BUILDING Resilience

Making homes climate ready.

VICTORIA State Government

SHIRE OF CAMPASPE

CENTRAL GOLDFIELDS SHIRE COUNCIL

MOUNT ALEXANDER SHIRE COUNCIL

LODDON SHIRE

CITY OF GREATER BENDIGO

Foreword

Our region faces a number of climate risks including:

- Higher temperatures year round
- More days of extreme heat
- Harsher fire weather and longer fire seasons
- More frequent heat and intense heavy rainfall causing flooding
- Less rainfall in autumn, winter and spring[1]

As there is a large volume of valuable, existing information regarding the climate risk and resilience profile of properties, this booklet aims to simplify and summarise the information. Please refer to the **Useful Resources** section on page 30 for comprehensive external sources on this topic.

As we continue to experience more impacts from natural hazards on our buildings and assets, we encourage you to look for ways to prepare your own buildings. Together we can create a brighter and more resilient future.

This booklet was originally funded by the State of Victoria as part of the climate risk and resilience information provision for property buyer's project undertaken by East Gippsland Shire Council. The main aim of the project was to identify and summarise the climate change research, and provide property buyers and existing home owners practical and useable information on climate risks and adaptation options. It has since been reproduced in other areas across Victoria.

The participating councils extend their thanks and appreciation to the East Gippsland Shire for sharing this content.

Disclaimer: Although precautions have been taken to ensure the accuracy of the information, the publishers, authors and printers cannot accept responsibility for any claim, loss, damage or liability arising out of the use of the information provided.

bright FUTURES

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Introduction

Why renovate or build a resilient house?

Our world is getting warmer and our weather is changing. Records show our region is hotter and drier than ever before. Our average temperature is between 0.8 to 1.4 degrees warmer than in 1950, and rainfall has dropped 100-200mm a year. These trends are expected to continue.

This means we will have more hot days and warm spells, fewer frosts, less overall rainfall but heavier rain events more often than in the past.

Extreme weather events – extreme rain, storms, strong winds, floods, droughts, extreme heat and bushfires – are more common. This is likely to continue.[1]

These changes will affect us all but there are things we can do to minimise our risks.

This booklet outlines information to help homeowners, builders, developers and property buyers to make informed decisions, which will reduce the impact of these extreme events on our homes and properties.

By understanding the risks and making informed decisions we can help build resilience in our region at a 'property-by-property' level.

1 source: https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0023/60746/Loddon-Mallee.pdf

How will this affect us?

Climate and weather influences the way we design, build and maintain our buildings. Changes to our climate and weather can damage our buildings and increase the costs of construction and repair.

In 2013, an Australian parliamentary inquiry heard that property damage caused by extreme weather costs Australians between $900M and $4B a year.

Flood damage to building foundations

Extreme weather can impact buildings in many ways:

Extreme heat can:

- Cause heat stress damage to buildings and building materials, such as roofs, cladding and windows
- Increase the cost of keeping your building cool because you have to use more energy
- Increase the risk of your heating and cooling failing
- Cause a greater risk of power blackouts

Extreme rain can:

- Damage your property through flooding
- Increase costs of flood protection, insurance and property maintenance
- Interrupt your business and disrupt access and services
- Increase the cost of renovating a property or building a house
- Reduce the value of your property depending on where it is located
- Cause structural damage to buildings
- Increase maintenance costs

Bushfire can:

- Damage your property and other assets
- Increase costs of bushfire protection
- Interrupt business and disrupt access and services
- Cause structural damage

Drought can:

- Increase the cost of water and the need to supplement your normal water supply
- Lead to water restrictions, which may affect landscaping and property values
- Cause structural damage (dryness can cause soil to shrink)

> Extreme weather costs Australians between $900M and $4B a year

Benefits of resilient homes

Our homes are often our most valuable asset.

It's never too early to start thinking about how to climate-proof your home. The existing residential building stock in our region was not designed to meet the climate we are expecting in the future.

While planning and design of new housing incorporates controls guiding development, there is no regulatory framework driving adaption of existing homes and properties.

Property purchasers and property owners need to inform themselves of potential climate risks and actions to improve resilience of a property to future climate events and conditions.

Increasing the resilience of your home can have numerous benefits, including:

Reduce damage to your home

You can reduce the potential for damage to your property as a result of future weather events.

Increase community resilience

More resilient buildings and properties ease the burden on emergency services like the Country Fire Authority and State Emergency Service during extreme weather events.

Reduce costs of utilities

Modifications such as glazing, shading, water capture and storage, and passive solar heating can reduce your usage of electricity and water. These efficiencies save you money over time.

Increase property value

Improvements to the resilience of a house, particularly in terms of major capital improvements, will retain their value and could increase the resale value of the property.

Increase comfort

Resilient homes will maintain higher levels of comfort during extreme conditions such as heatwaves. This is significant for vulnerable people (such as the elderly or very young, or those with medical conditions).

Reduce costs and inconvenience of damage

Costs of repairing damage can be significant compared with the cost of preventative measures. While insurance can provide some financial security, property damage can make homes uninhabitable if major repairs are required, or cause inconvenience if minor damage occurs.

Reduce insurance premiums

Certain modifications could minimise increases in your insurance premiums (or prevent against you losing your cover), particularly in the case of flood protection.

For property buyers, it is important to understand your risks, and seek out additional information.

Guiding questions could include:

- What are the likely climate impacts, now and in the future, and what are the consequences for your property?
- Are there win-win/no-regret options, which may offer other benefits such as improved efficiency or liveability?
- Is there flexibility in the design in terms of allowing for further modifications in the future? For example, will the design standards allow me to retrofit for more on-site water storage or to strengthen the structure in the future?
- Will this modification affect the resilience of the property to other climate impacts? For example, if installing insulation or planting trees to address the impacts of heat, can this be done in a way which does not increase the susceptibility of the property to fire?

Seek professional advice from a builder or architect before acting – some changes to a house may require approval from Council. Check Council's planning controls:

- Each property sits within a planning zone, and each zone has specific requirements for building and earth works. Check your local planning scheme online at http://planning-schemes.delwp.vic.gov.au/
- Planning scheme overlays cover many properties i.e., heritage, design and development, bushfire management, land subject to inundation and environmental overlays which may influence building material, design choices, location of building sites and native vegetation.

How can we reduce the risk?

The trend towards warmer, drier conditions, more intense storms and more extreme heat will impact our homes and buildings now and in the future.

There are many things we can do to help protect our homes and properties against potential damage caused by extreme weather and create more resilient buildings.

These actions depend on factors such as the location of the property, the type of building, the hazards it might face and the outcome you hope to achieve.

Extreme heat

Considerations

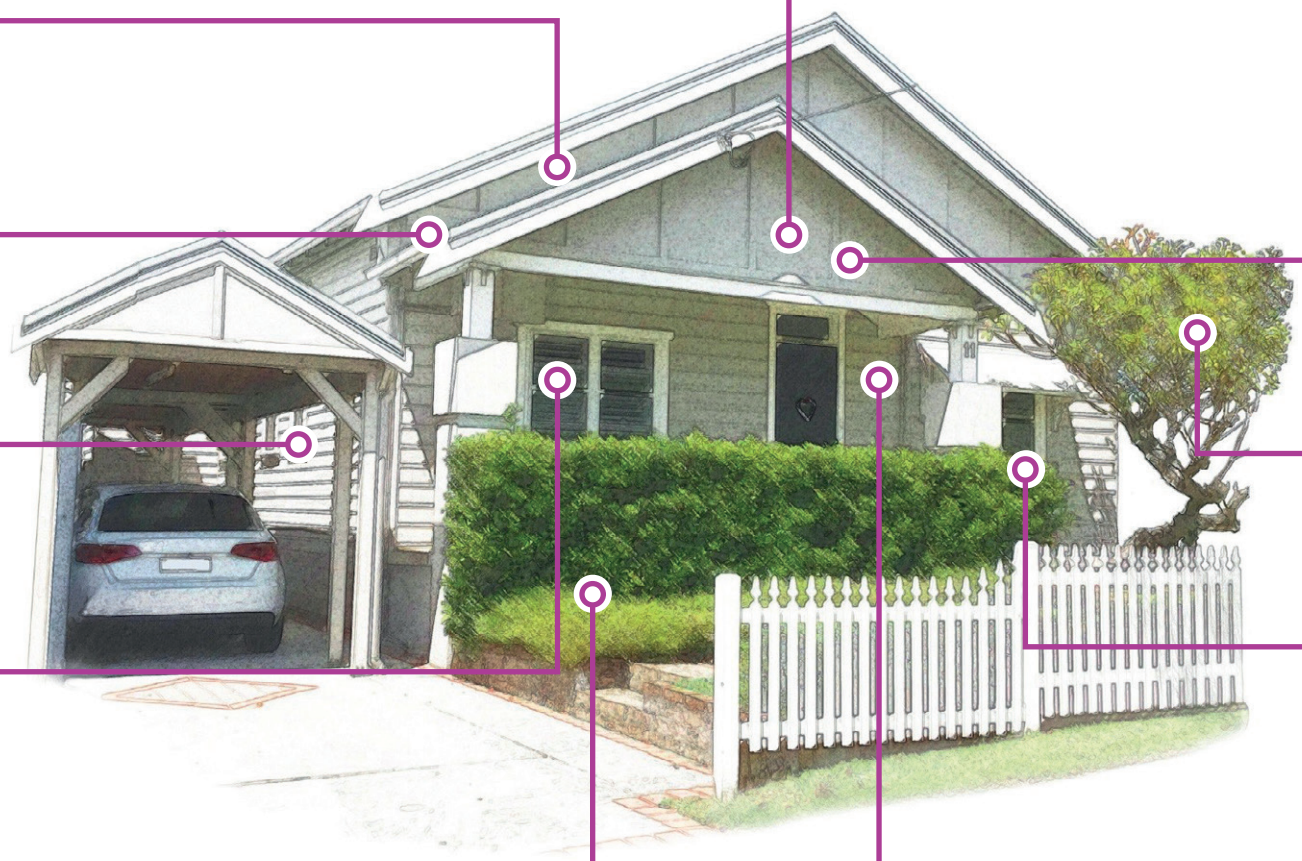
High-reflective or light-coloured roofing is best for summer comfort

Effective ventilation and cross-ventilation which use air pressure to remove heat

High levels of insulation in roof and walls

High performance glazing - aim for no more than a ratio of 12-15% glass to floor area (up to 17% if double glazed, higher if triple glazed.

Consider changes in soil moisture as temperatures rise. Foundations may need strengthening to avoid cracking



Mechanical ventilation in ceiling spaces can ensure air flow in summer and a complete seal in winter

Weather protecting sealants and paints protect against thermal movement of roofing, cladding and window systems

Install or grow external shade on the northern and western side

Plant woody trees and shrubs for shade

Consider the impact of materials with high thermal mass (such as concrete, bricks and tiles) . Thermal mass can be useful but too much can also work against you in winter.

Extreme heat

Floors

- Foundations may need strengthening to avoid movement, caused by charges in soil temperature
- Ground-coupled heat exchangers use the near constant underground temperature to cool air inside using underfloor ductwork

Interior

- Use ceiling and pedestal fans
- Use effective ventilation and cross-flow ventilation which use air pressure to remove heat from a space. Allow night-purging of hot air
- Design (or renovate) buildings with balanced levels of internal thermal mass to help regulate temperature
- An air-tight building with a heat exchange ventilation system keeps air fresh and energy costs low

Construction

- Where possible, orientate new facilities or additions appropriately in relation to solar aspect and to make best use of wind direction for passive cooling, as well as to provide shaded north and west facing windows
- Use correctly sized eaves to shade out summer sun (but let in winter warmth), especially on north facing windows

Windows

- Consider the solar window to floor area ratio: in temperate climates aim for 12-15% glass to floor area (17% if double glazed)
- Where possible, maximise opportunities for passive solar shading of northerly windows. Shade all east and west glass in summer. Consider adjustable shading to allow variable solar access in spring and autumn
- Use different glazing types for each façade; low U-value glazing is essential in all cases. Double glaze living areas and consider using it in bedrooms. For north-facing windows select high SHGC glazing and passive shading. For east and west façades select low SHGC coatings (e.g. low-e). South-facing glass should have low U-value and high visible light transmittance
- Thermally improved or insulated frames (timber or PVC) are important. Poor frames can affect window performance and cause condensation

Climate change will affect us all but there are things we can do to minimise our risks. By understanding the risks and making informed decisions we can help build resilience in our region.

Landscaping

- Consider planting woody trees and shrubs to provide shade and lessen urban heat island effects. Consider landscaping gardens and exteriors with species providing high shade cover. Care must be taken that species are appropriate for bushfire conditions and proper maintenance is conducted (i.e. if deciduous species prone to leaf litter build up are chosen) and species have low water requirements (compatibility for drought)
- Consider reducing water resistant surfaces which may have high thermal mass
- Use lighter-coloured or reflective paving to reduce heat absorption
- Consider planting drought-tolerant species and installing a centralised irrigation system for efficient water use

Roofing

- Install insulation: use bulk and reflective insulation in ceilings. The higher the R-rating the better
- Consider installing high-reflective or light-coloured roofing, but consider neighbours. Avoid dark colours that absorb heat
- Use weather protecting sealants and paints to protect against thermal movement of roofing, cladding and window systems as the temperature fluctuates
- A ‘draft stoppa’ is a cheap way of sealing a ceiling exhaust fan, and is easy to install
- Consider mechanical ventilation heat recovery in ceiling spaces to ensure high-level flows of cooler (south-side or ground source) air in summer and a complete seal in winter

External structures

- Exterior shading of windows (blinds, awnings etc.) is more effective than internal shading (blinds and heavy curtains) - but consider both
- Cover or shade parking areas to reduce heat absorption of asphalt
- Rainwater and greywater tanks provide water during droughts

Walls

- Install insulation: use bulk and reflective insulation in walls if possible
- Consider using weather protecting sealants and paints to protect against thermal movement of roofing, cladding and window systems as temperature fluctuates over time
- Consider the risks of pest management in the future as the climate changes. The range of termites may expand with warmer temperatures and this should be considered in construction. Use pest resistant materials such as steel frames

Flooding

Considerations

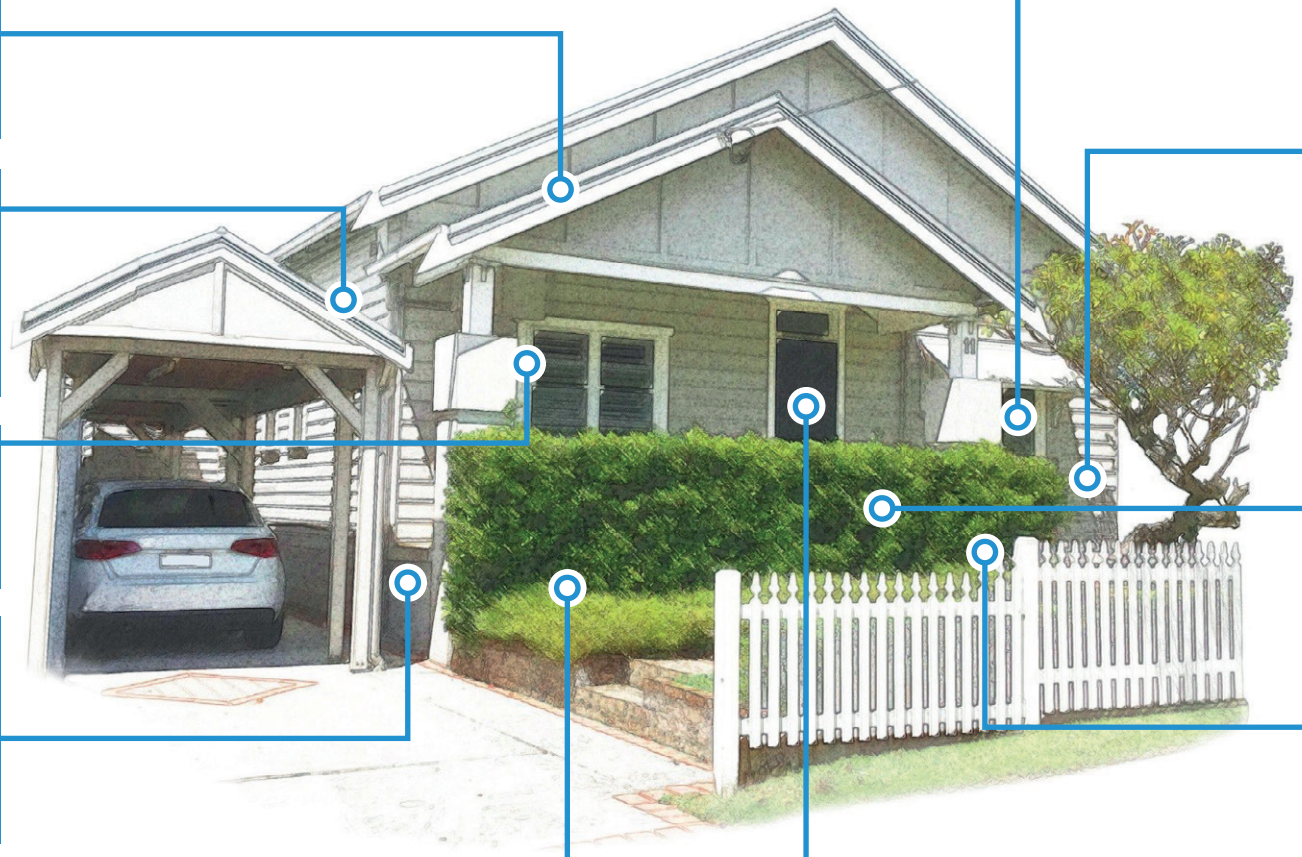
Use water resistant insulation material such as closed cell foam, rather than fibreglass, mineral wool, wool or cellulose foil

Elevate essential infrastructure such as electricity/powerpoints, cooling systems, fuel supply above flood level (using a licensed contractor)

Seal gaps around pipe and cable entries with water resistant product (such as silicone)

Fit drains, sinks and toilets with drainage bungs or non-return valves that seal to avoid sewerage contamination with rising floodwaters

A sump and pump system can remove flood water (from basements and voids under the floor)



Strengthened glass and frames can protect against water and collision from floating debris

Install snorkel vents or raise wall vents above flood level

Water-resistant floor materials include concrete, durable floorboards and clay tiles and waterproof wall materials include render, concrete blocks and membranes

A dry well, perimeter drainage or barriers can lead water away from the house. Designing buildings for flood forces must be carried out by hydraulic and structural engineers

Doors made with materials to withstand flood pressure and water intrusion

Flooding

Understand your risk

We recommend you check with your local council or Catchment Management Authority to find out if your property is in a flood risk area, and design to the highest flood level. Additional detailed information on how to prepare your home for flooding is provided by the SES at www.ses.vic.gov.au

Floors

- Consider installing waterproof membrane and a cavity drainage solution beneath the floor. Also requires a sump and pump
- Water saturated soils may build pressure and water may intrude through cracks and fissures. In the worst cases pressure that builds up may push the floor up or basement walls in if they have not been designed to resist the pressure
- Floors can be constructed of water resistant material (concrete, durable floorboards, clay tiles, rather than MDF, plywood or ceramic tile)

External doors

- Consider installing doors made from water resistant materials which are designed to withstand flood pressure and water intrusion. Inversely, doors may be installed that allow the flow of water which reduces pressure exerted on surrounding frames and walls. This may include an escape hatch built into the top half of the door
- Where practical, ensure doors have additional support such as barrel bolts or dead locks, as well as sturdy plates in the door jamb
- Consider installing waterproof seals on doors and windows, as well as sealing any gaps in frames with resistant products such as silicone

Construction

- Construct new buildings with floor levels above projected flood levels
- Where possible, ensure houses are not located on a floodplain
- Slab-on-ground construction prevents the building from being raised if needed, and has poor air flow after a flood
- Elevate essential infrastructure such as electricity/powerpoints, cooling systems, fuel supply above flood level (using a licensed contractor)
- Consider foundations that are resistant to soil erosion from water flow which can affect pilings, soil columns etc.

Windows

- Consider installing strengthened glass and frames to withstand water pressure/entry and collision from floating debris
- Seal around windows with water resistant product such as silicone where practical

External structures

- Permanent walls or auto barriers around a property can be constructed (which feature demountable/concealed/swing gates for access) to protect from water flow
- Engineered options should be discussed with hydraulic engineers and the Catchment Management Authority. Also consider your insurance and be aware that engineered solutions can fail (or create a false sense of security)
- Domestic flood alarms can be used for areas not served by official flood warnings
- Consider raising decking above water levels using strong and water resistant materials

Landscaping

- Consider installing a dry well (hole filled with gravel or stones) to lead rainwater away from the house and collect it before leaking into the soil
- Consider installing perimeter drainage to prevent dampness in basements and cellars
- Consider filling in land to maintain ground level above nearby lakes, streams and groundwater
- Where possible, avoid large cuts into unstable soils, or removal of vegetation that holds soil layers together
- Consider providing adequate drainage and soil cover near potentially unstable sites
- Consider reducing water resistant surfaces which do not allow rain water to infiltrate groundwater. This will reduce the burden on stormwater systems

Roofing

- Consider gutter-to-roof area ratio, in particular for internal gutters that may accumulate a heavy water load
- Keep gutters clean and install leaf guards or other protection where practical. Overflowing gutters are a common reason for water entering homes during storms and high rainfall events, causing extensive damage to roof and ceiling areas, walls and floors, and destroying precious items
- Consider enhancing access to roofs for maintenance and inspection
- Consider steeper slope roofing to faster remove water during heavy rainfall
- Consider using water resistant insulation material such as closed cell foam, instead of fibreglass, mineral wool, wool or cellulose foil

Flooding

Plumbing

- Consider installing toilet bungs, anti-backflow valves for sewer pipes and non-return valves for appliance waste pipes
- Consider installing a sump and pump system which removes flood water, particularly from basements and spaces underneath the floor. Ensure backup power is available in case of power failure

Walls

- Consider applying water resistant products to walls, such as render or waterproof tanking membranes to external walls
- Consider installing waterproof membrane and cavity drainage solution within wall cavities. Also requires a sump and pump system
- Consider installing snorkel vents or raising wall vent height above flood level
- Consider installing airbricks which feature membranes that allow ventilation of air, but not intrusion of water or debris
- Where possible, seal cracks and service inlets (such as washing machine or telephone lines) with water-resistant products
- Think about whether neighbouring buildings have flood resistance measures where shared walls are in place or water may seep through
- Consider installing pressure neutral rain screens to avoid water intrusion into walls
- Consider using water resistant insulation material such as closed cell foam, instead of fibreglass, mineral wool, wool or cellulose foil
- Consider using water resistant wall material/cladding such as fibre cement, concrete block, treated timber or PVC brick, instead of particleboard or plywood

Storms - wind, hail and lightning

Considerations

Use hail resistant roof materials and replace roofing nails with screws. Regularly check your roof for loose tiles or iron sheets

Flat roofs are more susceptible to uplift forces than pitched (sloping) roofs

Where practical, get a builder to check the structural integrity of your house

Windows should be able to withstand wind pressure from both positive pressure and suction

Windbreaks/planting dense vegetation around the building reduces wind pressure

Use an accredited arborist to remove dead or overhanging tree branches that could fall on your house if struck by lightning or strong winds

Roof tie-downs to foundation (rather than to walls) counteracts upward lifting from winds

Consider installing debris screens or shutters on windows

Use plywood, plasterboard, steel straps or timber to reinforce walls

A whole-of house surge-protection system prevents electrical damage

Storms - wind, hail and lightning

Arrange for a professional builder to check your building and identify ways you can increase the structural security of your home to withstand high winds. Ensure your home, contents and car insurance is current and adequate. Check the details of what your policy covers.

For information on how to respond and prepare for a storm visit www.ses.vic.gov.au/get-ready/stormsafe

Floors

- Consider installing waterproof membrane and a cavity drainage solution beneath the floor. Also requires a sump and pump system
- Water saturated soils may build pressure and water may intrude through cracks and fissures. In the worst cases, pressure that builds up may push the floor up or basement walls in if they have not been designed to resist the pressure
- Floors can be constructed of water resistant material (concrete, durable floorboards, clay tiles, rather than MDF, plywood or ceramic tile)

External structures

- House attachments (carports, porch roofs) can become damaged during storms and lead to damage to the main structure. Where possible, ensure these attachments are built to the same standards as the main building

External doors

- Ensure garage doors lock correctly and can withstand wind speed. New doors may have wind locks or other braces to resist wind loads. These loads transfer additional stress to ends of roller doors so walls must also be strengthened
- Where practical, doors should have have additional support such as barrel bolts or dead locks as well as sturdier plates in door jamb

Windows

- Windows should be able to withstand wind pressure from both positive pressure and suction. Ensure glass panels are correctly sized and frames are securely fixed to the house structure
- Consider installing debris screens or shutters on windows

Landscaping

- Consider constructing windbreaks/ planting dense vegetation around the building to reduce wind force
- Using an accredited arborist, remove dead or overhanging tree branches that could fall on your house if the tree is struck by lightning or affected by strong winds

Construction

- Flat roofs are more susceptible to uplift forces than pitched (sloping) roofs

Roofing

- Where practical, get a builder to check the structural integrity of your house. Uplifting forces must be accounted for in regions subject to high wind. Improved interior tie-downs and fasteners may be required to hold the roof onto the building. Ensure all fasteners are in good condition and free of rust
- Consider reinforcing your home with hail resistant roofing materials
- Regularly check your roof area for loose tiles or iron sheets. Consider replacing roofing nails with screws
- Consider anchoring roof battens to the rest of the structure well enough to carry all forces from the cladding. If the building was built prior to 1980s, this is a common weakness
- Consider installing roof tie-downs to foundation level rather than to walls as the stress from upward lifting winds may be too great for wall frames
- Learn what type of roof is appropriate for homes in your area in terms of hail and wind-resistance. No roofing material is fully storm-proof

Interior

- Consider a suppression or surge-protection system for your entire house

Walls

- Consider using plywood, plasterboard, steel straps or timber members to reinforce walls from roof level to floor
- Wall cladding should be strong enough to resist wind forces and debris impact

Bushfire

Considerations

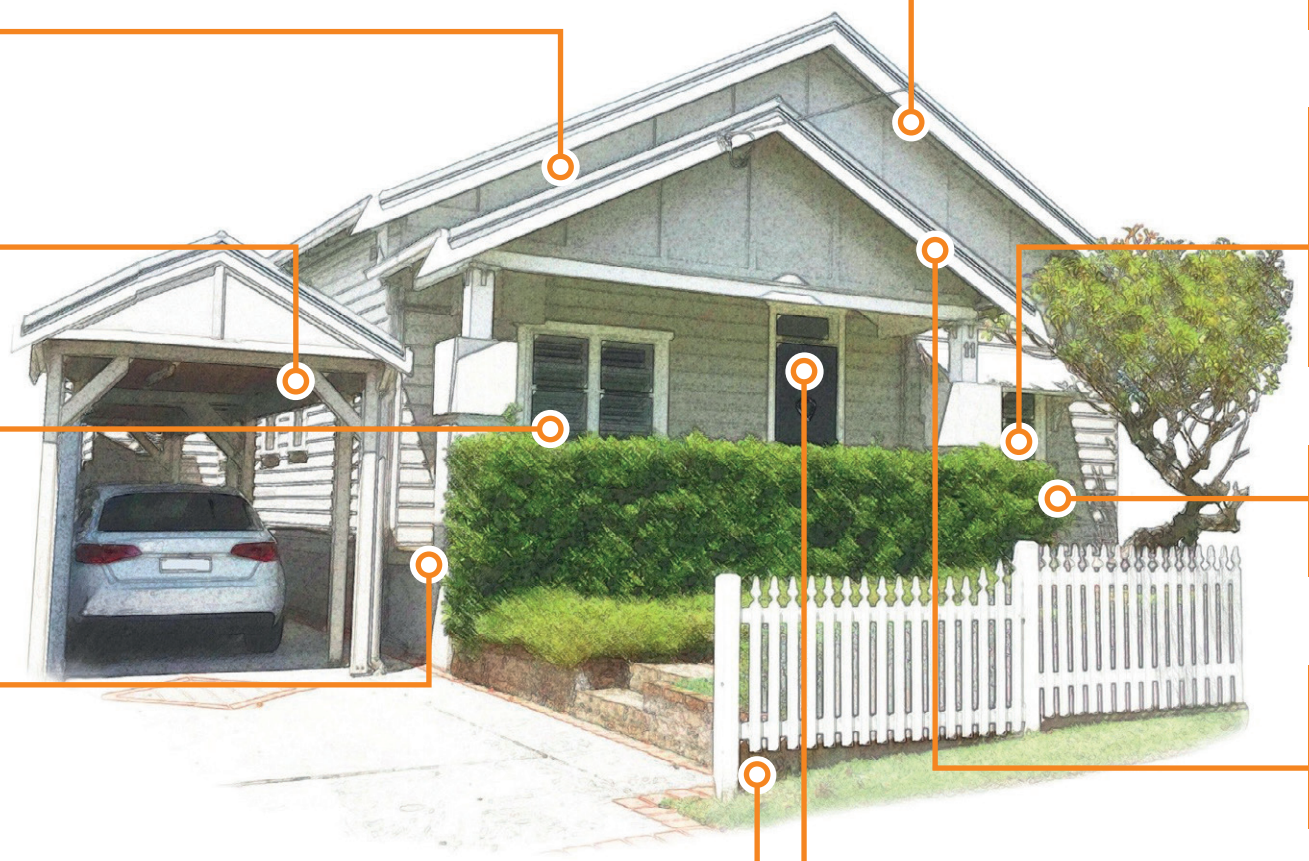
Keep gutters clean and ensure they are made from fire-resistant materials

Seal gaps with sarking, weather strips or guards made of non-combustible materials to prevent ember attack

If a new build, construct frames and joinery from bushfire-resistant timber, metal or reinforced PVC-U

Unenclosed subfloors should have posts and columns constructed of non-combustible or bushfire-resistant material

Keep grass short and remove dead plants and branches from trees within 10m of house, and ensure there is no fuel under the decking



Consider sprinkler systems and sealing and insulating roof with fire-resistant materials

The CFA recommends wire mesh screens (not aluminium) with 1.5mm holes are installed over windows and frames to prevent embers and reflect radiant heat

Consider applying product to timber to increase its resistance to fire

Clad timber or steel-framed walls with fibre cement, steel sheet or bushfire-resistant timber

Consider protecting doors with external screens or bushfire shutters

Bushfire

Understand your risk

Bushfire residential building standards apply to sites within a designated Bushfire Prone Area. There may also be statutory planning controls such as a Bushfire Management Overlay in higher risk areas. Check with your local council and the CFA before building or renovating in a bushfire prone area.

Floors

- Where practical, construct enclosed subfloors with non-combustible material (masonry, brick veneer, mud brick etc)
- Unenclosed subfloors should have posts, columns, stumps and poles constructed of non-combustible material or bushfire resisting timber

Eaves, gutters and downpipes

- Check that no leaves or debris have built up
- The most fire-resistant gutters are constructed from metal or PVC-U and feature valley leaf guards
- Eave linings made of fibre cement (>4.5mm thick) or fire resistant timber can increase fire resistance
- All above ground piping (water and gas etc.) should be constructed of metal where practical
- Consider removing gutters in high risk situations to reduce risk of embers collecting

External doors

- Doors should be constructed from either non-combustible materials, solid timber (>35mm thick), or a hollow core with non-combustible kick plate for the first 400mm above threshold
- Consider protecting doors with external screens or bushfire shutter – screen mesh should have a maximum hole size of 2mm and be made from corrosion resistant steel, bronze or aluminium. Gaps around edges should be no wider than 3mm and the frame should be a non-combustible material
- Consider applying product to timber to increase its resistance to fire
- Consider installing weather strips, draught excluders and seals at the base of doors
- Garage doors less than 400mm above ground level should be made from non-combustible materials such as fibre-cement cladding (>6mm thick) or bushfire-resistant timber. Suitable weather strips should be placed around edges with no gaps wider than 3mm, and guide tracks should be fitted with a nylon brush in contact with the door. Doors should not include ventilation slots

External structures (decking, stairs, etc.)

- Consider construction or covering external structures with non-combustible materials (masonry, brick veneer, concrete)
- Where glazed elements such as windows and doors are less than 400mm vertically, or 300mm horizontally from decking or stairs, the surface should be made of non-combustible materials where practical
- Consider separating external structures within six metres of the house with a 60/60/60 fire-resistant wall
- Consider applying product to timber to increase its resistance to fire
- If subfloor spaces are considered 'enclosed', consider protection of openings with <3mm mesh sheet
- Consider installing a private bushfire shelter

Windows

- Consider covering windows with bushfire shutters or screens made from non-combustible materials. Screen mesh should have a maximum hole size of 2mm and be made from corrosion resistant steel, bronze or aluminium. Gaps around edges should be no wider than 3mm and the frame should be a non-combustible material
- Consider constructing frames and joinery from bushfire resisting timber, metal, metal-reinforced PVC-U and with metal external hardware
- Consider applying product to timber to increase its resistance to fire
- Consider replacing glass with toughened glazing (>5mm thick) or laminated safety glass, and replace overhead glazing with 'Grade A' safety glass

Roofing

- Tiles, sheets and covering accessories should be non-combustible where practical
- Seal roof and wall gaps >3mm
- Roof lights, ventilators, mounted cooling units, aerials and solar connections should be sealed with no gaps >3mm and ember guards fitted. Cooling units can be fitted with non-combustible covers of 2mm.
- Consider insulating roof with compressed mineral wool insulation
- Enhancing access to roofs can allow firefighting equipment access
- Consider installing a sprinkler system to extinguish embers that land on the roof or other structures of the building. Ensure the system will run in event of mains power failure and that there is adequate water supply. Consider impact of wind on delivery of water on the structure

Bushfire

Landscaping

- Remove dead plants, weeds and dead branches from trees near the house
- Keep grass short within 10m of the house
- Remove vegetation from around decks or create separation between them where possible. Remove or prune plants growing on or around house
- Cover exposed woodpiles with fire resistant material or move away from the house

Walls

- Replace or cover external walls with non-combustible materials such as masonry, brick veneer, concrete etc.
- Consider sealing vents and holes with 2mm metal mesh
- Timber or steel-framed walls should be clad with fibre cement (6mm minimum thickness), steel sheet or bushfire resisting timber
- Seal all small gaps around the house with appropriate joining strips or silicone-based sealant
- Consider installing non-combustible sarking behind weatherboards, external cladding and roofs
- Consider applying product to timber to increase its resistance to fire

Useful resources

For further information about the possible impact of climate on your property:

Your Home

An Federal Government guide to environmentally sustainable homes. This publication is by the Federal Government, in partnership with the building and design industry and aims to provide expert independent advice.

www.yourhome.gov.au

Climate Ready

Learn how climate change is likely to affect you, your property or your business, then create your own Climate Ready action plan. Prepared specifically for residents, holiday home owners and businesses of Bayside City Council, Kingston City Council and Mornington Peninsula Shire to prepare themselves for the risks that climate change brings - flood, fire, drought and heatwave. It also contains general advice relevant for all home owners and businesses.

www.climateready.com.au

Climate change adaptation for building designers

Adapting building designs for climate change is about managing the unavoidable. While there is debate around what level of adaptation is needed, there is growing awareness that design practices need to take into account predictions of increased risk and intensity of extreme events. This paper examines potential climate change effects on buildings, highlights the potential for capacity building through education, and presents examples of adaptive strategies for building design.

www.environmentdesignguide.com.au/media/misc notes/EDG_66_MSa.pdf

Climate Change in Australia

Find out more about climate change science and the impacts of climate change across Australia (Federal Government/CSIRO).

www.climatechangeinaustralia.gov.au/en/climate-projections/climate-futures-tool/projections/

FEMA Protect Your Property

The US Department of Homeland Security landing page providing information on how to protect your home or business from floods, earthquakes, high winds, and manmade disasters. Read how others have protected themselves and how you can protect your home or business. Particularly relevant is the information on flood and storm retrofitting: Protecting Your Home and Property from Flood Damage, Mitigation Ideas for Reducing Flood Loss and Homeowner's Guide to Retrofitting 3rd Edition (2014).

www.fema.gov/protect-your-property

Climate change and Victoria

Find out more about climate change in Victoria. In order to help communities understand and prepare for climate change impacts, the Department of Environment, Land, Water and Planning has developed specific regional information sheets. The information sheets explain in detail what the likely effects of climate change will be, what communities need to do to ensure they adapt to a changing climate and what opportunities a new climate may bring.

www.climatechange.vic.gov.au

Country Fire Authority (CFA)

The Country Fire Authority recognises Victoria is one of the most fire-prone areas in the world. Understanding your level of risk is the first step in knowing how to prepare your house for a bushfire. Their website contains many resources dedicated to bushfire preparation for new or existing homes. A specific resource is 'How to prepare your house for bushfire - home improvements.'

www.cfa.vic.gov.au/plan-prepare/home-improvements/

Victorian Building Authority (VBA)

The Victoria Building Authority can provide you with expert advice and essential information whether you're building or renovating. The VBA has guides to retrofit your home for a better protection from a bushfire, and contains many references for considering bushfire standards.

www.vba.vic.gov.au/__data/assets/pdf_file/0003/21459/A-guide-to-Retrofit-Your-Home-for-Better-Protection-from-a-Bushfires.pdf

Glossary

Active solar heating: A system that uses roof mounted, solar exposed panels to collect heat and pump it to where it is needed

Accessible house: Designed to meet the needs of people requiring higher levels of access. Requirements set out in AS 1428.1-2001

Adaptable house: A liveable house that is also able to be easily adapted to become an accessible house should the need arise. Requirements set out in AS 4299-1995, Adaptable housing

Adaptation: Anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, or taking advantage of opportunities that may arise

Bushfire Attack Level (BAL): A rating given to a site that measures the risk of exposure to ember attack, radiant heat and direct flame

Bushfire Management Overlay (BMO): Applies to land that may be significantly affected by bushfire

Bushfire Prone Area: Areas that are subject to or likely to be subject to bushfires

Cladding: The non-loadbearing skin or layer attached to the outside of a home to shed water and protect the building from the effects of weather

Drainage bung: A device that can be put into a toilet or drain that stops backfilling during a flood

Egress: An exit route or way to leave the property and vacate the area

Fluvial: Related to rivers and streams and the deposits and landforms created by them

Greenhouse gases: Gases that trap heat in the atmosphere, leading to the greenhouse effect or global warming. The primary greenhouse gases in earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone

Greywater: Wastewater from non-toilet plumbing fixtures such as showers, basins and taps

Heatwave: According to the Bureau of Meteorology, a heatwave is three days or more of high maximum and minimum temperatures that is unusual for that location

Impact: Impact is an effect of climate change on the socio-bio-physical system (e.g. flooding, transmission line sagging, pole fires)

Impervious: Not allowing fluid to pass through

Indigenous/native plants: Flora that occurs naturally in an area

Lagging: Thermal insulation for wrapping around pipes, boilers

Liveable house: A house designed to meet the changing needs of most home occupants throughout their lifetime without the need for specialisation.

See also 'accessible house', 'adaptable house'

Orientation: Positioning of a building in relation to seasonal variation in the sun's path and to prevailing wind patterns

Passive cooling: Technologies or design features used to cool buildings without power consumption

Passive design: Design that takes advantage of the climate to maintain a comfortable temperature range in the home

Passive heating: A system of features incorporated into a building's design to use and maximise the effects of the sun's natural heating capability

Photovoltaics: A method of generating electrical power by converting solar radiation into direct current electricity

Renewable energy: Energy that is derived from sources that are renewed by natural processes or for all practical purposes cannot be depleted, e.g. solar energy, hydropower, wind, tide, geothermal and biomass

Residential buildings: Class 1, 2 and 4 buildings as defined in the Building Code of Australia

Resilience (climate): The Intergovernmental Panel on Climate Change (IPCC) defines climate resilience as, "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change." In a more general sense, resilience is the ability to manage and be prepared for effects, and to minimise their impact

SHGC (Solar Heat Gain Coefficient): A measure of how much solar radiation passes through the window and the corresponding ability of the system to reduce solar heat gain

Solar aspect: Orientation of the house in relation to the sun

Thermal mass: Dense material able to absorb and store warmth and cool: the 'battery system' of passive design

Thermal performance: The effectiveness of a building envelope in maintaining acceptable levels of human comfort in the building relative to the outside weather conditions, through minimising the need for artificial heating or cooling. In relation to a particular building material or element, the extent to which the material or element reduces or promotes heat loss or heat gain

Vulnerability: Climate vulnerability is the extent to which a system is susceptible to, or unable to cope with, adverse effects of climate change including climate variability. It is influenced by its adaptive capacity

Background

Climate data

Climate data provided in the information package is predominately sourced from the Climate-Ready Loddon Mallee sheet available from the Victorian Government's Climate Change and Victoria website. The CSIRO website 'Climate Change in Australia' was also used (to provide information on projected time in drought in the future).

Property resilience information

Property resilience information was compiled by Ramboll Environ from over sixty leading national and international publications, including:

- Information produced by government and non-governmental organisations
- Guides prepared by statutory authorities (such as the Victorian Building Authority, Country Fire Authority, Melbourne Water etc.)
- Reports and guides prepared by various insurance industry representatives (such as Insurance Council of Australia)
- Reports and guides prepared by research institutions

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