SUBMISSION TO THE NSW PORTFOLIO COMMITTEE NO 2

HEALTH 'INQUIRY INTO THE HEALTH IMPACTS OF EXPOSURE TO POOR LEVELS OF AIR QUALITY RESULTING FROM BUSHFIRES AND DROUGHT'

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**Please note, the opinions and views expressed by Dr Benjamin Edokpolo do not represent the position or opinions of EPA Victoria.*

The Clean Air Society of Australia and New Zealand is a non-profit, professional association with over 600 members representing a broad range of sectors including national, state and local government, science, business, industry, education, management and policy. It has been active for over 50 years with the primary objective that members and stakeholders are well informed about air quality problems and solutions. The health evidence referred to in this submission is drawn from the pool of available peer-reviewed Australian publications produced over the past twenty years; a full summary is available in the recent peer reviewed publication *"The health impacts of bushfires in Australia"* link: https://onlinelibrary.wiley.com/doi/full/10.1111/resp.13798

It is important to note this evidence is not drawn from the past 2019/2020 bushfire season. This past season was more severe and prolonged and therefore the associated impacts are likely to be greater than those reflected in the currently available research.

1. The health impacts of exposure to poor levels of air quality resulting from bushfires and drought including:

(a) the impact of at-risk groups including children, pregnant women, people with asthma and other respiratory-related illnesses, the elderly and other high-risk groups as well as vulnerable companion animals;

Ambient air pollution is estimated to contribute to an annual 4880 premature deaths in Australia (IHME, 2018). Tiny airborne particles (particulate matter) produced from combustion processes such as; bushfires, wood-heaters, vehicle emissions and coal-fired power station can enter the lungs where the smallest sized particles can then translocate into the blood stream, causing systemic inflammation and damage to other organs. The list of causal associations is continuing to expand in response to mounting evidence (Figure 1) (Thurston et al., 2017).

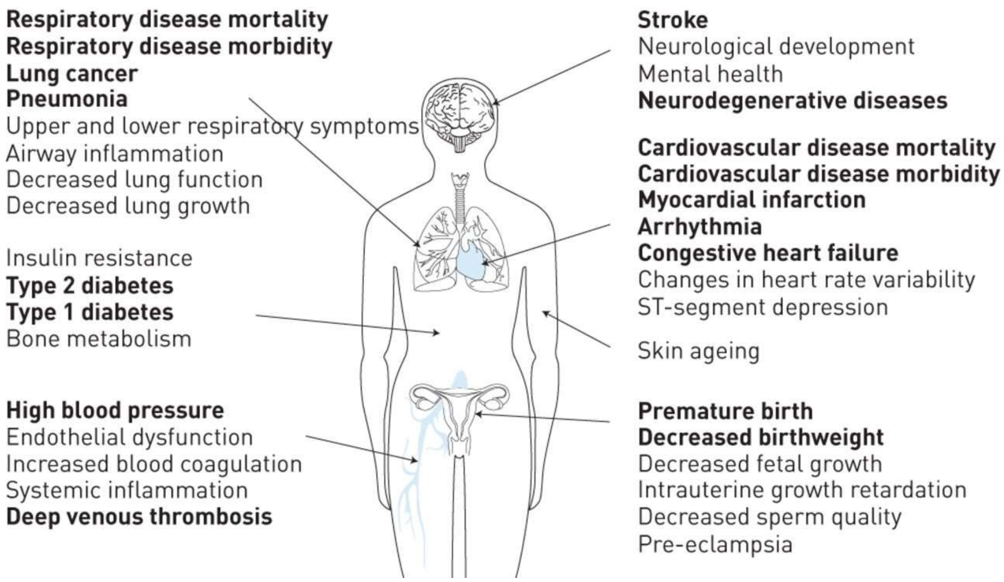

Figure 1*. Overview of diseases, conditions and biomarkers affected by outdoor air pollution. Bold type indicates conditions currently included in the Global Burden of Disease categories. Source, Thurston, 2017*

In alignment with international evidence, Australian evidence reveals vulnerable populations with heightened sensitivity to air pollution impacts including; unborn children (Chen et al., 2018, Li et al., 2016, Pereira et al., 2012, Pereira et al., 2011), children (Knibbs et al., 2018, Patel et al., 2019, Chen et al., 2016), elderly (Johnston et al., 2019, Patel et al., 2019, Haikerwal et al., 2015, Dennekamp et al., 2015), low income earners (Patel et al., 2019) and carriers of certain genetic polymorphisms in the endogenous antioxidant; glutathione (Bowatte et al., 2017).

Evidence to date suggests there are differences in magnitude, pattern of effects, and specific sub-sets of vulnerable groups associated with bushfire pollution (Walter et al.). For example, the asthma impacts of vehicle emissions are substantially stronger in children; however evidence to date indicates bushfire smoke exerts greater respiratory impacts on adults (Walter et al., 2020). It is unclear whether this is due to altered cellular responses or protective behaviour of parents, but it highlights that it is important where possible, to consider source specific impacts rather than assuming internationally established risk coefficients represent the Australian context of bushfire impacts.

Some of the general patterns of impact arising from Australian bushfires/vegetation burns are:

- Asthma impacts occurring on the same day as exposure, with the highest risk in adults. One study which stratified for sex, also found higher risks in women > 20 years.
- General respiratory impacts also have the greatest magnitude on the day of exposure with higher risks in the elderly
- Cardiac arrests occur predominantly in men within the first 48 hours of exposure
- Ischaemic heart disease (IHD) occurs more frequently in women at lagged intervals of two to three days post exposure
- Indigenous Australians were found to have significantly higher risks for same day respiratory outcomes including chronic obstructive pulmonary disease (COPD), respiratory infections and ischaemic heart disease (IHD) 3 days post exposure.

To date, most epidemiological evidence is generated from investigating the link between health outcomes and particulate matter (PM), the pollutant deemed most detrimental to human health. However, general PM measurements are unable to account for the specific chemical composition of bushfire produced particulate matter which includes a unique suite of organic and inorganic compounds, and heavy metals. Bushfire emissions also include; carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen oxides and a wide range of airborne toxics including respiratory irritants, formaldehyde and acrolein and heavy metals of which mercury is a particular concern (MacSween et al., 2019).

(b) the impact on people who are exposed to poor outdoor air quality in the workplace;

The severity and duration of fires over this past season made it virtually impossible for outdoor workers to avoid exposure. While facemasks with high filtration capacity may provide some protection, they are uncomfortable, often do not seal properly and are hard to bear for extended periods in hot temperatures. Using personal carbon monoxide (CO) monitors, MacSween et al., demonstrated that Australian firefighters can exceed Worksafe Australia exposure standards during planned burns and that in addition to the respirable particulate matter, air toxics such as acrolein and formaldehyde made significant contributions to the cumulative toxicity. The study also revealed significant spikes in short-term mercury concentrations leading to potential neurotoxic health impacts. It was concluded that in addition to criteria pollutants, exposure methodology should also account for the numerous air toxics emitted during a fire (MacSween et al., 2019). Unplanned bushfires tend to occur on days of extreme heat, a concurrent hazard which outdoor workers are not able to avoid. Extreme heat has its own independent health impacts and also compounds the impacts of smoke exposure. In excess of their independent impacts, the combination of heat and air pollution generated from wildfires during the Russian heatwave of 2010 was estimated to have contributed to an additional 2000 deaths (Shaposhnikov et al., 2014). Oxides of Nitrogen and volatile organic compounds are also present in bushfire smoke and when combined with high temperatures and sunlight, they react to form ground level ozone; a criteria pollutant with its own separate impacts on cardio-respiratory health. The health impacts of ground level ozone in Australia are sharply increasing (Figure 2), and are forecast to further increase (Keywood, 2016).

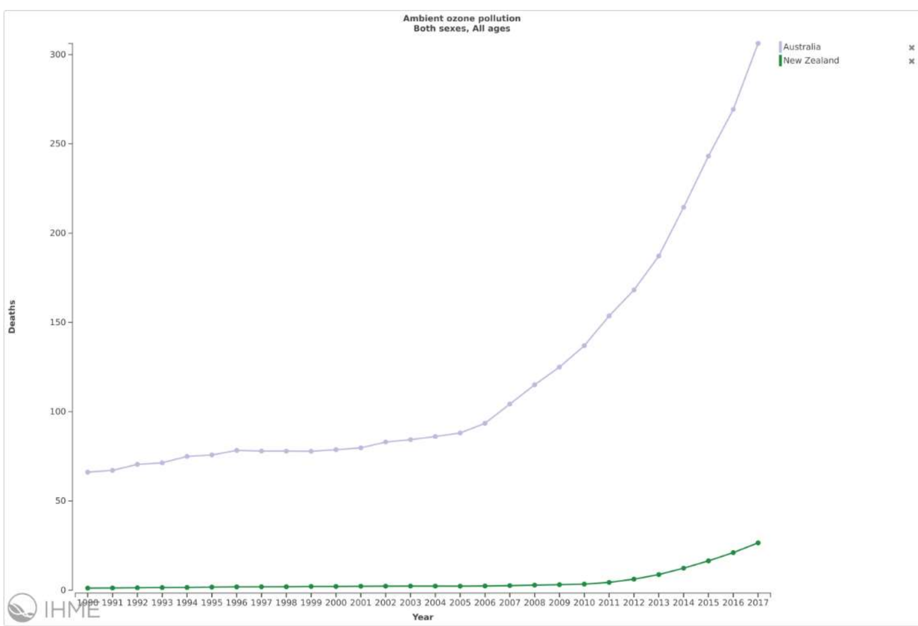

Figure 2. Premature deaths attributed to ambient ozone pollution in Australia and New Zealand. Source: *Institute for Health Metrics and Evaluation, 2018*

Transitions of temperature are also important; a 10°C decrease in temperature, such as experienced with a 'cool change' after an extended heat wave, is associated with a 9% increase in the risk of acute myocardial infarction (Claeys et al., 2017). The potential mechanisms triggered by temperature drops include the stimulation cold receptors in the skin, leading to vasoconstriction, increasing the heart rate and blood pressure, and diuresis, reducing plasma volume and increasing the blood viscosity (Claeys et al., 2017).

(c) the long term impacts of exposure; and

Chronic exposures account for approximately two thirds of the health burden associated with general ambient air pollution (Begg et al., 2007). Bushfires are generally acute events of short duration and evidence to date has only considered short-term impacts. The duration and extent of population exposure this past summer was unprecedented, extending beyond 'short term' exposure. It will be some time before the impacts are known.

(d) the effectiveness of various protective materials and strategies to mitigate the health impacts of exposure.

Facemasks are of limited efficacy during prolonged exposure events. Remaining indoors and taking measures to reduce the penetration (closing windows, sealing windows and using the air conditioner may reduce exposure over a short period, however outdoor smoke that persists for several days will eventually penetrate most Australian homes. Air purifiers with HEPA monitors can be effective at reducing air pollution when confined to closed rooms (e.g. bedrooms); however the cost of commercially available filters is prohibitive to many Australians. Research of pollution events that were accompanied by widespread public health warnings indicates these warnings were successful in reducing the associated disease burden (Morgan et al., 2010, Barnett et al., 2012). Future warnings that specifically target the most vulnerable groups and provide constructive advice on best mitigation strategies are of likely to be of key importance. In order to achieve this and ensure the advice is indeed constructive, further research and innovation is required, particularly with respect to reducing the indoor penetration of air pollution and the provision of practical effective options such as 'clean air shelters'.

2. The effectiveness of the NSW Government to plan for and improve air quality including:

(a) the measurement, reporting and public awareness;

This past summer, air pollution was a tangible issue for most Australians and public awareness has subsequently increased. During the bushfire event, regular monitoring of air pollutants was carried out to trigger action to reduce pollution exposure. It is important to maintain and extend these measurements, monitoring and reporting so that the all the Australian public has access to real-time data informing them of all sources of localised air pollution sources in a manner that is consistent across Australian jurisdictions. This will further enhance public awareness on the relevance of air monitoring data and enable action to reduce air pollution exposures. Bushfire pollution represents a small portion of the overall pollutant sources that contribute to the 4880 annual premature deaths in Australia. Anthropogenic sources such as emissions from coal-fired power stations, wood heaters, planned burns and vehicles play a large role in population exposure to harmful pollutants. Minimising the contribution of these sources through targeted interventions and actions will effectively improve air quality and reduce the burden of bush fire smoke in an airshed.

It is important to note that, while we discuss bushfire pollution, Australia has the highest petrol sulfur content in the OECD, resulting in a greater proportion of pollutants per vehicle km travelled. Diesel vehicles are highly polluting and are currently being banned throughout Europe in an effort to improve public health. In contrast, diesel vehicle uptake in Australia is increasing and many Australians mistakenly consider diesel as an environmentally friendly option. A stroll past most urban schools and childcare centres reveals a line of large diesel SUVs often unnecessarily idling within metres of the most vulnerable section of society. Reducing the health burden of air pollution in Australia requires all major sources to be addressed and this is best approached by raising the general level of public awareness to bushfire smoke and additionally the pollutants from these other sources which whilst less visible, carry a greater long-term impact. Lowering the background pollution would result in a lower baseline of pollutants and air toxics to interact with and form secondary pollutants with the bushfire smoke on the occasions it blankets the population.

(b) the provision of various protective materials including face masks and air purifiers;

To prepare for future events, it would be prudent to install indoor HEPA filters in rest homes, childcare centres and schools. Studies have shown that, the use of air cleaners reduces indoor levels of PM2.5 from bushfire and wood smoke sources (Wheeler et al., 2014, Barn et al., 2016).

(c) the ability to ensure the health of at-risk groups;

Targeted messaging and where possible the provision of shelter with air conditioning and filtration for those most at risk.

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REFERENCES

BARN, P. K., ELLIOTT, C. T., ALLEN, R. W., KOSATSKY, T., RIDEOUT, K. & HENDERSON, S. B. 2016. Portable air cleaners should be at the forefront of the public health response to landscape fire smoke. *Environmental Health,* 15**,** 116.

BARNETT, A. G., FRASER, J. F. & MUNCK, L. 2012. The effects of the 2009 dust storm on emergency admissions to a hospital in Brisbane, Australia. *Int J Biometeorol,* 56**,** 719-26.

BEGG, S., VOS, T., BARKER, B., STEVENSON, C., STANLEY, L. & LOPEZ, A. D. 2007. The burden of disease and injury in Australia 2003.

BERNSTEIN, A. S. & RICE, M. B. 2013. Lungs in a warming world: climate change and respiratory health. *Chest,* 143**,** 1455-1459.

BOWATTE, G., LODGE, C. J., KNIBBS, L. D., LOWE, A. J., ERBAS, B., DENNEKAMP, M., MARKS, G. B., GILES, G., MORRISON, S., THOMPSON, B., THOMAS, P. S., HUI, J., PERRET, J. L., ABRAMSON, M. J., WALTERS, H., MATHESON, M. C. & DHARMAGE, S. C. 2017. Traffic-related air pollution exposure is associated with allergic sensitization, asthma, and poor lung function in middle age. *J Allergy Clin Immunol,* 139**,** 122-129.e1.

CHEN, G., GUO, Y., ABRAMSON, M. J., WILLIAMS, G. & LI, S. 2018. Exposure to low concentrations of air pollutants and adverse birth outcomes in Brisbane, Australia, 2003-2013. *Science of the Total Environment,* 622**,** 721-726.

CHEN, K., GLONEK, G., HANSEN, A., WILLIAMS, S., TUKE, J., SALTER, A. & BI, P. 2016. The effects of air pollution on asthma hospital admissions in Adelaide, South Australia, 2003-2013: time-series and case-crossover analyses. *Clin Exp Allergy,* 46**,** 1416-1430.

CLAEYS, M. J., RAJAGOPALAN, S., NAWROT, T. S. & BROOK, R. D. 2017. Climate and environmental triggers of acute myocardial infarction. *European heart journal,* 38**,** 955-960.

DENNEKAMP, M., STRANEY, L. D., ERBAS, B., ABRAMSON, M. J., KEYWOOD, M., SMITH, K., SIM, M. R., GLASS, D. C., DEL MONACO, A., HAIKERWAL, A. & TONKIN, A. M. 2015. Forest Fire Smoke Exposures and Out-of-Hospital Cardiac Arrests in Melbourne, Australia: A Case-Crossover Study. *Environ Health Perspect,* 123**,** 959-64.

GLOBAL BURDEN OF DISEASE COLLABORATIVE NETWORK. Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018. Available from http://ghdx.healthdata.org/gbd-results-tool.

HAIKERWAL, A., AKRAM, M., DEL MONACO, A., SMITH, K., SIM, M. R., MEYER, M., TONKIN, A. M., ABRAMSON, M. J. & DENNEKAMP, M. 2015. Impact of Fine Particulate Matter (PM2.5) Exposure During Wildfires on Cardiovascular Health Outcomes. *J Am Heart Assoc,* 4.

IHME 2018. Global Burden of Disease Study (GBD 2017). Burden by Risk 1990 - 2017. Seattle, United States: Institute for Health Metrics and Evaluation (IHME).

JOHNSTON, F. H., SALIMI, F., WILLIAMSON, G. J., HENDERSON, S. B., YAO, J. Y., DENNEKAMP, M., SMITH, K., ABRAMSON, M. J. & MORGAN, G. G. 2019. Ambient Particulate Matter and Paramedic Assessments of Acute Diabetic, Cardiovascular, and Respiratory Conditions. *Epidemiology,* 30**,** 11-19.

KEYWOOD, M., EMMERSON, K., HIBBERD, M. 2016. State of the environment. *In:* ENERGY, A. G. D. O. T. E. A. (ed.). Canberra.

KNIBBS, L. D., DE WATERMAN, A. M. C., TOELLE, B. G., GUO, Y. M., DENISON, L., JALALUDIN, B., MARKS, G. B. & WILLIAMS, G. M. 2018. The Australian Child Health and Air Pollution Study (ACHAPS): A national population-based cross-sectional study of long-term exposure to outdoor air pollution, asthma, and lung function. *Environment International,* 120**,** 394-403.

LI, S. S., GUO, Y. M. & WILLIAMS, G. 2016. Acute Impact of Hourly Ambient Air Pollution on Preterm Birth. *Environmental Health Perspectives,* 124**,** 1623-1629.

MACSWEEN, K., PATON-WALSH, C., ROULSTON, C., GUÉRETTE, E.-A., EDWARDS, G., REISEN, F., DESSERVETTAZ, M., CAMERON, M., YOUNG, E. & KUBISTIN, D. 2019. Cumulative Firefighter Exposure to Multiple Toxins Emitted During Prescribed Burns in Australia. *Exposure and Health***,** 1-13.

MOELTNER, K., KIM, M.-K., ZHU, E. & YANG, W. 2013. Wildfire smoke and health impacts: A closer look at fire attributes and their marginal effects. *Journal of Environmental Economics and Management,* 66**,** 476-496.

MORGAN, G., SHEPPEARD, V., KHALAJ, B., AYYAR, A., LINCOLN, D., JALALUDIN, B., BEARD, J., CORBETT, S. & LUMLEY, T. 2010. Effects of bushfire smoke on daily mortality and hospital admissions in Sydney, Australia. *Epidemiology,* 21**,** 47-55.

PATEL, D., JIAN, L., XIAO, J. G., JANSZ, J., YUN, G. & ROBERTSON, A. 2019. Joint effect of heatwaves and air quality on emergency department attendances for vulnerable population in Perth, Western Australia, 2006 to 2015. *Environmental Research,* 174**,** 80-87.

PEREIRA, G., COOK, A. G., HAGGAR, F., BOWER, C. & NASSAR, N. 2012. Locally derived traffic-related air pollution and fetal growth restriction: a retrospective cohort study. *Occupational and Environmental Medicine,* 69**,** 815-822.

PEREIRA, G., NASSAR, N., COOK, A. & BOWER, C. 2011. Traffic emissions are associated with reduced fetal growth in areas of Perth, Western Australia: an application of the AusRoads dispersion model. *Aust N Z J Public Health,* 35**,** 451-8.

SHAPOSHNIKOV, D., REVICH, B., BELLANDER, T., BEDADA, G. B., BOTTAI, M., KHARKOVA, T., KVASHA, E., LEZINA, E., LIND, T. & SEMUTNIKOVA, E. 2014. Mortality related to air pollution with the Moscow heat wave and wildfire of 2010. *Epidemiology (Cambridge, Mass.),* 25**,** 359.

THURSTON, G. D., KIPEN, H., ANNESI-MAESANO, I., BALMES, J., BROOK, R. D., CROMAR, K., DE MATTEIS, S., FORASTIERE, F., FORSBERG, B. & FRAMPTON, M. W. 2017. A joint ERS/ATS policy statement: what constitutes an adverse health effect of air pollution? An analytical framework. *European Respiratory Journal,* 49.

WALTER, C. M., SCHNEIDER-FUTSCHIK, E. K., KNIBBS, L. D. & IRVING, L. B. 2020. Health impacts of bushfire smoke exposure in Australia. *Respirology,* https://onlinelibrary.wiley.com/doi/full/10.1111/resp.13798

WHEELER, A. J., GIBSON, M. D., MACNEILL, M., WARD, T. J., WALLACE, L. A., KUCHTA, J., SEABOYER, M., DABEK-ZLOTORZYNSKA, E., GUERNSEY, J. R. & STIEB, D. M. 2014. Impacts of air cleaners on indoor air quality in residences impacted by wood smoke. *Environmental science & technology,* 48**,** 12157-12163.

WOLF, K., SCHNEIDER, A., BREITNER, S., VON KLOT, S., MEISINGER, C., CYRYS, J., HYMER, H., WICHMANN, H.-E., PETERS, A. & GROUP, C. H. R. I. T. R. O. A. S. 2009. Air temperature and the occurrence of myocardial infarction in Augsburg, Germany. *Circulation,* 120**,** 735.

ZANOBETTI, A., O'NEILL, M. S., GRONLUND, C. J. & SCHWARTZ, J. D. 2012. Summer temperature variability and long-term survival among elderly people with chronic disease. *Proceedings of the National Academy of Sciences,* 109**,** 6608-6613.