 | 2 | 0 | 0 | 3 | 0 | 5 | 1 | 1 | 0 | 2 | 2 | 3 | 1 | 4 | 0 | 1 | 2 | 50 |
| | Stawell to SA border | 17 | 27 | 13 | 16 | 23 | 15 | 23 | 17 | 13 | 12 | 6 | 8 | 10 | 10 | 11 | 17 | 11 | 5 | 15 | 15 | 284 |
| **Total** | | 73 | 76 | 57 | 52 | 50 | 43 | 58 | 52 | 48 | 49 | 40 | 47 | 47 | 47 | 37 | 56 | 54 | 24 | 36 | 42 | 988 |

### *Table 9: Other person-injuries*

| Road | Summary sections | Other person-injuries | | | | | | | | | | | | | | | | | | | | 20yr total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | |
| **Western Fwy** | Deer Pk BP to Fwy end | 54 | 53 | 44 | 39 | 46 | 41 | 30 | 18 | 30 | 36 | 41 | 37 | 39 | 40 | 40 | 69 | 53 | 36 | 47 | 69 | 862 |
| **Western Hwy** | From Fwy thru Beaufort | 0 | 7 | 0 | 1 | 4 | 1 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 2 | 0 | 4 | 0 | 4 | 1 | 29 |
| | **Beaufort to Buangor** | **14** | **2** | **0** | **1** | **3** | **0** | **1** | **1** | **9** | **2** | **2** | **1** | **4** | **2** | **8** | **1** | **2** | **2** | **2** | **1** | **58** |
| | **Buangor to Ararat** | **2** | **2** | **1** | **3** | **5** | **1** | **0** | **1** | **1** | **0** | **1** | **0** | **1** | **1** | **3** | **6** | **4** | **2** | **3** | **4** | **41** |
| | Through Ararat | 1 | 0 | 2 | 1 | 5 | 3 | 1 | 1 | 3 | 0 | 0 | 4 | 3 | 1 | 2 | 9 | 8 | 3 | 1 | 1 | 49 |
| | Ararat to Stawell | 8 | 7 | 5 | 3 | 0 | 3 | 1 | 3 | 0 | 2 | 6 | 0 | 1 | 2 | 1 | 3 | 5 | 3 | 8 | 0 | 61 |
| | Stawell to SA border | 34 | 26 | 21 | 20 | 22 | 25 | 18 | 20 | 19 | 18 | 23 | 21 | 19 | 29 | 19 | 30 | 20 | 20 | 20 | 64 | 488 |
| **Total** | | 113 | 97 | 73 | 68 | 85 | 74 | 51 | 44 | 62 | 59 | 77 | 63 | 67 | 75 | 75 | 118 | 96 | 66 | 85 | 140 | 1588 |

As already noted with crash rates, the inherent randomness of crash occurrences affects the shortest road sections most. This randomness also affects the distribution of fatalities more than injuries.

Some key observations can be made from this data regarding the Beaufort-Buangor and Buangor-Ararat sections:

- There were 10 fatalities from Beaufort to Buangor. Three of these occurred after the April 2016 upgrade.
- There have been 3 fatalities from Buangor to Ararat in 20 years; they were all in 2002, so there have been no fatalities for 18 years. According to the detailed information, these lives were lost in two separate crashes which occurred at almost the same location, 400-500m south-east of the Heath Street intersection. This is a short distance from the 80km/h speed signs just outside Ararat. Both involved head-on vehicle collisions.
- Excluding fatalities, there were 111 person-injuries in 64 crashes from Beaufort to Buangor (1.7 injuries per crash), and 70 person-injuries in 47 crashes from Buangor to Ararat (1.5 injuries per crash).

A reasonably consistent measure of crash severity is possible by using the Australian Transport Appraisal and Planning (ATAP) guidance values to attach a 'human capital' value to each crash, based on the number of fatalities, serious and other injuries in each crash.

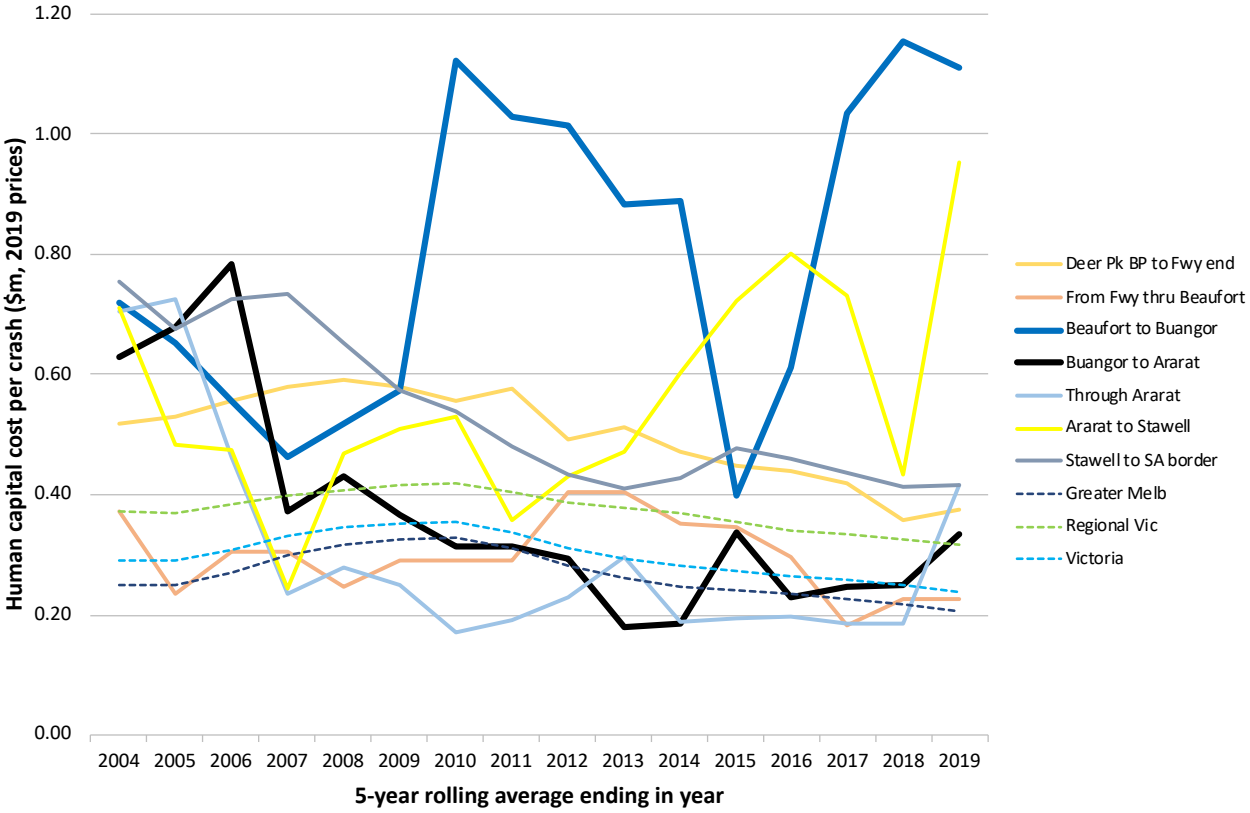
The ATAP guidance (Part PV2, Table 13) assigns total human capital costs of $2.316M per fatality, $0.569M per serious injury and $0.020M per other injury, all per person and updated to June 2019 prices. These costs include human costs (e.g. medical, lost labour), vehicle costs (e.g. repairs, insurance) and general costs (e.g. emergency services, traffic delays).

Assigning these values gives the human capital costs per crash as given in Table 10 and Figure 3 (5-year rolling average annual costs).

***Table 10: Human capital costs per crash (as an indicator of crash severity)***

| Road | Summary sections | Length (km) | 5-year rolling average HC crash values (2019 $M per crash) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
| **Western Fwy** | Deer Pk BP to Fwy end | 128 | 0.52 | 0.53 | 0.56 | 0.58 | 0.59 | 0.58 | 0.56 | 0.58 | 0.49 | 0.51 | 0.47 | 0.45 | 0.44 | 0.42 | 0.36 | 0.37 |
| **Western Hwy** | From Fwy thru Beaufort | 7 | 0.37 | 0.24 | 0.31 | 0.31 | 0.25 | 0.29 | 0.29 | 0.29 | 0.41 | 0.41 | 0.35 | 0.35 | 0.30 | 0.18 | 0.23 | 0.23 |
| | **Beaufort to Buangor** | **23** | **0.72** | **0.65** | **0.56** | **0.46** | **0.52** | **0.57** | **1.12** | **1.03** | **1.01** | **0.88** | **0.89** | **0.40** | **0.61** | **1.03** | **1.15** | **1.11** |
| | **Buangor to Ararat** | **17** | **0.63** | **0.68** | **0.79** | **0.37** | **0.43** | **0.37** | **0.31** | **0.31** | **0.29** | **0.18** | **0.18** | **0.34** | **0.23** | **0.25** | **0.25** | **0.34** |
| | Through Ararat | 6 | 0.70 | 0.73 | 0.46 | 0.23 | 0.28 | 0.25 | 0.17 | 0.19 | 0.23 | 0.30 | 0.19 | 0.19 | 0.20 | 0.19 | 0.19 | 0.42 |
| | Ararat to Stawell | 24 | 0.71 | 0.48 | 0.47 | 0.24 | 0.47 | 0.51 | 0.53 | 0.36 | 0.43 | 0.47 | 0.60 | 0.72 | 0.80 | 0.73 | 0.43 | 0.95 |
| | Stawell to SA border | 205 | 0.75 | 0.68 | 0.72 | 0.74 | 0.65 | 0.57 | 0.54 | 0.48 | 0.43 | 0.41 | 0.43 | 0.48 | 0.46 | 0.44 | 0.41 | 0.42 |
| **Total** | | 410 | 0.65 | 0.61 | 0.63 | 0.61 | 0.59 | 0.56 | 0.56 | 0.54 | 0.49 | 0.50 | 0.47 | 0.46 | 0.45 | 0.44 | 0.38 | 0.41 |
| **For comparison** | Greater Melb | | 0.25 | 0.25 | 0.27 | 0.30 | 0.32 | 0.33 | 0.33 | 0.31 | 0.28 | 0.26 | 0.25 | 0.24 | 0.23 | 0.23 | 0.22 | 0.21 |
| | Regional Vic | | 0.37 | 0.37 | 0.38 | 0.40 | 0.41 | 0.42 | 0.42 | 0.41 | 0.39 | 0.38 | 0.37 | 0.35 | 0.34 | 0.34 | 0.33 | 0.32 |
| | Victoria | | 0.29 | 0.29 | 0.31 | 0.33 | 0.35 | 0.35 | 0.35 | 0.34 | 0.31 | 0.29 | 0.28 | 0.27 | 0.26 | 0.26 | 0.25 | 0.24 |

*Figure 3: Human capital costs per crash*




The results show that crashes on the Buangor to Ararat section of the highway have been steadily declining in severity since 2007 (when the effect of the 3 fatalities in 2002 is outside the 5-year average), although with a slight uptick in 2015 and 2019 due to concentrations of injury accidents in those years.

The Beaufort to Buangor section however is affected by the number of fatalities occurring there, even after the 2016 upgrade to dual carriageway. It has consistently higher costs per crash than any other section in the analysis and does not show evidence of continuous decline.

The Ararat to Stawell section also shows increasing crash severity over time, due in particular to five fatalities since 2013.

In other sections of the route, crash costs are tracking downwards over time in recent years and are reasonably close to the regional Victoria average.

## 3.7 Crash causation

Further analysis has been done to explore crash causation on sections of the Western Freeway/ Highway. Note that in the tables following, the total number of crashes may not always be consistent; this is because some crash entries did not have records of the factors analysed.

### *3.7.1 Crash types and conditions*

Crash types are summarised in Table 11. The Buangor to Ararat section shows a higher incidence of collisions with fixed objects than for the Highway as a whole (41% instead of 26%), and a corresponding reduction in collisions with vehicles. Collisions with animals are also a higher percentage, though numbers are small.

### *Table 11: Crash types 2000-2019*

| Crash type | Number of crashes (2000 to 2019) | | | | | % by section | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat |
| Collision with vehicle | 869 | 452 | 417 | 28 | 16 | 50% | 47% | 53% | 42% | 33% |
| Collision with a fixed object | 516 | 310 | 206 | 21 | 20 | 30% | 32% | 26% | 32% | 41% |
| Vehicle overturned (no collision) | 165 | 97 | 68 | 5 | 5 | 9% | 10% | 9% | 8% | 10% |
| No collision and no object struck | 57 | 38 | 19 | 5 | 1 | 3% | 4% | 2% | 8% | 2% |
| Struck pedestrian | 52 | 22 | 30 | 0 | 1 | 3% | 2% | 4% | 0% | 2% |
| Collision with some other object | 36 | 20 | 16 | 1 | 2 | 2% | 2% | 2% | 2% | 4% |
| Struck animal | 33 | 15 | 18 | 5 | 3 | 2% | 2% | 2% | 8% | 6% |
| Fall from or in moving vehicle | 8 | 3 | 5 | 1 | 0 | 0% | 0% | 1% | 2% | 0% |
| Other accident | 3 | 1 | 2 | 0 | 1 | 0% | 0% | 0% | 0% | 2% |
| **Total** | **1,739** | **958** | **781** | **66** | **49** | 100% | 100% | 100% | 100% | 100% |

Table 12 shows the number of vehicles involved in each crash. Despite being a single carriageway, the Buangor to Ararat section has a lower incidence of two-plus vehicle crashes than the route as a whole (43% compared to 55%). However, it has a higher incidence of single-vehicle crashes (57% compared to 45%).

### *Table 12: Number of vehicles involved 2000-2019*

| Number of vehicles involved | Number of crashes (2000 to 2019) | | | | | % by section | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat |
| Single vehicle | 782 | 452 | 330 | 35 | 28 | 45% | 47% | 42% | 53% | 57% |
| Two vehicles | 787 | 406 | 381 | 23 | 17 | 45% | 42% | 49% | 35% | 35% |
| Three or more vehicles | 170 | 100 | 70 | 8 | 4 | 10% | 10% | 9% | 12% | 8% |
| **Total** | **1,739** | **958** | **781** | **66** | **49** | 100% | 100% | 100% | 100% | 100% |

Weather conditions are shown in Table 13. In common with the Highway as a whole, the majority of crashes on the Buangor to Ararat section occurred in clear weather conditions.

### *Table 13: Weather conditions 2000-2019*

| Weather conditions | Number of crashes (2000 to 2019) | | | | | % by section | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat |
| Raining | 230 | 150 | 80 | 17 | 4 | 13% | 15% | 10% | 22% | 8% |
| Clear | 1,386 | 714 | 672 | 48 | 43 | 76% | 71% | 84% | 63% | 86% |
| Fog | 47 | 31 | 16 | 2 | 1 | 3% | 3% | 2% | 3% | 2% |
| Not known | 61 | 52 | 9 | 0 | 1 | 3% | 5% | 1% | 0% | 2% |
| Snowing | 8 | 7 | 1 | 1 | 0 | 0% | 1% | 0% | 1% | 0% |
| Strong winds | 71 | 48 | 23 | 7 | 1 | 4% | 5% | 3% | 9% | 2% |
| Dust | 7 | 4 | 3 | 1 | 0 | 0% | 0% | 0% | 1% | 0% |
| Smoke | 2 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 0% | 0% |
| **Total** | **1,812** | **1,008** | **804** | **76** | **50** | 100% | 100% | 100% | 100% | 100% |

Road conditions are shown in Table 14. Again, there is no difference between the Buangor to Ararat section and the Highway as a whole; 84% of crashes occurred in dry surface conditions.

### *Table 14: Road conditions 2000-2019*

| Road conditions | Number of crashes (2000 to 2019) | | | | | % by section | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat |
| Dry | 1,363 | 703 | 660 | 46 | 41 | 78% | 72% | 84% | 68% | 84% |
| Wet | 315 | 203 | 112 | 19 | 7 | 18% | 21% | 14% | 28% | 14% |
| Muddy | 4 | 3 | 1 | 0 | 0 | 0% | 0% | 0% | 0% | 0% |
| Icy | 30 | 26 | 4 | 3 | 1 | 2% | 3% | 1% | 4% | 2% |
| Snowy | 6 | 6 | 0 | 0 | 0 | 0% | 1% | 0% | 0% | 0% |
| Unknown | 37 | 29 | 8 | 0 | 0 | 2% | 3% | 1% | 0% | 0% |
| **Total** | **1,755** | **970** | **785** | **68** | **49** | 100% | 100% | 100% | 100% | 100% |

### 3.7.2 Vehicle types

Table 15 shows the vehicle types involved in crashes.

***Table 15: Vehicle types 2000-2019***

| Vehicle types | Number of crashes (2000 to 2019) | | | | | % by section | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat | Whole route | Freeway section | Highway section | Beaufort - Buangor | Buangor - Ararat |
| **Single vehicle crashes** | | | | | | | | | | |
| Bicycle | 1 | 0 | 1 | 0 | 0 | 0% | 0% | 0% | 0% | 0% |
| Motorcycle | 56 | 35 | 21 | 4 | 0 | 7% | 8% | 6% | 11% | 0% |
| Car | 505 | 310 | 195 | 24 | 14 | 65% | 69% | 59% | 69% | 50% |
| Light commercial | 105 | 67 | 38 | 1 | 10 | 13% | 15% | 12% | 3% | 36% |
| Heavy commercial | 100 | 34 | 66 | 6 | 3 | 13% | 8% | 20% | 17% | 11% |
| Bus | 4 | 3 | 1 | 0 | 0 | 1% | 1% | 0% | 0% | 0% |
| Other/not known | 11 | 3 | 8 | 0 | 1 | 1% | 1% | 2% | 0% | 4% |
| **Single vehicle total** | **782** | **452** | **330** | **35** | **28** | **100%** | **100%** | **100%** | **100%** | **100%** |
| **Two vehicle crashes** | | | | | | | | | | |
| Bicycle | 11 | 0 | 11 | 0 | 0 | 1% | 0% | 3% | 0% | 0% |
| Motorcycle | 17 | 10 | 7 | 2 | 0 | 2% | 2% | 2% | 9% | 0% |
| Car | 524 | 270 | 254 | 15 | 12 | 67% | 67% | 67% | 65% | 71% |
| Light commercial | 109 | 59 | 50 | 3 | 1 | 14% | 15% | 13% | 13% | 6% |
| Heavy commercial | 110 | 55 | 55 | 3 | 3 | 14% | 14% | 14% | 13% | 18% |
| Bus | 2 | 2 | 0 | 0 | 0 | 0% | 0% | 0% | 0% | 0% |
| Other/not known | 14 | 10 | 4 | 0 | 1 | 2% | 2% | 1% | 0% | 6% |
| **Two vehicle total** | **787** | **406** | **381** | **23** | **17** | **100%** | **100%** | **100%** | **100%** | **100%** |
| **Three+ vehicle crashes** | | | | | | | | | | |
| Bicycle | 1 | 0 | 1 | 0 | 0 | 1% | 0% | 1% | 0% | 0% |
| Motorcycle | 2 | 0 | 2 | 0 | 0 | 1% | 0% | 3% | 0% | 0% |
| Car | 111 | 66 | 45 | 8 | 3 | 65% | 66% | 64% | 100% | 75% |
| Light commercial | 26 | 19 | 7 | 0 | 1 | 15% | 19% | 10% | 0% | 25% |
| Heavy commercial | 26 | 13 | 13 | 0 | 0 | 15% | 13% | 19% | 0% | 0% |
| Bus | 1 | 0 | 1 | 0 | 0 | 1% | 0% | 1% | 0% | 0% |
| Other/not known | 3 | 2 | 1 | 0 | 0 | 2% | 2% | 1% | 0% | 0% |
| **Three+ vehicle total** | **170** | **100** | **70** | **8** | **4** | **100%** | **100%** | **100%** | **100%** | **100%** |
| **All crashes** | | | | | | | | | | |
| Bicycle | 13 | 0 | 13 | 0 | 0 | 1% | 0% | 2% | 0% | 0% |
| Motorcycle | 75 | 45 | 30 | 6 | 0 | 4% | 5% | 4% | 9% | 0% |
| Car | 1,140 | 646 | 494 | 47 | 29 | 66% | 67% | 63% | 71% | 59% |
| Light commercial | 240 | 145 | 95 | 4 | 12 | 14% | 15% | 12% | 6% | 24% |
| Heavy commercial | 236 | 102 | 134 | 9 | 6 | 14% | 11% | 17% | 14% | 12% |
| Bus | 7 | 5 | 2 | 0 | 0 | 0% | 1% | 0% | 0% | 0% |
| Other/not known | 28 | 15 | 13 | 0 | 2 | 2% | 2% | 2% | 0% | 4% |
| **TOTAL** | **1,739** | **958** | **781** | **66** | **49** | **100%** | **100%** | **100%** | **100%** | **100%** |

Compared to the Highway section as a whole, the Buangor-Ararat section has a higher incidence of light commercial vehicles in crashes (24% compared to 12%).

Given the high proportion of heavy vehicles in the traffic stream, it is noteworthy that they appear to be involved in crashes less than for the Highway as a whole (12% compared to 17%).

## 3.8 Conclusions

### 3.8.1 Crash rates

All figures are 5-year rolling average to 2019, injury crashes per million vehicle-kilometres:

- The crash rate on the Western Freeway/Highway route as a whole is well below the Regional Victoria average (0.06 compared to 0.17).
- The Buangor to Ararat section has a slightly higher crash rate of 0.10, while the Beaufort to Buangor section is lower, at 0.05.
- The highest crash rate on the sections analysed is through Ararat city (0.23).

Despite these variations, the route as a whole is safer than the Victorian average.

### *3.8.2 Crash severity*

There have been no fatalities on the Buangor to Ararat section for 18 years.

Three deaths occurred in 2002. These lives were lost in two separate head-on collisions, both of which were very close to the Ararat end.

The Beaufort to Buangor section has experienced 10 deaths since 2000, including three since the dual carriageway upgrade was completed in April 2016.

Using 5-year rolling average 'human capital' costs, crashes from Beaufort to Buangor are much more severe ($1.1 million per crash) than from Buangor to Ararat ($0.34 million per crash).

Because of the lack of fatalities, the Buangor to Ararat section has a lower human cost per crash than the average for the entire Western Freeway/Highway, which is $0.44 million.

### *3.8.3 Crash causation*

Over twenty years, compared to the Highway overall, the Buangor to Ararat section has:

- A higher proportion of collisions with fixed objects, and lower with other vehicles
- A correspondingly higher incidence of single-vehicle crashes (and hence a lower incidence of multiple-vehicle crashes)
- No significant differences in weather or road surface conditions
- Lower involvement of heavy commercial vehicles in crashes, despite the high proportion of trucks in the traffic stream.

### *3.8.4 Improving safety*

Despite the relatively high traffic level and truck component, the safety record of the Buangor-Ararat section of the Western Highway is comparatively good. The crash rate is substantially lower than the State average and crashes are of relatively low severity. At the time of writing, there have been no fatalities for 18 years.

However, if improved safety is a key priority, low-cost treatments would probably be quite effective. Reducing the speed limit, installing safety barriers and/or improving road markings and hazard signage is a common solution in Victoria and would be well suited to this section of road.

Subject to further research, there are probably several examples elsewhere in Victoria where such strategies have been implemented, on single-carriageway roads with comparable traffic volumes.