Expert Witness Statement of Roger Fenwick

(Expert retained by Union Fenosa Wind Aust P/L)

1 Name and address

Roger Fenwick, Bush Fire Consultant

26/16-22 Helen St Lane Cove NSW 2066

2 Area of expertise

(a) My area of expertise is bush fire safety planning, management and investigation .

(b) My qualifications and experience are detailed in Annexure A.

(c) I am sufficiently expert to make this statement because:

- I have qualifications and many years of practical experience in all facets of bush fire management including planning and control.
- I have extensive experience in preparing land and vegetation management plans for unusual or complex use areas such as National Parks, plantations and Defence sites.
- I introduced the use of helicopters in fire control in the ACT in the 1976/77 fire season, and helped pioneer their use in helibucket-based fire suppression as well as for aerial ignition of large hazard reduction blocks.
- I worked for 3 years in the USA as a field representative for a fire retardant company, and was heavily involved with the US Forest Service's air tanker program.
- I directed field and air operations for Project Aquarius, the CSIRO investigation of the cost-effectiveness of large air tankers in Australia.
- I have a good understanding of the principles of air tanker use in fire control, including their limitations in practical fire control.

3 Scope

3.1 Instructions

I was asked to investigate the complexities of fire control on land, some of it supporting raised bed cropping, in an area on which it is proposed to establish a wind farm. I am to investigate the real and perceived problems which would result from the probable removal of aerial fire fighting within the site, and suggest solution(s) to allow effective fire control.

3.2 Process and methodology

I reviewed maps and plans of the area, studied general descriptions of Raised Bed Cropping, and reviewed the submissions to the Panel. I then visited the area, inspected a number of treated paddocks, and spoke directly or by telephone with a number of landowners and CFA members. I prepared a map of affected paddocks, inspected the public roads in and around the site, and prepared a report in which I analysed probable fire spread and suppression options with and without the wind farm.

I prepared a separate report on fire management principles and elements which is appended to this Statement.

3.3 Reports reviewed

I reviewed numerous submissions to the Panel, and spoke to landowners involved in the proposed project, and opposed to it. I have not identified those to whom I spoke, but have reported their comments fairly. I have drawn my own conclusions based on my own knowledge and experience.

3.4 Assumptions

I have not made any assumptions.

3.5 Limitations and exclusions

I am not aware of the details of operations of wind farms, or the (potential) fire problems associated with the turbines used. I have made a few general comments based on information provided by the proponent.

4 Findings

4.1 Summary of opinions

In my opinion, the fire control difficulties on the site are a function of the pre-existing practice of Raised Bed Cropping. While installation of wind turbines would remove the option of aerial suppression of grass fires over the area, I do not believe that to have been a viable technique in any case and its loss is thus null.

My detailed analysis of bushfire issues for Berrybank, and the derivation of my conclusions, are set out in the attachment to this statement.

4.2 Basis for opinions

I believe that the implementation of the recommendations within my report would improve the safe and effective management and control of fires within the general area, and in particular the site of the proposed wind farm. A principal objection concerns the loss of aerial fire control techniques, but I do not believe that they were ever a viable option at this site in any case. Alternate passive management practices are recommended, which I believe would result in a better outcome than at present, and which, by taking advantage of some of the wind farm infrastructure features, would improve fire control capabilities.

4.3 Management recommendations

I am told that it is standard practice to require preparation of a wildfire prevention and emergency response plan in consultation with appropriate stakeholders where developments of this scale are approved. Normal conditions include:

- Static water provision,
- Vegetation management, fuel control, and provision of fire fighting equipment,
- Access road standards,
- Introductory and ongoing site familiarisation visits for emergency service personnel, &
- Training in suppression of fires in wind energy facility equipment.

I agree that a fire management plan should be prepared for the area, although more on the basis of the limitations created by Raised Bed Cropping than in response to the proposed wind

farm. I do not intend to be argumentative, but to assess this matter as a fire technician. Considering the standard points in order:

- No wind farm activity will create an increased need for static water supply for fire fighting, and it would therefore be inappropriate to require such provision.
- The proponent is not engaged in any land or vegetation management activity, is not likely to initiate fire, and it would be inappropriate to require the provision of fire control equipment other than as needed on their own service vehicles operating on formed roads and tracks.
- Internal tracks were originally intended to be 3.5m in width. I have recommended that the driveable, permanently clear of vegetation, surface be 5m wide, on the basis that research shows this to be the most effective width. It would also allow vehicles to pass. This is a cost to the landowners, in terms of loss of productive land, but is a desirable if not necessary response to the RB cropping practice that has resulted in the loss of direct fire attack capability.
- Agreed, and suggest that local agricultural aviation operators should be included.
- Agreed, to the extent that it is possible to undertake any form of active fire fighting in connection with wind farm equipment.

5 Response to key submissions

The fire-related comments made and objections raised are:

5.1 Hamilton Highway fire-break[1], [2], [3]

Agreed that annual burning/slashing/ploughing should continue, to protect against fires escaping Raised Bed (RB) paddocks in which direct fire-fighting cannot be undertaken.

5.2 No turbines south of Hamilton Highway[1], [2], [3]

I see no reason for, or merit in, such a restriction. If wind turbines were an established fire risk, and the Hamilton Highway a major fire containment line to deal with that threat, the suggestion may have value. However, without a supporting rationale based on bushfire grounds associated with a wind farm, I do not consider the suggestion to be reasonable.

5.3 60m wide cleared area around entire perimeter[1], [3]

60m is an arbitrary figure, but one which, if implemented, would require an additional 20m within adjoining private property where existing road easements of 40m (2 chains) already exist, and an extra 40m where 20m (1 chain) easements were already established. 20m is a regarded as a wide break in grass. To put it in perspective, in NSW a 60m wide fuelbreak is the widest listed, and is specified around a subdivision exposed to forest fire travelling up a 15° slope. Half of that width would be only thinned of trees and shrubs to the extent needed to prevent crown fire, with 30m in a mown-grass equivalent condition.

The whole farming area has generally well-prepared road verges evidently intended to form the basis of a broad-scale fire containment strategy. To require an additional break of the suggested magnitude around the designated wind farm perimeter, which does not necessarily correspond to public road, farm or even existing paddock boundaries, would take a lot of agricultural land out of production, without creating a recognised benefit. On fire technical grounds, it is in my view an unwarranted response to any wind farm issues.

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[1] Graham & Catherine Keating

[2] Brendan Keating

[3] Country Fire Authority

5.4 Proximity of proposed Stockyard Hill terminal station[1]

This is some 3km away from the Berrybank site boundary, will be built to relevant standards, and I see no fire-related relevance to the Berrybank proposal.

5.5 Buffer zone between wind farm and terminal station[1]

I see no point in such a requirement. There must be fire protection measures in place around the terminal station, and being an integral part of the wind farm, wherever it is located will be part of the wind farm in any case.

5.6 Fire management strategy for Raised Bed Cropping areas[4, 1, 2, 3, 5, 6, 7, 8, 9]

I agree that a series of passive protection measures needs to be implemented to overcome the limitations imposed by RB, and some possibilities have been addressed in my report. However, the limitations imposed by the presence of wind farm turbines do not, in my view, significantly impede active fire control. The only restriction is on aerial activity, which would be of very limited utility under Extreme fire danger conditions. The creation of additional access roads and fuelbreaks within presently inaccessible areas would more than offset the loss of a highly questionable capability.

5.7 Fire vehicles and crews are unable to access land due to RB[12]

Agreed that there are significant limitations due to RB. However, that already present problem will be partly alleviated by the increased provision of access tracks (which will double as fuelbreaks) to the wind turbine towers. If (as recommended) the access tracks have a 5m wide fuel-free width, passing will be possible along their entire length. Turnaround facilities will exist at every tower site.

5.8 Loss of aerial fire-fighting capability within the wind farm area[1, 2, 3, 6, 8, 9]

I agree that this will be lost, but I do not believe, for the reasons elaborated in the body of my attached report, that this is a real loss of a technique which could have been used effectively in any case. Slow-moving fires under mild conditions will still be able to be dealt with by a mixture of direct and indirect attack by ground crews. (Expensive, slow to react) helitack is not the first choice for initial attack on grass fires under bad conditions. Under Extreme conditions, aerial fire-fighting is almost completely ineffective within grass areas, and would make almost no useful contribution to fire fighting within the proposed wind farm area. A possible loss may be the inability to make drops to protect houses within the site boundary, although they will be (at least) 500m from any turbine tower. However, the owners of such properties are aware of this possibility, and have the opportunity to implement and maintain adequate passive protection measures.

5.9 Increased fire hazard[2, 6, 10]

I assume that the reference is to an increased risk of ignition (hazard refers to the amount and condition of the fuel). I am advised that the incidence of fires arising from wind turbines is very low, and that substantial measures are taken to protect these $3.5m pieces of equipment from any sort of damage. Those measures include lightning and thermal overload protection. While it is possible for a catastrophic failure to cause fire within the turbine mechanism, the system is designed to contain fire. Installation of integrated internal fire suppression presently under

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[4] Ann Keating

[5] Patrick Toohey

[6] Russell White

[7] Anne & Allan Schafer

[8] Barry White

[9] D, G & E Baxter

[10] David Hocking

development will be considered when it becomes available, possibly by the time construction could commence on the Berrybank site. However, the likelihood of fire commencing from a tower equipment failure is many orders of magnitude lower than from a faulty header or other farm machinery.

5.10 Upskilling the CFA[2], [6]

The method of dealing with fire in a turbine nacelle is to isolate it electrically, immobilise it mechanically, and wait for fire to burn out before replacing the damaged or defective parts. There is limited material available to burn, but the role of the CFA would be to attend nearby and contain/extinguish fires arising from burning material striking the ground below and downwind of the tower. This is exactly the same scenario as a burning hollow tree which cannot be felled in safety, the differences being that the increased height of the tower fire means that it could throw fire further, but burning material is more likely to burn out before reaching the ground.

5.11 Berrybank Terminal Station buffer[2], [8]

The terminal station should be surrounded by a fuelbreak intended to protect against fire entering or leaving, but it is an integral part of the wind farm, and must be on wind farm property. Screening vegetation, if required to be planted, must be selected and maintained with fire protection in mind.

5.12 60m buffers on the Eastern and Southern boundaries of the site[1], [3]

As discussed (5.3), 60m is an arbitrary value of no proven intrinsic merit to my knowledge. I believe it to be as important to prevent fire from entering the site as leaving it, under the influence of both (generally) NW as well as SW winds. The provision of internal potential fire control lines would assist in the case of fires entering the site as well as originating within it, and enhance the opportunity to prevent fire leaving in any direction. Internal lines includes public roads as well as paddock-based measures, but all of these are primarily a necessary response to RB rather than the proposed wind farm. I do not believe the suggestion is based on a real need, or has technical merit. Continued maintenance of accessible public-road based fuelbreaks on all sides and internally would be a more productive and effective fire control tool.

5.13 Local brigades would like to be involved in preparing a fire management plan for the area[3], [11]

I absolutely agree. If approval is given to proceed, more detailed planning must involve those who manage the land, those who will manage the wind farm equipment and infrastructure, and those who manage fires.

5.14 Lack of CFA policy on RB fire-fighting[12]

This should be addressed, and the impetus created by the wind farm proposal should be maintained. As stated, integration of the limitations, complexities and benefits arising from wind farming should also be addressed by all parties with an interest in fire protection.

5.15 Water tanks under each tower[6], [8]

It is hard to have too much water available when fighting fires, and any activity that raises the likelihood of water being needed should provide it. However, I do not see how the proposed wind farm will create an increased need for water. If such a requirement arises from RB, then the RB farm owner should (and presumably already has) attended to that need. The wind farm infrastructure will add to the existing network of passive fire control lines, which would, if anything, decrease the need for water.

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[11] Corangamite Shire Council

[12] All parties

5.16 6m wide firebreak around all RB paddocks[6], [7]

I agree that a fuel-free (which could include summer-green crops, so long as they can be driven over by fire vehicles) reserve of at least 5m width around paddocks would be sound practice, and would like to see it applied to all paddocks. However, I do not see such a requirement being relevant to a proposed wind farm.

5.17 Turn off turbines on high fire risk days[6]

High, on the McArthur Grassland Fire Danger scale[13], starts at an index of 8, which is too low to be the intended meaning. 'High fire risk days' presumably means something approaching Total Fire Ban levels, ie Extreme fire danger. The equipment is designed to operate in winds up to about 90km/hr, above which it is shut down for its own protection. Given that wind-powered electricity generators are not a particular ignition risk, I see no reason for shutting them down when an unrelated event (weather causing uncontrollable fires) occurs.

5.18 Increased risk of fires due to wind farms[10]

I am not aware of any data to support this assertion.

5.19 RB should be prohibited under and around wind farms[10]

I see no likelihood of an unavoidable or increased threat to life and property as a result of the combination, and therefore do not agree that this is a valid objection.

5.20 Inadequate 3m wide internal breaks[7], [8]

I agree that a 3m wide break in grassland is of limited utility, and recommend 5m wide fuel-free breaks (if supplemented by additional mowing or low-flammability adjacent vegetation, so much the better) be used.

5.21 Construction in last quarter of 2010[8]

Construction crews will need to be aware of the risks of their activities with respect to starting fires, and both minimise the risk and have suitable equipment immediately available to deal with ignitions if they do occur. That should include the ability to traverse RB areas, such as with an all-wheel drive grader or similar supported by a tanker, if working in dried grass areas on warm or windy days.

5.22 Substation location near occupied dwellings[3], [8]

As a fire-related issue, the substation should be surrounded by suitable fuel-reduced and fuel-free zones intended to protect against fire entry or escape. So should the houses.

5.23 Screen planting within or along roadside fuelbreaks[6]

Planting of visual screening vegetation within an area already used for strategic fire control would jeopardise or negate its value, and should be reconsidered. In my view, screen planting should be within private land and managed so that the surface fuels created or supported do not add to the likelihood of embers spotting across the adjacent road. Creation of even pockets of forest fire behaviour elements may seriously compromise a fire management plan based on grassfire behaviour. Screen planting including shrubs and trees can be done, but only if carefully integrated.

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[13] An image of a McArthur Fire Danger Meter is appended in Annexure B. It shows an output for input conditions of an air temperature of 40°C, Relative humidity of 10%, which in a fully cured pasture corresponds to a Fuel Moisture Content of 3%.

At a wind speed of 40km/hr, a good pasture carrying 5 tonnes/ha of grass would support fire spread at 9km/hr, and a Fire Danger Rating of Extreme.

5.24 Fuel levels adjacent to structures etc[3], [6]

The maximum fuel level figures proposed by the CFA are agreed in principle, although they appear to be somewhat generic. It is not practicable to restrict the operation of machinery in long grass when harvesting oats, barley or hay, for example, although few farmers would operate equipment under Extreme fire danger conditions. The wind tower bases will have surrounding bare earth and reduced fuel (uncropped) areas for a few metres.

6 Comment on permit conditions and/or EMP

A Bush Fire Management Plan should be prepared for the approved design and layout, in consultation with the relevant stakeholders, regulatory and management agencies. I have commented more fully on this point in Para 4.3.

If a Native Vegetation Management Plan is prepared, its effect on current and proposed bushfire protection measures may require a re-assessment of roadside (in particular) hazard reduction. Vegetation planting should not compromise fire management capability, including detection, access and control.

7 Conclusion

Raised Bed Cropping over part of the area of the proposed Berrybank Wind Farm precludes or restricts direct attack on grassfires, and it has been argued that this in turn necessitates the use of aerial fire fighting – in this area, generally helicopters.

The installation of wind turbine towers associated with a wind farm on this site will preclude aerial fire fighting. However, indirect attack by ground-based equipment is standard practice wherever, for a variety of reasons, direct attack cannot be undertaken. In addition, I strongly doubt the value of aerial attack on grassfires under low, medium and high fire danger conditions, in the belief that it would be overkill at the low end of the scale, and too slow in terms of both initial response time and rate of fireline construction to be effective at the high end. In my opinion, analysis shows that the loss of aerial fire fighting capability in this grassland setting is more imagined than real.

Other infrastructure, and in particular the provision of access tracks with a secondary fuelbreak function within presently inaccessible areas of RB, will create an increased ground-based fire fighting capability.

Provision of improved perimeter access around RB paddocks, as suggested by some respondents, and improved signage for the benefit of firefighters unfamiliar with the layout of individual holdings, would offset the fire fighting capability lost by the practice of RB.

I am not aware of any evidence that Wind Farm installations increase the risk of fire ignitions, and believe that overall, at this site, there are more potential benefits than actual disbenefits with respect to fire control.

8 Provisional opinion

The opinions that I have expressed in this report are based on my experience and the experience and advice provided to me by Union Fenosa Wind Australia Pty Ltd and the local residents and fire control staff I consulted. Subject to any limitations and exclusions, my opinions are complete and accurate in every respect.

I am satisfied through my inquiries that the opinions I have expressed are reasonable in regard to the management of fires within and immediately surrounding the area of the proposed Berrybank wind farm.

9 Declaration

I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the panel.

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Roger Fenwick

Annexure A – Qualifications

Name:	**Roger FENWICK**
Born:	1946
Qualifications:	B Sc (For) Australian National University, Canberra, 1969. Member, Institute of Foresters of Australia. Member, Fire Protection Association of Australia.
Positions Held:	
1988-Present	Consultant.
1986-87	Chief Fire Control Officer, (CFCO) ACT Bush Fire Council
1985	Secretary, ACT Bush Fire Council
1982-1984	Experimental Officer, CSIRO, Project Aquarius
1979-1981	Field Service Representative for Chemonics Industries, USA
1976-1978	CFCO of the ACT Bush Fire Council
1972-1975	Deputy CFCO, including one year of acting CFCO, ACT Bush Fire Council
1971	Assistant Forester at Pierces Creek Forest, and assistant to the CFCO
1970	Assessment Section, ACT Forests, and assistant to the CFCO of the ACT Bush Fire Council

Fields of Special Competence:

Fire risk assessment and control measures to minimise fire risk, fire control and organisation and management of rural fire fighting services, fire forensic investigations, training in bush fire fighting, fire fighting equipment selection and maintenance, and chemical fire retardant use.

2009

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW. Reported on School and Affordable Housing projects for the Nation-Building program.

2007-8

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW.

2006

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW & South Australia.

2005

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW and SA.

Assist with preparation of a Development Control Plan and Structured Growth Management Plan for Nambucca Shire Council, and a DCP for Penrith Council.

2004

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW.

Investigate and report on fire causation in connection with civil litigation in Tasmania

2003

Provide advice to ACT Government on protection measures appropriate to Black Mountain Reserve.

Provide advice to Monash City Council in Victoria on preparation of fire management plans for various Reserves, Victoria.

Assist with a study of fire station design for the CFA in Victoria.

Preparation of Maximum Probable Loss estimates for plantations in SA and WA for insurance purposes, and evaluate small-holding plantation insurance proposals.

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW.

Preparation of Fire Management Plans for the Department of Defence at 2 sites in NSW, and update fire season preparation recommendations for 5 sites in Victoria.

Engaged to investigate and report on fire causation and fire management practice in connection with civil litigation in both NSW and the ACT.

2002

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW.

Preparation of Fire Management Plans for the Department of Defence at 6 sites, Vic.

2001

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW.

2000

Preparation of Fire Management Plans for 2 military establishments, NSW.

Investigate and provide expert evidence in connection with litigation arising from injuries to a crew of fire-fighters, NSW.

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions and single residences, NSW.

1999

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions in NSW.

Engaged to investigate and report on fire causation and fire management practice in connection with civil litigation in NSW.

1998

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions, NSW.

Engaged to investigate and comment upon the practices relevant to the cause of a fire on agricultural land in NSW in connection with civil litigation.

1997

Preparation of fire safety guidelines and fire safety compliance reports to accompany applications for development of proposed subdivisions in NSW, and appearances in the Land and Environment Court of NSW.

Fire Management Consultant in FORTECH team preparing a report on plantation risk evaluation for a firm of agricultural insurance brokers.

1996

Investigate the cause and origin of an escaped fire resulting in loss of life, property and stock on a NSW estate.

Fire Management Consultant in FORTECH team developing a draft Fire Management Plan for the Murramarang National Park, for NSW National Parks and Wildlife Service.

Preparation of fire safety guidelines and a fire safety compliance report to accompany an application for development of a proposed sub-division, NSW.

1995

Carried out inspections and provided technical reports for presentation to the Land and Environment Court on fire safety compliance in contested development applications in southern coastal NSW.

Fire Consultant carrying out an assessment of the probable maximum loss for a major pine plantation estate in the Green Triangle of South Australia.

Inspections, technical advice and report preparation on fire safety guideline compliance for various development applications within NSW.

1994

Preparation of fire safety guidelines and a fire safety compliance report to accompany an application for development of proposed sub-divisions, NSW.

Expert witness in the matter of an escaped bushfire in the Bungendore area, NSW.

1993

Preparation of a detailed bush fire control training manual for the Department of Defence, specific to the needs of Puckapunyal Training Area, Victoria. This assignment follows on from earlier work in which a fire management plan was prepared.

Expert witness in the matter of two escaped bushfires in the Mudgee and south coast areas of NSW. The investigations required determination of the cause and origin of the fires.

Preparation of fire safety guidelines and a fire safety compliance report to accompany an application for development of proposed sub-divisions, NSW.

1992

Consultant to Shoalhaven City Council in southern NSW responsible for the interpretation and mapping of the "subdivision strategy for high bushfire risk areas" which was developed in a related project in 1991.

Fire Management Specialist on Puckapunyal Bushfire Management Plan study for Department of Defence. This major study involved 9 specialist consultants and produced an operational plan for fire management including hazard reduction and control strategies, training and equipment needs, emergency fire procedures and the role of bushfire decision support systems in augmenting current expert land management systems. The Fire Management Plan adapted to current land management systems and as such required a full appreciation of the Puckapunyal environmental rehabilitation program, training needs and demands these placed on the environment and the stock grazing arrangements in place at the time. Because of the sensitivity of bushfire management, a full community consultation program was implemented to address issues raised by neighbouring landowners and communities. Impacts of various fire management scenarios on wildlife populations were assessed and considered in making the final recommendations.

Expert witness responsible for provision of technical advice and investigation of the conduct of a roadside hazard reduction burn in NSW.

Preparation of fire safety guidelines and a fire safety compliance report to accompany an application for development of proposed sub-divisions, NSW.

Expert witness investigating origin and cause of grassfire in the Hunter Valley, NSW.

1991

Preparation of fire safety guidelines and a fire safety compliance report to accompany applications for development of proposed sub-divisions and single dwellings, NSW.

Consultant to the Shoalhaven City Council in Southern NSW responsible for the preparation of a "subdivision strategy for high bush fire risk areas" within the city of 4600 square kilometres. The task involved identifying a set of objective criteria by which subdivision applications could be assessed in respect of bush fire danger. The consultant worked with a committee involving Council and State Government Land and Fire Management Agency representatives.

1990

Preparation of fire safety guidelines and a fire safety compliance report to accompany applications for development of proposed sub-divisions and single dwellings, NSW.

Team Member in a study for the NSW Government Insurance Office to assist in the defence of a Supreme Court writ against a NSW Government land manager.

1989

Preparation of fire safety guidelines and a fire safety compliance report to accompany applications for development of proposed sub-divisions and single dwellings, NSW.

1985-87

Chief Fire Control Officer for ACT Bush Fire Council responsible for fire management planning and co-ordination of fire suppression activities in forest and grass fires in and around the ACT. In this and previous roles with Bush Fire Council attended or attended to (from Control Room) over 2000 fires in grass, heath, eucalypt forest and pine plantations. Responsible for training and co-ordination of volunteer fire fighters.

1984

Consultant in court case arising from 1980 Ash Wednesday fires in South Australia. Provided expert opinions as to probable course of events in respect of these fires.

1982-84

As experimental officer with CSIRO Project Aquarius was team member in several major fire investigations to determine fire behaviour including fire spread rates, intensity and origin. Investigated the major Mt Hickey fire in Victoria which was one of the first using new aerial suppression techniques.

1984

Consultant and expert witness for Tasmanian Crown Law Department investigating the probable cause and origin of a fire in the Deloraine area.

1981

USA For the East Bay Regional Parks District prepared a hazard reduction and fire management plan for the Lake Chabot Eucalyptus plantation near Berkeley, California.

1979-81

USA As field service representative for Chemonics Industries, USA advised on use of chemical fire retardants in a variety of fuel and fire types in west coast USA. Team member in US Forest Service Investigations involving fire forensic work to determine cause and origin of wild fires in various locations.

1972-78

As Deputy then Chief Fire Control Officer of ACT Bush Fire Council, responsible for fire management planning and co-ordination of fire suppression activities in and around the ACT. Lectured in fire behaviour, fire management and fire planning at graduate level at Australian National University and Canberra College of Advanced Education.

1970-71

In varying capacities assisted the Chief Fire Control Officer of the ACT.

Fire Management Plan principles and elements

Fire control is the final component of the whole fire management process, and since all fires involve fuel, the principal variable susceptible to manipulation is vegetation. Animals are dependant on vegetation for shelter and food, and vegetation cover is critical to protection of the soil surface (and subsurface strata). Thus a good fire management plan requires consideration of all aspects of land management, and aims to prevent unacceptable damage to land values as well as protecting life and (built) property. The protection of life must include consideration of firefighters as well as residents, and recognise that firefighters may have little or no control over land management practices which can create an uncontrollable situation under less than Extreme fire weather conditions.

Crops as well as fences and farm structures are built property, and even in intensively farmed areas, remnant native vegetation as well as introduced crops to which they have adapted constitute habitat for native insect and animal species.

Fire management also has to consider the problems of fires originating outside the area and moving in, fires originating within the area, and fires leaving the site. Generally, containment and control of fires starting on the site will be the responsibility of the landowners, and require a rapid response to an initially small fire. Incoming fires can be on an enormous scale, and defences against widespread damage on site are needed. Fires (wherever their origin and whatever their cause) can create liability issues if they leave a site and cause damage on neighbouring property.

The Berrybank site is effectively cleared grassland so far as fire control is concerned, with minimal stands of trees and shrubs mainly in the form of isolated windbreaks and shelterbelts. Some native vegetation has been retained along some roadsides. Forest areas support relatively slow (about 3-5km/hr) fire spread under Extreme fire weather conditions, and periodic hazard reduction burning can modify fire behaviour for a number of years. Grasslands and summer-dry crops are an annual hazard and must be dealt with each year in the absence of almost-continuous summer rain. Once dried ('cured' in fire control parlance, ie turned a designated percentage of brown from green), grasslands will support very rapid fire spread, of the order of 16-20km/hr. Fires in fully-cured grasslands produce very little smoke initially, making their detection difficult until rapid spread produces visible smoke as a result of incomplete combustion. Partially cured grass produces visible smoke almost immediately, and spreads relatively slowly as the remaining green material slows the combustion process. Therefore in grasslands, retaining or introducing an element of green slows the spread of fire, enables earlier detection, and thus doubly improves the chances of successful early attack.

It has long been the practice in Victoria, with one of the world's worst fire weather exposures, to carry out roadside hazard reduction burning and mowing, plus so-called firebreak (fuelbreak) ploughing, on its generously wide roadside reserves.

The existing condition.

Raised Bed Cropping

Soils susceptible to waterlogging, becoming 'sour' and poorly productive, are widespread in the area, resulting from a combination of soil type and poor drainage from relatively flat areas. To overcome this, the practice of Raised Bed Cropping was introduced. Soil is banked up about 20-25cm high into beds about 2m wide between ruts about 25-30cm wide. Tractors and drawn wheeled trailers with a suitable track width (distance between tyres left and right) run along the ruts, into which excess water will drain and then flow away to a broader collection and removal drain at the lower end of the raised bed paddock. An un-mounded, un-furrowed section about 30m wide is left at each end of the beds, to allow trucks and farm equipment to operate and turn on flat ground. Driving any tyred equipment across furrowed ground requires very slow travel, and subjects both the equipment and the beds to damage. Bogging or high-centring on the softer raised bed is a potential hazard for fire tankers, and travel even along the rows may not always be possible for such vehicles. It is standard practice to maintain a mowable strip a few metres wide on each side of a raised bed paddock, inside the fence-line, to allow tanker access from one end to the other and as a form of fuelbreak.

It is not normal practice to create raised beds unless drainage requirements necessitate it, and once created they are likely to be maintained, with the same orientation for optimal drainage, by periodic resculpting.

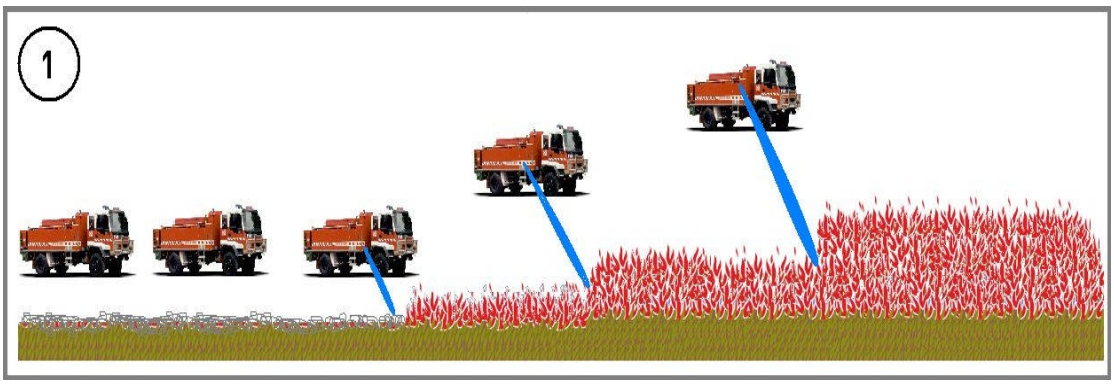
Roadside Fuelbreaks

Local CFA Brigades are active in carrying out roadside hazard reduction burning, and most road reserves have ploughed breaks as well, forming a fuel-free strip additional to the fuel-reduced burn area. Some unburnt areas appear to be mown, leaving a more compact fuel-bed than existed with standing grass. This will carry fire at about the same speed as an unmown area, but with reduced flame height and length, less likely to allow fire to spread to the other side of the road. The first rain following burning or mowing will usually see a greening up of both burnt and mown tussocks, improving the value as a fuelbreak as well as speeding up redevelopment of vegetative cover on exposed soil.

The timing of roadside burning is important. Rainwater accumulates in road reserve table-drains, and that can make roadsides too boggy to allow trucks to turn except at formed property entry driveways or intersections for very many days after rain. If delayed, and conditions attached to burning during the fire season require a 5m wide ploughed or graded break beside the burn area, the whole exercise can become too difficult for volunteers to conduct. A key component in fire control in the entire area (not just RB and/or wind farm sites) will be compromised.

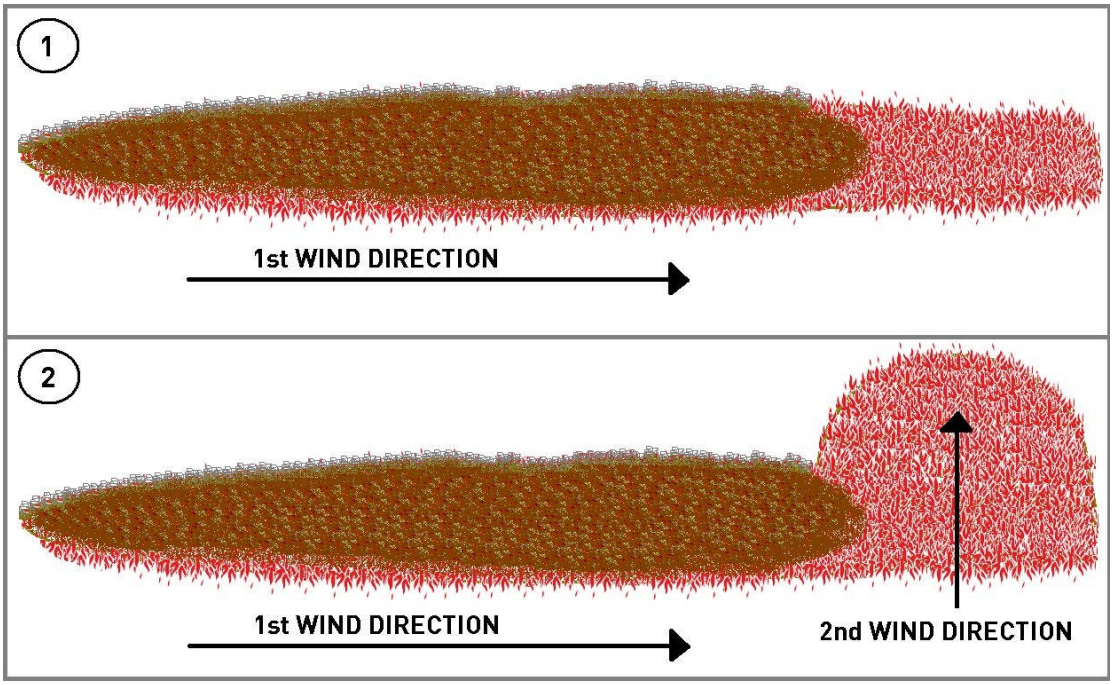
Normal grassland firefighting practice

Normal practice in fighting grassfires is to commence at the rear of the fire, near the ignition point, and work along one or both sides towards the head of the fire, and gradually pinching it out. Tankers operating in relay feed in from the rear, so that the back section of the fire is constantly patrolled to prevent a relight from running up beside the recently extinguished flank, negating the work already done and endangering those working between what would be two fire edges. The leading tankers work together, so that (in principle) the first will do general flame knockdown, working a safe distance from the heat of the active edge, the second will work closer and more thoroughly put out the flaming edge, and the third will be right on the edge, making sure that everything is extinguished. When the first tanker runs out of water and peels off to refill, number two will assume the knockdown role, number three will step up to position 2, and the previously inactive number 4 will commence the sweeper duties. All following tankers join the queue, so that if a late relight occurs, someone will spot it and deal with it immediately.

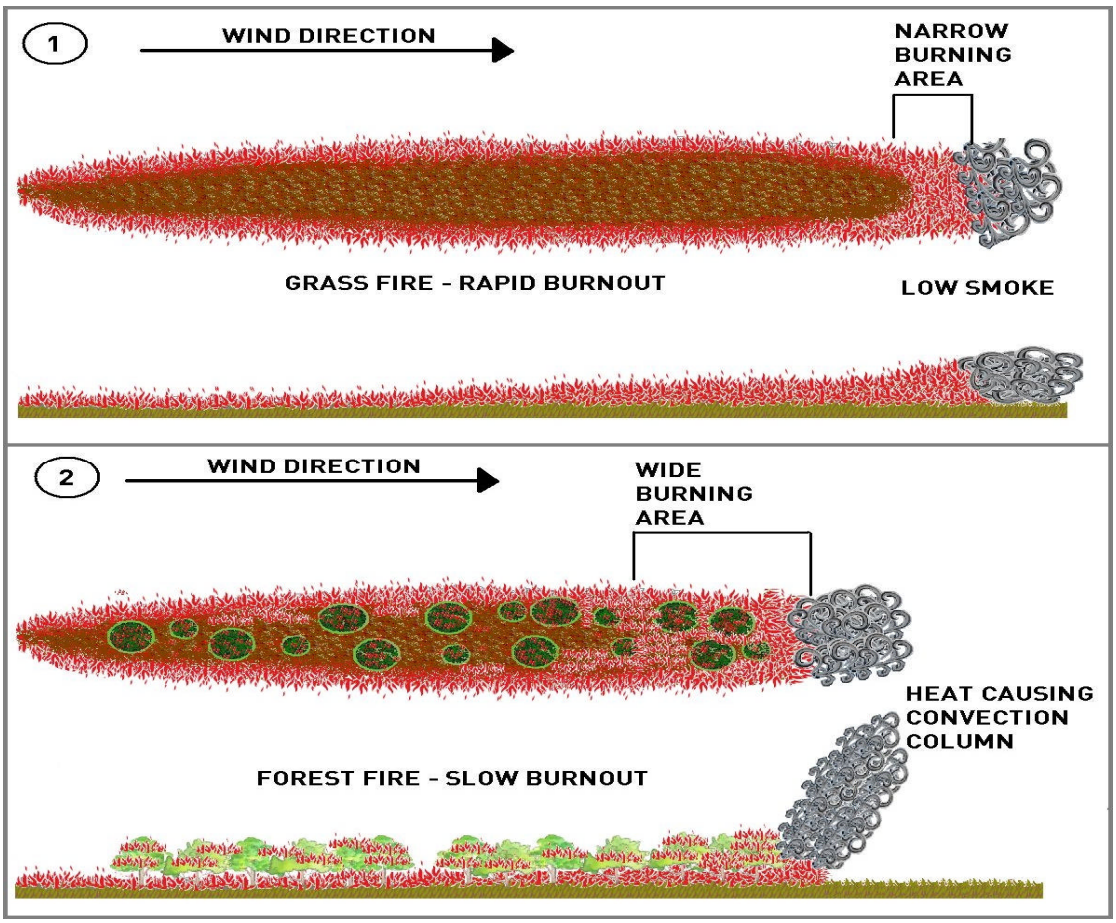


It is common for high-intensity grassfires to be driven by a NW wind ahead of a frontal change to a SW wind, and for that reason maximum effort may be focussed on the NE flank of a fire, to minimise the width of the new headfire when a 90° wind shift arrives. Crews located on the NE side of grassfires before a wind change need to be particularly aware of this possibility, and work either very close to the fire edge (and able to move to safety onto burnt ground) or sufficiently far away to be able to escape to safety. This is a particularly important factor in indirect firefighting, where instead of working directly on the fire edge crews operate some distance away, preparing or manning a containment line.

In indirect attack, fire may be lit at the containment line and allowed to burn towards the main fire, a process called burning out. However, lateral spread is fairly slow, and the forward spread of the newly lit edge-fire has to be controlled somehow so that the fire-fighting process does not simply exacerbate fire spread. Backburning is the process of burning out the fuel between a proposed containment line and the head of a fire. (Backfires, spreading into the wind, travel extremely slowly, and in order to create a line of adequate width to stop a fast-moving headfire, may have to be commenced some hours ahead – often determined, with hindsight, to be before the original fire commenced. Therefore breaks intended to stop a headfire need to be prepared long – months – in advance.)

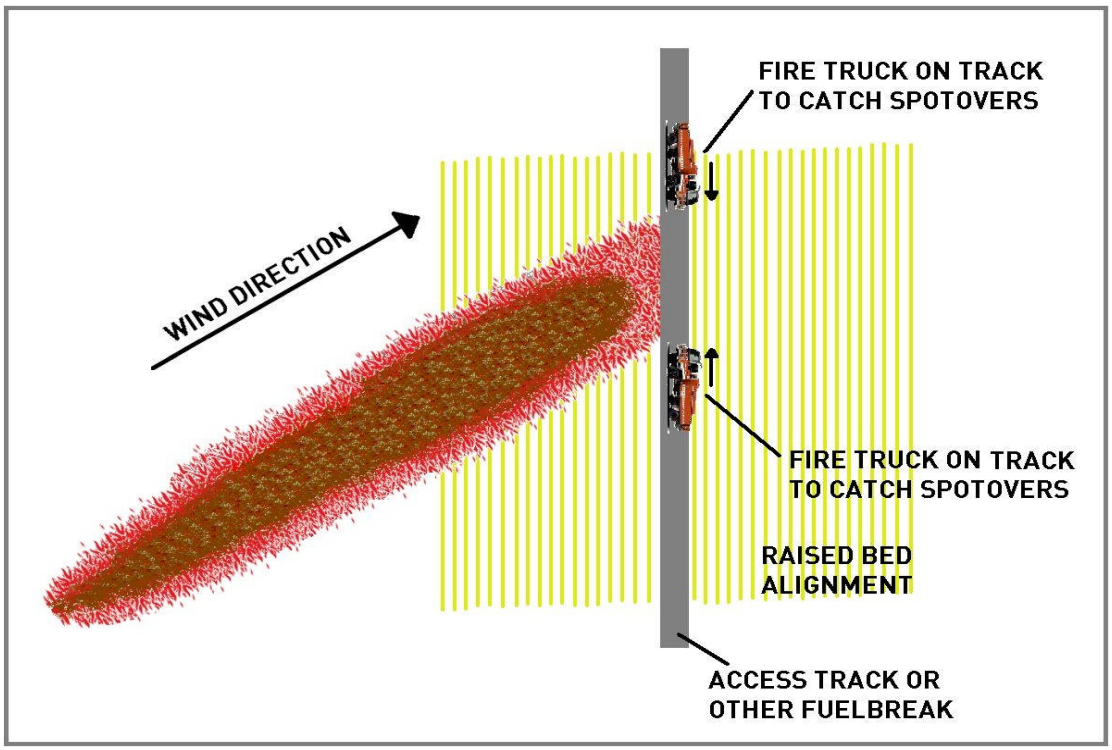


A characteristic of grassfires is that the head of the fire has a fairly shallow burning depth, as the fine fuels burn out very rapidly and leave little smouldering residue. In a forest fire, the fine fuels spread the fire, but the larger material burns out over a period of hours, continuing to release heat as well as smoke. In addition the greater amount of fine fuel burning, at a lower speed, means that a significant convection column is produced – dragging most of the smoke produced upwards and leaving relatively clear air immediately ahead of the fire. By contrast, a grassfire does not generally create a well-defined convection column, and the smoke output from the head of the fire and most of the smouldering material behind it flows along with or ahead of the flame front, substantially masking its location and thus making headfire attack almost impossible.



Indirect grassland firefighting

In an area affected by raised bed cropping, direct travel beside a grassfire will usually not be possible, as the wind direction and fire spread are unlikely to create a fire edge exactly along a bed, and able to be followed by fire vehicles. Thus indirect attack is normally required, so that once fire has entered (or originated on) such a paddock, it can only be fought remotely, at the paddock perimeter. Where that involves the NE side of the fire, and a frontal wind change is approaching, there is a high degree of danger and crews need to remain aware and very alert – and leave before the wind change strikes.



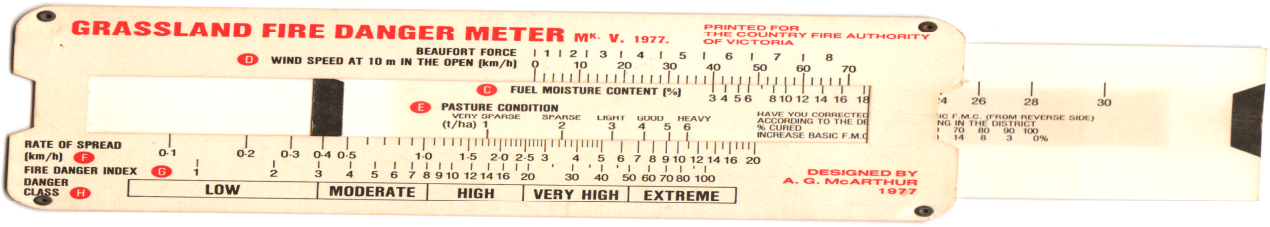
Forced dependence on indirect fire fighting by ground-based equipment creates the need for better than usual passive defence measures, in the form of a denser network of pre-prepared fuel-breaks from which crews can operate in (relative) safety. This will include, in this raised bed cropping setting, a series of fuelbreaks from which crews can operate to contain fires under the normal predominantly NW summer wind direction, and the common complication of a SW change.

Aerial attack

Where ground-based direct attack is not possible, for whatever reason, it is increasingly common to rely on aerial attack. Helicopters are the preferred vehicle, and locally, aircraft fitted with 1400 litre belly tanks (as opposed to externally slung buckets) are available. I understand that one is stationed at Colac, and another at Ballarat, both on about a one-hour callout. In the event of a major approaching fire, several additional aircraft including very large (up to 9000 litre capacity) may already be deployed.

Almost without exception, these aircraft will be dropping either plain water, or water to which a foaming compound has been added. While long-term fire retardant is available at fixed bases for use on relatively slow-moving forest fires, the logistics of providing such a facility for grassfires are impractical.

A 1400 litre aircraft given perfect delivery and no wastage could paint a fireline with 1cm of water depth, over a width of 1.4m, for a total length of 100m. With a turnaround time of 5 minutes (to travel to a water source, refill, locate and return to the end of the previous drop, and reposition for the next drop) such a system could create fireline at 1.2km/hr. That spread rate corresponds to fire burning at a Fire Danger Index of about 10, just into the High bracket, well below the 6km/hr associated with the top of Very High, and way below the 16-20km/hr spread rate at the top of the Extreme range. Five aircraft operating perfectly in series and each able to create line as portrayed would in theory be able to produce a 1.4m wide line 1cm deep at 6km/hr; more aircraft could not advance that rate because of separation safety requirements. An illustration of a Fire Danger Meter follows.



In actual operation, the need to coordinate aircraft would be unlikely to achieve continuous line construction at 2km/hr with 5 aircraft available and a very high availability of dams from which to refill them. Helicopters are magnificent in their ability to deliver a critical payload of water to spot fires associated with forest fires, holding them from establishing and getting moving until ground crews can arrive. In my view water-bombing helicopters (and even large US style fixed-wing aircraft) have very little application in open grass fire situations where the speed of travel of the fire, and the ability of ground crews to travel relatively quickly, negate the aircraft advantage of prompt arrival at remote or inaccessible spot fires.

Aerial firefighting – Berrybank windfarm site

The following analysis is to determine whether the use of, or reliance on, aircraft for fire control within the raised bed cropping area of the proposed wind farm is feasible. A fire approaching from the NW under almost Extreme conditions and travelling at 6km/hr would take an hour to move across the widest part of the project area, a distance of 6km from near the Boundary Rd/Berrybank-Wallinduc intersection to the SE corner of the Hirth property on the Hamilton Highway. In the event that fire originated at the property boundary, it would be off the site before the first mobilised aircraft could arrive.

If fire originated on the Lismore-Scarsdale Rd (aka Lismore/Pitfield Rd), it would be just entering the site as the first aircraft was (or were) ready to commence fire-fighting. That process would necessitate anchoring the rear and holding all the length of the flank of the fire first, a process which would take some time, even assuming that ground crews were able to operate without impediment over all that land and across the Gnarpurt Chain of Ponds watercourse.

Thus neither a fire starting on site nor one starting 6km away upwind and about to enter the Berrybank site would be likely to be attacked by helicopter. The first available aircraft could be in a position to assist attempted containment of the head of a fire either about to enter or leave the site, but their effective utilisation within the area of the proposed wind farm for flank containment is unlikely.

Should the wind farm be established, it would be hazardous in the extreme to attempt to use any aircraft apart from as observation platforms over the site. While fixed or rotary-wing cropduster pilots may be happy to fly between wind turbine towers, they operate under low-wind, zero-smoke conditions, and can plan their flight paths to suit. Even if conditions were such that pilots could safely see the turbine blades under smoke, dropping small quantities of water from that height (say 150m above ground) would be completely futile, as none would be likely to hit the ground at all under windy summer fire weather conditions.

If wildfire originated on or entered the site, regardless of the fire danger rating, it would be open to fire fighting authorities to request that the turbines be shut down. However, I do not see a useful purpose in this, as a non-rotating turbine blade may be as, or more, difficult to see from the air as one in normal operation. Under smoky and/or windy conditions, I consider aerial operations within the confines of this proposed wind farm site to be unacceptably high-risk.

Future management recommendations

Passive protection measures

There is a very good network of public roads in the vicinity of the proposed wind farm site, and increased utilisation of them is recommended. This should not be tied to areas adjacent to raised bed cropping paddocks, more of which may be created in the future, but should be part of a more strategic regional fire protection program. This recommendation is a function or result of the inaccessibility of the area to direct ground attack, however, and not arising from the disqualification of air attack – which I believe could never be relied upon in this setting to make any effective contribution to fire control.

Additional practices which could be considered by property-owners includes rotational or strategic planting of summer-green crops. While it would not be practicable to require alternate planting of the less flammable canola with wheat or oats, consideration might be given to strips a few metres wide of turnips for sheep feed, or lucerne on suitable ground, to supplement existing internal access roads and make them more likely to succeed as containment lines.

Supplementary water storage

It was suggested by a number of stakeholders who made submissions to the panel that supplementary water storage should be a condition of approval of the installation of wind turbines, as a sort of substitute for the inability to use aerial fire-fighting. I am not able to see the logic of such a proposal. Increased reliance on passive measures such as more and wider fuelbreaks, whereby fire is allowed or assisted to burn up to a predetermined bare-earth containment line able to stop the spread of fire, would result in a lower demand for water than direct ground-based fire-fighting where the actively burning part of the fire is to be extinguished by the application of water. If elements of the wind farm contributed to an increased need for water, I would strongly support the installation of additional water storage. If the need already existed, either because of the nature of the site or the addition of RB cropping practices, I imagine it would already have been addressed.

Internal access road alignment

The proposed wind farm turbines will be accessible by tracks within the paddocks in which they are located, and a reasonably direct path between them, and the shortest possible route for the electrical conductors, are sought. However, the necessity for internal drainage lines to run downhill, and for the collection drain to similarly be aligned downslope, creates a conflict with respect to optimal track alignment and location from the point of view of the turbine operator.

A substantial area is needed if machinery has to turn at the end of a row, and an access track which cut across a series of rows would stop the flow of water – and a series of piped culverts at about 2m intervals is not an option. While the deeply buried conductor could be run in straight lines between nodes, I believe it will be necessary for turbine tower access tracks to run parallel to the crop bed alignment, except at the sides/ends of paddocks. This suggests that either the turbine tower access tracks to be created must run parallel to the existing rows (or at right angles, at the ends of paddocks), or that RB paddocks must be resculpted so that crop bed alignment parallels the access tracks. That would be a matter to be determined between landowners and Union Fenosa. Future RB areas will have to conform to the existing track alignment. In addition, tower access tracks should not dead-end – it is important that they continue to the edge of a paddock where there is the opportunity to reverse, turn left or right, or go through the fence if not a gate into the next paddock.

Fuelbreak width

Research by CSIRO[14] on fuelbreak widths in grassland found that, in the absence of trees or shrubs likely to throw embers, a 5m wide break was almost as effective as a 15m wide break in stopping fire spread. There were significant incremental improvements in performance up to 5m in width, and a sudden drop from 5m upwards in terms of effectiveness per unit of width. All widths performed better with reduced grass height on each side, but based on that work, I recommend that the bare-earth width of internal roads should be 5m. That would have the added benefit of allowing vehicles to pass, which while not a benefit to the wind-farm operator, could improve the utility of the tracks in the event they were needed for fire control.

Marking Raised Bed areas

In the event of fire in the area, units from afar and crewed by volunteers not familiar with the area could be involved. They, efficient operations, and their safety may be assisted by the provision of signs at entries to raised bed paddocks, such as the letter R with an arrow showing the alignment of the beds, either across the line of entry through a gate, or parallel to it.

R or **R↕**

↔

If accepted as a useful principle, such signage should be standardised by the CFA and deployed by the CFA or individual landowners within all RB areas.

Turbine nacelle fires

The subject of fires within turbine nacelles was raised by a number of stakeholders. The subject is beyond my personal knowledge, but I have been advised by the proponent that the possibility of

[14] From a CSIRO Newsletter *Rural Research 139*, Winter 1988. Article by Wilson AAG published in *Canadian Journal of Forest Research* 1988.

fitting fire suppression equipment to deal with internal fires will be considered when it becomes available. That will be a commercial decision based on the economics of protecting very expensive equipment, and not a response to what is believed to be a very low potential to create fires externally. The incidence of internal fires is understood to be low, and there is little flammable material within each nacelle and consequently a limited potential for burning or incandescent material to be dropped to the ground – especially under high wind conditions, such material would be more likely to self-extinguish or burn out before hitting the ground. The very expensive equipment installed atop each pylon already has extensive self-protection features built in.