

Southeast Queensland Fire and Biodiversity Consortium

Fire Management Operational Manual



**Guidelines for planning and conducting fuel reduction
and ecological burns on your property**

Best Practice Fire Management Manual

OPERATIONAL LEVEL

GUIDELINES AND PROCEDURES

Cuong Tran

SEQ Fire and Biodiversity Consortium

The Southeast Queensland Fire and Biodiversity Consortium aims to gather and disseminate information on fire management practices that will support conservation of the region's biological diversity.

The project covers the area from Noosa Shire in the north to the New South Wales border, and from the islands of Moreton Bay to the Great Dividing Range in the west.

January 2002

Flowchart of Fire and Biodiversity Consortium Products

...where does this product sit in the big scheme of things?

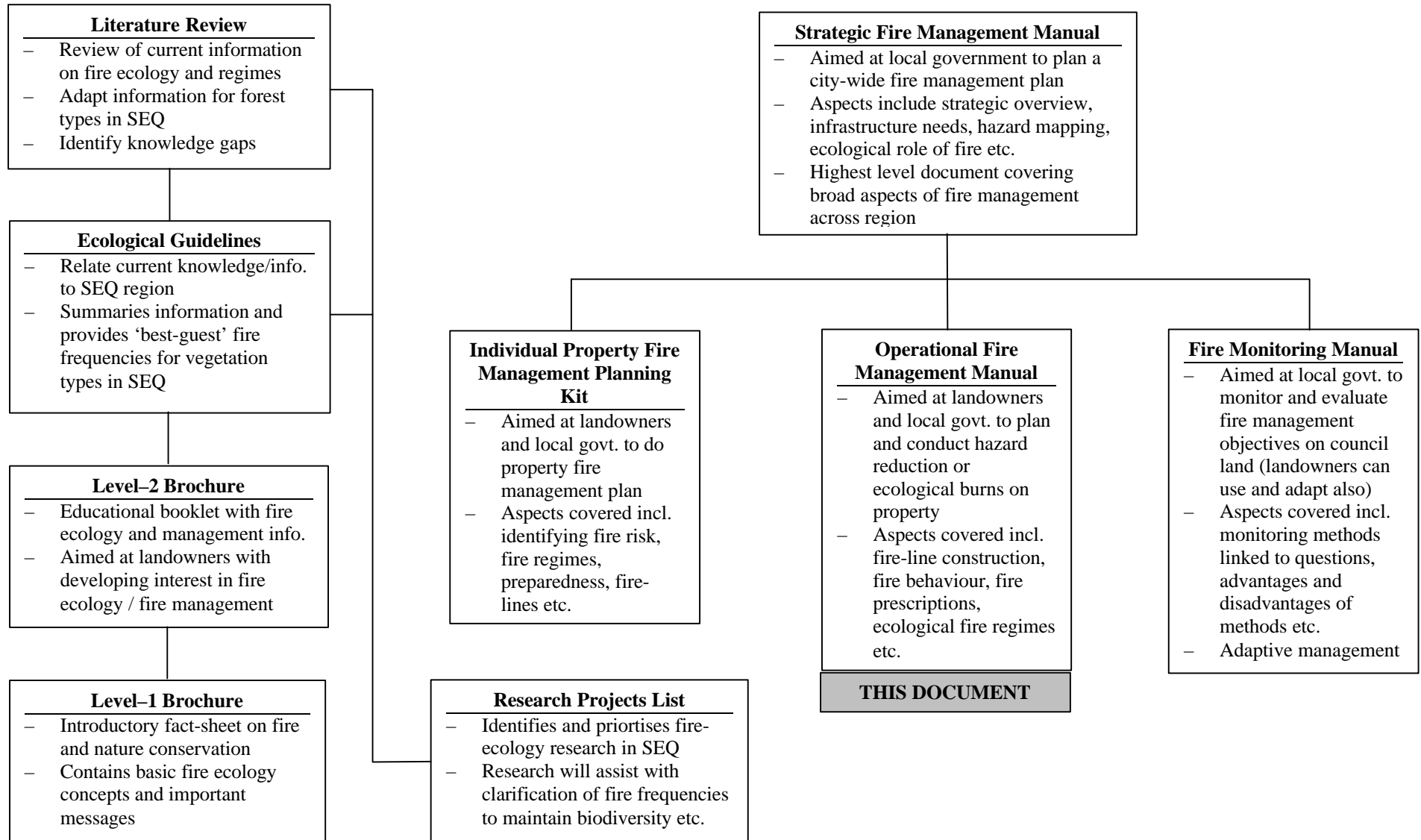


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Purpose of Operational Manual

The primary target group of the “Operational Manual” is private property owners who wish to conduct planned burns for the purposes of hazard reduction and/or ecological purposes. It may also be of use to councils and other land management agencies wishing to conduct burns. Furthermore, it could also be of use for fire wardens, rural fire brigades, councils, and large state agencies in working with community members.

The document provides information on preparing your property for prescribed burning, the procedures and requirements to follow and what weather conditions are most suitable for the fire. The Operational Manual also covers aspects of fire monitoring and evaluation, and emergency procedures to follow.

This is **not** a training manual. It will assist you with the planning and provisions that you will need to cover before you conduct a burn.

The Operational Manual and the Individual Property Fire Management Planning Kit

These two manuals from the Fire and Biodiversity Consortium are accompanying documents.

They have been designed to help landowners develop a fire management plan (Individual Property Fire Management Planning Kit) through to implementing and conducting a burn (Operational Manual).

When you have completed your fire management plan, you should submit a copy to:

1. Your local Rural Fire Brigade
2. Your local Council – Environment Services (or similar)
3. (if you are close or next to large conservation areas like a National Park or State Forest) the Queensland Parks and Wildlife Service or Department of Primary Industries.

If these organisations know your burn schedule, then there will be increased cooperation and coordination which will be extremely valuable for risk/hazard reduction and biodiversity conservation.

GLOSSARY OF TERMS

Firebreaks – are constructed breaks of discontinuity (irregular or patchy) of the fuel bed used to segregate, stop and control the spread of wildfire or to provide a fireline from which to suppress a fire. Firebreaks should be located in areas where fuel levels are lowest, which will increase the chances of successfully containing a fire. Compare with vegetative firebreaks.

Fire trails – are usually roads constructed and maintained for fire management purposes to an appropriate standard. Fire trails are likely to be more trafficable than tracks and are also used for prescribed burning and other fire management practices.

Fire tracks – are tracks or roads constructed and maintained expressly for fire management purposes. They are generally of a lower standard of construction than trails. Some examples include: tracks to water sources and strategic access routes for fire suppression.

Vegetative Firebreaks – also known as ‘green firebreaks’. These are areas that contain lower flammability vegetation (groundcovers, shrubs and trees) which can be used similarly to regular firebreaks. These firebreaks can vary in length and width. The advantages of these firebreaks are that in addition to arresting the spread of fire due to inherent characteristics, they can absorb radiant heat, trap embers and reduce wind intensity.

Mop-Up – is the process of ensuring all fires, smouldering logs, branches and any other material that is still in combustion is completely and properly extinguished. This term also refers to the patrolling that is required. To ‘mop-up’ is to patrol and put out any fires.

Rakehoe – is a tool that has been specifically designed for fire-fighting, preparing and constructing fire-lines.

Spotover – (or flashover) is a term that is given to a situation where fire that has escaped into an area beyond your fire-line or perimeter. Essentially, a spotover has the potential to become a large wildfire, as it has progressed beyond control lines and personnel. During wildfires, spotovers can occur over many kilometres.

Incident Controllers – are fire-fighting personnel who have been specifically trained in managing and handling fire-suppression and reduction burn procedures. Incident Controllers have excellent knowledge of (a) fire behaviour, (b) operations plans, (c) weather forecasts, and (d) logistics of operation. Incident Controllers form one part of the ‘Fire Team’.

Headfire – is the term given to the main front of the fire. A headfire burns with the direction of the spread of the fire (which closely follows the wind direction).

Flankfire – refers to the ‘sides’ of a fire. This is generally perpendicular to the direction of the fire spread. Flankfires can quickly form into a headfire, given a wind change. This can be highly dangerous.

Introduction

Fire is a characteristic and influential part of the Australian environment and has been for many millions of years (Moran and Watson 2000).

As Watson (2001) and others (eg Tran and Wild 2000) have stated, the major vegetation types throughout Australia are characterised by particular natural fire frequencies. Depending upon the type of understorey, dry eucalypt forests have frequent fires with fire intervals ranging from 3–6 years (grassy understorey) and 7–25 years (shrubby understorey). The majority of fires are low intensity and often burn in patches amongst the forest, which ultimately results in a multi-aged stand containing seedling, saplings, regrowth and mature trees. Wet-sclerophyll (or wet-eucalypt) forests often have dense understoreys with fire intervals ranging from 20–100 years. Fires in these forest types are usually of high intensity, and is characterised by eucalypt regeneration which is largely even aged. Coastal heathlands cover a wide ranges of vegetation types and composition, with some heathlands often treeless and may be both ‘wet’ and ‘dry’ often depending on the relationship with the water table. Typically, coastal heathlands have a fire frequency of 7–20 years. The fire frequencies of mountainous rocky heath is very dependent on the surrounding vegetation complexes. With this in mind, a fire frequency of 15–50 years generally occurs in these areas. Melaleuca wetlands often adjoins heath and eucalypt woodlands. Similar to rocky heath, the capacity for Melaleuca to burn is quite often dependent on the neighbouring vegetation types. It would seem apparent that fire frequencies between 15–30 years are suggested for this vegetation type, but this is still very speculative.

Some vegetation communities, such as rainforest can be very fire sensitive and dominant trees show no clear adaptation to fire. Even though there is empirical evidence to suggest rainforest can often regenerate quite vigorously after fire, in general, fires should be excluded from these areas. The distribution of this forest type is quite dynamic and changes in the fire intervals in some areas may cause a change in the species composition and structure of the forest.

With fire exerting such a dominant influence on the local vegetation, the use of fire in native forests needs to take account and notice of the *natural* fire frequencies in the forest type being managed. Previous management practices of exclusion of fire from a forest (other than rainforest and associated complexes) especially in fire-adapted and dependent ecosystems can often result in the very large accumulation of fuel. When a fire occurs in such forests, the result is often uncontrollable, highly destructive fires rather than a lower intensity fire which would do little damage to the dominant trees. Therefore, in fire-adapted vegetation, it is neither desirable nor feasible to exclude fires. The better solution is to ensure that the fire-adapted forests burns within a fire regime consistent with its ecological requirements, that also lowers fire risk.

This document outlines the procedures of conducting burns on your property. The purposes of burning are either to:

1. Reduce fuel loads of surrounding vegetation (lowering fire risk, reducing fire intensity of fires etc.), or
2. To achieve ecological objectives (eg the area has reached its maximum recommended fire interval etc.).

This document will outline the procedures required to perform fuel reduction/ecological burns on your property. It provides detailed information on the pre-burn procedures, fire-weather and predicting fire-behaviour of burns, fire-mitigation procedures such as firebreaks and fire-lines,

and post-burn procedures. The document also outlines the procedures to follow should burns escape, what resources and access points are required and the necessary legal requirements (permits etc.) that are necessary to obtain before burns are conducted.

This Operational Manual fulfils one of the objectives of the South-east Queensland (SEQ) Fire and Biodiversity Project. This project, which is funded by the National Heritage Trust through the Bushcare program, is managed by Logan City Council on behalf of the SEQ Fire and Biodiversity Consortium (FABC). The Consortium includes representatives from local authorities throughout SEQ, the Rural Fire Service, the Queensland Parks and Wildlife Service (Parks and Forest Management divisions), the Department of Primary Industries, Landcare, Greening Australia Queensland, and Universities. Other Consortium products include an individual property fire management planning kit, ecological guidelines with recommended fire regimes and fact sheets targeted to private landholders (list is available at end of the document).

Vegetation Types—Outcomes from Ecological Guidelines

We have extensively covered the importance of fire in the Australian landscape (Watson 2001, Tran and Wild 2000). There is no need to repeat this information, however it is worthwhile summarising the recommended fire-regimes for the different vegetation community types occurring in the southeast Queensland region. To reiterate one of our key messages: “*Different vegetation types will require different fire frequencies*”. Therefore, if you have a variety of vegetation types on your property, it is important to recognise the distinct ecological and management requirements of each vegetation type. This is particularly significant when you are planning ecological burning to conserve biodiversity.

NOTE: Remember you must decide what the **objective** of your burning program is. If it is purely for ecological management purposes, then you should try to maintain variability in fire regimes and use the fire-frequency regimes as we have outlined below. Alternatively, if you are burning to promote grass-growth or purely for protection purposes, you may have to sacrifice some ecological values. This is the same message we have used in the Individual Property Fire Management Planning Kit, providing a balance between property protection and biodiversity conservation.

In the table below, recommended fire-intervals for vegetation types are summarised. It is highly recommended that landholders read the ‘*The Role and Use of Fire for Biodiversity Conservation in South-east Queensland: Fire Management Guidelines Derived from Ecological Research*’ by Penny Watson (2001) to gain a better understanding of the concepts of fire ecology and the role of fire in the Australian environment.

Suggested Fire Intervals for Vegetation Types in SEQ

VEGETATION COMMUNITY TYPE	SUGGESTED FIRE INTERVALS
Rainforest	Fire exclusion
Wet-Sclerophyll Forest	20–100+ years
Dry Sclerophyll Forest & Woodlands	3–6 years (<i>grassy</i> understorey) 7–25 years (<i>shrubby</i> understorey)
Heathlands	7–20 years (coastal heath) 15–50 years (rocky heath)
<i>Melaleuca quinquenervia</i> (Paperbark) woodlands	15–30 years

Adapted from Watson (2001)

The other key point for fire frequencies and biodiversity conservation is **variability**, both in season and time. Creating a mosaic (or patchwork) of different ages of forest exposed to different time-since-fire will provide the most varied environments which will support the highest species diversity.

Fuel Reduction Burning

Low intensity planned burning is best defined as “...(planned) burning that is undertaken where weather conditions and the state of the fuels are such that fire intensity is restricted, resulting in only target light fuels being burnt without damage to other values (property or ecological) and the fires can be controlled or go out overnight” (adapted from Tasmania Parks and Wildlife Service 1998). The DPI (Forestry) Fire Manual (1998) describes ‘prescribed burning’ as “the *skilful* application of fire to natural fuels under conditions of weather, fuel moisture and soil moisture that will allow confinement of the fire to a predetermined area, at rates of spread and intensity appropriate to providing planned benefits with minimum damage at an acceptable cost”.

Objectives of Fuel Reduction

The most common objective of fuel reduction burning is to reduce fuels safely and with minimum damage to the remaining standing vegetation to reduce wildfire intensity, rate of spread and damage and make fire-suppression efforts quicker, cheaper and most importantly safer. To achieve this objective, every burn must aim to:

- (a) minimise (fire) escapes
- (b) reduce fuel on 70% or more of the planned burning area
- (c) cover 60–80% of planned burn area in a mosaic (or patchwork) pattern
- (d) keep the area of the total crown scorch to less than 10% of burnt area
- (e) ideally, no significant scorch with average flames no greater than 1.0 m in height
- (f) fire rates of spread in the range of 40–100 m/hr and intensities below 500 kw/m

Objective for Ecological Burning

The objective of this type of understorey/habitat manipulation is to maintain an environment because:

- (a) the area has reached its maximum suggested fire intervals as specified in the Ecological Guidelines (Watson 2001), or
- (b) has been scheduled to be burnt to maximise variability and patchiness (mosaic) – if this is the case, it may not have reached the maximum recommended fire intervals
- (c) there are rare or endangered plants in the area which are scheduled to be burnt
- (d) it contains poorly conserved plant communities
- (e) the area contains rare or endangered wildlife that requires the maintenance of a vegetation community that is dependent upon a particular fire regime.
- (f) there are weeds which may be controlled with fire, which will assist habitat reinstatement, or to
- (g) promote seed activation of fire-adapted species.

CLEARING & ZONING ETC.

As the next section will illustrate, a zoning pattern is the only method to maximise protection from fire risk in addition to maintaining suitable areas for conservation. This will include some level of clearing, especially in the close proximity of any built asset (home, shed, drive or access-way etc.). It has been recommended that these “inner zones” be completely removed of canopy-tree species, but can be maintained with shrubby/small tree species. In areas of high fire risk, safety issues warrant the removal of canopy species. If, however, the canopy species may be significant in terms of providing refuges or habitat for wildlife then you may consider keeping the species after some appropriate management (eg selective clearing of lower branches and manual removal of fuel). The Individual Property Fire Management Planning Kit uses this zonation concept for developing a fire management plan for your property. A depiction of this is shown below. The distances are useful only as a guide and not a rule (a useful rule of thumb – the tree height = distance from house). Use your own local knowledge and draw upon local expertise to help determine the different zones and spacings required.

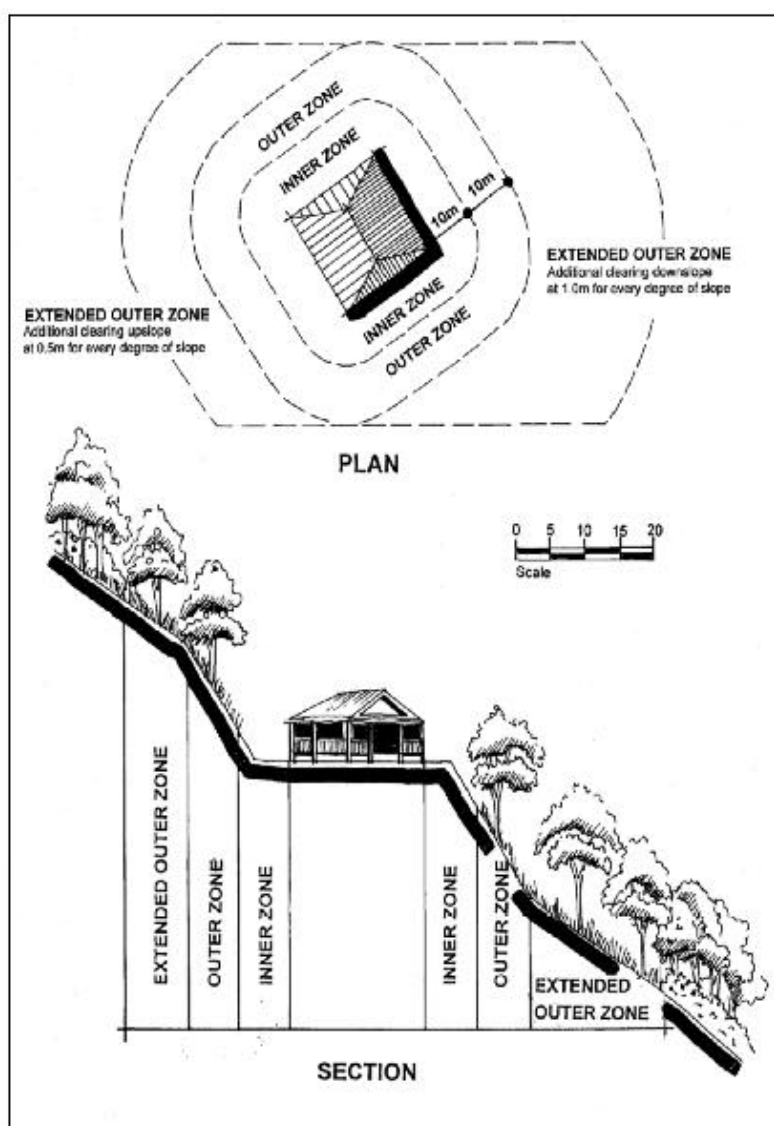


Figure 1 – Clearing and Zoning Patterns for Property Protection (from Gold Coast City Council 1998)

CONCEPT OF PROPERTY PROTECTION ZONES (PPZ) – POINT TO INFORMATION COVERED IN THE INDIVIDUAL PROPERTY FIRE MANAGEMENT PLANNING KIT

Achieving the objectives of property protection and conservation of biodiversity is a difficult task. In many instances these two objectives are mutually exclusive. The Individual Property Fire Management Planning Kit covers the concepts of ‘property protection zones’ where we recommend that areas surrounding your assets become the primary protection zone, where most work will be required in vegetation management. It should be noted that not all of the vegetation within this zone require complete removal – rather the opposite, where some appropriate species have ‘fire-retardant’ characteristics assisting in slowing fire spread or intensity. The Individual Property Fire Management Planning Kit has some broad characteristics you should look for in assessing which trees or shrubs will be useful to maintain within your protection zone (refer to Individual Property Fire Management Planning Kit – Step 3).

For other areas outside property assets, these outer zones will also require maintenance, which may include prescribed burning, the primary objective in these areas may be the conservation of the bushland, and therefore biodiversity, or other values associated with your forests such as farm forestry.

Remember to consult your maps which shows all your assets and risks when planning a burn and to ensure the proper precautions are in place well before any fires are conducted.

CONCEPT OF FUEL MANAGEMENT—MONITORING AND OTHER ASPECTS TO CONSIDER

Fuels and how they can be measured will be discussed in the next section. It is important to monitor the fuel loads of any high-fire risk areas that you have identified on your property. This will assist you in planning burns in the future (in addition to contributing to your multi-year burn schedules). Step 2 of the Individual Property Fire Management Planning Kit is assigned to assessing your ‘fire-risks’ and this section will provide some guidance on determining this level of risk.

Monitoring fuel loads can be a laborious and time-consuming task. Typically, this involves sampling multiple areas of similar vegetation (to provide more representative sites) to sample, gravimetric (which is an analysis in which the amounts of the constituents, in this case fuels, are determined by weight) analysis of fuel and repeated sampling over a period of time (usually many months). However, for many landowners, it is not necessary to have such an involved process with monitoring fuel loads. There are a couple of simpler methods available, which include:

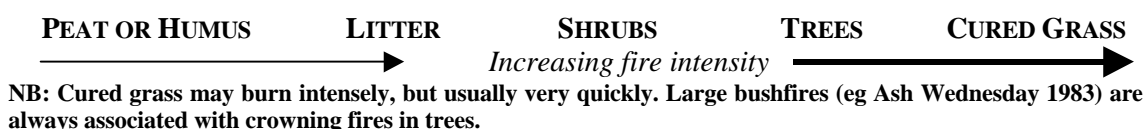
- visual assessment of fuel loads using a general guide (refer Figure 2)
- visual assessment of ground and elevated fuel according to Victorian guidelines (please refer to Appendix 1 at end of document – follow easy-to-understand directions), or
- initiate photo-monitoring at fixed photo-points on your property, where points 2–3 m apart are used as guides for photos.

WHAT IS FUEL AND HOW DO YOU MEASURE IT?

Trees and shrubs, regardless of the specific vegetation community type in which they occur, constantly produce fuels. In general, all plant material both living and dead can be considered as 'fuel', because provided there is enough heat, all plant material will burn. There are three different aspects of fuel, which will affect the fire behaviour during a fire. Fire behaviour will be covered in greater detail in the next section. These three aspects are:

1. FUEL TYPE

Obviously, plant material from various sources will burn with different degrees of intensities, and can be divided into broad categories (below):



2. FUEL CONDITION

The fuel condition relates to the fuel's moisture content. Whether the fuel is 'wet' or 'dry' will dramatically affect the intensity of a fire. For example, some grasses will not burn even when green, but burns quite rapidly when fully cured (dried).

3. FUEL ARRANGEMENT

The arrangement of fuel has a dramatic effect on the way in which fuel burns. Twigs packed close together will burn quite rapidly, but separate the twigs, and in all probability the fire will go out. In planning your burn, study and locate the area for places where fuel is concentrated which could become a problem situation during a fire. If this is the case, additional resources or preparation may be required to lower the risk of flare-ups, excessive scorch or escapes.

There is a fourth aspect which is a combination of the three key aspects outlined above. This is known as fuel quantity...

4. FUEL QUANTITY – FUEL LOAD

Typically, the total accumulated fuel is known as the fuel quantity or fuel load. This is usually estimated over a particular area and is measured in tonnes per hectare (t/ha). The composition of this fuel load also has a significant effect on the fire behaviour. Fuels up to pencil thickness (6 mm) such as dead leaves, twigs and bark are called '**FINE**' fuels and quite possibly has one of the greatest effect on the rate-of-spread of fires (elevated or above-ground fuels being the other). In general, the doubling of the quantity of fine fuels will double flame height and rate of spread and quadruples fire intensity and damage on each hectare. It also quadruples the area burnt within a given time. As these effects are additive, the doubling of fine fuel quantity effectively increases the damage by a staggering **SIXTEEN TIMES** (Tasmania Parks and Wildlife Service 1998).

However, for some forests such as sub-tropical rainforests, the high decomposition rates results in small amounts of fuel load accumulating on the ground, which is one reason for the lower fire risk of these forest types. Conversely, in dry forests (such as eucalypt) decomposition cannot match the production, which allows fine fuels to accumulate and in general, more than 10 tonnes of fuel per hectare will amass just 10 years following the last burn. Even though fine fuels do stabilise over this period of time, heavier fuels, such as larger branches, logs, and dead roots will continue to accumulate until the next fire.

HOW DO I MEASURE THE FUELS ON MY LAND?

Fine fuels occur mostly as litter on the ground as standing scrub and their quantity can be easily measured and assessed without the laborious task of weighing and drying fuels.

The simplest method to estimate the fuel load in the area you plan to burn is:

1. Find a typical or representative patch (of land) within your planned area
2. Estimate (visually) the percentage (%) cover (amount of ground shaded by the fuel) in a circle approximately 2 m in diameter. Use a 1 m stick (such as a broomstick handle) to 'draw' a circle around you to visualise this 2 m circle.
3. Record this information on your map of the planned burn.
4. Use the diagram (below) to estimate the fuel load in that area.
5. Repeat process for areas of different vegetation composition in your planned burn area.

Note: Choosing a representative area is not an easy task. Your local knowledge and expertise will be very valuable in these circumstances. Alternatively, your local council or conservation group can assist in determining this.

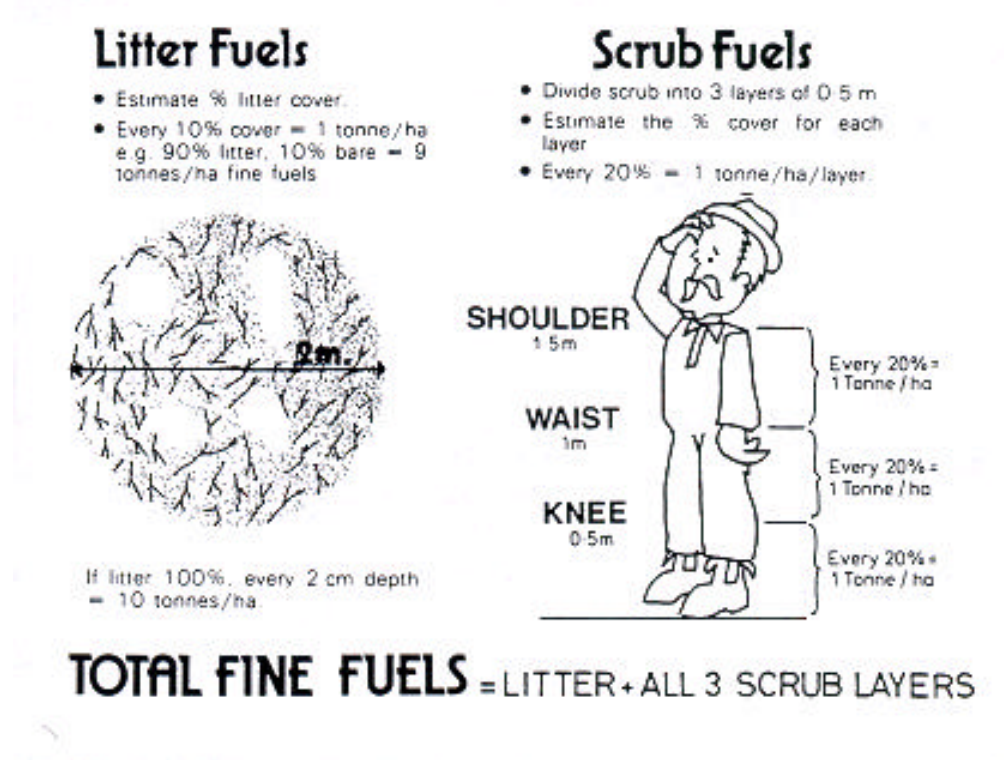


Figure 2 – Visual estimation for fuel (from Tasmania Parks and Wildlife Service 1998)

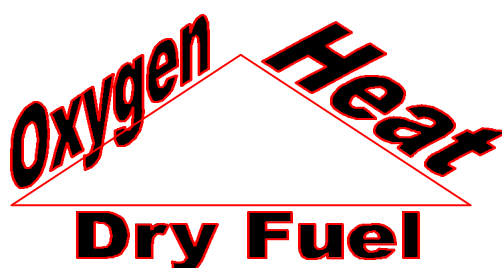
Another visual fuel estimation technique is also available (see Appendix). This technique has been widely used in southeast Queensland, by Queensland Parks & Wildlife Service (Wayne Kington, pers. comm.) and compares favourably (ie, produced accurate results) with more traditional methods (gravimetric analysis etc.) from a number of studies (Kington, unpubl. data and Tran, unpubl. data). The step-step guide in the Appendix was developed in Victoria, and for many of the criteria is comparable to vegetation types that we have in southeast Queensland, with the notable exception, that of bark-hazard. In southeast Queensland, the bark-hazard is not as influential as in Victoria, and in most cases, bark-hazard will rank 'low' on this fuel assessment scale.

What is Fire Behaviour and the Effects of the Weather on Fires?

The prevailing weather conditions have the greatest influence on fires. Even if you have completed the best fire management planning possible, periods of prolonged drought or rain will most certainly prevent you from burning during your scheduled times. Changes to some conditions such as relative humidity, temperature and windspeed will dramatically alter how fires will 'behave'. In this section, we will introduce the concepts of fire behaviour and how these environmental variables influence the way in which a fire will burn and what you need to do to measure these variables prior to and during your planned burn.

FIRE BEHAVIOUR?

We have already covered how fuels (and attributes such as compactness, fuel moisture and quantity) can affect fire behaviour. Fire behaviour is essentially a term describing how a fire reacts to changes in environmental and physical conditions. For a fire to start there needs to be three key ingredients which must be linked, and is commonly known as the 'fire triangle'...



Remember, one of the prime objectives of your fire management plan is the *reduction* of fuel (the other being ecological purposes). The other two elements are beyond our control, but they can be measured. Sound planning can take advantage of variations in **oxygen** (wind speed) and **heat** (temperature and relative humidity) that occur in a daily cycle or that can be predicted from prevailing weather patterns.

Fires are measured in terms of intensity (rate of energy released per metre of fire), ROS or Rate Of Spread, size (extent or area burnt) and other variables including flame height, flame angle and flame depth. Webster (2000) summarised the factors that can affect fire behaviour as:

Table 1 – Fire intensity and rate of spread are affected by:

1.	type of vegetation dryness of vegetation density of vegetation depth of shrub layer	fuel
2.	temperature of the day wind direction wind speed low relative air humidity unstable atmospheric pressure	weather
3.	slopes or complicated building shape	topography
4.	width of ignition line size and shape	fire itself

Changing any factor – fuel, weather, or how the fire is lit – and the intensity, shape and speed and ‘controllability’ of a fire is also changed.

The manner in which fires can be lit and how this affects the landscape is discussed in the section (Procedure on the Day of the Burn) below.

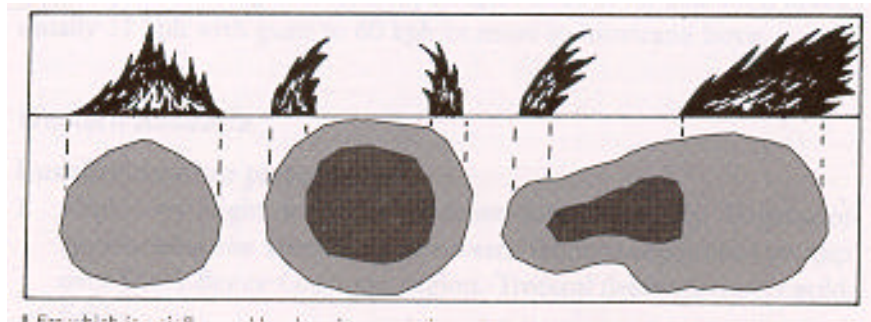


Figure 3 – A fire which is influenced by changing vegetation, wind or topography will spread steadily in a widening circle, like a burning doughnut with a black, incinerated circle. Once these factors change, the shape of a spreading fire becomes elongated and the fire front moves faster than the rear. (Adapted from Webster 2000).

WIND SPEED AND FIRE BEHAVIOUR

Recent studies (Gould *et al.* 2001, Tran and Pyrké 1999) have shown that wind speed has the greatest influence on fire behaviour. High wind speeds provide more oxygen for fires, angles the fire which allows a greater amount of preheating adding to combustion, can cause spotting (or sending firebrands or embers large distances downwind) and has a direct effect on relative humidity. Winds that are the *fastest* and *strongest* have travelled over long flat distances (Webster 2000). The general rule for wind speed is a mathematical formula that predicts a fire's speed (or rate of spread) if the wind speed is known:

‘Wind speed increases fire speed by its square’ (adapted from Webster 2000)

For example: a fire is spreading at 50 m/hr with a wind speed of 5 km/hr. If the wind speed increases to 10 km/hr, then the fire will spread at a rate of 200 m/hr. For this example the wind speed increased by a factor of 2 (ie doubling) – therefore, the fire will increase its rate-of-spread by 2-squared (2²) or 4 times (ie $50 \times 4 = 200$ m/hr).

For wind speed to be accurately measured requires specialised equipment (vane or handheld anemometers) and a wide open clearing as any surrounding vegetation directly affects wind speeds. In many cases, this type of equipment or clearing is not available. It is generally accepted that the ‘Beaufort Scale’ ranging from 0 (calm conditions) to 12 (hurricane conditions) which was devised in the 1800s is an accurate estimator of the wind speed and today remains widely used. This scale uses visual cues such as the effect of the wind on local vegetation (movement of twigs, branches) and other noticeable features (smoke, dust etc.) to estimate wind speeds. The Beaufort Scale is included in the Appendices.

CHANGES IN WIND DIRECTION

In addition to wind speed, changes in the **direction** where the wind is travelling from will also have a strong influence on fire behaviour. As stated above, it is the hot, dry winds that flow across the continent that cause most fires. For southeast Queensland, it is the westerly or north-westerly winds which are associated with worsening fire weather (ie, increase chances of fire escapes and wildfires). The other meteorological phenomenon associated with the fire-season that may be significant to changes in fire-behaviour is the passage of a cold front. This is usually linked to a wind change to the W-SW, that could cause an eastern fire flank becoming the main front, that will result in a substantial increase in the fire area and increase danger to personnel and fire-fighters.

NB: when you talk about wind direction, it means where the wind originates from, **NOT** where the wind is blowing too.

A NOTE ABOUT PROJECT VESTA (MEDIUM-HIGH INTENSITY EXPERIMENTAL FIRES CONDUCTED BY CSIRO), AND HOW FIRE BEHAVIOUR IS AFFECTED BY CHANGING WIND SPEEDS

Results from this project, conducted in the dry-eucalypt forests in Western Australia, shows that there is **threshold of 12–15 km/hr for wind speed and fire behaviour**. At wind speeds below this threshold, fire ROS may appear deceptively slow, but as wind speeds pass this threshold, there can be a large increase in fire behaviour. Be wary of this wind speed threshold!

More information on this project can be found on the Internet at:

<http://www.ffp.csiro.au/nfm/fbm/vesta/index.html>

RELATIVE HUMIDITY

Relative humidity (RH) is the relative degree of dampness in the air at any particular temperature, and the air's ability to hold moisture rapidly increases with temperature (Webster 2000). Relative humidity strongly influences bushfire behaviour, as much as temperature and wind speed. As Webster (2000) explains, even in mild temperature conditions, low relative humidity encourages the spread of bushfires by evaporating moisture from vegetation, and any spark will quickly set grass and other understorey alight. If wind speed increases or a change in wind direction is present, control becomes increasing difficult.

The general guidelines are as follows:

Relative Humidity usually reaches its lowest between midday (12 p.m.) and 3 p.m.

Relative Humidity of 30% or less is the danger mark. At 30% RH, sparks can be given off burning material which may cause spotting. Relative humidity values below 15% usually become a critical situation (after Webster 2000).

As Webster (2000) explains “vegetation is the fuse that leads to bushfire, and low relative humidity is the match. It adds the vital ingredient to the recipe for extremely dangerous bushfire weather and has been the distinguishing attribute of all major conflagrations.”

Measuring the relative humidity requires some prior knowledge of meteorology and the use of a wet and dry bulb hygrometer. The Bureau of Meteorology can also provide relative humidity

readings from the closest weather station to your property. Their details are provided in the 'Procedures on the Day of the Burn' section.

ATMOSPHERIC INSTABILITY

In the worst fire conditions, atmospheric instability causes 'high-reaching' flames, crown fires and long spotting distances, which is usually detectable from accompanying gusty winds that make fire behaviour very difficult to predict and control (Webster 2000). Webster (2000) further explains that in calm conditions, an inversion layer (a layer of stable air) inhibits the rising of warm air convection currents. However, before and after a cold front and wind-change, the upper atmosphere is unstable and the inversion layer is not there, and therefore if a bushfire occurs, heat rises unhindered (Webster 2000). The increased oxygen available and the unstable atmospheric conditions can cause firestorm conditions. This column of hot rising air, called the convection column, can send burning embers and other fire-brands many kilometres downwind, starting spot fires.

What this information shows is that comprehensive prior planning and updated weather information is crucial for a successful burn to proceed.

TOPOGRAPHY

The physical conditions (terrain, slope) will influence other important fire behaviour characteristics such as wind speed and direction, and the rate of fire spread. Variations in terrain can cause eddying of the wind, increasing turbulence and making fires unpredictable and uncontrollable. The increased turbulence and gusty eddying that occurs at the peaks of hills is the primary factor behind the recommendations to limit or prevent residential developments at these sites.

THE INFLUENCE OF SLOPE

"For each 10 per cent increase in slope, up to 30 degrees, doubles the speed of bushfire" (Webster 2000)

For example, a fire travelling up a 20-degree slope travels **four** times faster than on flat ground. This is the reason why it is dangerous to attempt to outrun a fire up a hill, with many deaths having been attributed to this. Fires travelling downhill will go proportionally slower (Webster 2000). Slope also has an effect on 'tipping' the flame to a very acute angle (refer figure below), which brings flame and hot gases closer to unburnt vegetation (Webster 2000). This has an added effect of preheating vegetation, drying it out, making it burn quicker.

Webster (2000 p58) succinctly concludes that "as the more complex the bushland, dense the undergrowth, the more hilly a bush block or overgrown the country property, the more unstable will be the eddying of air currents, and the more intense the bushfire. *As we keep arranging the ancient pattern of vegetation by adding houses to it, we increase the complexity and the dangers of the bushfires that happen within it*" (italics – my emphasis).

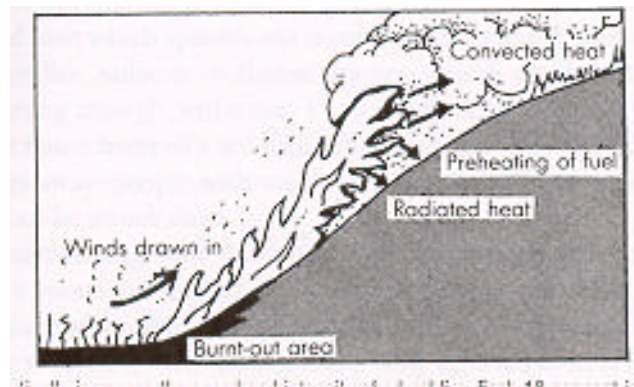


Figure 4 – Slope dramatically increases the speed and intensity of bushfires. Each 10 per cent increase in slope (up to 30°) doubles the speed of a fire. Slope also tips the flame to an acute angle, bringing hot gases nearer unburnt vegetation, drying it out so it burns more quickly. (Adapted from Webster 2000).

Fire Danger Rating – Using the Fire Danger Meter

As we have discussed, the weather conditions have a profound effect on the drying of fuel and the way it burns. Some pioneering work by McArthur (1973) has allowed us to more accurately predict the chances of fires occurring according to important variables, such as: long term drought, recent rain, days since last rain, air dryness, air temperature and wind speed. The sum of these effects is known as the Forest Fire Danger Index. Recently, in the high-intensity fire experiments conducted by CSIRO's Project Vesta in Western Australia, highlighted the fact that the McArthur Fire Prediction Tables under-predicted the potential rates-of-spread of fires. They recommended that a change to the prediction tables is not required, as the McArthur Meter is still a good estimator for fire behaviour.

Forest Fire Index ranges from 0 (low fire danger) to 100 (extreme fire danger), and the ratings are:

Table 2 – Forest Fire Danger Index Ranges

DANGER RATING	DESIGNATION
0–4	Low
5–11	Moderate
12–23	High
24–49	Very High
50–100	Extreme

} – Recommended FDR for prescribed burns

For any prescribed or planned burns, it is recommended to have either a 'low' or 'moderate' forest fire danger index (further prescriptions are outlined in the next section). In southeast Queensland, McArthur's Index is not as widely used as other indices used to plan fires. Department of Primary Industries uses the Drought Index (DI) and the Soil Dryness Index (SOI) as good reliable measures.

For some ecological burning to achieve the desired results, a 'high' index is probably required. These conditions which encourage flame propagation and fire intensity also increase the

chances of escapes, spot-fires and increased risk to life and property. Expert advice should always be consulted for this type of planned burn.

CALCULATING THE MCARTHUR FIRE DANGER INDEX

McArthur provided the equations to determine fire danger following his work on *Eucalyptus* woodlands in Tasmania in the 1950 and 1960s. These have shown to be relevant and applicable to most regions in Australia, including southeast Queensland. To make the calculation of fire danger an easier and quicker process, there is a simple cardboard meter, which calculates the Index given assumptions about the moisture content of the fuel resulting from rainfall. It also allows the user to 'dial-in' the temperature, relative humidity, and wind-speed to determine the fire danger rating.

Information about rainfall and time since last rain can be obtained from the Bureau of Meteorology (BoM) – contact details are supplied in Appendix 2. Relative humidity is obtained using a hygrometer (or from forecasts from the BoM), and wind-speed can be obtained using an anemometer or from a reliable estimator, such as the Beaufort Scale (discussed above and included in Appendices).

McArthur Fire Danger Meters are a valuable resource tool. These useful devices are copyrighted to the CSIRO and can be obtained from one supplier, and their contact details are:

Styrox (Aust) Pty Ltd.
Unit 8/ 7 Jubilee Ave Warriewood 2102
(02) 9997 1000

The Appendix outlines the steps required to determine the fire danger index using the meter and information obtained from a Bureau of Meteorology forecast.

Another well-used measure of the likelihood that potential intense fires will occur is the Drought Index (DI). This index is also known as the Soil Dryness Index (SDI) which is used in other regions of Australia. A good guide to the Index is described in the following table:

Table 3 – Explanation of Drought Index and Soil Conditions

SOIL AND FUEL CONDITIONS (after recent rains have dried off)	D.I.
Soils and fuels are wet to touch. Fires are unlikely to burn	0–13
Soils wet, but fine fuels off the ground may be dry enough to burn	13–25
Soil is damp and cool to touch each morning but dry in the afternoon. Underside of half-buried wood is wet all day. There is sufficient moisture in the soil to wet fine fuels on the surface overnight. Every fine day the moisture in the fine fuels and upper soil evaporates faster than it can be replaced and the fine fuels become dry enough to burn. At night, evaporation usually ceases, fuel moisture content rises and fires go out in fine fuels. Heavier fuels may remain alight overnight.	25–50
Soil is dry to touch in the morning and the underside of half-buried wood is dry as there is little moisture in the top 300 mm of the soil. Heavier fuels are also dry and will catch and stay alight. Finer fuels will burn overnight and can cause problems if the following day is hot and windy.	50+

This index is a measure of moisture deficiency (corresponding to the dryness of the soil), and works on the assumption that 200 mm of rain is enough to fully saturate the soil. Therefore, the DI is an expression of the moisture deficiency on a scale from 0–200, where 0 = totally saturated, and 200 (very dry requiring 200 mm of rain to reach saturation). As you can tell, this index is quite reliable, as prolonged drought always proceeds damaging bushfire periods.

Determining the DI is not an easy process, even though there is a stepwise procedure (Appendix 2 provides you with the instructions required to determine the DI). It requires the use of updated information about the last amounts and timing of recent rainfall, current temperature and the use of drought tables (relevant to your area) and other indices.

Information on DI are available from the BoM, either by phone or over the Internet. The contact details for the BoM are listed in the section ‘Procedure on the Day of the Burn’. In the preparation of your property for burning, we recommend that you contact the BoM to obtain information on the DI and use their forecasts accordingly.

Drought Index – A Quick Estimation Method

Mark Webster, Brisbane City Council Bushfire Management Officer, describes a method, where you get a shovel or use your boots to dig (or kick) the dirt until you find damp soil. If possible, repeat this method in a number of places. This will provide a good estimator of the condition of the soil.

Fire, Soil Conditions and Effects on Biodiversity

Fires can smoulder underground for many days following the passing of the fire-front, and this can have damaging effects on old trees, undermining their root systems and eventually toppling them over. As Mark Webster (pers. comm.) mentions, “this is the main difference between prescribed and wildfires. The soil moisture protects the root systems of older trees, maintaining vital habitat trees and biodiversity”. When you are preparing your property for planned burns or for the fire season, we have a few recommendations that will assist in preparing these older trees, and hollow logs and other important habitat areas for the fire. This is outlined in the ‘Fire-lines’ section.

What fire management practises can be conducted if there is a LOW Drought Index?

Conducting a burn during low DI conditions can be ideal for:

- Fire sensitive areas (plants and certain habitats)
- Areas which are difficult to control fire in good situations – especially if there is a steep slope, high fuel load, high fuel quantity or is adjacent to vulnerable areas,
- Fires in ridge tops. Along with the low DI, the time of day and seasonality, fire along a ridge top can be achieved. Middle slope to bottom slope fire regimes can follow a mosaic with the use of higher DI and suitable weather conditions, so there is a staggered burning regime.
- Low intensity fires, where only light fuels will be burnt (including grasses).

What fire management practises can be conducted if there is a HIGH Drought Index?

- As stated above, mid- and lower-slope fires.

- Higher intensity fires for weed management or regeneration objectives,
- Burning ‘wetter’ or moister areas such as wet-sclerophyll forests, and
- Reducing overall fuel loads, including larger diameter fuels

A quick and easy way to measure the Drought Index...

Even though we highly recommend obtaining Drought Indices from the Bureau of Meteorology or calculating the index prior to any burning, according to Mark Webster (Brisbane City Council Bushfire Management Officer), the telltale sign of an increasing drought index is the presence of many green Eucalyptus leaves on the ground.

Coupled with the calculated Drought Index figures and local effects (presence of green Eucalyptus leaves) will provide an accurate estimation of the Drought Index in your area.

Ecological Regeneration Burning

As previously stated, not all planned burns are aimed to reduce fuel loads and fire risk on your property. Burning may be planned for ecological reasons. These reasons could be the use of fire to:

Weed Control

- reduce the population and spread of weeds like lantana (*Lantana* sp.) or mother-of-millions (*Bryophyllum delagoense*). Fires for the use of weed control is the subject of intensive research. The Department of Natural Resources and Mines have produced a number of fact-sheets on control methods for many weeds in southeast Queensland. They are available on the Internet at: <http://www.dnr.qld.gov.au/>

Be wary that some fires may increase weed populations. Research has shown that fire intensity plays an important role in controlling weeds like lantana (which requires hot fires).

Stimulation of Regeneration

- open up the canopy and stimulate regeneration (this will require medium to high intensity fires – consultation and coordination with relevant experts is required for these types of planned burns).

Influence Vegetation Community Structure and Composition

- remove (or thin out) single dominant stand of plants (which could be native) on your property to promote diversity and different aged stands of native vegetation. Similar to the point above, this may require higher intensity fires, which will require the assistance and experience of local experts! An example where this has occurred are the planned high intensity fires to thin and remove some stands of the Black She-Oak (*Allocasuarina littoralis*) groves at Downfall Creek conducted by Brisbane City Council. The stands of Black She-Oak dominated the area from the lack of fire, resulting in a mono-specific stand with low biodiversity. Due to the higher intensities involved, more planning and personnel were required, and the area burnt was small in extent (to limit potential escapes). Post-fire assessment of the plots showed increased diversity of other species with remaining stands of Black She-Oaks.
- meet objectives of maintaining variability (in fire frequencies) and mosaic burning throughout your property. As explained in the 'Ecological Guidelines' creating and maintaining different aged (since fire) vegetation communities is required to maintain a diverse and vibrant community. Varying planned burns over a range of fire frequencies will provide a variety of different community types to serve as habitats and refuges for a multitude of plants and animals. In some instances, wildfires will occur and burn a portion of your property where you had planned an ecological burn. Cases where this occurs should not be considered as detrimental, moreover the opposite, as this increases the natural variation in fire regimes and will most likely increase the variability of vegetation communities and maximises diversity (this relates to Step 5 – Individual Property Fire Management Planning Kit).

Fuel Reduction Options Without Use of Burning

Even though the proper application of fire is very effective in reducing fuel loads, it is not the only means to reduce fuel on your property. As this document shows, a great deal of planning and resources are required to complete a burn successfully. In your pre-operational planning to reduce fuel loads, you may wish to investigate other effective methods that are certainly less resource-intensive and ‘risky’ options available to reduce fuel loads. These include:

MANUAL REMOVAL OF FUEL – the Individual Property Fire Management Planning Kit (a Fire and Biodiversity Consortium product, see last page) recommends and outlines a zoning pattern to apply to your property based upon geographical characteristics and the location of assets. In some areas, burning may not be required and the manual removal of fuel may be adequate to reduce the fire risk. In areas, where the continuity of fuel is sparse (widely spaced canopy trees or large shrubs) and there are natural fire barriers (creeks, gullies etc.) on your property, burning will provide only limited efficiency in reducing fuel loads. Though this method is physically demanding, it is far more beneficial from an ecological and fire-risk perspective. The method involves the manual removal of large braches and dead fuels from the ground, trimming dead branches on large trees and shrubs up to 2 m in height, trimming on taller braches on canopy trees to limit the interlocking of tall branches. Local knowledge has an important role here. All fuel within a 2 m radius of known habitat trees (with hollows etc.) or culturally significant vegetation should be cleared regardless of your fuel reduction options (to burn or not to burn). Care should be taken when manually removing fallen tree logs. These logs may be an important habitat for many fauna species and should be retained wherever possible. You may also risk your personal safety by removing these logs.

STOCK MANAGEMENT FOR MANAGING FUEL LOADS – In some instances, the introduction of grazing animals (goats, cattle etc.) may adequately reduce fuel loads within your property. This is particularly effective in more grassy regions. Bill Mollison’s (1983) Permaculture recommends the use of less-flammable plants (discussed below and elsewhere) and the use of animals (namely goats) as two extremely valuable and cost-effective measures of reducing fire risk, without the need for burning. The number of animals required depends upon the size of the area, which needs to be enclosed, but the general guide is:

- Native Forest Areas/Tall Open Forests with 500–700 mm mean annual rainfall, 1 animal per 16 ha
- Grassy Open Ridges/Forested Areas, 1 animal per 15 ha,
- Well-Grassed Open Forest (eg D’Aguilar Ranges), 1 animal per 5–10 ha

Again this is just a guide to provide all year-round grazing for your animal. In good production years, these numbers can be tripled (Gourley pers. comm.). These refer to larger animals, like cattle, so if you use smaller animals such as goats, you can increase the number accordingly and still provide enough stock for the animals. If you require more assistance with stock management, the Department of Primary Industries Agricultural Production section will be able to assist.

A note about the use of stock animals and biodiversity values:

If one of your primary objectives is the conservation of biodiversity, then you may wish to reconsider the use of stock animals for managing fuel levels. There are a number of impacts that are caused by these animals (such as trampling) which could be to the detriment of native animal species. The impact of grazing and fire and its effects on biodiversity is currently being

researched. We aim to provide you with a number of options for fire management on your property. Remember to think about the consequences (ecologically and otherwise) of all your land management practice.

REPLACEMENT PLANTING WITH LESS-FLAMMABLE PLANTS – Research by others (Tran *et al.* 2001, Sheridan 1996, Bellamy 1985) has shown that vegetation can be used to effectively reduce fire risk. The utilisation of lower-flammability vegetation confers many advantages over conventional fire risk reduction methods. Properly sited, this band of low flammability vegetation form an effective fire barrier which can slow/stop fire spread, reduce and absorb radiant heat, reduce wind speed, and ‘catch’ burning embers. It should be noted that under the most extreme fire-weather conditions, even this low-flammability vegetation would be considered as fuel. It should also be noted that these so called ‘green firebreaks’ will require many years for the trees to reach maturity and constant maintenance is required if they are to be fully effective. Generally, large leaved, succulent (high moisture content) plants with minimal or no bark are the more effective green firebreak species. Native plants within the region should only ever be used as a potential firebreak plant-species (eg it would be useless planting plants that occur in sub-tropical rainforests in a western district). Some well-documented examples include: Moreton Bay Fig (*Ficus macrophylla*), Flooded Gum (*Eucalyptus grandis*), Spotted Gum (*Eucalyptus maculata*), and Sweet Pittosporum (*Pittosporum undulatum*). Please note, Sweet Pittosporum has been listed as a weed in some areas of New South Wales (native species can be considered weeds as well).

Natural green firebreaks have been successfully and extensively used by Mike Hall (Senior Ranger) from Springbrook National Park, in which they ‘lead’ the highly intense fires (in 1994, 1981 etc.) into sub-tropical rainforests sections of the Park, where the fires self extinguished. It is worth reiterating that caution should be taken when selecting the appropriate species to form a firebreak. Also, do not solely depend upon these green firebreaks as your only fire management strategy, it must be incorporated into and accompanied by other strategies to maximise your preparedness for the fire season. Green firebreaks also offer an ecological advantage. These vegetated areas provide a natural refuge for animals and plants, increasing the conservation value of that property. If you have any of these areas on your property, ensure that they are properly identified on your fire management plans and to ensure neighbouring properties are notified. They may be useful for evacuation and escape routes, and could less-flammable buffers adjacent to back-burning operations.

A note about the use of less flammable vegetation:

It is also important to note that if you live in an area where these less flammable plant species do not occur naturally, then it is not recommended that these be planted. This will not only alter the ecological balance of your landscape, but is fraught with difficulties (especially if planted in a large area which may increase its chances of becoming an environmental weed). The local conditions and lower rainfall in the drier regions of southeast Queensland will not support many of the less-flammable species. These plants will not only perform poorly, they will also add to the fire risk.

Fire-lines

Fire-lines, as the name suggests are tracks that are prepared and managed to serve a variety of purposes for your planned burns. The majority of this information has been collated from the Department of Natural Resources (1998) Forestry Fire Manual, which is currently under review (Tony Baker DNR, *pers. comm.* 2001). They can be used to break the continuity of fuel that can assist in segregating, slowing or stopping the spread of a fire (**firebreak**) or providing a 'safe' line to suppress a fire, or are specific roads constructed and maintained for fire management purposes (**fire-trail**), or are roads or tracks constructed and maintained (generally lower standard) for other fire management purposes like a track to water source etc. (**fire-track**). Fire-lines can vary dramatically in grading and quality to suit the definitions just outlined – and is important to differentiate between the intended uses of each of these types of fire-lines.

Note: fire-access trails need to be considered on two levels ... one for vehicle and on foot, where vehicles will not be able to access.

PURPOSE OF FIRE-LINES

The main purposes of fire-lines is providing: (1) access and (2) to break the continuity of (potential) fuel. Fire-lines serve many other recognised and equally important functions (escape routes, back-burning operations etc.). As such, all fire-lines, regardless of grading and type form an essential component of your fire management infrastructure. It is therefore essential that all your fire-lines and that of the adjoining properties be regularly assessed and properly maintained. The location of all fire-lines should also be properly located and recorded on fire management plan maps.

WHAT FIRE-LINES CAN AND CANNOT DO

Fire-lines can be very effective and should form an important (but not the only) aspect of your fire management infrastructure planning. However, it should be noted that fire-lines will not provide you with complete protection or be absolutely effective in certain conditions. With most fire management mitigation strategies currently available, there are limitations to their use, even if they are perfectly planned and implemented. This has been well demonstrated locally and in other areas throughout Australia. The footage of the wildfires 'jumping' and crossing over highways in New South Wales in 1994 not only shows the enormous power of high-wind driven fires, but also the total ineffectiveness of a 30–40 m wide fire-break (such as the highway) in slowing the spread of a fire. This is of course an extreme example of what can happen with existing infrastructure arrangements. You must remember that all the strategies that we employ simply *reduces the risk* of damaging fires to life and property, but *we are never able to totally eliminate* the risk of fire. As we have mentioned previously in other documents, we live in an environment where fires will always have an important role, and no matter what we do, fires will occur. Please keep this in mind when planning to construct fire-lines or any other form of infrastructure.

Fire-lines can be:

- effective in slowing or stopping the spread of a low intensity fire from one area to another (this is dependent on the fuel type and width of the fire-line). Typically, only grassfires are effectively managed by fire-lines.

- used as an area where the low (or nil) fuel load can be used to perform back-burning operations
- used as an access route for fire vehicles and other appliances. The standard of the fire-line will influence the type of equipment (also known as an ‘appliance’) that can access these lines.
- used as an escape route or evacuation or (temporary) assembly area for fire personnel (dependent on fuel types and fire intensity)
- used to separate different compartments or areas of different vegetation or fuel types or areas with different ecological-burn requirements.

However, fire-lines cannot be:

- used to stop or slow the spread of medium–high intensity fires. Cheney (1981) showed that firebreak widths needed to be much wider to slow/stop grassfires, which usually burn with high intensity but also very quickly.
- used as a recognised assembly area for personnel during a fire. It may be used temporarily, but with a high amount of traffic and proximity to the fire, has an increased risk of causing injury and harm. Fire-lines are usually areas of lower fuel loads and/or usually cleared of all vegetation, which when burnt, directly exposes personnel and equipment to the fire and maximum radiant heat exposure. Radiant heat is recognised as the most dangerous threat to human safety (Webster 2000).

LOCATION OF FIRE-LINES

The Queensland Parks and Wildlife Service Draft Code for Fire Management (Schedule 7) has established some general standards to the planning, constructing, using, maintaining and decommissioning on ground fire management infrastructure. This infrastructure may include firebreaks, fire trails, tracks and other ‘disturbed’ areas (helipads or ramps).

In wildfire situations, it may be difficult to construct fire management infrastructure without compromising environmental values, but all efforts should be taken into account when constructing this type of infrastructure.

Fire management infrastructure should be located to avoid areas of:

- steep slopes/unstable areas,
- landscape values,
- rare/threatened flora and fauna
- highly erodible soil, and
- cultural heritage

The construction of firebreaks (defined in Glossary of Terms) must be developed and maintained to:

- reduce the levels of radiant heat to firefighters and buildings,
- provide a refuge and escape route for firefighters
- provide adequate width that allows firefighting vehicles to pass and turn safely (except for hand-constructed fire-lines), and
- arrest the spread of fire and provide a safe line to perform backburning operations

In general, fire-lines should be constructed so that the firebreak, trail or track should:

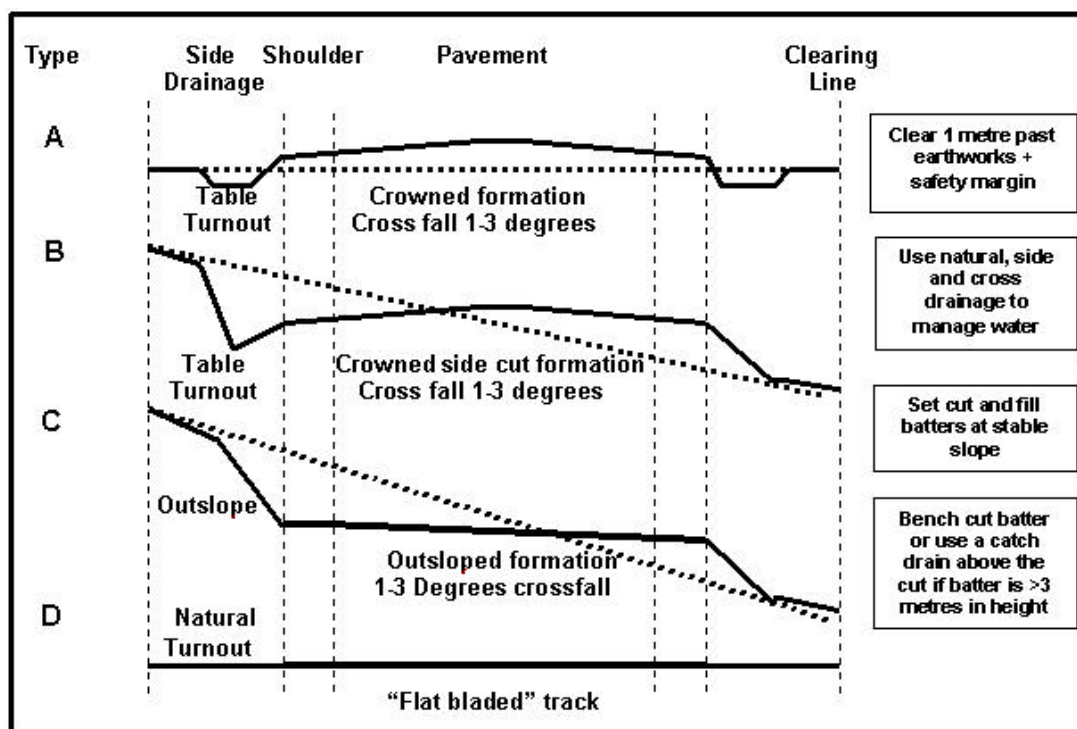
- not follow watercourses
- be located to minimise the area disturbed

- not exceed widths of 4 m (except in strategic areas, or to provide an adequate and safe turn around for vehicles and passing points—which should also be recorded on your fire management plan)
- utilise natural crossfall to where is no crossfall or other natural drainage features, construct cross drains as required
- retains the maximum amount of surface vegetation, litter and organic matter consistent with safety and access considerations

To achieve the functions required in fire-lines, roads, tracks and trails should aim to:

- use any existing access where possible (fence-lines, property boundaries etc.)
- meets the necessary access requirements with minimum required infrastructure (ie minimal impact)
- minimise adverse visual impact
- avoid exclusion zone (of ecological, commercial or cultural heritage importance) and areas prone to instability or flooding (minimise erosion of fire-line)
- uses existing geographic features (such as ridge-tops, benches and gentle slopes)
 - avoiding where possible, the use of ‘box-cuts’ (explained below), which are difficult to drain, unless there is no other alternative
 - minimises side cutting and avoids potential instability through the limited construction to side slopes less than 30°
- minimises watercourse crossings and interference with natural drainage
- consult the relevant authorities where proposed access joins a gazetted road

Some general standards apply for the construction of all types of fire-lines. The design of fire-lines, should achieve the desired function, and must be able to carry the anticipated type and frequency of traffic safely whilst protecting environmental values. It should also suit site conditions and function to maintain its integrity and stability. Some acceptable standards for fire-lines, are shown in the table (below). This information has been drawn from the Queensland Parks and Wildlife Service Draft Code for Fire Management (Schedule 3–Inland Cypress Pine Plantations), but is applicable to the region.



Road and Track Formation Types (Draft Code for Fire Management. QPWS 2000)

Table 4 – Design Standard for Fire-lines

Design Parameter	Access Type			
	Main Access	General Access	Minor Access	Track ⁽¹⁾
Use Standard	Two lane, All weather	Single lane, Good weather	Single lane, Good weather	Single lane, Dry weather ⁽²⁾
Formation	A or B	A or B	A,B or C	Minimal D
Pavement Surface ⁽³⁾	Gravel	Gravel Patch gravel	Patch gravel	Natural
Pavement Width	6 metres+	4 metres	4 metres	4 metres
Clearing Width ⁽⁴⁾	1 metre beyond earthworks plus safety considerations			
Maximum Grade ⁽⁵⁾	7 degrees (12%)	7 degrees (12%)	9 degrees (16%)	10 degrees (17.5%)
Cross Drainage Type ⁽⁶⁾	Culverts	Culverts Inverts ⁽⁷⁾	Inverts ⁽⁷⁾ Water bars ⁽⁸⁾	Natural Inverts ⁽⁷⁾ Water bars ⁽⁸⁾

Notes:

- (1) **Lessee Track** requirements should be negotiated between the lessee and other authority, eg DPI-Forestry. These will commonly be flat bladed tracks. Surface drainage should avoid the use of water bars, where possible, and particularly where the track has to remain trafficable. Firstly locate to utilise natural drainage. Secondly ensure the edge berm is breached at water bar spacings to permit side drainage. Thirdly consider the use of inverts where cross drainage is required. Water bars would be used where the track is no longer required. Wet spots in the track surface should be either drained, filled and raised or corded to avoid bypasses.
- (2) **Temporary Tracks** – Limit clearing and earthworks to the absolute minimum–use the natural surface. Avoid box cuts unless absolutely necessary. Blading-off of track surfaces should be minimal and must not leave a continuous edge berm. Break berm at water bar spacings to permit side drainage. Stabilise with necessary side and cross drainage on completion of use.
- (3) **Pavement Surface** must be matched to road use. Gravel as necessary to ensure traction, avoid rutting and to maintain effective drainage.
- (4) **Clearing width** may be extended to avoid a safety risk. Extend by the minimum necessary, subject to advice from experts, to correct the risk or consider alternatives such as restricting traffic to “one way”.

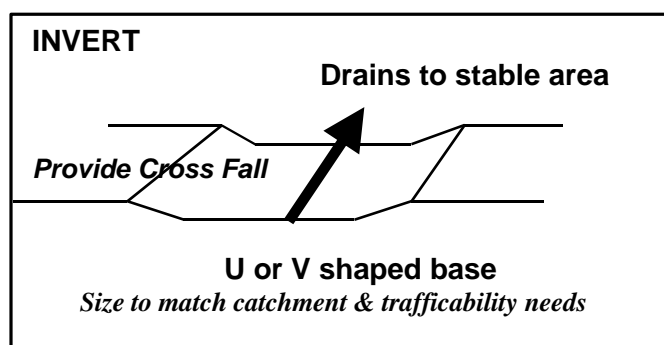
- (5) **Grades** - Steeper grades may be permitted where construction will result in less disturbance and can be safely used. Gravel may be needed to utilise steeper slopes. Seek advice.
- (6) **Drainage** should utilise appropriate combinations of natural, side and cross drainage. Space cross/side drainage structures as per Table 2. Note: drainage construction may not be practical in “bull dust” conditions. Use inverts, debris or breach ruts/berm to provide temporary drainage until rainfall settles the dust.

Table 5 – Cross/Side Drain spacing (metres)

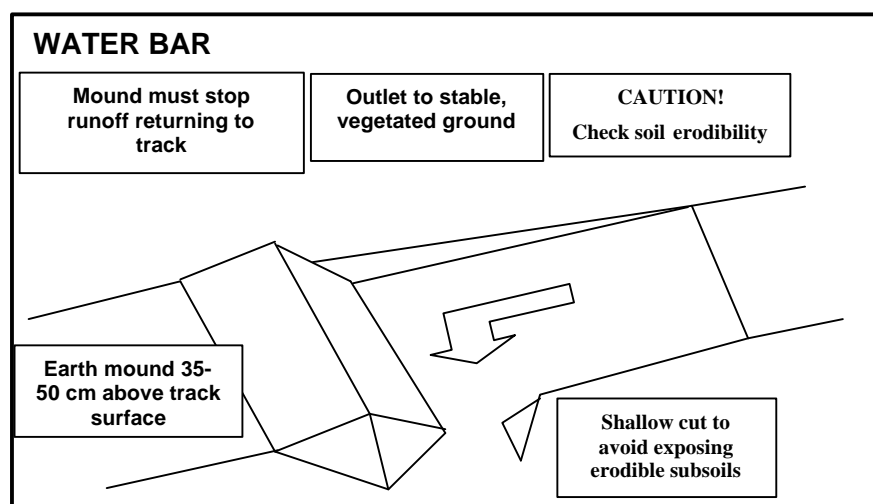
GRADE Degrees	DRAINAGE OFFSET Degrees	SOIL ERODIBILITY RATING (*)		
		Low	Moderate	High
< 2	Up to 30	200	175	100
3–5	Up to 30	160	120	60
6–7	Up to 20	120	75	40
8–10	Up to 20	75	50	25
11–15	Up to 10	30	20	15
15+	Up to 5	20	15	15

(*) Use the high erodibility rating unless actual erodibility is known

- (7) **Inverts** are cross drainage structures that maintain the trafficability of the road. They may be constructed with V or U shaped bases. Ensure cross fall will drain the base and outlet drains to a stable, vegetated area.



Water Bars are primarily erosion control structures best used to stabilise surfaces on the completion of use. Broader “roll over” water bars can be used where road is subject to traffic. They operate by slowing and diverting water from tracks to a stable outlet without water returning to the track down slope. **Caution!** Before construction check soil erodibility and consider the risks and alternatives if soils are highly erodible or dispersible.



Construction is generally not practical in “bull dust” conditions – use temporary inverts or debris and await rainfall to stabilise the dust. They must be sited and built to avoid erosion and not create a problem. Locate at critical locations such as significant changes in slope or direction, points of concentration of overland flow and 10 metres before any watercourse crossing or junction with another track. Construct additional bars, as necessary, to achieve listed spacings. Construct a shallow, flat-bottomed ditch using a shallow cut to avoid exposing erodible soils. Use spoil to create a mound that will divert water from the track and has an unconsolidated height of 35-50 cm above track surface (height should be matched to management need). Angle as per table 2. Where used for road closure, tree heads or other

obstacles should be pulled over the top of the mound where there is a risk of cattle trampling and vehicle disturbance.

OTHER IMPORTANT CONSIDERATIONS

Removal of Fuel – As the recommendations show, the minimum width of a fire-line is 4 m (see note below). The main aim is the reduction of fuel (but not always total removal to bare mineral earth) – as this may have adverse environmental effects (namely weed introduction and increase erosion). There is also the risk of feral animal invasion with the increase in the number of tracks. Therefore, only construct fire-lines where is the least environmental impact (direct and indirect). If you have tall canopy trees on your property, the fire-lines should avoid the overhanging branches of these taller trees. There is an increase in danger from falling branches causing injury in fire events.

Note: The 4 meter minimum width applies to machine constructed fire-lines, and **not** to hand-constructed fire-lines. It would be both too impractical and time consuming to build such a wide hand-line. Typically, a hand-constructed fire-line is usually only 1–1.5 m in width.

Allocation of Fire-lines – Ideally, fire-lines should be located to suit the surrounding vegetation types. Fire management plans for National Parks use this theory to separate their ‘burning blocks’ not according to access, but by the different vegetation types. The advantage of doing this is that the fire-lines help allocating the timing of the burning blocks in accordance to some ecological requirements, so it assists in increasing the variability within fire regimes. If you have a variety of vegetation types but they are of relatively small size, it may be worthwhile clumping these smaller areas together into one burning block until a minimum of 1 hectare blocks is achieved. Increasing the fragmentation of the landscape by installing too many fire-lines is an undesirable and unnecessary outcome. Remember that these areas (because they are smaller) can contain high biodiversity with a number of rare or threatened species.

An alternative option – the use of vegetation types for locating fire-lines was discussed for use and implementation for Brisbane City Council (Mark Webster, pers. comm.). This was not approved, but Brisbane City Council has decided to use fuel-moisture and Drought Index (discussed earlier) differentials to imitate natural conditions. The boundaries, therefore, remain *flexible* (important for biodiversity) and expand/shrink similar to natural systems and are changed by events such as fire.

You should consider which option is more appropriate for your property, but for smaller properties, Drought Index differentials to determine ‘natural’ fire-lines will be more suitable.

Use of Existing Infrastructure –The planning and construction guidelines for fire-lines can be exhaustive and expensive to implement. It is recommended that landowners use existing infrastructure as potential locations for fire-lines. These include fences/fence lines, property boundaries, vegetation boundaries (discussed above), and general geographic similarities (slope, aspect) for construction of firebreak or fire-lines.

Probably the most useful existing infrastructure that can be serve as a fire-line, are **roads** – as they are generally well trafficked, known to many people and regularly maintained. Roads have the width and clearance to be used for all types of fire-lines, and are the perfect areas to conduct back-burning or clean-up operations. If you are intending to use the roads near your property as fire-lines, please note that you are

required to provide appropriate notification and signage to warn drivers about the smoke and potential reduced visibility during the day of burning (other requirements are specified below).

A note about the use of roads as fire-lines. Most roads will be under the jurisdiction of your local government authority. Your local government may then have their own fire management plan in place with these roads, and with that will have their own conditions of use that you will be required to abide by. In your pre-burn planning, contact your local authority to inform them you are in the process of developing a fire management plan for your property which may incorporate planned burns. If the road/s you intend to use have no fire management plan in place, work with your local authority to develop one. Not only will this meet your objectives, it enhances cooperation with your council.

Maintenance of Fire-Lines – fire-lines will be **effective** if they are *properly* and *regularly* maintained. Overgrown and poorly maintained fire-lines will not stop fires, nor will they allow safe access to personnel, making the fire-line useless and dangerous. Fire-lines should be clearly marked on the maps that accompany your fire management plans, and prior to each fire season, they should all be checked to ensure that they remain in good working condition (eg cleared of vegetation, properly graded of adequate width etc.). Firebreaks should be maintained to reduce vegetation that may increase the rate of spread of fire or fire intensity. To determine if the width of the firebreak is adequate, picture the vegetation on each side of the firebreak lying flat – if this can link the two areas separated by the firebreak, then you may need to consider widening the length of the firebreak OR remove more vegetation. If you have ‘habitat’ trees on your property (large tree hollows, generally older trees), then these serve an important ecological role and should be maintained within reasonable fire-risk parameters. The fuel around all habitat trees should be removed to a 2 m radius. This should reduce the chances of fire reaching the tree possibly causing further damage. Other trees that will require additional clearing at the base are those ribbon-barked species (namely eucalypts) and young-hollow stage trees.

Rehabilitation of Fire-Lines – fire-lines should be situated in areas where they will be used on a semi-permanent or permanent basis. This requires good planning and local knowledge (your local Rural Fire Brigade should be able to assist you in this regard). If, in some cases, fire-lines are no longer required due to changed management requirements, these fire-lines will require rehabilitation. Most fire-lines are along cleared tracks that intersects property boundaries, and left unattended, the disused fire-lines will be extremely prone to weed infestations which may result in an increase of the area’s fire risk and loss of biodiversity values. Another undesirable outcome from abandoned fire-lines is the increase chances of erosion, which may affect water quality and loss of productivity. To limit these effects, a recovery plan for all decommissioned fire-lines should be initiated. Replanting with local native species, mulching and regularly watering and weed removal should be considered to return the area to natural conditions in areas where natural regeneration is likely to be inadequate. In time, areas previously ‘fragmented’ by these fire-lines will be ‘connected’ again, benefiting local biodiversity. It may be unfeasible to rehabilitate an entire fire-line. Areas that are prone to increased chances of erosion or weed infestation should be given priority.

Preparing Fire-Lines on Your Property

This section relates to Step 6 of the Individual Property Fire Management Planning Kit

It is important to prepare and maintain fire-lines on your property to ensure maximum efficiency. The following section describes different methods of constructing fire-lines in preparation of planned burns. As the previous section showed, the location of fire-lines is important not only for effective fire management, but also to limit erosion or risk of weed invasion.

Remember also that fire-lines and firebreaks can be naturally occurring features such as wet gullies, rainforest vegetation, and commonly are features such as roads, mown areas, dozed tracks or hand-constructed tracks. In complex terrain, such as steep, stony wet or environmentally sensitive or where there is limited time to use machinery, hand fire-line construction using trained personnel is an efficient system of firebreak construction (Gourley 1996).

You will note the in the terminology (below) there are references to fire-crews, bosses and fire leaders, which refers to a group within a fire-fighting unit (from the Rural Fire Service, or Dept. Primary Industries–Forestry etc.). Expert advice is recommended when preparing fire-lines, as these experts will also be helping you conduct any hazard reduction burning or fire suppression.

The following method is called the **“Step-Up” Method of Hand Fire-Line Construction**, and follows guidelines used in Level-1 Fire Training in a Manual written by Gourley (1996):

- It is the most versatile and efficient method of line construction for most fire situations, by ensuring a clean line of control is established when the last person passes any point.
- It is a safe method, as people are not passing one another with sharp tools, and are always well spaced apart whilst working.
- This method differs from previous methods in that each person maintains the same position in relation to other personnel throughout the line construction.
- It is named the ‘step-up’ method because the underlying principle is that each person on the line has a definite task to accomplish and will continue to work that section or until the person behind finishes and asks the next person to move (or step) up. Then, ALL the crewmembers will move forward to new ground.
- **SPACING** – usually 3 metres between each crewmember along the line location.
- **NUMBER OF CREW REQUIRED** – usually 5 to 6 people are required to operate efficiently. Work efficiency rates decline with larger groups, as the system becomes too complicated. Conversely, smaller groups also work less efficiently, whereas the 5–6 people that is recommended remains manageable whilst maintaining a good work rate.

PROCEDURE (assume 5 people in line)

- Leader walks 15 metres to starting point, number two person 12 metres, with the following people (numbers three, four and five) spacing themselves the required three metres apart,
- Once the crew line is out, work should begin simultaneously on order of the crew leader

- Everyone will work at a different rate according to a combination of personal physical condition and the type of terrain they are working in. This will invariably result in one or more people reaching the starting point of the person ahead before the rest of the crew can all complete the sections.
- When a person finishes the section, they call out “**step up!**”, where each person will then move forward one space to the next incomplete section of the line. The leader will move forward another 5 or so metres.
- This means any person behind the team leaders who has to move up will continue to work to complete the sections.
- When two people have completed their sections simultaneously, the first will call ‘up one’ and the second then call ‘up two’, which will trigger each person ahead of them to move up two spaces to leave some uncompleted sections for the two who are ready to move along...
- The last person in the crew must ensure all the sections in the line are complete and clean to a nominated standard. The Crew Leaders position must be allocated to an experienced operator to ensure the quality and effectiveness of the fire-lines.



Figure 5 – The ‘Step-Up’ method of fire-line construction (photo: Neil Gourley).

Things to note in the construction & location of the fire-line

Again, the key word here is **preparation**. By paying close attention to the location of fire-lines, valuable time and energy can be saved. Typically, the Crew Boss or leader will choose the fire-line location. Some points to consider in the location of fire-lines are:

- try to pick the easiest way through heavy undergrowth,
- keep to open spaces as much as possible, but do not wander offline too much,
- use natural barriers as much as is allowable. These include areas of very low fuel, breaks, streams, paths, roads, even areas of old burns. Prior planning and mapping will assist in identifying these areas, and may greatly reduce the amount of work required,

- try to avoid rocky areas, stumps, fallen trees etc. all of which will add to the amount of work required,
- steer fire-lines away from the most dangerous fuels (typically fibrous/stringybark and paperbark trees, any elevated fuels such as dead or flammable shrub layers, and dead or live hollow trees especially those that have elevated exit hollows that may form ‘roman candles’ or ‘fire/spark chimneys’, with the ability to throw sparks or spots over your control lines),
- avoid sudden turns and sharp corners in a line. Any sharp turns may increase radiant heat exposure at that point increasing the chances of spotover,
- Always ‘anchor’ the fire-line on a safe and sure fire barrier such as a stream, road, or area of low-flammable scrub etc.,
- Though this should not occur, if the location of a fire-line is required in going fire situations, good knowledge of the rates of spread, work-rate of the available crew, general topography and weather conditions is crucially important – to maintain safe control of your personnel and the fire,
- Avoid steep slopes,
- Avoid locating fire-lines across steep slopes, as falling/rolling burning material may easily cross this line.
- **Straight lines** are the easiest fire-lines, to patrol and monitor due to the ability to see clearly by one person over a distance, particularly at night.

WHAT’S INVOLVED IN MAKING A FIRE-LINE?

As Gourley (1996) explains, the job of preparing fire-lines consists of:

1. Cut and remove all shrubs, branches, small saplings, bushes, vines and other light material from the line for easy walking and raking. The minimum width of this clearing is one metre (1 m).
2. Raking all groundcover and ‘debris’ along the line down to mineral soil. All material should be raked and removed to the **OUTSIDE** of the line away from the fire. The width of this ‘rake line’ will vary from 0.5–1 m, depending on the heaviness of the fuel at that point.
3. If you have any heavy timber across the line, it should be cross-cut with a chainsaw or axe and rolled out. If this cannot be done, all loose bark and decayed wood should be trimmed off the log (**and underneath it**) to make it as fireproof as possible. If the break is 1 m in width, clear up and down the log for 1 m, therefore, a total of 3 m is now the width of the line at the log. If the log does catch on fire, it will provide added time for a cross cutting before the protected areas are also ignited (refer photo below).



Figure 6 – Fire break constructed to mineral earth, 1 m wide. At the log, break must be 1 m up & down on both sides of log, with loose debris on top and beneath the log to be removed. Photo shows litter beside log and only break constructed down the log. (Photo & explanatory note: Neil Gourley).

4. All fibrous bark tree and dead stags near the fire-line should be raked around and made as safe as possible to prevent it catching alight. Highly dangerous trees may need to be felled. Spread out the material that has been removed from the base of the trees so it doesn't impact (locally) on the heat intensity/flame height from the build-up of additional fuel. This is particularly important in areas involving slope (ie on the downhill side). For biodiversity conservation, it may be useful to do this procedure for habitat trees and other ecologically or culturally significant trees. Refer to figure-7 (below) for an indication of how to prepare tree-base cleared areas.

Note: It may be necessary to have a chainsaw operator to handle the removal of larger branches and trees. In fire-suppression activities, qualified chainsaw operators are essential members of the fire-crew, and serve an equally important role in fire-line preparation. The designated Crew Leader must coordinate all activities of the chainsaw operator and to notify the crew of chainsaw activities.



Figure 7 – Preparation around habitat trees or hollows. Provide at least 1 m wide mineral earth break surrounding with additional width on downhill side. It is important to remove litter from the base of the tree. (Photo and explanatory note: Neil Gourley).

A NOTE ABOUT FIRE-LINES AND EROSION

As Gourley (1996) importantly points out, fire-lines may be prepared by removing all litter and fuel down to mineral earth. This, can in some instances, lead to increased rates of erosion. As described above, the location of fire-lines is important to maximise efficiency and limit environmental damage. Cross-drains have already been described, the following information below is a guide for the spacing of these cross-drains according to the slope of the terrain where the fire-line is constructed.

The drains should be cut below the soil surface at 30° to the break, opening into vegetation which will allow free drainage. As a guide, Table 5 lists the spacings that should be adhered to depending on the slope of the land.

Table 6 – Cross-drain spacings based on slope

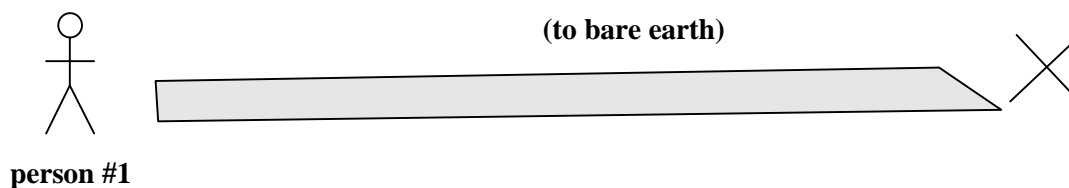
Degree of Slope	Cross-drain spacing
Up to 5°	Every 40 m
Between 5° — 15°	Every 30 m
Between 15° — 35°	Every 20 m

Remember: the crew leader/boss will help you determine the most appropriate position of the fire-line. They should be well aware of these cross-drainage spacings, but it is good for everyone to have a good knowledge of these spacing details.

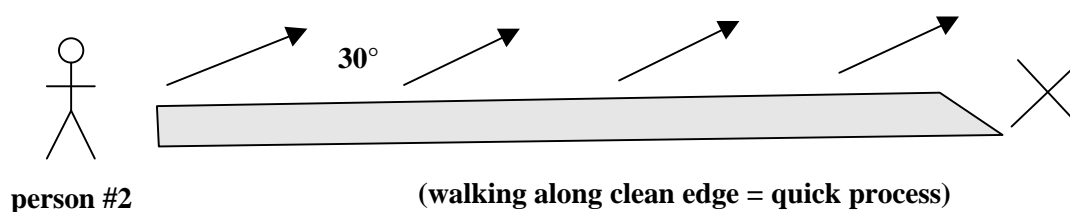
WHAT IF WE HAVE LESS THAN 5 PEOPLE AVAILABLE?

The fire-line preparation above requires a minimum of 5 people to be effective (though 2–3 people **can still do** the Step Up Method, but not as quickly...). If you have only 2 or 3 people available, then it is recommended you follow this method:

1. One person to make a bare-earth line. Continue fire-line preparation to designated end-point.



2. Second person to work off this clean-edge and increase width of fire-line by working at 30° to this edge. This increases the rate of fire-line preparation. This method is also known as the 'Daylesford Method'.



Note: the landowner can use an existing bare-earth path, such as a cow-trodden path etc.

Water Sources

Water is the most effective means of controlling a fire. It helps break the fire-triangle that we have discussed earlier.

Here are a few general guidelines to water sources and your fire fighting capacity:

- Locating the sources of water on your property is described in your Individual Property Fire Management Planning Kit (Step 1). It is a good idea to identify water sources according to seasonal availability of water, which is especially important in times of drought, where some water sources can dry up. Therefore, on your fire management maps, remember to list those water sources and dams where you can always source water and if possible, provide approximate capacities of these water sources.

Remember fire-lines also described access tracks to water sources, roads, escape routes etc. and are equally as important as fire control lines and fire-breaks. Ensure that an open, safe and easy access is maintained to all water supplies.

- You may wish to consider the construction of a dam (standard guideline is 10,000 L) for fire management procedures. This is an expensive exercise to undertake but will provide a reliable source of water in times of high fire hazard. You should know the contact details of your local water-carriers, include their phone numbers and availability on your fire management planning sheets.

Ensure your tanks have compatible coupling to suit Rural Fire Service's vehicles and appliances.

- Make sure those people attending your planned burn are well aware of the water carrying capacity of the vehicles they are using. Make sure these are recorded and verified by the Rural Fire Brigade–Fire Boss or Incident Controller.
- Make sure all personnel attending your planned burn know the exact location of all the water sources (providing a map to each person is highly recommended).

Weather Prescriptions for Low Intensity Burning

Remember that the objective of prescribed burning is to reduce the amount of fuel in the area by 70–75% and to achieve a 60–80% coverage of the area with ‘manageable’ flame heights with minimal amounts of tree scorch. To successfully fulfil these objectives requires good planning and a good degree of luck, especially in relation to prevailing weather conditions. It may seem that the opportunities for performing planned burns are limited. Indeed, this may be true as there are clearly outlined requirements on air-quality issues (namely smoke management) and prior notification (to Firecom etc.) which will need to be met before any burning is permitted.

However, in most cases, since your planned burns are usually small in size (limited to a few hectares), these burns will be allowed, given favourable weather conditions. It should be noted that if you do not achieve all the objectives of your planned burn, it may be possible to complete these objectives for a burn on the following day(s) (Please remember to ensure you have updated weather forecasts and adequate resources and facilities).

For most generic fuel reduction burning activities, the typical “window of opportunity” (adapted from the DPI Forestry Fire Manual the operational parameters) for conducting a planned burn are:

Table 7 – Operational Parameters for Burning in SEQ

PERIOD OF BURNING	May–August
DROUGHT INDEX	Wet Sclerophyll Forest: 50–75 Dry Sclerophyll Forest: 20–75
TEMPERATURE RANGE	22°C–30°C
RELATIVE HUMIDITY	30%–60%
WIND STRENGTH	1–3 Beaufort Scale (between 1–20 km/hr)
NB: Remember the 12–15km/hr threshold for wind speeds from Project Vesta	
WIND DIRECTION	SE–NE (no W. comp)
AVAILABLE FUEL WEIGHT	10–30 t/ha
BURN INTERVAL	Wet Sclerophyll Forest: min 7–10 years Dry Sclerophyll Forest: min 3–5 years
BLOCK SIZE	Wet Sclerophyll Forest: 2–5 ha Dry Sclerophyll Forest: 2–5 ha See Note (below)

* AIM FOR 60%–80% COVERAGE OF AREA DURING BURN

NOTE ABOUT BLOCK SIZE

This recommendation is only a guide. The size of the planned burn depends on many factors, not least of which is the area of your property. If your property is less than 2 ha, then you will need to consider involving your neighbours into the planning of the burn. Always remember to keep in mind the aims and objectives of your planned burn when considering the extent of your burn. In general, larger areas need to be burnt if your aim is to reduce weeds. Biodiversity related burns will involve longer fire intervals and larger block sizes. Cooperation between your neighbouring properties will also influence the extent of your planned burn.

The DPI Forestry Fire Manual recommends some variation in the **time** of conducting burns. The idea of conducting burns during this “late summer–autumn” period confers many advantages for both fuel reduction and ecological purposes. By alternating the timing of scheduled burns (from Winter to include Summer periods), increases the variability in fire intervals and regimes, a recommendation by Watson (2001) and others (Tran and Wild 2000, and references within), adds to the landscape level mosaic pattern, and permits safer burning conditions in wetter forest types (which typically contains greater fuel loads). Furthermore, burning at this time is favoured by the Department (Neil Gourley pers. comm. 2001) as opposed to burning in September–October when higher risk fire weather conditions can be expected, which may cause relights and possible severe damage to the forest, as well as compromising the safety of fire-crews.

Even though this late-summer/autumn burning schedule is favoured (see following table), it is not always possible to achieve. This is important to note if you have developed a multiple-burn schedule in accordance with neighbouring areas which prescribes burning a different area every year over a set number of years. The DPI Forestry Manual advises that this type of burning regime later in the season may only be possible once every five–seven years. If the September–October option is chosen, it is important to light some test-fires (see section ‘Preparation on Day of Burn’) to ensure the fire behaviour characteristics are within the parameters set out below. Furthermore, ensure that you have obtained an updated weather forecast information from the Bureau of Meteorology on the day of the burn to ensure a stabilised temperature pattern is established over the region. When this has been completed, the following operational parameters (table below) should be adhered to. It is important to recognise that expert local knowledge will be an important factor in the success of these planned burns.

Table 8 – Operational Parameters for ‘Late Summer/Autumn’ Burning in SEQ

PERIOD OF BURNING	Late January–April
DROUGHT INDEX	Wet Sclerophyll Forest: 25–75
TEMPERATURE RANGE	22°C–30°C
RELATIVE HUMIDITY	30%–60%
WIND STRENGTH	1–3 Beaufort Scale (between 1–20 km/hr)
NB: Remember the 12–15km/hr threshold for wind speeds from Project Vesta	
WIND DIRECTION	SE–NE (no W. comp)
AVAILABLE FUEL WEIGHT	10–30 t/ha
BURN INTERVAL	Wet Sclerophyll Forest: min 7–10 years
TIMING OF BURN & RAINFALL REQUIREMENT	Within 10 days of a minimum of 15 mm rainfall
BLOCK SIZE	Wet Sclerophyll Forest: Variable, but generally below 5 ha See Note (below)

* AIM FOR 60%–80% COVERAGE OF AREA DURING BURN

NOTE ABOUT BLOCK SIZE

This recommendation is only a guide. The size of the planned burn depends on many factors, not least of which is the area of your property. If your property is less than 2 ha, then you will need to consider involving your neighbours into the planning of the burn. Always remember to keep in mind the aims and objectives of your planned burn when considering the extent of your burn. In general, larger areas need to be burnt if your aim is to reduce weeds. Biodiversity related burns will involve longer fire intervals and larger block sizes. Cooperation between your neighbouring properties will also influence the extent of your planned burn.

You can see from these operational parameters, that in southeast Queensland, the acceptable times for burning cover late January to the end of August. There has been some emphasis on the ‘summer’ burning as per the parameters in the table above. This is an effort by DPI–Forestry to increase variability in fire seasons, and is also recommended for your property planned burns.

TIMING OF BURNS – POINTS TO CONSIDER

The operational parameters shown above cover the timing of the burns for southeast Queensland. However, we should point out that you should be mindful of the following factors and should be considered in planning your burn, especially if it is to achieve ecological objectives:

- (a) the known presence of rare or endangered species
- (b) the likely occurrence of suitable burning weather and the number of burns planned

- (c) the seasons that other recent burns in that (and surrounding) areas were conducted

It is important to emphasise that a diversity of season of burns in any one area should be maintained where possible to minimise the risks and impacts on breeding populations of small mammals and birds, in addition to any flowering plant communities.

In areas where particular rare or endangered plant or animals occur, find some information about their regeneration or breeding habits, so your planned burn will not affect them when there are young plants or animals likely to be severely affected by a fire. The Queensland Parks and Wildlife Service, Environmental Protection Agency, local Council bushland/environment officer, Greening Australia or a local Landcare or Bushcare group can help you with information on any rare/threatened species. One cannot make allowances for every plant or animal in the planning of a prescribed fire, and it is always wise to consider the overall community diversity. However, in the instances where your objectives are to provide suitable habitats for a rare or threatened species, then you will need to adjust your burning plans to suit their specific requirements.

When planning ecological burns, remember that season of burn is particularly important here. We have previously discussed the need for higher intensity fires to meet some ecological objectives. In southeast Queensland, the high-fire danger periods occur from October to mid-November. If you have planned a prescribed burn during this period, remember to take particular care and observe the upper limits of the Drought Index (DI) – which we have discussed in a previous section.

Timing is also crucial when fires can affect the safety and lifestyle of the residents. Remember to take high priority if you are planning a fire near public roads – where smoke and heat can be a safety hazard, eg if the road is a bus route etc. Use your forecasts from the Bureau of Meteorology to use prevailing winds, and the time of day to facilitate the best outcomes and restrict safety issues. Furthermore, be wary of any key times for residents when planning your burn, in particular if there are periods where more traffic is expected on the roads. Some examples include: public events, school holiday periods, school times, shows like the Brisbane Exhibition or other events.

The Fire and Biodiversity Consortium advocates the use of adaptive management in the preparation of any fire management plan. If you have planned a burn and for some reason it has not been conducted, consider moving it to another day, week – do not just shelve your plans...ie do not be tied into a strict deadline or schedule, and maintain flexibility. If your plans are not achieved in one day it is not considered a failure, it has only failed if your fire escapes (Neil Gourley, pers. comm.).

SUMMER OR WINTER BURNING?

In this section, we will provide some outlines to assist you in determining which season is more appropriate to conduct your burns.

- Remember that burning in winter means shorter availability of actual burning time hours. In winter, there is usually quite heavy dews which increases moisture uptake by the fuels (making it more difficult to burn, and achieving a lower than required intensity to achieve objectives). Actual burning time will vary, but generally ranges from 11:00am to 3:00pm.
- Burning in summer will usually allow an effective burning ‘window’ from 9:30am to 7:00pm.

- Keep in mind that the time between 1:00 – 2:00pm is the highest fire danger period, with higher temperature, lower relative humidity and changing wind direction.
 - Any fires lit prior to this time will CHANGE in behaviour, as this period is usually referred to as an ‘increasing hazard’ – where we know the conditions will worsen
 - A fire lit AFTER 3:00pm is seen as burning to a decreasing hazard as temperatures are reducing, with coastal sea breezes and winds are more easterly in influence, and fuel moistures increases with the relative humidity, which means better control measures.
- WINTER BURNING – lower temperatures, usually lower relative humidity and higher westerly winds, whereas in
- SUMMER BURNING – higher temperature, more stable relative humidity and calmer winds

SMOKE MANAGEMENT AND WEATHER CONDITIONS

‘Where’s there smoke, there’s fire’

As we have discussed, be aware of prevailing wind conditions and influences. During the months of September and October and into November, southeast Queensland is under a westerly wind influence, which commonly initiates the start of the fire season.

Burning in winter with its shorter burning hours and higher moisture usually produces more smoke and commonly, there are inversion layers which trap smoke in the early-mid mornings. Currently, most of the fuel reduction burning operations in southeast Queensland occur during this winter period, resulting in high smoke pollution that can be mixed with urban pollution. The Environmental Protection Agency has some strict guidelines with smoke management. When you are planning a burn, please take caution and note these circumstances.

Low Intensity Planned Burning

USE THE CONCEPT OF A MULTI-YEAR BURN SCHEDULE

You will have used the Individual Property Fire Management Planning Kit to develop a fire management plan for your property. We have already discussed the objectives of planned burns. In the development of your fire management plan, you will have assigned a number of different zones, whether they be property-protection zones or bushland-protection zones.

For those areas you have set aside for bushland protection, specific fire regimes will be required depending on their specific vegetation type. A number of documents which discuss the optimal fire frequencies in vegetation types that occur in our region are available. This information is summarised further above (Section ‘Vegetation Types–Outcomes from Ecological Guidelines’), but it is highly recommended that you obtain these documents for your own perusal. The Individual Property Fire Management Planning Kit uses the zoning pattern to identify **BOTH** property protection and bushland conservation zones. The list of products available from the Fire and Biodiversity Consortium is shown on the last page.

One of the important messages we are conveying is the idea of increasing the amount of variability (in terms of fire intensities and frequencies) in your landscape. This idea of variability extends to your burning schedule. We have recommended a number of ranges in the fire regimes for vegetation types occurring in southeast Queensland, eg 7–25 years for *Eucalyptus* woodlands with a shrubby understorey. For example, if the last fire in your bushland-protection zone was in 1994, then you may want to a planned burn in 2002, some 8 years since the last fire. If you do get to conduct the burn in 2002, then you may want to leave this zone free from fire for another 14 years, and then maybe 7 years (a wildfire may meet these objectives for you, so you will not need to plan a burn). Varying the time since the last fire creates more areas supporting a greater diversity of plant and animal species. The point here is to consider your burning schedule over a number of burning cycles, and not just till then next planned burn.

INCORPORATING UNPLANNED BURNS INTO YOUR BURN SCHEDULE

Fires will occur irrespective of our planning. If the necessary precautions are taken to ensure protection of your life and property, then this should not be considered as a ‘bad’ outcome.

Unplanned burns, namely from wildfires, and even events that are caused by humans should be used and incorporated into your burn schedule. This helps increase the variability within your fire regimes and frequencies (**NB:** It has been well demonstrated, too frequent fires are detrimental to biodiversity). While every effort will be used to control and suppress wildfires, consider that these fires may be achieving your objectives. If a wildfire burns your bushland protection zone in 1999, and you had planned to do a burn in that area in 2000/1, then there is no need for you to do a planned burn. Adapting your management plan to incorporate these unexpected events will be beneficial to your objectives of fire risk reduction and for conserving biodiversity.

INCORPORATING VARIATIONS IN WEATHER/RAINFALL INTO THE BURN SCHEDULE

As for the incorporation of wildfires and other unplanned fire events into your schedule, scheduling your planned burns to different climatic conditions will also be useful in creating

mosaic patterns in your bushland areas. This is particularly so for ecological burning rather than fuel reduction objectives.

Incorporating variations in weather and rainfall into your burn schedule should not be associated with extreme weather events. You will not be permitted to burn after a prolonged drought, as the fire danger and risk of escape is too great, nor would a fire be likely to burn following recent rains. Scheduling your planned burn at different times since the last rain or in a different season from your last burn will assist with improving the biodiversity of your region and is something you should consider in your planning process.

TYPES OF LOW INTENSITY PLANNED BURNS

1. Spot Burning or Small-Heaps Burning

This is defined as the burning of small patches of fine fuels without burning the general litter layer, peat or heavy fuels. SDI 5–20, litter moist, elevated fuels dry, weather conditions RH 40%, temperature < 20°C, wind speed < 15 km/hr, with Drought Index and FDR both: **low**.

This type of burning is particularly useful in *grassy* areas.

2. “Under-Burning” – The Most Common Application of Fuel Reduction Burning

This is defined as the burning of litter and other natural accumulations of fine fuels under trees and large shrubs (in all forest types) without scorching the trees. Achieving 75% coverage (varies from 70–80%) of the area is sufficient (remember: an area can be burnt in one or more stages—this is particularly important if resources, equipment and experience is lacking). Heavier fuels should not be burnt and the fires should go out at night. However, please note that this should not lessen your mop-up and patrol procedures of the burn area—remember a good burn requires good planning and obtaining up to date weather forecasts will allow you to be confident in using the weather to contain a fire. Caution should also be taken if the dominant understorey vegetation in the planned burn area is over 2–3 m in height. This may increase the chances of excessive tree scorch and less manageable fire behaviour, risking escapes.

Typical weather conditions are: RH – 40%, temperature < 25°C, wind speed < 20 km/hr, SDI 25–50 and FDR: **low**.

Medium–High Intensity Planned Burning

In some instances, fuel reduction is not the primary objective of a planned burn. There may be well-founded ecological reasons to burn a specific area. One of the products from the Southeast Queensland Fire and Biodiversity Consortium, is the 'Ecological Guidelines' (Watson 2001) which outlines recommended fire regimes from the existing fire-ecology literature. Details for obtaining this document are located on the last page. Depending on the specific vegetation type of your area, there are well-referenced suggestions on what fire regimes (minimum and maximum fire intervals) are appropriate to maintain the **overall** biodiversity of that community. If this is the case, low-intensity burning of the area may **not** be adequate to produce the required results. This is especially important in wet-sclerophyll forest types, where a common aim is to achieve a higher intensity fire to open up the canopy and initiate regeneration.

There are many other reasons for planning a burn to suit ecological objectives. These are more clearly outlined and discussed in 'Ecological Regeneration Burning' on page 19.

Planned burns designed to produce ecological outcomes usually require:

- some degree of high-tree scorch (aiming to open up the canopy, eg in the sub-tropical rainforests of Springbrook to rejuvenate the rare cycad *Lepidozamia peroffskyana*). This involves substantial risks which could lead to loss of control of the fire, leading to escapes, spotting and increased safety hazards. To achieve this high degree of scorch and fuel consumption also requires weather conditions which can also lead to loss of control of the fire.
- high consumption of fine fuels (included elevated fuels). Again, this requires suitable weather conditions to sustain rapid fuel consumption, and may lead to the loss of control of the fire.

Please remember that in some cases, low-intensity burns may be adequate to achieve your ecological objectives. There is no set rule which states that an ecological burn equates to the requirement for medium-high intensity fires. Usually, if you follow the guidelines set out in the Individual Property Fire Management Planning Kit, life and property protection is of utmost importance and your fire management plans should reflect this, but the other property protection zones (*FMP Sheet 1*) in your property should be reserved for conservation purposes. One point to note: Scorch Height = 7× Flame Height (eg a 1 m flame = 8 m Scorch, which can lead to aerial fuel removal), so in some cases, low intensity burns may reach your objectives.

With the risks involved in these types of burns, for most instances, these burns will **not** be permitted (a requirement of the Permit-to-Light notification system) due to the increased dangers and risks. Therefore, if you are planning this type of burn:

- **NEVER ATTEMPT** to implement this type of burn as you would for a low intensity burn, and
- it is **ABSOLUTELY ESSENTIAL** to always refer and consult an expert in the planning and implementation process. Inevitably, you will need these experts on hand to assist with the burn.

Many property owners wishing to conduct ecological-related burns are likely to share their property-boundaries with larger conservation areas, state forests, gazetted National Parks or other similar areas. Areas such as National Parks, some State Forests and council-controlled

conservation areas will already have existing fire management plans. Ensuring that you are aware of the relevant authority's plans for burning would allow your own plans to be included and a **coordinated** approach to be achieved. If you have a Land for Wildlife property, then your local Land for Wildlife Officer, or local council can assist you with coordinating ecological burns.

During consultation with the appropriate experts, ensure you are well aware of the need for the different operational parameters (ie different burn times, extent etc.) which may apply to your area and the necessity to have adequate resources and personnel available.

In the planning process for these higher intensity fires, it is absolutely essential you have:

- identified the location of fire-lines and fire-breaks (if escapes occur in these more heavier fuel vegetation types, then fires can be very difficult to contain),
- a back-up plan for emergency situations. The chances of escapes are increased and so you will need to have made enough contingencies for these situations.

Another thing to consider in the planning of higher intensity burns is the location of previously burnt regions. If an area adjacent to your planned burn was burnt (either through prescribed burning or wildfire) then this will provide an ideal 'firebreak' and edge for your burn. With a reduced fuel load and hazard, the likelihood of escapes is further minimised and you will have a good firebreak edge to conduct this type of burn.

We have covered the aspects you will need to consider in planning a burn for your property. The key point we have emphasised is **preparation**. Ensuring you have the latest details on weather forecasts, the location of fire-lines, water sources and escape routes and fall-back plans/areas and that you have consulted the appropriate experts are all essential elements for a successful burn. There are a few more items you must attend to, before you light any fires. The next section covers these remaining items...

Preparation Prior to Day of Burn

There are a few essential steps involved prior to conducting a planned burn. These include:

1. Obtain burning permit from the local Rural Fire Service Fire Warden
2. Review your Fire Management Plan that you completed using the Individual Property Fire Management Planning Kit.

Ask yourself...

- Has a fire occurred in the area, so that a fire is now not required?
- Does your fire fit in with the recommended fire regimes for that vegetation type?

3. Ensure all necessary equipment and people are available and both in good working order!
4. Contact neighbours to inform of intent to burn (as required by the Permit)
5. Conduct edge burning if specified in the burning plan. Edge-burning involves lighting the area immediately bordering your fire control lines, to provide added buffering capacity, and to decrease the chances of escapes. Perform this task as you would for a spot-fire, but extended along your fire-lines.
6. Obtain latest weather forecast information for day of the burn.

YOUR APPROACH TO BURNING

We cannot stress enough that meticulous and professional planning is needed well before any burn is actually lit. The Coronial Inquiries into the deaths of New South Wales – National Parks and Wildlife Service staff (the Ku-Ring-Gai Chase National Parks fire) and the Victorian Country Fire Authority volunteers near Linton, and its consequent recommendations showed that poor planning and inadequate preparation (such as maps) were contributing factors to their deaths. Do not 'relax' just because your planned burn will be a lower intensity fire (and therefore considered less dangerous). As we have discussed, even the slightest changes in fire weather can lead to large changes in fire behaviour ... do not let complacency from any person involved in the fire become the cause of any serious accidents.

This should be the approach you should take to all burns and all the aspects involved in the burn. Otherwise, an inadequately planned or poorly executed burn may cause one or more of the following problems:

- adverse reactions from the public and adjacent landholders,
- **EITHER** excessive scorch, crown damage and reduced growth, **OR** insufficient fuel reduction,
- unnecessary bole (stem/trunk) damage,
- increased risk of escapes, and
- pose danger to lives and property

Remember, **you** are responsible for any fires using the Permit to Light system. **You can be liable** for any costs incurred for suppressing fires that escape or cause damage to other property/assets.

SAFETY ISSUES

Remember that safety always starts at the planning stage and ends when the burns are completely out. Your planning of the burn should identify areas where there are public risks and the appropriate agencies to be involved in the planned burn to ensure maximum safety. This should be emphasised: **ALWAYS THINK SAFETY!** To ensure this is done, the following actions must be undertaken:

- (a) Notification/warning signs must be displayed in areas planned for burning at least 2 weeks prior to the expected ignition date (we acknowledge this may be difficult to arrange such an advanced warning time, but try to provide as **MUCH** time as possible of the planned burn). For example, this could in the form of a letter to all neighbouring properties that states your permit allows a burn between eg May 4–May 16 and that you have made preparations to burn between these dates etc.
- (b) On the day of the burn the area must be thoroughly checked to ensure no other people other than the fire-crew and helpers are present in the burn area. Check that signs are placed to warn of smoke hazards where they are necessary.
- (c) Familiarise each person present with the burning plan and the area to be burnt. Provide each crew leader (if any) with a copy of the burning plan and map,
- (d) Point out significant features in and near the burning unit such as swamps, creeks, steep or rocky slopes and water sources,
- (e) **NEVER** send people into dangerous places; such as steep slopes, areas of high fuel loads or difficult access, or areas where fire are burning *below* them
- (f) Ensure all crews know the escape route and fall-back areas,
- (g) Consider any likely wind changes (this is where updated weather forecast information is vitally important to obtain) and the possible effects of fire behaviour.
- (h) Give **CLEAR** and **CONCISE** instructions at all times and ensure the chain-of-command is well defined in the briefing and made known to all participants, and
- (i) Maintain **COMMUNICATION** throughout burn process.
- (j) Ensure you have the **proper protective equipment** (clothing etc.)
- (k) **Maintain safety at all times!**

INSPECTION OF AREA(S) TO BE BURNT

There are many aspects to consider and map **well in advance** of the burn, and these include:

- (a) TYPES OF VEGETATION AND THEIR EFFECT ON FIRE BEHAVIOUR – particularly any types that may produce adverse fire behaviour such as spotting or high intensity fire.

- (b) ACCEPTABLE SCORCH HEIGHTS and areas of young (less mature) trees/shrubs which would require lower intensity fires. These less-mature areas may be adversely affected with a fire, so ensure your plans define these areas clearly, and where scorch heights are higher than acceptable, then appropriate action (ie extinguishing the fire) will be required etc.
- (c) FUEL QUANTITY AND DISTRIBUTION: Assess the area for your prediction of fire intensity and flame heights. As we have explained, scorch height is approximately seven times flame height (×7). Flame heights can be accurately estimated using the table on the back of the Forest Fire Danger Metre.
- (d) DANGER AREAS, which may be due to extraordinary fuel quantities or arrangements, dead trees, overgrown tracks etc. If there are overgrown tracks, you will need to manually clear these to provide a safe fire line for personnel and equipment.
- (e) 'PROBLEM EDGES AND BOUNDARIES' which could include boundaries that are located at the top of steep slopes or boundaries adjacent to areas of regeneration, fire-exclusion areas, plantations etc.
- (f) LOCATION OF INTERNAL TRACKS/ACCESS
- (g) STEEP SLOPES
- (h) TEST FIRE SITES: it is recommended to light a test fire before the main burn in an area **REPRESENTATIVE** of the whole burning unit. However, in some instances where conditions may be highly variable, or where there is a particularly sensitive area to be burnt then more than one test fire is required.

*Selecting a test fire site is not easy...but it should be **representative** of:*

- (1) ground and aerial fuels;
- (2) fuel moisture on the day. Generally, gullies will be moister and ridges drier; and
- (3) general geography such as aspect, slope and exposure to sun and wind.

This is one area where your local knowledge and experience will be extremely valuable and useful in selecting test sites.

Furthermore, test sites should be located at least 20 m away from roads and tracks to limit the influences of edge-drying effects. Test fires should also be located within an area where the fire can be easily extinguishable if the conditions do not permit the main burn to proceed.

PREPARATION OF BURNING PLANS

The map(s) prepared during your detailed assessment of the burning unit will be used in the preparation of the 'burning plan'. The burning plan should cover the following details:

- (a) GENERAL DESCRIPTION OF BURNING UNIT AND ADJACENT AREAS. This includes geography (topography, slope and aspect), vegetation type(s), ground and scrub fuels, tracks and boundaries. This should also include adjacent areas, should emergency procedures be required.

(b) LIGHTING METHOD:

These options include:

- handlighting
- aerial lighting with fixed wing aircraft or helicopter (uncommon in southeast Queensland, but it does happen). This would occur when large areas (eg 1000 ha) will be burnt (or in steep and dangerous terrain). The objective is to complete your burn in 2-hour window, so for these areas, aerial ignition is needed. Large costs are involved with aerial lighting.
- one, two or more stage burning (only in large planned burn plots)

(c) WEATHER CONDITIONS. Within the burning guidelines outlined in the weather prescriptions section (page 32) there exists a considerable flexibility in the range, where ‘hotter’ burns can be achieved by ensuring all weather parameters are at the top end of the range, whereas ‘cooler’ burns can be achieved by selecting conditions at the lower end of the range.

(d) CREW AND EQUIPMENT NEEDED

The size of crews required at the burn can be gauged from the following guidelines:

Edge Lighting: 2 or 3 people/500 m/hr

**This is adequate only for GRASSY areas;
In FORESTED areas, the crew would be:
2 or 3 people/200 m/hr**

- these are only a guide and will vary according to fuel, wind speed and weather conditions
- the number of people required at the fire will be specified in your Permit, so abide by those requirements also

The following equipment will be required at burning operations:

- latest weather forecast from the Bureau of Meteorology, or weather kit (desirable).
- drip torches, fuel and matches
- fire fighting tools (see section ‘Other Important Information’)
- tanker(s) (if applicable) plus operator(s)
- First aid kit (see section ‘Equipment Checks and Repairs’)

(e) LOCATION OF TEST FIRE(S)

Indicate on the map the location and extent of test fire sites. On the map, also state the time of proposed lighting (typically around midday), the maximum acceptable flame heights (usually 1 m) and the rate of spread (ROS), below which the planned burn will not proceed.

ARE THE WEATHER AND FUEL CONDITIONS SUITABLE TO BURN?

You will have already read how much influence the weather conditions have on fire.

Make sure you have an updated forecast from the Bureau of Meteorology. Ensure these forecasts are within the limits recommended (previously discussed) in the prescriptions for burning. If any of these variables are outside the recommended guidelines, do not proceed with the burn.

If you have the necessary equipment available (thermometers, hygrometer, anemometer etc.) on the morning of the planned burn, ascertain and record the prevailing conditions of temperature, relative humidity and wind-speed. Use these forecasts or newly recorded information to determine if the weather conditions are appropriate to conduct the burn safely and effectively.

The type and arrangement of fuel is another critical factor in determining a 'good' time to be conducting a burn. The figure below outlines a simple, effective way to test that the fuels are in the right condition to perform a prescribed burn. It is known as the 'Single Leaf Test' (see figure 7, below).

PROCEDURE

1. In a sheltered area away from wind, light the end of a dead leaf (sometimes you can act as a shield to wind)
2. Once lit, take ignition source away.
3. The main aim here is to discover the angle at which a small flame *neither goes out nor flares up*. Refer to Figure for further descriptions.

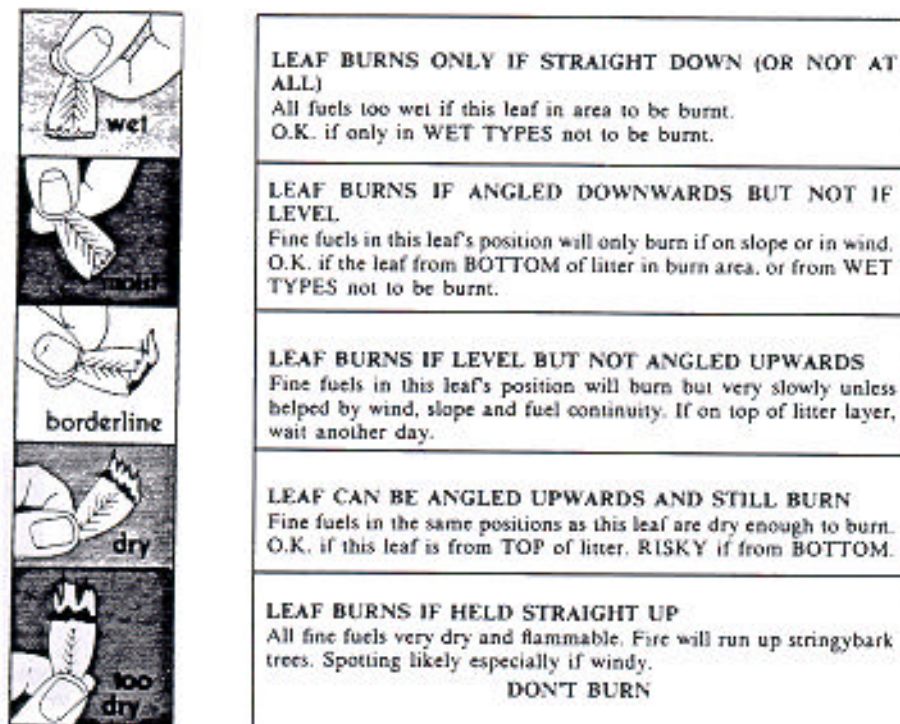


Figure 8 – Single leaf tests for flammability. (Adapted from Tasmania Parks and Wildlife Service 1998).

Procedure on the Day of the Burn

TIME	FUNCTION/PROCEDURE
0700–0800	<ul style="list-style-type: none"> Phone Bureau of Meteorology for weather forecast and ‘further outlook’ forecast. The Bureau’s Weathercall (Voicecall) number for the SEQ Forecast is [1900 969 929], and the Weather-by-Fax SEQ Number is [1902 935 272] or on the Internet [http://www.bom.gov.au]
OR	
<u>Day Before</u>	<ul style="list-style-type: none"> Modify burning plan to suit prevailing weather conditions if necessary
THEN	<ul style="list-style-type: none"> Confirm Permit (using Permit to Light from RFS) Inform neighbours, police, rural fire authorities etc. Check proper operation of all equipment Take first-aid kit and ample drinking fluids Check boundaries for fallen trees and those defined by vegetation type and fuel moisture content to have a suitable fuel moisture content to facilitate burning according to objectives Use a wet and dry bulb thermometer and monitor temperatures and relative humidity throughout the proposed burn Brief people involved in burn on command structure and the burning plan After 1030 – Phone Bureau of Meteorology for updated weather forecast. The Bureau provides a precise update after this time.
Remember: Use a timing appropriate to your objectives... – for self extinguishing fires – perform your burn in the early evening – for hot fires, be <u>prepared</u> and early eg: 1100–1200	<ul style="list-style-type: none"> Light <i>test</i> fire as a 3 m line along the contour (or across wind direction). After 15 minutes, measure the flame height of the head fire (refer notes above). If it is too high (typically over 1 m) STOP. Consider postponement until after 1300 hrs or another day Typical Rate of Spread [ROS] of test-fire is <u>50 m/hr</u>. Test fire ROS above <u>80 m/hr</u> is too high. STOP and Reconsider. Measure the Rate of Spread of the test fire over a 10 minute interval AFTER the initial 15 minute build up period From the table (below: Spot Fire Spacing Calculation Table) estimate the spacing between spot fires for the main burn. Recalculate spot fire spacing every hour until lighting is complete <p>NOTE: This depends upon the size of the area to be burnt. Larger burns will probably require you to do a test burn earlier, though under the Permit system, there will be NO burning before 1430.</p>
DANGER	<ul style="list-style-type: none"> Do not reduce the calculated distance between spot fires (unless the actual rate of spread is much less than the test fire indicates). Spots lit too closely along a contour will quickly join up to become a line of fire. The part burnt by the headfire rises from one third to five-sixths or more of the area. Head flame heights may double and fire whirlwinds will occur as two spots join up (known as the Junction Zone Effect). This will lead to unacceptable high levels of scorch and control of fire may become difficult. Start edge burning (if applicable)
1300-1400	<ul style="list-style-type: none"> NOTE: REFER TO PERMIT – In most cases, you will not be permitted to burn before 1400 [after the peak of fire-hazard]. <p>Light DOWNHILL [ie start at the ‘worse’ area and burn to ‘easiest’ area] edges and ridges, if not previously burnt, using close spaced spots or line of fire close to the top</p>

TIME	FUNCTION/PROCEDURE
In COASTAL areas, wait for the sea-breeze	<ul style="list-style-type: none"> ◆ Start Main Burn. Use grid of spaced dots, as per lighting plan ◆ Aim to complete burn plot within TWO/THREE HOURS of starting mains burn. ◆ Patrol area!
In INLAND areas, wait for the temps to drop	<ul style="list-style-type: none"> ◆ Mop up! ◆ Patrol area!
Eg: 1400–1800	
NEXT DAY	<ul style="list-style-type: none"> ◆ MORNING – Patrol and continue mop-up. The high dew in the morning assists with control procedures ◆ MIDDAY – Continue patrol until all fires are completely out
Other Days	<ul style="list-style-type: none"> ◆ Patrol and continue mop up until ALL fires are completely out

POST-BURN FOLLOW-UP

- (a) Patrol, patch out and mop-up as soon as possible. Patrol!
- (b) Check each dry day until fire is completely out

Continue to do this for a minimum of 48 hours after the burn
- (c) Check your burn-plan records. Did the burn achieve your pre-set outcomes? Update your burn schedule to suit these objectives.
- (d) Record the burn on your Fire Management Plan from the Individual Property Fire Management Planning Kit. Update your maps and supply updated Fire Management Plan to Rural Fire Service.

Conducting the planned burn

Remember, the purpose of the burn is either to reduce fuel loads or for sound ecological purposes. It is also important to note that these procedures cannot fully eliminate fires. Planned (also known as prescribed or controlled) burning is effective in lowering the risk of higher intensity fires occurring (as there will be less fuel available and lowered chances of fires reaching the canopies) and are the safest areas to contain wildfire but this does not mean fires won't occur in the area following planned burning. This is an important distinction worth noting.

Lighting Patterns

The manner in which a fire is lit will dramatically affect the rate that it covers an area and the “damage” it causes. Ideally, the fire should be slow burning and of low intensity to minimise damage and also burn out to safe boundaries on the day of lighting minimising the chances of a fire escaping. In general, for areas one hectare or larger in size, the one fire cannot do both.

Outlined below are a few methods for lighting fires with associated diagrams to illustrate the advantages and disadvantages of each method. Consultation with an appropriate expert, such as a member of the Rural Fire Service, is useful to help determine which type of lighting is most suitable for your purposes.

1. **Single Spot Fires (ideal for TEST FIRES)**

As mentioned, single spot fires make ideal ‘test fires’. Note that the fast-moving head-fire has the highest flames but that the back-fire and the two side-fires together account for two-thirds of the area burnt.

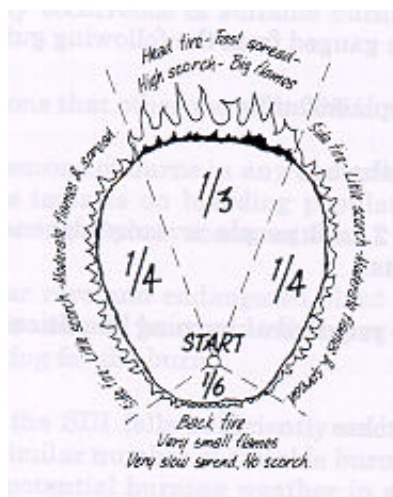


Figure 9 – Single spot fires (adapted from Tasmania Parks and Wildlife Service 1998)

If you intend to use the spot lighting method, then it is often a much safer and cost effective option to use ‘Fusee’ matches – with no need to use drip-torches, which can exacerbate the extent of planned fires.

To determine the spacing requirements of your spot fires, please consult the following table:

Table 9 – Spot fire spacing calculator

SPACING OF SPOT FIRES (METRES)					
Available Time (hrs)	Rate of Spread of Head of Test Fire (m/min)				
	0.2	0.4	0.6	0.8	1.0
1	10	20	30	40	50
2	20	40	60	80	100
3	30	60	100	130	160
4	40	80	130	170	220
5	50	100	160	220	270

It is important to recalculate the spot fire spacing every hour until lighting is completed.

Also note – all planned burns should be completed within 2–3 hours of initial lighting.

2. Line of Fire Straight Down Spurs

This method is suitable for areas where any head-fire is likely to cause unacceptable scorch. It is not widely used, as the main concerns are that any sudden wind changes could turn it all to head-fires. For this reason, it is only recommended on relatively calm days (Low Fire Danger Index). When successfully implemented, 90% of the area is burnt by the side-fire. Flame heights and rates of spread can be partially controlled by the rate of lighting down each spur.

A safety warning: be wary of crossed spurs when lighting! This means you need to have good mapping and communications. If you have more than one lighter, watch for each other smoke pattern from their fires and keep a watch on their lighting patterns (speed etc.)

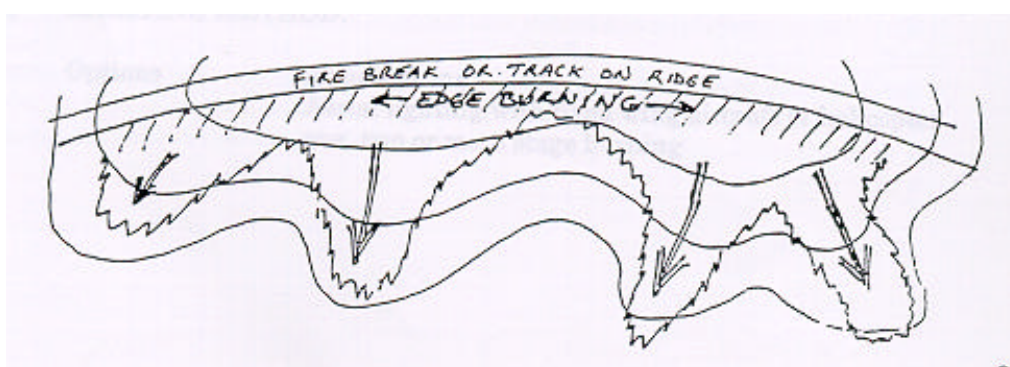


Figure 10 – Line of fires down spurs.

3. Line of Fire (or ‘closed-spaced spots’) across the slope (or on the flat)

This method is best employed along ridge tops to reinforce an uphill fireline where the head-fire will die because of lack of available fuel, and the back-fire moves slowly downhill^{NB}.

NB: It is not recommended to light a line of fire at the foot of a forested slope because this will maximise the scorch and other possible damage, in addition to increasing the risks of escape as

the fires race up the hill. This is known as 'Lazy Line' lighting, and should only be used in circumstances where;

- (a) there is nothing to scorch,
- (b) there are light winds, or
- (c) there is only a short run to a good firebreak
- (d) keep in mind, the safety of your lighters!

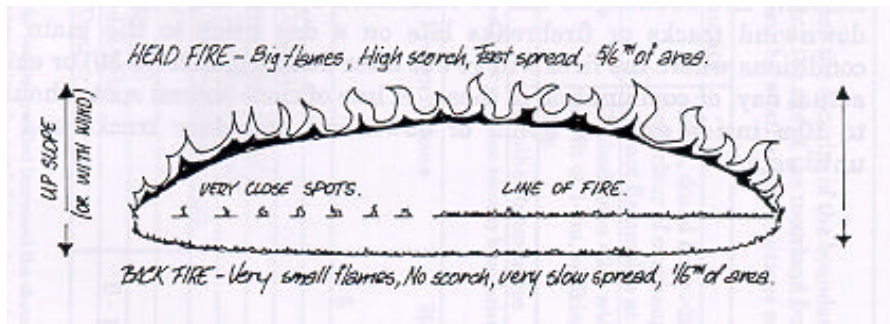


Figure 11 – Line of fires across slopes

4. Well-spaced spots (for all large burns) – also known as the Forward Burning Technique

Spots spaced so that they only join up as their flames die down in the evening are ideal lighting patterns for covering an area in one day. The pattern is usually a square grid. The row of spots furthest up the hill is always lit first with successive rows of spots downhill and parallel to it. Ideally each row follows one contour. Where the wind is significant on the day, particularly in flat or undulating country, light the downward edge first to prevent smoke obscuring your vision.

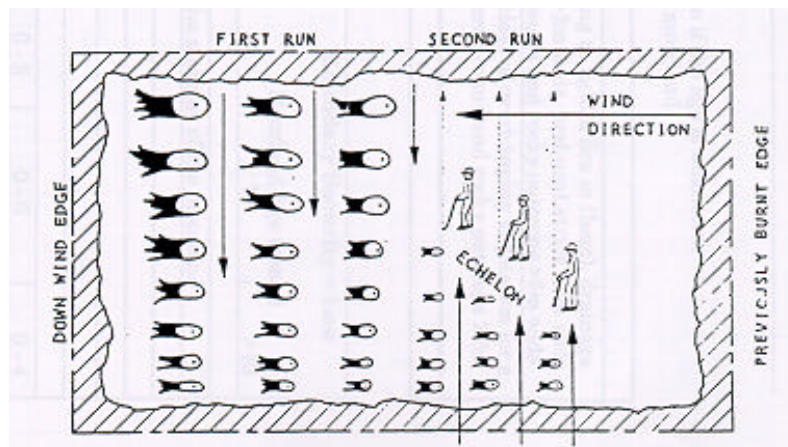


Figure 12 – Fires for well-spaced spots (Forward Burning)

5. Grid Ignition Technique

As Gourley (1996) explains, this is the favoured technique to achieve a mosaic of burnt and unburnt areas. As the name suggests, fires are lit in a grid pattern at some predetermined spacing. The spacing of the fires is dependent on factors such as fuel loads, wind velocity, humidity and air temperature. With this burning technique, the aim is to complete the burn within 2 hours of initial lighting (Gourley 1996).

This burning technique is very similar to figure 10, where the difference is the determination of spacings between the fires, which then depends on the objective of your mosaic burn and your vegetation types.

Burning Operations Guide

The following procedure is for conducting a burn to suit southeast Queensland conditions, according to Gourley (1996).

Who should light?

The actual lighting of the fire should be conducted by an experienced person with a detailed knowledge of fire behaviour, and is knowledgeable enough to use the topography, fuel and weather conditions to their advantage.

When to light?

As we have stated above, lighting should only occur in the mid-afternoon, after the test fires have been lit and the results deem that the fires will be safe to proceed with. Remember, the peak times for hazard lies between 12:00 pm and 2:30 pm (with 1–1:30 pm the highest hazard). Lighting the main burn after the peak hazard period will allow for more stable conditions and weather patterns, with wind direction in southeast Queensland coastal areas predominantly easterly which provides higher relative humidity. There is also a reduction in temperature and as the afternoon progresses, the wind usually drops with some dew to assist with maintaining sufficient fuel moisture content. Lighting a fire after the main peak in fire-hazard also means that any flare ups will occur early so control will be easier as the fire will be smaller (because the fire has only just started).

The key word when lighting up is patrolling. You will need to keep a close eye on the progression of the fire, and to ensure there are sufficient staff to monitor each zone to mop up and to prevent spot fires and escapes. In particular, these staff should be stationed to monitor the initial fire zones. At the initial fire lighting edge – the most vulnerable point for spot-over due to flame height and width of the fire-line – at least one person is required on foot (with the assistance of a vehicle mop-up unit if available) for patrol and monitoring (Gourley 1996).

Personnel are also required away from the initial firing zones to monitor and patrol. Fire-fighting units from the Rural Fire Service, DPI-Forestry, QPWS are also needed if your neighbouring land is under their control. It is always important to seek expert advice in your burns! Typically, the minimum number would be the vehicle (with 2 people) and an additional 2 people on foot.

Gourley (1996) points out that with any burning, it is the intention to use existing firebreaks, whether they are natural (creeks, moist vegetation types etc.) or prepared (roads, tracks, constructed breaks, dozer/hand lines) as much as possible, without the need to construct new fire-lines. Remember to remain in control of your planned burn, even if a fire has escaped. For fires that have escaped, send fire-fighters after it (if you have enough personnel), but the burn area **MUST** be completed before it can be deemed safe.

To reiterate the important messages for the correct burning procedures:

- Always burn from the top down
- Be aware and watch for sudden wind changes (these have been the main cause of deaths for fire-fighting personnel)

- Be aware and identify close burning trees/stags (especially those close to fire-lines)
- Be aware of topographic features that may influence local wind direction
- PATROL PATROL PATROL!
- Don't hurry the burning process – this only increases the heat intensity
- “Be patient, be skilled, be aware of changes (fire behaviour or meteorological), be prepared, have an alternative strategy if things go wrong...be planned!”
- A continuous burnt edge is essential against the break to eliminate the risk of a possible run lower in the fire from running back and spotting over
- Ensure you have done the proper pre-fire preparation – the person lighting the fire should carry a rakehoe to clear around trees susceptible to catching fire on the edge of the fire-line. Raking the litter around trees vulnerable to lighting or are habitat trees you want to keep will reduce patrol/mop up time, and the initial chances of spot overs quite dramatically.
- If an area to be burnt is not large (which would apply to most landowners), the leader should be aware that the backburn face of the fire will progress across the area and may lead to the other side of the area. This will occur with changing wind conditions, topography and time of day. It is important that this other edge and protected areas are monitored as the fire progresses to limit spotovers and escapes.
- Remember that in all planned fires to ensure you have secured all edges and breaks and to employ the ‘grid ignition system’ to burn out the area if time (or lack thereof) is an important criteria.
- As we have previously mentioned, it is absolutely essential to keep and maintain detailed fire management maps of all fires, whether they are planned/prescribed or wildfires. This will assist you for planning for wildfire suppression tactics in addition to any future planned burning of blocks where any schedules may have been altered (Gourley 1996). In addition to size and extent of recent fire, weather details and fire observations are also to be kept.
- This obviously depends upon the **severity** of the wildfire. Your local expertise and judgements will assist you greatly in determining the best way to handle the situation. Advice from the Rural Fire Service should be sought and adhered too.
- From experience, the fire that **YOU** light is probably the one that will escape, not fires coming into your property. Remember these fires should be under your control.

If a fire escapes (also known as a ‘breakaway’ or ‘spot-over’) occurs, as we explained on the previous page, complete the burn, and send fire-fighting units to contain the spot-over. However, if the escape is minor and will not require significant resources, continuing lighting may be the best option to minimise the size of the escape fire. Seek professional opinion from the Incident Controllers or other senior officials at your planned burn to decide the best course of action if a fire has escaped from your planned burn. The recommended option is to halt all lighting, suppress or contain the escape fire, reassess the situation (ask yourself, what caused the escape, was there a change in the weather conditions, are your fire control lines coping etc.) before relighting. It is dangerous leaving a high intensity fire burn to its own devices, whereas in most cases, low intensity fires are ok to self-extinguish, but remember to make sure it is being watched.

NEVER PERFORM ANY PLANNED BURNS FOR WILDFIRE CONTROL — In the event that a wildfire is approaching, do not attempt to backburn to control the fire...call 000 and ensure you are properly prepared for the oncoming fire. The Rural Fire Service will decide if backburning is required. If you are a member of the local Rural Fire Brigade, then you can assist and provide vital expertise to control the fire. If you are not a member of the Rural Fire Brigades, remember to consult your Fire Management Plan that you developed using the Individual Property Fire Management Planning Kit (*Step 7 and Fire Management Plan Sheet 4*) to ensure you are properly prepared for the oncoming fire.

Mopping up and patrol

The key word again is preparation. If you have prepared the property thoroughly enough, the amount of mopping up, which covers all the procedures required to render an area safe, will be minimal.

Mopping up is an essential and critical aspect of the planned burn, especially for many forested areas and great care and skill is necessary for it to be completely successful. And its an area of fire control which is **“difficult to impress the importance of this operation on even trained staff”** (Gourley 1996).

The procedure of mopping up may carry on for many days after the initial timing of the planned fires depending on the current weather conditions. This is important in times of high drought index when larger pieces of vegetation (such as logs, stumps) can catch fire and continue to burn. In areas with high amounts of decomposing plant material, such as peat swamps, fire may smoulder for days, sometimes weeks, and could cross into unburnt areas.

As Gourley (1996) states, in many instances where fires escapes from an area in which a burn has been properly conducted and controlled and meticulously prepared are caused by poor mopping up standards.

When the fire has stopped, the perimeter must be secured. The width of these strips where total fire extinction is needed varies according to local conditions. It is usual to deal with ALL smouldering or burning material within 10 m of the fire-line and to treat only the more dangerous hazards within 100 m or possibly more on steep sloping ground (Gourley 1996).

While forest fires will require more attention than grass fires, smouldering material close the perimeters of ANY fire should be thoroughly mopped up. The following points should be attended too:

- Mop-up could closely follow initial lighting up – but we recommend you save your resources for any possible escapes (there is no use using up valuable water or mop-up when a spot-over occurs). Commence mop-up once lighting is finished. Remember to **PATROL, PATROL and PATROL!**
- Water and earth can often be used to cool down material sufficiently to permit handling,
- The spreading of piles of fuel will help reduce heat, making mopping up quicker,
- Some fuels may be allowed to burn out of they do so quickly and safely,
- Small branches and logs should be dragged well back inside the fire-line. Rakes, axes, saws and levers can be used to make this procedure more efficient,
- Longer pieces of fuel too heavy to carry should be rolled around so that they lie up and down hill slopes,
- If small pieces of plant material are likely to roll downhill, trenches should be dug,
- Stags, rotten logs and stumps will require additional treatment especially if close to the fire-line (this may involve use of foam retardant, additional clearing or complete removal). Extreme caution is necessary felling dead or hollow trees and should only be undertaken by qualified operators,

- If complete extinction of such material is doubtful, it is wise to widen the fire-line at this point, or construct a ‘backstop’ trail connecting to the main fire-line,
- Roots burning underground are dangerous (much like peat fires) and will require digging up or other suitable treatment (such as considerable use of water etc.),

Remember we previously mentioned the importance of the Drought Index to assist you with controlling fires in roots.

- In some cases, it may be necessary to wet down or cover with earth flammable fuels on the unburnt side of the line. This is where the use of ‘backstop’ fire-lines may be useful,
- Watching for ‘spot overs’ is an important duty for all mop-up crews,
- For safety and economy, water should be used to cool down the fuel to allow further handling and separation,
- A cool fire edge is essential. The only real test for signs of heat at possible danger points is by checking with the back of a bare hand,
- Pay close attention to hollow logs close to the edge which can funnel and act like a blow torch, possibly sparking across to unburnt vegetation,
- You may wish to maintain hollow logs for conservation purposes, and if this is the case, then be sure to provide additional treatment to these logs with wider clearing and the use of water where necessary. Otherwise, hollow logs which are alight can act like a fire funnel or ‘Roman candle’ sparking across into unburnt vegetation.

Constant patrolling is the key here. Once the perimeter has been mopped-up, patrols are necessary to ensure the fire-lines remain secure. Patrols and mop-up are intricately linked together (Gourley 1996). Once mop-up is complete, only smaller crews are required to deal with any problems which may arise. If the weather conditions are favourable, the frequency of patrols may be reduced.

Even though the work of any mop-up and patrol is mechanical, dirty and monotonous (Gourley 1996), it is nevertheless one of the most important aspects of fire-control and planned burning procedures. There must be NO possibility for a fire to escape or relight.

FIGHTING THE FIRE

As Gourley stated (1996) remember the fire triangle, the three required elements for fires to start. To prevent fires starting and spreading, the fire triangle must be broken by removing one or more elements. Quite simply, this is achieved by:

1. Reducing the oxygen by smothering

Even though we can do nothing about stopping the wind, once the fire has started we can smother the fire using foam or soil, preventing oxygen getting to the fuel. This is only feasible if the fire is small, which is applicable to most of the burns you will be conducting.

2. Removing the fuel with fire breaks

This is self-explanatory and is covered in detail elsewhere. Most fire breaks have all available fuel removed and if the fire is low in intensity, will burn itself out (this does not mean leave fire breaks unattended to an oncoming fire!).

3. Reducing the heat using water

This is also self-explanatory, where fire-fighters can use knapsacks and pumps to suppress a fire. In situations where there are large fires, it may become quite difficult to control with water, so a combination of water and fire breaks is needed.

This is explained in further detail below.

If a fire that you have lit has escaped, ensure the proper authorities are alerted. Call 000 and provide as much detailed information as possible.

You will most likely have expertise on hand, and if they see a fire has escaped will take appropriate action.

NEVER ATTEMPT TO FIGHT THE FIRE YOURSELF!

Not only will this place your life in danger, but it may put others trying to help you at risk as well. It cannot be stressed strongly enough, joining your local rural fire brigade will not only provide you with the experience and training required to assist with fire control, they will probably be the first emergency personnel to arrive and assist with fire suppression.

FIRE EXTINGUISHING PRACTICES

It is helpful though to list the ways that fires can be suppressed. Having this type of information available will help you understand the type of equipment and procedures required to suppress fires. There are a number of methods available to suppress fires, and the use of any method, or a combination of them, will depend upon the extent of the fire situation, the number of personnel, tools and equipment at your disposal.

Use of water to suppress fires

Properly applied, water is by far the best and quickest tool to stop fires. It can be supplied from a number of methods, ranging from trucks, to backpacks and even the use of buckets. Water is applied to the base of fires (sprayed parallel to fire edge), and once flames are extinguished, mopping up with hand tools is required. Conservation of water is vital, so shutting off the flow at every opportunity is important. Remember that you will need to patrol and keep an eye on the fire-line, even after the application of water, to ensure all fires are completely extinguished.

Some facts about conserving water

A standard knapsack carries between 16–18 litres of water. The spraying capacity of the knapsack spray pump is approximately 3 litres per minute. Therefore, if the knapsack is sprayed continuously, the knapsack will empty in about 5 minutes. Please take this into consideration so you take note of your refilling point (so you are not too far away)

The Rural Fire Service operates a number of pumps to supply water to suppress fires. Lets consider the smallest pump (3.75 kW – 5 hp) can pump 225 litres per minute. A standard 650 litre tank will be emptied in only 3 minutes! Larger tank capacities, for example 3 000 litres, could be emptied in about 13 minutes. Also remember to note that refilling will also take time. This is particularly evident when the water source is some distance away.

How to conserve water?

- (1) **use a rakehoe and other hand-tools to attack and remove fuel (most important)**,
- (2) use appropriate hoses and always select the smallest nozzle to effectively complete the job,
- (3) shut off the nozzle when water is not required,
- (4) use a jet-stream for the initial knock down of the fire, but then change to spray so water covers greatest area possible,
- (5) direct the water where it will have maximum effect – at the fuel, not the flame,
- (6) break up solid burning material, eg logs, so the water can penetrate into the centre where it will have the greatest cooling effect,
- (7) if using a pump, operate the pump at the speed necessary to complete the task...operating the pump above the required speed will waste water and may cause damage to the pump,
- (8) if possible, use a wetting agent in the water. Wetting agents are chemicals which are added to water to aid in breaking the surface tension allowing water to spread out and cover a greater area.
- (9) use of foam. Foams have been very useful and act exactly like a wetting agent, but holding onto fuel, increases surface area and creates a thermal barrier. The environmental effects of foam use is not well understood. However, there are recommendations that limit the use of foam near watercourses, where the foam may enter the water catchment.

Use of dirt/soil to suppress fires

Very similar to water, soil can help cool and smother fires. The soil should be thrown in a swinging motion to scatter it in a thin layer at the base of the flames along the fire edge. A fast continual action will provide the best results.

Use of green tree branches or gunnysacks – ONLY IN EMERGENCIES

In some instances (grass fires or low shrub fires) you can use green tree branches to stop the fire, by cooling the edge of a fire in advance of fire-line construction. However, it should be noted that the use of branches should be limited.

The method is to swing the branch (also known as bough) toward the fire so that any embers or sparks are thrown back into the burnt rather than unburnt areas. Gunnysacks are operated in the same way. These are usually wetted first to increase its effectiveness. Remember, this is a very physically stressing activity, and there is a danger with your 'backstroke' which can flick embers back into unburnt areas.

PROCEDURE AFTER THE BURN

As this document shows, a lot of prior planning is required for any burn to run smoothly and trouble-free. Once the burn has been completed, there are many things to do to ensure your next planned burn are more effective.

Recording – An Essential Element of Fire Management

As we have reported in the Individual Property Fire Management Planning Kit, it is vital that all fires, whether planned or wildfires are properly reported. Remember this document ties in closely with the Individual Property Fire Management Planning Kit. After you completed the Fire Management Plan, we suggest you inform your local Rural Fire Brigade about your plans. Keep a personal copy of the fires. Many local councils are in the process of recording fire histories for their regions, and will require as much assistance as possible, so your records may contribute to this.

This information provides a written account of the path and extent of the fires and over time can assist you in understanding the fire frequencies and regimes occurring on your land. Having a good record of past fires will help you plan future fires, and will assist you and the local rural fire brigade with expert knowledge on where fires may travel and how to control any fires.

Recording fires is also important from an ecological perspective. You may want to start collecting information on how some species (which could be rare or threatened species) respond to fires. You may want to see if the fire regimes that you employ are effective in controlling any weed species you may wish to control or eliminate. Additionally, you may wish to start monitoring which animal species recolonise an area following your planned fire or wildfire. The Fire and Biodiversity Consortium has produced a monitoring manual that can help you determine the appropriate method to monitor fire and its effect on your land. Contact your local council's conservation officer for further assistance. These are a small selection of the multitude of questions you may want to answer following fires on your land.

Recording fire behaviour is an aspect of fire management that is often neglected, but equally as important as plant/animal responses etc. Accurately recording the fire in terms of scorch height, estimated rate of spread, and particulars about the headfire itself, will provide enough information to estimate fire intensity and other important fire behaviour characteristics. In other documents we have expressed the significance of variability for maintaining biodiversity. This also applies to fire intensity, and provides another reason that keeping records is a worthwhile activity. We have provided a number of sheets for you to record fire behaviour (see yellow sheets). Please photocopy these pages for future fire reporting.

The other important reason for record-keeping is to provide a link between the fire and the weather conditions. Again, this will help you guide any future burns and will help you 'predict' and choose which weather patterns will be best suited to the objectives of your planned burn. It

also provides you some forewarning about which conditions are potentially more hazardous. Recording should be completed as soon as possible after the fires have been controlled and all your maintenance schedules are completed. The longer you take to write fire reports, the more likely it is you will forget some specific and important information which will only assist you with better planning.

An example of this type of recording proforma is included in the appendices (blue pages). It is recommended that all fields are completed soon after the fire. Keep these sheets as your master-copy and photocopy the sheets for all your fire records.

ADAPTIVE MANAGEMENT OF YOUR BURNING PLAN.

...HOW WE COULD THIS BETTER NEXT TIME?

There is no perfect rule or list of guidelines to perform the ideal prescribed burning plan. Even though we have a good idea of how fires move and behave, it is also an intrinsically random and variable force. Add to this mix, an uneven landscape with a high level of vegetation diversity and of course the human factor...something may occur that is outside of our original intentions.

To ensure that the next planned burn accounts for these variations, after the burning and mop up has concluded, write down on the burn record:

- what procedures went well during the day,
- what effect did the weather have? This is why a thorough and accurate reporting process is needed,
- what procedures didn't go so well and
- what could be done to ensure it went better the next time you do a planned burn. These could include such aspects as equipment, resources, personnel, prior preparation, communication strategies, notification etc. It is essential to provide an accurate account of the aspects which can be enhanced or streamlined.

IMPLICATIONS FOR YOUR INDIVIDUAL PROPERTY FIRE MANAGEMENT PLANNING KIT

In keeping with adaptive management practice, you should update your Fire Management Plan that you have completed using the Fire & Biodiversity Consortium's Individual Property Fire Management Planning Kit.

The map should be updated to show the extent of the planned burn.

Other things to consider (much like *Step 9* of your Individual Property Fire Management Planning Kit) include:

- Are your land uses still the same?
- Do you have any additional assets?
- Do any of your fire-lines require adjustment or rehabilitation?
- What has the fire taught you about the fire regimes required in your bushland?
- How will this fire fit in with your multi-year burn schedule?
- Has the burn allowed you to reach a balance between property protection and biodiversity conservation?

Update your plan to suit any changes occurring after the fire. We also recommend you update the plan yearly.

REHABILITATION OF FIRE-LINES & OTHER AREAS

Fire-lines must be maintained for them to remain effective outside of the planned burn times. For most fire-lines, this means that the break must be cleared of all vegetation. All your fire-lines must be mapped, recorded and checked well in advance of the upcoming fire season (starting in September).

As you can see from this document, a successfully executed prescribed burn requires a lot of pre-planning. Ensuring your fire-lines remain effective is a laborious task, especially if you have a large property which may require a number of fire-lines, but the effort you put in will certainly pay off when you do your planned burn or you encounter wildfires. In your post-burn records, you should describe the effectiveness of your fire-lines. For those fire-lines which were less effective or not required, consider if you would like to change the fire-line in some aspect (width, grading, location etc.) or to discard them. If you do decide to discard them or change existing fire-lines, remember to update your records and mapping system to reflect these changes.

In the instances where you do not require existing fire-lines, rehabilitation of these fire-lines is highly recommended. Rehabilitation will require some work on your part to restore the fire-lines to its 'natural' conditions. Leaving a cleared line unattended to revegetate is fraught with many difficulties, namely from weed invasion. Therefore, you will need to invest time to replant with species native to your area and to ensure the conditions are suitable for growth. Your local Landcare or Bushcare group can provide you with plant-species list native to your region, and can assist you with replanting. In time, with your assistance, these formerly bare-earth lines will be fully restored. Weed invasion will only occur in areas where there are existing sources of weed seeds. In situations where there is an intact native vegetation community, free of exotics, weed invasion is unlikely and natural regeneration may require little or no assistance.

EQUIPMENT CHECKS AND REPAIRS AFTER THE FIRE

An essential element to any coordinated approach to fire management is the use of the proper equipment. This is especially important in relation to hose fittings for firefighting vehicles. Therefore, ensure your tanks and other supplies of water have the correct fitting so any Rural Fire Service hose can connect to your tanks. Your local Rural Fire Brigade can help with providing these requirements.

Once all the patrols and mop-ups and maintenance has occurred, equipment that you have used in the preparation for the planned burns, the control, and mop-up will require maintenance.

Proper upkeep and repair of equipment is essential. In emergency situations, equipment failure from improper or inadequate maintenance may injure personnel and endanger people's lives.

Maintenance may be as simple as ensuring the equipment is cleaned and stored properly, or to make sure drip-torches nozzles are cleaned and the fuel is topped up. Other equipment may require oiling to keep moving parts from rusting and seizing up. This type of maintenance also refers to personal protective equipment, such as helmets, face-masks should also be cleaned and properly stored. Make sure all first-aid kits are checked and restocked where necessary.

Keep an '**Equipment Maintenance Schedule**' which lists all your equipment and update this to show when it was last used and cleaned. Other easily forgotten maintenance requirements include:

- all pumps should be started **once every fortnight** and checked that all parts are in working order. This regular use of the pumps will ensure they will start when you need them, especially in emergency situations,
- knapsacks should be regularly maintained.
- carry spares (hose clamps, o-rings etc.) with a spare set of screwdrivers and pliers. Again remember you may need them in emergency situations.

Most of the firefighting equipment and resources will be made available through the Rural Fire Service, but you may wish to keep some equipment on your property (these may include rake-hoes, axes, shovels, brush hooks etc.). There is a list of equipment suppliers at the end of the document should you want to purchase any of this equipment.

Here is a list of recommended first aid equipment to have available:

2–3 crepe bandages of each of sizes: 5 cm, 7/5 cm and 10 cm wide	Leucoplast adhesive tape to secure dressings and bandages
3 melolin/melolite non-stick dressings	Space blanket
2 triangular bandages	Safety pins
2–3 combine dressings of each of various sizes available	Scissors
Betadine antiseptic	Tweezers
Staminade or other electrolyte replacement satchels	Probe
Saline solution (9%) in small vials or ampoules	Notebook and pencils

(adapted from QPWS Fire Management System 2000)

You can obtain a standard Red Cross Vehicle First-Aid Kit that will cover three people for about \$75. A more comprehensive list of personal protective equipment that each personnel should have in preparation for the planned burn is included in the Appendix. There is no obligation to obtain all this equipment personally. The local firefighting authorities such as the Rural Fire Service who will most likely assist you with the implementation of your planned burn will have this personal and other safety equipment available. This again stresses the importance of joining your local Rural Fire Brigade.

For many landowners, the most easily forgotten personal protective equipment is a helmet. There are many overhead hazards (falling limbs/trees etc.) so it is especially important to have a suitable helmet. Helmets will also provide suitable protection from radiant heat, which has been recognised as the greatest human killer in fires (Webster 2000).

FIRE BEHAVIOUR CALCULATION & MONITORING

It is difficult to monitor everything during a planned burn. One aspect of fire monitoring which is often neglected is the measurement of fire behaviour. Recording fire behaviour provides some important information on the fire intensity and rate of spread of the fire. This in turn provides important information on the variability of the fires in your land, which is an important aspect to maintaining biodiversity. We have discussed above the importance of keeping accurate records of your burns.

Appendix 4 – Day of Burn Record outlines some generic information you should record during the burn. This should be done at half-hourly intervals following the initial lighting of the fire.

Flame heights, significant events such as scorch height, spotting and other significant events should be recorded. Any changes in weather conditions should also be noted.

Notification of the Public

In Queensland, the unique 'Permit-to-Light' system applies. If you want to light a fire in the open, then you will, by law, be required to obtain a permit. This applies to any planned burns. Your local Rural Fire Service Fire Warden issues permits. In preparing your Individual Property Fire Management Plan, you will have obtained the name and contact for your fire-warden.

However, before obtaining a permit, your Fire Warden will advise you that it is a requirement that you:

- inform all neighbours—including government departments and absentee landholders—of your intention to burn,
- inform Firecom of the time/s of your planned burn (the number will be on the permit, but we have included a list of Firecom phone contacts at the end of the document),
- prepare or obtain signs notifying motorists of burning off,
- organise a sufficient number of people to help control the fire,
- have firefighting equipment ready and in good working order, and
- comply with all the conditions set out on the permit.

(adapted from Rural Fire Service Fire Warden's Manual 2000)

Permits are issued for different lengths of time depending upon each individual situation and the weather conditions. If there is likely to be a smoke issue causing potential safety problems on roads, you will need to arrange appropriate warning signs and traffic control provisions (if required). This is something the Rural Fire Service will assist you with, given a small donation. Communication throughout this process is crucial. Linking up with your neighbours, agencies in adjoining land and the RFS will not only encourages camaraderie between landholders, but the coordinated approach ensures all possibility of success.

Prior notification of your intention to burn will also include:

- Queensland Fire & Rescue Authority – Firecom
 - Fire Warden,
 - Neighbours, and
 - Media (only if the burn is done in conjunction with local council).

Your Fire Warden will let you know the responsibilities and conduct required of you for obtaining the permit. Your application for a permit may be approved even if a neighbour objects to your plan to burn, but the Fire Warden must inform the objector of the reasons for approving the permit. Permits may be cancelled at any time, but must be in writing.

Local Government Nuisance Laws

As the Fire Warden Manual (2000) states, many local governments have introduced nuisance laws and many other councils are considering similar legislation. Typically, these local laws address issues related to smoke, noise, odour and visual amenity. An example of such a local law is Redland Shire Council Local Law No. 18 (Control of Nuisances), which allows the local government to restrict or prohibit the lighting of fires in the open.

Under the *Queensland Fire and Rescue Authority Act 1990*, the legislation that grants the authority and power to Chief Fire Wardens and Fire Wardens is superior legislation to Local

Government Nuisance laws and overrides those laws. This is reflected in the Redland Shire Council example, where that local law cannot restrict or prohibit fires with a valid permit.

There is a requirement for any Fire Warden to consider the intent and implication of these Local Government Nuisance Laws when processing any permit applications. As the Fire Warden Manual (2000) states, in most situations a win/win situation is possible through the “judicial conditioning” of any Permit to Light issued.

We have supplied a checklist (next page) for you to record the names of people/organisations to contact prior to the burn.

Planned Burning Notification Checklist

Below is a list of names and contacts you should contact before you conduct your planned burn.
Keep this list regularly updated and easily accessible.

TYPE OF CONTACT	NAME	ADDRESS	TELEPHONE	OTHER INFO.
Fire Warden				
Queensland Fire & Rescue Authority				
Neighbours				
Media – (only if burn is in conjunction with local council)				
Other				

Escapes and Accidental Fires Report Checklist

Reporting of fires is essential to facilitate better planning. This includes all fires, regardless of the level of control. We have outlined how reporting can assist you to better plan and execute a future fire, but it is as important if a fire escapes.

You will need expert input in the implementation of any planned burns on your property. However, since fires are almost impossible to completely control despite our best intentions, in some circumstances, with some adverse or unexpected changes in the weather or terrain, fires may sometimes escape.

In the event of an escape, the proper authorities will be notified so emergency action can be implemented to suppress the fires. Experienced personnel from the Rural Fire Service, DPI Forestry, QPWS and local government with incident management training will take over the suppression activities. If you have a fire which escapes:

- Call Firecom – inform them if the fire is containable using the available personnel and resources, otherwise, let Firecom know the location and extent of the fire
- Keep Firecom informed of fire-suppression details, and finally
- If the fire is beyond your control, call 000.

Note: we have asked you to employ some value judgment here for controlling escapes. Don't try to tackle an escaping fire if you do not have the resources at hand.

Following the containment of any breakaway fires, you should write a formal report which is to be sent to the Rural Fire Service so that the cause(s) can be taken and appropriate action taken to improve fire management practices. This report should address the points below:

1. Identifying Information

- Planned burn number
- Fire Season, eg 1998/99
- Type of Planned Burn
- Area of Planned Burn
- Accident location
- Type of accident

2. Weather

Report the weather conditions,

- at the time of ignition
- the outlook (forecast) obtained
- at the time of escape/accident
- subsequent to escape/accident
- Drought Index and Soil Dryness Index

3. Ignition

Briefly describe how the burn was lit noting changes that were made to the lighting plan, any problems you encountered and the fire behaviour

4. Boundaries

Describe the boundary to the planned burn where the fire escaped and any other factors used to contain the burn, eg differences in fuel moisture etc.

5. Fuel Type (Internal)

Describe the type, quantity and distribution of fuels from where the fire escaped

6. Fuel Type (External) and Fire Behaviour

Describe the type, quantity and distribution of fuels into which the fire escaped. Note fuel moisture conditions (if possible) and how the fire spread.

7. Resources

Indicate your resources present at time of escape.

8. Listing Losses

List any items damaged, burnt or lost in the escaped fire.

9. Contributing Factors to Escape

Summarise how the fire escaped and how it is likely to have occurred and the factors likely to have contributed.

10. Recommendations Arising

Every effort should be made to assess causes of all escapes and the resultant damage. Consider the contributing factors and how these eventualities may have been avoided or otherwise dealt with in future burns to prevent the same situation occurring again.

Fire Competency – Training Options

It is important for landowners to understand the requirement of appropriate training in fire fighting. Nationally, there exists a competency-based learning system for fire training. This system is commonly known as Level–1 and Level–2 Competency training, but is also known as the ‘Fire Management Level 1 and 2 Training). There are a few avenues to attain this type of training. Level–1 competency covers aspects such as fire behaviour, fire weather, safety issues, personal safety, methods of fire suppression, communication and the appropriate legislation. Higher level training includes risk management, incident control systems and focuses on communication and control of other crew members.

As we have strongly advocated throughout this document, we highly recommend that landowners join the local Rural Fire Brigade. Not only will the Rural Fire Brigade provide the appropriate training, it will instil a better sense of your community by joining the Rural Fire Service (RFS). As most of the planned burning operations will likely involve the assistance and expertise of the local brigade, by being an active member, will be beneficial for all concerned. Rural fire brigades regularly maintain training-days to ensure all members remain familiar with the procedures require during planned burn and fire suppression efforts. In addition to being able to maintain a competent level of training, it also provides an opportunity to attend and assist in wildfire and planned burning suppression efforts.

To maintain your level of competency, you must attend a fire every 12 months. This is another benefit for joining the Rural Fire Service.

For some landowners, where attaining accreditation for fire fighting forms an essential part of their job, then it may be useful to do this training at a commercial centre. The same type of information is provided with training from the RFS. Some places in southeast Queensland that provide this type of training includes, the Gympie Training Centre (operated by the Department of Primary Industries) and the Nudgee College Outdoor Education Centre offers both Levels of training and some TAFE colleges offer the basic level of training.

Other Important Information

Personal and Crew Safety Issues

Here is some information to help with the procedures to follow if someone is injured at the fire. These are not training notes, and it is recommended you do a certified first aid course. In all cases where injury occurs, immediately contact emergency services and stay with the patient. The following information is adapted from Gourley's (1996) 'Fire Training Manual'.

1. No pulse – Perform CPR (if appropriately trained). Seek medical help.

2. Bleeding

- Place person at rest – reassure – restrict their movement
- Apply dressing and constrictive bandage
- Raise injured part (if possible)
- If severe – apply direct pressure plus above. Seek medical help.
- For **severed parts** – place in clean plastic bag – keep cool and do not immerse directly in water.

3. Fractures

- Immobilise part – patient's comfort
- Seek Medical help

4. Smoke Inhalation

Symptoms include – Stress to eyes, lungs and throat

- Excessive coughing
- (Extreme cases) possible throat and lungs burnt

Treatment includes:

- Remove person from fire front and rest them
- Be aware of possible burn to throat. Seek medical help if serious.

5. Burns

There are three types: 1st, 2nd and 3rd degree burns. In fire fighting, usually 1st and 2nd degree burns result from direct contact with flames or touching hot objects:

- In these cases, remove patient
- Cool the burnt area and surrounds – 10–15 minutes cool running water (not pressure)
- Cover the area with clean cotton material (NOT bandages)
- Seek medical help

DO NOT

- Break blisters
- Use antiseptic preparations
- Remove charred clothing or particles from burnt area

6. Heat Stress

- Caused by restriction of airflow, sometimes from Protective Clothing (Overalls)
- Body needs to sweat and cool by evaporation
- Needs large and frequent amounts of cool water (1.8 L per hour)

If body does not sweat/cool, circulation is overloaded and dehydration occurs

Symptoms include: feeling weak, dizzy, weak pulse, shallow breathing, clammy skin and pale face

Treatment includes:

- Move person to cooler area
- Give small frequent amounts of cool water
- Remove restrictive clothing
- **NEVER** give alcohol or carbonated drinks – these will increase dehydration!

7. Snake or Spider Bites

Identify snake/spider if possible

Red-Back Spider Bites

- Apply cold pack, immediately seek medical help
- DO NOT BANDAGE

Snake and others

- Do not wash area
- Apply constrictive bandage – up and down bit limb
- Immobilise limb and person
- Seek medical help
- Reassure

Some suppliers for equipment include:

McArthur Fire Meters – are a registered product from the CSIRO. Styrox (Aust.) Pty Ltd. are the only registered company to supply the McArthur FDI meters. They are located at Unit 8/7 Jubilee Avenue, Warriewood NSW 2102, phone (02) 9997–1000.

Final Checklist Before You Light

Have you...

1. A valid Permit to Light from your Fire Warden,
2. Obtained the latest available weather information and forecasts, such as wind speed and direction, humidity and rainfall,
3. Located, outlined and recorded where the different types of fuel occur on your property,
4. Located, outlined and recorded where your fire-lines are situated (do you have a contingency plan if these control lines are breached),
5. All the available and functioning firefighting and fire-lighting equipment,
6. All available firefighters and personnel required for the burn,
7. All appropriate personal safety equipment. These can be either overalls (ideal) or cotton pants and long sleeve shirt, along with heat resistant boots, and suitable head protection,
8. A comprehensive first aid kit
9. An available supply of water (for fire suppression efforts, and for personal use),
10. Updated your fire management plan for your property, and
11. A readily available list of contacts of assistance is needed.
12. Notified your Neighbours, Firecomm of your intention to burn?

If you answered **NO** to any of these questions, then you cannot proceed with the planned burn.

It may be worthwhile reiterating that under the Permit to Light system, that **you can be liable** for any costs incurred for suppressing fires that escape or cause damage to other property/assets.

Appendices

1. Fuel Assessment Guide (from McCarthy 2000)
2. McArthur Wheel (Steps to Use)
3. Firecom Phone Numbers for Southeast Queensland
4. Day of Burn Record
5. Fuel Reduction and Ecological Planning Burning Form (from Tasmania Parks and Wildlife Service 1998)
6. Beaufort Scale
7. Comprehensive First Aid Kit







Overall Fuel Hazard Card (Draft Sept 2000)

Assessing Fuel Component Hazard Ratings





(Overall = Bark + Elevated + Surface)

Assess levels of Bark, Elevated and Surface Fine Fuel Hazard as follows.

Bark Hazard Rating

Low	No flammable bark. Little bark to add to fire behaviour.		Significant loose bark. Fires will climb most trees. Spotting causes problems.	
Moderate			Very High	
	Some loose fibrous bark. Some fire will climb trees. Some spotting.		Large amounts of loose bark. Fires climb all trees. Severe spotting.	
High			Extreme	

Elevated Fuel Hazard Rating

Description	Low
No elevated fuel. "Easy to walk through in any direction."	
Little elevated fuel. "Easy to walk through, but vegetation does brush legs occasionally."	Mod
Some scattered elevated fuel. "Moderately easy to walk through, but brush against or step over vegetation most of the time." 0.5 m high. 0-20% dead. Patchy increase in fire behaviour	
	High
Significant elevated fuel. "Difficult to walk through. Need to carefully select path and step high." 20-30% dead. 0.5 to 1.5 m high. Fuel elements mostly 2mm or less. Elevated fuel mostly determines fire behaviour.	
	Very High
Taller, dense elevated fuel. "Very difficult to see where you are going. Need to use arms to push through vegetation." 30-50% dead. 2.0+ m high. Fuel elements mostly 2mm or less. Elevated fuel completely determines fire behaviour.	
	Extreme

Surface Fine Fuel Hazard
Rating System based on
Litter Bed Height (measure with
gauge)



Surface Fine Fuel Hazard	Low	Mod	High	Very High	Extreme
Litter Bed Height (mm)	<15	15-25	25-35	35-50	>50
Equivalent Surface Load (t/ha)	<4	4-8	8-12	12-20	>20

Combining Bark, Elevated and Surface Fine Fuel Hazards to give an Overall Fuel Hazard for a site:

Table 1. Bark Hazard: Low or Moderate

		Surface Fine Fuel Hazard				
		L	M	H	VH	E
Elevated Fuel Hazard	L	L	M	M	H	H
	M	L	M	M	H	H
	H	L	M	H	VH	VH
	VH	VH	VH	VH	VH	VH
	E	E	E	E	E	E

Table 2. Bark Hazard: High

		Surface Fine Fuel Hazard				
		L	M	H	VH	E
Elevated Fuel Hazard	L	L	M	H	H	H
	M	L	M	H	H	H
	H	L	H	H	VH	VH
	VH	VH	VH	VH	VH	E
	E	E	E	E	E	E

Table 3. Bark Hazard: Very High/Extreme

		Surface Fine Fuel Hazard				
		L	M	H	VH	E
Elevated Fuel Hazard	L	M	VH	VH	VH	E
	M	M	VH	VH	E	E
	H	M	VH	E	E	E
	VH	E	E	E	E	E
	E	E	E	E	E	E

Equivalent Fuel Loads (t/ha) for given Hazard ratings
(Insert total of components into McArthur Meter for
predictions of forward rate of spread and flame height)

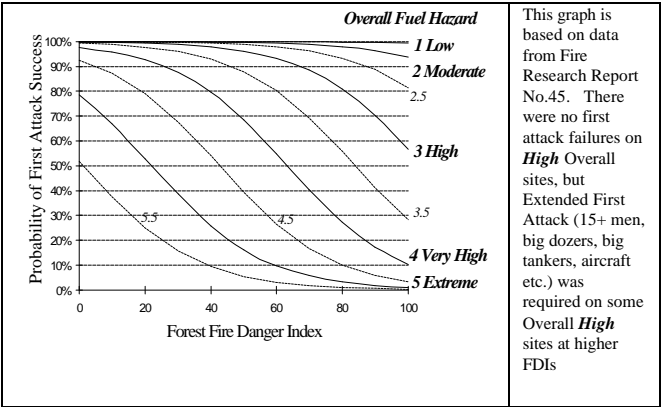
Fuel	Low	Mod	High	V High	Extreme
Bark	0	0	2	5	7
Litter/ Surface	2	6	10	16	20
Elevated	0	0	2	6	10

e.g. *High* Bark *High* Surface *V. High* Elevated
2 + 10 + 6 = 18 t/ha Overall

Suggested Overall Hazard levels for Fuel Management Zones

- FMZ 1 (P1) - Moderate
- FMZ 2 (P2) - High
- FMZ 3 (P3) - High on 50% of total area. (i.e. other 50% may be higher)

Probability of First Attack Success



For further information: Fire Research Officers Orbost 03 51541208, Creswick 03 53214181.
Refs : Fire Research Reports No. 45 & 47. Prepared by : Greg McCarthy Sept 2000.

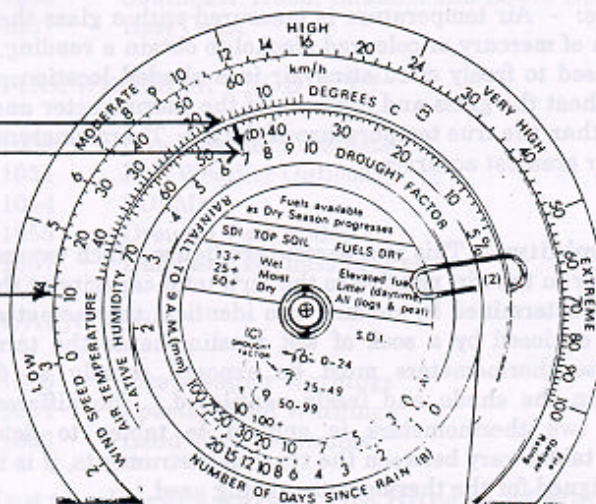
FIRE WEATHER FORECAST for Friday 26 / 11 / 1993

Station	Rain mm 24hr 6hr	Max Temp	RH %	Wind km/h Dirn Spd	Dew Pt	Fire Danger Rating Forest Scrub Moor	Drgt Fact
Currie	0.0 0.0	28	35	W/NW 45	11	- H19 -	7.3
Smithton	0.0 0.0	23	45	N/NW 35	11	M8 - -	7.0
Marrawah	0.0 0.0	24	40	W/NW 25	9	M10 M10 H20	7.0
Waratah	0.0 0.0	21	40	NW 20	6	L4 L3 H12	4.0
Erriba	0.0 0.0	21	40	W/NW 20	7	M5 - -	5.0
Devonport	0.0 0.0	21	50	N/NW 30	10	M6 - -	5.8

1. Inner moveable disc:

Set the dark arrow against a Drought Factor derived EITHER: from calculating the effect of recent rainfall against Soil Dryness Index (follow steps shown on the meter)

OR: directly from the Fire Weather Forecast using the closest reporting station or an area of comparable climate and altitude. Once set, secure with a paper clip.



Meter Mk 5 Designed by A. G. McArthur, Canberra, 1973
Scaled down & BKDI replaced with SDI, 1982.
Tasmania Forestry Commission, G.P.O. Box 2076 Hobart 7001

2. Outer moveable disc:

Set the air temperature, in this example it is 15°C, against the relative humidity, in this case 45%.

3. Read off the Fire Danger Rating against the estimated or measured average wind speed, in this case 10 kilometres per hour. The FDR is LOW

4. If the wind was 20 kph it would be LOW 5 and so on according to windspeed.

Firecom Contact Details

REGION / LOCALITY	PHONE NUMBER
Brisbane (Central)	1–800–017029
Southport (Southern) Offices	1–800–689958 5583–7500 (#5)
Kawana (North Coast) Offices	1–800–354621 5493–4964
Caboolture Rural Fire Service (Northern)	5499–1009
Ipswich Rural Fire Service (Western)	3202–1444
Other Important Contacts:	
Bureau of Meteorology (Weather Forecast)	3239–8705 (#3)

DAY OF BURN RECORD

Date: / /

Drought Index:..... Days Since Rain:..... Rainfall:.....mm

Drought Factor:..... Ignition Time:.....

WEATHER DETAILS (Attach Weather Forecast)

[illegible]

(adapted from Brisbane City Council)

Fuel Reduction and Ecological Burning Reduction Form

(adapted from Tasmania Parks and Wildlife Service 1998)

Contact Details

Burn Planned Prepared By:
Contact No.:

Location and Objectives

District: Location (grid reference):
Tenure: Location (describe):
Year/Month(s) of Burn: Gross Area (ha):
Fire Permit No.:
Objective:

Origin of Burn (fire management plan, neighbour request, coordinated burn with RFS, DPI etc.)

Fuels to be Burnt

Vegetation Type	Location (eg N slopes)	Fuel Type (litter, shrub etc.)	Area (ha)	Fuel Age (yrs)	Fuel Qty (t/ha)

Special Planning Considerations

Rare and Threatened Species Present:
.....
.....

Other Planning Constraints (eg nearby assets, hazards, fuel distributions, neighbours etc.) ..

.....
.....
.....
.....

Boundary Preparation

Boundary Type	Length (meters)	Work Required	Date Completed

Other Pre-Burn Preparation

Work Required (eg waterholes, fence lines, line construction, edge burning)	Date Completed

Weather Prescriptions

Max Flame Height (m): **Max Rate of Spread (m/min):**
Temperature (°C): to **SDI (mm):** to
Humidity (%): to **Forest FDR:** to
Wind (km/hr): to
Wind Direction: to
Other (eg sunshine, days since rain):.....
.....
Outlook:.....
.....

Lighting and Patrol Strategy

Lighting Method (state):
Lighting Strategy:.....
.....
.....
.....
Mop Up and Patrol Strategy (eg, resources, timing, next high FDR day):
.....
.....
.....

Lighting Plan

Attach/Consult: Topographic Map (name, scale, and North point)

Indicate:

– Access	– Assets	– Potential Hazards
– Boundary Types	– Test fire locations	– Water stations/points
– Fuel types, dist. & quantity	– Crew placement/assembly points	– Lighting pattern

Resources

Fire Controller (name):	Ignition Equip (No):
Navigator (name):	Ignition Fuel (litres/caps):
Slipons (No.):	Pumps (No.):
Other Personnel (No.):	Other:

Notification Checklist

	To Contact (tick box)	Names	Phone No.	Done (Date/Time)
<input type="checkbox"/>	Fire Warden			
<input type="checkbox"/>	Local Brigade			
<input type="checkbox"/>	Local Council			
<input type="checkbox"/>	Local Police			
<input type="checkbox"/>	Adjoining landowners			
<input type="checkbox"/>	Neighbours			
<input type="checkbox"/>				
<input type="checkbox"/>				
<input type="checkbox"/>	Other			
<input type="checkbox"/>				
<input type="checkbox"/>				

Pre-burn Monitoring

Date									
Rainfall (mm)									
Peat/Soil (wet, moist, dry)									
Leaf Litter <u>Bottom</u> (wet, moist, dry)									
Leaf Litter <u>Top</u> (wet, moist, dry)									
Aerial Fuel (wet, moist, dry)									

Weather Forecast for Day of Burn

Obtain the latest information for:

Rainfall to 9am (mm): SDI (mm): Max Temperature (°C): Relative Humidity (%): Wind Speed (km/hr): Forest FDR:	Days Since Rain: Drought Factor: Haines Index (if appl): Dew Point (°C): Wind Direction:
---	---

Briefing Check-List

A briefing is essential for all planned burns. Deliver briefing in sections, each covering one aspect of the burn plan. Involving the input of experts is essential here. Obtain feedback at the end of the briefing. Briefings should cover:

- 1. Objectives**
- 2. Chain of Command**
- 3. Lighting & control strategy**
- 4. Allocation of crews to tasks**
- 5. Coordinating Instructions**
 - timing
 - communication channels
 - command signals
 - reporting requirements
- 6. Logistics**
 - water and turning points
- 7. Safety**
 - safety equipment
 - hazards
 - escape routes
- 8. Recording requirements**

Test Fires

Record fire behaviour for a 10 minute period after test fire has been alight for 10 minutes

	No.1	No.2	No.3
Time Test Fire Lit:
Headfire Rate of Spread (m/min)
Flankfire ROS (m/min)
Backfire ROS (m/min)
Headfire Flame Height (m)
Hours to 1800 hrs EST
Ignition Spacing (see table below)

Hours to 1800 Hrs EST	Forward Rate of Spread of Test Fire				
	0.2	0.4	0.6	0.8	1.0
	Spacing of Spots (m)				
1	10	20	30	40	50
2	20	46	60	80	100
3	30	60	100	130	160
4	40	80	130	170	220
5	50	100	160	220	270

Lighting Up

Date: **Time Light-Up Commenced:**.....

Ignition Spacing (m): **Time Light-Up Completed:**

Time to Burnout (hrs):.....

Weather and Fire Behaviour Observations

Time (24 hr clock)											
Temperature (dry bulb) °C											
Temperature (wet bulb) °C											
Relative humidity (%)											
Tree top Wind Speed (km/h)											
1.7 m Wind Speed (km/h)											
Wind Direction											
Cloud (%)											
Forest FDR											
Vegetation Type											
Location (eg N slopes)											
Fuel Types											
Rate of Spread (m/min)											
Flame Height (m)											

What effect did the weather have on your burn?

.....

.....

.....

.....

Post Burn Evaluation

Vegetation Type	Location Eg N slopes	Fuel Type	Area Burnt %	Fuel Load Remaining t/ha	Overstorey Scorched %

Comments on Light Up (note modifications to burning plan or lighting pattern as a result of conditions on the day):

.....

Comments and Recommendations:

.....

What procedures went well during the day?

.....

What procedures didn't go so well?.....

.....

Date Burn Declared Out:

Escapes

Did the burn escape? Yes / No

If the burn escape, please file report

Beaufort Scale for Estimating Wind Velocity

<i>Beaufort Number</i>	<i>Term</i>	<i>Wind Speed (km/hr)</i>	<i>Description</i>
0	Calm	0	Smoke rises vertically
1	Light air	1–5	Smoke drifts slowly; wind vanes not affected
2	Light breeze	6–11	Wind felt on face; leaves rustle; ordinary wind vanes move
3	Gentle breeze	12–19	Leaves and twigs in motion; wind extends light flag
4	Moderate breeze	20–28	Dust and loose paper raised; small branches move
5	Fresh breeze	29–38	Small trees sway
6	Strong breeze	39–49	Large branches in motion; whistling heard in telephone wires
7	Near gale	50–61	Whole trees in motion; inconvenience felt when walking against wind
8	Gale	62–74	Twigs broken off trees; progress of walkers impeded
9	Strong gale	75–88	Branches broken off trees, slight damage to buildings
10	Whole gale	88–101	Trees uprooted; much damage to buildings
11		102–120	
12	Hurricane	120+	

COMPREHENSIVE FIRST AID KIT

MANDATORY	
Ideal – Proban* Overalls as per standard issue	Helmet with chin-strap (check replacement date of helmet and harness)
Satisfactory – long sleeve cotton pants and shirt	Goggles
Fire resistant boots (steel cap is desirable) with fire resistant sole (Nitrile or similar)	Leather gloves (eg riggers gloves)
Triangular bandage or face mask	Torch
Personal water bottle/s (enough for 1 L/hr)	
Personal first aid kit (see below)	
HIGHLY DESIRABLE	
Matches	Pocket knife (Leatherman Tool or equivalent)
Compass (in vehicle)	Broad brim to attach to helmet
DESIRABLE	
Waist pack or belt to carry water, first aid kit, radio, matches etc.	Earplugs and spares
Emergency ration pack / thermos	

CONTENTS FOR PERSONAL FIRST AID KIT	
3 large combine dressing pads	2 melolin/melolite non-stick dressings
1 triangular bandage	1 crepe bandage (5 cm wide)
2 crepe bandages (7.5 cm wide)	2 crepe bandages (10 cm wide)
1 chlorhexidine/centrimide aqueous irrigation ampoule (30 ml)	1 dressing strip (6 cm × 1 cm)
Skin closure (8 cm)	

*Proban is a chemical treatment to increase the fire-retardance of fabric.
(adapted from QPWS Fire Management System 2000)

References

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- Tran, C. Wild, C. and Zubrinich, T. 2001. Testing Mutch's Hypothesis in southeast Queensland: plant flammability revisited. In [Eds] Pearce, G. and Lester, L. *Proceedings of Joint Bushfire2001/FRFANZ Conference, Christchurch, New Zealand*. Pp 43–52.
- Watson, P. 2001. *The Role and Use of Fire for Biodiversity Conservation in South-east Queensland: Fire Management Guidelines Derived from Ecological Research*. 49 pp.
- Webster, J. 2000. *The Complete Bushfire Safety Book*. Random House (Aust) Pty Ltd. 352 pages. ISBN –174051-034-8.

Consortium publications

The SEQ Fire and Biodiversity Consortium has produced a suite of materials to support land managers and those who work with them. Materials completed, or nearing completion as of February 2002 include:

A comprehensive literature review

Tran, C. and C. Wild. 2000. *A Review of Current Knowledge and Literature to Assist in Determining Ecologically Sustainable Fire Regimes for the Southeast Queensland Region*. 106pp.

A database of fire ecology literature

Tran, C. 2000. *CD-Rom of Fire Regime Literature*.

A database of SEQ fire research and monitoring projects

Tran, C. and P. Maidens. 2000. *Southeast Queensland Fire and Biodiversity Research Studies Database*.

Ecological guidelines, for professionals who want a moderately in-depth summary of the management implications of the fire ecology literature

Watson, P. 2001. *The Role and Use of Fire for Biodiversity Conservation in South-east Queensland: Fire Management Guidelines Derived from Ecological Research*. 49pp.

A list of potential research projects

List of potential fire ecology research projects and contacts. 16pp.

An introductory fact sheet for private landholders and the general public (Level-1 brochure)

Watson, P. 2001. *Fire and Nature Conservation in Southeast Queensland: an Introduction*. 4pp.

A more comprehensive fact sheet for landholders and community group members (Level-2 brochure)

Watson, P. and Tran, C. 2001. *Fire in Bushland Conservation*. 20 pp.

A fact sheet for Land for Wildlife landholders, produced in conjunction with Land for Wildlife

Moran, C. and Watson, P. 2000. *Fire as a Wildlife Habitat Management Tool*. Land for Wildlife Note No. 14. Land for Wildlife Program Southeast Queensland. 8pp.

A kit to assist landholders develop a fire management plan for their property

Individual Property Fire Management Planning Kit: Balancing Fire Safety with Conservation of Bushland Plants and Animals. 41pp.

A manual to assist local government and landowners plan and conduct hazard reduction/ecological burning for their property

Tran, C. 2002. *Best Practice Fire Management Manual – Operational Level: Guidelines and Procedures*. 100 pp.

A manual to assist local government plan and develop a fire management strategy for council-administered land

Tran, C. 2002. *Best Practice Fire Management Manual –Strategic Level: Guidelines and Procedures*. 35 pp.

A manual to assist local government officers with various methodologies that can be used to monitor and evaluate fire management of council-owned land.

Fire Monitoring Manual: Methods and Decision Matrices. 2002.

Copies of these materials can be obtained from the Southeast Queensland Regional Bushcare Facilitator, Queensland Parks and Wildlife Service, phone (07) 3202-0223.