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**BLACKWOOD DISTRICT FIRE 18
BRIDGETOWN
27 DECEMBER 2003**

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DEPARTMENT OF CONSERVATION
& LAND MANAGEMENT
WESTERN AUSTRALIA

FIRE NARRATIVE

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Executive Summary

Blackwood District Fire 18 (BWD 18) started 13 km NNW of Bridgetown during the late morning on 27 December 2003 and was driven towards the town by strong gusty winds under conditions of extreme fire danger. The main fire run was contained on the western side of Bridgetown at about 1800 hrs on 27 December. This report describes the development and spread of the fire and the actions taken to suppress it during the initial work period. The purpose of this report is to document the contribution of the Department of Conservation and Land Management and the Forest Products Commission to fire suppression operations. Volunteer bush fire brigades, the Bridgetown-Greenbushes Shire, personnel from the Fire and Emergency Services Authority of Western Australia and local residents were also involved in fire suppression and mop-up operations but their contribution is outside the scope of this report.

During a period of about 6 hours the fire burnt an area of 4621 ha which included radiata pine and eucalypt plantations, pasture, remnant vegetation and native forest. The fire also resulted in significant losses of fencing, fodder, stock and other farm assets. Two houses and a third partially constructed dwelling were destroyed by fire. Losses could have been much greater had the fire danger remained extreme for a longer period in the afternoon, and had an effective fire suppression organisation not been promptly mobilised.

BWD 18 provided a cogent demonstration of the threat that bushfires pose to rural communities and the primary industries that sustain these communities. Important issues raised by the fire include:

- the need to clarify the responsibilities that electricity supply utilities and occupiers of land have in relation to inspection and maintenance of native and cultivated vegetation growing near powerlines;
- the need for rural communities, and in particular the residents of rural towns, to become more aware of fire safety and to make preparations prior to the summer bushfire season;
- the need for the commercial plantation industry to maintain high standards of fire prevention, detection and preparedness in order to minimise potential losses of timber assets and disruption of wood supply to industry.

Fire behaviour observed in pine plantation and cured pasture with remnant eucalypt forest was consistent with predictions from current fire prediction guides.

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1. Introduction

Blackwood District Fire 18 (BWD 18) started 13 km NNW of Bridgetown during the late morning on 27 December 2003. Strong, gusty winds drove the fire towards the town under conditions of extreme fire danger. The fire spread through a landscape of pasture, remnant vegetation, farm woodlots and pine plantation along the valley of the Blackwood River. The head-fire reached the western outskirts of the Bridgetown townsite during the late afternoon where it was contained by fire-fighters from the Department of Conservation and Land Management (CALM), Forest Products Commission (FPC) and volunteer bush fire brigades. Work to contain and mop-up the fire continued over the following 4 days.

This report describes the development and spread of the fire and the associated actions taken for containment and mop-up, and is intended to provide a concise summary of the following issues:

- weather conditions and other predisposing factors contributing to the fire,
- probable cause of the fire,
- contribution made by CALM to fire suppression response and post-fire recovery efforts,
- predicted and observed fire behaviour,
- fire losses, particularly state-owned plantations of radiata pine (*Pinus radiata*) and public lands managed by CALM.

The focus of this report is on the initial work period up to about 1800 hrs on 27 December when the main fire run was contained on the western outskirts of Bridgetown.

For the purposes of this report officers of the FPC have been included as part of the fire suppression resource available to CALM under the memorandum of understanding and service agreements operating between the two agencies. The substantial contribution made to fire suppression and mop-up operations by volunteer bush fire brigades, the Bridgetown-Greenbushes Shire, personnel from the Fire and Emergency Services Authority of Western Australia (FESA) and local residents is outside the scope of this report.

Information sources used to compile this report include the Blackwood District log book and fire diary, records kept by the Incident Management Team (IMT), personal fire diaries and interviews with fire-fighters. People interviewed during the post-incident analysis are listed in Appendix A. Field inspections of the fire-ground were also undertaken on a number of occasions in the days and weeks following the fire. Maps prepared by the IMT showing the final fire perimeter overlaid on to a topographic map base and ortho-photo base are provided in Appendices B and C.

2. Other relevant documents

The Bureau of Meteorology (BoM) has prepared a report describing the fire weather conditions that prevailed throughout the south-west of Western Australia on 27 December 2003 (Anon. 2004a). Issues addressed in the Bureau's report include fire climatology, meteorological aspects of the fire weather situation on the day, and the detail of weather forecasts issued. This report is available on request from the

Regional Director (BoM) for Western Australia at 1100 Hay Street West Perth 6005. An abbreviated version of the report was presented as a conference paper by Reader and Hanstrum (2004).

An investigation into the origin of the fire was undertaken on Sunday 28 December by Mr Bryn Weir (FESA) and Mr Mick Zwart (CALM). Both officers have been formally trained as wildfire cause investigators through the joint-agency training program operating in Western Australia. The investigation involved a field inspection of the suspected point of fire origin and interviews with witnesses and volunteer fire fighters who undertook initial attack on the fire.

Officers from the Energy Safety Division of the Department of Consumer and Employment Protection (DOCEP) undertook a separate investigation into the cause of the fire. The report on this investigation is available on the DOCEP website (www.energysafety.wa.gov.au).

Perspectives of private plantation owners and farm forest growers regarding the fire and its aftermath have been presented in articles published in the autumn and spring issues of the Australian Forest Grower magazine (Anon. 2004b, McArthur 2004)

3. Weather conditions and predisposing factors

3.1 Seasonal dryness and pasture curing

Rainfall at Bridgetown was 826 mm during the 12 month period to December 2003, closely matching the average of 823 mm. However the period from October to December was slightly drier than average (Anon. 2003). The month of December was dry with only 4 mm of rain recorded over four days from 18 to 21 December. At the time of the fire most dams retained good water levels, including some smaller dams that would normally dry out completely by the end of summer. Good seasonal conditions resulted in heavier than average growth of annual grasses. Dense swards of Wild Oats more than 1m tall were common in un-grazed areas. By the end of December, grasses in upland pastures and pine plantations were fully cured. Grass curing was incomplete in moist sites along the valley of the Blackwood River, including within and around the Bridgetown townsite. Swards of Kikuyu grass along drainage lines remained green and lush (Fig. 1).

3.2 Forecast and actual conditions on 27 December

Weather observations relevant to BWD 18 are available from BoM automatic weather stations (AWS) located at Bridgetown, and at Manjimup a further 35 km to the south. Manual weather observations are also recorded hourly during the day at Styles Tower 22km WNW of Bridgetown.

The four-day weather outlook issued to CALM by the BoM on Tuesday 23 December indicated that conditions in the Lower West and South West weather districts on Saturday 27 December would be hot to very hot with the likelihood of NW winds accompanying the movement of a low pressure trough. This outlook was maintained over subsequent days, augmented by a prediction of winds gusting to 60 km/h on Saturday morning.

A deep trough near the west coast moved inland on Saturday morning under the influence of an approaching cold front. Strong upper winds accompanied the trough movement, with wind speeds of 99 km/h recorded between 3000 and 5000 feet above ground level by the balloon sonde launched at Perth Airport.



Figure 1. View NW from the Brockman Highway across the Blackwood River in early January 2004. Low lying areas still carried green grass at the time of the fire, while upland pastures were fully cured. The extent of crown damage in pine plantation north of the river varies from minor crown scorch through to complete defoliation. Buildings are on Loc. 6361.

The forecast issued at 0750 hrs for Bridgetown predicted Extreme grassland fire danger with a maximum temperature of 36°C, dew point of 14°C, and minimum relative humidity of 27 per cent. Forecast winds during the morning were N to NW at 25-35 km/h, moving W at 30 km/h by 1500 hrs and WSW at 20 km/h by 1700 hrs. Wind speeds represent the mean value recorded over a 10 minute interval at an anemometer located at 10 m height above ground in an open area unobstructed by trees or buildings. This forecast was confirmed at 0910 hrs.

Fire danger at Bridgetown peaked at around 1100 hrs with a Grassland Fire Danger Index of 76 (Extreme) in fully cured grass. Observed conditions were slightly more severe than forecast, particularly in the case of dew point and relative humidity which fell to minimum values of 5.7°C and 14 per cent respectively (Table 1). Manjimup also experienced severe fire weather, with wind speeds of 46 km/h resulting in a Grassland Fire Danger Index of 84 (Extreme) at 1100 hrs. Winds of up to 80 km/h from the NNW were recorded at Styles Tower during Saturday morning. These wind speeds are not directly comparable with the Bridgetown or Manjimup AWS observations due to the anemometer at Styles Tower being in a higher and more exposed position.

Fire weather conditions at Bridgetown began to moderate after 1300 hrs with a substantial reduction in wind speed and a slight decline in temperature (Table 1). Wind direction at Bridgetown remained NW until after 2100 hrs when it shifted W. At Manjimup Extreme fire danger conditions persisted until after 1400 hrs when a shift to WSW resulted in falling temperature, rising humidity and a decline to wind speeds of less than 20 km/h.

Light rain (1.0 mm) was recorded overnight at both Bridgetown and Manjimup.

3.3 Conditions during the mop-up and recovery phase

Weather conditions on Sunday 28 December were mild with a maximum temperature of 24°C at Bridgetown and SSW winds at 10-15 km/h. The air mass associated with the SSW winds was notable for its dryness, with dew points in the range 1.7–4.9°C recorded throughout Sunday afternoon. Dew points were considerably lower than recorded on the previous day when the fire danger was Extreme.

Monday 29 December saw a continuation of mild temperatures but strong winds re-developed from the NW, with wind speed of 50 to 65 km/h recorded at Styles Tower throughout the day.

4. Fire detection

4.1 Departmental fire detection system

At 1115 hrs smoke was sighted from Styles Tower on a bearing of 103 degrees. This report was relayed to the CALM Kirup Office and entered in the office log book at 1119 hrs. The CALM Blackwood spotter aircraft provided a direct sighting of the fire at 1135 hrs at a location of GD 62 58 (using CALM alpha-numeric grid system) on land vested in the Executive Director of CALM. The fire was estimated to be 3 ha in size and burning in a southerly direction. Over the next 20 minutes the spotter aircraft reported a further two independent fires in pine plantation and three fires in pasture, including a 2 ha fire on Loc. 886 south of Davies Rd approximately 3.5 km SE of the initial fire location. These additional fires are most likely to have been ignited by firebrands blown downwind ahead of the main fire front that was burning in the plantation (Fig. 2). The first report by the spotter of fire east of the Blackwood River was at 1145 hrs when fire was observed on the banks of the river adjoining Loc. 639.

4.2 Detection by local residents

Peter and David Browne, who reside on a property on Thompson Rd, observed smoke to the north of their house shortly after 1100 hrs and drove directly to the scene of the fire to investigate. Mrs Colleen Browne, who was also at the property, telephoned the local volunteer bushfire brigade and a neighbour to advise them of the fire. These details were provided to fire investigators from FESA/CALM on 28 December and subsequently also to the investigator from the Energy Safety Division.

TABLE 1. Hourly weather observations from Bridgetown and Manjimup automatic weather stations on 27 December 2003. Data provided by the Bureau of Meteorology, Perth. Wind speed represents the mean speed recorded over a 10 minute period prior to the observation time, and the wind gust represents the strongest gust over the same period.

Time (WST)	Bridgetown						Manjimup					
	Temp (°C)	RH (%)	Dew point (°C)	Wind speed (km/h)	Wind direction (deg.)	Wind gust (km/h)	Temp (°C)	RH (%)	Dew point (°C)	Wind speed (km/h)	Wind direction (deg.)	Wind gust (km/h)
0600	18	65	11.6	7	S	13	18	65	11.5	13	NNE	33
0700	22	54	11.9	7	SSE	13	22	53	11.8	24	N	37
0800	28	34	10.5	18	N	33	25	43	11.6	26	N	43
0900	32	27	11	33	N	52	30	32	11.7	37	N	57
1000	35	22	10.1	35	N	54	33	27	11.7	35	NNW	56
1100	38	14	5.7	39	N	63	36	20	9.2	46	NNW	68
1200	36	19	8.8	35	NNW	57	36	21	10.0	33	NNW	52
1300	35	23	10.7	26	NNW	37	36	22	11.0	39	NW	61
1400	35	21	9.3	24	NW	39	36	20	9.7	37	NW	57
1500	35	23	10.5	26	NNW	37	33	35	15.8	17	WSW	31
1600	34	28	12.8	18	NW	31	31	44	16.9	18	WSW	33
1700	30	30	10.8	24	NW	43	28	49	16.2	20	WSW	35
1800	28	33	10.3	18	NW	28	25	55	14.9	20	WSW	28



Figure 2. Photograph taken by the pilot of the CALM spotter aircraft looking north towards the origin of the fire at around 1200 hrs on 27 December. The large smoke plume appears to originate from fire in the Dalgarpur pine plantation. In the foreground a number of spot fires are visible in private property (Locs. 20 and 886) adjoining Davies Rd.



Figure 3. View southwards along the easement beneath the power line. The vehicle is parked immediately adjacent to Five Gates Rd. Two large Manchurian Pear trees can be seen growing on the easement directly beneath the power line. Spraying has restricted the growth of grass and weeds on the easement.

5. Probable cause of ignition

Investigations undertaken by FESA/CALM and the Energy Safety Division both concluded that the most probable cause of the fire was vegetation contacting the 12.7 kV power line that traverses the Dalgarpine plantation south of Five Gates Rd. Under the extreme weather conditions prevailing during the late morning on 27 December the fire ignited in sparse leaf litter and dead grass on the easement beneath the power line (Fig. 3). The easement had been sprayed to remove the grass for a width of at least 20 m beneath the power line and most of the grass residue was in a decomposed state that would have made it difficult to ignite (Fig 4). Despite the sparse fuels, the fire continued to spread into the plantation where it developed rapidly in a fuel bed of cured grass and pine needles (Fig. 5)



Figure 4. Section of easement south of the two pear trees showing the sparse condition of the ground fuels and patches of bare ground and unburnt grass residue.



Figure 5. Fuel bed of pine needles and cured grass fuel in Dalgarup pine plantation about 500 m east of the fire origin.



Figure 6. Looking ESE along the direction travelled by the head-fire. Longs Plantation and the Blackwood River are visible in the foreground. Much of the remnant native forest in paddocks and along the river has not been fully scorched by the fire, and there are unburnt patches where the pasture has not fully cured.

6. Fire development and spread

6.1 Landscape of the Blackwood Valley around Bridgetown

The Blackwood River valley follows a generally westerly direction for about 9 km downstream of Bridgetown then turns sharply to the north for about 6 km before turning westwards again in the area known as the Peninsula. Terrain associated with the river valley is steep and rocky, with local variation in elevation from below 120 m ASL in the river channel to more than 280 m on the crests of the higher ridges. The complex terrain of the Blackwood Valley added to the difficulty of fire suppression by influencing the speed and direction of the wind at different locations on the fire-ground, and by restricting the movement of vehicles and heavy machinery.

6.2 Predicted fire behaviour

Rates of forward spread in pasture grass were predicted using the CSIRO Grassland Fire Spread Meter assuming fully cured conditions. Predicted rates of spread were 10 km/h during the most severe burning conditions in late morning, but declined to 4 km/h by 1600 hrs as the wind speed moderated and the relative humidity increased. In practice rates of spread across the landscape would be expected to vary considerably, reducing where grass curing was incomplete, and increasing in tall un-grazed grass swards.

Leaf litter fuels in native forest had a minimum moisture content of 4 per cent based on predictions made using the Forest Fire Behaviour Tables for Western Australia. The tables predicted a potential rate of spread of 1660 m/h in Jarrah forest (4:1 wind ratio) with 5 year-old fuel during the most severe conditions in the late morning. Under these conditions the predicted rate of spread in pine plantation with an available fuel quantity of 20 t/ha was 2112 m/h. During the mid-afternoon when wind speeds were 24-26 km/h the predicted rate of spread was 240 m/h (Very High) in Jarrah forest and 792 m/h in pine plantation.

Predicted rates of spread for both grassland and forest fuels apply to level terrain and would be substantially greater on slopes above 5 degrees.

6.3 Chronology of fire development and spread

Key events in the development of the fire and the associated fire suppression response are presented in Table 2.

The fire developed rapidly and within 30 minute of ignition had spread more than 1 km to the south, making the forward rate of spread at least 2 km/h through the Dalgarpur plantation. During this initial period the fire also crossed to the eastern side of the Blackwood River. Multiple spot fires ignited several kms downwind of the main head fire (Fig. 2). After travelling a distance of about 1.5 km through the plantation the fire moved into open pasture, re-entering timbered country south of Thompson Rd. The western flank of the fire spread into a second rotation Bluegum plantation that carried fully cured slash from a coppice thinning operation (Figs. 7 and 8). The main head-fire crossed Thompson Rd around midday having travelled 3 km in 45 minutes, making the forward rate of spread about 4 km/h.



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Figure 7. View to the south-east across Loc. 2 showing burnt second rotation Bluegum plantation in the foreground, and unburnt Bluegum plantation behind.



Figure 8. Looking into burnt second rotation Bluegum plantation on Loc. 2 showing coppice stems re-grown from harvested stumps, and white ash resulting from consumption of thinning slash on the ground.

The head-fire could not be attacked directly because of the rapid rate of spread and the risk of fire-fighters being trapped by spot fires. Suppression crews therefore directed their efforts towards the protection of buildings and other farm assets. Fire-fighters re-grouped along the Maranup Ford Rd around midday but were unable to prevent the fire from crossing the road on a wide front by 1245 hrs. Fluctuations in wind direction observed at this time were probably due to the effects of complex local terrain.

During the next two hours the head-fire spread through a mixture of pasture, remnant native forest, pine plantation and eucalypt woodlots (Figure 6). By 1500 hrs the fire had crossed the Blackwood River and spot fires were burning in pasture up to 1 km south-east of the river. The shape of the fire indicates that wind direction shifted westerly sometime shortly after 1500 hrs driving the fire eastwards towards State Forest in the Glenlynn block. This change in wind direction was not evident in the observations from the Bridgetown AWS. At about 1600 hrs a second major fire run crossed the Blackwood River about 2 km north-east of where the head-fire had crossed an hour earlier.

By 1700 hrs the fire was encroaching on the western outskirts of the Bridgetown townsite north of the river, while to the south fire continued to spread actively through the Glenlynn forest block threatening a number of houses on small rural subdivisions. Running fire was brought under control during the next hour due to a combination of moderating weather conditions, coordinated and concentrated suppression action, and the presence of substantial areas of green grass in moister sites adjoining the Blackwood River. The threat to the town had been averted by 1830 hrs.

7. Fire suppression response

7.1 Fire Preparedness at District, Region and Departmental level

Blackwood District was in a high state of preparedness in anticipation of the extreme fire danger conditions expected on 27 December. Resources on standby for fire service included field officers and clerical staff, fire crews, 4 bulldozers and 1 Front End Loader (FEL) with low-loader transport (Table 3). The District had no fire commitments prior to detection of BWD 18.

A high level of preparedness was in place across all CALM work centres in the forest regions, South Coast and Wheatbelt in recognition of forecast extreme fire danger across much of the South-West Land Division. Fires had been burning around Collie for several days leading up to and including 27 December, resulting in full commitment of resources from CALM Wellington District. During the morning of 27 December CALM Donnelly District responded to a fire in Diamond State Forest about 15 km south of Manjimup. Water-bombing aircraft based at Manjimup were tasked to the Diamond block fire prior to BWD 18 being detected. A serious grassfire started at about 1330 hrs near Tenterden north of Albany, necessitating substantial commitment of resources from FESA, volunteer brigades and local government in the Great Southern. Personnel and heavy duty fire trucks from CALM South Coast Region were also deployed to this fire.

TABLE 2. Chronology of key events during Fire 18 constructed from incident records and interviews with CALM personnel. Individuals working in the Incident Management Structure are identified by their role in the Incident Management Team or by radio call-sign for officers working in the field. Personnel interviewed for the post-fire analysis are listed in Appendix A. Grid references are based on the CALM alpha-numeric system.

Time (WST)	Observation/Action
1115	Smoke sighted from Styles Tower on a bearing of 103 degrees.
1119	Smoke report from Styles Tower received at CALM Kirup. Blackwood Duty Officer telephoned on-call officer (FPC 18) requesting him to proceed immediately to the location of the smoke report.
1128	CALM Blackwood spotter aircraft reports indirect smoke sighting at GD 61 to CALM Kirup.
1135	FPC 18 arrived at the fire, by which time volunteer firefighters were already in attendance. Blackwood spotter reported direct sighting of fire burning in Dalgarup pine plantation at grid reference GD 62 59, with an estimated fire area of 3 ha.
1140	Blackwood spotter reported fire at GD 62 52 burning in Dalgarup plantation.
1141	FPC 18 telephoned CALM Kirup to advise that a house on Loc. 13 south of Five Gates Rd was under threat from the eastern flank of the fire.
1145	BWD 10 arrived at the fire, travelling via Southhampton Rd to Five Gates Rd. Blackwood spotter reported fire at GD 62 68 burning on the eastern bank of the river.
1150	BWD 3 arrived at the fire, travelling via Southhampton Rd to Five Gates Rd.
1151	Blackwood spotter reported fire at GE 62 76 in grass on Loc.2, estimated fire area of 12 ha.
1155	Blackwood spotter reported fire at GF 63 39 in grass on Loc.886, estimated fire area of 2 ha. Call-out received by water-bomber and Air Attack aircraft based at Bunbury.
1200	Head-fire had crossed Thompson Rd travelling in a SSE direction.
1210	CALM firefighters re-grouped on Maranup Ford Rd. Spot fires observed to be starting east of the road. The main head fire crossed the road about 1230 hrs
1224	Air Attack aircraft ready to take off from Bunbury.
1235	First water-bomber drop on fire.
1400	Water-bombers engaged in protecting farm buildings and assets (eg. hay) on properties adjoining Maranup Ford Rd and the Brockman Hwy.
	Fire behaviour report from Air Attack aircraft indicated average flame heights of 6 m at the head-fire, 3 m on flank-fires and estimated rate of spread of 1 km/h.

1515	Head-fire had burnt to the Brockman Hwy. at GG 65 83 and spotted across the Blackwood River into pasture on Loc.8843. BWD 10 and heavy duty fire trucks working to contain spot fires in Loc 8843. Winds reported to be shifting to the west.
1600	A second major fire front crossed the Blackwood River at GG 66 89 through Loc. 8361 and reached Mockerdillup Rd by 16:00 hrs
1640	Two additional water-bombing aircraft from Manjimup were tasked to the fire, completing first drop at 1700 hrs.
1645	Fire encroached on the western outskirts of Bridgetown adjoining Loc. 9000 on the northern side of the Blackwood River. Police implemented traffic management on the South-West Hwy and notified Bridgetown residents of procedures to be followed in the event of fire entering the townsite.
1830 overnight	Running fire stopped on western margin of Bridgetown townsite. Extensive work to contain flank fires within mineral earth tracks and commence mop-up around the fire perimeter.

TABLE 3. Summary of CALM and FPC personnel, fire crews and heavy machinery available for fire service in Blackwood District on 27 December 2003.

Resource category	Available for fire service
Field officers	12 personnel
Clerical staff	3 personnel
Crews	Kirup – 13 personnel including 2 machine operators, on 4 trucks Nannup – 15 personnel including 2 machine operators, on 4 trucks Busselton – 6 personnel on 2 trucks
Departmental machines	Margaret River – FEL & Low loader (contract) Nannup – D65 bulldozer & Low loader Kirup – D65 bulldozer & Low loader
Contract machines	D7 bulldozer (Denham) dry hire D65 bulldozer (Mader) & Low loader

7.2 Deployment of fire-fighting resources

The first departmental officer arrived at the origin of the fire at 1135 hrs, by which time local volunteer fire-fighters were already in attendance (Table 2). Officers and fire crews from the CALM Kirup and Nannup work centres were despatched immediately to the fire once the point of origin had been confirmed by the spotter aircraft, and began to arrive on the fire-ground by 1145 hrs (Table 4).

By 1230 hrs, 3 more personnel had joined the IMT at Kirup and 2 additional contract bulldozers had been despatched to the fire. Water-bombing aircraft supported by an Air Attack Supervisor also began operating over the fire shortly after this time. Aerial fire suppression was directed towards protection of houses, sheds and other assets on rural properties in the path of the fire.

In the initial stages of the fire the Blackwood District Duty Officer assumed the role of Incident Controller, handing this role over to a more senior officer as the complexity of the fire escalated. Personnel available within the Blackwood District initially filled the key roles of Operations, Planning and Logistics within the IMT. An accredited Level 3 Incident Controller from Bunbury was appointed to manage the IMT and had received a hand-over briefing from Blackwood District personnel at Kirup by 1400 hrs.

The number of personnel committed to the incident continued to increase throughout the afternoon with 80 personnel, 20 trucks and 10 bulldozers deployed on the fire-ground by 1530 hrs. The IMT expand in size to 24 personnel as a wide variety of planning and logistics roles were filled and continued to function overnight, although 10 personnel were stood down after 2100 hrs in order to be available for the day shift commencing at 0600 hrs on Sunday morning.

The following four days saw the continuation of extensive work with heavy earth-moving machinery to construct tracks around the entire perimeter of the fire, and extinguish burning trees and logs close to the edge that might pose a threat of escape into adjacent unburnt areas.

TABLE 4. Deployment of CALM and FPC fire-fighting resources to Fire 18 during the initial work period to 1830 hrs on 27 December 2003.

Personnel committed on the fire-ground		
Time	Personnel (CALM & FPC)	Notes
1130	38	Officers and crews despatched from Kirup and Nannup work centres
1230	40	Re-grouping after fire crossed Maranup Ford Rd.
1330	51	All Blackwood District crews on fire ground.
1430	75	Arrival of crews from Donnelly District.
1530	80	Arrival of additional field staff from Bunbury.
1630	80	Organisational structure in place

Personnel working in the Incident Management Team (IMT) at Kirup office		
Time	Personnel	Notes
1130	5	Initial team formed from Blackwood District personnel.
1230	8	Arrival of Busselton and Bunbury staff.
1330	12	Arrival of further Bunbury staff.
1400	13	Hand-over to Level 3 Incident Controller at Kirup
1530	14	
1630	18	Arrival of Swan Region staff.
1830	24	Swan Region and Bunbury support staff – 10 staff stood down from 2100 hrs to be available for Shift 2.

Fire Fighting trucks on Fire Ground (Heavy Duty and Gang Truck types)		
Time	Appliances on fire ground	Notes
1130	8	Trucks despatched with Nannup and Kirup crews.
1330	11	All Blackwood District trucks on fire ground.
1430	20	Manjimup and Pemberton trucks arrive.
1530	20	

Machines on Fire Ground		
Time	Machines on fire ground	Notes
1130	2 bulldozers	Blackwood District
1230	4 bulldozers	Mader / Denham (contract)
1330	6 bulldozers	Bridgetown Bulldozing (contract)
1430	8 bulldozers	SW Haulage/ Seesink (contract)
1530	10 bulldozers	CALM Donnelly/ Archibald (contract)

8. Losses resulting from the fire

The total area burnt by BWD 18 was 4621 ha which included 3367 ha held in private freehold title, 353 ha of State Forest and Nature Reserve vested in the Conservation Commission of Western Australia, and 901 ha of other Crown land.

Commercial losses resulting from the fire included two houses and a third dwelling under construction, damage to farm buildings and fences, death of stock, and loss of fodder. More than 1000 ha of commercial tree plantation were burnt (Table 5), the great majority being Radiata Pine older than 20 years and in the final decade of rotation. Salvage harvesting operations commenced within two weeks of the fire and nearly 150 000 cubic metres of wood delivered to mills, although the onset of blue-stain fungi eventually rendered some logs unsaleable (Anon 2004 b). BWD 18 caused softwood plantation losses comparable to those resulting from fires associated with Cyclone Alby in April 1978, and somewhat larger than the Gngangara plantation fire of December 1994 which burnt 850 ha of *Pinus pinaster* (Burrows *et al.* 2000). On a national scale BWD 18 is also significant, being one of only 12 recorded fires to have burnt in excess of 800 ha of softwood plantation.

TABLE 5. Area commercial tree plantation burnt (ha) by land tenure.

Tenure	Tree species		
	<i>P. radiata</i>	<i>E. globulus</i>	Other eucalypt
CALM estate	429.1	-	-
FPC Sharefarm	204.4	-	-
Private	347.7	89.8	3.0
Total	981.2	89.8	3.0

The area of eucalypt plantation and woodlots burnt by BWD 18 is likely to exceed the figure shown in Table 5 because CALM does not have access to accurate data for all tree plantings on freehold land, particularly for smaller farm woodlot plantings.

9. The post-fire recovery process

Post-fire recovery actions were identified as a high priority during the first work period and commenced almost immediately after the fire had been contained. These actions were coordinated by the Shire of Bridgetown-Greenbushes through the Local Emergency Management Committee and included provision of essential services, dealing with immediate hazard and hygiene issues, and initial assessment of damage to rural properties and infrastructure. In addition to CALM and FPC, other Government agencies were also involved in the post-fire recovery operation to repair damaged electrical power infrastructure (Western Power), provide community assistance (Department of Community Development), and advise landowners regarding treatment of injured stock and management of burnt pastures (Department of Agriculture).

A public meeting called by the Shire of Bridgetown-Greenbushes on the evening of 7 January to discuss management of the fire and the post-fire recovery process attracted over 300 people including about 100 rural landholders. This meeting was

acknowledged to be the largest turnout in Bridgetown for any emergency services related event since Cyclone Alby in April 1978. The meeting included a community feedback session conducted by a trained facilitator. Issues identified during the meeting as requiring further action were directed to the Shire for follow-up, mostly through the Bush Fire Liaison Committee, with some actions also directed to relevant Government agencies.

Responsibility for ongoing management of the incident was formally transferred from CALM to the Shire of Bridgetown-Greenbushes on 2 January 2004.

10. Conclusions

BWD 18 provided a cogent demonstration of the threat that bushfires pose to rural communities and the primary industries that sustain these communities. Losses could have been much greater had the fire danger remained extreme for a longer period in the afternoon, and had an effective fire suppression organisation not been promptly mobilised. Effective mobilisation of fire suppression resources available to CALM was achieved despite a number of simultaneous fire commitments within the South-West Land Division. Advance warning from BoM of the likelihood of extreme fire danger conditions meant that sufficient personnel could be made available for fire service during the traditional holiday period between Christmas and New Year. During a rapidly escalating incident such as BWD 18 most losses are incurred during the first work period and it is essential that a competent and properly resourced IMT be established quickly in a well equipped control centre.

Important issues raised by the fire include:

- the need to clarify the responsibilities that electricity supply utilities and occupiers of land have in relation to inspection and maintenance of native and cultivated vegetation growing near powerlines;
- the need for rural communities, and in particular the residents of rural towns, to become more aware of fire safety and to make preparations prior to the summer bushfire season;
- the need for the commercial plantation industry to maintain high standards of fire prevention, detection and preparedness in order to minimise potential losses of timber assets and disruptions of supply of wood to industry.

Fire behaviour observed in various fuel types during BWD18 was consistent with predictions from current fire behaviour guides. The fire travelled a distance of 13 km in a period of about 5 hours, making the average rate of spread about 3 km/h. Rates of forward spread observed in pine plantation during the period of extreme fire danger in the late morning of 27 December were around 2 km/h which is close to the rate of spread predicted by the Forest Fire Behaviour Tables. Rates of spread in mixed pasture and remnant eucalypt forest were more than double those observed in pine plantation. Had the fire occurred later in the summer when all grass was fully cured and the drought index was near the seasonal peak it is likely that suppression difficulty would have been even greater than experienced on 27 December, with potential for more extensive damage to rural properties and residential buildings on the outskirts of Bridgetown.

11. Acknowledgements

We thank the many people who provided personal accounts and observations which helped to re-construct and document the events of 27 December 2003. John Tillman, Fire Coordinator South West Region and John Mosaj of Forest Management Branch Bunbury provided the data on area burnt by the fire. Aerial photographs were taken by Bjorn Prescott (Figure 2) and Alf Lorkiewicz, and ground photographs by Lachlan McCaw.

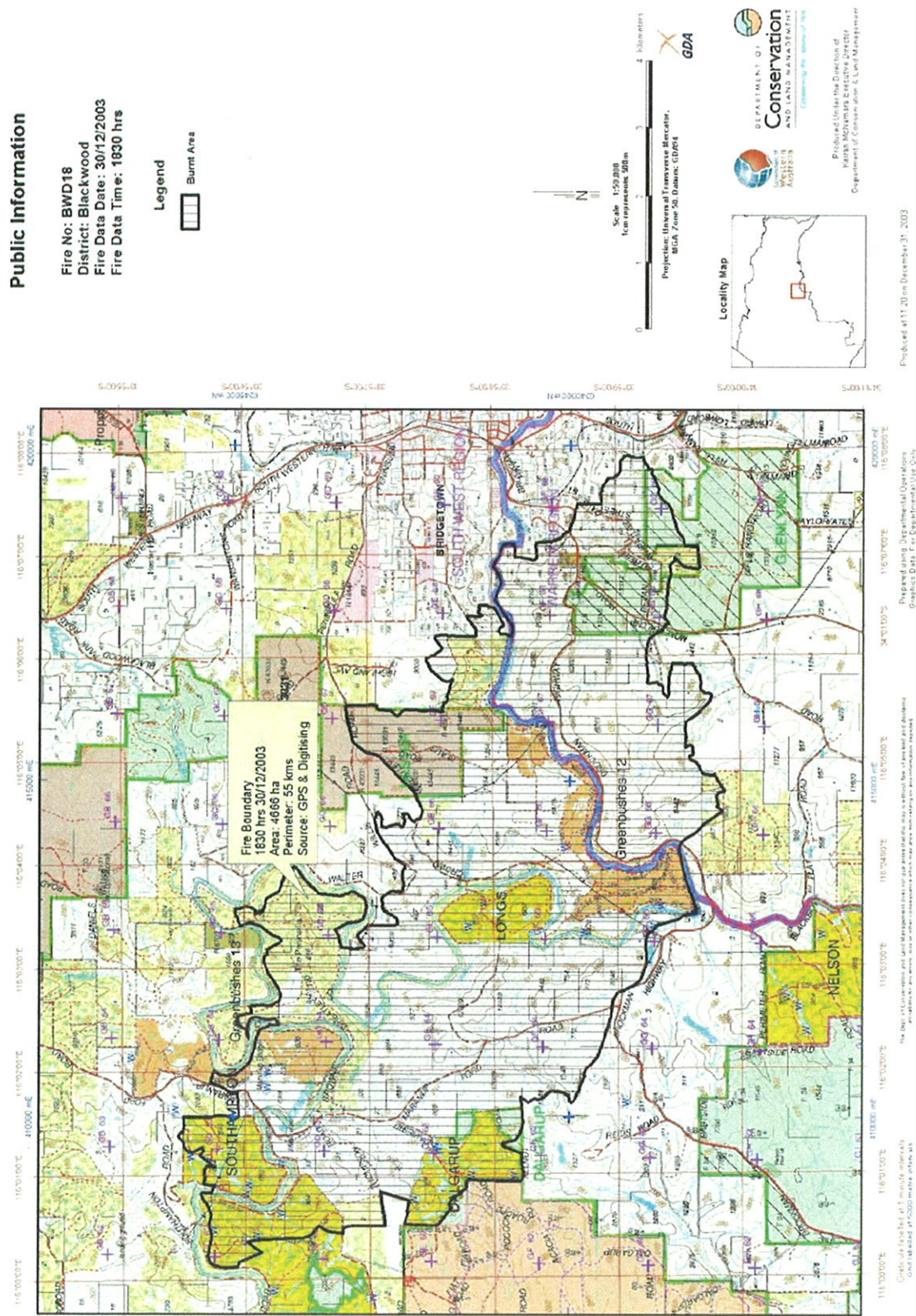
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APPENDIX A. Personnel interviewed during the preparation of this report.

Person	Role at fire	Date of interview	Topics discussed
Roger Armstrong	Incident Controller (Shift 1, 1430 hrs onwards)	5-Feb-04	Decision making during first shift.
Don Boothey	Sector Commander	5-Jan-04	Fire behaviour.
Brad Commins	Incident Controller (Shift 1, 1200-1430 hrs)	29-Dec-03	Initial fire report and despatch of crews.
Vince Hilder	Situation Unit	5-Jan-04	Fire spread and mapping.
Alf Lorkiewicz	Air Attack Supervisor	26-Feb-04	Water bombing operations
Greg Mair	Incident Controller (Shift 2 onwards)	30-Dec-04 13-Jan-04	Post-fire recovery actions.
Bjorn Prescott	Spotter Aircraft Pilot	13-Jan-04	Fire detection and initial stages of development.
Julie Proctor	Management Support Officer	30-Dec-03	Details of initial fire report.
David Rawet	Planning Officer	29-Dec-03	Fire spread records.
Mick Zwart	Fire investigator	29-Dec-03 6-Jan-04	Investigation and interviews with witnesses.

Appendix B. Map showing the final perimeter of BWD 18 and major geographic features mentioned in the text.



Appendix C. Ortho-photo showing the final perimeter of BWD 18 and vegetation cover.

