THE ORIGIN AND DEVELOPMENT

OF THE

DWELLINGUP FIRES

19th-25th JANUARY, 1961.

by

A.G. McARTHUR

C O N T E N T S

Maps

A map showing the fire perimeters at 6 hourly intervals on each day is available but does not accompany this paper.

THE DWELLINGUP FIRES

19th - 25th January, 1961.

1. INTRODUCTION.

The term "Dwellingup Fires" is used in this report to describe an area burnt by a series of lightning fires which started mainly in State Forest areas within the Dwellingup Forest Division on the evening of Thursday, 19th January, and the night of Friday, 20th January. In both storms nineteen separate fires were started by lightning across an area embracing some 300 square miles of high quality Jarrah forest. The lightning storms were not confined to this area alone, but extended from Mundaring in the north to Manjimup in the south, right throughout the Jarrah belt. The presence of other lightning-caused fires had a very significant bearing on the development of the Dwellingup fires, as other forest fire control forces were desperately engaged on controlling fires in their areas, and thus could not render ready assistance to Dwellingup. Here one fire had remained dormant for nineteen hours and broken away under extreme conditions.

There appears little doubt that all the fires originating from the first storm could have been controlled by Friday night or Saturday morning and the burnt area kept to less than 10,000 acres. However, a second thunderstorm laid a semi-circle of fresh lightning fires around the southern perimeter of the one running fire between 9 - 10 p.m. on Friday night and, under severe overnight burning conditions, these fresh fires spread throughout the night and forced the abandonment of a very large length of fire perimeter on the original Torrens fire. From this point onwards, it was inevitable that a very large area would be burnt.

A continuance of very severe fire weather conditions made control of these fires, which joined as one large conflagration, very difficult.

However, by Monday night, January 23rd, most of the fire perimeter had been brought under control. Extreme fire danger on Tuesday, 24th influenced by an intense tropical cyclone along the North-West coast once again caused the southern perimeter to break away at various points, and a cyclonic wind squall around 8.30 p.m. on Tuesday night resulted in extremely rapid movement of all uncontrolled headfires, and the township of Dwellingup, and the mill settlements of Holyoake and Nanga Brook were engulfed and suffered heavy property losses.

A remarkable feature of these fires was the fact that no lives were lost, nor was any firefighter or town dweller seriously injured. This speaks very highly of the ability of the Forester in charge of firefighting operations, to quickly recognise the dangers involved under blow-up conditions.

During the disastrous run of the Dwellingup fires, the early action taken to warn all settlers and fire-fighters working in the path of the running fire of the impending danger and the successful and timely evacuation of the Holyoake settlement played a very important part in averting what could easily have resulted in tragic loss of life.

Rain which fell during the afternoon of the following day stopped the running fire, and suppression forces effectively brought the huge perimeter under control.

Minor breakaways occurred at intervals during the next three weeks but were quickly controlled. The immense job of consolidating fire lines, mopping up and maintaining a constant patrol of over 200 miles of fire edge continued for more than one month after the main fire was halted.

The Dwellingup fires will become famous in the history of Australian fire control as being one of the largest areas of high quality forest land burnt in what is virtually a single firefighting operation, and the fire behaviour characteristics and suppression difficulties experienced can provide valuable information to other firefighting authorities throughout Australia.

In view of the very widespread interest aroused by these fires and the difficulty of showing the overall pattern of fire behaviour when it embraces such a large area, the development and spread of the fires has been treated in detail in this report. It is hoped that this detail will help foresters, farmers and graziers and the general public to appreciate the difficulties involved in fire suppression activities in heavily timbered lands, and tend to show how certain events become almost inevitable during the unprecedented weather conditions which Western Australia experienced during the period these fires burned in January, 1961.

2. CAUSE AND ORIGIN OF THE FIRES.

All the individual fires which arose in the Dwellingup Division and which eventually combined into a single fire area were caused by lightning. Whether these lightning strikes first ignited trees and then the floor of the forest or immediately ignited the leaf litter is not known. Probably both processes were involved. Ten fires ignited from lightning strikes

in a storm which passed over the Darling Range between 1730-1800 hours on Thursday, 19th January, and a further nine fires ignited from lightning strikes in a storm which passed over the area between 9 - 10 p.m. on Friday, 20th January. It is of interest to mention that the intensity of the second thunderstorm may have been significantly increased by the presence of the Torrens fire, which was making a high-intensity run around this time. The second series of lightning fires was laid in a semi-circle around the southern perimeter of this fire at a distance of 3-4 miles from the burning edge.

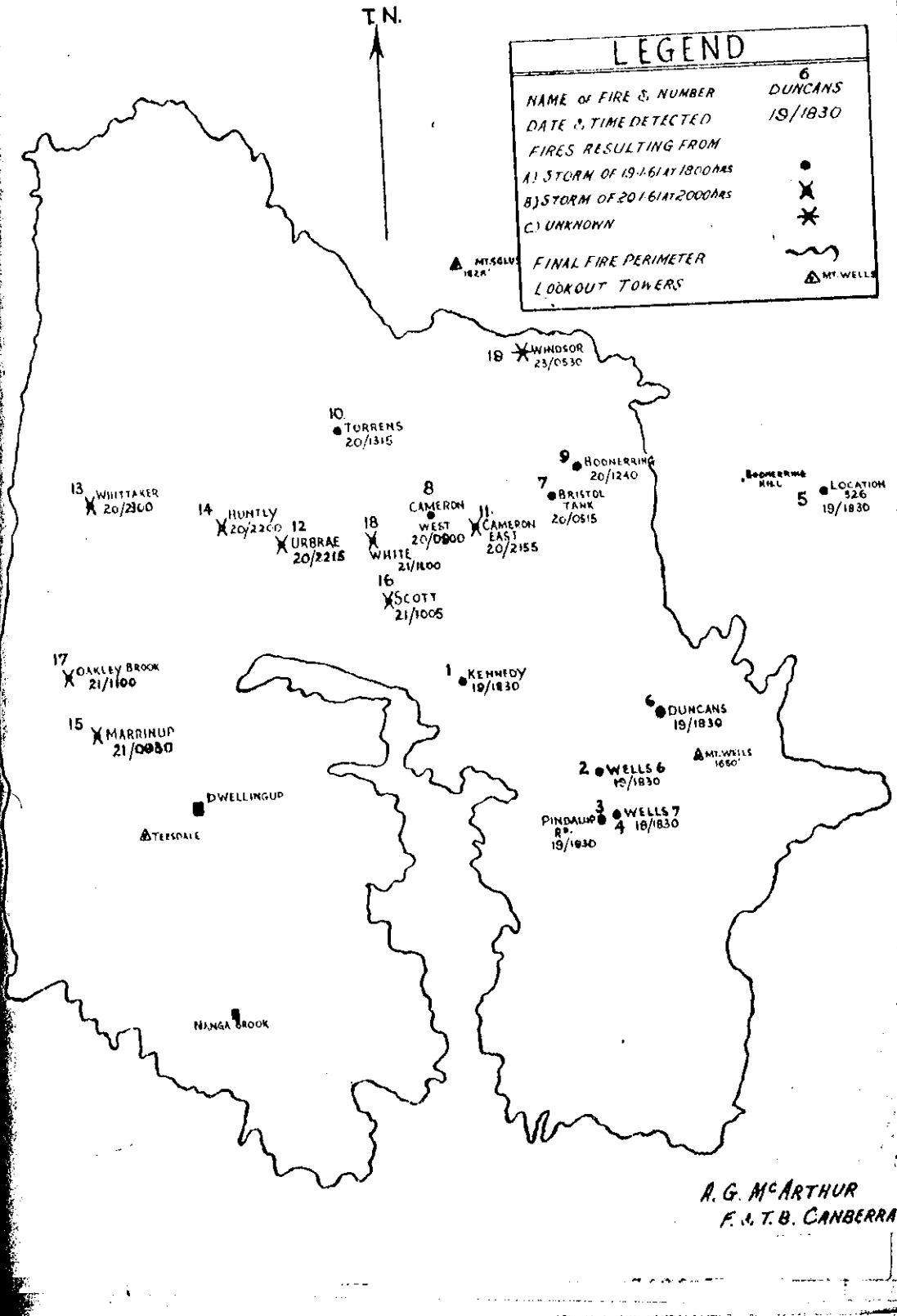
The point of origin of each individual lightning fire is shown on Plan 1 attached to this report. The detection time of each fire is given in Table 1. Both storms were accompanied by some rain, which had a two-fold effect. Firstly, it probably extinguished a considerable number of ignition points and kept the number of fires resulting from strikes down to a much lower figure than if it had been a completely dry storm. Secondly, it had an adverse effect insofar as it damped down but did not extinguish a number of fires which then remained dormant until the following day when they commenced to burn under severe conditions. Thus the potential of these "sleeping" fires was very much greater than those ignited and controlled the previous evening when burning conditions were at a low ebb. The tenth fire, which came up at 1.15 p.m. on Friday, 20th, made a high-intensity run from the time of commencement, and the whole Dwellingup fire can be said to have originated from this point.

THE DWELLINGUP FIRES – JAN. 19–25 1961.

LOCALITY PLAN
SHOWING
POINTS OF ORIGIN OF INDIVIDUAL
LIGHTNING FIRES

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



A. G. McARTHUR
F. A. T. B. CANBERRA.

Table 1. Lightning Fires caused by the storms of 19th and 20th January, 1961 and their time of detection.

Fire Name	Fire No.	Time of Origin	Time of Detection
Kennedy 10	1	1800/19	1830/19
Kennedy 6	2	1800/19	1830/19
Wells 7(a)	3	1800/19	1830/19
Wells 7(b)	4	1800/19	1830/19
Location 526	5	1800/19	1830/19
Duncan 6	6	1800/19	1830/19
Bristol Tank	7	1800/19	0515/20
Cameron West	8	1800/19	0800/20
Boonerring	9	1800/19	1240/20
Torrens	10	1800/19	1315/20
Cameron East	11	2130/20	2155/20
Urbrae	12	2130/20	2215/20
Whittaker	13	2130/20	2300/20
Huntley	14	2130/20	2200/20
Marrinup	15	2130/20	0930/21
Scott	16	2130/20	1005/21
Oakley Brook	17	2130/20	1100/21
White	18	2130/20	1100/21
Windsor	19	2130/20	0530/23

The fire in Windsor block probably resulted from the storm on Friday, 20th, although this is not certain. It was reasonably big fire when detected early Monday, 23rd and probably started up on Saturday, 21st but was blanketed out by smoke from fires to the west. It was then probably damped down by rain which fell in the area on Saturday night.

There were undoubtedly hundreds of strikes which occurred during these two storms, as evidenced by the number of struck trees which were counted after the fires. One observer counted 27 heavy ground strikes during Friday night storm. The Boonerring fire (No.9) was, in fact, a series of strikes running in a south west-north east direction at intervals of 1-1½ chains. There were 15-20 individual strikes which started this one fire.

3. DEVELOPMENT OF THE FIRES.

Initially, the suppression action and development of each lightning fire will be described separately until all or most of them joined as one common front sometime on Saturday, 21st January. Many were quickly controlled and later engulfed by other fires. The Wells fire (No. 4) remained separated from the northern group of fires until the early hours of Wednesday, 25th January and had a significant effect on the fire-fighting operations in the whole division, as efforts to keep it contained drew heavily on both manpower and equipment reserves which were sorely needed on other fronts. Similarly, never enough men and equipment could be spared so that absolute control of the Wells fire could be achieved.

(a) Thursday, 19th January.

Maximum temperature 104°F. Minimum relative humidity 15%. Wind mainly NW 10-14 m.p.h. before the thunderstorm.

Thunderstorms passed over Darling Range between 1730-1800 hrs. All gangs were alerted for fast action if any lightning fires were reported. At 1830 hrs. Wells lookout reported six fires and gangs were immediately

despatched to each fire. The delay in report of these fires was due to the fact that the lookout tower was struck by lightning and the telephone system was blown out. An emergency system was then made up by the towermen.

Unfortunately, only one lookout could observe the smokes as most had been dampened down by rain and no cross bearings could be given. Consequently some gangs had difficulty in locating the fire.

Fires Nos. 1, 2, 5 and 6 were located and controlled that night. All were checked around 0800 hrs. the next day and found to be safe. No further breakaways occurred from these fires. Fire No. 5 was handled by a Gleneagle gang.

Fires Nos. 3 and 4 could not be located by gangs between 1900-2300 hrs. Further search the next day found No. 3 at 1230 hrs. which was controlled. Fire No. 4 came up about the same time and gained momentum very rapidly and could not be controlled by the initial attack force. This then developed into the Wells fire and is described separately.

(b) Friday, 20th January.

Maximum temperature 106°F. Minimum relative humidity 13%. Wind ESE 15 m.p.h. then N. 15 m.p.h. at 2300 hrs.

At 0515 hrs. Fire No. 7 (Bristol Tank) was reported from Mt. Wells. A gang of 6 men, plus a heavy duty pumper, was despatched at 0600 hrs. and the fire was controlled by 1100 hrs. Mopping up continued until 1800 hrs. It was checked at 1100 hrs. the next day and found to be safe. No further breakaways occurred from this fire.

At 0800 hrs. the Cameron West Fire (No. 8) was reported and a gang of 4 men despatched. The fire was located in a swamp area and was about 2 acres in extent. At 0930 hrs. it started breaking away in a peaty area. A heavy duty pumper was brought in to water the peat fire down. Chain saws were brought in at 1400 hrs. on final mopping up and the fire was controlled by 1830 hrs.

At 1240 hrs. the Boonerring Fire (No. 9) was reported and a gang of 5 men despatched from Dwellingup at 1245 hrs. This was the last remaining operational gang. The gang arrived at 1330 hrs. and found the fire to be burning strongly. Additional assistance was called for and another gang from the Wells area was diverted onto this fire, together with part of the initial attack crew working on the Bristol Tank fire. This fire gave considerable trouble and was not rendered safe until 1800 hrs. on Saturday, 21st. Chain saws were used extensively in mopping up this fire and did a very thorough job. The burnt area was restricted to approximately 50 acres.

At 1315 hours the Torrens fire was reported. This was Fire No. 10. All gangs in the Dwellingup Division were at this time committed on other fires and only one officer and one man were available for despatch to this fire. The Wells fire also commenced to burn strongly at this time and the gang in that area was calling for assistance. An immediate reconnaissance was made of the Torrens Fire in a 1-ton Jeep unit. At 1340 hrs. the fire was well established and consisted of a series of small fires covering about 10 acres. The fire had commenced in a swamp area and was crowning and throwing spot fires. A heavy duty pumper was despatched from the Cameron West fire. Fire headquarters were advised that all available equipment was required. At 1350 hrs. a D.4 bulldozer was immediately despatched, together with an aqua-track unit. A gang would be provided when available.

At 1430 hrs. the headfire was crowning and making rapid progress. It was then 40 chains from the point of origin.

At 1430 hrs. Dwellingup requested urgent assistance from adjoining Divisions to assist in the control of this and any other fires which may start. From 1530 hrs. men and equipment began arriving and started working the tail and flanks of the fire. By 1800 hrs. the headfire had travelled 4 miles and was spotting heavily. The wind was blowing from the east south-east at 16-17 m.p.h.

At 1900 hrs. a hopover was reported in Myara 7 west of Cronin Brook, and this fire also commenced to make rapid progress under the ENE wind. The distance of this throwover was 2 miles from the main headfire and 6 miles from the commencement of the fire. At around 2130 hrs. a massive thunderstorm developed over the fire area. The thunderstorm downdraft winds probably affected the southern perimeter of the fire and numerous hopovers occurred around this time. After the thunderstorm passed over, with a few very light showers which only had the effect of raising the humidity for an hour or so, the wind backed north-easterly and the southern face of the Torrens fire spread fairly rapidly in a south-westerly direction. The spotfire, which had started at Myara 7 had run for a distance of a little over 1 mile onto the boundary of private property in location 473 and had then thrown a spot fire ¾ mile to the south-west around Marshall's property. Further lightning fires started by the thunderstorm at 2130 hrs. were burning in Whittaker 6, Urbrae 2 and Urbrae 3 near the junction of Wrens Road and Seven Mile Road. Gangs were still operating on the Cameron West, Boonerring and Wells fires.

The position of the fire edges up to midnight on the 20th January, is shown on the attached plan. The area burnt by this time was 4400 acres and the total fire perimeters on the individual fires exceeded 25 miles.

THE DWELLINGUP FIRES - JAN. 19-25 1961.

PLAN SHOWING

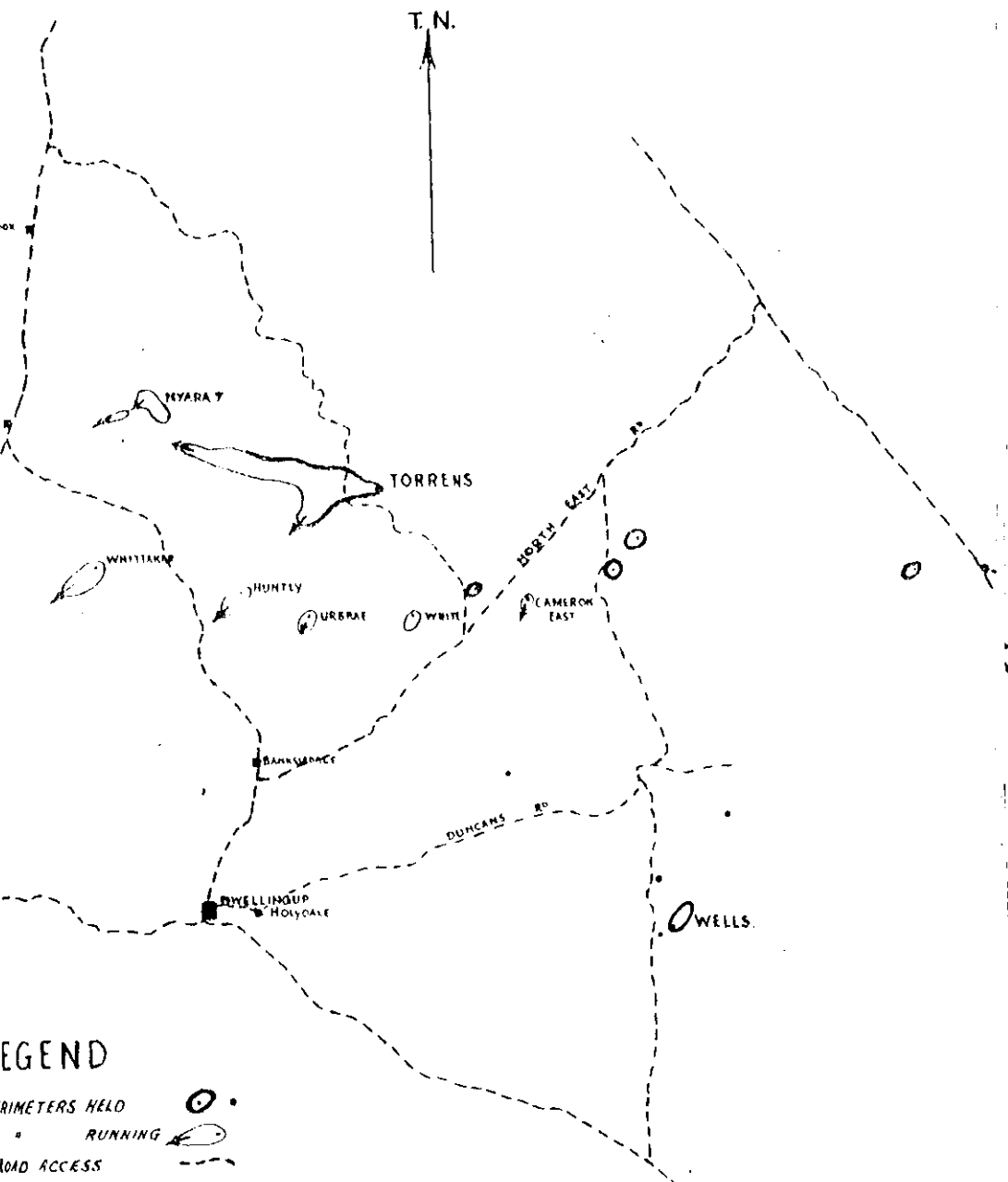
FIRE PERIMETERS

AT

MIDNIGHT FRIDAY 20 JAN

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



EGEND

RIMETERS HELD

RUNNING

OAD ACCESS

THIS PLAN IS PRODUCED FROM INFORMATION ON FIRE PERIMETERS SUPPLIED BY FOREST DEPARTMENT AND RURAL FIRE BRIGADE OFFICERS AND INTERPOLATION FROM KNOWN METEOROLOGICAL AND FIRE BEHAVIOUR CHARACTERISTICS.

A. G. Mc ARTHUR.
F.F.T.B. CANBERRA.
1.3.61

(c) Saturday, 21st January.

Maximum temperature 103°F. Minimum relative humidity 20%. Wind NE to N at 15 m.p.h. until 11 a.m. then WSW to SW 5 - 15 m.p.h. until 9 p.m.

A reconnaissance of the fire edge was undertaken during the early morning hours and at 0345 the decision was made to concentrate suppression action on the northern face of the fire as the position on the southern face was confused, due to the fresh lightning fires which were burning. From evidence collected after the fire, the position around 0600hrs. was as follows :-

(i) The head which had resulted from the Cronin Brook fire, and which had then spotted across to Marshall's, had moved down the escarpment and was threatening pasture lands just east of North Dandalup.

(ii) The lightning fire which had commenced in Whittaker 6 had moved rapidly down the escarpment and, at 4 a.m., a narrow tongue of the fire had reached the South Dandalup River near the Fairbridge Farm School.

(iii) The lightning fire in Urbrae 2 had cut across the Huntley Road just south of the old settlement and had burnt into Turner 1.

(iv) The second Urbrae lightning fire had moved down Wrens Road and had crossed Observatory Road.

(v) From reports from various officers and men during the night, it also appeared that there were fresh fires in Wilson, White, O'Neil and Cameron blocks. These were some of the fires located during the morning. It is probable that there were other lightning fires which started but were then quickly engulfed in the main fire.

This fresh crop of lightning fires completely out-flanked all work done on the southern face of the Torrens fire during the previous night. Consequently all gangs working in this area were recalled to Dwellingup

for regrouping.

At 0900 hrs. Teesdale lookout tower reported fire number 15 in Marrinup block. Gangs were immediately despatched, but the fire could not be located until around 1100 hours, due to poor visibility. By this time the visibility was less than 5 miles from all the towers, and great difficulty was being experienced in obtaining cross bearings on the different fire heads. In the process of searching for the Marrinup fire, gangs found and suppressed another lightning fire in private property near Oakley Brook. Also around this time (1000-1100 hrs.) the gangs working on the northern face of the Torrens fire were placed in a dangerous position as a strong west to south-westerly wind change had been forecast and, if this occurred, it was possible that their access routes would be cut off. The Cameron West fire was also giving trouble and suppression forces were diverted onto this breakaway as further movement of this head could cut the North-East Road, one of the major access routes. Ranger Road, had already been cut by a breakaway on the south-eastern end of the Torrens fire.

A strong westerly, later backing south-westerly, wind change occurred around 11 a.m. as forecast, and the entire northern face of the Torrens fire broke away at various points and assumed a massive spread to the north and north-east. All gangs and equipment were withdrawn via Maiden Bush and O'Neil Brook Roads to the North East Road and regrouped. Reports at this time indicated that the North-East Road was cut by fire between the assembly point and Dwellingup and, as a consequence, all men and equipment had to return to Dwellingup via Jarrdale and Serpentine and up the Bunbury Road and thence to Dwellingup. They did not return to Dwellingup until 5.30 p.m.

The south-westerly change had also blown the Marrinup fire away and all available gangs were then concentrated on this fire, which was only 4 miles north-west of Dwellingup. The main suppression effort was directed towards controlling the eastern and southern flanks, as the western flank was being held by recently control burnt country and the north-moving headfire was running towards uncontrolled heads of the Torrens fire.

Considerable ground reconnaissance was undertaken during the afternoon as visibility from the lookout towers was critically reduced, and it was essential to obtain an overall picture of the fire situation before planning further suppression action. By nightfall there was a very extensive area of running fire from Marrinup in the south-west to Boonerring in the north-east, a distance of some 19 miles, and from Boonerring North through O'Neil, Clinton, Myara to North Dandalup in the north-west.

During the day, bush fire brigades on the western side of the fire commenced various backburning operations to prevent the spread of the fire onto the highly improved coastal plain country. Two distinct operations were involved in this work. Firstly, from about 0800 hours onwards, brigades burned from the North Dandalup River southwards to Fairbridge Farm School so as to contain the two heads which had penetrated down the escarpment during the early hours of the morning. This burning was carried out in sections under various fire control officers. This whole line generally covered the area between the North and South Dandalup Rivers.

The second backburning line was from the South Dandalup River southwards along the edge of the cleared pasture country to Woolheads Road near location 1173.

This operation was carried out between 1600 hrs. and midnight and was motivated by the large volume of smoke arising from the Marrinup fire some 4 miles to the east. There may be some doubt as to whether this back-burn was necessary as a large belt of recently-burnt country existed between the western edge of the Marrinup fire and the escarpment and the wind was blowing from a south-westerly direction. There was certainly no urgency about the operation as the Marrinup fire edge never burnt through this country. However, as the general fire position was obscure on all fronts, the action taken in this instance by the rural fire control officers appeared reasonable and at least established a firmly held line. The burn was carried out under ideal conditions as the south-westerly wind took the backburn up the escarpment into forest country.

When the overall position of the various fire edges had been determined in the State Forest area, the general suppression plan envisaged holding the fire along the North-East Road from Dwellingup to the Albany Highway by backburning during the night. This was somewhat complicated by the fact that the fire had already broken across the North-East Road in Cameron Block and a lightning fire was burning south of the road in Scott block. These salients were also to be stopped by backburning.

The southern face of the fire was considered the most critical as north to north-east winds were expected and all townships and intensively managed forest areas lay to the south. Country to the north had been extensively control burnt and the Serpentine Dam clearing constituted a safe break on this side.

The position of the fire edge and area burnt up to midnight on the 21st January is shown on the attached plan. By this time some 70,500 acres had been burnt and the fire perimeter exceeded 85 miles.

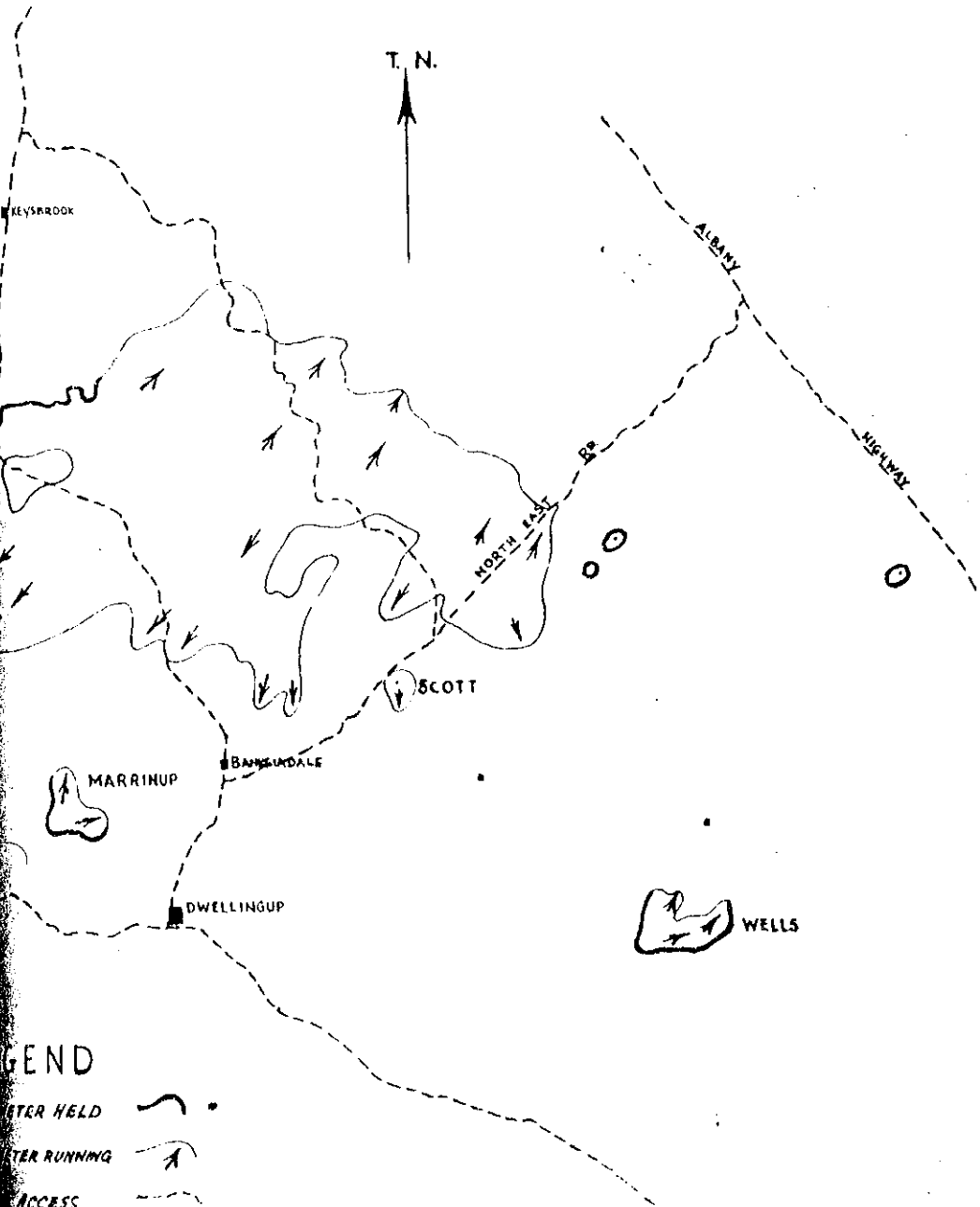
15-16

THE DWELLINGUP FIRES - JAN. 19-25 1961.

PLAN SHOWING
FIRE PERIMETERS
AT
MIDNIGHT SATURDAY 21 JAN.

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



GEND

TER HELD

TER RUNNING

ACCESS

THIS PLAN IS PRODUCED FROM INFORMATION ON FIRE PERIMETERS SUPPLIED BY FORESTS DEPARTMENT AND RADIO TIME BEARINGS OBTAINED AND BY INTERPOLATION FROM METEOROLOGICAL AND FIRE BEHAVIOUR CHARACTERISTICS.

A. G. McARTHUR

(d) Sunday, 22nd January.

Maximum temperature 100°F. Minimum relative humidity 20%. Wind SSE to S. 10-15 m.p.h. from 0300-1600 hrs., then decreasing to 5 m.p.h. by 2100 hrs., then again gradually increasing from the south.

Weather conditions had eased considerably overnight and, until 12 noon, the relative humidity was high, being generally over 60%. Temperatures were still high and rising. This allowed suppression forces to begin the immense job of consolidating the fire perimeters along the southern face.

Control lines on the southern front were established and consolidated from Marrinup along the Back Huntly Road, then down the Huntly Road north of Banksiadale onto the Banksiadale line and back up onto the North East Road - a total distance of 21 miles. Light showers of rain had fallen in various areas during the early hours of the morning and this tended to quieten down various sections of both the northern and southern perimeters. A reconnaissance of the northern forest perimeter was carried out during the morning and in most sections the fire was burning slowly.

From around midday the humidity fell very rapidly after the early morning showers and, by 4 p.m., was down to 20% with the temperature around 98°F. Under the influence of a light to moderate south to south-easterly wind, the northern perimeter became active in various sections. One tongue travelled in a north-westerly direction through private property blocks in the vicinity of Bell's and was burning strongly between 4 - 6 p.m. A second head had travelled almost due north and crossed Karnet Road shortly after 6 p.m. and had spotted across Snake Brook into Karnet 5. A third head had also crossed Karnet Road into Karnet 2. That evening a back-burn was organised from the junction of Spencer's Road

and Karnet Road, along Spencer's Road thence south west to Skinner's location 600 and around his southern boundary. Approximately 20-30 men were organised by the Serpentine Fire Control Officer under the direction of a Forest officer, who later handed over control to a local bush boss who had an intimate knowledge of the country.

Forest gangs were also working on the north east section of the fire in O'Neil block. Early in the morning backburning operations were commenced from the Serpentine Dam clearing on Big Brook southwards along O'Neil Brook Road. Before this could be completed, the fire crossed O'Neil Brook and it was then necessary to run another backburning line along tracks between O'Neil Brook and Windsor Roads. This burn had been carried southwards to within 1 mile of the North-East Road by midnight. Two main spot fires were burning east of O'Neil Brook but not making rapid progress.

During the afternoon the big lightning fire in the Gleneagle Division was discovered and men and equipment belonging to that Division, who had been working on the O'Neil sector, were withdrawn to that fire.

On the western front of the fire along the Darling escarpment, various backburning operations were continued by local fire control officers. The extreme southern end of the backburn done the previous day to Woolhead's Road commenced fairly rapid progress up the escarpment during the morning and this necessitated local brigades burning north east along Woolhead's Road to the eastern side of location 446 to stop the south-easterly run of this fire and also to protect sheds and buildings from being burnt. The backburn gave considerable trouble and local brigades were reinforced by some forestry personnel. Later on Monday 23rd January, the burn was run from Woolhead's down to the railway dam on Oakley Brook so as to

make this section safe.

Further north a backburn was commenced along Palmer's Road (40 mile) north of location 460 and down that road a distance of about 3 miles. This was done in an endeavour to box in the head which had already burnt through Bell's further to the north. This burn was still proceeding at midnight.

The areas burnt by midnight on Sunday, 22nd January, are shown on the attached plan, together with the fire perimeters which were held at this time or were in the process of being established. The total area burnt to this time was 113,200 acres and the fire perimeter was in excess of 100 miles. Approximately 60 miles of fire edge was being held and, of this mileage, approximately 36 miles was held by Forest Department gangs and 24 miles by bush fire frigades along the western foothills of the escarpment.

(e) Monday, 23rd January.

Maximum temperature 100°F. Minimum relative humidity 32%. Wind southerly, then backing easterly 10-15 m.p.h. by 0500 hrs., remaining generally easterly to east south-east 7-15 m.p.h. throughout the remainder of the day and night.

Under the somewhat milder weather conditions experienced during Monday, good progress was being made with mopping up operations and a considerable length of perimeter was brought under control. The only two sections which were giving trouble were the north-eastern sector in O'Neil block and the Wells fire. The backburn established the previous day between O'Neil Brook and Windsor Roads had broken in various places during the early hours of the morning. These breakaways were mostly due to spot fires which had been thrown across the line by strongly burning heads the previous evening. Throughout the day efforts were made to contain these hopovers and, by evening, the position was fairly well stabilised, although most lines were very thinly held. The Wells fire had broken away around 9.15 a.m. and had been making a fairly strong run in a west north-westerly direction throughout the day. Another minor breakaway occurred along the Huntly Road and a new line was established through Nowra block. By nightfall, a reasonably stable controlled line was held right along the southern face of the main fire from the Darling escarpment through Marrimup, north of Banksiadale and through to O'Neil Brook on the North-East Road. The distance of held line along these sectors was over 30 miles.

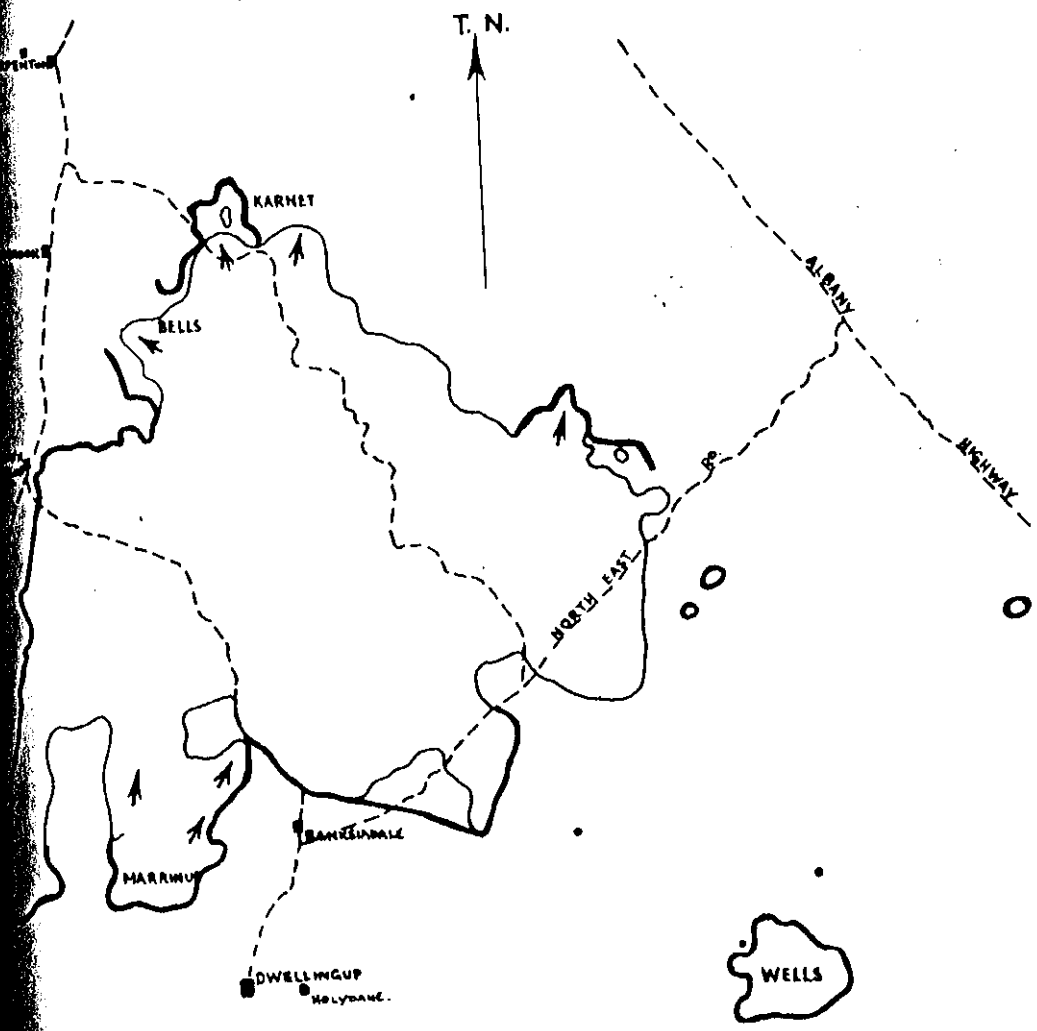
SUN 22.

THE DWELLINGUP FIRES – JAN 19–25 1961.

PLAN SHOWING
FIRE PERIMETERS
AT
MIDNIGHT SUNDAY 22 JAN.

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



LEGEND

METER HELD

METER RUNNING

ROAD ACCESS

THIS PLAN IS PRODUCED FROM INFORMATION ON FIRE PERIMETERS SUPPLIED BY FOREST DEPARTMENT AND RURAL FIRE BRIGADE OFFICERS AND BY INTERPOLATION FROM KNOWN METEOROLOGICAL AND FIRE BEHAVIOUR CHARACTERISTICS.

A. G. McARTHUR.
F. & T. B. CANBERRA.

On the western front, rural fire control officers and brigades carried out further backburning operations. The wind was, on this day, blowing from an easterly direction and was causing the coastal plain farmers considerable concern. The head, which had burnt through Bell's property the previous evening, was continuing to burn slowly in timbered land. Local brigades had commenced a burn down Palmer's Road the previous evening. Around 8 a.m. another burn was commenced from Skinner's north-west corner down Gobbin Road (38 mile). As the headfire was burning down the escarpment fairly rapidly, a gang was detached from this burn to link across to the burn coming down Palmer's Road. This section was blocked off by mid-day. The line down Gobbin Road was considered to be safe, as the wind was blowing across the road into burnt ground.

Around 12.30 p.m. an inspection was made of the fireline from the Bunbury Road, up Gobbin Road, around Skinner's to Myara Road and thence to the "fourways". All this edge was under good control, and it was being mopped up and patrolled by adequate forces.

Although the backburn down Gobbin Road from Skinner's had been carried out successfully, the burn down Palmer's Road appears to have broken away in location 668 early in the morning. This then broke the line from North Dandalup to Palmer's Road and, apparently, fire control officers in the area were not prepared to contain this breakaway except by a massive backburn along the edge of the cleared pastureland on the foothills. This burn was carried out during the Monday morning.

Around 2 p.m. or a little before, a breakaway occurred in Karnet 5 under a fresh SE wind. Steps

were immediately taken to control this jumpover by backburning northwards along the "34 mile" Road. This burn was carried out mainly by volunteer fire-fighters under the direction of a bush boss operating on behalf of the Forests Department. The Police Department provided radio communication between the fire and Keysbrook. A departmental TD.6 bulldozer was clearing a trail in front of the backburning gang. At around 7 p.m. the backburn had been carried to a point in a dirty swamp area about 1¼ miles north of Spencer's Road. Between 7-8 p.m. the east south-easterly wind drove a fast-moving tongue of fire up the swamp and the backburn broke across the 34 Mile Road towards location 737. In view of the breakaway, the volunteer forces, together with the Forests Department personnel, were withdrawn down to the Bunbury Road.

At this point there was apparently a lot of confusion amongst local fire control officers as to where the fire was and what was the best course of action. A reconnaissance of the breakaway west of the 34 Mile Road showed it to be burning very slowly in an eighteen-months-old burn, after travelling about half a mile west of the breakaway. Experienced personnel considered there would be no trouble in containing the breakaway. Without an adequate inspection and appreciation of the fire situation, fire control officers commenced lighting a backburn along the edge of pastureland from the 38 Mile (Palmer's Road) northwards. This burning had commenced around 2100 hrs. and had some serious implications, as there were several small farmers located over the escarpment to the east, and the burn-out of the country between the 38 and 36 Mile Roads would seriously endanger these farms. The operation was proceeding at midnight.

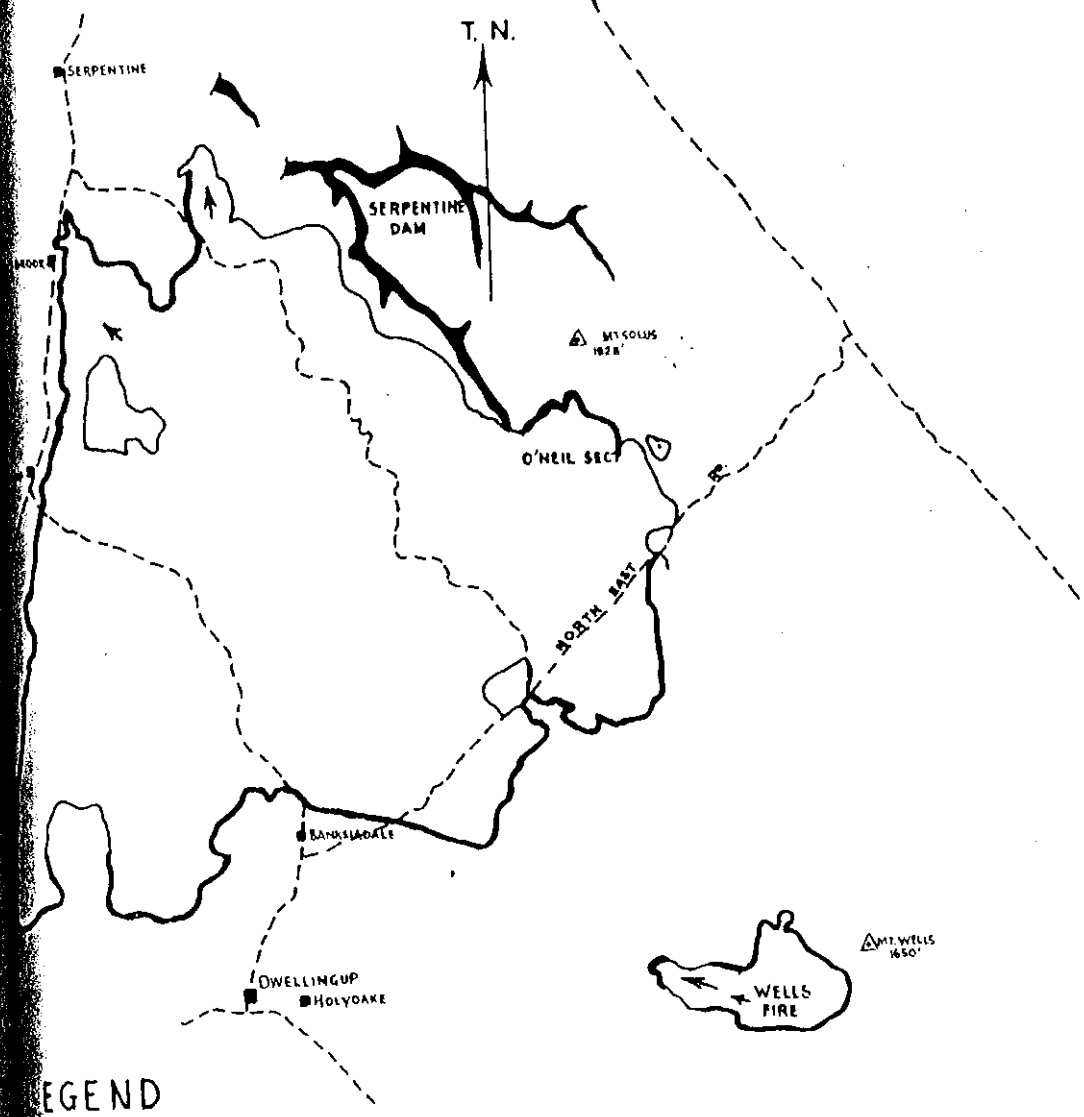
The area burnt by midnight on Monday, 23rd January, are shown on the attached plan, together with the fire perimeters which were held at this time or were in the process of being established. The total area burned at this stage was 134,500 acres and the fire perimeter was in excess of 100 miles.

THE DWELLINGUP FIRES – JAN. 19-25 1961.

PLAN SHOWING
FIRE PERIMETERS
AT
MIDNIGHT MONDAY 23 JAN.

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



LEGEND

PERIMETER HELD

PERIMETER RUNNING

ROAD ACCESS

THIS PLAN IS PRODUCED FROM INFORMATION ON FIRE PERIMETERS SUPPLIED BY FOREST DEPARTMENT AND RURAL FIRE BRIGADE OFFICERS AND BY INTERPOLATION FROM KNOWN METEOROLOGICAL AND FIRE BEHAVIOUR CHARACTERISTICS.

A. G. McARTHUR

F. F. T. B CANBERRA.

1.3.61

(f) Tuesday, 24th January.

Maximum temperature 106°F. Minimum relative humidity 14%. Wind E. 12-16 m.p.h. throughout the early morning hours and commencing to back northerly after 7 a.m.

At about 11 a.m. the wind changed suddenly to the north-west at around 23 m.p.h. and this was the severest burning condition experienced during the course of the Dwellingup fires so far.

This day was the culmination of an extended period of extreme fire danger and resulted in the whole of the southern part of the Dwellingup fires "blowing up" and assuming massive spread during the latter part of the afternoon and evening. When the township of Dwellingup and the mill settlements of Holyoake and Nanga Brook were engulfed, the rapid spread of the fire on this day and the numerous incidents which occurred allow only a brief summary of the sequence of happenings. However, it is hoped that it will give some idea of the position which faced officers in charge of fire-fighting operations on the various sectors of the fire.

From a fire behaviour viewpoint, the run of the fire on this day contains many features which have very great importance to fire suppression operations and which will help in a fuller understanding of how a fire will behave under extreme burning conditions.

(i) The North-western Section.

The backburning operation commenced by local fire control officers and brigade members on Palmer's Road at around 9 p.m. on the previous evening was carried along the edge of the foothills and up the 36 Mile Road. Apparently great difficulty was experienced in controlling

the burn as the wind was blowing very strongly from the east and setting up extremely turbulent conditions on the lee side of the escarpment. Fire whirlwinds were carrying rolling flames back down the hill and, at around 5 a.m., a breakaway occurred about half a mile south of the 36 Mile junction and the fire was carried into pasture land on the west side of the highway. It was very fortunate that heavy concentrations of men and pumper equipment were on the spot and the fire was stopped on the railway line some 30 chains to the west. The easterly wind dropped around 7 a.m. and started to back northerly and the burn was then carried quickly up the 36 mile to a point just south of location 1166. When the wind direction changed to a strong north-westerly at around 10-11 a.m. the whole face of the backburn lit along the edge of the pasture land assumed high intensity spread and funnelled up Dirk Broom towards Skinner's and Fawcett's. This high intensity headfire caused heavy pasture losses to these farmers and seriously endeangered their homes, stock and even their lives. The action of the fire control officers in setting this backfire showed little appreciation of the dangers involved or of the fire situation generally. Up to this point most of the burning carried out by these groups along the edge of the escarpment was sound in principle and reasonably well executed. The last mentioned burn between the 34 and 36 Mile Roads was ill-advised and dangerous and had little to commend it. The main fire was not spreading down the escarpment between the 34 and 36 mile road when the burn was commenced and the breakaway north of the 36 mile was burning in light fuel and was easily contained later in the day.

Later in the morning the gang which had originally been on the 34 Mile Road backburn completed suppression action on the fire edge north of the 36 Mile by trailing the breakaway of the previous afternoon and then trailing the fire down into the Serpentine Dam.

(ii) The North-eastern Section.

Work had continued on the backburn between O'Neil Brook and Windsor Roads. However, at about 2 a.m. a new fire was discovered to the east of this line and to the east of Windsor Road. This fire was the nineteenth in the series of lightning strikes and had probably originated during the storm of Friday, 20th January and had then reamined dormant until Monday, 23rd. Heavy smoke haze had prevented detection by the lookout towers and it was picked up by ground reconnaissance. Headquarters were advised of the new situation and forces were withdrawn to Windsor Road until a new appraisal of the situation could be made. At 5 a.m. it was decided to backburn along the North East Road from O'Neil Brook to the Serpentine River in order to contain the new fire. The backburn had almost reached the Serpentine River by 11 a.m. The winds during this operation were light easterly to south-easterly, but a fresh NW wind was blowing in the upper air. At a little after 11 a.m. surface winds changed to a fresh north-westerly and the backburn broke away in various sections shortly afterwards and commenced a southerly run. All forces in this sector were then withdrawn to Dwellingup, travelling via the North-East Road. Difficulty was experienced in travelling this road as it was cut in several places by fire. After scouting several alternative routes, the men and equipment finally got through to Dwellingup at 4 p.m. Some heavy equipment was left on previously burnt ground.

These breakaways on the north-east sector made major runs in a southerly direction through Cameron, Duncan and Kennedy Blocks and finally ran into the northern edge of the Wells fire sometime after midnight.

(iii) Southern Sector.

The southern section from Marrinup to the North-East Road had been under control for over two days except for a minor breakaway in Nowra during the previous afternoon. The line had been well mopped up and patrolled.

Around 12 noon the eastern edge of the Marrinup fire was commencing to give some trouble in some one-year-old litter where the main fire and the backburn had not met. This breakaway was in Turner 8 between Del Park and Northern Spur Roads. Gangs were despatched to contain this fire, which was controlled by 5 p.m. by a fire line running through Holmes 6 to the southern end of location 1063 then west back onto the original fire line.

At about 1.15 p.m. the eastern face of the Marrinup fire broke away on the Back Huntly Road in Nowra 7. This breakaway commenced rapid high-intensity spread in a south-easterly direction through Nowra 7 and Nowra 5 after crossing the South Dandalup River. It had spotted across into Nowra 4 on the east side of the Banksiadale Road by around 2.15 p.m.

Further to the north-east, the section south of White Road, where a backburn had not joined with the main fire, was commencing to spread around 12 noon.

By 12.30 p.m. the headfire was driving down towards CN 70-4 under a strong NW wind and had reached the road in several places. It was being held when all forces were ordered to withdraw to Dwellingup. Shortly after 1-2 p.m. this fire probably broke away into Scott 6 and made a major run through Cameron and Kennedy Blocks.

Thus, by 1.30 p.m. the overall position was that three breakaways had occurred at widely scattered points - Holmes 6, Nowra 7 and Scott 6 and the two latter ones were uncontrolled and making a high-intensity run. The breakaway in Holmes 6 was being controlled in light litter. In view of the dangerous fire conditions existing and a forecast of strong north-westerly winds, and a lack of precise knowledge of the various fire positions, the officer-in-charge of operations recalled all outlying gangs to Dwellingup by radio with a view to regrouping and deploying all forces for further attack during the night, when conditions were expected to ease. The only forces not withdrawn at this time were those protecting Banksiadale township, some 50 men on the Wells fire, a gang holding a line through Nowra 7 and gangs attacking the Marrinup breakaway in Holmes 6.

The Pinjarra Police were advised of the situation and asked to notify all settlers west of Dwellingup of the danger.

The Boddington Police were notified at 2.45 p.m. that fires in the Mt. Wells and North-East Road areas were out of control and could threaten Boddington and surrounding districts. The officer-in-charge at Dwellingup warned of the danger of attempting to fight these fires from the front and urged that all persons directly in the line of the fires should be warned to evacuate.

The strong north-west wind continued until around 3 p.m. then started to moderate. However, the direction was variable. At 4.50 p.m. a strong northerly gust occurred for a short period, then the wind again backed to the west for a short period and then veered again to the north. This caused the running heads to spot fairly long distances in many places and made the fire situation even more confused. By 6 p.m. all outlying gangs had returned to Dwellingup. At this stage a semicircle of uncontrolled fire was lying to the north of Dwellingup and a tongue of headfire had crossed the Banksiadale Road and was threatening Holyoake settlement. The fire perimeter was not a continuous one, but was confused by the fact that a considerable number of spot fires were burning independently of the main heads. A moderate north wind of 7-10 m.p.h. was blowing at the time and all fires were being carried southwards towards Dwellingup and Holyoake. At around 6.30 p.m. the officer-in-charge decided to evacuate all families at Holyoake and assemble them at Dwellingup. Settlers were notified by 'phone and by courier of the fire situation and advised to assemble at Dwellingup, as a large uncontrolled fire was bearing down from the north end could not be held under present weather conditions.

Between 8 - 8.30 p.m. the wind rose to a gale force and the whole perimeter of fire surrounding Dwellingup to the north blew up. All fire perimeters commenced rapid spread and were spotting very heavily. The wind was so strong that sheets of iron were being lifted from roofs and verandahs. Burning debris was being showered

over the town long before the advancing fire front reached the outskirts, and buildings were commencing to catch alight.

From all accounts, buildings in Dwellingup started to catch alight from 8 p.m. onwards. At about 8.30 p.m. the Waroona Police were in contact with Dwellingup telephone exchange and were told by the operator that the Police Station had burnt down and many other buildings were alight and that all exits from the town were blocked. The line went dead during the conversation.

At 8.30 p.m. desperate efforts were being made to protect the Hospital by Forests Department gangs and pumper equipment. It caught alight at 8.50 p.m. and the intense heat drove the firefighters into the cleared area in front of the Community Hotel where bulldozed heaps were extinguished and the hotel protected.

All attempts to save the old Forestry houses, sawmill, office and store sheds were unsuccessful and these were well alight by 8.35 p.m. The new Forest settlement was given protection by mobile gangs and only one house and several out-buildings were lost in this area. In the township itself, most of the buildings which burnt were over 40 years old. The ignition of buildings appeared to follow no set pattern and they ignited over widely separated points, depending on where a burning ember landed and if anyone was in attendance. Most houses in the town were of timber construction and little significance can be placed on whether a particular type of building material was more

effective than others. However, houses of fibro cement construction did burn. It is certain that the ease of ignition depended largely on the age of the building, and generally timber dwellings built within the last 5-10 years gave little trouble whereas a very high proportion of the old wooden buildings over 30 years of age were destroyed.

The strong wind blast lasted in the town for 1½-2 hours, after which it gradually moderated. The initial wind gust which caused the fire to blow away only lasted for some 15 minutes outside the fire area. It would thus appear that the gale force wind which Dwellingup experienced was largely fire-induced and was probably caused by large areas to the south of the town being mass-ignited by spot fires and then burning out very intensely. From all eye-witness accounts, and from an investigation of the structural damage done to the town, it is estimated that the wind force blowing through the town was in the vicinity of 60-70 m.p.h. The initial gust velocity of the gradient wind was only 30-35 m.p.h. so that it appears that the fire-induced wind was double the gradient wind and persisted for a much longer period.

A second strong burst of wind occurred a little after midnight, and this more or less coincided with the destruction of Nanga Brook settlement, some 6½ miles to the south south-east of Dwellingup.

Once the fire struck Dwellingup overall control of firefighting forces became virtually impossible and each unit or group undertook independent action to safeguard life and property in its own small sector.

Families were taken to open ground on the oval, schoolground and the hotel parking area. Doors and windows were shut and inflammable material removed from verandahs and areas surrounding the houses.

The position of the various fire fronts at midnight on Tuesday, 24th January, are shown on the attached plan. The area burnt at this stage was approximately 214,000 acres and the fire perimeter around 165 miles.

THE DWELLINGUP FIRES - JAN. 19 - 25 1961.

PLAN SHOWING

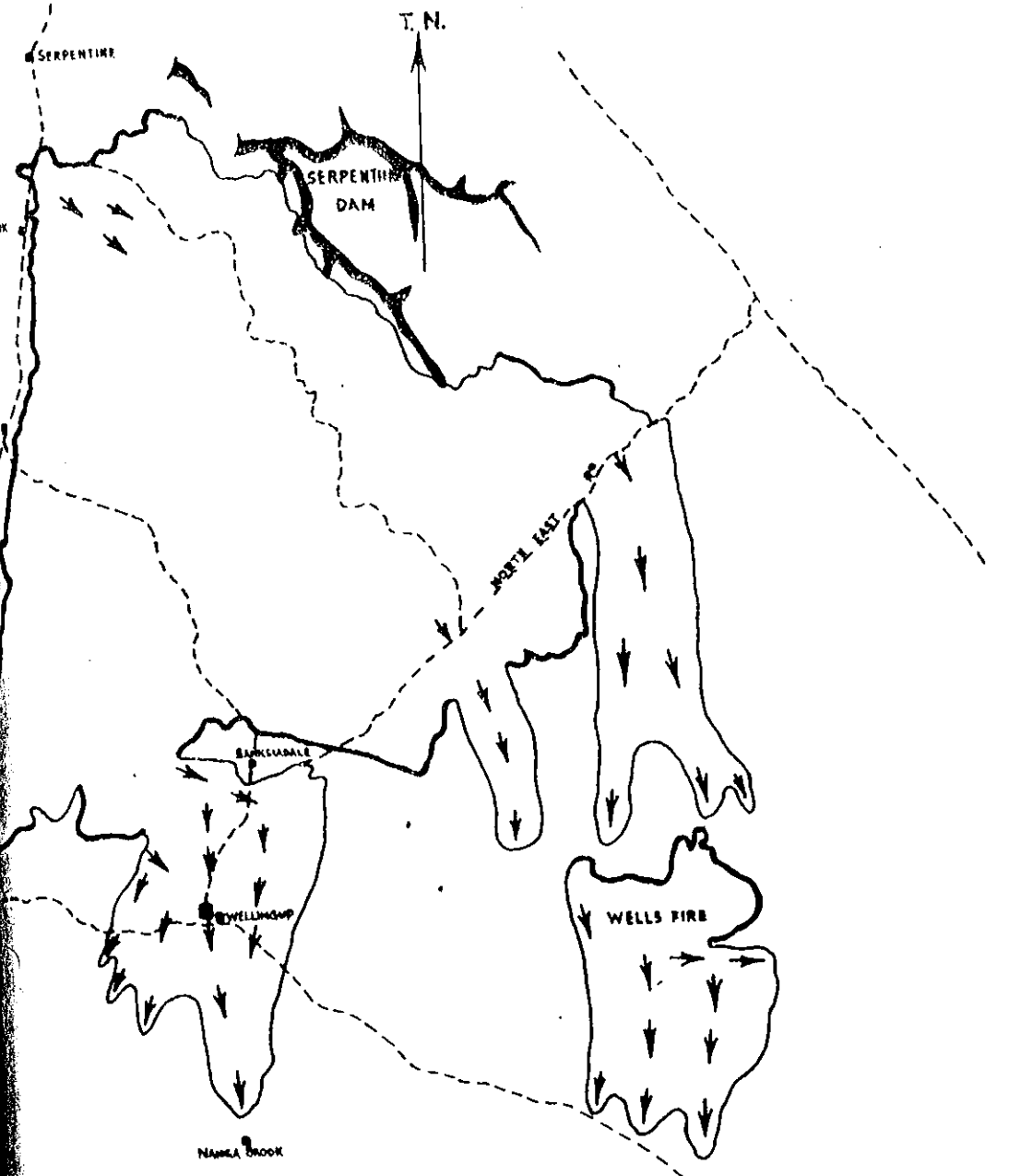
FIRE PERIMETERS

AT

MIDNIGHT TUESDAY 24 JAN.

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



GEND

FIRE HELD

FIRE RUNNING

ACCESS

THIS PLAN IS PRODUCED FROM INFORMATION ON FIRE PERIMETERS SUPPLIED BY FOREST DEPARTMENT AND RURAL FIRE BRIGADE OFFICERS AND BY INTERPOLATION FROM KNOWN METEOROLOGICAL AND FIRE BEHAVIOUR CHARACTERISTICS.

A. G. McARTHUR
F. & T.B. CANBERRA 1.3.61

1961

(g) Wednesday, 25th January.

Maximum temperature - 98°F. (at 0200 hrs.) then decreasing throughout the day.
Minimum relative humidity - 26% to 0400 hrs. then increasing throughout the day.
Wind - North to north north-east until 0900 hrs. then a strong westerly change gradually backing to the south.
Rain commenced during the afternoon generally around 1600 hrs. on the western and southern fronts but earlier at around 1.30 - 2 p.m. on the eastern side.

The main headfire, which had passed through Holyoake and Dwellingup, continued to burn southwards in the early hours of the morning. Nanga Brook settlement was destroyed around 12.30 a.m. although the main fire had been spotting into the vicinity around 9.30 - 10 p.m. the previous evening. The headfire had burnt some 2½ - 3 miles south of Nanga Brook down the valley of the Murray River by 9 a.m.

Around this time the strong westerly wind change took this eastern side of the main fire due east on a strong, high-intensity run through the Swamp Oak and Yarragil Brook area for a distance of 4 - 5 miles, when it was doused by rain shortly after 4 p.m. that afternoon. Apparently this westerly change did not penetrate to the extreme eastern side of the fire around Wuraming and Tullis, where the winds remained generally from an easterly direction and where heavy rain commenced to fall between 1.30 and 2.30 p.m.

On the western side, the main fire perimeter had not penetrated into private land but had been generally held by recently control burnt forest along the top of the escarpment. Local brigades in both the Murray and Waroona Shire areas were extremely apprehensive of the further movement of the fire and had commenced

backburning operations in various areas. The Murray Shire brigades early in the morning commenced plans for a massive backburn along the edge of the cleared country below the escarpment but, at the request of Police and Forestry Officers, had delayed this burn whilst the evacuation of families and firefighters from Dwellingup was proceeding. In order to keep the Dwellingup-Pinjarra Road open, local brigades burnt up both sides of the road to a point some 3 miles west of Dwellingup. They then proceeded to burn in both directions from the Murray River in the south to Woolhead's Road in the north - a distance of 7 miles. There is some doubt as to whether this burning was necessary, especially in view of the distinct westerly change which occurred around 9 a.m. and the fact that the main fire and the backburn did not meet along most of the escarpment in this area. However, in view of the complete confusion which existed early on Wednesday morning, this action may have been justified. Nevertheless, it does appear that, in some cases, the fire control officers did not give sufficient thought to the positioning of the back-burning line, and some unnecessary property losses occurred.

South of the Murray River, brigades in the Waroona Shire commenced to fight the southern face of the fire around 3 a.m. in the morning and worked in close co-operation with the Forests Department directed from Harvey Divisional Office. The south-western section from a point near location 507 to the Murray River was

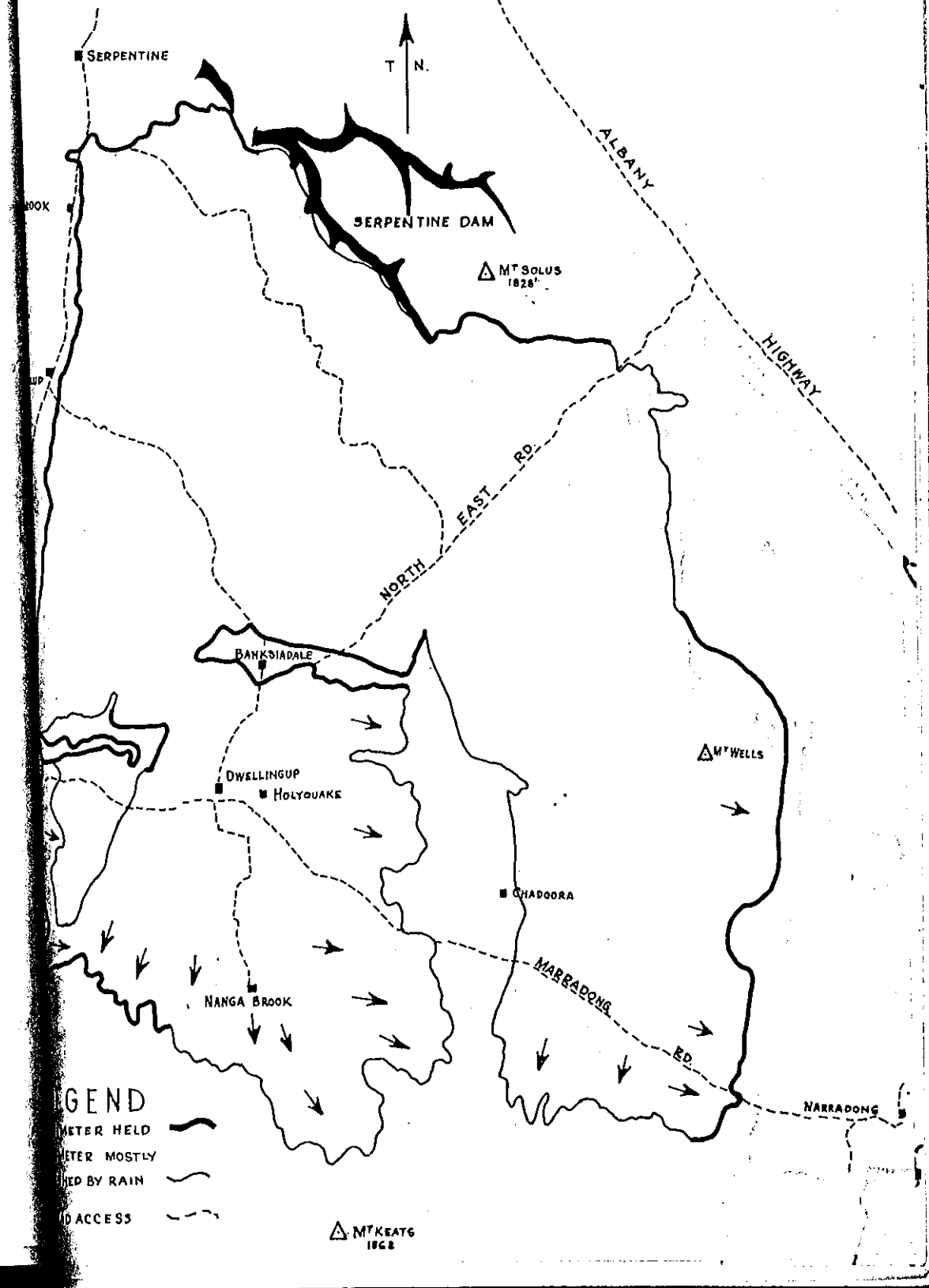
33-34

THE DWELLINGUP FIRES - JAN. 19-25 1961.

PLAN SHOWING FIRE PERIMETERS, AT 1600 HRS. WEDNESDAY 25 JAN

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



largely handled by Waroona Shire brigades - a distance of some 6 miles. Forests Department gangs were handling the section eastwards across to near the Hotham River, and were organised by the Harvey Division. The south-eastern and eastern perimeters were being handled very efficiently by brigades from the Boddington Shire. The section north of Banksiadale had been held throughout Tuesday night by a very experienced forestry gang. Had this line broken during the blow-up period there is little doubt that the mill township of Banksiadale would have suffered very heavy losses. During the day further forestry gangs consolidated this line.

By the evening of Wednesday, 25th, all running fire was stopped by heavy rain averaging from 50 - 120 points. The area burnt at this stage was 343,000 acres and the fire perimeter was around 180 miles.

(h) Subsequent Action.

The rain which fell on the 25th-26th January temporarily extinguished all running edges and allowed firefighters to commence the huge task of constructing a fireline around the southern and eastern edges. The entire southern perimeter was consolidated by Forests Department gangs, whilst the eastern side was initially handled by Boddington Brigades until the Dwellingup Division resources were reorganised and took over control of the eastern perimeter on Tuesday, 1st February.

Extreme difficulty was experienced on the southern sector by the presence of a large number of spot fires which had been thrown by the main fire during the night of Tuesday, 24th January or early on Wednesday, 25th.

These spot fires had been damped down by the rain but when hot, dry conditions returned by the weekend of the 28th January, many of these dormant spot fires started up and necessitated prompt suppression action. Up to the 8th February, over 20 such fires had been suppressed.

Breakaways occurred on the eastern front on Saturday, 28th January, Sunday, 29th January and on Monday, 30th January. These were all controlled by Boddington Brigades. Further outbreaks occurred on Friday and Saturday, 10th and 11th February, and these were handled by the Forests Department.

At the same time, a salient of unburnt forest lay between the main headfire which had passed through Dwellingup and the headfire which had burnt south from the Mt. Wells fire. These two fires had been extinguished by rain before they joined up. This gave a very long, ragged edge of fire perimeter which was constantly breaking out over a period of three weeks, and at various times threatened the Chadora Mill settlement. Much of the area was burnt out in blocks during mild conditions so as to consolidate this salient.

The huge perimeter could not be considered "dead out" until heavy rains fell in late March, and there was always the possibility of a breakaway from burning logs and stumps. It says a lot for the mopping up and patrol work which was done on this fire that no breakaways occurred during the very serious fire period in early March.

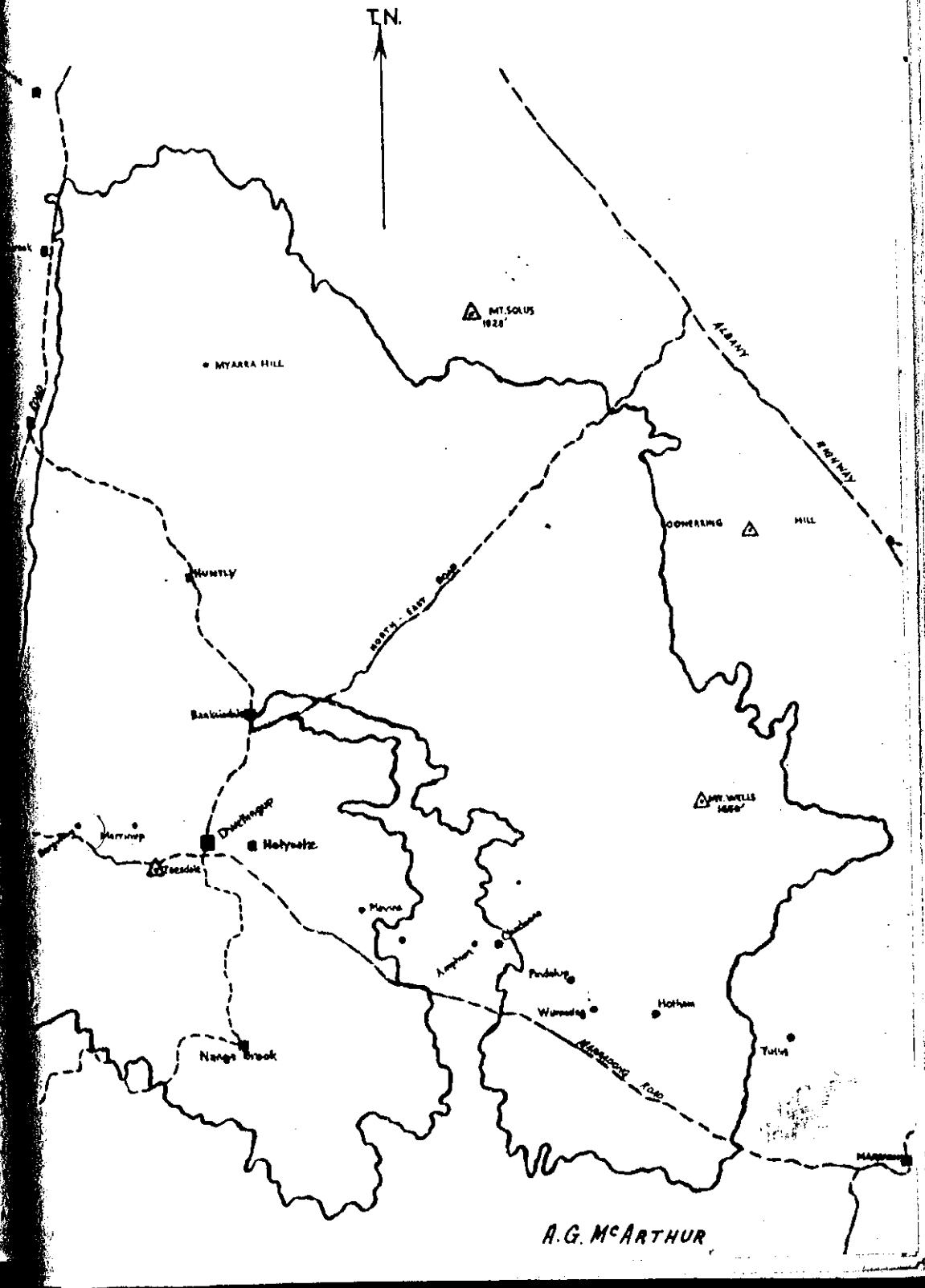
Attach 37

THE DWELLINGUP FIRES - JAN. 19-25 1961.

LOCALITY PLAN
SHOWING
FINAL PERIMETER

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH



A.G. McARTHUR

THE DWELLINGUP FIRES - JAN. 19-25 1961.

PLAN SHOWING

FIRE PERIMETERS

AT

MIDNIGHT ON EACH DAY

0 2 4 6 8 10

SCALE: 4 MILES TO 1 INCH

The Wells Fire.

(1) INTRODUCTION

The Wells fire although originating from one of the lightning fires which occurred on Thursday, 19th January is described separately as it remained separated from the main Dwellingup fire until early on Wednesday morning 25th January, when breakaways from the main fire joined with it.

Suppression action on this isolated fire caused a serious drain on available man-power and equipment required for work on the main fire further to the north. Control of both suffered accordingly. Insufficient men and equipment could be spared to ensure absolute control of the Wells fire and it was continually breaking away day by day. Conversely, if the men and equipment which were diverted to this fire had been available on the main fire, the southern perimeter of it may not have broken away on Tuesday 24th.

(2) ORIGIN.

At the end of a thunderstorm which passed over the Wells area around 6 p.m. on Thursday, 19th January, the smoke from six lightning fires was reported by Wells tower. Three of these fires were reported as being in Wells block; one in compartment 8 and two in compartment 7. The bearings to the two fires in compartment 7 were 234 deg. and 235 deg. from Wells tower.

(3) DEVELOPMENT OF THE FIRE.

(a) Thursday, 19th.

The fire was reported by the lookout tower as being in Wells 8 was actually in Kennedy 6, and was controlled by midnight. Mopping up was completed by 1100 hours on Friday, 20th January, and this fire caused no further trouble.

The two fires reported in Wells 7 could not be located and the initial attack gangs returned to headquarters at 2300 hours on Thursday, 19th January. These fires were damped down by a fairly heavy shower of rain which fell shortly after ignition. Some 68 points were recorded at Wells lookout tower 4 miles to the north-east and around 5-10 points fell in the fire area.

(b) Friday, 20th.

A light duty gang returned to the area at 0700 hours and located and extinguished one lightning-struck tree. At 1320 hours, smoke was reported 20 chains north of reference tree 8 and the other fire commenced to make slow progress in a northerly direction. The gang consisting of an overseer and two men commenced suppression action, but found difficulty in controlling the fire. By 1515 hours it was still burning and smoke was increasing. By 1635, the fire had spread some 60 chains in a north-easterly direction. At 1740, the overseer in charge of the fire notified headquarters that he was unable to hold it with three men. A model "D" grader had been made available at 1700 hours.

Additional equipment and men came on to the fire at around 1900 hours. These comprised 16 men, a heavy-duty pumper and a "TD6" bulldozer.

The area burnt by 1800 hours was 210 acres and 310 acres had been burnt by midnight.

(c) Saturday, 21st.

The first run of the fire was controlled during the early hours of the morning and mopping up proceeded. Approximately 550 acres had been burnt.

Control was maintained until 1000 hours. At this stage there were 22 men on the fire, plus a heavy-duty pumper and a "TD6" bulldozer. Four men were felling burninge trees with chain saws.

At a little after 1000 hours, a breakaway occurred on the eastern side of the fire in Wells 7 and at 1030 hours, another breakaway occurred on the northern section in Wells 8. A strong westerly wind was blowing and the headfire was throwing 20 - 40 chains ahead. A quick reconnaissance of the breakaway was carried out, and back-burning commenced along the Telephone Road on the southern face of the fire and had reached CU78-5 by 1820 hours. The original backburn had been carried out by a gang of 8 men and at 1830, these were reinforced by another gang which had been mopping up the western perimeter. The backburn proceeded in a northerly direction up the old formation and reached reference tree 3 by 2200 hours. One gang was stood down for rest and the burn was continued with 8 men from Nanga Brook. At a little after 2300 hours, light showers occurred and this prevented any further burning for 2 hours. When the fuel had dried sufficiently, the burn was continued with two bulldozers clearing trail. The area burnt by midnight was 1600 acres and the fire perimeter was 800 chains.

(d) Sunday, 22nd.

As soon as the trails were cleared, the backburn was carried around the northern edge of the fire. The operation was completed by around 0700 hours. The area burnt at this stage was approximately 2500 acres.

The fire again broke away on the northern section around 1300 hours and commenced a run in Wells 6 under a south-westerly wind. Backburning was commenced on the northern boundary of compartment 6 to contain the headfire. A dozer trail was punched through some 20 chains to the east of Pindalup Road and around a hopover which had also occurred in Duncan 6. The fire was contained by 2000 hours. A hopover had occurred on the northern section into Wells 9 at 1950 hours and this was controlled by 2220 hours by bulldozer trailing.

The area burnt by 2200 hours on 22nd January was 3200 acres, and the length of fire perimeter was 90 chains.

(e) Monday, 23rd.

Mopping up continued during the early hours of the morning. Fresh gangs started to come in by 0800 hours and by 1000 hours there were 40 men on the job, including 6 chain saw fellers, a "D4" bulldozer and two heavy-duty pumpers.

At 0915 hours, the western side of the fire broke towards Pindalup Road under a strong easterly wind. A hopover also occurred in the northern sector in a swamp at 1030 hours. All available manpower and equipment were split and deployed on these two breakaways. The northern breakaway in Wells 9 and Kennedy 2 was controlled by 2000 hours and kept to a relatively small area. The breakaway in Wells 7 crossed Pindalup Road and made a major run through Pindalup 12 and Kennedy 6 for a distance of 2½ miles under an east south-easterly wind. By midnight, this head had reached the eastern side of Kennedy 7 where it had been halted in recently control burnt bush. The fire had spotted heavily ahead and numbreous spot fires existed in Kennedy 13 and Pindalup 13, but were in light country and not making progress.

The area burnt by midnight on this day was 5120 acres and the fire perimeter was 1300 chains.

(f) Tuesday, 24th.

During the early hours of the morning, strenuous efforts were being made to control the breakaway on the previous day. All available manpower was split into two groups - one on the northern edge in Kennedy 6 and the other on the southern face in Pindalup 11.

Approximately 35 men were available from midnight to 1000 hours with two "TD6" bulldozers, one "D4", one "D6" and two heavy-duty pumpers. The "D6" broke down around 0500 and was replaced with a "D7" at 0800 hours.

Around 1000 hours, the overnight gangs were relieved by some 60 fresh men, many of whom were, however, inexperienced fire-fighters. Two bulldozers were working ("TD6" and "D7") together with one heavy duty pumper.

The southern trail broke away around 1100 hours in Pindalup 11 and from this point onwards, control of the Wells fire was lost. The dormant spot fires which had been thrown into Kennedy 13 and Pindalup 13 the previous evening also commenced to spread during the afternoon.

The breakaway in Pindalup 11 drove straight down Pindalup Road under a north north-west wind to reference tree 2 on the south-east corner of Pindalup 9. The wind then backed to a west north-westerly and drove the eastern face of the fire through Wells 10 under a strong wind. The wind then veered back to a north north-easterly around 2000 hours and a wide face of over 5 miles then made rapid progress in a southerly direction. The headfire from the O'Neil sector of the main fire which had broken

away along the North East Road around 1100 hours made a high intensity run through Duncan block during the afternoon and joined with the northern side of the Wells fire at a little after midnight.

Some men on the southern face of the Wells fire withdrew to Boddington during the afternoon and others returned to Dwellingup when it was realised that the fire was completely out of control.

The northern group, reinforced by some men from the southern group, continued to hold the northern sector, but were later engulfed by the headfire coming south through Duncan block and sheltered on burnt ground during the early hours of Wednesday morning.

This group of 35 men cut their way down Pindalup Road after daybreak and returned to Dwellingup.

4. METEOROLOGICAL CONDITIONS.

The forest area of Western Australia lies within a climatic zone with a defined winter rainfall and almost absolute summer drought, and is one of the few true Mediterranean climates in Australia. Spring rainfall is usually fairly reliable but autumn rains are quite variable. The effect of heavy winter rains and moderate spring rainfall usually extends into the early summer months and fires are generally not common during December. By January, the Jarrah belt is usually dry and hazardous, and the severity of a particular fire season will then depend on the occurrence of periods of high fire danger occasioned by high temperatures, low humidities and strong winds - days which, in the Eastern States, are termed "blow-up".

The 1960/61 season in the Jarrah belt was marked by a distinct rainfall deficiency during the winter and spring months, and there had been a considerable build-up of fuel dryness over several months. This would particularly affect the larger fuel components on the forest floor and, also, would have a considerable effect on the moisture content of the green eucalypt leaves and shrubby vegetation. A period of extreme heatwave conditions during January climaxed this long-term seasonal drying effect and, when the Dwellingup fires started on the 19th January, the whole Jarrah belt was in an explosive condition .

(a) Seasonal Conditions leading up to the January, 1961 fire period.

(i) Rainfall.

As in most parts of the South West Division, rainfall had been below average for several months and the monthly deficiencies are shown in Table 2 following:-

Table 2. Rainfall registrations recorded at Dwellingup during 1960.

Month	Rainfall Average pts.	Rainfall Actual pts.	Cumulative Rainfall Deficiency pts.	Cumulative Deficiency Percent.
June	1017	806	211	20.8
July	1049	1041	219	10.6
August	886	372	733	24.8
September	552	324	961	27.5
October	292	126	1127	29.7
November	170	54	1243	31.3
December	86	32	1297	32.0
TOTAL	4052	2755	1297	32.0

For the seven months ended December 31st, 1960, the cumulative rainfall deficiency was just on 13 inches, which is 68 percent of the average rainfall for those months.

(11) Temperatures.

In conjunction with the below-average rainfall, temperatures were well above average. During October, high temperatures were recorded and at Perth and Guildford 96.6°F. and 99°F. were recorded on 24th October, these being the highest October registrations on record. November was a generally cool month, although a hot period was experienced at the beginning of the month and at Dwellingup the mean monthly maximum temperature was slightly above normal.

During December, temperatures were generally above normal and at Dwellingup 5 days were between 91° - 100°F. and one day over the century. The mean monthly maximum temperatures at Dwellingup are shown in Table 3.

Table 3. Mean Monthly maximum temperatures recorded at Dwellingup - 1960.

Month	Mean °F.	Actual °F.	Departure from Mean °F.
October	67.0	70.0	+ 3.0
November	74.4	76.1	+ 1.7
December	79.5	83.7	+ 4.2

(iii) Fuel State.

Grasses and lesser vegetation were commencing to cure by the 29th October and, by the 23rd November, were around 70% cured. By the 8th December, most grasslands were fully cured and, by December 23rd, were cured in all areas.

(b) Weather conditions from 1st-18th January, 1961, leading up to the fire period.

Weather conditions were very severe during this period and both fire hazards and temperatures were high. The lowest fire hazard recorded at Dwellingup was 7.8 (High Summer) and the lowest daily maximum temperature was 82°F.

The fire hazard distribution for the 18-day period is shown in Table 4.

Table 4. Fire Hazard Distribution at Dwellingup 1st - 18th January, 1961.

Fire Hazard	Range of Moisture Content - ¼" hazard rods.	No. of days.
High Summer	4.8 - 6.0%	5
Severe Summer	3.7 - 4.7%	10
Dangerous	2.7 - 3.6%	3

The temperature, relative humidity and wind velocities for the six days preceding the Dwellingup fires are given in Table 5. The fire hazard, as given

by the West Australian scale is shown, together with the fire danger, which represents the combination of all factors which determine the chances of a fire starting, its rate of spread and general behaviour characteristics, its damage potential and difficulty of suppression.

Table 5. Meteorological conditions, fire hazard and fire danger on the days immediately preceding the Dwellingup Fires.

Date	Max. Temp. °F.	Min. Rel. Humid. %	Max. Wind Velocity m.p.h.	Fire Hazard Index	Fire Hazard Class'n	Fire Danger Index	Fire Danger Class'n
Jan.13	90	15	13	8.3	Severe	37	Very High.
14	97	17	13	9.2	Dangerous	48	Extreme
15	102	17	18	9.6	Dangerous	66	Extreme
16	91	22	19	8.3	Severe	40	Very High
17	98	24	15	8.8	Severe	28	Very High
18	107	11	11	10.0	Dangerous	50	Extreme

These very severe conditions were occasioned by troughs of low pressure which formed along the west coast and were associated with a tropical cyclone which was moving slowly down the North-West coast and intensifying. Such persistent low pressure troughs almost invariably give rise to extended heatwave conditions.

Towards the latter part of the period, the weather system was characterised by marked air instability which induced the severe electrical storms which triggered off the lightning fire concentrations on the 19th and 20th January.

(c) Weather Conditions during the course of the Dwellingup Fires. 19th - 25th January, 1961.

Following a very hot, dry day, thunderstorm activity commenced on the evening of the 19th January and

set lightning fires over a wide area of the Jarrah forest belt. Fires which commenced on this day burnt under continuing extreme conditions and were followed by another severe lightning storm on the evening of the 20th January. Conditions then eased a little but were then culminated by an extremely bad day on Tuesday, 24th when the fire perimeter blew up in various places and the breakaways commenced rapid uncontrollable spread during the afternoon and evening.

The weather conditions on these days will be treated in greater detail, as the overnight weather conditions play a very significant part in firefighting operations. It will be seen that, on several days, these overnight conditions were very severe and did not allow the fire suppression organisation any real chance of holding constructed fireline with any degree of safety. A marked feature of the period was the strong easterly winds which commenced to blow during the early hours of the morning, and it was these winds which caused great difficulty in consolidating firelines. Normally, firefighters rely on mild conditions during the night to bring a fire under control, but this was generally not experienced during the period. Naturally, if a fire is not controlled by early morning, it will then increase in intensity during daylight hours and spread with increasing rapidity.

(i) Wind Velocity.

Wind velocity is one of the major factors controlling fire behaviour and is frequently the "straw that breaks the camel's back". A fire which starts on a day of dangerous hazard will undoubtedly be of high intensity and will possibly crown. If conditions are relatively calm, its rate of spread will not be excessive and

suppression forces can usually handle such fires with relative ease. However, if there is a wind of more than 10-15 miles per hour blowing, the rate of spread increases greatly, and extreme difficulty will be experienced in controlling the fire, due mainly to the concentrated and long distance spotting which will occur especially in heavy fuel concentrations. Jarrah forests are particularly bad insofar as spotting is concerned, due to the bark characteristics of the species, and spot fires thrown one to two miles were quite common during these fires. After the major run commenced on Tuesday evening, the fire was spotting heavily up to 4 or 5 miles ahead as spot fires were starting to the west of Nanga Brook around 9.30 p.m. when the headfire was no more than 2 miles south of Dwellingup. Spot fires thrown outside held fireline were one of the major problems facing suppressi n forces on these fires, and were mostly associated with strong bursts of wind. The quantity of fuel on the ground is also a controlling factor in fire behaviour and spotting potential, and its reduction by control burning is one of the chief aims of proper forest fire management.

Wind velcoities recorded during the course of the Dwellingup fires are shown in Table 6 below.

Table.6. Average wind velocities as recorded at Wells Fire Tower.
19th - 25th January, 1961.

Date	Time 03	06	09	12	15	18	21	24
19/1/61	6	6	4	10	14	12	10	6
20/1/61	7	9	10	11	14	16	16	14
21/1/61	6	5	10	15	14	8	8	10
22/1/61	12	10	11	13	16	9	3	7
23/1/61	11	14	12	10	7	7	15	14
24/1/61	13	17	14	16	14	10	20	4
25/1/61	6	3	7	12	16	1	1	-

The strong winds experienced during the evening of Friday, 20th had a significant influence on the spread and development of the Torrens fire during that night and made control very difficult. Similarly, the strong early morning winds of Tuesday, 24th resulted in some firelines being uncontrolled or weakly held when conditions deteriorated during the day. The maximum wind during the afternoon of Tuesday, 24th January was 23 m.p.h. at 2 p.m., with a 15-minute windstorm at 8 p.m. rising to 34 m.p.h., and a second windstorm at around midnight rising to 37 m.p.h.

(ii) Wind Direction.

Not only does wind velocity play an important part in fire suppression operations, but wind direction is also very important. A constant wind direction enables fire strategy to be planned in advance, but constantly changing wind directions make proper planning difficult. A sudden wind change striking an uncontrolled or weakly held fire edge frequently results in a very massive spread process.

Winds in the Dwellingup area were very variable during the fire period and further increased the difficulty of the fire suppression job. These wind direction changes over the period are shown in Table 7.

Table 7. Wind directions as recorded by Mt. Wells Lookout Tower. 19th - 25th January, 1961.

Date	Time							
	03	06	09	12	15	18	21	24
19/1/61	E	NE	NNE	W	W	E	SSE	S
20/1/61	S	E	ENE	ESE	ESE	ESE	ENE	N
21/1/61	NNE	ENE	NE	WSW	WSW	SW	WSW	WNW
22/1/61	S	SSE	SSE	S	SW	S	S	SSE
23/1/61	SE	E	E	E	ENE	ENE	E	E
24/1/61	E	E	NNE	NW	NW	NNW	NNE	NNE
25/1/61	NNE	N	W	WSW	SW	SSW	-	-

The sudden wind change during the evening of Friday, 20th January, resulted in a massive spread of the southern flank, and the equally sudden change during the following morning, then drove the northern face away on a wide front. The change from north-west to north north-east proved equally disastrous during the evening of Tuesday, 24th.

(iii) Temperature and Relative Humidity.

Although humidities increased for a time during the course of the fire, temperatures remained very high and gave little variation in fire hazard conditions.

The diurnal trends in temperature and relative humidity are given in Table 8 below :-

Table 8. Temperature and relative humidity as recorded on autographic instruments at Dwellingup during the period 19th - 25th January, 1961.

Date Jan.	Time 03	06	09	12	15	18	21	24
19	71-48	69-53	89-38	104-16	93-26	82-53	80-58	78-60
20	76-69	74-56	81-55	96-43	104-18	98-22	88-62	82-47
21	75-60	71-76	88-54	92-72	103-22	92-34	78-60	78-70
22	73-90	70-94	81-70	94-70	98-26	94-35	83-44	77-62
23	70-85	67-93	81-67	96-41	97-40	85-70	82-63	78-65
24	75-70	72-81	85-39	106-18	92-23	89-46	130-4	105-22

NOTE: In the above Table the first figure refers to temperature and the second figure to relative humidity.

A feature of this data is the generally high overnight temperatures and low humidities. It was only on the nights of the 22nd and 23rd January that humidities rose to a sufficiently high value to dampen down the running fires.

The figures given for 2100 hrs. on the 24th January are quite remarkable and have probably never been recorded in Australia before. They actually represent the air mass which was passing through the town of Dwellingup in the centre of an extensive area of fast running fire, and give some indication of the conditions immediately in front of such a fire. The hygrograph and thermograph were taken down from the Stevenson Screen at around 6 p.m. when it appeared likely that the enclosure would be overrun by fire and brought into Dwellingup and placed on a verandah of the Research Station. This position was quite sheltered and was not in close proximity to any direct fire-radiation effects. The temperature arm went off the chart when the first blast of hot fire-driven air reached the town and probably exceeded 140° for a period of 10-15 minutes. The humidity dropped from a value of 40% down to 4% at the same time. The temperature of the air blowing through the town in advance of this fire has been verified by the fact that the leaves on eucalypt trees in cleared areas of the town were scorched and partially killed, whilst there were no burning buildings or fire within 200 feet. Generally, it is agreed that eucalypt leaves are killed by exposure to a temperature of 130° - 135° for a period of time.

The autographic charts showed that the temperature and humidity were fluctuating quite a lot during Tuesday afternoon, and this was probably due to the fact that heavy smoke was at times blanketing the town. This apparently had the effect of reducing the air temperature considerably.

(iv) General.

Although the meteorological conditions during the course of this fire were severe, it would be dangerous and, perhaps, quite incorrect to say that they are the

severest ever experienced at Dwellingup. To compare them with other fire periods in the past would require a lot of research which is beyond the scope of this report. From a cursory check it is quite probable that equally severe conditions have occurred in the past and some, on appearance, have been worse. Certainly, there have been drier preseasonal conditions, there have been periods when temperatures were higher and humidities lower for a considerable period, and there have also been periods when the winds were just as strong, if not stronger. Whether all these factors coincided at the one time is not known.

There is feeling amongst many fire control authorities that Western Australia has a fairly constant severe fire season. This does not appear to be the case, and there are undoubtedly mild seasons interspersed with average bad seasons and occasionally, once every 10-11 years or so, a very severe fire season will occur when large areas of forest country may be burnt.

As in other States of the Commonwealth, it would also appear from past historical records that bad forest fire years to not necessarily coincide with years when extensive grassfires occur in rural areas.

The occurrence of lightning fires and the meteorological situation which leads up to such occurrences is something which vitally concerns fire control generally. Historical records also show that Western Australia has been very subject to such fires, and, in particular, the area embracing the Darling Ranges. The early recognition of a meteorological situation conducive to summer thunderstorms, and a suppression plan flexible enough to handle a fire load of at least 60 fires which may result from one storm, should be given increasing attention in the Jarrah belt.

The very dry nature of the fuel bed when these lightning strikes occurred played a major part in their ignition and subsequent development. Due recognition should be given to the long term build up in seasonal dryness and the fire suppression organisation alerted for the possibility of unusually severe fire when they start.

5. SUPPRESSION ACTION.

The Forests Department has received a lot of criticism of its handling of the Dwellingup fires in letters to the press and in certain evidence given before the Royal Commission. In almost every case the criticism is by persons who have little or no knowledge of fire-fighting in forest country or even of conditions in the forest areas. Many people have stated that the Forests Department undertakes little or no control burning in the forests and that the fires were caused by excessively dirty bush. The West Australian Forests Department has always undertaken control burning of extensive areas each year since the formation of the Department some 40 years ago.

Since that time the only change which has taken place is that control burning is now on a more thoroughly planned basis, and areas of young regenerated forest are now in a condition which will allow a control burn without damage to the stand. In the period 1932-1954 these areas were afforded complete protection. At the present time between 10-13 percent of the total forest area is systematically control burnt each year and certainly the Department cannot be criticised for allowing an excessive fuel hazard to build up in its forest.

Many people who have criticised the Department have only a vague idea of how the fires started - and few would realise that there were nineteen separate fires started, of which several united and resulted in a large area being burnt. And lastly, very few people realise the explosive nature of the 1960/61 season and the extreme conditions under which these fires were fought.

It is very difficult for any one person to comprehend the development of these fires, their fire behaviour characteristics and the enormous combination of factors which have some influence on the suppression action involved in a fire of this size. There are very few foresters in Australia who have been faced with the problem of such large-scale fire suppression action, let alone the general public.

It has taken many hundreds of working hours to make an analysis of the development of these fires, the meteorological conditions associated with them, the fire behaviour characteristics of individual headfires burning in different fuel types under an infinite variety of meteorological conditions, and the suppression action taken and the reasons behind certain decisions. It is only when all these factors are taken into account can anyone person obtain a reasonably clear picture of the overall situation. Even then, many factors remain undetermined and it must be recognised that one factor which always defies analysis is the human element.

Consequently, the comments which are made here on the suppression action taken during the course of these fires are by no means complete nor, probably, have all the factors involved been taken into account.

(1) The one point which stands out is that the individual efficiency of all officers, overseers and workmen engaged on this fire was of the highest order and would not be exceeded by any Forest Authority in Australia or overseas. For sheer courage, determination and loyalty to their organisation, all forest personnel engaged on this fire should indeed be very proud.

(2) The fire behaviour knowledge displayed by the overseers and men on the fireline has always been a feature of fire control operations in Western Australian forests and is, no doubt, due to the large amount of practical training they receive on control burning operations. Absolute control must be assured on these fires and this naturally leads the men into safe and efficient practices.

(3) Not only were the operations on the fireline carried out efficiently, but the direction of overall operations by the officers-in-charge were also of the highest order and showed a true appreciation of fundamental principles of fire behaviour and suppression action. Perhaps the fact that difficult withdrawals and redeployment of forces were carried out safely and efficiently, and the fact that no lives were lost in the face of several critical fire situations, are the best measures of efficiency which can be drawn from the happenings on this fire. Safety in working and protection of the people under his direction is one of the big factors which often govern a fire boss' decisions. Not only was ample protection given to the employees under his charge but, in the later stages of the fire, protection had also to be given to many hundreds of women and children and outlying farmers and settlers. The fact that dangerous situations were recognised and steps taken to ensure the safety of the whole community reflects very much to the credit of the forest officers charged with the direction of fire-fighting operations.

(4) Despite the efficiency and fire behaviour knowledge of officers and employees of the Department, a very large-scale fire developed. An analysis of the reasons

for this happening is extremely difficult and possibly defies any reasonable decision. It may be that the prevailing weather conditions which gave rise to such high-intensity fires, and the number of fires which started, would have defied any economic fire suppression organisation.

Such an organisation can only be designed to handle average bad conditions and not worst possible conditions, just the same way as most engineering projects are designed. The cost of a fire organisation which is designed to handle all fires which may start and keep the burned area down to a low percentage of the total forest area may well be beyond the economic return gained from this degree of protection. However, there were certain organisational breakdowns which occurred during the course of these fires which may have resulted in larger areas being burnt than the conditions warranted.

These included -

(a) Insufficient reserve gangs and equipment being held available to mount a fast initial attack on further fires as they occurred. This was the situation when the tenth lightning fire occurred in Torrens Block. Admittedly, even if two or three gangs had been available, this fire may still have made a major run but, then again, it may have been stopped on Ranger Road. No matter what the fire situation is, it would appear essential to always have some forces in reserve in the event of a new fire starting or even to throw in on an existing fire which is insufficiently manned, or to relieve fatigued crews. In this case, the Dwellingup Division had used all their own gangs and, as far as is known, had not called on help from outside the

Division. A system of "co-operators" would seem to be essential in a forest firefighting organisation, whereby preseasonal arrangements are made for sawmills, local townspeople or rural bushfire brigades to supply reinforcements as soon as an unusually heavy fire load appears likely. A routine preseasonal effort by local forest officers should have little difficulty in organising such groups and so provide much-needed manpower reserves. Greater fire concentrations from lightning storms have previously occurred in the Dwellingup Division, and it would seem that provision must be made for at least 15-20 such fires to be fought simultaneously. This, in most cases, can only be done by outside help. The organisation of an elite firefighting gang of 6 or more men, who are highly trained and well equipped, and who would act as a fast, mobile, first-attack crew, would also appear to be one way in which initial attack could be improved. This gang would, in most instances, only be expected to hold the headfire until other forces arrived and then move on to another fire or return to base and be held in reserve for further outbreaks.

(b) The deployment of gangs from one central headquarters to far distant fire fronts appears an unnecessary waste of effort in many cases. Some of the fire fronts or sectors were considerable distances from Dwellingup and relief crews and provisions were transported to and from these sectors. The provision of camping equipment and messing arrangements on the job would save a lot of transport time necessary when headquarters are so far removed from the fireline. The provision of mobile workshop facilities to give adequate service attention to heavy equipment on the spot would also save a lot of lost equipment time.

(5) Communications.

Radio communication during days of extreme fire danger proved inadequate on many occasions, and much wasted time and loss of control resulted. It would be difficult to estimate the number of man-hours virtually wasted on this fire due to lack of adequate communication, but it would certainly have run into many hundreds of hours.

High frequency radio systems have always proved inadequate during such periods and an efficient very high frequency system appears the only solution to reliable communication on the fireline. It is understood that the Forests Department is in the process of installing such a system in certain Divisions in the near future.

(6) Detection.

The standard of lookout towermen is generally very high and they did a remarkably good job throughout most of this fire. However, provision was only made for a fairly widely spaced primary detection system and detection coverage was drastically reduced on most days during the course of these fires. Difficulty was experienced in obtaining a cross-bearing on fires or suspected hopovers on many occasions. It would seem that some attention should be given to providing a secondary lookout system for manning during periods of high fire danger when visibility may be restricted due to smoke or dust haze.

A lookout observer can be a very valuable man in a fire suppression organisation by relaying progress of a fire and certain behaviour characteristics to the officer in charge of suppression action. In some cases it would appear that insufficient attention is given to the choice of a towerman. Additional training of these men could prove valuable in future fire-fighting operations.

(7) Fire line construction by Forests Department gangs was generally carried out in a very efficient manner. Access within the forest area is very good and seldom was it necessary to cut virgin trail as most counter-firing was done from existing roads and tracks. However, it was attempted during initial attack on the Torrens fire and deserves special mention for the fact that a D4 bulldozer was cutting trail at a rate of over 1 mile per hour during nighttime and working as close as possible to the fire edge. This is a very fast rate of trail construction and shows that, provided sufficient forces are available for mopping up and patrol along the constructed trail, a fire edge can be controlled very rapidly. It was unfortunate that in this case sufficient follow-up forces were not available and the fireline was lost when a sudden wind change occurred during the following morning. This only serves to illustrate the fact that large manpower resources are necessary to hold constructed fireline during severe burning conditions. It is estimated that at least 16 men, plus adequate pumper equipment, are needed for each mile of constructed line for at least the first 8 hours. Such heavy reinforcements can only be obtained from outside organisations and co-operators.

(8) Counter-firing operations by most gangs were handled efficiently but, as in most firefighting operations, the degree of efficiency depends on the experience and training of the men. One could perhaps compare the results of counter-firing along the Back Huntly Road, and especially the line constructed through Nowra 7, with the counterfiring carried out along the North East Road east of O'Neil Brook. The former operation was carried out

by some of the most experienced men in the Dwellingup Division and was held safely during the night of Tuesday, 24th January, when a large distance of other lines had broken under the extreme conditions experienced that day. If the section of line through Nowra 7 had broken that day, the township of Banksiadale would undoubtedly have suffered heavy fire damage. The counterfiring along the North East Road was handled by relatively untrained personnel and broke away shortly after commencement. Admittedly the operation was an emergency one and the gangs were not allowed sufficient time for adequate preparation or consolidation of the line before extreme burning conditions arose.

(9) In some instances the counter-fire did not join up with the main fire when the burning was first carried out. This was due mainly to the fact that such counter-fires were carried out under low burning conditions and in sparse fuels. L ter, when severe burning conditions returned, the main fire again commenced progress and spotted across the area burnt by the counter-fire. This occurred on the south-eastern edge of the Marrinup fire and along the North East Road near White Road. It is generally essential to ensure that the complete area is burnt out between a counter-fire and the main fire edge, so as to prevent an active fire edge arising under extreme burning conditions.

(10) The instances where this happened largely resulted from the fact that most foresters underestimated the effect of a recent control burn in holding a fire under extreme conditions. On many occasions a headfire burnt quite rapidly through Spring 1960 burnt country,

although doing little damage to the stand but frequently these low-intensity fires were spotting ahead for some distances. It is obvious that recently control-burnt country will not stop the spread of a fire on a day of extreme fire danger, and the main effect of such fuel reduction burns is to reduce the fire intensity and rate of spread and so allow fire suppression forces to attack the fire more easily and with greater safety. When positioning a counterfiring line, it would be good practice to endeavour to have the recently-burnt country behind the line and not between the counterfire and the mainfire. If the backburn is lit in heavier fuels, it would be much easier to ensure that the two fires meet and an unburnt strip does not remain.

(11) Fire suppression operations carried out by rural bush fire brigades and fire control officers on both the western and eastern perimeters of the Dwellingup fires showed varying degrees of efficiency and, to a very large extent, reflected the experience of brigade personnel in forest firefighting conditions. The eastern brigades from Boddington Shire showed extremely high efficiency in controlling the eastern perimeter on Wednesday, 25th January and in controlling breakaways up until 1st February, when Forests Department gangs again assumed control of operations in the sector. These brigades were prepared to fight the fire in timbered land and did so very efficiently. This was largely due to the fact that they were led by men who had worked in the forest and thoroughly understood the principles involved in such firefighting, and who had a very good knowledge of the country.

With few exceptions, brigades and fire control officers on the western side of the Darling escarpment showed a decided lack of knowledge of firefighting methods in timbered lands, had a very poor knowledge of the country outside the cleared pastureland and, in the main, were only prepared to fight the fire when it reached the edge of open country or, if it did not reach this land, to set a counter-fire from the edge of the escarpment up into forest land. This naturally led to some very doubtful counterfiring decisions and, undoubtedly, a much larger area of land was burnt in some areas than was warranted from the position of the main fire. The exceptions to this were in the north-western sector where some very efficient operations were carried out under several people connected with the sawmilling industry and, as would be expected, these men had a good knowledge of the bush and of the requirements of forest firefighting techniques.

(12) Not only was there a decided lack of co-operation and co-ordination between rural brigades and Forests Department gangs, but there was an equal lack of co-ordination between individual fire control officers and brigade personnel. A system of rural brigades or fire control officers operating within a small brigade area is probable reasonably efficient on small grass fires. However, when a large-scale fire occurs, all such brigades must be co-ordinated into a single firefighting unit under one single control. Efficient fire-fighting operations can never be carried out by individual brigades operating independently of adjoining organisations. Frequently the action taken by one brigade forced an adjoining brigade or the Forests

Department into action which they did not consider necessary or, in some cases, considered to be dangerous to life and property. As an example, the action taken in counterfiring between the 38 and 36 Mile Roads, against the advice of both the Forests Department and more experienced fire control officers, seriously endangered property and even the lives of some settlers living further up in the forest land. This burn was lit by one section of the farming community against the interests of another section of the community.

In order to overcome any future repetition of this type of suppression action, it would appear essential that some form of a loosely knit Darling Escarpment co-operative fire authority be organised whereby one person or authority would assume overall direction of firefighting operations on a large scale fire. This co-ordination should also be extended to cover control burning operations and the like, and it is certain that the Forests Department must play a dynamic role in its operation. The formation of a fire brigade, or brigades, to cover private property fire protection in the hills districts would also seem an essential first step in improving fire-fighting services in this area.

6. FIRE BEHAVIOUR.

A full analysis of the fire behaviour characteristics of this fire would constitute a major piece of research. In this report only certain aspects can be very briefly dealt with. One very important long-term project which requires study as a result of this fire is the effect of fire damage on volume production and height growth of jarrah forest of varying ages and site qualities. The full damage effect of varying fire intensities will probably only show up after 2 or 3 years, or even longer and, consequently, little comment can be offered in this report on such damage effects.

The Forests Department has been carrying out an active programme of research on fire weather and its relation to fire hazard for many years, and has also carried out a considerable amount of research into the effect of fire on the physical properties of the soil and microfauna. An active co-operative programme of fire behaviour research has been undertaken over the last three years by the Commonwealth Forestry and Timber Bureau and the Forests Department. By and large, the behaviour of fires in jarrah forest is fairly well known, although a considerable amount of this research is at present unpublished.

The various phases of the Dwellingup fires confirmed many of the previous research findings and will enable the data to be extended considerably, especially on the behaviour of high-intensity crown fires.

The factors which govern rate of fire spread are known, as are also the factors which govern the intensity of a fire and the damage which may be expected under a range of varying intensities. The amount of fuel available for burning is a controlling factor in both these aspects of fire behaviour, and a reduction of fuel quantity is the basis of most control burning work carried out

in the Jarrah forests. This fuel reduction work aims to prevent, or at least reduce, the formation of high-intensity fires and so prevent excessive damage to the forest, enable fires to be controlled more quickly and so keep the burnt area down to a minimum figure.

(a) Lightning Fires.

The Dwellingup Division has recorded a high proportion of lightning fires and, for the 21 year period 1940/41 to 1960/61, 105 fires have resulted from this cause, or an average of 5 fires per annum. The main concentrations of these fires occurred in the following years :-

1941	-	14
1944	-	10
1951	-	14
1959	-	12
1961	-	19

The present series of lightning fires show a very significant correlation between point of origin and fuel age. Of the 17 fires which started in State Forest, 12 originated in a fuel bed 15 years or older, 2 originated in 7 year old fuels and 3 originated in 4 year old fuel beds. Two of the fires originated in private property and the fuel age was not known.

It would seem that there is a much higher probability of a fire originating in a heavy fuel bed than in a light fuel and, thus, control burning would seem to have an added advantage of at least reducing the probability of lightning fires.

The topographical position of the points of origin of these fires is also interesting, insofar as 7 fires

originated on or near ridge tops, 7 originated in or close to the edge of swamps and 3 originated on flat forest country. It would therefore, seem that lightning has an equal preference for striking on a ridge top or in a swamp area.

The fact that a high proportion of lightning fires originated in heavy fuel types is fairly logical. Most of these thunderstorms were accompanied by some rain or light showers. The moisture resulting from these showers would tend to penetrate a light fuel but would have little chance of fully penetrating a heavy fuel bed. Here the fire would continue to burn, or at least smoulder, and break out at a later date. Also, as it is likely that the fire originates at the base of a live tree, or along a root system the chance of a struck tree starting a fire at or near its base would be much greater in a heavy fuel than in a light fuel. If a fire did start in light fuel, there would be a very good chance of it being self extinguished due to lack of fuel.

This relationship between fuel quantity and lightning fires may tend to explain why the incidence of lightning fires is increasing in many forested areas of Eastern Australia. With improved fire control measures, lesser areas are being burnt over and fuel quantities are increasing in the absence of widespread control burning and thus, if lightning storm occurrence remains constant, the incidence of lightning fires will tend to increase as fuel quantity builds up.

(b) Rates of Spread.

(i) Forward progress of the Headfires.

Generally, the rate of spread during the various runs of individual headfires was within predictable limits.

Some of the major runs are given in Table 9 below :-

Table 9. Rates of forward progress of various headfires during the course of the Dwellingup Fires.

Date	Fire	Period	Distance Travelled chns.	Average rate of spread c.p.h.
Jan. 20	Torrens	1315-1800	312	66
20	Torrens	1800-2400	130	22
21	Torrens	2400-0600	170	28
21	Wells	1200-1800	80	13
23	Wells	1200-1800	90	15
24	Marrinup	1315-1800	360	76
24	Marrinup	1800-2100	120	40
24	Marrinup	2100-2400	360	120
24	Duncan's	1200-1800	260	43
24	Duncan's	1800-2400	480	80

The above figures are some examples taken from major headfires. Generally, rates of spread were much less than those quoted and depended very largely on the fuel quantity through which the headfire was travelling.

Previous research has shown that rate of spread under a given set of meteorological conditions is directly proportional to the amount of fuel available for burning - that is to say that a fire will spread twice as fast in a 10 ton per acre fuel as in a 5 ton per acre fuel.

A great deal of evidence was given of the fantastic rate of spread at which these fires were travelling. Even under the worst possible conditions experienced on Tuesday, 24th January, the headfire had not travelled at a rate exceeding 120-140 chains per hour. This is disastrous enough in high forest, and even this rate of spread was produced more by intense long-distance spotting than by an even progression of the headfire. It would

appear that once a fire in Jarrah forest spreads at a rate faster than 20 chains per hour, spotting becomes the main fire spread agent. If the spots are not thrown beyond half a mile, the main fire front generally catches up with the spot fire before it has progressed very far. However, a definite increase in the rate of spread occurs under these conditions.

Many of the exaggerated stories about rate of fire spread are caused by the spotting process, and it is often assumed that, if an area catches alight, then the main fire has travelled that distance. In reality, the main fire may still be a mile or more behind such spots. It appears fairly definite that on Tuesday afternoon the original breakaway from the Back Huntly Road was throwing spots 3 miles ahead under a 23 m.p.h. wind, and that the main head, which passed through Dwellingup at 8.30 p.m., was throwing spot fires up to 5 miles ahead under a 35 m.p.h. wind.

(ii) Area Spread.

The area burnt at midnight on each day of the Dwellingup fires is shown in Table 10 below :-

Table 10. Area Spread of the Dwellingup fires at midnight of each day.

Date	Area acres.	Probable Error acres	Increase per day acres.
20/1/61	4,400	± 1,000	4,400
21/1/61	70,300	± 5,000	65,900
22/1/61	113,200	± 7,500	42,900
23/1/61	134,500	± 10,000	21,300
24/1/61	214,100	± 20,000	79,600
25/1/61	343,400	± 10,000	127,300
11/2/61	361,200	± 10,000	1,000

(c) Crown Fire Development.

Crown fire development depends very largely on severe meteorological conditions and on the quantity of fine fuel available for burning on the floor of the forest. As fuel quantity increases, so the likelihood of a crown fire development increases proportionately as long as meteorological conditions remain constant. Expressed in another way, crown fire development can occur in heavy fuels even when the meteorological conditions are relatively mild. If fuel quantity is kept at a low figure by regular control burning, crown fire development is retarded and needs increasingly severe weather conditions to produce a destructive fire. There were many instances during some of the major runs of the Dwellingup fires where recently control burnt forest stopped a running headfire and, in many cases, stopped the fire altogether. Usually, however, the fire had already spotted considerable distances ahead and continued to make progress on the other side of the burn. In most instances old, protected compartments, where the fuel was older than 15 years, crowned out and carried a destructive fire even under relatively mild weather conditions.

A detailed study of the relationship between fuel quantity, fire intensity and degree of damage done to the forest would reveal some very interesting comparisons on the effectiveness of control burning. Several examples are given to illustrate the type of damage effect to be expected.

(i) In Nowra 5 the main headfire from the breakaway on Tuesday afternoon on the Back Huntly Road at 1315 hrs., was crowning out in a heavy 15-year-old plus fuel type. The head then ran into an area control burnt in 1953/54 and was almost immediately reduced to a ground fire

scorching all leaves to the top of th trees. Some 10 chains further on, it then ran into a Spring '58 burn and penetrated for a distance of a few chains and was stopped. The fire was of very high intensity and had already spotted ahead for a distance of 2 miles into heavy 15-year-old plus fuels.

(ii) During the massive run of the fire through Dwellingup on Tuesday evening around 8.30-9 p.m., an area in Holmes 14 control burnt in 1953-54 suffered very severe damage and an area alongside, control burnt in 1955/56 suffered only light to moderate damage. In this instance it would be interesting to have details of the control burning conditions, and it would appear likely that the 1953/54 burn in Holmes 14 may have only removed a small quantity of the inflammable material, whereas the 1955/56 burn may have been hotter and consumed more material.

(iii) In Holmes 13, an area control burnt in 1953/54 was burnt severely, but an area to the south control burnt in 1958/59 has only been moderately scorched. The fire, however, had run through the area.

In general, it can be said that areas burnt up to six years previously have a marked effect on reducing the fire intensity, and even fires burning under worst possible conditions will not do heavy damage to the forest. As the fuel age increases from this point, fire intensity will increase and severe damage can be caused even under relatively mild conditions when the fuel age exceeds 20 years.

Areas control burnt up to three years previously will not carry a crown fire, and fires are of relatively low intensity and easily controlled. It is only when a massive, fast-spreading headfire moves into such fuels that the fire can move through fairly rapidly and cause some damage.

The presence of even isolated pockets of heavy fuel types within the forest area can result in a fire blowing up and spotting ahead for considerable distances. The elimination of any fuel type older than 10 years of age appears desirable from a fire control viewpoint.

7. FIRE DAMAGE.

The total area burnt by the Dwellingup fires was 361,000 acres. Of this area 335,000 acres were State Forest and 26,000 acres were private property. A large proportion of this private property was timbered land, and there would have been no more than 5,000 acres of pasture land burnt.

The main damage resulting from the fire was damage to timber values and heavy property loss suffered to the township of Dwellingup and the mill settlements of Holyoake and Nanga Brook.

It must be clearly emphasised, that, in Australia, there has never been any real attempt to study the effect of fire damage in our Eucalypt forests, and the figures given here can only be taken as a very rough and ready estimate with no firm basis of calculation. No attempt has been made to include damage to catchment values, siltation of streams etc., which may have resulted from this fire. Part of the fire area lies within the Serpentine Dam catchment where a recently constructed reservoir is filling, and other parts lie within the North Dandalup, South Dandalup and Murray River catchments. None of the latter streams are at present dammed. Estimates of property damage are taken from Police sources.

(A) Damage to Buildings and Private Property

(i) Dwellingup Police District	£
116 houses with numerous outbuildings and garages	170,000
2 Service Stations and 3 General Stores	30,000
School and Post Office (Holyoake)	4,000
District Hospital	30,000
Forests Department - loss of mill timber, stores, offices and buildings (excluding houses)	65,000
74 Motor Vehicles	25,000

	£
Damage to State Building Supplies Mill	45,000
Damage to fruit trees and orchards	10,000
Stock losses - 600 head cattle and sheep	8,000
Loss of fodder and pasture	15,000
Fencing	20,000
Machinery	20,000
Damage to P.M.G. telephone lines and installations	3,000
Bridges and culverts	2,000
TOTAL	£447,000

(ii) Waroona Police District.

Damage to Nanga Brook Mill including plant, vehicles and buildings	25,950
Loss of 16 mill houses and 8 huts	4,800
Loss of furniture and personal effects destroyed	20,000
Damage to Murray River Bridge	1,000
Damage to farming property including fencing, feed and stock losses	8,270
Damage to P.M.G. telephone lines	200
TOTAL	£60,220

(iii) Boddington Police District.

Fencing and gates	50
Fencing, pasture, stock and sheds on Murray Location 1229	988
Pasture - 200 acres	200
Damage to 26,800 acres of private property timber lands @ 10/- per acre	13,400
TOTAL	£14,638

Total property losses £522,000

These estimates were made immediately after the fire and should be considered approximate only.

As a check on their accuracy, the insurance liability from various underwriters on 135 houses, sheds, furniture, vehicles etc. was assessed at £325,000 in the Dwellingup District. Thus the total figure of £522,000 appears reasonable and perhaps conservative, as a great majority of houses, personal effects, vehicles etc. were grossly underinsured.

(B) Damage to Forest Values.

The State Forest area was air photographed shortly after the fire and accurate plans drawn which defined the damage in three broad classes viz. -

(i) Areas completely defoliated by crown fire - severe damage.

(ii) Areas where the leaves were scorched to the full height of the trees - moderate damage.

(iii) Areas where green crowns remained and leaf scorch may vary from 10' - 40' high - light damage.

The area burnt within each of the above damage classifications is as follows :-

(i)	Severe damage	60,830 acres
(ii)	Moderate damage	177,970 acres
(iii)	Slight damage	96,280 acres
	TOTAL ...	335,080 acres

Within each of these categories there is a considerable range of fire damage. For the purpose of a rough estimation of the effect that this damage may have on the future growing stock of the forest, the following basis has been used :-

(i) Completely defoliated areas.

(a) Very severe damage, where 60-80% of the standing stems have been killed - generally 30-40 year age class 5,000 acres

(b) Severe damage, where 30-60% of the standing stems have been killed or the leader killed, and stems have suffered degrade 20,000 acres

(c) Moderate to severe damage, where 10-30% of the leaders have been killed and the stems have suffered some degrade. 35,830 acres.

(ii) Areas where all leaves were scorched to the height of the trees and re-generation suffered some damage.

Moderate Damage	100,000 acres
Light Damage	77,970 acres

(iii) Areas where crowns are generally unaffected 96,280 acres

The damage to timber values suffered in each of the above intensity classes has been estimated on the basis of loss of increment which, for this class of jarrah bush is estimated at 10 c.ft. per acre per annum. The monetary loss is calculated on a stumpage value of 30/- per load (50 c.ft. true volume).

LOSS OF TIMBER INCREMENT.

	c.ft.
(A) Completely defoliated areas.	
(i) Very severe - 40 years' loss of increment on 5,000 acres	2,000,000
(ii) Severe - 10 years' loss of increment on 20,000 acres	2,000,000
(iii) Moderate to severe - 5 years' loss of increment on 35,830 acres	1,791,500
(B) Scorched areas.	
(i) Moderate damage - 4 years' loss of increment on 100,000 acres	4,000,000
(ii) Light damage - 2 years' loss of increment on 77,970 acres	1,559,400
(C) Areas where green crowns remain - 1 year's loss of increment on 96,280 acres	962,800
Total loss of increment	12,313,700 c.ft.

Monetary Value -

246,274 loads @ 30/- per load = £369,411

Add loss of ½ load per acre in burnt out merchantable timber

335,000 acres @ 12½ c.ft/acre
83,750 loads @ 30/- per load = 125,625

Total timber loss = £495,336

The above figures on increment loss are very approximate as little information is available on the effect of fire on timber production. In many instances, although the younger age classes in a stand appear to have been severely damaged, these stems may not have any significance on the final crop trees and therefore the stand has, in effect suffered little real loss. Jarrah has a remarkable power of recovery from fire, and it is considered that the above figures represent the maximum loss which would have been sustained to timber values. The figure may conceivably be only half the above estimate. Until long-term studies on fire damage in jarrah forests have been completed, a more accurate damage assessment would be impossible. A considerable number of the fire-killed pole sized trees will be salvaged and give a good financial return to the Department. This would largely offset the monetary loss shown against (A) (i) above.

Thus, it can be estimated that the maximum damage resulting from the Dwellingup fire would be :-

	£
Damage to State Forest growing stock	495,000
Damage to houses, sheds and outbuildings garages, stores etc.	255,000
Damage to sawmills, stocked timber etc.	121,000
Motor Vehicles	25,000
Damage to farming property, including fencing, pasture, stock and sheds	63,000
Miscellaneous items, including machinery private timber losses etc.	60,000
Total fire loss	£1,019,000

In view of the possible over-estimate in State Forest losses, it would be safe to say that the total loss would be between £750,000 and £1,000,000.

The suppression costs incurred on this fire are difficult to estimate with any degree of accuracy. However, during the period 19th January to 10th February, it is estimated that the Forests Department would have expended 33,000 man hours on suppression and patrol whilst the rural brigades and volunteer firefighters during the same period would have expended some 17,000 man hours.

At a rate of 10/- per hour this represents a combined figure of £25,000. To this must be added plant hire charges and depreciation of equipment, and for both the Forests Department and rural brigades this is further estimated at around £25,000.

The total firefighting cost would thus be around £50,000. of which around £35,000. would be borne by the Forests Department and £15,000 in terms of voluntary effort in the rural brigades. The actual figure may conceivably be as high as £75,000.