Resilience in Action

A guide for safer, insurable homes

Australian Government
National Emergency Management

Resilient
Building
Council

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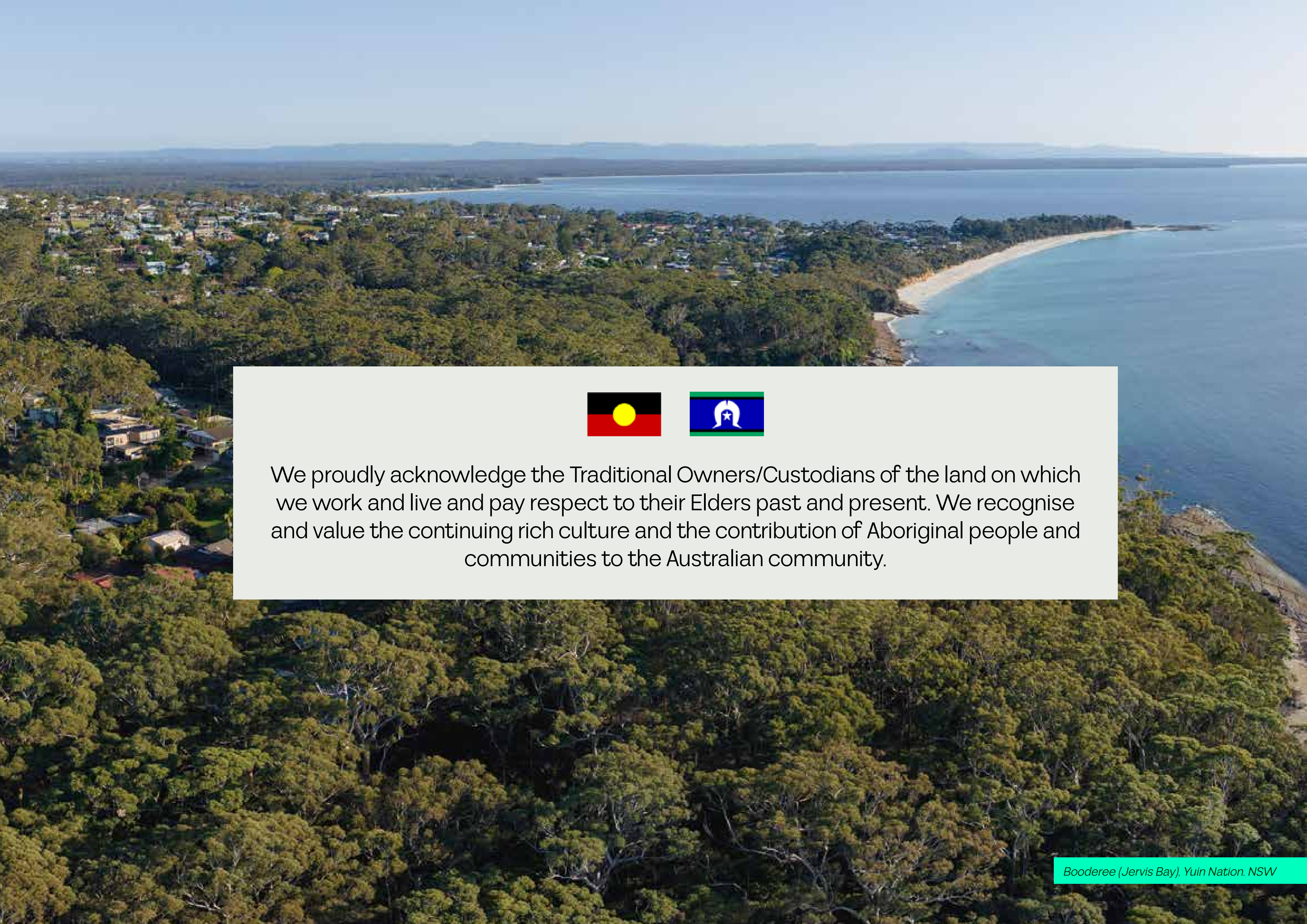


We proudly acknowledge the Traditional Owners/Custodians of the land on which we work and live and pay respect to their Elders past and present. We recognise and value the continuing rich culture and the contribution of Aboriginal people and communities to the Australian community.

Booderee (Jervis Bay), Yuin Nation. NSW

Table of contents

FOREWORD - RESILIENCE IN ACTION

Australia's disaster risk is increasing. Floods, bushfires, storms and heatwaves are becoming more frequent and severe - and many homes were not designed to withstand them. As a result, households are facing rising repair costs, longer recovery times, and growing pressure on insurance access and affordability.

The problem is accelerating. In a single year, the number of households unable to afford home insurance rose 30% - from 1.24 million to 1.61 million (Actuaries Institute, 2024). That's over $1 trillion in property value at risk.

The impact of the Black Summer bushfires and the 2022 eastern Australia floods have shown the impacts of widespread home loss and long recovery times. Future estimates put property value losses at A$611 billion by 2050 unless homes are adapted to these conditions.

But there is a clear path forward.

I established the Resilient Building Council to help households answer a simple but critical question: what can I do to make my home more resilient?

Every home is different - its location, construction, environmental risk and vulnerabilities all influence which resilience actions will be the most effective for your home. While this guide gives you a strong foundation, the most effective pathway to resilience comes from understanding your own home.

That is where Resilience Ratings home assessments play a critical role. They provide a tailored assessment of how your home performs under different hazards, along with a prioritised, customised action plan. This allows you to focus on the upgrades that will have the greatest impact - strengthening your home and improving its insurability.

Developed with government and industry over more than a decade, the Resilience Ratings system helps translate resilience into practical, measurable action. The insurance industry is now beginning to recognise Resilience Ratings in the pricing and availability of insurance, consistent with the Hazards Insurance Partnership guiding principles for resilience investment.

The Resilience in Action guide and video series explains why homes fail during disasters, what measures can make the biggest difference, and how households across Australia are already taking practical steps to strengthen resilience in both new and existing homes.

By taking practical action - whether through new design decisions, maintenance or upgrades to your existing home - you can protect what matters most, and improve your ability to remain insured and financially secure in a changing climate.

Kate Cotter

Kate Cotter
Founder & CEO
RESILIENT BUILDING COUNCIL

PART ONE

Getting started

Making your home stronger, safer and more insurable

This guide is designed to help you understand how homes are damaged during floods, bushfires, severe storms, cyclones and heatwaves - and what practical steps can reduce that damage.

Homes do not fail randomly. They fail through known weak points: roofs, windows, doors, walls, foundations, services, surrounding vegetation, drainage, materials and maintenance. Once you understand these weak points, it becomes easier to see which upgrades matter, why they work, and how they can be planned over time.

The guide is useful whether you are building a new home, renovating, retrofitting an existing home, or simply trying to understand what resilience could mean for your property. It can also help you make sense of a Resilience Ratings report by explaining the principles behind the recommendations.

For new homes, the guide highlights design choices that are easiest to make early - such as siting, orientation, structure, materials, openings, landscaping and services.

For existing homes, it focuses on practical improvements that can be staged over time - from maintenance and small upgrades through to larger retrofit or renovation works.

Across the guide, you will see common high-impact strategies, real household examples, and links to videos that show resilience in action.

The aim is to help you understand your options, ask better questions, and take practical steps toward a stronger, safer and more resilient home.

Designing for resilience

Beyond minimum code requirements

Most building codes set minimum standards based on historical hazard data. For example, they may be based on a 1% AEP flood, which means a flood with a 1-in-100 chance of occurring in any given year, or on wind classifications drawn from historical records. These benchmarks do not fully reflect how risks are changing with extreme weather events becoming more frequent and more severe.

Building codes focus on protecting life and preventing structural collapse - not on whether the home itself survives, remains functional or recoverable after a disaster. A code-compliant home can still be lost after a flood, storm or bushfire. It may be uninhabitable, uninsurable and costly to restore.

New builds and retrofits

For new builds, resilience means making good decisions early.

This includes briefing your architect, building designer, builder and engineer to:

- Design for flood levels, wind speeds and fire and heat conditions above minimum requirements where feasible
- Consider how hazards may combine or follow one another, such as storm then flood, bushfire then storm, or heatwave during a power outage
- Make resilience decisions early, when they are usually cheaper and easier to include
- Design the whole home as a connected system, not as separate parts

For existing or legacy homes, resilience usually means improving the home over time.

For retrofits, this means:

- Prioritising upgrades to the most vulnerable parts of the home
- Choosing solutions that perform under severe conditions, not just average ones
- Making staged improvements over time
- Using maintenance, repairs and renovations as opportunities to improve resilience
- Focusing first on actions that reduce risk, strengthen the home, or support faster recovery

Passive protection

Active systems such as generators, pumps, sprinklers and temporary flood barriers can fail due to power outages, blocked access, or there's no one home to operate them during extreme weather events.

Passive protection is when measures work without needing power, manual operation or someone being home during a disaster. These are the most reliable form of protecting your home.

For this reason, the strategies in this guide focus on passive, durable measures built into the home or its surroundings.

Emergency planning, safety and recovery

A resilient home reduces damage and supports faster recovery but is just one aspect of disaster resilience. This guide doesn't cover emergency planning, warnings, evacuation, safe shutdown of services, or cleanup and recovery.

Always follow the safety and evacuation instructions of your local emergency services.

About RBC

The Resilient Building Council (RBC) is an independent, not-for-profit organisation that translates research into practical approaches for building safer, more insurable homes.

RBC's Resilience Ratings program provides assessments and customised action plans for individual homes.

A glossary, references and additional resources to support further learning and action can be found on the Resilience Revolution website rbcouncil.org

PART 2

Why multi-hazard resilience matters

Why Multi-Hazard Resilience Matters

Preparing for one hazard typically strengthens the home against others. Well-chosen upgrades can improve resistance to bushfire, storm, flood and heat while also improving day-to-day living.

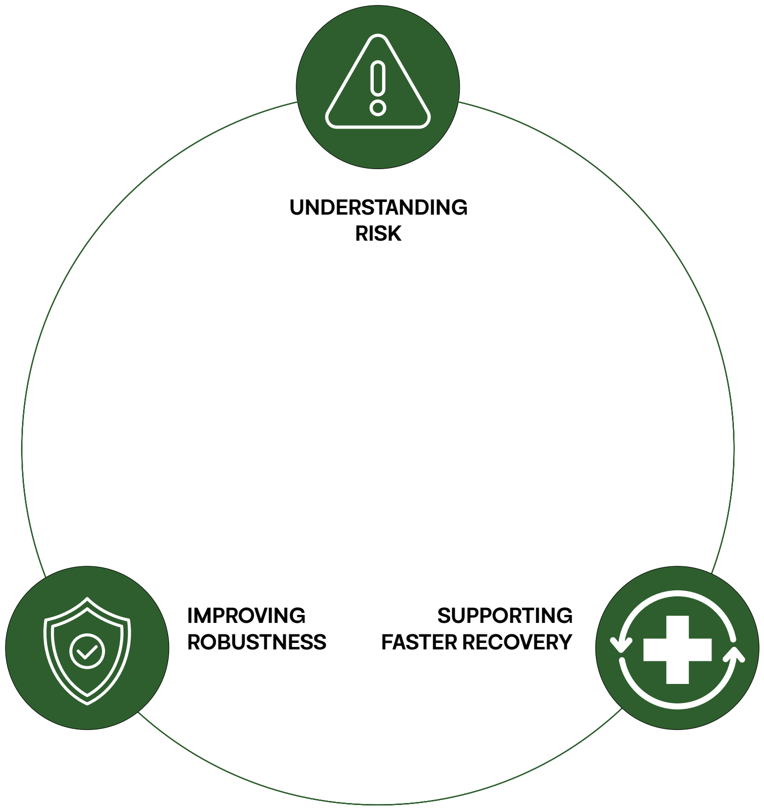
These upgrades can:

- ✓ Improve durability and lifespan of building materials
- ✓ Increase energy efficiency and thermal comfort
- ✓ Reduce moisture, mould and pest problems
- ✓ Lower long-term maintenance costs
- ✓ Provide protection from multiple hazards at once

This guide focuses on actions that protect against several hazards simultaneously, helping households make smarter and more cost-effective upgrades.

Emergency services advice for most disasters is to leave early. By following the strategies in this guide, you give your home the best chance of protecting itself while you are away — and of still being there when you return.

These strategies are structured around three principles:



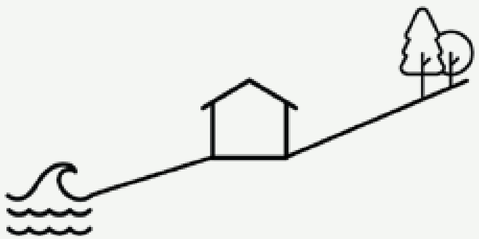
> It costs the environment so much - it costs everyone time, money, energy and to build houses and spaces that aren't going to last a long time, that aren't resilient to the environment that we have here.
>
> *Graham Tippins - Director, Reddog Architects*

This flood-resilient Queensland home during and immediately after the 2022 Brisbane floods, demonstrates how resilient design can support faster recovery.

1. RISK

Risk is about exposure. It considers how hazards interact with the home, its site and its surroundings. Reducing the chance that hazards will severely impact the home. The safest home is not just well built — it is well positioned and well maintained. Reducing exposure is often the most effective and lowest-cost resilience measure.

A resilient home reduces the number of ways hazards can reach or affect it.



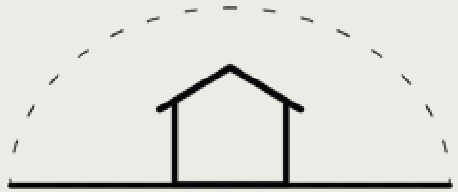
Reduce exposure - site the home well

Choose lower-exposure locations
Avoid areas prone to flooding, high winds, heat or fire

Avoid hazard-amplifying landforms
Stay clear of low points, drainage lines, steep slopes and exposed ridgelines where water, wind or fire can be intensified

Maintain separation from key hazards
Keep distance from vegetation, unstable ground and likely paths of fire, water or debris

Orient the home to reduce exposure
Limit vulnerable openings and exposed surfaces on the side most likely to be affected by extreme winds, approaching floodwaters, and bushfire attack



Reduce hazard build up - manage the surroundings

Keep fuels and debris away
Reduce materials that can ignite, move or accumulate near the home

Maintain clear space around the building
Keep a low-fuel, well-managed zone (typically 3–10 m or more) so fire, debris and water are less likely to build up at the home

Position elements to maintain flow
Avoid blocking drainage, trapping debris or restricting airflow so water, wind and debris don't build up at the home

Get through the hazard - maintain access and function

Keep access routes usable
Ensure entry and exit remain available during hazards

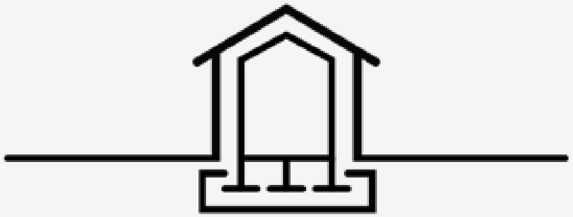
Avoid single points of failure
Provide multiple entry and exit points

Plan for continued use
When power, water or access is disrupted, ensuring the home will still function.

2. ROBUSTNESS

Robustness is about how well the home holds together and keeps hazards out. It relies on a strong structure and a well-performing external shell, working together to manage forces and protect occupants.

A robust home works as one connected system—forces are carried safely down into the ground without weak links, so damage is less likely to spread if one part is stressed.



Strong structure

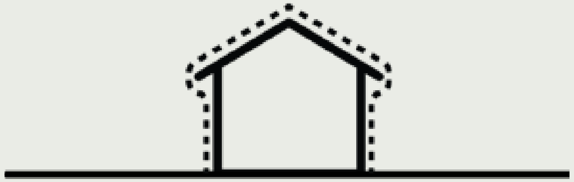
The structure is the bones of the home—holding everything in place when wind, water and impacts push against it. A strong structure consists of solid foundations and framing that transfer these forces safely down into the ground, so the building stays stable. If those “bones” are weakened or fail, the home can become unsafe to occupy and recovery is often slow, complex and costly.

Direct forces safely down
from roof to ground without breaks

Lock everything together
strong, well-fixed connections matter most

Expect multiple hazards
don’t design for just one condition

Protect what you can’t see
hidden damage can weaken the whole system



External shell

The external shell is the armour of the home—its first line of defence against wind, water, heat and debris. A well-designed shell keeps hazards out while allowing the building to breathe and dry when needed. Every part of your building that faces the elements is part of the external shell. It includes:

- Windows, doors and glazed openings
- Wall cladding and the sarking/membrane behind it
- Vents, weepholes, eaves and service penetrations
- Screens, shutters and protective systems
- Roofing, ridges, flashings, gutters, and roof penetrations

External shell

Like armour, it only works if it is continuous. Small gaps, weak points or damaged areas can act as “chinks,” allowing embers, wind-driven rain or debris to get inside and cause hidden damage. If the shell is breached, problems can spread quickly through the building.

Keep the shell continuous
Close gaps and weak points where hazards can enter

Protect and strengthen openings
Windows, doors, vents and junctions are the most vulnerable

Secure materials and fixings
Prevent cladding, roofing and attachments from failing under load

Use layered protection
Combine outer cladding with secondary barriers behind it

Simplify the form
Fewer corners, junctions and penetrations mean fewer failure points

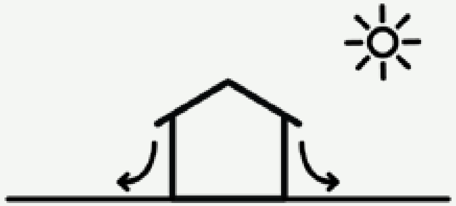
Allow for drainage and drying
Let water escape and the building dry after wetting

Maintain over time
Small defects can quickly become major entry points

3. RECOVERY

Design your home so you can get back to living in it as quickly as possible after a disaster. Recovery is about what happens after the event.

Even strong homes may experience damage, but resilient homes are designed so that damage is manageable and repairable, returning to safe use quickly and affordably.



Make clean up and drying easier

Let water drain and the home dry out
Design walls, floors and hidden spaces so water can drain away and air can move through — avoiding spots where water, silt or debris can get trapped and hold moisture

Use resilient, low-absorbency materials
Resist swelling, rot and mould, and support cleaning after exposure

Keep wall build-ups simple
Use simpler wall layers where possible, and avoid complex build-ups that can trap moisture between materials or slow down drying after wetting

Make repairs easier

Make damage easy to find and fix
Use accessible, replaceable materials so damaged parts can be removed, cleaned or repaired without major demolition

Maintain safe and functional living conditions

Use cleanable, non-toxic finishes
Select materials that can be washed down and won't trap contaminants or release pollutants

Protect, locate and access critical services
Position electrical, water and mechanical systems above likely flood levels, shield them from debris and heat, and avoid placing them in the most exposed locations

Provide backup services where possible
Support continued use with secondary power, water or cooling and avoid single points of failure

> We came close to losing our home in the Black Summer bushfires and it took many of our friends five years to rebuild. We were determined never to go through that, and for our home not to end up in landfill. We used the Resilience Ratings report to make sure we were the most resilient we could be and invested $17,000, we've got our 3-star rating and have accessed our insurance premium reduction. **You can't put a price on our peace of mind**. We are feeling hopeful about the future and proud of our strong, sustainable home.
>
> *Val, Shoalhaven*

PART THREE

Value of a resilient home

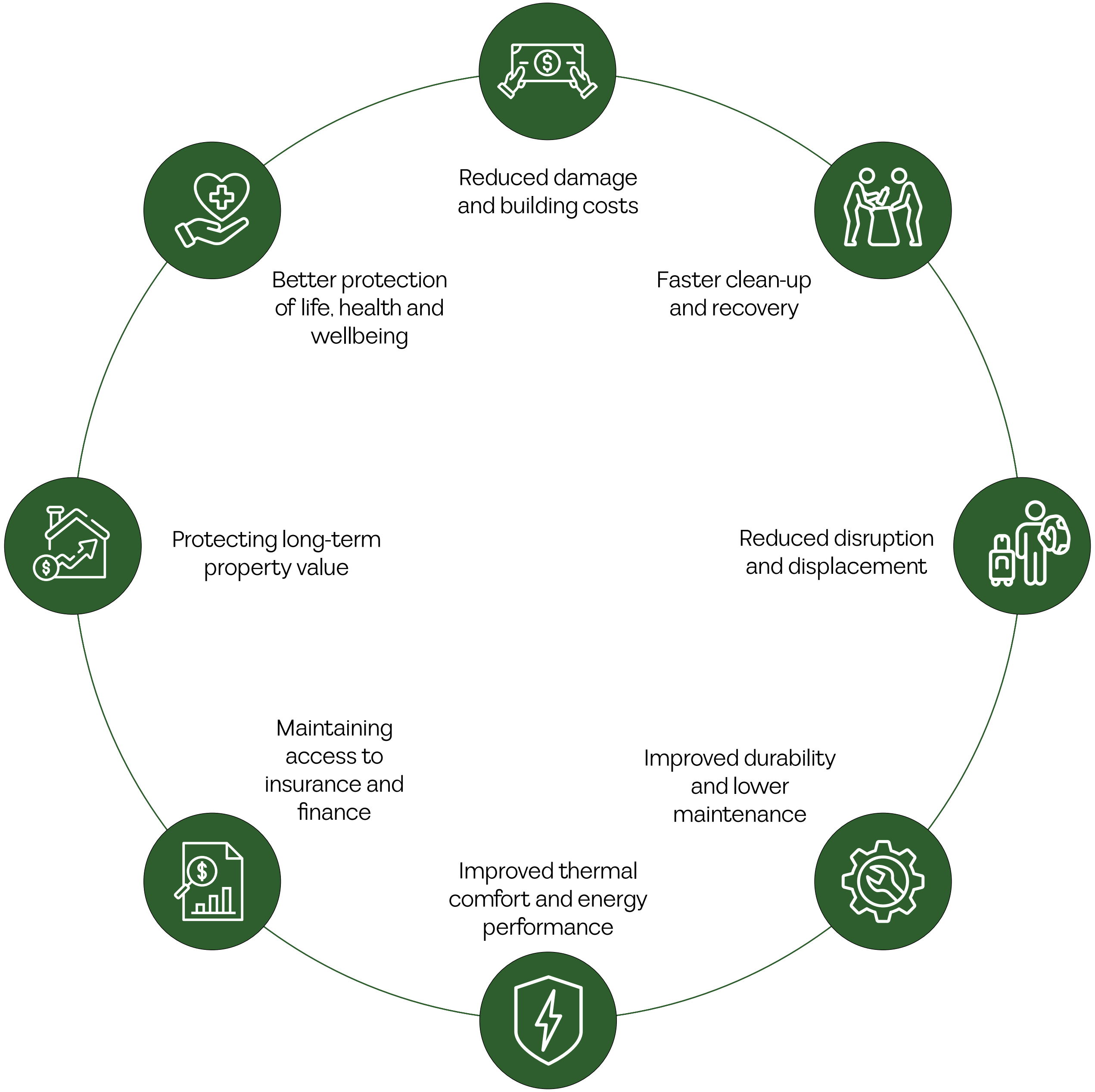
The Benefits of Resilience

For new homes, incorporating resilience during the design and construction stage is often far cheaper than retrofitting later.

Resilient homes are more likely to remain intact, repairable and in use after disasters, helping reduce landfill waste, carbon-intensive rebuilding, replacement of damaged materials and loss of embodied carbon over the life of the home.

A typical household investing around $23,000 in resilience upgrades can avoid an average of $230,000 in future losses - a return of around 10 times their investment
.
For many households, the cost of not improving resilience can be far greater than the cost of taking action.

So what does this look like in reality?



Vulnerable Home vs Resilient Home

The difference between a vulnerable and resilient home is significant and can completely change the outcome for a household.

Household A
No resilience improvements

- ✗ Major internal damage to walls, floors, insulation and services
- ✗ Lost belongings and ongoing disruption
- ✗ Insurance premiums rise sharply, or cover becomes unavailable
- ✗ Unable to refinance or sell due to insurance limitations

OUTCOMES
The family experiences ongoing stress, uncertainty and financial pressure. The home becomes a financial and emotional burden, with long-term financial and mental health impacts.

Repair costs:	$180,000+
Accommodation:	$50,000+ for 9-18 months

Estimated costs:

$230,000+

Household B
Completed recommended resilience actions

- ✓ Limited damage of replaceable items and minor clean-up
- ✓ Able to remain in the home, or return within days
- ✓ Stays insurable and financeable

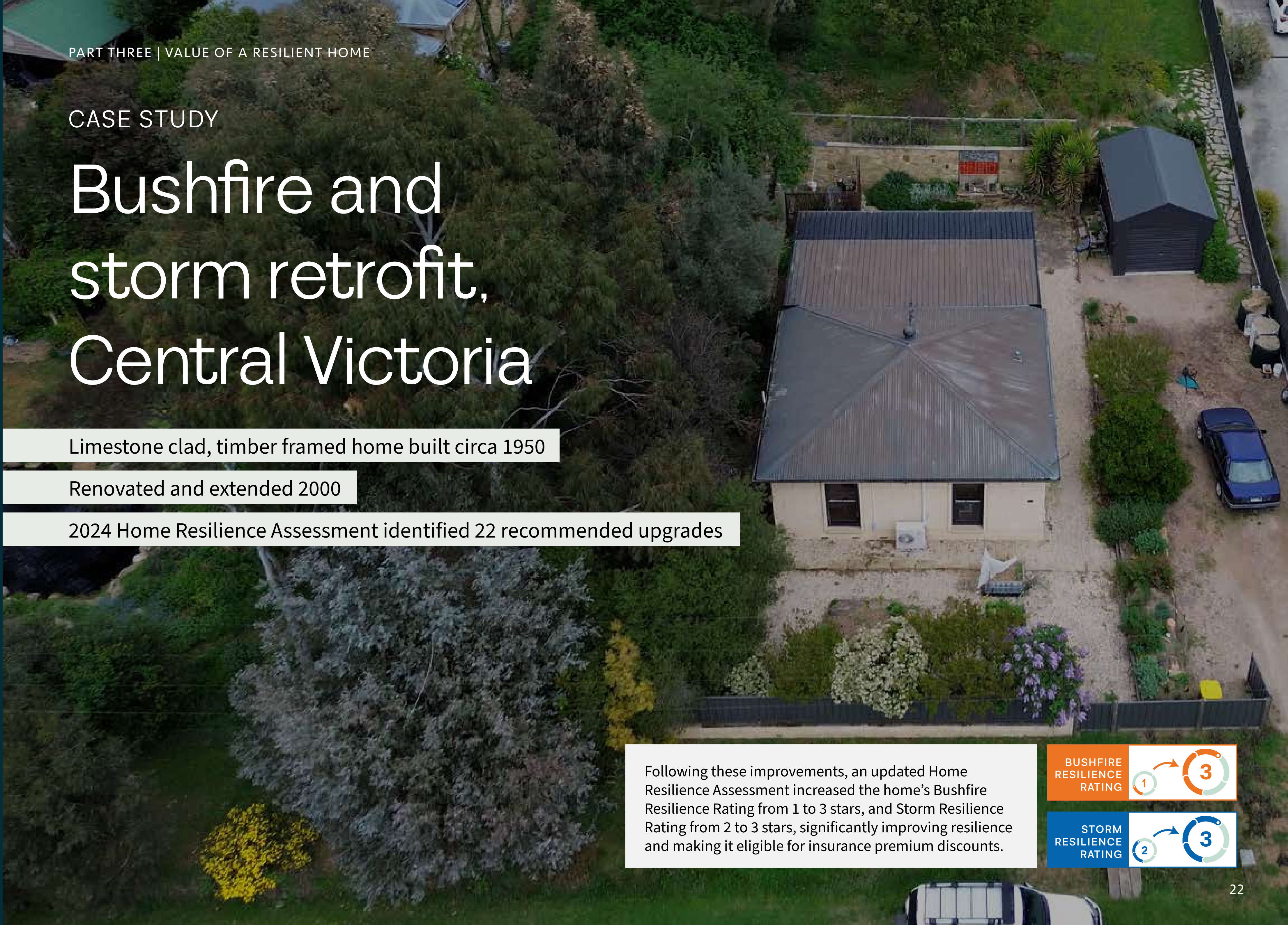
OUTCOMES
The home remains functional, insurable and financially stable.

Repair costs:	$5,000-$10,000+
Upfront resilience imporvement costs:	$15,000+

Estimated costs:

Under $25,000+

Source: Resilient Building Council and Castlemaine Institute, Whole of Home Resilience Pilot project report.



CASE STUDY

Bushfire and storm retrofit, Central Victoria

Limestone clad, timber framed home built circa 1950

Renovated and extended 2000

2024 Home Resilience Assessment identified 22 recommended upgrades

Following these improvements, an updated Home Resilience Assessment increased the home's Bushfire Resilience Rating from 1 to 3 stars, and Storm Resilience Rating from 2 to 3 stars, significantly improving resilience and making it eligible for insurance premium discounts.

BUSHFIRE RESILIENCE RATING 1 → 3

STORM RESILIENCE RATING 2 → 3

> We had the Harcourt fires, and as much as I tried to maintain our home in the lead up, I just remember on the day getting up there and panicking because not only were their leaves on top, but they were actually getting underneath the eaves and in between the roof. **I had to leave with just the hope that everything was going to be okay**.
>
> *Jem, homeowner in Castlemaine, Victoria*

Resilience journey

Jem lives with their partner and child in Castlemaine, where bushfire risk and increasingly severe weather events are a constant part of life. Since buying their first home, they've focused on creating a safer and more resilient place to live and work, particularly because both run businesses from home and regularly have clients visiting the property.

Creating a resilient home forms part of a holistic approach to living with increasingly severe weather events and high bushfire-risk. They've undertaken major works recommended through their Home Resilience Assessment, including upgrading their roof for ember attack, installing gutter guards and engaging an arborist to reduce fuel loads around the property.

> The costs can seem quite big. But when you think about what this actually means for savings, insurance and energy and then just wear and tear to the house over time, the money is made back very quickly.
>
> *Jem*

After the Harcourt fires early 2026, Jem actioned the following:

- ✓ Roofing sheets and screws inspected & upgraded
- ✓ Roof penetrations sealed or removed
- ✓ Bushfire-rated gutter guards installed
- ✓ Large nearby trees cut back
- ✓ Doors fitted with resilient door seals

Indicative costs of resilience measures

Professional roof inspection	$350
Sealing roof penetrations	$300
Mineral wool installed beneath flashing	$1100
Gutter guards installed including cleaning access points	$3250
BAL-FZ rated profile inserts to roof perimeter edge	$1300
Replacing roof sheets & roof screws up to code	$2200
Refalling gutters to downpipes	$700
Large nearby trees cut back	$900
Doors fitted with resilient door seals	$800
Clearing flammable and windborne items around home	No Cost
Removing flammable plants, pruning back shrubs	No Cost
Total cost of measures	**$10,900**

> Considering we were at one star, and when I realised most houses receive one, I was like, “oh, no”. That’s another story about the state of Australian housing. But it was incredible that with just a couple of steps and a little bit of an investment, how quickly that rating jumped up.
>
> *Jem*

Watch this **Resilience in Action** case study video.

WATCH NOW

UPDATE

PART FOUR

Understanding and responding to hazards

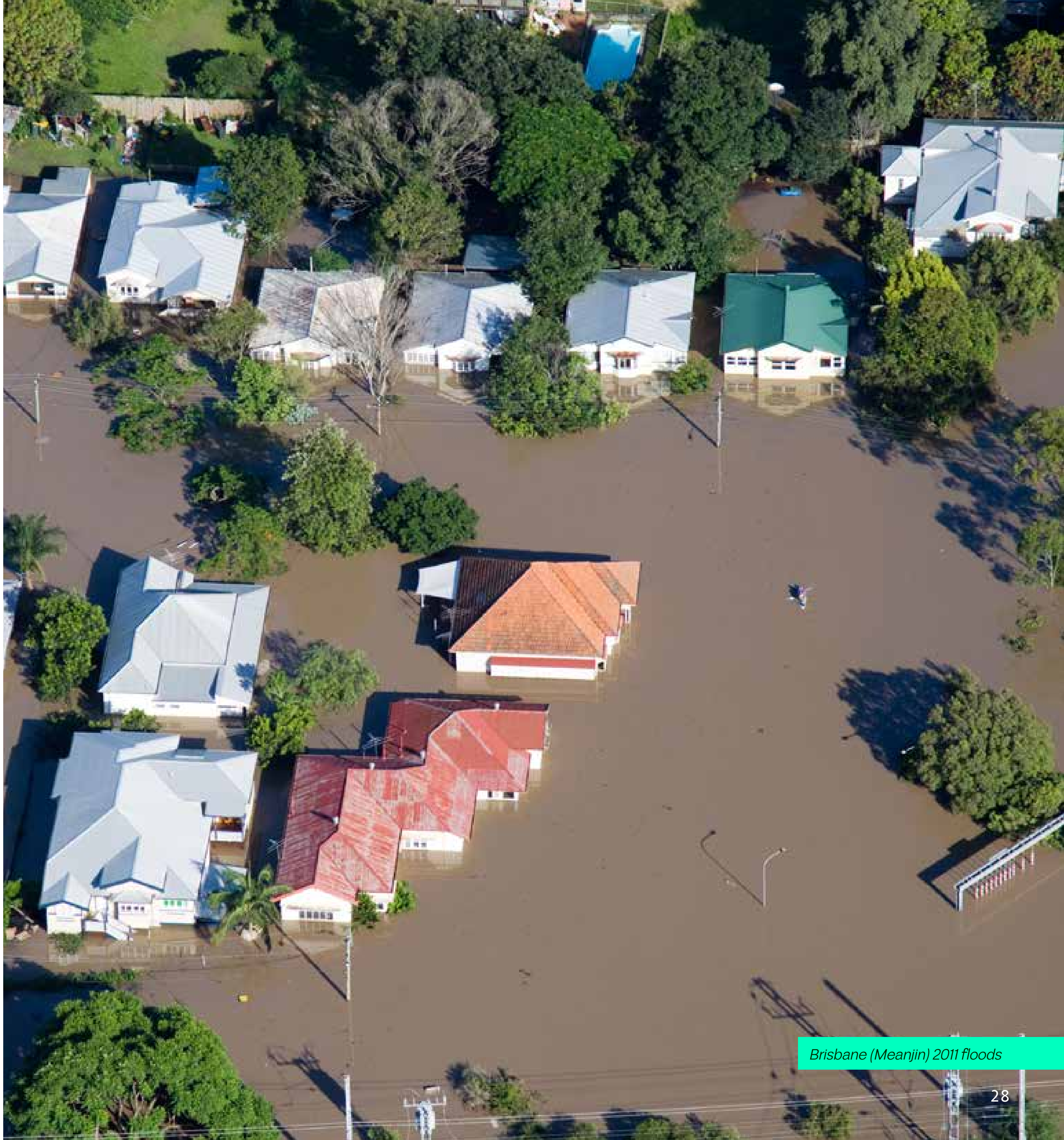
Flood

Why do homes fail in flood?

Flooding is one of the most frequent and costly disasters in Australia, with damage driven by both the initial impact and the time it takes to recover.

Flood damage is not caused by rising water alone. Moving floodwater can push against walls, wash away supporting soil, flow beneath the building and weaken structural materials. These effects often interact, increasing damage as the flood persists. Many homes fail not from a single cause, but from several flood forces acting together at the same time.

The following section outlines the main ways this happens.



Brisbane (Meanjin) 2011 floods

Flood Risks

1 **Water pressure**
The weight of floodwater pushes hard on a building and can lead to structural collapse

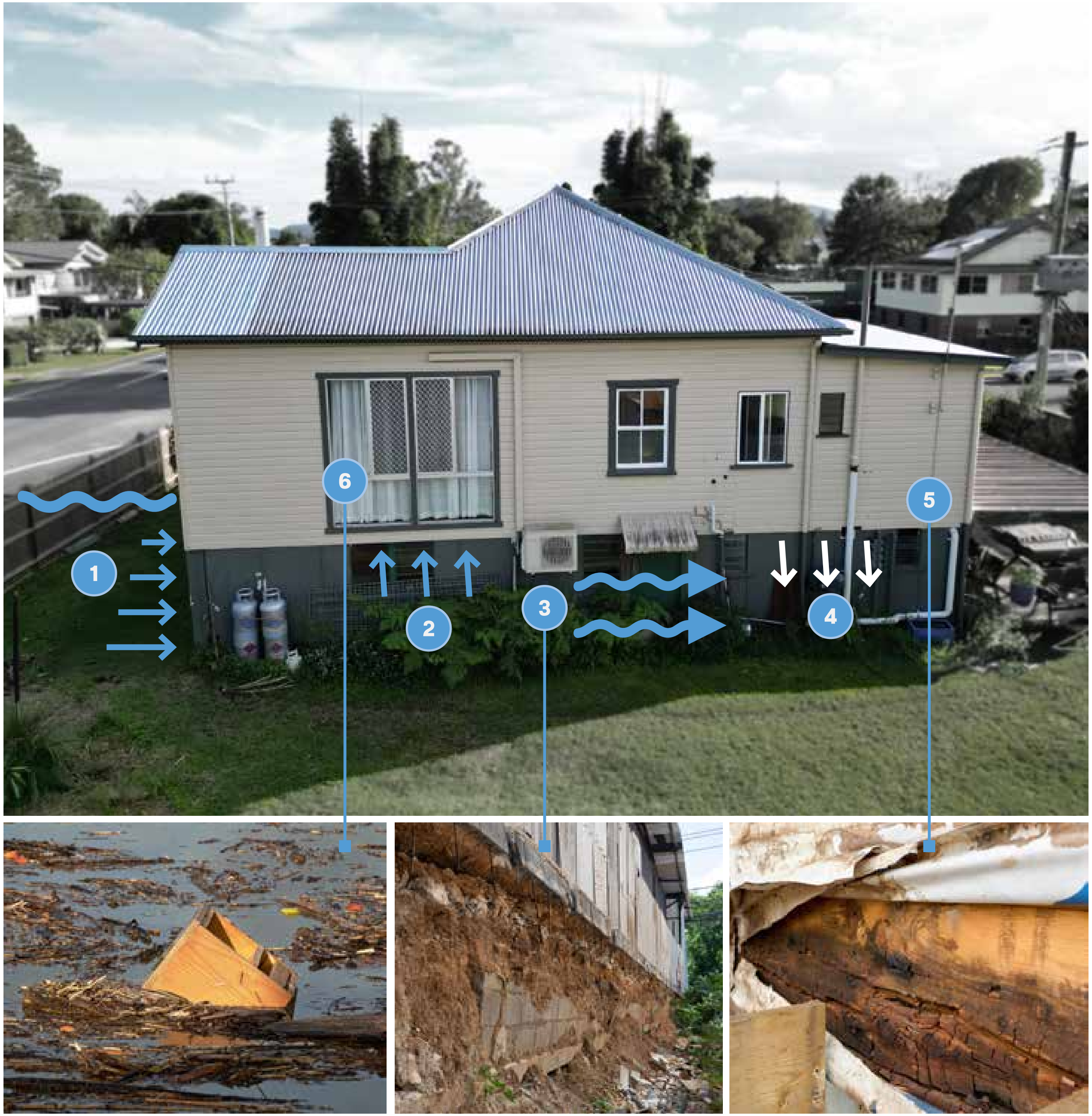
2 **Floating**
Floodwater can lift and shift lightweight parts of a building or site items, causing them to move, break connections or become unstable.

3 **Ground giving way**
Fast-moving floodwater can scour soil away around footings, while prolonged saturation can weaken and soften the ground until it can no longer properly support the building.

4 **Suction**
As water moves past a building, especially around corners, it can create a suction effect and pulling on side or rear walls.

5 **Material deterioration**
Floodwater damages materials by soaking in and breaking them down, leading to reduced strength and lifespan.

6 **Debris impact**
Floodwater can slam debris buildup or items into the building, hitting walls, doors and windows with damaging force.



FLOOD RISK

Water pressure and suction

By the time waters reach as little as 60cm up the wall, your home is at risk of structural damage. In deeper floodwaters, the weight can be the same as having **12 cars stacked on top of each other**, leaning against the side of your house. This immense force can knock over walls or make them structurally unsound. As fast-moving floodwater water speeds up around corners or under buildings, it can also create suction that pulls materials off the home.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD

- Consider location
- Simple geometry
- Best orientation
- Future flood design
- Robust wall systems
- Deep footings

NEW BUILD + RETROFIT

- Elevate floor level
- Pressure balancing
- Structural connections
- Minimise obstructions

RETROFIT

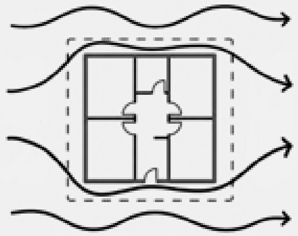
- Repair wall elements
- Clear subfloor obstructions
- Reinforce joint

Resilience strategies: Water pressure and suction

NEW BUILD

Consider location

The safest option is not to build on flood plains. Where unavoidable, the home should be sited on the highest point on the property. This includes such as known flow channels, constricted areas like steep creeks, and flood plains.



Use simple building geometry

Adopt compact, regular floor plans with square shapes offering the greatest robustness in floods. Avoid long, narrow layouts, large projections and complex corners that can increase pressure and flow acceleration.

Design for future flood risk

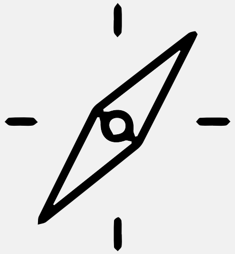
Engineer the structure to withstand flood depths beyond the historical 1% AEP flood depth (minimum standards) to increase resilience to less frequent but higher consequence floods.

Resilience strategies: Water pressure and suction

NEW BUILD
(continued)

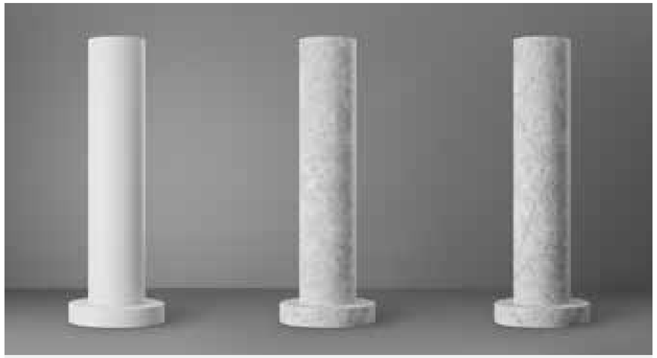
Design robust wall systems

Use reinforced concrete or reinforced masonry wall systems, rather than light-weight construction which is less resilient to flood loads, including water pressure and impact from debris.



Choose best orientation

If a square design is not feasible, the shorter, stronger walls should face the expected direction of flood water flows.



Provide deep, stable footings and pier systems

Use footings or piers that extend below potential scour depth and are capable of resisting erosion and movement from flowing water. Streamlined or rounded pier shapes, along with adding protective layers like

Resilience strategies: Water pressure and suction

NEW BUILD + RETROFIT

Elevate floor level

Either design or raise the home as high above potential flood depths as practicable For two-storey homes, the ground floor should be an open, non-habitable, flood resilient space.

Minimise obstructions that increase water pressure

Avoid solid fencing, enclosed subfloors or poorly placed walls that can trap water or accelerate flow, increasing pressure on the building.

Strengthen structural connections and bracing

Improve the continuity and strength of the structural frame so loads from water pressure can be safely transferred through the building.

Pressure balancing

Allow water to flow in and out of enclosed spaces through openings or dedicated vents. Automatic two-way vents fitted on opposite sides of the home work best, as they let pressure equalise on both faces of the wall.

Resilience strategies: Water pressure and suction

RETROFIT

Repair cracks, gaps and deteriorated wall elements

Seal or repair damaged masonry, cladding or joints so water cannot enter and weaken materials under pressure. Small defects can become failure points when exposed to sustained water loads.

Clear subfloor and perimeter obstructions regularly

Remove stored items, debris and vegetation from under and around the home so floodwater can flow freely. Obstructions can trap water and increase pressure against walls.

Reinforce joint

Strengthen joints between structural elements to improve load transfer, reducing the risk of cracking, separation or structural failure under water pressure.

FLOOD RISK

Ground giving way

Floodwater can erode, soften or destabilise the soil beneath a building. When ground support weakens or is washed away, foundations can settle unevenly, lose bearing capacity or fail. Fast-moving water can scour soil from around footings, while prolonged saturation can reduce soil strength even without visible erosion.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Build site
- Site levels
- Design foundations
- Extend footings

NEW BUILD + RETROFIT
- Subfloor area
- Manage site drainage
- Soil stabalisation

RETROFIT
- Structural assessment
- Retaining walls

Resilience strategies: Ground giving way

NEW BUILD

Site the building on stable ground and away from flow paths

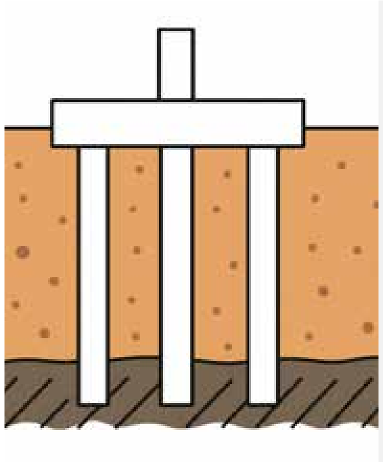
Avoid erodible or waterlogged soils and keep clear of areas where water is likely to concentrate or move quickly, such as gullies and low points.

Plan site levels to direct water away from the building

Grade the ground to fall away from the building on all sides and avoid low points near footings where water can pool. Swales or drainage channels can help carry surface water around the structure to a safe discharge point.

Design foundations for flood conditions

Design foundations to suit the site's soil conditions and the specific risks posed by flooding, including scour around footings, loss of soil strength when saturated, and uneven settlement. Going beyond minimum building code requirements increases resilience against less frequent but higher-consequence floods.

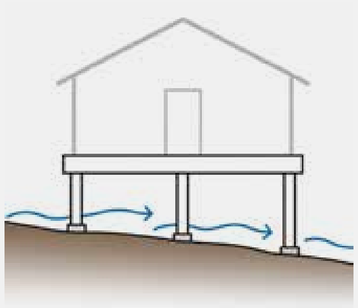


Extend footings below likely scour depth

Where floodwater may flow fast, extend footings below the estimated scour depth with a safety margin. Pier or pile foundations are generally preferred over shallow footings. Protect the base with scour-resistant materials such as rock or concrete aprons. A structural or civil engineer can estimate scour depth for your site.

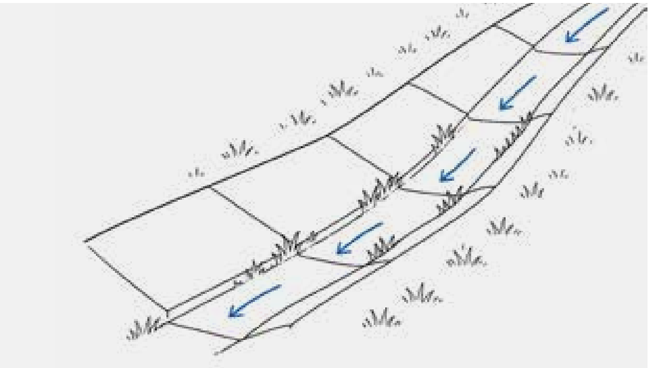
Resilience strategies: Ground giving way

NEW BUILD + RETROFIT



Keep subfloor areas open and free-draining

Avoid enclosing subfloor spaces with solid walls or storing items that block water movement. Maintain clear paths for floodwater to flow through and drain away, so water does not become trapped around stumps, piers or footings.



Manage site drainage and water flow

Shape the site so water drains away from foundations and does not become trapped or accelerated around the home. Use swales, drainage channels, pits or underground drains where needed, and ensure downpipes discharge well clear of the building. Avoid landscaping, retaining walls or stored items that obstruct floodwater or redirect it toward the structure.

Stabilise soil around footings where exposed

Maintain dense ground cover such as grass or low vegetation and avoid bare soil. Surface treatments such as gravel or geotextiles can further reduce erosion and preserve support around foundations.

Resilience strategies: Ground giving way

RETROFIT

Commission a structural assessment

Engage a structural engineer to assess the condition and capacity of your existing footings, stumps or piers. Check for exposed, undermined or deteriorated foundations and address any issues before failure occurs.

Install retaining walls where appropriate

Retaining walls can support soil and reduce erosion near the building. Ensure they include adequate drainage, are designed to withstand flood loads, and do not block or redirect floodwater toward the home.

FLOOD RISK

Material deterioration

Floodwater soaks into absorbent materials and hidden cavities, causing swelling, warping, mould, rot, corrosion, loss of strength and very long drying times. The worst damage typically occurs in wall linings and framing, floor assemblies and cabinetry, where materials absorb water, lose structural integrity and are difficult to dry or restore. Insulation, underlays and trapped silt can worsen the problem by holding moisture against framing long after the flood recedes.

The overarching strategy is to use flood-resilient materials, keep assemblies simple with as few layers and cavities as possible, and ensure any water that enters can drain and dry.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Single skin-wall construction
- Flood resilient floor systems
- Flood resilient windows and doors

NEW BUILD + RETROFIT
- Removable skirtings, kickboards and panels
- Corrosion resistant components and fittings
- Flood resilients cabinetry, joinings and fittings

RETROFIT
- Replace flood vulnerable materials
- Maintaing drainage and drying paths
- Repair degraded surfaces

Resilience strategies: Material deterioration

NEW BUILD

Use single-skin wall construction

Walls without layers like solid masonry or concrete are referred to as single skin. Single-skin walls avoid the cavities, insulation and linings that trap water, hold moisture against framing and are difficult to dry. Where single-skin is not practicable, use flood-resilient cladding, framing, insulation and linings.

Choose flood-resilient floor systems

Use reinforced concrete or galvanised steel piers rather than timber stumps and specify flood-resilient materials throughout the floor assembly - bearers, joists, sheathing and coverings.

Use flood-resilient windows and doors

Specify window frames, door frames, seals and door cores that tolerate submersion without swelling, delaminating or seizing.

Resilience strategies: Material deterioration

NEW BUILD + RETROFIT

Install removable skirtings, kickboards and access panels

These allow wall cavities, wall-floor junctions and under-cabinet spaces to be opened for cleaning, drying and inspection after a flood.

Use corrosion-resistant components and fixings

Use fixings, fasteners and metal components that tolerate repeated wetting without rusting, so connections remain sound after flooding.

Use flood-resilient cabinetry, joinery and fittings

Specify cabinetry, built-in fittings and trims that tolerate wetting, rather than particleboard carcasses and absorbent fittings that swell and lose integrity.

Resilience strategies: Material deterioration

RETROFIT

Replace flood-vulnerable materials below likely flood levels

Swap out absorbent materials in floor, wall, window, door and cabinetry systems for flood-resilient alternatives when undertaking repairs, renovations or upgrades.

Maintain drainage and drying paths

Keep weep holes, vents, drainage points and airflow paths clear so that if water enters, it can escape and materials can dry out. Add drainage points to existing assemblies where water can become trapped.

Repair degraded surfaces and seal gaps

Fix cracks, failed joints, deteriorated sealants and unsealed penetrations that allow water to reach concealed areas or compromise the building fabric.

FLOOD RISK

Floating

Floodwater creates buoyancy that can lift and move buildings, outdoor structures and equipment. Lightweight elements, raised homes, empty tanks and other buoyant objects can float, shift or break their connections if they are not weighted, anchored or elevated above likely flood levels. Water trapped beneath or within the building can also create uplift pressure on floors and lower structures. Loose floating items can also strike the building, causing further damage.

RESILIENCE STRATEGIES AT A GLANCE

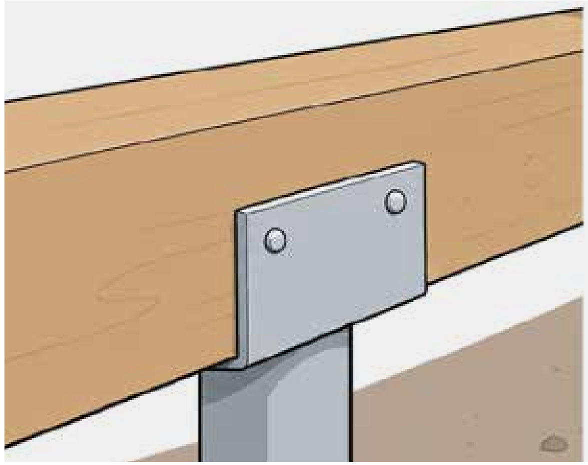
NEW BUILD
- Foundation design
- Avoid integrated garages

NEW BUILD + RETROFIT
- Floor elevation
- Anchor external equipment
- Lightweight structure handling

RETROFIT
- Flood risk for existing integrated garages
- Subfloor enclosures and water flow

Resilience strategies: Floating

NEW BUILD



Design foundations and floor systems to resist uplift

Ensure elevated floor systems and footings are designed with sufficient weight, anchorage or tie-down to counter buoyancy forces. Provide continuous load paths from the floor down to foundations.

Avoid integrated garages

Vehicles and other heavy items can float once water rises inside a garage, striking the walls of the home and structural supports. Design garages as detached carports on higher ground.

Resilience strategies: Floating

NEW BUILD + RETROFIT

Elevate the floor level above likely flood depths

Raise the building's floor level as high as feasible above the 1% AEP flood depth. Higher floor levels protect against larger floods and reduce buoyancy, uplift and water damage.

Anchor tanks, services and external equipment

Secure rainwater tanks, gas bottles, hot water systems, air conditioning units and other buoyant or loose items with concrete pads, straps or engineered anchors so they cannot float, shift or impact the building during flooding.

Ballast or tie down lightweight structures

Ensure lightweight outbuildings, sheds, decks and modular elements are weighted or anchored to resist flotation, especially where they are timber-framed or not connected to a heavy foundation.

Resilience strategies: Floating

RETROFIT

Manage flood risk for existing integrated garages

Help water drain out fast by installing automatic two-way flood vents and upgrading to more permeable garage doors. Reinforce garage walls if feasible. Before flood events, relocate vehicles, caravans, boats and other large items to higher ground. Note: permeable garage doors are not suitable in bushfire or storm-prone areas.

Open up subfloor enclosures to allow water flow

Remove or modify solid enclosures beneath the building, or add flood vents, so floodwater can flow through and drain away rather than building up as uplift pressure on the floor system.

FLOOD RISK

Debris and impact forces

Fast-moving floodwater can carry branches, vehicles, outdoor items and structural debris into the building at damaging speeds. Cars can begin to float in just 30 cm of water, turning them into hazards for nearby buildings. Debris can also accumulate against the building, increasing drag forces and placing sustained pressure on walls, doors and windows.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Building site
- Guiding water away from the site

NEW BUILD + RETROFIT
- Strengthen openings
- Physical protection
- Attached structure strengthening
- Permeable elements
- Vegetation/loose items

Resilience strategies: Debris and impact forces

NEW BUILD

Site the building away from fast-flow paths

Avoid locations where water concentrates or accelerates, such as channels, gullies, constricted areas and slopes between higher ground and a flood outlet.

Shape the site to divert water and debris away from the building

Use landscaping, levels, walls and drainage to guide water and debris around the building rather than funnelling it into the home. A hydrologist or civil engineer can confirm the best approach for your site and ensure strategies do not redirect floodwater onto neighbours.

Resilience strategies: Debris and impact forces

NEW BUILD + RETROFIT

Strengthen lower-level openings and exposed elements

Use impact-resistant glazing (especially laminated glass, which can crack but stay in place), solid-core doors, and wind-rated garage doors to resist debris impact. Reinforce cladding and external fittings below likely flood depths.

Add physical protection to vulnerable openings

Install external shutters, screens or impact-resistant panels over windows, doors and glazing exposed to likely debris paths. These can be deployed before flood events or permanently fitted.

Anchor and strengthen attached structures

Verandahs, decks, pergolas and awnings can become floodborne debris if they detach, striking the home or neighbouring buildings. Brace them well and tie them securely to the main structure, with posts firmly anchored to deep footings, so they stay in place under flood loads, drag and debris impact.

Manage vegetation and loose items around the home

Maintain trees and large shrubs at a safe distance from the building, prune dead or overhanging branches, and secure or store outdoor furniture, bins, tools and equipment before flood events.

Use permeable external elements

Choose fencing, landscaping and standalone structures that allow water and debris to pass through rather than blocking them. Avoid solid fencing, blocked subfloors and other obstructions that trap debris, increase drag and load walls.

BREAKOUT

Flood-resilient vs vulnerable materials

Floodwater can soak, stain, warp and weaken materials, often causing more damage after the water recedes than during the event itself. Choosing flood-resilient materials below likely flood depths significantly reduces damage, recovery time and cost.

What makes a material more flood-resilient

RECOVERY

Sanitation and system continuity

Floods often disable the systems people rely on most — power, communications, hot water, solar, pumps and drainage. Sewer and stormwater backflow can also contaminate the home, creating health risks and slowing recovery.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Locate services
- Separate electrical circuits

NEW BUILD + RETROFIT
- Backflow protection
- Main shutoffs
- Install backups

RETROFIT
- Critical services
- Access improvement

Resilience strategies: Sanitation and system continuity

NEW BUILD

Locate services above likely flood depths

Position electrical, mechanical and communication systems above likely flood depths, including switchboards, meters, outlets, hot water systems, air conditioning units, solar inverters, batteries and modems. Where components must sit below flood level, anchor them securely so they cannot float, shift or detach.

Separate electrical circuits between levels

Design wiring so upper-level lighting, appliances, power and communications can continue operating if lower levels are inundated, allowing the home to remain partially usable during recovery.

Resilience strategies: Sanitation & system continuity

NEW BUILD + RETROFIT

Install backflow protection on sewer and stormwater systems

Use non-return valves to prevent contaminated water flowing back into the home through toilets, drains and stormwater pipes. Inspect and maintain valves regularly so they function when needed.

Locate main shutoffs for safe isolation

Position main switches and shutoffs for power, solar, gas and water in accessible locations above likely flood depths, so systems can be safely turned off before a flood and turned back on after (by qualified professionals), without disassembling the building.

Install backup power, water and communications

Backup systems such as solar with batteries, rainwater tanks with pumps, and alternative communications keep critical home functions operating when mains supply is unavailable for extended periods.

Improve access to services for inspection and repair

Position services so they can be reached, inspected and repaired without removing large sections of internal linings or fittings. Removable access panels in walls, floors and ceilings make post-flood recovery much faster.

RECOVERY

Cleanup, drying, contents

Floods leave silt, contamination and moisture in rooms, cavities, joinery, walls and floor layers. Homes designed to drain, dry and clean out easily recover faster and at lower cost. Contents also need to be stored above flood depths to avoid loss.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Water exit design
- Rasied storage

NEW BUILD + RETROFIT
- Internal finishes
- Appliance raising
- Enclosed spaces
- Ventilation

RETROFIT
- Raised storage
- Drainage improvement

Resilience strategies: Cleanup, drying, contents

NEW BUILD + RETROFIT

Use hard, cleanable internal finishes

Sealed flooring, washable wall finishes and hard-wearing surfaces can be hosed, scrubbed and disinfected after a flood. Porous or textured finishes hold contamination and are difficult to clean.

Raise appliances above likely flood depths

Position dishwashers, washing machines, dryers, ovens, fridges and other appliances above likely flood depths where possible. Appliances at floor level are frequently written off after flooding, adding to recovery costs.

Remove or avoid enclosed spaces below likely flood depths

Enclosed bathtubs, under-stair spaces and cabinetry trap water, silt and contamination and are difficult to clean and dry. In new builds, avoid building these enclosures below likely flood depths. In retrofits, remove panels and replace with open or removable alternatives.

Provide ventilation for drying

Openable windows on opposite sides of rooms, clear subfloor vents and air paths through enclosed spaces all support airflow and drying after flooding. Removable skirtings and access panels (see ‘Material Deterioration’) extend this ventilation into concealed spaces

Resilience strategies: Cleanup, drying, contents

NEW BUILD *(continued)* + RETROFIT

Design for water to exit the building

Use flush or low thresholds at external doors, grade floors to fall toward exits, and avoid upstands or step-downs that trap water.

High-risk flood home

1 Solid fences and barriers
Block water and catch debris, increasing pressure and the risk of failure.

2 Loose outdoor items and unsecured structures
Things like furniture, decks, pergolas, sheds and tanks can be picked up by floodwater and impact the home.

3 Brick veneer and cavity walls
Trap water inside leading to deterioration and mould if soaked for long periods.

4 Closed-in subfloors
Block water flow, putting extra stress on the structure.

5 Windows without protection
Vulnerable to debris impact, often failing first during a flood.

6 Single Storey Home
Living spaces and vulnerable items are forced to be on the lower storey.

High-risk flood home

7 Insulation with air gaps

Traps moisture, leading to mould and damage.

8 Power points, switchboards and appliances at low levels

Easily damaged by floodwater, creating electrical hazards, repair costs and long recovery times.

9 Plasterboard, carpet and other absorbent materials

Soak up water, swell, grow mould and usually need replacing.

10 Built-in cupboards, baths and enclosed spaces

These trap water and mud, making cleaning slow and difficult.

Resilient flood home

1 Elevated home
The occupied level sits well above the 1% AEP flood depth, protecting the living areas from most flood events.

2 Grading and drainage around the house
Slopes and drains that guide water away quickly and prevent it from being trapped.

3 Open space under the house or free-flowing lower level
Lets water move through instead of building up pressure against the structure.

4 Secured outdoor items and attached structures
Prevents flotation and impact damage on the home during a flood.

5 Fences that let water pass through
Reduces water pressure and debris buildup, keeping fences and nearby structures intact.

Resilient flood home

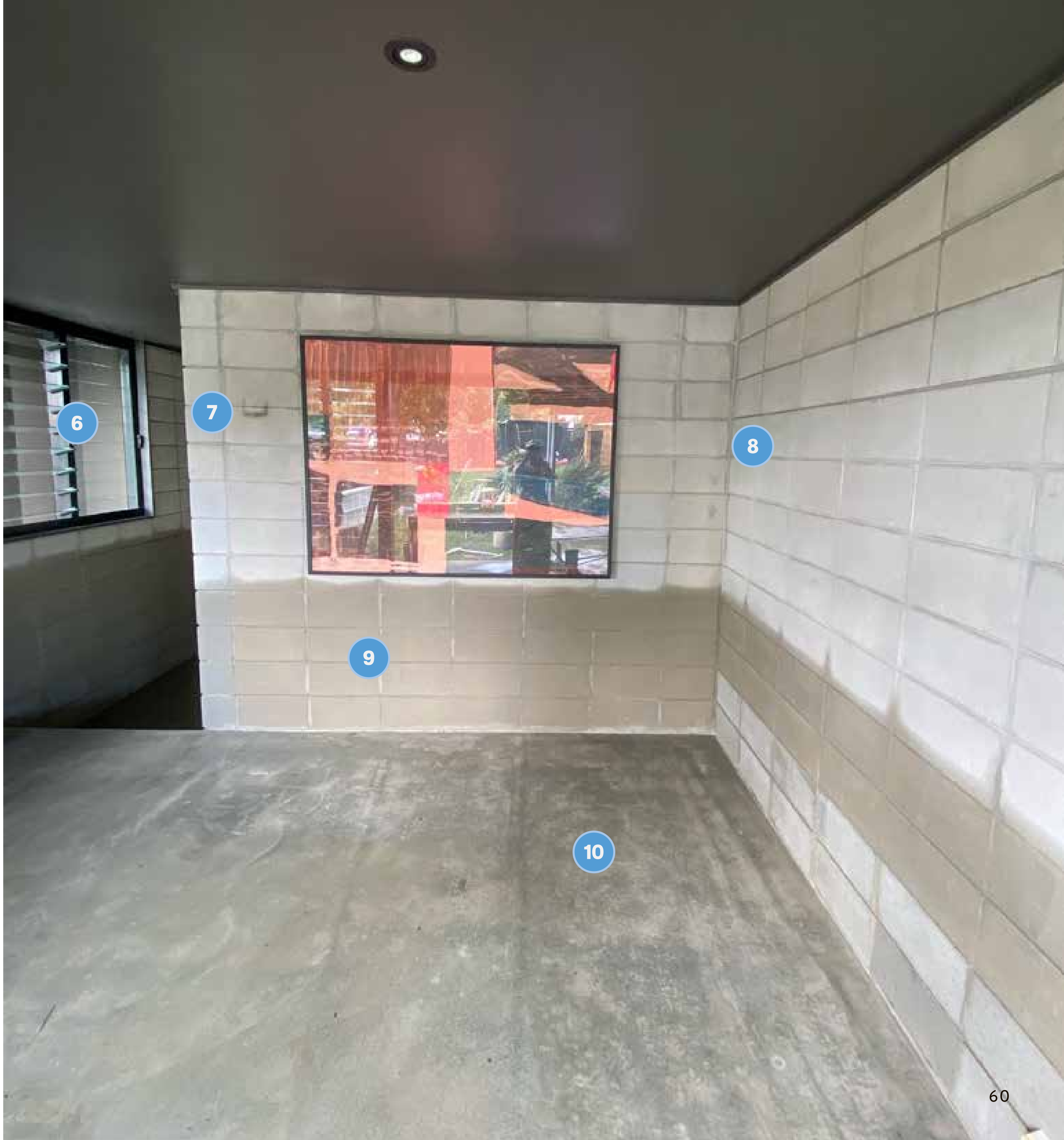
6 **Strong windows and shutters at lower levels**
Impact-resistant toughened glazing and shutters to handle knocks from floating debris.

7 **Power points, switchboard and key equipment placed above flood height**
avoids electrical hazards and repair costs and speeds up recovery time.

8 **Solid walls**
Reinforced concrete or masonry walls without cavities are stronger and recover faster.

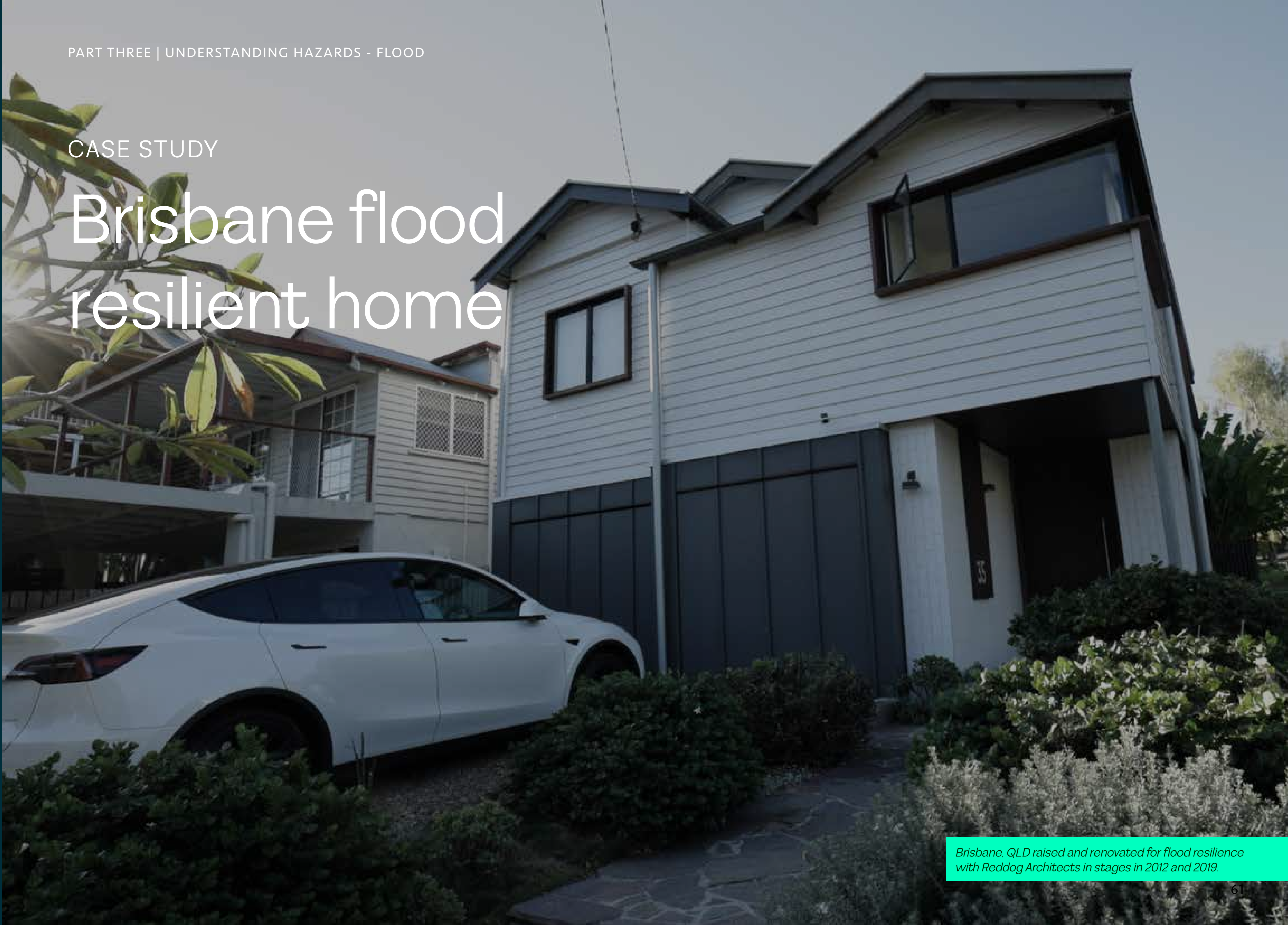
9 **Flood resilient, removable and washable interiors**
Features like removable skirting and kickboards, washable walls and raised cabinetry for a faster, lower-cost cleanup.

10 **Ground floor used for storage, not living**
If flood waters enter the ground floor there is less damage and a fast clean up.



CASE STUDY

Brisbane flood resilient home



Brisbane, QLD raised and renovated for flood resilience with Reddog Architects in stages in 2012 and 2019.

Located less than a kilometre from the Brisbane River, Nicholas and his family were in the advanced stages of completing a renovation. But just as they had finished their new kitchen upgrade, the 2011 floods hit and severely damaged their home, ruining their new kitchen.

With the guidance of Graham Tippins and Reddog Architects, they raised the home above the anticipated level of future flooding, incorporating a subfloor space built with resilient materials purposely designed to allow flood waters in.

When the 2022 floods came through their home, the materials and the new resilient design ensured a smooth clean-up process.

“After 2011 flooding our insurance gave us about 12 months of paid rental and we decided we were going to lift the house and do some work. But that 12 months ran out and because we didn’t have finances to cover us for additional rent we decided to move back in. We had one finished bathroom, but we were living in a property that had no windows. **That process we were living through close to year and a half.**

And then coming through the second flood, being up there and seeing the house, we were quite confident. We hosed out in a probably half a day and I think we were **back in within 4 or 5 days, long before a lot of our neighbours.** I’m really glad that the design stood the test of time and the materials worked and performed the way they were supposed to.”

Nicholas, homeowner in Brisbane, Queensland

Materials such as block masonry, concrete and stone-tiled floors, and fibre cement walls, are intended to let floodwaters in without causing significant damage.

Flood water is able to pass through the home with openable aluminium-framed doors and exit through the resilient steel front door

Their BBQ area made of marine ply, has removable doors and cabinets, and all furniture downstairs is permanently-installed concrete or easily removable prior to a flood.

Other benefits:

- ✔ Under-croft space creates outdoor living area suited to the Brisbane climate
- ✔ Robust entertaining area, easy to prepare for oncoming floods
- ✔ Materials selected for longevity, ease of maintenance

"After the first flood payout we did see **a sharp incline in the insurance premium**. They wouldn't allow us to opt out of the flood cover so we shifted provider who allowed us to opt out.

Now, it's almost mandatory to have the flood cover, which, even after the second flooding, we wouldn't have had any use for the flood cover component of the insurance anyway in terms of the damage done.

We're a little concerned if we do have to change again or that a rule will come in where it becomes mandatory."

Nicholas

Watch this **Resilience in Action** case study video.

WATCH NOW

Storm

Why do homes fail in storm?

Extreme storms and cyclones bring strong winds, intense rainfall, large waves and storm surge, and are expected to become more intense and affect a wider range of locations, increasing exposure to homes not designed for these conditions.

Homes fail in storms because wind, rain and debris act together on a building. Strong winds push against walls and openings and pull at roofs and cladding. Rain can be driven into small gaps, and heavy rainfall can overwhelm drainage, allowing water to enter and collect around the home. If a window, door or part of the building fails, wind can rush inside and make the damage worse. Debris and erosion can further weaken the structure. These effects often happen at the same time and can escalate quickly once the building is breached.

The following section outlines the main ways this happens.

Storm risks

1 Inward pressure

Wind hitting the front of a building creates strong pressure that pushes inward on walls and openings, which can break windows, deform doors and force cladding to fail.

2 Outward suction

As the wind passes over the roof and non-windward walls of a home, a suction force is creates pulling materials away from the building.

3 Internal blow outs

When a window or door fails, wind rushes inside and increases internal pressure, pushing up on the roof and outward on walls.

Storm Risks

4 Wind driven rain

Rain will move upwards, sideways, and be drawn inwards under extreme winds. Water will be blown into the home through gaps in roofing, around doors and windows, which can lead to extensive damage.

5 Extreme rainfall

When rainfall exceeds drainage capacity, water can back up and enter the roof, walls and foundations, causing internal damage, material deterioration and potential movement in footings.

6 Debris impact

Wind can pick up and throw objects of all sizes into the home, striking walls, windows and doors with damaging force.

7 Erosion and storm tide

Cyclones can raise sea levels several metres and generate waves that erode ground, damage structures and expose buildings to saltwater.

STORM RISK

Inward pressure

When strong winds hit the windward side of a building, they create a build-up of pressure that pushes inward on walls, windows and doors. This force is concentrated on large or weak elements such as garage doors, glazing and lightly fixed cladding. The pressure can also push the whole structure sideways, causing it to rack or lean out of shape. If the building or its connections are not strong enough, this movement can loosen fixings, crack materials and lead to failure of openings or wall systems.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Large opening size limits

NEW BUILD + RETROFIT
- Securing elements
- Secondary barriers
- Additional bracing
- Protecting vulnerable elements
- Strengthen openings

Resilience strategies: **Inward pressure**

NEW BUILD

Limit size and exposure of large openings

Reduce the size or change the orientation of large windward openings like garage doors, large windows and doors.

Resilience strategies: **Inward pressure**

NEW BUILD + RETROFIT

Strengthen garage doors and large openings
Use garage doors and other large openings rated for the site's wind classification (AS 4505), with strong tracks, fixings and restraints such as drop bolts to help resist wind pressure. In existing homes, upgrading older doors, improving track connections or adding bracing kits may reduce the risk of failure, though modifications may require a qualified installer.

Protect vulnerable windows and doors

Use impact-resistant glazing such as laminated or toughened glass, and/or install external shutters or heavy-duty screens to reduce the risk of breakage from wind pressure and wind-borne debris. When retrofitting older homes, consider upgrading vulnerable glazing and openings, particularly large windows and doors.

Secure cladding and external elements

Ensure cladding, flashings and trims are firmly fixed with appropriate fasteners so they resist lifting or detachment under wind pressure, particularly at edges and corners. A well-secured outer layer helps prevent the building envelope from being breached during strong winds.

Seal gaps and provide a secondary barrier (sarking)

Seal gaps around windows, doors and service penetrations using durable seals or gaskets to limit air entry. Incorporate continuous sarking or membrane behind cladding or roofing as a backup if the outer layer is compromised.

Provide additional bracing

Add cross bracing to subfloor supports and stumps, particularly in elevated homes. An engineer can assess whether additional wall bracing is needed to prevent sideways movement (racking) and sway.

STORM RISK

Outward suction

As strong winds pass over a home, they speed up around the roof and along the sides and back walls, lowering air pressure and creating a suction force that pulls materials away from the building. This effect is strongest at roof edges, corners and ridges. If connections are weak, this suction can lift roof sheets, peel back flashings and loosen cladding, allowing wind and rain to enter and trigger more widespread damage.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Roof forms

NEW BUILD + RETROFIT
- Load paths
- Roof strengthening
- Envelope integrity

RETROFIT
- Repair and maintain roof systems

Resilience strategies: **Outward suction**

NEW BUILD

Use simple, compact roof forms

Use roof shapes like hip roofs that have fewer edges and junctions to reduce pressure concentrations, limiting where suction can build and initiate failure.

Resilience strategies: Outward suction

NEW BUILD + RETROFIT

Provide a continuous load path

Ensure the roof, walls and foundations are securely tied together with appropriate tie-downs, brackets and fixings so wind uplift forces are safely transferred to the ground.

Strengthen roof fixings and connections

Use strong, corrosion-resistant fixings and closer spacing at roof edges, eaves, ridges and corners where wind suction forces are highest. Ensure roof cladding, ridge capping and flashings are firmly secured to resist lifting and prevent openings forming under wind pressure.

Maintain envelope integrity

Ensure windows, doors and junctions are in good condition, well-fixed and well-sealed so they resist wind pressure and prevent wind entering the home, which increases the risk of

Resilience strategies: **Outward suction**

RETROFIT

Repair and maintain roof systems

Replace damaged or corroded roofing, loose sheets or tiles, deteriorated fixings and cracked or failed pointing. Regularly inspect roofs for loose fixings, gaps, corrosion and batten deterioration so vulnerabilities are identified before storms occur.

STORM RISK

Internal blow-outs
(after envelope failure)

If a window, door or section of cladding fails on the windward side, wind can rush inside and quickly build up pressure. This pushes outward on walls and upward on the ceiling and roof, while strong winds outside are also pulling on the building. Together, these forces can turn a small break into major damage, including parts of the roof lifting or walls giving way. This often starts when debris breaks a window or door.

In addition to the preventative measures listed under "Windward Pressure" the following strategies can be used to strengthen the home if wind enters and pressure builds up inside.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Internal linings
- Roof-to-wall tie-downs

Resilience strategies: **Internal blow-outs**

NEW BUILD + RETROFIT

Strengthen internal linings and connections where accessible

Ensure ceilings and wall linings are securely fixed back to the frame, with enough fixings and good connections so they don't dislodge under wind loading or pressure changes.

Strengthen roof-to-wall tie-downs and load path continuity

Ensure roof framing is securely connected to the walls and tied through to the ground to resist uplift forces. In practice, this means using or upgrading tie-down systems such as cyclone straps, brackets or tie-down rods. These connect the rafters or trusses (roof structure) to the top plate (top of the wall frame), then walls down to foundations.

STORM RISK

Wind driven rain

Winds can force rain through small gaps in the building envelope, even where there is no major structural failure. Water commonly enters through roofs, flashings, windows, doors, vents and service penetrations, damaging ceilings, wall linings, floors and contents.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Roof geometry
- Protect openings
- Minimise penetrations

NEW BUILD + RETROFIT
- Robust flashings
- Seal junctions
- Best practice
- Sarkings
- External protections

RETROFIT
- Cavity systems
- Moisture-tolerance
- Continuous sealing

Resilience strategies: **Wind driven rain**

NEW BUILD

BUILDING FORM AND LAYOUT

Simplify roof geometry

Reduce the amount of roof planes and junctions required, avoiding valleys. Hip roofs can shed water in all directions and reduce pressure zones.

Protect openings

Locate windows, and doors away from predominant wind exposure where possible.

Minimise penetrations

Reduce services passing through roof sheets.

Resilience strategies: **Wind driven rain**

NEW BUILD + RETROFIT

ROOF SYSTEM

Install robust flashings

Extra care is needed for flashings as wind can change normal water flow and drive it upwards or sideways. Increase flashing overlaps, upstand heights (for taller edges to stop water getting over), stop ends (closed ends that stop water escaping), and more than one protective layer of sealing.

Seal junctions

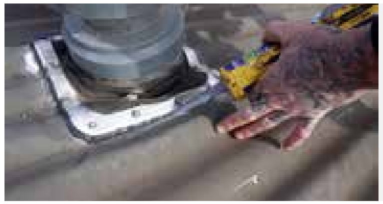
Most failures occur where building elements meet, rather than on flat surfaces. Pay extra attention to the wall-to-roof, wall-to-floor, and wall-to-window junctions. Strategies include back dams (small upstands that stop water flowing back under flashings), liquid flashing (a flexible waterproof coating used to seal joints and penetrations).

Use best practice fasteners and sheets

Install high quality cyclonic screws and washers, above minimum spacing requirements at edges, corners, and ridges. Overlap roof sheets properly and minimise unnecessary joints to reduce leaking.

Add or upgrade sarking

Sarking, also known as the building membrane, is a protective layer under the roof or wall cladding that acts as a backup if water gets past the outer surface. It should be continuous with no gaps, well-sealed at joints, and installed so any water can drain away rather than collect.



Seal external penetrations

Particularly roof penetrations

Resilience strategies: **Wind driven rain**

NEW BUILD + RETROFIT

WALLS AND CLADDING

Use drained cavity systems

A drained cavity is a small gap between cladding and building wrap on the building frame. This gap ensures any water that does get in can find a way out. It also provides ventilation behind the cladding to allow for drying.

Use moisture-tolerant materials and finishes

Wind-driven rain can enter through gaps, junctions and around windows and doors. Use materials, linings and finishes that resist water damage, drain and dry easily, and avoid assemblies that trap moisture.

NEW BUILD + RETROFIT

DOORS AND WINDOWS

Use continuous sealing

Use threshold seals at door bases and storm-rated compression seals around doors and windows to close gaps and stop rain getting in

Resilience strategies: **Wind driven rain**

RETROFIT

Repair or replace roof cladding, flashings and fasteners

These are common leak points. Ensure they are secure and reinforced where needed.

STORM RISK

Extreme rainfall

When intense rainfall exceeds the capacity of the roof and site drainage systems, water can back up in gutters, overflow into the roof space or walls, and collect around the foundations. Water may also be forced into junctions and openings, especially during storms. This can damage internal linings and insulation, accelerate material deterioration, and in some cases soften the ground, leading to movement in footings.

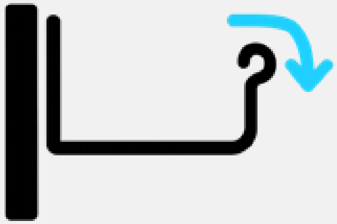
RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Using gutters

NEW BUILD + RETROFIT
- High capacity gutters
- Downpipe specifications
- Site drainage
- Overflow outlets

Resilience strategies: **Extreme rainfall**

NEW BUILD



Use gutters with overflow measures

Design gutters so overflow from heavy rain is directed away from walls and foundations. Use gutter profiles that have an external lip lower than the internal upstand. Avoid roof valleys and box gutters, which concentrate water and increase the risk of overflow into the building.

Resilience strategies: Extreme rainfall

NEW BUILD + RETROFIT

Use adequately sized, high-capacity gutters

Select gutters large enough for your roof size and local rainfall. Building codes provide guidance based on the rainfall intensity of your region. Bigger gutters, combined with enough slope (around 3–5 mm fall per metre) and regularly placed downpipes, are less likely to overflow in heavy rain. Smooth gutter shapes, such as half-round gutters, can also help leaves and debris wash through more easily.

Use well-sized and closely spaced downpipes

Provide sufficient downpipes to carry water away and reduce overflow. Space them in line with the Stormwater Drainage Standard (AS/NZS 3500.3), and consider additional downpipes for long runs, roof valleys and large roof areas.

Manage site drainage

Use swales, grading and drains to move water away from the home and prevent pooling near foundations. Permeable surfaces can help water soak in and dissipate.

Provide overflow outlets

Install overflow points, such as pop outlets, so excess water can discharge before it backs up into the building during extreme rainfall.

STORM RISK

Debris impact

Strong winds can lift and carry objects ranging, from furniture and branches to trampolines, sheds or even boats, hurling them into the wind-facing side of a home. These impacts can crack or shatter windows, deform doors and dislodge cladding or roof elements. Even a single strike can create openings that allow wind and rain to enter, increasing internal pressure and accelerating further damage. Debris can also build up against the building, adding sustained pressure and increasing the likelihood of failure in already weakened areas.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD + RETROFIT

- Anchoring items
- Secure small items
- Strong fences
- Manage vegetation
- Protect vulnerable elements
- Pre-storm routines
- Attached structure strengthening

Resilience strategies: **Debris impact**

NEW BUILD + RETROFIT

Anchor large external items and structures

Secure items with appropriate anchoring systems to prevent them becoming airborne. This includes sheds, water tanks, boats, caravans, trailers, trampolines, rainwater tanks, gas bottles, and lightweight outbuildings. Anything that could be lifted or moved in strong winds should be properly fixed or weighted.

Secure or relocate smaller loose items

Store or tie down outdoor furniture, bins, tools and equipment before severe weather to prevent them becoming projectiles. This includes items like outdoor chairs and tables, umbrellas, BBQs, garden tools, toys, hoses, ladders and loose materials—anything lightweight or movable should be brought inside or secured.

Strong permeable fences

Ensure fences are well constructed and securely fixed so they are less likely to fail in strong winds and become debris. Where possible, use more open or permeable designs that reduce wind loads compared to solid panels, and avoid long, continuous runs of solid fencing that can act like a sail and fail under pressure.

Manage vegetation to reduce debris generation

Maintain trees by removing dead branches, thinning canopies and ensuring adequate clearance from the building to reduce the likelihood of branches becoming wind-borne debris.

Resilience strategies: **Debris impact**

NEW BUILD *(continued)* + RETROFIT

Protect vulnerable windows and doors

Install external shutters or heavy-duty screens or consider upgrading older windows to impact-resistant glazing such as toughened and laminated glass, to reduce the risk of breakage.

Strengthen verandahs, decks and attached structures

Ensure verandahs, decks and awnings are well braced and securely tied to the main structure, with posts firmly anchored to footings. Repair or replace rotten posts, and fix loose or corroded nails and screws. Use robust, well-fixed materials and ensure roof sheeting and connections can resist wind and debris so parts do not break loose.

Establish a pre-storm securing routine

Develop a simple checklist, aligned with advice from agencies like State Emergency Service and Bureau of Meteorology, to secure loose items, vehicles, boats and equipment ahead of forecast high winds.

STORM RISK

Erosion and storm tide

During a cyclone, sea levels can rise several metres above normal high tide, allowing water and waves to reach areas not typically exposed. Just like with floodwaters, this can cause erosion, washing away soil and undermining foundations. Wave action also adds impact forces on buildings and seawater introduces salt, which can accelerate corrosion and material deterioration.

These effects in combination can damage structures, weaken the ground beneath them, and increase the risk of failure in exposed coastal areas.

The **flood risk** section has further guidance and comprehensive information on water impacts.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Hazard zones
- Storm tide levels
- Foundation systems

NEW BUILD + RETROFIT
- Lower level treatments
- Corrosion-resistant materials

RETROFIT
- Coastal-facing elements

Resilience strategies: Erosion and storm tide

NEW BUILD

Avoid siting in storm tide and coastal erosion hazard zones

Locate buildings outside mapped storm tide inundation and erosion-prone coastal areas, including zones exposed to wave action, shoreline recession and dune instability.

Elevate above storm tide levels, including wave effects

Set floor levels above the defined storm tide level, allowing for wave run-up and freeboard, not just still water levels.

Use deep, erosion-resistant foundation systems

Design foundations (e.g. piles or deep piers) to extend below expected scour and erosion depth so they remain stable even if surrounding soil is removed by wave action.

Resilience strategies: Erosion and storm tide

NEW BUILD + RETROFIT

Allow water and waves to pass through lower levels

Avoid solid enclosures below design levels so water and waves can pass through without building up pressure or increasing structural loads.

Use corrosion-resistant materials

Specify and maintain materials, fixings and connectors suited to marine environments, as saltwater accelerates corrosion and reduces structural life.

RETROFIT

Inspect and maintain foundations and coastal-facing elements

Regularly check for signs of erosion, scour or corrosion—particularly around footings and connections—and repair early to prevent loss of support.

High-Risk Storm Home

1. **Inadequate roof drainage capacity**
   Gutters and downpipes that are undersized can overflow during intense rainfall, forcing water back into the building.

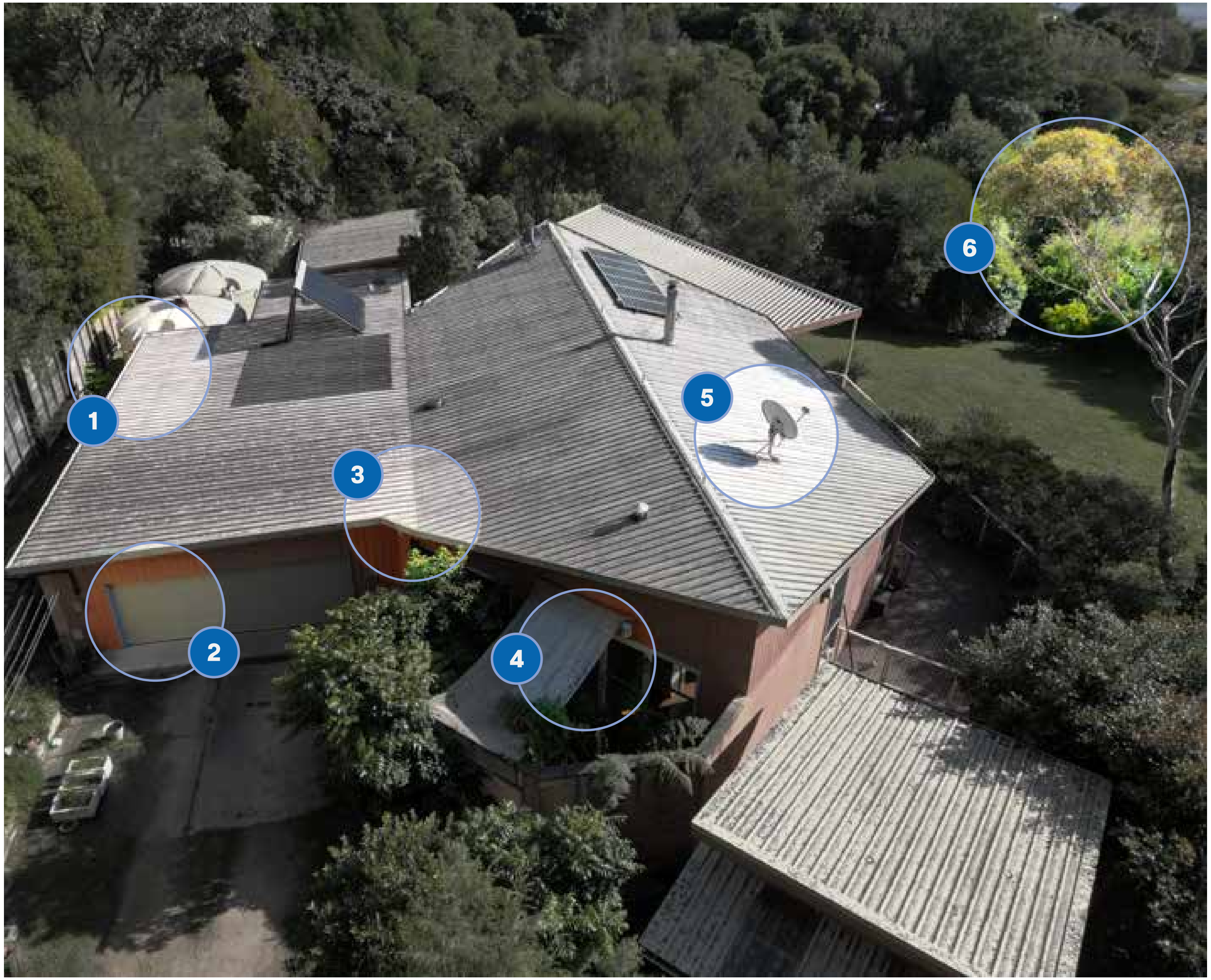
2. **Weak or poorly sealed doors (especially garage doors)**
   Large doors can fail under wind pressure, creating major openings on the windward side.

3. **Complex roof shapes and junctions**
   Multiple ridges, valleys and intersections create weak points where wind pressure and rain can enter.

4. **Poorly secured external structures**
   Pergolas, shade sails and other lightweight outdoor structures can fail in extreme winds, becoming wind-borne debris that damages the home or nearby properties.

5. **Poorly attached roof items**
   Antennas and other roof mounted items that are only fixed to the roof sheets rather than the structure below are prone to be torn away in strong winds.

6. **Tree strike**
   Trees overhanging or adjacent to the home can be toppled in extreme winds causing major damage.



High-Risk Storm Home

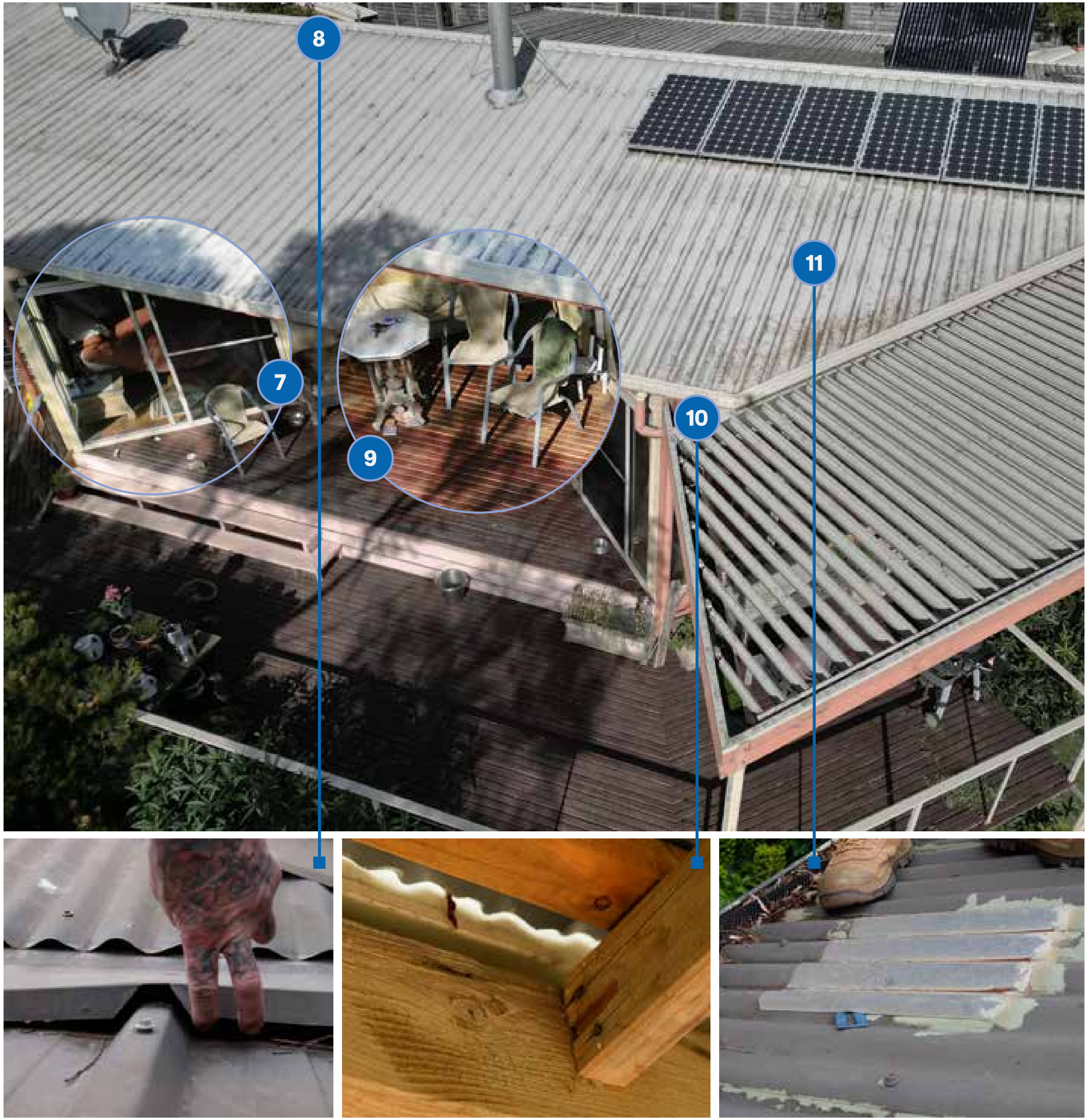
7 Unprotected windows and large glazed areas
Glass can break under debris impact, allowing wind and rain to enter and pressurise the home.

8 Poorly detailed flashings and roof penetrations
Weak points at ridges, valleys and service penetrations can allow water in under pressure.

9 Loose Items
Unmoored outdoor furniture, building materials and heavy items live kayaks and caravans can become projectiles in extreme winds.

10 Poorly attached structures
Weak connections between roof, walls and floors can allow parts of the building to lift or separate in strong winds.

11 Poorly fixed roof cladding or ageing roofs
Loose sheets, tiles or fixings can lift under suction, creating openings for wind and rain.



Robust Storm Home

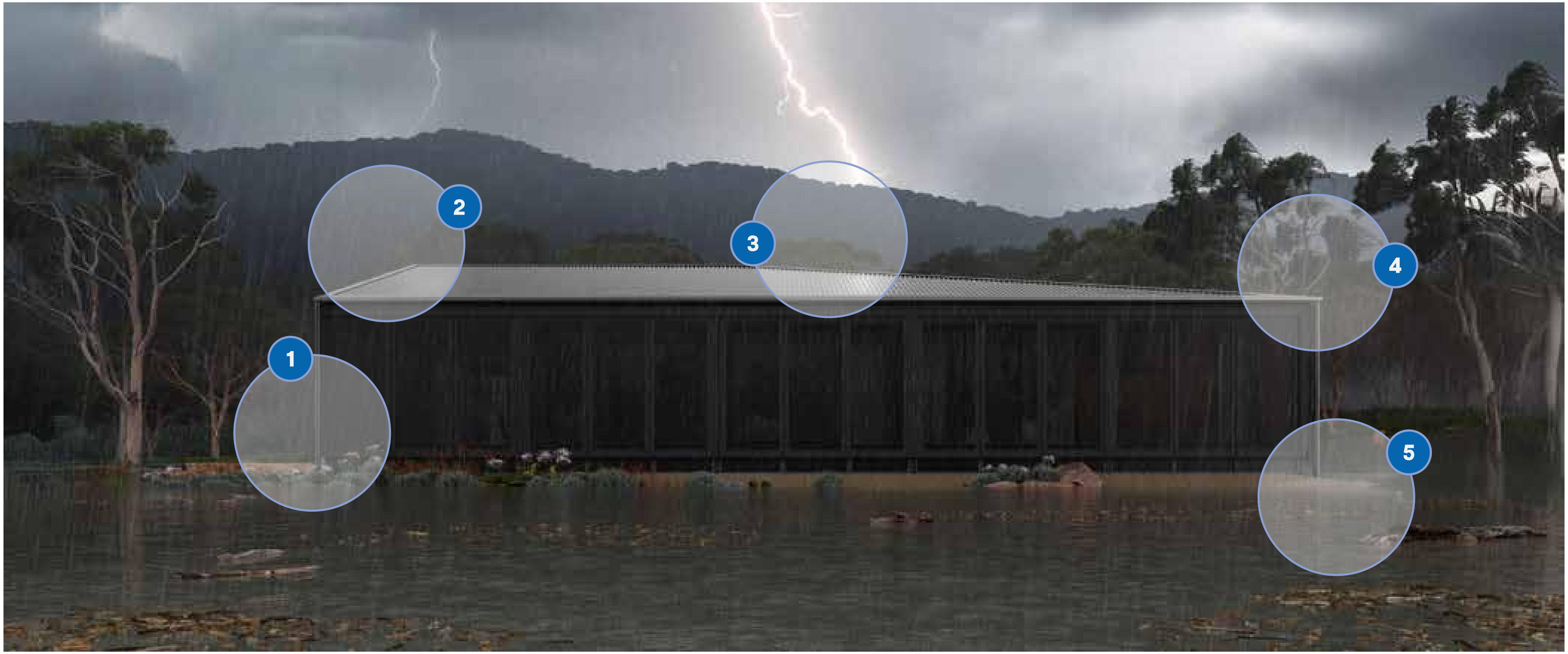
1 Continuous load path from roof to foundations
All parts of the structure are firmly tied together so wind forces are transferred safely to the ground.

2 Cyclone-rated roof system with dense edge fixings
Roof cladding is tightly fixed, especially at edges and corners where uplift is highest.

3 Simple, compact building and roof form
Designs avoid complex shapes and large exposed planes, reducing pressure concentrations and weak points.

4 Protected openings to prevent breach
Windows and doors are impact-resistant or protected (e.g. shutters), preventing debris breakage and internal pressurisation.

5 Elevate above storm tide levels, including wave effects
Set floor levels above the defined storm tide level, allowing for wave run-up and freeboard, not just still water levels.



Robust Storm Home

6 Robust flashings and junction detailing

Flashings in critical junctions like ridges and valleys are in good condition, with anti-corrosive screws at close spacings, with laps and seals detailed to limit water ingress.

7 Roof drainage designed for extreme rainfall

Gutters and downpipes are sized and detailed to prevent overflow into the building during intense storms.

8 Resilient wall and cladding systems

External walls are securely fixed and able to resist both wind pressure and water penetration.

9 Debris risk minimised around the home

Outdoor items, sheds and nearby hazards are secured or removed to reduce impact risk during storms.

8 Secondary moisture barrier under roofing

A continuous membrane under the roof catches and drains water that gets past the outer layer.

CASE STUDY

Strengthening an older cyclone exposed home

High-set weatherboard home in Townsville built approx. 1960

Upgraded in approx. 2015

Exposed to low overland flooding, tropical cyclones

Resilience is a really important part all around the country for severe weather are storms, whether it's thunderstorms, hailstorms, tropical cyclones, we want to be able to be confident that we can shelter in our homes and that homes can function afterwards. We've got to be able to have a way of retrofitting to improve our old homes, to give them a chance to resist these huge forces.

Dr. David Henderson

Resilience journey

Dr David Henderson, Chief Engineer at the Cyclone Testing Station in Townsville, has been studying the effects of cyclones on buildings for more than 20 years. His research and advice have helped fortify homes across tropical Australia.

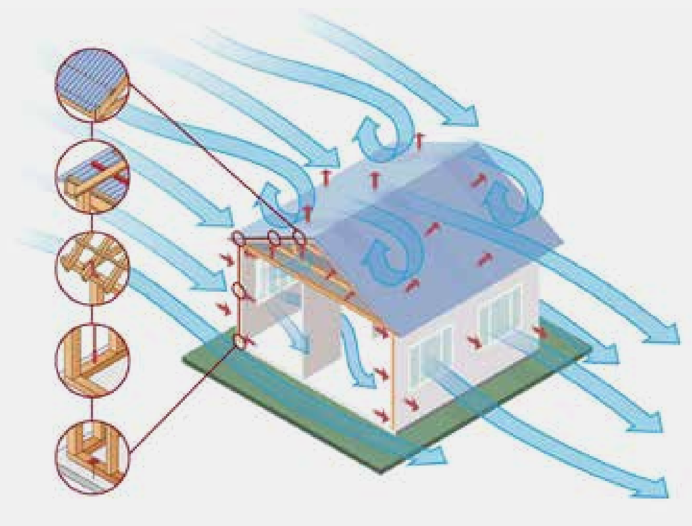
“It’s all about tying the roof structure all the way down to the ground, because as the winds coming over, it’s trying to pick the whole house up by its roofing.”

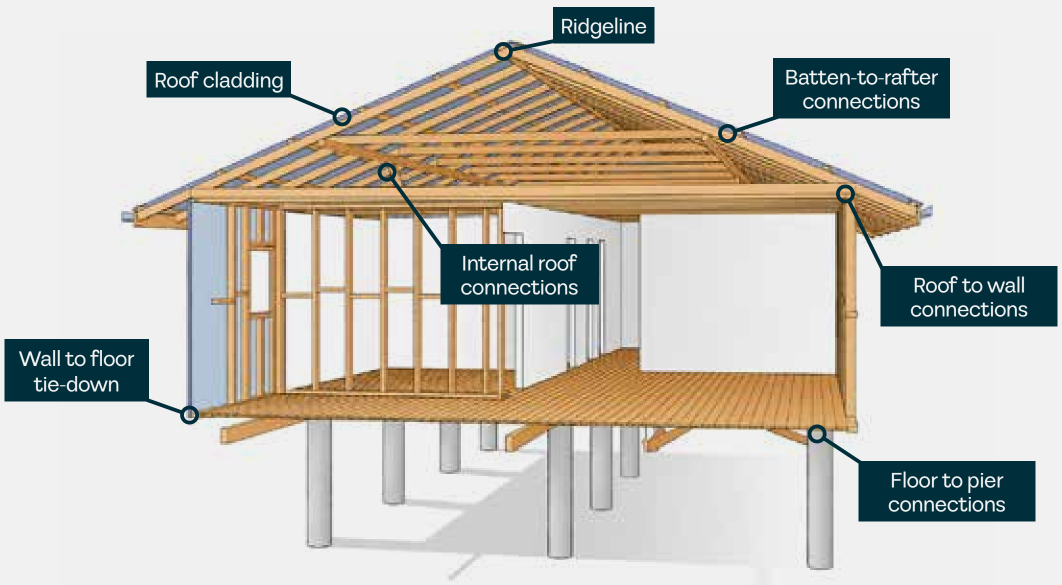
This high-set weatherboard home in Townsville was built in the 1960s and upgraded in 2015 in response to tropical cyclone and overland flood risk. It is a strong example of how simple upgrades to the tie-down chain can improve resilience and reduce damage.

What is the tie-down chain

As extreme winds pass over a roof, they create severe suction forces that pull upward on the home. Every part holding the home together is tested by these loads, from the roofing screws and battens down to the foundations. Together, these connected structural elements form what's known as the home's tie-down chain, transferring wind forces safely down into the ground.

If any link in the chain fails, that is where the home will break, with the winds carrying away everything above the failure. This is why a robust tie-down chain is crucial with every connection strong enough to resist uplift and keep the structure intact.





Source: James Cook University, weatherthestorm.com.au

Secure the outer roof layer

Roof sheets are often fixed with screws that are corroded, loose or spaced too far apart. Roof sheets or tiles should be fixed using screws, clips or fasteners suited to the local wind region.

Cyclone-rated washers can also help spread the load and reduce the risk of sheets tearing around the fixings.

Strengthen batten-to-rafter connections

Roof battens on older homes are often fixed only with nails, which provide little resistance to uplift forces. Battens should be securely connected to rafters or trusses using appropriate screws, straps or connectors.

Tie the roof securely to the walls

Where trusses and rafters are not tied down adequately to the walls, the entire roof will lift off. Galvanised metal strapping with appropriate screws can anchor the roof structure securely down.

Tie the wall frame to foundations

Modern homes often use cyclone rods that connect from the top of the wall structure, through the top and bottom plates, and down into the floor system to the bearer, slab, or footings. In existing homes, strapping can be used to tie the wall structure to the bearers, and bearers to the footings.

Additional storm resilience measures

Secured large external items like kayaks and boats

Protected windows with cyclone-rated screens

Removed hazardous trees or branches nearby

Kept yard clear of loose items that could become projectiles

Other benefits

- ✓ Improved flood resilience through stronger tie-down chain
- ✓ Protected windows provide better year-round thermal comfort
- ✓ Reduced maintenance costs

Watch this **Resilience in Action** case study video.

WATCH NOW

UPDATE

Recovery

Rapid Make-Safe and Weatherproofing

After a storm event the damage is often localised, but even small breaches can allow large volumes of wind-driven rain inside the home. The priority is to quickly stabilise the building and stop further water from getting in before conditions worsen or additional rainfall occurs.

This stage is about acting fast to protect the structure, internal spaces and services from compounding damage, while creating a safe environment for inspection and repair works.

STRATEGIES

1.

Install temporary weather protection

Quickly cover or seal damaged roofs, windows, doors and other openings using tarps, boards or similar materials to reduce further wind-driven rain entering the home. Prioritise roof damage and wind-facing openings, where water entry is often greatest.

2.

Secure loose or partially detached elements

Stabilise roof sheets, flashings and cladding that have lifted or loosened so they do not tear away further or create larger openings. Early intervention can prevent small failures from escalating into major damage.

3.

Remove immediate hazards

Arrange a professional to clear loose debris, fallen materials and unstable elements that pose a risk to people or the building. Making the site safe is critical before carrying out further inspection or repair work.

Recovery

Repair, Drying and System Recovery

Once the building is stabilised the focus shifts to drying, cleaning and repairing damage. Recovery is about removing moisture quickly, restoring damaged elements and ensuring essential services are safe and functional.

Addressing hidden damage early and using more resilient materials during repair can reduce long-term costs and improve performance in future events.

STRATEGIES

1. Remove water, debris and contaminants

Remove standing water, mud, debris, salt and other contaminants as soon as possible. Wash down affected surfaces with fresh water where needed, particularly after storm tide or coastal flooding, as salt residues can continue causing corrosion and deterioration after the building has dried.

2. Repair and strengthen damaged building elements

Restore roofing, cladding, flashings, windows, doors and other damaged elements to reinstate the building envelope. Where possible, use repairs and replacement materials that improve resilience rather than simply restoring the original condition.

3. Restore services safely

Reconnect electricity, gas, water and communications only after inspection by licensed professionals. Ensure safe access around the property is restored to support ongoing repair works and safe occupation.

4. Dry the building quickly

Ventilate internal spaces and use appropriate drying methods to reduce moisture in walls, floors and cavities. Rapid drying helps prevent mould growth, material deterioration and longer-term structural damage. Inspect for hidden structural or moisture damage.

5. Inspect hidden damage

Use qualified professionals to inspect roof cavities, wall systems, fixings and structural elements for hidden moisture, corrosion or structural damage before closing up or repairing the building. Early identification helps avoid repeat failures and concealed deterioration.

> From a wind perspective, we've had some downpours. The property has been designed to keep water away from the subfloor level of the house. We've got swales across the back, like faux creek beds. They've worked very effectively in diverting water away from the property and around the house.
>
> *Terry , homeowner in South Australia*

Bushfire

Why do homes fail in bushfire?

Bushfires are complex events, with an approaching fire front providing multiple pathways to attack homes. Most homes destroyed in bushfires survive the passing fire front but are later destroyed in the following hours by ember attack or surrounding elements .

Some bushfire risks are easy to identify, like flame contact igniting combustible cladding. Others are more unexpected, like embers sneaking down your flue and igniting items in your roof space, or a car five metres away spreading fire to the home. Understanding how homes fail in bushfires can guide an action plan for resilience.

In bushfire there are two key principles for resilience:

- The **Risk** management of the property and gardens, removing combustible and impact hazards from around the home, starting closest to the home and working out.
- The **Robustness** of the home itself, particularly the external shell of the home being continuous, tough, and resistant to heat without any chinks in the armour.

Bilpin. North-west of Sydney 2019 Bushfires

Bushfire risks

1 Surface fires
Dry grass and mulch act as fine fuels that ignite easily and allow fire to spread rapidly across open ground.

2 Ember attack
Burning embers can travel ahead of the fire and enter small gaps, igniting the building shell, and materials inside the home.

3 Radiant heat
Heat generated by the bushfire flame front, nearby burning structures and other items can ignite materials, crack windows and weaken building elements without direct flame contact.

4 Bushfire flame contact
Direct contact from the bushfire's flames can ignite combustible parts of the building.

Bushfire risks

5 Secondary fires
Embers start fires in nearby elements like decks, cars, or stored vegetation, bringing flames or radiant heat next to the building.

6 Debris impact
Extreme winds often occur on catastrophic bushfire days and can cause tree strike, loosen cladding and roofing allowing ember attack, or hurl unsecured items at the home.

7 Extreme winds
Strong winds can drive embers and flames, increase fire intensity and compromise the building envelope.

8 House-to-house ignition
Burning homes, fences and nearby structures can spread flames, embers and radiant heat to neighbouring properties.

BUSHFIRE RISK

Ember attack

Embers are the most common cause of house loss in bushfires. The burning bark, leaves, and other material can travel with the wind many kilometres ahead of the fire front. Embers tend to collect in vulnerable locations such as roofs, gutters, decks, vents and corners where debris also builds up. Even very small gaps can allow embers to enter roof spaces, wall cavities or underfloor areas, where they can start fires inside the building. Because ember attack can continue for hours, homes can ignite even after the fire front has passed.

The following strategies focus on how to prevent embers from landing on or entering the home. Ember attack is also the primary cause of **Secondary Fires** around the home, addressed in the next section.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD

- Building shape
- Roof penetrations
- Non-combustible framing

NEW BUILD + RETROFIT

- Roof gaps and edges
- Seal doors and windows
- Screen openings
- Subfloor areas
- Lower building elements

RETROFIT

- Repair weak elements

Resilience strategies: Ember attack

NEW BUILD

Simple building shape and roof design

Reduce internal corners, valleys and junctions where embers and debris can build up. These recessed or L-shaped areas tend to trap leaves and embers, unlike ridges and external corners which shed debris more easily.

Minimise roof penetrations

Limit rooftop elements such as vents, evaporative coolers and service penetrations where possible. Where they are required, ensure they are fully sealed and protected so embers cannot enter the roof space through gaps or poorly detailed edges.

Use non-combustible framing

Ensure supports and floor assemblies won't ignite on ember entry by using materials like steel or concrete.

Resilience strategies: Ember attack

NEW BUILD + RETROFIT

Seal all roof gaps and protect roof edges

Prevent embers entering the roof space by sealing gaps at ridges, flashings, roof-to-gutter junctions, eaves and around penetrations such as flues and services.

Seal doors and windows tightly

Reduce gaps around doors and windows by installing close-fitting frames, thresholds and non-combustible seals (like EPDM rubber or silicone). Check that doors close firmly.

Screen all openings

Install corrosion-resistant metal mesh with openings or aperture less than 2mm. These will go over vents, weepholes, roof vents and service penetrations to block embers. Ensure window and door screens are well-maintained and check all mesh is securely fixed and sealed.

Enclose or screen subfloor areas

Install non-combustible mesh screening or sheeting around the subfloor to prevent embers from entering under the house. Ensure ventilation openings are protected while still allowing airflow and avoiding moisture build-up.

Harden vulnerable lower building elements

Upgrade or protect materials within the first ~400 mm above ground—such as veranda posts, door bases, lower cladding and decks—using non-combustible materials or metal guards.

Resilience strategies: Ember attack

RETROFIT

Repair weak points

Fix gaps like those in cladding, damaged window frames, loose seals and torn screens. Small defects can allow embers to enter and start fires inside concealed spaces.

BUSHFIRE RISK

Secondary fires and Home-to-home ignition

Bushfires can be devastating due to the multiple forces at play. When bushfires approach built-up areas, they can create secondary fires. Nearby elements such as fences, decks, garden beds or stored materials can ignite and spread flames. These fires act as a bridge to the home even when the main fire front doesn't directly reach the property, producing their own flame, heat and ember attacks.

These strategies focus on reducing fuel nearby and stopping small ignitions from spreading fire to the home.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD

- Building shape and roof design
- Roof penetrations
- Non-combustible framing

NEW BUILD + RETROFIT

- Remove debris
- Non-combustible pathway
- Combustible storage
- Vehicle relocation
- Material clearance
- Outdoor item replacements
- Resilience improvement

Resilience strategies: Secondary fires and Home-to-home ignition

NEW BUILD

Simple building shape and roof design

Reduce internal corners, valleys and junctions where embers and debris can build up. These recessed or L-shaped areas tend to trap leaves and embers, unlike ridges and external corners which shed debris more easily.

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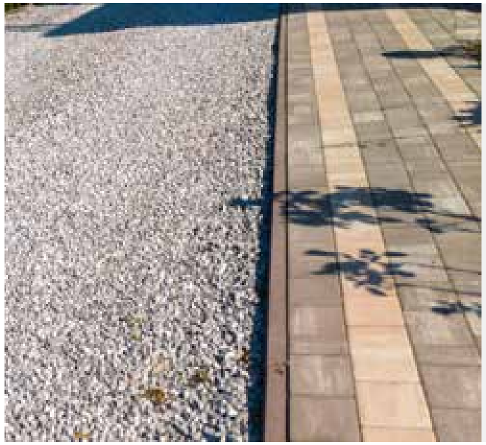
Resilience strategies: Secondary fires and Home-to-home ignition

NEW BUILD + RETROFIT



Create a non-combustible pathway around the home at least 1.5m wide

Use gravel, pavers, concrete. Remove mulch, plants and any stored items. Removes fuel where embers are most likely to land and ignite.

Keep roofs, gutters and corners free of debris

Regularly clear gutters, valleys and junctions where leaves and debris collect. Consider non-combustible metal gutter guards to reduce build-up, but maintain regular cleaning as guards do not eliminate ignition risk as debris can still accumulate over time.

Store combustibles away from the building

Keep combustible items such as furniture, firewood and plastic bins at least 3m away from the home, ideally in a resilient shed.

Relocate high-risk vehicles and equipment

Move cars, boats, caravans and other large combustible items to a cleared area at least 10m away from the home and any other building. Secure gas bottles upright with pressure relief valves facing away from the home.

Resilience strategies: Secondary fires and Home-to-home ignition

NEW BUILD (continued) + RETROFIT

Clear materials from under the home

Remove stored items such as timber, firewood, plastics, cardboard and general clutter from subfloor and under-deck areas. These sheltered spaces can trap embers and allow fires to start unnoticed beneath the building.

Replace outdoor items with non-combustible alternatives

Swap plastic, timber and fabric outdoor items for metal, masonry or other non-combustible materials, particularly near walls, decks, doors and windows.

Improve the resilience of sheds and outbuildings

Sheds, pergolas, fences and outbuildings are common sources of secondary fires. Upgrade vulnerable structures with non-combustible materials and ember-resistant detailing.

BREAKOUT

ZONE 1: Immediate (0-1.5m) Keep a fuel-free perimeter

This is the most critical zone because embers can ignite fuels directly beside the building, allowing fire to reach walls, decks, windows, eaves or underfloor areas. The aim is for fire to have almost nothing to burn at the building edge.

- Use non-combustible surfaces such as gravel, concrete, stone or pavers.
- Remove organic mulch, leaf litter, bark, twigs, firewood, stored items, flammable pots dense vegetation.
- Avoid vines or climbing plants on walls, keep shrubs to an absolute minimum, and do not allow branches to overhang roofs, gutters, windows, decks or verandahs.
- Keep grass below 5 cm and move potted plants away during high fire weather.

ZONE 2: Inner zone (1.5m-10m) Well-managed vegetation

This zone should slow surface fire and prevent flames from moving continuously toward the house. Breaking up fuel continuity reduces ember ignition, ladder fuels, radiant heat and the chance of flames reaching vulnerable parts
of the building.

- Use lower-flammability species and keep vegetation sparse, healthy and well-watered.
- Maintain grass below 5 cm
- Keep shrub cover low where possible, and avoid dense or continuous planting
- Separate shrubs, trees and garden beds with mown lawn, gravel paths, or other low-fuel breaks.
- Avoid shrubs beneath trees, prune low branches, and prevent vegetation from extending back into the fuel-free zone.

ZONE 3: Outer zone (10m-30m) Reduce fuel load and continuity

This zone helps reduce fire intensity before it reaches the inner zones. Managed trees can help filter embers and reduce wind speeds, but only where surface fuels, ladder fuels and canopy continuity are controlled.

- In this zone, trees can remain part of the landscape, but ground fuels should be kept low.
- Remove heavy litter, bark ribbons, fallen branches and dead plant material.
- Thin dense regrowth, prune low branches, remove shrubs directly beneath tree canopies and maintain separation between trees or tree groups.
- Retain mature trees where appropriate, particularly deciduous trees, with thick moist leaves, but avoid dense thickets and continuous canopy cover.

THE 3 LANDSCAPING ZONES

Work with neighbours to reduce shared risks

Coordinate pruning, vegetation spacing and debris management with neighbours. Focus on key trees that could fall, shed debris or carry fire toward the home.

A coordinated approach strengthens resilience across properties and reduces the chance of damage spreading.

BUSHFIRE RISK

Bushfire flame contact, Surface fires and Radiant heat

Bushfires can expose homes to direct flame contact through grassfires moving extremely quickly through dry grass and weeds, or from shrubs and trees producing taller flames, heavier ember attack and much greater radiant heat. Once flames reach the property, they can directly ignite walls, decks, fences and other combustible elements of the home. This usually occurs where vegetation or nearby structures are close enough for flames to physically contact the building.

Radiant heat from nearby flames can also ignite materials without direct flame contact. Heat transfers across open space, meaning surfaces exposed to nearby fire can rapidly heat up even when flames are not touching the home. This heat can crack or break windows, allowing embers and flames to enter - drying, weakening or deforming building materials. The larger the fuel source and the closer it is to the home, the greater the radiant heat exposure.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Vegetation separation
- External materials

NEW BUILD + RETROFIT
- Outer shell hardening
- Screen/shutter protection
- Treatment of grasses

RETROFIT
- Vulnerable materials upgrading

Resilience strategies: Bushfire flame contact Surface fires and Radiant heat

NEW BUILD

Maximise separation from surrounding vegetation

Site the home to maintain as much distance as possible from bushland or dense planting, reducing the chance of flames reaching the building. Increasing separation is one of the most effective ways to limit direct fire exposure.

Use non-combustible external materials

Specify fibre cement, masonry, metal or similar materials for roof edging, walls, doors, soffits, eaves, posts, subfloors, decking, vents and all exposed elements. You can further reduce the likelihood of building ignition by using non-combustible internal materials such as steel framing, mineral wool insulation. Refer to the MultiHazard materials table, page xx for further guidance. <hyperlink>

Resilience strategies: Bushfire flame contact Surface fires and Radiant heat

NEW BUILD + RETROFIT

Harden the outer shell for flame contact

Combustible timber decking, verandahs, posts or external stairs, should be changed out for non-combustible materials or protected with fire-resistant covers. Especially where fire can spread from adjacent structures or large fuel sources, including neighbouring homes, fences, sheds, vehicles or stored materials.

Protect windows and doors with shutters or screens

Install bushfire-rated shutters or heavy-duty screens to shield glazing from heat and debris.

Keep grass short and avoid continuous dry grass

Maintain grass below 5 cm during fire season and avoid large continuous areas of dry grass around the home. Short, well-maintained grass produces lower flame heights and reduced radiant heat, while broken fuel continuity helps slow fire spread toward buildings.

Resilience strategies: Bushfire flame contact Surface fires and Radiant heat

RETROFIT

Upgrade vulnerable materials at key failure points
Flames and heat can crack or distort windows, flammable cladding, decking, posts, stairs, eaves and roof junctions. Replace or shield with non-combustible lining or sheeting and install bushfire rated window shutters.

BUSHFIRE RISK

Extreme winds

Bushfires are often accompanied by and can generate their own strong, turbulent winds, sending embers and flames to the home. These winds not only create secondary fires, but they place significant pressure on the outer shell of the home - lifting roof elements, loosening flashings and cladding, and forcing open gaps at joints and connections. When the envelope of the home is compromised, new pathways are created for embers and flames to enter.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Door & window reinforcement
- Secure roofing & cladding

Resilience strategies: Extreme winds

NEW BUILD

Reinforce doors and windows against wind

Use wind-rated doors, windows, and garage doors, and strengthen them with features like drop bolts, multi-point locks, reinforced tracks, toughened glass, and shutters. These measures reduce the chance of wind opening the home to embers and flame.

Secure roofing and cladding to prevent breaches

Ensure roof sheets, flashings and cladding are firmly fixed with robust fasteners and closer spacing than minimum requirements. Check that they are in good condition so they don't lift or detach in strong winds.

BUSHFIRE RISK

Debris Impact

Strong winds can hurl debris, including burning branches and other materials, at the exterior of the home. Falling trees or large limbs can also strike the building with significant force. These impacts can break windows, damage cladding or dislodge elements, creating openings that allow embers and flames to enter the building.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD + RETROFIT
- Protection from ember entry
- Reduce strike risk
- Securing loose items

Resilience strategies: Debris impact

NEW BUILD + RETROFIT

Protect windows and doors from impact and ember entry

Use toughened glazing to improve resistance to heat and impact. Consider laminated glazing in combination where additional integrity is required. Install shutters or heavy-duty screens to reduce heat and flame exposure.

Manage trees to reduce strike risk

Space trees so that, when mature, they can fall without hitting near the home or structures. Remove weak or overhanging branches. Falling trees and limbs are a leading cause of severe structural damage and can breach the building envelope, allowing embers and flames to enter.

Secure loose and movable items

Tie down or relocate lightweight items such as outdoor furniture, bins, tools and materials, which are likely to become airborne in bushfire winds.

BREAKOUT

Combustible vs non-combustible items around the home

Combustible materials can ignite, burn, or melt when exposed to embers, heat or flames. Around the home, these materials often act as the first point of ignition — starting small fires that spread to the building. Non-combustible materials do not readily burn and are far less likely to ignite from flame contact, embers or radiant heat. Using these non-combustible materials significantly reduces risk.

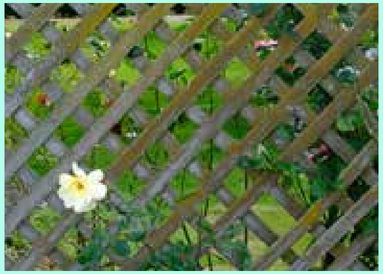
Common combustible items to watch for

Timber furniture, offcut building materials stowed beneath decking and stored firewood

Plastic items such as bins, outdoor furniture, toys and storage tubs

Doormats, cushions, shade cloth and outdoor fabrics

Mulch, leaf litter and dry garden beds



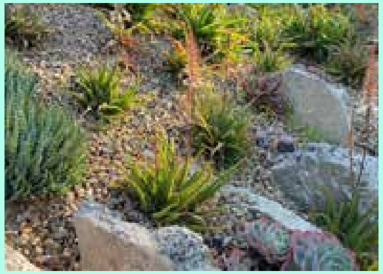
Timber fencing and screening near walls or windows

Stored materials under decks or floors

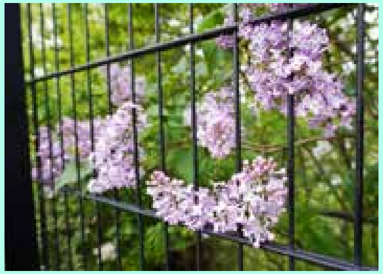
Safer non-combustible alternatives

Metal furniture, steel storage and aluminium products

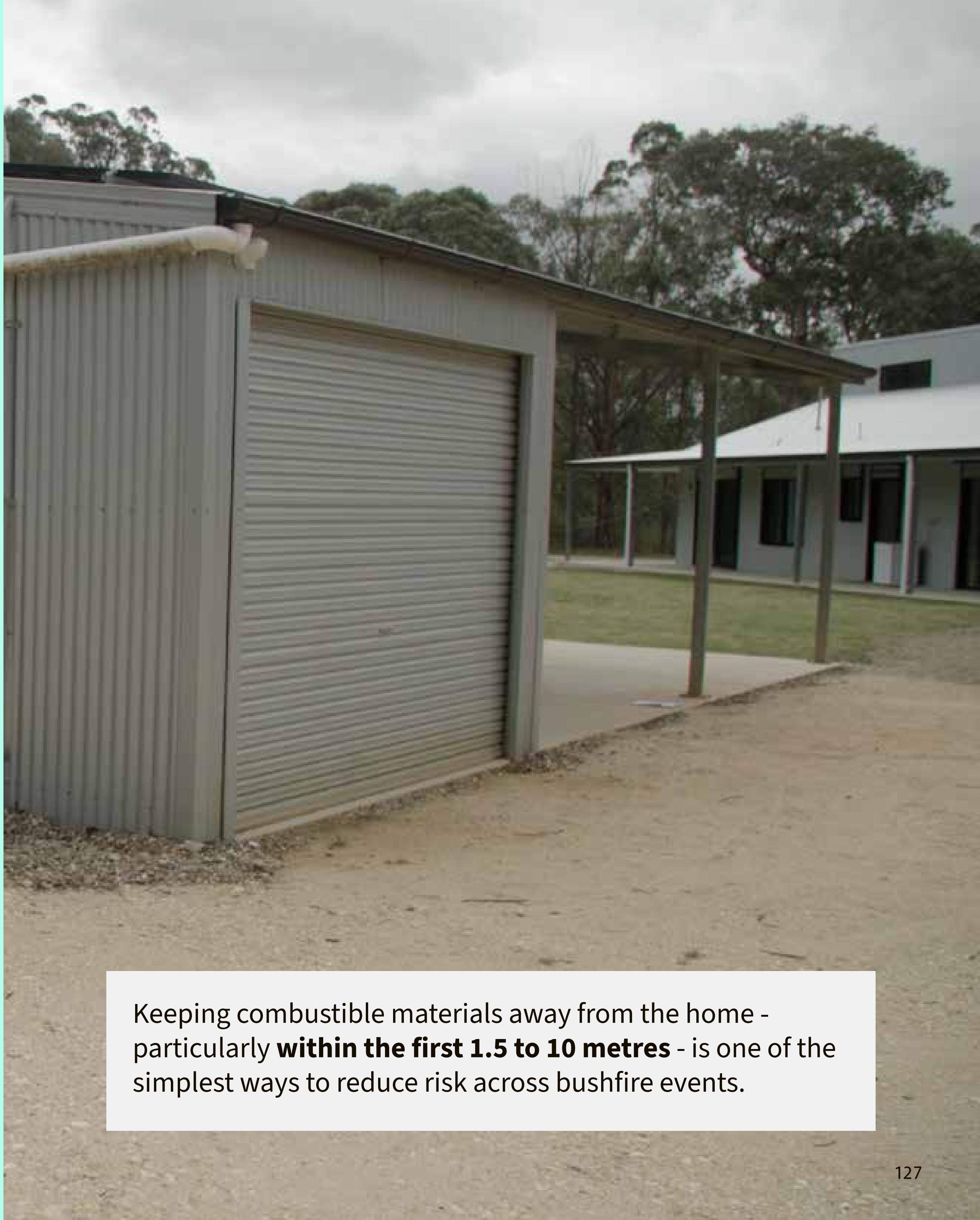
Concrete, brick, stone and masonry hardscaping



Gravel, pebbles or paved surfaces instead of organic mulch



Fibre cement or metal screening in place of timber



Keeping combustible materials away from the home - particularly **within the first 1.5 to 10 metres** - is one of the simplest ways to reduce risk across bushfire events.

Recovery

Making the home stable

Life safety

Immediately after a bushfire, life safety and emergency management are the priority. Conditions can be complex and unpredictable, so follow emergency service advice and only return when it is safe to do so. For example, trees may have been weakened by fire and can fall without warning, so they should be inspected before entering the site.

Even where damage appears minor, heat exposure can weaken structural elements, and there may be undetected fires burning in roof spaces, wall cavities or underfloor areas. Ember attack can continue after the fire front has passed, and small ignitions may develop slowly over time. Services such as electricity and gas may also be compromised. Solar panels can remain live during daylight hours even when systems are shut down and should not be handled or cleared of debris without appropriate expertise.

Toxic gasses

Building materials, home furnishings and nearby stored items such as cars, caravans, boats, fuels and paints produce toxic gases when exposed to bushfire attack. Consider the toxicity when selecting building materials and furnishings and keep toxic stored items away from the home. More information about indoor and outdoor air quality is available from the Australian Building Codes Board and the Department of Energy, Climate Change, Environment and Water.

Site access

This stage focuses on making the site safe to access, isolating hazards and preventing any ongoing or secondary damage. This work is typically undertaken by emergency services and qualified trades, alongside continued monitoring for any signs of ignition.

Recovery

Making the home stable

STRATEGIES

1.

Remove immediate hazards and secure the site

Avoid fire-damaged structural debris and restrict unsafe areas until emergency services and trades can inspect and support recovery.

2.

Isolate and secure damaged services

Turn off electricity, gas and other services until they can be properly assessed, as heat may have damaged systems.

3.

Check for structural damage and instability

Inspect key elements like the roof, walls and supports for signs of weakening, movement or collapse risk before entering or occupying the home.

4.

Identify and extinguish hidden fire risks

Check concealed spaces such as roof cavities and underfloor areas for smouldering materials that could reignite.

Recovery

Make the home ready to occupy

Once immediate risks are controlled, the focus shifts to making the home safe and functional for occupants. Bushfires can leave behind ash, soot and residues that are harmful to health, as well as hidden damage from heat, smoke and firefighting water.

This stage involves cleaning contaminants, confirming the building is safe to live in, and restoring essential services so the home can be used again, even if full repairs are still to come.

STRATEGIES

1.

Clean ash, soot and contaminants

Remove residues from internal and external surfaces, as these can be harmful and corrosive if left in place.

2.

Assess visible and hidden damage

Check roof spaces, wall systems and internal linings for heat, smoke or water damage before reoccupation.

3.

Use professionals to restore essential services

Reconnect power, solar, batteries and gas once confirmed safe and functional. Water supplies will likely be contaminated after a fire and should be tested by authorities before use.

4.

Carry out temporary or essential repairs

Repair or cover damaged areas such as roofs, windows and doors to make the home weather-tight and secure. Recovery provides an opportunity to upgrade vulnerable components, improve detailing and reduce ember entry pathways to limit further damage.

High-Risk Bushfire Home

1 Timber decks and steps connected to the house

These often ignite from embers and transfer fire directly to walls and doors.

2 Flammable mulch vegetation adjacent to decks

Dry shrubs and mulch can easily ignite and crack windows or spread fire to the home.

3 Vulnerable glazing

Glass windows and doors can crack letting embers in. Particularly when adjacent to flammable decks, items and garden beds.

4 Combustible materials stored against the house

Firewood, bins, furniture and stored items can ignite and act as a bridge to the building.

High-Risk Bushfire Home

5 Trees overhanging roofs

Trees overhanging roofs shed debris, cause damage when fallen in extreme winds, and bring flame contact and radiant heat immediately over the home.

6 Unprotected vents and eaves

Openings into roof spaces are one of the most common ember entry points, especially where mesh is missing or too coarse.

7 Accumulated debris in gutters and roof valleys

Leaves and twigs ignite easily and can start fires directly on the roof.

8 Gaps at roof edges and under flashings

Small gaps where roofing meets walls or gutters allow embers to be drawn into the roof cavity.

9 Complex roof geometry with valleys and junctions

These areas trap debris and create multiple ember entry points.

10 Horizontal timber elements

Combustible surfaces where embers can accumulate increase the likelihood of fire starting on the building envelope.

Bushfire resilient home

1 **Detached or separated combustible elements**
Fences, garden beds, and stored materials are isolated away from the home

2 **Water access provisions for firefighting**
Accessible water supply and clear access improve the defendability of the home

3 **Managed Immediate and Inner Zones around the home**
Hard surfaces, short grass, and no fuel areas create a buffer from flame contact and radiant heat

4 **Clean protected roof and gutter**
Prevents accumulation and ignition of debris on the roof

5 **Simple roof design with minimal junctions**
Reduces debris build up and minimises vulnerable points in building shell

6 **Reduced fuel load and managed vegetation**
Trees and gardens have open space between them, are well watered, and free of debris and dead branches.

Bushfire resilient home

7 **Sealed and ember proofed envelope**
All gaps, joints, vents and penetrations are screened or sealed to prevent ember entry

8 **Avoid or protect subfloors**
Eliminate the chance of secondary fires beneath the home

9 **External shutters over openings**
Doors and windows are shielded from shattering under radiant heat

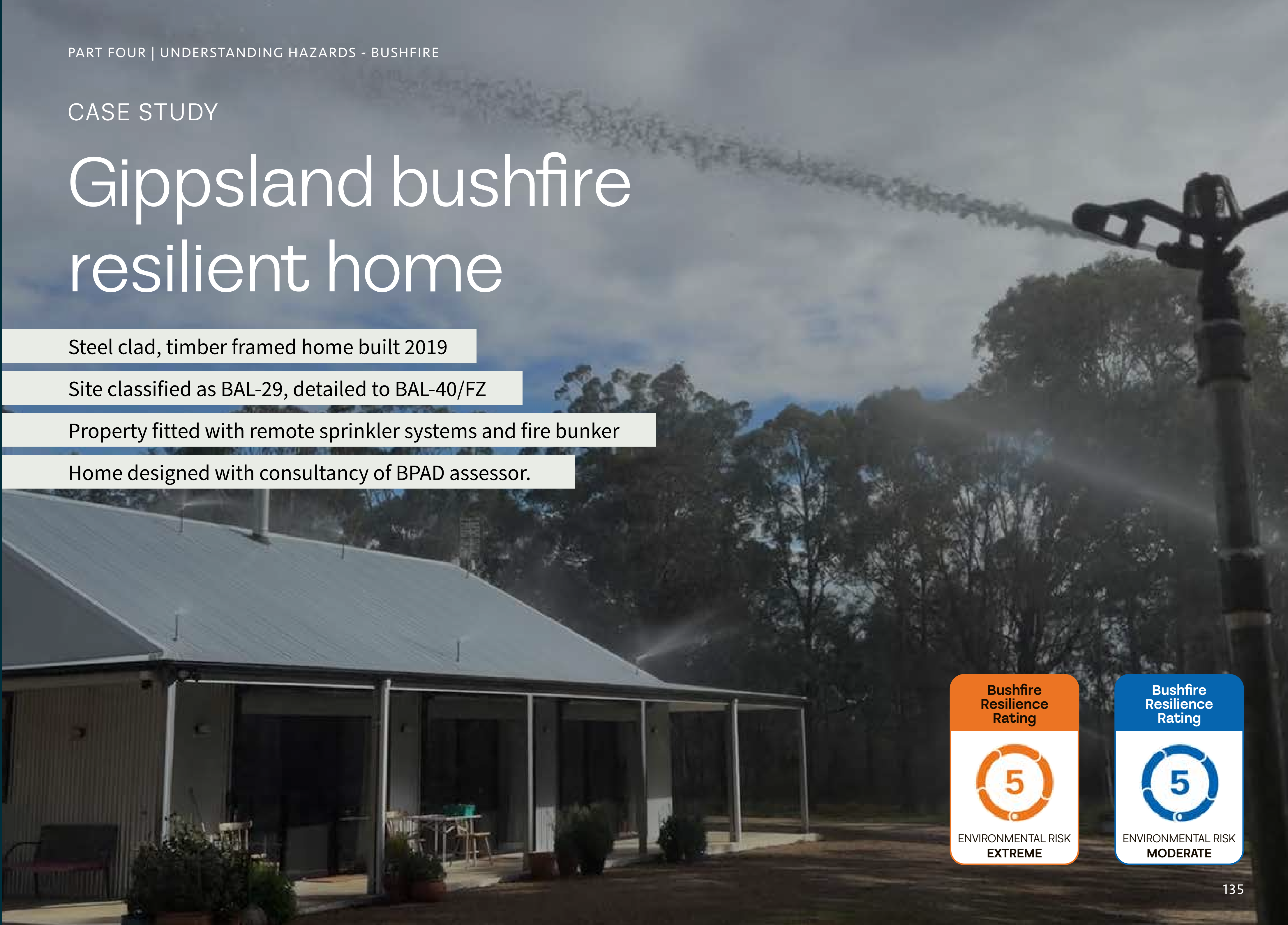
10 **Toughened windows and doors**
Provides back up strategy to shutters to prevent window failure as a result of radiant heat or debris impact

11 **Non-combustible materials externally**
Walls, decks, roofs and key elements resist ignition

CASE STUDY

Gippsland bushfire resilient home

- Steel clad, timber framed home built 2019
- Site classified as BAL-29, detailed to BAL-40/FZ
- Property fitted with remote sprinkler systems and fire bunker
- Home designed with consultancy of BPAD assessor.



Resilience journey

Kim and her partner originally planned to build a mud brick home on this East Gippsland property using recycled materials. They started clearing the block and laid a concrete slab. But after witnessing the catastrophic scale of the 2019-2020 bushfires, alongside rising labour and material costs, they changed direction.

They worked closely with their builder to design a simpler, practical home with bushfire resilience as their central goal. They collaborated with a bushfire design assessor to map their property's risk and determine their BAL rating, and engaged bushfire pump specialists to install a remote sprinkler system.

> We realize, obviously we can't foresee every particular circumstance, but we've tried the best we can to make the property survivable.
>
> *Kim, homeowner in East Gippsland*

The surrounding landscaping is managed to reduce fuel load, but it also forms part of the home's broader defence strategy. Mineral earth surrounds the robust concrete verandah and a non-combustible driveway encircles the home to create effective firebreaks.

Vegetation is deliberately positioned away from the home and moveable ceramic pots nearby mean any combustible materials can be easily removed during high-risk periods.

The non-combustible driveway acts as a firebreak.

The robust concrete verandah reduces risk of surface fires reaching the home.

Vegie garden is sited well away from the main building.

Movable ceramic pots can be repositioned away from home during high-risk seasons.

Costs of resilience measures:

Approximately $50k more than typical build

> The idea of staying and defending the house is just absolutely terrifying to me. I have no desire at all. **It was leave early, lock the place up**. The absolute last resort is the bunker in the backyard, it's a bit of peace of mind, although you'd have to drag me kicking and screaming into there.
>
> *Kim, homeowner in East Gippsland*

Watch this **Resilience in Action** case study video.

WATCH NOW

Heatwave

Why do homes fail in heatwave?

Heatwaves are Australia's most deadly natural hazard and are becoming longer, hotter and more frequent. For many homes, the issue isn't just the temperature outside, but how heat builds up and stays trapped inside over consecutive days and nights.

Homes struggle in heatwaves because heat doesn't just enter once and leave. It is absorbed through roofs, walls and windows, stored in building materials, and reinforced by hot outdoor air and surrounding hard surfaces. When this heat can't escape, indoor temperatures remain high overnight, reducing the home's ability to recover before the next hot day. This cycle of heat gain and retention intensifies over time, leading to hotter indoor conditions, higher cooling demand and reduced comfort.

The following section outlines the main ways this happens through trapped heat, lack of shading, air gaps and poor insulation.

Heatwave Risks

1 **Lack of shading**
Direct sun through windows, especially west-facing glazing, can rapidly heat indoor spaces and drive most of the heat gains.

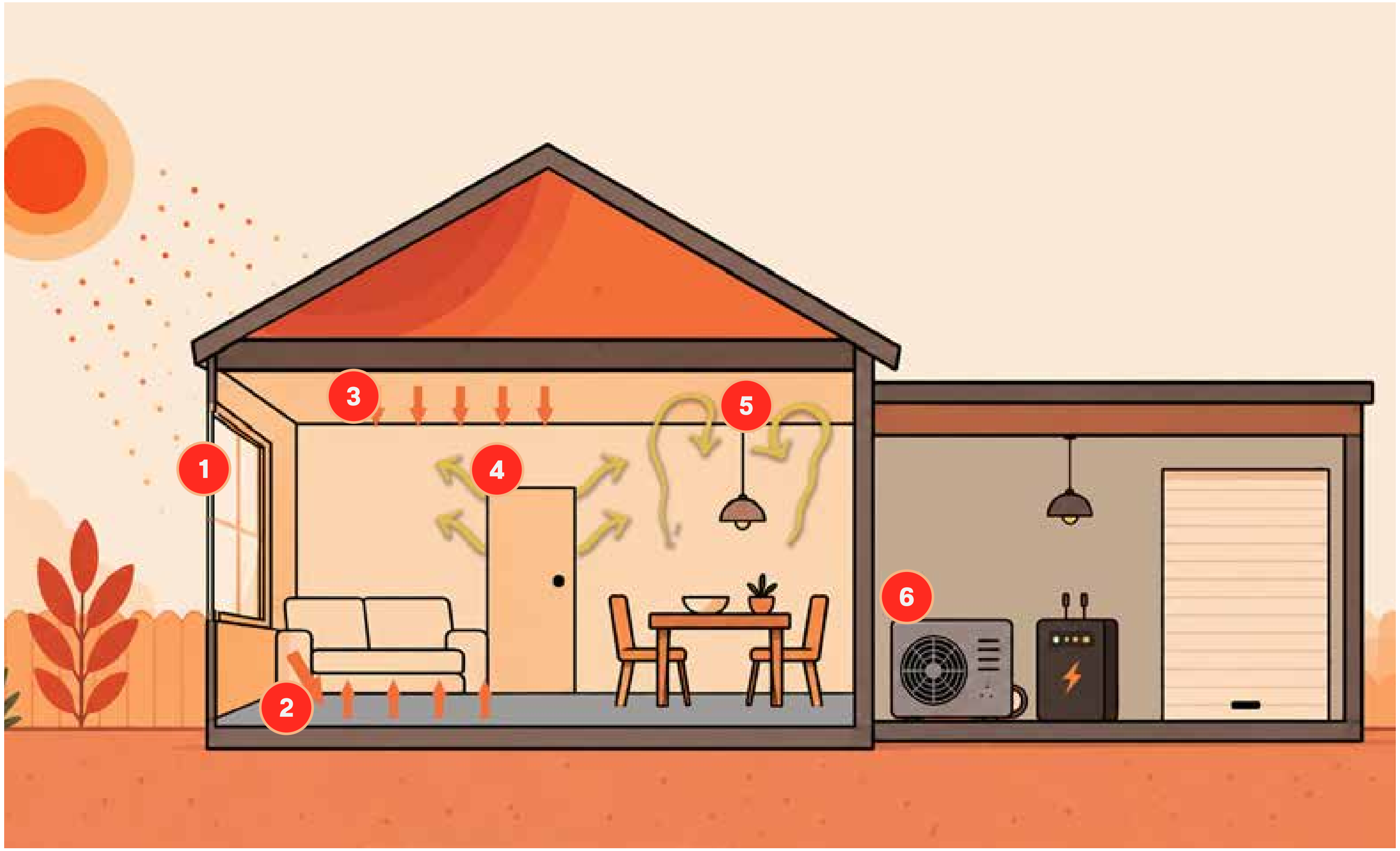
2 **Poorly designed thermal mass**
Materials that absorb and store heat during the day, such as concrete, brick and stone, can release unwanted heat back into the home overnight if exposed to excessive sun.

3 **Inadequate insulation**
Poorly insulated roofs, walls and ceilings allow external heat to transfer quickly into living spaces, especially from heat build-up in roof cavities.

4 **Air leakage**
Gaps, cracks and poorly sealed openings allow hot outside air to enter the home uncontrollably, increasing indoor temperatures and reducing cooling efficiency.

5 **Trapped heat**
Heat builds up during the day and can't escape at night, causing indoor temperatures to stay high and **worsen over time.**

6 **Heatwave safety and mechanical systems**
Poorly maintained cooling systems and a lack of backup power can reduce the home's ability to stay cool during extreme heat conditions.



HEATWAVE RISK

Trapped heat

During a heatwave, homes absorb heat through the roof, walls and windows, as well as from hot outdoor air and surrounding hard surfaces. If this heat isn't managed, it builds up inside the home, especially where there is limited shading or insulation. Warm air rises, and without clear ventilation pathways such as low and high openings, it becomes trapped indoors. This means hot air can't escape and cooler night air can't move through the home to flush it out. Over several hot days, heat accumulates, leading to rising indoor temperatures, increased reliance on cooling systems and reduced comfort.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Home site
- Cross-ventilation design
- High-level openings

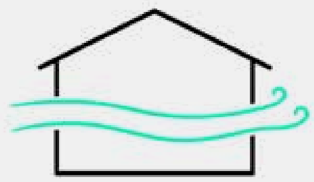
NEW BUILD + RETROFIT
- Day/night heating & cooling
- Door screens
- Openable windows

Resilience strategies: Trapped heat

NEW BUILD

Site the home to allow space

So cool breeze can move through, avoid tight setbacks that block airflow between buildings.



Design for cross-ventilation

To allow cool breezes through, place windows and doors on opposite sides of the home and limit floorplan depth so air can move through rooms effectively. Keep layouts open or doors aligned to maintain clear airflow paths between rooms.

Include high-level openings to release hot air

Use high windows or stairwell openings to let rising hot air escape. Warm air naturally rises, so opening higher points in the home allows it to flow out, drawing in cooler air from lower openings. This “chimney effect” helps flush heat from the home more effectively, especially during night-time cooling.

Resilience strategies: Trapped heat

NEW BUILD + RETROFIT

Purge heat at night, close up during the day

Open windows when the outside air becomes cooler than indoors, typically in the evening and overnight, to flush out stored heat. Close windows, external shutters and curtains early in the morning before outdoor temperatures rise. This prevents heat building up day-to-day and keeps cooler night air inside for longer.

Install tough flyscreens and lockable door screens

Securely fix metal mesh screens (e.g. stainless steel) to openable windows and external doors. These allow safe night-time ventilation while keeping insects out and maintaining security. In bushfire areas, use fine apertures (around 2 mm) to block embers and select thicker wires and robust frames for storm resilience and rodent-proofing.

Provide openable windows to key rooms

Ensure bedrooms and living areas have operable windows that allow natural ventilation and crossflow. In existing homes, this may involve replacing or modifying fixed windows where practical.

HEATWAVE RISK

Lack of shading

Direct sunlight is one of the main ways heat enters a home, especially through windows and sun-exposed walls. When the sun hits glass or external surfaces, it quickly warms the building and the air inside. This is most noticeable on west-facing windows and walls, where the low afternoon sun is strong and harder to block. Even a short period of direct sun can quickly lift indoor temperatures.

Without proper external shading, the amount of heat entering the home is largely uncontrolled and once that heat gets inside it's difficult to remove. Materials like concrete, brick and stone absorb heat during the day and release it slowly over time. If these materials are exposed to direct sun or the home cannot be cooled at night, they can release heat back into the home overnight, keeping indoor temperatures high.

Using eaves, shutters, vegetation or other external shading to block sunlight before it can reach the home is the most effective way to reduce heatwave impacts.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD

- Fixed eave design
- Directional glazing

NEW BUILD + RETROFIT

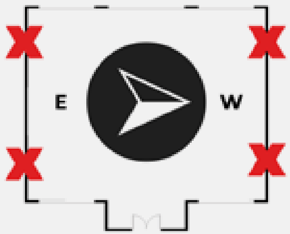
- External shutters
- Heat-reflective surfaces
- Avoid skylights
- Using lined curtains
- Gardens for shade and cooling
- Permeable landscaping

Resilience strategies: Lack of shading

NEW BUILD

Design fixed eaves to north-facing windows

Use eaves sized to block high summer sun while still allowing lower winter sun where that is desirable for your climate. North-facing windows are the easiest orientation to shade well with roof eaves.



Minimise east- and west-facing glazing

Keep east and especially west-facing windows smaller where possible and avoid relying on large areas of unprotected glass on these sides. The low summer sun makes it hard to shade these orientations effectively.

Resilience strategies: Lack of shading

NEW BUILD + RETROFIT

Add external shutters

Use external shutters as a robust shading measure, particularly on exposed East and West windows. They block heat before it enters and, unlike lightweight shade sails or many fabric blinds.

Use light-coloured, heat-reflective surfaces

Roofs and walls exposed to the sun can get very hot. Lighter, more reflective finishes bounce heat away instead of absorbing it, helping keep indoor temperatures lower.

Avoid large, unprotected skylights

Skylights can admit significantly more summer heat than the same area of vertical glazing, while also increasing risks of water ingress, hail damage and ember entry if poorly detailed. Where roof glazing is used, favour smaller, well-sealed systems with insulated glazing and robust flashing. High-level openings can help purge heat through stack ventilation, but clerestory windows are a more resilient option.

Resilience strategies: Lack of shading

NEW BUILD *(continued)* + RETROFIT

Use lined curtains as a backup to external shading

Insulative window furnishings like lined drapes with pelmets or honeycomb blinds can reduce heat entering through windows, but they are most effective when used with external shading. Blocking the sun outside the window is the priority.

Garden for shade and cooling

Use trees, planting and shaded outdoor areas to reduce direct sun on the home and limit heat reflected and radiated from nearby surfaces. They also offer cooling microclimates through transpiration.

Permeable landscaping

Use permeable surfaces that retain moisture instead of dark paving or concrete to reduce heat build-up around the home.

HEATWAVE RISK

Air leakage

Hot outside air can enter a home through gaps, cracks and unsealed openings in the building envelope. This happens at joints in cladding, around windows and doors, at flashings, and where services pass through walls and ceilings. Wind and pressure differences drive this air movement, allowing hot air to replace cooler indoor air in an uncontrolled way.

When air leakage is not managed, it undermines insulation and shading by bringing heat directly inside. Complex building shapes, poorly sealed junctions, and unprotected openings make this harder to control.

Effective cooling relies on controlling where and when air enters the home. This means creating a well-sealed building envelope using wall wraps and careful detailing, sealing gaps at junctions and penetrations, and using tight-fitting windows, doors and dampers so openings remain closed when not in use.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Wall wraps
- Effective sealing

NEW BUILD + RETROFIT
- Roof gaps and edges
- Seal doors and windows
- Screen openings
- Subfloor areas
- Lower building elements

RETROFIT
- Repair weak elements

Resilience strategies: Air leakage

NEW BUILD

Reduce air leaks with well-installed wall wraps

Wall wraps act as a protective thermal barrier, improve energy efficiency, and manage moisture, but only if they are properly sealed at joins, junctions, and around windows and doors. High-performance homes, including Passive House, rely on this approach - controlling when air enters rather than letting heat drift in through hidden leaks.

Simplify building and roof shape for effective sealing

Junctions and complex ceiling shapes are the hardest elements to seal reliably. This is typically done with a high-performance tape which covers the joins and tricky details. A simple ceiling shape and rectangular floorplan support ensure best execution.

Resilience strategies: **Air leakage**

NEW BUILD + RETROFIT

Seal windows, doors with durable multi-hazard seals

Use well-fitted windows and doors with compression seals where possible to limit air leakage.

Resilience strategies: Air leakage

RETROFIT

Seal unused openings and leakage points

Close off unused chimneys, vents and service penetrations, and seal gaps around flashing, cladding junctions and pipe penetrations using durable sealants, gaskets or compression flashings. Pay particular attention to roof penetrations and gaps where services pass through the building envelope, as these are common pathways for hot air, moisture and draughts to enter the home.

Fit dampers to required vents and exhausts

Where ventilation openings are required, use backdraft dampers or gravity-operated shutter grilles so vents close automatically when fans are not operating, helping reduce hot air, draughts and pests entering the home.

HEATWAVE RISK

Inadequate insulation

Insulation slows the flow of heat through the roof, walls and ceiling, helping to keep indoor temperatures more stable. Without it, or where it is poorly installed, heat from hot roofs and walls passes quickly into the home.

During a heatwave, roofs are the greatest source of heat gains and the direct sun can make surfaces reach very high temperatures. Without effective insulation, this heat is transferred directly indoors, creating a steady flow of heat throughout the day.

Good insulation helps keep heat out during hot periods and reduces how quickly any cooling gained overnight is lost, improving comfort and reducing the need for mechanical cooling. It also helps slow the loss of heat from the home in winter.

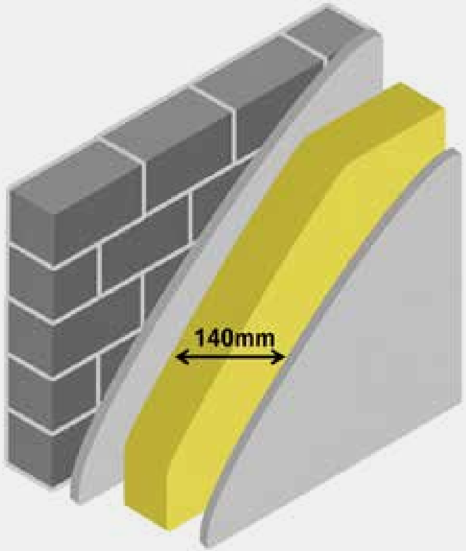
RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Maximum insulation design

NEW BUILD + RETROFIT
- Ceiling insulation
- Wall insulation
- Window upgrades
- Best performance choice

Resilience strategies: Inadequate insulation

NEW BUILD



Design roof and wall spaces for maximum insulation

Design to suit thicker, high R-value insulation (e.g. 140mm cavities). Ensure it can be laid continuously around corners, junctions and structural elements. Gaps or compressed insulation will significantly reduce performance.

Resilience strategies: Inadequate insulation

NEW BUILD + RETROFIT

Prioritise ceiling insulation

Focus on insulating the ceiling or roof first, as this is the main pathway for heat entering the home. In new builds, work with your electrician to select lighting and exhaust fan systems that allow insulation to be laid continuously over ceiling penetrations.

Insulate walls where possible

Wall insulation is most beneficial in lightweight homes or where walls are highly exposed to sun. When renovating, consider adding insulation and a wall wrap.

Upgrade windows to high performance glazing

Use double glazing and low-e coatings where possible to reduce heat transfer and unwanted solar heat gain while maintaining natural light. In hotter climates, select glazing with a low solar heat gain coefficient (SHGC), particularly for west-facing windows.

Choose best performing window and door frames

Aluminium and steel frames can transfer heat into the home. Timber, thermally broken aluminium, and uPVC are typically more insulative.

HEATWAVE RISK

Poorly designed thermal mass

Materials such as concrete, brick and stone can help stabilise indoor temperatures by absorbing and storing heat or cool, and releasing it more gradually over time, helping reduce rapid indoor temperature swings. In climates with cool nights and good ventilation, this can reduce daytime overheating and improve comfort.

But during prolonged heatwaves or in humid climates where night's stay warm, thermal mass can become a heat trap. If stored heat cannot be flushed out overnight, these materials will continue releasing heat back indoors long after sunset. This causes temperatures to build over consecutive days, making the home progressively harder to cool.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD
- Thermal mass matching
- Ground-coupled slabs
- Thermal mass protection

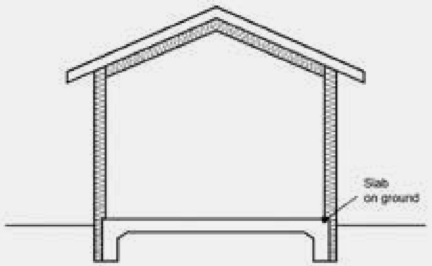
NEW BUILD + RETROFIT
- Overnight cooling
- External shading

Resilience strategies: Poorly designed thermal mass

NEW BUILD

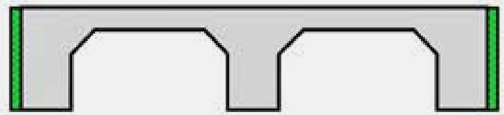
Match thermal mass to climate

Reduce thermal mass use in humid climates or urban heat islands where nights do not cool down enough for stored heat to escape.



Consider ground-coupled slabs where appropriate

Concrete slabs connected directly to the ground can help keep temperatures down in areas with stable deeper ground temperatures. This is typically climate zones 3, 4, and 5. It may be suitable in zones 2 & 6 but expert advice is recommended to make sure it is suitable for your home.
Check the ABCB Climate Map | NCC >



Locate and protect thermal mass within the insulated envelope

Concrete slabs and masonry walls work best when insulated from external heat and direct summer sun. Uninsulated slab edges and exposed masonry can absorb and transfer unwanted heat into the home during prolonged hot weather.

Resilience strategies: Poorly designed thermal mass

NEW BUILD + RETROFIT

Cool the home overnight

Ensure thermal mass can release stored heat at night through ventilation or cooling systems.

Use external shading

Shade thermal masses from summer sun to stop heat being absorbed into internal floors and walls during the day.

HEATWAVE RISK

Heatwave safety and mechanical systems

Mechanical systems such as fans, air conditioning or ventilation systems are important for occupant health during heatwaves. They help remove accumulated heat, improve air movement and maintain safer indoor temperatures, especially overnight when recovery is essential.

However, they are often less reliable than passive design measures, particularly during power outages or prolonged extreme events. Shading, insulation, airtightness and well-designed ventilation reduce the amount of heat entering the home in the first place, helping cooling systems work more effectively, reducing energy demand and improving comfort even if mechanical systems fail or become unavailable.

RESILIENCE STRATEGIES AT A GLANCE

NEW BUILD + RETROFIT

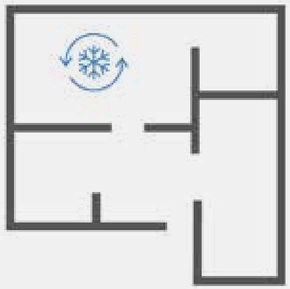
- Maintain cooling systems
- High-use zones
- Comfort improvement
- Power outage planning
- Overnight cooling
- External shading

Resilience strategies: Heatwave safety and mechanical systems

NEW BUILD + RETROFIT

Maintain cooling systems before summer

Service air conditioners, clean filters and check controls regularly to ensure systems can operate efficiently during heatwaves.



Prioritise high-use zones

Prioritise cooling for bedrooms and regularly occupied spaces to help maintain safe indoor temperatures during heatwaves.

Use ceiling and portable fans to improve comfort

Air movement can significantly improve thermal comfort and reduce heat stress.

Plan for power outages and extreme events

Heatwaves can coincide with power failures. Consider backup power, cooler refuge rooms, battery storage or alternative cooling locations for vulnerable occupants.

High-risk heatwave home

1 **Large heat-absorbing hard surfaces**
Extensive concrete, paving and dark hardscaping absorb and radiate heat into surrounding areas, increasing local temperatures around the home and outdoor living spaces.

2 **Windows that cannot be opened**
Fixed windows prevent natural ventilation and night purging, trapping heat indoors and limiting passive cooling during hot weather and power outages.

3 **Dark roof and wall colours**
Dark external surfaces absorb significantly more solar heat, increasing roof and wall temperatures and driving more heat into the building.

4 **Large west-facing windows without protection**
Unshaded western glazing is exposed to intense afternoon sun, creating severe indoor overheating during summer and heatwaves.

5 **No eaves or external shading**
Homes without shading allow direct summer sun onto walls and windows, dramatically increasing indoor heat gain and cooling demand.

High-risk heatwave home

6 Single-glazed aluminium windows with poor seals

Single glazing and conductive aluminium frames transfer heat rapidly, while poor seals allow hot outside air to leak into the home.

7 Poor ceiling and wall insulation

Inadequate insulation allows external heat to rapidly penetrate into living spaces, especially through roofs exposed to intense summer sun.

8 Large unprotected skylight

Skylights admit high levels of direct solar heat and can become major overheating points unless carefully shaded, insulated and ventilated.

Heatwave resilient home

1 Gardens for shade and microclimate cooling

Trees, shrubs and planted areas help cool the surrounding environment through shading and evapotranspiration, reducing heat around the home and outdoor spaces.

2 Deep eaves for external shading

Wide eaves block high summer sun before it reaches windows and walls, particularly on western and northern sides where heat loads are greatest.

3 Smaller, protected west-facing windows

Limiting west-facing glazing and protecting it with eaves, shutters or screens reduces exposure to intense late-afternoon summer sun.

4 Light-coloured, reflective external finishes

Pale roofs and wall finishes reflect more solar radiation and absorb less heat, helping reduce indoor temperatures during hot weather.

Heatwave resilient home

5 Thermally efficient windows and doors

Insulated glazing, thermally broken frames and well-sealed doors reduce unwanted heat transfer into the home.

6 Openable windows for cross-ventilation

Carefully positioned operable windows allow breezes to move through the home, improving natural cooling and supporting night-time heat purging.

7 High-performance insulation

Effective ceiling and wall insulation slows heat transfer through the building envelope and helps maintain safer indoor temperatures during heatwaves.

8 Airtight and well-sealed building envelope

Sealed gaps around windows, doors and service penetrations help keep hot external air out and improve the effectiveness of passive and mechanical cooling systems.

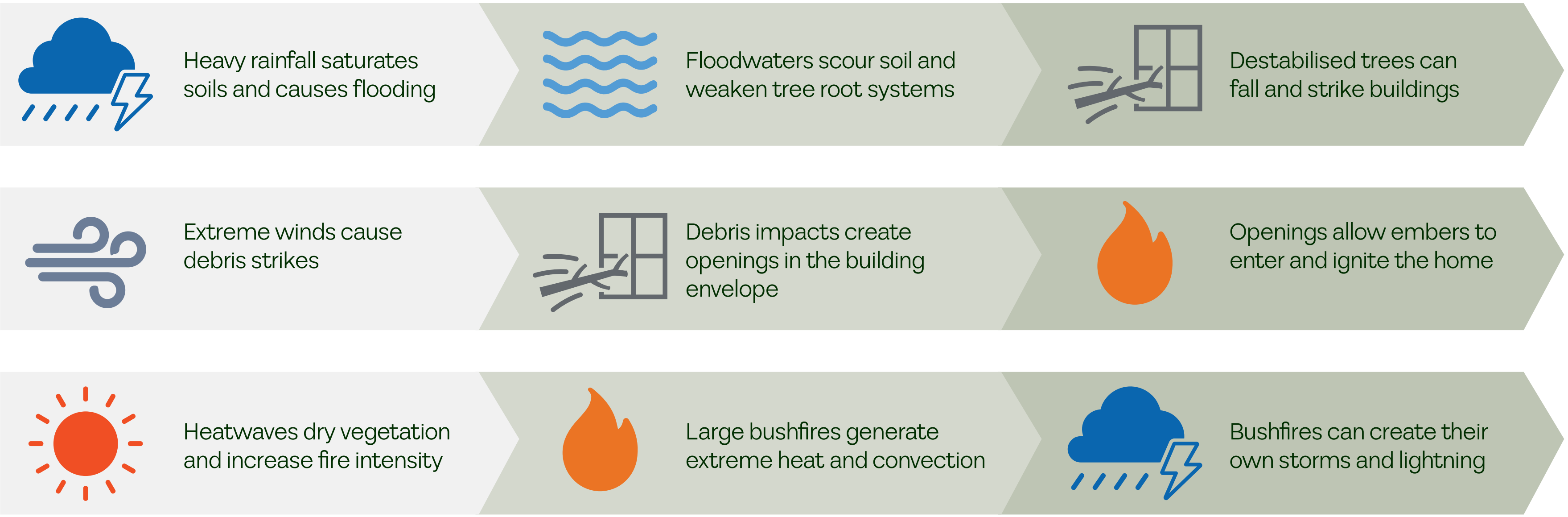
> Because I didn’t have insurance at that time, I started immediately pulling things apart and cleaning up because I couldn’t afford to wait or leave damaged materials sitting there.
>
> The resilient design features made a huge difference because a lot of the downstairs areas were **basically just a hose off**.
>
> *Anette Rowley*

PART FIVE

Design principles for multiple hazards

Common Hazard Interactions

Most disasters are not driven by a single hazard acting alone, but by hazards that occur together or in sequence. When homes are designed or upgraded for only one hazard, these interactions are often missed, leaving weak points that can still lead to damage.

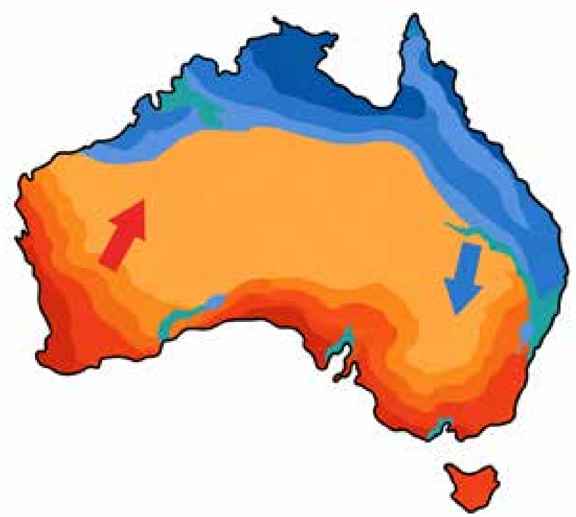


Risk is shifting

Many areas that historically faced limited hazard exposure are now experiencing conditions they were not designed for. Bushfire, flood, storm and heat risks are expanding in both intensity and geographic reach—particularly across urban fringe areas.

- Bushfire risk is expanding into new areas and the season is lasting longer
- Storm and cyclone impacts are reaching further inland and south
- Intense rainfall events are increasing the risk of flash flooding to areas not historically mapped as flood-prone
- Homes built to past conditions are under increasing pressure

This is changing how homes need to be designed, located and upgraded.



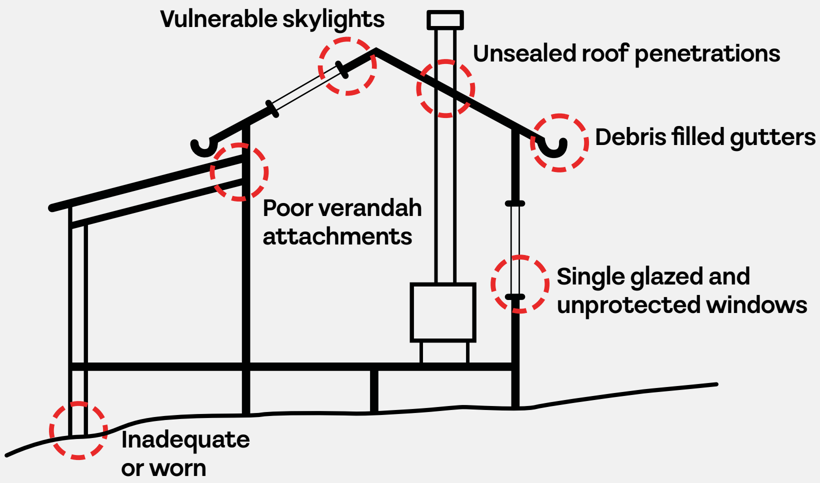
Benefits of multi-hazard thinking

A multi-hazard approach focuses on the common ways homes are damaged—embers entering gaps, wind lifting elements, water finding pathways, and debris striking weak points. Rather than treating each hazard separately, it targets these shared vulnerabilities.

By strengthening the building envelope, managing what surrounds the home, and controlling how water and air move, a single set of upgrades can reduce risk across bushfire, storm, flood and heat. This leads to:

- Reduced maintenance, moisture, and pests
- Maximised return on investment for your home upgrades
- Robust performance in real conditions

Common weakpoints across hazards



Overlapping strategies

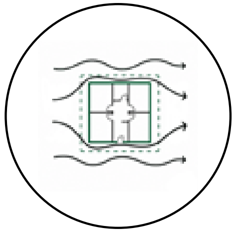
In many cases, upgrading for one hazard can provide benefits across others. Some of the most effective actions work across multiple risks. Below are some of the highest impact actions across multiple hazards

1. Protect windows with shutters or impact-resistant glazing

- Prevents ember entry and reduces radiant heat exposure that can break glass
- Protects against debris impact and prevents internal pressurisation from window failure
- Protects against debris shattering glazing
- Improves shading, reducing solar heat gain

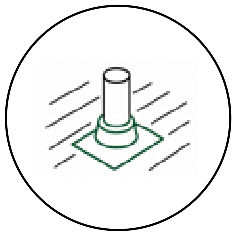
2. Install solid, well-sealed external doors

- Reduces ember entry through gaps and door assemblies
- Improves resistance to wind pressure and reduces wind driven rain
- Limits water ingress at door thresholds during heavy rain
- Improves sealing, helping maintain cooler indoor conditions



3. Use a compact, simple building form (new builds)

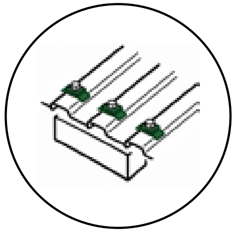
- Reduces corners and junctions where embers and debris can accumulate
- Lowers wind pressure concentrations on the building envelope
- Compact, square building forms allow floodwater to flow more evenly around the structure, reducing pressure concentrations, debris impact and local scour
- Reduces external surface area relative to volume, limiting heat gain and improving overall thermal efficiency



4. Seal roof junctions and penetrations

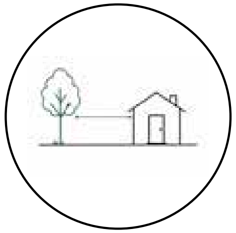
- Blocks ember entry through roof gaps, reducing a primary ignition pathway
- Reduces wind-driven rain entering the roof space during storms

Overlapping strategies



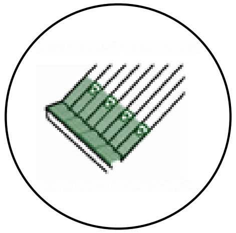
5. Strengthen roof fixings and tie-downs

- Helps maintain roof integrity under bushfire winds, reducing ember entry and limiting exposure of vulnerable internal materials
- Prevents roof uplift and structural failure during extreme winds, maintaining the building envelope and limiting water ingress



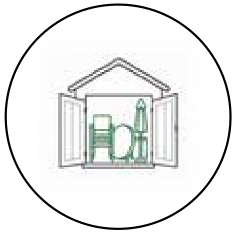
6. Maintain tree separation from the home

- Reduces radiant heat exposure, debris buildup, and removes nearby fuel sources
- Lowers risk of tree strike, falling branches



7. Install non-combustible gutter guards (with maintenance)

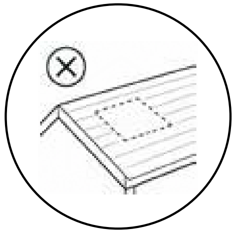
- Reduces build-up of dry leaves that can ignite from embers in gutters
- Supports gutters to drain freely without overflowing during heavy rains



8. Secure or store loose outdoor items

- Removes combustible items that can ignite close to the home
- Prevents items becoming wind-borne debris
- Reduces floating projectiles

Overlapping strategies



9. Avoid skylights or use only appropriately rated systems

- Skylights are vulnerable to ember attack and radiant heat, increasing ignition risk
- Skylights are prone to breakage from debris and wind pressure and create direct pathways for water entry during heavy rain
- Skylights can significantly increase solar heat gain, contributing to overheating

10. Install backup water and power systems

- Provides water for firefighting (hoses, sprinklers) when mains supply or power fails
- Maintains power for pumps and critical systems during storms and outages
- Supports pumping, drainage, and clean water access during and after flooding
- Enables continued cooling (fans, A/C, ventilation) during heatwaves and grid outages

Managing trade-offs

Designing for multiple hazards means balancing competing priorities. Some upgrades reduce one risk while introducing another, like clearing vegetation for fire safety but increasing heat exposure. The goal is to understand and prioritise the most significant risks to your site, and then make upgrades whilst limiting unwanted consequences. Below are some of the most common or significant trade-offs to manage, and some responses to them.

Blocking roof and gable vents

Benefits

- Reduces ember entry through roof openings
- Limits wind-driven rain entering roof spaces

Trade-offs

- Poorly ventilated roof spaces can trap heat and moisture, increasing overheating and condensation risk

Suggestions

- Use ember-protected vents rather than permanently sealing ventilation openings
- Provide controlled ventilation through operable windows, vents or designed airflow paths
- Use vapour-permeable sarking and ventilated cavities where appropriate
- Ensure roof spaces can release built-up heat safely

Trees near buildings

Benefits

- Can reduce solar heat gain to improving indoor and outdoor comfort

Problems

- Trees and shrubs close to the home increase fuel load, and ember exposure
- Branches or entire trees are capable of striking and causing major damage

Suggestions

- Place trees at safe distances from the home
- Select lower-flammability species and keep them well irrigated
- Retain strategic, well-spaced vegetation further away
- Keep branches clear of roofs and windows
- Avoid dense understorey beneath trees

Hard surfaces near or around the home

Benefits

Breaks up fuel continuity near the home

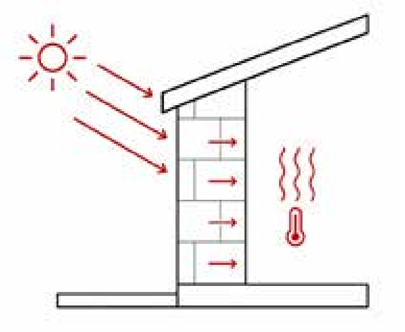
Problems

Hard surfaces increase runoff and can direct water toward the building or neighbours

Suggestions

- Use gravel, or pavers that retain some level of permeability
- Grade surfaces away from the house
- Use swales, rain gardens or gravel areas to slow water
- Avoid concentrating runoff into single discharge points

Specifying non-combustible materials



Benefits

Reduces ignition risk and improves fire resistance

Improves durability under wind and rain exposure

Problems

Can increase heat absorption and internal temperatures, especially with dark colours

Suggestions

- Use lighter-coloured, reflective finishes
- Add insulation and ventilated cavities
- Provide external shading to exposed surfaces
- Protect thermal mass from direct summer sun

Opening sub floors beneath the home

Benefits

Allows water to flow through, reducing pressure on the structure.

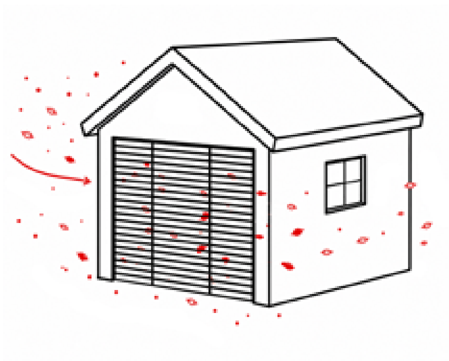
Problems

Openings can allow ember entry to ignite the floor structure or debris beneath the home

Suggestions

- Use corrosion-resistant ember screens that allows water to pass through
- Keep subfloor areas clear of combustible materials
- Use engineered openings where flood risk is high

Permeable garage doors for flood resilience



Benefits

Allows floodwater to pass through the garage, reducing pressure build-up on walls and doors

Problems

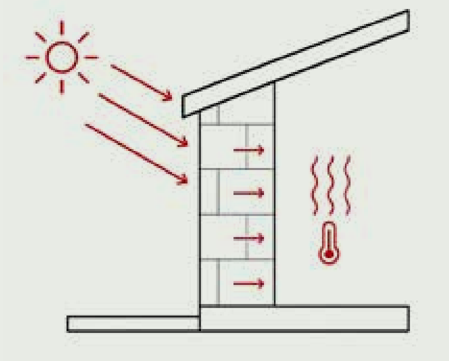
Not suitable for bushfire-prone areas where openings increase ember entry risk

Can reduce wind and debris resistance during storms and cyclones

Suggestions

- Only use in appropriate flood-focused contexts
- Combine with robust structural design and water-resistant materials
- Installing automatic two-way flood vents to the garage
- Consider opening a standard garage door ahead of an anticipated flooding event

Solid wall systems
(full masonry, concrete, blockwork)



Benefits

- More tolerant of floodwater inundation and easier to clean and dry after an event
- Often provide strong impact resistance and robust structural performance
- Fewer concealed cavities where embers or debris can accumulate

Problems

- Masonry and concrete have limited insulative value, leading to overheating during prolonged heatwaves, particularly on sun-exposed walls or locations where nights remain warm

Suggestions

- Use external shading to limit direct summer sun on masonry walls
- Insulate solid walls in habitable areas above flood levels
- Combine with night-time ventilation and protected thermal mass strategies where climates allow overnight cooling

Multi-hazard materials

There are common characteristics to materials that hold up well across hazards. They tend to be dense, robust and inorganic. They are often harder to ignite, less vulnerable to water damage, more resistant to debris impact, and less likely to detach or deform under extreme conditions. However, resilience depends not just on the material itself, but also on good detailing, fixings, drainage and maintenance.

It's important to note that there are materials that are not resilient in every situation. A material that performs well in bushfire may perform poorly in flood conditions. That's why we consider trade-offs, particularly where homes face risks from an extreme hazard (or multiple hazards).

Key multi-hazard resilient materials principles

There are some key traits in materials that show up repeatedly across hazards. The most effective materials tend to:

Allow drying and recovery

Able to be cleaned, dried and returned to service without major replacement

Offer long-term durability

Resisting corrosion, UV degradation and weathering, especially at fixings and interfaces

Integrate well into building systems

Able to be securely fixed, sealed and detailed with minimal gaps

Limit water uptake

Avoiding swelling, rot, delamination or loss of strength after soaking

Remain stable under stress

Resisting wind loads, water forces, debris impact and heat without major cracking, warping or failure

When prioritising resilience, the structure is the most critical element, followed by the exterior shell, while interior linings are generally of lower importance.

The materials listed in the ‘Robust’ column are anticipated to perform well in most high-risk areas. In extreme-risk locations such as BAL-Flame Zones, or high-velocity flood zones, or wind Region C/D (those exposed to tropical cyclones), material selection and detailing become highly specialised, and project-specific professional design is essential.

This table provides general guidance on material performance across multiple hazards including bushfire, flood, storm/cyclone and heat. Performance also depends heavily on system design, detailing, installation quality and maintenance. The materials in this guide align with the Resilience Ratings methodology used by the Resilient Building Council and the body of research utilised to inform our methodology. Materials should always be selected and installed in accordance with the NCC, relevant Australian Standards, manufacturer specifications and local hazard requirements.

Understanding the Material Categories

The materials in the table on the following page are grouped into three broad categories based on their anticipated performance across multiple hazards.

✓ ROBUST MATERIALS

These materials are generally expected to perform well across multiple hazards when properly designed, detailed and maintained.

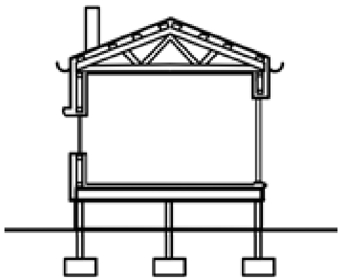
⚠ LIMITED USE MATERIALS

These materials can still perform well in some situations, but involve important trade-offs, limitations or detailing requirements.

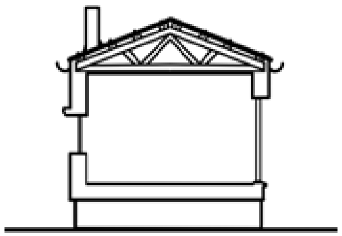
✗ MATERIALS TO AVOID

These materials are generally more vulnerable to moisture damage, combustion, corrosion, deterioration or failure during extreme events, particularly in high-risk areas.

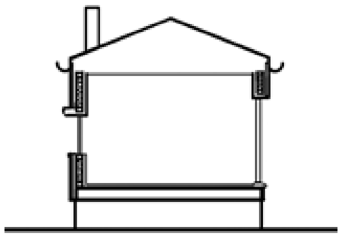
Multi-hazard zones



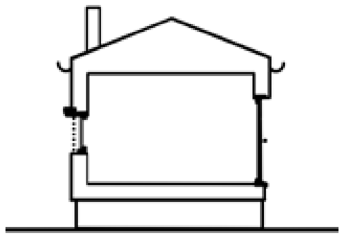
Structure



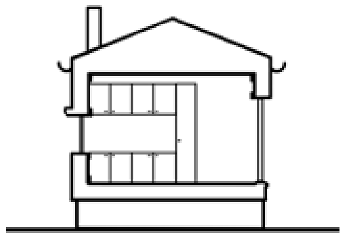
Roof elements



Wall elements

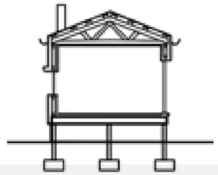


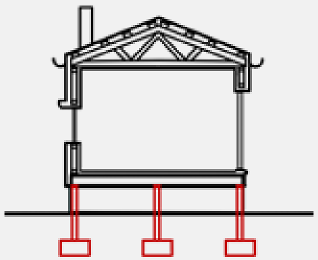
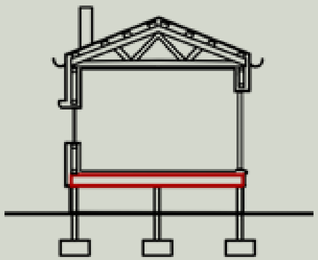
Doors and windows



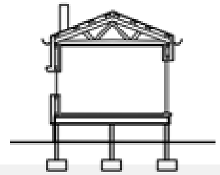
Internal linings

Multi-hazard materials: **Structure**



BUILDING ELEMENT	✓ ROBUST	⚠ LIMITED USE	✗ AVOID
Piers, posts and footings Failure here can lead to partial or total structural collapse. 	✓ **Reinforced concrete** ✓ **Galvanised steel** ✓ **Stainless steel** (for critical elements in corrosive/coastal environments)	⚠ **Unprotected (plain carbon) steel** Not suitable in flood areas due to corrosion risk. ⚠ **Hardwood ≥650 kg/m³** Only applicable at lower BAL ratings, not suitable above BAL 29 and should always be shielded. More flood tolerant than softwood, but still vulnerable to swelling, movement and long-term moisture exposure after inundation.	✗ **Treated Softwood** ✗ **Other untreated timber in ground contact**
Floor structure – bearers, joists, and structural flooring Subfloor framing is costly and disruptive to replace. Vulnerable to hidden rot, corrosion and fire spread. 	✓ **Galvanised steel Frame** ✓ **Concrete slab**	⚠ **Hardwood ≥650 kg/m³** Only applicable at lower BAL ratings, not suitable above BAL 29 and should always be shielded. More flood tolerant than softwood, but still vulnerable to swelling, movement and long-term moisture exposure after inundation. ⚠ **Engineered timber (LVL, I-joists)** Strong for wind but performs poorly if wetted; only suitable where fully protected from moisture and bushfire. ⚠ **Unprotected (plain carbon) steel** Not suitable in flood areas due to corrosion risk.	✗ **Softwood** ✗ **Particleboard** ✗ **Low-durability sheet flooring**

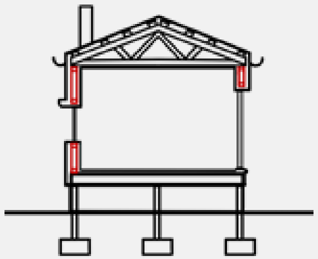
Multi-hazard materials: **Structure**



BUILDING ELEMENT

Wall framing/structure

Wall structure is critical for the integrity of the home. Damage here can lead to partial or total collapse of the home.



✓ ROBUST

- ✓ **Thermally broken galvanised steel framing**
  Needs to be detailed to avoid thermal bridging in heatwaves.
- ✓ **Reinforced concrete**
- ✓ **Structural Masonry**

⚠ LIMITED USE

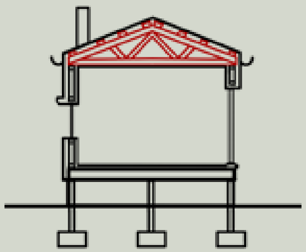
- ⚠ **Softwood timber framing (MGP10/12)**
  Widely used and acceptable when fully protected by compliant wall systems. Typically, not suitable below 1:100 flood levels. Wall systems should be sealed enough to stop wind-driven rain and embers entering, while still allowing any trapped moisture to drain and dry out through ventilated cavities or drainage gaps. Avoid wall systems that trap moisture with no drying path, particularly in flood-prone areas.
- ⚠ **Rammed earth**
  Excellent fire resistance, durability and thermal mass, but requires good moisture detailing and is less suitable in prolonged inundation zones.

✗ AVOID

- ✗ **Treated Softwood**
- ✗ **Other untreated timber in ground contact**

Roof structure

Failure here can lead to partial or total roof loss, major water entry, ember entry and structural collapse



Installation Note:
Non-combustible roof battens are preferred in higher bushfire exposure areas

Robust

- ✓ **Reinforced concrete**
- ✓ **Galvanised steel framing**
- ✓ **Stainless steel fixings/ connectors**
  For coastal or highly corrosive environments
- ✓ **Steel roof battens**

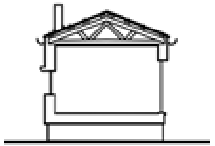
Limited use

- ⚠ **Timber trusses or rafters with galvanised connections**
  Acceptable where protected from weather, termites and ember exposure, but combustible and vulnerable to decay or connection failure if moisture is trapped.
- ⚠ **Engineered timber roof members**
  Only where adhesives are moisture-resistant and exposure to inundation is unlikely.
- ⚠ **Heavy hardwood roof framing**
  May perform better than lightweight timber in fire, but still combustible and vulnerable to moisture movement.

Avoid

- ✗ **Ungalvanised structural steelwork**

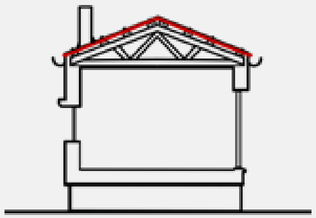
Multi-hazard materials: **Roof elements**



BUILDING ELEMENT

Roof cladding

Roof cladding is the first defence against embers, wind-driven rain, hail and debris impact. Failure can rapidly lead to water ingress, internal pressurisation and major structural damage.



Installation notes:
Exposed-fix steel roofs rely on screws and washers remaining in good condition, especially near the coast.

Roof tiles should be mechanically fixed for improved performance in severe winds.

Older loose-laid or mortar-fixed tiled roofs are more vulnerable to wind damage and tile loss.

ROBUST

- **Steel roof sheeting**
- **Corrosion-resistant aluminium roof sheeting**
  For severe coastal environments
- **Mechanically fixed concrete roof tiles with non-combustible sarking**

LIMITED USE

- **Terracotta roof tiles**
  Non-combustible but more brittle and vulnerable to displacement, breakage and progressive failure in severe wind events. Can be acceptable when mechanically fixed with non-combustible sarking below.

AVOID

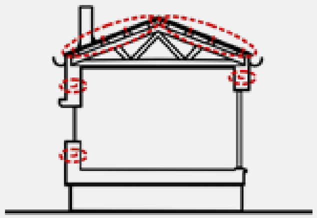
- **Timber shingles**
- **Bitumen based shingles**
- **Plastic or Polycarbonate roof sheeting**

Multi-hazard materials: **Roof elements**

BUILDING ELEMENT

Fixings and wall ties

Connections are often the weakest point during storms, floods and bushfires. Failure can lead to cladding loss or structural instability.



✓ ROBUST

- ✓ **Galvanised or stainless steel ties, straps, brackets and fixings**
- ✓ **Corrosion-resistant cavity battens and top hats**

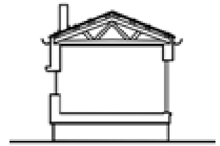
⚠ LIMITED USE

- ⚠ **Hot-dip galvanised steel brick ties**
  Widely used and durable in most environments but prolonged wetting, coastal exposure or coating damage can reduce long-term corrosion resistance.

✗ AVOID

- ✗ **Plain steel ties and fixings**
- ✗ **Corroded or undersized fasteners**
- ✗ **Mixed metals without isolation**
  Combining incompatible metals can cause galvanic corrosion when moisture is present, weakening fixings and connections over time. Common problems include aluminium in contact with steel, and galvanised steel exposed to copper runoff or incompatible treated timber.

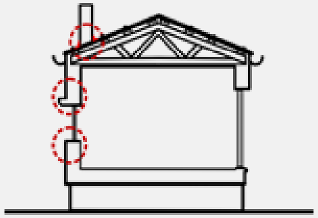
MultiHazard materials: **Roof elements**



BUILDING ELEMENT

Sealants

Sealants close small gaps that can allow embers, wind-driven rain and moisture inside.



Installation note:
Sealants work best as a secondary defence behind flashings, laps and drained cavities - not as the only waterproofing layer.

Check sealants regularly, as UV, movement and moisture can cause cracking, shrinkage or loss of adhesion over time.

✓ ROBUST

- **Polysulphide sealants**
  Highly water resistant and durable in exposed joints.
- **Neutral-cure exterior silicone sealants**
  Flexible, durable and widely used for weather sealing.

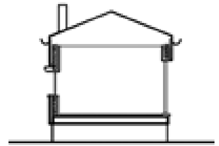
⚠ LIMITED USE

- **Fire-rated silicone and hybrid/MS sealants**
  Designed for high-heat or fire-rated joints, but performance depends on the tested system and exposure conditions.
- **Polyurethane sealants**
  Strong and flexible, but performance varies under UV, heat and prolonged water exposure.
- **Rubber-based sealants**
  Good water resistance, but fire and long-term durability vary between products.
- **Epoxy putty**
  Useful for rigid repairs and patching, but unsuitable for moving joints.
- **Bitumen-based fillers**
  Suitable for some external joints but can soften under heat and weathering.

✗ AVOID

- **Water-based acrylic sealants**
- **Cheap gap fillers**
- **PVC joining strips in bushfire-prone gaps**

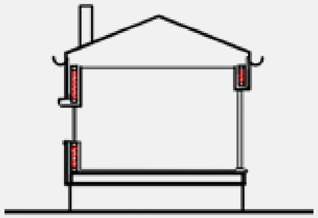
MultiHazard materials: **Wall elements**



BUILDING ELEMENT

Wall insulation

Insulation can trap moisture after floods, contribute fuel in bushfires, or reduce heat resilience if poorly selected.



Installation note:
Best practice for flood prone areas is to avoid insulating below anticipated flood levels.

✓ ROBUST

✓ **EPS insulated concrete form (ICF) systems**
Reinforced concrete wall systems with permanent EPS insulation can provide strong thermal performance and robust resistance to wind, debris and flood forces when correctly detailed.
Use only tested assemblies suitable for the site hazard exposure (including required BAL ratings), ensure the foam remains fully protected behind non-combustible finishes and flood-resilient internal linings.

⚠ LIMITED USE

⚠ **Stone wool slabs**
Non-combustible, moisture tolerant and dimensionally stable insulation boards with excellent fire performance and good drying potential when used within ventilated wall systems.

⚠ **Stone wool batts**
Non-combustible, more moisture tolerant than many other batt insulations, and generally preferred in high bushfire-risk wall systems.

⚠ **EPS and XPS foam insulation**
Best option below flood levels. Highly flammable, need to be fully enclosed behind: non-combustible cladding, with appropriate cavity detailing, fire-rated linings.

⚠ **Hempcrete**
Excellent thermal performance, vapour permeability and fire resistance, with good moisture buffering and mould resistance. However, it is not suited to prolonged saturation or flood-prone areas.

⚠ **Fibreglass batts**
Non-combustible and widely used, but can retain moisture, lose thermal performance and slow cavity drying after flooding. Best kept above likely flood levels.

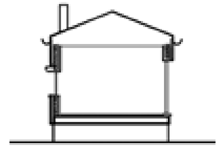
⚠ **PIR / polyisocyanurate and phenolic foam boards**
Good moisture resistance and thermal performance. Forms a protective char layer that slows heat transfer and fire spread but remain combustible and should only be used within compliant, tested wall systems in high bushfire-risk areas.

✗ AVOID

✗ **Loose-fill insulation**
Difficult to dry, inspect and recover after flooding, and can retain moisture, contaminants and mould within cavities.

✗ **Natural fibre batt insulation (wool, cellulose, hemp batts)**
Absorb and retain moisture readily, can lose thermal performance after wetting, and may slow drying or promote mould within wall cavities.

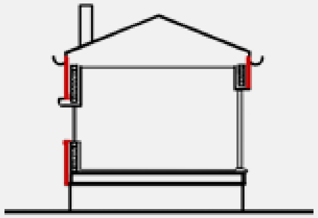
MultiHazard materials: **Wall elements**



BUILDING ELEMENT | ✓ ROBUST | ⚠ LIMITED USE | ✗ AVOID

Wall cladding

Cladding is the first defence against embers, wind-driven rain, debris and floodwater.



Installation Note:
Cladding systems require durable sealing and flashing at joints and penetrations to limit water ingress and improve flood resilience.

✓ ROBUST

- ✓ **Fibre cement sheet**
- ✓ **Reinforced concrete**
- ✓ **Concrete blockwork**
- ✓ **Corrosion-protected steel cladding systems (corrugated iron)**
- ✓ **Stone**
- ✓ **Face brick or blockwork**
- ✓ **Solid brick construction**

⚠ LIMITED USE

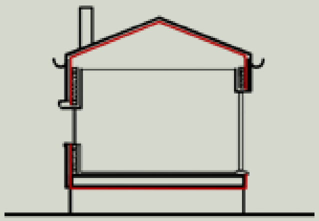
- ⚠ **Brick veneer and cavity wall systems**
  Cavities can trap floodwaters, contamination and moisture that may require wall opening and clean-out
- ⚠ **AAC panels and blocks**
  Porous and reliant on coatings, joints and moisture detailing in flood-prone areas.
- ⚠ **Hempcrete with lime render**
  Excellent thermal performance, vapour permeability and fire resistance. Lime render improves weather protection but isn't load-bearing and is less suitable in prolonged saturation or flood-prone areas.
- ⚠ **Mud brick / adobe**
  Good thermal mass and bushfire resistance, but vulnerable to prolonged wetting and erosion.

✗ AVOID

- ✗ **Timber weatherboards**
  Moisture sensitive and combustible in most areas without adequate detailing
- ✗ **PVC/vinyl cladding**
- ✗ **Combustible composite cladding**
- ✗ **EPS-based rendered systems**
- ✗ **Combustible-core metal composite panels**

Wall and building control layers

These layers manage water, air, vapour and ember entry within the wall system. Poor detailing can trap moisture or allow ember and rain penetration.



✓ ROBUST

- ✓ **Bushfire-rated vapour-permeable wraps**

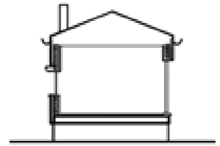
⚠ LIMITED USE

- ⚠ **Reflective foil wraps and low-permeability sarking**
  Can improve radiant heat and weather protection, but some products may trap moisture in cooler climates or highly insulated walls unless carefully detailed for condensation management.
- ⚠ **Breathable wall membranes**
  Improve drying and condensation control but must be bushfire tested and detailed to resist ember entry.

✗ AVOID

- ✗ **Unrated combustible sarking**
  In bushfire-prone areas.
- ✗ **Foil wraps**
  Used without drainage/ detailing.

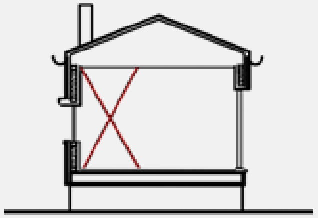
MultiHazard materials: **Wall elements**



BUILDING ELEMENT | ✓ ROBUST | ⚠ LIMITED USE | ✗ AVOID

Wall bracing

Bracing resists sideways wind loads and helps prevent wall collapse during floods, storms and cyclones.



ROBUST

- ✓ **Galvanised steel strap bracing**
- ✓ **Fibre cement bracing systems**
  Structural performance depends on the tested system, including sheet type, fixing pattern and framing compatibility.

LIMITED USE

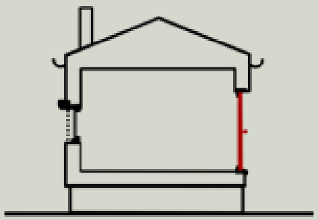
- ⚠ **Proprietary steel bracing systems**
  Can provide high structural capacity and good durability, but performance depends on having a tested proprietary system, fixing pattern and corrosion protection.
- ⚠ **Plywood bracing**
  Strong and widely used, but combustible and vulnerable to prolonged wetting unless

AVOID

- ✗ **OSB bracing**
- ✗ **Hardboard bracing**

Solid doors

Doors are critical weak points during bushfire, storms and floods. Failure can allow ember entry, wind-driven rain, debris impact and internal pressurisation.



ROBUST

- ✓ **Metal-clad solid-core doors**
- ✓ **Insulated steel doors**
- ✓ **Solid-core bushfire- and cyclone-rated door systems**
- ✓ **Corrosion-resistant frames and hardware**

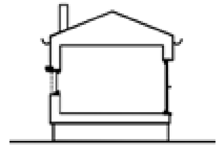
LIMITED USE

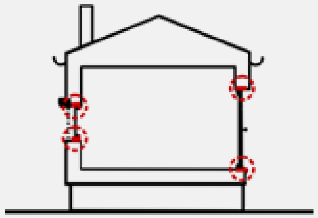
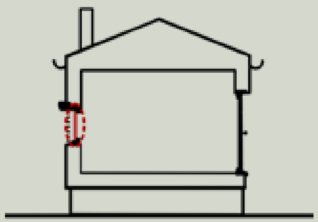
- ⚠ **Solid timber doors**
  Can perform well when thick, well-sealed and maintained but remain combustible and can swell or distort after prolonged wetting.
- ⚠ **Fibreglass composite doors**
  Moisture-resistant and dimensionally stable, with better resistance to warping and swelling than many timber doors. Fire, impact and structural performance vary between systems and should be checked against tested ratings where required.

AVOID

- ✗ **Hollow-core doors**
- ✗ **MDF or particleboard-core doors**
- ✗ **Untreated timber doors in flood-prone areas**
- ✗ **Doors with combustible foam cores**

Multi-hazard materials: **Doors and windows**



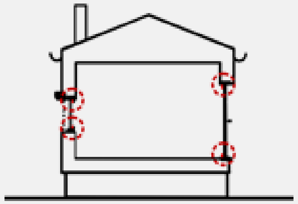
BUILDING ELEMENT	✓ ROBUST	⚠ LIMITED USE	✕ AVOID
Door and Window Frames Door and window frames hold glazing in place and must resist heat, water, corrosion and wind pressure. 	✓ **Aluminium frames with thermal breaks** ✓ **Aluminium clad hardwood frames** ✓ **Thermally broken steel frames**	⚠ **High density hardwood timber frames (e.g. blackbutt, spotted gum)** Good thermal performance and repairability, but require ongoing maintenance and can swell, rot or ignite if poorly protected. ⚠ **uPVC frames** Good thermal and moisture performance but can soften or deform under high heat and may have limitations in high bushfire-risk areas. ⚠ **Standard aluminium frames** Durable and corrosion resistant, but thermally conductive without thermal breaks.	✕ **Softwood timber frames (e.g. cedar)** ✕ **Lower-density hardwood frames (e.g. mountain ash, Tasmanian oak)** Generally less durable and less resistant to fire, moisture and decay.
Glazing Glass failure can allow ember entry, wind-driven rain, debris impact and dangerous internal pressurisation. 	✓ **Toughened laminated safety glass**	⚠ **Toughened glass** Strong against thermal stress and moderate impact, but shatters completely when broken. ⚠ **Double glazing** Improves thermal performance and can improve resilience when combined with laminated or toughened panes, but performance depends heavily on glass type, thickness and treatment. ⚠ **Laminated safety glass** May help retain broken glass and reduce ember entry, but performance varies by product and framing system. Use tested bushfire-rated assemblies where required	✕ **Annealed (standard) glass** This is the common single-paned glass found in older homes. It is vulnerable to impact, thermal shattering and dangerous breakage.

Multi-hazard materials: **Doors and windows**

BUILDING ELEMENT

Door and Window Seals

Seals help reduce ember entry, wind-driven rain, smoke, draughts and minor water ingress around openings. Poor seals can shrink, crack, melt or detach under UV, heat, moisture and movement.



Installation note:
An ideal seal should leave no gap when installed. For effective bushfire detailing aim to ensure any gaps are less than 2mm

✓ ROBUST

- ✓ **Silicone rubber seals**
- ✓ **EPDM rubber seals**
- ✓ **High-quality compression seals used in tested bushfire- or cyclone-rated systems**
- ✓ **Corrosion-resistant metal weather strips and threshold plates**

⚠ LIMITED USE

- ⚠ **PVC/vinyl seals**
  Widely used, economical and reasonably water resistant, with some products rated to be BAL or storm appropriate systems. However, they are generally less resistant to UV, heat and long-term ageing than silicone or EPDM seals.
- ⚠ **Brush seals with metal backing**
  Useful for reducing ember and smoke entry where in good condition with no gaps greater than 2mm. Generally less effective against wind-driven rain and water intrusion than compression seals
- ⚠ **Neoprene rubber seals**
  Generally durable and water resistant, but less heat/UV stable than silicone or EPDM in exposed locations.

✗ AVOID

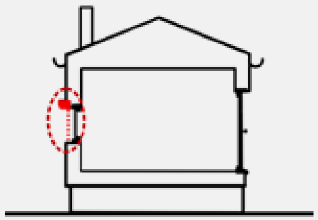
- ✗ **Open-cell foam seals**
- ✗ **Cheap adhesive foam weather strips**
- ✗ **Plastic brush seals in bushfire-prone areas**
- ✗ **Brittle PVC seals in exposed locations**

MultiHazard materials: **Doors and windows**

BUILDING ELEMENT

External awnings, shutters and screens

External protection can reduce glass breakage, ember entry, wind-driven rain, flood debris impact and heat gain through windows. Poorly chosen products can burn, detach or become wind-borne debris.



✓ ROBUST

- ✓ **Tested metal shutter systems**
  Aluminium or steel shutters tested for local wind, debris impact, flood, and bushfire exposure.
- ✓ **Stainless steel security, ember, and debris screens**
  Heavy-gauge corrosion-resistant metal mesh systems that can provide ventilation, ember protection and debris resistance when Arelevant hazards. Bushfire screens should use metal mesh with apertures of 2 mm or less.

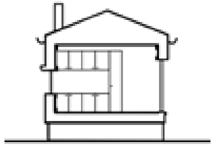
⚠ LIMITED USE

- ⚠ **Aluminium insect and security mesh -**
  Corrosion resistant and widely used, but lighter mesh systems provide limited debris or fire protection unless independently tested.
- ⚠ **Non-rated metal roller shutters**
  Can improve shade, privacy and moderate weather protection, but should not be relied on for debris impact, cyclone or bushfire protection unless independently tested and rated.

✗ AVOID

- ✗ **Fibreglass or plastic insect mesh in bushfire-prone areas**
- ✗ **PVC/plastic shutters and screens**
- ✗ **Timber shutters in high bushfire- or cyclone-risk areas**
- ✗ **Fabric awnings and shade blinds**

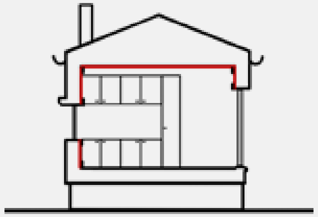
MultiHazard materials: **Internal linings**



BUILDING ELEMENT

Internal wall and ceiling linings

Internal linings influence fire protection, flood recovery, and mould risk after water or impact damage. Poor-performing linings can trap moisture, deteriorate after flooding or contribute fuel during bushfire.flood resilience.



ROBUST

- **Fibre cement sheet**
- **Ceramic or porcelain tiles over fibre cement or compressed fibre cement sheet**
- **Cement and lime-cement rendered masonry walls**
  Durable, non-combustible and moisture tolerant, with good flood cleanability and thermal mass when applied over brick, block or concrete walls.
- **Glass block feature walls in wet or flood-prone areas**

LIMITED USE

- **Water-resistant plasterboard**
  Widely used and suitable outside flood-prone zones, but prolonged wetting can still lead to deterioration and mould.
- **Exterior-grade plywood**
  Stronger and more moisture tolerant than standard plywood, but combustible and vulnerable to prolonged wetting unless sealed and detailed to dry.
- **Acrylic/polymer render systems**
  Flexible and water shedding, but more combustible and dependent on substrate, detailing and moisture management.
- **Gypsum skim coat**
  Smooth and widely used internally, but vulnerable to prolonged wetting and flood damage.
- **Fully sealed solid timber linings**
  Durable and repairable, but combustible and can swell or distort after flooding.
- **Vinyl wall finishes**
  Moisture resistant and easy to clean, but combustible and capable of producing dense smoke and toxic gases during fire.

AVOID

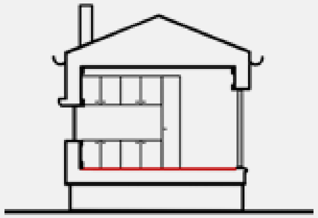
- **Standard plasterboard in flood-prone areas**
- **MDF or particleboard linings**
- **Hardboard**
- **Standard plywood**
- **Wallpaper**
- **Fabric wall coverings**
- **Strawboard or fibreboard linings**

MultiHazard materials: **Internal linings**

BUILDING ELEMENT

Floor coverings

Floor finishes affect flood recovery, mould risk, fire load, cleanability and heat performance. Poor choices can trap water, slow drying or become difficult to decontaminate.



Installation note:
Floating and overlay flooring systems can trap moisture beneath the floor finish and slow drying after flooding.

✓ ROBUST

- ✓ **Polished or sealed concrete**
- ✓ **Terrazzo**
- ✓ **Epoxy or cementitious toppings on concrete**
- ✓ **Sealed stone**

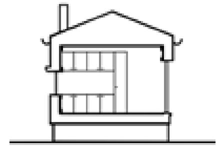
⚠ LIMITED USE

- ⚠ **Ceramic or porcelain tiles on concrete or masonry**
  When using cement-based adhesives and grout this system can be durable, non-combustible and generally easy to clean after flooding.
- ⚠ **Adhesive-fixed tile systems**
  Prolonged flooding can weaken some adhesives, membranes and grout systems, or trap moisture beneath tiles.
- ⚠ **Polished hardwood timber**
  Has some level of flood resistance, but may cup, swell or need refinishing after inundation.
- ⚠ **Rubber sheet, rubber tiles and vinyl sheet**
  Perform reasonably in floods when installed with chemically set/water-resistant adhesives but are combustible and less suitable where bushfire heat exposure is likely.
- ⚠ **Loose rugs or removable carpet tiles**
  Can be lifted before flooding or removed for cleaning, but must be checked for contamination before reuse.
- ⚠ **Vinyl plank / luxury vinyl tile**
  Moisture resistant, but joints, adhesives and substrate sensitivity make it less robust than sheet vinyl or tiled concrete.
- ⚠ **Engineered timber**
  More stable than laminate flooring, but layered construction and adhesives can delaminate or distort after prolonged wetting.

✕ AVOID

- ✕ **Wall-to-wall carpet**
- ✕ **Seagrass matting**
- ✕ **Cork**
- ✕ **Traditional linoleum with absorbent backing**
- ✕ **Laminate floating floors MDF/HDF cores swell and distort rapidly after flooding and are often irreparable**
- ✕ **Carpet underlay**
- ✕ **Hardboard underlay**
- ✕ **Particleboard-based flooring systems**

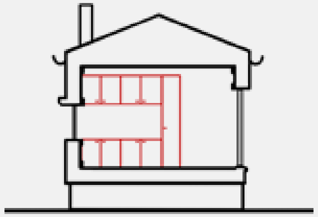
MultiHazard materials: **Internal linings**



BUILDING ELEMENT

Cabinets and joinery

Cabinetry is expensive to replace after flooding and can trap moisture, mould and contaminants. Swollen or delaminated joinery can greatly slow recovery.



Installation note:
Raise cabinetry above likely flood levels where possible or use removable kickboards and modular units to improve cleaning and drying.

✓ ROBUST

- **Stainless steel cabinetry**
- **Aluminium cabinetry**
- **Compact laminate panels**
  Dense solid laminate panels are commonly used in wet-area and commercial joinery, with much better moisture resistance than MDF or particleboard cabinetry.

⚠ LIMITED USE

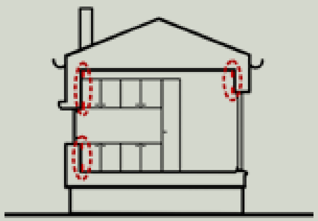
- **Marine plywood joinery**
  More water resistant than standard plywood, but still combustible and vulnerable to swelling, staining and edge damage after prolonged wetting.
- **Solid timber joinery**
  Durable and repairable when sealed, but combustible and can swell, distort or stain after flooding.
- **Exterior-grade plywood cabinetry**
  Better wet strength than standard sheet products but still moisture sensitive over time.

✕ AVOID

- **MDF cabinetry**
- **Particleboard cabinetry**
- **Melamine-on-particleboard**
- **Vinyl-wrapped MDF cabinetry**
- **Hardboard cabinet backs**
- **Laminate cabinetry with exposed particleboard edges**
- **PVC-heavy cabinetry systems**
  Can produce dense toxic smoke during fire.

Skirtings, kickboards and trims

These low-level finishes are often the first materials damaged during flooding and can trap moisture, mould and debris. Poor-performing materials can greatly slow drying and repair.



✓ ROBUST

- **Fibre cement skirtings and trims**
- **Ceramic or porcelain tiled skirtings**
- **Aluminium or stainless-steel trims**
- **Removable dense hardwood skirtings**

⚠ LIMITED USE

- **Solid timber skirtings and trims**
  Durable and repairable when sealed, but combustible and vulnerable to swelling, staining and movement after flooding.
- **Vinyl or PVC trims**
  Moisture resistant and easy to clean but combustible and capable of producing dense smoke and toxic gases during fire.

✕ AVOID

- **MDF skirtings**
- **Particleboard trims**
- **Hardboard trims**
- **Fixed enclosed kickboards that trap moisture**
- **Laminate trims with exposed particleboard edges**

Multi-hazard maintenance

Routine maintenance

Buildings are systems that shift and change over time, and there is an ongoing need to maintain your property for disaster resilience.

Small gaps, blocked drainage, loose fixings or unmanaged vegetation can quickly become failure points during flood, storm, bushfire or heatwave events.

Align your annual maintenance plan with your highest risk season (e.g. summer).

After any extreme weather event, inspect the home for damage to the structure, external shell and services, and repair issues early to prevent further deterioration.

MONTHLY

- Remove combustible and loose items from around the house
- Maintain landscaping, keep grass short, remove invasive weeds, manage understory
- Use non-combustible door mats, store shoes and other items often kept by the doors inside

QUARTERLY (03 Months)

- Clear ember screens, vents and weepholes of debris
- If you are flood-prone, ensure subfloor areas remain clear and free-flowing (no stored items or obstructions)
- Check site drainage paths (swales, drains, downpipes) are directing water away from the home
- Confirm vents and openings that allow pressure equalisation are not blocked
- Clear gutters, check gutter guard is still tight fitting and not damaged
- Check firefighting water levels and ensure water pumps are in good working condition
- Ensure access routes (driveways, paths) are clear and usable
- Test any automatic shutters, sprinklers, water pumps, check doors are tight fitting and in good working order
- Monitor nearby vegetation: prune overhanging branches and remove trees that could impact the home if they fell

ANNUALLY (12 Months)

Each year, complete a comprehensive check-up:

- Check roof fixings, flashings and ridge caps for looseness or damage, tighten or replace
- Inspect seals around windows and doors (replace worn or degraded seals)
- Check wall-to-roof and wall-to-window junctions for gaps or deterioration, and seal them
- Check bolts and screws in cladding and fixtures, tighten if needed
- Replace any elements that are damaged, incorrectly installed or deteriorated
- Check external blinds, screens or shutters are functional and in good condition
- Ensure roof and ceiling insulation is intact and not degraded
- Service cooling systems and check backup options (fans, ventilation)
- Talk to your neighbour about helping each other manage vegetation together and reduce shared risk ahead of hazard seasons
- Practice your emergency plan, check and refill emergency kits, make sure vehicles are in good condition, keep electronic copies of important documents

PART SIX

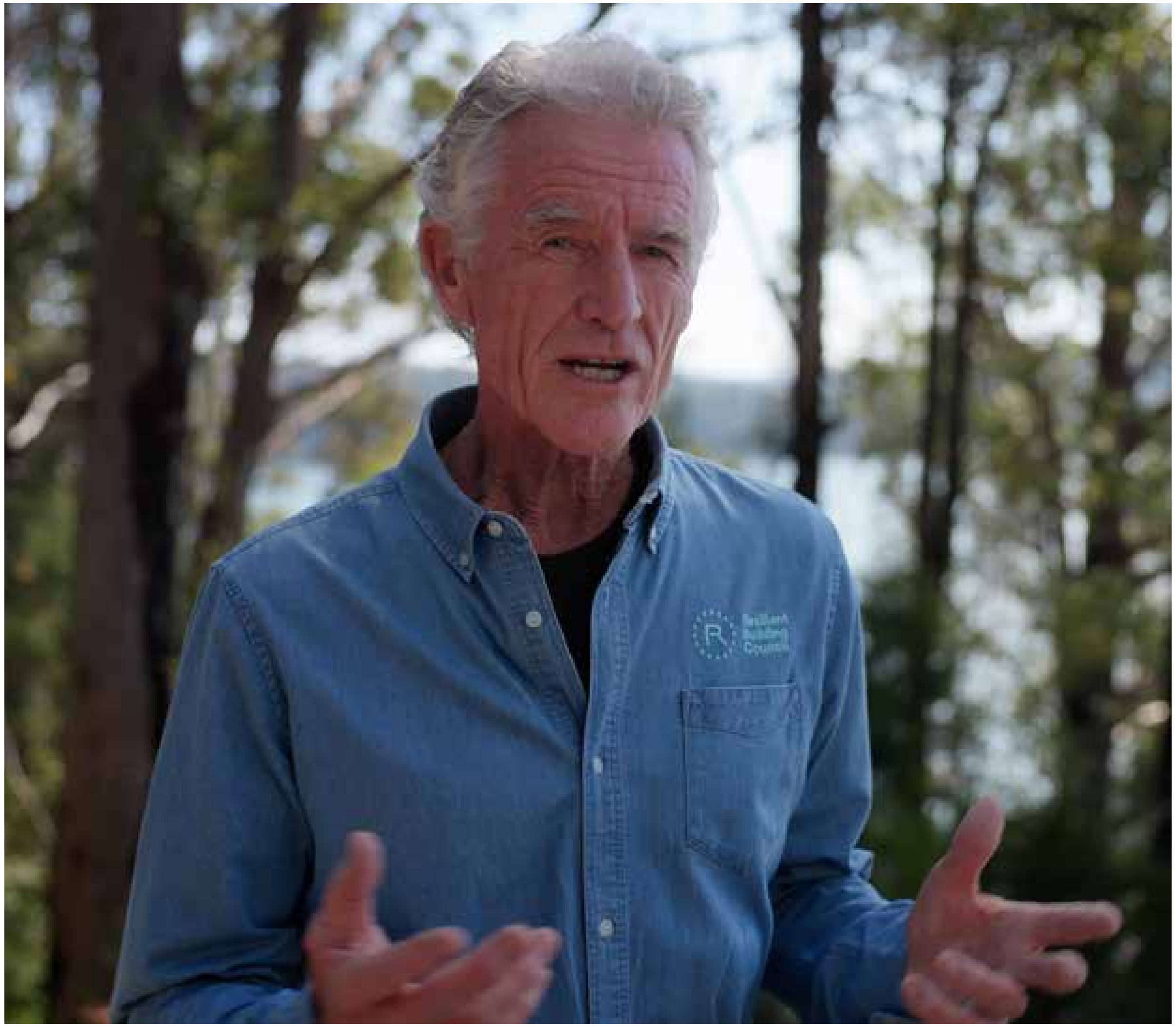
Resilience strategies in action

Resilience in action

Builders, trades, homeowners, resilience experts, architects and engineers share practical ways to strengthen homes and reduce risk in our video series. They show the types of actions that can improve your home's resilience and support a stronger Resilience Rating, from simple DIY improvements to more advanced upgrades.

You'll also see case studies of homes that have applied these strategies and have made a meaningful difference to their home's safety, performance and recovery.

Click on one of the links on the next page, or scan the QR codes to watch our Resilience in Action series.



Resilience in action videos

Backyards and gardens

The things that make a backyard enjoyable can also cause the most damage in extreme weather - especially within the first few metres around your home.

Watch how to manage your backyard for multiple hazards.

Verandahs, fences and decks

Often overlooked, these structures can quickly become the weakest link in bushfires, storms and floods.

Watch how to strengthen your home's decks, fences and verandahs

Walls and foundations

Flood, fire and wind will always find the weakest points - and how you address them can determine whether your home survives.

Watch how to strengthen your home's walls and foundations

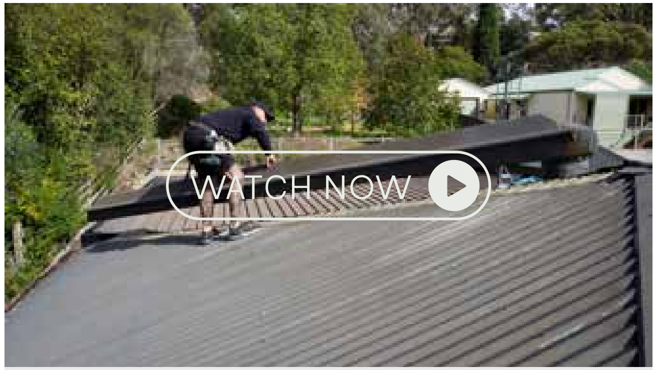
Windows and doors

Doors and windows are among the most vulnerable parts of a home, allowing heat, wind, water and embers to enter.

Watch how to protect the openings in your home.

Roof

Your roof protects your home every day - but during disasters, it must withstand wind, rain, embers and debris.



Watch how to improve the resilience of your roof.

Infrastructure and services

Resilience isn't just about surviving a disaster - it's about how quickly your home can function again afterwards.

Watch how to protect the critical services that keep your home running.

PART SEVEN

Rate your home’s resilience

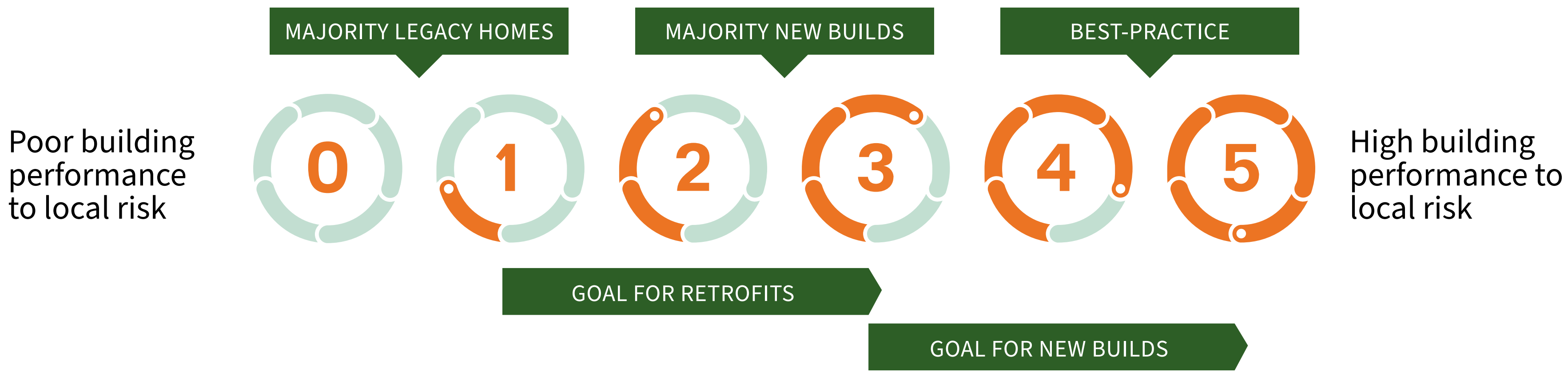
Understanding Resilience Ratings for existing homes

For existing homes, achieving a Resilience Rating of 2 or 3 stars is often a very positive outcome. Many Australian homes were built before modern resilience standards, climate considerations and hazard-specific design approaches became more common. As a result, even well-maintained homes can still have vulnerabilities to hazards such as flood, bushfire, storm, cyclone or extreme heat.

A 2- or 3-star Rating generally means the home already includes a range of resilience features and is performing better than many homes of a similar age, type or location. It also means there are practical opportunities to further strengthen the home over time through targeted upgrades and maintenance.

Higher ratings of 4 or 5 stars are typically much harder to achieve in existing homes without significant structural upgrades, major retrofitting or a full rebuild.

Resilience Ratings are designed to support continuous improvement over time. Small, practical upgrades can still make a meaningful difference to damage reduction, recovery, comfort, insurability and long-term resilience.

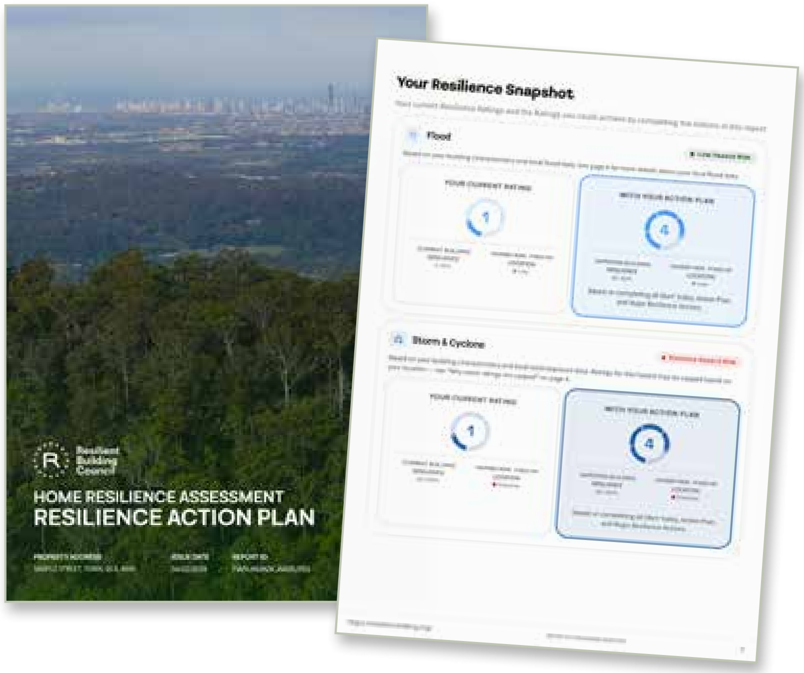


Why every home needs tailored recommendations

No two homes perform the same way.

Two homes on the same street may respond very differently during the same disaster due to their site, floor height, roof shape, materials, drainage and condition. That is why every home needs tailored recommendations.

General guidance helps households understand resilience principles. A Resilience Ratings assessment identifies the vulnerabilities and actions most relevant to the specific home.



Your Resilience Action Plan

Resilience Ratings help households understand:

- how their home is likely to perform
- where key vulnerabilities exist
- what actions can improve resilience over time

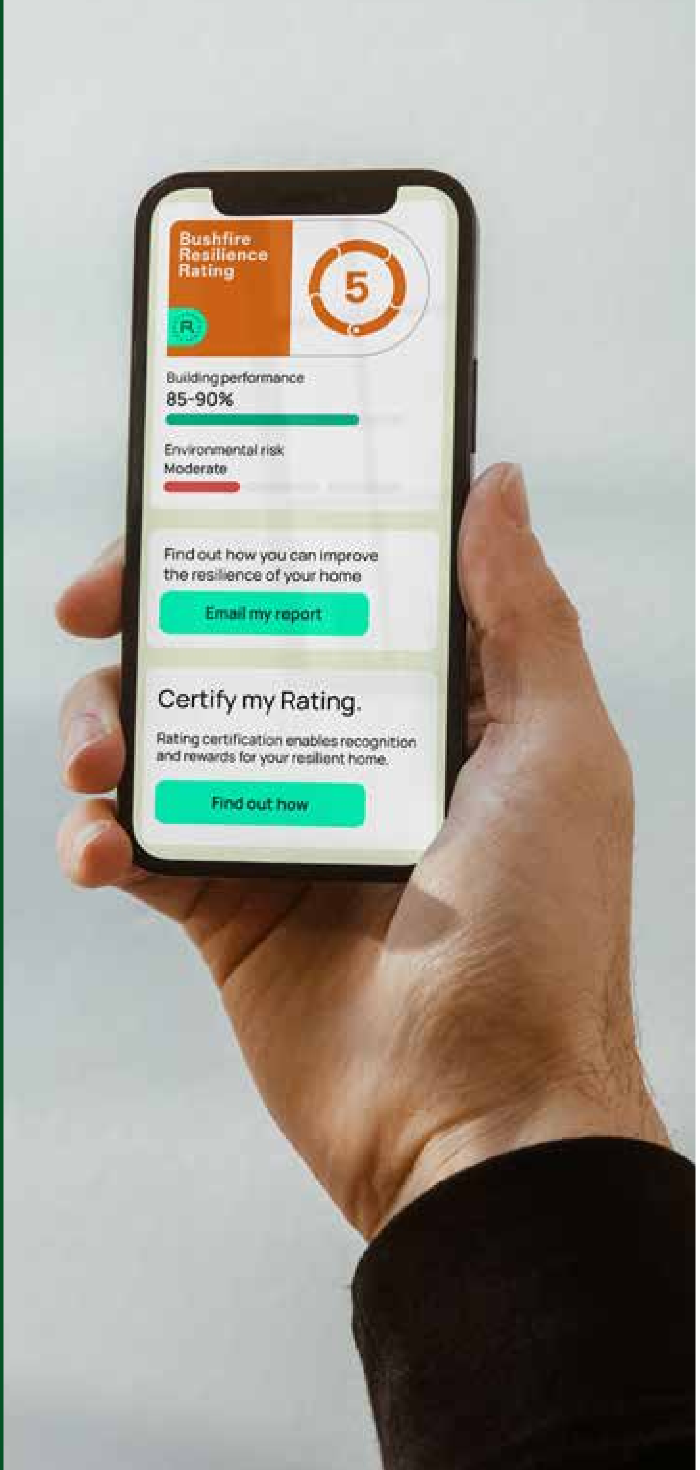
Following an assessment, households receive a customised Resilience Action Plan with prioritised recommendations tailored to their home.

Recommendations may include:

- maintenance and housekeeping
- low-cost resilience improvements
- upgrades during renovation or repair
- larger retrofit opportunities

Many actions improve resilience across multiple hazards at the same time.

Importantly, households do not need to complete everything immediately. Most resilience improvements are completed progressively over time during maintenance, repairs, renovations or planned upgrades.



How to Access Your Resilience Ratings Assessment

Bushfire Resilience Ratings

The Bushfire Resilience Rating self-assessment is currently available online at https://rating.rbcouncil.org

The Bushfire Resilience Rating has been provided by the Resilient Building Council and National Emergency Management Agency as a free service since 2023. Information about certification pathways and insurers providing insurance premium benefits is available here: https://rbcouncil.org/certify-my-rating

Multi-Hazard Resilience Ratings

Multi-Hazard Resilience Ratings assessments were delivered through pilot programs between 2023–2025, including expert on-site assessments and prototype self-assessment pathways. These assessments are not currently publicly available.

The Resilient Building Council is continuing to work with government, insurers, banks and industry partners to support future rollout and expanded access to household resilience assessments.

Households can register interest in future assessment programs and pilot opportunities when funding permits. For more information or to register interest, contact our team info@rbcouncil.org