## Introduction

This submission to the Royal Commission is in response to a request from the Premier's office, and is a retrospective summary of building inspections and interviews.

This study started as an investigation into how Earth Walled Buildings performed during the fires, as an R & D project for my business ***Amcer Earth Building Technology***.

Initially, I contacted many of my clients to see how they had been affected, and to offer any that had lost their house free replacement bricks. The interesting response was that none appeared to have been affected, despite reports of fires reaching their buildings.

It would appear that was because most were of modern load bearing design, well finished, with relevant roof and eaves detail that reduced the impact of ember attack, combined with good luck on the day as many earth buildings that survived were not defended during the period the fire front moved through their area.

Having gained approval to access the fire areas, and after speaking to numerous people, it became obvious that there was a need for photographs to be taken and details documented prior to the clean up and reconstruction.

I contacted the executive of the Earth Building Association of Australia, and invited Mr. Peter Hickson (the Chairman) to come to Melbourne and spend a day inspecting the fire damaged and destroyed buildings.

Due to the sensitive nature of the project, many properties were not photographed, and only sites that owners had given permission to enter were investigated in detail.

I believe that there would have been considerable benefit if every site had been documented and photographed prior to commencement of clean up and reconstruction.

My Background is mechanical engineering, with 40 years experience including –

- The manufacture of earth and cement stabilized bricks
- Design and construction of buildings
- Design and manufacture of Earth Brick Plants
- Consultant to Qantas .and engineering groups
- Guest Speaker on sustainable Earth Building
- Submission to Federal Government Productivity Commission
- Consultant to ATSIC and Aboriginal Communities on Brick Manufacture Training
- Planning and building projects
- Executive Member Earth Building Association of Australia

Rob Freeland

P.O Box 232 Hurstbridge VIC 3099

Ph (03) 9714-8688 www.amcer.com.au

**Enclosed is a copy of information submitted to the**

**Victorian Bushfire Royal Commission**

**Note** Pages 9 & 10 have been deleted due to the sensitive material

**"Built in fire resistance should be regarded as a basic design consideration and not be something that can be imparted to an element of construction selected without initial regard to its fire resistance."**

*Extract Experimental Building Station NSB 87 October 1965*

- Earth walled buildings combine quality accommodation with a small carbon footprint
- NBTC tested 250mm earth bricks to Australian Standard AS1530 part 4 and achieved a 4 hour fire resistance.
- Earth Walls can offer a high level of protection from Radiant Heat
- Have low embodied energy and have high thermal mass
- And are aesthetically pleasing
- Earth bricks are easy to lay in earth mortars
- Do not use cement or other chemicals
- Excellent sound reduction up to 50 decibel
- Have excellent humidity control
- Can be laid on either a slab or strip footings
- Are suitable for load bearing multi storey applications
- Are low maintenance
- And are recyclable

When designing new buildings consider using low pitched or curved roofs and parapet walls to reduce the impact of radiant heat and possibility of embers entering the roof area.

# Contents

---

## Summary

This submission has been prepared with an emphasis on the impact of extreme temperature on masonry buildings that have been inspected.

As a result of observations it would appear that there are several areas of concern, including design, material performance, and several recommendations included in the document- "**Australian Standards AS 3959-2009** Construction of buildings in bushfire prone areas".

1. The impact of radiant heat and ability of materials to provide sufficient personal protection prior to or during a fire front attack period lasting 30 to 45 minutes.
2. Recommendations for buildings for temperature to 1090 deg Kelvin, when many suggested materials and methodology would have failed well below the projected temperature.
3. The use of 90 mm single leaf fired masonry for external walls.
4. The use of single skin concrete masonry in external walls.
5. The use of cement mortars.
6. The use of post and beam construction when used with Earth Walls.
7. Performance of water storage tanks and on site protection for domestic fire-fighting equipment.
8. Commercial building company offers to provide new residential buildings that may be accepted as deemed to comply, without the system being tested to the Australian Standard AS 3959-2009 eg. light weight steel framed buildings.
9. Incorporation of a fire safe refuge to be incorporated as a standard, in replacement and new housing. **(It is noted in the Standard that consideration of bunkers will be investigated)**
10. Using the recommended guidelines in areas like Clonbinane being considered as BAL19 when there has been a high percentage loss of housing.
11. The apparent failure of various departments to consider many of the previous submissions and research documents from the past that have highlighted options to mitigate risk.
12. Failure of Councils and the Victorian Planning Provision policies requiring the removal off and/or restriction on the planting of non native deciduous trees in public areas communities and private properties and the requirement to replace with native trees and foliage.
13. The effect that green groups influence policy restricting the removal of trees, foliage and ground fuel material in rural areas and road reserves.
14. The public advice of leave or stay and defend was quoted by many that a third level of advice should have been included being "How to survive a fire".
15. The impact of modern furnishing products on air quality inside buildings, and the risk to occupants from toxic chemical emissions due to off gassing as a result of increased air temperature.
16. Emission levels from composite, plastic and reconstituted timber building components, adhesives, paints, electrical appliances and wiring and their impute to fuel levels in internal fires.

17. Question recommendations for the use of steel window frames, these can transfer heat quickly that could cause materials close to them like curtains to ignite. Reports of heat transfer would tend to indicate that steel frames would fail test requirements.

18. Consideration of using wall construction detail that can provide some protection for window frames. Reports of aluminum frames failing and then letting the glass fail whereas timber frames often did not fail until the house was well alight.

19. Promotion of the performance of earth walled buildings for protection of lives and property in suburbs and high fire risk areas.

**Earth walls were tested to Australian Standards, and exceeded a 4 hour rating 8th July 1982**

20. The need for Government to provide funding to research alternative designs, material and construction methods. Small businesses cannot afford to have alternative designs for fire safe building systems tested for approval.

21. Re instatement of rights and options for Owner builders. Many new commercially built homes are not as well constructed as those that are designed and built by the people who will live in them.

22. Need for strategic emergency plan and improved exit access in emergencies, including areas that were not affected in this instance that are fringe suburbs adjacent to rural or green wedge shires eg. Diamond Creek, Eltham, Warrandyte, etc

23. Rights and responsibilities of people to have a choice of lifestyle, and the need for balance in maintaining lifestyle and a safe environment

24. The concept of having window fire shutters requires people to be available and capable of operating them prior to a fire front.

25. If the temperature range is sufficient to melt glass then shutters are likely to have failed.

26. There were reports of 3mm glass panes failing during the fire front period but several reports were of window failure occurring as a result of the building burning when temperatures were sufficient to change the structure of the glass

27. Roof design, good workmanship and sealing, eaves design and material selection appear to have been critical factors in the survival and performance of earth walled buildings.

## Brief Comment

Described as a *once in one hundred years disaster,* the Saturday 7th February fires have provided the opportunity for detailed investigation of the performance of building materials under the extreme temperatures and wind loads that were experienced. Revised building design and construction methods could provide occupants with a level of protection during the fire front period.

**The inclusion of a fire refuge room built into houses in high risk areas could reduce the possibility of people being trapped in burning buildings, being overcome by toxic fumes or risking leaving their home and being caught in the open, or trapped in vehicles.**

With a 4 hour fire rating, the inclusion of an earth or other suitable walled and roofed room built into the house design, that included a fire retardant timber door to provide direct access to the rest of the house and a protected safe external exit, could save lives.

There is a need to review requirements before re-building commences.

The combination of many different factors, high temperature, heavy ground fuel loads, wind changes, and the speed the fire travelled, resulted in extreme conditions, highlighting problems with accepted building design, material selection and construction methods.

When inspecting sites, any observations can only be retrorespective. There is very limited surviving documentation to indicate the conditions of the buildings and their surrounding environment before the fires. Photographs provide a vivid reminder of what is left, and a limited insight into the threats to life for the residents of many towns and the conditions that helped others survive.

There is no rational answer as to why one building was lost and an adjacent residence remaining almost untouched irrespective of construction type.

Several owners of earth homes advised that their neighbors and pets were able to shelter in their house until the fire front passed, allowing them to then leave the building. They also reported that during the critical period of the fires, oxygen levels in their earth home were adequate. Surveys of buildings have provided considerable information about the benefits of earth building, that are being documented for further reference.

Earth buildings have provided twenty to forty minutes shelter for many people and their animals until the fire front passed. This protection from the radiant heat and the associated temperatures reported to be in the 1000 to 1300 Deg Centigrade helped several people and their pets survive.

Only general observations of destroyed buildings can be documented, as some walls would have collapsed as a result of roof or floor sections failing. The few bluestone chimneys or arched entrances appear to have survived with limited impact except for surface sprawling

In many cases survival depended on the design and construction of earth walled buildings providing protection from radiant heat, and the personal survival skill so many people possessed. In other instances the change of wind direction meant survival for some and terrible losses for others.

The widespread damage has provided an opportunity to review their performance of the various mortar mixes used over the years during building site inspections.

The following comments are based on the inspection of a large number of sites and the wide range of cladding materials and soil types used for bricks and mortar.

The best performing mortars were identical in composition to the material that the bricks had been made from. The higher bond strength resulted in structurally stable walls that had

maintained their original form even though window and door lintels had been burnt out, with minimum or no damage to the walls in some areas.

Silt mortars that were widely used in the Eltham area ten to twenty years ago, indicated an acceptable level of bond, and in many instances could be removed from the brick surface and collected for reuse.

Where earth bricks were made from poorer soils, or had dispersive type clays, the bond strength of the mortar was weaker, often failing to retain the walls' integrity. Failure on some sites was noticeable after the roof had been lost and the walls exposed to the heavy rains and high winds since the fires.

Cement mortars and cement based renders indicated general poor performance for a number of reasons, including the failure of single skin fired brickwork (veneer construction)

Where earth walls had no render, the impact from the high temperatures was often negligible, but performance depended on the types of soil used. If the bricks were rendered or contained lumps of rocks larger than 20mm, surface fragmentation was visible.

In some instances the high temperature had changed the surface chemical structure of the soil used in earth bricks, resulting in change of color and a semi glazed surface. Structural integrity in some instances may have been affected, with the face being glazed and brittle, but the balance width of the brick remaining un marked and stable.

It needs to be appreciated that the temperature in some areas was high enough to affect the surface of large rocks and fired bricks used for landscaping. A combination of moisture in the material and uneven temperature in the rock reproduced the method our ancestors used centuries ago to split large rocks for use in buildings.

There are examples of pre-1900 timber cottages that the fire has passed on both sides with no damage to the buildings. Buildings have been destroyed while others a few metre's away, with overhanging trees, survive. Well defended properties were often lost others were saved when the fire front passed, only to be destroyed when a wind change sent the fire back over the properties for a second time.

It is difficult to write articles about the performance of building construction after the fires, without recognizing some of the many aspects that have had an influence on the impact on people, buildings and the environment.

Topography, wind direction and velocity, building design and finish, window and door design, material selection, gaps in sealing between roof and wall sections, roof and eaves design, but most important the luck on the day, community support and individuals' skill and ability to survive.

Several houses surrounded by non native vegetation survived even though the houses were un-attended. Others in the middle of cleared areas with the closest major timber being hundreds of metres away and defended were lost.

Observations are retrospective, and on many sites it is difficult to determine the sequence of building failure. Many of the people interviewed who remained in their homes have provided detailed information indicating the level of protection earth homes provided.

The Royal Commission will consider submissions, but it will depend on recommendations handed down being made and implemented that will reduce the future risk to people in fire areas, It must be remembered it is about people, their habitat and the beauty of the environment that many have chosen to live in.

Further to media releases about fast tracking building approvals, it appears there may be a quick fix approach at the bequest of the building industry, rather than planning for the long term reconstruction of risk minimised communities.

There may be considerable influence on the Government by big business to fast tract rebuilding with minimum consideration to the implementation of alternative design and materials that could help reduce loss of life and the high cost to replace assets and infrastructure.

Successive governments have supported and even encouraged construction of inefficient energy sub standard residential construction under the guise of various energy rating programs that prejudice solar passive free running energy efficient design and construction.

Misleading information has often been disseminated to the public in their rush to introduce large numbers of residents to Victoria, despite the lack of infrastructure and services including transport, health, education, police, water and fire services.

If the above is applicable, the Government will achieve a reconstruction program that will not provide protection for future generations.

It is also about the qualities of the people involved, their commitment to help others, the strength and resilience of residents to rebuild their communities and reclaim their lives

A few days after the disastrous fires on the Saturday, reports appeared on the news and other media, often indicating that in many areas the only parts of the building standing were chimneys and earth walls.

Earth walled buildings combine many natural advantages, and when used in well designed and finished buildings can provide a level of protection for occupants.

Research is required to understand why people who sheltered and survived reported that their air (oxygen levels) quality was adequate or normal.

However irrespective of design and construction methods, the best results can only be to achieve the highest level of protection for people and the reduction of risk and damage to property and other assets.

# New Regulations and the possible effect on rebuilding

**Earth walls have had a 4 fire hour rating since testing to Australian Standards in the 1980's**

Introduction of the new regulations has taken the performance of earth walled buildings into consideration as they are one of the recommended mediums for new construction for the highest level Fire Zones.

The fact that so many buildings with different, designs, building fabric and variation of construction detail, together with variations of surrounding fuel loads, were lost or survived in the same area cannot be explained by regulation alone.

There is an immediate need for Government to provide funding for research into roof system design, and the testing of the performance characteristic of materials for eaves lining etc. as it appears that the main point of entry could have been the roof areas.

The use of low pitch, or curved roof design and parapet walls instead of steep pitched gable roof could reduce the impact of radiant heat and ember attack.

Reports indicate that the failure of aluminium and low fire retardant timber frames for doors and windows also contributed to building loss.

Proposed amendments to the Victorian Planning Provisions, Building Codes and Australian Standards appear as though they could affect the rights of people to make decisions that could improve their safety and allow for commonsense decision making in many instances.

In Victoria, the 5 star energy rating system does not represent the ambience, comfort zone and performance that most residents with earth buildings have enjoyed. In N.S.W where the BASIX program is acceptable, designers and builders have the option to use this system to assess solar passive buildings with earth walls.

The 5 Star Rating system used in Victoria is computer generated, and based on the premise of housing being mechanically heated and cooled. There is no program that allows for naturally ventilated free-running designs, so well designed sustainable buildings suffer with low energy ratings.

This rating program prejudices the rights of people to choose how they can reduce their impact on the environment, use low embodied energy earth bricks, and have maximum input into their house design choice of materials, and the right to build accommodation that meets their requirements.

New building regulations will impose additional costs for those rebuilding, and may restrict many people from replacing their home, because well meaning political rhetoric and regulations will override people's rights, choice and common sense.

Statements made by authorities and in publications could be viewed as giving many people who may move into an area covered by a fire overlay a false sense of security, as the new requirements are for temperature levels far lower than those that occurred.

Government and CFA Authorities publicised the two main items of advice:

> *"Leave early, or have a fire plan to stay and defend the property."*

After speaking to many people it became obvious that more people needed better advice of how to save there lives and have protection from radiant heat.

Pages 9 and 10 have been deleted, due to privacy concerns for those who died in the residences depicted.

Pages 9 and 10 have been deleted, due to privacy concerns for those who died in the residences depicted.

## Impact and planning for recovery

It is appreciated that there are many factors that will need to be assessed prior to recommendations being finalised.

There have been several comments by Insurance investigators, regulatory staff, and other authority representatives, that in some areas temperatures had appeared to exceed the 1100 to 1300 degree temperature range. Indications are that they may have exceeded 2000 degrees plus, resulting in steel sections and other iron items melting.

Irrespective of the actual temperatures reached, observations of earth having been heated to produce changes in structure that resembled fired pottery certainly indicate the extreme range that buildings were exposed to.

There were people who lost their lives in earth walled buildings, but many others survived.because of the protection these structures offered.

The feedback from these people can provide valuable insight into the performance of their houses that should be considered prior to preparation of any standard or new regulations.

Problems may occur in the future where new buildings constructed to Australian Standards are assumed to provide a safe refuge resulting in a false sense of security for occupants.

Certainly improved design and choice of material could reduce the impact from future disasters. However the promotion of building systems, materials and inappropriate design in a rush to meet resident's expectations, government spin for a quick fix, or the motivation of a quick profit from building supply companies and contractors must not override the future safety of residents.

Media footage of buildings failing under the impact of the fires as a result of increased internal air temperatures and pressures combined with the low pressure aerofoil effect on roof structures highlights another advantage of earth walled buildings.

Minimal internal temperature fluctuation has been reported by surviving occupants in earth buildings, resulting in the buildings maintaining a minimum change in internal air volume, reducing the internal and external pressure difference.

Another aspect is that roof structures of earth walled buildings are generally very well tied down, either by the posts in post and beam construction, or tie down rods in modern load bearing applications, similar to the requirements for cyclone prone areas

Living in heavily timbered rural or urban residential areas increases the risk and projected impact to residents, and infrastructure that requires different planning and building regulations. This would assist people to take responsibility for their choice of lifestyle while maintaining and enjoying the environment.

Risk assessment, practical application of planning requirements, and acknowledgement that there is need for a change to many preconceived attitudes, impractical and or excessive regulation without the historic re invention of the wheel approach that has put so many at risk in recent times.

## Strathewen #1

Double storey load bearing Earth House

The extreme temperatures of the fire, estimated to be in excess of 1000 to 1300deg, destroyed everything except the earth bricks. It should be noted that the white wash on the internal walls still remains intact with the external render having been damaged.

The fire damage to the building destroyed the fire retardant timber door and window frames that had been built in during construction.

As the walls are structurally sound, the timber window and door frames are being replaced with steel frames and bricked in to the earth walls.

The internal walls will require minimum repair, however the concrete floor has been badly damaged because of severe spawling, requiring a new concrete floor to be poured on top of the existing one.

The floor beams had been cut at an angle and installed so that in the case of fire the burnt timbers can fall out without causing the walls to collapse.

The occupants of this residence left the property prior to the fire front but neighbours lost their life in a post and beam house that was destroyed. After the fires the earth walls were still standing almost intact in silent memory of the owners.

## Strathewen #2

A house that owners sheltered in with their horses.

These earth walls provided residents and their horses with protection from the radiant heat and the flames until fire front passed.

Their comment was their earth house saved their lives.

The effect of high temperature fires on post and beam construction is clearly seen in this series of photographs.

Another problem that is highlighted has been the use of timber lintels above the windows.

It is difficult to determine if the roof was tied down to the walls. Post And Beam construction is usually tied down using the posts.

The large timber lintels used above the windows have allowed the brickwork above the windows to fail.

This photo from the site of the above residence gives an indication of the topography and the extent of the fire.

## Strathewen #3

A typical example of the effect of extreme temperatures experienced on motor vehicles.

Most alloy components melted, indicating temperatures far exceeded the 659 deg C required to melt aluminium.

There were numerous reports of tractors sagging in the centre, after aluminium gearbox components had melted.

Other items including agricultural equipment concrete mixers, mowers, and fire pumps using aluminium castings also melted.

Plastic components used in interior fittings, seats carpets and door linings together with the toxic emissions from chemicals released from electrical components and paints may have contributed to the loss of life of any occupants prior to the fire front reaching the vehicle.

Bluestone chimney and earth walls are the only sections of this post and beam earth walled house still standing.

It is reported that the owners sheltered with their horses inside the building until the fire front passed, and the building was alight. They were then able to leave the building having survived with their horses.

Well designed earth walled farm building could offer protection to animals in many instances.

## Loss of heritage

The shell of this double storey load bearing earth brick house stands as a testament to the structural integrity of well constructed earth walls.

Since the fires, the walls have withstood recent high winds without the bracing from internal floors and roof systems that provide house walls **with lateral** support.

Inspection of the walls indicated that most of the damage was limited to the render finish that had been applied to the bricks.

The impact on earth buildings is as varied as any other building materials. Several buildings showed the effect of the heat from fires destroying plastic down-pipes and tanks, but with damage to the building being limited to minor water damage to the surface of the walls as a result of owners defending their homes.

Some of the earth homes that were destroyed had been examples of the owner built homes built thirty to fifty years ago, when living in a secluded but special environment was a matter of personal choice. Often these houses were built with friends, keeping costs to a minimum but contributing to individual designs combining innovation colour and ambience.

People were free to express their ideas without the restrictions of today's regulations. Enthusiasm and the need for economic housing and the availability of second-hand materials allowed the use of recycled heavy timbers, classic lead light window, doors and second-hand bricks for floors and foundations.

Owners/occupiers of these special buildings have lost a lifetime collection of furniture, musical instruments, photos and irreplaceable family items.

Our society has lost a special part of Australia's earth building history.

Perhaps councils should allow people to rebuild in a similar style if that is their wish, without the same regulations that new conventional buildings will be subject to.

Many recently constructed earth buildings have survived, often while the occupiers were absent, providing some answers, more often reminding us that good design and finishing together with greater consideration to topography and fire retardant design has helped.

The last 20 years has seen a growth in load bearing brickwork using contemporary and traditional designs, combining the use of new materials and technology with the opportunity to detail the finish and seal gaps.

# Performance of Earth Bricks Walls

The cross section of this wall section clearly indicates the minimal effect of heat penetration on earth walls, which varies from 12 to 25mm from the outside of the render mix.

These bricks were hand-made and 200mm thick, with a heavy render applied.

It is difficult to determine the mortar mix, but it appears to be similar to Arthurs Creek silt, which was widely used in the 1970's and 80's prior to new regulations restricting its extraction.

Today, earth bricks are laid in a mortar of similar material to that of the bricks, with the addition of a small quantity of brick laying sand, and mixed with water No cement should be used in mortars, and good natural bricks do not require the heavy renders used in the past.

Inspection of a wall section from O'deas Rd. indicates the heat damage to the render coat and the depth of heat moving into the wall, with projected temperatures in the 1100 – 1300 degree range.

Earth mortars of similar material as that used in the bricks has maintained the bond to the bricks. On other sites, dissimilar mortar, in particular cement mortars, have shown failure of bond to the bricks.

This is an interesting earth oven that had been made by forming a frame of black wattle boughs bent and then tied with wire, covered with newspapers and then covered with a earth mortar mix.

When the oven had dried, a fire was lit in the oven burning out the paper and wattle form

The oven survived the fires even though adjacent trees had burnt out the root system deep down into the ground. Fired bricks close by showed considerable deterioration.

## Failure of Cement Mortars and single skin masonry walls

In many of the fired brick buildings inspected, it was noted that cement based mortars appeared to have failed because of the high temperature causing calcining of the cement/sand mortar, destroying the bond strength to the masonry component used in the wall's construction.

This effect was most noticeable in single skin brick veneer walls, where bricks had fallen into heaps close to the base of the building line. It was noticeable that many of the bricks were clean, with no mortar attached.

It would appear that the collapse of many single skin brick veneer walls preceded the failure of the stud walls and roof system because the walls were not pushed outwards.

In sections of these buildings that had incorporated double or triple brick in the building design, some parts of the structure had retained structural integrity

Few brick chimneys appeared stable enough to be retained.

(Photos: Skyline Road)

The earth walls of this split level post and beam building remain almost intact, with minimum effect on the walls.

The photograph shows the rear wall and the split level retainer wall that supports the top slab.

This wall of fired bricks has been affected by the heat, with approximately 90% of the bricks losing their face to a depth of approximately 20mm

Discussions with a fire expert confirmed this is a common problem in buildings where fires occur

The wall may still have sufficient integrity.

In some instances the high temperatures had changed the surface chemical structure of the soil used in earth bricks resulting in change of colour and a semi glazed surface. Structural integrity in these instances may have been affected with the face being glazed and brittle with the balance width of the brick remaining stable.

## Hollow Concrete Masonry

(Photos: Clarke Road Upper Plenty)

Hollow concrete masonry generally indicated poor performance under extreme conditions. Many of these walls failed, with the blocks being reduced to small shattered closed fist sized lumps or smaller. It would appear that the failure of the wall then contributed to the destruction of the building, without providing protection to the occupants or their belongings.

Reports of the poor performance of hollow concrete masonry were well known after the Ash Wednesday fires, but were still accepted by councils in locations with a fire area overlay.

The use of Concrete Masonry was only represented in a small number of the building sites inspected

This site in Upper Plenty contained four buildings. The residence was located in a cleared area in the bottom of a small valley.

There was a cleared driveway of approximately 6 metre width between the building and the steep heavily timbered slope behind the buildings.

The site and surrounding area included light to heavy timber, with the fire burning deep into years of accumulated ground litter mixed with soil, and then entering the root system of many of the trees.

These concrete masonry walls were 200mm thick and showed minimum impact from the fire.

The area appeared to have been exposed to a lower temperature range than most others on Ninks Rd.

The topography may have also reduced the levels of radiant heat.

## Skyline Road Christmas Hills

Earth walls are intact, even though the roof timbers and cladding have failed.

Another example of the structural integrity of earth walls.

One of three buildings that survived in Skyline Road.

## Restricted access by fallen trees

Inspection of many sites confirmed the extreme temperatures and wind velocities that would be similar to those that have been widely reported in the media, and the problems associated with blocked road access.

Fallen trees across driveways restricted access for people wanting to leave in their vehicles.

The high temperature burn often left large trees, that will have to be removed because the fire has burnt into the root system destroying the ability to survive but leaving them standing.

The long drought period had reduced soil moisture, causing the soil to dry out and the clays to shrink, reducing the bond between the root system and the soils.

The impact of these climatic conditions may have contributed to the large number of trees that fell across roadways, restricting vehicular movement.

The extreme winds that drove the fires destroyed many of the large mountain ash, blackwood, and other species that had survived for perhaps the last century.

The root ball of this tree was torn out of the ground, causing the 60 to 70 metre high and 5 meter in circumference tree to fall, uprooting several large blackwood's that had formed part of the forest canopy

*(Photo: Ninks Road St Andrews.)*

## Ninks Road

This residence provided shelter for four adults and two young children until the floor of the second storey started to burn, when they were able to leave the building after the fire front passed.

They reported that there was no apparent reduction in air quality due to the oxygen reduction.

Further research into the properties of earth walls and air quality is required.

These walls are still standing and are structurally sound.

The walls had been built around a timber frame, which extended to form the second storey which was destroyed in the fires. Melted glass is visible on the top of the walls from the thin windows that had failed, letting the fire enter the upper storey. The use of earth walls can provide additional protection for vehicles and equipment that may be required after the fire front has moved through.

Brick paved floors out-performed concrete slabs, which indicated surface failure.

This paved floor is on a bed of sand and sound concrete footings. The double storey building that was on this site displayed no failure of the footings or any sign of failure in the earth walls.

Councils demand that the footings must be replaced, and that the owners cannot use them again for a new building on the same footprint is an irrational request.

Common sense needs to replace impractical demands to comply to new regulations that will not provide any additional benefit only cost to the owners

The earth brick walled chook pen retained its integrity even though the window frames, roof timbers and cladding were destroyed.

## Ninks Road #2

This photograph indicates the effect heat had on internal earth wall surfaces.

The impact of the temperature generated by the fire destroying the second storey internal fittings and furnishings only penetrated the surface of the brick work by 10-12 mm

The effect on the outer face of the earth walls was minimal.

The render coatings failed, and there was limited heat transfer of 15 to 25mm into the brick.

Several people who sheltered in earth houses reported that the external temperature was 48+ deg outside prior to the fires, and 33 degrees inside during the fire front period

Despite the high temperatures, earth walls generally retained their structural integrity.

This internal wall would require the render coating to be stripped and replaced prior to being suitable for reuse.

## Ninks Road St Andrews

This fired brick residence's long walls had collapsed. The end walls, which included the chimney and fireplace at one end and a double brick wall, were still stable.

The failure of the walls appeared to be a combination of failure of the mortar to retain bond strength, and the subsequent failure of doors and window frames.

The roof and eaves structure was completely destroyed.

This site was one of several new light weight construction residences to be totally destroyed, even though it was located in a sparsely treed area.

Buildings of this design and material choice provide no protection for occupants.

As above the only recognisable item being the roof sheeting and hot water service tank.

## Buildings that survived in Ninks Road St Andrews

There were approximately six buildings that survived in the Ninks Road area.

This old timber residence, built in the early 1900's, and a timber clad building on the opposite side of the road, had a combination of cleared areas and non indigenous trees

This earth brick building had deciduous and evergreen trees in the immediate area around the building.

Indigenous trees in the background and on the road verge were burnt

Topography wind direction and force may have assisted these buildings to survive.

This modern timber pole framed multi story residence survived, and indicates numerous features that may have contributed to its survival.

A fire safety plan to provide for the building's protection, with water tanks protected from fire front.

The low profile roofline, and the building being recessed into the hill giving it reduced exposure to the fire

Circular cleared roadway as fire break. Deciduous trees in the foreground and the residence to the left still had their goats grazing in the paddock where the fire had jumped the bottom of the valley.

## Skyline Road Christmas Hills

In several communities the most prominent features of the landscape are the numerous earth walls still standing often interspersed with surviving houses.

This house was one of three that survived in the Skyline Road area affected by the fires. Two were earth houses, the other home being saved by its occupants

It was designed and built to survive bushfires using a wide range of materials in its construction.

Damage to the house was very limited, slight charring to the fascia, and damage to a window frame, plastic pipes and windows.

The owner explained that most of the damage to the house was as a result of items having been left close to the wall, that had ignited prior to the actual fire front.

The damage to the rear corner post, fascia and pipes resulted from a caravan close to the building being destroyed. Pot plants located around the plastic pipes resulted in the localised damage.

Door mats and a dog basket had caught fire, and resulted in minimal damage to a low level window frame that had since been repaired when the windows were replaced.

The end wall shows some of the variety of materials used, including fire resistant timbers Fibro cement sheet and rock wall

Thirteen of the original windows were cracked by the heat with the only aluminium framed window actually failing .

The windows have been replaced since the fire with toughened glass.

Attention to detail and good workmanship prevented the ingress of the fire and or embers into the building. The eaves design enabled the roof areas to be sealed, preventing the fire entering the roof system. The timber fascia only suffered minor damage despite the house reported as being under attack on two occasions.

## Skyline Road Yarra Glen

(Photos of outbuildings in Skyline Road Yarra Glen)

Total destruction to steel framed buildings was consistent on all but one site that had been inspected.

Earth walls in background were intact even though the roof system was destroyed

Steel framed buildings would not have protected anyone seeking shelter from radiant heat or any items located in them.

This building had been on the steel pipe stumps and would have had a beautiful view.

## Clonbinane

This site was 3 to 400 metres or further from other buildings or clumps of trees, and about 1.5 km from the pine forest where the fire was first observed on the opposite side of the Hume highway.

The buildings were located in a cut with only a few trees close by.

The two ferro-concrete tanks in the background showed the typical damage to this type of tank.

The surrounding area consists of low sparsely treed hills.

The fire destroyed numerous buildings in this area and the owner was advised that theit area was rated as fl19 following guidelines in the Australian Standard.

These outbuildings and equipment were destroyed despite being hundreds of metres from clumps of established foliage.

## Hazelwood Vic

Earth Walled building that survived the fire

This well finished earth house survived the fires when the owners and a friend defended the property.

Flames were reported to be two to three times the height of the surrounding forest area.

The site is located on the ridge with the slope away from it on both sides.

This photo indicates the quality workmanship and the sealing off of the timber where it passes through the wall, preventing embers entering the roof space

Corner post of the veranda which was the closest to the fire front.

Reports were that the short grass erupted into a sheet of flame.

Looking back towards the house shows the position of buildings and the large area of mown lawn surrounding the house that had burnt. Deciduous trees and shrubs and a low hedge provide some resistance to the flame front

The posts and door of the tool shed to the left were destroyed but the earth walls protected the shed's contents. Properties on both sides were destroyed, with loss of life in the light weight buildings on adjacent home sites.

## Out buildings

The design and location of outbuildings needs to be carefully considered, as in an emergency they can provide shelter for persons caught away from their main area of protection. If buildings are built from fire rated materials, vehicles and equipment may be protected, thereby reducing losses and insurance claims but more importantly providing people with transport to leave the area once the risk was reduced, or in the following weeks.

This light weight steel building survived with minimum damage. It can be assumed that the reasons were because of two factors;-the site had been excavated into the hill providing considerable protection because of the limited exposure to the fire front, and that the protruding building may have been below the flame level

The skillion type roof also provided reduced exposure to radiant heat and the flame zone. Another steel clad building housing farm equipment, located approximately 15 to 20 metres from the bottom of the slope adjacent to this building, was destroyed

(Photos Clarkes Road Upper Plenty)

This steel framed building was located adjacent to the house on the flat site about 6 metres from the bottom of the slope. Distortion of the steel framework was typical of the numerous buildings inspected, and would not have provided any protection, resulting in the total loss of any contents stored in the building.

Further along the road there were examples of a new home of lightweight construction.

The owners had been able to protect the residence which was located in a large cleared area with more distance between the building and the base of the slope.

The house was fitted with a sprinkler system, and a large swimming pool that provided the water reserve

A timber residence that survived appeared to have been completely missed by the fire, whereas numerous other surrounding properties were destroyed; these buildings included brick veneer and cement sheet and other cladding materials. Vehicles agricultural equipment and other items including caravans were destroyed.

# Commercial sites


**Glenburn Hotel**

There were no other destroyed buildings for a considerable distance back towards Flowerdale.

All fired brick walls have collapsed, with many of the bricks showing no signs of mortar still bonded to them

(Photos Glenburn Hotel Melba highway)

There was limited indication of the fire's impact on foliage within several hundred metres of the site from the Flowerdale fire side

Clumps of trees on the other side of the highway, 400 to 600 metres away, showed signs of possible spotting from ember attack.

**The general store**

Kinglake Whittlesea Road

The light weight steel framed building was totally destroyed

The petrol pump and gas cylinder rack appear to have no damage.

# Observations of Water tanks and Fire pumps

**Plastic Tanks**

Numerous examples of plastic tanks showed considerable damage down to the water line.

In the background the large tree detailed elsewhere is clearly visible.

When empty, plastic tanks had melted and often represented a flat plastic plate as indicated in the foreground

**Large poured on site concrete water tanks**

Large concrete tanks that had been poured on site with wall thicknesses between 100 and 150mm appeared to have withstood the impact of the fires although several showed signs of sprawling on the surface but not sufficient to cause failure to the tank..

Concrete surfaces tend to exhibit the problem of localised surface fracture and damage, as the concrete heats the surface expands and tends to explode and become dislodged.

**Large Fibreglass tanks (30,000 litre)**

Examples of fibreglass tanks appeared to have failed completely when exposed to the fire front, causing the wall section to separate from the base of the tank and total loss of water.

**Galvanised water tanks with plastic liners**

Discussions with a manufacture indicated that they had experienced instances where the plastic liner above the water level had suffered damage, but they had been able to pump out remaining water repair the liner and return the water to the tank.

**Ferro cement tanks**

Regulations call for the installation of a separate tank and fire pump for new developments in high Fire Zone areas.

Consideration should be given to provide protection for light weight transportable tanks, either by the use of earth mounds, or fire retardant walls to protect infrastructure.

Large numbers of this style of tank indicated signs of major damage, including emergency water reserves used by fire fighters as a refill point.

These tanks failed in many applications, with the concrete breaking away in large sections exposing the steel fabric, and then failure occurs of the inner cement layer that results in failure and loss of water.

(Photo Skyline road Christmas Hills)

This photo highlights the problem of concrete spawling from surface exposing reinforcement leading to failure of the inner concrete surface.

(Photos Clonbinane)

**Fire Pumps**

Comments by owners tend to support CFA Officers' comments, that probably up to 6 out of 7 domestic petrol powered fire pumps failed because they did not have the protection of a fire retardant wall and or a fine spray above them.

Fuel vaporisation can be a major problem with petrol engines at relative low temperatures.

Diesel powered fire pumps may drop in efficiency due to heat and reduced oxygen levels, but can maintain operational status in a high temperature environment. There were several reports of people losing their fire fighting capacity when pumps and hoses were destroyed.

## Wallace Road Christmas Hills

While the fire entered the centre section of this building, the dividing earth walls that extended to the roof line acted as a barrier, preventing it from spreading, and enabling it to be bought under control.

This photo was taken looking back to Skyline road

The foreground shows repaired walls and a replacement tank installed since the fires.

This modern steel sheet clad house was well designed for the area.

It did not come under the same level of attack as the Skyline road area, and the trees close to the building had minimal damage.

The house was well protected with hose outlets, and had just been handed back to the owners after a $50,000 repair.