Bushfire Risk Study - Wilton Growth Area

NSW Department of Planning, Industry & Environment

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Template 2.8.1

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Abbreviations

Abbreviation	Description
ABCB	Australian Building Codes Board
DPIE	NSW Department of Planning, Industry & Environment
ELA	Eco Logical Australia
PBP	Planning for Bush Fire Protection
RFS	Rural Fire Service

Executive Summary

This study presents a bushfire spread modelling exercise relevant to the Wilton Growth Area. The results are presented and then discussed in terms of the bushfire risk context and a bushfire risk assessment for each precinct is presented. Both of these outputs are recommended to be used to inform future planning and development control within Wilton Growth Area and the individual precincts.

The bushfire spread models were generated utilising the SPARK Wildfire Simulation Toolkit developed by the CSIRO. A conservative approach was utilised for the bushfire spread modelling, in order to explore potentially worst-case bushfire attack to and within Wilton Growth Area. Fire spread modelling for a set of bushfire attack scenarios, informs the potential time to arrival, which can be used to inform emergency management responses, including the available time to take refuge onsite or evacuate offsite, as well as the potential impact on evacuation routes out of the area.

The results of the bushfire spread models demonstrate potential bushfire spread to the Wilton Growth Area and surrounds as well as penetration into the retained lands of the Growth Area. The 'Arrival Time' summaries presented should be used conservatively, and it should be noted that these results summarise the model outputs, rather than providing a defined estimate of the required time to safely refuge or evacuate from a bushfire attack scenario. The latter is influenced by the Cue; Response; Delay; and Movement periods and these concepts are raised in the report. Further, a factor of safety should be considered when evaluating the required time against available time. As such, additional time beyond the arrival times presented in the results, are required to provide an appropriate timeframe, for the safe relocation of people for either onsite refuge or offsite evacuation.

The study notes that there are many potential bushfire attack scenarios and it may not be safe, appropriate or even relevant to trigger offsite evacuation for all of them. Taking refuge in another part of the Growth Area or refuging within a subject precinct, may provide a valid emergency option and should be considered in further planning and development control.

The application of bushfire protection measures is a requirement for all land development proposed on bushfire prone land. Further, the staging of future development, including the provision of critical infrastructure and the removal of bushfire hazards from earlier stages, is a key consideration. Egress options for movement within and away from Wilton Growth Area, needs to be carefully planned to ensure they have adequate capacity and would be safe to use during a bushfire emergency, also assuming alternate options may be unavailable.

Bushfire risk varies across the Growth Area, with Wilton South East (B) & (C) and the Northern Precinct (A) assessed as having higher bushfire risk exposure than the other precincts. Planning and development control should be carefully considered, for future development of these higher risk precincts, and any others where the provision of adequate bushfire protection measures, on-precinct or nearby refuge options and off-site evacuation may be restricted.

1. Introduction

1.1 Background

A strategic bushfire assessment for the Wilton Growth Area was finalised in 2018 (Eco Logical Australia (ELA) 2018). This assessment responded to the requests of the NSW Rural Fire Service (RFS) that have since been formalised into the strategic planning requirements of Planning for Bush Fire Protection (PBP) (RFS 2019). It identified (amongst other matters) that emergency evacuation from bushfire, had not been well demonstrated.

In response to the above findings, the NSW Department of Planning, Industry and Environment, engaged ELA to prepare a Bushfire Risk Study (the Study) for the Wilton Growth Area. The study was a collaboration with the NSW Department of Planning, Industry & Environment (the client), NSW Rural Fire Service (RFS), Wollondilly Shire Council and Roads and Maritime Services (RMS).

1.2 Aims and Objectives

The aim of this study was to investigate the bushfire attack and risks of the Wilton Growth Area for the purpose of further informing planning and development control, both across the Wilton Growth Area and for the individual precincts comprising it. The study was undertaken in light of the strategic planning principles of PBP (RFS 2019) with regard to bushfire evacuation, specifically: '*providing infrastructure associated with emergency evacuation and firefighting operations*' and '*ensuring land is suitable for development in the context of bush fire risk*'.

The approach taken in this study is detailed in Section 2. It involved bushfire spread modelling to investigate the potential rate of spread and time to arrival, from various bushfire attack scenarios. The results of this bushfire spread modelling were then analysed and are presented in Section 3. The results of the study are informative and need to be considered in light of the emergency management options available to occupants of the area, as well as the level of protection afforded to them, through the incorporation of bushfire protection measures as per the requirements of PBP and building constructions standards as per AS 3959 (SA 2018).

In addition to the bushfire spread modelling, a bushfire risk assessment is presented in Section 4 to inform future planning and development control.

1.3 Site and Study Area

The Wilton Growth Area is the focus of this study (Figure 1) and is located at the intersection of Picton Road and the Hume Motorway, at the southern end of the Cumberland Plain. The Wilton Growth Area is within the Wollondilly Shire Local Government Area and is located between Douglas Park to the north and Pheasants Nest to the south. The township of Picton is located approximately 8 km to the west.

The land uses proposed for the Wilton Growth Area by the Wilton 2040 plan (DPE 2018) were utilised to identify areas proposed for development versus those areas proposed to be retained following development of the Wilton Growth Area.

The extent of the study area for this assessment was to a distance of 5 km from the Wilton Growth Area, in order for the bushfire threat within the adjoining landscape to be incorporated (Figure 2).

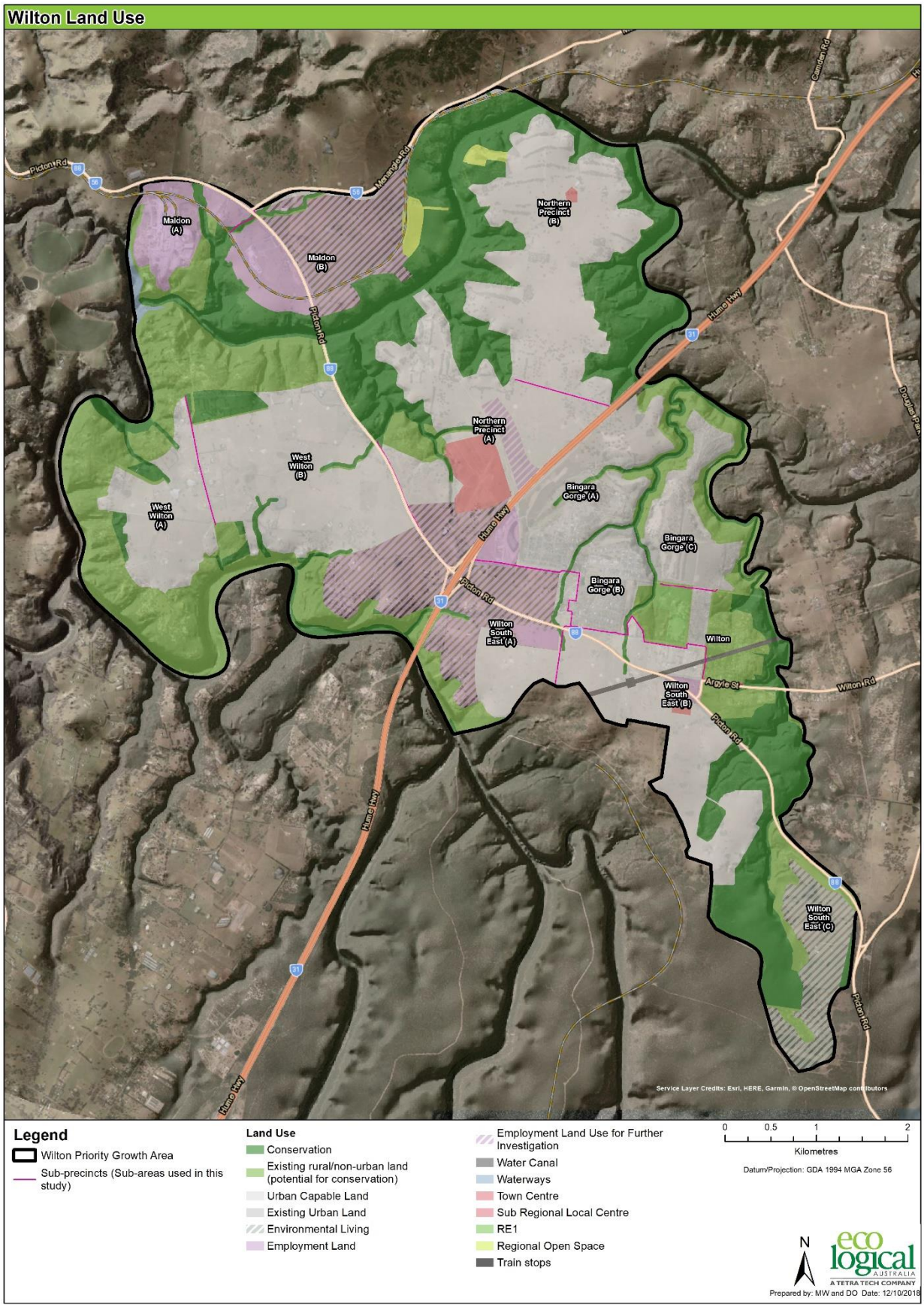

Figure 1: Wilton Growth Area and Proposed Land Uses

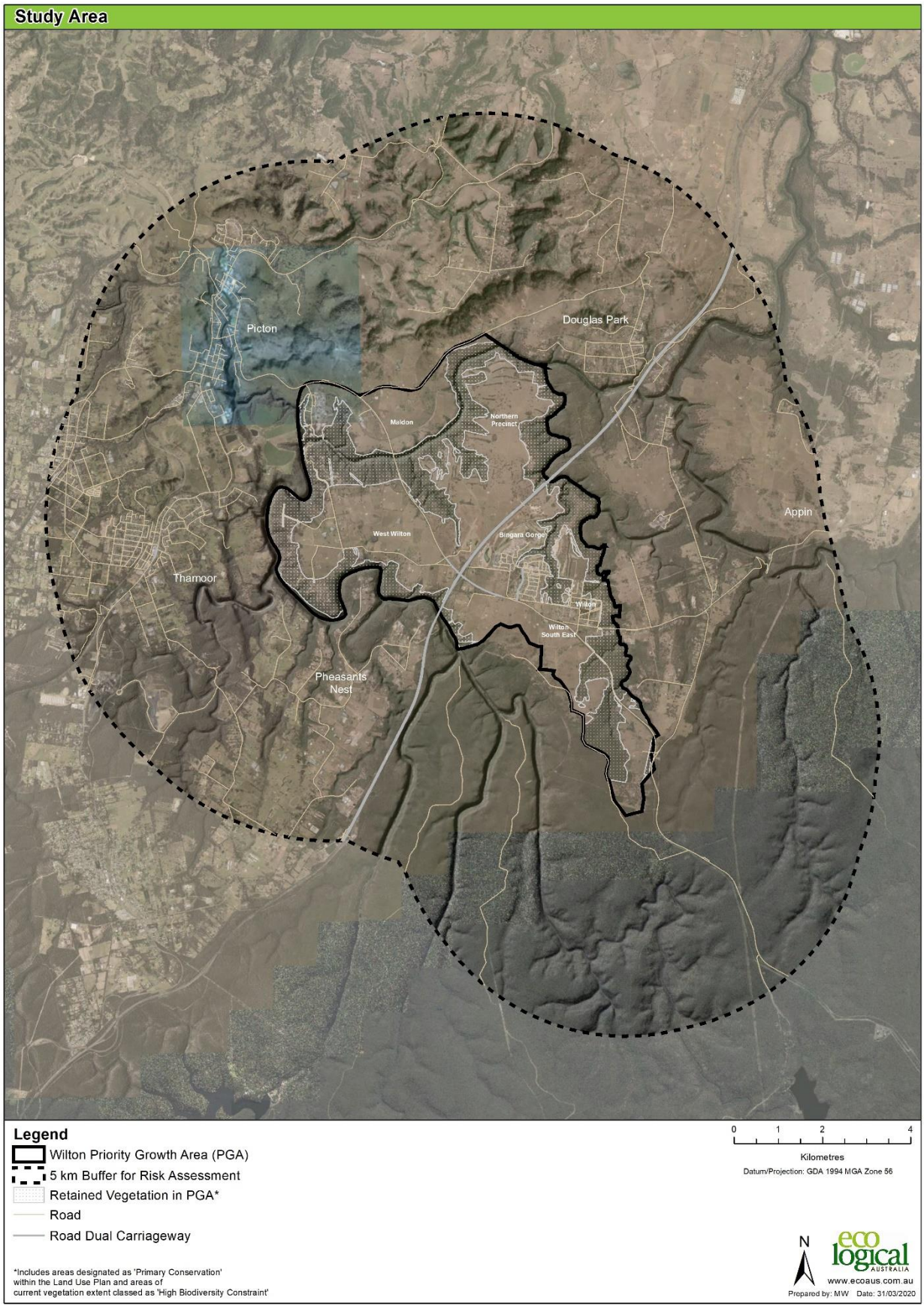

Figure 2: Extent of Study Area

2. Methods

2.1 Bushfire Spread Modelling

Fire spread modelling for a set of bushfire attack scenarios, informs the potential time to arrival, for bushfires with similar characteristics to those being modelled, as well as inform more generally how bushfire may move through the landscape. The time to arrival, can be used to inform emergency management responses, including the available time to shelter onsite or evacuate.

The modelling was undertaken in two parts, being:

- Part 1 – Bushfire spread models from select ignition points (8); and
- Part 2 - Bushfire spread models from a ring of ignition points.

Undertaking these two different approaches to the modelling, allows for the analysis of the potential bushfire spread from a point ignition source, alongside the broader potential bushfire catchment exposure of the Wilton Growth Area, say should it be exposed to a larger landscape scale bushfire.

The bushfire spread models were generated utilising the SPARK Wildfire Simulation Toolkit (CSIRO 2018). The scenarios modelled, technical approach taken, base (bushfire hazard) data utilised, and parameters adopted for the bushfire modelling are detailed in the sections below.

2.1.1 Model Scenarios

The bushfire attack scenarios modelled were three (3) differing weather conditions / wind directions from two (2) different sets of ignition points.

As outlined above, the Part 1 model runs consisted of fire spread simulations from eight manually selected ignition locations. The selected ignition points were located approximately 5 km from the Wilton Growth Area, in locations that were expected to provide relevant results, given the differing wind directions being modelled, and in consideration of the Growth Area precincts and main road network. The Part 2 model runs utilised a ring of ignitions located around a 5 km buffer of the Wilton Growth Area boundary, and regularly spaced every 100 m. The ignition points utilised for both the Part 1 and Part 2 model runs are shown on Figure 3.

For each part (i.e. Part 1 and Part 2) the fire spread models were run using 3 differing sets of weather conditions, including different wind directions, in order to investigate the potential bushfire attack of the Wilton Growth Area under differing bushfire spread scenarios. The weather parameters utilised are detailed in Section 2.1.4 and are consistent with the weather analysis undertaken for the Strategic Bushfire Study (ELA 2018). Further, recent research by Douglas and He (2019) indicates that the values used in this study represent a reasonable estimate of potential future fire weather conditions under climate change. The 3 differing sets of weather conditions utilised in the modelling are expressed below in terms of the Forest Fire Danger Index (FFDI) analysed for a directional sector (ELA 2018):

- FFDI 116 from south-west to north;
- FFDI 63 from north to south-east; and
- FFDI 47 from south-east to south-west.

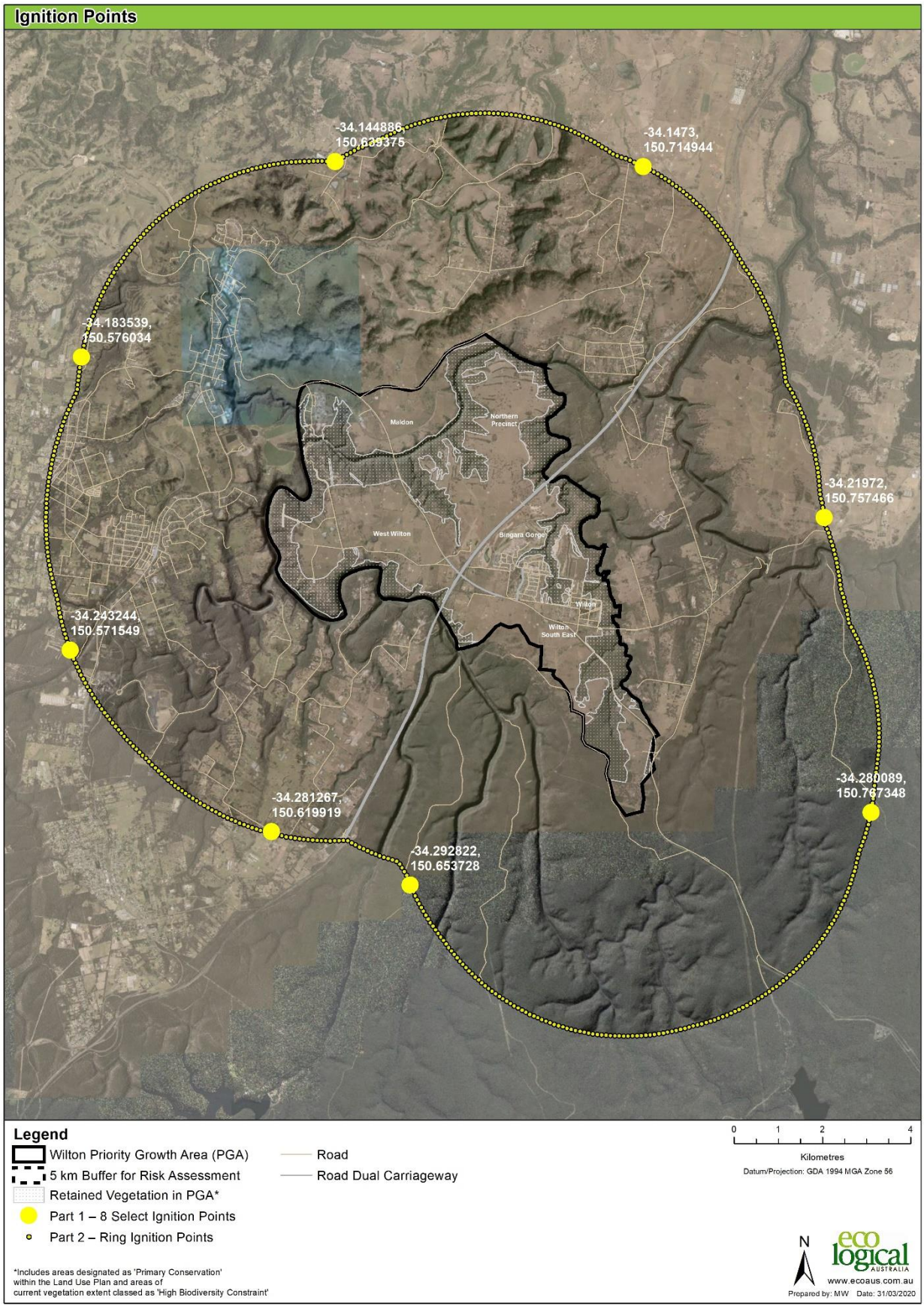

Figure 3: Ignition Points Utilised

2.1.2 Technical Approach

The SPARK Wildfire Simulation Toolkit (CSIRO 2018) allows for bushfire simulations to be run with a high level of configurability. The SPARK software is designed to incorporate a multitude of user inputs, current fire behaviour propagation models and state-of-the-art simulation science. This allows modelling of fire spread across the landscape using specific location and environmental conditions displayed in 2D/3D.

The primary input into SPARK is the Rate of Spread (RoS) formula that drives the resultant fire spread prediction based on the differing inputs i.e. vegetation types and topography. The latest guide on Rate of Spread modelling for Australian vegetation is *A Guide to Rate of Fire Spread Models for Australian Vegetation* (Cruz et al. 2015). Different models were used in this study dependent on differing vegetation types, as following:

- Grassland and Grassy Woodlands - formula by Cheney et al. 1998 in Cruz et al. 2015;
- Heath & Temperate Shrublands - formula by Anderson et al. 2015 in Cruz et al. 2015; and
- Eucalypt Forests - formula from Project Vesta and Cheney et al. 2012 in Cruz et al. 2015.

The other inputs configured for this study included the bushfire hazard data and weather parameters discussed below. All other configurations where left at default settings.

The Part 1 models were run for 4 hours, whilst the Part 2 models where run for 10 hours of simulation.

2.1.3 Bushfire Hazards

The bushfire spread models rely on spatial data representing the bushfire hazard, namely vegetation/fuel and topography. The assessment of bushfire hazard for this study leverages on the previous work compiled for the Strategic Bushfire Study (ELA 2018) for vegetation formations / fuel and topography across the study area.

2.1.3.1 Vegetation / Fuel

Vegetation types present across the study area were compiled from best available vegetation mapping and then classified into vegetation formations and classes using Keith (2004). This vegetation classification allowed the assignment of appropriate fire spread model type / formula and the assignment of relevant fuel characteristics (Table 1) using data complied as part of the previous work (ELA 2018) and RFS (2019). This classification is presented in Figure 4, noting that extant vegetation in areas earmarked for development within in the Wilton Growth Area were removed and conversely, areas marked as environmental conservation were retained / added. That is, the expected future 'bushfire prone vegetation' was compiled. Areas within the Growth Area earmarked for development have mostly been cleared of wooded vegetation, however a grassland hazard persists in some areas. Protection of early stages of development, by say temporary APZs should be considered. Further, vegetation introduced into the developed area, such as landscaping, will need to be APZ compliant.

2.1.3.2 Topography

Topographic data is based on a 10 m grid cell Digital Elevation Model (DEM) covering the Wilton Growth Area and surrounding lands out to a distance of 5 km. This data is utilised to analyse slope (Figure 5) and aspect.

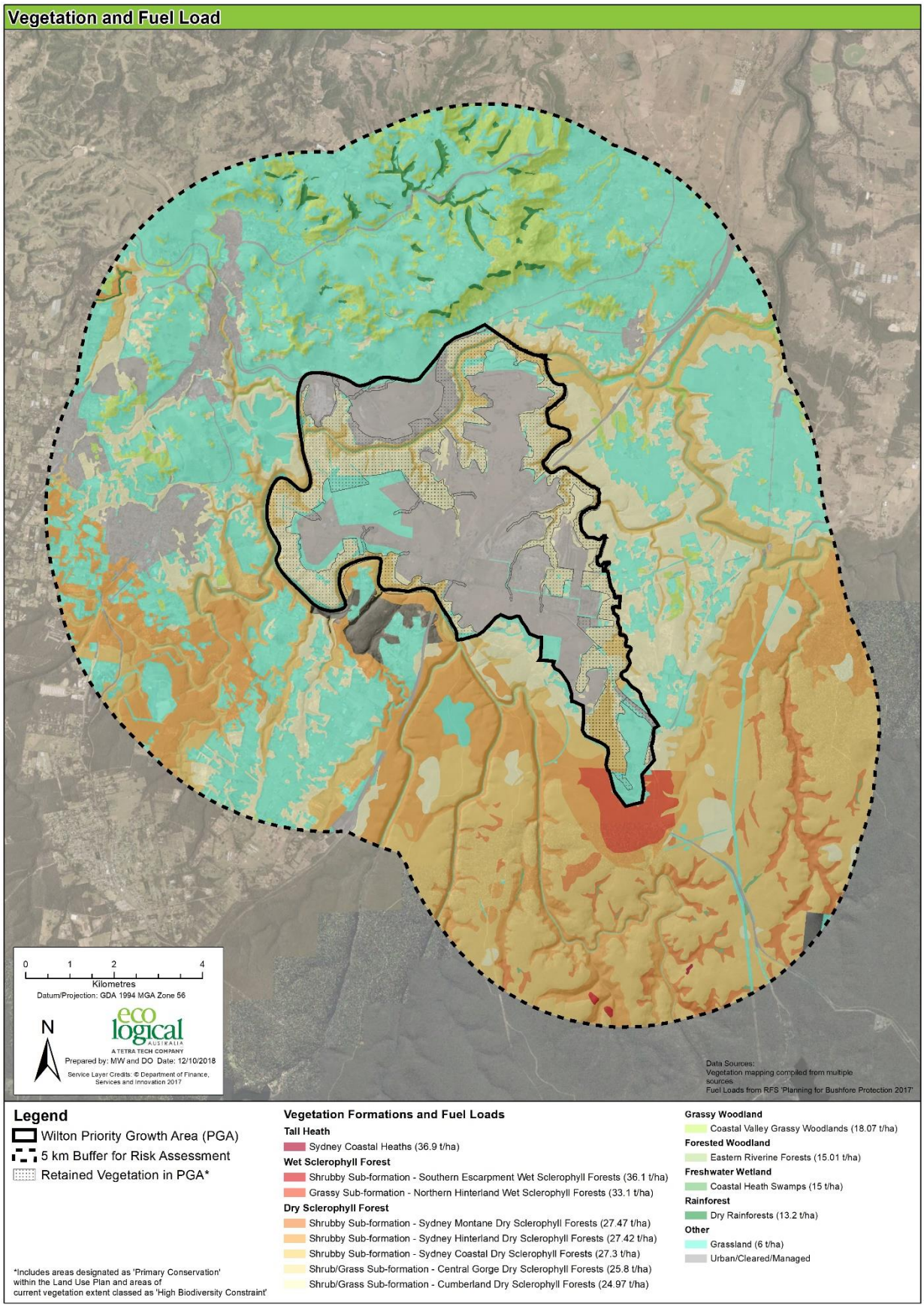

Figure 4: Vegetation and Fuel Loads

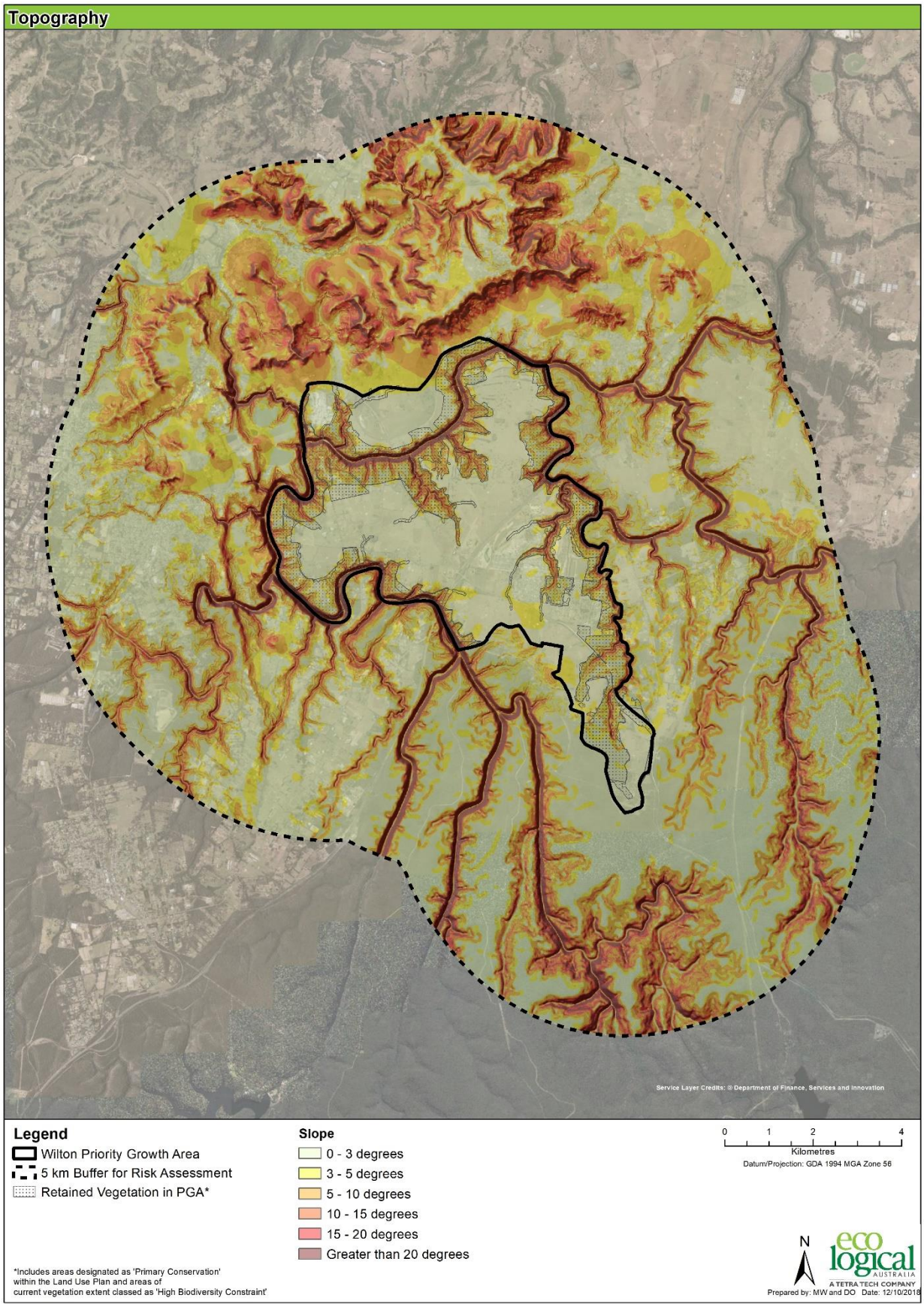

Figure 5: Topography (Slope) of the Study Area

Table 1: Vegetation Formation, Class and Fuel Allocation for the Study

Keith Formation	Keith Class	Overall Fuel (t/ha)*
Rainforest	Dry Rainforests	13.2
Wet Sclerophyll Forests (Grassy)	Northern Hinterland Wet Sclerophyll Forests	33.1
Wet Sclerophyll Forests (Shrubby)	Southern Escarpment Wet Sclerophyll Forests	36.1
Dry Sclerophyll Forests (Shrub/Grass)	Central Gorge Dry Sclerophyll Forests	25.8
	Cumberland Dry Sclerophyll Forests	24.97
Dry Sclerophyll Forests (Shrubby)	Sydney Coastal Dry Sclerophyll Forests	27.3
	Sydney Hinterland Dry Sclerophyll Forests	27.42
	Sydney Montane Dry Sclerophyll Forests	27.47
Woodlands	Coastal Valley Grassy Woodlands	18.07
Forested Wetlands	Eastern Riverine Forests	15.1
Heathlands (Tall Heath)	Sydney Coastal Heaths	36.9
Freshwater Wetlands	Coastal Heath Swamps	15.0
Grasslands	Grasslands	6.0
N/A	N/A	0.0

2.1.3.3 Bushfire Hazard Overview

Surrounding the Wilton Growth Area is a mix of rural, rural-residential, residential and water catchment / conservation lands. When reviewing the landscape context and bushfire hazard of the study area the following observations are made.

To the north, west and south-west are predominately rural lands with small urban - rural/residential villages with surrounding rural lands used predominately for livestock grazing. These lands are dissected by steep river valleys. The rural lands are generally undulating with grassland and grassy woodland vegetation predominating whereas the incised valleys contain mostly forest vegetation.

To the east and south-east are the WaterNSW metropolitan Special Areas, being the water catchment area for Cataract, Cordeaux, Avon and Nepean Dams, the latter is gazetted as Upper Nepean State Conservation Area. Shrubby forest vegetation predominates in these areas across a mix of broad ridgelines and steep incised valleys.

Bushfire hazards are expected to be the greatest in areas of higher fuel loads and on steeper slopes, downhill from development, particularly in areas where there is potential for longer fire runs through contiguous hazard vegetation towards the at-risk asset.

2.1.4 Weather Parameters

The weather parameters utilised for this study arose from the detailed weather analysis undertaken for the Strategic Bushfire Study (ELA 2018). The analysis was of long term weather records (1972-2015) from Sydney Airport Weather Station, the closest weather station available within the National Historical Fire Weather Dataset (Lucas 2010). The weather parameters utilised in this study are shown in Table 2 below.

Table 2: Weather Inputs

	FFDI 116 (SW to N)	FFDI 63 (N to SE)	FFDI 47 (SE to SW)
Wind direction (°)	292.5	45	225
Wind variation (+/- °)	10	10	10
Wind speed (km/hr)	59.4	35.3	40.7
Temperature (°C)	39.2	42.5	29.7
Relative humidity (%)	9	13	10
Drought factor	8.5	8.3	8.2

3. Results

3.1 Part 1 - Bushfire Spread Models

The bushfire spread predictions from the Part 1 model runs for the three bushfire weather scenarios (i.e. SW-N (FFDI 116), N-SE (FFDI 63), and SE-SW (FFDI 47)) are shown in Figure 6, Figure 7 and Figure 8. These three predictions are based on a 4 hour fire spread simulation using the weather conditions (including wind characteristics), the 8 selected ignition locations and other inputs identified in Section 2.

These predictions demonstrate potential bushfire spread to the Wilton Growth Area and surrounds within the 4 hour duration. A summary of the modelled 'Arrival Time' (i.e. the time duration of the model prediction from its start to the time it is modelled to reach the Wilton Growth Area or primary (external) road network) is provided in Table 3.

Table 3: Summary of Part 1 Bushfire Spread Models

Scenario	Arrival Time: Growth Area Boundary	Arrival Time: Primary Roads
1 – N to SE	45 mins	Menangle Road = 45 mins Picton Road = 120 mins
2 – SE to SW	105 mins	Hume Motorway = 120 mins
3 – SW to N	105 mins	Picton Road = 180 mins

It should however be noted that these results summarise the model outputs rather than providing a defined estimate of the required time to refuge or evacuate from a bushfire attack scenario. There are many factors relevant to emergency management decision making and evacuation. Further, there are many potential bushfire attack scenarios and it may not be safe, appropriate or even relevant to trigger offsite evacuation for all.

Safe evacuation is often considered in terms of the Required Safe Evacuation Time (RSET) and Available Safe Evacuation Time (ASET) (ABCB 2005). The RSET should be less than the ASET plus an appropriate factor of safety. The components of RSET can be considered in the following terms: Cue period (i.e. the time to notice or be notified of a cue for action); Response period (i.e. the time from occurrence of a cue to recognition of a need for action); Delay period (i.e. the period following cue recognition to occupant initiation of movement); and Movement period (i.e. the period required to relocate from the origin to destination, noting that increased time may be required due to road closures or other factors) (ABCB 2005). In this regard, additional time beyond the timings presented in Table 3 are required to provide an appropriate timeframe, for the safe relocation of people for either onsite refuge or offsite evacuation.

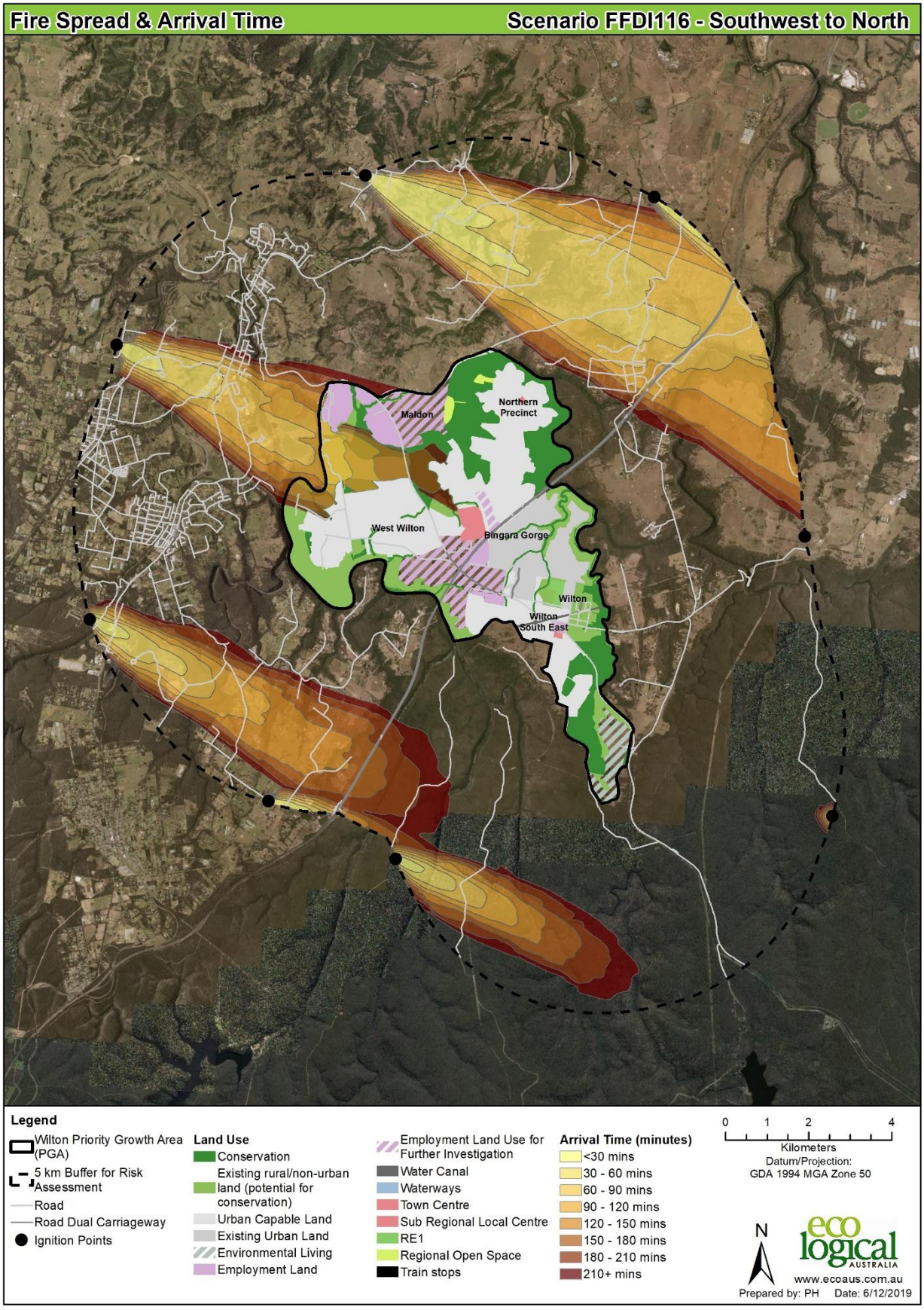

Figure 6: Part 1 - Fire Spread & Arrival Time - FFDI 116 (SW to N)

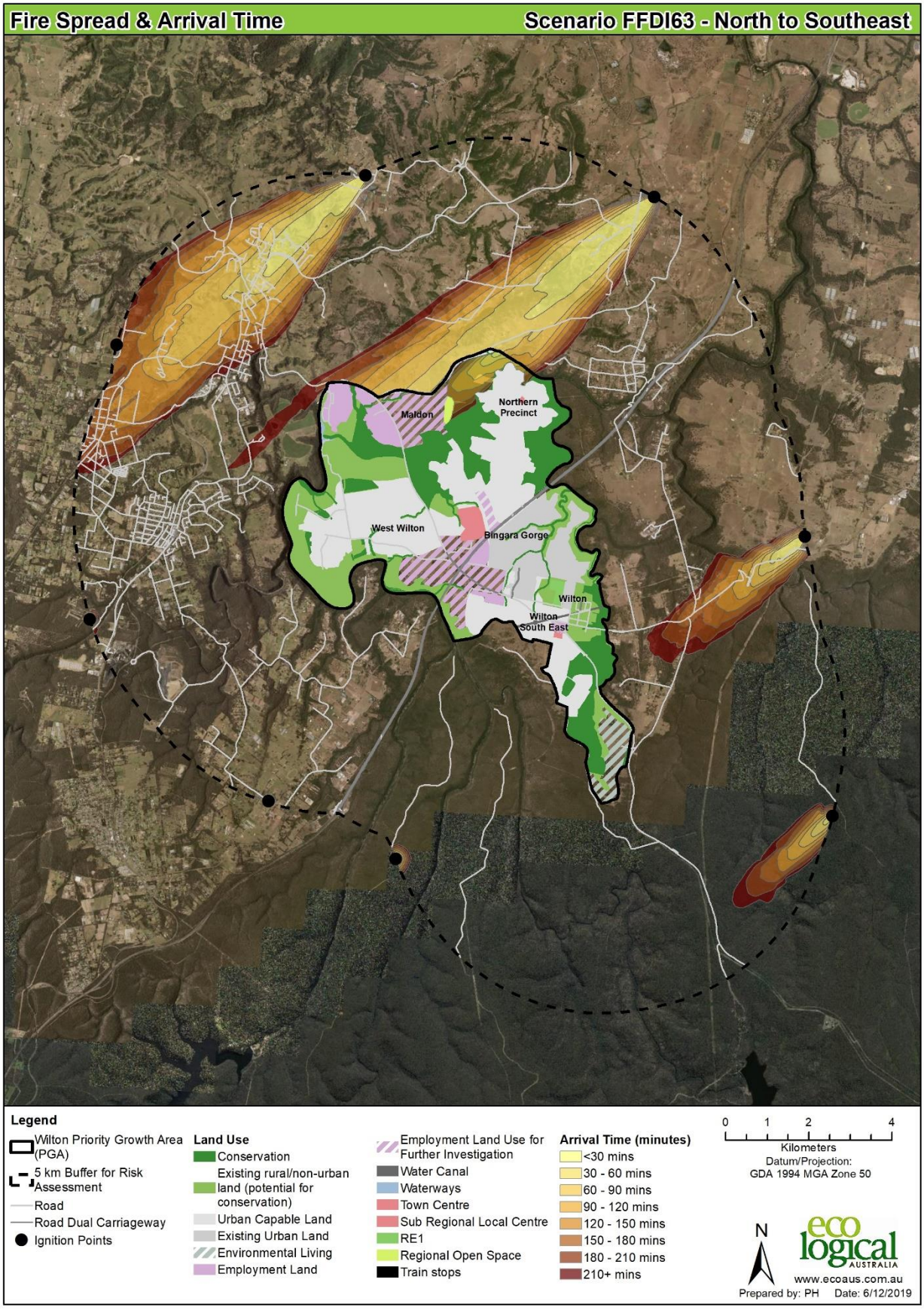

Figure 7: Part 1 - Fire Spread & Arrival Time - FFDI 63 (N to SE)

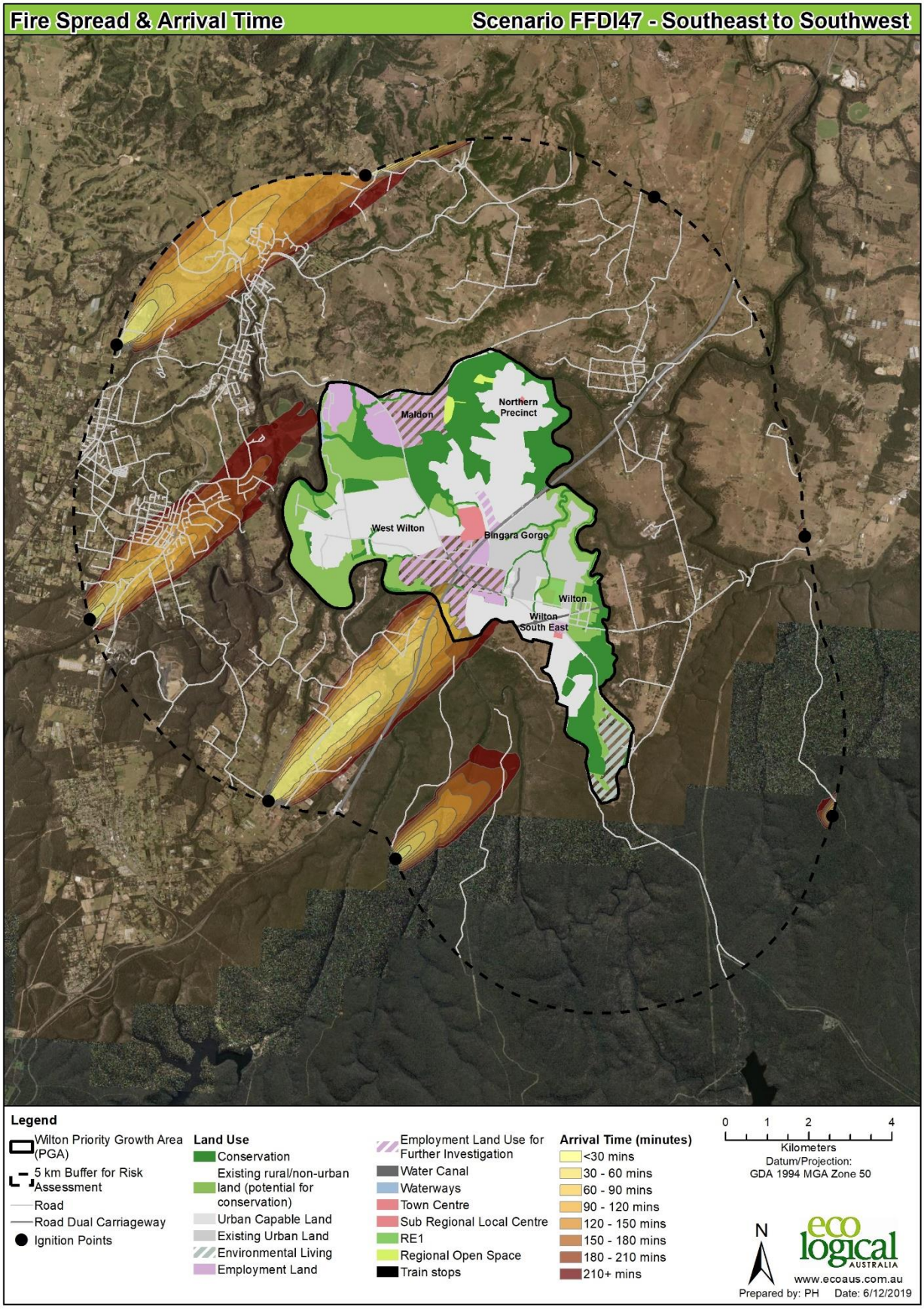

Figure 8: Part 1 - Fire Spread & Arrival Time - FFDI 47 (SE to SW)

3.2 Part 2 – Bushfire Spread Models

The bushfire spread predictions from the Part 2 model runs for the three bushfire weather scenarios (i.e. SW-N (FFDI 116), N-SE (FFDI 63), and SE-SW (FFDI 47)) are shown in Figure 9, Figure 10 and Figure 11. These three predictions are based on a 10 hour fire spread simulation using the weather conditions (including wind characteristics), the ring of ignition locations and other inputs identified in Section 2.

These predictions demonstrate potential bushfire spread to the Wilton Growth Area and surrounds as well as penetration into the retained lands of the Growth Area within the 10 hour duration of the models. A summary of the modelled 'Arrival Time' (i.e. the time duration of the model prediction from its start to the time it is modelled to reach a point of interest) is provided in Table 4, Table 5 and Table 6. These tables identify the potential arrival time for the leading edge of each precinct within Wilton Growth Area as well as fire flanking around the sides of the precincts. A high level analysis of the arrival times to potential internal and external evacuation routes is also provided. High level observations are made relating to offsite evacuation. It is however noted that taking refuge in another part of the Growth Area or refuging within a subject precinct may provide a valid emergency option and should be considered in further planning and development control.

It should however be noted that these results summarise the model outputs rather than providing a defined estimate of the required time to refuge or evacuate from a bushfire attack scenario. There are many factors relevant to emergency management decision making and evacuation. Further, there are many potential bushfire attack scenarios and it may not be safe, appropriate or even relevant to trigger offsite evacuation for all.

Safe evacuation is often considered in terms of the Required Safe Evacuation Time (RSET) and Available Safe Evacuation Time (ASET) (ABCB 2005). The RSET should be less than the ASET plus an appropriate factor of safety. The components of RSET can be considered in the following terms: Cue period (i.e. the time to notice or be notified of a cue for action); Response period (i.e. the time from occurrence of a cue to recognition of a need for action); Delay period (i.e. the period following cue recognition to occupant initiation of movement); and Movement period (i.e. the period required to relocate from the origin to destination, noting that increased time may be required due to road closures or other factors) (ABCB 2005). In this regard, additional time beyond the timings presented in Table 4, Table 5 and Table 6 are required to provide an appropriate timeframe, for the safe relocation of people for either onsite refuge or offsite evacuation.

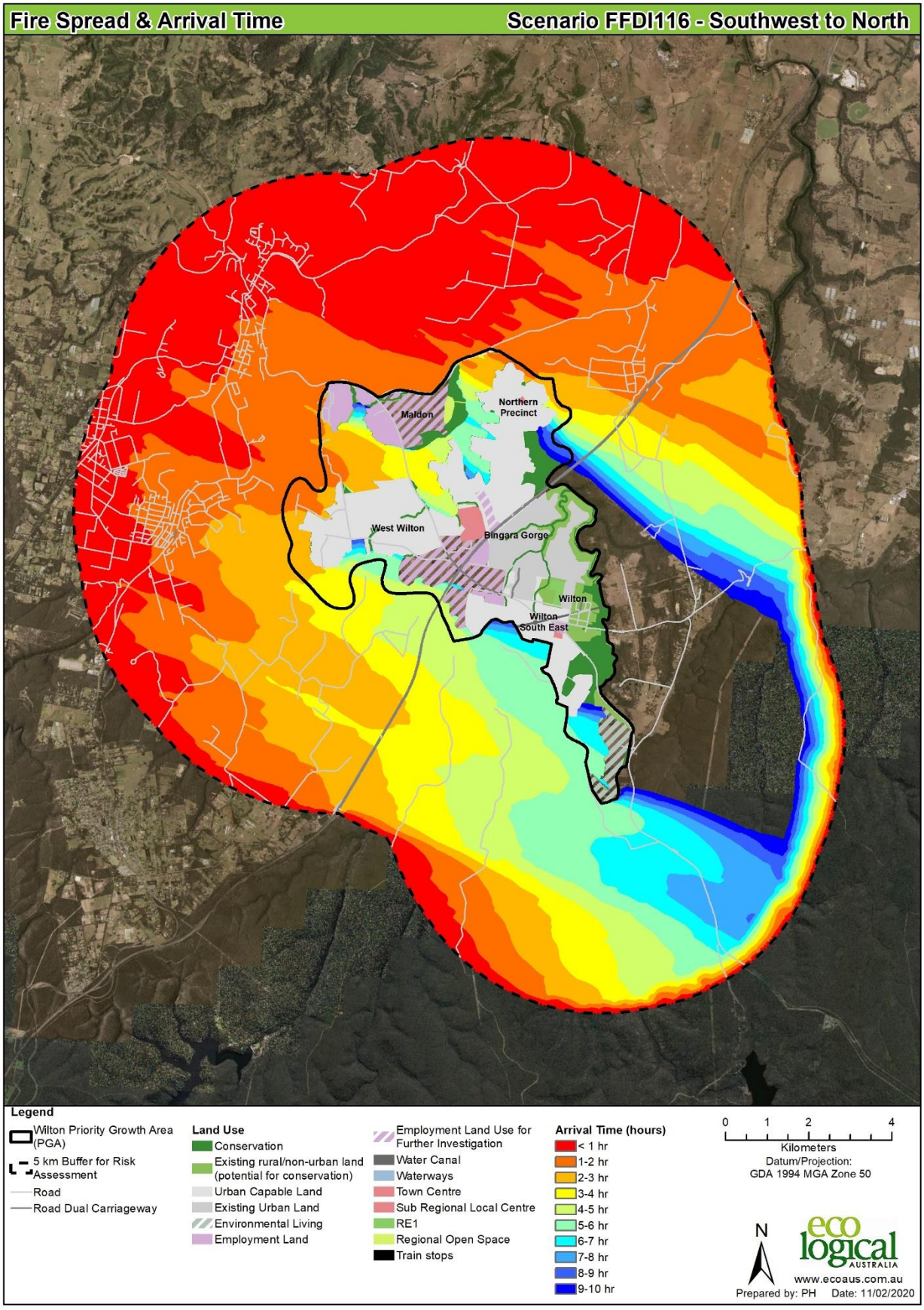

Figure 9: Part 2 - Fire Spread & Arrival Time - FFDI 116 (SW to N)

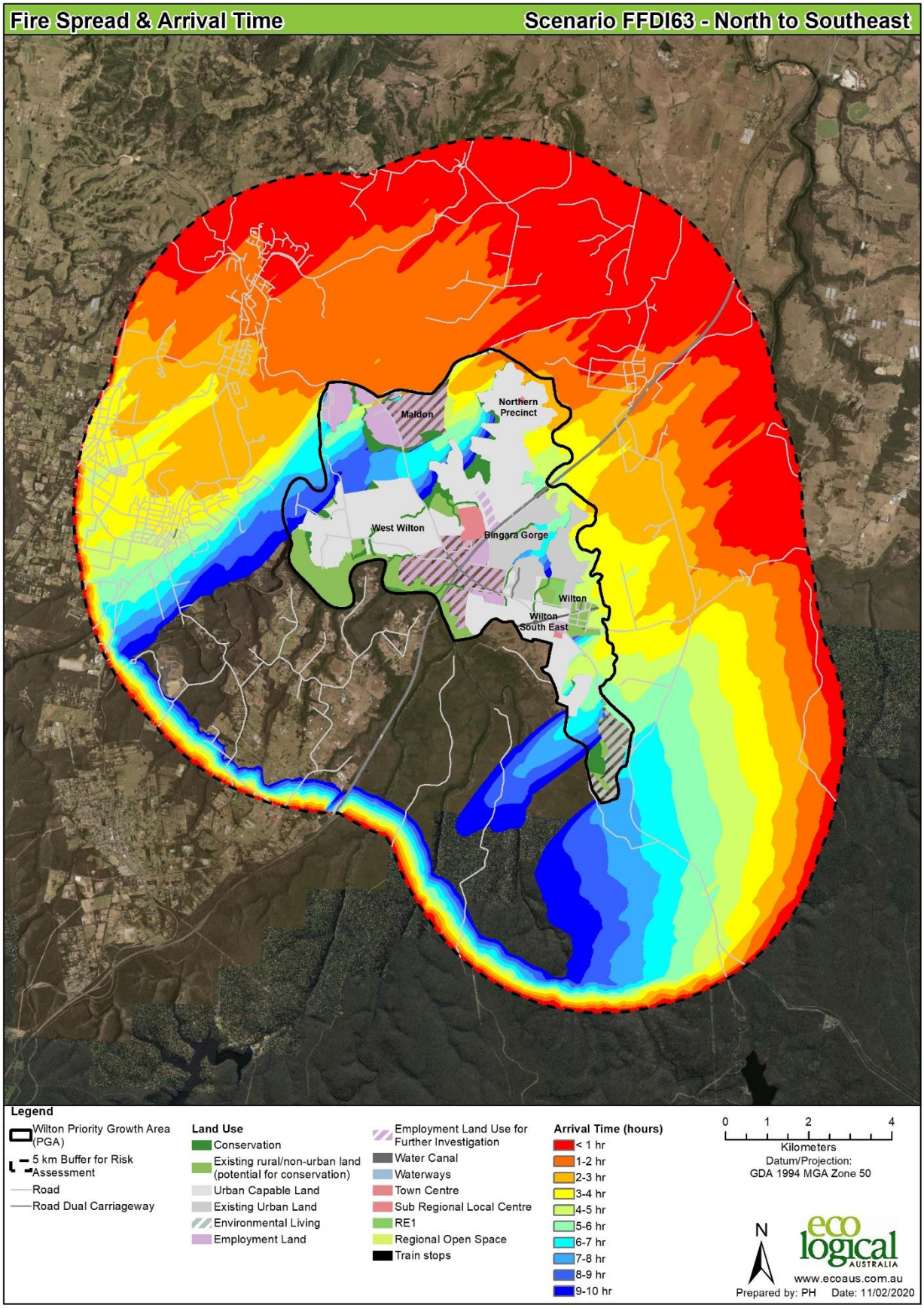

Figure 10: Part 2 - Fire Spread & Arrival Time - FFDI 63 (N to SE)

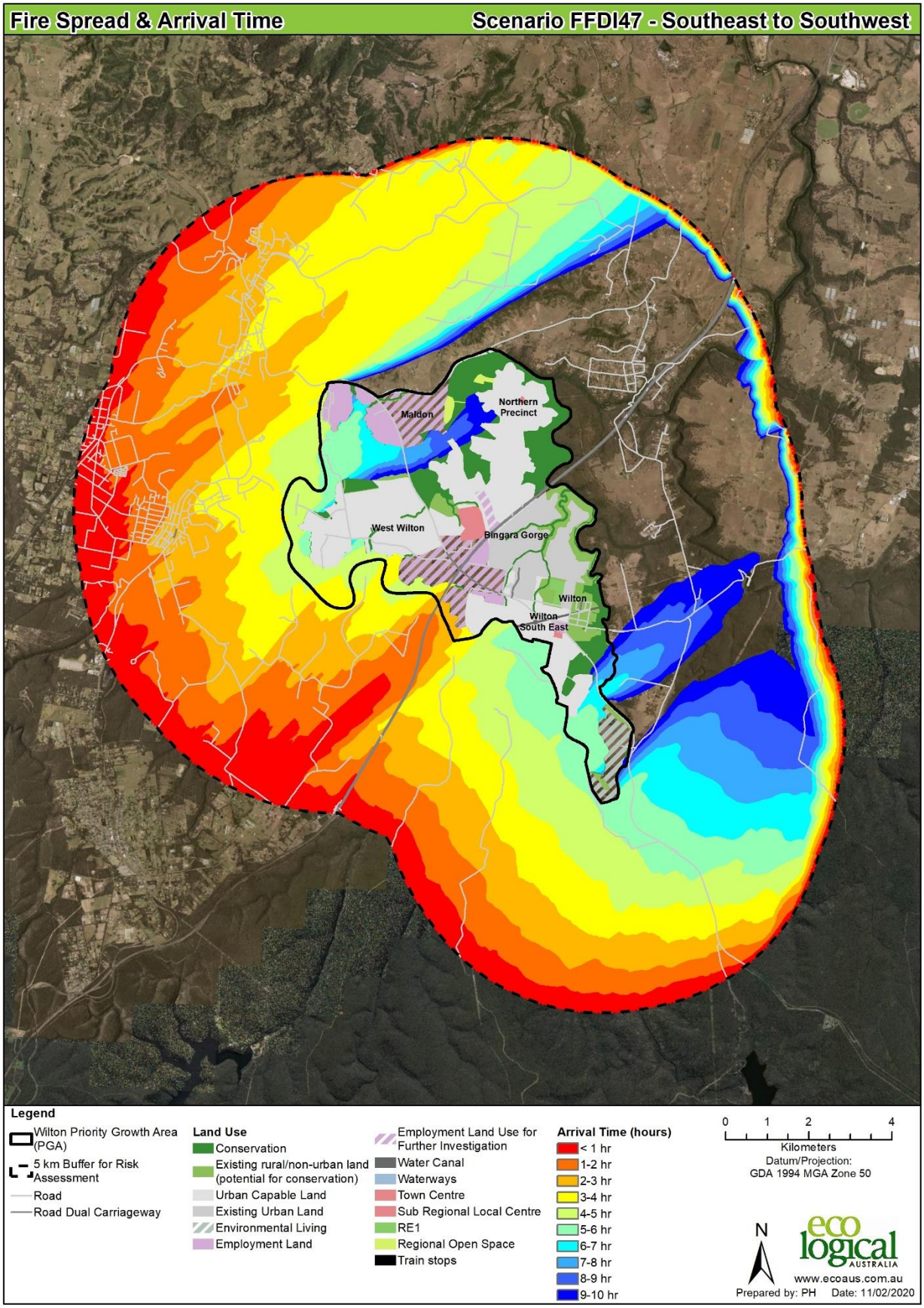

Figure 11: Part 2 - Fire Spread & Arrival Time - FFDI 47 (SE to SW)

Table 4: Summary of Part 2 Bushfire Spread Models - FFDI 116 - Southwest to North

Sub-Precinct	Arrival Time edge of precinct	Arrival Time flanks of precinct	Time when internal evacuation routes out of precinct are cut	Time when external evacuation routes out of precinct are cut	Observations regarding offsite evacuation
	hrs	hrs	hrs	hrs	
Bingara Gorge (A)	00:00:00	00:00:00	00:00:00	01:33:46	Hume Motorway may be cut in both directions, egress to the east.
Bingara Gorge (B)	00:00:00	00:00:00	00:00:00	01:33:46	Hume Motorway may be cut in both directions, egress to the east.
Bingara Gorge (C)	00:00:00	00:00:00	00:00:00	01:33:46	Hume Motorway may be cut in both directions, egress to the east.
Maldon (A)	01:04:20	01:31:38	01:00:04	01:00:04	Picton Road impacted and southern egress into the Growth Area impacted
Maldon (B)	01:01:06	03:19:00	02:48:01	02:48:01	Picton Road impacted and southern egress into the Growth Area impacted
Northern Precinct (A)	03:13:29	03:47:15	00:00:00	01:33:46	Hume Motorway may be cut to the north or in both directions, egress to the east.
Northern Precinct (B)	01:24:21	05:10:19	00:00:00	01:33:46	Hume Motorway may be cut to the north or in both directions, egress to the east.
West Wilton (A)	01:10:22	02:19:44	00:00:00	01:33:46	Hume Motorway may be cut to the south or in both directions, egress to the east.
West Wilton (B)	01:24:09	04:06:53	00:00:00	01:33:46	Hume Motorway may be cut to the south or in both directions, egress to the east.
Wilton	00:00:00	00:00:00	00:00:00	09:30:10	Hume Motorway may be cut in both directions, egress to the east.
Wilton South East (A)	04:50:37	08:03:20	00:00:00	09:30:59	Hume Motorway may be cut to the south or in both directions, egress to the northeast or east.
Wilton South East (B)	05:30:10	07:41:43	00:00:00	09:30:59	Hume Motorway may be cut to the south or in both directions, egress to the northeast or east.
Wilton South East (C)	05:25:19	06:50:20	00:00:00	09:30:59	Hume Motorway may be cut to the south or in both directions, egress to the northeast or east.

*Note that a '0' indicates that the sub-precinct is not impacted within 10 hours of simulation

Table 5: Summary of Part 2 Bushfire Spread Models - FFDI 63 - North to Southeast

Sub-Precinct	Arrival Time edge of precinct	Arrival Time flanks of precinct	Time when internal evacuation routes out of precinct are cut	Time when external evacuation routes out of precinct are cut	Observations regarding offsite evacuation
	hrs	hrs	hrs	hrs	
Bingara Gorge (A)	03:24:52	05:26:35	00:00:00	00:00:00	Egress to the southwest not impacted
Bingara Gorge (B)	06:23:37	08:42:02	00:00:00	00:00:00	Egress to the southwest not impacted
Bingara Gorge (C)	02:12:00	03:43:22	00:00:00	00:00:00	Egress to the southwest not impacted
Maldon (A)	01:03:42	01:53:04	04:57:40	01:05:56	Picton Road and south east egress impacted
Maldon (B)	01:01:30	02:29:12	08:21:53	00:58:17	Picton Road and south east egress impacted
Northern Precinct (A)	00:00:00	06:24:14	00:00:00	00:00:00	Egress to the southwest not impacted
Northern Precinct (B)	01:20:41	03:00:03	00:00:00	00:00:00	Egress to the southwest not impacted
West Wilton (A)	08:49:20	09:16:02	00:00:00	00:00:00	Egress to the southwest not impacted
West Wilton (B)	06:36:03	07:37:22	00:00:00	00:00:00	Egress to the southwest not impacted
Wilton	03:23:30	03:52:35	00:00:00	00:00:00	Egress to the southwest not impacted
Wilton South East (A)	00:00:00	00:00:00	00:00:00	00:00:00	Egress to the southwest not impacted
Wilton South East (B)	03:36:13	05:19:13	00:00:00	00:00:00	Potential loss of egress to/from SE part of precinct
Wilton South East (C)	05:25:01	06:40:15	04:55:55	04:55:55	Egress potentially impacted in all directions

*Note that a '0' indicates that the sub-precinct is not impacted within 10 hours of simulation

Table 6: Summary of Part 2 Bushfire Spread Models - FFDI 47 - Southeast to Southwest

Sub-Precinct	Arrival Time edge of precinct	Arrival Time flanks of precinct	Time when internal evacuation routes out of precinct are cut	Time when external evacuation routes out of precinct are cut	Observations regarding offsite evacuation
	hrs	hrs	hrs	hrs	
Bingara Gorge (A)	00:00:00	00:00:00	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Bingara Gorge (B)	00:00:00	00:00:00	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Bingara Gorge (C)	00:00:00	00:00:00	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Maldon (A)	03:17:36	05:12:43	05:39:13	00:00:00	Egress to the northeast on Menangle Road and Hume Motorway
Maldon (B)	05:50:14	08:01:49	06:56:46	00:00:00	Egress to the northeast on Menangle Road and Hume Motorway
Northern Precinct (A)	03:20:41	05:28:48	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Northern Precinct (B)	07:00:22	07:51:41	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
West Wilton (A)	04:20:15	05:25:32	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
West Wilton (B)	03:22:04	05:53:09	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Wilton	00:00:00	00:00:00	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Wilton South East (A)	01:41:46	03:45:33	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Wilton South East (B)	04:07:19	05:13:36	00:00:00	00:00:00	Egress on the Hume Motorway to the northeast not impacted
Wilton South East (C)	05:33:46	05:46:49	05:48:41	09:33:21	Egress potentially impacted in all directions

*Note that a '0' indicates that the sub-precinct is not impacted within 10 hours of simulation

4. Discussion

4.1 General Considerations

The bushfire modelling outputs of this study are informative rather than determinative. They inform the potential bushfire spread to the precincts, for scenarios similar to those modelled. The variation in potential scenarios is however somewhat limitless, and every possible scenario cannot be modelled, nor do they need to be to achieve the study objectives. The scenarios were chosen to explore bushfire spread relevant to the precincts, in general terms. They are suitable to be utilised to inform appropriate planning and development control responses.

A conservative approach was utilised for the bushfire spread modelling, in order to explore potentially worst case bushfire attack of the Wilton Growth Area. Likely maximum fuel loads were utilised along with likely worst case bushfire weather conditions for each direction of attack. Further, worst case conditions where used, however the Part 2 models used a 10 hour duration of simulation, whereas worst case conditions would unlikely be sustained for that length of time.

The bushfire weather conditions utilised, were determined by analysis of long term weather records (1972-2015) from the closest weather station available within the National Historical Fire Weather Dataset (Lucas 2010). Maximum values from the 1:50 return period analysis were utilised for each direction and in the case of attack from the western direction, the values utilised exceed that utilised by PBP. Further, research by Douglas and He (2019) indicates that the values used in this study represent a reasonable estimate of potential future fire weather conditions under climate change. Given the above, it is considered that the modelling has been undertaken with a reasonable degree of conservatism.

As with any modelling exercise however, the results are limited by the modelling process and the data utilised to generate the models. Pertinent limitations of this study are the input data utilised, including the ignition points; along with the parameters utilised for the scenarios. Whilst these limitations are important to recognise, the application of the modelling methodology in a consistent, logical, transparent and repeatable manner provided outcomes that are fit for purpose.

4.2 Risk Context

It is also relevant to consider the context of the study area and how that influences bushfire risk exposure. Bushfire attack within the region is primarily under the influence of hot and dry conditions, with winds typically from the westerly direction (ELA 2018). A southerly change following these conditions can also pose elevated risk. Significant bushfire attack is often not experienced from easterly orientated winds however less significant attack from these directions is still possible and could present an emergency situation.

The Wilton Growth Area is surrounded by a mixture of land uses (ELA 2018), which provide different bushfire hazard context. To the west there is a mixture of mostly agricultural, rural-residential as well as residential land uses. There is also unmanaged wooded vegetation in pockets, linear corridors as well as conservation and water catchment lands further afield (west of Picton). The land uses to the south are primarily agricultural, rural-residential as well as conservation and water catchment lands. The later adjoins the southern part of the Wilton Growth Area. To the north, land uses are primarily agricultural and rural-residential with unmanaged vegetation in river valleys, some adjoining Wilton Growth Area.

The bushfire hazard of primary concern is unmanaged wooded vegetation, however grassland vegetation can also pose a risk as well as a vector to transfer fire between pockets of unmanaged wooded vegetation. Given the context of potential bushfire attack outlined above, and the bushfire hazard upwind from these directions, the risk profile varies for different parts of the Wilton Growth Area. The risk profile for each precinct is further explored in Section 4.3.

In a relative and wholistic sense, compared to some areas of existing development in other locations in NSW, the Wilton Growth Area, once developed, is considered to have a somewhat reduced bushfire risk context. This is due to a number of factors including: the fragmented nature of the bushfire hazard in the north to south-west sector and the vegetative hazard being mostly grassland on undulating terrain, rather than wooded vegetation on steep slopes; in combination with increased observability of ignitions and better access for rapid response, due to the landscape character, terrain and access network. Further, given the contemporary bushfire requirements that apply to bushfire prone land and the current stage of planning, future development should be able to incorporate an appropriate suite of bushfire protection measures as per the requirements of PBP (RFS 2019).

Of note, the significant bushfires that burnt through extensive areas of Blue Mountains and Nattai National Parks and the Warragamba Special Area in the summer of 2019-2020, did not extend far from the areas of wooded vegetation in most cases. Despite burning under significant bushfire weather conditions and during a season where fire fighting resources were incredibly stretched, these bushfires did not reach the Wilton Growth Area (Figure 12). Further, whilst these bushfires caused significant impact to some existing suburbs, such as Balmoral (Wollondilly Advertiser 2020) the level of impact was likely influenced by the high landscape scale exposure and the likely lack of adequate bushfire protection measures afforded the suburb holistically as well as individual properties within it. These factors will not apply to future development in the Wilton Growth Area, as it has a different landscape scale exposure, and both the precincts and individual properties, will be required to provide an appropriate suite of bushfire protection measures, as per current legislative requirements.

4.3 Precinct Risk Assessment

To better understand the risk profile of each precinct after undertaking the bushfire scenario modelling, a high level risk assessment has been undertaken, and is presented below. This has been informed by the results and findings of this study as well as the bushfire intensity modelling (Figure 13), fire scenario assessments and other background detailed in the Strategic Bushfire Study (ELA 2018). It has been undertaken on the basis that future development within the Wilton Growth Area will provide an appropriate suite of bushfire protection measures that address the performance requirements of PBP.

The assessment provided throughout this Section and summarised in Tables 7, 8, 9 and 10 assesses the risks from bushfire to people and property (infrastructure, assets, private property) within the precincts. The methodology adopted is that given in AS/NZS 31000:2018 ‘Risk management – Principles and guidelines’ whereby a risk classification scheme is developed through qualitative scales of likelihood and of consequence.

This assessment adopts a definition of likelihood based on likelihood of occurrence in perpetuity. The scale of likelihood is shown below and is based on AS/NZS ISO 31000. Values have been allocated to the likelihood descriptors on a scale of 1 to 5 with 1 being extremely rare (extremely unlikely) and 5 being almost certain, as outlined in Table 7.

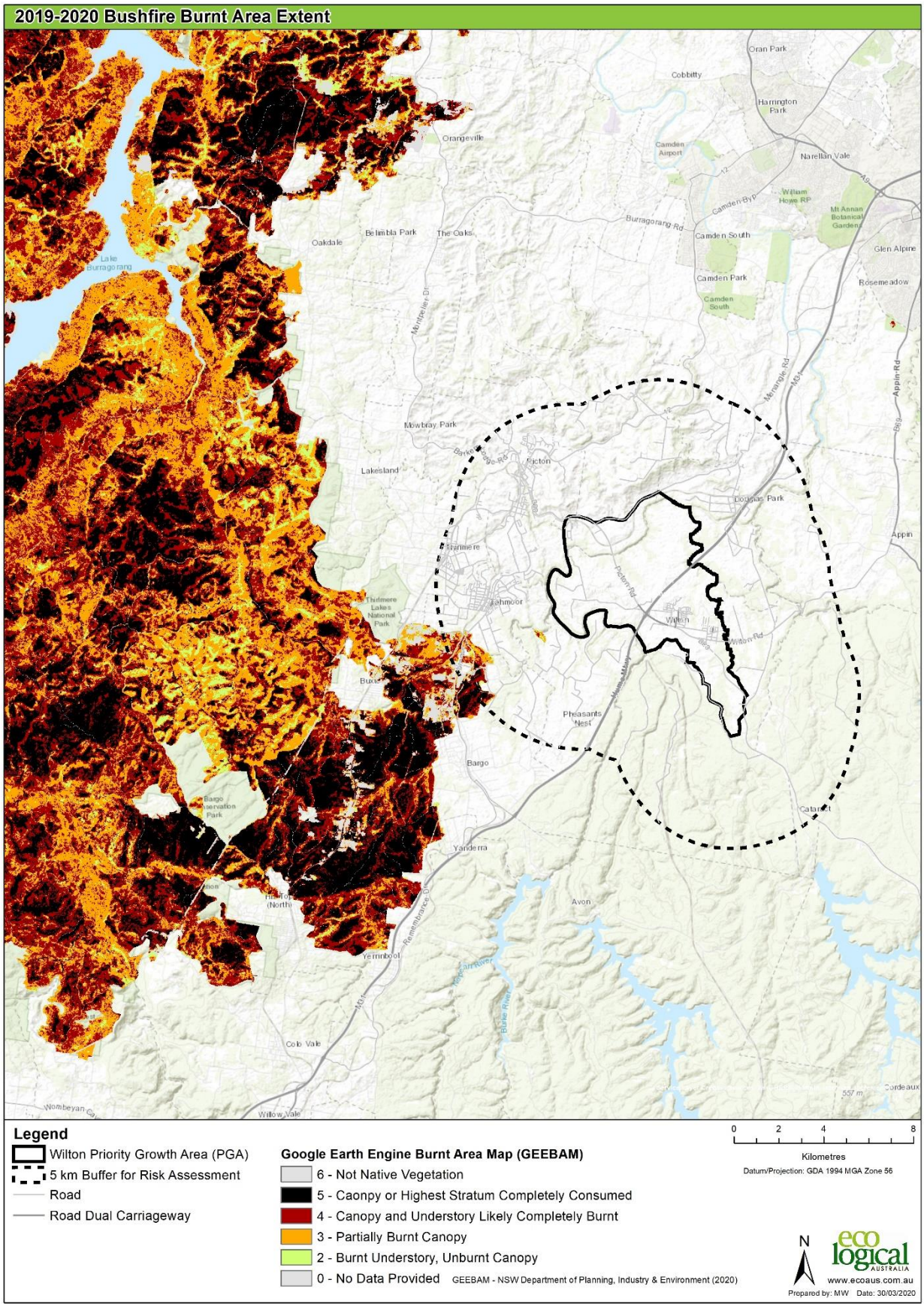

Figure 12: Extent of 2019-2020 Bushfires (DPIE 2020)

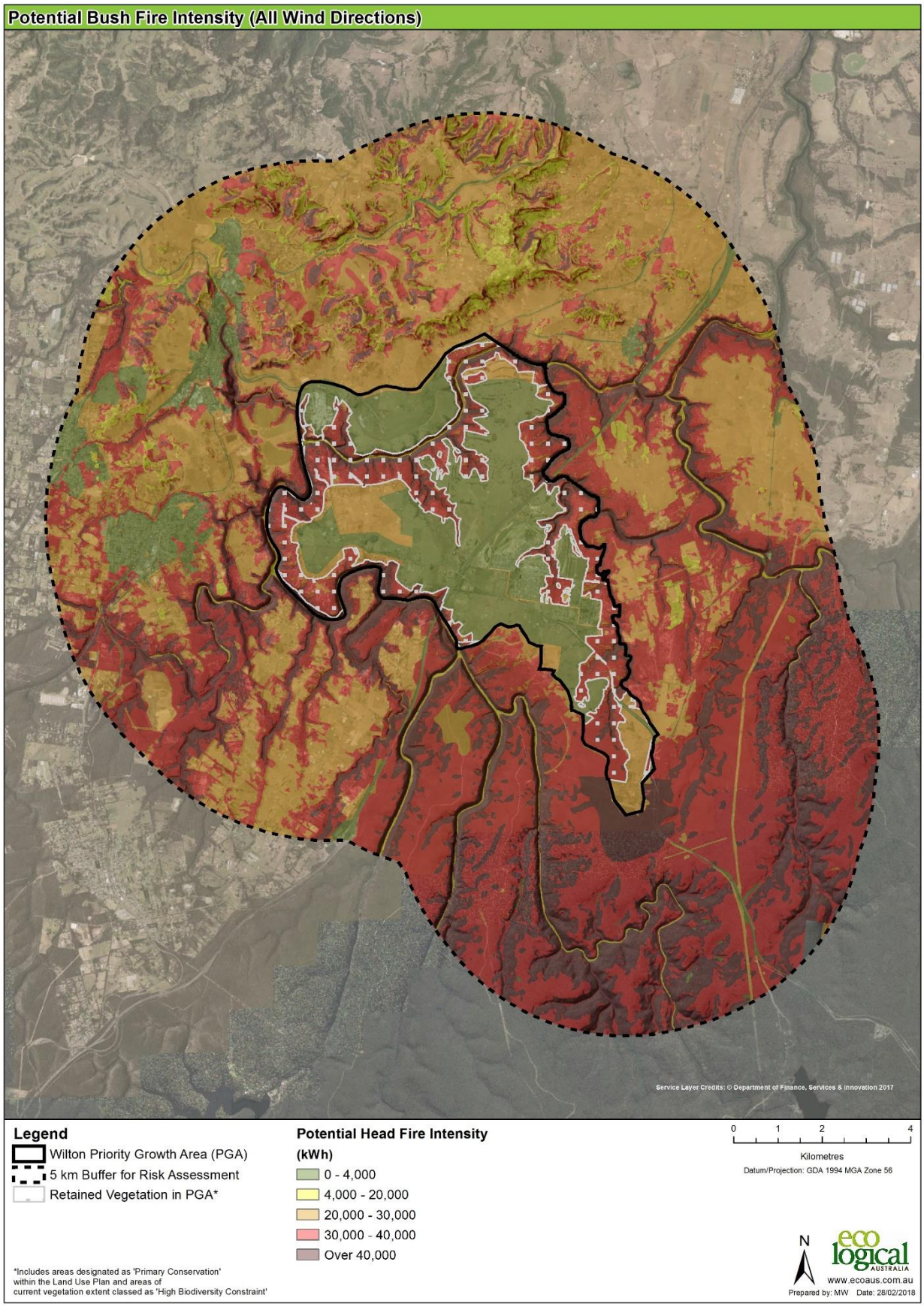

Figure 13: Bushfire Intensity Modelling (ELA 2018)

Table 7: Likelihood Description

Likelihood Descriptor	Description
Almost certain (5)	The event is expected to occur
Likely (4)	The event will probably occur
Possibly (3)	The event might occur at some time
Unlikely (2)	The event could occur at some time
Rare (1)	The event may occur in exceptional circumstances

The scale of consequence is shown below. Values have been allocated to the consequence descriptors on a scale of 1 to 5 as outlined in Table 8 below.

Table 8: Consequence Description

Consequence Descriptor	Description
Catastrophic (5)	Widespread death and injury, huge financial loss, irreversible widespread environmental damage
Major (4)	Extensive injury or limited death, major financial loss, irreversible local environmental damage
High (3)	Injury requiring medical treatment, high financial loss, Long-term environmental damage
Medium (2)	First aid, medium financial loss, Short-term environmental damage
Low (1)	No injuries, low financial loss, minor environmental impact

Rating codes and the level of risk have been then calculated by multiplying likelihood levels and consequence levels with the rating determined as per the scale outlined in Table 9 below.

Table 9: Risk Rating

Level of risk	Risk rating
0 - 4	Insignificant
5 - 9	Minor
10 - 14	Moderate
15 - 19	Major
20 - 25	Extreme

The risk assessment for each of the precincts is presented in Table 10. Precincts with a higher risk ranking does not necessarily preclude them from future development. Rather, those precincts assessed with a higher risk ranking require more careful planning of land use and infrastructure along with emergency management provision. Risk management options are discussed further in Section 4.4.

Table 10: Bushfire Risk Assessment – Wilton Growth Area Precincts

Precinct	Likelihood (A)	Consequence (B)	Level of risk (A x B)	Risk Rating	Notes
Bingara Gorge (A)	3	3	9	Minor	Only exposed to the northeast, which is considered a lower risk direction for bushfire in terms of likelihood and consequence. Limited amount of direct exposure to larger areas of bushfire hazard. Narrow areas of hazard within riparian zones protrude into the precinct. Bushfire protection measures, on-precinct or nearby refuge options, and off-site evacuation should be able to be adequately provided.
Bingara Gorge (B)	3	3	9	Minor	Only exposed to the northeast, which is considered a lower risk direction for bushfire in terms of likelihood and consequence. Limited amount of direct exposure to larger areas of bushfire hazard. Narrow areas of hazard within riparian zones protrude into the precinct. Bushfire protection measures, on-precinct or nearby refuge options, and off-site evacuation should be able to be adequately provided.
Bingara Gorge (C)	3	4	12	Moderate	Only exposed to the northeast, which is considered a lower risk direction for bushfire in terms of likelihood and consequence. Moderate amount of direct exposure to larger areas of bushfire hazard. Narrow areas of hazard within riparian zones protrude into the precinct. Potential restrictions to provision of on-precinct or nearby refuge options, and off-site evacuation, which should be planned carefully.
Maldon (A)	4	3	12	Moderate	Exposed to the north and west, which are considered higher risk directions for bushfire attack in terms of likelihood and consequence. However, the vegetative hazard is mostly grassland on undulating topography, along with fuel breaks due to existing developed areas and roads, all of which reduces the risk. Narrow areas of hazard within riparian zones protrude into the precinct. Bushfire protection measures and on-precinct refuge options should be able to be adequately provided However, this is countered by potentially short time to arrival from bushfire attack and restrictions on off-site evacuation.
Maldon (B)	4	3	12	Moderate	Exposed to the north, which is considered a higher risk direction for bushfire attack in terms of likelihood and consequence. However, the vegetative hazard is mostly grassland on undulating topography, along with fuel breaks due to existing developed areas and roads, all of which reduces the risk. Narrow areas of hazard within riparian zones protrude into the precinct. Bushfire protection measures and on-precinct refuge options should be able to be adequately provided However, this is countered by potentially short time to arrival from bushfire attack and restrictions on off-site evacuation.

Precinct	Likelihood (A)	Consequence (B)	Level of risk (A x B)	Risk Rating	Notes
Northern Precinct (A)	4	4	16	Major	Exposed to the north and west, which are considered higher risk directions for bushfire attack in terms of likelihood and consequence. The vegetative hazard is wooded vegetation on steep slopes and the hazard is found on three sides of a narrower precinct, which increases the risk. Narrow areas of hazard within riparian zones protrude into the precinct. Bushfire protection measures should be able to be adequately provided. However, there may be restrictions to on-precinct refuge options and off-site evacuation, which should be planned carefully.
Northern Precinct (B)	4	3	12	Moderate	Exposed to the west, north and east, the former of which, are considered higher risk directions for bushfire attack in terms of likelihood and consequence. The vegetative hazard is wooded vegetation on steep slopes and the hazard is found on three sides of the precinct, which increases the risk. Potential landscape scale exposure is lessened to much of the precinct, which moderates the risk. Bushfire protection measures, on-precinct refuge options and off-site evacuation should be able to be adequately provided for this larger precinct.
West Wilton (A)	4	3	12	Moderate	Exposed to the northwest to southwest, which are considered higher risk directions for bushfire attack in terms of likelihood and consequence. The vegetative hazard adjoining the precinct is wooded vegetation on steep slopes and the hazard is found on three sides of the precinct, which increases the risk. Potential landscape scale exposure is lessened however by fuel breaks due to existing developed areas and roads, which moderates the risk. Bushfire protection measures, on-precinct refuge options and off-site evacuation should be able to be adequately provided for this larger precinct.
West Wilton (B)	4	3	12	Moderate	Exposed to the northwest to southwest, which are considered higher risk directions for bushfire attack in terms of likelihood and consequence. The vegetative hazard adjoining the precinct is wooded vegetation on steep slopes and the hazard is found on three sides of the precinct, which increases the risk. Narrow areas of hazard within riparian zones protrude into the precinct. Potential landscape scale exposure is lessened however by fuel breaks due to existing developed areas and roads, which moderates the risk. Bushfire protection measures, on-precinct refuge options and off-site evacuation should be able to be adequately provided for this larger precinct.
Wilton	3	3	9	Minor	Exposed to the northwest, but only a limited amount of direct exposure, which moderates the risk. Narrow areas of hazard within riparian zones protrude into the precinct. Bushfire protection measures, on-precinct or nearby refuge options, and off-site evacuation should be able to be adequately provided.

Precinct	Likelihood (A)	Consequence (B)	Level of risk (A x B)	Risk Rating	Notes
Wilton South East (A)	4	3	12	Moderate	Exposed to the southwest to southeast, the former which is considered a higher risk direction for bushfire attack in terms of likelihood and consequence. The vegetative hazard adjoining the precinct is wooded vegetation on steep slopes connected to extensive landscape hazard to the south, which increases the risk. The hazard is only found on one side of the precinct, which moderates the risk. Bushfire protection measures, on-precinct or nearby refuge options and off-site evacuation should be able to be adequately provided for this precinct.
Wilton South East (B)	4	4	16	Major	Exposed to the southwest to southeast, the former which is considered a higher risk direction for bushfire attack in terms of likelihood and consequence. The vegetative hazard adjoining the precinct is wooded vegetation on a mix of plateaus and steep slopes, connected to extensive landscape hazard to the south, which increases the risk. The hazard is only found on one side of the precinct, which moderates the risk. Bushfire protection measures, on-precinct or nearby refuge options and off-site evacuation may be restricted in some locations of this precinct, particularly the far south east, which should be planned very carefully.
Wilton South East (C)	5	4	20	Extreme	Exposed to the west through to northeast, the former which is considered a higher risk direction for bushfire attack in terms of likelihood and consequence. The primary vegetative hazard adjoining the precinct is wooded vegetation, connected to extensive landscape hazard in most directions, which significantly increases the risk. Bushfire protection measures, on-precinct or nearby refuge options and off-site evacuation may be restricted for this precinct. Future development of this precinct should be planned very carefully.

4.4 Bushfire Risk Mitigation Options

The mitigation of bushfire risk for land development is generally considered in terms of the bushfire protection measures detailed in PBP, along with the prescribed performance requirements. The bushfire protection measures of PBP are shown in Figure 14.

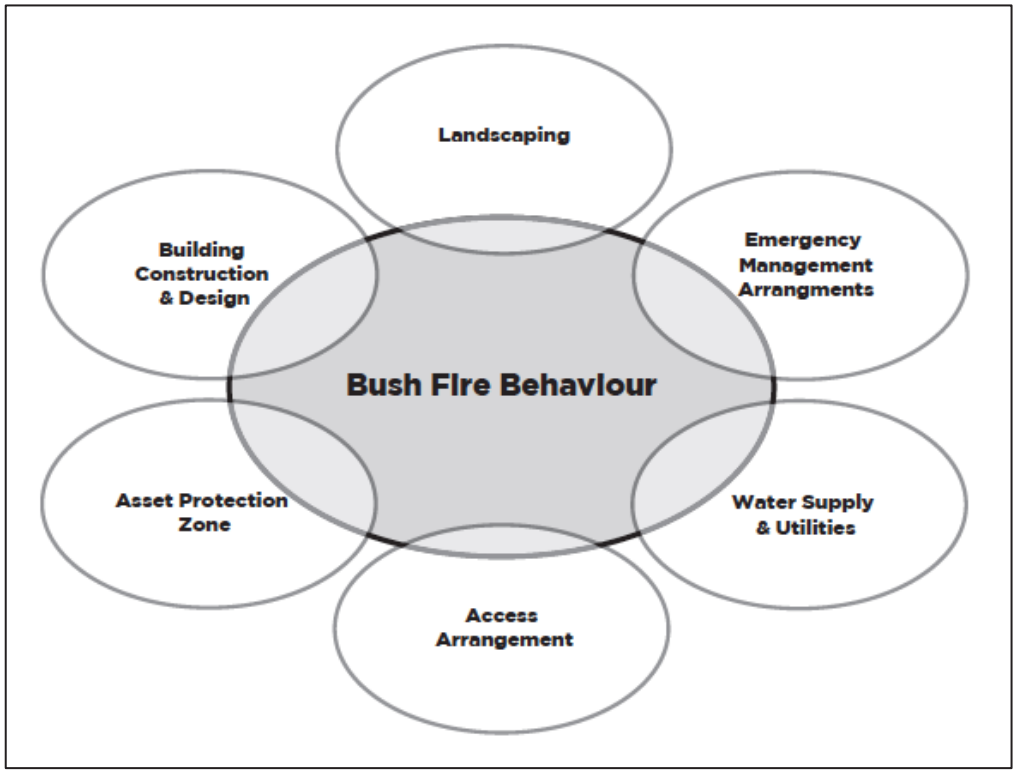

Figure 14: Bushfire Protection Measures (RFS 2019)

The application of these bushfire protection measures is a requirement for all land development proposed on a bushfire prone land. Whilst they do not provide for complete removal of bushfire risk, they can significantly reduce it.

The staging of land development and the provision of bushfire protection measures for the stages should also be considered, such that appropriate protection is afforded development as it proceeds, and prior to completion of development for say an entire precinct. Further, the planning of infrastructure for a precinct needs to consider any dependencies that other precincts may have, on the infrastructure within the subject precinct, as well as the staging of that infrastructure.

4.4.1 Shelter, Refuge and Evacuation Options

With regard to emergency management, there are a number of options available. The order of priority that they should be considered is as follows:

- Offsite evacuation, provided it is safe to do so
- Take refuge in a dedicated refuge location/building within the precinct or in a neighbouring precinct, provided that it can be safely accessed. Figure 15 shows an indicative assessment (ELA 2018) of those areas that may be suitable for the provision of an Open Space or Building

Neighbourhood Safer Place (NSP). The provision, or safe access to, an NSP should be considered in future planning of each precinct.

- Take shelter within the closest and best available building or private residence. This is the lowest priority, particularly for unprepared properties or those that are less defendable, and for more vulnerable persons. It should be noted that this option provides the lowest chance of survivability out of the three options.

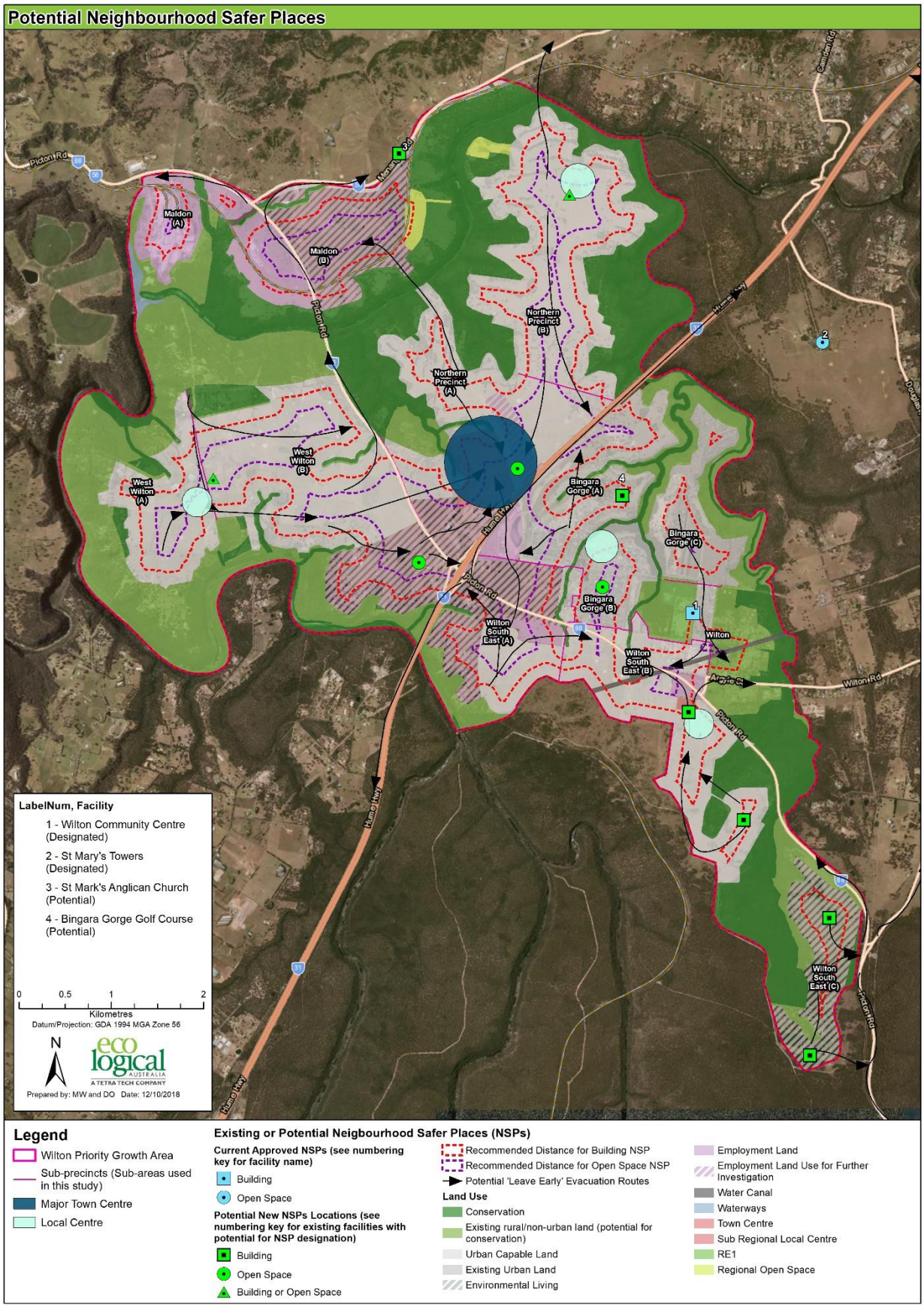

Figure 15: Neighbourhood Safer Place Analysis (ELA 2018)

5. Conclusions and Recommendations

This study has presented a bushfire spread modelling exercise relevant to the Wilton Growth Area. The results are presented and then discussed in terms of the bushfire risk context and a bushfire risk assessment for each precinct is presented. Both of these outputs should be used to inform future planning and development control within Wilton Growth Area and the individual precincts.

The staging of future development, including the provision of critical infrastructure and the removal of bushfire hazards from earlier stages, is a key consideration. Egress options for movement within and away from Wilton Growth Area, need to be carefully planned to ensure they have adequate capacity, assuming alternate options may be unavailable, and would be safe to use during a bushfire emergency.

Conclusions and recommendations of the study include:

- The results of the study are informative and need to be considered in light of the emergency management options available to occupants of the area, as well as the level of protection that will be afforded to them, through the incorporation of bushfire protection measures as per the requirements of PBP and building constructions standards as per AS 3959.
- The results of the bushfire spread models demonstrate potential bushfire spread to the Wilton Growth Area and surrounds as well as penetration into the retained lands of the Growth Area. The 'Arrival Time' summaries presented should be used conservatively, and it should be noted that these results summarise the model outputs, rather than providing a defined estimate of the required time to safely refuge or evacuate from a bushfire attack scenario.
- The required time to safely refuge or evacuate should be considered in terms of the sum of the: Cue; Response; Delay; and Movement periods. Further, a factor of safety should be considered when evaluating the required time against available time. As such, additional time beyond the arrival times presented in the results, are required to provide an appropriate timeframe, for the safe relocation of people for either onsite refuge or offsite evacuation.
- There are many potential bushfire attack scenarios and it may not be safe, appropriate or even relevant to trigger offsite evacuation for all of them. Taking refuge in another part of the Growth Area or refuging within a subject precinct, may provide a valid emergency option and should be considered in further planning and development control.
- In a relative and wholistic sense, compared to some areas of existing development in other locations in NSW, the Wilton Growth Area is not considered to have a significantly high bushfire risk context.
- Precincts with higher bushfire risk exposure (than the other precincts) include Wilton South East (B) & (C) and the Northern Precinct (A).
- Planning and development control should be carefully considered, for future development of these higher risk precincts, and any others where the provision of adequate bushfire protection measures, on-precinct or nearby refuge options and off-site evacuation may be restricted.
- The application of bushfire protection measures is a requirement for all land development proposed on bushfire prone land. Appropriate protection should also be afforded individual development stages. Further, the planning of infrastructure for a precinct needs to consider any dependencies that other precincts may have, on the infrastructure within the subject precinct, as well as the staging of that infrastructure.

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