GOVERNMENT OF
WESTERN AUSTRALIA

"Reframing Rural Fire Management"

Report of the Special Inquiry into the January 2016 Waroona Fire

Volume 2: Appendices

APPOINTMENT TO CARRY OUT SPECIAL INQUIRY
made under s24H(5)(b) of the Public Sector Management Act 1994

Mr Euan Ferguson AFSM

I, MALCOLM CHARLES WAUCHOPE, Public Sector Commissioner, having been directed on 20th January 2016 by Hon Colin Barnett MLA, Premier and Minister responsible for the administration of the *Public Sector Management Act 1994*, to arrange for the holding of a special inquiry pursuant to section 24H(2) of that Act into the organisation and management of the bushfire in the Waroona area in January 2016, being a matter related to the public sector, HEREBY APPOINT Euan Arthur Ferguson AFSM, to carry out the special inquiry.

I further require that you shall prepare a report, on or before 30 April 2016 on the conduct and findings, and any recommendations, of the special inquiry in accordance with the attached terms of reference and provide me with a copy of that report.

Dated this 20th day of January 2016.

M C Wauchope
PUBLIC SECTOR COMMISSIONER

Schedule A

PUBLIC INQUIRY INTO JANUARY 2016 WAROONA FIRE
TERMS OF REFERENCE

Preamble

The January 2016 Waroona Fire has caused significant damage, particularly to the town of Yarloop, and the tragic loss of life. The Government of Western Australia is committed to managing bushfire-related risk and continuously improving the State's capabilities to prevent, mitigate and respond to major bushfires to protect the Western Australian community and the assets it values.

For this purpose, the Government has committed to the establishment of an open and independent review of the management of the fire, with broad terms of reference that will allow for consideration of what has been learned from previous major bushfires, what can be learned from the Waroona Fire, and strategies for future reforms and capability enhancements to efficiently and effectively manage bushfire-related risk.

Terms of Reference

The terms of reference for the Inquiry are to examine and report on:

1. The response to the January 2016 Waroona Fire

(a) The effectiveness of pre-incident bushfire prevention and mitigation activities;

(b) The effectiveness of emergency management plans and procedures;

(c) The effectiveness of the suppression strategies and tactics used during the fire;

(d) The effectiveness of incident management, including coordination of agencies, volunteer fire and emergency services and interstate assistance;

(e) Protection of essential services infrastructure and access to essential services (power, transport, water, communications) by emergency services organisations and the community;

(f) The effectiveness of public messaging including the adequacy and timeliness of emergency warnings issued to residents and visitors;

(g) Effectiveness of assistance to and management of those affected by the fire:

(i) Evacuation procedures

(ii) Communications with the community over the course of the fire

(iii) Provision of welfare support

(iv) Management of people seeking to return to their properties, and

(h) Livestock and companion animal management and welfare issues.

2. Lessons learned from previous bushfire emergencies

(a) The extent to which the findings and recommendations of the following Western Australian bushfire reviews undertaken since 2011 have been implemented:

(i) A Shared Responsibility – Report of the Perth Hills Bushfire February 2011 Review (Keelty, 2011);

(ii) Appreciating the Risk – Report of the Special Inquiry into the November 2011 Margaret River Bushfire (Keelty, 2012);

(iii) Post-Incident Analysis of the 2011 Margaret River and Nannup bushfires (Noetic Solutions, 2012);

(iv) Parkerville Stoneville Mt Helena Bushfire Review (State Emergency Management Committee (SEMC, 2014);

(v) O'Sullivan and Lower Hotham Bushfires Review (SEMC, 2016); and

(vi) The Western Australian State Emergency Management Committee Preparedness reports.

(b) The effectiveness of reforms implemented by the State since 2011 on the State's ability to prevent, mitigate and respond to major bushfires and the community's understanding of and preparedness for bushfire risk.

3. The need for further reform

Any legislative, policy or functional reforms relating to bushfire risk management, emergency management and processes for review of major incidents to strengthen the State's capability to efficiently and effectively manage bushfire-related risk.

Appendix 2 – Acronym List

A	
ABC	Australian Broadcasting Corporation
AFAC	Australasian Fire and Emergency Service Authorities
AIIMS	Australasian Interagency Incident Management System
ANZEMC	Australia-New Zealand Emergency Management Committee
AVBFB	Association of Volunteer Bush Fire Brigades of WA
AVL	Automatic Vehicle Location
AWU	Australian Workers Union
B	
BFAC	Bushfire Advisory Committee
BFB	Bushfire Brigade
BoM	Bureau of Meteorology
BRIG	Bushfire Review Implementation Group
BRMP	Bushfire Risk Management Plan
C	
CALM	Conservation and Land Management Act
CBFCO	Chief Bushfire Control Officer
CESM	Community Emergency Services Manager
CFA	Country Fire Authority
CMS	Critical Messaging System
COAG	Council of Australian Governments
COMCEN	Communications Centre
CPFS	Department of Child Protection and Family Services
CPSU	Community and Public Sector Union
D	
DAFWA	Department of Agriculture and Food
DCBFCO	Deputy Chief Bushfire Control Officer
DEMC	District Emergency Services Committee
DER	Department of Environment Regulation
DFES	Department of Fire and Emergency Services
DIC	Deputy Incident Controller
DoL	Department of Lands
DPC	Department of the Premier and Cabinet
E	
EM Act	Emergency Management Act
ESD	Emergency Services Directory
ESL	Emergency Services Levy
ESVA	Emergency Services Volunteer Association
F	
FDI	Fire Danger Index
FDR	Fire Danger Rating
FES Commissioner	Fire and Emergency Services Commissioner
FESA Act	Fire and Emergency Services Act
FMC	Fuel Moisture Content
FMP	Fire Management Plan
FPC	Forest Products Commission
G	
GFDI	Grassland Fire Danger Index
GIS	Geographic Information System
H	
Helitak	Water Bombing helicopter
HMA	Hazard Management Agency
I	
IAP	Incident Action Plan
IBMC	Interagency Bushfire Management Committee

IBRMS	Interagency Bushfire Risk Management System
IC	Incident Controller
ICC	Incident Control Centre
ICS	Incident Control System
ICV	Incident Control Vehicle
IMS	Incident Management System
IMT	Incident Management Team
ISG	Incident Support Group
J	
JAOA	Joint Agency Operational Audit
L	
LAT	Large Air Tanker
LEMA	Local Emergency Management Arrangement
LEMC	Local Emergency Management Committee
LMZ	Land Management Zone
M	
MIR	Major Incident Review
MOC	Metropolitan Operations Centre
MOU	Memorandum of Understanding
N	
NBMP	National Bushfire Mitigation Program
NBN	National Broadband Network
O	
OASG	Operations Area Support Group
OBRM	Office of Bushfire Risk Management
OIC	Officer in Charge
P	
P&W	Department of Parks and Wildlife
PIA	Post Incident Analysis
PIO	Public Information Officer
PIT	Public Information Team
PPRR	Prevention Preparedness Response Recovery
PSC	Public Sector Commission
R	
RAP	Restricted Access Permit
RDC	Regional Duty Coordinator
RFS	Rural Fire Service
RMS	Resource Management System
ROC	Regional Operations Centre
S	
SAP	Standard Administrative Procedure
SECG	State Emergency Coordination Group
SEMC	State Emergency Management Committee
SEMP	State Emergency Management Policy
SES	State Emergency Service
SESVA	State Emergency Service Volunteers Association of WA (Inc)
SEWS	Standard Emergency Warning Signal
SMS	Short Message Service
SOC	State Operations Centre
SOCMET	State Operations Centre Meteorologist
SOP	Standard Operating Procedure
SRC	State Recovery Controller
SRCG	State Recovery Coordination Group
SSO	State Solicitors Office
SWORD	State Wide Operational Response Division
T	
TFB	Total Fire Ban
TMP	Traffic Management Plan

U	
UCL	Unallocated Crown Land
UFU	United Fire Fighters Union
UMR	Unmanaged Reserves
V	
VAC	Volunteer Advisory Committee
VBFB	Volunteer Bush Fire Brigade
VCP	Vehicle Control Point
VFRS	Volunteer Fire and Rescue Service
VLAT	Very Large Air Tanker
W	
WALGA	WA Local Government Association
WAPOL	Western Australia Police
WESTPLAN	WA State Emergency Management Plan

Appendix 3 – Traffic Light of the Status of Previous Review Recommendations

Key

	Complete
	Intent not fulfilled / in progress / unable to measure
	Incomplete

A Shared Responsibility – Report of the Perth Hills Bushfire February 2011 Review

Recommendation	Agency Comment	Special Inquiry Comment	Special Inquiry Assessment
Recommendation 1: The Fire and Emergency Services Authority (FESA) and the Department of Environment and Conservation develop and finalise their Memorandum of Understanding and commit to working in partnership.	A Memorandum of Understanding (MOU) was signed in November 2011, and renewed in 2015. This MOU is underpinned by Westplan Fire and regional arrangements.	This recommendation is complete. However, the Special Inquiry queries why the MOU is not reviewed annually? The Special Inquiry also queries whether there may be value in including any other agencies in the MOU?	
Recommendation 2: Emergency Management Western Australia establish an inter-agency working group to continue the development of the new single emergency services Act.	An inter-agency working group was established, with membership including relevant government agencies and volunteer associations. The working group continued to have oversight of the project during the stages of developing the legislation. Three stages have been undertaken: 1. Initial consultation phase, including a submissions process and public meetings; 2. Expert panel workshops, which considered specific issues to be addressed in the new legislation; and 3. Release of a Concept Paper, on which public submissions were invited. Additional targeted consultation within Government continues, as further work is being undertaken to develop the	Whilst the inter-agency working has been established, the intent of this recommendation was that the working group continue the development of the Act. As legislation is yet to be finalised, this recommendation should be considered to be in progress.	

	proposed legislation.		
Recommendation 3: The State Government transfer responsibility for declaring bushfire prone areas from local government to the Western Australian Planning Commission. The Western Australian Planning Commission should urgently assess those areas that should be declared bushfire prone.	An amendment was made to the *Fire and Emergency Services Act*, assented to on 26 August 2015, enabling the FES Commissioner to designate bushfire-prone areas. The FES Commissioner will also be responsible for maintaining and updating any database which designates an area as bushfire prone. The *Building Amendment Regulations (No. 3) 2015* attained Executive Council approval on 13 October 2015, to allow for the four month delay for industry. The bushfire prone area maps, and associated mapping standard developed by OBRM, were publicly released in December 2015.	This recommendation is complete	
Recommendation 4: The State Government give legislative effect to the *Planning for Bush Fire Protection Guidelines*.	The State Government (via the WA Planning Commission) prepared the revised 'State Planning Policy 3.7 – Planning in Bushfire-Prone Areas' policy, under the *Planning and Development Act 2005*, in December 2015. The *Planning and Development (Local Planning Schemes) Regulations 2015* came in to effect in December 2015. The Regulations require that, before development in designated bushfire prone areas, that a bushfire attack level (BAL) assessment be undertaken and, in certain circumstances where planning approval will be required before development.	This recommendation is complete	
Recommendation 5: Local Government recognise the work of the Gas Technical Regulatory Council and ensure any amendments to the Australian Standard are enforced. Local Government provide information to residents on any changes to the Australian Standard relating to tethering gas tanks and encourage property owners to take action to comply with the Standard.	*Prepare.Act.Survive.* and other relevant DFES publications have been amended to include references to tethering. A voluntary guideline on tethering gas cylinders has been developed by EnergySafety WA. The guideline provides information on where and how to position gas cylinders and safety valves, and actions to take during a bushfire. The guideline has been promoted to all local governments who have been encouraged to provide it to property owners with other fire prevention information. Although EnergySafety has recommended changes to the Australian Standard to make support or tethering of LPG cylinders mandatory, this is a lengthy process and would only	This recommendation is complete.	

	apply to new installations. Energy Safety WA will continue to liaise with the Gas Technical Regulatory Council regarding amendments to the relevant Australian Standard.		
Recommendation 6: FESA, in partnership with local governments, conduct more focused pre-season bushfire education, which emphasises: • Water supply is not guaranteed during a bushfire • Power supply is not guaranteed during a bushfire • Saving life will be a priority over saving property so expect to be evacuated • Once evacuated, access to affected areas may not be possible for several days • Water "bombing" by aircraft cannot be guaranteed in bushfire • SMS warnings are advice only and may not be timely.	The DFES web page content has been reviewed and updated to include information on water requirements and availability. The DFES bushfire program includes scheduled activities and targeted distribution of materials designed to saturate all bushfire prone areas in accordance with findings from the research conducted by the Bushfire Cooperative Research Centre. The program employs a range of approaches with Local Governments, Brigades, Groups and Units delivering localised strategies in targeted high risk communities including the establishment of community Bushfire Ready groups. There are currently 148 Bushfire Ready Groups in the South West Land Division. .	This recommendation is complete. The Parkerville Bushfire Review found that significant work has been undertaken to implement the recommendations of the Perth Hills Report which relate to community preparedness.	
Recommendation 7 (TOR 4): FESA review its distribution of information material, including Prepare. Act. Survive. FESA should also consider including the community in pre-season exercising, in consultation with the Department for Child	*Prepare.Act.Survive*. was rewritten following the Keelty recommendations and the content is reviewed each year. DFES' 17 preparedness Fact Sheets for Bushfire support the key national community engagement document *Prepare.Act.Survive*. These are available online, distributed to regional stakeholders, and promoted by local Bushfire Ready Groups.	It is evident that a large volume of work has been undertaken to address this recommendation. However, this does not assess the effectiveness of this work. Outcomes of the report on the effectiveness of the publication campaign should be included in progress reports on implementation, and used as the basis for continually assessing this work.	

Protection and local governments.	DFES has conducted community engagement campaigns including delivering 94,500 *Prepare Act Survive* to high bushfire risk locations. A report on the effectiveness of the distribution on DFES' publications has been produced. The consultation with the Department for Child Protection was documented and accepted. A number of State and regional exercises have been conducted where community members have been invited to participate.	The annual SEMC Preparedness Report might be a good document to record the effectiveness of community programs.	
Recommendation 8 (TOR 4): Local governments continue to include information on bushfire risk and preparedness with rates notices.	WALGA has worked with members to increase local awareness of bushfire risk and the ongoing inclusion of relevant information in mail outs. This includes mail outs separate to rates notices, so that information is provided closer to when burning can commence. WALGA has raised awareness of bushfire risk with its members, in particular those with considerable bushfire risk (in the Perth Hills and the South West) through normal communications mechanisms such as presentations to WALGA Zones.	WALGA has significant undertaken work in fulfilment of this recommendation. However, as the distribution of information is the responsibility of Local Governments, it is difficult to ascertain the extent to which this has occurred.	
Recommendation 9 (TOR 4): FESA work in partnership with the Real Estate Institute of Western Australia to develop a package of information for new residents moving into bushfire prone areas, and a process to ensure this information is provided through real estate agents.	DFES worked with REIWA to complete this information. However, there is a lack of clarity between agencies concerning the process for the ongoing distribution of information to residential owners and tenants.	This recommendation is complete.	
Recommendation 10 (TOR 4): The Department of Education oversee the provision of bushfire education in schools that are located in bushfire prone areas,	The "Principal's Guide to Bushfires" was placed is updated annually and the latest version was published in August 2015. DoE in consultation with DFES has developed additional educational materials that reference research on bushfire	This recommendation is complete	

ensuring that all schools in these areas incorporate key bushfire messages in their curriculum.	education and appropriate disaster pedagogical approaches. Bushfire education is a mandated teaching component in the latest draft curriculum documentation.		
Recommendation 11 (TOR 4): FESA consider alternative wording to Total Fire Ban that ensures people gain a more complete understanding of what actions are prohibited.	In response to a letter from DFES, the Australasian Fire and Emergency Service Authorities Council (AFAC) advised that WA should retain the existing wording to ensure consistency across Australia. As a consequence of the requirement to retain the existing terminology a communication strategy was developed to provide further education to the general community and the agricultural community in particular about total fire bans.	This recommendation is complete but should be considered as an ongoing task for DFES.	
Recommendation 12 (TOR 4): FESA work in partnership with Main Roads Western Australia and local governments to develop and implement a comprehensive strategy for the use of mobile variable message boards to alert the community to the declaration of a total fire ban and what it means.	Following a review of the capacity of other agencies in regard to mobile message boards, an alternative communication strategy has been developed which includes the use of fixed message boards to notify when a total fire ban is in place.	This recommendation is complete	
Recommendation 13 (TOR 1): The State Government consider resourcing the Department of Environment and Conservation and local governments to develop and administer a comprehensive prescribed burning program in Perth's urban/rural interface to compliment DEC's existing landscape-scale program.	P&W has completed a number of successful prescribed burning programs, and continues to work closely with DFES and Local Governments to plan and undertake more collaborative hazard reduction measures. **Residual or Ongoing Elements** • P&W to document its specific program for fire mitigation on P&W managed lands around the Perth urban interface and integrate into its overall master burn plan. • P&W will brief DFES and WALGA on the results of this project. • DFES and local governments will develop a strategy	Whilst the establishment of three priority zone approach to hazard reduction burning is underway, burn targets for previous years have not been fulfilled and subsequent targets are not reassessed as a result. Recommendations 3 and 4 of this Report will assist in the further implementation of this recommendation.	

	for the planning and implementation of prescribed burning programs on non-P&W-managed lands, and resources required to implement this strategy.		
Recommendation 14 (TOR 1): FESA, the Department of Environment and Conservation and local governments take proactive steps to conduct their prescribed burning programs as joint exercises. This will give effect to: • Reducing fuel load • Improving inter-operability A mutual understanding of the fire fighting techniques of each agency	P&W has completed a review of burn approval process to include a formal process for including DFES and/or local governments in the conduct of prescribed burns. There are plans for DFES and local governments to develop a reciprocal process with P&W on this matter	The Special Inquiry believes that all agencies should show a greater commitment to the fulfilment of this recommendation. In other jurisdictions, such as South Australia and New South Wales, volunteers are, to some degree, successfully integrated into planning burning on public and private land.	
Recommendation 15 (TOR 1): FESA and local governments ensure that the ability to: • measure and map fuel loads • maintain fuel load databases • draw up prescriptions for, and oversee controlled burns are included as key competencies in any future recruitment of Chief Bushfire Control Officers and Community and Emergency Services Managers.	DFES has developed a training pathway for its volunteers and staff, and encourages adoption by local governments. Development of the Bushfire Risk Management Planning Project is also continuing, which will include Guidelines for developing BRMPs, a prescribed burning course training resource kit and a GIS database for storing fuel load information. The implementation of the joint agency State Prescribed Burning manual will establish standards for measuring fuel loads, planning and overseeing controlled (prescribed) burns. CESMs are currently not trained to measure and map fuel loads. The appropriate competency in the professional development pathways for bushfire managers, including CESMs has been established but has not yet been delivered. WALGA has agreed to set competency standard for adoption by Local Governments.	The Special Inquiry concurs that further work is outstanding to fulfil this recommendation.	
Recommendation 16 (TOR 1	WALGA has completed the development of 'pin2fix'	This recommendation is complete.	

and 3): The State Government give its full support to the Western Australian Local Government Association's *Send to Solve* initiative	application as an alternative to 'Send to Solve'.		
Recommendation 17 (TOR 1 and 3): Local governments consider increasing the number of green waste collections carried out each year to encourage a more proactive approach to property (and vegetation) maintenance by residents.	WALGA continues to encourage all local governments to increase their green waste collections.	This recommendation is complete.	
Recommendation 18 (TOR 1 and 3): The Western Australian Local Government Association explore the feasibility of local governments utilising aerial and satellite imagery to monitor firebreaks and fuel loads on private property.	Local governments, DFES, and DPaW, utilise the best available GIS tools, including aerial and satellite imager when available and feasible.	This recommendation is complete. The Special Inquiry notes that this technology is continually evolving and suggests that this be monitored by relevant agencies.	
Recommendation 19 (TOR 1): The State Government reaffirm its 2009 decision to approve DEC exercising greater flexibility in managing smoke within national guidelines, in order to achieve its prescribed burn program.	This was fulfilled by a statement released by the Minister for Environment in November 2011.	This recommendation is complete.	
Recommendation 20 (TOR 1): FESA, the Department of Environment and Conservation and local governments closely monitor the research and development of alternative fuel reduction techniques to ensure that the most efficient and effective programs are adopted	DPaW, DFES and local Government continue to use the full range of mitigation techniques as part of fuel management programs.	This recommendation is complete. The Special Inquiry as identified an opportunity for P&W and the Forest Products Commission to explore policy options for mechanical thinning of forest, including mining rehabilitation forest, for the purpose of bushfire mitigation.	

Recommendation 21 (TOR 1 and 5): FESA, the Department of Environment and Conservation and local governments jointly develop a single, integrated system for fuel load assessment and management. The system should enable public access to allow members of the community to access information about the fuel load in a given locality.	The pending completion of the Bushfire Risk Management Plan project and development of the Bushfire Risk Management System (BRMS) supports the intention of Recommendation 21. This is subject to the availability of funding. The P&W have a separate system for forest management purposes, however the systems complement each other and P&W will be full participants in the BRMP process where the agency is the land manager	As discussed in Chapter 5 of this Report, the Special Inquiry supports the development of the BRMP process, and acknowledges funding difficulties which have impeded its progress. However the practicality of developing a BRMS system that is accessible to the public is queried; given the highly variable nature of fuel accumulation, and the challenges in forecasting the impact of land management (e.g harvesting and grazing), the development of an accurate database that would be meaningful for the public would be highly difficult.	
Recommendation 22 (TOR 1 and 5): The State Government ensure that the continued development of the FESA's Integrated Bushfire Risk Management System (IBRMS) is dependent on an independent comparative assessment of its functionality and cost effectiveness against the Spatial Support System (SSS) used by the Department of Environment and Conservation	The Interagency Bushfire Management Committee has examined the IBRMS and SSS and concluded that the systems are complimentary.	This recommendation is complete.	
Recommendation 23 (TOR 1 and 5): The Interagency Bushfire Management committee develop and oversee a work program to: • conduct site specific assessments to assess current fuel loads • assess, analyse and prioritise bushfire risk on land within and adjacent to communities • develop a three year rolling mitigation works	Works programs by DFES staff and local government-based Community Emergency Services Managers is on-going. Following the recommendation that a joint DFES/P&W developed Bushfire Threat Analysis be the basis for bushfire risk, DFES developed BRMS and it is in a final testing phase. P&W have a three year rolling mitigation works program for their land, including its recent 3 zone approach.	The Special Inquiry concurs that further work is outstanding to fulfil this recommendation; in particular, the development of a three year rolling mitigation works program by DFES.	

program with annual implementation and review. This work should commence independently of any decision on the most effective online integrated system. All data collected should be uploaded to the SLIP.			
Recommendation 24 (TOR 4): FESA convene a facilitated debriefing session between the families who remained behind to protect their properties, and the incident controllers. This session should include open discussion and explain the decisions of all parties – including how the incident controllers determined priorities, and why residents chose not follow their advice to evacuate. The learning outcomes should be promulgated across all agencies and incorporated in future level 3 incident controller training programs.	Debrief sessions were held in October and December 2011 in fulfilment of this recommendation. Learning outcomes from the debriefing sessions were shared with the appropriate stakeholders. To date, no learning's have required changes to the level 3 incident controller training programs.	This recommendation is complete.	
Recommendation 25 (TOR 5): FESA immediately comply with the provisions of WESTPLAN BUSHFIRE and formally declare incidents at their appropriate level and document and communicate those decisions in a similar way to the systems used by the Department of Environment and Conservation and the Western Australian Police.	New incident level declaration forms have been created and agreed to by all agencies. The Major Emergency Coordination Guidelines have been updated and renamed "Operational Procedure for the Command, Control and Coordination of Major Incidents' DFES reports that new L3 IC appointment and incident level declaration forms implemented and are working effectively.	This recommendation is complete.	
Recommendation 26 (TOR 5): The Fire and Emergency Services	New incident level declaration forms have been created and agreed to by all agencies. The Major Emergency Coordination	This recommendation is complete.	

Authority develop formal procedures for mandating the completion of Incident Action Plans, ensuring the documents are detailed and that they record critical decision making.	Guidelines have been updated and renamed "Operational Procedure for the Command, Control and Coordination of Major Incidents'	This Special Inquiry suggests that DFES and P&W, in conjunction with AFAC, explore the development of a standardised approach and content for an "initial (4 hour)" Incident Action Plan.	
Recommendation 27 (TOR 5): FESA review its use of the Australian Interagency Incident Management System to ensure that the most appropriate resources (including aerial resources) are used to respond to an incident. If resources are rejected during an incident either through the decision making process or other grounds, the reason for the decision should be documented.	Updated work practices and information tools have been developed including a review of the Australasian Incident Management System and improvements in the personal incident diary. The establishment of a State Air Desk jointly operated by DFES and P&W to effectively manage mobilisation of aerial resources Improvement in communications between the SOC and ROCs through the implementation of WebEOC	Whilst there has been work successfully undertaken to address this recommendation (including the establishment of the State Air Desk), this Special Inquiry noted a number of issues relating to the deployment of appropriate resources during the Waroona fire. The Special Inquiry suggests that DFES to review the policy of dispatching task force resources from Perth metropolitan and regional urban locations to bushfires to ensure that only vehicles that are fit for purpose and appropriate to the task are deployed. Also, that resources, on arrival mat the incident, are under the control and direction of the Incident Controller (not the ROC or SOC).	
Recommendation 28 (TOR 5) The Fire and Emergency Services Authority review its program to decommission vehicles and ensure that when such vehicles are offered during an incident that FESA staff adhere to FESA's own policy of 'Use of Private Vehicles in Fires"	DFES' internal and external procedures have been updated, including an operational circular about the new *Guidelines for Operating Private Equipment at Fires.*	The Special Inquiry notes that this Guideline was reviewed in February 2016 however further work should be undertaken to enable landowners to access decommissioned vehicles. The Special Inquiry suggests that DFES (and when established, the Rural Fire Service) and in consultation with the Association of Bush Fire Brigade Volunteers, to review the policy for disposal of "retired" firefighting vehicles to first make disposed vehicles available to landowners who are sponsored by the local Brigade. Such vehicles to be subject to a limited decommissioning process.	
Recommendation 29 (TOR 5): The Fire and Emergency Services Authority and the Department of Environment and Conservation ensure that their Incident	New incident level declaration forms have been created and agreed to by all agencies, and the Major Emergency Management Coordination Guidelines have been updated and renamed 'Operational Procedures for the Command, Control	Whilst work has been undertaken to fulfil this recommendation, this Special Inquiry suggests that SEMC to develop an aide-memoire for Incident Controllers to guide the initial recovery considerations during an incident. The aide-memoire to include triggers for the	

Controllers identify critical infrastructure as part of their initial assessment and preparation of Incident Action Plans when attending major incidents.	and Coordination of Major Incidents'. The DFES joint Intelligence Project which seeks to establish a joint intelligence desk, will also improve joint agency transfer of information held or collected by the agencies in support of emergency operations.	initiation of rapid impact assessment and the escalation of the recovery function; immediate and likely future community health, welfare and safety considerations. These triggers will inform the Incident Controller/s when considering the discretionary appointment of "Deputy Incident Controller, Recovery" during an incident that impacts on the community. Role of "Deputy Incident Controller, Recovery" would be (with the Incident Controller) to consider the initiation of the recovery process and to manage the transition from incident response to the recovery phase.	
Recommendation 30 (TOR 1 and 2): Main Roads Western Australia undertake more frequent examinations of its bridges located in areas prone to bushfire and ensure that the risk posed to loss of infrastructure in a fire is understood by local authorities.	Main Roads provided a report to local governments pertaining to vegetation levels at timber and timber hybrid bridges in the State. The development of an overall accelerated bridge inspection program is ongoing.	This recommendation is complete.	
Recommendation 31 (TOR 5): FESA and the Western Australian Police ensure they receive all necessary legal clarification in relation to Bushfire Responsibilities of Police Officers – Powers Used in Assisting Fire Authorities in Responding to Bushfires, to be promulgated across FESA and WAPOL.	As an interim measure, DFES signed a standing appointment for all police officers responding to an emergency where the FES Commissioner is the Hazard Management Authority (HMA) and as such have declared an emergency situation to act as Hazard Management Officers. It is intended that in the future, a legislative solution will be introduced. The Emergency Management Act review "green paper" has been circulated to the members of the Emergency Management Act Review Working Group for comment.	This recommendation is complete.	
Recommendation 32 (TOR 4 and 5): The Western Australian Police and the FESA jointly examine the Traffic Management System developed in response to the 2009 Victorian bushfires and seek its adaptation to use in WA	A Traffic Management Working Group was established to examine and report on this issue. The final report to the SEMC that examined the Traffic Management System utilised in Victoria was considered at the SEMC meeting of 13 March 2012 (resolution number 27/2012 refers). The report recommended that Western Australia should not adopt the Victorian Traffic Management model as it is considered cumbersome.	The Special Inquiry found that the application of the traffic management policy at some locations during the Waroona fire did not meet the expectations of the community. On this basis, the policy requires review. This Special Inquiry recommends that SEMC to review the policy for traffic management at emergency incidents so it reflects national "best practice". This includes the	

with additional attention to the access and egress by bona fide residents to areas that are evacuated.	A new traffic management policy and accompanying guideline have been developed and promulgated, based on national best practice.	production and issuing of an "aide-memoire" to guide traffic management, emergency and incident management personnel. The policy should provide a practical balance between risk to life and the public value of enabling the timely restoration of livelihoods and the movement of critical resources, (including essential services, critical businesses and livestock welfare services), through traffic management points. The review will involve a range of stakeholders including DFES, P&W, WA Police, Department of Agriculture and Food WA, Main Roads WA, WA Farmers Federation, WA Local Government Association, Forest Industries Federation, and the Transport Industry and ensure that the views of the community are considered.	
Recommendation 33 (TOR 4): FESA and the ABC commence a thorough review of emergency warning messages. This review should give consideration to: • The content, structure and presentation of emergency warning messages • Media access to the Incident Management Team and State Operations Centre. This review should be expanded to include other media organisations should they demonstrate a willingness and capacity to contribute.	DFES, DPaW and the ABC have worked collaboratively to implement this recommendation, which has resulted in a number of measures, including a numbered system for DFES alerts and warnings, and a review of the DFES Standard Operating Procedure for activating ABC emergency broadcasting.	This recommendation is complete.	
Recommendation 34 (TOR 4	The purchase of a Critical Messaging Service has been the	The Special Inquiry supports the prompt establishment of the Critical Messaging Service	

and 5): FESA develop in partnership with other emergency service agencies a 'one source: one message' multi layered system similar to that recommended by the Victoria Bushfire royal Commission.	subject of a tender process, with a contract being awarded to Whispir on 8th February 2016.[1] DFES are funding the initial development and establishment of the CMS on behalf of all government agencies and P&W anticipates becoming a user of the system once it is established.		
Recommendation 35 (TOR 4 and 5): FESA and local governments jointly review radio communications capability prior to the 2011/12 bushfire season with a view to improving the current delivery of service to fire fighters.	Standard Operating Procedures and general guidelines have been reviewed, including updated information about WAERN radio and general communications protocols state wide. Legacy mid band VHF is a continuing issue and key risk. A business case was developed but not funded. Local governments do not have a standardised approach to the use of private vehicles in BFB leading to appliances which may not be fitted with appropriate communications equipment fit outs.	The Special Inquiry notes that this is a challenging issue throughout Australia. The Special Inquiry has discussed future whole of government emergency information technology requirements with the WA Chief Government Information Officer (CGIO). The Special Inquiry understands that the SEMC has developed an Emergency Services Communication Strategy for the consideration of Government. One of the key themes of the Strategy is interoperability.	
Recommendation 36 (TOR 4 and 5): The Department for Child Protection, the Western Australian Police and the FESA develop improved arrangements for communicating the loss of home and possessions to persons gathered at evacuation centres with a view to increasing privacy.	A common protocol was endorsed by a subcommittee of the SEMC and all Hazard Management Agencies were advised to incorporate this into their Standard Operating Procedures.	This recommendation is complete. As noted in the O'Sullivan and Lower Hotham Bushfires Review, the Department of Child Protection and Family Services has developed a database of endorsed centres, and advised that there was much better consultation by principal agencies in the choice of evacuation centres.	
Recommendation 37 (TOR 4 and 5): Hazard Management Agencies overseeing the response to incidents on the urban fringe select evacuation centres that are well within the urban environment and unlikely to be	The process for enabling the use of urban welfare centres for emergency events can now be facilitated, and DCPFS will provide regular updates as part of its core agency business.	This recommendation is complete.	

[1] DFES Project Status Report Feb 2016

impacted by the incident.			
Recommendation 38 (TOR 1 and 3): Local governments institute a comprehensive program to assess fuel loads and bushfire preparedness on private properties. The program should give reference to the creation and maintenance of a Building Protection Zone, in line with FESA guidelines. This program should be implemented and managed under the *Bush Fires Act 1954* in a manner similar to the fire break inspection program.	Following the assessment of the BRMP Pilot, the Guidelines have been updated and a training package has been developed. The roll out of the BRMP project, and the Bushfire Risk Management System, will fulfil this recommendation.	As discussed in Chapter 5 of this Report, the Special Inquiry supports the development of the BRMP process, and acknowledges funding difficulties which have impeded its progress.	
Recommendation 39 (TOR 2 and 3): State and locals governments: a) recognise that regardless of future declarations of bushfire prone areas, the existing planning and building problems in the Perth Hills related to bushfire risk will persist; b) urge residents in these areas to retrofit their homes and evaporative air conditioners in compliance with AS 3959 - 2009; c) examine options to retrospectively bring these areas into compliance with Planning for Bushfire Protection Guidelines	An Information Sheet on AS3959 has been developed. Local governments have updated and increased availability of community information The Department of Commerce, Building Commission and DFES have developed material for homeowners and manufacturers of evaporative coolers requesting the fitting of ember screens in bushfire prone areas. The Building Commission is progressing an amendment to regulations in relation to the fitting of evaporative air-conditioners. The revised WA Planning Commission Guidelines for Planning Bushfire Protection were released in December 2015 cannot be applied retrospectivity; however, they provide strengthened guidance for future planning and development in designated bushfire prone areas.	Whilst significant work has been undertaken to address parts (a) and (b) of this recommendation, work towards part (c) remains outstanding. The Special Inquiry acknowledges however that it is very challenging to address legacy issues in existing high bushfire risk areas. The Special Inquiry has also identified Opportunities for Improvement in relation to: • clearing of vegetation around houses; and • household bushfire refuges • community bushfire refuges.	
Recommendation 40 (TOR 2): The State Government mandate that the title deeds for relevant properties be amended to indicate if the property is in a declared	OBRM have provided legal terminology to Landgate for inclusion in Property Interest Reports (PIR) generated for properties in designated bushfire-prone areas. State Planning Policy 3.7 'Planning in Bushfire Prone Areas' recommends that local governments also include notification for	This Recommendation is complete	

bushfire prone area.	subdivision.		
Recommendation 41 (TOR 2): Western Power and the Water Corporation continue to work collaboratively to assess options to better protect the power supply to water pumping stations in bushfire prone areas.	Western Power and the Water Corporation have reviewed and reaffirmed their existing interagency incident communication and co-ordination processes, with risk assessments conducted in an ongoing manner.	This Recommendation is complete	
Recommendation 42 (TOR 1): The State Government recognise the projected changes in climate and potential impact on future fire events.	In December 2015 the OBRM published the *Mapping Standard for Bushfire Prone Areas* and Guidelines for Preparing a Bushfire Risk Management Plan. Both documents recognise climate change as a factor in bushfire risk.	This Recommendation is complete	
Recommendation 43 (TOR 5): The State Emergency Management Committee amend State Emergency Management Policy 4.1 (Operational Management) to: • give clear and explicit direction about when and how an incident should be declared • clearly articulate the actions to be taken • clearly define accountabilities provide detailed criteria for elevating issues and engaging other agencies	State Emergency Management Policy 4.1 and WESTPLAN – FIRE have been amended to provide clear guidance about the declaration of emergencies.	This Recommendation is complete	
Recommendation 44 (TOR 5): The State Government amend section 50 of the *Emergency Management Act 2005* to allow the Chair of the State Emergency Coordination Group to declare an	Section 50 of the *Emergency Management Act 2005* was amended to provide that the State Emergency Management Coordinator can declare that an emergency situation exists in any area of the state in respect to any hazard.	This Recommendation is complete	

emergency situation.			
Recommendation 45 (TOR 5): Emergency Management Western Australia and the State Emergency Management Committee amend WESTPLAN-BUSHFIRE to require State Emergency Coordination Group meetings to be held at the State Coordination Centre in West Leederville.	State Emergency Management policy 4.1 and Westplan – Fire have been updated to reflect agreed meeting arrangements of the affected agencies.	This Recommendation is complete	
Recommendation 46 (TOR 5): The State Government restructure the Fire and Emergency Services Authority as a Department. As part of this restructure, Emergency Management Western Australia should either be: 1. clearly separated from the fire and emergency services response function; or 2. moved to the Department of the Premier and Cabinet; or 3. moved to the Attorney-General's Department,	DFES was established on 1 November 2012. EMWA has been restructured as the State Emergency Management Committee (SEMC) Secretariat. SEMC itself has also been reformed by the inclusion of an independent chair and two independent members.	This Recommendation is complete; however, the Special Inquiry notes that the State Emergency Management Committee Secretariat would benefit from greater independence from DFES. The Special Inquiry recommends that Government to explore options for streamlining the functions and the independence of the SEMC Secretariat and the Office of Bushfire Risk Management with a view to including an inspectorate function, and appointing a person who is dedicated to that role. The purpose is to provide assurance and reporting, and to inquire into, monitor and report transparently on emergency management standards, preparedness, capability, service delivery and investment performance outcomes. Within two years of the establishment of this arrangement the government to review and assess whether it is meeting the desired outcomes.	
Recommendation 47 (TOR 5): Emergency Management Western Australia develop mechanisms to calculate the estimated total cost of a fire to the community.	The SEMC Secretariat has undertaken initial research and held initial discussions with the Insurance Council of Australia.	The Special Inquiry notes that whilst only scoping work has been undertaken, this recommendation is difficult to achieve. The Special Inquiry has attempted in Chapter 6 of this Report, to estimate the cost of the Waroona fire to the community.	
Recommendation 48 (TOR 5):	It was determined that the Department of Finance was not best	The Special Inquiry believes that the consideration of this	

The State Government move the responsibility for the management and distribution of the Emergency Services Levy to the Department of Finance.	placed, in terms of functional expertise, to undertake this role.	recommendation was not sufficiently inclusive or transparent. The Special Inquiry recommends that Government conduct an independent review of the current arrangement for the management and distribution of the Emergency Services Levy. The review will have the specific purpose of: • Seeking input from key fire management entities including Department of Fire and Emergency Services, Department of Parks and Wildlife, WA Local Government Association, the Office of Bushfire Risk Management, and the Department of Lands. • Ensuring the arrangement has the flexibility and agility to deal with emerging bushfire risk priorities. • Establishing a budget process that enables a shift in investment towards prevention, mitigation and building community resilience and capability.	
Recommendation 49 (TOR 5): Emergency service agencies undertake more consultation and joint exercising involving the Fire and Emergency Services Authority, the Department of Environment, the Western Australian Police, the Department for Child Protection, local governments and volunteers – including Volunteer Bush Fire Brigades. This should include field exercises which test: • Evacuation centres • Critical infrastructure (including at the local level) • Traffic management,	WESTPLAN-FIRE has been updated to reflect the need for multi-agency exercises that test evacuations centres, critical infrastructure and traffic management. State Bushfire Exercise Plans are produced in conjunction with P&W, WAPOL, Local Emergency Management Committee (LEMC), local governments and Department for Child Protection.	This recommendation is complete; however the Special Inquiry found significant deficiencies with respect to traffic management during the Waroona fire.	

including road blocks. • Consideration should also be given to involving the community in exercising (see Recommendation 7) and using prescribed burns as exercises (see • Recommendation 14). • More detailed planning for exercises should be included in a revised WESTPLANBUSHFIRE to be endorsed by the State Emergency Management Committee.			
Recommendation 50 (TOR 5): The State Government transfer responsibility for the installation, removal, maintenance of fire hydrants to the Water Corporation, in accordance with the recommendations of the 2006 CDJSC *Inquiry into Fire and Emergency Services Legislation.*	Legislation was passed in 2012 which transferred ownership of street fire hydrants to the Water Corporation. Since that time, maintenance backlog has been reduced. An audit was jointly undertake by the Water Corporation and DFES of all outstanding maintenance orders and of missing hydrants.	This recommendation is complete.	
Recommendation 51 (TOR 5): The Water Corporation immediately review the outstanding orders for hydrant repairs and develop strategies to reduce the backlog.	As per Recommendation 51.	This recommendation is complete.	
Recommendation 52 (TOR 5): The Fire and Emergency Services Authority and local governments ensure that Community	The MOU relating to Community Emergency Service Managers has been reviewed and where a CESM is not located within a local government, it is at the local government's request.	This recommendation is complete.	

Emergency Service Managers are physically based in local government.			
Recommendation 53 (TOR 1 and 5): The Fire and Emergency Services Authority and local governments examine the current competencies of Chief Bushfire Control Officers and Community Emergency Services Managers (or Community Fire Managers) and consider what further development is needed to ensure these staff are capable of: • measuring and mapping fuel loads • maintaining fuel load databases • drawing up prescriptions for, and overseeing controlled burns building effective working relationships with all relevant stakeholders.	As per Recommendation 15.	The Special Inquiry concurs that further work is outstanding to fulfil this recommendation.	
Recommendation 54 The Interagency Bushfire Management Committee develop a consistent program of education, training (including media), testing and review of Incident Controllers. This should include provision for a formal review of the performance of individual Level 3 Incident Controllers after every incident.	An Accreditations Pathways Process for all Level 3 Incident Controllers who operate on bushfires in Western Australia has been developed and continues to be implemented by DFES and P&W.	This recommendation is complete.	
Recommendation 55 The State	Agencies regularly report back to the SEMC on the	Ascertaining the progress towards implementation of each	

Government Review the implementation of the Special Inquiry's recommendations in two years.	implementation of a number of bushfire reviews, including the Perth Hills Review.	recommendation was not a straightforward task for this Special Inquiry. This can be attributed to the following reasons: • Deficiencies in internal processes for capturing recommendations and opportunities for improvement; • A lack of clear reporting lines to oversight bodies; • A lack of clear Key Performance Indicators set by oversight bodies; and • Differing views as to what constitutes "complete". The Special Inquiry recommends that Government explore options for streamlining the functions and the independence of the SEMC Secretariat and the Office of Bushfire Risk Management with a view to including an inspectorate function, and appointing a person who is dedicated to that role. The purpose is to provide assurance and reporting, and to inquire into, monitor and report transparently on emergency management standards, preparedness, capability, service delivery and investment performance outcomes. Within two years of the establishment of this arrangement the government to review and assess whether it is meeting the desired outcomes.	

Appreciating the Risk – Report of the Special Inquiry into the November 2011 Margaret River Bushfire

Recommendation	Agency Comment	Special Inquiry Comment	Special Inquiry Assessment
Recommendation 1: The Department of Environment and Conservation review its current policies and operational guidelines in particular by: • strengthening the governance of operations by ensuring the Guidelines are relevant and	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. In addition, the Leeuwin-Naturaliste Capes Area Parks and Reserves Management Plan was released by the Minister for Environment on 9 January 2015.	This Recommendation is complete.	

practical; • ensuring the processes that are implemented for prescribed burns are: (a) value adding to the decisions and approvals required (b) informed by substantive input (c) focused on outcome rather than process; • completing the draft management plan for the Leeuwin-Naturaliste Capes Area Parks and Reserves in accordance with the provisions of the Conservation and Land Management Act 1989; • exploring the possibility of automating and streamlining the various processes for formulating a prescription for prescribed burns for ease of access and updating; and • clarifying the guidance provided to decision makers as to the 'edging' and security of prescribed burns.			
Recommendation 2: The Department of Environment and Conservation urgently undertake a review of its risk management practices as they relate to prescribed burns including but not limited to: • reviewing risk management practices to ensure that they are in accordance with AS/NZS ISO 31000:2009;	The Office of Bushfire Risk Management continues to regulate prescribed burning through its oversight of the DFES and P&W prescribed burning activities and alignment of these activities to the AS/NZS ISO31000 Risk Management Framework.	This recommendation is complete, but the Special Inquiry notes that further enhancements could be made to OBRM's role. The Special Inquiry recommends that Government explore options for streamlining the functions and the independence of the SEMC Secretariat and the Office of Bushfire Risk Management with a view to including an inspectorate function, and appointing a person who is dedicated to that role. The purpose is to provide assurance and reporting, and to inquire into, monitor and report	

• finalising and implementing the new complexity model developed in house by the DEC; • considering a broader set of parameters of risk by conducting an environmental scan or similar tool for areas under consideration for a prescribed burn; • updating the prescribed fire plans to reflect the broader risk considerations discovered through environmental scanning; • better informing the risk considerations by updating the 'Red Book' to reflect current research on burning in coastal heath; and • reconsidering the utility of the 'Red Flag Burn' notification on files and either adopting it as a policy across the State or removing it as a consideration		transparently on emergency management standards, preparedness, capability, service delivery and investment performance outcomes. Within two years of the establishment of this arrangement the government to review and assess whether it is meeting the desired outcomes.	
Recommendation 3: The Department of Environment and Conservation review its implementation of the findings of the Ferguson Review conducted in 2010.	P&W has reviewed its implementation of the Ferguson findings in relation to the Boorabbin fire. Of 17 observations from the Ferguson review, 10 are considered to have been satisfactorily addressed whilst seven have been partially addressed or are in train.	This recommendation is complete	
Recommendation 4: The Department of Environment and Conservation be supported to conduct further research into the fuel management of coastal heath in the south west of Western Australia exploring alternatives to burning as well as best practice for burning.	Completed through a collaborative project with the CSIRO. P&W will continue to explore alternative methods to burning such as tenure blind vegetation management buffers.	This recommendation is complete	

Recommendation 5: The Department of Environment and Conservation explore human resourcing models that: • make succession planning a priority; • look at options for the attraction and retention of staff; and • review how the salary levels of staff matches the decision making required in major activities such as prescribed burns.	P&W have developed and implemented a range of measures to better attract and retain of staff, including a professional development pathway. It is recognised that staff attraction and retention includes a number of factors including remuneration, occupational health and safety, welfare of staff including indemnity associated with decision-making processes, and support from Government.	The Special Inquiry suggests that P&W, in consultation with their workforce and the Community and Public Sector Union and the Australian Workers Union, to carry out a workforce workload analysis of its fire program (covered by both the CPSU and the AWU workforce). The analysis to have a particular emphasis on the management of workload and fatigue in employees involved in the fire program.	
Recommendation 6: The Department of Environment and Conservation review its practices and procedures in the undertaking of prescribed burns so as to fully utilise the skills available to it in a seamless way including but not limited to: • volunteer bushfire brigades, especially in regard to use as a source of local advice; and • staff of the Fire and Emergency Services Authority of Western Australia.	P&W amended procedures for the spring 2011 prescribed burning season to give local governments, volunteer bushfire brigades and DFES officers the opportunity to participate in prescribed burns.	The Special Inquiry believes that all agencies should show a greater commitment to the fulfilment of this recommendation. In other jurisdictions, such as South Australia and New South Wales, volunteers are successfully integrated into planning burning on public and private land.	
Recommendation 7: The Department of Environment and Conservation review the utility of its current regional model in terms of the capability of operational centres such as Kirup to service major fire activity on land proximate to the rural urban area (this recommendation should also be considered in the context of Recommendation 5)	A P&W office has been established in the Margaret River area.	This recommendation is complete.	
Recommendation 8: The Department of Environment and Conservation develop and	P&W has: • worked closely with DFES, OBRM and the community to develop a communications strategy	This recommendation is complete	

implement a strategy to better inform the community about the complexities and decisions surrounding prescribed burns when they are undertaken in the rural urban area.	which will build and maintain community awareness and understanding of prescribed burning; • rolled out the regional media activities focussed on the spring 2012 prescribed burning program; and • made recent improvements to the P&W website providing better access and clearer information about prescribed burns		
Recommendation 9: The response operation to the Margaret River bushfire in November 2011 be the subject of a review with independent oversight.	In March 2012 the Western Australian Government engaged Noetic Solutions Pty Ltd to prepare reports on the Margaret River and Nannup bushfires which occurred in November 2011. The Margaret River report deals with the suppression of the fire, building on the work previously completed by Mr Mick Keelty AO detailed in his 2012 report 'Appreciating the Risk'. The Nannup report deals with matters relating to the escape of the prescribed burn and the suppression of the resulting fire.	This recommendation is complete	
Recommendation 10: The Government consider enacting legislation to facilitate the review of all future major incidents, including but not limited to fire, earthquake, storm and marine inundation, and the emergency response to them.	The Government has considered this recommendation and decided not to enact legislation to facilitate the review of all future major incidents. Instead, SEMCs functions will specifically refer to its role in reviewing and reporting on the implementation of past reviews and investigations of emergencies.	This recommendation is complete, but the Special Inquiry notes that further enhancements could be made to the role of the SEMC Secretariat. The Special Inquiry recommends that Government explore options for streamlining the functions and the independence of the SEMC Secretariat and the Office of Bushfire Risk Management with a view to including an inspectorate function, and appointing a person who is dedicated to that role. The purpose is to provide assurance and reporting, and to inquire into, monitor and report transparently on emergency management standards, preparedness, capability, service delivery and investment performance outcomes. Within two years of the establishment of this arrangement the government to review and assess whether it is meeting the desired outcomes.	

Appreciating the Risk – Report of the Special Inquiry into the November 2011 Margaret River Bushfire: Additional Government Commitments

Government Commitments	Agency Comment	Special Inquiry Comment	Special Inquiry Assessment
1. DEC will suspend further prescribed burns within five kilometres of townsites and rural subdivisions until it has reviewed its prescribed burning processes and brought them into compliance with the latest International Organisation for Standardisation (ISO) standard. The Minister for Environment will determine when prescribed burns in these locations can resume.	This recommendation is complete.	This recommendation is complete, but the Special Inquiry notes that it caused an increase in the backlog of incomplete burns for P&W	
2. Any Level 3 bushfire, being a complex fire in which life and property are at risk, will automatically fall under the overall control of the Fire and Emergency Services Commissioner. This will not necessarily mean that FESA will assume the Incident Controller role, but the Commissioner's authority to direct the response is reinforced.	This recommendation is complete.	This recommendation is complete.	
3.New Fire Districts will be gazetted before next Summer for the following areas: • The area bounded broadly from Busselton to Vasse to Smiths Beach; • The area bounded broadly from Redgate to Witchcliffe to Cowaramup to Gracetown; and	The Capes Enhanced Delivery Reform has delivered: • Gazettal of the town sites of Yallingup, Cowaramup, Gnarabup / Prevelly and Witchcliffe as DFES fire districts. Bushfire Brigades in these areas have been transitioned to dual registered fire brigades with responsibility for, and the capacity to service a 'special cape zone response' area established for both structural and bushfire response; • Development, exercising and implementation of a special	The Capes enhanced service delivery reform, led by DFES and the Shire of Augusta-Margaret River, has impressed the Special Inquiry as an example of a positive reform following the 2011 Margaret River Bushfire Report.	

• August and a strip adjoining Bussell Highway north to Karridale	Capes Zone Response arrangements between DFES, Local Governments and P&W in areas of high bushfire risk; and • Establishment of multi-agency and all hazards major incident control centres in Busselton and Margaret River, which are capable of managing level 2/3 incidents.		
4.The Bunbury gazetted fire district to be expanded	Bunbury to Dalyellup is currently being considered for gazettal.	The Special Inquiry notes this is in progress.	
5.Within three years the new gazetted areas will be subsumed within a single gazetted fire district	The appropriateness of gazetted fire districts is being considered as part of the Emergency Services Act Review currently being undertaken.	The Special Inquiry notes this is in progress.	
6.Before next summer, Perth metropolitan fire districts will be extended to accommodate suburban expansion in areas such as Yanchep, Alkimos, Byford and Banjup	The northern boundaries of the metropolitan areas around Yanchep and Alkimos have been completed. DFES is continuing discussions in relation to gazettal changes in Byford and Banjup.	The Special Inquiry notes this is in progress.	
7.A South West bushfire risk zone will be declared, within which a new Office of Bushfire Risk Management, will oversee and authorise all prescribed burns	The Office of Bushfire Risk Management (OBRM) was established in May 2012 with the Director reporting directly to the FES Commissioner. OBRM's powers include determining whether any prescribed burn in the South West bushfire risk zone and higher risk burns state wide may proceed, be delayed or not proceed.	This recommendation is complete.	
8. Main Roads WA will immediately initiate discussions with the relevant local authorities and communities to identify options and assess their feasibility for improved access into Prevelly, Yallingup and Gracetown, and in the College Grove area, with the objective of affording reasonable avenues of evacuation in any future bushfire. The events of November	Working Group has met a number of times to provide specialist and stakeholder input into the secondary access road alignments. A preferred alignment has been agreed by this group for both Prevelly/Gnarabup and Gracetown. Further spring flora surveys will be required to confirm the environmental impact. The Shire will undertake consultation with the aim of selecting final road alignments. As all options pass through a National Park this is likely to be a lengthy process	The Special Inquiry notes this is in progress.	

highlighted the limited opportunities for escape in a number of settlements.			
9. A financial assistance scheme will be developed along the lines of that applied to those directly affected by the Toodyay fire of 2010. The scheme will entitle property owners whose houses, outbuildings or property were destroyed or damaged in the fire to up to $190,000 for any uninsured losses, net of any assistance they have received under the Lord Mayor's Disaster Relief Fund to which the Government donated $500,000. The scheme will be administered by Riskcover. Full details of the scheme, including criteria for entitlement, will be finalised and announced within the next several days. This measure is expected to cost the Government up to $5million. The receipt of assistance under the scheme will not preclude individuals from taking legal action if that is their intention.	This recommendation is complete.	This recommendation is complete.	

Post Incident Analysis of the 2011 Margaret River Bushfire

Recommendation	Agency Assessment and Comment	Special Inquiry Assessment and Comment	Special Inquiry Assessment
Lesson 1. Establish procedures and doctrine to support an embedded forecaster working	P&W does not support embedding weather forecaster(s). P&W supports the embedding of fire behaviour experts in	The Special Inquiry notes this is in progress.	

alongside fire behaviour experts.	principle. However, development of fire behaviour experts takes considerable time. Agreements with interstate agencies provide access to a wider pool of fire behaviour experts for sustained demand periods but are not the solution in the crucial first 24 hours of major fires.		
Lesson 2. A risk management approach is needed which considers risks both inside the prescribed burn and the risks that will need to be managed if the fire escapes. This risk assessment should be dynamic in line with the four day and seven day weather forecast. **Action:** Review existing risk management tools to ensure that processes exist to periodically re-confirm their results.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 3. There should be clearly established criteria for burns which are specially challenging, and these criteria need to extend beyond the intended boundaries of the prescribed burn. **Action**: Update red flag burn criteria to include consideration of challenges faced outside the prescribed burn area.	The assessment and recognition of risk levels associated with prescribed burns, and the identification and implementation of appropriate controls, is formally addressed as part of revised risk management procedures approved by OBRM. P&W and the Fire and Emergency Services Authority (FESA) believe that all burns should have appropriate risk management criteria developed in line with risk management principles.	This recommendation is complete	
Lesson 4. Prescribed burns which meet the 'red flag' criteria should have mandated risk management criteria imposed. **Action:** Establish risk management criteria for burns that meet red flag criteria	The 'red flag' criteria was a regional initiative and is not part of P&W's formal fire management doctrine. In areas where the red flag concept was previously used, it has been replaced by identifiers consistent with the new risk assessment process approved by OBRM.	This recommendation is complete	
Lesson 5. Improved understanding of fire behaviour in coastal heathlands would	Completed through a collaborative project with the CSIRO. P&W.	This recommendation is complete	

support sound risk management through the southwest of WA. **Action**: Initiate research to develop accurate models, or broaden existing models, for fire behaviour in coastal heath.			
Lesson 6. Maps prepared for prescribed burns should address the fuel type and burn history of the burn area as well as surrounding areas. Predicted rates of spread under prescribed and other conditions should recognise the complexity of coastal heathlands. **Action:** Amend the documentary requirements for burn prescription.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 7. Fuel loads on private property need to be identified and included in understanding fire behaviour in determine the contribution they make to the burn risk assessment. **Action:** Risk assessments include consideration of private property fuel age and availability.	The BRMP process will assist in identifying fuel loads on private property.	As discussed in Chapter 5 of this Report, the Special Inquiry supports the development of the BRMP process, and acknowledges funding difficulties which have impeded its progress.	
Lesson 8. Inter-agency cooperation to manage fire precincts in a tenure-blind fashion is necessary for effective fire suppression. **Action:** Develop policy to support a land tenure blind, precinct approach to fuel management.	The BRMP process is based upon a tenure blind approach to fuel management.	As discussed in Chapter 5 of this Report, the Special Inquiry supports the development of the BRMP process, and acknowledges funding difficulties which have impeded its progress.	
Lesson 9. All forms of fuel modification should be available to fire managers. **Action:** Increase community	DEC and FESA currently use a variety of fuel modification processes when managing mitigation works on DEC-managed land, Unallocated Crown Land and unmanaged reserves. Some of these processes (which include slashing, chaining,	This Special Inquiry has identified as an opportunity for improvement, P&W and the Forest Products Commission explore policy options for mechanical thinning of forest, including mining rehabilitation forest, for the purpose of	

awareness of different fuel modification types and their appropriate use.	grading or the application of chemicals) are not supported by all stakeholders.	bushfire mitigation.	
Lesson 10. Greater investment in training on specific functions within the AIIMS structure will improve the support provided to the Incident Controller**.** **Action:** Conduct a Training Needs Analysis to identify fire-specific training needed by IMT members. Expand the availability and scope of AIIMS training in DEC, FESA and LG	DFES provides training to paid staff and volunteers through the Professional Pathways Project, which includes leadership, technical and operational training.	The Special Inquiry suggests that SEMC develop an aide-memoire for Incident Controllers to guide the initial recovery considerations during an incident. The aide-memoire to include triggers for the initiation of rapid impact assessment and the escalation of the recovery function; immediate and likely future community health, welfare and safety considerations. These triggers will inform the Incident Controller/s when considering the discretionary appointment of "Deputy Incident Controller, Recovery" during an incident that impacts on the community. Role of "Deputy Incident Controller, Recovery" would be (with the Incident Controller) to consider the initiation of the recovery process and to manage the transition from incident response to the recovery phase.	
Lesson 11. As presently implemented, the AIIMS planning role is under-developed and provides insufficient support to the Incident Controller. **Action:** AIIMS IV is presently under development – engage with this process to ensure the situation role is sufficiently well defined.	Like other aspects of AIIMS, the planning role can be expanded or contracted to suit the circumstances. The issue to which this lesson alludes may be more closely related to the availability of suitably skilled people to meet incident demands, particularly where a number of incidents are running simultaneously	This issue is addressed through national revisions to AIIMS	
Lesson 12. Communications planning for geographic regions with recognised black spots and specific communications challenges should be prepared in advance of an emergency in order to support the IMT Communications Planning Officer. **Action:** Develop communications maps for fire prone regions that clearly identify	FESA has reviewed Communication Plans for the Hills and rural regions.	This recommendation is complete	

nulls and dead-spots			
Lesson 13. Rolling risk assessment conducted during ignition of prescribed burns should identify whether an escape is likely to develop into a Level 3 incident. As soon as possible after it has been identified that the escape cannot be contained, the incident should be declared a Level 3.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 14. For incidents of this complexity, effective control in the critical phase (first 24-36 hours of the fire) requires an appropriately resourced IMT. **Action:** DEC's State Duty Officer should review the proposed Incident Management structure of a Level 3 incident with the State Duty Director FESA to ensure that the proposed structure has the capacity to deal with anticipated scale and complexity of the incident.	P&W will continue its efforts to build the number of staff available for incident management support roles in order to free more skilled fire management staff for core fire roles. A whole-of-government approach to this issue is required to fully service the demand during large, sustained and multi-fire situations.	The Special Inquiry recommends that Government establish an arrangement to develop a "network" of WA Government agency personnel who can be called upon for bushfire and emergency incident management capability within WA.	
Lesson 15. The state should identify the number of fully trained, experienced and accredited Level 3 Incident Controllers required to be available at any time and establish a process for identification of suitable personnel, ongoing training and accreditation. **Action:** Establish the number of Level 3 Incident Controllers required across the state and develop supporting processes (training ,exercising and the	The IBMC undertook a process of identifying Level 3 Incident Controllers prior to the 2011/12 season. DFES reports on the number of its Level 2 and Level 3 Incident Controllers in its annual reports. A list of accredited level 3 Incident Controllers is held by the State Hazard Operations Officer. An Accreditations Pathways Process for all Level 3 Incident Controllers who operate on bushfires in Western Australia has been developed and continues to be implemented by DFES and P&W.	This recommendation is complete	

provision of appropriate experience) to sustain that number.			
Lesson 16. Within the AIIMS IMT doctrine the roles of the Incident Controller and Deputy Incident Controllers should be defined and well-practiced**.** **Action:** Ensure Incident Controller training is regularly updated, regularly conducted and consistent with current emergency management standards. Ensure that the divisions between the IC and Deputy IC roles are clear and understood	The Incident Controller role is clearly defined in AIIMS, which also discusses the role of the Deputy Incident Controller. Upcoming revisions of AIIMS through the Australasian Fire and Emergency Services Authorities Council will address the role of the Deputy Incident Controller in more depth. There is an opportunity for input by State representatives.	The Special Inquiry suggests that the SEMC develop an aide-memoire for Incident Controllers to guide the initial recovery considerations during an incident. The aide-memoire to include triggers for the initiation of rapid impact assessment and the escalation of the recovery function; immediate and likely future community health, welfare and safety considerations. These triggers will inform the Incident Controller/s when considering the discretionary appointment of "Deputy Incident Controller, Recovery" during an incident that impacts on the community. Role of "Deputy Incident Controller, Recovery" would be (with the Incident Controller) to consider the initiation of the recovery process and to manage the transition from incident response to the recovery phase.	
Lesson 17. An intensive exercise/training program should be developed and maintained across agencies to identify and establish a pool of current Incident Controllers who are capable of managing a Level 3 incident. **Action:** Develop and implement appropriate training material for Level 3 Incident Controllers.	An Accreditations Pathways Process for all Level 3 Incident Controllers who operate on bushfires in Western Australia has been developed and continues to be implemented by DFES and P&W.	This recommendation is complete	
Lesson 18. Predetermined locations for Level 3 IMTs should be reviewed and adequately resourced with necessary communications and IT capacity. **Action:** Establish a baseline standard for Level 3 IMTs and undertake assessment of predetermined IMT locations and ensure that any shortcomings are	DEC has conducted an internal assessment, and has developed a fully functional mobile Incident Control Centre (ICC). Listing of Level 3 IMT locations are included in inter-agency arrangements. FESA has completed an incident control vehicle review; 17 appliances have been scheduled to be built and will be deployed to country and metropolitan regions.	This recommendation is complete	

mitigated.			
Lesson 19. Early contact with the LGA is critical. **Action:** Develop or update doctrine and procedures to include early and sustained contact with the LGA.	Agencies liaise with local government authorities as soon as possible after a fire commences. The State Emergency Management Committee (SEMC) examined the issue of the engagement of local expertise in IMTs as part of its current review of State Emergency Management Policy 4.1 – Operational Management.	This recommendation refers to both early contact and sustained contact. The Special Inquiry heard that the Chief Executive Officers (CEOs) of the affected Shires – Waroona and Harvey – had concerns about the handover of the transition to recovery plan from DFES to the local governments. Emergency response agencies are often well equipped to deal with some of the recovery issues before they decamp; their expertise and resources could be better applied before the handover is completed.	
Lesson 20. There would be value in progressively aligning the geographical boundaries of emergency management agencies and co-locating where possible within regions and districts. **Action:** Undertake a strategic review of geographic boundaries of each agency and locations and identify opportunities to align and colocate.	HMA response to emergencies is blind to geographical boundaries and when responding to emergencies, the HMA determines an "operational area." In the AIIMS context, this allows functional management to be geographically separated, as long as a communication link is maintained. Co-location would have to be subject to a cost-benefit analysis and business case that takes account of DEC"s core statutory functions.	The Special Inquiry accepts the difficulties in aligning each agency's boundaries.	
Lesson 21. Suitably experienced local representatives should be engaged to provide advice to the IMT in all Level 2 and Level 3 incidents at the earliest opportunity. **Action:** Develop or update doctrine to identify and include local representatives in appropriate areas of IMTs at the earliest possible stage.	P&W liaises with local government authorities as soon as possible after a fire commences. However, the need for greater local engagement will be incorporated in guidance for IMTs. Local area engagement by agencies extends beyond local government authority representatives. P&W has a regionalised staff presence and those staff have good local knowledge.	Placing appropriate qualified volunteers into Sector Commander roles will allow their local knowledge and bushfire fighting expertise to be effectively applied by themselves and those under their command on the fire ground. This will ensure that the IMT is best informed about the fire, and that resources are most appropriately deployed. An opportunity for improvement identified by the Special Inquiry is for DFES, P&W and the Rural Fire Service (when established) to agree on minimum targets for volunteer participation as Sector Commanders, and in Incident Management Teams	
Lesson 22. Opportunities be sought to utilise local government representatives in other areas of the IMT particularly in public	See response to Lesson 21.	This recommendation is complete	

information or other community related functions. **Action:** Identify IMT roles where local government representatives can be best employed.			
Lesson 23. Procedures to relocate IMTs need to be established in doctrine and exercised to ensure continuity of control. **Action:** Develop doctrine and training programs for relocating an IMT without disrupting its control of an incident.	This lesson is supported as an inter-agency initiative between DEC, FESA and local government.	The Special Inquiry noted that during the Waroona fire, the relocation of the ICC to Waroona impacted IMT operations in the transition period.	
Lesson 24. The expected scenario, with a view to the worst-case scenario should provide the basis for an IAP. **Action:** Doctrine for IAPs should be focused on 'most likely' situations while acknowledging and hedging against the 'most dangerous' situation arising.	This is current practice as set out in the AIIMS toolbox for the preparation of an Incident Action Plan (IAP). Early assessment and recording of scenarios needs to be emphasised in pre-season training. The rapid deployment, and/or formation, of an effective IMT close to an incident often takes a number of hours to achieve and this can influence the timeliness of Incident Action Plan (IAP) production.	The Special Inquiry noted that during the Waroona Incident, fire progression predictions by the IMT during operational period 1 were appropriately based calculations to ensure a worst case scenario of fire progression.	
Lesson 25. Contingency planning is a critical function in the early stages of an escalating incident, and should provide the foundation of an IAP. **Action:** Doctrine for contingency planning should be developed and should be triggered by decisions to ignite 'red flag' burns. The contingency plans that result offer a first cut IAP to an IMT that is assembling and coming into action under the pressure of events.	WESTPLAN Bushfire defines the requirements for operational personnel to submit initial IAPs within the 1st hour, progressing to a full IAP on subsequent shifts. The timeframe identified for the production of an IAP will be reinforced in training	This Special Inquiry suggests that DFES and P&W, in conjunction with AFAC, explore the development of a standardised approach and content for an "initial (4 hour)" Incident Action Plan.	
Lesson 26. Incident Controllers should be supported by a planning function that combines experienced weather forecasters,	This lesson is supported in principle but implementation is subject to availability and incident complexity. See response to Lesson 11.	This issue is addressed through national revisions to AIIMS	

fire behaviour experts and local knowledge**.** **Action:** Ensure AIIMS IV has adequate provision for a planning function that is supported by an appropriate intelligence function.			
Lesson 27. IMTs need to establish early and effective liaison with Local Governments**.** **Action:** Develop or update doctrine and procedures to include early and sustained contact with the LGA possibly including enhancing the role of the Local Emergency Management Committee.	See response to Lesson 19.	The Special Inquiry heard that the Chief Executive Officers (CEOs) of the affected Shires – Waroona and Harvey – had concerns about the handover of the transition to recovery plan from DFES to the local governments. Emergency response agencies are often well equipped to deal with some of the recovery issues before they decamp; their expertise and resources could be better applied before the handover is completed.	
Lesson 28. State-wide all agency reporting should be established to facilitate the interactions of emergency management agencies, support agencies and governments. **Action:** Develop agency processes to support IMT chain of command reporting.	The use of a software program such as WebEOC could enhance across agency reporting. Both DFES and WAPOL use WebEOC. P&W have previously investigated the adoption of WeBEOC however it was found that to do so would require substantial additional resources.	The Special Inquiry has discussed future whole of government emergency information technology requirements with the WA Chief Government Information Officer (CGIO). The Special Inquiry understands that the SEMC has developed an Emergency Services Communication Strategy for the consideration of Government. One of the key themes of the Strategy is interoperability. The Special Inquiry also understands that the SEMC is developing a proposal to implement a joint agency Crisis Information Management System based on WebEOC that will be hosted by WA Police and connect the existing siloed implementations of WebEOC. These actions are supported.	
Lesson 29. Section 13 arrangements need to be clarified across key agencies. **Action:** Develop an agreed responsibilities document regarding Section 13 appointments for all emergency	This lesson refers to Section 13 of the Bush Fires Act 1954 which provides that FESA may delegate powers of bushfire control to an appropriate person. During the Blackwood Fire 8 incident, Section 13 appointments led to some confusion over responsibilities and lines of communication in DEC and FESA. This issue has been addressed through revisions to WESTPLAN Bushfire.	This recommendation is complete	

management agencies			
Lesson 30. Logistics and resource officers in IMTs need to collaborate and establish full awareness and control over the available resources. **Action:** Review IMT doctrine and update roles to emphasise collaboration between logistics and resource planning. Develop training to support implementation.	Agencies advise this is standard practice within IMTs. The underlying issue to which this lesson alludes may be the limited number of skilled staff available and the resulting limited capacity to track incident resources. This issue will be addressed in training and exercising for specific IMT roles. Greater use of information technology will be employed where possible.	The Special Inquiry recommends that DFES and P&W to investigate and adopt an emergency services resource management system as a matter of priority. The system should enable the registration, tasking, tracking, management and coordination of emergency management personnel, vehicles, plant and aircraft.	
Lesson 31. A review of the manner in which resourcing is conducted across all agencies needs to occur with a review identifying the best manner to ensure all agencies adapt to the same process. **Action:** N/A	This lesson relates to the systems used to track and record resources at an incident. DEC supports a review of available approaches as this is recognised as an issue affecting fire agencies nationally.	The Special Inquiry recommends that DFES and P&W to investigate and adopt an emergency services resource management system as a matter of priority. The system should enable the registration, tasking, tracking, management and coordination of emergency management personnel, vehicles, plant and aircraft.	
Lesson 34: Clear direction to divisional and sector commanders and a common communications platform enables maximum return to be gained from the application of tactical resources and this rests on good incident action planning, and good command and control. **Action:** Determine and implement an appropriate communications platform for emergency management.	See responses to lessons 24, 25 and 42. DFES standard operations are aligned to the principles of AIIMS and include the early development of effective communication planning, sector and divisional plans with strategies and tactics that contribute to meeting the incident objectives and assigning experienced personnel as sector and divisional commanders. WESTPLAN Bushfire defines the requirements for operational personnel to submit initial IAPs within the 1st hour, progressing to a full IAP on subsequent shifts.	The Special Inquiry recommends that DFES and P&W to investigate and adopt an emergency services resource management system as a matter of priority. The system should enable the registration, tasking, tracking, management and coordination of emergency management personnel, vehicles, plant and aircraft.	
Lesson 35. In multi-agency responses the culture, training and equipment characteristics of each of the agencies should be considered in their employment. **Action:** Increase frequency of multi-agency exercises and	Agency practice is for personnel at any incident to be tasked based on their skill set, known capability, area of expertise, and having regard to their organisational mandate. This can be difficult in the early stages of a large multi-agency response, particularly where life and property are under threat. In these circumstances, tasking of resources is realigned to experience and skills when the opportunity allows.	Placing appropriate qualified volunteers into Sector Commander roles will allow their local knowledge and bushfire fighting expertise to be effectively applied by themselves and those under their command on the fire ground. This will ensure that the IMT is best informed about the fire, and that resources are most appropriately deployed.	

ensure debriefings cover effective deployments and update doctrine and training to reflect changes		An opportunity for improvement identified by the Special Inquiry is for DFES, P&W and the Rural Fire Service (when established) to agree on minimum targets for volunteer participation as Sector Commanders, and in Incident Management Teams	
Lesson 36. Better maps are required for urban/rural interface fires. **Action:** Develop high quality maps for use in urban/rural interface fires.	Emergency Services Directories (ESD) are a good resource and issued to all South West fire-fighting appliances.	The Special Inquiry received evidence from numerous witnesses regarding the lack of suitable maps. Those affected ranged from members of the IMT, to out of town volunteer bush fire brigade members. In all cases, the lack of a suitable map impacted on the ability of the individual to perform their respective role. The adequacy and availability of maps need to be addressed by both DFES and P&W as part of the resource management system. Personnel at all levels must have access to maps that are recent and suitable if they are to operate safely and efficiently.	
Lesson 37. A system of vehicle tracking should be fitted to all fire appliances and linked to the common operating picture. Good communications planning is essential for good command and control. **Action:** Determine and implement an appropriate communications platform for emergency management	P&W has tracking capability on all of its fire trucks, heavy machinery and aircraft and on most light fire vehicles. Its Spatial Support System provides a capable viewer interface. Installing AVL on DFES vehicles is a work in progress.	AVL is important for the safety of personnel, and is a very effective resource management tool. The Special Inquiry believes that the future resource management system adopted by P&W and DFES must incorporate AVL. The Special Inquiry recommends that DFES and P&W to investigate and adopt an emergency services resource management system as a matter of priority. The system should enable the registration, tasking, tracking, management and coordination of emergency management personnel, vehicles, plant and aircraft.	
Lesson 38. There would be benefit in progressively aligning the geographic boundaries of each of the agencies and seeking to co-locate their headquarters within those boundaries**.** **Action:** Undertake a strategic review of geographic boundaries of each agency and locations and identify opportunities to align and	Co-location would have to subject to a cost-benefit analysis and business case that takes account of DEC's core statutory functions. FESA continually monitors and adjusts regional boundaries that offer a best fit solution for its service delivery model.	The Special Inquiry accepts the difficulties in aligning each agency's boundaries.	

colocate.			
Lesson 39. Legislative change may be needed to enable FESA to better manage firefighting resources across the state **Action:** Review current legislation to ensure FESA is able to effectively allocate fire fighting resources.	DFES chairs an inter-agency working group set up to oversee the development of a single emergency services act. It is however anticipated that the legislative change process will be lengthy due to the complexity of the issues involved.	The Special Inquiry notes that this work is continuing.	
Lesson 40. The role of district and local emergency management committees should be reviewed to ensure they are appropriately engaged in the active management of emergencies across the PPRR continuum **Action:** Develop or update doctrine and procedures to include early and sustained contact with the LGA.	The engagement of district and local emergency management committees across the PPRR spectrum would run counter to the current emergency management structure and framework prescribed in the *Emergency Management Act 2005*. However, alternative roles could be considered in the context of the development of a single emergency services act. WALGA supports a review of the district and local emergency management committees to ensure appropriate governance and communication frameworks are in place.	The Special Inquiry notes that this work is continuing.	
Lesson 41. Increased acceptance of mutual obligations will be fundamental to the management of fire risk across the state **Action:** Develop policy to support a land tenure blind, precinct-wide approach to fuel management.	Following the assessment of the BRMP Pilot, the Guidelines have been updated and a training package has been developed. The roll out of the BRMP project, and the Bushfire Risk Management System, will fulfil this recommendation.	As discussed in Chapter 5 of this Report, the Special Inquiry supports the development of the BRMP process, and acknowledges funding difficulties which have impeded its progress.	
Lesson 42. The state should progressively align on a shared platform, such as WebEOC, to establish a COP. **Action:** Determine and implement an appropriate communications and operations management platform for all emergency management agencies.	The use of a software program such as WebEOC could enhance across agency reporting. Both DFES and WAPOL use WebEOC. P&W have previously investigated the adoption of WeBEOC however it was found that to do so would require substantial additional resources.	The Special Inquiry has discussed future whole of government emergency information technology requirements with the WA Chief Government Information Officer (CGIO). The Special Inquiry understands that the SEMC has developed an Emergency Services Communication Strategy for the consideration of Government. One of the key themes of the Strategy is interoperability. The Special Inquiry also that the SEMC is developing a proposal to implement a joint agency Crisis Information Management System based on WebEOC that will be	

		hosted by WA Police and connect the existing siloed implementations of WebEOC. These actions are supported.	
Lesson 43. The state should converge on a single communications platform for all emergency management and support agencies**.** **Action:** Determine and implement an appropriate communications platform for emergency management.	The WA Emergency Radio Network (WAERN) provides the basis for a common communications platform for emergency services. Use of the network will enhance interoperability.	This recommendation is complete. Communication plans were identified within the IAPs, with the primary Command Channel 648 utilised during the course of the Waroona fire, supported by tactical Division and Sector Channels. However, these appear not to have been clearly defined until several days into the incident.	
Lesson 44. Reporting and control should be through the incident chain of command and not through agency chains of command**.** **Action:** Develop agency processes to support IMT chain of command reporting.	Agencies advise that this is standard practice at an inter-agency level, although there will often be a period early in major incidents where the singular incident chain of command takes time to establish. Individual agency chains of command are the default until this occurs.	This recommendation is complete.	
Lesson 45. DEC's fire management expertise should be augmented by multi-agency IMTs that incorporate the expertise of other agencies and in fast developing situations the appropriate decisions will need to be made early. **Action:** Increase frequency of multi-agency exercises and ensure debriefings cover effective deployments and update doctrine and training to reflect changes.	This occurs already with regional IMTs that are established from existing rostered resources when forecast conditions are severe and above. However, there is opportunity to increase the involvement of other agencies. State level inter-agency arrangements under consideration in the review of WESTPLAN Bushfire will provide appropriate strategies.	The Special Inquiry considers the lack of inter-agency pre-formed IMTs to be an ongoing rather than an 'emerging' issue. The need for inter-agency pre-formed IMTs was discussed in the Major Incident Review of Toodyay Fire December 2009, and the Post Incident Analysis for the 2011 Margaret River Bushfire. The immediate need is to move to multi-agency pre formed IMTs for bushfire. It appears from evidence presented to the Special Inquiry that all is required to complete the inter-agency preformed IMT model for bushfires, is for DFES staff to be incorporated into the teams. The Special Inquiry recommends that DPaW and DFES adopt the policy that all bushfire Level 3 Incident Management Teams in the Perth Hills and the South West will be integrated and pre-formed from the start of the 2016/17 fire season with substantial involvement of both DFES and P&W personnel on all teams.	

Lesson 46. At Level 3, the available fire management expertise should be applied overwhelmingly to the fire management aspects of emergency management, possibly in incident control, and certainly in situations planning and operations roles. **Action:** Increase frequency of multi-agency exercises and ensure debriefings cover effective deployments and update doctrine and training to reflect changes. Employ DEC fire managers in IMT positions where this expertise is especially critical.	Agency practice in DFES is that IMT personnel are tasked based on their skill set, validated capability and area of expertise. The filling of functional roles within an IMT is prioritised to ensure the critical incident management functions of Incident Controller, Operations, Planning, Logistics, Public Information and situation are resourced sufficiently, followed by other unit functional roles as personnel become available.	This recommendation is complete	
Lesson 47. To be effective, multi-agency IMTs will need to be exercised regularly and supported by sound and comprehensive doctrine. **Action:** Increase frequency of multi-agency exercises and ensure debriefings cover effective deployments and update doctrine and training to reflect changes.	P&W will continue to explore, with DFES, opportunities to undertake exercising of IMTs, however resourcing this work is a major constraint. Doctrine development is ongoing and forms an important component of work being undertaken towards the implementation of the Perth Hills Special Inquiry recommendations**.**	The Special Inquiry considers the lack of inter-agency pre-formed IMTs to be an ongoing rather than an 'emerging' issue. The need for inter-agency pre-formed IMTs was discussed in the Major Incident Review of Toodyay Fire December 2009, and the Post Incident Analysis for the 2011 Margaret River Bushfire. The immediate need is to move to multi-agency pre formed IMTs for bushfire. It appears from evidence presented to the Special Inquiry that all is required to complete the inter-agency preformed IMT model for bushfires, is for DFES staff to be incorporated into the teams. The Special Inquiry recommends that DPaW and DFES adopt the policy that all bushfire Level 3 Incident Management Teams in the Perth Hills and the South West will be integrated and pre-formed from the start of the 2016/17 fire season with substantial involvement of both DFES and P&W personnel on all teams.	
Lesson 48. Timely alerts and	In response to Recommendation 33 of the Special Inquiry into	This recommendation is complete	

updates to the community are essential. **Action**: Review and update doctrine regarding community information management	the Perth Hills Bushfire, DFES engaged with the ABC on matters relating to enhancing the structure, content, presentation and timeliness of emergency warning messages.		
Lesson 49. The process for initiating and releasing StateAlert messages requires review. **Action:** Review procedures for StateAlert with a view to streamlining processes for evacuations.	Being managed as part of the Critical Messaging (CMS) Project	The Special Inquiry supports the prompt establishment of the CMS	
Lesson 50. Expand the exploitation of social media, including graphical content for state alerts and warnings. Consider increasing the graphical content of web-based warnings. **Action:** Undertake a review of current state alert and warning procedures and incorporate social media use and graphical content	DFES and P&W use social media, and will continue to work together over the detail, content, quality and capabilities for alerts and warnings. The inter-agency approach will be consistent with State-level guidance on the use of social media.	The Special Inquiry recommends that the Department of Fire and Emergency Services investigate and adopt a system that will allow the public to opt in, monitor and receive, through a 'push mechanism', bushfire and other emergency warnings, maps and information using a wide variety of devices including personal hand held smart devices.	
Lesson 51. Radio bulletins need to be up to date and time stamped. Where social media is used the messages need to be up to date and accurate. Websites need to be up to date and accurate. **Action:** Review and update doctrine regarding community information management, including time stamping radio bulletins and social media/websites**.**	Agencies do not control the broadcasting of alerts and warnings. The agencies work with the media to encourage them to be as accurate, clear and up to date as possible. ABC Local Radio (which has a Memorandum of Understanding with DFES and P&W, through the SEMC Public Information Group) has committed to time stamping their broadcasts.	This recommendation is complete.	
Lesson 52. Decisions on evacuations need to be made early enough for people to be fully informed, prepared and to move to a place of greater safety.	The review of State Emergency Management Policy 4.7 - Community Evacuation as part of the 2012/13 SEMC in April 2014 implements this action.	The Special Inquiry recommends that DFES work with the Department of Planning and local governments to adopt a policy which enables local governments to identify, register and communicate 'Places of Bushfire Last Resort' in settlements and townsites where the life	

Failure to conduct good planning can create situations where loss of life can occur. **Action:** Review doctrine to ensure decisions on evacuation are given the highest priority.		risk from bushfire is very high or greater.	
Lesson 53. Good Local Government planning and management facilitates community resilience. **Action:** Ensure local emergency management plans are established and well exercised	DFES has provided local government with publications that will assist community members with planning for and preparing for bushfires. For example, *Planning for Bushfire* and the *Bushfire Survival Manual*. Developing the capacity of local governments and local emergency management committees remains a focus of the SEMC.	The Special Inquiry recommends that DFES work with the Department of Planning and local governments to adopt a policy which enables local governments to identify, register and communicate 'Places of Bushfire Last Resort' in settlements and townsites where the life risk from bushfire is very high or greater.	
Lesson 54. Procedures to resolve issues surrounding financial assistance need to be reviewed to ensure they are as smooth, fast and transparent as possible. **Action:** Review and streamline current financial relief procedures.	Where the need for specific changes have been identified DCPFS has revised policies and procedures as a result of the Margaret River bushfire.	The Special Inquiry makes no comment in relation to this recommendation	
Lesson 55. Shire experiences in managing these traumatic events should be captured and passed into state emergency management procedures.	SEMC consults with WALGA in respect of all amendments to state emergency management policies and procedures. This enables individual shire experiences to be captured in emergency management doctrine, where appropriate.	Based on evidence received of the Waroona fire, the Special Inquiry is of the view that there is greater scope to build local government considerations into policies and procedures pertaining to recovery. Emergency response agencies are often well equipped to deal with some of the recovery issues before they decamp; their expertise and resources could be better applied before the handover is completed.	
Lesson 56. An early decision on relief funding enables timely responses. DCP should review their communication of relief arrangements to ensure that they are clear.	DCPFS provide immediate financial assistance when required and in the Margaret River incident provision of assistance commenced quickly in response to need.	This recommendation is complete.	
Lesson 57. Given the prominent role played by the Shire in the management of welfare aspects in this emergency, there may be a	DCPFS coordinates local welfare committees which include local community services and local government representatives. As part of this DCPFS facilitate exercises and training which are open to all relevant key stakeholders. DCP	The Special Inquiry makes no comment in relation to this recommendation.	

need for state sponsored training for shire staff who are involved in implementing state emergency management policies and plans including how to deal with traumatised individuals. **Action:** Establish procedures to identify and provide training to local government staff involved in providing welfare services	has also been successful in obtaining Natural Disaster Resilience Program (NDRP) funding to develop a standardised training package which will be provided in four locations, will be available to all key stakeholders and members of the community and will subsequently be rolled out across the State.		
Lesson 58. When communities are grieving there is a need to provide special forms of support to affected residents.	DCPFS provide a wide range of support to affected residents, including financial support and counselling.	The Special Inquiry makes no comment in relation to this recommendation.	

Post Incident Analysis of the 2011 Nannup Bushfire

Recommendation	Agency Comment	Special Inquiry Comment	Special Inquiry Assessment
Lesson 1. There should be clearly established criteria for burns which are specially challenging, and these criteria need to extend beyond the intended boundaries of the prescribed burn. The criteria should be clarified and adopted as agency SOPs. **Action:** Review and update red flag burn criteria	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 2. A risk-management approach is needed which considers risks both inside the prescribed burn and the risks that will need to be managed if the fire escapes. The risk	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	

assessment should be organised and in line with the four and seven day weather forecast. **Action:** Review and update red flag burn criteria			
Lesson 3. Prescriptions should mandate consideration of measures to retire risk. **Action:** Review and update red flag burn criteria	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 4. Once a burn is ignited, it needs to be the subject of continuing risk assessment and appropriate mitigation. **Action:** Review existing risk management tools to ensure that processes exist to periodically re-confirm their results.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 5. Contingency plans for escaping burns should be prepared in advance. **Action:** Doctrine for contingency planning should be developed and should be triggered by decisions to ignite 'red flag' burns. The contingency plans that result offer a first cut IAP to an IMT that is assembling and coming into action under the pressure of events. The burn prescription should provide guidance on the contingency plans required.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 6. Prescriptions need to be interpreted by experienced and knowledgeable personnel to ensure risk is fully understood. It is important that the	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of	This recommendation is complete	

background and justification for these decisions are captured at each stage and are visible to all levels in WA fire management hierarchy **Action:** Review burn prescription procedures to ensure that the appropriate staff are consulted on identified high risk burns and that their input and direction is attached to the burn prescription	prescribed burn plans.		
Lesson 7. The burn prescription should capture the fuel characteristics and potential rate of spread for those areas outside the burn that will likely be critical during the initial attack on any escaping fire. **Action:** Amend the documentary requirements for burn prescription.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 8. Core ignition, particularly of red flag burns, should be informed by the 4 & 7 day forecasts (including a longer term perspective over 3 to 4 months. **Action:** Review existing risk management tools to ensure that processes exist to periodically re-confirm their results.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 9. DEC should investigate embedding an experienced forecaster in the state operations centre. **Action:** Establish procedures and doctrine to support an embedded forecaster to work alongside fire behaviour	P&W does not support embedding weather forecaster(s). P&W supports the embedding of fire behaviour experts in principle. However, development of fire behaviour experts takes considerable time. Agreements with interstate agencies provide access to a wider pool of fire behaviour experts for sustained demand periods	The Special Inquiry notes this is in progress.	

experts.	but are not the solution in the crucial first 24 hours of major fires.		
Lesson 10. A rolling risk assessment is required which captures the risks of the burn escaping and provides adequate resources. **Action**: Review existing risk management tools to ensure that processes exist to periodically re-confirm their results.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 11. Decisions taken on the basis of this risk assessment need to be captured and distributed across district and state. **Action:** Update procedures to reflect decisions upon risk management and establish a distribution network.	Prescribed burning governance, policy and have been completely overhauled to meet Office of Bushfire Risk Management requirements, including compliance to ISO 31000. OBRM continue to monitor the compliance of prescribed burn plans.	This recommendation is complete	
Lesson 12. On a regional basis there would be value in closer working relationship between DEC crews and VBFBs to build mutual trust and confidence. This could be done by opportunity engagement of VBFBs in DEC fire management or through exercises. **Action**: Update doctrine and procedures to capture VBFBs in fire management exercises and in appropriate emergencies.	P&W currently has a process for inviting DFES staff and Volunteer Bushfire Brigades (VBFB) to assist in prescribed burns. P&W also supports joint training and exercising opportunities as providing important forums in which to establish closer working relationships. DFES has established a Community Liaison Unit and protocols to enable local government Bushfire Brigade Liaison Officers to be embedded in Emergency Coordination Centres and DFES Taskforce deployments. Volunteers are provided opportunities to participate in state and regional exercises.	A number of recommendations and agency opportunities for improvement made by the Special Inquiry are intended to further strengthen the relationship between P&W, DFES and volunteers. It is noted that whilst the relationship between P&W and volunteers has improved since the Post Incident Analysis of the Nannup fire was undertaken, challenges remain with respect to the relationship between DFES and volunteers.	
Lesson 13. The State Duty Officer from DEC and the State Duty Director, FESA need to confer whenever a Level 2 or 3 incident is declared to satisfy	This recommendation is complete.	This recommendation is complete.	

themselves that they have appropriate incident management structures and resources across the state are at an appropriate level of preparedness. **Action:** Develop appropriate doctrine to support inter-agency communication prior to ignition of a prescribed burn.			
Lesson 14. There needs to be a better appreciation of the role of VCPs and how they are managed in bushfire emergencies by all key agencies and the community. **Action:** Review role of VCPs and establish agreed doctrine for deployment. Ensure community awareness of VCP role is well communicated	A Traffic Management Working Group was established to examine and report on this issue. The final report to the SEMC that examined the Traffic Management System utilised in Victoria was considered at the SEMC meeting of 13 March 2012 (resolution number 27/2012 refers). The report recommended that Western Australia should not adopt the Victorian Traffic Management model as it is considered cumbersome. A new traffic management policy and accompanying guideline have been developed and promulgated, based on national best practice.	The Special Inquiry found that the application of the traffic management policy at some locations during the Waroona fire did not meet the expectations of the community. On this basis, the policy requires review. This Special Inquiry recommends that SEMC to review the policy for traffic management at emergency incidents so it reflects national "best practice". This includes the production and issuing of an "aide-memoire" to guide traffic management, emergency and incident management personnel. The policy should provide a practical balance between risk to life and the public value of enabling the timely restoration of livelihoods and the movement of critical resources, (including essential services, critical businesses and livestock welfare services), through traffic management points. The review will involve a range of stakeholders including DFES, P&W, WA Police, Department of Agriculture and Food WA, Main Roads WA, WA Farmers Federation, WA Local Government Association, Forest Industries Federation, and the Transport Industry and ensure that the views of the community are considered.	
Lesson 15. VCPs are one of the instruments by which the Incident Controller manages the emergency. VCPs without communications cannot be fully effective in their role. **Action:** Determine and implement an appropriate	A Traffic Management Working Group was established to examine and report on this issue. The final report to the SEMC that examined the Traffic Management System utilised in Victoria was considered at the SEMC meeting of 13 March 2012 (resolution number 27/2012 refers). The report recommended that Western Australia should not adopt the Victorian Traffic Management model as it is considered cumbersome.	The Special Inquiry found that the application of the traffic management policy at some locations during the Waroona fire did not meet the expectations of the community. On this basis, the policy is inadequate. This Special Inquiry recommends that SEMC to review the policy for traffic management at emergency incidents so it reflects national "best practice". This includes the	

communications platform for emergency management	A new traffic management policy and accompanying guideline have been developed and promulgated, based on national best practice.	production and issuing of an "aide-memoire" to guide traffic management, emergency and incident management personnel. The policy should provide a practical balance between risk to life and the public value of enabling the timely restoration of livelihoods and the movement of critical resources, (including essential services, critical businesses and livestock welfare services), through traffic management points. The review will involve a range of stakeholders including DFES, P&W, WA Police, Department of Agriculture and Food WA, Main Roads WA, WA Farmers Federation, WA Local Government Association, Forest Industries Federation, and the Transport Industry and ensure that the views of the community are considered.	
Lesson 16. Local knowledge should be accessed to inform the placement and operation of VCPs. **Action:** Develop or update doctrine and procedures to include early and sustained contact with the LGA.	A Traffic Management Working Group was established to examine and report on this issue. The final report to the SEMC that examined the Traffic Management System utilised in Victoria was considered at the SEMC meeting of 13 March 2012 (resolution number 27/2012 refers). The report recommended that Western Australia should not adopt the Victorian Traffic Management model as it is considered cumbersome. A new traffic management policy and accompanying guideline have been developed and promulgated, based on national best practice.	The Special Inquiry found that the application of the traffic management policy at some locations during the Waroona fire did not meet the expectations of the community. On this basis, the policy is inadequate. This Special Inquiry recommends that SEMC to review the policy for traffic management at emergency incidents so it reflects national "best practice". This includes the production and issuing of an "aide-memoire" to guide traffic management, emergency and incident management personnel. The policy should provide a practical balance between risk to life and the public value of enabling the timely restoration of livelihoods and the movement of critical resources, (including essential services, critical businesses and livestock welfare services), through traffic management points. The review will involve a range of stakeholders including DFES, P&W, WA Police, Department of Agriculture and Food WA, Main Roads WA, WA Farmers Federation, WA Local Government Association, Forest Industries Federation, and the Transport Industry and ensure that the views of the community are considered.	
Lesson 17. There is a need for community education on how road-blocks and VCPs operate in the event of an emergency.	A Traffic Management Working Group was established to examine and report on this issue. The final report to the SEMC that examined the Traffic Management System utilised in Victoria was considered at the SEMC meeting of 13 March	The Special Inquiry found that the application of the traffic management policy at some locations during the Waroona fire did not meet the expectations of the community. On this basis, the policy is inadequate.	

Action: Ensure community awareness of VCP role is well communicated.	2012 (resolution number 27/2012 refers). The report recommended that Western Australia should not adopt the Victorian Traffic Management model as it is considered cumbersome. A new traffic management policy and accompanying guideline have been developed and promulgated, based on national best practice.	This Special Inquiry recommends that SEMC to review the policy for traffic management at emergency incidents so it reflects national "best practice". This includes the production and issuing of an "aide-memoire" to guide traffic management, emergency and incident management personnel. The policy should provide a practical balance between risk to life and the public value of enabling the timely restoration of livelihoods and the movement of critical resources, (including essential services, critical businesses and livestock welfare services), through traffic management points. The review will involve a range of stakeholders including DFES, P&W, WA Police, Department of Agriculture and Food WA, Main Roads WA, WA Farmers Federation, WA Local Government Association, Forest Industries Federation, and the Transport Industry and ensure that the views of the community are considered.	
Lesson 18. Suitably experienced personnel with local knowledge should be connected to the Operations and Planning section in all Level 3 incidents in the vicinity of substantial settlements. **Action:** Develop or update doctrine to identify and include local representatives at the earliest possible stage.	This is current practice where possible and this principle will be emphasised in pre-season briefings and training.	Placing appropriate qualified volunteers into Sector Commander roles will allow their local knowledge and bushfire fighting expertise to be effectively applied by themselves and those under their command on the fire ground. This will ensure that the IMT is best informed about the fire, and that resources are most appropriately deployed. An opportunity for improvement identified by the Special Inquiry is for DFES, P&W and the Rural Fire Service (when established) to agree on minimum targets for volunteer participation as Sector Commanders, and in Incident Management Teams	
Lesson 19. Opportunities should be sought to embed other local government representatives in other areas of the IMT particularly in public information. **Action:** Review IMT roles and identify roles where local government representatives can	P&W liaises with local government authorities as soon as possible after a fire commences. However, the need for greater local engagement will be incorporated in guidance for IMTs. Local area engagement by agencies extends beyond local government authority representatives. P&W has a regionalised staff presence and those staff have good local knowledge.	Placing appropriate qualified volunteers into Sector Commander roles will allow their local knowledge and bushfire fighting expertise to be effectively applied by themselves and those under their command on the fire ground. This will ensure that the IMT is best informed about the fire, and that resources are most appropriately deployed. An opportunity for improvement identified by the	

be employed effectively.		Special Inquiry is for DFES, P&W and the Rural Fire Service (when established) to agree on minimum targets for volunteer participation as Sector Commanders, and in Incident Management Teams	
Lesson 20. There would be benefit in progressively aligning the geographic boundaries of each of the agencies and seeking to co-locate their headquarters within those boundaries. **Action:** Undertake a strategic review of geographic boundaries of each agency and locations and identify opportunities to align and co-locate.	Co-location would have to subject to a cost-benefit analysis and business case that takes account of DEC's core statutory functions. FESA continually monitors and adjusts regional boundaries that offer a best fit solution for its service delivery model.	The Special Inquiry accepts the difficulties in aligning each agency's boundaries.	
Lesson 21. Legislative change may be needed to enable FESA to manage fire-fighting resources across the state. **Action**: Review current legislation to ensure FESA is able to effectively allocate fire fighting resources.	DFES chairs an inter-agency working group set up to oversee the development of a single emergency services act. It is however anticipated that the legislative change process will be lengthy due to the complexity of the issues involved.	The Special Inquiry notes that this work is continuing.	
Lesson 22. The role of district and local emergency management committees should be reviewed to ensure they are appropriately engaged in the active management of emergencies across the PPRR continuum. **Action:** Develop or update doctrine and procedures to include early and sustained contact with the LGA.	The engagement of district and local emergency management committees across the PPRR spectrum would run counter to the current emergency management structure and framework prescribed in the *Emergency Management Act 2005*. However, alternative roles could be considered in the context of the development of a single emergency services act. WALGA supports a review of the district and local emergency management committees to ensure appropriate governance and communication frameworks are in place.	The Special Inquiry notes that this work is continuing.	
Lesson 23. The state should progressively align on a shared platform, such as WebEOC , to	The use of a software program such as WebEOC could enhance across agency reporting. Both DFES and WAPOL use WebEOC.	The Special Inquiry has discussed future whole of government emergency information technology requirements with the WA Chief Government	

establish a COP. **Action:** Determine and implement an appropriate communications platform for emergency management.	P&W have previously investigated the adoption of WeBEOC however it was found that to do so would require substantial additional resources.	Information Officer (CGIO). The Special Inquiry understands that the SEMC has developed an Emergency Services Communication Strategy for the consideration of Government. One of the key themes of the Strategy is interoperability. The Special Inquiry also understands that the SEMC is developing a proposal to implement a joint agency Crisis Information Management System based on WebEOC that will be hosted by WA Police and connect the existing siloed implementations of WebEOC. These actions are supported.	
Lesson 24. The state should converge on a single communications platform for all emergency management and support agencies. **Action**: Determine and implement an appropriate communications platform for emergency management.	The WA Emergency Radio Network (WAERN) provides the basis for a common communications platform for emergency services. Use of the network will enhance interoperability.	This recommendation is complete. Communication plans were identified within the IAPs, with the primary Command Channel 648 utilised during the course of the Waroona fire, supported by tactical Division and Sector Channels. However, these appear not to have been clearly defined until several days into the incident.	
Lesson 25. Reporting and control should be through the incident chain of command, and not through agency chain of command. **Action**: Develop agency processes to support IMT chain of command reporting.	Agencies advise that this is standard practice at an inter-agency level, although there will often be a period early in major incidents where the singular incident chain of command takes time to establish. Individual agency chains of command are the default until this occurs.	This recommendation is complete.	
Lesson 26. Early in an incident, close and effective liaison needs to be established with local government agencies. **Action:** Develop or update doctrine and procedures to include early and sustained contact with the LGA possibly including enhancing the role of the Local Emergency	Agencies liaise with local government authorities as soon as possible after a fire commences. The State Emergency Management Committee (SEMC) examined the issue of the engagement of local expertise in IMTs as part of its current review of State Emergency Management Policy 4.1 – Operational Management.	This recommendation refers to both early contact and effective contact. The Special Inquiry heard that the Chief Executive Officers (CEOs) of the affected Shires – Waroona and Harvey – had concerns about the handover of the transition to recovery plan from DFES to the local governments. Emergency response agencies are often well equipped to deal with some of the recovery issues before they decamp; their expertise and resources could be better	

Management Committee.		applied before the handover is completed.	
Lesson 27. Web sites need to be kept updated. **Action:** Review and update doctrine regarding community information management, including time stamping radio bulletins and social media/websites.	P&W and DFES time stamp all alerts and warnings appearing on their respective web sites. Agencies do not control the broadcasting of alerts and warnings. The agencies work with the media to encourage them to be as accurate, clear and up to date as possible. ABC Local Radio (which has a Memorandum of Understanding with DFES and P&W, through the SEMC Public Information Group) has committed to time stamping their broadcasts.	This recommendation is complete	
Lesson 28. A high level review of alerts, warnings and messaging is needed to match community expectations with what is practical and achievable. **Action:** Undertake a review of current state alert and warning procedures and incorporate social media use and graphical content. Ensure community consultation is included.	DFES and P&W aligns its alerts, warnings and messaging to national standards.	The Special Inquiry received extensive and varying evidence regarding the effectiveness of the alerts and warnings issued in the Waroona Bushfire. DFES is currently proceeding with the purchase of a CMS to replace the existing software. The Special Inquiry supports the prompt establishment of the CMS.	
Lesson 29. Further community education may be needed on how to interpret messages. Action: Provide workshops within the community around community information management procedures. **Action:** Provide workshops within the community around community information management procedures	DFES and P&W aligns its alerts, warnings and messaging to national standards.	The Special Inquiry received extensive and varying evidence regarding the effectiveness of the alerts and warnings issued in the Waroona Bushfire. DFES is currently proceeding with the purchase of a CMS to replace the existing software. The Special Inquiry supports the prompt establishment of the CMS.	
Lesson 30. The agencies need to develop techniques to ensure accuracy of information across all media. **Action:** Undertake a review of current state alert and warning procedures and incorporate	The Special Inquiry received extensive and varying evidence regarding the effectiveness of the alerts and warnings issued in the Waroona Bushfire.	The Special Inquiry received extensive and varying evidence regarding the effectiveness of the alerts and warnings issued in the Waroona Bushfire.	

social media use and graphical content. Ensure community consultation is included.			
Lesson 31. Local emergency management committees and planning should identify modes of community contact. **Action:** Update planning doctrine in the local emergency management committees to include collecting information around means of contact for members of the community.	Local Emergency Management Arrangements include contact information for local community members. There is scope for this to be clarified in respect of identifying networks to assist in the dissemination of public information during emergencies	The Special Inquiry does not comment on this recommendation.	
Lesson 32. When people are being moved away from their homes it's important that they move to a place of greater safety and that their movement is relatively assured. **Action:** Review doctrine to ensure decisions on evacuation are given the highest priority.	This is current practice. However, P&W understands that, despite its best efforts, limited resources resulted in less than ideal arrangements in the early stages of the Milyeannup fire.	The Special Inquiry does not comment on this recommendation.	
Lesson 33. Early resolution and clear communication of the financial and other support measures that will be available to affected residents is an important contributor to community resilience.	Where the need for specific changes have been identified DCPFS has revised policies and procedures as a result of the Nannup bushfire.	The Special Inquiry makes no comment in relation to this recommendation	

Parkerville, Stoneville, Mt Helena Bushfire Review (SEMC June 2014)

Recommendation	Agency comment	Special Inquiry comment	Special Inquiry Assessment
3.1 Legislation, Policies and Plans: The forthcoming review by SEMC of SEMP 4.4 Recovery	State Emergency Management Policy 4.1 and WESTPLAN – FIRE have been updated to reflect agreed meeting arrangements of the affected agencies.	This recommendation is complete	

Coordination and Westplan – Recovery Coordination and SEMP 4.1 Incident Management should include consideration of: • the process for establishing a State Emergency Coordination Group (SECG) and the frequency of SECG meetings during an emergency; • clarifying of the criteria for declaring an incident at Level 2 or 3 • clarifying the criteria for handing over control of the incident from the Controlling Agency to local government and the transition from response to recovery • the development of processes to ensure that 'betterment' is considered in recovery plans, including the identification of roles and responsibilities.	Handover to recovery documents updated and uploaded onto the DFES IM Toolbox. Development and continuous review of DFES Standard Administrative Procedure 3.1.I - Recovery. This SAP includes clarification of the role of the State Recovery Controller and has been sent to the State Recovery coordinator and Executive Director SEMC for consideration as a whole-of-government procedure.		
3.2 Bushfire Prevention: Staff and consultants skilled in community engagement practice should be specifically included in bushfire risk management planning and preparedness building programs undertaken by State agencies and/or local government	DFES has six Community Engagement Officers located in regional offices who support community engagement practice in the region. These officers implement community engagement programs at the local level, advising and training DFES personnel in effective community engagement practice and working with local government to deliver bushfire preparedness activities. 118 bushfire preparedness activities have occurred across the South West Land Division since July 2015. (This does not include activities conducted by Bushfire Ready groups).	This recommendation is complete	
3.3.2 DFES should review its	Through the IBMC, agencies have discussed a uniform	This recommendation is complete	

training courses and Standard Operating Procedures to satisfy itself that all incident management personnel have the required level of understanding of WA emergency management arrangements, including those that relate to the roles of the Incident Management Team and Incident Support Group and the declaration of incident levels.	accreditation process. Work is currently being undertaken by AFAC toward establishing a national level 3 certification process. While this process is ongoing, the IBMC has agreed that accreditation will continue to be undertaken at agency level. DFES has developed level 1, 2 and 3 Incident Controller Pathways. These pathways and associated courses are reviewed by subject matter experts to ensure they reflect current SOPs and State Emergency Management Arrangements. The pathways include the currency requirement of ICs through the Department's endorsement process.		
3.3 Bushfire Preparedness: **3.3.1** SEMC Secretariat Community Emergency Management Officers should work with the Shire to document the Shire of Mundaring's learnings from the Parkerville Stoneville Mt Helena fire with a view to sharing this with other local authorities particularly those facing similar situations in order to extend the range of tools available to assist local governments to understand their roles and responsibilities in future emergencies	This recommendation is complete	This recommendation is complete	
3.4 Leadership Expertise in rural-urban interface fire leadership: **3.4.1** DFES should increase and maintain urban interface bushfire skills and expertise. Appointments to senior roles within the agency should include people with experience and credibility in bushfire firefighting and	Rural Urban Interface and bushfire training has been included into appropriate DFES courses including Trainee Foundation Training, Firefighter Development Program and Volunteer Firefighter 1 Pathway. The importance for DFES of bushfire expertise is reflected in the number of personnel accredited as level 3 and level 2 ICs. DFES has bushfire expertise through different levels of the agency, including at senior levels.	A range of stakeholders have expressed concern that DFES staff do not have sufficient expertise in rural fire management. In the view of the Special Inquiry, it is imperative that bushfire skillsets are incorporated into succession planning. In a general sense, in an organisation where the principal means of entry level recruitment into operational positions is through urban fire stations, there will be a resultant effect on the culture and approach of that organisation. In the absence of a clear policy on lateral entry, applicants for more senior operational	

management.		positions are assessed against competencies that are primarily gained through urban career fire experience.	
3.4.2 The Executive Teams of both DFES and DPaW should meet quarterly to review and agree joint improvements relating to issues of interoperability, complementarity and the alignment of firefighting doctrine. The establishment of a unified command in joint State Operations Centre, Regional Operations Centre and Incident Management Teams should be pursued as an overarching goal.	The FES Commissioner and Director General (DG) P&W meet regularly to discuss matters and arrangements necessary to coordinate the agencies' bushfire command, control and coordination arrangements DFES and P&W executive teams are meeting regularly through IBMC. DFES/ P&W Common Doctrine Working Group has been established and is reporting to the Operations Sub Committee under the IBMC Implementation as envisaged by the recommendation can be achieved only in the bush fire environment which presents operational limitations for DFES as an all hazards agency. P&W have advised that their remit is in the States Parks and Forests although their expertise can be employed outside those boundaries in support of other agencies.	The Special Inquiry considers the lack of inter-agency pre-formed IMTs to be an ongoing rather than an 'emerging' issue. The need for inter-agency pre-formed IMTs was discussed in the Major Incident Review of Toodyay Fire December 2009, and the Post Incident Analysis for the 2011 Margaret River Bushfire. The Special Inquiry notes the condition emphasised by the FES Commissioner that any IMT arrangement reflects "*my all-hazard requirements"*. The immediate need is to move to multi-agency pre formed IMTs for bushfire. It appears from evidence presented to the Special Inquiry that all is required to complete the inter-agency preformed IMT model for bushfires, is for DFES staff to be incorporated into the teams. The Special Inquiry recommends that DPaW and DFES adopt the policy that all bushfire Level 3 Incident Management Teams in the Perth Hills and the South West will be integrated and pre-formed from the start of the 2016/17 fire season with substantial involvement of both DFES and P&W personnel on all teams.	
3.5. Bushfire Response: A range of opportunities for continuous improvement in relation to operational matters was noted during the Review. These are discussed in particular in Section 7. It should be noted that the fact that the Response benefitted from improvements identified as a result of previous incidents enabled more refined or detailed improvements to be identified, the adoption of which is designed to lead to best practice.	The Departments now participate in the annual Westplan Fire bushfire exercise and participate in Incident Management Teams with representatives from both agencies wherever possible. Rural Urban Interface firefighting strategies and common techniques are agreed.	In this Report, the Special Inquiry outlines a number of areas in which bushfire response can be improved.	

3.5.1 Standard Operating Procedure 1 (Mobilisation Zone 2, Perth Hills area) should be reviewed to ensure that appropriate escalation triggers and levels of operational readiness are in place for future periods when severe fire weather conditions are forecast.	The Zone 2 & 2A Operational Protocols reviewed and amended in consultation with P&W.	This recommendation is complete	
3.5.2 Appropriately equipped Incident Control Centres should be identified and/or established throughout the Perth Hills to meet the requirements of a fully resourced Incident Management Team in future bushfire events.	A Review of ICCs in WA was completed in June 2013 which provides recommendations for 20 ICC area locations, capacity and minimum equipment requirements across the state. A fit for purpose assessment of identified Incident Control Centres (ICC) in specific locations is now underway. The ICC review identified sites (towns or areas) for placement of ICCs including in the Perth South East and Perth North East regions.	This recommendation is complete	
3.5.3 Future appointments to the role of Incident Controller should be limited to one for the entire duration of the incident, with nominated Deputy Incident Controllers to assist or 'take charge' in the Incident Controller's absence. This measure will provide for a single point of responsibility and control for the incident and assist with any subsequent review or enquiry. If it is not possible to implement this proposal for liability reasons, the number of Incident Controllers should nevertheless be reduced to the minimum.	An interagency working group established to review State Emergency Management Policy (SEMP) 4.1 has agreed to the following wording for the amended policy: • "In the case of a protracted incident where it may be necessary for the Controlling Agency to appoint more than one Incident Controller, the number of Incident Controllers appointed will be kept to the minimum appropriate in the circumstances."	The Special Inquiry believes that a 24 hour shift it would allow the IMT focus more on the incident, rather than being preoccupied with preparing an IAP for the next shift's arrival, relatively early on, as occurs in a 12 hour shift. The Special Inquiry suggest that DFES and P&W assess the merits and disadvantages of the Incident Controller and the IMT work cycle extending over a 24 hour period (but still allowing for individual rest times in line with fatigue policy)	
3.5.4 Whenever a Bush Fires Act 1954 section 13 transfer of control is invoked, the Incident level of an	State Emergency Management Policy Manual Operating Procedure – 23 Incident Level Declaration requires all incidents to be continually monitored and re-assessed in order	This recommendation is complete.	

event should also be reviewed and any changes documented.	to ensure that any changes are identified and the incident level escalated or de-escalated, where necessary.		
3.5.5 All agencies engaged in bushfire response should develop expeditious procedures for the mobilisation of resources in support of other agencies. See discussion in Section 7.1.	The Departments now participate in the annual Westplan Fire bushfire exercise and participate in Incident Management Teams with representatives from both agencies wherever possible.	The Special Inquiry considers the lack of inter-agency pre-formed IMTs to be an ongoing rather than an 'emerging' issue. The need for inter-agency pre-formed IMTs was discussed in the Major Incident Review of Toodyay Fire December 2009, and the Post Incident Analysis for the 2011 Margaret River Bushfire. The Special Inquiry notes the condition emphasised by the FES Commissioner that any IMT arrangement reflects "*my all-hazard requirements"*. The immediate need is to move to multi-agency pre formed IMTs for bushfire. It appears from evidence presented to the Special Inquiry that all is required to complete the inter-agency preformed IMT model for bushfires, is for DFES staff to be incorporated into the teams. The Special Inquiry recommends that DPaW and DFES adopt the policy that all bushfire Level 3 Incident Management Teams in the Perth Hills and the South West will be integrated and pre-formed from the start of the 2016/17 fire season with substantial involvement of both DFES and P&W personnel on all teams.	
3.5.6 Radio infrastructure in the Perth Hills should be reviewed to assess whether it is practicable for radio and/or mobile phone coverage to be improved to achieve better coverage across the area	This work has been assigned to the SEMC Essential Services Group.	The Special Inquiry notes that this work is currently underway.	
3.5.7 The role of the Ground Controller should be reaffirmed in operational doctrine and reinforced in Incident Management Team training. During incidents involving aircraft	The IBMC Aerial Fire Suppression Sub-committee reviewed the role of the ground controller (GC) and determined the GC should remain the IMT's first point of contact for Air Attack Supervisors in the initial attack. As incidents escalate and become more complex, a qualified Aviation Operations Officer or AIIMS Aircraft Officer will	This recommendation is complete.	

the appointment of a Ground Controller should be confirmed by the Incident Controller.	be dispatched to the IMT to assist in Aerial Fire Suppression planning and management.		
3.5.8 Procedures should be reviewed to address the risks associated with response aircraft all working from one forward operating base, including the need for a designated fire protection unit to be available in the event	Air Base Manager training with volunteer members of the State wide Operational Response Division (SWORD) has been undertaken. These volunteer Air Base Managers are now on roster for each fire season, an appliance is also available through the SWORD.	This recommendation is complete	
3.5.9 Training and awareness raising should be conducted to enhance the appreciation and understanding of DFES State and Regional operational personnel, including potential Incident Management Team members, of the nationally adopted Bushfire Alert and Messaging Matrix, in order to ensure that the most appropriate alert levels and associated community messaging are applied during bushfire incidents.	A comprehensive initiative to expose all DFES District Officer and Area Officer ranks and comparable P&W personnel to the ICL2 course (which has updated information on bushfire alert and messaging matrix) has seen over 80 personnel trained during 2014 and 2015	The Special Inquiry considers that there is room for improvement by reinforcing the primacy of warnings during bushfire events to all those involved in the response to a Level 3 bushfire. In particular, the Special Inquiry considers that the role of the ROC and the SOC needs to be-visited to ensure that a facilitating, supporting and enquiring role in relation to the dissemination of public emergency information is clearly defined.	
3.5.10 Procedures should be established to monitor the use of heavy plant during a bushfire incident, including the tasking of support appliances. Procedures should provide for the appointment of a dedicated Machinery Supervisor as prescribed within the Australasian Interservice Incident Management System	A WebEOC Board for Machinery management is being developed to support IMT. Appointment of a machinery supervisor in the IMT remains a decision of the IC on the basis of need in accordance with AIIMS arrangements. When the position is filled it is usually for a L3 incident. DFES' procedures and training materials relating to machinery supervision are consistent with expanded control in AIIMS. Machinery Supervision V3.2 Training Resource Kit and Operational Doctrine 3.5 Bushfire, machinery details are logged on the DFES resource tracking form.	WebEOC is not a resource management system and will not meet all agency expectations into the future.	
3.5.11 Automatic Vehicle	GPS/AVL functional specifications are being finalised. A	AVL is important for the safety of personnel, and is a very	

Location technology should be adopted to enable a better appreciation of the deployment and location of appliances at an incident, in order to increase situational awareness.	number of technical options remain to be analysed and risk assessed prior to going to market. This work is expected to be completed by June 2016. The GPS/AVL tracking system will then be tendered and integrated with other Crew Cab Protection components. As an interim measure all new Incident Control Vehicles have been equipped to access FESMaps and have an A3 printer available.	effective resource management tool. The Special Inquiry believes that the future resource management system adopted by P&W and DFES must incorporate AVL. The Special Inquiry recommends that DFES and P&W to investigate and adopt an emergency services resource management system as a matter of priority. The system should enable the registration, tasking, tracking, management and coordination of emergency management personnel, vehicles, plant and aircraft.	
3.5.12 Consideration should be given to an automatic 'Advice' notice being issued as soon as a fire is reported in a pre-determined high risk area such as the Darling Scarp on days when adverse fire weather conditions are forecast.	Being managed as part of the Critical Messaging (CMS) Project. All scrub fires reported to 000 will be available for the community to see on the public facing website. Further enhancements relating to specific 'higher risk' areas have been considered (e.g. notices to media for all fires in these areas), however due to the number of insignificant fires (e.g. small mulch fires, shed fires) that occur, it is not considered desirable to issue enhanced warnings to all fires. Incident Controllers currently provide advice regarding fires that pose a higher risk to the community. Potential to automate of that advice is being considered as part of the CMS Project.	The Special Inquiry supports the prompt establishment of the Critical Messaging Service	
3.5.13 Relevant policies and Westplans should be amended to require that full consultation occurs between the Controlling Agency and the Department for Child Protection and Family Support regarding the location of the evacuation centre(s) in a bushfire incident	WESTPLAN-FIRE has been updated to reflect the need for multi-agency exercises that test evacuations centres, critical infrastructure and traffic management State Bushfire Exercise Plans are produced in conjunction with P&W, WAPOL, Local Emergency Management Committee (LEMC), local governments and Department for Child Protection	This recommendation is complete.	
3.5.14 DFES should prepare a Standard Operating Procedure for the conduct of community meetings, and have available the appropriate audio visual and other equipment, to ensure that such meetings are able to fulfil their	Directive 3.2 Incident Control Standard Administrative Procedure 3.2.1 – Community Meetings developed and now included in the Operations Toolbox. DFES Incident controllers have undertaken training in both Community Meeting procedures along with the use of audio equipment including the use of microphones.	This recommendation is complete	

function in providing information and direction.			
3.5.15 A Restricted Access Permit system for the entry/ re-entry of residents, based on the one developed for the Parkerville Stoneville Mt Helena Bushfire should be finalised.	The process to provide residents with access to their properties post evacuation has been reviewed and updated. DFES developed a proposed Restricted Access Permit process and documentation which was sent to SEMC for noting. The new process and documentation will be trialled during the 2015/16 southern bushfire season after which time DFES will report back to the SEMC on its effectiveness.	The Special Inquiry found that the application of the traffic management policy at some locations during the Waroona fire did not meet the expectations of the community. On this basis, the policy is inadequate. This Special Inquiry recommends that SEMC to review the policy for traffic management at emergency incidents so it reflects national "best practice". This includes the production and issuing of an "aide-memoire" to guide traffic management, emergency and incident management personnel. The policy should provide a practical balance between risk to life and the public value of enabling the timely restoration of livelihoods and the movement of critical resources, (including essential services, critical businesses and livestock welfare services), through traffic management points. The review will involve a range of stakeholders including DFES, P&W, WA Police, Department of Agriculture and Food WA, Main Roads WA, WA Farmers Federation, WA Local Government Association, Forest Industries Federation, and the Transport Industry and ensure that the views of the community are considered.	
3.5.16 DFES, in consultation with bushfire volunteers should develop a procedure for the controlled entry and exit of volunteers to the fire ground.	Volunteers enter and exit Incident Fire grounds utilising existing procedures, as part of a responding crew or as an individual reporting to the Incident Control point.	The Special Inquiry is of the view that further work is required to ensure a sufficient visibility of volunteers deployed during an incident, and the provision of welfare (e.g food and fatigue management) to those volunteers. The Special Inquiry recommends that DFES issue a photo identification card to each DFES member, including members of Bush Fire Brigades, volunteer emergency services, Incident Management Teams, forestry industry brigade members and Networked Government Emergency Agency members. DFES to also consider temporary windscreen signage to identify vehicles carrying such personnel.	
3.5.17 Every effort should be made to enhance the ability of	A Field Operations Vehicle (FOV) is currently in build as a concept vehicle which allows for communication system to be	This recommendation is complete	

communications personnel to cope with fast moving and time critical fire events by providing and maintaining: • ongoing extensive communications training; • advanced vehicle capability for clear communication within areas of radio coverage dead spots; • ability to receive Air intelligence live streaming; • map production facilities; • deployment of multiple Incident Control Vehicles when required; • all Incident Control Vehicles with access to DFES Information Technology Systems.	mobile within reduced radio coverage areas and to establish an emergency services network around the incident. The communication data (live Streaming, 3G/4G and wireless) able to be sent and received by all appliances at the incident and to Command centres within the state. All new Incident Control Vehicles have been equipped to access FESMaps and have an A3 printer available.		
3.6.1 SEMP 4.4 and Westplan – Recovery Coordination should be amended to: • clarify the wording around handing over control of the incident from the Controlling Agency to local government and the transition from response to recovery; • include principles and criteria that will assist the Controlling Agency and local government to determine the best time	Westplan Recovery reviewed. Handover to recovery documents updated and uploaded onto the DFES IM Toolbox. Development and continuous review of DFES Standard Administrative Procedure 3.1.I - Recovery. This SAP includes clarification of the role of the State Recovery Controller and has been sent to the State Recovery coordinator and Executive Director SEMC for consideration as a whole-of-government procedure.	The Special Inquiry heard that the Chief Executive Officers (CEOs) of the affected Shires – Waroona and Harvey – had concerns about the handover of the transition to recovery plan from DFES to the local governments. More time needs to be spent ensuring all parties are comfortable with the handover. Emergency response agencies are often well equipped to deal with some of the recovery issues before they decamp; their expertise and resources could be better applied before the handover is completed. The Special Inquiry suggests that the SEMC develop an aide-memoire for Incident Controllers to guide the initial recovery considerations during an incident. The aide-memoire to include triggers for the initiation of rapid impact assessment and the escalation of the recovery	

to effect a hand over of control of the incident; • make explicit the roles and responsibilities of the parties involved in the handover of control of the incident; • specify the information required in the needs and impact assessments provided to local government by the Controlling Agency so that local government is given sufficient information to take control of incidents; • clarify the roles, responsibilities and the title of the State Recovery Controller and ensure that the appropriate wording is reflected in Westplans and State Emergency Management Policies; • Hazard Management Agencies, combat and support agencies and local governments need to fully inform themselves of the role of the State Recovery Controller and implement a more effective approach to communicating internally the changes or additions to Westplans, State Emergency Management		function; immediate and likely future community health, welfare and safety considerations. These triggers will inform the Incident Controller/s when considering the discretionary appointment of "Deputy Incident Controller, Recovery" during an incident that impacts on the community. Role of "Deputy Incident Controller, Recovery" would be (with the Incident Controller) to consider the initiation of the recovery process and to manage the transition from incident response to the recovery phase.	

policies or procedures adopted by the SEMC;			
3.6.2 Consultation with the Board of the Lord Mayor's Distress Relief Fund and other disaster appeal organisers should be undertaken to determine the potential for software development to consolidate the application and approval process, including provision of templates and application forms.	This Special Inquiry did not receive information on this recommendation		
3.6.3 Development of a template contract for the clean-up of affected properties to speed-up the process;	This Special Inquiry did not receive information on this recommendation	One of the issues brought to the Special Inquiry's attention is that there are no pre-existing contracts, approved tenders or panels of contractors that can be immediately drawn on to assist with recovery efforts. The usual State Government processes for procurement have generally applied to, and have in some ways hindered, the recovery efforts.	

SEMC – O'Sullivan and Lower Hotham 2015

As this Report was released in February 2016, agencies have not yet at the opportunity to review its recommendations. As such, the Special Inquiry has not assessed the implementation, and has chosen to list the recommendations below.

Recommendation
PFT.1 While recognising that workforce management, resourcing and geographical constraints present significant challenges, DFES and Parks and Wildlife should consider alternative approaches to determine how they will establish flexible multi-agency pre-formed IMTs, at both Levels 2 and 3, to be prepared for forecast levels of bushfire risk.
PFT.2The process developed by the IBMC for joint accreditation of Level 3 personnel should be further developed, including by extending the current arrangements to Level 2.
PFT.3The Fire and Emergency Services Commissioner and Parks and Wildlife Director General should jointly review the list of accredited Level 2 and 3 Incident Controllers, on an annual basis, to ensure that those listed are competent and current in their skill and knowledge.
PFT.4More use should be made of non-DFES and non-Parks and Wildlife personnel in IMTs where available, such as local government communications and mapping specialists.
PFT.5The IBMC should consider the benefits of using the AIIMS format for multi-agency training purposes during prescribed burning operations
IMS.1 A common understanding of the implementation of AIIMS should be agreed upon & followed by DFES and P & Inherently inefficient departures from AIIMS principles (such as to have more than one logistics unit) should be addressed immediately). Any residual differences in approach between the agencies should be made explicit.
IMS.2 As part of a shared understanding of the implementation of AIIMS, DFES and Parks and Wildlife should agree on the role and function of the Incident Controller. The

agencies should reach agreement on the minimum duration that Incident Controllers will serve at future incidents.
SEMC should review supra-coordination arrangements between all bushfire response and support organisations operating above the IMT level and clarify each organisation's legal, administrative and financial responsibilities.
ISE.1 DFES and Parks and Wildlife should jointly undertake a review of available resource management systems which could be readily integrated into their current human resources, vehicle and equipment systems. Develop an integrated inter-agency resource management system. An integrated system will improve the response to fire by supporting agencies to identify potential resources, track resources and plan deployments more effectively. Incidents will be sufficiently resourced and deployed resources will be utilised appropriately while minimising risk. (Nous)
ISE.2 The IBMC should consider the benefits of using a flexible AIIMS format for multi-agency training purposes during prescribed burning operations.
ISE.3 Bushfire response and support organisations should investigate the type of radio system best suited to WA bushfire situations for multi-agency operability and each future incident should have a Communications Plan
ISE.4Prescribed burning operations in a flexible AIIMS format could provide an opportunity to enhance interoperability through systems and processes training.
ISE.5 At multi-agency bushfires there should be agreement on the minimum shift length that all firefighters operate to during the emergency situation.
ISE.6During incidents when heavy plant is involved in fire suppression activities, DFES and Parks and Wildlife should require the IMT to have a Plant Operations Manager to enhance the effectiveness and efficiency of plant management
ID.1DFES and Parks and Wildlife should confer on what amendments to the AIA may be necessary to address the gaps identified by AFAC in relation to the implementation of the AIA in its first year of operation; greater compatibility of administrative systems and processes should also be pursued between DFES and Parks and Wildlife
ID.2 Common Use Agreements to facilitate the provision of air travel, ground transportation and accommodation should be developed to cover the specific circumstances of interstate deployments
ID.3 Consideration could be given to the identification of a pre-formed Interstate Liaison Unit to enhance preparedness for future incoming deployments and to provide a basis for network building with counterpart groups in other jurisdictions.
ID.4 Briefings for incoming crews should be rationalised and opportunities taken to provide general briefings during the transportation phase with more detailed briefings conducted in the area of operations; use of charter flights for incoming crews could assist in the provision of advance briefings. Consideration could be given to specific briefings for local personnel on interstate deployments arrangements.
R.1 An assurance process should be developed to ensure that amended Westplans have been fully reticulated and absorbed.
R.2A template style approach to impact assessment that meets the needs of interim Westplan – Recovery Coordination should be finalised.
R.3 A specific role definition for SEMC Secretariat Community Emergency Management Officers should be adopted in order to make clear that they can advise Incident and Operational Area Support Groups and act as advisor to local government at the commencement of incident recovery
R.4Incident Controllers should become more familiar with financial arrangements governed by the WA Natural Disaster Relief and Recovery Arrangements so as to be able to advise local governments and the State Recovery Coordinator on the status of an event in relation to WANDRRA
R.5 Standardised guidance on the management of common hazards to emerge in the wake of a bushfire, in particular asbestos exposed in 12 premises damaged or destroyed by fire, should be developed and made widely available.
R.6 Networked agreements between neighbouring local governments should be encouraged in order to provide better support for council officers affected by emergency incidents, including for the purpose of fatigue management.

Reconstruction of the spread and behaviour of the Waroona bushfire (Perth Hills 68)

6-7 January 2016

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Department of Parks and Wildlife Western Australia

Government of Western Australia
Department of Parks and Wildlife

This report was compiled to inform the Waroona Bushfire Special Inquiry, and is based on information available to the fire behaviour reconstruction team up to 14 March 2016.

Further information about meteorological aspects of the Waroona bushfire is available in a report prepared by the Western Australian Regional Office of the Bureau of Meteorology.

Version 1.1

Date of issue 6 April 2016

Cover image: View from Mt William to the east north east showing widespread defoliation due to crown fire on the morning of Thursday 7 January 2016.

Summary

The Waroona bushfire (Perth Hills Fire 68) was ignited by lightning in the Murray River valley south-east of Dwellingup and was detected at 0630 hr on Wednesday 6 January 2016. Burning under prevailing E to NE winds the fire made a series of major runs to the west, eventually burning to the Indian Ocean near Lake Preston. Around sunset on 7 January the fire burned through the town of Yarloop resulting in the loss of two lives, destruction of more than 100 homes and severe damage to other buildings and infrastructure. The fire burnt a total area of 69165 ha including 31180 ha of freehold land, making it the second largest individual fire in the south-west since the Dwellingup fire of January 1961. The fire was notable for its size and complexity, for the scale and duration of suppression operations, and for its significant social and economic impacts on the community of south-west Western Australia.

This report reconstructs the development of the Waroona bushfire from the time of detection on 6 January to midnight on 7 January based on four distinct phases of fire development.

The initial phase of fire development took place in open forest and areas subject to current bauxite mining activity. Initial attack on the fire was hampered by steep and inaccessible terrain along the Murray River valley, and by rapid escalation of fire behaviour in long unburnt forest fuels during the late afternoon.

During Wednesday evening the fire made an unexpectedly rapid run under ESE winds through a complex fuel mosaic of remnant native forest, rehabilitated bauxite pits and current mining activity. This phase of fire development was characterised by extensive spotting, and may have been facilitated by further lighting ignitions from pyro-cumulonimbus activity during the late afternoon. Fire threatened the town of Waroona and spread rapidly through the agricultural landscape of the coastal plain.

During Thursday the fire grew on a broad front under the influence of ENE winds and spread down the Darling escarpment near the Wagerup bauxite refinery and east of the town of Yarloop. This phase of fire development was characterised by extensive crowning in fuels unburnt for 20 years or more and two further pyro-cumulonimbus events.

The McArthur Forest Fire Danger Index was High to Very High for most of 6 and 7 January, increasing to Severe for a period over parts of the fireground on the evening of 7 January due to a combination of increasing wind speed and falling dew point. Fire behaviour was greater than might be expected under these conditions on account of very dry fuel profiles, long unburnt and heavy fuels, and areas of steep slope.

There is a need to better understand the interactions between weather, fuels, atmospheric conditions and extreme fire behaviour associated with the formation of pyro-cumulonimbus.

The circumstances and impacts of this fire highlight the importance of fuel management in bushland in and around settlements, as well as across the broader landscape. This includes fuel management in the complex mosaic of vegetation age and structure that arises following bauxite mining operations in State forest.

Overview of the fire

The Waroona bushfire (Perth Hills Fire 68) was one of two fires ignited by lightning in the Murray River valley south-east of Dwellingup in the Lane Poole Reserve. Burning in jarrah forest, Perth Hills Fires 68 and 69 were detected on satellite imagery by Department of Parks and Wildlife personnel at 0630 on Wednesday 6 January 2016. Fire 69 was suppressed during the initial response at a size of 11 ha. Fire 68 was unable to be contained at initial attack due to inaccessibility and steep terrain, despite a sustained effort by ground forces and water bombing aircraft. During the afternoon of 6 January the fire spread west across the Murray River valley and escalated rapidly in size and intensity. During the evening the fire continued spreading rapidly to the west through the Alcoa mining envelope, comprising a mosaic of jarrah forest, and rehabilitated and non-vegetated mining pits, haul roads and other infrastructure. Later that evening the towns of Waroona and Hamel, and adjacent areas of agricultural land on the Swan coastal plain came under threat. By the early hours of 7 January, the fire had extended west across the coastal plain burning through a mosaic of agricultural land and remnant bushland. After sunrise on 7 January, the southern flank of the fire, which was burning in the jarrah forest mosaic on the Darling plateau, became an active head fire that spread in a west south west direction under the influence of ENE-NE winds. The fire remained active throughout the day with an extensive and complex perimeter that included agricultural land, State forest and other reserves, and major industrial infrastructure at the Wagerup alumina refinery and adjoining Willowdale minesite. Around sunset on 7 January, the wind veered to the east and increased in speed. Under hot, dry conditions, the south-eastern flank positioned to the north and east of the town of Yarloop became an active head fire that spread rapidly west, causing severe damage to the township of Yarloop and resulting in the loss of two lives.

The Waroona bushfire burnt a total area of 69165 ha including 31180 ha of freehold land, making it the second largest individual fire in the south-west since the Dwellingup fire of January 1961. The fire was notable for its size and complexity, for the scale and duration of suppression operations, and for its significant social and economic impacts on communities in the Shires of Waroona and Harvey. Impacts of the fire were experienced more broadly across the south-west as result of temporary closure of the South West and Forrest Highways during a busy holiday period, and closure of the railway line linking Perth and Bunbury. The fire also caused extensive damage to the electricity transmission grid with more than 1000 poles destroyed. Many thousands of hectares of forest and commercial plantation were fully crown scorched and defoliated by high intensity fire with significant and long-lasting implications for biodiversity, ecosystem health and vitality, water catchments and future forest productivity.

The process of reconstructing the spread of major bushfires provides a valuable opportunity to identify and analyse factors that contributed significantly to fire behaviour, and to learn lessons that can inform future policy and management practice. Well documented fire reconstructions are valuable for training, and for evaluating the performance of fire behaviour prediction systems and tools (Cheney 2010, Cheney et al. 2012, Burrows et al. 2015). Fire reconstruction can also contribute to better understanding of fire behaviour, particularly by identifying unusual phenomena that are not explained readily by existing theory and modelling approaches (Peace et al. 2015).

This report reconstructs the development of the Waroona bushfire from the time of detection on 6 January to midnight on 7 January. In order to meet the reporting timeframe of the Special Bushfire Inquiry commissioned by the Western Australian Government we have chosen to focus on this period when the fire grew most rapidly, setting the scene for impact on Yarloop during the evening of 7 January. Reconstruction of fire spread from 8 January onwards may be undertaken at a later stage, subject to demonstrated need and the availability of resources.

Examination of response and recovery actions to manage the impact of the fire on the community and environment are outside the scope of this report but are the subject of a Major Incident Review process.

Methods

Structure of this report

This report is divided into four parts:

1. An overview of the fire environment in the general area affected by the Waroona bushfire including topography, vegetation, land use and previous fire history.

2. Description of antecedent climate leading up to January 2016 and an overview of weather and atmospheric conditions during 6 and 7 January.

3. Chronological description of weather, fuel conditions and fire behaviour during four time periods representing different phases of fire activity:

   Phase 1 - 0630 to 1900 on 6 January
   Phase 2 - 1900 on 6 January to 0930 on 7 January
   Phase 3 - 0930 to 1830 on 7 January
   Phase 4 - 1830 to 2400 on 7 January

   Observed fire behaviour is compared with predictions from fire behaviour guides, and unusual weather phenomena identified through observations and reported by field observers are described.

   The reconstructed spread of the fire is presented using two maps showing fire isochrones and the direction of spread indicated by field observations of leaf freeze. Isochrones and leaf freeze are presented on a tenure map base (Appendix A), and on a on a base image showing categories of crown damage determined from high resolution aerial photography (Appendix B).

4. Synthesis of major findings drawn from the fire reconstruction

Data sources for climate and weather

The large size of the fire and variability of topography within its perimeter made it necessary to draw on weather observations from a number of locations to properly characterise conditions on the fireground. These observation sites are managed by several different agencies including the Bureau of Meteorology (BoM), the Department of Agriculture and Food Western Australia (DAFWA) and Alcoa. These sites include:

- BoM automatic weather stations at Dwellingup (-32.71° 116.06°, 267 m asl) and Collie East (-33.36° 116.17°, 200 m asl) which are located approximately 15 km north and 70 km south of the fire respectively, and represent conditions on the Darling plateau. Wind speed and direction are measured at 29 m height above forest canopy at Dwellingup and 10 m height above ground at Collie East. Dwellingup data are plotted as 30 minute observations.
- DAFWA automatic weather stations at Harvey (-33.06° 115.85°, 20 m asl), Logue Brook (-32.99° 115.85°, 200 m asl) and Waroona (-32.85° 115.89°, 20 m asl). Wind

speed and direction are measured at 3 m height at these stations, with a multiplier of 1.3 applied to make these equivalent to 10 m observations.
- Alcoa automatic weather stations at the Minesite (-32.79° 116.05°, 340 m asl) and at the Wagerup Refinery close to the base of the escarpment (-32.92° 115.91°, 40 m asl). Wind speed and direction are measured at 30 m height at the Minesite, and simultaneous observations for 10 m and 30 m heights are available for the Wagerup Refinery. Wagerup data are plotted as 6 minute observations.

Data sources for reconstruction of fire behaviour

Details of vegetation type and the number of years since last prescribed burn or bushfire were accessed from datasets maintained by the Department of Parks and Wildlife Fire Management Services Branch. The anniversary date for time since fire records is 1 July.

Fire spread was reconstructed from incident records which included:

- a detailed fire chronology prepared during a series of workshops attended by personnel representing Parks and Wildlife, Department of Fire and Emergency Services (DFES) and the Shires of Harvey and Waroona
- individual fire diaries and notes
- recollections gathered during interviews (Appendix C)
- maps prepared from field intelligence and aerial surveillance
- photographs and video images taken by personnel on the fire ground
- evidence collected from the fire ground by members of the fire investigation team including observations of crown defoliation, crown scorch, stem charring, fuel consumption and vegetation (leaf) freeze. Vegetation freeze refers to the orientation of scorched leaves, twigs and finer shrub stems following the passage of a flame front. Heat from the flames makes the finer plant material supple and those components that are scorched but not consumed are bent by the wind. On cooling, the vegetation remains 'frozen' in the direction of fire spread downwind. Vegetation freeze is a valuable indicator of wind direction at a location, and can be used to locate the position of a fire at the time of a wind change. Freeze can also provide a crude indication of wind strength with more pronounced freeze indicating stronger winds. Vegetation freeze can be variable and difficult to interpret in areas where fire behaviour has been severe and a high proportion of leaves have been consumed, or in areas where fire behaviour has been very mild. Numerous observations of vegetation freeze are generally required to indicate reliably the direction of spread of a large and complex bushfire.

A range of remote sensing products were also used for the fire reconstruction including MODIS and Himawari 8 satellite imagery. Satellite images provide an indication of the active fire and area burnt at time of overpass (only active fire during the night, where only thermal bands are used) when there is no cloud obscuring the image. Post-fire high resolution aerial photography and subsequent classification and patterning of overstorey canopy damage was valuable in reconstructing the fire's path and aspects of its behaviour. Four band (RGB and NIR) imagery was captured approximately 2 weeks after the fire. Data were captured with 30 cm pixels but for this analysis the imagery was re-sampled to 3 m pixels. The analysis provided a classified image delineating forest areas with green canopy, scorched canopy, defoliated canopy and cleared areas (gravel pits, roads, etc.). Ashbed from burning logs was also clearly visible and was categorised with the cleared areas. Analysis was performed in ENVI® image analysis software and processing was performed using decision tree analysis. The result was a high resolution map of canopy damage categories.

Images from the BoM Doppler radar at Serpentine were used to examine the characteristics of the convective plume above the fire. Lightning discharge data were obtained from GPATS and Weatherzone.

Data were used to prepare maps with isochrones showing the estimated position and shape of the fire at intervals according to the rate of growth of the fire and the availability of reliable observations of the position of the fire.

Fire behaviour predictions

The Forest Fire Danger Index (FFDI) was calculated using the McArthur Mark V meter with the Drought Factor set at 10. FFDI values presented in tables and figures are based on 30 minute observations. Fire behaviour was predicted using the Dry Eucalypt Fire Model (DEFM) of Gould et al. (2007) with equations programmed into a spreadsheet format (WA Fire Models 2014). Fuel hazard scores and indicative fuel loadings were based on a Jarrah North West type with a fuel age of 10-20 years, and a wind ratio of 3:1. Fine fuel moisture content was predicted using the three models presented in the DEFM with the transition to Model 3 (night) conditions set at 2000 hrs. Two sets of predictions were made for each time period for which a reliable rate of spread observation was available from direct observation of spread, or from reconstructed spread. These predictions reflected:

- the mean fine fuel moisture content, slope and wind speed for the period, or
- maximum conditions based on the 25th percentile value of fine fuel moisture content, and 75th percentile values of slope and wind speed for the period.

Regional fire environment

Landform and topography

The fire extended across the western margin of the Darling Plateau and the Swan Coastal Plain. These broad landforms are separated by the Darling escarpment which rises about 300 m above the plain and has localised areas of steep and rugged terrain, and is deeply dissected by the drainage lines of the Drakes, Samson and Logue Brooks and smaller tributaries.

The Darling Plateau is an undulating lateritic upland at an elevation of 300-340 m above sea level, with occasional higher points exceeding 450 m elevation at Mt William and Mt Keats. The plateau is dissected by the Murray River valley which trends roughly north-south in the area affected by the fire, and has localised slopes up to 20° and outcropping of the basement igneous rock. Summer flows in the Murray River are intermittent and the river itself provides no barrier to the spread of fire. Vehicle crossing points are limited, with more than 20 km separating the crossing at Driver Rd on the southern end of the fire and the Nanga Road bridge.

The Swan Coastal Plain is flat and elevation varies by only a few metres between Waroona to the coast at Preston Beach. The Harvey River drains the central section of the plain between Waroona and the Bassendean dunes of heavily leached grey sand closer to the coast. Between the Bassendean dunes and the coast are younger dunes and a system of seasonally dry lakes, the largest of these being Lake Preston and Lake Clifton.

Climate and weather

The area experiences a Mediterranean-type climate with cool moist winters and warm to hot summers that are typically dry and have median monthly rainfall below 20 mm from December to March. The Darling escarpment creates orographic uplift that leads to increased rainfall on the western margins of the plateau, with mean annual rainfall of 1234 mm at Dwellingup and 992 mm at Waroona over an 80 year recording period. Mean annual rainfall declines steadily with distance east from the escarpment. Rainfall has been declining across much of south-west Western Australia since the mid-1970s and the period since 2000 has seen a number of years with rainfall very much below normal. Mean monthly temperatures are 1-2° cooler on the plateau than on the coastal plain.

During the summer months anti-cyclones move along the southern edge of the continent directing easterly winds across the south-west, accompanied by the development of a west coast trough. Winds associated with this synoptic pattern are predominantly easterly overnight and during the morning, and may be strong and gusty close to the escarpment and on adjacent parts of the coastal plain. A sea breeze from the S to SW is common during the afternoon, with the influence zone dependent on the temperature gradient and strength of the easterly gradient. Summer seas breezes commonly reach the escarpment, and may influence Dwellingup and the Murray Valley under favourable circumstances. Winds typically return to the E and increase in strength after sundown. This weather pattern is normally associated with McArthur Forest Fire Danger ratings of Moderate to High, increasing to Very High (>32) when winds are strong and the air mass is warm and dry.

Vegetation, land use and recent fire history

On the Darling plateau the dominant vegetation type is open eucalypt forest of jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) with a potential height of 25-30 m. Moister and more fertile sites support extensive stands of bullich (*Eucalyptus megacarpa*) and blackbutt (*Eucalyptus patens*), while skeletal soils associated with the escarpment support a woodland of wandoo (*Eucalyptus wandoo*) and marri. Open forests have an understorey of woody shrubs that can vary from scattered low shrubs (<0.5 m) on harsh sites to dense stands of taller shrubs (>1.5 m) on fertile sites associated with streams and swamps. Fuel structure and loading are influenced strongly by time since fire, and default fuel characteristics are provided for four age classes of the Jarrah North West forest type in Parks and Wildlife Fire Operations Guideline 22.

Most of the forest is public land vested in the Conservation Commission and managed by the Department of Parks and Wildlife as conservation reserve or State forest where timber harvesting may occur periodically. Large parts of the Waroona, Samson and Federal forest blocks in State forest have been mined for bauxite to supply the Wagerup refinery since the mid-1980s. These areas have become highly fragmented by mine pits, haul roads, conveyor lines and other infrastructure. Mining takes place on the lateritic uplands where the depth and grade of ore are superior, and mine pits are dispersed over a wide area rather than working on a single active front. Following mining the pits are ripped and rehabilitated with a seed mix that includes native tree and understorey shrub species. Remnant patches of unmined forest are dispersed throughout the mining envelope, and tend to be in lower lying areas where bullich and blackbutt dominate the overstorey.

Most of the forest burnt on 6 and 7 January had been unburnt for at least ten years, some of it for over 30 years (Fig. 1). Younger fuels resulting from prescribed burning were located east of the Murray River in Young block (6 years old), and west of the river in Nanga block (2 years old). A large area of 6 year old fuel was also located east of the Muja Northern terminal powerline in Driver and Hoffman blocks as a result of a bushfire in December 2009.

The area affected by bauxite mining comprises a mosaic of active operations, rehabilitated pits and patches of remnant forest that has not been burnt since mining operations commenced (Fig. 2). Rehabilitated pits are densely stocked with even-aged saplings, and fuel structure and loading depend on stand age. For most rehabilitated pits time since fire would be the same as stand age, except for those burnt a bushfire in January 2006. This fire started in the Murray Valley and spread westwards through State forest, reserve and the Willowdale minesite before being eventually contained on the eastern side of the Wagerup refinery at a final size of 11090 ha. This fire burnt several hundred hectares of rehabilitated bauxite pits in the southern part of Samson forest block. Experience gained during this fire indicated that rehabilitated stands less than 5 years old were unlikely to support intense fire behaviour due to light and discontinuous fuels, but that older stands could support intense fires with active crowning facilitated by the low and uniform canopy height (Fig. 3). The absence of an overstorey of taller trees means that within-stand wind speeds are likely to be greater than in uneven-aged native forest.

Remnant native forest within mined areas has generally been unburnt for several decades, and fuel ages date from the time that broadscale aerial fuel reduction burning was last undertaken in the 1980s and early 1990s. These stands have abundant surface and near-surface fuels, with very high to extreme fuel hazards and loadings exceeding 20 t ha^{-1}. Remnant stands that include bullich may have a large component of bark pieces in the near-surface fuel layer, and long strands of bark loosely attached to the trunks of standing trees (Fig. 4). Bullich has a similar bark to karri (*Eucalyptus diversicolor*) which has been shown to have potential for long distance spotting because of its low terminal velocity and slow burn-out time as a firebrand (Ellis 2010).

Vegetation on the escarpment includes jarrah forest, wandoo woodland and shrubland fringing rock outcrops. The escarpment is predominantly freehold land, and much of it has been partially cleared and grazed. Fire history on freehold has not been recorded systematically and is unlikely to be a useful indicator of fuel hazard or loading in grazed areas. Annual grasses on the escarpment would have been fully cured in Jan 2016. Bushland to the east and south of Waroona townsite was burnt by an unplanned fire in late January 2015, and a small reserve in the Yarloop townsite immediately west of the South West Highway was burnt by prescribed fire in May 2015.

The coastal plain is predominantly freehold land used for a range of agricultural enterprises including irrigated dairying, horticulture and dryland beef production. An extensive network of irrigation channels and deep drains has been established to service agricultural lands, but over the past decade open channels have been replaced with pipes to reduce water loss from seepage and evaporation (Fig. 5). The eastern half of the coastal plain adjoining the South West Highway has been cleared more extensively than the western half. Vegetation ranges from woodland of jarrah, *Banksia* and *Allocasuarina* on drier sites to Melaleuca swamps in seasonal wetlands. Remnant vegetation on the eastern side is limited to small reserves, roadside verges and drains, much of it in degraded condition and invaded by annual grasses and weeds (Fig. 6).

State-owned plantations of *Pinus pinaster* and *Pinus radiata* have been established on the Bassendean dunes adjoining the Forrest Highway (Fig. 7). West of the highway the Yalgorup National Park includes woodland of tuart (*Eucalyptus gomphocephala*), peppermint (*Agonis flexuosa*) and a variety of coastal shrubland communities. Prescribed burning of native vegetation adjacent to pine plantations has taken place on a limited scale for hazard reduction. Most of Yalgorup National Park had been unburnt for at least 20 years prior to January 2016.

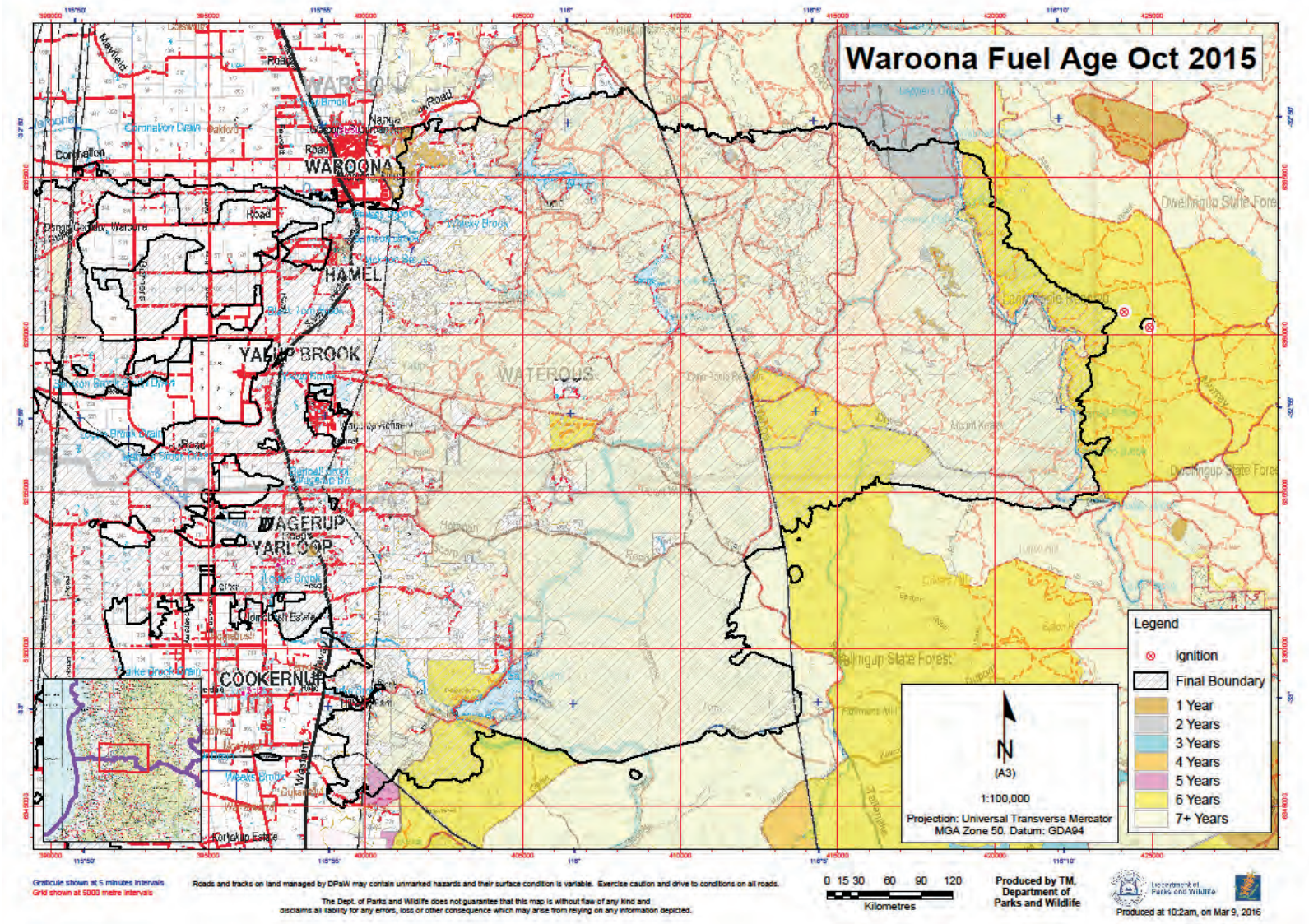

Figure 1. Fuel age at the time of the Waroona fire.

Figure 2. Minesite west of Nanga Rd with remnant jarrah forest, rehabilitated bauxite pit and haul road.

Figure 3. Rehabilitated bauxite pit burnt during the evening of 6 January 2016.

Figure 4. Stand of bullich and blackbutt on Nanga Brook Rd, typical of remnant native forest on lower lying areas within the minesite. This stand has not been burnt for 30 years and has abundant surface and near-surface fuel with a large proportion of bullich bark.

Figure 5. Trees planted along disused open irrigation channel north of Waroona main drain.

Figure 6. Remnant vegetation along Somers Rd west of Waroona.

Figure 7. View to the east from McLarty plantation towards the Darling escarpment.

Weather overview

Antecedent conditions

The trend of below average rainfall in the south west region of Western Australia, particularly since the 1970s and consistent with climate change modelling, is clearly illustrated in Fig. 8 (source: Brad Santos BoM). Local weather conditions leading up to the Waroona fire were derived from the BoM AWS at Dwellingup, some 24 km north of the origin of the fire. Annual rainfall at Dwellingup for 2015 was 780 mm, about 35% below the long term average (1234 mm) and the third lowest rainfall on record.

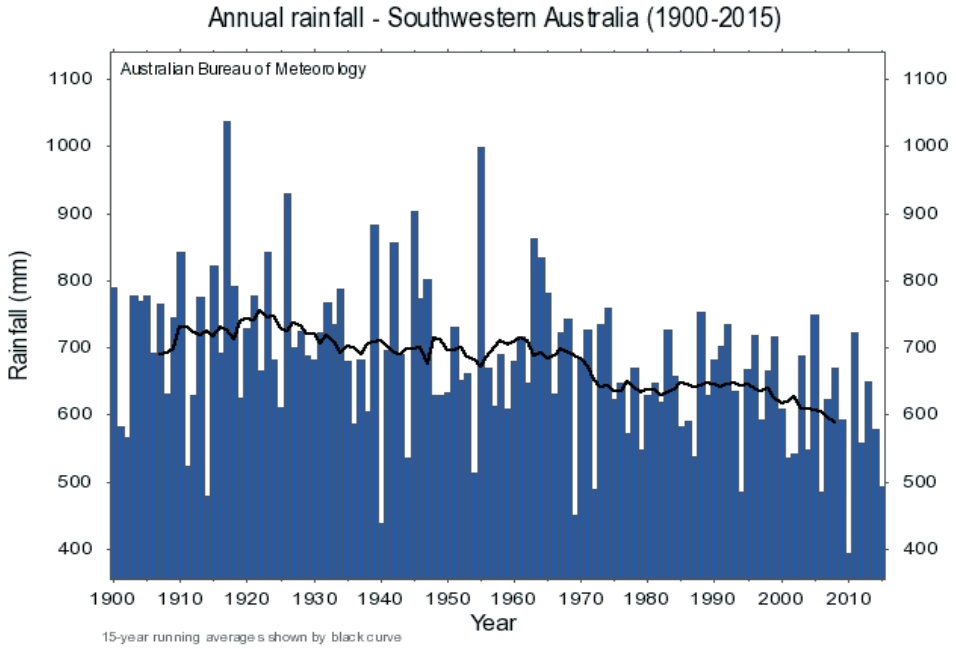

Figure 8. Annual rainfall and running annual average for south-west WA (Courtesy Brad Santos BoM).

The last significant rainfall (>5 mm) recorded at Dwellingup prior to the fire was 24 mm over two days on 5-6 December 2015. Below average rainfall and above average temperatures in spring and early summer 2015/16 resulted in a Soil Dryness Index (SDI, mm) at Dwellingup of 175 on 6 January 2016 (Fig. 9), some 45 mm higher than the previous five-yearly average and equal highest since 1992 for the same time of the year. The SDI as used in fire management (Mount 1972; Burrows 1985) is a measure of regional dryness or 'drought' and ranges from 0 when the surface soil (top 30-40 cm in Western Australia) is saturated (field capacity) to 200 when the surface soil profile is 'bone' dry. A SDI of 175 indicates that surface soil, heavy forest fuels including coarse woody debris and deeper forest fuel profiles were exceptionally dry for this time of year, as was the forest understorey and bark on standing trees. Consequently, the total available forest fuel load was maximal as reflected in a McArthur Drought Factor of 10. Unirrigated paddocks were fully cured.

Synoptic situation

During the summer months, a high pressure system in the Great Australian Bight and the west coast trough are regular features of the synoptic chart for Western Australia and are dominant features of weather experienced in the south-west. Typically, areas east of the trough experience hot, dry winds from the north-east whereas areas to the west experience mild, cooler weather associated with southerly breezes. Atmospheric instability and thunderstorms are common east of the trough line.

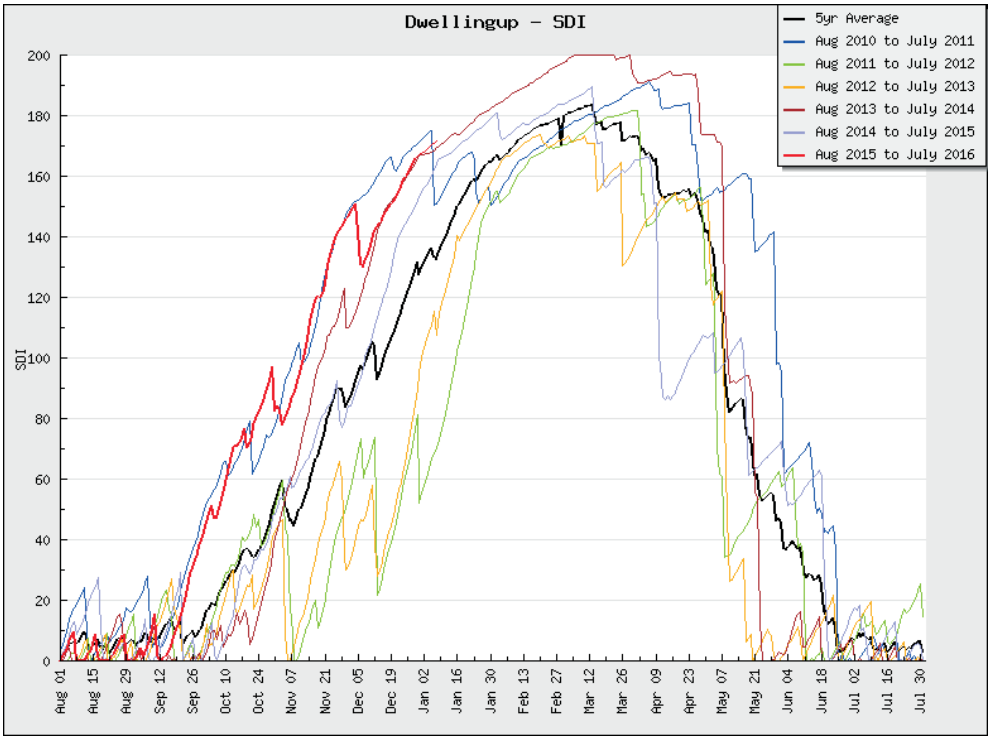

Figure 9. Soil Dryness Index (mm) for Dwellingup showing trend for 2015/16 season (red line) and the five year average (black line).

The formation and movement of the trough is variable and sometimes difficult to predict accurately, but usually the systems move east within a couple days of formation. However troughs can persist for extended periods, particularly in association with hot conditions in the northern interior/Pilbara region of the state. Movement of the weather systems from west to east is accompanied by changing temperature, moisture, wind speed and direction. As the high pressure system moves east, winds back from the east in an anticlockwise direction. If bushfires burning in heavy, dry forest fuels are not controlled in their initial stages before the anti-clockwise movement in wind direction they have the potential to the wind change turns extended flank fires into wide head fires.

The synoptic charts in Figure 10 show the position of the west coast trough and the high pressure system at 0800 hrs 5-7 January. An interesting feature of these charts is the persistence of the west coast trough. Lightning associated with the trough started two fires in the Lane Poole Reserve, one of which developed to become the Waroona fire.

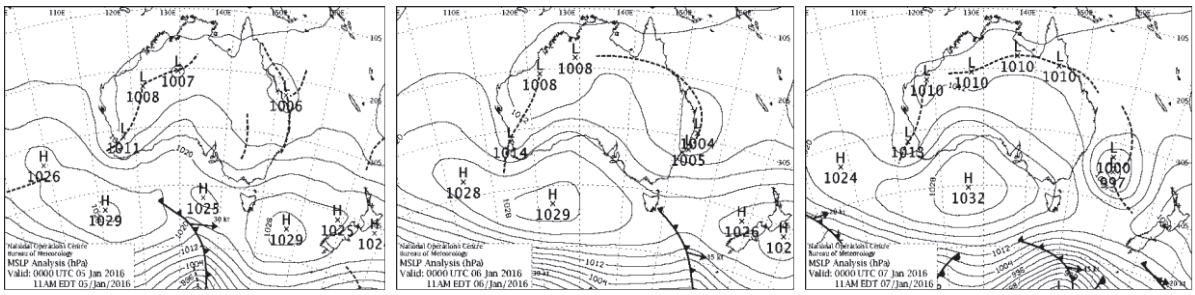

Figure 10: 0800 (WST) daily synoptic (weather) charts for the period of the Waroona fire from 5-7 January 2016. Lightning associated with the trough started the Waroona fire.

Atmospheric stability

Atmospheric stability, or the rate of change of air temperature with altitude, can influence fire behaviour through its influence on the buoyancy or rate of rise (kinetic energy) of the convection column. Extreme or erratic fire behaviour is usually associated with an unstable atmosphere because of the increased kinetic energy or buoyancy of the convection column. Beyond recognising broad associations, understanding of the complex processes and interactions between bushfires and the upper atmosphere is limited and documenting large fire events such as this provides an opportunity to improve our knowledge.

Aerological diagrams provide information about the vertical structure of temperature, moisture (dew point) and winds in the upper atmosphere so can be used to determine atmospheric stability and to provide information about the strength and dryness of winds aloft. The diagrams can also detect layers of warm, very dry air (dry slots) and there is evidence that, under some circumstances, bushfires can induce mixing of dry slots to the surface, significantly influencing fire behaviour. Figure 11 shows aerological diagrams for 6 January constructed from balloon flights at Perth Airport, some 100 km north of the fire and modelled atmospheric profiles on 7 January for the fire ground location (courtesy Brad Santos, BoM).

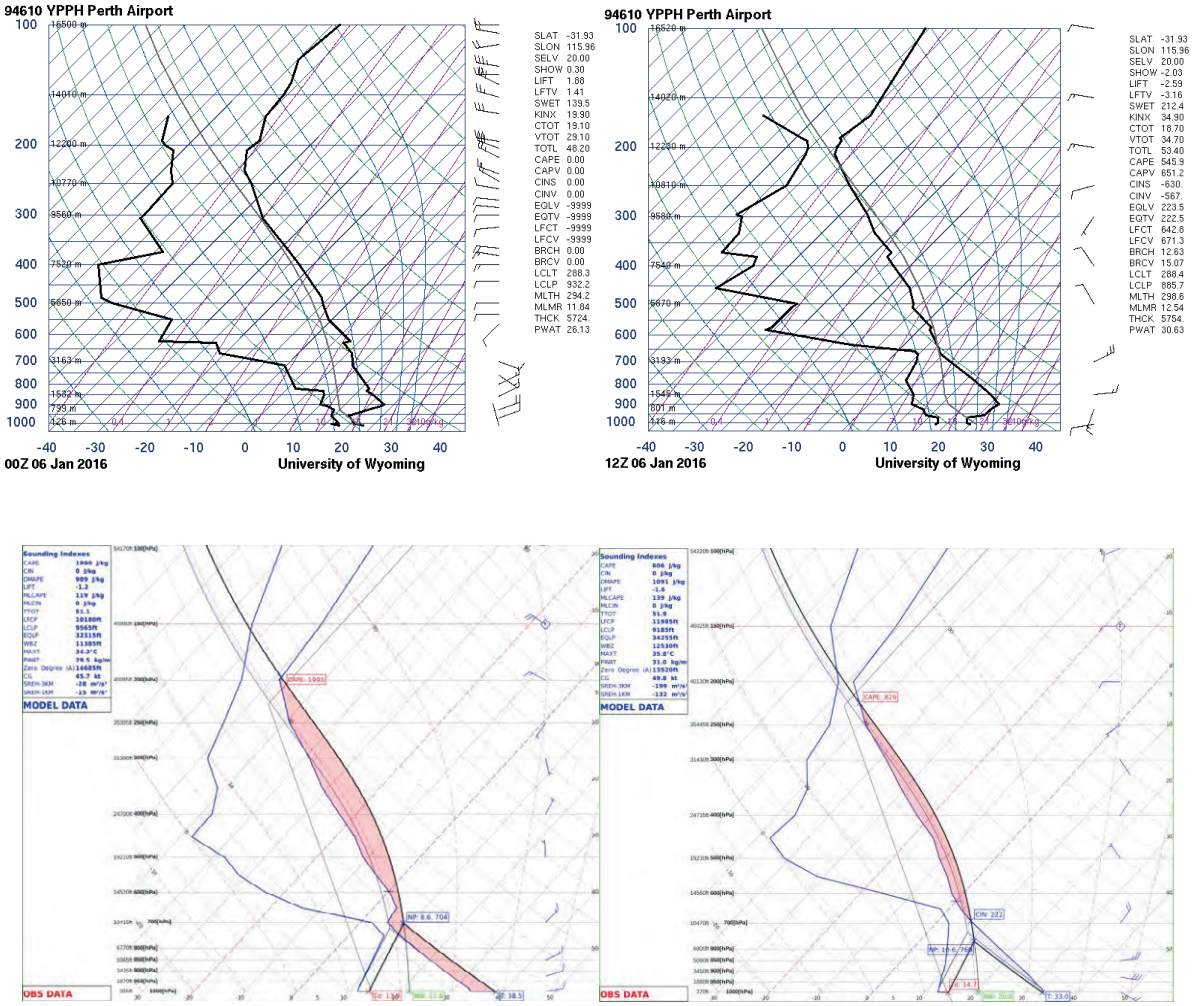

Figure 11: Aerological diagrams for Perth Airport at 0800 hr and 2000 hr on 6 January (upper panel) and modelled atmospheric profiles for the Waroona fire ground at 1400 hr (L) and 2000 hr (R) on 7 January (lower panel)(courtesy B. Santos BoM).

Significant features illustrated in Fig. 11 include:

- 6 January 0800 hrs: surface inversion, stable atmosphere (Lift Index = +1.88; c-Haines = 5.8), with dry air above 3,000 m.
- 6 January 2000 hrs : weak surface inversion, unstable atmosphere (Lift Index = -2.59; c-Haines = 9.6), dry air above 3,000 m.
- 7 January 1400hrs and 2000 hrs: unstable atmosphere (Lift Index = -1.2 and -1.6; c-Haines = 8.3 and 9.1), light to moderate ENE winds to 3,000 m.

The 95th percentile value for the c-Haines at Perth Airport is 8.8. Values above the 95th percentile have been consistently associated with unexpectedly severe fire behaviour in southern Australia (Mills and McCaw 2010).

Fire spread and behaviour

Phase 1 - 0630 to 1900 on 6 January

Weather

Wednesday 6 January was a hot dry day with a maximum temperature of 37°C and minimum relative humidity of 14% recorded relatively late in the afternoon at Dwellingup (Fig. 12). Morning winds were ESE and moderately strong, becoming lighter and more east NE during the afternoon (Fig. 13). Dew point fell steadily during the day to a minimum of 5.4°C at 1630 hrs then increased rapidly as the wind swung to the west south west. The McArthur FFDI peaked at 38 during the mid afternoon then declined as humidity increased and winds became lighter (Fig. 14). The Western Australian Forest Fire Behaviour Tables (Sneeuwjagt and Peet 1985) predicted a minimum Surface Moisture Content of 5% and a jarrah rate of spread index of 130 m h^{-1} at Dwellingup.

Wind speeds during the day were similar at Dwellingup and the Alcoa minesite which is 9 km closer to the fire ground than Dwellingup and measures wind at 30 m height (Fig. 15). After 1900 hr Dwellingup recorded significantly higher wind speeds. No data are available from the Alcoa minesite after 0130 hr on 7 January, because the power system was interrupted by the fire.

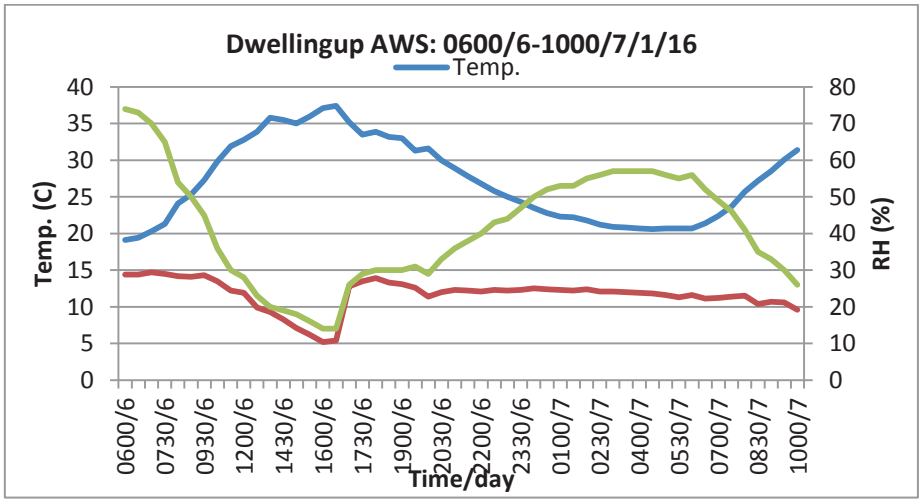

Figure 12. Dry bulb temperature (blue), dew point (brown) and relative humidity (green) recorded at Dwellingup from 0600 hr on 6 January to 1000 hr on 7 January 2016.

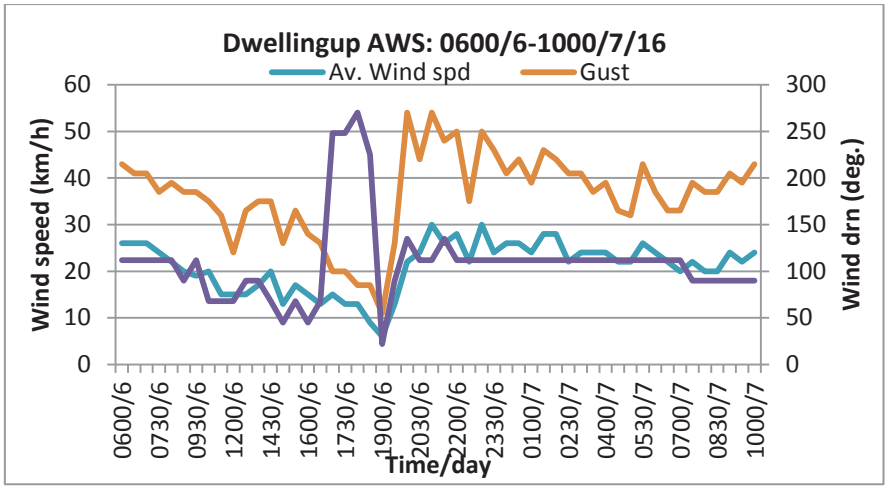

Figure 13. Average wind speed (blue), gust speed (brown) and wind direction (purple) recorded at Dwellingup from 0600 hr on 6 January to 1000 hr on 7 January 2016.

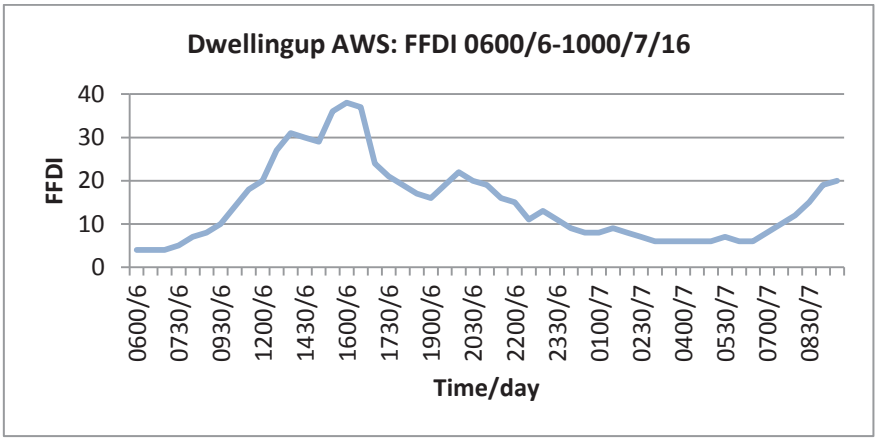

Figure 14. McArthur FFFDI at Dwellingup from 0600 hr on 6 January to 1000 hr on 7 January 2016.

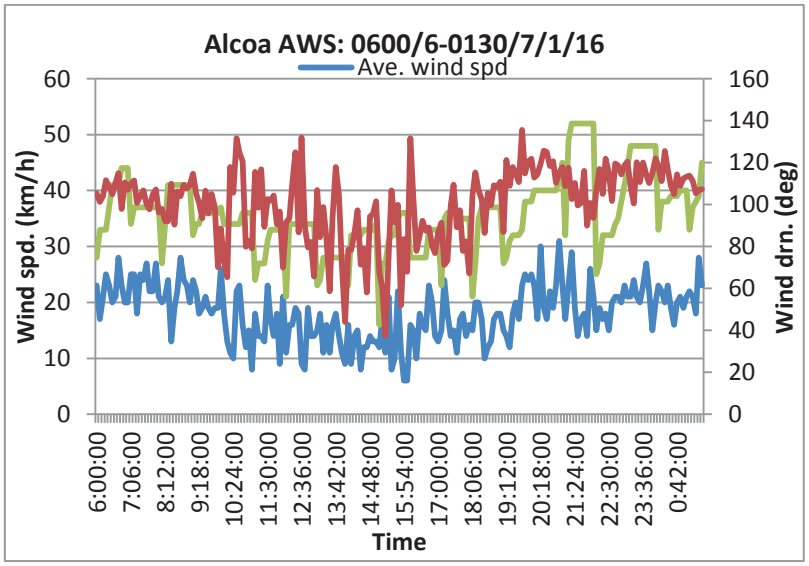

Figure 15. Average wind speed (blue), gust speed (green) and wind direction recorded at the Alcoa minesite from 0600 hr on 6 January to 0130 hr on 7 January 2016.

Fuels

The fire developed initially in open forest of jarrah and marri on the eastern side of the Murray River valley in 6 year old fuels dating from a spring 2009 prescribed burn in Young forest block (Fig. 1). Reports from Perth Hills District personnel indicate that the 2009 prescribed burn was of moderate intensity and consumed surface and near-surface fuels on the uplands, but that much of the steep west-facing aspect of the valley burnt patchily or not at all (M. Pasotti, pers. comm.). Fuel hazard and loading on these slopes may therefore have been considerably greater than indicated by the nominal fuel age of six years. Observations made by members of the fire investigation team near the origin of Fire 68 on 29 January supported this view, with an absence of bark charring on jarrah trees and a continuous and deep layer of surface fuel. In contrast, unburnt fuels near the origin of Fire 69 on the upland landform had considerable bark charring and a shallower surface fuel layer, as would be expected for 6 year old fuel.

West of the Murray River fuels were considerably older, ranging from 10 to 37 years since last fire. Much of the State forest within this phase of the fire run was through current mining activity that included active pits and expanses of recently cleared forest. As the fire progressed further west of Nanga Rd it encountered an increasing proportion of older rehabilitated bauxite pits densely stocked with jarrah and marri saplings (Fig. 3).

Fire behaviour

Lightning activity during the evening of Tuesday 5 January ignited two fires west of Murray Rd in Young forest block. These were first detected on satellite imagery by Parks and Wildlife personnel at 0630 on Wednesday 6 January. The eastern-most fire (Fire 69) was burning in open forest on a gentle slope above the 300 m contour at -32.89° 116.19°. First arriving crews reported mild fire behaviour with flame heights less than 2 m and this is supported by post-fire observations of char, defoliation and crown scorch height. The origin of Fire 69 was confirmed to be a mature marri tree struck by lightning with an obvious scar on the trunk (Fig. 16). Ground forces concentrated initial attack on Fire 69 because the prevailing easterly winds made it necessary to contain this fire before personnel could safely commence attacking Fire 68 which was further to the west. Fire 69 was contained at 1143 hr at a size of 11 ha.

Figure 16. Lightning struck tree at the origin of Fire 69.
Arrow points to fresh scarring on the trunk.
(Photo: Peter Moore, Parks & Wildlife Dwellingup)

The point of origin of Fire 68 was approximately 3 km west of Murray Rd in moderately steep terrain of the Murray River valley at -32.89° 116.17°. At 0815 hr the Parks and Wildlife spotter aircraft reported the fire to be 8 ha in size and burning with a rate of spread of 50-100 m h^{-1}. Aerial attack with water bombing aircraft commenced shortly afterwards with the aim of restricting the development of this fire until Fire 69 was contained and a direct attack made with bulldozers and ground crews on Fire 68. By 1000 hr the fire was reported to be spotting. Direct attack by ground crews and machines was hampered by the inaccessibility of the fire, the presence of large numbers of dead trees and the escalating intensity of the fire (Fig. 17 &18). Rock outcropping presented difficulties for bulldozers attempting to track the edge of the fire. By 1330 hr the fire had crossed the Murray River and was spreading west south west through steep and inaccessible terrain, with an estimated size of 160 ha.

The reconstruction of spread indicates that by 1450 hr the fire had reached the active bauxite mining operations in Keats forest block (Appendices 1 and 2).The reconstructed rate of forward spread of the fire between 1140 hr and 1450 hr was 1105 m hr^{-1} with a corresponding mean fireline intensity of about 12000 kW m^{-1} (Table 1). The predicted rate of spread ranged from 815 m h^{-1} to 1608 m h^{-1} depending on whether inputs represented the mean or maximum conditions of fine fuel moisture content, slope and wind speed.

Between 1450 hr and 1906 hr the rate of spread increased to a mean of 1320 m h^{-1} over the 4.25 hour period. A period of very rapid spread occurred between 1800 hr and 1906 hr when the observed rate of spread was 3272 m h^{-1}, exceeding the predicted rate of spread by a significant margin even when the maximum input values were applied. This period coincided with the fire encountering an area of un-mined forest in proposed national park between King Jarrah Formation and Nanga Rd last burnt in 1978 and carrying 37 year old fuel. The fire spread uphill on slopes of up to 12° for a distance of 1-1.5 km through the 37 year old fuel. Field inspection and aerial photography indicate sustained periods of crown fire with flame heights in excess of 30 m.

Abundant firebrands generated by intense fire behaviour in the long unburnt fuel are likely to have contributed to mass spotting during the early evening.

Table 1. Observed and predicted forward rate of spread (FROS), fireline intensity and McArthur Forest Fire Danger Index (FFDI) for spread periods from 1130 hr to 1906 hr on Wednesday 6 January. Values are mean and (maximum) for observations and predictions. Weather observations are from the Alcoa minesite.

Time period	Wind speed (75%) (km h^{-1})	Wind gust (Max) (km h^{-1})	Temp (Max) (°C)	RH (Min) (%)	Slope (Max) (deg.)	SMC (Min) (%)	Obs. FROS (Max) (m h^{-1})	Pred. FROS (Max) (m h^{-1})	Obs. Intensity (kW/m)	FFDI (Max)
1140-1450	14.3	31	34.3	23.5	+3	4.9	1105	815	12155	26
	(17)		(35.8)	(18)	(+6)	(4.2)	(n/a)	(1608)		(33)
1450-1906	15.0	33	35.8	23.2	+1	4.8	1320	800	14520	27
	(17)		(37.2)	(14)	(+5)	(3.7)	(3272[a])	(1814)		(40)

[a] FROS observed from 1800 hr to 1906 hr.

Figure 17. View from the origin of Fire 68 west across the Murray River valley. Note the slope, evidence of intense fire behaviour and presence of numerous dead trees that pose a risk to firefighters.

Figure 18. Aerial view of Fire 68 spreading west towards the Murray River at 1149 hr on 6 January. Camera is pointing north east, with the river in the foreground. (Photo: Alf Lorkiewicz, Parks & Wildlife Bunbury)

Figure 19. Pyro-cumulonimbus cloud visible at 1934 hr on 6 January from Dwellingup, about 19 km north of the headfire position at that time. (Photo: Allan Clarke, Parks & Wildlife Dwellingup).

By 1730 hr a large pyro-cumulonimbus cloud had formed above the fire, with the plume moving towards the south-west (Fig. 19). Numerous ground lightning discharges were detected by sensors from 1612 hrs onwards, peaking between 1830 hr and 1930 hr. Discharges were detected mostly on the southern side of the fire but a smaller number were also detected west of the fire towards the escarpment. Lightning activity ceased after 2038 hr.

Phase 2 – 1900 hr on 6 January to 0930 hr on 7 January

Weather

Overnight the temperature declined to a minimum of 21°C and relative humidity increased to 57% (Fig. 12). Dew point remained relatively constant between 11°C and 12°C throughout the night. A secondary peak in FFDI of 22 occurred around 2000 hr as the ESE wind re-developed and increased in strength to up to 30 km h^{-1} with gusts to 54 km hr^{-1}. Winds remained consistently from the ESE overnight with average speeds from 24-33 km h^{-1} and gusts to 56 km h^{-1}. These dry windy conditions would have provided little opportunity for overnight recovery of fine fuel moisture, and DEFM models indicate that fine fuels would have stabilised at a moisture content of 11-12%.

Fuels

From Nanga Rd west to the escarpment the fire spread through a complex mosaic of active mining operations, mining infrastructure, rehabilitated bauxite pits and remnant native forest. Much of this area carried fuels older than 20 years, apart from along the southern flank which abutted the January 2006 fire.

Once the fire reached the edge of the escarpment it encountered a mixture of remnant woodland and pasture. The northern flank of the fire encountered one year old fuels immediately east of the Waroona townsite which resulted from the January 2015 bushfire. Fuels on the coastal plain included fully cured pasture, irrigated pasture and remnant woodland and swamp vegetation along drains and road verges.

Fire behaviour

By 1900 hr the headfire was up to 2 km west of Nanga Rd. Aircraft returned to base overnight with the result that information about the location and behaviour of the fire was reduced greatly and limited to field observations often made from a considerable distance away. This was compounded by the complexity of accessing and navigating the minesite. Estimates of the rate of spread of the fire are therefore based on a reconstruction of spread made using limited field observations, post-fire observation of leaf freeze and interpretation of patterns of crown scorch and defoliation from aerial photography.

The headfire continued spreading towards the west-north-west and maintained a rapid rate of spread estimated to have been around 2000 m h^{-1}. The pattern of crown damage indicates little moderation in the rate of spread of the fire over the next four hours. Mass spotting appears to have been an important mechanism that allowed the fire to maintain uninterrupted spread through the minesite despite the presence of wide haul roads, powerline easements and pits. There is also evidence of a number of independent ignition points that may have arisen from long distance spotting or have been ignited by lightning strikes associated with the pyro-cumulonimbus event earlier in the evening. The reconstruction map indicates a concentration of spot fires reported at 2340 hr between Lake Navarino and Lake Moyanup and directly east of Waroona townsite (-32.85° 115.97°). A distinct band of defoliated forest extending westwards from Lake Kabbamup along the valley of the Sampson Brook is also visible on the high resolution air photography, several kilometres south of the main fire. The pattern of crown defoliation suggests a separate run of fire arising from an ignition just west of the Sampson dam wall (-32.88° 116.01°), but it is not possible to determine whether this was caused by lightning ignition or spotting.

The reconstructed rate of spread of the fire from 1900 hr to 2300 hr is considerably faster than the predicted rate of spread by a factor of at least twofold (Table 2). Possible reasons for this underprediction include the contribution of mass spotting to fire propagation, and the presence of extensive areas of rehabilitated forest that are prone to crowning and greater wind influence than the native forest.

Shortly after 2100 hr reports indicated that the Waroona townsite was under sustained ember attack and that a number of spot fires had begun to develop in pasture and bushland on the escarpment east of the town. An experienced Parks and Wildlife firefighter despatched from the Dwellingup office to gather field intelligence reported that the fire impacting Waroona appeared to be well advanced and separate from the main fire front which was further to the north and still burning in the minesite.

By 2130 hr a tongue of fire is reported to have crossed the South West Highway between Waroona and the small locality of Hamel about 1 km further south. This tongue of fire appears to have originated from the multiple spot fires around Lake Moyanup and from spot fires starting downwind of the fire run in the Sampson Brook. The area where the fire crossed the highway is the convergence of the Drakes and Samson Brooks and it is likely that the alignment of the incised terrain and the prevailing winds contributed to channelling of the wind and the path of the fire.

Table 2. Reconstructed and predicted forward rate of spread (FROS) and fireline intensity for spread periods from 1130 hr to 1906 hr on Wednesday 6 January. Values are mean and (maximum) for observations and predictions. Weather observations are from the BoM Dwellingup station.

Time period	Wind speed (75%) (km h^{-1})	Wind gust (Max) (km h^{-1})	Temp (Max) (°C)	RH (Min) (%)	Slope (Max) (deg.)	SMC (Min) (%)	Recon. FROS (Max) (m h^{-1})	Pred. FROS (Max) (m h^{-1})	Recon. Intensity (kW/m)	FFDI (Max)
1900-2100	20.6	54	30.8	31.7	0	7.7	2000	549	22000	21
	(28)		(33.4)	(29)	(+2)	(5.6)	(n/a)	(1391)		(27)
2100-2300	27.5	56	28.8	36.0	0	8.4	2000	661	22000	19
	(28)		(28.2)	(26)	(+5)	(6.9)	(n/a)	(1342)		(25)

West of the highway the fire entered the Waroona main drain and followed the drain to the north west for two kilometers before crossing Fawcett Rd where the drain turns due west (Fig. 20). Channelling by the drain resulted in a very long and narrow fire shape. Firefighting efforts focussed on restricting lateral spread of the flanks, but efforts to contain the headfire were hampered by the speed and intensity of the fire in the remnant vegetation adjoining the drain. By 0400 hr on 7 February fire had spread to the western side of the Southern terminal powerline and was burning between Coronation Rd on the north flank and Buller Rd on the south flank.

Figure 20. Waroona main drain looking east back towards Fawcett Rd. This area burnt during the early hours of Thursday 7 January.

By 0200 hr on 7 January fire was impacting on the eastern outskirts of the Waroona townsite (Fig. 21), presumably as a result of spotting from the main fire which had spread on the southern side of Lake Navarino. Sparse 1 year old fuels dating from the January 2015 bushfire would have reduced the likelihood of spotfires starting and their potential fire intensity.

Figure 21. Waroona townsite, property at Woodley Heights impacted by spotting from the main fire run early on the morning of 7 January.

Phase 3 – 0930 hr to 1830 hr on 7 January

Weather

Observations at Dwellingup show that the temperature rose steadily throughout the morning to reach a maximum of 40°C at 1530 hr, coinciding with a minimum relative humidity of 11% (Fig. 22). Dew point declined throughout the day to a minimum of 0.6°C at 2130 hr. The Western Australian Forest Fire Behaviour Tables (Sneeuwjagt and Peet 1985) predicted a minimum Surface Moisture Content of 5% and a jarrah rate of spread index of 130 m h^{-1} at Dwellingup.

At Dwellingup the winds shifted from ESE to E around 0700 hr and then remained easterly until after midday when a north easterly influence is evident (Fig. 23). At Waroona the influence of ENE winds became evident after 0900 hr. Observations from Wagerup shows winds southerly in the morning, shifting ENE around 1230 hr with some periods of due northerly wind during the afternoon.

However, satellite imagery, consistent with the scorch pattern, shows clearly that the southern flank of the fire was under the influence of an ENE wind from around 0700 hr on 7 January. This influence was not detected in 30 minute observations at any of the observation sites, but was evident in the 1 minute observations for brief periods. The possibility of localised wind influence over the fireground warrants further investigation. The lack of observations representative of the fireground creates some uncertainty over comparisons between reconstructed and predicted fire behaviour during this phase of fire activity.

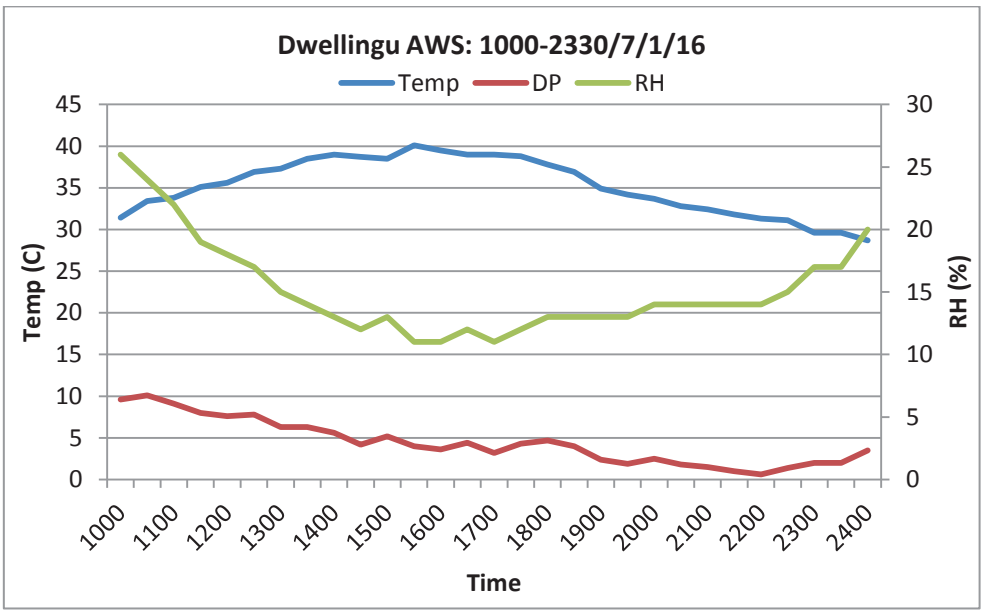

Figure 22. Dry bulb temperature (blue), dew point (brown) and relative humidity (green) recorded at Dwellingup from 1000 hr to 2400 hr on 7 January 2016.

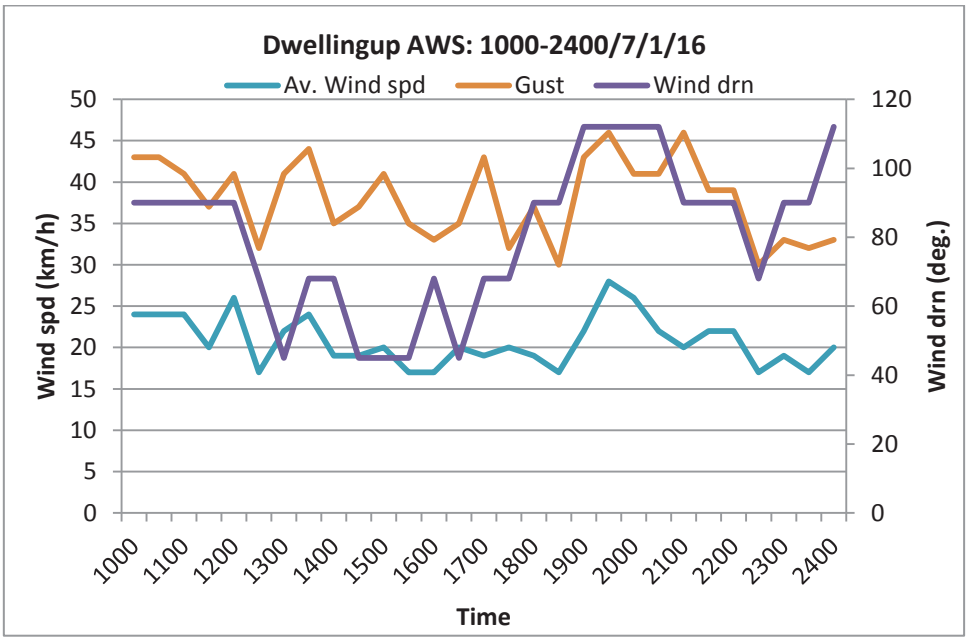

Figure 23. Average wind speed (blue), gust speed (brown) and wind direction (purple) recorded at Dwellingup from 1000 hr to 2400 hr on 7 January 2016.

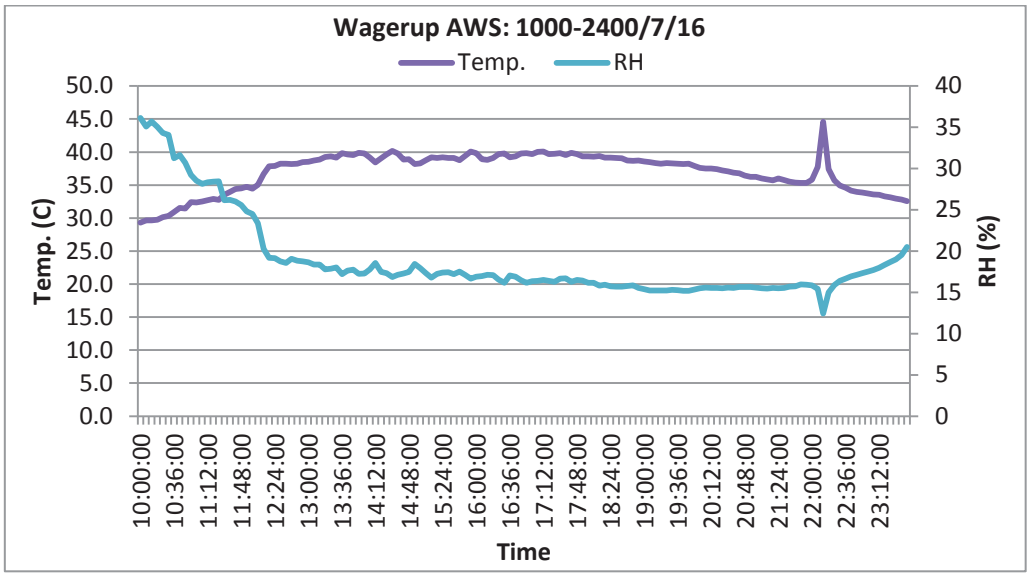

Figure 24. Dry bulb temperature (purple) and relative humidity (blue) recorded at Wagerup Refinery from 1000 hr to 2400 hr on 7 January 2016.

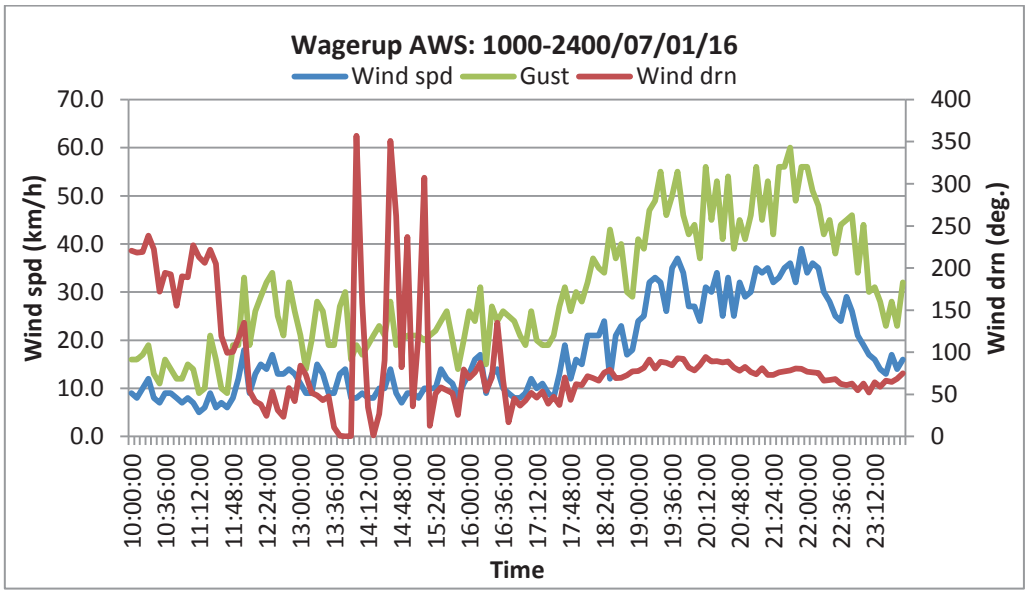

Figure 25. Average wind speed (blue), gust speed (green) and wind direction (brown) recorded at Wagerup Refinery from 1000 hr to 2400 hr on 7 January 2016.

Fuels

East of the Muja Northern terminal powerline fuels were jarrah marri forest 6 to 10 years old, with some areas of recent mining activity. West of the powerline fuels were jarrah marri forest mostly unburnt for at least 20 years, including some areas unburnt for up to 37 years. There were also extensive areas with rehabilitated mine pits of varying ages, mostly to the west and south of the minesite conveyor line. South of the Willowdale-Wagerup Rd the vegetation was predominantly native forest, with the youngest fuels being 8 years old in the western portion of Waterous forest block.

Fire behaviour

The aerial photography shows a distinct band of unscorched crowns running in an east to west direction about 1 km south of the junction of the Willowdale mine conveyor and the Muja Northern terminal powerline. This feature is likely to indicate the position of the southern flank of the fire during its overnight run towards Waroona. South of the unscorched band the direction of fire spread indicated by leaf freeze shows a change to the west south west and there is an obvious increase in fire intensity to full crown scorch and extensive defoliation suggestive of widespread crown fire, particularly in the older fuels west of the powerline. This indicates the beginning of a major run by the southern flank of the fire under ENE winds sometime between 0700 hr and 0800 hr. This run continued throughout the morning with a reconstructed rate of spread averaging 1500 m h^{-1} over a period of four hours (Table 3). We have confidence in this reconstruction as it is based on air intelligence and time-stamped photographs of the fire at known locations including Mt William (Fig. 26).

A large pyro-cumulonimbus developed over the fire during the later part of the morning, attaining its maximum development between 1100 hr and 1200 hr when the fire was spreading on a very broad front to the south west through forest unburnt for 20 years or more (Fig. 27 & 28). A second pyro-cumulonimbus cloud developed over the fire during the early afternoon, and was evident on satellite imagery at 1350 hr.

Table 3. Reconstructed and predicted forward rate of spread (FROS) and fireline intensity for spread periods from 0930 hr to 1830 hr on Thursday 7 January. Values are mean and (maximum) for observations and predictions. Weather observations are from the BoM Dwellingup station.

Time period	Wind speed (75%) (km h^{-1})	Wind gust (Max) (km h^{-1})	Temp (Max) (°C)	RH (Min) (%)	Slope (Max) (deg.)	SMC (Min) (%)	Recon. FROS (Max) (m h^{-1})	Pred. FROS (Max) (m h^{-1})	Recon. Intensity (kW/m)	FFDI (Max)
0930-1330	22.5	39	30.5	20.5	+1	4.5	1500	1420	16500	28
	(24)	(50)	(38.5)	(14)	(+5)	(3.8)	(n/a)	(2587)		(37)

Figure 26. View of Mt William at 1140 hr on 7 January, with numerous spot fire ignitions evident in forest on the right hand side of the image. The main fire run has not yet arrived at Mt William. (Photo: Jessica Newman, Parks & Wildlife Bunbury).

Figure 27. Jarrah forest defoliated by crown fire north of Driver Rd at Willowdale during later morning on 7 February.

Figure 28. Pyro-cumulonimbus cloud observed from Dwellingup at 1134 hr on 7 January. The upper part of the plume appears to be under a westerly wind influence. (Photo: Steve Gunn, Parks and Wildlife Dwellingup).

Under the influence of NE winds the southern flank of the fire spread down the escarpment towards the Wagerup Refinery, crossing the South West Highway south of Waroona in a number of places by 1300 hr (Figs. 29 & 30). As the afternoon progressed wind strengths eased and the rate of spread and intensity of the fire reduced. This is reflected in the pattern of crown damage with a shift from defoliation to crown scorch during this period. The escarpment area appears to have been under the influence of northerly winds for periods during the afternoon, based on anemometer observations at Wagerup and the direction of leaf freeze. The 1 minute observations from Waroona record a NNW wind at 1400 hr. This northerly influence had the effect of extending the fire southwards along the escarpment to the east of Yarloop.

Figure 29. Fire crossing South West highway just north of Bancell Rd, 1313 hr on 7 January. (Photo: Jessica Newman, Parks & Wildlife Bunbury).

Figure 30. View north towards Yarloop townsite at 1310 hr on 7 January showing extensive fire activity on the escarpment and several spot fires well to the west of the main fire front. (Photo: Jessica Newman, Parks & Wildlife Bunbury).

Figure 31. Belt of planted trees adjoining a drainage channel, looking east from Somers Rd towards the escarpment. The fire has run as an elongated narrow tongue following the heavier fuel in the planted belt, with minimal lateral spread into eaten-out pasture.

Throughout the day the fire also remained active in agricultural lands on the coastal plain west of Waroona, particularly in the area between Buller Rd and Coronation Rd. The pattern of fire spread on the coastal plain was complex and influenced strongly by factors of land use and the condition of pastures, remnant native vegetation and belts of planted trees (Fig. 31).

Phase 4 – 1830 hr to 2400 hr on 7 January

Weather

Temperatures remained hot for an unusually long time into the evening, exceeding 35°C at Wagerup until 2200 hr (Fig. 24). Relative humidity also remained low and very stable at 15% well into the evening with the falling dew point offsetting any reduction in temperature. After 1700 hr the winds became consistently ESE and increased steadily in strength for the next 2.5 hours rising to a peak around 1930 hr with average winds at Wagerup of 35 km h^{-1} and gusts to 56 km h^{-1}. During the peak conditions the FFDI increased to between 50 and 60, in the lower end of the Severe fire danger rating class.

Weather conditions at Dwellingup followed a similar pattern, although there was some moderation of temperature after 1900 hr and winds were not as strong as at Wagerup near the base of the escarpment.

Fuels

By 1830 hr the south west flank of the fire was burning in freehold land on the escarpment which included extensive areas of remnant native forest, partially cleared lands with pasture, a vineyard and other agricultural enterprises. On the eastern side of Yarloop townsite there were a number of small Crown reserves with a total area of about 100 ha established for a variety of purposes including a rifle range, nature reserve, recreation, road verge and rubbish pit. North of Hoffman Rd and east of the South West Highway were a number of small freehold blocks, many of which retained a considerable cover of native vegetation. Bushland around Yarloop is typically an open forest of jarrah with a dense mid-storey of *Allocasuarina* and a well developed understorey of low shrubs. The recent fire history of this area is not well documented but local knowledge indicates that most of the bushland around Yarloop had not been burnt for at least 20 years, with the exception of a small nature reserve at the southern end of the townsite and west of the highway that was burnt by prescribed fire in May 2015.

Fire behaviour

Personal accounts provided by firefighters present in the Yarloop area during the evening of 7 January indicate that the behaviour of the fire was quite mild as it spread down the escarpment under relatively light winds. This is consistent with the pattern of crown damage which shows incomplete crown scorch and an absence of any extensive defoliation east of the Wagerup-Worsley powerline which runs parallel to, and about 1 km east of, the highway at this point. Up until 1900 hr the possibility of holding the fire along a defensive line constructed east of Yarloop along the powerline appeared realistic.

Shortly after 1900 hr a spotfire was noticed on the west side of the highway burning in a paddock just south of Clifton Rd. A second tongue of fire crossed west of the highway near the northern end of town just south of Boundary Rd a few minutes later. Fire behaviour along the entire south west flank of the fire escalated dramatically around this time as the fire spread into the bushland reserves on the eastern side of the highway and then continued to spread west through Yarloop. The reconstructed rate of spread of the fire from 1830 hr to 2030 hr is 2000 m h^{-1} (Table 4), and undoubtedly there were shorter periods of much faster spread coinciding with wind gusts and fire spread in heavy, continuous fuels. Predicted rates of spread in forest and eaten-out grassland were comparable to the reconstructed rate of spread. The extreme fire behaviour in heavy fuels caused massive spotting that impacted on Yarloop resulting in the ignition of a large number of buildings in a very short time. For the remainder of the evening strong easterly winds continued to push the fire west of Yarloop across the coastal plain for a further 12 km.

Table 4. Reconstructed and predicted forward rate of spread (FROS) and fireline intensity for spread periods from 1830 hr to 2400 hr on Thursday 7 January. Values are mean and (maximum) for observations and predictions. Weather observations are from the Alcoa Wagerup Refinery station.

Time period	Wind speed (75%) (km h^{-1})	Wind gust (Max) (km h^{-1})	Temp (Max) (°C)	RH (Min) (%)	Slope (Max) (deg.)	SMC (Min) (%)	Recon. FROS (Max) (m h^{-1})	Pred. FROS (Max) (m h^{-1})	Recon. Intensity (kW/m)	FFDI (Max)
1830-2030	27.7 (32.4)	44 (56)	38.2 (39.1)	15 (15)	-4 (0)	3.8	2000 (n/a)	Forest 2318 Grass[a] 3566	Forest 22000 Grass[a] 2764	51 (60)

[a] Assumed to be eaten out.

The rapid escalation in fire behaviour experienced at Yarloop during the evening of 7 January was reflected more broadly across the entire western side of the fire including east of Waroona in the Lake Navarino area, and west of Waroona on the coastal plain where the fire made a major run through the McLarty pine plantation and the Yalgorup National Park. This run was interrupted by Lake Preston although spot fires landing on the western side of the lake ignited coastal heathland that continued to burn westwards until reaching bare dunefields. The major break-out west of Waroona caused a significant increase in the scale and complexity of the fire by closing the Forrest Highway, severing both major highway connections and the passenger rail connection between Perth and Bunbury for a number of days.

Synthesis of major findings drawn from the fire reconstruction

Antecedent conditions

The south-west of Western Australia has experienced a consistent drying trend since the mid 1970s, with the past 15 years including notably dry years in 2001, 2006, 2010 and 2015. Rainfall decline has been particularly pronounced in the late autumn and early winter period. Average temperatures have also increased steadily over this period, resulting in greater evaporation and transpiration of moisture to the atmosphere. These trends have important implications for the dryness of forest fuels and for the condition of riparian vegetation and wetlands that have developed during wetter climate phases when seasonal inundation occurred with greater reliability. Fine forest fuels are now drying out earlier in the spring and remaining at low moisture content for an extended period through into the autumn in most years. Dry winters are limiting the opportunity for moisture uptake by larger woody fuels including standing dead trees, stumps and fallen logs with the result that these are available to burn earlier in the spring, and may burn away completely under dry summer conditions. Combustion of greater quantities of woody fuel adds to the total heat output and emissions from forest fires, leads to greater impact on living vegetation and soils, and increases the difficulty of fire suppression and mop-up. The spring of 2015 saw a rapid onset of dry conditions with the Soil Dryness Index rising steeply from early September and trending at near-record dryness (based on 24 year observation period) for the four months leading up to the fire. These conditions would have ensured a very high level of fuel availability.

The long term drying trend for the south-west is also influencing land use and water management practices in the agricultural sector with a shift to dryland farming on the coastal plain and the replacement of open channel irrigation with piped systems for water distribution. This is important from the perspective of bushfire management because it changes the nature of fuel availability across the landscape. Where irrigated pastures and green vegetation might once have limited the opportunity for fire spread on a large scale, this is no longer the case on many parts of the coastal plain. Similarly, seasonal wetlands that may have retained moisture well into the summer period and acted to retard the spread of fires are now drier and prone to burning, including combustion of deep organic soils. The January 2016 fire was the largest to impact on the coastal plain between Perth and Bunbury for many decades, and this should prompt a re-evaluation of the potential for large fires in this landscape.

Increased area of long unburnt forest fuels

For most of 6 and 7 January the fire was burning in forest fuels that were at least 10 years old, with sizeable areas of fuel more than 20 years old. The existence of large tracts of old fuel undoubtedly contributed to the rapid spread and high intensity of the fire, and to other phenomena including crown fire, mass spotting and the development of multiple events of pyro-convection.

There was a strong coincidence between long unburnt fuels, positive (uphill) slopes and pyro-convection events on the afternoon of 6 January and late morning of 7 January. These events warrant further study to better understand the relationship between burning conditions at the surface and the development of pryro-convection. There is also an important question regarding the extent to which rate of spread, intensity and spotting are enhanced by the formation of a pyro-cumulonimbus cloud above a fire. Evidence from the fire reconstruction is mixed, with predicted rates of spread falling well short of observed spread between 1800 hr and 1906 hr on 6 January, but corresponding reasonably well with observed rates of spread on the morning of 7 January.

We are unable to fully explain the rapid spread and long distance spotting that took place after 1900 hr on 6 January causing the fire to reach Waroona much sooner than expected. Possible explanations include the presence of numerous patches of remnant native forest unburnt for several decades or more within the mining envelope, and the contribution of further ignitions from lightning caused by the pyro-convection earlier in the afternoon. It is also likely that the moisture content of the older, deeper surface fuel profiles is not increasing significantly over night enabling active fire behaviour to be maintained.

Localised areas of long unburnt fuel adjoining Yarloop clearly played a key role in generating very high fire intensities and mass spotting that resulted in extensive damage to a large number of buildings in the town.

Abundant and long unburnt fuels in road verges and other vegetation corridors also probably contributed to the scale of the impact on the electricity transmission grid by facilitating the combustion of power poles.

Acknowledgements

Personnel from the Department of Parks and Wildlife, Department of Fire and Emergency Services, Shires of Waroona and Harvey provided information used in this reconstruction. Appendix C lists those people who were interviewed as part of the reconstruction work. A number of people provided photographs which have been included in this report and their work is credited where appropriate. All other photographs used in this report were taken by Lachlan McCaw. We thank Theo Menne of the Department of Parks and Wildlife for assistance with GIS and map production for the report, and the Spatial Services Group of the Department of Fire and Emergency Services for making data available.

We also thank Brooke Stephen for making available data from Alcoa weather stations, and staff from the Bureau of Meteorology Perth Regional Forecasting Centre for providing and interpreting a range of weather data and derived products.

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Appendix A
Reconstruction of the spread of Perth Hills Fire 68 on 6-7 January 2016 overlaid on a land tenure base map.

Appendix B
Reconstruction of the spread of Perth Hills Fire 68 on 6-7 January 2016 overlaid on a base image showing categories of crown damage determined from high resolution aerial photography.

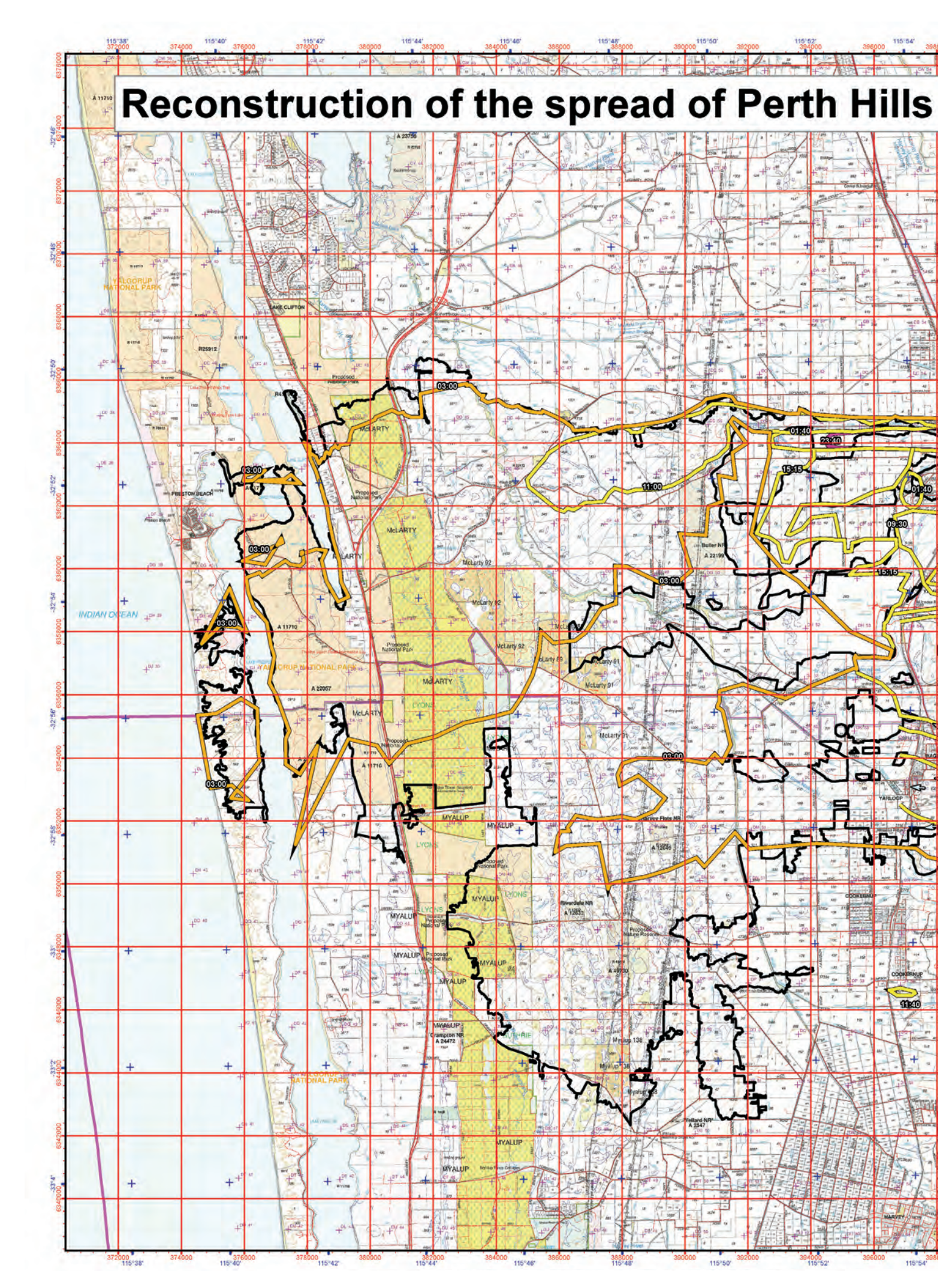
Appendix C List of people interviewed for the fire behaviour reconstruction.

APPENDIX C

LIST OF PEOPLE INTERVIEWED FOR THE FIRE BEHAVIOUR RECONSTRUCTION

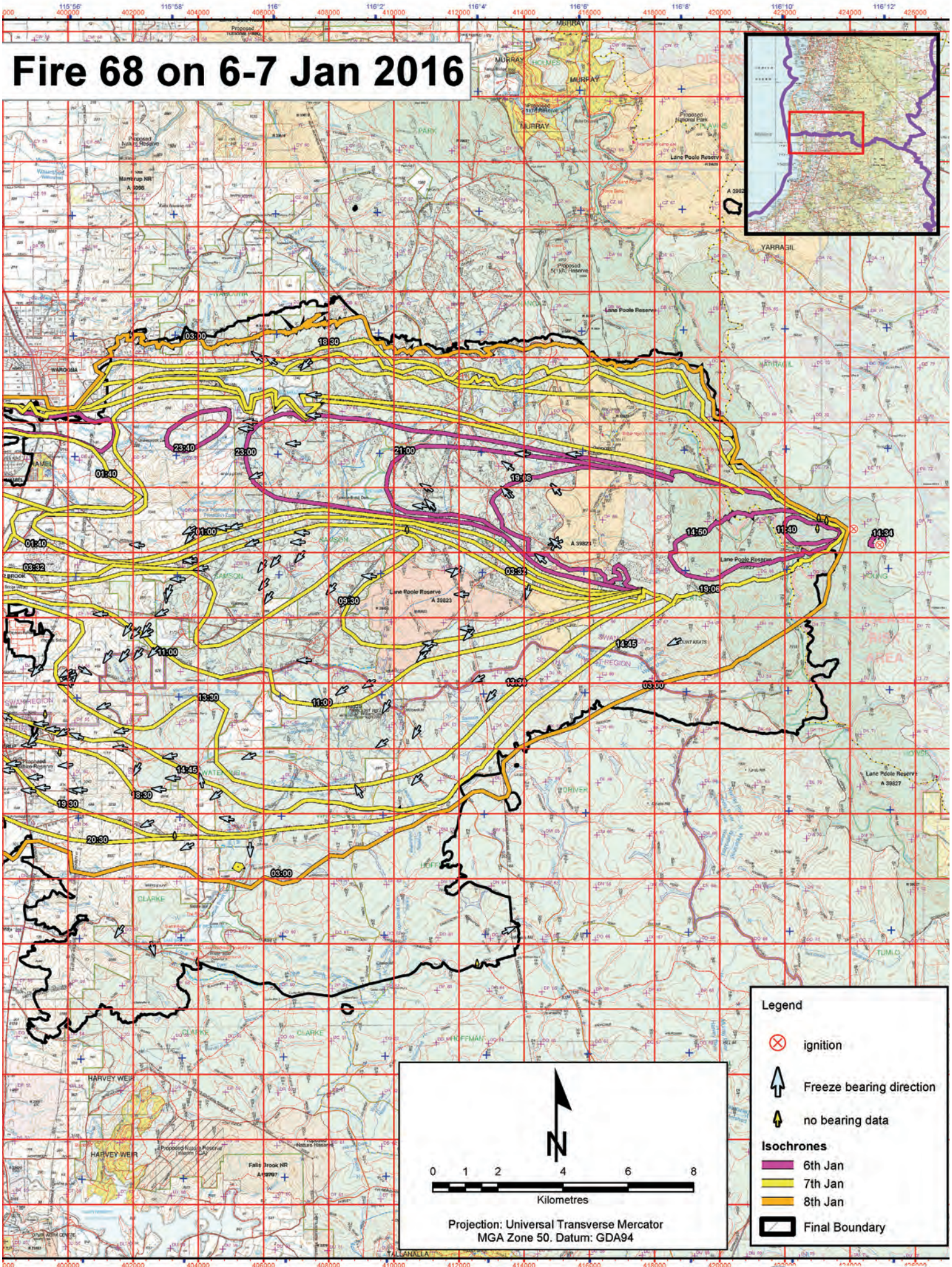
Name	Organisation
Department of Parks and Wildlife	Alan Brown
	George Bradshaw
	Mike Cantelo
	Erin Davis
	Tom Conlan
	Trevor Dye
	Ian Freeman
	Steve Gunn
	Bob Hagan
	Carl House
	Greg Mair
	Alan Madgwick
	Jess Neuman
	John Prins
	Chris Roberts
	Brian Smith
	Rob Young
Department of Fire and Emergency Services	Clinton Kuchel
	Antony Nicholas

Reconstruction of the spread of Perth Hills



Graticule shown at 2 minutes intervals
Grid shown at 2000 metre intervals

Fire 68 on 6-7 Jan 2016

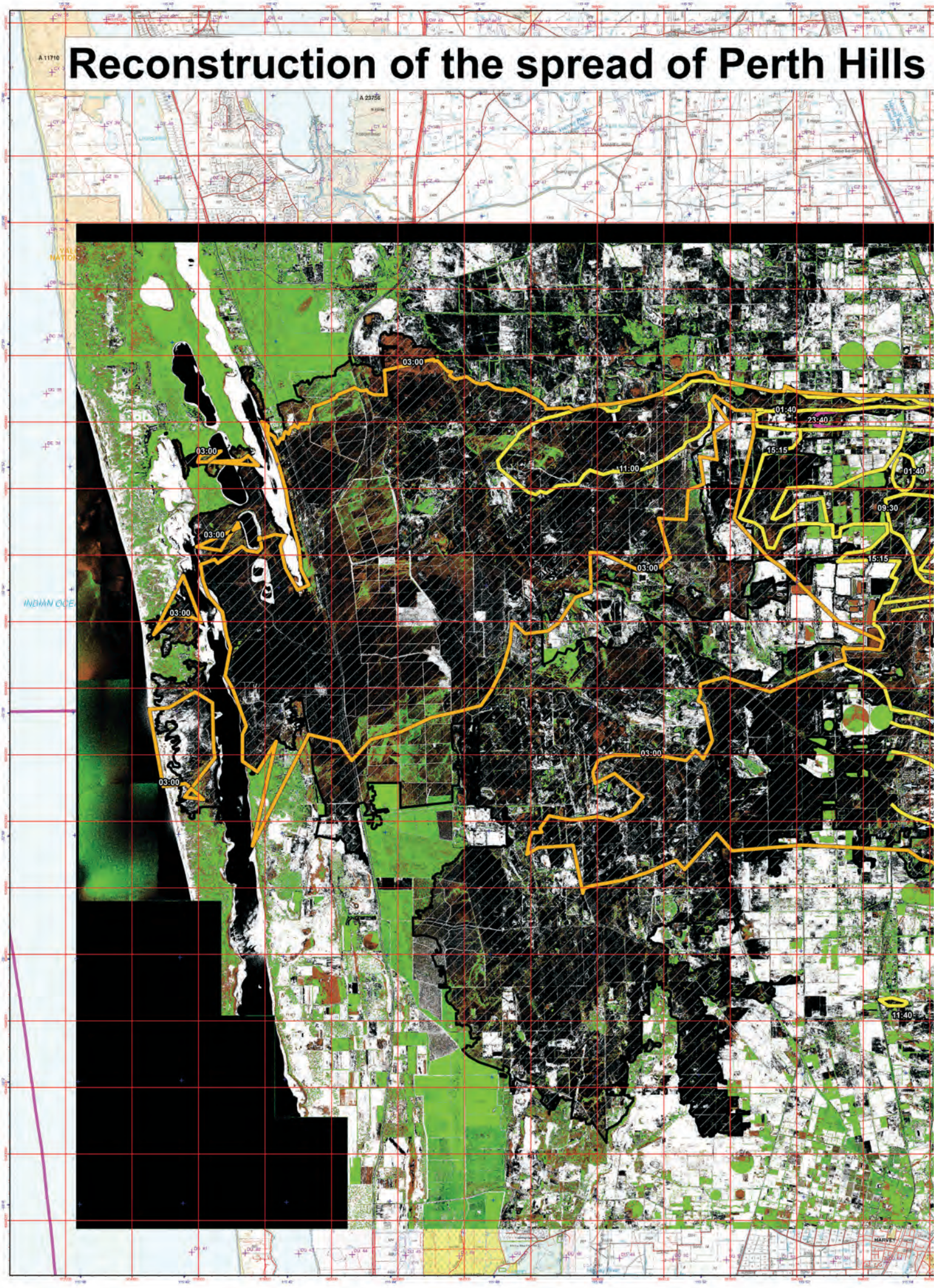


Produced by TM,
Department of
Parks and Wildlife

Produced at 10:8am, on Feb 29, 2016

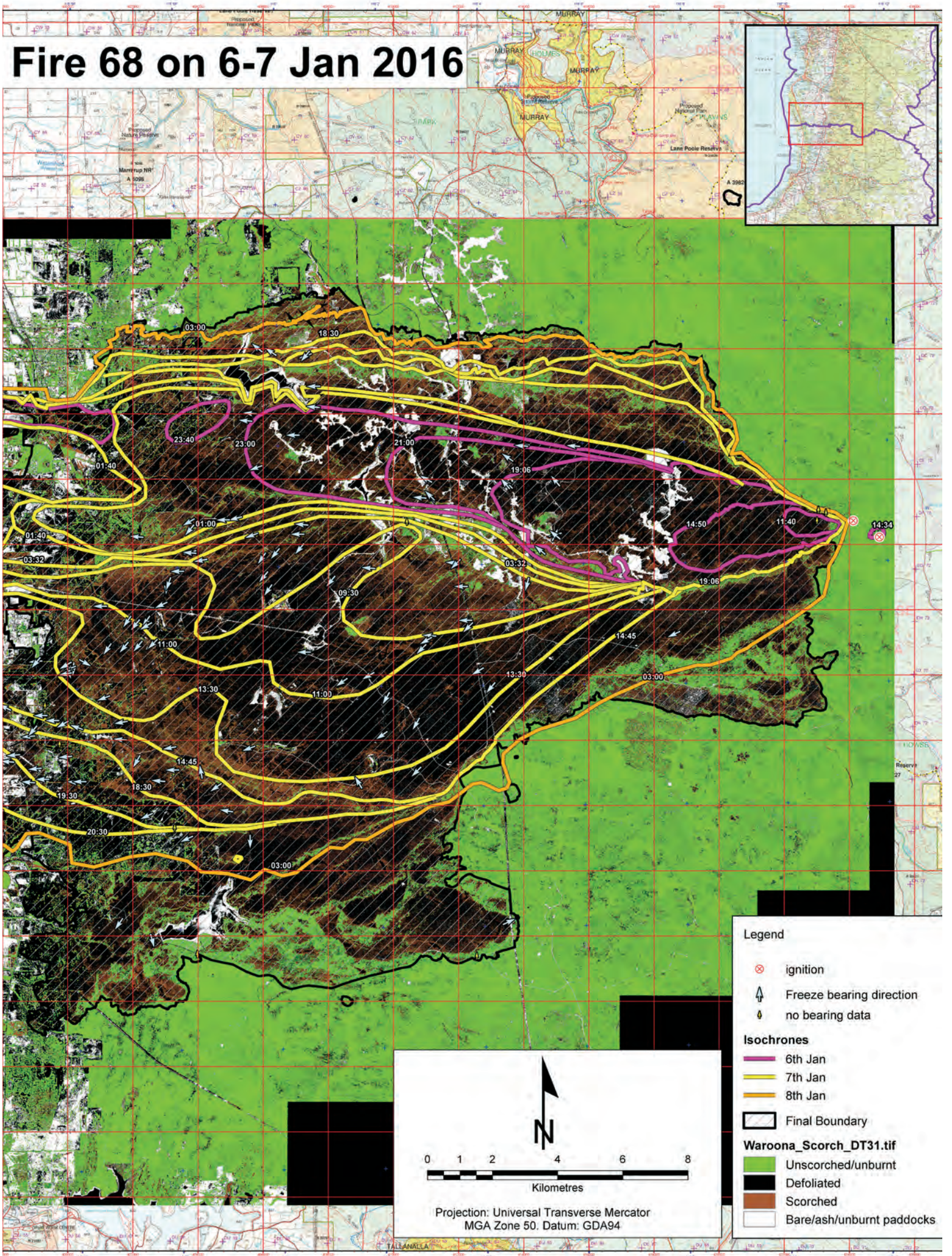
Department of
Parks and Wildlife

Reconstruction of the spread of Perth Hills



Graticule shown at 2 minutes intervals
Grid shown at 2000 metre intervals

Fire 68 on 6-7 Jan 2016



Legend

- ignition
- Freeze bearing direction
- no bearing data

Isochrones

- 6th Jan
- 7th Jan
- 8th Jan
- Final Boundary

Waroona_Scorch_DT31.tif

- Unscorched/unburnt
- Defoliated
- Scorched
- Bare/ash/unburnt paddocks

N

0 1 2 4 6 8

Kilometres

Projection: Universal Transverse Mercator
MGA Zone 50. Datum: GDA94

Produced by TM,
Department of
Parks and Wildlife

Produced at 10:8am, on Feb 29, 2016

Department of Parks and Wildlife

Australian Government
Bureau of Meteorology

Meteorological Aspects Of The Waroona Fire January 2016

Western Australian Regional Office
Bureau of Meteorology, Perth, WA

Pyrocumulonimbus cloud over the Waroona area 7 January 2016. Photo courtesy of Tracy Vo, Channel 9.

Version number/type	Date of issue
1.0	March 2016

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1 Introduction

The purpose of this report is to provide an account of the weather conditions over the Waroona Fire, specifically during the period 5 to 7 January 2016 and focussed on Waroona and surrounding areas. This report also records the Bureau of Meteorology's (Bureau's) fire weather forecast service associated with this fire.

This report includes;

- description of the topography of the fire ground;
- details of lightning activity over the fire ground from 5 to 7 January 2016;
- weather conditions during 6 and 7 January 2016;
- the listing of data for the Automatic Weather Stations (AWSs) closest to the fire ground for the period 0000 AWST 6 January to 2330 AWST Thursday 7 January 2016;
- Fire danger forecasts for 6 and 7 January 2016 for the fire weather districts in which the fire ground was situated; and
- the Bureau's forecast products issued specifically for the Waroona Fire.

There were a number of non-Bureau AWS located on and around the fire ground. There were no Bureau AWS on any part of the fire ground. The weather conditions detailed in this report are a 'best interpretation' based on the following information;

- Expert meteorological opinion;
- Bureau and non-Bureau AWS data;
- Weather satellite data (one infrared and one visual image every ten minutes);
- Radar data from the Serpentine weather watch radar (coverage at 6 minute time intervals);
- Lightning strike data, courtesy of Global Position and Tracking Systems Pty Ltd (GPATS) and ENGLN Lightning Detection System; and
- Meteorological theory on topographical influences on weather conditions.

Where appropriate, possible errors between this 'best interpretation' and actual weather conditions will be indicated. Further explanation of the methodology used to describe the weather conditions over the fire ground is provided in Section 3.

1.1 Terminology and units

Except where noted, times are quoted as Australian Western Standard Time (UTC[1] + 8 hours). Wind speeds are ten minute averages measured in kilometres per hour (km/h) and measured at a standard height of 10 metres above ground level except where noted. Wind directions refer to the direction from which the wind is coming and are given in 16 points, or

[1] Coordinated Universal Time (UTC), allows time zones around the world to be expressed as positive or negative offsets from UTC).

degrees, of the compass as indicated. Temperatures and dew point temperatures are measured in degrees Celsius (°C). A location map showing key sites mentioned in this report is shown in Figure 1.

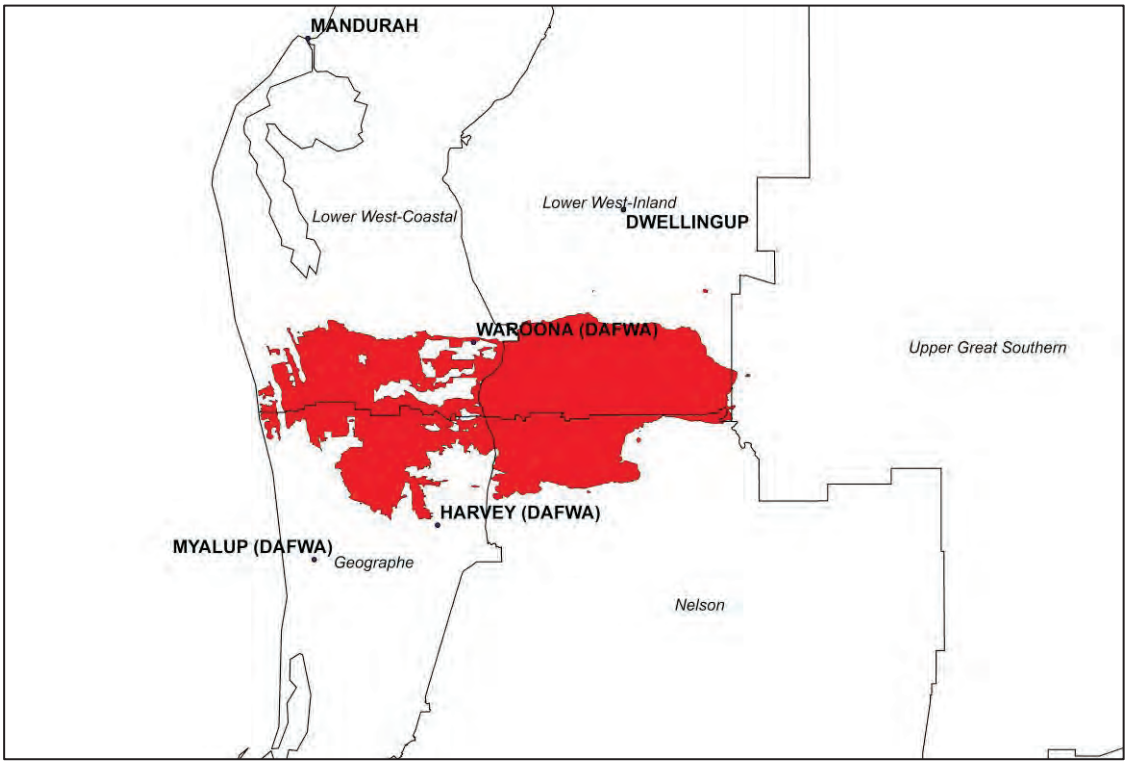

Figure 1: Final fire shape (red shading) of the Waroona Fire relative to BoM and DAFWA Automatic Weather Stations (capitalised) and fire weather districts (italicised).

Final fire shape courtesy of the Department of Fire and Emergency Services (DFES).

2 Antecedent Conditions

2.1 Rainfall

Southwest WA recorded very low rainfall in 2015 with totals in the lowest 10% of records in areas west of a line from Jurien Bay to Wagin to Albany, including the Waroona region (see Figure 2). Rainfall totals around Waroona were generally in the range of 450 mm to 600 mm in 2015 and 60% to 70% of the normal annual rainfall. From May to October 2015, the Waroona region also recorded rainfall in the lowest 10% of records. November was near average, whilst December rainfall was above average in the region, with totals mostly in the 10 mm to 20 mm range and occurring in the first week of the month.

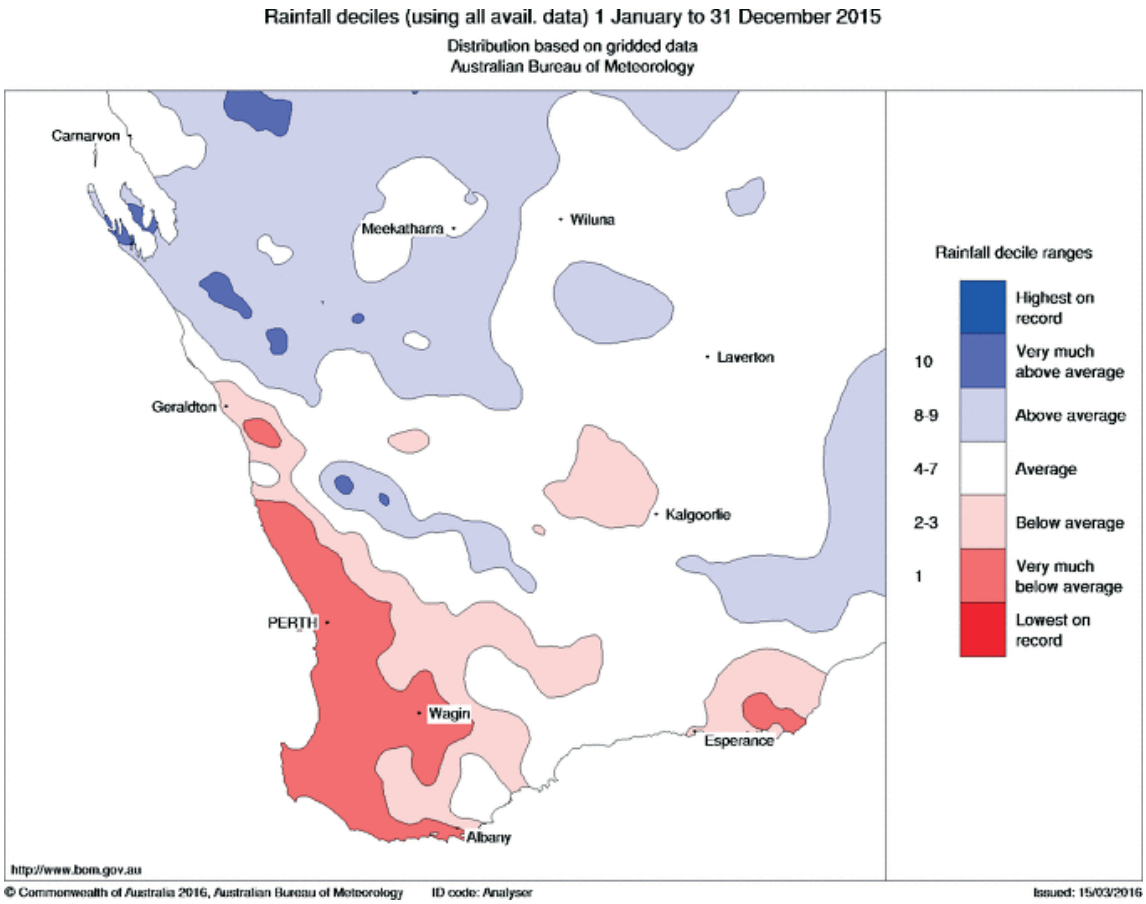

Figure 2: Rainfall deciles for southwest parts of WA for 2015.

The below average rainfall in 2015 is consistent with a trend of declining annual rainfall that has been observed over the past 40 years. Southwestern Australia is defined as

an area southwest of a line from Jurien Bay to Bremer Bay. In 2015 this area recorded its eighth-driest year since comparable records commenced in 1900 (Figure 3).

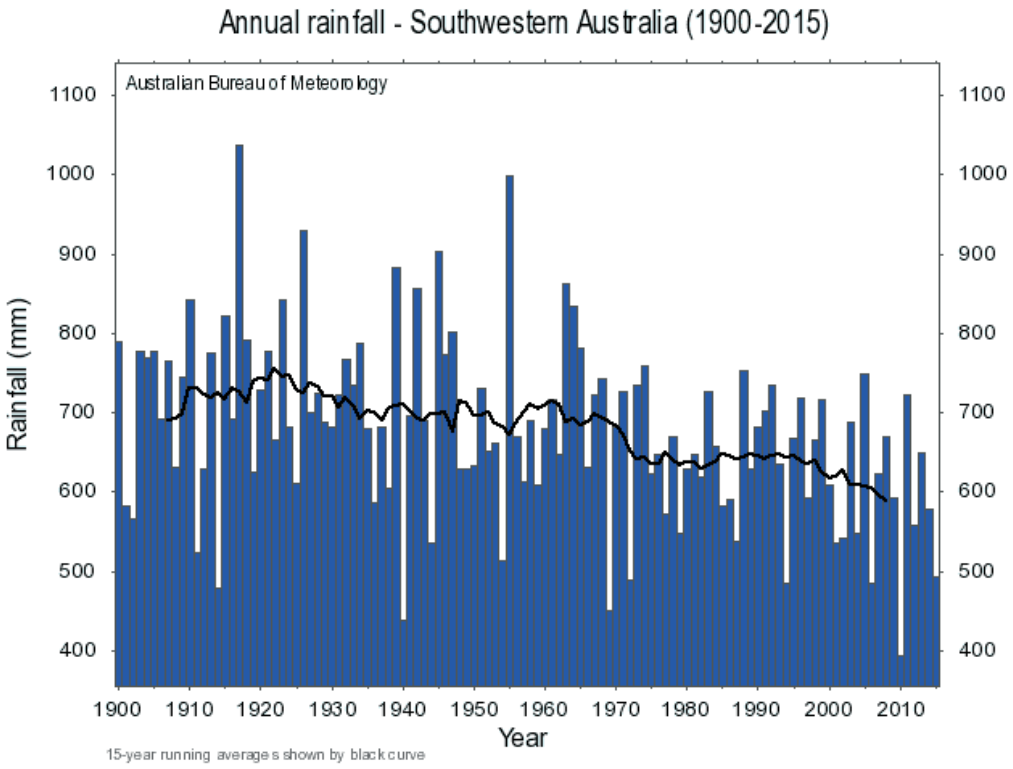

Figure 3: Annual rainfall for Southwestern Australia between 1900 and 2015.

2.2 Temperature

2015 was a particularly warm year with most of the State recording above average temperatures. Several sites in Southwestern Australia recorded their warmest year on record (Figure 4), including Dwellingup, which registered its warmest year in terms of day-time maximum temperatures in its 75 years of record.

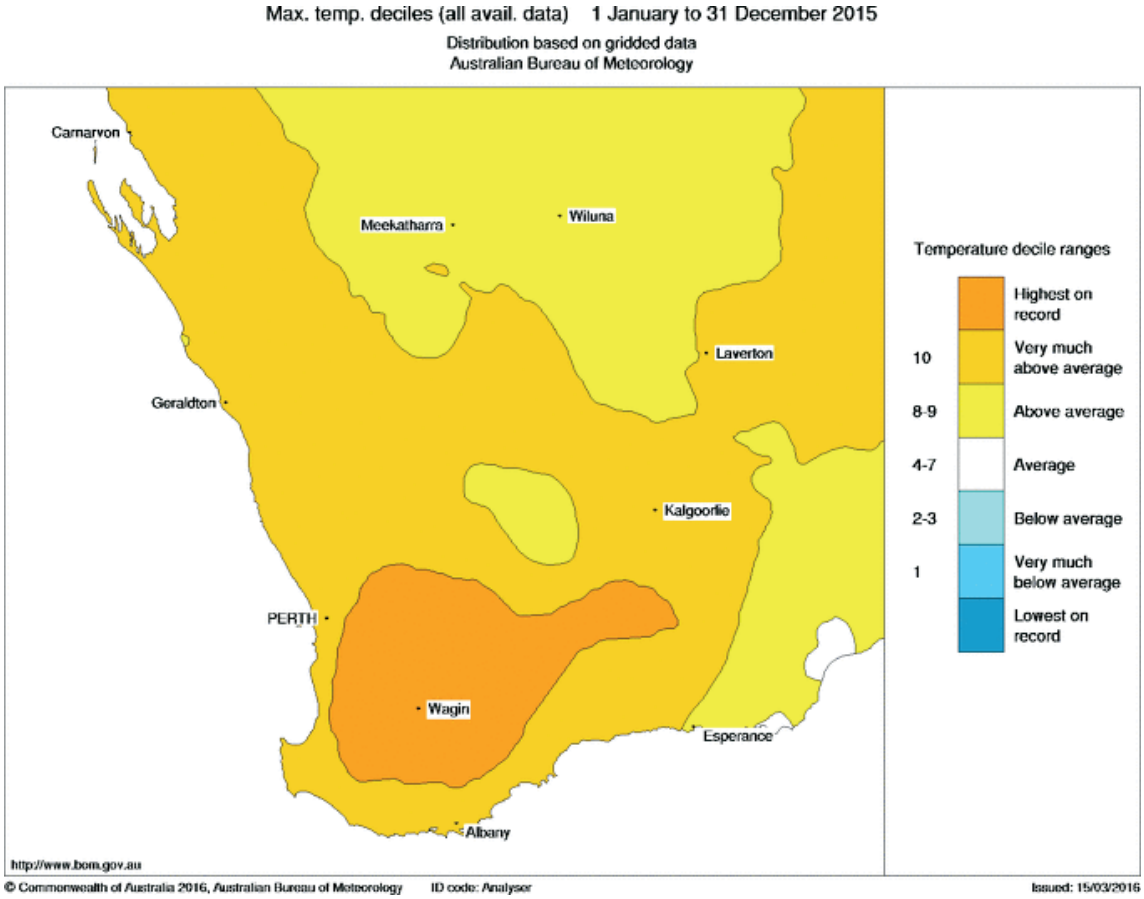

Figure 4: Maximum temperature deciles for southwest parts of WA for 2015.

Temperatures in Southwestern Australia have risen by approximately 1 °C over the past one hundred years. It is clear from maximum temperature observations (Figure 5) and minimum temperature observations (Figure 6) averaged across the region that the last few years have been some of the warmest since comparable records commenced in 1910.

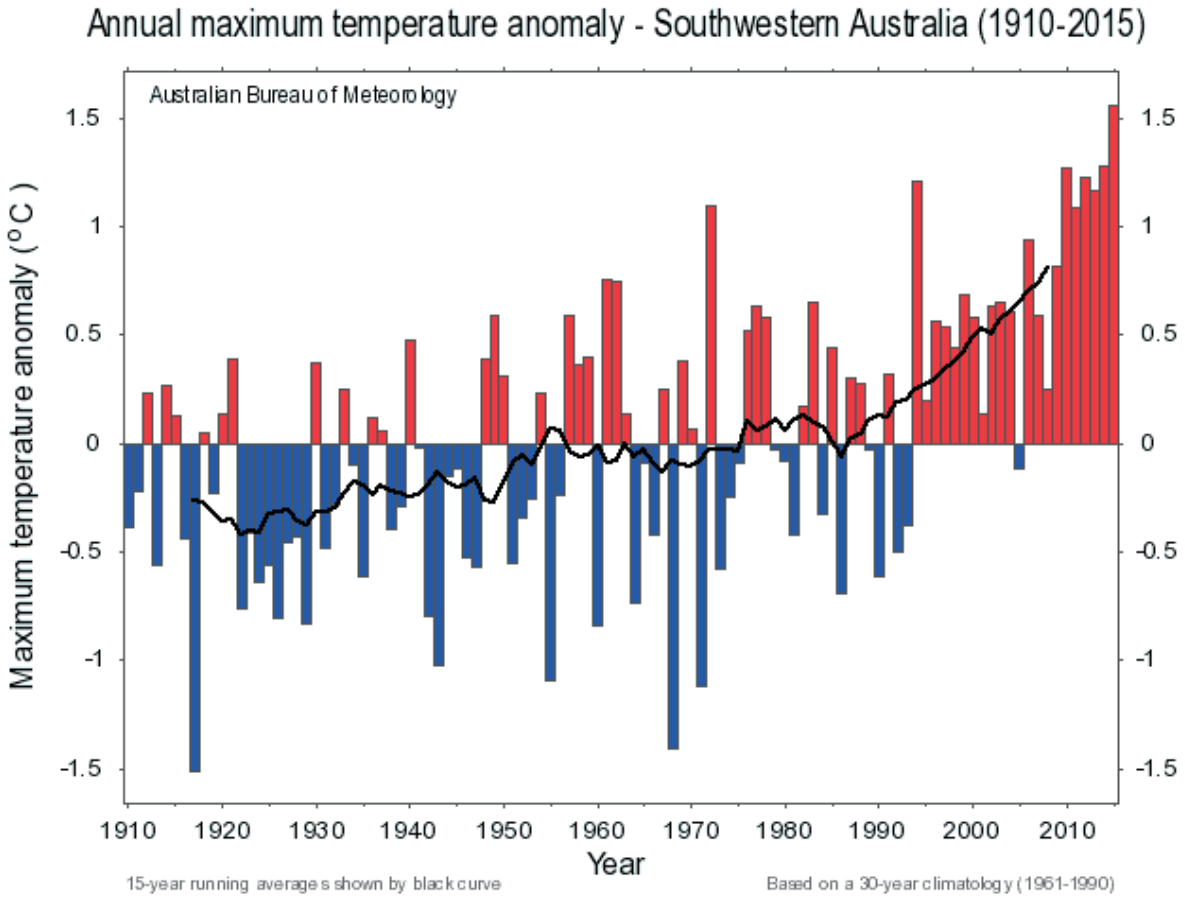

Figure 5: Trend in annual minimum temperatures in Southwestern Australia since 1910.

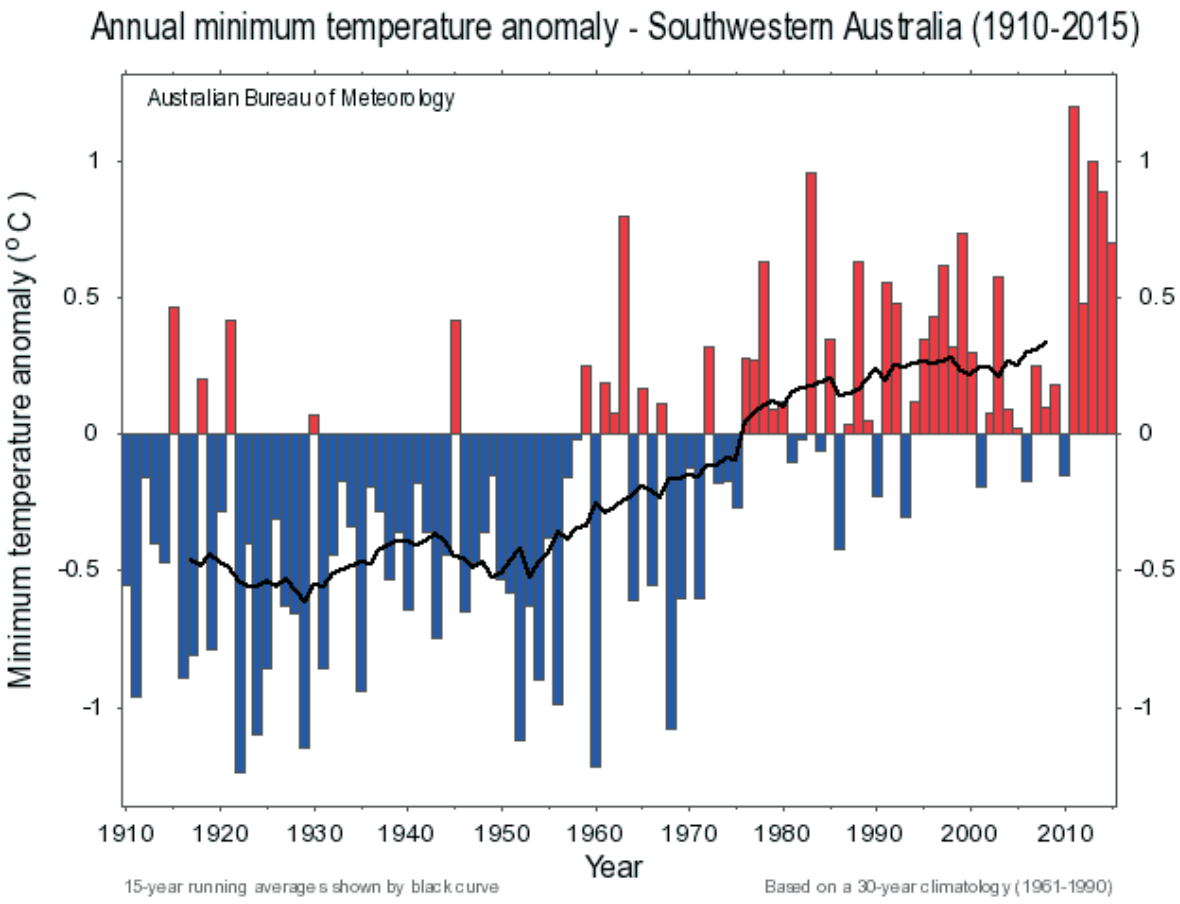

Figure 6: Trend in annual minimum temperatures in Southwestern Australia WA since 1910.

2.3 Drought Indices and Fuel[2]

The Soil Dryness Index (SDI) and Keetch-Byram Drought Index (KBDI) are measures of the long term dryness (dryness of heavy fuels) of the forest. It estimates the amount of rainfall (in mm) needed to saturate the soil profile. When the SDI/KBDI = 0, the ground is saturated. When the SDI/KBDI = 200, the ground is extremely dry.

The Drought Factor (DF) is a measure of the short term dryness (or dryness of fine fuels) in a forest. It estimates the proportion (in tenths) of the fine fuels (< 6mm) in a forest that will burn in a fire. DF = 0 all fuels wet, no fires possible, DF = 5 half the fine fuel will burn, DF = 10 all fuels dry and ready to burn, including peat and logs. The SDI/KBDI feeds into the calculation of the DF. A DF of 10 requires an SDI/KBDI of > 100.

Dwellingup and Harvey are the closest ground moisture stations to the fire ground and were considered to be representative of the conditions over the fire ground. Dwellingup AWS is also referred to as Dwellingup Forestry AWS. This station was used to determine ground moisture values (DF, SDI, KBDI) and to provide high resolution weather observations.

During spring and the weeks leading up to the event, both the SDI (Figure 7) and KBDI (Figure 8) were significantly drier than the five year average.

[2] In both the KBDI and SDI, the water balance is expressed in terms of soil moisture deficit (SMD), which is the amount of water (i.e. rain) in mm necessary to bring the soil moisture content back to field capacity - the amount of water the soil can hold in its capillaries against gravity. A low soil moisture deficit therefore means there is little or no constraint to evaporation from soil or transpiration from plants. However, it also means that there is a low capacity for infiltration in case of heavy rainfall. A high soil moisture deficit means that there is very little water available for either soil evaporation or plant transpiration. Under moderate to high soil moisture deficit, vegetation becomes drought stressed and the point at which this occurs depends on plant species as well as soil properties.
Both KBDI and SDI models assume a maximum soil moisture deficit of 200 mm and a minimum soil moisture deficit of zero (Finkele et. al 2006).

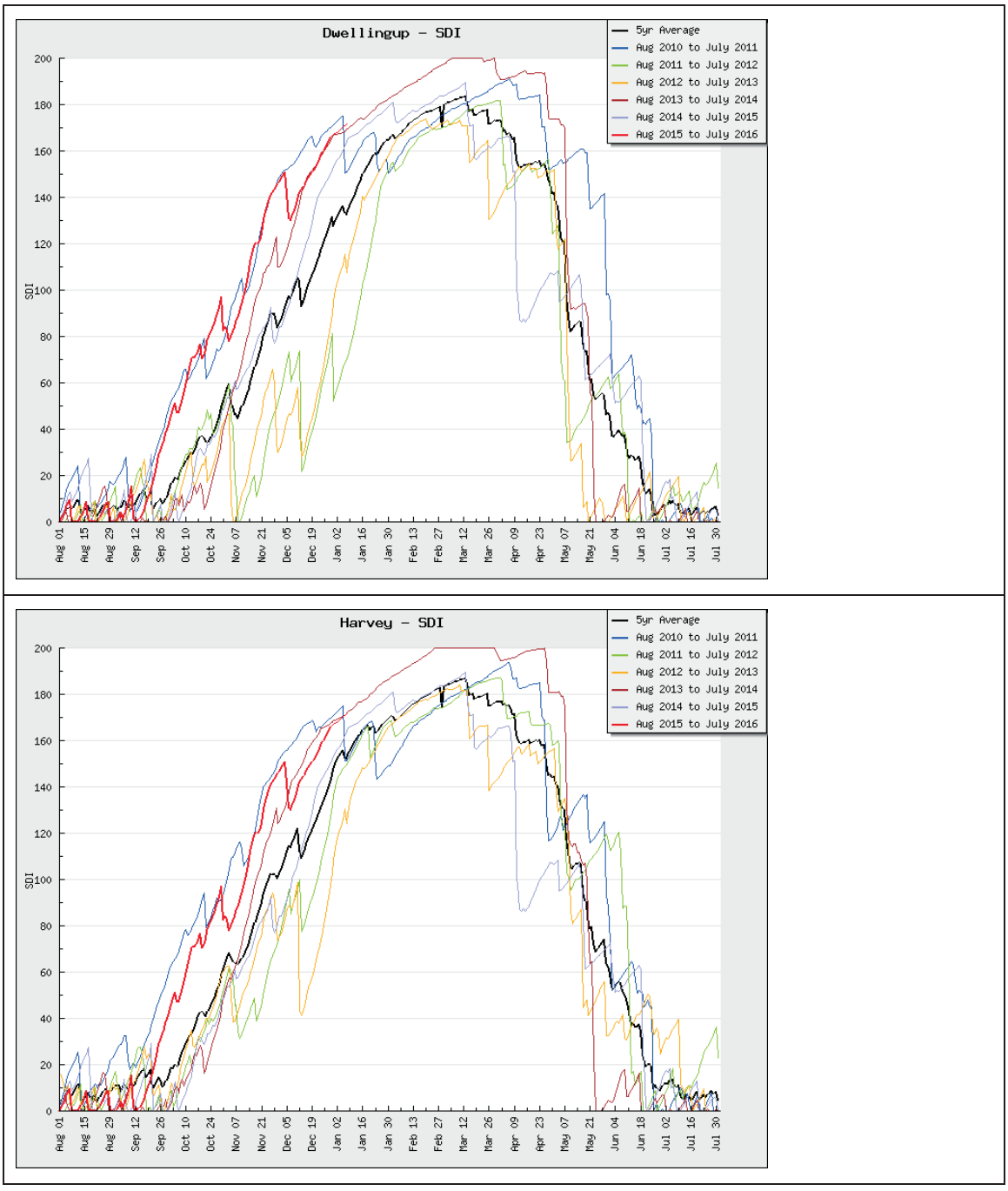

Figure 7: SDI observations for Dwellingup (top) and Harvey (bottom).

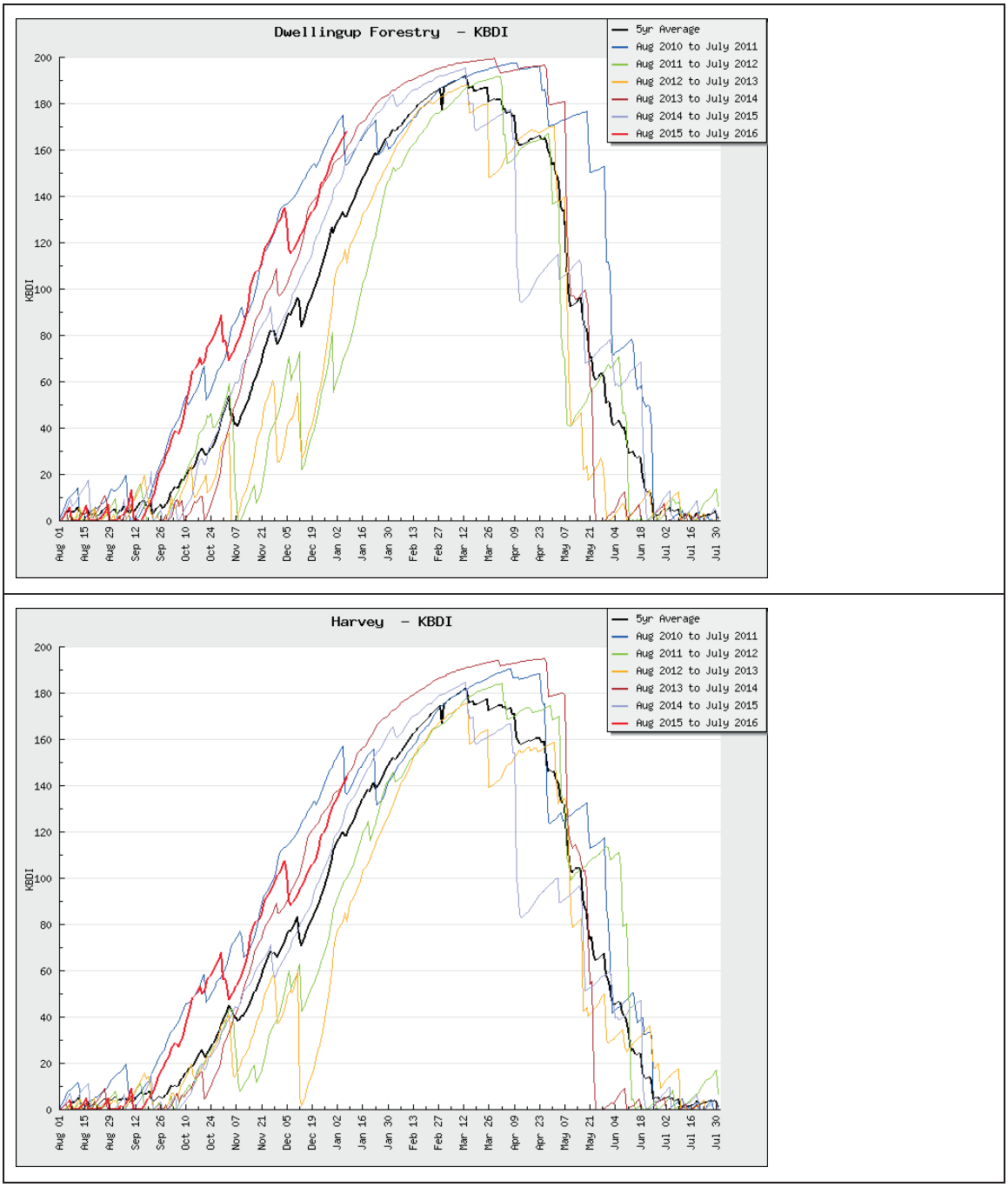

Figure 8: KBDI observations for Dwellingup (top) and Harvey (bottom).

The Drought Factor (DF) was at a maximum of 10. At Harvey, the DF reached 10 on 28 December 2015 and remained at 10 until 9 January when it dropped briefly to 8.4, then returned to 10 by 11 January 2016. Dwellingup had similar values but reached a DF of 10 on 22 December 2015.

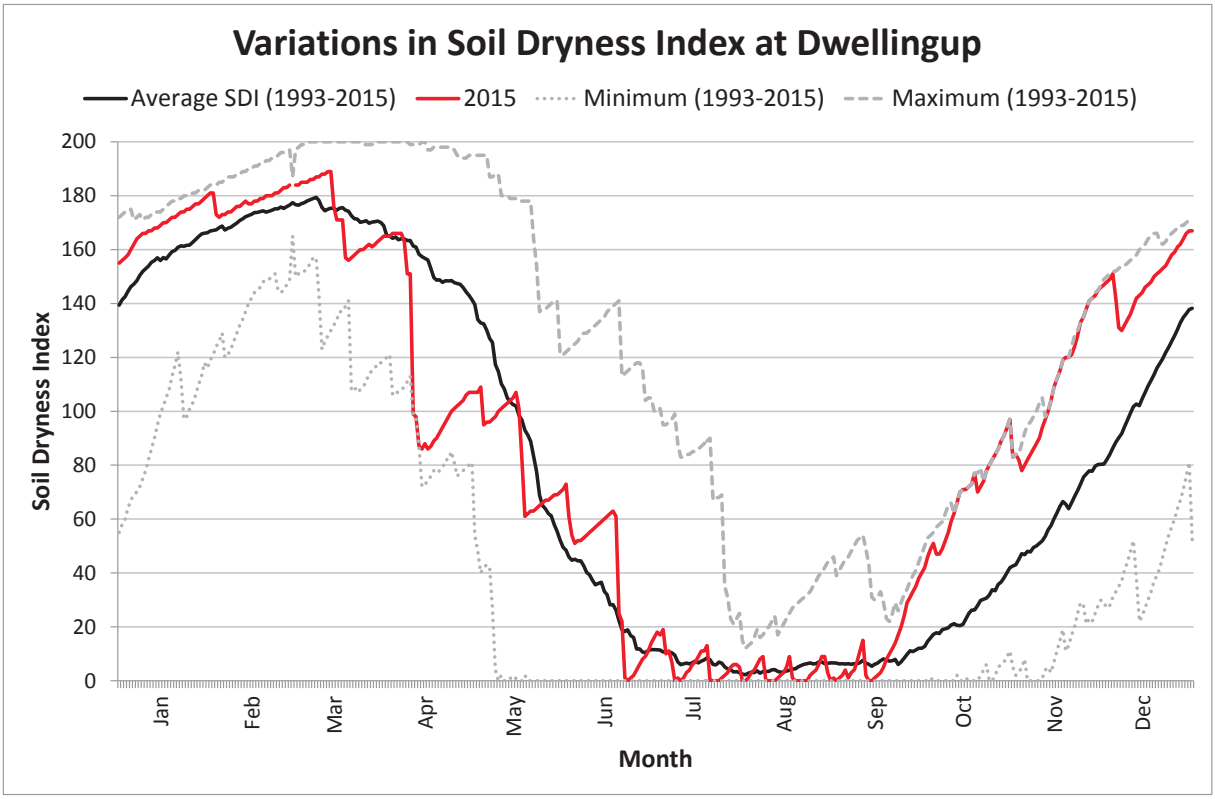

Figure 9: SDI at Dwellingup for 2015 (red line) compared to the maximum, minimum and average SDI values between 1993 and 2015.

The comparison between SDI and KBDI in 2015 with the 5-year average may not fully reflect how dry conditions were in the south west of Western Australia leading up to this fire event, given that the past 5 years have all been exceptionally dry. A better comparison is to evaluate 2015 against a longer term average. Figure 9 compares the SDI at Dwellingup in 2015 with the average calculated over the past 23 years. This clearly showed that from mid September 2015, the SDI was much drier than the long term average and the driest or very close to the driest over the past 23 years. In addition, during the winter months, when the majority of the annual rainfall is received

in the South West, the soil profile remained saturated for only very brief periods. This indicated that the rainfall was sporadic and insufficient to fully saturate the soil profile for any substantial length of time.

3 Methodology used to interpret weather conditions over the fire ground

This section provides a detailed explanation of the methodology used when estimating weather parameters over an area where there are no direct observations. These techniques have been used for the Waroona Fire unless otherwise noted.

3.1 Temperature

Any nearby AWS temperature data was used to help assess near surface temperature conditions over the fire ground. In a well mixed atmosphere, where air can freely mix between the surface and levels above the surface, the temperature typically cools 1°C for every 100m gained in height. This fact has been used to interpret temperature over the topography of the fire ground. After a wind change[3] has passed through an area the cooling with height assumption can become invalid.

3.2 Relative Humidity

Nearby AWS data was also used to help assess near surface relative humidity conditions over the fire ground. AWS either directly measure relative humidity or another moisture parameter called wet bulb temperature. From these parameters the AWS calculates a third moisture parameter called dew point, which is the moisture parameter relayed by the AWS to the Bureau. Relative humidity can be recalculated given the temperature and dew point. Unlike relative humidity, the dew point is independent of temperature and varies only with the moisture content. In a very well mixed atmosphere, the dew point can remain reasonably constant over the height differences experienced in the Waroona Fire. This assumption of negligible variation of dewpoint temperature with height is no longer valid after a wind change[3] has passed through an area. Using these temperature and dew point assumptions, nearby AWS dew point data was used in conjunction with the temperature data, to calculate relative humidity over the fire ground.

3.3 Wind speed and direction

Nearby AWS data was used to help assess near surface wind conditions over the fire ground. Local topography can influence both the speed and direction of winds. Low level winds can be funnelled along valleys and around and over hills. However, in a well mixed atmosphere, local topography has less effect than after a wind change[3], when conditions typically suppress vertical mixing, allowing topography to have a stronger effect.

It should also be noted that near large and intense fires, wind speed and direction can become very erratic because of the interaction between the fire and the general wind flow to

[3] A wind change can also produce changes in temperature, relative humidity and atmospheric stability.

produce local fire-generated winds. This report does not address any possible fire effects on wind speed and direction on the fire ground.

Winds above the surface are based on six hourly wind flights conducted at Perth Airport (approximately 110 km to the north of the fire ground).

The anemometer at Dwellingup AWS (BoM) is at a non-standard height of 29 metres (above the tree canopy).

3.4 Department of Agriculture and Food (DAFWA) AWS

Waroona, Harvey and Myalup AWS are maintained by the Department of Agriculture and Food (DAFWA) and are considered as non-standard weather observations (anemometer height 3 metres, unknown exposure, calibration and maintenance regime) but provide a guide to the weather conditions in the area. As they are the closest observation sites to the fires, observations from Waroona and Harvey have been included in this report.

3.5 Lightning

GPATS and ENGLN Lightning Detection System lightning data, which indicate location, time and type of lightning strike (cloud to cloud, positive cloud to ground or negative cloud to ground), were the sources of lightning data. They have different sensitivities when recording lightning strikes due to different triangulation methods. These systems have been assessed for the period 1900 AWST 5 January 2016 through to 2359 AWST Thursday 7 January 2016. Both lightning detection systems have been cross-checked against satellite and radar data.

However, there are some instances when not all strikes are recorded by these systems. The following procedure has been used to account for this possibility:

- when an area is judged to be covered in convective cloud (conditions where cloud is sufficiently deep to support heavy showers or thunderstorms, as determined by radar or satellite) then lightning cannot be completely ruled out even if GPATS and ENGLN Lightning Detection System data indicate no lightning in the area;

It should be noted that although most lightning associated with a thunderstorm occurs close to the storm, it is possible for the lightning to strike the ground up to 20-30 kilometres away from the originating storm.

Timing and coverage of lightning, as shown by GPATS and ENGLN Lightning Detection System, were cross checked by radar and satellite, are indicated for the fire ground and displayed in various figures in Section 5.

4 Fire Danger Indices and Ratings

Grassland Fire Danger Index (GFDI) and Forest Fire Danger Index (FFDI) forecasts are provided for all fire weather districts except for the North and South Interior Districts, where only GFDI forecasts are produced. The dominant fuel type (as agreed to with DFES, Parks and Wildlife and BoM) is used to determine if GFDI or FFDI is used to determine the FDR

The fire danger rating (FDR) for the Lower West Coastal and Geographe fire weather districts are based on the maximum GFDI. The FDR for the Lower West Inland and Nelson fire weather districts are based on the maximum FFDI.

DFES may request that an FDR be modified to account for meteorological (e.g. dry lightning) and non-meteorological considerations (e.g. resource constraints associated with significant ongoing bushfires).

All FFDIs in Bureau of Meteorology products for the Western Australia region are calculated using the McArthur Mark 5 Forest Danger Meter (McArthur, 1967). The specific algorithm used was developed by Noble et al (1980), as reproduced below:

FFDI = e^(ln(2)−0.45+0.987*ln(DF)−0.0345*RH+0.0338*T+0.0234*V

Where:

DF = Drought Factor (dimensionless number between 0 and 10)

T = air temperature (°C)

V = 10-minute mean wind speed at 10 metres (km/h)

RH = relative humidity (%)

For FFDI, the fuel component is the Drought Factor (DF) which is derived from the Keetch-Byram Drought Index (KBDI).

All GFDIs quoted in Bureau of Meteorology products for the Western Australia region are calculated using the CSIRO-modified McArthur Mark 4 Grassland Fire Danger Meter (Cheney and Sullivan, 1997). The specific algorithm used is that of Purton (1982) as reproduced below:

$GFDI = e^{(-1.523+1.027*\ln(Q) - 0.009432*(100-C)^{1.536} + 0.02764*T + 0.6422*(V)^{0.5} - 0.2205*(RH)^{0.5})}$

Where:

GFDI = Grassland Fire Danger Index

Q = fuel quantity (t/ha)

C = degree of curing (%)

T = air temperature (°C)

V = 10-minute mean wind speed at 10 metres (km/h)

RH = relative humidity (%)

Curing is a measure of the percentage of dead material in a grassland environment. A curing value of 0% represents totally green vegetation and 100% represents totally dry vegetation.

By agreement with DPaW and DFES, the fuel quantity used in grassland fire danger index (GFDI) calculations is set to 4.5 t/ha in all districts at all times.

5 The Waroona Fire

5.1 Topography of the fire ground

The fire extended across the western margin of the Darling Plateau and the Swan Coastal Plain. These broad landforms are separated by the Darling escarpment which rises about 300 m ASL above the plain and has localised areas of steep and rugged terrain, and is deeply dissected by the drainage lines of the Drakes, Samson and Logue Brooks and smaller tributaries. The Darling Plateau is an undulating lateritic upland at an elevation of 300-340 m ASL, with occasional higher points exceeding 450 m ASL at Mt William and Mt Keats. The plateau is dissected by the Murray River valley which trends roughly north-south in the area affected by the fire, and has localised slopes up to 20° and outcropping of the basement igneous rock. The Swan Coastal Plain is flat and elevation varies by only a few metres between Waroona to the coast at Preston Beach. See Figure 10 for further details.[4]

Dwellingup AWS is located along the Darling Scarp at an elevation of 267m ASL. Waroona and Harvey DAFWA AWS are located on the coastal plain at elevations of 36m and 38m ASL respectively.

[4] Topographic analysis was provided by the Department of Parks and Wildlife.

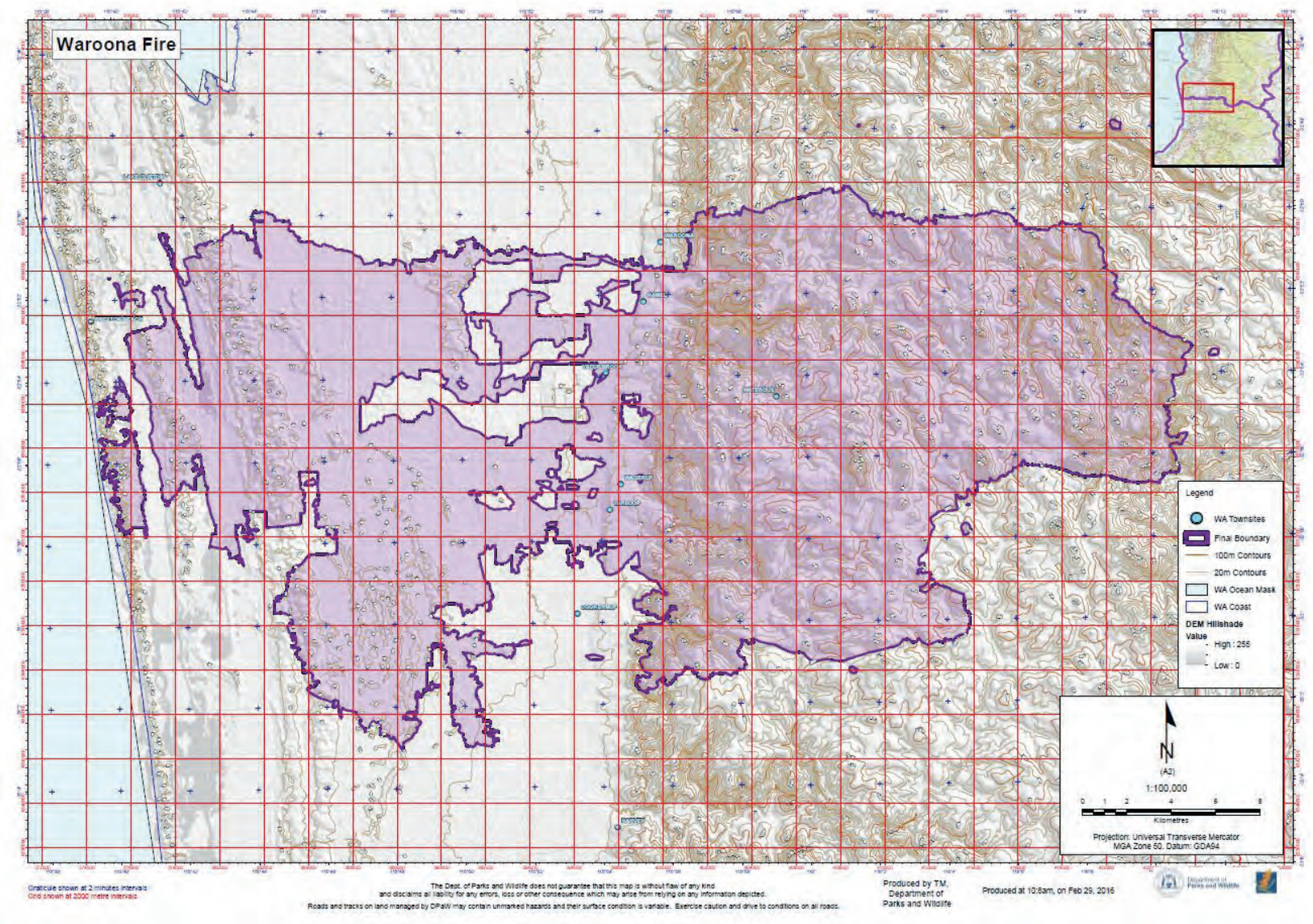

Figure 10: Topographical map of the fire ground.

5.2 Weather Conditions

5.2.1 Tuesday 5 January 2016

At 2000 AWST 5 January, a surface trough extended from central parts of WA towards the southwest corner of the state (see Figure 11). A ridge of high pressure was located well to the south of the state.

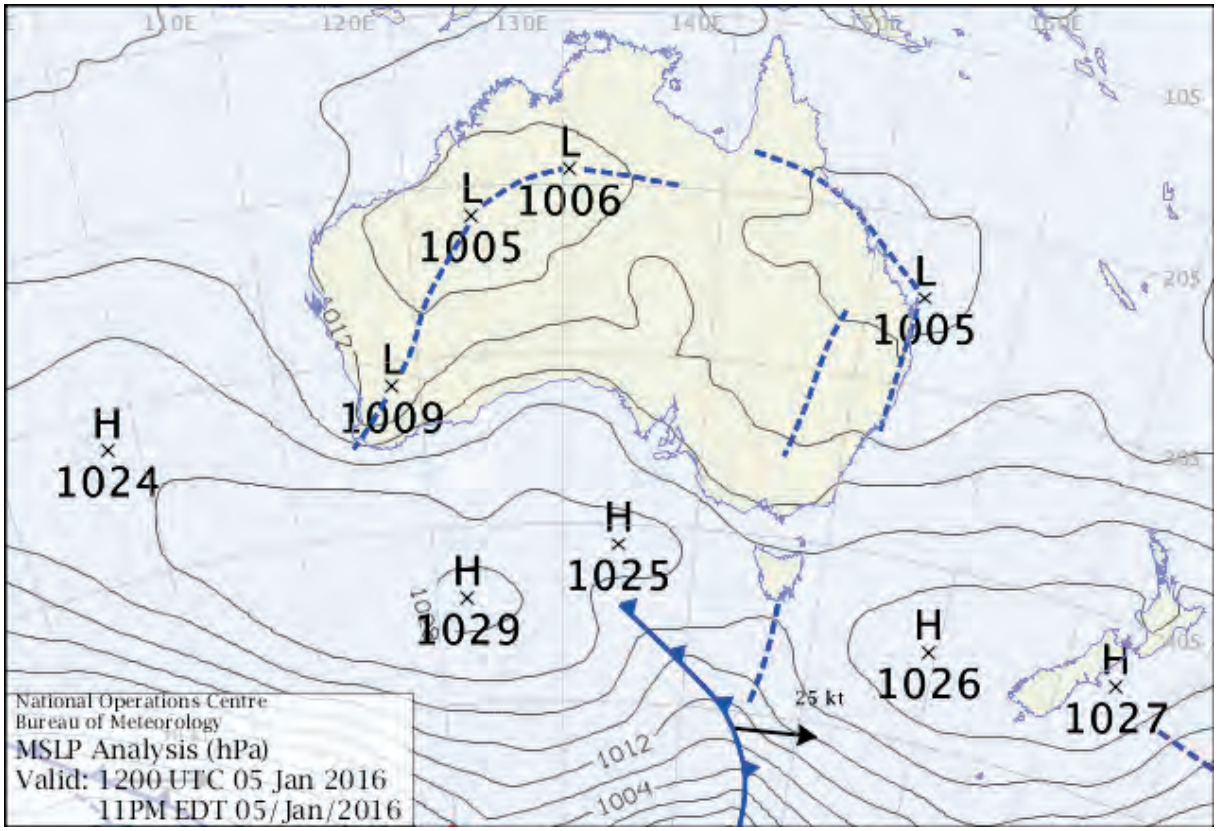

Figure 11: Mean Sea Level Pressure (MSLP) chart for 2000 AWST 5 January 2016.

Showers and thunderstorms developed along the surface trough during the evening to the southeast of Dwellingup.

5.2.1.1 Lightning on Tuesday evening 5 January 2016

GPATS, ENGLN Lightning Detection System, radar and satellite data were analysed for Tuesday evening 5 January 2016. Figure 12 shows lightning recorded between 1800 and 1900 AWST and Figure 13 between 1900 and 2000 AWST. Lightning was recorded in an area to the southeast of Dwellingup and east of Waroona.

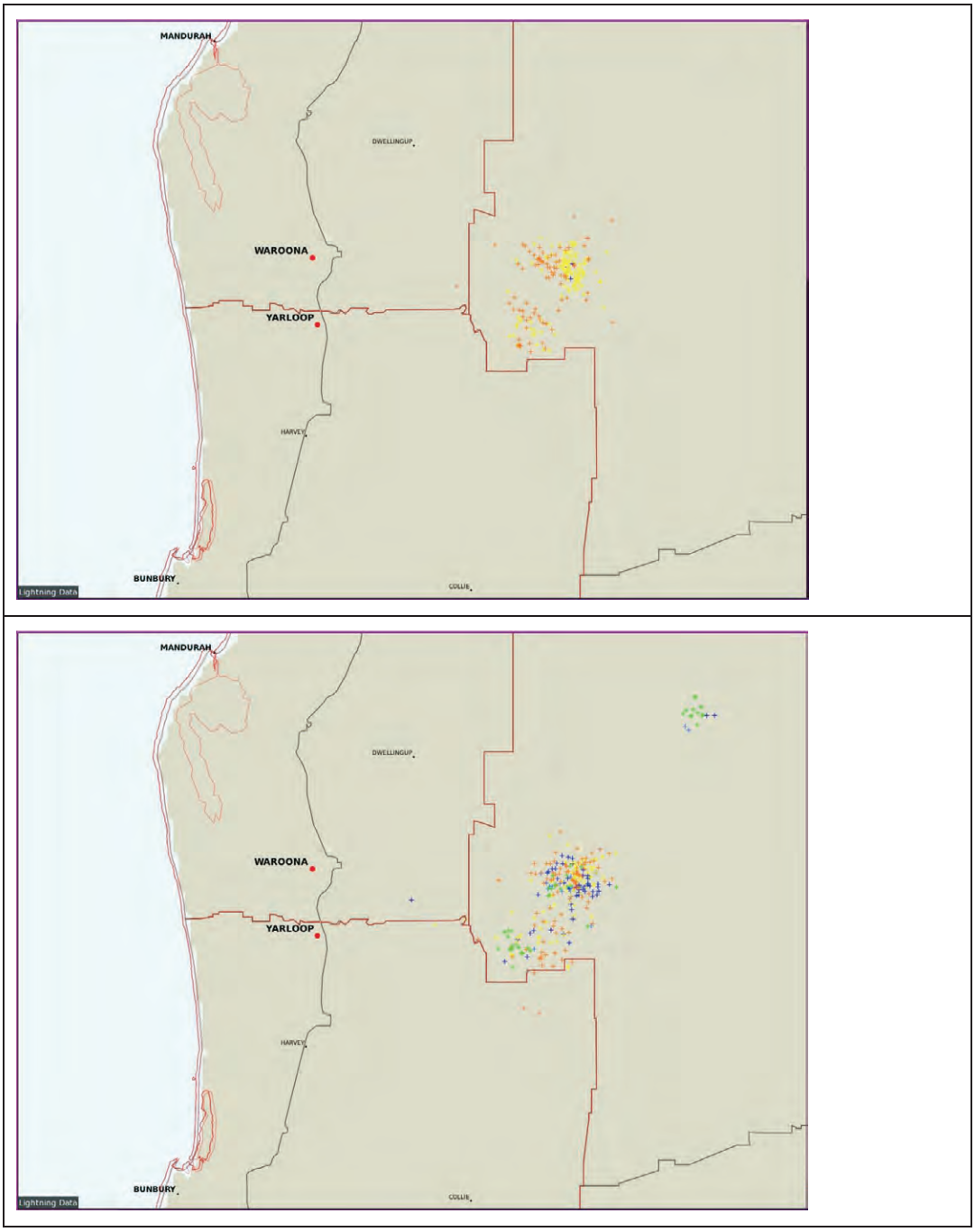

Figure 12: GPATS (top) and ENGLN Lightning Detection System (bottom) lightning during the period 1800 to 1900 AWST 5 January 2016.

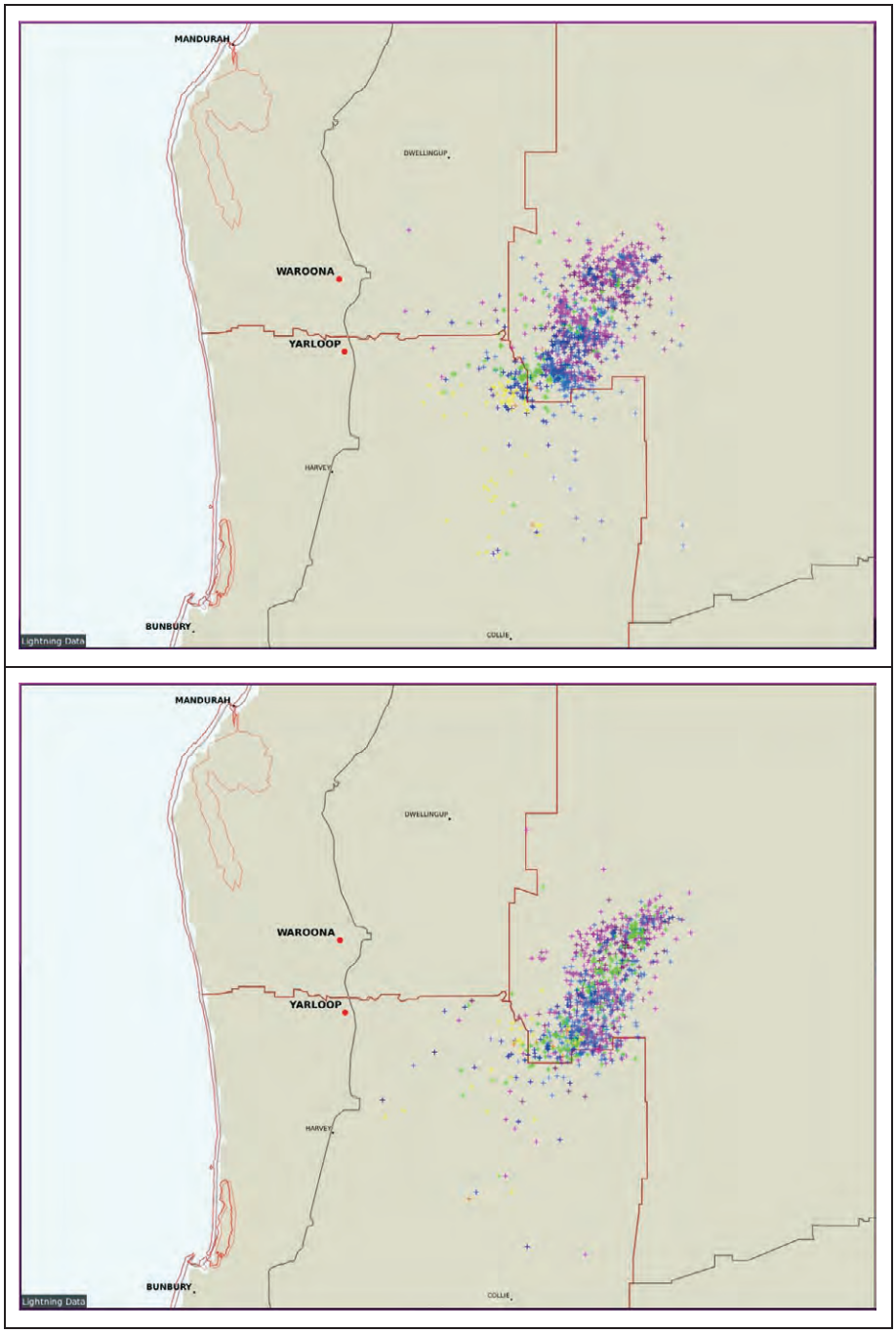

Figure 13: GPATS (top) and ENGLN Lightning Detection System (bottom) lightning during the period 1900 to 2000 AWST 5 January.

The Serpentine radar image at 1930 AWST (Figure 14) showed areas of strong radar reflectivity, consistent with thunderstorms, coincident with the area where lightning was recorded.

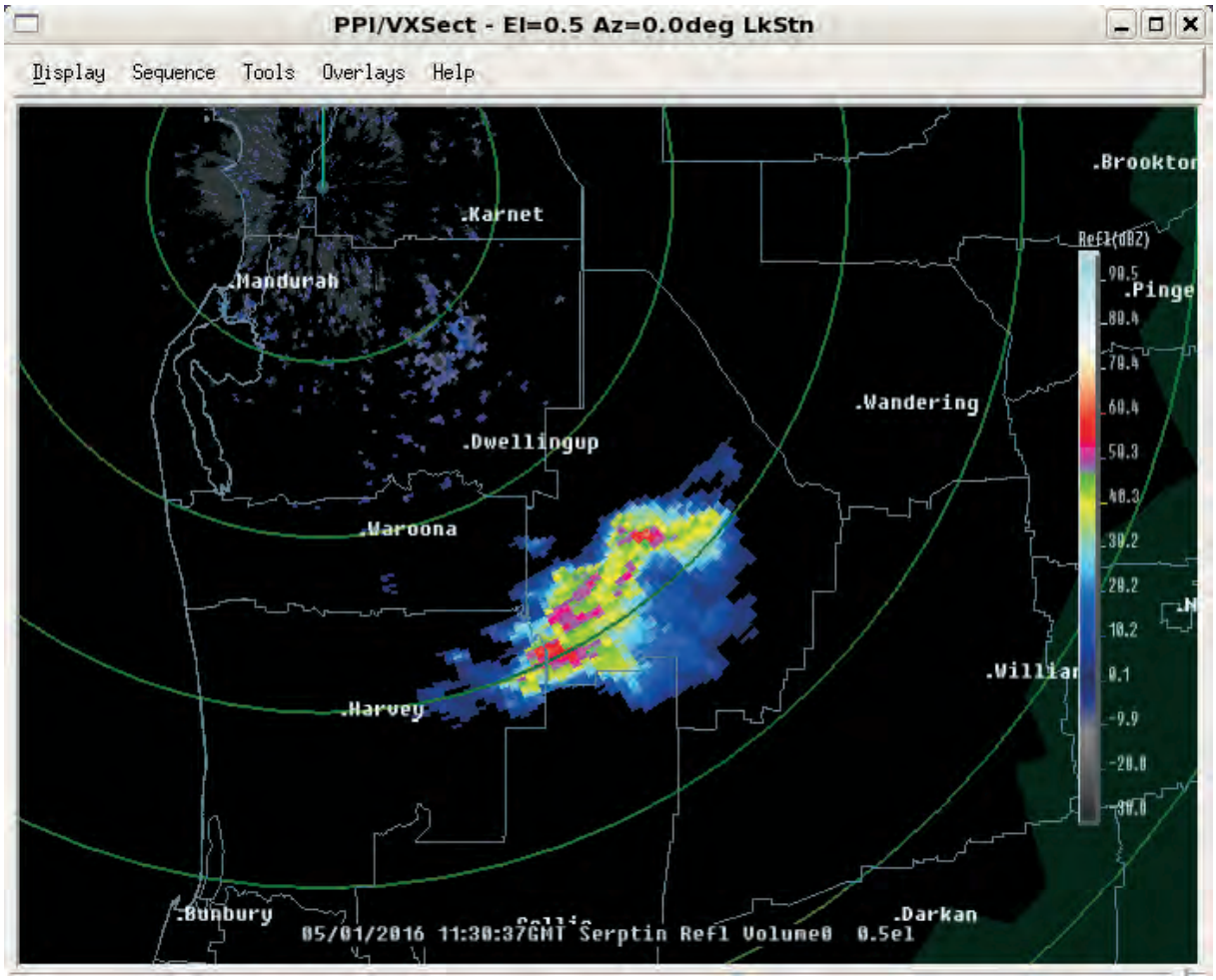

Figure 14: Serpentine radar image at 1930 AWST 5 January.

5.2.2 Wednesday 6 January 2016

At 0800 AWST Wednesday 6 January, a surface trough was located offshore from the southwest of WA and a high pressure system (1029hPa) had moved south of the Great Australian Bight (see Figure 15), resulting in an easterly pressure gradient over the southwest of WA.

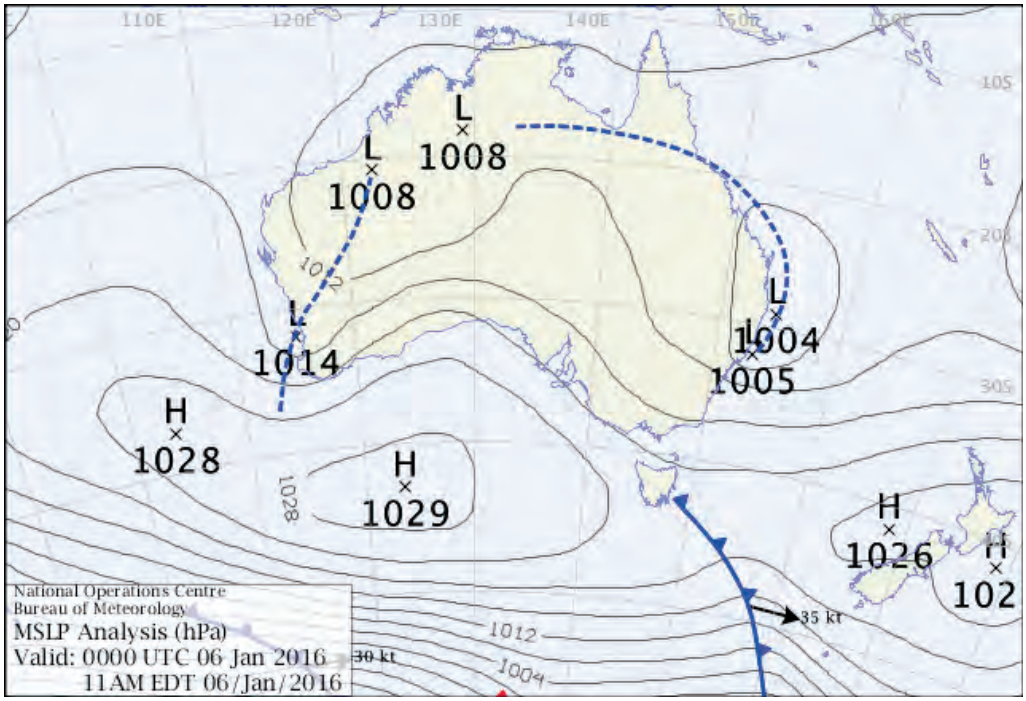

Figure 15: Mean Sea Level Pressure (MSLP) chart for 0800 AWST 6 January 2016.

Dwellingup AWS was considered to be representative of the weather conditions along the Darling Scarp part of the fire ground. Waroona (DAFWA) and Harvey (DAFWA) AWS were considered representation of the weather conditions on the coastal plain part of the fire ground.

The easterly pressure gradient resulted in gusty east to southeast winds during the morning. The peak 10 minute average winds at Dwellingup during the morning of 6 January was southeast 32 km/h at 0200 AWST and the peak gust during this period was 50 km/h at 0211 AWST.

At 0500 AWST, temperatures ranged from about 19°C at Dwellingup to 21°C at Waroona. The relative humidity was between 70 and 75%. Winds along the Darling Scarp were east southeast 15 to 25 km/h whilst winds on the coastal plain were east northeast around 10 km/h.

Detailed weather observations from Dwellingup (BoM), Waroona (DAFWA) and Harvey (DAFWA) AWS on 6 January can be found in Appendix 4: Detailed Weather Observations.

Table 1 indicates the strength and direction of the winds above the surface at Perth Airport recorded at 0700 AWST. Perth Airport is located about 110 km to the north of the Waroona Fire but in general, upper winds across the fire ground are likely to have been consistent with those observed at Perth Airport, i.e. light east southeast winds just above the surface tended east northeast above about 300m ASL and increasing to 45 km/h. The east northeast winds mixed down to the surface during the day as a result of surface heating.

Wind Direction (degrees)	Wind Speed (km/h)	Height ASL (m)
115	3	126
070	18	366
085	45	590
070	33	799
045	22	1052
065	24	1532
065	27	2046
135	18	2588
110	22	3163
210	13	4200
270	14	5846
270	28	7522
270	22	9555
295	26	10772

Table 1: Upper winds recorded at Perth Airport at 0700 AWST 6 January 2016.

At 0800 AWST, temperatures ranged from 23°C at Dwellingup to 26°C at Waroona. The relative humidity was generally between 50 and 60%. Winds along the scarp were east southeast around 20 km/h whilst winds along the coastal plain were east northeast 10 to 15 km/h.

At 1100 AWST, temperatures ranged from 31°C at Dwellingup to 32°C at Waroona. The relative humidity was between 30 and 40%. Winds along the scarp and coastal plain were generally from the east between 15 and 20 km/h.

Table 2 indicates the strength and direction of the winds above the surface at Perth Airport, recorded at 1400 AWST. The sea breeze is evident in the low levels at and below 600m ASL with wind directions between 200 and 245 degrees. The sea breeze was evident in observations from Dwellingup and Waroona later in the afternoon.

Wind Direction (degrees)	Wind Speed (km/h)	Height ASL (m)
245	24	108
215	18	300
200	11	600
170	7	802
175	8	900
075	33	1540
085	37	2094
070	35	2704
015	25	3172
350	9	4200
315	22	5854
310	21	7529
275	17	9562
265	25	10785

Table 2: Upper winds recorded at Perth Airport at 1400 AWST 6 January 2016.

At 1400 AWST, temperatures ranged from 36°C at Dwellingup to 38°C at Waroona. The relative humidity was between 20 and 25%. Winds along the scarp and coastal plain were from the east to northeast between 10 and 20 km/h.

The Perth Airport aerological diagram at 0700 AWST 6 January (Figure 16) showed a temperature inversion between about 500m and 1000m ASL. This inversion was eroded during the day due to surface heating. During the afternoon and evening the atmosphere was sufficiently unstable for the fire to produce a pyrocumulonimbus (pyro CB) cloud. Pyro CB clouds can produce gusty winds at the surface and this was indicated on the Spot Forecasts (see Section 6.5). Lightning was observed from 1612 to 2038 AWST (Figure 17).

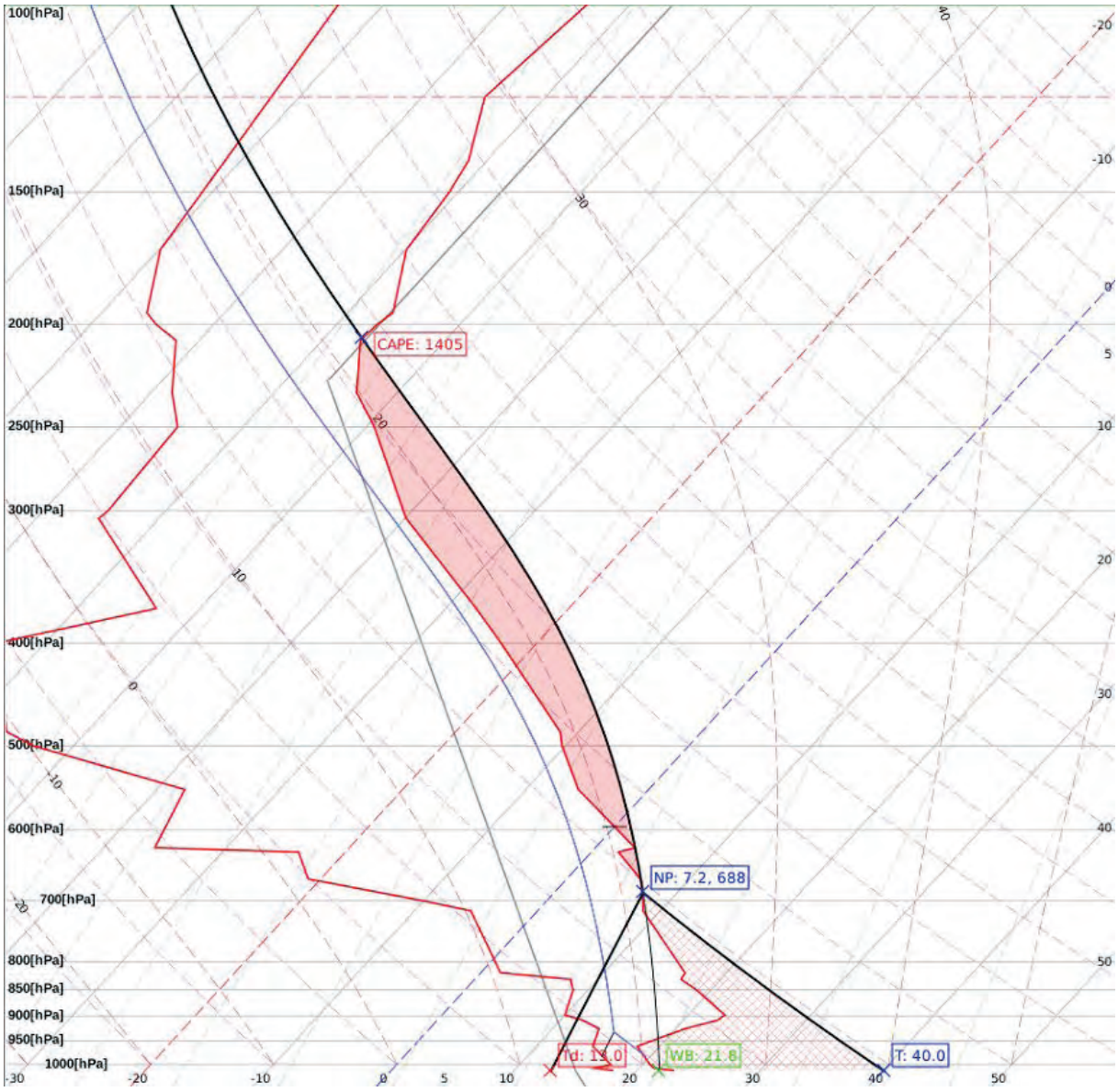

Figure 16: Aerological diagram from Perth Airport 0700 AWST 6 January, modified with afternoon surface conditions from Waroona.

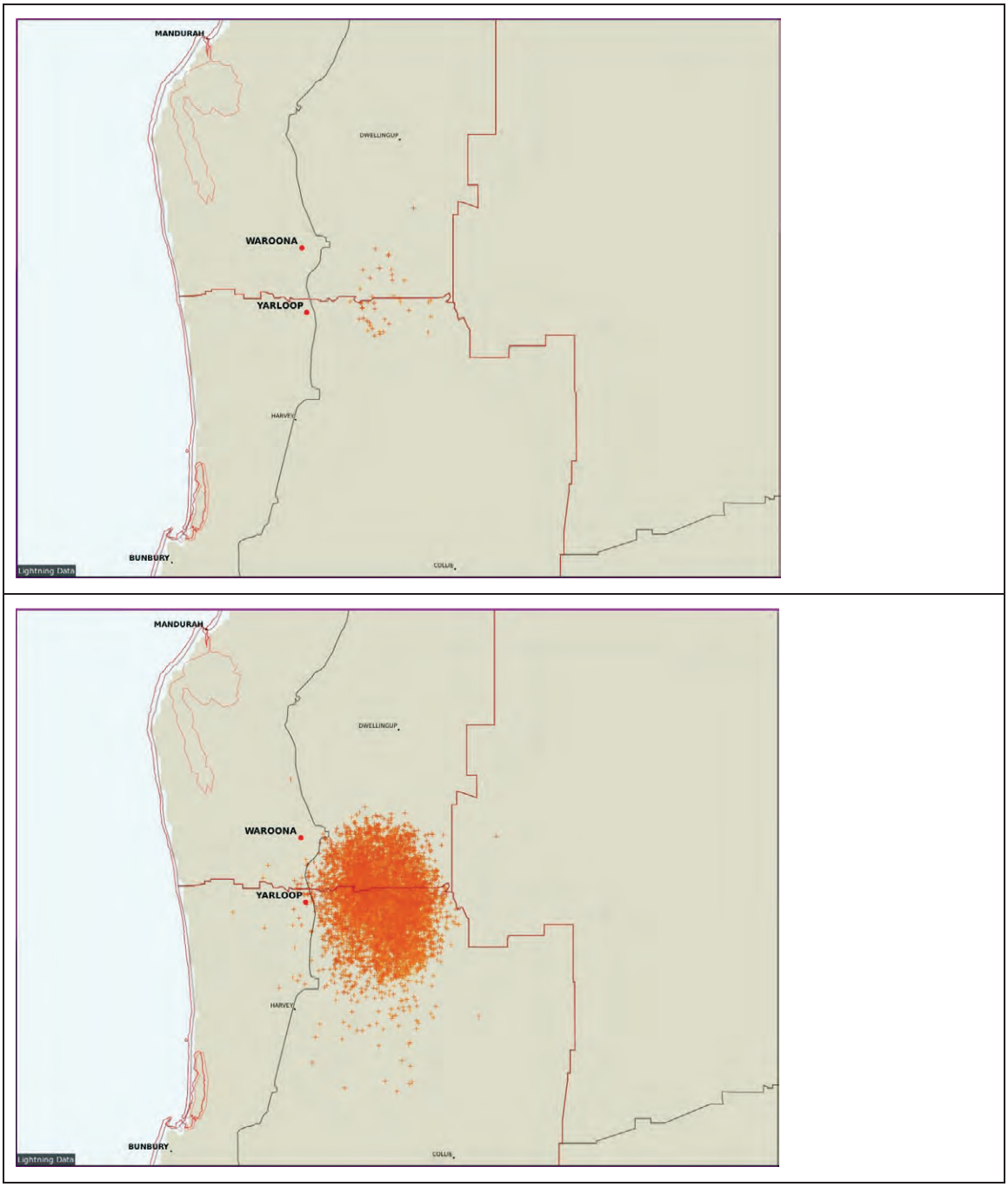

Figure 17: GPATS (top) and ENGLN Lightning Detection System (bottom) lightning during the period 1400 to 2000 AWST 6 January 2016.

The peak FFDI observed at Dwellingup on 6 January was 40[5] at 1613 and 1614 AWST. This corresponds to an FDR of Very High. At that time the temperature was 36.6°C, dew point 4.8°C, relative humidity 14% and wind northeast at 18 km/h.

The sea breeze affected Waroona between 1545 and 1935 AWST, Harvey between 1613 and 1806 AWST and Dwellingup between 1640 and 1835 AWST.

At 1700 AWST, temperatures ranged from 35°C at Dwellingup and Harvey to 34°C at Waroona. The relative humidity was about 25% at Dwellingup and between 30 and 40% at Waroona and Harvey. Winds were from the west southwest at 15 km/h.

Bureau Observers at Perth Airport reported a cumulonimbus cloud to the south of the airport at 1800 AWST.

[5] The expression of a FDI as a single integer implies an unrealistic level of precision. Any forecast FDI value should be considered as a central value within a spread of possible FDI values, which reflect the inherent precision of the input values. See Appendix 2: Fire Danger Index Uncertainty for further details.

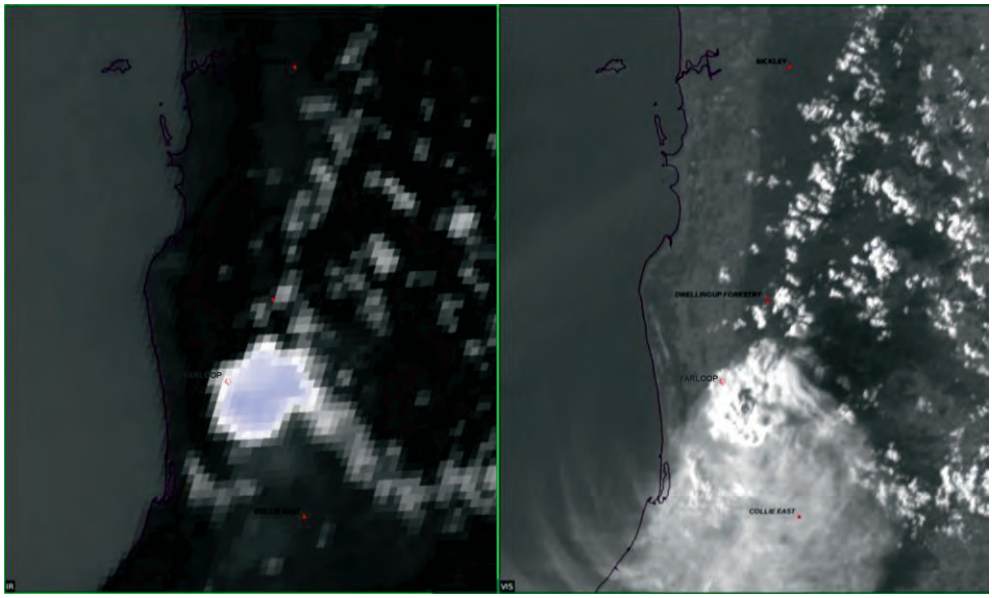

Figure 18: Infrared (left) and visible (right) satellite images at 1730 AWST on 6 January showing pyrocumulonimbus clouds over the fire ground.

Table 3 indicates the strength and direction of the winds above the surface at Perth Airport, recorded at 1900 AWST. The sea breeze remained evident in the low levels below about 800m ASL. Between 1000m and 4200m ASL, the winds backed from the east to the northeast.

Wind Direction (degrees)	Wind Speed (km/h)	Height ASL (m)
245	16	116
205	30	367
195	34	510
200	24	801
105	10	1077
085	26	1545
075	33	2100
075	40	2322
065	43	3193
035	41	4200
330	19	5868
325	19	7541
215	10	9580
255	21	10805

Table 3: Upper winds recorded at Perth Airport at 1900 AWST 6 January 2016.

Between 1930 and 1945 AWST, the sea breeze at Waroona weakened and easterly winds returned (around 20 km/h). The temperature increased from 30°C to about 33°C. There was also a corresponding decrease in dew point (from about 17°C to 15°C) and relative humidity (from about 45% to 35%). These changes were also reflected in observations from Dwellingup and Harvey (Appendix 4: Detailed Weather Observations).

At 2000 AWST, temperatures ranged from 32°C at Dwellingup to 33°C at Waroona. The relative humidity was between 30 and 35%. Winds along the scarp and coastal plain were generally from the east southeast about 20 km/h.

The peak GFDI observed at Dwellingup was 27[6] at 2020 AWST. This corresponds to an FDR of High. At that time the temperature was 30.4°C, dew point 11.9°C, relative humidity 32% and wind east southeast at 33 km/h.

The peak 10 minute average winds at Dwellingup during the evening of 6 January were east southeast 33 km/h at 2020 AWST and the peak gust during this period was 56 km/h at 2146 AWST.

By 2300 AWST, temperatures ranged from 25°C at Dwellingup to 29°C at Waroona. It is possible that heat from the fire caused the temperature at Waroona to be higher than would be expected in the absence of the fire. The low levels of the atmosphere were also well mixed as shown by the strength of the surface winds and would have accounted for some of the temperature difference (difference in elevation between Dwellingup and Waroona would account for about 2°C in a well mixed environment). The relative humidity was between 40 and 45%. Winds along the scarp and coastal plain were generally from the east southeast 25 to 30 km/h.

5.2.3 Thursday 7 January 2016

Whilst there was little change in the overall synoptic pattern on Thursday 7 January, the high pressure system (1032hPa) strengthened to the south of the Bight and the surface trough deepened offshore from the southwest of WA, resulting in an increase in the easterly pressure gradient over southwest parts of the State (Figure 19).

[6] The expression of a FDI as a single integer implies an unrealistic level of precision. Any forecast FDI value should be considered as a central value within a spread of possible FDI values, which reflect the inherent precision of the input values. See Appendix 2: Fire Danger Index Uncertainty for further details.

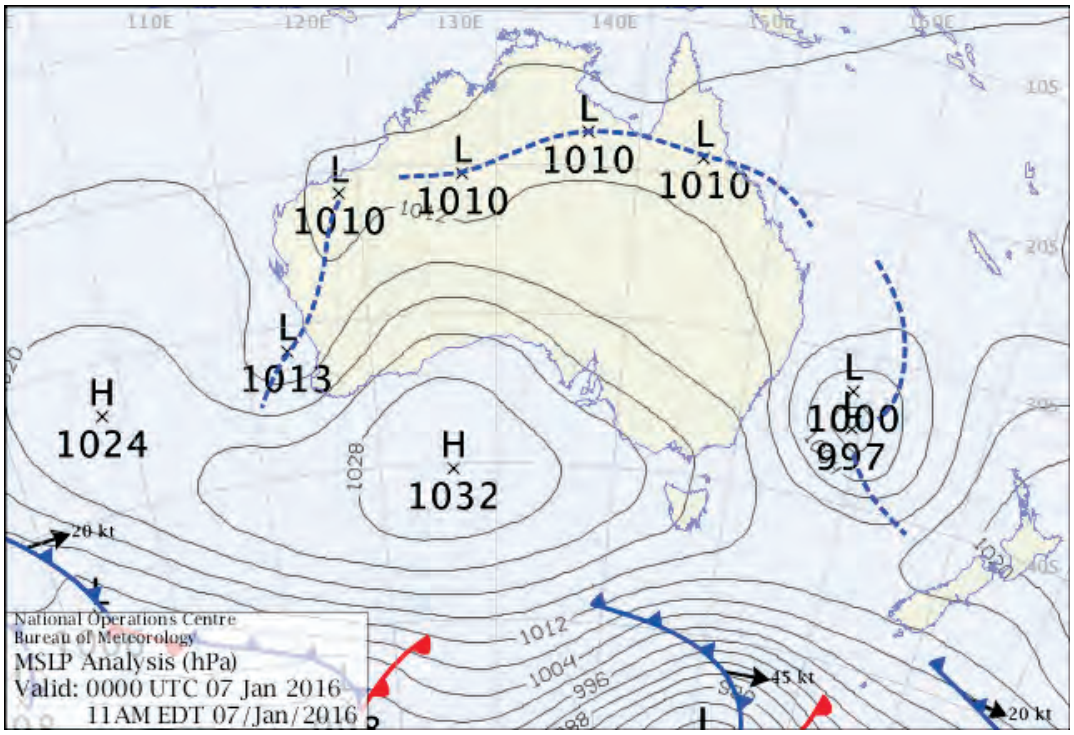

Figure 19: Mean Sea Level Pressure (MSLP) chart for 0800 AWST 7 January 2016.

Table 4 indicates the strength and direction of the winds above the surface at Perth Airport, recorded at 0000 AWST 7 January. Very strong east northeast winds are evident above 500m to about 2100m ASL with peak winds of 76 km/h at 610m ASL.

Wind Direction (degrees)	Wind Speed (km/h)	Height ASL (m)
095	25	114
080	76	610
070	75	803
070	72	900
060	73	1540
050	52	2100
035	32	2531
025	33	3181
115	13	4200
320	9	5862
005	14	7536
305	25	9573
300	21	10794

Table 4: Upper winds recorded at Perth Airport at 0000 AWST 7 January 2016.

Detailed weather observations from Dwellingup (BoM), Waroona (DAFWA) and Harvey (DAFWA) on 7 January can be found in Appendix 4: Detailed Weather Observations.

The peak 10 minute average winds at Dwellingup during the morning of 7 January were east southeast 29 km/h at 0140 AWST. The peak wind gust during this period was 54 km/h at 0020 AWST.

At 0200 AWST, temperatures were about 22°C at Dwellingup and 23°C at Harvey. Waroona recorded a temperature of 28°C. Again it is possible that heat from the fire caused the

temperature at Waroona to be higher than would be expected in the absence of the fire. Also the gusty surface winds and strong low level winds resulted in a well-mixed layer which would have contributed to some of the temperature difference. The relative humidity was between 50 and 55% (Waroona was about 40%). Winds along the Darling Scarp and on the coastal plain were between east and east southeast around 30 km/h.

At 0500 AWST, temperatures were around 21°C at Dwellingup and 23°C at Harvey. Waroona recorded a temperature of 26°C. Once again it is possible that heat from the fire caused the temperature at Waroona to be higher than would be expected in the absence of the fire. Winds were also stronger at Waroona as compared with Dwellingup and the well-mixed layer would have accounted for some of the temperature difference. The relative humidity was around 55% (Waroona was about 40%). Winds along the Darling Scarp were east southeast around 20 km/h and on the coastal plain were between east and east northeast at 20 to 25 km/h.

Table 5 indicates the strength and direction of the winds above the surface at Perth Airport, recorded at 0700 AWST. Very strong east northeast to north northeast winds are evident in the low levels below about 1000m. Peak winds were 82 km/h at 589m ASL.

Wind Direction (degrees)	Wind Speed (km/h)	Height ASL (m)
075	44	111
035	82	589
025	62	798
030	57	900
030	28	1540
350	20	2040
300	19	2834
340	32	3184
360	5	4200
285	11	5865
310	16	7539
300	29	9574
260	83	10795

Table 5: Upper winds recorded at Perth Airport at 0700 AWST 7 January 2016.

At 0800 AWST, temperatures were about 26°C at Dwellingup and Harvey. Waroona recorded at temperature of 28°C. The relative humidity was around 40%. Winds along the Darling Scarp were from the east at 20 km/h and on the coastal plain were between east and east northeast at 20 to 30 km/h.

At 1100 AWST, temperatures were about 34°C at Dwellingup and 32°C at Harvey. Waroona recorded at temperature of 36°C. The relative humidity was between 20 and 30%. Winds along the Darling Scarp and on the coastal plain were from the east at 20 to 25 km/h.

Bureau Observers at Perth Airport reported a smoke plume and pyrocumulus cloud from 1100 until 1446 AWST.

The Perth Airport aerological diagram at 0700 AWST 7 January (Figure 20) showed a temperature inversion between about 430m and 750m ASL. This inversion was eroded during the day due to surface heating. During the late morning and early afternoon, the atmosphere was sufficiently unstable for the fire to produce a pyrocumulonimbus (pyro CB) cloud. Pyro CB clouds can produce gusty winds at the surface and this was indicated on the Spot Forecasts (see 6.5). Lightning was observed from 1138 to 1417 AWST (Figure 21).

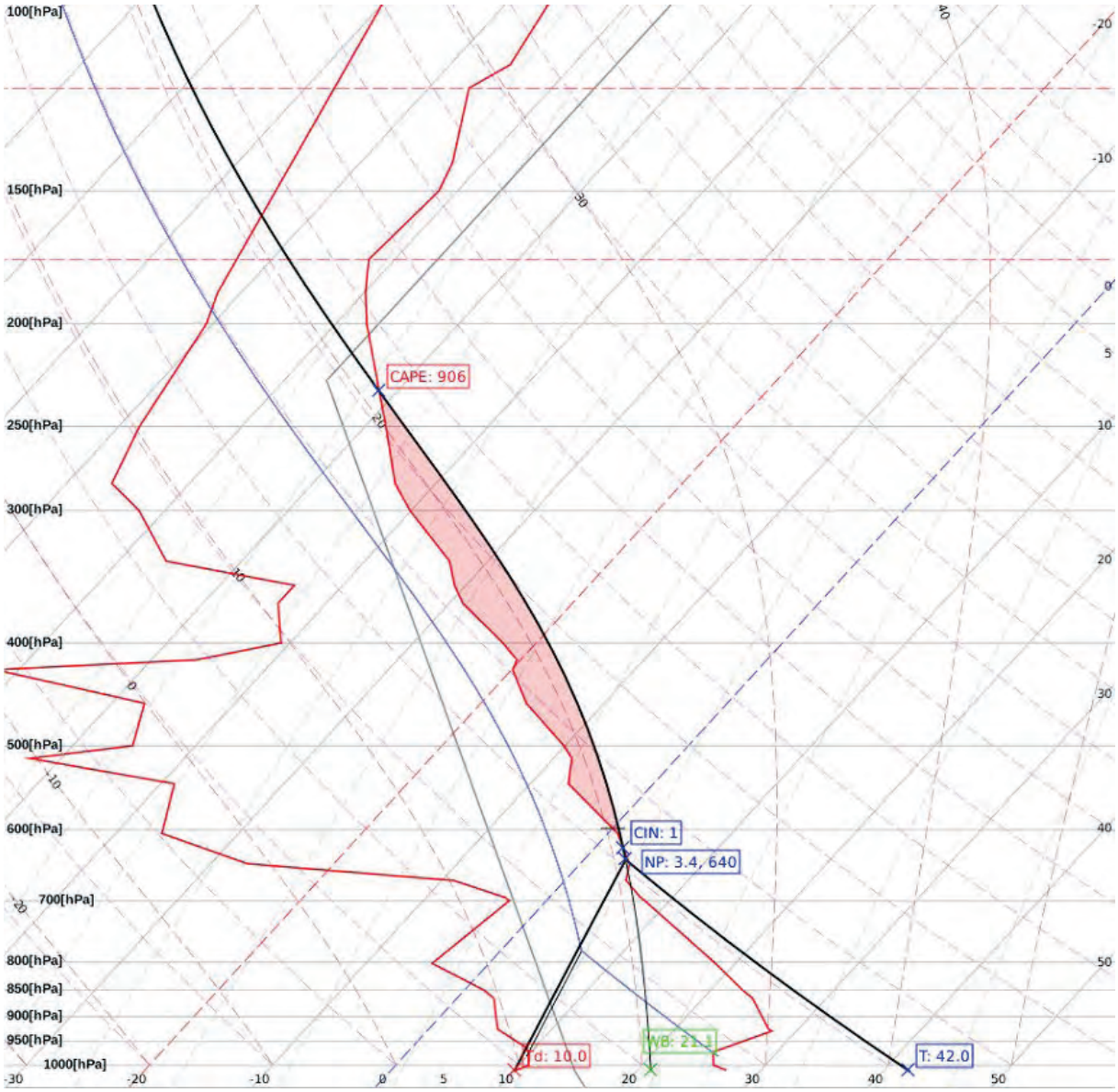

Figure 20: Aerological diagram from Perth Airport 0700 AWST 7 January, modified with afternoon surface conditions from Waroona.

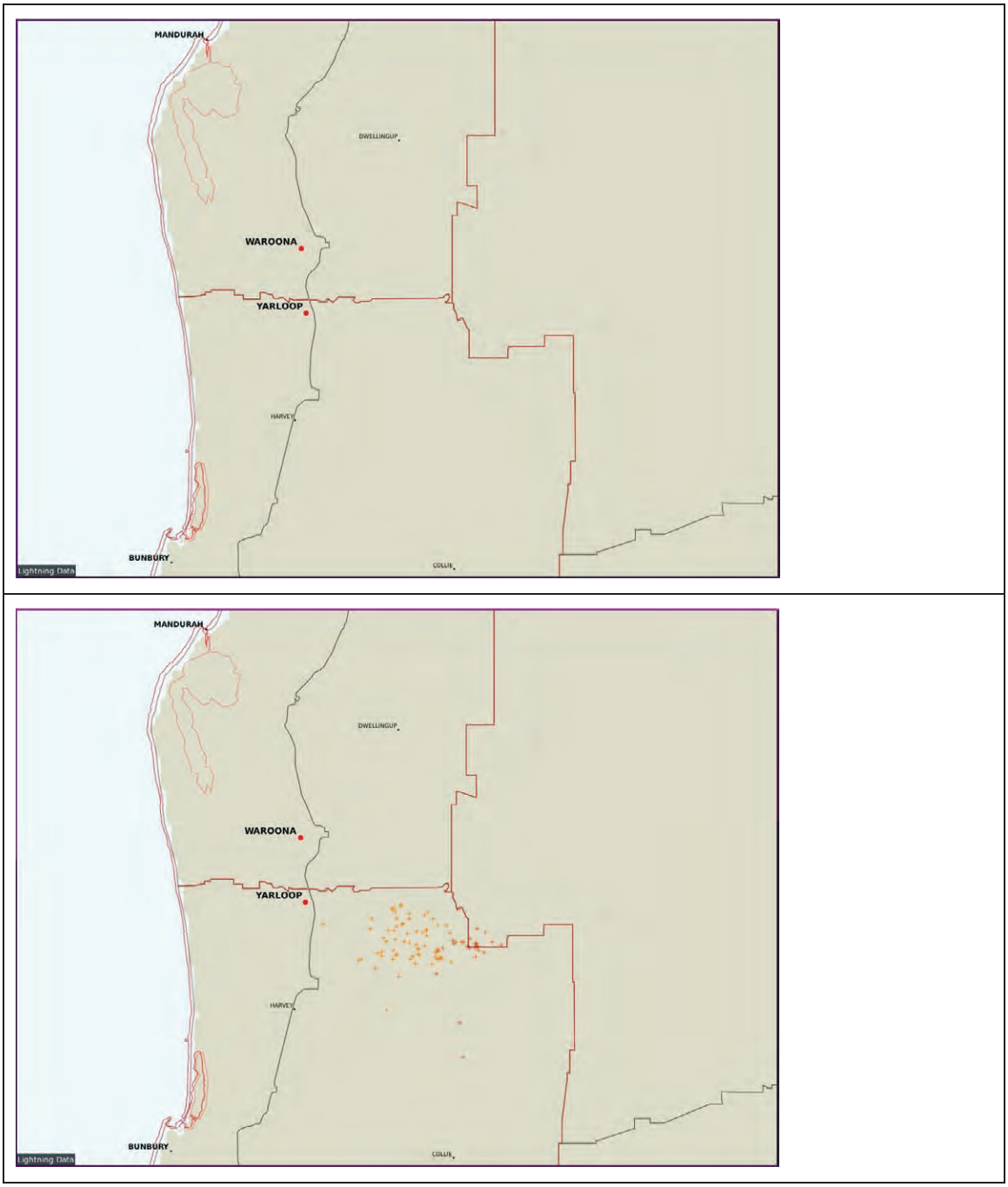

Figure 21: GPATS (top) and ENGLN Lightning Detection System (bottom) lightning during the period 0800 to 1400 AWST 7 January 2016.

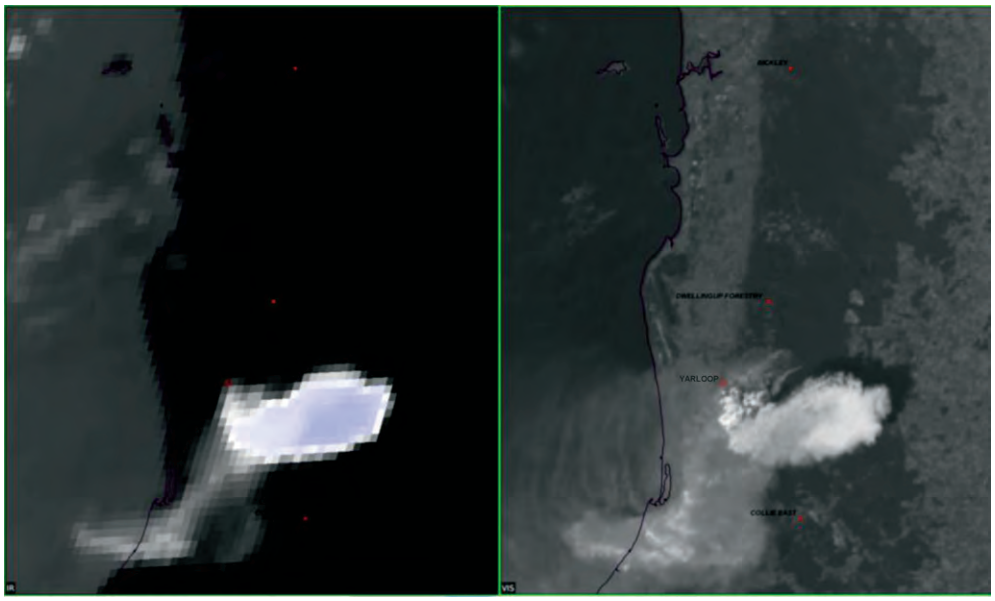

Figure 22: Infra-red (left) and visible (right) satellite images at 1200 AWST on 7 January showing pyrocumulonimbus clouds over the fire ground.

Table 6 indicates the strength and direction of the winds above the surface at Perth Airport, recorded at 1400 AWST. East northeast to northeast winds are evident in the low levels at and below about 2000m ASL. Between 2500m and 4000m ASL, winds tended north northeast.

Wind Direction (degrees)	Wind Speed (km/h)	Height ASL (m)
065	32	104
060	35	300
055	40	570
065	35	808
070	33	900
070	30	1555
075	25	2050
010	19	2723
020	27	3204
315	28	4200
340	31	5875
300	22	7553
270	57	9600
275	67	10828

Table 6: Upper winds recorded at Perth Airport at 1400 AWST 7 January 2016.

At 1400 AWST, temperatures were about 39°C at Dwellingup and 36°C at Harvey. Waroona recorded at temperature of 41°C. The relative humidity was generally between 15 and 20%. Winds along the Darling Scarp were east north east at around 20 km/h and on the coastal plain were southeast between 10 to 15 km/h. A low pressure system developed in the surface trough and caused the winds at Waroona to tend north northwest between 15 and 20 km/h. The north northwest winds occurred for periods between 1400 and 1600 AWST.

The peak FFDI observed at Dwellingup on 7 January was 54[7] at 1613 AWST. This corresponds to an FDR of Severe. At that time the temperature was 39.2°C, dew point 3.4°C, relative humidity 11% and wind from the east at 23 km/h.

At 1700 AWST, the temperature at Dwellingup was 39°C and at Harvey was 37°C. Waroona again was higher and recorded a temperature of 41°C. Winds on the Darling Scarp were east northeast and along the coastal plain were between east northeast and east southeast 15 to 20 km/h.

Table 7: Upper winds recorded at Perth Airport at 1900 AWST 7 January 2016. indicates the strength and direction of the winds above the surface at Perth Airport, recorded at 1900 AWST. Low level winds below 1000m ASL were from the north northeast generally between 30 and 50 km/h.

[7] The expression of a FDI as a single integer implies an unrealistic level of precision. Any forecast FDI value should be considered as a central value within a spread of possible FDI values, which reflect the inherent precision of the input values. See Appendix 2: Fire Danger Index Uncertainty for further details.

Wind Direction (degrees)	Wind Speed (km/h)	Height ASL (m)
020	29	108
020	35	300
030	48	468
020	42	806
025	41	968
050	30	1549
075	52	2092
075	52	2100
055	36	3198
025	18	3600
325	28	4200
310	45	5874
345	43	7562
350	42	9621
325	44	10855

Table 7: Upper winds recorded at Perth Airport at 1900 AWST 7 January 2016.

The peak GFDI observed at Dwellingup on 7 January was 34[8] at 1916 and 1918 AWST. This corresponds to an FDR of Very High. At that time the temperature was 34.2°C, dew point 1.9°C, relative humidity 13% and wind from the east southeast 27 km/h.

High resolution radar imagery (Figure 23, Figure 24, Figure 25) from Serpentine Radar (located about 50 km north of Waroona) showed low level smoke moving generally towards the west under the influence of easterly winds. In the upper levels (around 3000m), the smoke moved generally towards the southwest under the influence of northeast winds. The red REF circle denotes Yarloop. The top left panel in each of the RADAR images shows the lowest level scan, which is at a height of 650m at Waroona and 1025m at Harvey. The bottom left panel shows a cross section along a radial (shown in light blue). The right panel is a constant altitude image at about 3000m AGL.

[8] The expression of a FDI as a single integer implies an unrealistic level of precision. Any forecast FDI value should be considered as a central value within a spread of possible FDI values, which reflect the inherent precision of the input values. See Appendix 2: Fire Danger Index Uncertainty for further details.

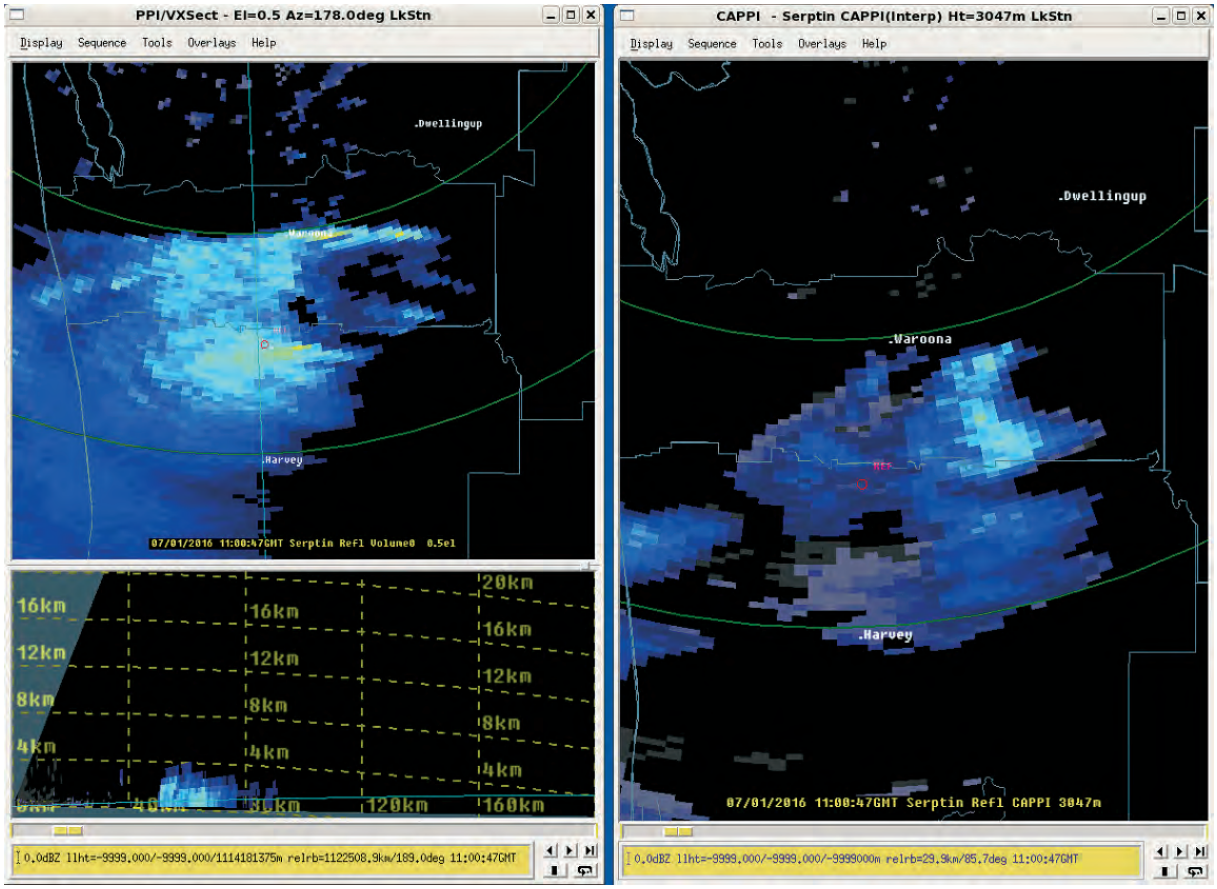

Figure 23: Serpentine radar image at 1900 AWST showing the lowest (0.5º) elevation scan (top left), a cross-section through the smoke plume (bottom left) and a constant altitude scan at 3047m (right).

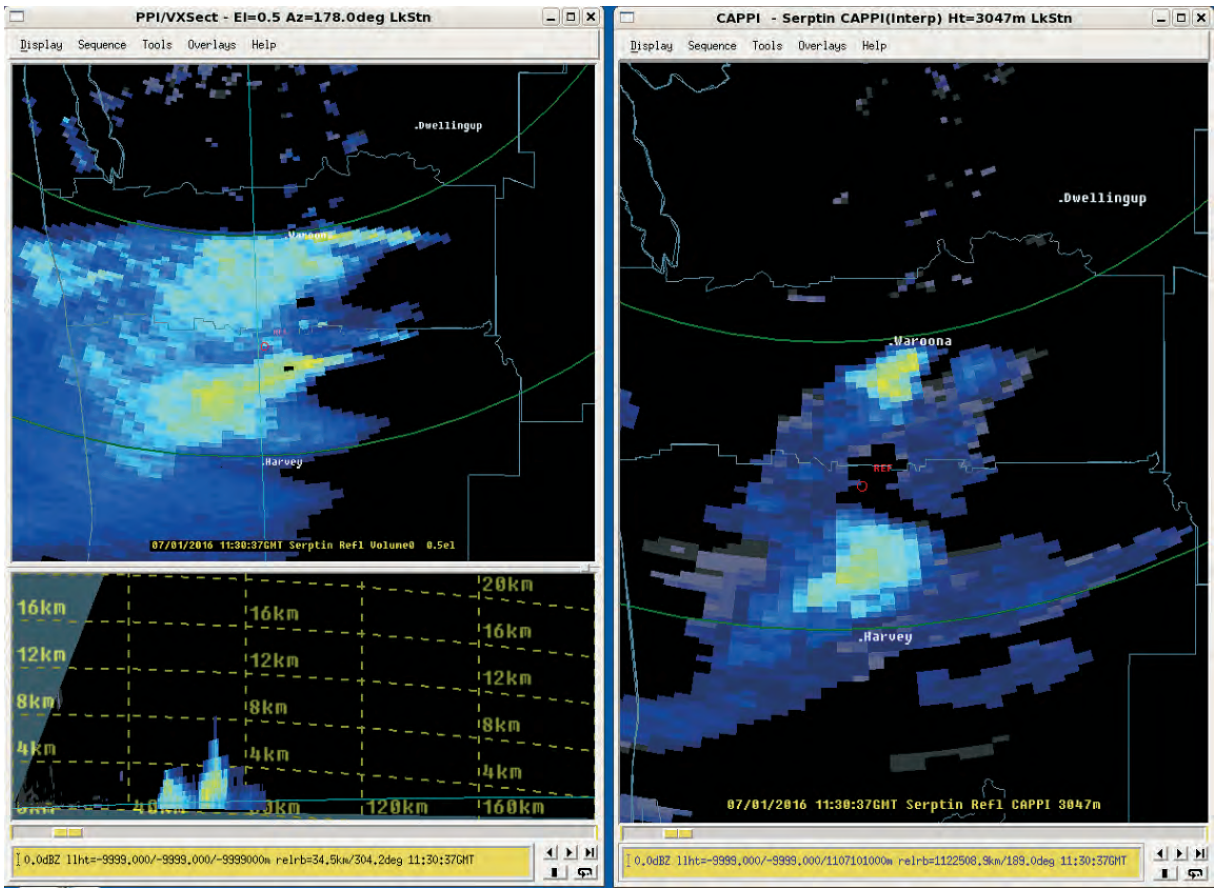

Figure 24: Serpentine radar image at 1930 AWST showing the lowest (0.5º) elevation scan (top left), a cross-section through the smoke plume (bottom left) and a constant altitude scan at 3047m (right).

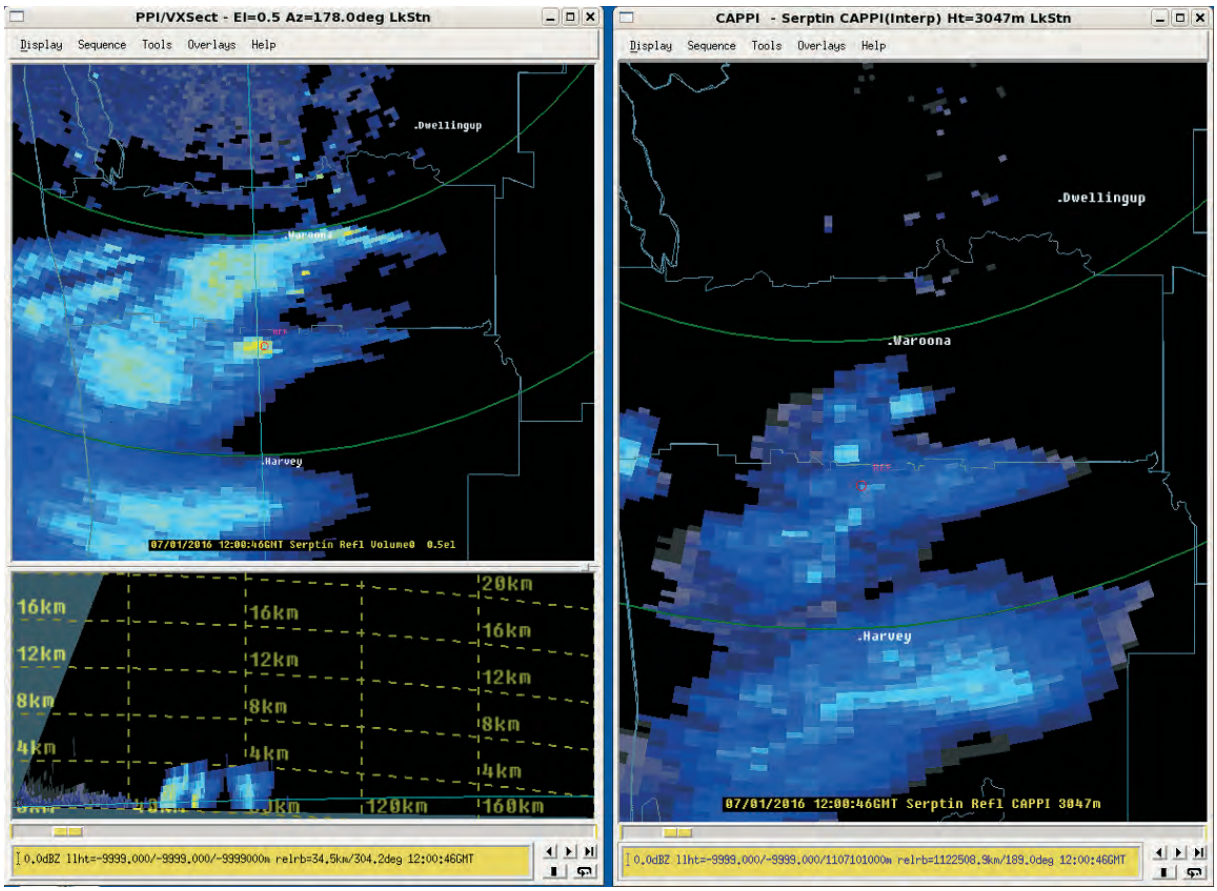

Figure 25: Serpentine radar image at 2000 AWST showing the lowest (0.5º) elevation scan (top left), a cross-section through the smoke plume (bottom left) and a constant altitude scan at 3047m (right).

There was a general increase in wind during Thursday evening 7 January. The increase was observed at Dwellingup generally between 1900 and 2000 AWST, Waroona between 2000 and 2200 AWST and Harvey between 2000 and 2130 AWST. There was also a decrease in moisture as shown by the decrease in dew point. Dwellingup decreased from 4.9°C (1840 AWST) to 0.6°C (2020 AWST), Waroona decreased from 9.3°C (1745 AWST) to 4.7°C (2100 AWST) and Harvey decreased from 4.9°C (1900 AWST) to 2.6°C (2130 AWST).

The source of the dry air observed in the vicinity of and over the fire ground on the evening of 7 January was traced back to the Great Southern weather district from earlier in the day. Figure 26 shows the evolution of the dew point temperature at Dwellingup, Wandering, Lake

Grace and Newdegate Research Station on Thursday 7 January. Detailed weather observations from these sites can be found in Appendix 4: Detailed Weather Observations. The location of these weather stations are shown in Figure 27. Similar rapid drops in dew point temperature are observed at several locations well to the east of the fire site, with moderate easterly winds directing the dry air towards the west coast during the day.

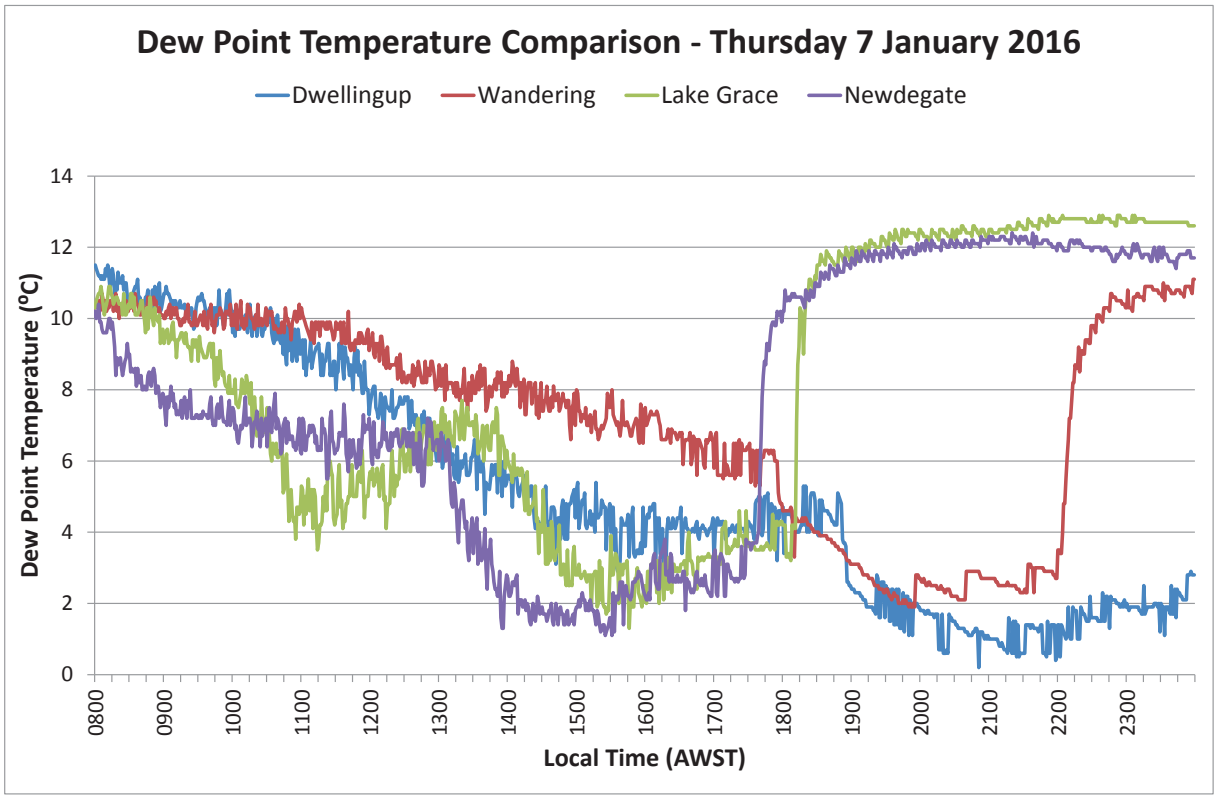

Figure 26: Dew point temperature comparison at Dwellingup, Wandering, Lake Grace and Newdegate AWS on 7 January 2016.

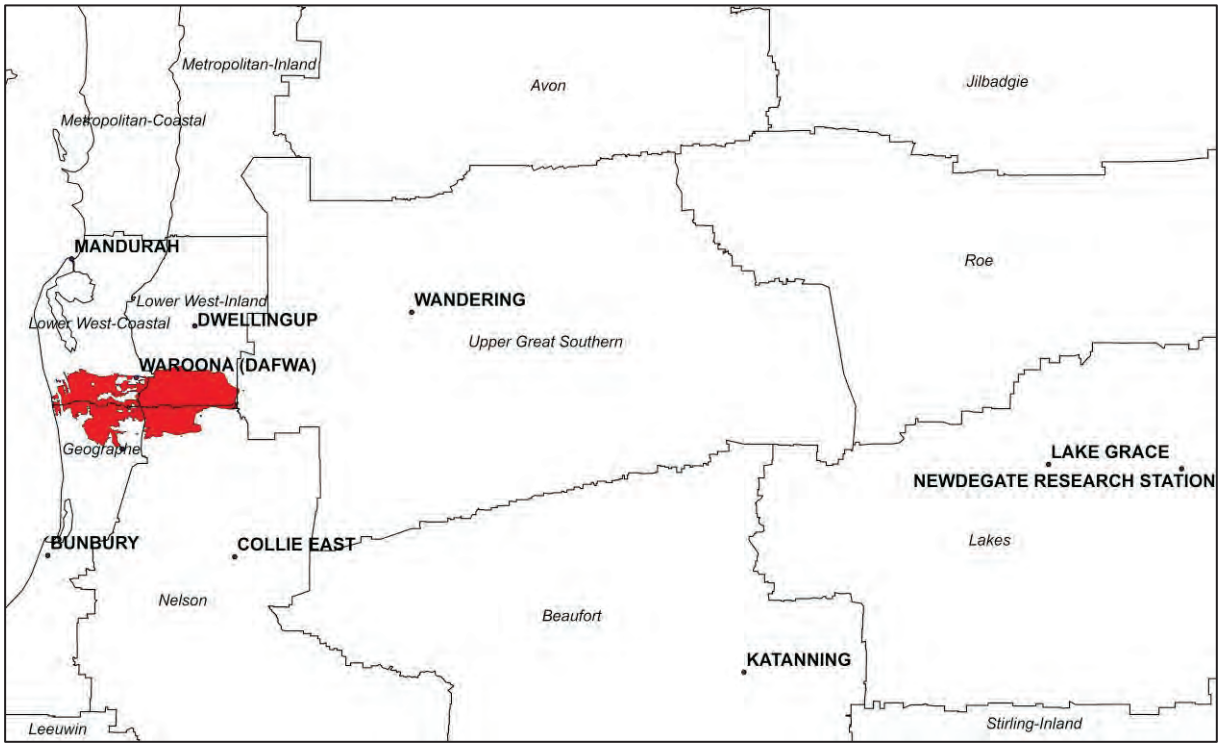

Figure 27: Final fire shape (red shading) of the Waroona Fire relative to BoM and DAFWA Automatic Weather Stations (capitalised) and fire weather districts (italicised).

Both Newdegate and Lake Grace showed sharp drops in dew point temperature as atmospheric mixing process started shortly after sunrise due to surface heating. Further west, at Dwellingup and Wandering, the decrease in dew point temperature during the morning period is more gradual, becoming more rapid later in the day as the dry air moved over the area from the east.

Sharp increases in dew point temperature after the dry air has passed through each location were also clearly evident, with the temporal evolution of this process indicating an east to west migration of the drier air mass.

The dry air becomes difficult to observe east of Newdegate, suggesting that the most likely source of the dry air is from the low to mid-levels of the atmosphere over eastern parts of the Great Southern weather district, brought to the surface by mixing processes during the morning due to surface heating.

Infrared (IR) satellite imagery at 2000 AWST 7 January showed high cloud over the fire ground. The last recorded lightning strike was at 1417 AWST. The atmosphere was not as

unstable compared to the previous afternoon and evening, as shown in Figure 28. Based on the available evidence, it is unlikely that pyrocumulonimbus clouds were present around 2000 AWST.

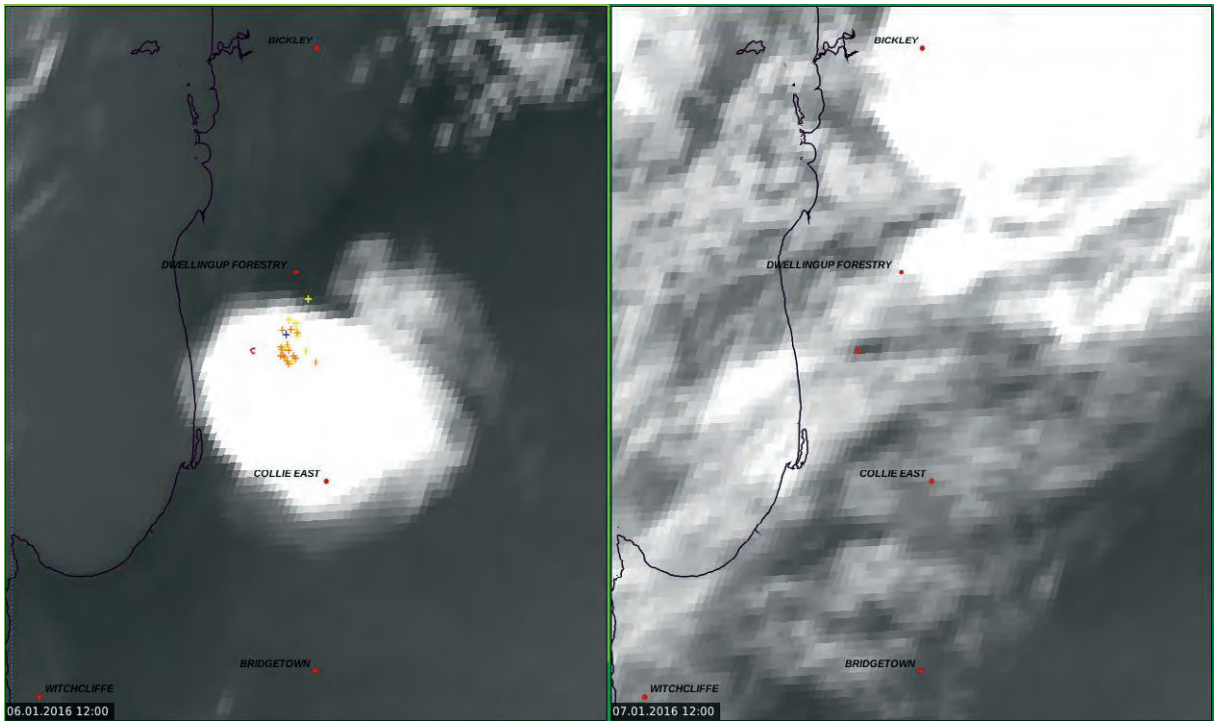

Figure 28: Comparison between infra-red images from 2000 AWST 6 January (left) and 2000 AWST 7 January (right), with a pyrocumulonimbus cloud clearly evident on 6 January over the fire ground.

At 2000 AWST, Serpentine radar detected smoke from the fire at Yarloop (yellow pixels very close to red REF circle, Figure 25). A cross-section through Yarloop showed that the smoke extended to about 4000m AGL.

At 2000 AWST, the temperature at Dwellingup was 33°C and at Harvey was 35°C. Waroona again was higher and recorded a temperature of 36°C. Some of the temperature difference may have been caused by the proximity of the fire to the Waroona AWS. Winds on the Darling Scarp and along the coastal plain were between east and east southeast 20 to 25 km/h.

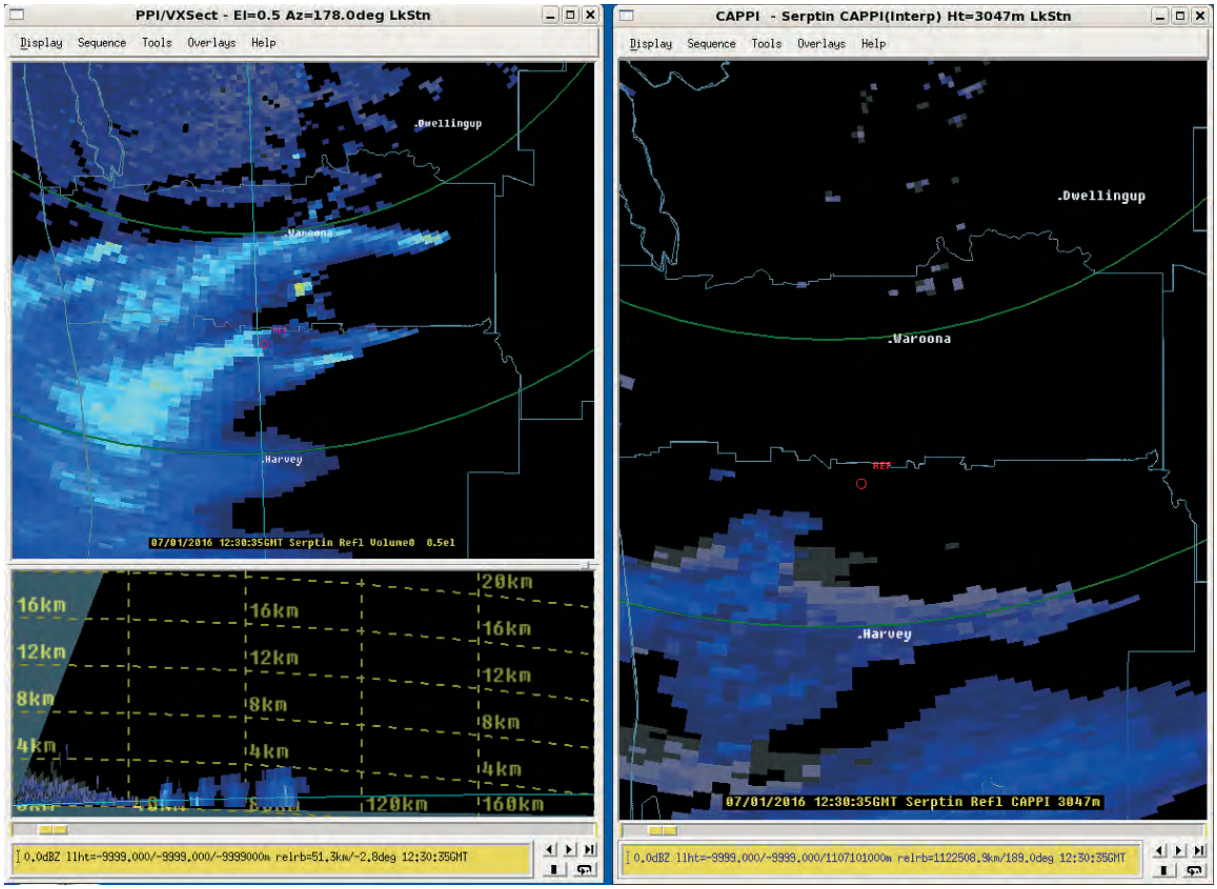

Figure 29: Serpentine radar image at 1230 AWST showing the lowest (0.5º) elevation scan (top left), a cross-section through the smoke plume (bottom left) and a constant altitude scan at 3047m (right).

The peak 10 minute average winds at Dwellingup during the evening of 7 January were east southeast 27 km/h at 1916 and 1918 AWST. The peak wind gust during this period was 46 km/h at 1913, 2022 and 2140 AWST.

At 2300 AWST, the temperature at Dwellingup and Harvey was 30°C. Waroona again was higher and recorded a temperature of 33°C. Again, this may have been caused by the proximity of the fire to the Waroona AWS. Winds on the Darling Scarp were from the east at about 20 km/h and along the coastal plain were northeast between 5 to 15 km/h.

Between 2330 AWST and midnight, the winds at Waroona tended north northwest at around 10 km/h as the surface trough was nearby.

6 Weather Forecasts

6.1 Bureau of Meteorology Fire Weather Services

The BoM provides fire weather services as part of the national framework in accordance with the Meteorological Act 1955[9]. The Bureau's fire weather service provides fire management authorities with briefings and routine forecasts for operational planning purposes. Spot Fire Weather Forecasts, both ad-hoc and routine are issued to fire authorities to assist in carrying out hazard reduction burns and in combating ongoing fires. The Bureau's fire weather services in Western Australia are determined in consultation with DPaW, DFES and the Western Australia Local Government Association (WALGA). These services are documented in the Fire Weather Directive (Bureau of Meteorology, 2015). Fire Weather Warnings are issued to the public when the forecast Fire Danger Ratings (FDRs) are Severe, Extreme or Catastrophic. Total Fire Bans (TFBs) for the state are the sole responsibility of DFES.

6.2 Routine Fire Weather Forecasts

Fire Weather Forecasts for the Southwest Land Division (SWLD) are routinely issued at approximately 0430 and 1600 AWST daily. The forecasts valid for 6 January and 7 January can be found in Appendix 5: Fire Weather Forecasts for 6 and 7 January 2016. The forecast Fire Danger Ratings (FDRs) for the Geographe, Nelson, Lower West-Inland and Lower West-Coastal districts are summarised in Table 8.

Date	*Geographe*	*Nelson*	*Lower West-Inland*	*Lower West-Coastal*
6 January	High	High	High	High
7 January	High	Very High	Very High	High

Table 8: Forecast Fire Danger Ratings (FDRs) for 6 and 7 January 2016.

6.3 Additional Services to DPaW

The Bureau provides a recorded video briefing service for DPaW during the Spring, Summer and Autumn prescribed burning periods (generally between October and May). The forecast

[9] THE METEOROLOGY ACT 1955
No. 6 of 1955. An Act relating to the Commonwealth Bureau of Meteorology, Comlawld – C2008C00066.

information contained in the briefing includes any weather that is significant to DPaW's burning program over the following four days[10].

Recorded weather briefings are prepared each afternoon, typically between 1400 AWST and 1500 AWST, and are viewed by DPaW at approximately 1600 AWST.

From Monday 4 January, the recorded weather briefings mentioned the risk of thunderstorms in the vicinity of the Perth hills from Wednesday 6 January, with thunderstorm activity most likely on Friday 8 January. This message was refined over subsequent days, as confidence in the positioning of the surface trough increased.

Tuesday's briefing mentioned gusty easterly winds and hot conditions over the area on Thursday and Friday, with the trough forecast to move inland during Saturday, initiating an easing trend in fire weather conditions from that point. Although weather conditions were not forecast to produce severe, extreme or catastrophic FDI's for Thursday and Friday, the likelihood of very high FDI's in the area was noted in the summary slide on Wednesday's briefing.

The briefing on Thursday 7 January highlighted the unstable atmosphere and the risk of pyrocumulonimbus clouds over the fire site (Figure 30).

Figure 30: Screen shot of information given in the video briefing on Thursday 7 January.

6.4 Additional Services to DFES

The Emergency Services Weather Briefing issued by the SOCMET (State Operations Centre Meteorologist)[11] on Monday 4 January mentioned Very High FFDIs over the Lower West Inland, Nelson and adjacent Geographe and Leeuwin fire weather districts from Thursday 7 January, as well as thunderstorms developing over the fire area along the trough.

During the routine Emergency Services Weather Briefing to DFES at 0900 AWST Thursday 7 January, the risk of pyrocumulonimbus clouds was mentioned: "The atmosphere will be unstable and it is possible that pyrocumulonimbus with associated dry lightning and wind gusts up to 80 km/h may form over the Waroona fire site."

[10] If significant weather is expected in the 4 to 7 day range, this is also brought to the attention of DPaW.
[11] Refer to the Agreement between The Commonwealth of Australia represented by the Bureau of Meteorology and the Department of Fire and Emergency Services (DFES).

The Emergency Services Weather Briefings are included in Appendix 7: Emergency Services Weather Briefings.

6.5 Spot Fire Weather Forecasts

Spot fire weather forecasts or "Spot Forecasts" are site-specific forecasts issued in response to a request from a fire agency. They may be requested to assist with tactical decision making in operations for an uncontrolled fire or for hazard reduction burns.

Spot Forecasts are issued with a validity of 12, 18, 24 or 30 hours. A monitoring and amendment service is maintained for all Spot Forecasts. Spot forecasts are not routinely reissued; they must be re-requested.[12]

The initial spot forecast request for this event was received by the Bureau from DPaW at approximately 0900 AWST on Wednesday 6 January. The initial location was Murray Rd (east of Nanga Brook, approximately 25 kilometres south-southeast of Dwellingup), very close to where thunderstorm activity had occurred the previous evening. This forecast was issued at 0923 AWST then re-issued at 1619 AWST later that day. There were no further spot forecast requests for this location.

A spot forecast request for Waroona was first received later that evening at approximately 2130 AWST, with the forecast being issued at 2151 AWST. Subsequent Spot Forecasts for this location were issued during 7 January at 0621 AWST, 0809 AWST and 1459 AWST.

Spot Forecasts for Preston Beach (representing the western extent of the fire) were issued on 7 January at 0248 AWST, 0259 AWST, 0809 AWST and 1459 AWST.

All Spot Forecasts issued for the Waroona Fire on 6 and 7 January can be found in Appendix 6: Spot Fire Weather Forecasts.

[12] Refer to the Fire Weather Directive 2015/2016 for further details.

7 Summary

The Waroona Fire occurred over an area of southwest WA which received very much below average rainfall and record high maximum temperatures during 2015. The below average rainfall in 2015 is consistent with a trend of declining annual rainfall that has been observed in southwest WA over the past 40 years. Temperatures in southwest Western Australia have risen by approximately 1°C over the past one hundred years with the last few years some of the warmest since comparable records commenced in 1910.

The fires occurred in generally hot, dry and windy conditions. Gusty easterly winds were observed at times, particularly during the morning and evening of 6 and 7 January due to a strong easterly pressure gradient over southwest parts of WA.

Pyrocumulonimbus clouds were observed on 6 and 7 January due to the fire interacting with an unstable atmosphere. Numerous lightning strikes were observed. During 7 January, conditions remained hot and dry well into the evening and easterly winds strengthened for a period during the evening.

The Bureau of Meteorology provided fire agencies with routine and site-specific fire weather forecasts during the Waroona Fire. Briefings were also conducted with a focus on the weather conditions over the fire ground.

The Waroona Fire was the second significant fire event over southern Western Australia during the 2015/16 fire season, following the Esperance District Fires during November 2015.

Appendix 1: South West Western Australia Fire Weather Districts

Figure 31: Map of fire weather forecast districts.

Appendix 2: Fire Danger Index Uncertainty

When forecasting the elements from which the FDI is calculated, small changes in forecast temperature, humidity and wind speed can combine to produce relatively large changes in forecast FDI. For this reason, the expression of a FDI as a single integer implies an unrealistic level of precision. Any forecast FDI value should be considered as a central value within a spread of possible FDI values, which reflect the inherent precision of the input values.

For FDI values of 50 and above, a spread of +/- 20-30% is typical for GFDI and a spread of +/- 15-20% is typical for FFDI.
The spread is generally larger for GFDI because the Grassland Mk 4 fire meter (either original or CSIRO Modified) is particularly sensitive to wind speed.

The impacts of these variations are also evident when observing weather elements and taking into account the accepted accuracy of sensors. The table below provides an example of the spread of observation-based GFDI values based on a temperature of 40˚C, relative humidity of 8%, wind speed of 30 km/h, and precision levels of the input variables of:

Temperature: +/- 0.3 ˚C
RH: +/- 3 %
Winds: +/- 3.7 km/h

Scenario	**T=40˚C +/- 0.3˚C, RH= 8% +/- 2%, Wind +/-3.7 km/hr**	
Central FDI Value	**GFDI range** 4.5 tonnes/ha	**FFDI range** DF=10
50	36 - 71	40 -60
75	55 - 104	60 -90
100	74 - 138	85 - 120

Example of the spread of FDI around selected FDI values due to an assumed precision of +/- 0.3 C, +/-3% Relative Humidity and +/- 3.7 km/h in wind speed.

NB. These accuracy values are inferred from the accepted accuracy of the sensors in a BoM AWS.

Appendix 3: Weather Station Details

Station Number	Station Name	Latitude	Longitude	Height above sea level (m)
009538	Dwellingup	-32.71	116.06	267
010917	Wandering	-32.67	116.67	275
010911	Lake Grace	-33.10	118.46	286
010692	Newdegate Research Station	-33.11	118.84	320

Table 9: BoM Automatic Weather Stations.

The following DAFWA weather stations (Table 10: DAFWA) referred to within this report are considered as non-standard weather observations (anemometer height 3 metres, unknown exposure, calibration and maintenance) but provide a guide to the weather conditions over the fire ground.

Station Number	Station Name	Latitude	Longitude	Height above sea level (m)
509575	Waroona	-32.86	115.89	36
509576	Harvey	-33.06	115.85	38

Table 10: DAFWA Automatic Weather Stations.

Appendix 4: Detailed Weather Observations

Dwellingup AWS (BoM) (267m ASL)

Date Time (AWST)	Temperature (°C)	Dew Point (°C)	Relative Humidity (%)	Wind Speed (km/h)	Wind Direction (degrees)	Wind Gust (km/h)
6/01/2016 0:00	24.6	13.2	49	24	130	37
6/01/2016 0:30	23	13.8	56	26	120	44
6/01/2016 0:47	22.1	14.2	61	28	120	48
6/01/2016 1:00	21.7	14.4	63	28	120	46
6/01/2016 1:30	20.8	14.5	67	26	130	37
6/01/2016 1:51	20.2	14.6	70	28	120	46
6/01/2016 2:00	19.9	14.5	71	31	120	46
6/01/2016 2:11	19.9	14.5	71	30	120	50
6/01/2016 2:30	19.6	14.6	73	28	120	43
6/01/2016 2:45	19.7	14.7	73	28	120	48
6/01/2016 3:00	19.3	14.6	74	28	120	48
6/01/2016 3:30	19.3	14.6	74	26	120	39
6/01/2016 4:00	19.1	14.6	75	26	120	43
6/01/2016 4:30	19	14.5	75	24	120	44
6/01/2016 5:00	18.9	14.4	75	24	110	39
6/01/2016 5:30	18.8	14.3	75	24	110	46
6/01/2016 6:00	19.1	14.4	74	26	110	43
6/01/2016 6:30	19.4	14.4	73	26	110	41
6/01/2016 7:00	20.3	14.7	70	26	110	41
6/01/2016 7:30	21.3	14.5	65	24	110	37
6/01/2016 8:00	23.3	14.6	58	20	110	35
6/01/2016 8:30	24.1	14.2	54	22	110	39
6/01/2016 9:00	25.3	14.1	50	20	100	37
6/01/2016 9:30	27.3	14.3	45	17	120	31
6/01/2016 10:00	27.9	13.4	41	20	90	37
6/01/2016 10:30	29.8	13.5	37	20	80	35
6/01/2016 11:00	30.9	12.8	33	15	100	30
6/01/2016 11:30	31.9	12.2	30	15	80	31
6/01/2016 12:00	32.8	11.9	28	15	70	24
6/01/2016 12:30	33.2	11.1	26	13	60	26

6/01/2016 13:00	34.4	10.9	24	15	50	31
6/01/2016 13:30	33.9	9.9	23	22	100	33
6/01/2016 14:00	35.8	9.3	20	17	100	35
6/01/2016 14:30	35.5	8.3	19	24	80	35
6/01/2016 15:00	35	7.1	18	13	40	26
6/01/2016 15:30	36	6.2	16	11	50	17
6/01/2016 16:00	37.1	5.2	14	15	30	28
6/01/2016 16:30	37.4	5.4	14	13	60	26
6/01/2016 17:00	35.2	12.8	26	13	260	19
6/01/2016 17:30	33.5	13.5	30	13	250	20
6/01/2016 18:00	33.9	13.9	30	13	270	17
6/01/2016 18:30	33.2	13.3	30	9	220	17
6/01/2016 19:00	33	13.1	30	4	10	9
6/01/2016 19:30	31.3	12.6	32	13	90	26
6/01/2016 19:59	31.6	11.4	29	28	130	54
6/01/2016 20:00	31.6	11.4	29	28	130	54
6/01/2016 20:30	30	12	33	24	120	44
6/01/2016 20:36	29.7	12.2	34	28	120	52
6/01/2016 21:00	28.9	12.3	36	30	110	54
6/01/2016 21:30	27.8	12.2	38	26	130	48
6/01/2016 21:40	27.4	12.2	39	28	120	54
6/01/2016 22:00	26.8	12.1	40	28	120	50
6/01/2016 22:30	25.8	12.3	43	22	120	35
6/01/2016 22:45	25.4	12.3	44	28	120	50
6/01/2016 23:00	25	12.2	45	30	110	50
6/01/2016 23:30	24.3	12.3	47	24	120	46
7/01/2016 0:00	23.5	12.5	50	26	120	41
7/01/2016 0:02	23.4	12.4	50	28	120	50
7/01/2016 0:30	22.8	12.4	52	26	120	44
7/01/2016 0:39	22.6	12.5	53	28	110	48
7/01/2016 1:00	22.3	12.3	53	24	120	39
7/01/2016 1:09	22.2	12.2	53	28	120	46
7/01/2016 1:30	21.9	12.2	54	26	120	52
7/01/2016 1:34	21.9	12.2	54	28	120	52
7/01/2016 2:00	21.8	12.4	55	28	110	44

7/01/2016 2:30	21.2	12.1	56	22	110	41
7/01/2016 3:00	20.9	12.1	57	24	120	41
7/01/2016 3:30	20.8	12	57	24	110	37
7/01/2016 4:00	20.7	11.9	57	24	110	39
7/01/2016 4:30	20.6	11.8	57	22	120	33
7/01/2016 5:00	20.7	11.6	56	22	120	31
7/01/2016 5:30	20.7	11.3	55	26	120	43
7/01/2016 6:00	20.7	11.6	56	24	110	37
7/01/2016 6:30	21.4	11.1	52	22	110	33
7/01/2016 7:00	22.4	11.2	49	20	110	33
7/01/2016 7:30	23.7	11.4	46	22	100	39
7/01/2016 8:00	25.7	11.5	41	20	90	37
7/01/2016 8:30	27.2	10.4	35	20	90	37
7/01/2016 9:00	28.5	10.7	33	24	100	41
7/01/2016 9:30	30.1	10.6	30	22	90	39
7/01/2016 10:00	31.4	9.6	26	24	100	43
7/01/2016 10:30	33.4	10.1	24	24	100	43
7/01/2016 11:00	33.8	9.1	22	17	70	26
7/01/2016 11:30	35.1	8	19	17	80	28
7/01/2016 12:00	35.6	7.6	18	26	90	41
7/01/2016 12:30	36.9	7.8	17	17	50	31
7/01/2016 13:00	37.3	6.3	15	22	30	41
7/01/2016 13:30	38.5	6.3	14	24	70	44
7/01/2016 14:00	39	5.6	13	19	60	35
7/01/2016 14:30	38.7	4.2	12	19	30	30
7/01/2016 15:00	38.5	5.2	13	13	20	24
7/01/2016 15:30	40.1	4	11	19	30	35
7/01/2016 16:00	39.5	3.6	11	15	80	28
7/01/2016 16:30	39	4.4	12	20	40	35
7/01/2016 17:00	39	3.2	11	19	70	43
7/01/2016 17:30	38.8	4.3	12	20	80	31
7/01/2016 18:00	37.8	4.7	13	19	90	37
7/01/2016 18:30	36.9	4	13	17	80	30
7/01/2016 19:00	34.9	2.4	13	22	110	43
7/01/2016 19:16	34.2	1.9	13	28	110	46

7/01/2016 19:30	33.7	2.5	14	26	110	41
7/01/2016 20:00	32.8	1.8	14	22	100	41
7/01/2016 20:30	32.4	1.5	14	20	100	46
7/01/2016 21:00	31.8	1	14	22	90	39
7/01/2016 21:30	31.3	0.6	14	22	100	39
7/01/2016 22:00	31.1	1.4	15	15	60	20
7/01/2016 22:30	30.2	1.6	16	19	70	35
7/01/2016 23:00	29.6	2	17	19	90	33
7/01/2016 23:30	29.6	2	17	17	90	31

Waroona AWS (DAFWA) (36m ASL)

Date Time (AWST)	Temperature (°C)	Dew Point (°C)	Relative Humidity (%)	Wind Speed (km/h)	Wind Direction (degrees)
6/01/2016 0:00	20.9	17.7	82	2	160
6/01/2016 0:30	25.2	15.9	56	7	100
6/01/2016 1:00	24.1	15.7	59	11	100
6/01/2016 1:30	23.2	15.8	63	9	100
6/01/2016 2:00	22.5	15.9	66	15	120
6/01/2016 2:30	21.7	15.9	70	13	110
6/01/2016 3:00	21.3	15.9	71	9	120
6/01/2016 3:30	21.1	15.7	71	9	110
6/01/2016 4:00	21.1	15.8	72	9	100
6/01/2016 4:30	21.1	15.7	71	7	110
6/01/2016 5:00	21	15.7	72	6	90
6/01/2016 5:30	20.9	15.6	72	6	80
6/01/2016 6:00	21.4	15.7	70	9	90
6/01/2016 6:30	22.1	15.8	67	11	90
6/01/2016 7:00	23.7	16	62	9	100
6/01/2016 7:30	24.5	15.9	59	11	70
6/01/2016 8:00	26	16.1	54	9	80
6/01/2016 8:30	26.7	16.2	53	15	100
6/01/2016 9:00	28.1	15.8	47	13	70
6/01/2016 9:30	28.8	16	46	17	90
6/01/2016 10:00	29.3	16.3	45	15	110
6/01/2016 10:30	31.6	16.5	40	15	90
6/01/2016 11:00	31.7	15.7	38	13	110
6/01/2016 11:30	33.9	16.1	35	11	90
6/01/2016 12:00	35.4	15.4	30	13	70
6/01/2016 12:30	35.1	15	30	13	110
6/01/2016 13:00	35.6	14.3	28	11	130
6/01/2016 13:30	36.9	14.1	26	11	80
6/01/2016 14:00	38.5	13.9	23	7	50
6/01/2016 14:30	37.6	13.5	24	9	90
6/01/2016 15:00	38.5	11.8	20	11	40

6/01/2016 15:30	38.9	11.9	20	13	100
6/01/2016 16:00	35.5	17.3	34	17	260
6/01/2016 16:30	33.7	16.9	37	20	250
6/01/2016 17:00	33.6	17.1	37	15	240
6/01/2016 17:30	32.5	17.7	41	13	230
6/01/2016 18:00	32.1	17.5	42	11	230
6/01/2016 18:30	31.9	17.6	43	9	240
6/01/2016 19:00	32	17.4	42	4	270
6/01/2016 19:30	30.2	17.3	46	4	340
6/01/2016 20:00	33	14.7	33	19	120
6/01/2016 20:30	31.8	14.4	35	20	110
6/01/2016 21:00	30.9	14.2	36	19	110
6/01/2016 21:30	30.7	13.8	36	22	110
6/01/2016 22:00	29.6	13.9	38	24	120
6/01/2016 22:30	29.1	13.7	39	26	110
6/01/2016 23:00	28.6	13.6	40	24	110
6/01/2016 23:12	27.9	13.7	42	28	110
6/01/2016 23:23	27.7	13.9	43	31	120
6/01/2016 23:34	27.5	14	44	31	120
6/01/2016 23:45	27.3	13.9	44	30	120
6/01/2016 23:56	27.3	14	44	30	120
7/01/2016 0:10	30.9	13.8	35	28	110
7/01/2016 0:21	30.8	13.8	36	30	100
7/01/2016 0:54	29.9	13.5	37	28	90
7/01/2016 1:05	29.7	13.4	37	30	100
7/01/2016 1:16	29.4	13.4	38	30	100
7/01/2016 1:27	29.1	13.6	39	30	90
7/01/2016 1:38	28.9	13.5	39	30	100
7/01/2016 1:49	28.7	13.5	39	28	100
7/01/2016 2:00	28.4	13.4	40	30	100
7/01/2016 2:11	28.1	13.5	41	30	100
7/01/2016 2:22	27.8	13.5	41	30	100
7/01/2016 2:33	27.7	13.7	42	28	100
7/01/2016 2:53	27.2	13.5	43	28	100
7/01/2016 3:30	26.9	13.5	44	22	90

7/01/2016 4:00	26.5	13.4	44	22	90
7/01/2016 4:30	26.6	13	43	24	100
7/01/2016 4:37	26.5	13	43	28	90
7/01/2016 4:50	26.1	12.9	44	28	90
7/01/2016 5:00	25.9	12.9	45	24	90
7/01/2016 5:09	26	12.8	44	28	90
7/01/2016 5:30	26.2	12.8	43	26	90
7/01/2016 6:00	26.4	12.6	42	20	80
7/01/2016 6:30	26	12.4	43	20	90
7/01/2016 7:00	26.3	12.5	42	19	80
7/01/2016 7:30	27.3	12.5	40	24	90
7/01/2016 8:00	28.1	12.8	39	28	90
7/01/2016 8:30	29.5	12.8	36	24	90
7/01/2016 9:00	31	12.9	33	22	80
7/01/2016 9:30	32.8	13	30	20	90
7/01/2016 10:00	33.5	12.7	28	19	90
7/01/2016 10:30	35.6	12.9	26	13	80
7/01/2016 11:00	35.8	12.1	24	22	70
7/01/2016 11:30	36.9	12.2	23	19	80
7/01/2016 12:00	38	11.6	21	20	80
7/01/2016 12:30	39.3	11.2	19	22	70
7/01/2016 13:00	40.4	11.2	18	19	60
7/01/2016 13:30	41.4	10.5	16	17	60
7/01/2016 14:00	41.3	10.2	16	17	30
7/01/2016 14:30	42.1	10.5	15	9	50
7/01/2016 15:00	40.6	9.1	15	13	40
7/01/2016 15:30	42.2	9.9	15	9	30
7/01/2016 16:00	41.1	9.6	15	15	70
7/01/2016 16:30	40.8	9.6	16	15	80
7/01/2016 17:00	40.8	9.4	15	15	70
7/01/2016 17:30	39.3	9.3	16	15	90
7/01/2016 18:00	39	8.4	16	13	90
7/01/2016 18:30	37.7	7.7	16	17	100
7/01/2016 19:00	36.8	7.1	16	13	100
7/01/2016 19:30	36.2	6.1	16	17	100

7/01/2016 20:00	35.9	6	16	19	90
7/01/2016 20:30	35.4	5.5	16	17	90
7/01/2016 21:00	34.9	4.7	15	20	90
7/01/2016 21:30	34.5	4.7	16	20	100
7/01/2016 22:00	34.1	4.7	16	15	90
7/01/2016 22:30	33	4.6	17	11	30
7/01/2016 23:00	32.6	4.7	17	11	40
7/01/2016 23:30	32.4	4.9	18	9	40

Harvey AWS (DAFWA) (38m ASL)

Date Time (AWST)	Temperature (°C)	Dew Point (°C)	Relative Humidity (%)	Wind Speed (km/h)	Wind Direction (degrees)
6/01/2016 0:00	25	15.2	55	15	120
6/01/2016 0:30	23.6	15	59	15	110
6/01/2016 1:00	22.7	14.9	61	15	100
6/01/2016 1:30	22	14.8	64	17	120
6/01/2016 2:00	21.4	14.7	66	13	110
6/01/2016 2:30	21.3	14.8	66	17	120
6/01/2016 3:00	21	14.8	68	19	110
6/01/2016 3:30	20.7	14.8	69	13	110
6/01/2016 4:00	20.7	14.7	69	17	110
6/01/2016 4:30	20.7	14.7	69	15	100
6/01/2016 5:00	20.5	14.6	69	7	90
6/01/2016 5:30	20.6	14.6	68	9	100
6/01/2016 6:00	21	14.6	67	7	110
6/01/2016 6:30	21.7	14.9	65	9	70
6/01/2016 7:00	22.9	14.9	61	11	90
6/01/2016 7:30	24.3	14.9	56	13	70
6/01/2016 8:00	25.4	14.6	51	15	70
6/01/2016 8:30	26.7	14.7	48	17	70
6/01/2016 9:00	28.1	15.1	45	15	80
6/01/2016 9:30	29.3	15.1	42	19	80
6/01/2016 10:00	30.9	14.9	38	15	80
6/01/2016 10:30	31.6	15.3	37	15	80
6/01/2016 11:00	32.3	15	35	19	70
6/01/2016 11:30	33.3	14.6	32	17	70
6/01/2016 12:00	34.5	14.7	31	15	60
6/01/2016 12:30	35.8	14.6	28	15	60
6/01/2016 13:00	35.4	13.4	27	15	50
6/01/2016 13:30	36.3	13	25	9	30
6/01/2016 14:00	37	12.4	23	9	80
6/01/2016 14:30	36.6	11.6	22	15	90
6/01/2016 15:00	37.8	10.8	20	11	110

6/01/2016 15:30	37.1	11.4	21	11	100
6/01/2016 16:00	37.6	11	20	11	100
6/01/2016 16:30	35.7	15.3	30	13	170
6/01/2016 17:00	34.6	14.9	31	15	180
6/01/2016 17:30	35.3	16	32	13	190
6/01/2016 18:00	34.7	16.4	34	7	200
6/01/2016 18:30	37	10.5	20	9	120
6/01/2016 19:00	36	10.3	21	9	120
6/01/2016 19:30	33.2	11.8	27	20	110
6/01/2016 20:00	32	12.3	30	20	100
6/01/2016 20:30	30.8	12.6	33	22	110
6/01/2016 21:00	30	12.6	34	20	100
6/01/2016 21:30	29	11.9	35	26	110
6/01/2016 21:33	28.9	11.8	35	28	110
6/01/2016 21:47	28.6	11.8	35	28	100
6/01/2016 22:00	28.3	11.9	36	26	100
6/01/2016 22:30	27.5	12	38	24	100
6/01/2016 22:39	27.3	12.1	39	28	100
6/01/2016 23:00	26.7	12.2	41	24	100
6/01/2016 23:05	26.5	12.2	41	28	100
6/01/2016 23:16	26.3	12.6	43	30	100
6/01/2016 23:27	26	12.6	43	30	100
6/01/2016 23:38	25.7	12.7	44	28	100
7/01/2016 0:00	25.2	12.8	46	24	100
7/01/2016 0:15	24.9	12.8	47	28	100
7/01/2016 0:30	24.6	12.8	48	26	100
7/01/2016 0:31	24.6	12.8	48	28	100
7/01/2016 0:44	24.3	12.8	49	28	100
7/01/2016 1:00	23.9	12.9	50	24	90
7/01/2016 1:30	23.4	12.8	51	26	100
7/01/2016 1:35	23.4	12.8	51	28	100
7/01/2016 1:46	23.2	12.7	52	28	100
7/01/2016 1:57	23.2	12.7	52	30	90
7/01/2016 2:08	23.1	12.7	52	28	100
7/01/2016 2:19	23.1	12.6	52	28	100

7/01/2016 2:30	22.8	12.6	53	26	100
7/01/2016 3:00	22.8	12.6	53	26	90
7/01/2016 3:10	22.9	12.6	52	28	100
7/01/2016 3:30	22.6	12.5	53	24	90
7/01/2016 4:00	22.6	12.5	53	26	100
7/01/2016 4:30	22.6	12.5	53	22	90
7/01/2016 5:00	22.5	12.3	52	19	70
7/01/2016 5:30	22.7	12	51	7	320
7/01/2016 6:00	22.9	12	50	7	150
7/01/2016 6:30	23.4	11.9	48	19	90
7/01/2016 7:00	24.1	12	47	22	80
7/01/2016 7:30	25.8	12.1	43	20	90
7/01/2016 8:00	26	12.1	42	20	80
7/01/2016 8:30	26.6	11.9	40	11	70
7/01/2016 9:00	28.2	11.8	36	11	90
7/01/2016 9:30	29.4	11.9	34	17	80
7/01/2016 10:00	30.4	11.5	31	19	80
7/01/2016 10:30	32.7	11.2	27	17	80
7/01/2016 11:00	31.6	11	28	9	90
7/01/2016 11:30	32.4	10.8	27	9	120
7/01/2016 12:00	33.7	11.1	25	11	90
7/01/2016 12:30	34.8	10.2	22	11	100
7/01/2016 13:00	34.6	9.7	22	13	100
7/01/2016 13:30	34.9	9.3	21	15	100
7/01/2016 14:00	36	9.4	20	11	120
7/01/2016 14:30	36.6	9.2	19	13	110
7/01/2016 15:00	36.7	8.5	18	15	100
7/01/2016 15:30	37	8.5	18	17	110
7/01/2016 16:00	37.1	8.1	17	17	110
7/01/2016 16:30	37	7.5	17	19	110
7/01/2016 17:00	36.8	7	16	15	100
7/01/2016 17:30	36.7	6.8	16	13	100
7/01/2016 18:00	36.4	5.5	15	17	110
7/01/2016 18:30	35.8	5.2	15	13	100
7/01/2016 19:00	35.1	4.9	15	15	100

7/01/2016 19:30	34.9	3.9	14	17	100
7/01/2016 20:00	34.5	4.2	15	20	100
7/01/2016 20:30	33.6	4	16	13	90
7/01/2016 21:00	33.2	3.7	16	17	100
7/01/2016 21:30	33.2	2.6	14	19	90
7/01/2016 22:00	32	3.7	17	13	100
7/01/2016 22:30	31	6.4	21	11	90
7/01/2016 23:00	30.4	8.7	26	4	70
7/01/2016 23:30	30.3	9.9	28	7	90

Lake Grace AWS (BoM) (286m ASL)

Date Time (AWST)	Temperature (°C)	Dew Point (°C)	Relative Humidity (%)	Wind Speed (km/h)	Wind Direction (degrees)	Wind Gust (km/h)
7/01/2016 8:00	22.5	10.3	46	19	90	26
7/01/2016 8:30	24	10.3	42	19	80	26
7/01/2016 9:00	25.5	9.3	36	19	90	28
7/01/2016 9:30	26.4	8.8	33	20	80	35
7/01/2016 10:00	28.8	7.9	27	24	90	35
7/01/2016 10:30	29.6	7.5	25	22	90	35
7/01/2016 11:00	30.9	5.3	20	28	90	41
7/01/2016 11:30	31.6	4.4	18	28	80	43
7/01/2016 12:00	32.2	5.7	19	28	80	43
7/01/2016 12:06	33.3	5.8	18	28	80	46
7/01/2016 12:30	33.2	5.7	18	28	90	41
7/01/2016 12:44	33	6.3	19	28	90	48
7/01/2016 13:00	33.7	6.9	19	24	80	35
7/01/2016 13:30	34	7.1	19	24	90	39
7/01/2016 14:00	34.6	6	17	24	80	37
7/01/2016 14:30	34.3	4	15	24	70	39
7/01/2016 15:00	34.1	2.8	14	20	80	26
7/01/2016 15:30	34.2	3.9	15	24	80	37
7/01/2016 16:00	34.7	2.3	13	26	80	35
7/01/2016 16:30	34.2	2.9	14	24	100	31
7/01/2016 17:00	33.3	3.2	15	22	90	33
7/01/2016 17:30	33.9	3.7	15	20	100	35
7/01/2016 18:00	33.5	4.2	16	22	100	39
7/01/2016 18:30	30.5	11.5	31	28	110	41
7/01/2016 18:32	30.5	11.5	31	28	110	46
7/01/2016 19:00	28.5	12	36	28	120	46
7/01/2016 19:30	26.8	12.1	40	26	120	43
7/01/2016 20:00	25.3	12.5	45	26	120	39
7/01/2016 20:30	24	12.3	48	22	120	37
7/01/2016 21:00	22.6	12.5	53	20	120	30
7/01/2016 21:30	21.7	12.5	56	22	110	31

7/01/2016 22:00	21	12.7	59	20	110	30
7/01/2016 22:30	20.7	12.7	60	20	100	30
7/01/2016 23:00	20.2	12.7	62	19	100	30
7/01/2016 23:30	19.9	12.7	63	20	100	31

Newdegate Research Station AWS (BoM) (300m ASL)

Date Time (AWST)	Temperature (°C)	Dew Point (°C)	Relative Humidity (%)	Wind Speed (km/h)	Wind Direction (degrees)	Wind Gust (km/h)
7/01/2016 8:00	22.4	10.2	46	26	090	33
7/01/2016 8:30	24.3	9.1	38	24	080	33
7/01/2016 9:00	25.2	7.8	33	26	090	33
7/01/2016 9:30	26.8	7.3	29	22	080	33
7/01/2016 10:00	29	7.6	26	24	080	35
7/01/2016 10:30	29	6.4	24	26	080	39
7/01/2016 11:00	30.3	6.2	22	26	080	43
7/01/2016 11:30	31.2	6.3	21	30	100	37
7/01/2016 12:00	32.8	6.9	20	26	090	39
7/01/2016 12:30	32.8	6.9	20	31	100	41
7/01/2016 13:00	32.7	6.1	19	28	090	41
7/01/2016 13:30	33.6	3.4	15	31	100	43
7/01/2016 14:00	34	2.8	14	30	100	43
7/01/2016 14:30	34.3	2	13	24	090	39
7/01/2016 15:00	34.3	2	13	26	100	37
7/01/2016 15:30	33.7	1.5	13	28	110	41
7/01/2016 16:00	33.4	2.3	14	24	080	33
7/01/2016 16:30	34	2.8	14	24	090	33
7/01/2016 17:00	33.6	3.4	15	26	080	35
7/01/2016 17:30	32.8	3.7	16	22	100	31
7/01/2016 18:00	30.3	10.3	29	31	130	44
7/01/2016 18:30	28.3	10.9	34	33	130	44
7/01/2016 19:00	26.4	11.7	40	31	130	39
7/01/2016 19:30	24.5	11.8	45	26	120	37
7/01/2016 20:00	22.9	11.9	50	26	130	35
7/01/2016 20:30	21.5	12.1	55	26	120	41
7/01/2016 21:00	20.4	12.4	60	22	120	30
7/01/2016 21:30	19.5	12.3	63	19	120	28
7/01/2016 22:00	18.6	12.1	66	11	100	17
7/01/2016 22:30	18.2	12.0	67	11	110	17
7/01/2016 23:00	17.8	11.8	68	9	110	13

7/01/2016 23:30	17.7	11.7	68	11	110	13

Wandering AWS (BoM) (275m ASL)

Date Time (AWST)	Temperature (°C)	Dew Point (°C)	Relative Humidity (%)	Wind Speed (km/h)	Wind direction (Degrees)	Wind Gust (km/h)
7/01/2016 8:00	26.1	10.3	37	20	100	33
7/01/2016 9:00	28.8	10	31	20	100	31
7/01/2016 10:00	31.3	10.1	27	17	100	28
7/01/2016 11:00	34.4	10.3	23	17	90	30
7/01/2016 12:00	35.8	9.3	20	19	70	31
7/01/2016 13:00	36.9	8.7	18	17	60	30
7/01/2016 14:00	37.2	8.1	17	22	70	35
7/01/2016 15:00	38.2	8	16	13	100	35
7/01/2016 16:00	37.6	7.5	16	17	50	31
7/01/2016 17:00	37.9	5.8	14	19	90	30
7/01/2016 18:00	36.4	4.6	14	20	110	41
7/01/2016 19:00	34.5	3.1	14	19	110	35
7/01/2016 20:00	32.7	2.7	15	19	110	31
7/01/2016 21:00	31.6	2.7	16	15	110	24
7/01/2016 22:00	30.5	3.5	18	15	110	24
7/01/2016 23:00	28.1	10.3	33	13	90	26

Appendix 5: Fire Weather Forecasts for 6 and 7 January 2016

Australian Government
Bureau of Meteorology

IDW15000
Australian Government Bureau of Meteorology
Western Australia

Fire Weather Forecast for Southwest Land Division WA for Wednesday 6 January 2016

Issued at 4:30 am WST on Wednesday 6 January 2016.

FORECASTS ARE ISSUED REGULARLY: PLEASE ENSURE YOU HAVE THE LATEST VERSION

Summary

District	District FFDI	District GFDI	District Rating	Percent Coverage	Fire Weather Warning
Coastal Central West - North	27	24	High	54	
Inland Central West - North	30	21	High	81	
Coastal Central West - South	13	8	Low-Moderate	100	
Inland Central West - South	32	15	High	59	
Lower West Coast	26	18	High	56	
Lower West Inland	30	21	High	100	
Geographe	29	25	High	100	
Leeuwin	22	18	High	76	
Nelson	29	26	High	100	
Stirling Coast	9	16	Low-Moderate	100	
Stirling Inland	15	18	High	94	
Ravensthorpe Shire Coast	11	20	Low-Moderate	100	
Ravensthorpe Shire Inland	17	15	High	76	
Esperance Shire Coast	14	22	High	74	
Esperance Shire Inland	23	15	High	52	
Upper Great Southern	34	34	Very High	27	
Roe	34	26	High	86	
Beaufort	28	27	High	97	
Lakes	25	22	High	99	
Mortlock	37	16	High	63	
Ninghan	36	22	High	90	
Avon	39	32	Very High	14	
Jilbadgie	35	23	High	98	

* Ratings information are provided in conjunction with Fire Authorities.
* District FDI is the representative peak FDI in the district for that fuel type. 10% of the district has a max FDI higher than this value.
* Percent Coverage is the percentage of the district that falls in or above the District Rating threshold.

Wednesday

A trough lies along the west coast, as a high to the south of the State extends a ridge across the south coast.

District Weather Elements for Wednesday 6 January 2016

Issued at 4:30 am WST on Wednesday 6 January 2016.

District	TAL	Prob Rain >5mm
Coastal Central West - North	0	< 5
Inland Central West - North	0	< 5
Coastal Central West - South	0	< 5
Inland Central West - South	1	< 5
Lower West Coast	0	< 5
Lower West Inland	1	< 5
Geographe	0	< 5
Leeuwin	1	< 5
Nelson	1	5
Stirling Coast	1	15
Stirling Inland	1	20
Ravensthorpe Shire Coast	1	10
Ravensthorpe Shire Inland	1	10
Esperance Shire Coast	1	< 5
Esperance Shire Inland	1	< 5
Upper Great Southern	1	< 5
Roe	1	5
Beaufort	1	15
Lakes	1	15
Mortlock	1	< 5
Ninghan	1	10
Avon	1	< 5
Jilbadgie	1	10

Detailed District Forecast for Wednesday 6 January 2016

Issued at 4:30 am WST on Wednesday 6 January 2016.

	Fuel Type	Dist FDI	FFDI > 32 GFDI > 32			FFDI > 50 GFDI > 50			FFDI > 75 GFDI > 75			FFDI > 100 GFDI > 100		
			%	Start	Hrs	%	Start	Hrs	%	Start	Hrs	%	Start	Hrs
Coastal Central West - North	F	27	< 1	NA	NA	0			0			0		
	G	24	0			0			0			0		
Inland Central West - North	F	30	< 1	NA	NA	0			0			0		
	G	21	0			0			0			0		
Coastal Central West - South	F	13	0			0			0			0		
	G	8	0			0			0			0		
Inland Central West - South	F	32	14	14	2	0			0			0		
	G	15	0			0			0			0		
Lower West Coast	F	26	0			0			0			0		
	G	18	0			0			0			0		
Lower West Inland	F	30	1	15	1	0			0			0		
	G	21	0			0			0			0		
Geographe	F	29	0			0			0			0		
	G	25	0			0			0			0		
Leeuwin	F	22	0			0			0			0		
	G	18	< 1	NA	NA	0			0			0		
Nelson	F	29	< 1	NA	NA	0			0			0		
	G	26	0			0			0			0		
Stirling Coast	F	9	0			0			0			0		
	G	16	0			0			0			0		
Stirling Inland	F	15	0			0			0			0		
	G	18	0			0			0			0		

	Fuel Type	Dist FDI	FFDI > 32 GFDI > 32			FFDI > 50 GFDI > 50			FFDI > 75 GFDI > 75			FFDI > 100 GFDI > 100		
			%	Start	Hrs	%	Start	Hrs	%	Start	Hrs	%	Start	Hrs
Ravensthorpe Shire Coast	F	11	0			0			0			0		
	G	20	0			0			0			0		
Ravensthorpe Shire Inland	F	17	0			0			0			0		
	G	15	0			0			0			0		
Esperance Shire Coast	F	14	0			0			0			0		
	G	22	1	15	3	0			0			0		
Esperance Shire Inland	F	23	0			0			0			0		
	G	15	0			0			0			0		
Upper Great Southern	F	34	39	14	5	0			0			0		
	G	34	27	18	2	0			0			0		
Roe	F	34	39	14	4	0			0			0		
	G	26	0			0			0			0		
Beaufort	F	28	0			0			0			0		
	G	27	0			0			0			0		
Lakes	F	25	0			0			0			0		
	G	22	0			0			0			0		
Mortlock	F	37	61	14	4	0			0			0		
	G	16	0			0			0			0		
Ninghan	F	36	44	12	5	0			0			0		
	G	22	0			0			0			0		
Avon	F	39	54	15	5	0			0			0		
	G	32	14	17	2	0			0			0		
Jilbadgie	F	35	66	13	6	0			0			0		
	G	23	0			0			0			0		

Australian Government
Bureau of Meteorology

IDW15000
Australian Government Bureau of Meteorology
Western Australia

Fire Weather Forecast for Southwest Land Division WA for Thursday 7 January 2016

Issued at 4:30 am WST on Thursday 7 January 2016.

FORECASTS ARE ISSUED REGULARLY: PLEASE ENSURE YOU HAVE THE LATEST VERSION

Summary

District	District FFDI	District GFDI	District Rating	Percent Coverage	Fire Weather Warning
Coastal Central West - North	27	18	High	26	
Inland Central West - North	45	22	High	91	
Coastal Central West - South	30	13	High	19	
Inland Central West - South	42	26	High	99	
Lower West Coast	39	28	High	96	
Lower West Inland	41	25	Very High	76	
Geographe	30	28	High	100	
Leeuwin	30	18	High	100	
Nelson	34	24	Very High	22	
Stirling Coast	15	18	High	26	
Stirling Inland	23	19	High	98	
Ravensthorpe Shire Coast	15	18	High	47	
Ravensthorpe Shire Inland	23	16	High	100	
Esperance Shire Coast	17	21	High	63	
Esperance Shire Inland	28	16	High	57	
Upper Great Southern	35	22	High	100	
Roe	38	23	High	100	
Beaufort	35	23	High	99	
Lakes	36	24	High	100	
Mortlock	43	32	Very High	12	
Ninghan	43	34	Very High	17	
Avon	43	27	High	100	
Jilbadgie	38	22	High	100	

* Ratings information are provided in conjunction with Fire Authorities.
* District FDI is the representative peak FDI in the district for that fuel type. 10% of the district has a max FDI higher than this value.
* Percent Coverage is the percentage of the district that falls in or above the District Rating threshold.

Thursday

A weak low lies offshore from the Geraldton coast and extends a trough through to the Inland Gascoyne. A ridge lies south of the State, causing winds to remain moderate to fresh between the ridge and the trough.

District Weather Elements for Thursday 7 January 2016

Issued at 4:30 am WST on Thursday 7 January 2016.

District	TAL	Prob Rain >5mm
Coastal Central West - North	0	< 5
Inland Central West - North	1	< 5
Coastal Central West - South	0	< 5
Inland Central West - South	0	< 5
Lower West Coast	0	< 5
Lower West Inland	1	< 5
Geographe	1	< 5
Leeuwin	1	< 5
Nelson	1	< 5
Stirling Coast	0	0
Stirling Inland	0	0
Ravensthorpe Shire Coast	0	0
Ravensthorpe Shire Inland	0	0
Esperance Shire Coast	0	0
Esperance Shire Inland	0	0
Upper Great Southern	0	< 5
Roe	0	0
Beaufort	0	< 5
Lakes	0	0
Mortlock	0	0
Ninghan	1	< 5
Avon	0	0
Jilbadgie	1	< 5

Detailed District Forecast for Thursday 7 January 2016

Issued at 4:30 am WST on Thursday 7 January 2016.

	Fuel Type	Dist FDI	FFDI > 32 GFDI > 32			FFDI > 50 GFDI > 50			FFDI > 75 GFDI > 75			FFDI > 100 GFDI > 100		
			%	Start	Hrs	%	Start	Hrs	%	Start	Hrs	%	Start	Hrs
Coastal Central West - North	F	27	4	14	3	0			0			0		
	G	18	0			0			0			0		
Inland Central West - North	F	45	76	10	9	0			0			0		
	G	22	0			0			0			0		
Coastal Central West - South	F	30	2	12	3	0			0			0		
	G	13	0			0			0			0		
Inland Central West - South	F	42	93	09	14	0			0			0		
	G	26	2	10	1	0			0			0		
Lower West Coast	F	39	76	11	7	0			0			0		
	G	28	0			0			0			0		
Lower West Inland	F	41	76	11	8	0			0			0		
	G	25	0			0			0			0		
Geographe	F	30	3	15	2	0			0			0		
	G	28	0			0			0			0		
Leeuwin	F	30	2	15	2	0			0			0		
	G	18	< 1	NA	NA	0			0			0		
Nelson	F	34	22	15	3	0			0			0		
	G	24	0			0			0			0		
Stirling Coast	F	15	0			0			0			0		
	G	18	< 1	NA	NA	0			0			0		
Stirling Inland	F	23	0			0			0			0		
	G	19	0			0			0			0		

	Fuel Type	Dist FDI	FFDI > 32 GFDI > 32			FFDI > 50 GFDI > 50			FFDI > 75 GFDI > 75			FFDI > 100 GFDI > 100		
			%	Start	Hrs	%	Start	Hrs	%	Start	Hrs	%	Start	Hrs
Ravensthorpe Shire Coast	F	15	0			0			0			0		
	G	18	0			0			0			0		
Ravensthorpe Shire Inland	F	23	0			0			0			0		
	G	16	0			0			0			0		
Esperance Shire Coast	F	17	0			0			0			0		
	G	21	< 1	NA	NA	0			0			0		
Esperance Shire Inland	F	28	0			0			0			0		
	G	16	0			0			0			0		
Upper Great Southern	F	35	64	13	4	0			0			0		
	G	22	0			0			0			0		
Roe	F	38	80	13	6	0			0			0		
	G	23	0			0			0			0		
Beaufort	F	35	53	14	4	0			0			0		
	G	23	0			0			0			0		
Lakes	F	36	35	14	4	0			0			0		
	G	24	0			0			0			0		
Mortlock	F	43	100	10	10	0			0			0		
	G	32	12	09	3	0			0			0		
Ninghan	F	43	81	10	14	0			0			0		
	G	34	17	08	5	0			0			0		
Avon	F	43	97	11	8	0			0			0		
	G	27	0			0			0			0		
Jilbadgie	F	38	64	11	8	0			0			0		
	G	22	0			0			0			0		

Appendix 6: Spot Fire Weather Forecasts

Australian Government
Bureau of Meteorology

IDW31260
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Murray Rd - E of Nanga Brook

Issued at 9:23 am WST on Wednesday 6 January 2016.

Incident Type: Wildfire	Website Form No: 010
Spot Forecast Location: Murray Rd - E of Nanga Brook	Request No: 1
Latitude/Longitude: -32.896 116.21	Fax Number: 93679913
Elevation (metres ASL): ##	Contact Ph: 92199234
Fuel Type: Not required	Contact Name: Jenn Debono

Weather Forecast starting 1000 hours Wednesday 6 January 2016

Mostly sunny. Slight chance of an afternoon shower or thunderstorm. Expected rainfall < 1mm.

Significant wind changes and uncertainties associated with the forecast

Winds may reach 30km/h (gusting to 45km/h) between 8pm and 10pm this evening. ENE'lies may become gusty, possibly reaching 30km/h (gusting 45km/h) after 7am Thursday morning. Variable wind gusts to 80km/h possible in and around thunderstorms.

24 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
1000	26	14	48	E	15	30	NE	30	8	5
1300	31	12	31	E	15	20	ENE	30	17	8
1600	34	12	26	ESE	20	30	E	30	25	15
1900	30	13	35	ESE	20	30	E	35	16	11
2200	25	13	47	ESE	20	35	E	55	9	8
0100	21	14	64	ESE	20	30	ENE	65	4	6
0400	18	13	73	E	20	30	NE	60	3	5
0700	20	13	64	ENE	20	35	NE	45	4	5
1000	28	13	40	ENE	25	40	NE	40	14	14

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31260
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Murray Rd - E of Nanga Brook

Issued at 4:19 pm WST on Wednesday 6 January 2016.

Incident Type: Wildfire	Website Form No: 010
Spot Forecast Location: Murray Rd - E of Nanga Brook	Request No: 2
Latitude/Longitude: -32.896 116.21	Fax Number: 93679913
Elevation (metres ASL): ##	Contact Ph: 92199234
Fuel Type: Not required	Contact Name: Jenn Debono

Weather Forecast starting 1700 hours Wednesday 6 January 2016

Mostly clear tonight. Slight chance of a shower or thunderstorm this afternoon. Expected rainfall < 1mm.

Mostly sunny tomorrow. Slight chance of an afternoon shower or thunderstorm. Expected rainfall < 2mm.

Significant wind changes and uncertainties associated with the forecast

Winds may become light and variable for a period this afternoon until around 8pm. E'lies may reach 25km/h (gusting to 40km/h) between 8pm and 10pm this evening. ENE'lies may become gusty, possibly reaching 30km/h (gusting 45km/h) between 7am and 10am Thursday morning. Variable wind gusts to 80km/h possible in and around thunderstorms this afternoon, up to 90km/h possible tomorrow afternoon.

24 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
1700	33	9	23	E	20	35	E	40	27	16
2000	29	10	31	ESE	20	30	ENE	60	18	12
2300	24	11	44	ESE	20	35	ENE	70	10	8
0200	21	12	56	E	20	35	NE	65	6	6
0500	19	12	64	E	20	30	NE	50	4	5
0800	23	12	50	ENE	25	40	NE	45	9	10
1100	30	12	33	ENE	20	35	NE	35	17	12
1400	35	11	23	ENE	15	25	NE	35	26	11
1700	36	10	21	ENE	15	25	ENE	35	29	12

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31800
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Waroona

Issued at 9:51 pm WST on Wednesday 6 January 2016.

Incident Type: Wildfire	Website Form No: 015
Spot Forecast Location: Waroona	Request No: 1
Latitude/Longitude: -32.854 115.935	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DFES Comms

Weather Forecast starting 2200 hours Wednesday 6 January 2016

Clear. Slight chance of a thunderstorm Thursday afternoon and evening.

Significant wind changes and uncertainties associated with the forecast

Gusty east to southeasterly winds developing Thursday night - 10pm winds may be 10-20km/h lighter than forecast increasing to forecast strength by 11.30pm.

24 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
2200	27	14	45	ESE	35	55	ENE	65	15	22
0100	25	14	50	E	40	65	ENE	70	13	25
0400	23	13	53	E	40	65	NE	70	11	23
0700	26	13	45	ENE	40	60	NNE	50	16	28
1000	33	12	28	ENE	30	50	NNE	45	29	27
1300	37	12	22	ENE	20	30	NE	35	32	18
1600	38	10	19	ENE	15	25	NE	30	33	13
1900	32	11	28	E	10	20	ENE	30	18	6
2200	30	10	29	E	20	30	ENE	45	20	13

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31800
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Waroona

Issued at 6:21 am WST on Thursday 7 January 2016.

Incident Type: Wildfire	Website Form No: 015
Spot Forecast Location: Waroona	Request No: 2
Latitude/Longitude: -32.854 115.935	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DFES Comms

Weather Forecast starting 0700 hours Thursday 7 January 2016

Clear. Slight chance of a thunderstorm Thursday afternoon and evening.

Significant wind changes and uncertainties associated with the forecast

Winds to the west of spot location may experience a brief southwesterly sea breeze to 15km/h between 1pm and approximately 4pm however not expected to reach
the spot location. Winds may briefly be variable to 10km/h after 1pm at spot location until approximately 4pm.

18 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
0700	28	13	40	ENE	40	60	NNE	50	20	32
1000	33	12	28	ENE	30	50	NNE	45	29	27
1300	37	12	22	ENE	15	20	NE	35	29	12
1600	38	10	19	ENE	10	20	NE	30	29	9
1900	32	11	28	E	10	20	ENE	30	18	6
2200	30	10	29	E	20	30	ENE	45	20	13
0100	28	10	32	E	30	50	NE	55	21	21

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31800
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Waroona

Issued at 8:09 am WST on Thursday 7 January 2016.

Incident Type: Wildfire	Website Form No: 015
Spot Forecast Location: Waroona	Request No: 3
Latitude/Longitude: -32.854 115.935	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DFES Comms

Weather Forecast starting 0800 hours Thursday 7 January 2016

Chance of a thunderstorm, most likely Thursday afternoon and evening.

Please refer to SPOT forecast for Preston Beach for western side of fire

Significant wind changes and uncertainties associated with the forecast

Variable gusts to 80km/h possible with thunderstorms.

Winds may tend light and variable or S/SW'ly 15 gusting 25km/h for a period between 1- 5 pm. Winds are forecast to tend E/NE'ly and gusty again overnight.

Please refer to SPOT forecast for Preston Beach for western side of fire

18 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
0800	28	11	35	ENE	35	60	NNE	45	22	27
1100	35	11	23	ENE	25	40	NE	35	33	23
1400	38	11	20	ENE	15	25	NE	30	32	13
1700	36	10	21	VRB	15	25	ENE	30	29	12
2000	31	11	29	E	10	20	ENE	45	16	6
2300	29	9	29	E	25	35	NE	55	22	17
0200	27	10	34	ENE	40	65	NE	50	24	35

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31800
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Waroona

Issued at 2:59 pm WST on Thursday 7 January 2016.

Incident Type: Wildfire	Website Form No: 015
Spot Forecast Location: Waroona	Request No: 4
Latitude/Longitude: -32.854 115.935	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DFES Comms

Weather Forecast starting 1500 hours Thursday 7 January 2016

Chance of a thunderstorm, most likely during the afternoon and evening period of Thursday and Friday however there is still a risk Friday morning.

The atmosphere over the fire ground is unstable and hence fire generated storms (pyrocumulonimbus) will continue to be possible over intense fire activity up to including Saturday evening.

Please refer to SPOT forecast for Preston Beach for western side of fire

Significant wind changes and uncertainties associated with the forecast

Variable gusts to 90km/h possible with thunderstorms.

Winds may tend light and variable for a period between 3-8 pm, and may tend E/SE'ly 20 gusting 30km/h for a period between 8pm and midnight. Winds are forecast to tend E/NE'ly and fresh gusty again overnight.

Please refer to SPOT forecast for Preston Beach for western side of fire

24 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
1500	38	11	20	NE	20	30	NE	30	36	19
1800	34	10	23	ENE	15	25	ENE	30	25	11
2100	30	10	29	E	15	25	ENE	45	18	9
0000	29	10	31	E	25	45	ENE	55	20	17
0300	26	9	34	ENE	40	60	NE	55	24	34
0600	26	9	34	ENE	40	60	NNE	45	24	34
0900	30	10	29	ENE	30	45	N	50	25	24
1200	32	11	28	NE	20	30	NNE	25	22	14
1500	34	13	28	NE	15	20	NE	20	21	10

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31900
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Preston Beach

Issued at 2:48 am WST on Thursday 7 January 2016.

Incident Type: Wildfire	Website Form No: 016
Spot Forecast Location: Preston Beach	Request No: 1
Latitude/Longitude: -32.882232 115.655929	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DPAW

Weather Forecast starting 0300 hours Thursday 7 January 2016

Risk of a thunderstorm Thursday afternoon and evening. Variable gusts to 80km/h possible with thunderstorms. Storms most likely east of fire area.

Significant wind changes and uncertainties associated with the forecast

Brief change to SSE near 3pm Thursday may not occur and winds may stay easterly.

18 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
0300	25	14	50	E	40	65	NE	70	13	25
0600	25	15	54	ENE	40	60	NNE	60	11	23
0900	32	15	36	ENE	35	50	NNE	50	24	29
1200	38	14	24	ENE	20	35	NE	35	31	18
1500	38	13	23	SSE	15	25	NE	30	29	12
1800	34	14	30	E	15	20	ENE	30	20	9
2100	30	14	38	E	20	30	ENE	45	15	11

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31900
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Preston Beach

Issued at 2:59 am WST on Thursday 7 January 2016.

Incident Type: Wildfire	Website Form No: 016
Spot Forecast Location: Preston Beach	Request No: 1
Latitude/Longitude: -32.882232 115.655929	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DPAW

Weather Forecast starting 0300 hours Thursday 7 January 2016

Risk of a thunderstorm Thursday afternoon and evening. Variable gusts to 80km/h possible with thunderstorms. Storms most likely east of fire area.

Significant wind changes and uncertainties associated with the forecast

Brief change to SSE near 3pm Thursday may be SSW or not occur and winds may stay easterly - please note forecast change here.

18 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
0300	25	14	50	E	40	65	NE	70	13	25
0600	25	15	54	ENE	40	60	NNE	60	11	23
0900	32	15	36	ENE	35	50	NNE	50	24	29
1200	38	14	24	ENE	20	35	NE	35	31	18
1500	38	13	23	SSE	15	25	NE	30	29	12
1800	34	14	30	E	15	20	ENE	30	20	9
2100	30	14	38	E	20	30	ENE	45	15	11

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31900
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Preston Beach

Issued at 8:09 am WST on Thursday 7 January 2016.

Incident Type: Wildfire	Website Form No: 016
Spot Forecast Location: Preston Beach	Request No: 2
Latitude/Longitude: -32.882232 115.655929	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DPAW

Weather Forecast starting 0800 hours Thursday 7 January 2016

Slight chance of a thunderstorm, more likely further inland and most likely Thursday afternoon and evening.

Please refer to SPOT forecast for Waroona for the part of fire near Waroona

Significant wind changes and uncertainties associated with the forecast

Variable gusts to 80km/h possible with thunderstorms.

Winds expected to tend SW'ly 20 gusting 30 km/h for a period between 1- 8 pm. Winds are forecast to tend E/NE'ly and gusty again overnight.

Please refer to SPOT forecast for Waroona for the part of fire near Waroona

18 Hour Forecast

Drought factor: 10 **Curing value (%): 100**

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
0800	29	12	35	ENE	35	55	NNE	50	22	28
1100	36	12	24	NE	25	40	NE	35	33	23
1400	39	13	21	SW	15	25	NE	30	32	13
1700	36	14	27	SW	15	25	ENE	30	23	11
2000	31	14	36	E	15	25	ENE	45	14	8
2300	30	13	35	E	25	40	NE	50	18	16
0200	27	13	42	E	40	65	NE	50	18	30

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Australian Government
Bureau of Meteorology

IDW31900
Australian Government Bureau of Meteorology
Western Australia

Spot Fire Weather Forecast for Preston Beach

Issued at 2:59 pm WST on Thursday 7 January 2016.

Incident Type: Wildfire	Website Form No: 016
Spot Forecast Location: Preston Beach	Request No: 3
Latitude/Longitude: -32.882232 115.655929	Fax Number: ##
Elevation (metres ASL): ##	Contact Ph: ##
Fuel Type: Not required	Contact Name: DPAW

Weather Forecast starting 1500 hours Thursday 7 January 2016

Chance of a thunderstorm, most likely during the afternoon and evening period of Thursday and Friday however there is still a risk Friday morning.

The atmosphere over the fire ground is unstable and hence fire generated storms (pyrocumulonimbus) will continue to be possible over intense fire activity up to including Saturday evening.

Please refer to SPOT forecast for Waroona for the part of fire near Waroona

Significant wind changes and uncertainties associated with the forecast

Variable gusts to 90km/h possible with thunderstorms.

SW'ly sea breeze up to 20 gusting 30 km/h forecast to tend S'ly around 6pm before tending E/NE'ly between 8-10pm. Winds may tend E/SE'ly for a period between 8pm-midnight. Winds are forecast to become fresh and gusty E/NE'ly again overnight.

A NW/SW'ly 15 gusting 25km/h sea breeze may develop over the coastal fringe again Friday from around 2pm.

Please refer to SPOT forecast for Waroona for the part of fire near Waroona

24 Hour Forecast

Drought factor: 10 Curing value (%): 100

Local Time	Temp (C)	Dewpt (C)	RH (%)	10m Wind (km/h)			1000m AGL Wind (km/h)		FFDI	GFDI
				Dir	Speed	Gust	Dir	Speed		
1500	38	13	23	SW	15	25	NE	30	29	12
1800	34	14	30	S	15	25	ENE	30	20	9
2100	30	14	38	E	20	30	ENE	45	15	11
0000	30	10	29	E	25	45	ENE	50	23	18
0300	26	9	34	E	40	60	NE	50	24	34
0600	25	9	36	ENE	40	60	NNE	50	21	32
0900	30	10	29	NE	30	45	N	55	25	24
1200	32	11	28	NE	15	25	N	25	20	9
1500	32	13	32	NNE	10	15	ENE	25	15	5

AGL - Above Ground Level, RH - Relative Humidity, Dir - Direction, Dewpt - Dew Point

Appendix 7: Emergency Services Weather Briefings

IDW30200
Australian Government Bureau of Meteorology Western Australia

Emergency Services Weather Briefing
Issued at 11:15 am WST on Monday 4 January 2016 for the period until midnight WST Monday 4 January 2016.

ROUTINE ISSUE

Covering the weather conditions from Monday 4 to Friday 8 January 2016.

MAIN POINTS

Broad thunderstorm areas over southern parts contracting back to western parts from Thursday.

Very high FFDIs over the Lower West Inland, Nelson and adjacent Geographe and Leeuwin subdistricts from Thursday.

NORTHERN PARTS (INCLUDING THE KIMBERLEY, PILBARA AND THE NORTH INTERIOR)

No significant lows are forecast for the next week. Relatively inactive conditions persisting with seasonal shower and thunderstorm activity over the Kimberley, eastern Pilbara and North Interior and low rainfall totals expected.
Moderate to heavy falls may return to the Kimberley and North Interior from Thursday. A broad trough lies through the North Interior generating moderate NW/SW flow and very high, potentially severe, FDIs over the Pilbara for the outlook period.

SOUTHERN PARTS (INCLUDING THE GASCOYNE, GOLDFIELDS, SOUTH INTERIOR, EUCLA AND THE SOUTH WEST LAND DIVISION)

A surface trough extends from the Perth area to the northern Goldfields and is near stationary today and Tuesday. Moderate to fresh E'ly winds to the east of the trough will shift moderate and W'ly on the western side and severe FDIs are forecast over the Gascoyne, northern Goldfields and South Interior districts over the next four days. Thunderstorms are forecast through central parts of the State including the Esperance shire Inland and Coastal today, but will also trigger over the Perth Hills and adjacent areas, including northern parts of the Southwest district, this afternoon. A similar area of thunderstorms develops along the

trough on Tuesday, though will also extend through the Central Wheat Belt and Great Southern districts. Warm to hot temperatures are forecast over mainly inland parts of the Southwest Land Division today, but will gradually return to western parts during the course of the week.

A new high pressure system moves into the Bight by Wednesday which will develop a trough near the west coast. This will bring a return of moderate to fresh and gusty E'ly winds during the morning to the Darling Escarpment and adjacent areas. FFDIs over the Lower West Inland, Nelson and adjacent Leeuwin and Geographe subdistricts is forecast to increase to very high as temperatures increase over these parts. The trough is forecast to generate storms over western parts of the State generally north of Bunbury Wednesday and Thursday, but will likely extend all the way south on Friday.

Please note: This advice is preliminary information and is provided for organisation planning purposes only. It may present a range of weather risk scenarios and should be accompanied by a briefing. It is not intended for public distribution.

IDW30200
Australian Government Bureau of Meteorology Western Australia

Emergency Services Weather Briefing
Issued at 10:46 am WST on Thursday 7 January 2016 for the period until midnight WST Thursday 7 January 2016.

ROUTINE ISSUE

Covering the weather conditions from Thursday 7 January to Wednesday 13 January 2015.

MAIN POINTS

Isolated dry and gusty storms and hot, windy conditions over western parts of the State, including Perth and Waroona, extending eastward over the weekend, with a wind change on Saturday as a surface trough moves eastward.

Very High fire dangers over parts of the SWLD today including the Lower West Inland (Perth hills) subdistrict, extending to include the Lower West Coastal (Perth metro) on Friday.

NORTHERN PARTS (INCLUDING THE KIMBERLEY, PILBARA AND THE NORTH INTERIOR)

No significant lows are forecast for the forecast period. Hot conditions and fresh and gusty easterly winds during the morning today will produce Very High to Severe fire dangers over Pilbara and North Interior districts, easing to High to Very High for the remainder of the period. Seasonal shower and thunderstorm activity continues throughout northern parts. Moderate to heavy falls are possible over the Kimberley and North Interior districts, extending into eastern parts of the Pilbara district from Saturday. Elsewhere through the Pilbara district storms will be mostly dry and gusty.

SOUTHERN PARTS (INCLUDING THE GASCOYNE, GOLDFIELDS, SOUTH INTERIOR, EUCLA AND THE SOUTH WEST LAND DIVISION)

A deep trough lies near the west coast and will begin to move eastward across the State over the weekend, producing hot, windy conditions and widespread thunderstorm activity over the next week. Low-intensity heatwave conditions will persist across parts of southern WA, including Perth, for the next few days and temperatures overnight will remain elevated.

It will be very hot and humid over western parts of the State today. Winds over central and southern parts of the State, including Perth and the Waroona fire site, will be fresh and gusty east to north-easterly this morning (40 gusting 60km/h), easing during the afternoon. The west coast may experience weak and variable sea breezes up to 20km/h during the afternoon, with a slight chance of a variable or south-westerly sea breeze reaching the Waroona area this afternoon, before winds again become easterly during the evening. Severe fire dangers are forecast for the Inland Gascoyne and Very High fire dangers are forecast over the Lower West Inland (Perth hills) and Nelson, Mortlock and Ningham subdistricts. Isolated afternoon storms are forecast over the Gascoyne and Goldfields districts and parts of the SWLD west of Albany to Southern Cross with a 20% chance of thunderstorms over the Perth area this afternoon. The atmosphere will be unstable and it is possible that pyro-cumulonimbus with associated dry lightning and wind gusts up to 80km/h may form over the Waroona fire site.

On Friday east to north-easterly winds will again be fresh and gusty (40 gusting 60km/hr) from midnight, easing to 30 gusting 50km/h after dawn then easing again by midday. A weak sea breeze is likely in coastal parts in the afternoon. Hot conditions will extend to remaining southern parts of the State.
Isolated storms are again forecast west of Albany to Southern Cross to Leinster, during the morning and afternoon, including over Perth and the Waroona fire site. Fire dangers will be Very High over the Lower West district (Perth metro and hills) and Mortlock subdistrict, Severe in the Inland Gascoyne.

Over the weekend the trough will move eastward and temperatures will ease slightly close to the west coast, but remain hot elsewhere. On Saturday fresh and gusty north-easterly winds will be inland from the west coast. Near the west coast, in the vicinity of Perth and the Waroona fire, the wind direction will shift significantly during the day. Overnight and into the morning winds will be east to north-easterly up to 20km/h, tending northerly during the morning, north-westerly late morning to early afternoon and then west to south-westerly by late afternoon. Isolated storms are forecast west of Esperance to Laverton, including the Perth and Waroona areas, most likely during the afternoon. There is a chance a Severe Thunderstorm Warning for damaging winds and large hail may be issued for Saturday afternoon for an area near the west coast, including Perth. Severe fire dangers are again likely in the Inland Gascoyne district over the weekend, extending into the Goldfields on Sunday. Thunderstorm activity will contract to east of Albany to Paraburdoo on Sunday.

A new ridge of high pressure will develop over southern parts from early next week. Storms will contract to far eastern parts of the State and temperatures will become mild over the South West Land Division by mid-week.

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IDW30200
Australian Government Bureau of Meteorology Western Australia

Emergency Services Weather Briefing
Issued at 11:36 am WST on Friday 8 January 2016 for the period until midnight WST Friday 8 January 2016.

NON-ROUTINE ISSUE

Covering the weather conditions over the Waroona fire site and Perth area from Friday 8 January until Wednesday 13 January 2016.

MAIN POINTS

Hot conditions, isolated storms and east to north-easterly winds will continue over the Waroona fire site and Perth area today, with sea breezes near the coast.

A significant wind change will occur on Saturday with the movement of a surface trough. Hot conditions and isolated storms will continue. Severe thunderstorms may occur in the afternoon and evening over Perth and the Waroona fire site.

Conditions will become mild on Sunday, and remain so into early next week, however afternoon sea breezes will be fresh and gusty.

FORECAST CONDITIONS

Temperatures will be hot again today, in the mid to high 30s for both the Perth area and the Waroona fire site. Fresh and gusty east to north-easterly winds will ease to around 20km/h by early afternoon. A weak northwest to southwest sea breeze up to 15km/h is possible in coastal parts during the afternoon.

Further inland from the coast winds may become light and variable for a period during the afternoon and early evening. The sea breeze is not expected to reach as far inland as Waroona. Isolated storms are occurring this morning and are likely to increase during the afternoon and evening. Storms will be mostly dry and may produce variable wind gusts up to 90km/h. A Severe Thunderstorm Warning for damaging winds, large hail and heavy rainfall has been issued for an area bounded by Northampton to Gingin to Wongan Hills to Mt Magnet to Northampton for this afternoon and evening. This does not include the Perth area, however there is a slight risk of severe storms over the Perth hills this afternoon and evening if storms move further south than expected.

Away from the west coast, conditions inland will be hot and isolated thunderstorms are forecast for an area northwest of Albany to Kalgoorlie.

Winds overnight from Friday into Saturday will not be fresh and gusty as they have been the previous two nights, however Saturday will be another hot day and a trough passage will begin to move eastward from the west coast. In the vicinity of Perth and the Waroona fire site, the wind direction will shift significantly during the day. Overnight winds are likely to be light and variable over the Perth area and east to north-easterly up to 20 km/h in the vicinity of the Waroona fire, however there is some uncertainty in the timing of the trough passage. It is possible that winds will tend northerly up to 15km/h overnight if the trough moves earlier, otherwise winds will become northerly during the morning. A moderate north-westerly change up to 25 km/h will extend from the west coast in the middle of the day. During the late afternoon and evening winds will shift westerly up to 15km/h. Isolated afternoon storms are forecast for Perth and the Waroona fire site, and a Severe Thunderstorm Warning may be issued for Saturday afternoon for an area near the west coast, including Perth and the Waroona fire site. Severe storms could produce damaging wind gusts in excess of 90km/h, large hail and heavy rainfall.

The Perth hills area is more likely to experience these severe conditions than coastal areas, however a risk does remain for the metropolitan area and the Waroona fire site. The requirement for a Severe Thunderstorm Warning will be assessed today and tomorrow morning.

Away from the west coast, conditions inland will continue to be hot and winds fresh and gusty, and isolated thunderstorms are forecast for an area northwest of Albany to Norseman.

On Sunday temperatures near the west coast will have dropped to the high 20s and winds will remain west to south-westerly. During the morning winds will be light, however they will increase to around 20km/h during the afternoon, up to 30km/h near the coast, before easing again overnight. On Sunday the area of thunderstorms will have contracted to central and eastern parts of the South West Land Division, away from both Perth and the Waroona fire site.

Early next week conditions will remain relatively mild and winds south to south-westerly, however sea breezes will be fresh and push inland during the afternoon, with wind speeds of 30 to 40km/h possible. By mid-week winds will become south-easterly, with afternoon sea breezes continuing, as a new ridge of high pressure develops over southern parts of the State.

Please note: This advice is preliminary information and is provided for organisation planning purposes only. It may present a range of weather risk scenarios and should be accompanied by a briefing. It is not intended for public distribution.

IDW30200
Australian Government Bureau of Meteorology Western Australia

Emergency Services Weather Briefing
Issued at 10:57 am WST on Monday 11 January 2016 for the period until midnight WST Monday 11 January 2016.

ROUTINE ISSUE

Covering the weather conditions from Monday 11th to Friday 15th January 2016.

MAIN POINTS

A weak cold front will cross the South West Land Division on Tuesday, as winds shift moderate to fresh SW'ly, however the front is expected to produce little rainfall.

Fresh and gusty E'ly winds will develop over western parts of the State on Wednesday evening into Thursday morning.

The development of a surface trough near the west coast from Thursday will lead to an increase in winds and temperatures again and the potential for more thunderstorm activity over western parts, including the Perth metro and Waroona fire site by Friday.

NORTHERN PARTS (INCLUDING THE KIMBERLEY, PILBARA AND THE NORTH INTERIOR)

No significant lows are forecast for the next week. Seasonal storm activity persists over northern parts with the possibility for moderate to heavy falls over the Kimberley and North Interior increasing later this week. A moderate E'ly flow that develops over the inland Pilbara and North Interior from Thursday is only likely to generate Very High FDIs.

SOUTHERN PARTS (INCLUDING THE GASCOYNE, GOLDFIELDS, SOUTH INTERIOR, EUCLA AND THE SOUTH WEST LAND DIVISION)

A surface trough lies through eastern parts of the State with thunderstorm activity remaining northeast of a line Meekatharra to Eucla today until Wednesday. Likewise Severe fire dangers are forecast over the Inland Gascoyne, and parts of the South Interior, Eucla and Goldfields, generally remaining northeast of Kalgoorlie, today and Tuesday.

Today over the Waroona fire site conditions will be mild and winds will be light W'ly, increasing up to 20km/h in the afternoon. Over the Esperance fire site conditions will also be mild and winds generally light to moderate S'ly.
On Tuesday a weak cold front will bring a shift to moderate to fresh SW'ly winds over southwest parts of the State including the Waroona fire site.
Little, if any, rainfall is expected from the cold front. During Wednesday a new ridge of high pressure develops to the south of the State with winds over southern parts tending S/SE'ly during the day.

A surface trough develops near the west coast by Thursday morning. As a result winds will tend fresh and gusty E'ly over western parts of the State, including over the Darling Escarpment and Waroona fire site, overnight Wednesday and into Thursday with potential wind gusts up to 60km/h. These winds strengths will be similar to those experienced over the Waroona fire site on Wednesday and Thursday night last week. Thunderstorms are forecast to develop over the Gascoyne district and extend down the trough Thursday afternoon, at this stage remaining to the north of the Perth Metropolitan area. Low to mid-30's temperatures are also forecast to extend down the trough during Thursday.

By Friday the trough will have deepened further, driving mid to high 30's temperatures and drying dew points over western parts of the Southwest Land Division. Mostly dry and gusty thunderstorm activity is also likely to extend further down the trough, to include the Perth metropolitan area and possibly the Waroona fire site and into the Southwest district. As a result of the increase in temperature Very High fire dangers are forecast over northern parts of the Lower West Inland on Thursday, and are likely to extend over the remaining Lower West Inland and over the South West district during Friday.

Into the weekend and early next week very hot temperatures are forecast to continue. Isolated thunderstorm activity is again possible over western parts on Saturday.

Please note: This advice is preliminary information and is provided for organisation planning purposes only. It may present a range of weather risk scenarios and should be accompanied by a briefing. It is not intended for public distribution.

References

Agreement between the Commonwealth of Australia represented by the Bureau of Meteorology and the Department of Fire and Emergency Services (Western Australia) (DFES). Agreement for the provision of:

- Fire and significant weather briefing services in the DFES State Operations Centre, and
- Evaluation of weather-related operational procedures and training for DFES.

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Noble, I. R, Bary, G. A. V. and Gill, A. M. (1980) McArthur's fire-danger meters expressed as equations. *Australian Journal of Ecology*, 5, 201-203pp.

Purton, M. (1982) Equations for the McArthur Grassland Meter Mk IV. Bureau of Meteorology Meteorological Note No. 147, 12 pp.

THE METEOROLOGY ACT 1955

No. 6 of 1955. An Act relating to the Commonwealth Bureau of Meteorology, Comlawld – C2008C00066.

Meteorological Aspects of the Kilmore East Fire on 7 February 2009. Bureau of Meteorology, Victoria Regional Office.

Appendix 7: Waroona Bushfire Chronology

Operational Period 1 - 0630 hours 6 January 2016 to 0600 hours 7 January 2016
Operational Period 2 - 0600 hours 7 January 2016 to 1800 hours 7 January 2016
Operational Period 3 - 1800 hours 7 January 2016 to 0600 hours 8 January 2016
Operational Period 4 - 0600 hours 8 January 2016 to 1800 hours 8 January 2016
Operational Period 5 - 1800 hours 8 January 2016 to 0600 hours 9 January 2016
Operational Period 6 - 0600 hours 9 January 2016 to 1800 hours 9 January 2016
Operational Period 7 - 1800 hours 9 January 2016 to 0600 hours 10 January 2016
Operational Period 8 - 0600 hours 10 January 2016 to 1800 hours 10 January 2016

Date	Time (Hours)	Event
5 January 2016	Evening	Significant thunderstorms were noted in the Dwellingup area.
6 January 2016	0600	Residents preparing to leave for work in Waroona reported a smell of smoke.
6 January 2016	0630	Two lightning caused the fires1.2km east of the Murray river were detected by P&W staff on the LandGate Fire Watch website (fire 68 and fire 69). The P&W Perth Hills District Officer performed the role of IC until approximately 2100.
6 January 2016	0645	First response from Dwellingup. Decision to attack Fire 69 due to safety concerns on Fire 68.
6 January 2016	0658	Spotter plane became airborne.
6 January 2016	0700	Alcoa security noted the presence of fire to the east.
6 January 2016	0703	P&W District Duty officer contacted P&W crews for dispatch from the Dwellingup depot.
6 January 2016	0720	P&W machinery mobilised.
6 January 2016	0725	P&W spotter aircraft confirms two small fires about 1km apart. The fires were 3ha and 6ha in size.
6 January 2016	0730	Two fires reported at Lane Poole Reserve and the adjoining State forest by spotter aircraft. Trucks and loader were despatched from Dwellingup. Work centre coordinator from Jarrahdale started getting resources available for 0745 hours start.
6 January 2016	0735	Initial P&W resources despatched from Dwellingup to respond to the fire including four 4WD heavy fire vehicles, one Front End Loader (FEL) and an Operations Officer, together with four fixed wing water bombers, two from Jandakot and two from Bunbury.
6 January 2016	0800	Base level IMT was established at the P&W Mundaring Office.
6 January 2016	0804	DFES COMCEN advised of the fire by P&W IMT.
6 January 2016	0815	Spotter aircraft reported the fire was 8 hectares in size. Fire Rate of Spread was 50-100 metres per hour.
6 January 2016	0830	Fire declared a Level 1 incident by P&W IMT.
6 January 2016	0845	Helitaks requested by P&W to help fight the fire.
6 January 2016	0850	P&W issue the first Bushfire Advice alert for Lane Pool Reserve. The fires are not threatening the major recreation site in Lane Poole Reserve and visitors are not being asked to leave.
6 January 2016	0930	The first IAP prepared and approved by P&W. The objectives were to contain both fires to the east of the Murray River and west of Murray Rd.
6 January 2016	0942	Aircrane requested by P&W to assist in fighting the fire.
6 January 2016	1045	Further Advice alert issued by P&W in relation to the Lane Poole Reserve. The previous Bushfire advice is upgraded to a “Watch and Act” and amended to include the Shire of Boddington.
6 January 2016	1130	Fire 68 jumps over Murray River.
6 January 2016	1143	Fire 69 contained.
6 January 2016	1200	Fire 68 800m east of Murray River.
6 January 2016	1210	Further Advice alert issued by P&W in relation to the Lane Poole Reserve.

Date	Time (Hours)	Event
6 January 2016	1330	Fire grown to 160 ha, the closure of Nanga Rd ahead of the fire was authorised by the IC.
6 January 2016	1405	A further Advice alert for the Lane Poole Reserve was issued.
6 January 2016	1530	The IC makes the decision to elevate the incident from Level 1 to Level 2 Planning commences for the P&W pre-formed Red IMT activated and readied for a shift changeover at 0600 on 7 January. Fire burning through the Alcoa rehabilitation forest. CBFCO Waroona raises concern at area covered by warnings and rings property owners in path of fire and warns them to prepare / leave.
6 January 2016	1555	Resources sent to protect mine site.
6 January 2016	1600	P&W IMT decided to locate the forward ICC at Waroona Showgrounds.
6 January 2016	1605	Fire was impacting on mine site.
6 January 2016	1625	2 FW bombers dispatched from Manjimup.
6 January 2016	1630	The IMT issues a Smoke Alert for Waroona, Yarloop and Preston Beach.
6 January 2016	1700	Fire plotted as 800ha, moving at 1 to 1.5km/h. Fire approximately 2200 hectares in size.
6 January 2016	1710	P&W pre-formed Red IMT activated by the P&W State Duty officer along with a request shortly after for assistance to DFES seeking a sector commander, eight tankers, a resource officer and local government representative to be available next morning.
6 January 2016	1900	Fire 2800 ha in size with a forward rate of spread of 1.5-2km/hr. Pyrocumulonimbus (PyroCB) activity with lightening was widely observed. Fire was 13km from Waroona.
6 January 2016	1912	Fire crossed Nanga Rd, 4km east of Samson Brook Dam.
6 January 2016	1930	Fire crossed Alcoa belt line, east of Samson Brook Dam.
6 January 2016	2007	P&W requested DFES liaison officer be sent to Mundaring.
6 January 2016	2100	The first Watch and Act alert was issued for the Lane Poole Reserve and the Alcoa mine site and adjoining private properties, but not including the Waroona township.
6 January 2016	2110	Waroona is reported to be under sustained ember attacks coming from the fire.
6 January 2016	2113	Waroona Chief has Bushfire Brigades incoming to assist in defending Waroona.
6 January 2016	2115	IMT requested additional resources from the LGA and DFES to be deployed into Waroona for asset protection.
6 January 2016	2136	Fire was well across the South Western Hwy and heading west through farmland.
6 January 2016	2147	Deputy Chief Superintendent advised Bunbury Regional Operations Centre to start up.
6 January 2016	2156	DFES requests traffic management crews attend a bushfire that has jumped South Western Hwy.
6 January 2016	2200	Decision taken to issue an Emergency Alert (EA) telephone message. DFES State Operations Centre was fully activated along with the Metropolitan Operations Centre and three Regional Operations Centres. At the P&W Mundaring office, the initial IC commenced a handover to the incoming Level 3 IC Attempted telephone alert unsuccessful due to technical issues.
6 January 2016	2208	The first EA telephone message was sent covering an area to the east of Waroona advising people to seek shelter now and actively defend. A technical difficulty was reported.
6 January 2016	2215	The formal escalation of the event from Level 2 to Level 3 completed with a s.13 *Bush Fires Act 1954* authorisation.
6 January 2016	2224	The MOC in Perth, along with the Bunbury, Northam and Manjimup ROCs were escalated at 2224hrs in support to assist with the provision of resources.
6 January 2016	2225	Emergency warning issued by P&W for Waroona townsite, Alcoa mine site and adjacent properties in Shire of Waroona. Specifies areas bounded by Willowdale Rd, Johnston Rd, Somers Rd, Coronation Rd, and Nanga Brook Rd.

Date	Time (Hours)	Event
6 January 2016	2226	Murray Leisure Centre opened as an evacuation centre.
6 January 2016	2227	DFES released Emergency Warning for the Waroona townsite, Alcoa mine site and adjacent private properties in Shire of Waroona.
6 January 2016	2236	A second EA message was sent with a coverage area from Waroona south to Yarloop, and east to just short of the Forrest Hwy. Main Roads issues tweet that South Western Hwy closed.
6 January 2016	2240	MOC activated.
6 January 2016	2246	Resources departed Byford including 2 fire managers, 6 pumps, 6 light tanker and an RUI taskforce.
6 January 2016	2253	Waroona Controller informed fire upgraded to Level 3.
6 January 2016	2259	Waroona Controller informed from SCC that water pumping station was critically damaged and required attention.
6 January 2016	2300	A further EW was issued for Waroona and Hamel.
6 January 2016	2315	DFES media called P&W media to advise that DFES was standing up the SOC and that DFES was available to take over the issuing of all Alerts if approved by the IC. Waroona Controller advises that fire was close to water treatment point threatened by fire.
6 January 2016	2325	Issues reported with Telstra system in sending out messages. P&W Officer reported that main fire was within approximately 1km of Waroona townsite and a second (spot) fire had crossed Fawcett Rd to the west of Waroona. Local Bushfire Brigades were operating around Waroona and Hamel and to the west.
6 January 2016	2330	A further EW was issued for Waroona. Main headfire had connected with separate spot fires.
6 January 2016	2335	The fire is reported by P&W to be 1km of the Waroona townsite.
6 January 2016	2358	Main Roads reports South Western Hwy shut Coronation Rd to Uduc Rd.
7 January 2016	0000	The fire had covered 35kms and reached 12,000ha in area. The First Incident Support Group meeting is held via teleconference. Vehicle control points established on South Western Hwy.
7 January 2016	0002	Reports received by the IMT that the electricity distribution network was being impacted.
7 January 2016	0015	Emergency Warning issued for western edge of Waroona townsite in the Shire of Waroona. Specifies area bounded by: Somers Rd, Mayfield Rd, Hayes Rd and Nanga Brook Rd in the western edge of Waroona townsite in the Shire of Waroona. This includes the Waroona and Hamel townsites.
7 January 2016	0022	22 trucks on site to respond to fire south of Waroona. Wind gusts 80km/h, fire 3m high.
7 January 2016	0035	Emergency Warning issued for Waroona townsite, Alcoa mine site and adjacent private properties in Shire of Waroona. Specifies area bounded by: Willowdale Rd, Johnston Rd, Somers Rd, Coronation Rd and Nanga Brook Rd including Waroona townsite in the Shire of Waroona.
7 January 2016	0050	Fire predicted to cross Forrest Hwy in 2 hours.
7 January 2016	0100	Fire impacts Hamel.
7 January 2016	0105	DFES assumes responsibility for issuing all incident alerts. Emergency Warning issued for Waroona town site, Alcoa mine site and adjacent private properties in Shire of Waroona. Specifies area bounded by: Willowdale Rd, Johnston Rd, Somers Rd, Coronation Rd, and Nanga Brook Road including Waroona townsite in the Shire of Waroona.
7 January 2016	0120	Second IAP was prepared by the Planning Officer and approved by the IC. This IAP highlighted the erratic fire behaviour, with the objective to protect life and property and to contain the fire by 2400 hours on 7 January.
7 January 2016	0150	Information sent out regarding the closure of Forrest Hwy. Alcoa reports that that it will need access to Wagerup refinery for shift change.
7 January 2016	0243	Traffic warning issued regarding the closure of the Forrest Hwy.
7 January 2016	0254	16 trucks depart Narrogin to assist.

Date	Time (Hours)	Event
7 January 2016	0300	Emergency Warning issued for Waroona and surrounding areas, including Preston Beach, in Shire of Waroona.
7 January 2016	0309	Power is reported as lost at Waroona. Water Corporation reports water ok.
7 January 2016	0320	Transformer on Riley Rd on fire.
7 January 2016	0335	25 trucks arrive into Waroona.
7 January 2016	0400	Resources as of this time: DFES resources: 40 appliance and 100 personnel P&W: IMT 75 people transitioning including 30 trucks, 30 light units and 12 loaders.
7 January 2016	0423	Main Roads reports fire is 7km from Forrest Hwy.
7 January 2016	0436	2 front loaders and 1vehicle on way on from Shire of Waroona.
7 January 2016	0445	Forrest Hwy reported cut. Properties under threat in Waroona- no response from Waroona LT.
7 January 2016	0447	South Western Hwy and Forrest Hwy reported as being closed.
7 January 2016	0454	Fire reported as being 5km from Forrest Hwy.
7 January 2016	0500	Fire bombers begin to water bomb south flank of fire east of Coronation St.
7 January 2016	0545	4 rescue vessels depart from Mandurah and 1 vessel from Bunbury for Preston Beach evacuation.
7 January 2016	0548	Samson Brook bridge reported damaged by the fire.
7 January 2016	0553	Fire reported as being 1km from Forrest Hwy.
7 January 2016	0600	IMT handover occurs.
7 January 2016	0602	Forrest Hwy now shut from Pinjarra Rd.
7 January 2016	0726	Power and communications control telemetry to the Yarloop Town Water System lost.
7 January 2016	0736	SOC briefing was told that up to 90 per cent of the fire was untracked and that there was no expectation the fire would be held on that day.
7 January 2016	0745	Drake Brook Bridge reported as damaged. RUI to inspect. Waroona briefing takes place.
7 January 2016	0755	Emergency warning received that Preston Beach needs evacuation.
7 January 2016	0757	Waroona reported as about to run out of water.
7 January 2016	0800	Water Corporation's State Emergency Liaison Officer took up desk space at the DFES SOC . IC relocating to Waroona. Main fire coming into Hamel Total fire ban request rejected.
7 January 2016	0800 (approx)	Waroona Shire staff briefed on the situation. 11 appliances and 2 earthmovers operating to east of Yarloop township are tasked to stop the westward movement of the fire towards South West Hwy.
7 January 2016	0809	30 people evacuated from Preston Beach by boat. 1 shed reported as damaged Preston Beach.
7 January 2016	0900	Fire moving towards Wagerup, possible threat.
7 January 2016	0917	The IMT was installed in the Waroona ICC and held its first meeting at Waroona Town Hall. Waroona reported as about to run out of water.
7 January 2016	0923	Alcoa high voltage sub-station under threat.
7 January 2016	0940	3 trucks sent to Wagerup.
7 January 2016	0953	Water Corporation taking water from Dandalup dams.
7 January 2016	1000	First All Hazards Liaison Group meeting held. CBFCO for Waroona goes off shift but not replaced.
7 January 2016	1028	Wagerup reported as under threat.
7 January 2016	1030	Samson Brook bridge reported as destroyed. ISG meeting at Waroona Town hall.
7 January 2016	1100	IC attends a community meeting at Waroona.
7 January 2016	1100 (approx.)	Fire activity around the Wagerup refinery to the north east of Yarloop generated spotting activity. A separate transformer fire broke out at Cookernup.
7 January 2016	1105	Fire and rescue crews are dispatched to Yarloop to help fight the oncoming

Date	Time (Hours)	Event
		fire.
7 January 2016	1207	Updated list of resources: Bunbury 2nd Pump LT Coronation Rd West, South Coronation Rd Bunbury 3rd pump and LT.
7 January 2016	1210	Emergency Warning issued for Waroona and Harvey and surrounding areas, including Preston Beach, in the Shires of Harvey and Waroona.
7 January 2016	1234	Lightning observed in the fire area.
7 January 2016	1253	IC participated in a pre-recorded ABC radio interview. The interview included that the fire was bearing down on the townships of Yarloop, Cookernup and Harvey. The interview was not broadcast. IC was unaware of this.
7 January 2016	1254	Yarloop reported as contained.
7 January 2016	1300	Request by Water Corporation to provide generators to the Yarloop TWS was rejected by the IMT on safety grounds. Third IAP was prepared by the Planning Officer and approved by the IC.
7 January 2016	1310	Resources released from Waroona to assist at Harvey, 4x 2.4, 1x front end loader.
7 January 2016	1316	Discussion on whether fire is a risk to Yarloop and whether to issue an evacuation order for Harvey.
7 January 2016	1347	Water Corporation reports only 24hr of water left in Yarloop.
7 January 2016	1400	IC attends community meeting in Pinjarra.
7 January 2016	1430	Resources committed as of this time: DFES- 40 appliances, 100 fire fighters, CLT, USAR RDAT. P&W- approximately 75 personnel, 30 trucks, 30 light units, 23 earthmoving machines.
7 January 2016	1433	Updated road closures: Forrest Hwy from Forrestry Rd to Pinjarra Rd; South Western Hwy from Harvey townsite to Greenlands Rd;and Old Coast Rd from Old Bunbury Rd to Forrest Hwy. People advised to use Albany Hwy.
7 January 2016	Until 1500	PIO has problems accessing mapping.
7 January 2016	1500	IMT meeting at Waroona Town Hall. Deputy Operations Officers appointed (P&W for east and DFES for west of South West Hwy). Red Flag Warning issued. South West District Emergency Management Committee meeting held. Fire was about 3km north and 5km east of Yarloop. It was also evident that there was no water supply to the town. Power outage to Wagerup - half of plant lost power.
7 January 2016	1505	Incident Controller interview with ABC. Advised that an emergency warning was in place for Waroona, Harvey and surrounds. P&W had up to 11 appliances and 2 earthmovers near Yarloop protecting the eastern flank.
7 January 2016	1513	P&W crews start working in Hoffman / Scarp Rd area
7 January 2016	1537	Road closures in place: -Forrest Hwy from Greenlands Rd to Forestry Rd; - Old Coast Rd from Old Bunbury Rd to Forrest Hwy; -Old Bunbury Rd from Forrest Hwy to South Western Hwy; - South Western Hwy from Greenlands Rd to Uduc Rd; -Myalup Beach Rd at Forrest Hwy; -Forrest Hwy at Forestry Rd; - Udac Rd and Harvey Quindaining Rd at South Western Hwy; - Forrest Hwy at Raymond Rd- traffic control point; and - South Western Hwy at Coalfields Hwy- traffic control point;
7 January 2016	1550	Approximately 200 people on Preston Beach.
7 January 2016	1556	Main Road notes that CMT 2pm meeting advised fire heading south - Yarloop and Harvey under threat.
7 January 2016	1600	Harvey evacuation centre has been closed and relocated to Australind.

Date	Time (Hours)	Event
7 January 2016	1630	People on Preston Beach informed to return home.
7 January 2016	1700	Water Corporation advised the IMT of its intention to tank water into Yarloop, Incident Support Group meeting at Waroona Shire Office. Western Power reports 3500 people without power. Water Corporation reports no water in Yarloop or Preston Beach. Waroona Shire reports recovery plans commencing.
7 January 2016	1745	Harvey CBFCO requests more resources for Yarloop.
7 January 2016	1753	DFES emergency warning for Waroona and Harvey and surrounding areas including Preston Beach in the Shires of Harvey and Waroona.
7 January 2016	1800	P&W crews withdrawn from fireline east of South Western Hwy. Tankers and plant fall back to highway, then Yarloop.
7 January 2016	1830	Fire reported to be near the power lines 1-2km north and east of Yarloop and displaying moderate behaviour. Strike force of 16 personnel and 5 appliances have been deployed from lower south west region of Harvey.
7 January 2016	1906	Wagerup Refinery gas plant reported as being under imminent threat of fire.
7 January 2016	1916	Fire crossed the South Western Hwy and entered Yarloop.
7 January 2016	1920	Localised very strong wind event in the Yarloop area. Fire behaviour rapidly escalated, triggered by the sudden arrival of a strong easterly wind estimated at around 80km/hr. Yarloop township reported seriously impacted by fire.
7 January 2016	1921	Forrest Edge Recreation Camp is reported as coming under threat from the fire.
7 January 2016	1935	EW alert was issued for Waroona, Harvey and surrounding areas and Preston Beach, which also specifically mentioned Yarloop.
7 January 2016	1951	Priority message. Need Peppermint Grove Rd shut immediately. 50m flame height in pine plantation. Fire unstoppable and will jump highway.
7 January 2016	2000	Waroona DAFWA weather station recorded a temperature of 36 degrees Celsius and relative humidity of 16%. Community meeting held in Australind.
7 January 2016	2110	Yarloop fire station, railway museum, shops and houses destroyed.
7 January 2016	2015	P&W crews impacted directly by a head fire. A P&W loader is immobilised but escapes major damage. The P&W crew force to move to safer ground north and south of Yarloop.
7 January 2016	2027	Fire reported as having crossed South Western Hwy between Yarloop and Cookernup.
7 January 2016	2029	Lake Preston is reported as coming under attack from the fire. Fire reported as having jumped Forrest Hwy 2.5km north of Coronation Rd.
7 January 2016	2035	Taskforce earlier formed at Waroona to respond to urgent requests for structural fire assistance in the region dispatched to Yarloop. Samson Brook bridge was impassable, as were most of the roads west of the South Western Hwy.
7 January 2016	2050 (approx.)	A Fire Strike Team manages to enter Yarloop and begins to assess what structures can be defended from the fire with minimal water.
7 January 2016	2100	An Emergency Situation Declaration is issued under the *Emergency Management Act 2005*.
7 January 2016	2121	Yarloop Hotel was reported to be on fire followed by the hospital, fire station and multiple houses. A message to DFES is received stating that an estimated 200 people at Preston Beach require evacuation.
7 January 2016	2129	71 people reported as staying on Yarloop oval.
7 January 2016	2142	Yarloop fully impacted by the fire. At this time the fire station and police station are on fire.
7 January 2016	2347	The fire was already 4km south west of Yarloop.
8 January 2016	0000	The Yarloop Strike Team leader makes contact with other Volunteer fire crews.

Date	Time (Hours)	Event
		Throughout the night the Strike Team and Volunteers extinguish fires around Yarloop properties, door knocked residents, responded to 000 calls and respond to reported injuries and missing persons. Fire crews are unable to relieve and assist the Strike Team and Volunteers during the night given the hazardous conditions. 70-80 people gathered at town recreation centre and were advised to make their way to recreation ground.
8 January 2016	0146	Fire reported to be jumping Forrest Hwy near Myalup.
8 January 2016	0150	2 strike teams at Lake Clifton.
8 January 2016	0210	IMT Meeting. Fire has now cut off Preston Beach.
8 January 2016	0329	Report of fire burning between Lake Clifton and Myalup
8 January 2016	0400	The fourth IAP was prepared by the Planning Officer and approved by the IC.
8 January 2016	0419	Approximately 100 residents reported as having taken refuge at a local oval in Yarloop.
8 January 2016	0510	IMT Meeting. Concerns expressed by DFES about townsites west of South Western Hwy.
8 January 2016	0600	A Yarloop community meeting held at recreation ground.
8 January 2016	0750	Harvey ordered to evacuate.
8 January 2016	0840	Crews withdrawn from Yarloop and deployed to Harvey, backed up by volunteers.
8 January 2016	0930	40 seat bus deployed for Yarloop evacuation.
8 January 2016	0933	Lightning strikes observed to the west of Waroona. Information requested for a safe route out of Preston Beach. Harvey reported as under threat from fire.
8 January 2016	1003	140-150 people evacuated to Harvey.
8 January 2016	1130	South West District Emergency Management Committee meeting held. Community meeting at Waroona Recreation Centre.
8 January 2016	1133	Strike team assembled for Harvey.
8 January 2016	1140	Evacuation of Yarloop approved.
8 January 2016	1236	Reports that 100 people from Preston Beach cannot get out.
8 January 2016	1300	Community meeting at Australind.
8 January 2016	1315	60 residents in private transport commenced evacuation from Yarloop to Pinjarra under escort by HSR.
8 January 2016	1400	Aerial food drop to Preston Beach complete. Community meeting at Murray Leisure Centre.
8 January 2016	1407	Fire reported as having progressed into Cookernup.
8 January 2016	1439	Main Roads report the following roads are shut: - Forrest Hwy both directions from Raymond Rd to Pinjarra Rd; - South Western Hwy from Coalfields Hwy to Greenlands Rd; and - Old Coast Rd from Lakeside Parkway to Forrest Hwy.
8 January 2016	1541	Request for air support Coronation Rd.
8 January 2016	1552	Immediate air support needed at Nicholas Rd.
8 January 2016	1600	Metro reports it cannot provide any more resources due to lightning strikes in Perth Hills.
8 January 2016	1620	Fire breaks begin near Lake Clifton.
8 January 2016	1638	Report of a fire 5-8km south of current maps.
8 January 2016	1850	MOC advises that Singlelton crew is being withdrawn by city of Rockingham for fire.
8 January 2016	1900	People on Preston Beach informed to return home.
8 January 2016	1917	Road Closures in place: - Forrest Hwy both directions from Raymond Rd to Pinjarra Rd; - South Western Hwy from Coalfields Hwy to Greenlands Rd; - Old Coast Rd from Lakeside Parkway to Forrest Hwy; -Old Bunbury Rd between Forrest Hwy and South Western Hwy; -Nanga Rd between Murray River Bridge and Driver Rd; - Uduc Rd/Harvey Quindanning Rd at South Western Hwy;

Date	Time (Hours)	Event
		-Myalup Beach Rd between Forrest Hwy and Forrestry Rd; and - Forrestry Rd between Forrest Hwy and Uduc Rd.
8 January 2016	1942	3 pumps sent to relieve 3 existing pumps in Waroona.
8 January 2016	2000	IC meeting held reports fire burnt around Cookernup.
8 January 2016	2115	IMT meeting held.
8 January 2016	2144	Fire breakout reported near Kennett Rd, 2-3 appliances sent to contain.
8 January 2016	2245	Fire is reported as 5km out of Harvey.
8 January 2016	2325	Emergency warning issued for Harvey.
9 January 2016	0130	Fire moving towards Harvey at a slower rate.
9 January 2016	0300	IMT meeting.
9 January 2016	0446	Road closures in place: - Forrest Hwy from Pinjarra Rd to Buffalo Rd; - Old Coast Rd from Lakeside Parkway to Forrest Hwy; and - South Western Hwy from Greenlands Rd to Marriott Rd.
9 January 2016	0450	Preston Beach warning downgraded to watch and act.
9 January 2016	1000	IMT meeting held.
9 January 2016	1000	All Hazard Liaison Group Teleconference Meeting.
9 January 2016	1130	South West District Emergency Management Committee meeting held/
9 January 2016	1130	Community meeting at Waroona Recreation Centre.
9 January 2016	1300	Community meeting at Australind.
9 January 2016	1400	Community meeting at Murray Leisure Centre.
9 January 2016	1600	All Hazard Liaison Group Teleconference Meeting.
9 January 2016	1435	SOC advises of 2 fires bearing down on Harvey.
9 January 2016	1632	Advised Harvey fires are spot fires.
10 January 2016	1000	All Hazard Liaison Group Teleconference Meeting.
10 January 2016	1000	IMT meeting.
10 January 2016	1130	South West District Emergency Management Committee meeting held.
10 January 2016	1316	Road closures: - Forrest Hwy from Pinjarra Rd to Myalup Beach Rd; - Old Coast Rd from Old Bunbury Rd to Forrest Hwy; and - South Western Hwy from Greenlands Rd to Uduc Rd.
10 January 2016	1600	All Hazard Liaison Group Teleconference Meeting.
10 January 2016		Water Corporation is able to entre Yarloop to install two temporary taps for use near oval. Unable to assess extent of damage to water infrastructure in Yarloop at this time
11 January 2016	1000	All Hazard Liaison Group Teleconference Meeting reports 1 fire appliance lost, 143 properties destroyed.
11 January 2016	1600	All Hazard Liaison Group Teleconference Meeting.
11 January 2016		Waroona townsite ceased being under Emergency Warning in early morning.
12 January 2016	0625	Main Roads re-opens Forrest Hwy in both directions from Mandurah to Bunbury.

Appendix 8 – List of Written Submissions

Number	Submitter
1.	Confidential Submission
2.	Member of the public
3.	Member of the public
4.	Member of the public
5.	Member of the public
6.	Community Alliance For Positive Solutions
7.	Member of the public
8.	Member of the public
9.	Transafe WA
10.	Member of the public
11.	Member of the public
12.	Member of the public
13.	Member of the public
14.	Mundaring Volunteer Fire Control Officers and Captains Group
15.	Member of the public
16.	Member of the public
17.	Harvey Water
18.	Harvey Water supplementary
19.	Member of the public
20.	Member of the public
21.	Nicholas Read (owner Leaf Directional Vortex Conservatory)
22.	Australian Manufacturing Workers' Union
23.	Member of the public
24.	Member of the public
25.	Member of the public
26.	Member of the public
27.	Member of the public
28.	Member of the public
29.	Firewise WA
30.	Confidential Submission
31.	Confidential Submission
32.	Member of the public
33.	Member of the public
34.	Member of the public
35.	Member of the public
36.	Member of the public

Number	Submitter
37.	Member of the public
38.	Member of the public
39.	Member of the public
40.	Confidential Submission
41.	WA Division of the Institute of Foresters of Australia
42.	Advocacy South West
43.	Member of the public
44.	Member of the public
45.	Confidential Submission
46.	Member of the public
47.	Confidential Submission
48.	Member of the public
49.	Member of the public
50.	Member of the public
51.	Hon Wilson Tuckey MP
52.	Member of the public
53.	Confidential Submission
54.	Member of the public
55.	Hon Alannah MacTiernan MP
56.	Member of the public
57.	Member of the public
58.	Member of the public
59.	Member of the public
60.	Member of the public
61.	Member of the public
62.	Member of the public
63.	Member of the public
64.	Member of the public
65.	Emergency Services Volunteer Association
66.	Member of the public
67.	Charles Hull Contracting Earthmoving Specialists
68.	WA Police
69.	Member of the public
70.	Member of the public
71.	Member of the public
72.	Member of the public
73.	Confidential Submission
74.	State Emergency Services – Communications Support Unit

Number	Submitter
75.	Member of the public
76.	Member of the public
77.	Bee Industry Council of Western Australia
78.	Australian Veterinary Association Limited
79.	Member of the public
80.	The Bushfire Front Inc.
81.	Member of the public
82.	Member of the public
83.	Member of the public
84.	Confidential Submission
85.	Member of the public
86.	Dardanup Bushfires Brigades
87.	Confidential Submission
88.	Confidential Submission
89.	Livestock and Rural Transport Association of WA
90.	Member of the public
91.	Confidential Submission
92.	Member of the public
93.	Confidential Submission
94.	Hon Dr Sally Talbot MLC
95.	Forest Industries Association
96.	Western Australian Pork Producers Association
97.	BioCentral Laboratories Ltd
98.	Aerial Fire Defence WA
99.	Australian Worker's Union
100.	Member of the public
101.	The Wilderness Society and the WA Forest Alliance
102.	Member of the public
103.	Telstra
104.	City of Mandurah
105.	Member of the public
106.	Community & Public Sector Union/Civil Association of WA
107.	Alcoa
108.	Member of the public
109.	The Western Australian Farmers Federation Inc
110.	Confidential Submission
111.	Member of the public
112.	Western Australian Local Government Association

Number	Submitter
113.	City of Gosnells
114.	Forest Industries Federation of WA Inc
115.	Member of the public
116.	Member of the public
117.	Confidential Submission
118.	Member of the public
119.	Member of the public
120.	Uduc Volunteer Bush Fire Brigade
121.	Member of the public
122.	Confidential Submission
123.	Member of the public
124.	Member of the public
125.	Member of the public
126.	Association of Volunteer Bush Fire Brigades of WA Inc
127.	Member of the public
128.	Member of the public
129.	Confidential Submission
130.	Swiftworks
131.	Confidential Submission
132.	Member of the public
133.	Friends of Fire
134.	Vincent Nicholas & Christine Ellen Hyde
135.	Confidential Submission
136.	Shire of Murray
137.	Member of the public
138.	Member of the public
139.	Member of the public
140.	Member of the public
141.	Christanya Maya, David Ryan & Mark Pitts-Hill
142.	Department of Parks and Wildlife
143.	The WA Volunteer Fire and Rescue Services Association Inc
144.	State Emergency Management Committee Secretariat
145.	Department of Agriculture and Food, Western Australia
146.	United Firefighters Union of Australia - WA Branch
147.	Forest Products Commission
148.	Dardanup Bushfires Brigade
149.	Member of the public
150.	Member of the public

Number	Submitter
151	Member of the public
152.	Member of the public
153.	Western Power
154.	Department of Fire & Emergency Services
155.	Hon Dr Christopher Back MP
156.	Bernie Masters Environmental Consultant
157.	Confidential Submission
158.	Member of the public
159.	Confidential Submission
160.	Member of the public
161.	Member of the public
162.	Confidential Submission
163.	Confidential Submission
164.	Member of the public
165.	Member of the public

Appendix 9 – List of Hearings

Date	Witness	Location of Hearing
3 March 2016	**Institute of Foresters** Mr F. Batini, Member of the Institute of Foresters Mr J. Clarke, Forester Dr E. M. Mattiske, Member of the Institute of Foresters	West Leederville
3 March 2016	Mr B. Porter, Resident - Seville Grove	West Leederville
3 March 2016	Mr J. Roche, Resident - City Beach	West Leederville
3 March 2016	Mr D. Keene, Resident - Bouvard	West Leederville
4 March 2016	Mr E. Herring, Resident - Benger	Harvey
4 March 2016	Mr R. Lawrence, Resident - Cookernup	Harvey
4 March 2016	Mr L. Liddington, Resident - Yarloop	Harvey
4 March 2016	Mr M. Morton, Resident - Harvey	Harvey
4 March 2016	Mr A. Toop, Resident - Yarloop	Harvey
4 March 2016	**Shire of Waroona** Mr J. Twaddle, Chief Bushfire Control Officer	Harvey
4 March 2016	Mr. M. Colebrook, Resident - Yarloop	Harvey
9 March 2016	**SES Volunteers Association of Western Australia (Inc)** Mr G. Hall, President Mr. P. Peterson, Member Ms L. Booth, Secretary	West Leederville
9 March 2016	**Emergency Services Volunteers Association** Mr M. Quinlan, President Mr J. Iffla, Representing ESVA	West Leederville
10 March 2016	Mr V. Pitter, Resident - Hamel	Harvey
10 March 2016	Mr L. Ierace, Resident - Wagerup	Harvey
10 March 2016	Mr A. Johnson, Resident - Waroona	Harvey
10 March 2016	**Shire of Harvey** Mr P. Penny, Chief Bushfire Control Officer	Harvey
11 March 2016	**Bush Fire Front** Mr R. Underwood, Chairman Mr F. Batini, Consultant in the management of natural resources	West Leederville
11 March 2016	**The Australian Workers Union** Mr S. Price, Secretary Mr M. Zoetbrood, Assistant Secretary Mr D. Cullen, South West Organiser	West Leederville
11 March 2016	Ms B. Schulze, on behalf of the WA Forest Alliance Mr P. Robertson, WA campaigner the Wilderness Society	West Leederville
16 March 2016	**Department of Parks and Wildlife** Mr K. Low, Principal Policy Officer for the Fire Management Services branch	West Leederville

Date	Witness	Location of Hearing
16 March 2016	**Department of Parks and Wildlife** Mr M. Pasotti, District Fire Coordinator for the Perth Hills District	West Leederville
16 March 2016	**Department of Parks and Wildlife** Mr B. Todd, District Manager for the Perth Hills District	West Leederville
16 March 2016	**Department of Parks and Wildlife** Mr R. Towers, Regional Operations Officer	West Leederville
17 March 2016	**WA Farmers** Mr D. Park, Farmer	West Leederville
17 March 2016	**Department of Parks and Wildlife** Mr J. Ridley, Parks & Visitor Services Officer	West Leederville
17 March 2016	**Community and Public Sector Union/Civil Service Association** Mr R Smith, Deputy Delegate for the CSA Ms T. Walkington, Branch Secretary of the Community and Public Sector Union and General Secretary of the Civil Service Association Mr G. Townend, Union Organiser with the CPSU/CSA Ms C. Goodhall, Union Organiser with the CPSU/CSA	West Leederville
17 March 2016	Mr R. Hurst, Resident - Girrawheen	West Leederville
17 March 2016	Mr. T. Muir, Resident - Manjimup	West Leederville
18 March 2016	Mr J. Boswell - No fixed address	Bunbury
18 March 2016	**Firewise WA** Ms P. Townsing	Bunbury
18 March 2016	**Department of Parks and Wildlife** Mr G. Mair, Regional Manager of the South Coast Region	Bunbury
18 March 2016	**Department of Parks and Wildlife** Mr P. Henderson, Acting Regional Manager for the Southwest Region	Bunbury
18 March 2016	**Department of Parks and Wildlife** Mr C. Hill, Project Officer for Fire Management Services	Bunbury
22 March 2016	Mr T. Spurge, Resident - Waroona	Waroona
22 March 2016	Mr L. Tyler & Mr Lionel Tyler, Residents - Lake Clifton	Waroona
22 March 2016	Ms D. and Mr Andrew Kaw, Residents - Yarloop	Waroona
22 March 2016	Mr L.Holbrey, Resident - Yarloop	Waroona
22 March 2016	Mr G. and Ms A. Lalor, Residents - Waroona	Waroona
22 March 2016	Ms A. Archer, Resident - Greensfield	Waroona
22 March 2016	Mr R. McKay, Resident - Yunderup	Waroona
23 March 2016	Ms C. Maya, Mr D. Ryan & Mr M. Pitts-Hill	West Leederville
23 March 2016	**Forest Products Commission** Mr A. Milne, Forester	West Leederville

Date	Witness	Location of Hearing
24 March 2016	**Department of Fire and Emergency Services** Mr P. Norman, District Officer Acting Superintendent South West	West Leederville
24 March 2016	**United Firefighters Union of Australia, West Australian Branch** Ms L. Anderson Branch Secretary Mr K. Jolly, Union President and Station Officer, Department of Fire and Emergency Services	West Leederville
24 March 2016	**Department of Fire and Emergency Services** Mr G. Gifford, Assistant Commissioner	West Leederville
24 March 2016	**Working on Fire Asia Pacific** Mr L. Conradie, Managing Director Mr R. Sneeuwjagt, Consultant	West Leederville
24 March 2016	**Department of the Premier and Cabinet** Mr B. Hay, State Recovery Co-ordinator	West Leederville
29 March 2016	Mr L. Maiolo, Resident - Dianella	West Leederville
29 March 2016	**Department of Fire and Emergency Services** Mr R. Delany, Superintendent, South East Metropolitan	West Leederville
29 March 2016	**WA Police** Mr J. Tuttle, Acting Assistant Commissioner for Support and Specialist Services	West Leederville
30 March 2016	**State Emergency Management Committee** Mr F. Edwards, Chairman Mr M. Cronstedt, Executive Director, State Emergency Management Committee, Secretariat	West Leederville
31 March 2016	**Community Alliance for Positive Solutions** Mr V. Puccio, Chair Mr A. Jovanovich, Resident - Yarloop Mr T. Cockerham Ms M. Palmer	Harvey
31 March 2016	Ms S. Stampone, Resident - Waroona	Harvey
31 March 2016	**Shire of Harvey** Mr M. Parker, Chief Executive Officer	Harvey
31 March 2016	**Association of Volunteer Bushfire Brigades WA Inc.** Mr D. Gossage, Vice President Mr T. Papafilis, Chief Executive Officer	Harvey
1 April 2016	Mr J. McCall, Resident - Margaret River Mr A. Jones, Resident - Yallingup	Bunbury
1 April 2016	**Department of Parks and Wildlife** Mr S. Gunn, Fire Operations Officer	Bunbury
1 April 2016	**Department of Parks and Wildlife** Mr J. Carter, Acting District Fire Coordinator in Blackwood District	Bunbury
1 April 2016	**Department of Parks and Wildlife** Mr J. Chick, Sustainable Forest Management Coordinator in Blackwood District	Bunbury

Date	Witness	Location of Hearing
4 April 2016	**Shire of Harvey** Mr P. Penny, Chief Bushfire Control Officer	Waroona
4 April 2016	**Shire of Waroona** Mr I. Curley, Chief Executive Officer	Waroona
4 April 2016	**Alcoa** Mr B. Robinson, Willowdale Mine Manager Mr A. Gilbert, Production Manager at the Wagerup Alumina Refinery	Waroona
5 April 2016	**Office of Bushfire Risk Management** Mr M. Carter, Director	West Leederville
6 April 2016	**Department of Fire & Emergency Services** Mr W. Gregson, Commissioner	West Leederville
6 April 2016	**Department of Parks and Wildlife** Mr L. McCaw, Principal Research Scientist, Science and Conservation Division Mr N. Burrows, Senior Principal Research Scientist	West Leederville
7 April 2016	**Department of Parks and Wildlife** Mr J. Sharp, Director General	West Leederville
14 April 2016	**Department of Fire & Emergency Services** Mr A. Hamill, Station Officer	West Leederville
21 April 2016	Mr K. Brown, Volunteer Fire and Rescue, Australind	West Leederville
21 April 2016	**Department of Fire & Emergency Services** Mr T. Wegwermer, Acting District Officer, South Coastal Bushfire Service	West Leederville
26 April 2016	**Department of Parks and Wildlife** Mr G. Mair, Regional Manager of the South Coast Region	West Leederville

List of Telephone Hearings

Date	Witness
15 April 2016	Mr S Henry, Resident - Wagerup
15 April 2016	Mr S Smith, Resident - Australind
19 April 2016	Mr L Winter, Resident - Australind
19 April 2016	Ms E Marchetti, Resident – West Coolup
26 April 2016	Mr B Farrell, Resident - Harvey

Appendix 10 - Introductory Scoping Meetings

Date	Attendees
1 February 2016	Department of Fire and Emergency Services Department of Parks and Wildlife Shire of Harvey Shire of Waroona
3 February 2016	Office of Bushfire Risk Management State Emergency Management Secretariat WA Association of Volunteer Bushfire Brigades
5 February 2016	Bush Fire Front (2 people) United Fire Fighters Union (2 people)
9 February 2016	Department of Child Protection and Family Support (2 people) City of Wanneroo (5 people)
10 February 2016	Murray Cowper MLA Waroona Resident Forrest Edge Recreation Camp Chief Fire Controller Shire of Harvey
11 February 2016	Western Australia Police (2 people)
15 February 2016	Volunteer Emergency Services Assocation (3 people) Bureau of Meteorology (3 people)
16 February 2016	Forest Industries Federation (WA) Inc. (3 people) Perth Airport Authority Forest Products Commission (4 people) Waroona Residents (2 people) Margaret Quirk MLA
17 February 2016	Department of Fire and Emergency Services Margaret River Residents (7 people) Shire of Augusta/Margaret River Residents (2 people)
18 February 2016	Cookernup Meeting (30 people)
22 February 2016	Department of Lands (3 people)
23 February 2016	WA Farmers Federation (2 people) Western Australian Local Government Association (3 people)
24 February 2016	Department of Parks and Wildlife WA Volunteer Fire & Rescue Services Association (2 people) Office of Bushfire Risk Management ((2 people)
25 February 2015	Department of Defence (2 people)