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INTEGRATING BUSHFIRE RISK REDUCTION AND STATUTORY MECHANISMS IN SOUTH AUSTRALIA

Assessment of the Draft Planning and Design Code 2019

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INTRODUCTION

Bushfires pose significant threats to life and property in many parts of Australia. The frequency and intensity of bushfires are increasing over time in association with worsening weather conditions that support extreme fires (Dowdy, 2018) and ongoing settlement growth (Allen, 2018). High bushfire risks generally occur when fires interact with human settlements, where housing and other structures are near flammable vegetation and associated impacts such as ember attack.

This report is an output of the wider project "Integrating Urban Planning with Disaster Risk Reduction" funded by the Bushfire Natural Hazard Cooperative Research Centre. It is part of a critical review of the integration of emergency management and urban planning in South Australia focusing on the detail of bushfire treatment mechanisms proposed in the State Planning Reform Document *Draft Planning and Design Code – Phase 2 Rural Areas* (DPTI, 2019b) released in October 2019 by the *Department of Transport, Planning and Infrastructure*, and *State Planning Commission*. In parallel, the review also considered other relevant regulations and codes such as *AS 3959-2018 Building in Bushfire Prone Areas* (Standards Australia - Committee FP-020, 2019) and *Ministerial Building Standard MBS008 Designated Bushfire Prone Areas – Draft October 2019* (DPTI, 2019a). The present report provides a basis for later work in subsequent stages that develops new approaches and improvements in collaboration with practitioners.

The review begins by setting out the conceptual and theoretical basis of integration and moves to presenting a general description of bushfires and the main factors that contribute to bushfire risks in the built environment. Then, it sets out the main elements of investigation relating to the integration of bushfire risk reduction in the built environment, summarising the adopted research approach and the role of this report in the wider research project. Then the report moves to critically analysing the outcomes of applying these integration principles to bushfire risks as they are dealt with by the draft Code. Findings point to elements of the Code that could be improved to reduce risks across the areas of hazard, exposure, and vulnerability.

TOWARDS INTEGRATION IN STATUTORY INSTRUMENTS

INTEGRATION OF URBAN AND REGIONAL PLANNING WITH RISK MANAGEMENT

Urban and regional planning seeks to bring about improvements and avoid problems in human settlements; objectives that would not be achieved without intervention, organisation and facilitation (Hall, 2007). While urban planning can occur in various forms and can use many mechanisms that seek a range of goals, its actions are primarily oriented to the physical characteristics of cities, towns and regions. This orientation combines with the profile and distribution of people and the interactions and activities they undertake in various locations, as the outcomes of planning. There is a general consensus, in high-level policy at least, that there is a need to improve the integration of urban planning and natural hazard mitigation. The Sendai Framework (UNISDR, 2015) contains numerous references to the need to integrate urban planning and natural hazard mitigation – however, it is notable that actual mechanisms to do this are still largely absent. This theme, of seeking conceptual understandings and practical methods for integration is common, as is the need to find context-specific solutions in parallel with overarching and "connected" frameworks of action and governance (Godschalk, 2003).

The Oxford Dictionary defines *integration* in its noun form as "[t]he making up or composition of a whole by adding together or combining the separate parts or elements; combination into an integral whole: a making whole or entire". This whole-of-system view of integration suggests that effective action can only occur when all stakeholders take into account natural hazards risks and ensure that actions complement and reinforce risk management. The Productivity Commission (2014, p. 30) reports a:

> *[…] growing awareness of the need to integrate natural disaster risk management into all aspects of the land use planning process, but this is not always achieved in practice. [It also points to] concern that development continues to be approved in high-risk areas, or that good local government decisions are being overturned.*

Emergency management seeks to successfully avoid or treatrisks by establishing systems that reduce vulnerability to hazards and avoid or cope better with disasters, making it a key contributor to the overall goal of natural hazard mitigation. While historically oriented to response activities, such as firefighting, sandbagging or rescue, emergency management now seeks to act across a much wider spectrum of stages in the "disaster cycle" to prevent, prepare for and recover from hazards and any subsequent events (Wamsler, 2014).

The location and physical arrangements of any town, city or region are key drivers of its risk profile. These risk drivers interact with the hazards emerging from the natural environment with which human settlements interact, and the characteristics of their social, economic and environmental context. For example, a small town located in a bushfire prone area with limited transport options, communications, response and warning systems is likely to be more vulnerable than a similar community that has actively developed fuel reduction, building maintenance, community and household plans, warning, evacuation and response capabilities. While the integration of emergency management and urban planning includes notable historical highlights such as the imposition of planning and building controls in London after the Great Fire of 1666, or the relocation of Concepcion, Chile after the devastating 1751 tsunami (March & Leon, 2013), it remains problematic to consistently draw these disciplines together to achieve the greatest risk reduction outcomes, because of their wide scope and apparent static qualities compared with inherent dynamism and complexity.

Emergency management is usually oriented to strategies that assume the built environment is static, while urban planning's ultimate impact is via permit processes when change is occurring, otherwise having little choice but to accept the existing built environment in its current state. However, it is important to note that overarching strategic planning processes frame and contextualise permit processes. Further, planning faces multiple demands from competing forces, often leaving risk assessment and treatment aside or as secondary to other concerns. The context of changing or emergent hazards and risk profiles, climate change, technologies and dynamic growth and change in human settlements continue to challenge the management of risks.

The *National Emergency Risk Assessment Guide* – NERAG (EMA, 2015) states that the application of risk assessment methodology needs to ensure that emergency-related risk management:

> *… integrates into all organisational processes – risk management is a mainstream activity that is most effective when integrated into standard business practices of organisations, governments and communities (Australian Institute for Disaster Resilience, 2015).*

In urban planning terms, this would require a wide understanding of all elements and decisions of the planning system addressing risks, comprehensively matching it with an evidence base appropriate to the decisions being made (Godschalk, 2003). There is a long legacy of urban planning seeking to integrate activity to achieve a range of goals across various processes. Further, there is a need for processes to be systematic and inclusive, understanding that failures to include key elements will lead to ineffectiveness (Wamsler, 2014). A wide range of relevant parties needs to be involved in the most effective ways possible.

An approach to **integration** must include, in combination, the following elements (March et al., 2018, p. 19):

1. *intra-organisational / agency integration, horizontally and vertically;*
2. *inter-organisational / agency integration, horizontally and vertically;*
3. *comprehensive coverage of all hazards;*
4. *full use of all planning treatment options;*
5. *integration of a wide range of other relevant parties;*

6. *procedural integration;*
7. *integration across PPRR;*
8. *goals, objectives and terminology integration;*
9. *treatments integration;*
10. *acknowledgement of local, cultural, social, economic and ecological matters; and*
11. *management of legacy and emergent risks in the built environment.*

BUSHFIRE RISKS IN THE BUILT ENVIRONMENT

The challenges facing Australian settlements relating to bushfire require integrated approaches that manage risks across a wide range of relevant factors. Bushfire frequency, intensity, location and other characteristics are impacted upon by human activities and the multiple ways we occupy land. Bushfire risk profiles in a location can be understood as a function of the characteristics of the bushfire hazard, exposure to that potential bushfire, and the level and type of vulnerability in a given location (adapted from Crichton, 1999).

As a type of hazard, bushfires progress through landscapes influenced by: ignition location/s and timing, vegetation (fuel loads, arrangement and continuity), topography, and weather conditions (humidity, temperature, wind speed) (Country Fire Authority, 2007). The risks of negative consequences such as deaths, physical and psychological injury, property loss and environmental loss, relate to being exposed to the bushfire and being vulnerable when exposed. This risk could be expressed as a function of proximity to the vegetation that is burning (Raphaele Blanchi et al., 2014) and being vulnerable to the impacts of the hazard such as a lack of shelter for humans and/or combustibility of structures in proximity to the fire (Raphaele Blanchi et al., 2014). Urban planning potentially provides powerful mechanisms to manage and improve many of these bushfire risk elements.

Bushfires are primarily hazardous when there is the likelihood that they will interact with human settlements. Certain landscapes are naturally fire-prone, and their ecosystems often rely on fire processes. In these contexts, wildfire disasters usually occur when residential development or infrastructure is exposed to extreme wildfire conditions, resulting in the ignition of multiple homes, properties or other structures and the fire cannot be contained by emergency response systems (Cohen, 2008). Bushfire disasters are more likely to occur in rural and urban fringe areas because of physical conditions and fuel sources of the surrounding environment. Furthermore, settlement patterns in urban-rural interfaces can affect the frequency and intensity of catastrophic wildfires, increasing risks (Butt, Buxton, Haynes, & Lechner, 2009).

A fire's capacity to burn depends on oxygen, fuel and heat (Mell, Manzello, Maranghides, Butry, & Rehm, 2010). Weather, terrain, wind, fuel size, moisture and energy content all influence wildfire risk (Sharples et al., 2016). Slope affects speed, fire-spread patterns and flame length. Wildfires progress faster travelling uphill because the fuel bed higher up the slope has already been exposed to additional heat and ignites more quickly. Wind impacts wildfire behaviour through its effect on heat, speed and spread of the fire, and on ember attacks (Sharples et al., 2016). Directional changes to wind drive fires into new areas, creating larger and more dangerous fire fronts.

Structures ignite in bushfires when there are sufficient fuel, heat and oxygen to initiate and maintain a fire (Cohen, 2008). Radiation and convection heating preheat the house for ignition, creating ideal conditions for flame contact, radiant heat and ember attacks to ignite the house (Mikkola, 2008). Ember attacks are one of the most prevalent causes of property loss in wildfires (Raphaele Blanchi et al., 2014). Because wind can carry embers for multiple kilometres, ember attacks pose a risk before the impact of the fire front, during and for a period after impact. Building materials, structural design, site location and vegetation management can make a building more resilient or vulnerable to ignition during a wildfire (Price & Bradstock, 2013).

ASSESSING INTEGRATION OF TREATMENTS AND BUSHFIRE

Previous research has established that urban planning treatments to bushfire risk fall into five main categories (March et al., 2018, p. 16):

1. *Avoidance of exposure to hazards*
2. *Reduction of hazard impacts or exposure in situ*
3. *Reduce vulnerability or increase resistance in situ*
4. *Improving Response*
5. *Improving Recovery*

The following sections expand on these categories.

Avoidance of exposure to hazards

The key short-term mechanisms for human death and injury resulting from bushfires are heat, flames, suffocation and poisoning, followed by secondary causes associated with fire-fighting or injuries from car crashes or falling trees and debris (Raphaele Blanchi et al., 2014). Structures are damaged and destroyed by bushfires via heat, direct flame contact, ember attack and secondary aspects such as extreme winds, fallings trees and flying debris (R Blanchi, Leonard, & Leicester, 2006).

A risk treatment approach is to minimise exposure to a hazard such as a bushfire, mainly by avoiding exposure altogether in the first place, before any need for subsequent remediation. A key focus of strategic urban planning processes is to manage overall growth patterns across states, regions and peri-urban areas. It is at this stage of decision-making, when growth is being directed at a wide geographic scale, that exposure can be limited or avoided altogether. Further, the need for urban planning to manage a range of competing demands can be understood at a broad level at this stage, avoiding some of the detailed issues of self-interest, land ownership, local politics, and the need for "workarounds" and excessive expenditure across communities and government resulting from uninformed prior decisions.

In simple terms, if housing, infrastructure and other land development and growth are directed away from high-risk areas, then considerable levels of risk to property and populations can be avoided altogether, in addition to minimising the need for responders to be exposed to further risks. Locations with high bushfire risk topography, vegetation, weather systems and other risk factors should be identified and assessed in advance. Urban planning processes and terminologies vary considerably by jurisdiction, but each state in Australia contains possibilities for the direction and prevention of urban areas via the definition of growth corridors, settlement areas, expansion areas and so forth. Similarly, parks and reserves, biodiversity areas, farming and rural zones, vegetation protection areas and limited growth areas can be identified in advance and managed in association with the range of values associated with them, in addition to bushfire risks. It is also worth noting that even if some areas have been developed previously, it may be worthwhile restricting or modifying future change to manage risks appropriately.

Reduction of hazard impacts or exposure in situ

Urban planning and hazard treatments need to be undertaken at a range of spatial scales to be effective. It is sometimes appropriate, usually in areas where overall risk is assessed as low (or to remediate existing areas), to employ site-based treatments that manage exposure and impacts at the precinct or site scale. Accordingly, the clearing of vegetation around new or existing structures or urban-edge areas is a way to reduce heat, flame contact and, to some extent, ember impacts upon structures. Often carried out by non-planning agencies or occupiers, fuel reduction measures can reduce the intensity and behaviour of fires. It is often the case that in combination with clearing or fuel reduction, that new structures are sited (if lot size allows) to minimise bushfire impacts via locating them away from the likely worst impacts of a future fire.

Importantly, the risk treatments described will have implications for other aspects of land and urban management that should be considered. The use of fuel reduction via prescribed burning or mechanical means has many resource and environmental implications, as well as aesthetic and health concerns. Further, the density of buildings, sizes of lots and amount of vegetation clearing needed will have implications for social, economic and environmental outcomes associated with development that may interact with the multiple goals sought by planning authorities in a given location. For example, large lot sizes may allow for retention of significant vegetation but provide low yields in terms of new housing provision and be difficult to service in terms of infrastructure and basic services.

Reduce vulnerability or increase resistance in situ

Vulnerability is the status of an individual and the "extent to which a community, structure, service or geographic area is likely to be damaged or disrupted by the impact of a particular hazard" (EMA, 2015, p. 118). Reducing vulnerability in situ, while related to exposure (proximity), is a distinct approach, being mainly a function of the characteristics of the particular at-risk element and its ability to withstand the hazard. In terms of bushfire, this aspect includes social and physical elements.

Physically improving the resistance of structures to withstand ember attack, heat, and flame contact effects, is a key aspect of physical resistance, employed mainly via application of the *Building Code of Australia* (ABCB, 2019a, 2019b), and features in the *AS 3959-2018 Building in Bushfire Prone Areas* (Standards Australia - Committee FP-020, 2019) in association with planning regulations relating to siting and vegetation management. Social aspects of vulnerability relate to the highly variable capabilities and vulnerabilities of people when they are exposed to bushfire hazard. For example, consider the dimensions of vulnerability associated with locating aged care, medical facilities, childcare centres and schools, or tourism facilities in bushfire prone areas. Further, factors such as social-economic-status and disadvantage are now understood to have impacts on vulnerability in multiple ways. Other factors such as demographic change over time can modify vulnerability as the characteristics of a population change.

Australian urban planning systems have traditionally been oriented to managing land use and development via the processes of developing regulations, and then issuing permits to proposed development that complies with the standards prescribed in these regulations. Significant vulnerability and physical resistance can be delivered by these relatively traditional zoning and regulatory approaches, based on the possibility of withholding permission for development that does not adequately manage risk. By improving the physical resistance of structures and by limiting vulnerable people's presence in bushfire-prone areas, significant gains can be obtained.

Improving Response

Response is action "taken in anticipation of, during and immediately after an emergency to ensure that its effects are minimized" (EMA, 2015, p. 112). In bushfires, these actions will include warnings and evacuation suggestions, active defence via personnel, trucks and planes fighting the fire, and may also include rescue operations, provision of relief and medical care. Careful coordination and deployment of resources are key to success in response activities, and the integration of related assistance from police, local government, earthmoving companies and interactions with news media are all important aspects.

While urban planning does not play a direct role in response itself, the design and management of urban areas can significantly impact upon the need for, and effectiveness of response at a range of spatial scales. Three main areas of response can be positively facilitated via urban planning: provision of fire-fighting water; ensuring movement in and around settlements, access and active defence facilitation around structures; and location of fire stations, refuges and safer places. While response is typically seen as a formal agency activity, the actions of community members is also a key aspect or response in terms of their ability to prepare themselves and their homes for response (sometimes including active defence by residents), and the ability to leave to an appropriate safe area in a timely manner to avoid being at risk.

Improving Recovery

Recovery is the "*process of supporting affected communities in the reconstruction of the built environment, and restoration of emotional, social, economic, built and natural environment wellbeing*" (EMA, 2015, p. 112). In bushfires, the scale of destruction can include deaths, the loss of houses, businesses, farms, significant changes to the natural environment and far-reaching economic, and psychological impacts. Recovery can understandably be oriented to seeking to restore as many features of previous circumstances as possible to assist with a return to normalcy. However, a wider view of resilience would suggest that the opportunity to improve risk profiles during recovery is significant (Meerow, Newell, & Stults, 2016).

The opportunity to improve risk profiles in recovery processes is not always sufficiently taken up. We note that urban planning in Australia often has limited formal roles in recovery. In particular, we suggest that proactively establishing mechanisms to deal with potential improvements to risk-prone areas *before* any events occur could allow considered approaches to be developed. We contend that fundamental improvements to the risk profiles of settlements are possible by using the opportunities possible after an event. Realignment of lots, buy-back schemes, improved structures, changes to access and response capabilities, and careful location of sensitive land uses are examples of matters that could be considered.

RESEARCH APPROACH

This report is a discreet output of the BNHCRC Integrated Urban Planning for Natural Hazard Mitigation project. While it contributes to addressing the wider project objectives, it does focus its attention on the following primary question, sub-question and milestone, as applied to bushfires in South Australia.

PRIMARY QUESTION

How can key planning regulations for bushfire risk decision-making in the built environment be improved, including generalisable and adaptable model processes and codes?

SUB-QUESTION

Using the analytical framework developed in Stage 1 and refined in Stage 2, how can the general planning treatment approaches used in South Australia be improved with new approaches or modifications, and what aspects of the South Australian Case can be examined in detail to highlight best practice?

PROJECT MILESTONE THIS REPORT CONTRIBUTES TO

Detailed report on SA to improve synergies between EM and planning.

CHOICE OF CASE STUDY

The South Australian case study was chosen because it has a well-developed yet incompletely integrated process of applying bushfire management via urban planning. This perspective was developed after a preliminary assessment of the treatment controls against the integration criteria set out above, in addition to discussion with stakeholders in key South Australian government agencies. Also, the release on October 2019 of a State Planning Reform Document *Draft Planning and Design Code – Phase 2 Rural Areas* (DPTI, 2019b) released in October 2019 by the Department of Transport Planning and Infrastructure, and State Planning Commission represented an opportunity to assist in engaging with critical urban planning change processes.

APPROACH UNDERTAKEN

The research followed a policy analysis approach to assess the general comprehensiveness of the instruments contained in the draft policy against the conceptual model of integration discussed above. First, the regulatory tools and mechanisms were identified, in association with end-users and other key parties. In parallel, the review considered end-users' comments and inputs over the life of the project.

The general characteristics of the planning instruments were described, followed by a categorisation of disaster risk reduction measures in terms of the categories of integration. Table 1 summarises the data categorisation approach:

HAZARD BASED PLANNING INTEGRATION ASSESSMENT – Bushfire					
"Site" for Assessment	SA "system" Consultation Draft Planning and Design Code – Phase 2 and associated documents.				
Fundamental Processes	Based on the combination of oxygen, heat and fuel, *bushfire* generally describes a fire moving through an Australian landscape. The behaviour of bushfires is influenced significantly by the nature of fuels, consisting mainly of vegetation, and which can vary considerably across landscapes. Fire characteristics are also significantly impacted by topography and weather.				
Mechanisms of Interaction – Structures	Heat, direct flame, and embers can ignite structures. Fire driven wind and tree strike can damage structures and facilitate ignition or other damage.				
Mechanisms of Interaction – Human and Other Values	Heat, direct flame, ember, fire-driven wind, tree strike, smoke and gases. Can impact on unprotected humans and livestock or pets, and damage property, infrastructure and other valued assets or systems. Secondary impacts can occur from injuries and deaths during escape on foot or in vehicles, fire fighting, heat, stress and trauma.				
Impacts/ Consequences	Death and injury, property damage, economic, environmental and social impacts.				
Planning Regulation					
	Description	**Risk Aspect**			**Assessment (Summary)**
		Exposure	**Resistance/ Vulnerability**	**Hazard**	
Regulatory Treatment					
Emphasis on Prevention, Preparedness, Response and/or Recovery?					
Interactions with other systems					

FIGURE 1. CATEGORISING INTEGRATION OF URBAN PLANNING AND BUSHFIRE RISK REDUCTION.

Table 1 summarises the key characteristics of integration and treatments to reduce bushfire risks, identified during the review. Data in this table were analysed and critically reviewed against the three components of disaster risk, namely hazard, exposure and vulnerability – these constituted the main headings in the results and discussion sections.

LIMITATIONS

The research reported here has some limitations that need to be acknowledged. First, it reviews a draft code that exists within a range of other, often conflicting, planning provisions and goals. The code is still in draft form and is associated with extensive mapping and associated methodologies that are not assessed in this research. Further, some aspects of the draft code are dependent upon and inter-related with associated nationally established standards, particularly *AS 3959-2018 Building in Bushfire Prone Areas* (Standards Australia - Committee FP-020, 2019).

RESULTS AND DISCUSSION

CONTEXT

The current report was written while South Australian planning is undergoing a significant modernisation. The update to the planning system seeks to improve ongoing processes and outcomes underpinned by the new Planning, Development and Infrastructure Act 2016 (State Parliament of South Australia, 2019). The reforms include the introduction of a 24/7 digital ePlanning system and other mechanisms to improve accessibility and reduce the time taken for decisions and changes to community consultation processes.

A critical component of the new controls is the introduction of a single, state-wide *Planning and Design Code* that consolidates South Australia's 72 development plans into one set of planning regulations. Under Section 65 of the Planning, Development and Infrastructure Act 2016 (the Act), the State Planning Commission (the Commission) is responsible for preparing and maintaining the Planning and Design Code as a statutory instrument (State Parliament of South Australia, 2019).

The focus of this current report is to assess the *Bushfire Provisions* of Phase 2 (Rural Areas) of the *Planning and Design Guide* (DPTI, 2019b), released in October 2019 by the Department of Transport Planning and Infrastructure, and State Planning Commission, currently open for public consultation. In parallel, the review also considers other relevant regulations and codes such as AS 3959-2018 Building in Bushfire Prone Areas (Standards Australia - Committee FP-020, 2019) and Ministerial Building Standard MBS008 Designated Bushfire Prone Areas – Draft October 2019 (DPTI, 2019a).

GENERAL DESCRIPTION OF PROPOSED PROVISIONS

The Planning and Design Code (DPTI, 2019c) is given legal force under Section 65 of the *Planning, Development and Infrastructure Act 2016* (State Parliament of South Australia, 2019). Under section 66 of the Act, the primary purpose of the Planning and Design Code is to

> *set out a comprehensive set of policies, rules and classifications which may be selected and applied in the various parts of the State through the operation of the Planning and Design Code and the SA planning database for the purposes of development assessment and related matters within the State.*

The policies and rules form a library organised into:

- Zones;
- Sub-zones;
- Overlays; and
- General Development Policies.

The policies are applied according to development classes and spatial location. This application is based on the Zones, Subzones and Overlays having mapped spatial boundaries across the state.

Development is classified in the Planning and Design Code (DPTI, 2019b) as follows:

a) accepted development (s104(1) of the Act);

b) deemed-to-satisfy development (s105(a) of the Act); and

c) restricted development (s108(1)(a) of the Act).

> *All development is classified firstly by reference to its location and the Zone, Subzone and Overlays that apply to the location. Classification tables applicable to each Zone identify Accepted Development, Deemed-to-Satisfy development and Restricted Development (DPTI, 2019b, p. 7).*

Performance Assessed Development is a classification for development not classified as *accepted*, *deemed-to-satisfy*, *restricted* or *impact-assessed* and which is to be assessed on its merits against the *Planning and Design Code* (DPTI, 2019b), as contemplated by s107 of the Act (State Parliament of South Australia, 2019).

Spatial areas considered to have some level of bushfire risk are included within one of the following six mapped hazard overlays:

- Bushfire – Outback Overlay
- Bushfire – Regional Overlay
- Bushfire – General Risk Overlay
- Bushfire – High Risk Overlay
- Bushfire – Medium Risk Overlay
- Bushfire – Urban Interface Overlay

In general, areas considered to be at the most significant risk are included in the *Bushfire – High Risk Overlay* which includes the most onerous standards to be met, while the *Bushfire – Urban Interface Overlay* is relatively easily met. Similarly, the *Bushfire – Outback Overlay* contains less onerous provisions than the is relatively more stringent standards established by the *Bushfire – Regional Overlay* or the *General*, *Medium* or *High-Risk* Overlays. The Overlays set *Desired Outcomes* and *Performance Outcomes,* and *Deemed to Satisfy*, or *Designated Performance Features* for various aspects relating to bushfire. These include:

- Decision Criteria and Objectives
- Siting and Distances to Vegetation
- Clearing of Vegetation
- Vehicle Access,
- Asset Protection

- Development Classes
- Referrals (in some cases)
- Land Division

Ministerial Building Standard MBS008 Designated Bushfire Prone Areas – Draft October 2019 (DPTI, 2019a) also works in conjunction with the *Planning and Design Code* (DPTI, 2019b). MBS008 (DPTI, 2019a) forms part of the Building Rules under the *Planning, Development and Infrastructure Act 2016* (the Act) (State Parliament of South Australia, 2019) and, accordingly, works in conjunction with the Act. MBS008 (DPTI, 2019a) delineates *designated bushfire prone areas* for the purposes of the *Building Code of Australia* (ABCB, 2019a, 2019b) and additional fire safety provisions to those *required* by the *Building Code of Australia* (ABCB, 2019a, 2019b) for the protection of new Class 1, 2 and 3 buildings in *designated bushfire prone areas*. This means that standards *AS 3959-2018 Building in Bushfire Prone Areas* (Standards Australia - Committee FP-020, 2019) will apply to certain land.

Clause 2.1 of MBS008 (DPTI, 2019a) states that:

> *A building is in a designated bushfire prone area if it is in an area identified in the Planning and Design Code (P&D Code) [(DPTI, 2019b)] as-*
>
> *(a) a general, medium or high bushfire risk area; or*
>
> *(b) an area within an urban interface area that is within 500 metres of a high bushfire risk area.*

In the cases above, both the bushfire requirements of the relevant overlay of the *Planning and Design Code* (DPTI, 2019b) and the relevant building requirements of *AS 3959-2018 Building in Bushfire Prone Areas* (Standards Australia - Committee FP-020, 2019) will apply. As a result, buildings in general, medium or high bushfire risk area and urban interface areas within 500 metres of a high bushfire risk area will have planning and building BAL (Bushfire Attack Level) standards applied as appropriate. MBS008 (DPTI, 2019a) does not stipulate a requirement that land in the Bushfire – Outback and Bushfire – Regional Overlays meet standards required by *AS 3959-2018* (Standards Australia - Committee FP-020, 2019).

MBS008 (DPTI, 2019a) sets out additional requirements for Water Supply (5.2) depending on the size of allotment and presence of mains connection, Pumps (5.3), Pipework (5.4), and Hoses (5.5).

ASSESSMENT

The following assessment sections follow the general categories set out in Figure 1, presented earlier. Rather than to reproduce large amounts of text already contained in the *Planning and Design Code* (DPTI, 2019b), *Ministerial Building Standard MBS008 Designated Bushfire Prone Areas – Draft October 2019* (DPTI, 2019a) and *AS 3959-2018 Building in Bushfire Prone Areas* (Standards Australia - Committee FP-020, 2019), this report assumes that those documents will be read in conjunction with this assessment. Relevant sections and clauses are referred to as necessary.

Regulatory Treatment – Exposure

A fundamental risk treatment approach for bushfire is to minimise exposure of people and structures to the hazard itself, which is usually related to the presence and characteristics of vegetation. This approach is potentially powerful for the treatment of risk before any need for subsequent remediation. However, exposure can also include secondary fuels, such as outbuildings and other structures or flammables.

Each of the overlays reviewed in this report includes a Desired Outcome that seeks to minimise exposure, such as in the case of the Outback:

> *"Development is located to minimise the threat and impact of bushfires on life and property" (DPTI, 2019b, p. 1441).*

This is supported by Performance Outcome 1.1 which states that

> *Residential and tourist accommodation (including boarding houses, hostels, dormitory style accommodation, student accommodation and workers accommodation):*
>
> *(a) are sited to avoid narrow gullies, steep slopes (especially slopes with a northerly or westerly aspect) and vegetated areas (including unmanaged grasslands) that pose an unacceptable bushfire risk […] (DPTI, 2019b, p. 1441).*

In parallel, *Deemed to Satisfy / Development Performance* Framework Criteria 1.1 (DPTI, 2019b, pp. 1441-1442, for the Outback Zone, for example) requires that:

> *Development meets the following requirements:*
>
> *(a) an asset protection zone with a minimum width of 50m already exists and can continue to be maintained around the accommodation; and*
>
> *(b) the asset protection zone is contained wholly within the allotment of the development.*

These requirements are of considerable value but highlight a few instances in which the *Planning and Design Code* (DPTI, 2019b) is ambiguous or silent.

- The objective and subsidiary clauses appear to be generally written with the assumption that refusal is unlikely, rather than providing a measure against which the suitability or otherwise of the proposal are tested.
- Is the 50-metre distance for the asset protection zone appropriate in all situations? The variability of weather, slope, vegetation and resistance of structures would suggest it is unlikely to be the "correct" distance in all situations, particularly when there is no requirement for construction to meet AS 3959-2018 (Standards Australia - Committee FP-020, 2019) in the Outback, Regional and General Overlay.
- The 100-metre APZ requirement for High-Risk Overlay areas would seem a somewhat unsophisticated approach that may significantly reduce the flexibility of use of land and discourage the full use (if applicable) of the range of BAL responses appropriate for structures on a given site. Further, the imposition of a 100-metre radius (minimum around a structure)

presupposes lots of at least 4 hectares as a minimum. This requirement would seem needlessly restrictive and may go against other goals.

- DTS 1.1 for the Outback Overlay and DTS 3.2 for the Regional Overlay require that development must have a pre-existing APZ of 50 metres to comply, or it will be assessed on its merits and as Restricted Development. However, it is not clear how its merit would be assessed. It would seem more appropriate to allow clearing to 50 metres as of right if this is considered appropriate or to provide a performance test to reduce uncertainty.
- The lack of specification of the characteristics of the Asset Protection Zone leaves considerable doubt as to the efficacy of this area in a range of settings and adjacent to a range of different structures. Further, no certainty of maintenance exists, and no stipulation for mandatory conditions of permits exists.
- Asset Protection Zones must be contained wholly within an allotment. While this provides a level of certainty, there are many situations where it could be advantageous to vary this.
- Detailed garden or yard planting design criteria are not included, particularly in terms of proximate interactions with structures including vegetation or mulch near to windows, overhanging trees, tree strike and detailed design of structural elements such as gas bottles, sheds, decks and pergolas.
- Outbuilding or other flammable structures are not mentioned and may be a significant cause of risk to primary structures which provide shelter and protection.
- The High-Risk Overlay at DO2 states (DPTI, 2019b, p. 1461) that:

  > *Activities that increase the number of people living and working in the area or where evacuation would be difficult is situated away from areas of unacceptable bushfire risk.*

  This is an ambiguous and somewhat untestable objective, except to suggest that the very purpose of the overlay means that inherently no new land division or development may occur.

Regulatory Treatment – Resistance/ Vulnerability

Increasing the resistance of structures, while inter-related to exposure (essentially proximity to hazard) is a distinct treatment option, being mainly a function of the characteristics of the particular at-risk element and its ability to withstand the hazard. In terms of bushfire, this aspect includes social and physical elements. Critical aspects of the proposed Planning and Design Code (DPTI, 2019b) that appear ambiguous are as follows.

- Ember attack is known to be a common source of bushfire ignition. Not requiring the building to AS 3959-2018 (Standards Australia - Committee FP-020, 2019) in the Outback, Regional and General Overlay would seem a missed and low-cost opportunity (given they could relatively easily be built to BAL 12.5).

- The stipulation of predetermined BAL Levels for the Medium and High-risk overlays would seem to suggest that the predetermined APZ distance and BAL level is going to be appropriate in every case, despite considerable variation between sites' slope, exterior and internal landscape and vegetation and weather conditions, and accessibility. There may be a range of reasons to vary this, including cost-effectiveness for occupants and vegetation retention.
- The term "site" has a different meaning in AS 3959-2018 (Standards Australia - Committee FP-020, 2019) and the Planning and Design Code (DPTI, 2019b) – 2.4 of the MBS008 (DPTI, 2019a) leaves this ambiguous.
- Location of associated hazard elements such as gas bottles, fuel and other storage areas, vehicle parking and related matters are not considered.
- The regulations relating to response by emergency responders are detailed and effective, such as truck clearances, passing and turning distances.
- The use of a building mechanism to provide signage for firefighters would seem an ineffective long-term solution in terms of enforcement.
- The elements of the Planning and Design Code (DPTI, 2019b), and MBS008 (DPTI, 2019a) that facilitate firefighting access and water appear to be thorough and a valuable aspect of the provisions.
- The land division provisions include worthy intentions and general directions. However, they do not include tests against which the "bushfire buffer zone" (Regional Overlay: PO 4.3) can be calculated or assessed.
- The diagram (DPTI, 2019b, p. 1450, Figure 1) for land division layout communicates many useful principles such as using managed vegetation such as parklands to create separation, redundancy in roads and fire-fighting access. However, it makes ambiguous the provision of a perimeter road by suggesting a Council-maintained fire track is acceptable in place of a properly made road at the developer's expense that is more sustainable in terms of resources. Additionally, the figure does not show a number of useful additional principles: the use of graduated BALs with distance from vegetation, water provision, and shared Asset Protection Zones – APZs in fully designed divisions.

Regulatory Treatment - Hazard

Hazard treatments undertaken at a range of spatial scales are the most effective. Accordingly, the management of vegetation around new or existing structures or urban-edge areas is a critical way to reduce heat, flame contact and to some extent ember impacts upon structures. The treatment of the hazard (vegetation) in the *Planning and Design Code* (DPTI, 2019b) is ambiguous in some respects, even while the emphasis upon the creation of APZs is clearly a core and essential component of the risk strategy used. A number of matters arise, often relating to the need for synergistic understandings between Hazard, Exposure and Vulnerability as raised above.

- No detail of the understandings of more comprehensive risk profiles of communities is provided in a manner which relates to risk reduction and design responses expressed in plausible solutions.
- There is no clear definition of and enforcement process for APZs. The detailed design and characteristics of gardens and yards have a significant impact on fire's interactions with structures.
- While mentioned above, it is repeated here again due to the synergistic nature relationship between exposure and hazard management - is the 50-metre distance for the asset protection zone appropriate in all situations? The variability of weather, slope, vegetation and resistance of structures would suggest it is unlikely to be the "correct" distance in all situations, particularly when there is no requirement for construction to meet *AS 3959-2018* (Standards Australia - Committee FP-020, 2019) in the Outback, Regional and General Overlay.
- Following from the above, the 100-metre APZ requirement for High-Risk Overlay areas would seem a somewhat unsophisticated approach that may significantly reduce the flexibility of use of land and discourage the full use (if applicable) of the range of BAL responses appropriate for structures on a given site. Further, the imposition of a 100-metre radius (minimum around a structure) presupposes lots of at least 4 hectares as a minimum. This requirement would seem needlessly restrictive and may go against other goals.
- The *Planning and Design Code* (DPTI, 2019b) is generally silent regarding the variance inherent to fire behaviour in various locations, although avoidance of gullies and slopes is a useful principle.
- Rules for Vegetation clearing are unclear (acknowledging these are also dealt with elsewhere) and are dealt with via non-compliance processes which complicate the effectiveness of the *Planning and Design Code* (DPTI, 2019b) – particularly since the decision criteria of such processes are unclear.
- There is no policy position expressed on the dependability of fuel reduction and areas likely to be managed in a fuel reduced state.
- No detail of hazard risk reduction of interactions with structures' weak points is included – the emphasis seems to be on the structure alone – when it is more useful to also consider management of fuels to lessen likely impacts.

Emphasis: Prepare, Respond, Recover

The ability to deploy resources is key to success in response activities. The design and management of urban areas can significantly impact upon the need for, and effectiveness, of response at a range of spatial scales. The *Planning and Design Code* (DPTI, 2019b) is quite comprehensive in its approach to enabling response: provision of fire-fighting water; and ensuring movement in and around settlements and structures. However, the lack of detailed design principles for APZs may hinder movement around structures.

The *Planning and Design Code* (DPTI, 2019b) emphasises urban planning as a core mechanism for risk reduction. This is supported as one of the most effective approaches to risk reduction, particularly as it allows treatments across the spectrum of risk reduction in the built environment. However, some issues remain unresolved:

- In terms of recovery, the *Planning and Design Code* (DPTI, 2019b) is silent. It is suggested here that strong principles are put in place to ensure recovery activities undertaken significantly improve risk profiles in the event of reconstruction. This supports a wider view of resilience that improves risk profiles during recovery (Meerow et al., 2016).
- Preparation is focussed on important risk reduction aspects as demonstrated above.
- Mechanisms for treating bushfire risks in existing settlements are dealt with to some limited extent, although development control is emphasised. No mention is made of overall settlement design and neighbourhood and of community safer places.

Interactions with Other Systems

The *Planning and Design Code* (DPTI, 2019b) includes referrals to the South Australian Country Fire Service only for sites included in the High-Risk Overlay. This assumes that no other sites required a detailed examination. It would seem appropriate to consider the range of other circumstances whereby referrals are appropriate while paying heed to the challenges of burdening the CFS excessively.

NEXT STEPS

The proposed *Planning and Design Code* (DPTI, 2019b) is a relatively comprehensive and valuable mechanism to coordinate and improve bushfire risks across the state. It is recommended here that stakeholders work with the Bushfire and Natural Hazards Cooperative Research Centre "Integrating Urban Planning with Disaster Risk Reduction" team members to develop ways to build upon and improve the Planning and Design Code (DPTI, 2019b) in the areas outlined above.

TEAM MEMBERS

The Integrated Urban Planning for Natural Hazard Mitigation Project comprises an interdisciplinary team of researchers with expertise in the fields of urban planning, natural hazard mitigation, resilience, decision support systems, climate change, governance, disaster risk management and public policy.

PROF ALAN MARCH

Alan March is Professor in Urban Planning. He is also Director of the Bachelor of Design across the Faculties of Architecture, Building and Planning; Engineering; and, Faculty of Fine Arts and Music. Alan has twice won the Global Planning Education Network's prize for "Best Planning Paper" (2007, 2011). His teaching includes urban design, planning law and planning theory subjects, and he was awarded a Faculty teaching prize in 2007. Alan has successfully supervised over 60 students' theses encompassing a range of urban design and planning research topics. He won the Planning Institute of Australia's Victoria division "planner of the Year" prize in 2016 and won a National Commendation in the same category in 2017.

Alan has practised since 1991 in a broad range of private sector and government settings and has had roles in statutory and strategic planning, advocacy, and urban design. He has worked in Western Australia, the UK, New South Wales and Victoria. Alan's early career included projects as diverse as foreshore protection plans, rural to urban subdivision approval and design, the Mandurah Marina and Urban Design Guidelines for the Joondalup City Centre. In England, he has worked in brownfield and inner-city redevelopment, including land assembly and urban regeneration projects. Alan has extensive experience in inner city redevelopment projects in Melbourne since 1996.

Alan's publications and research include examination of the practical governance mechanisms of planning and urban design, in particular the ways that planning systems can successfully manage change and transition as circumstances change. He is particularly interested in the ways that planning and design can modify disaster risks, and researches urban design principles for bushfire. His current work also considers the ways that urban planning is seeking to establish new ways to spatialise urban management.

DR LEONARDO NOGUEIRA DE MORAES

Leonardo Nogueira de Moraes is a postdoctoral research fellow in resilience and urban planning at the Faculty of Architecture, Building and Planning of the University of Melbourne. He is part of the research team for the Integrated Urban Planning for Natural Hazard Mitigation project, funded by the Bushfire and Natural Hazards Cooperative Research Centre.

His background includes a Bachelor of Tourism (Development and Planning) degree and a Specialisation in Tourism and Hospitality Marketing Management from the University of São Paulo, Brazil. His PhD in Architecture and Planning at The University of Melbourne focused on the effects of tourism development and the implementation of protected areas on the resilience of small oceanic islands, from a social-ecological complex adaptive systems perspective.

His current research on resilience and urban planning also includes the effects of tourism development to the resilience of local communities to natural hazards. This is being developed with the aid of grounded theory methods, coupled with social media analysis and data visualisation by means of interactive timelines.

DR GRAEME RIDDELL

Graeme is a researcher and consultant across the fields of urban planning, disaster risk and resilience. His work revolves around developing and applying innovative modelling and participatory approaches to tackle complex planning and policy issues. Graeme is currently a research fellow at the University of Adelaide (Australia) and associate consultant at RIKS, the Research Institute for Knowledge Systems (the Netherlands).

He is also a PhD Candidate at The University of Adelaide researching how to develop effective policies under conditions of complexity and uncertainty considering both robust and adaptive approaches. His aim is to develop decision support systems to assist policy development. Graeme is also involved with the BNHCRC Project Decision support system for policy and planning investment options for optimal natural hazard mitigation led by Professor Holger Maier.

EMERITUS PROFESSOR STEPHEN DOVERS

Emeritus Professor Steve Dovers was originally trained as an ecologist and natural resource manager, and worked in local government and heritage management. He later studied geography at graduate level, and gained a PhD in environmental policy in 1996. He became an academic member of staff at the then Centre for Resource and Environmental Studies at the ANU in 1997. From 2009-2017 he was Director of the Fenner School of Environment and Society at the ANU, and an inaugural ANU Public Policy Fellow. He is a Fellow of the Academy of Social Sciences in Australia, was inaugural Chair of the Management Committee of Future Earth Australia; a member of the Advisory Council of the Mulloon Institute, Associate Editor of the Australasian Journal of Environmental Management, and member of the editorial Boards of the journals Local Environments, Environmental Science and Policy, and Resilience. Steve is a Senior Associate with the advisory firm Aither.

A/PROF JANET STANLEY

Janet Stanley is an Honorary Principal Fellow at the Faculty of Architecture, Building & Planning, visiting Professor at the University of Hiroshima, Japan, a Director of the National Centre for Research in Bushfire & Arson and a Director of Stanley & Co., consultants in sustainable policy. Prior to this, Janet was Chief Research Officer at Monash Sustainability Institute, Monash University.

Originally specialising in child protection and family violence, Janet now focuses on the interface between social, environmental and economic issues in climate change and sustainability, across policy, system design, and at community levels. This work particularly focuses on sustainability issues for those people experiencing social exclusion and disadvantage. Most recent work has been on transport and land use in a 20-minute city, social policy and climate change and the prevention of bushfire arson. Janet has been an advisor to state and federal governments, is on the Board of the charitable trust, the George Hicks Foundation and is a member of the Future Melbourne Network.

A/PROF HEDWIG VAN DELDEN

Hedwig van Delden is Director of the Research Institute for Knowledge Systems (RIKS) in the Netherlands and Adjunct Associate Professor in the School of Civil, Environmental and Mining Engineering at the University of Adelaide.

Her work focuses on applying research into planning and policy practice, and in particular on understanding and modelling of land use dynamics, integrating socio-economic and bio-physical processes, bridging the science- policy gap and the development of strategic scenarios. In doing so she focuses on the integration of disciplines as well as techniques (analysis, modelling, participation).

Hedwig has managed and contributed to a vast range of projects with multiple partners and objectives, for various governmental organisations worldwide. Her work in Australia includes the development of integrated models to support long-term decision-making for disaster risk reduction policies as part of the Bushfire & Natural Hazard CRC project.

PROF RUTH BEILIN

Ruth Beilin is an internationally recognised expert in community based resource management, in urban and non-urban resilience studies—especially in the area of social and environmental resilience and in complexity theory and the application of uncertainty to the everyday experiences of those on the ground—whether in fire, flood, sea rise, or drought. As examples: she has co-authored in excess of 90 peer-reviewed papers in high quality, international journals, including ecological and social journals. She co-designed and authored four chapters in the textbook Reshaping Environments, used by upwards of 6000 students to-date. In 2015 she co-edited two Special Issues of high impact international journals, Sustainability Science and J of Urban Studies, on Governance for Urban Resilience. She is an Associate Editor of Society and Natural Resources, among others. Since 2015, Professor Beilin has been a member of the New Zealand Science Advisory Panel for Land and Water. Her lab at the University of Melbourne is based on interdisciplinary research and her leadership in Australian Research Council Linkages and in the CRC Bushfires has involved applied and theoretical outcomes. For example, in the project The Social Construction of Fire and Fuel in the Landscape (CRC Bushfires) CFA and equivalent agency staff across the country can use the social-ecological/visual mapping techniques she co-developed.

PROF HOLGER MAIER

Holger Maier is Professor of Integrated Water Systems Engineering and Deputy Head of the School of Civil, Environmental and Mining Engineering at the University of Adelaide. Prior to joining the University in 1999, he worked as a consultant in the private and public sectors in South Australia, as a senior civil engineer with the Western Samoa Water Authority and as a postdoctoral research fellow at the University of British Columbia.

Holger's research is focussed on developing improved techniques for the sustainable management of water resources and infrastructure in an uncertain environment and includes elements of modelling, optimisation and multi criteria and uncertainty analysis. He has co-authored more than 10 book chapters and in excess of 100 refereed papers. He has received a number of national and international awards for his teaching and research.

REFERENCES

National Construction Code 2019 - Building Code of Australia - Volume One, (2019a).

National Construction Code 2019 - Building Code of Australia - Volume Two, (2019b).

Allen, L. (2018). A whole-of-government approach to population policy for Australia. *Australian Population Studies, 2*(2), 22-32.

Australian Institute for Disaster Resilience. (2015). *National Emergency Risk Assessment Guidelines: Handbook 10*. Retrieved from Canberra:

Blanchi, R., Leonard, J., Haynes, K., Opie, K., James, M., & Dimer de Oliveira, F. (2014). Environmental circumstances surrounding bushfire fatalities in Australia 1901–2011 *Environmental Science & Policy, 37*(March), 192-203.

Blanchi, R., Leonard, J., & Leicester, R. (2006). *Bushfire risk at the rural-urban interface*. Retrieved from Melbourne: http://bushfirecrc.com/sites/default/files/managed/resource/bushfire_risk_at_the_rural_urban_interface_-_brisbane_2006_0.pdf

Butt, A., Buxton, M., Haynes, R., & Lechner, A. (2009). *Peri-urban growth, planning and bushfire in the Melbourne City Region*. Paper presented at the Stat of Australian Cities, Sydney.

Cohen, J. D. (2008). The wildland-interface fire problem: a consequence of the fire exclusion paradigm. *Forest History Today, 20*, 20–26.

Country Fire Authority. (2007). *Building in a Wildfire Management Overlay: Applicant's Kit* Retrieved from

Crichton, D. (1999). The risk triangle. In J. Ingleton (Ed.), *Natural Disaster Management* (pp. 102-103). London: Tudor Rose.

Dowdy, A. J. (2018). Climatological Variability of Fire Weather in Australia. *Journal of Applied Meteorology and Climatology, 57*(2), 221-234. doi:10.1175/jamc-d-17-0167.1

Draft Ministerial Building Standard MBS 008 - Designated bushfire prone areas - additional requirements, (2019a).

Draft Planning and Design Code - Phase Two (Rural Areas) October 2019, (2019b).

DPTI. (2019c, 30/09/2019). Planning and Design Code. Retrieved from https://www.saplanningportal.sa.gov.au/planning_reforms/new_planning_tools/planning_and_design_code

EMA. (2015). *National Emergency Risk Assessment Guidelines - 2nd Edition*. Retrieved from Canberra: https://www.aidr.org.au/media/1489/handbook-10-national-emergency-risk-assessment-guidelines.pdf

Godschalk, D. (2003). Urban Hazard Mitigation: Creating Resilient Cities. *Natural Hazards Review, 4*(3), 136-143.

Hall, P. (2007). *Urban & Regional Planning* (Fourth ed.). London: Routledge.

March, A., & Leon, J. (2013). *Urban Planning for Disaster Risk Reduction: Establishing second wave criteria* Paper presented at the State of Australian Cities, Sydney, Australia. http://www.be.unsw.edu.au/research-centres-and-clusters/city-futures/soac

March, A., Nogueira de Moraes, L., Riddell, G. A., Stanley, J., van Delden, H., Beilin, R., . . . Maier, H. (2018). *Practical and Theoretical Issues - Integrating Urban Planning and Emergency Management* (1). Retrieved from https://www.bnhcrc.com.au/file/8951/download?token=u4pNzrhc

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning, 147*, 38–49.

Mell, W., Manzello, S., Maranghides, A., Butry, D., & Rehm, R. (2010). The wildland-urban interface fire problem – current approaches and research needs. *International Journal of Wildland Fire, 19*, 238-251.

Mikkola, E. (2008). Forest fire impacts on buildings In J. Heras, C. Brebbia, D. Viegas, & V. Leone (Eds.), *Modelling, monitoring and management of forest fires.* . Southampton: WIT Press.

Price, O., & Bradstock, R. (2013). Landscape scale influences of forest area and housing density on house loss in the 2009 Victorian bushfires *Plos One, 8*(8).

Productivity Commission. (2014). *Natural Disaster Funding Arrangements, Inquiry Report - Volume 1* (74). Retrieved from Canberra: https://www.pc.gov.au/inquiries/completed/disaster-funding/report/disaster-funding-volume1.pdf;

Sharples, J., Cary, G., Fox-Hughes, P., Mooney, S., Evans, J., Fletcher, M., . . . Baker, P. (2016). Natural hazards in Australia: extreme bushfire. *Climatic Change, 139*(1), 85-99.

Australian Standard 3959:2018 Construction in Bushfire-Prone Areas - Incorporating Amendment No. 1, (2019).
Planning, Development and Infrastructure Act 2016 - Version 01-07-2019, (2019).
UNISDR. (2015). *Sendai Framework for Disaster Risk Reduction 2015 - 2030*. Retrieved from Geneva: http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf
Wamsler, C. (2014). *Cities, Disaster Risk and Adaptation*. Abdingdon: Routledge.