Coal and health in the Hunter:
Lessons from one valley for the world

CLIMATE AND HEALTH ALLIANCE

Background to this report

This report has been produced on behalf of the Climate and Health Alliance (CAHA) to support its advocacy for the protection and promotion of health from the impacts of climate change and environmental degradation. The health implications of energy policy are a key concern for CAHA and highlighting the risks to health from energy choices is a core element of its work.

This report was developed using a combination of sources, including international and national health and medical literature on coal and health, as well as grey literature, including submissions to government inquiries, academic, scientific and industry reports, reports from think tanks, community organisations, and media and from interviews with local community members and experts. It represents an analysis and synthesis of the selected sources. It is not a systematic scientific review.

This report aims to highlight the risks to health associated with the rapid expansion of coal mining in the Hunter Valley for the local population as well as the risk to the global community from the contribution to climate change from coal exports. It is aimed at politicians, policymakers, media, those advocating for policy change, health professionals, and communities affected by coal mining and combustion, in the Hunter Valley and elsewhere.

A website with the report, full set of recommendations, a summary for policymakers, infographics, additional images and short videos is available at: http://caha.org.au/ projects/hunter-coal/

About the Climate and Health Alliance

The Climate and Health Alliance (CAHA) is a not-for-profit organisation dedicated to protecting and promoting health from the adverse impacts of climate change and environmental degradation, and promoting sustainable healthcare. Its members include health professional organisations representing doctors, nurses and midwives, psychologists, physiotherapists, social workers, rural and remote nurses and allied health professionals, as well as healthcare service providers, academic institutions, primary healthcare services, health consumers, and individual health professionals. It is the Australian affiliate of the international not-for-profit organisation Health Care Without Harm.

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The analysis of the economic costs associated with health impacts and social costs of carbon have been reviewed and independently verified by Economists at Large (see Appendix B for further details).

Written by Fiona Armstrong

Any errors are those of the Climate and Health Alliance.

For more information about this report contact:

Fiona Armstrong Convenor
Climate and Health Alliance
PO BOX 343 Clifton Hill VIC 3068
convenor@caha.org.au
www.caha.org.au

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Quick facts

Coal from the Hunter Valley is **Australia's largest single source of carbon dioxide** (CO_2) emissions to the atmosphere.[2]

The Hunter Valley is responsible for around **two-thirds of NSW coal production**.[3]

Coal from the Hunter Valley is currently responsible for the **production of around 348 million tonnes of carbon dioxide equivalent each year**.[4]

1. Executive summary

The rapid expansion of the coal industry in the Hunter Valley is out of step with the global requirement to reduce greenhouse gas emissions, and is leading to increasing concerns about adverse impacts on local communities and the state's economy.

The production of coal is one of the most greenhouse gas intensive activities in the world, and is one of the main drivers of climate change – considered the biggest threat to global public health.

Coal production also poses serious risks to the health of local communities, as well as causing substantial environmental damage – both of which incur substantial economic costs.

The impacts on local communities in the Hunter Valley include exposure to harmful air, noise and water pollution, distress associated with social disruption, and a sense of abandonment as government's prioritise the interests of the coal industry above that of the community. Government regulations are failing to protect the community and the Hunter Valley's natural assets from the negative impacts of the region's intensive coal mining and coal combustion industries.

Air quality monitoring in the region demonstrates the residents of the rural village of Camberwell are being exposed to higher levels of air pollution than some inner Sydney suburbs. As a major coal export hub, parts of the city of Newcastle are already experiencing intolerable levels of coal dust, and a proposed fourth coal export terminal threatens to increase by 50 per cent the number of coal trains (to approximately 42,000 each year) passing through the city.

Estimated costs of health damages associated with coal combustion for electricity in Australia amount to $2.6 billion per annum. This report estimates the annual costs of associated health damages from the five coal fired power station in the Hunter Valley at around $600 million per annum.

For the towns of Singleton and Muswellbrook, the burden of health damages is estimated at $47 million in Singleton and $18.3 million in Muswellbrook each year from exposure to fine particles (PM2.5) emitted from coal mines and coal fired power stations into the air. These particles travel deep into the lungs and pass into the blood stream, posing a risk of stroke and heart attacks.

This report uses published estimates of the economic costs associated with the local health impacts as well as wider global impacts (the social costs of carbon) associated with Hunter Valley coal, outlined in the tables below.

Table 1: The local health costs of coal in the Hunter Valley

Source of health damage	Value of health costs
Externalised health costs associated with pollution from five coal fired electricity generators in the Hunter Valley	$600 million per annum
Health costs associated with fine particle pollution (PM2.5) from coal sources (coal mines and coal fired power stations) in Singleton	$47 million per annum
Health costs associated with fine particle pollution (PM2.5) from coal sources (coal mines and coal fired power stations) in Muswellbrook	$18.3 million per annum
Health costs associated with air pollution (PM10) from coal sources in Newcastle	$13 million per annum

Table 2: Social costs of carbon associated with Hunter Valley coal

Estimates of the social costs of carbon (SCC)	Current production volume of Hunter Valley coal	Social cost of carbon associated with Hunter Valley coal
$37/tonne CO_2e – $190/tonne CO_2e	145 million tonnes per annum	$16 billion – $66 billion per annum

Despite these serious and costly impacts, recent changes to planning laws remove the rights of communities to contest proposed projects. The views of health experts and community members have little impact on policy and approvals, and projects are failing to account for greenhouse emissions, human health and broader environmental impacts.

Insights into the impacts on individuals and communities are provided in the report's case studies (and via video), illustrating the adverse impacts of air pollution, noise, disempowerment, and a failure to adequately research or regulate to prevent adverse impacts on individuals and the broader community.

The recommendations accompanying this report call for:

- A ban on new coal projects in the Hunter Valley
- The development of a transition plan to assist the region develop new industries as coal is phased out
- Stronger regulation of any projects in the planning pipeline to adequately evaluate and limit health, climate, and environmental damages
- Stricter air quality standards and monitoring of all coal sources, with data publicly available
- Increased consultation with communities affected by coal projects
- The implementation of mandatory health impact assessments as part of all project assessment processes still in the planning phase
- Comprehensive health research studies to evaluate
  - the environmental health risks faced by local communities from exposure to pollutants associated with the coal industry, and
  - the social impacts associated with disruption to communities, to landscapes, ecosystems and other industries.

Photo © Leo Farrell

2. Introduction: local, state, global impacts

The Hunter Valley is one of the largest river valleys in the Australian state of New South Wales and stretches from the coastal towns of Newcastle and Lake Macquarie in the southeast to the rugged ranges of the Barrington Tops in the north and west past the Merriwa Plateau.

The valley floor is rich in carbon formed from the fossilisation of plants during the Permian period, over 200 million years ago. Over the intervening period, that carbon became coal.

Traditionally regarded as a bucolic rural landscape of rolling green hills and fertile farmland, little in the Valley now remains untouched by coal mining. While mining coal has been part of the Hunter Valley history over the last two centuries, there has been an explosion in coal mining activity in the region over the past decade which means many local communities (and other industries) are literally surrounded by coal mines.

There are widespread community concerns that the expansion of mining in the Hunter Valley is occurring at the expense of community wellbeing and natural ecosystems, including the clean air, water and soil that support the other important regional industries of viticulture and winemaking, thoroughbred breeding, farming and agriculture, and tourism.

Health and medical literature points to serious harm to human health from all stages of the coal lifecycle – including mine development, mining activities, and coal transportation and combustion (collectively called 'coal production' in this report).

The risks to health can be both physical and psychological, and arise from direct causes such as air pollution and water contamination, and less directly from economic burdens, emotional distress, social conflict, ecological degradation, loss of biodiversity and climate change.

The coal mined and burned in the Hunter Valley and exported to other countries poses risks not only for the health and wellbeing of local communities, but also for communities where the exported coal is burned and, because of coal's significant contribution to climate change, for communities around the world.

Hunter Valley coal produces around 348 million tonnes of carbon dioxide (CO_2) each year,[6] making it Australia's largest single source of CO_2. These emissions are generated from the coal-fired power stations and other industries in the region, and from the 126 million tonnes of Hunter Valley coal exported annually to be burnt in power stations in Japan, Taiwan, Korea, and other destinations.[7]

Of all the energy sources, coal is the single biggest contributor to greenhouse gas emissions and a major driver of climate change.

Climate change poses the most serious risk to global public health this century and averting further global warming is an international public health priority.[8] Climate change is already a leading global cause of death, and is responsible for 400,000 deaths globally each year.[9] The annual toll of the global intensive carbon economy is estimated at 4.5 million deaths, mainly from air pollution, hazardous occupations and cancer.[10]

The harm to health, industry and infrastructure from climate change costs the global economy more than one trillion dollars annually.[11]

The impacts on people's health from climate change are already significant and intensifying: including illnesses, injuries and deaths from cyclones, storms, bushfires and floods; increasing deaths from heatwaves; changes to the spread of climate sensitive infectious diseases; and issues such as malnutrition and stunting among children in developing nations from declining food yields.[12]

The greatest threat to human health and survival comes from the harm to life-supporting systems of the biosphere. The only ways to address that threat are a rapid transition to renewable energy and halting the destruction of natural assets and ecosystems.[13] Continued exploitation of coal and other fossil fuels is anticipated to drive global warming beyond safe climate limits.[14] Estimates of the available carbon 'budget' indicate only one-fifth of proven reserves of fossil fuels can be burned before 2050 if we are to reduce the likelihood of exceeding 2°C warming above pre-industrial temperatures.[15] If all the coal reserves from the Hunter Valley are mined and burnt, it will limit the chances for the world to meet that goal.

Many countries around the world, including Australia, are already experiencing significant negative and costly impacts from global warming on health and wellbeing, on agriculture, and on infrastructure. The further exploitation of coal resources for domestic production and export is inconsistent with global public health and safe climate goals.

Once an unquestioned source of economic prosperity, the damage caused by coal to people's health, natural capital and the global climate has led to closer scrutiny of its impacts.

The evidence suggests coal is becoming an unwelcome social and economic burden, and a risk to community wellbeing, the economy and a safe climate.

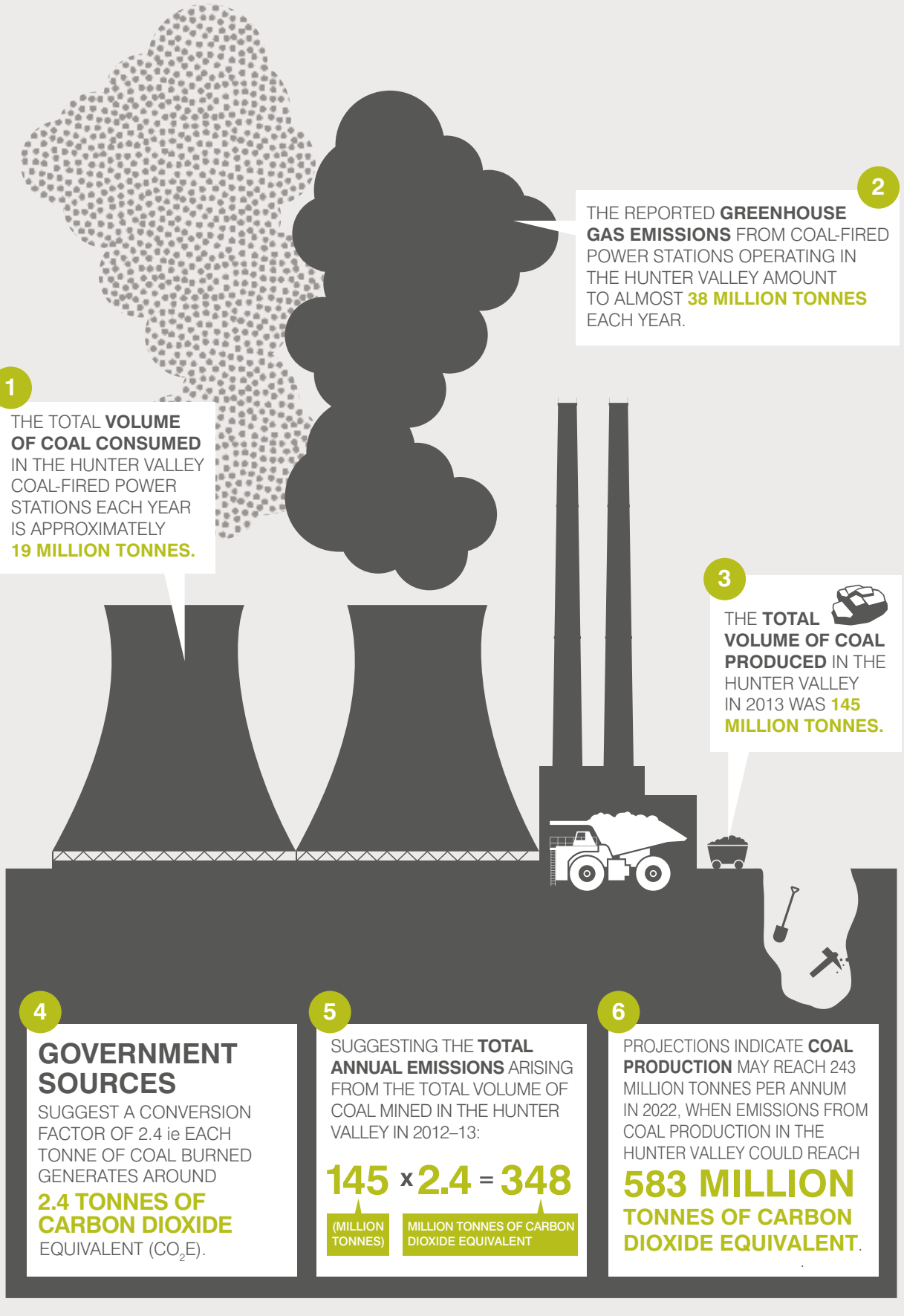
This paper will review the health risks of coal mining in the Hunter Valley as well as the global impacts associated with the unprecedented expansion within the region.

Carbon emissions from Hunter Valley coal

- The total volume of coal consumed in the Hunter Valley coal-fired power stations each year is approximately 19 million tonnes.[16]
- The reported greenhouse gas emissions from coal-fired power stations operating in the Hunter Valley amount to almost 38 million tonnes each year.[17]
- The total volume of coal produced in the Hunter Valley in 2013 was 145 million tonnes.[18]
- Government sources however suggest a conversion factor of 2.4 ie each tonne of coal burned generates around 2.4 tonnes of carbon dioxide equivalent.[19]
- This suggests the total annual emissions arising from the total volume of coal mined in the Hunter Valley in 2012-13: 145 million tonnes x 2.4 = 348 million tonnes of carbon dioxide equivalent (CO^2e).[20]
- Projected for future growth put production is expected to reach 243 million tonnes per annum in 2022, when total annual greenhouse gas emissions from coal production in the Hunter Valley could reach 583 million tonnes of carbon dioxide equivalent.[21]

Carbon emissions from Hunter Valley coal

HUNTER VALLEY COAL



1 THE TOTAL **VOLUME OF COAL CONSUMED** IN THE HUNTER VALLEY COAL-FIRED POWER STATIONS EACH YEAR IS APPROXIMATELY **19 MILLION TONNES.**

2 THE REPORTED **GREENHOUSE GAS EMISSIONS** FROM COAL-FIRED POWER STATIONS OPERATING IN THE HUNTER VALLEY AMOUNT TO ALMOST **38 MILLION TONNES** EACH YEAR.

3 THE **TOTAL VOLUME OF COAL PRODUCED** IN THE HUNTER VALLEY IN 2013 WAS **145 MILLION TONNES.**

4 **GOVERNMENT SOURCES** SUGGEST A CONVERSION FACTOR OF 2.4 ie EACH TONNE OF COAL BURNED GENERATES AROUND **2.4 TONNES OF CARBON DIOXIDE** EQUIVALENT (CO_2E).

5 SUGGESTING THE **TOTAL ANNUAL EMISSIONS** ARISING FROM THE TOTAL VOLUME OF COAL MINED IN THE HUNTER VALLEY IN 2012–13:

145 (MILLION TONNES) x **2.4** = **348** MILLION TONNES OF CARBON DIOXIDE EQUIVALENT

6 PROJECTIONS INDICATE **COAL PRODUCTION** MAY REACH 243 MILLION TONNES PER ANNUM IN 2022, WHEN EMISSIONS FROM COAL PRODUCTION IN THE HUNTER VALLEY COULD REACH **583 MILLION TONNES OF CARBON DIOXIDE EQUIVALENT**.

3. Coal operations in the Hunter Valley

There are currently 31 coal mining operation sites in the Hunter Valley, including 22 open cut and 17 underground mines (eight sites have both), and five coal-fired power stations. These mines currently produce 145 million tonnes of coal per annum (Mtpa).[22] In 1999, the coal mines were estimated to collectively account for a land surface area of 520 square kilometres.[23] Mining exploration leases cover 128,000ha, or 64%, of the Hunter Valley floor.[24]

Coal production from the region has increased dramatically in recent decades, as the figure below illustrates.[25]

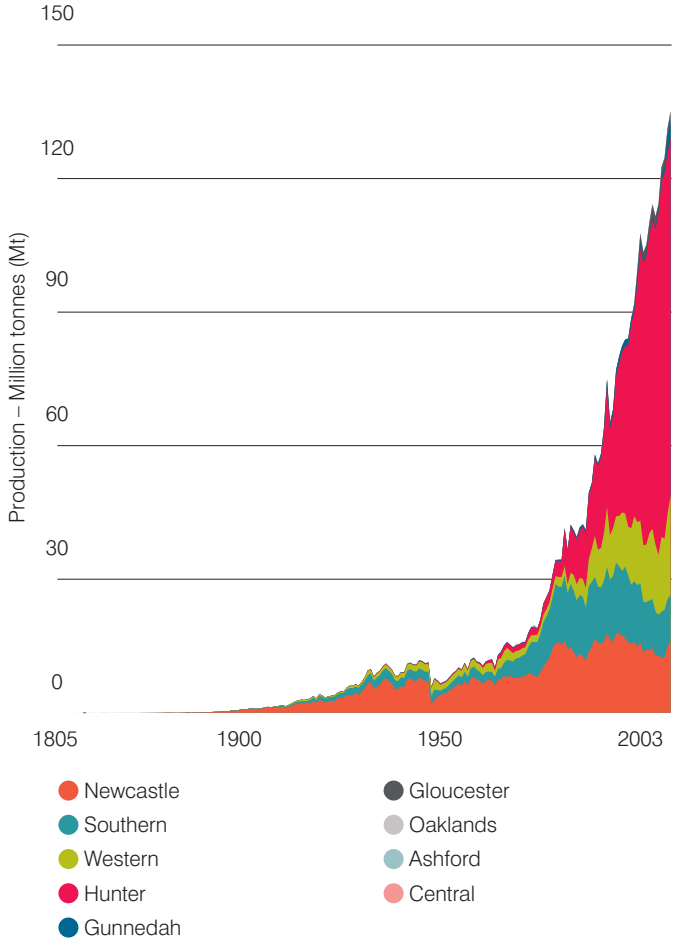


Figure 1: NSW coal production trends

Around 19 million tonnes of coal is burned in the region's coal-fired electric power stations,[26] and the remainder exported via the Port of Newcastle, site of the largest coal export terminals in the world.

There are at least 21 additional coal mines proposed for the Hunter Valley, either as expansions of existing mines or new projects.

Projections of growth suggest coal production in the Hunter Valley could reach 243 Mtpa by 2022.[27]

3.1 Coal mining

Open cut mining in the Hunter Valley involves drilling and blasting through rocks covering the coal seam, which is then removed by large dragline excavators and electric or hydraulic shovels and trucks.[28,29] Draglines work in strips that are typically 40 to 90 metres wide and a few kilometres long.[30] Mining waste known as 'overburden' (waste soil removed to access coal seams) is excavated by the dragline and dumped adjacent to the mine, creating mountains of dusty waste.[31] Each tonne of coal excavated from an open cut coal mine creates approximately 6m^3 of overburden.[32] The large scale of open cut operations, with some mines up to eight kilometres long and 200 metres deep,[33,34] leaves large 'voids' in the landscape following mine closure.

Underground mining in the Hunter largely used the 'longwall' method, in which mechanical shears cut through coal in long deep tunnels. Once coal is removed from the underground mine, the supports are moved forward and the roof is collapsed behind them, which can result in subsidence of the earth above.[35]

This can impact dramatically on water catchments through damage to swamps and vegetation that protects water from evaporation and loss and by cracking of river beds and draining water into deep inaccessible aquifers.[36]

Dust and particulate matter arise from coal mining, from blasting (using explosives to blast through rocks covering coal seams), wind erosion of large areas of 'overburden', unpaved roads around mine sites, and the use of dragline excavators.[37]

The use of explosives for blasting also produces toxic gases hazardous to health.[38]

3.2 Transport

Coal is washed at coal preparation plants, and transported to coal-fired power stations in the region or via rail to coal export terminals in Newcastle. Coal dust and particulates are produced when coal is transported, loaded and unloaded, and when blown by the wind from coal stockpiles and piles of overburden.

Each year 22,000 trains with four million coal wagons travel through the Hunter Valley to the port of Newcastle.[39] Each wagon is uncovered, so there is no barrier to wind blowing coal dust along the rail corridor, across communities in the Hunter and in the city of Newcastle, which is home to the world's biggest coal export terminal.

Diesel powered coal trains, trucks and other heavy vehicles and machinery used in the coal mining industry also produce air emissions that can be harmful to health. Around 50 per cent of non-road diesel emissions in Australia are estimated to come from mining and construction.[40,41]

Diesel emissions include particulates, carbon dioxide (CO_2), carbon monoxide (CO), oxides of nitrogen, polycyclic aromatic hydrocarbons (PAH), dioxins and furans, and a range of volatile organic compounds (VOCs).[42]

In addition, coal dust arises from coal stockpiles, both prior to transportation and at the port prior to export. Air quality is assessed according to the New South Wales Environment Protection Agency's PM10 air quality standard (measuring particles of less than 10 micrometers in diameter).

These particles are likely responsible for adverse health effects because of their ability to reach the lower regions of the respiratory tract.

In addition to air emissions from transport, the increased volume of traffic on the region's roads from increased mining activity has prompted health and community concerns about a higher risk of road trauma.[43]

A 2005 study found there were 29 car crashes involving vehicles travelling to and from coal mines in New South Wales each year, with associated injuries and deaths amounting to a cost of $4.5 million (2002$) each year.[44]

3.3 Combustion for electricity

There are five coal-fired power stations in the Hunter Valley, including two of Australia's most polluting: Bayswater and Eraring, which together with Liddell, Vales Point and Redbank power stations produced 38 million tonnes of greenhouse gas emissions in the financial year 2012–13.[45] (The Redbank power station went into receivership in October 2013, and was not operating at time of writing.)

Reported emissions from Hunter Valley power stations were 38Mtpa in 2012–13, around one-fifth of Australian total power station emissions (184Mtpa).[46]

The process for preparing coal for generating electricity from coal involves crushing chunks into a fine powder, which is fed into a combustion chamber where it is burned. Heat from the burning coal is used to produce steam that drives one or more turbines to generate electricity. The waste gases from the combustion process are typically expelled into the air through a tall stack after filtering. Waste heat is extracted through cooling towers, requiring a steady supply of fresh water.

As well as producing greenhouse gas emissions, burning coal for electricity in the Hunter Valley power stations produces large quantities of hazardous air pollutants including particulate matter, sulphur dioxide, oxides of nitrogen, carbon monoxide, hydrochloric acid, volatile organic compounds and polyaromatic hydrocarbons.[47]

These pollutants threaten human health at the local level by affecting people's cardiovascular, respiratory and nervous systems, and reproductive health.[48,49]

3.4 Coal waste

Coal mining produces large quantities of waste products, such as coal 'slurry' which, along with coal ash waste from coal combustion, also pose risks to human health due to the presence of toxic pollutants.[50]

Slurry is produced in the process of washing coal prior to transport for export or combustion. This process uses large quantities of water and creates a liquid waste that may contain heavy metals, and other toxic pollutants.

A Hunter Valley mine operator, Bulga Coal Management, was recently fined $64,000 when hundreds of litres of coal slurry leaked from a containment dam into the nearby Nine Mile Creek.[51]

3. Coal operations in the Hunter Valley

4. Health impacts of coal in the Hunter Valley and beyond

International health and medical research has documented the contribution of coal to the development of heart and lung disease, including lung cancer, kidney disease, impacts on neurological development and, in relation to combustion, effects on reproductive health, as well as premature deaths.[52]

In the Hunter Valley, health concerns associated with the rapid expansion of coal mining include:

- declining air quality from coal dust and other air emissions
- exposure to toxic gases from explosive blast plumes, transport and combustion
- potential for water contamination
- noise and light pollution from 24 hour mining operations
- social disruption and destruction of communities as mining companies buy out houses, farms, and small villages
- damage to fragile, remnant or threatened natural ecosystems
- aesthetic impacts from changes to the landscape
- health risks associated with global warming.

Internationally, pollutants produced by coal combustion pose direct and immediate risks to human health and have been identified as among the leading contributors to poor air quality globally.[53]

Estimates of the annual global health toll from coal combustion range from 210,000 – 387,000 deaths, almost two million serious illnesses and over 151 million minor illnesses.[54] (NB. These figures do not represent a complete global picture and do not reflect the health toll from other parts of the coal production chain.)

Many of those deaths occur in developing nations, where power plant emissions controls are less stringent than in Australia, creating a profound ethical dilemma for Australia as the world's biggest coal exporter.[55,56]

4.1 Pollution – air, noise and water

4.1.1 Air pollution

There is a considerable body of evidence on the adverse health impacts of outdoor air pollution. Risks relate predominantly to cardiovascular and respiratory health, lung cancer,[57] and premature death.[58]

Air pollution is an increasing concern for many people and communities in the Hunter Valley, and is a significant health problem for New South Wales more broadly. The major contributors are industrial activity (including mining), motor vehicle exhaust and coal-fired power generation.[59]

Air pollution from coal mining, transport and combustion for electricity is not always visible but it carries serious and well documented risks to health, and can travel long distances, affecting people far from the source.[60]

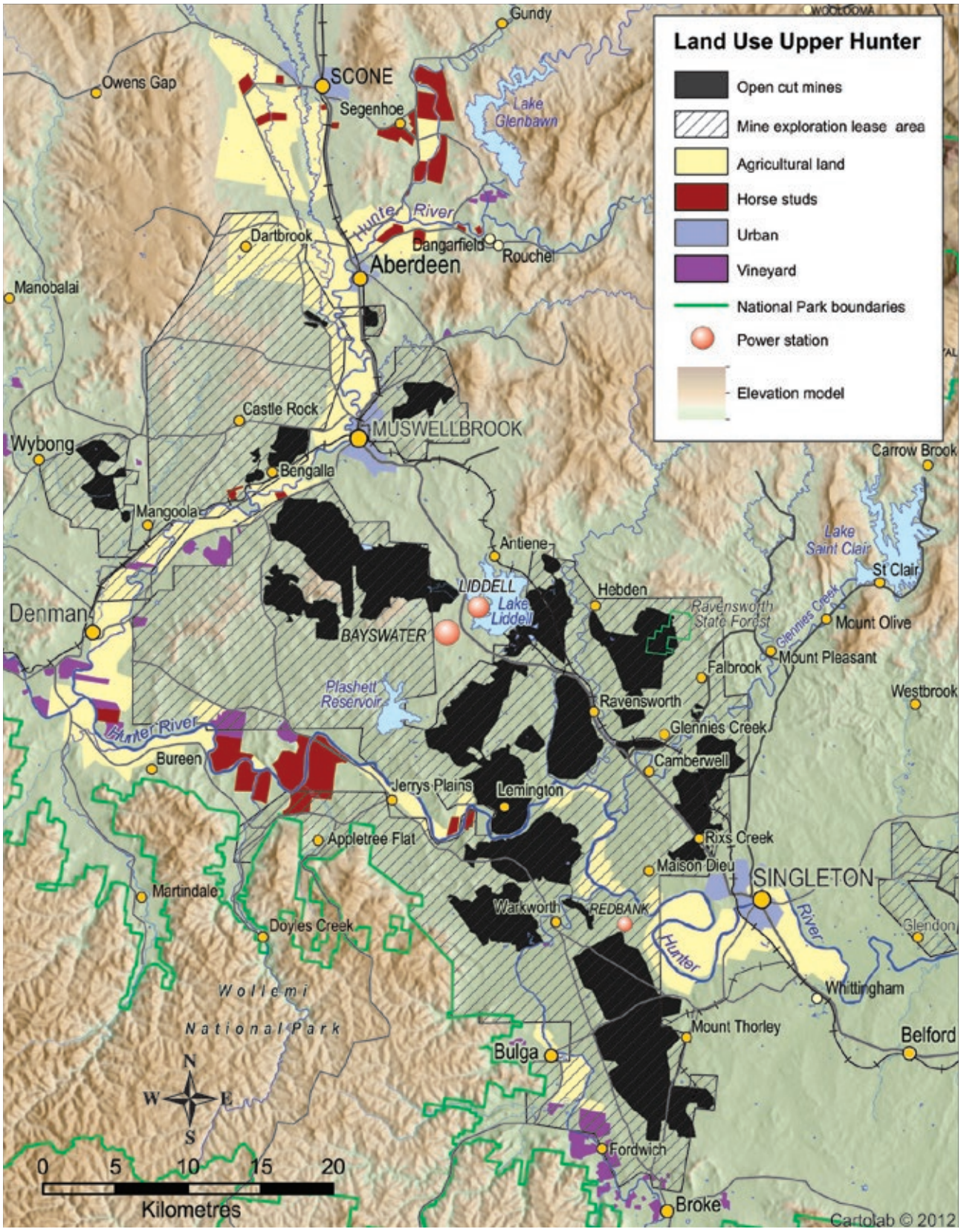
Many of the mines and power stations in the Hunter Valley are close to populated areas and towns.

The Muswellbrook, Bengalla, and Mount Arthur coal mines are just three, four and five kilometres respectively from the town of Muswellbrook.

The town of Camberwell is surrounded by coal mines: Integra mine to the north, Narama to the west, Ashton to the south, and there is a proposal for a new open cut mine to the east.

Liddell and Bayswater Power Stations are both around 15 kilometres away from Muswellbrook, while the Vales Point power station is just one kilometre away from the town of Mannering Park; Eraring power station is just three kilometres away from the town of Morriset.

Figure 2. Coal mines close to the towns of Singleton, Muswellbrook and Camberwell



Of all the air pollutants produced by coal mining activities, particulate matter is the most significant health threat.

Most health and medical research on particulates has focused on fine particles known as PM2.5 (measuring less than 2.5 micrometres in diameter) and PM10 (less than ten micrometres in diameter) as these are associated with the most significant health impacts.

The National Environment Protection (Ambient Air Quality) Measure (NEPM) developed in 1998 sets uniform national ambient air quality standards for six air pollutants: carbon monoxide; lead; sulphur dioxide; nitrogen dioxide; ozone and particles with diameter less than 10 μm (PM10).

In 2003, an advisory reporting standard for particles with a diameter less than 2.5 μm (PM2.5) was added. However, having no air quality standard for PM2.5 puts Australia out-of-step with the World Health Organisation (WHO) guidelines.

Australia's air pollution standards and implementation practices are outdated and do not reflect current air pollution science, although they are under review. The current approach is to regulate to certain air quality targets as the standard, when in fact exposure to air pollution at the standard itself is not safe, and aiming to regulate to keep air quality from exceeding the (known to be inadequate) standard will fail to bring about reductions in air pollution to safer levels. (See Appendix A for more details).

Particulates in the Hunter Valley

Once renowned for its clean air, the Hunter Valley was identified in 2014 as an air pollution 'hotspot',[61] with the national standard for PM10 exceeded 118 times in 2013 across 11 air quality monitors in the Upper Hunter.[62]

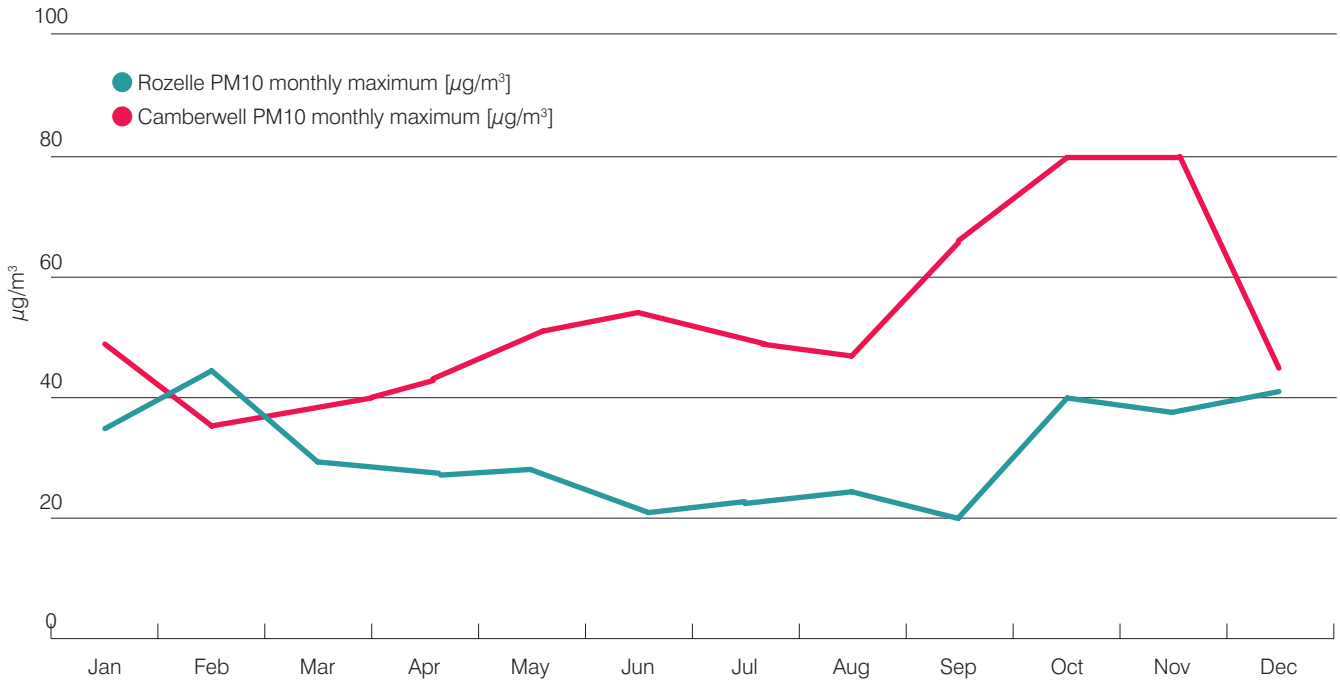
The most recent New South Wales Air Emissions Inventory (published in 2012 using 2008 data) indicates emissions of PM10 in the Sydney Greater Metropolitan Region (GMR) increased 20 per cent from 1992 to 2008, an increase largely attributed to increased coal mining in the Hunter Valley.[63]

Data released in February 2013 from the recently installed Upper Hunter Air Quality Monitoring Network (UHAQMN) shows particle pollution in the population centres of Singleton and Muswellbrook exceeded national standards and was higher than the network average for the GMR.[64]

Air quality monitoring records reveal that, in the regional towns of Singleton and Muswellbrook and the village of Camberwell, national air quality standards for PM10 were breached 12 times in Singleton, three times in Muswellbrook and 36 times in Camberwell in 2013.[65]

Despite being a rural village, Camberwell has higher monthly maximum levels of PM10 than Rozelle, a suburb in Sydney's inner west.[66]

Figure 3. Monthly maximum levels of PM10 in Camberwell (Hunter Valley) and Rozelle (inner western Sydney) in 2014



According to the New South Wales Environment Protection Agency, the dominant source of particle emissions in the Upper Hunter is coal mining (87.6 per cent of PM10 and 66 per cent of PM2.5).[67]

Other significant sources of fine particulates are power generation (13.5 per cent of PM2.5 and 5.6 per cent of PM_{10}) and non-road diesel equipment (13.2 per cent of PM2.5 and 3.1 per cent of PM10).[68]

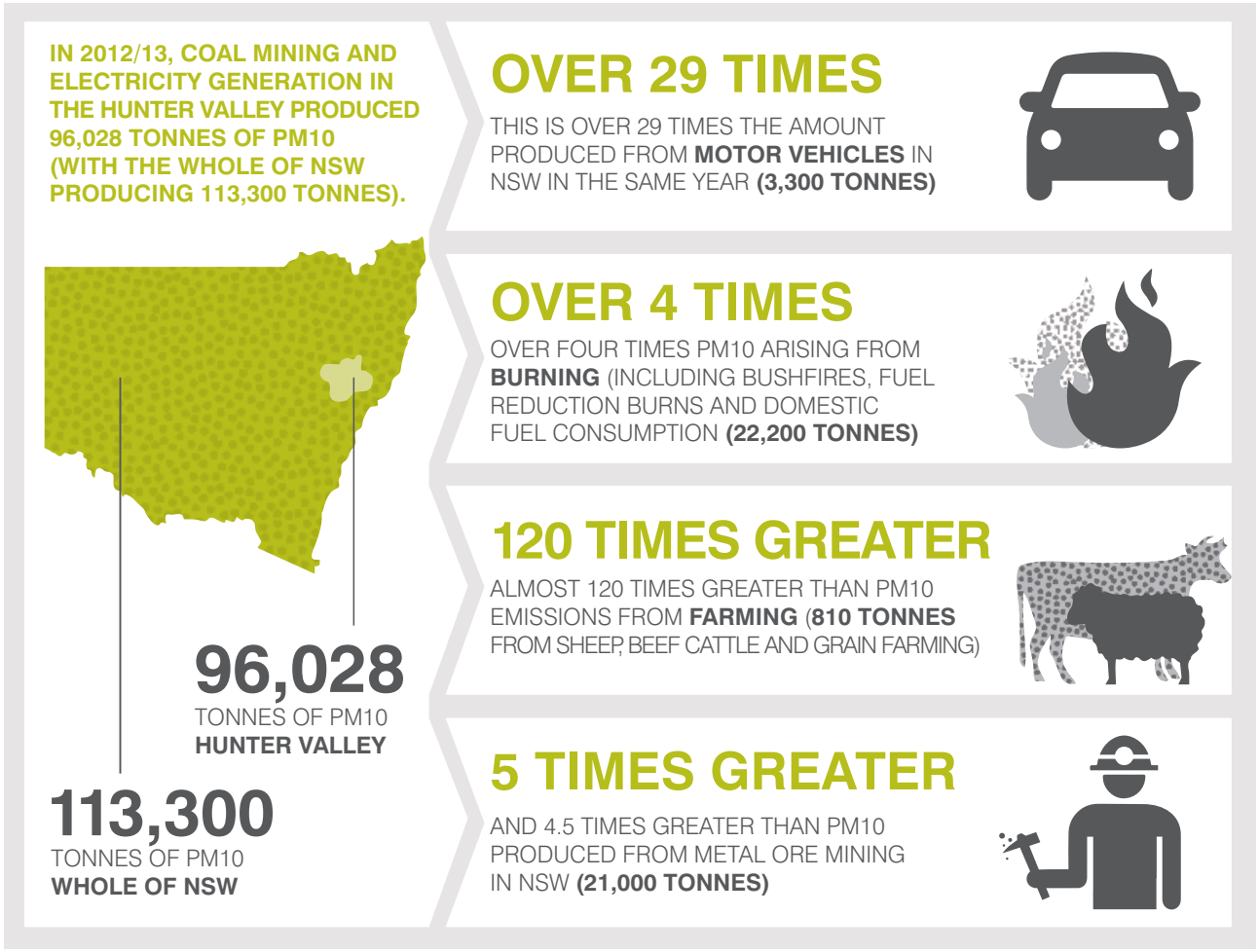
A recent study by the Commonwealth Scientific Investigation and Research Organisation (CSIRO) investigating the sources of PM2.5 in Singleton and Muswellbrook found the main sources of PM2.5 in Singleton were secondary sulphate (from power stations); industry aged sea salt;[69] and vehicles/ industry. For Muswellbrook, the top three factors were wood smoke, secondary sulphate, and industry aged sea salt.[70]

Vehicle exhaust, which produces emissions of nitrogen dioxide and sulphur dioxide, is another source of air pollution in the Hunter Valley and in the towns of Muswellbrook and Singleton.[71]

In the Lower Hunter, community air quality monitoring near Newcastle's coal terminals and rail corridor in 2013 suggests that Newcastle residents may be exposed to higher levels of particle pollution than government monitoring stations indicate.[72]

In 2012/13, coal mining and electricity generation in the Hunter Valley produced 96,028 tonnes of PM10 (with the whole of NSW producing 113,300 tonnes).

This is over 29 times the amount produced from motor vehicles in NSW in the same year (3,300 tonnes), and over four times PM10 arising from burning (including bushfires, fuel reduction burns and domestic fuel consumption - 22,200 tonnes); almost 120 times greater than PM10 emissions from farming (810 tonnes from sheep, beef cattle and grain farming); and 4.5 times greater than PM10 produced from metal ore mining in NSW (21,000 tonnes).[73]



Health effects of particulates

Both the varied size of air particulates and their total number are implicated in affecting human health.

Figure 4. Particulate size relative to a human hair

Image: Upper Hunter Air Quality Monitoring Annual Report

As a major component of outdoor air pollution, particulates can trigger heart attacks and strokes, and particulate matter has been deemed carcinogenic by the World Health Organisation's International Agency for Research on Cancer.[74]

In 2013, the World Health Organisation stated:

> "There is no evidence of a safe level of exposure (to PM10 or PM2.5) or a threshold below which no adverse health effects occur."[75]

Health risks are associated with both short and long-term exposure to particulates. Over a long period, even relatively modest increases in the levels of PM2.5 can significantly increase the risk of premature death.

Due to their very small size, PM2.5 (along with other toxins which attach to it, including heavy metals) can travel deep into the lungs and pass into the blood stream, where they can trigger cardiovascular events, such as heart attacks and strokes.[76] They stimulate chronic inflammation, may contribute to asthma incidence and severity and may cause direct tissue damage due to heavy metals and other toxins adhered to their surface.

Exposure over long periods to increased levels of PM2.5 is associated with serious health impacts: an increase of 10 $\mu g/m^3$ is associated with a 4 per cent increase in deaths from all causes, a 6 per cent increase in cardiopulmonary deaths, and an 8 per cent increase in deaths from lung cancer.[77]

Short term exposure is harmful too: exposure to a 10 $\mu g/m^3$ rise in PM2.5 can increase daily mortality by 1 per cent and increase hospital and emergency room visits for cardiovascular illness by more than 3 per cent and for respiratory illness by 4 per cent.[78]

These associations have been demonstrated in areas with mean 24 hour PM2.5 concentrations as low as between 6.1 and 22 $\mu g/m^3$ [79] – levels that are frequently exceeded in the Hunter Valley.[80]

The dispersal of PM2.5 is of particular concern given its propensity to be airborne for longer than other heavier particles, leading to wider distribution, and given the strong links with a range of diseases and mortality.[81]

Short-term exposure to larger particles (PM10) can trigger adverse health responses leading to hospital admissions.[82] A recent Australian study found an increase of 10 $\mu g/m^3$ [83] in PM10 was associated with a 1 per cent rise in hospital admissions for respiratory disease.[84]

Longer term PM10 exposure was associated with the development of lung cancer in a recent large European study, which supports earlier studies and suggests particulate matter in ambient air pollution contributes to the development of lung cancer even at levels below current European air quality standards.[85]

Particulate matter is thought to be the most important component of diesel engine exhaust, which was recently classified as a human carcinogen by the International Agency for Research on Cancer.[86,87]

Health effects of other air pollutants

While particulates are a key pollutant associated with both coal mining, combustion, and transportation, other air pollutants produced in the process of mining and/or burning coal such as sulphur dioxide, oxides of nitrogen, carbon monoxide, hydrochloric acid, volatile organic compounds and polyaromatic hydrocarbons are also associated with adverse health impacts.

Substances present in vehicle emissions are also harmful to health. Diesel emissions are particularly toxic as they emit fine particulate matter (PM2.5) containing polycyclic aromatic hydrocarbons (PAHs), a known carcinogen.[88] Diesel emissions also include volatile organic compounds which can, in the presence of sunlight, combine to form ground level ozone which is harmful to respiratory and cardiovascular systems.[89]

The table below shows the volume in tonnes of these pollutants produced by coal sources in the Hunter Valley as reported to the National Pollutant Inventory in 2012–13.

Figure 5. Air emissions from Hunter Valley coal sources (tonnes) 2012–13[90]

Air pollutant	Coal-fired power stations	Coal mines and coal terminals	Total
PM10	1,673	94,196	95,868
PM2.5	894	2,241	3,136
Sulphur dioxide	134,176	49	134,225
Oxides of nitrogen	91,266	28,419	119,685
Volatile organic carbons	566	1,751	2,317
Carbon monoxide	4,702	17,358	22,061

*See Figure 7 below for an overview of health impacts associated with each of these pollutants.

Communities at risk from poor air quality

The communities most affected by open cut coal mining and coal-fired power generation in the Upper Hunter region and most at risk from poor air quality are the larger regional towns of Singleton and Muswellbrook,[91] and the smaller towns of Camberwell, Warkworth, Maison Dieu, Jerrys Plains and Wybong.[92]

In the Lower Hunter, air quality concerns have been in relation to the two coal-fired power stations on southern Lake Macquarie,[93] and more recently in relation to expanding coal exports and the associated increase in coal trains through the city of Newcastle to the port.[94]

The recent and rapid expansion of the industry has led to considerable and increasing concern about the impacts of coal on the health of the local population, particularly among vulnerable groups.[95,96,97,98]

The people most at risk of exposure to and health effects from poor air quality are: babies and children, elderly people, Indigenous people, those with chronic ill health, low socio-economic status, or with pre-existing cardiovascular and respiratory disease.[99]

A New South Wales Health Report from 2010 reported that the Hunter regions most affected by open cut coal mining and coal-fired power generation have higher rates of emergency visits and hospital admissions for asthma and respiratory disease and cardiovascular disease compared with the rest of the state.[100]

An earlier study (1990s) found self reported asthma was more common among children living in a town near two coal fired power stations compared with another similar control town,[101] and a more recent survey (2010) found the Hunter region had the highest proportion of children diagnosed with asthma in the state.[102]

While there has been an increase in air quality monitoring in response to community concerns in recent years, there has been no comprehensive epidemiological or toxicological studies of the health impacts of the long term effects of coal on the Hunter Valley community to date.

Health effects from blasting

The use of explosives in coal mines to uncover deep coal seams produces dust and particulates as well as toxic gases which contribute to air pollution, such as nitrogen dioxide (NO^2), nitric oxide (NO) and carbon monoxide (CO).

The most toxic of these, nitrogen dioxide, creates orange/brown plumes and a pungent odour, such as occurred in Muswellbrook following an explosive blast at BHP Billiton's Mount Arthur Mine in February 2014.

Exposure to nitrogen dioxide at low levels can cause irritation of eyes, nose and throat, dizziness and headache, shortness of breath and wheezing, and can worsen asthma.[103]

At high levels, nitrogen dioxide can cause pulmonary oedema (inflammation of the lungs) which can be fatal.

Current World Health Organisation guidelines for NOx (the generic term for nitric oxide and nitrogen dioxide) are a one-hour level of 200 μg m3 (approximately 200 parts per billion) and an annual average of 40 μg m3.[104]

The concentrations of these gases considered Immediately Dangerous to Life or Health (IDLH) for NO_2, NO, and CO are 20, 100, and 1,200 parts per million (ppm), respectively.[105]

However, typical concentrations of NOx in post-blast clouds can measure anywhere between 5.6 to 580 ppm, exceeding the safe limits by around 30 to 3,000 times.[106]

The most recent scientific study on blast fumes in the Hunter Valley was published in 2007. It suggests many blasting events lead to levels of dangerous gases within the blast exclusion zone that are "many times higher" than occupational exposure standards, while exposure levels of communities downwind from the blast were unknown.[107]

Two miners were hospitalised and five mine staff treated for exposure to toxic fumes following a blast at the Mount Thorley Warkworth mine in the Hunter Valley in September 2013.[108] In February 2014, a blast at the Mount Arthur mine in the Upper Hunter turned the sky bright orange when an explosive mixture of ammonium nitrate and fuel oil was detonated at the mine. The resulting blast plume containing nitrogen dioxide spread several kilometres from the site, causing respiratory irritation among nearby residents.[109,110]

Local communities are concerned about the cumulative impact of the noise and dust associated with blasting. In the absence of publicly available information on the frequency of blasting from the region's regulatory authorities, Camberwell resident Deirdre Olofsson undertook her own analysis in 2013, reviewing the Annual Environmental Management reports of 15 mines in the Upper Hunter from the previous year. This revealed 2,490 blasts occurred at 15 open cut mines – 425 at Coal and Allied's Mount Thorley Warkworth mine and 347 at the same company's Hunter Valley Operations mine.[111]

Figure 6. Blast plume Mount Arthur Mine, February 2014

Image supplied

Figure 7. Air emissions and health effects

Air pollutant	Abbreviation	Health effect	Sources
Particulate matter	PM2.5 and PM10	Recent epidemiological research suggests that there is no threshold at which health effects do not occur. Associated with respiratory and cardiovascular disease, and cancer.[1,2] Health effects may be influenced by the duration of exposure.[3]	Vehicle exhaust, including diesel trucks and trains; woodsmoke; coal dust; coal combustion; bushfires.
Sulphur oxides	SOx	Repeated or prolonged exposure may cause inflammation of the respiratory tract, wheezing and lung damage. Those with impaired heart or lung function and asthmatics are at increased risk.[4]	Combustion of coal and other fossil fuels, including vehicle exhaust.
Oxides of nitrogen/ nitrogen dioxide	NOx	Can irritate eyes, nose, throat and lungs, cause coughing, shortness of breath, tiredness and nausea. High levels of oxides of nitrogen can cause swelling of tissues in upper respiratory tract, reduced oxygenation of tissues, and maybe even death.[5]	Combustion of coal and other fossil fuels, including vehicle exhaust; burning of wood for domestic heating; bushfires.
Carbon monoxide	CO	Inhalation of low levels of carbon monoxide (200 parts per million (ppm) for 2-3 hours) can cause headache, dizziness, and fatigue. Exposure to higher concentrations (400 ppm) can cause loss of consciousness and death.[6]	Coal mining; coal combustion; fuel burning for heating; vehicle exhaust.
Polyaromatic hydrocarbons	PaHs	Exposure can cause respiratory symptoms. Considered a probable carcinogen (that is, causes cancer) by The International Agency for Research on Cancer.[7]	Emitted to air during combustion of coal, and other fossil fuels; vehicle exhaust.
Volatile organic compounds	VOCs	Can cause irritation to the eyes, nose and throat; headaches; and damage to the liver, kidney and central nervous system. Can cause cancer in humans.[8]	Industrial processes; vehicle exhaust; fuel tanks.

1 Brunkreef B and Forsberg B, 2005, Epidemiological evidence of effects of coarse airborne particles on health, European Respiratory Journal, 26, pp.309-318.

2 Brook RD et al, 2010, "Particulate matter – air pollution and cardiovascular disease: an update to the scientific statement from the American Heart Association, on behalf of the American Heart Association Council on Epidemiology and Prevention, Council on the Kidney in Cardiovascular Disease, and Council on Nutrition, Physical Activity and Metabolism, Circulation, 121:2331–2378.

3 National Pollutant Inventory, Substances, Fact sheets, Particulate matter (PM10 and PM2.5), available at http://www.npi.gov.au/resource/particulate-matter-PM10-and-pm25

4 National Pollutant Inventory, Substances, Fact sheet, Sulphur Dioxide, available at http://www.npi.gov.au/resource/sulphur-dioxide

5 National Pollutant Inventory, Substances, Fact sheets, Oxides of Nitrogen, available athttp://www.npi.gov.au/resource/oxides-nitrogen-0

6 National Pollutant Inventory, Substances, Fact sheets, Carbon Monoxide, available at:http://www.npi.gov.au/resource/carbon-monoxide-0

7 National Pollutant Inventory, Substances, Fact sheets, polycyclic-aromatic-hydrocarbons, available at http://www.npi.gov.au/resource/polycyclic-aromatic-hydrocarbons

8 National Pollutant Inventory, Substances, Fact sheets, Total Volatile Organic Compounds, available at: http://www.npi.gov.au/resource/total-volatile-organic-compounds

Figure 8. Increase in emissions from Hunter Valley coal mines (tonnes) compared with 2008/09[113]

Air pollutant	2008–09	2012–13	% increase
PM10	52,595	93,845	78%
PM2.5	1,745	2,241	28%
Oxides of nitrogen	20,088	28,417	41%
VOCs	1,428	1,751	23%
CO	11,976	17,351	45%

4.1.2 Noise pollution

As well as being an occupational hazard for miners,[114] the noise and light from mining operations (many of them 24-hour operations) can disrupt lives and interfere with the sleep of people living in communities close to mines. The health impacts of noise are not addressed in the current assessment framework used to determine whether mine proposals are approved.

Mining activities such as blasting, drilling and digging, coal loading, the operations of excavators, trucks, conveyor belts and other machinery all contribute to elevated levels of environmental noise. Alongside other impacts such as loss of visual amenity, and social disruption (see next section), noise can lead to a stress response that can adversely affect people's health and sense of wellbeing and impair quality of life.[115]

The recommended maximum for industrial noise in New South Wales is 75 decibels,[116] however many coal mines are allowed higher limits which vary according to their licence conditions. For some mines, this is as high as 120 decibels.

Particularly given the expectation of quiet surroundings in a rural environment, the application of an industrial noise policy in the region is inappropriate. Explosions at some sites such as Integra's Camberwell mine exceed 120 decibels. Local people complain regularly about noise at Rio Tinto's Mount Thorley Warkworth mine near Bulga, where noise regularly exceeds the limit by more than five decibels.[117] This mine attracted 800 noise complaints in 2012 [118] but has not led to any change in the mine licence conditions. Given plans to significantly expand this mine, locals are very concerned about the impact of noise on the physical and mental health of the community.

Bulga resident John Krey says the noise from the nearby mines at Mount Thorley and Warkworth is "extremely disruptive".

> "It makes sitting outside impossible, with noise akin to an airplane continuously overhead. Blasting from the mine shakes the house, and the noise of machinery at the mine, which works 24 hours a day, is loud enough to wake us up at night."

*See the Bulga case study p.42 for more information.

4.1.3 Water pollution

Water security and water quality is fundamentally important to human health, given our reliance on water for drinking, cooking, bathing, as well as for irrigation, watering stock, fishing and recreation.

Coal mining and combustion in the Hunter Valley pose threats to both water security and water quality.

Coal mines and power generators are big water users: mines use water to wash coal and generators use it for cooling. Two of the biggest power stations in the Hunter – Bayswater and Liddell – use more than 60 gigalitres of fresh water each year.[119] Access to water is a contentious issue for farmers in the Hunter region, where water shortages during drought have prompted criticism that "such a precious commodity as water" is used to wash coal for export.[120] Water contamination can occur when 'slurry' (coal mine waste) leaches into groundwater and underground waterways.[121]

Local Denman farmer Grantley Blake says he grew up swimming in the Hunter River, but that the pollution from the coal industry has damaged it beyond recognition:

> "The Hunter River is dead. We used to drink that water when I was a kid. Now it's full of salt, and it's black. That's got to come from the mines."[122]

Many coal facilities in New South Wales are issued with 'licences to pollute', which allow them to discharge wastewater contaminated with salt and heavy metals into surrounding waterways.[123] Underground coal mining in the state has been linked to subsidence of surface soil, water contamination and structural damage to creek beds,[124] and discharges of contaminated water and toxic waste have left previously pristine waterways devoid of biodiversity.[125]

Pollutants from coal mining dispersed by air also contribute to water pollution,[126] as does the routine discharge of wastewater – the composition of which can cause harm to downstream aquatic ecosystems.[127]

Abandoned mines can leach toxic pollution for decades, posing a significant environmental health threat.[128] The Xstrata mine, the Great Greta Colliery, ceased operations in 1999 after 50 years but in 2012 began leaking highly saline contaminated water into Eui Creek and then into the Hunter River.[129]

Further water quality risks are posed by extreme weather events, exacerbated by climate change. Increased intensity of precipitation may lead to flooding of coal mines as occurred in 2011 in Queensland, when around 20 mines were heavily flooded, and contaminated water, thought to contain heavy metals and toxic chemicals, was discharged into local rivers.[130]

Recent changes to the rules governing water use will exempt coal mines in the Hunter from rules to protect the groundwater systems and rivers from 2015, particularly during periods of drought.[131] This is a serious risk, given threats to water availability under predicted climate change scenarios.

A further risk is posed by the massive 'voids' that will be left by open cut mines in the land once all the coal is mined. As these voids are rarely filled in, the open pits (some of them hundreds of metres deep and kilometers long) become bodies of water or 'pit lakes' with poor water quality that is highly saline, and which becomes more saline over time as evaporation concentrates the already salty groundwater exposed through the coal seams.[132]

A 2005 New South Wales Department of Planning report predicted operations at that time would leave 1,272 hectares of final voids across the Hunter Valley landscape.[133]

Due to their large size, it is likely many final voids from coal mines in the Hunter Valley will become 'net sinks' for groundwater, ie they will continue drawing water from surrounding aquifers, affecting local groundwater supply and turning the pit lake progressively saline.[134] Researchers warn this phenomenon may impact on the Hunter River by reducing its annual flow.[135]

Pumping polluted water from coal mine, Bowen Basin Qld. Photo: Dean Sewell

4.2 Stress – mental, physical and social

The health impacts from coal are not just physical. Coal mining and production are also associated with serious mental health impacts. The expansion of coal mining into farming regions is causing severe psychological distress among a constituency already facing serious mental health burdens.[136] Many farmers and other people in rural communities have strong emotional connections to their land, and place great value on the physical environment as well as the social values of their rural lifestyle and community.[137] Changes to the landscape associated with mining, and contests over land, can lead to depression, anxiety and psychological stress.[138,139,140, 141,142]

Local communities in the Hunter Valley are worried about declining air quality and have been for over a decade. Air pollution was the most frequently named environmental health concern in a 2003 study;[143] while a 2014 survey found a majority of Hunter residents think coal mining is having a negative effect on air quality in the region.[144] Over 80 per cent do not want to see the industry expand and 41 per cent would like to see it contract or be phased out.[145]

In Newcastle, communities are concerned about the proposal to expand coal exports: the proposed establishment of a fourth coal terminal was opposed by 77 per cent of residents in a 2012 community survey.[146]

A recent review of the social harms associated with mining in the Hunter region found multiple examples of social injustice and revealed significant community concerns that government authorities are failing to act in the community's interests.[147]

Community concerns include:

- anxiety about the health impacts of mining
- feelings of loss and disempowerment associated with the information 'asymmetry' between the community and government/industry
- social divisions due to inequitable compensation and unequal wages in the community
- distress in relation to environmental harm and the negative impacts of coal mining and combustion on future generations.[148]

In some circumstances, whole villages are 'acquired' by mines unable to meet air quality requirements – as is proposed in the village of Camberwell (see case study below). This disrupts the social fabric of communities and can lead to serious psychological and emotional consequences for those affected.[149]

Many people seeking to oppose or limit challenging mining projects that they fear will destroy their landscape, ecological values and community describe a sense of shock and frustration when their concerns are ignored and the likely impacts downplayed by both mining companies and government agencies.[150]

Local resident Wayne Blake says he is convinced that the government is on the side of miners, not the community:

> "The community is sick and tired of the government not telling the truth, and failing to act in the community interest. It is not a level playing field for the community against mining companies and the government."[151]

Given heightened concerns regarding the adverse health and environmental consequences associated with existing mines and power stations, proposals for new projects cause considerable anxiety and alarm within communities with regard to risks to future health and wellbeing and the loss of their valuable rural amenity, with attendant risks to air, soil and water.

Projects that promise economic benefits to the community, whether real or imagined, but also bring health and environment risks can also create social division among community members. Such a loss of social cohesion over proposed mining projects can harm both individual and community health.

Communities experience multiple sources of stress, including:

- long periods of uncertainty about the impact of the project
- distress at the disruption to generational succession plans
- a sense of powerlessness about their inability to intervene in the process
- anxiety about a negative economic impact on land values
- the fear of loss – of the landscape, friendships, social networks, and of the land itself.[152]

The sense of powerlessness reported within local communities stems from the unequal power balance between coal-affected communities and mining companies. Mining companies possess far more political and institutional power; have superior resources and capacity; and greater control over natural and financial resources than local coal affected communities.[153]

The failure of positive economic benefits from coal mining to flow to local communities leads to further negative impacts. The expansion of mining occurs at the expense of other industries. This compromises the economic and cultural capital provided by other industries to communities and can diminish their economic resilience, create labour shortages in other sectors, and threaten their sustainability.[154]

The sense of hopelessness described by communities unable to influence the outcome of mining proposals can contribute to depression.[155] In rural communities, where many people are already at risk of poor mental health from a variety of stressors, proposing a coal mine can have a strong negative psychological impact.[156]

Health experts in the Hunter Valley say the issue of 'environmental injustice' affects many communities in relation to regional coal projects; that is, those who face the greatest harm from a project's social and environmental impacts have the least say in whether or not it will proceed.[157]

Laying explosives at Moolarben. Photo: Max Phillips

4.3 Work health and safety

Coal mining, whether it is underground or open cut, is inherently a dangerous occupation.[158] Underground miners face risks of falling rocks, injuries from machinery, exposure to silica and coal dust, toxic fumes and explosions and, in some parts of the world, occupational heat stress.[159]

Open cut coal mining, the main form of mining in the Hunter Valley, also poses risks from machinery, falls and rocks. Heat stress is also a factor, and is likely to increase from ongoing climate change.[160] Exposure to toxic fumes from blasts is a very real risk.

Occupational exposure to loud noise carries serious risks for miners, with prolonged exposure carrying the risk of permanent damage and hearing loss.[161,162]

While Australia has strong work health and safety laws, deaths in the mining industry are still one of the nation's leading causes of occupational deaths.[163] There has been a disturbing recent increase in mining deaths, with 2013 the worst Australian year on record.[164]

Mining accidents

More than 1,800 mine workers have been killed in the Hunter Valley coal mines since mining began.[165]

Two miners died in early 2014 when a wall collapsed in Chinese mining company Yancoal's Austar underground mine at Cessnock in the Hunter Valley.[166] Just months earlier, a woman was crushed to death by a coal truck at Glencore's Ravensworth open cut mine near Singleton in 2013.[167]

A truck driver was crushed to death by falling coal at the Ravensworth mine in 2009.[168] In the same year a mine worker in the Integra Coal underground mine at Glennies Creek near Singleton died when he was struck on the head by a piece of machinery.[169]

Photo: Max Phillips

4.4 Global warming

As outlined above (see Introduction), the greenhouse gas emissions produced when Hunter Valley coal is burned, whether in Australia or in the countries to which it is exported, contribute to the increasing and serious risks to health from climate change caused by global warming.

At a regional level, particular global warming risks faced by those in the Hunter region of New South Wales include rises in sea levels that may lead to very large increases in the frequency of coastal flooding, threatening cities, towns and supporting infrastructure (including ports, industrial buildings and rail lines) in low-lying coastal areas.[178] More severe droughts are predicted as well as more intense rainfall events that will increase the risk of severe flooding when rain does occur.[179] There will be increases in the number of very high to extreme fire danger days each year; and more frequent and intense fires will pose even higher risks to human health, property and infrastructure.[180]

Increasing heat stress from more severe and more frequent heatwaves that are anticipated will put already vulnerable people at greater risks of heat-related illnesses and deaths.[181]

People with kidney and heart diseases, as well as children, and those who are elderly, work in heat-exposed jobs or have low incomes, are all at greater risk from heat extremes.[182] Those working in outdoor settings in the region's agriculture, viticulture, tourism, and mining industries will be particularly vulnerable.

As well as threatening human health, rising temperatures associated with climate change are likely to adversely affect other species in the region.[183] Many rare and threatened species, particularly those with small geographical ranges, will be particularly vulnerable to additional stresses from climate change, such as high temperature extremes, increased and more intense bushfires and changes to rainfall patterns.[184]

Increased risks of bushfires during extreme weather events

The recent fire at the Hazelwood coal mine near the Latrobe Valley town of Morwell in Victoria highlighted the serious risks posed to communities living in proximity to open cut coal mines, particularly in the context of heightened bushfire threats from climate change.[170,171]

Plumes of smoke from the burning coal in an abandoned mine pit exposed people in Morwell to extremely high concentrations of particulates and elevated levels of carbon monoxide over a period of several weeks as firefighters and emergency service fought to bring the fire under control.[172] Thousands of local residents were advised to leave,[173] and several firefighters were admitted to hospital with carbon monoxide poisoning.[174]

An Inquiry into the coal mine fire found the event constituted a serious public health emergency and a major complex fire emergency.[175] Many Morwell citizens and other residents of the Latrobe Valley experienced adverse health effects and may be affected for an indeterminate period into the future.[176]

The Inquiry has recommended that a health study of the affected community continue for at least 20 years "given the long lead times of some potential pollutants" and the exposure of young children to pollution from the fire. The impacts of the Hazelwood coal mine fire have been estimated to cost over $100 million.[177]

Hazelwood coal mine fire, Feb 2014. Photo: Chris Morley, used with permission.

5. The economics of health and environmental damage from coal

The annual economic costs of the harm caused by mining in the United States have been estimated in one study to be US$345 billion.[185] Another study suggests the costs of coal are greater than the value of the industry to the US economy.[186]

The same question ought to be investigated here: is coal costing Australia more than the industry is worth? Assessments of some coal projects in NSW suggest this may well be the case.[187]

An economic assessment of six coal projects in New South Wales found the economic and employment benefits of proposed projects are frequently overstated by the industry project proponents, while the environmental costs and greenhouse gas emissions are downplayed. The adverse economic effect on other industries (caused by high mining wages) is also downplayed, and the health costs ignored.[188]

This assessment suggests that while the industry accrues profits from these projects, New South Wales taxpayers may ultimately bear a cost that exceeds their value from unaccounted for damages to health, biodiversity and the climate.[189]

5.1 Royalties and subsidies

Any perceived economic benefits of the industry must be weighed against the subsidies provided by taxpayers to support the profitability of the industry, the damages it causes through harm to health and natural capital, the costs of climate change, and the lost opportunities from the failure to develop other industries, like clean renewable energy.[190]

Hunter Valley coal delivers profits to international mining companies and mining royalty payments to the New South Wales government ($1.3 billion in 2012–13).[191] The industry claims these royalties are vital to the delivery of essential services in New South Wales,[192] but they only account for around 2 per cent of state government revenue.[193]

Given the bulk of coal mines in the Hunter Valley are foreign owned, the profits from the industry do not end up in the region, but overseas.[194]

Substantial subsidies are provided to the mining industry despite its legacy of harm and risks to health. For example, mining companies are exempt from a federal tax on diesel, amounting to a subsidy of around $2 billion each year. Nationally, government support for coal-fired electricity was $3.6 billion in 2012–13, compared to $1.4 billion for renewable energy.[195]

The New South Wales government has provided $873 million in subsidies for the minerals and fossil fuel industries from 2008–2014.[196]

Additional public support for the industry has been the provision of coal from the state-owned Cobbora coal mine to state owned electricity generators at one-third of the price generated from exports.[197] Coupled with other subsidies, this means the people of New South Wales are effectively subsidising an industry that causes significant harm to their natural capital, adds millions of dollars to health costs, and limits their opportunities to diversify their economy and invest in other industries for a stable economic future.[198]

While the externalities are hard to evaluate, there are dangers in failing to do so, as academics Linda Connor and Stuart Rosewarne wrote in 2012:

"The costs to the natural environment and farming land are hard to estimate in dollar values. While the NSW Minerals Council says "coalmining is a temporary use of land," in fact, coalmining leaves large tracts of sterile landscape, punctuated by former open-cut voids filled with toxic fluid. Creek beds and aquifers are punctured and cracked. Contaminated mine water is released into river systems, which adds to salinity and harms native species.

The expansion of mining threatens rural enterprises such as agriculture, viticulture and horse breeding, and the communities these industries sustain."[199,200]

Mining industry lobbyists are inclined to overstate the value of the industry to the state, as well as the number of jobs it creates, frequently claiming jobs created as part of the industry's interaction with the wider economy, rather than those directly employed in mining.[202] The higher wages paid in the mining sector attracts workers away from other jobs and is creating acute skills shortages in manufacturing and other sectors.[203]

Industry profiles rarely acknowledge the adverse economic impacts of the mining sector on other sectors, such as agriculture and tourism, which have been negatively impacted by the high Australian dollar – driven by rapid growth in resource exports.[204,205]

Those people directly employed in mining in New South Wales represent just 1.4 per cent of a 3.5 million workforce;[206] the 13,000 people working in mining in the Hunter make up just 5 per cent of the region's workforce.[207]

Image: Conor Ashleigh [201]

5.2 Unaccounted health and environment costs

There are many costs associated with the coal industry that are not reflected in coal's price, nor in the price of electricity produced from coal, and are considered 'external' to production and consumption decisions.[208] However this means industry profits are occurring at the expense of health and wellbeing for local communities, while damaging valuable natural capital and contributing to climate damage.

The full cost to taxpayers of pollution from mining, transporting and burning coal in the Hunter Valley, or indeed Australia, is unknown.[209]

However the significant health impacts of air pollution provide some insight into total costs.[210]

In 2009, the health costs of air pollution associated with coal combustion in Australia were estimated to amount to $2.6 billion annually, based on a health damage estimate of $13/MWh.[211]

In 2012–13, the five power stations in the Hunter Valley (Eraring, Bayswater, Liddell, Vales Point and Redbank) generated approximately 43 terawatt hours (TWh) of electricity.[212]

Using the estimate above, the health damages associated with coal-fired power in the Hunter Valley in 2012–13 are around $600 million annually.

The available economic analysis of health costs associated with air pollution in the Hunter region are limited to two studies: one associated with the costs of exposure to large particle pollution (PM10) in the Newcastle region[213] and another that estimates the costs associated with exposure to fine particle pollution (PM2.5) for 'significant urban areas' – which in the Hunter Valley include Muswellbrook and Singleton.[214]

In the more heavily populated areas of Newcastle, the annual health costs per tonne of PM10 have been estimated to be $63,000 (2003 Australian dollar (AUD) values) – amounting to a total of $1.76 million (2003 AUD) in 2005.[215]

Using this analysis and more recent studies of health costs associated with PM2.5, estimates of current health costs associated with particle pollution in two regions of the Hunter are provided in the boxes below.

As outlined earlier, exposure to PM2.5 is associated with potentially greater health risks than larger particles.

A 2013 study by economic consultants Pae Holmes estimates the economic damages to health from each tonne of PM2.5 in the Singleton area as $36,000.[216] The same study suggests the costs in the larger and less populated Muswellbrook area as $13,000 per tonne.

The five power stations together with operating coal mines in the Hunter Valley produced 96,028 tonnes of PM10 and 3,428 tonnes of PM2.5 in 2012–13.[212]

Health costs associated with PM2.5

In 2012–13, the National Pollutant Inventory reported that coal sources in the Singleton area produced 1,300 tonnes of PM2.5 (from 11 coal mines) and 5 tonnes of PM2.5 from the Redbank Power Station.

In the Muswellbrook area in 2012–13, 730 tonnes of PM2.5 was produced from six coal mines and 680 tonnes of PM2.5 from two coal-fired power stations (Bayswater and Liddell).

This indicates the health costs associated with PM2.5 emissions in the Singleton and Muswellbrook areas in 2012–13 amounted to $47 million and $18.3 million respectively – a total cost of $65.3 million.

*These estimates do not reflect the total PM2.5 emissions in the area, i.e. from other sources, nor the dispersal of particulates into other LGAs so actual health damage costs may be higher, or lower, depending on exposure.

HEALTH COSTS ASSOCIATED WITH PM2.5

SINGLETON AREA

1,305
TONNES OF PM2.5
FROM COAL SOURCES IN SINGLETON.
COST $36,000/TONNE HEALTH DAMAGES

MUSWELLBROOK AREA

1,410
TONNES OF PM2.5
FROM COAL SOURCES IN LESS POPULATED MUSWELLBROOK.
COST $13,000/TONNE HEALTH DAMAGES

THE COST ON HEALTH

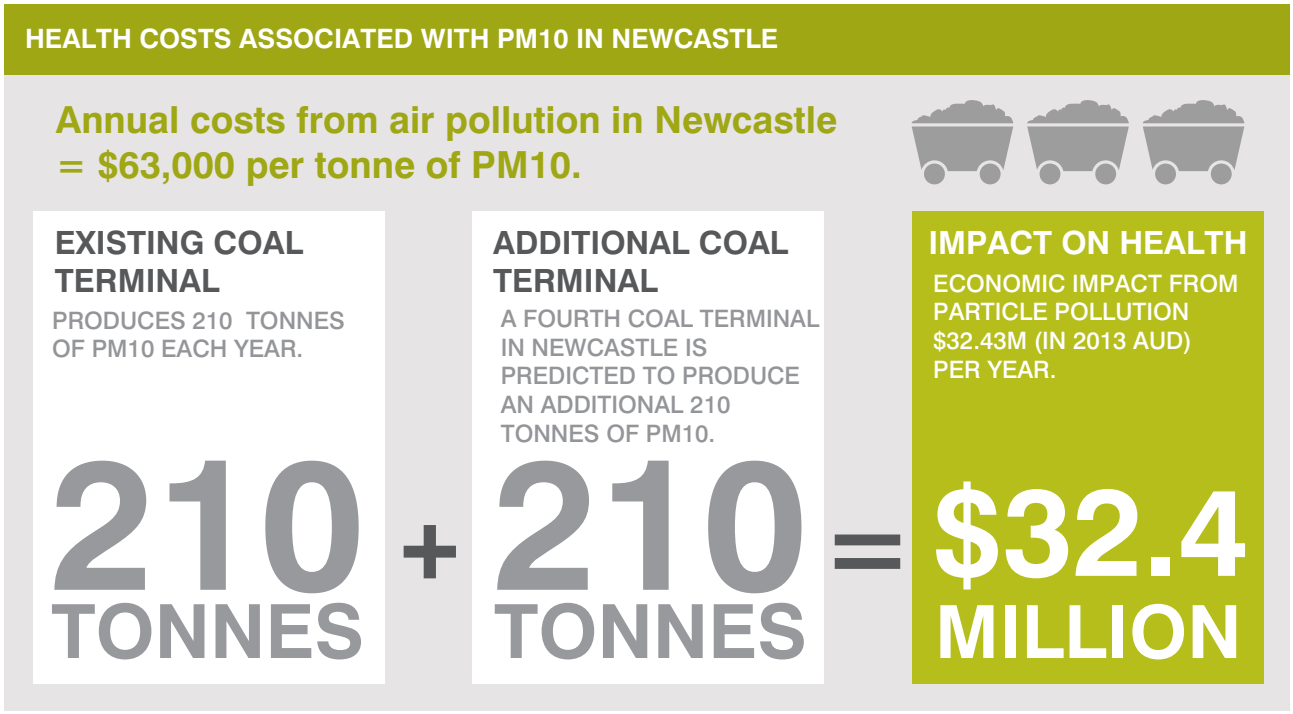
$65.3 MILLION

Health costs associated with PM10 in Newcastle

A 2005 study suggested the annual costs associated with adverse health impacts from air pollution in Newcastle amounted to $63,000 per tonne of PM10.

The existing coal terminal at Kooragang Island at Newcastle (known as T3) has capacity to handle 120Mtpa and produces 210 tonnes of PM10 each year.[218]

A fourth coal terminal in Newcastle is predicted to add 70Mtpa capacity, with a master plan to expand capacity to 120Mtpa,[219] potentially producing an additional 210 tonnes of PM10.[220] Using this assessment of costs, the current economic impact from the particle pollution from the existing coal terminal on the health of the Newcastle community is around $13 million per year. The additional terminal may double this to $26 million (in 2005 AUD) or $32.43m (in 2013 AUD) per year.



5.3 Economic costs of global warming

Given the threat to Australia and the world from global warming, the high carbon intensity of coal projects should be a key factor in energy and resources policy decision-making.

In addition to the adverse economic impacts associated with the 'externalities' of mining and burning coal on state budgets, the global economic damage from its contribution to climate change must also be considered.

These damages include health and property damage, impacts on agriculture, damage to ecosystem services, and other welfare costs associated with climate change.[221]

The method of establishing this cost is known as the 'social cost of carbon' – essentially a monetised estimate of the damages caused by emitting an additional tonne of carbon dioxide in one year.[222] Estimates of the social costs of carbon vary widely.

Using a range of estimates from the literature, current coal production in the Hunter Valley is estimated to be contributing to a global social cost of carbon of between $16 and $66 billion per annum.

Social cost of Hunter Valley carbon emissions

Evaluations of the social costs of carbon are highly variable and range from $37/tonne of carbon dioxide emitted to $190/tonne. Using figures from this range, it is estimated that the social cost of carbon associated with the carbon emissions (348Mt) from current production levels of Hunter Valley coal (145Mtpa) range from $16 billion to $66 billion annually.

The social cost of carbon associated with estimated emissions (583Mtpa) from projected productions of Hunter Valley coal in 2022 (243Mtpa) is predicted to increase to a range from $26 billion to $111 billion annually.

Reference	Annual social cost of carbon	Annual Social Cost of Carbon in $AUD per tonne of CO_2e, 2013 dollars	Annual Social cost of Carbon from 2013 coal production in Hunter Valley (AUD$ 2013)	Annual Social cost of Carbon from 2022 coal production in Hunter Valley (AUD$ 2013)
US Government (2013, Table 2) [Reference 1]	$USD37 (US$/tonne CO_2 emitted, 2007 dollars	$44.74	$16 billion	$26 billion
Tol (2013, Table 2) [See Reference 2]	$USD135, per tonne of C or $US37 per tonne of CO_2e 2010 dollars	$42.29	$15 billion	$25 billion
Anthoff (2009) [See Reference 3]	$USD206 per tonne of C or $US56 per tonne of CO_2e in 2008 dollars	$65.36	$23 billion	$38 billion
Stern 2008 as reported in Anthoff, 2009 [See Reference 3]	$USD300 per tonne of C or $US82 per tonne of CO_2e in 2008 dollars	$95.19	$33 billion	$56 billion
Stern 2008 adjusted to reflect "doubling of risk" [See Reference 4]	$USD600 per tonne of C or $USD163.49 per tonne of CO_2e in 2008 dollars	$190.38	$66 billion	$111 billion

1. Interagency Working Group on Social Cost of Carbon, 2013, Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis, United States Government, available at http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf
2. Tol R, 2013, "Targets for global climate policy: An overview," Journal of Economic Dynamics & Control, 37, 911–928, available at http://www.parisschoolofeconomics.eu/IMG/pdf/tol_paper.pdf
3. Anthoff D et al, 2009, "Risk aversion, time preference, and the social cost of carbon," Environmental Research Letters, 4, available at http://iopscience.iop.org/1748-9326/4/2/024002/pdf/1748-9326_4_2_024002.pdf
4. Stewart, H. & Elliot, L. 2013, 'Nicholas Stern: 'I got it wrong on climate change – it's far, far worse'", The Observer, 27 January. Available at: http://www.theguardian.com/environment/2013/jan/27/nicholas-stern-climate-change-davos

6. Inadequate regulation with a bias towards approvals

While there is a substantial body of evidence and growing community concern regarding the adverse impacts on human health from coal in the Hunter region, this has had little effect on the approval rate of new mining projects.[223] Despite concerns raised by researchers, health organisations, the New South Wales Department of Health, community groups, and individual medical practitioners, little has been done through stronger regulations or changes to planning laws to protect health and wellbeing.[224]

The views of health experts and community members appear to have little impact on planning policy decisions.

Even when there is strong opposition to coal projects, concerns are all too frequently ignored and decisions made in the interests of mining companies.[225,226]

While new mining projects are obliged to evaluate the cumulative impacts of many mines operating together, these frequently assess a narrow scope of cumulative impacts, and fail to accurately account for greenhouse emissions, human health and broader environmental impacts.

State-based regulations which require Environmental Impact Assessments for mining projects are inadequate in assessing human health impacts and are frequently non-transparent.[227]

Federal environmental laws, such as the *Environmental Protection and Biodiversity Conservation Act*, are aimed at protecting biodiversity and supporting conservation of ecosystems, not the protections of humans.

While links between human health and the environment are well understood within the public health and environmental health professions, this has not been reflected in policy decisions and is ignored in industry regulations.[228]

Current processes for the approval of coal projects in New South Wales burden, rather than protect, the community. While health impact assessments (HIAs) are well established methods for evaluating the health impacts of infrastructure projects, these are rarely employed in assessing coal project proposals by state planning decision-makers. Without an HIA, or a comprehensive assessment of environmental impacts, communities are concerned projects are being approved without an accurate assessment of the health, social or economic costs.[229]

The failure to conduct health impact assessments as part of the process of assessing applications for mining licences means projects are going ahead without an adequate assessment of the health consequences for local communities.

Where included, health impacts are either narrowly defined or ignored in planning decisions, and the removal of local government powers to influence decisions about coal mining projects limits the ability of local communities to exercise any power in opposing new projects.[230,231]

For example, the Muswellbrook Shire Council says the community is “exhausted” by the “negative consequences of the mining industry”[232] but, due to changes to planning laws, local governments now lack any power to approve or reject new coal projects.[233]

Other changes to state planning laws include the removal of the principles of Ecologically Sustainable Development (ESD), which allows economic considerations to take precedence over social and environmental concerns, and limits to the rights of communities to appeal decisions on coal and gas development, with no appeal rights at all when there has been a public hearing by the Planning Assessment Commission.[234]

Newcastle public health academics have advised that the construction of T4, the fourth coal export terminal in the city of Newcastle, will cause a critical increase in harmful coal train pollution along the rail corridor through Hunter towns and Newcastle suburbs. They assert that carcinogenic diesel exhaust combined with PM10 and PM2.5 dispersals from coal trains creates a toxic pollution source that must be mitigated at the development planning stage. However, New South Wales Planning and Environment does not require such 'upstream' impacts to be considered in the approval process for T4.[235]

The recent introduction of a 'gateway' approval process following amendments to New South Wales planning laws – ostensibly to protect agricultural land and groundwater – has failed to provide assurance to communities concerned about the evaluation of public benefit in relation to new coal projects.[236]

The first project to be considered under the 'gateway process', the Bylong Valley Coal Project in the Hunter Valley, failed to meet 12 out of 13 criteria, and will have significant impacts on productive land and local water supplies, but was still awarded a conditional certificate and has progressed to the next stage of planning development.[237]

Other community concerns about the approvals process involves the practice of contracting out environmental assessments for projects (which evaluate impacts on air, soil and water quality, as well as on social, economic, cultural, and heritage values) to private consultants who frequently also work for the coal industry.

This practice has led to considerable distrust of the findings of experts employed by industry that show proposed coal projects will not cause adverse impacts or that the source of pollution causing concern is not from the coal industry.[238]

This has the effect of further undermining community confidence in the industry and in the responsibility of regulatory and government agencies to act in the community interests, and adds to the mental health burden of communities due to a sense of distress and abandonment.[239]

7. Conclusion

The impacts of coal in the Hunter Valley on the health and wellbeing of communities and the environmental foundations on which health depends (clean air and water, fertile soil) suggest the costs of the industry to society are considerable.

Coupled with the contribution of coal to global warming and the consequences for the health and wellbeing of people globally, it is clear that the expansion of coal in the region will have adverse consequences at a local, national and global level.

As a recent editorial in the *Australian and New Zealand Journal of Public Health* concluded, coal is a fuel that is "no longer fit for purpose on a crowded and overheated planet".[240]

Australia is extremely fortunate in that it has access to some of the most abundant renewable energy resources in the world. Coupled with energy efficiency initiatives, it is possible to replace coal-fired electricity generation in the Hunter Valley with cleaner, healthier alternatives – and in doing so, support the development of a new regional industry.

It is time for policy and planning decisions to be implemented that allow regions like the Hunter Valley to begin a transition to other less harmful industries that will provide a safe, healthy and economically secure future.

The people of the Hunter Valley and the natural values of the region should not be sacrificed in the interests of short term profit for an industry that is causing harm.

It is hoped this report will shed some light on some of the risks posed by coal in the Hunter Valley, assist in a public effort to influence policy decisions to minimise those risks, and provide the opportunity for the region to consider an alternative future.

Photo: 100% Renewables

Case studies


Photo © Conor Ashleigh

Newcastle

Professor Nick Higginbotham has been researching the impacts of coal on people in the Hunter for over two decades.

Nick Higginbotham is an Associate Professor at the University of Newcastle and has worked in the public health research group for 27 years. His research has involved looking at the impact of coal mining on the community and the social lives of people in the Hunter. Along with Linda Connor and Glen Albrecht, Professor Higginbotham developed the 'Environmental Distress Scale', which is now applied worldwide to evaluate people's distress and sense of loss associated with landscape transformation. In recent years, his research has shifted to investigating the health impacts associated with the expansion of coal loading in the Newcastle area.

The proposed development of a fourth coal export terminal (T4) in the city of Newcastle threatens to expose an already vulnerable population to even higher levels of particle pollution. With all three existing terminals operating at capacity, the addition of T4 could see coal exports reach 280 million tonnes per annum. The proposal is expected to increase by 50 per cent existing annual coal train transport, which would mean an almost continuous passage of coal trains, with one train around every 7 minutes. Operating at its full capacity of 120Mtpa, T4 and the associated rail transport could potentially add 363 tonnes of particle pollution to Newcastle's already polluted air.[241]

There are 25,680 people who live within 2 kilometres of the proposed facility, one-third of whom are children (under 14 years) or elderly (over 65 years). Their neighbourhoods include 24 schools, preschools and nursing homes. Household incomes in the community are lower than the state average, making it more vulnerable to health risks.

Local residents are concerned the development of the fourth terminal will have serious implications for children at school and quality of life for local residents in terms of both noise and air pollution.

Coal transport exposes people along the rail corridor to harmful and carcinogenic air pollution from the diesel fumes emitted by trains and from the coal dust dispersed as trains move along the rail corridor.

Professor Higginbotham says the increase in coal trains is adding an extra burden of air pollution around the rail corridor from both coal dust and diesel fumes.

> "Diesel powered coal trains are a major source of toxic pollution, their passage creates a plume of pollution combining cancer causing diesel exhaust with harmful particulate matter (PM10 and PM2.5).
>
> "This means we are going to see new cases of asthma, of lung disease and heart disease, and Newcastle is already well known for having a higher rate of heart disease than the rest of New South Wales."

There are currently no regulations limiting diesel emissions from coal trains or non-road vehicles.

The local New South Wales Health office, Hunter New England Local Health District, reports increasing numbers of complaints from residents about coal dust and particle pollution as well as noise pollution associated with coal handling and loading facilities.[242]

Monitors at nearby Kooragang Island already record levels of particle pollution above World Health Organisation annual air quality standards for PM10 of 20 $\mu g/m^3$; another monitor at Stockton regularly records levels that exceed National Environment Protection Measure (NEPM) particulate standards.[243]

EPA Air quality monitoring stations in communities several kilometres from the coal loading terminals show levels of air pollution that exceed the World Health Organisation standards for PM10 and the national advisory standard for PM2.5.

Professor Higginbotham and other public health experts in the region have mounted a comprehensive case against the approval of the terminal, arguing the project threatens a key determinant of health and wellbeing for the Newcastle community: clean air. They say the failure to undertake a Health Impact Assessment is "profoundly negligent", given the existing poor air quality in the region, existing poorer health of residents, and additional contributions to poor air quality that will come from trains carrying coal to the port.[244]

They also argue the project's assessment of air quality uses outdated research, proposes inadequate standards, fails to account for significant levels of rail line pollution, will likely see substantial breaches of emissions standards during extreme weather events – which are increasing in both frequency and severity[245] – and would result in air quality standards being regularly exceeded along the rail corridor.[246]

Monitoring undertaken by an alliance of concerned residents groups in Newcastle found 'hot spots' of industrial pollution in suburbs adjacent to the existing coal facilities, indicating several areas in which national air quality standards may be regularly breached.[247]

A 2013 study of particulate pollution from coal trains commissioned by the Dust and Health Committee of the Coal Terminal Action Group found coal trains increased particulate pollution, with unloaded wagons responsible for higher levels of particle pollution than loaded.[248] Monitoring undertaken by the Australian Rail Track Corporation found loaded coal trains increased particulate by 4.8 $\mu g/m^3$ for PM10 and 1.2$\mu g/m^3$ for PM2.5.[249]

However local community monitoring of particulate levels associated with loaded coal trains found spikes in both PM2.5 (thought to be from diesel emissions) and PM10 (likely to come from coal dust). The monitoring found average increases in PM10 pollution of 18.9 $\mu g/m^3$ for unloaded trains and an increase of 16.3 $\mu g/m^3$ for loaded coal trains.[250]

"We have done research ourselves with community groups and found that each additional coal train 'pass-by' is contributing to increased air pollution – in some case (there is) a doubling or even ten times the amount of pollution in the air after a train has gone by," Professor Higginbotham said.

Using the estimates of health impacts from air pollution in the Hunter in 2005,[251] Newcastle epidemiologist Dr Ben Ewald estimated the additional pollution of the proposed fourth terminal would increase health costs in the Newcastle community by $29 million each year.[252]

Also of concern is the cancer cluster found among coal loading workers at Port Waratah Coal Services at the Kooragang coal terminal in Newcastle, the proposed site of the new coal export terminal.[253]

A University of Newcastle study found Kooragang workers were 1.8 times more likely to be diagnosed with a cancer compared to the rest of the Australian population and 2.8 times more likely to be diagnosed with a cancer than workers at the Carrington coal terminal.[254] Coal operators (those most exposed to coal) were 3.3 times more likely to be diagnosed with a cancer. The study did not offer an explanation for this increase.

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Camberwell

Farmer Wendy Bowman is one of the last remaining residents at Camberwell – and she refuses to leave.

The Ashton South East Open Cut project is a proposed new open cut coal mine near the village of Camberwell near Singleton. It would extend the existing Ashton mine site over the New England Highway and into grazing land on the banks of Glennies Creek – one of the Hunter River's most significant tributaries.

The importance of Glennies Creek for the health of the Hunter River, and in particular its importance for irrigation of the nearby Pokolbin and Broke-Fordwich wine regions, led the New South Wales Office of Water to initially oppose the new mine. However the Office suddenly and inexplicably reversed its opposition in 2012, which led to the mine being approved (despite opposition from the New South Wales Health Department).[255]

The village of Camberwell already has coal mining on three sides. If the South East Open Cut mine goes ahead, Camberwell will be surrounded by coal mines.

The bulk of the houses (87 per cent) in the village have been purchased by the mine owner, Chinese Government-owned Yancoal, in anticipation of the mine extension proceeding, leaving few original residents.

One local resident and farmer, however, refuses to sell – and the mine is not economically viable without the property.

Wendy Bowman has been a farmer in the region since 1957. She was forced off her previous farm, Ashton, by the Ravensworth South open cut coal mine when co-existence with constant dust and water pollution from the mine became untenable for Wendy and her dairy herd.

Her Droughtmaster cattle farm, Rosedale, is now in the sights of Yancoal, one of the world's biggest coal producers, as an extension to its Ashton mine. The existing mine is both open cut and underground and produces 5.2 million tonnes of coal each year.

The threat of losing another farm to an open cut mine has Mrs Bowman digging in. Despite being in her late 70s, and having being diagnosed with "dust in the lung", she says she has no intention of uprooting herself to convenience an international mining corporation and will stay to defend the land and its agricultural and ecological values.

The mine is small, relative to others in the region, and will only operate for seven years.

"Why dig up and destroy all the creek flats that will feed people for hundreds of years?" she asks.

An economic assessment of the project found the cost benefit analysis (submitted by the mine owners to the planning approval process as part of an Environmental Assessment) overstated the value of the project to New South Wales by $378 million, and to the world by $460 million.[256] There was no value assigned to ecological impacts and no consideration of health impacts.

The destruction of communities through property acquisition and attrition as people leave for a cleaner, quieter environment is one of mining's little acknowledged 'social harms'.

This social and psychological disruption is a significant health impact, and one that is, according to public health physician Dr Craig Dalton, likely to have a "far greater impact than the current particulate levels".[257]

Mrs Bowman's main concern now is not for her own health, but for that of children in the community. She cites many examples of children suffering chronic respiratory illnesses, so ill they are missing months of school each year, with many only improving when they leave the region for a holiday, where their health rapidly recovers.[258]

Wendy describes the impact of blasting from the nearby Ravensworth mine as "significant", both from the noise and the dust it leaves behind, but says it's very difficult to get the mine to take responsibility for the impact. "You ring the compliance officer at the mine, and they ask 'how do you know the dust is from this mine?'. It comes right after the blasting explosion, and yet they want you to collect samples and prove it came from their mine."

Photo © Conor Ashleigh

Denman

Grantley Blake is a farmer whose family has owned Blakefield near Denman for more than a century. The farm is bordered by Mount Arthur mine to the north, Mangoola to the west, and a proposed underground coking coal project, Spur Hill, on the southern side.

Grantley lives on the farm with his wife, a retired nurse, his two sons and their families, including seven grandchildren, the oldest of whom is eight. He is deeply concerned about the health of his family – and says the coal dust from the Mangoola coal handling facility and stockpiles just three kilometres away from the farm causes constant respiratory problems.

The children are constantly on antibiotics for ear, nose and throat problems related to poor air quality, Mr Blake says, with the youngest suffering a near fatal respiratory illness, an event the family believes to be related to fumes from blasting at the mine.

The family now purchase their drinking water and the children are only allowed to play outside when the wind blows from the south – a respite that will be lost if the Spur Hill mine goes ahead.

While he understands the proponents of the Spur Hill mine are keen to buy his property, Mr Blake refuses to talk to them, and says he's holding on for the sake of protecting "some of the best farmland in the country".

"This land has been farmed by my family for more than a century because it's the best, but once it's mined, that's gone."

The water in the adjacent Hunter River is heavily polluted by the mines, affected by waste water heavy with salt and other contaminants that the mine is allowed to discharge into the river. Along with cattle, Mr Blake farms fish, but if he puts water from the river into his fish tanks, the fish are "dead within three days".

"We used to drink that water when I was a kid. Now it's full of salt, and it's black. That's got to come from the mines."

In addition to the health burden, Mr Blake says it's the additional costs associated with mining that must be borne by local communities and families that he objects to.

"We've got to buy water. Pay more for electricity because the kids can't go outside in the summer and have to have the air con on. Buy extra filters for the fish. Pay extra health bills. These are because of mining, mining by international companies, whose profits don't even stay in this country. Why should we pay?"

Mr Blake's son Wayne is deeply concerned about the health of his own and other children and the impact of mining on the future of other industries in the Valley.

"My kids are always sick – they always have throat infections, respiratory problems, coughs and so on. They always need their [asthma] puffers, always have runny noses."

The source, according to Mr Blake, is the dust from overburden at the adjacent mine and from the coal preparation plant across the river. In his view it has been getting steadily worse for the last five years (the mine has been operating for six years).

He believes poor regulation of the industry has led to the towns of Muswellbrook, Singleton and Denman being 'over-populated' with coal mines, and that the government is on the side of miners, not the community.

"The recent events at Bentley [where community protests led to the removal of Metgasco's exploration licence to drill for coal seam gas due to insufficient community consultation] show the community is sick and tired of the government not telling the truth, and failing to act in the community interest. It is not a level playing field for the community against mining companies and the government," he said.

Mr Blake sees little regard also for the longer term, leaving him concerned about the future of the region.

"We rely on the agriculture industry to feed us, but you can't regenerate land damaged by mining to grow food."

"What happens to the Hunter Valley after mining?" he asks.

Bulga – Warkworth

The tiny town of Bulga is less than 5 kilometers away from three of the largest open cut coal mines in the Hunter Valley: Mount Thorley Warkworth (owned by Rio Tinto), the Bulga mine (Glencore-Xtrata), and Wambo (Peabody Energy).

Proposed expansions seek to extend existing mines and would bring the Mount Thorley Warkworth mine right up to the edge of the village.

If the mine extension goes ahead, it will produce 18 million tonnes of coal each year for 17 years. The total volume of coal produced over this project's lifetime will reach 306 million tonnes.

The project will see the mine expand through areas previously identified as environmental offsets for the protection of biodiversity approved for the previous project. It breaks a previous Deed of Agreement that Rio Tinto signed in 2003 not to expand the mine any further – to preserve it "in perpetuity", an agreement locals had relied on when purchasing or upgrading property.

The local community opposes the extension, citing the destruction of almost 500 hectares of endangered ecology, including habitat for threatened species, as well as radical changes to the character of the village and the landscape. The land to be cleared was set aside as a biodiversity offset when the mine was originally approved.

In 2013, represented by the New South Wales Environment Defender's Office, the Bulga Milbrodale Progress Association took their concerns to the New South Wales Land and Environment Court, seeking to overturn the government's decision to allow Rio Tinto to expand the mine.

The Court found in favour of the local community, with Judge Brian Preston ruling that the harm to the environment from impacts on endangered woodland and the community of Bulga outweighed any economic benefit of expanding the mine.[259]

The decision was upheld in the Supreme Court. Both courts agreed that the social, environmental, and economic impacts of expanding the mine were so great that they exceeded the benefits the project would bring to the state. The courts found that Rio Tinto had systematically overestimated the economic value of the project, and underestimated the impacts.

Despite the legal wins, Rio Tinto resubmitted its application again in 2014.[260] Under recent changes to New South Wales Planning Laws, the community has no right to appeal the new application and, if it is approved, the decision cannot be challenged in court.

An economic assessment of this project suggests economic benefits of the extension are overstated and that the harm to the community and environment from noise, vibration, effects of air quality, dust and loss of amenity were not accounted for.[261]

There was no estimate of the social value of the community, nor of the environmental services provided by the land.[262]

John Krey is a local resident and the former Chair of the Bulga Milbrodale Progress Association. He helped lead the legal challenge and says the community is now back to where it was four years ago.

"We've got two court cases behind us now, both of which said the mine extension shouldn't go ahead. But the New South Wales government has made new amendments to the planning laws which mean the project will be approved. Now the value of the resources is the only consideration – the impacts on the community or ecology are irrelevant. The government has removed all the impediments to getting this approved."

Mr Krey says the noise from the existing mines at Bulga is extremely disruptive for residents. It makes sitting outside impossible, due to sounds like "an airplane continuously overhead". Blasting from the mine "shakes the house".

The noise of machinery at the mine, which works 24 hours a day, wakes people at night. For people who came to Bulga to enjoy the peacefulness of the bush, the constant intrusion is upsetting and disruptive.

According to Mr Krey's monitoring, the noise levels exceed the New South Wales industrial noise policy for the two mines.

When locals are able to get the relevant government department (in this case the Department of Planning) to respond to their concerns, an offer to send a consultant to monitor noise invariably occurs during a week when the mine is quiet, he says.

It's not just the noise that is upsetting, it is knowing the noise levels are being exceeded and that no-one will enforce them.

"The mine will work to the limits of its approvals – we accept that, but when the body that is supposed to be monitoring them refuses to do so, that is not acceptable," he said.

Dust is also a problem, and like Wendy Bowman in Muswellbrook, John Krey finds it very difficult to get the mine or the authorities to accept responsibility for the dust – or respond to the concerns of local residents.

"We ring the Department (EPA) to report excessive dust, and they say: "Which mine is the dust coming from?"

"And then they phone the mine to ask them if it's their dust. It's farcical."

And it's not only the dust from the mine (mostly larger particles PM10), but the health risks from diesel used in mining vehicles and equipment. Just one mine uses 20 million litres of diesel each year, according to Mr Krey, and there are no catalytic converters on mine equipment.

The mining industry is not interested in addressing the concerns of local residents, he says, but even more demoralising for local residents is the unwillingness of the government to control their activities.

Another member of the Bulga Milbrodale Progress Association, John Lamb, says this makes people angry and frustrated, and leads to negative impacts on people's mental health.

"It's the loss of control over our environment that is the most difficult. We came here to enjoy the peacefulness of the bush. Now there's continuous noise, plus the blasting – they shake the house and wake you up."

John Krey's wife Leslie says: "It's wrong that citizens should be forced to experience the emotional fall out from mining – the loss of amenity, the loss of quality of life, the loss of the future."

Appendix A
Air quality standards in Australia

The National Environment Protection (Ambient Air Quality) Measure (NEPM) developed in 1998 sets uniform national ambient air quality standards for six air pollutants: carbon monoxide; lead; sulphur dioxide; nitrogen dioxide; ozone and particles with diameter less than 10 μm (PM10). In 2003, an advisory reporting standard for particles with a diameter less than 2.5 μm (PM2.5) was added.[263]

In having no air quality standard for PM2.5, Australia is out of step with the World Health Organisation (WHO) guidelines. The WHO standard for PM2.5 is a 24 hour average of 25 μg/m^3 and annual average of no more than 10μg/m^3.[264] The WHO standard for PM10is a 24 hour average of 50 μg/m^3 and annual average of 20 μg/m^3.[265]

Australia's air pollution standards and implementation practices are outdated and do not reflect current air pollution science, although they are under review.[266] The current approach is to regulate to certain air quality targets as the standard, when in fact exposure to air pollution at the standard itself is not safe, and aiming to regulate to keep air quality from exceeding the (known to be inadequate) standard will fail to bring about reductions in air pollution to safer levels.[267]

Table 2.1: Ambient air quality NEPM standards and goals[268]

Pollutant	Averaging period	Maximum concentration	Goal within 10 years – maximum allowable exceedences
Carbon monoxide	8 hours	9.0ppm	1 day a year
Nitrogen dioxide	1 hour	0.12ppm	1 day a year
	1 year	0.03ppm	None
Photochemical oxidants	1 hour	0.10ppm	1 day a year
(as ozone)	4 hours	0.08ppm	1 day a year
Sulphur dioxide	1 hour	0.20ppm	1 day a year
	1 day	0.08ppm	1 day a year
	1 year	0.02ppm	None
Lead	1 year	0.50μg/m^3	None
Particles as PM10	1 day	50μg/m^3	5 days a year
Particles as PM2.5	1 day	25μg/m^3	Advisory reporting standard
	1 year	8μg g/m^3	

Appendix B
Economic analysis

Explanation of health costs of coal production

Coal mining, transport and combustion (otherwise known as coal production) in the Hunter Valley all cause 'external costs' or 'externalities'. This means that the production of coal leads to effects that are borne by people who are neither the direct producers, nor the consumers, of coal. Where these effects are negative the externalities are known as negative externalities. Negative externalities are often corrected by imposition of a financial penalty: a 'price' or tax on the offending item.

Health costs from coal production are a significant negative externality in the Hunter Valley.

The estimates for the health costs of air pollution (measured in dollar terms) in the Hunter Valley are based on a study by Pae Holmes Consultants in 2013.

The estimates of the health costs associated with coal-powered electricity in the Hunter Valley are based on an evaluation by Tom Beigler: *The Hidden Costs of Electricity: Externalities of power generation in Australia*, a 2009 report for Australian Academy of Technological Sciences and Engineering (ATSE).

Estimates of the social costs of carbon

The social cost of carbon seeks to measure the gap between the socially optimal price of carbon (on an intergenerational basis) and the actual price of carbon.

The estimates for the social costs of carbon, that is the cost to society associated with increased greenhouse gas emissions and other externalities, are drawn from a range of recognised sources.

Social costs should include all costs to society including but not limited to damage to agricultural productivity, infrastructure and harm to human health but many estimates fail to include all of the important physical, ecological, and economic impacts of climate change.[269]

The estimates used in the range presented in this report include the most recent assessment from the US Government Working Group on Social Cost of Carbon, estimates from economists Richard Tol and David Anthoff, and estimates from the international authority on the social costs of carbon, Lord Nicholas Stern, using both his published estimates, and an estimate of costs based on Sterns' recent comments that continued global warming now presents a "doubling of risk".[270]

Estimates of the value of the social cost of carbon vary widely, and it should be noted that even those estimates at the higher end may underestimate the costs of damage.

Explanation of Hunter Valley coal production estimates

Coal production is defined as the mining, transportation and combustion of coal in the Hunter Valley as well as the combustion of coal mined in the HV but combusted elsewhere in the world as a result of export from the Port of Newcastle.

This report has defined the Hunter Valley as the region surrounding the rail line from Newcastle through to Muswellbrook and west to Ulan. It includes the following nine Local Government Areas: Singleton Council, Muswellbrook Shire, City of Newcastle, City of Lake Macquarie, City of Cessnock, City of Maitland, Upper Hunter Shire, Wyong Shire, and Midwestern Regional Shire. Other reports have defined the HV in different terms.

Hunter Valley (HV) coal is defined as excluding the coal produced in the Gunnedah region and transiting the Werris – Muswellbrook rail corridor. This coal affects the HV via the air emissions from transit (i.e. coal dust and diesel exhaust sourced from coal trains) but the coal is mined elsewhere and is therefore excluded from the HV production estimates.

The estimate of coal production in the Hunter Valley in this report referenced the Australian Government Bureau of Resource and Energy Economics (BREE) June 2014 Quarterly report to calculate coal production from the areas defined as Hunter Valley in this report.

Forecast methodology for coal production from the Hunter Valley

Annual production from 2013 was estimated from BREE data.[271] Data from the Hunter Valley Corridor Capacity Strategy (HVCCC) 2012–2021 produced by the Australian Rail Track Corporation (ARTC) was used to calculate projected production in 2022. Produced by the Australian Rail Track Corporation Ltd (ARTC), which runs the railway system from the mines to the Port of Newcastle, the HVCCC document details the manner in which this corporation will meet the demand for coal transport in the HV corridor to the end of the forecast period. The graphs in this document detail likely coal production increases on a quarterly basis from 2013 to 2022. We have used the relevant graphs[272] to estimate projection of Newcastle Port coal exports, on a yearly basis, to 2022, excluding coal from the Gunnedah region.

ARTC provided forecasts for coal exports that are already contracted for delivery and forecasts of prospective coal exports. Prospective exports are exports that would occur if proposed mines are successfully advanced. Such mines are under active development but the owners are not ready to commit to contractual arrangements.

The following table shows projected increases to estimated actual 2013 coal production in the CAHA definition of the HV. These estimates use the ARTC projected growth in HV coal export production.

Local coal consumption is assumed to remain unchanged throughout the period as solar/ renewables/efficiency gains soak up any local demand increases.

Year ending	Dec 2013	Dec 2014	Dec 2015	Dec 2016	Dec 2017	Dec 2018	Dec 2019	Dec 2020	Dec 2021	Dec 2022
Contracted coal exports from Newcastle/Hunter Valley by HVCC 2013	145	160	165	165	175	185	185	185	185	185
Prospective coal exports from Newcastle/Hunter Valley by HVCC 2013	0	2	2	14	12	27	54	58	58	58
Total prospective and contracted coal exports from Newcastle/ Hunter Valley by HVCC 2013	145	162	167	179	187	212	239	243	243	243

The projections of growth allow us to calculate a total coal production number for the CAHA HV out to 2022. It shows coal production reaching 243 MTPA by 2022.

These figures have been independently verified by Francis Grey from Economists at Large.

Appendix C

Air emissions from power stations in 2012–13

The Eraring Power Station operated by Origin Energy on the shores of Lake Macquarie in the Hunter Valley produced 23,305,771 kg of sulphur dioxide; 15,856,714 kg of oxides of nitrogen; 395,233 kg of PM10; 201,799 kg of PM2.5; 1,972 kg ammonia; 76,190 kg of boron; 495,252 kg of fluoride; 942,694 kg of hydrochloric acid; 138,596 kg of VOCs; and 1,147,337 kg of carbon monoxide.

AGL Macquarie Bayswater Power Station at Muswellbrook produced 63,338,887 kg of sulphur dioxide; 37,574,171 kg of oxides of nitrogen; 932,765 kg of PM10; 523,995 kg of PM2.5; 2,665 kg ammonia; 70,682 kg of boron; 324,821 kg of fluoride compounds; 904,877 kg of hydrochloric acid; 220,145 kg of VOCs; and 1,836,703 kg of carbon monoxide.

Another AGL Macquarie plant, Liddell Power Station on Lake Liddell, produced 29,677,093 kg of sulphur dioxide; 15,335,437 kg of oxides of nitrogen; 287,703 kg of PM10; 159,544 kg of PM2.5; 1,463 kg ammonia; 69,193 kg of boron; 378,077 kg of fluoride compounds; 49,717 kg of hydrochloric acid; 95,785 kg of VOCs; and 792,823 kg of carbon monoxide.

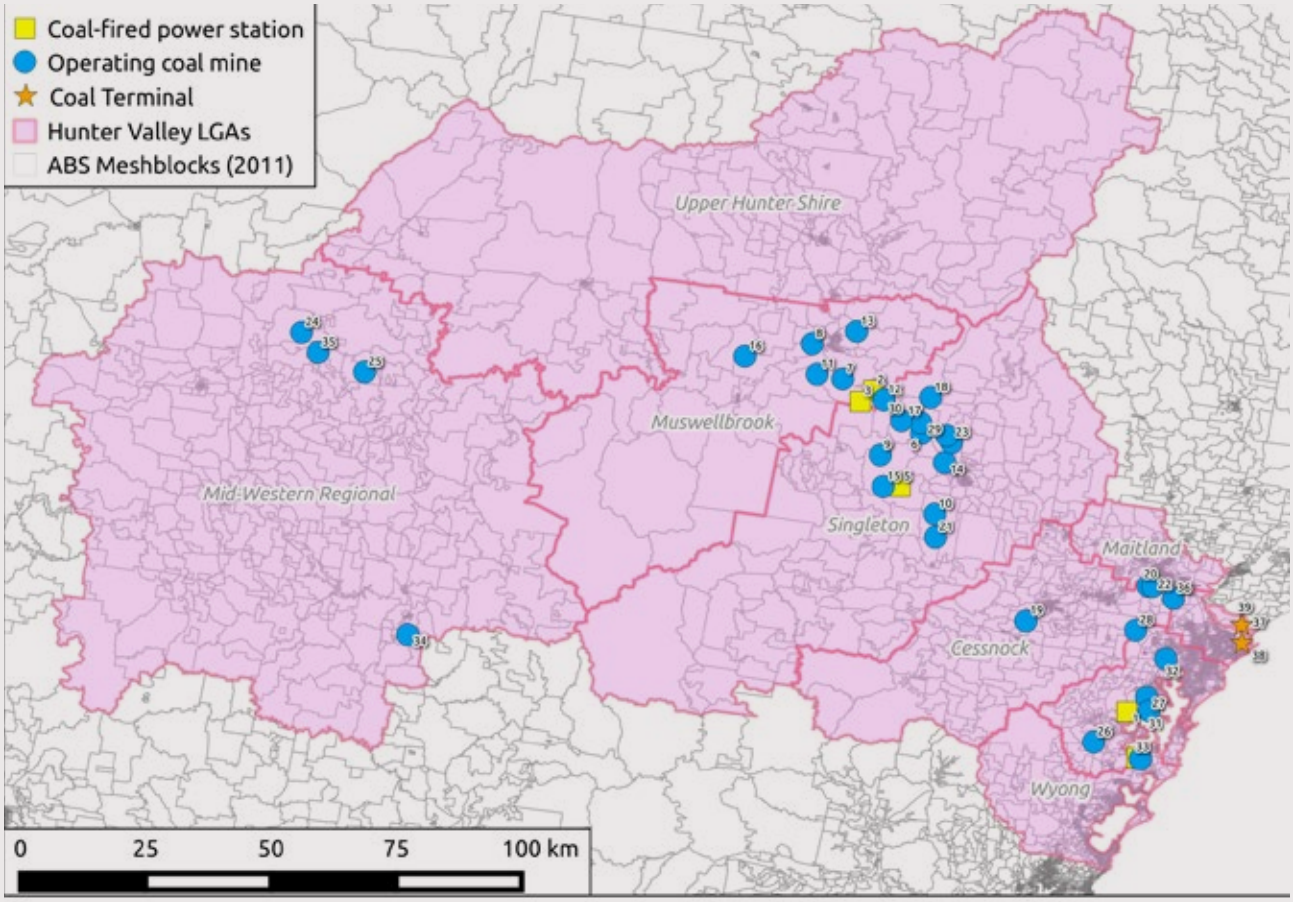
The NSW Government owned Delta Electricity operates the Vales Point Power Station also on the shores of Lake Macquarie. Vales Point produced 16,000,000 kg of sulphur dioxide; 22,000,000 kg of oxides of nitrogen; 41,300 kg of PM10; 3,900 kg of PM2.5; 1,300 kg of ammonia; 53,000 kg of boron; 54,000 kg of fluoride compounds; 290,000 kg of hydrochloric acid; 92,510 kg of VOCs; and 770,000 kg of carbon monoxide.

Redbank Power Station at Warkworth closed in 2013, however data for the previous reporting period was available. The pollutants recorded for Redbank include 1,854,223 kg of sulphur dioxide, 499,975 kg of oxides of nitrogen; 15,512 kg of PM10; 5,034 kg of PM2.5; 237 kg ammonia; 6616 kg of boron; 3933 kg of fluoride compounds; 368,933 kg of hydrochloric acid; 18,685 kg of VOCs; and 155,554 kg of carbon monoxide.

Source: *National Pollutant Inventory*, 2012-13.

Appendix D

Coal mines and coal-fired power stations in the Hunter Valley



Map produced by Herve Senot, Groundtruth

Appendix E

Coal fired power stations, coal mines and coal export terminals in the Hunter Valley

1	Coal-fired power station	Eraring	Origin Energy	Lake Macquarie
2	Coal-fired power station	Liddell	AGL Macquarie	Muswellbrook
3	Coal-fired power station	Bayswater	AGL Macquarie	Muswellbrook
4	Coal-fired power station	Vales Point	Delta Electricity	Lake Macquarie
5	Coal-fired power station	Redbank Power Station	Redbank Energy	Singleton
6	Operating coal mine	Ashton	Yancoal Australia Ltd	Singleton
7	Operating coal mine	Drayton (Muswellbrook)	Anglo American	Muswellbrook
8	Operating coal mine	Bengalla (Muswellbrook)	Coal and Allied, Rio Tinto Coal Australia	Muswellbrook
9	Operating coal mine	Hunter Valley Operations Lemington (Singleton)	Coal and Allied, Rio Tinto Coal Australia	Singleton
10	Operating coal mine	Mount Thorley (Warkworth)	Coal and Allied, Rio Tinto Coal Australia	Singleton
11	Operating coal mine	Mount Arthur (Muswellbrook)	BHP Billiton	Muswellbrook
12	Operating coal mine	Liddell	Liddell Coal, Glencore (Xstrata)	Muswellbrook
13	Operating coal mine	Muswellbrook Coal No. 1 and No. 2	Idemitsu Kosan Company Limited	Muswellbrook
14	Operating coal mine	Rix's Creek (Singleton)	Bloomfield Group	Singleton
15	Operating coal mine	Wambo (Warkworth)	Peabody Energy Australia	Singleton
16	Operating coal mine	Mangoola (Muswellbrook)	Glencore (Xstrata)	Muswellbrook
17	Operating coal mine	Glendell & Ravensworth East (Mt Owen complex)	Glencore (Xstrata)	Singleton
18	Operating coal mine	Mount Owen	Glencore (Xstrata)	Singleton

19	Operating coal mine	Austar (Paxton)	Yancoal Australia Pty Ltd	Cessnock
20	Operating coal mine	Bloomfield Colliery (Ashtonfield)	Bloomfield Group	Cessnock
21	Operating coal mine	Bulga	Glencore (Xstrata)	Singleton
22	Operating coal mine	Donaldson (Black Hill) Abel	Donaldson Coal, Yancoal Australia Pty Ltd	Maitland
23	Operating coal mine	Integra (Camberwell)	Vale Australia	Singleton
24	Operating coal mine	Ulan	Glencore (Xstrata)	Mid-Western Regional
25	Operating coal mine	Wilpinjong (Ulan-NSW)	Peabody Energy Australia	Mid-Western Regional
26	Operating coal mine	Mandalong	Centennial Coal Co Ltd	Lake Macquarie
27	Operating coal mine	Newstan	Centennial Coal Co Ltd	Lake Macquarie
28	Operating coal mine	Tasman	Donaldson Coal, Yancoal Australia Pty Ltd	Lake Macquarie
29	Operating coal mine	Integra UG	Vale Australia	Singleton
30	Operating coal mine	Ravensworth Operations	Glencore (Xstrata)	Singleton
31	Operating coal mine	Myuna	Centennial Coal Co Ltd	Lake Macquarie
32	Operating coal mine	West Wallsend	Glencore (Xstrata)	Lake Macquarie
33	Operating coal mine	Chain Valley	Lake Coal Pty Ltd	Lake Macquarie
34	Operating coal mine	Charbon	Centennial Coal Co Ltd	Mid-Western Regional
35	Operating coal mine	Moolarben	Yancoal Australia Pty Ltd	Mid-Western Regional
36	Operating coal mine	Abel	Donaldson Coal, Yancoal Australia Pty Ltd	Maitland
37	Coal Terminal	Kooragang Port Waratah Coal Services	Port Waratah Coal Services	Newcastle
38	Coal Terminal	Carrington	Port Waratah Coal Services	Newcastle
39	Coal Terminal	Kooragang Island	Newcastle Coal Infrastructure Group	Newcastle

1 Acknowledgement does not imply endorsement of all material in this document.

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CLIMATE AND HEALTH ALLIANCE

Climate and Health Alliance
PO BOX 343 Clifton Hill VIC 3068
convenor@caha.org.au
www.caha.org.au