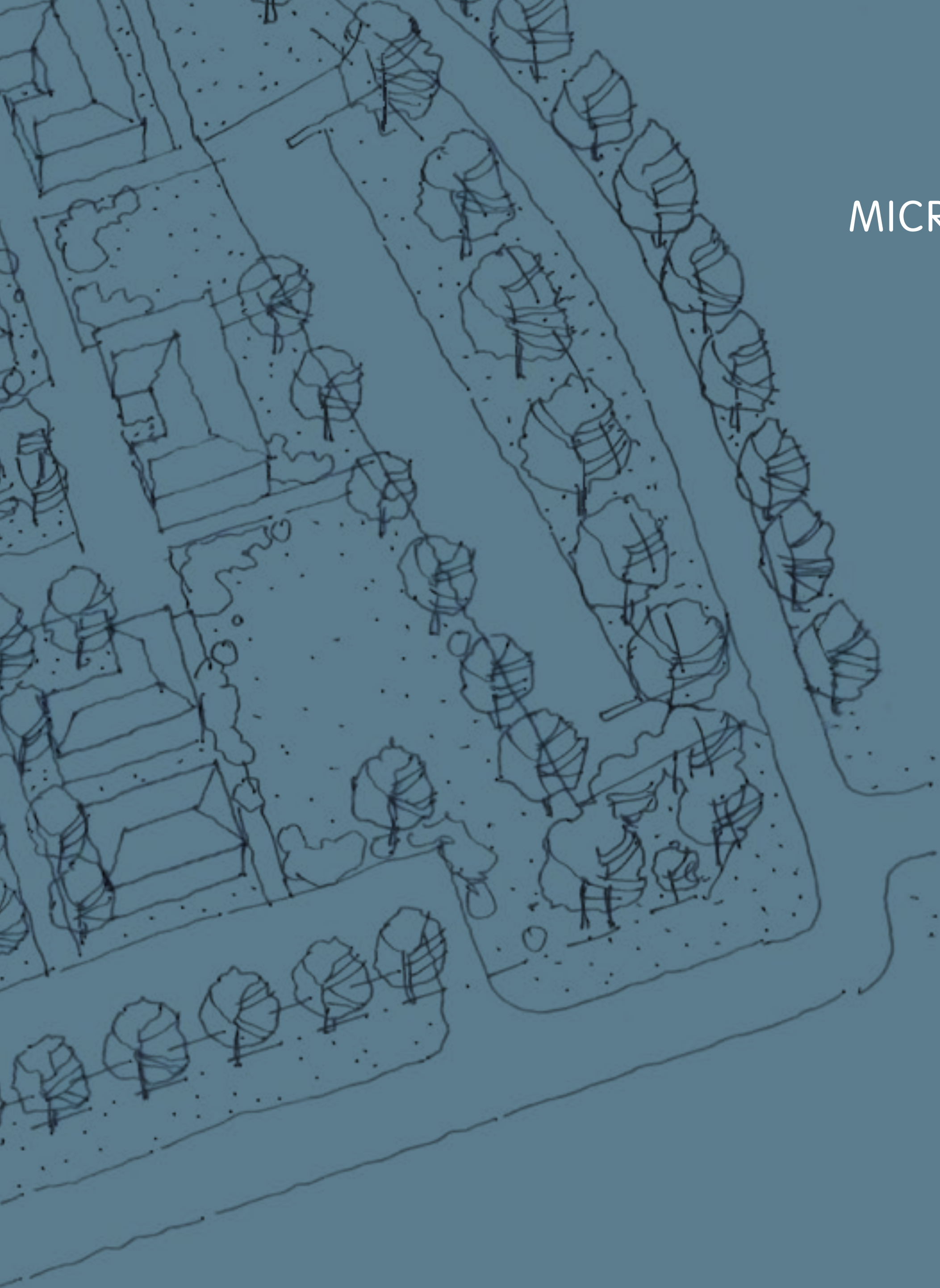


APPENDIX 4B

MICROSIMULATION EVACUATION MODELLING REPORT

Engineering a better future for over 20 years!

North Stoneville Structure Plan

Microsimulation Evacuation Modelling Report

PREPARED FOR:
Satterley Property Group

May 2024

Document history and status

Author	Revision	Approved by	Date approved	Revision type
Mohammad Rasouli	r01	B Bordbar	31/01/2022	1st Draft
Mohammad Rasouli	r01a	B Bordbar	29/04/2022	2nd Draft
Mohammad Rasouli	r01b	B Bordbar	19/05/2022	3rd Draft
Mohammad Rasouli	r01c	B Bordbar	09/12/2022	4th Draft
Mohammad Rasouli	r01d	B Bordbar	24/01/2023	5th Draft
Mohammad Rasouli	r01e	B Bordbar	25/01/2023	6th Draft
Mohammad Rasouli	r01f	B Bordbar	09/02/2023	Final
Mohammad Rasouli	r01g	B Bordbar	31/05/2024	Revised Final

File name: t20.341mr.r01g.docx

Author: Mohammad Rasouli

Project manager: Mohammad Rasouli

Client: Satterley Property Group

Project: Microsimulation Evacuation Modelling Report

Document revision: r01g

Project number: t20.341

TABLE OF CONTENTS

REPORT FIGURES

REPORT TABLES

1 Introduction

Transcore has been engaged by Satterley Property Group to develop a traffic model to establish if, and how, the existing and proposed population of North Stoneville and the broader catchment within the defined traffic modelling area would evacuate as a result of a severe bushfire.

Accordingly, Transcore developed microsimulation models using Aimsun software for traffic evacuation from the North Stoneville Structure Plan (NSSP) and surrounding area, in the case of a severe bushfire.

Subsequent to Transcore's initial evacuation modelling, JBS&G, in conjunction with Covey Associates Pty Ltd, have conducted bushfire simulation modelling for multiple bushfire scenarios which are explained in this report. The details of the bushfire simulation modelling are documented in "Bushfire Simulation Modelling Report, JBS&G Australia Pty Ltd T/A JBS&G (Rev 4)".

Hatch also established forecast dwellings for different assessment years for the traffic modelling area. The details of the dwellings forecast are documented in Hatch report. According to the information obtained from Hatch the NSSP is expected to have a projected population of approximately 2,803 individuals after full development.

The outcome of assessments undertaken by JBS&G and Hatch were used to develop the microsimulations models by Transcore.

The intent of this traffic modelling report is to document the assumptions, methodology and outcome of the microsimulation traffic evacuation modelling.

The objectives of undertaking the traffic modelling and analysis, are to:

- Assess whether the current and proposed road network is capable of facilitating the evacuation of the traffic modelling area (as defined) including NSSP area, in a timely and safe manner in all relevant bushfire scenarios;
- Assess whether, in the context of evacuation time, the proposed NSSP affects the level of bushfire risk in the traffic modelling area; and,
- Identify what mitigation measures, if any, are necessary to enable the population of the traffic modelling area, including the NSSP area, to evacuate in a timely manner, and ensure that the bushfire risk in the surrounding area is managed.

2 Methodology

A fit-for-purpose methodology was developed to investigate the evacuation of the existing and future population which would be affected by a potential severe bushfire. The methodology considers the outcome of the bushfire modelling and includes a number of assumptions for evacuation in response to bushfire.

It is acknowledged that bushfire behaviour is highly variable and dependent on multiple factors which are difficult to predict. Accordingly, Transcore has developed microsimulation traffic models to assess the evacuation traffic conditions for multiple bushfire scenarios.

The microsimulation model details the incremental trip generation of the evacuees in response to bushfire progression and visually presents the fire front geographical location compared to queue location of evacuees throughout the simulation period. This will enable the modeller to trace the location of the fire front and back of queue during the evacuation. It is expected that for a satisfactory and safe evacuation, the back of evacuation queue should always be ahead of the fire front.

The microsimulation models also report the total time required for residents that are affected by a potential bushfire to evacuate satisfactorily. The following sections provide further information on the methodology used for development of the microsimulation models.

2.1 Modelling platform

Traffic microsimulation modelling has been developed using Aimsun version 8.4.0 platform. Five different 'seed' values were used to replicate the variation in traffic conditions during the model run. The outcome of the model runs was established using the average of the five different model runs.

2.2 Traffic modelling area

In order to establish the traffic modelling area consideration was given to the bushfire study area, because a bushfire in the area would likely impact a much broader population catchment than only the NSSP, and so a wider catchment was considered when determining evacuation traffic demand.

It is acknowledged that fires generally progress in elliptical format from the ignition point and build progressively to full intensity. Therefore, the bushfire study area for identifying potential bushfire scenarios extends approximately 5-10km from the boundaries of the NSSP. This is the area in which a bushfire could ignite resulting in ultimate evacuation of residents from the considered area.

The traffic modelling area covers the roads likely to be used by the population of the NSSP area and surrounding suburbs in the traffic modelling area to evacuate in the event of a bushfire. **Figure 1** shows the traffic modelling area used in Aimsun transport modelling platform. The traffic modelling area is bounded by Toodyay Road to the north, Great Eastern Highway (GEH) to the south and environmental conservation reserves, John Forrest National Park and Leschenaultia Conservation Park, to the west and east respectively.

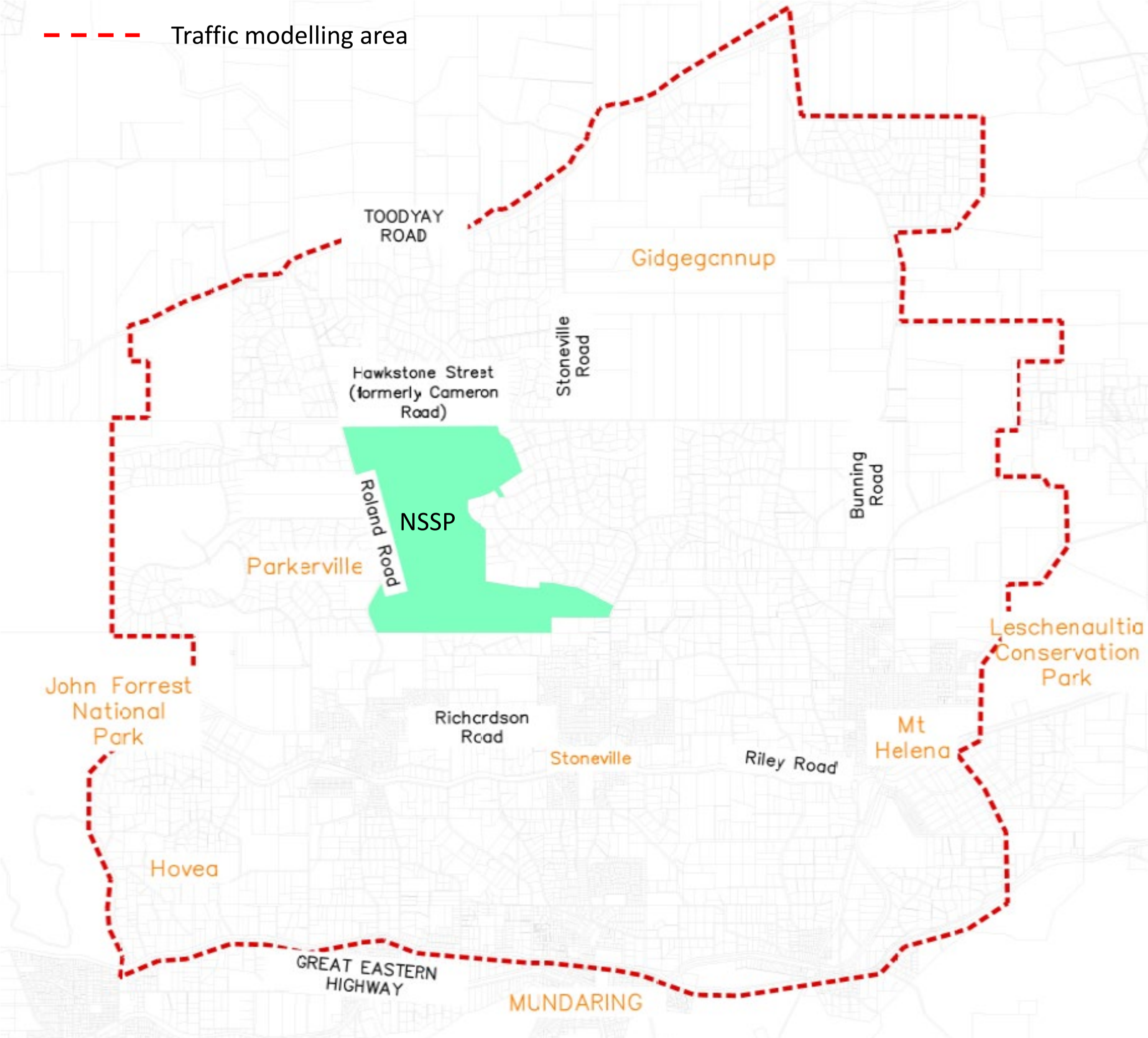


Figure 1: Traffic modelling area

2.3 Traffic modelling zones

Figure 2 shows the proposed traffic modelling zones (internal and external zones) for the microsimulation modelling. Two types of zones were used for developing the microsimulation models:

- External zone: this zone is defined as an area from which vehicles are released into or removed from the network. They generally represent the 'cuts' in the external road network, where vehicles enter or exit from the model.
- Internal zone: this zone represents an internal destination within the study area. Vehicles enter the study area from the external zones and drive to one

of the internal zones. Conversely, they exit from the internal zones and drive to the external zones.

The microsimulation models were developed with 13 internal and 6 external zones. The internal zones were established in such a manner that they have almost the same size and generally bordered by public gazetted roads. In **Figure 2,** Zone 5 shows the extent of the NSSP.

Evacuation traffic from all internal zones were considered and distributed to the road network within the traffic modelling area.

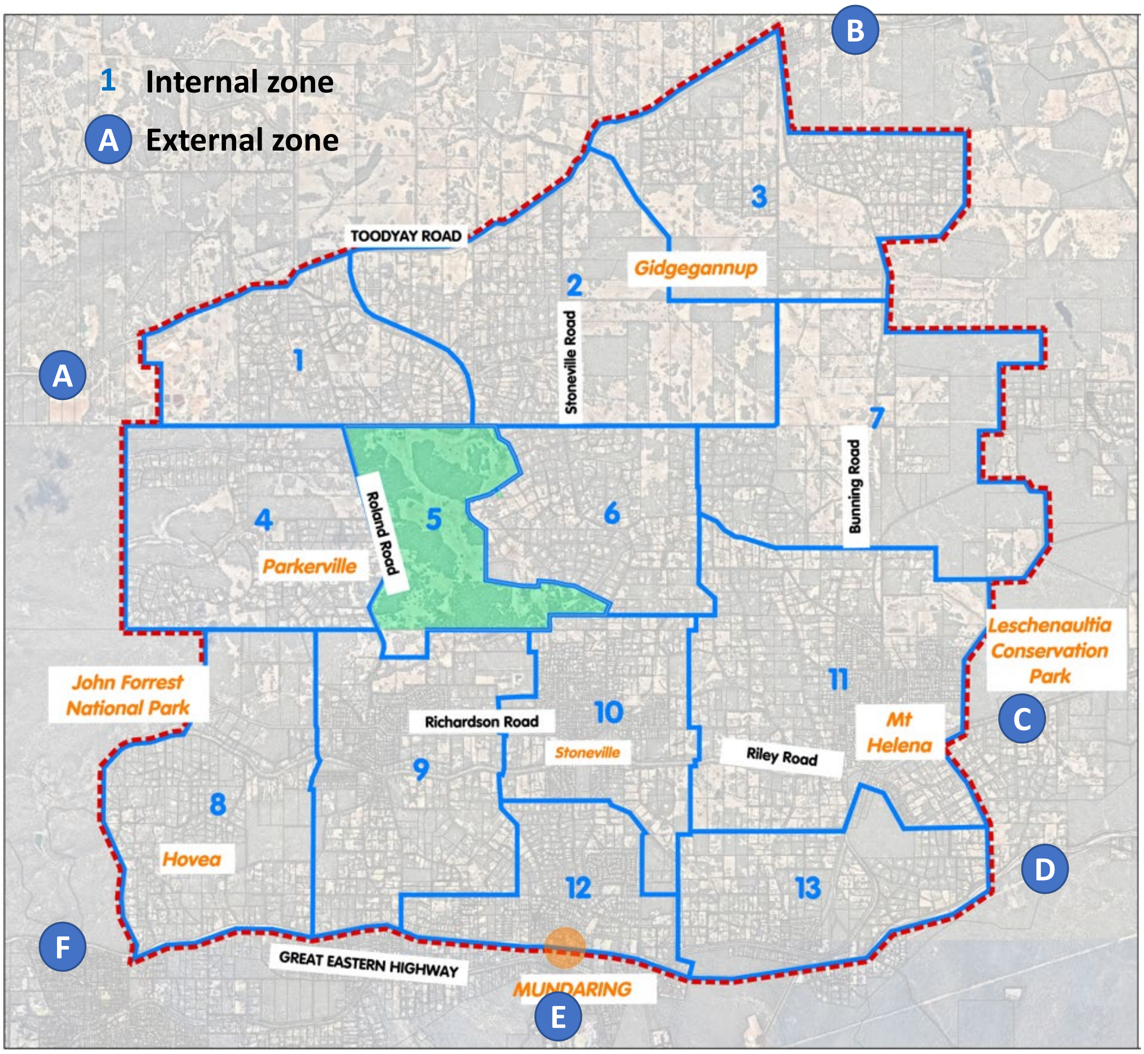


Figure 2: Traffic modelling zones

2.4 Forecast dwelling estimates

The forecast dwellings for 2021, 2031 and 2038 for the traffic modelling area were established by Hatch based on the best information and data at hand including the future urban areas designated in the North-East Sub-regional Planning Framework (WAPC, March 2018), The Shire of Mundaring Local Planning Strategy, and known structure plans in the area sourced from the DPLH website for the Shire of Mundaring and City of Swan and is summarised in **Table 1**. (Internal zone plan is shown in **Figure 2**). In this figure Zone 5 shows the NSSP. Upon completion of the development, the projected population of the NSSP is estimated to be 2,803 individuals.

Details on estimated population growth is contained in the Hatch report.

Table 1: Forecast dwelling estimates

Modelling Year	Dwellings within Internal Zones													Total Dwellings
	1	2	3	4	5	6	7	8	9	10	11	12	13	
2021	177	210	203	210	2	226	86	219	606	762	960	599	252	4512
2031	177	210	203	210	400	226	86	219	666	762	1040	749	252	5200
2038	177	210	203	210	1001	226	86	219	666	762	1070	924	252	6006

2.5 Road network

The road network coded into the Aimsun model includes key routes including Toodyay Road, GEH, Roland Road, Seaborne Street, Brooking Street, Bunnings Road and Sawyers Road as shown in **Figure 3**. The road specifications including number of lanes, lane widths, line markings and posted speed limits were coded as per existing situations. During the evacuation the road specifications did not change except the operational speed on all roads which was reduced to 40kmh. Roland Road and Stoneville Road speed limit were reduced to 60kmh. The speed reduction on roads were used to reflect the impact of smoke on drivers during the evacuation.

There is only one signalised intersection within the traffic modelling area which is located at GEH/ Stoneville Road. This intersection was modelled to operate as a signalised intersection with existing phasing and timing before the bushfire approaches this intersection (depending on the bushfire direction, the timing for bushfire approaching this intersection would differ). The signalised intersection was assumed to operate as priority-controlled intersection during the evacuation to enable the evacuation traffic to discharge faster. This would reflect the anticipated operation of such an intersection under bushfire conditions, as it would be likely that signals would be 'blacked out' or otherwise overridden with emergency protocol enacted instead, such as emergency services manual control.

It should be noted that the modelled road network in future scenarios would reflect some level of upgrades. These upgrades are identified in Section 8: Proposed Road Network Upgrades, of this report.

The future Perth to Adelaide National Highway ("Orange Route" or "East Link") was considered to be developed beyond 2031.   The East Link is ultimately planned as a dual carriageway with interchanges and overpasses to freeway standard, enabling access for RAV 7 heavy vehicles (36.5m combinations) between Perth and Northam.

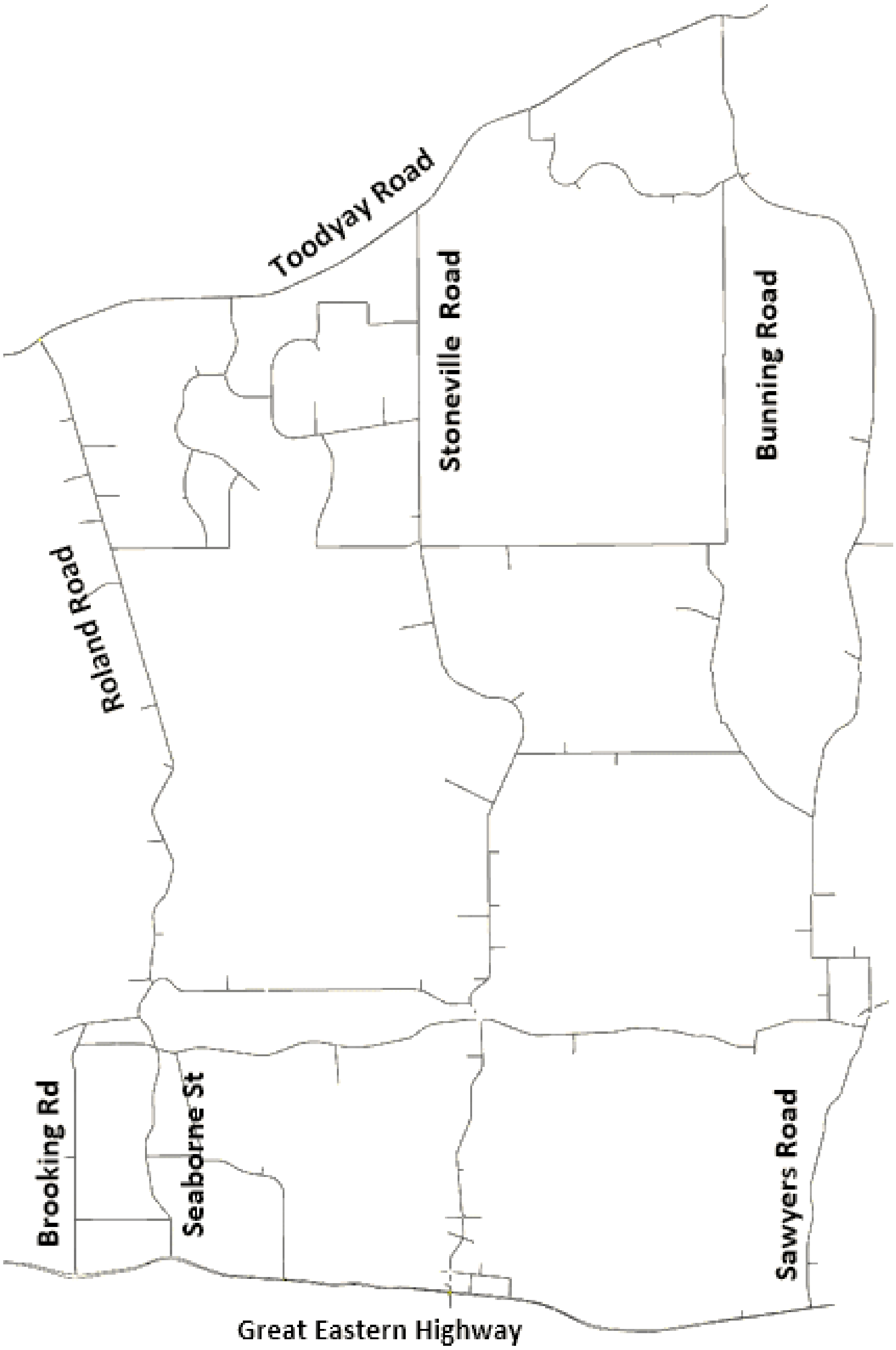


Figure 3: The modelled road network

2.6 Assessment years

The assessment years for modelling and analysis are 2021, 2031 and 2038.

2021 represents the existing situation. At this time NSSP has not been developed. The coded road network in Aimsun reflets the existing road conditions.

2031 reflects the progressive development of the NSSP up to 400 lots. At this time road upgrades associated with NSSP would be in place.

2038 reflects the ultimate development of the NSSP (about 1001 lots). At this time road upgrades associated with NSSP and East link would be in place.

The proposed road upgrades are identified in section 8: Proposed Road Network Upgrades.

2.7 Modelling scenarios

The microsimulation models were developed for the following scenarios:

2.7.1 2021 scenario

2021 scenario represents the existing road network and existing population/dwelling numbers within the traffic modelling area. Transport modelling and analysis undertaken indicated that, for the critical bushfire modelling scenario, some road upgrades to the existing road network would be required for the existing situation (year 2021) to ensure safe evacuation of current residents within the traffic modelling area. The details of the 2021 traffic modelling and analysis are documented in Section 7.1: 2021 scenario.

On this basis, separate traffic models were also developed for year 2021 with the proposed road network upgrades to test satisfactory evacuation. The 2021 upgrades required to meet the evacuation criteria are shown in **Appendix A** and include:

- A dedicated left turn lane on Stoneville Road with approx. 100m merge on Toodyay Road; and,
- A dedicated left turn lane on Roland Road with approx. 500m merge on Toodyay Road.

It should be noted that if approval is granted for the proposed NSSP, the developer will fund the suggested 2021 road network upgrades at the outset of the project.

2.7.2 2031 scenario

2031 scenario is the interim scenario and reflects partial development of the NSSP up to 400 lots and proposed road upgrades associated with the development of NSSP. At this time, some general population growth for surrounding suburbs within the traffic modelling area was also assumed.

In order to compare the traffic conditions during the evacuation in 2031 for with and without development of the NSSP, separate traffic models were also developed for 2031 scenario but without NSSP.

The without NSSP scenario was undertaken for the following sub-scenarios:

- Without the suggested 2021 road upgrades; and,
- With the suggested 2021 road upgrades.

As the outcome of the 2021 modelling scenario indicated that the existing population within the traffic modelling area would not be able to evacuate satisfactorily without the suggested 2021 road upgrades, separate 2031 models for without NSSP were also developed with the 2021 road network upgrades to enable assessment of the traffic impact of the with and without NSSP under a similar base network condition. The details of the 2031 traffic modelling and analysis are documented in section 7.2: 2031 scenario. The suggested upgrades associated with the development of the NSSP are identified in Section 8: Proposed Road Network Upgrades, of this report. It should be noted that if approval is granted for the proposed NSSP, the developer will fund the suggested road network upgrades at the outset of the project.

2.7.3 2038 scenario

2038 scenario is the ultimate scenario and reflects the full development of the NSSP. For this scenario the East Link and all the road network upgrades associated with the development of the NSSP are coded in the Aimsun model. The suggested upgrades associated with the development of the NSSP as identified in Section 8: Proposed Road Network Upgrades, of this report will be funded by the developer at the outset of the project if approval is granted for the proposed NSSP.

In order to compare the traffic conditions during the evacuation in 2038 for with and without development of the NSSP, separate traffic models were also developed for 2038 scenario without NSSP. The details of the 2038 traffic modelling and analysis are documented in section 7.3: 2038 scenario.

2.8 Day and time of modelling

The microsimulation modelling aims to robustly test the road network's ability to accommodate evacuation traffic for the critical time period that would have the greatest impact on road network operations. The Sunday midday period was selected as the critical time period. At this time the majority of local population would be at home which would result in highest evacuation trips due to a potential bushfire.

2.9 Model duration

Review of the Bushfire Simulation Modelling Report undertaken by JBS&G indicated that the time for the head bushfire to reach NSSP would vary between 2 hours to 3 hours (depending on the bushfire direction) which reflects a fast rate of fire spread. The fast rate of fire spread assumed for the evacuation will impact evacuation times, however it has been accepted and modelled to reflect what is considered to be a worst-case scenario.

Therefore, a 2.5-hour model peak period was established to assess the evacuation trips with 30-minute cool down period which results in 3-hour model duration. A 30-minute warm-up period was also included to replicate the traffic pattern before fire arrival. The time periods modelled in Aimsun are as followings:

- Warm-up: 11:30 – 12:00
- Peak hours: 12:00 – 14:30
- Cool down: 14:30 – 15:00

The warm-up period reflects the existing traffic pattern on the road network under normal conditions (before bushfire). For year 2021 or existing situation the warm-up period reflects the base case model. However, in future years (2031 and 2038) the warm-up period reflects the future traffic pattern on the future road network under normal condition (no bushfire).

The 2021 warm-up period was established by reviewing the existing traffic counts on major roads and the turning movements of the key intersections within the traffic modelling area. It should be noted that the warm-up period is a necessary model function but is not representative of road network conditions during the evacuation and is not used for assessment. Therefore, typical model calibration and validation for the warm-up period is not necessary. Further, once a bushfire is detected and evacuation is initiated the traffic pattern would completely change and evacuation traffic would replace the warm-up traffic.

The peak hours of 12:00 to 14:30 reflects the evacuation traffic period and is used for assessment and reporting. At 12:00 the first residents begin to evacuate; bushfire continues to develop and progress towards the NSSP and the evacuation trips will increase. During the bushfire progression some part of the road network would be impacted by the bushfire and would not be usable for evacuation. At 14:30 the bushfire has reached or passed the NSSP (depending on bushfire direction) and progressed to the other end of the traffic modelling area.

The cool down period is used to allow the vehicles already in the network to complete their trips and reach the external zones. At this time no more evacuation trips would be generated. This period is used to locate the back of queue of vehicles with respect to the fire front during the latest stages of the fire.

2.10 Evacuation profile

An incremental evacuation profile was established for the evacuees in response to bushfire progression. Considering that the traffic modelling area is reasonably large, the evacuation profile for each traffic zone would be different depending on the proximity to the bushfire. The traffic zones closer to the fire front would evacuate earlier than the traffic zones located further away from the fire. Section 6: Evacuation trip generation & distribution details the incremental evacuation profile for each individual traffic zone within the traffic modelling area.

Accordingly, demand matrices were loaded onto the road network over the 2.5-hour period; however, the model was set up to continue to run until traffic was fully evacuated from the modelling area and arrived at the external model zones i.e., an additional half hour (cool down period) taking the full extent of modelling to 3 hours.

On this basis, the model duration commenced at time 12:00 (assuming that the bushfire has started, has been detected and has built up at this time).

The evacuation started at 12:00. The demand matrices were loaded onto the network at half hour intervals:

- 12:00 – 12:30 (0 to 0.5-hour);
- 12:30 – 13:00 (0.5 to 1-hour);
- 13:00 – 13:30 (1 to 1.5-hour);
- 13:30 – 14:00 (1.5 to 2-hour); and,
- 14:00 – 14:30 (2 to 2.5hour).

A cool down period of 0.5-hour from 14:30 to 15:00 was added at the end of the model duration to ensure all the traffic within the modelling area were captured.

It should be noted that half hour intervals were selected to be able to locate and report the location of the back of evacuation queue with respect to the fire front for every half hour. Considering that residents would evacuate linearly through the model duration, then the size of the time split/ intervals are not affecting the outcome of the assessments. For example, changing the intervals from half hour to 15-minutes or one hour would not change the outcome of the analysis; it would simply be a different way to input the same data.

2.11 Background traffic

There are two different types of traffic on the road network during the bushfire: evacuation traffic and background traffic. Evacuation traffic refers to traffic that is generated by the residents/ visitors within the traffic modelling area during the bushfire. This represents residents and visitors who use their private vehicle to evacuate in response to the risk posed by a bushfire. The evacuation traffic will be discussed in detail in Section 6: Evacuation trip generation & distribution.

Background traffic refers to traffic on the road network which are not evacuating but happen to be on the road network during the warm-up period (before bushfire) and the emergency vehicles that enter and exit the traffic modelling area during the bushfire.

Background traffic can be classified to passing trips mainly on GEH and Toodyay Road or trips that are generated by residents within the traffic modelling area. The trip generation of the residents (within the internal zones) during the warm-up period (no fire) was established by reviewing the existing number of dwellings within each internal zone and existing traffic volumes and turning movements at major intersections within the traffic modelling area. A trip rate of 0.2vph per dwelling was applied (for the Sunday midday time period) to establish the trip generation of the internal zones and achieve satisfactory calibration during the warm-up period.

Trip distribution to the external zones during the warm-up period was established proportional to the existing traffic counts at external zones.

The traffic data used to replicate the background traffic or existing traffic condition during the warm-up period was collected from Main Roads WA traffic data on major roads within the traffic modelling area and SCATS data for the signalised intersection of GEH/ Stoneville Road.

The background traffic during the warmup period for future scenarios (2031 and 2038) was established by reviewing the historical traffic growth and ROM24 outputs sourced from Main Roads WA. Table 2 summarises the ROM24 outputs for 2016, 2026, 2031 and 2036 on Great Eastern Highway and Toodyay Road along a screen line immediately east of the NSSP area as shown in **Figure 4**. The observed 2019 traffic counts on these roads were also obtained from Main Roads WA.

Table 2: Exsting and ROM24 projections source: Main Roads WA

Traffic projections	From	To	2016 (ROM)	2019 (observed)	2026 (ROM)	2031(ROM)	2036 (ROM)
Great Eastern Hwy	Stoneville	Sawyers	23700	16135	29000	21000	23000
Toodyay Rd/ East Link	Stoneville	Reserve	12500	5329	14000	23000	24000
Total			36200	21464	43000	44000	47000

Distribution between GEH and East Link	From	To	2016 (ROM)	2019 (observed)	2026 (ROM)	2031(ROM)	2036 (ROM)
Great Eastern Hwy	Stoneville	Sawyers	65%	75%	67%	48%	49%
Toodyay Rd/ East Link	Stoneville	Reserve	35%	25%	33%	52%	51%
Total			100%	100%	100%	100%	100%

Traffic growth rate per annum	From	To	2016 (ROM)	2019 (observed)	2026 (ROM)	2031(ROM)	2036 (ROM)	
Great Eastern Hwy	Stoneville	Sawyers			2.0%	-1%	-0.1%	
Toodyay Rd/ East Link	Stoneville	Reserve			1.1%	4%	3.3%	avg
Total					1.7%	1%	1.3%	1.5%

A review of the ROM 24 outputs indicated that ultimately (2036 or 2038 with East Link):

- The average annual traffic growth on Great Eastern Highway and Toodyay Road would be about 1.5%; and,
- Once East Link is implemented, the directional split of traffic on Great Eastern Highway and East Link would be about 49%/51%.

Accordingly, for the 2038 scenario the above assumptions were used to establish the projected traffic volumes during the warmup period on GEH and Toodyay Road.

For the 2031 scenario, conservatively a 2% traffic growth was applied to the existing traffic on GEH and Toodyay Road.

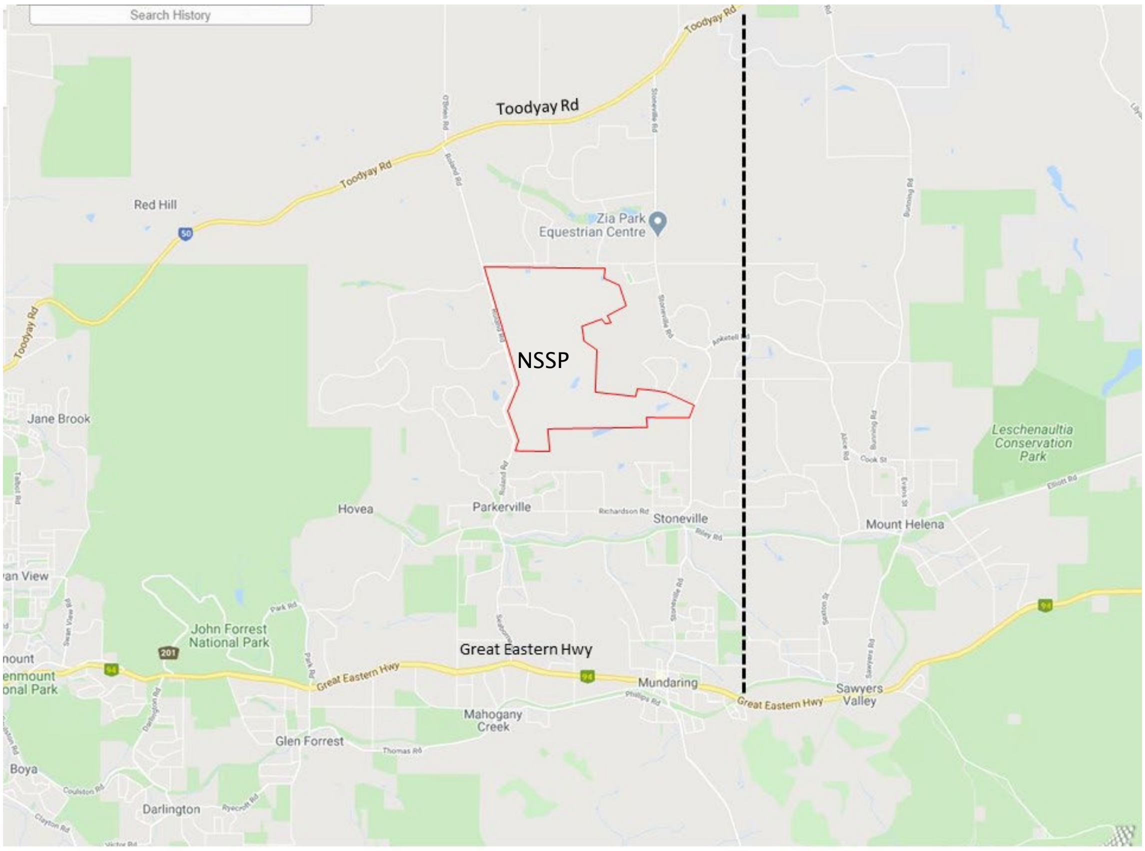


Figure 4: Screen line for assessment of the existing and projected traffic volumes on Great Eastern Highway and Toodyay Road

2.12 Traffic management in Aimsun

Traffic management strategy is a tool in Aimsun which consists of a number of policies which are applied to a traffic network to replicate existing conditions or to test specific traffic management measures, that is, to manage traffic around roadworks or incidents. This tool in Aimsun was used to change the destination of the residual background traffic during the warmup period which would continue to travel within the road network during the evacuation. For example, if a pass by vehicle travelling west on Great Eastern Highway notices that the road is closed due to the bushfire, it would change its destination (external zone) to return back to the origin zone or another external zone which would provide alternative routes to the original destination of the vehicle.

2.13 Assignment

A dynamic user equilibrium assignment with stochastic route choice was used to assign the traffic during the warmup and evacuation periods. However, during the evacuation period the number of available routes is limited due to the potential road closure in response to the bushfire.

2.14 Vehicle type

The vehicle type for each route within the traffic modelling area was established by reviewing the existing traffic mix on each route and using the Austroads Vehicle Classification System in accordance with Tables 6.4 to 6.8 of Main Roads WA Operational Modelling Guidelines. Toodyay Road and Great Eastern Highway are permitted for vehicles up to RAV Network 4 vehicles. RAV Networks 2, 3, and 4 permit access by a number of vehicle combinations up to 27.5m long

Public transport, pedestrian and cyclists are not coded into the microsimulation model, given the relatively small volume and limited impact to general and evacuation traffic particularly during Sunday midday.

The microsimulation models assumed that all residents would evacuate by cars, no special considerations were made to other modes of transport such as motorbike, cycle or buses.

2.15 Behaviour parameters

Default driver behaviour in Aimsun was adopted with no modifications.

2.16 General assumptions

Model coding is representative of generally accepted best practice and in line with Main Roads WA Operational Guidelines requirements with no manual adjustments.

3 Model Limitations

The microsimulation models developed with documented bushfire and evacuation assumptions in this report offer the opportunity to gain a better understanding of the potential performance of the existing and proposed road network in evacuation situations. However, it cannot provide a guaranteed network performance during a bushfire but it can identify bottlenecks across the road network as a result of evacuation process.

A number of limitations of the model were identified which are summarised below:

1. Bushfire behaviour is highly variable and dependent on multiple factors such as ignition location, time of day, weather conditions and factors associated with bushfire progression. It is not possible to model all bushfire scenarios with different conditions. However, the most critical bushfire scenario which conservatively include climate change based on 25-year projection was used for development of the microsimulation models.
2. Driver behaviour and people reactions to the bushfire are not predictable and cannot be modelled accurately by microsimulation model.
3. Non-typical conditions caused by the bushfire such as fallen trees, fallen power lines and vehicle accidents or multiple fire fronts coming from multiple directions have not been considered in the microsimulation models.
4. The road network and intersections outside of the traffic modelling area may be adversely impacted during the evacuation, however these impacts were not assessed and modelled.
5. Bushfire progression assumed to be linear and progress evenly during the modelling period.
6. Bushfire progression in microsimulation modelling assumed to move forward without changing direction during the modelling period.

Although the above-mentioned model limitations are acknowledged, the assumptions used to develop the bushfire simulations and traffic microsimulations were selected to be extremely conservative to cover uncertainties and model limitations.

4 Assumptions

A number of assumptions were made for the development of the microsimulation models which are summarised in **Table 3** and explained further in this section and throughout the different sections of this report. These assumptions have been provided and agreed with by relevant experts on NSSP project team. The bushfire scenarios were developed on the basis of the most critical impact on the availability of the evacuation routes, in line with both the bushfire scenario models contained in this report and the JBS&G bushfire modelling report.

Table 3: Modelling assumptions

Items	Assumptions
Assessment years	2021, 2031 and 2038
Vehicle ownership	2 vehicles per dwelling
Home occupancy	100%
Evacuation trip rates	2 vehicles per dwelling (i.e. every vehicle owned by each dwelling is used to evacuate and no households are assumed to have only 1 vehicle or using only 1 vehicle to evacuate)
Model duration	0.5 hour warmup period + 2.5 hours + 0.5 hour cool down period
Evacuation profile	Half hour interval (0-0.5hour, 0.5-1hour, 1-1.5hour, 1.5-2hour; 2-2.5hour)
Day and time of day to be modelled	Sunday midday
Traffic control points	Only on major regional roads of GEH and Toodyay Road affected by fire
Evacuation centres	Zero (0) within the model area
Background traffic	Allowed
Rate of fire spread	Approximately 5kmh to 6kmh
East Link construction	Constructed between 2031 and 2038
Stay and Defend numbers	Zero (0)
Emergency vehicle movements	Modelled during the evacuation period
Speed on internal roads	Reduced to 40kmh during the evacuation except Roland Road and Stoneville Road which was reduced to 60kmh. No speed reductions were assumed for GEH and Toodyay Road.
Potential bushfire suppression	Not allowed
Impact of smoke	Considered by reducing the vehicle speeds
Evacuation process	No advance warning assumed; immediate evacuation modelled
Bushfire Scenarios	45-degree angle fire from every corner of the traffic modelling area (4 bushfire scenarios)

4.1 Vehicle ownership

ABS Data (2016) states the average number of motor vehicles registered per private dwelling in the Shire of Mundaring is 2.2 per dwelling. In comparison, the average for Greater Perth is 1.8 vehicles per dwelling.

It is expected vehicle ownership in the Shire will reduce to 2.0 vehicles per dwelling in the future for the traffic modelling area. This assumption is on the basis that future housing development in the locality will be by way of consolidation of existing townsites (primarily the Mundaring town centre) and the new townsite of North Stoneville.

This new development will be built to higher densities than the predominately rural-residential and large lot urban development characteristic of the existing residential catchment, with more compact and sustainable neighbourhoods, access to shops, schools and other services by walking and cycling, and reduced local car dependence which in turn justifies a lower overall car ownership rate.

4.2 Evacuation trip rate

With regard to trip rate, in the absence of published data on evacuation trip rates it is assumed that each dwelling would generate two vehicle trips during the evacuation reflecting the forecast car ownership. In practice this is likely to be overly conservative and not all vehicles from every property will be used to evacuate.

4.3 Emergency vehicles

Emergency vehicles are vehicles that would enter and exit the internal zones within the traffic modelling area during the bushfire. They are mainly ambulances, fire trucks or police cars. The microsimulation models allow for one or two emergency vehicles to enter and exit each individual internal traffic zones during the bushfire.

4.4 Home occupancy

The number of people that would leave their homes by private vehicles to access the road network in the event of a bushfire is dependent on how many houses are occupied at that time.

The ABS (2016) states that 91.8% of homes in the Shire of Mundaring are occupied compared to 89% for Greater Perth. The remaining 9-11% of properties are unoccupied and may comprise second homes or holiday homes, for example.

It should be noted that the actual home occupancy during the evacuation period would likely be even lower because some people may not be home at the time of fire and during evacuation period. On a sunny and warm (bushfire conditions) Sunday midday, a considerable proportion of residents of any suburb would likely be away from their dwelling, for example at the beach or park, at sporting events, at retail venues such as shops, or even working.

As with vehicle ownership, it is expected that the home occupancy would reduce in future on the basis that future developments would be by way of urban consolidation with densities and housing types more characteristic of Greater Perth, and the occupancy rate will, therefore, be closer to the Greater Perth average.

However, for the purpose of the traffic modelling and analysis, 100% home occupancy was assumed for all assessment years. The assumption of 100% occupancy and two vehicles from each dwelling evacuating is considered extremely conservative, nevertheless these assumptions have been adopted for a robust evacuation modelling.

4.5 Stay and defend

The report on "Community Preparedness and Response to the 2018 NSW Bushfires" identified several key insights with respect to stay and defend behaviour:

- "48% of survey respondents left or were away from their house or property during the fire; 47% stayed to defend; and 6% sheltered inside a house or somewhere outside."
- "When asked what they would do if a Catastrophic Fire Danger warning was issued for their area next summer... 27% indicated that they would get ready to stay and defend."
- "Based on these figures, 54% of households had plans involving leaving/evacuation and 34% had plans involving property defence (see Figure 21)."
- "46.7 % of respondents stayed/returned to defend the house and/or property, although some were not impacted, and some attempted to defend then left."
- "Around half of the survey respondents who were threatened or impacted by bushfire in 2017 left or were away from their house or property during the fire. The other half stayed to defend or shelter on their property."

The SEMC "Parkerville Stoneville Mount Helena Bushfire Review" (June 2014) estimated 150 people stayed to defend their homes. The Review noted:

"It is recognised by the Review that active support for those who stayed to defend poses a dilemma for authorities who promote the message that leaving is the safest course of action in a bushfire. However, it is obvious that many are choosing to stay and defend and, while this is presented as a legitimate option for residents, and assistance is given to them to do this, there is also responsibility to provide all the information that residents may need to prepare successfully to be self-sufficient and also to plan for how to support such residents practically after the bushfire has gone through."

The DFES "*Homeowners Bushfire Survival Manual*" (September 2014) acknowledges that some homeowners may stay and defend and provides advice on how to make an informed decision on whether to stay and defend, including preparation of a Bushfire Survival Plan. The bushfire Watch and Act warning also anticipates that some may stay and defend.

It is evident that the reality of human behaviour when acting in the event of a bushfire remains largely counter to fire agency policy and messaging regarding actions individuals should take.

In order to be consistent in providing what is considered to be a highly conservative assessment, **no** stay and defend was assumed for establishing the microsimulation models which thereby increases the number of vehicles on the road network seeking to evacuate during the bushfire emergency.

4.6 Evacuation process

Emergency response follows the evacuation process described in 'WA Community Evacuation in Emergencies Guidelines, SEMC 2020'. It uses the nationally recognised five stages of the evacuation process as a framework for planning an evacuation shown in **Figure 5**.

Figure 5: Five stages of the evacuation process

The community warnings for bushfire will normally have three levels:

- Advice: General information about a potential hazard and advice to keep up to date with developments;
- Watch and Act: The community is likely to be impacted and should take action to protect themselves; and,
- Emergency Warning: The community will be impacted and must take action immediately.

For an immediate evacuation no warning maybe provided and limited preparation time may be available. In order to be consistent in providing what is considered to be a highly conservative assessment an immediate evacuation with no advance warning was assumed for the purpose of modelling.

4.7 Evacuation window

The evacuation window is driven by the bushfire ignition and propagation, and the authorities' response to the bushfire. The Victorian Bushfire Royal Commission following the 2009 Victoria Bushfires (Black Saturday) determined the departure times during the fires which are summarised in **Table 4**.

It is therefore concluded that if given advance warning, as was the case during Black Saturday, about 33.4% (7.2% + 8.8% + 17.4%) of people would still wait until the last hour before fire arrival to evacuate, with a further 19.9% only evacuating after the fire had arrived.

However, for an immediate evacuation with no advance warning the evacuation window will be reduced significantly. As outlined before, for the purpose of a conservative assessment, an immediate evacuation was assumed for developing the microsimulation models.

Table 4: Evacuation departure data for the 2009 Victorian Bushfires

Departure time before the fire arrival	Percentage of those who left during the bushfire
More than 8 hours	11.8%
4 hours – 8 hours	7.4%
2 hours – 4 hours	12.7%
1 hour – 2 hours	14.8%
20 minutes – 1 hour	17.4%
10 minutes – 20 minutes	8.8%
Less than 10 minutes	7.2%
Left when the fire had already arrived	19.9%

4.8 Traffic control points

It is assumed that appropriate traffic control points would be put in place after the start of the bushfire on Great Eastern Highway and Toodyay Road with enough pre-warning that no through traffic will be passing through the traffic modelling area because of bushfire. This would include switching off / manually operating the traffic lights by emergency traffic controllers to expedite evacuation.

However, the modelling includes emergency vehicles that would enter and exit the modelling area during the bushfire evacuation.

4.9 On-site evacuation centre and neighbourhood safe places

In situations where safe evacuation is a challenge within the available evacuation window, alternative evacuation arrangements including an on-site emergency evacuation centre or neighbourhood safe places could overcome the need to evacuate the entire population within the modelling area.

In this instance, and in order to undertake a consistently conservative model it is assumed that all the population would evacuate to destinations outside the modelling area (the external zones shown in **Figure 2**) regardless of the fact that evacuation on-site may well present a lower risk option and significantly reduce the evacuation burden on the local road system and responsible authorities.

4.10 Bushfire scenarios

The following bushfire scenarios were considered for the purpose of transport modelling and analysis:

- A 45-degree angle bushfire from the south-west towards the north-east;
- A 45-degree angle bushfire from the south-east towards the north-west;
- A 45-degree angle bushfire from the north-west towards the south-east; and,
- A 45-degree angle bushfire from the north-east towards the south-west.

While there are a multitude of scenarios that could be modelled, these four scenarios were chosen because they result in the closure of one of the major evacuation corridors i.e. Great Eastern Highway or Toodyay Road, thereby restricting evacuation directional options and placing pressure on the network. On this basis these scenarios are considered to have the most critical impact on the traffic movement and evacuation routes.

Figure 6 illustrates the proposed road closure at 12:00 (start of the evacuation) for each bushfire scenario. At 12:00 the through traffic on Great Eastern Highway or Toodyay Road toward the bushfire (depending on proximity to ignition point for each bushfire scenario) is assumed to reduce to minimal level.

It is evident that when bushfire spreads through the traffic modelling area through time, more internal roads would be closed or inaccessible for each bushfire scenario. The through traffic on GEH or Toodyay Road would reduce when bushfire is approaching these roads as more drivers would be aware of the bushfire progression in the locality.

The through traffic on Great Eastern Highway or Toodyay Road is assumed to reduce to 50% after 1-1.5hour period and to minimal levels during the 1.5-2.5hour period (depending on bushfire progression under each bushfire scenario). These assumptions are considered valid on the basis that the general public will either avoid the bushfire area or be directed by Emergency Services away from the area. The other bushfire scenarios such as bushfire from the east or west are not considered as critical as the four modelled scenarios because fires from those directions would result in both Great Eastern Highway and Toodyay Road remaining open and available for evacuation as major evacuation routes with highest capacities.

The likelihood and the assumed severity of provided bushfire scenarios with the resultant evacuation assessment, has been used to provide a conservative stress test of the road system and an indication of how long it would take to action the evacuation as outlined.

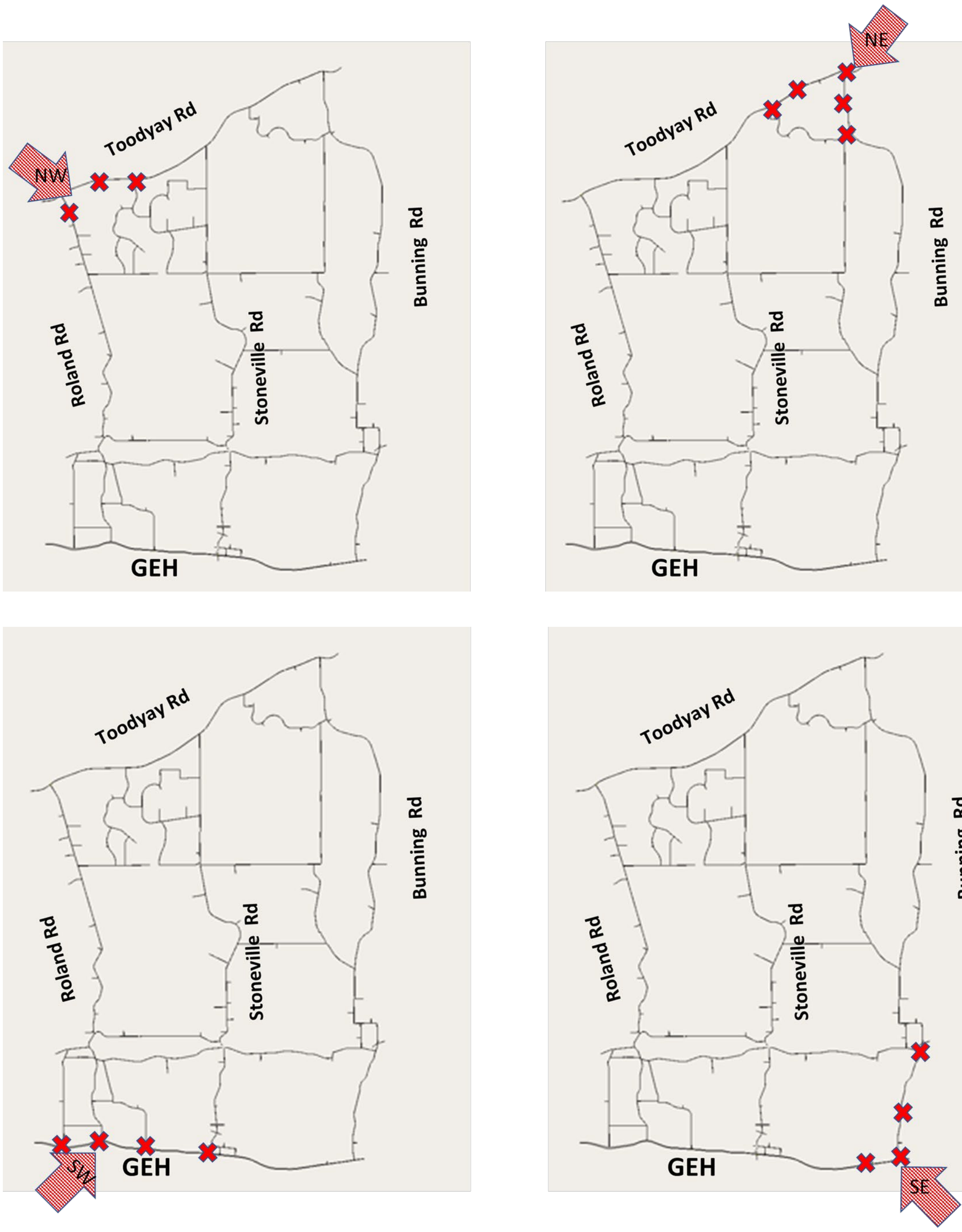


Figure 6: Proposed road closures at 12:00 for each bushfire scenario

4.11 Potential bushfire suppression

Firefighting suppression activities, especially in the early stages of the bushfire, could reduce the extent of the bushfire through containment of the flanks, but may also have some impact on the rate of spread while the bushfire is smaller. The impact of the potential bushfire suppression was not considered in bushfire microsimulation modelling to provide a robust assessment.

5 Bushfire Modelling

Subsequent to Transcore's initial evacuation modelling, JBS&G, in conjunction with Covey Associates Pty Ltd, have developed bushfire simulation models for the four bushfire scenarios outlined previously in this report, to establish the time it would take for the bushfire to approach the NSSP under each bushfire scenario. The outcome of the bushfire modelling and analysis are summarised in Bushfire Simulation Modelling Report (Rev04). This section of the traffic report provides a summary of the bushfire simulation modelling.

The bushfire simulation models use the CSIRO-developed program SPARK, and adopt the following fire rate of spread (RoS) models as recommended by the CSIRO publication, A Guide to Rate of Fire Spread Models (Cruz et al., 2015):

- Dry Eucalyptus Forest Fire Model or Project VESTA Mark 1 [Cheney et al (2012)]
- CSIRO grassland fire spread model [Cheney et al (1998)]

A build up phase of 45 minutes was adopted for the bushfire simulations. The ignition locations were selected approximately 6.5 to 7.0 km from the site to enable the bushfire to impact either Great Eastern Highway or Toodyay Road reasonably quickly after ignition, while still producing head fire widths several kilometres wide at NSSP site in order to warrant large-scale evacuation of NSSP and the surrounding local area.

The estimated time for the bushfire to approach the NSSP involved the use of Forest Fire Danger Index (FFDI). FFDI is a measure of fire severity in forest or treed landscapes including potential for elevated rate of spread and intensity, and is derived from a combination of air temperature, relative humidity, wind speed and long- and short-term drought effects. Using historical weather data from Bickley weather station FFDI analysis was conducted to determine the "worst credible" bushfire weather for a 1:50 year recurrence rate with and without climate change, producing the following results:

- FFDI 62.1 (1: 50 year event without climate change factored)
- FFDI 74.9 (1:50 year event including 25 year projection of climate change based)

Each of the four bushfire scenarios was simulated using the two FFDI's nominated above, in addition to two fuel characteristic states (Calibration and Conservative) and two RoS models (Growth and Mature).

The Rate of Spread (RoS), using the conservative fuel state and mature ROS model, produced the quickest bushfires, with the following results reproduced below from the bushfire simulation report:

- for FFDI 62.1 scenarios, 1.35 – 2.25 km/hr after 2 hours, and 1.6 – 3.15 km/hr after 4 hours, with peak RoS over a 1-hour period of up to 3.5 km/hr but more typically between 1.5-2.5 km/hr

- For FFDI 74.9 scenarios, 1.62 – 2.8 km/hr after 2 hours, and 2.0 – 3.0 km/hr after 4 hours, with peak RoS of up to 4.2 km/hr but more typically between 2-3 km/hr

The RoS of about 5km/h to 6km/h was used for the evacuation microsimulation modelling for all bushfire scenarios which exceeds the RoS reported by the worst-case scenario of FFDI 74.9 in the bushfire simulation modelling. The fast rate of bushfire would result in fast approach of fire towards NSSP area and therefore reduce the time available for residents to evacuate, to ensure a robust assessment.

The time for the head bushfire to reach NSSP based on bushfire modelling is summarised in **Table 5**. This table also summarises the time for bushfire to reach NSSP extracted from Transcore's evacuation models for each bushfire scenario (refer last column of the table).

Table 5: Time to impact the NSSP

Bushfire Scenarios	**Time for fire run to impact NSSP**		
	Bushfire simulation (FFDI 62.1) minutes (JBS&G)	Bushfire simulation (FFDI 74.9) minutes (JBS&G)	Evacuation simulation minutes (Transcore)
south-west towards the north-east	>=240	207	120
north-west towards the south-east	**164**	**137**	**112**
south-east towards the north-west	226	189	135
north-east towards the south-west	>=240	208	120

Review of the time for bushfire to reach NSSP results indicates that the evacuation microsimulation models by Transcore were developed conservatively and indicates that the time for fire run to reach NSSP would be faster than the conservative FFDI 74.9 figures. It should be noted that the FFDI 74.9 figures were developed as sensitivity analyses and conservatively include climate change based on 25-year projection. The critical fire scenario in terms of time to impact NSSP is the fire from north-west towards the south-east, which is highlighted in **Table 5**.

The fire from north-west would reach the NSSP sooner than the other fire scenarios due to the proximity of the NSSP to north-west corner of the modelling study area. Under this fire scenario in the evacuation models, it was conservatively assumed that the fire would reach the NSSP approx. 25 minutes earlier (137 - 112 = 25min) in Transcore's microsimulation evacuation model than fire simulation model for FFDI 74.9. Further assessments are undertaken for this fire scenario to investigate if the evacuation traffic can satisfactorily evacuate before fire reaches the NSSP.

The outcome of the microsimulation modelling and analysis are documented in Section: 7.4 Bushfire from North-West.

6 Evacuation trip generation & distribution

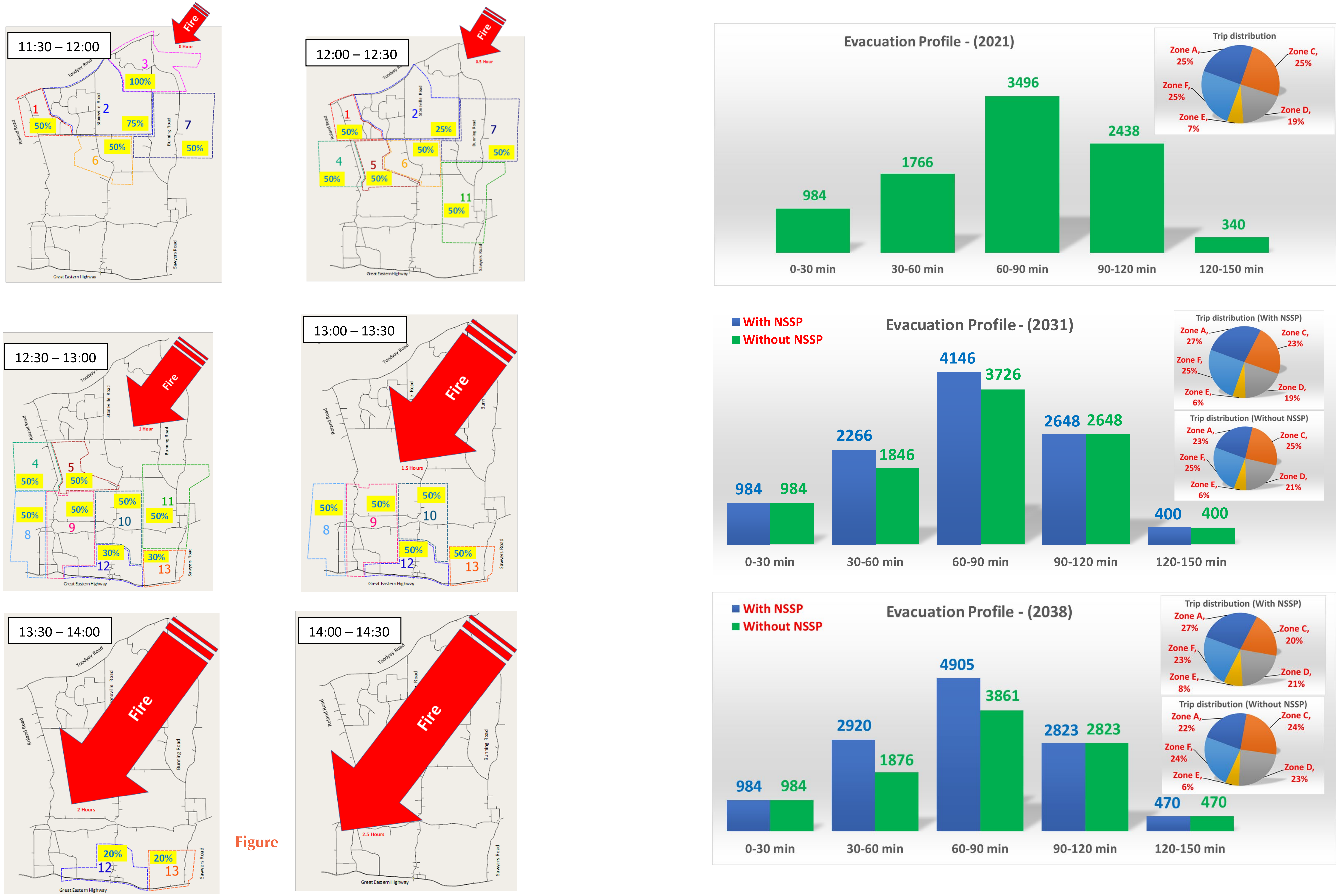
The evacuation trip generation for each half hour is demonstrated in **Figure 7** to **Figure 10** for 2021 (without NSSP), 2031 (with and without NSSP) and 2038 (with and without NSSP) modelling scenarios. The evacuation trip generation in each half hour was based on assumptions illustrated in **Figure 7** to **Figure 10** for the percentages of trips which would evacuate from each zone within the traffic modelling area. The progressive evacuation rates for each half hour were established based on proximity of the zones to the fire. Closer zones would evacuate earlier than distant zones.

The evacuation trip distribution after the warmup period to the external zones are shown in **Figure 7** to **Figure 10.** No allowance has been made for the distribution of trips to evacuation centres *within* the modelling area. Further, no residents were assumed as remaining at home to defend their property, despite literature suggesting some 20%-40% would do so under certain circumstances.

A conservative trip rate of 2 vehicles per dwelling was adopted for the purpose of evacuation trip generation (after warmup period). Trip distribution after the warmup period was established by reviewing the realistic evacuation routes from each internal zone to the nearby external zone/s. Most of the evacuation trips were distributed to the nearby external zone/s however a few trips were also distributed to the other distant external zones to reflect known/anticipated behaviours.

It should be noted that trip distribution to external zoned during the bushfire is dynamic and would change due to location of the fire front, closure of some of internal routes and delay caused due to the vehicle queues at some portion of the traffic modelling area. On this basis the trip distribution for each half hour interval would be slightly different to the other half hour intervals for some of the bushfire scenarios. Further, for distribution of the evacuation trips no consideration was given to the on-site evacuation centres or evacuation towards family or friends house. The only consideration for trip distribution during the evacuation was to evacuate to the nearby external zone in opposite direction of the fire.

Figure 7: Trip generation and distribution for the bushfire from SW



Figure

Figure 8: Trip generation and distribution for the bushfire from NE

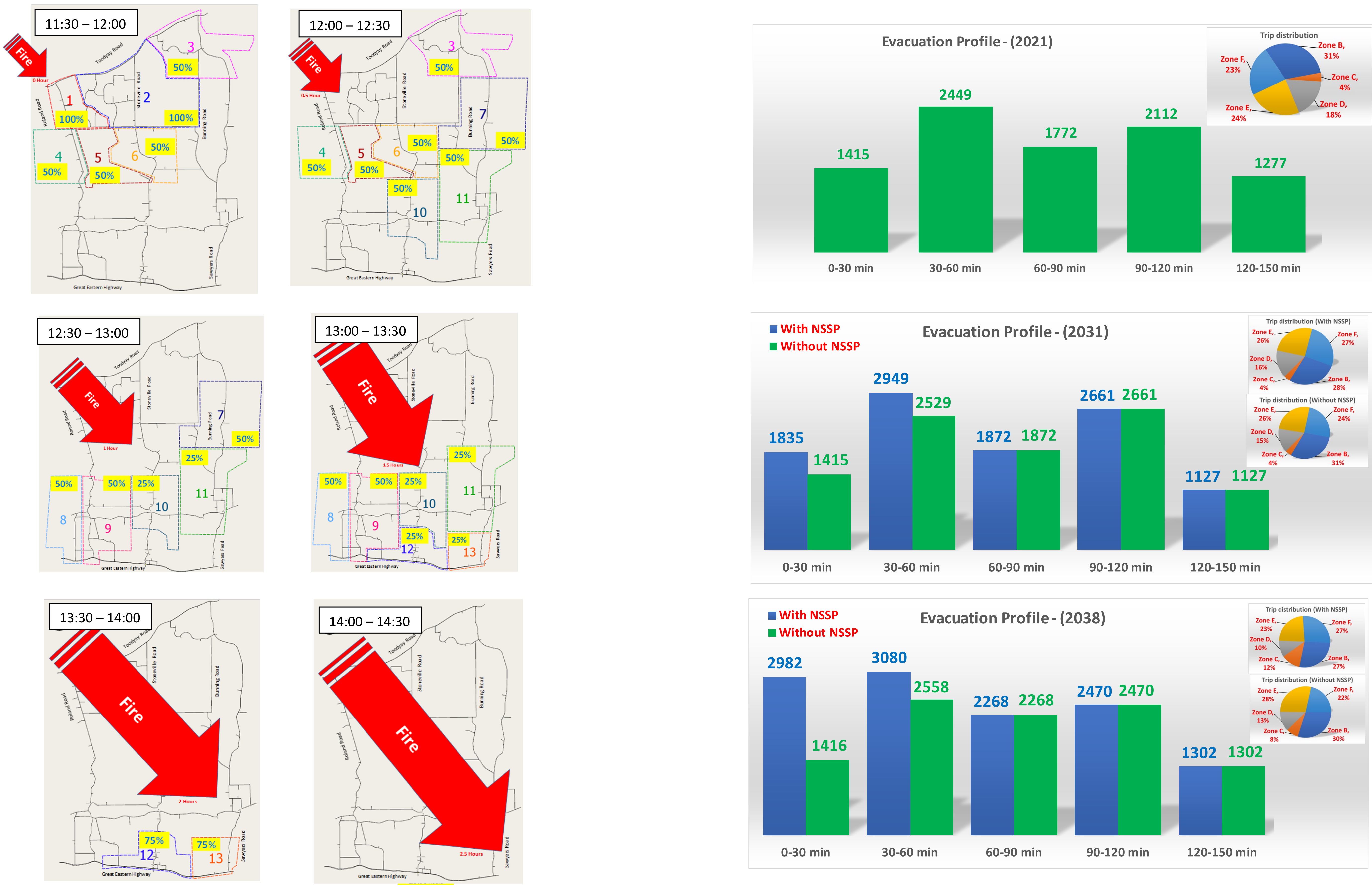


Figure 9: Trip generation and distribution for the bushfire from NW

Figure 10: Trip generation and distribution for the bushfire from SE

7 Modelling Results

The microsimulation models for different assessment years and bushfire modelling scenarios were run and observed several times with different seed numbers to trace the back of the evacuation queue with respect to the fire front. It is important that during the evacuation and cool down period (between 12:00 to 15:00) the back of queue be ahead of the fire front, so no risk opposes evacuees. It should be noted that due to the size of the traffic modelling area not all the internal traffic zones would evacuate at the same time. The evacuation would be incremental based on the evacuation profiles provided in Section 6. Review of the time for bushfire to reach NSSP results indicates that the evacuation microsimulation models by Transcore were developed conservatively and indicates that the time for fire run to reach NSSP would be faster than the conservative FFDI 74.9 figures. It should be noted that the FFDI 74.9 figures were developed as sensitivity analyses and conservatively include climate change based on 25-year projection.

The critical fire scenario in terms of time to impact NSSP is the fire from north-west towards the south-east, which is highlighted in **Table 5**.

The fire from north-west would reach the NSSP sooner than the other fire scenarios due to the proximity of the NSSP to north-west corner of the modelling study area. Under this fire scenario in the evacuation models, it was conservatively assumed that the fire would reach the NSSP approx. 25 minutes earlier (137 - 112 = 25min) in Transcore's microsimulation evacuation model than fire simulation model for FFDI 74.9. Further assessments are undertaken for this fire scenario to investigate if the evacuation traffic can satisfactorily evacuate before fire reaches the NSSP.

The outcome of the microsimulation modelling and analysis are documented in Section 7.4. Therefore, the most important parameter for satisfactory evacuation of each zone is that the evacuation traffic from each zone should be always ahead of the fire front.

The microsimulation models were also reviewed and analysed to establish the total time required for all residents within the traffic modelling area to evacuate satisfactorily. It should be noted that if all residents from all traffic modelling zones evacuate satisfactorily (i.e. evacuees are always ahead of the fire front) during the model duration, then it can be concluded that each individual zone has evacuated sooner than three-hour model duration. Reporting the evacuation from each model zone is not necessary as the evacuation timing will be less than evacuation from the entire traffic modelling area.

The following sections of the report outlines the outcome of the modelling and analysis.

7.1 2021 scenario

2021 scenario represents the existing road network and existing population/dwelling numbers within the traffic modelling area. Review of the microsimulation model for the 45-degree angle bushfire from the south-west towards the north-east indicated that under current conditions (with no upgrades) the evacuation traffic will gradually increase towards Toodyay Road and the queue will start to build up at the existing T-intersections of Stoneville Road/ Toodyay Road and Roland Road/ Toodyay Road. At the same time the fire front would progress towards Toodyay Road and at around 1310 hours the bushfire would reach the back of queue (refer **Figure 11** without road network upgrade scenario) and would spread faster than the evacuation progression.

Therefore, the modelling results for 2021 with no road network upgrades indicate that with the assumed evacuation parameters and at the current road network standard and capacity constraints i.e., Stoneville Road / Toodyay Road and Roland Road / Toodyay Road intersections, some level of road upgrades are required now (year 2021) to enable the safe evacuation of the entire existing population within the stipulated model duration.

The upgrades required to meet the evacuation criteria for 2021 scenario (existing situation) as shown in **Appendix A** include:

- Intersection of Stoneville Road/Toodyay Road - A dedicated left turn lane on Stoneville Road with approx. 100m merge on Toodyay Road; and,
- Intersection of Roland Road/Toodyay Road - A dedicated left turn lane on Roland Road with approx. 500m merge on Toodyay Road.

It is understood that if approval is granted for the proposed NSSP, the developer will fund the above suggested road network upgrades at the outset of the project.

Figure 11 to **Figure 14** show the snapshots of the microsimulation models at 1310 hours (the critical time for SW bushfire) for 2021 (with and without road network upgrades) for all four bushfire scenarios. As evident the critical scenario is the 45-degree angle bushfire from the south-west towards the north-east which indicates long queues extending back to the fire front with no road network upgrades. It should be noted that the evacuation for all other bushfire scenarios is satisfactory at 13:10 (as the figures illustrate) and satisfactory for the remainder of the evacuation period.

The evacuation graph under each bushfire scenario shows the number of vehicles within the traffic modelling area during the bushfire progression. With no road network upgrades, the SW bushfire evacuation scenario indicates that around 1310 hours over 2,000 vehicles would still be within the traffic modelling area, but all vehicles would be able to evacuate to external zones before 15:00 hours.

7.2 2031 scenario

2031 scenario represents the progressive development of the NSSP (about 400 lots) and surrounding areas. The road network in 2031 includes the suggested 2021 upgrades. It is understood that if approval is granted for the proposed NSSP, the developer will fund the suggested 2021 road network upgrades at the outset of the project.

However, a separate scenario was also developed to replicate the situation where NSSP is not constructed, and no road upgrades are in place. This modelling scenario was undertaken for the critical bushfire established in 2021 modelling which is the 45-degree angle bushfire from the south-west towards the north-east.

The 2031 modelling and analysis indicate that if NSSP is not developed and no road upgrades are provided, the back of queue at 1310 hours would extend back to the bushfire (refer **Figure 15**) which indicates that road upgrades would be essential to be able to safely evacuate the current and anticipated future 2031 residents (not associated with NSSP) within the traffic modelling area.

Furthermore, the evacuation graph under the bushfire scenario which shows the number of vehicles within the traffic modelling area during the bushfire progression indicates that without NSSP and no road network upgrades, after three hours approximately 144 vehicles would remain within the traffic modelling area inside the bushfire envelope.

The 2031 modelling and analysis, including 2021 road network upgrades, indicates that approximately 400 lots of NSSP could be developed by this timeframe and still enabling the NSSP and the remaining population of the traffic modelling area to evacuate within the adopted three hours model duration.

The modelling and analysis also indicate that further upgrades in addition to the 2021 upgrades are required as part of the NSSP development to safely evacuate the NSSP residents. These upgrades include:

- Upgrade to the proposed NSSP northern roundabout on Roland Road;
- Construction of the missing portion of Hawkstone Street along the northern boundary of NSSP; and,
- The committed upgrade of the intersection of GEH/Seaborne St.

It is understood that if approval is granted for the proposed NSSP, the developer will fund the above suggested road network upgrades at the outset of the project.

7.3 2038 scenario

The 2038 scenario represents the full development of NSSP (about 1,001 dwellings) plus general population growth by this time. All road network upgrades associated with NSSP would be in place in 2038 (funded by the developer at the outset of the project) and East Link is assumed to be constructed by others by 2038.

Review of the 2038 modelling and analysis undertaken indicates that under all bushfire scenarios the NSSP and the remaining population of the traffic modelling area would be able to evacuate within the adopted three-hour model duration. The back of queue would not extend back to the bushfire envelop in 2038.

For comparison purposes, without NSSP scenarios were also developed under all four bushfire scenarios. The modelled road network for without NSSP scenario included the 2021 upgrades but did not include the upgrades associated with NSSP.

Table 6 and **Table 7** show the total vehicles inside the traffic modelling area during the evacuation period for future scenarios (2031 and 2038) with and without NSSP. The with NSSP scenarios include the 2021 suggested road network upgrades plus all the proposed road network upgrades because of the NSSP. The without NSSP scenarios included the suggested 2021 road network upgrades (**Appendix A**) but does not include the upgrades because of the NSSP development (**Appendix B**).

In order to compare the with and without NSSP scenarios, the total number of vehicles within the traffic modelling area was extracted for each scenario at 1445 hours (just before conclusion of the three-hour model duration). As evident, the total number of vehicles within the traffic modelling area in both scenarios is not significantly different and most importantly for this scenario there are zero vehicles within the traffic modelling area at time 1500 hours meaning all vehicles would have been evacuated before the end of the three-hour model duration.

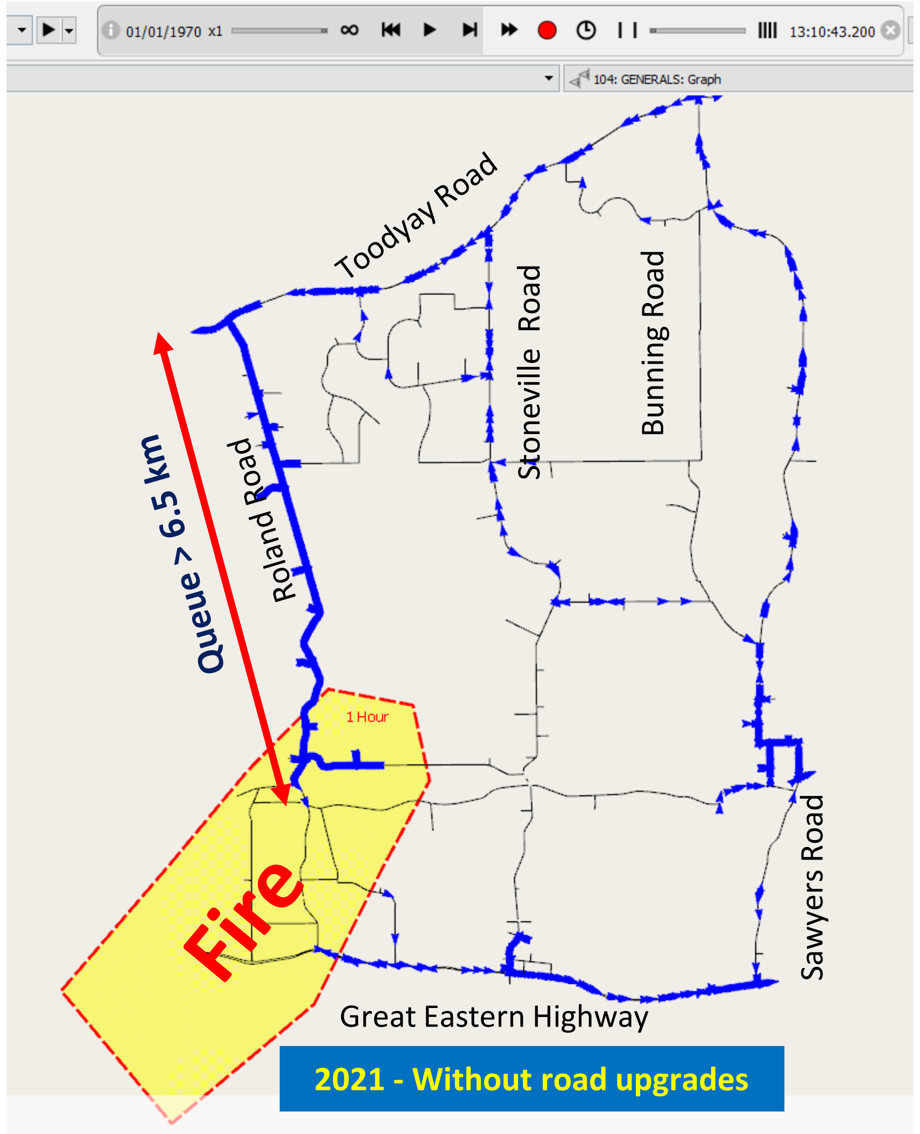
7.4 Bushfire from North-West

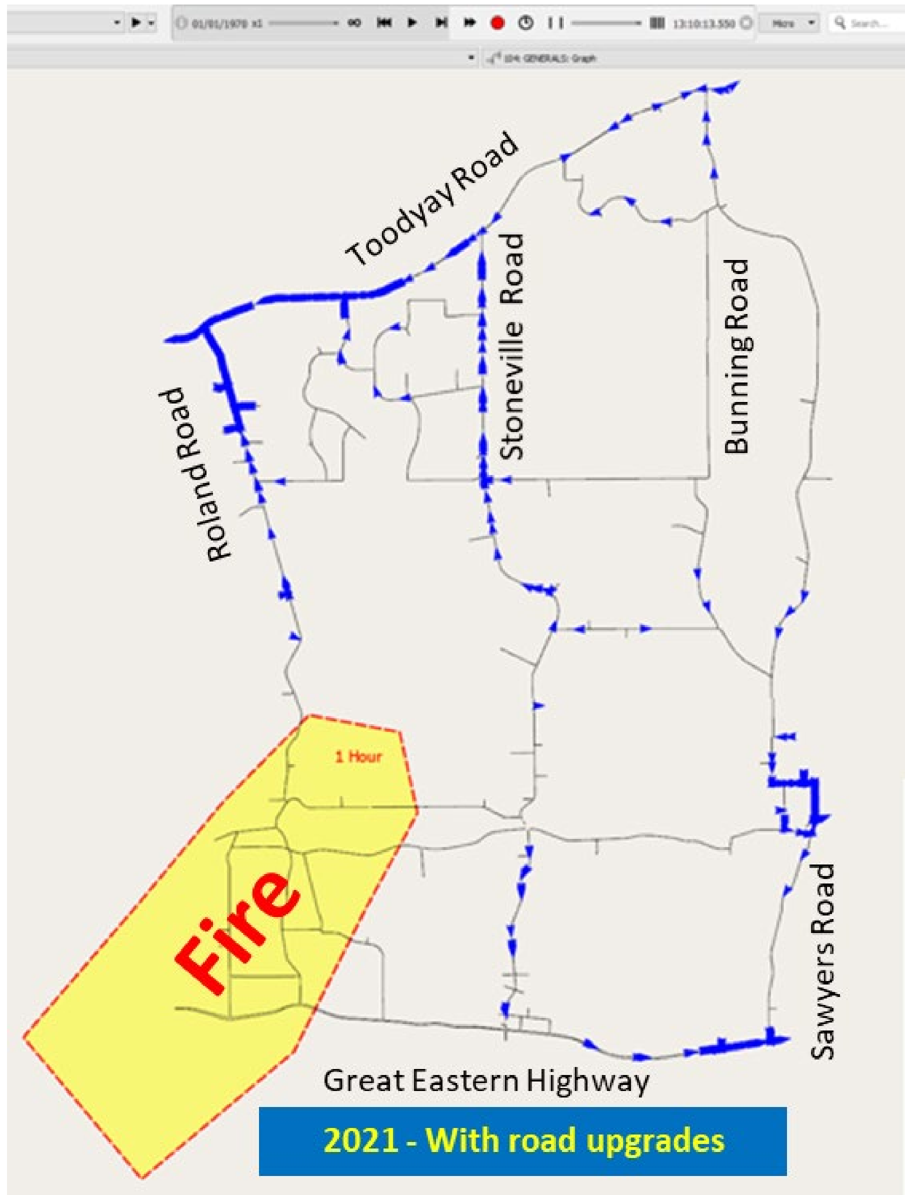
The critical bushfire scenario in terms of time to impact NSSP is the bushfire from north-west towards the south-east, which was highlighted in **Table 5** . The bushfire from north-west would reach the NSSP sooner than other bushfire scenarios due to the proximity of the NSSP to north-west corner of the traffic modelling area. Under this bushfire scenario in the evacuation models, it was conservatively assumed that the bushfire would reach the NSSP approx. 25 minutes earlier (137 - 112 = 25min) in traffic microsimulation evacuation model than bushfire simulation model for FFDI 74.9.

In all evacuation model scenarios including the bushfire from north-west, it was assumed that all NSSP residents would have been evacuated before the bushfire reach to NSSP (i.e. the NSSP trips were released to the network before fire arrival).

To investigate the bushfire scenario from north-west further and to ensure that the back of evacuation queue would be ahead of the fire front, additional modelling and analysis was undertaken to establish the level of traffic queue at the time that bushfire from north-west reached the NSSP. This task involved additional modelling and analysis for year 2031 and 2038 scenarios at the time just after 1300 hours (when the fire arrived and progress towards NSSP and all NSSP residents have evacuated the site).

Figure 11 to **Figure 15** illustrates the back of evacuation traffic queue to the bushfire front in 2031 and 2038 for the fire run from north-west towards NSSP. As evident under both scenarios the back of queue is about 3km away from the fire front which demonstrate safe evacuation of the residents of NSSP and all the other residents within the traffic modelling area.





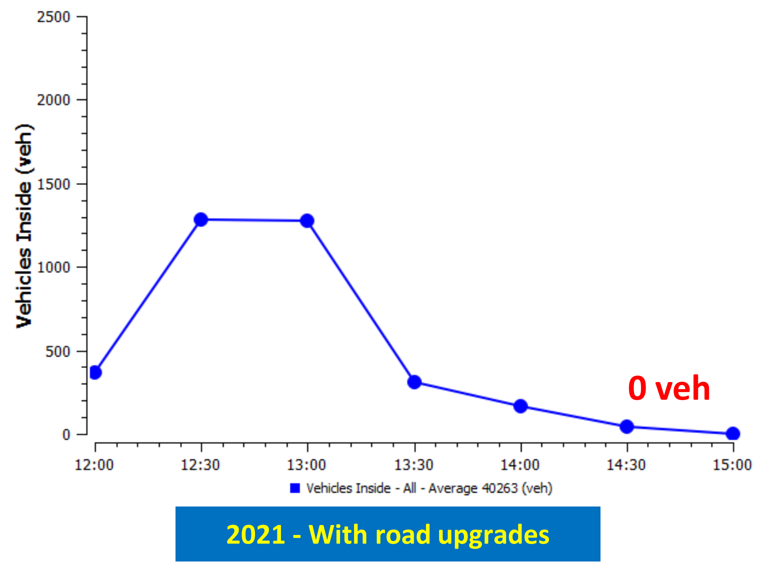


Figure 11: 2021 model outputs (with & without road upgrades) – Bushfire from SW

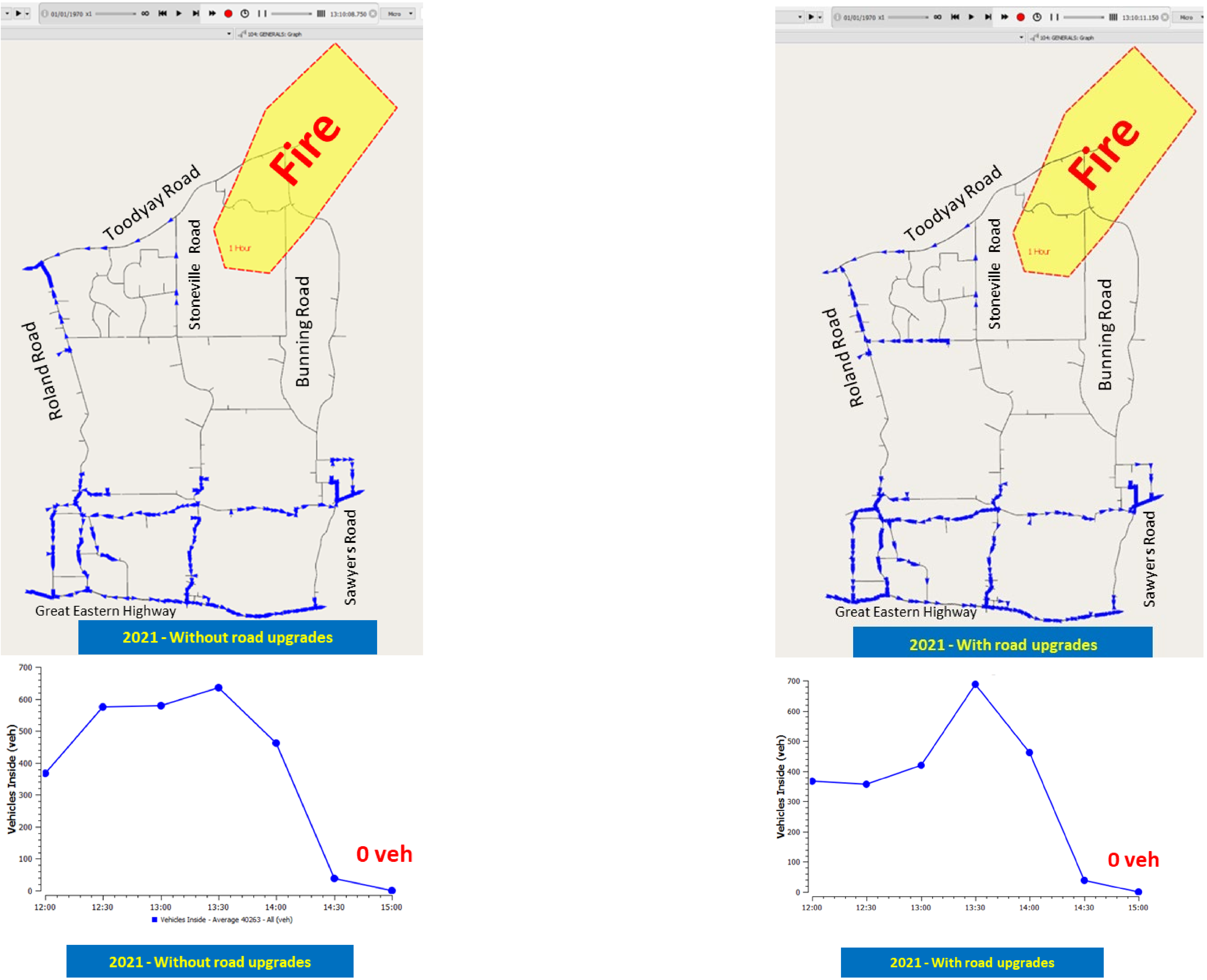


Figure 12: 2021 model outputs (with & without road upgrades) – Bushfire from NE

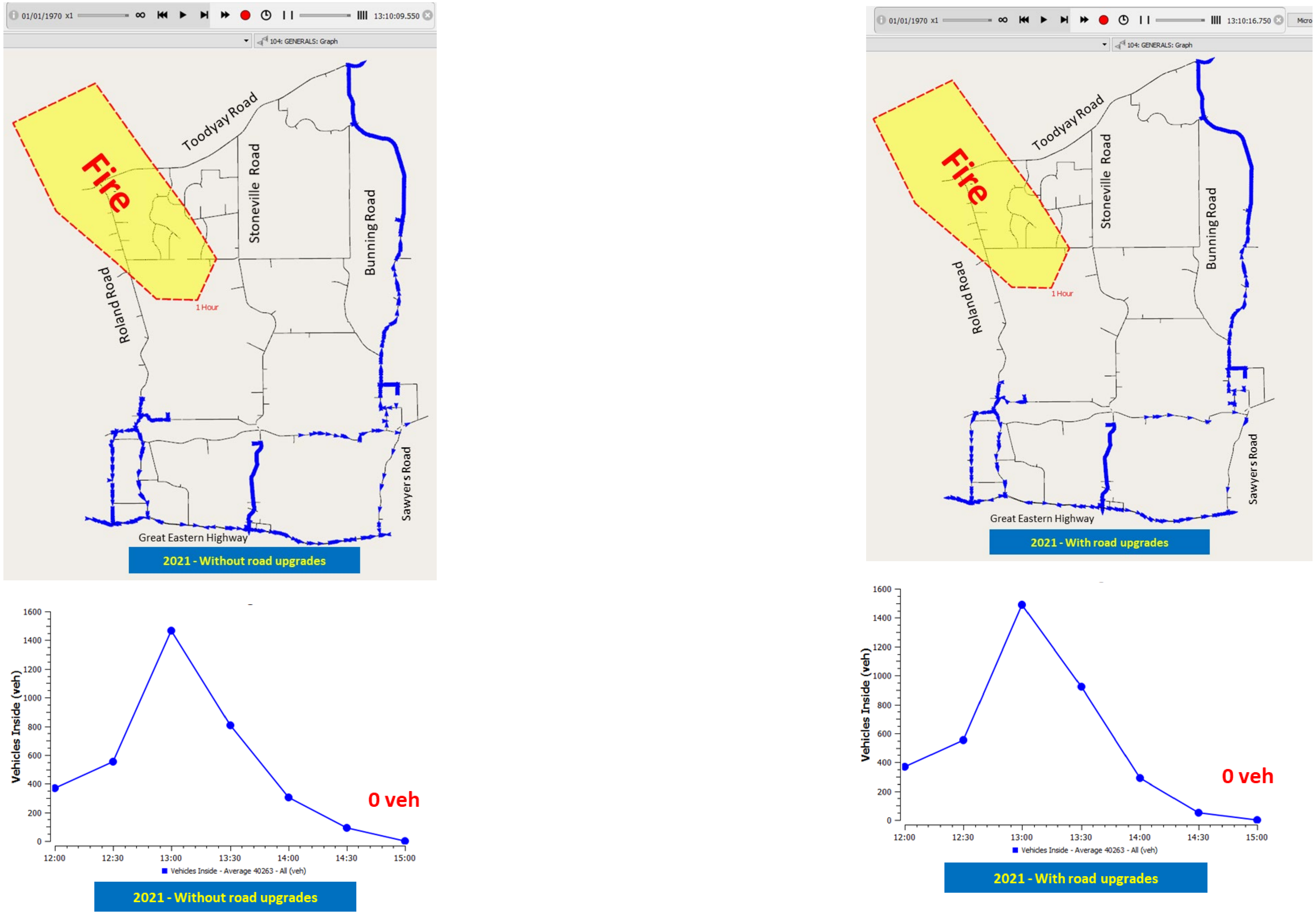


Figure 13: 2021 model outputs (with & without road upgrades) – Bushfire from NW

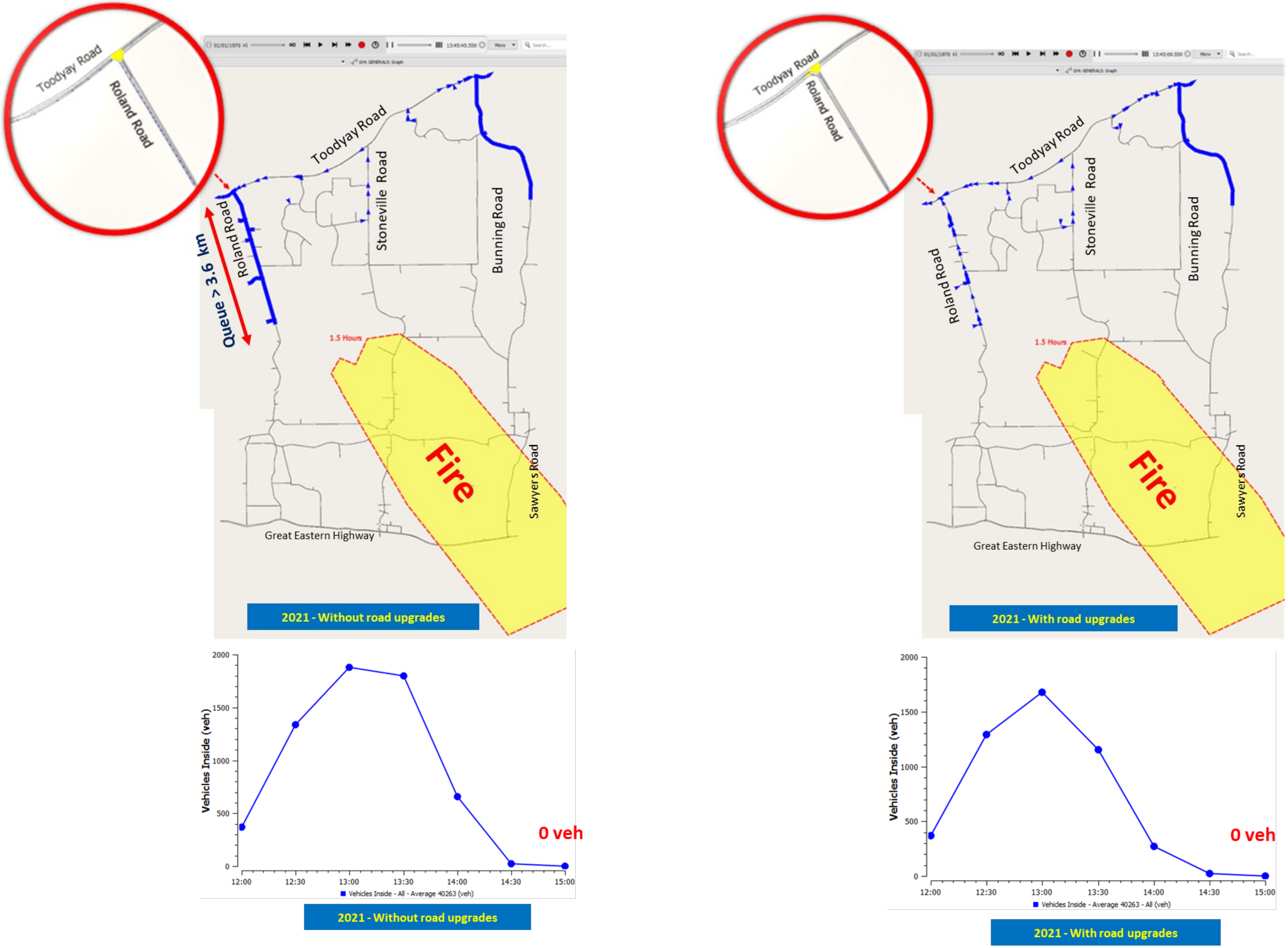


Figure 14: 2021 model outputs (with & without road upgrades) – Bushfire from SE

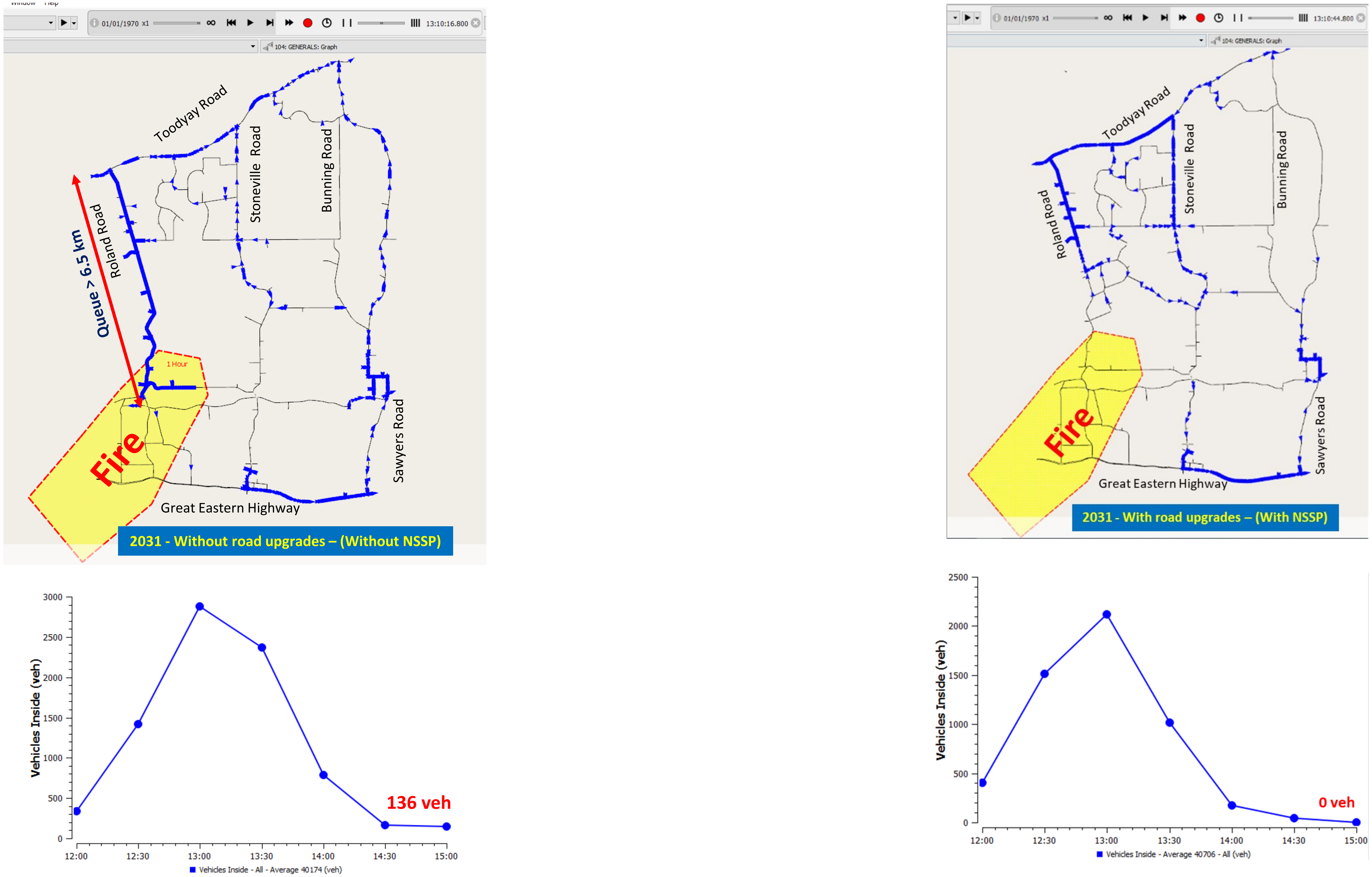
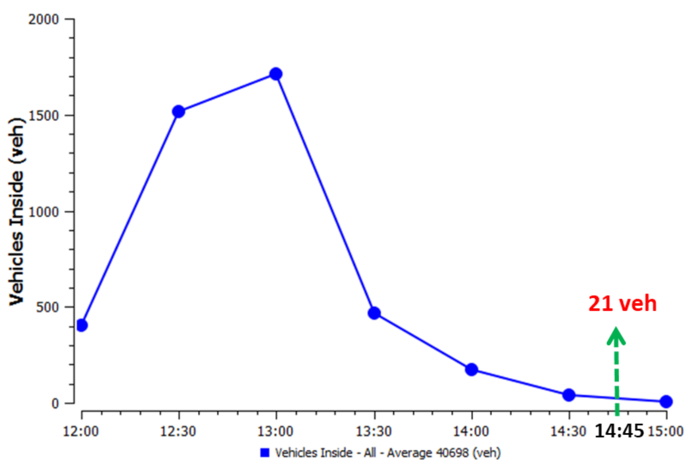
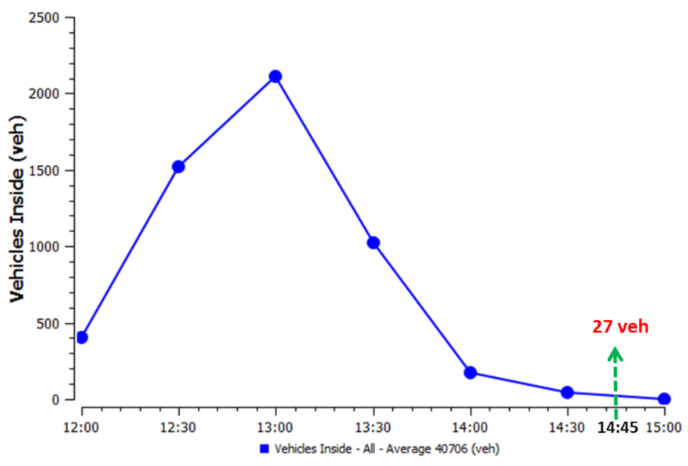
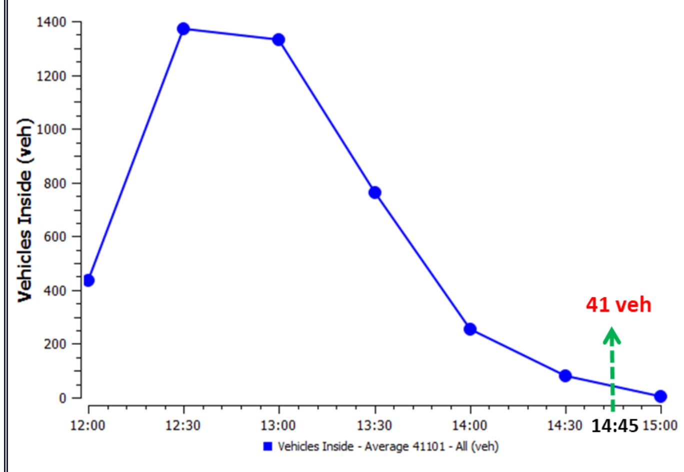
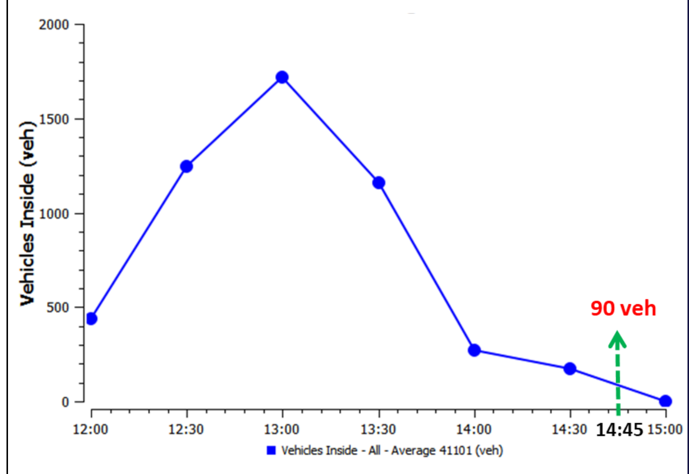
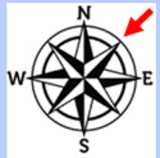


Figure 15: 2031 model outputs (with & without NSSP) – Bushfire from SE

Table 6: Vehicles inside the traffic modelling area for future scenarios – SW and NE bushfire scenarios (including the 2021 suggested road upgrades)

<table>
<tr><th rowspan="2">Scenarios</th><th colspan="2">2031</th><th colspan="2">2038</th></tr>
<tr><th>Without NSSP</th><th>With NSSP</th><th>Without NSSP</th><th>With NSSP</th></tr>
<tr>
<td>

Bushfire from SW</td>
<td>
</td>
<td>
</td>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>

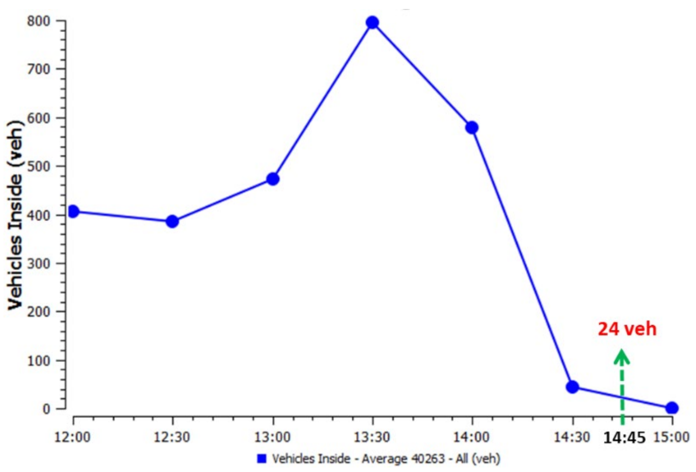
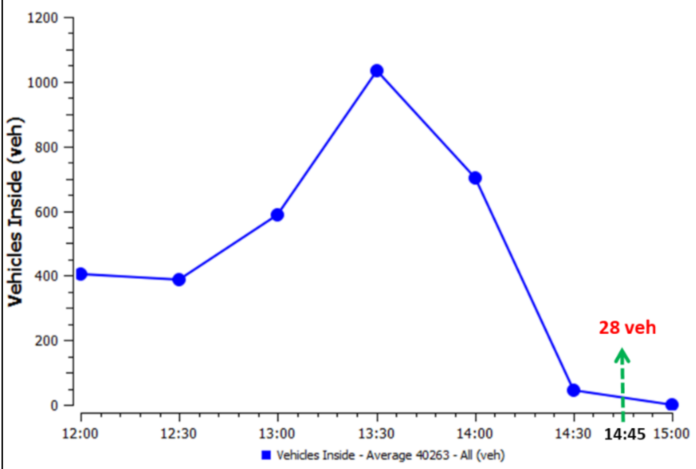
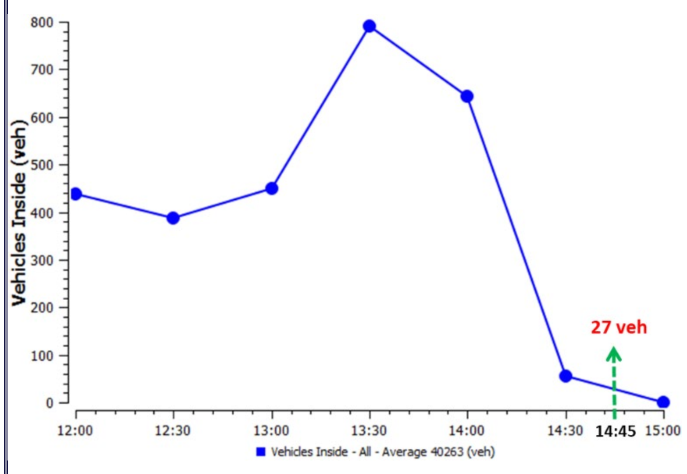
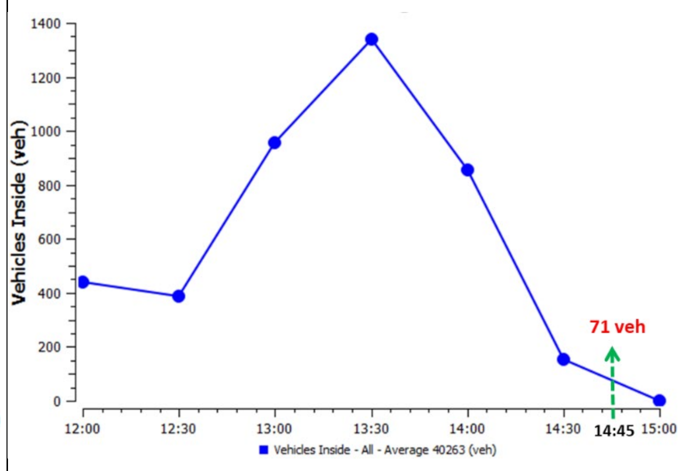
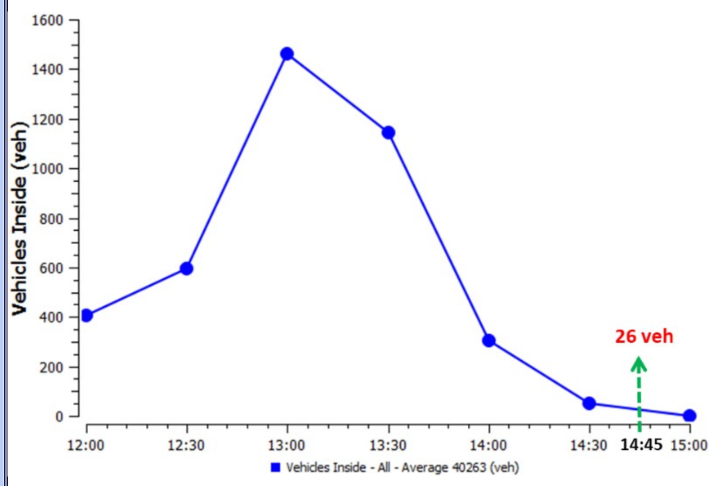
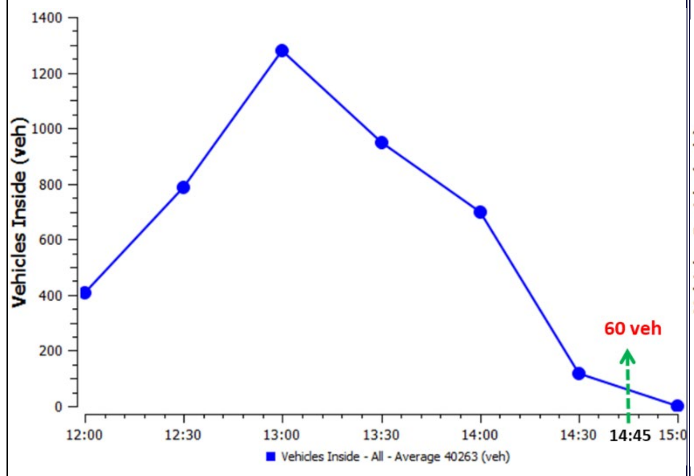
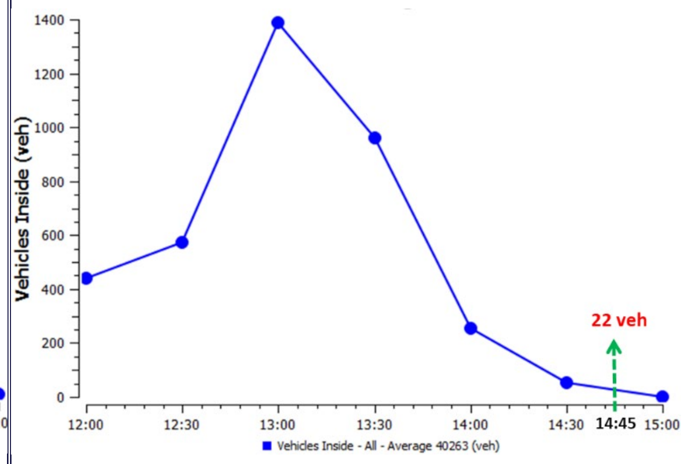
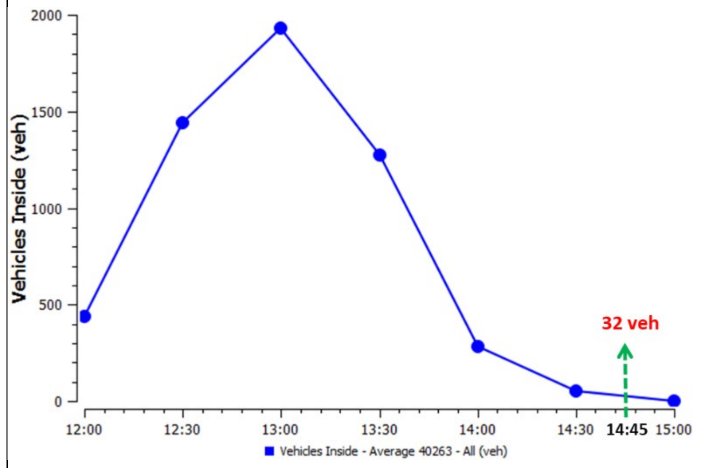
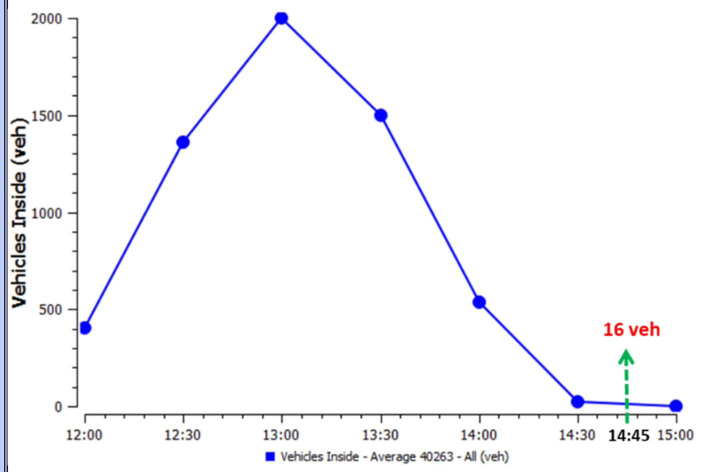
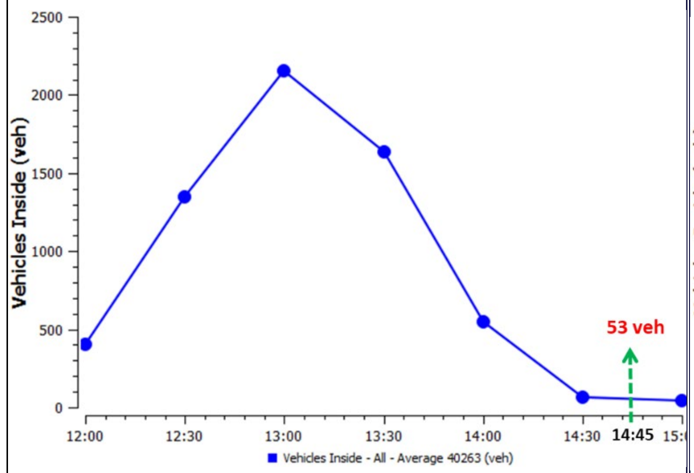
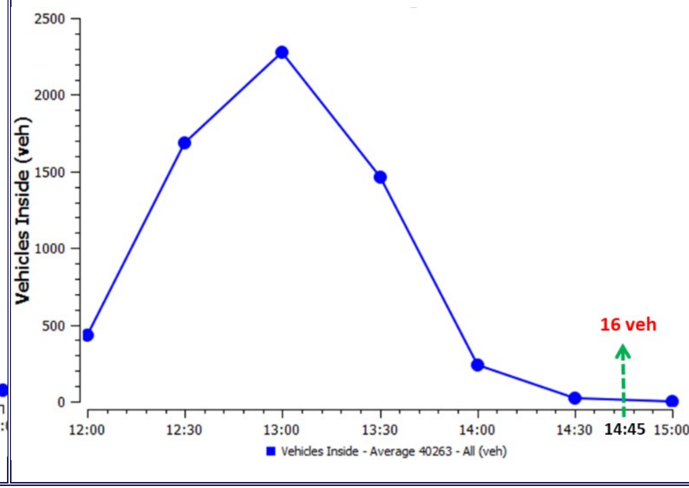
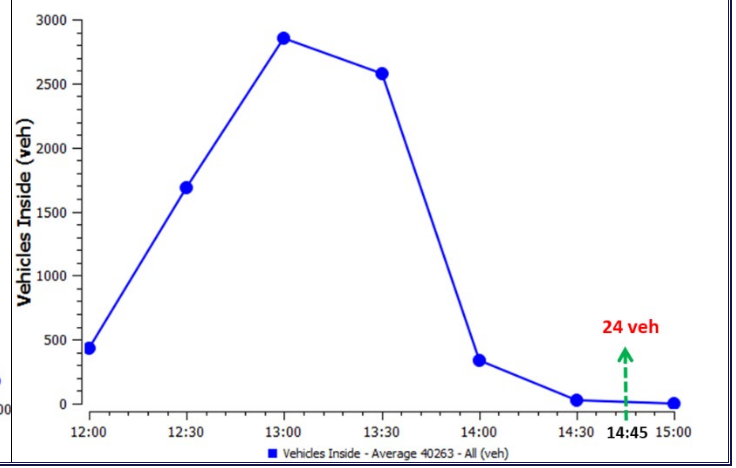
Bushfire from NE</td>
<td>
</td>
<td>
</td>
<td>
</td>
<td>
</td>
</tr>
</table>

Table 7: Vehicles inside the traffic modelling area for future scenarios – NW and SE bushfire scenarios (including the 2021 suggested road upgrades)

Scenarios	2031		2038	
	Without NSSP	With NSSP	Without NSSP	With NSSP
 Bushfire from NW				
				

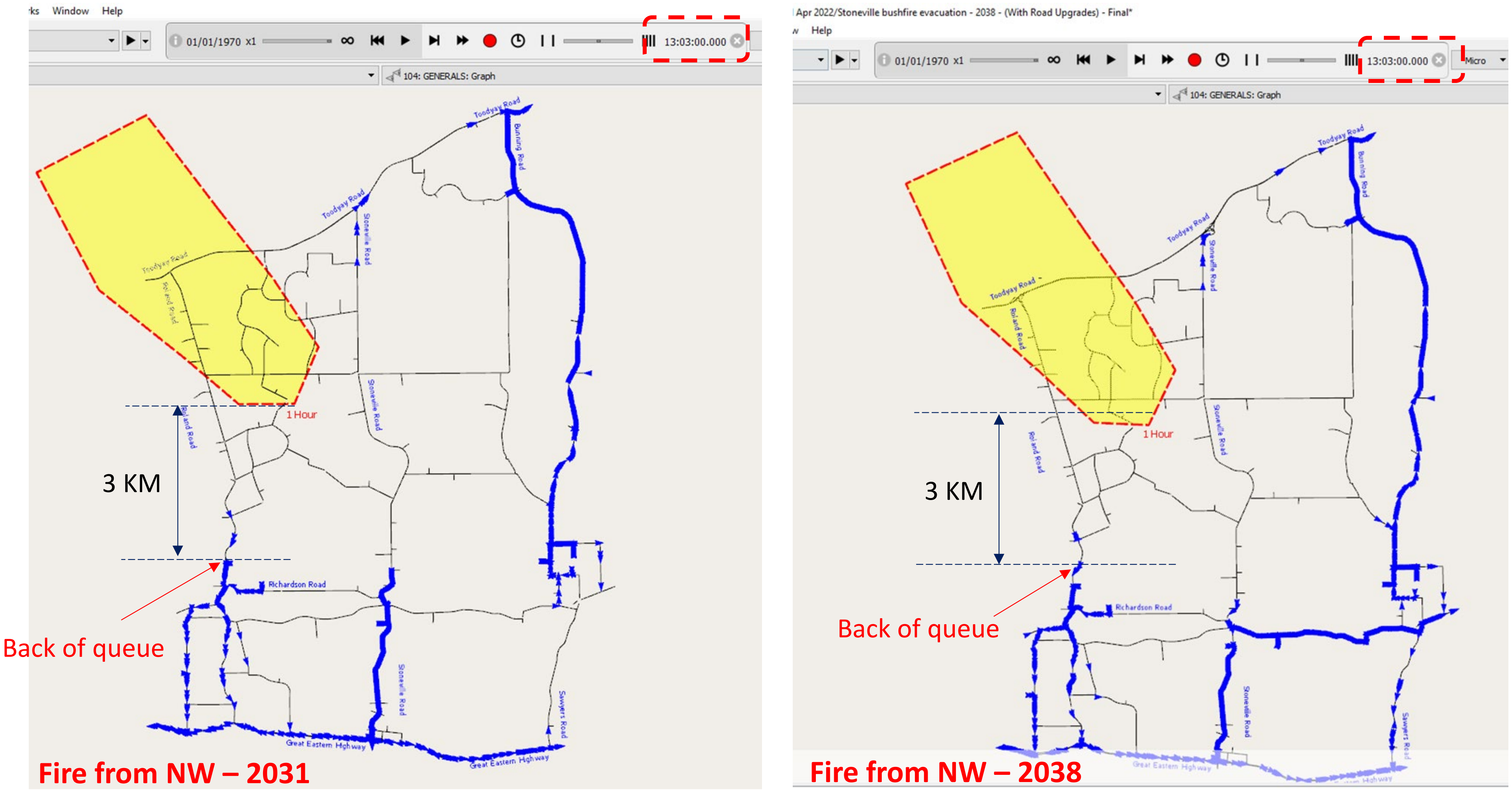


Figure 16: Back of evacuation queue to the bushfire front in 2031 and 2038 – NW bushfire scenario

8 Proposed Road Network Upgrades

Based on the 2021 evacuation modelling, the current road network standards and capacity constraints at the Stoneville Road / Toodyay Road and Roland Road / Toodyay Road intersections currently require some level of road upgrades to enable the evacuation of the existing population of the modelling area from a worst-case bushfire scenario, within a three-hour model duration.

The upgrades required to meet the evacuation criteria as shown in **Appendix A** include:

- Stoneville Road/Toodyay Road intersection - A dedicated left turn lane on Stoneville Road with approx. 100m merge on Toodyay Road; and,
- Roland Road/Toodyay Road intersection - A dedicated left turn lane on Roland Road with approx. 500m merge on Toodyay Road.

In addition to the above road network upgrades, the NSSP northern roundabout intersection on Roland Road would need to be constructed with 2 northbound through lanes with approx. 150m merge to facilitate the continuous evacuation northbound on Roland Road. Refer **Appendix B** for the proposed roundabout concept sketch.

It is further recommended that the missing portion of Hawkstone Street along the northern boundary of NSSP between Waterfront Drive and Strawberry Hill Drive should be constructed to assist e-w connection for evacuation traffic.

The committed upgrade of the intersection of GEH/Seaborne Street as part of NSSP, would also assist the evacuation traffic for the NW and NE bushfire scenarios. **Appendix C** illustrates the committed upgrade of the intersection of GEH/Seaborne Street.

Table 8 summarise the timing, responsibility and the reason for the proposed road network upgrades. It is understood that if approval is granted for the proposed NSSP, the developer will fund the suggested road network upgrades at the outset of the project.

Table 8: Summary of the proposed road network upgrades

Proposed upgrades	Time of upgrade	Responsibility	Reason for the upgrade
1. A dedicated left turn lane on Stoneville Road	At the outset of NSSP	Developer	To enable the existing population of the traffic modelling area, to evacuate in a timely manner.
2. A dedicated left turn lane on Roland Road	At the outset of NSSP	Developer	Same as above
3. Upgrade to the proposed NSSP northern roundabout on Roland Road	At the outset of NSSP	Developer	To enable the NSSP population to evacuate in a timely manner.
4. Construction of the missing portion of Hawkstone Street along the northern boundary of NSSP	At the outset of NSSP	Developer	To enable the NSSP population to evacuate in a timely manner.
5. The committed upgrade of the intersection of GEH/Seaborne St	At the outset of NSSP	Developer	To improve traffic operations and safety of the intersection under normal (no fire) conditions due to NSSP traffic.

9 Conclusions

The microsimulation models developed and assessed with documented bushfire and evacuation assumptions in this report offer the opportunity to gain a better understanding of the potential performance of the existing and proposed road network in bushfire evacuation situations. However, it cannot provide a guaranteed network performance during a bushfire but it identifies bottlenecks across the road network because of evacuation process.

The bushfire evacuation modelling and analysis have been undertaken for the critical bushfire scenarios (most impacts on evacuation routes) with a conservatively rapid-fire progression which would result in a window of three hours to evacuate the entire population within the defined traffic modelling area.

The microsimulation modelling and analysis undertaken indicates that, with the assumed evacuation parameters, the current road network is not capable of facilitating the safe evacuation of the existing population within the stipulated evacuation window. Regardless of the NSSP, road network upgrades (refer items 1 and 2 in **Table 8**) are recommended to the existing road network now, to achieve satisfactory evacuation. It is understood that if approval is granted for the proposed NSSP, the developer will fund the suggested 2021 road network upgrades.

After construction of the proposed 2021 road network upgrades the NSSP can progress and develop up to 400 lots before construction of East Link. After construction of East Link, the NSSP can be fully developed.

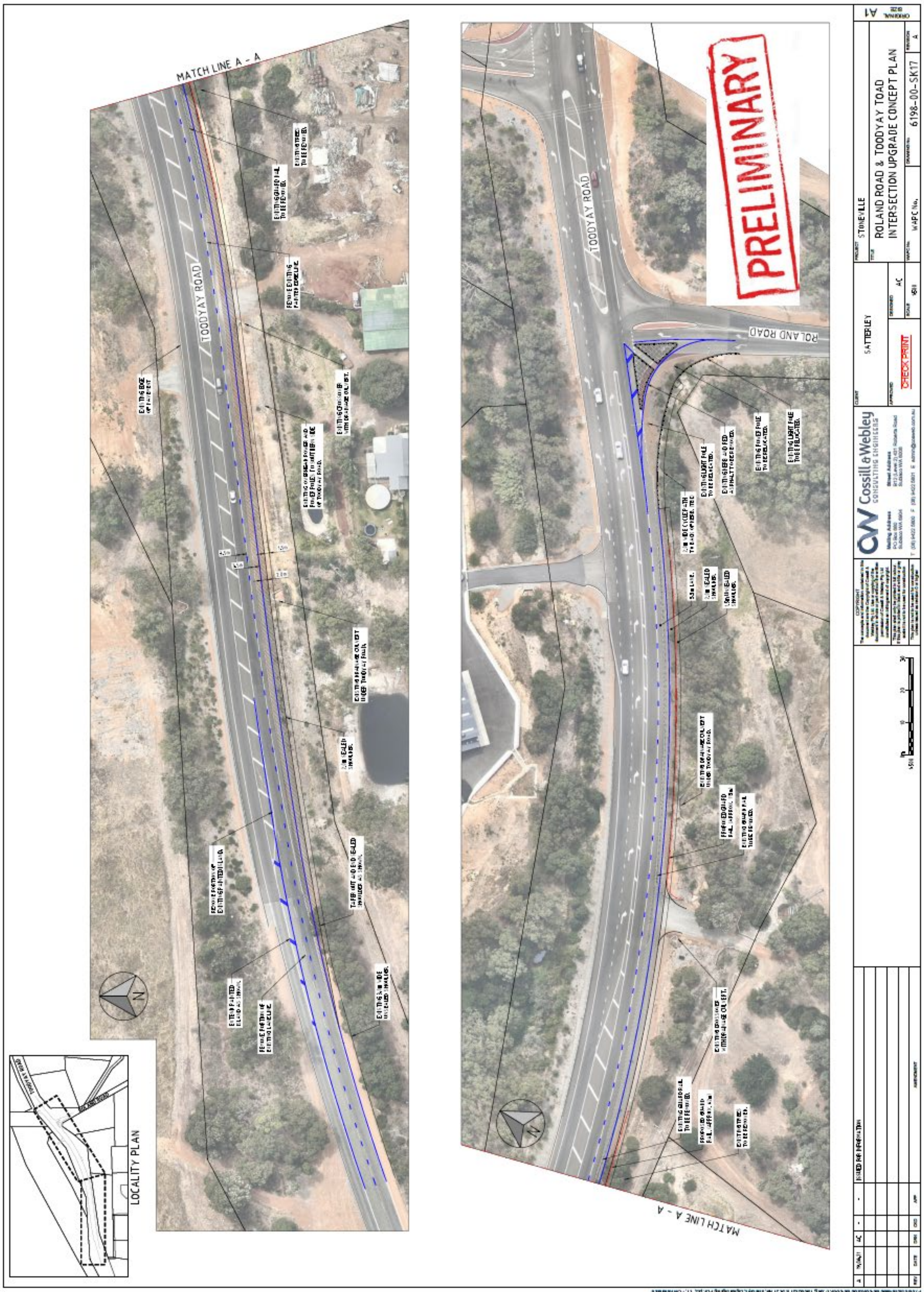
With the additions of NSSP, some additional road network upgrades would be required. These road upgrades (refer item 3,4 and 5 in **Table 8)** would be included as part of the development works associated with the NSSP and would be triggered at the outset of the project. These upgrades will be funded by the developer.

The microsimulation models undertaken indicates that with the proposed road network upgrades the existing and future residents would be able to evacuate satisfactorily in the event of a bushfire and the back of queue during the evacuation would be away from the fire front under all modelling scenarios.

Appendix A

REQUIRED UPGRADES REGARDLESS OF THE DEVELOPMENT OF NSSP

transport planning
traffic engineering
modelling


MATCH LINE A - A
TOODYAY ROAD
ROLAND ROAD
PRELIMINARY
LOCALITY PLAN
STONEVILLE
ROLAND ROAD & TOODYAY TOAD
INTERSECTION UPGRADE CONCEPT PLAN
SATTERLEY
Cossill & Webley
CONSULTING ENGINEERS
CHECK PRINT
6198-00-SK17
A1


PRELIMINARY
TOODYAY ROAD
STONEVILLE ROAD
Cossill & Webley
CONSULTING ENGINEERS
SATTERLEY
STONEVILLE
STONEVILLE ROAD & TOODYAY TOAD
INTERSECTION UPGRADE CONCEPT PLAN
6198-00-SK16
A1

Appendix B

PROPOSED UPGRADES ASSOCIATED WITH THE DEVELOPMENT OF NSSP


PRELIMINARY
ROAD 1
ROAD 2
ROLAND ROAD
MATCH LINE A - A
TRAFFIC FLOW PLAN
STONEVILLE
SATTERLEY
ROLAND ROAD & FINGERLEAF ROAD
PRELIMINARY CONCEPT LAYOUT
Cossill & Webley
CONSULTING ENGINEERS
CHECK PRINT
6198-00-SK18
A1

Appendix C

COMMITED UPGRADES AT THE INTERSECTION OF GEH/SEABORNE ST


TRANSFORMER
LIGNT POLE
Intersection Great Eastern Hwy and Seabourne St
Proposed Intersection Modification -Option 3
t16.318.sk03
15/03/2020
Scale: 1:500 @ A3
transcore