Risk Management Framework for Prescribed Burning

PRODUCED BY THE NATIONAL BURNING PROJECT

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An Australian Government Initiative

— Centre of Excellence —
PRESCRIBED BURNING

INTRODUCTION

The National Burning Project (NBP) has brought together inter-related aspects of prescribed burning across Australasia to design guiding frameworks and principles for a more holistic and consistent approach to prescribed burning. A number of detailed reports have been produced (as shown on page 14), each of which stands alone, yet with synergies across reports that have been drawn together into a number of easy to use synopses:

- *Process Map of Prescribed Burning*
- *Best Practice Principles for Prescribed Burning*
- ***Risk Management Framework For Prescribed Burning (this document)***
- *Objectives, Monitoring and Evaluation Framework for Prescribed Burning*
- *Program Logic for Prescribed Burning*

The synopses are designed to facilitate greater utilisation of the prescribed burning principles by land and fire professionals and aim to improve consistency nationally, and provide orientation to users about the NBP products and how they fit together.

The frameworks produced by the NBP identify four phases of planning and implementing prescribed burning. All of these ready-to-utilise synopses are presented across the four phases of prescribed burning as described below.

Figure 1 | The four phases of prescribed burn planning and implementation

STRATEGIC PLANNING	PROGRAM PLANNING	OPERATIONAL PLANNING	BURN IMPLEMENTATION
Objectives, risk management, consultation and communication			
Long-term planning driving the scale and nature of an agency's prescribed burning program.	Programming the scheduling of burns one to five years ahead.	Advance planning for individual burns usually resulting in a burn plan.	Mobilisation, briefings, test burn, light up, mitigation measures, control strategies, mop-up, patrol and reporting.
=> 5 years	1 – 5 years	Months/year	Days
Jurisdiction, region, property	Jurisdiction, region, property	Individual burn	Individual burn
Research, monitoring, evaluation and reporting			

The *Risk Management Framework For Prescribed Burning* offered here is a ready-to-utilise synopsis of the key material produced for the National Burning Project's four risk management frameworks:

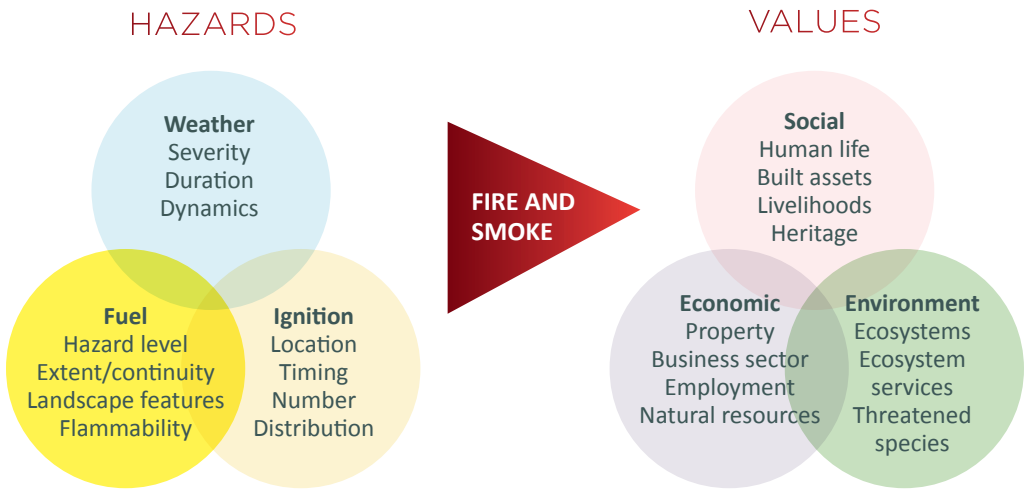
- *Risk Management and Review Framework for Prescribed Burning Risks Associated with Fuel Hazards*
- *A Risk Framework for Ecological Risks Associated with Prescribed Burning*
- *Risk Management Framework – Smoke Hazard and Greenhouse Gas Emissions*
- *A Risk Framework for Operational Risks Associated with Prescribed Burning*

This risk framework synopsis is expected to have benefits to those involved in developing or reviewing organisational procedures, IT systems, business processes or policy as well as assist people who are undertaking burn planning or implementation.

Department of Environment, Water and Natural Resources, South Australia

Commonly, risk is considered as a combination of the likelihood of an event arising together with the consequences of the event. In a prescribed burning context, values attributes may sometimes be equivalent to 'consequence' risk factors because they are factors influencing the severity of impacts arising from a fire. Hazard attributes may sometimes be referred to as 'likelihood' risk factors (see Figure 2).

Figure 2 | Prescribed burning risk arises from the intersection of hazards with values



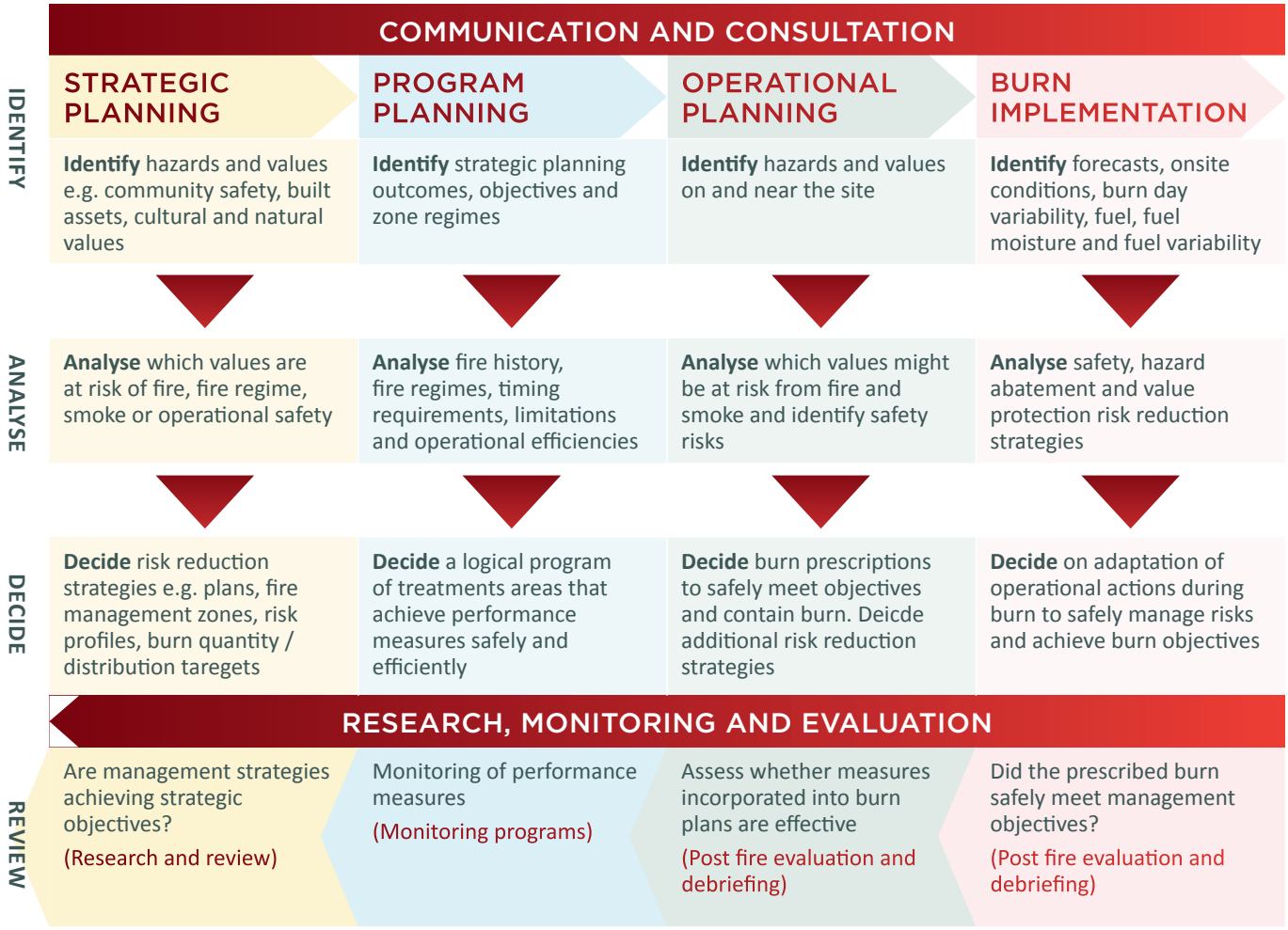
Risk can be considered in terms of its dimensions. The dimensions of risk are the topics under which risk can be considered, such as burn security, crew safety, public safety, and the environment. Within each dimension of risk, the degree of risk can be reduced by adding risk-control measures into layers of protection that back each other up, leading to a reinforced risk-management system (i.e. Swiss cheese model as proposed by Reason, 1990). Table 1 broadly outlines risk-dimensions referenced to the risk frameworks presented in this document.

Table 1 | Risk dimensions against phases of prescribed burning

REF.	RISK DIMENSION	STRATEGIC PLANNING PHASE	PROGRAM PLANNING PHASE	OPERATIONAL PLANNING PHASE	IMPLEMENTATION PHASE
Figure 4	**Fuel**	Models/simulators, hazard/risk assessments, strategies/zones	Fire history, fuels, targets, staging	Prescriptions, fuel reduction measurable objectives	Ignition strategies, post fire assessment of measurable objectives
Figure 5	**Ecology/ environment**	Knowledge, systems, strategies	Prioritisation trade-offs, fire intervals and seasons	Prescriptions, specific risk controls	Ignition strategies, specific risk controls, post fire evaluation
Figure 6	**Smoke**	Pollutions standards	Cumulative smoke issues, scheduling	Prescriptions and constraints (e.g. wind direction)	Smoke dispersal models/ simulators, forecasts, ignition strategies
Figure 7: Operational risks	**Burn containment**	Systems, procedures, standards	Scheduling of burn and works, cumulative impact on resourcing	Planning suitable boundaries, resources and contingencies	Assessing control lines, adjusting ignition patterns, monitoring fire and conditions
	Crew safety	Systems, procedures, standards, training	Allocation of suitable resources and staff, being realistic when programming burns	Burn complexity matched to crews/ burn manager, contingencies, identify safety hazards	Safety and site checks, briefings, equipment, command structure, debriefs
	Public safety	Regulation, policies and procedures	Burn area selection	Prescriptions, risk controls, traffic control contingencies	Signage and notifications, site checks and resources to manage public and traffic
	Impact on values	Knowledge, guidelines, systems, strategies	Seasons, scheduling, timing requirements	Prescriptions, boundaries, risk controls	Ignition strategies, monitoring fire and conditions, post fire evaluation

Figure 3 presents an outline of the risk management solution as adopted in the risk management frameworks presented in Figure 4, 5, 6 and 7. Risk management actions are presented against each stage of prescribed burning. Communication and consultation occurs as a continuous process with actions embedded within each phase as required. Research, monitoring and evaluation complete a feedback loop, with actions addressed at the bottom of each phase.

Figure 3 | Overview risk management framework for prescribed burning



Although these risk management frameworks begin with strategic planning level considerations, prior to the strategic planning phase are a range of considerations of which planners must be aware. These include policy and organisational level considerations that significantly influence prescribed burning. Planners should be aware of:

- Agency wide objectives and policies for prescribed burning, ecological, environmental, safety, public and staff management.
- Systems and procedures for prescribed burning, safety, risk, impact assessment and community engagement.
- Technical guidelines and decision support systems for fuel assessment, fire behaviour, fire spread, smoke management, ecological fire regimes etc.
- Public engagement information systems, portals and procedures (e.g. internet portals, social media, text messaging systems).
- GIS, asset management, human resource and other data systems.
- Technical capability, resources, equipment, staffing and financial allocation supporting the quantity, type and complexity of prescribed burning activities required.
- Prescribed burning approval, referral and quality checking processes.

PRINCIPLES OF RISK MANAGEMENT

Each of these frameworks has been based on *ISO 31000:2009 Risk Management – Principles and Guidelines* which is the primary standard on risk management in Australia and New Zealand. The ISO standard presents 11 risk management principles. These have been contextualised to prescribed burning below.

1. Create and protect value

Good risk management contributes to the successful achievement of an agency's prescribed burning program and objectives (e.g. objectives relating to employee and public safety, operational effectiveness, financial efficiency and loss minimisation, agency reputation and social licence, environmental protection, legal compliance and meeting political imperatives) through the continuous review of its processes and systems.

2. Be an integral part of organisational processes

Risk management needs to be integrated with an agency's governance framework and become an embedded part of its planning processes, through all phases of the prescribed burning process from strategic planning, through program and operational planning phases, to implementation.

3. Be part of decision making

The process of risk management assists decision makers to make informed choices, identify priorities and select the most appropriate action. This applies through all the phases of prescribed burning.

4. Explicitly address uncertainty

Identifying uncertainties is a necessary part of identifying potential risks – agencies can implement controls and treatments to optimising the chance of success while reducing (but not necessarily eliminating) the chance of failure or loss.

5. Be systematic, structured and timely

The process of risk management should be consistent across an agency to ensure efficiency, consistency and the reliability of results. Well-formed and clear risk management procedures and systems enable staff to have a structured and timely response to risks.

6. Based on the best available information

To effectively manage risk it is important to understand and consider all available information relevant to a prescribed burning activity and to be aware that there may be limitations on that information, potentially creating uncertainties. It is then important to understand how all this information informs the risk management process, and to adjust risk management as new and improved information becomes available (e.g. as commonly occurs during the burn implementation process).

7. Be tailored

An agency's risk management framework needs to include its risk profile, as well as take into consideration its internal and external operating environment.

8. Take into account human and cultural factors

Risk management needs to recognise the contribution that people and culture have on achieving an agency's objectives. Prescribed burning is implemented by people who are influenced by their organisational culture.

9. Be transparent and inclusive

Engaging stakeholders, both internal and external, throughout the risk management process recognises that communication and consultation is key to identifying, analysing and monitoring risk. External stakeholders may have key information or insights relevant to managing prescribed burning risks, and in many cases may be able to contribute to controlling risks. Transparency in the form of clear and timely public information will enable the community to make any necessary preparations to mitigate impacts such as smoke.

10. Be dynamic, iterative and responsive to change

The process of managing risk needs to be flexible. The challenging and dynamic environment of fire management requires agencies to consider the context for managing risk as well as continuing to identify new risks that emerge. Allowances should be made for those risks that no longer exist or which change.

11. Facilitate continual improvement

Agencies with a mature risk management culture are those that have invested resources in review and evaluation processes over time, and are able to demonstrate the continual achievement of their objectives because they have developed sophisticated procedures and systems for addressing uncertainties.

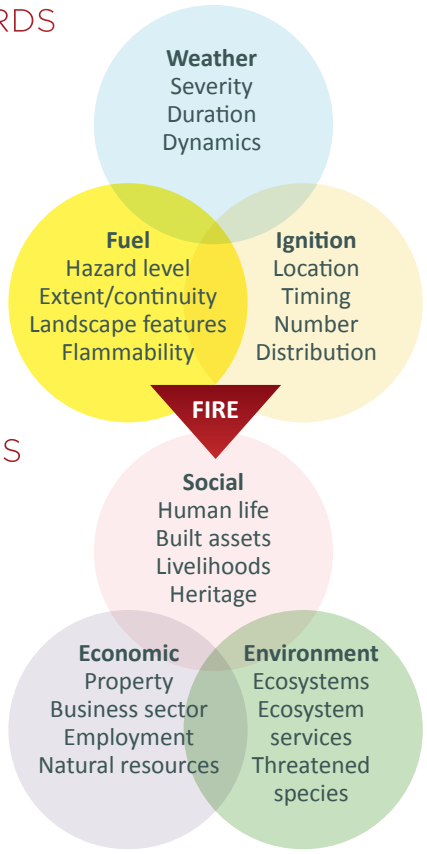
Northern Territory Fire and Rescue Service

Figure 4 | Fuel hazard risk management framework for prescribed burning

COMMUNICATION AND CONSULTATION

STRATEGIC PLANNING

HAZARDS



Prepare strategic planning documents

IDENTIFY

Identify how bushfires can develop and spread through fuel hazards in the landscape, and determine their potential impact zones (intersection with assets/values).

ANALYSE

- Hazard type (fire behaviour potential)
- Hazard extent (fire size and impact area potential)
- Hazard topographic location (fire behaviour escalation potential)
- Hazard proximity to fire-vulnerable values (impact potential)

DECIDE

- Which fuel hazard types to fuel-reduce
- Treatment types, objectives and dimensions
- Re-treatment regimes or trigger conditions
- How much of the landscape to treat
- How to arrange treatments/zones in the landscape to maximise risk reduction benefits and optimise trade-offs

Identify residual risk and how hazard reduction will work with complementary bushfire risk reduction strategies.

PROGRAM PLANNING

Burn programs

IDENTIFY

The fuel hazard related outputs of strategic planning may be such things as designation of fuel management zones, with different fuel reduction objectives, treatment area dimensions and fire-return cycles attaching to each. Alternatively, outputs may be expressed as residual risk targets or desired fuel age distribution patterns in the landscape (e.g. a bushfire should not be able to run more than X km before running into an area with a fuel age of Y or less). However strategic planning outputs are expressed, program planning of fuel hazard reduction is aimed at giving effect to the strategic plans.

ANALYSE

- Strategic planning implementation requirements and desired fire regimes
- Fire history as compared to strategic planning requirements
- Areas recently burnt by bushfires
- Areas recently treated by hazard reduction
- Areas in designated burning zones approaching (or beyond) treatment trigger thresholds
- Current seasonal climate effect on fuel hazard distribution and condition
- Works carrying over from previous planning periods
- Risk reduction enhancement opportunities offered by recent fuel hazard-reducing events including bushfires
- Availability of man-made and natural features to facilitate burn containment
- Values-conflicts requiring consideration

DECIDE

Based on available options, priorities, resources and seasonal conditions, decide the works quantum and timing to be implemented over the planning cycle.

The output from a burn program usually consists of a prioritised list of nominated burns with maps indicating their treatment boundary. However, the process may generate draft or partially completed burn plans requiring development during operational planning phase.

RESEARCH, MONITORING AND EVALUATION

Are fuel management strategies decreasing fire size, severity and impact? Are social, economic and environmental loss/damage rates reduced? (Review of strategies and performance measures).

Assess extent to which the burn program is sufficient to achieve fuel management zone/distribution specifications. Periodically review program planning practices.

Fuel hazard risk management framework for prescribed burning (cont)

COMMUNICATION AND CONSULTATION

OPERATIONAL PLANNING

Prepare burn plans

IDENTIFY AND ANALYSE

To achieve burn objectives, comply with prescriptions and identify resources and risk management requirements. Consideration of what fire behaviour will occur during burning is essential and necessitates consideration of fuel hazard factors. Consider:

- Fuel (vegetation) type and variability within the burn area
- Fuel quantity or hazard level variability within the burn area
- Anticipated fuel availability (as determined by moisture content) within the burn area
- How slope and lighting patterns will affect fire behaviour in the different fuels
- Locations where fuel factors pose elevated risks of fire breaching burn boundaries or damaging assets in or adjacent to the burn
- Fuel characteristics to allow fire behaviour prediction in fuels adjacent to the burn area
- Contingency areas and actions

A range of risk factors are assessed in addition to fuel hazards (as covered by other risk frameworks). They can be used for the purpose of triggering different levels of burn review, authorisation and supervision and contingency planning requirements.

DECIDE

- Establish measurable fuel/hazard reduction objectives for individual burns (i.e. post-treatment fuel outcome specifications)
- Burn prescriptions (ideally these should include fire behaviour prescriptions not just weather parameter prescriptions)
- Conditions to avoid (e.g. particular wind directions)
- Burning operations/site preparatory requirements
- Resource requirements and burn implementation organisation (e.g. sectors) if required
- Notification requirements
- Operating instructions (including lighting sequence and patterns; burn inclusion and exclusion areas, and site-specific risk management measures for the burn)

BURN IMPLEMENTATION

Implement burn

IDENTIFY AND ANALYSE

Burn supervisors and crew members make frequent assessments (mostly mental and undocumented) of fuel hazard risk factors throughout a burn, making decisions to amend lighting patterns and alter resource deployment arrangements to maintain burn crew and public safety, burn security, and to ensure burning objectives are met. Fuel hazard risk assessment actions undertaken include:

- Assessing burn containment lines to identify specific areas where adjacent fuel hazards may pose risks to burn security (e.g. patches of heavy fuel; roadside windrows; long-unburnt stringybark trees; hollow trees, vegetation types in which fire behaviour can suddenly escalate; heavy fuels in gullies sloping up to containment lines etc.)
- Brief crews using SMEACS or similar format ensuring they understand objectives, prescriptions, risk management and safety considerations.
- Considering how fire will behave as it moves between vegetation types and how this will affect burn security and objectives
- Considering how fire behaviour will change on different slopes and aspects, and how this will affect burn security and objectives
- Considering how diurnal fuel moisture cycles will affect fire behaviour, including variation in drying rates on different aspects
- Considering how changes in wind direction and/or speed may change during the day and how this will affect fire behaviour and burn security
- Considering how different lighting methods, patterns and spacing will affect fire behaviour in different fuel types and topographic positions, and how these will affect burn security and objectives
- In marginal conditions (e.g. bordering on too moist or too dry) considering where or when best to start burning operations to take best advantage of diurnal fuel moisture cycles (or deciding not to burn)
- When fire behaviour is sub-optimal to meet burn objectives, considering how to increase or decrease fire behaviour whilst maintaining burn security
- Considering what fire behaviour will occur if fire escapes across boundaries in different locations and what suppression resources are appropriate to contain any escapes

DECIDE

Decide when the burn is safe and when crews can be stood down. Consider ongoing patrolling needs.

RESEARCH, MONITORING AND EVALUATION

Assess whether the volume and quality of burning operations is sufficient to deliver the burn program. Periodically review planning practices and delivery model.

Assess burn outcomes against objectives, prescriptions and risk control specifications. Record outcomes. Periodically review operating practices.s.

Figure 5 | Ecological risk management framework for prescribed burning

COMMUNICATION AND CONSULTATION

STRATEGIC PLANNING

Prepare strategic planning documents

IDENTIFY

Identify values in and near the plan area and determine which values are vulnerable to fire or smoke impacts:

- Loss of ecosystem health, function or biodiversity due to inappropriate fire or fire regimes
- Identify ecological communities that are fire adapted and fire sensitive
- Identify ecosystem condition, identify conservation and biodiversity priorities
- Identify species populations, population trends where available and rare and threatened species
- Identify habitat improvement and rehabilitation priorities

ANALYSE

- Ecosystem / region specific synthesis of all available knowledge to identify appropriate fire regimes from research, local knowledge including practitioner, Traditional Owners, expert opinion, monitoring, surveys, modelling & extrapolation
- Compare current fire management trends against desirable fire regimes and the organisations' position for ecological risk
- Evaluate areas & causes of unacceptable risk, e.g. inappropriate fire regimes
- Evaluate competing objectives (e.g. fuel management, grazing)
- Triage ecosystems and areas of highest priority
- Determine any special considerations for rare, vulnerable, endangered or regionally/locally significant species and their habitats
- Potential environmental impacts e.g. weeds, waterways.

DECIDE

- Establish ecological objectives for prescribed burning. Determine strategic planning scope.
- Record recommended fire regimes and prescribed burning requirements for zones/areas
- Decide any additional risk mitigations required for rare and threatened species or habitats
- Determine risk treatments for environmental impacts to waterways, or from pets/weeds etc.
- Synergise risks, risk treatments, zoning and objectives and document expectations for the management of ecological risk

PROGRAM PLANNING

Plan burn programs

IDENTIFY

Examine political, environmental, social, technical, legal and economic (PESTLE) sources of risk including:

- Key performance indicators e.g. regime targets, vegetation age class structure, GMAs etc.
- Inappropriate fire regime
- Prioritisation risk (ecological burning not high enough priority/traded off, sometimes need to prioritise specific ecological issues over others)
- Scheduling risks (season, conditions, species needs, addressing particular issues with correct timing)
- Resourcing risks (sufficient resources?)
- Community engagement and support

ANALYSE

Evaluate the potential sources of ecological risk against the objectives of the program:

- Review strategic requirements including fire regime requirements and objectives
- Review previous fire history (including bushfire) and its influence on the burn program (are burns/objectives still valid?)
- Review current fire regime status against identified ideals or targets
- Review competing priorities for burning and find synergistic solutions
- Review any timing requirements for burns (e.g. for threatened species), consult experts as required
- Identify timing constraints
- Be aware of progressive burning requirements (burning off the back of other burns)

DECIDE

- Identify suitable scheduling of burning that balances competing objectives and priorities
- Identify suitable scheduling of burning that respects timing requirements of ecosystems and species
- Identify suitable scheduling of burning that respects timing constraints (e.g. social and natural)
- Identify a burning program that achieves good ecological value for money/resources
- Engage with and garner community support for the program

RESEARCH, MONITORING AND EVALUATION

Are strategies controlling adverse ecological outcomes? Are current fire regimes on track, off track or well outside of ideal regime? (Strategy review, review of monitoring outcomes and research)

Did the program achieve longer term ecological outcomes such as maintaining ecosystems, diversity and species populations? (Monitoring)

Ecological risk management framework for prescribed burning (cont)

COMMUNICATION AND CONSULTATION

OPERATIONAL PLANNING

Prepare burn plans

IDENTIFY

Examine political, environmental, social, technical, legal and economic (PESTLE) sources of risk including:

- Not reflecting strategic/program requirements
- Poor burn objectives or prescriptions
- Properly identifying values at risk
- Unrealistic or overly prescriptive risk mitigations
- Legal/social constraints becoming unwieldy

ANALYSE

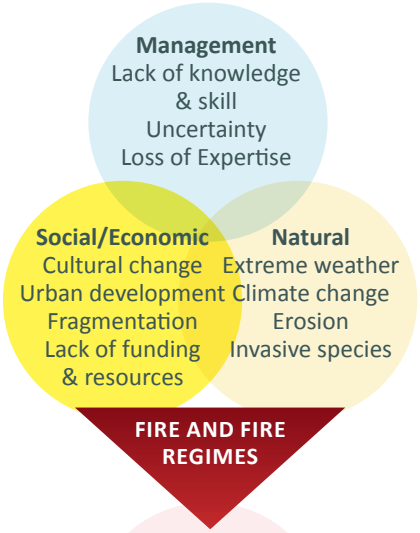
- Evaluate the potential sources of ecological risk against the objectives of the burn
- Review strategic/program requirements
- Observe/understand your ecosystem's condition and requirements (consult experts as required)
- Desktop and field assessments of specific values at risk (species, sensitive vegetation etc.)
- Identify environmental risks (to waterways, weed spread etc.)
- Manage legal and social constraints in a timely and strategically considered fashion

DECIDE

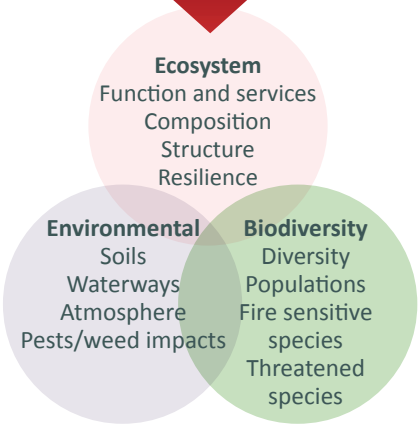
- Well thought out objectives that understand the ecosystem and any specific biodiversity needs and balance competing needs
- Identify prescriptions and ignition tactics to achieve the desired fire behaviour to meet objectives
- Identify specific ecological issues, species and fire sensitive vegetation that require specific measures above and beyond the ecological prescription above (do not include issues that are already catered for within the ecological prescription above unless required for legal or social reasons)
- Identify specific risk management strategies for issues, species and fire sensitive ecological values identified above
- Identify environmental controls (e.g. to control weed spread, waterway impacts etc.)

BURN IMPLEMENTATION

HAZARDS



VALUES



Implement burn

IDENTIFY AND ANALYSE

- Brief crews using SMEACS or similar format ensuring they understand objectives, prescriptions and risk management considerations
- Monitor approaching windows of opportunity for best timing
- Determine if pre-burn activities are complete (e.g. species management, weed control, establishment of monitoring plots, control lines)
- Evaluate ignition pattern & strategy, plus weather and fuel dryness to achieve desired fire behaviour
- Allow flexibility of ignition, but understanding how different fire behaviour scenarios will effect ecological outcomes

DECIDE

- Adequate skill & experience of practitioners to create ideal fire behaviour & patterns
- Implement hygiene & operational risk controls
- Ensure fire behaviour meets objectives, record fire behaviour
- Post-burn evaluation
- Good mapping of burn contributing to useful fire history

RESEARCH, MONITORING AND EVALUATION

Was the burn plan practical, suitable and comprehensive but flexible? (Debriefs)

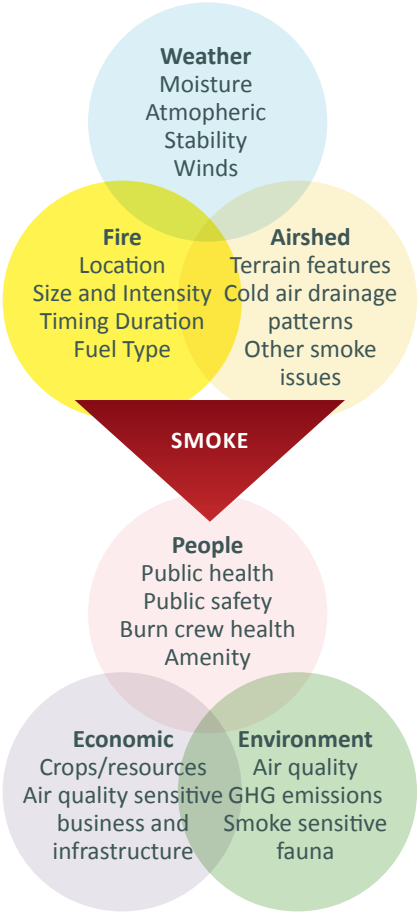
Did the prescribed burn meet objectives? (Post-burn evaluation and mapping)

Figure 6 | Smoke and greenhouse gas emissions risk management framework for prescribed burning

COMMUNICATION AND CONSULTATION

STRATEGIC PLANNING

HAZARDS



Prepare strategic planning documents

IDENTIFY

- Values sensitive to smoke impact (location/extent, exposure timing, and sensitivity threshold dimensions)
- Areas prone to smoke concentration/persistence (with consideration of background particulate pollution levels)
- Weather patterns conducive to poor smoke dispersal and accumulation of smoke at surface level
- Burning types, scales and times that produce problem quantities of smoke at surface level

ANALYSE

- Analyse where, when, how, and why problem level smoke concentrations occur and identify how potential smoke impact events or areas intersect with smoke-sensitive values

DECIDE

- Weather patterns to avoid (poor smoke dispersal)
- Landscape locations requiring special or extra risk controls
- Burn timings/locations to avoid
- Burn activity level limits under different conditions

Put in place capacity, systems and tools to implement smoke management strategies

PROGRAM PLANNING

Plan burn programs

IDENTIFY AND ANALYSE

The following smoke risk reduction strategies can influence burn program planning:

- Fuel management zone types which typically involve large-scale, long-duration, burning operations can, where practicable, be placed an appropriate distance from smoke sensitive assets/values. (Note: fuels closest to assets can generate the highest risks, so there are practical limitations on the extent to which smoke risk avoidance can be achieved)
- Where bushfire hazards requiring fuel reduction are in close proximity to smoke sensitive assets/values, burn programming can consider:
  - Choice of time to avoid high sensitivity exposure, or
  - Choice of burn area dimensions to avoid high smoke exposure level events, or
  - Choice of seasonal timing or weather pattern to maximise smoke dispersal, or
  - Choice of lighting method or pattern to achieve rapid burn-out and therefore limit period of exposure
- Where at-risk values are vulnerable to smoke only at certain times, burn timing to avoid sensitive times can be considered
- Where particular weather patterns are conducive to poor smoke dispersal or surface level smoke concentration, burn timing to avoid such weather patterns can be considered
- Where landform features serve to concentrate smoke under particular conditions, special prescriptions might be considered
- Awareness of cumulative smoke impacts and avoiding where necessary or practical, programming too many burns in the one locality
- Awareness of Pollution/ EPA standards
- Limit GHG emissions by choosing seasons and conditions that avoid the consumption of heavy fuels where possible. Early dry season burning to reduce extent of late season fires (northern Australia)

DECIDE

Decide burn program scheduling. While smoke risk avoidance/reduction strategies can be considered, conflicts between at-risk values and safe burning practice limitations may still arise where smoke risk cannot be eliminated. In these cases, smoke impact reduction measures may be limited to operational burning techniques

RESEARCH, MONITORING AND EVALUATION

Are smoke management strategies decreasing adverse incident frequency, duration & severity? Are smoke impact consequences reduced? (Periodic review of strategies)

Assess extent to which the burn program is sufficient to achieve fuel management zone/ distribution specifications. Periodically review program planning practices

Smoke and greenhouse gas emissions risk management framework for prescribed burning (cont)

COMMUNICATION AND CONSULTATION

OPERATIONAL PLANNING

Prepare burn plans

IDENTIFY AND ANALYSE

Burn plans may include:

- Types of smoke-sensitive assets/values near the burn area and their locations
- Desired smoke plume behaviour and smoke dispersal trajectories
- Desired weather parameters to achieve desired smoke behaviour and trajectory
- Desired fuel moisture conditions to minimise smoke quantity
- Desired burn-out timeframe to minimise over-night burning/smoke generation and surface smoke ponding
- Fire exclusion areas to avoid high volume smoke and GHG production (e.g. peat areas or particular vegetation types)
- Identification of specific weather patterns or ignition timings which should be avoided
- Where possible identify conditions that avoid smouldering of heavy fuels (for GHG mitigation)

The above measures in operational plans are designed to minimise smoke production and impact to at-risk values. All burns will generate smoke and some degree of local level impact, therefore smoke consequence management also needs to be planned. This includes:

- General warnings to local community and stakeholders (ideally incorporating smoke considerations in messaging)
- Specific notifications, especially to smoke sensitive facilities/utilities (including businesses which own smoke sensitive animals which can be relocated/sheltered)
- Smoke hazard signage and traffic control requirements
- Personal protective equipment and first aid requirements

DECIDE

Record any fire behaviour, weather prescriptions, weather restrictions (e.g. wind direction), fuel condition, signage, traffic control or other mitigation measures required in the burn plan

BURN IMPLEMENTATION

Implement burn

IDENTIFY

Brief crews using SMEACS or similar format ensuring they understand objectives, prescriptions and risk management considerations

ANALYSE AND DECIDE

Burn supervisors and burn program coordinators make numerous operational decisions in the immediate lead-up to, and during burning operations which are taken to manage smoke risks. Smoke risk assessment and management actions undertaken include:

- Assessing ambient smoke levels and current and forecast weather conditions, and/or Ventilation Index and Air Quality Index levels to determine if burning should proceed
- Assessing predicted smoke plume trajectories and concentrations in relation to smoke sensitive locations to determine if conditions are suitable for burning
- Notifying likely-to-be-impacted smoke-sensitive or vulnerable facilities, people and businesses of what impact avoidance or reduction measures they should take and when they need to take them
- Assessing the location of roads that may be impacted by smoke and making appropriate traffic management arrangements
- Assessing fuel types and their fuel moisture content to determine ignition timing and lighting patterns for optimising burn security and minimising smoke production;
- Considering desirable burn-out completion timeframes so as to ensure the bulk of the smoke is produced during favourable dispersal conditions, and that residual smouldering after dispersal conditions deteriorate is minimised
- Prior to down-scaling operations, assess the current location and density of smoke, and forecast conditions overnight – revise smoke hazard signage arrangements accordingly
- If smoke aloft is considered likely to descend and pool at surface level overnight, consider which parts of the terrain this is most likely to occur in and make appropriate arrangements to check smoke conditions in the morning
- If heavy surface ponding of smoke occurs, issue appropriate warnings and notifications so smoke risk mitigation measures can be taken
- Where possible, avoid non-target fuels and use conditions that avoid excesses smouldering of heavy fuels (GHG mitigation)

RESEARCH, MONITORING AND EVALUATION

Assess whether standards and guidelines for incorporation of smoke and GHG management requirements in operational burn plans are relevant and effective

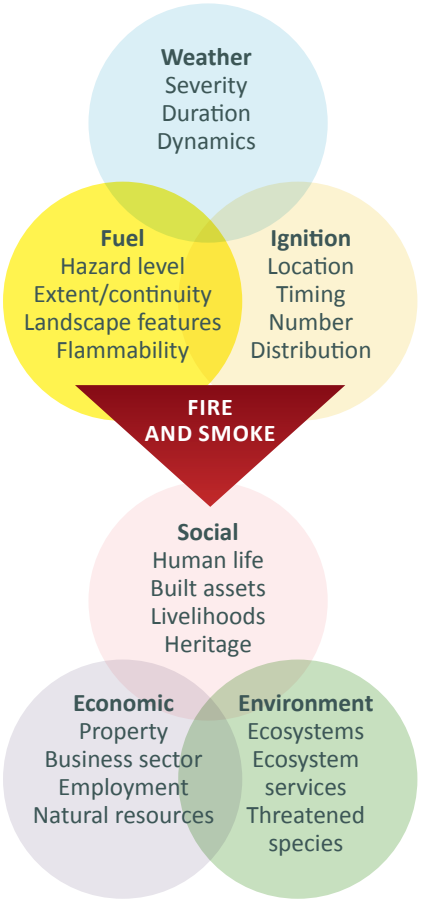
Assess outcomes of burns against objectives, prescriptions and risk control specifications. Record outcomes. Periodically review operating practices

Figure 7 | Operational risk management framework for prescribed burning

COMMUNICATION AND CONSULTATION

STRATEGIC PLANNING

HAZARDS



IDENTIFY AND ANALYSE

Operational safety objectives at a strategic level are addressed mostly through agency policy, procedures, training and systems:

- Systems and procedures are matched to the scale of complexity of prescribed burning required including:
  - Procedures, technical guidelines and decision support systems for fuel assessment, fire behaviour, fire spread, smoke management, ecological values and community engagement.
  - GIS, asset management, human resource and other data systems
- Technical capability/capacity, resources, equipment, staffing and financial allocation commensurate to quantity, type and complexity of prescribed burning activities required
- Training competencies, training material, trainers and training systems. Recruitment and retention strategies. Mentoring and professional development opportunities
- Approval, referral and quality checking processes

DECIDE

Ensure fire strategies are in alignment with organisational policy, capacity and capability. Strategies should address:

- Risk assessment
- Community engagement
- Protection of life and property
- Bushfire mitigation
- Protection of built, natural and cultural values

PROGRAM PLANNING

Plan burn programs

IDENTIFY AND ANALYSE

Agency policy and performance measures

Resources, equipment and staffing matched to burn program scale and complexity:

- Assess burn program quantity, complexity and technical difficulty in relation to internal capacity and capability
- Avoid nominating burns into programs that are beyond the technical capability of available resources. Be aware of resourcing implementation of aggregate burn program

Appropriate selection of burn area and timing:

- Prescribed burn area, location, boundary, timing and sequence selection are not avoidably difficult or risky to treat operationally
- Assess the extent to which prudent program design (timing, sequencing and placement of burns) can reduce operational risks. Decide fire control line investment that could reduce operational delivery risks
- Avoid programming burns during periods with conditions that pose high risks of escapes or during periods of escalating bushfire risk. This needs to be weighed against risks of delaying burns
- Burn area selection and timing will not generate undue smoke impacts or unnecessary cumulative smoke impacts
- Burn area dimension, location and timing do not generate collateral impacts to built assets, cultural and natural values that are outside of tolerable limits
- Be aware of burns that have particular sequencing requirements to build protective buffers of lower fuel for subsequent burns
- Program more burns where possible so that in the event of inclement weather in one location, burns in other locations can be brought forward.

Consultation and awareness raising:

- Consult members of public as required and raise level of public awareness of burn programs (newspapers, internet) well in advance of prescribed burning activity to increase community acceptance of burn programs and allow community members to be prepared
- Determine sector engagement that may be required

DECIDE

Decide burn program scheduling that addresses operational risks

RESEARCH, MONITORING AND EVALUATION

Are operational risk and safety policy, procedures and systems leading to improvements in safety? (Periodically review policy, procedures and systems)

Assess extent to which program planning contributes to reducing operational risks. (Review performance measures or metrics on safety)

Operational risk management framework for prescribed burning (cont)

COMMUNICATION AND CONSULTATION

OPERATIONAL PLANNING

Burn control and security

IDENTIFY AND ANALYSE

- Use prescriptions that are suitable to achieve prescribed burn objectives while safely containing the burn. Be aware of conditions that may produce unexpected fire behaviour
- When monitoring windows of opportunity for burning, select a day, or sequence of days when forecast weather conditions are predicted to generate controllable fire behaviour, and in which the burn can be completed and securely mopped-up
- Apply higher level of rigour/approval when it is determined that it is necessary to burn outside of prescription
- Confirm burn boundary features are appropriately located and are suitable to contain predicted fire behaviour. For unbounded burns, understand where the burn is likely to stop /extinguish and how. Seek local knowledge when determining suitability of boundaries
- Have in place ready to activate fall-back containment and consequence management contingencies

Burn crew safety

- Scope out risks to crew safety and identify any planned mitigation strategies required to reduce risk
- Consider hazardous trees, vehicle movement, head stress/medical, equipment use, environmental, built obstructions, flame and smoke
- Confirm burn access routes and boundaries for lighting and burn management are identified and accessible. Confirm escape routes and safety zones are clear and safe to use

Public safety

- Consult neighbours and stakeholders prior to the burn so they can raise issues pertinent to burn planning and take any actions required to prepare their property
- Scope out any public safety hazards particular to the burn site and contingency area and plan any mitigation measures required to reduce risks to acceptable levels
- Consider people unexpectedly present in the burn area, smoke impacting on sensitive receptors (e.g. nursing homes) and transport infrastructure, traffic risks and hazardous trees
- After ignition phase, site safety checks are often conducted prior to re-opening the site to crews or the public

Impact on values

- Identify values using desktop and field assessment. Record their location in the burn plan and consult asset owners/ specialists to confirm avoidance or protection measures
- Plan and implement the burn at a time and in conditions that are within acceptable limits of impact potential and damage to values. Ensure containment boundaries are suitable

DECIDE

Record smoke and fire-vulnerable values and risks, and prescriptions, mitigations and contingencies within a burn plan

BURN IMPLEMENTATION

IDENTIFY

- Brief crews using SMEACS or similar format ensuring they understand safety, values and risk management considerations and any objectives identified for operational risks. It is important to brief crews about contingency arrangements and ensure they understand triggers that may activate planned contingencies

Burn control and security

ANALYSE AND DECIDE

- Boundaries may have been prepared weeks or months in advance, and therefore there is a need to check boundaries close to the day of burning
- Confirm the ignition method and lighting sequence, pattern and timing are suitable for site conditions (e.g. fuels, slope, weather, resources) and will keep containment lines manageable, and meet burn objectives and fire behaviour prescriptions
- Ensure crews are appropriately skilled for lighting and containing the burn in their sector(s) and maintain leadership over lighting crews
- Monitor fire behaviour and containment security, and apply control measures to any fire events and circumstances which pose unacceptable threats.
- Enact contingencies where required

Burn crew safety

- Ensure burn personnel have competencies, experience and skills appropriate for the burning operation and their role. Ensure crews are supervised and are following correct procedure
- Treat hazards identified in the burn plan and ensure all areas where crews will be working are assessed for site and operation-specific crew safety hazards
- Crews should be appropriately equipped, dressed in approved PPE and have effective means of communication

Public safety

- Ensure that neighbours and other potentially affected stakeholders are notified that the burn is taking place and reminded of their opportunity to complete preparations for impact avoidance or minimisation of smoke effects
- Ensure public information signage, smoke warning hazard signage, traffic control and any other planned public safety measures are in place
- Confirm members of the public are clear of the designated burn area and areas immediately adjoining the burn site
- Ensure operational measures are implemented to maintain public awareness and safety throughout prescribed burning operations, and enact contingency measures if required

Impact on values

- Implement mitigation strategies identified in the burn plan and any other mitigation measures required to protect values. A wide range of measures are possible such as burning away from the values, using particular wind directions and raking fuel away from values
- Monitor success of protection measures and adjust if required
- Monitor fire behaviour and containment security, and apply control measures to any fire events and circumstances which pose unacceptable threats to values (e.g. flare-ups, increased fire behaviour or spot-overs)

RESEARCH, MONITORING AND EVALUATION

Assess whether operational safety and values protection measures incorporated into burn plans are relevant and effective

Assess success of risk mitigation strategies through debrief and post burn evaluations

NATIONAL BURNING PROJECT

The National Burning Project was jointly commissioned by the Australasian Fire and Emergency Service Authorities Council (AFAC) and the Forest Fire Management Group (FFMG) and has produced a range of products as shown below.

FUNDAMENTAL

SYNOPSES

SYNOPSES

A great resource summarising the guidelines and frameworks developed by the National Burning Project as simple and ready-to-use brochures.

NATIONAL POSITION

The National Position articulates a nationally agreed position on prescribed burning and establishes principles for the development and implementation of prescribed burning policies and programs.

AN APPROACH TO OBJECTIVES SETTING

A tool for clearer identification of costs and benefits when analysing competing objectives in planning for prescribed burning.

PROCEDURAL

BEST PRACTICE GUIDELINES

Strategic

Operations

The frameworks and principles identified in these documents will be valuable to practitioners, planners and land managers with an interest in planning or undertaking prescribed burning in the best possible way.

RISK FRAMEWORKS

Operations and safety

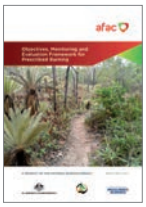
Smoke and GHG

Fuel hazard

Ecological

These reports build and present frameworks that can be adopted by practitioners and agencies to facilitate improved approaches and greater appreciation of risks associated with undertaking prescribed burning.

MEASURING PERFORMANCE



Objectives & monitoring

Performance measures

A framework and set of performance measures for evaluating prescribed burning against desired objectives.

BEST PRACTICE SYNOPSES

Process map

Step-by-step best practice guide for prescribed burning, from strategic planning through to burning implementation.

Best practice principles

Best practice principles for prescribed burning summarised into a ready-to-use synopsis for the benefit of prescribed burning professionals.

RISK MANAGEMENT SYNOPSIS

The risk management framework for prescribed burning summarised into a ready-to-use synopsis for the benefit of prescribed burning professionals.

PROGRAM LOGIC

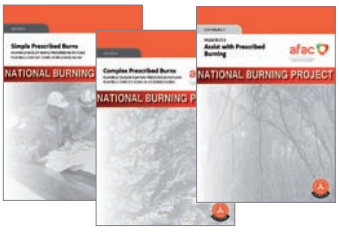
Diagrammatic summary of the rationale behind prescribed burning.

TECHNICAL

TRAINING MANUALS

These learner resources provide instruction and theory that can be used by students or by instructors for lesson planning.

- Assist with prescribed burning
- Simple prescribed burns
- Complex prescribed burns



TOOLBOX

The National Tool Box is a repository of existing decision support tools that can aid in prescribed burning.

SUPPORTING PUBLICATIONS

OVERVIEW

This report is a very useful introduction and overview of prescribed burning in Australasia and the evidence base that underpins the use of planned fire.

BEST PRACTICE REVIEW

This report provides a detailed account of the prescribed burning practices that are considered to be examples of best practice.

SCIENCE REVIEW

Reviewing science, practical and Traditional Owner knowledge around the use of prescribed burning as a land management tool.

CAPABILITY REVIEWS

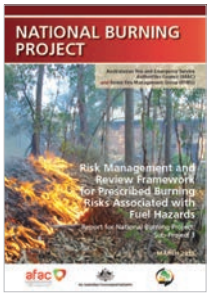
Training

Resources

A review of prescribed burn training and resource capability to aid in improving training and resource sharing outcomes.

Department of Parks and Wildlife, Western Australia

This synopsis was derived from four risk management frameworks produced by the National Burning Project and which consider management and review of risk management in relation to fuel hazard, smoke and greenhouse emissions, ecology and operations. Hard copies are available from the AFAC shop at ww.afac.com.au and more information is available from www.afac.com.au/initiative/burning.



This report reviews the approaches undertaken by various Australian and New Zealand land and fire management agencies with regard to management of risks associated with bushfire fuels. From this starting point, it builds and presents a framework that can be adopted by Australian and New Zealand agencies to facilitate an improved alignment of approaches and greater appreciation of fuel risks.

AFAC has engaged with land and fire management agencies to bring together a risk management framework for ecological risks associated with prescribed burning. This framework offers a synthesis of concerns, approaches and activities that organisations across Australia engage in to manage ecological risks across all phases of planning, implementation and evaluation of prescribed burns.

This document reviews the approaches undertaken by various Australian and New Zealand land and fire management agencies with regard to management of risks associated with smoke and greenhouse gas emissions. From this starting point, it builds and presents frameworks that can be used in the context of prescribed burning, to manage smoke and emissions impacts on amenity, prosperity, health and safety.

The objective of this report is to design a nationally-agreed risk management framework for prescribed burning operations, for use by anyone involved in prescribed burning. It addresses risks associated with burn containment, crew safety, public safety and impacts on values.

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Australasian Fire and Emergency Service Authorities Council Limited (ABN 52 060 049 327)

Level 1, 340 Albert Street East Melbourne
Victoria 3002

This document has been developed from consultation and research between Australasian Fire and Emergency Service Authorities Council Limited (AFAC), its members and stakeholders. It is intended to address matters relevant to fire, land management and emergency services across Australia, New Zealand and the Pacific Region.

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BEST PRACTICE PRESCRIBED BURNING SYNOPSES:

- ***Process Map of Prescribed Burning***
- ***Best Practice Principles for Prescribed Burning***
- ***Risk Management Framework for Prescribed Burning (this document)***
- ***Objectives, Monitoring and Evaluation Framework for Prescribed Burning***
- **Program Logic for Prescribed Burning**

www.afac.com.au/initiative/burning

Bushfire and Natural Hazards CRC

Cover photo credit: Department of Parks and Wildlife, Western Australia

AFAC Limited (ABN 52 060 049 327)
Level 1, 340 Albert Street,
East Melbourne, Victoria, 3002
Phone: 03 9419 2388
Email: afac@afac.com.au
www.afac.com.au

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