Australian Government

BUILDING OUR FUTURE

Barton Highway Duplication

Business Case

October 2019

Contents

1. Executive summary

1.1 Purpose

Transport for NSW has prepared this business case on the staged duplication of the Barton Highway on behalf of the Australian Government.

During this process, Transport for NSW consulted the Barton Highway Duplication Steering Committee, comprising stakeholders from:

- Department of Infrastructure, Transport, Cities and Regional Development
- Transport for NSW
- Yass Valley Council.

The Barton Highway is a strategically important rural highway linking the southern and western areas of NSW to the ACT. This business case for staged duplication of the highway will deliver the safety improvements and increased capacity required to meet current and future traffic demands. It will also support the continued economic growth and connectivity commitments as identified in the *Barton Highway Improvement Strategy* (2017).

The five proposed stages of duplication are:

- **Stage 1:** Duplicating from the ACT border towards Kaveneys Road
- **Stage 2:** Duplicating from Kaveneys Road to Gooda Creek Road
- **Stage 3:** Realigning and building two carriageways from Gooda Creek Road to Vallencia Drive
- **Stage 4:** Building the Murrumbateman bypass from Vallencia Drive to the Gounyan Curves realignment
- **Stage 5:** Duplicating from the Murrumbateman bypass to the existing dual carriageways south of the Hume Highway.

Stage 1 forms the base case for this business case.

1.2 Barton Highway Improvement Strategy

The *Barton Highway Improvement Strategy* (2017) outlined some short, medium and long term actions to address road safety and travel delay issues along the highway's 52-kilometre length while maximising the existing road performance. It recommended developing additional overtaking lanes as the short to medium term investment priorities, with full duplication a long term priority.

The Australian and NSW governments committed $100 million to implement safety upgrades between 2017 and 2021 to address these short term investment priorities.

1.3 Case for duplication

Strategic design of the short term action to construct overtaking lanes south of Murrumbateman found geographical and construction issues that would severely impact motorists with travel delays, increased delivery time and costs, and provide unsafe conditions for workers during construction. Predicted traffic growth will see new overtaking lanes reach capacity around 10 years from completion, requiring duplication soon after. New research has also found that more overtaking lanes will be required to address the southbound morning peak period to the ACT than recommended in the *Improvement Strategy*, however there are insufficient opportunities to build new overtaking lanes to current standards.

Further investigation determined that duplication from the ACT border towards Kaveneys Road

1. Executive summary (continued)

would provide better outcomes for the allocated funding to improve this section of the highway. With Stage 1 as the base case, this business case determined it is more cost effective, safer and efficient to build full duplication in stages rather than build overtaking lanes. Full duplication provides motorists with consistent, separated two lane driving conditions along the length of the highway and constant overtaking opportunities without the need to merge. It also generates the most travel time and safety benefits, and increases capacity to meet current and future levels of service. The stages of duplication were assessed and prioritised to determine the best delivery program according to need.

1.4 Traffic, congestion and safety

The Barton Highway has a poor crash history with 105 crashes recorded between 2012 and 2017, three of which were fatal. It has a casualty crash rate of 0.3 crashes per kilometre per year, around 50 per cent higher than the average crash rate for similarly classified roads.

Traffic volumes have steadily increased in recent years due to the growing population and economic activity in the wider Canberra areas and south west NSW. The highest traffic volumes are between Murrumbateman and the ACT border, with morning and afternoon peak periods causing congestion that contributes to driver frustration and poor decision making. These volumes are predicted to grow, with the highway due to reach full capacity around 2037 in its current single carriageway formation.

1.5 Regional connectivity

The Barton Highway provides essential connections for the Yass Valley and Hilltops Local Government Areas (LGAs) to business, employment and education opportunities in the ACT.

It plays a vital role in the economic growth and connectivity of Yass Valley and Hilltops LGAs, as well as those in south west NSW's Riverina and Murray regions and northern Victoria. The highway is a crucial route for tourists to explore the Canberra area, Snowy Mountains and Riverina Murray regions. South west NSW residents also rely on the highway to access health services in Canberra.

Growing populations and economic activity in Yass Valley and Hilltops LGAs, as well as broader south west NSW, contribute to the Barton Highway's increased traffic volumes. This regional growth is projected to continue in the coming decades and will place greater pressure on the highway's performance.

1.6 Community expectations

Community and stakeholder workshops conducted for the *Improvement Strategy* found driving on the highway was often described as a stressful experience. Lack of safe overtaking opportunities, increasing congestion, 'racetrack behaviour' at the start and end of overtaking lanes, poor driver behaviour and the number of road users with differing speed capabilities were identified as the top causes of this stress. Intersections and property accesses also cause safety concerns, with difficulty getting on and off the highway safely at these points highlighted. Crashes and near misses had been experienced by most workshop participants. Stakeholders and the community view these safety concerns as urgent issues that are best addressed by full duplication.

Community and stakeholder consultation has taken place on proposed duplication for over 20 years. There is a strong desire for duplication to happen as a short term priority; however, the community and stakeholders accept that full duplication will be a staged process over some years.

1. Executive summary (continued)

1.7 Duplication objectives

Full duplication of the Barton Highway has been determined as the best way to deliver the increased capacity required for current and future traffic volumes, local community needs and regional connectivity.

Full duplication will:

- increase safety by reducing the occurrence and severity of crashes
- provide consistent driving conditions along the corridor
- improve driver behaviour
- improve travel times, journey reliability and reduce congestion
- meet community expectations
- provide safer working conditions for maintenance and operations staff, including emergency services
- better manage traffic incidents with contraflow arrangements
- improve access to Canberra and services
- increase regional connectivity and economic growth.

Without full duplication, the Barton Highway will continue to experience high crash rates and increasing safety issues and overtaking lanes will not cope with the predicted traffic growth and will amplify driver frustration and poor behaviour. Regional connectivity and economic growth will be at risk and community expectations will not be met on safety, travel time savings, journey reliability and value for money.

Existing Barton Highway dual carriageway, south of the Hume Highway, near Yass

2. Overview

This business case is for the staged full duplication of the Barton Highway to meet current and future traffic volumes and service needs. Proposed duplication includes:

- staged construction of new dual carriageway from the ACT border towards Murrumbateman with a 100 km/h speed limit
- improved intersections
- bypass of Murrumbateman
- realigning the existing road where required and building new carriageways.

After detailed assessment, a staged approach to full duplication was found to provide the best value for money to meet current and future levels of service when compared with building overtaking lanes. Staged duplication will also increase delivery flexibility, as stages could be progressively delivered or even combined to suit available funding.

Five stages of duplication:

Stage 1: **duplicating from the ACT border towards Kaveneys Road**

Stage 2: **duplicating from Kaveneys Road to Gooda Creek Road**

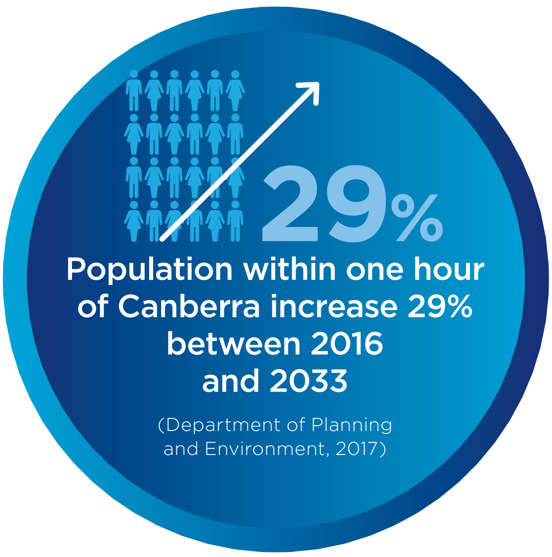
Stage 3: **realigning and building two carriageways from Gooda Creek Road to Vallencia Drive**

Stage 4: **building the Murrumbateman bypass from Vallencia Drive to the Gounyan Curves realignment**

Stage 5: **duplicating from the Murrumbateman bypass to the existing dual carriageways south of the Hume Highway**

2.1 Transport demand

The Barton Highway is experiencing strong traffic growth. This growth is expected to continue as Canberra and the surrounding regions experience continued increases in population and economic development.



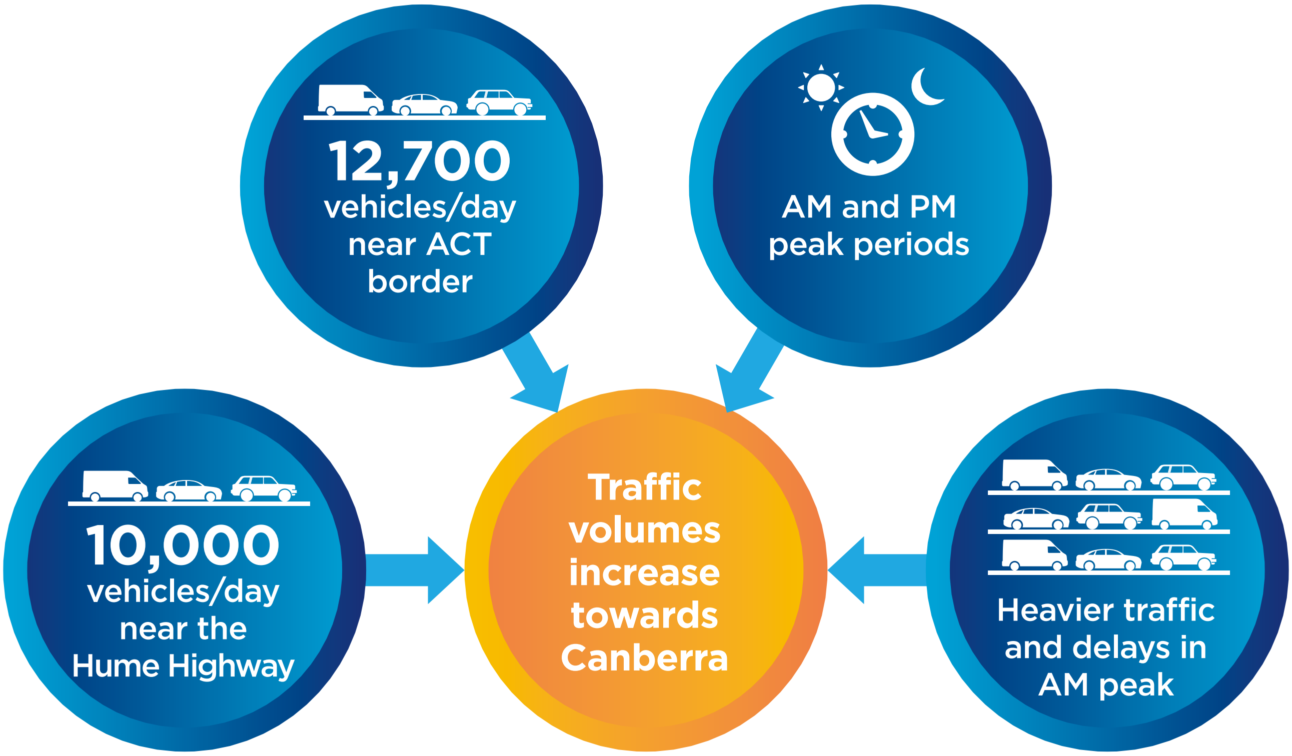
2. Overview (continued)

Yass Valley LGA's population increase is already visible from the number of new dwellings that have appeared in Murrumbateman and Yass in recent years.

This continued traffic growth is causing significant travel delays and safety issues, particularly during the morning and afternoon peak periods between Murrumbateman and the ACT border. Traffic growth will be monitored and this data will be incorporated in future economic studies for future projects.

2.2 Traffic and congestion

Increased traffic volumes also cause congestion at the end of overtaking lanes, when traffic merges back to a single lane and at intersections and property access points along the highway. Building more overtaking lanes would not provide sufficient capacity to meet future demand due to lack of space and topography.

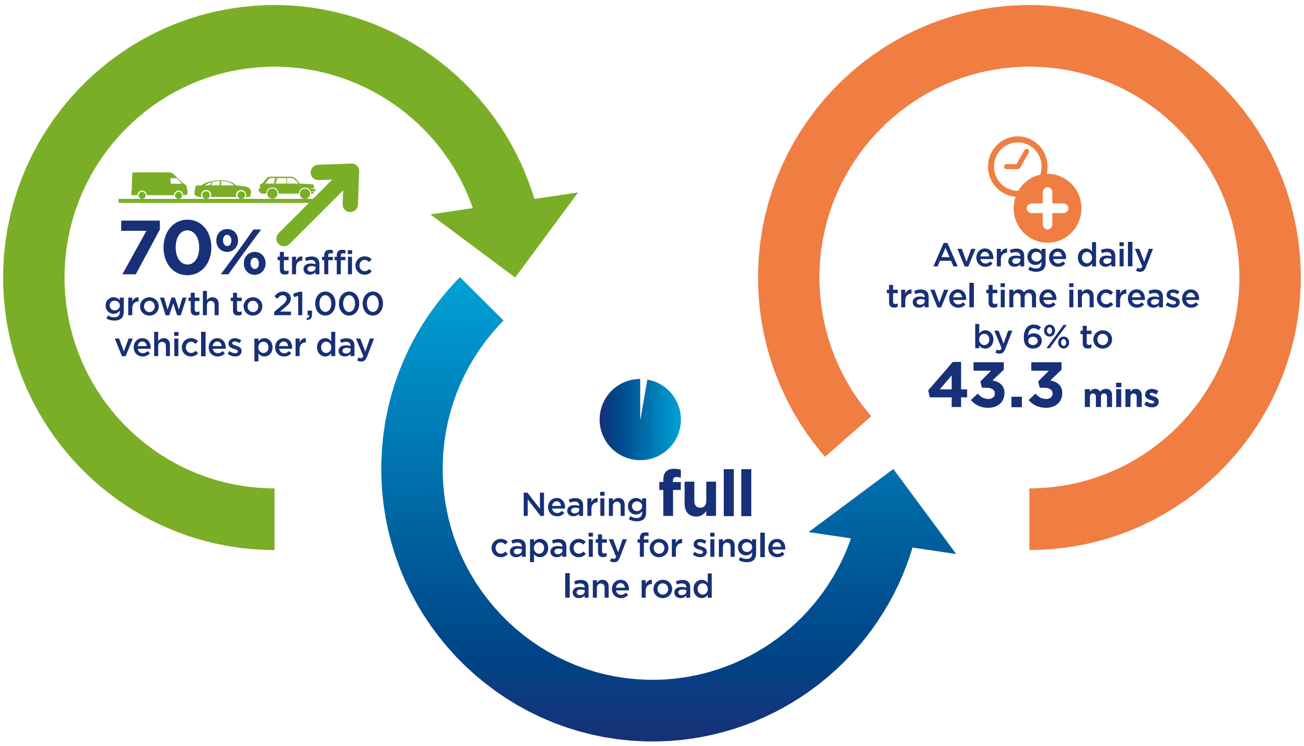


(Roads & Maritime, 2017)

All overtaking lanes on the highway are short by current standards. Although there are enough overtaking lanes along the length of the highway to meet current requirements, they are not evenly spread and can increase driver frustration, poor decision making and safety issues, including crashes. For more traffic detail see **Appendix A**.

2. Overview (continued)

Barton Highway traffic predictions by 2037 (without capacity improvements):



(AECOM, 2018)

The Barton Highway will not perform well under these predicted traffic increases without significant improvements. Current traffic congestion is evident by a poorer level of service for morning southbound travel south of Murrumbateman. Without highway improvements, levels of service are predicted to reach capacity and deteriorate to levels D and E for Murrumbateman commuter travel times during the northbound afternoon peaks and levels E and F for southbound morning peaks by 2037.

2.3 Driver behaviour

The fatality rate on NSW country roads is four times that of metropolitan roads. In 2017, 272 people lost their lives on a country road. This trauma affects local communities and families. On average, over 70 per cent of the lives lost on country roads are locals (Transport for NSW, 2018).

While many factors are contributing to higher risk on country roads – higher speeds, roadside hazards such as trees and embankments, longer travel distances and older vehicles – research shows that driver behaviour is still the most significant factor in crashes.

Speeding, driver fatigue, drink driving and not wearing a seatbelt are more likely to contribute to country fatalities and serious injuries. These contributors indicate there are higher levels of risk-taking behaviours among country drivers (Transport for NSW, 2018). Risky driver behaviour was identified by the community as a significant issue during the consultation process for the *Improvement Strategy*.

2. Overview (continued)

2.4 Road safety

The Barton Highway has a poor crash record. More than half (59 per cent) of the crashes were casualty crashes, or around 0.3 casualty crashes per kilometre, per year – more than double the average rate for similarly classed roads.

105 crashes recorded 1 July 2012 to 30 June 2017

Three fatalities	91 injured	17 crashes dual carriageway	88 crashes single carriageway

Head-on crashes	12 between 2012–17	Two fatalities	17 people injured

(Transport for NSW, 2017)

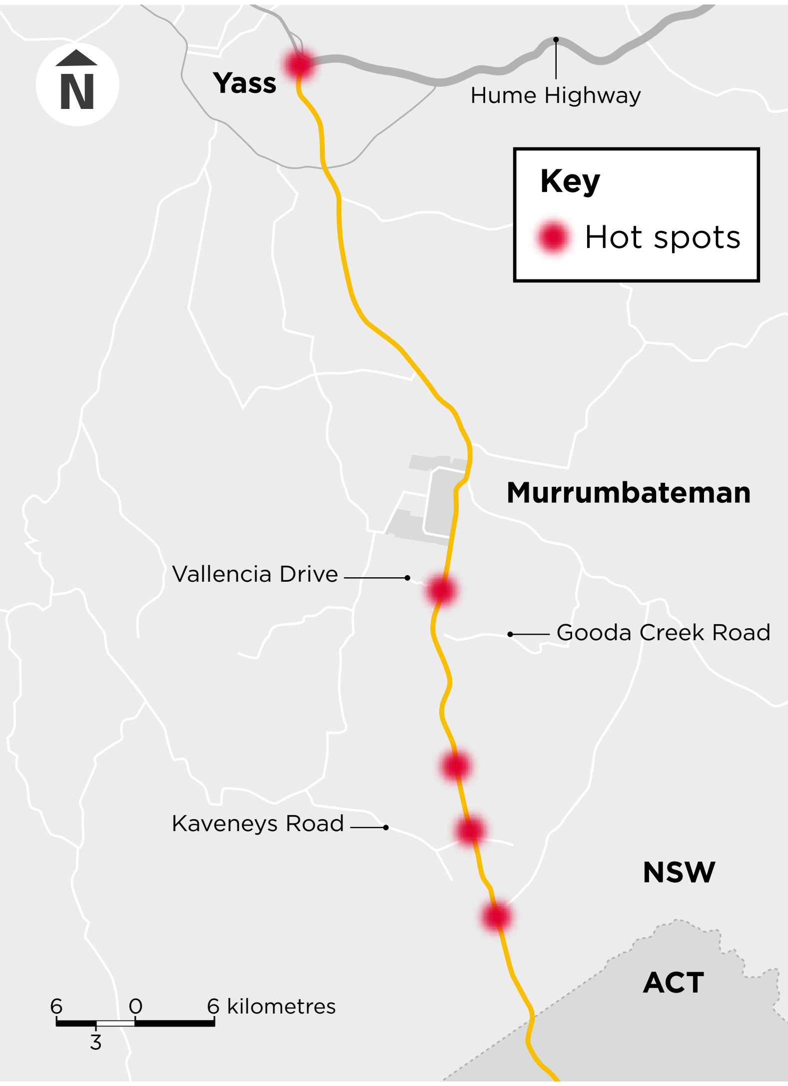
Head-on crashes appear to be caused by unsafe overtaking and driver frustration. Duplicating the highway would reduce head-on crashes by providing two lanes in each direction and median separation.

Further safety issues include:

- difficulty turning on and off the highway from private and commercial properties and at intersections due to heavy traffic
- varying speed zones, narrow shoulder and lane widths, lack of appropriate clear zones and reduced visibility due to vegetation
- incident management, which can be difficult due to the amount of single carriageway. Incidents can block the highway for long periods, with traffic diversions up to an extra 110 kilometres in some locations. Larger vehicles, such as B-doubles, are unable to use local roads south of the Hume Highway and must be diverted to the Federal Highway, causing further delays
- narrow shoulder and lane widths also increase the proximity of workers to traffic, creating work safety issues.

2. Overview (continued)

Figure 1: Barton Highway crash hot spots



2.5 Community expectations

Community and key stakeholders have repeatedly called for the Barton Highway to be duplicated, with consultation on duplication dating back to 1996.

Local Members of Parliament and Yass Valley Council have continuously petitioned for duplication to be actioned to address the community's serious concerns around safety issues.

The *Barton Highway Improvement Strategy* identified the local community finds driving on the highway stressful, with poor driver behaviour, lack of overtaking opportunities and difficulty navigating intersections and property accesses as crucial safety issues.

Population increases in Canberra and surrounding regions and resulting traffic impacts are expected to amplify these safety concerns and calls for duplication. For more information on stakeholder engagement, see **Appendix E**.

3. Benefits

Duplicating the Barton Highway has numerous benefits including:

- increased safety by reducing the occurrence and severity of crashes
- consistent driving conditions along the corridor
- increased lane and shoulder widths
- improved driver behaviour
- improved travel times, journey reliability and reduce congestion
- safer intersections and property accesses
- improved bus stop facilities
- meeting community expectations
- safer working conditions for maintenance and operations staff, including emergency services
- improved traffic incident management with contraflow arrangements
- improved access to Canberra and services
- increased regional connectivity and economic growth
- potential for off carriageway cycle way.

These benefits extend beyond the Canberra region and Yass Valley Council LGA.

The Barton Highway supports significant economic activity in NSW through the movement of freight to markets and communities to employment hubs from the Hilltops and Upper Lachlan LGAs to Canberra, as well as those in south west NSW from Albury and the Snowy Valleys to Wagga Wagga, Griffith and Hay.

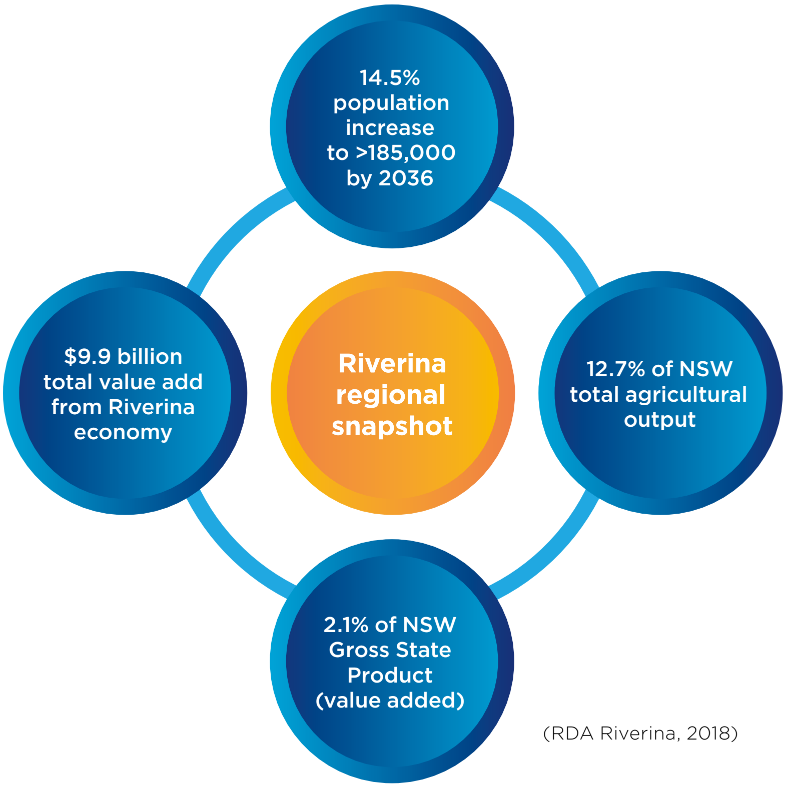
Residents living closer to Canberra rely on the Barton Highway to travel to work and school. The broader regions increasingly use it to access healthcare and economic markets, with heavy vehicle and commercial traffic expected to increase as these regions grow.

Like Yass Valley Council LGA, the Hilltops LGA and Riverina and Murray regions are also experiencing population and economic growth that is projected to continue over the coming decades.

Wine, grain, livestock, horticulture, dairy, and forestry are key economic drivers of the communities and regions surrounding Canberra, as well as those hundreds of kilometres away to the south and west. Manufacturing and construction industries are also key economic players from the Visy timber and paper mill in Tumut, to cast concrete in Griffith and manufactured engineering in Albury (RDA Riverina, 2018).

Access to international, national and regional markets is crucial to the economic development of these regions and communities, with the Barton Highway playing a strategic trade role to potential international markets via Canberra Airport.

3. Benefits (continued)



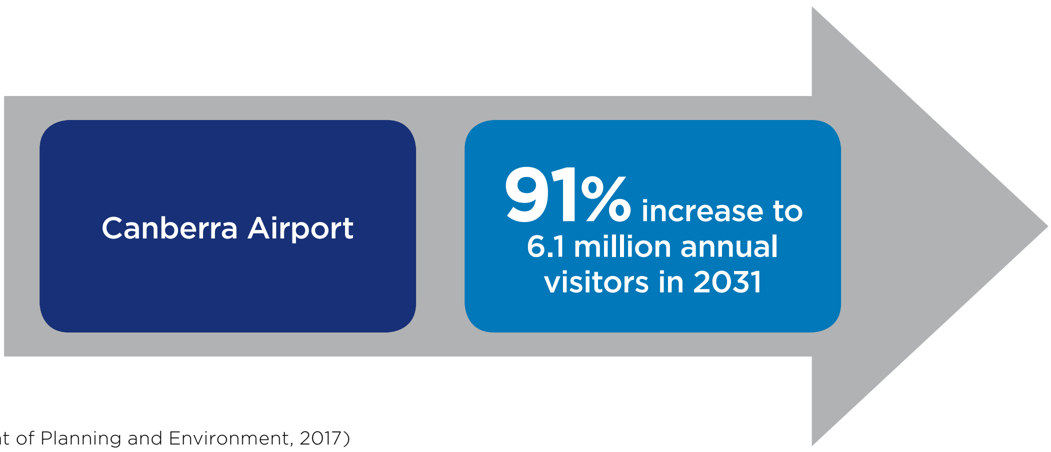
(RDA Riverina, 2018)

The Canberra Airport upgrade in 2014 has increased domestic and international tourism in the regions surrounding Canberra, as well as the Snowy Mountains and Riverina Murray regions (Canberra Airport, 2015).

This passenger growth is expected to increase demand for tourism in the Canberra and surrounding regions, particularly recreational activities in the Snowy Mountains, and food and wine found in the Yass Valley Council and Hilltops LGAs, and the Riverina.

The *Canberra Airport Master Plan 2014* outlines plans for a freight hub in the coming years, which, if approved, is expected to increase use of the Barton Highway by producers from the Canberra region, south west NSW and Victoria to export domestically and internationally to Middle East and Asian markets, particularly China (Canberra Airport, 2015).

These growth factors will place extra pressure on the highway's capacity to cope with increased traffic and freight demands from growing populations and trade opportunities in its neighbourhood, south west NSW and Victoria. Staged duplication will meet these demands.



(Department of Planning and Environment, 2017)

4. Duplication assessment

The *Barton Highway Improvement Strategy's* short term actions recommended the development of two overtaking lanes between the ACT border and Nanima Road to address capacity issues.

Restrictive traffic, safety and physical environment factors were identified during the strategic design phase that increased construction and operating costs of that short term action. Further investigation led to the short term action becoming Stage 1 of the highway's duplication from the ACT border towards Kaveneys Road, and the base case for the staged full duplication proposal of this business case.

A range of options were examined and modelled in traffic and economic terms to determine the order of delivery for the staged duplication of the Barton Highway.

Ultimately, staged duplication is dependent on traffic volumes and growth. The highest priorities in terms of condition, congestion, safety, deficiencies, traffic volume and growth are all located south of Murrumbateman.

4.1 Value management workshop

A facilitated value management workshop was held with NSW Government stakeholders in Wagga Wagga on 6 June 2018.

The workshop group reviewed investigations carried out to date, then evaluated the duplication staging options against the agreed assessment criteria, detailed below in Table 1, which were then weighted and ranked. For further detail on the workshop, see **Appendix B**.

Table 1: Staging priority value management assessment criteria

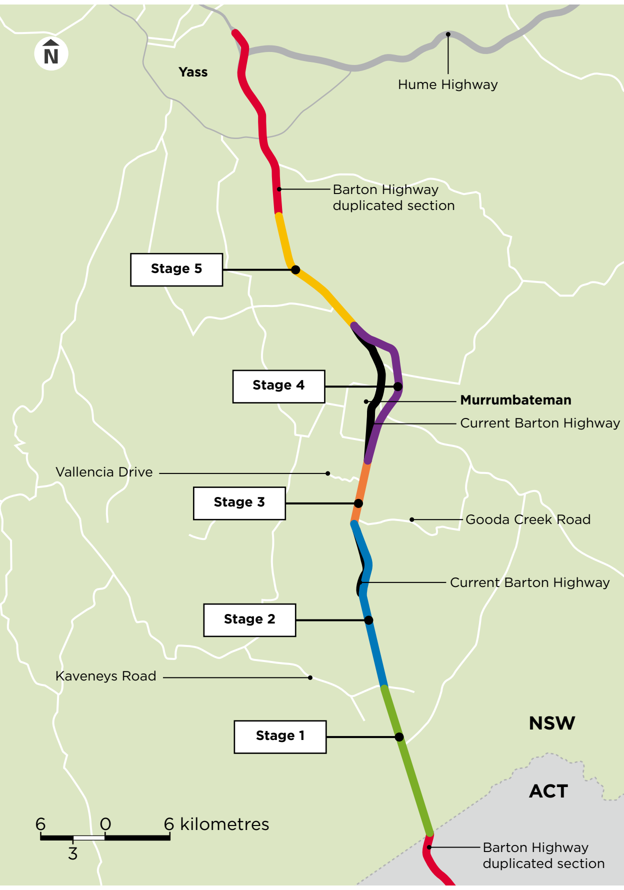
Assessment criteria
Improves travel efficiency for local and regional users
Improves road safety by reducing overtaking and head-on crashes as well as providing a more forgiving road environment
Avoids creating safety issues from building an inconsistent road environment
Improves local community amenity and gives the community and property owners confidence in the direction taken

After a detailed assessment, workshop participants agreed on the recommended priority order to build each duplication stage, as well as general process and design requirements, detailed below:

- **Stage 1:** ACT border towards Kaveneys Road – 8.1 kilometres
- **Stage 2:** Kaveneys Road to Gooda Creek Road – 7.4 kilometres
- **Stage 3:** Gooda Creek Road to Vallencia Drive – 2.2 kilometres
- **Stage 4:** Murrumbateman bypass from Vallencia Drive to Gounyan Curves – 5.3 kilometres
- **Stage 5:** Murrumbateman bypass to south of the Hume Highway – 7 kilometres.

4. Duplication assessment (continued)

Figure 2: Barton Highway duplication stages



Barton Highway and Kaveneys Road intersection, southbound

All stages

Environmental impacts, including Aboriginal heritage impacts, will be investigated, assessed and mitigated where relevant during each respective project concept phase.

Property acquisition will also be identified early in the concept phase and managed in line with the required guidelines throughout the duplication.

Concept design development for each project will consider urban design principles in line with a corridor urban design strategy.

Utility adjustments are expected for all stages and these will be investigated further during concept development.

Design requirements

The design requirements have been adopted to ensure a consistent approach when developing each stage's concept and detailed design phases. The design standards will also help provide a safer and more efficient road environment, allow for future traffic capacity and maximise value for money.

Generally, a duplicated Barton Highway will meet a minimum 110 km/h design speed to allow a posted 100 km/h speed limit. Local road connections to and from the new highway, including interchange connections, will meet a minimum 60 km/h design speed.

For more detail on each stage of duplication and adopted design guidelines, see **Appendices B and C**.

5. Scope

Using Stage 1 of the Barton Highway duplication from the ACT border towards Kaveneys Road as the base case, the scope of this business case is for continued staged duplication of the highway from the ACT border to the Hume Highway.

Staged duplication provides the best value for money solution for the highway's current and future capacity requirements. It generates optimal travel time and road safety benefits for the local community, as well as continued regional connectivity and economic growth.

The progressive staging involves building a duplicated highway in the agreed priority sequence outlined in section 4 of this business case.

6. Costs

Estimated total cost to deliver full duplication of the Barton Highway in the identified stages is around $1070 million ($2018). This cost includes contingencies to cover the proposed staged duplication over some years that may see higher cost increases in the later stages of delivery. Further detail on cost estimates, contingencies and lump sum items, are outlined in **Appendix D**.

Individual business cases will be developed for each construction stage noting that future funding may not align completely with the specified stages.

7. Environmental and sustainability impacts

Environment and sustainability are essential considerations during all project phases. Concept development and environmental assessment for each stage of the Barton Highway duplication will consider sustainability, including direct and cumulative environmental impacts to natural and physical environments, in line with NSW and federal legislation.

The highway mostly passes through open rural areas with few major environmental issues. Environmental issues for highway duplication include native vegetation impacts, Aboriginal heritage, and some non-Aboriginal heritage issues near the ACT border. Based on strategic environmental advice, no project impact is expected to be classified as a significant impact. Environmental approval is likely to fall within Division 5.1 of the *NSW Environmental Planning and Assessment Act 1979*. This will be confirmed as each stage is developed.

8. Project management and delivery

The program in this business case is to develop and deliver Barton Highway duplication in line with the agreed staging priority. Each stage will be considered as a separate project in the development and delivery phases for clear project management and reporting.

The current project stage estimates assume that construction will follow a traditional design then construct model using specialised contractors, except for Stage 1. Stage 1 is using an alliance contract to accelerate delivery. As funding becomes available the delivery model for each stage will be tested and an appropriate model selected. The timing for delivery, scale of funding and construction climate will affect that decision.

9. References

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Appendices

A – Traffic

B – Duplication assessment

C – Design requirements

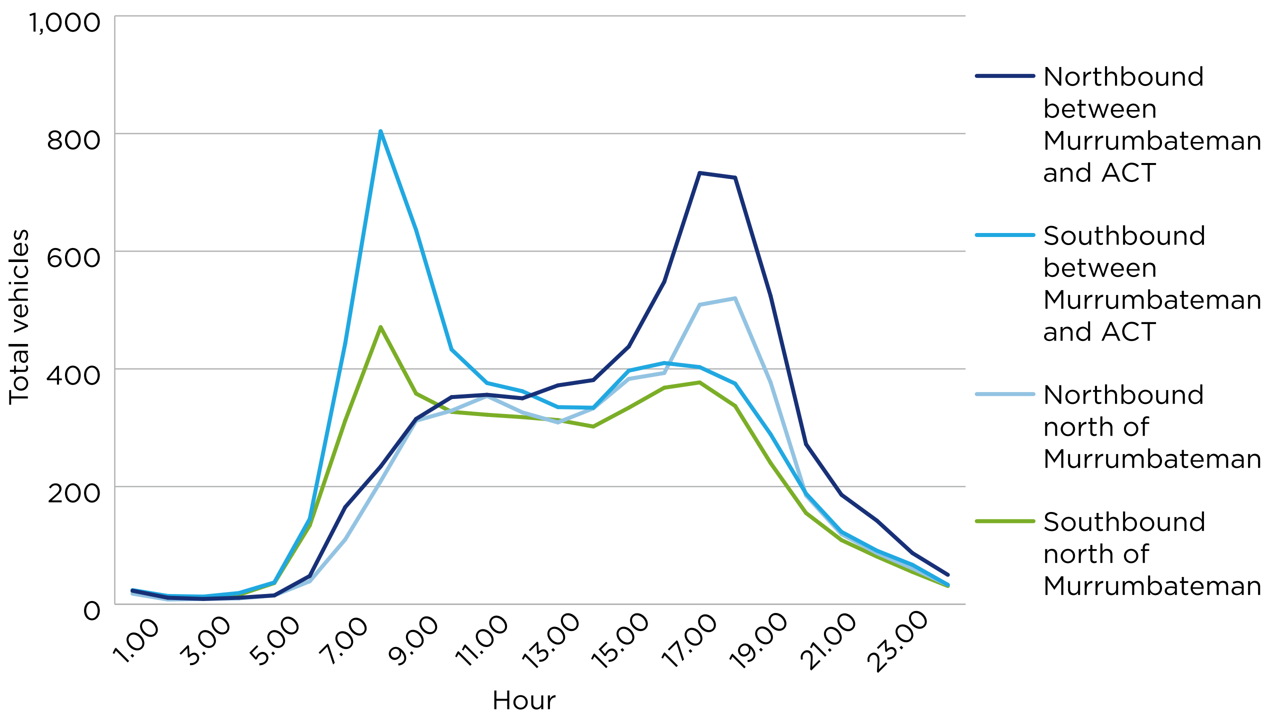
D – Economic assessment

E – Stakeholder engagement

Appendix – A Traffic

The Barton Highway currently carries around 12,700 vehicles per day (around 12 per cent heavy vehicles) close to the ACT border, with around 10,000 vehicles per day (around 11 per cent heavy vehicles) north of Murrumbateman. Figure 3 below shows the highway's peak period traffic distribution with clear southbound morning peak and evening northbound peak between Murrumbateman and the ACT border. A commuter travel pattern is also seen north of Murrumbateman, however morning and afternoon peaks are less pronounced indicating a relatively more even traffic flow.

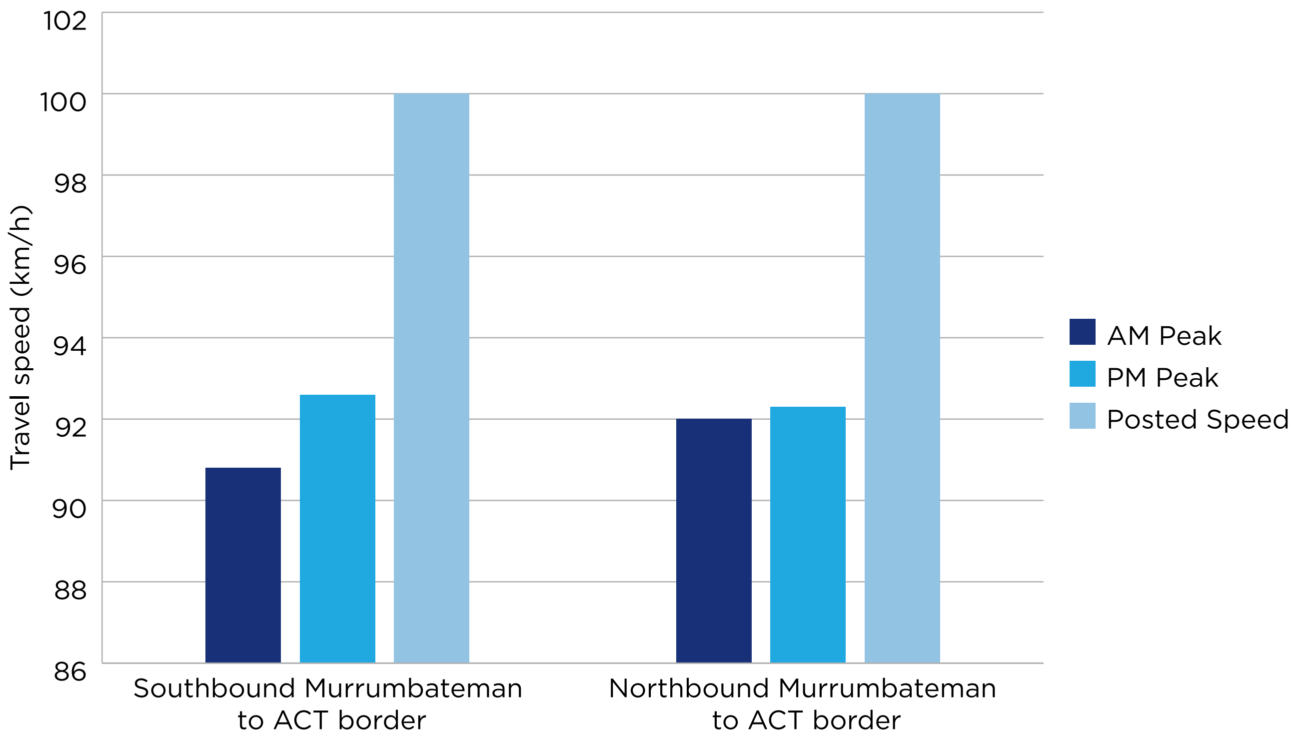
Figure 3: Barton Highway traffic distribution (2017)



Appendices (continued)

Peak flows reach more than 800 vehicles per hour for the southbound morning peak movement between Murrumbateman and the ACT border, creating congested conditions. As a result, traffic moves at a slower speed than the legal limit (see Figure 4 below) and commuters experience longer travel times.

Figure 4: Travel speed, Murrumbateman to ACT border (2016)



Morning travel time is also impacted by unreliable travel conditions and crashes interrupting traffic flow. With few overtaking opportunities, a slow moving vehicle may cause platooning, where traffic becomes grouped together, resulting in lower travel speeds. As determined in the *Barton Highway Improvement Strategy* between 60 per cent and 80 per cent of typical journeys are in grouped, or platooned, traffic. While the averages show travel speeds of 85 km/h to 92 km/h (posted speed 100 km/h) the individual journey for customers can vary substantially. Sustained following speeds in the high 70s and low 80s are regularly reported due to slower motorists on the roads. Modelling shows only one minute gain in the journey time for the average motorist following duplication. However this assumes the motorist is able to maintain or better the average speed for their journey. If instead of 88 km/h a customer is reduced to 75 km/h, the travel time increases by almost four minutes. This happens frequently enough to impact customer perception of the highway's capacity.

Appendices (continued)

Traffic modelling predicts traffic will grow by 3.5 per cent per year, or by around 70 per cent by 2037. This growth rate is in line with Yass Valley Council's predicted population growth. Assuming the strong commuter travel pattern continues over this time, this volume is close to the capacity for a single carriageway. Modelling predicts average daily travel times for the whole corridor length will increase from around 40.8 minutes in 2017 to around 43.3 minutes (increasing by around 6 per cent) in 2037 without provision of any extra capacity. Travel speed issues caused by a slow-moving vehicle would also increase with more traffic, further increasing driver frustration. Traffic growth will be monitored and this data will be incorporated in future economic studies for future projects.

Current and predicted levels of service for morning and afternoon peak periods are shown in Table 2 below. Currently, southbound level of service between Murrumbateman and the ACT border is level E. Without any change it is predicted to deteriorate to level of service F by 2037. In the afternoon peak, northbound is currently level of service D, expecting to deteriorate to levels E/F by 2037. At level of service D, passing capacity approaches zero and time spent behind other vehicles in platoons is noticeable. At level of service E, there is no passing capacity and most traffic is platooned.

Levels of service do not factor unpredictable travel conditions and are based solely on traffic volumes. Should a slow-moving vehicle be encountered, or an incident reduces travel speeds, these levels of service would deteriorate rapidly.

Table 2: Midblock level of service

Corridor section	Description	Level of service* (2017)		Level of service* (2037)	
		AM (Southbound)	PM (Northbound)	AM (Southbound)	PM (Northbound)
2**	End of the dual carriageway to Murrumbateman	D	D	E	E
3	Murrumbateman village precinct	D	D	F	F
4	Murrumbateman village to the ACT border	E	D	F	E/F

*Values based on *Austroads GtTM Part 3, Table 4.4 Volume to Capacity thresholds*
**Corridor section 1 includes duplicated section of road

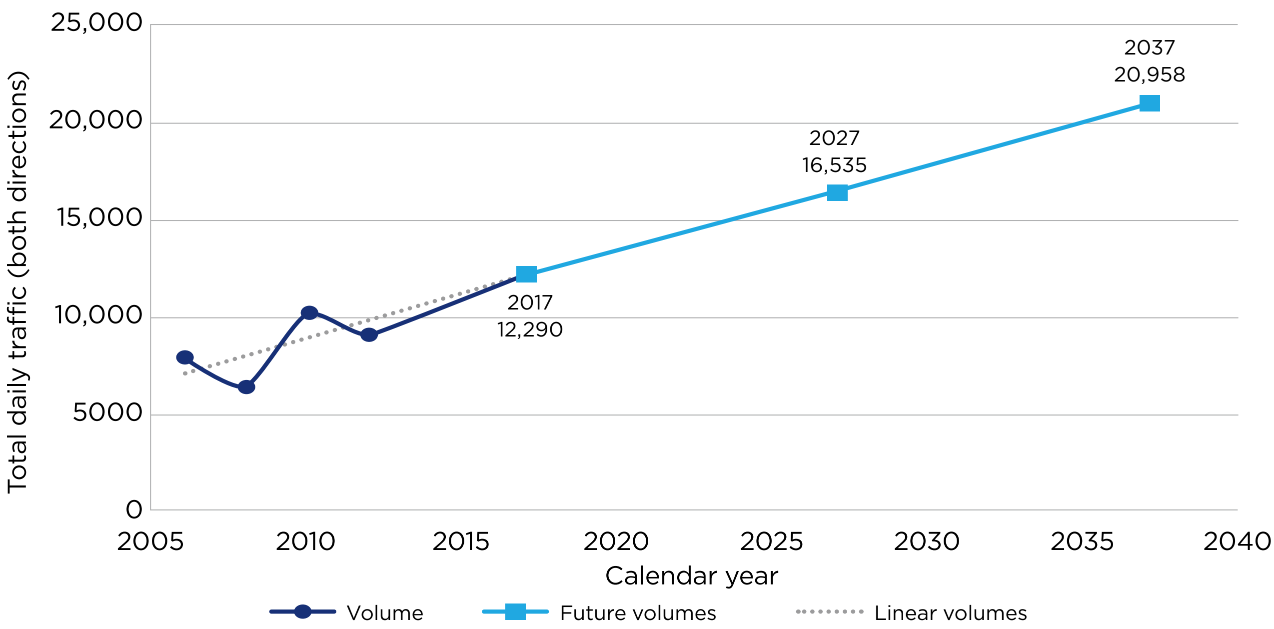
Appendices (continued)

Traffic growth has been determined by reviewing historic daily vehicle counts collected just south of Murrumbateman (Station ID 94445). These are summarised in Figure 5, together with a trend line for expected future growth. This shows a trend forecast growth rate around 442 vehicles per year. This reflects a growth rate around 3.5 per cent growth from 2017 traffic figures.

Future traffic growth projections from the Canberra Strategic Transport Model are similar with rates between 3.2 and 3.8 per cent, depending on the year. This review concludes traffic volumes in the corridor are growing at 3.5 per cent per year.

Growth will vary in different parts of the corridor. It will be highest on the Barton Highway south of Murrumbateman, with passing capacity approaching zero. Time spent behind other vehicles in platoons will be noticeable. Daily traffic volumes on local sideroads are generally less than 300 vehicles per day, so a broad linear traffic growth assumption across the model should not impact on model outcomes.

Figure 5: Historic and future traffic growth



Appendices (continued)

Table 3 compares total daily network results between base models for various model years. It shows the gradual growth in vehicle kilometres travelled (VKT), vehicle hours travelled (VHT) and average travel time per vehicle on the current network.

Total daily vehicles represent all vehicles in the network and not just through traffic. Travel time represents the average travel time for all vehicles in the model. Increasing travel times relate to increasing congestion in the network, including for highway through traffic.

Table 3: Total daily model network results comparison*

Year	Peak	VKT	VHT	Average travel time per vehicle (min)**
2017	AM	41,954	532	17.9
	PM	35,407	395	15.6
2027	AM	53,879	822	21.6
	PM	47,946	549	16.0
2037	AM	54,202	1,119	28.3
	PM	60,341	707	16.4

* Modelled on current corridor conditions
** Approximate figures as values have been rounded

A considerable drop in traffic efficiency is modelled in future base scenarios, with the total morning peak VHT more than doubling in 20 years. While part of this increase can be attributed to traffic growth, the rate of increase in VHT is not proportional to increases in demand. Similarly, average network travel time per vehicle would be over 10 minutes longer in 2037 compared to 2017 which equals a 58 per cent increase in 20 years. Most of this travel time increase is likely to be experienced by southbound morning peak commuters. These network-wide modelling results provide extra evidence that significant capacity constraints on the Barton Highway would limit its ability to maintain acceptable levels of service in the future if no improvements are completed.

Appendices (continued)

Appendix – B
Duplication assessment

The strategic design phase for Stage 1 identified building short, one-sided widenings that also tie in with the dual carriageway in the ACT was not feasible in the traffic, safety and physical environments. As an alternative, it was proposed to deliver a short length of duplication to provide the overtaking opportunity. This developed into a proposal to build a new northbound carriageway and use the existing southbound carriageway with safety work improvements.

This approach became the basis for full duplication of the Barton Highway. Previous planning suggested a full motorway standard road with grade separated interchanges, service roads and similar features.

In order to prioritise delivery, a range of sub options was examined and modelled in both traffic and economic terms. Ultimately, staging is dependent on traffic volumes and traffic growth with most traffic occurring south of Murrumbateman.

Traffic volume and efficiency is reflected in the level of service based on traffic conditions.

Highway duplication designs were reviewed and considered where they could be broken into reasonable project sections. When considering each section length, a project budget around $50 to $100 million ($2018) was assumed for each individual project except for the Murrumbateman bypass. This assumption was based on current funding commitments and resulted in some shorter sections. Subsequent modelling saw sections refined to five separate stages. Stage lengths considered locations where new road would connect to the existing road at safe tie-in points. Generally, this included avoiding intersections and below standard curves.

All intersections in the separate duplication stages have been assumed as at grade intersections. Two grade separated interchanges are planned for the Murrumbateman bypass at Hillview Road and a partial interchange at Euroka Avenue.

Once duplication staging lengths were determined, strategic quantities were prepared for each stage. These quantities informed strategic estimates for each stage. Estimates were prepared using appropriate unit rates for relevant quantities, allowances for unknown additional items including median crossovers and off-road (separate) cycle ways, and included appropriate contingency levels. Estimates are covered in more detail below however estimated costs are:

Table 4: Stage capital cost estimates

Stage	$ P50 (2018)*	$ P90 (2018)*
Stage 1: ACT border to Kaveneys Road	$160m	$180m
Stage 2: Kaveneys Road to Gooda Creek Road	$170m	$190m
Stage 3: Gooda Creek Road to Vallencia Drive	$80m	$85m
Stage 4: Murrumbateman bypass (dual carriageway)	$290m	$320m
Stage 5: Murrumbateman bypass to existing dual carriageways	$260m	$295m
Total	**$950m**	**$1070m**

* Approximate figures as values have been rounded

Appendices (continued)

The staging was modelled to determine benefits from each stage. When estimating traffic benefits, each stage was considered independently. Traffic modelling for each stage north of Kaveneys Road assumed highway duplication to Kaveneys Road.

Traffic modelling compared each stage against a base case without duplication. Travel time savings from each stage was the most important traffic benefit modelling estimated. Modelling also provided other inputs including predictions when traffic volumes and traffic delays would be great enough to require duplication.

Once strategic cost estimates and traffic benefits were calculated, an economic analysis was carried out for each stage. Benefits calculated included:

- travel time savings based on traffic model results, as outlined above
- crash saving benefits generated from reducing or eliminating crash types by duplicating the highway
- reduced vehicle operating costs by building an improved and smoother road surface
- benefits from providing for contraflow with a duplicated highway, eg reducing travel time and vehicle costs from avoiding detours when an incident closes the existing highway.

Economic benefits were calculated over a 30-year economic analysis period.

Value management workshop

A variety of options for staging the works were considered and included as an input to a value management workshop. The following information was assessed at the workshop:

- travel time savings, indicating how each section would meet the improved travel time and journey reliability objective
- crash reduction information, indicating how each section would address the safety objective
- estimated costs and economic benefits for each section to inform relative economic viability
- environmental constraints for each section to provide information on any sensitive environmental issues
- high level risks for each section.

A facilitated value management workshop was held with key stakeholders to consider what priority each section should have in different assessment areas as outlined below.

Table 1: Staging priority value management assessment criteria

Assessment criteria
Improves travel efficiency for local and regional users
Improves road safety by reducing overtaking and head-on crashes as well as providing a more forgiving road environment
Avoids creating safety issues from building an inconsistent road environment
Improves local community amenity and provides the community and property owners with confidence on the direction taken

Value management workshop results generated an agreed sequential order to build each stage, essentially from south to north, including the Murrumbateman bypass ahead of duplicating north of Murrumbateman.

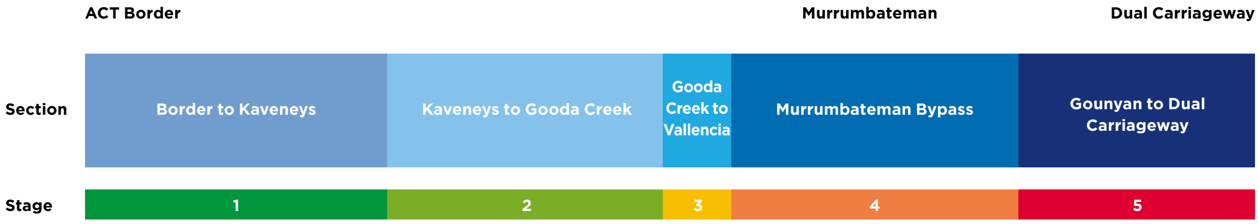
Appendices (continued)

Various staging options were discussed at the workshop. These were:

- **Option 1** – progressively build the dual carriageway from the ACT border to the north, finishing at the Hume Highway end
- **Option 2** – progressively build from both southern and northern ends of the highway, finishing at Murrumbateman bypass
- **Option 3** – progressively build from the ACT border to Murrumbateman, then from the Hume Highway to Murrumbateman, leaving a bypass last
- **Option 4** – progressively build the dual carriageway from the border and from Murrumbateman, followed by the bypass and then to the north
- **Option 5** – build an improved alignment and bypass with a single carriageway, followed by duplicating progressively from the border
- **Option 6** – build the Murrumbateman bypass first with other sections to follow.

Option 1 was recommended as the preferred option by participants, followed closely by Option 3. The preferred option is shown below.

Figure 6: Proposed staging



Duplication analysis

Full duplication is expensive in the short term and includes potential for the Barton Highway to be "over built", however it performs better in other areas including:

- **community expectations**
  - duplication matches community expectations
  - may create issues with right turn exit from properties being removed
- **effectiveness**
  - duplication removes or limits the potential for speed differential to create driver frustration
  - eliminates head-on style crashes
  - removes the majority of poor vertical curves improving visibility and overall safety
  - allows specific hazards to be addressed either by road improvement or protection
- **constructability**
  - no limitation on construction period
  - allows fast tracking of works
  - significant improvements in worker and public safety by removing plant and equipment near traffic
  - allows improved durability solutions
- **feasibility**
  - accesses, intersections and other impediments are more easily managed.

Acknowledging the early investment (over building) issue possible with duplication, it is still the preferred solution for further Barton Highway development.

Appendices (continued)

Appendix – C
Design requirements

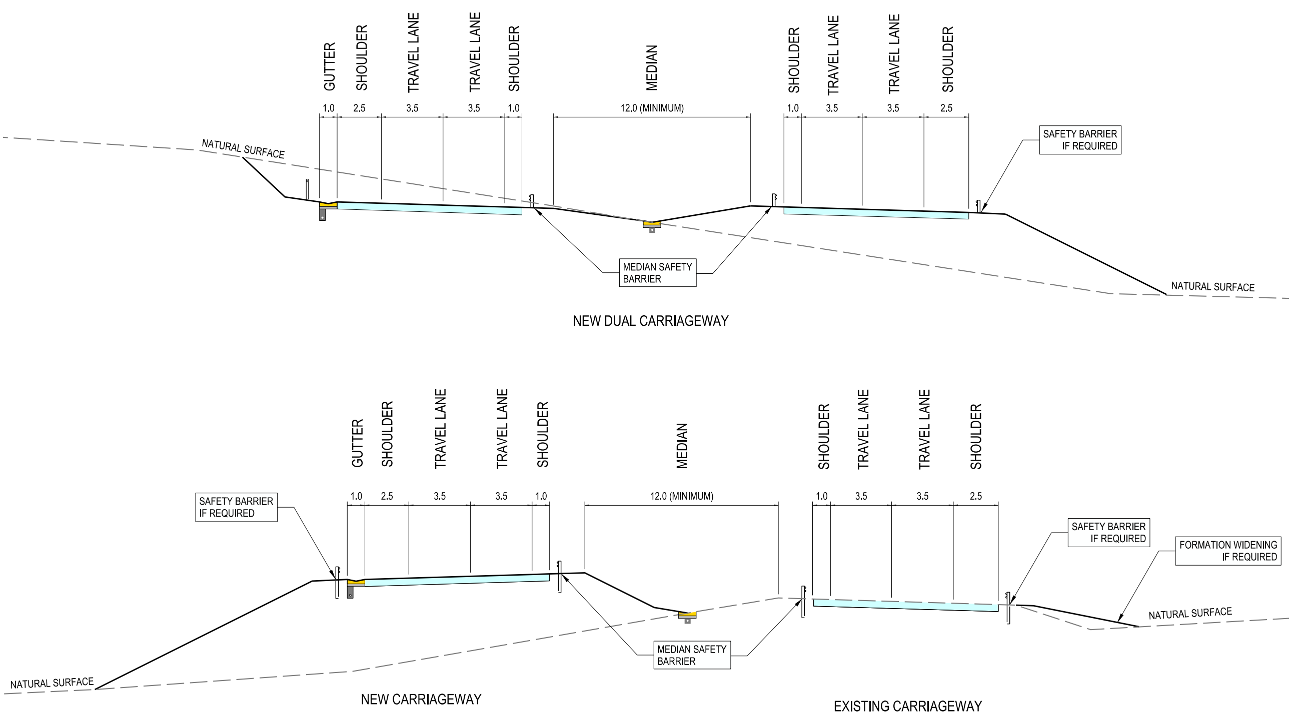
The following design requirements have been adopted to form a consistent approach when developing each stage's concept and detail designs. These design standards have been adopted to help road designs achieve highway duplication objectives by outlining parameters providing a safer and more efficient road environment. These standards allow for future traffic capacity and enable value for money for each individual stage's design.

Generally, a duplicated Barton Highway will meet a minimum 110 km/h design speed to allow a posted 100 km/h speed limit from Murrumbateman towards the ACT border. Local road connections to and from the new highway, including interchange connections, will meet a minimum 60 km/h design speed. Table 5 and Figure 7 below outline key adopted criteria for the dual carriageway.

Table 5: Adopted Barton Highway design cross-section elements

Design element	Roadway
Traffic lanes	2 x 3.5 m wide each direction
Shoulder width	2.5 m outside/1.0 m median 3.0 m outside/2.0 m median (next to barrier)
Median width (minimum)	12.0 m, including central median barrier
Verges	1.0 m (minimum)
Design speed	110 km/h

Figure 7: Typical cross-section for adopted guidelines



Appendix – D
Economic assessment

Cost estimates

Cost estimates for duplication have been carried out by AECOM based on strategic duplication design and are outlined in Table 6 below. The duplication estimated costs and rates are determined on the basis of the project being delivered by a competitive tender process.

Escalation has been applied to project costs in line with federal guidelines. This accounts for inflationary impacts on labour, material and equipment based on recent price outcomes for infrastructure investment across the state.

This rate has been applied based on an indicative expenditure profile relative to the nominated project timeline. Expenditure profiles have been calculated on this basis for P50 and P90 project cost estimates. It should be noted escalated costs have not been included in economic modelling.

Table 6: Capital project costs ($ million)

Capital costs	Duplication	
	P50*	P90*
Base estimate	$680	$680
Contingency	$170	$280
Project estimate	$850	$960
Escalation	$100	$110
Cost	$950	$1070

* Approximate figures as values have been rounded

Contingency

Contingency amounts on base estimates for duplication have been determined by using an empirical method. A contingency percentage was applied to each of the sub-elements of the budget estimate to develop P50 and P90 estimates.

This approach provides overall contingency amounts equivalent to the following base cost percentages:

- P50: 25 per cent contingency on base cost
- P90: 41 per cent contingency on base cost.

These estimates are considered to represent appropriate levels of risk.

Value of benefits

Duplication will generate substantial benefits to road users, particularly through savings in travel time and reduction in crash costs. As part of this economic analysis, potential benefits were quantitatively evaluated against a base case (Stage 1). Benefits quantified include:

- vehicle operating cost (VOC) savings
- vehicle travel time savings (VTTS)
- crash cost reduction
- environmental and other benefits
- incident detour route avoidance.

Table 7 provides a summary of the present value of benefits associated with each of these parameters, calculated over a 30-year evaluation period for each stage and based on a seven per cent real discount rate.

Table 7: Summary of benefit present values (P50, 7 per cent discount rate)

Benefit	Value ($2018)
	Duplication ($'000s)*
Vehicle operating cost savings	$5000
Savings in travel time	$103,000
Crash cost reduction	$120,000
Environmental and other benefits	<$1000
Worksite safety benefits	<$1000
Residual asset value benefits	$22,000
TOTAL	**$255,000**

* Approximate figures as values have been rounded

Vehicle operating cost (VOC) savings

VOC savings were derived from the Australian Transport Assessment and Planning (ATAP) Guidelines: *PV2 Road Parameter Values (2016)*. Adopted roughness information applied parameters were used for flat, straight, rural roads.

It is important to note the following tables incorporate all associated VOC including fuel consumption. Existing road roughness data were used to identify the surface quality for each stage to compare against the improved case and estimate cost savings. This assumed the new road is rated a very good surface. VOC used in the economic analysis are presented in Table 8, and includes cost savings due to avoiding extra vehicle kilometres travelled (VKT) due to road closure diversions. VOC costs per kilometre are slightly increased for duplication higher travel speeds.

Appendices (continued)

Table 8: Weighted average vehicle operating costs – resource cost (cents/km)

Option	Percentage in vehicle fleet	Base case	Duplication
Car	92.3%	30.62	30.62
Car towing	2.7%	36.84	36.84
Medium truck	4.4%	57.00	57.00
Semi-trailer	0.4%	113.01	113.01
B-Double	0.2%	134.91	134.91
Total average	**100.0%**	**32.49**	**32.49**

Total VOC savings were determined by comparing existing base case with duplication. The base case and duplication values used to calculate VOC savings are the same, and the savings (the difference based on fewer VKT than the base) are provided in Table 9.

Table 9: VOC savings ($ million, present value)

Option	Base case VOC	Upgrade VOC	Savings (base – upgrade)
Duplication	$1,059	$1,054	$5

Travel time savings

Vehicle hours travelled (VHT) was determined based on the vehicle travel time output provided in the traffic modelling and is presented in Table 10.

Table 10: Vehicle hours travelled (annual)*

Year	Base case	Duplication
2017	1,660,000	1,660,000
2027	2,300,000	2,100,000
2037	3,000,000	2,700,000

Unit economic costs for modelled travel times were based on ATAP *Road Transport Parameter Values*. Travel time savings are shown in Table 11 below.

Table 11: Travel time savings ($ million, present value)

Option	Base case	Upgrade	Savings
Duplication	$1,478	$1,379	$103.2

Appendices (continued)

Crash cost savings

Crash costs were calculated using parameters from Table 20 *Estimation of crash costs by injury severity, inclusive WTP values, June $2013* from the ATAP Guidelines *PV2 Road Parameter Values (2016)*.

To determine the safety benefits for duplication, a comparative analysis was carried out using crash statistics provided by Roads and Maritime Services for the base year. Improvement rates outlined in Table 13 are assumed at mid-points of ranges within that document. Estimates of crash costs were applied based on the severity of each crash as detailed in Table 12.

Crash costs have been divided into three categories (fatality, injury and property damage (tow-away) as shown in Table 12.

Table 12: Crash cost parameters (rural)

Crash severity	Cost per crash ($2018)*
Fatal	$9,840,000
Injury	$600,000
Property damage only (tow-away)	$600,000

* Approximate figures as values have been rounded

Average crash rates (crashes per 100MVKT) based on road type were applied to the average crash cost to derive crash cost savings.

Table 13: Barton Highway average annual crash rates

Section	Road type	Crash rate (crashes per 100MVKT)		
		Fatal	Injury (all)	Non-casualty (tow-away)
Base (existing crash stats)	Rural undivided	0.9	12.5	14.2
Stage 1	Partial rural divided	0.8	12.0	14.6
Stage 2	Partial rural divided	0.7	11.5	15.0
Stage 3	Partial rural divided	0.6	11.3	15.1
Stage 4	Partial rural divided	0.5	10.7	15.6
Stage 5	Partial rural divided	0.4	10.2	16.0

Appendices (continued)

Table 14 outlines safety benefits for duplication against the base case. Full duplication returns a significant safety benefit by dividing the road and eliminating head-on crashes as well as bypassing Murrumbateman where variation in speed, merging and congestion cause a higher incident rate.

Table 14: Safety benefits ($ million, present value)

Option	Base case	Upgrade	Savings
Duplication	$819.4	$699.1	$120.3

Environmental and other benefits

The ATAP guidelines recommend values from the Austroads report: *Updating Environmental Externalities Unit Values (2014)* for evaluating environmental and other benefits be used as the basis for the assessment. Table 15 presents the value of environmental and other benefits as adopted in this analysis.

Table 15: Value of environmental and other benefits

Vehicle type	Cost (cents/km, $2018)
Light vehicle	1.72
Heavy vehicle	9.57

Estimated value of environmental and other benefits depends on changes in VKT between the base case and duplication. The largest increases in environmental and other benefits were found through diversion due to road closures. Increased benefits were realised for duplication due to it enabling contraflow which eliminates the need for road closures. Overall environmental and other benefits, outlined in Table 16 below, are much lower than other benefits and have limited impact on the economic viability of options assessed.

Table 16: Environmental and other benefits ($ million, present value)

Option	Base case	Upgrade	Savings
Duplication	$66.5	$66.2	$0.3

Worksite safety

The calculation of worksite safety benefits is summarised in Table 17.

Table 17: Worker safety benefits ($ million, present value)

Section	Base Case ($ million)	Upgrade ($ million)	Savings ($ million)
Duplication	$0.10	$0.07	$0.07

Appendices (continued)

Road closure diversion

The calculation of road closure benefits is summarised in Table 18. Benefits associated with road closure minimisation are included within travel time savings.

Table 18: Road closure diversion benefits ($ million, present value)

Stage	Base case	Upgrade	Savings*
Duplication	$7.1	$2.2	$5

* Approximate figures as values have been rounded

Residual asset value

The residual value has been included in the benefits calculation as the 30-year evaluation period is less than the expected life of the road. A useful operating life of a road has been taken as 100 years. Table 19 outlines capital cost and residual asset value.

Table 19: Residual asset value ($ million, present value, 7 per cent discount rate)

Option	Capital cost	Residual value
Duplication	$547.1	$22

Intangible economic benefits

The Barton Highway upgrade project is likely to generate a range of benefits that are difficult to quantify and have not been included in the economic model. These intangible benefits have the potential to drive better economic and social outcomes for local communities along the corridor. Key benefits include:

- **improved regional connectivity** – duplication will improve access for communities between the ACT and the Hume Highway such as Murrumbateman and Yass. These communities have strong economic links to Canberra particularly in terms of employment opportunities and providing social services. Better and safer road links, as provided for through this upgrade, are likely to benefit these regional communities and further support ongoing opportunities related to their proximity to Canberra.
- **contribution to the local economy** – duplication will increase investment in the local area, especially during its construction phase. Capital spending, especially large-scale civil and earthworks, has the potential to boost local employment and businesses along the corridor.
- **better network resilience** – this analysis incorporates specific road safety benefits realised from building duplication. Additional (dual lane) capacity will provide better and more reliable access in the event of a traffic incident.
- **reduced operations and maintenance costs** – installing a new road is likely to provide interim benefits through reducing operation and maintenance requirements. Current standard road elements and roadside furniture such as barriers are likely to provide enhanced road performance requiring fewer operation and maintenance costs.

Economic appraisal

This economic appraisal examines the full Barton Highway duplication.

Sensitivity analyses results

The assessment depends on a range of assumptions, both in terms of financial parameters (i.e. discount rates) and cost and benefit assessments (e.g. traffic growth rates, strategic cost estimates).

Sensitivity analysis examined a range of factors within the economic model to test for the degree of change or 'sensitivity' of outputs. Factors include:

- varying the cost estimate
- varying the benefits
- delaying the project start.

A material reduction in project cost may be feasible when developing the stages of duplication further. At this strategic level, project costings are conservative and include significant contingency and lump sum allowances. Reducing costs through reducing development uncertainties and value engineering would improve the economic viability of duplication, especially those involving larger capital investments.

Financial impacts

The P50 ($2018) costs of the whole delivery program are estimated to be $950 million. The P90 ($2018) costs of the whole delivery program are estimated to be $1070 million. Individual staging strategic estimates are outlined below:

Table 20: Stage strategic cost estimates

Stage	$ P50* (2018)	$ P90* (2018)
Stage 1: ACT border to Kaveneys Road	$160m	$180m
Stage 2: Kaveneys Road to Gooda Creek Road	$170m	$190m
Stage 3: Gooda Creek Road to Vallencia Drive	$80m	$85m
Stage 4: Murrumbateman bypass	$290m	$320m
Stage 5: Murrumbateman bypass to existing dual carriageway	$260m	$295m
Total	**$950m**	**$1070m**

* Approximate figures as values have been rounded to millions

Above figures include amounts for work to improve the existing carriageway to meet agreed duplication standards. Cost estimates also include allowances for the following items:

- a rest area, median crossover or heavy vehicle enforcement bay in each section
- ultimate-level interchanges for the Murrumbateman bypass
- off-road (separate) cycle ways
- Intelligent Travel Systems (ITS).

Appendices (continued)

Appendix – E
Stakeholder engagement

Extensive consultation has been carried out to develop previous Barton Highway documents. Key relevant consultation has included extensive consultation with stakeholders and the broader community, including drop-in sessions and individual landowner discussions confirming duplication boundaries for Yass Valley Council's Local Environment Plan. Consultation sessions were also held during *Barton Highway Improvement Strategy* development.

Previous consultation has shown the local community consider:

- travelling on the Barton Highway to be stressful, particularly at peak times
- reducing travel delays and improving road safety were most important
- most community issues were between Mundays Lane and Murrumbateman. Issues related mostly to traffic delays in the area due to slow moving vehicles
- sections between Murrumbateman village and Euroka Avenue and between Nanima Road to the ACT border were most frequently identified as areas needing most improvement
- key issues most commonly reported by the community and stakeholders were poor driver behaviour, lack of overtaking opportunities and difficult intersection access. These issues received significantly more responses than other issues.

The community is well aware of the duplication and is a strong advocate for its delivery. Specific consultation for each delivery stage will be carried out during development of each project and will meet communication guidelines and processes. Key consultation for each duplication stage will occur during environmental assessment when potential social, environmental or economic impacts will be communicated, and appropriate mitigation measures considered before project determination. Consulting with the community and stakeholders during environmental assessment satisfies NSW and Commonwealth legal requirements.

Appendices (continued)

Table 21 below identifies stakeholders with an interest in the project. These stakeholders may either be impacted by a duplicated highway or may influence or advocate for it to be built. This list will be expanded as more stakeholders are identified for each project.

Table 21: Key stakeholders

Stakeholder group	Stakeholder	Issues/ potential issues	Recommended communication activities
Elected government representatives	Member for Goulburn (NSW) Member for Eden-Monaro (Aust)	Overall program and project progress and impacts	Individual briefings by Regional Director, regular briefs and updates through communications collateral
Other Government	ACT Government	Community impacts, travel delays	Information briefing before starting work within the ACT
	Department of Infrastructure, Transport, Cities and Regional Development	Regular reporting on progress and milestones	Steering Committee Member Monthly reporting
NSW Government	Transport for NSW	Funding and business cases, monthly reporting	Steering Committee Member Monthly reporting
	Infrastructure NSW	Assurance activities	Reporting as required
	Service NSW	Community inquiries	Ensure up to date program and project information is available
Local Government	Yass Valley Council	Community impacts, travel delays, business opportunities	Steering Committee Member Face-to-face, and on-site where required, meetings with Council staff and elected representatives, community updates, updates for council website

Appendices (continued)

Stakeholder group	Stakeholder	Issues/ potential issues	Recommended communication activities
Emergency services	Ambulance Police Force Rural Fire Service SES Local emergency management committee	Program delivery, project design, delays and emergency access during construction	Consultation during development and construction
Utilities	Telecommunications Gas Power Water	Program and project impacts on existing and proposed utility locations	During concept design and construction
Local residents	Adjacent residents	Program progress and impacts on access and final access arrangements	Updates during development and construction
	Highway communities	Program progress, project design, delays during construction, employment opportunities	Community updates and meetings
Local business	Yass Valley Business Chamber; business operators and owners	Business opportunities and transport delays	Briefings, community updates and meetings
Local community (other)	Local Aboriginal Lands Council	Program content and progress, project design and potential impacts on heritage	PACHCI engagement, community updates and meetings
	Local schools	Delays during construction on school bus routes/ travel times	Community updates

Appendices (continued)

Stakeholder group	Stakeholder	Issues/ potential issues	Recommended communication activities
Road users	Highway users including heavy and light vehicles	Program progress, project design and delays during construction. Alternative routes available	Community and industry updates and meetings
	NRMA	Program progress, project design and delays during construction. Alternative routes available	Consultation during development and construction
	Bus operators	Delays to scheduled services Project design	Industry consultation and updates
	Cycling groups	Program progress, project design and delays during construction	Community updates and meetings
Interest groups	Tourism, travel and accommodation industry	Program progress, project design and delays during construction. Alternative routes available	Community and industry updates and meetings
	Long distance recreational travellers including caravans/RVs	Program progress, project progress and delays during construction. Alternative routes available	Community updates and targeted information distribution
Transport and business	Transport operators and businesses using transport on the Barton	Program progress, project design and delays during construction	Community and industry updates and meetings
Air transport	Canberra Airport	Program progress, project design and delays during construction	Community and industry updates and meetings

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October 2019