HAZELWOOD MINE FIRE INQUIRY

Submission cover sheet

Post your submission with this cover sheet to:

Submissions Hazelwood Mine Fire Inquiry
PO Box 3460
GIPPSLAND MC Vic 3841

Email your submission with this cover sheet to info@hazelwoodinquiry.vic.gov.au.

Title: MR.	First Name: ROBERT	Surname: TEMPLE
Organisation represented(*if applicable*): NONE.		
Email address: [redacted]		
Postal address: [redacted]		CHURCHILL VICTORIA 3842
Telephone: [redacted]		Mobile: [redacted]
☐ Origin and circumstances of fire ☐ Measures by Hazelwood Coal Mine to prevent fire ☐ Application and administration of regulatory regimes ☑ Other (please state) DANGER POSED BY ORGANIC COMPOUNDS.		Response to fire by: ☐ Hazelwood Coal Mine ☐ Emergency Services ☑ Environmental Agencies ☑ Public Health Officials ☐ Other Government Agencies

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Signature R.J. Temple

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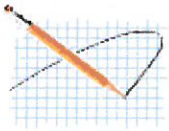

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To Hazelwood Inquiry info/DPC@DTF
cc
bcc
Subject Submission by Robert Temple to the Hazelwood Mine Fire Inquiry

5 attachments


Application side A.pdf


Application side B.pdf


Attachment 1.pdf


Attachment 2.docx


Attachment 3.docx

Robert Temple's submission to the Hazelwood Mine Fire Inquiry
Date 8th May 2014

Firstly I would like to thank everyone involved, for this opportunity to lodge a submission to the Hazelwood Mine Fire Enquiry.
With regard to the fire there is no doubt that the residents of Morwell in particular and the Latrobe Valley in general are fortunate that the fire fighting services were able to finally bring the fire under control and end the direct threat to life and property.

In this submission I will confine my attention to the threat posed by organic compounds to the future health of residents exposed to the emissions from the fire. In particular I am very concerned about chronic exposure to a group of compounds called Polycyclic Aromatic Hydrocarbons (PAH) which are known to affect the long term health of exposed individuals. PAH are stable and therefore persistent substances. They are formed when carbonaceous materials burn slowly with a restricted air supply. The type of combustion in the Open Cut fire favours the formation of PAH because the fire on the coal face rapidly migrates into the lower layers of coal where its rate of progress is controlled by the supply of air reaching the combustion zone.

From the first day of the fire, air-constrained combustion would have been a common mode of fire behaviour, so PAH formation was taking place from the start.
The ash formed in the combustion of brown coal is a very fine mineral particulate due to the way the mineral components of the coal are dispersed throughout the bulky organic coal structure. Thus the ash contains a preponderance of microfine particles known scientifically as PM 10 and PM 2.5 by their size measured in microns (10 and 2.5 micrometres).
The presence of a large quantity of PM 10 and PM 2.5 particles in the fire zone gives an enormous surface area for the condensation of PAH.
PAH are termed high molecular weight compounds with a corresponding high melting point and low volatility. By themselves they would quickly condense and precipitate close to the fire but due to association with the fine ash particles their dispersion in the atmosphere is greatly enhanced.

As a chemist with extensive experience in both the power industry and coal gasification I have long been aware of PAH and the risks they pose to health.
I researched the Internet looking for a suitable reference to PAH and the South Australian

Government Fact Sheet document is both succinct and quite readable, so this document has formed the basis for my approaches firstly to the Victorian Government and now this inquiry. (see Attachment 1)

I watched the progress of the fire for the first 3 weeks, all the time getting increasingly concerned that the official line from the EPA and Dept. of Health was that the smoke was harmless and did not present a health risk, despite the fact that ABC Radio presented numerous interviews with Morwell residents who were definitely reporting quite serious symptoms such as nausea, breathing difficulties and enhanced asthma. All the time the authorities tried to sooth concern by focusing on the threat posed by carbon monoxide. Intense efforts were made to monitor the atmospheric concentration of carbon monoxide while there appeared to be no consideration given to other possible contaminants. The only other monitoring conducted at this time was measurement of Air Particle Index (API). Slowly from API measurements it became apparent that the atmosphere in Morwell was seriously degraded. The focus swung to air borne fine particulates and a monitoring network of PM 10/PM 2.5 instruments was set up. This soon confirmed that a serious situation existed in Morwell due to fine particulates in the air. For the first time the risk from 'respirable particulates was discussed on by medicos and a concerned public, but still the official line from Government agencies played down the risk to health from exposure to the emissions.

I wrote to our local member Mr. Russell Northe early on 28th February expressing my deep concern about the situation in Morwell. (see Attachment 2) Late in the afternoon of the 28th Feb I received a call from Mr Northe's office seeking my permission to pass on my letter to the EPA. I agreed and then heard nothing for more than 2 weeks. However in the meantime the official advice to residents changed significantly so that a by very early March aged, infirm, the young and pregnant mothers were advised to leave Morwell if possible. Later in the month a payment system was introduced to assist people in need to leave the town.

By Mid March, having heard nothing from the EPA, I decided to re-submit my letter of the 28th Feb. This time I emailed Mr. Northe together with the Premier, his Deputy, and the Health and Environment Ministers. Mr Northe thanked me for my letter but once again there was no response from the Government agencies. By this time Mr. Northe had been promoted to Minister for Energy.

In mid to late March the EPA released a number of monitoring reports on their official website.
The data included in the reports were simply results of ash and soil analysis taken around Morwell and gave little indication of personal exposure. The analyses were comprehensive in scope but were of little use without interpretation and there was none given in the reports.
By late in March there had been no atmospheric monitoring data released for the town and time was running out to gather any before the fires were extinguished. I am still amazed that there appears to have been no direct atmospheric monitoring conducted around the mine or in Morwell. What analysis that has been done is confined to soil and ash and it is left for researchers to guess how this relates to the true situation in the atmosphere.
It is definitely too late to perform any atmospheric monitoring once the fires are out so it is left to mathematical modeling to assess the intensity and dispersion of pollutants.

To help me understand the exposure of a person living in Morwell South I derived a simple model using some assumptions and the data supplied by EPA, to calculate the daily burden of particulates and PAH inhaled by a resident exposed to the emissions. (See Attachment 3)
I have no training in Occupational Health but I am certain no industrial site would permit the levels of contaminants indicated by my calculations.
The problem for residents is their exposure lasted for weeks and the population sample covered all ages and conditions of health.
END of SUBMISSION

Public Health Fact Sheet

Polycyclic Aromatic Hydrocarbons (PAHs): Health effects

PAHs can be released into the air, water and soil from burning, industrial processes and use of some household products. They can persist in the environment for very long periods of time.

The effects on human health depend on the concentration of PAHs and the type and extent of exposure.

What are Polycyclic Aromatic Hydrocarbons (PAHs)?

PAHs comprise a group of over 100 different chemicals that are produced during the incomplete burning of fuels, garbage or other organic substances such as tobacco, plant material or meats. These combustion processes produce a mixture of chemicals with soot being a well known example. Tobacco smoke contains many chemicals including PAHs which are found in the tar that accumulates in the lungs of smokers.

Some of these PAHs are manufactured for research or are used in medicines, dyes, plastics and pesticides such as naphthalene found in mothballs. PAHs can also be found in coal tar, bitumen, crude oil, creosote and roofing tar.

The distribution of PAHs in the environment is extensive and the general public may be exposed to PAHs found in soil/dust, air, water, food or household products.

17 PAHs have been identified as being of greatest concern with regard to potential exposure and adverse health effects on humans and are thus considered as a group. These include:

- acenaphthene
- acenaphthylene
- anthracene
- benz[a]anthracene
- Benzo[a]pyrene
- benzo[e]pyrene
- benzo[b]fluoranthene
- benzo[g,h,I]perylene
- benzo[j]fluoranthene
- benzo[k]fluoranthene
- chrysene
- dibenz[a,h]anthracene
- fluoranthene
- fluorene
- indeno[1,2,3-c,d]pyrene
- phenanthrene
- pyrene

What are the acute or short-term health effects of PAHs?

The effects on human health will depend mainly on the extent of exposure (length of time, etc), the amount one is exposed to (or concentration), the innate toxicity of the PAHs and whether exposure occurs via inhalation, ingestion or skin contact. A variety of other factors can also affect health impacts from such exposure, including pre-existing health status and age.

Intake of PAHs from contaminated soil may occur via ingestion, inhalation or dermal (skin) exposure to contaminated soil/dust, and from inhalation of PAH vapours. Tilling of dry soil can result in ingestion of small but measurable amounts of soil.

Government of South Australia
SA Health

The ability of PAHs to induce short-term health effects in humans is not clear. Occupational exposures to high levels of pollutant mixtures containing PAHs has resulted in symptoms such as eye irritation, nausea, vomiting, diarrhoea and confusion. However, it is not known which of the mixture components were causative for these effects. Mixtures of PAHs are known to cause skin effects in animals and humans such as irritation and inflammation. Anthracene, benzo(a)pyrene and naphthalene are direct skin irritants while anthracene and benzo(a)pyrene are reported to be skin sensitisers, i.e. cause an allergic skin response in animals and humans.

What are the chronic or long-term health effects of PAHs?

Health effects from chronic or long-term exposure to PAHs may include cataracts, kidney and liver damage and jaundice. Repeated contact with skin may induce redness and skin inflammation. Naphthalene, a specific PAH, can cause the breakdown of red blood cells if inhaled or ingested in large amounts.

Animals exposed to levels of some PAHs over long periods in laboratory studies have developed lung cancer from inhalation, stomach cancer from ingesting PAHs in food and skin cancer from skin contact.

Long-term studies of workers exposed to mixtures of PAHs and other workplace chemicals have shown an increased risk of skin, lung, bladder and gastrointestinal cancers. These studies have also reported asthma-like symptoms, lung function abnormalities, chronic bronchitis and decreased immune function. However, it is not clear from these studies whether exposure to PAHs was the cause as other potential cancer-causing agents were also present.

Are there any other health effects of PAHs?

Laboratory studies in mice have demonstrated that ingestion of high levels of a specific PAH known as benzo[a]pyrene during pregnancy resulted in difficulty in reproducing. This effect was also seen in the offspring. Effects in the offspring also included birth defects and decreased body weight. It is not known whether these effects can occur in humans.

What are the effects of exposure to children?

The effects of short-term exposure to children are the same as for adults. However children, who have lower bodyweights than adults, do not require as great an exposure to experience the same health effects as adults. Young children are also prone to behaviours that may increase their potential for exposure, e.g. crawling on bare dirt surfaces, eating soil, and more hand-to-mouth activities.

Populations at special risk

Some people have an increased susceptibility to the effects of PAHs. This generally includes the elderly who have declining organ function and young children with immature and developing organs. Such susceptibility is however, common for all chemicals not just PAHs.

In addition, people who smoke (and therefore inhale PAHs and thus have higher exposure), have a history of excessive sun exposure (enhanced skin cancer response if simultaneously exposed to PAHs via skin), have liver and skin diseases and women of child bearing age have an increased susceptibility to PAHs. It is also recognised that PAHs (e.g. in mothers who smoke tobacco) may cross the placenta and enter the body of the unborn fetus.

What is the safe level of PAH intake?

Prudent public health practice is to minimise exposure to any agent that may have cancer-causing potential. Estimations of safe PAH intake levels are problematic because of the complexity of such mixtures. Regarding cancer risk, this is complicated by the need to rely on high dose benzo(a)pyrene animal studies and by differences in risk estimation approaches of various jurisdictions.

How can potential exposure be determined (environmental monitoring)?

Potential exposures to chemicals may be assessed by testing contaminated soil, air or water for the chemicals of interest and estimating the degree of intake of each of these media into the human body.

Can the level of PAHs in the body be tested (biological monitoring)?

Several methods have been developed to assess internal exposure (the amount absorbed by the body and distributed to various organs and tissues) to PAHs. Most of these methods are based on determining metabolites in urine of exposed people.

The most widely used method is the determination of 1-hydroxypyrene in urine and this has been demonstrated to provide useful evaluation of recent exposures to PAHs in workers exposed to PAHs. However, this test is not generally recommended for the general population.

What precautions should I take to reduce potential exposure to soil contaminated with PAHs?

Should you be living on a site known to contain PAHs in the soil potential exposure may be reduced by various common sense precautions. Young children and pets should be excluded from bare earth areas in the garden if the soil contains PAHs.

Cessation of gardening activities will diminish most soil exposure. If gardening is continued, precautions to avoid contact with soil should be used such as gloves, dust masks and washing of gardening equipment and footwear. Contaminated soil should not be allowed to enter the indoor environment.

Some PAHs may evaporate from contaminated soil and result in the detection of odours. Should odours arising from ground sources be detected, avoid the inhalation of these odours and contact SA Health's Scientific Services on 8226 7100 for advice.

What is the safe distance from an area contaminated with PAHs?

The safe distance from a site will be dictated by onsite activities that may result in release of contaminated dust or vapours. Appropriate management of a contaminated site includes ensuring that off-site releases are minimised and do not result in significant exposure to surrounding residents.

Should I continue to use groundwater from my bore?

It is possible for soil contaminants to migrate from areas of soil contamination to the groundwater. This will depend on many factors such as subsurface hydrogeology, types of soil contaminants, their distribution, and how long the contaminants have been in the soil.

It is important that groundwater is tested to ensure it is suitable for its intended use irrespective of whether there is a potential for contamination from a contaminated soil source. If there is a concern regarding contamination arising from a contaminated site further investigation is necessary.

How can I protect children from soil containing PAHs?

In young children, particularly those aged under 5 years, exposure to PAHs from contaminated soil may occur from ingestion of the soil or from skin contact with the soil.

Children's hands should be washed before eating and after playing in the yard. Young children's toys that are taken outside should be cleaned frequently to reduce the risk of transferring soil to the mouth.

Contaminated soil should be kept out of homes in which very young children live. Dirty boots that have been worn for gardening in contaminated bare earth areas should be cleaned of soil before entering the house.

Children should be excluded from areas where odours from ground contamination are noticed, particularly where these odours are confined in small areas such as small pits (sandpits), cellars and cubby houses.

Who can I contact for more information?

If you have any health queries, please call SA Health's Scientific Services on 8226 7100.

Translation service

For information in languages other than English, call the Interpreting and Translating Centre and ask them to call the Department of Health.

This service is available at no cost to you; contact 8226 1990.

Contact

Scientific Services
Public Health
SA Health

1st floor, Citi Centre Building
11 Hindmarsh Square
Adelaide SA 5000

PO Box 6, Rundle Mall
Adelaide SA 5000

Tel 08 8226 7100
Fax 08 8226 7102

ABN 97 643 356 590

Email: public.health@health.sa.gov.au
Web: www.health.sa.gov.au/pehs/environ-health-index.htm

Last revised February 2009

Government of South Australia
SA Health

General comments on the Mine Fires **26th February 2014**

Since the Hazelwood Mine fire started nearly three weeks ago, I have been very concerned that the Victorian Government has adopted a cavalier attitude towards informing the local residents of the real dangers posed to health by the slow burning coal fire in the Mine.
I am a chemist with extensive experience in Brown coal gasification and ambient air monitoring, so I feel I can offer an opinion. In addition, I am a long term resident of the Latrobe Valley and I can still remember the significant fire in the Hazelwood Open Cut in the 1970's and its effect on Morwell.

At the outbreak of the Hazelwood Open Cut fire, the official focus was confined to the danger posed by carbon monoxide and its effect on the fire fighters and residents. While this is laudable, the contribution of sulphur dioxide and nitrogen oxides to the health of the public was seemingly not considered. Sulphur and nitrogen dioxides are acidic gases and represent a real danger to asthmatics and sufferers of other respiratory ailments. Early statements by Government claimed the smoke posed no health hazard.

After more than a week, it was reported by the EPA that testing indicated the presence of respirable PM2.5 particulates, countering the earlier position of the EPA that breathing the smoke and dust posed no hazard to health. Particles with a diameter of less than 2.5 microns (termed PM2.5) are carried deep into the lungs by respiration, despite the body's natural defenses.

On Friday 21st Feb, when I was driving home from work on the Freeway, close to the southern edge of Morwell, I distinctly smelt a naphthalene-like odour suggesting the presence of Polycyclic Aromatic Hydrocarbons (PAHs) in the combustion products from the fire.

On ABC Radio the same day, two senior managers of the EPA disputed reports by Morwell residents that the smoke had a tar-like smell and they went further by saying that they could not understand the cause of such an odour. I found this statement to be incredible, coming from the expert body in charge of atmospheric monitoring at the fire site.
Now, nearly three weeks into the fire event I have not heard any mention of hydrocarbon components in the smoke, *even though these compounds possibly represent the greatest danger to human health.*

PAHs and other organic compounds are known to be formed when coal burns with a restricted air supply. The rate of combustion of coal burning inside a coal face is limited by the supply of oxygen. Such combustion conditions favour the formation of carbon monoxide. Coal, burning in free air, results in the formation of carbon dioxide, and little or no carbon monoxide is formed.

Mechanism of underground coal combustion

When coal is burnt in free air, the hydrocarbons and carbon it contains are converted to carbon dioxide, water and traces of carbon monoxide, sulphur dioxide and nitrogen oxides. The combustion temperature is high enough to ensure that there is effectively total destruction of all the constituents of the coal, except for the mineral ash.
However when coal burns underground the situation is entirely different, due to restriction of oxygen. Combustion takes place slower and at much lower temperature. This leads to the formation of carbon monoxide, along with a multitude of hydrocarbon compounds, either by destructive distillation of the coal or formed by synthesis under the conditions of combustion. The combustion conditions are said to be 'fuel rich' and replicate a coke or char retort.

Much of the coal mass escapes from the combustion zone as unburnt hydrocarbons and phenols, with a significant proportion being synthesized to other compounds during combustion. Heavy molecular weight PAHs are very stable to heat, compared to lower molecular weight compounds, so the slow, low temperature combustion favours the formation of PAHs. The heavy hydrocarbons give the smoke its characteristic tarry smell and are very irritating to the eyes and nasal passages.
PAHs are solids with melting points in the hundreds of degrees, so they quickly condense when cooled. Their stability also tends to make them very persistent in the environment.
I expect that when the fire penetrates deeper into the coal the rate of combustion could be further reduced by an even greater restriction of oxygen. The chemistry of combustion and the hydrocarbons formed along the way will no doubt be different to that in the shallower, hotter fire at the surface.
Brown coal contains small amounts of nitrogen and sulphur and during combustion these elements are either converted to their oxides or become associated with hydrocarbons as amines, mercaptans etc.
Unmentioned till now is the fact that Brown coal also contains a fair proportion of oxygen which probably leads to the formation of phenols during combustion. Phenols pose a significant danger to the environment should they find their way into streams.

The Role of Particulates and PAHs in the smoke plume.

The smoke plume has been confirmed to contain PM2.5 particles, most likely coal ash. Respiration can carry PM2.5 particles directly into the lungs. The fine ash particles pose an unknown health hazard with their burden of mineral constituents. PM2.5 particulates are not normally encountered by the body except for carbon soot in diesel exhaust gas.

In the case of the Mine fire the risk to health from PM2.5 is compounded by the presence of polyaromatic hydrocarbons. As the combustion products leave the fire zone, they cool and the PAHs in the vapour state condense and coat the micro finePM2.5 ash particles.
PM2.5 particles are too fine to settle out of the air so they can travel great distances as a constituent of the smoke plume.
Inhalation of PM2.5/PAH particulates contaminates the deep lung structure with compounds similar to those encountered in cigarette smoke.
Nobody can give any assurance that breathing Hazelwood Mine Fire smoke does not pose a significant health risk. Once again as in the case of smoking and asbestos the latency period, before the onset of symptoms, makes it difficult to specifically associate a future health condition with the most likely cause.

<u>Points for Further Study</u>

- There is an urgent need to determine the PAH concentration associated with the fine particulates, as well as gaseous sampling of the smoke plume.
- PAHs can be speciated by analysis using gas chromatography/ mass spectroscopy (GCMS) and high performance liquid chromatography (HPLC)

Robert Temple ARACI. CChem
[redacted]
Churchill Vic. 3842
[redacted]

Comments on '**Ash sampling data from Willis Street'** report by the EPA

The EPA report entitled "**Ash Sampling Data from Willis** (Wallace**?) Street**" published on the Internet makes interesting reading, though it doesn't give the full picture without figures relating the concentration of pollutants to the total burden of ash in the air (particularly the PM 2.5) as breathed by a typical person, during a day.

The EPA reported some days the 'air quality index' in Morwell South was over 1000 on a scale where good air quality is <25 and poor is >80.

In the '**Air quality terms'** page of the EPA's Air monitoring information sheets, the Air quality index directly relates to the Particulate matter concentration, measured in ug/cubic metre. This is a good indicator for general use because the Index has no unit.

Using this data I have tried to do a 'back of the envelope' calculation to perhaps put things in a better perspective with regard to people and their exposure

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The steps in process I used to calculate the daily exposure of a person to PAH's, assumes that the bulk of the particles are PM 2.5 and the particles are retained in the lungs during exhalation.

When I did SCUBA training many years ago the rate of air consumption was assumed to be 1 ft^3/min at the surface. Since one ft^3 = 28.3 litres, the approx breathing rate for an adult may be taken as 28litres/min.

1. A rough daily respired air volume of 40 $metres^3$ can be derived from the 28L/minute value.

2. Assuming the EPA's 'worst case' reported Air Quality Index of 1000; equates to a Particulate concentration of 1000ug/m3

Combining the adult respired air volume and the $1000ugm^3$ gives a daily burden of inspired fine ash particles of 40,000 ug or 40mg, mostly retained in the lungs. This level of solids deposition in the lungs is of great concern.

3. The 'Column 3 data for Total PAH's in ash' from the EPA report on 3/3/2014, quotes 7.6mg/Kg or (7.6ppm) for the total PAH's associated with 1Kg of ash (7.6mg/Kg =7.6mg/1000000mg of ash

4. By further calculation, the daily burden of total PAH's deposited in the lungs, during respiration **= 0.000304mg or 0.3 micrograms** on a '**1000**' Air quality index day.

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It's tempting to discount such a small mass as insignificant, but the deposited PAH's are finely divided onto the surface of a far greater quantity of ash and this gives it a much greater surface area to affect lung tissue and directly enter the blood stream .

It should be remembered that apart from smokers, lung tissue doesn't normally come in contact with such levels of these contaminants. A big problem with PAH's in the body is their stability and very low volatility, giving them a long lifetime in the lungs

Assessment of the danger posed to the lung from this level of contaminants must be left to and pulmonary specialists and occupational health scientists.

A group at far greater risk is the fire fighters who have been exposed to far higher levels of contaminated ash as well as volatile PAH's in the hot emissions. Estimating their exposure will be difficult unless there was on-the-spot monitoring conducted during the fire event.

Mention has been made in the media of the inorganic elements in the ash, particularly mercury, but in reality the elemental analyses in the 'Ash sampling data from Willis Street 'report are very typical of power station fly ash. Unlike black coal, brown coal ash is relatively free of heavy metals.

Robert Temple
18th March 2014