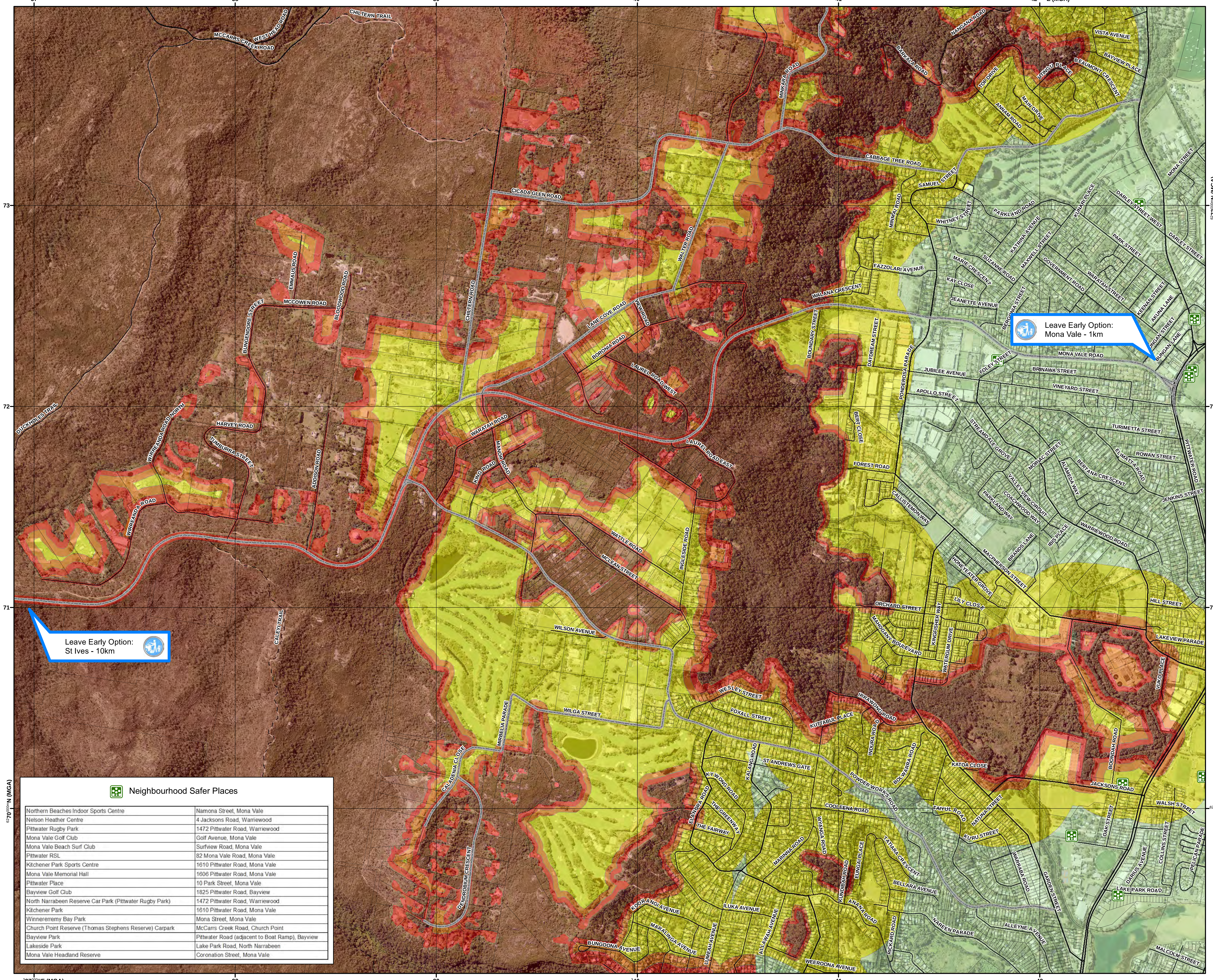
Bush Fire Survival Map

Elanora Heights & Ingleside (Sth)



Northern Beaches Indoor Sports Centre	Namona Street, Mona Vale
Nelson Heather Centre	4 Jacksons Road, Warriewood
Pittwater Rugby Park	1472 Pittwater Road, Warriewood
Mona Vale Golf Club	Golf Avenue, Mona Vale
Mona Vale Beach Surf Club	Surfview Road, Mona Vale
Pittwater RSL	82 Mona Vale Road, Mona Vale
Kitchener Park Sports Centre	1610 Pittwater Road, Mona Vale
Mona Vale Memorial Hall	1606 Pittwater Road, Mona Vale
Pittwater Place	10 Park Street, Mona Vale
Bayview Golf Club	1825 Pittwater Road, Bayview
North Narrabeen Reserve Car Park (Pittwater Rugby Park)	1472 Pittwater Road, Warriewood
Kitchener Park	1610 Pittwater Road, Mona Vale
Winnererremy Bay Park	Mona Street, Mona Vale
Church Point Reserve (Thomas Stephens Reserve) Carpark	McCarrs Creek Road, Church Point
Bayview Park	Pittwater Road (adjacent to Boat Ramp), Bayview
Lakeside Park	Lake Park Road, North Narrabeen
Mona Vale Headland Reserve	Coronation Street, Mona Vale

What is Your Bush Fire Threat?

Flame Impact
You and your property are likely to be directly impacted by flame, deadly levels of radiant heat, significant embers and smoke from a bush fire. The risk of death and property destruction from bush fire is greatest in this area. Leaving early is your safest option.

Radiant Heat Impact
You and your property are likely to be impacted by deadly levels of radiant heat, significant embers and smoke from a bush fire. You and your property must be well prepared if you choose to stay and defend.

Ember Impact
You and your property are likely to be impacted by lower levels of radiant heat, significant embers and smoke from a bush fire. You and your property must be well prepared if you choose to stay and defend.

Be Aware
Embers can cause fires kilometres from the main fire and can impact on houses up to one hour before the fire arrives and several hours after the fire has passed. It only takes one ember to ignite your house and property. Ensure that you and your property are well prepared and monitor your property carefully during a bush fire.

Extreme Fire Danger Rating. Information provided on this map is not to be used for building / planning purposes.

A well designed and prepared building will provide more protection against bush fire.

Neighbourhood Safer Place
Neighbourhood Safer Places are a ***Place of Last Resort*** during a bush fire. Have you identified a Neighbourhood Safer Place and Other Safer Locations in your Bush Fire Survival Plan?

See attached List.

Main Road
Roads may become impassable during a bush fire Your safest option is to Leave Early.

Leave Early
Leaving early means leaving LONG before a bush fire is in your area. On days of Catastrophic fire danger you should leave early in the morning or even the night before.

Your Bush Fire Survival Options

Know the Fire Danger Rating

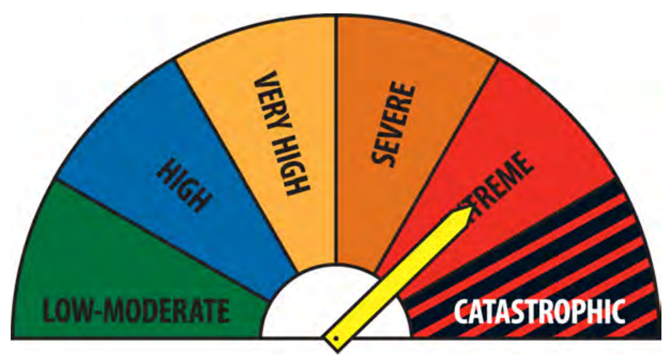
Leave Early

or

Stay and Defend a Well Prepared Property

Have a Back Up Plan !

Stay informed about local fire conditions. Check the NSW RFS website or listen to the local emergency radio broadcaster for information on the Fire Danger Rating and Bush Fire Alert Level.



The needle indicates the Fire Danger Rating.

The Three Bush Fire Alert Levels.

PREPARE. ACT. SURVIVE.

KEEP YOURSELF INFORMED

Emergency Local Broadcaster
ABC Local Radio 702 AM
ABC National Radio 576 AM

RTA Traffic Info Line: 132 701

www.facebook.com/nswrfs

www.twitter/nswrfs

000 EMERGENCY

BUSH FIRE INFORMATION LINE
1800 NSW RFS
1800 679 737
www.rfs.nsw.gov.au

BUSH FIRE COORDINATING COMMITTEE

PRODUCTION INFORMATION

Base Data: LPMA Casastre and Topo Database
Map Projetion: GCS GDA 1994

BFMC Approval: 3 December 2013

Re-Print Date: 7 January 2015
Produced by: Sarah Kemble
1 grid square = 1 km² Scale: 1: 10,000

0 0.4 0.8
Km

WARNING INFORMATION

N W E S

1. This map has been prepared by the NSW Rural Fire Service ("The Service") using data supplied to it by other agencies and entities. See the "Data Dictionary" for further information about the sources of this data.
2. The Service has not verified or checked the data used to prepare this map. The map may contain errors and omissions. The Service has not made any attempt to ground truth the map.
3. There will be a margin of error in relation to the location of features recorded on the map. The Service is unable to specify the extent or magnitude of that margin of error.
4. Significant changes may have occurred;
   i. In the time between which the data was originally collected and the map produced; and
   ii. Since the map was produced
5. Users must, wherever possible, ground truth the map before relying on it or the accuracy of the map or the information recorded on the map for any purpose.
6. The Service accepts no responsibility for any injury loss or damage arising from the use of this map or any errors or omissions in the information recorded on the map.

Appendix C ELA Bushfire Intensity Modelling Report

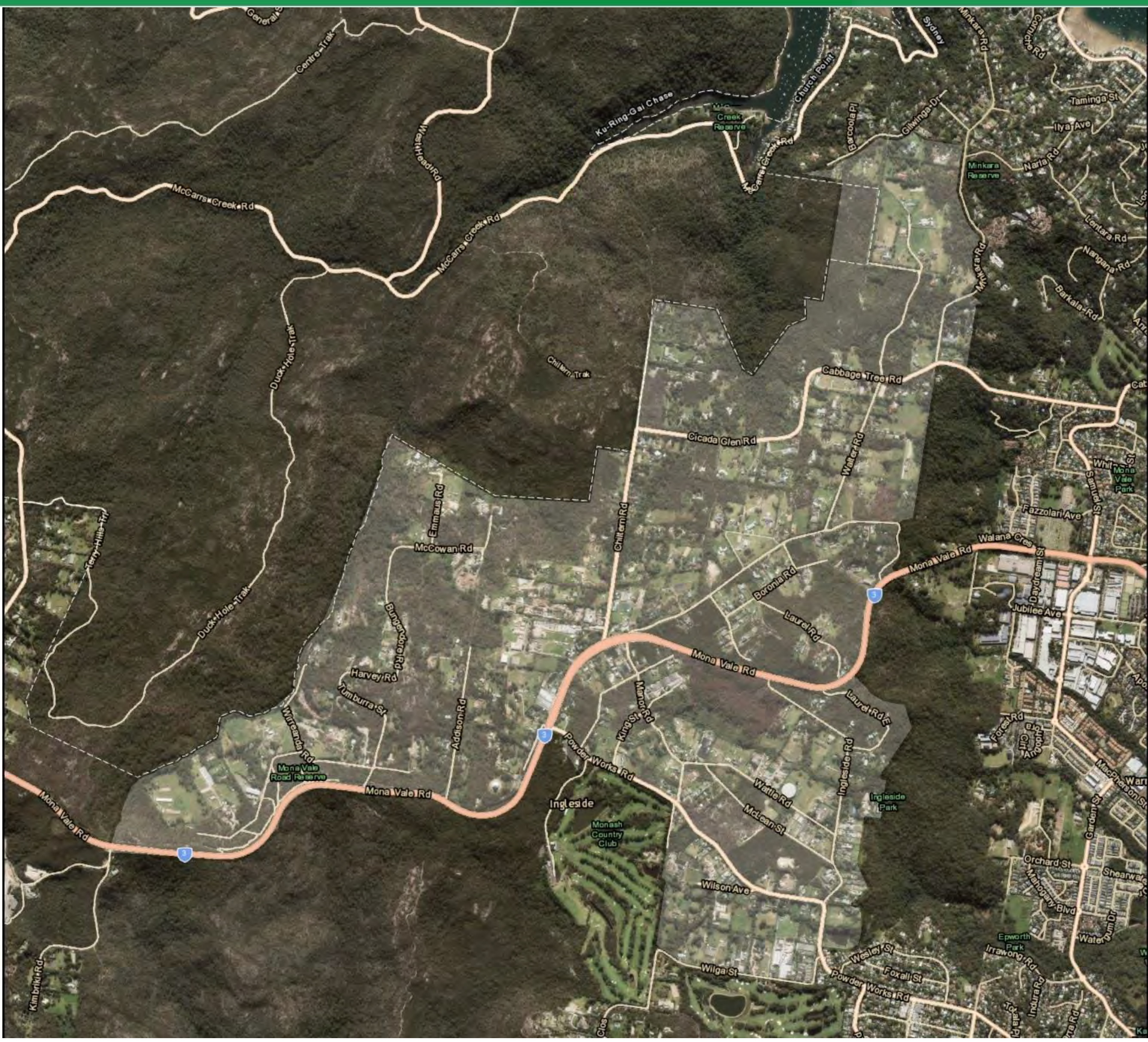
eco logical AUSTRALIA

Bushfire Intensity Modelling

Ingleside Precinct

Prepared for
NSW Department of Planning & Environment

May 2018



DOCUMENT TRACKING

Item	Detail
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Contents

1 Introduction 5

1.1 Background 5

1.2 Study Area 5

2 Bushfire Intensity Modelling 7

2.1 Bushfire Hazard 7

2.1.1 Slope 7

2.1.1 Aspect 7

2.1.2 Vegetation / Fuel 7

2.2 Bushfire Intensity Modelling 12

2.2.1 Bushfire Weather Analysis 13

3 Results 15

References 30

List of figures

Figure 1: Ingleside Precinct Location & Study Area 6

Figure 2: Slope across the study area 9

Figure 3: Aspect across the study area 10

Figure 4: Current vegetation formation / fuel classification of the study area 11

Figure 5: Potential Fire Intensity (north to south-east wind, FFDI 63, existing vegetation) 16

Figure 6: Potential Fire Intensity (south-east to south-west wind, FFDI 47, existing vegetation) 17

Figure 7: Potential Fire Intensity (south-west to north wind, FFDI 116, existing vegetation) 18

Figure 8: Potential Fire Intensity (average of all directions, existing vegetation) 19

Figure 9: Potential Fire Intensity (south-west to north wind, FFDI 62, existing vegetation) 20

Figure 10: Potential Fire Intensity (south-west to north, FFDI 134, existing vegetation) 21

Figure 11: Potential Fire Intensity (south-west to north, FFDI 100, existing vegetation) 22

Figure 12: Potential Fire Intensity (north to south-east wind, FFDI 63, proposed vegetation) 23

Figure 13: Potential Fire Intensity (south-east to south-west wind, FFDI 47, proposed vegetation) 24

Figure 14: Potential Fire Intensity (south-west to north wind, FFDI 116, proposed vegetation)..............25

Figure 15: Potential Fire Intensity (average of all directions, proposed vegetation) 26

Figure 16: Potential Fire Intensity (south-west to north wind, FFDI 62, proposed vegetation)................27

Figure 17: Potential Fire Intensity (south-west to north wind, FFDI 134, proposed vegetation)..............28

Figure 18: Potential Fire Intensity (south-west to north wind, FFDI 100, proposed vegetation)..............29

List of tables

Table 1: Vegetation formation, class and fuel allocation for the study area 8

Table 2: Bush fire intensity models run in this study 12

Table 3: FFDI for a 1 in 50-year event 14

1 Introduction

1.1 Background

The Department of Planning & Environment (DPE) is in the process of reviewing its draft structure plan for the Ingleside Precinct (**Figure 1**). The aim of this study was to prepare bushfire intensity models for a number of bushfire scenarios to provide context to the potential bushfire risk that the precinct is exposed to.

To meet this aim, the agreed project approach was to:

1. Assess the bushfire hazard relevant to the Ingleside Precinct (specified for this study as being the precinct and the surrounding landscape out to a distance of 5km); and
2. Prepare models within a GIS of the potential bush fire intensity across the study area for an agreed set of bushfire scenarios.

1.2 Study Area

The Ingleside Precinct is the focus of this study (**Figure 1**), however the area surrounding the Precinct (to a distance of 5 km) is also included in the study area, in order for the landscape bushfire risk to be assessed.

The Ingleside Precinct is located along Mona Vale Road on Sydney's Northern Beaches and within the Local Government Area of the newly amalgamated Northern Beaches Council. The Precinct is located between Ku-ring-gai Chase National Park to the northwest, Katandra Bushland Sanctuary and Ingleside Chase Reserve to the east, and Garigal National Park to the southwest. Existing urban and rural/urban development and other landuses are located within the Precinct as well as surrounding the Precinct to the north, east, southeast and in part to the west in the Terrey Hills area.

Figure 1: Ingleside Precinct Location & Study Area

2 Bushfire Intensity Modelling

The bushfire intensity modelling undertaken for this project is outlined in Section 2.2 and relied on a series of inputs representing various elements of the bushfire hazard setting for the landscape across the study area, outlined in Section 2.1 below.

2.1 Bushfire Hazard

The assessment of bushfire hazard for this study leverages on a classification of topography (slope and aspect) and vegetation formations / fuel across the study area. The assessment leveraged off the draft guidelines *Planning for Bushfire Protection* (PBP) (RFS 2017).

2.1.1 Slope

Slope (in degrees) has been derived across the study area from a 10 m grid cell Digital Elevation Model (DEM) and provides an overview of the terrain within the study area. It shown in **Figure 2** in the following slope classes (as per PBP):

- Upslope and flat;
- >0° – 5° downslope;
- >5° – 10° downslope;
- >10° – 15° downslope;
- >15° – 20° downslope;
- >20° downslope.

2.1.1 Aspect

Aspect (in degrees) has been derived across the study area from a 10 m grid cell Digital Elevation Model (DEM). It is shown in **Figure 3** and is a relevant input into the intensity models in combination with wind direction and slope given the influence on intensity of fire burning uphill (faster and hotter) downhill (cooler and slower) or on flat ground.

2.1.2 Vegetation / Fuel

Vegetation types present across the study area have been compiled from best available vegetation mapping, then classified into Keith Formations and Keith Class (Keith 2004) and then assigned a potential total fuel load (tonnes / hectare) using Table A1.11.21 from PBP (RFS 2017).

Two different vegetation/fuel layers where developed as follows:

- Existing vegetation, based on extant vegetation mapping;
- Potential future vegetation, based on the above for areas outside the precinct and the potential future vegetation inside the precinct given the proposed land uses presented in the draft structure plan. That is, extant vegetation in areas identified in the Ingleside Precinct Draft Structure Plan for development were removed and conversely, areas marked as environmental conservation or high constraint were retained / added.

The vegetation/fuel classification (existing) is presented in **Figure 4** with the allocation of formations, classes and assignment of fuel load as per **Table 2**. The vegetation/fuel datasets where generated from a compilation of the following:

- Sydney Metro Catchment Management Area Vegetation Mapping (OEH 2016)
- Ingleside Precinct Validated Vegetation Mapping (ELA 2016)

Table 1: Vegetation formation, class and fuel allocation for the study area

Keith Formation	Keith Class	Overall Fuel (t/ha)*
Rainforest	Littoral Rainforests	13.2
	Northern Warm Temperate Rainforests	
Wet Sclerophyll Forests (Grassy)	Northern Hinterland Wet Sclerophyll Forests	33.1
Wet Sclerophyll Forests (Shrubby)	North Coast Wet Sclerophyll Forests	35.98
	Southern Lowland Wet Sclerophyll Forests	32.8
Dry Sclerophyll Forests (Shrubby)	Sydney Coastal Dry Sclerophyll Forests	27.3
	Sydney Hinterland Dry Sclerophyll Forests	27.42
	Coastal Dune Dry Sclerophyll Forests	31.1
Forested Wetlands	Coastal Swamp Forests	34.1
Heathlands (Tall Heath)	Sydney Coastal Heaths[##]	15
	Coastal Headland Heaths	36.9
	Low Hazard[#]	13.2
Freshwater Wetlands	Coastal Heath Swamps	15.0
	Coastal Floodplain Wetlands	15.1
	Coastal Freshwater Lagoons	4.4
Grasslands	Maritime Grasslands	6.0

*Overall fuel as per Bark and Canopy field in Table A1.11.21 from PBP (RFS 2017)

[#] 'Low Hazard' vegetation as per PBP, Rainforest Fuel used.

[##] Short Heath fuel used given abundance of rock outcrops.

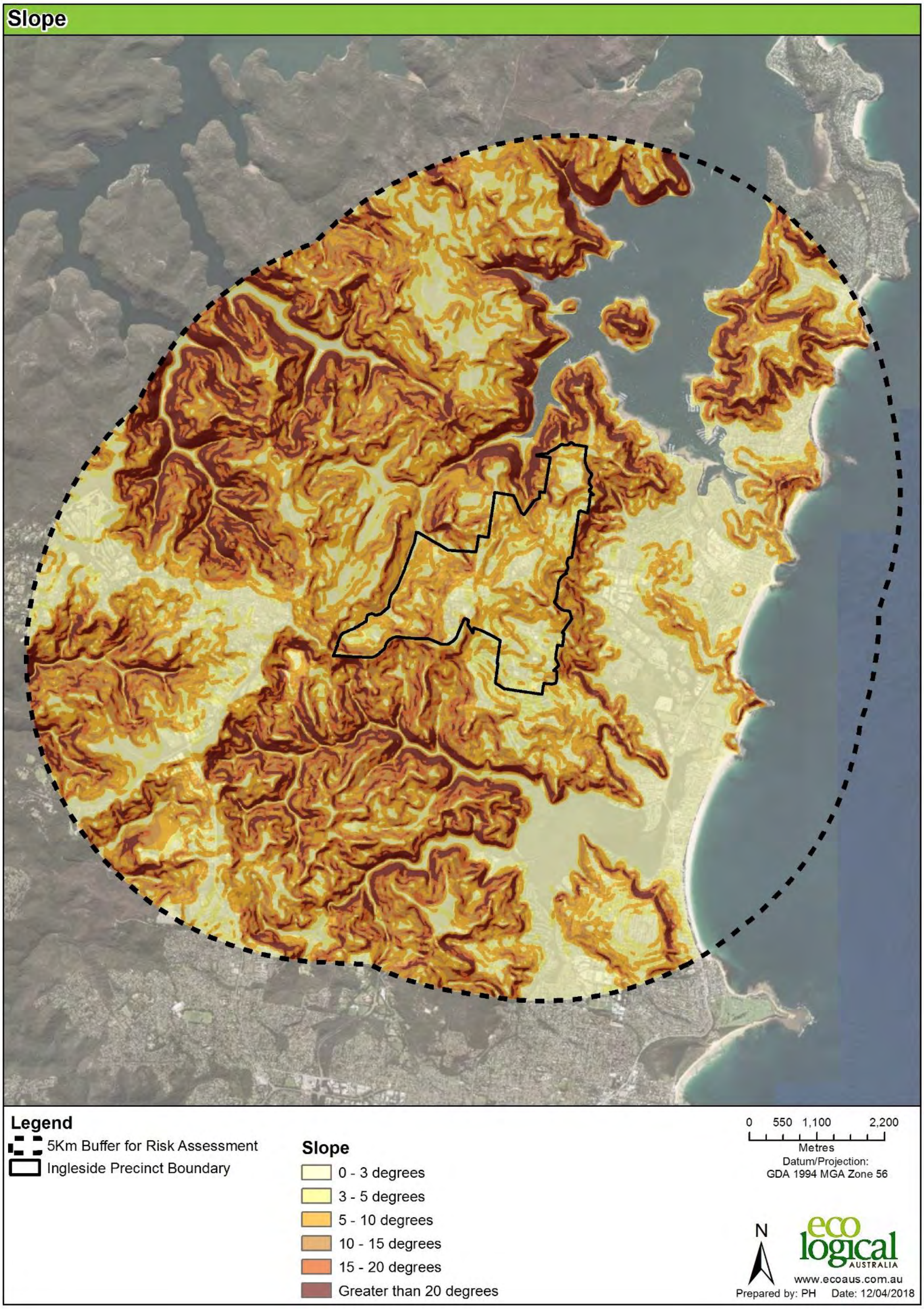

Figure 2: Slope across the study area

Figure 3: Aspect across the study area

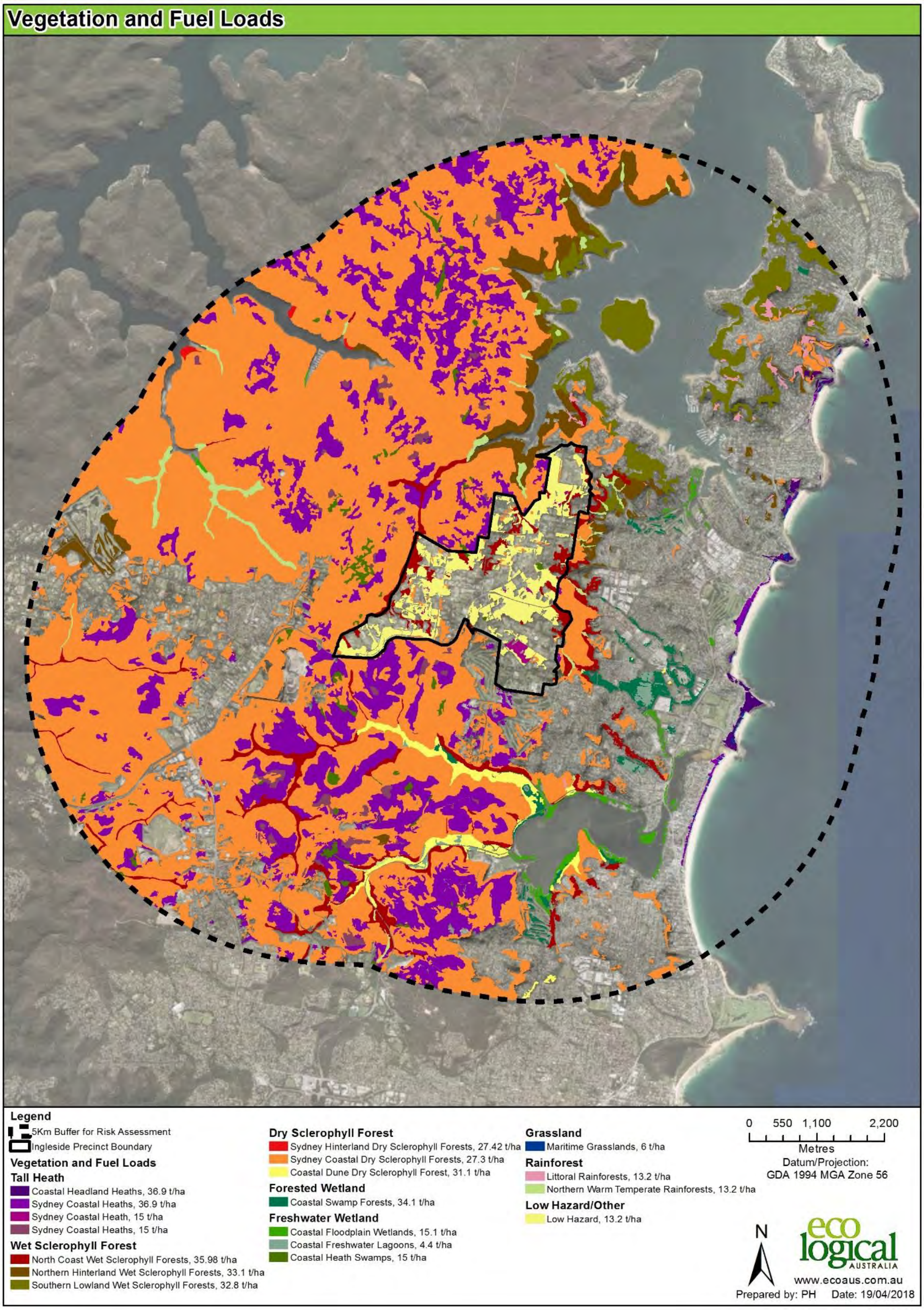

Figure 4: Current vegetation formation / fuel classification of the study area

2.2 Bushfire Intensity Modelling

A series of bushfire intensity models were prepared based on the approach and scenarios outlined below and the inputs outlined in Section 2.1 above. The models provide an indication of the potential head fire intensity from the direction of attack for the scenario's being modelled, with intensities greater than 4,000 kW/m generally considered uncontrollable in all weather conditions.

The models were generated spatially for the entire study area utilising the bushfire hazard data (as detailed in Section 2.1) and in light of an analysis of bushfire weather (documented in Section 2.2.1 below). These models use the following parameters to identify the potential bushfire intensity:

- Terrain (slope and aspect);
- Fuel (vegetation);
- Likely bushfire weather scenarios including the Forest Fire Danger Index (FFDI) and wind direction.

The modelling approach calculates potential head fire intensity using established fire intensity formulae documented in Cheney et al 2012 (for Forest and Woodland), Anderson et al 2015 (for Heath and Shrubland), and Cheney et al 1998 (for Grassland). Three core models where prepared for the following bushfire attack scenarios:

- Bushfire attack from the north to south-east direction (clockwise) at FFDI 63 (**Figure 5 & 12**);
- Bushfire attack from the south-east to south-west direction (clockwise) at FFDI 47 (**Figure 6 & 13**);
- Bushfire attack from the south-west to north direction (clockwise) at FFDI 116 (**Figure 7 & 14**).

The three core models have been compiled together to provide an overall "average" intensity from all directions (**Figure 8 & 15**).

In addition, models were run to simulate bush fire attack from the south-west to north direction (clockwise) at FFDI 62, representing the likely conditions experienced on 8th of January 1994 (**Figure 9 & 16**), and also south-west to north direction (clockwise) at FFDI 134, representing a scenario for potential climate change conditions (**Figure 10 & 17**). Lastly, final models were run at FFDI 100, following stakeholder requests (**Figure 11 & 18**).

Each of the above model intensity scenarios were modelled to represent the existing vegetation environment, and in addition; each model scenario was run for the potential future vegetation fuel loads based on the Draft Structure Plan. **Table 3** summarises the scenarios modelled and the resultant figures (presented in Section 3).

Table 2: Bush fire intensity models run in this study

	Item	Bushfire Scenario	Existing vegetation	Proposed vegetation (based on draft Structure Plan)
Core Models	1	N to SE wind - FFDI 63	**Figure 5**	**Figure 12**
	2	SE to SW wind - FFDI 47	**Figure 6**	**Figure 13**
	3	SW to N wind - FFDI 116	**Figure 7**	**Figure 14**

	Item	Bushfire Scenario	Existing vegetation	Proposed vegetation (based on draft Structure Plan)
	4	Average intensity from all scenario's above	**Figure 8**	**Figure 15**
Additional Models	5	SW to N wind - FFDI 62 (representing the likely conditions experienced on 8th January 1994)	**Figure 9**	**Figure 16**
	6	SW to N wind - FFDI 134 (representing potential climate change conditions)	**Figure 10**	**Figure 17**
	7	SW to N wind - FFDI 100	**Figure 11**	**Figure 18**

2.2.1 Bushfire Weather Analysis

Weather data developed by Lucas (2010) under the National Historical Fire Weather Dataset (1972-2015) incorporates the daily Forest Fire Danger Index (FFDI), where suitable inputs are available, from over 70 weather stations across Australia. Data from the Sydney Airport and Richmond weather stations (station numbers 66037 and 67033/67105 respectively) was analysed to determine the maximum FFDI for a 1 in 50-year event, being the accepted recurrence period for land use planning (RFS 2006).

The dataset for each site was split into subsets based on wind directions including:

- All directions;
- North to south-east (clockwise);
- South-east to South-west (clockwise);
- South-west to North (clockwise).

To determine the 1:50 recurrence value, a Generalised Extreme Value (GEV) analysis method was undertaken to calculate the FFDI value within each data subset (**Table 4**). Although the GEV model has been used in other disciplines for analysing extreme events (i.e. flooding recurrence values), it is only in recent times to have been considered appropriate for bushfire weather analysis (Douglas 2017). The GEV methodology and its use to analyse bushfire weather data is discussed in a number of papers by Douglas et al (2014; 2016).

Table 3: FFDI for a 1 in 50-year event

Weather Station	Max Recorded FFDI	All directions	N to SE	SE to SW	SW to N
Sydney Airport	116	116	63	47	116
Richmond Airport	96	105	52	45	105

The FFDI values for Sydney Airport are worse (higher) than those for Richmond Airport, so the former was considered more appropriate for consideration as ‘worst case’.

3 Results

The models show that the greatest intensities are possible on the western facing slopes containing forest and heath vegetation, which are present in the surrounding National Parks areas to the west and south. The areas to the east are modelled as generally having lower potential levels of intensities.

It is noted that each bushfire event is different, responding to changes in fuel, weather conditions and FFDI. Thus, the models are an indication of what could be experienced under the bushfire weather scenario modelled provided the fuel and terrain are similar to the input data used in the model.

It is important to note that the models of potential fire intensity do not provide an indication of ignition risk or the rate of spread of a bushfire. It is specifically noted that, although the grassland areas will not carry a fire of the same intensity as the forested areas, these areas potentially have the highest risk of ignition and rate of spread. Conversely, fires within the grassland areas are potentially more controllable under certain weather conditions given the lower potential fire intensities in these locations.

It is lastly noted that the above intensity modelling approach does not account for events under extreme fire behaviour / weather including such phenomena as:

- Spotting/Fire storm;
- Fire tornado/whirls;
- Lateral vortices;
- Junction zones (Jump fires);
- Eruptive fires;
- Conflagrations;
- Downbursts;
- Pyro-convective events;

Figure 5: Potential Fire Intensity (north to south-east wind, FFDI 63, existing vegetation)

Figure 6: Potential Fire Intensity (south-east to south-west wind, FFDI 47, existing vegetation)

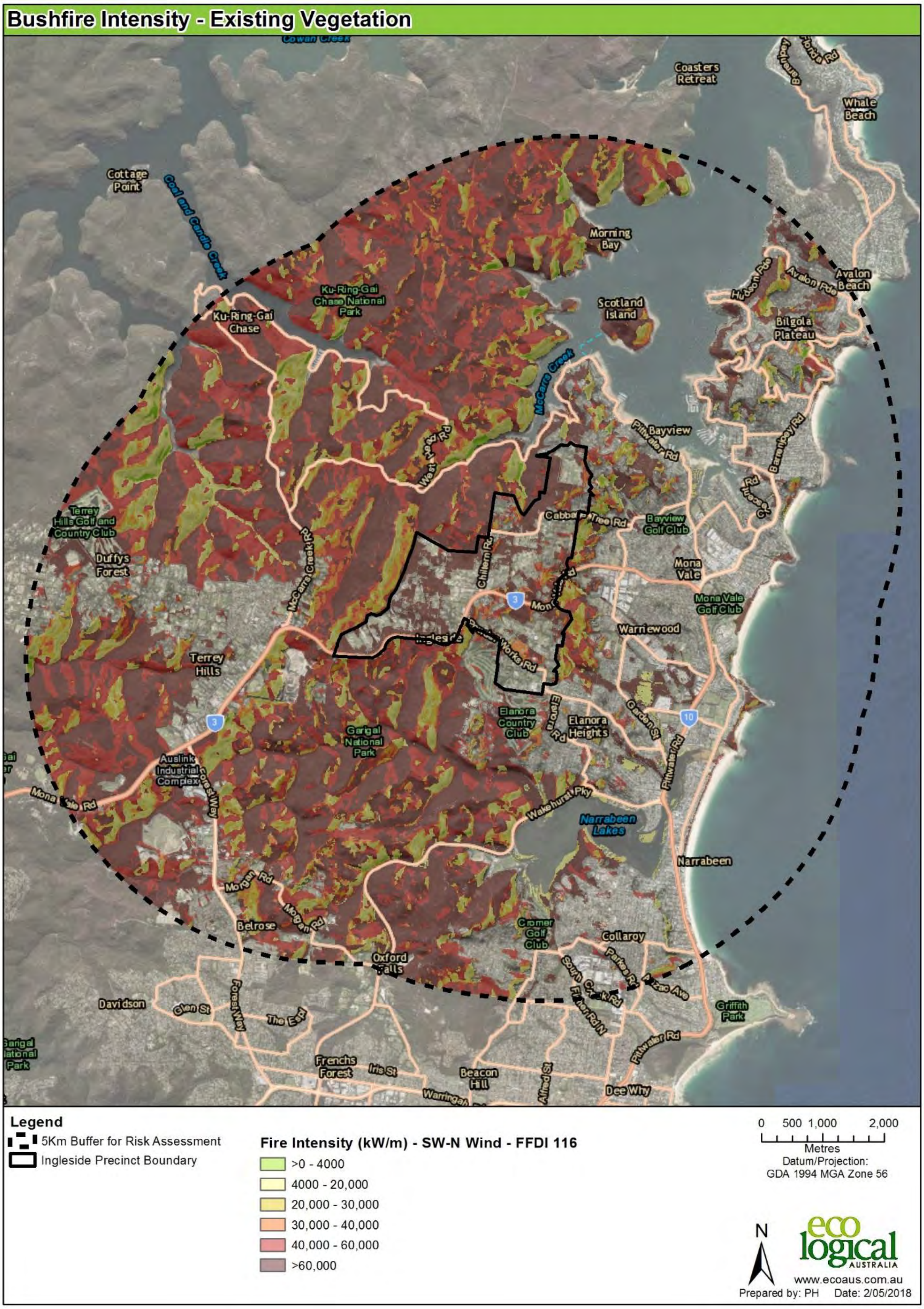

Figure 7: Potential Fire Intensity (south-west to north wind, FFDI 116, existing vegetation)

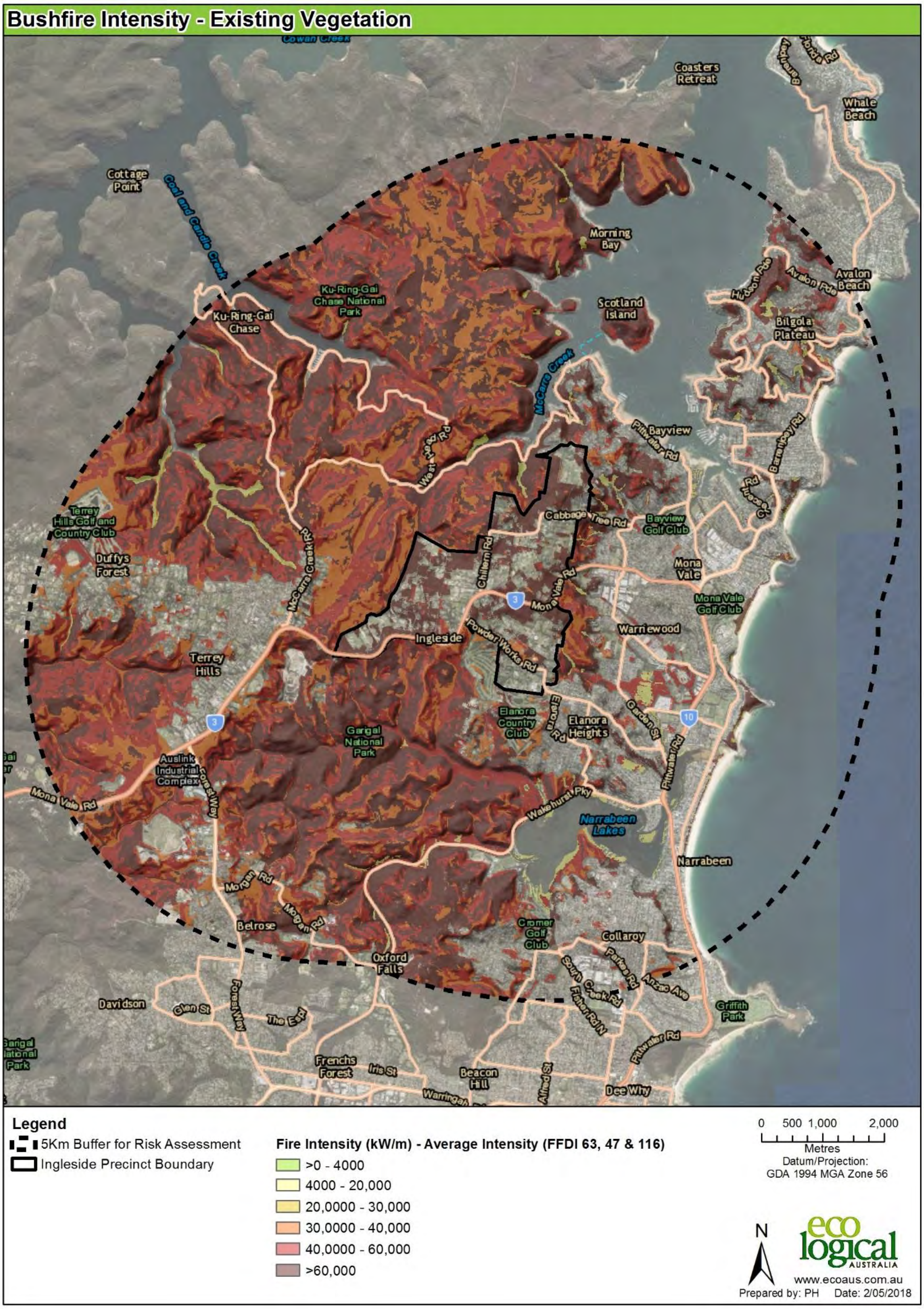

Figure 8: Potential Fire Intensity (average of all directions, existing vegetation)

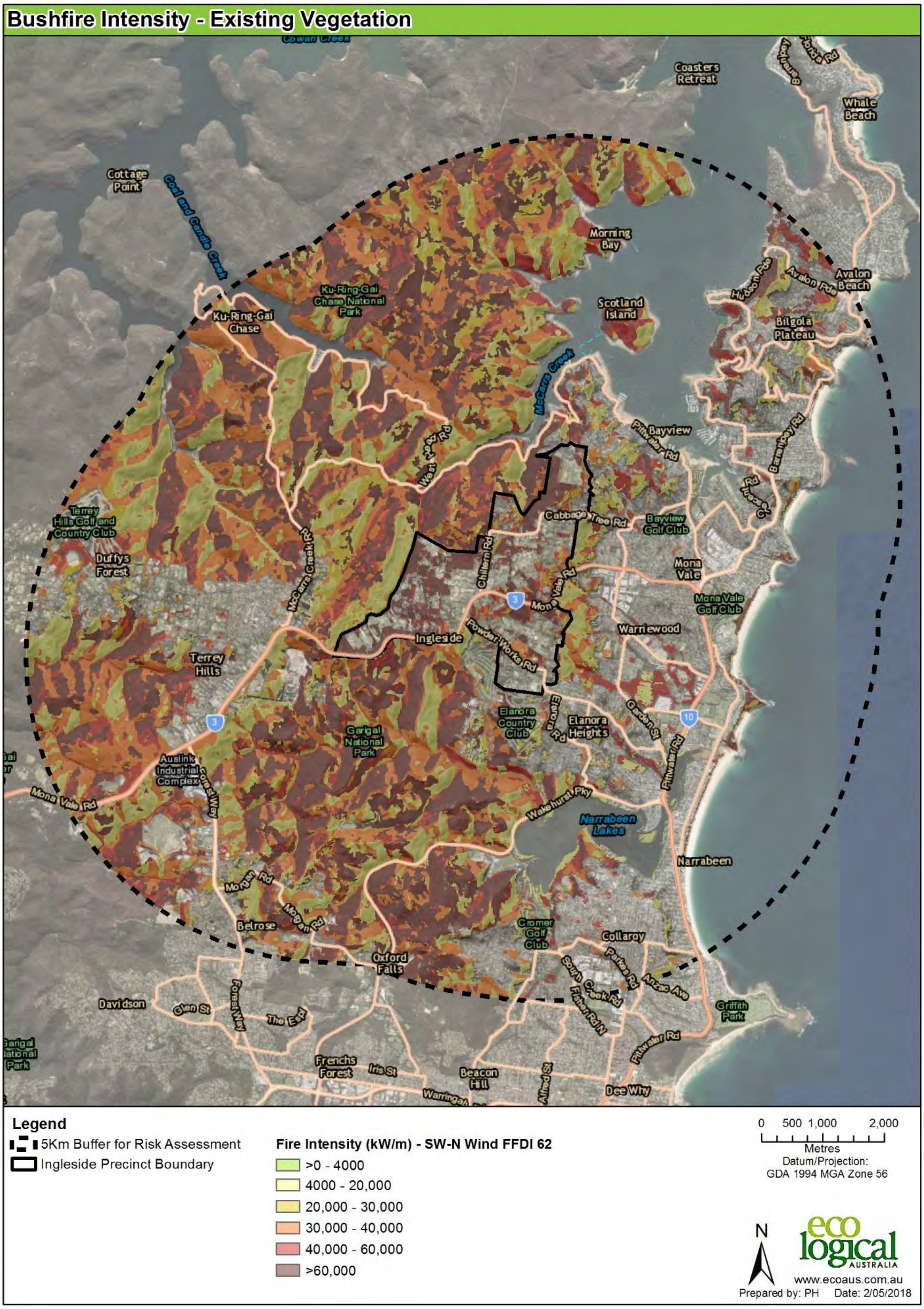

Figure 9: Potential Fire Intensity (south-west to north wind, FFDI 62, existing vegetation)

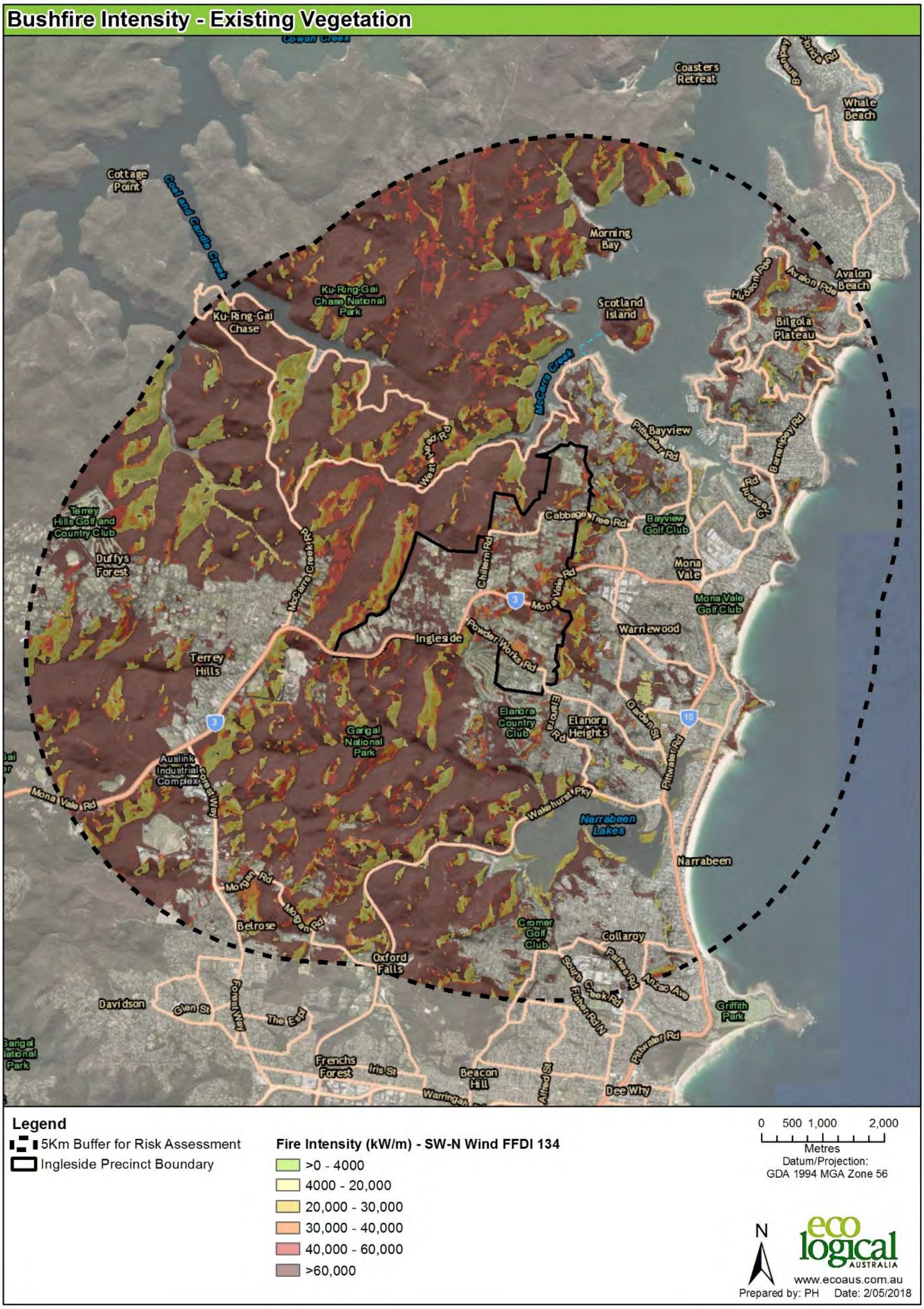

Figure 10: Potential Fire Intensity (south-west to north, FFDI 134, existing vegetation)

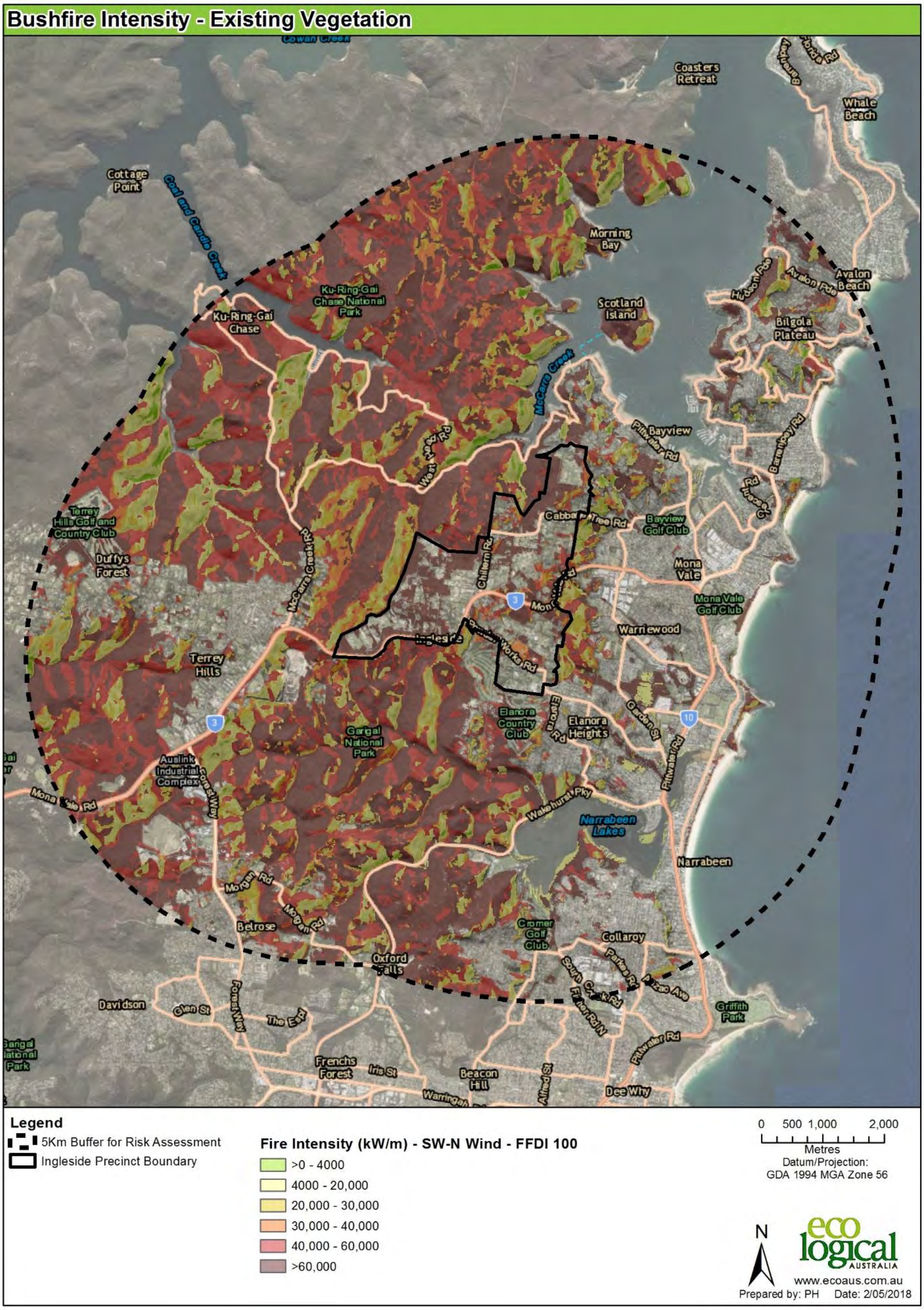

Figure 11: Potential Fire Intensity (south-west to north, FFDI 100, existing vegetation)

Figure 12: Potential Fire Intensity (north to south-east wind, FFDI 63, proposed vegetation)

Figure 13: Potential Fire Intensity (south-east to south-west wind, FFDI 47, proposed vegetation)

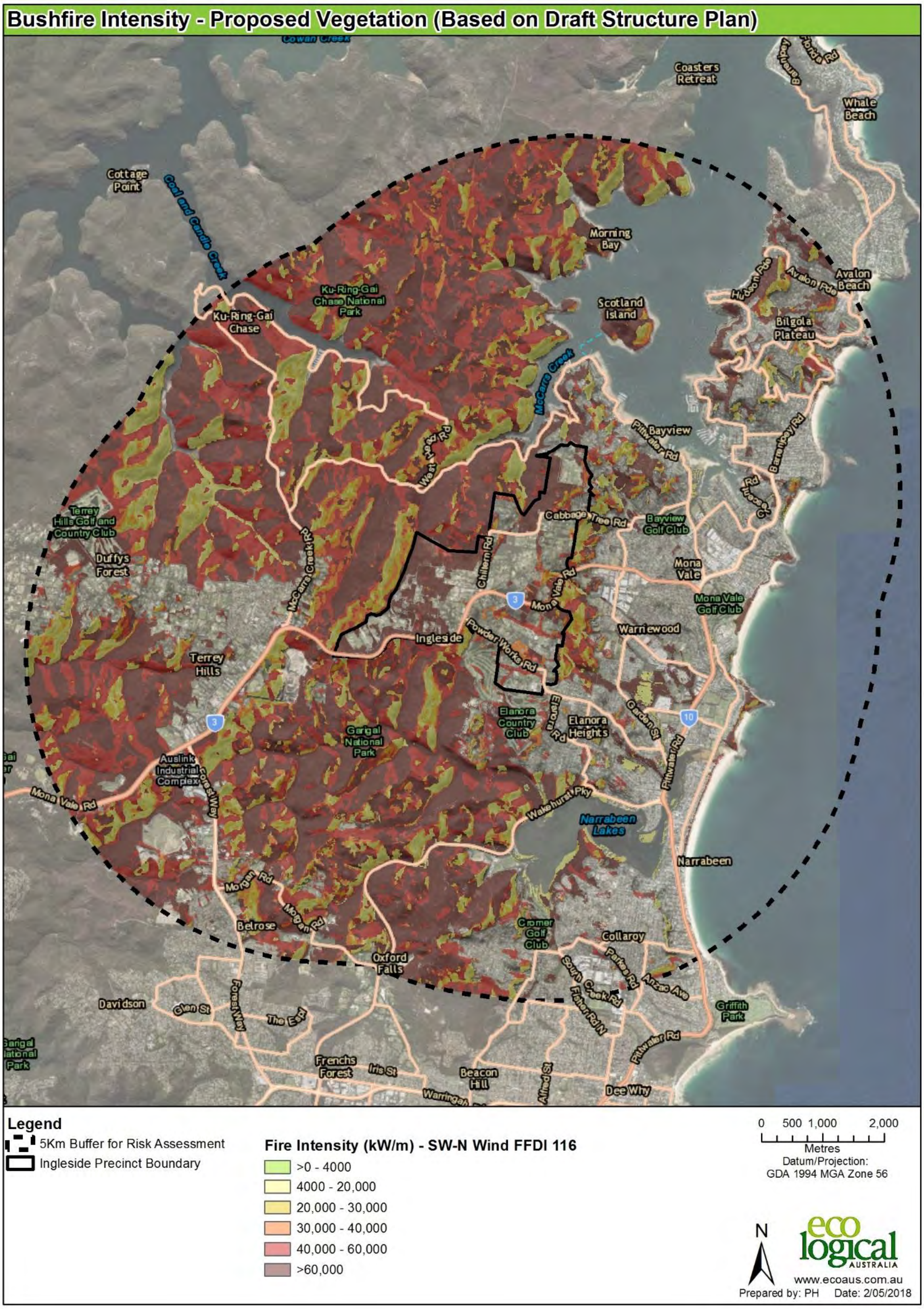

Figure 14: Potential Fire Intensity (south-west to north wind, FFDI 116, proposed vegetation)

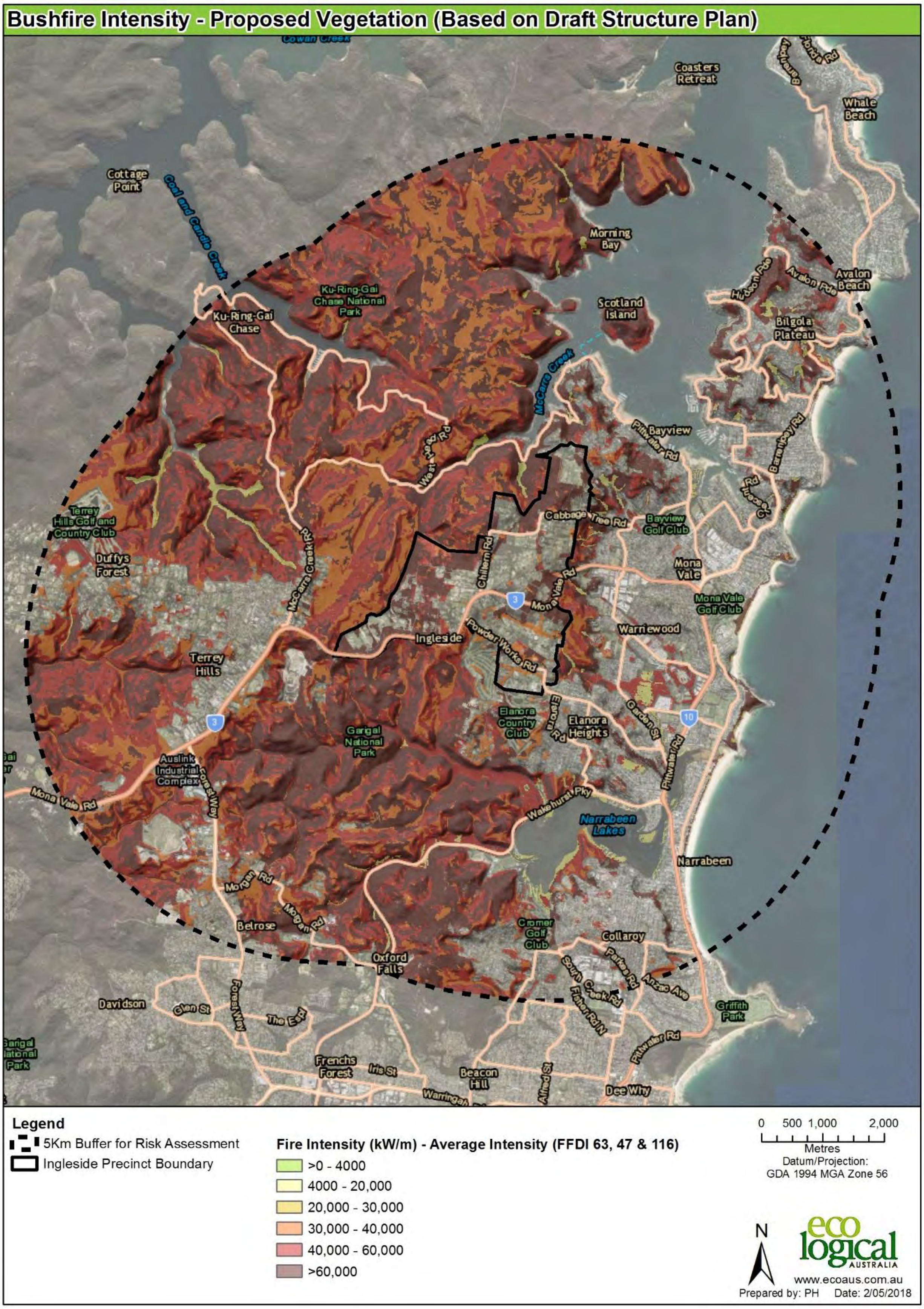

Figure 15: Potential Fire Intensity (average of all directions, proposed vegetation)

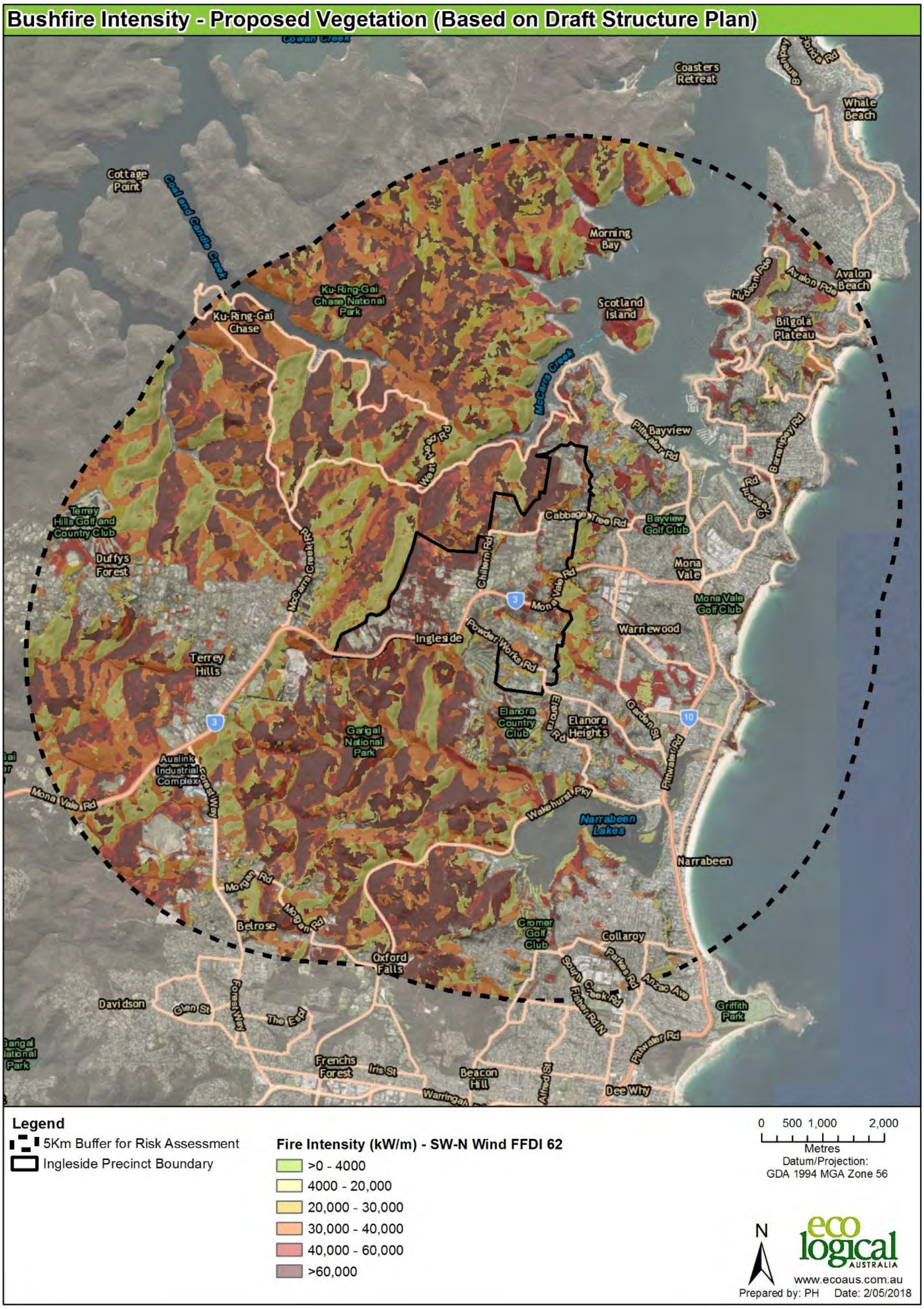

Figure 16: Potential Fire Intensity (south-west to north wind, FFDI 62, proposed vegetation)

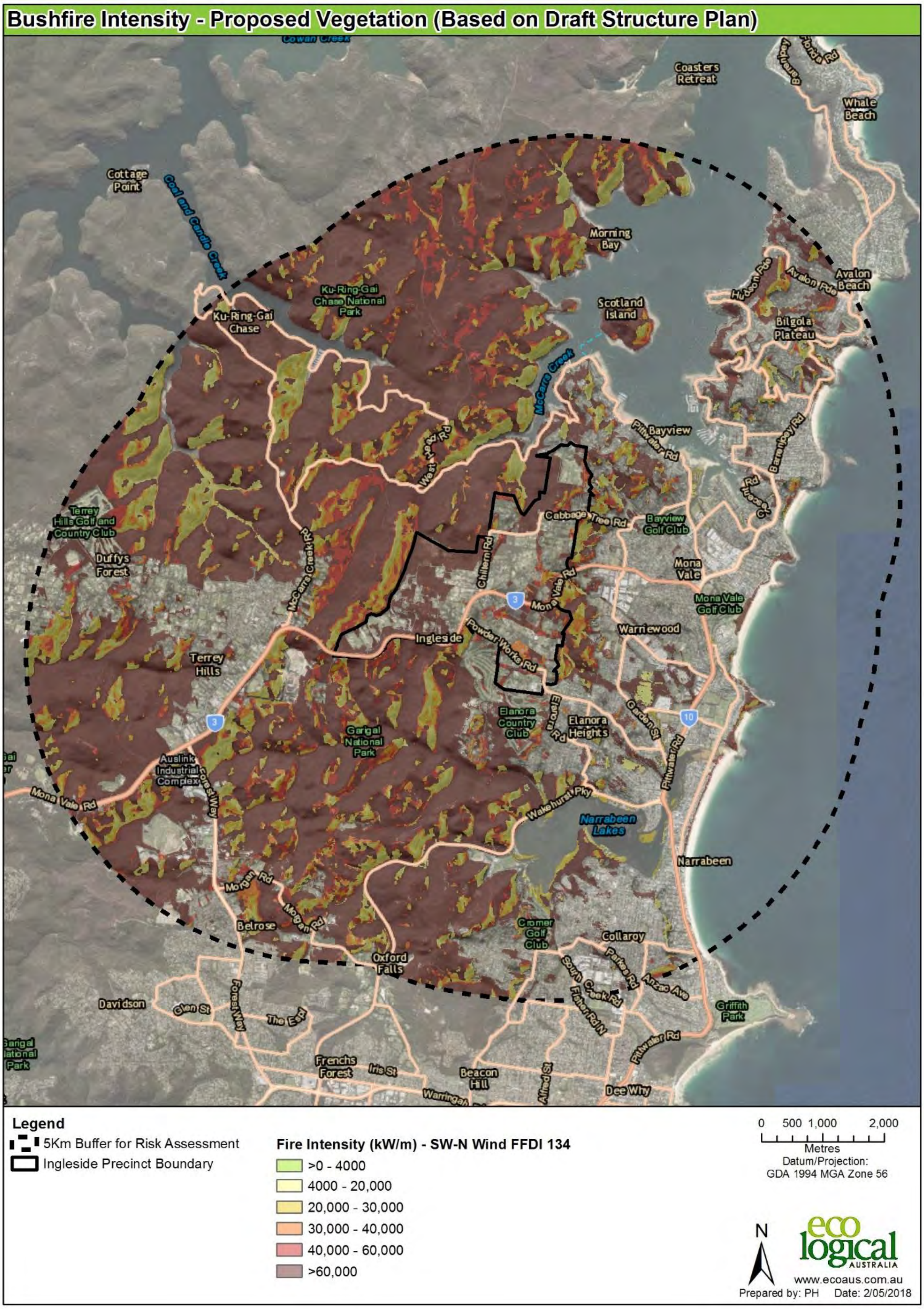

Figure 17: Potential Fire Intensity (south-west to north wind, FFDI 134, proposed vegetation)

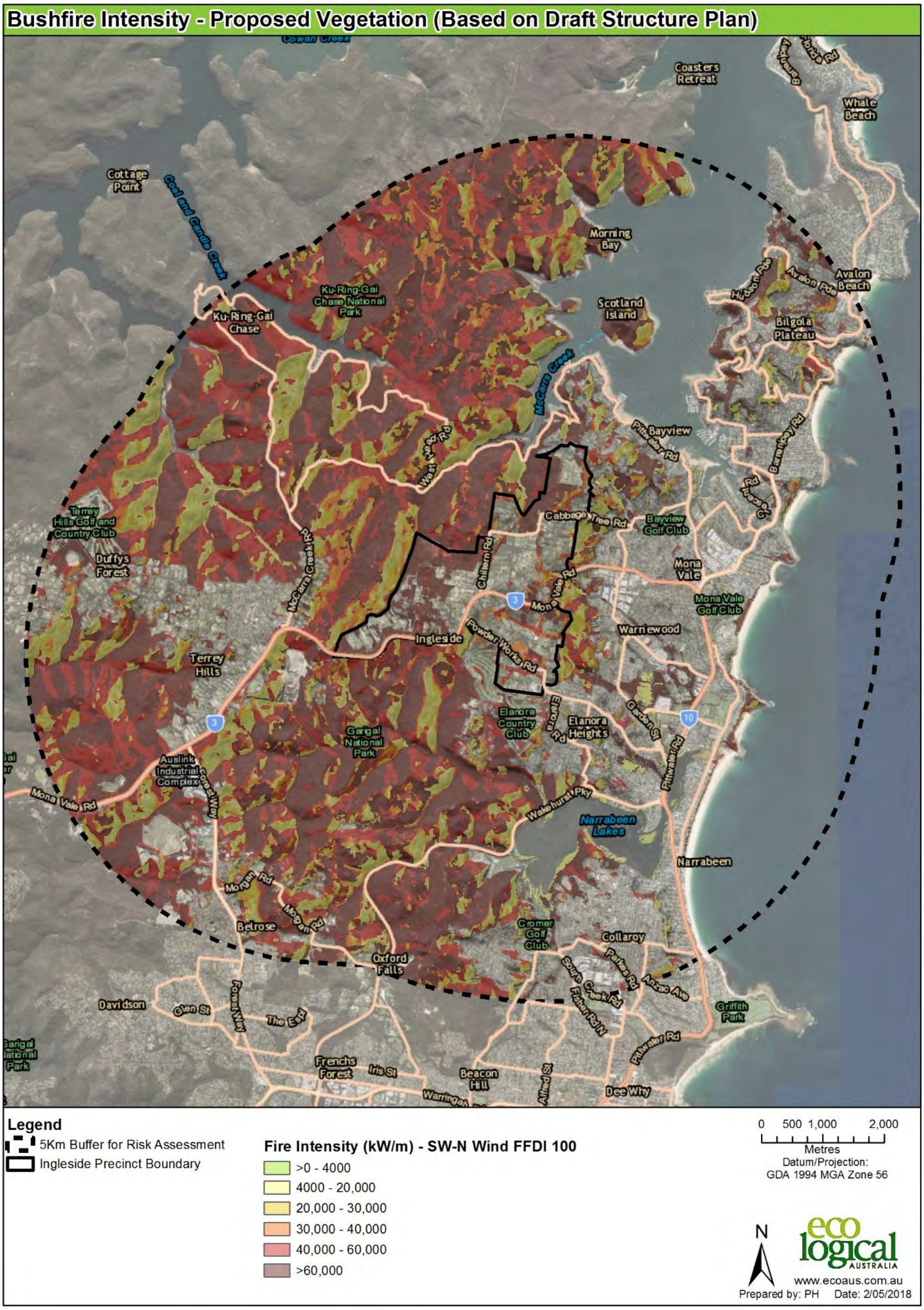

Figure 18: Potential Fire Intensity (south-west to north wind, FFDI 100, proposed vegetation)

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Appendix D Mapping of Existing and Proposed Risk Exposure