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Guidance for Evaluating Human Health Impacts in Environmental Assessment:

AIR QUALITY

Canada

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1 ACRONYMS

ACRONYM	MEANING
AQMS	Air Quality Management System
CWS	Canada-wide Standards
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CEA	cumulative effects assessment
CEAA 2012	*Canadian Environmental Assessment Act*, 2012
CEPA 1999	*Canadian Environmental Protection Act*, 1999
CI	continuous improvement
CO	carbon monoxide
CO_2	carbon dioxide
COPC(s)	contaminant(s) of potential concern
EA	environmental assessment
EIS	environmental impact statement
HHRA	human health risk sssessment
IARC	International Agency for Research on Cancer
KCAC	keeping clean areas clean
LSA	local study area
$\mu g/m^3$	micrograms per cubic metre
μm	micrometres
mg/m^3	milligrams per cubic metre
MW	molecular weight
NAAQOs	National Ambient Air Quality Objectives
NH_3	ammonia
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
PAHs	polycyclic aromatic hydrocarbons (e.g. benzo[a]pyrene)
ppb	parts per billion
ppm	parts per million
$PM_{2.5}$	particulate matter less than 2.5 μm in diameter
PM_{10}	particulate matter less than 10 μm in diameter
RA	responsible authority
RfC	reference concentration
RSA	regional study area
SO_2	sulphur dioxide
TOR	terms of reference
TSP	total suspended particulates
VOCs	volatile organic compounds (e.g. benzene, toluene, xylene)
US EPA	United States Environmental Protection Agency
UFP	ultrafine particles
WHO	World Health Organization

2 PURPOSE OF THIS DOCUMENT

This document provides generic guidance on predicting health risks of air quality in federal environmental assessments (EAs) of proposed major resource and infrastructure projects (such as mines, dams, pipelines and other projects). It presents the principles, current practices and basic information Health Canada looks for when it reviews the environmental impact statements (EIS) or other reports submitted by project proponents as part of the EA process.

It was prepared for the benefit of proponents and their consultants and to support an efficient and transparent project review process. The foundational information described here should be supplemented appropriately with additional information relevant to specific projects.

The guidance was also prepared for responsible authorities and stakeholders to the EA process to communicate our normal areas of engagement and our priorities within these areas to help ensure that sufficient evidence is available to support sound decisions. As part of its review, Health Canada may suggest that a responsible authority (RA), review panel or others collect information not specifically described here in order to assess the health effects of specific projects. As the guidance provided here is generic and designed to support EA under multiple jurisdictions, the scope of our review will also necessarily be amended according to specific jurisdictional requirements.

Health Canada updates guidance documents periodically and, in the interest of continuous improvement, accepts comments and corrections at the following address: ead@hc-sc.gc.ca

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3 | INTRODUCTION AND CONTEXT

Health Canada provides expertise to assist RAs, review panels and/or other jurisdictions leading environmental assessments to determine whether there are potential health risks associated with proposed projects and how to prevent, reduce or mitigate them.

Health Canada brings to bear its expertise in health risks associated with air quality, water quality, radiation, noise and country foods when it reviews and provides comments on information submitted by proponents in support of proposed projects. Health Canada also provides guidance to help stakeholders, including responsible authorities, review panels and affected communities, better understand how to conduct health assessments for proposed major resource projects.

This document concerns the assessment of health risks associated with air quality. It contains information on the division of roles and responsibilities for issues related to air quality at various levels of government in Canada; health effects associated with air quality; indicators of these effects; and, steps in Health Canada's preferred approach to assessing air quality-related health effects.

Appendix A contains a checklist that can be used to verify that the main components of an air quality assessment are complete and to show where this information can be found within an EA document.

Appendix B lists online sources of national and provincial air quality standards, data and general information.

Appendix C lists the Canadian Ambient Air Quality Standards (CAAQS) and National Ambient Air Quality Objectives (NAAQOs) for various ambient air contaminants, current as of the date of publication of this document. Definitions and equations for converting units are provided at the end of this appendix.

4 ROLES AND RESPONSIBILITIES WITH RESPECT TO AIR QUALITY

In Canada, the protection and improvement of ambient air quality is a shared responsibility. The most current and up-to-date criteria and guidelines should be used for any comparisons made in environmental assessments. Health Canada encourages readers to consult with provincial, territorial and municipal authorities, as appropriate, to determine or verify which standards exist for specific regions. Refer to Appendix B for a list of online resources for national and provincial air quality standards, data and general information (current as of the publication date of this guidance document).

The Clean Air Regulatory Agenda is a federal initiative, led by Environment and Climate Change Canada, aimed at improving air quality and protecting human health through reduced emissions of outdoor and indoor air pollutants and greenhouse gases. Health Canada's key role is to provide guidance through health risk assessments and research to ensure risk management actions effectively reduce the health impacts of air pollution. The air quality research, monitoring and modelling activities of Environment and Climate Change Canada and Health Canada aim to quantify priority air pollutants and determine trends, in order to predict air quality in both the near term and long term. The research builds knowledge on atmospheric processes and emissions measurements related to industrial and non-industrial sectors, thereby helping to relate air pollutant emissions to exposure and environmental impacts and in turn, informing the review of environmental assessments (EAs).

4.1. HEALTH CANADA

Health Canada's primary role with respect to air pollution is to identify hazards posed to the Canadian population and to collaborate with others, often Environment and Climate Change Canada, to reduce the identified risks. Health Canada's scientists conduct, evaluate and remain current on domestic and international scientific research on the effects of air quality on human health.

Health Canada's review of air quality assessments for EA processes is project-specific. Health Canada's expertise in this context focuses on assessing the risks to human health resulting from exposure to air contaminants—using health-based evaluation tools, guidelines and toxicological reference values. Health Canada reviews the baseline conditions described (i.e. air quality in the existing environment) and the predicted project-related air pollutant concentrations for different assessment scenarios at locations where human receptors may be affected. Health Canada can comment on whether the assessment of effects of air quality on human health undertaken by the proponent was scientifically valid, and may request further information or rationale. Health Canada may make available additional information or knowledge when predicted air quality changes have the potential to affect human health. Health Canada may also comment on the adequacy of mitigation measures proposed to reduce project-related changes and/or health impacts. The responsible authority, review panel or other jurisdiction conducting the assessment will ultimately determine how the information or knowledge provided by Health Canada will be used in the EA process.

Health Canada does not possess the expertise to verify air quality modelling results and assumes that the assessment has used correct, accepted and/or validated methods. Health Canada relies on the expertise of Environment and Climate Change Canada in the areas of emissions, dispersion and atmospheric modelling. Health Canada may also seek Environment and Climate Change Canada's advice on the adequacy of an EA's ambient air quality predictions. If Environment and Climate Change Canada notes errors and/or gaps in the modelling of air quality, revisions may be requested by the responsible authority to address the errors. If the revised results differ from the originally submitted results, Health Canada suggests that the report be resubmitted to Health Canada for review.

Health Canada does not possess expertise on:

- modelling emissions and deposition; and
- assessing or evaluating of the potential effects of odour.

Environment and Climate Change Canada possesses expertise in areas such as emissions modelling and environmental fate and may share information with Health Canada to inform the evaluation of environmental assessments.

4.2. PROVINCES AND TERRITORIES

In general, provinces/territories are responsible for controlling pollution emissions, including air pollutants, from industry and business operations. The provinces manage air pollutant emissions through regulations and their approach to granting (or issuing) permits that describe the allowable levels of emissions of various pollutants from a given facility, including emissions from associated mobile sources. Provinces may also adopt ambient air quality standards or objectives (see Appendix B), which are used to inform their processes for issuing pollution emission permits (e.g. using air quality modelling to predict how ambient air quality in a neighbouring community will be impacted by a facility's emissions and how the predicted pollution levels compare to the air quality standard) and other air quality management actions. In 2012, the Canadian Council of Ministers of the Environment (CCME), with the exception of Quebec, agreed to begin implementing the new Air Quality Management System (AQMS), which includes the new ambient air quality standards as a key component. Those conducting assessments are encouraged to seek information as early as possible as to which provincial, territorial and/or municipal legislation and regulations concerning ambient air quality may apply to the project.

4.3. AIR QUALITY STANDARDS AND GUIDELINES

The *Canadian Environmental Protection Act*, 1999 (CEPA 1999) is the principal federal legislative tool governing environmental contaminants. It is administered jointly by Environment and Climate Change Canada and Health Canada. CEPA 1999 enables the Minister of the Environment and the Minister of Health to regulate substances and allows the federal government to assess air pollutants and provide targets that can be used in setting goals for reducing health risks from contaminants of potential concern (COPCs). The federal government also has the authority to address air pollution caused by the transboundary flow of air pollutants (e.g. across the Canada-U.S. border) and to identify key air pollutants as toxic substances under CEPA 1999.

Under the auspices of the CCME, Health Canada and Environment and Climate Change Canada have been working with provincial/territorial governments and non-governmental stakeholders on the development of a new AQMS—a comprehensive and national approach to improving air quality in Canada. A key element of the AQMS is new health-based CAAQS, which set the bar for air quality management across the country. In May 2013, the federal government established new CAAQS for fine particulate matter ($PM_{2.5}$) and ozone, using the authority of CEPA (Canada Gazette Part I, May 25, 2013). These new CAAQS, which are to be achieved by 2015 and 2020, are more stringent than the previous Canada-wide Standards (CWS), which they replace.

Like the CWS, the CAAQS are based on the principles of keeping clean areas clean (KCAC) and continuous improvement (CI) (CCME 2000, 2007 and 2012). Provinces and territories will use the CAAQS in air quality management decision-making aimed at improving poor outdoor air quality and maintaining good outdoor air quality. At the time of publication of this guidance document, additional CAAQS for nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) were under development and will replace the former National Ambient Air Quality Standards (NAAQOs) for these pollutants.

Consult the CCME's website for up-to-date information on the AQMS and CAAQS: **www.ccme.ca**

5 COMMON AMBIENT AIR POLLUTANTS

5.1. AMBIENT AIR QUALITY AND HEALTH

There is consensus among international and national organizations (e.g. the World Health Organization (WHO), Health Canada, the United States Environmental Protection Agency (US EPA), the European Union and the International Agency for Research on Cancer (IARC)) that air pollution has significant human health impacts. Causal associations have linked poor air quality to respiratory and cardiovascular illnesses, hospitalizations and mortality. The reaction of an individual to air pollutants depends on the type of pollutant to which a person is exposed, the degree of exposure and the individual's health status and genetics. Harmful health outcomes attributable to air pollution can range from respiratory symptoms to premature death—encompassing acute irritation and respiratory problems, the development or worsening of existing respiratory and/or cardiovascular diseases, and cancer. These effects can result in higher medication use, increased visits to doctors or emergency rooms and more hospital admissions. Epidemiological studies that make use of administrative databases that track information such as mortality, hospital admissions and emergency room visits have been used to characterize population risk; these studies are now a common tool in assessing the health implications of air quality changes related to environmental pollutants. Based on such studies, there is a growing awareness that increasing concentrations of air pollutants in many parts of Canada are associated with morbidity (incidence of disease) and mortality (Judek et al., 2004). The WHO's Global Burden of Disease Study recognizes outdoor air pollution in the form of fine particles as one of the top-ten global health risk factors (Lim et al., 2012), while IARC has recently identified air pollution as a whole, as well as component particles ($PM_{2.5}$ and PM_{10}), as causes of cancer (2013).

5.2. PARTICULATE MATTER

The general term "particulate matter" (PM) can be defined as particles (solid or liquid, or a mixture of both) less than 100 micrometres (µm) in diameter. Particles of 10 µm or less in diameter are referred to as $\mathbf{PM_{10}}$. Particles of 2.5 µm or less in diameter are referred to as $\mathbf{PM_{2.5}}$ or **fine PM**. Particles intermediate in size (i.e., $PM_{10\text{-}2.5}$) are generally known as the coarse fraction of PM_{10}. All three size designations (PM_{10}, $PM_{10\text{-}2.5}$ and $PM_{2.5}$) have been demonstrated to affect various aspects of human health, with the respiratory and cardiovascular systems being the major targets. The fine (smaller) particles pose a greater risk to human health, as they can be inhaled deeply into the lungs, are chemically reactive and have complex characteristics. Despite the overlap between each of these size fractions (i.e. the PM_{10} size fraction includes the $PM_{2.5}$ size fraction), there is also variation in the deposition patterns within the lungs because of differences in the physical and chemical composition, as well as the sources of the particles (WHO 2003). Particulate matter can be primary or secondary in nature; primary particles are emitted directly from a source, while secondary particles arise from the chemical reaction of precursors in the atmosphere.

The WHO *Air Quality Guidelines* (2006) provide exposure-response relationships describing the relationship between ambient PM and various health endpoints. These guidelines do not propose a specific guideline value for PM, as a threshold could not be identified below which no adverse effects on health occur. Recent scientific evidence also indicates that there is no apparent lower threshold for the effects of PM on human health. Scientific evidence shows that fine particles ($PM_{2.5}$) are strongly associated with mortality and other human health endpoints, such as hospitalization for cardio-pulmonary disease (WHO 2003). The new CAAQS for PM also recognize that there is no population health threshold for human health effects; therefore, any increase in exposure will result in an incremental population risk (Environment and Climate Change Canada and Health Canada, 2012; CCME, 2000). In other words, PM_{10} and $PM_{2.5}$ are considered to be non-threshold substances, meaning that health effects may occur at any level of exposure. Health Canada has concluded that the risk associated with fine particles, particularly $PM_{2.5}$, is higher than the health risks associated with coarse PM or total suspended particulates (TSP).

Ultrafine particles (UFPs) refer to very small, usually reactive particles with a diameter smaller than 0.1 µm that achieve widespread deposition within the respiratory tract. Therefore, by definition, $PM_{2.5}$ (and PM_{10}) includes ultrafine particles (UFPs). The results of recent studies on UFPs are not entirely consistent, and the scientific literature in this field continues to evolve. Therefore, Health Canada does not currently make specific conclusions on the potential health effects of UFPs. Rather, Health Canada encourages the inclusion of an assessment of $PM_{2.5}$ and a discussion of the predicted levels in relation to human health in all air quality assessments.

5.3. SECONDARY POLLUTANTS

Secondary pollutants such as ground-level ozone and secondary $PM_{2.5}$ are formed in the atmosphere through the reaction of gaseous precursors; in the case of ozone, the presence of sunlight is required for these reactions to occur. Project-related emissions may contribute to secondary pollutants formation. Including predicted concentrations of secondary pollutants from project-related emissions in an air quality assessment provides a more comprehensive estimate of project-related effects; a qualitative discussion of precursors and secondary pollutant formation (especially ozone and secondary $PM_{2.5}$) is helpful in the absence of a quantitative assessment. Secondary pollutants may be important elements of an air quality assessment, especially when the secondary pollutant precursors (e.g. nitrogen oxides (NO_x), ammonia (NH_3), sulphur dioxide (SO_2), volatile organic compounds (VOCs)) are emitted from project activities. PM and ozone precursor pollutants need to be managed—both in terms of mitigating their own associated health risks and with regard to their contribution to the formation of secondary pollutants. As examples, ground-level ozone is formed from reactions involving NO_x and VOCs, and $PM_{2.5}$ is formed from complex reactions involving NO_x and VOCs and SO_2, as well as other substances. Ground-level ozone is a constituent of photochemical smog and is linked to serious health impacts, including chronic bronchitis, asthma, increased medical and hospital visits, and premature deaths (Environment and Climate Change Canada and Health Canada, 2012; WHO, 2003). Ozone, along with PM, should be treated as having no safe level; that is, on a population basis, there is no threshold below which no adverse effects on health may occur (Environment and Climate Change Canada and Health Canada, 2012).

5.4. OTHER AMBIENT AIR POLLUTANTS

The use of equipment such as engines and generators, as well as other industrial processes, may lead to increased levels of PM and fuel combustion by-products (e.g. PM, NO_x, SO_2, carbon monoxide (CO), polycyclic aromatic hydrocarbons (PAHs), VOCs, metals). NO_x can impair lung function and irritate the respiratory system and are especially problematic for people who already suffer from asthma, bronchitis or other respiratory disease. Similarly, SO_2 at relatively high levels of exposure can cause breathing problems in people with asthma, and there is some evidence that exposure to elevated levels may increase hospital admissions and premature deaths. Exposure to CO may increase hospital admissions for cardiac diseases and, at high levels, CO exposure can cause mortality.

PAHs are relatively non-volatile compounds of low solubility in water. These compounds are mostly adsorbed to particulate matter, on which they are transported. Some PAHs are known to be carcinogenic (e.g. benzo[a]pyrene) (Government of Canada, 1994), as are some volatile organic compounds (VOCs), such as acetaldehyde, formaldehyde, benzene and 1,3-butadiene.

Road transportation (including fuel combustion, tire friction on road pavement and brake usage) is a source of many air pollutants. Equipment used in large development projects can be a significant source of diesel engine exhaust, which is a mix of gases and particles, including criteria air pollutants and air toxics that may damage the lungs and potentially cause cancer. In addition to PM and fuel combustion by-products, traffic-related pollutants include 1,3-butadiene, benzene, formaldehyde, acetaldehyde and acrolein.

Additional air pollutants of concern include hydrogen sulphide (H_2S), toxic metals (e.g. cadmium, lead, mercury, manganese, arsenic and nickel), polychlorinated biphenyls (PCBs), dioxins and other persistent organic compounds.

6 CONDUCTING AN AIR QUALITY ASSESSMENT FOR AN ENVIRONMENTAL ASSESSMENT

Section 6 provides general information about the assessment of project-related changes in ambient air quality in EAs and the potential impacts of these changes on human health. In general, an assessment begins by characterizing the project study area and identifying the people who may be impacted by changes to the environment due to the project. This includes considering the manner of exposure (e.g. inhalation). Next, the possible COPCs are identified and characterized. The existing environment is described, and the emissions and COPCs generated from the project activities are predicted using scenarios and modelling software. The predicted COPC concentrations should be analyzed in relation to appropriate air quality standards (e.g. CAAQS). After estimating the changes in air quality, the assessment should examine and consider the risks to human health due to these changes. Mitigation measures may be recommended to reduce the potential changes to air quality. Measuring COPC levels during the project may assist with implementing or modifying mitigation measures.

6.1. DEFINE SPATIAL AND TEMPORAL BOUNDARIES

"Regardless of whether direct measurement or environmental modelling is used, both spatial and temporal variability need to be characterized. Spatial definition of the site is particularly important for the application of any microenvironment analysis. Temporal definition of the site is needed to address changes in chemical concentrations over time." (Health Canada, 2010)

Spatial boundaries identify and define the area(s) to be considered in the air quality assessment, including local and regional boundaries. The spatial boundaries of air quality effects are project-specific. Depending upon the amount and types of emissions, a project may affect air quality over a larger or smaller area. Often, a local study area (LSA) and a larger regional study area (RSA) are delineated for the assessment. Maps, diagrams and figures should be used to illustrate the boundaries and distances to project site(s). It is good practice to consider adjacent land use if the ecosystem is sensitive; if the land is or will be used for residential purposes; or if on-site contamination is migrating off-site and potentially impacting adjoining properties (Health Canada, 2010). This step of defining boundaries may be conducted in conjunction with the receptor identification step.

It is good practice to focus a discussion of potential human health impacts on locations where people could be most affected, such as those nearest to the emission sources or those who may be exposed to the highest concentrations of COPCs. The latter point is particularly important if there is high variability in air quality within the spatial boundary identified. However, care must be taken to identify those area(s) where there are people who may experience less exposure—but who are at potential greater risk as a result of higher sensitivity. Identification of these areas may be conducted in conjunction with the receptor identification step (Health Canada, 2010). Note that Health Canada is generally interested in all exposures. Medium- and long-range transport is usually evaluated to the extent that it is bounded by the LSA and RSA. Health Canada encourages the evaluation and discussion of long-range transport, if it is important for a particular project.

Temporal boundaries address the timing and lifespan of the potential impacts of the project, and may be described based on the various project phases (i.e. construction, operation, modification, decommissioning and abandonment). It is good practice to clearly determine the most appropriate temporal scales and descriptions of air quality data (e.g. seasonal or annual variation, 24-hour maximum and averaging times, such as 8-hour, 1-hour, etc.)—particularly when the EA will include a comparison of measured or predicted values for air pollutants to existing standards or guidelines. To enable the evaluation of the impacts of project-related air quality changes on human health over time, it is important that the temporal scales provided in both the modelling predictions and health effects assessment are consistent.

To better characterize the types of exposure experienced by humans near the project site(s), it is good practice to differentiate between acute and chronic exposures when describing potential air quality impacts on humans.

6.2. IDENTIFY AND CHARACTERIZE HUMAN RECEPTORS

The identification and description of all existing and reasonably foreseeable human receptors that may be affected by project-related air emissions are necessary for an assessment of potential air quality impacts on human health. It is a good practice to select the most sensitive or exposed individuals in determining these potential impacts. Some individuals are more susceptible to contamination exposure due to the following:

- Physiology (e.g. newborns, children, pregnant or breastfeeding women and elderly people);
- Health status (e.g. immune-compromised persons, and persons suffering from heart disease, respiratory conditions or allergies);
- Behaviour (e.g. amount of time spent outdoors); and
- Lifestyle (e.g. smoking, Body Mass Index (BMI) and exercise status).

It is important to clearly describe the location and distance from the project site(s) of all potential human receptors (permanent, seasonal or temporary)—taking into consideration the different types of land uses (e.g. residential, recreational, industrial, etc.); and identifying all sensitive people (e.g. in schools, hospitals, retirement complexes or assisted care homes). Note that the types of residents and visitors in a particular area will depend on land use, and may include members of the general public and/or members of specific population subgroups (Indigenous peoples, campers, hunters, etc.).

To identify the people that may be affected by project-induced air quality changes, it is useful to provide a map illustrating through isopleths (contour lines showing constant concentration levels) or other means, the predicted pollutant concentrations for those COPCs approaching or exceeding appropriate guidelines and/or standards, overlaid with the receptor locations in the LSA and RSA. Consider that the dispersion of substances into air can affect receptors that are either in close proximity or at considerable distances to the source. If any humans or residences are omitted from the air quality assessment, provide an evidence-based rationale for the exclusion.

Note that occupational exposure and health issues are typically under provincial or territorial jurisdiction.

6.3. DESCRIBE EXPOSURE PATHWAYS

Exposure to air pollutants, such as particulate matter, gaseous chemicals or chemicals adsorbed to particulate matter, occurs primarily via inhalation, which is the main pathway considered in an air quality assessment.

Another potential exposure pathway is the consumption of vegetation, dairy products, meat or game meat from crops or animals that have been exposed to elevated concentrations of airborne contaminants through air deposition to produce, fodder and grazing crops. Health Canada possesses the expertise to review the predicted human health impacts of this mode of contamination, but does not have the ability to verify modelling results that are predictive of this exposure pathway (as discussed in Section 4.1.). It is good practice to employ prediction models obtained from published or other sources that have received peer or regulatory endorsement. Modelling results may indicate that over time, the chemical concentration of contaminants in environmental media may increase (e.g. accumulation over time in soils, bioaccumulation and bio-concentration) due to emissions of airborne contaminants.

6.4. IDENTIFY CONTAMINANTS OF POTENTIAL CONCERN

COPCs are chemicals whose concentration(s) may become elevated in ambient air as a result of project-related activities, and which have the potential for adverse health impacts based on documented scientific evidence or suspected causal relationships.

The COPCs to be characterized for a project EA are often detailed in the project-specific terms of reference (TOR) or EIS Guidelines. It is good practice to include an inventory of all emissions and potential COPCs resulting from the proposed project in an air quality assessment. All sources should be considered, including project-related processes, on-site vehicle usage and fugitive emissions. All phases of the proposed project should also be considered (e.g. construction, operation, modification, decommissioning and abandonment). The inventory should include the following (as applicable):

- Criteria Air Contaminants, (i.e. sulphur oxides, NO_x, particulate matter including total PM, PM_{10}, and $PM_{2.5}$, CO, NH_3, ground-level ozone, and secondary PM);
- Volatile Organic Compounds (VOCs);
- Air pollutants on the *List of Toxic Substances* in *Schedule 1* of CEPA 1999;
- Diesel PM; and
- Other contaminants as appropriate (e.g. heavy metals and PAHs).

As discussed in Section 5, it is widely accepted that PM_{10} and $PM_{2.5}$ are considered non-threshold substances, meaning that health effects may occur at any level of exposure. Health Canada holds the view that there is more risk associated with exposure to very fine particles, particularly $PM_{2.5}$. IARC recently classified particulate matter as carcinogenic to humans (2013). Health Canada suggests that when assessing the potential health effects of PM, there is acknowledgement that there is no threshold below which there is no adverse health effect.

Various sources can help identify COPCs that may be emitted from development projects. These sources include the following: EIS reports, risk assessments, air modelling studies or monitoring data for other similar projects; Environment and Climate Change Canada's National Pollutant Release Inventory; the US EPA; and the Agency for Toxic Substances and Disease Registry.

6.5. ASSESSMENT SCENARIOS AND OTHER CONSIDERATIONS

As good practice, an air quality assessment includes information on baseline conditions and predicted increases in airborne concentrations of COPCs associated with the project, along with appropriate comparisons to applicable standards and guidelines, and discussions of potential impacts and risk to human health due to the predicted changes in air quality.

6.5.1 Assessment Scenarios

Health Canada encourages the inclusion of four assessment scenarios in the air quality assessment, namely: *i) baseline; ii) project alone; iii) baseline plus project; and iv) cumulative or future development,* as appropriate. These scenarios are described below. Additional "development or application" cases or scenarios may be assessed for comparative purposes. Assessment scenarios for v) *decommissioning or abandonment* phases may also be relevant.

i) Baseline Conditions (Pre-project or Base Case Scenario)

The existing baseline levels of air pollutants must be adequately described in order to establish the extent of possible air quality changes related to future project activities (and thus, the subsequent potential impacts on human health). Baseline conditions are the current levels of air pollutants in the RSA, including existing sources, and are usually reported in concentrations, with units of micrograms per cubic metre ($\mu g/m^3$). Comparing predicted COPC concentrations for the project activities to this type of baseline provides information on the sole impact of the project, and the project contributions to the airshed;[1] it does not, however, consider the predicted contributions of already-approved developments in the area.

In some EAs, baseline conditions are reported as concentrations of air pollutants from baseline plus approved but not-yet-built developments. These baseline conditions have higher COPC concentrations than a baseline that excludes approved developments. Comparing predicted COPC concentrations for the project activities to this type of baseline does not present as clear a picture of the contributions of the proposed project alone; it may also contain additional uncertainties associated with the predicted emissions of the approved developments. However, the use of this baseline in the application/development scenario will yield predictions that are higher than the contributions of the project alone, and this may result in additional mitigation measures or more intensively applied mitigation measures to reduce the impacts of the project. It is a good practice to clearly describe if the baseline conditions include—or exclude—approved but not-yet-built facilities or developments.

1 "An airshed is generally described as an area where the movement of air (and, therefore, air pollutants) can be hindered by local geographical features such as mountains, and by weather conditions." Source: B.C. Air Quality (main page) **www.bcairquality.ca/airsheds/bc-airsheds.html**

In areas where industrial activity is prevalent, the baseline concentrations of contaminants may be elevated compared to surrounding undisturbed or less-developed areas. In these cases, discuss the effect of these higher baseline concentrations of contaminants in the context of project activities during the construction, operation or decommissioning phases.

When describing the existing environment, it may be useful to use actual data available from air quality monitoring networks or stations, including regional or air zone air quality monitoring programs, and monitoring initiated by the proponent or other companies in the project area. Note that Environment and Climate Change Canada collects air quality measurements across Canada through monitoring networks and emissions reporting, although there may be limitations to the applicability of the data (e.g. the distance from the project site to monitors may be substantial). Ambient air quality data for specific monitoring stations can be requested from Environment and Climate Change Canada (see Table B1 in Appendix B) and may also be available from provincial authorities.

For particulate matter ($PM_{2.5}$), Health Canada considers 1.8 µg/m^3 to be the average background (or baseline) level of $PM_{2.5}$ in Canada (Judek *et al*, 2004). When there are no site-specific values or measurements, it may be appropriate for the air quality assessment to apply this value as the average background level of $PM_{2.5}$. As previously discussed in Section 5.2, there is no recognized threshold for the health effects of $PM_{2.5}$.

ii) Project Alone Scenario

Even if the predicted effects of a proposed project may be low, there will be some impacts. Therefore, it is a good practice to report the anticipated project emissions in a "project alone" scenario (i.e. not added to the baseline concentrations). The project-alone scenario provides a clear description of the project's contribution to regional air quality. These data may be predicted using air quality and atmospheric dispersion modelling software—or estimated using measurements obtained from other project operations of a similar type and scale.

It is important to report the emissions from the project alone, as in the following situations:

- in urban or near-urban areas;
- in those regions subject to continuing development; and
- when the assessment includes application scenarios that comprise existing and future facilities.

When discussing predicted concentrations for this scenario, also consider the importance of the values for each project phase, e.g. what percentage of the project is construction versus operation? For example, a construction phase may last 1–2 years, producing types of emissions that would not be released during the project's operation phase.

iii) Baseline + Project Scenario (Application or Development Case)

It is a good practice to report the development case as the combination of the baseline conditions and the predicted concentrations of COPCs associated with the project (i.e. the project alone scenario). This scenario is key to the determination of air quality impacts of a project, as it estimates the potential future air quality conditions that would exist if the project is approved and proceeds.

iv) Cumulative or Future Development Scenario(s) (Baseline + Project + Future Projects)

Cumulative effects are the environmental effects of the proposed project in combination with effects from existing and reasonably foreseeable future projects within the same area of influence. An assessment of cumulative effects is required under CEAA 2012 (refer to Section 7 of this document).

Cumulative effects for air quality may be assessed as one scenario, often called the cumulative or future development scenario. Typically, this scenario includes the baseline conditions and predicted changes in COPCs from the project—plus the predicted contributions of COPCs from facilities that are approved but not yet operating, and/or other proposed or likely developments within the study area. The EA may also assess additional future development or application case scenarios for comparative purposes, and to provide additional information on potential future ambient air quality. To model predicted changes in air quality, emissions data from existing projects can be combined with predicted emissions from reasonably foreseeable future projects (estimated from industry averages).

When considering a cumulative effects assessment (CEA) for air quality, note that the evaluation of multiple sources of a COPC from the project (for example, diesel PM from generators and truck-traffic emissions) is considered to be the project-specific scenario and does not constitute a CEA.

v) Project Decommissioning or Abandonment Scenario

If applicable to the project, consider and discuss anticipated changes in air quality due to decommissioning or abandonment of the project facilities in the air quality assessment. The COPCs to consider will depend on the specific post-project activities undertaken—but are likely to resemble those generated in the construction phase. Identify the duration of decommissioning activities, and the measures that may be incorporated to monitor and control PM and other emissions generated from heavy machinery during demolition. Special consideration is advised when decommissioning or abandonment activities of contaminated soils introduce additional COPCs to ambient air. If applicable, it is good practice to provide information related to monitoring and mitigation measures during the decommissioning phase to ensure acceptable air quality is maintained.

6.5.2 Considerations

It is good practice for the air quality assessment to consider the following points for all scenarios:

- Include a map clearly showing the study area(s) and receptor locations. For COPCs with concentrations predicted to approach or exceed guidelines and/or standards, include maps illustrating the predicted concentrations and the location of the human receptors.
- Provide an evidence-based rationale for the omission of any COPCs from the assessment. (Note that the absence of an applicable screening guideline is not a sound rationale for excluding a COPC from further assessment.)
- Provide the predicted or estimated COPC concentrations for the maximally exposed population, for the most sensitive receptors and at the point of maximum impingement.[2]

2 A point of impingement is a technical term used in dispersion modelling of air pollutants - it is the pollutant concentration measured when the plume from a source reaches the ground or a building. Maximum point of impingement concentrations are the maximum level projected by the air quality model. Point of impingement concentrations are used in provincial regulations of industrial sources (rather than top-of-stack levels).

- Report data in concentrations (µg/m^3) (see equations for converting units at the end of Appendix C) that are determined or predicted for time periods corresponding to the applicable health-based standards, guidelines or objectives (e.g. 30- minute, 8-hour, 24- hour and annual intervals). Health-based reference concentrations[3] (RfCs) for COPCs will provide guidance on the appropriate averaging times for COPC concentrations (e.g. if there is a 1-hour RfC, then 1-hour averaging of concentrations should be reported and compared).

- It is necessary to consider both **acute (short-term) exposures and chronic (annual/long-term) exposures** for some COPCs. Annual average concentrations for COPCs with chronic health effects should be provided. For COPCs capable of causing toxic effects following short-term exposures (i.e. chemicals to which short-term exposure may result in human health effects), average daily maximum values may not provide adequate information to address potential health risks. Consider SO_2, where short-term exposures such as 1-hour or in some cases 8-hours, are more important than long-term exposures in terms of toxicity and health effects.

- To enable a comparison of predicted data to health-based standards and guidelines, report contaminant concentrations in µg/m^3, rather than reporting only the emission rates, such as tonnes/year.

- Include predictions of particulate matter in the assessment, including $PM_{2.5}$. When benchmarking predicted air quality levels against the CAAQS or other standards, it is important to consider not just the numerical target of the standard—but also the averaging time period and the statistical form (for the CAAQS, see Table C1 in Appendix C). For $PM_{2.5}$, there are two CAAQS aimed at reducing the health effects of short-term and long-term exposure. The CAAQS are not a "pollute-up-to" level and population health effects occur at levels below the CAAQS. Jurisdictions are urged to take remedial and preventive actions to reduce anthropogenic emissions to the extent practicable to protect against significant air quality deterioration—as there are no recognized thresholds for the health effects of $PM_{2.5}$ and ozone.

- Ozone itself is rarely emitted from project activities, although its precursors often are. The effect of a proposed project on ground-level ozone levels should not be dismissed because the predicted change will be "very small." Ideally, the project's contribution to regional formation of ground-level of ozone will be modelled and included in assessments. If not, provide a discussion of the regional environment, for example, a description of ozone formation, and the regional emissions and conditions that influence its formation. Compare the predicted ozone levels against the CAAQS. As with $PM_{2.5}$, health effects of ozone exposure occur at all levels.

- Discuss the emission of precursors to urban smog and ground-level ozone (NO_2, SO_2, VOCs, etc.). If secondary pollutants (e.g. ground-level ozone and secondarily-formed PM) are not being considered in an air quality assessment, include a thorough, evidence-based rationale for their exclusion. If a quantitative assessment is not possible, it is useful to include a qualitative assessment that analyzes the likely directional impact—based on precursor emissions and the local air quality regime.

3 **Reference Concentration:** An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non-cancer health effects during a lifetime (US EPA).

6.6. DETERMINE IMPACTS OF CHANGES TO AIR QUALITY

Compare predicted concentrations for each assessment scenario to appropriate and relevant human health-based air quality guidelines and standards. If predicted concentrations or levels of COPCs and particulate matter remain well below the CAAQS or applicable criteria or guidelines, then generally no further assessment is necessary. However, it is important to identify and comment on the project's overall contribution of pollutants to the local airshed, regardless of whether the predicted values are well below the standards or criteria. Keep in mind that CAAQS for $PM_{2.5}$ and ozone are not to be considered as thresholds or limits of pollution.

Where the predicted COPC concentrations approach or exceed air quality guidelines and standards, the environmental assessment should include a discussion of the potential impacts of these exceedances on human health. In some cases, it may be prudent to proceed to a further level of assessment—using a detailed quantitative human health risk assessment (HHRA).

It is a good practice to conduct a quantitative HHRA in the following situations:

- The assessment predicts that COPC values exceed applicable guideline or standards.
- The project contributes to local air pollutant levels (e.g. the project is the dominant source of pollutant "X" in the area).
- The project contribution leads to a significant deterioration in air quality compared to current levels.
- The project is proposed for a region that is already experiencing environmental pressures from other development projects.

Note that in some cases, contaminants bound to PM may pose unacceptable risk to human health at low levels of PM concentrations—making further assessment necessary to determine if an unacceptable risk may occur.

A detailed quantitative HHRA generally yields more refined conclusions of risk, especially for complex projects with various activities. An HHRA considers the hazards and risks of multiple COPCs, toxicities and exposure pathways, including country foods. In keeping with the precautionary principle, a quantitative HHRA should assess COPCs that are known or suspected carcinogens as carcinogens (i.e. where there may be limited information on carcinogenicity in humans, but strong evidence based on animal studies). IARC provides information and classification on the carcinogenic risks of various substances.

6.7. MITIGATION

Mitigation aims to eliminate, reduce or control adverse environmental effects related to a project. Health Canada prefers that all projects attempt to minimize air emissions to the greatest extent possible, regardless of any upper limits referenced in the applicable criteria, guidelines or standards.

Health Canada views mitigation of negative impacts to air quality as important, especially in the following situations:

- The project contribution leads to a significant deterioration in air quality over existing levels.
- Exceedances or near-exceedances of air quality objectives and guidelines are anticipated.
- The project "load" or contribution to the local airshed is a large proportion of the criteria or guideline value.
- The project is proposed for a region that is already experiencing environmental pressures from other development projects.
- Potential human health impacts are predicted.

Health Canada encourages the use of all available mitigation measures that are technically and economically feasible to limit negative impacts to air quality. The best management activities outlined in *Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities* (Cheminfo, 2005) can be implemented to mitigate air quality effects during the site preparation and construction phase.

Health Canada prefers that mitigation measures also be used in instances when project-related human health impacts are considered minor (in keeping with the CAAQS principles of KCAC and CI). If a low-cost mitigation measure exists and its ability to reduce harmful air emissions is well established, Health Canada encourages the implementation of the measure. It is good practice to describe in the EA documentation the mitigation measures to be employed to address any exceedances or near-exceedances of guidelines. If possible, include details of modelling studies, monitoring or past experience with a mitigation strategy to outline the anticipated effectiveness of a specific measure. If substantial baseline air quality contamination exists at or near the project site(s), the potential for air quality contamination introduced by project-related activities may necessitate consideration of additional mitigation measures.

An Air Quality Management Plan, often part of an environmental management plan for a project, may form the basis for mitigation measures; ideally, this plan addresses the management of all potentially harmful emissions from project-related activities. Such a plan may be implemented during the various project phases, to ensure that potentially harmful air pollutants and possible adverse human health impacts are minimized. Air quality management plans often include measures to limit the frequency and duration of people's exposure to COPCs, airborne dust and $PM_{2.5}$ during all phases of the project.

Upon request from a responsible authority, review panel or other jurisdiction conducting an EA, Health Canada may review an air quality management plan and provide information or knowledge on the effectiveness of any proposed mitigation measures.

6.8. MONITORING

For some projects, air quality monitoring may be advisable to determine the accuracy of predictions; to help verify whether standards are being met; and to assist with implementing or modifying mitigation measures. The extent of monitoring will depend on the project activities, predicted health effects and predictions of COPCs approaching unacceptable concentrations. Monitoring activities may be part of a follow-up program as defined in CEAA 2012.

Health Canada encourages the monitoring of air contaminants when exceedances or near-exceedances of air quality criteria, standards and/or guidance values are predicted or reported—or if the project is predicted to contribute significantly to the elevation of COPC levels above baseline concentrations. Monitoring is also advisable if there is a high degree of uncertainty regarding the project's effects on air quality.

The following questions may assist in determining if monitoring is appropriate:

- Is there significant public concern about the possibility of changes in air quality?
- Is there uncertainty about one or more predicted emissions/COPCs as a result of project activities (e.g. due to difficult modelling issues)?
- Is there potential for novel contaminants to be released, emitted, mobilized or modified as a result of project activities?
- Are new technologies, substances and/or monitoring techniques being used for project activities?
- Have any exceedances been predicted for COPCs in any of the assessment scenarios?
- Are there especially sensitive receptors nearby (e.g. children or seniors)?

Health Canada may make available information or knowledge regarding monitoring plans upon request by a responsible authority, review panel or other jurisdiction conducting an EA. In regards to monitoring activities, Health Canada prefers that a representative number of samples be collected, during different seasons, at locations where potential receptors may be affected. Upon request, Health Canada may also make available information or knowledge on the siting of monitoring stations for regions with an appreciable human presence (e.g. permanent residences, seasonal or temporary residences).

7 ASSESSMENT OF CUMULATIVE EFFECTS

Under CEAA 2012, subsection 19(1), an environmental assessment must consider “the environmental effects … and any cumulative environmental effects that are likely to result from the … designated project in combination with other physical activities that have been or will be carried out.”

Considerations for a cumulative effects scenario in an air quality assessment are discussed in Section 6.5 of this document. If the cumulative effects assessment identifies changes to ambient air quality that exceed project-only effects, Health Canada encourages that further monitoring and/or mitigation measures be considered.

For guidance on assessing cumulative effects, consult the Canadian Environmental Assessment Agency’s website for up-to-date guidance materials: **www.ceaa.gc.ca**

8 FOLLOW-UP PROGRAMS

Under CEAA 2012, a "follow-up program" means a program for:

a) verifying the accuracy of the environmental assessment of a designated project; and

b) determining the effectiveness of any mitigation measures.

It may be appropriate to consider a follow-up program for air quality if one of the following applies (note: this is not a comprehensive list):

- There is uncertainty about the modelling of contaminant(s) emissions;
- There is uncertainty whether proposed mitigation measures will be effective (e.g. the use of novel technologies or complex systems); or
- The project is located near large population centres, therefore posing a greater potential for exposure and health effects.

For further and up-to-date information on follow-up programs, contact the Canadian Environmental Assessment Agency, Canadian Nuclear Safety Commission, or National Energy Board, as appropriate.

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APPENDIX AI **AIR QUALITY IN EA CHECKLIST**

This checklist can be used to verify that the main components of an air quality assessment have been completed. It is helpful to include this checklist with the EIS or application, to indicate where the components of the air quality assessment are located in the document. This is especially helpful if the components are located in more than one section of the document.

OVERALL		
✓	***Item***	
	1. Background concentrations of air pollutants and predicted values of Contaminants of Potential Concern (COPCs) are presented in concentrations (i.e. reported in µg/m^3), not only as emission rates, to enable comparisons to human health-based guidelines.	
	2. All phases of the project activities are considered in the assessment (construction, operation, etc.).	
	3. Assumptions are clearly stated and justified (modelling of worst-case scenarios, etc.).	
DESCRIPTION OF BOUNDARIES, COPCS, ETC.		
✓	***Item***	***Section in EA***
	4. Spatial and temporal boundaries are clearly reported.	
	5. Potential human receptors, with particular attention to Indigenous peoples, are identified and characterized. Distances from the project site(s) to all potential human receptors within the area affected by the project are delineated (using maps if applicable), and different land uses are identified (residential, recreational, Indigenous, etc.).	
	6. All possible COPC emissions as result of project activities are identified.	
	7. Any COPCs not carried forward to assessment are identified and accompanied by a scientific rationale.	
SCENARIOS FOR THE ASSESSMENT		
✓	***Item***	***Section in EA***
	8. The assessment scenarios are clearly described and assumptions are stated, and include i) baseline, ii) project alone, iii) baseline plus project, iv) cumulative or future development, and v) decommissioning or abandonment.	
	9. Predictions are accompanied by map(s) showing the estimated COPC concentrations and the location of human receptors.	
	10. The assessment discusses the project's contribution to the local airshed and considers the importance of the project phases (e.g. the portion of the project that consists of construction activities).	
	11. The assessment includes a discussion of ground-level ozone levels, and any project emissions that are precursors to formation of ozone and urban smog in the area affected by the project.	
	12. Predicted exceedances of health-based reference concentrations are identified and their significance is discussed.	

MITIGATION MEASURES, MONITORING ACTIVITIES AND FOLLOW-UP PLANS		
✓	***Item***	***Section in EA***
	13. The mitigation measures to be employed are described in sufficient detail, including any criteria for the implementation of mitigation.	
	14. The assessment includes a discussion of how the Canadian Ambient Air Quality Standards (CAAQS) principles of Keeping Clean Areas Clean and Continuous Improvement will be taken into account in designing mitigation measures, monitoring and follow-up activities.	
	15. The details or a description of monitoring activities (i.e. frequency and duration of monitoring activities, COPCs to be monitored) are provided.	
	16. A description of the air quality portion of the follow-up program is provided, if available.	

APPENDIX BI **NATIONAL AND PROVINCIAL AIR QUALITY: ONLINE RESOURCES**

Table B1. Nationally focused ambient air quality resources and information available online (Current as of the publication date of this guidance document)

SOURCE	RESOURCE	URL
Environment and Climate Change Canada	Backgrounder: Clean Air Regulatory Agenda	**www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=295B1964-9737-4F80-B064-B3088D9910BE**
Government of Canada	Health; Environmental Health; Air Quality	**www.healthycanadians.gc.ca/health-sante/environment-environnement/outdoor-air-exterieur/index-eng.php**
Canadian Council of Ministers of the Environment (CCME)	Our Work: Air (Main page)	**www.ccme.ca/ourwork/air.html**
CCME	Air Quality Management System (*includes link to CAAQS levels*)	**www.ccme.ca/ourwork/air.html?category_id=146**
Health Canada	Air Quality (Main page)	**www.healthycanadians.gc.ca/healthy-living-vie-saine/environment-environnement/air/index-eng.php**
Environment and Climate Change Canada	Air Quality (Main page)	**www.ec.gc.ca/air-sc-r**
Environment and Climate Change Canada	Air Quality Science and Research (includes link to *"Access air quality data"*)	**www.ec.gc.ca/air-sc-r**
Environment and Climate Change Canada	Air Quality (Main page)	**www.ec.gc.ca/rs-mn**
Environment and Climate Change Canada	The National Air Pollution Surveillance Network (NAPS)	**www.ec.gc.ca/rnspa-naps**
Environment and Climate Change Canada and Health Canada	Air Quality Health Index	**www.airhealth.ca**
Environment and Climate Change Canada and Health Canada, 2012	Canadian Smog Science Assessment: Highlights and Key Messages.	**www.ec.gc.ca/Publications/default.asp?lang=En&xml=AD024B6B-A18B-408D-ACA2-59B1B4E04863**

Table B2. Select provincial ambient air quality resources, guidelines, objectives and standards available online (Current as of the publication date of this guidance document)

PROVINCE	RESOURCE	DATE	URL
British Columbia	British Columbia Air Quality Objectives and Standards	January 18, 2016	**www.bcairquality.ca/reports/pdfs/aqotable.pdf**
	B.C. Air Quality (main page)		**www.bcairquality.ca/**
Alberta	Alberta Ambient Air Quality Objectives	March 2016	**aep.alberta.ca/air/legislation/ambient-air-quality-objectives/default.aspx**
	Alberta Air (main page)		**esrd.alberta.ca/air/default.aspx**
	Clean Air Strategic Alliance (main page)		**casahome.org**
Saskatchewan	Saskatchewan Ambient Air Quality Standards	1996	**www.environment.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=6b1f40c1-7d4a-499b-a366-e5ffa76324d5**
	Saskatchewan Environment, Programs and Services: Air (main page)		**www.environment.gov.sk.ca/Default.aspx?DN=23774f60-0917-47ed-ba54-3a40d99e23c0**
Manitoba	Objectives and Guidelines for Various Air Pollutants: Ambient Air Quality Criteria	July 2005	**www.gov.mb.ca/conservation/envprograms/airquality/aq-criteria/ambientair_e.html**
	Manitoba Conservation: Air Quality Management (main page)		**www.gov.mb.ca/conservation/envprograms/airquality/index.html**
Ontario	Ontario's Ambient Air Quality Criteria (Sorted by Contaminant Name)	April 2012	**www.airqualityontario.com/downloads/AmbientAirQualityCriteria.pdf**
	Air Quality Ontario (main page)		**www.airqualityontario.com**
Quebec	Les normes et critères québécois de qualité de l'atmosphère (version 4)	2014	**www.mddep.gouv.qc.ca/air/criteres/Normes-criteres-qc-qualite-atmosphere.pdf**
	Normes et critères de qualité de l'atmosphère (main page)		**www.mddep.gouv.qc.ca/air/criteres/index.htm**
New Brunswick	New Brunswick Air Quality Objectives	March 2002	**www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Air-Lair/OrderEstablishingObjectives.pdf**
	New Brunswick Environment—Air Quality (main page)		**www2.gnb.ca/content/gnb/en/departments/elg/environment/content/air_quality.html**

Nova Scotia	Air Quality Regulations	2014	**www.novascotia.ca/just/regulations/regs/envairqt.htm**
	Nova Scotia Environment—Air (main page)		**www.novascotia.ca/nse/air**
Prince Edward Island	Air Quality Regulations	2004	**www.gov.pe.ca/law/regulations/pdf/E&09-02.pdf**
	PEI Environment—Air (main page)		**www.gov.pe.ca/environment/air**
Newfoundland and Labrador	Air Pollution Control Regulations, 2004	2004	**www.assembly.nl.ca/legislation/sr/regulations/rc040039.htm**

APPENDIX CI CANADIAN AMBIENT AIR QUALITY STANDARDS (CAAQS) AND NATIONAL AMBIENT AIR QUALITY OBJECTIVES (NAAQOs)

The values listed in the tables below are valid as of the date of publication of this document. In addition, you will find information and equations for converting units. Check the appropriate source(s) (i.e. CCME, provincial authorities, etc.) for the most up-to-date and current criteria, standards, and/or objectives. Consult the CCME website for the latest updates and information on the implementation of the Air Quality Management System, including the Canadian Ambient Air Quality Standards (CAAQS).

CAAQS for fine particulate matter and ground-level ozone are listed in Table C1. The CAAQS were established under CEPA in 2013 and replace the Canada-wide Standards for $PM_{2.5}$ and ozone (2000). The CAAQS are both more stringent (i.e. lower) and more comprehensive with the addition of a new long-term standard for $PM_{2.5}$.

National Ambient Air Quality Objectives (NAAQOs) are listed in Table C2. However, these NAAQOs are in the process of being reviewed and updated. CAAQS are currently under development for nitrogen dioxide and sulphur dioxide, with the intent to replace the existing NAAQOs for these pollutants.

Table C1. CAAQS for $PM_{2.5}$ and ozone (CCME, 2012)

POLLUTANT	AVERAGING TIME	STANDARDS (numerical values)		METRIC
		2015	2020	
$PM_{2.5}$	24-hour (calendar day)	28 μg/m^3	27 μg/m^3	The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations
$PM_{2.5}$	annual (calendar year)	10.0 μg/m^3	8.8 μg/m^3	The 3-year average of the annual average concentrations.
Ozone	8-hour	63 ppb	62 ppb	The 3-year average of the annual 4th-highest daily maximum 8-hour average concentrations.

Table C2. National Ambient Air Quality Objectives for Canada (NAAQOs)
(Canada Gazette Part I, August 12, 1989)

POLLUTANT	YEAR	AVERAGING TIME	MAXIMUM DESIRABLE LEVEL	MAXIMUM ACCEPTABLE LEVEL	MAXIMUM TOLERABLE LEVEL
Carbon Monoxide (CO)	1996	8 hours	5 ppm	13 ppm	17 ppm
		1 hour	13 ppm	31 ppm	–
Nitrogen Dioxide (NO_2)	1989	Annual	32 ppb	53 ppb	–
		24 hours	–	106 ppb	160 ppb
		1 hour	–	213 ppb	532 ppb
Sulphur Dioxide (SO_2)	1989	Annual	11 ppb	23 ppb	–
		24 hours	57 ppb	115 ppb	306 ppb
		1 hour	172 ppb	334 ppb	–
Total Suspended Particulates (TSP)	1989	Annual	60 μg/m^3	70 μg/m^3	–
		24 hours	–	120 μg/m^3	400 μg/m^3

Definitions and Equations for Converting Units (mg/m^3 to parts per million)

Milligrams per cubic metre (mg/m^3): milligrams of gaseous pollutant per cubic metre of ambient air.

Parts per million (ppm): one part per million (by volume) is equal to a volume of a given gas mixed in a million volumes of air.

Parts per billion (ppb): one part per billion (by volume) is equal to a volume of a given gas mixed in a billion volumes of air.

Convert concentrations in **ppm to mg/m^3** using the following general equation:

$$Y_{mg/m^3} = (X_{ppm})\ (MW)\ /\ 24.45$$

Convert concentrations in **mg/m^3** to ppm using the following general equation:

$$X_{ppm} = (Y_{mg/m^3})\ (24.45)\ /\ (MW)$$

Where:

Y_{mg/m^3} is the concentration of an element or compound expressed in units of mg/m^3

X_{ppm} is the concentration of an element or compound expressed in units of ppm

24.45 is a constant (unitless) representing the volume (litres) of a mole (gram molecular weight) of a gas or vapour when the pressure is at 1 atmosphere and the temperature is 25 °C

MW is the molecular weight of the gaseous pollutant (element or compound) expressed in units of grams/mole. The molecular weight of an element (atomic weight) can be found in the periodic table of elements. The molecular weight of a compound is the sum of the atomic weights of each element comprising the compound.