Bannockburn South East Precinct Structure Plan

Integrated Transport Assessment

PREPARED FOR THE VICTORIAN PLANNING AUTHORITY
DECEMBER 2024 | 300304732

We design with community in mind

Stantec

Revision

Revision	Date	Comment	Prepared By	Reviewed By	Approved By
Dr-1	03/10/2024	Draft	Liz Irvin / Todd Mexted	Alex Blackett	Reece Humphreys
Fin-1	03/12/2024	Final	Alex Blackett	Alex Blackett	Reece Humphreys
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For and on behalf of

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Acknowledgment of Country

Stantec would like to acknowledge the Traditional Owners of the lands on which this report was prepared, the Wurundjeri people of the Kulin Nation. We pay our respect to their Elders past and present, and extend that respect to all Aboriginal and Torres Strait Islander peoples.

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1. Introduction

1.1 Background

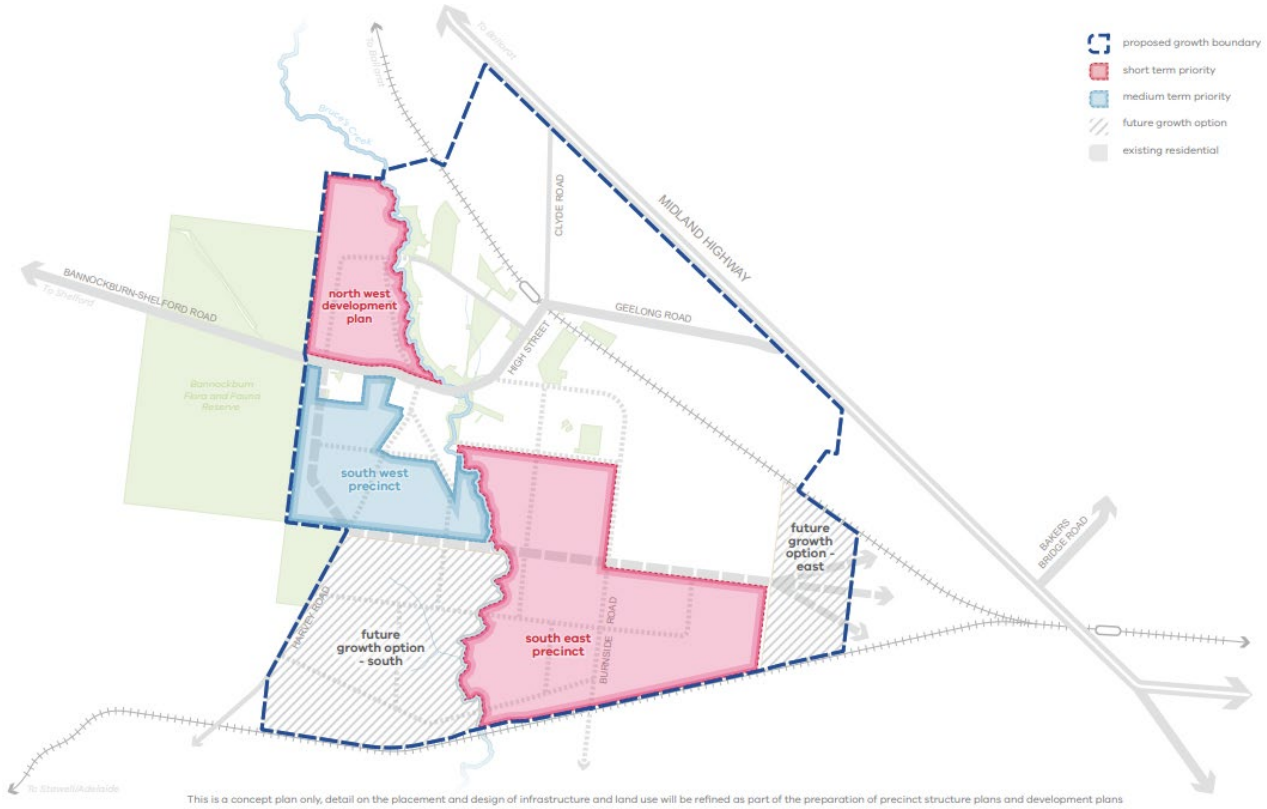
Stantec has been engaged by the Victorian Planning Authority (VPA) to prepare an Integrated Transport Assessment (ITA) to inform the development of a Precinct Structure Plan (PSP) for Bannockburn South East.

The PSP is located south of the Bannockburn town centre, which is the largest urban centre in Golden Plains and is located approximately 20km northwest of Geelong. Bannockburn has been a fast growing regional area, where it has had an annual average population growth rate of 5.8% between 2006 and 2011, and 6.6% between 2011 and 2016, as indicated through Victoria in Future (VIF, 2019). The town is expected to grow to some 13,000 people by 2036 (VIF, 2019), which is more than double its current population based on the 2021 census.

To help with this expected continued growth in the area, the Bannockburn Growth Framework Plan[1] was developed and gazetted in 2021, providing guidance around the sustainable development of Bannockburn to the year 2050. The Framework Plan focused on the delivery of the North West, South West and South East PSPs, which are expected in total to accommodate some 6,200 dwellings and 18,300 residents. However, it also gives some consideration to other potential PSPs within the Bannockburn Growth Boundary to help support population projections beyond 2050.

Figure 1.1 illustrates the location of the South East PSP in the context of the other PSPs within the Bannockburn Growth Plan, with the Framework Plan provided in Figure 1.2 illustrating the proposed land uses and other key features. Figure 1.1 and Figure 1.2 also show the key roads providing access and the two freight lines that converge to the east of Bannockburn. Going through Bannockburn, the main road is the C143 (which includes Bannockburn-Shelford Road, High Street and Geelong Road) that forms the main street in the town centre, crosses the Geelong-Ballarat railway line and connects to the Midland Highway (A300).

Figure 1.1 – Bannockburn Growth Plan – Proposed Growth Areas



Source: VPA, 2021

[1] Bannockburn Growth Plan - VPA

Figure 1.2 – Bannockburn Growth Plan – Framework Plan

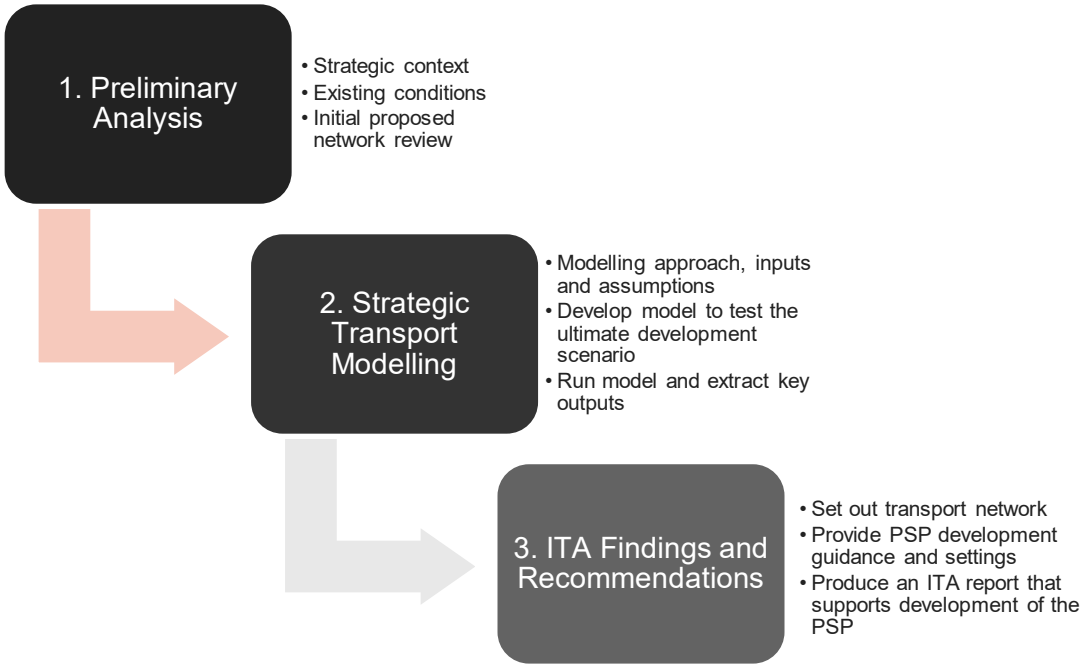
Source: VPA, 2021

1.2 Study Purpose

The purpose of the ITA is to assess the ability of the traffic and transport planning elements of the South East PSP to support the proposed land uses. The study relies upon transport modelling to inform and support the preparation of the PSP. The strategic modelling considers the full delivery of the Bannockburn Growth Areas in 2051 (resulting in a population for Bannockburn of 47,784), to assess the transport network within the Bannockburn South East PSP, including consideration to a proposed east-west arterial road.

An overview of the key tasks associated with the ITA are provided in Figure 1.3.

Figure 1.3 – Project Process Overview



2. Strategic Planning Context

2.1 Precinct Planning

The undertaking of the ITA for the Bannockburn South East PSP forms part of the broader precinct planning process, which is a core activity of the VPA. Guidance on the preparation of PSPs in Greenfield areas is provided by the VPA and published in 2021[2]. A guidance note was also published about applying the PSP Guidelines in regional areas. The purpose of the guidance document is to set out what should be addressed in preparing or assessing a PSP. They aim to deliver outcomes consistent with the 20-minute neighbourhood, which is all about living locally – giving people the ability to meet most of their daily needs within a 20-minute walk from home.

In this regard, the PSP guidance sets out the following target adaptations that must be responded to in an integrated and flexible manner:

- Viable densities
- Safe, accessible & well-connected
- High quality public realm
- Connect people to jobs & services
- Services & destinations
- Thriving local economies.

2.2 Growth Planning

Victoria is growing and is expected to continue to do so in the coming decades. While metropolitan Melbourne will accommodate the majority of this growth, regional Victoria is expected to grow from 1.5 million people today to 2.2 million people in 2051. The total Victorian population is projected to reach over 10 million people by 2051. This growth requires the provision of many new dwellings, jobs and other community infrastructure[3].

As this growth is not expected to be accommodated solely by infill development and urban renewal, growth areas are planned within Melbourne's urban growth boundary, and along and around major regional transport corridors.

Bannockburn is identified as a sub-regional employment centre by the G21 Geelong Region Plan, and the VPA has developed a Growth Framework Plan to guide the sustainable development of Bannockburn to the year 2050. The document identifies three priority growth areas and two future growth options. The South East growth area is the largest of the priority three, with an estimated net developable area (NDA) of 345 hectares, which will provide some 5,400 dwellings for a population of some 15,750 people. It is also noted that the other priority growth areas in the North West and South West will supply some 2,400 dwellings for some 7,150 people.

Whilst the South East PSP is the focus of this report, all PSPs will be considered in the modelling to better plan for the anticipated transport needs of Bannockburn. Further details in relation to the growth anticipated in 2051 with each PSP resulting in a total Bannockburn population of 47,784 is provided in Section 6 of this report.

[2] Precinct Structure Planning Guidelines - VPA
[3] Plan Melbourne 2017-2050

2.3 Other Planning Documents

There are a range of other planning documents that inform the development of the Bannockburn South East PSP. Table 2.1 provides a summary review of the documents most relevant to the development of the South East PSP and ITA.

Table 2.1 – Other Planning Documents Summary Review

Document	Description	Implications
G21 Regional Growth Plan	G21 is the formal alliance of government, businesses, and community organisations, working together to improve people's lives in the Geelong region.	Identifies Bannockburn as a district town that will support significant residential growth. Bannockburn is also identified as a sub-regional employment centre for retail and commercial functions. Bannockburn provides larger lifestyle lots and affordable housing options compared to Metropolitan Melbourne and Geelong. The town provides services for its residents and those of surrounding smaller towns such as Lethbridge, Shelford, Inverleigh, Teesdale and Batesford.
Bannockburn Growth Framework Plan	The Growth Framework Plan sets out the vision and strategy for a sustainable development of the town for the next 30 years.	The Plan proposes an indicative east-west arterial road connecting Bannockburn-Shelford Road via the southern growth areas to the Midland Highway to reduce traffic through the town centre. A modal shift towards active and public transport is encouraged. The document advocates for the reinstatement of a passenger train service on the Geelong-Ballarat rail line.
Bannockburn South East Draft Place Based Plan	Draft Place Based Plan which outlines proposed land uses and precinct boundary.	The plan shows the location of the potential east-west arterial road, noting there are various options in how it might connect with Midland Highway.
Bannockburn South East PSP Co-Design Summary Document (2022)	Summary of the Co-Design Workshop for the Bannockburn South East PSP held online in August 2022. It provides the basis for the development of a place-based plan for the PSP.	One of the outcomes of the workshop is further investigation to revisit traffic modelling to determine function and design of arterial road and broader transport network.
Bannockburn Urban Design Framework (2011)	Review of an older UDF to address issues arising from strong growth and resulting development in Bannockburn. The intent of the Framework is to identify principles to guide appropriate growth and development in the town.	The document identifies a need for a bypass route to accommodate future increased traffic flow. There is a high number of service road and driveway entries into High Street that are confusing and have poor sightlines. Bannockburn's town centre requires consolidation, rationalisation and a clear definition of the extent.
Bannockburn Transport Strategy (2019)	Document prepared by Stantec that sets out traffic management, sustainable transport and car parking strategy.	High volumes of heavy vehicles use Shelford-Bannockburn Road and travel through Bannockburn town centre to access the Midland Highway. The strategy recommends to advocate for a heavy vehicle bypass route through Bannockburn South East PSP.
Bannockburn Transport Strategy Traffic Modelling Report	Appendix of the Bannockburn Transport Strategy that presents traffic modelling findings.	The modelling did not include heavy vehicle bypass options and assumed full development in 2036. A 2.1% traffic growth per annum was calculated for Shelford-Bannockburn Road.
Bannockburn Transport Strategy Existing Conditions & Issues and Opportunities Assessment Report	Appendix of the Bannockburn Transport Strategy that describes the existing transport conditions and opportunities and informs the strategy.	Around 10,000 vehicles travel through Bannockburn's town centre of which approximately 10% are heavy vehicles (including B-doubles). Shelford-Bannockburn Road is expected to exceed its capacity in the future. This document also advises to consider a heavy vehicle bypass to detour freight vehicles around Bannockburn town centre onto the Midland Hwy.
Bannockburn Growth Framework Plan - Traffic Network Assessment (2020)	Document prepared to identify a possible future road network and arterial road options for further investigation.	Document concludes that an additional arterial road is required to provide an alternative for heavy vehicles and improve traffic operations, safety and amenity in Bannockburn's town centre. It assess five route options of which two are deemed suitable. One of these suitable options has a similar alignment to the Bannockburn Growth Plan east-west arterial road alignment.
Midland Highway Upgrade Business Case project	DTP are actively engaged in a comprehensive study aimed at assessing the current and future transport capacity of the Midland Highway between Bannockburn and Geelong. The study seeks to gain a	The project is investigating the potential duplication of the Midland Highway. Ultimately this would provide improved access between Bannockburn and Geelong via the eastern extent of Shelford-

Document	Description	Implications
	thorough understanding of existing data and identify possible potential interventions to accommodate future growth. There is no construction funding committed to any of the infrastructure improvements on the Midland Highway that will be identified by the study. Future upgrades will require funding bids to be submitted to Government for consideration.	Bannockburn Road (C143) where it meets the Midland Highway.
Expert Evidence for Draft Amendment to the Golden Plains Planning Scheme Bannockburn Growth Plan (2021)	Expert Evidence report on behalf of the VPA to undertake a review of the transport elements of the draft Bannockburn Growth Plan and to prepare a traffic expert evidence statement.	Submissions have been received with concerns in relation to the form and alignment of the proposed east-west arterial road and in relation to the need for two bridges across Bruce Creek within the South East Precinct. The evidence document states that the development of the South East PSP will result in key routes in Bannockburn's town centre being over capacity. The delivery of the proposed east-west arterial road is required.
Bannockburn SE Bridges Feasibility Assessment Options Assessment	The feasibility assessment considered three bridge locations to cross Bruce Creek in the Bannockburn South East Precinct.	Due to environmental constraints only one of the locations was deemed feasible. This location is in the northern region of the precinct, along a future un-named east-west arterial road approximately 100m south of the southern extent of Levy Road.
Bannockburn Heavy Vehicle Alternative Route Study Draft Final Report (2013)	The study proposes high-level options for an alternative heavy vehicle route around Bannockburn feasible to be further investigated.	Heavy vehicle traffic on High Street has been an ongoing issue for Bannockburn town centre. Proposed bypass option 5 is similar to the alignment to the Bannockburn Growth Plan east-west arterial road alignment.

3. Existing Network Conditions

3.1 Modal Priorities

Modal priorities are classified through the Movement and Place (M&P) framework[4]. The M&P framework recognises that streets not only keep people and goods moving, but they are also places for people to live, work, and enjoy. In this regard, road corridors and streets are defined by the context of the interfacing land use and assigned various 'movement' and 'place' classifications. This way of thinking implies that during planning and development of our transport network, we need to consider for movement and placemaking simultaneously (i.e. providing suitable levels of access to places while making them attractive for people to spend time in).

The Department of Transport and Planning (DTP) provides the Movement and Place classification across the Victorian transport network through an online mapping portal. The provided M&P classifications represent the current long-term aspirations, rather than the existing conditions. They are regularly updated as part of typical transport network and land use planning activities, such as the development of the Bannockburn PSP and ITA.

The current M&P classifications for the South East Precinct and wider Bannockburn have been identified and included in Appendix A. High Street (C143) is the key road running through the Bannockburn town centre and it performs an important through movement function, whilst the town centre is also classified as a place of neighbourhood importance. As such, a balance is required in the town centre between maintaining the through movement function and providing appropriate levels of placemaking and road safety for all users, at least until an alternative regional level through movement route is provided.

The existing transport network proximate to the South East Precinct is generally intended to support M&P functions at a local level. It is noted that a potential east-west arterial road is not contemplated in the available M&P mapping, however its inclusion is expected to provide a regional level movement function through the precinct and help downgrade the current movement function of High Street through the town centre, helping to improve its place function and associated activities.

The Midland Highway, which connects Bannockburn to Geelong, currently includes M&P classifications intending to support general traffic and freight through movements, whilst also proposed to support walking.

3.2 Road Network

Approximately 10,000 vehicles per day travel through the Bannockburn township on High Street. Around 10% of these vehicles are heavy vehicles and include B-doubles. The growth of Bannockburn is expected to have a significant impact on the traffic flow and character of its town centre, especially given it provides the only current crossing of the Geelong-Ballarat railway line. This single crossing point connects Bannockburn to the Midland Highway.

The existing road network within and proximate to the Bannockburn South East Precinct is outlined in Figure 3.1 and the key characteristics of the main roads are summarised in Figure 3.1.

[4] Movement and Place in Victoria | vic.gov.au (www.vic.gov.au)

Figure 3.1 – Road Network Bannockburn

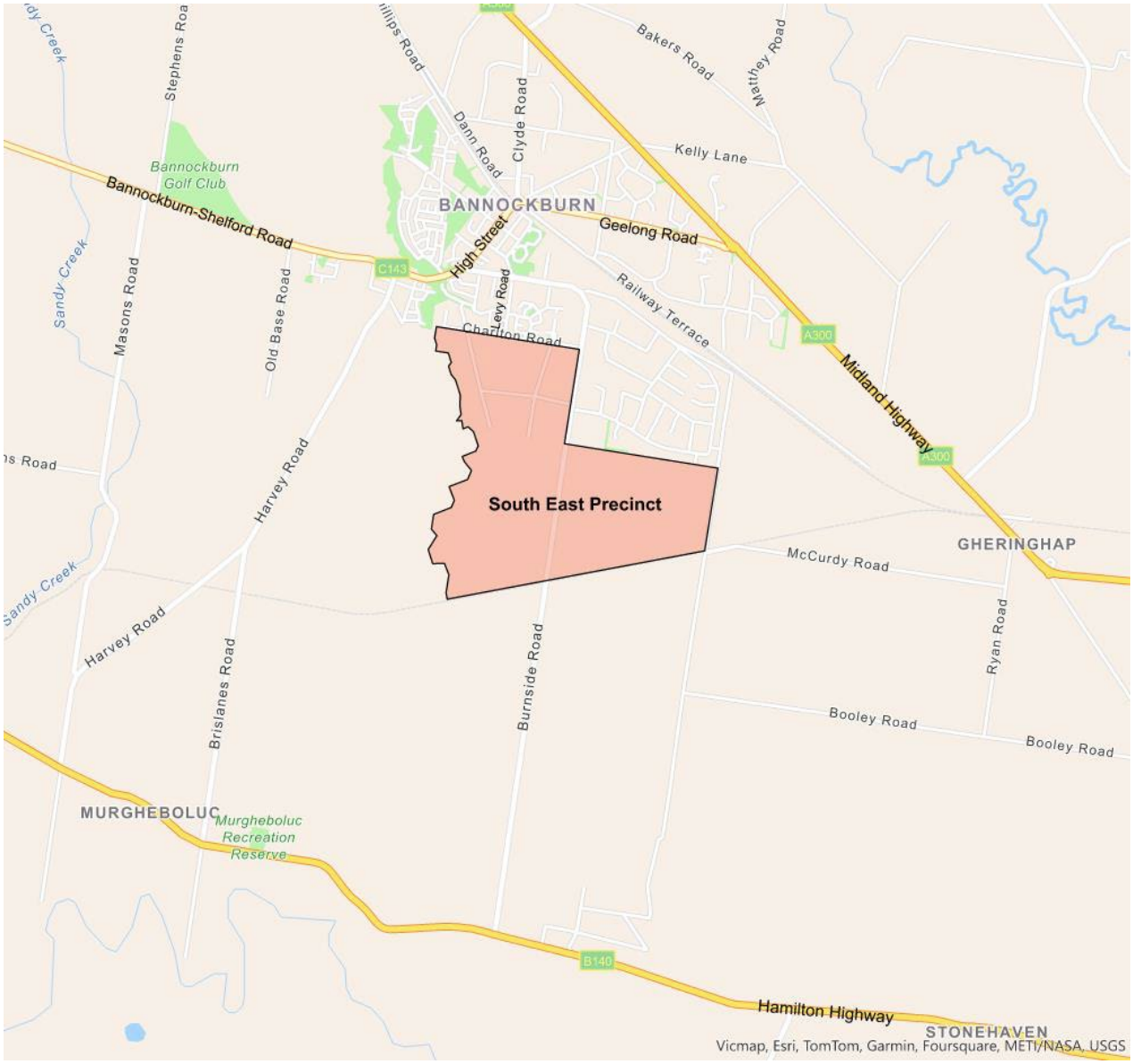


Table 3.1 – Existing Road Characteristics

Name	Type	Carriageway Configuration	Road Reserve Width	Speed Zone	Daily Volumes[5]
Midland Highway (A300)	Primary State Arterial	Undivided with 2-lanes, with short section of 4-lanes (for overtaking)	65m	80-100km/h	16,000
Hamilton Highway (B140)	Primary State Arterial	Undivided with 2-lanes	20-60m	100km/h	5,300
Bannockburn-Shelford Road (C143)	Secondary State Arterial	Undivided with 2-lanes	60m	60-100km/h	3,600
High Street (C143)	Secondary State Arterial	Divided with 2-lanes and service road both sides	60m	60km/h	9,200

[5]DTP, Traffic Volume | Traffic Volume | Department of Transport (arcgis.com), accessed: 09/07/22 or as provided by Council.

Name	Type	Carriageway Configuration	Road Reserve Width	Speed Zone	Daily Volumes[5]
Geelong Road (C143)	Secondary State Arterial	Undivided with 2-lanes	60m	60-80km/h	9,200
Burnside Road	Major Local Road	Undivided with 2-lanes	20-60m	60-80km/h	1,800
Charlton Road	Local Traffic Street	Undivided with 2-lanes	20m	50km/h	180
Levy Road	Local Traffic Street	Undivided with 2-lanes	20m	50km/h	850

3.3 Road Safety

A review of the reported accident history for the roads in Bannockburn including the South East Precinct area has been undertaken and is included in Appendix B. This review indicates that 28 of the 34 crashes in the area occurred on the State Arterial Road network, with 8 occurring along C143 and 20 along the Midland Highway. Proximate to the South East Precinct, two 'other injury' crashes occurred along Burnside Road. One serious injury occurred north of the South East Precinct along Burnside Road.

Consideration of these existing crashes and general road safety within and accessing Bannockburn has been considered throughout this report, noting that any new roads would be expected to be designed to the current and best practice design standards, which adopt the Safe System principals in trying to eliminate serious and fatal injuries.

3.4 Active Transport

Within the South East Precinct there are no existing active transport facilities. Within the areas proximate to the PSP boundary, the active transport facilities are as follows:

- A footpath along the northern section of Burnside Road, on the east side of the road, which is to the east of the South East Precinct. This footpath then runs east along Glen Avon Drive
- A shared user trail along Bruce Creek, beginning at Earl Court, north of Charlton Road
- Sporadic provision of footpaths within the residential areas north of the South East Precinct.

These paths are identified in M&P mapping included at Appendix A.

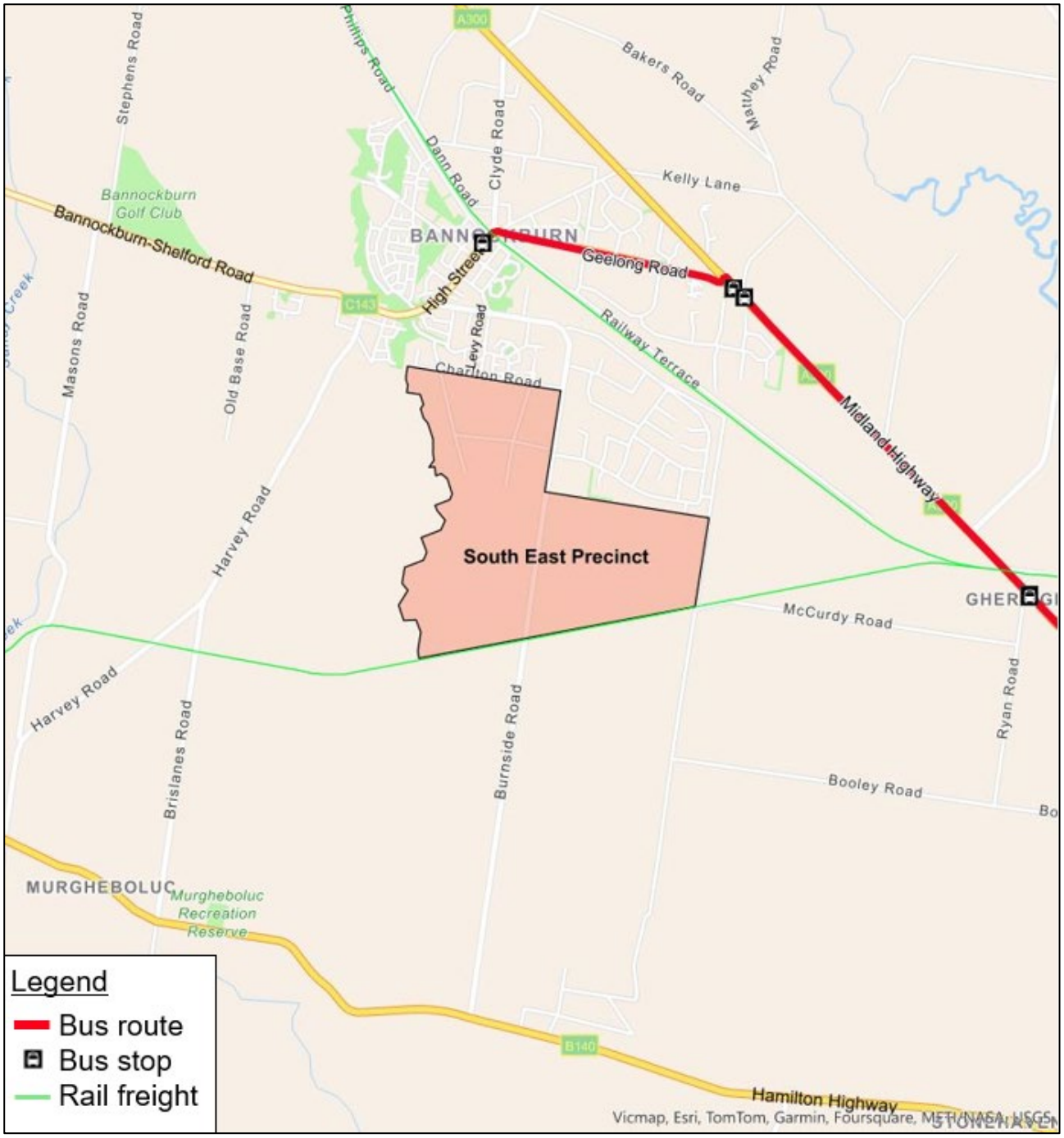
3.5 Public Transport

Public transport in Bannockburn is limited to a V/line operated coach route between Bendigo and Geelong and Route 19 bus service between Geelong and Bannockburn. Route 19 operates one afternoon commuter service on weekdays, stopping in central Bannockburn at McPhillips Road / High Street and to the east at Geelong Road / Midland Highway. The V/Line coach has four weekday services stopping at McPhillips Road / High Street. Bannockburn does not have a local bus service and as such a majority of residents are not within walking distance of a bus stop.

There are two train lines running through Bannockburn, the Yelta line running between Geelong and Ballarat, going through the town centre and the western standard gauge line running south of the South East PSP area between Gheringhap and Maroona. These two train lines do not serve a commuter purpose but rather serve a freight function.

The bus route and rail freight lines are shown in Figure 3.2.

Figure 3.2 – Bannockburn Bus Route & Rail Freight

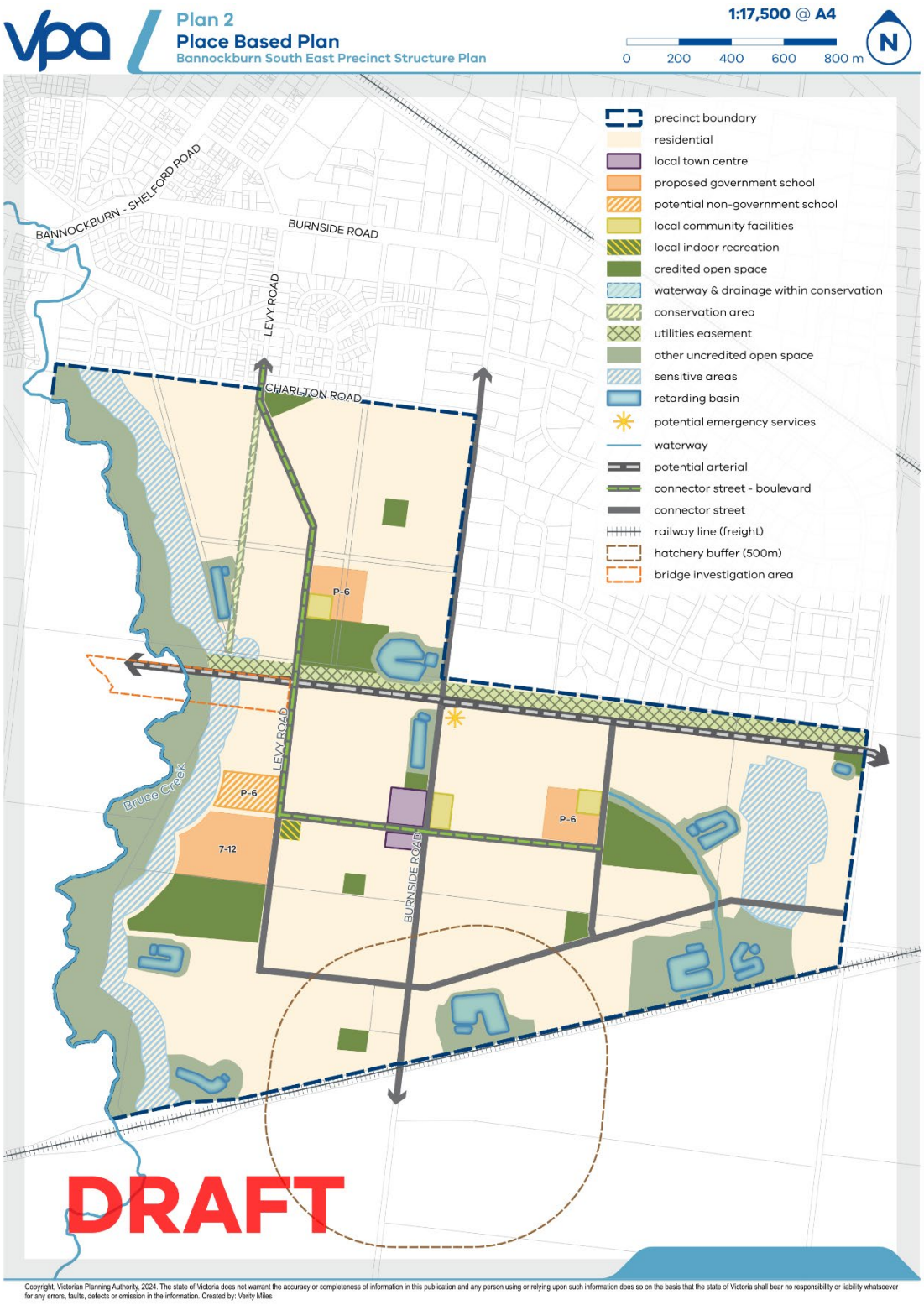


4. The PSP

4.1 Urban Structure

The Bannockburn South East PSP consists of residential land uses, a local activity centre, three primary schools and a secondary school. It is the first of the Bannockburn Growth Area PSP's to be prepared since gazettal of the Framework Plan in 2021. The draft Place Based Plan for the Bannockburn South East PSP is shown in Figure 4.1.

Figure 4.1 – Draft Place Based Plan (source VPA)



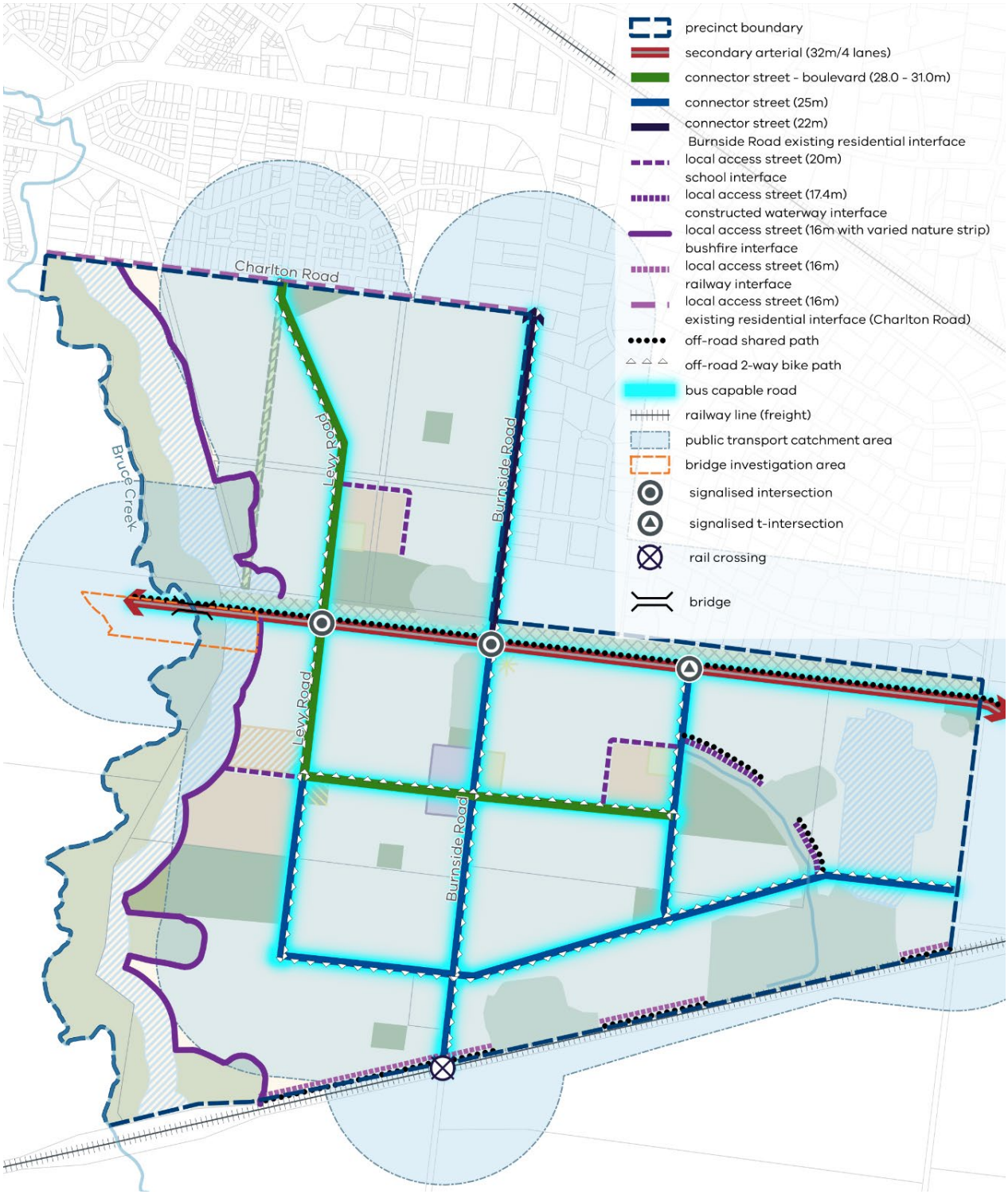
4.2 Transport and Movement Plan

The PSP will be supported by a series of local streets that will connect future residents to the broader network. When constructed, the network will include the following:

- An east-west arterial road centrally located within the PSP area, running parallel to a utility's easement. It is noted that this road would cross Bruce Creek via a bridge which abuts the western boundary of the South East PSP.
- Levy Road will be extended south of Charlton Road, with this section being a 31 metre wide boulevard connector street, reducing to a 25 metre wide connector road in the southern portion of the PSP.
- Burnside Road will be updated between Charlton Road and the railway line as a 25m wide connector street (only 22m when abutting existing residential development).
- Series of other connector streets to the south of the east-west arterial road that integrate with Levy Road and Burnside Road, as well as the proposed local town centre, school, open spaces and other community facilities.
- 16m wide local access street along the length of the Bruce Creek, as well as various other indicative locations around key destination land uses (e.g. local town centre, school, open spaces and other community facilities).

The proposed internal transport network for the Bannockburn South East Precinct is shown in Figure 4.2, whilst an assessment of the suitability of the proposed internal transport network is provided in Section 7.

Figure 4.2 –Draft Transport & Movement Plan



4.3 East West Arterial

Bannockburn currently has one at-grade crossing on the Geelong-Ballarat railway line that runs through the town centre. This railway crossing is located on High Street (C143) at the eastern end of the town centre, meaning that traffic that requires access to the Midland Highway from the western side of the railway must use this level crossing. Having a single crossing has multiple implications to town centre amenity, safety and prosperity, as well as broader road network resilience and capacity limitations.

This issue has been considered through the Bannockburn Growth Plan. The Plan identifies nine (9) principles in its vision with the third principle focused on building an "integrated and safe transport network". Importantly, it identifies a need to "maintain strong connections to the broader region" which is provided by the proposed east-west arterial road that would connect the Bannockburn – Shelford Road in the west to the proposed Gheringhap Employment PSP to the east.

The proposed east-west arterial road and opportunities it provides for place making within the town centre is presented in Plan 10 of the Bannockburn Growth Plan, which is reproduced in Figure 4.3.

Figure 4.3 –Bannockburn Growth Plan – Road Network

Having regard for the above, this ITA has examined the transport modelling impact of connections from the PSP to the surrounding transport network, including the network performance with the delivery of the full arterial road network, including with and without the east-west arterial road. It is noted that the adopted alignment of the proposed east-west arterial road, especially its connection with the Midland Highway / Fyansford-Gheringhap Road roundabout, is based on initial discussions with authorities for strategic transport modelling purposes and will require further investigations and analysis to determine the exact location of its preferred alignment.

5. Strategic Transport Modelling

5.1 Modelling Overview

Transport modelling is used to forecast the number of users (demand) that will travel on a transport system at a given point in time and how the associated system will likely operate. There are generally three layers of models: strategic, tactical and operational. They vary in their application and purpose of use, often relating to the size of the modelled area (larger the area more suitable strategic model use is) and the level of interaction detail needing to be understood (increasing interaction detail the more suitable operational model use is). As part of this planning project, strategic transport modelling has been used to understand how Bannockburn functions now and in the future with consideration of its broader network context.

The traditional approach to strategic transport modelling is undertaken through the following four-step process, noting they are iterative and there are feedback loops within the process:

1. Trip Generation – how many users are travelling

2. Trip Distribution – where users are travelling to and from

3. Mode Choice – what form of transport users choose to make a trip

4. Route Assignment – what routes users take.

The four-step model provides the fundamental basis for insights into future transport patterns. However, the more significant the levels of development and/or the transport initiatives being implemented, the more an iterative approach guided by a top-down transport vision and strategy should be used to arrive at an 'acceptable' solution or ‘desired’ arrangements. Relying on a model to determine the ‘best’ network arrangements, reflect how people will behave, or consideration of interconnected urban form factors, is beyond its capability. This more iterative outcome-based approach to modelling aims to try and not provide ‘enough’ road network capacity, but rather a more integrated and user-centric transport and land use outcomes.

Moreover, a common limitation of strategic modelling in growth areas is the future provision of public transport services, especially buses. They have often not been determined, so only the existing bus services and frequencies are included in future year models. This leads to an overestimation of traffic generation, which is considered to be especially applicable with this project given there is only a single infrequent bus service accessing Bannockburn (refer to Section 3.4) and no additional public transport services accessing Bannockburn are currently included in the 2051 model year of the strategic transport model that has been used. Most likely, as its population increases, so will the provision of public transport services that will be provided to residents.

5.2 A State-Wide Model

The strategic transport modelling investigations have been completed using the State-wide Victorian Integrated Transport Model (S-VITM). S-VITM is a tool held by the Department of Transport (DTP) to assist in the planning of road and public transport infrastructure in Victoria. S-VITM is a multimodal strategic model that uses future population, employment and land use data projections to forecast travel behaviour and the impacts of changes to the road and public transport networks. It is important to understand the limitations and assumptions used in the modelling when making an assessment based upon the model outputs.

It is important to note that the model is based on mathematical modelling, which provides a simplification of travel behaviour. The main limitations in using this strategic model are as follows:

- Level of detail – strategic models cannot model detailed characteristics of traffic behaviour, such as lane changing, queuing, signal timings or other operational aspects. Detail associated with urban design and demographics are also lost with the aggregation of each zone.
- Accuracy of input assumptions – strategic models require generalised inputs relating to land use and the road network and cannot produce outputs that are more accurate than the data used. For example, population, employment and enrolment numbers are the inputs into the model that trip generation rates are applied to, with no further breakdown of their characteristics done beyond that in the model.
- Estimation of real-world behaviours – the model relies on mathematical modelling which aims to estimate real world (and historic) behaviours. However, it does not consider other factors that influence travel behaviour such as user perception and driver awareness.

5.3 Model Development

5.3.1 Overview

The VITM version (VITM22v2_04_RC22v1_09) obtained from DTP and used as the reference case for this project was the latest available at the time. The model was compared against the Geelong Growth Area Transport Infrastructure Strategy (GGATIS) model, which Stantec calibrated and validated in 2019 for Geelong and its surrounds as part of a DTP engagement (DTP reviewed the calibration and validation of the model and approved it for use in the associated project).

It was found that the internal Bannockburn network and corridors accessing it were better developed in the Reference Case when compared to GGATIS. Based on the GGATIS model experience, some adjustments were made, as discussed in Section 5.3.2 below.

5.3.2 Model Adjustments

In comparing the VITM version provided by DTP and our previous GGATIS model experience, the trip generation rate in the reference case model is considered low. This is due to a number of reasons which are typical to regional areas that apply a higher amount of trip chaining (i.e. multiple trips for shopping in one day) and regional travel (i.e. tourist travel) that are not captured.

Based on this understanding, the following adjustments have been applied to the VITM Reference Case for this project (their suitability is considered to have been confirmed through validation results presented in Section 5.4):

- Intercity and Freight Movement Model Recalibrations have been incorporated
- Household trip rates for Geelong, Golden Plains and Ballarat LGA's have been increased by 19%.

With only a single future year full build-out scenario is being modelled, the 2051 GGATIS Base Case model year land use arrangements have been utilised, which considers the broader growth changes across and surrounding Geelong.

It is noted that the provided Reference Case does not assume any duplication of the Midland Highway. Again, the 2051 GGATIS Base Case model year Midland Highway arrangements have been utilised, which assumes full duplication to Bannockburn by 2051.

5.3.3 Base Year Model Network Inputs

The number of lanes posted speed limits and link classes for Bannockburn's network have been reviewed through satellite imagery and open source data available from DTP and VicRoads websites. The road network around Bannockburn in the latest VITM version is coarse, therefore the following changes were made to the base year model:

- Added missing sections of road network to reflect existing conditions
- Changed some of the link classes within the existing urban extent to better reflect their network role and function
- Amended posted speed limits where these were incorrectly coded
- Added overtaking lanes on the Midland Highway
- Realigned road sections in the model to better represent actual conditions.
- Applied the increased trip rate of 19%.

These conditions and changes are reflected in the 2021 Base Year model inputs that are shown in Figure 5.1 to Figure 5.3.

Figure 5.1 – Bannockburn Link Classes, 2021

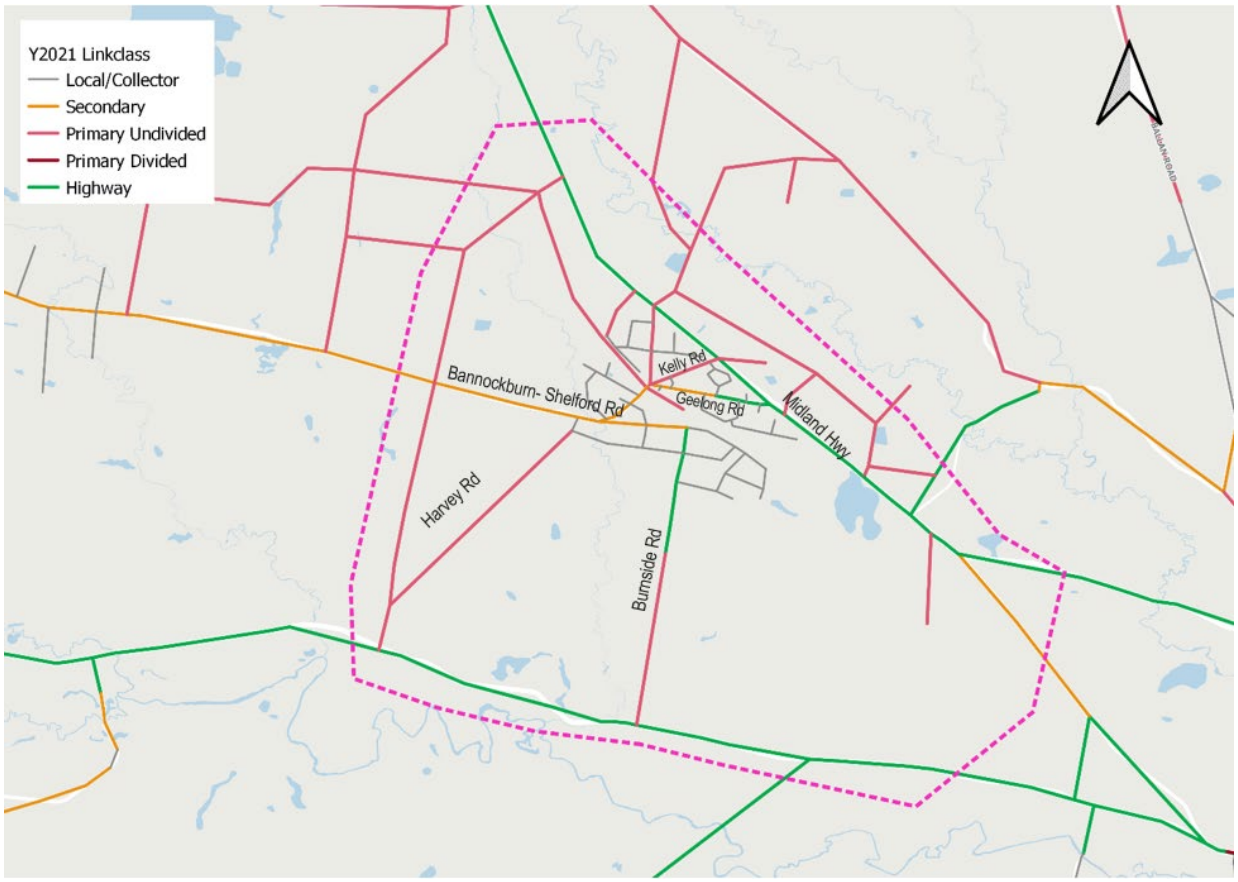


Figure 5.2 – Bannockburn Network Lanes, 2021

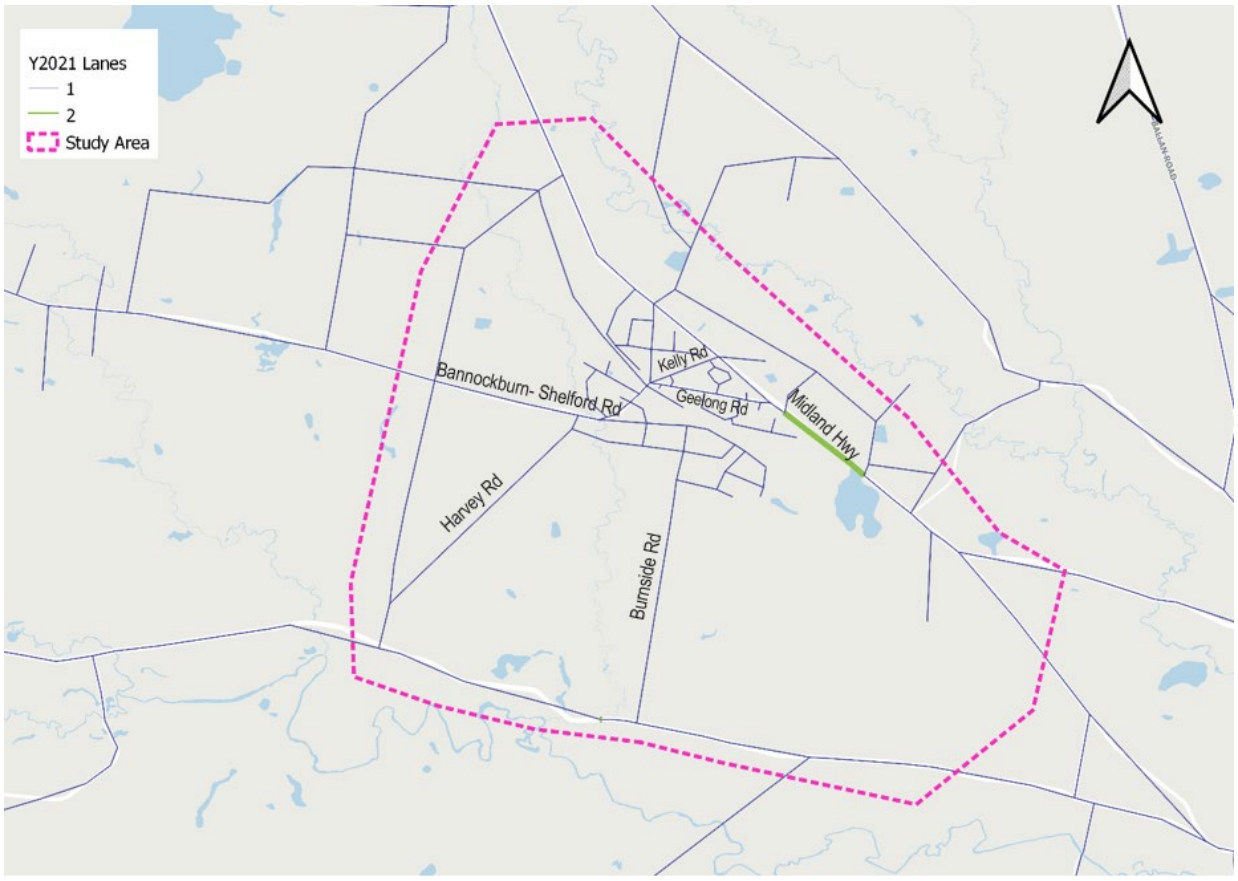
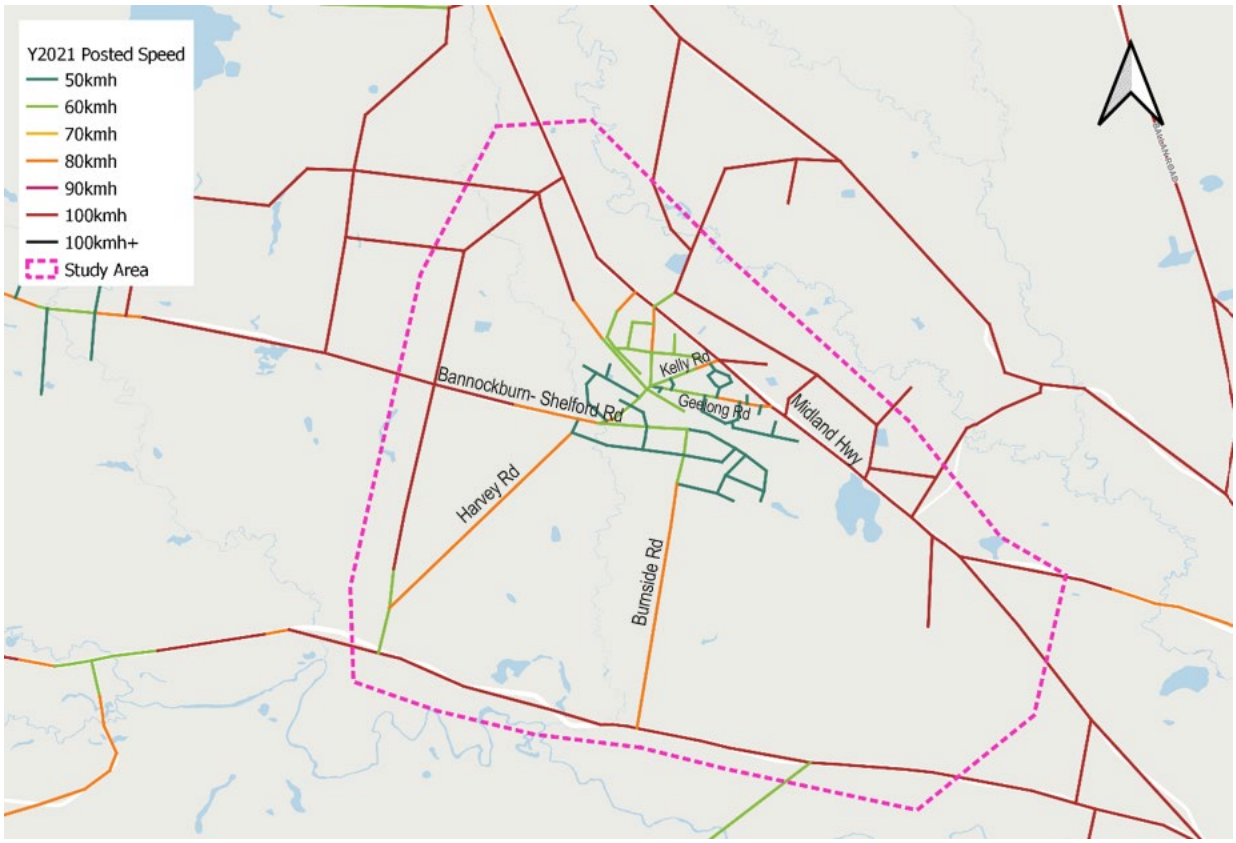


Figure 5.3 – Bannockburn Posted Speed Limits, 2021



5.4 Base Model Validation

Model calibration and validation is a process in which the model inputs are refined to reflect observed conditions. Strategic network models are generally calibrated to reflect existing traffic counts across a wide corridor or regional area. These models are not expected to accurately match traffic counts at individual locations, instead model validation is typically measured by comparing counts across a number of locations such as a screenline, and/or a group of counts at a regional level.

To strengthen models for projects of this nature, particular importance is placed on town centres. Particular attention is also paid to the calibration and validation of car movements in the network and freight trips on main roads, to provide a solid framework for interpretation of the future results and model outcomes.

5.4.1 Validation Criteria

Model calibration and validation procedures are found in VicRoads Transport Modelling Guidelines, Volume 2: Strategic Modelling Draft 3, 26/04/2012. The targets set out in the guidelines are presented in Table 5.1, along with comments of the process undertaken for this project, noting the general intent and purpose of precinct structure planning.

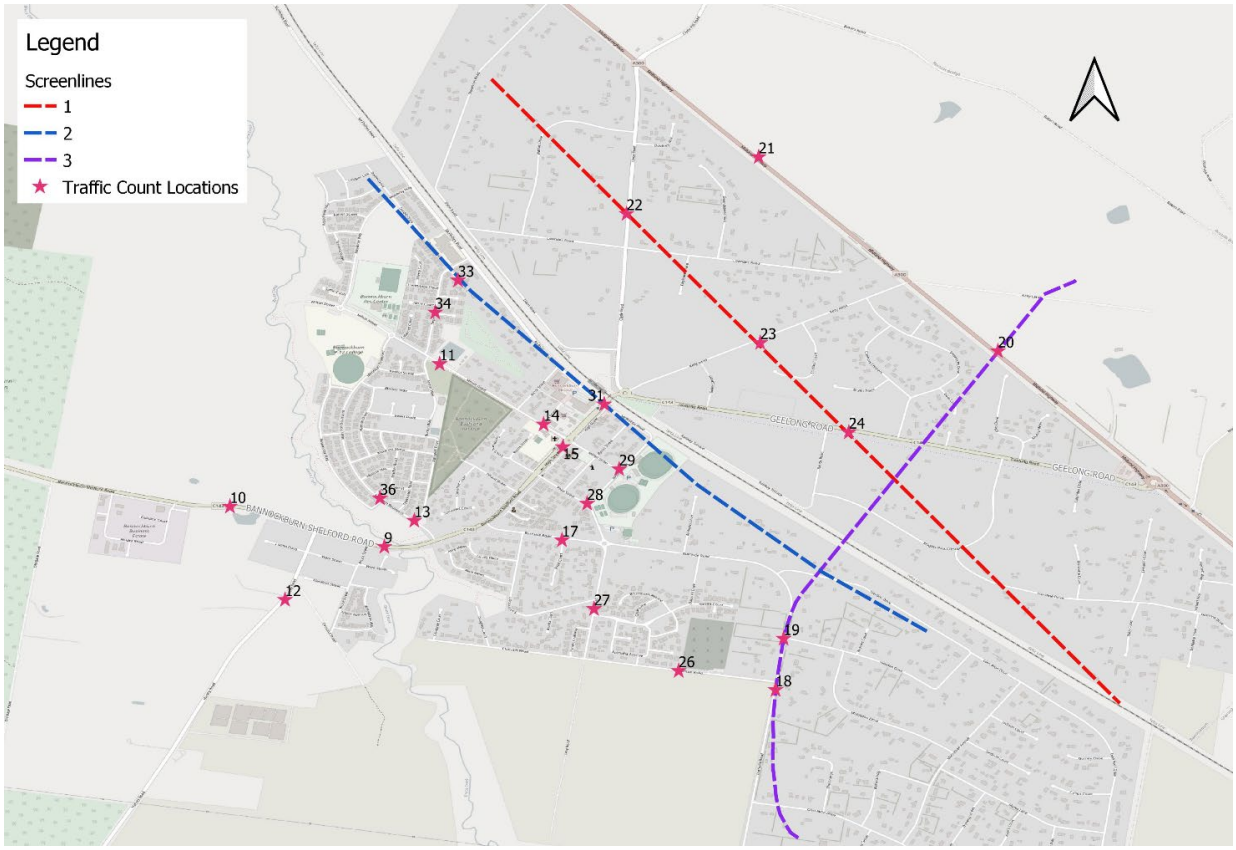
Table 5.1 – Validation targets set out in modelling guidelines

Criteria	Acceptable Targets	Comments
Assignment Convergence (Vehicles)	Relative Gap (RGAP) less than 1%	Undertaken per discussion in Section 5.4.3
Screenline Validation (Vehicles)	% Change between observed and modelled volumes within acceptable bounds	Undertaken per discussion in Section 5.4.4
Scatter Plots	Line of best fit slope: 0.85 – 1.15	Undertaken per discussion in Section 5.4.5
	Coefficient of Determination (R^2) above 0.85	
Traffic Volume Comparison (Geoffrey E. Havers Statistic)	50% of cases have a GEH <5	Undertaken per discussion in Section 5.4.6
	80% of cases have GEH <10	
Percentage Road Mean Square Error (%RMSE) (Vehicles)	%RMSE of surveyed links below 30%	Undertaken per discussion in Section 5.4.7
Travel Times (Vehicles)	>95% of Cases with within 15% or one (1) minute of observed mean surveyed time	Travel Time validation is out of project scope and not considered needed for this work

5.4.2 Transport Data

Existing transport data was available for this project due to recent transport studies having been undertaken for Bannockburn in 2018 and 2022. These traffic count locations were assessed using screenlines for the validation process. Screenlines are imaginary lines drawn across traffic count locations to measure the amount of traffic entering or leaving an area. Three screenlines have been developed for the model based on the available traffic data and the locations that would capture the key traffic movements within the study area. These are illustrated in Figure 5.4

Figure 5.4 – Traffic Count & Screenline Locations



5.4.3 Assignment Convergence

The following criteria are required to be satisfied under the VicRoads guidelines:

- RGAP: Relative difference between the costs along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as a percentage of the minimum costs (also referred to as 'Delta' or the Duality Gap),
- Average absolute difference in link flows between successive iterations,
- Relative average absolute difference in link flows between successive iteration, and
- Pdiff: Percentage of links whose change in volumes between iterations is less than a set value.

The results of the assignment convergence validation against the targets set out in the guidelines are shown in Table 5.2. These are for both the AM and PM peak periods.

Table 5.2 – Validation Summary – Assignment Convergence

No	Parameter	Bannockburn Model	Requirement
1	RGAP	0.1%	<1%
And one of the following (stability)			
2	RAAD	0.05%	<1%
3	AAD	0.5	<1 veh/h
4	Pdiff	1%	<5%

The results indicate that assignment convergence has been met and the guidelines are satisfied.

5.4.4 Screenline Validation

Screenline validation has been undertaken to ensure the local operating conditions are replicated by the base model within the power function based curves from Figure 7-2, Page 91, of the manual published by USA's Federal Highway Administration (1997) and includes an arbitrary 25% reduction in the maximum percent difference for 24-hrs.

Three screenlines have been developed for the model. These are illustrated in Figure 5.4.

The screenlines have been compared to observed traffic volume counts. A comparison of the daily observed and modelled volumes is provided in Table 5.3 and is illustrated in Figure 5.5 and the peak period results are provided in Table 5.4, Table 5.5, Figure 5.6 and Figure 5.7.

Figure 5.5 – Daily (24 hour) Screenline Validation

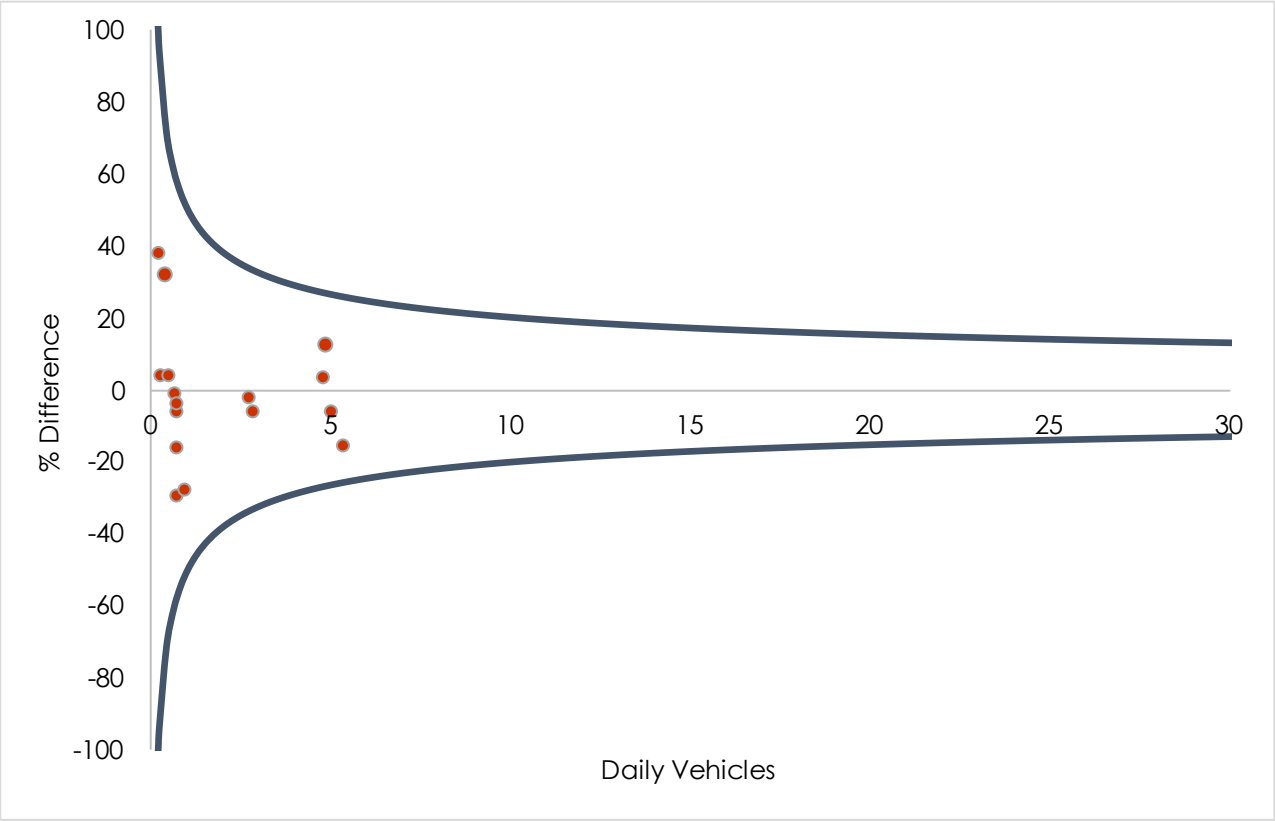


Table 5.3 – Screenline Volumes – Daily Trips

Screenline	Direction	Observed	Modelled	Difference	Difference %
1	Outbound	5,803	6,304	501	9%
	Inbound	5,732	5,772	40	1%
2	Outbound	5,541	5,271	-270	-5%
	Inbound	5,695	5,007	-688	-12%
3	Outbound	4,514	4,042	-472	-10%
	Inbound	4,138	4,058	-80	-2%

Figure 5.6 – AM Peak Screenline Validation (All Vehicles)

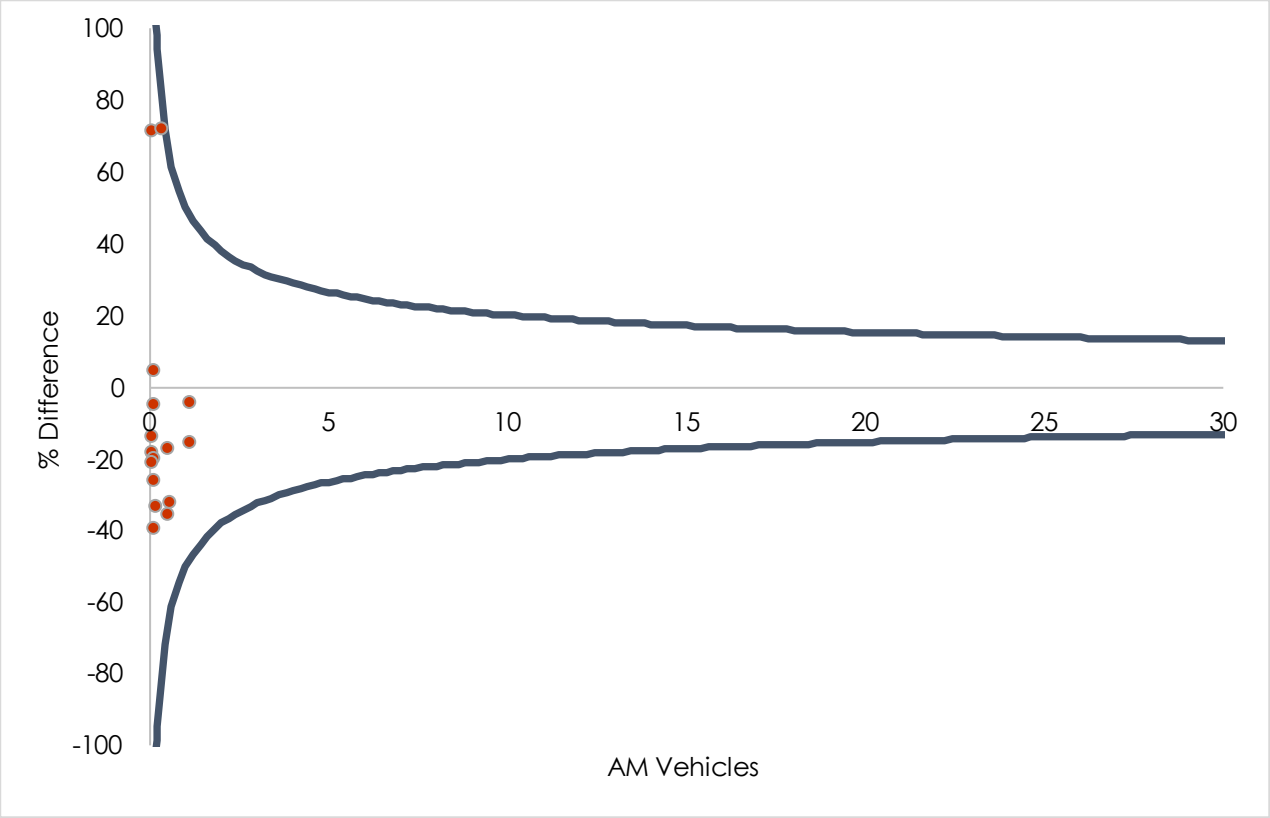


Table 5.4 – Screenline Volumes – AM (2-hour) Trips

Screenline	Direction	Observed	Modelled	Difference	Difference %
22	Outbound	1,273	1,204	-69	-5%
	Inbound	614	508	-106	-17%
23	Outbound	1,198	995	-203	-17%
	Inbound	614	454	-160	-26%
24	Outbound	687	518	-169	-25%
	Inbound	633	799	166	26%

Figure 5.7 – PM Peak Screenline Validation (All Vehicles)

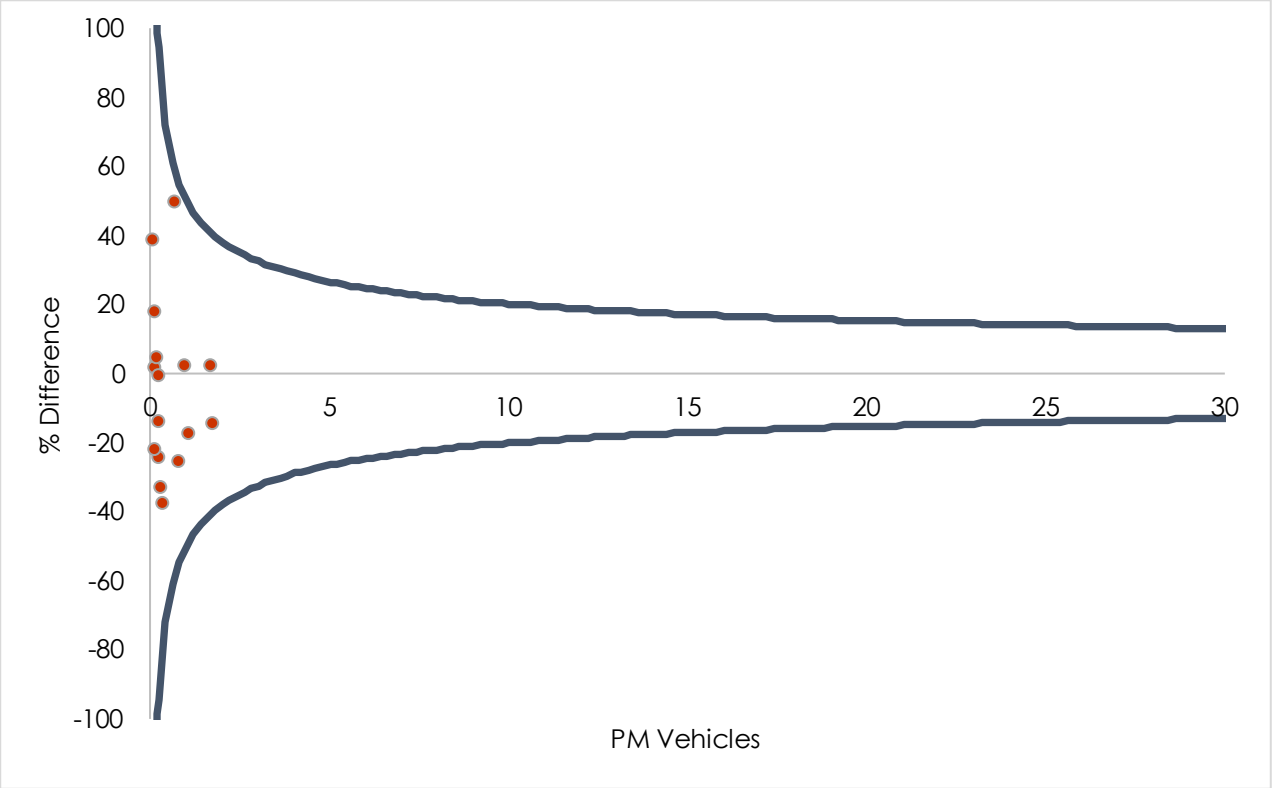


Table 5.5 – Screenline Volumes – PM (3-Hour) Trips

Screenline	Direction	Observed	Modelled	Difference	Difference %
22	Outbound	1,180	1,138	-42	-4%
	Inbound	1,925	1,909	-16	-1%
23	Outbound	1,149	983	-166	-14%
	Inbound	1,807	1,559	-248	-14%
24	Outbound	1,180	1,353	173	15%
	Inbound	1,097	909	-188	-17%

The results show that most of the estimated volumes sit within the bounds of the functions recommended in the VicRoads Guidelines. It is also noted that the data points with the higher percent difference are those with low volumes.

5.4.5 Scatter Plots

Figure 5.8 and Figure 5.9 present AM and PM comparison between surveyed and modelled traffic volumes for traffic counts in the vicinity. A total of 42 observed count locations were used. Each plot shows the best fit regression line and the coefficient of determination (RSQ). The VicRoads guidelines set out targets for slope of the best fit regression line between 0.9 and 1.1 and greater than or equal to 0.90 for RSQ.

Figure 5.8 – Modelled vs. Observed Traffic for all Traffic Counts (AM 2 hours)

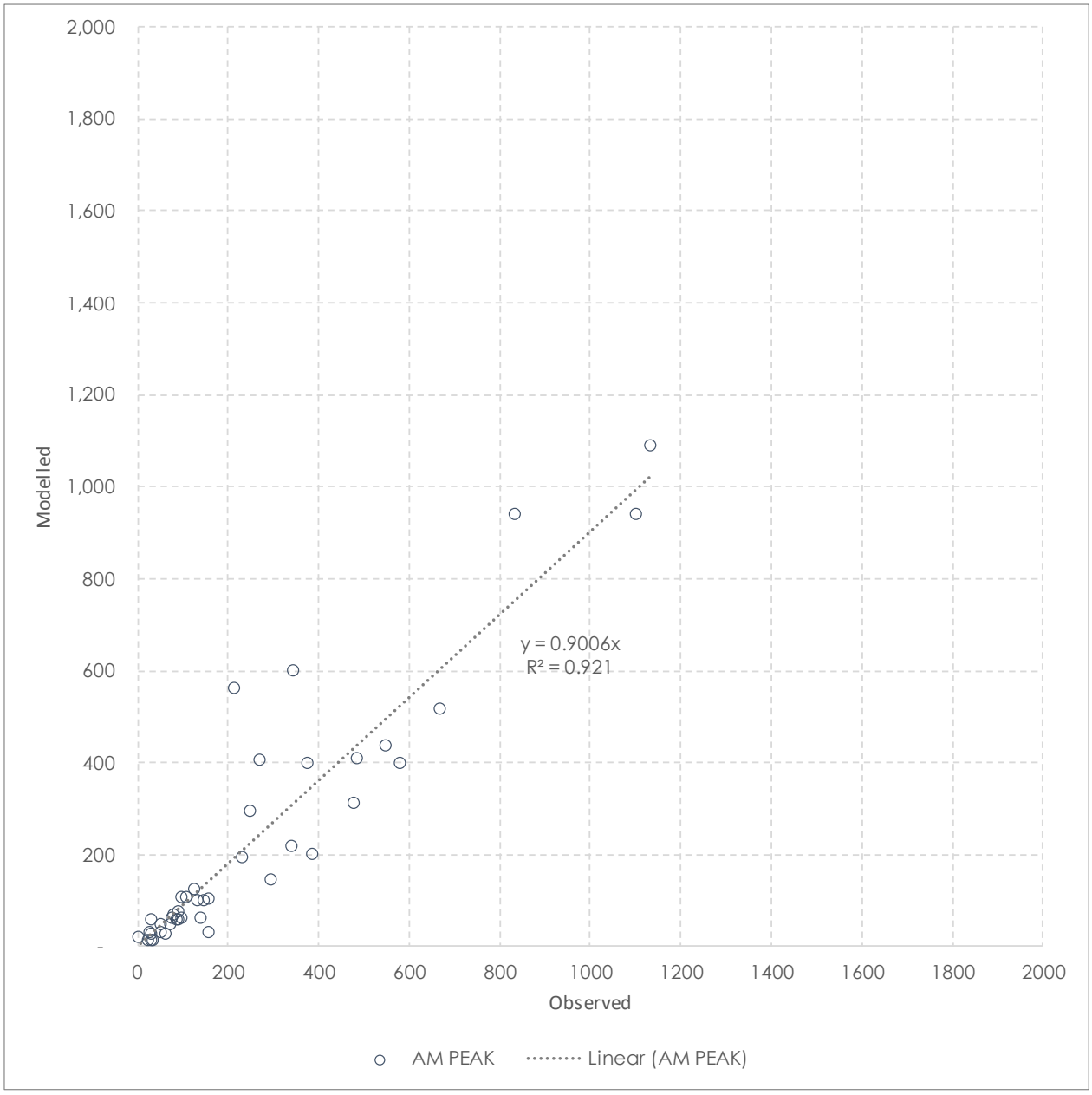


Figure 5.9 – Modelled vs. Observed Traffic for all Traffic Counts (PM 3 hours)

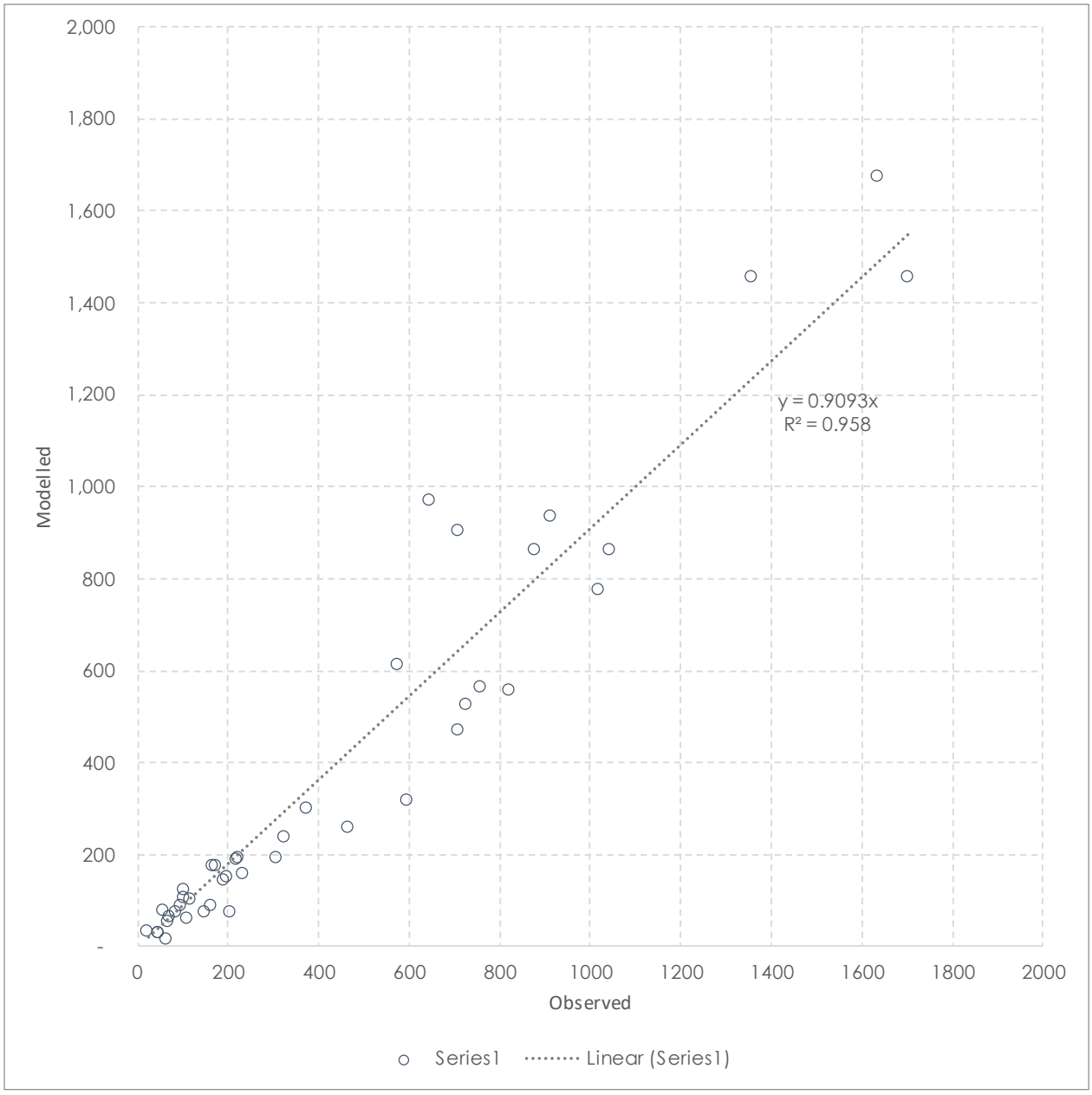


Table 5.6 – summarises the results of the traffic count validation. It shows that the link volumes meet the criteria for the slope of best-fit and the RSQ.

Table 5.6 – Traffic Count Validation Results

Criteria	Target	AM	PM
Slope of Best Fit	0.90 - 1.10	0.90	0.91
R2	>90%	92%	96%

5.4.6 GEH Statistic

The GEH statistic is an alternative measure to scattered plot to compare observed and model vehicle volumes. It is one of a number of measures used to assess a model, other than using percentage differences between observed and modelled volumes, which can be difficult when large and small volume traffic volumes are presented together.

The results are presented in Table 5.7.

Table 5.7 – GEH Results summary for AM and PM peaks

AM			PM		
GEH	Number of Links	% of Links	GEH	Number of Links	% of Links
<5	27	64%	<5	23	55%
<10	37	88%	<10	37	88%
<15	41	98%	<15	42	100%
<20	42	100%	<20	42	100%
<25	42	100%	<25	42	100%

The results meet the "50% of links with a GEH of less than 5" criteria and "80% of links with a GEH less than 10" criteria in both peak periods.

5.4.7 Percent Root Mean Square Error (%RMSE)

The %RMSE statistic provides an indication of the difference between observed and modelled volumes. Generally, lower link volumes produce a higher %RMSE. Table 5.8 and Table 5.9 summarise the results for the AM and PM peak periods respectively.

Table 5.8 – %RMSE Results – AM Peak Period

1-way volume	Number of Sites	Sum of Survey Volumes	Sum of model volumes	%RMSE
0-1000	40	8410	7427	2%
1000-2000	2	2240	2028	3%
2000-5000	0	0	0	-
5000-10000	0	0	0	-
10000+	0	0	0	-
All	42	10650	9455	3%

Table 5.9 – %RMSE Results – PM Peak Period

1-way volume	Number of Sites	Sum of Survey Volumes	Sum of model volumes	%RMSE
0-1000	37	11734	9980	2%
1000-2000	5	6764	6216	3%
2000-5000	0	0	0	-
5000-10000	0	0	0	-
10000+	0	0	0	-
All	42	18498	16196	3%

The target set in the VicRoads Guidelines is for a %RMSE of < 30% across all links which has been met. This indicates the adopted model is fit for the purposes of future year forecasting.

5.5 Summary

Based on the information presented in this section of the report, the model meets the requirements of the VicRoads guidance, noting that a detailed validation of travel times has not been undertaken as this is not included in the project scope. Notwithstanding, based on the guidance provided, the model is considered suitable for testing the future year land use projections and network.

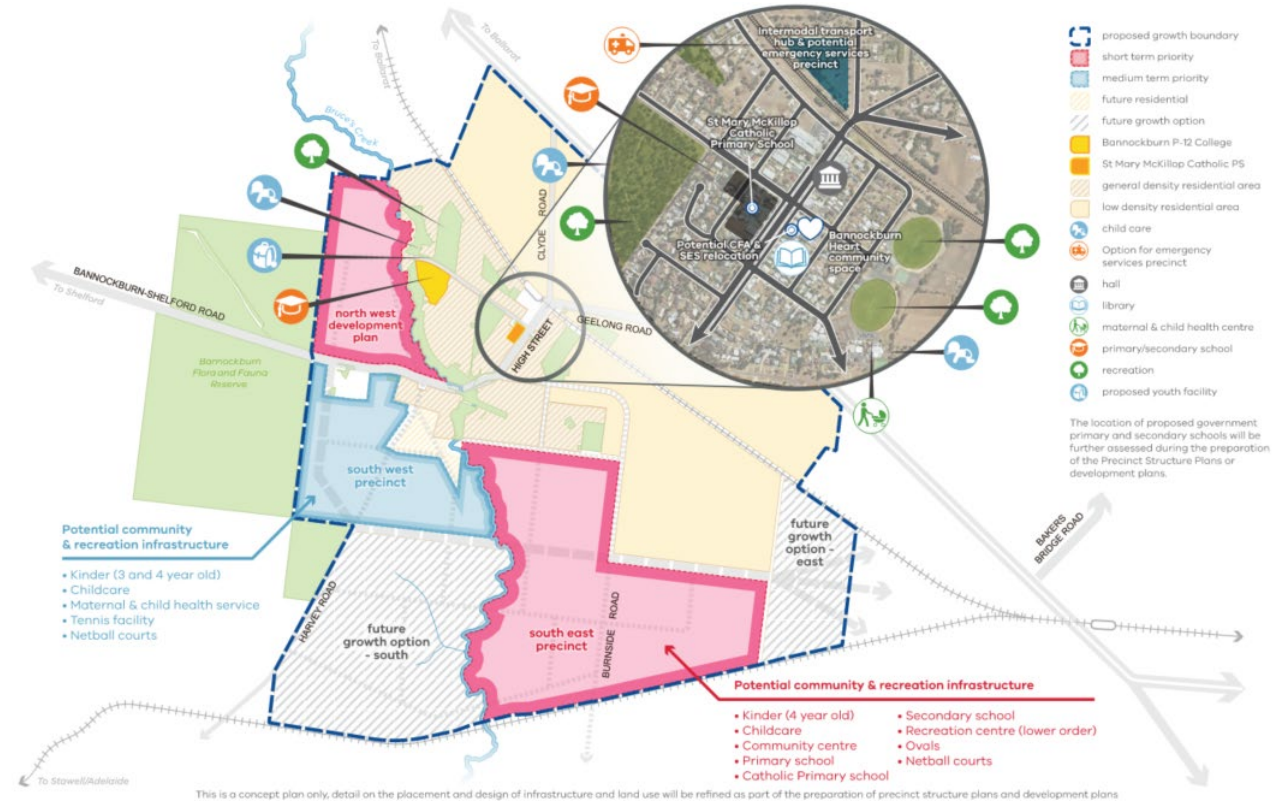
6. Future Year Assessment

6.1 Future Conditions

6.1.1 Land Use

The future land use inputs to the model have been informed by future growth forecasts, including the 2021 Bannockburn Growth Plan to identify the 2051 scenario. Figure 6.1 identifies three growth areas and two future growth options, which have all been factored into the modelling. An additional rezoning development site at Ormond Street has also been included in the modelling, as has the existing Bannockburn township area, and the proximate Lethbridge's growth areas and the Gheringhap Employment PSP.

Figure 6.1 – Bannockburn Future Housing and Community Infrastructure



Source: Bannockburn Growth Plan, VPA, 2021

The 2051 future year land use inputs for these areas are summarised in Table 6.1.

Table 6.1 – Future Year Land Use Inputs

Location / Area	Population	Households	Retail Employment	Total Employment	Primary Enrol.	Secondary Enrol.	Tertiary Enrol.
Bannockburn South East	15,747	5,338	293	386	1,350	800	0
Bannockburn South West	4,292	1,455	0	82	450	0	0
Bannockburn North West	5,353	1,815	0	45	0	0	0
Existing Bannockburn Town	8,300	2,651	359	2,782	892	389	0
South Future Growth Option	10,355	3,510	0	82	450	0	0
East Future Growth Option	3,230	1,095	0	0	0	0	0
Ormond Road	507	172	0	0	0	0	0

Location / Area	Population	Households	Retail Employment	Total Employment	Primary Enrol.	Secondary Enrol.	Tertiary Enrol.
Rezoning							
Total	**47,784**	**16,036**	**652**	**3,377**	**3,142**	**1,189**	**0**
Other Surrounding Growth Areas							
Lethbridge Growth Areas	568	293	0	0	0	0	0
Gheringhap Employment PSP	0	0	0	1,300	0	0	0

As stated earlier in this report, Bannockburn's population growth is expected to increase to 47,784 people in 2051. This includes the South Future Option Area (10,355 residents) and the East Future Growth Option Area (3,230 residents). Ultimately, these areas will need to be rezoned and go through a PSP process to determine its planning controls and requirements.

6.1.2 Transport Network

The 2051 road network has been prepared based on the network depicted in the Bannockburn Framework Plan. The key differences between the existing conditions and the 2051 network include:

- A future east-west arterial road connecting the Midland Highway to Burnside Road, Harvey Road and Bannockburn-Shelford Road, bypassing the town centre.
- An expanded local road network in the south east precinct and south growth areas (noting only a single new bridge crossing of the Bruce Creek has been included, associated with the future east-west arterial road).

It should be noted that the transport networks included in the VITM Reference Case and refinements made to the Project Case are for strategic evaluation purposes only, and do not represent government commitments to individual infrastructure improvements.

Moreover, as discussed in Section 5.1, no change to the existing bus network has been applied to the 2051 model year, which is a common limitation of strategic modelling in growth areas and results in an overestimation of traffic generation.

The resulting 2051 future year modelling road networks are shown in Figure 6.2 to Figure 6.4, which include the following key features:

- The Midland Highway upgraded to two-lanes north east of Bannockburn
- A new two-lane east-west arterial road with a 60km/h speed limit within the PSP and increasing to 80km/h east of the future South East Precinct (adopted alignment for strategic modelling purposes only).
- A local road network consisting of 50km/h and 60km/h posted speed limits.
- In order to help increase the place function of the town centre and reduce the attractiveness for through traffic, High Street between Burnside Road and McPhillips Road has been reduced to a post speed limit of 40km/hr.
- Roads on the periphery of the town generally have posted speed limits of 80km/h.

Figure 6.2 – 2051 Road Network

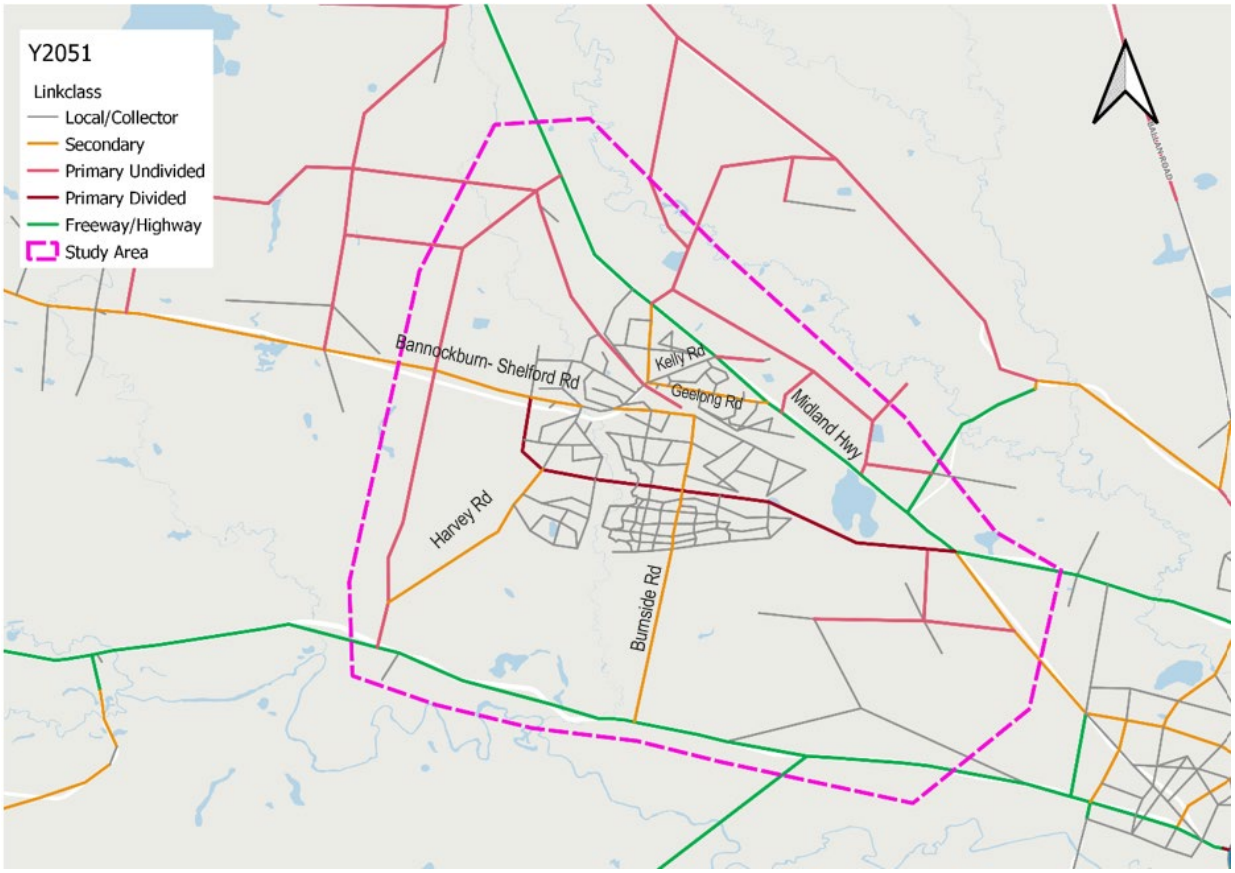


Figure 6.3 – 2051 Lane Inputs

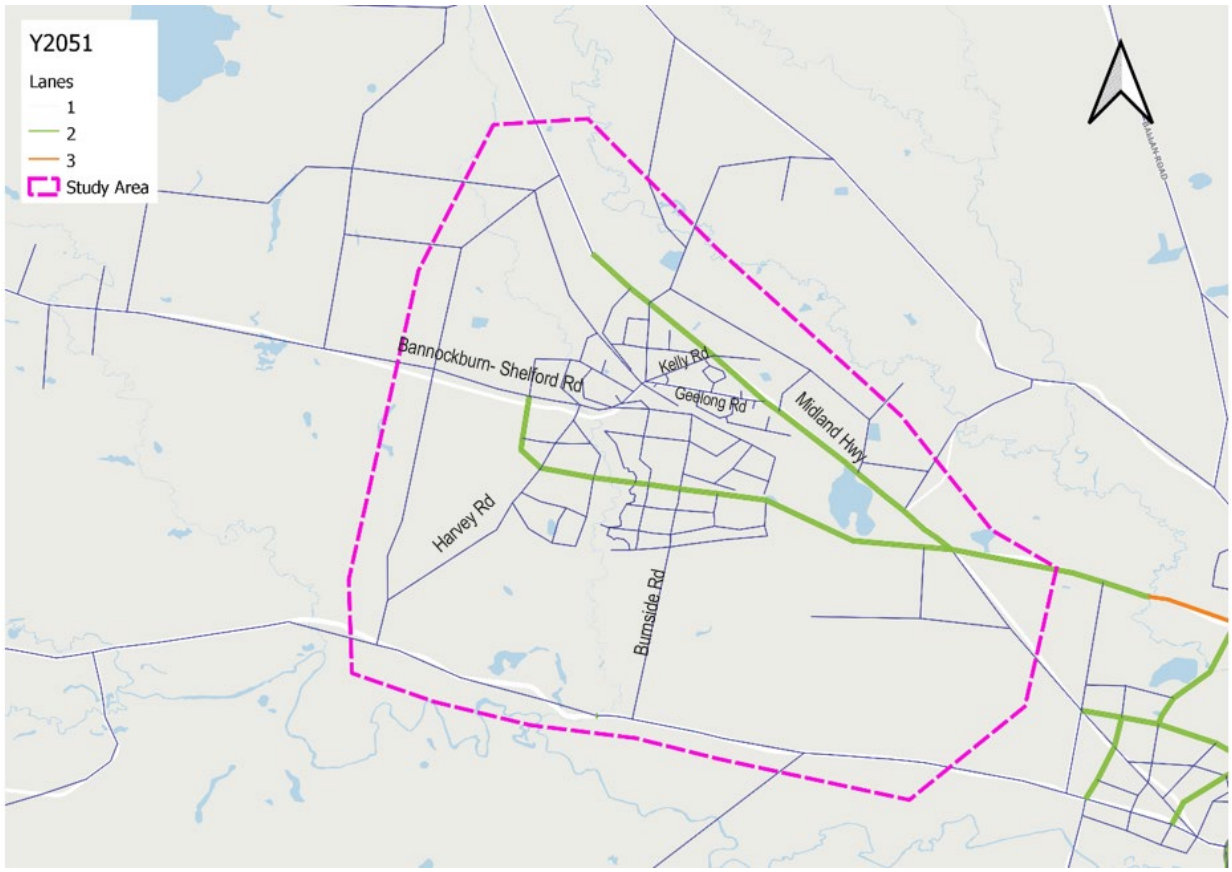
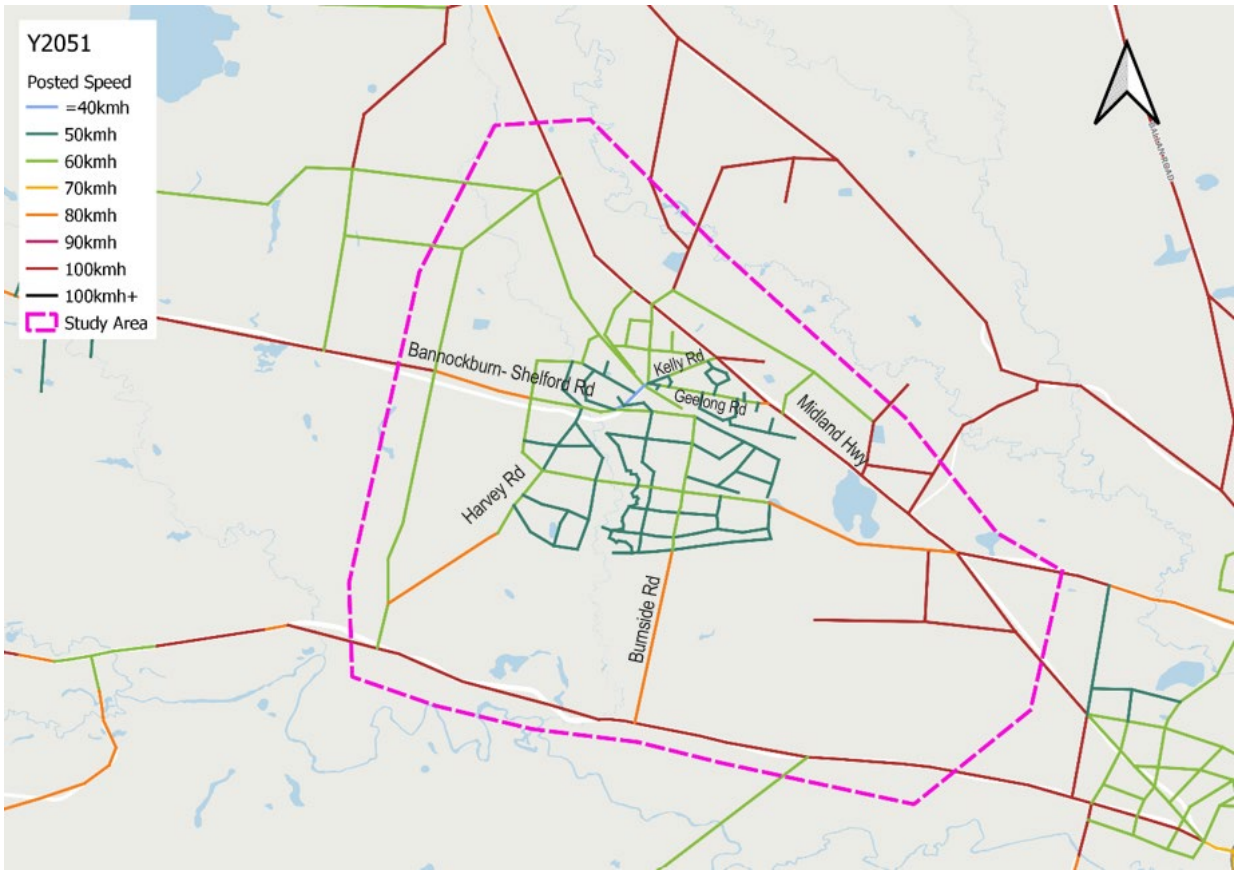


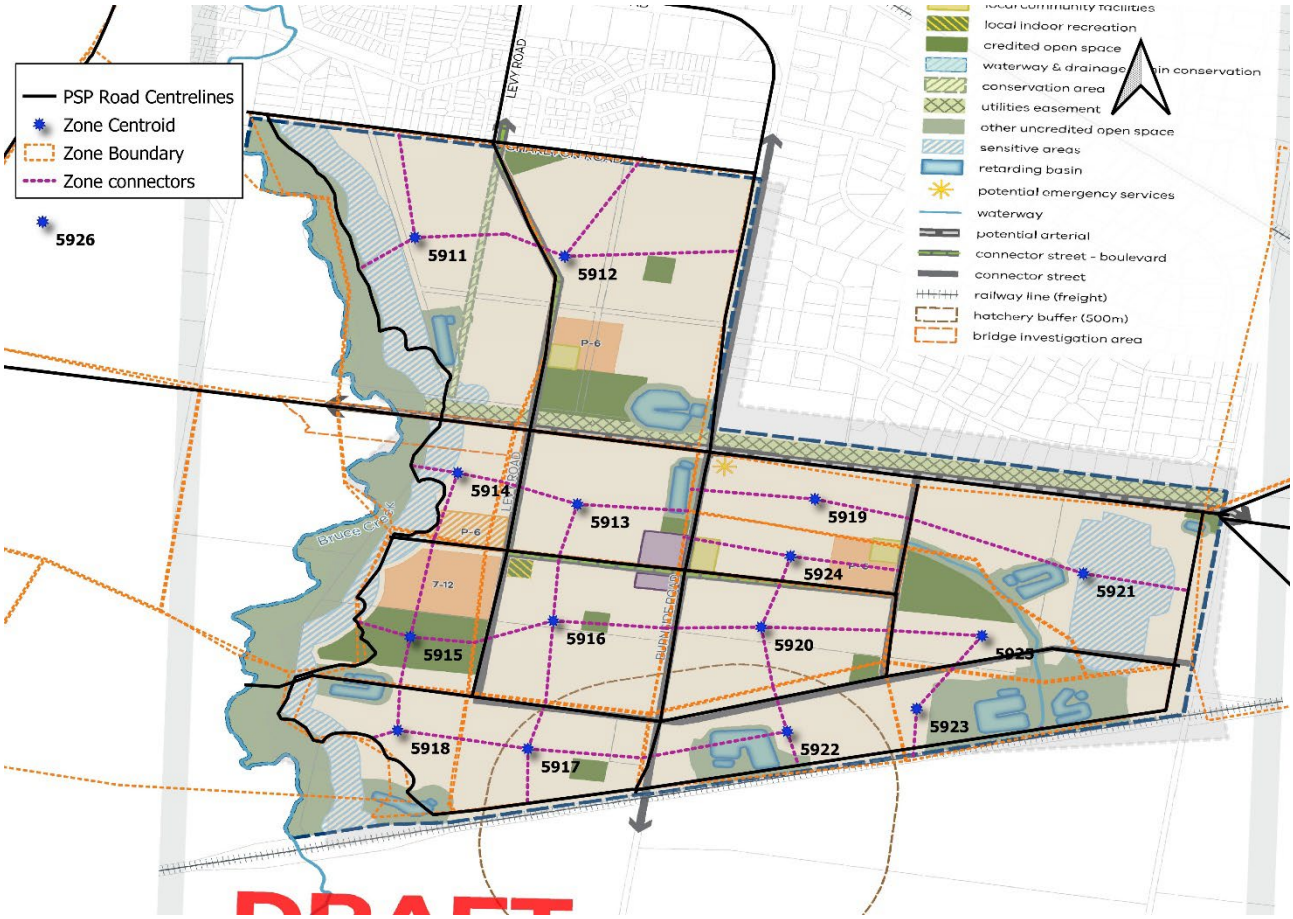
Figure 6.4 – 2051 Posted Speed Limits



6.1.3 Zone Structure

Traffic zones and connectors, which are where traffic is loaded onto the network in the model, have been adjusted to reflect the realigned transport network. The zone structure for Bannockburn South East is shown in Figure 6.5, overlaid with the draft PSP.

Figure 6.5 – Bannockburn South East Zone Structure



6.2 Modelling Results

6.2.1 Preamble

The Bannockburn Growth Framework Plan identified the need for an additional east-west arterial-type road to support the transport and movement objectives of the growing township. As such, this strategic transport modelling includes analysis of the network with and without the delivery of proposed east-west arterial road. This has been undertaken by running modelling scenarios with and without the arterial road connection between the South East PSP and the Midland Highway / Fyansford-Gheringhap Road intersection.

It is noted that the adopted alignment of the proposed east-west arterial road, especially its connection with the Midland Highway / Fyansford-Gheringhap Road roundabout, is based on initial discussions with authorities for strategic transport modelling purposes only and will require further investigations and analysis to determine a preferred alignment should it be implemented.

The results of the modelling are discussed in this section. A more detailed assessment of the internal road network arrangements for the South East PSP are provided in Section 7.

6.2.2 Without the East-West Arterial Road Connection

Traffic Volumes

Figure 6.6 shows the 2051 daily traffic volumes without the proposed east-west arterial road connection through to the Midland Highway / Fyansford-Gheringhap Road intersection.

Figure 6.6 – 2051 Daily Vehicles, Without Proposed East-West Arterial Road

The following comments are made in relation to the resulting daily traffic volumes:

- High Street in the Bannockburn town centre is expected to carry a traffic volume of 24,350 vehicles per day (vpd) at its eastern end, which is considered to exceed its theoretical capacity and limit the ability to provide a high quality place experience for users.
- Geelong Road and Kelly Road are expected to each carry traffic volumes just over 18,000vpd, which are near their theoretical capacities.
- Burnside Road south of the South-East PSP is expected to carry traffic volumes in the order of 21,250vpd, which well exceeds its theoretical capacity for a rural road.

Volume Capacity Ratios

To measure congestion, peak period Volume to Capacity (VC) ratios have been used, which compare the demand to the theoretical capacity of a link. Figure 6.7 and Figure 6.8 show the VC ratios for the AM Peak and PM Peak respectively.

Links that exhibit VC ratios greater than 0.9 will exhibit low speeds and congestion, with links over 1.0 indicating flow breakdown and likely require upgrades, demand management and/or other related measures. Links that are less than 0.5 will operate in uncongested conditions close to free flow speeds.

The VC plots shown in Figure 6.7 and Figure 6.8 indicate the following likely results without the east-west arterial:

- Roads within the South East PSP operate well, with VC values less than 0.5 in both peaks.
- Burnside Road to the south of the South East PSP will operate over 1.0 in both peaks, resulting in flow breakdown.
- Various link sections around Bannockburn will experience high levels of congestion with the VC ratios above 1.0 in both peak periods. Examples include the eastern end of High Street, Midland Highway between Geelong Road and Fyansford-Gheringhap Road, and Hamilton Highway between Burnside Road and Pollocksford Road.

Figure 6.7 – AM Peak (2 hour) Volume Capacity Ratio, Without Proposed East-West Arterial Road

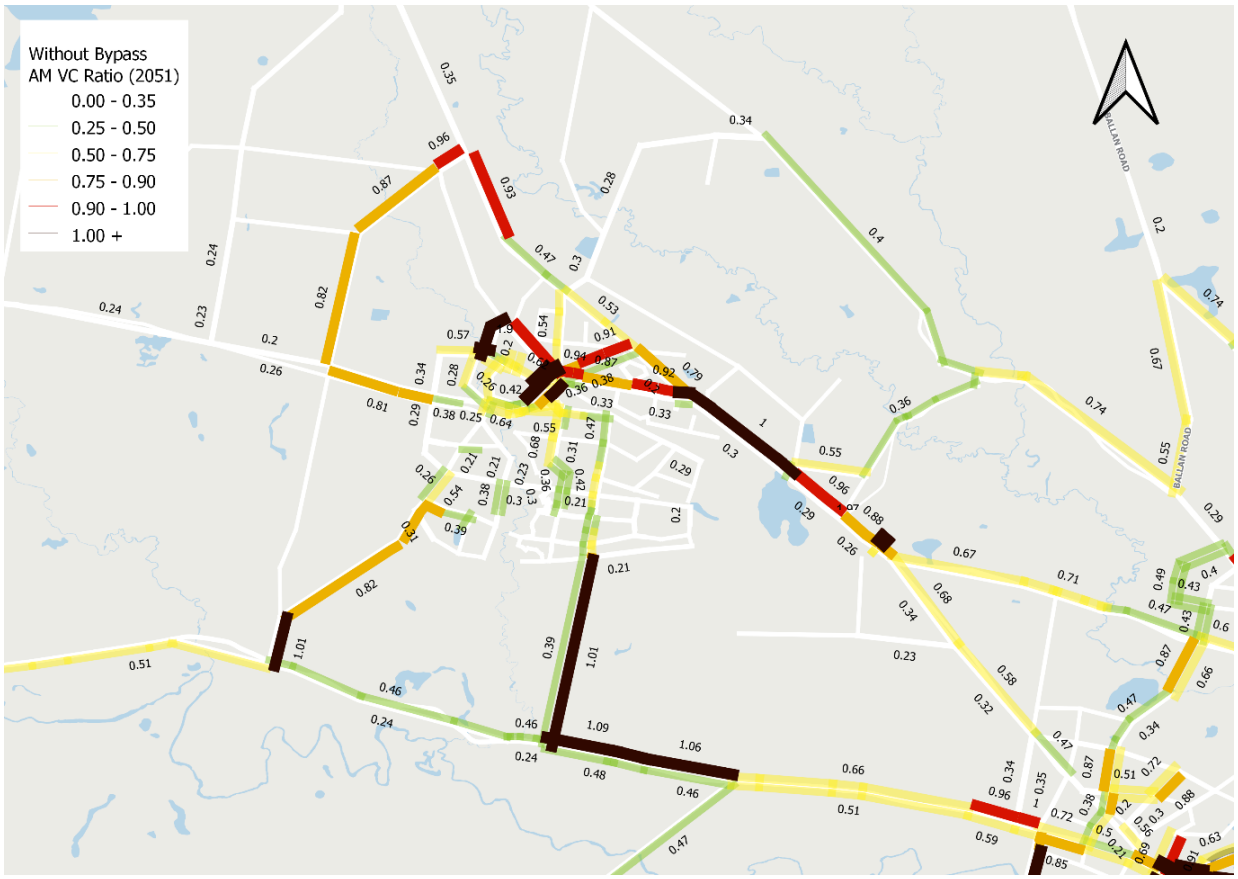
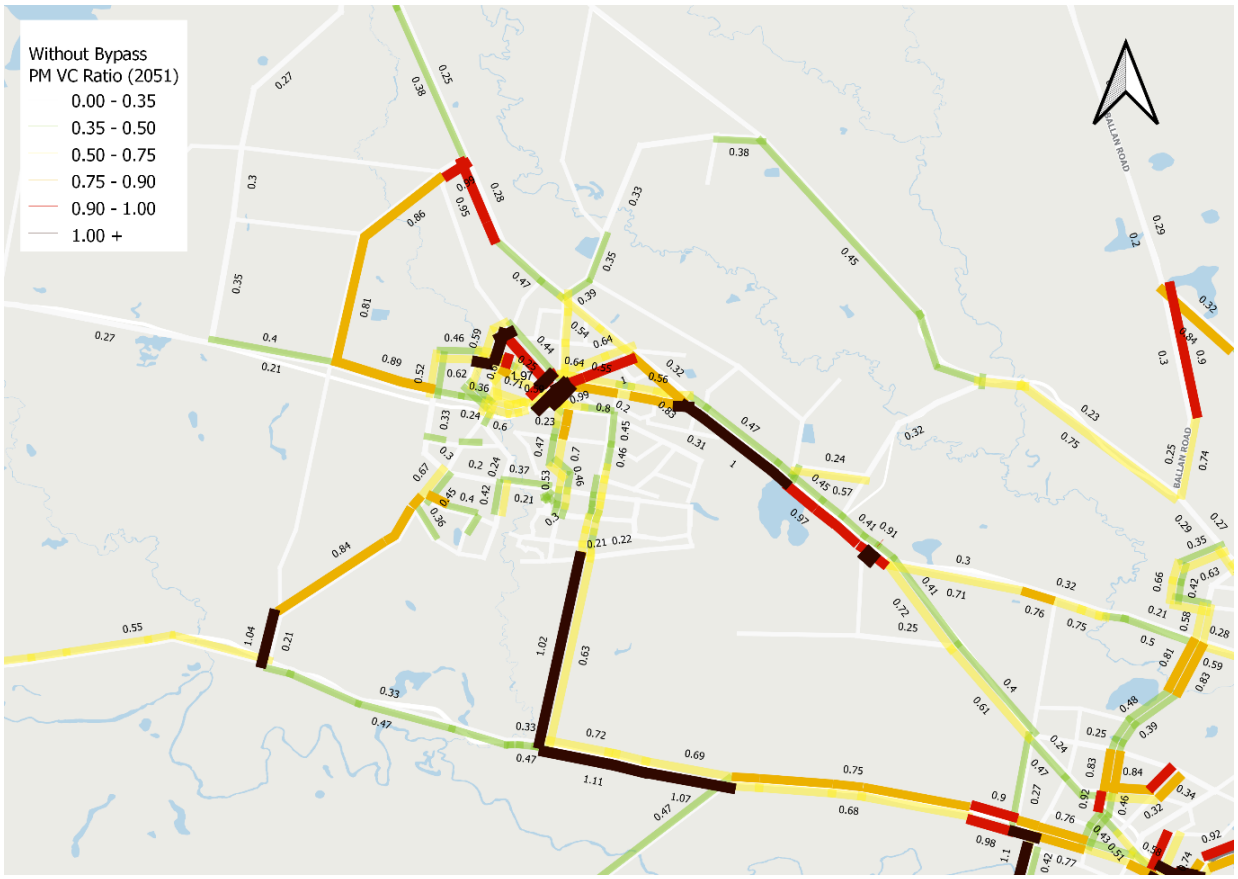


Figure 6.8 – PM Peak (2 hour) Volume Capacity Ratio, Without Proposed East-West Arterial Road



6.2.3 With the East-West Arterial Road Connection

Traffic Volumes

Figure 6.9 shows the 2051 daily traffic volumes with the proposed east-west arterial road connection through to the Midland Highway / Fyansford-Gheringhap Road intersection.

Figure 6.9 – 2051 Daily Vehicles, With Proposed East-West Arterial Road

The following comments are made in relation to the daily traffic volumes:

- The proposed east-west arterial road is expected to carry traffic volumes in the order of 43,600 vpd within the South East PSP, then up to 50,400 vpd over the connection between the PSP and the Midland Highway / Fyansford-Gheringhap Road intersection.
- A carriageway of two lanes in each direction is considered suitable within the PSP given the below VC ratios and conservative nature of the strategic transport modelling.
- In terms of the connection between the PSP and the Midland Highway, keeping the required carriageway to two lanes in each direction will be more difficult as the VC ratios are nearing 1.0, so the required cross section is recommended to be further investigated to help determine the most appropriate long-term transport network response. This should consider the associated infrastructure costs associated with providing an extra traffic lane in each direction against other transport alternatives and the broader infrastructure requirements associated with Bannockburn's growth.
- High Street is expected to carry traffic volumes in the order of 8,800 vpd for the majority, except for the section between McPhillips Road and the Geelong Road / Clyde Road intersection where in the order of 20,350 vpd is expected. As such, the majority of High Street can be expected to operate well, with potential to consider localised treatments at the eastern end to accommodate the traffic volumes, or broader network arrangements to reduce traffic demands and/or re-direct them.
- Geelong Road is expected to carry traffic volumes in the order of 8,600 vpd, which is considered to be able to be suitably accommodated.
- Burnside Road is expected to carry traffic volumes in the order of 5,650 vpd, which is also considered to be able to be suitably accommodated.

Volume Capacity Ratios

To measure congestion, peak period Volume to Capacity (VC) ratios have been used, which compare the demand to the theoretical capacity of a link. Figure 6.10 and Figure 6.11 show the VC ratios for the AM Peak and PM Peak respectively.

As stated previously, links that exhibit VC ratios greater than 0.9 will exhibit low speeds and congestion, with links over 1.0 indicating flow breakdown and likely require upgrades, demand management and/or other related measures. Links that are less than 0.5 will operate in uncongested conditions close to free flow speeds.

The following comments are provided in relation to the plots shown in Figure 6.10 and Figure 6.11:

- Roads within the South East PSP operate below their capacity, with VC values less than 0.5 in both peaks
- The proposed east-west arterial generally operates between 0.5 and 0.81 within the South East PSP. To the east of the PSP the VC values are nearing 1.0, indicating congestion may occur and consideration should be given to the benefits of an additional lane in each direction. However, as previously raised further investigations to help determine the most appropriate long-term transport network response should be undertaken.
- Various road sections within Bannockburn are indicated to experience conditions above 1.0 in both peak periods. These include High Street at its eastern end, and the north-western leg of the Midland Highway and Fyansford-Gheringhap Road roundabout intersection. Both of these locations are fairly isolated and best considered through more detailed analysis and investigations that are beyond the scope of this work.

Figure 6.10 – AM Peak (2 hour) Volume Capacity Ratio, With Proposed East-West Arterial Road

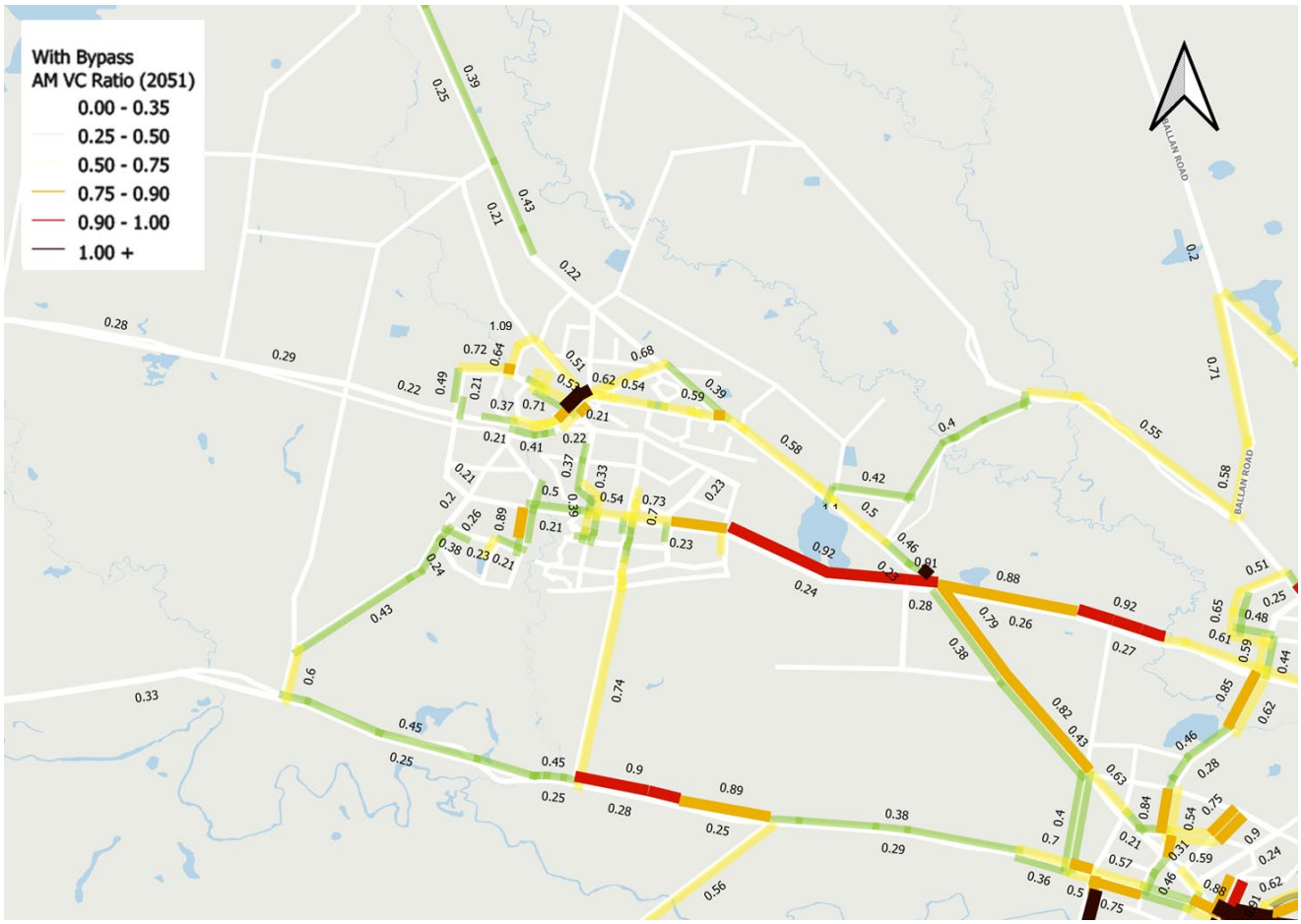
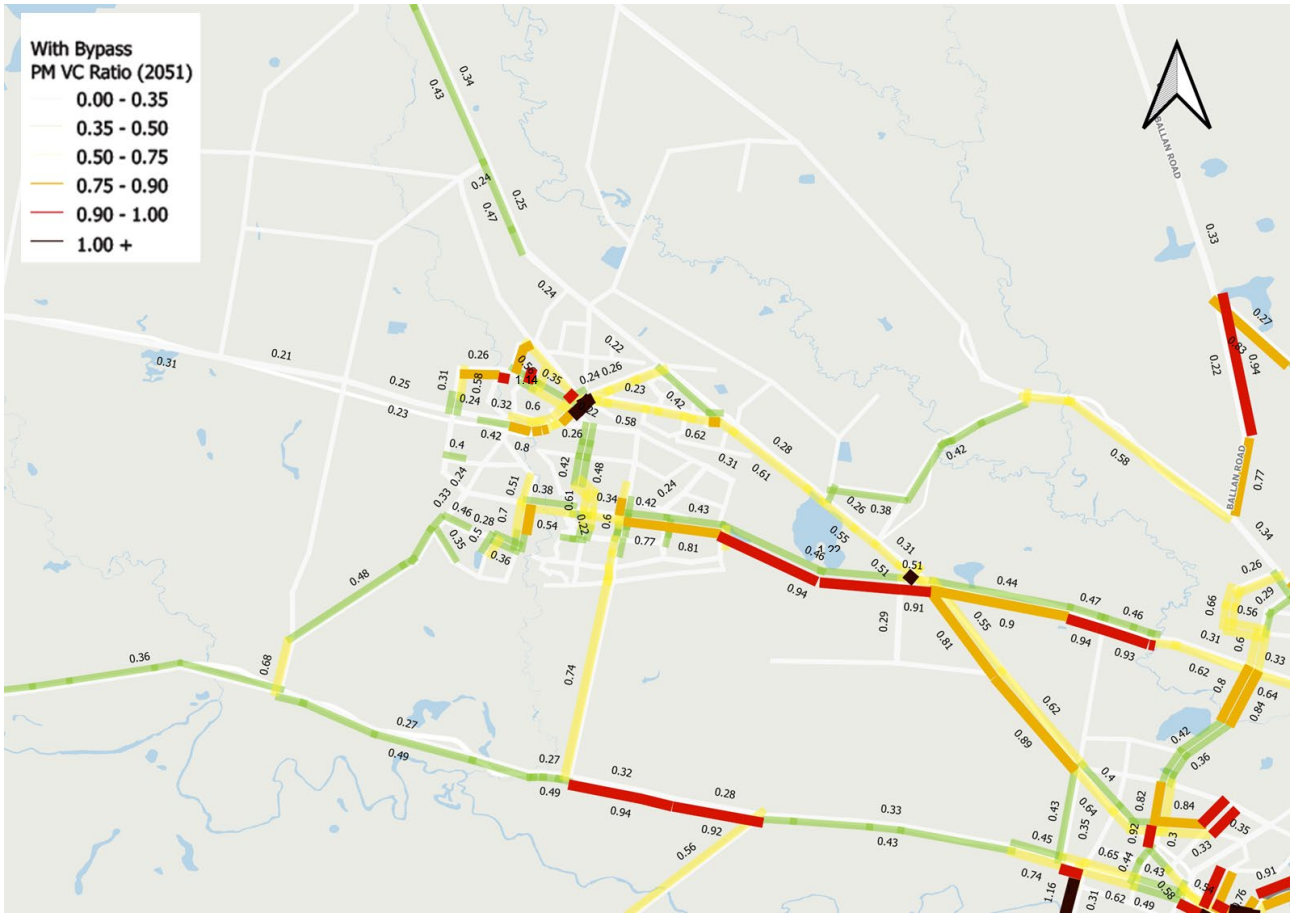


Figure 6.11 – PM Peak (2 hour) Volume Capacity Ratio, With Proposed East-West Arterial Road



6.2.4 Select Link Analysis

A Select Link Analysis (SLA) has been undertaken for the future east-west arterial road to help understand who would use it. Table 6.2 and Table 6.3 provide the proportion and volume, respectively, of daily traffic expected to use the future east-west arterial road.

Table 6.2 – Proportion of Two-Way Trips using Proposed East-West Arterial

No.	PSP	Daily	AM	PM
1	Bannockburn South-East PSP	36%	39%	40%
2	Bannockburn Future Growth Option South	23%	22%	20%
3	Bannockburn South-West Precinct	10%	10%	10%
4	Bannockburn North-West Precinct	4%	1%	2%
5	Bannockburn Future Growth Option East	10%	11%	11%
6	Bannockburn Existing Township	6%	7%	7%
7	External	11%	10%	11%
	Total	**100%**	**100%**	**100%**

Table 6.3 – Number of Two-Way Trips using Proposed East-West Arterial

No.	PSP	Daily	AM	PM
1	Bannockburn South-East Precinct	18,173	2,403	2,940
2	Bannockburn Future Growth Option South	11,492	1,353	1,433
3	Bannockburn South-West Precinct	5,100	645	733
4	Bannockburn North-West Precinct	2,082	65	123
5	Bannockburn Future Growth Option East	4,877	673	789
6	Bannockburn Existing Township	3,268	433	494
7	External	5,407	628	765
	Total	**50,400**	**6,201**	**7,278**

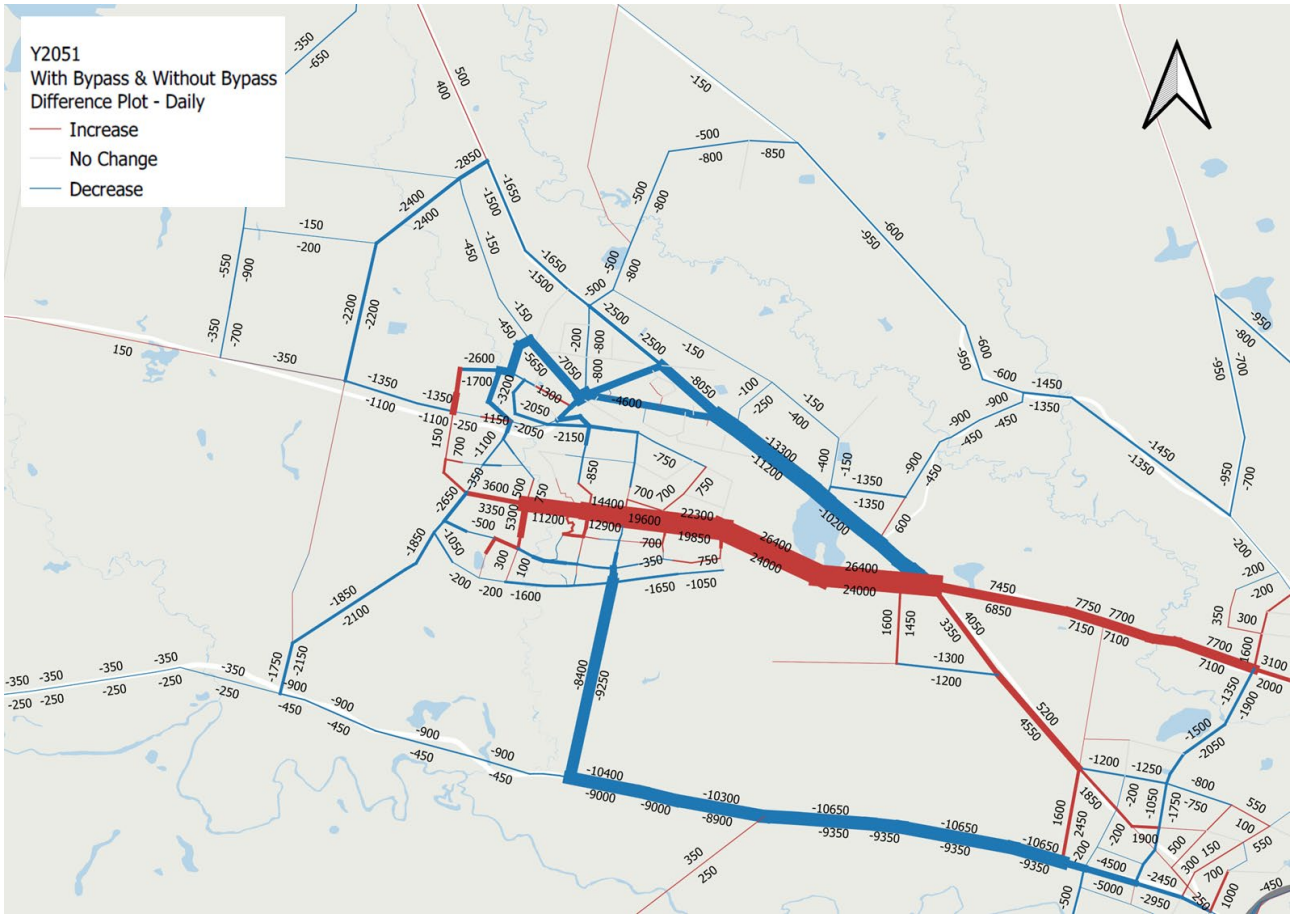
The following comments are made in relation to the SLA findings presented in Table 6.2 and Table 6.3:

- The majority of traffic using the proposed east-west arterial road has a destination or origin in Bannockburn.
- 36% of traffic using the proposed east-west arterial road are associated with the Bannockburn South East Precinct.
- The next highest user of the proposed east-west arterial road is traffic from the Bannockburn Growth Option South, which represents more than 20% of traffic on the arterial.
- 6% of the existing Bannockburn Township traffic will use the proposed east-west arterial road, and
- 11% of traffic using the bypass are classified as external traffic.

6.2.5 Difference Plot

Figure 6.12 shows the daily traffic volume differences with and without the proposed east-west arterial road connection between the Bannockburn Growth Areas and through to the Midland Highway / Fyansford-Gheringhap Road intersection.

Figure 6.12 – With and Without Proposed East-West Arterial Connection Difference Plot, Daily Volumes



The following comments are made in relation to Figure 6.12 of the daily traffic difference plot:

- Inclusion of the future east-west arterial road will result in reduced traffic volumes through the existing Bannockburn town centre and key existing routes used to access Geelong and Melbourne, namely Midland Highway via Geelong Road and Hamilton Highway via Burnside Road.
- The other key area of traffic volume reduction is High Street through the town centre and to a lesser extent the proximate local roads, which will be critical to helping create an area with high place function.
- The proposed east-west arterial results in traffic directly accessing the Midland Highway / Fyansford-Gheringhap Road roundabout, with increased traffic volumes experienced on the Midland Highway and Dog Rocks Road when compared to the without scenario, as more traffic uses the Hamilton Highway via Burnside Road in the scenario without the east-west arterial.

6.3 Discussion

Bannockburn is expected to continue to grow and develop at a rapid rate, with an ultimate population of almost 50,000 residents in 2051. With relatively lower increases in employment, residents will be required to travel beyond the township to access employment and retail opportunities.

At full development of the Growth Areas, the resultant traffic volumes will result in increased congestion on the existing road network which will present challenges to their operation and management. This is reflected in the modelling scenario that does not include the future east-west arterial road connection between the Bannockburn Growth Areas and the Midland Highway / Fyansford-Gheringhap Road intersection, which will have the following implications:

- The key local roads used to access Geelong and Melbourne, namely Geelong Road to access Midland Highway, and Burnside Road to access Hamilton Highway, will need to be upgraded. Upgrading the existing connecting roads will have their challenges, given Geelong Road is within an existing urban environment, and Burnside Road has an at-grade level crossing.

- With the associated location and volume of traffic that would use Midland Highway and Hamilton Highway, their capacity over quite meaningful lengths may also need to be upgraded to provide a suitable level of service. It is also noted that these roads have a meaningful crash history and are not built to current best practice design standards that adopt the Safe System principals (these would be adopted as part of the proposed East-West arterial road)
- Within the town centre, High Street would continue to provide the only through movement function across the Geelong – Ballarat railway line to Midland Highway. Road upgrades of High Street would need to consider the ability to achieve a high 'Place' function within the Bannockburn town centre.
- Moreover, the ability to increase the throughput capacity of the existing at-grade level crossing on High Street at the eastern end of the town centre is highly constrained given the short road lengths either side.

The introduction of the future east-west arterial road connection between the Bannockburn Growth Areas and the Midland Highway / Fyansford-Gheringhap Road intersection will result in benefits to the network, including:

- The need for upgrades to the existing local roads is much reduced, with Geelong Road and Burnside Road all operating with generally acceptable levels of service.
- The impacts on the proximate higher order arterial road network, namely Midland Highway to the west of Fyansford-Gheringhap Road and Hamilton Highway to the east of Burnside Road, is reduced. Moreover, the adopted connection (preliminary in nature based on initial authority discussions for modelling purposes) helps direct Bannockburn traffic to the east of the Midland Highway / Fyansford-Gheringhap Road intersection.
- The volume of traffic expected to go through the town centre is reduced, helping to enable the ability to create a high quality "place". It is noted that traffic volumes proximate to the existing at-grade crossing of the railway line are still anticipated to be high, but there is an opportunity to encourage traffic associated with the North West PSP to utilise the future east-west arterial to access Midland Highway instead of McPhillips Road and Geelong Road.

Other benefits to the community for the inclusion of the future east-west arterial road connection include:

- Increased level of safety, as it will put more traffic on roads with a higher safety standard (the proposed east-west arterial road will be designed to current arterial road standards that include Safe System principals) and reduce the number that will use the existing at-grade crossings of the railway lines on High Street and Burnside Road.
- Increase level of network performance, not just on the basis that there will be reduced lengths of roads with high levels of congestion but provides a more direct route to Geelong and Melbourne (where majority of commuter trips go) for the majority of the future residential development across the Bannockburn Growth Areas.
- Increased road network resilience with a second crossing point of the Geelong-Ballarat railway line and connection to Midland Highway.

It is noted that the analysis undertaken to date has the potential to over-estimate traffic generation, namely due to likely mode shift away from private car sue (refer to Section 5.1). There will be meaningful benefit in investing in improved public transport facilities and services in the area, especially buses. Benefits would include:

- Achieving a meaningful mode shift away from private car use would help reduce the overall vehicle demands needing to be supported in the future. Buses have much higher people throughput capacity than cars, as cars typically average around 1.1 occupants per vehicle, yet they have around half the spatial footprint to that of a bus.
- With a reduction in traffic volumes the potential scale and cost of additional road infrastructure could be reduced, or at least delayed. This would help ensure the need for a third lane in each direction for the future east-west arterial road between Bannockburn and Midland Highway is not required as part of the prosed level of development.
- Given the concentration of trips that are expected to go from Bannockburn to Geelong (and Melbourne via the rail network), only a few bus routes would be needed to support these movements, which helps minimise the required investment to provide high frequency and direct routes that provide some potential users with a level of service that is reasonably comparable to driving.

It is noted that the ultimate future population of Bannockburn will be in the order of 48,000 people in 2051. This would make it comparable to the existing regional centres of Sunbury and Shepparton (larger than Wodonga, Mildura and Warrnambool). As such, the associated arterial road and public transport networks should be at least commensurate to these other regional centres to support the growth in Bannockburn.

7. Assessment of the PSP

7.1 Overview

At this stage of planning for the Bannockburn South East PSP, an assessment of the internal and connecting transport network has been undertaken based on the modelling outputs, the draft Transport and Movement Plan and associated typical mid-block cross-sections prepared by VPA.

The assessment focuses on the ability for the proposed transport network to achieve the following:

- Key road links can suitably accommodate the anticipated traffic volumes
- Identify the likely key intersection types and any key operational requirements
- Provision of suitable walking and cycling facilities
- Ability to support and integrate with public transport services

7.2 Key Road Link Capacity

The proposed internal and connecting road network for the Bannockburn South East PSP was presented in Figure 4.2. For ease of reference, Figure 7.1 has been developed to provide a numbering convention for each of the key road links. Moreover, a more detailed model output of the 2051 daily volumes within and connecting the PSP has been prepared and presented in Figure 7.2.

Figure 7.1 – Key Road Links

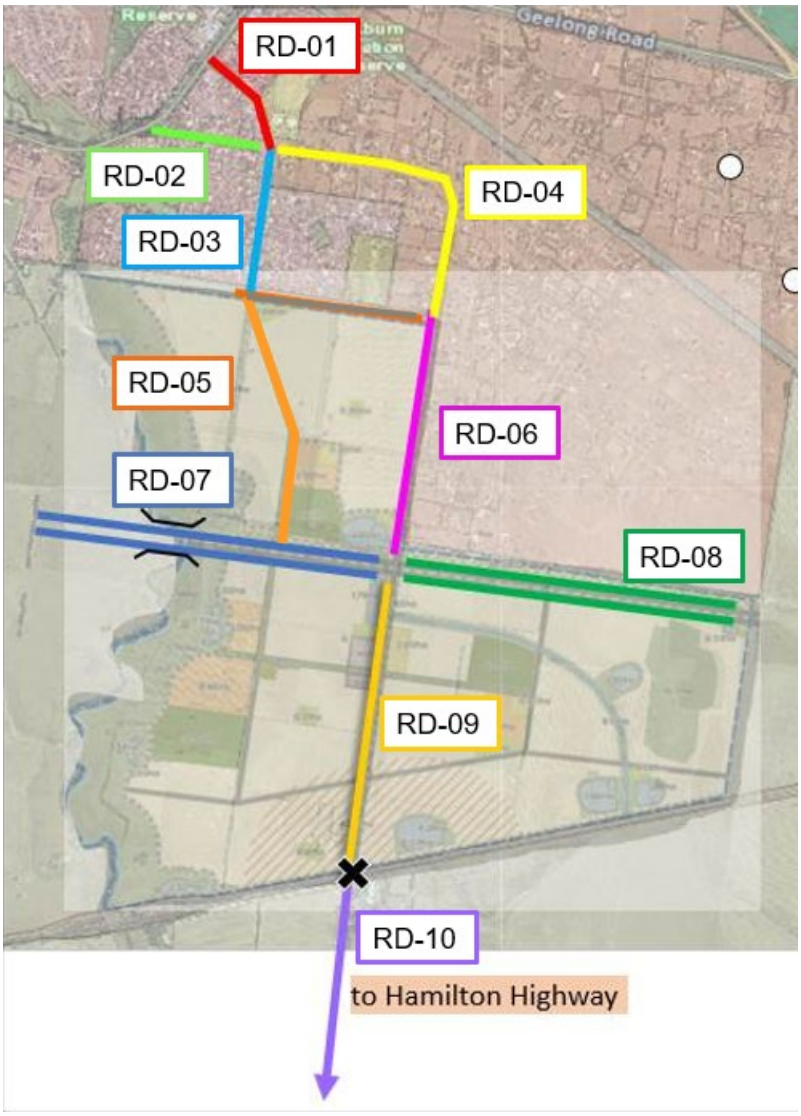
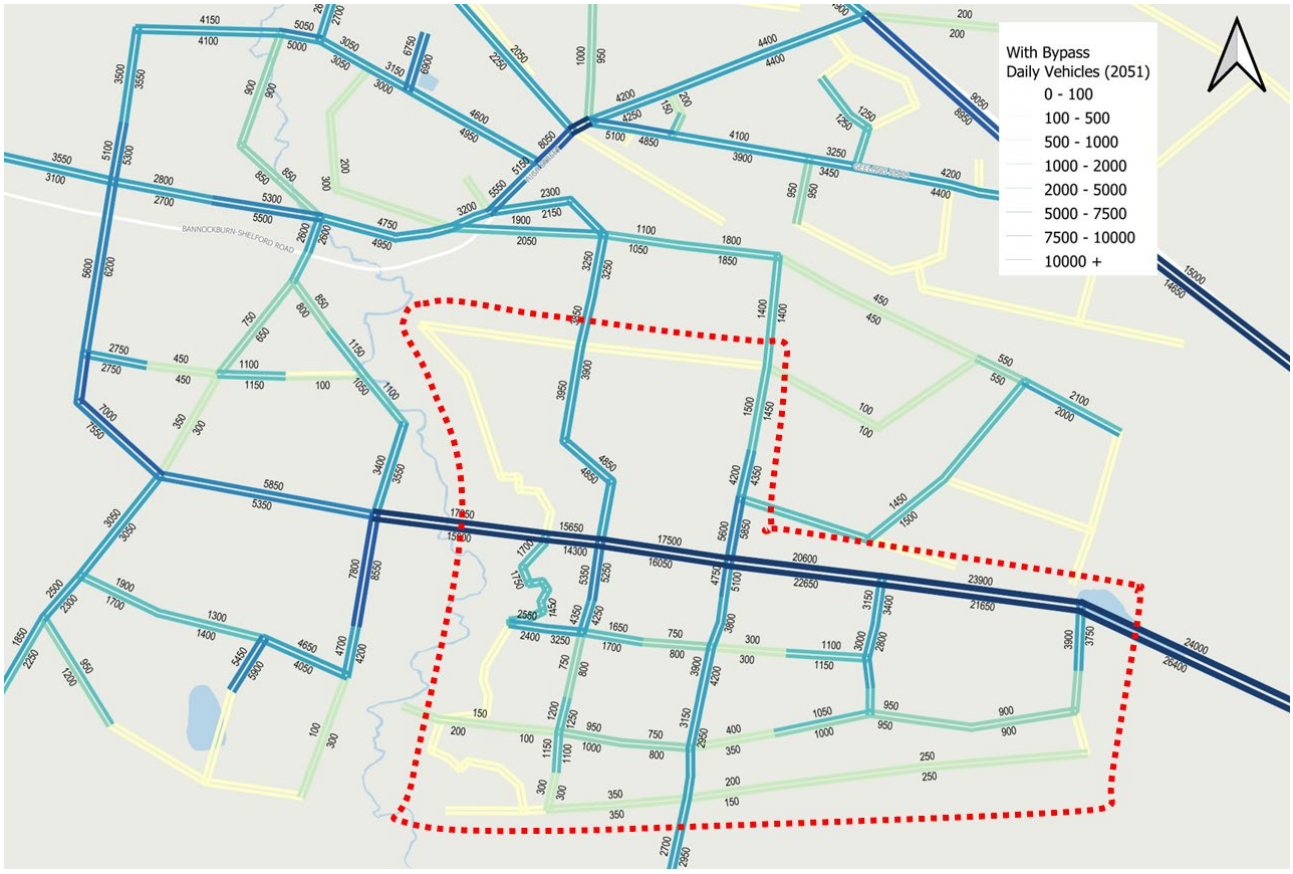


Figure 7.2 – 2051 Daily PSP Traffic Volumes (with east west arterial)



Utilising the above information, a comparison of the daily traffic volumes for the key links of the proposed PSP road network against those targeted for the relevant street classification in Table C1 of Clause 56.06 of the Golden Plains Planning Scheme has been undertaken, and the results presented in Table 7.1.

Table 7.1 – Key Road Link Traffic Capacity (with east west arterial)

No.	Road Name	Description	Daily Volume[1] (vpd)	Classification[2]	Target Daily Volume (vpd)[2]	Capacity for Vehicle Volume
RD-01	Pope Street	Existing Connector	4,450	Connector 2	3,000-7,000	Yes
RD-02	Burnside Road	Existing Connector	3,950	Connector 2	3,000-7,000	Yes
RD-03	Levy Road	Existing Connector	6,500	Connector 2	2,000-3,000	Yes
RD-04	Burnside Road	Existing Connector	3,650	Connector 2	3,000-7,000	Yes
RD-05	Levy Road	Connector Street - Boulevard	9,700	Connector 2	3,000-7,000	No
RD-06	Burnside Road	Connector Street	11,450	Connector 2	3,000-7,000	No
RD-07	East-West Arterial	Secondary Arterial	33,250	Arterial	40,000[3]	Yes
RD-08	East-West Arterial	Secondary Arterial	45,550	Arterial	40,000[3]	No
RD-09	Burnside Road	Connector Street	9,800	Connector 2	3,000-7,000	No
RD-10	Burnside Road	Connector Street	5,650	Connector 2	3,000-7,000	Yes

[1] Based on modelling.

[2] Based on Clause 56.06 (access and mobility management) of the Golden Plains Planning Scheme.

[3] Based on 10,000 vpd/lane.

Table 7.1 shows that the volumes expected on the network are generally within the target volumes indicated in Table C1 of Clause 56.06 of the Golden Plains Planning Scheme. However, there are a number that exceed the target range and are discussed further as follows:

- RD-05 Levy Road: As Levy Road approaches the future east-west arterial road the traffic volumes get higher and over a localised extent expected to exceed the connector street target traffic range. They will be able to operate in a satisfactory manner for this short section and operate more like an arterial road, where vehicle movement is the focus (e.g. no kerbside car parking and property access points). Traffic volumes are, however, likely to be lower as the subdivision is delivered and a local network is provided that will help disperse traffic.
- RD-06 & RD-09 Burnside Road: As Burnside Road approaches the future east-west arterial the traffic volumes get higher get higher and over localised extents expected to exceed the connector street target traffic range. They will be able to operate in a satisfactory manner if for the associated short sections operates more like an arterial road, where vehicle movement is the focus (e.g. no kerbside car parking and property access points).
- RD-08 East-West Arterial Road: At the eastern end of the future east-west arterial road the traffic volumes are the highest and have been found to exceed the target traffic range. However, in terms of peak period VC ratios presented in Figure 6.10 and Figure 6.11 they are expected to still be able to operate less than 0.9 within the South East PSP.

On the above basis, the proposed road network is expected to be able to be able to accommodate the anticipated traffic volumes for the delivery of the entire growth area of Bannockburn, noting the above localised considerations.

It is further noted that the typical mid-block cross-sections that have been provided by VPA for each road type that forms part of the proposed road network have been reviewed and the provided carriageway widths and arrangements are considered generally consistent with the relevant design aspects from Table C1 of Clause 56.06 of the Golden Plains Planning Scheme.

Furthermore, these proposed roads will be of a higher design and safety standard to those that currently exist in the area. This is expected to help address the existing local road crash history indicated in Section 3.3 that included two 'other injury' and one serious injury crashes along a section of Burnside Road that will be upgraded.

7.3 Key Intersection Types

The proposed internal and connecting road network for the Bannockburn South East PSP was presented in Figure 4.2. For ease of reference, Figure 7.3 has been developed to provide a numbering convention for each of the key road intersections. Table 7.2 has been prepared to provide guidance on the intersection type that will likely be required given the intersecting road types, volumes and other modes.

Table 7.1 indicates a range of potential intersection treatment types that will be required for the internal and connecting intersections based on relevant Austroads and DTP guidance. The consideration of any others will require more further analysis, which is expected as part of subsequent planning and design stages.

Figure 7.3 – Key Intersections

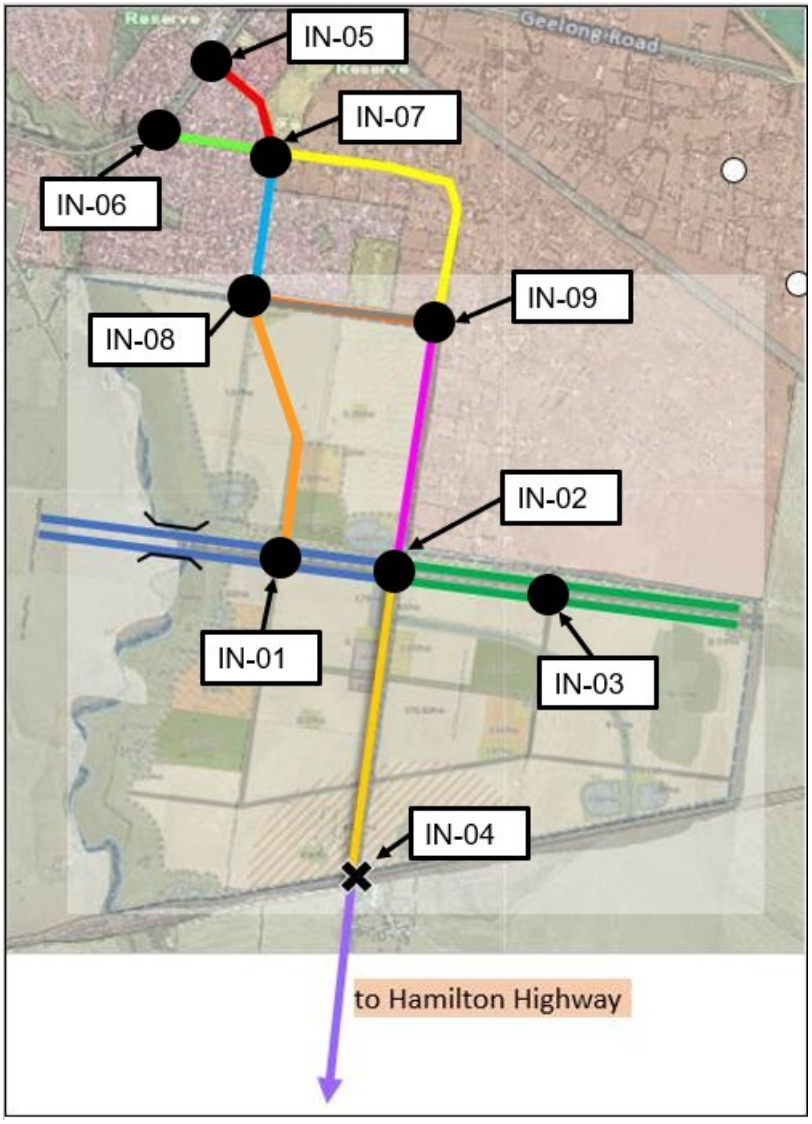


Table 7.2 – Key Intersection Types

Intersection	Intersection type	Notes
IN-01	Signalised	High intersecting traffic volumes with very high east-west dominant movement
IN-02	Signalised	High intersecting traffic volumes with very high east-west dominant movement
IN-03	Signalised	High intersecting traffic volumes with very high east-west dominant movement
IN-04	Level crossing	Specific arrangements to be determined through relevant analysis and authority discussions
IN-05	Stop, Give way or signalised intersection	High Street is a secondary arterial road with the highest level of pedestrian activity in Bannockburn. Overall town centre and/or corridor approach to inform selection.
IN-06	Give way or signalised intersection	High Street is a secondary arterial road with the highest level of pedestrian activity in Bannockburn. Overall town centre and/or corridor approach to inform selection.
IN-07	Roundabout	High intersecting traffic flows and active transport crossing movements.
IN-08	Stop, give way, or roundabout	Dependent on turning vehicle volumes as dominant movement north-south

Intersection	Intersection type	Notes
IN-09	Stop, give way, or roundabout	Dependent on turning vehicle volumes as dominant movement north-south

Reference: Table 2.5 of 'Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings', and Section 3 of the DTP Supplement to Austroads Guide to Traffic Management, Part 6 (2013) - October 2015

7.4 Walking and Cycling

The typical mid-block cross-sections that have been provided by VPA for the road network include the following various walking and cycling facilities:

- The future east-west arterial road will have shared paths on each side of the main carriageway and a footpath on the property side of any service road.
- Each connector street includes a separated two-way bicycle path on one side of the road and footpaths on each side of the road
- Each local street includes footpaths on each side of the road, except those against the Bruce Creek, rail line, open space or easements where a two-way shared path will be provided instead.

Based on the above walking and cycling facilities and the overall road network structure, the majority of roads will have cycling facilities, and all will have walking facilities. As such, there can be expected to be a holistic active travel network across the South East PSP. However, the following matters should be considered further as part of the PSP planning:

- Ensure there will be connections between the South East PSP, existing town centre, adjacent PSPs and key land uses (e.g. schools).
- Safe system aligned crossing treatments of roads (e.g. impact speeds of 30km/h or less)
- Provide minimum 0.5m off-sets between all paths and adjacent physical obstructions (e.g. property boundaries, trees, street lights, etc.). Currently some of the provided cross-sections do not include the minimum 0.5m off-sets, especially between the footpaths and property boundaries on the local streets.

7.5 Public transport

The proposed internal and connecting road network for the Bannockburn South East PSP presented in Figure 4.2 indicates that all of the arterial and connector streets will be bus capable. This is considered reasonable, noting that specific bus routes have not been nominated but there is considered ability to accommodate stops within the provided cross-sections.

In the future it would be expected that there will be a holistic local bus network, as well as regular and direct intra-town services connecting with key locations in Geelong, including the rail stations for those wanting to access Melbourne. The provision of bus services is the responsibility of DTP.

7.6 Aspirational Transport Network

Building on the above assessment of the proposed internal transport network, reflecting of the existing Movement and Place network classifications and the Bannockburn Growth Plan's principle of building an "integrated and safe transport network" that "encourages modal shift by supporting opportunities for active and public transport", an aspirational transport network plan for the Bannockburn South East PSP has been developed.

The aspirational transport network plan identifies the priority routes by each transport mode within, through and accessing the Bannockburn South East PSP. Consideration of the future role and function of High Street in the town centre on the basis that the proposed east-west arterial road is implemented has also been undertaken, which does not change the current role and function of High Street if the proposed east-west arterial road is not implemented.

The resulting aspirational transport network plan is presented in Figure 7.4 and the recommended changes to the existing Movement and Place network classifications are presented in Table 7.3.

It should be noted that the aspirational transport network plan and recommended changes to the existing Movement and Place network classifications are focused on the Bannockburn South East PSP within the context of the broader Bannockburn township and where people are likely wanting to travel. It should not be considered to be a full transport network plan or all the required changes to the existing Movement and Place network classifications to support the entire growth anticipated for Bannockburn out to 2051.

A full transport network plan and revised Movement and Place network classifications are currently beyond the scope of this study and require further analysis and consultation with stakeholders to determine and agree on all the associated arrangements.

Figure 7.4 – Bannockburn South East PSP – Aspirational Transport Plan

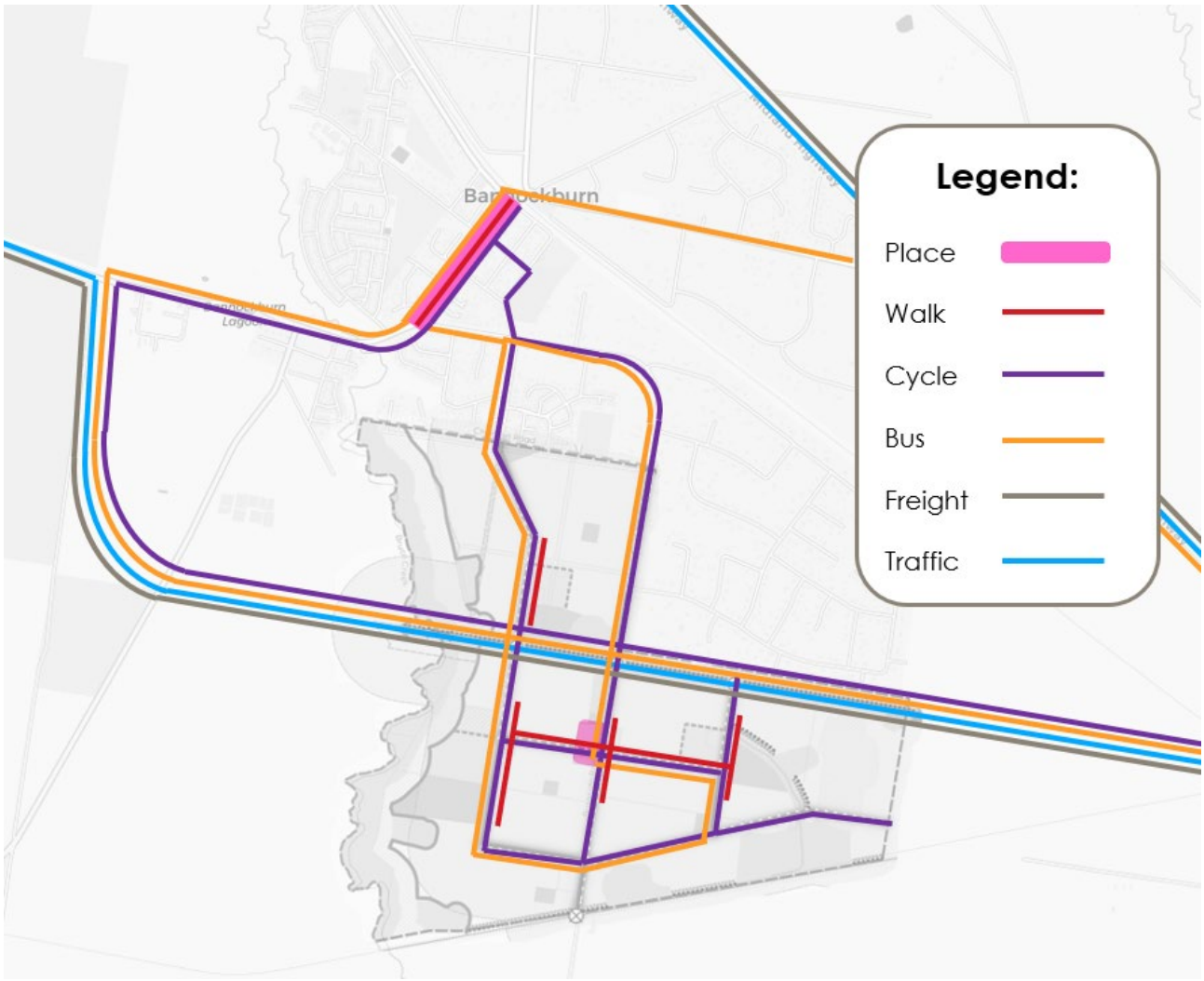


Table 7.3 – Recommended Changed to Existing Movement and Place Classifications

Type	Recommend Change
Place	• High Street, within the town centre, change from a P4 to a P3 • Bannockburn South East PSP local town centre be a P4
Walk	• High Street, within the town centre, change from a W3 to a W2 • Along the school and local town centre road frontages in the Bannockburn South East PSP be W3
Cycle	• Continuation of C2 along Bannockburn – Shelford Road to the proposed east-west arterial road • Along the length of the proposed east-west arterial road be a C2 • Along all the connector streets be C2, connecting with the existing C2 routes on Burnside Road and Levy Road (while not mapped, this is considered to be potential for a recreational cycle route along the Bruce Creek; CR2)
Bus	• Along arterial roads connecting Bannockburn be B2 • Along connector streets within the Bannockburn South East PSP and linking to the Bannockburn town centre be B3
Freight	• Change the F2 route that currently goes along High Street through the Bannockburn town centre to the proposed east-west arterial road.
Traffic	• Change the GT3 route that currently goes along High Street through the Bannockburn town centre to the proposed east-west arterial road. • Along connector streets within the Bannockburn South East PSP and linking to the Bannockburn town centre be GT4.

8. Summary

An assessment of the proposed Bannockburn South East PSP's transport network has been undertaken, including strategic modelling that considered the full build out of the Bannockburn Growth Framework Plan in 2051. The analysis assessed the suitability of the proposed road, active and public transport network arrangements, with the following comments provided:

- Bannockburn is expected to grow to a total population forecast of almost 50,000 people in 2051. The resultant growth will exhibit more traffic and congestion on the existing road network, especially for Bannockburn residents seeking to travel to/from Geelong and Melbourne for employment.
- Strategic transport modelling and analysis indicates that there will be benefits to the Bannockburn and broader arterial road network with the introduction of the proposed east-west arterial road.
- The proposed internal and connecting road network to the PSP is expected to be able to suitably accommodate the anticipated traffic volumes, noting there are some localised sections, such as the intersections of the connector roads with the east-west arterial, that will potentially operate above targeted traffic volume ranges. These can be suitably managed through specific design treatments.
- Active travel infrastructure is proposed to be included as part of each road corridor. The combination of all the facilities is expected to provide a holistic active travel network across the South East PSP. Consideration of connections to other parts of Bannockburn and safe system aligned road crossing facilities will ultimately be required to make active travel use an attractive option for the whole community.
- All of the proposed arterial and connector roads will be bus capable, which will support public transport in and accessing Bannockburn, which is expected to be able to meaningfully reduce the current traffic volumes determined through the strategic transport modelling that has been undertaken.
- An aspirational transport network and recommended changes to Movement and Place network classifications have been provided for the South East PSP within the context of the broader Bannockburn township and where people are likely wanting to travel. A full transport network plan and all the required changes to the existing Movement and Place network classifications to support the entire growth anticipated for Bannockburn out to 2051 is recommended.

Appendix A. Movement & Place

Transport planning has undergone many evolutions over the years, from only focusing on the movement of vehicles within the carriageway, to including consideration and integration of other modes, to now the interaction with the adjacent land use and associated activities.

This latest evolution is referred to as the Movement and Place Framework, which has been adopted by the State Government, and is beginning to be applied industry wide.

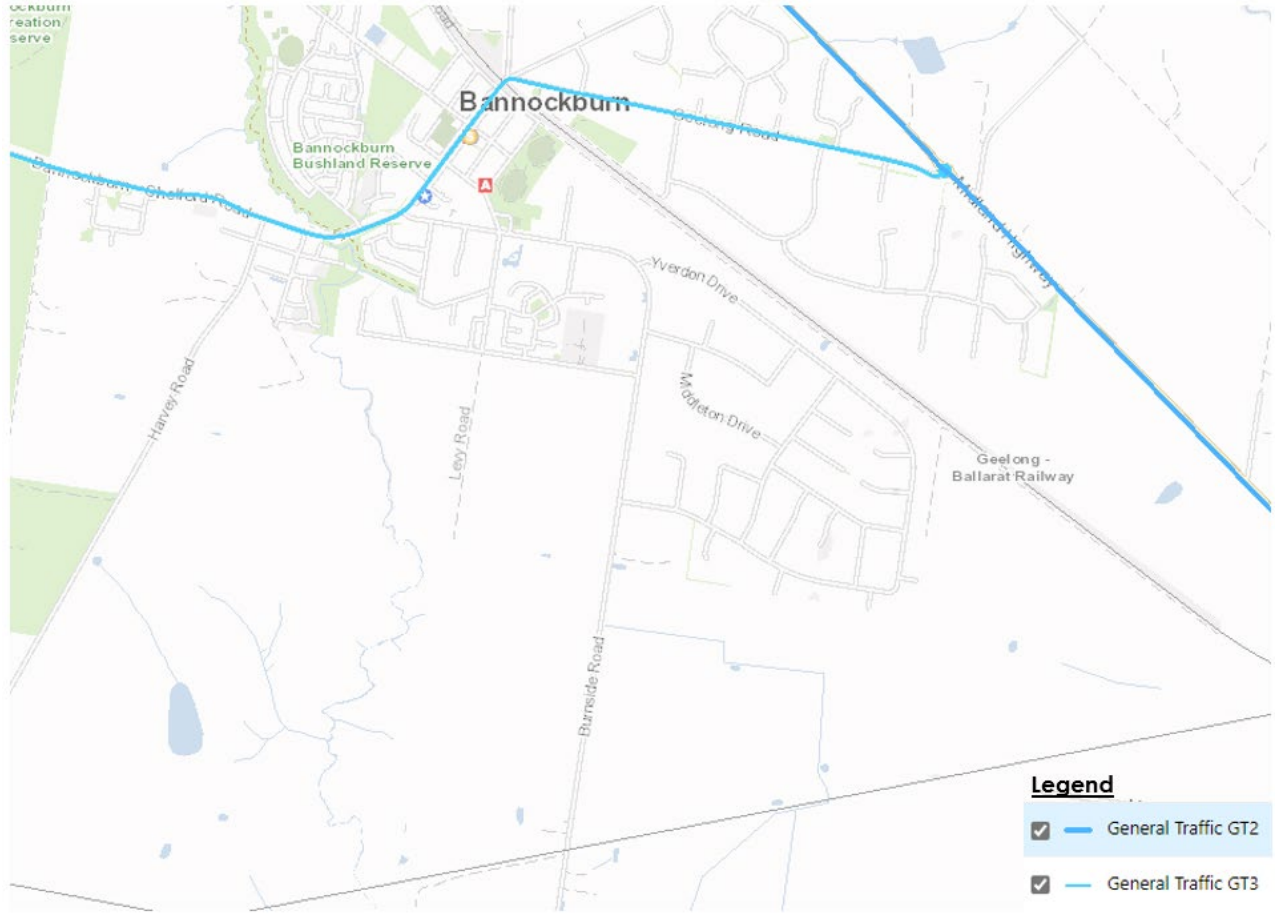
Movement and Place classifications have been generated through an automatic mapping process by the DTP across Victoria. It is noted that the associated Movement and Place classifications should not be considered as being fixed. Rather, they provide an initial starting point and understanding of some of the key directions that should be targeted in the planning and development of the transport network.

An ongoing iterative process is expected, especially within greenfield growth area, as precinct and major project planning activities occur and resolve and integrate the various elements in more detail.

The current generated Movement and Place modal classifications for Bannockburn and surrounds are shown in Figure A.1 to Figure A.7, summarised as follows:

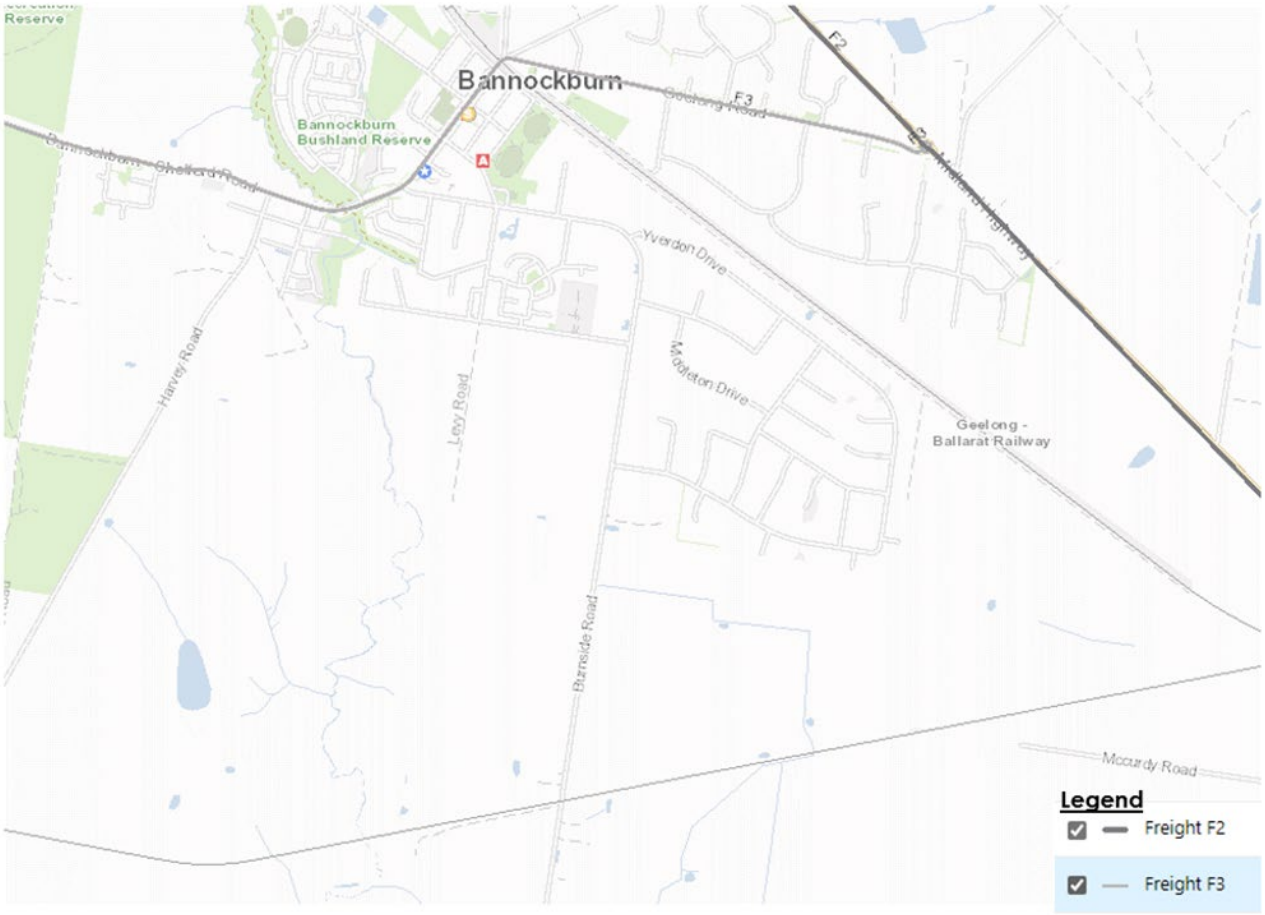
- General Traffic (GT) – Midland Highway is GT2 whilst the C143 is GT3, indicating the higher function they perform regarding traffic movement. All other roads in Bannockburn are the lowest order GT5.
- Freight (F) – Midland Highway is F2 whilst the C143 is F3, indicating they are required to perform a freight movement function.
- Cycling (C) – C2 cycling routes surrounding the South East Precinct include Burnside Road, Glen Avon Drive and Levy Road north of Charlton Road, which are intended to link places within the town. Lower order C4 routes surrounding the South East Precinct include Charlton Road and Levy Road south of Charlton Road, providing for local movements.
- Walking (W) – Roads surrounding the South East Precinct including Charlton Road, Levy Road and Burnside Road are neighbourhood linking W4 routes, with the Midland Highway and C143 being slightly higher order W3 routes. It is generally noted that the walking network is sporadic, particularly in the south east area of Bannockburn.
- Bus (B) – The bus network in Bannockburn is classified B5, being movement of people by low/irregular frequency services. The network includes the Midland Highway through to the Bannockburn town centre along Geelong Road and High Street, as far as Milton Street. A bus route also connects to the Midland Highway via Clyde Road.
- Rail (R) – The two rail lines through Bannockburn are classified R1, defined as providing for “Mass movement of people providing high frequency access to high-level Places”.
- Place (P) – All roads within Bannockburn are local P5 roads, except for the Bannockburn town centre has slightly higher order P4 roads being a place of neighbourhood level importance.

Figure A.1 – Bannockburn Movement and Place Classifications (General Traffic)



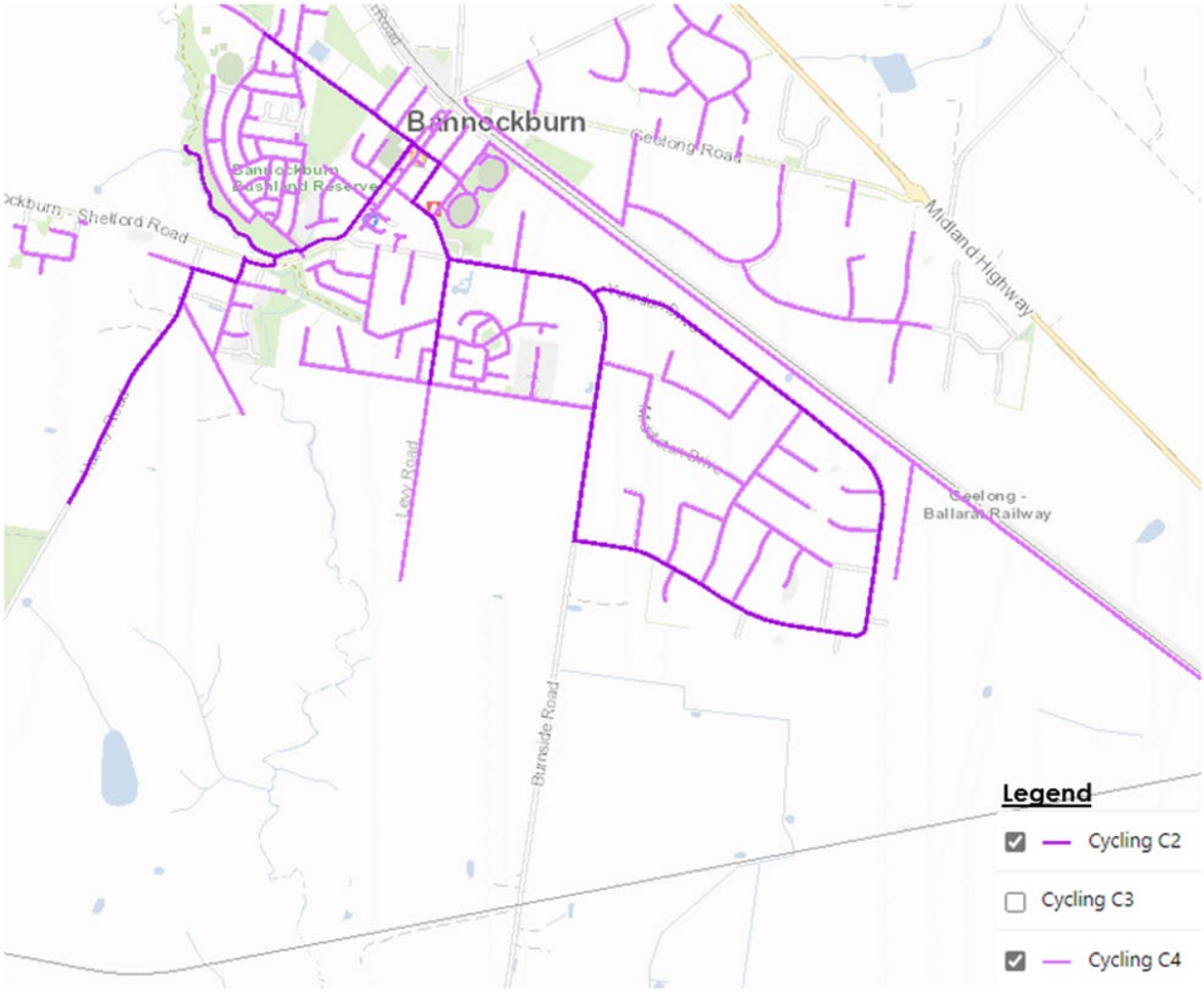
Source: vicmaps.vicroads.vic.gov.au

Figure A.2 – Bannockburn Movement and Place Classifications (Freight)



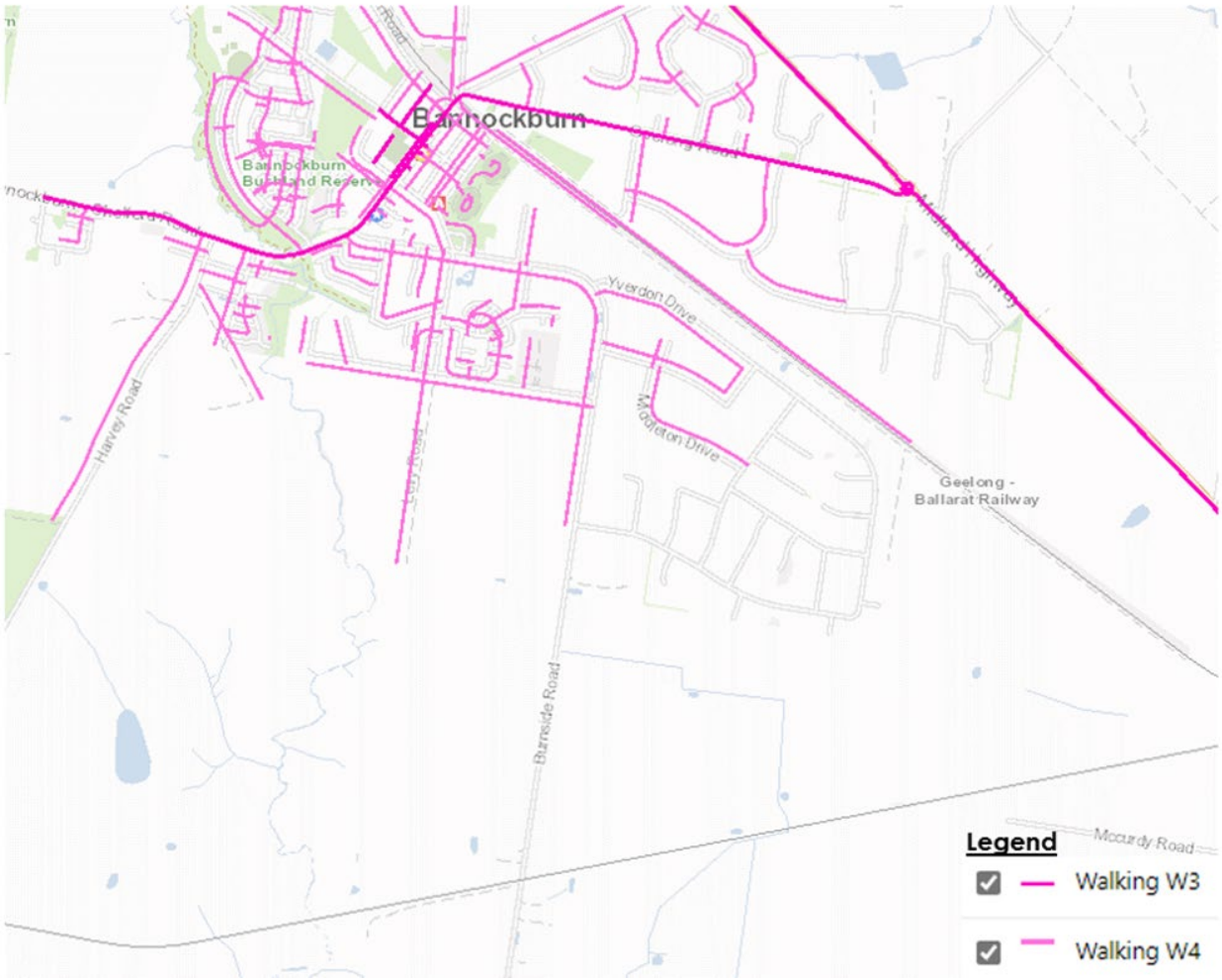
Source: vicmaps.vicroads.vic.gov.au

Figure A.3 – Bannockburn Movement and Place Classifications (Cycling)



Source: vicmaps.vicroads.vic.gov.au

Figure A.4 – Bannockburn Movement and Place Classifications (Walking)

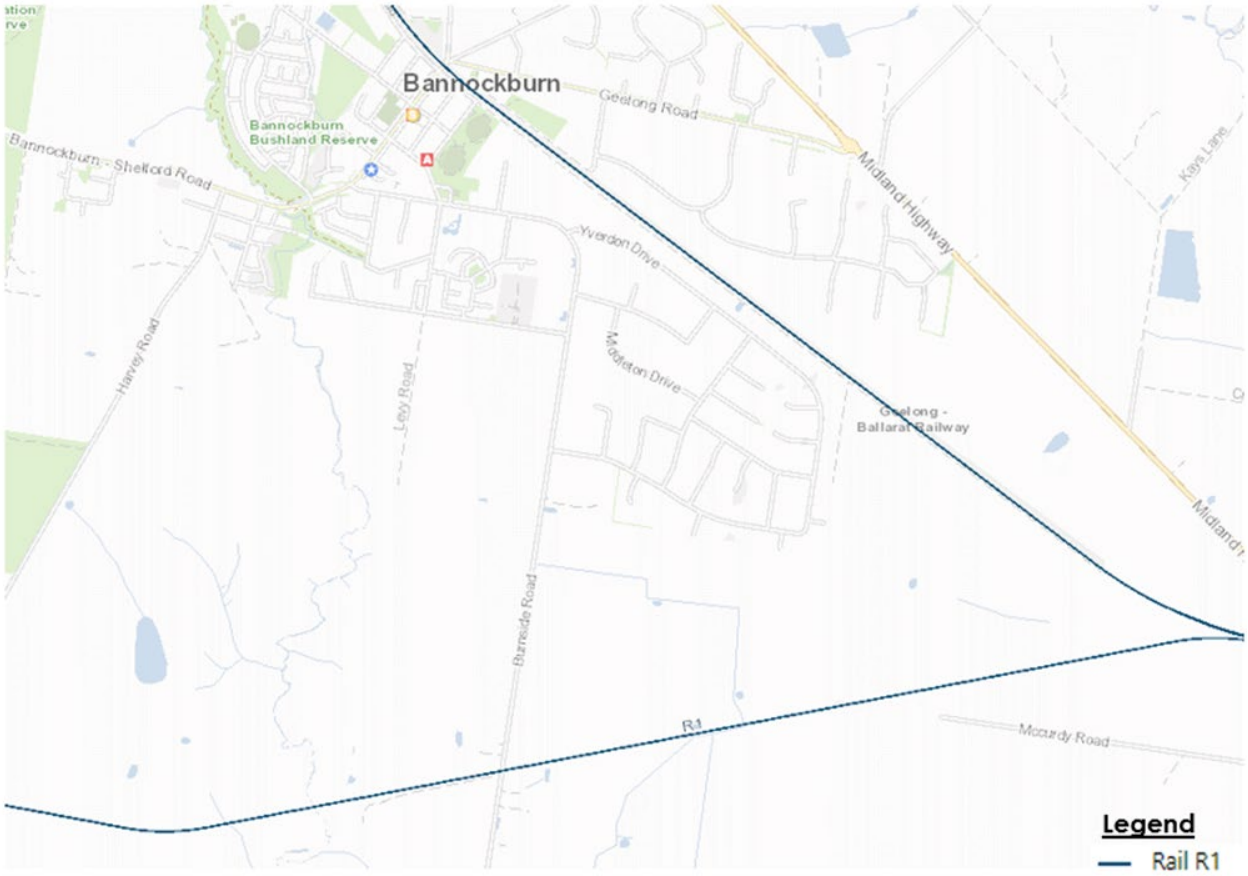


Source: vicmaps.vicroads.vic.gov.au

Figure A.5 – Bannockburn Movement and Place Classifications (Bus)

Source: vicmaps.vicroads.vic.gov.au

Figure A.6 – Bannockburn Movement and Place Classifications (Rail)



Source: vicmaps.vicroads.vic.gov.au

Figure A.7 – Bannockburn Movement and Place Classifications (Place)

Source: vicmaps.vicroads.vic.gov.au

Appendix B. Safety Review

A review of the reported accident history for the roads and intersections internal and adjoining the Bannockburn South East PSP has been sourced from VicRoads CrashStats accident database.

This database records all accidents causing injury that have occurred in Victoria since 1987 (as recorded by Victorian Police) and categorises these accidents as follows:

- Fatal injury: at least one person was killed in the accident or died within 30 days as a result of the accident.
- Serious injury: at least one person was sent to hospital as a result of the accident.
- Other injury: at least one person required medical treatment as a result of the accident.

The crash locations along with an assessment area surrounding the South East Precinct is shown in Figure B.1, with a summary of the accidents for the last available five year period (2014-2018) inclusive presented in Table B.1.

Figure B.1 – Crash Locations Proximate to the South East Precinct

Source: VicRoads

Table B.1 – Crash Type and Location Summary

Location	Fatality	Serious Injury	Other injury
Shelford-Bannockburn Rd		2	1
Guinane Crt (south of Shelford-Bannockburn Rd)			1
High St			4
Geelong Rd			1
Midland Hwy (near Geelong Rd)			4
Midland Hwy (north of rail crossing)	1	3	7
Midland Hwy (south of rail crossing)	1	3	1
Garrone Dr			1

Location	Fatality	Serious Injury	Other injury
Burnside Rd		1	2
Glen Avon Dr		1	

Source: VicRoads

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