SUBMISSION TO THE VICTORIAN GOVERNMENT INQUIRY INTO THE HEALTH IMPACTS OF AIR POLLUTION

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INTRODUCTION

Improving air quality is the single most impactful and cost-effective way to improve the health of Victorians now and in the future.

The authors of this submission form a collective group of concerned health professionals, academics and scientists representing combined expertise in public health, respiratory biology, respiratory medicine, epidemiology, pharmacology, oncology, urban planning, and atmospheric chemistry.

Air pollution makes a significant contribution to the burden of disease and premature death in Victoria, and much of it is avoidable. Compared to other risk factors of similar magnitude, air pollution receives a disproportionate level of attention and preventative action and so we welcome the opportunity to comment on the Victorian inquiry into air pollution and hope it leads to measurable health improvements for Victorians. Our submission draws on both international and Australian research to help provide relevance in the Australian context.

KEY RECOMMENDATIONS

- The main anthropogenic sources of air pollution involve combustion processes. Vehicle emissions, coal-fired power stations and wood heaters are the key sources of preventable air pollution in Victoria and therefore mitigation strategies should include a strong focus on these sources.

- Children are disproportionately impacted by air pollution and merit particular attention. Exposing children to vehicle emissions contributes to our already very high prevalence of asthma and allergies along with leading to a host of other lifelong health complications. There are international examples of successful strategies that have reduced children's exposure to roadside pollution and resulted in measurable health improvements (Figure 14). Australian practice lags by international standards. To address this lag and improve Victorian children's health, emulation of these international strategies should be swiftly implemented.

- The smoke generated by wood heaters is more than a nuisance for many Victorians. It has serious health impacts. It should be in the remit of the EPA to protect Victorians who are impacted by woodsmoke. There needs to be a clear and fair recourse for action that is consistent across all of Victoria for people unduly affected by wood heater smoke.

- Victorian brown coal-fired power stations are now among the worst point sources of pollution in the world per kilowatt energy. They are the largest single source of Victoria's air pollution and create a significant environmental injustice to the surrounding regional community. There is pollution reducing equipment that is commonly used around the rest of the world that could reduce the emissions by over 90% (EPA, 2018). Despite years of advocacy and expert health advice that Victoria follow international example and retro-fit these stations, EPA licensing allows them to continue operation with no filters. This needs closer examination including a transparent cost benefit analysis that uses data from appropriate non-biased sources.

- Health risk assessments should be transparent, conducted in a language that is honest and comprehensible to affected communities, incorporate recent evidence and all appropriate health endpoints rather than relying on mortality in the adult population. Risk assessment methodology should be harmonised with international best practice methods. Affected communities should be included in the selection of independent health experts to conduct these analyses.

KEY RECOMMENDATIONS (continued)

- Whole of government approaches need to be conducted with greater transparency and accountability particularly in relation to the influence and narratives supplied by polluting industry stakeholders.

- Raising public awareness is perhaps the single most important required action. The significant government investments into improving air pollution in Victoria should include advertising campaigns, similar to previous anti-tobacco and current anti-idling campaigns in the UK and New York.

- COVID has changed public perceptions of air pollution, climate, transport options and key aspects that contribute to a liveable city. Globally there is a movement to direct post-COVID economic stimulus towards 'green new deal' packages. This is an important moment for Victoria that will dictate future directions for decades. Investing in 'shovel ready' projects that focus on cycling infrastructure and other active transport options are a win-win-win for economy, health, and environment.

BACKGROUND

Outdoor air pollution is the leading environmental cause of disease and death with an annual 4.2 million attributable premature deaths (WHO, 2018). Over 90% of the world-wide urban population are exposed to unhealthy air (Landrigan et al. 2018). By international comparison, air pollution concentrations in Australia are considered low. However, air pollution remains a key contributor to the overall burden of disease and death in Australia with estimates of annual attributable deaths varying, depending on methodologies, from 2,600 (AIHW, 2020) to 4,884 (GBD, 2018).

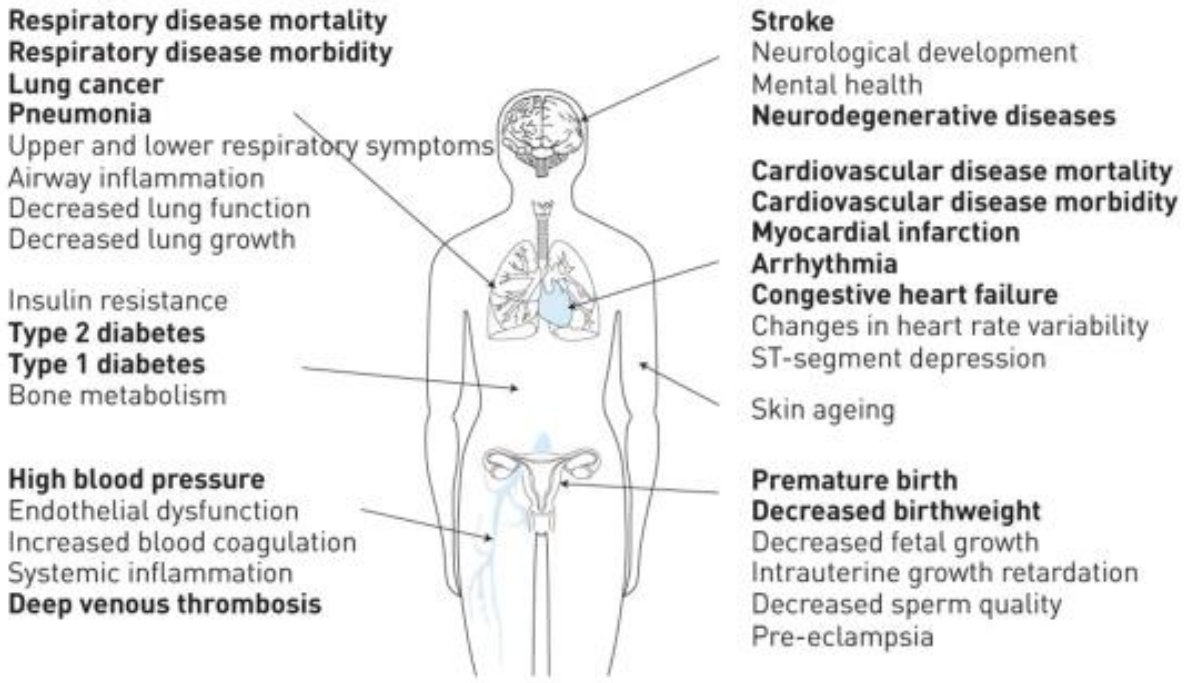
Air pollution is a mixture of liquid and solid airborne particles (particulate matter) and gases which are harmful to human health when inhaled. There are six key air pollutants designated as 'criteria' air pollutants based on evidence demonstrating their measurable direct impact on human health: particulate matter <10 µm, and <2.5 µm in aerodynamic diameter (PM_{10} and $PM_{2.5,}$ respectively), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO) and lead (Pb). Additionally, there are air toxics which are not routinely monitored but known to have detrimental health impacts, with regulation under Safe Work Australia exposure standards (MacSween et al. 2020).

To date, particulate matter is considered the pollutant with the most detrimental impacts on human health. It is produced by man-made (anthropogenic) combustion processes such as vehicle emissions, coal-fired power stations and wood heaters; and is also produced by natural sources such as dust, pollen, and bushfires. A recent analysis estimated an annual 2,616 premature deaths in Australia were attributable to the man-made fraction of fine particulate matter (Hanigan et al., 2021).

The main sources of anthropogenic $PM_{2.5}$ in Victoria are vehicle emissions, coal fired power stations and wood heaters.

The finer (smaller) fraction of particulate matter ($PM_{2.5}$) is predominantly produced by combustion processes. Compared to coarse particulate matter (PM_{10}), $PM_{2.5}$ is comprised of a greater proportion of toxic chemically reactive substances. It is lighter, travelling further in the atmosphere and travels further internally throughout our bodies when inhaled. Particles less than 1 micron in diameter (which include most tailpipe emissions) diffuse from the lungs into the systemic circulation, causing systemic inflammation and affecting various organs throughout the body (Figure 1).

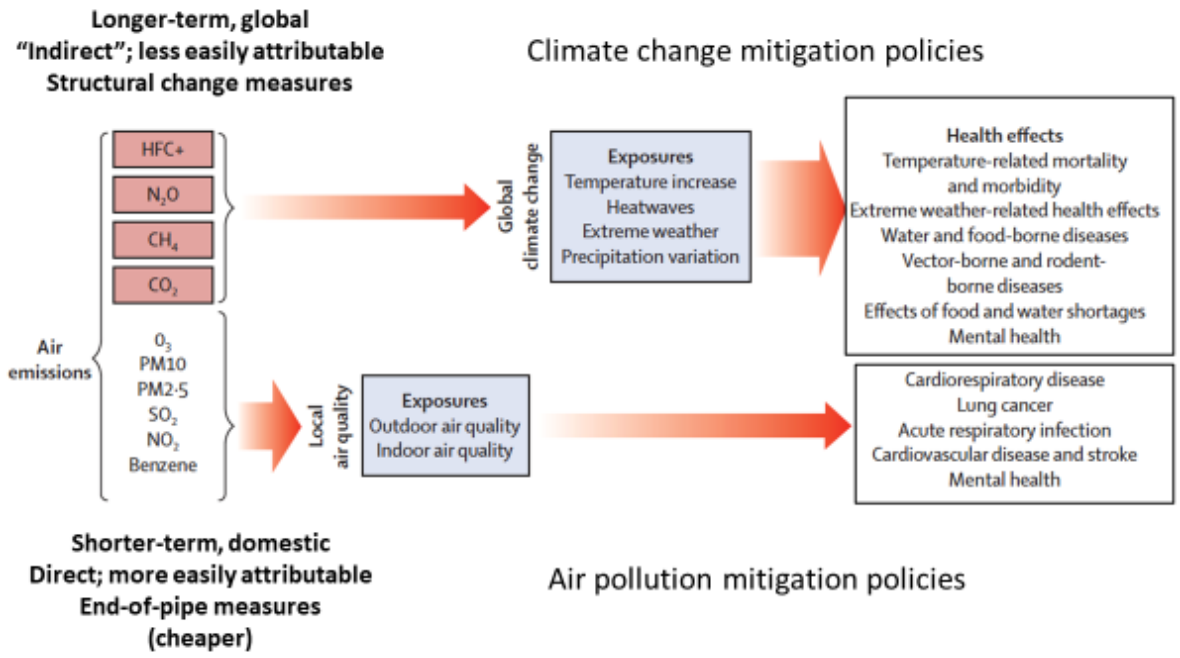
Figure 1: The health impacts of air pollution ((Thurston et al., 2017))



Many air toxics with health consequences, beyond the criteria pollutants are difficult to monitor, or are not published for Victoria. The pollutant formaldehyde is formed both naturally and from a range of anthropogenic sources including traffic, power generation and from smoking (U. S. EPA 2000). It is an indoor health threat with wide ranging health implications and is readily observable from satellite observations, with a recent validation study for metropolitan Melbourne being conducted (Ryan et al.2020). Mercury is another non-criteria air pollutant for which health implications are widely acknowledged, and the specific health burden for Victoria's Latrobe Valley has recently been evaluated (Department of Agriculture (2020); Schofield et al., 2021). Control of mercury will become international law upon Australia' ratification of the Minamata convention on mercury (UN, (no date provided)) .

Most anthropogenic air pollution arises from the burning of fossil fuels which runs in tandem with greenhouse gas (GHG) emissions (Figure 2). GHGs also have health impacts, however these are less direct, harder to measure and can be conflated with competing political interests. We acknowledge they pose an enormous health threat, however we have intentionally omitted these impacts from our submission restricting our focus to the direct measurable health impacts of local air pollution exposure.

Figure 2: Health and climate change: policy responses to protect public health (Watts et al., 2015)



Air pollution as a risk factor has been conservatively* estimated to account for 1.2 % of the total fatal burden of disease (years of life lost), placing it at a similar level to high sun exposure (AIHW, 2020). Unlike other major risk factors for death and disease, air pollution exposure is generally beyond the control of the individual, placing additional importance on preventative policies (Figure 3). Unfortunately, by international comparison, long-term preventative measures aimed at reducing the public health impacts of air pollution in Australia are significantly lagging.

Figure 3: *Risk factors included in the Australian Burden of Disease Study, 2015 (AIHW, 2020)*

Behavioural	Environmental	Metabolic
Tobacco use	Occupational exposures & hazards	Overweight & obesity
Illicit drug use	High sun exposure	High blood pressure
Alcohol use	Air pollution	High blood plasma glucose
Physical inactivity		High cholesterol
Intimate partner violence		Impaired kidney function
Unsafe sex		Iron deficiency
Child abuse and neglect		Low bone mineral density
Dietary risks		

**AIHW methodology does not incorporate the full range of current causal associations and assumes no impact below $PM_{2.5}$ concentrations of 5.9µg/m³. Impacts occur below this threshold and recent evidence indicates a steeper dose-response relationship at lower concentrations.*

There is a dominant narrative throughout policy and regulatory bodies of 'good air quality in Australia' which has contributed to an unfortunate complacency. While our air quality is often 'good' by international comparison, it is important to keep in mind three issues:

1. There is no lower threshold beyond which health impacts do not occur. Even when air quality is 'good', health impacts will occur and therefore any improvement will be associated with a reduction in health impacts. There is substantial room for improvement, which if achieved would result in significant health and economic gains for Victoria.
2. For a given level of exposure to air pollution, some individuals are more susceptible than others. This is particularly the case for pregnant women, young children, the elderly, the socially deprived and people with pre-existing atopy and chronic illnesses.
3. Air quality is obtained through the Victorian EPA network of monitors which are placed in areas to reflect background urban levels. This approach will underestimate the exposure of Victorians who live, work, or attend schools near busy roads, construction sites or industrial areas (see example).

EXAMPLE: KEELE ST CHILDREN'S CENTRE:

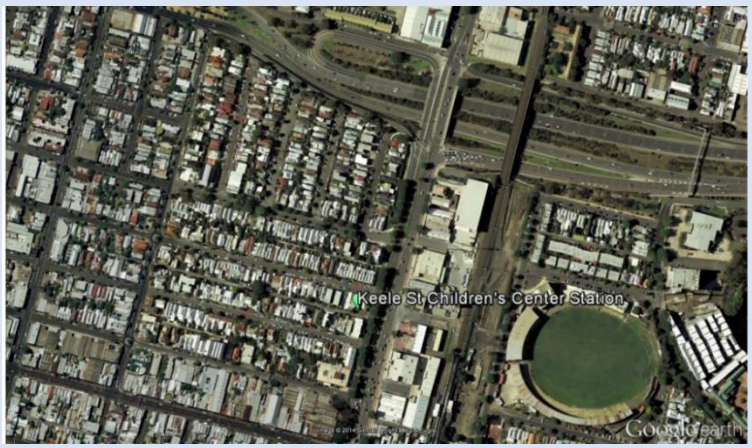


Figure 4: Keele St Children's Centre.

Average PM2.5 (obtained from hourly data over 3 months)

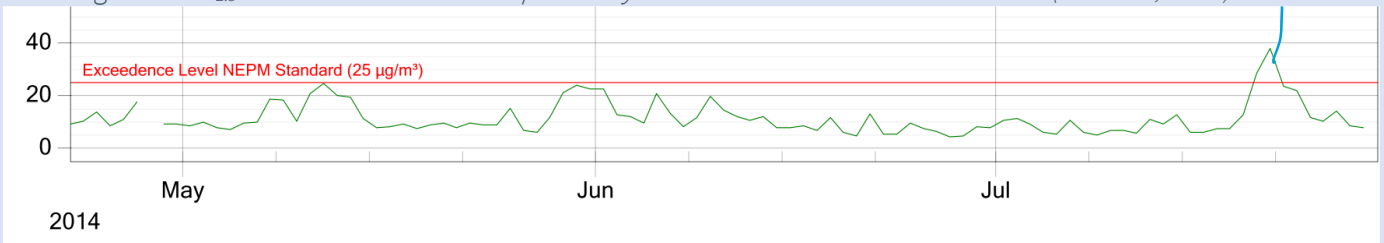
= 11.4 µg/m³

The 2013 the Comprehensive Impact Statement (CIS) for the Eastern section of the proposed East West link assessed the exposures of identified 'sensitive sites' including the Keele St Childcare Centre in Collingwood using air quality data obtained from the closest EPA monitor, located in a park in Alphington, 3 km away (Ecotech, 2014).

The average $PM_{2.5}$ level was determined to be 6.8 µg/m³ and this figure was used to calculate air pollution exposure. Independent monitoring undertaken at Keele St Childcare Centre revealed an average $PM_{2.5}$ of 11.4 µg/m³ (obtained from hourly data over 3 months).

Applying the risk coefficient from a large meta-analysis of global evidence (Bowatte et al., 2015), an increase in the annual exposure from 6.8 µg/m³ to 11.4 µg/m³ is associated with a 37% increase in the risk of developing childhood asthma.

Figure 5: *$PM_{2.5}$ levels monitored from April – July 2014 at Keele St Children's Centre (Ecotech, 2014).*



Combustion vehicles are the main urban source of nitrogen dioxide. Epidemiological studies which include multi-pollutant models demonstrate NO_2 is the key pollutant driving respiratory risks. Population exposure to NO_2 varies widely depending on proximity to roads, traffic volumes and fleet mix. Diesel vehicles emit the highest proportion of NO_2. Australian measurements across 25 roadside sites in Sydney and Perth revealed an annual average NO_2 concentration of 11ppb, 3ppb higher than the annual average obtained from a network of 80 EPA urban background sites (Knibbs et al., 2016). The Australian Children's Health and Air Pollution Study (ACHAPS) conducted across 12 cities found a 4.03ppb increase in annual NO_2 was associated with a 54% (95% CI 1.26 – 1.97 p<0.001) increase in current asthma. School place exposures were also associated with reductions in certain lung function tests, indicating potential stunting of children's lung development. (Knibbs et al., 2018). This very high asthma risk estimate may in part be due to the poor underlying respiratory health of Australian children, who have one of the highest asthma prevalence rates globally. Reducing children's exposure to vehicle exhaust should be a high priority for Australian policy-makers looking to improve health outcomes, yet in sharp contrast to Europe, we are increasing our intake of diesel vehicles, our fuel standards are among the worst in the world (Schofield et al., 2017) and we continue to follow urban planning policies that deliberately place childcare centres and schools on major roads (C. Walter, Schneider-Futschik, & Irving, 2019).

Ground-level ozone is deemed the second-most detrimental pollutant to human health. It is formed through chemical reactions with NO_x and its concentration depends on this dynamic reaction, which can alter depending on meteorological conditions. In Melbourne, this dynamic is dictated by the concentration of NO_x year-round, signifying all measures to reduce NO_x will result in not only the health benefits from decreased NO_x but also from decreased ozone (Ryan, Rhodes, Tully, & Schofield, 2020). The following example demonstrates the impact of NO_x on human health.

EXAMPLE: NO_X IMPACTS ON HUMAN HEALTH

Figure 6: Ella Kissi-Debrah.

Ella Kissi-Debrah was nine years old when she died in 2013. The last two years of her life were punctuated by severe asthma attacks that did not coincide with pollen or respiratory infections, but rather the NO_2 levels from traffic. Ella lived 30 metres from the South Circular Road in London.

The level of evidence demonstrating the link between air pollution and respiratory illness' and stunted lung growth has mounted to the point where Ella's death certificate now lists air pollution as the cause, setting a legal precedent and capturing global attention. The circumstances behind Ella's tragic and entirely preventable death are not completely out of context for Victoria, where many childcare centres and schools are placed on or near major traffic routes.

Over the past few years we have noted with concern hospital prevalence data indicating high rates of cardio-respiratory diseases in certain Victorian post codes coinciding with known air pollution issues including the Latrobe Valley (coal-fired power stations), and the City of Maribyrnong (truck freight corridor). Concerns were met with comments regarding likely confounders such as smoking rates or low socio-economic outcomes, which prompted the gathering of data (Figure 7 and Figure 8). Ninety-five per cent of Victorians fall within the box plots, with the dark line indicating the fiftieth percentile. Figure 7 and Figure 8 include comparative data for inner-western suburbs and Frankston and demonstrate that despite a younger population and lower smoking rates, the City of Maribyrnong has an unusually high prevalence for a range of cardio-respiratory health outcomes that are known to be causally associated with traffic emissions.

Figure 7: Inner West of Melbourne and Frankston areas. The panel on the left shows the age distribution of the population in each geographical area, and the panel on the right shows the concentration of nitrogen dioxide, where darker shaded areas have a higher predicted NO_2 concentration. (Lycett, 2020)

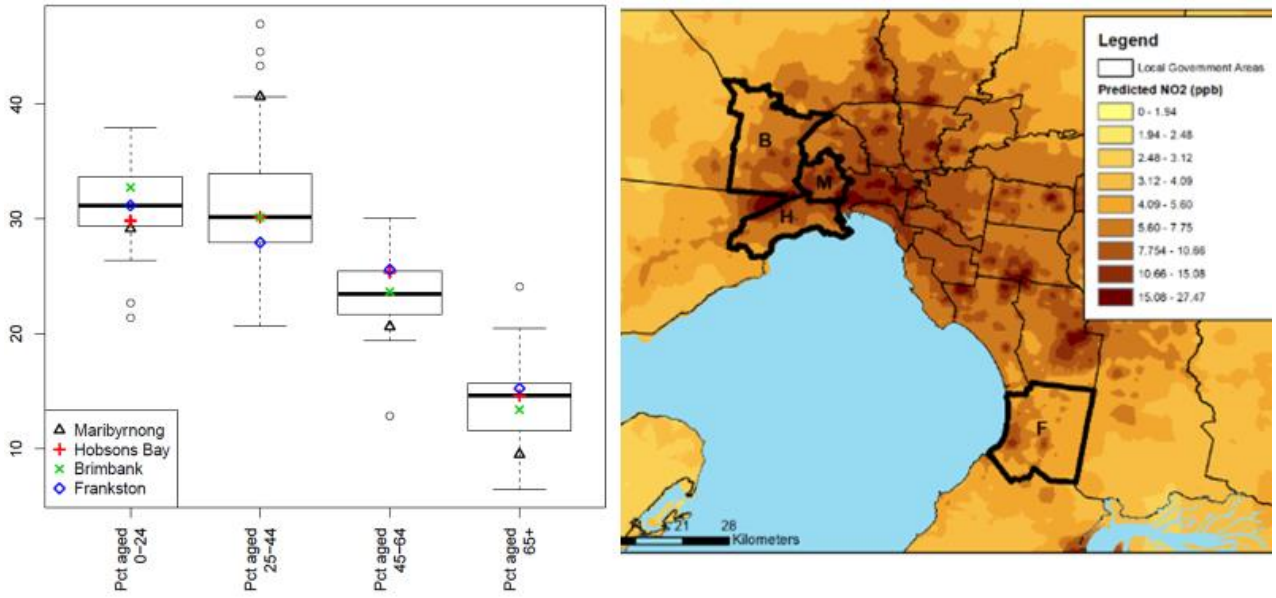
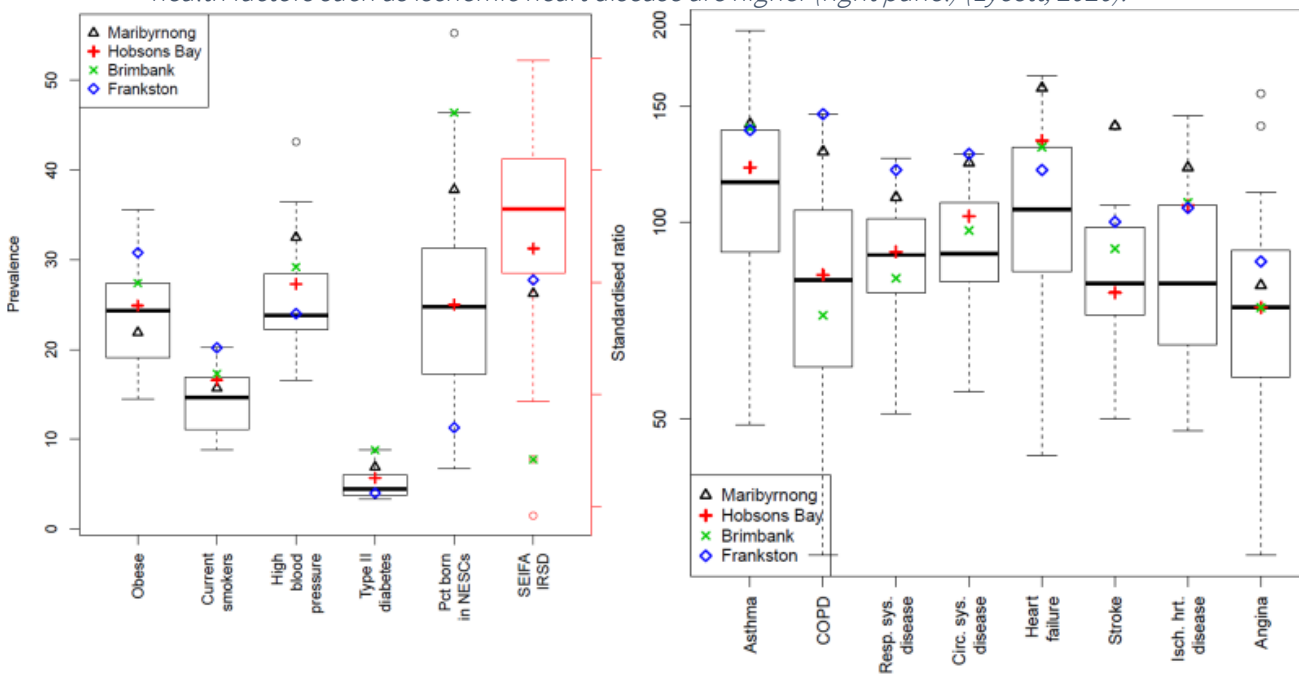


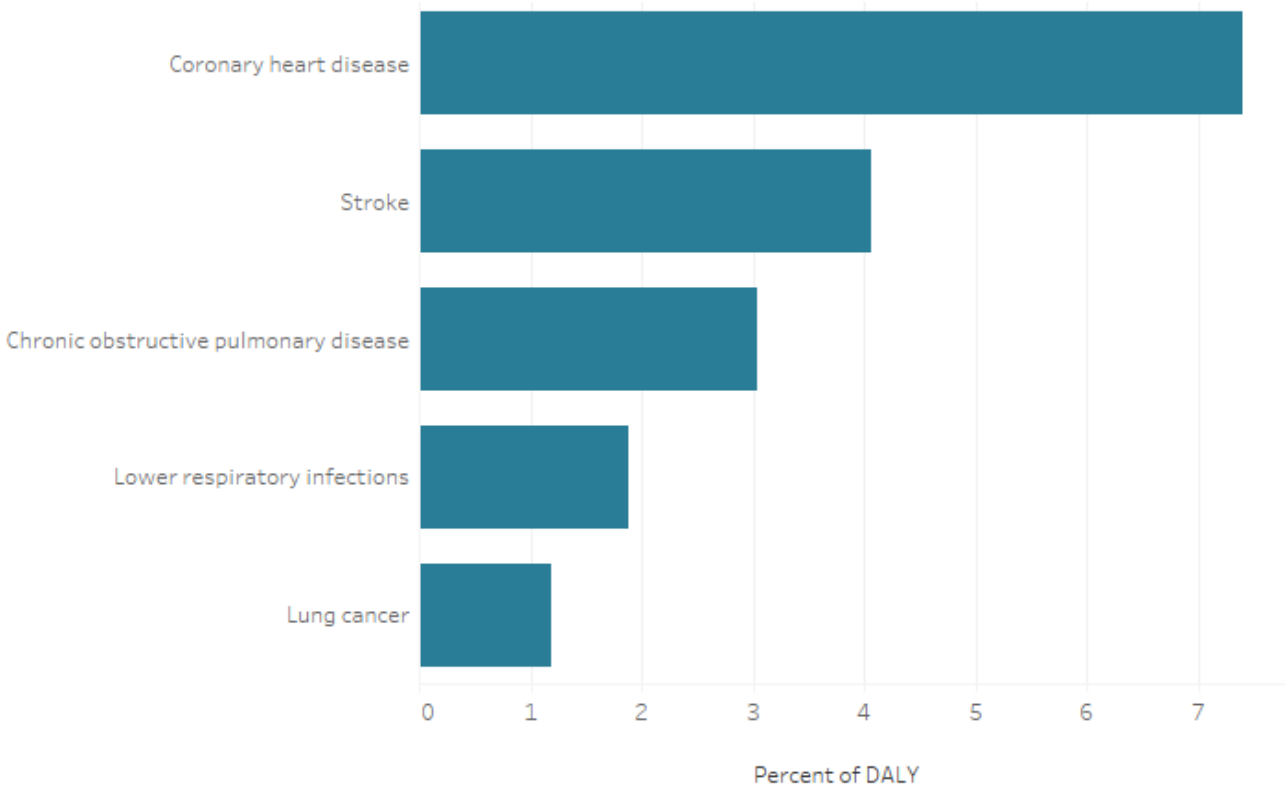
Figure 8: Prevalence of health factors in each area. The left panel shows that in Maribyrnong (shown by the black triangle), the prevalence of smokers is lower than other areas (left anel), but that cardio-respiratory health factors such as ischemic heart disease are higher (right panel) (Lycett, 2020).



This data presents a disturbing picture. The city of London is attempting to tackle nitrogen dioxide levels with road-side monitoring, low emission zones where diesel vehicles are banned, increased cycling infrastructure, anti-idling policies, upgrading to electric buses and banning combustion vehicles as of 2030 (UK Government, 2020). Melbourne is moving in the opposite direction with an increasing reliance on road transport and a rapidly expanding fleet of freight trucks that drive through densely populated inner-city areas.

Given our collective background, our submission focuses on the elderly and children as they are the most vulnerable group to the respiratory impacts of air pollution. Air pollution travels to the lungs first, however as previously mentioned it then travels throughout the body with numerous impacts along the way. Most of the premature mortality relates to cardiovascular impacts in the elderly (Figure 9). Diabetes is also a causal association that is yet to be included in the AIHWs estimates. Exposure to traffic emissions has been shown to cause systemic inflammation in Australian school children (Clifford et al., 2018). This is concerning given systemic inflammation can lead to myriad health issues.

Figure 9: Disability-Adjusted Life Years (DALY) due to air pollution. Data represented shows all persons for the year 2015. One DALY is representative of the loss of one equivalent full health year (AIHW, 2020).



Vulnerable groups include unborn children, children, people with pre-existing diseases, pregnant woman, and the elderly (Figure 10). In Australia, income level is disproportionately associated with air pollution exposure (Cooper, Green, & Knibbs, 2019); a double whammy as lower income also correlates to other factors that increase the vulnerability to air pollution impacts. These factors include a poorer diet (as anti-oxidants can reduce oxidative stress in the body from air pollutant exposure), lower education level (lower level of awareness), poorer underlying health status, and dwellings that have a higher infiltration of outdoor air pollution. Aboriginal Australians are also at higher risk. Studies with stratified results demonstrate higher risk estimates for bushfire related PM associations with respiratory diseases, pneumonia, and ischaemic heart disease in the Aboriginal Australian study population (Hanigan, Johnston, and Morgan (2008); (Johnston, Bailie, Pilotto, & Hanigan, 2007)).

There is emerging evidence indicating variations in vulnerable groups that are contingent on pollution source. For example, Australian evidence has revealed traffic emissions exert greater respiratory impacts on children (C. Walter et al., 2019), yet evidence related to bushfire pollution thus far indicates greater respiratory impacts in adults and higher risks for same day cardiovascular events in males (C. M. Walter, Schneider-Futschik, Knibbs, & Irving, 2020). Source specific impacts, meaning the type and chemical composition of atmospheric pollutants, may play an important role in developing targeted preventative strategies.

Figure 10: Vulnerable groups to impacts of air pollution (Holgate et al., 2016)

STRATEGIES TO REDUCE POLLUTANT EXPOSURE

This section discusses state-wide practical, real-time, cost-effective strategies to reduce human health impacts from atmospheric pollutants. The most effective mitigation strategy is the reduction of anthropogenic emissions; of which wood heaters, traffic and coal-fired power stations are the main sources.

TRAFFIC EMISSIONS

Traffic is the most widespread source of anthropogenic air pollution affecting the largest proportion of the Victorian population. Combustion engine vehicles emit particulate matter, nitrogen dioxide and a cocktail of other toxic gases. Both petrol and diesel are highly polluting, however by comparison, diesel exhaust generally contains higher amounts of particulate matter, black carbon and nitrogen dioxide. Diesel exhaust was categorised as a class 1 carcinogen for lung adenocarcinoma in 2012, a cancer that continues to increase in Australia despite reductions in cigarette smoking (Benbrahim-Tallaa et al., 2012). European cities are responding to the mounting evidence against diesel with policy measures designed to rapidly phase out diesel vehicles. The proportion of diesel vehicles in the Australian fleet continues to increase. Nitrogen dioxide is commonly used as a marker of traffic emissions and is associated with mortality and a range of cardiovascular and respiratory impacts.

Children are particularly vulnerable to the respiratory impacts of traffic emissions. Australian studies which have stratified respiratory impacts according to age groups consistently reveal larger effects in children (Chen et al., 2016; Hinwood et al., 2006; Morgan, Corbett, & Wlodarczyk, 1998; Pereira, Cook, de Vos, & Holman, 2010; Rutherford, Clark, McTainsh, Simpson, & Mitchell, 1999). Exposure to traffic emissions prior to 15 years of age can permanently stunt lung growth leading to a host of other cardio-respiratory impacts throughout the course of life. In Southern California, a suite of mitigation strategies adopted to reduce school children's exposure to roadside pollution resulted in declining pollution levels over the subsequent two decades which in turn were associated with the development of larger lungs in children (Gauderman et al. 2002 ; (Gauderman et al., 2015). The mitigation strategies included anti-idling legislation, classroom ventilation from non-traffic sides, pollution barriers, upgrading of diesel buses and buffer zones between new schools and major roads. In Victoria, there are local metropolitan councils that have policies actively encouraging the siting of childcare centres on major roads.

Figure 11: Childcare centres and major roads in Melbourne (C. Walter et al., 2019)

The inner West part of Melbourne is an area particularly affected by diesel emissions from the high frequency of freight trucks passing through the narrow suburban streets. Although this area has received some attention in recent years, there has been little progress resulting in practical improvements for the residents of this polluted area. One of the key areas of concern for this community is the high rate of asthma and respiratory admissions of children from this area, yet the 331 page technical health risk assessment for the WestGate project failed to include specific risk calculations and mitigation strategies for asthma risks in children (Wright, 2017). The government planning panel recommended further consideration be given to mitigation strategies before proceeding with the project, however this was overlooked, and the project was approved in the current format. Another example from this project which shows how little regard is given to health in the planning of major projects is the veloway (Figure 12). Figure 13 illustrates the ECG changes that occur in a small case crossover study of stable cardiac patients. The blue line represents ST segment change for subjects exercising in clean air. The red line indicates ST segment change for subjects exercising in air containing 10% diesel emissions (mimicking roadside conditions). The depression correlates to oxygen reduction in the heart, which increases the risk of cardiac arrest. Whilst cycling is a healthy transport option both for the cyclist and for general public health, we find the positioning of this veloway counter-intuitive to health and an example of the very low priority given to reducing population exposure to air pollution.

Figure 12:Cross-section of planned veloway in West Gate Tunnel Project (Western Distributor Authority, 2017)

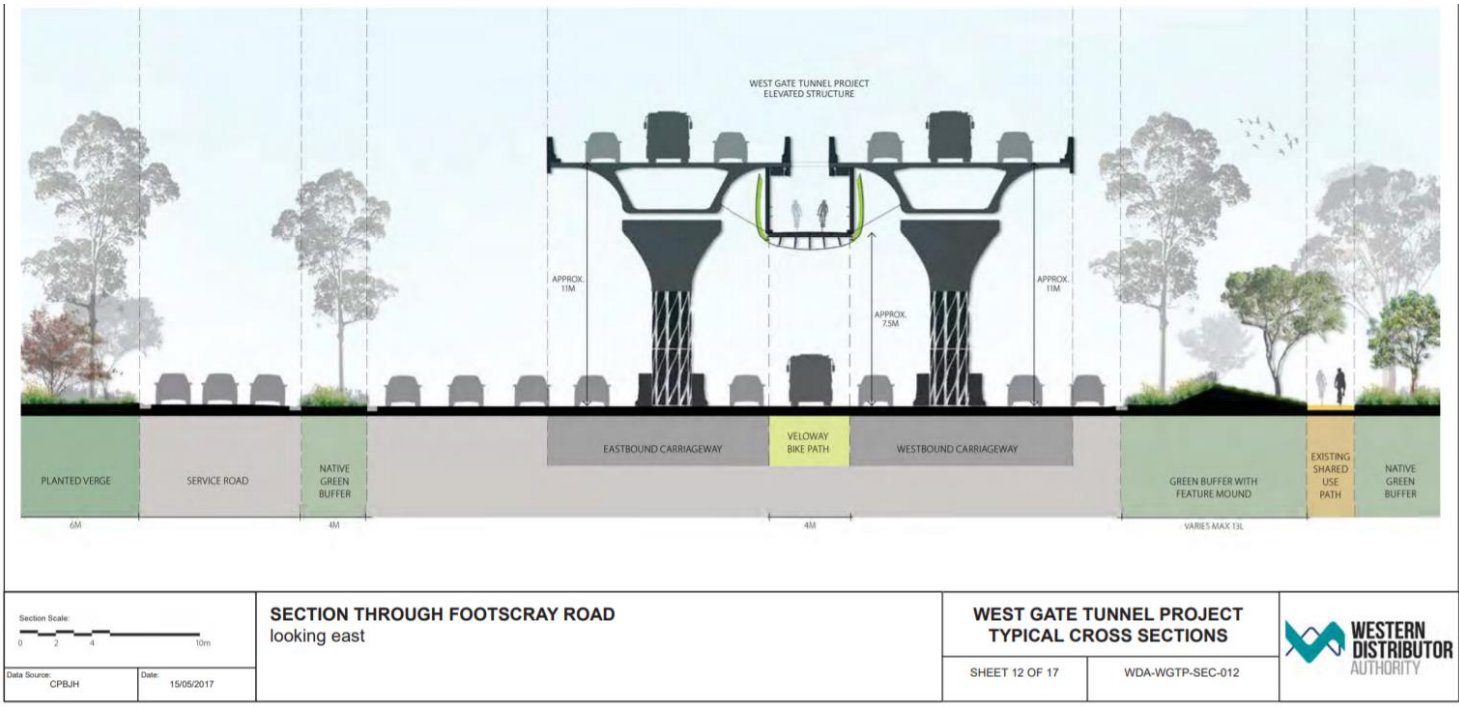
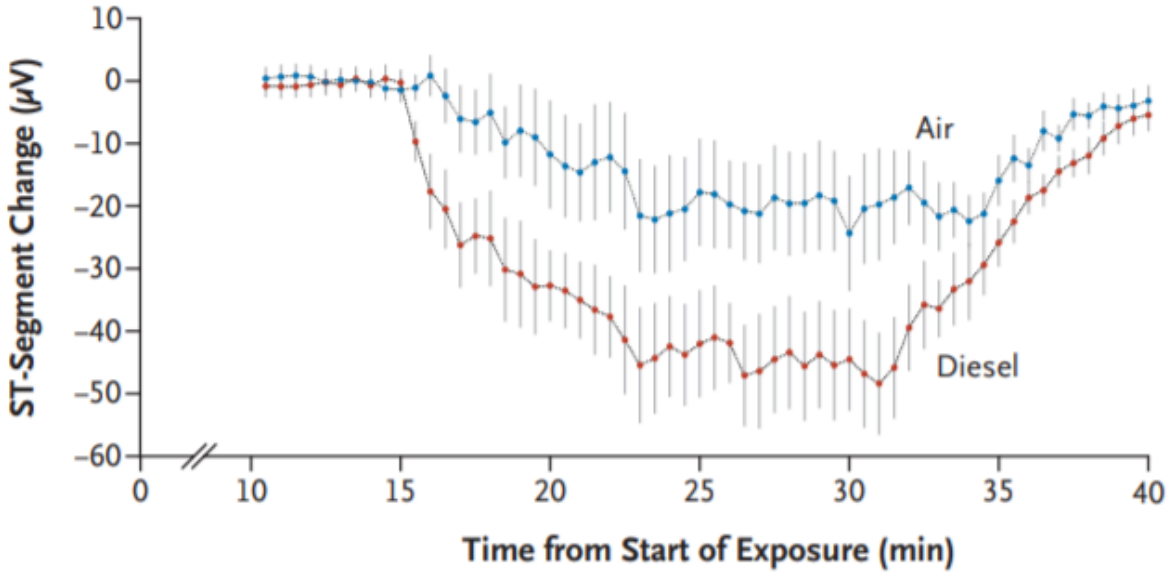


Figure 13: Myocardial Ischemia during 15-minute intervals of exercise-induced stress and exposure to diesel exhaust or filtered air in 20 subjects. Adapted from (Mills et al., 2007).

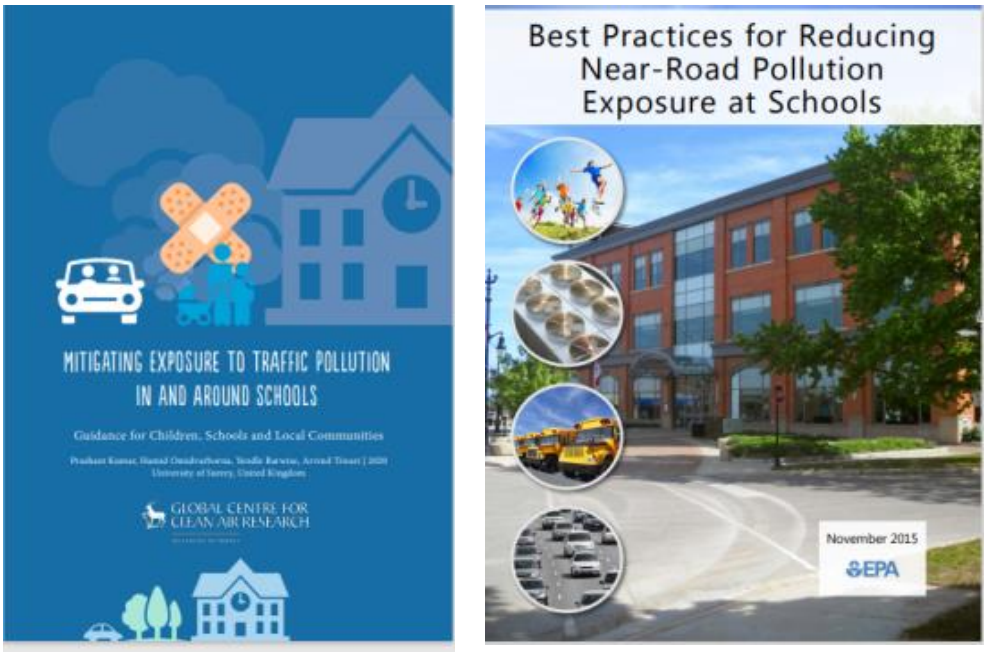


RECOMMENDATIONS TO MITIGATE TRAFFIC EMISSIONS

There is a wealth of international research and policy advice which could be adapted to the Australian context. Figure 14 shows the cover pages of two booklets produced in the UK and US. Both contain a suite of evidence-based policy recommendations designed to reduce children's exposure to traffic emissions. Many of these policies have been implemented resulting in measurable health improvements in children (Gauderman et al., 2015).

Policies to reduce exposure to traffic emissions operate on two levels. The first is to separate vulnerable populations from direct exposure to traffic-induced pollution and the second is to reduce the total volume of traffic emissions by encouraging shifts to cleaner modes. Policies to reduce car-dependence in cities with settlement patterns like those found in most of greater Melbourne have been clearly articulated over many decades (Mees, 2009; Vuchic, 1999). These centre on the creation of fast, frequent, and well-connected public transport networks enabling cross-town and radial travel. International experience shows that these networks can be operated efficiently and effectively without dramatically increasing residential densities in existing suburbs.

Figure 14: Example of policy advice for reducing near-road pollution exposure near schools (Kumar, Omidvarborna, Barwise, & Tiwari, 2020 & US EPA, 2015)



1. MITIGATING IMPACTS OF TRAFFIC EMISSIONS

- Create a ‘clean air zone around schools’ with anti-idling policies, encouragement of active transport, staggered drop offs, and buffer zones where possible.
- Design considerations such as ventilation intakes and siting outdoor areas and playgrounds away from positions downwind of heavy traffic.
- Utilise green infrastructure pollution barriers such as low-level dense hedges, trees and green walls dependent on the surrounding urban environment (Abhijith et al., 2017; Barwise & Kumar, 2020) .
- Raise public awareness through an anti-idling campaign.

An anti-idling campaign is in bold as of all the strategies it is the easiest to implement and perhaps the simplest way to gain the impetus required to achieve the rest of the recommendations. If the public were made aware that leaving their engine running was tantamount to smoking a cigarette around a non-smoker, it is easy to envisage behaviours and attitudes rapidly changing. Raising awareness is imperative to the success of any of the mitigation strategies that require behavioural change.

2. SHIFTING TO CLEANER MODES OF TRANSPORTATION

- Improve infrastructure that promotes safe active transport such as protected cycle lanes and a combination of walking and taking school buses.
- Accelerate the decommissioning of diesel buses and conversion of the fleet to zero-emission vehicles.
- Provide greater incentives for faster uptake of electric passenger vehicles.
- Perform appropriate Health Risk Assessments for major road projects that specifically include respiratory morbidity endpoints in children using roadside nitrogen dioxide concentrations.
- Re-direct transport policy and infrastructure funding to reduce urban car-dependence by creating seamless public transport networks for cross-town and radial travel.

WOODHEATERS

Woodheaters are a major source of wintertime air pollution in both urban and regional Victoria. In 2001, a wood heater replacement and community education intervention program began in Launceston, Tasmania. The resultant 61% fall in average daily wintertime PM_{10} concentration (from 44 µg/m3 during 1994-2000 to 27 µg/m3 during 2001-2007) was associated with small reductions in mortality which became larger and significant when restricting results to the male population, with a 17.9% (95% CI -30.6 – -2.8% p = 0.02) and 22.8% (−22.8%, −40.6% to 0.3%; p=0.05) reduction in cardiovascular and respiratory mortality respectively (Johnston, Hanigan, Henderson, & Morgan, 2013). The Launceston wood heater prevention strategy was associated with clear health benefits and demonstrates that should Victoria affectively address this issue, there are significant health and associated economic gains to be made. Currently, people who are affected by wood smoke have no practical recourse for action. The EPA directs complainants to the local council, who often then redirect back to the EPA and little of practical benefit to the affected party is achieved.

EXAMPLE:

2020 started well for Sarah and Mick, they had finally moved their family back into their home after completing a large and much anticipated renovation. In the middle of the COVID-19 lockdown, which saw them home schooling four children and trying to keep their business afloat, they suddenly had to contend with their neighbours' COVID project: a homemade chimney built into the existing roof line which flooded their home with so much smoke that visibility inside their home became an issue. Phone calls to the VBA, EPA and local council ensued. The VBA agreed the chimney breached building regulations however the onus was on Sarah and Mick to provide the written report and photos detailing the building. The EPA referred them to the local council, who referred them back to the VBA who then referred them back to the EPA. No-one helped. It became clear to Sarah and Mick there was no recourse for action that was not going to further inflame the deteriorating relationship with their neighbours. They cannot open any windows on that side of the house when the neighbour is using their chimney. Rather than face another winter exposing their young children to their neighbour's smoke, they are in the process of moving out of their dream home.

RECOMMENDATIONS TO MITIGATE WOOD HEATER EMISSIONS

To mitigate the air quality and subsequent health impacts from wood heater emissions, this report recommends the creation of a task force whose objectives include:

- Formulating and providing a clear recourse for action for people who are unduly affected by woodsmoke that is consistent across Victoria.
- Penalise the polluter in such a way that deters the polluter and strongly promotes the core legal objective of equivalent protection from air pollution wherever people live.
- Liaise with local governments to educate and assist the implementation of policies related to wood heaters, such as the one-off incentive grant which successfully replaced wood heaters with electric and gas alternatives in Launceston (NEPSC, 2013).
- Campaign to raise public awareness of the health impacts.

COAL FIRED POWER STATIONS

The unfiltered brown coal fired power stations in the Latrobe valley are the single largest source of Victoria's anthropogenic air pollution. They are among the worst polluting power stations per kilowatt hour of electricity produced in the world. We were recently very disappointed to note the re-issuing of the licence agreement to the Yallourn power station without stipulating the need for immediate upgrades requiring the installation of filters and scrubbers which are now standard use worldwide and can reduce SO_2 point source emissions by over 90% (US EPA, 2018). To our knowledge, outside of the Hazelwood study in relation to the uncontrolled mine fire of 2014 (Hazelwood Health Study, 2020), there has been no formal epidemiological research undertaken in this geographical area, however we have noted a high prevalence for a range of diseases in this area similar to that of the Inner West.

An added concern for this area is the mercury emissions produced from the power station. Mercury is a heavy metal that is extremely toxic to all humans but particularly unborn children and young children, due to the irreversible brain damage that can occur with exposures during development. It is the reason why pregnant woman are advised against eating large bioaccumulating fish such as tuna. Due to the lack of formal research it could be said there is no evidence to demonstrate mercury is adversely impacting population health of this area; however as health professionals we have been concerned for some time, and welcome this opportunity to put this concern on record. In addition to mercury, the northern area of Hazelwood is now facing the prospect of lead emissions and soil contamination with the recent approval of a Chunxing lead smelter in the area, despite the council's decision to decline the permit based on health concerns. The underpinning legislative objective of equivalent protection is somewhat incongruous for the people of Morwell and Hazelwood who are exposed to the ongoing emissions of a power station that lacks standard pollution controls, and must now consider the addition of harmful pollutants to the air they breathe.

RECOMMENDATIONS TO MITIGATE IMPACTS OF COAL FIRED POWER STATIONS

- Installation of flue gas desulfurisation and selective catalytic reduction equipment into all coal fired power stations
- Analysis of health data for the Latrobe valley including mercury testing in children.

LANDSCAPE FIRE SMOKE (LFS)

Landscape Fire Smoke is also an important source of air pollution to the Victorian population, where atmospheric particulate matter arises from combustion in bushfires and planned burns. It is not within our expertise to discuss the merits and disbenefits of planned burns and there has been much recent policy discussion on mitigating the health impacts of LFS in the wake of the 2019/2020 summer of bushfires.

We endorse the recommendations made by the Royal Commission into bushfires and would like to emphasise the importance of communicating the planned burns in advance so areas that are likely to be affected can take preventative measures to reduce their exposure to harmful air quality.

KEY CONSIDERATIONS IN IMPROVING VICTORIAN AIR QUALITY

This report presents a few key areas for consideration in improving air quality in Victoria including enforcement of air quality standards, the impact of economic and population growth on air quality outcomes, the need for government cross-portfolio policy implementation, intergenerational equity, the role of large companies in air quality policy, and cost-benefit analysis.

ENFORCEMENT OF AIR QUALITY STANDARDS

Enforcement is the key issue here. Victoria has excellent standards for particulate matter, but they are not currently enforced. Our standards for nitrogen dioxide, sulfur dioxide and ozone lag by international comparison and we are currently waiting to hear the outcome of the federal review of these pollutants. The rhetoric used for standards needs to change. Our standards review to air pollution thresholds as 'health-based thresholds' yet evidence consistently demonstrates health impacts occur below these thresholds. We would argue that the notion of 'health-based thresholds' as standards is outdated. There is no safe level, therefore the concept of health-based thresholds is not in keeping with the current evidence and potentially misleading. Thresholds are useful if there are mechanisms for enforcement, but currently there are not. We can congratulate ourselves on having some of the best standards for particulate matter in the world, but the reality is this has provided little actual improvement for Victorians. Unless we measure the air quality where the population is most exposed and aim for a continuous reduction framework implementing real life changes to meet this, it remains a paperwork exercise only.

Additional to a framework that supports continual reduction, breaches of standards need to be met with penalties that are large enough to serve as a disincentive to the polluter or shareholders of the company which is polluting.

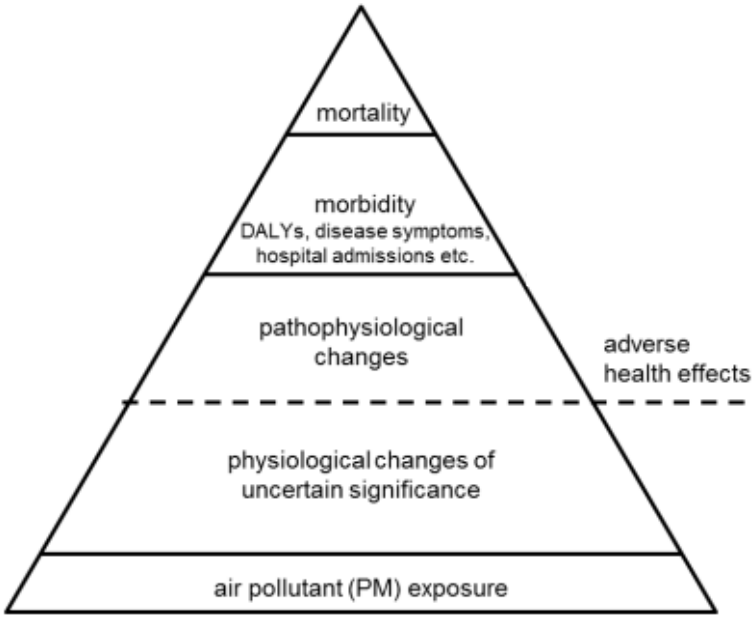
Throughout relevant policy documents there are frequent comparisons of our air quality to other countries with favourable results, yet there are very few international comparisons of our mitigation strategies. By comparison to other first world countries, we have the worst fuel standards, vehicle emission standards and a complete absence of road-side mitigation strategies and filtration of point source emissions. Recent health risk assessments for major projects such as the East West link, Westgate project and North-East link have failed to account for recent evidence nor do they include specific consideration of vulnerable groups and the full range of appropriate health endpoints. In some recent major project consultations the phrase 'world's best practice' has been changed to 'Australian best practice'. If international best practice standards are to be met or exceeded, they need to be actively considered first, rather than surreptitiously omitted from the narrative.

IMPACT OF ECONOMIC AND POPULATION GROWTH ON AIR POLLUTION AND HEALTH OUTCOMES

There are numerous estimates of the economic costs of air pollution, however firm dollar evaluations for the Australian context are currently limited or lack nuance. A common method is to apply the government value of a statistical life (currently $4.9 million AUS) to the number of premature deaths. Applying this method using the most recent figure of premature deaths due to anthropogenic air pollution (2,616) arrives at a figure of $12.8 billion per annum for Australia. The WHO estimates 81% of air pollution attributable deaths occur in people aged over 60 years (Ostro, 2004), yet the value of a statistical life is based on a young adult with forty years of life left. On the other hand this approach omits the substantial contribution made by bushfires and other sources of LFS and only accounts for mortality impacts which are the proverbial 'tip of the iceberg' (Figure 15). Australian estimates of costs only considered mortality impacts as they were previously thought to contribute 95% of the total cost. This is hard to reconcile with the substantial costs involved with hospitalisation and treatment for the range of causal associations including diabetes, COPD, stroke, lung cancer, heart disease. Mortality impacts are rare in children, therefore Australian analyses only consider impacts in people aged > 35 years, yet asthma, stunted lung growth, pre-term birth and reduced intra-uterine growth predominantly affect children and are associated with lifelong poorer health outcomes.

The costs of treating these conditions and associated lack of productivity from related illness are unaccounted for, as is the lost productivity and economic impacts of parents needing to take time off work to care for these children. The value put on a new case of respiratory disease (life-long) used in the discussion paper for the current federal review of the gas pollutants NO_2, SO_2 and O_3 is $341. Even a child with mild asthma who never requires hospitalisation would in most cases exceed this cost far more than this figure in medication and doctor visits alone. An asthma exacerbation would frequently require time off school/childcare requiring a parent or guardian to care for them, meaning an adult also taking time off work. For most families, even a mild case of asthma with one exacerbation per year would likely cost more than $341.

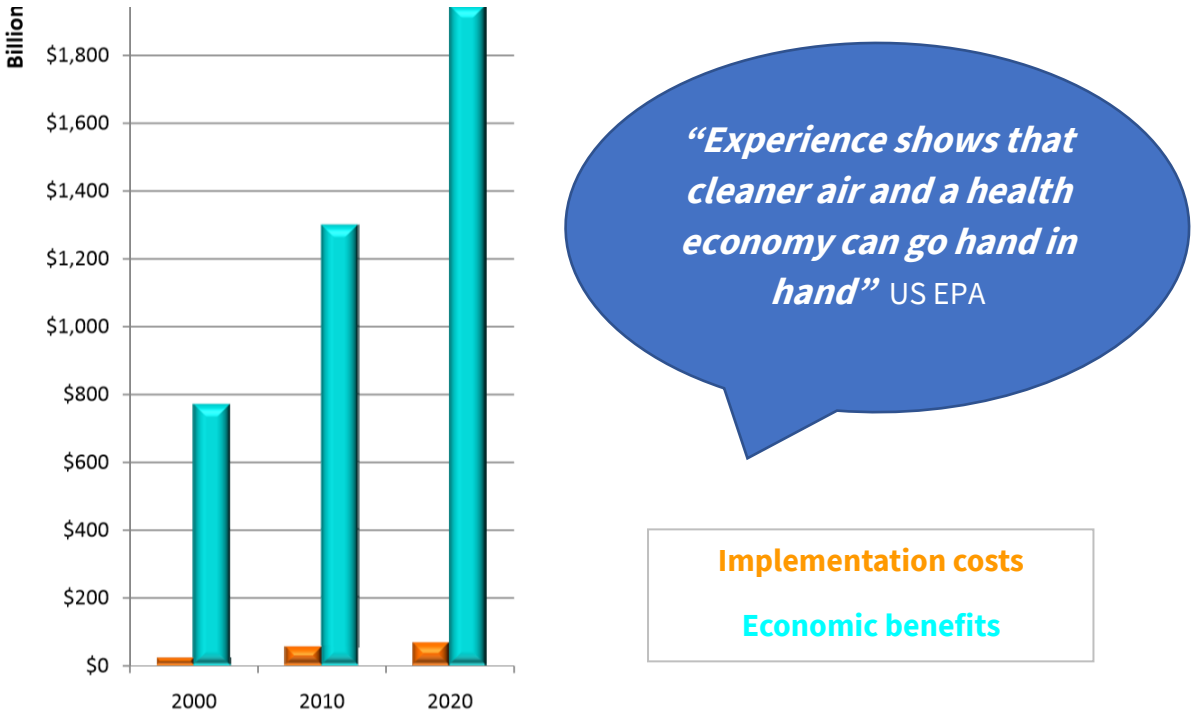
Figure 15: Schematic representation of the distribution of impacts of particulate matter pollution on population health, adapted from (de Hollander, Melse, Lebret, & Kramers, 1999).



The total annual cost of asthma in Australia including health, productivity and the burden of disease was estimated to be $28 billion per year in a 2015 report by Deloitte Access Economics (Deloitte, 2015). Asthma is only one outcome and is small by comparison to other impacts such as cardiovascular disease. Asthma is not currently included in the AIHW's estimates of DALYs due to air pollution (Figure 9). If this one disease is estimated to cost $28 billion per year, then considering the attribution of other diseases to the total figure of DALYs (Figure 9) the costs according to the Deloitte methodologies are likely to be exponentially greater than current crude estimates.

In 1970 America passed 'The Clean Air Act'. This Act and subsequent amendments resulted in binding pollutant thresholds across all states and jurisdictions which were accompanied with meaningful penalties for breaches. Subsequent improvements included fitting coal-fired power stations with filtration equipment that reduced over 90% of the point source emissions. At the time of proposal these changes were met with a large debate between environmental lobby groups who were focused on longer term benefits of reducing climate emissions and industry lobby groups who claimed it would create 'a crushing blow to the economy'. Side stepping both groups and creating a narrative that focused on the immediate health benefits, particularly to children, enabled the government to successfully pass the legislation. Subsequent economic evaluation of this act reveals the benefits of reduced healthcare costs and improved productivity outweigh the costs of implementation by a ratio of 30 to 1 (Figure 16).

Figure 16: Direct benefits and costs of the Clean Air Act, USA (US EPA, 2011)



Despite the lack of clarity regarding exact costs in Victoria, several points are very clear.

1. The current costs are substantial and merit immediate action.
2. The trajectory of urban growth, particulate matter pollution levels, rising temperatures (supra-additive effects with pollution) and increasing reliance on roads rather than public and active transport infrastructure indicate whatever the exact economic impacts currently are, they are likely to get worse.
3. The initial expenditure required to move towards 'green' or 'greener' industry and transport options which adopt COVID recovery packages similar to the 'green new deal' recovery packages in other countries, will be outweighed by the subsequent health and economic benefits.

GOVERNMENT CROSS-PORTFOLIO AIR POLLUTION POLICY IMPLEMENTATION

Unlike other major risk factors for death and disease, air pollution is largely outside the control of the individual and therefore effective government policy is the mainstay of public protection. To date, government involvement and expenditure related to air pollution has contributed towards characterisation of the problem, however since the successful removal of lead from petrol, there has been little further action that has resulted in tangible health improvements. It is time to move the focus from characterising the problem to implementing practical initiatives that result in tangible improvements for Victorians.

Such changes will require cross-portfolios coordination and cooperation from all levels of government. In reality this is very difficult to achieve. Previous attempts at 'joined up government' (JUG) or 'whole-of-government' approaches such as the Australian Government Ministerial Forum on Vehicle Emissions which failed to include the Department of Health have been unsuccessful in implementing policies that improve health. Lessons could be applied from the implementation of Health in All Policies (HiAP) in South Australia. A longitudinal analysis of HiAP found a more systematic and mandated response to promoting health in other sectors was required and that formal institutionalism embedded by legislation was required for health considerations to be built into all relevant policy developments from the outset (Baum et al., 2017).

Much of this analysis is highly relevant and transferable to the Victorian context of addressing the health impacts of air pollution. Additional relevant points included strong performance-based accountabilities and incentive mechanisms to support integration (Carey, Crammond, & Keast, 2014). Structural integration via the use of a joint multi-skilled team working across all relevant government departments has been met with both positive and negative outcomes (Carey et al., 2014) and is something that would need to be considered carefully for the Victorian context.

Process integration using health impact assessments is potentially problematic given the current lack of methodological consistency and inadequate guidelines for conducting health impact assessments in Australia. Health impact assessments are generally undertaken by private consultancies paid by the government or private corporations whose interests are often not served by a focus on health. The last three proposed major road projects in Victoria (EW link, Westgate and North-East link) failed to extensively consider the pollution mitigation strategies that are commonly adopted for similar projects internationally. Nor did they include the most recent available evidence applicable to the project. We note the government appointed planning panel for the Westgate project shared our concern regarding the lack of mitigation strategies for an area already noted as an asthma 'hot spot', yet the project was approved without recommended adaptions. Health risk assessments methodology should be standardised, include the most robust recent evidence and each assessment peer reviewed by a team of independent experts selected by both the affected community and the government.

Rather than designing a project and then justifying it in its current format to the community, consultation should be front loaded with every consideration on the board from the start and include a team whose express focus is not on how the assessments can be arranged so the air pollutants fall under 'acceptable levels of risk' but rather on whether every possible mitigation strategy was being considered and how the project could be made as healthy as possible.

Political short-termism needs to be navigated. Government resource allocation for health does not follow the adage prevention is better than cure. Appeasing medical lobby groups focused on acute care and providing short-term media soundbites holds more appeal as it results in political credit that is attributable to one person or political party in a time frame that sits within with the election cycle. Addressing air pollution generally will not deliver these short-term political advantages and this reflected in the disproportionately small allocation of resources committed to addressing air pollution and other long term preventative health initiatives. A broader vision and commitment to the future is required, but this seems at impossible odds with the current political context. Perhaps the best approach is to focus on raising public awareness so longer term initiatives are appreciated even if the desired outcomes are not yet achieved and to simultaneously pick off some of the easier initiatives that are likely to meet with less resistance and could yield measurable results in a short time frame, such as anti-idling policies.

INTERGENERATIONAL EQUITY

There is large issue of intergenerational equity at stake. Children bear a disproportionate weight of the impacts and the effects can be life lasting and multigenerational. DNA mutations caused by diesel exhaust can occur in germ cell lines, potentially generating epigenetic changes (Somers, 2011; Sram et al., 2007). The current practice of assessing risk based on $PM_{2.5}$ related mortality endpoints in adults is not fair to children. Nitrogen dioxide related morbidity endpoints in children should be specifically addressed for any traffic related project using risk coefficients adopted from a combination of Australian literature such as the Australian Children's Air Pollution and Health study (ACHAPS) and recent and robust international evidence (Khreis et al., 2017). The risks should then be accompanied with an economic evaluation using methods such as the Asthma report undertaken by Deloitte Access Economics (Deloitte, 2015). The resulting cost-benefit analysis could then be a useful tool to help surmount political short termism and swing action towards a long-term focus on the health of our most vulnerable group, children.

THE ROLE OF LARGE COMPANIES IN AIR QUALITY POLICY

"There are few if any greater threats to the determinant of health than the actions of large corporations who produce unhealthy commodities. These entities are generally very powerful, well-resourced and highly skilled at influencing public policy" (Cullerton, Debia, Ferguson, & Johnston, 2021).

If this inquiry is to deliver any success beyond rhetoric, then the influences that oppose health need to be acknowledged, transparent and circumvented.

A recent example involves the cost-benefit analysis of installing filtration equipment into coal-fired power stations in Australia. This was outsourced by the Victorian EPA to Aurecon (Aurecon, 2018). The costs of filtration equipment were estimated based on publicly available data citing a study by the Electric Power Research Institute (Cichanowicz, 2010). Closer inspection of this reference reveals a non-peer-reviewed report commissioned in America by the Utility Air Regulatory Group (UARG), an anonymous group funded by electric generating companies for the purpose of dismantling the American Clean Air Act. This group formed after the 1977 US amendments to the Clean Air Act which forced power companies to reduce air emissions by installing filtration equipment (implementation costs in Figure 16). The UARG have now been party to over 200 lawsuits challenging US federal clean air regulations over the past twenty years and are clearly not a reliable scientific source of data.

There are many other similar examples of obfuscation and faux science used to prioritise immediate economic gains and prioritisation of powerful vested interests over public health. There needs to be greater critical evaluation of where information is coming from, who is controlling the narrative and whether this aligns with the public's interests.

Favouring economic interests does not always involve a trade-off between economy and health. Internationally, 'green new deals' are being rolled out as COVID economic recovery packages that focus on renewable energy and active transport infrastructure. Improving the cycling infrastructure of Melbourne would provide a 'shovel ready' project that boosts the economy, begins to make the required changes to infrastructure and urban planning to meet longer term carbon reduction commitments and resulting in a much healthier population. Economically, Victoria relies on population growth underpinned by immigration. In the wake of COVID, migration patterns will change and stronger preferences will be given to considerations such as public health, renewable energy, transport options and clean air. The earlier the interventions, the larger the resulting dividend.

CONCLUSION

This key issues and strategies discussed in this submission resonate with previous Victorian government commitments made in the response to the Inquiry into the EPA, resulting in an additional $182.4 million equipping the EPA to address current and future environmental challenges. In addition to air quality monitoring, the EPA's actions included providing planning advice to local governments, licensing major emitters and limiting their emissions, investigating reports of air pollution from the community, issuing pollution abatement notices to prevent further air pollution from premises and providing education and information to help Victorians prevent air pollution occurring. The government air quality statement 'Clean Air for All Victorians' included the following potential actions:

- Strengthening Victorian equipment standards, such as for wood heater emissions.
- Increasing the government's own use of clean technologies and emission reduction practices.
- Increasing national advocacy, recognising the importance of cost-effective and consistent national approaches to reducing air pollution.
- Using the planning system to encourage the development of walkable neighbourhoods to decrease the dependence of communities on motor vehicles.
- Establishing an 'exemplar industry' program to promote and recognise best practice in business and industrial air quality management.
- Increasing investment in science to identify risks and trends.
- Improving guidance on the location and design of sensitive sites (such as education, childcare and aged care facilities) exposed to significant road traffic emissions.

Additionally, a key recommendation from the Victorian Auditor General's Office was for the EPA and DELWP to

"clarify the roles and responsibilities of relevant Victorian Government agencies with respect to air quality management, and develop protocols to ensure accountabilities are understood and coordination is achieved" (VAGO, 2017)

It is difficult to reconcile these previous commitments and associated investment with the current situation of continued low public awareness, families leaving homes due to woodsmoke pollution and the daily queue of polluting vehicles with engines idling outside most Victorian primary schools. COVID has understandably impacted progress in achieving previous goals and yet it also presents opportunities for Victoria to follow international examples in striking a green new deal. We are at a cross-roads and decisions now will dictate the legacy for future Victorians.

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