CAPE
Canadian Association of Physicians for the Environment

Association Canadienne des Médecins pour l'Environnement
ACME

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To: Canadian Council of Ministers of Environment (CCME)
Air Quality Management System (AQMS)
Stakeholder Advisory Group (SAG)
Via email to: bacalder@icloud.com

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The following contains our advice and comments on the new online 'State of the Air' report produced by CCME, and as posted on-line at: http://airquality-qualitedelair.ccme.ca/en/, in order topic occurrence.

Overall, the website/report is fairly easy to use, provides information that is useful to the general public, and links to more detailed material. The graphics provided are also easy to understand. However, section hierarchy isn't clear from the design/fonts. For instance, higher-level section titles are given in the top menu, but the level/hierarchy of these ('Canada's Air', 'AQMS', 'CAAQS', 'Emissions & Ambient Trends', 'Acid Rain' and 'Actions') are not clear within the report itself (due to the inconsistent use of font, colour, etc.).

We have included specific comments regarding the report and its presentation in the following, and thank-you for the opportunity to comment on this report.

Canada's Air

In addition to "heavily populated and industrial areas"—where ozone and particles (largely from transportation sources or home heating) may cause localized air quality issues—there are other parts of Canada where emissions of additional and potentially harmful pollutants are still on the rise. For instance a recent pilot study found elevated levels of volatile organic compounds (VOC), such as benzene or its metabolites, to be elevated in the urine if pregnant woman in an oil and gas dominated region of

northeast British Columbia (BC)[1]. An earlier study in this remote and lightly populated region found it to boast higher rates of respiratory illness and certain cancers than otherwise comparable areas or provincial and national averages[2]. In addition, emissions of sulphur and nitrogen oxides (SO_x and NO_x, respectively), pollutants associated with 'acid rain', have been increasing in western Canada over the past two decades or so, largely due to enhanced upstream oil and gas sector activity [3,4]—this is in contrast to significant decreases in these pollutants throughout eastern Canada over the past few decades. Furthermore, spatially explicit data for western Canada continue to be excluded from national 'acid rain' maps (see: 'Acid Rain' below); and monitoring stations in the western province have actually been reduced in number over time[4] (also see: 'Acid Rain' map in report).

Although these parts of western Canada would maybe classify 'industrialized', they are not what the average Canada pictures when considering an 'industrial area'. Perhaps something about 'remote areas with low population density dominated by resource extraction' or 'remote areas with low population density dominated by the upstream oil and gas industry' would help clarify the statements made in this section and provide a more accurate account of Canada's air quality nation-wide. Canada has some of the best air quality in the world, but we don't always seem to measure (or manage) what we should or where we should.

Air Quality Management System

In this section it isn't clear which pollutants will be monitored/measured under this system (AQMS), or whether every 'air zone' will require the same level of monitoring (number of pollutants, station density, etc.).

It also isn't clear whether Québec will be developing its own unique/provincial AQMS program or equivalent. The note that explains Québec's stance is hidden by the following section after the first two lines.

[1] Élyse Caron-Beaudoin, Naomi Valter, Jonathon Chevrier, Pierre Avotte, Katherine Frohlich, and Marc-André Verner, 2017. Gestational exposure to volatile organic compounds (VOCs) in Northeastern British Columbia, Canada: A pilot study. Environment International, published online November 6, 2017. Doi: 10.1016/j.envint.2017.10.022

[2] Krzyzanowski, J., 2012. Environmental Pathways of Potential Impacts to human Health from Oil and Gas Development in Northeast British Columbia, Canada—a review. *Environmental Reviews* 20: 122–134. http://www.nrcresearchpress.com/doi/abs/10.1139/a2012-005

[3] Zbieranowski, A.L., Aherne, J., 2011. Long-term trends in atmospheric reactive nitrogen across Canada: 1988-2007. Atmospheric Environment 45(32): 5853-5862.

[4] US EPA and Environment Canada, 2012. Canada–United States Air Quality Agreement: 2012 Progress Report: chapter 2. In: Canada, E. (Ed.). Environment Canada. URL: https://www.canada.ca/en/environment-climate-change/services/air-pollution/publications/canada-united-states-air-quality-report-2012/chapter-1.html

Under Mechanisms, 'Mobile Sources' doesn't seem to fit, as it is the only mechanism that isn't an action item. How about 'regulating mobile sources', 'mobile source standards' or similar? In addition, the terms 'Foundation' and 'Driver' are both active buttons with pop-up links; however, the 'Mechanisms' button of the same style is inactive. The addition of a pop-up for this, or a removal of the 'button-like design' would be helpful.

Canada-wide Air Pollutant Emissions Trends Over Time

The graph and related text are based on National Pollutant Release Inventory (NPRI) and Air Pollutant Emission Inventory (APEI) Data. However, as published annually in the *Canada Gazette* there exist emission reporting thresholds based on sector, emission intensity or employee number. For instance, in the *Gazette's Notice with respect to the substances in the National Pollutant Release Inventory for 2016 and 2017* published on February 27, 2016, Schedule 3, Part 4 para. 12 only those emissions from stationary combustion equipment need to be reported if the installation is a pipeline (12(b)) or has an annual total of less than 20 000 employee hours (approximately 10 full-time employees). These thresholds are in addition to those for the Mass Reporting of 'criteria 'substances as listed in Table 2 of Part 4[5].

Due to the various thresholds (and hence exemptions) that exist in the emissions reporting being relied upon, we think it would be good to show error bars, or confidence intervals, or provide some sort of indication regarding the large margin of error that may exist. For instance, and as mentioned above, SO_2 and NO_2 are still increasing in many parts of western Canada; however, many of the (primarily oil and gas) installations that are responsible for these emissions are too 'small' to require emissions reporting. Past thresholds of a similar nature have been shown to severely underestimate emissions of this nature[6].

The title of this section is a little long, and the word 'emissions' should have an apostrophe at the end because the trends belong to many emissions.

Effects on Human Health and the Environment

In this section's summary it reads: "….heart and breathing problems…."; but we suggest "….heart and lung problems….", "….cardiac and respiratory problems…" or two other terms of the same/complimentary nature.

[5] *Canada Gazette* Vol. 150, No. 9, URL: http://gazette.gc.ca/rp-pr/p1/2016/2016-02-27/html/notice-avis-eng.php

[6] Krzyzanowski, J., 2009. The importance of policy in emissions inventory accuracy—a lesson from British Columbia, Canada. *Journal of the Air and Waste Management Association* 59: 430–439. http://www.tandfonline.com/doi/pdf/10.3155/1047-3289.59.4.430

The drop-down menu for different pollutants is effective and a good idea. However, under 'ozone' it may be helpful to distinguish between stratospheric (layer) and tropospheric (pollutant) ozone. The general public tends to think ozone is 'good' because it protects us from UV. The idea of ozone as a pollutant can be confusing. I would also ensure it is clear the ozone is a secondary pollutant and not emitted directly. This will help clarify some of the emissions versus ambient trends presented later.

'Attacks' should be removed after the term 'asthma' under $PM_{2.5}$, because asthma can be a long-term and chronic condition in addition to causing more acute attacks (it really makes too many 'attacks' for one sentence; and the same is also true for the page summary).

Under SO_2 the 'formation of $PM_{2.5}$' should maybe include the term 'acidic aerosol' and maybe be mentioned in the health section instead. SO_2 contributes to soil and freshwater acidity even when not an aerosol, but damage to lungs is severely enhanced when in liquid aerosol form. Also the term 'sulphuric acid in acid rain' seems to be out-dated terminology. Although 'acid rain' is a term the public will recognise, it neglects the dry deposition of S compounds that may be just as important as dissolved ones. This would also make more sense following directly after the mention of $PM_{2.5}$ formation (i.e. liquid acidic aerosols) rather than after (and before) gaseous uptake by plants. Please clarify and separate the liquid and gas phases. Lastly, does SO_2 damage structures or is it the liquid acidic aerosols formed on contact with water?

For NO_2 'health effects', please remove the "and" before "airway inflammation". As with SO_2, you may want to mention 'dry deposition' and the formation of acidic aerosols (i.e. PM as nitric acid). Also, under environmental effects, something should be said regarding ecosystem enrichment/eutrophication and changes in species composition that are related to NO_2 deposition.

For VOC, in addition to mentioning that health impacts depend on the 'nature of the chemical', it may be useful to give an idea of the vast number of VOC chemical species in the air. This is touched on with the mentioning of varied health impacts (or lack thereof), but even the number of VOC regulated/reported in Canada (i.e. some Group A, Parts 1, 2 and 5 substances[5]) could be helpful.

In terms of all pollutant's Environmental Effects, what about health impacts on wild animals? Could these effects not be equivalent, or in some cases worse than, direct impacts on human health (a 'canary in the coal mine' so to speak)? First Nations communities in some of the more 'industrialised' parts of Canada have reported instances of such wildlife impacts.

CAAQS

The table cuts off at 1-hour NO_2 in multiple browsers and the row heading ('nitrogen dioxide') cannot be seen. It may be good to remind people that there is no CAAQS for VOC because they represent such a diverse number of chemical compounds. May also be good to explain why $PM_{2.5}$ is measured in $\mu g/m^3$

instead of ppb. Also, didn't there used to be a CAAQS for PM_{10} in addition to $PM_{2.5}$? And what happened to carbon monoxide (CO), despite that ambient levels rarely if ever get high enough to cause impacts? Lastly, what about toxics or emerging substances of concern? Many of these (emissions) are reported in Canada, but are they ever measured either federally or as part of the provincial/territorial management of air zones? How may they fit into the AQMS or its evolution?

Air Zones and Airsheds

Some information about how air zones and airsheds are delineated would really help. There are obviously economic considerations in addition to geographic ones, and zone size seems to be somewhat related to population. Also, as with the table in the previous section, the bottom of the map is cut off (even after dragging).

How is it decided which air zones measure what under the AQMS? After reading the remainder of the report, it seems that only $PM_{2.5}$ and ozone are systemically monitored under the national AQMS. Not every 'air zone' report in Canada was reviewed, but as an example 'Northeast BC' and Alberta's 'Peace' are regions known for increasing levels of SO_2 and NO_2, but only $PM_{2.5}$ and O_3 are being monitored. entirety.

However, $PM_{2.5}$ and O_3 are largely pollutants that plague more urban areas those with higher population density. While they may be the most important pollutants in much of Canada's south or in more populated areas, they may not be the primary pollutants of concern in more remote (or 'industrialized') zones.

What is the purpose of 'air zones' if the pollutants monitored do not represent those associated with the specific economic activities occurring within that zone? Do you really consider southern Québec and northern Alberta to have the same problem pollutants? Why not specify which pollutants (for which there are CAAQS) should be monitored within each 'air zone' based on dominant emission sources/pollutants? If all 'air zones' monitor the same two pollutants, at any location/density the local/provincial government chooses, it is hard to understand the purpose of 'air zones' as management units. Why separate areas at all if their uniqueness is not accommodated within management actions?

CAAQS Management Levels

The table doesn't need to read "Management Levels for…" in each column; the columns already have the title 'Air quality management levels'. A "CAAQS" in parentheses following the general column title would allow 'CAAQS' to be removed from each individual column heading as well (they are too long). You can also use "ppb" for units, something already defined.

If only $PM_{2.5}$ and ozone are being measured, how do the 'management levels' for other criteria pollutants fit into the AQMS and other management goals, priorities or actions?

In addition, is a change (or reduction) of 1 ppb (for O_3) or 1 µg/m^3 (for $PM_{2.5}$) over 5 years (2015-2020) a commendable, or satisfactory, goal? Couldn't Canada do more to reduce the levels of these pollutants across the country? On what science are these 'management levels', or essentially changes in AAQS) based? There are no references to scientific literature, the World Health Organization (WHO), other authorities in the field, or even CCME's own work in the area of AAQS.

Furthermore, what sort of 'management actions' will be taken when pollutants exceed these levels? What actions will become 'more stringent'? Will there be trajectory analyses conducted to figure out who (what source) is causing the problem and will they will face some sort of punishment? What happens when levels increase, but remain below specific management levels? It would be helpful to know the sort of 'management actions' or enforcement involved in the management of these colour-coded levels. If each colour had a list of actions/priorities the reader would gain a better understanding of the approach.

Lastly, why include other criteria pollutants in the table if they are not measured under the AQMS despite having CAAQS and related 'management levels'? Are there future plans for managing additional contaminants for which there are already CAAQS? Are there plans to develop CAAQS and/or management goals for toxics or emerging contaminants of concern? Otherwise, the addition of these unmanaged (AQMS excluded) criteria pollutants under 'CAAQS', 'management plans' and other sections, seems somewhat misleading—unless air zones must monitor and manage them as well.

In regards to the second paragraph of this section, which reads: "When determining the CAAQS Management Levels…", it seems the level is 'determined' simply through a measurement of the pollutant in question, so the 'determining' is unclear. Additionally, it isn't clear what happens under each colour/level—are specific actions triggered at the air zone level?

CAAQS Achievement

This is confusing considering the last section provides four different management levels, while this section simply indicates whether a specific CAAQS is exceeded or not. Would these 'red' areas correspond to 'red' management levels? It seems so, but what about orange, yellow or green; and where does the blue fit in to the CAAQS Management Levels? Additionally, what about the other pollutants (SO_2, NO_2, VOC) for which management levels and/or CAAQS are provided in other sections?

Sources of Pollutant Emissions in 2015

This section returns to including SO_2 and NO_2, but doesn't explain why they are not measured as part of the AQMS or included in the CAAQS Management Levels. Further, there is again no indication of the potential errors or omissions associated with the emissions' estimates, either due to reporting thresholds[5], or due to the method used (e.g. emissions' factors). It may be helpful to at least mention something about how emissions' estimates are reported/compiled in Canada.

Also, the term 'open sources' should be better defined. It isn't clear whether something 'like road dust' would be included in the PM emissions shown, or whether it would be removed as it was from the Canada-wide total. Furthermore, it would be desirable to continue using '$PM_{2.5}$' rather than 'fine particulate matter', for the sake of consistency with previous sections and to avoid confusion.

Ambient Trends by Pollutant

It would be helpful to label the red dashed line (CAAQS) on the graph itself so that people don't think it represents the actual annual peak 98th percentile averaged over time or something. It would also be helpful to see a map of where the monitors are that made these measurements (before going to the 'Acid Rain' section, assuming the stations correspond).

If only $PM_{2.5}$ and O_3 are seemingly managed/monitored under the AQMS, where do measurements of the additional criteria pollutants come from? Were the same number of data points (monitoring locations) used to calculate each year's average for each pollutant, and if not are the data comparable across time/years? Are there enough measurements across Canada's diverse landscape to present nationwide averages at a spatially meaningful level? From the map shown under 'CAAQS Achievement', it would appear that air pollution issues vary across different air zones, and that this would also be true for SO_2 and NO_2, that do not appear to be measured in each air zone. Furthermore, which VOC are included in these data, is it total VOC, non-methane VOC, BTEX? Are the same VOC monitored at each station where they are measured and have they been consistently measured over the entire time series?

Emission Trends by Source

Similar to where and when ambient pollutants have been measured from 1999–present (above section) the reporting of emissions (e.g. substance and activity thresholds, and 'how' emissions are reported), have changed in Canada since 1990. For instance, provinces used to report emissions to the federal government, but now industry reports directly to the federal government (NPRI) and there are likely differences in estimates caused by such changed in reporting. Are these data in any way standardised or smoothed to account for such changes in reporting, and if not can they be compared, or treated equivalently, across time as shown?

Is it necessary to have both this section and the section above showing 'Canada-wide Air Pollutant Emissions Trends Over Time'? Why not show totals on these graphs and remove the previous graph/section?

It may also be good to remind people (in case they navigate to this section directly) that ozone is not reported as an emission because it is a 'secondary pollutant', and that rather than being emitted directly, forms in the atmosphere from NO_2 and (certain) VOC.

Pollutant Emissions by Province and Territory

As mentioned for the last section you can also put a national total on the same graphs and remove the graph/section entitled: 'Canada-wide Air Pollutant Emissions Trends Over Time'.

Additionally, if these emissions are presented without any concept of error (numerical or otherwise) as they currently are, it isn't clear how these emissions may differ from those compiled by individual provinces or territories. Again, some information on how emissions are reported in Canada would be helpful in this regard; otherwise the disclaimer is confusing and makes the data seem questionable.

Acid Rain

This section would be good earlier on, or at least the concept of 'deposition' (rather than 'rain') should be introduced earlier on. Also, aluminium should not be presented as a 'toxic chemical' considering it is a natural element; how about the term 'toxic metals' instead? Additionally, please change 'sensitive tree species' to 'sensitive plant species' as more than trees are affected.

The line: "Regular reporting on SO_2 and NO_2 emissions and forecasts and progress in implementing The Strategy is required." Is awkward and needs rewording. Even just removing one of the 'and's would help.

From the map, it is clear that: 1) the number and location of monitoring stations has changed over time; and 2) we don't have a good spatial representation of acid deposition in either western or northern Canada (making the Canada-wide averages presented previously questionable in their 'Canada-wide' representation).

Why is only nitrate deposition provided by the map rather than showing sulphate as well? Is only NO_3^- represented by the values/measurements or do values include equivalents of others reactive nitrogen species as well?

Also the title box of the next section overlaps the text of this section and needs remedying.

Improving our Air Quality Benefits Canadians

Please consider removing the "main pollutant in smog" in reference to PM, because ozone is actually the main pollutant in (photochemical) smog, as stated in the 'Air Pollutants' section. Although the word 'smog' developed to describe a mixture of smoke (PM) and fog, the term has evolved scientifically. Why not replace it with 'a pollutant of primary health concern due to its ability to cause respiratory (or lung) damage', or something along those lines? Also when referring to "particulate matter" here, are you referring to $PM_{2.5}$, PM_{10}? Please use consistent terminology. Whatever happened to PM_{10} anyway?

It seems (from the reference provided) that the 'deaths', 'hospital visits' and 'asthma events' are related solely to (fine) PM ($PM_{2.5}$)? If not, why not remove the reference to PM entirely and refer (or even link) the reader back to the 'Ambient Trends by Pollutant', etc.? Are there no estimates available for other, or mixed, pollutants? I believe some of the work by Michael Brauer may be able to assist in this regard[7].

The second paragraph is too definitive in language. You don't know for certain that instances of breathing symptoms or restricted activity would have occurred without these management actions. As in the cited paper's title, please add the word 'estimated' or 'potential' or some other qualifier of uncertainty in the presentation of these public health figures.

Also please add a space before the third paragraph for consistency in style.

Air Quality Actions

This should maybe be entitled 'Citizens' Air Quality Actions' in order to distinguish between what Canadians can do as a whole, and what the government is doing or planning to do.

The tips are good, particularly the addition of 'repair' to the usual 3 r's; however, some more information/guidance, particularly on 'consumer behaviour' could be helpful. There is a lot of 'green-washing' out there, and the average consumer is not likely able to assess the emissions associated with a product beyond the 'shipping' aspect (i.e. where it is made). Also, some information on transboundary air pollution could help, because quite often emissions associated with manufacturing and resource extraction happen beyond our own borders; and one could almost argue that as a result of our emissions' management we now divert or export more pollutants than ever before. But, we also directly import pollutants, for instance the west coast of Canada is known to receive particle emissions from Asia[8,9].

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[8] McKendry, I.G., Macdonald, A.M., Leaitch, W.R., van Donkelaar, A., Zhang, Q., Duck, T., and Martin, R.V., 2008. Trans-Pacific dust events observed at Whistler, British Columbia during INTEX-B. Atmospheric Chemistry and Physics 8: 6297-6307.

[9] Zhao, T.L., Gong, S.L., Zhang, X.Y., and Jaffe, D.A. , 2008. Asian dust storm influence on North American ambient PM levels: observational evidence and controlling factors. Atmospheric Chemistry and Physics 8: 2717-2728.

Synopsis

In short, to a group representing medical physicians, human health impacts are of utmost importance. Considering the varied effects that air pollutants have on the environment and health, and the information presented above and in the report, we ask that aspects of the report be clarified as suggested above and that the program (AQMS) be expanded to include pollutants in addition to O_3 and $PM_{2.5}$. This will harmonise AQMS priorities with CAAQS and other management actions presented in the report.

We thank you for providing us with the opportunity to comment.