Submission on the review of the National Pollution Inventory (NPI) on behalf of Clean Air and Urban Landscapes (CAUL) Hub and the Centre for Air pollution, energy and health Research (CAR)

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Executive Summary

Thank you for the opportunity to comment on the National Pollutant Inventory (NPI) Discussion paper. Researchers at CAR and CAUL feel that there is indeed a need for an NPI for the purposes of improving population health and environmental quality. However we believe that the aims of the NPI, in supporting the National Environment Protection Measures (NEPMs), need to better reflect the link between health and environmental quality. We also believe that there is a need to better explain how the NPI differs from and could complement other similar inventories. We propose improvements to the current NPI such as better temporal data, new pollution sources to monitor (e.g. aviation and maritime), improvements to better reflect the exposure of populations to pollution and the introduction of uncertainty estimations. Finally, we provide input into on the question of how the NPI can be resourced into the future. CAR and CAUL welcome enquiries about our submission in the next stages of the NPI review.

1. Presentation and Objectives of the NPI

1.1 The need for the NPI in the context of health impacts and policy development

CAR and CAUL believe that an NPI is needed to improve and maintain public health through the following three mechanisms:

1. Tracking how a population's exposure to pollution changes over time, estimating long term trends of exposure with respect to government regulations and assessing positive health impacts of interventions.
2. Providing inputs for modelling studies to guide evidence-based policy and research. This in turn allows for:
    a. Regulating or monitoring of pollution sources and exposures by governments
    b. Improved assessment of a population's exposure for use in epidemiological research studies
    c. Health impact assessments of emissions from specific sources (including downstream effects, such as deposition to ecosystems and transport to different jurisdictions)
3. Education and raising awareness of pollutants and their health impacts amongst the population.

The benefits of having a national inventory rather than independent inventories for different pollutants or jurisdictions is that many pollution problems cross administrative boundaries. A nationally consistent approach can also address the fact that populations can have widely differing exposure risk profiles. Comparisons amongst these populations are difficult unless standardised methods are used across the country. It is also far more cost-effective to maintain maximum expertise in one place than disperse it across jurisdictions.

1.2 The focus of the NPI should emphasise health and well-being in the context of environmental quality

A driving force behind the NPI is the objective of managing hazardous human waste (i.e. pollution of soil, water and air) that threatens environmental conditions that support human health and well-being. However the discussion paper focuses primarily on environmental quality and natural resource management with very few explicit links made to human health and well-being.

In the context of the need for an NPI for population health purposes (section 1.1), we recommend that the link between **environmental quality and human health and well-being**

be strengthened when discussing the role of the NPI in supporting NEPMs. For example, on page 10 of the discussion paper the National Environment Protection (National Pollutant Inventory) Measure (1998) it states that:

> *"The desired environmental outcomes of the Measure are:*
>
> *(a) the maintenance and improvement of:*
>
> *(i) ambient air quality; and*
>
> *(ii) ambient marine, estuarine and fresh water quality;*
>
> *(b) the minimisation of environmental impacts associated with hazardous wastes; and*
>
> *(c) an improvement in the sustainable use of resources."*

This statement focuses exclusively on environmental quality and natural resource management. The aims should therefore be revised to define environmental "quality" as inextricable from the impacts on human health and well-being.

Encouragingly, the National Environment Protection (Ambient Air Quality) Measure (2003, 2016) states the desired environmental outcome is "ambient air quality that allows for the **adequate protection of human health and well-being**." We recommend adopting similar language throughout the discussion paper. For example, we recommend that the statement on page 10: "For the purposes of this discussion paper, the assessment of the NPI's outcomes and goals will be considered through an examination of the extent to which the NPI: enhances **environmental quality**…" be revised to explicitly include the notion that environmental quality includes measures of impacts on human health and well-being and not just focus on outcomes that "minimise environmental impacts or improve the sustainable use of resources".

We recommend the NPI statements regarding desired environmental outcomes be reframed in a way that strengthens calls for regulation of pollutant emissions to ensure that human health, well-being, the environment and the health of the economy are maintained.

1.3 Clarification of the differences and synergies with similar inventories is needed

Differences between the NPI and other national pollutant inventories and reporting schemes are complicated and difficult to explain. Other data collection activities which currently exist include the National Greenhouse Energy Reporting Scheme (NGERS) and the National Greenhouse Gas Inventory. There is also currently a proposal for a future National Air Emissions Inventory being developed.

On page 50 of the discussion paper the relation of the NPI to air inventories is discussed:
"The NPI is not intended to be an air inventory. . . . A proposal to develop a National Air Emissions Inventory is currently being developed to address many of the issues discussed

above. Ideally, the NPI's data relating to air emissions could be improved to integrate with [this]".

On page 38 the difference (and potential overlap) between NPI and NGERS is raised:
"A popular suggestion to the survey from industry was for either the National Greenhouse Energy Reporting Scheme (NGERs) to take on the NPI reporting function and/or for both programs to be better integrated with State and Territory EPA licence data."

We recommend further elaboration of the differences and synergies among these measures, especially drawing out discussion of any benefits and costs of a coordinated national approach across all national pollutant inventories and reporting schemes.

2. Improvements to the NPI

2.1 New additions to the NPI would improve modelling and policy development

Simulations from chemical transport models (CTMs), which are used to better estimate pollution, require data inputs from pollution inventories such as the NPI. CTMs can be used not only to estimate population exposure to air pollution, but also to address a range of questions relevant to policy. These include:

(i) the likely impacts of air pollution interventions,
(ii) the contribution of different emission sources to air pollution (e.g. natural vs anthropogenic, local vs regional, industry vs domestic) in a given region,
(iii) likely changes to air quality under future climate change scenarios, and
(iv) pollution levels likely to be experienced under different land-use and transport scenarios which are helpful for government planning.

Furthermore, pollution inventories are an important input for consulting firms contracted to provide environmental impact assessments of proposed developments, since without quality information about existing nearby emission sources it is difficult to say how much the new development would affect exposure in the region.

Emission inventories are one of the most important inputs for such simulations. Poor quality emission inventories cannot result in high quality CTM simulations. For most areas in Australia, the only publicly available gridded emission inventories are global in scope, coarse in spatial resolution, lacking in quality-controlled activity and several years old. Given the lack of a nationally-consistent emission inventory for Australia, if one is to perform any medium-to-high resolution air pollution simulations, the first step is to generate one's own emission inventory. This can be done by multiplying gridded population density maps by 'emission factors'

(assuming fixed amounts per person per year), or ‘down-scaling’ lower-quality global emission inventories by higher-resolution population maps (assuming fixed total emissions and distributing based on the population distribution). This is less than ideal, because there is no standardised methodology for doing this, and different approaches will result in different conclusions in terms of modelled pollutant concentrations.

Some emission sectors may be well described by these methods (e.g. household emissions from gas and solid fuels) over a long time period, but this representation would be very poor for other source sectors (e.g. rail, shipping, industrial processes). Similarly, these downscaling methods do little to help understand impacts of variability over shorter timescales (e.g. days to months).

We believe the solution to this would be for the NPI to feature temporal profiles. The NPI currently provides annual totals for specific pollutants at industrial sites. The inclusion of estimated temporal profiles (i.e. distribution across hours of the day, days of the week or weekday versus weekend, months of the year) could be a relatively small addition of information to impose upon submitters, but would make these data significantly more useful for CTM simulations. Understanding the temporal distribution can have a big impact on the ensuing simulations, as there can be significant variation throughout the course of the day. For example, night-time emissions are often much more concentrated near the surface due to more stable conditions in the lower atmosphere. Also, day-time emissions of nitrogen oxides and volatile organic compounds typically lead to downwind photochemical production of ozone during the daytime only, as this process requires sunlight. These considerations are particularly important since 24-hour exposures form part of air quality standards.

To facilitate CTM simulations, emissions should be available as a geospatial (raster) array, broken down into emitted species and emission type (e.g. domestic, mobile sources, industrial). This could be supplemented with temporal profiles (as described above, or, for example, with one value per hour of the year) for each source sector. A spatial resolution of 1km would be sufficient for the majority of modelling applications. Higher spatial resolutions can be achieved by down-scaling via land use regression (LUR)-like techniques.

While the NPI focuses on terrestrial sources, there are important emissions from shipping and aviation. Over 80% of Australians live within 50km of the coast, and coastal activities (fishing, recreation, tourism, goods transport) are associated with considerable economic revenue for the nation. Emissions of sulfur dioxide and nitrogen oxides from shipping lead to the formation of additional particulate matter and ozone. These emissions can be estimated based on a global ship-tracking database (AIS) and we recommend that ship-emissions be considered for inclusion in the review of the NPI. Similarly for aviation, many of Australia’s main airports are located within a few kilometers of residential areas, and aviation emissions can contribute

significantly to the local air quality. As such, we recommend that these also be considered for inclusion in a gridded NPI database.

While anthropogenic emissions are not the only source of trace gases and aerosols, there are already models for most natural sources, such as sea-spray aerosols, wind-blown dust, and emissions of volatile organic compounds from plants. These can be estimated with existing modelling tools, and although improvements are needed, these should not be the primary focus of the NPI. Relatively high-quality data about wildfires is available from global databases (e.g. GFED, GFAS), and these emission sources need not be included. Nevertheless, it would be ideal if the NPI linked to higher resolution mapping of burned areas where these exist.

2.2 Population exposure versus exceedances in air pollution regulations

Like many countries, Australia implements a categorical approach based on ‘exceedances’ to regulate air pollution concentrations. One of the roles of the NPI is to monitor such exceedances, by adding information of emissions from various sources and tracking the resultant concentrations that occur in the environment. The use of population exposure (as opposed to categorical exceedances) is increasingly seen as a useful tool to quantify health costs and the effectiveness of emission reduction strategies. In the context of section 1.1 about the need for the NPI for health research, the NPI data could be used as inputs to population exposure estimates. However what we know about air pollution exposures is limited due to a lack of data at locations where the majority of the population resides, or where particularly susceptible populations live. Improvements to the NPI could help resolve this data gap.

The World Health Organization has concluded that “Small particulate [air] pollution have health impacts even at very low concentrations” and that “no threshold has been identified below which no damage to health is observed” [1]. The apparent lack of a lower threshold of population health effect for fine particulate matter (defined as those less than 2.5 microns, $PM_{2.5}$) is a strong argument for Governments to implement exposure based emission reduction targets compared to threshold based exceedance standards. This approach has been adopted in Europe [2] and has previously been discussed by Canadian and Australian Governments.

2.3 Estimates of uncertainty should be integrated into the NPI

All emission inventories contain some degree of uncertainty. This applies when emissions are estimated based on activity data and emission factors, and also when estimated by direct measurement from exhaust stacks. These uncertainties play an important role in setting up simulations to estimate effects of emission-control scenarios. Also, uncertainties allow users of the NPI to assess whether observed trends are likely to be real or whether they may be due to random variation.

Uncertainties also impact risk analysis, which is playing an increasing role in policy development. We encourage the NPI to implement a standardised uncertainty-estimation framework to both individual sites and to any gridded emission data products. Given the wide range of uses of the NPI we recommend that, where possible, uncertainty on the inputs to the NPI is also recorded.

Uncertainty is both a difficult concept to convey and is difficult to quantify. Incorporating uncertainty information into submissions to the NPI may pose an additional challenge to submitting entities. Therefore a staged approach may help minimise these difficulties. This would involve inviting a fraction of the NPI submitters to participate in a trial of providing uncertainty estimates for their data, followed by a survey about how this was managed internally. Lessons learned from such a step may be rolled into any broader-scale adoption of uncertainties in the NPI submission process. Another approach would simply be to request additional metadata that could aid in quantifying error, such as including the measurement instrument, sampling frequency and the era of the underlying data sources.

3. Funding model

One question raised by the NPI Discussion Paper is how the NPI should be resourced in the future. In terms of addressing air quality policy, it is important that the NPI be as comprehensive and accurate as possible. While the “polluter-pays” principle provides a valid basis for leveraging costs for submitting entities, it may have the effect of either dissuading industry from submitting data or encouraging companies to underestimate their emission totals. In the interests of maintaining accurate and comprehensive records, the NPI could be funded by a joint Commonwealth-State pool. A justification for this is that an expanded NPI could feasibly result in efficiency gains when looking across the State EPAs.

An alternative model would be to fund it from a broad-based levy across businesses, independent of whether the individual companies do or do not need to submit to the NPI. The justification for this is that all Australian businesses benefit economically from national emissions, either directly (through their own activities) or indirectly (through goods and services purchases). However this alternative is less practicable, given that the NPI is far too small an initiative (even if it were expanded considerably) to justify imposing a separate levy.

4. Summary of recommendations

As scientists working with monitoring and modelling of air quality and human exposure, and the health impacts of air pollution, we recognise the ongoing importance of the NPI. The NPI enables both public policy development and cutting-edge scientific research. We hope to see

the NPI continue into the future, and the NPI review to consider the recommendations outlined above. These include:

- centralising and standardising some of the inventory compilation activities undertaken by States and Territories;
- emphasising the importance of the NPI for human health and well-being in the context of environmental quality and resource management;
- clarifying differences and synergies between the NPI and similar inventories;
- emphasising the need for the NPI to support the move toward population exposure (as compared with categorical exceedances);
- developing nationally-consistent gridded inventories for anthropogenic emissions;
- requesting of submitters temporal profiles of diurnal, weekly, annual patterns in emissions;
- extending the pollution sources included in the NPI to include maritime and aviation emissions;
- considering the estimation of uncertainties alongside the magnitude of the emissions themselves; and
- aiming for a funding model that ensures that the NPI is as comprehensive and accurate as possible.

5. About us

CAUL

The Clean Air and Urban Landscapes Hub (CAUL) is a consortium of four universities: The University of Melbourne, RMIT University, The University of Western Australia and the University of Wollongong. The CAUL Hub is funded under the National Environmental Science Program (NESP) of the Australian Government's Department of the Environment. The task of the CAUL Hub is to undertake research to support environmental quality in our urban areas, especially in the areas of air quality, urban greening, livability and biodiversity, and with a focus on applying research to develop practical solutions.

CAR

The Centre for Air pollution, energy and health Research (CAR) is a Centre of Research Excellence funded by the National Health and Medical Research Council. CAR has a national scope and brings together over 30 researchers at the forefront of their fields to investigate how air pollution and new forms of energy affect our health. The CAR Exposure Sub-committee (CARES) have contributed to this submission on behalf of the general membership of CAR.

6. References

[1] http://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
[2] http://ec.europa.eu/environment/air/quality/directive.htm