CITY OF WHITEHORSE

CITY OF

Bushland Reserves Fire Management Strategy 2010



EXECUTIVE SUMMARY

1 What is the purpose of the Strategy?

The purpose of the Strategy is to assess the risk of bushfire affecting City of Whitehorse bushland reserves and/or the surrounding properties, and consider any necessary response(s).

The benchmark for the actions needed to minimise the risk while retaining the bushland character of the reserves is a "Level of Security" (p.4).

2 What process was used to produce the Strategy?

This 2010 revision of the Strategy has been carried out using the Australia- New Zealand Standard for Risk Management 4360:2004. See Chapter 2.

3 What is the result of the Risk Evaluation?

The evaluation has shown that the bushfire risk to Whitehorse Bushland Reserves is a risk that requires treatment.

4 What actions does the Strategy recommend?

High intensity bushfires cannot be controlled (p.12) so other strategies are needed to minimise bushfire damage.

The Strategy relies on *fuel management* and a range of *fire prevention and fire suppression measures* to reduce the occurrence and severity of bushfires. *Fire management plans* are an integral part of the City of Whitehorse Bushland Reserves Fire Management Strategy (p.21). A plan has been prepared and implemented for each of the four larger reserves.

Fire detection and suppression activities, limiting public access to parks and reserves during extreme fire danger weather, and community involvement all have a role to play.

A summary of actions required to implement the Strategy is provided (P.50).

A process of monitoring the implementation of the actions needed to implement the Strategy is included in Chapter 8.

Extensive community consultation and the recommendations of the 2009 Victorian Bushfire Royal Commission were considered prior to finalising the strategy.

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Chapter 1: Introduction

"Fire and people do in this agree Servants good but masters poor they be"

John Brooke

1 Purpose

The purpose of the City of Whitehorse Bushland Reserves Fire Management Strategy is to assess the risk of bushfire affecting the reserves and/or the surrounding residents, and consider any necessary response(s).

The Strategy recognises and reinforces the value of the reserves as a community resource, and as remnants of the vegetation that once covered the landscape.

2 Coverage

Forty one reserves were assessed as potentially exposed to bushfire. Details are included in Chapter 4 and Appendix 1.

3 Background

Council has carried out fire abatement works in the Bushland Reserves over many years in consultation with the Metropolitan Fire Brigade (MFB). Following the formation of the City of Whitehorse, it was clear that an overall strategy for bushfire management was needed. A meeting was held with the MFB Southern Zone Command and agreement on an annual management program was confirmed in late spring 1995.

Council discussed bushfire management policy for the reserves during 1995. The Combined Parks Advisory Committee took up the matter in July 1996.

A Subcommittee formed from Advisory Committees formulated a brief for the selection of a suitably qualified Fire Advisor in November 1996. Rod Incoll, a forester with extensive bushfire management experience was appointed, and a framework for the Strategy was presented to a further meeting on 23 April 1997.

The Council approved the Strategy in December 1997. Its provisions were and continue to be fully implemented.

Feedback from stakeholders and the MFB has vindicated the Council's investment in the Strategy and the need to build on the progress made to date.

4 Requirement for revision

The Strategy included a requirement for periodic review, and the first revision was approved by Council in 2002.

This 2010 revision of the Strategy has been aligned with the Australia/New Zealand Standard for Risk Management AS/NZS 4360:2004.

The Strategy has also been aligned with the 2009 Victorian Bushfires Royal Commission final report where this is relevant.

5 Level of security

The level of security used in previous versions of this Strategy has been changed in response to the public fire danger warning system introduced after the bushfires of Saturday 7th February 2009. The fire danger warnings now include a "Code Red" rating that applies when the forest fire danger index exceeds 100 (Figure 13).

The new warning system includes advice that the protection offered by current building standards does not extend beyond a forest fire danger index of 100 (Appendix 5). The level of security is therefore revised as follows.

The Strategy aims to provide a level of security so that:

- the personal safety of residents is assured during a bushfire;
- while loss of fences, garden sheds, and trees may occur, houses that are *directly affected* will survive bushfires burning under extreme fire danger conditions up to a fire danger index of 100;
- survival of houses that are *directly affected* by a bushfire burning under "Code Red" conditions, i.e., a fire danger index of more than 100, cannot be predicted. This depends on site factors like the standard of building construction and maintenance, and the amount and type of vegetation on the individual property.

6 Communication and Consultation

A key strength of the Strategy is the wide ranging consultation that underpins it. This has continued through the preparation of the revisions.

The Strategy was seen as a positive development by all stakeholders and respondents. Vegetation management was widely discussed during consultation. Many comments suggested more boundary breaks and vegetation reduction, while others did not want additional clearance. The effect of new plantings increasing fire hazard was raised.

7 Partnerships

The Metropolitan Fire Brigade (MFB) has statutory responsibility for fire prevention and suppression in the City of Whitehorse and is a key partner in fire prevention and suppression activities carried out in the City of Whitehorse Bushland Reserves.

The Bushland Reserves Fire Management Strategy interfaces with the responsibilities of other City of Whitehorse departments. These include Community Laws, Municipal Emergency Management, and City Works.

The arrangements for emergency management during bushfire(s) are included in Chapter 7.

This Strategy is one of a number of initiatives that are used to manage bushland reserves. Other programs include the appropriate Park Management Plans, and a range of environmental and ecological plans and programs.

8 Acknowledgments

The widespread interest in the Strategy is reflected in many individual and group contributions since the first draft was circulated. These are gratefully acknowledged.

The technical expressions used in this strategy are drawn from the "Glossary of Rural Fire Terminology" of the Australasian Fire Authorities Council, use of which is acknowledged.

Chapter 2: Bushfire Risk Management

1 Introduction

The purpose of the City of Whitehorse Bushland Reserves Fire Management Strategy is to assess the risk of bushfire affecting the reserves and/or the surrounding residents, and consider any necessary response(s).

The 2010 assessment uses a framework based on the Australian/New Zealand Standard 4360:2004, Risk Management, published by Standards Australia, 3rd ed., 2004. This Chapter introduces the framework.

2 Risk management

The Australian and New Zealand Standard *Risk Management* defines risk management as "the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating, and monitoring risk".



Figure 1: Risk Management Overview

The risk matrix used in the study has been aligned with the City of Whitehorse Risk Identification, Assessment and Control process from the Corporate Policy Manual.

The risk management process is shown as a flow chart in Figure 1, and each step is explained as follows.

2.1 establish the context

The background, history, and description of the reserves provide the social and physical components of the context. Together with the strategic, organizational and management arrangements for the Bushland Reserves, this section sets the scene for the risk assessment process.

2.2 risk assessment

There are three components that together make up the risk assessment process. These are identifying, analysing, and evaluating the risks, which are explained as follows:

identify the risks

"Identify the risk," means what, why, and how bushfire related events could arise in the Bushland Reserves. Fire behaviour information, fuel types and potential for fires within the reserves, and the ecological impact of bushfire are other risks.

analyse the risks

"Analysing the risk" means determining the existing controls, the likelihood of a bushfire occurring in the Bushland Reserves, and its consequences and magnitude. This provides an estimated level of risk.

evaluate the risks

The risk determined by the assessment process is then assessed to identify what, if any, action need be taken. If the level of risk is low, the risk may be acceptable and treatment may not be required.

2.3 treat the risks

Having carried out the risk assessment, the next step identifies actions required to reduce risks. Low priority risks may be accepted and monitored for change. Specific course(s) of action are developed and implemented for other risks.

2.4 monitor and review

Monitoring and reviewing the performance of the risk management system is required to adapt to the inevitable changes that occur over time. Periodic assessment of factors affecting bushfire risk across the reserves must be provided for in the risk management system.

3 Summary

This chapter described the risk management process set out in the Australian and New Zealand Standard 4360:2004 *Risk Management*, and how the methodology will be applied in the Bushland Reserves Fire Management Strategy.

Chapter 3: Establish Context

1 Introduction

The Bushland Reserves are public land owned or managed by the City of Whitehorse, for the benefit of all residents. Over time, bushfire has been a constant visitor, and has the potential to significantly reduce the amenity value and ecology of the reserves and damage adjacent property.

The Fire Management Strategy provides a framework to regulate planned and unplanned fires in the reserves to protect bushland assets, and improve security for adjoining residents.

2 How the Reserves developed

The early days

In the time before European settlement, the land in the east of the Port Phillip district provided the Wurrundjeri people with all of their needs. The first European settlers thought the land was poor and did not warrant clearing for agriculture.

Until the end of the nineteenth century, large areas of native bushland between Blackburn and Vermont remained intact, as selectors ventured further afield in search of more productive country.

Food for a growing city

As the 20th century dawned, the demands of the nearby city for agricultural produce began to escalate. Pockets of better land were selected for intensive production, such as fruit and flower growing and poultry farming. Tracks were constructed for access to the markets. Local cooperatives were formed as a spirit of cooperation and community emerged amongst the pioneer settlers.

New estates and new suburbs in the 1950's

After the 1939-45 war, the demand for residential land increased. Many of the farms and orchards were converted into house lots. New estates grew into residential suburbs during 1950-60. Some of the remaining bushland was also converted for housing, road and service easements. There was a real prospect of the area becoming another uniform sea of houses.

The spirit of community

However the spirit of community which had emerged in the early years of settlement had not waned. Far sighted citizens, and the Councillors, saw the need to retain bushland areas as part of an extensive parks system within the municipality.

Interest in nature was strong, and community groups like the Blackburn and District Tree Preservation Society were formed.

Over the years, public spirited citizens with a love for the native bush have entrusted bushland to the Council, rather than selling it for development. Antonio Park, Wandinong Sanctuary, and Trove Park are examples of reserves acquired in this way for the benefit of future generations.

3 The Reserves today

The reserves are an integral part of community life, providing-

- a range of open space recreation opportunities
- high quality urban landscapes and streetscapes
- conservation of the native flora and fauna including several significant plant species.
- a range of education opportunities
- an opportunity to keep in touch with and appreciate natural values
- a reference to the original plant communities of the area.

Various studies have identified the values of the reserves. For instance, from a conservation viewpoint, Antonio Park has twelve native plant species that are considered significant, to make this park "one of the best remnant stands in metropolitan Melbourne" (Carr, Reid and Albrecht, 1987).

"Land for Wildlife" status has been accorded to many of the reserves by the Department of Sustainability and Environment. "Land for Wildlife" is a prestigious award which reflects the high commitment of the City of Whitehorse, the various "Friends" groups, and local residents have made to conservation.

A point that was emphasized by the community during the initial consultation phase of the Strategy was that the unique nature of the reserves was widely recognised.

The value of the reserves as a community resource will increase as pressure mounts for yet more residential living space.

The opinion that the Bushland Reserves should continue in much their present form, provided provision was made for the security of life and property, was identified during consultation. This is acknowledged as a foundation value for this strategy.

4 How the Reserves are managed

The 2009-2013 City of Whitehorse Council Plan includes "sustainability" as a core value. This requires decisions about social, economic, built and natural environments to be made to benefit both present and future generations.

Strategies include "Protect, enhance, and appropriately develop open space for current and future generations", and "maintain and enhance Council's physical assets for long-term sustainability, safety, and public amenity".

Council's key priorities envisage "the protection and enhancement of our natural environment in parks, suburbs and landscape; empowering the community to collaborate with Council to plan, develop and protect healthy, thriving ecosystems across the municipality".

This is an appropriate frame of reference for the strategic management of bushfire in Whitehorse Bushland Reserves. This Strategy will complement the "Native Vegetation Management Strategy", when this has been prepared.

Council's "Arts and Recreation Development" group has a policy and planning responsibility for all open space including bushland.

Advisory Committees have long been established for many of the reserves. These Committees provide community input in various ways, including the provision of many thousands of hours of service work each year, and ensuring that the Council is kept informed on matters concerning the reserves. Many reserves have active "Friends" groups working with the Advisory Committees.

Through the efforts of many dedicated people, weeds have been replaced with native plants grown from local seed, trees have been planted, growth has been nurtured, and much work has been carried out on facilities.

Members of the local community also assist by reporting smoke, fallen tree limbs or vandalism, as well as generating interest about the reserves within the local community.

Chapter 4: Identify Bushfire Risk

1 Introduction

In business analysis, risks are identified during the assessment. In this case, the risk was pre-determined as the risk of bushfires affecting the reserves and/or adjacent private property.

Fire behaviour information, fuel types in the reserves and potential for bushfires within the reserves are relevant to the risk of bushfires.

Scenarios will identify what, why, and how bushfires can arise in Whitehorse Bushland Reserves, as a basis for analysis and action.

Bushfire can reduce ecological diversity, cause habitat tree death and adversely affect bird and mammal populations in a small reserve. This was noted as an ecological risk.

2 Bushfire in the landscape

Over geological time, fire has greatly influenced the development of Australian ecosystems. Climate warming after the last ice age resulted in an increase in natural fire frequency. This generated a range of fire adapted plants, including the eucalypts with their ability to regenerate quickly after bushfires.

Aboriginal use of fire is generally recognised as having increased fire frequency and maintained the open nature of the forests. The use of fire by aboriginals was well noted by the early explorers, including Cook, who referred to southern Australia as "the continent of smoke" in his journal.

The advent of European settlement radically changed the fire regime, with the widespread clearing of forests for agriculture and the exclusion of fire from areas which were once frequently burnt. Severe bushfires in drought years have resulted in the extensive loss of life and property.

Research carried out by the CSIRO and state authorities during the 1960's demonstrated the effectiveness of using science and technology in forest fire management. Techniques such as prescribed burning and aerial fire suppression are now widely used in broad area forest management.

3 Bushfire Behaviour

fire danger

The fire danger is whether a bushfire can ignite, spread and do damage, and whether it can be controlled. Fire danger is a function of air temperature, relative humidity, wind velocity, and drought. McArthur (1967) developed a forest fire danger index that is widely used by fire and weather agencies to express the degree of fire danger (Figure 2). At a **fire danger index** (FDI) of 1 (cold, humid, calm weather) a fire will not burn. The worst possible conditions (very hot, dry, and windy weather) are represented by an FDI of more than 100.

The forest fire danger index is subdivided into five fire danger sub-classes of low, moderate, high, very high and extreme. The upgraded fire danger warning system (Figure 13) is based on this index but is separate from it.



Figure 2: Forest Fire Danger Meter (front view)

can a bushfire be controlled?

The controllability of a bushfire is whether it can be put out by fire fighting forces. There is a perception that bushfires can be extinguished and that the effectiveness of modern technology and fire fighting organisation provides a safety net. To explore this idea consider Figure 3.

As the forward rate of spread of a fire front increases, the heat energy generated (known as the fire intensity and measured in kilowatts per metre of fire edge or kW/m) also increases, until a point is reached where the capacity of fire fighters to halt the forward spread of the fire fails. The upper limit is generally accepted as 2,500 – 3,500 kW/m for forest fuels.

TECHNIQUE	FIRE INTENSITY LIMIT (kW/m)
experienced hand tool crew	800
bulldozer and tanker crew	2000-3000
air tanker (fire retardant)	2500-3500

Figure 3: The intensity level at which fire suppression is likely to fail on a fire burning in eucalypt foothill forest

The fire intensity of a bushfire burning during extreme fire danger weather conditions may exceed 100,000 kW/m and was estimated at 150,000 kW/m at the peak of the "Black Saturday" bushfires on Saturday 7th February 2009. This extreme level of energy results from the almost instantaneous release of the sun's energy that has been locked up in vegetation over decades, as the high intensity fire front accelerates through it.

So it is obvious that high intensity bushfires cannot be controlled. CSIRO research has signposted the criteria for living safely near native forest. Much of the pioneering work was carried out by Alan McArthur and his team (1967). An important part of McArthur's work is the relationship between fire danger, fuel quantity, and the rate of spread of a fire front.

Fuel quantity is a key determinant in fire behaviour, fire intensity, and hence the controllability of a bushfire.

FUEL	FIRE						FIRE	DANGER	INDEX					
(Vha)	BEHAVIOUR	5	10	15	20	25	30	40	50	60	70	80	90	100
	R (km/h)	0.03	0.06	0.09	0.12	0.14	0.17	0.23	0.28	0.34	0.39	0.45	0.50	0.56
5	H (m)	0.3	0.6	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	S (km)	-	-	-	0.1	0.2	0.3	0.6	0.8	1.0	1.2	1.4	1.7	1.9
	R (km/h)	0.06	0.12	0.18	0.23	0.29	0.34	0.45	0.56	0.67	0.78	0.89	1.00	1.11
10	H (m)	1.0	2.0	3.0	4.0	5.0	5.5	7.0	8.5	10.00	11.0	12.00	13.0	14.0
	S (km)	-	-	0.2	0.4	0.6	0.8	1.2	1.7	2.1	2.5	3.0	3.4	3.8
	R (km/h)	0.09	0.18	0.26	0.35	0.43	0.51	0.68	0.85	1.02	1.18	1.35	1.52	1.68
15	H (m)	2.0	3.5	5.0	7.0	8.0	9.5	12.0	14.0	-	- CROV	N FIRE -		
	S (km)	-	0.2	0.6	0.9	1.2	1.5	2.2	2.8	3.4	4.1	4.8	5.4	6.0
	R (km/h)	0.12	0.24	0.36	0.48	0.60	0.72	0.96	1.20	1.44	1.68	1.82	2.16	2.39
20	H(m)	2.5	5.0	7.0	9.0	11.0	13.0		- CROW	N FIRE -		-	-	
	S (km)	0.1	0.5	0.9	1.3	1.7	2.2	3.0	3.8	4.7	5.6	6.4	7.2	8.1
	R (km/h)	0.14	0.30	0.45	0.60	0.75	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00
25	H (m)	3.0	7.0	10.0	12.0	14.0		- CROW	WN FIRE -		-			
523	S (km)	0.1	0.6	1.1	1.6	2.1	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6

R = rate of forward spread in kilometres per hour. H = flame height in metres. S = average spotting distance in kilometres. Fuel Quantity is expressed in tonnes per hectare of combustible material less than 6 millimetres in diameter.

Figure 4: Showing fire behaviour variation (rate of spread, flame height, spotting distance) for FDI and fuel loadings. (McArthur 1967)

The table in Figure 4 is found on the reverse side of the Forest Fire Danger Meter and summarises fire behaviour information for eucalypt forests recorded during McArthur's (1967) research.

This shows the Rate of Spread of a fire front in kilometers per hour (R), flame height in metres (H) and spotting (ember throw) distance (S) in kilometres.

In Figure 5, this table has been converted to approximate fire intensity values (kW/m). This graphic shows the ability of a bulldozer and tanker crew to control a bushfire. It also shows the value of fuel management, showing that for minimal fuels fire may be controlled across the FDI range, whereas in heavy fuels fires quickly become uncontrollable.

FIRE DANGER CLASS	LOW	M	IOD	н	IGH	VERY	HIGH		EXTR	REME	
FDI <u>FUEL</u> <u>t/ha</u>	5	10	15	20	25	30	40	50	60	80	100
5 t/ha	75	150	225	300	350	425	575	700	850	1125	1400
10 t/ha	300	600	900	1150	1450	1700	2250	2800	3350	4450	5550
15 t/ha	675	1350	1950	2625	3225	3825	5700	6375	7650	10125	12600
20 t/ha	1200	2400	3600	4800	6000	7200	9600	12000	14400	18200	23900
25 t/ha	1750	3750	5625	7500	9375	11250	15000	18750	25500	30060	37500
]						1	TRALL	
IRES CON	TROLL	ABLE						FIRES N	UT CON	TROLL	ABLE

Figure 5: Fire intensity values of cells in Table 5, and bushfire controllability

"Project Vesta" was initiated by the CSIRO in 1994 to gather additional data about the behaviour of bushfires burning under extreme weather conditions.

Vesta results generally supported MacArthur's relationship between fire behaviour and fuel load, but determined that faster rates of spread would be obtained in forests with a shrubby understorey. Under extreme conditions fires will be more difficult to control than indicated due to intense short-distance spotting. (N P Cheney, Project Vesta, pers. comm.).

Updated fire behaviour tables based on Project Vesta results have been released as a field guide. The authors have stipulated that as the fire behaviour tables have not yet been validated for some vegetation types including Victorian foothill forest, the guide should not be cited in bibliographies. For this reason the data has not been used in this revision of the Strategy and it is not cited as a reference. The latest research emphasises the importance of fuel management throughout the Whitehorse Bushland Reserves.

Figure 4 shows the spotting distance ("S"). For instance fires in eucalypt forest fuel loads of 25 t/ha under extreme conditions (FDI of 100) will throw embers 9.6 km ahead of the main fire. Much greater distances were experienced in the bushfires of 7^{th} February 2009 – see Appendix 4 for more information.

influence of fuel

The rate of forward spread of a bushfire approximately doubles as fuel quantity doubles, for a given level of fire danger.

The overall fuel hazard is a significant measure as fuel quantity is the only factor in the bushfire equation that can be altered.

Since a bushfire starts in the ground litter or surface fuel, and progressively moves into tree crowns through near surface fuel, elevated fuel (or shrub fuel) and bark fuel to the tree crowns, the "Overall Fuel Hazard" on a site needs to be described to determine the fuel hazard.

The concept was developed by the Department of Sustainability and Environment (Wilson 1992, McCarthy et al, 1999) to give a measure of the "Overall Fuel Hazard" on a Victorian forest site.







MODERATE OVERALL FUEL HAZARD

fine fuel hazard	4-8 t/	′ha
elevated fuel hazard	moder	ate
bark hazard	high	(old char)
overall fuel rating	mode	rate

Bushfires controllable to about Fire Danger Index 40.

Figure 6b Mo

Moderate overall fuel hazard



Figure 6c

High overall fuel hazard



VERY HIGH FUEL OVERALL HAZARD

fine fuel hazard12-18 t/haelevated fuel hazardhighbark fuelvery high (unburnt)overall fuel hazardvery high

Bushfires controllable up to about Fire Danger Index 10

Figure 6d

Very High Overall Fuel rating



EXTREME OVERALL FUEL HAZARD

fine fuel hazard	exceeds 18 t/ha
elevated fuel hazard	extreme
bark fuel hazard	extreme
overall fuel hazard	extreme

Bushfires controllable up to about Fire Danger Index of 5

Figure 6e Extreme Overall fuel rating Figure 6: Typical Overall Fuel Hazards in the Reserves.

influence of wind

Extreme fire weather is characterised by strong to gale force winds. These are from the northwest quarter in almost every case during the development of a high intensity fire as shown in Figure 7.



Figure 7: Typical weather pattern during high intensity bushfires.

This leads to a skewing of the "axis of fire risk" and the exposure for assets adjacent to bushland as shown in Figure 8.

Location of asset	Relative fire risk exposure
west to north of bushland	least exposure
south to east of bushland	greatest exposure

Figure 8: Fire exposure for assets adjacent to bushland

So the main bushfire risk to assets from bushfire is in the south to east quarter downwind from a Reserve.

A south west wind change may occur while a bushfire is burning, as seen in Figure 7. This extends the fire front to the east and north east, usually as the final phase of fire development before the weather changes. This effect is shown in Figure 9.

The risk to assets is maximised around the point of wind change when the most severe fire behaviour occurs. After the change, fire intensity reduces and the fire can usually be controlled if the weather moderates.



Figure 9: Effect of southwest wind change on fire spread shown as "Secondary Spread".

4 Is the bushfire risk equal between Reserves?

The Bushland Reserves listed in Appendix 1 were scored for exposure to bushfire risk during field work. A range of factors was assessed including:

- fuel present within the Reserve
- fuel breaks present within the Reserve
- size and shape of Reserve
- orientation of Reserve
- a range of site factors including local topography
- access to boundaries of Reserve
- public access to Reserve
- fire history of Reserve
- separation distance of structures from the Reserve boundary
- fire hazard on adjoining properties

Brief comments on these factors follow.

Fuel present within reserves

Fuel rating within the reserves was sampled and significant variation was observed between the reserves – (Figure 6).

Fuel breaks present within Reserve

Whether fuel is continuous or separated into patches by fuel breaks, as continuous fuels favour the development of more intense fires; whether access is available for firefighting within the Reserve.

Size and shape of Reserve

A high intensity fire requires space and time to build up momentum as it climbs from the litter layer through the elevated fuel to the tree crowns. In the smaller reserves there is less space for this process to become established, thus relatively limiting the potential risk.

Orientation of Reserve

Given that fire winds blow from the northern quarter, a north-south orientation of a Reserve favours the spread of fire under extreme conditions, relative to an east-west orientation.

A range of site factors

Examples include slope and aspect. These are important, where the assets are uphill from the Reserve on a north west-facing slope which has the greatest exposure to fire winds.

Access to boundaries of Reserve

A fuel break between the fence line and the Reserve significantly reduces the intensity of fire on adjoining property and provides access for fire fighting, particularly on the southern and eastern boundaries. In some cases, for example on the southern side of Blackburn Lake Sanctuary, a formed road outside the Reserve provides a fuel break.

Public access to Reserve

While most reserves are freely accessible to the public, some have limited access and are overseen from neighbouring houses. This relates to opportunities for unobserved fire lighting.

Fire history indicators

Fire history is a statement of the past risk and is indicative for the future if the activity pattern within the Reserve is unchanged. Although recorded fire history is incomplete, past fires leave indicators such as charred bark, butt scars, dead tops, and charring of wooden fences.

Separation distance of structures from the Reserve boundary

In the event of high intensity fire in a Reserve, structures close to the Reserve boundary may have direct flame or significant mass spotting exposure that places them at greater risk of fire involvement.

Fire hazard on adjoining properties

Should a fire hazard on a residential property ignite during a bushfire during extreme fire danger weather conditions, fire transmission to adjoining properties may take place by direct flame contact or intense mass spotting. This was a significant issue during the 2003 Canberra bushfires.

5 Risk profile of the Reserves

The field work based on these factors enabled classification of a fire risk profile for the reserves as follows:

Group One: Reserves with a relatively higher bushfire risk

ANTONIO PARK and ANTONIO NEWLANDS BELLBIRD DELL BLACKBURN LAKE SANCTUARY YARRAN DHERAN and YARRAN DHERAN NORTH

Group Two: Reserves with an identified bushfire risk

COOTAMUNDRA WALK ELGAR PARK HEATHERDALE RESERVE HIGHBURY PARK JOSEPH STREET RESERVE KOONUNG CREEK RESERVE LOOKOUT TRAIL PARK MULLUM MULLUM CREEK RONALD E GRAY RESERVE SOMERS TRAIL EAST TROVE PARK WANDINONG SANCTUARY

Group Three: Reserves with a relatively lower bushfire risk

ABBEY WALK **BLACKS WALK BUCKANBE PARK** BUSHY CREEK RESERVE (EAST) BUSHY CREEK RESERVE (WEST) CAMPBELLS CROFT CASELLA HOLLOW COLLINA GLEN DAGOLA RESERVE DAMPIER GROVE ERAM PARK FURNESS PARK GARDINERS CREEK RESERVE KALANG PARK MEMORIAL PARK MORACK GOLF COURSE MORESBY DALE **ROOKS RESERVE** SIMPSON PARK SCHWERKOLT COTTAGE SOMERS TRAIL CENTRAL STEPHENS RESERVE SURREY PARK WURUNDJERI WALK

6 Causes of fires in urban bushland

A constant background level of ignition events from arson, accident, negligence and other causes occurs at random intervals. When an ignition event coincides with extreme fire weather conditions and a dry fuel mass, bushfires severe enough to threaten life and property will result.

Victorian bushfire statistics show that lightning starts about one third of bushfires, and two thirds result from human activities. Of the latter category, about one fifth is deliberately lit. Does this data apply to Whitehorse Bushland Reserves?

Lightning

No instance of lightning strike causing bushfires has been recorded for the Whitehorse Bushland Reserves.

Should a lightning strike occur in a Bushland Reserve, any resulting fire will be quickly detected. The humid weather associated with a thunderstorm would result in a low rate of fire spread and allow control of the outbreak.

Lightning can be discounted as a cause of high intensity bushfire in the Bushland Reserves.

Human activity

The detailed fire records kept by the City of Whitehorse since 1997 indicate that almost all recorded fires were caused by human activities.

The main causes have been:

- children playing with fire
- illegal camp fires
- deliberate lighting of fire

Special note on arsonists or fire setters

Arson is a recurring problem for Whitehorse Bushland Reserves. Research indicates that fire setters tend to be young, 66% of arrests being persons of 20 years or younger. They are predominately male, of below average academic achievement, most having problems at school. Often from dysfunctional families, they experience problems forming relationships except that they sometimes set fires in pairs. While homes and schools were the prime target, fields and forests were next on the list of assets deliberately set alight.

Personal experience with arsonists indicates that another category, malicious firelighters, must be considered.

These are otherwise normal, functional community members from all walks of life, who harbour a grudge. They seek revenge by deliberately selecting a target and setting a fire in such a way as to maximise damage.

They are intelligent, capable of great cunning in carrying out their mission, and thus are difficult to detect or identify. Malicious arsonists are a potential cause of bushfires in Whitehorse Bushland Reserves.

other causes of bushfire

Accidental lighting of fire from domestic or industrial activities, including the use of motor powered tools and equipment within a Reserve, and use of projected pyrotechnics like sky rockets within or near a Reserve, have been responsible for bushfires in other urban areas. These agencies could start bushfires in City of Whitehorse Bushland Reserves.

ignition from bushfires burning elsewhere

How could a Bushland Reserve be affected by a bushfire that is burning elsewhere?

If a bushfire is described as "an ignition in an area of natural fuel in which a high intensity unplanned fire could develop sufficient intensity to pose a threat to people and/or property", then all grassland and bushland areas need to be assessed for the risk of burning embers being generated that could start fires in a Bushland Reserve.

To create a bushfire risk, an "axis of threat" extended from a distant natural fuel area would need to intersect with a Whitehorse Bushland Reserve.

The "primary axis of threat" is a line from the north west to the south east from an area of natural fuel. This is a line bearing 135° from true north, and is the direction a fire front would be driven by the north west winds (vector 315°) that invariably accompany extreme fire danger conditions (Figure 7).

A "secondary axis of threat" from the south west to the north east $(45^{\circ} / \text{vector } 225^{\circ})$ would apply to a natural fuel area if the wind changed from north west to south west while an intense bushfire was burning, (Figure 7).

There are two broad classes of natural fuels that need to be examined: natural fuels at maximum spotting distance, and natural fuels outside the Reserve but within the local area.

up to maximum spotting distance for natural fuels

The Whitehorse Bushland Reserves are located approximately twenty kilometres from the northern boundary of the metropolitan area, where significant high intensity bushfires have occurred.

Evidence of extreme spotting distances was given to the Royal Commission of Inquiry into the "Black Saturday" fires of 7th February 2009; Fabian Crowe of DSE stated that the Don Road, Healesville bushfire was started from the East Kilmore fire, 47 kilometres distant (Appendix 4).

There is an identifiable risk of bushfires being initiated in the larger reserves by embers from large intense bushfires burning north west of them.

bushfires within the local area

When a fire is burning in an adjoining natural fuel area, then there is a risk to any Whitehorse Bushland Reserve located south to south east of the fire. This may occur through short to mid distance spotting, by flame spread, or both.

An example is given in Figure 10, which shows potential for bushfire spread south along Mullum Mullum Creek to Yarran Dheran and Antonio Park.

Examination of the other Whitehorse Bushland Reserves shows that this is the main vulnerability from local fire spread.

secondary axis of spread

No instances of spread from a local fire to a Bushland Reserve during a south west wind change have been identified.

While relatively unlikely, it is possible that a wind change could occur while a bushfire was burning in a Bushland Reserve. The effect of this would be to extend the eastern fire edge as shown in Figure 9, thereby increasing the risk to properties on this front.

7 Identified Risk

Bushfire Risks to the Whitehorse Bushland Reserves have been described and are now summarised as "Risk Scenarios".

Scenario One: "Ignition from a distant bushfire"

This may occur as a result of "ember throw" or "spotting" from bushfires that may be burning more than 20 km to the north west.

Scenario Two: "Ignition from a bushfire burning nearby"

Ignition within a Bushland Reserve may occur by spotting or direct flame spread from a bushfire burning in a nearby location (Figure 10). This includes fire spread from private property.

Scenario Three: "Ignition within the Reserve"

Ignition within or directly adjacent to a Bushland Reserve

These scenarios will be explored in Chapter 5.



Figure 10: Possible fire spread along Mullum Mullum Creek

Chapter 5 – Analyse Bushfire Risk

1 Introduction

"Analysing the risk" means determining the likelihood of a bushfire occurring in the Bushland Reserves. Reference is made to fire history and the weather cycle, to identify the risk of bushfire, its consequences and magnitude, and the existing controls.

2 Bushfire history

Victoria suffered its first baptism of fire on Black Thursday, 6th February, 1851, when according to the History of the Colony of Victoria-

"early in the morning the wind increased to a hurricane, and bushfires swept across whole districts with the speed of lightning, crossing wide roads and streams, destroying men, women, and children, cattle and sheep, crops, fences and houses and everything that stood in its way... the thermometer ranged from 118 to 119 degrees...the settlers were not aware of the danger until the furious roar of the bushfire broke upon their ears, when they had to fly and abandon the whole of their property."

Fires burnt over about one quarter of Victoria, causing the deaths of six people and much loss of property.

The earliest local record is from 10–23 January 1916, when a succinct note in Foley (1947) indicates "grass and bush fires at Box Hill". There are no further records of fire in Foley (1947) for the area, including the peak fire years of 1926, 1939, and 1944.

"The Sun News-Pictorial" of Monday 15 January 1962 carried a report of a fire in the Heathmont-Vermont area on 14 January, which destroyed an unoccupied house and damaged the roof of another. The fire burnt an area "a mile long" and burnt "within a few feet of many houses" in the Heatherdale Rd - Canterbury Rd area. From the scant details given in the report it seems that this fire burnt south along Heatherdale Creek from Canterbury Road.

Other severe fires in January 1962 caused deaths in the Dandenong Ranges and across the northern suburbs including the Mullum Mullum Creek and Eltham, see front page of "The Sun" from 20 January 1962 at Appendix 2.

There is an eyewitness report that Antonio Park and Heatherdale Park were burnt during the 1962 fires, and an unconfirmed report that Blackburn Lake Sanctuary was also burnt at this time.

3 Recent fire history

Figure 11 shows fire incidence since 1984. Records for each reserve are included in Appendix 3. A detailed record of fires occurring in the reserves is now maintained by ParksWide.

ANNUAL	BUSHFIRES
year	No of fires
1984	1
1987	4
1988	1
1989	9
1990	1
1991	1
1992	0
1993	1
1994	2
1995	1
1996	0
1997	4
1998	4
1999	1
2000	3
2001	7
2002	1
2003	2
2004	2
2005	20
2006	4
2007	2
2008	2



Figure 11: Recent Fire History, Whitehorse Bushland Reserves

All 73 bushfires recorded in the period 1984 - 2008 were the result of human activity. 14 of the 20 fires recorded in 2005 occurred in Wandinong Sanctuary, which previously had no record of fire. These fires were deliberately lit by one offender and ceased after police action. Apart from the intense bushfires of 1984, 1994 and 1997 fires in Blackburn Lake Sanctuary, all of the fires recorded were small and readily put out.

Deliberate lighting was involved in more than half the total number of fires.

Any fire occurring under extreme fire weather conditions has potential to develop rapidly, scorch the Reserve, and threaten adjacent property.



Figure 12a - Effect of 1984 fire at Blackburn Lake Sanctuary. The fire burnt approximately 3ha west of the Primary School on 15 February 1984. (Courtesy Mr. G E Fielding)



Figure 12b - The 1994 fire in progress at Blackburn Lake Sanctuary The fire burnt some 7 ha west of the school to Lake Road in October 1994 (photo: Nunawading Gazette).

Figure 12 shows the Blackburn Lake Sanctuary bushfires of 1984 and 1994. The 1997 bushfire occurred on 21 January (Figures 14, 15).

Intense bushfires were burning in other areas on that day, including a fire in the Dandenong Ranges where two lives were lost and several houses were burnt.

This illustrates the point that high intensity fires are most likely to occur in the Whitehorse Bushland Reserves when severe property damage and loss of life is being experienced in widespread bushfires elsewhere.

4 Fire weather forecasting

When are intense bushfires likely to occur? An analysis of bushfire history shows that:

- almost all bushfire damage in Victoria occurs between mid December and mid March (Luke and McArthur, 1978)
- intense bushfires burn under hot, dry weather conditions, when strong winds are blowing
- some bushfire seasons are more severe than others
- most bushfire damage occurs in a relatively short time
- 95% of bushfires that have occurred in the City of Whitehorse Bushland Reserves have been small and have not seriously threatened private property.

Fire weather conditions are now forecast up to seven days in advance by the Bureau of Meteorology.

FIRE DANGER RATING				
Category	Fire Danger Index			
CODE RED	/ 100+ / /			
EXTREME	75 - 99			
SEVERE	50 - 74			
VERY HIGH	25 - 49			
HIGH	12-24			
LOW - MODERATE	0-11			

Figure 13: Updated public fire warning system

The public fire warning system has been upgraded following the "Black Saturday" bushfires of 7th February 2009. It has six categories as shown in Figure 13.

The 100+ category is described as a "Code Red" fire danger day, as experienced on "Black Saturday" 2009.

When a bushfire is burning under these conditions, it will be uncontrollable, unpredictable and very fast moving with flames extending high above tree tops. Burning embers may be thrown more than 20 km ahead of the main fire. Power, water and phone networks may fail as high winds bring down trees, and power lines well ahead of the fire.

More information is included in Appendix Five, or can be read direct from the CFA website "Fire danger rating Brochure".

5 Potential for property damage near the Reserves

McArthur (1967) produced fire spread tables and demonstrated that a bushfire burning during extreme fire weather would throw spots or embers for many kilometres. This has been reinforced by data from "Project Vesta".

During the fires of "Black Saturday" 7th February 2009, very significant life and property loss occurred in rural townships close to forested land, and new records were set for recorded spotting distances from forest fires (Appendix 4).

However the fact that burning embers are thrown into a residential area does not identify how many fires actually start in or threaten buildings.

Insurance claims resulting from past fire losses in residential areas give a realistic view of the potential for property damage.

Analysis by Risk Frontiers (Chen and McAneney 2004) identifies <u>distance</u> <u>from the bushland fringe</u> as the single-most important factor determining the probability of building destruction in a bushfire.

They advocated the use of a five-point scale, where risk is highest at distances less than 100m from bushland (Zone 1); high between 100 and 200m (Zone 2); medium between 200m and 400m (Zone 3); low between 400m and 700m (Zone 4); and negligible for distances beyond 700m.

Applying Risk Frontiers model to the Whitehorse Bushland Reserves, in most cases a firebreak and/or roadway modify the Zone 1 effect. A fence and rear yard will further moderate flame impact on buildings. This is the "separation distance of properties from the Reserve boundary" referred to previously (p.19).

Examples from past high intensity fires illustrate this point. The 1994 fire at Blackburn Lake Sanctuary scorched vegetation and resulted in the death of trees at the rear of a house in Clifton Street, east of the Reserve.

The 1997 fire damaged a fence adjoining a Lake Road residence at the southeast corner of the Sanctuary (Figure 14).

No significant property loss has occurred during the three recent high intensity fires at Blackburn Lake Sanctuary.

Since the implementation of the Whitehorse Bushland Reserves Fire Management Strategy in 1997, fire prevention has been significantly upgraded.

Should a bushfire start under extreme weather conditions then it will quickly become uncontrollable, and in the worst case, the fire will have burned to the boundary of the Reserve before significant suppression action begins. As the fire will then have run out of fuel, there will be no further flame or ember impact on property, and the fire brigade will be in a position to extinguish any fire(s) on private property, subject to their resource availability.



Figure 14 - Effect of 1997 fire at Blackburn Lake Sanctuary. (photo: Rod Incoll)

All homes potentially affected by bushfires in the Whitehorse Bushland Reserves are directly accessible by the Fire Brigade and all of the subdivisions likely to be affected by ember throw have at least the prescribed number of hydrants.

Fuel hazards in the bushland reserves are generally at a Moderate to High Overall Fuel Level. Should a bushfire occur during less than extreme fire danger weather conditions, there would be little ember throw, no effect upon adjacent property, and the fire brigade would be able to suppress the fire in the Reserve. This has been the usual case. It should be noted that protective measures do not operate effectively when the forest fire danger index exceeds 100, that is, on "Code Red" fire danger days (Figure 13).

Survival of structures involved in a bushfire under these conditions is not predictable, and depends on the amount and type of vegetation on the individual property, and the standard of building construction and maintenance, and the preparedness of the occupants.

Accordingly the potential for property damage is maximised on days of "Code Red" fire danger days.

The "skewing" of the bushfire risk to the south and east sectors of a high intensity fire as shown in Figure 8, is relevant to the potential for property damage.



Figure 15 - Aerial view of fire area at Blackburn Lake Sanctuary, taken 13 July 1997. The point of origin and rapid, intense run to the south-east are clearly visible

This is clearly shown in Figure 15, which shows the most intense fire and therefore the greatest potential for property damage, was in the south east of the fire area in the 1997 bushfire at Blackburn Lake Sanctuary.

6 Potential for loss of life

Conditions directly downwind of a fire front are life-threatening, and unpleasant and uncomfortable with abundant acrid smoke and wind driven debris impacting structures throughout.

However loss of life outside the reserves is unlikely, as relative safety is available a short distance from the Reserve in the built up area.

Disabled or immobile persons trapped in burning houses would be at greatest risk. This is improbable in terms of the support available under such circumstances.

7 Evaluation of Identified Risk

The bushfire risk to the Whitehorse Bushland Reserves has been described and summarised as "Risk Scenarios". These are now evaluated.

Scenario One: "Ignition from a distant bushfire"

This may occur as a result of "ember throw" or "spotting" from bushfires that may be burning more than 20 km to the north west.

By definition these fires will only be burning during "Extreme" or "Code Red" fire danger weather. So embers falling in a Bushland Reserve will also be subject to extreme fire weather. Unless they are immediately put out, these embers will quickly develop into intense fires with potential to damage property.

This scenario is most likely to apply to the "Group One" Reserves (p.21)

Scenario Two: "Ignition from a bushfire burning nearby"

Ignition may occur within a Bushland Reserve by mass short distance spotting or direct flame transfer from a bushfire burning nearby (Figure 10).

For this to happen, Scenario 2 bushfires will be burning during "Extreme" or "Code Red" fire danger weather. This means that embers falling in a Bushland Reserve will rapidly develop into bushfires, and fire spread will be intense. These fires have the potential to damage nearby property.

On the other hand, bushfires burning under less than extreme conditions will be controlled without delay and pose little risk to property.

This scenario is also more likely to apply to the "Group One" Reserves, particularly Yarran Dheran and Antonio Park (Figure 10).

Scenario Three: "Ignition within the Reserve"

Ignition within or adjacent to a Bushland Reserve is by far the most common cause of bushfire in the Whitehorse Bushland Reserves.

The 1984, 1994 and 1997 bushfires in Blackburn Lake Sanctuary were caused by direct internal ignition, and were intense fires with potential to damage property, notwithstanding that actual damage caused was minimal.

Apart from these intense bushfires, the fire statistics (Figure 12) show that all the fires recorded were small and readily put out. They were all caused by human agency and more than half the outbreaks were deliberately lit.

So the bushfire history indicates that the most likely cause of an intense fire in a Whitehorse Bushland Reserve is ignition within the Reserve by a human agency, and on the balance of probabilities, it is likely to be a deliberate act of arson.

High intensity bushfires in the reserves are most likely when severe property damage and loss of life is being experienced in widespread bushfires elsewhere.

Chapter 6 - Evaluate Bushfire Risk

1 Introduction

The risk determined by the assessment process is assessed to identify what, if any, action need be taken. If the level of risk is low, the residual risk may be acceptable and treatment may not be required.



Figure 16 - Number of homes destroyed in bushfires 1926 -2009

2 Frequency of exposure

The following observations are based on the history of bushfire damage and fire behaviour research. The strong to gale force winds experienced during extreme fire danger weather are almost invariably from the north west in Victoria (Figure 7).

On such days the Forest Fire Danger Index will exceed 50 so a "Total Fire Ban Day" will generally be declared.

The more severe bushfires are often associated with drought years, and usually the "El Nino" or ENSO drought pattern. (Verdon et al, 2004). In drought years there is an increased incidence of serious property damage and loss of life from intense bushfires.

Most intense and damaging bushfires occur on hot, dry, windy days in January and February. Most fire damage occurs in a short time frame of minutes rather than hours.

Such years have been decades apart Figure 16 shows the annual number of homes lost by bushfire 1926 - 2009.

Few locations have had more than one exposure to severe bushfire in this 83 year period. In Victoria, the 1983 Ash Wednesday bushfires re-burned some of the areas burnt in 1939, for instance the Dandenong Ranges (44 years later). The township of Macedon was burnt in 1905 and again in 1983 (78 years later). These locations were either within broad acre forest, or on its margins, rather than small urban reserves as in this case.

There are considered to be many more opportunities for ignition of relatively small, accessible, and heavily used Bushland Reserves than would be found in broad acre forest.

The bushfire statistics for the reserves indicate that more than half the fires were deliberately lit. Arson is an erratic factor that is difficult to quantify in terms of risk. For instance no bushfires were recorded for Wandinong Sanctuary prior to 2005, when 14 fires were deliberately lit in the space of a few weeks.

Should a Whitehorse Bushland Reserve be targeted by a "malicious" arsonist during extreme fire danger weather, as was almost certainly the case in 1997, then a high intensity bushfire will result. The probability that this will happen again cannot be discounted.

This results in a view that high intensity bushfire occurrence caused by lighting within a Reserve will be a more frequent event than fires caused under the other Scenarios. By definition this will only occur during when the fire danger index exceeds FDI = 50.

Should a bushfire occur under "normal summer" weather conditions, there would be little or no ember throw and the fire brigade would be able to suppress the bushfire within the Reserve.

Intense bushfires in the Whitehorse Bushland Reserves are most likely when severe property damage and/or loss of life are being experienced in widespread bushfires elsewhere.

3 Level of risk

The next step is to assess and prioritise the level of risk of damaging high intensity bushfires from each of the three scenarios identified in Chapter 5.

The level of risk may be expressed in terms of "Likelihood" or probability of the event taking place, and "Consequences", or the impact of the event when it happens. Five levels of probability ("ALMOST CERTAIN" to "RARE") and five levels of consequences ("INSIGNIFICANT" to "CATASTROPHIC") have been used to describe the level of risk in this Strategy in a "5x5 matrix" (Figure 17)

Scenario One: "Ignition from a distant bushfire"

This happens as a result of "ember throw" or "spotting" from bushfires that may be burning more than 20 km to the north west during "Code Red" (FDI 100+) fire danger weather.

"Extreme" or "Code Red" fire danger will also be prevailing locally, meaning that embers falling in a Bushland Reserve are likely to quickly develop into bushfires. The fire spread will be intense, with potential to seriously impact on the ecological and recreational amenities of a Bushland Reserve and threaten adjoining property.

The outcome of a bushfire burning intensely during "Code Red" weather (Fire Danger Index 100+) in a small urban Bushland Reserve surrounded by residential property must be considered as potentially catastrophic, as the loss of dwellings cannot be ruled out.

Fire history shows the probability of a large intense bushfire burning during "Code Red" (Fire Danger Index 100+) weather in the distant area is about once in 100 years. In terms of the risk matrix this is a "RARE" occurrence (Figure 17).

The level of risk of Scenario One thus falls in the Class CATASTROPHIC - RARE, or a 1 in 100 year event (Figure 17).

Scenario Two: "Ignition from a bushfire burning nearby"

Ignition within a Bushland Reserve may occur by spotting or direct flame spread from a nearby bushfire. This scenario is more likely to apply to the "Group One" Reserves, particularly Yarran Dheran and Antonio Park (Figure 10).

To endanger bushland downwind, the "other bushfire" will be burning during at least "Extreme" (FDI 50+) fire danger weather. This means that embers falling in a Bushland Reserve will rapidly develop into bushfires, and the fire spread will be intense.

Based on past intense bushfires in the reserves, loss of dwellings is less likely, so a "MAJOR" impact is allocated.

The frequency of such fires is likely to be greater than for Scenario 1, or once in 50 years. This is classed as an "UNLIKELY" event.

Scenario Two thus falls in the Class "MAJOR – UNLIKELY" (Figure 17).

Scenario Three: "Ignition within the Reserve"

The 1984, 1994 and 1997 bushfires in Blackburn Lake Sanctuary were intense fires with potential to damage property. They occurred before the implementation of the Bushland Reserves Fire Management Strategy, with improvements to fuel management, bushfire prevention measures and fire patrols of the larger reserves from 1997.

The fire history indicates that the most likely cause of an intense bushfire in a Whitehorse Bushland Reserve will be ignition within the Reserve by a human agency, and on the balance of probabilities, it is likely to be a deliberate act.

While the fire statistics (Figure 11) show that all the bushfires recorded in the Bushland Reserves were small and readily put out, any ignition during extreme fire weather is likely to develop into a high intensity bushfire.

Loss of dwellings is unlikely based on the history of past intense bushfires, so a "MAJOR" impact is allocated.

However Scenario Three bushfires are likely to occur more often. These are "POSSIBLE" events with a 1 in 30 year probability.

A risk class of "MAJOR – POSSIBLE" is allocated to Scenario 3 (Figure 17).

The level of risk of the three bushfire scenarios is shown in the Risk Matrix, Figure 17.

LIKELIHOOD	CONSEQUENCES OF HIGH INTENSITY BUSHFIRE									
of bushfire	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC					
ALMOST CERTAIN (every year)										
LIKELY (every 5 years)										
POSSIBLE (every 30 years)										
UNLIKELY (every 50 years)										
RARE (every 100 years)										



Expected risk level Scenario 1 Expected risk level Scenario 2

Expected risk level Scenario 3

Figure 17 – Level of Risk of Bushfire Scenarios

As the matrix indicates, high intensity bushfires can be expected to burn periodically in the larger reserves during extreme fire danger weather. The more intense incidents may damage adjacent property.

The evaluation has shown that the bushfire risk is a risk that requires treatment.

4 Climate Change

Even a climate change skeptic would need to acknowledge that the Victorian climate has become hotter and drier since the last glaciations of the ice age some 10,000 years ago.

A study by Hennessy et al (2006) showed that since 1950, rainfall has decreased, droughts have become more severe, and the number of extremely hot days has risen.

So independent of the drought cycle, the climate of south-east Australia may become hotter and drier in future. This hypothesis has been dubbed "climate change".

According to this study, the combined frequencies of days with very high and extreme Forest Fire Danger Index ratings are likely to increase in south-east Australia by 4–25 per cent by 2020, and 15–70 per cent by 2050.

Taking Hennessy's worst case scenario, the number of Total Fire Bans could increase from 10 in a drought year to around 16 in a drought year by 2050. This would increase the frequency of bushfire risk for the Bushland Reserves.

Should this hypothesis be valid, increased bushfire risk would be experienced. This emphasises the value of keeping accurate fire records for review at subsequent revisions of the Strategy.

Lucas (2007) identified earlier starts to recent bushfire seasons and suggested this would lead to a smaller window for fuel reduction burning; and more frequent and intense fires would require increased resources to maintain current levels of bushfire suppression effectiveness. He commented that shorter intervals between bushfires may significantly alter ecosystems and threaten biodiversity.

Chapter 7 - Treat Bushfire Risk

1 Introduction

The risk evaluation has shown that the bushfire risk in the Whitehorse Bushland Reserves is not a low priority risk. Specific course(s) of action thus need to be developed and implemented to reduce bushfire risk. This chapter identifies these actions.

2 Fuel management

The occurrence of bushfire could be eliminated by reducing fuel levels to a low fuel rating throughout.

This would result in significant change to the floristic structure of the reserves as shown in Figure 18.



Figure 18: Low Overall fuel rating = no bushfires

The initial research for the Strategy showed that the unique nature and value of the Bushland Reserves was widely recognised.

The opinion that the reserves should continue in much their present form, "*provided provision was made for the security of life and property*" was identified.

Options for fuel management in small reserves that retain the Reserve as bushland, yet deliver a level of bushfire protection are summarised in Figure 19.

LEVEL	TREATMENT	OUTCOMES
1	NIL	Unimpeded fire spread
2	Perimeter fire breaks and internal tracks	Access provided for firefighters; low intensity fires controlled at breaks
3	Level 2 plus remove or slash down leafy deadfall trees and limbs	Lower fine fuel load delivers lower rate of bushfire spread and reduced fire intensity
4	Level 3 plus manual removal of understory to "see through" state	Reduced fire intensity and rate of fire spread; control of fires possible at relatively higher FDI's
5	Level 2 plus mosaic of fuel reduction burning of sufficient intensity to char tree bark	Significantly reduced ember throw for 10 -15 years; lower fire intensity and rate of spread, so fires are controllable at higher FDI's for 3-5 years

Figure 19: Treatment options for reducing bushfire spread in small bushland reserves

Treatment to levels 3 or 4 has been carried out in all City of Whitehorse Bushland Reserves. Blackburn Lake Sanctuary has residual bark charring from the 1997 bushfire and is thus at Level 5.

fuel reduction burning in Bushland Reserves

The application of fire at the intensity needed to char tree bark has been shown by extensive research to be effective in reducing bushfire spread in broad forest areas. Prescribed burns of this intensity impede the spread of bushfire for 3-5 years and reduce spotting during intense bushfires beyond 10 years.

The effective long-term use of fire as a fuel reduction measure involves the creation of a mosaic of different age burn classes in a stand to establish fuel reduced zones, so that the last burnt areas would be extensive enough to impede bushfire development.

As a generalization this would require an area of at least ten hectares for a useful regime to be maintained on a sustainable basis. All Whitehorse Bushland Reserves except Blackburn Lake Sanctuary have less than 10ha of eucalypt forest. Patch or localised burning for hazard reduction has been carried out in a number of reserves since the Strategy was first implemented in 1997. The planned application of fire for specific purposes, e.g., further one-off hazard reduction, wildflower stimulation or weed control, may be employed in future where appropriate.

The physical removal of understory is routinely used to reduce overall fuel levels. For instance the vigorous understory growth that followed the 1997 bushfire in Blackburn Lake Sanctuary was manually reduced at the rate of 15 tonne/ha in 2002 and has been maintained at the "see-through" level since by annual maintenance.

Fallen trees and accumulations of dead vegetation are identified during the annual inspection, and removed from all reserves before summer.

3 Reducing bushfire risk

The *bushfire risk* is the probability that a bushfire will start, and relates to the presence or absence of fire causing agencies. A range of options are available for managing the fire risk. These include fire prevention and fire suppression activities.

fire prevention

Fire prevention includes all of the activities associated with minimising the incidence of bushfire. The range includes publicity and education, regulation and enforcement, and the annual fire inspection and works program. Fire prevention activities are the responsibility of the land manager, or in the case of private property, the land holder.

publicity and education

Targeted publicity and education aims at changing behaviour in the mid to long term. The main causes of bushfire in the reserves were identified as children playing, illegal camp fires, and deliberate lighting. Targeted programs are needed to include 'hard to reach' and ethnic groups.

A significant State Government information program "Fire Ready Victoria" includes advice on household bushfire self assessment, the revised bushfire weather ratings, and bushfire safety. This is available online or from the Bushfire Information Line freecall 1800 240 667.

The Junior Fire Awareness Intervention Program", administered by the MFB is a free education program. It is designed to help young people develop a greater respect for fire and awareness of consequences of its misuse.

The City of Whitehorse distributes information on bushfire safety annually to residents living near Whitehorse Bushland Reserves. This includes emergency contact numbers and actions that householders can take to protect their properties. This is hand delivered to relevant properties. Before each fire season, a Community Bushfire Safety meeting is conducted by the Metropolitan Fire Brigade and the City of Whitehorse. Bushfire information is distributed, and residents can obtain information about fire preparedness.

regulation and enforcement

Bushfires with potential to cause damage to property close to reserves are high intensity fires that occur under extreme fire weather conditions. Fires that occur at other times will be suppressed within the Reserve and are unlikely to cause property damage.

A "fire patrol" (Figure 20) has been used since 1997 to establish an official presence to deter fire lighting, identify and put out smouldering debris, and assist with the early detection of bushfires during extreme fire weather conditions. The patrol concentrates on reserves having a relatively higher bushfire risk. Patrol with two vehicles commences when the FDI exceeds 55, or a Total Fire Ban is in force. Three vehicles operate when the FDI exceeds 75.

The patrol has an impressive record of achievement in locating and putting out camp fires and smouldering debris. No bushfires have been recorded in the Bushland Reserves during extreme fire weather conditions since its inception. The patrol has wide public acceptance particularly from residents living near a Reserve. Note the patrol is not a fighting service; this is an MFB responsibility.



Figure 20: Fire Patrol

annual pre-season fire inspection

The annual inspection is carried out by a representative of the City of Whitehorse, a forest fire management advisor, and the Metropolitan Fire Brigade.

The inspection considers:

- the exposure of properties around the Reserve to a bushfire risk
- the fuel levels adjoining properties adjacent to the Reserve
- issues identified during the year by the Parks management group (e.g., from input by residents and the Advisory Committee), including the location of significant vegetation within the "green firebreak"
- input from the Metropolitan Fire Brigade
- the seasonal bushfire risk predicted by the Bureau of Meteorology.
- obvious bushfire hazards on private property
- changed circumstances e.g., new subdivisions

The items identified during the annual inspection are implemented through a works program before the fire danger period.

public access to parks and reserves during extreme fire danger weather.

The risk assessment process for this Strategy has demonstrated that human activities are the main cause of bushfires in City of Whitehorse Bushland Reserves, and significant impact results from bushfires that burn during extreme fire danger weather conditions.

Limiting public access to the reserves during such weather to reduce the risk of ignition is a possible risk reduction measure.

Options to address park access during extreme fire danger weather include:

- closure of all Bushland Reserves;
- closure of selected reserves;
- restriction of approvals for organised activities in reserves.

A program for installing and maintaining official signage at every point of access, supplemented by site security checks to ensure compliance, would need to be made to exclude public use. This must be present every extreme fire danger day on a sustainable basis into the future and would require significant funding.

The fire patrol has reported that public use on hot dry windy days is virtually nil during the heat of the day. The patrol can call for backup and/or enforcement action when this is required.

Restriction of approvals for organised activities on Total Fire Ban Days is achievable, can be verified by the fire patrol, and is recommended for trial for the 2010/11 fire danger period.

fuel management on private property

Protective measures in Bushland Reserves are less effective when a bushfire is burning on "Code Red" days, that is, when the forest fire danger index exceeds 100.

Survival of structures directly involved in a intense bushfire under these conditions depends on the amount and type of vegetation on the individual property, and the standard of building construction and maintenance. House yards that are well maintained are less likely to transmit fire from the boundary to the house.

A notice may be issued to remove a fire hazard from private property. Removal of the fire hazard is the owner's personal responsibility. If no action is taken, Council may remove the hazard at the owner's cost.

Many properties have paling fences in good condition. While these would ultimately burn in an intense bushfire, timber paling fences are an effective barrier to radiant heat and deflect wind driven embers.

Timber paling fences should be used for all fire prone boundary fences.

fire management plans

Fire management planning is an integral part of the City of Whitehorse Bushland Reserves Fire Management Strategy.

Fire Management Plans have been prepared for the four larger reserves, Blackburn Lake Sanctuary, Bellbird Dell, Yarran Dheran, and Antonio Park.

These plans describe how fire management arrangements are implemented in each of the larger reserves, and include the arrangements for fire prevention, the security of Council property and the security of the adjoining residents.

4 Fire detection

Efficient fire detection is an integral part of an effective response to a bushfire. While this strategy assumes that fires starting in the reserves under extreme conditions will burn to the Reserve boundary, early detection of fires can lead to their suppression (McArthur 1967).

There is no organised bushfire fire detection system; the MFB relies on smoke reports from residents or passers-by. The need to report smoke promptly should be included in the fire brochure that is distributed to residents living near reserves annually.

Early fire detection and the opportunity for prompt action while the fire is small is another advantage of the "fire patrol".

5 Fire suppression

Fire suppression includes all of the activities involved in putting fires out. The statutory responsibility for fire suppression in the City of Whitehorse rests with the Metropolitan Fire Brigade (MFB).

Fire detection or finding fire outbreaks before active fire spread commences, is the first step in minimising bushfire damage. Any person who becomes aware of the occurrence of fire, has a duty to report the fire to the MFB, and take whatever measures are within that person's capability to bring the fire under control.

Fighting bushfires in Bushland Reserves during extreme fire weather conditions is a hazardous task demanding a high level of professional skill which should not be attempted by householders.

However householders have a valuable self-help role during bushfires in watching for and extinguishing burning embers that fall into their property with a mop and bucket and/or garden hose.

Bushfires burning under less than extreme conditions are unlikely to threaten property and will be dealt with by the MFB.

Houses adjacent to the reserves are covered by the Melbourne Hydrant System with a maximum spacing of 200 metres apart for residential areas. Hydrants are spaced at a maximum of 120 metres apart for commercial and industrial areas.

Council arranges a hydrant access check prior to each bushfire season.

Houses adjacent to the reserves fall within the Metropolitan Fire Brigade's standard response time of "7.7 minutes at the 90% percentile", that is, from the time a call is registered with the Fire Service, an appliance will be at the address given within 7.7 minutes, 9 times out of 10.

The MFB has advised that the arrangements for fire hydrants adjacent to the reserves meet the requirements for effective fire suppression on both residential properties and in the reserves.

safety of persons within reserves

The safety of persons present within a reserve when a bushfire breaks out was raised during public consultation for the initial Strategy.

Large bushfire development is only likely during very high and extreme fire danger. Pathways and access are generally good within the reserves, so that even under the worst conditions, escape from a flame front would be achieved by moving out of the Reserve along a path, or if this is cut off, then laterally through the bush to another path.

In some circumstances movement through the bush could be hindered by fence lines, which have been erected to prevent damage to vegetation. All fences in reserves are now reviewed from a fire safety perspective.

Personal safety during bushfires is taken into account when planning facility development, for instance, walking tracks or information signs.

6 Municipal Emergency Management Plan

The Victorian Emergency Management Act requires each municipal council to have a Municipal Emergency Management Plan (MEMP).

Whitehorse City Council's MEMP addresses how to prevent, prepare, respond to and recover from emergencies and natural disasters within the municipality.

Whitehorse is generally a low risk area; however, storm, flood damage, major transport emergencies, chemical spillage or bushfire, requires an appropriate and prompt response.

It is important for residents to know how the MEMP operates and what to do in an emergency.

The MEMP has been developed by the Municipal Emergency Management Planning Committee (MEMPC). This has representatives from a number of emergency services including Police, Metropolitan Fire Brigade, Victorian State Emergency Service, Department of Human Services, medical professionals and others.

The MEMP recognises the inevitability of the economic and social effects of emergencies including loss of life, destruction of property and dislocation of individuals and communities.

Under the MEMP many services can be called in to help manage the emergency, including ambulance and fire services, local councils, service authorities, Department of Human Services, other state and federal government departments and service organisations such as Red Cross. These organisations all have a specific role to play that depends on the nature of the emergency. The City of Whitehorse Municipal Emergency Response Officer manages the MEMP. More information can be accessed from the City of Whitehorse website or by telephone (9262 6333).

In a bushfire emergency the Municipal Emergency Response Officer would

- Liaise with the Metropolitan Fire Brigade and respond to requests from the Incident Controller;
- Liaise with the Victoria Police Coordinator and respond to requests from the Incident Controller;
- Manage municipal resources deployed in the bushfire response;
- Manage support that may be provided from adjoining municipalities
- Assist the affected community to recover after the bushfire.
- Complement other local, regional and state planning arrangements

7 Integrated Fire Management Planning

The key element of Integrated Fire Management Planning (IFMP) is bringing together a range of agencies in Victoria to discuss, plan and manage fire in the community.

These organisations are responsible for fire prevention, preparedness, response, recovery and cultural and environmental uses of fire. By working together, they will ensure a more strategic and integrated approach to fire management planning, reducing the impact of fire in Victoria.

IFMP will assist in establishing a consistent, state-wide planning approach and develop processes for continuous improvement.

IFMP involves organisations through the establishment of state, regional and municipal committees, through which members have the opportunity to better understand each other's roles in fire management planning and bring their individual plans together.

The IFMP arrangements for the City of Whitehorse are co-ordinated by the Municipal Emergency Response Officer.

8 Community involvement

A level of community concern about bushfire was identified during the study, particularly by some individuals living close to reserves. The bushfires that occurred in Blackburn Lake Sanctuary had given rise to feelings of stress and insecurity in some people.

This has resulted in an inability to take holidays during the summer on the part of one individual, and consideration of moving elsewhere on the part of two others.

Overall a "feeling of community" has been readily apparent when bushfires occur, with individuals doing all they can to combat the fire and assist neighbours. This community feeling may well also support neighbourhood groups associated with a particular Reserve for the following typical purposes (for instance):

- support between neighbours during periods of absence
- overview of Reserve contact network
- contributing to Reserve interest groups on bushfire issues
- liaison with the Council's Parks management group
- help others to leave safely when a bushfire breaks out.

Community groups have the potential to facilitate bushfire safety in the vicinity of the reserves.

Information on bushfire safety could also be distributed to residents concerned about bushfires, including measures people can employ to protect their own properties. This includes educating occupiers who discard tree cuttings and other vegetation into adjacent reserves, thereby increasing the fuel loading.

9 Action items

The following action items are an outcome of this Strategy and need to be implemented.

annual works cycle

Annual inspection and works program	An annual site inspection of all reserves will be conducted to identify fuel reduction work needed for the fire season. This inspection is to be based on bushfire risk management criteria, in addition to meeting the statutory requirements of the Metropolitan Fire Brigade. The works program shall be signed off to ensure completion at a satisfactory standard before the fire danger period commences.					
Monitoring of bushfire risk	The bushfire risk in the reserves shall be monitored during the fire danger period and any corrective action needed shall be taken as soon as possible.					
	City of Whitehorse personnel work in the reserves on a daily basis and should report items affecting the bushfire risk for attention.					
Establishment and maintenance of graduated fuel management zones	A network of firebreaks and graduated fuel management zones will be introduced and maintained on all Reserve boundaries to protect adjacent property.					
Priority fuel reduction	Fuels in areas which are not overseen by residents, and are close to public roads, should be monitored for their potential as points of deliberate lighting. Fuel reduction should be considered where houses would be threatened by bushfires lit under extreme fire danger weather conditions.					
Training of ParksWide employees	Bushfire training for ParksWide employees and fire patrol personnel shall be carried out before the start of each fire danger period.					

annual works cycle (continued)

Fire patrol	An official presence or "fire patrol" will operate within the larger reserves when extreme fire danger conditions prevail, to improve fire security and assist in the early detection and initial suppression of bushfires.					
Fire detection	The need for early detection of bushfires will be recognised, and promoted in City of Whitehorse publications about the bushfire risk. The fire patrol is also an effective means of detecting and reporting fires.					
Record of bushfires in Reserves	A record shall be kept of all bushfires in reserves with details of date, time of report; location by geographic reference; area and vegetation type burnt; and cause (if known).					
Total fire ban day Restrictions	Approval for organised activities in Whitehorse Bushland Reserves will not be granted on Total Fire Ban Days					
Powerline clearance	An annual inspection shall be made of power lines that abut or pass through any Reserve, and action shall be taken to ensure any work needed is carried out.					
	Safety Act and its Regulations currently before Parliament (August 2010) may impact on relevant authorities responsibilities in tree management and maintenance. Once these amendments are adopted, management plans will be developed to ensure Whitehorse City Council meets its legislative responsibilities.					
Hydrant access	An annual inspection and maintenance program will be carried out to ensure that hydrants are fully accessible.					

periodic works cycle

Accountability	A statement of accountabilities shall be set up to allocate corporate responsibility for actions items required to implement this Strategy.				
Performance monitoring	A performance monitoring system shall be set up to audit the implementation of the Strategy. This means that actions needed to implement the Strategy or a Fire Management Plan shall be allocated to an individual, signed off by a supervisor, and noted as complete for the annual report.				
Annual Fire Management Report	An annual report shall be drawn up detailing compliance with action items from the Strategy at the end of each fire danger period as part of the Corporate Reporting process.				
Fuel management	Fuel hazard ratings in the reserves will be monitored during annual inspections, to identify changes in fuel hazard that could threaten houses, particularly in the south and east of the four larger reserves.				
	Reserves by an experienced fire manager or planner to record fuel hazards and advise on works is recommended.				
Fire management plan	A Fire Management Plan must be maintained for each of the four larger reserves, to record fire risk factors and fire related works required for the Reserve.				
	These plans shall be reviewed periodically to ensure the most up to date information has been applied to bushfire management.				
	The review will ensure that changes are made to the fire risk classification of reserves where this is appropriate.				
	This plan is only one component of overall Reserve management that is needed to maintain the natural ecology.				

periodic works cycle (continued)

Publicity and education	The community should be encouraged to access the "Fire Ready Victoria" program on- line or via the Bushfire Information Hotline.					
	Education and publicity to increase awareness of the bushfire risk should be included in all relevant City of Whitehorse media and brochures. This includes a brochure on fire safety measures and the need to report fires to the MFB promptly, to be distributed to residents living near reserves annually. A joint MFB - City of Whitehorse Community Fire Safety meeting will be held annually prior to the fire danger period subject to resource availability.					
	MFB shall distribute fire safety leaflets to properties abutting Bushland Reserves in line with their commitment.					
Review of Strategy	The City of Whitehorse Bushland Reserves Fire Management Strategy should be reviewed on an eight year cycle, to identify changes in risk factors and identify innovations that may improve bushfire safety.					
Fences within Reserves	Public safety is to be considered when siting fences within reserves and fences within reserves should be reviewed from a bushfire safety perspective.					
Boundary fences abutting Reserves	Consider opportunities for timber paling fences for private property abutting reserves where this is practicable.					

Chapter 8 – Monitor and Review

1 Introduction

The risk management model requires arrangements for monitoring and review of the risk management system, and any changes that might affect it.

Monitoring and reviewing the performance of the Bushland Reserves Fire Management Strategy is required as more information becomes available and organisations change over time.

2 Monitoring program

accountability

A statement of accountabilities shall be set up to allocate corporate responsibility for actions items from Chapter 7 required to implement this Strategy.

performance monitoring

A performance monitoring system shall be set up to audit the implementation of the Whitehorse Bushland Reserves Fire Management Strategy as set out in Chapter 7.

annual works program

The annual fire inspection of the reserves (Chapter 7) identifies works to be carried out prior to the fire danger period.

The works program is to be monitored and signed off to ensure completion at a satisfactory standard before the fire danger period commences.

changes in bushfire risk

Factors contributing to the bushfire risk in the reserves shall be monitored during the fire danger period and any corrective action needed shall be taken as soon as possible.

City of Whitehorse personnel work in the reserves on a daily basis and should report items affecting the bushfire risk for attention.

annual report

An annual report shall be drawn up detailing compliance with action items from this Strategy at the end of the fire danger period as part of the Corporate Reporting process.

other measures

A periodic review of all Whitehorse Bushland Reserves by an experienced fire manager or planner to record fuel hazards and advise on progress of works is recommended.

Appendix One: Reserves reviewed for fire risk assessment

NAME OF RESERVE

- 1. ABBEY WALK
- 2. ANTONIO NEW LANDS
- 3. ANTONIO PARK
- 4. BELLBIRD DELL
- 5. BLACKBURN LAKE SANCTUARY
- 6. BLACKS WALK
- 7. BUSHY CREEK EAST
- 8. BUSHY CREEK WEST
- 9. BUCKANBE PARK
- 10. CAMPBELLS CROFT
- 11. CASELLA HOLLOW
- 12. COLLINA GLEN
- 13. COOTAMUNDRA WALK
- 14. DAGOLA RESERVE
- 15. DAMPIER GROVE
- 16. ELGAR PARK
- 17. ERAM PARK
- 18. FURNESS PARK
- 19. GARDINERS CREEK RESERVE
- 20. HEATHERDALE RESERVE
- 21. HIGHBURY PARK
- 22. JOSEPH STREET RESERVE
- 23. KALANG PARK
- 24. KOONUNG CREEK RESERVE
- 25. LOOKOUT TRAIL PARK
- 26. MEMORIAL PARK
- 27. MORACK GOLF COURSE
- 28. MORESBY DALE
- 29. MULLUM MULLUM CREEK
- 30. RONALD E GRAY RESERVE
- 31. ROOKS RESERVE
- 32. SCHWERKOLT COTTAGE
- 33. SIMPSON PARK
- 34. SOMERS TRAIL CENTRAL & EAST
- 35. STEPHENS RESERVE
- 36. SURREY PARK
- 37. TROVE PARK
- 38. WANDINONG SANCTUARY
- 39. WURUNDJERI WALK
- 40. YARRAN DHERAN
- 41. YARRAN DHERAN NORTH

Appendix Two: 1962 Bushfire

From the "Sun News-Pictorial" of 20 Jan 1962



Construct P 2

Appendix Three: Recent fire history

Information has been gathered from Council files, press reports, contact with Advisory Committees, the MFB, members of the public, and field inspections. While the record is incomplete, a detailed record of fires occurring in the reserves is now maintained by ParksWide.

Apparent absence of fire

The apparent absence of fire for at least twenty years was indicated by an absence of charcoal traces on tree bark at Campbell's Croft; Joseph Street; Blacks Walk; Kalang Park; Furness Park.

Antonio Park

1989 - Newspaper report of a medium sized fire within the Reserve.

- 2000 1 ha fuel reduction burn in north central area
- 2001 One fire on 17 February which burnt 100m²
- 2005 MFB attended a small vegetation fire (less than 1ha)

Bellbird Dell

- 1991 A small fire occurred in the central area of the Reserve
- 1997 A small fire occurred on the eastern boundary of the Reserve.
- 1999 A 1 ha fuel reduction burn was carried out on the western boundary
- 2001 Three fires burnt less than 1000m², on 01 January, 17 February, and 22 February.
- 2002 6000m² burnt 11 March
- 2006 5m² burnt near Barnesdale Drive entry in October

Blackburn Lake Sanctuary

The Sanctuary has an extensive fire history; for instance a resident of Clifton Street reported that many small fires occurred in the area prior to 1984. The record of fires is more complete at this site owing to vegetation studies and other research that has been carried out.

- 1984 A 3ha fire occurred west of the Blackburn Lake School on 15 February (Figure 12a)
- 1987 Four small fires occurred east of Blackburn Lake
- 1989 Three small fires occurred between Duck Point and Lake Road. A further small fire occurred near the BMX track
- 1990 A small fire occurred near Duck Point
- 1993 A small fire occurred near the south-east corner

- 1994 On October 23 a small fire started east of Blackburn Lake. On October 24, a larger fire burnt through the forest between Blackburn Lake, the school, and the eastern boundary of the Reserve (Figure 12b)
- 1997 On January 21, a fire burnt most of the eastern half of the Reserve. Part of the area burnt in 1994 was burnt again. (Figures 14, 15)
- 1999 A campfire escape burnt 60m² in October.
- 2001 A 1 ha fuel reduction burn was carried out west of the primary school
- 2004 MFB attended two fires, a small vegetation fire (less than 1ha), and a fire in a rubbish bin
- 2005 A fire burnt 20m² in January

Buckanbe Park:

Evidence of past fires from char signs on tree bark

Cootamundra Walk

2006 - 60m² burnt on 13 December

Elgar Park

2000 - A small fire occurred on 25 December

2001 - A small fire occurred on 17 February

2003 - 50m² burnt 21 November

2006 - 200m² burnt 5 February, another small fire later in February.

Furness Park

2005 - 50m² burnt in January

Eley Park

2007 - 5m² burnt in November

Heatherdale Reserve

Evidence of past fires from char signs on tree bark.

- 1998 Fires burnt 200m² in November and 80m² in December
- 2000 200m² was burnt on 25 December, 1.5ha fuel reduction burn 11th April
- 2005 Two fires $100m^2$ and $8m^2$, burnt 15-16 January

Koonung Creek

- 1998 400m² burnt in April
- 2000 20m² burnt 25 December
- 2001 100m² burnt 21 January, 100 m² burnt 17 February
- 2003 30m² burnt near Valda Avenue, mid April
- 2005 50m² burnt in August
- 2007 250m² burnt 28 November

Lookout Trail Park

2009 - 500m² burnt 9 January; 6m² burnt 2 February

R E Gray Reserve

Evidence of past fires from char signs on tree bark

Stephens Reserve

1997 – A small fire, eastern boundary.

Somers Trail

Evidence of past fires from char signs on tree bark - small patch, eastern end.

Trove Park

There is evidence of fire occurrence in the southern half of the Reserve.

Wandinong Sanctuary

2005 - 14 small fires (1m 2 - 400m 2) burnt between 13 January and 23 May.

Wurunjdjeri Walk

- 1998 A fire burnt 900m² in March
- 2005 50m² burnt in February

Yarran Dheran/Yarran Dheran North

- 1988 medium to large fire deliberately lit 13 November
- 1989 small fires lit on 25 December, 26 January, 24 February and 1 March
- 1995 report of a fire in 1995.
- 1997 100m² burnt in November 1997

Appendix Four: What is High Intensity fire?

The term "high intensity fire" describes the behaviour of a bushfire burning during hot dry windy weather, described as "extreme" or "Code Red" fire danger conditions. A high intensity fire in eucalypt forest can develop a fire intensity exceeding 100,000 kW/m; fire intensity during the bushfires of "Black Saturday" 7th February 2009 has been estimated as 150,000 kW/m.

The best way to describe a high intensity fire is to liken it to a blizzard, to being exposed to a wind so strong that you can barely stand up, so hot you would burn to a crisp, and instead of wind driven snow, a continuous shower of burning bark and leaves hitting you hard. You cannot see or breathe because of acrid wind driven smoke and the noise is fearful. Unless you reach shelter the searing heat will scorch your lungs and peel off your skin, and you will quickly die.

The whole forest structure becomes a roaring, searing, flaming mass, blown forward by the wind at speed. This is known as a "three dimensional" or "crown" fire. A high intensity bushfire would move all the way through a Bushland Reserve in a short time.

Forests become burnt spars with nothing but white powder underfoot, and homes are reduced to charred and twisted shells. If you have ever come close to experiencing high intensity fire, you will never forget or doubt its awesome power. Fires starting under conditions of high temperature, low humidity and strong winds quickly move from ground fuels through the shrub layer to the tree crowns, and assume unstoppable momentum while fuel and weather conditions persist.

A major mechanism of fire spread in eucalypt forest is known as "spotting" in which burning embers are blown ahead of the main front, causing new fires to start. Massive short distance spotting is a major mechanism of fire spread for bushfires. For instance fires in eucalypt forest fuel loads of 15 t/ha under extreme conditions (FDI of 90) will throw embers 5.4 km ahead of the main fire.

Under the most extreme bushfire conditions, for instance those experienced on "Black Saturday", 7 February 2009, spotting up to 10km was reported. An extreme example from the evidence of Fabian Crowe of DSE given to the Royal Commission (2009) was that a fire in Don Road, Healesville was started by spotting from the Kilmore East fire which he calculated as a spotting distance of 47 kilometres.

When a bushfire becomes uncontrollable, fire fighters must delay their attack on the fire front until weather conditions change, for instance, when the wind strength decreases or it runs out of fuel.

Appendix Five: Updated Fire Weather Warning.								
anger Ratings	 If you live in a bushfire prone area the safest option is to leave the night before, or early in the morning. Leaving is the safest option for your survival if you live in a bushfire prone area finalise your options for relocation Activate your Bushfire Survival Plan - Now Prepare to leave - check your Fina Plan - Now Monitor the washer and fire situation in any way you can: through CFA website, ABC or local radio. TV and newspapels. 	The safest option is to leave early in the day if you live in a bushfire prone area and your Bushfire Survival Plan is to leave. Only stay if your home is well prepared, well constructed and you can actively defend it. Activate your Bushfire Survival Plan – Now. Prepared for the anothoral, mental and physical impact of defending your property – if in doubt, leave. Monitor the weather and fire situation in any way you can: through CFA website, ABC or local radio. TV and newspapers.	The safest option is to leave early in the day if you live in a bushfire prone area and your Bushfire Survival Plan is to leave. Only stay if your home is well prepared and you can actively defend it. Prepare for the emotional, mental and physical impact of defending your property – if in doub, lawa Only stay if your home is well prepared and you can actively defend it Only stay if your home is well prepared and you can actively defend it Monito the weather and the situation in any way you can: through CFA website, ABC or local radio. TV and newspapers.	If you live in a bushfire prone area and your Bushfire Survival Plan is to leave, the safest option is to leave at the beginning of the day. If you live in a bushfire prone area and you plan to leave; finalise your options and leave ady on the day. Only stay if your home is well prepared and you can actively defend it. Only stay if your home is well prepared and you can actively defend it. Montof the weather and fire struation in any way you can: through CFA website, ABC or local radio. TV and newspapers.	 Check your Bushfire Survival Plan. Make sure your family and property are well prepared for the risk of bushfire Review and practise your bushfire plan for different scenarios (e.g. kids at school/home, visitors) Know where to get more information – CFA website. 	Check your Bustrifire Survival Plan. Make sure your family and property are well prepared for the risk of bustrifire Review and practise your bustrifire plan for different scenarios (e.g. tike at schouchorne, visitors) Know where to get more information – CFA website.		
ding Fire D	People may die or be injured. People may die or be injured. Thousands of homes and businesses may be destroyed well defended homes may not be safe during the fire. DO NOT EXPECT A FIRE TRUCK.	 People may die and be injured. Hundreds of homes and businesses may be destroyed Only well propared, well constructed and actively defended houses are likely to offer safety during a fire DO NOT EXPECT A FIRE TRUCK. 	 There is a chance people may dia and be injured. Some homes and built prepared and actively defended Well prepared and actively defended houses can offer safely during a free DO NOT EXPECT A FIRE TRUCK. 	There is a low chance people may die or be injured. Some homes and businesses may be damaged or destroyed Well prepared and actively defended houses can offer safety during a fre.	 Loss of life is highly unlikely and damage to property with be limited Well prepared and actively defended houses can offer safety during a fire. 	 There is little to no risk to life and property. 		
Understan	 Fires may be uncontrollable, unpredictable and fast moving - unpredictable and fast moving - unpredictable and fast moving - finense and sof embers will be hown around Spot fires will start, more quickly and come from many directions, 20km or more ahead of the fire. 	 Fires may be uncontrollable, unpredictable and fast moving - itames will be higher than noof tops Thoussands of embers will be blown around Spot fires will start, will move quickly and come from mary directions, up to 6km ahead of the fire. 	 Fires may be uncontrollable and move quickly - flames may be higher than root tops Expect embers to be blown around Spot fires may occur up to 4km ahead of the fire. 	 Fires can be difficult to control – flames may burn into the tree tops. Embers may be blown ahead of the tree Spot fires may occur up to 2km ahead of the fire. 	 Fires can be controlled Embers may be blown ahead of the fire Spot fires can occur close to the main fire. 	 Fires can be easily controlled. 		
M FIRE DANGER RATING	CODE RED	EXTREME	SEVERE	VERY HIGH	HIGH	LOW- Moderate		

Source: CFA website Fire danger rating brochure, page 2:

(http://www.cfa.vic.gov.au/residents/documents/summer/fire_danger_rating_brochure.pdf)

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