HAZELWOOD MINE FIRE INQUIRY REPORT 2015/2016

VOLUME II – INVESTIGATIONS INTO 2009–2014 DEATHS

Hazelwood
Mine Fire
Inquiry

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HAZELWOOD MINE FIRE INQUIRY REPORT 2015/2016 VOLUME II – INVESTIGATIONS INTO 2009–2014 DEATHS

THE HON. BERNARD TEAGUE AO – CHAIRPERSON

PROF. JOHN CATFORD – BOARD MEMBER

MRS ANITA ROPER – BOARD MEMBER

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Hazelwood
Mine Fire
Inquiry

LETTER OF TRANSMISSION

The Honourable Linda Dessau AM
Governor of Victoria
Government House
Melbourne VIC 3004

2 December 2015

Your Excellency,

In accordance with the Terms of Reference dated 26 May 2015, we have the honour of presenting to you the second volume of the report of the 2015/2016 Hazelwood Mine Fire Inquiry.

This volume addresses paragraph 6 of the Terms of Reference relating to whether the Hazelwood Coal Mine Fire contributed to an increase in deaths, having regard to any relevant evidence for the period 2009–2014. The report discusses the health impacts of emissions from fire, investigations into the community's concerns about the possible increase in deaths, and the analysis of the Victorian Registry of Births, Deaths and Marriages death records by experts in biostatistics and epidemiology.

The Board makes several commendations and recommendations as a result of this Inquiry.

Undertaking this work has been a privilege and we would like to thank the people of the Latrobe Valley for their hospitality and generosity. We also appreciate the contribution of the community, industry and government agencies to the Inquiry's conclusions and recommendations.

Yours sincerely,

The Hon. Bernard Teague AO

Prof. John Catford

Mrs Anita Roper

Victoria Government Gazette

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Inquiries Act 2014

APPOINTMENT OF A BOARD OF INQUIRY INTO THE HAZELWOOD COAL MINE FIRE

Order in Council

The Governor in Council, on the recommendation of the Premier under section 53(1) of the **Inquiries Act 2014**, appoints:

- the Honourable Bernard George Teague AO;
- Professor John Charles Catford; and
- Mrs Anita Michele Roper

to constitute a Board of Inquiry to inquire into and report on the terms of reference specified in paragraphs 6 to 11 of this Order.

The Honourable Bernard George Teague AO is appointed as Chairperson of the Inquiry.

This Order comes into effect on the date it is published in the Government Gazette.

BACKGROUND

1. In early February 2014 a fire ignited which, on or about 9 February 2014, took hold in the Hazelwood Coal Mine.
2. The Hazelwood Coal Mine Fire impacted the Latrobe Valley communities.
3. In March 2014, a Board of Inquiry was established to inquire into and report on the following specified matters:
    1. *The origin and circumstances of the fire, including how it spread into the Hazelwood Coal Mine.*
    2. *The adequacy and effectiveness of the measures taken by or on behalf of the owner, operator and licensee of the Hazelwood Coal Mine to prevent the outbreak of a fire, and to be prepared to respond to an outbreak of a fire including mitigating its spread and severity, in the Hazelwood Coal Mine, including whether the owner, operator and licensee of the Hazelwood Coal Mine, or any person or entity acting on behalf of any of them:*
        i. *implemented the recommendations arising from reviews of previous events; and*
        ii. *in the opinion of the Board, breached or did not comply with the requirements of (or under) any relevant statute or regulation, including any notification or directive given under such statute or regulation and any code of practice, management plan or similar scheme, developed and/or implemented due to such requirements.*
    3. *The adequacy and effectiveness of the application and administration of relevant regulatory regimes in relation to the risk of, and response to, fire at the Hazelwood Coal Mine.*
    4. *The adequacy and effectiveness of the response to the Hazelwood Coal Mine Fire by:*
        i. the owner, operator and licensee of the Hazelwood Coal Mine;
        ii. the emergency services; and
        iii. other relevant government agencies, including environmental and public health officials,

    and in particular, the measures taken in respect of the health and well-being of the affected communities by:

SPECIAL

iv. informing the affected communities of the Hazelwood Coal Mine Fire and about its known effects and risks; and

v. responding to those effects on, and risks to, the affected communities.

5. *Any other matter reasonably incidental to the matters specified in paragraphs 1 to 4.*

4. That Inquiry's report was tabled in the Victorian Parliament on 2 September 2014.

5. Since that report was tabled, further concerns have been raised about the potential health impacts of the fire on the Latrobe Valley communities and future options for rehabilitating Victorian mines in the Latrobe Valley.

TERMS OF REFERENCE

You are required to inquire into and report on the following terms of reference:

6. Whether the Hazelwood Coal Mine Fire contributed to an increase in deaths, having regard to any relevant evidence for the period 2009 to 2014;

7. Short, medium and long term measures to improve the health of the Latrobe Valley communities having regard to any health impacts identified by the Board as being associated with the Hazelwood Coal Mine Fire;

8. Short, medium and long term options to rehabilitate:

   (a) land on which work has been, is being or may lawfully be done in accordance with a Work Plan approved for the Hazelwood Mine, the Yallourn Mine, and the Loy Yang Mine; and

   (b) land in relation to which an application for variation of the Work Plan is under consideration for the Hazelwood Mine, the Yallourn Mine, or the Loy Yang Mine;

9. For each rehabilitation option identified under paragraph 8:

   (a) whether, and to what extent, the option would decrease the risk of a fire that could impact the mine and if so, the cost of the option relative to the cost of other fire prevention measures;

   (b) whether, and to what extent, the option would affect the stability of the mine;

   (c) whether, and to what extent, the option would create a stable landform and minimise long term environmental degradation;

   (d) whether, and to what extent, the option would ensure that progressive rehabilitation is carried out as required under the **Mineral Resources (Sustainable Development) Act 1990**;

   (e) the estimated timeframe for implementing the option;

   (f) the option's viability, any associated limitations and its estimated cost;

   (g) the impact of the option on any current rehabilitation plans for each mine;

   (h) whether, and to what extent, the option would impact the future beneficial use of land areas impacted by the mines; and

   (i) whether the option is otherwise sustainable, practicable and effective;

10. Having regard to the rehabilitation liability assessments that have been or will be reported in 2015 by the operators of each of the Hazelwood Mine, the Yallourn Mine, and the Loy Yang Mine, as required by the **Mineral Resources (Sustainable Development) Act 1990**, and to the outcome of the Rehabilitation Bond Review Project:

    (a) whether the rehabilitation liability assessments referred to above are adequate;

    (b) whether the current rehabilitation bond system, being one of the measures to provide for progressive rehabilitation by end of mine life as required under the **Mineral Resources (Sustainable Development) Act 1990**, is, or is likely to be, effective for the Hazelwood Mine, the Yallourn Mine, and the Loy Yang Mine; and

(c) any practical, sustainable, efficient and effective alternative mechanisms to ensure rehabilitation of the mines as required by the **Mineral Resources (Sustainable Development) Act 1990**;

11. Sustainable, practical and effective options that could be undertaken by the mine operator to decrease the risk of fire arising from or impacting the Anglesea Mine for the 2015/2016 summer season, noting the impending closure of the mine on 31 August 2015; and

12. Any other matter that is reasonably incidental to those set out in paragraphs 6 to 10.

REPORTING DATES

You must report your findings and any recommendations to the Governor as soon as possible, and not later than:

(a) 31 August 2015, in respect of the Anglesea mine Term of Reference in paragraph 11 of this Order, and any reasonably incidental matters;

(b) 2 December 2015, in respect of the Health Terms of Reference, and any reasonably incidental matters; and

(c) 15 March 2016, in respect of the Mine Terms of Reference, and any reasonably incidental matters.

CONDUCTING THE INQUIRY

13. You may:

(a) conduct your inquiry as you consider appropriate, subject to the requirements of procedural fairness, including by adopting any informal and flexible procedures to: engage with the relevant local communities; ascertain the relevant facts as directly and effectively as possible; and avoid unnecessary cost or delay;

(b) have regard to any research, past inquiries, reports and evaluations that may inform your inquiry and avoid unnecessary duplication;

(c) have regard to any documents, things or evidence received by, and any matters submitted to, the Board of Inquiry referred to in paragraph 3 as if those documents, things or evidence had been received by you, or those matters had been submitted to you, as the case may be, for the purposes of your inquiry and any report or reports under this Order;

(d) consult with the relevant local communities; and

(e) consult with and engage experts (including Australian legal practitioners) as necessary to provide relevant advice and assistance.

14. You must conduct your inquiry in accordance with this Order, the **Inquiries Act 2014**, and all other relevant laws.

15. It is anticipated that in conducting your inquiry you will, to the extent you think it appropriate, work co-operatively with, and seek not to prejudice, any ongoing response or recovery activities or investigations into the Hazelwood Coal Mine Fire.

16. The powers of the Board of Inquiry, at the discretion of the Chairperson may, at any time, be exercised by one or more Inquiry members.

BUDGET

17. You may incur expenses and financial obligations to be met from the Consolidated Fund up to $3.378 million in conducting this Inquiry.

DEFINITIONS

18. In this Order:

Anglesea Mine means the land the subject of the Mines Aluminium Agreement (Agreement 6829) as in force from time to time, which was ratified by the **Mines (Aluminium Agreement) Act 1961**;

Hazelwood Coal Mine Fire means the fire that took hold in the Hazelwood Mine on or about 9 February 2014;

Hazelwood Mine means the land the subject of Mining Licence Number 5004, as in force from time to time;

Health Terms of Reference means the terms of reference in paragraphs 6 and 7 of this Order;

Loy Yang Mine means the land the subject of Mining Licence Number 5189, as in force from time to time;

Mine Terms of Reference means the terms of reference in paragraphs 8, 9 and 10 of this Order;

Rehabilitation Bond Review Project means the current review into rehabilitation bonds and the methodology by which they are calculated, as referred to at page 1612, lines 7–8 of the transcript of the Hazelwood Mine Fire Inquiry dated 10 June 2014;

Work Plan means a work plan approved under the **Mineral Resources (Sustainable Development) Act 1990** or endorsed pursuant to clause 21A of the Agreement set out in Schedule 1 to the **Mines (Aluminium Agreement) Act 1961**, as amended by the Amendment Agreement set out in Schedule 2 to that Act, as the case may be;

Yallourn Mine means the land the subject of Mining Licence Number 5003, as in force from time to time.

Dated 26 May 2015

Responsible Minister:
THE HON DANIEL ANDREWS MP
Premier

YVETTE CARISBROOKE
Clerk of the Executive Council

Victoria Government Gazette

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Inquiries Act 2014

AMENDMENT TO THE TERMS OF REFERENCE FOR
THE BOARD OF INQUIRY INTO THE HAZELWOOD COAL MINE FIRE

Order in Council

The Governor in Council under section 53 of the **Inquiries Act 2014**, amends the Order in Council dated 26 May 2015 establishing the Board of Inquiry into the Hazelwood Coal Mine Fire by:

1. For paragraphs (b) and (c) under the heading 'Reporting Dates' **substitute** –

"(b) 2 December 2015, in respect of the Term of Reference in paragraph 6 of this Order, and any reasonably incidental matters; and

(c) 29 January 2016, in respect of the Term of Reference in paragraph 7 of this Order, and any reasonably incidental matters; and"

2. After paragraph (c) under the heading 'Reporting Dates' **insert** –

"(d) 15 March 2016, in respect of the Mine Terms of Reference, and any reasonably incidental matters."

Dated 4 November 2015

Responsible Minister
THE HON. DANIEL ANDREWS MP
Premier

MATTHEW McBEATH
Clerk of the Executive Council

CONTENTS

GUIDE TO READING THIS REPORT

This report constitutes the Board of Inquiry's response to the Hazelwood Mine Fire Inquiry's Term of Reference 6. Term of Reference 6 requires the Board to inquire into and report on whether the Hazelwood mine fire contributed to an increase in deaths, having regard to any relevant evidence for the period 2009 to 2014.

This report takes into account information provided through public submissions, witness statements and expert reports, and at public hearings held in Morwell on 1–3 and 9 September 2015, and in Melbourne on 22 October 2015.

In this report, the term 'State' is used broadly to refer to both the Napthine Victorian Government and the Andrews Victorian Government, which came into office on 30 November 2014. Reference to the 'Department of Health' or the 'Department' is used to describe both the Department of Health under the Napthine Victorian Government and the Department of Health and Human Services under the Andrews Victorian Government.

Part 1 of this report provides an overview of the Inquiry.

Part 2 of this report provides background information on the Hazelwood mine fire and its effect on the health of the Latrobe Valley community.

Part 3 of this report discusses investigations into community concerns about a possible increase in deaths in the Latrobe Valley.

Part 4 of this report provides an overview of the analyses of death records relevant to the Latrobe Valley, undertaken by Associate Professor Adrian Barnett, a statistician from the Institute of Health and Biomedical Innovation and School of Public Health, Queensland University of Technology, and Dr Louisa Flander, Senior Research Fellow, Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health, University of Melbourne. The analyses discussed in this part of the report were undertaken prior to the Inquiry being re-opened on 26 May 2015.

Part 5 of this report describes the analyses of death records carried out for the Inquiry and the evidence presented at public hearings held on 1–3 and 9 September 2015. The Board heard from experts, namely Professor Bruce Armstrong, medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney; Professor Ian Gordon, Director of the Statistical Consulting Centre and Professor of Statistics in the School of Mathematics and Statistics at the University of Melbourne; Associate Professor Barnett, and Dr Flander. The Board also received a report from Professor John McNeil, Professor and Head of the Department of Epidemiology and Preventive Medicine at Monash University.

Part 6 of this report provides an overview of the expert evidence that was provided to the Inquiry after the September 2015 public hearings concluded and that was the subject of a further hearing on 22 October 2015. On 22 October 2015, the Board heard again from the experts who gave evidence at the September 2015 hearings and also from Dr Philip McCloud, Director and Principal Statistician, McCloud Consulting Group, and Dr Fay Johnston, a public health physician and environmental epidemiologist from the University of Tasmania.

Part 7 of this report sets out the Board's findings in relation to whether there was an increase in deaths during the Hazelwood mine fire and whether the mine fire contributed to that increase. This part also discusses the legal framework that applies to the Board and other matters that are incidental to the Board's Terms of Reference. The Board finds that:

- It is likely that there was an increase in deaths in the Latrobe Valley between February and June 2014 when compared with the same period during 2009–2013.
- It is likely that the Hazelwood mine fire contributed to some of the increase in deaths in the Latrobe Valley in 2014.

Part 8 of this report discusses other matters relevant to the Inquiry, including the Board's consideration of incidental matters under Term of Reference 12. In particular, the Board makes adverse findings against Dr Lester, the former Chief Health Officer, and the Department of Health, in relation to their investigation of and response to the concerns of the community about a possible increase in deaths in the Latrobe Valley.

Part 9 of this report summarises the Board's findings and presents the Board's commendations, affirmations and recommendations.

Image source *Herald Sun*

PART ONE
INTRODUCTION TO THE INQUIRY

PART 1 INTRODUCTION TO THE INQUIRY

The 2014 Hazelwood Mine Fire Inquiry was held from February to September 2014. On 26 May 2015, The Honourable Lily D'Ambrosio MP, Minister for Energy and Resources, and The Honourable Jill Hennessy MP, Minister for Health, announced the re-opening of the Inquiry. The purpose of the re-opened Inquiry is to investigate and report on whether the 2014 Hazelwood mine fire contributed to an increase in deaths; measures to improve the health of the Latrobe Valley; rehabilitation options for Latrobe Valley coal mines; and minimising fire risks at the Anglesea coal mine for the 2015/2016 summer season.

TERMS OF REFERENCE

This report addresses paragraph 6 of the Hazelwood Mine Fire Board of Inquiry's Terms of Reference (Term of Reference 6). Under Term of Reference 6, the Board is to inquire into, and report on, and make any recommendations that it considers appropriate in relation to whether the Hazelwood Coal Mine Fire contributed to an increase in deaths, having regard to any relevant evidence for the period 2009 to 2014.

ESTABLISHMENT OF THE INQUIRY

THE BOARD

On 26 May 2015, the Governor in Council established the Hazelwood Mine Fire Board of Inquiry and appointed the following Board members:

BERNARD TEAGUE, CHAIRPERSON

Justice Bernard Teague AO was a Supreme Court Judge from 1987 to 2008. During this period he also chaired the Adult Parole Board and the Victorian Forensic Leave Panel, and was a Council Member at the Institute of Forensic Mental Health. Prior to his appointment to the Supreme Court, Justice Teague was a solicitor specialising in defamation and other civil law.

Justice Teague was Chair of the 2009 Victorian Bushfires Royal Commission and Chair of the 2014 Hazelwood Mine Fire Inquiry.

JOHN CATFORD, BOARD MEMBER

Professor Emeritus John Catford is a registered medical practitioner and the Executive Director, Academic and Medical, of the Epworth HealthCare Group.

Professor Catford has been a Professor of public health for 30 years and has held senior academic and health service management positions in Australia and the United Kingdom, and with the World Health Organization. In 2008, Professor Catford led the establishment of the School of Medicine at Deakin University in Geelong. He was appointed Vice President and Deputy Vice Chancellor of Deakin University in 2011.

Professor Catford was a Board member of the 2014 Hazelwood Mine Fire Inquiry.

ANITA ROPER, BOARD MEMBER

Mrs Anita Roper is an experienced Director with a strong background in sustainability. Her career spans the public and private sectors. She has over 30 years of experience in senior management roles working with business, government, communities and multi-lateral agencies in Australia and internationally. She is currently a Director of Yarra Valley Water, a Board member of the Fitzroy Football Club, and a member of the Victorian Public Sector Commission Advisory Board.

Mrs Roper's previous roles include Chief Executive Officer at Sustainability Victoria and Global Director of Sustainability with Alcoa (New York). She has also previously served as a non-executive Director of Pacific-Hydro and as Chair of the Board's Health, Safety, Sustainability and People Committee; as a member of AngloGold Ashanti's Global Panel on Sustainability; and as a Board member of the Women's Network for a Sustainable Future (New York).

HAZELWOOD MINE FIRE INQUIRY SECRETARIAT

The Hazelwood Mine Fire Inquiry Secretariat was established to support the Board of Inquiry. The Secretariat was headed by Ms Genelle Ryan. Members of the Secretariat are listed in Appendix A. The Board thanks them for their dedication and commitment to this Inquiry. The Board also thanks K&L Gates for contributing their legal expertise, and particularly Ms Justine Stansen for her additional hard work in developing and coordinating this report.

COUNSEL ASSISTING

Counsel Assisting, Mr Peter Rozen and Ms Ruth Shann, provided the Board with legal advice and guidance throughout the Inquiry, and managed the Inquiry's public hearings in Morwell and Melbourne. The Board thanks Mr Rozen and Ms Shann for their assistance.

ACKNOWLEDGEMENTS

The Board thanks the Victorian Government Solicitor and his Office, other contributing government departments and agencies, Voices of the Valley and its solicitor Environmental Justice Australia, GDF Suez Australian Energy and its solicitor King & Wood Mallesons, and Dr Rosemary Lester and her solicitor Perry Maddocks Trollope, for their assistance throughout the Inquiry.

THE BOARD'S APPROACH

The Board recognised that effectively conducting this Inquiry called for genuine engagement with the Latrobe Valley community. The Board emphasised transparency and accessibility throughout this Inquiry and endeavoured to hear and understand the concerns of the Latrobe Valley community relevant to Term of Reference 6. Members of the Board, Counsel Assisting and Secretariat staff visited the Latrobe Valley as part of this Inquiry.

PUBLIC SUBMISSIONS

Individuals and organisations contributed to the Inquiry by making public submissions. The Board accepted written submissions specific to Term of Reference 6 until 10 August 2015. Board members read and considered all written submissions (listed at Appendix B) received from individuals and organisations.

COMMUNICATIONS

A website (http://hazelwoodinquiry.vic.gov.au/) was established for the 2014 Hazelwood Mine Fire Inquiry. This website was updated when the Inquiry was re-opened, and has since been continuously updated to provide information to the Latrobe Valley and broader Victorian community about the Board, Terms of Reference, public submissions, community consultations and public hearings. The Latrobe Valley community was informed about how they could participate in, or attend the Inquiry, through brochures, posters, mail-outs, media promotion and advertising. Members of the public were able to contact the Inquiry by phone (1300 556 034) and email (info@hazelwoodinquiry.vic.gov.au) for the duration of the Inquiry.

INDEPENDENT EXPERT

The Board engaged Emeritus Professor Bruce Armstrong AM, medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney, to provide information and advice to the Inquiry as an independent expert. The Board thanks Professor Armstrong for his expertise and report.

PUBLIC HEARINGS

Public hearings were held over five days in Morwell and Melbourne, from 1-3 September, on 9 September and on 22 October 2015. Counsel Assisting, Mr Rozen and Ms Shann, led evidence and made final submissions to the Board. Leave to appear before the Inquiry was granted to the State, Voices of the Valley, GDF Suez Australian Energy, Dr Rosemary Lester, and the Environment Protection Authority.

The Board received evidence from senior government officials from the Department of Health and the Victorian Registry of Births, Deaths and Marriages, expert epidemiologists and statisticians, expert medical professionals and a member of Voices of the Valley. Appendix C lists the names of witnesses who appeared at the public hearings. Appendix D lists exhibits that were tendered at the public hearings.

INQUIRIES ACT 2014 (VIC)

In the 2014 Hazelwood Mine Fire Inquiry report, there was a discussion of the challenges faced by a Board of Inquiry in the absence of an Inquiries Act. Those challenges included the lack of a power to restrict publication of its proceedings and no ability to deal with contempt of its processes. It was noted that the Inquiries Bill 2014 (Vic) was introduced into the Parliament on the eve of the report's publication.[1] The *Inquiries Act 2014* (Vic) commenced on 15 October 2014. The present Inquiry is the first to be established under Part 3 of the Act.

Section 76 of the Act prescribes a procedure to be followed in the event that a Board established under Part 3 'proposes to make a finding that is adverse to a person.' In this Inquiry, the Board determined, at the conclusion of the public hearings and after the receipt of written submissions from the parties, that it would make adverse findings against Dr Rosemary Lester, the former Chief Health Officer, and against the State (Department of Health). In compliance with s.76(1)(b) of the Act, the Board provided both of these parties with a copy of a final draft of part of this report and invited them to make any submissions they wished to make. As required by s.76(2), the Board has considered those submissions in this report. Part 8 of the report sets out the responses of Dr Lester and the State of Victoria to the Board's proposed findings.[2]

PART TWO
BACKGROUND INFORMATION

PART 2 BACKGROUND OF THE HAZELWOOD MINE FIRE AND ITS IMPACT ON THE HEALTH OF THE COMMUNITY

The Hazelwood mine fire ignited on 9 February 2014 and burnt for 45 days before being declared safe. It was the largest and longest running mine fire in the history of the Latrobe Valley. The impact of the mine fire on the community's health was significant, with residents suffering many adverse health effects.

2.1 HEALTH EFFECTS OF THE HAZELWOOD MINE FIRE

In the 2014 Hazelwood Mine Fire Inquiry, the Board was required to consider the health effects that smoke and ash produced by the Hazelwood mine fire had on the community, the likely cause of these health effects, and potential long-term health impacts.

The 2014 Hazelwood Mine Fire Inquiry found that the Latrobe Valley community, and in particular residents of Morwell, reported suffering distressing adverse health effects from the Hazelwood mine fire, including sore and stinging eyes, headaches and blood noses. The majority of these symptoms resolved when smoke and ash from the mine fire dissipated, but some residents reported continuing symptoms. In addition to these symptoms, a small number of residents reported developing new health conditions as a result of exposure to smoke and ash during the mine fire. There were a number of vulnerable groups in the community who were particularly susceptible to the potential adverse health effects of the smoke and ash, namely those with pre-existing cardiovascular and respiratory conditions, pregnant women and unborn children, children and the elderly.[1]

Professor Donald Campbell, Professor of Medicine, Southern Clinical School, Monash University and Program Director, General Medicine Program, Monash Health, advised the Board during the 2014 Hazelwood Mine Fire Inquiry that the probable cause of these adverse health impacts was the smoke and ash produced by the mine fire.[2]

Professor Campbell identified specific components of smoke and ash from the mine fire and indicated the potential short and long-term effects of exposure to those components.[3]

Professor Campbell informed the Board that people with pre-existing health conditions, including asthma, chronic obstructive pulmonary disease, ischaemic heart disease and congestive heart failure, were at increased risk from exposure to $PM_{2.5}$, carbon monoxide and ozone.[4] Also at increased risk were smokers, who generally have compromised lung function, and people undertaking vigorous activity.[5] Research has shown that individuals with chronic obstructive pulmonary disease have an increased risk of requiring emergency care after exposure to elevated levels of $PM_{2.5}$.[6] $PM_{2.5}$ is described in the 2014 Hazelwood Mine Fire Inquiry Report as fine particulate matter that is found in smoke and haze and has the potential to cause adverse health effects.[7]

Professor Campbell advised that potential adverse health effects for people with pre-existing cardiovascular and respiratory disease range from exacerbation of their condition, hospital admission, stroke, heart attack, and in severe cases, death.[8] People with pre-existing cardiovascular and respiratory conditions are particularly susceptible to potential adverse long-term health effects when exposed to ozone, $PM_{2.5}$ and larger particles. In particular, they are susceptible to an aggravation or progression of their underlying condition, an increased risk of lung cancer, and potential effects on coagulation, which could result in an increased risk of arrhythmias, morbidity, hospital admissions, psychosocial effects, and death.[9]

Professor Campbell further advised the Board that there is a risk that the general population could develop medium to long-term effects from exposure to $PM_{2.5}$ and ozone, including but not limited to the development of respiratory conditions, effects on cardiac conduction, increased risk of heart attack, stroke and lung cancer, long-term cognitive decline, psychosocial effects and death.[10] Unborn children are particularly susceptible to high doses of carbon monoxide, which can lead to low birth weight, premature labour and foetal death.[11] Table 1 describes the medium to long-term health effects that may be caused by exposure to substances in smoke from a brown coal fire.

Table 1: Medium to long-term health effects that may be caused by exposure to smoke from a brown coal fire, prepared by Professor Campbell[12]

Affected Group	Effect	Substance
Unborn	Pre-term birth. Reduced birth weight due to intrauterine growth retardation. Reduced postnatal growth rates. Reduced lung function growth rates.	Ozone Ozone and $PM_{2.5}$
Young Children	Reduced lung function growth rates. Respiratory tract: new onset asthma and bronchitis; exacerbation of existing asthma creating ongoing reactive airways which are sensitive to further insults, eg virus. Increased morbidity and hospital admissions.	Ozone and $PM_{2.5}$
	Impaired growth in lung function.	Ozone and $PM_{2.5}$
	Impaired neurological development.	Ozone
	Psychosocial effects which increase the risk of family violence, drug and alcohol use, depression and anxiety, post-traumatic stress and phobia.	$PM_{2.5}$ and larger particulates
Firefighters & General Population*	Respiratory tract: increased risk of sinusitis, new onset asthma, acute bronchitis; exacerbation of pre-existing asthma creating ongoing reactive airways which are sensitive to further insults, eg virus. Exacerbation of unrecognised Chronic Obstructive Pulmonary Disease (COPD). Increased risk of morbidity, hospital admissions and death.	Ozone and $PM_{2.5}$
	Effects on cardiac conduction: increased risk of arrhythmias and death.	Ozone and $PM_{2.5}$
	Effect on coagulation state: increased risk of stroke, heart attack and death.	Ozone and $PM_{2.5}$
	Increased risk of lung cancer and death.	$PM_{2.5}$
	Psychosocial effects which increase the risk of family violence, drug and alcohol use, depression and anxiety, post-traumatic stress and phobia.	$PM_{2.5}$ and larger particulates

* Diabetes and current smoking may increase risk in these categories

Affected Group	Effect	Substance
People with pre-existing ailments (COPD, asthma, ischaemic heart disease, congestive cardiac failure)	Irritation to respiratory tract: sinusitis, exacerbation of asthma and COPD, creation of hyper-reactive airways which are sensitive to further insults, eg virus, and increased risk of bacterial infection. Increased risk of hospital admissions, pneumonia and death.	Ozone and $PM_{2.5}$
	Effects on cardiac conduction: increased risk of arrhythmias, morbidity, hospital admissions and death.	Ozone and $PM_{2.5}$
	Effect on coagulation state: increase risk of stroke, heart attack, morbidity, hospital admissions and death.	Ozone and $PM_{2.5}$
	Increased risk of lung cancer and death.	$PM_{2.5}$
	Long-term cognitive decline.	Ozone
	Exacerbation of pre-existing congestive cardiac failure. Increased risk of hospital admissions and death.	Ozone and $PM_{2.5}$
	Psychosocial effects which increase the risk of family violence, drug and alcohol use, depression and anxiety, post-traumatic stress and phobia.	$PM_{2.5}$ and larger particulates

During the current Inquiry, the Board received a report from Dr Jonathan Burdon, a consultant respiratory physician, titled *The respiratory effects of smoke, fume and other particulate inhalation*.[13] The report notes that the inhalation of smoke, dusts, fumes and other particulate matter is recognised as a potential cause of lung injury and disease.[14] Inhaled substances vary in their potential to cause lung disease. As stated in the report:

> Particulates cause non-specific irritation to the airway and lead to the symptoms of cough, sputum production and sometimes a sensation of breathlessness in the short term. More prolonged exposure over several weeks leads to these symptoms becoming more severe and lead to the development of chronic sinusitis, chronic bronchitis and chronic obstructive airways disease (COPD) in some individuals. The latter are usually permanent or, at least, very long standing. In those persons with pre-existing lung disease, such as COPD or asthma, their condition may be aggravated leading to an increased severity in the symptoms of breathlessness, cough, chest tightness and discomfort. In some cases, the increased severity of the condition will lead to acute respiratory failure necessitating admission to hospital, with or without an Intensive Care Unit admission. Death may occur in some more severe cases.[15]

In conclusion, Dr Burdon reported that prolonged exposure to smoke inhalation from combusted coal may lead to increased mortality, particularly among those with underlying disease.[16]

Professor Bruce Armstrong, medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney, informed the Board that any emission from a fire is potentially inhalable and can cause illness and death. In relation to particulate matter, Professor Armstrong noted that smaller particulate matter such as $PM_{2.5}$[17] is able to persist in the lungs longer than larger particulate matter and can have effects at the functional level of the lungs and on the heart.[18]

Associate Professor Adrian Barnett, a statistician from the Institute of Health and Biomedical Innovation and School of Public Health, Queensland University of Technology, referred the Board to reports published by the American Heart Association and World Health Organization that describe the relationship between

particulate matter pollution and death and morbidity. He told the Board that there is very strong evidence of the short and long-term effects of air pollution on stroke, increased risk of death and increased risk of emergency hospital admissions for cardiovascular and respiratory disease.[19]

2.2 RAPID HEALTH RISK ASSESSMENT

During the Hazelwood mine fire, the Department of Health commissioned the Monash University School of Public Health and Preventative Medicine to undertake a Rapid Health Risk Assessment and provide information about the short-term health effects of the mine fire on the local community. The findings of the study, submitted to the Department on 12 March 2014, include:

- No additional deaths would be expected even if the level of exposure to the measured level of air quality continued for six weeks. The report used the air quality level at the average exposure in Morwell during the fire, however the actual exposure level was not detailed.
- If the fine particulate matter levels remained in the extreme range (over 250 micrograms per cubic metre) for three months this may result in additional deaths in the community.[20]

In her evidence to the 2014 Hazelwood Mine Fire Inquiry, Dr Rosemary Lester, former Chief Health Officer, Department of Health, advised the Board that the Rapid Health Risk Assessment concluded that the level of exposure of the Morwell community to smoke and ash from the mine fire would not be expected to cause any additional deaths, because exposure did not extend for longer than six weeks.[21]

Professor Michael Abramson, Professor of Clinical Epidemiology and Deputy Head of the Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine at Monash University, provided evidence to the Board that whilst the Rapid Health Risk Assessment was the best assessment that could have been done at the time, it was subject to several limitations.
These limitations included:

- There had not been a previous comparable fire in a brown coal mine for which a health effects study had been conducted and published in peer-reviewed literature.[22]
- The Environment Protection Authority (EPA) did not collect any air quality data in the first few days of the Hazelwood mine fire. Accordingly, it was likely that the community's exposure to smoke would have been higher than the study suggests and the modelling conducted by Monash University may have been an underestimate of the effect of the smoke.[23]
- The 45 days that the community was exposed to mine fire smoke is a period that is somewhere in between short and long-term exposure, and a specific model to consider exposures of this duration had not been developed.[24]
- The modelling used in the study applied to the population at large, which included a proportion of children and elderly who are known to be at greater risk.[25]
- The modelling did not take into account vulnerable groups particular to the Morwell population.[26]

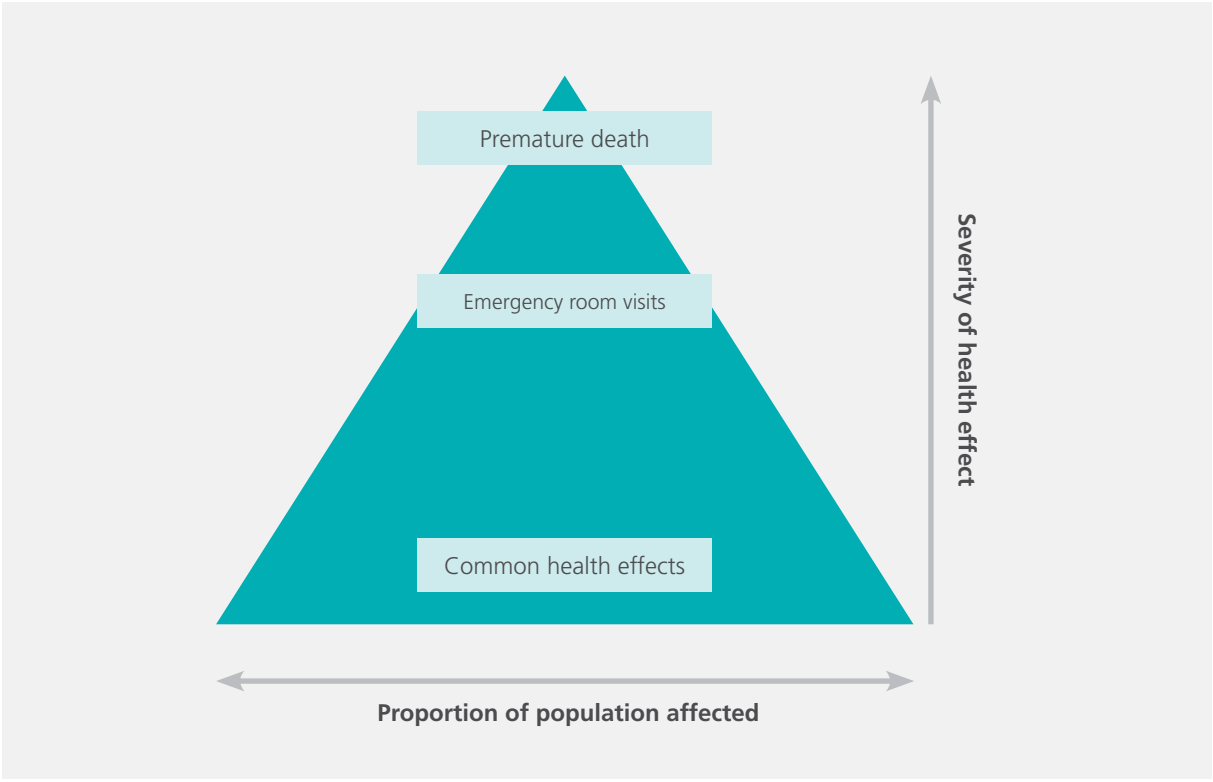
Professor Abramson indicated to the Board that based on the data received from the EPA, it was unlikely that there would be health effects from the mine fire from sulphur dioxide, nitrogen dioxide, ozone[27] and mercury.[28] Professor Abramson acknowledged that he was not provided with any data on the measurement of air toxins, including polycyclic aromatic hydrocarbons, dioxins, boron, formaldehyde or other volatile organic compounds.[29]

Further discussion of the Rapid Health Risk Assessment can be found in the 2014 Hazelwood Mine Fire Inquiry Report at Chapter 4.5 Health effects.

Professor Abramson told the Board that on 5 February 2015, Monash University was retained by the Department of Health to update the Rapid Health Risk Assessment conducted during the Hazelwood mine fire.[30] This update involved a literature review, authored by Dr Diogenes S. Ferreira, Dr Martine Dennekamp and Professor Abramson, that considered whether increased mortality could be attributed to an environmental smoke event in the absence of any observed increase in morbidity.[31] It is noted that mortality relates to deaths and morbidity refers to illness and disease and includes hospital admissions, emergency presentations, consultations with physicians, and ambulance call-outs.[32] As part of the review, the authors undertook a wide search for peer-reviewed publications about the health effects of smoke from fires in brown coal mines. Their search did not reveal any publications. On that basis, the authors considered studies of outdoor biomass burning of similar duration to the Hazelwood mine fire.[33]

In their May 2015 report to the Department of Health titled *Updated Literature Review on Mortality and Morbidity associated with Environmental Smoke Events*,[34] the authors reproduced an air pollution health effects pyramid (included in this report at Figure 1), to demonstrate the likely severity of health effects and the proportion of the population affected as a consequence of air pollution.[35] Professor Abramson explained to the Board that at the top of the pyramid is premature death, which is 'fortunately, relatively rare', and that health effects towards the base of the pyramid are more common. The pyramid shows that there are a higher number of emergency room visits than there are deaths.[36]

Figure 1: The air pollution health effects pyramid, adapted from Professor Abramson[37]



In their review, the authors state that '[w]hilst it is not possible to definitively conclude from these studies whether increase mortality attributable to environmental smoke events could ever occur in the absence of an observed increase in morbidity, we consider this possibility unlikely.'[38]

Professor Abramson advised the Board that one would not necessarily expect to see increased mortality even where there is an increase in morbidity from an event. An increase in morbidity would be a consequence of how extreme the exposure to the smoke event was and the health of the underlying population that was exposed.[39] He indicated that it was more probable that any death or deaths as a result of the exposure to particulate matter would affect people living in areas where there were greater levels of exposure.[40]

Professor Abramson qualified for the Board that his co-authored report was subject to the following limitations:

- The authors could not identify any directly comparable event to the Hazelwood coal mine fire.[41]
- There are very few studies that have looked both at mortality and morbidity.[42]
- Conclusions in the report are based primarily on one study, which looked at exposure to smoke from bushfire in Sydney combined with exposure to urban air pollution, however there are qualitative differences between the populations of Sydney and Morwell.[43]
- The Sydney study was based on 32 independent days of bushfire/pollution over an eight-year period whereas Latrobe Valley residents were exposed to 45 consecutive days of smoke.[44]

Professor Abramson also noted that whilst he had been provided with death records for the Latrobe Valley for the purpose of the updated literature review, he had not undertaken any statistical analysis of those death records. He also noted that he was not provided with any data showing the number of hospital admissions, Emergency Department visits, outpatient visits to physicians, or visits to other clinics in the Latrobe Valley, for the period of the Hazelwood mine fire.[45] Accordingly, Professor Abramson was not in a position to provide any opinion as to whether the Hazelwood mine fire contributed to an increase in deaths, or to an increase in morbidity.[46]

PART THREE
INVESTIGATIONS INTO COMMUNITY CONCERNS

PART 3 INVESTIGATIONS INTO COMMUNITY CONCERNS ABOUT A POSSIBLE INCREASE IN DEATHS IN THE LATROBE VALLEY

At the time of the Hazelwood mine fire, the long-term adverse effects of exposure to smoke and ash were unknown, and this has been of great concern to the community. Wendy Farmer, President of Voices of the Valley, submitted to the Board of Inquiry that she had heard from families in the Latrobe Valley who wondered what the future might hold for them. She noted that many community members have raised serious health concerns and that 'these people may never know 100% whether these have happened because of the fire.'[1]

Various organisations and individuals expressed concerns to the Board about a possible increase in deaths in the Latrobe Valley during and following the Hazelwood mine fire. These concerns led to requests for investigations, and the conduct of investigations by various organisations and government departments.

Many of the investigations undertaken focused on analysing death records kept by the Victorian Registry of Births, Deaths and Marriages (the Registry). The Board heard evidence from Ms Dawn Sims, Enterprise Data and Intelligence Consultant, Victorian Registry of Births, Deaths and Marriages, that the Registry registers all deaths that take place in Victoria. The Registry is governed by the *Births Deaths and Marriages Registration Act 1996* (Vic) and any request made for death records is assessed pursuant to s.48 of that Act.

Ms Sims told the Board that all deaths in Victoria are registered upon the lodging of a death registration statement by a funeral director, and the provision of a Medical Certificate of Cause of Death by a medical practitioner. Both documents record the usual residential address of the deceased and the place of death, as identified by the funeral director and medical practitioner.[2] Where the Coroner is investigating a death, the registration of that death is delayed until the coronial inquest is completed.[3] Where the death registration is not finalised (that is, there is insufficient information about the cause of death), the Registry records the death as 'pending.' When the cause of death and all other inquiries about the death have been finalised, the Registry records the death as 'complete.' In some cases, a death may not be recorded as 'complete' for a number of years.[4] Generally, when a request is made for death records, the Registry only provides information on completed death registrations.[5]

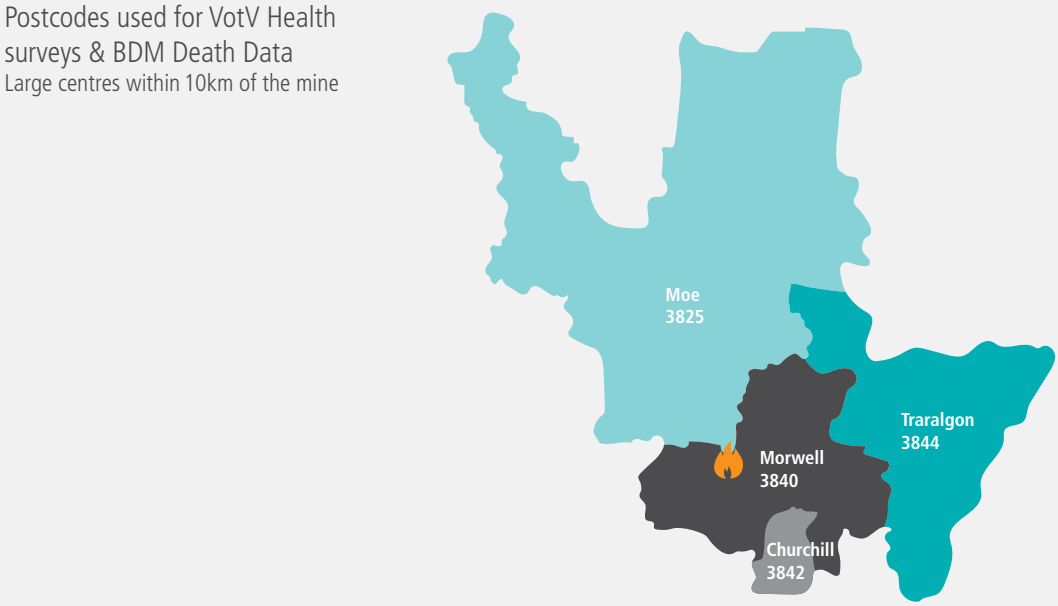
3.1 INVESTIGATIONS BY VOICES OF THE VALLEY

Voices of the Valley (previously named Disaster in the Valley) is an incorporated association that was established at the time of the Hazelwood mine fire by a group of local residents who had concerns about the fire's effects. The organisation continues to advocate for the Latrobe Valley community.[6]

During and immediately after the Hazelwood mine fire, members of Voices of the Valley began to hear concerns from the community about whether the mine fire had caused the deaths of local residents.[7]

On 27 May and 12 June 2014, Voices of the Valley made requests to the Registry for registered death records between January and June 2009 to 2014 in the four postcodes closest to the Hazelwood mine—Morwell (3840), Moe (3825), Traralgon (3844) and Churchill (3842).[8] Figure 2 shows the location of these four areas relative to the mine fire (which is depicted by the flame symbol).[9]

Figure 2 – Four postcodes closest to the mine fire – adapted from an image prepared by Voices of the Valley[10]



Voices of the Valley did not receive a response from the Registry, and so undertook their own research by collating death notices that appeared in the local newspaper.[11] Members of Voices of the Valley used this information to compare mortality statistics for 2014 with the previous five years. Mr Ron Ipsen, a member of Voices of the Valley, advised the Board that an assessment of this data, whilst comprising a very rough statistical analysis, showed an 'indicative and alarming increase in deaths.'[12]

Figure 3 is a graph produced by Mr Ipsen based on death notices published by the Latrobe Valley Express and other media.[13]

Figure 3 – Comparative number of deaths in 2009, 2010–2013 and 2014 recorded in local media, adapted from the graph prepared by Voices of the Valley[14]

After noticing an apparent increase in deaths in the Latrobe Valley between February and March 2014, Voices of the Valley again sought official statistics from the Registry on 4 and 25 August 2014.[15]

On 14 August 2014, Voices of the Valley wrote to the Board of Inquiry seeking its help in relation to its concerns about the possible increase in deaths during the mine fire. The Board was unable to provide any assistance to Voices of the Valley as it was in the process of finalising the 2014 Hazelwood Mine Fire Inquiry Report. However on 22 August 2014, the Board provided the information collated by Voices of the Valley to the Department of Health for the purposes of a long-term health study (discussed below), and to the State Coroner for his consideration.[16]

On 17 August 2014, following receipt of the request by Voices of the Valley, the Registry contacted the Department of Health to ascertain whether the Department would assist Voices of the Valley with its request for the data. The Department declined to assist.[17]

Accordingly, on or about 4 September 2014, the Registry assessed the request pursuant to s.48 of the *Births Deaths and Marriages Registration Act 1996* (Vic). The Registry determined that it would provide Voices of the Valley with the registered monthly death records between January and June 2009 to 2014, for the areas of Morwell, Moe, Traralgon and Churchill.[18] The data provided by the Registry did not identify the cause of death for any of the registered deaths. Table 2 shows the data provided by the Registry to Voices of the Valley.[19]

Table 2 –Table of deaths by date and usual place of residence, produced by Victorian Registry of Births, Deaths and Marriages[20]

DEATHS BY DATE AND USUAL PLACE OF RESIDENCE

	POSTCODE							
YEAR	**3840**		**3842**		**3825**		**3844**	
2009	January	19	January	5	January	23	January	21
	February	18	February	4	February	11	February	22
	March	23	March	4	March	16	March	19
	April	9	April	2	April	11	April	13
	May	11	May	2	May	24	May	19
	June	6	June	3	June	15	June	23
2010	January	11	January	1	January	16	January	18
	February	17	February	2	February	14	February	12
	March	9	March	6	March	15	March	17
	April	19	April	3	April	19	April	12
	May	17	May	1	May	20	May	18
	June	18	June	1	June	12	June	17
2011	January	10	January	4	January	13	January	20
	February	11	February	3	February	15	February	11
	March	11	March	1	March	17	March	17
	April	19	April	4	April	24	April	14
	May	7	May	3	May	20	May	15
	June	9	June	0	June	10	June	9
2012	January	10	January	3	January	17	January	20
	February	11	February	2	February	12	February	13
	March	17	March	0	March	16	March	18
	April	12	April	2	April	17	April	10
	May	22	May	1	May	14	May	22
	June	17	June	1	June	19	June	21
2013	January	13	January	3	January	22	January	10
	February	4	February	3	February	15	February	11
	March	15	March	3	March	20	March	13
	April	10	April	5	April	18	April	22
	May	9	May	2	May	15	May	13
	June	13	June	0	June	17	June	34
2014	January	18	January	0	January	17	January	19
	February	10	February	4	February	16	February	20
	March	12	March	3	March	24	March	23
	April	15	April	2	April	29	April	8
	May	15	May	1	May	26	May	20
	June	18	June	0	June	20	June	19

NB: As extracted on 2 September 2014

PROVISION OF DATA BY VOICES OF THE VALLEY TO AN EXPERT FOR ANALYSIS

Voices of the Valley provided the data it received from the Registry to the Australian Broadcasting Corporation's (ABC) 7.30 Report program for the purpose of a report it was preparing about the Hazelwood mine fire.

In turn, the ABC provided the Registry's data to Associate Professor Adrian Barnett, a statistician from the Institute of Health and Biomedical Innovation and School of Public Health, Queensland University of Technology. Associate Professor Barnett undertook a statistical analysis of the data and prepared a report titled *Analysis of death data during the Morwell mine fire*, dated September 2014.[21] Associate Professor Barnett's analysis is discussed in more detail in Part 4 of this report.

On 2 October 2014, Voices of the Valley requested further death records from the Registry, including data from January to December for the years 2004 to 2014 for six postcodes (Morwell, Moe, Traralgon, Churchill, Yinnar and Boolarra South), and data for Victoria for the same period.[22] On or about 9 October 2014, the Registry agreed to this request on the condition that information about cause of death was excluded from the data.[23] This data was provided to Voices of the Valley upon payment of an invoice dated 12 December 2014 in the amount of $485.[24] The data provided by the Registry to Voices of the Valley was then provided to Associate Professor Barnett. He undertook a further statistical analysis and prepared a further report titled *An updated analysis of death data during the Morwell mine fire*, dated December 2014.[25] The updated analysis is discussed in more detail in Part 4 of this report.

At various times in 2015, the Registry provided updated and corrected registered death records to Voices of the Valley, including on 13 February 2015 and 7 August 2015.[26]

3.2 INVESTIGATIONS BY THE DEPARTMENT OF HEALTH

During the Hazelwood mine fire, the Department of Health issued health warnings about the effects of smoke from the fire. Those health warnings are described in Chapters 4.2 and 4.6 of the 2014 Hazelwood Mine Fire Inquiry Report. The Department also undertook its own investigation into whether there was an increase in deaths in the Latrobe Valley during the mine fire and it obtained independent expert opinion on the subject.

On 3 September 2014, the Registry provided registered death records prepared for Voices of the Valley to Dr Rosemary Lester, then Chief Health Officer at the Department of Health, and to Neil Robertson, Emergency Services.[27] This data was reviewed by departmental staff in the Health Intelligence Unit and the Office of the Chief Health Officer, and by Dr Lester.[28]

In early September 2014, the Department of Health was contacted by the ABC's 7.30 Report program. On 11 September 2014, the Department provided a statement to the program which noted that it had received data from the Registry and that the data showed no increase in deaths in Morwell during the period of the Hazelwood mine fire relative to the same period in the previous years. The statement went on to note that the 'official data from the Registry of Births, Deaths and Marriages shows no significant pattern. The reasons for individual deaths can have many explanations, including age, an individual disease profile and external factors such as heatwave.'[29]

In an ABC report published on www.abc.net.au on 12 September 2014, the then Deputy Premier of Victoria, Mr Peter Ryan, was quoted as saying 'there have not been deaths and no indications of such' and that 'we are concerned, of course, to undertake the health studies the Inquiry has recommended and we will do that.'[30]

PROVISION OF DATA BY THE DEPARTMENT OF HEALTH TO AN EXPERT FOR ANALYSIS

On 16 September 2014, Dr Lester contacted Professor Terry Nolan at the School of Public Health, University of Melbourne, to request an analysis of death records where deaths occurred in the Latrobe Valley during the Hazelwood mine fire.[31] Dr Lester stated to the Board that she sought an opinion from the University of Melbourne because it had the relevant independent expertise to undertake the analysis.[32] Professor Nolan delegated the task to Dr Louisa Flander, Senior Research Fellow, Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health at the University of Melbourne.[33]

The project brief provided to the University of Melbourne by the Department requested an analysis of the data provided by the Registry of Births, Deaths and Marriages on 4 September 2015, and advice on what conclusions could be drawn about any increase or decrease in deaths during the mine fire (February to March 2014), or for the six month period January to June 2014.[34]

On 26 September 2014, Dr Lester provided a report to the Department of Health titled *Review of Birth Deaths & Marriages Victoria (BDMV) mortality data for the Latrobe Valley at the time of the Hazelwood coal mine fire in Morwell*.[35] This review is discussed in more detail in Part 4 of this report.

FACTSHEETS PUBLISHED BY THE DEPARTMENT OF HEALTH

In mid-September 2014, at the time the Department of Health was seeking expert opinion on data from the Registry, it published two factsheets on its website. The first of these factsheets, dated 17 September 2014, was titled *Reports of deaths in the Latrobe Valley related to the Hazelwood coal mine fire*.[36] The second factsheet, dated September 2014, was titled *Reports of deaths in the Latrobe Valley claimed to be related to the Hazelwood Coal Mine Fire*.[37] The second factsheet contained a table identifying the number of deaths in Morwell, Moe, Traralgon and Churchill, for the periods February–March and January–June for the years 2009–2014. An extract of the first factsheet, dated 17 September 2014, is reproduced at Figure 4.

Figure 4 – Extract of *Reports of deaths in the Latrobe Valley related to the Hazelwood coal mine fire factsheet* dated 17 September 2014, produced by the Department of Health[38]

Morwell

The highest exposure of fine particles from the smoke was in Morwell, especially in the southern part of Morwell. Therefore, if the mine fire had any impact on the number of deaths, it would be expected to be seen in Morwell.

However, for February and March 2014, there was a 19 per cent decrease in deaths compared to the same period in the previous five years.

For the six month period, the number of deaths (88) was similar to 2012 (89), 2010 (91) and 2009 (86).

Traralgon

There was an increase in deaths during February and March but the number (43) was similar to 2009 (41).

For the whole period (January to June 2014) there was an increase in deaths, with again the 2014 figure (109) being similar to the 2009 figure (117).

Churchill

The actual numbers were very small which was then reflected in an increase of 25 per cent for February and March 2014 but a decrease the other way of minus 32 per cent for the six month period.

Moe

There were increases of 32 per cent and 33 per cent in the deaths for these two time periods. The Department is obtaining additional data to better understand this issue.

The Department's factsheet dated 17 September 2014 discussed the impact of heatwaves on deaths and noted that there was a 21 per cent increase in deaths (against the previous five year average) across all four postcodes (3840, 3844, 3842 and 3825) for March 2014. The factsheet noted that the number of deaths was equal to the number for the same postcode group in 2009, which was also subject to heatwave conditions.[39]

On 22 October 2014, the Department of Health published an updated factsheet on its website, titled *Reports of deaths in the Latrobe Valley related to the Hazelwood coal mine fire*.[40] The updated factsheet contained information about the analysis undertaken at the University of Melbourne, including the following:

> They found that while a small increase in the overall number of deaths for the first 6 months occurred, they "cannot conclude that the 2014 mortality observed is due to any single cause, or whether it has occurred by chance alone." (p3)
>
> Under limitations, they state they "did not take external factors such as local weather conditions into account in these analyses. Analysis of the cause of death for this period would be required to explore common risk factors." Also that they "…have no information on the underlying age/sex distribution of these localities, or the recent demographic changes in these communities, both trends that could underlie the mortality observed in 2014." (p3)

COMMISSION OF THE LONG TERM HEALTH STUDY

On 30 October 2014, the Department of Health commissioned Monash University, in collaboration with the Monash University School of Rural Health, Federation University Australia, University of Tasmania and Flinders University of South Australia, to undertake the Hazelwood Mine Fire Health Study.[41] This study is a long-term consideration of any health effects that may have been caused by the Hazelwood mine fire, including cardiovascular and respiratory disease, low birth weight, psychological impacts and the development of cancer.[42]

It is intended that the study will answer the following questions:

- Is there evidence that people who were heavily exposed to smoke from the mine fire are more likely to have developed heart and lung conditions or to develop them in the future, when compared with another similar community with less exposure to the mine fire?
- Is there evidence of any impact of smoke exposure during pregnancy or infancy on the health and development of children in the Latrobe Valley compared to otherwise similar infants and children with less exposure to the mine fire?
- Is there evidence that people who were heavily exposed to smoke from the mine fire have a higher level of psychological distress than otherwise similar people with less exposure to the mine fire and is this associated with particular vulnerable groups?
- Is there evidence that people who were heavily exposed to smoke from the mine fire are more likely to develop cancers over a long period of time than otherwise similar people with less exposure to the mine fire?[43]

The Hazelwood Mine Fire Health Study is divided up into multiple streams, including the Adult Study and the Older People Study. Both streams have either commenced or will commence in 2015.[44]

As discussed in Part 7 of this report, under its current scope the Hazelwood Mine Fire Health Study will not consider whether or not the mine fire contributed to any increase in deaths in the Latrobe Valley during the period of the mine fire.

PROVISION OF FURTHER DATA BY THE DEPARTMENT TO AN EXPERT FOR ANALYSIS

On 8 December 2014, the Department of Health made a request to the Registry for daily death records of deaths occurring in Morwell, Moe, Traralgon and Churchill from 2009 to 2014, including cause of death; together with comparative data for the whole of Victoria.[45] This data was provided to the Department on 15 January 2015.[46]

On 2 February 2015, the Department of Health engaged the University of Melbourne to undertake an analysis of this new data set, as well as a peer review of Associate Professor Barnett's report dated December 2014 (which had been commissioned by Voices of the Valley).[47]

On 11 February 2015, the Department of Health requested a further data set from the Registry that included daily death registrations for deaths occurring in Morwell, Moe, Traralgon and Churchill for the years 2004 to 2008.[48]

On 12 March 2015, the Registry consented to the Department providing copies of registered daily death records (including cause of death information) to the University of Melbourne.[49]

On 28 April 2015, Dr Flander provided a report to the Department titled *Review of "Analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2014, Queensland University of Technology) and "An updated analysis of death data during the Morwell mine fire," A. Barnett, working paper; unpublished (2015, Queensland University of Technology)*.[50] This is discussed in more detail in Part 4 of this report.

On 4 June 2015, the University of Melbourne provided the Department with a third report titled, *Age-standardised mortality and cause of death in the Latrobe Valley at the time of (and five years prior to) the Hazelwood coalmine fire in Morwell, Victoria.*[51] This report is discussed in more detail in Part 4 of this report.

On 22 June 2015, the Registry provided the Department with a further data set that covered daily death registrations for deaths occurring in Morwell, Moe, Traralgon and Churchill for the years 2004 to 2008.[52]

On 8 July 2015, the Registry consented to the Department providing copies of registered daily death records (including cause of death information) to Dr Lester following her retirement from the Department.[53]

3.3 INVESTIGATIONS BY THE STATE CORONER OF VICTORIA

On 4 March 2014, the United Firefighters Union of Australia expressed its concern about the potential for adverse health outcomes for firefighters and community members as a result of the Hazelwood mine fire, and sought an investigation by the State Coroner.[54]

On 20 July 2014, Occupy Latrobe Valley also made an application to the State Coroner to investigate the Hazelwood mine fire, on the basis of community concerns about a possible increase in deaths as a consequence of air pollution caused by the mine fire.[55]

The Coroner decided to wait for the report of the 2014 Hazelwood Mine Fire Inquiry before determining whether to investigate.[56]

On 22 August 2014, the Board of Inquiry sent a letter to the State Coroner attaching the information provided to it by Voices of the Valley on 14 August 2014. The Board advised the Coroner that it was unable to provide any assistance to Voices of the Valley as it was in the process of finalising its report for the Governor of Victoria.[57]

On 11 September 2014, Voices of the Valley made an application to the State Coroner seeking an investigation into the Hazelwood mine fire, on the grounds that air pollution from the mine fire may have caused deaths.[58]

In the course of receiving submissions in the re-opened Inquiry, the Board received a submission from Ms Kiery-Ann Clissold of Morwell, which stated that she had made a request to the State Coroner on 17 September 2014 to investigate the death of her husband, Mr Harry McCormack. On 3 October 2014, after receiving advice from a forensic pathologist, the State Coroner determined that Mr McCormack's death was not a reportable death and therefore no coronial investigation would be conducted.[59]

On 11 November 2014, Coroner Hawkins determined not to investigate the Hazelwood mine fire, whilst acknowledging that the concerns and issues outlined in the applications made by the United Firefighters Union of Australia, Occupy Latrobe Valley and Voices of the Valley were serious and worthy of examination. Coroner Hawkins determined that the applications did not align with the Coroner's responsibilities under the *Coroners Act 2008* (Vic).[60] In making her decision, Coroner Hawkins had regard to obligations under the Act that require that the Coroner not duplicate other inquiries and investigations (such as the Hazelwood Mine Fire Inquiry, the long-term health study to be led by Monash University and the Department of Health statistical analyses published in September and October 2014).[61]

On 15 and 22 July 2015, the Board of Inquiry received correspondence from the State Coroner that there had been no coronial investigations into any deaths alleged to be linked to the Hazelwood mine fire.[62]

PART FOUR
ANALYSIS OF DEATH RECORDS

PART 4 ANALYSIS OF DEATH RECORDS BY ASSOCIATE PROFESSOR BARNETT AND THE UNIVERSITY OF MELBOURNE

As noted in Part 3 of this report, prior to the Hazelwood Mine Fire Inquiry being re-opened on 26 May 2015, Associate Professor Adrian Barnett from the Queensland University of Technology, and Dr Louisa Flander from the University of Melbourne, undertook various assessments which sought to determine whether there was an increase in deaths in the Latrobe Valley during the Hazelwood mine fire and if so, whether these deaths were associated with air pollution from the mine fire.

4.1 ANALYSIS BY ASSOCIATE PROFESSOR BARNETT

Associate Professor Barnett is employed as a statistician by the Institute of Health and Biomedical Innovation and School of Public Health at the Queensland University of Technology.[1]

In September and December 2014, Associate Professor Barnett undertook statistical analyses of death records produced by the Victorian Registry of Births, Deaths and Marriages. He produced two reports relevant to these analyses, titled *Analysis of death data during the Morwell mine fire*[2] and *an updated analysis of death data during the Morwell mine fire*.[3]

Associate Professor Barnett analysed the monthly numbers of deaths in the Latrobe Valley over the period 2009 to 2014 for the months of January through June. He compared the death records for 2014 against the statistical average number of deaths for the period 2009–2013. His first assessment and report covered death records for four postcodes during this period—Morwell (3840), Moe (3842), Traralgon (3844) and Churchill (3825).[4] His second assessment and report covered death records related to these four areas and the additional postcodes of Yinnar (3869) and Boolarra South (3870).[5]

In his first report, Associate Professor Barnett concludes that there was an 89 per cent probability that the death rate was higher during the Hazelwood mine fire than the statistical average for the Latrobe Valley in 2009–2013. He further concludes that the mean increase in deaths in 2014 was 14 per cent and the 'absolute number of deaths per postcode per month is 1.8, which over 4 postcodes and 2 months is 14.1.'[6]

In his second report, Associate Professor Barnett reaches the following conclusion:

> The updated analysis gives a 79% to 82% probability of an increase in deaths during the two months of the fire. This is similar to the 80% to 89% probability from the previous analysis. The reduction in probability is because the two additional postcodes (3869 and 3870) showed a slight reduction in death risk.[7]

In his second assessment and report, Associate Professor Barnett took into account monthly temperatures when calculating the probability of an increase in deaths and adjusted his findings accordingly. The mean increase in deaths as a relative risk was calculated as 1.1 (or a 10% increase), with the likely number of deaths across the six postcodes for the two month period being 9.6.[8]

4.2 ANALYSIS BY DR FLANDER AND COLLEAGUES

As discussed in Part 3 of this report, in late 2014 and early 2015, the Department of Health engaged the Melbourne School of Population and Global Health at the University of Melbourne to undertake three analyses to consider whether there was an increase in deaths in the Latrobe Valley caused or contributed to by the Hazelwood mine fire.

The University of Melbourne selected Dr Flander to undertake each of these analyses. Dr Flander is an epidemiologist and Senior Research Fellow in the Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health at the University of Melbourne.[9]

The first report commissioned by the Department of Health was written by Dr Flander and Professor Dallas English, Melbourne School of Population and Global Health at the University of Melbourne, and is titled *Review of Birth Death & Marriages Victoria (BDMV) mortality data for the Latrobe Valley at the time of the Hazelwood coal mine fire in Morwell*.[10] The report describes the methodologies used for the analysis as the Poisson regression model and a linear regression model. The analysis indicates that there were '37 additional deaths overall in the 2014 period (339 observed for 2014, compared to the 302 annual average predicted by the model)', and that:

- For Morwell: there was weak evidence of additional deaths in 2014 compared with 2009–2013 but that there were fewer deaths for the period February–March than in previous years. The results are inconclusive due to wide confidence intervals and large p-values.[11]
- For the Latrobe Valley: there were 7.4 additional deaths per month in 2014 when compared with 2009–2013 and 9.2 additional monthly deaths for February–March 2014 compared with February–March 2009–2013. The results are inconclusive due to wide confidence intervals.[12]

In conclusion, Dr Flander and Professor English state:

> Our review of the BDMV mortality data (2009–14) for the Latrobe Valley shows that slightly more deaths occurred in the period January to June 2014 compared with the period January to June 2009–13 but the evidence that this is not due to just chance is inconclusive.
>
> …
>
> We do not find this increase to be conclusive evidence of any particular effect, given the very wide confidence intervals around the observations, and the lack of useful denominators to compare health events in these postcodes. These uncertainties include, but may not be limited to, the small population size under review, and the fact that we have no information about the underlying age or sex distribution or population movements over time within the postcodes concerned.[13]

The second report commissioned by the Department of Health was written by Dr Flander, Mr Antony Ugoni and Dr Cindy Hauser, all of the University of Melbourne. It is dated 28 April 2015 and titled *Review of "Analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2014, Queensland University of Technology) and "An updated analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2015, Queensland University of Technology).*[14]

The second report is in part a critique of the analysis undertaken by Associate Professor Barnett in his two reports. The report records that the authors consider that Associate Professor Barnett's conclusions are not supported by the evidence. The authors state:

> These papers do not discuss the ambiguities in interpretation of estimates when such estimates are based on small datasets in the context of rare environmental events. There is no discussion of the decrease in deaths for the postcode (Morwell) where the Hazelwood mine is located and the fire occurred. Cause of death for these mortality data were not included in these analyses and strongly mitigate the author's assertions about the deaths at the time of fire.
>
> There is no statistical interpretation of evidence for any particular effect on the observed differences in reported mortality across the Latrobe Valley postcodes for the period of the Hazelwood coal mine fire. Although the fire's effect on mortality may be a supposition worthy of investigation, the data presented in these papers do not suggest strong evidence for the author's assertion of a significant effect of the period of the fire on mortality at that time. The mean increase in deaths (given as a relative risk with 95% credible intervals) for the February–March 2014 period with and without the seasonal temperature correction is not evidence of statistical significance. The evidence given in these analyses of broad uncertainty around the estimated mortality shows that there were *no* additional deaths, rather than the 0.8 deaths per postcode per month and 9.6 deaths per postcode over two months reported by Barnett (2015).[15]

The third report commissioned by the Department of Health was undertaken by Dr Flander, Dr Driss Ait Ouakrim, Dr Seyedeh Ghazaleh Dashti and Mr Ugoni, all of the University of Melbourne. It is dated 4 June 2015 and titled *Age-standardised mortality and cause of death in the Latrobe Valley at the time of (and five years prior to) the Hazelwood coalmine fire in Morwell, Victoria.*[16]

This third report examines the mortality data from the Latrobe Valley (Morwell, Moe, Churchill and Traralgon) during the period February–March 2014 and February–June 2014, compared with the same periods for the previous five years. The third report notes that the authors examined the epidemiological evidence for any excess number of deaths and the possible impact of air quality and temperature in relation to these deaths.[17]

The third report concludes that:

> While deaths may have been higher in 2014 than some previous years, we are not able to attribute these deaths to the fire, as there was insufficient number of deaths and lack of personal level data and circumstances of deaths. This means we are not able to rule in or rule out evidence for excess regional deaths because of the coal fire.
>
> The analysis of these data shows that 2014 mortality rates did not differ from comparable rates for the same months in 2009, a season similar to 2014 with respect to high temperatures and high particulate matter from bushfire smoke. However, the statistical uncertainty in these estimates, expressed by broad confidence intervals for each of the rate ratios for the years 2009–2013, shows the lack of statistical evidence for an overall higher rate of mortality in 2014.[18]

The third report also states that the authors' key findings are to be interpreted cautiously. In particular, the authors state that their finding that there is no statistical evidence of association between the mine fire and deaths in the Latrobe Valley cannot be interpreted as evidence for or against a particular cause of death.[19]

PART FIVE
EXPERT ANALYSIS OF THE DEATH RECORDS PROVIDED TO THE INQUIRY

PART 5 EXPERT ANALYSIS OF THE DEATH RECORDS PROVIDED TO THE INQUIRY

After the Hazelwood Mine Fire Inquiry was re-opened on 26 May 2015, the Board of Inquiry held public hearings in September 2015 to consider whether the Hazelwood mine fire contributed to an increase in deaths in 2014, having regard to any relevant evidence for the period 2009 to 2014.

The Board heard from experts, namely Emeritus Professor Bruce Armstrong, a medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney; Professor Ian Gordon, Director of the Statistical Consulting Centre and Professor of Statistics in the School of Mathematics and Statistics, University of Melbourne; Associate Professor Adrian Barnett, a statistician from the Institute of Health and Biomedical Innovation and School of Public Health, Queensland University of Technology; and Dr Louisa Flander, a senior research fellow from the Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health, University of Melbourne. The Board also received a report from Professor John McNeil, Professor and Head of the Department of Epidemiology and Preventive Medicine at Monash University.

The Board held a further hearing into evidence provided to the Inquiry after the September public hearings concluded. That hearing is discussed in Part 6 of this report.

5.1 EXPERT ANALYSIS PROVIDED TO THE INQUIRY

Upon the re-opening of the Inquiry, the Board retained Professor Armstrong to provide expert opinion in relation to questions that the Board must consider under the Inquiry's Terms of Reference, namely:

- Was there an increase in the number of deaths during the mine fire?
- If so, did the mine fire contribute to that increase in deaths?

Professor Armstrong is a medical practitioner, public health physician and an epidemiologist and is currently Emeritus Professor at the School of Public Health, The University of Sydney, Senior Advisor to the Sax Institute, and Chairman of the Bureau of Health Information, Government of New South Wales.[1] Professor Armstrong authored a report titled *Expert assessment and advice regarding mortality information as it relates to the Hazelwood Mine Fire Inquiry Terms of Reference – Final report*, dated August 2015.[2]

Voices of the Valley retained Professor Gordon to provide an opinion on the questions posed to the Board of Inquiry. Professor Gordon is the Director of the Statistical Consulting Centre and a Professor of Statistics in the School of Mathematics and Statistics at the University of Melbourne. Professor Gordon has a PhD in Mathematical Statistics from the University of Melbourne and is accredited as a statistician by the Statistical Society of Australia Incorporated. Professor Gordon is also a founding member of the Australasian Epidemiological Association.[3] Professor Gordon authored a report titled *Commentary on the Hazelwood mine fire and possible contribution to deaths*, dated 11 August 2015.[4]

Dr Rosemary Lester, former Chief Health Officer, Department of Health, retained Professor McNeil to provide an opinion on the questions posed to the Board under Term of Reference 6. Professor McNeil is a Professor and Head of the Department of Epidemiology and Preventive Medicine at Monash University. Professor McNeil provided a report to the Board under cover of a letter to Dr Lester's solicitors, dated 28 August 2015. Professor McNeil's report is a critique of the reports undertaken by Associate Professor Barnett and Dr Flander. Professor McNeil's report does not include any conclusions on the questions posed to the Board of Inquiry by way of his own analysis of the death data provided to him by Dr Lester's solicitors. Accordingly, Professor McNeil did not give evidence at the hearing or participate in the expert meeting on 31 August 2015, however his report was tendered as evidence to the Inquiry.[5]

As discussed in Part 4 of this report, the Board also obtained the reports of Associate Professor Barnett and Dr Flander, which included opinions on whether there was an increase in deaths in the Latrobe Valley during the Hazelwood mine fire.

In the days leading up to the public hearings, the Board invited Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander to discuss their analyses and respective conclusions as a group. During the discussion on 31 August 2015, Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander produced a joint expert report that identified areas of agreement and disagreement in relation to the conclusions reached in Professor Armstrong's report.[6] Each of the experts also gave evidence to the Board as a panel at the public hearings in September 2015.

5.2 DATA AND METHODOLOGY

In order to understand the conclusions reached by these experts, this section provides an overview of the data considered, and the methodologies and analytical tools used.

DATA USED FOR ANALYSIS

The data provided to Professor Armstrong, Professor Gordon and Associate Professor Barnett was:

- Monthly death records data for the years 2009–2014 for four postcodes—3840 (Morwell), 3825 (Moe), 3842 (Churchill), and 3844 (Traralgon)
- Daily death records data for the years 2013 and 2014 for the same four postcodes
- Records of emergency hospital admissions for the years 2013 and 2014 for each of the same four postcodes
- Data on mean temperatures in Morwell for 2014
- Particulate matter readings (actual or estimated) in each of the same four postcodes for the period of the Hazelwood mine fire.[7]

Professor Armstrong and Professor Gordon also received daily death records data provided by the Victorian Registry of Births, Deaths and Marriages to the Board in July 2015, including cause of death information, for the period January 2009–July 2015.

Dr Flander analysed daily death records, which she received directly from the Department of Health, including information about cause of death, for the years 2009–2015 for four postcodes—3840 (Morwell), 3825 (Moe), 3842 (Churchill), and 3844 (Traralgon). The Department also provided Dr Flander data on temperature, air pollution and hospital admissions for the same period and areas.

Associate Professor Barnett analysed monthly death records data for the years 2004–2014 for six postcodes—3840 (Morwell), 3825 (Moe), 3842 (Churchill), 3844 (Traralgon), 3869 (Yinnar) and 3870 (Boolarra South)—and data on temperature for the same period and areas.

There was discussion at the Inquiry's public hearings about whether the data was available to the experts in a form that allowed them to reach the conclusions that they articulate in their respective reports.

Dr Flander acknowledged that whilst the death records she considered had cause of death information, they did not contain complete medical records about the deceased, nor information about whether the deceased had been exposed to air pollution from the mine fire, or to high temperatures. Dr Flander told the Board that it would be useful to know whether or not the deceased were actually resident in the Latrobe Valley at the time of the mine fire and what their levels of exposure were to the air pollution from the mine fire.[8] Associate Professor Barnett agreed with this statement.[9]

Associate Professor Barnett acknowledged that a more accurate analysis could be undertaken if death records data for the period of the mine fire excluded deaths that were not possibly related to the mine fire. However, he qualified that excluding deaths on this basis would be challenging as air pollution is associated with many causes of death.[10]

Professor McNeil indicated in his report that the monthly data used by Associate Professor Barnett was 'very crude' as it did not include age-specific death rates and there was no information about changing age structures or population numbers within each of the postcodes.[11] Associate Professor Barnett accepted that the monthly death records data was crude relative to daily death records data.[12]

METHODOLOGY

Professor Gordon explained to the Board that each expert assessed the death records to calculate the statistical average of the number of deaths in the Latrobe Valley for the 2009–2013 period, and then predicted what number of deaths they expected to see in 2014, based on this statistical average. Each expert then compared the statistical average, or predicted number of deaths for 2014, with the actual observed number of deaths in 2014.[13]

In interpreting their results, the experts used several tools or indicators to assess whether their observations were significant and not the result of chance or random variation, including relative risk ratios, 95 per cent confidence intervals and probability (P) values. The experts described these tools and their application to the Board as follows:

- A relative risk ratio of the observed actual number of deaths in 2014 was calculated to indicate the excess or reduction relative to the predicted number of deaths.[14]
- A 'confidence interval' was used to demonstrate whether the predicted number of deaths and observed number of deaths fall within a range where the statistician can be 95 per cent confident that the true unknown value falls within that interval. The confidence interval is intended to reflect the imprecision that arises through natural variation when dealing with a hypothetical.[15] According to Professor Gordon, a confidence interval demonstrates the size of the effect and what interval may contain that effect.[16] A credible interval demonstrates that there is a 95 per cent probability that the true value is within the interval or range.[17]
- A P-value is a probability between zero and one, which attempts to show the likelihood of the data performing to the expectation or theory. The closer the P-value is to zero, the more it demonstrates that the data is not conforming to the predicted average.[18] Professor Gordon explained to the Board that there is a conventional level of statistical significance used in research, which is 0.05.[19] Accordingly, P-values that are 0.05 or lower are said to be more statistically significant and tend to show stronger statistical evidence. However, there was some agreement between Professor Gordon and Professor Armstrong that the threshold of 0.05 was not 'magic' and they did not consider it to be a critical threshold.[20]

Professor Armstrong told the Board that these tools are used in combination with other evidence that the expert considers relevant to the situation:

> [E]ssentially what we're doing through a statistical analysis like this is trying to get some of the evidence that we need to make a decision about whether this is the way the world is or this is what's happened versus something else. So we get our relative risk, if that's what we've calculated, that is one bit of information…then we've got the 95 per cent confidence interval, that is another bit of information, and then we have the P-value, that is another bit of information. That doesn't allow us to say well, yes, the P-value is very low, the [relative risk] ratio is higher, the confidence [interval] is narrow, therefore definitely this caused that. There is a number of other factors that have to be taken into consideration…in epidemiology…even if we do get a very strong association with a low P-value and so on, we still have to consider all of those things that might bias that and give us still a misleading result. So my message is that's just some of the evidence that we use ultimately to decide, in this particular situation, how strongly we believe in the proposition that the death rate in Morwell in the first part of 2014 was more than you'd expect to see under normal circumstances and therefore something must have caused it, perhaps, and then all the possibilities that we might put on the table.[21]

Dr Flander agreed with explanations about the application of statistical tools provided by other experts.[22] Dr Flander told the Board that the outcome of the analysis would depend on the quality of the data (which is crucial), the kind of analysis used and the assumptions adopted.[23]

5.3 WAS THERE AN INCREASE IN DEATHS IN THE LATROBE VALLEY DURING THE MINE FIRE?

This section discusses the analyses conducted by the experts, as well as the content of the joint expert report. This section also describes the evidence provided by the experts as a panel at the public hearings held in September 2015.

COMPARISON OF 2014 DEATH RECORDS

As discussed in Part 4 of this report, Associate Professor Barnett reached the conclusion in his second report that, after adjusting the death record data for monthly temperatures, there was an 82 per cent probability that the death rate was higher during the fire than the average number of deaths. This meant that there is an 18 per cent probability that the death rate was not higher during the mine fire than the average. The mean increase in deaths as a relative risk was calculated as 1.1 (or a 10 per cent increase from the average). Associate Professor Barnett ultimately concluded that the likely number of deaths across the six postcodes for the two-month period was an additional 9.6 deaths.

Dr Flander concluded in her third report that the statistical uncertainty in these estimates, expressed by broad confidence intervals for each of the rate ratios for the years 2009–2013, showed a lack of statistical evidence to demonstrate an overall higher rate of deaths in 2014.[24]

In his report to the Board titled *Expert assessment and advice regarding mortality information as it relates to the Hazelwood Mine Fire Inquiry Terms of Reference – Final Report*, dated August 2015, Professor Armstrong undertook a further analysis of the research published by Dr Flander and others in their third report for the Department of Health, titled *Age-standardised mortality and cause of death in the Latrobe Valley at the time of (and five years prior to) the Hazelwood coalmine fire in Morwell, Victoria*.[25]

Professor Armstrong disagreed with some of the conclusions reached by Dr Flander and others in their third report, including the conclusion that there is 'a lack of statistical evidence [to demonstrate]…an overall higher mortality in 2014 than in 2009–2013.'[26] Professor Armstrong considered that there is 'moderate evidence' to demonstrate an increase in deaths from all causes of death and from cardiovascular disease in 2014, relative to 2009–2013.[27] He further concluded that there is 'some evidence' that the increase in deaths between February and March 2014 was greater than the increase in deaths in the period February to June 2014.[28]

Table 3: Deaths in the Latrobe Valley in 2009–2013 compared to 2014, for the months February to June and February to March, produced by Professor Armstrong as Table 2 in his expert report.[29]

Years	February–June			February–March		
	Rate ratio	95% CI	P-value	Rate ratio	95% CI	P-value
Deaths from all causes						
2014	1			1		
2009–2013	0.90	0.80–1.00	0.04	0.83	0.68–1.02	0.08
Deaths from respiratory causes						
2014	1			1		
2009–2013	1.20	0.88–1.66	0.25	1.31	0.77–2.23	0.31
Deaths from cardiovascular causes						
2014	1			1		
2009–2013	0.80	0.61–1.04	0.10	0.64	0.42–0.97	0.04

Professor Armstrong explained to the Board that the analysis he undertook for the period February–March shows a 17 per cent lower rate of death in 2009–2013 compared with the rate of death in 2014, and that there is a 1 in 12 probability that this result was from chance.[30]

Professor Armstrong explained that his conclusion was based on his assessment of the P-values he calculated. He told the Board:

> I see the P-value as a useful indicator of the strength of the statistical evidence for a particular proposition and while, you know, there is this convention around 0.05 which I don't adhere to, once you start to get down with P-values below 0.05 you say well, I'm starting to believe the proposition.[31]

Professor Armstrong told the Board that his understanding is that exposure to particulate matter would lead to an increase in cardiovascular deaths, but not necessarily an increase in respiratory deaths. In his analysis, Professor Armstrong saw an increase of around 20 per cent more deaths caused by cardiovascular disease in 2014 than in 2009–2013, and around 20 per cent fewer deaths caused by respiratory causes in 2014 than in 2009–2013.[32]

Professor Gordon arrived at a similar conclusion to that reached by Professor Armstrong. At pages 3 and 4 of his report titled *Commentary on the Hazelwood mine fire and possible contribution to deaths,* Professor Gordon reviewed the analysis undertaken by Dr Flander and Professor English in their first report for the Department of Health, titled *Review of Birth Deaths & Marriages Victoria (BDMV) mortality data for the Latrobe Valley at the time of the Hazelwood coalmine fire in Morwell,*[33] and undertook some further analysis.[34] Professor Gordon stated in this report that:

> it is reasonable to believe that any effect of the fire on mortality may have continued for some time after the fire was declared safe on 25 March 2014. It is not hard to envisage scenarios for which this is a logical possibility. A frail elderly person with chronic obstructive pulmonary disease, for example, could have their respiratory system stressed by the air pollution from the fire in such a way that their death is accelerated, without it necessarily occurring during the period of the fire.[35]

Professor Gordon supplemented the analysis undertaken by Dr Flander and Professor English by setting out the observed and predicted number of deaths for individual months (February and March) and then as a range of months, and then calculating a P-value for each.[36] Professor Gordon's calculations are set out in Table 4.[37]

Table 4: Comparison of observed and predicted numbers of deaths in 2014, adapted from Table 1 in the Flander and English report, produced by Professor Gordon.[38]

Period	Predicted	Observed	Ratio	P-value
February 2014	43.38	50	1.15	0.175
March 2014	52.98	62	1.17	0.122
Feb–March 2014	96.36	112	1.16	0.064
Feb–April 2014	146.26	166	1.13	0.058
Feb–May 2014	199.24	228	1.14	0.024
Feb–June 2014	249.64	285	1.14	0.015

Professor Gordon concluded that, based on the numbers extracted from Dr Flander's report, there was 'quite strong and statistically significant evidence that the death rates from February to June 2014 were abnormally high.'[39]

During the hearing, Dr Flander disagreed with Professors Armstrong and Gordon about whether a more appropriate statistical analysis involved a comparison of the 2014 data with an average of the 2009–2013 data (the method adopted by Professors Armstrong and Gordon), or with each of the years from 2009 to 2013 (the method adopted by Dr Flander).[40] Professor Armstrong told the Board that the analysis approach should be governed by the question posed, and that:

> the question as I understood it was, was there a higher death rate in Latrobe Valley in Morwell, either or both, in 2014, than would usually be expected and that might be attributable to the mine fire? With that question I would say that what I said was the preferred approach would be what most people would do, that is to say they wouldn't say well, we will just compare with 2013 or with 2009, we'll take a number of years to try and get a reasonable estimate of what it's usually like and then make the comparison, so 2014 with 2009 to 2013. If the question is a more complex one well, how is mortality varied and how does it compare between 2014 and different years, well then surely do it year by year. You can unpack if it you want but there is a phenomenon in this that I worry about, I don't know that every analyst worries about it, and that's what we refer to as multiple testing.[41]

Professor Gordon agreed with Professor Armstrong on this point.[42]

Dr Flander explained that she stood by the approach she adopted because 'if we had treated those years as a single unit and just averaged them we would have lost information we may find out to be useful.'[43] Dr Flander accepted that the different approaches would give a different outcome: 'I think we have abundant evidence that every time we make a pass through these data and alter the, how should I put it, the architecture of it, which variables go in and how we perform the analysis, we will get slightly different results.'[44]

CONCLUSIONS REACHED BY THE EXPERTS

In his review of Associate Professor Barnett's reports, which was tendered as evidence at the Inquiry's public hearings, Professor McNeil concluded that the observed number of deaths during the months of the Hazelwood mine fire was within the range of variation seen in the same postcodes during previous years.[45]

In his report, Professor Armstrong concluded that there is 'moderate evidence' for an increase in deaths from all causes of death and from cardiovascular disease in 2014 compared with 2009–2013. He also concluded that there is 'some evidence' that the increases in deaths in February to March 2014 were greater than those in the longer period of February to June 2014.[46] Professor Armstrong described this latter conclusion as being supported by 'some' or 'weak' evidence.[47] Professor Armstrong told the Board that he considered these terms to describe the same concept.[48]

In their joint expert report dated 31 August 2015, Professor Gordon, Associate Professor Barnett and Dr Flander agreed with Professor Armstrong's conclusions, preferring to use the terminology 'some evidence' over 'weak evidence' with respect to the second conclusion.[49]

Further, assuming that the period of risk to health extended beyond the actual duration of the mine fire (for example, to May 2014), the experts agreed that the excess of deaths for that longer period is statistically significant at conventional levels (that is, a P-value of 0.05 or less).[50]

5.4 IF THERE WAS AN INCREASE IN DEATHS, DID THE MINE FIRE CONTRIBUTE TO THE INCREASE?

The second question posed to the Board was, if there was an increase in deaths, did the mine fire contribute to any increase?

Professor Armstrong explained to the Board the role of epidemiology in the assessment of data.[51] Professor Armstrong stated:

> This is where you start to move from just, you know, numbers and confidence intervals into causal thinking, what caused what to happen…it is not just description of numbers, it's about making a decision at least as I understand this Inquiry's purpose, that firstly whether or not there was a higher death rate in 2014 than would be normally expected to be, and secondly, what caused it. Once you ask the second question you then have to think what is the universe of possible causes...[52]

The joint report of the experts dated 31 August 2015 identified that there were four possible factors, exposure to which might have increased mortality in the Latrobe Valley during the mine fire.[53] These factors were:

- associated bushfires
- fine particulate matter air pollution
- carbon monoxide air pollution
- high temperatures.

Each of these factors is discussed in turn below.

ASSOCIATED BUSHFIRES

Professor Armstrong's analysis included testing whether bushfires had a contributing effect on the increase in mortality in the Latrobe Valley in 2014. He compared data from 2009 death records against data from 2014 death records, because in both these years major bushfires affected the Latrobe Valley area.[54]

In February 2009, parts of the Latrobe Valley were affected by the Black Saturday bushfires, during which 11 people in Churchill died.[55] In February 2014, the Latrobe Valley was affected by the bushfires that started in Hernes Oak and Driffield and burnt for about three weeks.[56]

Using data from the third report of Dr Flander and others, Professor Armstrong concluded that the number of deaths from all causes of death in February and March, and between February and June 2014, was closer to that in the corresponding periods of 2009 than those for the overall period 2009–2013. Professor Armstrong considered that this comparison may suggest that bushfires contributed to the probable increase in mortality from all causes of death in 2014. However, he noted that there was no evidence of a relationship between the bushfires and deaths from cardiovascular disease, suggesting that something else, not present in 2009, was responsible for the increase in deaths from cardiovascular causes in 2014.[57]

Professor Armstrong's calculations are recorded in Table 5.

Table 5: Latrobe Valley mortality in 2009–2013 compared with 2014, for the months February to June and February to March, produced by Professor Armstrong as Table 3 in his expert report.[58]

Years	February–June			February–March		
	Rate ratio	95% CI	P-value	Rate ratio	95% CI	P-value
Deaths from all causes						
2014	1			1		
2009	0.93	0.81–1.06	0.30	1.01	0.79–1.28	0.91
2009–2013	0.90	0.80–1.00	0.04	0.83	0.62–1.02	0.08
Deaths from respiratory causes						
2014	1			1		
2009	0.95	0.61–1.47	0.82	1.08	0.54–2.17	0.81
2009–2013	1.20	0.88–1.66	0.25	1.31	0.77–2.23	0.31
Deaths from cardiovascular causes						
2014	1			1		
2009	0.70	0.49–1.00	0.06	0.58	0.34–0.99	0.05
2009–2013	0.80	0.61–1.04	0.10	0.64	0.42–0.97	0.04

Professor Armstrong explained to the Board that his conclusions were based on the fact that the rate ratios from all causes of death and for respiratory causes of death in 2009 were closer to one (which is the 2014 reference value), than the rate ratios for the period 2009–2013. This suggests that deaths from all causes or from respiratory causes in 2009 may have been more similar to those in 2014 than the average from 2009–2013.[59]

The joint expert report dated 31 August 2015 recorded the agreement of Professor Armstrong, Professor Gordon and Dr Flander that:

> Mortality from all causes in February and March and February to June 2014 was closer to that in the corresponding periods of 2009 than those of 2009–2013. This observation may suggest that bushfires, which occurred in Latrobe Valley in February in both 2014 and 2009, contributed to the probable increase in mortality from all causes in 2014. This was not evident for deaths from cardiovascular disease.[60]

Professor Gordon clarified this joint conclusion for the Board, stating that the words 'may suggest' were carefully selected to convey that it was a logical possibility, but by no means a certainty, that bushfires contributed to the probable increase in mortality.[61]

Associate Professor Barnett did not agree with this conclusion. The joint report notes his reservation that in 2014 there were two sources of fire (bushfire and the mine fire) and that there is a difficulty in distinguishing between their impacts. Associate Professor Barnett was of the view that it would be desirable to compare further air quality data across the two time periods, and to get an expert opinion about what proportion of the air pollution was due to the mine fire, before reaching a conclusion.[62]

During the public hearings for this Inquiry, Professor Gordon questioned whether the 2009 death records data should be modified to exclude those deaths that were the direct consequence of bushfires (excluding from the data the death records of those who died in the Black Saturday bushfires in February 2009). He suggested that a comparison of the adjusted 2009 death records data and the 2014 death records data would demonstrate that the years were not as similar as Professor Armstrong's calculations suggested, and that the 2009 data would likely look similar to data for the years 2010–2013.[63] Assuming this analysis could be done, there was some uncertainty about what number of deaths should be deducted.[64]

After attending the public hearings on 2 September 2015, Professor Gordon undertook a further analysis of the 2014 death records data compared with the 2009 data,[65] after deducting 11 deaths from the February 2009 data.[66] The results of this additional analysis are described in Table 6 and demonstrate a lower predicted number of deaths for each of the periods (with the exception of March, which remained the same).[67]

Table 6: Comparison of observed and predicted number of deaths in 2014, based on Table 1 in the Flander and English report, but adjusted to account for deaths caused by the Black Saturday bushfires, produced by Professor Gordon.[68]

Period	Predicted	Observed	Ratio	P-value
February 2014	41.67	50	1.20	0.115
March 2014	52.98	62	1.17	0.122
Feb–March 2014	94.65[69]	112	1.18	0.044
Feb–April 2014	144.55[70]	166	1.15	0.043
Feb–May 2014	197.53[71]	228	1.15	0.018
Feb–June 2014	247.93[72]	285	1.15	0.011

Dr Flander told the Board that the analysis undertaken by Professor Gordon 'makes good sense' but that she was unable to say whether it would affect the results she obtained due to the difficulty in comparing the two results. Dr Flander had modelled her analysis on temperature and exposure to particulate matter (PM_{10}), whereas Professor Gordon had not.[73]

FINE PARTICULATE MATTER AIR POLLUTION

Professor Armstrong informed the Board that any emission from a fire is potentially inhalable and can cause illness and death. In relation to particulate matter (an emission from a fire), Professor Armstrong noted that smaller particulate matter such as $PM_{2.5}$[74] was able persist in the lungs longer than larger particulate matter, and can have effects on the functional level of the lungs and on the heart.[75] Professor Armstrong further stated that the dominant effect of air pollution on health is cardiovascular rather than respiratory.[76]

Professor Armstrong stated that one would expect to see increased deaths, caused by inhalation of particulate matter, as occurring proximate to the air pollution event. However, notwithstanding that expectation, he analysed the death records data covering a longer period of time to consider whether there was evidence of an increase in deaths in that longer period.[77]

Associate Professor Barnett referred to reports published by the American Heart Association and World Health Organization, which describe the relationship between particulate matter pollution and death and morbidity, and demonstrate that there is very strong evidence of the short and long-term effects of air pollution on stroke, increased risk of death, and increased risk of emergency hospital admissions for cardiovascular and respiratory disease.[78]

Dr Flander noted that given the evidence of a probable increase in deaths, a causal relationship between exposure to particulate matter and deaths could not be excluded.[79]

In their joint expert report dated 31 August 2015, the experts agreed that across the period 2009–2014, the number of deaths in the Latrobe Valley in both February and March and from February to June was higher on days when particulate air pollution was greater than or equal to 50 micrograms per cubic metre of PM_{10}, relative to when particulate air pollution was lower than this level.[80] Professor Gordon noted that his agreement with this conclusion was qualified, as he had not independently assessed the data.[81] Associate Professor Barnett also qualified his agreement with this conclusion, as he considered that the method adopted was not the best available way to analyse the impact of air pollution on health. He suggested that air pollution be considered as a linear variable rather than as a threshold scale.[82] He provided no explanation to the Board as to what effect this would have on the observations of death rates.

The experts further agreed that there was no evidence that deaths from all causes, or from cardiovascular causes during the duration of the Hazelwood mine fire, were more frequent on days with higher $PM_{2.5}$ levels than on days with lower $PM_{2.5}$ levels. This observation was not consistent with the work of Flander and others in their third report, where it was concluded that mortality from all causes over the whole period 2009–2014 was approximately two-fold higher for Latrobe Valley residents exposed to PM_{10} at levels of 50 micrograms per cubic metre or more on the day of death than in people not so exposed.[83] Notwithstanding those observations, the experts agreed that Dr Flander's reasoning was sound and that it was very likely that 'particulate air pollution during the mine fire caused an increase in deaths, realistically, perhaps, more in the period after the mine fire than during it.'[84]

Professor Armstrong told the Board that he and Dr Flander undertook two different analyses to consider the effect of particulate matter on death rates. Whilst Professor Armstrong indicated that the two analyses should have obtained 'roughly the same results', Dr Flander's results (showing an association between particulate exposure and an increase in deaths) had 'more statistical power.'[85] Professor Armstrong explained that there was a weakness in his analysis, which was that the estimates of exposure that he used potentially led to significant measurement error. This measurement error may have obscured associations that may otherwise be present.[86]

Professor Gordon noted that his agreement with this conclusion was qualified, as he had not independently assessed the data. Associate Professor Barnett also qualified his agreement with this conclusion, as he considered that PM_{10} should be regarded as a linear variable rather than as a threshold scale.[87] Again, Associate Professor Barnett did not indicate what effect this would have on the observations of the effect of particulate matter on the rate of deaths.

CARBON MONOXIDE AIR POLLUTION

A conclusion reached in Professor Armstrong's expert report was that 'there is good evidence that environmental exposure to increased levels of carbon monoxide is associated with an increased risk of emergency department visits and hospitalisations for cardiovascular disease.'[88] The evidence that carbon monoxide is also associated with an increased risk of death is less certain, particularly whether its effect on health is due solely to exposure or also to other air pollutants that are commonly correlated with carbon monoxide.[89] As described in the 2014 Hazelwood Mine Fire Inquiry Report, carbon monoxide is produced as a result of the incomplete combustion of coal.[90]

Given this context, Professor Armstrong investigated whether there was any evidence that carbon monoxide played a role in the probable increase in deaths in the Latrobe Valley during the mine fire. Professor Armstrong did not find any consistent evidence showing any effect of carbon monoxide on the number of deaths in Morwell and the Latrobe Valley.[91]

Dr Flander, Associate Professor Barnett and Professor Gordon did not address the effect of carbon monoxide on the number of deaths in the Latrobe Valley in their respective reports.

In their joint report dated 31 August 2015, the experts agreed with the conclusions reached by Professor Armstrong that there was no consistent evidence that deaths from all causes or from cardiovascular disease during the mine fire were more frequent on days with higher carbon monoxide levels than on days with lower carbon monoxide levels.[92]

Professor Gordon agreed with this conclusion, with the reservation that he had not independently assessed the data.[93] Associate Professor Barnett also agreed with this conclusion, with a reservation that he had concerns about the use of carbon monoxide as a threshold scale rather than as a linear measure.[94] Again, Associate Professor Barnett did not indicate what effect this might have on the observations of the effect of carbon monoxide on the rate of deaths.

HIGH TEMPERATURES

Dr Flander, Associate Professor Barnett and Professor Armstrong all conducted analyses that took into account the effect of temperature on deaths in the Latrobe Valley.

Dr Flander noted that there were more deaths occurring on days with mean temperatures at or over 30 degrees in 2009 and 2014, than in the years 2010–2013. There were 27 deaths that occurred on days with mean temperatures at or over 30 degrees in the four Latrobe Valley postcodes, with 13 of those deaths in 2009 and seven in 2014. In their third report, Dr Flander and others concluded that there was no statistical evidence of an association between higher temperatures and all causes of mortality in the February–March period in 2009–2013, compared with February–March 2014. Rather, there was 'moderate evidence' of an association of colder temperatures with mortality for the months February to June.[95]

Professor Armstrong also concluded that there was no evidence to suggest that higher temperatures in the Latrobe Valley during the mine fire were associated with a higher risk of death.[96]

In their joint expert report dated 31 August 2015, the experts agreed that across the whole period 2009–2014, the number of deaths in the Latrobe Valley in February to June was greater on days when the temperature was less than 30 degrees than on days when it was higher. This difference was not evident in February and March of those years.[97] Professor Gordon agreed with this conclusion, with the reservation that he had not independently assessed the data.[98]

The experts also agreed in their joint expert report that there is no evidence that higher temperatures in the Latrobe Valley during the period of the mine fire were associated with a higher number of deaths, whereas there is strong evidence that a higher death rate was associated with lower temperatures. Lower temperatures, however, do not appear to explain the higher death rate in February and March 2014, as compared with the same months in 2009–2013, as the mean daily temperatures in these two periods were observed to be nearly identical.[99]

DECREASED OBSERVED NUMBER OF DEATHS IN MORWELL DURING THE MINE FIRE

The death records provided by the Registry shows that the number of deaths during the Hazelwood mine fire for persons who usually resided in Morwell, was less than preceding years. This is discussed in Part 3 of this report.

Associate Professor Barnett also observed in his second report that Morwell had a decreased mean risk of death over the duration of the mine fire.[100]

Professor Armstrong told the Board that whilst the observed number of deaths in Morwell seemed inconsistent with a theory that Morwell would see the greatest increase in deaths given its proximity to air pollution from the mine fire, the statistical evidence supporting the difference in death rates between Morwell and the other locations is 'not strong.'[101] Professor Armstrong considered it possible that factors such as the small sample size of the death records data in Morwell, might have 'obscured an effect of the mine fire' on mortality rates.[102] Professor Armstrong concluded that he would 'discount that inconsistency' (the lower death rate in Morwell) in reaching a conclusion about whether there was an increase in deaths overall during the mine fire.[103]

Professor Gordon agreed with Professor Armstrong about the death rate in Morwell, and also referred to the possibility of natural variation affecting the results observed for Morwell, considering the small sample size.[104]

Professor Armstrong identified that another factor that may have played a role in reducing the deaths in Morwell was the Department of Health's relocation advice. It was possible that the advice to the community for vulnerable people to relocate during the mine fire could have 'reduced the population at risk in Morwell, that is the people who are likely to suffer death during that period, by a material number.'[105]

Professor Gordon noted that there was a level of uncertainty regarding the number of people who travelled to Morwell for work during the mine fire, but who lived in other towns, and the number of people who lived in Morwell, but who worked in other towns during the mine fire. He stated to the Board that this circumstance may have impacted Morwell residents' exposure to air pollution from the mine fire and the death rate in Morwell.[106]

Professor Armstrong told the Board that whilst he had not seen any data that indicated the actual number of people who vacated Morwell during the mine fire, it was not unreasonable to speculate that the circumstance of some people vacating the area could have had an impact on the overall death rate in Morwell in the relevant period.[107]

In their joint expert report dated 31 August 2015, Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander agreed that as Morwell was the most exposed of the Latrobe Valley towns to emissions from the mine fire, the comparative lack of greater deaths in Morwell in 2014 relative to 2009–2013 is inconsistent with the mine fire being the cause of an increase in deaths in the Latrobe Valley. However, the experts also agreed that this conclusion does not take into account the evacuation of some residents from Morwell during the period of the mine fire.[108]

Further, the experts considered that there was 'statistical uncertainty' in relation to the finding in Associate Professor Barnett's second report that there was a decrease in deaths in Morwell during the mine fire. Accordingly, the experts agreed that 'a large increase in mortality in Morwell cannot be ruled out.'[109] Professor Armstrong told the Board that, based on Barnett's analysis and the large confidence intervals, a large decrease in deaths could also not be ruled out.[110]

HOSPITAL ADMISSION RECORDS

Professor Armstrong undertook a statistical analysis of the frequency of emergency hospital admissions in 2014 relative to 2013. The purpose of this analysis was to test whether there was any association between the number of admissions to hospital and the mine fire. Professor Armstrong suggested to the Board that if there was an increase in emergency admissions in 2014 from 2013, then the mine fire may have caused an increase in adverse health effects, and therefore also an increase in deaths.[111]

Professor Armstrong's analysis indicated that:

- The rate of emergency hospital admissions for all conditions in the Latrobe Valley during the mine fire was 16 per cent greater in 2014 than it was for the same period in 2013 and that the probability that this was due to chance is 1 in 1,000 (P-value of 0.0001).
- The rate of emergency hospital admissions for cardiovascular conditions was also 16 per cent greater in 2014 than it was for the same period in 2013, and the probability that this difference was due to chance is 1 in 4 (P-value of 0.26).
- The rate of emergency hospital admissions for all other conditions was also 16 per cent greater in 2014 than it was for the same period in 2013 (P-value of 0.006).
- The rate of emergency hospital admissions for respiratory conditions was 31 per cent greater in 2014 than it was for the same period in 2013 (P-value of 0.07).
- The rate of emergency hospital admissions for cancers was 16 per cent less in 2014 than it was for the same period in 2013, albeit with greater uncertainty about the statistical significance of this difference (P-value of 0.61).
- The rate of emergency hospital admissions for the age group 0–4 years was 16 per cent greater in 2014 than it was for the same period in 2013, however statistical evidence for this finding is weak (P-value of 0.48).
- The rate of emergency hospital admissions for the age group 25–39 years was 64 per cent greater in 2014 than it was for the same period in 2013, and the probability that this was due to chance is 1 in 1,000.
- The rate of emergency hospital admissions for the age group 65–74 years was 38 per cent greater in 2014 than it was for the same period in 2013, and the probability that this was due to chance is 1 in 110.[112]

Professor Armstrong told the Board that the evidence of an increase in hospital admissions strengthens the proposition that there was an increase in deaths during the period of the mine fire.[113]

In their joint expert report dated 31 August 2015, all the experts agreed to the following conclusions (with a qualification from Professor Gordon that he had not independently assessed the data):

- Emergency hospital admissions for all conditions in the Latrobe Valley during the period of the mine fire in 2014 were more frequent than they were for the same period in 2013. Hospital admission rates for respiratory and cardiovascular diseases, considered individually, were also greater in 2014 than in 2013, although the statistical evidence for these increases is weaker.
- There is strong evidence that emergency hospital admissions were greater in 2014 than in 2009–2013 for people aged 25–39 years.
- Emergency hospital admissions were greater in infants and children (0–4 years of age), albeit with statistically weaker evidence in 2014 than in 2009–2013. This age group is recognised as vulnerable to adverse health impacts from pollution.
- Emergency hospital admissions were greater for older people (aged 65–74 years and to a lesser extent, for those aged 75 years and older). This age group is recognised as vulnerable to adverse health impacts from pollution.[114]

CONCLUSIONS REACHED BY THE EXPERTS

In answer to the question whether the mine fire contributed to any increase in deaths in the Latrobe Valley, Professor Armstrong told the Board that:

> Firstly, I think we have as described moderate evidence for an increase in deaths during that period so anything I say about the cause of it has to take into account the fact that the evidence for the increase itself is not strong…But given that evidence, I think of the various explanations that one can put forward, the most likely is that an increase, if one occurred, was due to the increase in the particulate pollution of the air during that period of time, most likely due to the mine fire but possibly added to by bushfires that occurred at the same time…[115]

Professor Armstrong told the Board that his conclusion was based on strong evidence that there is a relationship between particulate pollution and risk of death. He stated that short-term increases in particulate pollution are associated with short-term increases in deaths and that long-term exposures are associated with longer-term increases in deaths.[116] Professor Armstrong relied on the results obtained by Dr Flander, rather than his own, with respect to the effect of air pollution.[117]

Professor Gordon told the Board that he was in 'substantial agreement' with Professor Armstrong's conclusions.[118] In explaining to the Board the cautious approach that he took to this question, he indicated that:

> we are in a situation here where causation cannot be attributed on the basis of the gold standard paradigm in science of a randomised controlled—we're nowhere near that, nonetheless there are plenty of very important situations in research and in life where we have to think about this question of causation without the paradigm and epidemiologists and statisticians have thought about that issue a lot and have addressed their minds to the criteria one might apply to draw a conclusion of various strengths…I agree with Professor Armstrong, taking into totality the statistical evidence, the other factors that were looked at that might partly explain the results such as temperature, which in my view do partly explain it but not nearly enough to remove the apparent effect of the coal mine fire.[119]

Associate Professor Barnett's conclusion on this question was informed by his understanding of the health effects of air pollution and its association with increases in morbidity and mortality. Associate Professor Barnett indicated to the Board that 'it really feels from my point of view that there would have to be something very surprising going on in Morwell not to see that increase [in deaths].'[120] Associate Professor Barnett further explained that his conclusion took into account that the relative risk of an increase in deaths, being between 10 and 15 per cent, was around the size expected by him, and that the increase in emergency hospital admissions was likely associated with an increase in deaths.[121] Associate Professor Barnett also agreed with the observations made by Professors Armstrong and Gordon.[122]

Associate Professor Barnett considered that it was not merely a coincidence that there was an increase in deaths at the same time as the mine fire. He indicated the probability results he obtained were based on a regression model analysis, which worked on having a known cause and looking for an effect.[123]

Dr Flander indicated that she had 'no fundamental disagreement with information that Professor Armstrong put forward' and 'no objection to the further analyses done by Associate Professor Barnett or Professor Gordon.'[124] Dr Flander stated to the Board:

> So my answer to the first question is yes, there is moderate evidence of an increase, these data do show that. Do I have a feeling or opinion or judgment about the effect of exposure to PM_{10}? Yes, I do, I think we do show that. I think I concluded…that there is uncertainty around these estimates…as a final caveat I would just like to say that we make our best estimate and we use different methods and we have different judgments and assumptions, and in the case of small numbers we're dealing with here we all have been taught well that we do not want to conclude there is an effect if there is none, nor do we want to miss an effect if there is one.[125]

Dr Flander further stated that in this matter, she did not consider that there were enough observations to enable her to choose between alternative explanations, which means that no explanation can be ruled out.[126]

Dr Flander noted that the longitudinal health study (the Hazelwood Mine Fire Health Study, referred to in Part 3) will assist to inform the effect of the exposure to the mine fire on health. She noted that the value of the study is that it 'yields more robust information, information we could not hope to get from the kind of study we did.'[127]

Professor McNeil noted in his report that the data provided in the reports of Associate Professor Barnett and Dr Flander did not exclude an excess of deaths amongst those most exposed to the mine fire. He stated that 'any increase in a smaller number exposed may have been concealed within the much larger group with little exposure.'[128]

PART SIX
FURTHER EXPERT ANALYSIS PROVIDED TO THE INQUIRY

PART 6 FURTHER EXPERT ANALYSIS PROVIDED TO THE INQUIRY

On 15 September 2015, after scheduled public hearings for this Inquiry were completed, the Board received an additional report from Associate Professor Adrian Barnett, a statistician from the Institute of Health and Biomedical Innovation and School of Public Health, Queensland University of Technology.

That report was the subject of further analysis and comment by Professor Bruce Armstrong, a medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney; Professor Ian Gordon, Director of the Statistical Consulting Centre and Professor of Statistics in the School of Mathematics and Statistics at the University of Melbourne; and Dr Louisa Flander, Senior Research Fellow, Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health at the University of Melbourne. GDF Suez Australian Energy (GDF Suez), the owner/operator of the Hazelwood mine, engaged Dr Philip McCloud, Director and Principal Statistician, McCloud Consulting Group, to provide his opinion on reports provided by other experts.

The Board also received an opinion about the possible effect of the mine fire on mortality in the Latrobe Valley community from Dr Fay Johnston, a public health physician and environmental epidemiologist from the University of Tasmania.

6.1 EXPERT EVIDENCE RECEIVED AFTER THE SEPTEMBER HEARING

Associate Professor Barnett was provided with daily death records data immediately prior to the Inquiry's public hearings, which commenced on 1 September 2015.[1] He decided that an analysis using daily death records data would add value to his original analysis, which only considered monthly death records data.[2] Associate Professor Barnett therefore undertook a further analysis, using daily death records data, in the weeks following the hearing.[3]

On 15 September 2015, Associate Professor Barnett provided his further report, titled *Analysis of daily death data during the Morwell mine fire*, to the Inquiry. This report is an analysis of daily death records data from the Victorian Registry of Births, Deaths and Marriages, for Latrobe Valley postcodes 3840, 3842, 3825 and 3844, for the period 2009–2014.[4]

In this further report, Associate Professor Barnett reached the following conclusion:

> This latest analysis gives a 99% probability of an increase in deaths during the 45 days of the fire, with an estimate of 23 additional deaths. This is larger than the 79% to 89% probability and 10 to 14 additional deaths from my two previous analysis [sic]. This increase in probability and deaths occurred because this analysis used daily data whereas the previous analyses used monthly data. Using days instead of months reduces the measurement error between exposure and death, and an increased statistical significance and risk is entirely expected based on the theory of measurement error.[5]

On 17 September 2015, the Board provided Associate Professor Barnett's further report to Professor Armstrong for his comment.[6] Taking into account comments made by Professor Armstrong on 18 September 2015,[7] Associate Professor Barnett provided an expanded analysis to the Board on 25 September 2015.[8]

On 30 September 2015, the Board provided Associate Professor Barnett's report, dated 25 September 2015, to Professor Gordon and Dr Flander.[9]

On 6 October 2015, solicitors for GDF Suez posed questions to Associate Professor Barnett about his analysis dated 25 September 2015.[10] Associate Professor Barnett provided written responses to these questions on 7 October 2015.[11] These responses expanded on the methodology that Associate Professor Barnett employed in his further analysis, but did not alter his conclusions.

On 8 October 2015, Professor Armstrong provided further comments to the Board in relation to Associate Professor Barnett's report dated 25 September 2015.[12] In response to these comments, Associate Professor Barnett provided a further analysis to the Board on 9 October 2015.[13]

On 12 October 2015, Professor Gordon and Dr Flander were asked to independently comment on the methodology employed by Associate Professor Barnett, and his conclusions.[14]

On 13 October 2015, Dr Flander provided her opinion about the content of Associate Professor Barnett's report of 25 September 2015, in an email to the Board of Inquiry.[15] On 14 October 2015, Professor Gordon provided a report to the Board titled *Commentary of Associate Professor Barnett's recent reports, Hazelwood Mine Fire*.[16]

On 13 October 2015, Dr Johnston emailed the Board to indicate that she had reviewed the work of Associate Professor Barnett, Professor Armstrong, Professor Gordon and Dr Flander, which was published on the Inquiry's website.[17]

Dr Johnston's email stated that 'the observed higher mortality in the Latrobe Valley does not appear to be consistent with the known temporal relationships that have been characterised for airborne PM and mortality.'[18] Dr Johnston's email further stated 'I am not aware of evidence suggesting that mortality impacts might occur months after exposure to particle concentrations of the order experienced in most places in the Latrobe Valley.'[19] Dr Johnston referred in her email to a meta-analysis undertaken by Atkinson and others, which considered the health effects of exposure of $PM_{2.5}$. The Atkinson analysis was tendered as evidence to the Board.[20]

In explaining her reasons for contacting the Board on 13 October 2015, Dr Johnston said that the Environment Protection Authority (EPA) has retained her as an independent expert witness for an investigation into the Hazelwood mine fire. Dr Johnston explained that she had provided a detailed report to the EPA about the health impacts of smoke from the mine fire on the people of the Latrobe Valley, which includes an assessment of deaths.[21] Dr Johnston also told the Board that she was motivated to contact the Inquiry as she considered that the findings of the Inquiry, if it was found that emissions from the mine fire increased the number of deaths in the Latrobe Valley, may have policy implications for planned burns in Australia.[22] Dr Johnston was one of the authors of the Rapid Health Risk Assessment dated 12 March 2014,[23] which was considered by the 2014 Hazelwood Mine Fire Inquiry. She also conducted a peer review of the carbon monoxide response protocol for the EPA during the mine fire.[24]

Dr Johnston confirmed that she had not been approached by the Board, or any of the parties or experts involved in the Inquiry, to provide an opinion.[25]

On 15 October 2015, the Board received two letters from Dr McCloud critiquing Associate Professor Barnett's report dated 25 September 2015.[26] Dr McCloud concluded that the probable increase in the number of deaths during the mine fire 'does not prove that the pollution from the mine fire was the cause of the increase' and instead may result from changing demographic characteristics of the region, or random variation.[27]

On 16 October 2015, Dr Johnston's email and Dr McCloud's letters were distributed to the other experts assisting the Inquiry.[28]

On 18 October 2015, Dr Johnston provided a report to the Board.[29] On 19 October 2015, the Board forwarded this report to Dr McCloud and the other experts assisting the Board.[30] On 19 October 2015, Dr McCloud produced a table titled *Number of Deaths in the La Trobe Valley by Year with 95% confidence interval Postcodes 3825, 3840, 3842, 3844,* which he prepared to inform a further meeting of the experts organised by the Board.[31]

On 19 October 2015, Dr McCloud, Dr Johnston and the experts assisting the Board, met to discuss the additional evidence that the Board had received since 9 September 2015. At the conclusion of that meeting, they produced a joint expert report for the Board.[32]

6.2 FURTHER HEARING

On 22 October 2015, the Board held an additional hearing and heard further evidence from Professor Armstrong, Professor Gordon, Associate Professor Barnett, Dr Flander, Dr McCloud and Dr Johnston.

Associate Professor Barnett explained to the Board that he undertook further analysis after the September public hearings because he expected a more accurate result from daily death records data than from monthly data:

> [M]onthly data is quite a crude estimate of exposure and there will be some measurement error in there. When we move from monthly data to daily data we have a much clearer picture and will reduce measurement error. We know from statistical theory that whenever we reduce measurement error if we have a true association between two variables any reduction in measurement error will strengthen that association.[33]

Professor Gordon agreed that there was a general expectation that an analysis would be more refined using daily data rather than monthly data.[34]

The evidence given by experts at the additional hearing principally related to:

- Whether each of the experts agreed with the conclusions and methodology employed by Associate Professor Barnett in his further reports.
- Whether any or all of the four experts who had already given evidence had changed their opinions in light of the conclusions in the further reports of Associate Professor Barnett.
- Whether, having regard to the reports of all the experts provided since 9 September 2015, each of the experts considered that there was an increase in mortality in the Latrobe Valley during the mine fire, and if so, whether the mine fire contributed to any increase.

OPINIONS ON ASSOCIATE PROFESSOR BARNETT'S FURTHER REPORTS

In their joint report dated 19 October 2015, the experts (with the exception of Associate Professor Barnett) did not agree with Associate Professor Barnett's conclusion that his further analysis demonstrates 'a 99% probability of an increase in deaths during the 45 days of the fire, with an estimate of 23 additional deaths.'[35] The experts generally agreed that there was an increase in the number of deaths, but not of the degree ascribed by Associate Professor Barnett.[36]

The experts (again, with the exception of Associate Professor Barnett) indicated that they had difficulties understanding how Associate Professor Barnett reached his conclusions in his further analysis, due to a lack of detail in his further report.[37]

In his report dated 14 October 2015, Professor Gordon referred to multiple issues relating to the method or variables used by Associate Professor Barnett in his further analysis provided to the Board on 15 September 2015. These issues included uncertainties around the number of deaths, the population data, and the use, nature and implications of the natural splines for trend and temperature.[38] Professor Gordon also referred to uncertainties around the adoption of a single, overall relative risk for all postcodes. Having reviewed the further report provided by Associate Professor Barnett dated 9 October 2015, which was prepared in response to queries about the use of a single overall relative risk, Professor Gordon agreed with Associate Professor Barnett's conclusion that there was little evidence for a postcode-specific effect, however he was unable to reconcile the relative risk estimates.[39]

Dr McCloud told the Board that he did not agree with the model used by Associate Professor Barnett in his further analysis, because it included all days in the period 2009–2014, rather than just the days within the period of the mine fire. He stated that considering only the days within the period of the mine fire would have allowed a good control sample, whereas considering all days meant that a mathematical model was required to satisfactorily account for variations introduced by different seasons.[40] Dr McCloud further stated that a large control sample (all days) tends to dilute the particular qualities of the mine fire period.[41]

Dr McCloud was also critical of the modelling used by Associate Professor Barnett on the grounds that 'very few of the parameters in the statistical model demonstrate a significant effect with the number of daily deaths, and most could be removed from the statistical model without impacting the expected number of deaths each day.'[42]

Dr Flander told the Board that whilst she agreed that the methods used and results presented in Associate Professor Barnett's analysis appeared correct, she had concerns about the lack of specificity around explanations provided in the reports.[43] Professor Armstrong agreed.[44]

Having considered the analysis by Associate Professor Barnett, Professor Armstrong and Professor Gordon indicated that it did not change their earlier conclusions,[45] but that they were now more confident about those conclusions as a consequence of the further analysis.[46] Professor Gordon explained:

> I accept that the daily data is likely to be more refined, and therefore I'm influenced by that finding. That's one thing. The second thing, and this really arises out of the conclave [of experts], is what we heard from Dr Johnston about the specific indications of $PM_{2.5}$ and its impact on deaths.[47]

Professor Armstrong told the Inquiry that his confidence in earlier conclusions was consolidated by the further analysis for 'essentially the same reasons as Professor Gordon gave' and because the data analysed was 'precisely circumscribed to the period of the mine fire' (45 days), rather than all of February and March, which included days outside the period that the mine fire was burning.[48]

WAS THERE AN INCREASE IN DEATHS?

In the joint report dated 19 October 2015, Professor Armstrong and Dr Flander agreed that 'there was moderate evidence that the mortality was increased in the Latrobe Valley during the coal mine fire.'[49] Both Professor Gordon and Associate Professor Barnett concluded that there was an increase in mortality.[50] Dr Johnston agreed that it was likely that there was an increase in deaths, but not of the magnitude estimated by Associate Professor Barnett.[51] Dr McCloud stated that although there was an observed increase in mortality during the mine fire, the increase was within the bounds of natural random variation.[52]

Dr McCloud put the further alternative proposition that the increase in deaths may be explained by demographic changes in the region. The basis for this proposition is found in Dr McCloud's assessment of the 2015 data for deaths in the Latrobe Valley. Dr McCloud noted that the number of deaths in 2014 was 83 and in 2015, 77.[53] The similarity of these numbers and the fact that there was not a mine fire in 2015, led Dr McCloud to conclude:

> Therefore the increase in deaths in 2015 relative to the years of 2009–2013 must be the result of demographic changes in the regions such as an ageing or growing population, or natural variation. Both the demographic changes in the region, and random variation are likely explanations for the increase in deaths in 2014 relative to the previous years of 2009–2013.[54]

Further, Dr McCloud stated that his review of the death records data for 2015 adds weight to a finding that the increase in deaths seen in 2014 is within the bounds of natural variation, because the 2015 data is very similar to 2014.[55]

Professor Armstrong did not agree that the 2015 data assists a consideration of the comparative number of deaths in 2014 and in 2009–2013, and it did not change his opinion that there was a probable increase in deaths in 2014.[56] Professor Armstrong provided the Board with the following converse proposition:

> [the 2015 data] does raise a question, "Well, is it possible that there are some delayed effects of the mine fire, and we are still seeing them in 2015?" There has been some recent literature around that in a rather different context, in an air pollution context, suggesting that there can be for intense periods of exposure effects that last for a significant period of time later.[57]

Dr McCloud was invited to consider the draft Commonwealth Scientific and Industrial Research Organisation (CSIRO) air pollution model provided to Professor Abramson for the purpose of the Hazelwood Mine Fire Health Study.[58] After reviewing the draft model, Dr McCloud acknowledged that there were areas where smoke was modelled that were outside the four postcodes analysed by the experts in this Inquiry. Similarly, he noted there were areas in the four postcodes that were not affected by the mine fire smoke.[59] Dr McCloud indicated that the effect of using postcodes rather than something like the draft CSIRO model was that the results obtained would capture irrelevant information and add to 'random noise' in the analysis.[60]

Professor Armstrong told the Board that an analysis using the population identified by the draft CSIRO model was preferable 'in an ideal world' because the model allows a better representation of those exposed to the mine fire. However, Professor Armstrong noted that the draft CSIRO model also has its own uncertainties and he queried whether it was feasible to approach the data in the way it had been approached in the model.[61]

Professor Gordon stated that the use of postcodes for the analysis rather than a model such as the draft CSIRO model did not concern him as he considered that the greatest concentration of residents in those postcodes were likely to live in a town that was shown to be affected by smoke. He concluded that the inclusion of a small population in the postcode who were unaffected by smoke from the mine fire, was unlikely to affect the results. He also indicated to the Board that using a model like the draft CSIRO model in the statistical analysis could in fact improve the results obtained for the relative risk of an increase in deaths.[62]

Dr Johnston agreed with the proposition that one of the issues in interpreting a small sample size of data is that even quite significant changes may just be the result of natural random variation.[63]

DID THE MINE FIRE CONTRIBUTE TO AN INCREASE IN DEATHS?

In the joint report dated 19 October 2015, Professor Armstrong stated that it is 'likely that the coal mine fire contributed to the increase in mortality but it [the mine fire] does not explain the apparent magnitude of the increase.'[64] Professor Gordon and Dr Johnston also concluded that it is likely that the coal mine fire contributed to the increase in deaths.[65] Associate Professor Barnett provided an unqualified opinion that the mine fire did contribute to the increase in deaths.[66]

Dr Flander stated that she was 'not prepared' to say what the causes of the increase in deaths during the mine fire were 'as the numbers observed are so small.'[67] Dr Flander told the Board:

> At the risk of repeating myself, may I say that all along I have been loath to ascribe or, more accurately, attribute different causes of death to the mortality observed because the number of observed cases is so small. I think that it's very likely that there is some background variation in the mortality observed. I think it's also likely, although hard to say how likely, that there were other causes of mortality.[68]

Dr McCloud did not consider that the question of the mine fire's contribution to deaths could be answered affirmatively based on statistical analysis because of 'inherent random variation.'[69] It was Dr McCloud's view that only a detailed examination of death certificates could ascertain the number of deaths caused by air pollution from the mine fire.[70]

In his letter to the Board dated 13 October 2015, Dr McCloud stated that the absence of direct evidence, such as death certificates that record that death was caused by smoke, carbon monoxide or other pollutants from the mine fire, 'weakens any claim that the mine fire caused an increase in deaths.'[71] Dr McCloud stated:

> In my opinion the numbers alone are not adequate to justify a conclusion that the pollution from the mine fire caused the increase in deaths compared to previous years. A necessary additional step should be a medical assessment that attributes specific deaths to have been caused by the pollution of the mine fire.[72]

Dr Flander indicated to the Board that she had access to cause of death information when completing her analysis and that it was not 'overwhelmingly informative' and that 'it didn't point us in any significant direction.'[73]

Consistent with the evidence of Dr Flander, Professor Armstrong disagreed that medical records would assist to answer the questions posed to the Board of Inquiry:

> In this situation what we have is an exposure which affects a range of conditions, mainly respiratory and cardiac, which are very common in the absence of that exposure. So they are occurring all the time. It would be extremely hard to draw any sensible conclusions from an examination of the causes of death other than those that have already been drawn and are covered in my report…Going down and looking at individual death certificates will not be the slightest bit informative.[74]

In his letter dated 13 October 2015, Dr McCloud stated that the decrease in the rate of deaths in Morwell during the mine fire was contrary to the expected dose-response relationship—that is, the greatest increase in mortality rates should be seen in areas with the greatest proximity (dose) to the event. Accordingly, the failure to demonstrate that dose-response relationship showed a weakness in the claim that there was an increase in deaths caused by the mine fire.[75]

Dr McCloud referred to the Rapid Health Risk Assessment[76] written by Professor Abramson and others, to support his conclusion that the expected number of deaths that would arise from six weeks or three months of exposure to smoke from the mine fire would be between zero and 1.1 additional deaths (well below the figure of 23 deaths estimated by Associate Professor Barnett). Whilst accepting that the Assessment was predictive, Dr McCloud stated that it was still relevant, as the conclusions set out in the Assessment were not confounded by random variation.[77] Dr McCloud told the Board that the Rapid Health Risk Assessment assists in giving a 'ballpark' figure of the likely deaths associated with exposure to air pollution caused by the mine fire.[78] Dr Johnston agreed.[79]

Dr McCloud stated that, based on the work of Dr Johnston and Professor Abramson, the more likely number of deaths during the mine fire would be between zero and two. He stated that his conclusion was supported by the meta-analysis published by Atkinson and others.[80]

In her report dated 18 October 2015, Dr Johnston expressed an opinion, based on her assessment of the population exposure to $PM_{2.5}$, that it is plausible that there would be a mortality increase of 3.6 per cent (being the upper bound of that percentage increase), but that an increase as large as 30 per cent was not likely to be explained as an effect of exposure to smoke.[81] Dr Johnston told the Board that other explanations should be considered for results that exhibit a higher magnitude than expected.[82]

When asked by Counsel Assisting what those other explanations might be, Dr Johnston referred to the small community in the Latrobe Valley, which makes it more difficult to interpret observed results, particularly in circumstances where a different result is expected.[83] Dr Johnston qualified this reference on the basis that some of the characteristics of populations in the Latrobe Valley are known:

> But, having said that, when you take known dose-response concentrations and then apply them to a very small community or an individual, you need to do that with caution as well because the impact on the community comes down to underlying vulnerability, the people who were there, what their risks were. We know, for example, that in the Latrobe Valley many health indicators are poorer compared with the wider Australian population. You would expect this community to be more vulnerable than an average population. So it might be higher than what we expect from the literature, but I wouldn't expect it to be an order of magnitude higher.[84]

Dr Johnston also noted that when looking at a small population, anomalous results can occur. She explained that 'just one death can have a huge change in the proportion of people who have died when deaths are not a frequent event.'[85] Equally, as stated by Dr Johnston, '[y]ou can fail to see a result that's there' when the data size is small.[86]

Dr Johnston told the Board that some deaths in the Latrobe Valley during the mine fire could have been caused by stress. She explained that there are studies that show increased numbers of deaths from cardiovascular disease following a natural disaster and events such as the World Trade Center disaster. Dr Johnston acknowledged that this was not an area of her expertise, but that all factors should be considered.[87]

Dr Johnston's email to Professor Catford, dated 13 October 2015, identified two graphs that indicate that particulate matter levels in Traralgon during the mine fire were similar to levels in 2013 arising from planned burns. One of the graphs shows a spike in January 2013 (representing the effect of a bushfire) and a spike in May 2013 (representing planned burns).[88] When asked to compare the graphs with the graphs published in the 2014 Hazelwood Mine Fire Inquiry Report, Dr Johnston conceded that there were notable differences between the 2013 and 2014 particulate matter levels, most significantly that the $PM_{2.5}$ levels in 2014 peaked well above the 25 micrograms per cubic metre threshold on five occasions and remained around the threshold level of 25 micrograms per cubic metre for a sustained period.[89] Dr Johnston made similar concessions in relation to the difference in observed levels of PM_{10} in 2014 compared with 2013.[90]

Whilst Dr McCloud told the Board that the increase in deaths may be explained by natural variation, he could not rule out that the mine fire could have been 'a cause' of the increase in deaths, stating 'so when we look at the increase from 70 to 83 [deaths] in 2014, there may be a portion of that which is associated with the mine fire but a good portion of that may well be explained by just the natural random variation within this process.'[91]

PART SEVEN
DISCUSSIONS AND CONCLUSIONS ABOUT DEATHS IN THE LATROBE VALLEY

PART 7 DID THE HAZELWOOD MINE FIRE CONTRIBUTE TO AN INCREASE IN DEATHS IN THE LATROBE VALLEY?

In this part of the report, the Board of Inquiry articulates its findings about whether the Hazelwood mine fire contributed to an increase in deaths in the Latrobe Valley, and explains the reasons for those findings.

7.1 DISCUSSION OF RELEVANT LEGAL CONCEPTS

There are a number of inter-related legal issues that are relevant to the Board's consideration of whether the Hazelwood mine fire contributed to an increase in deaths.

The first of these legal issues concerns the meaning of the phrase 'contributed to' for the purposes of this Inquiry.

THE MEANING OF 'CONTRIBUTED TO'

Counsel Assisting the Inquiry and several of the parties who were granted leave to appear at the public hearings, made submissions to the Board about the correct meaning of the phrase 'contributed to' in Term of Reference 6.

Counsel Assisting submitted that 'contributed to' is an ordinary English expression meaning 'to play a part in the achievement of a result.'[1] They submitted that 'to contribute' is not the same as 'to cause' and that 'an event can contribute to an outcome without necessarily causing the outcome.'[2]

Senior Counsel for GDF Suez Australian Energy, the owner and operator of the Hazelwood mine, submitted that 'the word "contribute" clearly has a causal connotation'[3] and that 'it has been plain through the course of the Inquiry that the word "contribute" has been understood to mean "cause" and that the very lengthy examination of expert witnesses in this case has in part included the premise of a causal correlation.'[4]

Counsel for the former Chief Health Officer, Dr Rosemary Lester, adopted the submission of GDF Suez.[5] Voices of the Valley, a local Latrobe Valley advocacy group, made no specific submission on this question, but generally approached the issue as one of causation.[6]

As noted in Part 1 of this report, this Board of Inquiry is not a court. The Board is constituted under Part 3 of the *Inquiries Act 2014* (Vic). The Board is not bound by the rules of evidence in conducting this Inquiry and may inform itself as it sees fit.[7]

Despite the differences between this Board of Inquiry and a court, it is appropriate to be guided by relevant legal principles that have been authoritatively stated by the courts, when construing the meaning of the Inquiry's Terms of Reference.

In *Maxwell v GTI International Pty Ltd,*[8] the Victorian Court of Appeal was required to determine if the deliberate removal of a brake on the front axle of a trailer attached to a prime mover had 'contributed to' the inability of the vehicle to avoid a collision, in circumstances where the vehicle had collided with other vehicles. There were 11 other brakes on the vehicle at the time, which were in poor repair. The Court (Ashley, Mandie and Hansen JJA) unanimously held that the missing brake did contribute to the collision.

Ashley JA, referring to *March v E & MH Stramare Pty Ltd*—the leading High Court case on causation—found that in cases of 'multiple conjunctive causal factors the concept of material contribution to an event is important in the analysis of cause and effect'.[9] Mandie JA approved the trial judge's view, also referring to *March v E & MH Stramare,* that 'the relevant question is whether the [appellant] has shown that the disconnection of the brake was so connected with the accident that, as a matter of ordinary common sense, it should be regarded as contributing to it.'[10]

In *March v E & MH Stramare*, the High Court was concerned with the application of the rules of causation to a civil negligence case where there were two or more acts or events, each of which would have been sufficient to bring about the plaintiff's injury.[11] Mason CJ, who delivered the leading judgment, held that the traditional 'but for' test of causation gives rise to difficulties when applied to such cases. His Honour favoured a test involving the application of common sense to the facts of each case.[12]

In *Bennett v Minister of Community Welfare,*[13] Mason CJ, Deane and Dawson JJ stated that 'in the realm of negligence, causation is essentially a question of fact, to be resolved as a matter of common sense.'[14]

An event or an act can be found to have 'contributed to' an outcome even if it is not the only contributing factor. For example, in *Keown v Khan*,[15] the Court of Appeal was concerned with the meaning of the phrase 'contributed to the cause of death' in s.19(1)(e) of the *Coroners Act 1985* (Vic). In the leading judgment, Callaway JA held that 'the test of contribution is solely whether a person's conduct caused the death. It may have been the only cause or one of several causes.'[16]

On the basis of the above, and having regard to the submissions it received, the Board concludes that, if there was an increase in deaths, the question of whether the mine fire 'contributed to' an increase in deaths means 'does the evidence establish, to the requisite standard of proof, that at least one cause of the increase in deaths was the mine fire, even if there may be other causes?' In other words, 'to contribute' means something less than 'to cause', in the sense that what has contributed to an outcome does not have to be the sole or main cause of that outcome.

EPIDEMIOLOGICAL EVIDENCE

The Board's findings in relation to the expert evidence provided to this Inquiry will be discussed in detail below. At this point it is only necessary to note that much of this evidence consists of epidemiological and biostatistical analysis of the mortality data provided to the Board by the Victorian Registry of Births, Deaths and Marriages. Such evidence is occasionally led by parties involved in civil negligence litigation to prove or disprove that a given disease has been caused by the plaintiff's exposure to a particular substance, such as asbestos.

In *Sienkiewicz v Grief (UK) Ltd,*[17] Lord Phillips described the role of the discipline of epidemiology in answering questions of causation in litigation in the following terms:

> Epidemiology is the study of the occurrence and distribution of events (such as disease) over human populations. It seeks to determine whether statistical associations between these events and supposed determinants can be demonstrated. Whether those associations if proved demonstrate an underlying biological causal relationship is a further and different question from the question of statistical association on which the epidemiology is initially engaged.[18]

This passage was cited with approval by the plurality in the High Court decision of *Amaca Pty Ltd v Booth*.[19] This case was concerned with the question of whether a motor mechanic could prove that his exposure to asbestos had caused his mesothelioma. The mechanic's employer relied on epidemiological studies to cast doubt on any association between the work performed by motor mechanics and the onset of the disease.

In the same case (as pointed out by Voices of the Valley in its submissions to this Inquiry),[20] French CJ observed that:

> The existence of an association or a positive statistical correlation between the occurrence of one event and the subsequent occurrence of another may be expressed as a possibility, which may be no greater than a 'real chance' that, if the first event occurs, the second event will also occur. The mere existence of such an association or correlation does not justify a statement, relevant to factual causation in law, that the first event 'creates' or 'gives rise to' or 'increases' the probability that the second event will occur. Such a statement contains an assumption that if the second event occurs it will have some causal connection to the first. However, if the association between two events is shown to have a causal explanation, then the conclusion may be open, if the second event should occur, that the first event has been at least a contributing cause of that occurrence. An after-the-event inference of causal connection may be reached on the civil standard of proof, namely, balance of probabilities, notwithstanding that the statistical correlation between the first event and the second event indicated prospectively, no more than a 'mere possibility' or 'real chance' that the second event would occur given the first event. There may of course be cases in which the strength of the association, as measured by relative risk ratios, itself supports an inference of a causal connection.[21]

French CJ noted that 'the distinction between a statistical correlation and factual causation precedes any consideration of the distinction between factual causation and legal causation which was discussed in *March v E & H Stramare Pty Ltd*.'[22] His Honour then summarised the correct approach to the use of epidemiology in relation to questions of legal causation:

> In summary, a finding that a defendant's conduct has increased the risk of injury to the plaintiff must rest upon more than mere statistical correlation between that kind of conduct and that kind of injury. It requires the existence of a causal connection between the conduct and the injury, albeit other causative factors may come into play. As demonstrated by medical evidence in this case...a causal connection may be inferred by somebody expert in the relevant field considering the nature and incidents of the correlation.[23]

In *Seltsam Pty Ltd v McGuiness,*[24] Spigelman CJ, discussing the difference between statistical association and legal causation, observed that '...the proposition that the stronger the association the lower the probability that it would occur without a causal relationship, is a common sense proposition which a court will readily accept.'[25] The Board agrees that this is a 'common sense' proposition.

STANDARD OF PROOF

As noted earlier, the rules of evidence have no application in this Inquiry. Practices or procedures applicable to a court of record also do not apply to this Inquiry.[26] It is a common feature of statutes establishing Royal Commissions and Boards of Inquiry that the rules and processes of a court are not applicable. However, there is surprisingly little authority concerning the standard of proof that does apply to the fact-finding process of Boards of Inquiry.

Counsel Assisting the Board submitted that a finding of fact in this Inquiry must be based on 'some material that tends to show the existence of facts consistent with the finding' and further, the reasoning supporting the finding must not be 'logically self-contradictory'.[27] Counsel Assisting referred to the decision of the Privy Council in *Mahon v Air New Zealand*[28] in support of this proposition.[29]

In *Mahon v Air New Zealand*, the Privy Council held that the need for a sound factual basis for a finding was one of the requirements of procedural fairness in an administrative inquiry. Applying this test, the Privy Council overturned a finding by the Inquiry that officers of Air New Zealand had engaged in a 'pre-determined plan of deception' in their approach to a public inquiry.[30]

The approach of the Privy Council in *Mahon v Air New Zealand* has not found favour with the High Court of Australia. In *Australian Broadcasting Tribunal v Bond,*[31] Mason CJ stated that it 'had not so far been accepted by this Court.'[32] The learned author of *Royal Commissions and Permanent Board of Inquiry* notes that 'procedural fairness in Australia does not require findings to be based on logically probative material', at least in the context of judicial review processes.[33]

As Counsel Assisting submitted,[34] the learned author of *Justice in Tribunals* states that the *Mahon v Air New Zealand* test may be less demanding than the 'balance of probabilities' standard applicable to civil litigation.[35] Counsel for GDF Suez argued that this submission 'involves a misreading of what the author is saying', and that 'what in fact is being said by the author is [that] in circumstances where the *Briginshaw* test does not apply, it may be that some lesser standard than probability could be applicable.'[36] The Board does not consider that Counsel Assisting has misread the relevant part of the text.

In courts where the rules of evidence do apply, the standard of proof in a civil case is on 'the balance of probabilities.'[37] Although not strictly applicable to this Inquiry, it is useful to consider the civil standard of proof, as like other rules of evidence, it represents 'the attempt made, through many generations, to evolve a method of inquiry best calculated to prevent error and elicit truth.'[38] A consideration of what the standard of proof on the balance of probabilities entails, assists the Board in its fact-finding role.[39]

In *Tabet v Gett*, Kiefel J held:

> The common law requires proof, by the person seeking compensation, that the negligent act or omission caused the loss or injury constituting the damage. All that is necessary is that, according to the course of common experience, the more probable inference appearing from the evidence is that a defendant's negligence caused the injury or harm. "More probable" means no more than that, upon a balance of probabilities, such an inference might reasonably be considered to have some greater degree of likelihood; it does not require certainty.
>
> ....
>
> The general standard of proof required by the common law and applied to causation is relatively low. It does not require certainty or precision. It requires that a judge be persuaded that something was probably a cause of the harm the plaintiff suffered. Historically the standard may have been chosen in order to minimise errors in civil jury trials, but it nevertheless serves also to accommodate a level of uncertainty in proof.[40]

THE BRIGINSHAW PRINCIPLE

The principle in the case of *Briginshaw v Briginshaw*[41] is often referred to by courts that are required, in civil proceedings, to determine whether a person has engaged in criminal conduct, or to make findings which will have serious adverse impacts on a person's reputation. In *Briginshaw*, Dixon J held that such a finding ought not be made unless the evidence as a whole leads the finder of fact to a 'reasonable satisfaction' having regard to the consequences for any affected parties.[42]

In *Neat Holdings Pty Ltd v Karajan Holdings Pty Ltd & Ors*, the High Court explained the application of the principle in the following terms:

> The ordinary standard of proof required of a party who bears the onus in civil litigation in this country is proof on the balance of probabilities. That remains so even where the matter to be proved involves criminal conduct or fraud. On the other hand, the strength of the evidence necessary to establish a fact or facts on the balance of probabilities may vary according to the nature of what it is sought to prove. Thus, authoritative statements have often been made to the effect that clear or cogent or strict proof is necessary "where so serious a matter as fraud is to be found". Statements to that effect should not, however, be understood as directed to the standard of proof. Rather, they should be understood as merely reflecting a conventional perception that members of our society do not ordinarily engage in fraudulent or criminal conduct and a judicial approach that a court should not lightly make a finding that, on the balance of probabilities, a party to civil litigation has been guilty of such conduct.[43]

Counsel Assisting made the following submissions on the application of *Briginshaw*:

> We submit that, in carrying out its fact-finding role in relation to this term of reference, the Board should follow the *Briginshaw* formula. A finding that the Hazelwood mine fire contributed to an increase in deaths could have significant adverse consequences for a range of parties and should therefore not be made unless the evidence before the Board leads to a "reasonable satisfaction" having regard to the consequences for any affected parties.[44]

Senior Counsel for GDF Suez submitted, after referring to the *Briginshaw* principle, that the present Inquiry:

> most clearly deals with matters of gravity, it concerns the question of death, and in those circumstances, the relevant test must be well beyond, we would say, a simple more likely than not scenario and something that corresponds to but perhaps does not go so high as the criminal standard.[45]

Senior Counsel for Dr Lester agreed with the submissions of Senior Counsel for GDF Suez.[46]

The Board considers that the passage from *Neat Holdings* quoted above makes clear that submission is misconceived. The nature of the finding to be made has no effect on the standard of proof. There is no shifting standard. In a civil case, that standard remains the balance of probabilities. The Board is not prepared to apply an indeterminate standard of proof that 'corresponds to' the criminal standard.

Counsel for Voices of the Valley questioned whether the *Briginshaw* principle is relevant to the current Inquiry as no 'questions of fraud or intentional or malicious or deceitful conduct' are involved.[47] While this is the case, the *Briginshaw* principle equally applies where the 'consequences flowing from a particular finding' to a person are of great significance.[48]

For these reasons, the Board is satisfied that the present Inquiry calls for the application of the *Briginshaw* principle. The Board is cognisant of the need for any finding to be made on a proper factual basis.

7.2 WAS THERE AN INCREASE IN DEATHS DURING AND FOLLOWING THE HAZELWOOD MINE FIRE?

Based on the legal principles discussed in Part 7.1, the Board now considers the evidence that was adduced at the hearings.

EXPERT EVIDENCE

In the hearings held under Term of Reference 6, the Board received evidence from seven experts in the fields of biostatistics and epidemiology, each of whom undertook either analysis of the data relevant to deaths in the Latrobe Valley during the mine fire, or critiques of those analyses, or both. Those experts were:

- Professor Bruce Armstrong, a medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney
- Professor Ian Gordon, Director of Statistical Consulting Centre and Professor of Statistics in the School of Mathematics and Statistics at the University of Melbourne
- Professor John McNeil, Professor and Head of the Department of Epidemiology and Preventive Medicine at Monash University
- Associate Professor Adrian Barnett, statistician from the Institute of Health and Biomedical Innovation and School of Public Health, Queensland University of Technology
- Dr Louisa Flander, Senior Research Fellow, Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health at the University of Melbourne
- Dr Fay Johnston, public health physician and environmental epidemiologist from the University of Tasmania
- Dr Philip McCloud, Director and Principal Statistician, McCloud Consulting Group.

The Board also received two joint expert reports. The first joint report recorded the conclusions reached by Professor Armstrong, Dr Flander, Associate Professor Barnett and Professor Gordon at the first expert meeting on 31 August 2015. The second joint report recorded the conclusions reached by Professor Armstrong, Dr Flander, Associate Professor Barnett, Dr Johnston, Dr McCloud and Professor Gordon at the second expert meeting on 19 October 2015.

The evidence of Professor Armstrong, Dr Flander, Associate Professor Barnett, Dr Johnston, Dr McCloud and Professor Gordon, was tested at the Inquiry's public hearings by Counsel Assisting and counsel for the parties with leave to appear, namely the State of Victoria, GDF Suez, Dr Rosemary Lester, and Voices of the Valley.

On 28 August 2015, solicitors for Dr Lester provided a report from Professor McNeil to the Board. Professor McNeil's report comments on the reports of Associate Professor Barnett and Dr Flander (both of which were produced before the Inquiry was re-opened).[49] Dr Lester's solicitors did not request that Professor McNeil appear at the public hearings.[50] As his report did not provide any independent statistical or epidemiological analysis of the death records data, the Board did not invite Professor McNeil to participate in the expert meeting on 31 August 2015 nor to give evidence in the September public hearings. Professor McNeil's report was tendered as evidence. Professor McNeil was invited to participate in the second expert meeting on 19 October 2015 and to give evidence at the October public hearing, however he was not available to do so.

The Board also heard from Professor Michael Abramson, Professor of Clinical Epidemiology and Deputy Head of the Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine at Monash University. Professor Abramson gave evidence relevant to the Rapid Health Risk Assessment, which predicted the health effects of exposure to the Hazelwood mine fire.[51] Professor Abramson co-authored this Assessment and he has since updated it by conducting a further literature review.[52] Professor Abramson also gave evidence about his role in the Hazelwood Mine Fire Health Study, which has been commissioned by the Department of Health. The Health Study will monitor and record the effects of the mine fire on various cohorts of residents in the Latrobe Valley.[53] The Board heard that Professor Abramson has not conducted any analysis of the death records for the Latrobe Valley nor reviewed any of the analyses undertaken by other experts. He therefore did not provide any statistical evidence in relation to the questions posed to the Board of Inquiry in Term of Reference 6.[54]

Senior Counsel for GDF Suez submitted that the Hazelwood Mine Fire Health Study would better assist in a determination of whether the mine fire contributed to any additional deaths.[55] Senior Counsel for Dr Lester agreed with that submission.[56] The Board heard evidence from Professor Abramson that the study may not be able to investigate whether there were any additional deaths attributable to the mine fire for a number of reasons including that there may not be sufficient data about the deceased (such as the information that will be collated for persons in the Adult Survey) to exclude other confounding factors that may have caused their death.[57] Accordingly, the Board does not consider that it can rely on any potential outcomes of the study to answer the question posed to the Board in this Inquiry.

The Board has considered the conclusions reached by the experts, and the limitations and assumptions that each has articulated in their reports and evidence. The Board is conscious that each expert has undertaken thorough investigations to test the questions posed to this Inquiry.

Senior Counsel for GDF Suez put to Associate Professor Barnett that he was not independent of Voices of the Valley and that he was in fact campaigning on the group's behalf. Associate Professor Barnett responded that his reputation as a bioscientist was paramount and stated that: 'I've always felt very down the line with the science, I have never changed any scientific decision that I have felt was important; I never changed any of my analysis in reaction to anybody else.'[58]

Based on the evidence of other experts, who endorsed Associate Professor Barnett's statistical analyses, and the Board's observations of Associate Professor Barnett, the Board does not consider that Associate Professor Barnett has aligned his work to meet any particular point of view.

Dr Flander was questioned in relation to the substantial changes she made to her reports after receiving comments from the Department of Health on drafts of these reports.[59] Dr Flander agreed that the Department of Health had on more than one occasion communicated its view to her about how the death records data should be interpreted.[60] However, she rejected the suggestion that she had adopted the Department's propositions without sufficient reflection.[61] Dr Flander maintained that her work was independent of the Department and was not a collaborative piece of work.[62]

The Board notes that the other experts who gave evidence at the public hearings accepted much of Dr Flander's analyses. The Board accepts the evidence of Dr Flander that she adopted the comments provided by the Department only after consideration.

Dr Johnston told the Board that she was motivated to contact the Inquiry for a number of reasons. These reasons included that she had concerns that findings of the Inquiry may have policy implications for planned burns in Australia, especially if the Board finds that emissions from the mine fire contributed to an increase in deaths in the Latrobe Valley.[63] The Board is satisfied that Dr Johnston did not contact the Board to campaign for a particular position. On this basis, and on the basis of her expertise in the health effects of smoke, the Board accepted her input.

The Board notes the significant assistance provided by all experts, their high level of professionalism, their collaborative approach, their willingness to acknowledge the limits of their expertise and their diligence in expressing conclusions, both in reports and before the Board at public hearings. The Board considers that each of the experts who provided evidence was candid in their views.

CONCLUSIONS REACHED BY THE EXPERTS

The experts who contributed to this Inquiry reached the following conclusions in relation to whether there was an increase in the number of deaths in the Latrobe Valley during the Hazelwood mine fire:

- Professor Armstrong concluded that there was moderate evidence of an increase in deaths in the Latrobe Valley during the mine fire. Professor Armstrong told the Board that his confidence in this position was strengthened by the analyses and conclusions of Associate Professor Barnett and Dr Johnston.[64]
- Professor Gordon agreed with the conclusions reached by Professor Armstrong and noted that his confidence was similarly reinforced.[65]
- Associate Professor Barnett concluded that there was a 99 per cent probability that there was an increase in deaths in the Latrobe Valley during the mine fire.[66]
- Dr Flander concluded that there was moderate evidence of an increase in deaths during the mine fire.[67]
- Dr Johnston agreed that it was likely that there was an increase in deaths, but did not consider that this increase was as high as that posited by Associate Professor Barnett.[68]
- Dr McCloud stated that although there was an observed increase in deaths during the mine fire, the increase was within the bounds of natural random variation.[69]

LIMITATIONS OF THE ANALYSES

Senior Counsel for GDF Suez raised concerns about the potential for inaccuracy in the data recorded by the Registry regarding 'usual place of residence' and 'postcode of place of death'.[70] The Inquiry heard that the Registry's data fields on 'usual residential address' and 'postcode of place of death' are populated from information provided by the family of the deceased, the funeral director, or the medical practitioner who completes the death certificate. There were concerns that as the Registry did not take steps to verify this data, there was a possibility that some of this information was inaccurate. Accordingly, the data may not accurately capture all those who were resident in the Latrobe Valley during the mine fire, either by including deaths that are not relevant to the Inquiry, or excluding relevant deaths.[71]

The Board acknowledges that there is the potential for inaccuracies in all data that is collected. The Board nonetheless is prepared to accept the Registry's data as being the appropriate source of data for the analyses conducted by the experts in this Inquiry.

Further, GDF Suez raised concerns that the analysis of the death records used populations defined by postcodes, rather than considering populations actually exposed to smoke from the mine fire. Senior Counsel for GDF Suez suggested that the analysis should have been based on a model like the draft CSIRO air pollution model, which was provided to Professor Abramson as a preliminary model of the trajectory of smoke from the mine fire across the Latrobe Valley.[72] The modelling of smoke in the draft CSIRO model was not the subject of any investigation by the Board. The draft CSIRO model seeks to demonstrate that there were areas in the four postcodes selected for analysis that were not affected by smoke from the mine fire. It also suggests that there were areas or postcodes affected by smoke that were not included in the analysis.[73] Dr McCloud indicated that the effect of using postcodes rather than the draft CSIRO model is that there would be 'random noise' in the analysis and the results obtained.[74]

Professor Armstrong told the Board that the population identified by the draft CSIRO model was preferable because it better represents those exposed to the mine fire.[75] Dr Flander agreed.[76] Professor Armstrong also noted that the draft CSIRO model has its own uncertainties and queried the feasibility of conducting an analysis using the model.[77]

Professor Gordon initially agreed in principle that the draft CSIRO model may have improved the analysis, but noted the practical difficulty in identifying people affected by smoke from the mine fire on the draft CSIRO model.[78] He stated:

> It would be desirable to do it in terms of the actual exposure experienced. I doubt very much whether that's feasible, for reasons of practically geo-coding residents and where people live in relation to the [CSIRO] map shown in those levels of exposure. That's a common situation in epidemiology. We resort to proxies for what would be the ideal.[79]

Professor Gordon stated that he was not concerned about the use of postcodes in the analysis, rather than populations identified by the draft CSIRO model. With respect to postcode 3285, he noted that the greatest concentration of residents in that postcode were likely to live in Moe and that the inclusion of a small number of unaffected others in the postcode was unlikely to significantly impact the results.[80] He further indicated that using a model like the draft CSIRO model may increase the statistical estimate for the relative risk of an increase in deaths.[81]

The Board notes the evidence of Professor Abramson that the CSIRO model was a draft and was to be further refined.[82] The Board accepts that it seems probable that a model similar to the draft CSIRO model would be more accurate in identifying the most appropriate death records data. However, the Board accepts the opinion of Professor Gordon that refining the data selection in this way would not alter the results significantly, nor would it increase the probability of an increase in deaths. On that basis, and for the purposes of this Inquiry, the Board is comfortable relying on the data used in the analyses.

Each of the experts acknowledged that the sample size used in the analyses was small. Dr Johnston's evidence was that a small sample size could affect the results by either obscuring a finding or producing an anomalous result.[83] However, Professor Armstrong, Professor Gordon and Associate Professor Barnett were satisfied that the evidence at hand enabled them to reach their conclusions.[84] Dr Flander concluded that the analyses showed an increase in the number of deaths during the mine fire, however she was not prepared to ascribe a cause to that result based on the sample size.[85] Dr Johnston concluded that there was an increased probability of an increase in deaths during the mine fire.[86]

The Board accepts that there are some limitations in the analyses undertaken by the experts, including the small sample size and whether the most appropriate population of death records data was available. The Board is persuaded that notwithstanding the limitations in the modelling and statistical analyses, each of the experts was able to come to a considered and cautious view that there was an increase in deaths.

The Board is comfortable adopting the observations and findings of the experts.

The Board finds that it is likely that there was an increase in deaths in the Latrobe Valley from February to June 2014 when compared with the same period during 2009–2013.

7.3 DID THE MINE FIRE CONTRIBUTE TO THE INCREASE IN DEATHS?

Having determined that there was an increase in the number of deaths in the Latrobe Valley during the mine fire, the experts then considered whether the mine fire contributed to that increase. As part of those considerations, the experts took into account whether there were other factors that might be solely or partially responsible for the increase in deaths.

In their joint expert report dated 19 October 2015:

- Professor Armstrong stated that it 'is likely that the coal mine fire contributed to the increase in mortality but it does not explain the apparent magnitude of the increase.'[87]
- Professor Gordon and Dr Johnston concluded that it is likely that the mine fire contributed to the increase in deaths.[88]
- Associate Professor Barnett provided an unqualified conclusion that the mine fire contributed to the increase in deaths.[89]
- Dr Flander stated that she was not prepared to say what the causes of the increase in deaths during the mine fire were 'as the numbers observed are so small'.[90]
- Dr McCloud did not consider that the question could be answered affirmatively based on statistical analysis because of the 'inherent random variation'.[91]

In considering possible factors that may have contributed to the increase in deaths, the experts took into account air pollution (particulate matter and carbon monoxide) from the mine fire or bushfires, temperature, and random variation.

Dr Johnston noted that stress arising from the mine fire could have contributed to the increase in deaths, although she acknowledged that this was not an area of her expertise.[92] Stress was not a factor discussed by any of the other experts. The Board did not hear any evidence of any other factors that may have contributed to an increase in the number of deaths during the mine fire, for example there was no evidence of a demographic change in the area or another incident leading to a large number of deaths.

The experts tested their conclusions about the contribution of the above factors against other matters, including whether there was:

- Evidence consistent with the known dose-response theory relating to air pollution, namely, that the population closest to the dose (air pollution) should see the greatest response (increase in deaths).
- Evidence of an increase in hospital admissions during the mine fire, where an increase in deaths associated with the mine fire is only likely if there was a corresponding increase in illness (recorded through hospital admissions).

EFFECT OF AIR POLLUTION DURING THE MINE FIRE AND BUSHFIRES

Professor Armstrong, Professor Gordon, Associate Professor Barnett, Dr Flander and Dr Johnston all agreed that there was a likely association between the air pollution from the mine fire and an increase in deaths in the Latrobe Valley.[93]

Professor Armstrong also concluded that it was possible that some of the increase in the deaths during the mine fire was associated with emissions from the bushfires that burned around Morwell during the period of the mine fire. However, Professor Armstrong's analysis noted that there was no evidence of a relationship between the bushfires and deaths from cardiovascular disease, which suggested that something else was responsible for the increase in deaths from cardiovascular causes in 2014.[94]

Dr McCloud told the Board that without a detailed examination of death certificates, it was not possible to determine whether the emissions from the mine fire contributed to an increase in deaths in the Latrobe Valley.[95] Dr Flander told the Board that this type of investigation would not assist, as exposure to emissions from the mine fire could cause a range of conditions that are common without such exposure.[96] Professor Armstrong strongly asserted that a detailed examination of death certificates 'would not be the slightest bit informative.'[97]

Both Dr Flander and Professor Armstrong are epidemiologists. Professor Armstrong is also a medical practitioner and a public health practitioner. The Board is persuaded by Dr Flander's and Professor Armstrong's evidence on this point.

An alternative position put by Dr McCloud, based on the work of Dr Johnston and Professor Abramson, was that the more likely number of deaths during the mine fire would be between zero and two. His conclusion was supported by the meta-analysis published by Atkinson and others[98] and the Rapid Health Risk Assessment, which he suggested assists in estimating a 'ballpark' figure of likely deaths associated with exposure to air pollution caused by the mine fire.[99] Dr Johnston agreed.[100]

Dr Johnston's report dated 18 October 2015 expressed a conclusion, based on an assessment of the population exposure to $PM_{2.5}$, that it was plausible that there would be a mortality increase of up to 3.6 per cent, but that an increase as large as 30 per cent was not likely to be explained as an effect of exposure to smoke.[101] Dr Johnston told the Board that other explanations should be considered when the result of an analysis is a higher increase in mortality than expected.[102]

In her report, Dr Johnston referred to the meta-analysis undertaken by Atkinson and others, which discusses whether short-term exposure to particulate matter is associated with an increased risk of death.[103] The Board has read and considered the meta-analysis undertaken by Atkinson and others, which provides:

> There are a number of plausible biomedical explanations for association between short-term exposure to fine particles and adverse health outcomes. It is hypothesised that small effects cause clinical events when experienced by individuals who are already vulnerable due to existing chronic or acute disease. Our review indicates that such effects are observed even at the relatively low levels of fine particles found in developed countries. Our results reinforce the public health importance of fine particles on health. While the estimates are small, the impact is substantial because the entire population is exposed.[104]

In answer to a question about what conclusions can be drawn where there are disparate findings in different studies about the effect of particulate matter on health and the analysis, Dr Johnston stated:

> It means we have to look very hard before we attribute—there was certainly a statistical increase in deaths. I don't dispute that. I think it's likely particles contributed. But I'm very cautious about attributing the increase in deaths to particles alone, given there may be other causes. We know it's small numbers. We know there is background variation. I would want to look a bit harder and do more studies before I became more confident of the conclusion.[105]

The Board has considered the evidence of Dr Johnston in relation to the observations of the levels of air pollution in the Latrobe Valley in 2013 and in 2014 during the Hazelwood mine fire. The evidence recorded in Dr Johnston's email, dated 13 October 2015, to Board Member Professor Catford, suggests that the two periods were similar in terms of air pollution and hence there should not be a different outcome observed in 2014 when compared with 2013.[106] The Board notes that in answering questions from Counsel for Voices of the Valley, Dr Johnston was directed to consider the EPA air pollution graphs in the 2014 Hazelwood Mine Fire Inquiry Report. Dr Johnston conceded that there was a difference between the air pollution experienced during the mine fire compared with the air pollution recorded in 2013. Dr Johnston agreed that the air pollution during the mine fire had more spikes of high levels of particulate matter and that there was a greater sustained period of particulate matter measured above the threshold level in 2014 compared with the air pollution recorded in 2013.[107]

The Board accepts the evidence of the experts that particulate matter in smoke from the Hazelwood mine fire is likely to have contributed to an increase in deaths in the Latrobe Valley.

EFFECT OF TEMPERATURE

The experts agreed that high temperature did not appear to have contributed to a higher rate of death in the Latrobe Valley during the mine fire.[108]

The Board accepts this conclusion.

RANDOM VARIATION

The majority of the experts agreed that it was likely that random variation or chance may be responsible for at least some of the increase in deaths observed during the mine fire.[109]

Dr McCloud stated that it was possible that the entire increase in deaths could be accounted for by random variation. However, Dr McCloud also stated to the Board that he could not rule out that the mine fire could have been 'a cause' of the increase in deaths.[110]

To support his conclusion on random variation, Dr McCloud cited that the number of deaths in the Latrobe Valley in 2015 was not dissimilar to the number of deaths in 2014.[111] Dr McCloud had calculated the confidence interval for the 2015 number of deaths and prepared a diagram comparing the data for the years 2009 to 2015.[112]

Professor Gordon disagreed that the 2015 data demonstrated that the increase in 2014 was accounted for by random variation. He calculated the relative risk and the P-values for the 2015 data based on the work done by Dr McCloud. He concluded that the 2015 data 'is essentially consistent with the results we were discussing [in the September public hearings] and my own findings in my first report.'[113]

Professor Armstrong disagreed that using 2015 death records was useful in conducting an analysis that compares 2014 death records with the period 2009–2013.[114] The Board accepts the evidence of Professor Armstrong that the 2015 data analysis does not assist the Board in determining whether the observed deaths in 2014 are greater than the deaths in years 2009–2014 (the period prescribed in Term of Reference 6).

Professor Armstrong also stated that, despite the generally held view that the greater impact on the health of Latrobe Valley residents would be incurred proximate to the event (during or within days of the mine fire), it is possible that the impact on the health of the Latrobe Valley population from exposure to the mine fire will be seen in the longer-term.[115]

The Board heard evidence from various experts about the short and long-term health effects of exposure to particulate matter:

- In his report to the 2014 Hazelwood Mine Fire Inquiry, Professor Donald Campbell, Professor of Medicine, Southern Clinical School, Monash University and Program Director, General Medicine Program, Monash Health, identified the potential medium to long-term effects of air pollution from the mine fire, which include death.[116]
- Dr Torre, Science Officer, Environment Protection Authority, told the 2014 Hazelwood Mine Fire Inquiry that there are significant gaps in the scientific understanding of the effects of exposure to fine particles, such as $PM_{2.5}$, at the levels recorded in and around Morwell during the mine fire.[117] Dr Johnston agreed that this knowledge gap exists because of very limited available evidence in this area.[118]
- Dr Burdon, a consultant respiratory physician, provided a report to the Board that states that prolonged exposure to smoke inhalation from combusted coal may lead to an increased mortality rate, particularly among those with underlying disease.[119]
- Associate Professor Barnett referred to reports published by the American Heart Association and World Health Organization, which describe the relationship between particulate matter pollution, and death and morbidity.[120] Associate Professor Barnett told the Board that these reports contain strong evidence of the short and long-term effects of air pollution on health, including increased risk of stroke, increased risk of death, and increased risk of emergency hospital admissions for cardiovascular and respiratory disease.[121]

- Professor Abramson told the Board that there has not been a previous comparable fire in a brown coal mine for which a health effects study has been conducted and published in peer-reviewed literature. Given these circumstances, the Rapid Health Risk Assessment was the best assessment possible at the time.[122]
- Dr Johnston told the Board that she was not aware of any evidence that smoke emissions for a period of two to six weeks would contribute to deaths several months or a year later.[123]

The Board notes that uncertainty about the long-term health effects of air pollution has led to the commissioning of the Hazelwood Mine Fire Health Study.[124] The Board accepts the possibility that exposure to the mine fire could have a long-term effect on the health and mortality of those exposed and hence the 2015 data may be confounded by the effect of the mine fire.

The Board notes the submissions of Counsel Assisting that Term of Reference 6 specifically directs the Board to have regard to 'any relevant evidence for the period 2009 to 2014' when conducting this Inquiry. The Board assumes that the language of this Term of Reference does not just describe what the Board can inquire into, but also denotes what is outside the scope of its inquiry. Whilst the Board has been directed under the Terms of Reference to inquire into 'any other matter that is reasonably incidental to' the questions posed by the Terms of Reference, the Board does not consider that this entitles it to inquire beyond the period stipulated in Term of Reference 6.

In response to the submission made by Counsel Assisting on this point, it was put by Senior Counsel for GDF Suez that the Board has had regard to evidence outside the period 2009 to 2014, by virtue ofthe fact that Associate Professor Barnett considered data from 2004–2008 in his second report.[125] The Board distinguishes the use of earlier data in Associate Professor Barnett's report on the basis that:

- Associate Professor Barnett's report was considered as an historical analysis and was not produced for the purpose of this Inquiry.
- The analysis and discussion that was undertaken by the experts for the purpose of the Inquiry, excluding the analysis by Dr McCloud, was limited to the years 2009 to 2014.

The Board's view is that the 2015 data should not be considered in answering the question posed to this Inquiry. Further, the 2015 data has not been sufficiently analysed for the Board to be properly informed about its relevance and effect.

EXPECTED DOSE-RESPONSE RELATIONSHIP

The experts disagreed about what conclusions should be drawn in light of the observed decrease in the number of deaths in Morwell during the mine fire, compared to the number of deaths in earlier years.

Dr McCloud concluded that the decrease in the rate of deaths in Morwell during the mine fire was contrary to the expected dose-response relationship and therefore weakened an argument that the mine fire contributed to an overall increase in deaths.[126]

Professor Armstrong and Professor Gordon agreed that the decrease in the number of deaths in Morwell was not consistent with the dose-response expected, however there were other plausible reasons for the decrease, including that some Morwell residents vacated the town during the mine fire.[127]

Dr Flander and Associate Professor Barnett agreed with the observations and conclusions of Professor Armstrong and Professor Gordon.[128]

Whilst Associate Professor Barnett's further analysis dated 25 September 2015 changes his observations about a decrease in the deaths in Morwell during the mine fire,[129] the Board notes the uncertainty expressed by the other experts about this analysis, as discussed in Part 6. Consequently, the Board defers to the evidence provided at the September public hearings.

USE OF HOSPITAL ADMISSION DATA

Professor Armstrong considered evidence about the health of the Latrobe Valley population during the mine fire to test his conclusions. His analysis of hospital admissions data found that there was an increase in admissions for all causes of illness and for cardiovascular conditions during the mine fire, compared with admissions in 2013. Professor Armstrong indicated that he would expect to see an increase in cardiovascular conditions from exposure to particulate matter, a product of both the mine fire and bushfire, and that the hospital admission records demonstrated that this in fact occurred. His analysis also showed that there was an increase in hospital admissions during the mine fire for the more vulnerable age groups, which he also expected.[130]

The Board accepts the analysis undertaken by Professor Armstrong and notes that Professor Gordon, Dr Flander and Associate Professor Barnett agreed with the conclusions reached by him.[131]

CONCLUSIONS REACHED BY THE BOARD

The Board is required to make findings about whether the mine fire contributed to an increase in deaths in the Latrobe Valley. The Board notes that the experts involved in this Inquiry provided considered and cautious approaches to their analyses.

The Board accepts the conclusions reached by Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Johnston that the most likely explanation for some of the increase in deaths in the Latrobe Valley in 2014 is air pollution arising from the Hazelwood mine fire, and possibly also the bushfires that occurred at that same time.

The Board further accepts the conclusions of Professor Armstrong, Professor Gordon and Dr Johnston that it is unlikely that air pollution from the mine fire was solely responsible for the increase in deaths observed.

The Board finds that it is likely that the Hazelwood mine fire contributed to some of the increase in deaths in the Latrobe Valley in 2014.

The Board's Terms of Reference do not require it to make any findings about whether the mine fire contributed to a precise number of deaths and it does not make any such findings.

PART EIGHT
OTHER RELEVANT MATTERS

PART 8 OTHER RELEVANT MATTERS

Pursuant to Term of Reference 12, the Board is required to inquire into and report on any other matter that is reasonably incidental to its Terms of Reference. A number of incidental matters that warrant discussion have arisen from the evidence before the Board.

Dr Rosemary Lester, the former Chief Health Officer, submitted to the Board that the matters raised in this Part of the report do not fall within the scope of Term of Reference 12 because they are not reasonably incidental.[1] The Board notes that the meaning of the word 'incidental' is dependent on the context in which the word is used. In the present Inquiry, this context includes the findings of the 2014 Hazelwood Mine Fire Inquiry (see paragraphs 3 and 13(c) of the Terms of Reference). The Board is satisfied that the following matters fall clearly within Term of Reference 12.

8.1 COMMUNICATION AND ENGAGEMENT BY THE DEPARTMENT OF HEALTH

In the 2014 Hazelwood Mine Fire Inquiry, the Board was required to inquire into, amongst other matters, the adequacy and effectiveness of the response to the Hazelwood mine fire by relevant government agencies, including environmental and public health officials.[2] The Board found that:

- While electronic communication has the benefit of speed and access, the best form of communication remains face-to-face.
- Much of the frustration the community was experiencing during the mine fire was a result of one-way communication, with government authorities and agencies doing much of the telling and talking and not enough listening and local engagement.
- Some agencies did not adequately express empathy, concern, care and assurance to the Latrobe Valley community during the mine fire.[3]

In her evidence to the 2014 Hazelwood Mine Fire Inquiry, Dr Lester acknowledged shortcomings in the Department of Health's communication strategy during the mine fire. Dr Lester stated that 'the community has fed back to us that some people did not hear the message, some people did not understand the messages, so we need to go back and do a thorough review of our communication strategy…'[4] In the 2014 Hazelwood Mine Fire Inquiry Report, the Board commended this review as 'appropriate in the circumstances.'[5]

During and following the 2014 Hazelwood Mine Fire Inquiry, the State committed to more openly and effectively communicating with the Latrobe Valley community. This commitment was made in a number of ways, including:

- written submissions to the Board detailing the State's commitments
- assertions by Counsel for the State outlining the State's commitments during the Inquiry's public hearings in June 2014
- the State's acceptance of the Board's recommendations in the 2014 Hazelwood Mine Fire Inquiry Report
- the State's appointment of a monitor to report on progress in implementing the State's commitments and the Board's recommendations.[6]

The *Public Health and Wellbeing Act 2008* (Vic) (Public Health Act) confers various responsibilities on the Secretary to the Department of Health,[7] including to:

- support, equip and empower communities to address local public health issues and needs[8]
- appoint a Chief Health Officer who remains subject to the direction and control of the Secretary and whose functions include developing strategies to promote and protect public health and wellbeing, and providing advice to the Minister or Secretary on matters relating to public health and wellbeing.[9]

The Public Health Act sets out a number of principles that guide the manner in which the Secretary and Chief Health Officer should administer their responsibilities under the Act.[10] These principles include:

- collaboration, including with communities and individuals[11]
- evidence based decision-making—decisions should be based on relevant and reliable evidence[12]
- accountability—'persons who are engaged in the administration of this Act should as far as is practicable ensure that decisions are transparent, systematic and appropriate' and 'members of the public should therefore be given access to reliable information in appropriate forms to facilitate a good understanding of health issues.'[13]

These statutory responsibilities mean that the Department of Health was in 2014, and remains, the appropriate government agency to respond to community concerns about whether the Hazelwood mine fire contributed to an increase in deaths in the Latrobe Valley.

The Board heard from Mr Ron Ipsen, member of Voices of the Valley and a local Latrobe Valley resident, that the Department of Health did not respond to a letter sent by Voices of the Valley outlining concerns about an increase in deaths.[14] Mr Ipsen explained that Voices of the Valley sent its analysis of the death notices published in local papers to the Board of Inquiry on 14 August 2014, because there was 'nobody else we trusted.'[15]

During the Inquiry's public hearings on 1 September 2015, Senior Counsel for the State, in response to questions posed to Ms Linda Cristine, Director, Inquiry Response Team, Department of Health and Human Services, indicated that evidence of the government's engagement with Voices of the Valley would be tendered to the Inquiry.

At the public hearings on 2 September 2015, Senior Counsel for the State tendered documents as evidence of interaction between the State and Voices of the Valley. These documents included five letters, one of which was sent by the Department of Health and two of which were sent by the Minister for Health, to Voices of the Valley. The letter from the Department dated 28 November 2014 simply refers Voices of the Valley to the Department's website and the Hazelwood Mine Fire Health Study.[16]

The Board notes that the Health Study is not likely to consider whether the mine fire contributed to an increase in deaths in the Latrobe Valley in 2014.[17] Having designed the study, the Department of Health was aware that reference to it may not answer all of the concerns raised by Voices of the Valley, in particular concerns about a possible increase in deaths in the Latrobe Valley during the mine fire.

The Board heard from Ms Cristine that one of the strategies put in place by the Department of Health to improve community engagement was to recruit a community engagement officer specifically for Morwell. The Board is concerned that, as at the time of the public hearings in September 2015 (some 12 months after the 2014 Hazelwood Mine Fire Inquiry Report was published), this community engagement role had not been filled.[18]

In her evidence to the Board, Ms Cristine stated that there is 'always room for us to do better and learn from that and we're open to that.'[19] Senior Counsel for the State also acknowledged that 'community consultation and engagement can be improved and should be improved'[20] and conceded that the government has not adequately communicated and engaged with Voices of the Valley with respect to its concerns.[21]

In her further supplementary witness statement, Dr Lester stated that she did not agree with the proposition that she had failed to communicate and engage with the Latrobe Valley community.[22] Dr Lester also disagreed with the proposition that the Department of Health had failed to discharge its responsibilities under the Public Health Act.[23] Dr Lester further disagreed that the Department of Health's engagement with the Latrobe Valley community, in relation to concerns raised about the possible increase in deaths, exacerbated the mistrust of the community towards the Department.[24]

The Board considers that the Department of Health has not adequately communicated nor meaningfully engaged with Voices of the Valley and the community generally, regarding its concerns about the vital issue of whether the mine fire contributed to an increase in deaths in the Latrobe Valley. The Board notes the correspondence produced in evidence during the September public hearings and considers that it does not demonstrate appropriate consultation or engagement by the Department with Voices of the Valley.

The Board also considers that since the publication of the 2014 Hazelwood Mine Fire Inquiry Report the Department of Health does not appear to have met its responsibilities under the Public Health Act as they relate to community collaboration and engagement about the issue of whether there has been an increase in deaths in the Latrobe Valley.

8.2 INVESTIGATIONS UNDERTAKEN BY AND ON BEHALF OF DR LESTER

From September 2014, Dr Lester responded in various ways to concerns raised by Voices of the Valley about a possible increase in deaths in the Latrobe Valley during and following the Hazelwood mine fire. These included:

- reviewing the death records provided by the Victorian Registry of Births, Deaths and Marriages to the Department of Health on 3 September 2014[25]
- likely reviewing the brief for a media release statement from the Department of Health sent to the Australian Broadcasting Corporation (ABC) 7.30 Report program on 11 September 2014[26]
- personally sourcing and briefing a consultant to undertake an independent analysis of the death records produced by the Victorian Registry of Births, Deaths and Marriages on 3 September 2014
- approving several factsheets that were published on the Department of Health's website in September and October 2014[27]
- reviewing and providing comments on draft reports produced by the consultant engaged by the Department of Health[28]
- briefing the Minister for Health.[29]

A number of these actions are discussed in more detail below.

ENGAGEMENT WITH VOICES OF THE VALLEY

The Board heard from Mr Ipsen that requests made by Voices of the Valley to the Victorian Registry of Births, Deaths and Marriages, on 27 May 2014 and 12 June 2014, went unanswered. Voices of the Valley made a further request to the Registry on 4 August 2014 and received a response on 14 August 2014 that the request was being considered.[30]

The Board also heard evidence that the Victorian Registry of Births, Death and Marriages contacted the Department of Health in relation to data requested by Dr Michael Gunter, a Latrobe Valley resident associated with Voices of Valley. The Registry suggested to the Department that it address the questions and concerns raised by Voices of the Valley.[31] In response, Dr Lester advised the Registry that

> [y]our decision on his request is obviously yours; if you refer him to us my response will be that there has been an independent inquiry into the fire, and we have nothing further to add. Obviously his "research" is up to him.[32]

On 4 September 2014, the Registry determined to provide the data requested by Voices of the Valley in the form of monthly death records without information on cause of death.

Mr Ipsen explained to the Board that Voices of the Valley was able to pay the Registry's invoice for production of the data because 'we had a little bucket there and had people put a dollar or two in and we had our membership fees, you know, a dollar, and we collected $600 and spent $550 of that buying these statistics.'[33] The Board notes that the Registry's invoice was in fact $485.[34]

The Board heard that the Registry also forwarded the data requested by Voices of the Valley to the Department of Health, and subsequently forwarded further updated death records to the Department, which contained more detailed information than that provided to Voices of the Valley. This second set of data consisted of daily death records rather than monthly records and contained information on cause of death.[35] The Department of Health was not required to pay for the data.[36]

Counsel for the State informed the Board that the State intends to reimburse Voices of the Valley the amount it paid to the Registry to obtain the data. The Board affirms this decision.[37]

ENGAGEMENT OF AN EXPERT TO ANALYSE DEATH RECORDS

As discussed in Part 3 of this report, the Board heard that Dr Lester directly contacted Professor Terry Nolan at the Melbourne School of Population and Global Health, University of Melbourne, to request that the School undertake an analysis of the death records supplied by the Registry, and to provide an opinion about whether there was an increase in deaths in the Latrobe Valley during the mine fire. Dr Lester's contact with Professor Nolan was made by telephone and then by email dated 16 September 2014. In this initial contact, Dr Lester requested a 'quick' review of the death records data.[38]

The Board received evidence that on 16 September 2014, the Department of Health entered into a contract with the Melbourne School of Population and Global Health, University of Melbourne, to undertake the analysis.[39]

The Board considers that, in the circumstances and because of the importance of the issue, the Department should have engaged in a competitive quote process that included consideration of other relevant experts to undertake this analysis.

Dr Lester confirmed that the Department's initial engagement with the Melbourne School of Population and Global Health was a contract of just over $3,000. In answer to a question from Counsel Assisting about whether it was normal for the Chief Health Officer to be in charge of a contract of that size, Dr Lester told the Board that these were quite unusual circumstances and that as it was such an important issue, she felt that she needed to take personal carriage of it.[40]

Dr Lester told the Board that she accepted Professor Nolan's delegation of the data analysis to Dr Flander and did not inquire into Dr Flander's background or expertise other than being aware that Dr Flander was a longstanding employee of the School.[41] The Melbourne School of Population and Global Health was engaged to provide two further reports, one of which was the critique of Associate Professor Barnett's analysis. On both occasions, the work was delegated to Dr Flander.

Dr Lester was asked by Board Member Professor Catford if it was 'helpful' to have Dr Flander peer review the work of Associate Professor Barnett in these circumstances. Dr Lester's reply was that she didn't see it as inappropriate and that it was an extension of the original request to Dr Flander.[42]

The Board considers that Dr Flander was an inappropriate choice of expert to review Associate Professor Barnett's work, because she had already undertaken her own analysis of the data and provided an opinion on it in September 2014. The Board considers that a review of both Associate Professor Barnett's analysis and Dr Flander's analysis should have been commissioned to a third party who had not already formed an opinion about what the data showed.

In her evidence to the Board, Dr Lester accepted that it was important that the University of Melbourne be engaged in such a way that maintained its complete independence from the Department.[43] The Board considers that the approach taken by Dr Lester and those who took over management of the consultancy after Dr Lester's retirement in February 2015, did not serve to maintain this independence.

Counsel Assisting the Board asked Dr Lester whether, having regard to criticisms made in the 2014 Hazelwood Mine Fire Inquiry Report about some of the Department's responses in relation to the mine fire under her authority, it might have been appropriate for someone else to manage an investigation into possible deaths caused by the mine fire. Counsel Assisting reiterated this question in terms of whether Dr Lester considered that she might have had a conflict of interest in personally engaging the Melbourne School of Population and Global Health to undertake an analysis of the death records.[44] Dr Lester did not agree she should have remained at arm's length in relation to the process.[45] She stated:

> No, I don't believe that I had a conflict of interest. I went to the University of Melbourne as a very reputable internationally recognised unit of epidemiology and biostatistics that were quite independent from anything that had been to do with the fire and I thought they would bring a very expert independent set of eyes to the data.[46]

The Board is of the view that the Department's overall process in seeking an analysis from the Melbourne School of Population and Global Health lacked rigour.[47]

APPROVAL OF THE DEPARTMENT OF HEALTH'S FACTSHEETS

The Department of Health published three factsheets in September and October 2014 about whether there was an increase in deaths during the Hazelwood mine fire. The content of these factsheets is discussed in Part 3 of this report.

The Board has reviewed the factsheet dated 17 September 2014 and the later-published factsheet dated September 2014, and has noted the following:

- The factsheets only reference comparative number of deaths for years where these numbers were similar. For example, the number of deaths in Morwell in January–June 2014 is only compared with the same period in 2009, 2010 and 2012. Years where the difference between the number of deaths in that year and in 2014 is greater (for example 2011 and 2013), are not referenced. The same is noted in relation to the reporting for the February–March and January–June periods for Traralgon.
- There was no reference in the factsheets to the 11 per cent increase in deaths between January–June 2009–2013 and the same period in 2014 in Morwell; whilst the 19 per cent decrease in deaths between the period February–March 2009–2013 and the same period in 2014 are referenced.
- There was no reference in the factsheets to the 40 per cent increase in deaths between February–March 2009–2013 and the same period in 2014 in Traralgon.[48]

The Board notes that the two September factsheets, which indicate that the mine fire has not contributed to an increase in deaths in the Latrobe Valley, were published before the Department of Health had received any advice from the Melbourne School of Population and Global Health about whether the data supported this account.[49]

Dr Lester acknowledged that whilst the number of deaths (88) in Morwell for the period January to June 2014 was recorded in the factsheets, the factsheets did not state that this number was higher than the number of deaths for the same period in 2011 (67 deaths) and 2013 (64 deaths).[50] In answer to a question from Counsel Assisting about why the numbers of deaths in 2011 and 2013 were not referenced, Dr Lester said 'well, is it not self-evident that if someone is suggesting it's a higher figure you look back and say well, it's actually similar to some previous years. I don't quite understand why you think we should then make reference to every other figure.'[51]

Dr Lester agreed that the increase in deaths in Traralgon in 2014, compared with the average for the previous five years, was 40 per cent. Dr Lester agreed that this increase was considerably more than the 19 per cent decrease that was referred to (in bold type face) in the factsheet in relation to Morwell.[52] In answer to a question from Counsel Assisting about why the factsheet did not give a complete picture to the reader by referring to the percentage change in number of deaths in all towns, rather than just Morwell, Dr Lester answered:

> Morwell is obviously the key town of question because Morwell was very much more exposed to the smoke than the other towns. So if we were to see an effect of the fire we should see it in Morwell. Therefore it makes logical sense to treat Morwell differently to the other towns and in any case, as I said, the data we presented in the table so that the community could see what the actual figures were.[53]

Dr Lester agreed that the table referred to was not published in the 17 September 2014 factsheet. She stated that the complete number of deaths was published in the later factsheet, dated September 2014, so that the reader could draw their own conclusions on the data.[54]

Dr Lester agreed that the provision of accurate and complete information was of the utmost importance, especially in the context of the concerns raised by the Latrobe Valley community about the Department of Health's response to the mine fire and its health impacts.[55]

When asked by Counsel Assisting whether she was satisfied that the Department of Health's factsheet dated 17 September 2014 provided accurate and complete information to the community, Dr Lester responded that she was satisfied.[56]

Counsel Assisting suggested to Dr Lester that there was a degree of selectivity about the presentation of the information in the Department of Health's factsheet dated 17 September 2014 in an attempt to support an argument that there was no relationship between the mine fire and any increase in deaths. Dr Lester told the Board that the 17 September 2014 factsheet accurately described the data seen at the time and that it indicated that further expert opinion on the data was being sought.[57] In her further supplementary statement, Dr Lester:

- stated that the information in the factsheets was accurate and clear[58]
- disputed that the factsheets breached the requirements of the Public Health Act[59]
- disputed that she had misled the public.[60]

It is the view of the Board that it was of the utmost importance that the Department of Health communicated openly and accurately about all the information it had on any link between an apparent increase in deaths in the Latrobe Valley and the mine fire. This was especially important in light of criticism of the Department in the 2014 Hazelwood Mine Fire Inquiry Report.

The Board has carefully reviewed the Department of Health's factsheets and has considered the opinions of Dr Lester about their contents. The Board is not satisfied that the factsheets presented an accurate and adequately complete picture about the mortality rate in the Latrobe Valley in 2014 relative to the earlier five years.

The Board considers that the factsheets published by the Department of Health and approved by Dr Lester were, in material respects, incomplete, misleading and unbalanced, and failed to acknowledge uncertainties concerning the number of deaths in the Latrobe Valley during the mine fire.

REVIEWING AND COMMENTING ON DRAFT REPORTS OF THE CONSULTANT

Dr Flander provided three reports to the Department of Health. Each of these reports went through several drafts—the first report, dated 26 September 2014,[61] went through at least three drafts;[62] the second report, dated 28 April 2015,[63] went through at least two drafts;[64] and the third report, dated 4 June 2015,[65] went through at least three drafts.[66]

The Board received evidence that demonstrates that both Dr Lester (before she retired in February 2015) and departmental officers (thereafter) provided extensive commentary to Dr Flander on drafts of these reports prior to them being finalised.[67] This commentary related to substantial content in the reports and led to substantial changes to content before the reports were finalised. In particular, the Department of Health communicated to Dr Flander, at various stages during her engagement, the proposition that the data did not show an increase in deaths in the Latrobe Valley. This was communicated in the Project Brief[68] and in emails to Dr Flander about report content before the reports were finalised.[69]

For example, after Dr Lester had received what was described by Dr Flander as a 'final report' under cover of an email dated 23 September 2014,[70] she responded shortly after with an email seeking further changes to the report. Dr Lester's email included the following: 'One of the things that gives us comfort that this is nothing more than random variation is the increase [in deaths] was greatest in Moe postcode which is 13 km away from the fire.'[71]

When asked by Counsel Assisting what comfort the Chief Health Officer could draw from an increase of ten in the number of deaths in Moe in 2014 compared to the previous five years, Dr Lester said: 'All I can go back to is saying what we're looking at here is, are these increased deaths caused by fire, and the information that we have suggests that that is not the likely explanation.'[72]

The following exchange then occurred between Counsel Assisting and Dr Lester:

> Counsel Assisting: What you meant by the phrase 'gives you comfort' is that it fitted with your position, your theory about there being no connection between the fire and the deaths?
>
> Dr Lester: Well, it fits with basic principles of causation, cause and effect.
>
> Counsel Assisting: Did it occur to you that by so clearly stating your position, that you were compromising Dr Flander's independence in her analysis?

> Dr Lester: I think, as I said, that Professor Nolan's unit is extremely highly regarded and I don't think that any of his staff would compromise themselves because of a public servant.
>
> Counsel Assisting: Why was it necessary to state your position at all in correspondence with Dr Flander if what you wanted her to do was an objective analysis of the data?
>
> Dr Lester: Yes, I don't know why I included that there.[73]

A further example is provided by an email sent by the Department after Dr Lester retired. On 27 March 2015, after Dr Flander had submitted a draft report (dated 13 March 2015) to the Department of Health, which assessed Associate Professor Barnett's analysis of the death records, she received two pages of comments by email from a Senior Medical Advisor from the Department of Health.[74] Comments numbered '2' and '6' suggested that substantive changes be made to the draft.

Comment 2 included the following text: 'Alternatively, is it possible that the conclusion could be drawn instead that the data presented do not suggest strong evidence for the author's hypothesis that the fire had an effect on mortality.'[75] Comment 6 made reference to 'our interpretation' of the data and suggested that Associate Professor Barnett's conclusion about the fire having caused an increase in deaths 'needs to be challenged more directly.'[76]

Asked by Counsel Assisting if such comments to an independent consultant were acceptable practice within the Department of Health, Ms Cristine told the Board that 'there is no rule book for us as public servants in providing feedback to consultants.'[77] Ms Cristine accepted that a comment asking for a conclusion to be altered would be inconsistent with 'engaging people independently to come up with an independent conclusion.'[78]

The next draft of this report was dated 8 April 2015.[79] As foreshadowed in her email to the Department of Health dated 27 March 2015,[80] Dr Flander incorporated all of the comments that had been sent to her into the report. For example, the suggestion that the phrase 'plausible hypothesis…"really means"…supposition worthy of investigation' was re-worded by Dr Flander in her report in precisely the suggested manner.[81]

Dr Flander agreed that the Department of Health had on more than one occasion communicated its view to her about how the mortality data should be interpreted.[82] However, she denied that she had adopted the Department's suggestions without sufficient reflection. Dr Flander told the Inquiry that what she meant in her email of 27 March 2015 was that she would consider all of the suggestions.[83] Dr Flander maintained that her work was independent of the Department and was not a collaborative piece of work.[84]

The Board considers it concerning that in the three reports provided to the Department of Health by Dr Flander, there is no disclosure of the changes that were made to earlier drafts in response to comments made by departmental officers.

Dr Lester did not agree with the suggestion put by Counsel Assisting that she did not want an objective analysis from Dr Flander, but rather an analysis of the data that supported the Department of Health's stated position that there was no link between the deaths and the mine fire. Dr Lester maintained that she sought an objective analysis of the data.[85]

The Board considers that the Department of Health's final factsheet on this issue, dated 22 October 2014, clearly demonstrates that the Department of Health wanted to present an impression to the public that it had obtained reputable independent advice and that the advice supported its position that there was no link between the increase in deaths in the Latrobe Valley and the mine fire.

The Board considers that the process of obtaining an independent opinion on matters of public significance should be transparent, systematic and appropriate in line with the requirements for decision-making in the Public Health Act. Having examined all of the numerous lengthy emails from the Department to Dr Flander commenting on her draft reports and suggesting changes to those drafts on matters of substance and opinion, the Board does not consider that the Department of Health engaged in a process that was transparent or appropriate.

ACTUAL OR PERCEIVED CONFLICT OF INTEREST

Until her retirement in February 2015, Dr Lester maintained control over the Department of Health's investigation about whether there was an increase in deaths associated with the Hazelwood mine fire.

Dr Lester assumed this role despite the controversy surrounding her conduct during the mine fire itself. Dr Lester was the subject of criticism and adverse findings by the Board of the 2014 Hazelwood Mine Fire Inquiry, particularly regarding the timing of the Department of Health's advice that vulnerable people should temporarily relocate from the southern areas of Morwell during the mine fire.[86]

In these circumstances, the Board considers that Dr Lester showed a lack of judgment in deciding to manage the investigation about whether the mine fire contributed to an increase in deaths. It should have been clear to Dr Lester that the community may well have difficulty accepting the results of an investigation that she managed.

The Board was informed that following Dr Lester's retirement in February 2015, Dr Lester's acting replacement in the role of Chief Health Officer, Dr Michael Ackland, did not take over management of the investigation. Instead, that task reverted to the health protection branch and was managed by a departmental official in that branch and a senior medical advisor in the Office of the Chief Health Officer.[87]

Dr Lester was unable to explain to the Board why she personally managed the investigation, other than to say she did not see any conflict of interest in doing so,[88] and that she felt she needed to because it was an issue of such 'significance and importance to the people of the Latrobe Valley.'[89]

The Board considers that Dr Lester's investigations into whether the mine fire contributed to deaths in the Latrobe Valley gave rise to a real or perceived conflict of interest. Had the finding of these investigations been that there was an increase in deaths, that finding would have reflected poorly upon Dr Lester in the context of criticisms about how she discharged her role during the mine fire. This should have been plain both to Dr Lester and to those more senior to her within the Department of Health.

Under s.20(2) of the Public Health Act, the Chief Health Officer is subject to the general direction and control of the Secretary of the Department of Health. The Board considers that, in these circumstances, it would have been more appropriate for the Secretary to appoint someone with no vested interest in the outcome to oversee investigations into whether the mine fire contributed to deaths in the Latrobe Valley.

8.3 PROCEDURAL FAIRNESS

Dr Lester and GDF Suez were granted leave to appear before the Board of Inquiry. Both parties complained that they were not accorded procedural fairness by the Board. Those concerns are addressed in this section of the report.

First, it is necessary to note that under s.59(a) of the *Inquiries Act 2014* (Vic), the Board is required to comply with the requirements of procedural fairness. The requirements of procedural fairness are not fixed. As Mason J observed in *Kioa v West*:

> ...the expression "procedural fairness" more aptly conveys the notion of a flexible obligation to adopt fair procedures which are appropriate and adapted to the circumstances of the particular case. The statutory power must be exercised fairly, that is, in accordance with procedures that are fair to the individual considered in the light of the statutory requirements, the interests of the individual and the interests and purposes, whether public or private, which the statute seeks to advance or protect or permits to be taken into account as legitimate considerations.[90]

Applying this approach, the Board's objective was to conduct the Inquiry in a manner that enabled all parties granted leave to appear to be provided with all relevant evidence before the Board, and to be given an opportunity to test that evidence by examining witnesses and making submissions to the Board.

ADVERSE FINDINGS AGAINST DR LESTER

In his final address to the Board on 9 September 2015, at the conclusion of the public hearings in Morwell, Senior Counsel for Dr Lester submitted that Dr Lester had been denied procedural fairness because Counsel Assisting had not given her an opportunity to respond to various matters submitted that provided the factual basis for adverse findings against Dr Lester.

One of the adverse findings that Counsel Assisting submitted the Board should make was that it was a conflict of interest for Dr Lester personally to investigate claims by Voices of the Valley and then manage subsequent expert investigations into its concerns.[91]

Over the course of Dr Lester giving evidence on 2 September 2015, Counsel Assisting, raised the issue of a conflict of interest:

> Counsel Assisting: Can I ask a little bit about the engagement of the University of Melbourne?
>
> Dr Lester: M'mm
>
> Counsel Assisting: You personally contacted the department of epidemiology to engage them to do work, is that right?
>
> Dr Lester: Yes, I did.
>
> Counsel Assisting: You had of course been the subject of some criticism in the first Hazelwood Mine Fire Inquiry Report?
>
> Dr Lester: M'mm
>
> Counsel Assisting: About the communication of the evacuation information and warning to the community of the Latrobe Valley and Morwell in particular, did you think that it might have been better if someone other than you within the department was responsible for engaging Melbourne University, in other words did you feel that you may have had a conflict of interest in doing this work?
>
> Dr Lester: No, I don't believe that I had a conflict of interest. I went to the University of Melbourne as a very reputable internationally recognised unit of epidemiology and biostatistics that were quite independent from anything that had been to do with the fire and I thought they would bring a very expert independent set of eyes to the data.
>
> Counsel Assisting: I understand that but did it not occur to you that it might have been better if you were at arm's length from that process, put it that way?
>
> Dr Lester: No, look, I don't agree with that.[92]

Other matters that Counsel Assisting submitted should result in adverse findings against Dr Lester were raised with her in a similar fashion.

In his final address to the Board, Dr Lester's counsel submitted that Dr Lester had not been sufficiently challenged by Counsel Assisting on these matters. After referring to the quoted section of the transcript above, Senior Counsel for Dr Lester submitted that '[i]t was never then gone on, the questioning never then went on to say to her well, you were wrong about that, you did have and I want to suggest to you that you did have a conflict of interests; that was never put.'[93]

This submission appears to be based on the proposition that the rule in *Browne v Dunn*[94] applies to a Board of Inquiry established under Part 3 of the *Inquiries Act 2014* (Vic). As was explained by Gummow and Heydon JJ of the High Court, 'the rule requires the cross-examiner of a witness in adversarial litigation to put to that witness the nature of the case on which the cross-examiner's client proposes to rely in contradiction of that witness.'[95] In effect Senior Counsel for Dr Lester contended that his client was not cross-examined by Counsel Assisting.

The Board considers that, because it is not bound by the rules of evidence or any practices or procedures applicable to a court of record, the rule in *Browne v Dunn* has no application to this Inquiry. Counsel Assisting the Board has no 'client' and had no 'case' to put against Dr Lester.[96]

However, even if the rule in *Brown v Dunn* applies and Counsel Assisting had such a duty, the Board is satisfied that it was met in the examination of Dr Lester during the public hearings in Morwell.

Further, at the conclusion of the hearing, the Board accepted a submission by Counsel Assisting that Dr Lester be permitted to file a further statement with the Board.[97] In response to this invitation, Senior Counsel for Dr Lester specifically reserved Dr Lester's right to file a supplementary statement with the Board.[98]

A further supplementary statement of Dr Lester, dated 28 September 2015, was in due course filed with the Board and tendered by Counsel Assisting at the hearing on 22 October 2015.[99] In that statement, Dr Lester addressed each of the matters identified in the submissions of Counsel Assisting that provided the basis for the Board to make adverse findings concerning Dr Lester's conduct.[100]

In relation to the question of conflict of interest, Dr Lester's further statement refers to paragraph 94 of the submissions of Counsel Assisting, dated 8 September 2015, which states that 'the [Department] response to the issue [of increased deaths] should have been overseen by someone with no vested interest in the outcome.'[101] Dr Lester then stated 'this proposition was never put to me either. If it had been put to me, I would have denied it.'[102]

The Board noted in Part 1 of this report that s.76 of the *Inquiries Act 2014* (Vic) imposes on a Board constituted under Part 3 of the Act a procedure which must be followed in relation to proposed adverse findings. This is an important aspect of the requirements of procedural fairness.

For the reasons outlined above, the Board considers that Dr Lester was appropriately apprised of the factual matters said by Counsel Assisting to provide a basis for adverse findings to be made against her, and given an opportunity to respond as required by the principles of procedural fairness.[103]

The Board has considered the various responses made by and on behalf of Dr Lester and, having determined to make the adverse findings against Dr Lester outlined above, has fairly set out her responses pursuant to the Act.[104]

THE RE-OPENING OF THE PUBLIC HEARINGS

The circumstances in which the Inquiry's public hearings were re-opened have been described in Part 6 of this report.

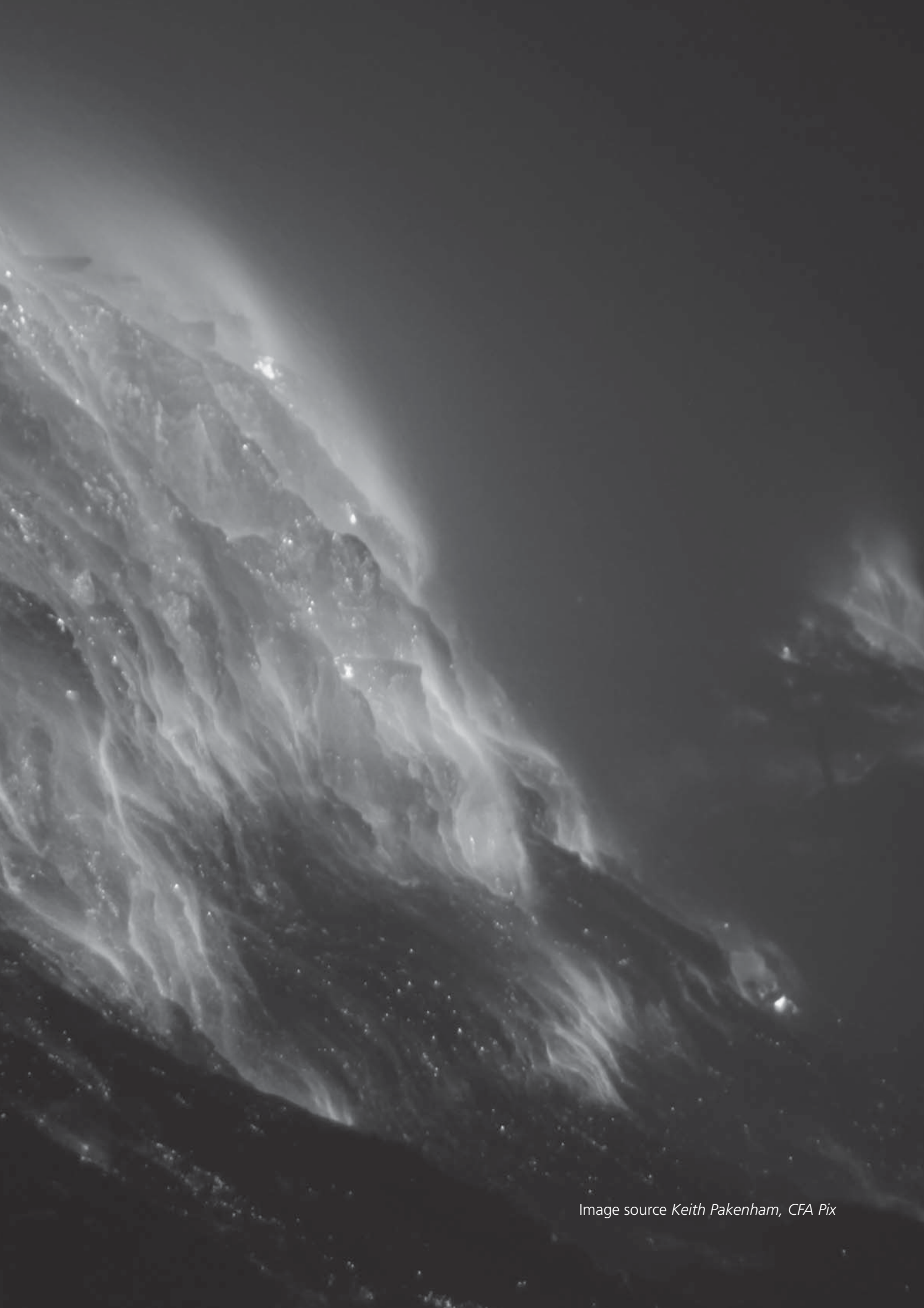
When the parties were notified of the Board's intention to re-open the hearings to consider further reports that came to light after 9 September 2015, complaints of a lack of procedural fairness were made on behalf of both Dr Lester and GDF Suez in correspondence to the Board's solicitor. These complaints were repeated in written submissions to the Board.[105]

In recognition of these concerns, at the commencement of the hearing on 22 October 2015, the Chair of the Board made the following remarks:

> It's appropriate that we, the Board, offer explanation for the course of events that has led to the hearing today. We are here because the Board has dealt with certain events in a way that has been calculated to maximise procedural fairness. At the conclusion of the hearing of submissions on September 9…the announced intention of the Board [was] that that was the end of the hearings on Term of Reference 6.
>
> Subsequently, two developments caused the Board to reconsider that announcement. Both involved the receipt of materials that were not expected by the Board, by Counsel Assisting or by anyone within the Secretariat when the last hearings concluded. The first materials were those received from Associate Professor Barnett. The second materials were those received from Dr Johnston.
>
> Despite the major dilemmas raised by the provision of those materials, the Board does not criticise either of the two experts. It accepts that the motive for providing the information was to assist the Board to arrive at more satisfying conclusions on Term of Reference 6.
>
> In both cases the Board spent considerable time in robust discussion as to the course to be followed. One solution to the dilemma was to insist that the announced deadline must be observed regardless of other considerations. The Board was primarily concerned with questions of procedural fairness.

> While observing the deadline had its limitations, so too did the other options and the Board had also to be concerned with issues of inconvenience to parties. The Board also had to allow for restrictions as to time and as to costs imposed on it under its Terms of Reference.
>
> The Board concluded that the compromise ultimately arrived at, which involved the hearing of some further evidence and then the hearing of further final submissions, was the least unsatisfactory of the options. That compromise involved substantial inconvenience to several academic witnesses and to parties and to their legal representatives and to members of the public.[106]

The Board does not consider that either Dr Lester or GDF Suez have been denied procedural fairness in the conduct of the Inquiry. The Board has fulfilled its obligations pursuant to the *Inquiries Act 2014* (Vic) and its Terms of Reference in the conduct of the Inquiry.



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PART NINE
COMMENDATIONS, AFFIRMATIONS AND RECOMMENDATIONS

PART 9 COMMENDATIONS, AFFIRMATIONS AND RECOMMENDATIONS

In response to Term of Reference 6, the Board makes two principal findings:

1. It is likely that there was an increase in deaths in the Latrobe Valley between February and June 2014 when compared with the same period during 2009–2013.
2. It is likely that the Hazelwood mine fire contributed to some of the increase in deaths in the Latrobe Valley in 2014.

These findings are based on epidemiological reasoning informed by statistical analysis and interpretation. As the Board's principal expert, Professor Bruce Armstrong, a medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney, has stated—epidemiology is not an exact science. Accordingly there is no absolute proof for these findings, rather they are the most reasonable judgment based on the available evidence. Given the known health consequences of breathing air contaminated with particulate matter over a prolonged period, it would be surprising if the air pollution caused by the mine fire did not contribute to some deaths. However because of the imprecise nature of the analysis, it is not possible to attribute any specific death to the mine fire.

This Inquiry has been a lengthy, laborious and costly process requiring the cooperation and goodwill of many organisations and individuals, often at short notice. The Board wonders whether alternative approaches could have avoided the anxieties and concerns that the Latrobe Valley community has raised for more than a year. At the heart of the matter are issues of openness, engagement and trust between government agencies and the community.

In the 2014 Hazelwood Mine Fire Inquiry, the Board found that there were shortcomings in the way that the State engaged and communicated with the Latrobe Valley community regarding the public health impact of the mine fire. Unfortunately the Department of Health came to a premature view about the possibility of an increase in deaths in the Latrobe Valley due to the mine fire. In the Board's opinion, the Department became defensive in response to community concerns. Had the Department adopted a more open and engaged approach, the need to re-open the Inquiry may have been avoided. Similar findings to that made by the Board may well have been reached earlier and at less expense.

There are broader lessons to be learnt from this Inquiry that have universal application. With increasing health literacy amongst individuals and communities, coupled with greater community confidence and empowerment to question authority, and with improved information and communication technology, it is inevitable that similar situations of acute community concern will occur in the future. This will be challenging for the State and other service and industry organisations to manage in a timely and responsive way. As the Board highlighted in its 2014 Hazelwood Mine Fire Inquiry Report, these challenges call for a fundamental rethink of community engagement approaches and in particular management of issues and crises. Boards of Inquiry by definition occur after the event. An early intervention and preventive approach is much more preferable.

The conclusions reached in this report also have a bearing on Term of Reference 7, which concerns health improvements required in the Latrobe Valley. Consideration of Term of Reference 7 is already well advanced and the Board will present its report to the Governor on 29 January 2016. The Board will also give further consideration to the remit and governance of the Hazelwood Mine Fire Health Study.

In light of the findings for Term of Reference 6 of the Inquiry, the Board makes the following commendations, affirmations and recommendations.

COMMENDATIONS

The Board commends:

- The State of Victoria for re-opening the Inquiry to address the concerns of the Latrobe Valley community that the possibility of increased deaths from the mine fire had not been adequately investigated and communicated.
- Voices of the Valley for their concern, enterprise, and persistence in pursuing an investigation into possible increases in death as a consequence of the Hazelwood mine fire.
- Associate Professor Adrian Barnett for undertaking mortality analyses in a timely and rigorous way, and on a pro bono basis.
- Professor Bruce Armstrong, and the other experts who contributed to this Inquiry— Professor Michael Abramson, Associate Professor Adrian Barnett, Dr Louisa Flander, Professor Ian Gordon, Dr Fay Johnston, Professor John McNeil and Dr Philip McCloud—for the diligent, responsive and authoritative manner in which they advised the Board.

AFFIRMATIONS

The Board affirms the State's commitment to reimburse Voices of the Valley the amount it paid to the Victorian Registry of Births, Deaths and Marriages for death records data.

RECOMMENDATIONS

The Board recommends that:

1. The State should review the State Smoke Framework and the Community Smoke Air Quality and Health Protocol in light of the findings of this Inquiry about an increased risk of death from air pollution due to fire. The State should engage independent expert consultants to assist in this review.
2. The State should reconsider, as a matter of priority, its approach to improving community engagement relevant to the health of the Latrobe Valley, which it committed to improving in the *Hazelwood Mine Fire Inquiry Report Victorian Government Implementation and Monitoring Plan*, October 2014.
3. The State should strengthen its processes to ensure that health information provided by the State to the general public is transparent, reliable and appropriate, to facilitate a good understanding of public health issues as required by the *Public Health and Wellbeing Act 2008* (Vic).
4. The State should mandate a rigorous process for the investigation of matters of public health concern to avoid real or perceived conflicts of interest, which includes requiring independent experts to declare whether the State has suggested any substantial changes to their advice and whether any changes have been adopted.
5. The State should engage the Hazelwood Mine Fire Implementation Monitor to monitor and report publicly, on a regular basis, the implementation of the recommendations adopted by the State arising from this report.

APPENDICES

Image source *Keith Pakenham, CFA Pix*

APPENDICES

APPENDIX A: INQUIRY PERSONNEL

NAME	ROLE
BLACKMAN, Joel	Paralegal Support
HORSFIELD, Sam	Editor
JACKSON, Candice	Business and Paralegal Support
KELLY, Monica	Health Lead
MITTEN, Spencer	Communications Manager
NICHOLLS, Cassie	Senior Policy Officer
PIERIS, Gregory	Legal Advisor
RADOJKOVIC, Andrew	Technical Officer – Mines
ROZEN, Peter	Counsel Assisting
RYAN, Genelle	Head of Secretariat
SEAH, Shyuan	Project Officer – Mines
SHANN, Ruth	Counsel Assisting
STANSEN, Justine	Principal Legal Advisor
STOCK, Kristen	Business Support
WELLINGTON, Bethany	Legal Advisor

APPENDIX B: PUBLIC SUBMISSIONS

ORGANISATIONS
Asbestos Council of Victoria
Australian Medical Students' Association
Climate and Health Alliance
Doctors for the Environment
Environment Victoria
Healthy Futures
Monash University
Public Health Association Australia
Quit Coal Collective
Voices of the Valley

INDIVIDUALS
BROWELL, Julia
CLISSOLD, Kiery-Anne
DOIG, Tom
FARMER, Wendy
FITZGERALD, Grace
HAMILTON, Christine
NICHOLSON, Deearn
ROBINSON, Marianne
YACANO, Peter

APPENDIX C: WITNESSES APPEARING AT THE PUBLIC HEARINGS

TITLE	NAME	ROLE
Prof	ABRAMSON, Michael	Professor of Clinical Epidemiology and Deputy Head of the Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine at Monash University
Prof	ARMSTRONG AM, Bruce	Medical practitioner, public health physician and epidemiologist from the School of Public Health, University of Sydney
Assoc Prof	BARNETT, Adrian	Statistician from the Institute of Health and Biomedical Innovation and School of Public Health, Queensland University of Technology
Ms	CRISTINE, Linda	Director, Inquiry Response Team, Department of Health and Human Services
Dr	FLANDER, Louisa	Senior Research Fellow, Centre for Epidemiology and Biostatistics, Melbourne School of Population and Global Health, University of Melbourne
Prof	GORDON, Ian	Director of the Statistical Consulting Centre and Professor of Statistics in the School of Mathematics and Statistics at the University of Melbourne
Mr	IPSEN, Ron	Latrobe Valley resident, Voices of the Valley member
Dr	JOHNSTON, Fay	Public health physician and environmental epidemiologist, University of Tasmania
Dr	LESTER, Rosemary	Former Chief Health Officer, Department of Health and Human Services
Dr	McCLOUD, Philip	Director and Principal Statistician, McCloud Consulting Group
Prof	McNEIL AM, John	Professor and Head of the Department of Epidemiology and Preventive Medicine at Monash University
Ms	SIMS, Dawn	Enterprise Data and Intelligence Consultant, Victorian Registry of Births, Deaths and Marriages

APPENDIX D: EXHIBITS TENDERED AT 2015 PUBLIC HEARINGS

EXHIBIT	TITLE
Exhibit 1A	Extract from submission filed by Voices of the Valley dated 10 August 2015
Exhibit 1B	Extract from submission filed by Voices of the Valley dated 10 August 2015
Exhibit 1C	Extract from submission filed by Voices of the Valley dated 10 August 2015
Exhibit 2	Witness statement of Ms Dawn Alvine Sims, undated
Exhibit 3	Witness statement of Ms Linda Cristine dated 18 August 2015
Exhibit 4	Supplementary witness statement of Ms Linda Cristine dated 31 August 2015
Exhibit 5	Letter from Victorian Government Solicitor's Office to Hazelwood Mine Fire Inquiry dated 28 August 2015
Exhibit 6	Witness statement of Professor Michael Abramson, undated
Exhibit 7	Bundle of correspondence tendered by Mr Richard Attiwill QC
Exhibit 8	Copies of correspondence between the Department of Health and Human Services and University of Melbourne
Exhibit 9	Draft 'Review of "Analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2014, Queensland University of Technology) and "An updated analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2015, Queensland University of Technology)' report dated 13 March 2015 (2:30pm)
Exhibit 10	Draft 'Review of "Analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2014, Queensland University of technology) and "An updated analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2015, Queensland University of technology)' report 8 April 2015 (11.28am)
Exhibit 11	Report of Professor John McNeil AM and letter of instructions dated 18 August 2015
Exhibit 12	Copies of correspondence between the Department of Health and Human Services and University of Melbourne
Exhibit 13	Bundle of draft 'Age-standardised mortality and cause of death in the Latrobe Valley at the time of (and five years prior to) the Hazelwood coalmine fire in Morwell, Victoria)' reports dated 22 May 2015; 30 May 2015 and 31 May 2015
Exhibit 14	Witness statement of Dr Rosemary Lester dated 24 August 2015
Exhibit 15	Supplementary witness statement of Dr Rosemary Lester dated 26 August 2015
Exhibit 16	Copies of correspondence between the Department of Health and Human Services and University, of Melbourne
Exhibit 17	Draft 'Review of Birth Deaths & Marriages Victoria (BDMV) mortality data for the Latrobe Valley and the time of the Hazelwood coal mine fire in Morwell' report dated 19 September 2014
Exhibit 18	Draft 'Review of Birth Deaths & Marriages Victoria (BDMV) mortality data for the Latrobe Valley and the time of the Hazelwood coal mine fire in Morwell' report dated 23 September 2014 (11.36am)
Exhibit 19	Draft 'Review of Birth Deaths & Marriages Victoria (BDMV) mortality data for the Latrobe Valley and the time of the Hazelwood coal mine fire in Morwell' report dated 23 September 2014 (1.30pm)
Exhibit 20	Draft 'Review of Birth Deaths & Marriages Victoria (BDMV) mortality data for the Latrobe Valley and the time of the Hazelwood coal mine fire in Morwell' report dated 26 September 2014 (4.30pm)
Exhibit 21	Report of Dr Louisa Flander dated 16 September 2014 'Review of Birth Deaths & Marriages Victoria (BDMV) mortality data for the Latrobe Valley and the time of the Hazelwood coal mine fire in Morwell'

EXHIBIT	TITLE
Exhibit 22	Report of Dr Louisa Flander dated 28 April 2015 'Review of "Analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2014, Queensland University of technology) and "An updated analysis of death data during the Morwell mine fire," A. Barnett, working paper, unpublished (2015, Queensland University of technology)'
Exhibit 23	Report of Dr Louisa Flander dated 4 June 2015 'Age-standardised mortality and cause of death in the Latrobe Valley at the time of (and five years prior to) the Hazelwood coalmine fire in Morwell, Victoria)'
Exhibit 24	Curriculum Vitae of Dr Louisa Flander
Exhibit 25	Curriculum Vitae of Associate Professor Adrian Barnett
Exhibit 26	Report of Associate Professor Adrian Barnett dated September 2014 'Analysis of death data during the Morwell mine fire'
Exhibit 27	Report of Associate Professor Adrian Barnett dated December 2014 'An updated analysis of death data during the Morwell mine fire'
Exhibit 28	Expert report of Professor Bruce Armstrong 'Expert assessment and advice regarding mortality information as it relates to the Hazelwood Mine Fire Inquiry Terms of Reference – Final report'
Exhibit 29	Report of Professor Ian Gordon dated 11 August 2015 'Commentary on the Hazelwood mine fire and possible contribution to deaths'
Exhibit 30	Joint expert report of Professor Bruce Armstrong, Associate Professor Adrian Barnett, Dr Louisa Flander and Professor Ian Gordon dated 31 August 2015
Exhibit 31	Bundle of emails – Professor Adrian Barnett
Exhibit 32	Report of Dr Jonathon Burdon undated
Exhibit 33	Determination by Coroner Hawkins dated 11 November 2014
Exhibit 34	Letter from Coroner to the Board of Inquiry dated 15 July 2015 and 22 July 2015
Exhibit 35	Letter from Victorian Government Solicitor's Office to Hazelwood Mine Fire Inquiry dated 9 July 2015 Morwell deaths enquiry 2015
Exhibit 36	Minutes – Hazelwood Study Steering Contract Committee dated 24 June 2015
Exhibit 37	Bundle of Reports
Exhibit 38	Email chain between the Victorian Registry of Births, Deaths and Marriages and the Department of Health
Exhibit 39	Receipt from the Victorian Registry of Births, Deaths and Marriages for Voices of the Valley dated 12 December 2014
Exhibit 40	Bundle of correspondence between the Board, the parties and the experts
Exhibit 41	Victorian Registry of Births, Deaths and Marriages data extracted 8 October 2015
Exhibit 42	Report of Associate Professor Adrian Barnett, 'Analysis of daily death data during the Hazelwood mine fire dated September 2015'
Exhibit 43	Report of Associate Professor Adrian Barnett, 'Analysis of daily death data during the Hazelwood mine fire dated 25 September 2015'
Exhibit 44	Report of Associate Professor Adrian Barnett, 'Analysis of daily death data during the Hazelwood mine fire dated 9 October 2015'
Exhibit 45	Email Dr Fay Johnston to Professor John Catford dated 13 October 2015, 1.11pm
Exhibit 45A	Email Justine Stansen to all parties dated 18.10.15 at 11:50am, email Justine Stansen to all parties 18.10.15 at 11:52am and email Justine Stansen to all parties dated 18.10.15 at 11:55am

EXHIBIT	TITLE
Exhibit 46	Report Dr Fay Johnston dated 18 October 2015 and email Dr Fay Johnston to Justine Stansen dated 18 October 2015 at 9:50pm, email Justine Stansen to experts dated 19 October 2015 at 10:09am and email Justine Stansen to Emily Heffernan dated 19 October 2015 at 10:11am
Exhibit 46A	Email Justine Stansen to all parties dated 19 October 2015 enclosing joint expert report dated 19 October 2015
Exhibit 47	Curriculum Vitae of Dr Fay Johnston
Exhibit 48	Email Dr Louisa Flander to Justine Stansen dated 13 October 2015, 3.27pm
Exhibit 49	Report of Professor Ian Gordon dated 14 October 2015
Exhibit 50	Letters from Dr Philip McCloud to King & Wood Mallesons dated 13 and 14 October 2015
Exhibit 51	Curriculum Vitae of Dr Philip McCloud
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Exhibit 54	Summary of daily deaths recorded by postcode of usual place of residence in four postcode areas in the period 9 February—26 March 2014 as per Births, Deaths and Marriages (BD&M) mortality data received from the Board on 8 October 2015
Exhibit 55	Map prepared by King & Wood Mallesons overlaying Commonwealth Scientific and Industrial Research Organisation Mine Fire air pollution modelling with postcode boundaries determined in reference to Australian Statistical Geography Standard
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Exhibit 58	Table produced by Dr Philip McCloud on 19 October 2015
Exhibit 59	Further Supplementary Statement of Dr Rosemary Lester dated 28 September 2015; letter from Perry Maddocks Trollope to the Inquiry dated 28 September 2015 and two letters from the Inquiry to Perry Maddocks Trollope dated 18 September 2015 and 29 September 2015
Exhibit 60	Report of Associate Professor Adrian Barnett, 'Analysis of daily death data during the Hazelwood mine fire' dated 7 October 2015
Exhibit 61	Atkinson R, Kang S, Anderson H, Mills I, & Walton, H, 2014 'Epidemiological time series studies of $PM_{2.5}$ and daily mortality and hospital admissions: a systematic review and meta-analysis', *Thorax*

APPENDIX E: TENDERED AT 2014 HEARINGS

EXHIBIT	TITLE
Exhibit 35	Statement of Simon Ellis, 2 June 2015
Exhibit 48	Expert report of Professor Donald Campbell, 28 May 2014

SHORTENED FORMS, GLOSSARY AND BIBLIOGRAPHY

SHORTENED FORMS

SHORTENED FORM	CONTRACTIONS
ABC	Australian Broadcasting Corporation
COPD	Chronic Obstructive Pulmonary Disease
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EPA	Environment Protection Authority
GDF Suez	GDF Suez Australian Energy
$PM_{2.5}$	particulate matter of 2.5 micrometres or less in diameter
PM_{10}	particulate matter of 10 micrometres or less in diameter
Public Health Act	*Public Health and Wellbeing Act 2008* (Vic)
the Assessment	Rapid Health Risk Assessment
the Board	Hazelwood Mine Fire Inquiry Board of Inquiry
the Department	refers to the Department of Health or means both the Department of Health under the Napthine Victorian Government and the Department of Health and Human Services under the Andrews Victorian Government.
the Registry	Victorian Registry of Births, Deaths and Marriages
the State	refers to both the Napthine Victorian Government and the Andrews Victorian Government, which came into power on 30 November 2014.

GLOSSARY

TERM	EXPLANATION
Age-standardised	A method of removing the influence of age when comparing populations with different age structures. This is usually necessary because the rates of many diseases vary strongly (usually increasing) with age. The age structures of the different populations are converted to the same 'standard' structure, then the disease rates that would have occurred with that structure are calculated and compared.
Chronic Obstructive Pulmonary Disease	Serious, progressive and disabling long-term lung disease where damage to the lungs, usually because of both emphysema and chronic bronchitis, obstructs oxygen intake and causes increasing shortness of breath. By far the greatest cause of COPD is cigarette smoking. Is also referred to as Chronic Obstructive Airways Disease.
Confidence intervals	A statistical term describing a range (interval) of values within which we can be 'confident' that the true value lies, usually because it has a 95% or higher chance of doing so.
Congestive heart failure	The heart's inability to pump enough blood to satisfy the needs of the body.
Epidemiology	The study of the patterns and causes of health and disease in populations, and the application of this study to improve health.
Heatwave	Generally defined as a period of abnormally and uncomfortably hot weather that could impact on human health, community infrastructure and services.
Ischaemic heart disease	Heart attack and angina (chest pain). Also known as coronary heart disease.
Morbidity	Refers to ill health in an individual and to levels of ill health in a population or group.
Mortality	Death
Natural splines	A way of examining the relationship between two variables without assumming it is a straight line such as examining the risks of low and high temperatures.
Particulate matter or PM	Refers to everything in the air that is not a gas; with the particulate matter and air mixture referred to as aerosol. It includes both solid particles and vapours (liquid particles). It is highly heterogeneous in size and composition and often chemically active in the environment and in humans, and it can be transported long distances in the atmosphere.
Planned burns	Involves lighting fires under carefully managed conditions. It aims to reduce the impacts of bushfires on communities, property and the natural environment. The State carries out planned burns in parks and forests, both near communities and in remote areas.
P-value	The probability that an observed difference has arisen by chance alone. By convention, a P-value of 0.05 or less is usually considered statistically significant because the difference it relates to would occur by chance alone only one in twenty times or less often.
Random variation	The variability that is contained within a process that cannot be determined. These fluctuations and variations are caused by erratic and irregular actions that are the result of random chance. These random variations cannot be eliminated or determined.
Relative risk	The ratio of the chance of a disease developing among members of a population exposed to a factor compared with a similar population not exposed to the factor. In many cases the relative risk is modified by the duration or intensity of exposure to the causative factors.
Reportable death	A special category of death required to be reported to the court and investigated by a coroner. There does not have to be anything suspicious in order for a coroner to investigate a death. In fact, the majority of deaths investigated by coroners do not have any suspicious circumstances at all.

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2 Inquiries Act 2014 (Vic) s.76(3)

PART 2

1 Hazelwood Mine Fire Inquiry Report 2014, p. 308
2 Hazelwood Mine Fire Inquiry Report 2014, p. 308
3 Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014, pp. 6-22
4 Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014, p. 24
5 Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014, para 54
6 Hazelwood Mine Fire Inquiry 2014 Exhibit 37 – California Guide for Public Health Officials
7 Hazelwood Mine Fire Inquiry Report 2014, p. 243
8 Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014, p. 24
9 Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014, p. 26
10 Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014,, p. 26
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12 Adapted from Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014, p. 3
13 Exhibit 11 – Report of Jonathon Burdon, undated
14 Exhibit 11 – Report of Jonathon Burdon, undated, p 2
15 Exhibit 11 – Report of Jonathon Burdon, undated, p. 7
16 Exhibit 11 – Report of Jonathon Burdon, undated, p. 8
17 See the Hazelwood Mine Fire Inquiry Report 2014, Part 4.1
18 Armstrong T473:20-474:6
19 Barnett T474:22-475:1; T525:3-21
20 Exhibit 14 – Statement of Dr Rosemary Lester, 24 August 2015, Attachment RAL-2, pp.18 & 21
21 Evidence from Dr Rosemary Lester in the Hazelwood Mine Fire Inquiry 2014 (T1190:4-9)
22 Abramson T354:21-25
23 Abramson T355:5-23
24 Abramson T358:15-21
25 Abramson T359:13-21
26 Abramson T359:22-31
27 Abramson T355:30–T356:9
28 Abramson T357:9-13
29 Abramson T378:1-5
30 Exhibit 6 – Statement of Michael Abramson, undated, para 26
31 Exhibit 6 – Statement of Michael Abramson, undated, para 29
32 Abramson T361:4-11
33 Abramson T360:22-27

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40 Abramson T374:4-20
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44 Abramson T376:22-377:1
45 Exhibit 6 – Statement of Michael Abramson, undated, para 33
46 Abramson T362:1-6; T363:8-364:9

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1 Submission of Wendy Farmer, 11 August 2015, p. 2
2 Exhibit 2 – Statement of Dawn Sims, undated, paras 2 & 3; Sims T285:5-15
3 Sims T282:22-24
4 Exhibit 2 – Statement of Dawn Sims, undated, paras 5 & 6
5 Exhibit 2 – Statement of Dawn Sims, undated, para 7; Sims T286:10-19
6 Ipsen T268:1-9; 2014 Hazelwood Mine Fire Inquiry Exhibit 35 – Statement of Simon Ellis, 2 June 2015, paras 33-37
7 Ipsen T268:14-269:8
8 Ipsen T269:9-270:20
9 Exhibit 1A – Map of the four postcodes closest to the mine fire
10 Exhibit 1A – Map of the four postcodes closest to the mine fire
11 Ipsen T270.21-271:17
12 Ipsen T272:4-26
13 Exhibit 1B – Graph of analysis of data from local newspapers and media
14 Exhibit 1B – Graph of analysis of data from local newspapers and media
15 Exhibit 2 – Statement of Dawn Sims, undated, paras 9 & 11
16 Exhibit 7 – Letter from Hazelwood Mine Fire Inquiry to Department of Health, 22 August 2014
17 Exhibit 2 – Statement of Dawn Sims, undated, para 10
18 Ipsen T269:9-270:25
19 Exhibit 1C – Table of deaths by date and usual place of residence
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21 Ipsen T274:18-31; Exhibit 26 - Report of Associate Professor Barnett, September 2014
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24 Exhibit 39 – Receipt from Registry of Births, Deaths & Marriages to Voices of the Valley dated 12 December 2014
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26 Exhibit 2 – Statement of Dawn Sims, undated, paras 18, 20, 22, 27 & 28
27 Exhibit 2 – Statement of Dawn Sims, undated, para 12
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33 Lester T406:16-17
34 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, para 15.3, Attachment 5A & 5B
35 Exhibit 21 – Report of Dr Flander and Professor English, 26 September 2014
36 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachment 2
37 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachment 3
38 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachment 2
39 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachment 2
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50 Exhibit 22 – Report of Dr Flander, Mr Ugoni and Dr Hauser, 28 April 2015
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53 Exhibit 2 – Statement of Dawn Sims, undated, paras 25 & 26
54 Exhibit 33 – Determination of Coroner Hawkins, 11 November 2014
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58 Exhibit 33 – Determination of Coroner Hawkins, 11 November 2014, para 6
59 Submission of Kiery-Anne Clissold, undated, Attachment
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61 Exhibit 33 – Determination of Coroner Hawkins, 11 November 2014, paras 18-36
62 Exhibit 34 – Letters from Coroners Court of Victoria to the Hazelwood Mine Fire Inquiry Secretariat, 15 July 2014 and 22 July 2015

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2 Exhibit 26 – Report of Associate Professor Barnett, September 2014
3 Exhibit 27 – Report of Associate Professor Barnett, December 2014
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5 Exhibit 27 – Report of Associate Professor Barnett, December 2014, p. 1
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10 Exhibit 21 – Report of Dr Flander and Professor English, 26 September 2014
11 See Part 5 for a discussion about statistical methodology and terminology
12 Exhibit 21 – Report of Dr Flander and Professor English, 26 September 2014, p. 2 & 3
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16 Exhibit 21 – Report of Dr Flander, Dr Ait Ouakrim, Dr Ghazaleh Dashti and Mr Ugoni, 4 June 2015
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3 Exhibit 29 – Report of Professor Gordon, 11 August 2015, p. 1
4 Exhibit 29 – Report of Professor Gordon, 11 August 2015
5 Exhibit 11 – Report of Professor McNeil, 28 August 2015
6 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015
7 Exhibit 35 – Department of Health and Human Services death data
8 Flander T529:20-530:16
9 Barnett T563:17-26
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11 Exhibit 11 – Report of Professor McNeil, 28 August 2015, p. 4
12 Barnett T563:3-4; Associate Professor Barnett later used daily data, which is discussed in Part 6
13 Gordon T476:21-477:2
14 Gordon T476:21-477:10
15 Gordon T484:26-485:18
16 Gordon T486:19-25
17 Barnett T487:1-4
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19 Gordon T479:10-17
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21 Armstrong 487:25-488:25
22 Flander T489:6-13
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24 Exhibit 23 – Report of Dr Flander Dr Ait Ouakrim, Dr Ghazaleh Dashti and Mr Ugoni, 4 June 2015, p. 18
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28 Exhibit 28 – Report of Professor Armstrong, August 2015, p. 8
29 Exhibit 28 – Report of Professor Armstrong, August 2015, p. 8
30 Armstrong T573:10-18
31 Armstrong T492:27-493:6
32 Armstrong T599:24-600:18
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34 Exhibit 29 – Report of Professor Gordon, 11 August 2015, pp. 2-5
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36 Exhibit 29 – Report of Professor Gordon, 11 August 2015, pp. 3 & 4
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38 Exhibit 29 – Report of Professor Gordon, 11 August 2015, p. 4
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40 Flander T489:20-29
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47 Exhibit 28 – Report of Professor Armstrong, August 2015, p. 9
48 Armstrong T576:28-577:13
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50 Exhibit 29 – Report of Professor Gordon, 11 August 2015, paras 14 & 40; Gordon T604:11-21; Exhibit 30 – Joint expert report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 2
51 Armstrong T496:10-20
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57 Exhibit 28 – Report of Professor Armstrong, August 2015, pp. 8 & 9
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59 Exhibit 28 – Report of Professor Armstrong, August 2015, p. 9
60 Exhibit 30 – Joint expert report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 2
61 Gordon T507:10-17
62 Exhibit 30 – Joint expert report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 2
63 Gordon T497:5-17, Exhibit 29 – Report of Professor Gordon, 11 August 2015, para 33
64 Gordon T496:22-498:19; Flander T498:25-500:13
65 The calculation was based on the data set out in Dr Flander's first report (Exhibit 21 – Report of Dr Flander and Professor English, 26 September 2014)
66 Gordon T508:19-509:8 noting that there was some uncertainty as to whether deducting 11 deaths was the appropriate number given the evidence of Dr Flander at T498:25-500:13

67 Gordon T508:19-510:18
68 Gordon T508:19-510:1; Exhibit 29 – Report of Professor Gordon, 11 August 2015, p. 4
69 Calculated by deducting 1.17 from the original calculation in Table 1 of Professor Gordon's report due to the change in predicted deaths for February 2014
70 Calculated by deducting 1.17 from the original calculation in Table 1 of Professor Gordon's report due to the change in predicted deaths for February 2014
71 Calculated by deducting 1.17 from the original calculation in Table 1 of Professor Gordon's report due to the change in predicted deaths for February 2014
72 Calculated by deducting 1.17 from the original calculation in Table 1 of Professor Gordon's report due to the change in predicted deaths for February 2014
73 Flander T514:11-18
74 See the Hazelwood Mine Fire Inquiry Report 2014, Part 4.1
75 Armstrong T473:20-474:6
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79 Flander T531:8-29
80 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 2
81 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 2
82 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 2
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88 Exhibit 28 – Report of Professor Armstrong, August 2015, p. 14
89 Exhibit 28 – Report of Professor Armstrong, August 2015, p. 14
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92 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 3
93 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 3
94 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 3
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98 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 3
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102 Armstrong T520:7-12
103 Armstrong T519:30-520:12
104 Gordon T521:20-27
105 Armstrong T523:6-14
106 Gordon T524:12-18
107 Armstrong T601:2-27
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109 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 3
110 Armstrong T586:4-8
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112 Exhibit 28 – Report of Professor Armstrong, August 2015, pp. 20 & 21
113 Armstrong T519:19-25
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115 Armstrong T518:15-26
116 Armstrong T518:26-519:12
117 Armstrong T519:5-12
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119 Gordon T520:18-521:8
120 Barnett T525:21-526:2
121 Barnett T525:21-526:2

122 Barnett T526:30-527:1
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124 Flander T527:6-11
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2 Barnett T760:17-25
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4 Exhibit 40(b) – Email from Associate Professor Barnett to Monica Kelly, 15 September 2015; Exhibit 42 – Report of Associate Professor Barnett, September 2015
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6 Exhibit 40(c) – Email from Justine Stansen to Professor Armstrong, 17 September 2015. See also Exhibit 40(p) - Email from Justine Stansen to Professor Armstrong, 7 October 2015
7 Exhibit 40(e) – Email from Professor Armstrong to Justine Stansen, 18 September 2015
8 Exhibit 40(g) – Email from Associate Professor Barnett to Justine Stansen, 25 September 2015; Exhibit 43 – Report of Associate Professor Barnett, 25 September 2015
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20 Exhibit 61 – Atkinson, Kang, Anderson, Mills & Walton, *Epidemiological time series studies of $PM_{2.5}$ and daily mortality and hospital admissions: a systematic review and meta-analysis,* 4 April 2014
21 Johnston T730:9-27
22 Johnston T819:6-24
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24 2014 Hazelwood Mine Fire Inquiry Report, pp. 336 & 337
25 Johnston T730:20-27
26 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015 & Letter from Dr McCloud to Emily Heffernan, 14 October 2015
27 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, p. 1
28 Exhibit 40(jj) – Email from Justine Stansen to Associate Professor Barnett, 16 October 2015; Exhibit 40(kk) – Email from Justine Stansen to Professor Gordon, 16 October 2015; Exhibit 40(ll) – Email from Justine Stansen to Dr Flander, 16 October 2015; Exhibit 40(mm) – Email from Justine Stansen to Professor Armstrong, 16 October 2015; Exhibit 40(nn) – Email from Justine Stansen to Emily Heffernan, 16 October 2015; Exhibit 40(oo) – Email from Justine Stansen to Dr Johnston, 16 October 2015
29 Exhibit 46 – Report of Dr Johnston, 18 October 2015
30 Exhibit 46 – Email from Justine Stansen to all experts, 19 October 2015 & Email from Justine Stansen to Emily Heffernan, 19 October 2015
31 Exhibit 58 – Dr McCloud Table; McCloud T734:21-735:1
32 Exhibit 57 – Joint Expert report, 19 October 2015
33 Barnett T760:17-24
34 Gordon T765:18-29
35 Exhibit 57 – Joint expert report, 19 October 2015, p. 1
36 Exhibit 57 – Joint expert report, 19 October 2015, p. 1
37 Exhibit 57 – Joint expert report, 19 October 2015, p. 2
38 Exhibit 49: Report of Professor Gordon, 14 October 2015, pp. 2 & 3; See Exhibit 60 – Report of Associate Professor Barnett, 7 October 2015, pp. 2 & 3 for a discussion on the definition of 'splines'
39 Exhibit 49: Report of Professor Gordon, 14 October 2015, p. 4
40 McCloud T754:19-755:10

41 McCloud T782:31-783:7
42 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 14 October 2015, p. 2; McCloud T772:30-773:9
43 Flander T762:12-24, T798:15-19; Exhibit 48 – Email from Dr Flander to Justine Stansen, 13 October 2015
44 Armstrong T796:19-22
45 The conclusions of the experts who gave evidence at the September hearings are discussed in Part 5
46 Exhibit 57 – Joint expert report, 19 October 2015, p. 2
47 Gordon T765:27-766:1
48 Armstrong T767:5-12
49 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
50 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
51 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
52 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
53 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, p. 4
54 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, pp. 4 & 5
55 McCloud T776:11-15
56 Armstrong T795:5-21
57 Armstrong T795:5-21
58 Exhibit 6 – Statement of Michael Abramson, undated, Attachment 1; Abramson T373:29-374:3
59 McCloud T769:6-771:13
60 McCloud T771:23-27
61 Armstrong T788:24-789:3
62 Gordon T832:22-834:14
63 Johnston T745:22-31
64 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
65 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
66 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
67 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
68 Flander T801:2-9
69 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
70 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
71 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, p. 1
72 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, p. 2
73 Flander T803:7-14
74 Armstrong T793:21-794:8
75 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, p. 3
76 Exhibit 13 – Statement of Rosemary Lester, 24 August 2015, Attachment RAL-2
77 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, p. 3; McCloud T754:1-14
78 McCloud T811:26-812:8
79 Johnston T813:2-7
80 McCloud 786:1-19; Exhibit 61 – Atkinson, *'Epidemiological time series studies of $PM_{2.5}$ and daily mortality and hospital admissions: a systematic review and meta-analysis',* 2014
81 Exhibit 46 – Report of Dr Johnston, 18 October 2015, p. 1
82 Johnston T744:1-21; Exhibit 46 – Report of Dr Johnston, 18 October 2015, p. 1
83 Johnston T744:17-21
84 Johnston T744:22-745:2
85 Johnston T743:30-744:4
86 Johnston T744:1-2
87 Johnston T745:6-21
88 Exhibit 45 – Email from Dr Johnston to Professor Catford, 13 October 2015
89 Johnston T842:28-843:22
90 Johnston T843:23-844:10
91 McCloud T752:28-753:1, T757:18

PART 7

1 Written submissions of Counsel Assisting, 8 September 2015, para 2
2 Written submissions of Counsel Assisting, 8 September 2015, para 2
3 Neal T657:29-658:5

4 Neal T657:29-658:5
5 Blanden T675:24-676:1
6 See, for example, written submissions of Voices of the Valley, 9 September 2015, para 3.15
7 *Inquiries Act 2014* (Vic), s.61
8 [2011] VSCA 448
9 (1991) 171 CLR 506 at para 6
10 [2011] VSCA 448 at para 19
11 (1991) 171 CLR 506
12 Toohey and Gaudron JJ agreed with the Chief Justice
13 (1992) 176 CLR 408
14 (1992) 176 CLR 408 at pp. 412 & 413
15 [1999] 1 VR 69
16 *Keown v Khan* [1999] 1 VR 69 at p. 76
17 [2011] 2 AC 229
18 [2011] 2 AC 229 at pp. 263 & 264
19 (2011) 246 CLR 36 at p. 67 (Gummow, Hayne and Crennan JJ)
20 Written submissions of Voices of the Valley, 9 September 2015, para 3.34
21 (2011) 240 CLR 36 at pp. 53 & 54 *Seltsam Pty Ltd v McGuiness* (2000) 49 NSWLR 262 at pp. 278-285 per Spigelman CJ; see also Fleming (10th ed) at para 13.100 where the learned author discusses the use by American courts of epidemiology
22 (2011) 246 CLR 36 at p. 56 citing March & Stramere [E & SH] Pty Ltd (1991) 171 CLR 506 at para 47
23 (2011) 246 CLR 36 at p. 57
24 (2000) 49 NSWLR 262
25 (2000) 49 NSWLR 262 at para 147
26 *Inquiries Act 2014* (Vic), s. 61
27 Written submissions of Counsel Assisting, 8 September 2015, para 3
28 [1984] AC 808 at pp. 820 & 821
29 Counsel also referred to JRS Forbes, *Justice in Tribunals* (Federation Press, 4th ed, 2014) at [17.17]
30 [1984] AC 808 at p. 818
31 (1990) 170 CLR 321
32 (1990) 170 CLR 321 at p 356 & 357; Brennan J agreed. In *MIMA v Eshetu* (1999) 197 CLR 611 at p. 654, Gummow J reiterated this position
33 S. Donoghue, *Royal Commissions and Permanent Board of Inquiry* (Butterworths, 2000) at p. 196
34 Written submissions of Counsel Assisting, 8 September 2015, para 4
35 JRS Forbes, *Justice in Tribunals* (Federation Press, 4th ed, 2014) para 17.17
36 Neal T658:16-27
37 *Evidence Act 2008* (Vic), s. 140(1)
38 *R v War Pensions Entitlement Appeals Tribunal; Ex parte Bott* (1933) 50 CLR 228 at p. 256 (Evatt J)
39 Written submissions of Voices of the Valley, 9 September 2015, para 3.33
40 *Tabet v Gett* (2010) 240 CLR 537, paras 111 & 145; see also written submissions of Voices of the Valley, 9 September 2015, para 3.32
41 (1938) 60 CLR 336
42 (1938) 60 CLR 336 at pp. 361 & 362
43 *Neat Holdings Pty Ltd v Karajan Holdings Pty Ltd & Ors* (1992) 110 ALR 449, at pp. 449 & 450 (citations omitted)
44 Written submissions of Counsel Assisting, 8 September 2015, para 5
45 Neal T659:21-27
46 Blanden T675:26-676:1
47 Szydzik T695:8-15
48 (1938) 60 CLR 336 at p. 362 (Dixon J)
49 Exhibit 11 – Report of Professor McNeil, 28 August 2015
50 As required under the Hazelwood Mine Fire Inquiry Practice Direction No 2.
51 Exhibit 14 – Statement of Dr Rosemary Lester, 24 August 2015, Attachment RAL-2
52 Exhibit 6 – Statement of Michael Abramson, undated, para 27
53 Exhibit 6 – Statement of Michael Abramson, undated, paras 2 & 4; Abramson T333:11-15, T334:2-7
54 Abramson T362:1-6; T363:8-364:9
55 Written submissions of GDF Suez, 27 October 2015, para 59
56 Written submissions of Dr Lester, 9 September, para 15
57 Exhibit 6 - Witness statement of Michael Abramson, undated, para 24
58 Barnett T554:31-555:8
59 Exhibit 16 – Email chain between the University of Melbourne and the Department of Health, pp. DHHS.1008.001.0041, DHHS.1008.001.0042 & DHHS.1008.001.0049
60 Flander T439:13-26

61 Flander T446:19-27
62 Flander T448:3-16
63 Johnston T819:6-24
64 Exhibit 57 – Joint expert report, 19 October 2015, p. 2; Armstrong T767:5-12
65 Gordon T765:27-766:1
66 Exhibit 42 – Report of Associate Professor Barnett, September 2015, p. 1
67 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
68 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
69 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
70 Written submissions of GDF Suez, 9 September 2015, para 9(a)
71 Exhibit 2 – Witness statement of Dawn Sims, undated, para 34(c); Sims T282:29-283:17; T293:7-22
72 Abramson T373:29-374:3
73 McCloud T769:6-771:13
74 McCloud T771:23-27
75 Armstrong T788: 24-31
76 Flander T799:3-18
77 Armstrong T788:24-789:3
78 Gordon T804:11-23
79 Gordon T833:1-8
80 Gordon T833:9-20
81 Gordon T833:26-834:14
82 Abramson T373:29-374:3
83 Johnston T743:30-744:4
84 See for example, Exhibit 28 – Report of Professor Armstrong, August 2015; Exhibit 29 – Report of Professor Gordon, 11 August 2015; Exhibit 57 – Joint expert report, 19 October 2015
85 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
86 Exhibit 57 – Joint expert report, 19 October 2015, p. 1
87 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
88 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
89 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
90 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
91 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
92 Johnston T745:6-21
93 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, pp. 283; Flander T801:10-14; Armstrong T573:29-574:14; Barnett T474:22-475:1; T525:3-21; Exhibit 46 - Report of Dr Johnston, 18 October 2015
94 Exhibit 28 – Report of Professor Armstrong, August 2015, pp. 8 & 9
95 Exhibit 57 – Joint expert report, 19 October 2015, p. 3
96 Flander T803:7-14
97 Armstrong T793:21-794:8
98 McCloud T786:1-19
99 McCloud T811:26-812:8
100 Johnston T813:2-7
101 Exhibit 46 – Report of Dr Johnston, 18 October 2015, p. 1
102 Johnston T744:1-2; Exhibit 46 – Report of Dr Johnston, 18 October 2015, p. 1
103 Exhibit 46 – Report of Dr Johnston, 18 October 2015, p. 1
104 Exhibit 61 – Atkinson, Kang, Anderson, Mills & Walton, *Epidemiological time series studies of $PM_{2.5}$ and daily mortality and hospital admissions: a systematic review and meta-analysis*, 4 April 2014, p. 4
105 Johnston T820:16-26
106 Exhibit 45 – Email from Dr Johnston to Professor Catford, 13 October 2015
107 Johnston T842:28-844:10
108 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, pp. 3 & 4; Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 14 October 2015, p. 2; Dr Johnston did not provide an opinion on the effect of temperature on the analysis of death rates.
109 McCloud T752:23-753:1; Flander T801:2-9; Johnston T745:27-31; Armstrong T792:16-18; Exhibit 29 – Report of Professor Gordon, 11 August 2015, para 39
110 McCloud T752:18-753:1
111 McCloud T776:11-15
112 Exhibit 58 – Table prepared by Dr McCloud titled *Number of Deaths in the La Trobe Valley by Year with 95% confidence interval*
113 Gordon T832:14-16
114 Armstrong T795:5-21
115 Armstrong T795:5-21

116 Hazelwood Mine Fire Inquiry 2014 Exhibit 48 – Expert report of Donald Campbell, 28 May 2014, p. 3

117 Hazelwood Mine Fire Inquiry Report 2014, Part 4.5

118 Johnston T844:29-845:23; See also Exhibit 61 – Atkinson, Kang, Anderson, Mills & Walton, *Epidemiological time series studies of $PM_{2.5}$ and daily mortality and hospital admissions: a systematic review and meta-analysis,* 4 April 2014

119 Exhibit 32 – Report of Dr Burdon, undated, pp. 7 & 8

120 Exhibit 37 – Brook, R, Rajagopalan, S, Pope, A, Brook, J, Bhatnagar, A, Diez-Roux, a, et al (2010), *Particulate Matter Air Pollution and Cardiovascular Disease,* American Heart Association, http://circ.ahajournals.org; World Health Organization (2014), *Ambient (outdoor) air quality and health,* http://www.who.int/mediacentre/factsheets/fs313/en/;

121 Barnett T474:22-475:1; T525:3-21

122 Abramson T354:21-25

123 Johnston T817:28-31

124 Hazelwood Mine Fire Inquiry Report 2014, pp. 318, 319 & 352

125 Written submissions of GDF Suez, 27 October 2015, para 8

126 Exhibit 50 – Letter from Dr McCloud to Emily Heffernan, 13 October 2015, p. 3

127 Armstrong T523:6-14; T601:2-27; Gordon T524:12-18

128 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 3

129 Exhibit 43 – Report of Associate Professor Barnett, 25 September 2015, p. 3

130 Exhibit 28 – Report of Professor Armstrong, August 2015, pp. 20-22

131 Exhibit 30 – Joint report of Professor Armstrong, Professor Gordon, Associate Professor Barnett and Dr Flander, 31 August 2015, p. 4

PART 8

1 Letter from Perry Maddocks Trollope to the Board of Inquiry, 6 November 2015

2 Appointment of a Board of Inquiry into the Hazelwood Coal Mine Fire, Order in Council, Victoria Government Gazette, No S91 Friday 21 March 2014, Term of Reference 4

3 Hazelwood Mine Fire Inquiry Report 2014, p. 400

4 Evidence in the 2014 Hazelwood Mine Fire Inquiry, Lester T1200:12-18

5 Hazelwood Mine Fire Inquiry Report 2014, p. 401

6 2014 Hazelwood Coal Mine Fire Inquiry, Second Submission from the Victorian Government, June 2014; Supplementary Submissions to Inquiry Board on the Department of Health Response to the Hazelwood Fire, undated; Evidence in the 2014 Hazelwood Mine Fire Inquiry, Wilson T2563; T2577, T2582; Hazelwood Mine Fire Inquiry Report Victorian Government Implementation and Monitoring Plan, October 2014

7 Public Health and Wellbeing Act 2008 (Vic), s.17(1)(d)

8 Public Health and Wellbeing Act 2008 (Vic), s.17(2)(d)

9 Public Health and Wellbeing Act 2008 (Vic), ss.20(1), 20(2), 21(a) & 21(b)

10 Public Health and Wellbeing Act 2008 (Vic), s.4(3)

11 Public Health and Wellbeing Act 2008 (Vic), s.10

12 Public Health and Wellbeing Act 2008 (Vic), s.5

13 Public Health and Wellbeing Act 2008 (Vic), s.8

14 Ipsen T279:8-12

15 Ipsen T272:5-273:1

16 Exhibit 7 – Bundle of correspondence between the State and Voices of the Valley

17 Exhibit 6 – Statement of Michael Abramson, undated, para 24

18 Cristine T324:8-15. On 6 November 2015, the Board was informed by the State that the role, which has been renamed 'Communications (Public Health)', has now been filled and the expected commencement date for that role is 1 December 2015

19 Cristine T330:19-27

20 Attiwill T384:3-7

21 Attiwill T655:26-28

22 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 6

23 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 7

24 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 8

25 Exhibit 2 – Statement of Dawn Sims, undated, para 12; Lester T393:1-3

26 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachment 1; Lester T392:1-22 (Although she did not specifically recall this briefing, Dr Lester accepted that it was likely that she had input into the brief that went to the ABS 7.30 Report program.)

27 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachments 2 & 3; Lester T392:1-22; T393:25-394:1

28 See discussion at page 7 of this Part

29 Lester T401:26-31

30 Ipsen T270:10-25; Exhibit 7 – Letter from Hazelwood Mine Fire Inquiry to Department of Health, 22 August 2014

31 Exhibit 38 – Email chain between Victorian Registry of Births, Deaths and Marriages and the Department of Health

32 Exhibit 38 – Email chain between Victorian Registry of Births, Deaths and Marriages and the Department of Health

33 Ipsen T276:11-19

34 Exhibit 39 – Receipt of payment from Victorian Registry of Births, Deaths and Marriages to Voices of the Valley
35 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, para 14
36 Cristine T328:10-15
37 Attiwill T655:28-656:1
38 Exhibit 16 – Correspondence between the University of Melbourne and the Department of Health, p. DHHS.1008.001.0054
39 Exhibit 16 – Correspondence between the University of Melbourne and the Department of Health, pp. DHHS.1008.001.0052-DHHS.1008.001.0054
40 Lester T400:15-28
41 Lester T406:16-31
42 Lester T421:27-422:13
43 Lester T405.25-29
44 Lester T399:28-400:11
45 Lester T400:12-14
46 Lester T399:28-400:11
47 Dr Lester disagreed with this proposition in the submissions of Counsel Assisting – See Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 12
48 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachment 2
49 Exhibit 16 – Correspondence between the University of Melbourne and the Department of Health, pp. DHHS.1008.001.0052-DHHS.1008.001.0054
50 Lester T395:21:-24
51 Lester T395:25:-30
52 Lester T396:20-27
53 Lester T396:28-397:7
54 Lester T397:8-14
55 Lester T397:24-29
56 Lester T397:30-398:1
57 Lester T397:15-23
58 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 17
59 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 18
60 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 19
61 Exhibit 20 – Report of Dr Flander and Professor English, 26 September 2014
62 Exhibit 18 – Draft report, 23 September 2014; Exhibit 19 – Draft report, 23 September 2014; Exhibit 20 – Draft report, 26 September 2014
63 Exhibit 22 – Report of Dr Flander, Mr Ugoni and Dr Hauser, 28 April 2015
64 Exhibit 9 – Draft report dated 13 March 2015; Exhibit 10 – Draft report dated 8 April 2015
65 Exhibit 23 – Report of Dr Flander, Dr Ait Ouakrim, Dr Ghazaleh Dashti and Mr Ugoni, 4 June 2015
66 Exhibit 13 – Draft reports dated 22 May 2015, 30 May 2015 and 31 May 2015
67 Exhibit 8 – Correspondence between University of Melbourne and the Department of Health; Exhibit 12 – Correspondence between University of Melbourne and the Department of Health; Exhibit 16 – Correspondence between University of Melbourne and the Department of Health
68 Exhibit 3 – Statement of Linda Cristine, 18 August 2015, Attachment 5A
69 Exhibit 16 – Email chain between the University of Melbourne and the Department of Health, pp. DHHS.1008.001.0041, DHHS.1008.001.0042 & DHHS.1008.001.0049
70 Exhibit 16 – Correspondence between University of Melbourne and the Department of Health , p. DHHS.1008.001.0050
71 Exhibit 16 – Correspondence between University of Melbourne and the Department of Health, p. DHHS.1008.001.0049
72 Lester T418.28-419.2
73 Lester T419.3-16
74 Exhibit 8 – Correspondence between the University of Melbourne and the Department of Health, p. DHHS.1008.001.0064, p. DHHS.1008.001.0062 and p. DHHS.1008.001.0063
75 Exhibit 8 – Correspondence between the University of Melbourne and the Department of Health, p. DHHS.1008.001.0062
76 Exhibit 8 – Correspondence between the University of Melbourne and the Department of Health, p. DHHS.1008.001.0063
77 Cristine T305:4-19
78 Cristine T304:21-23
79 Exhibit 10 – Draft report, 8 April 2015
80 Exhibit 8 – Correspondence between the University of Melbourne and the Department of Health
81 Flander T440:25-441:8
82 Flander T439:13-26
83. Flander T446:19-27
84 Flander T448:3-16
85 Lester T417:14-28
86 Hazelwood Mine Fire Inquiry Report 2014, Part 4.6
87 Cristine T306:13-25
88 Lester T399:30-400:6

89 Lester T400:24-28

90 (1985) 159 CLR 550 at para 33 (citations omitted)

91 Written submissions of Counsel Assisting, 8 September 2015, paras 90-94

92 Lester T399:24-400:14

93 Blanden T689:2-6

94 (1894) 6 R 67

95 Re Minister for Immigration and Multicultural Affairs [2003] HCA 60 at para 55

96 Re Minister for Immigration and Multicultural Affairs [2003] HCA 60 at para 55

97 Rozen T653:20-25

98 Blanden T694:3-5

99 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015

100 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015

101 Written submissions of Counsel Assisting, 8 September 2015, para 94

102 Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015, para 10

103 Inquiries Act 2014 (Vic), s.76(1)(a) & 76(1)(b)

104 Exhibit 14 – statement of Rosemary Lester, 24 August 2015; Exhibit 15 – supplementary statement of Rosemary Lester, 26 August 2015; Exhibit 59 – Further supplementary statement of Rosemary Lester, 28 September 2015; written submissions of Dr Lester dated 9 September 2015, written submissions of Dr Lester dated 27 October 2015, Blanden T675:22-694:1; Letter from Perry Maddocks Trollope to the Board of Inquiry, 6 November 2015

105 Written submissions on behalf of GDF Suez Australian Energy, 27 October 2015; written submissions on behalf of Dr Lester, 27 October 2015

106 Teague T717:8-718:15

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