Department of National Parks,
Recreation, Sport and Racing

Planned Burn Guidelines

How to Assess if Your Burn is Ready to Go

Queensland Government

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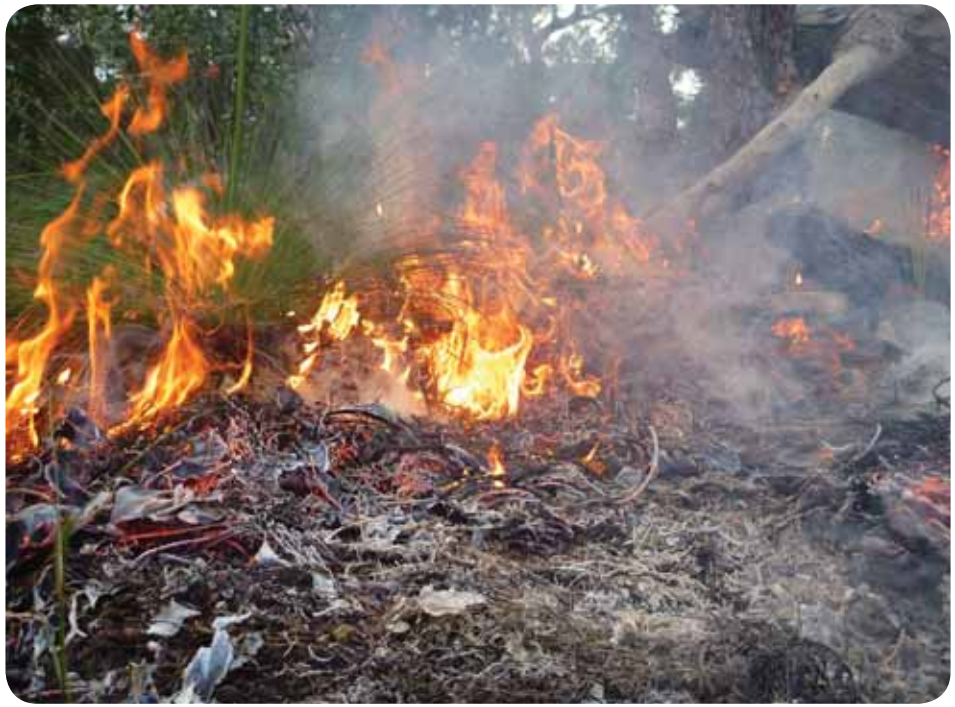
Introduction

This document is a 'how to' guideline supporting a series of bioregional planned burn guidelines, intended to optimise the use of fire to:

- protect life and property
- maintain biodiversity
- improve fire management
- provide rangers and other land managers with the knowledge and ability to adapt fire management practices within a changing climate.

This guideline was developed as part of the Department of National Parks, Recreation, Sport and Racing (NPRSR), Queensland Parks and Wildlife Service (QPWS) Fire Management System.



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How to assess if your planned burn is ready to go

Use these instructions to assess if conditions are appropriate for your planned burn to proceed. Follow the steps below and refer to the tools provided as required. A site assessment form is provided to assist you in recording your results (refer to page 22).

Initial assessment

Initial assessment can be undertaken in an office using weather forecasts.

Step 1: Assess weather patterns

Assess weather patterns before, during and after the burn.
Then proceed to Step 2.

It is important to be aware of weather conditions in the month following a burn, particularly with seasonal changes and the possibility of severe fire weather. Re-ignition can occur in more severe fire weather weeks after a burn, and the risk is higher for mild burns with unburnt mosaics, retained duff layer, or unburnt boundary sections.

Note: Ensure a 'go to burn' is obtained from your regional manager (or delegate) for planned burns during fire risk periods (as defined by local fire preparedness procedures).

It is recommended you consult the following websites:

- Bureau of Meteorology (BoM) fire weather forecast (including regional forecasts, and weather observations) ‹www.reg.bom.gov.au/reguser/by_user/bomw0129/›.
  Note: you must be a registered user. If the registered users' page is unavailable, then use the general BoM website ‹www.bom.gov.au› for general information.
- Four day fire danger forecast—refer to Queensland Fire and Rescue Service (QFRS) rural website ‹www.ruralfire.qld.gov.au/FDRG.html›. The maps show forecast fire danger ratings for grassland and forest for the next four days. For forecast details, open the Fire Danger Rating Graphic (FDRG) spreadsheet.

Step 2: Assess drying time (number of days before you can burn)

Using the table below, assess the number of days before you can burn after rain. Then proceed to Step 3.

Rainfall event Amount of rain (mm)	Open forests and woodlands		Wallum and heath	Open grassland
	A site with leaf litter	A grassy site with some leaf litter		
	Minimum drying time (days) *(approximate)			
2	1–2	1	1	1
5	2–3	2	1	1
10	4–6	3	2	1
20	6–10	4	2	2
30	7–12	4	3	2
40	8–14	5	3	2
50	10–18	6	3	2
75+	14–22	9	5	3

*Drying time may vary dependent on seasonal conditions (adapted from Qld Forestry, c.1970).

Step 3: Assess fuel moisture

Using local weather forecasts (for relative humidity and temperature), estimate your sites' fuel moisture factor using the table below. Then proceed to Step 4.

Figures inside the thick lines indicate optimum conditions for planned burns.

Relative humidity (%)	Temperature (° C)									
	14	16	18	20	22	24	26	28	30	32
	Fuel moisture factor									
15				5.6	5.1					
20				6.0	5.8	5.5	5.1			
25		7.4	7.1	6.8	6.5	6.1	5.7	5.4	5.0	
30	8.5	8.0	7.7	7.5	7.1	6.8	6.4	6.0	5.6	5.3
35	9.2	8.7	8.4	8.0	7.8	7.4	7.0	6.7	6.3	6.0
40	9.8	9.3	9.0	8.6	8.4	8.1	7.7	7.3	7.0	6.7
45	10.5	10.0	9.7	9.3	9.0	8.8	8.4	8.0	7.7	7.3
50	11.1	10.7	10.3	10.0	9.7	9.4	9.0	8.7	8.3	8.0
55	11.8	11.3	11.0	10.6	10.3	10.0	9.7	9.3	9.0	8.7
60	12.4	12.0	11.6	11.3	11.0	10.7	10.3	10.0	9.7	9.3
65	13.1	12.7	12.3	12.0	11.6	11.3	11.0	10.7	10.4	10.0
70	13.7	13.3	13.0	12.6	12.3	12.0	11.7	11.3	11.0	10.7
75	14.4	14.0	13.6	13.3	13.0	12.6	12.3	12.0	11.7	11.4

Note: Add one per cent for heavily shaded fuels; subtract 0.5 per cent for very open forest. (Adapted from QDPIF, 2005).

On-site assessment

This assessment should be undertaken at the site of the proposed planned burn.

Step 4: Assess on-site weather conditions

Assess your on-site wind force, temperature, and humidity; then proceed to Step 5.

The fire behaviour models in Step 6 assume prevailing wind conditions not influenced by vegetation (i.e. 10 metres above ground at an open level site). This can be estimated by using the Beaufort table below, or by using a hand held anemometer at 2 m at an open site on level ground, and multiplying the result by 1.25 (CSIRO 1999). Ensure you measure wind speed over several minutes to gain an average.

Use a hand held meter (such as a Kestrel) to determine air temperature and relative humidity for your site.

Ensure you take measurements at the time of day you intend to burn. Be aware of the need to check and calibrate your hand held meter, as they have been known to develop inaccuracies over time.

The Beaufort scale

Wind force (Bf. No.)	Title	Characteristics	Km/h	Knots
0	Calm	Smoke rises vertically, no perceptible wind.	‹ 1	0
1	Light air	Smoke drifts, leaves barely move.	1–5	1–3
2	Light breeze	Wind felt on face, leaves rustle, small twigs move.	6–11	4–6
3	Gentle breeze	Leaves and small twigs in constant motion, light flags extended.	12–19	7–10
4	Moderate breeze	Raises dust, small branches are moved.	20–29	11–16
5	Fresh breeze	Small trees sway, large branches sway.	30–39	17–21
6	Strong breeze	Large branches in constant motion, wires whistle, umbrellas held with difficulty.	40–49	22–27
7	Near gale	Whole trees in motion, inconvenience felt when walking against wind.	50–61	28–33
8	Gale	Branches break off trees.	62–74	34–40
9	Strong gale	Slight structure damage, branches litter the ground.	75–88	41–47

Step 5: Estimate fuel load

To assess fuel load, estimate fine fuels and elevated fuels as described below. Then proceed to Step 6.

Fuel load is the combined total of surface fine fuels (dead fuels less than 6 mm in diameter, or the thickness of a pencil) and elevated fuels (elevated fine fuels and near-surface fine fuels) and is represented in tonnes per hectare (t/ha). Fuel load differs from fuel hazard. For more information about fuel hazard, refer to the glossary.

Stage 1—Choose representative locations

Every proposed burn area contains natural variations in topography, understorey or vegetation types. It is recommended that you select at least three locations that will be good indicators for the whole burn area (leave out areas you do not intend to burn). At these locations, walk around or if visibility is good look about, and average the result in your mind.

Stage 2—Estimate surface fine fuels (exclude fuels greater than 6 mm diameter)

- Estimate litter-bed depth in centimetres. As you walk or look about, use your finger or a ruler and take numerous litter depth measurements to support your estimate (litter depth is measured under slight pressure).
- Estimate the percentage of surface fine fuel cover. Walk around or take a 10 m radius and estimate the cover of leaves, twigs and bark on the ground.
- Apply the following formula (formula assumes 100 per cent cover and 1 cm depth is 5 t/ha).

  % cover / 100 x depth (cm) x 5 (t/ha) = fuel load (t/ha)

  Examples:
  - For 50 per cent cover and 1 cm of litter depth: **50 / 100 x 1 x 5 = 2.5 t/ha**
  - For 100 per cent cover and 2 cm of litter depth: **100 / 100 x 2 x 5 = 10 t/ha**
  - For 30 per cent cover and 5 cm of litter depth: **30 / 100 x 5 x 5 = 7.5 t/ha**

Stage 3—Estimate elevated fuels

- Vertically divide the area into three layers (knee, waist, shoulder—see diagram) of approximately 0.5 m each.

Shoulder (1.5 m)—includes shrubs and suspended material (e.g. leaves, bark, or twigs) less than 6 mm diameter.

Waist (1.0 m)—includes grasses, shrubs and suspended material less than 6 mm diameter.

Knee (up to 0.5 m)—includes grasses, forbs, herbs, small shrubs etc.

- Estimate percentage cover for each of these layers. Walk around or take a 10 m radius and estimate the cover of grasses or shrubs, this can be done at the same time as taking litter cover estimates.
- Apply the following formula (formula assumes that for each layer—100 per cent cover is 5 t/ha):

  (% cover of knee layer + % cover of waist layer + % cover of shoulder layer) / 100 x 5 (t/ha) = fuel load (t/ha)

  Examples:
  - Layer one has 10 per cent cover, layer two has 50 per cent cover and layer three has 30 per cent cover: **(10 + 50 + 30) / 100 x 5 = 4.5 t/ha**
  - Layer one has 100 per cent cover, layer two has 60 per cent cover and layer three has 40 cover: **(100 + 60 + 40) / 100 x 5 = 10 t/ha**

Stage 4—Estimate total fuel load

- Apply the following formula:

  Total fuel load = surface fuels + elevated fuels + bark (as required).

  If flammable bark fuel is present on boles or suspended in forks, and it is sufficient to carry fire into the branches of many trees, add one tonne per hectare. If most trees will carry fire up into the branches, add 2 t/ha.

  Example: For 6 t/ha surface fine fuels, 8 t/ha elevated fuels and a moderate amount of bark fuel present, therefore total fuel load is 15 t/ha, or 6 + 8 + 1 = 15 t/ha.

Step 6: Predict fire behaviour

Predict your fire behaviour. Then proceed to Step 7.

Stage 1—Estimate Fire Danger Index (FDI) using a CSIRO McArthur Meter

Use the relevant CSIRO McArthur Fire Danger Meter (instructions on the meter) and CSIRO Fire Spread Meter (as required) to ensure the FDI is within the parameters of your planned burn proposal. The CSIRO McArthur Fire Danger Meter can also be used to predict fire behaviour. However, be aware that these meters overestimate for planned burn conditions. Therefore, you are encouraged to use the QPWS adapted Queensland Forestry Fire Behaviour Tables provided in Stage 2 for more precise fire behaviour predictions.

For the digital version of the CSIRO Fire Danger and Fire Spread Calculator, go to the CSIRO website ‹www.csiro.au/products/fire-danger-and-spread-calculator›.

When using either the Grassland Fire Danger Meter or the Grassland Fire Spread Meter refer to Table 1 below to help estimate grass curing.

Table 1. Grassland degree of curing (indicative guide across an area)

Percentage (%) cured		Colour	Physiological changes
0	‹ 20 % difficult to ignite	Green	From germination to commencement of seed head development.
10	‹ 50 % will not carry a continuous flame front or result in intense fire	Green	Seed heads formed and flowering.
20		Greenish-yellow	Seed heads maturing and opening from the top.
30–40		Yellowish-green	Most seed heads mature and seeds dropping.
50–60	Fires will spread effectively in grasses cured › 50 %	Straw—odd patch of green or yellow green	Seeds dropped. Lower portions of stem still green. Some paddocks may be fully cured, others fairly green.
70–80	75–90 % results in a significant change in fire spread	Straw—very little green showing	Some greenness in lower third of some stalks.
90	› 90 % full fire spread potential reached	Straw	Odd stalk may show some green. Some gullies may show some greenness.
100		Bleached	All stalks fully cured. Seed head and stalk break easily.

(Adapted from QFRS 2005).

Stage 2—Fire behaviour predictions for planned burns under mild conditions

The following QPWS adapted Queensland Forestry Fire Behaviour Tables (Queensland Forestry, c.1970) have been modified to suit QPWS conservation requirements and so are useful to gain finer predictions for planned burning especially within the low to moderate fire danger ratings (FDI: 0 to 11).

Predict fire behaviour using the following tables.

- For areas with a light cover of leaf litter and sparse grass cover—refer Table A.
- For areas with a heavy cover of shrubs—refer to Table B.
- For grassy forests—refer to Table C.
- For grasslands—refer to Table D.

(Tables are based on optimum burning times in normal conditions—noon to 3.00 pm).

Notes:

1) The figures inside the thick lines are indicative of suitable conditions for planned burning. However, be guided by the recommended objectives and conditions in the relevant bioregional planned burn guidelines.
2) Rates of spread (RoS). These tables use average RoS for a mix of running and backing fires used in a grid lighting pattern.
3) Slope and its influence on fire behaviour. The QPWS adapted Queensland Forestry Fire Behaviour Tables are based on flat country.

Slope needs to be factored in as follows:

Upslope	Multiply by		Down-slope	Divide by
5˚ ↑	1.3	The rate of spread doubles for every 10˚ upslope and conversely halves for every 10˚ down slope.	5˚ ↓	1.3
10˚ ↑	2.0		10˚ ↓	2.0
15˚ ↑	3.0		15˚ ↓	3.0
20˚ ↑	4.0		20˚ ↓	4.0
25˚ ↑	6.0		25˚ ↓	6.0
30˚ ↑	8.0		30˚ ↓	8.0

Upslope example:

- 10˚ slope increases R, H by 2 (R: 3 m/hr x 2 = 6 m/hr, H: 2 m x 2 = 4 m).
- 30˚ slope increases R, H by 8 (R: 3 m/hr x 8 = 24 m/hr, H: 2 m x 8 = 16 m).

(R = rate of spread, H = flame height).

Table A. Light fuels = 8 t/ha

Figures inside the thick lines indicate optimum conditions for planned burns.

Wind force (Bf no.)	Fuel moisture factor							Details
	12	11	10	9	8	7	6	Percentage (%)
0	7	9	10	14	18	27	28	Rate of spread (m/hr)
	0.1	0.2	0.2	0.3	0.3	0.4	0.6	Flame height (m)
	1.0	1.0	1.0	2.0	2.0	2.0	3.0	Scorch height (m)
1	10	11	15	18	25	35	48	Rate of spread (m/hr)
	0.2	0.2	0.3	0.3	0.4	0.5	0.7	Flame height (m)
	1.0	1.0	2.0	2.0	2.0	3.0	3.5	Scorch height (m)
2	12	15	18	23	31	42	59	Rate of spread (m/hr)
	0.2	0.3	0.3	0.4	0.5	0.6	0.8	Flame height (m)
	1.0	2.0	2.0	2.0	3.0	3.0	4.0	Scorch height (m)
3	16	20	25	33	43	59	81	Rate of spread (m/hr)
	0.3	0.3	0.4	0.5	0.6	0.8	1.1	Flame height (m)
	2.0	2.0	2.0	3.0	3.0	4.0	5.5	Scorch height (m)
4	20	25	33	42	55	75	109	Rate of spread (m/hr)
	0.3	0.4	0.5	0.6	0.8	1.0	1.3	Flame height (m)
	2.0	2.0	3.0	3.0	4.0	5.0	6.5	Scorch height (m)
5	28	34	43	56	74	99	136	Rate of spread (m/hr)
	0.4	0.5	0.6	0.8	1.0	1.3	1.7	Flame height (m)
	2.0	3.0	3.0	4.0	5.0	6.5	8.0	Scorch height (m)

Subtract one from wind force when burning in stands with greater than 60 per cent canopy cover, to allow for reduction in wind.

Example calculation* from the table above:

If slope = 0˚; the wind force = 2 bf; and the fuel moisture factor = 8, then:
- Rate of spread = 31 m/hr
- Flame height = 0.5 m
- Scorch height = 3 m.

*Calculation assumes flat country (use slope calculation as required).

QPWS adapted Queensland Forestry Fire Behaviour Tables

Table B. Moderate–heavy fuels = 12 t/ha

Figures inside the thick lines indicate optimum conditions for planned burns.

Wind force (Bf no.)	Fuel moisture factor							Details
	12	11	10	9	8	7	6	Percentage (%)
0	12	15	17	23	30	45	61	Rate of spread (m/hr)
	0.3	0.3	0.4	0.5	0.7	1.0	1.3	Flame height (m)
	1.5	2.0	2.0	2.5	3.5	5.0	6.5	Scorch height (m)
1	16	18	25	30	42	57	80	Rate of spread (m/hr)
	0.4	0.4	0.6	0.7	0.9	1.2	1.7	Flame height (m)
	2.0	2.0	3.0	3.5	4.5	6.0	8.0	Scorch height (m)
2	20	25	30	39	52	70	98	Rate of spread (m/hr)
	0.5	0.6	0.7	0.9	1.1	1.5	2.1	Flame height (m)
	2.5	3.0	3.5	4.5	5.5	7.0	9.5	Scorch height (m)
3	27	33	42	55	72	98	135	Rate of spread (m/hr)
	0.6	0.8	0.9	1.2	1.5	2.1	2.7	Flame height (m)
	3.0	4.0	4.5	6.0	7.0	9.5	11.5	Scorch height (m)
4	34	42	55	70	93	125	172	Rate of spread (m/hr)
	0.8	0.9	1.2	1.5	2.0	2.8	3.8	Flame height (m)
	4.0	4.5	6.0	7.0	9.0	12.0	15.0	Scorch height (m)
5	47	57	72	93	124	165	227	Rate of spread (m/hr)
	1.0	1.2	1.5	2.0	2.8	3.8	4.8	Flame height (m)
	5.0	6.0	7.0	9.0	12.0	15.0	18.0	Scorch height (m)

Table C. Grassy forest

Figures inside the thick lines indicate optimum conditions for planned burns.

Wind force (Bf no.)	Fuel moisture factor							Details
	12	11	10	9	8	7	6	Percentage (%)
0	10	18	25	30	40	60	80	Rate of spread (m/hr)
	0.2	0.3	0.3	0.4	0.6	0.8	1.1	Flame height (m)
	1.5	2.0	2.0	2.0	3.0	4.0	5.5	Scorch height (m)
1	16	23	32	40	50	72	96	Rate of spread (m/hr)
	0.2	0.3	0.4	0.6	0.7	1.0	1.2	Flame height (m)
	1.5	2.0	2.0	3.0	4.0	5.0	6.0	Scorch height (m)
2	23	30	40	50	63	88	111	Rate of spread (m/hr)
	0.3	0.4	0.6	0.7	0.8	1.2	1.5	Flame height (m)
	2.0	2.0	3.0	4.0	4.0	6.0	7.5	Scorch height (m)
3	36	47	58	71	90	120	148	Rate of spread (m/hr)
	0.5	0.7	0.8	1.0	1.2	1.6	1.9	Flame height (m)
	3.0	4.0	4.0	5.0	6.0	8.0	9.0	Scorch height (m)
4	52	64	77	96	122	160	194	Rate of spread (m/hr)
	0.7	0.8	1.0	1.2	1.6	2.0	2.4	Flame height (m)
	4.0	4.0	5.0	6.0	8.0	9.0	10.5	Scorch height (m)
5	74	89	108	136	171	218	265	Rate of spread (m/hr)
	1.0	1.2	1.4	1.7	2.1	2.6	3.0	Flame height (m)
	5.0	6.0	7.0	8.0	9.5	11.0	12.0	Scorch height (m)

This table is based on average fuel condition of 4–8 t/ha, grasses 90 per cent cured and average canopy cover.

Heavy grass fuels will produce greater flame height than these average figures.
For open stands (20–40 per cent cover), add 1 to the wind force.

QPWS adapted Queensland Forestry Fire Behaviour Tables

Table D. Open grassland

Wind force (Bf no.)	Fuel moisture factor							Details
	12	11	10	9	8	7	6	Percentage (%)
0	10	18	25	30	40	60	80	Rate of spread (m/hr)
	0.2	0.3	0.4	0.4	0.6	0.8	0.8	Flame height (m)
1	30	39	49	61	77	105	133	Rate of spread (m/hr)
	0.4	0.6	0.7	0.8	0.8	0.8	0.9	Flame height (m)
2	75	90	110	137	173	220	265	Rate of spread (m/hr)
	0.8	0.8	0.9	0.9	1.0	1.1	1.1	Flame height (m)
3	120	150	185	235	294	390	450	Rate of spread (m/hr)
	0.9	0.9	1.0	1.1	1.2	1.3	1.4	Flame height (m)
4	350	450	550	650	760	880	1000	Rate of spread (m/hr)
	1.3	1.4	1.6	1.8	1.8	2.0	2.5	Flame height (m)
5	800	940	1000	› 1000	› 1000	› 1000	› 1000	Rate of spread (m/hr)
	2.1	2.3	2.5	2.5	2.5	2.5	2.5	Flame height (m)

This table is based on average native pasture which is 90 per cent cured.

Step 7: Predict fire severity

Predict your fire severity, and then proceed to Step 8.

Take your predicted flame height and/or scorch height from Step 6, and use these to estimate your fire severity class from the tables below. You will need to take note of the fire vegetation group that you are in and use the closest matching table below.

Fire severity class includes the concepts of fire intensity (the energy released by fire during combustion) and fire severity (the physical effect on vegetation and soil immediately after fire such as organic matter consumption and vegetation mortality). A moderate fire severity class equates to moderate fire intensity or a moderate fire severity depending on what phase of the fire you are describing.

Table 1. Open grassland/sedgeland (excludes tropical savanna)

Fire severity class	Fire intensity (during the fire)		Fire severity (post fire)	
	Fire Intensity (kWm-1)	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Patchy (P)	‹ 50	‹ 0.3	≤ 1.5	High percentage of patchiness. Does not remove all the surface fuels (litter) and near surface fuels.
Low (L)	50–100	0.3–0.5	≤ 2.5	Some patchiness. Most of the surface and near surface fuels have burnt. Stubble still evident.
Moderate (M)	100–1500	0.5–1.5	Complete standing biomass removed.	All surface and near surface fuels burnt. Stubble burnt to blackened remnants.
High (H)	1500–5300	1.5–4.0	Complete biomass removed.	Ground burnt completely. Stubble burnt to ash.
Very high (VH)	› 5300	› 4.0	Complete biomass removed.	Usually for high biomass grasses. Ground burnt completely. Stubble burnt to ash.

Note: based on fuel load at 6 t/ha, grasses cured at 90 per cent, Byram fireline intensity at 18 000 kilojoules per kilogram (kJ/kg).

Table 2. Tropical savanna woodlands and grasslands

Fire severity class	Fire intensity (during the fire)		Fire severity (post fire)	
	Fire intensity (kWm-1)	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Patchy (P)	‹‹ 100	‹‹ 0.5	‹‹ 2.0	High percentage of patchiness. Does not remove all the surface fuels (litter) and near surface fuels. Some scorching of elevated fuels (no higher than 2 m). No canopy scorch.
Low (L)	‹ 100	‹ 0.5	‹ 2.0	Some patchiness, most of the surface and near surface fuels have burnt. Some scorching of elevated fuels. Little or no canopy scorch.
Moderate (M)	100–500	0.5–1.5	2.0–5.0	All surface and near surface fuels burnt. All or most of mid-storey canopy leaves scorched. Upper canopy leaves may be partly scorched.
High (H)	500–10 000	1.5–4.0	Complete canopy scorch.	All ground material affected by fire. All mid storey canopy leaves scorched or charred. All upper storey canopy leaves scorched.
Very high (H) to Extreme (E)	› 10 000	› 4.0	Completely charred.	Ground, mid-storey, and upper-canopy are completely affected by fire. Most leaf material is removed or charred.

Note: based on fuel load at 6 t/ha, Byram fireline intensity at 20 000 kJ/kg. Higher fire intensities at high to extreme fire severity classes due to tropical savanna conditions—but flames heights are still compatible with the fire behaviour tables.

(Adapted from Edwards, A. 2009 - Bushfire CRC).

Table 3. Open forests/woodlands

Fire severity class	Fire intensity (during the fire)		Fire Severity (post fire)	
	Fire intensity (kWm-1)	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	‹ 150	‹ 0.5	‹ 2.5	Significant patchiness. Litter retained but charred. Humus layer retained. Nearly all habitat trees, fallen logs, and grass stubble retained. Some scorching of elevated fuels. Little or no canopy scorch.
Moderate (M)	150–500	0.5–1.5	2.5–7.5	Moderate patchiness. Some scorched litter remains. About half the humus layer and grass stubble remain. Most habitat trees and fallen logs retained. Some scorch of elevated fuels. Little or no canopy scorch.
High (H)	500–1000	1.5–3.0	7.5–15.0	Some patchiness. Some humus remains. Some habitat trees and fallen logs affected. At least some canopy scorch in moderate ‹ 20 m height canopy, mid stratum burnt completely (or nearly so).
Very high (VH)	1000–3000	3.0–10.0	Extensive scorching.	All understorey burnt to ash (or nearly so). Most habitat trees and fallen logs affected. Extensive crown scorch.
Extreme (E)	› 3000	› 10.0	Partial or total defoliation.	All understorey burnt to ash (or nearly so). Loss of nearly all habitat trees and fallen logs. Partial or total defoliation.

Note: based on fuel load at 8 t/ha, grasses cured at 90 per cent, Byram fireline intensity at 18 000 kJ/kg.

Table 4. Low open forest/woodland with heath dominate understorey ‹ 10 m

Fire severity class	Fire intensity (during the fire)	Fire severity (post fire)	
	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Patchy (P) to Low (L)	‹ 1.0	‹ 5.0	40–60 per cent vegetation burnt. Unburnt vegetation (green patches) in the ground and shrub layer. Does not remove all the surface fuels (litter) and near surface fuels. Can create distinct ‘holes’ in closed heath. Overall little canopy scorch. Some scorching of shrubs and small trees.
Moderate (M) to Extreme (E)	› 1.0	› 5.0	Understorey burnt to mineral earth. Greater than 60 per cent vegetation burnt. Extensive to total foliage burnt. Minimal evidence of green vegetation remaining. Largely only skeletal frames of shrubs and small trees remain.

Note: based on fuel load at 12 t/ha, Byram fireline intensity at 18 000 kJ/kg.

Table 5. Heathland ‹ 2 m (coastal, sandstone, montane)

Fire severity class	Fire intensity (during the fire)	Fire severity (post fire)
	Average flame height (m)	Description (loss of biomass)
Patchy (P) to Low (L)	‹ 1.0	40–60 per cent vegetation burnt. Unburnt vegetation (green patches) in the ground and shrub layer. Does not remove all the surface fuels (litter) and near surface fuels. Can create distinct ‘holes’ in closed heath. Overall little canopy scorch. Some scorching of shrubs and small trees.
Moderate (M) to Extreme (E)	› 1.0	Greater than 60 per cent vegetation burnt. Understorey burnt to mineral earth. Extensive to total foliage burnt. Minimal evidence of green vegetation remaining. Skeletal frames of shrubs.

Note: based on fuel load at 12 t/ha, Byram fireline intensity at 18 000 kJ/kg.

Table 6. Cypress dominated communities

Fire severity class	Fire intensity (during the fire)		Fire severity (post fire)	
	Fire intensity (kWm-1)	Average flame height (m)	Average scorch height (m)	Description (loss of biomass)
Low (L)	‹ 50	‹ 0.3	‹ 1.5	High percentage of patchiness with minimal encroachment into cypress dominated communities. Undamaged cypress crowns. No signs of stem or bark damage.
Moderate (M)	50–200	0.3–1.0	1.5–5.0	Some patchiness, most of the surface fuels have burnt. Moderate scorch with up to 50 per cent of crown affected. Up to 25 per cent of stem circumference charred or weeping.
High (H)	200–500	1.0–2.0	5.0–10	Ground and mid-stratum burnt. Some habitat trees and fallen trees affected. Severe scorch with 50–100 per cent of crown affected. Up to 50 per cent of stem circumference charred or weeping.
Very high (VH)	500–2000	2.0–4.0	Complete canopy scorch.	All understory burnt. Most habitat trees and fallen logs affected. Full crown scorch with high probability of death expected. All butt stem (0.5 to 1 m height) circumference charred or weeping. Occasional flaring to tree tops.
Extreme (E)	› 2000	› 4.0	Completely charred.	All understory burnt. Most habitat trees and fallen logs affected. Full crown removal with no recovery expectation. All stem circumference charred or weeping. Frequent flaring and/or crown fires.

Note: Based on fuel load at 6–12 t/ha, Byram fireline intensity at 18 000 kJ/kg.

Step 8: Consider fuel arrangement

Consider how the arrangement of fuel at your site could moderate fire behaviour predicted from previous steps; especially if there is a large amount of available elevated fuel or high biomass grasses. Then move to Step 9.

For open forests and woodlands the Overall Fuel Hazard Assessment Guide (Hines et al. 2010) is useful to understand the influence of fuel arrangement. The digital version can be sourced online from the Victorian Department of Sustainability and Environment at ‹www.dse.vic.gov.au›.

Fuel hazard is the ‘condition of the fuel taking into consideration such factors as quantity, arrangement, current or potential flammability and the difficulty of suppression if fuel should be ignited’ (Wilson 1992). It differs from fuel load (dry weight of fuel).

The below photos used the same volume of fuel (18 pages of newspaper). However, this can result in quite different fire behaviour depending on how it is arranged.

Photo 1: Fuel hazard (left) vs. fuel load (right) pre ignition.

Photo 2: Fuel hazard (left) vs. fuel load (right) post ignition.

Step 9: Review burn proposal parameters

Check that your weather conditions, FDI and your predicted fire behaviour are within the limits of the conditions outlined in your burn proposal. Also, ensure the overall fire severity planned, the planned coverage or patchiness, and the measurable objectives set for this burn will be achievable given the predicted fire behaviour. Then move to Step 10.

Step 10: Test burn

Prior to commencement of a planned burn, test burns should be conducted. Before igniting a test burn, ensure you have adequate resources to easily extinguish the burn.

There are different ways test burns can be used:

- Test burning may also be used to monitor drying conditions leading up to the likely burn window. Sometime before the day of the burn—in conditions similar to those you intend to use for the main burn—test burn to refine your understanding of the precise conditions that will be suitable to achieve the objectives of your burn proposal.
- On the day of the burn, conduct a test burn in order to improve your understanding of how the fire will behave prior to proceeding with the main burn.
- Many sites, particularly large sites, have variation in fuel and moisture, and burning in different locations and at different times will help you understand the different ways fire will behave. Sometimes test burning extends into progressive burning, where small fires within the planned burn area are ignited over months as conditions are monitored and a mosaic of burnt and unburnt areas is built.

Choose a site and conditions for your test burn:

- The site(s) chosen for test burning should be representative of your planned burn area (avoid edges of road due to drying effects).
- You might also choose sites that test particular issues such as if a fire will carry into a non-target area such as a riparian zone, or to see if a fire will carry into a lantana infestation.

Conduct test burn:

- You should conduct the test burn during a similar time of day that you intend to do the main burn (not hours before hand).
- Ignite test burn with a single point ignition.
- Monitor test burn in order to estimate flame height and rate of spread without the fire becoming difficult to control (about six to 15 minutes in duration or five metres in diameter should be sufficient); To get an more accurate fire behaviour indication, the test burn can be allowed to proceed for a longer period, but contain if the fire appears too intense or unsuitable.
- Ensure the burn is completely extinguished before leaving.

Assess test burn:

- Measure the distance the flame travelled in metres over six minutes and calculate the rate of spread in metres per hour (m/hr) (e.g. travelled four metres in six minutes: 4 x (60/6) = RoS 40 m/hr).
- If flame height or rate of spread is not within the range to achieve the objectives of the planned burn, then extinguish the test burn.
- Be prepared to proceed if the test burn indicates the fire will achieve the objectives of your planned burn.

Glossary of fire terminology

(**Primary source:** Australasian Fire Authorities Council 2011).

Terminology	Definition
Available fuel	The portion of the total fuel that would actually burn under current or specified conditions.
Backing fire	The part of a fire which is burning back against the wind or down slope, where the flame height and rate of spread is minimal.
Beaufort scale	A system of estimating and reporting wind speeds, invented in the early 19th century by Admiral Beaufort of the Royal Navy. It was originally based on the effects of various wind speeds on the amount of canvas that a fully-rigged frigate of the period could carry, but is now modified and modernised.
Char height	Height to which former green leaves still suspended on plants are turned black by the flame of the fire (Note: This cannot be measured on the stems of plants as fire 'climbs' the bark).
Crown scorch	Browning of the needles or leaves in the crown of a tree or shrub caused by heat from a fire.
Drought index	A numerical value, such as the Byram-Keetch Drought Index, reflecting the dryness of soils, deep forest litter, logs and living vegetation.
Fire sub-zone (fire association)	Term used in the QPWS fire management system for an area, within a fire management zone, that requires a particular fire management regime. The regime may be based on the fire management requirements of vegetation, fauna habitat, cultural resources, infrastructure or production values or a combination thereof.
Fire Danger Index (FDI)	A relative number denoting an evaluation of rate of spread, or suppression difficulty for specific combinations of fuel moisture and wind speed.
Fire intensity	Fire intensity is the product of rate of spread, fuel load, and the heat released from the fuel during combustion. This measure describes the amount of energy released per unit length of fire front, in units of kilowatts per metre of the fire line.
Fire severity	A measure of the effect of fire on vegetation and soil after the fire (e.g. vegetation consumption, vegetation mortality, soil alteration).
Fire severity class	A qualitative indicator of the effects of fire on an ecosystem, whether it affects the forest floor, canopy, or some other part of the system. Like fire intensity, fire severity reflects the amount of heat released by a fire, and therefore it is also dependent on fuels and fire behavior. But a fire severity class also integrates fuel and soil conditions before a fire, energy released during and after flaming combustion, and visible effects after a fire.
Fire vegetation group	Group of related regional ecosystems that share common fire management intent. For the purpose of practical fire management, these ecosystems are treated as a group.

Terminology	Definition
Flame height	The vertical distance between the average tip of the flame and ground level, excluding higher flares.
Fuel	Any material such as grass, leaf litter and live vegetation, which can be ignited and sustains a fire. Fuel is usually measured in tonnes per hectare (t/ha).
Fuel hazard	The condition of the fuel, which takes into consideration such factors as quantity, arrangement, current or potential flammability and the difficulty of suppression if fuel should be ignited. To estimate fuel hazard (recommended for use in planned burn objectives) use the Victorian Overall Fuel Hazard Assessment Guide (Hines et al. 2010). The latest version of fuel hazard guide can be downloaded from the Victorian Department of Sustainability and Environment website ‹www.dse.vic.gov.au›.
Fuel load	The dry weight of combustible materials per area, usually expressed as tonnes per hectare. A quantification of fuel load does not describe how the fuel is arranged, nor its state or structure.
Fuel moisture content	The water content of a fuel particle expressed as a percent of the oven dry weight of the fuel particle.
Grid ignition	A method of lighting planned burns where ignition points are set individually at a predetermined spacing through an area.
Humus (or duff layer)	The mat of undecomposed or partly decomposed vegetation matter on the forest floor, the original vegetative structures still being recognisable.
Keetch-Byram Drought Index (KBDI)	A numerical value reflecting the dryness of soils, deep forest litter, and heavy fuels and expressed as a scale from 0–203.
Litter	The top layer of the forest floor composed of loose debris of dead sticks, branches, twigs, and recently fallen leaves and needles, little altered in structure by decomposition (the litter layer of the forest floor).
Mineral earth	Being completely free of any vegetation or other combustible material.
Mosaic burn	A planned burning approach which aims to create spatial and temporal variation in fire regimes across fire-prone communities and landscapes.
Patchiness	A percentage or proportion of the ground layer vegetation (grasses, herbs and trees/shrubs less than one metre) not affected by fire (i.e. 20 per cent patchiness = 80 per cent burnt).
Rate of spread (RoS)	The forward progress per unit time of the head fire or another specified part of the fire perimeter, defined as metres per hour (m/hr).
Relative humidity (RH)	The amount of water vapour in a given volume of air, expressed as a percentage of the maximum amount of water vapour the air can hold at that temperature.
Scorch height	Height to which former green leaves still suspended on plants is turned brown by the heat of a fire.
Test burn	A controlled fire ignited to evaluate fire behaviour.

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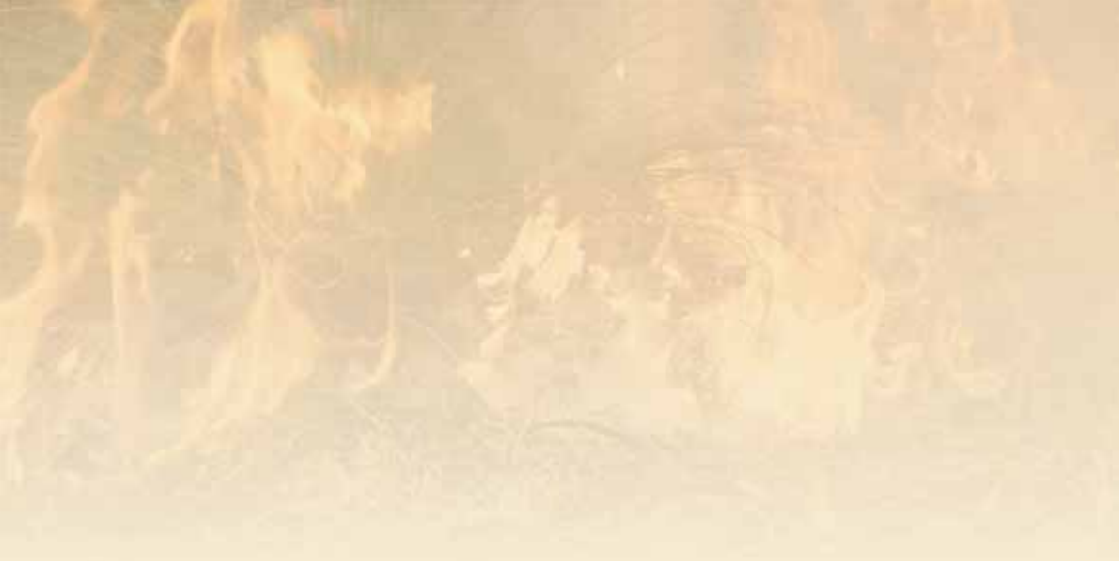
Notes

Burn ready—Site assessment form

(File with your fire report)

Date:	/ /		Assessor(s):		
Burn proposal #:			Location:		
Step 1 Assess weather					
Forecasted weather:	Days prior to burn:		Day of burn:		Days after burn:
KBDI:	KBDI		KBDI		KBDI
Relative humidity:	%		%		%
Temperature:	˚C		˚C		˚C
Wind speed:	km/h		km/h		km/h
Step 2 Assess drying time (number of days before you can burn)					
Rain event (amount of rain):	mm		Minimum drying time:		days
Step 3 Assess fuel moisture factor (FMF)					
Relative humidity:	%	Temp:	˚C	FMF:	
Step 4 Assess wind speed					
Wind force (Bf. No.):	Bf No.		Wind speed:		km/h
Step 5 Fuel load assessment					
Stage 1—Choose representative locations (three sites ideally)					
Stage 2—Surface fine fuels (< 6 mm): % cover / 100 x Depth (cm) x 5(t/ha) = Fuel Load (t/ha)					
Stage 3—Elevated fuels: (% cover of knee layer + % cover of waist layer + % cover of shoulder layer) / 100 x 5(t/ha) = Fuel Load (t/ha)					
Stage 4—Total fuel load = surface fuels + elevated fuels + bark (as required) (if bark fuel is present add 1 or 2 tonnes/hectare)					
Stage 1—Site	**Stage 2**—Surface Fuels	**Stage 3**—Elevated Fuels	**Stage 4a**—Bark (add as required)		**Stage 4b**—Total fuel load
Site 1					t/ha
Site 2					t/ha
Site 3					t/ha
Stage 4c: Average total fuel load (sites: 1 + 2 + 3 / 3)			Av		t/ha
Step 6 Predict fire behaviour					
Specifications	**Fire danger meter**				**QPWS fire behaviour tables**
Rate of spread (no slope):	Slope: 0 ˚		km/h		m/hr
Rate of spread (max. slope):	Slope:	˚	km/h		m/hr
Curing (as required):			%		%
Flame height:			m		m
Spotting distance:			km	Scorch height:	m
Fire danger rating/ index:	FDR:		FDI:		
Step 7	**Predict fire severity**				
Habitat type:			Fire severity class:		



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