FINAL REGULATION IMPACT STATEMENT

Proposal to amend the Building Code of Australia to include requirements for private bushfire shelters

January 2011

The Australian Building Codes Board (ABCB) has commissioned The Centre for International Economics to prepare this Final Regulation Impact Statement (RIS) in accordance with the requirements of *Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies,* endorsed by the Council of Australian Governments in 2007. Its purpose is to inform interested parties regarding a proposal to amend the Building Code of Australia to include requirements for Private Bushfire Shelters.

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REPORT

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Final regulation impact statement

Prepared for

Australian Building Codes Board

Centre for International Economics
Canberra & Sydney

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1 Executive summary

Since the Black Saturday Fires there has been a significant increase in interest for private bushfire shelters as individuals in bushfire prone areas reassess the probabilities of major bushfire events occurring. This is indicative that a reasonably large number of consumers may expect a low probability of failure of a private bushfire shelter. However there is only very limited evidence available on the rate of success of private bushfire shelters. In fact fire safety experts have voiced considerable concerns about the potential for such shelters to provide a high guarantee of safety. The lack of scientific evidence relating to the efficacy of shelters makes policy recommendations difficult.

This uncertainty is also likely to lead to sub-optimal decisions being made by individuals facing a fire event. In particular, there are two different information asymmetries occurring in the market for private bushfire shelters. The first is the lack of understanding by consumers on the quality of a shelter and the second that even with a well built shelter consumers are unaware of how or when to use it properly.

The second of these failures brings the behavioural responses of individuals to the fore. The faith that individuals place on shelters will to some extent determine their decision to stay or go, or how long to stay and defend. Where intervention increases the knowledge individuals have about their true chances of surviving in a fire with and without shelters, better decisions will be made. However, if regulation is seen as government endorsement of shelters, it is possible that the behavioural response will place excessive dependence on shelters for survival.

The five different options explored in the Regulation Impact Statement (RIS) to address these information asymmetries are to:

- continue the status quo;
- discourage the use of fire shelters;
- develop information only non-mandatory guidelines;
- develop mandatory guidelines for voluntary construction; and
- develop mandatory guidelines and require mandatory construction.

The evaluation focuses on the qualitative impacts of the options as the behavioural uncertainties make it difficult to quantify the actual costs and benefits of options. However, a simple quantitative analysis is provided to demonstrate the tension between the behavioural assumptions and demonstrate empirically the main drivers of the impacts of each option.

The analysis of the options shows that even with a well built shelter the chance of survival may still be low, due to the limited ability for residents to use them properly. Additionally the analysis describes the potential for shelters in some circumstances to be relied upon in place of more effective strategies to survive a bushfire. This problem is theoretically exacerbated through the provision of a government endorsed standard.

In introducing any regulation to the market for private bushfire shelters, this potential to affect residents' perceptions of the risk of bushfire needs to be acknowledged. There is a risk that attitudes and preferences towards other risk reducing strategies (due to the presence of shelters) such as reducing fuel loads, preparing houses against bushfire assault and making decisions about when to leave may also be altered. This has the theoretical potential to increase the number of people who would be categorised as having an 'ineffective survival strategy'.

The decision to implement mandatory standards for voluntarily constructed shelters is a judgement on the trade-off between whether the lives saved due to the avoidance of deaths in poorly constructed fire shelters is greater than the lives lost from the inefficient decision to 'stay' and rely on a government-endorsed shelter.

Overall, the RIS notes that all options involve the potential for lives to be lost. However, it does recommend that a mandatory standard for voluntarily constructed shelters is, on balance, the best option to address the information asymmetry.

2 Problem

Australia is often referred to as the most fire-prone country in the world (McAneney 2007). The Victorian 'Black Saturday' bushfires of February 2009 resulted in considerable loss of life and property and in many ways were uncharacteristic of bushfires experienced in Australia over the past century.

On 7 February 2009, the Black Saturday fires in Victoria resulted in the death of 173 people — two thirds of these victims were inside their homes (VBRC, 2009). Broad classifications of these deaths have been made by the Victorian Bushfires Royal Commission (VBRC).

- One hundred and thirteen people died in their homes, seven in other buildings and a further 27 outside but near to their home. In total, death from 'staying' accounted for 85 per cent of total deaths on that day.
- The remaining 26 people died outside of buildings, including: 11 in vehicles; 10 near vehicles or on roads; one on a reserve and four away from the locations of the fires.

Directly after the Black Saturday fires, there was a reported increase in the level of both demand and interest in private bushfire shelters.[1] This increase in interest and demand suggests that there has been a change in risk preferences or attitudes of Australians following the severity of fires in 2009 possibly driven by a number of factors.

- Recognition that it may not be possible to defend a property and survive a bushfire event without the use of a private bushfire shelter, assuming no change in average bushfire intensity.
- Consideration that future bushfire events are more likely to reflect the intensity of Black Saturday fires rather than previous bushfires in Australia.
- An increase in the number of residents requiring peace of mind who never intend to use the shelter, but are willing to pay for the option.

In deciding to purchase a private bushfire shelter, consumers will weigh up the net benefits they expect in terms of potential protection of life with the

1 Note that the terms 'private bushfire shelter', 'bushfire shelter' and 'shelter' are used interchangeably in this RIS.

cost of purchasing a shelter. This should then be weighed up against the opportunity cost of investing money into construction of a private bushfire shelter relative to investing in an alternative bushfire preparedness strategy such as evacuating early or increasing the bushfire resistance of their house. Importantly though, their expected benefit from the shelter will be determined by the information they have about the probability of success or failure of the shelter in the untested circumstances of a life threatening fire.

Development of bushfire policy in Australia

Prior to the Black Saturday bushfires in Victoria, observed fire patterns across Australia led to a certain level of confidence in those patterns such that the policy of 'prepare, stay and defend or leave early' was developed. More commonly known as 'stay or go', this policy gives residents the option to either evacuate early or to stay and defend their house. The 'stay or go' policy was developed on the premise that:

- compared with late evacuation, the probability of life and property survival is increased where residents stay and actively defend their property, extinguishing ember fires as they start.

The implications of the 'stay or go' policy were that:

- there was an acceptable probability that able bodied residents would be able to defend their property, therefore they would be able to survive the passing fire front; and
- residents that defend their property from ember attacks during a bushfire have a higher expected rate of survival than those residents that are unable to or do not physically defend their houses.

Embedded in these policies is an, occasionally implicit, understanding that the greatest risk to human life in a bushfire is late evacuation. Severe fires experienced in 1983, known as Ash Wednesday, led to the identification of three broad categories of bushfire victims (Handmer and Tibbits, 2005). These include:

- *ineffective survival strategy* — those that recognised the threat from fire and had sufficient time but chose an inadequate survival strategy;
- *time poor* — those that did not recognise the real threat to their safety in sufficient time to follow an effective survival strategy; and
- *physically constrained* — those who were physically incapable of implementing an effective survival strategy.

The size and nature of the problem: information failure

The significant increase in interest for private bushfire shelters after the Black Saturday fires indicates that a reasonably large number of consumers may expect a low probability of failure of a private bushfire shelter. However:

- there is only very limited and unverified information/evidence available on the rate of success/failure of commercially available non-regulated private bushfire shelters; and
- fire safety experts have voiced considerable concerns about the potential for such shelters to provide a high guarantee of safety.

Therefore, there is a risk that the construction of non-regulated shelters could be fuelling a false sense of security where consumers may not be weighing up all of the expected costs in their decision. This can lead to a market failure where too many consumers are purchasing sub-standard shelters and potentially putting their lives at risk. Given the high value of life, this could represent a large economic problem. This is also evidence of that even with a well built shelter consumers are unaware of how or when to use it properly, or the relative potential for survival even in a well built shelter. This can lead to potential loss of lives through increasing the length people choose to stay and defend their house.

Proposed options to address market failure

Currently, the market for private bushfire shelters is relatively immature with only a small number of consumers and suppliers in Australia.

There is also no regulatory oversight of the market in terms of construction standards, testing or quality assurance procedures. This RIS considers a range of implementation options:

- maintenance of a status quo type market structure with no government sponsored construction standards or guidelines;
- no amendments are made to the BCA and the construction and use of private bushfire shelters is actively discouraged;
- introduction of information only non-mandatory guidelines;
- introduction of BCA Performance Requirements for all private bushfire shelters that are voluntarily constructed; and
- consideration of the effect of a mandatory construction requirement for private bushfire shelters to be constructed with new dwellings in high risk bushfire areas.

Perceptions and Behaviour

The policy on whether residents should stay and defend their property or leave early (the 'stay or go' policy) is one for respective State and Territory Governments to decide on. The Victorian Royal Bushfires Commission (VBRC) in its final report made a number of recommendations about the State revising its bushfire policy to improve public safety. The VBRC recommended "The State establish mechanisms for helping municipal councils to undertake local planning that tailors bushfire safety options to the needs of individual communities. In doing this planning, councils should urgently develop for communities at risk of bushfire local plans that contain contingency options such as evacuation and shelter[2]." The ABCB is not in a position to influence this policy.

Even if residents decide to leave early rather than stay and defend their property, they may find they make the decision to leave too late. The road access may be cut by the approaching bushfire, or residents may underestimate the speed of the advancing bushfire, or there may be insufficient warning. In addition residents may have a physical or medical condition that restricts their ability to evacuate quickly. In such cases, the only option available to residents may be to defend their property and seek refuge in their house, or as a last resort, seek refuge in a private bushfire shelter.

For those residents that are seeking greater protection should they decide to stay and find that the severity of the fire is too extreme to protect or shelter within their house, access to a private bushfire shelter may provide an important last option.

Even if the State actively encourages residents to leave early, some people undoubtedly will disregard the advice and stay to attempt to defend their property. In these cases shelters can again provide an important option of last resort.

Likewise, even if the State actively discourages the construction and use of private bushfire shelters, some residents will undoubtedly decide to build one for use as a last resort if attempts to protect the house fail, or the bushfire intensity is extreme. However, if the shelter is of poor quality and contains inadequate facilities, the chance of survival in the shelter would be very low.

However, in introducing any regulation to the market for private bushfire shelters, the potential to affect residents' perceptions of the risk of bushfire

2 2009 Victorian Bushfires Royal Commission, Final Report Recommendations

needs to be acknowledged. There is a risk that attitudes and preferences towards other risk reducing strategies such as reducing fuel loads, preparing houses against bushfire assault and making decisions about when to leave may also be altered.

Therefore, private bushfire shelters are unlikely to be (and should not be) a 'stand-alone' solution to bushfire risks. Accordingly, the evaluation needs to be assessed in light of a broader government approach to assist residents in aligning their risk expectations from 'staying' to defend their properties.

Black Saturday — changing risks and policy

As noted, the bushfire events, and actions of residents on Black Saturday have called into question bushfire safety policy in Australia. Firstly, the proportion of victims that stayed in or near their homes during the Black Saturday fires has been noted to be 'strikingly different from previous fires' (VBRC, 2009). In addition, whilst a review of houses that were destroyed in the Victorian bushfires showed that active defence by those residents who stayed was still a determinant of house survival, direct flame attack appeared to be more prevalent than in previous bushfires observed in Australia. Such an increase in direct flame attack on houses would greatly reduce the ability of residents to defend their homes.

Reiterated throughout the VBRC report has been the finding that in the event of a severe bushfire, many people expect to be able to defend their properties and then at the critical point appear to panic and leave after this fails. Given the prevalence of people who, before the event, consider themselves likely to stay and defend, it has been suggested that the presence of and access to a bushfire shelter may potentially improve the rate of survival in these cases where there is a high risk of deciding to evacuate late. A key caveat to this is that the actions of the individual in accessing and exiting the shelter are just as important as the quality of the shelter in determining the probability of survival.

Summary of the Problem

The Black Saturday fires in Victoria again showed bushfires have the potential to result in considerable loss of lives, with two-thirds being in their

homes. This has fuelled demand for the construction of private bushfire shelters.

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Currently there is limited evidence on the effectiveness of shelters being constructed. In fact fire experts have voiced concerns over the quality of many of the shelters being built and the ability of individuals to use them properly. This is evidence that two different information asymmetries are occurring in the market for providing private bushfire shelters:

- the lack of understanding by consumers on the quality of a shelter; and
- that even with a well built shelter consumers are unaware of how or when to use it properly.

3 Background

Description of draft regulatory proposal

The ABCB has prepared a draft proposal to include a new classification within the BCA, being Class 10c — private bushfire shelters. Private bushfire shelters have been defined as 'a structure associated with a Class 1a dwelling that may, as a last resort, provide shelter for occupants from immediate life threatening effects of a bushfire' (ABCB, 2010). Also included in the draft proposal, in Volume Two, is a new Objective, Functional Statement, Performance Requirement and consequential editorial changes (to both Volumes One and Two), (see appendix A).

Factors that are considered in the Performance Requirement include:

- safe access to the building;
- a means of determining the external environmental conditions;
- safe egress from the building; and
- a means of identification of the location of the building for the purpose of rescue.

In addition, the shelter must also have regard to:

- the number of occupants likely to use the building;
- actions to which the building may be subjected;
- the effects of nearby permanent features such as topography, vegetation and other buildings;
- the potential external fire intensity; and
- the prevention of conditions within the building that are untenable.

The draft proposal provides that all Class 10c buildings will need to meet the Performance Requirement for private bushfire shelters. The Performance Requirement has been taken from the 'ABCB Performance Standard for Private Bushfire Shelters — Part 1'.[3] Whilst the draft BCA amendments do not include any Deemed-to-Satisfy (DTS) provisions, the ABCB Performance Standard contains Acceptance Criteria which would

[3] A document developed by the ABCB at the request of the VBRC for individual use by States and Territories.

assist building practitioners and building certifiers in achieving compliance with the Performance Requirement.

The Performance Requirement has been developed based on the best scientific information available. All experts that were questioned agreed that there would be a marked progression in structural integrity and proper use moving from status quo to information to mandatory performance requirements.

Without a dedicated testing facility that is able to mimic the myriad of bushfire conditions as well as the myriad of construction designs, getting a more 'scientific' measure of structural integrity is not possible.

To date, there has been no bushfire in which to thoroughly observe the structural integrity of a shelter in situ. Further, there are no testing facilities available in Australia that can mimic the effects of a full bushfire. Accredited shelters have been exposed to the best testing facilities currently available in Australia. While both bushfire experts and testing experts were willing to allow a "very high probability of survival" they were not willing to go on the record with a guaranteed rate of survival. When pressured for an opinion on structural integrity, responses were between 90-95 per cent if used properly.

Evidence of market failure

Evidence brought before the VBRC following the Victorian bushfires of 2009 suggests that there is a lack of oversight in the market for bushfire shelters. The concern surrounding these findings is that without a construction standard for private bushfire shelters, or some equivalent process through which consumers may measure the performance of these shelters, a consumer's ability to make informed decisions is restricted.

Through the course of the VBRC, there have been reports of both survival and deaths associated with the use of bushfire shelters.

While it is acknowledged that there is the potential for well-designed bushfire shelters to provide life saving protection from a passing bushfire front, this is not guaranteed. Further, a poorly-designed private bushfire shelter has an even greater potential to place those sheltering inside at risk.

The conclusions of the VBRC (2009) were that:

> "Those who find themselves threatened by bushfire need options. During bushfires, some people will find themselves in circumstances where they need to take shelter other than in their homes. This may be because their plan to

> defend their home cannot be implemented in the circumstances, or their plan fails and the house burns. They may also plan to leave but are unable to reach a place away from the firefront in time. Visitors to an area threatened by fire may find themselves caught in the open and some people may not have planned well enough for the risk of fire. Finally, some people with well prepared plans may change their minds when faced with an extremely dangerous fire."
>
> "While a well designed and constructed shelter may provide a temporary place of refuge during the passage of the fire front, shelters are not a panacea. Misplaced reliance on a shelter can be life threatening. For those situations in which a shelter is a viable option as part of an overall fire plan, the evidence to date suggests that the design, siting and construction of a suitable bunker are neither simple nor inexpensive."
>
> "It is clear that a minimum standard for bunkers must be developed as the basis for regulating their design, siting and construction, and that this should occur immediately."

A review conducted as part of the VBRC process entitled, 'Bushfire Bunkers: A summary of products and concepts', provides information on the current market for bushfire shelters in the aftermath of the Victorian bushfires. The review presents an array of private bushfire shelters that are either currently available for construction or in the design and development phase.

The review indicates two key findings in the market for bushfire shelters. Firstly, there has been an increase in demand for bushfire shelters since 7 February 2009 (VBRC, 2009). Secondly, there is a great divergence in the apparent characteristics of advertised bushfire shelters that have become available.

A number of additional observations about the products and product statements were evident and/or presented in the review.

- *A range of definitions for shelters* — ranging from purpose built underground shelters to cellars and safe rooms that form part of the house structure, to partially buried or fully above ground shelters.
- *Product summaries focused on similar product features* — features most emphasised were strength and structural integrity, as well as air supply and filtration.
- *Confused understanding about standards* — whilst some product specifications noted that there was no current standard for bushfire shelters; others made the claim that the product and/or components of the product met Australian Standards. Such statements were thought to

imply that there were standards for the bushfire shelters as a product, rather than standards for the components.

- *Contradictory advice* — including contradictory information on the optimal location relative to houses, either distanced for protection or nearby for easier access.

The nature of private bushfire shelters currently available and presented in the VBRC report varies widely. Many of the advertised products appear to be modifications of pre-existing constructions, such as cyclone shelters and concrete water tanks. The VBRC noted in its review of products available on the market that some modifications of products were made to target survival in bushfire, but many were simply limited to locating the structure underground (as opposed to above ground).

The results of the review indicated that the market for private bushfire shelters was beginning to develop a discontinuity in design, sophistication and cost.

- In the lower price range — there were a number of kit form shelters available that are designed from a range of different materials, from reinforced concrete to composite plastic to galvanised tubing. Product costs range from $1 000 and $5 000, excluding installation costs.
- In the upper price range — products available included converted above ground concrete cyclone shelters to below ground specific purpose built shelters with independent air supplies, sirens and flashing lights. Prices ranged from around $9 000 to $20 000.

Importantly, there was considered to be no clear relationship between cost and the effectiveness of design to prevent loss of life. It is also continuingly difficult to assess the quality of the product, without any existing mechanisms to conduct a comparable test on each product.

Other public policy imperatives

Other reasons for assessing the potential requirement to regulate the market for private bushfire shelters are the potential supplementary benefits to both individuals and communities caught in fire and emergency services personnel. A number of potential subsidiary effects were examined through targeted consultation with representatives of the private bushfire shelter and fire protection industry.

- *The potential for reduced congestion on the roads* — where there was consensus that the size of the private bushfire shelter market was small such that there was unlikely to be any noticeable alleviation of congestion on the roads.

- *The potential relief to emergency services personnel* — where there was consensus that the access of a household to a shelter was unlikely to alter the decision of emergency services personnel of whether to support a house or individuals within a house. Rather, respondents suggested additional due diligence may be required for a household with access to a private bushfire shelter.
- *The potential for scrambling effects* — where the general view was that 'scrambling effects', where the neighbours arrive to use the shelter potentially causing excessive shelter occupancy, were highly likely although were inappropriate and difficult to regulate.

Preliminary discussions with experts in the fire industry showed there to be little evidence to support the inclusion of 'other' public policy considerations into this RIS.

Current legislative framework

There are currently no specific provisions within the BCA that address the design, construction or performance of private bushfire shelters. Given the increased interest in the role that private bushfire shelters may play in protecting lives and property after the Black Saturday bushfires, interim regulations have been introduced in Victoria.

In November 2009, the Victorian government issued interim regulations that are intended to provide guidance to consumers and ensure that performance standards are met by suppliers (Building Commission, 2010). These guidelines are intended to be used in the intervening period in Victoria prior to the creation of national requirements — which are under consideration in this RIS.

Under the interim Victorian regulations, in order to obtain a building permit, building/property owners have three options. They may purchase an accredited shelter, gain certification of the product from a fire safety engineer or obtain a determination from the Building Appeals Board that the alternative solution complies with the interim regulations.

As of October 2010, one manufacturer had received accreditation for a bushfire shelter design, with an estimated cost of approximately $10 500 per shelter plus GST and before installation costs (Wildfire Safety Bunkers, 2010). A number of other manufacturers were awaiting approval for their designs.

The BCA contains the required technical provisions for building construction in Australia. The goal of the BCA is to achieve the minimum necessary standards that are nationally consistent to ensure health, safety

(including structural safety and safety from fire), amenity and sustainability objectives are met. The BCA is the key mechanism through which the technical building requirements are regulated.

The current fire management provisions for buildings in bushfire prone areas, as specified in the BCA, require that new residential buildings and additions constructed in designated bushfire-prone areas (BPAs) be designed and constructed to reduce the risk of ignition from a bushfire as the fire front passes in order to reduce the danger to life and minimise the risks of building loss (BCA, 2010).

The DTS provisions for building in bushfire prone areas refer to the Australian Standard AS 3959-2009 (AS 3959). The standard covers the fire-resistance and combustibility of materials according to their functionality, provisions for fittings and specification for the building structure such as positioning and dimension.

The provisions specified within AS 3959 vary according to the Bushfire Attack Level (BAL) — the expected level of exposure to ember attack, heat flux and direct flame in the event of bushfire. The assessment of a site BAL takes into consideration a number of factors, including the Fire Danger Index, the slope of the land, types of surrounding vegetation and its proximity to any building.

The requirements as set out in AS 3959 are intended to protect buildings while a fire front passes; however the underlying motivation is the protection of housing occupants. Any increase in the risk of house destruction associated with inadequate design and maintenance or a high site BAL level also raises the risk associated with individuals staying to defend their property. Where the BAL is over 40 and for under BAL 40 sites that are not built to AS 3959 (that is, those built before the standard was introduced), it becomes particularly important that house occupants have an alternate option where there is a real prospect that the house may not provide adequate protection.

In the wake of the Black Saturday fires, there has been discussion of changes to development applications requiring private bushfire shelters to be included in the construction of all new houses in higher risk areas. Should such development based requirements be enacted, the draft BCA amendments for private bushfire shelters would essentially become a mandatory requirement in certain areas under local council development application requirements. The inclusion of option 5 below is to ensure that this unintended risk is assessed.

Description of Options

To fully explore the options and comply with Council of Australian Governments (COAG) Best Practice Regulation guidelines, options have been drafted to address the information failures of the market for private bushfire shelters in Australia. The following options are being considered:

1. Status quo — in which no amendments are made to the BCA and current supply options for private bushfire shelters continue in Australia with limited regulatory oversight or provision of information from authorities.
2. Discourage the use of private bushfire shelters – no amendments are made to the BCA, no government endorsed standard or guideline on private bushfire shelters is prepared, and the construction and use of private bushfire shelters is actively discouraged through an information campaign.
3. Implementation of non-mandatory guidelines and information — in which the 'ABCB Performance Standard for Private Bushfire Shelters — Part 1[4]' are published as an information source but are not required to be met.
4. A voluntary construction requirement for private bushfire shelters — this option outlines the Performance Requirement to be met by all private bushfire shelters that are constructed including information on how to use it properly, but does not require a bushfire shelter to be constructed.
5. A mandatory construction requirement for private bushfire shelters to be constructed and meet the Performance Requirement — where option 4 is based on a voluntary decision to construct a private bushfire shelter, there is the potential that development authorities in bushfire prone areas may include a requirement that a private bushfire shelter be constructed before approval is given for the construction of a residence.

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4 A performance-based standard developed by the ABCB for voluntary use.

4 Bushfire risk

In determining the extent of bushfire risk in Australia, it is important to assess both the probability of an event occurring and the cost of that event should it occur. Over the past 53 years, bushfires have claimed over 400 lives in Australia and destroyed more than 8000 houses (Haynes et al, 2008; Blanchi et al, 2010). Whilst the average probability of a bushfire event endangering a single life or house in Australia is extremely low, there are areas within Australia where individuals and properties are subjected to considerably greater risk. There is the potential for the level of bushfire risk in the future to be greater than the historical trend, as a result of increasing urbanisation and climate change (see Hennessy, 2007).

As a point of clarity, when considering the nature of bushfire events, probability and likelihood will be used to express the observance of a bushfire event. The term risk will be used to express the loss, in terms of life and property, likely to be experienced due to the observance of a bushfire event.

This section comprises a review of current literature and information with respect to the following parameters.

- *The probability of bushfire in Australia* — where bushfire risk varies according to region and climate and the distance of the household to the urban-bushland boundary.
- *The impact of climate change on risk* — allowing for the likelihood of future bushfire events to diverge from the incidence of bushfire in the past.
- *The cost of bushfire in Australia* — in terms of the cost of property destruction and loss of life resulting from a given event.
- *The expected future risk of bushfire in Australia* — where the overall risk of future bushfires would be dependent on the expected probability and cost of bushfire.

Probability of fire

Recent research into the distribution of bushfire events in Australia has highlighted the relatively consistent probability of fire and fire damage from bushfire events and property damage over time.

An assessment conducted by Risk Frontiers, using the PerilAUS database, suggests that the likelihood of losing a house in a bushfire has remained relatively constant for any given year over the past 100 years.

- The assessment showed that over the period 1900–2003, there was an approximately uniform 55 per cent probability of some building destruction in Australia due to bushfires during a given year.
- Analysis of larger bushfires also shows a relatively constant distribution of probability, with an annual probability of losing 25 and 100 houses to bushfires in a year (across a single week of that year) of around 40 and 20 per cent respectively (McAneney and Pitman, 2009).

Driven by weather, climate and geographic conditions, the probability of a bushfire event varies by location with the current risk of fire by region being broadly indicated by the prevalence of fire in the past. That is, most high risk areas have experienced bushfire events in the past. Chart 4.1 indicates the risk category by region, with extreme bushfire potential areas being concentrated in the southern and south-eastern regions of Australia (ABCB, 2009).

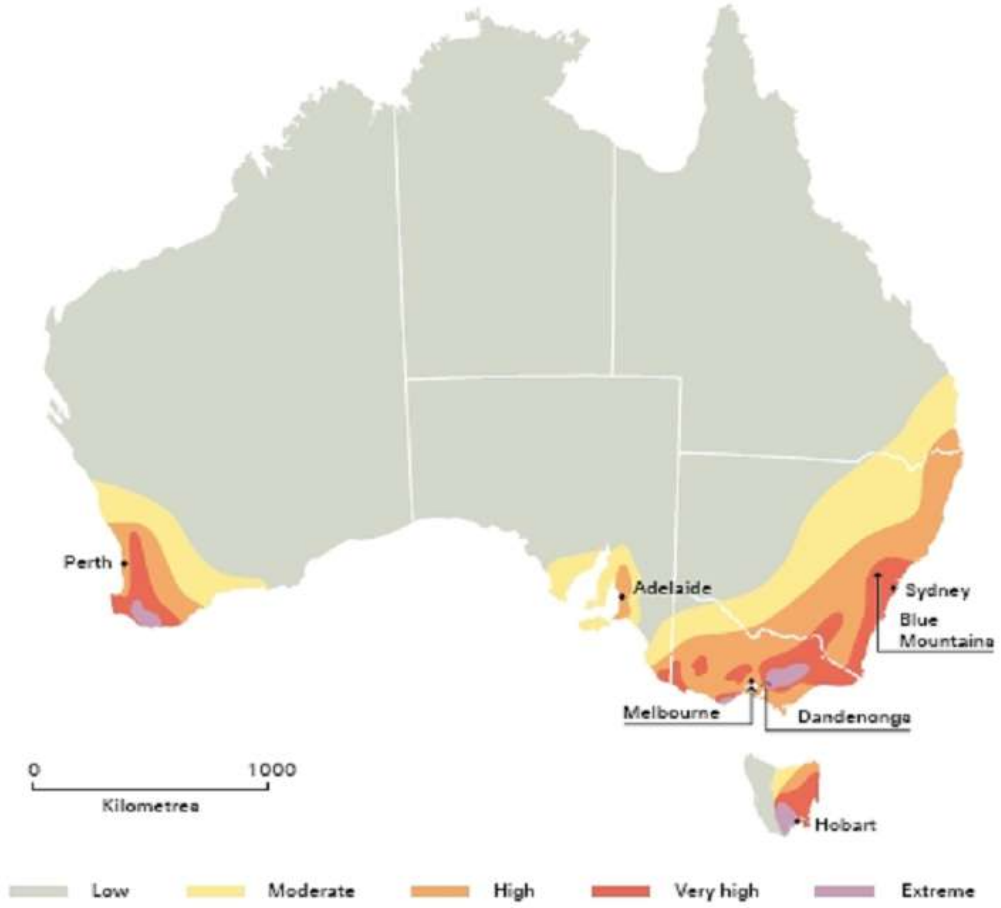
The impact of climate change on bushfires

Whilst bushfires have been a continuing part of the Australian experience for centuries, there have been a number of particularly large fires over recent years. The severity of bushfire and whether houses and people are exposed to ember attack or by direct flame, has a direct impact on the most effective policies and strategies to protect lives and properties.

Despite the remarkably consistent prevalence of bushfire throughout Australian history, there has recently been some reconsideration of whether risk and climate models based on the past are an accurate reflection of the current bushfire risk. There are two prominent factors that are placing upwards pressure on bushfire risk in terms of loss of life and property:

- *climate change and the associated increase in drought severity* — increasing the probability of ignition and fire spread in bushlands; and
- *the increase in number of people living on the urban-bushland boundary* — where the risk of fire may increase as a result of an increasing probability of the burning bushland interfacing with an urban population.

4.1 Regional bushfire risks in Australia



Source: ABCB (2009) Final regulatory Impact Statement for Decision: Proposal to revise the BCA requirements for construction in bushfire prone areas — reproduced from Blong RJ et al. (2000) Natural perils in Australia and New Zealand.

Climate change is suggested to increase the risk of bushfire through increasing the fire weather risk — only one of several important factors contributing to bushfire risk. The daily temperature, precipitation, relative humidity and wind-speed together constitute the degree of fire weather risk. In addition to fire weather, the fuel load, the terrain and the potential for suppression are critical factors affecting the risk of starting a fire and its rate of spread, intensity or difficulty to suppress (Hennessy, 2006).

An increase in fire weather risk, forecast to be a resulting impact of climate change, is anticipated to both increase the probability of a fire (McArthur 1967) and increase the expected intensity of the fire. This may increase the vulnerability of structures and surrounding elements to ignition and destruction by a fire (Blanchi et al, 2010).

The pivotal question concerning the community following the Victorian bushfires of 2009 is the extent to which our understanding of historical bushfire risk would be a valid representation of future bushfire risk.

Increased fire weather risk anticipated to result from climate change is based on *forecasted rather than observed* temperature changes. It may be too early to make a full assessment of the impact of climate change on the interaction of fire ignition potential, fire spread and intensity, and the intersection of bushfire with urban populations. Therefore, there remains a possibility that future bushfire risk will deviate from the observed historical trend.

The cost of bushfire

Another key factor determining the likelihood of purchasing a private bushfire shelter is related to the likelihood that firstly a house is threatened by a bushfire, and secondly that it is not able to withstand the bushfire.

Although the average risk of bushfire to any household across Australia is statistically low, the risk of bushfire is significantly higher across some regions of Australia and the likelihood of fire ignition and the potential for fire to intersect with the populated area varies by region. At the most basic level, in the event of bushfire, the potential destruction of houses would depend on the number of houses located proximate to bushland.

When considering the risks to property, analysis conducted by Risk Frontiers indicates that the distance to extensive bushland is the single most critical determinant of risk to property destruction from bushfire within a given area. Table 4.2 summarises the risk categories developed by Risk Frontiers based on the distance to the urban-bushland boundary.

4.2 Risk of property destruction from fire, distance to bushland

Risk rating	***Distance to extensive bushland***	***Proportion of capital city houses***
Very high (5)	Less than 100m	6.0% or 486 000 houses
High (4)	Between 100-200m	3.2% or 259 000 houses
Medium (3)	Between 200-400m	5.0% or 405 000 houses
Low (2)	Between 400-700m	6.1% or 494 000 houses
Negligible (1)	More than 700m	79.7% or 6 456 000 houses

Data source: McAneney, J., Chen, K. and Pitman, A. (2009) 100 years of Australian bushfire property losses: is the risk significant and is it increasing?, Journal of Environmental Management 90 pp 2819-2822.

With corresponding estimates about the proportion of capital city houses located in each risk zone, these risk categories are put into a meaningful context. Utilising 2006 data from the Australian Bureau of Statistics (ABS), Risk Frontiers estimated that of the 8.1 million dwellings located in Australian capital cities, 6 per cent, or almost half a million, were located less than 100m from the urban-bushland fringe.

The average likelihood of a random home being *threatened* by bushfire on the urban-bushland boundary (within 50 metres) has been estimated at approximately 1 in 3000 for each year, based on the observation of mega-fires in the last 50 years, excluding the Victorian bushfires of 2009 (McAneney et al, 2007). Given a mega-fire, the probability of home destruction in the first 50 metres is approximately 60 per cent, such that the annual probability of destruction of a home in the urban-bushland boundary is approximately 1 in 5000 (McAneney et al, 2007).

Despite the variability in the cause of spread of fire, the correlation between distance to bushland and house destruction remains remarkably consistent. Furthermore, the distance to bushland appears to be a strong indicator of the future distribution of risk across the housing population.

To consider the distribution of damage by region, table 4.3 indicates the number of housing losses by state, over the period 1939–2009.

Where risk profiles vary by region and even by site, as opposed to at the State level, there will be different benefits derived from the construction of private bushfire shelters across their different risk profiles. As the proposed implementation options being considered in this RIS ensure that it is voluntary to construct a shelter, these differing risk profiles will result in differing demand profiles by region, across Australia.

4.3 Housing losses by state over the period 1939–2009

State	***House losses***	***Portion of total losses***
	No.	%
Victoria	6 861	61.9
New South Wales	1 530	13.8
Tasmania	1 376	12.4
South Australia	548	4.9
Australian Capital Territory	521	4.7
Western Australia	212	1.9
Queensland	43	0.4
Northern Territory	1	0.0
Total	11 092	100.0

Data source: Blanchi et al. 2010.

5 Individual risk and private bushfire shelters

It is important to understand that there are varying levels of bushfire risk that are associated with an individual's response to a fire event. That is, it is the actions of the resident both before the bushfire and during that will have the most influence on their probability of survival and the probability of property survival.

Risks associated with response to fire

Whilst fires are extremely complex, there is considerable documented evidence suggesting that the level of risk to individuals in fire varies by their type of response to the fire. In the 50 years to 2007, there have been approximately 257 deaths from bushfires. The Bushfire CRC has conducted research on the circumstances surrounding each of these deaths (Haynes et al, 2008).

Table 5.1 provides a summary of deaths related to bushfires over the period 1956–2007. A significant portion of deaths reportedly resulted from defending property (over 28 per cent), late evacuation (26 per cent) and passively sheltering or awaiting rescue (13 per cent).

Whilst 'late evacuation' is known to present associated risks, a number of risks of 'staying and defending' — a strategy previously understood to have a reasonable prospect of success — have also been highlighted, particularly in the Victorian bushfires of 2009. Preliminary results from a survey of the residents of fire affected regions, conducted by the Bushfire CRC, indicated a range of difficulties experienced by residents leading up to and during the fire.

> The capacity of those that stayed to defend their homes and properties was inhibited by the severity of conditions, where heat exhaustion, dehydration, breathing difficulties and eye irritation may have diminished the capacity to defend their houses and subsequently their lives (Bushfire CRC, 2009).

5.1 Bushfire fatalities 1956–2007 — activity at time of death

Activity at time of death	*Deaths from bushfire*	*Percentage of deaths*
	No.	%
Late evacuation	66	26
Defending property from outside		
- Suburban location	28	11
- Rural location	35	13
Inside defendable property		
- Actively defending	1	<1
- Meagre and unsuccessful attempts to defend	4	2
- Passively sheltering	26	10
- Activities unknown	4	2
Travelling through the area unaware	28	11
Waiting rescue	7	3
Other or unknown	58	22
Total	**257**	**100**

Data source: Haynes, K. et al. (2008) 100 years of Australian civilian bushfire fatalities: exploring trends in relation to the 'stay or go policy'.

The potential role for private bushfire shelters

The current number of private bushfire shelters constructed in Australia is thought to be low, with Victoria anecdotally suggested as having the highest incidence. The manner in which demand for private bushfire shelters reportedly increased, particularly within but also outside of Victoria, directly after the Black Saturday fires may signal a potentially ongoing change in preferences for shelters, but may also represent a short term phenomena where residents' risk assessments are unduly influenced by extreme and recent events.

In the event of a major bushfire, a private bushfire shelter could provide an important survival option, as a measure of last resort, where the house has been destroyed or as an alternative to late evacuation.

This is not to suggest, however, that all private bushfire shelters available at present or in the past would be sufficient to prevent all of these deaths or necessarily better protect other individuals whose 'activity' during the fire threat did not result in death.

The possibility of a private bushfire shelter to be used as a measure to save lives would require that the following measures be met.

- *Maintenance of tenable and safe conditions for the occupants during the fire* — where the provisions for the shelter construction and design within the draft BCA amendments are expected to promote a safe and tenable environment during a bushfire event.
- *Safe route to the shelter* — the draft BCA amendments include the provision for the location of the private bushfire shelter relative to fire hazards, including predominant vegetation, adjacent buildings and structures, allotment boundaries and other combustible materials, as well as the external signage detailing the location of the shelter.
- *The maintenance of the private bushfire shelter* — whilst there is a provision in the draft BCA amendments for the 'appropriate degree of essential maintenance', the individual is ultimately responsible to undertake the necessary maintenance to ensure that the private bushfire shelter provides a safe and tenable environment in the event of fire.
- *The appropriate use of the private bushfire shelter with respect to entry and exit time* — where there are varied opinions among experts, the individual must make an assessment about the safe use of the shelter in a bushfire event. The draft BCA amendments include provisions for internal signage.
- *The appropriate use of the private bushfire shelter with respect to storage and occupancy* — where there are provisions within the draft BCA amendments related to the occupancy of the shelter, it is ultimately the responsibility of the individual to ensure that the number of occupants and storage in the private bushfire shelter is appropriate to the design.

It must be emphasised that individual performance is a key component of the prospect of survival in a private bushfire shelter. It is inevitable that there will be errors in judgement of individuals in the event of a bushfire. Used incorrectly, closing the door too early, staying too long or having too many people in the shelter, could for instance result in suffocation in a sealed shelter.

In light of the risks associated with the 'behavioural' elements of private bushfire shelter use, and considering that the draft provisions are only able to target the construction risk factors, it is important that the private bushfire shelter remain only one part of an array of bushfire risk mitigation requirements. Whilst the safest option is to leave early, there are alternative or complementary risk mitigation strategies that may be used to reduce the risk to those who stay to protect their property or are unable to leave early. These strategies range from building construction and design,

landscaping, emergency management arrangements, water supply and utilities, access arrangements and asset protection zones.

6 Consultation period

The consultation RIS was released for public comment on 11 August 2010. Public submissions closed on 22 September 2010. Public comments were accepted on all elements of the Consultation RIS, and were guided by a set of specific questions relating to key uncertainties. These uncertainties stem from a range of factors, including scientific constraints affecting the ability to replicate the effects of a bushfire, ability to control personal actions and decision making in the event of a fire, as well as issues related to the immature market, restricting the ability to observe demand and price effects over time.

Consultation responses

In total there were eight responses to the Consultation RIS, from a range of stakeholders including private citizens, local councils, State governments, manufacturers and industry associations. The majority of submissions avoided clarification or discussion around the parameters and modelling approach taken in the Consultation RIS, instead focussing on the broader implications of alternate bushfire safety policies and actions.

The primary area of consensus in the public submission was that shelters should be provided as a last resort only, and consumers should be made aware of their limitations. Following this view, all submissions that considered issues of shelter quality agreed that an increase in the average quality of shelters would be observed following a move from information guidelines to the performance requirements. Further, such an increase in quality is considered critical to ensure that government bushfire protection and response policy is adequately supported by the market for private bushfire shelters.

The only area of contention across the submissions was on the role of local councils and planning authorities in determining where and when private bushfire shelters should be required to be constructed compared to allowing residents to make a voluntary decision to construct.

Technical specifications

While outside of the scope of the RIS, a number of submissions raised queries on the draft technical specifications of private bushfire shelters that are being considered for inclusion in the BCA. The most significant in terms of regulatory costs is the omission of deemed to satisfy provisions in the BCA. Under the draft amendments, there is no design guidance given to manufacturers on how to meet the Performance Requirements, potentially increasing the burden on manufacturers, approval professionals, and consumers. This issue has been raised in the final section of the RIS, discussing implementation issues, where it is considered to have the potential to become a barrier to entry in the market.

Highlighting the difficulties associated with including deemed to satisfy conditions it is noted that there is pressure from the building certifiers' industry that only government accredited shelters are likely to have building permits issued. Such a view has been taken due to the extreme complexity and potential risks associated with constructing and relying on a shelter to save lives.

Less technical considerations included a request to consider broader application to class 1b (small commercial accommodation) buildings, and to expand consideration to cyclone and extreme weather shelters.

Role of local councils and planning authorities

With only one local council making a submission to the Consultation RIS, there were no opinions put forward from local planning authorities on the compulsory construction of bushfire shelters. In contrast, some stakeholders considered that a cross section of residents and communities could be required to have access to a private bushfire shelter. Such residents could include those living on BAL 40 and above properties, as well as residents facing any level of fire risk level who are planning to stay and defend their property in the event of a bushfire.

The opposing view was put forward in the public submission process predominately by groups concerned with the possible negative effects (including cost of building) of mandating the construction of shelters. There were a number of arguments put forward against such action being taken by local planning authorities.

- Residents are more likely to be better able to assess their private tradeoffs across alternate bushfire protection strategies and investment options based on their risk preferences.

- The role that construction regulations in bushfire prone areas (AS 3959) played was highlighted, with submissions proposing that in some bushfire prone areas some houses may be considered to be sufficient protection from a given bushfire threat.

Further to the arguments in public submissions, concerns were raised during the initial discussions held with bushfire industry experts that such a policy of mandating construction may increase the reliance on shelters beyond a sustainable level, further endangering lives.

In discussing the role of local councils, a number of submissions came to the correct conclusion that in being able to only address newly constructed houses, only a very small proportion of properties in these areas will be affected.

Planning approval

The final issue of delays in construction approval from local councils and planning authorities was raised a number of times during initial discussions with stakeholders, as well as in follow up discussions after the public consultation period. There have been some anecdotal reports that planning approval in Victoria for a bushfire shelter can take up to three months with manufacturers holding a backlog of orders that are still awaiting council construction approval. Such delays seem counter intuitive given the discussion around council potentially mandating the construction of private bushfire shelters, and this contrast is an important example of the potential risks for private bushfire shelters to become tied up in bureaucracy.

Human behaviour and shelter reliability

A number of submissions commented on the assumptions in the Consultation RIS about human behaviour and shelter reliability. The conclusions outlined in the Consultation RIS were a summary of the views expressed by fire industry experts, noting the current limitations on the testing of shelters in bushfire situations. No experts involved in the discussions were willing to confirm any shelter as having a guaranteed probability of structural integrity, although some noted that improved testing procedures and real life observation in the future may improve this probability.

In addition, further concern was raised about the effect of an apparent government endorsement of shelters through the publication of the Performance Requirements. In such a situation, residents may become

unreasonably confident in their chances of survival in a shelter built to standard, only because there is a government standard in place.

The conclusion holds that the main benefit of the Performance Requirement is the increased structural integrity of shelters in the market.

Average shelter quality

A number of submissions supported the assertion that average shelter quality will increase across the status quo, information and Performance Requirement options.

Current market for shelters

There were limited comments made on the current market for private bushfire shelters, noting the current restrictions on the market. Anecdotal evidence from South Australia indicated a similar increase in interest immediately after the bushfires, reducing to very limited interest being observed at the moment.

When considering the characteristics of the market, manufacturers indicated that where residents were purchasing shelters, they more often than not indicated a strong preference for leaving where possible, and using the shelter only as a very last resort. Such responses, while difficult to substantiate or test, do indicate that the initial market is comprised, at least to some extent, of risk-averse purchasers, who place a high value on peace of mind.

Maintenance costs

Following some discussion raised in public submissions, additional analysis of maintenance costs has now been evaluated. Estimates from manufacturers of approved bushfire shelters consider an annual maintenance cost of approximately $180 to be indicative. This estimate includes maintenance of technically advanced sealing and door systems and therefore is not considered to be necessarily indicative of maintenance costs for lower quality shelters.

Conclusion from consultation period

The conclusions drawn from the public consultation period were that while there appears to be broad level agreement with the consultation RIS, the uncertainty of the assumptions relating to the survivability in a shelter

raises concerns about a purely quantitative analysis. The assumed likely human behavioural responses outlined in the consultation RIS are uncertain, which has reinforced a decision to focus on a qualitative assessment of options, although a quantitative analysis is still provided.

7 Evaluation of options

Option 1: Status quo

Option 2: Discourage the use of private bushfire shelters

Option 3: Implementation of non-mandatory guidelines

Option 4: A voluntary construction requirement for private bushfire shelters

Option 5: A mandatory construction requirement for private bushfire shelters

Behavioural impacts of options

The evaluation focuses on the qualitative impacts of the options as there are behavioural uncertainties that make it difficult to quantify the actual costs and benefits of options. However, a simple quantitative analysis is provided to demonstrate the tension between the behavioural assumptions and demonstrate empirically the main drivers of the impacts of each option.

The focus on qualitative impacts is due to the fact that there is little information available on how a shelter will perform in a bushfire situation. While the structural performance of a shelter constructed to a suitable standard could be estimated to a reasonable level of reliability, the human behavioural aspects relating to the use of a shelter in a bushfire situation are more uncertain.

These behavioural uncertainties include decisions relating to residents leaving early as soon as a bushfire threat is identified or staying to defend property; and if a shelter is available, whether the residents opt to use the shelter; the possibility of entering a shelter too late, leaving it too early or staying in it too long; using the shelter correctly; whether those seeking refuge in a shelter accept being confined in a small space for the duration of the threat, and whether the owners have adequately maintained the shelter.

The current collective understanding of the market for private bushfire shelters is limited to observations of the movements in the demand and supply of shelters post-February 2009 — up to the point where interim accreditation measures were announced in Victoria. Despite the increase in monitoring of the private bushfire shelter market as a result of the VBRC process, considerable uncertainty remains around the size and nature of the private bushfire shelter market.

As such, this RIS will essentially involve some elements of judgement about how the market may evolve and to evaluate the relative merits of the options.

The qualitative assessment is informed by research and initial discussions with fire industry experts. Members of the fire industry involved in these initial discussions included State fire authorities, rural fire services, fire industry associations, fire safety experts, building surveyors and private bushfire shelter manufacturers.

There are considered to be several different 'types' of individuals intending to use a private bushfire shelter. These include:

- *those intending to stay to actively defend their property* — utilising the private bushfire shelter as a measure of last resort;
- *those intending to 'wait and see' whether they will stay or leave* depending on the expectations and information about the severity of the fire and whether the house is defensible against the fire front — where the private bushfire shelter provides a potentially safer option to late evacuation; and
- *those intending to leave early* — utilising the private bushfire shelter as a measure of last resort where they are unable to leave or have insufficient warning.

Preliminary discussions with the bushfire safety industry, including fire authorities and shelter manufacturers have indicated that the presence of a private bushfire shelter is unlikely to change an individual's decision to stay and defend or to leave in a bushfire situation. In addition, the VBRC in its interim report stated that "the suggestion that the mere provision of refuges increases the propensity of people to leave an area late was not supported by any formal research cited by the 2001 Working Party."

Nevertheless, it would seem reasonable that the availability of a private bushfire shelter constructed to a government endorsed standard would provide residents with a level of assurance that the shelter would provide an opportunity of last resort if the situation required, and could delay a resident's decision to leave early.

However, in introducing any regulation for the market for private bushfire shelters, the potential to affect residents' perceptions of the risk of bushfire needs to be acknowledged. There is a risk that attitudes and preferences towards other risk reducing strategies such as reducing fuel loads, preparing houses against bushfire assault and making decisions about when to leave may also be altered.

Also, where residents purchase a bushfire shelter based on their perceived benefits, which are greater than the actual benefits, such an inflated sense of security has the potential to place individuals in unnecessary danger, therefore lowering the community benefits.

Therefore, private bushfire shelters are unlikely to be (and should not be) a 'stand-alone' solution to bushfire risks. Accordingly, the evaluation needs to be assessed in light of a broader government approach to assist residents in aligning their risk expectations from 'staying' to defending their properties."

Quantitative Analysis

This section provides a simple quantitative analysis of the impacts of providing more information versus a decision to introduce mandatory standards. It should be treated as indicative only, as the results are based on assumptions derived from conversations with bushfire experts. However, it is useful in showing the main drivers of the impacts. That is, it demonstrates which factors are important in determining the costs and benefits.

Table 7.1 provides assumptions on the quality of shelters and the probability of correct use given the information available to consumers. Combined they show an indication of the actual probability of survival in a shelter. Under the assumptions in Table 7.1 even with a structurally sound shelter the likelihood of it being correctly used means that the actual chance of surviving is less than half.

Table 7.1: Probability of Survival in a Bushfire Shelter

Variable	*Status quo*	*Information only*	*Mandatory standards*
Probability of the shelter being structurally sound	40%	65%	90%
Probability of correct use	25%	35%	50%
Actual probability of survival in a shelter	10%	23%	45%
Financial costs of the shelter	$5 000	$10 000	$15 000

Source: The CIE.

Table 7.1 assumes that there will be a significant improvement in the structural integrity of shelters in moving from the status quo to the information only option, and a further increase in moving to the mandatory standards option. It also assumes a doubling in the probability of correct use in moving from the status quo to mandatory standards. The increase in costs of shelters between options is also shown and is based on discussions with industry.

Table 7.2 uses assumptions to estimate the value of lives saved. It makes assumptions on the number of shelter occupants, probability and timing of a bushfire event and probability of survival without a bushfire shelter. Taken together these assumptions provide an estimate of the probability of shelters being called upon, expressed in monetary terms. By multiplying these amounts by the estimates of survival under each option, the model provides a net present value of a representative shelter under each scenario.

Table 7.2: Average shelter evaluation

Variable	*Status quo*	*Information only*	*Mandatory standards*
Value of a life	$3 880 000	$3 880 000	$3 880 000
People per shelter	3	3	3
Years to bushfire event	20	20	20
Net present value of a life	$1 003 000	$1 003 000	$1 003 000
Probability of a bushfire event in the area	80%	80%	80%
Probability of surviving bushfire without shelter	97%	97%	97%
Actual probability of survival in a shelter	10%	23%	45%
Actual benefits of the shelter	$7 220	$16 430	$32 500
Financial costs of the shelter	$5 000	$10 000	$15 000
Actual benefit cost ratio	1.44	1.64	2.17
Net present value of shelter	$2 220	$6 430	$17 500

Source: The CIE.

Table 7.2 demonstrates that under the assumptions made, the mandatory standards option provides the highest net benefit. That is, the expected value of lives saved under this option more than outweighs the additional cost of a shelter when compared to the other two options.

However, this result is sensitive to changes in the assumptions. For example, if the probability of the shelter being structurally sound in the mandatory standards option was 80% instead of 90% and the probability of correct use was 35% instead of 50%, the mandatory standards option would no longer be the option with the highest net present value. Under

these assumptions, the net present value per shelter would have fallen from $17,500 to $5,200.

A second point of uncertainty in each option relates to the behavioural change induced by the increased information provided to individuals. Where individuals are made more aware of the dangers of using bushfire shelters incorrectly, lives are saved when individuals no longer use shelters when it is not in their best interest to do so.

For example, informed individuals may decide to leave early when they are more certain of being able to avoid the fire in doing so, rather than risk staying at their property and using the shelter. Hence, the merits of each of these options are in part due to the behavioural change the additional information provokes.

Table 7.3 below demonstrates this assertion empirically. It uses a similar approach to the tables 7.1 and 7.2, but includes estimates of the 'assumed' probability of survival. Individuals will use shelters when they believe them to be the best option based on their assumed level of survival in the shelter. When individuals overestimate their chance of survival in a shelter they may make sub-optimal decisions regarding their use.

Hence, this is the parameter which models individuals' level of misinformation, which is greater when the assumed level of survival is higher than the actual level of survival (that is, when consumers place too much faith in bushfire shelters).

Table 7.3: A quantitative model showing the value of information

Variable	*Status quo*	*Information only*	*Mandatory standards*
Probability of the shelter being structurally sound	40%	65%	90%
Probability of correct use	25%	35%	50%
Actual probability of survival in a shelter	10%	23%	45%
Assumed probability of survival	70%	60%	45%
Actual benefit cost ratio	1.44	1.64	2.17
Assumed benefit cost ratio	10.12	4.33	2.17
Actual net present value	$2 220	$6 425	$17 500
Assumed net present value	$45 535	$33 315	$17 500
Unaccounted for cost of lives lost	$43 315	$26 890	$0

Source: The CIE.

The analysis in Table 7.3 assumes that individuals are provided with the greatest information in the mandatory standards option, where their

assumed probability of survival is assumed to be exactly equal to their actual probability of survival. In this case, individuals are assumed to revise down their expectation of survival in a shelter from 70% to 45%, implying that they make correct decisions and hence there is no loss of life from incorrect decisions. Under the information only option it is assumed that individuals revise down their probability of survival, but not to the same extent that they do under mandatory standards. As discussed below, this is a questionable assumption, where it could be argued that the mandatory standards could be seen as a government endorsement of shelters, leading to greater use of them than under the status quo.

Under the assumptions presented above, the misinformation is estimated to cost an average of $43,315 in terms of lost life per shelter under the status quo, $26,890 under the information only option and be zero under mandatory standards due to the assumption that perceptions are correctly aligned with fact in that scenario.

More details of the model outlined above are provided in Appendix B. In summary, the quantitative analysis provides an indication of the impacts. It is most useful in demonstrating the main drivers of impacts, where these are: the quality of shelter construction, information on the correct use of shelters, information on the probability of survival when using shelters, and the cost of bushfire shelters. Therefore options should be evaluated with these drivers in mind.

Qualitative Analysis

Option 1: Status quo

For this option, no amendments are made to the BCA and current supply options for private bushfire shelters continue in Australia with limited regulatory oversight or provision of information from authorities.

Positives

- The status quo would avoid deaths occurring in the scenario where a resident chose to stay longer instead of leaving early due to the availability of a government endorsed private bush fire shelter and subsequently perished.
- The cost of shelters available in the market under this option is likely to be less than that under the other options involving information

guidelines, voluntary or mandatory shelter construction standards (although the quality and structural integrity would remain untested).

Negatives

- There would be no change to the current unregulated market for private bushfire shelters. Industry would be able to continue to market and sell a range of shelters including shelters that fire experts have raised serious concerns over there reliability and the ability of people to properly use them.
- There would be limited avenues for consumers to judge tradeoffs in cost and quality.
- Without sufficient information, residents are likely to put too much faith in the ability of poorly constructed private bushfire shelters to protect their lives — that is they will underestimate the necessary construction standards for a suitable shelter; underestimate the bushfire risks; underestimate the human behavioural responses during a crisis, and underestimate the effect of heat and smoke on human health.
- The ability for a market driven standard to be created is limited in the short term, given the long lead time between bushfire events that would make available information to buyers and sellers on the performance of private bushfire shelters.

Option 2: Discourage the use of private bushfire shelters

Under this option the construction and use of private bushfire shelters is discouraged through an information campaign. The option would involve no amendments to the BCA.

Positives

- The rationale for this option is that it will avoid deaths in scenarios where a fire shelter was relied upon at the expense of another more effective bushfire mitigation strategy. Fire experts have raised concerns about the ability of private bushfire shelters to live up to consumer's expectations. Given this information disconnect some lives will be saved from discouraging the use of fire shelters and promoting bushfire mitigation strategies with a high chance of survival, such as leaving the home early.

- The absence of shelters may promote residents to continue using other strategies to minimise bushfire risk, such as clearing vegetation close to the house, or improving the protection of their house against possible bushfire attack, rather than falling under a false sense of security that they can rely on a private bushfire shelter.

Negatives

- Discouraging shelters would result in the loss of lives where a resident who was unable to leave early would have been saved by the existence of a private bushfire shelter. If residents decide to stay and defend their house until the fire front passes, there is a risk that the bushfire is so intense the house defences are breached, the house starts to burn and the residents are unable to control the fire. If this occurs, the house no longer provides protection against the bushfire and in the absence of a shelter the residents must evacuate while the bushfire risk is at its most extreme.
- It is difficult to predict the size of the behavioural effect that the provision of a government standard for fire shelters will have on decisions to 'stay or go'. In fact preliminary discussions with the bushfire safety industry, including fire authorities and shelter manufacturers have indicated that the presence of a private bushfire shelter is unlikely to change an individual's decision to stay and defend or to leave in a bushfire situation. The VBRC also stated in its interim report that "the suggestion that the mere provision of refuges increases the propensity of people to leave an area late was not supported by any formal research cited by the 2001 Working Party".
- Even if the government actively encourages residents to leave early, some people undoubtedly will disregard the advice and stay to attempt to defend their property. Likewise, even if the State actively discourages the construction and use of private bushfire shelters, some residents will undoubtedly decide to build one for use as a last resort if attempts to protect the house fail, or the bushfire intensity is extreme.

Option 3: Non-mandatory guidelines and information

For this option, non-mandatory guidelines and information are produced in which the 'ABCB Performance Standard for Private Bushfire Shelters[5]' is published as an information source but is not required to be met. The market failure is seen to be one of information, where consumers are not able to distinguish a shelter that is capable of protecting lives from one that is not. Immediately after the Black Saturday fires, there was no national standard for the construction of shelters, nor was there a central source of information for consumers on the relative quality of shelters, nor the preferred characteristics that would increase the chances of survival.

Positives

- Providing non-mandatory guidelines and information would somewhat address the information asymmetry and assist consumers to make informed choices about a suitable construction standard for private bushfire shelters should they choose to construct one.
- This option would result in lives being saved where a resident who was unable to leave early was able to rely on a shelter.
- This option provides the ability to build 'cheaper' shelters (which might not be built under mandatory standards) that provide some level of protection in the event of a bushfire.

Negatives

- Under this option, there is no regulatory control to minimise the risk of constructing poor quality shelters. There is a risk consumers do not become aware of the guidelines and construct a poor quality shelter, or knowingly construct a shelter not in accordance with the guidelines, perhaps to save money. In these cases, the resident may be placing an inflated level of assurance in the shelter which potentially puts lives at risk.
- Where residents purchase a bushfire shelter based on their perceived benefits, which are greater than the actual benefits, such an inflated sense of security has the potential to place individuals in unnecessary danger.

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5 A performance-based standard developed by the ABCB for voluntary use.

Option 4: BCA amendments for voluntarily shelters

For this option, the BCA is amended to provide for voluntarily constructed private bushfire shelters. This option outlines the BCA Performance Requirement to be met by all private bushfire shelters that are constructed, but does not require a bushfire shelter to be constructed in the first place.

Positives

- The main impact of this option would be to avoid lives lost that result from residents relying on poorly constructed shelters. The option relies on the argument that while the number of shelters that would be built is smaller, the low chance of survival in a poor quality shelter means overall more lives will be saved under mandatory standards, as opposed to the status quo or a voluntary standard.
- The mandatory standard option would involve testing and accreditation of suppliers. The provision of meeting that test and accreditation process is expected to more adequately address the information asymmetry in the market for fire shelter than the simple provision of information itself, through the introduction of a non-mandatory standard.
- The provision of information about correct use of shelters can be highly targeted to those installing them and these risks can be mitigated to an extent through information built into the mandatory standard which emphasises that a fire shelter is an avenue of last resort and should not be used as a replacement to existing bushfire mitigation strategies.

Negatives

- The downside of mandatory standards is similar to the behavioural effects under the non-mandatory standards option; however the potential behavioural effects on decisions to stay or go under mandatory standards may be even greater than under a non-mandatory standard.
- Fire experts have advised that the chance of survival even in a quality constructed fire shelter is low (due to the inability of people to use them properly). Given this, a small alteration in the number of people who stay longer (when they shouldn't have), may correlate strongly with the number of deaths during a bushfire.

- The mandatory standards will dissuade some people from constructing a shelter, due to higher costs. Under this scenario there is potential for lives to be lost where a resident may have constructed a cheap shelter but were unable to do so. However, fire experts have advised that the chance of survival in many fire shelters being currently marketed is very low.
- Compliance costs will be incurred by manufacturers due to the need to get their shelter designs accredited and tested against the standard. The costs to businesses to comply with any regulation of the private bushfire shelter market are expected to be high. Reports from manufacturers have estimated the current accreditation process can cost up to $500 000 and take six months, depending on the number of times applications need to be adjusted or re-submitted.
- It is expected that the introduction of regulation in the market for private bushfire shelters will reduce competition. A sharp reduction in the number of suppliers of private bushfire shelters was observed in Victoria following the announcement of the introduction of interim regulations in 2009.

Option 5: Mandatory construction requirement for shelters

For this option, a house constructed in a bushfire prone area would be subject to a mandatory requirement for an associated private bushfire shelter to be also constructed which would need to meet the BCA Performance Requirement.

Positives

- The mandatory requirement to have a fire shelter would save lives, where a resident would not have voluntarily constructed a fire shelter (possibly due to the cost) but was saved by the existence of a fire shelter.

Negatives

- Any mandatory construction requirements for private bushfire shelters are likely to introduce market inefficiencies over and above the voluntary construction requirement option, in a similar manner to those market inefficiencies created by inflated expectations.
- Mandatory construction to a standard will also have the same competition and business compliance costs associated with Option 4.

- There are two forms of inefficiencies likely to be generated above the BCA amendments outcome.
    - Consumers who assess that their private benefits are lower than their private costs and are still forced into constructing a shelter.
    - Existing residents that incorrectly alter their risk perceptions of shelters, based on the actions of councils, subsequently deciding to inefficiently purchase a private bushfire shelter. At this point, the change in risk perceptions has imposed a cost, through the inefficient purchase of a shelter, and may endanger lives where the shelter is relied upon instead of an alternate bushfire plan.

  Residents whose preference to evacuate early remain unchanged are now forced to absorb costs that can never be attributed to any benefit that a shelter provides, simply because they will never use the shelters they were forced to buy. If the shelters had been considered privately to have a positive net benefit by residents, they would be purchased irrespective of the mandatory construction requirement. Therefore, given sufficient information in the market, it is likely that any additional shelters purchased over and above because of the compulsory requirement will have a negative value.

Construction quality of fire shelters

Following discussions with fire industry experts, there appears to be general consensus on the likely shifts in quality that may occur under the implementation options.

- *Under the non-mandatory information only option (option 3)* — the average level of quality is expected to increase above the status quo. That is, while there will still be some private bushfire shelters not constructed to standard, there will be a greater proportion that will be constructed to standard.
- *Under the voluntary construction requirement option for private bushfire shelters (option 4)* — it is expected that the average quality of private bushfire shelters would increase above the status quo and information only options. In this situation, no shelters in the market for private bushfire shelters that do not meet the draft performance requirements would be constructed.

- *Under a mandatory construction requirement option for private bushfire shelters (option 5)* — the average quality should be constructed to meet the Performance Requirement.
- *Behavioural errors* — under all options, there is a high element of risk associated with private actions. There is a risk that occupants may make ineffective or incorrect decisions with respect to using the shelter.

There was broad consensus during consultation with fire industry experts that the introduction of the BCA Performance Requirement would increase the average quality of a private bushfire shelter. This was based on the experts' understanding of the range of risks associated with fire, and the belief that the risks related to construction and design have predominantly been addressed by the Performance Requirement for private bushfire shelters. Allowing for random defects in design, there was the view that a shelter used appropriately may yield a high average prospect of survival.

Risks in using a fire shelter

The most significant risk of using a private bushfire shelter design to the draft Performance Requirement is of ineffective decision making by individuals both before and during a fire. The key risks identified in terms of behaviour were with respect to:

- the duration of occupancy;
- the ability of the occupant to safely enter and exit the shelter;
- the appropriate use of the shelter in terms of number of occupants and use of ventilation or other technical elements; and
- the adequate management of the shelter and surrounding environment.

Behavioural risks, or ineffective decision making, are considered to be of equivalent significance to the design and construction of the shelter.

Therefore, the average probability of survival in a private bushfire shelter would reflect both the quality of the shelter as well as the probability that it would be utilised correctly and able to protect lives.

Cost of private bushfire shelters

The average cost of a private bushfire shelter is expected to change under the different implementation options. This will be driven predominantly by the removal of lower quality and cheaper materials and designs as the stringency of regulations and level of information provided to the market

both increase. An increase in the average standard of quality is expected to be associated with an increase in the cost of inputs (marginal costs) and potentially increased fixed costs associated with entering the market.

A review conducted as a part of the VBRC process entitled, 'Bushfire Bunkers: A summary of products and concepts', provides information on the market for private bushfire shelters in the immediate aftermath of the Victorian bushfires. The products available on the market reportedly ranged from $2000 to $40 000 (VBRC). However, where there is a lack of market information on the number of each type of shelter sold, it is difficult to assess the average cost of a shelter.

Experiences reported by manufacturers have indicated that the market for private bushfire shelters is relatively price sensitive, and therefore, under the status quo option it is assumed that the average price likely to be at the lower end of the observed range. It is estimated that the average cost of a shelter may be approximately $5000 including the cost of installation and/or excavation.

An increase in the level of quality associated with the introduction of regulation would drive an increase in the minimum cost. Since the introduction of interim regulations in Victoria there has been one shelter accredited. The cost of the shelter available is approximately $10 500 excluding GST, plus the cost of delivery and installation (see Wildfire safety bunkers, promotional material, 2010). Based on limited market observations, the average cost of a shelter may be assumed to be approximately $15 000 inclusive of delivery and installation under the BCA Performance Requirement option. Installation costs can vary considerably depending on the difficulty and location of the site for the shelter.

Although not able to be observed, it is expected that the average price of a shelter in the non-mandatory guidelines option would be lower than under the voluntary construction requirement option. Where a manufacturer does not seek to have their shelter independently quality assured there would be a lower cost of compliance.

Under a mandatory construction requirement option, the average quality of a private bushfire shelter is expected to be consistent with the voluntary construction requirement option. The potential increase in market demand under a mandatory construction requirement option may have slight price effects — placing slight upwards pressure on prices. Given that the extent to which demand may increase is unknown; it has been assumed that the minimum price of a shelter may approximate the average price under the voluntary construction requirement option.

Initial consultation data summary

A summary of discussions with fire industry experts identified that the key movement across the options (from status quo, information, voluntary to mandatory construction requirements) were:

- an increase in structural integrity of the average shelter;
- an increase in the education of residents on how to use the shelters correctly; and
- an increase in the average price of a shelter.

Maintenance costs

As with any building, private bushfire shelters are likely to require some level of annual maintenance to ensure they maintain a given level of structural and operational integrity. However, given the limited experience with private bushfire shelters over an extended period of time, it is unclear as to the relative levels of maintenance costs that may be imposed across the implementation options.

Size of market inefficiencies

In addition to market inefficiencies previously mentioned there are two additional sources of market inefficiencies that must also be considered:

- the inefficient purchase of too many shelters when residents are misinformed as to the expected benefits of a bushfire shelter; and
- the inefficient use of a private bushfire shelter after it has been purchased, where residents may have been safer leaving early, or sheltering inside a defendable house.

These factors will affect both the size of the market for shelters, as well as the level of use/reliance on shelters in a bushfire event. The two observable factors that are key in terms of identifying the correct size of the market are:

- the rate of uptake of shelters, identifying who purchases shelters and for what reason (for example, intention to use, or peace of mind only); and
- the impact that having a shelter has on the survival plan on the day of a bushfire event.

Due to the lack of data and information on the size of the market for private bushfire shelters, such issues are not easily quantified. However, some key pieces of information have been gathered through initial

discussions with fire industry experts and manufacturers as well as through the deliberations of the VBRC.

Market uptake of shelters

Evidence presented at the VBRC indicates that there was an increase in the level of demand for private bushfire shelters since the Victorian Black Saturday bushfires of February 2009 until the announcement of the Victorian interim regulations.[6]

This preliminary increase in demand indicates that peoples' preferences for constructing shelters are affected by events and information including the observed bushfire events and the stories of survival and deaths associated with shelters.

There is some evidence that the announcement of the interim regulations for private bushfire shelters in Victoria signalled to consumers that the average quality of a shelter was lower than previously expected. Reports from manufacturers of a sharp drop in demand following the announcement may indicate that consumers held a preference for higher quality shelters and were willing to wait to purchase them.

Based on these observations, for the purposes of this RIS, it is therefore assumed that without information, consumers have an unjustifiably high perception of the benefits of bushfire shelters. In turn, the provision of information and regulation of the quality of shelters is expected to reduce the perceived benefits and bring them into line with actual benefits of shelters.

It is important to acknowledge that there are likely to be two distinct markets operating following either of the implementation options. Where the enforcement capacity of regulators is limited, there is still the allowance for individuals to firstly make the choice of whether to construct a shelter at all and secondly, whether to construct one to standard. Whilst taking the option of building a shelter not to standard is easier for individuals under the disincentive and non-mandatory guideline options, it could continue to be a possibility under the voluntary construction requirement option and mandatory construction requirement option. This could be observed, for example, through an increase in the number of over specified wine cellars, storage sheds and children's play houses.

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6 At which point, market movements could no longer be observed since there was a block placed on the sale of shelters until accreditation.

The assessment of the rate of uptake involves considerable levels of uncertainty and the immaturity of the market has limited the possibility of making conclusions about the market for shelters.

Business compliance costs

The costs to businesses to comply with any regulation of the private bushfire shelter market are expected to be high, particularly relative to the expected size of the market (and relative profit margin). Reports from manufacturers have estimated the current accreditation process can costs up to $500 000 and take six months, depending on the number of times applications need to be adjusted or re-submitted. The potential compliance costs can be identified by considering the recent experience of manufacturers in Victoria seeking to have their shelter accredited under the interim provisions and may include:

- the additional costs paid for design and engineering services above what would have been paid in the unregulated market;
- the cost of additional infrastructure and/or equipment to enable testing of designs;
- the cost of engaging a third party to test the final product;
- the engineering and design costs to diagnose and rectify potential problems; and
- the cost of applying for accreditation or the risk of applying for a permit for an Alternative Solution.

The cost of entering the market for private bushfire shelters to comply with the regulation would be higher than in an unregulated market, the extent to which would be determined by the degree of specification in the regulation. There are two key factors that may influence the compliance cost:

- *the specification of the quality of the shelter* — where an increase in the standard of the performance outcomes may subsequently increase the cost of compliance for some manufacturers; and,
- *the specification of test methods or provision of DTS provisions* — where an increase in the detail of how the Performance Requirements are assessed may decrease the cost of compliance.

However, it is important to note that while increased specification in terms of quality and accreditation has the potential to increase the cost of production and compliance for businesses; it should not necessarily be considered to be a market barrier.

Where increased specification provides efficient increases to consumer benefits (that is, the additional compliance costs are more than outweighed by the additional protection benefits) the increase is efficient.

A more important factor affecting the cost of compliance is the level of certainty surrounding the assessment mechanism. Where there is currently no widespread consensus on a testing method through which a shelter can be accredited or assessed as providing an Alternate Solution to meeting the Performance Requirements, the compliance costs for businesses to enter the market are expected to be relatively high.

Preliminary industry consultation suggested that a greater level of specification within the standards would significantly reduce the cost of compliance. It is understood that establishing a test method would be a pre-requisite for developing DTS provisions. Should DTS provisions be developed, the regulators would effectively have outlined the design components of a minimally complying shelter. This is likely to allow manufacturers to have their products certified at a lower cost of compliance and would reduce the risk (and subsequent cost) for building surveyors who would otherwise be required to assess an Alternate Solution.

Greater specification may assist manufacturers to design a product that meets the acceptable standards without having to over-engineer their product. Whilst over-engineering a design is not considered to be prohibitively expensive in terms of the additional cost of entering the market, it may significantly increase the cost of an individual private bushfire shelter. Anecdotal evidence taken from the recent experience of manufacturers seeking to become accredited in Victoria suggests that some manufacturers may be over-engineering their product to increase the likelihood their product is accredited — and substantially increasing the cost of the product.

Assessment of competition impacts

It is expected that the introduction of regulation in the market for private bushfire shelters will reduce competition relative to the status quo. This would be expected given the increase in the costs of compliance and the initial reduction in the size of the market as consumers are made aware of the inherent risks associated with the shelters in the unregulated market. A sharp reduction in the number of suppliers of private bushfire shelters was observed in Victoria following the announcement of the introduction of interim regulations in 2009.

It is difficult to assess efficiency of these competition impacts given the likelihood that there is information failure in the status quo, unregulated market. However, given that the draft BCA amendments are targeted at increasing the level of information in the market, as well as providing a level of quality assurance that would not exist in an unregulated market, the expected reduction in the number of manufacturers may actually reflect an efficient and necessary market adjustment. The introduction of the regulation is intended to provide a standard of quality in the market — to provide transparency for consumers to assess the relative costs and benefits of purchasing and using a shelter.

Despite this potential for the provisions to both reduce competition and increase efficiency in the market, it is important that wherever possible, the cost of compliance incurred by manufacturers is minimised. This is to prevent the risk of an inefficient barrier to entry being developed, providing a form of monopoly protection. As previously outlined, the current uncertainty surrounding the assessment method may pose high costs (of compliance) to manufacturers and subsequently reduce market competition.

8 Conclusion

This RIS investigates a number of options to address information asymmetry in the market for private bushfire shelters.

As demonstrated in the impact analysis all the options result in both the potential for some lives saved and some lives lost, depending upon the relevant behavioural responses. Therefore bushfire deaths will continue to occur under all options.

The RIS points out that a resident's decision to construct and use a private bushfire shelter may result in a behavioural change that comes at the expense of other more efficient bushfire mitigation strategies. For example, the availability of a shelter may influence a resident's decision to leave early or undertake other strategies such as vegetation clearing or making the house more bushfire resistant.

Whilst 'late evacuation' is known to present associated risks, a number of risks of 'staying and defending' — a strategy previously understood to have a reasonable prospect of success — have also been highlighted, particularly in the Victorian bushfires of 2009. A decision to discourage the construction and use of fire shelters (Option 2) would somewhat address this problem.

The decision to implement mandatory standards for voluntarily constructed shelters (Option 4) is a judgement on the trade-off between whether the lives saved due to the avoidance of deaths in poorly constructed fire shelters is greater than the lives lost from the inefficient decision to 'stay' and rely on a government endorsed shelter.

In order to maximise the net-benefits from implementing a mandatory standard for voluntarily constructed shelters, the surrounding implementation framework including any associated assessment criteria needs to address the risks and uncertainties associated with using a private bushfire shelter and ensure they are adequately communicated to buyers and sellers.

On the basis that there is not great certainty over the extent government endorsement of shelters increases the number of 'stayers' and the more certain knowledge that the chance of survival in a poorly constructed

shelter is low, the provision of a minimum standard can be argued to be a less risky option than the option which discourages the use of shelters.

The mandatory standard option involves testing and accreditation of supplies. The provision of meeting that test and accreditation process is expected to more adequately address the information asymmetry in the market for fire shelters than the simple provision of information itself, through the introduction of a non-mandatory standard (Option 3).

The indicative quantitative analysis provided indicates that Option 4 may be supported under a range of plausible assumptions about bushfire shelter effectiveness and behavioural responses. However, it also indicates that deviations from these assumptions, for example if individuals are lead to place greater faith in shelters due to the standards being in place, may reverse this finding.

On balance Option 4 is the recommended option. While the option creates the theoretical risk of unwanted behavioural impacts on decisions to 'stay or go', these risks can be mitigated to an extent through information built into the mandatory standard which emphasises that a fire shelter is an avenue of last resort and should not be used as a replacement to existing bushfire mitigation strategies.

In addition to these options, the RIS considered the effect of local councils mandating the construction of bushfire shelters with new houses (Option 5). Should such actions be taken, it would be expected to reduce market efficiency. There are two forms of inefficiencies likely to be generated above the BCA amendments outcome.

(a) Consumers who assess that their private benefits are lower than their private costs and are still forced into constructing a shelter.

(b) Existing residents that incorrectly alter their risk perceptions of shelters, based on the actions of councils, subsequently deciding to inefficiently purchase a private bushfire shelter. At this point, the change in risk perceptions has imposed a cost, through the inefficient purchase of a shelter, and may endanger lives where the shelter is relied upon instead of an alternate bushfire plan.

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Appendix A

A Draft BCA amendments for Private Bushfire Shelters

1.3.2 Classification

Class 10 — a non-habitable building or structure being:

(a) Class 10a — a non-habitable building being a private garage, carport, shed, or the like; or

(b) Class 10b — a structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like.

Class 10c — a private bushfire shelter

Objective

O2.3

The O*bjective* is to:

(a) safeguard the occupants from illness or injury:

  (i) by alerting them of a fire in the building so that they may safely evacuate; and

  (ii) caused by fire from heating appliances installed within the building; and

  (iii) in *alpine areas*, from an emergency while evacuating the building; and

(b) avoid the spread of fire; and

(c) protect a building from the effects of a bushfire; and

(d) reduce the likelihood of fatalities arising from occupants of a Class 1a dwelling not evacuating a property prior to exposure from a bushfire event.

Functional Statement

F2.3.5 Private bushfire shelters

A structure designed for emergency occupation during a bushfire event must provide shelter to occupants from direct and indirect actions of a bushfire.

Performance Requirement

P2.3.5

A *private bushfire shelter* must be designed and constructed to provide a tenable environment for occupants during the passage of untenable conditions arising from a bushfire event, appropriate to the:

(a) location of the private bushfire shelter relative to fire hazards including:
  (i) predominant vegetation; and
  (ii) adjacent buildings and structures; and
  (iii) allotment boundaries; and
  (iv) other combustible materials; and

(b) occupancy of the *private bushfire shelter*; and

(c) bushfire intensity having regard for the bushfire attack level; and

(d) fire intensity from adjacent buildings and structures, allotment boundaries and other combustible materials; and

(e) ready access to the private bushfire shelter from the associated dwelling and occupant egress after the fire; and

(f) tenability within the *private bushfire shelter* for the estimated maximum period of occupancy; and

(g) generation of smoke, heat and toxic gases from materials used to construct the *private bushfire shelter*; and

(h) structural and fire loads and actions to which it may reasonably be subjected, appropriate to:
  (i) the topography between the *private bushfire shelter* and the predominant vegetation or other fire hazards; and
  (ii) the distance between the *private bushfire shelter* and the predominant vegetation or other fire hazards; and
  (iii) the size of the potential fire source and fire intensity; and
  (iv) wind loading; and
  (v) potential impact from debris such as falling tree limbs; and

(i) degree of external signage identifying the location of the *private bushfire shelter*; and

(j) degree of internal signage identifying the design capacity and maximum period of occupancy; and

(k) degree of occupant awareness of outside environmental conditions; and

(l) degree of essential maintenance.

Appendix B

B Quantitative Analysis

The current collective understanding of the market for private bushfire shelters is limited to observations of the movements in the demand and supply of shelters post-February 2009 — up to the point where interim accreditation measures were announced in Victoria. Despite the increase in monitoring of the private bushfire shelter market as a result of the VBRC process, considerable uncertainty remains around the size and nature of the private bushfire shelter market.

As such, this evaluation will essentially involve some elements of judgement about how the market may evolve. A quantitative model is used to illustrate the relative net benefits at the individual shelter level of the implementation options, relative to the status quo.

Estimates have been provided on the value of parameters, based on research and initial discussions with fire industry experts. Members of the fire industry involved in these initial discussions included State fire authorities, rural fire services, fire industry associations, fire safety experts, building surveyors and private bushfire shelter manufacturers.

Value of lives

The objective of regulating the market for private bushfire shelters is to provide a known standard of quality in the market along with information on survivability to increase the capacity of individuals to effectively assess their level of risk. The benefits are expected to be the potential for individuals to increase their prospect of survival and potentially to reduce the loss of life through well informed decisions.

Whilst the option to use a private bushfire shelter may allow those that stay to defend their properties to have a greater prospect of survival, following discussions with both fire safety industry representatives and manufacturers, there is no clear evidence to suggest that the presence of a shelter would encourage residents to stay to defend their houses where they would otherwise have left. That is, it is assumed that there will be no change in the number of houses defended from the baseline. Subsequently, the estimated benefit derived from regulating the market will be presented in terms of the value of life, and will not include the value of houses.

Following the guidelines set out by the Office of Best Practice Regulation, this RIS utilises a value of a statistical life of $3.88 million, brought up to 2010 dollars (OBPR, 2008).

Probability of fire and probability of survival without a shelter

The probability of fire and probability of survival without a private bushfire shelter are considered to be important factors in determining the demand for shelters. The expected benefits of constructing a private bushfire shelter are heavily tempered by the probability that the area will be affected by bushfires and whether or not there is a direct risk to lives if there is a bushfire in the area. These pieces of information provide the baseline against which individuals will assess the private costs and benefits of constructing a private bushfire shelter in the first instance.

The probability of fire and probability of survival without a shelter *for each individual* would not alter under each implementation option; however, it will be different across different regions in Australia.[7]

Probability of survival in a shelter

The quality of private bushfire shelters being constructed in an unregulated market is one of the key concerns that arose through the VBRC in reference to private bushfire shelters. Immediately after the Black Saturday fires, there was no national standard for the construction of shelters, nor was there a central source of information for consumers on the relative quality of shelters, nor the preferred characteristics that would increase the chances of survival. This situation has improved to a certain extent based on the work published both in the Victorian interim regulations as well as the performance requirements being evaluated here.

Following discussions with fire industry experts, there appears to be general consensus on the likely shifts in quality that may occur with the introduction of the proposed provisions under each implementation option.

- *Under the non-mandatory information only option* — the average level of quality is expected to increase above the status quo. That is, while there will still be some private bushfire shelters not constructed to standard, there will be a greater proportion that will be constructed to standard.

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7 It should be noted that even in regions with a lower probability of fire, and a higher probability of survival without a shelter, there will still be individuals that, due to private risk assessments and preferences, will still efficiently choose to purchase a shelter.

- *Under the proposed BCA amendments option for private bushfire shelters* — it is expected that the average quality of private bushfire shelters would increase above the status quo and information only options. In this situation, no shelters in the market for private bushfire shelters that do not meet the proposed performance requirements would be constructed.
- *Under a mandatory construction requirement option for private bushfire shelters* — the average quality should be constructed to meet the Performance Requirement.

The quality of the private bushfire shelters, that is, the probability that they will save lives if used, is a key variable both in terms of the decision to construct as well as the estimated benefits of the options. Discussions with the fire industry highlighted the considerable uncertainty surrounding these parameters; however it is possible to identify confidence intervals within which the average 'quality' may be expected to fall.

In terms of the average prospect of survival of a shelter the following may be implied from these discussions:

- *under the status quo* — the average prospect of survival in a shelter is expected to lie between approximately 30–40 per cent, accounting for design and construction errors;
- *under the proposed BCA amendments for private bushfire shelters where the shelter is used appropriately* — it is expected that there would be a prospect of survival of between approximately 90 to 95 per cent;
- *behavioural errors* — under all options, it was presented that there is a high element of risk associated with private actions to the extent that up to 25 to 50 per cent of occupants may make ineffective decisions with respect to using the shelter and that this may result in fatality.

There was broad consensus during consultation with fire industry experts that the introduction of the proposed BCA amendments for private bushfire shelter construction would increase the average quality of a private bushfire shelter. This was based on the experts' understanding of the range of risks associated with fire, and the belief that the risks related to construction and design have predominantly been addressed by the Performance Requirement for private bushfire shelters. Allowing for random defects in design, there was the view that a shelter used appropriately may yield a fairly high average prospect of survival.

The most significant risk of using a private bushfire shelter design to the proposed Performance Requirement is of ineffective decision making by

individuals both before and during a fire. The key risks identified in terms of behaviour were with respect to:

- the duration of occupancy;
- the ability of the occupant to safely enter and exit the shelter;
- the appropriate use of the shelter in terms of number of occupants and use of ventilation or other technical elements; and
- the adequate management of the shelter and surrounding environment.

Behavioural risks, or ineffective decision making, are considered to be of equivalent significance to the design and construction of the shelter.

Therefore, the average probability of survival in a private bushfire shelter would reflect both the quality of the shelter as well as the probability that it would be utilised correctly and able to protect lives.

Cost of private bushfire shelters

The average cost of a private bushfire shelter is expected to change under the different implementation options. This will be driven predominantly by the removal of lower quality and cheaper materials and designs as the stringency of regulations and level of information provided to the market both increase. An increase in the average standard of quality is expected to be associated with an increase in the cost of inputs (marginal costs) and potentially increased fixed costs associated with entering the market.

A review conducted as a part of the VBRC process entitled, 'Bushfire Bunkers: A summary of products and concepts', provides information on the market for private bushfire shelters in the immediate aftermath of the Victorian bushfires. The products available on the market reportedly ranged from $2000 to $40 000 (VBRC). However, where there is a lack of market information on the number of each type of shelter sold, it is difficult to assess the average cost of a shelter.

Experiences reported by manufacturers have indicated that the market for private bushfire shelters is relatively price sensitive, and therefore, under the status quo option it is assumed that the average price likely to be at the lower end of the observed range. It is estimated that the average cost of a shelter may be approximately $5000 including the cost of installation and/or excavation.

An increase in the level of quality associated with the introduction of regulation would drive an increase in the minimum cost. Since the introduction of interim regulations in Victoria there has been one shelter accredited. The cost of the shelter available is approximately $10 500

excluding GST, plus the cost of delivery and installation (see Wildfire safety bunkers, promotional material, 2010). Based on limited market observations, the average cost of a shelter may be assumed to be approximately $15 000 inclusive of delivery and installation under the proposed BCA amendments option. Installation costs can vary considerably depending on the difficulty and location of the site for the shelter.

Although not able to be observed, it is expected that the average price of a shelter in the non-mandatory guidelines option would be lower than under the proposed BCA amendments option. Where a manufacturer does not seek to have their shelter independently quality assured there would be a lower cost of compliance. A figure of $10 000 is used to evaluate the non-mandatory guidelines option.

Under a mandatory construction requirement option, the average quality of a private bushfire shelter is expected to be consistent with the proposed BCA amendments option. The potential increase in market demand under a mandatory construction requirement option may have slight price effects — placing slight upwards pressure on prices. Given that the extent to which demand may increase is unknown; it has been assumed that the minimum price of a shelter may approximate the average price under the proposed BCA amendments option.

Initial consultation data summary

A summary of the data compiled through discussions with fire industry experts is presented in table B.1. The key movements across options that were identified in these discussions were:

- an increase in structural integrity of the average shelter;
- an increase in the education of residents on how to use the shelters correctly; and
- an increase in the average price of a shelter.

Quantitative model of average shelter

Table 4 presents the evaluation of the costs and benefits of three alternate private bushfires shelters positioned on a given fire prone site. The characteristics of the site are that:

B.1 Data drawn from initial consultations

Variable	*Status quo*	*Information only*	*Mandatory standards*
Probability of the shelter being structurally sound	40%	65%	90%
Probability of correct use	25%	35%	50%
Actual probability of survival in a shelter	10%	23%	45%
Financial costs of the shelter	$5 000	$10 000	$15 000

Source: The CIE.

B.2 Average shelter evaluation

Variable	*Status quo*	*Information only*	*Mandatory standards*
Value of a life	$3 880 000	$3 880 000	$3 880 000
People per shelter	3	3	3
Years to bushfire event	20	20	20
Net present value of a life	$1 003 000	$1 003 000	$1 003 000
Probability of a bushfire event in the area	80%	80%	80%
Probability of surviving bushfire without shelter	97%	97%	97%
Actual probability of survival in a shelter	10%	23%	45%
Actual benefits of the shelter	$7 220	$16 430	$32 500
Financial costs of the shelter	$5 000	$10 000	$15 000
Actual benefit cost ratio	1.44	1.64	2.17
Net present value of shelter	$2 220	$6 430	$17 500

Source: The CIE.

- the average probability of loss of life in the event of a severe bushfire is 3 per cent[8]; and
- there is an 80 per cent chance of a bushfire occurring in the area within the next 40 years:
  - this implies a 2.4 per cent (3 per cent of 80 per cent) probability of the private bushfire shelter having to be relied upon to save lives.

In addition, it is assumed in all options that:

- the net present Value of Life (VOL) is equal to $1.003 million per person, assuming that the fire occurs 20 years from purchase; and
- the average number of occupants per shelter is three.

8 On Black Saturday approximately 1 per cent of the people living in the areas devastated died. However, during consultation, the view was there are 'other areas where the average probability of loss of life could realistically be around 3 per cent'.

The actual expected benefits of a purchased shelter are calculated by multiplying:

- the value of a life ($1.003 million);
- the probability of having to use the shelter to save a life (2.4 per cent) based on the probability of a fire, and probability of being able to survive the fire without a shelter; and
- the probability of the shelter being used correctly to save a life (table B.2).

The increase in expected benefits from the status quo to the mandatory performance requirements is due to the increase in structural integrity of the shelters constructed, as well as the increased ability of residents to use them correctly. Both of these assertions were provided by fire industry experts through the initial consultation period.

On average, shelters across all three options return a positive net benefit. However, a shelter constructed under the mandatory performance requirements is expected to return a net present value of $17 500, almost eight times greater than a shelter under the status quo option.

Maintenance costs

As with any building, private bushfire shelters are likely to require some level of annual maintenance to ensure they maintain a given level of structural and operational integrity. However, given the limited experience with private bushfire shelters over an extended period of time, it is unclear as to the relative levels of maintenance costs that may be imposed across the three implementation options.

Discussions with manufacturers have indicated that annual maintenance costs of an accredited shelter could be in the vicinity of $180. Over the expected 20 years to the first bushfire, this equates to approximately $1900, or up to 10 per cent of the net present value.

Given the work involved in maintaining an accredited shelter (including testing of hydraulic doors and temperature gauges), it could be reasonably expected that unaccredited shelters would incur lower annual maintenance costs (commensurate with the lower level of structural integrity).

Allowing for annual maintenance costs of $130 per shelter in the information guidelines option could add up to $1400 of additional present value costs, equating to 22 per cent of the net present value.

Finally, allowing for $90 per year in annual maintenance costs for a status quo shelter, an additional $850 of present value costs may be imposed. This equates to almost 40 per cent of the net present value.

As can be seen in table B.3, the inclusion of maintenance costs does not alter the relative results presented in table 5.

B.3 Effect of maintenance costs

Variable	*Status quo*	*Information only*	*Mandatory standards*
Net present value of shelter	$2 220	$6 430	$17 500
Annual maintenance estimate	$90	$130	$180
Present value of maintenance costs	$850	$1400	$1 900
Maintenance costs as proportion of net present value	38%	22%	10%
Net present value including maintenance costs	$1 370	$5 030	$15 600

Source: TheCIE.

Size of market inefficiencies

While the results in table B.3 provide an indication of the net present values at the average shelter level, there are two additional sources of market inefficiencies that must also be considered:

- the inefficient purchase of too many shelters when residents are misinformed as to the expected benefits of a bushfire shelter; and
- the inefficient use of a private bushfire shelter after it has been purchased, where residents may have been safer leaving early, or sheltering inside a defendable house.

These factors will affect both the size of the market for shelters, as well as the level of use/reliance on shelters in a bushfire event. Where there are too many shelters purchased, due to incorrect information or decision making, additional costs, such as loss of life, will be imposed.

The two observable factors that are key in terms of identifying the correct size of the market are:

- the rate of uptake of shelters, identifying who purchases shelters and for what reason (for example, intention to use, or peace of mind only); and
- the impact that having a shelter has on the survival plan on the day of a bushfire event.

Due to the lack of data and information on the size of the market for private bushfire shelters, such issues are not easily quantified. However, some key pieces of information have been gathered through initial discussions with fire industry experts and manufacturers as well as through the deliberations of the VBRC.

Rate of uptake

Evidence presented at the VBRC indicates that there was an increase in the level of demand for private bushfire shelters since the Victorian Black Saturday bushfires of February 2009 until the announcement of the Victorian interim regulations.[9]

This preliminary increase in demand indicates that peoples' preferences for constructing shelters are affected by events and information including the observed bushfire events and the stories of survival and deaths associated with shelters.

There is some evidence that the announcement of the interim regulations for private bushfire shelters in Victoria signalled to consumers that the average quality of a shelter was lower than previously expected. Reports from manufacturers of a sharp drop in demand following the announcement may indicate that consumers held a preference for higher quality shelters and were willing to wait to purchase them.

Based on these observations, for the purposes of this RIS, it is therefore assumed that without information or the proposed BCA amendments, consumers have an unjustifiably high perception of the benefits of bushfire shelters. In turn, the provision of information and regulation of the quality of shelters is expected to reduce the perceived benefits and bring them into line with actual benefits of shelters.

It is important to acknowledge that there are likely to be two distinct markets operating following either of the implementation options. Where the enforcement capacity of regulators is limited, there is still the allowance for individuals to firstly make the choice of whether to construct a shelter at all and secondly, whether to construct one to standard. Whilst taking the option of building a shelter not to standard is easier for individuals under the non-mandatory guideline option, it could continue to be a possibility under the proposed BCA amendments and mandatory construction requirement options. This could be observed, for example,

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9 At which point, market movements could no longer be observed since there was a block placed on the sale of shelters until accreditation.

through an increase in the number of over specified wine cellars, storage sheds and children's play houses.

The assessment of the rate of uptake involves considerable levels of uncertainty and the immaturity of the market has limited the possibility of making conclusions about the market for shelters.

Impact to decision making

There are considered to be several different 'types' of individuals intending to use a private bushfire shelter. These include:

- *those intending to stay to actively defend their property* — utilising the private bushfire shelter as a measure of last resort;
- *those intending to 'wait and see' whether they will stay or leave* depending on the expectations and information about the severity of the fire and whether the house is defensible against the fire front — where the private bushfire shelter provides a potentially safer option to late evacuation; and
- *those intending to leave early* — utilising the private bushfire shelter as a measure of last resort where they are unable to leave or have insufficient warning.

Preliminary discussions with the bushfire safety industry, including fire authorities and shelter manufacturers have indicated that the presence of a private bushfire shelter is unlikely to change an individual's decision to stay and defend or to leave in a bushfire situation.

That is, the provision of information through non-mandatory guidelines or the proposed BCA amendments option is not likely to lead to a change in preference of whether to 'stay' or 'go'. This does not however, preclude those people with a plan to 'wait and see' to inefficiently rely on a poor quality shelter.

Therefore, there is a chance that individuals purchasing a private bushfire shelter may acquire a false sense of security, following the introduction of the proposed provisions (under each of the implementation options). Such a false sense of security may be encouraged purely through the existence of any shelter, or alternatively, through the provision of a perceived government endorsement of private bushfire shelters through the publication of a mandatory performance requirement.

Where residents purchase a bushfire shelter based on their perceived benefits, which are greater than the actual benefits, such an inflated sense of security has the potential to place individuals in unnecessary danger, therefore lowering the community benefits of the regulations.

Again, it is considered to be the provision of information to residents and potential purchasers of bushfire shelters that may help in alleviating an inflated sense of security.

Quantitative model of perceptions

For illustrative purposes, table B.4 considers the assumed benefit cost ratio and net present value of the average shelter when residents have incorrect information on the probability of being able to survive a bushfire in a shelter.

Following the assumption that the provision of more information allows for more accurate risk assessments, the difference between actual probability of survival and assumed probability of survival converge.

B.4 Effect of misinformation

Variable	*Status quo*	*Information only*	*Mandatory standards*
Probability of the shelter being structurally sound	40%	65%	90%
Probability of correct use	25%	35%	50%
Actual probability of survival in a shelter	10%	23%	45%
Assumed probability of survival	70%	60%	45%
Actual benefit cost ratio	1.44	1.64	2.17
Assumed benefit cost ratio	10.12	4.33	2.17
Actual net present value	$2 220	$6 430	$17 500
Assumed net present value	$45 600	$33 300	$17 500
Unaccounted for cost of loss of lives	$43 329.60	$26 719.92	$0

Source: The CIE.

Where residents incorrectly estimate the expected benefits of a private bushfire shelter, decisions to purchase and to use the shelter will be biased. The anticipated market effect is that where there is inaccurate information, too many shelters will be purchased resulting in an economic deadweight loss — equating to lives being put in additional danger.

As it is not possible to measure the deadweight loss associated with the artificially inflated market, Table B.5 illustrates the actual and assumed results for the marginal shelter in each option. Noting that consumers will purchase a shelter to the point where expected benefits equal expected costs, in each case the assumed benefits were equated with the financial cost of the shelter and then compared to the actual benefits of the shelter.

B.5 Illustrative quantitative model — for marginal shelter

Variable	*Status quo*	*Information only*	*Mandatory standards*
Value of a life	$1 003 000	$1 003 000	$1 003 000
Average number of people per shelter	3	3	3
Probability of needing to rely on the shelter for survival	0.24%	0.55%	1.11%
Assumed probability of survival in shelter by the consumer	70%	60%	45%
Assumed benefits by the consumer	$5 000	$10 000	$15 000
Assumed costs	$5 000	$10 000	$15 000
Assumed benefit cost ratio by the consumer	1.00	1.00	1.00
Actual probability of survival in shelter	10%	23%	45%
Actual benefits of the shelter	$700	$3 800	$15 000
Unaccounted for costs of loss of life	$4 300	$6 200	$0
Actual net present value	-$4 300	-$3 800	$0
Actual benefit cost ratio	0.14	0.38	1.00

Note: Under each option, the marginal shelter has a different probability of use. This reflects the fact that an increasing cost of the shelter means that only consumers with a higher expected benefit, and hence probability of use, will purchase.
Data source: TheCIE analysis.

Across the status quo and information only options, the actual net present values for the marginal shelters are a loss of $4300 and $3800 respectively indicating a greater potential for market inefficiencies under the status quo than under the provision of information. The smallest level of market inefficiency is expected under the performance requirements.