Bushfire Resilient Communities

Technical Reference Guide for the State Planning Policy State Interest 'Natural Hazards, Risk and Resilience - Bushfire'

October 2019

Queensland Government

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Authors: For further information on this publication, please contact: The Sustainable Development Unit, Queensland Fire and Emergency Services Email: sdu@qfes.qld.gov.au Telephone: (07) 3635 2540.

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1. PURPOSE

1. Purpose

The technical guidance in this document, Bushfire resilient communities (BRC), supports the State Planning Policy July 2017 (SPP) and associated State Planning Policy state interest guidance material –Natural hazards, risk and resilience – Bushfire (SPP guidance).

The SPP outlines the state interests in land use planning and development that underpin the delivery of local and regional plans and development. These state interests include natural hazards, including bushfire, and risk and resilience measures.

The SPP guidance assists:

- local governments to make or amend local planning instruments
- assessment managers and practitioners when applying the SPP assessment benchmarks to development applications (only where the state interests have not been integrated in local planning instruments).

The BRC provides technical guidance and the policy positions of Queensland Fire and Emergency Services (QFES) to state agencies, local governments, and practitioners engaged in land use planning for bushfire hazard and development activities that may be affected by bushfire hazard. This includes:

- making or amending state and local planning instruments such as planning schemes or regional plans
- designating land for community infrastructure
- making or assessing development applications.

Figure 1, illustrates the relationship between the SPP and supporting guidance material.

The BRC:

- outlines factors affecting bushfire hazard and potential bushfire risks and impacts
- outlines the methodology used to prepare the statewide mapping of bushfire prone areas included in the State Planning Policy Interactive Mapping System (SPP IMS)
- provides technical guidance on procedures for:
  - reviewing SPP IMS bushfire prone area mapping
  - undertaking a Bushfire Hazard Assessment (BHA) and Vegetation Hazard Class Assessment
  - calculating asset protection zone provisions
  - preparing a Bushfire Management Plan and Landscape Maintenance Plan
- provides additional information to inform development conditions
- guides the identification of suitably qualified people for assessments identified in the BRC.

This scope is summarised in Figure 2.

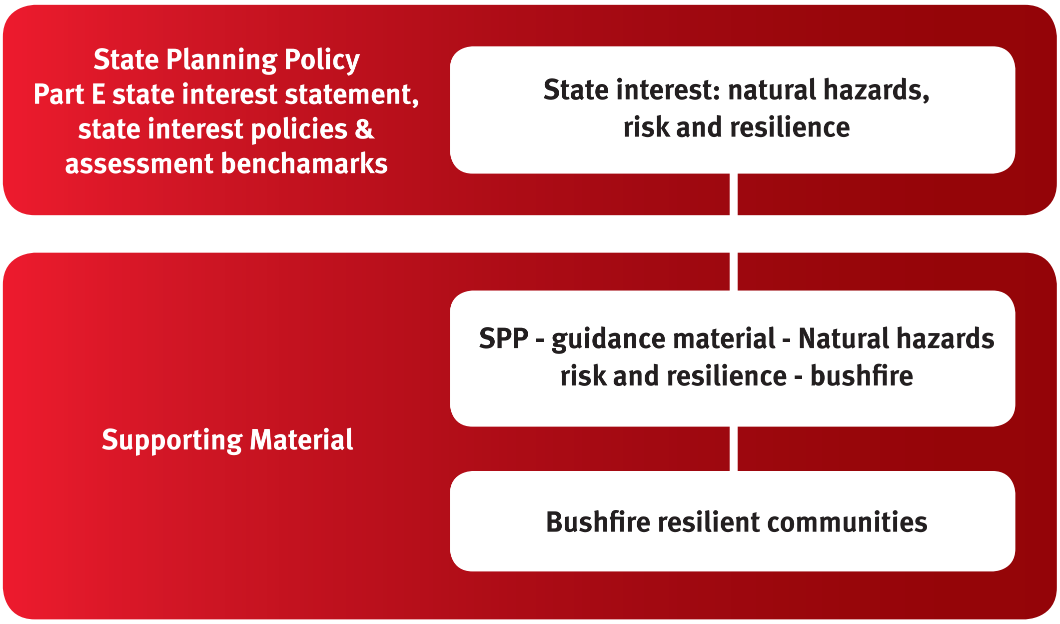


Figure 1: The relationship between the State Planning Policy (SPP) and the SPP natural hazards guidance material.

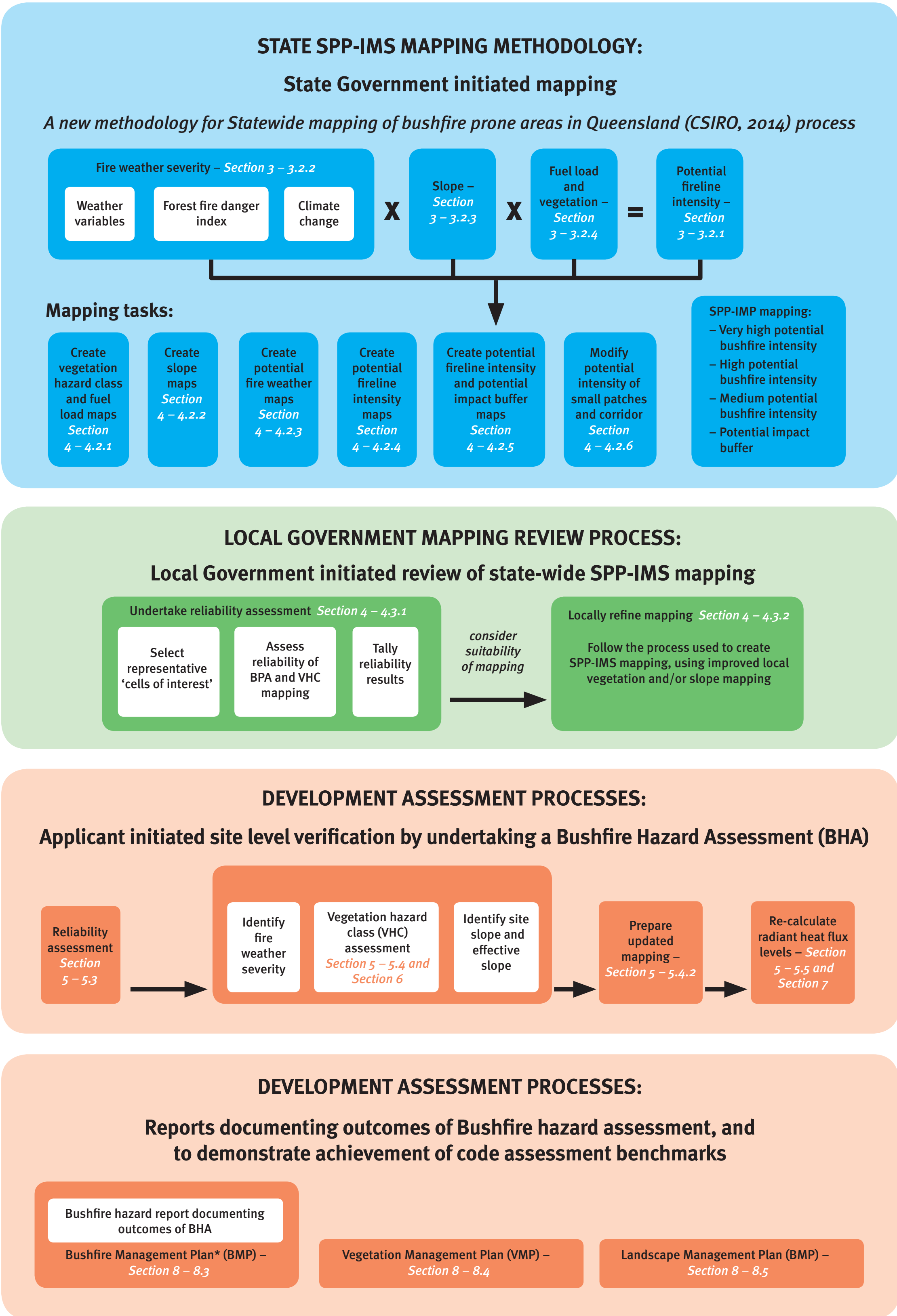


Figure 2: Overview of bushfire planning and assessment processes.

2. POLICY APPROACHES

2. Policy approaches

2.1 Context

Bushfires can cause extensive social, economic and environmental damage. With the increasing occurrence of days of extreme heat and frequency of severe fire weather, the potential impact of bushfires is of increasing concern in Queensland. The impact of bushfires will vary across the state, depending on the severity of the bushfire, the proximity and exposure of people and property to hazardous vegetation, and the vulnerability of different land uses to bushfire hazard. Bushfire impacts can affect people and property through flame attack, ember attack, radiant heat exposure, wind and smoke attack, and convective and conductive heat exposure.

Land use planning for bushfire hazard is one part of an integrated disaster management strategy in mitigating the risks associated with bushfire events to an acceptable or tolerable level.

2.2 Policy approaches

The QFES policy approaches to land use planning for bushfire hazard include the following ten positions.

Policy 1 – Mapping is robust and locally relevant.

As a minimum, the State Planning Policy Interactive Mapping System (SPP IMS) bushfire prone area mapping must be identified and applied to local government planning schemes.

Local governments should refine the SPP IMS bushfire prone area mapping, using the refinement process outlined in this document, and then adopt the refined mapping in their specific planning scheme. QFES may be able to assist local governments with limited resources, in this process.

Policy 2 – A fit-for-purpose risk assessment informs plan-making or amendments to achieve an acceptable or tolerable level of risk to people and property in bushfire prone areas.

Local governments should undertake a risk assessment when making or amending a planning scheme.

To understand the consequences of a potential bushfire event, the risk assessment should consider the exposure, vulnerability and resilience of communities and their assets to a bushfire as a first step in proposing a planning response. A risk assessment is a methodical assessment, considering the specific circumstances of the local government area. Preferably, the risk assessment:

- will be consistent with AS/NZS ISO 31000:2018 Risk Management – Principles and Guidelines[1]
- is undertaken by a suitably qualified person (further detailed in Section 10).

A comprehensive risk assessment may not be required for every planning scheme amendment, depending on the scope of the proposed instrument and whether an assessment has been previously undertaken.

QFES can provide advice to local governments early in the planning process to scope a risk assessment that is suited to the nature of the proposed scheme amendments (i.e. a risk assessment that is fit-for-purpose).

Note – The Queensland Government has endorsed the Queensland Emergency Risk Management Framework (QERMF) as the state's approach to emergency and disaster risk management. State–wide assessments conducted under this framework provide key information relevant to local assessments, and are held by Local or District Disaster Management Groups.

Policy 3 – The planning scheme or amendments following a risk assessment are based on the principle of avoidance as the first priority, and then mitigation of the risk to an acceptable or tolerable level.

The outcomes of the risk assessment should inform the drafting of the local planning strategic framework and assessment benchmarks to ensure a clear approach to managing bushfire risk.

Avoidance of the risk would include a local government minimising the expansion or increased density of existing development in mapped bushfire prone areas, particularly:

- vulnerable uses
- community infrastructure for essential services
- materials that are hazardous in the context of bushfire hazard.

After this, managing bushfire risk should be based on achieving an acceptable or tolerable level of risk for both existing and new development in bushfire prone areas.

An **acceptable risk** is a level that is sufficiently low to require no new treatments or actions to allow communities to live with the risk without further action.

A **tolerable risk** is low enough to allow the exposure to a natural hazard to continue but high enough to require new treatments or actions to reduce that risk. Communities can live with this level of risk, but as much as is reasonably practical should be done to reduce the risk. This may include planning responses for:

- reducing the likelihood of the risk (avoidance)
- reducing the consequences of the risk (mitigation and hazard management over time).

What constitutes an acceptable or tolerable level of risk will vary among local government areas and community context. If appropriate, community consultation could be undertaken to understand tolerance levels to bushfire risk and identify possible treatment options.

Note – Other responses may also be suitable for implementation via specific local government instruments such as local laws or asset management plans.

Policy 4 – Disaster management capacity and capabilities are maintained to mitigate the risks to people and property to an acceptable and tolerable level.

Mitigation involves a local government including provisions in its planning scheme to ensure subdivision layout:

- locates low fuel separation areas, such as roads, managed open spaces and large lots, to separate people from hazard
- does not hinder emergency service access and functions through active measures including:
  - ensuring sufficient access areas (e.g. via perimeter roads or fire trail and working areas) for firefighters and vehicles between assets and vegetation
  - allowing for vegetation management and wildfire response to provide opportunities to establish control lines from which hazard reduction or back-burning operations can occur

1 *It is acknowledged that ISO 31000–2018 is a generic standard for a broad range of risk assessments.*

- allows safe access and egress routes
- ensures water supply in both reticulated and non-reticulated areas.

Mitigation also involves local governments including provisions in their planning scheme for Bushfire Management Plans (BMPs) for ongoing vegetation management that maintains identified low fuel separation areas.

Policy 5 – Lot and neighborhood layout and design mitigates the risks to people and property to an acceptable and tolerable level.

Mitigation involves local governments including provisions in their planning scheme for:

- new subdivision design to minimise the interface with bushfire prone areas and facilitate connections to safe evacuation routes
- landscape design and management that does not increase the level of bushfire risk or mechanisms of bushfire attack.

The key mitigation approach for houses involve a local government defining all or part of its area as a designated bushfire prone area in accordance with section 12 of the Building Regulation 2006. This in turn triggers the requirement for adherence to Australian Standard 3959–2018 Construction of buildings in bushfire-prone areas at the building development application stage.

Policy 6 – Vulnerable uses are not located in bushfire prone areas unless there is an overwhelming community need for the development of a new or expanded service, there is no suitable alternative location and site planning can appropriately mitigate the risk.

The local government should include provisions in its planning scheme which articulate this policy position.

If located in a bushfire prone area, vulnerable uses maintain disaster management capacity and capabilities, and mitigate the risks to people and property to an acceptable and tolerable level (see Policy 4).

Policy 7 – Revegetation and rehabilitation avoids an increase in the exposure or severity of bushfire hazard.

Local governments should include provisions in their planning schemes which articulate this policy position and do not result in an unacceptable level of risk or an increase in the potential bushfire intensity level.

Policy 8 – Development does not locate buildings or structures used for the storage or manufacture of materials that are hazardous in the context of a bushfire within a bushfire prone area unless there is no suitable alternative location.

The local government should include provisions in its planning scheme which articulate this policy position.

If located in a bushfire prone area, the risks to public safety and the environment from the release of these materials during and after a bushfire event must be mitigated by positioning it:

- outside any asset protection zone applying to other buildings or structures on the site
- as close to the edge of the bushfire prone area as possible.

If located in a bushfire prone area, the storage or manufacture of materials that are hazardous in the context of a bushfire must be managed through:

- maintenance of appropriate disaster management capacity and capabilities
- mitigation of the risks to people and property to an acceptable and tolerable level (see Policy 4).

Policy 9 – The protective function of vegetation arrangements that can mitigate bushfire risk are maintained.

Local governments should include provisions in their planning schemes to mandate BMPs that uphold the protective function of vegetation arrangements, such as species selection, landscape design and ongoing vegetation management.

Policy 10 – Community infrastructure for essential services are not located in bushfire prone areas unless there is an overwhelming community need for the development of a new or expanded service and there is no suitable alternative location, and further, the infrastructure can be demonstrated to function effectively during and immediately after a bushfire event.

Local governments should include provisions in their planning schemes which articulate this policy position.

If located in a bushfire prone area, community infrastructure for essential services must be secured by:

- maintenance of appropriate disaster management capacity and capabilities
- mitigation of the risks to people and property to an acceptable and tolerable level (see Policy 4).

3. BACKGROUND

3. Background

3.1 State Planning Policy Interactive Mapping System approach

The State Planning Policy July 2017 (SPP) identifies bushfire prone areas as those with a medium potential bushfire intensity, high potential bushfire intensity or very high potential bushfire intensity with an additional 100 metre potential impact buffer, representing that part of the landscape that could support a significant bushfire or be subject to significant bushfire attack.

Bushfire impacts in a bushfire prone area are potentially harmful to people and property.

The areas mapped as medium, high or very high potential bushfire intensity in the State Planning Policy Interactive Mapping System (SPP IMS) bushfire prone area mapping include potentially hazardous vegetation that could support a significant bushfire. These areas have a 4,000–20,000, 20,000–40,000 or 40,000+ kW/m potential fireline intensity respectively (further described in Section 3.2.1).

Bushfires in these areas have the potential for high to extreme levels of flame attack, radiant heat and ember attack as a result of high potential fuel levels, slope and fire weather severity.

Potential impact buffer areas in the SPP IMS bushfire prone area mapping comprise land adjacent to potentially hazardous vegetation that is also at risk of significant bushfire attack from embers, flames or radiant heat. Potential impact buffer areas include all land within 100 metres of areas mapped as medium, high or very high potential bushfire intensity. This 100 metre width was informed by findings indicating 78 per cent of fatalities occur within 30 metres and 85 per cent of fatalities occur within 100 metres of hazardous vegetation (the forest edge) in Australia.[2]

The mapping of these two different layers – potential intensity and impact buffer areas – identifies the potential severity of bushfires and their potential exposure as seen below in Figure 3.

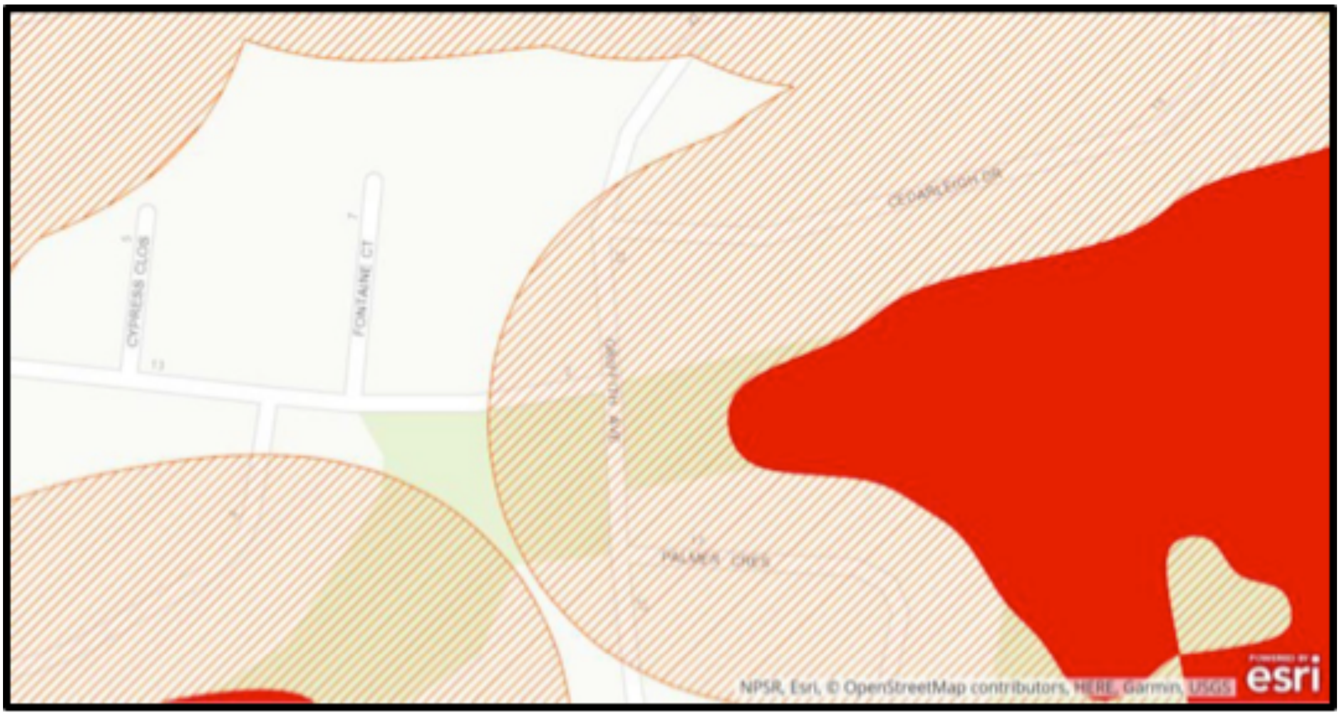


Figure 3: Example of a mapped bushfire prone area, including the potential impact buffer (land within 100 linear metres of mapped vegetation of greater than 4,000k/Wm fireline intensity). Source: SPP IMS

High Potential Bushfire Intensity

Potential Impact Buffer

2 *Life and house loss database description and analysis - https://publications.csiro.au/rpr/download?pid=csiro:EP129645&dsid=DS2*

3.2 Factors affecting bushfire hazard and risk

3.2.1 Potential fireline intensity

A new methodology for statewide mapping of bushfire prone areas in Queensland (CSIRO, 2014)[3,4,5] used to produce the current statewide Bushfire Prone Area map improved upon the previous SPP1/03 bushfire hazard mapping methodology approach by providing more in-depth consideration of regional differences in fire weather severity and diversity of vegetation types. Accordingly, bushfire prone areas were identified, mapped and categorised as a function of potential fireline intensity (kW/m).

Crown fires have the potential to dramatically increase fire intensity with the addition of the crown fuel and changes to the wind field. This will produce a related increase in ember production and spotting.

Fireline intensity greater than **30,000 kW/m** is commonly understood as blow-up conditions. Intensities exceeding 30,000 kW/m were a defining feature of the 2009 Black Saturday Fires.[11]

Vegetated parts of the landscape that would carry a vegetation fire at a intensity lower than 4,000 kW/m are categorised as grass fire prone land or low hazard areas (e.g. rainforest or water or

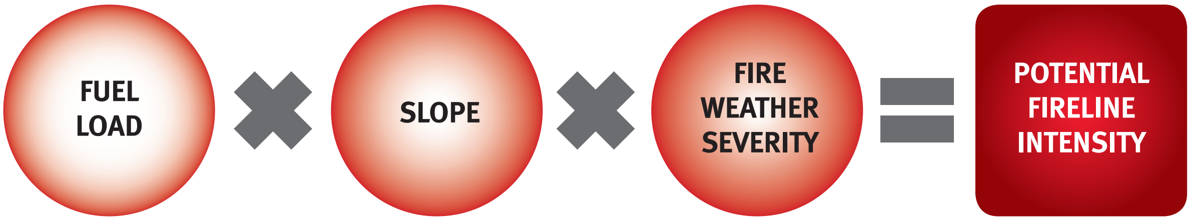


Figure 4: Method for calculation of potential fireline intensity.[6]

Potential fireline intensity is a function of fire weather severity (measured by the Forest Fire Density Index or FFDI), landscape slope and fuel load (refer Figure 4) based on classified vegetation communities according to the method described by the CSIRO methodology cited above.

Fireline intensity is a measure of energy released from the flame or combustion zone, one of whose sides is a unit length of fire front (measured in kilowatts per metre of flaming front).[7] The intensity depends on the heat of combustion of the fuel, the forward rate of spread and the amount of fine fuel consumed in the flaming front. This is a good predictor of the available energy that can be released from a fire based on certain weather, fuel and topographical information. The impact of this released energy affects the success of suppression efforts and scale of damage.

Potential fireline intensity is a standardised measure of the rate that an advancing head fire would consume fuel energy per second, per metre of the fire front.[8]

Areas identified as a medium, high or very high potential bushfire intensity in the SPP bushfire prone area mapping have a 4,000 k/Wm + fireline intensity.

A fireline intensity of **4,000 kW/m** is estimated to be the approximate threshold for the effective and safe direct attack on a head fire with aircraft and machinery as very vigorous or extremely intense surface fire control efforts on head may fail and be dangerous.[9]

The threshold for continuous crown fire is **10,000 kW/m**. Control in this scenario is extremely difficult and all efforts at direct control are likely to fail. Direct attack is rarely possible. Suppression action must be restricted to the flanks and back of the fire.[10]

non-vegetated urban areas). In the event of a fire, direct manual attack at fire's head or flanks by firefighters with hand tools and water is possible. This is the level of fireline intensity where most planned burning takes place.

Very little spot fire activity occurs at less than 1,000 kW/m.[12] Constructed breaks should hold fires at the upper end of the scale, however, will still be challenging if the fuels are prone to ember production and spotting.[13]

3.2.2 Fire weather severity

Fire weather severity (FWS) for land use planning in Queensland is determined using three inputs under the methodology. These are weather variables, FFDI and climate change.

Weather variables

FWS is influenced by a range of weather variables including wind speed, relative humidity, temperature and atmospheric stability, as well preceding drought conditions.

Winds increase the rate of fire spread by 'driving' or tilting flames forward, increasing the rate at which the unburnt fuels ahead of the fire are preheated, thus increasing the rate of spread and the intensity of bushfires.[14]

Wind and convective updraughts carry burning embers ahead of the fire front. Embers are mainly burning fragments of bark, leaves and twigs, which have the potential to ignite new fires in suitably recipient fuels and/or infrastructure. Strong winds can also cause burning trees or branches to strike buildings or fences and block access and evacuation routes.

3 Leonard, J., Newnham, G, et al. (2014), *A new methodology for State-wide mapping of bushfire prone areas in Queensland.*
4 The method for determining potential fireline intensity for small patches and corridors of vegetation has been refined as described in Leonard, J. and Opie, K (2017), *Estimating the potential bushfire hazard of vegetation patches and corridors.*
5 Potential fuel loads and vegetation hazard classes were updated for SEQ in 2017, information available from QFES.
6 Leonard, J., Newnham, G, et al. (2014), *A new methodology for State-wide mapping of bushfire prone areas in Queensland.*
7 Byram, GM (1959), *Combustion of forest fuels* and Tangren CD (1976), *The trouble with fire intensity.*
8 Leonard, J. and Blanchi, R (2012), *Queensland bushfire risk planning project.*
9 Alexander and DeGroote (1989) https://fireandemergency.nz/assets/Documents/Research-and-reports/Report-21-Fire-Behaviour-as-a-factor-in-Forest-and-Rural-Fire-Supression.PDF
10 Ibid.
11 Cruz et al. (2015), *Empirical based models for predicting head fire rate of spread in Australian fuel types.*
12 Gould et al. (2008), *Project Vesta: Fire in Dry Eucalypt Forest: Fuel structure, Fuel Dynamics and Fire Behaviour.*
13 Alexander and DeGroote (1989) https://fireandemergency.nz/assets/Documents/Research-and-reports/Report-21-Fire-Behaviour-as-a-factor-in-Forest-and-Rural-Fire-Supression.PDF
14 Byram, GM (1959), *Combustion of forest fuels.*

Relative humidity (RH) is the ratio of moisture actually in the air versus the maximum amount of moisture which the air could hold at the same temperature. RH is a measure of the drying power of the air and this affects the fine fuel moisture content. RH is expressed as a percentage with moisture saturation (fog) being 100 per cent. As air can hold more moisture at higher temperatures, the RH alone does not give an absolute measure of moisture content.

When the RH is high, the fine fuels absorb moisture from the atmosphere. Under drying conditions (decreasing RH), the moisture of the fine fuels is desorbed to the atmosphere, lowering the fine fuel moisture content and increasing the likelihood of fire ignition. Very low levels of humidity support extreme bushfire behaviour.

Air temperature also plays a significant role in affecting atmospheric conditions, winds and fuel moisture content.

Weather variables do not operate in isolation from each other (or other factors that influence fire behaviour). For example, low humidity coupled with high temperatures and hot winds dry out vegetation, increasing bushfire potential.

Forest Fire Danger Index

The McArthur Forest Fire Danger Index[15] (or FFDI) is the most common proxy of fire weather severity in Australia and is used for bushfire hazard assessments, emergency management and in regulations such as the Australian Standard 3959–2018 Construction of buildings in bushfire-prone areas.

Unlike Queensland's adoption of AS 3959–2018 that uses a single FFDI value for all of Queensland (40), the estimate of fire weather severity used as an input to identifying the SPP bushfire prone areas in Queensland recognises that weather conditions vary across the state.

Spatially explicit 5% annual exceedance probability (AEP) fire weather event FFDI values for Queensland have been estimated from a gridded (83 kilometre, three-hourly resolution) prediction of FFDI from long-term spatial weather products produced by the Australian Bureau of Meteorology (BoM).[16] The adopted FFDI values reflect a 5% AEP weather event. Adopted FWS (i.e. 5% AEP fire weather event FFDI) values for Queensland vary from 50 in Southeast Queensland and Cape York bioregions to 130 in the south-western parts of the state.[17]

The identification of location-specific FWS for the purposes of determining bushfire hazard is described in section 5.4.2 of this document. SPP mapping data of FWS can be obtained in raster format from the Queensland Government data portal under the title 'Bushfire hazard area – Bushfire-prone area – inputs – Queensland'.

Climate change

Climate change projections indicate an increase in the likelihood, intensity and extent of areas affected by bushfires and extended fire seasons. Climate change projections were incorporated into the SPP mapping of bushfire prone areas.

This was achieved by incorporating an adjustment to the gridded weather temperature and relative humidity data used to calculate 5% AEP fire weather event FFDI to reflect the expected climate in 2050 using an Intergovernmental Panel on Climate Change A1FI climate scenario.[18]

3.2.3 Slope

The slope of the land is a major determinant of fire behaviour, particularly the slope of the land under vegetation that contributes to bushfire hazard.

Fire burns faster as it travels up a slope, via preheating of unburnt fuels ahead of the fire, increasing the rate of spread and fireline intensity. Conversely, fires move more slowly as they travel downslope. Fireline intensity (kW/m) is a function of the rate of spread.[19]

As a general rule, the rate of fire spread (and fireline intensity) doubles up a 10-degree slope and quadruples up a 20-degree slope of the land.[20,21]

Where slope under hazardous vegetation is located downhill from the edge of the hazardous vegetation nearest to the asset location, it is considered 'downslope' irrespective of the slope of land between the asset and the edge of the hazardous vegetation.

Where the slope under hazardous vegetation is located uphill from the edge of the hazardous vegetation nearest to the site, it is considered 'upslope' irrespective of the slope of land between the site and the edge of the hazardous vegetation.

Accordingly, development located above hazardous vegetation (the vegetation is 'downslope') is typically subject to higher levels of potential ember attack, radiant heat, convective heating and longer flame lengths than development which is located below hazardous vegetation (the vegetation is 'upslope').

A statewide 25 metre resolution digital terrain model (DTM) was used to produce a statewide map of maximum landscape slope, representing the maximum potential slope of the landscape which could influence the rate of bushfire spread and fireline intensity.[22] The SPP map of maximum landscape slope can be obtained in raster format from the Queensland Government data portal under the title 'Bushfire hazard area – Bushfire-prone area – inputs – Queensland'.

The methodology used in section 5 describes procedures for measuring localised slope when determining suitable asset protection zone widths from hazardous vegetation.

15 *McArthur, AG (1967), Fire behaviour in eucalyptus forests.*
16 *Leonard, J., Newnham, G, et al. (2014), A new methodology for State-wide mapping of bushfire-prone areas in Queensland.*
17 *Ibid.*
18 *Ibid.*
19 *Byram, GM (1959), Combustion of forest fuels.*
20 *Assumes that slope and wind direction are aligned.*
21 *Leonard, J. and Blanchi, R (2012), Queensland bushfire risk planning project.*
22 *Byram, GM (1959), Combustion of forest fuels.*

3.2.4 Fuel load and vegetation

Vegetation is the primary source of fuel and combustion of fuel powers a bushfire.

In general, vegetation communities with a higher quantity of fuel available to burn (i.e. fuel load) will tend to give rise to higher intensity fires and present a higher risk to people and property. However, the fuel arrangement and composition, not just the quantity (load) also contributes to the rate of fire spread and fireline intensity. Only total fuel load is used in this planning process.

Under the SPP's planning parameters, the potential fuel load that a vegetation community would normally accumulate 10 years after a fire is used to estimate the fireline intensity and bushfire hazard, not the actual fuel load on any particular day or year. This approach ensures consistency in planning and design.

The potential fuel load represents the ambient fuel load that is combustible under severe weather conditions. It is calculated as the sum of surface fuel load, near-surface fuel load, elevated fuel load and standing bark fuel. The potential fuel load represents the 80th percentile fuel load for each fuel category based on the long-term unburnt condition.[23]

Long-term and sustained reduction of fuel load by clearing, cultivation or management of vegetation reduces the potential fireline intensity and hazard level.

The availability of fuel is a function of its moisture content, type, structure, arrangement and the size and severity of the fire.

Fine fuel load, structure and composition, is described using a series of vegetation hazard classes (VHCs). VHCs are based on the Queensland Herbarium's statewide regional ecosystem mapping at the broad vegetation group[24] level, and several other mapping data sets such as foliage projective cover mapping.

Hazardous vegetation within rural and urban landscapes is frequently fragmented, giving rise to smaller patches and narrow corridors of vegetation that are very likely to have lower fireline intensities than larger expanses of continuous vegetation.

The spatial context of these patches and corridors of vegetation has a major influence on the likelihood of fire arrival, the severity of a fire at the boundary of the patch, and the behaviour of a fire within the patch.

Because of the potential contribution of grass fires to the intensity of fire in tree- or shrub-dominated hazardous vegetation, bushfire hazard assessment of patches and corridors needs to take account of the fuel properties of adjacent vegetation or other land uses.

Continuous vegetation, such as forest, shrubland or grass, has a generally uniform distribution of fuel that supports a continuous flame front under a range of weather conditions. In contrast, non-continuous vegetation or land uses, such as built-up areas or water bodies, are not expected to support a continuous flame front because they do not contain sufficient fuel load to carry a fire.

The SPP VHC and associated potential fuel load input data can be obtained in shapefile format from the Queensland Government data portal under the title 'Bushfire hazard area – Bushfire-prone area – inputs – Queensland'. The format for VHC categorization in Queensland is described in Figure 6 .

3.3 Potential bushfire impacts and attack mechanisms

The main sources of direct bushfire attack that give rise to loss of life, and damage to property and infrastructure are[25]:

- direct flame contact
- radiant heat exposure
- convection and conduction
- ember attack
- wind and smoke attack.[26]

These attack mechanisms are not mutually exclusive and rarely operate in isolation. People and property are often subject to a combination of bushfire attack vectors.

Although bushfire attack vectors operate at a range of spatial scales, measures to reduce or mitigate the effects of direct flame contact, radiant heat exposure and ember attack occur at scales that can be addressed via land use planning and development assessment frameworks. The following sections describe these three bushfire attack mechanisms and their potential impacts.

3.3.1 Direct flame attack

Direct flame contact occurs when flames from a bushfire are in direct contact with a building, structure or people resulting in ignition, burns and radiant heat exposure effects ('flame zone'). Direct flame contact is only an issue for development that is directly adjacent to bushfire prone areas. Direct flame contact can cause:

- rapid, pilot ignition of fuel and structures consisting of flammable materials such as timber fences, powerline poles and timber homes
- burns to exposed skin.

Flame contact has obvious and significant impacts on people, property and emergency services.

23 *The long-term unburnt condition represents greater than 10 years without burning.*
For further information see Leonard, J., Newnham, G, et al. (2014), A new methodology for State-wide mapping of bushfire-prone areas in Queensland.
24 *Neldner, VJ, and Niehus et al. (2015), The vegetation of Queensland: Descriptions of broad vegetation groups.*
25 *Leonard, J. and Blanchi, R (2012), Queensland bushfire risk planning project.*
26 *Wind attack is an indirect or secondary source of bushfire attack. Wind-driven attack may extend flame lengths and height, increasing ignition likelihood and radiant heat exposure. Wind is also responsible for promulgating burning embers and smoke. Although smoke has a negligible impact on buildings and structures, direct impacts on civilians and emergency services can be significant in terms of health and visibility.*

3.3.2 Heat exposure

Heat transfer occurs via three processes:

1. Convection: the transfer of heat via the movement of hot air. Under certain circumstances, bushfires can generate sufficient heat to modify the atmospheric conditions around the fire, creating a convection column that can transport embers and burning debris. This represents 60 per cent to 80 per cent of the total heat generated by a bushfire.
2. Conduction: the transfer of heat within the fuel itself. This is significant during the initiation of a bushfire but insignificant in terms of radiant heat exposure. This represents about two per cent of the total heat generated by a bushfire.
3. Thermal radiation or radiant heat: the transfer of heat by means of electromagnetic waves. The transfer of heat by radiation involves the carrying of energy from an origin to the space surrounding it in straight lines in all directions. The energy is carried by electromagnetic waves and does not involve the movement or the interaction of matter. This represents 20 per cent to 40 per cent of the total heat generated by a bushfire.

Exposure to radiant heat can:

- distort, crack and warp materials (e.g. glass windows and plastic tanks) leading to structural failure and provide opportunities for ember attack
- cause ignition of exposed materials such as walls, fences and powerline poles
- limit the ability of emergency services to safely operate (refer to Figure 5)
- cause death or injury to people, even at low levels of radiation exposure (refer to Figure 5).

The potential impacts of radiant heat exposure on people, property and emergency services (expressed as radiant heat flux, kW/m^2) are indicated in Figure 5.

Evidence suggests that fatalities inside structures are strongly associated with high levels of radiant heat exposure and possible flame contact.[27, 28]

Radiant heat flux (kW/m^2)	Potential effects
Greater than 40	• unpiloted ignition of timber walls and fences
	• direct flame contact likely
	• extreme levels of radiant heat
29–40	• failure of toughened glass
	• direct flame contact possible, extreme levels of radiant heat
	• unpiloted ignition of some timber species after prolonged exposure (e.g. several minutes)[29]
19	• failure of screened float glass
16	• blistering of skin with › 5 seconds exposure
12.5	• failure of plain glass
	• piloted ignition of dry timber elements after prolonged exposure (e.g. several minutes)[30]
10	• fabrics inside a building could ignite spontaneously with long exposure
	• critical limit for emergency services – firefighters cannot operate
	• life threatening with ‹ 1 minute exposure in protective clothing.
7	• fatal to an unprotected person after exposure for several minutes
4.7	• firefighter in protective clothing will feel pain (60 seconds exposure)
3	• firefighters can operate for a short period (10 minutes)
2	• pain is felt on bare skin after 1 minute exposure (non-fatal)
	• firefighters with protective clothing can withstand this exposure level for a few minutes however, they are likely to experience rise in core body temperature
1	• maximum for indefinite skin exposure
0.5	• direct sunlight at noon on a bright sunny day

Figure 5: Potential effects of radiant heat.[31]

27 Blanchi, R, Leonard, J, et al. (2012), Life and house loss database description and analysis: Final report.
28 Blanchi, R, Leonard J, et al. (2014), Environmental circumstances surrounding bushfire fatalities in Australia 1901-2011.
29 Subject to exposure time, timber species and dryness of timber.
30 Blanchi, R, Leonard, J, et al. (2012), Life and house loss database description and analysis: Final report.
31 NSW Rural Fire Service (2010), Planning for bush fire protection.

3.3.3 Ember attack

Embers are small pieces of burning foliage, twigs and bark which are transported by wind, often ahead of the fire front. The main sources of embers are tree bark, fine litter and other fine fuels.

Ember attack is the main cause of damage to and loss of houses in Australia due to bushfire. Burning or 'live' embers are problematic because they can:

- Travel long distances and lead to 'spotting' by starting new fires ahead of the fire front (including fuel sources around homes such as fences, outdoor furniture and surface and near-surface fuels in gardens) up to 40 kilometres under severe conditions; however, 80 per cent of 'spotting' occurs within 100 metres of hazardous vegetation.
- Penetrate small gaps and holes, infiltrating buildings and structures, resulting in single or multiple sources of ignition.
- Accumulate around vegetation, buildings or other structures (e.g. roof gutters, decks and patios), resulting in slow onset ignition which can then engulf buildings and structures during or after a fire front passes. The accumulation of embers and ember density are estimated to be responsible for up to 90 per cent of ignitions leading to building loss in an urban environment.[32]

Through spotting, embers are a major contributor to the failure of fire containment methods and suppression. This can have direct impacts on people and property during a bushfire.

32 Blanchi, R, Leonard, J, et al. (2012), *Life and house loss database description and analysis: Final report.*

4. PROCESS FOR PREPARATION AND REVIEW OF STATEWIDE SPP IMS BUSHFIRE PRONE AREA MAPPING

4. Process for preparation and review of statewide SPP IMS bushfire prone area mapping

4.1 Introduction

The State Planning Policy July 2017 (SPP) identifies the State Planning Policy Interactive Mapping System (SPP IMS) bushfire prone area mapping layer as a tool to be localised for, and appropriately integrated into, local governments' planning instruments in a way that achieves the state's interest.

In some circumstances, the bushfire prone area footprint may change after local verification, more accurately depicting potential bushfire hazard. This provides a higher accuracy product to inform hazard and risk assessment processes for decision makers.

4.2 Methodology used for preparing the SPP IMS bushfire prone area mapping

The creation of the SPP IMS bushfire prone area mapping involved the following steps and processes.

4.2.1 Creation of vegetation hazard class and potential fuel load maps

Vegetation hazard classes (VHCs) and associated potential fuel load maps are prepared from a combination of regional ecosystem maps, foliage project cover maps, land use maps, water body maps and tree plantation maps (for additional information, refer to section 6).

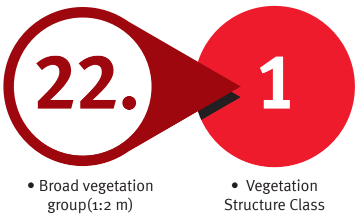


Figure 6

VHCs are described according to a binomial coding system, a combination of the vegetation community's broad vegetation group (BVG) classification (1:2 million) and the structural characteristics of the vegetation (Figure 6).

The first part of the VHC code refers to the 35 broad vegetation groups (1:2 million) in Queensland, according to Neldner et al. (2015)[33], with an additional eight categories representing built-up areas such as urban centres and towns, developed rural areas, cultivated areas (intensive and broad acre agriculture and plantations) and water bodies. The second part of the code describes six vegetation structure classes (refer Figure 16) ranging from mid-dense trees to shrubs to nil vegetation.

Where a patch or corridor of continuous tree- or shrub-dominated vegetation is surrounded by a continuous fuel type (such as unmanaged grassland, horticulture or cropping areas), fires that enter that patch of trees or shrubs from the adjacent grassland can quickly achieve a fireline intensity comparable to larger patches of continuous tree or shrub vegetation.

On the other hand, where a patch or corridor of hazardous tree- or shrub-dominated vegetation is surrounded by discontinuous fuel (such as grassland under 10 centimeters or low-hazard areas such as densely built-up areas or water), a larger patch size and width of vegetation is required before a fire would reach sufficient intensity to pose a significant threat to life or property (i.e. fireline intensity greater than 4,000 kW/m).

Details of fuel continuity of vegetation hazard classes, life form, height, and relative density of vegetation structural classes are provided in Figures 12 to 16 in section 6.

4.2.2 Creation of slope maps

Landscape scale slope maps are created from a 25 metre resolution digital terrain model by calculating the maximum slope (in degrees) from the central pixel in a group of 9 x 9 cells to the eight adjoining cells in that group.

4.2.3 Creation of potential fire weather maps

A potential severe fire weather map is created by a four-stage process:

1. Develop a gridded prediction of FFDI for Queensland, on an 83 kilometre grid and at three-hourly intervals, over the period from 1979 to 2011[34] from temperature, wind, relative humidity and precipitation weather products produced by BoM.
2. Incorporate future climate trends to 2050 by adjusting temperature and relative humidity using the Intergovernmental Panel on Climate Change A1FI climate scenario.[35]
3. Calculate the 5% AEP (i.e. 5% chance of occurring in any given year) FFDI based on a statistical distribution of FFDI for each cell of the adjusted BoM weather grid.
4. Resample the 83 kilometre BoM grid to 25 metre and to modify near-coastal FFDI estimates to account for an underestimation of FFDI in BoM grid cells that span both land and ocean.

4.2.4 Creation of potential fireline intensity maps

The three inputs – potential fuel load, potential severe fire weather and maximum slope – are combined using equation 1 below to calculate potential fireline intensity (PFI).

Equation 1. Calculation of potential fireline intensity:

$PFI = 0.62\ PFL\ 2\ \text{FFDI}\ \exp(0.069\ \text{Slope})$

Where:

PFI = potential fireline intensity (kW/m)

PFL = potential fuel load (tonnes / ha)

FFDI = potential severe fire weather (FFDI)

Slope = max slope (+20 ‹ slope ‹ -15, degrees)

4.2.5 Creation of potential bushfire intensity and potential impact buffer maps

Potential bushfire intensity maps are generated by classifying the potential fireline intensity for inclusion in the bushfire prone area as 4,000+ kW/m, with an additional potential impact buffer of 100 linear metres width delineated around the extent of hazardous vegetation identified as bushfire prone. The potential impact buffer forms part of the bushfire prone area.

33 Neldner, VJ, and Niehus et al. (2015), *The vegetation of Queensland: Descriptions of broad vegetation groups.*
34 This year range maybe extended to the present year depending on available datasets from the BoM.
35 This report and additional information regarding more recent climate scenarios can be found at https://www.ipcc.ch/report/emissions-scenarios/ accessed August 2019.

4.2.6 Modify potential intensity of small patches and corridors

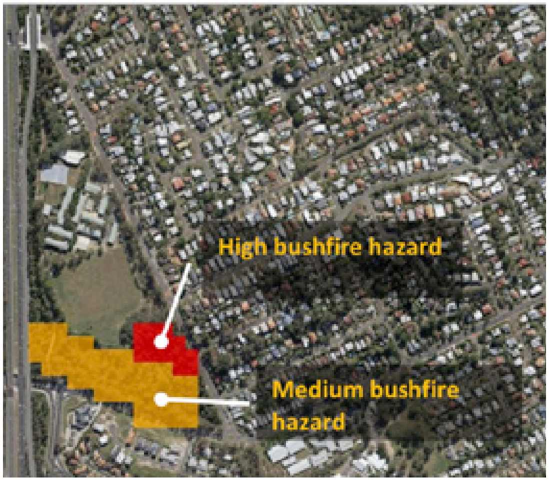
The SPP IMS bushfire prone area mapping layer has been further refined in some regions of Queensland. This process involves applying the following patch and corridor mapping rules to reflect the likelihood of lower fireline intensities in smaller vegetation patches and vegetation corridors.

Step 1

Remove sub-hectare areas of continuous fuel (i.e. surrounded by either no fuel or non-continuous fuel) that are further than 100 metres from any other continuous fuel greater than two hectares. These areas are not likely to ignite due to their disconnection with fuels that can carry running fire fronts. If ignited they are most likely to be caused by point ignitions that require both distance and area to develop into a fire front of considerable hazard.

If a fire front emerges from a one hectare patch, it is likely to be narrow and significantly less intense than a fire front that has had sufficient time and area to develop. The combination of these likelihood and intensity estimates deem it to be equivalent to a less than 4,000 kW/m fireline intensity and, accordingly, are considered as low hazard for the purpose of land use planning and development assessment.

(a) Example of vegetation patches of ‹1ha surrounded by discontinuous-fuel land cover and vegetation patch › 1ha



(b) Resulting Bushfire Prone Area mapping ittustrating removal of small isolated vegetation patches ‹ 1ha

Figure 7: Characteristics of appropriate sub-hectare area removal. Source: Leonard et al 2017.

Step 2

Downgrade the effective fuel load of continuous vegetation patches measuring (a) 1 to 2 hectares (by 66 per cent), and (b) 2-3 hectare patches (by 50 per cent) if the patch is surrounded by either non-continuous fuel or a low-hazard vegetation or land use type, and if the patch is further than 100 metres from any other continuous-fuel vegetation patch greater than two hectares.

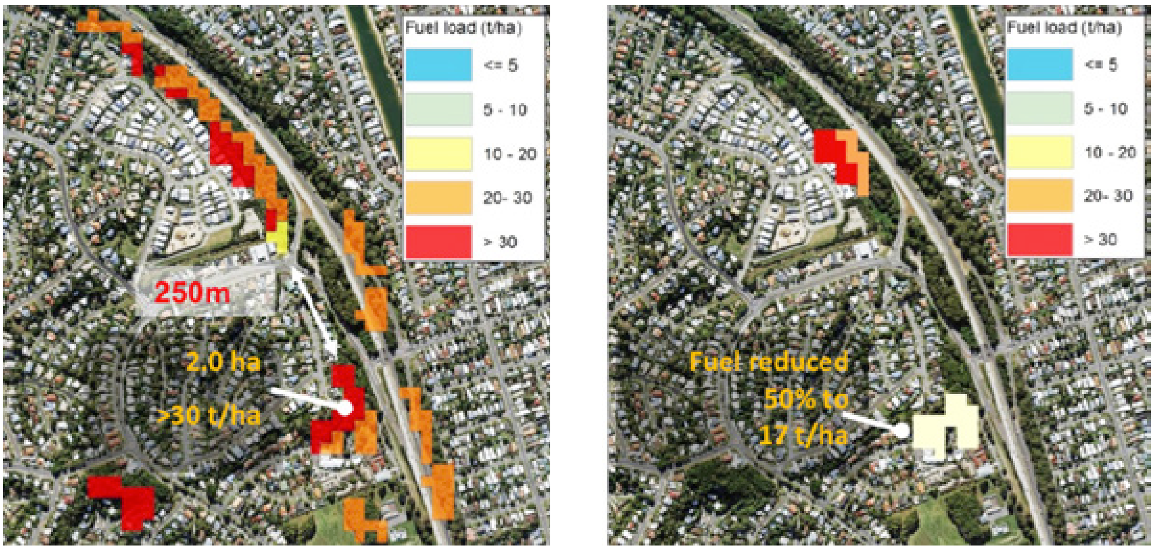
Patches of this size (‹ 3 hectares) and proximity to larger patches of continuous vegetation are less likely to ignite due to their disconnection with vegetation that can carry running fire fronts. If ignited, these patches are most likely to be ignited by point ignitions that require both distance and size to develop into a significant fire front of high intensity.

If a fire front emerges from these patches, it is likely to be narrow and of significantly lower intensity than a fire front that has had sufficient time and size to develop. The combined effect of both lower ignition likelihood and lower fireline intensity is likely to result in a fireline intensity that is significantly less than larger areas of continuous vegetation.

PATCH SIZE	APPROX. PATCH DIMENSIONS	ASSUMED DECREASE OF FIRE-LINE INTENSITY
(a) 0.5 – 2 hectares	100m x 100m – 100m x 200m	66%
(b) 2 – 3 hectares	100m x 200m – 150m x 200m	50%

(a) Greater than 2 hectares patch prior to fuel load downgrade

(b) Less than 2 hectares patch after fuel load downgrade



(a) Patch between 2 to 3ha prior to fuel load downgrade

(b) Patch between 2 to 3ha after fuel load downgrade

Figure 8: Characteristics of effective fuel load downgrades for small patches. Source: Leonard et al 2017.

Step 3

Remove narrow corridors and areas of continuous fuel ‹ 50 metres in width that are not sufficiently wide to support a fully developed flame front. These areas are less likely to ignite due to their disconnection with fuels that can carry running fire fronts. If ignited by a point or line ignition, these areas will limit the fire head width and, as a result, the fireline intensity. The combined effect of lower ignition likelihood and lower intensity is likely to result in fireline intensity of less than 4,000 kW/m, and this presents a low hazard to land use planning and development assessment.

(a) Continuous fuel 50m at narrowest part of corridor

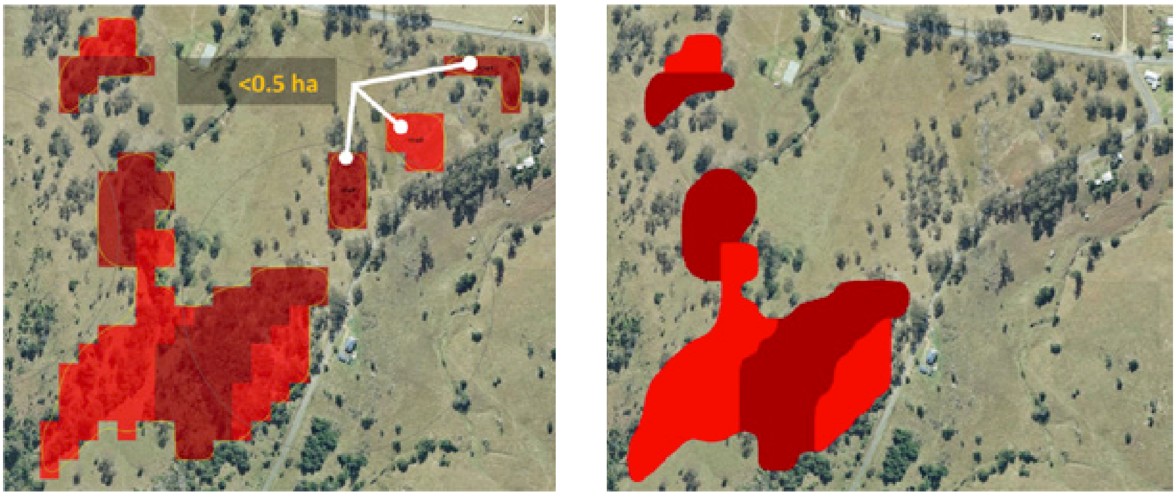
(b) Narrow corridor ‹75m has been removed

Figure 9: Characteristics of the effective removal of narrow corridors less than 50m. Source: Leonard et al 2017.

Step 4

Small fragments are removed because of the varied quality of the vegetation mapping inputs. Only patches of tree or shrub dominated vegetation greater than 0.5 hectares are consistently observed with high confidence. Smaller patches are often observed to contain mixtures of different land uses or continuous and discontinuous vegetation. As a consequence, isolated patches of hazardous vegetation less than 0.5 hectares in size are not likely to generate a fireline intensity of 4,000 kW/m or provide high exposure to built assets.

Therefore, isolated patches of less than 0.5 hectares, of very high, high or medium potential bushfire hazard are downgraded to low hazard. Any patch less than 0.5 hectares of the same class is downgraded to low hazard (no longer bushfire prone area).



(a) Hazardous vegetation patches ‹ 0.5ha

(b) Patches of hazardous vegetation ‹ 0.5ha removed

Figure 10: Characteristics of effective removal of small fragments ‹0.5ha. Source: Leonard et al 2017.

4.3 Methodology for local government review of SPP IMS bushfire prone area mapping

A local government may seek to locally refine the SPP IMS bushfire prone area mapping by following these steps and processes.

4.3.1 Undertake reliability assessment

Estimate the reliability of maps produced using this methodology. The steps are:

Step 1 – Select representative 'cells of interest'

Decide on an adequate number of representative 1 kilometre x 1 kilometre 'cells of interest' to cover the range of landscapes and land uses in the local government area, while considering future development priorities, the diversity of landforms, vegetation types and other factors affecting the risk of bushfires to people and property. The minimum number of 'cells of interest' is 45, but can be increased to 120 for diverse local government areas. These representative 'cells of interest' should include one or both of these two sample sets:

- sample set (a): randomly selected cells to confirm the reliability of mapping across the local government area
- sample set (b): subjectively selected (non-random) cells in known areas of poor reliability for initial or iterative refinement of the mapping.

All local governments will need to complete sample set (a) to confirm the reliability of bushfire prone area mapping, whereas set (b) is only required where the local government is seeking to improve mapping in conjunction with Queensland Fire and Emergency Services (QFES).

The 'cells of interest' should span all bushfire prone area categories – very high potential bushfire intensity, high potential bushfire intensity, medium potential bushfire intensity and potential impact buffer.

Step 2 – Assess and record the reliability of the bushfire prone area and VHC mapping

Within each 1 kilometre x 1 kilometre 'cell of interest', undertake a desktop assessment of the reliability of bushfire prone area and VHC mapping for each of the four 200 metre diameter circular assessment areas. An expert with experience in bushfire management and vegetation management should estimate the reliability of the mapping by referring to recent aerial photography, other mapping sources and local knowledge.

Reference to the relevant version of the Queensland Herbarium's regional ecosystem mapping is particularly useful. The assessment should also address the bushfire prone area mapping methodology, relevant input data sets (e.g. potential fire weather severity, maximum landscape slope) and the application of this information for land use planning, bushfire mitigation planning or risk assessment.

The reliability of each circular assessment area should be recorded as either:

- Satisfactory (S):
  - mapped boundaries coincide with the extent of vegetation or land use boundaries evident on aerial photography; differences are usually within 25 metres and occasionally within 50 metres, and
  - mapped hazard classes provide a close approximation of the potential bushfire intensity classes.

or

- Not satisfactory (N)
  - mapped boundaries are quite different from current vegetation and land use boundaries; differences are often 50 metres or more, and
  - mapped classes provide a poor approximation of potential bushfire intensity classes, or
  - mapping fails to adequately identify significant areas of hazardous vegetation, where either potentially hazardous vegetation (potential bushfire intensity classes) is not mapped (omission) or mapping indicates the presence of potentially hazardous vegetation that is absent (commission).

Step 3 – Tally reliability results

Results of the reliability assessment should be summarised for all areas of interest by calculating the number and percentage of circular assessment areas estimated as satisfactory (S) or not satisfactory (N) for the randomly selected cells.

Step 4 – Consider suitability of mapping

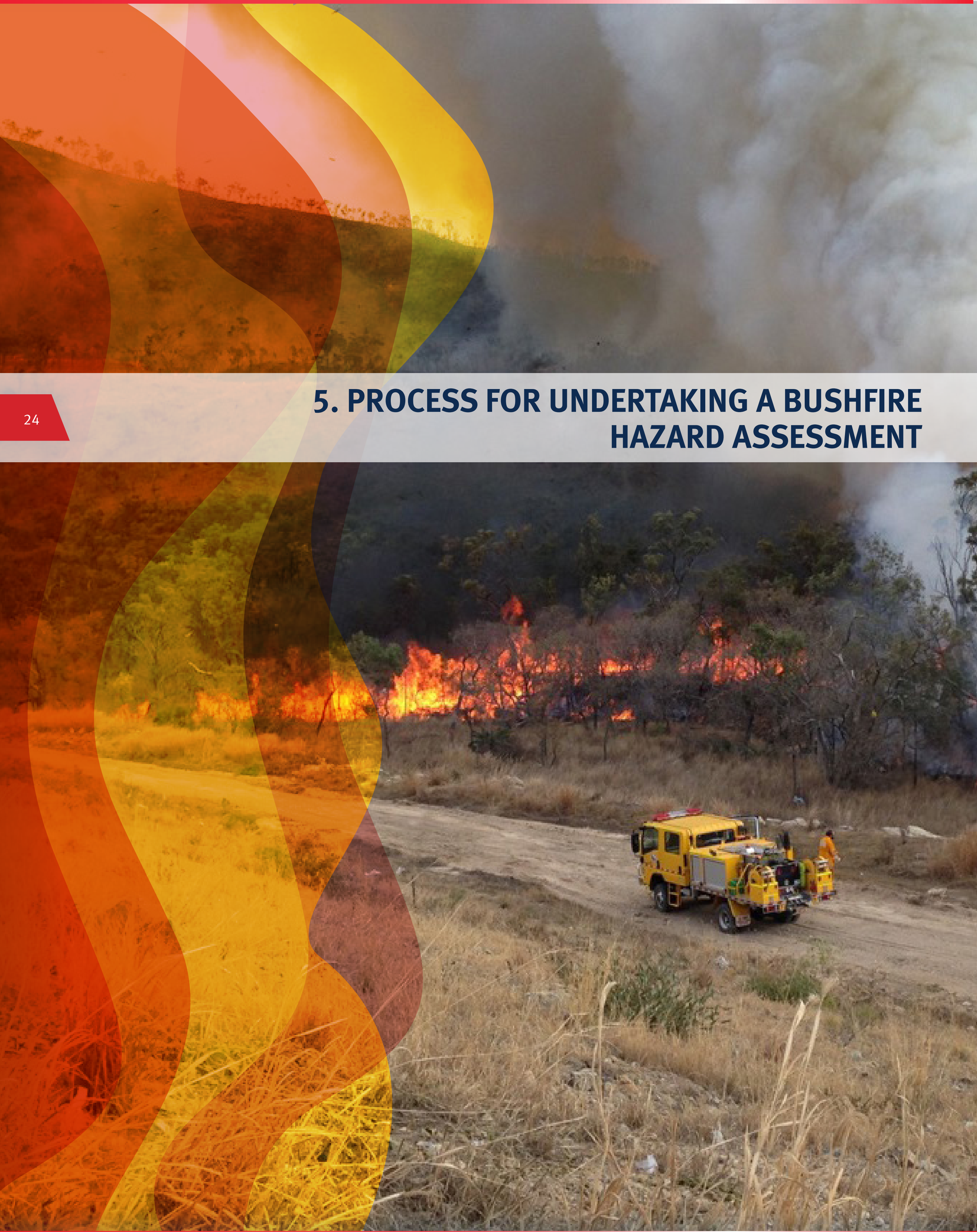
A report of bushfire prone area mapping should be prepared to summarise results of the reliability assessment and the suitability of maps for planning purposes. In general, a reliability of 90 per cent or greater for bushfire prone area maps is considered suitable for the preparation of local government planning schemes and other strategic planning decisions.

4.3.2 Locally refine mapping

Where mapping is not of sufficient reliability, local governments may seek to either:

- liaise with QFES to confirm and resolve identified mapping issues in statewide bushfire hazard area maps, or
- prepare local scale bushfire hazard area maps using improved local vegetation or slope mapping applying the same methodology as the state used in preparing the SPP IMS bushfire prone area mapping, as described in section 4.2.

5. PROCESS FOR UNDERTAKING A BUSHFIRE HAZARD ASSESSMENT



5. Process for undertaking a Bushfire Hazard Assessment

5.1 Introduction

This section is applicable where a local government's planning scheme contains provisions that enable or require an applicant to undertake a Bushfire Hazard Assessment (BHA) to review the applicable bushfire prone area mapping for an individual assessment area.

The applicant is then able to determine the extent of bushfire prone areas and level of risk to which a site is exposed, including assessment of spatial factors that contribute to bushfire hazard. In turn, this enables an applicant to propose alternative asset protection zone widths to the acceptable levels contained in the planning scheme.

Local governments may provide this option to applicants when they believes there is merit in allowing an applicant to:

- verify the precision, accuracy or currency of the map of bushfire prone areas or map input datasets (refer to section 2 for further explanation of why this is often justifiable), or
- modify any of the input variables applied in creating the planning scheme mapping to reflect changes that may have occurred over time, such as vegetation hazard class.

In addition, a BHA may be required by a local government as part of a development proposal that involves areas designated for revegetation and rehabilitation, to ensure this will not create a new/expanded area that would meet the criteria of becoming a bushfire prone area if assessed in accordance with the methodology used to generate the State Planning Policy Interactive Mapping System (SPP IMS) mapping.

Conclusions of a detailed BHA are typically presented as a bushfire hazard report or as part of a Bushfire Management Plan (BMP). Refer to section 8.3 for details to be included in a bushfire hazard report or BMP.

A local government may wish to either refer applicants to this technical guidance document or provide information about undertaking a BHA and preparing a bushfire hazard report or BMP in its planning scheme (for example as a planning scheme policy).

5.2 Overview: the three stages of a BHA

The BHA process consists of three stages:

1. Reliability assessment: The purpose of the reliability assessment stage is to verify the reliability of existing bushfire prone area mapping and streamline the detailed BHA process.
2. Hazard assessment: The reliability assessment stage determines the extent of bushfire prone areas and level of risk to which a site is exposed, including an assessment of spatial factors that contribute to bushfire hazard. Where the outcomes of the reliability assessment suggest that the precision and/or accuracy of the bushfire prone area map or map input datasets are insufficient or an applicant seeks to modify input data, a hazard assessment involving field investigations or ground truthing may be required. This would include the provision of sufficient evidence to support a change to bushfire prone area input data and remapping, or classification of the extent of bushfire prone areas and potential impact buffer for the purposes of the development application.
3. Separation and radiant heat exposure: Using the site specific assessment of factors, this stage comprises calculating the asset protection zone width needed to achieve the radiant heat flux limits identified in the planning scheme, using the Bushfire asset protection zone width calculator outlined in section 7.

Figure 11 below provides an overview of the BHA process.

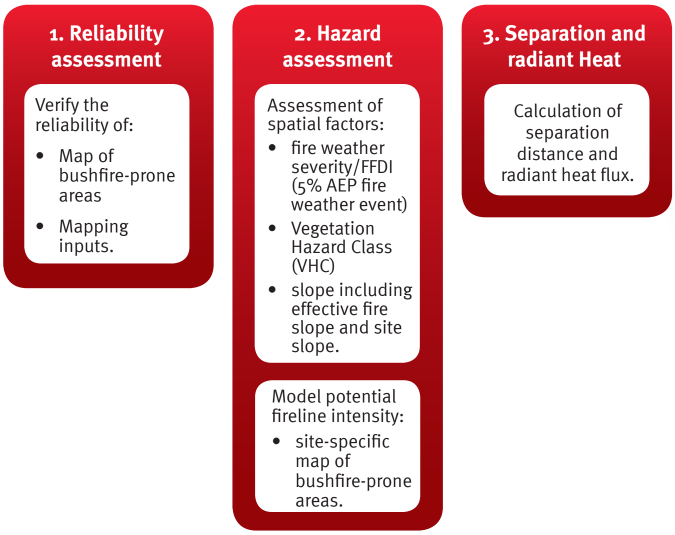


Figure 11: An overview of the Bushfire Hazard Assessment (BHA) process.

The BHA process adapts the method used to generate the SPP IMS bushfire prone area mapping described in 'A new methodology for State-wide mapping of bushfire prone areas in Queensland'.

The process enables applicants to either:

- adopt the input values for FFDI (5% AEP fire weather event), vegetation hazard classes (VHCs) and maximum landscape slope from the SPP bushfire prone area mapping and proceed to calculate fireline intensity and radiant heat flux levels, or
- create a local scale bushfire prone area map based on field surveys, mapping and modelling of spatial factors that contribute to potential fireline intensity.

5.3 Stage 1 – Reliability assessment

5.3.1 Approach

Although statewide bushfire prone area mapping is regularly updated, land use and vegetation cover, key contributors to bushfire hazard, are subject to change, particularly regarding the extent of hazardous vegetation.

Accordingly, first step of the BHA is to undertake a reliability assessment to determine whether the site's observed characteristics are consistent with the inputs used to create the mapping and the mapping outputs.

A reliability assessment is undertaken for the site and all land within 150 metres of the proposed development.

Where existing mapping of bushfire prone area input data is assessed as satisfactory, the map input data can simply be applied to determine radiant heat flux and asset protection zone width and then users proceed directly to Stage 3 - calculation of separation and radiant heat exposure.

Where the precision and/or accuracy of the bushfire prone area map or map input datasets are insufficient, the reliability assessment provides a mechanism to undertake a more detailed assessment to confirm the extent of bushfire prone areas.

5.3.2 Data sources

When undertaking a reliability assessment, relevant data sources to be consulted include:

- bushfire prone area mapping inputs:
  - in local government planning scheme mapping, or
  - if local government planning schemes reference out to the SPP IMS, data is available in raster format from the Queensland Government data portal as 'bushfire hazard area – bushfire-prone area – inputs – Queensland'
- recent aerial photography
- local knowledge
- field observations.

5.3.3 Procedure

The procedure for undertaking a site reliability assessment involves three steps:

1. Confirm the extent of mapped bushfire prone areas correlates with the extent of hazardous vegetation. This ensures the areas mapped as bushfire prone actually contain hazardous vegetation. This step can be undertaken using a combination of recent aerial photography, other available mapping and site observations.
2. Confirm the classification of hazardous vegetation is consistent with the mapped VHC. This ensures the underlying vegetation hazard class is consistent with the mapped hazard class (e.g. areas mapped as VHC 9 actually contain 'moist to dry eucalypt closed to open forests usually on coastal lowlands and ranges'.
3. Confirm site and effective slopes are generally consistent with the mapped maximum landscape slope.[36] This ensures the underlying slopes are consistent with the mapped maximum landscape slope. Although slope is unlikely to change substantially, landscape slope may be affected by development and earthworks on adjoining sites. Observed slopes that are within two degrees of the mapped maximum landscape slope are considered reliable (i.e. the maximum landscape slope can be used as an input to the State Planning Policy July 2017 (SPP) Bushfire asset protection zone width calculator).

Assessors should proceed to the hazard assessment stage where the results of any step indicate that errors or omissions in the mapping exist.

Where the results of this procedure indicate the input mapping is reliable, assessors can use the map input data and proceed to stage 3 to calculate separation and radiant heat exposure using the Bushfire asset protection zone width calculator outlined in section 7.

Example:

The bushfire prone area map indicates that part of the site is located within the potential impact buffer and within 100 metres of mapped areas with a medium, high or very high potential bushfire intensity.

Site inspection and comparison of aerial photography taken over a period indicates that some of the nearby vegetation on land mapped with a medium, high or very high potential bushfire intensity has been cleared and replaced with sparsely vegetated areas and built-up areas.

A detailed assessment may be necessary to demonstrate changes in the level of hazard and/or the location of the potential impact buffer.

The development area may require re-mapping of vegetation hazard classes and spatial modelling of bushfire prone areas, together with sufficient supporting evidence (e.g. time series aerial photography).

5.4 Stage 2 – Hazard assessment

5.4.1 Approach

The second step of the BHA involves the identification, ground truthing and mapping of spatial factors that contribute to potential fireline intensity and production of a site specific map of bushfire prone areas.

The hazard assessment must include the development footprint and all land within 150 metres of the development footprint.

The hazard assessment may require the re-modelling of bushfire behaviour and allow for potential re-mapping of the extent of bushfire prone areas. Re-modelling would require access to skills in spatial analysis and modelling, including the use of specialist geographic information system (GIS) software.

36 Available in raster format, from the Queensland Government data portal if mapping is referenced out to the statewide interactive mapping system.

5.4.2 Procedure

The procedure for undertaking a hazard assessment involves four steps:

1. Identify fire weather severity

Identify all FFDI (5% AEP fire weather event) values within the assessment area. Data can be obtained from the bushfire hazard area – bushfire-prone area – inputs – Queensland, which is available in raster format from the Queensland Government data portal.

Note – The site-specific FFDI (5% AEP fire weather event) index value is to be adopted for hazard assessment and modelling purposes. The FFDI value of 40, adopted in method 1 of AS 3959–2009, should not be used as it fails to consider regional differences in weather severity that might be expected for the 5% AEP fire weather event. The adoption of locally applicable FFDI (5% AEP fire weather event) values does not conflict with AS 3959–2018, which explicitly allows for refinement of FFDI values where sufficient climate data and modelling is available (refer to notes, Table 2.1, AS 3959–2018).

2. Identify vegetation hazard class within the site assessment area from map of VHC

Although the potential fuel loads for a VHC cannot be modified, an alternative VHC may be proposed where the results of a reliability assessment or site specific botanical survey demonstrate differences between the observed classification or extent of VHCs and those indicated by the mapping inputs for vegetation hazard class which is available in Esri® shapefile (.shp) format, from the Queensland Government data portal (if local government planning scheme mapping refers out to the statewide interactive mapping system).

Where alternative VHCs are proposed, field assessment of vegetation communities must be undertaken according to the VHC assessment methodology. Fine-scale assessment of VHCs should be carried out by a suitably qualified person with experience in botanical survey methods. Field assessments may be supported by other forms of evidence including:

- air photo interpretation using current, high resolution aerial photography
- Queensland Herbarium mapping of broad vegetation groups (BVGs) and regional ecosystems.

VHCs are then identified and mapped according to the procedure described in section 6. The outputs of the VHC assessment are to include the following maps as spatial data:

- Observed vegetation hazard classes.
- A post development vegetation hazard class map, as a minimum, which incorporates the effects of the proposed development on the configuration of vegetation within the assessment area including all necessary clearing to support the development and infrastructure or to meet requirements for revegetation, landscaping or environmental offsets.

  Note – Development approvals on land within the assessment area can modify the extent of hazardous vegetation within the landscape in ways that increase or decrease potential fuel loads:

  › In the short term, current development approvals that permit clearing but are not acted upon (in whole or in part) tend to maintain or increase levels of hazard within the landscape. As such, where there is land within the site assessment area in this circumstance, the vegetation is to be mapped and classified according to its current extent.

  › Conversely, where areas of revegetation are proposed, or current development approvals require revegetation of cleared areas to achieve environmental outcomes, an increased hazard within the landscape, not apparent during the initial stages of development can occur. Where there is land within the site assessment area in this circumstance, the vegetation is to be mapped according to the approved revegetation extent and then classified as though the vegetation had reached its 'remnant state', including rules for patches and corridors of vegetation.

- Potential fuel loads based on the post development distribution of vegetation hazard classes within the assessment area.

3. Identify site slope and effective slope from the mapping inputs for maximum landscape slope and determine whether the proposed lots or buildings are upslope or downslope of hazardous vegetation

Two slope input parameters are required for the estimation of fire behaviour and separation:

1. Effective slope – the more important of the two, refers to the slope of the land under hazardous vegetation measured in degrees. Effective slope has a direct influence on the potential rate of fire spread and rate of fuel consumption.
2. Site slope – is the slope of the ground between the edge of the proposed development or site boundary and the edge of hazardous vegetation.

For simple assessments the effective slope is identified according to the following procedure:

- Determine the slope (in degrees) of all land within the assessment area, including the slope under each VHC. Where multiple combinations of slopes and VHCs exist, a conservative approach should be adopted to ensure the risk of bushfire attack, particularly flame attack, is adequately assessed.
- Determine whether the VHCs within the assessment area which contribute to bushfire hazard ('hazardous vegetation') are located upslope or downslope of the proposed development or lot boundary in accordance with AS 3959–2018:

  › where the slope of the land containing hazardous vegetation is downhill from the proposed development or lot boundary, it is considered 'downslope' irrespective of the site slope

  › where the slope of the land containing hazardous vegetation is uphill or is flat (i.e. 0 degrees) from the proposed development or lot boundary, it is considered 'upslope' irrespective of the site slope.

Site slope can be determined using either the statewide map of maximum landscape slope, local government data or based on post development site slope, for example, after earthworks are completed.

Note – Topographic data may be used to create an alternative map of landscape slope within the assessment areas from:

- a contour map available from the Queensland Spatial Catalogue (or Qspatial)
- via survey prepared by a Surveyors Board Queensland registered surveyor
- digital terrain model or LiDAR data available from the Queensland Spatial Catalogue.

4. Prepare detailed mapping updates of potential bushfire intensity and potential impact buffer locations and intensity levels

Where a change to the distribution or classification of VHCs within the assessment area is proposed, re-modelling of bushfire hazard may be undertaken to determine how the changes to VHCs (and fuel loads) affect potential fireline intensity.

Potential fireline intensity for the assessment area should be calculated in accordance with the method described in 'A new methodology for State-wide mapping of bushfire prone areas in Queensland'.[37]

This updated site specific map of bushfire prone areas and any input maps produced via the hazard assessment may then 'replace' the SPP map or planning scheme map for the purposes of assessing the application.

5.5 Stage 3 – Separation and radiant heat exposure

5.5.1 Approach

Radiant heat exposure may be calculated using either:

1. The Bushfire asset protection zone width calculator (preferred), or
2. Method 2 of Method 2 of AS 3959–2018, subject to adoption of:
   - Site specific values of FFDI (5% AEP fire weather event) determined in accordance with procedure 5.4.2, Step 1.
   - Site specific vegetation hazard classes and their associated potential fuel loads determined in accordance with procedure 5.4.2 Step 2, together with modified surface fuel loads (w) for certain vegetation hazard classes.

For all forest and woodland vegetation hazard classes where fuel is continuous, surface fuel load (w) is the sum of surface and near surface fuel load for the purposes of calculating the rate of spread in Step 6 of Method 2 in AS 3959–2018. Figures 13, 14 and 16 indicate fuel load and structural classes for forest and woodland VHCs.

   - Effective site slopes determined in accordance with the procedure in 5.4.2 Step 3.

Where a reliability assessment was undertaken and the results of all steps indicate the input mapping is reliable, assessors should use the mapping input data (by default) as input data for the calculation of radiant heat flux. Where a site specific BHA has been undertaken, the data from steps 1 to 3 in section 5.4.2 should be used for the calculation of radiant heat flux.

5.5.2 Procedure for calculating

The procedure for calculating separation and radiant heat exposure involves two steps:

1. Measure asset protection zone width between the development and hazardous vegetation

The asset protection zone should be measured in accordance with clause 2.2.4 of AS 3959–2018 for each VHC and slope combination to which a development is exposed.

The asset protection zone is the horizontal distance (i.e. measured in plan) between the edge of hazardous vegetation (edge of canopy for forest, woodland and heath type VHCs) and for:

- subdivisions (reconfiguration of a lot or RAL: the closest point on a lot boundary or a building envelope (where applicable)
- material change of use:
  - the closest point of a building envelope, or
  - the external wall of a building, or
  - for parts of the building that do not have external walls (e.g. carports, decks, landings etc.), the supporting posts or columns.[38]

The edge of hazardous vegetation should be determined by a site survey of the edge of the vegetation canopy. Alternatively, a plan showing the edge of the development footprint in relation to hazardous vegetation may be used.

2. Calculate radiant heat exposure

The Bushfire asset protection zone width calculator enables applicants to determine radiant heat exposure or radiant heat flux (RHF, kW/m2) using either mapping input data (FFDI [5% AEP fire weather event], VHC and maximum landscape slope) or the input data obtained via steps 1 to 3 of the hazard assessment process:

- FFDI (5% AEP fire weather event)
- vegetation hazard class
- site slope (degrees), effective slope (degrees) and whether the effective slope is upslope or downslope of the development.[39]

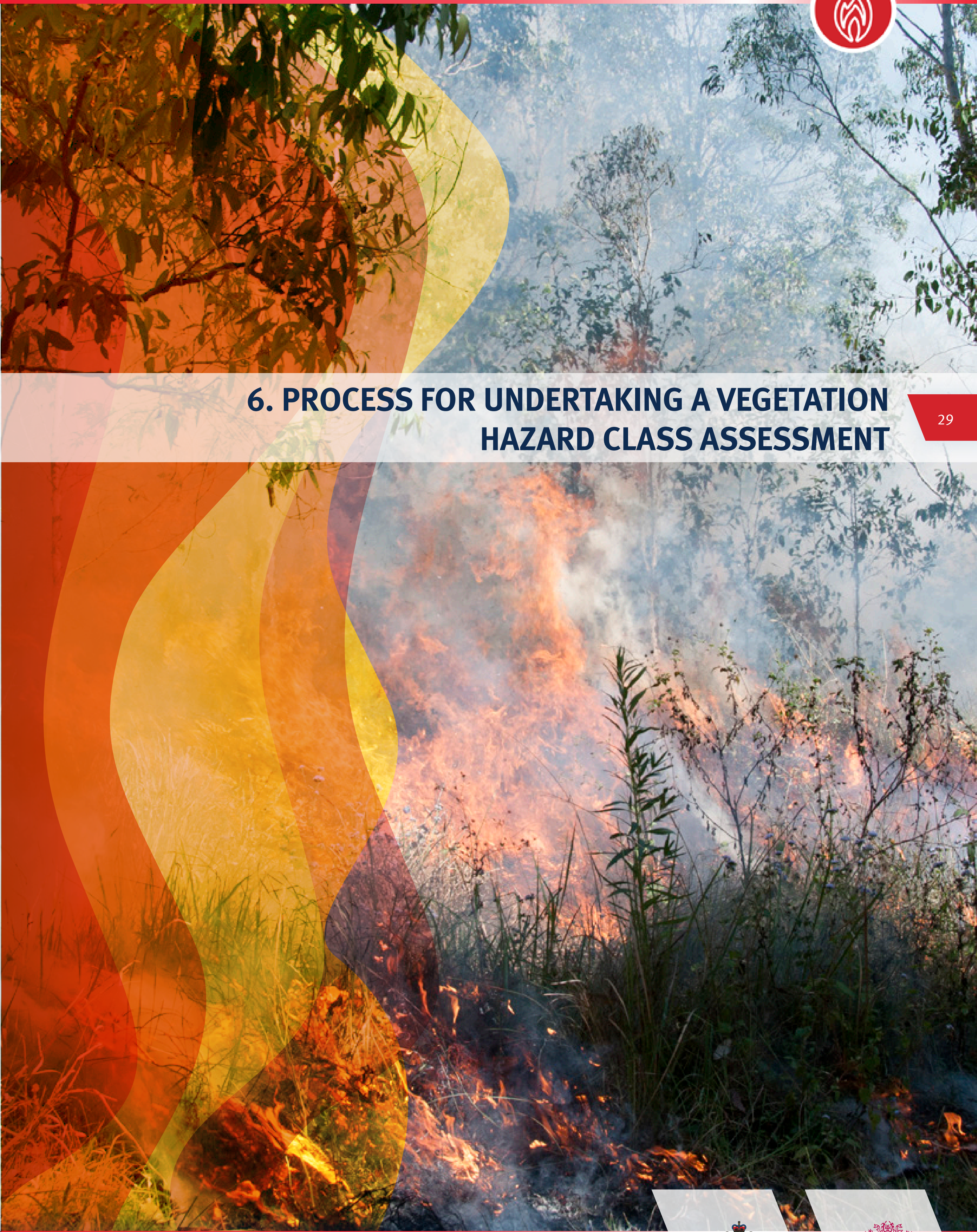
Land, where the effective or site slope is 'flat', shall have a minimum slope of 1 degree. Using a value of 1 degree is required to satisfy the mathematical formula, however it has negligible impact on the calculations.

Users can adjust the asset protection zone width to determine the distance necessary to achieve the identified acceptable levels of radiant heat flux.

Further information on the use of the Bushfire asset protection zone width calculator is in section 7.

37 *Leonard, J, Opie, K, et al. (2014), A new methodology for State-wide mapping of bushfire-prone areas in Queensland.*
38 *Drysdale, D (2011), An introduction to fire dynamics.*
39 *Where adopting the SPP IMS mapping input data, refer to hazard assessment step 3 in section 5.4.2 for determination of whether the effective slope is upslope or downslope of the development.*

6. PROCESS FOR UNDERTAKING A VEGETATION HAZARD CLASS ASSESSMENT



6. Process for undertaking a Vegetation Hazard Class Assessment

6.1 Introduction

This section is applicable where a local government's planning scheme contains provisions that enable or require an applicant to undertake a Bushfire Hazard Assessment (BHA) to review the applicable bushfire prone area mapping for an individual assessment area.

Fuel loads need to be determined when preparing a BHA. A Vegetation Hazard Class Assessment – the process for identifying, classifying and mapping vegetation hazard classes (VHCs) based on botanical survey of vegetation communities within an assessment area – can identify these potential fuel loads.

A local government may wish to refer applicants to this technical guidance document or provide information about undertaking a VHC assessment in its planning scheme (for example as a planning scheme policy).

6.2 Process

The process for identifying and classifying VHCs involves a botanical survey of the site and all land within the site assessment area (150 metres around the site) according to the following procedure:

1. Determine the life form of the ecologically dominant layer according to life form categories in Figure 15.

   The ecologically dominant layer is the structural layer which contains the greatest amount of above ground biomass and, because of its physiognomy and relative continuity, dominates the rest of the community in the sense that it conditions the habitats of other strata.[40, 41]

   Although a visual estimation is generally sufficient to identify the ecologically dominant layer, it may be necessary to measure the height, density and cover of each layer and to calculate the layer's approximate biomass volume.[42] As an example, trees are likely to be the ecologically dominant layer within open forest and woodland ecosystems.

2. Determine and document the average height of the ecologically dominant layer according to height classes in Figure 15 (e.g. trees 10-30 metres).

3. Estimate and document the relative density of the ecologically dominant layer according to Figure 15 (e.g. closed-mid-dense).

4. Determine vegetation structural class via the combination of life form, height and relative density according to Figure 15 (e.g. trees closed – mid-dense = vegetation structural class 1).

5. Determine the dominant plant species in the ecologically dominant layer and determine the Broad Vegetation Groups (BVGs)[43] from Vegetation of Queensland: Descriptions of Broad Vegetation Groups. [44]

   The identification of BVGs for remnant vegetation can also be determined via ground truthing of current regional ecosystems on a site according to *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland.*[45]

   Note – Vegetation communities are rarely homogeneous. In some cases, it may not be possible, nor useful from a modelling perspective, to map each individual vegetation community separately within the assessment area, particularly at scales less than 1:10,000. The minimum patch size for discrete VHCs is 1 hectare. In circumstances where the vegetation hazard class is found to be heterogeneous, the potential fuel load is the sum of the proportions of the potential fuel load for each observed VHC. The relative proportion of each VHC will need to be determined and the total potential fuel load calculated according to the sum of the proportions:

$$\sum_{i=m}^{n} p_i w_i$$

   Where:

   $\hat{W}$ = the sum of proportions of potential fuel load of *n* VHCs

   p_i = the percentage of the VHC comprised of the i^{th} vegetation community (VHC)

   w_i = the potential fuel load of the i^{th} vegetation community (VHC) in tonnes per hectare.

   The same formula should be used whether calculating total or surface fuel components. In this case, w_i is the potential surface fuel load of the i^{th} vegetation community (VHC) in tonnes per hectare and is the sum of surface fuel and near surface fuel components for the VHC.

6. Determine the VHC via the combination of BVG (1:2 million) and vegetation structural class according to Figure 6 on page x. Figure 6 provides an example of the combination of BVG and vegetation structural class to create the vegetation hazard class code.

7. Create a map of observed VHCs.

8. Develop a post-development VHC map.

   This should incorporate the effects of the proposed development on the configuration of vegetation within the assessment area including necessary clearing to support the development or to meet requirements for revegetation, landscaping or environmental offsets. Patch or corridor filtering rules described in section 4.2.6 should be applied to the final detailed map of vegetation hazard classes to produce a final map of post development VHCs.

9. Derive potential fuel loads based on the post development distribution of vegetation hazard classes, and corresponding fuel loads from Figure 14.

   Where radiant heat exposure is proposed to be assessed according to Method 2 of AS 3959-2018, modified surface fuel loads (w) apply for certain VHCs. For all forest and woodland vegetation hazard classes, calculate the surface fuel load (w) as the sum of surface and near-surface fuel load in Figure 14.

10. Assign a VHC to built-up areas such as urban centres and towns, developed rural areas and cultivated areas (intensive and broadacre agriculture and plantations). VHCs for built-up areas, rural areas, plantations, cropping and horticulture and water bodies, are determined via the combination of VHC from 36–43 listed in the 'Vegetation hazard class' column in Figure 14 and the corresponding vegetation structure class by following steps 1 to 4 above.

40 Beadle, NCW and Costin, AB (1952), *Ecological classification and nomenclature.*
41 Neldner, VJ (1984), *South Central Queensland – Vegetation Survey of Queensland.*
42 Neldner, VJ, Wilson, BA, et al. (2012), *Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland Version 3.2.*
43 *Broad vegetation groups are a high-level grouping of vegetation communities and are based on floristics, structural, functional, biogeographical and landscape attributes.*
44 Neldner, VJ, Niehus, RE, et al. (2015), *The vegetation of Queensland: Descriptions of broad vegetation groups. Version 2.0.*
45 Neldner, VJ, Wilson, BA, et al. (2012), *Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland Version 3.2.*

Figure 12 below shows an example of the difference between the published map of VHC and a verified map of observed VHCs prepared according to the VHC Assessment procedure.

Figure 13 indicates the differences in fuel loads for the same assessment area based on the changes to the VHCs.

Figure 12: Statewide map of vegetation hazard class (VHC) (left) and example of a ground truthed map of observed VHCs (right).87 Source: Leonard et al 2017.

Figure 13: Fuel load based on published map of vegetation hazard class (VHC) (left) and example of a fuel load raster based on observed VHCs (right). Source: Leonard et al 2017.

Vegetation hazard class descriptions and 80th percentile potential fuel load

	Vegetation hazard class	Potential fuel load (t/ha)						Prone type[46]		Fuel continuity[47]	
		Surface	Near-surface	Elevated	Bark	Total (Remnant)	Total (Non-remnant)	Remnant	Non-remnant	Remnant	Non- remnant
1.1	Complex mesophyll to notophyll vine forests	2.6	0.0	0.0	0.0	2.6	12.0	3	1	2	1
2.1	Complex to simple, semi-deciduous mesophyll to notophyll vine forest	3.5	0.0	0.0	0.0	3.5	12.0	3	1	2	1
3.1	Notophyll vine forest	4.5	0.0	0.0	0.0	4.5	12.0	3	1	2	1
3.3	Notophyll vine thicket	4.4	0.0	0.0	0.0	4.4	12.0	3	1	2	1
4.1	Notophyll and notophyll palm or vine forest	4.5	0.0	0.0	0.0	4.5	12.0	3	1	2	1
5.1	Notophyll to microphyll vine forests	3.9	0.0	0.0	0.0	3.9	12.0	3	1	2	1
5.2	Notophyll to microphyll vine forest with sparse overstorey	3.9	0.0	0.0	0.0	3.9	12.0	3	1	2	1
5.5	Sedgeland within notophyll to microphyll vine forests	3.9	0.0	0.0	0.0	3.9	12.0	3	1	2	1
6.1	Montane Notophyll vine forest and microphyll fern forest	3.9	0.0	0.0	0.0	3.9	12.0	3	1	2	1
6.3	Montane Notophyll vine thicket and microphyll fern thicket	3.9	0.0	0.0	0.0	3.9	12.0	3	1	2	1
7.1	Semi-evergreen to deciduous microphyll vine forest	6.0	0.0	0.0	0.0	6.0	12.0	3	1	2	1
7.2	Sparse semi-evergreen to deciduous microphyll vine forest	6.0	0.0	0.0	0.0	6.0	12.0	3	1	2	1
8.1	Wet eucalypt tall open forest	28.0	3.0	2.0	2.0	35.0	35.0	1	1	1	1
8.2	Wet eucalypt tall woodland	18.0	3.1	1.7	1.0	23.8	23.8	1	1	1	1
9.1	Moist to dry eucalypt open forests on coastal lowlands and ranges	17.5	3.5	2.2	1.0	24.2	24.2	1	1	1	1
9.2	Moist to dry eucalypt woodland on coastal lowlands and ranges	11.4	3.5	1.3	1.0	17.2	17.2	1	1	1	1
9.3	Shrubland within moist to dry eucalypt on coastal lowlands and ranges	7.8	3.0	1.9	0.0	12.7	12.7	1	1	1	1
10.1	Spotted gum dominated open forests	16.3	3.0	1.5	0.0	20.8	20.8	1	1	1	1
10.2	Spotted gum dominated woodlands	14.0	3.0	1.0	0.0	18.0	18.0	1	1	1	1
11.2	Moist to dry eucalypt woodlands on basalt areas	7.5	4.0	0.5	1.0	13.0	13.0	1	1	1	1
12.1	Dry eucalypt open forest on sandstone and shallow soils	15.0	3.5	1.5	1.0	21.0	21.0	1	1	1	1
12.2	Dry eucalypt woodlands on sandstone and shallow soils	12.0	2.6	1.8	1.0	17.4	17.4	1	1	1	1
13.1	Dry to moist eucalypt open forests on undulating metamorphics and granite	15.9	3.5	1.4	1.0	21.8	21.8	1	1	1	1
13.2	Dry to moist eucalypt woodlands on undulating metamorphics and granite	9.4	3.4	0.6	1.0	14.4	14.4	1	1	1	1

46 Prone type: 1 = Bushfire prone, 2 = Grass fire prone, 3 = Low hazard
47 Fuel continuity: 1 = Continuous, 2 = Discontinuous

Vegetation hazard class descriptions and 80th percentile potential fuel load

Vegetation hazard class		Potential fuel load (t/ha)						Prone type[46]		Fuel continuity[47]	
		Surface	Near-surface	Elevated	Bark	Total (Remnant)	Total (Non-remnant)	Remnant	Non-remnant	Remnant	Non- remnant
13.3	Shrubland associated with dry to moist eucalypt woodlands on undulating terrain	4.3	2.3	0.9	0.0	7.5	7.5	1	1	1	1
14.1	Open forest dominated by Darwin stringybark, Melville Island bloodwood or scarlet gum	22.3	1.4	2.1	2.0	27.8	27.8	1	1	1	1
14.2	Woodlands dominated by Darwin stringybark, Melville Island bloodwood or scarlet gum	8.4	2.4	0.8	1.0	12.6	12.6	1	1	1	1
14.3	Shrubland associated with woodlands dominated by Darwin stringybark, Melville Island bloodwood or scarlet gum	1.1	3.4	3.3	1.0	8.8	8.8	1	1	1	1
14.6	Sparsely vegetated areas associated with Darwin stringybark, Melville Island bloodwood or scarlet gum	0.0	0.3	1.3	0.0	1.6	1.6	3	3	2	2
15.1	Temperate open eucalypt forests	23.7	0.3	1.8	1.0	26.8	26.8	1	1	1	1
15.2	Temperate eucalypt woodlands	10.2	1.8	1.8	0.0	13.8	13.8	1	1	1	1
16.1	Eucalyptus dominated forest on drainage lines and alluvial plains	10.0	3.8	1.2	1.0	16.0	16.0	1	1	1	1
16.2	Eucalyptus dominated woodland on drainage lines and alluvial plains	7.5	3.6	0.5	0.0	11.6	11.6	1	1	1	1
16.3	Shrubland associated with eucalyptus woodlands on drainage lines	5.8	2.7	0.1	0.0	8.6	8.6	1	1	1	1
16.4	Grassland associated with eucalyptus dominated woodlands on drainage lines	0.3	2.1	0.1	0.0	2.5	2.5	2	2	1	1
16.5	Sedgeland associated with eucalyptus woodlands on drainage lines*	3.9	5.0	3.5	0.0	12.4	12.4	1	1	1	1
16.6	Sparsely vegetated areas associated with eucalyptus woodlands on drainage lines	1.2	2.0	0.0	0.0	3.2	3.2	3	3	2	2
17.1	Dry open forests dominated by poplar box, silver-leaved ironbark or White's ironbark on sand or depositional plains	10.6	4.1	0.3	0.0	15.0	15.0	1	1	1	1
17.2	Dry woodlands dominated by poplar box, silver-leaved ironbark or White's ironbark on sand or depositional plains	6.0	3.0	0.6	0.0	9.6	9.6	1	1	1	1
18.1	Dry eucalyptus open forests on sand or depositional plains	10.8	3.4	0.6	0.0	14.8	14.8	1	1	1	1
18.2	Dry eucalyptus woodlands on sand or depositional plains	7.1	3.3	0.6	0.0	11.0	11.0	1	1	1	1
18.5	Sedgeland associated with dry eucalypt woodlands on sand or depositional plains	3.9	3.4	3.5	0.0	10.8	10.8	1	1	1	1
19.2	Low open eucalyptus woodlands dominated by snappy gum, Cloncurry Box or Normanton box	4.3	3.0	0.8	1.0	9.1	9.1	1	1	1	1
19.3	Shrubland associated with low open eucalypt woodlands dominated by snappy gum, Cloncurry Box or Normanton box	1.7	1.5	1.3	0.0	4.5	4.5	1	1	1	1
19.4	Grassland associated with low open eucalypt woodlands dominated by snappy gum, Cloncurry Box or Normanton box	1.6	3.3	0.3	0.0	5.2	5.2	2	2	1	1
20.1	Open forests dominated by white cypress pine or coast cypress pine	12.5	2.4	0.6	1.0	16.4	16.5	1	1	1	1

Vegetation hazard class descriptions and 80th percentile potential fuel load

	Vegetation hazard class	Potential fuel load (t/ha)						Prone type[46]		Fuel continuity[47]	
		Surface	Near-surface	Elevated	Bark	Total (Remnant)	Total (Non-remnant)	Remnant	Non-remnant	Remnant	Non- remnant
20.2	Woodlands dominated by white cypress pine or coast cypress pine	5.4	3.1	0.8	0.0	9.3	9.3	1	1	1	1
21.1	Melaleuca dry open forest on sandplains or depositional plains	7.8	3.7	1.4	2.0	14.9	14.9	1	1	1	1
21.2	Melaleuca dry woodlands on sandplains or depositional plains	3.7	3.4	0.6	1.0	8.7	8.7	1	1	1	1
21.3	Shrubland associated with melaleuca dry woodlands on sandplains or depositional plains	4.3	2.3	0.9	0.0	7.5	7.5	1	1	1	1
21.6	Sparsely vegetated areas associated with melaleuca dry woodlands on sandplains or depositional plains	2.5	0.2	1.8	0.0	4.5	4.5	3	3	2	2
22.1	Melaleuca open forests on seasonally inundated lowland coastal swamps	15.4	8.0	3.0	2.0	28.4	28.4	1	1	1	1
22.2	Melaleuca woodlands on seasonally inundated lowland coastal swamps	10.6	7.1	1.0	1.0	19.7	19.7	1	1	1	1
22.3	Shrubland associated with melaleuca woodlands on seasonally inundated lowland coastal swamps	4.3	2.3	0.9	0.0	7.5	7.5	1	1	1	1
22.5	Sedgeland associated with melaleuca woodlands on seasonally inundated lowland coastal swamps	6.0	5.0	1.8	1.0	13.8	13.8	3	1	2	1
23.2	Mulga dominated woodlands on red earth plains, sandplains or residuals	1.2	3.6	0.2	0.0	5.0	5.0	1	1	1	1
23.3	Shrubland associated with mulga on red earth plains, sandplains or residuals.	1.4	3.2	0.1	0.0	4.7	4.7	1	1	1	1
23.4	Grassland associated with mulga on red earth plains, sandplains or residuals	1.6	3.3	0.3	0.0	5.2	5.2	2	2	1	1
24.1	Acacia open forest on residuals	6.9	2.6	0.6	0.0	10.1	10.1	1	1	1	1
24.2	Acacia woodlands on residuals	4.5	2.8	0.9	0.0	8.2	8.2	1	1	1	1
24.3	Acacia shrublands on residuals	2.6	2.1	2.1	0.0	6.8	6.8	1	1	1	1
24.4	Grassland communities associated with acacia on residuals	1.6	3.3	0.3	0.0	5.2	5.2	2	2	1	1
24.6	Sparsely vegetated areas associated with acacia on residuals	0.3	3.6	0.0	0.0	3.9	3.9	3	3	2	2
25.1	Brigalow belah open forests on heavy clay soils	10.5	2.6	1.9	0.0	15.0	15.0	1	1	1	1
25.2	Brigalow belah woodlands on heavy clay soils	3.4	2.1	0.7	0.0	6.2	6.2	1	1	1	1
25.3	Shrubland communities associated with brigalow belah on heavy clay soils	2.0	1.4	0.4	0.0	3.8	3.8	1	1	1	1
26.1	Gidgee blackwood dominated open forest	6.0	1.0	1.4	0.0	8.4	8.4	1	1	1	1
26.2	Gidgee blackwood woodland	2.0	1.6	0.2	0.0	3.8	3.8	1	1	1	1
26.3	Shrubland communities associated with gidgee blackwood woodland	1.4	1.9	1.5	0.0	4.8	4.8	1	1	1	1

Vegetation hazard class descriptions and 80th percentile potential fuel load

Vegetation hazard class		Potential fuel load (t/ha)						Prone type[46]		Fuel continuity[47]	
		Surface	Near-surface	Elevated	Bark	Total (Remnant)	Total (Non-remnant)	Remnant	Non-remnant	Remnant	Non- remnant
27.1	Mixed species open forests dominated by western whitewood, boree or wooded downs	2.1	0.7	0.1	0.0	2.9	2.9	1	1	1	1
27.2	Mixed species woodlands dominated by western whitewood, boree or wooded downs	2.0	2.5	0.3	0.0	4.8	4.8	1	1	1	1
27.3	Shrubland communities associated with mixed species woodlands	1.0	0.9	0.1	0.0	2.0	2.0	1	1	1	1
27.4	Grassland communities associated with mixed species woodlands	0.1	4.0	0.0	0.0	4.1	4.1	2	2	1	1
27.5	Sedgeland communities associated with mixed species woodlands	1.6	4.3	0.1	0.0	6.0	6.0	1	1	1	1
28.1	Open forests in coastal locations with species such as she-oak or swamp box	22.2	2.7	2.0	0.0	26.9	26.9	1	1	1	1
28.2	Woodlands in coastal locations with species such as she-oak or swamp box	13.8	3.2	1.3	0.0	18.3	18.3	1	1	1	1
28.3	Shrubland associated with woodlands in coastal location	12.2	2.2	2.5	0.0	16.9	16.9	1	1	1	1
28.4	Grassland associated with woodlands in coastal locations	8.0	2.4	2.0	0.0	12.4	12.4	1	1	1	1
28.5	Sedgeland associated with woodlands in coastal locations	6.0	5.0	3.5	1.0	15.5	15.5	1	1	1	1
28.6	Sparsely vegetated areas associated with woodlands in coastal locations	1.0	1.0	1.3	0.0	3.6	3.6	3	3	2	2
29.1	Forests associated with heathlands and scrubs	18.1	2.6	3.2	1.0	24.9	24.9	1	1	1	1
29.2	Woodlands associated with heathlands, scrubs and shrublands	12.0	4.8	7.5	0.0	24.3	24.3	1	1	1	1
29.3	Heathlands and associated scrubs and shrublands	11.6	2.9	5.6	0.0	20.1	20.1	1	1	1	1
29.4	Grassland communities associated with heathlands, scrubs and shrublands	4.8	4.4	2.0	0.0	11.2	11.2	1	1	1	1
29.5	Sedgeland communities associated with heathlands, scrubs and shrublands	3.0	5.0	3.5	0.0	11.5	11.5	1	1	1	1
29.6	Sparsely vegetated areas associated with heathlands, scrubs and shrublands	0.0	2.1	0.5	0.0	2.6	2.6	3	3	2	2
30.2	Woodlands associated with Mitchell grass or bluegrass	1.0	2.9	0.1	0.0	4.0	4.0	1	1	1	1
30.3	Shrublands associated with Mitchell grass or bluegrass	0.8	2.0	1.4	0.0	4.2	4.2	1	1	1	1
30.4	Mitchell grass or bluegrass tussock grasslands	0.8	4.0	0.0	0.0	4.8	4.8	2	2	1	1
30.5	Sedgelands associated with Mitchell grass or bluegrass	1.6	4.3	0.1	0.0	6.0	6.0	1	1	1	1
31.2	Woodlands associated with inland forblands to tussock grasslands	1.0	3.0	0.7	0.0	4.7	4.7	1	1	1	1
31.3	Shrublands associated with inland forblands to tussock grasslands	0.8	2.0	1.4	0.0	4.2	4.2	1	1	1	1
31.4	Mixed open forblands to tussock grasslands in inland locations	0.6	2.1	0.1	0.0	2.8	2.8	2	2	1	1
31.5	Mixed open sedgelands associated with inland tussock grasslands	0.6	0.2	0.1	0.0	0.9	0.9	3	3	2	2

Vegetation hazard class descriptions and 80th percentile potential fuel load

Vegetation hazard class		Potential fuel load (t/ha)						Prone type[46]		Fuel continuity[47]	
		Surface	Near-surface	Elevated	Bark	Total (Remnant)	Total (Non-remnant)	Remnant	Non-remnant	Remnant	Non- remnant
32.2	Woodlands associated with coastal closed tussock grasslands	2.4	4.4	0.0	0.0	6.8	6.8	1	1	1	1
32.3	Shrubland associated with coastal closed tussock grasslands	0.8	2.0	1.4	0.0	4.2	4.2	1	1	1	1
32.4	Closed tussock coastal grasslands	2.1	3.6	0.3	0.0	6.0	6.0	2	2	1	1
33.3	Shrublands associated with Hummock grasslands	0.8	2.0	1.4	0.0	4.2	4.2	1	1	1	1
33.4	Hummock grasslands dominated by spinifex or sand hill cane grass	0.6	1.2	0.2	0.0	2.0	2.0	2	2	1	1
33.5	Sedgeland associated with Hummock grasslands	0.4	1.1	1.2	0.0	2.7	2.7	3	3	2	2
34.1	Open forest dominated wetlands	6.0	3.4	5.3	1.7	16.4	16.4	1	1	1	1
34.2	Woodland dominated wetlands	2.5	4.0	0.2	1.3	8.0	8.0	1	1	1	1
34.3	Shrubland dominated wetlands	1.3	3.3	2.3	0.0	6.9	6.9	1	1	1	1
34.4	Grass dominated wetlands	1.0	4.0	0.0	0.0	5.0	5.0	2	2	1	1
34.5	Sedgeland dominated wetlands	3.0	5.0	5.0	0.0	13.0	13.0	1	1	1	1
34.6	Sparsely vegetated wetlands	1.1	3.1	0.0	0.0	4.2	4.2	3	3	2	2
35.1	Closed to open forest mangroves	0.0	0.0	0.0	0.0	0.0	0.0	3	3	2	2
35.3	Shrubland associated with mangroves and tidal saltmarshes	0.0	0.0	0.0	0.0	0.0	0.0	3	3	2	2
35.4	Tidal saltmarshes	1.0	2.9	0.2	0.0	4.1	4.1	2	2	1	1
35.5	Sedgeland associated with mangroves and tidal saltmarshes	0.4	1.3	0.0	0.0	1.7	1.7	3	3	2	2
35.6	Sparsely vegetated areas associated with mangroves and tidal saltmarshes	0.9	1.9	0.2	0.0	3.0	3.0	3	3	2	2
36.1	Exotic & hardwood plantation	22.3	1.5	1.2	1.0	26.0	26.0	1	1	1	1
37.1	Hoop plantations	3.0	2.0	0.0	0.0	5.0	5.0	3	3	2	2
38.4	Continuous dryland cropping and horticulture	0.8	3.0	0.0	0.0	3.8	3.8	2	2	1	1
38.5	Discontinuous irrigated cropping and horticulture	0.5	1.0	0.5	0.0	2.0	2.0	3	3	2	2
39.2	Low to moderate tree cover in built-up areas	2.0	3.0	2.0	1.0	8.0	8.0	3	3	2	2
40.4	Continuous low grass or tree cover	0.5	4.0	0.5	0.0	5.0	5.0	2	2	1	1
41.4	Discontinuous low grass or tree cover	0.5	2.0	0.5	0.0	3.0	3.0	3	3	2	2
42.6	Nil to very low vegetation cover	1.0	1.0	0.0	0.0	2.0	2.0	3	3	2	2
43.6	Water bodies or very low vegetation cover	0.0	0.0	0.0	0.0	0.0	0.0	3	3	2	2

Figure 14: Vegetation hazard class descriptions and 80th percentile potential fuel load. Source: QFES, 2017.

	Density			
Life form | Height	1. Closed	2. Mid-dense	3. Sparse	4. Very sparse
Trees				
Tall 30 m+	1. Trees closed – mid dense	1. Trees closed – mid-dense	2. Trees sparse – very sparse	2. Trees sparse – very sparse
Medium 10–30m	1. Trees closed – mid dense	1. Trees closed – mid dense	2. Trees sparse – very sparse	2. Trees sparse – very sparse
Low 2–10m	1. Trees closed – mid dense	1. Trees closed – mid-dense	2. Trees sparse – very sparse	2. Trees sparse – very sparse
Sclerophyllous shrubs				
Tall 2–8m	3. Shrubland	3. Shrubland	3. Shrubland	3. Shrubland
Medium 1–2m	3. Shrubland	3. Shrubland	3. Shrubland	3. Shrubland
Low <1m	3. Shrubland	3. Shrubland	3. Shrubland	3. Shrubland
Succulent shrub land				
Low <2m	3. Shrubland	3. Shrubland	3. Shrubland	3. Shrubland
Low vegetation				
Tussock grassland Low <2m	4. Grassland	4. Grassland	4. Grassland	4. Grassland
Hummock grassland Low <2m	4. Grassland	4. Grassland	4. Grassland	4. Grassland
Herbland Low <2m	5. Sedgeland	5. Sedgeland	5. Sedgeland	5. Sedgeland
Forbland Low <2m	5. Sedgeland	5. Sedgeland	5. Sedgeland	5. Sedgeland
Fernland Low <2m	5. Sedgeland	5. Sedgeland	5. Sedgeland	5. Sedgeland
Vineland Low <2m	5. Sedgeland	5. Sedgeland	5. Sedgeland	5. Sedgeland
Sedgeland Low <2m	5. Sedgeland	5. Sedgeland	5. Sedgeland	5. Sedgeland
Nil veg	6. Nil veg	6. Nil veg	6. Nil veg	6. Nil veg

Figure 15: Life form, height and relative density of vegetation structural classes. Source: QFES, 2017.

Vegetation structure class	Dominant life form	Density
1. Trees closed – mid-dense	Trees	Closed to mid-dense
2. Trees sparse – very sparse	Trees	Sparse to very sparse
3. Shrubland	Shrubland	Closed to very sparse
4. Grassland	Tussock or Hummock grassland	Closed to very sparse
5. Sedgeland	Herbland, forbland, fernland, vineland or sedgeland	Closed to very sparse
6. Nil veg	Nil vegetation	Nil vegetation

Figure 16: Vegetation structural classes. Source: QFES, 2017.

7. PROCESS FOR CALCULATING ASSET PROTECTION ZONES

7. Process for calculating asset protection zones

7.1 Introduction

This section is applicable where a local government's planning scheme contains provisions that identify acceptable radiant heat flux levels to inform asset protection zones (APZs). The radiant heat flux (kW/m2) output is generated by the Bushfire asset protection zone width calculator (the calculator).

The calculator can be used to determine radiant heat exposure, which then enables an applicant to identify the necessary lot boundary location or building location plan siting for example, to achieve the radiant heat flux outcomes sought by the planning scheme.

A local government may wish to refer applicants to this technical guidance document or provide information about the calculator in its planning scheme (e.g. as a planning scheme policy). The calculator is contained in a Microsoft Excel spreadsheet (.xls) and can be downloaded from Queensland Government data at https://data.qld.gov.au by searching 'bushfire defendable space width calculator'.

The calculator is also applicable to other assessments and, as such, this section includes content on those additional uses.

7.2 Purpose of the Bushfire asset protection zone width calculator

The calculator calculates fireline intensity, radiant heat flux and asset protection zone width using either the bushfire prone area mapping input data or the site specific input data.

The calculator is based on the view factor method equations described in Method 2 (Appendix 2) of AS 3959–2018. The calculator adapts this method Queensland-specific parameters to reflect the input parameters adopted by the State Planning Policy July 2017 (SPP) mapping of bushfire prone areas (Leonard et al., 2014[48]), including FFDI (5% AEP fire weather event) and vegetation hazard classes (VHCs).

The calculator enables rapid calculation of:

1. **Potential fireline intensity (kW/m)** – the rate of energy release per unit length of fire front, regardless of its depth
2. **Bushfire prone area intensity classes** – the class applicable to land in accordance with the medium, high and very high potential bushfire intensity classes used in the State Planning Policy Interactive Mapping System (SPP IMS) bushfire prone area mapping
3. **Radiant heat flux (kW/m2)** – according to separation between development and hazardous vegetation.

   Note – Radiant heat exposure, together with flame contact and ember attack, are the main mechanisms of bushfire attack and are implicated in loss of life and houses and damage to infrastructure[49, 50]. At certain levels of radiant heat exposure (time dependent), piloted ignition of timber occurs.[51] Houses exposed to levels of radiant heat which exceed 40 kW/m² are also exposed to a combination of bushfire attack mechanisms including direct flame contact and ember attack.

A distance needed to achieve 29 kW/m² also:

- reduces potential exposure to bushfire attack, particularly direct flame contact
- reduces the likelihood of piloted ignition due to radiant heat exposure
- improves consistency between planning and building outcomes
- reduces potential for conflicts between planning and building approvals
- avoids duplication and regulatory burden on home owners.

A distance needed to achieve 10 kW/m² also falls below the threshold for piloted ignition of dry timber and failure of plain glass.

7.3 Options for calculating the radiant heat exposure

Radiant heat exposure may be calculated using either:

1. The Bushfire asset protection zone width calculator (preferred), or
2. Method 2 of AS 3959¬–2018¬, subject to the adoption of site-specific values of FFDI (5% AEP fire weather event), site-specific vegetation hazard classes, modified modelling of surface fuel loads[52] and effective and site slopes determined in accordance with the hazard assessment process in section 5.4.

The procedure involves three steps:

1. Identification or measurement of site specific bushfire hazard factors via the hazard assessment process in section 5.4.
2. Measurement of the distance between the development and hazardous vegetation via field measurements or scaled plans.
3. Calculation of radiant heat exposure using the Bushfire asset protection zone width calculator (or Method 2 of AS 3959¬–2018 subject to the adoption of the site specific values and parameters described above).

7.4 Bushfire asset protection zone width calculator components

The Bushfire asset protection zone width calculator has three components:

1. Input values – user inputs necessary to operate the calculator correctly.
2. Output values – fuel loads for selected input values and, where applicable, the calculator estimates of radiant heat flux, fireline intensity and/or bushfire attack level.
3. VHC data – vegetation hazard class characteristics including fuel loads, fuel continuity and prone type according to remnant status.

Figure 17 shows a screenshot of the calculator start screen displaying the input and output values fields.

48 Leonard, J, Opie, K et al. (2014), *A new methodology for State-wide mapping of bushfire-prone areas in Queensland.*
49 Blanchi, R, Leonard J, et al. (2014), *Environmental circumstances surrounding bushfire fatalities in Australia 1901–2011.*
50 Crompton, R et al. (2010), *Influence of location, population, and climate on building damage and fatalities due to Australian bushfire: 1925–2009.*
51 *The long term unburnt condition represents greater than 10 years without burning. For further information see Leonard, J, Opie, et al. (2014), A new methodology for State-wide mapping of bushfire-prone areas in Queensland.*
52 *Total potential fuel loads (non-remnant) do not include surface, near-surface, elevated and bark fuel loads.*

SPP Bushfire Asset Protection Zone Width Calculator			
VARIABLE DESCRIPTION	VARIABLE	UNITS	VALUE
Input Values			
FIRE WEATHER SEVERITY	FDI		
VEGETATION HAZARD CLASS	VHC	-	
REMNANT STATUS	-	-	
SLOPE TYPE (UPSLOPE OR DOWNSLOPE)	ST	-	
EFFECTIVE SLOPE UNDER THE HAZARDOUS VEGETATION	eSlope	degrees	
SLOPE BETWEEN SITE AND HAZARDOUS VEGETATION	θ	degrees	
DISTANCE OF THE SITE FROM HAZARDOUS VEGETATION	d	m	
Output Values			
SURFACE FUEL LOAD	-	t/ha	
NEAR SURFACE FUEL LOAD	-	t/ha	
BARK FUEL LOAD	-	t/ha	
ELEVATED FUEL LOAD	-	t/ha	
TOTAL OVERALL FUEL LOAD	W	t/ha	
TOTAL SURFACE FUEL LOAD	w	t/ha	
POTENTIAL FIRE LINE INTENSITY	I	kW/m	
RADIANT HEAT FLUX	q	kW/m²	
BUSHFIRE ATTACK LEVEL (AS 3959-2009)	BAL	-	

DISCLAIMER: Fire-line intensity and radiant heat calculations where effective slope exceeds 20 degrees (downslope) or 15 degrees (upslope) may be unreliable. In these locations, specialist assessment is warranted.

Calculate

Copy Results

Figure 17: SPP Bushfire asset protection zone width calculator start screen.
Source: QFES, 2019.

Parameter	Process to identify calculator value
Fire weather severity (FWS)	Determined in accordance with the hazard assessment stage in section 5.4.2 (1)
Vegetation hazard class (VHC)	Identify VHC within the assessment area from the mapping inputs for VHCs (as described in section 6) or via botanical survey in accordance with the hazard assessment stage in section 5.4.2 (2) and section 6
Remnant status	Identify whether the VHC is remnant vegetation as defined in the Vegetation Management Act 1999 (Qld) or non-remnant vegetation.
Slope type	Identify whether the proposed development is upslope or downslope of hazardous vegetation in accordance with section 5.4.2 (3) or clause 2.2.5 of AS 3959–2018)
Effective fire slope	Identify the slope (degrees) of the land under hazardous vegetation for each VHC in accordance with section 5.4.2 (3)
Site slope	Identify the slope (degrees) of the land between the site and hazardous vegetation for each VHC in accordance with section 5.4.2 (3)
Distance from hazardous vegetation	Measure the asset protection zone width between the development and adjacent hazardous vegetation in accordance with section 5.5.2 (1)

7.5 Bushfire asset protection zone width calculator input parameters

The calculator requires seven input parameters. Values for each of these parameters should be determined before using the calculator, as outlined below:

Where a reliability assessment has been undertaken and the results of all steps indicate the input mapping is reliable, the mapping input data should be used for the calculation of radiant heat flux.

Where a site specific assessment of input factors has been undertaken, the data from steps 1 to 3 in section 5.4.2 should be used for the calculation of radiant heat flux.

Further information in relation to each parameter and its role in the calculation of radiant heat flux is outline below.

7.5.1 Fire weather severity

Equivalent to the McArthur Forest Fire Danger Index (FFDI)[53] 5% AEP fire weather event.[54]

53 Total potential fuel loads (non-remnant) do not include surface, near-surface, elevated and bark fuel loads.
54 McArthur, AG (1967), Fire behaviour in eucalyptus forests.
55 Noble, IR et al. (1980), McArthur's fire-danger meters expressed as equations.
56 Cheney, NP et al. (2012), Predicting fire behaviour in dry eucalypt forest in southern Australia.
57 McCaw, WL, et al. (2008), Existing fire behaviour models under-predict the rate of spread of summer fires in open jarrah (Eucalyptus marginata) forest.
58 Cruz, MG et al. (2015) Empirical-based models for predicting head-fire rate of spread in Australian fuel types.
59 McCaw, LW et al. (2012), Changes in behaviour of fire in dry eucalypt forest as fuel increases with age.
60 Noble, IR et al. (1980), McArthur's fire-danger meters expressed as equations.
61 Cheney, NP et al. (2012), Predicting fire behaviour in dry eucalypt forest in southern Australia.
McCaw, WL, et al. (2008), Existing fire behaviour models under-predict the rate of spread of summer fires in open jarrah (Eucalyptus marginata) forest.
Cruz, MG et al. (2015) Empirical-based models for predicting head-fire rate of spread in Australian fuel types.
McCaw, LW et al. (2012), Changes in behaviour of fire in dry eucalypt forest as fuel increases with age.
62 Cruz, MG et al. (2015) Empirical-based models for predicting head-fire rate of spread in Australian fuel types.

7.5.2 Vegetation hazard class (VHC)

The vegetation which contributes to bushfire hazard and is classified according to a modified version of Queensland's broad vegetation groups.[55] The identification of VHC determines whether the vegetation contributes to bushfire hazard (prone type).

The prone type is a categorical indicator of the status of VHC with respect to its capacity to support a significant bushfire. The prone type categories are:

- Forest or Shrub fires (1)
- Grassland fires (2)
- Low hazard (3).

All Queensland VHCs and their associated remnant and non-remnant prone type are listed in the VHC_Data sheet of the calculator spreadsheet.

7.5.3 Remnant status

Remnant status is a binary indicator of whether the VHC is remnant vegetation, as defined in the *Vegetation Management Act 1999* (Qld), or other hazardous, non-remnant vegetation. The determination of remnant status establishes:

- the total potential fuel load value used by the calculator ('Total (remnant)' or 'Total (Non-remnant)')
- fuel continuity
- rate of spread calculation method.

For certain VHCs, the prone type may vary according to the remnant status of the VHC. For example, certain non-remnant rainforest VHCs frequently include significant available fuel from woody or weed species and may have a prone type of 1, whereas the same remnant rainforest VHC may be considered 'low hazard'.

Remnant vegetation, as defined in the *Vegetation Management Act 1999* (Qld), includes relatively undisturbed woody or non-woody vegetation. Woody remnant vegetation – dominated by trees or shrubs – has a predominant vegetation canopy:

- covering more than 50 per cent of the undisturbed predominant canopy
- averaging more than 70 per cent of the vegetation's undisturbed height
- composed of species characteristic of the vegetation's undisturbed predominant canopy.

Non-woody remnant vegetation has not been cultivated for 15 years, contains native species normally found in the regional ecosystem, and is not dominated by non-native perennial species.

For remnant VHCs, the total potential fuel load represents the 80th percentile fuel load for each fuel category based on the long term unburnt condition[56](surface fuel, near-surface fuel, elevated fuel and bark fuel load). Total potential fuel loads, including surface, near-surface, elevated and bark fuel loads for each VHC are indicated in the VHC_Data sheet of the calculator spreadsheet.

Non-remnant vegetation includes hazardous woody or non-woody vegetation that has the potential to support a significant bushfire within the design life of a new settlement that does not meet the structural and/or floristic characteristics for remnant vegetation. This can include non-remnant rainforest, tree plantations, other non-native vegetation, regrowth vegetation, heavily thinned, logged or significantly disturbed vegetation, or vegetation within urban or cropping land. Total non-remnant, potential fuel loads for each VHC are indicated in the VHC_Data sheet of the calculator spreadsheet.[57]

Fuel continuity is a binary indicator of the capacity of remnant or non-remnant vegetation to support a continuous flame front under a range of weather conditions. Continuous fuel vegetation ('1') generally has a consistent distribution of fuel. Discontinuous fuel types ('2') include non-hazardous vegetation or land uses, such as mangroves, built-up areas or water bodies.

Fuel continuity varies according to the remnant or non-remnant status of the VHC. Fuel continuity values for both remnant and non-remnant categories of each VHC are indicated in the VHC_Data sheet of the calculator spreadsheet.[58]

Fuel continuity also varies the calculation of the forward rate of spread. Recent empirical evidence indicates that the rate of spread equations used in Method 2 of AS 3959–2018 under predict rate of spread (and hence fireline intensity) in open forest and woodlands when only surface fine fuels are used in the calculations.[59, 60, 61] There is strong empirical evidence which suggests that near-surface fuel characteristics, together with surface fuel, is a better predictor of rate of spread for moderate and high intensity fires than surface fuel alone.[62] To better reflect the contribution of near-surface fuel to rate of spread, surface fuel load (w) is calculated as the sum of surface and near-surface fuels for open forest and woodland VHCs where fuel is continuous. The result is indicated as 'Total Surface Fuel Load' in the calculator's output values table.

7.5.4 Slope type

Slope type refers to whether the effective slope is upslope or downslope, in accordance with Clause 2.2.5 of AS 3959–2018. Where the slope of the land containing hazardous vegetation is downhill from the proposed development or lot boundary, it is considered 'downslope' irrespective of the site slope. Where the slope of the land containing hazardous vegetation is uphill (or is flat) from the proposed development or lot boundary, it is considered 'upslope' irrespective of the site slope.

7.5.5 Effective fire slope

The effective fire slope is the slope under hazardous vegetation in degrees (refer also to AS 3959-2018). This is a value between 1 and 20 degrees downslope and 1 and 15 degrees upslope.

7.5.6 Site slope

Refers to the slope between the site and hazardous vegetation in degrees (refer also to AS 3959–2018). This is a value between 1 and 20 degrees downslope and 1 and 15 degrees upslope.

7.5.7 Distance from hazardous vegetation

Refers to the horizontal distance (i.e. measured in plan) of the managed separation area (often referred to as asset protection zone width) between the edge of hazardous vegetation (edge of canopy for forest, woodland and heath type VHCs) and the point identified in a planning scheme of building provisions. This is likely to be:

- the closest point on a lot boundary or a building envelope
- external wall of a building
- supporting posts or columns for parts of the building that do not have external walls (e.g. carports, decks, landings etc.), as per AS 3959–2018.

This distance is informed by the VHC and slope combination between the development and the hazardous vegetation.

Increasing separation reduces the intensity of bushfire attack (expressed as radiant heat flux) to which a development is exposed.

7.6 Parametric constraints and variations

The calculator incorporates a number of parametric constraints which apply in Queensland. This include:

1. The calculator does not permit manipulation of underlying data. For example, in accordance with a Bushfire Hazard Assessment (BHA), the calculator deliberately prohibits the creation of user-defined fuel loads. Consequently, a user must nominate a VHC according to the procedure described in section 5.4.2 to determine potential fireline intensity and radiant heat flux. Users can only select from one of the level 2 VHCs described in Figure 14.
2. 'Slope type' is a Boolean operator for effective slope, namely whether the effective slope under hazardous vegetation is upslope or downslope of the site.
3. Effective fire slope inputs are limited to values between 1 and 20 degrees for downslope and 15 degrees for upslope. Site slope inputs are limited to values between 1 and 20 degrees. Fireline intensity and radiant heat calculations for locations with an effective slope of greater than 20 degrees (downslope) or 15 degrees (upslope) may be unreliable. In these locations, specialist assessment is warranted. Land where the effective or site slope is 'flat' must have a minimum slope of 1 degree.
4. Bushfire attack level is not calculated where distance of the site from hazardous vegetation is greater than 100 metres in accordance with AS 3959–2018 and Leonard et al. (2014).[63]
5. Fireline intensity, radiant heat flux and bushfire attack level are not calculated for non-bushfire prone VHCs (grass fire prone VHCs [prone type = 2] or low hazard VHCs [prone type = 3]). Refer to the VHC_Data sheet of the calculator spreadsheet for a list of prone types for each VHC according remnant status.
6. The calculator deals only with discrete VHCs. Radiant heat flux and asset protection zone widths for mixed or heterogeneous VHCs cannot be calculated using the tool. Manual calculations are required where VHCs are heterogeneous or mixed, e.g. VHC 9.1 / VHC 16.1 (60%/40%).

The calculator's inbuilt parameter rules prevent entry of inappropriate values and manipulation of underlying data and assumptions, such as model constants and model equations. This ensures quality, consistency and reliability of model outputs.

Method 2 of AS 3959–2018 also includes several constants and assumptions for which default parameters are suggested. For the purposes of producing a fit-for-purpose tool, the calculator adopts the following default values:

- Ambient temperature (Ta): 308 K (350C)
- Heat of combustion: 18,600 kJ/kg
- Flame temperature (T): 1200K[64]
- Flame emissivity (ε): 0.95
- Flame width (Wf): 100 m
- Wind speed (V): 45 km/hr (for shrub and heath VHCs only)
- Vegetation height (H): 8m[65] (for shrub and heath VHCs only).

The above values are not visible to users and cannot be edited.

7.7 Bushfire asset protection zone width calculator software and hardware requirements

The calculator requires users to have installed a copy of Microsoft Excel 2007 or later. Users must have sufficient security privileges to enable the use of macros from within the program.

Procedure for first time use:

1. Save the file to a local hard drive or a network location.
2. When the calculator is opened for the first time, a security warning will appear. Select the **enable content** button to turn the calculator on.
3. If the **enable content** button is not visible, **trust centre** settings may need adjustment. To do this:
   a. go to **file › options** and select **trust centre**
   b. in **trust centre** select the **trust centre settings** button and on the next screen navigate to **macro settings**
   c. under the **macro settings** menu, check **disable all macros with notification**
   d. click **OK** to confirm this setting
   e. close the calculator and reopen it to apply this change – the **enable content** button should appear at the top of the worksheet as per step 1.
4. To save the calculator, the automatic recalculation of the calculator will need to be disabled. To do this:
   a. go to **file › options** and select **formulas**
   b. check that workbook calculation is checked to **manual** and that **recalculate workbook before saving** is unchecked.

63 Leonard, J, Opie, K et al. (2014), *A new methodology for State-wide mapping of bushfire-prone areas in Queensland.*
64 Sullivan, AL et al. (2003), *A review of radiant heat flux models used in bushfire applications.*
65 *Upper estimate of vegetation height of shrub and heath VHCs based on available CORVEG data: Queensland Herbarium (2012). Queensland CORVEG Database, Version 4/2017. State of Queensland (Department of Science Information Technology and Innovation). Brisbane, Queensland Government Data Portal <https://data.qld.gov.au/>, accessed August 2019.*

7.8 Using the Bushfire asset protection zone width calculator

The calculator requires seven inputs as described in section 7.5:

1. Fire weather severity/FFDI (5% AEP fire weather event) – (CELL REF: D4)
2. Vegetation hazard class (VHC) – (CELL REF: D5)
3. Remnant status – (CELL REF: D6)
4. Slope type – (CELL REF: D7)
5. Effective fire slope (e_{slope}, degrees) – (CELL REF: D8)
6. Site slope (θ, degrees) – (CELL REF: D9)
7. Distance from hazardous vegetation (d, metres) – (CELL REF: D10)

Figure 18 shows an example of the calculator input screen and example data inputs.

Once the data has been entered, press **'Calculate'** to assess whether the proposed separation complies with the separation outcomes sought by the example planning scheme provisions found in the SPP Guidance Material for Bushfire. N.B. Users should use the **'Calculate'** button provided in the calculator sheet and not Microsoft Excel's calculate buttons.

SPP Bushfire Asset Protection Zone Width Calculator			
VARIABLE DESCRIPTION	**VARIABLE**	**UNITS**	**VALUE**
	Input Values		
FIRE WEATHER SEVERITY	FDI		60.00
VEGETATION HAZARD CLASS	VHC	-	9.1 Moist to dry eucalypt open forests on coastal lowlands and ranges
REMNANT STATUS	-	-	Remnant
SLOPE TYPE (UPSLOPE OR DOWNSLOPE)	ST	-	Downslope
EFFECTIVE SLOPE UNDER THE HAZARDOUS VEGETATION	eSlope	degrees	10.00
SLOPE BETWEEN SITE AND HAZARDOUS VEGETATION	θ	degrees	10.00
DISTANCE OF THE SITE FROM HAZARDOUS VEGETATION	d	m	32.00

Figure 18: SPP Bushfire asset protection zone width calculator output values and sample results. Source: QFES, 2019.

7.9 Bushfire asset protection zone width calculator results

The calculator allows users to iteratively assess the effect of changes to input values. In particular, the effect of changes in asset protection zone width on radiant heat flux and bushfire attack level.

Reported results include:

- Surface fuel load (t/ha)
- Near-surface fuel load (t/ha)
- Bark fuel load (t/ha)
- Elevated fuel load (t/ha)
- Total overall fuel load (W) (t/ha)
- Total surface fuel load[66] (w) (t/ha)
- Potential fireline intensity (kW/m)
- Radiant heat flux (kW/m^2)
- Bushfire attack level, in accordance with AS 3959–2018.

Model output values are dynamic and not stored. Each time a user alters or enters new input values, results will need to be re-calculated by pressing the **'Calculate'** button. Users can select **'Copy Results'** to copy the inputs and results for display in a Bushfire Management Plan (BMP) and to assist in demonstrating compliance with asset protection zone width outcomes.

Figure 19 shows an extract using the **'Copy Results'** button within the tool. Copied results can be placed/pasted directly into a BMP or equivalent to expedite assessment of the application.

66 Used to calculate the forward rate of spread for woodland and forest VHCs with fuel continuity.

Output Values			
SURFACE FUEL LOAD	-	t/ha	0.00
NEAR SURFACE FUEL LOAD	-	t/ha	0.00
BARK FUEL LOAD	-	t/ha	0.00
ELEVATED FUEL LOAD	-	t/ha	0.00
TOTAL OVERALL FUEL LOAD	W	t/ha	24.20
TOTAL SURFACE FUEL LOAD	w	t/ha	21.00
POTENTIAL FIRE LINE INTENSITY	I	kW/m	43434.70
RADIANT HEAT FLUX	q	kW/m^2	28.67
BUSHFIRE ATTACK LEVEL (AS 3959-2009)	BAL	-	BAL 29

Figure 19: Bushfire asset protection zone width calculator output values and sample results. Source: QFES

7.10 Default asset protection zone width formula

The model provisions within SPP guidance contain a default separation distance table template that can be developed upon request to Queensland Fire and Emergency Services (QFES). This table may be included where a local government seeks to provide a quantifiable acceptable outcome for applicants that removes the need to determine radiant heat flux levels.

APZ widths are calculated using a modified Method 2 bushfire attack level assessment from AS 3959-2018, using conservative inputs. Width outputs use the highest FFDI and VHC fuel loads for each potential bushfire intensity category within the local government area. This process and formula are described below:

1. Pre-treatment of the VHC data.

All data should begin as snapped to the slope raster and projected in GDA 1994 Australia Equal Albers projection.

   a. The VHC layer as produced is a raster dataset with an attached lookup table. The two columns of interest are VHC_NIBBLE, and FUELLOAD_NIB. These columns are split using the 'Extract by Attributes' tool. This allows these two fields to be used with the 'Combine' tool to produce a fast lookup table.
   b. The BPA exists as vector data, but must first be converted to raster. Using 'Polygon to Raster', and selecting 'CLASS' as the value field, with a cell size of 25, and setting the environment variable 'Processing Extent, Snap raster' to the 25m slope grid, output to BPA_Merged in a geodatabase.
   c. The slope layer should be treated as the snap raster and clipped to the area of interest for performant operation as it is typically a whole of state data set.

2. Combine using the 'Combine' tool.
   a. The following should be combined and saved in a geodatabase:
      - FFDI
      - Slope
      - FUELLOAD_NIB
      - VHC_NIBBLE
      - BPA_Merged.

   This will force the raster to be saved in the Esri grid format and automatically associate a lookup table preserving all values from the input raster. This in turn allows field calculations between columns. This raster was named 'Combined_BPA_Slope_FFDI_VHC_Fuel'.

3. Add Field.
   a. Add a field named 'Category' to 'Combined_BPA_Slope_FFDI_VHC_Fuel'.
4. Calculate Field using Python.
   a. This process will assign one of 12 predefined categories to each cell in the raster based on a combination of slope and BPA.
   Field Name 'Category'
   Expression
   compareCalc(!slope_clipped! , !BPA_Merged!)

```
def compareCalc(slope, bpa):
    if int(slope) <= 4.9 and int(bpa) == 4:
        return '1'
    elif 5.0 <= int(slope) <= 9.9 and int(bpa) == 4:
        return '2'
    elif 10 <= int(slope) <= 90 and int(bpa) == 4:
        return '3'
    elif int(slope) <= 4.9 and int(bpa) == 3:
        return '4'
    elif 5.0 <= int(slope) <= 9.9 and int(bpa) == 3:
        return '5'
    elif 10 <= int(slope) <= 90 and int(bpa) == 3:
        return '6'
    elif int(slope) <= 4.9 and int(bpa) == 2:
        return '7'
    elif 5.0 <= int(slope) <= 9.9 and int(bpa) == 2:
        return '8'
    elif 10 <= int(slope) <= 90 and int(bpa) == 2:
        return '9'
    elif int(slope) <= 4.9 and int(bpa) == 1:
        return '10'
    elif 5.0 <= int(slope) <= 9.9 and int(bpa) == 1:
        return '11'
    elif 10 <= int(slope) <= 90 and int(bpa) == 1:
        return '12'
    else:
        return '0'
```

5. The table may be exported and interrogated.
6. Should individual categories wish to be queried (e.g. a 'Very High BPA' and 'High slope'), the 'Extract by Attributes' tool may be used with a SQL command of Where 'Category = 3'.
7. The steps from 2 onwards can be simply and easily modelled to the VHC or BPA to facilitate rapid assessment of an area.

8. PROCESS FOR PREPARING A BUSHFIRE MANAGEMENT, VEGETATION MANAGEMENT OR LANDSCAPE MAINTENANCE PLANS

8. Process for preparing a Bushfire Management, Vegetation Management or Landscape Maintenance Plans

8.1 Introduction

This section is applicable where a local government's planning scheme contains provisions that enable an applicant to prepare a Bushfire Management Plan (BMP) to demonstrate achievement of the outcomes contained in the planning scheme, for example:

- reporting on the outcomes of a Bushfire Hazard Assessment (BHA), or
- proposing design and management measures that avoid, minimise or mitigate bushfire attack risk to an acceptable or tolerable level, or
- proposing mitigation strategies including vegetation management or landscape management.

As such, a planning scheme may also include provisions for the preparation of a Vegetation Management Plan (VMP) or Landscape Management Plan (LMP).

A local government may wish to either refer applicants to this technical guidance document or provide information about preparing a BMP, VMP or LMP in its planning scheme (as a planning scheme policy, for example).

8.2 Management plan reporting

The following information should be included as part of all management plans:

- site details, such as real property description and street address
- description of the proposed development
- details of any relevant previous approvals.

8.3 Bushfire hazard reports and Bushfire Management Plans

A bushfire hazard report – typically containing the results of a BHA – is often a key component of a BMP. This bushfire hazard report, or the BMP, is to include maps and plans that show:

- vegetation hazard class (VHC) survey locations within the site assessment area
- the extent and configuration of VHCs within the site assessment area before and after development, including any vegetation to be retained, revegetation areas and/or environmental offsets
- the extent of bushfire prone areas (fireline intensity) and potential impact buffer, potential flame length and potential rate of spread in relation to the development.

A bushfire hazard report should detail the assessment methods and outcomes of any BHA that has been undertaken in accordance with the hazard assessment guidance in section 5.4 and is to document the results of that BHA, including:

- results of any reliability assessment
- potential fireline intensity, potential flame length, potential rate of spread and radiant heat flux.

A BMP also will include details of the proposed bushfire protection measures, such as:

- separation, including recommended asset protection zone, such as dimensions
- siting, including building envelopes
- landscape design and management, and vegetation management including fuel management areas/zones
- access and evacuation routes
- water supply.

8.4 Vegetation Management Plans

The preparation of a VMP may include measures for the long-term management of vegetation in rehabilitation or revegetation areas or of valuable vegetation (for example, where clearing is to be minimised) to reduce the ongoing risk of bushfires on the site and in surrounding areas.

Fuel management does not necessitate the removal of all vegetation. Vegetation management strategies may include:

- retaining trees as widely spaced individuals or in clumps that contribute to landscape design outcomes, without significantly increasing fuel loads or the severity of bushfire hazard
- selective removal of vegetation which facilitates ember attack, selective clearing of native understorey vegetation and replacement with low-flammability species (refer Figure 20).

8.5 Landscape Management Plans

The preparation of an LMP may include measures for the design and long-term management of landscaping within bushfire asset protection zones (APZs) to minimise the level of bushfire risk or mechanisms of bushfire attack, providing a reduced fuel area which is compatible with the asset protection zone.

These measures may include:

- landscape design that reduces vulnerability to bushfire attack
- plant selection that avoids or minimises opportunities for ignition of landscaping features
- long-term landscape management arrangements that reduce exposure to bushfire attack.

In addition, the use of barriers that limit the impact of direct flame contact, radiant heat, ember attack and wind can supplement measures targeting vegetation and fuel management.

Strategies that support each of these measures are detailed below.

8.5.1 Landscape design

- Establishing a minimal fuel around buildings of a nominal 10 metres.
- Ensuring flammable materials are not touching or close to vulnerable parts of buildings such as windows, decks and eaves. These materials include:

- › flammable shrubs and trees
  - › flammable mulches or fences
  - › trees where the canopy overhangs the building
  - › climbing plants or vines in contact with external timber fascia, pergolas, posts, beams and/or trellis.
- Establishing non-flammable features such as tennis courts, swimming pools, dams, maintained lawns, driveways or paths.
- Using paths and driveways made of non-combustible materials such as clay, concrete, gravel and pebbles.
- Ensuring potential hazardous features and out-buildings such as sheds, coops and machinery storages are sited well away from the development and preferably shielded from bushfire attack by other buildings so they are not consumed and contribute to hazard.
- Ensuring the layout of garden beds, lawns and driveways or paths are configured to avert the continuity of fuel loads within APZs. Continuous vegetation within APZs assists the spread of fire. By separating garden beds and clumps of trees or shrubs with areas of low fuel, fuel continuity is broken up, reducing the potential rate of spread and fire intensity. Examples include placing maintained lawns, pathways or ponds between clumps of trees or shrubs and garden beds.
- Creating gaps in canopy trees through selective clearing of existing vegetation or planting layout or ensuring tree canopies do not overlap. This measure reduces the potential spread of crown fires.
- Establishing lawn substitutes including non-flammable ground covers such as decorative stone or gravel.

8.5.2 Plant selection

- Planting or maintaining plant species which minimise leaf litter drop to reduce the accumulation of surface fuel (e.g. persistent leaf litter).
- Planting or maintaining low-flammability species (e.g. appropriate local natives) that are also adapted to local conditions and enhance habitat values for wildlife.

  Note – Environmental weeds are often garden escapees and contribute to fuel loads, increasing bushfire hazard. Examples of this include, lantana (Lantana camara) and gamba grass (Andropogon gayanus).
- Planting or maintaining species with attributes (such as avoiding species with fibrous bark) which reduce the ease of combustion, minimise contribution to potential fuel load or act as a potential barrier, reducing the rate of fire spread.
- Figure 20 indicates the characteristics of low flammability species and the effect of plant attributes on their performance in bushfire situations.[67]

Plant attribute	Effect	Design measure
Foliage moisture content	Leaves with higher moisture content retard ignition and slow the rate of combustion	Select species with high leaf moisture content (e.g. rainforest species, succulents and semi-succulents)
Foliage volatile oil content	Foliage with higher volatile oil content ignite more readily and enhance ignition of surrounding vegetation, even though volatile oils themselves do not contribute significantly to total radiant heat	Select species with lower volatile oil content[68, 69]
Foliage mineral content	Foliage with higher mineral content tend to be less flammable (e.g. Amyema spp mistletoes)	Species selection should favour species with higher leaf mineral content
Leaf fineness	The ratio of area-to-volume of leaves is one of the main factors affecting ease of ignition and intensity of burning. Finer leaves (greater area to volume ratio) tend to ignite and burn more easily than broader leaves	Species selection should favour broad-leafed species
Density of foliage and continuity of plant form	Species with continuous, denser foliage can act as a barrier to wind-borne embers and radiant heat; however, increased density can increase flammability. Species with open branching and low foliage density are less effective as a barrier, though can be less flammable	Select species on a case-by-case basis

67 *Ramsay, GC, and Rudolph, LS (2003), Landscape and building design for bushfire areas.*
68 *Middlemann, MH (ed.) (2007), Natural hazards in Australia: Identifying risk analysis requirements.*
69 *Neldner, VJ, Niehus, RE et al. (2015), The vegetation of Queensland: Descriptions of broad vegetation groups. Version 2.0.*

Plant attribute	Effect	Design measure
Height of lowest foliage	Shrub and tree species with persistent low height foliage are more likely to be ignited by surface fires, allowing the spread of fires into the canopy above	Species selection should favour species which can be maintained or pruned to reduce persistent, near-ground foliage
Size of plant (volume and spread)	The effect of plant size varies according to volume or spread. Species with a greater spread tend to be more effective as a barrier to the diffusion of radiant heat than narrower trees with the same volume. Species with a greater volume can result in increased ember attack, radiation and flame if ignited. For example, narrow columnar trees are less effective as a barrier than wider trees with the same overall volume	Species selection should ensure plant size (volume and spread) does not increase ignition likelihood
Dead foliage on plant	Persistent dead leaves and woody twigs increase flammability	Species selection should favour species which have a low volume of persistent dead leaves and woody material or can be maintained or pruned to reduce persistent, dead leaves and woody material
Bark texture	Loose, flaky, stringy, papery or ribbon-like bark contribute to ladder fuels which: • can contribute to destructive crown fires • act as a potential source of flame, radiant heat and ember attack	Avoid species with persistent loose, flaky, stringy, papery or ribbon-like bark. Species selection should favour smooth-barked and tightly-held bark species
Potential available surface fuel	The availability of surface fuel is a function of volume (quantity) and fineness. The fireline intensity increases in proportion to available fine fuel quantity. Fine fuel includes dead fallen material such as leaves, bark, twigs and branches up to 6mm in diameter (forest) and grass greater than 5cm in height (grass-lands). Coarse fuel ignites less readily but may burn for longer	Species selection should favour species which do not contribute significantly to persistent, fine ground fuel

Figure 20: Characteristics of low flammability species and effect on performance in bushfire situations. Source: *Ramsay, GC, and Rudolph, LS (2003), Landscape and building design for bushfire areas. (Same as footnote 67)*

8.5.3 Landscape management

- Ensuring street and road verges and nature strips containing hazardous vegetation are regularly pruned, mown or grazed.
- Removing accumulated leaf litter and woody debris at regular intervals.
- Keeping areas beneath retained or planted trees and shrub cleared of fuel. This may include vegetation management measures such as:
  - canopy lifting to reduce near-surface or ladder fuel loads and reduce flame heights
  - clearing of understorey vegetation
  - removal of accumulated litter and woody debris
  - removal of loose bark and dead limbs from standing trees.
- Regular mowing or slashing of grass to less than 10 centimetres in height.
- Availability of reliable and sufficient water and installation of irrigation and sprinkler systems to create a well-watered landscape.

8.5.4 Barriers

- Selection of low-flammability trees and shrubs with good barrier-forming attributes, such as rainforest species.
- Use of non-combustible fences and retaining walls, such as stone walls.
- Positioning non-combustible water tanks at key locations to act as radiant heat barriers.
- Positioning barrier plantings where they are likely to be most effective. Vegetation barriers should be located at a suitable distance from buildings or flammable objects (such as fences) so that, if ignited, the flames cannot come into contact with these elements.

9. INFORMATION THAT MAY INFORM DEVELOPMENT CONDITIONS

9. Information that may inform development conditions

9.1 Static water supply

Where a planning scheme contains an assessment benchmark for the provision of an appropriate static water supply, a development condition may specify how this is to be provided.

An appropriate static water supply (in bushfire prone areas where reticulated supply is not provided) to support effective emergency services response includes a water tank that is available solely for firefighting purposes and can be accessed by firefighting appliances. The water tank is to be provided within 10 metres of each building (other than a class 10 building), which:

a) is either below ground level or of non-flammable construction

b) has a take-off connection at a level that allows the following dedicated, static water supply to be left available for access by firefighters:

  i. 10,000 litres for residential buildings

  ii. for industrial, commercial and other buildings, a volume specified in AS 2304–2011 Water storage tanks for fire protection systems

c) is protected from bushfire attack, including shielding of tanks and pumps in accordance with AS 2304–2011 Water storage tanks for fire protection systems

d) allows medium rigid vehicle (15 tonne fire appliance) clear access within six metres of the tank

e) if serviced by a rural fire brigade, is provided with rural fire brigade tank fittings of a 50 millimetre ball valve and male camlock coupling and, if underground, an access hole of 200 millimetres (minimum) to accommodate suction lines

f) is clearly identified by directional signage at the street frontage.

9.2 Assembly and evacuation areas

Where a planning scheme contains an assessment benchmark for the provision of a safe assembly or evacuation area, a development condition may articulate how this could be achieved.

A safe assembly or evacuation area may be a suitable alternative to an evacuation route, where the site is in an isolated location, and any evacuation route would be long or pass through the bushfire prone area. A safe assembly or evacuation area would involve:

- Establishing the safe assembly or evacuation area within the development site and outside the identified bushfire prone area.
- Direct route/s to the designated area are designed to ensure:
  - › roads have sufficient capacity for the evacuating population
  - › occupants are directed away from rather than towards or through areas with a greater potential bushfire intensity
  - › minimising the length of route through bushfire prone areas
  - › compliance with AS 3745–2010 Planning for emergencies in facilities where deemed appropriate for isolated developments.

9.3 Protective landscape treatments

Developments should demonstrate that landscaping and open spaces have a potential available fuel load of less than 8 tonnes/hectare on aggregate, and fuel structure that remains discontinuous. These requirements may be included in a planning scheme where landscaping and open spaces are to comprise protective landscape treatments.

9.4 Asset protection zones for vulnerable uses, storage or manufacture of materials that are hazardous and community infrastructure for essential services

Site planning will form part the risk mitigation approach where these developments are unavoidable in a Bushfire Prone Area, and conditions under Policies 6, 7 and 8 of this document are met. Site planning may incorporate APZs as part of selected risk mitigation treatments. This may include a development footprint plan that is separated from the closest edge to the adjacent mapped medium, high or very high potential bushfire intensity area by a distance (APZ width) that achieves a radiant heat flux level of 10 kW/m2 or less at all development footprint boundaries.

Section 7 in this document provides guidance regarding the process for calculating asset protection zones.

Note – In addition to this guidance, the Work Health and Safety Act 2011 and associated Regulation and Guidelines, the Environmental Protection Act 1994 and the relevant building assessment provisions under the Building Act 1975 contain requirements for the manufacture and storage of hazardous substances. Information is provided by Business Queensland on the requirements for storing and transporting hazardous chemicals, available at: www.business.qld.gov.au/running-business/protecting-business/risk-management/hazardous-chemicals/storing-transporting

Note – Existing cleared areas external to the site may only be used in calculating necessary separation where tenure ensures that the land will remain cleared of hazardous vegetation (for example the land is a road, watercourse or highly managed park in public ownership).

10. EXPERTISE

10. Expertise

10.1 Introduction

This section is applicable where a local government:

- proposes to undertake a review of statewide State Planning Policy Interactive Mapping System (SPP IMS) bushfire prone area mapping as part of planning
- proposes to undertake a risk assessment for bushfire in accordance with AS/NZ 31000-2018 Risk management - guidelines, or
- contains provisions in a planning scheme for the undertaking of a BHA, Vegetation Hazard Class Assessment or BMP and preparation of a Bushfire Hazard Report as part of a development application.

10.2 Suitably qualified and experienced

The preparation of these planning scheme provisions or applicant-initiated assessments and reports should be prepared (or peer-reviewed) by suitably qualified and experienced people. These people should have the following qualifications and experience as a starting point:

- degree (AQF level 8) qualifications in environmental science, environmental management (or equivalent discipline)
- demonstrated experience in botanical survey and spatial analysis methods, including use of geographic information systems (GIS) software
- demonstrated experience in the assessment of bushfire hazard and risks or technical qualifications in environmental science, environmental management (or an equivalent discipline)
- demonstrated relevant industry experience in the assessment of bushfire hazard and risks for a minimum five years.

Where a local government proposes to include advice about the process for preparation of applicant-initiated assessments in its planning scheme (as a planning scheme policy, for example), it is recommended that advice on the necessary expertise also be included.

11. Acronyms and abbreviations

APZ	Asset protection zone
AEP	Annual exceedance probability
AS 3959–2018	Australian Standard 3959–2018 Construction of buildings in bushfire-prone areas
BPA	Bushfire prone area
BMP	Bushfire Management Plan
BVG	Broad vegetation group
FDI	Fire Danger Index
FFDI	Forest Fire Danger Index
FWS	Fire weather severity
IMS	Interactive mapping system
LMP	Landscape Management Plan
MCU	Material change of use
NCC	National Construction Code
QFES	Queensland Fire and Emergency Services
RH	Relative humidity
RAL/ROL	Reconfigure a lot/reconfiguration of lot
SPP	State Planning Policy
SPP map	Statewide map of bushfire prone areas (available via the SPP IMS)
SPP map input data	Statewide map of bushfire prone areas input data e.g. FFDI (5% AEP), maximum landscape slope and vegetation hazard class
VHC	Vegetation hazard class
VMP	Vegetation Management Plan

12. Glossary

Asset Protection Zone (APZ) – a specified area of land that enables emergency access and operational space for firefighting. Vegetation is modified and maintained within the APZ to reduce fuel load and mechanisms of bushfire attack such as flame and radiant heat. The zone may include a combination of elements such as perimeter road, fire trail and working area and open space where vegetation is managed.

> Note – The asset protection zone need not be maintained 'fuel free'. Sensible landscape design can ensure a balance between landscape design outcomes and minimising the vulnerability to bushfire attack. Refer to section 8.5 in this document for guidance on landscape design and vegetation management.
>
> Note – The asset protection zone considered as part of a planning development application is different from the siting of a building as part of designing and constructing the building to reduce the risk of ignition from a bushfire, appropriate to the intensity of the bushfire attack on the building and the associated requirements prescribed in AS 3959–2018 Construction of buildings in bushfire prone areas as part of a building development application.

Bushfire – a generic Australian term for an unplanned vegetation fire which includes grass fires, forest fires and scrub fires. Bushfires are synonymous with the terms 'wildfire' (North America, Asia, Europe, New Zealand) and 'veldt fire' (South Africa).

Bushfire hazard – a hazard can be defined as a condition event, or circumstance that could lead to or contribute to an unplanned or undesirable event. In the context of bushfires, hazards include smoke, radiation, hot gases, airborne particles, burning embers, fire-induced winds and flames.

Bushfire prone area – defined in the State Planning Policy (SPP) as the spatial representation of the natural hazard area of bushfire, to which the 'Natural hazards, risk and resilience state interest' applies. A bushfire prone area is sometimes referred to as the bushfire hazard overlay,

> Note – A 'designated bushfire prone area' for application of the bushfire building codes is different from the 'bushfire prone area' used for land use planning purposes. However, it is common for local governments to adopt the 'bushfire prone area' as the 'designated bushfire prone area'.
>
> A 'designated bushfire prone area' is defined by the Australian Building Codes Board as an area designated under a statutory mechanism as being subject to, or likely to be subject to, bushfires. The declaration typically occurs through state building legislation. In Queensland, section 12 of the Building Regulation 2006 (QLD) identifies that a local government may, in a local planning instrument, designate all or part of its area as a designated bushfire prone area for the Building Code of Australia (BCA) or Queensland Development Code (QDC).
>
> Building development applications in a designated bushfire prone area are required to meet the mandatory bushfire provisions in the National Construction Code (NCC) series (BCA) and in AS 3959–2018 Construction of buildings in bushfire-prone areas. Bushfire protection provisions in the NCC apply to Class 1, 2 and 3 residential buildings and accommodation buildings and associated Class 10a structures such as garages, sheds and carports.
>
> The NCC performance requirement is that "a building that is constructed in a designated bushfire prone area, must to the degree necessary, be designed and constructed to reduce the risk of ignition from a bushfire, appropriate to the potential for ignition caused by burning embers, radiant heat or flame generated by bushfire; and intensity of the bushfire attack on the building."
>
> The NCC performance requirement is deemed to be met where the building complies with AS 3959–2018. AS 3959–2018 contains provisions which can be used in construction to resist bushfires, to reduce the risk to life and minimise the risk of property loss. These provisions include requirements for burning debris and ember protection, controls on the combustibility of exterior material, and the protection of openings, such as windows and doors.
>
> A local planning instrument does not otherwise deal with building matters covered by AS 3959–2018.

Effective slope – the slope under vegetation that contributes to bushfire hazard in relation to the proposed development or site boundary. Where multiple slopes occur in relation to a proposed development or site boundary, the maximum slope under hazardous vegetation is used.

Exposure – the elements within a given area that have been, or could be, subject to the impact of a particular hazard . Exposure is also sometimes referred to as the 'elements at risk' and could include the number and characteristics of the values or assets exposed, where the values or assets could be tangible or intangible aspects of environmental, social, cultural, economic or political/reputational dimensions.

Fine fuel – that component of the fuel that burns in the flaming zone of a bushfire. Practically, this includes dead plant material such as grass, leaves, bark and twigs less than 6 millimetres thick and live plant material less than 2 millimetres thick. Fine fuels are typically described in strata as surface, near-surface, elevated, bark (on tree boles) and canopy fine fuels. This document only refers to fine fuel, so any reference to fuel should be taken to mean fine fuel.

Fire weather severity – is equivalent to the Forest Fire Danger Index (FFDI), as defined in AS 3959–2018, as calibrated by the document 'A new methodology for State-wide mapping of bushfire prone areas in Queensland'. It is based on a three-hourly, 83 kilometre gridded prediction of the FFDI from long-term spatial weather products produced by the Australian Bureau of Meteorology (BoM).

FFDI – Forest Fire Danger Index. The FFDI is a measure of the frequency of bushfire weather events that influence the nature of bushfire behaviour. They can be mitigated through land use planning. The FFDI is equivalent to a 5% annual exceedance probability (i.e. 5% chance of occurring in any given year). The index integrates the combined effect of a range of weather variables including long-term dryness, recent precipitation, current wind speed, relative humidity and temperature. The FFDI (5% AEP) index has been calculated using adjusted weather data to reflect projected changes to climate by 2050.

Hazard – a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.[72] In the context of bushfires, hazards include smoke, radiation, hot gases, airborne particles, burning embers, fire-induced winds and flames.

Hazardous vegetation – vegetation that contributes to fine fuels and results in a bushfire hazard when burnt. Areas that are mapped as either very high, high or medium potential bushfire intensity include potentially hazardous vegetation that could support a significant bushfire. This vegetation is classified and mapped as having a vegetation hazard class.

Head fire – the part of a fire perimeter where the rate of spread, flame height and intensity are greatest, usually the part of the fire perimeter most downwind or upslope.

Maximum landscape slope – the maximum potential slope of the landscape, over a 25 metre distance, that could influence the rate of fire spread. This term is synonymous with 'effective slope' in this document.

Mitigation – measures taken in advance of a bushfire event that aim to decrease or eliminate the bushfire's impact on society and the environment.

Potential fireline intensity – the rate of energy release per unit length of fire front, regardless of its depth. Several assumptions underpin the inputs for calculating the potential fireline intensity, including:

- the fire ignition must occur in a suitable time and place
- the fire must arrive fully developed at the time of the maximum daily FFDI
- the slope in the adjacent grid must be at the maximum
- the wind direction must align with the slope
- the fuel load at the time of the fire must match the potential fuel load

Therefore, while the fire weather severity is 5% AEP likelihood, when combined with the above factors, the actual likelihood is less by an order of magnitude.

Potential impact buffer – the spatial representation of the portions of a bushfire prone area that comprise lands at risk of significant bushfire attack from embers, flames or radiant heat. The potential impact buffer surrounds areas mapped as either very high, high or medium potential bushfire intensity.

Risk assessment – the process of risk identification, risk analysis and risk evaluation defined in AS/NZS ISO 31000:2018 and the Queensland Emergency Risk Management Framework (QERMF).

Site slope – the average slope of the ground between the edge of the proposed development or site boundary and the edge of hazardous vegetation.

Vegetation hazard class – the vegetation that contributes to bushfire hazard and is classified according to a modified version of Queensland's broad vegetation groups.

Vegetation hazard area – tree, shrub, grass or cultivated vegetation that represents a potential fire hazard, and includes hazardous vegetation and grass fire prone areas.

Vulnerability – the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

70 *Australian Emergency Management Institute (2015), National Emergency Risk Assessment Guidelines.*
71 *Leonard, J., Newnham, G, et al. (2014), A new methodology for State-wide mapping of bushfire prone areas in Queensland.*
72 *United Nations Office for Disaster Risk Reduction (2017).*

13. Figures

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