Approaches and Solutions for Canadian Ambient Air Quality Standards (CAAQS) Achievement in Alberta Project Team

Final Report

Clean Air Strategic Alliance

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About the Clean Air Strategic Alliance

The Clean Air Strategic Alliance (CASA) is a multi-stakeholder partnership composed of representatives selected by industry, government, non-government organizations, and participating First Nations and Métis groups. We provide strategies to assess and improve air quality for Albertans using a collaborative consensus process. Every partner is committed to a comprehensive air quality management system for Alberta..

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Corresponding members diligently stayed abreast of the project. In particular, Gerald Palanca (Alberta Energy Regulator) and Brian Asher (Environment and Climate Change Canada) provided invaluable technical expertise and guidance on the project approach.

The following table lists the members of the team over the span of the project.

Members of the CAAQS Achievement Project Team

Name	Stakeholder Group
Andria Panidisz (Former team member)	Canadian Association of Petroleum Producers
Craig Werner	Alberta Forest Products Association
Crystal Parrell	Alberta Environment and Parks
Darcy Walberg	Canadian Fuels Association
David Spink	Prairie Acid Rain Coalition
Don McCrimmon	Canadian Association of Petroleum Producers
Hamid Namsechi (Former team member)	Alberta Environment and Parks
Julie Carter (Co-chair)	Wood Buffalo Environmental Association
Rhonda Lee Curran (Alternate member)	Alberta Environment and Parks
Rob Bioletti (Former team member)	Alberta Environment and Parks
Sean Mercer	Chemistry Industry Association of Canada/Imperial Oil Limited
Sharon Willianen (Former Co-chair and team member)	Alberta Environment and Parks
Sheila Lucas (Co-chair)	Alberta Environment and Parks
Sunny Cho (Alternate Co-chair)	Alberta Environment and Parks

CASA Project Managers: Alec Carrigy, Anuja Hoddinott, Jacqueline Noga (former), Lauren Hall (former)

Acronyms

AAQOs	Ambient Air Quality Objectives
ADMF	Acid Deposition Management Framework
AEIR	Annual Emissions Inventory Reporting
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
ALSA	*Alberta Land Stewardship Act*
APEI	Air Pollutant Emissions Inventory
AQBAT	Air Quality Benefits Assessment Tool
AQHI	Air Quality Health Index
AQI	Air Quality Index
AQMF	Air Quality Management Framework
AQMS	Air Quality Management System
AZMF	Air Zone Management Framework
BC	British Columbia
BLIERs	Base-Level Industrial Emission Requirements
CAAQS	Canadian Ambient Air Quality Standards
CASA	Clean Air Strategic Alliance
CCME	Canadian Council of Ministers of the Environment
CMAQ	Community Multi-Scale Air Quality Model
COVID-19	Coronavirus Disease caused by the SARS-CoV-2 virus
CWS	Canada-Wide Standards
ECCC	Environment and Climate Change Canada
EE	Exceptional Events
EPEA	*Environmental Protection and Enhancement Act*
GoA	Government of Alberta
LAR	Lower Athabasca Region
LARP	Lower Athabasca Regional Plan
LUF	Land-use Framework
MSAPR	Multi-Sector Air Pollutants Regulations
NGOs	Non-Governmental Organizations
NPRI	National Pollutant Release Inventory
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
O_3	Ozone
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of 2.5 microns or less (fine particulate matter)
SIPs	State Implementation Plans
SO_2	Sulphur dioxide
SSR	South Saskatchewan Region
SSRP	South Saskatchewan Regional Plan
TF	Transboundary Flows

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Introduction

In 2019, a statement of opportunity from the Government of Alberta (GoA) was brought to the Clean Air Strategic Alliance (CASA), intended to inform policy options for managing air quality in consideration of anticipated exceedances of NO_2 Canadian Ambient Air Quality Standards (CAAQS) that may occur if no action is taken to reduce NO_x emissions. Further scoping discussions by a working group following the statement of opportunity resulted in a draft project charter for a project team to carry out. At the September 2020 meeting, the CASA Board of Directors approved the project charter and formed a project team. The project team's project charter can be found in Appendix 3.

The CAAQS are a component of the National, and Alberta's, Air Quality Management System (AQMS) used to drive air quality improvement. Further details on the CAAQS are in the background documents (Appendices 4a and 4b).

Through this project, a range of innovative policy options were identified and perspectives from sectors on those options were provided as a starting point for further investigation on how to address the NO_2 CAAQS challenge efficiently, effectively, and equitably in Alberta.

Project Goal and Objectives

As outlined in the CAAQS Achievement Project Team Project Charter (Appendix 3), the project had the following goal:

"[...] [T]o promote stakeholder awareness of, and gather cross-sector perspectives on, NO_2 CAAQS air quality issues and to identify and collaboratively develop potential approaches and solutions that have the support of implementers to manage NO_x emissions to prevent CAAQS exceedances."

The project objectives were as follows:

- Prepare a written background document providing an overview of NO_2 CAAQS, as well as O_3 and $PM_{2.5}$ CAAQS implementation in Alberta.
- Create a base of informed stakeholders who can contribute meaningful solutions to CAAQS implementation in Alberta.
- A list of collaborative approaches and solutions for NO_x CAAQS achievement in Alberta.
- Write final report and recommendations.
- Execute effective communication of the project work and deliverables.

Departures from the Project Charter

Following many discussions, the team realized it would not be able to provide specific NO_x policy recommendations that would have consensus due to the project's timelines, budget, lack of certain information and data, and virtual meeting challenges imposed by COVID-19 (objective 3). Rather, the team landed on providing their sectors' perspectives on some options that were identified by completing project objectives 1 and 2 (background documents and webinars).

The team intended to identify options that all sectors supported and could be identified as priorities for further analysis. It was recognized that this was not the outcome envisioned in the approved project charter with respect to the third objective (no workshops to develop and no way to test proposed options or solutions with a broad suite of stakeholders), and that there would be no, or at best very high-level and limited, specific policy recommendations in the final report. Extending the project timelines to undertake such discussions was not supported by all team members.

Following the revised approach as outlined above, the team prepared a list of options that have the potential to reduce NO_x emissions in the province, based on the background document, webinar content, webinar survey responses, and input from sectors on the team.

Perspectives from the sectors that participated on the project team have been gathered in place of specific policy recommendations, and modelling has been suggested as a valuable next step for AEP to consider external to this project.

Outcomes

The project team completed its four objectives, with some departures from the original intent, as noted in the previous section. The key documents prepared by the project team are the background documents, webinar proceedings and survey responses, and a table of potential options identified from the background document, webinar presentations, and webinar surveys. Some team member sectors also prepared documents with perspectives on the potential options and next steps in achieving the NO_2 CAAQS.

The team also developed a plan to guide communications upon completion of the work (Appendix 6).

Background Documents

Two background documents were completed which provide context for the NO_2 CAAQS air quality issue in Alberta: a full and a summarized version (Appendices 4a and 4b, respectively). Both documents outline Alberta's current policies, management frameworks, and requirements used to manage air emissions. As well, each summarizes Alberta's NO_x emission sources from three emission inventories and various research studies.

The full version is intended to inform future stakeholder discussions on potential options to reduce ambient NO_2 concentrations. The summarized version was condensed and organized to facilitate communicating the NO_2 CAAQS air quality issue to webinar speakers and participants.

The target audience for the full version is technical experts, while the target audience for the summarized version is both technical experts and those who are generally interested in air quality management but are less familiar with the NO_2 CAAQS issue.

To match the different purposes and audiences for the two versions, there are differences in structure and organization. The approach for the full version was to provide detailed explanations on each of the topics within the document so that it could be used in a workshop or similar setting without needing to access or refer to other materials. Also, some technical content intended for detailed discussion is only found in the full version. For example, a key section not included in the summarized version is a list of current regulatory and non-regulatory mechanisms for managing air emissions (Appendix B of the full version).

The approach for the summarized version was to provide references instead of detailed explanations, where appropriate (e.g., an overview of particulate matter and ozone management plans). In addition to briefer content, the summarized version is organized and written in a more narrative fashion to facilitate understanding for those less familiar with the NO_2 CAAQS issue.

Webinar Series

To further inform stakeholders on potential future approaches and options for reducing NO_x, CASA hosted a webinar series that expanded on information that was not covered in the background document. There were eight information sessions featuring 34 speakers who presented on a range of topics related to the NO_2 CAAQS issue from September to December 2021.

Speakers were from a range of sectors including the GoA, the Alberta Energy Regulator, federal government, academics with expertise on a range of topics, a presenter speaking to the experiences of minority groups (e.g., Black, Indigenous), and various industry and Non-Governmental Organizations (NGOs) sectors. The speakers were located across Canada (Alberta, British Columbia, Ontario), the USA (California, Texas, US EPA representatives), and Europe (Sweden and Britain).

Approximately 200 people in total attended the sessions, many of whom attended more than one. Many who could not attend live sessions watched recordings on their own time. Webinar attendees covered a broad range of stakeholders, including industry, government, NGOs, consultants, and others.

The webinar proceedings are in Appendix 5a. Recordings of the webinars are available upon request to CASA, except for the industry panel (webinar 6) which did not record successfully.

In addition to the webinars, the project team developed an electronic survey to gather initial thoughts from stakeholders on approaches and solutions to the CAAQS issue. A summary of the survey responses is in Appendix 5b.

Potential Options to Reduce NO_x Emissions

The project team compiled a list of over 130 options from the webinars, surveys, background documents and project team members' input. The list was consolidated to 53 options. From this shorter list, the project team members intended to provide a "project team" perspective on which options they felt had the potential to reduce NO_x emissions in the province. Due to time constraints, limited information and data, and other factors, the project team instead decided to provide sector perspectives on the list of options and collectively suggest that modelling would be a valuable next step. While not all 53 options can be modelled, a subset could be selected for empirical assessment. Modelling was mentioned in webinar 1 and covered in detail in webinars 3 and 5 (see webinar proceedings in Appendix 5a), and the learnings from these webinars informed proposed next steps.

Potential options to reduce NO_x emissions are in Appendix 1.

Next Steps

Emission Quantification and Modelling

The project team agreed that an important next step would be for Alberta to prepare for and conduct modelling that would help inform effective and practical approaches to reducing emissions to help achieve NO_2 CAAQS.

In preparation for modelling, several emission quantification tasks would ideally be completed beforehand, including:

- Develop an Emission Inventory: Filling gaps to improve current emission inventories; up-to-date and accurate emission inventories provide a solid foundation for photochemical modelling of ambient air quality conditions.
- Current Policy and Regulatory Context: Quantify changes to emissions anticipated in the short- to medium-term, with a focus on those that will have NO_x emission implications.
- Examine Technology Improvements and Changes: Identifying all technological changes that are anticipated to impact emissions in the short- to medium-term, and quantifying changes to emissions with a focus on those that will have NO_x emission implications.
- Assess Economic and Population Trends: Assessing any short- to medium-term changes in point or non-point source air emissions anticipated in response to economic or demographic trends, with a focus on those that will have NO_x emission implications.

Since the GoA was identified as the appropriate lead to conduct the modelling, the GoA would also lead the emission quantification tasks and scope the work for modelling various air emission reduction and control strategies.

Although the GoA will be leading modelling work it does not preclude industry, NGOs, municipalities, or other bodies from conducting modelling work to assess how they could reduce emissions.

In requesting these next steps for the GoA, the project team understands that preparing for and conducting modelling takes time to complete and interim actions might be required to support management of known sources.

The project team advised that the GoA include in its modelling work a process for stakeholder input on the identification of opportunities to reduce emissions.

Sector Perspectives on Options and Next Steps

Some project team sectors developed perspectives on the options and next steps for the CAAQS achievement initiative. While there were different perspectives on management priorities and actions that should be taken to reduce NO_x emissions, there were some sources and actions that all sectors who submitted perspectives felt should be considered by the GoA, which are listed below. It should be noted that these common themes represent the views of those who submitted perspectives and do not reflect a consensus view held by all members of the project team.

The common themes were:

- Undertake a comprehensive photochemical modelling exercise including all existing and forecasted point and non-point emission sources in Alberta.
- Some aspects of what the modelling should include, such as:
    - Categorize NO_x emission sources to allow for source type and/or sector type "back-out or reduced emission" runs.
    - Include different NO_x emission timeline scenarios and be linked to, and evaluated against, current ambient CAAQS related NO_2 levels to assess where and which emission scenario reductions result in the greatest decreases in ambient NO_2 levels relative to the CAAQS achievement goal.
    - Include a health impact assessment using an Air Quality Benefits Assessment Tool (AQBAT)-type model.
    - Consider and incorporate all planned federal and provincial greenhouse gas management measures that have NO_x emission reduction implications.
    - Have the modelling exercise be stakeholder-inclusive to maximize "buy-in" to the results.
- Perspectives noted that elements of this type of suggested modelling were undertaken as part of the Capital Region $PM_{2.5}$ Canada-Wide Standards (CWS) Achievement Project in the 2012–2015 period, and the use of this type of modelling was covered in webinars 1, 3, and 5 of this project.

The sector perspectives documents are found in Appendix 2.

Performance Measures and Indicators

The project team identified one performance indicator which CASA can evaluate following the project completion to gauge success of the project:

> That the Government of Alberta provide an update to the CASA board on the status of the emission quantification and scoping of the modelling work within one year of final report public release.

Process Evaluation and Lessons Learned

The project team discussed the CASA process, project team membership, and the effectiveness of virtual meetings and resources. Successes and challenges are summarized below.

Successes

CASA's multi-stakeholder process allowed team members to gain a common understanding of the NO_2 CAAQS, as well as Alberta's Air Quality Management System (AQMS) and how it links with the national AQMS.

The webinars provided an opportunity to hear from experts from a broader geographic and technical range than was available within the project team, which allowed the team to identify additional options.

Some project team members felt the CASA multi-stakeholder process was a good forum to learn about and discuss perspectives on potential policy options for reducing NO_x emissions. There is value in stakeholder involvement for future regional modelling and engagement efforts to explore options in more detail.

Challenges

The project team faced challenges in several areas, including:

- remote meetings due to the COVID-19 pandemic
- an ambitious project scope
- gaps in stakeholder membership on the project team (i.e., municipalities, academia, transportation industry, and regulators)
- project team member turnover and new members joining midway
- tight project timelines

The COVID-19 pandemic resulted in the team meeting virtually from project start to completion. These meetings were often shorter and did not allow face-to-face interaction which some felt was needed for having fulsome discussion, avoiding circular conversation, and fully exploring options; this emphasizes the value of future CASA project team meetings being held in-person, where possible.

The desired outcome of the original project charter scope was ambitious in asking for a list of options that could be implemented following project completion. While perhaps not fully recognized at the working group stage, it was difficult to fully assess and prioritize NO_x emission management options without the modelling information referred to in the "Next Steps" section of this report. This resulted in a shift in focus and direction and a need to rescope the outcomes, which was difficult and time consuming to undertake midway in the project. Also, following information gathering for the background documents, it became clear that there were some topics that were not relevant and some additions that were required which resulted in additional work for the team.

The project experienced several delays and extended beyond the original deadline of December 2021. Some of the delays were outside of CASA's and the project team's control, such as turnover in CASA staff and team membership, especially for project leads. A lack of familiarity with CASA and its process also resulted in additional discussion within and outside meetings which took away from time spent on project work.

Conclusion

According to current data, all Alberta air zones will approach or exceed the 2020 nitrogen dioxide (NO_2) CAAQS; this requires a management plan. In 2025, NO_2 CAAQS will become more stringent.

The multi-stakeholder CASA process and forum allowed participants to share information related to the NO_2 CAAQS issue. Project team meetings were held exclusively through remote meetings, which had its own set of benefits and challenges.

Despite not being able to fully achieve its original objectives, the project team was able to create a base of informed stakeholders, a list of potential options for reducing NO_x emissions, and gather perspectives from select stakeholders around those potential options and next steps. Collectively, these outcomes should assist the GoA in developing policies, requirements, and actions to help meet the NO_2 CAAQS. One such action is conducting comprehensive scenario modelling to help identify priorities for NO_x emission reductions.

Appendices

Appendix 1:
Potential options to reduce NO_x emissions

The table below is a list of options to reduce emissions of nitrogen oxides (NO_x) in Alberta developed by the project team based on the background documents, webinar presentations, webinar surveys, and project team sector input. The project team consolidated and categorized the options by themes.

Themes	Options
Communications	Increase public awareness via community outreach, developing key messages on changing behaviour around transportation (e.g., driving practices, vehicle purchasing, idling). Also, engage stakeholders to define what is "fair and equitable" and gather perspectives from experts and marginalized groups.
Cooperation	Develop policies, such as emissions trading, to encourage cooperation between sectors, and encourage private enterprise to do business with other enterprises that use low emissions vehicles (e.g., Amazon warehouses).
Data	Enable fair access to air quality data, including a publicly available provincial air emissions inventory, with all Alberta Energy Regulator (AER)-regulated sources accounted for (existing sources and approved applications).
Emission benchmarks/targets	Establish comparable emission targets across industry (all sectors), similar to Ontario's Air Contaminants Benchmarks List that itemizes approximately 5,100 contaminants with corresponding benchmarks (standards, guidelines, or screening levels) used by facilities to assess their contributions of a contaminant to air.
Emissions inventory	Develop an annual provincial air emissions inventory, with all AER regulated sources accounted for (existing sources and approved applications).
	Take into account episodic emission events and log into emissions inventory (flares, upsets, cooling towers, fugitive sources) especially of a new class of volatile organic compounds (reactive hydrocarbon emissions).
	Use an emissions inventory to demonstrate attainment and forecast air quality based on changes in emissions.
Emissions testing	Enact emissions testing requirements for vehicles, and perform on-road emissions testing and check stops for compliance, similar to Ontario's Drive Clean testing of vehicle emissions program, Quebec's Heavy Motor Vehicle Inspection and Maintenance Program (PIEVAL) and California's Heavy-Duty Inspection and Maintenance Program.
Emissions trading	Create a cap-and-trade system for emissions trading, including on imported goods.
Financial incentives	Create incentives and economic drivers for industry to reduce emissions of nitrogen oxides (NO_x) beyond existing regulatory obligations (e.g., emissions trading and credits programs, cap and trade, tax for NO_x on imported goods).
	Set up a government and industry-funded program (similar to GHGs) to fund initiatives to make it affordable for small businesses and individuals to reduce emissions of nitrogen oxides (NO_x) by replacing and buying low/zero emission vehicles (heavy and light duty), and for vehicle maintenance.
General NO_x management approaches	Track the status of Bill C-230 (to develop a National Strategy to Redress Environmental Racism Act) and aim for consistency with the national strategy, if it were enacted.
	Fund an accelerated research program like the Texas Air Quality Studies (TEXAQS) to confirm NO_x/NO_2 sources, pollutant travel in the atmosphere, and the effectiveness of different pollution controls.
	Have different classifications of non-attainment (marginal, moderate, serious, severe, extreme).
	Adopt Ontario's management actions such as the phase-out and banning of coal-fired generating stations.

Themes	Options
General NO_x management approaches	Utilize historical practices for managing CAAQS exceedances in the province (i.e., leverage regional/sub-regional groups to craft dedicated response plans as done for O_3 and $PM_{2.5}$).
	Allow incoming and recently enacted air quality policies to come into full-effect (e.g., Multi-Sector Air Pollutants Regulations (MSAPR)) and assess their effectiveness before enacting any additional policy.
	Alberta Environment and Parks (AEP) requesting an update to or revising Base Level Industrial Emission Requirements (BLIERs).
	Adopt Quebec's management actions such as developing Clean Air Regulations.
Industrial emission limits	Enhance pollution control regulation from point sources, starting with older compressor stations, as well as increasing emissions limits for facilities and their industrial operations, to encourage new technology adoption.
Industrial equipment upgrades	Develop incentive programs for technology or equipment upgrades, such as implementing higher fees for industrial facilities and older non-road diesel engines, and disallowing poor performers to continue using outdated air pollution control technology.
	Require all existing facilities in Alberta to replace or phase-out outdated NO_x control technologies, and mandate Best Available Technology Economically Achievable (BATEA) emission controls for new facilities.
Jurisdictional authority	AEP to direct AER on how to enhance AER regulatory controls and to develop new regulatory instruments to focus on NO_x (current instruments only focus on SO_2 from flares and incinerators).
	Establish a working relationship between the AER and ECCC to enforce MSAPR in Alberta using an Administrative Agreement between GoA and Environment and Climate Change Canada (ECCC).
	Alberta obtains jurisdiction to manage NO_x emissions from sources currently regulated by the federal government by creating a made-in-Alberta solution, to stand down MSAPR, and establish an Equivalency Agreement between the Government of Alberta (GoA) and ECCC.
	Develop a unique authority entity (local air district/air zone) delineated by meteorological air basins, which the province delegates authority to regulate stationary local air emissions sources. Mobile emission sources could remain regulated at the provincial level with a board (including air zones and local governments).
	Develop a framework/strategy for managing sources not regulated by GoA. This can include exploring whether NO_x emission sources not subject to provincial requirements could be regulated through municipal bylaws.
Local initiatives	Advocate for municipalities to enact anti-idling by-laws, and support local initiatives, including rural/urban incentives and policy for local areas that have CAAQS NO_2 exceedances.
Modelling	Develop a standardized air quality modelling tool for external industry stakeholders.
	Undertake an open and transparent Integrated Assessment Modelling exercise for specific options to garner air policy insights on cost-benefits, not estimates.
	Models should be used to evaluate policy performance and quantify uncertainty.
	Ensure air quality photochemical modelling has input from stakeholders on how to model and how modelling outputs should be used.

Themes	Options
Monitoring	Establish/increase monitoring in urban areas and large agricultural operations areas to localize high emission sources and determine where emissions are prevalent.
	Existing NO_2 monitoring instrumentation has a known positive bias; GoA should perform side-by-side studies with new “true NO_2” instrumentation in all areas with CAAQS NO_2 exceedances.
Planning	Coordinate planning for Criteria Air Contaminants, air toxics, and greenhouse gases, using State Implementation Plans (SIPs) like those in the US which are enforceable by federal law once approved by the US Environmental Protection Agency (EPA).
Policy assessments	Conduct a variety of policy assessments that evaluate intervention impacts: post-hoc policy evaluation, prospective policy impact analysis to inform policy design (including environmental justice measures), and use various indicators and cumulative hazard indicators to identify intersectionality.
	Adopt a decision-making tool to assess options and their holistic impacts such as: how impacts differ geographically, net emission impacts from a source(s), and identify system dynamics and potential trade offs.
Policy design approach	Take a systems approach to policy design and selecting the appropriate tool by considering the following aspects: economic and technological feasibility, enforceability, equity, climate co-benefits, public health implications, clarity, achieving outcomes, and build on existing regulatory systems.
	Government policy should be outcomes-based and provide obligated parties flexibility to meet compliance. (e.g., a bubble approach compared to equipment-specific requirements)
	Use a collaborative multi-stakeholder process in high pollution areas to develop emission reduction and monitoring plans for the area as a possible approach to develop plans that have a high degree of stakeholder buy-in.
	Full sector approach, including province-wide technical standards, based on good science, to ensure same level of management consistency.
	Targeted approach directed at specific facilities contributing to CAAQS exceedances, regulating industrial emissions through the site-specific standard, or source specific regulations.
	Develop a geographic (Airshed-wide) regulatory approach to ensure regional consistency in emission/technology requirements, such as complete Regional Plans for the remaining four Land Use regions in the province.
Priority setting	Properly identify NO_x contributing sources in regions that are contributing the most to ambient NO_2 levels, which sets priorities for management, by using environmental justice screening tools to identify priority areas for resource allocation.
Residential actions	Reduce emissions from residential sources, by using emission limits on appliances, including residential home heating.
Tax	Use tax incentives, such as for low NO_x transportation, or establish a NO_x tax on imported goods, while limiting impact on taxpayers.
Time-related policies	Set limits on the time that existing approved NO_x emission sources can operate before they are required to meet the NO_x emission limits applicable to that source at that time.
	Set reasonable timelines and manage expectations of stakeholders in terms of how quickly NO_2 CAAQS achievement should be realized, and when NO_x emissions from each individual priority source will need to be reduced, based on an appropriate level and pace for implementing more stringent NO_x emission requirements.

Themes	Options
Traffic/urban planning	Redesign traffic patterns in urban centres by increasing public transportation options, having fewer stop lights and more traffic circles, implementing road/congestion pricing, creating a means to move heavy-duty vehicles out of urban centres, and developing voluntary programs that encourage and facilitate reductions in vehicle use (e.g., the Calgary Region Airshed Zone's Commuter Connect Program).
Transition from combustion to electrification	Develop incentive programs to reduce combustion and move towards electrification (using alternative energy sources for electrification), including advocating for the federal government to have rail transition to zero-emissions/electric locomotives, and encouraging industrial fleet transition to electric or hybrid vehicles.
Transportation emission limits	Reduce NO_x from transportation, by adopting emission requirements for on-road vehicles and heavy-duty vehicles, beginning with diesel trucks.
Transportation regulations	Develop transportation regulations to reduction emissions from mobile sources such as anti-tampering regulations, and adopting California's Advanced Clean Trucks regulation, Clean Miles Standard, Diesel Reduction Plan, and mandating diesel exhaust emission retrofits.
Transportation upgrades	Implement public incentives to replace older vehicles with more fuel-efficient vehicles such as implementing vehicle scrappage/buy-back programs, requiring that certain vehicles use newer model year engines, requiring diesel exhaust emission retrofits, and assessing higher registration/renewal fees for older vehicles and equipment.
Update regulations	Update facility authorizations process to address NO_x emissions based on regional impact and source standards, and avoid relying on individual EPEA industrial approvals/ facility authorizations.
	Update Alberta's NO_x source emission standards and NO_x control requirements.

Appendix 2:
Sector Perspectives on Potential Options and Next Steps

NGO Sector Comments on the NO_x Emission Management Options Identified in CASA Canadian Ambient Air Quality Standards (CAAQS) Achievement Project Team's Final Report

Context

NO_2 is an important air quality parameter and achieving the CAAQS NO_2 levels in Alberta needs to be a high priority. NO_2 is an air pollutant that has both health and environmental impacts and contributes to $PM_{2.5}$ and O_3 formation, both of which have significant health and environmental impacts. Since all three of these air contaminants are non-threshold pollutants, all reasonable efforts need to be made to reduce their concentrations in ambient air in Alberta.

Many of the NO_x emission options identified by the Clean Air Strategic Alliance (CASA) CAAQS Achievement Project Team have the potential to significantly improve the air quality in Alberta, and these are the NO_x management options that need to be the focus of Government efforts. The Non-Governmental Organizations (NGO) Sector strongly supports the effort to try and get some prioritization of the actions. Many of the options identified will have no to limited impact on ambient NO_2 levels (e.g., increase public awareness, coordinating planning for Criteria Air Contaminants, tracking the status of Bill C-130, develop different classifications for non-attainment areas, adopting a new decision-making tool). The NGO position is that highest priority needs to be given to options that will reduce NO_x emissions in a substantial way and result in reduced ambient air quality levels of NO_2.

The NGO Sector recognizes that, while identifying the highest priority options that should be pursued should be relatively straightforward, i.e., the major NO_x emission sources in the province are known as the areas with high ambient NO_2 levels, ranking these highest priorities and developing the actions and programs under each of these actions will require additional assessment.

NGO Priorities

The following Tables outline four priority NO_x emission management categories that NGOs would like to see be the Government of Alberta's (GoA) focus in terms of reducing NO_x emissions and meeting the CAAQS ambient air quality NO_2 limits. The NGO Sector believes that these four categories are obvious priorities for advancing NO_x management in the province and that work can, and should, start immediately on evaluating and implementing some of the identified actions within each category. The NGO Sector suggests that the GoA consider how CASA could assist in identifying and developing specific program elements associated with each of these actions.

NGO Priority	Explanation and Specific Suggestions
Modelling	For NO_x emission reduction priority setting and the development of associated NO_x emission reduction plans and strategies, and to maximize the population health and multi-pollutant reduction benefits associated with NO_x emission reduction measures, there is a need to conduct comprehensive photochemical air dispersion modelling. This modelling should include all existing and forecasted point and non-point emission sources in Alberta with a focus on NO_x emission sources. NO_x emission sources need to be categorized into groupings that allow for source type and/or sector type NO_x emission "back-out or reduced emission" modelling runs. The scenario modelling would include different NO_x emission timeline scenarios and be linked to, and evaluated against, current ambient CAAQS related NO_2 levels to assess where and which emission scenario reductions result in the greatest decreases in ambient NO_2 levels relative to the CAAQS achievement goal. The modelling should also include a health impact assessment using an Environment and Climate Change Canada Air Quality Benefits Assessment Tool (AQBAT) type model to relate NO_2 reduction scenarios to not only reduced ambient NO_2 levels and CAAQS achievement but also to health impact benefits. The modelling should also consider and, as appropriate, incorporate all planned federal and provincially greenhouse gas management measures that will have NO_x emission reduction implications. All stakeholders need to be part of the planning for, and implementation of this type of modelling, in order to maximize "buy-in" to the results since the modelling will be used to set NO_x emission reduction priorities and timelines for existing sources (e.g., new NO_x emission reduction requirements in *Environmental Protection and Enhancement Act* [EPEA] approval renewals). The modelling would also help identify source types for which changes in current NO_x emission requirements need to be made to minimize the impact of new NO_x emission sources on ambient NO_2 levels. Elements of this type of suggested modelling were undertaken as part of the Capital Region $PM_{2.5}$ Canada-Wide Standards (CWS) Achievement Project in the 2012-2015 period. The use of this type of modelling was mentioned in Webinar 1 and covered in more detail in Webinars 3 and 5. Conducting this modelling should be a priority. It should be started immediately and completed before the 2025 NO_2 CAAQS comes into effect. The modelling results can/will inform the CAAQS Air Zone Management Plans that will be required for NO_2.
Regulatory – NO_x Emission Control Requirements	An immediate priority should be the reviewing and, as necessary, updating of all Alberta's NO_x source emission standards for major NO_x emission sources and/or source types that individually or collectively on a facility, regional and/or provincial basis (e.g., compressor stations, exceed a certain collective NO_x emission rate). Standards should be based on Best Available Technology Economically Achievable (BATEA) controls or "best practice" controls. The NGO Sector would note that the Multi-Sector Air Pollutants Regulations (MSAPR) Base-Level Industrial Emission Requirements (BLIERs) do not represent BATEA as it was a conscious decision under the BLIERs process that BLIERs would not be based on BATEA. An exercise of this nature is being undertaken as part of Industrial Heartland Designated Industrial Zone (DIZ) project. Examples of BLIERs that do not represent BATEA are NO_x limits applying to combined cycle and co-generation gas-fired units and NO_x limits for boilers and heaters. A number of comments identified compressor stations and reciprocating engines as another NO_x source that needed additional and better NO_x controls.

NGO Priority	Explanation and Specific Suggestions
	Design life criteria should be established for the NO_x emission sources/source types referred to above. At the end of this design life NO_x emission limits based on BATEA would be applied with provision for upgrading existing emission controls to a certain percentage of the BATEA limit (e.g., 80%, if this represents a cost-effective NO_x emission reduction strategy). To facilitate the reduction in NO_x emissions associated with BATEA limits, facility/area/regional based NO_x cap and trade systems could be considered, such as exists as a result of the CASA Electricity Framework (EF). The CASA EF incorporates the concepts of BATEA and regular BATEA updates, design life and flexibility with respect to meeting requirements at the end of design life. It also includes provisions for addressing “hotspots”; high CAAQS NO_2 Air Zones could apply relevant “hotspot” actions outlined in the EF.
Regulatory – Diesel (Compression Ignition (CI)) Engines	Pass anti-tampering legislation for, at a minimum, all on and off-road diesel engines. Such legislation could include gasoline engines but the priority and need in the context of NO_x emission reductions are compression ignition engines. Consideration needs to be given to regulatory measures to reduce NO_x emissions from the heavy haulers in the oil sands region as NO_x emissions from this source are a major contributor to the elevated NO_2 levels North of Fort McMurray. The current NO_x limits for combustion ignition Engines >750 hp in size in mobile applications do not even closely reflect BATEA NO_x control capability. (For more details on this issue see the “A Knowledge Synthesis of Non-Point Source Air Emissions and their Potential Contribution to Air Quality in Alberta: Final Technical Report to the Non-point Source Project Team”.) As part of the above initiatives, the province should implement a road-side testing program (analogous to photo radar) using Roadside Optical Vehicle Emissions Reporter (ROVER) like technology and should fine vehicles that exceed their emission limits. A mandatory vehicle inspection program should be implemented for all on-road diesel engines that would include emission testing, and, for certain off-road diesel equipment (e.g. mine fleet heavy haulers), a regular mandatory on-board in-use emission testing requirement should be established to ensure that these units are meeting federal NO_x emission limits. The NGO Sector notes that the above priorities and suggested actions are consistent with the following CASA Non-Point Source Project Team’s transportation related “Recommendations to Reduce Non-Point Source Air Emissions in Alberta”: • Recommendation 3: Anti-Tampering Requirements for Light-Duty and Heavy-Duty Vehicles • Recommendation 4: Inspect Commercial (On-Road Heavy-Duty) Vehicle Emission Controls • Recommendation 8: Conduct an On-Road Emission Testing Study

NGO Priority	Explanation and Specific Suggestions
Incentive Programs to Reduce Vehicle Emissions	Large urban centres in Alberta have elevated ambient NO_2 levels, a significant fraction of which is due to engine exhaust emissions. While the regulatory diesel exhaust control measures referred to above would result in urban centre transportation related NO_x emission reductions, there is also a need to reduce passenger vehicle related NO_x emissions. The federal government's requirement that: "... all new light-duty cars and passenger trucks sales to be zero emitting vehicles (ZEVs) by 2035" and the federal government plan to: "... develop a medium- and heavy-duty vehicle (MHDV) regulation to require that all MHDV sales be ZEVs by 2040 for a subset of vehicle types, based on feasibility" will have a very significant impact on NO_2 levels in large urban centres. When and how quickly these measures result in significantly improved NO_2 levels will depend on the penetration rate of ZEVs into the urban vehicle fleet mix. There are options to enhance the rate of ZEV penetration and the GoA should examine the different options available and their effectiveness and rigorously pursue those options that have been demonstrated to be effective in a context similar to Alberta's. Options that the NGO Sector would request be evaluated include: ● Incentive/rebate programs related to the purchase of passenger/light duty ZEVs like British Columbia and Quebec (note: Webinars 5 and 7 had presentations on how integrated assessment models and cost-benefit models could be used to put a social benefit cost to for each vehicle type that is electrified, and this type of analysis could be used to determine and justify such incentives). ● A municipal grant program that will incent larger municipalities to move to lower emitting public transportation systems such as EV buses, and lower emitting public works fleets such as garbage trucks. ● A vehicle scrappage program focused on certain vehicle types and vehicle ages could be a component of an overall vehicle transition incentive program that in combination with a ZEV incentive would encourage/assist vehicle owners in moving from a heavy polluting vehicle to a low/zero polluting vehicle. ● Have reduced vehicle registration or other provincial vehicle fee reductions for fleets that demonstrate that certain actions/measures are being taken that reduce fleet NO_x emissions. The NGO Sector would note that above suggested options are consistent with the following CASA Non-Point Source Project Team's transportation related "Recommendations to Reduce Non-Point Source Air Emissions in Alberta": ● Recommendation 1: Reduce Emissions from In-Use On-Road Light-Duty Vehicles ● Recommendation 2: Increase the Percentage of Zero and Lower Emission On-Road Light-Duty Vehicles ● Recommendation 7: Support and Develop Freight Strategies ● Recommendation 9: Energy Efficiency Alberta and the Transportation Sector

Sector perspective – NO_2 Canadian Ambient Air Quality Standards (CAAQS) achievement – Canadian Association of Petroleum Producers/Canadian Fuels Association/Forestry/Chemistry

The Clean Air Strategic Alliance (CASA) project has provided meaningful insight on the vast array of options that government and stakeholders could pursue to improve ambient NO_2 concentrations in Alberta. In alignment with other stakeholders, we the undersigned, are supportive of the provincial government convening interested stakeholders to commence a detailed photochemical modelling exercise to identify which policy options could offer the most efficient, impactful, and cost-effective, means of improving ambient air quality in the province.

We suggest that for NO_x emission reduction priority setting, there is a need to conduct regionally focused comprehensive photochemical modelling of all existing and forecasted point and non-point emission sources in Alberta, with a focus on NO_x emission sources. NO_x emission sources need to be categorized into groupings that allow for source type and/or sector type NO_x emission "back-out or reduced emission" modelling runs. The scenario modelling should include different NO_x emission timeline scenarios and be linked to, and evaluated against, current ambient CAAQS related NO_2 levels, to assess where and which emission scenario emission reductions result in the greatest and most cost-effective decreases in ambient NO_2 levels relative to the CAAQS achievement goal. The modelling should also include a health impact assessment using an Air Quality Benefits Assessment Tool (AQBAT)-type model to relate NO_2 reduction scenarios to not only reduced ambient NO_2 levels and CAAQS achievement but also to health impact benefits. The modelling should also consider, and as appropriate, incorporate, all planned federal and provincial GHG management measures that will have NO_x emission reduction implications.

All stakeholders need to be a part of the planning for, and implementation of, this type of modelling, in order to identify opportunities to reduce emissions and maximize "buy-in" to the results, since the modelling will be used to set NO_x emission reduction priorities and timelines for existing sources (e.g., new NO_x emission reduction requirements in *Environmental Protection and Enhancement Act* [EPEA] approval renewals). The modelling would also help identify source types for which changes in current NO_x emission requirements need to be made to minimize the impact of new NO_x emission sources on ambient NO_2 levels.

Elements of this type of suggested modelling were undertaken as part of the Capital Region $PM_{2.5}$ Canada-Wide Standards (CWS) Achievement Project in the 2012-2015 period. The use of this type of modelling was mentioned in Webinar 1 and covered in more detail in Webinars 3 and 5 (see webinar proceedings in Appendix 5a). Alberta has also collected significant data through the Annual Emissions Inventory Reporting Program which was explicitly intended to support science-based policy, photochemical modelling, and CAAQS achievement.

Given that NO_2 CAAQS challenges are likely nuanced and varied at the regional level, it is critical that modelling of policy outcomes be assessed at a regional resolution, rather than solely at a provincial scale. For example, transportation-focused policy may adequately address urban air quality challenges where in less urbanized areas additional focus on point-source emissions may be more appropriate. In these instances, localized action, rather than provincial action, may more effectively achieve similar outcomes. In instances where policy solutions could benefit adjacent regions, then a province-wide application of policy may be more appropriate. This modelling and policy development approach is in line with the current regional-level strategies to address the existing $PM_{2.5}$ CAAQS challenges.

Concurrent to the work above we suggest that government perform detailed regional analysis to assess the impacts of existing and forthcoming air quality and climate change policies, such as the Multi-Sector Air Pollutant Regulations. We anticipate that meaningful reductions in point source emissions will manifest across the province, and this should be factored into any new policy development.

Finally, where NO_2 CAAQS challenges have been identified we suggest that government and airshed associations expand to side-by-side analyses of NO_2 emissions using existing instrumentation and new "true" NO_2 instrumentation. There is a strong possibility that the existing NO_2 instrument fleet has a varying positive bias so upgrading instrumentation to obtain higher accuracy data will further ensure that any future policy development is right-sized to the address the challenge(s) at hand.

Appendix 3:
Project Charter
(Revised and Approved September 2021)

Approaches and Solutions for CAAQS Achievement in Alberta

Project Charter

Revised and approved by the CASA Board
September 2021

Contents

Introduction

To protect human health and the environment, the Canadian Ministers of the Environment, including the Government of Alberta (GoA), committed to implement an Air Quality Management System (AQMS) in 2012 to manage air emissions across Canada.

Canadian Ambient Air Quality Standards (CAAQS) are the component of the AQMS used to drive air quality improvement. CAAQS were developed through a collaborative process led by the Canadian Council of Ministers of the Environment and currently cover four air quality parameters: sulphur dioxide (SO_2), fine particulate matter ($PM_{2.5}$), and ozone (O_3), and more recently nitrogen dioxide (NO_2). The Standards are reviewed and updated on a 5-year cycle to ensure they align with the latest scientific information.

For each parameter, an air quality standard and three threshold levels are established that results in four colour-coded management levels (green, yellow, orange, and red). Each management level outlines the air management actions that should be taken in air zones falling within that management action level. For air zones falling in the "red" or "orange" management levels, air zone management plans must be developed to improve air quality through active air management. Current forecasts indicate that most Alberta air zones will likely reach the orange CAAQS level for annual NO_2 in 2021,[1] and for this reason, managing this pollutant is of interest for Alberta.

NO_2 is primarily formed through burning of fossil fuels. Conventional oil and gas represents almost half of all NO_2 emissions in Alberta; other major sources include transportation, oil sands, and electric power.[2] It is important to begin addressing the elevated NO_2 levels in Alberta in a timely manner as high concentrations of NO_2 lead to adverse environmental impacts (e.g., smog, acidification, eutrophication and phytotoxicity) and health issues (e.g., respiratory problems).

Background

The GoA, led by Alberta Environment and Parks (AEP) and the Alberta Energy Regulator (AER), have identified an urgent need to create innovative solutions to reduce NO_2 emissions in Alberta. These approaches and/or solutions to NO_2 emissions reductions, would have implications for, and serve the interests of, several organizations and sectors across the province.

In addressing this need, AEP and other GoA Integrated Resource Management System Partners see an opportunity to collaborate within the Clean Air Strategic Alliance (CASA) for information sharing and engagement with stakeholders by organizing and facilitating a project to:

- Bring together a diverse set of stakeholders and share awareness on the urgency to address this issue and the implications of Alberta failing to achieve CAAQS and associated regional Air Quality Management Framework (AQMF) limits,
- Garner diverse perspectives in a transparent setting on solutions for NO_x emissions reductions from a range of regulated and non-regulated NO_x emitting sectors,
- Identify considerations for socioeconomic and environmental concerns, any potential advantages or disadvantages to affected stakeholders, and alignment of provincial initiatives with federal legislation with the intent of reducing NO_x emissions,
- Engage in respectful dialogue with stakeholders to find common ground/interests on taking action to improve Alberta's air quality and meet CAAQS and AQMF limits while considering the economic implications of different possible emission management options, and

1 https://www.casahome.org/attachments/CAAQS%20and%20NO$_2$%202018-08-09.pdf

2 CASA Non-Point Source Project Team Final Report, p. 126, found at: https://drive.google.com/file/d/1M5Aq9AZA_QO$_0$vEVFO$_{44}$sR77vz8mo6EsX/view

- Inform current policies and identify opportunities to improve, or expand, those policies while recognizing and considering the associated administrative and regulatory implications of each policy change option.

Scope

The work of the project team will focus on engaging CASA members to:

- compile and summarize existing knowledge related to CAAQS emissions and exceedances at the orange and red levels,
- fill knowledge gaps around air emissions where CAAQS exceedances are expected,
- share the information gathered and confirm understanding with a broader audience, and
- develop recommendations, approaches, and/or solutions to reduce NO_x emissions and minimize CAAQS exceedances.

Approaches and solutions will be generated and vetted through a three-step process:

1. Develop a background information document on the state of air quality and NO_x emissions in Alberta, the national CAAQS framework, and the NO_2 CAAQS implementation challenge in Alberta,
2. Host webinar(s) based on the background report to share the information with a broader audience and confirm understanding, and
3. Execute one or more workshops with relevant experts to develop appropriate recommendations, potential approaches, and/or solutions to reduce NO_x emissions to achieve CAAQS.

Each step in the process will have a distinct target audience due to differences in the delivery format, content presented, and feedback/input required.

Project Goal

The goal of the project is to promote stakeholder awareness of, and gather cross-sector perspectives on, NO_2 CAAQS air quality issues and to identify and collaboratively develop potential approaches and solutions that have the support of implementers to manage NO_x emissions to prevent CAAQS exceedances.

Project Objectives and Strategies

Below is a list of project objectives, strategies, and potential outcomes/deliverables. The project team members will create and execute more detailed work plans following project kick-off, which will outline how each strategy is to be executed. As they do so, the project deliverables may be revised to what is most appropriate and useful for achieving each objective. As such, the 'Potential Outcomes/Deliverables' under each objective are not meant to be prescriptive or limit the creativity of the project team, rather to provide additional context around the intent of the objectives.

Generally, the objectives are ordered such that the outputs of one objective will be used as inputs to the work on the subsequent objective. For example, the information in the background document produced under Objective 1 will be presented in the Objective 2 webinar(s).

All large meetings (i.e., webinars, workshops) are proposed to be virtual due to current and expected social distancing requirements resulting from the COVID-19 pandemic, and budget limitations. If more than one workshop takes place, sector feedback and input could take place between events. The project team may wish to consider shorter, more frequent virtual meetings to minimize participant fatigue typical of long-duration virtual events.

Objective 1: Prepare a written background document providing an overview of NO_2 CAAQS, as well as O_3 and $PM_{2.5}$ CAAQS implementation in Alberta.

Summarize the Province's experience and approaches related to O_3 and $PM_{2.5}$ CAAQS (and former Canada-Wide Standards (CWS) implementation at the orange and red levels, including possible applicability to the NO_2 CAAQS. This information will be presented in one or more webinars under Objective 2.

Strategies

1.1 Prepare a written background document on the NO_2 CAAQS, as well as O_3 and $PM_{2.5}$ CAAQS/CWS implementation in Alberta. Document drafting will be led by the GoA with project team support and input to ensure stakeholder implementation experience, information needs, and concerns are included. The report is expected to be 20-30 pages in length and may include information on:

- The AQMS and CAAQS, how they are applied in Alberta, and a jurisdictional review of CAAQS exceedances
- O_3 and $PM_{2.5}$ management plans, including who was involved, how they were developed, the elements of the plan, and implementation
- SO_2 CAAQS management planning and implementation
- Experiences and outcomes from previous CAAQS/CWS orange and red management levels exceedances in Alberta
- A provincial and regional inventory of NO_x emission sources, which may include:
  - 2018 Draft Annual Emissions Inventory Report (AEIR)[3]
  - Draft 2018 National Pollutant Release Inventory[4]
  - Provincial Acid Deposition Management Framework assessments
  - Environment and Climate Change Canada
  - 2018 Provincial Air Quality Photochemical Modeling report[5]
  - CASA's ongoing project, 'Impacts of Reduced Consumer Transportation and Industrial Activity on Air Quality in Alberta due to COVID-19'
- Next steps for the project and expectations for participants in the project moving forward

1.2 Review and finalize background document with the project team

3 https://www.canada.ca/en/services/environment/pollution-waste-management/national-pollutant-release-inventory.html

4 https://open.alberta.ca/dataset/7f234172-a595-47b0-b8f9-4b3739bbcfda/resource/6c1cc270-ba68-4fff-8b12-f2b8eb6dfe73/download/aeir-standard-aug2018.pdf

5 https://open.alberta.ca/publications/9781460142387

Potential Outcomes/Deliverables

- Background document summarizing the province's NO_x status and data, experience with implementation of O_3 and $PM_{2.5}$ management plans in response to orange and red CAAQS/CWS levels in Alberta, and how other jurisdictions are approaching effective CAAQS implementation and management.

Objective 2: Create a base of informed stakeholders who can contribute meaningful solutions to CAAQS implementation in Alberta.

The project team will host one or more webinars to present the information from the background document to a broader audience. The target audience is expected to include:

- CASA Membership
- Airsheds
- Universities/researchers
- Industry (i.e., transportation, agriculture, oil and gas, mining, etc.)
- Indigenous communities
- Environmental groups and other Non-government organizations
- Government (federal, provincial, and municipal)

The target audience will be determined by the project team. The webinar(s) is an information session, and there may be benefits to extending the invitation to other interested parties, including the public. However, the intention is not to undertake full public engagement in relation to CAAQS.

The number of webinars required will be dependent on the amount of content in the background document, the availability of speakers, and other factors and will be determined following Objective 1.

Strategies

2.1 Develop key messages for webinar(s) and the associated feedback being requested

2.2 Prepare and deliver the webinar(s) either with in-house resources or via a consultant

- Choose presenters based on the content of the background document
- Develop cost estimates and plans for effective webinar delivery based on the experience of other organizations

2.3 Send out post-meeting emails or surveys to collect feedback on the material

- Feedback from participants during the webinar is expected to be limited to a question and answer session
- A brief follow-up survey to participants can include requests for feedback on the presented material and its effectiveness, options for improvement, level of interest from participants, etc.

2.4 Compile and summarize feedback to inform subsequent workshop(s)

Potential Outcomes/Deliverables

- One or more webinars presenting information from the background report to a broader audience.
- Organized feedback from participants to inform subsequent workshop(s).
- Report summarizing webinar proceedings.

Objective 3: A list of collaborative approaches and solutions for NO_x CAAQS achievement in Alberta.

Following the webinar(s), one or more workshops will be held to identify recommendations, potential approaches, and solutions on how to reduce NO_x emissions in Alberta.

The number of workshops and their format will be determined by the project team following the webinar based on the content required.

Strategies

3.1 Prepare and deliver one or more workshops including relevant experts

- The target audience for the workshops is proposed to be the CASA membership and other relevant stakeholders
- Speakers, if required, will be chosen by the project team based on the nature of the content to be covered, and will be determined following the webinar

3.2 During the workshop(s), participants will:

- Confirm and update information from background report (e.g. jurisdictional review)
- Develop a set of recommendations, potential approaches, and solutions for managing NO_x emissions in Alberta

Potential Outcomes/Deliverables

- Confirmed and updated information from the background report developed in Objective 1.
- Recommendations, potential approaches, and solutions that could be used in Alberta to address the expected NO_2 CAAQS exceedances, with rationale and including recommendations on when, which, and how stakeholders should be involved.
- A report on the proceedings of the workshop(s).

Objective 4: Write final report and recommendations.

Evaluate and recommend management actions and/or next steps to reduce NO_x emissions in Alberta based on the outcomes of Objectives 1 to 3.

Strategies

4.1 Develop a final report including the outcomes of Objectives 1 to 3. Additional inputs or considerations should include:

- Input from key stakeholders
- Evaluation of potential approaches, management actions, and/or next steps for emitters, leveraging existing available information wherever possible. Some considerations may include:
  - degree to which management actions reduce NO_x emissions in Alberta
  - cost/benefit analysis
  - ease of implementation
  - relevance to Albertan context

Potential Outcomes/Deliverables

- Recommendations for management actions and/or next steps to help manage NO_2 emissions in Alberta to meet the NO_2 CAAQS.

Objective 5: Execute effective communication of the project work and deliverables.

Develop and implement a strategy and action plan for communicating the work of the project team.

Strategies

5.1 Form a communications subgroup for development of communications materials and key messages

5.2 Identify existing communication channels that could be leveraged

5.3 Determine the appropriate audience, key messages, and how they will be communicated

5.4 Engage stakeholders as required throughout the project

5.5 Provide advice on stakeholder and public engagement to the implementers of management actions, where applicable

Potential Outcomes/Deliverables

Communications strategy detailing what, how, when, and to whom project information will be communicated.

- 1-2-page communications documents including key messages and webinar/workshop outcomes for colleagues, project participants, and the public.

Project Deliverables

The project team will provide the following deliverables:

1. A background report on CAAQS/CWS implementation in Alberta and the projected NO_2 CAAQS issues
2. A webinar (or webinars) to share the information from the background report including input from all sectors/stakeholders along with a report summarizing webinar proceedings
3. One or more workshops along with a workshop report to arrive at approaches and solutions to achieve NO_2 CAAQS in the province
4. Final report, including:
   - Lessons learned
   - Evaluation of recommendations received
   - Any project team recommendations
   - Webinar and workshop proceedings
5. A 1-2-page communications document including key messages and webinar/workshop outcomes for colleagues, project participants, and the public

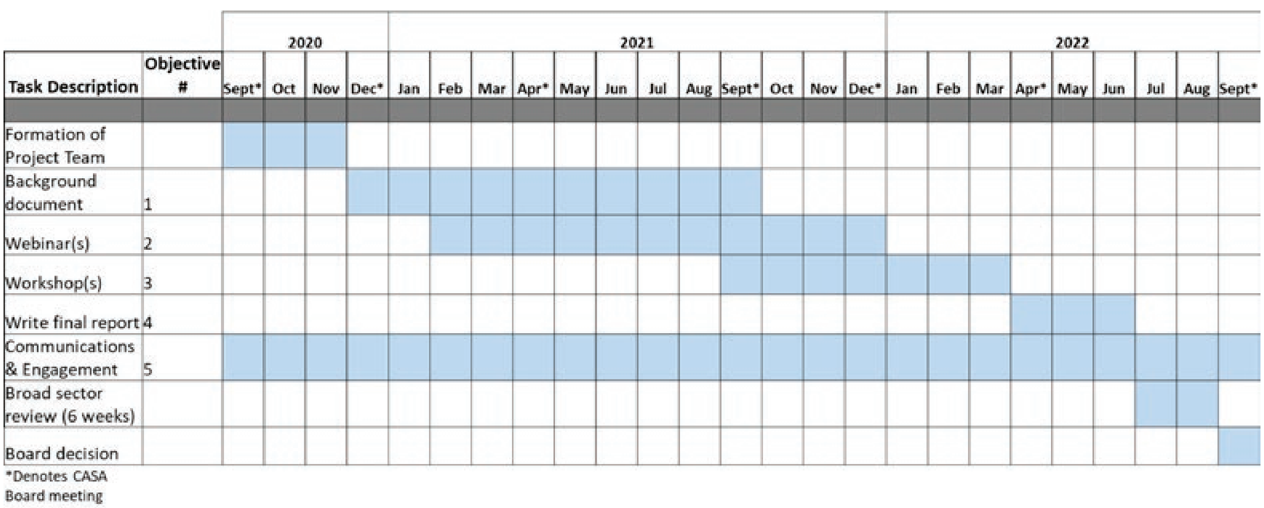
It should be noted that *CASA's Performance Measures Strategy: A "how-to" guide to performance measurement at CASA* indicates that each project team is required to generate one specific metric that will allow the success of the team to be evaluated five (5) years in the future. More guidance on how this can be achieved can be found in the strategy.

Project Structure and Schedule

Project work should begin in November 2020. The working group anticipates that the entire project will take approximately two years, with an estimated completion date of September 2022.

Refer to Table 1 for a high-level illustration of the process.

Table 1: CAAQS Achievement Project Timeline



Projected Resources and Costs

Table 2 outlines the potential external costs over the life of the project, as anticipated by the working group. As the work of the project team progresses, detailed work plans and associated budgets will be developed.

The cost for hosting virtual events is expected to be low, but the budget considers speaker costs, facilitators, or other meeting support, should they be necessary.

Table 2: Estimated CAAQS Achievement Project Budget

Item	Estimated Cost
Background document compilation (Objective 1)	$3,000
Hosting the webinar(s) (Objective 2)	$5,000
Hosting the workshop(s) (Objective 3)	$7,000
Final report writing (Objective 4)	$5,000
Development and implementation of communications strategy (Objective 5), to potentially include: Communications materials (e.g., message map, backgrounder, etc.)	$5,000
Total Estimated External Costs	$25,000

Risk Analysis

Identifying, analyzing, and mitigating project risks is a key component of executing a successful project. The project team will incorporate proactive risk management into the project to mitigate risks that could undermine its success.

Table 3 lists the risks as well as possible mitigation strategies identified by the working group that the project team should consider as they undertake their work.

Table 3: CAAQS Achievement Risk Analysis including Possible Mitigation Strategies

Risks	Possible Mitigation Strategies
Process	
COVID-19 delays and limitations	• Explore opportunities for the workshop and events to be held online instead of in-person as appropriate • Develop the workplan with additional time to accommodate potential project delays • Clear communication among project team members related to capacity and availability
Timely funding not available	• Identify who the clients of this work are. Pursue funding from clients if appropriate • Develop a strong value-proposition that includes examples of sectors that may be involved or affected • Project Team members discuss the work and associated need for funding with their constituents early in the process • Project Team members discuss additional mitigation measures as required
Recommended processes and learnings are too broad or not specific to the project goal	• Seek a balance between regional needs and provincial applicability in management actions chosen • Consider prioritizing cross-cutting actions that provide regional benefit and have the potential to be broadly applicable • Consider ways to align this work with existing or developing provincial policy, management frameworks and plans
Can't reach agreement, e.g., on content, potential processes/ management actions, or communications	• Determine in advance which pieces of work do and do not require consensus • Outline a clear decision-making process that includes what happens if the team can't agree – who will make the decision? • Have an explicit discussion around Interest-Based Negotiation, and get all the interests of the team members on the table
Project Team does not understand or follow the Project Charter	• The Project Manager reviews the Project Charter with the Project Team and together highlight areas that may require further clarification. If the Project Team is still unclear, the Project Team brings concerns to the Board for approval/direction • Board receives regular updates to ensure progress is monitored

Risks	Possible Mitigation Strategies
Process	
CASA Board disagrees with management actions identified in Objective 3	• Project Team members liaise with their constituents and Board members on an ongoing basis • Project Team provides regular status reports for Board meetings • Project Team determines if additional workshops/engagements are required to create Board consensus
Recommendations of the Project Team are not implemented. Specifically, advice given on implementing approaches and/or solutions in Objective 3.	• This risk is outside the scope of the project team to mitigate; however, this risk will be reduced if i) the parties potentially involved in implementation are engaged, and ii) reference to implementation (who and how) is included in the report's recommendations
Information Collection	
Few participants in online webinar(s), and/or workshop(s)	• Ensure that CASA network and membership fans out information on the webinar(s) and workshop(s) through various means, including social media networks • Targeted emails to CASA membership • Increase the frequency of communications and reminders and explore alternative channels to reach the public
Lack of/limited information (accessibility)	• Ensure Project Team membership enables the team access to information • Use judgement where information is unavailable • Any gaps in information will be noted during the process to promote transparency
Privacy concerns potentially impacting the ability to collect robust suggestions from internet engagement	• Remove key identifying information from responses • Follow FOIP and PIPA processes
Stakeholder Engagement	
During stakeholder engagement, "interested parties" don't agree with the list of management processes provided in Objective 3	• Try to develop the potential management actions collaboratively, and determine if additional engagement sessions are required • If stakeholders disagree, seek to understand stakeholder reasons for disagreement • Identify non-consensus recommendations where appropriate
Lack of engagement/ownership on Project Team	• Identify and communicate with potential stakeholders early in the process • Create a clear value proposition • Be clear about what is being asked of Project Team members
Obtaining stakeholder feedback and refining potential solutions with interested parties (Objective 3) takes longer than expected or causes scope creep	• Set specific parameters for this piece of work: ◦ Purpose of soliciting feedback ◦ Scope of influence outcomes will have on overall process ◦ Confirm timelines and availability

Operating Terms of Reference

An Operating Terms of Reference describes how the project team agrees to work together. The project team should discuss and reach consensus on the following items:

- Requirements for quorum
- Governance
- Meeting protocols
- COVID-19 social distancing procedures
- Roles and expectations of project team members
- How decisions will be made
- Ground Rules
- Frequency of project team meetings
- Frequency of updates and reports to the CASA Board
- Protocols for handling media requests
- Protocols for providing updates to interested parties
- Any other considerations for working together

Stakeholder Analysis and Engagement Plan

In general, stakeholders will be engaged in different capacities and at different times as necessary to meet the project outcomes.

The working group identified the following categories of stakeholders whose involvement would benefit the project:

- Project Team: Stakeholders who are required at the table to reach consensus agreement.
- Corresponding members: Stakeholders who receive all correspondence but are not required at the table to reach consensus agreement.
- Task Groups or Technical Experts: Stakeholders who have a specific interest or expertise and can be engaged as required.
- Other:
  - Stakeholders from whom feedback on management actions is sought, which may include potential implementers or those potentially impacted (Objectives 2, 3).
  - Members of the public who may be engaged and/or informed (Objective 2).

Table 4 includes a list of potential stakeholders for consideration. Additional stakeholders may become apparent as the work progresses; the project team will regularly evaluate whether the appropriate stakeholders are engaged.

Table 4: Potential Stakeholders to Consider for Involvement in the CAAQS Achievement Project

Individual or Organization	Possible Interests, Concerns, or Involvement
Provincial Regulators (e.g., Environment and Parks, Transportation, Rail,Agriculture and Forestry, Alberta Energy Regulator, Service Alberta, Alberta Justice, Alberta Health)	• Responsible for ensuring achievement of the CAAQS as well as provincial policy • Will likely be responsible for implementing many management actions • Interested in environmental protection and health of Albertans as well as ensuring sustainable economic prosperity • Involved in education/awareness initiatives • May be involved in implementing management actions or have interest in certain sectors (e.g., forestry trucks, shuttle buses to mine sites)
Federal Government (e.g., Environment and Climate Change Canada, Transport Canada)	• Interested in ensuring achievement of the CAAQS across Canada, effectiveness of and alignment with federal policies, as well as meeting transboundary commitments

Individual or Organization	Possible Interests, Concerns, or Involvement
Municipalities	• Involved in education/awareness initiatives • May be involved in implementing management actions • Interested in ensuring the health of communities • Interested in protecting the environment
First Nations and Métis	• Interested in ensuring the health of communities • Interested in protecting the environment
Trucking Companies/ Associations (e.g., CTA/ AMTA, Independent Trucking Association)	• Interested in fairness across the sector • Concerns regarding possible costs or inconvenience of potential management actions
Rail (e.g., CN, CP)	• Interested in fairness across the sector • Concerns regarding possible costs or inconvenience of potential management actions
Industry	• Interested in management actions to reduce NO_x emissions that include both industrial and non-industrial emission sources
Pacific NorthWest Economic Region (PNWER) Foundation	• Interested in awareness of requirements in each jurisdiction, for cross-border activities
Health and Environmental Non-Government Organizations	• Interested in ensuring the health of Albertans • Interested in protecting the environment
Airshed Organizations	• Involved in outreach/education/awareness initiatives • Involved in data collection to inform CAAQS management actions • May be involved in implementing management actions
Agriculture Associations (e.g., Alberta Canola Producers, Alberta Beef Producers, etc.)	• Interested in fairness across the sector • Concerns regarding possible costs or inconvenience of potential management actions
Academia/Research Councils (e.g., U of A Centre of Smart Transportation, and others)	• Interested in feedback received potential research implications of study results, or in possible concurrent studies
The Public	• General interest • Educational opportunity

Appendix A: Working Group Membership

Name	Role	Organization
Members		
Dan Moore	Member	Alberta Newsprint Company
Rob Beleutz	Member	Graymont
Sean Mercer	Member	Imperial Oil/Canadian Fuels Association
David Spink	Member	Prairie Acid Rain Coalition
Kristi Anderson	Member	Mewassin Community Council
Julie Carter	Chair	Wood Buffalo Environmental Organization
Sanjay Prasad	Member	Wood Buffalo Environmental Organization
Sheila Lucas	Member	Alberta Environment and Parks
Carolyn Tralnberg	Member	Alberta Environment and Parks
Crissy Handziuk	Member	NOVA Chemicals
Brittney Morgan	Chair	Capital Power
Ahmed Idriss	Member	Capital Power
Andria Panidisz	Member	Canadian Association of Petroleum Producers
CASA Secretariat		
Lauren Hall	Project Manager	Clean Air Strategic Alliance
Katie Duffett	Project Manager	Clean Air Strategic Alliance
Alec Carrigy	Project Manager	Clean Air Strategic Alliance

Appendix B: Reference Materials

The project team should review the following materials in preparation for project initiation:

- ROVER III documents[6]
- The current Alberta Air Quality Modelling Guideline 2013[7]
- The updated draft Alberta Air Quality Modelling Guideline 2020[8]
- Ambient Air Quality Objectives/AAQGs[9, 10]
- Canadian Ambient Air Quality Standards[11]
- Provincial O_3 and $PM_{2.5}$ Air Zone Management Plans[12]
- The CCME CAAQS *Guidance Document on Air Zone Management*[13]
- 2018 Provincial Air Quality Photochemical Modeling report[14]
- Alberta Regional Planning documents
- Appendix 4a: Full Background Document[15]

6 https://www.casahome.org/current-initiatives/rover-iii-53/
7 https://open.alberta.ca/publications/9781460105993
8 The 2020 guideline is no longer available online. The 2021 version is available here: https://open.alberta.ca/publications/air-quality-model-guideline-2021
9 https://www.alberta.ca/ambient-air-quality-objectives.aspx
10 https://open.alberta.ca/dataset/0d2ad470-117e-410f-ba4f-aa352cb02d4d/resource/97d1afdf-b66b-4805-be41-a5a3f589c988/download/aaqo-summary-jun29-2017.pdf
11 https://ccme.ca/en/air-quality-report
12 https://open.alberta.ca/dataset/2baa091e-2b5e-4d12-9da7-4c5e89bef71d/resource/5f87b061-e049-4549-8fde-b077cf0207fd/download/implementationframework-pm-ozone-sep2015.pdf
13 https://ccme.ca/en/res/guidancedocumentonairzonemanagement_secured.pdf
14 https://open.alberta.ca/publications/9781460142387
15 https://www.alberta.ca/land-use-regional-planning.aspx

Appendix 4A:
Full Background Document

Full Background Document

Clean Air Startegic Alliance

July 2021

Contents

Introduction

Intent and Purpose of the Project

Increasingly stringent national air quality standards require that Alberta reduce emissions to meet those standards. This is a complex issue to address, due to the cumulative effects resulting from numerous emissions sources which affect stakeholders across the province. For this reason, the Government of Alberta (GoA), led by Alberta Environment and Parks (AEP) and the Alberta Energy Regulator (AER), have identified an urgent need to bring a variety of perspectives together and capture a range of potential innovative policy and regulatory recommendations to address this issue practically and effectively.

AEP sought the support of the Clean Air Strategic Alliance (CASA) to assist in engaging with, and informing, stakeholders by organizing and facilitating a project to:

- Bring together relevant stakeholders to increase awareness of the urgency for action and the implications of Alberta failing to achieve national Canadian Ambient Air Quality Standards (CAAQS) and/or associated regional Air Quality Management Framework (AQMF) triggers/limits.
- Garner stakeholder perspectives on, through an open and transparent process, emissions reduction strategies, options, and approaches for both regulated and non-regulated emission sources and sectors.
- Engage in respectful dialogue with stakeholders to find common interests on taking action to improve air quality and meet CAAQS and AQMF triggers/limits while supporting Alberta's economic prosperity.
- Provide policy advice (in terms of quantified emissions reduction actions, timeframes, and accountable stakeholders at a minimum) to achieve NO_2 CAAQS.

Intent and Purpose of this Backgrounder Document

The current and potential cumulative impacts associated with existing and planned emission sources represent significant air zone stresses, especially where air pollutants cannot or are not being effectively dispersed. The intent of this document is to provide readers context on this issue to facilitate future discussions on options and approaches to reduce NO_2 emissions to meet the national NO_2 CAAQS.[16]

It is therefore important for stakeholders to not only understand the current policies and requirements used to manage air emissions, but also to understand why such policies have not been sufficient to prevent CAAQS non-achievement in certain areas of the province. Some of the challenges in managing emissions regionally include the mobile nature of some emissions sources (which can extend beyond a region or local authority to manage and falls under federal or provincial jurisdiction), continuous development in areas where the local meteorology exacerbates the air quality impacts of air emissions, and the extended period of time that can exist between implementation of policies and resultant emission reductions.

The hope is that this document will inform and help guide discussions on how to address the current challenges through the development and implementation of innovative, yet practical, emission management recommendations. In this regard, such recommendations need to:

- Target key emission sources while recognizing that uncertainties exist and, in some cases, improved knowledge and understanding of key emission sources and their air quality impacts is required.
- Be realistic in terms of what current and/or modified regulatory and non-regulatory policies and programs can achieve.
- Consider the economic implications to the province and targeted sectors.

16 This document was provided to the project team to inform the team's subsequent tasks. The information is accurate as of its completion date (July 2021), which is earlier than the public release of the final report. Some information and links within this document may no longer be current.

- Be implemental and measurable. For instance, the action identified is specific enough to establish an associated measurable performance measure(s). This will allow the implemented action to be monitored and evaluated to see if it has been effective in achieving the desired air quality outcomes.

Health Impacts of Air Quality and NO_2 Exposure

Air pollution can have many health impacts.[17] According to Health Canada's 2021 *Health Impacts of Air Pollution in Canada* report:[18]

"Overall, the total mortality attributable to above-background air pollution in Canada, based on population data for 2016 and air pollutant concentrations from 2014 to 2017, was estimated to be 15,300 premature deaths per year."[19]

The following population health impacts of $PM_{2.5}$, ozone and NO_2 were estimated (Values for individual pollutants may not match total due to rounding):

- *Chronic exposure to $PM_{2.5}$ air pollution contributed to 8.0% of all-cause nonaccidental mortality among Canadians over 25 years of age, equivalent to 10,000 deaths per year or 27 deaths per 100,000 population.*
- *Acute exposure to NO_2 air pollution contributed to 0.9% of all-cause nonaccidental mortality among Canadians of all ages, equivalent to 1,300 deaths per year or 4 deaths per 100,000 population.*
- *Acute exposure to ozone was associated with 2.7% of all-cause nonaccidental mortality among Canadians of all ages, equivalent to 2,800 deaths per year or 8 deaths per 100,000 population. This estimate was derived using the annual average of daily 1-h maximum ozone concentrations.*
- *Chronic exposure to ozone was associated with 10% of respiratory-related mortality among Canadians over 30 years of age, equivalent to 1,300 deaths per year or 4 deaths per 100,000 population. This estimate was derived using the summer average of daily 1-h maximum ozone concentrations.*
- *On a provincial and territorial basis, health impact estimates are generally proportional to population counts."*

The economic cost of the 15,300 premature deaths associated with air pollution was estimated at $114 billion per year (2016 CAD). Health Canada recognized and addressed the possibility of overlap or double counting of endpoints.

1.0 Air Quality Management in Canada

Canada began establishing national air quality levels in the mid-1970s. The first Canadian National Ambient Air Quality Objectives (NAAQOs) were published in 1976 and covered the following air quality parameters:

- sulphur dioxide
- suspended particulates
- carbon monoxide
- ozone
- nitrogen dioxide

These objectives consisted of three tiers which identified ranges of air quality designed to meet the varied needs for air quality objectives across Canada. The NAAQOs were the basis for many air quality criteria set by provinces, including Alberta.

In 1998, through the Canadian Council of Ministers of the Environment (CCME), a Canada-Wide Accord on Environmental Harmonization was signed which included a sub-agreement for the development of Canada-Wide Environmental Standards. Under this sub-agreement the first Canada-Wide Standards (CWS) for ambient air quality were established which covered particulate matter (PM) and ozone. Associated with these CWS were determination and reporting procedures. The CWS for PM and ozone were in the form of a "single-value," that is, there were no steps or levels as were provided in the NAAQOs.

To enhance air-related human health and environmental protection, in October 2012 the

17 https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/air-pollution-drivers-impacts.html

18 https://www.canada.ca/en/health-canada/services/publications/healthy-living/2021-health-effects-indoor-air-pollution.html.

19 $PM_{2.5}$: 2015–2017; ozone: 2014, 2015 and 2017; NO_2: 2015–2017

CCME,[20] and Canadian provinces and territories, except for Quebec, agreed to implement a national Air Quality Management System (AQMS). The national system is a collaborative approach by federal, provincial, and territorial governments to better protect human health and the environment by improving air quality. Key elements of the system include:

- Canadian Ambient Air Quality Standards (CAAQS)
- Industrial emission requirements, which set a minimum national level of performance for major industrial sectors or equipment types in Canada (Base-Level Industrial Emission Requirements [BLIERs]).
- A framework for air zone air management within provinces and territories that enables action tailored to specific sources of air emissions in a given area.
- Regional Airsheds[21] — broad geographic areas encompassing several air zones and which cross provincial and territorial boundaries. They provide a framework to address air quality issues when air pollution crosses a border.
- Activities focused on mobile sources building existing federal, provincial, and territorial initiatives that are aimed at reducing transportation sector emissions.

The CCME has developed a State of the Air website that provides information on the AQMS and air quality across Canada.[22]

1.1 Canadian Ambient Air Quality Standards (CAAQS)

In 2008, a National Round Table on the Environment and the Economy reviewed the CWS and proposed recommendations for the federal government to develop national ambient air quality objectives. In 2012, CAAQS officially replaced the CWS for $PM_{2.5}$ and O_3. CAAQS were also established for NO_2 (2017) and SO_2 (2015). Two standards (short- and long-term) were established for O_3, NO_2, and SO_2, with a 5-year period between the implementation dates for each set of standards. Table 1 shows the short- and long-term CAAQS for NO_2.

The intent of this approach was to establish future standards that jurisdictions and emitters could begin early planning to achieve. Similar to the CWS, CAAQS also include air quality management levels associated with each threshold that can be used to guide air quality management to encourage proactive prevention and further air quality deterioration in an air zone (see Section 1.5). CAAQS are health- and environment-based objectives developed to further protect human health and the environment, and to provide the drivers for air quality improvement across the country. The federal government established CAAQS as non-binding ambient air quality objectives under the *Canadian Environmental Protection Act,* 1999.

The CCME provides guidance on the application of CAAQS for ambient air quality management. However, jurisdictions have the flexibility to implement CAAQS in a manner that is consistent with their management practices. Alberta has described the overall process for implementing the CAAQS in "*Alberta's Implementation of the National Air Zone Management Framework*" (AEP, 2015), which outlines the NO_2 CAAQS established. The information for the other CAAQS parameters ($PM_{2.5}$, O_3, and SO_2) can be found on the CAAQS page of the Government of Alberta website.[23]

20 https://ccme.ca/en/res/aqms_roles_and_resp_e.pdf
21 Note there are differences in terminology between Regional Airsheds, air zones and Airsheds in Alberta. Regional Airsheds and air zones are terms to describe geographic areas, whereas in Alberta, Airsheds are not-for-profit organizations that monitor air quality within a certain area.
22 https://ccme.ca/en/air-quality-report
23 https://www.alberta.ca/canadian-ambient-air-quality-standards.aspx

Table 5: CAAQS management levels and associated NO_2 thresholds

	Nitrogen Dioxide (NO_2)			
	1-Hour		Annual	
	Effective 2020	Effective 2025	Effective 2020	Effective 2025
Action	Actions for Achieving Air Zone CAAQS			
Standard	60 ppb	42 ppb	17.0 ppb	12.0 ppb
Action	Actions for Preventing CAAQS Exceedances			
Threshold	31 ppb		7.0 ppb	
Action	Actions for Preventing Air Quality Deterioration			
Threshold	20 ppb		2.0 ppb	
Action	Actions for Keeping Clean Areas Clean			

1.2 Base-Level Industrial Emission Requirements

According to Environment and Climate Change Canada (ECCC), BLIERs are management tools intended to:

> *"… ensure that all AQMS sectors in Canada meet a consistent, good base-level of environmental performance, regardless of the air quality where facilities are located. They are not designed to be the sole instrument used to improve air quality."*

Under the BLIERs:

> *"… provincial and territorial governments will monitor and manage their local sources of air pollution and have the opportunity to be the front-line regulator and take additional action on all sources to achieve the CAAQS. Actions can include introducing more stringent industrial emission standards for significant air pollutant emitters."*[24]

ECCC is implementing the BLIERs using a mix of regulatory and non-regulatory instruments. The first phase of BLIERs implementation is the Multi-Sector Air Pollutants Regulations (MSAPR) for gaseous-fuel-fired boilers and heaters, stationary spark-ignition gaseous-fuel-fired engines, and natural gas-fueled stationary combustion turbines.[25]

It is important to note that MSAPR only applies to certain sectors. According to the cost-benefit analysis done by ECCC, MSAPR is estimated to cumulatively reduce 2,065 kt in NO_x emissions by 2035 across Canada. Most of the reductions (86%) will be attributed to improvements in stationary spark-ignition gaseous-fuel-fired engines, the majority of which are in Alberta.[26]

24 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/overview-multi-sector-air-pollutants-regulations.html

25 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/overview-multi-sector-air-pollutants-regulations.html

26 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/regulatory-impact-analysis-air-pollutants-regulations.html

The MSAPR for boilers and heaters and for spark ignition gaseous-fuel-fired engines have requirements for new and existing units which will result in future NO_x emission reductions. MSAPR includes mandatory performance standards requirements to limit NO_x emissions from these sources.

ECCC has the authority to use a full range of instruments, including regulations through Pollution Prevention (P2) planning notices, guidelines, standards, environmental performance agreements, and other non-legislative initiatives. Where appropriate, a P2 planning notice can be an efficient and effective risk-management instrument. Using the P2 planning provisions could minimize the need for additional regulatory or other governmental interventions.

In addition to regulatory tools like MSAPR, non-regulatory tools used under BLIERs include:

- two codes of practice for the potash sector and the pulp and paper sector
- one pollution prevention planning notice for the iron, steel, and ilmenite sector
- one guideline for stationary combustion turbines
- three performance agreements for the aluminium sector, the iron ore pellets sector
- five company-specific performance agreements for the base metals smelting sector

1.3 Mobile Sources

CCME recognized that mobile emissions are a significant source of air pollution in Canada. CCME also recognized that addressing this issue requires a comprehensive approach that encompasses regulations on vehicle and engine emissions and the fuels they burn, increasing fleet and system efficiencies, as well as addressing transportation demand. Many of these measures are governed by existing federal regulations, programs, or initiatives, while others are managed by provincial and municipal governments, and transportation infrastructure.

In recognition of the multiple jurisdictions responsible for managing mobile source emissions, on June 29, 2011, the Environmental Planning and Protection Committee (EPPC) of CCME established an inter-governmental Mobile Sources Working Group (MSWG). The mandate of the MSWG is to share information and identify areas of joint interest among jurisdictions, departments, and ministries, and to work collaboratively on initiatives to reduce air pollutant and GHG emissions from mobile sources. MSWG reports to EPPC and CCME's Air Management Committee (AMC).

1.4 Airshed Coordination

Under the AQMS, Canada was divided into Regional Airsheds (Figure 1) which are described as follows:[27]

> *"Six regional Airsheds cover all of Canada and allow for coordination and joint action in resolving issues involving the movement of air pollutants across provincial/territorial boundaries and international borders. These Airsheds were developed taking larger scale issues, such as the movement of large air masses, typical long-term meteorological conditions, topography, and air zone boundaries into consideration."*

27 https://ccme.ca/en/air-quality-report

Figure 1: The six Regional Airsheds under the AQMS

The CCME AMC may develop an Airshed framework to help address inter-jurisdictional transboundary air quality issues in the future.

1.4.1 CAAQS Determination & Transboundary Flows/Extreme Events

When provinces report on the air quality in their air zones, contributions or influences from transboundary flows (TF) and exceptional events (EE) (including natural sources, such as wildfires) over which a jurisdiction has little to no control may be considered for removal before determining the management level for the air zone. The *Guidance Document on Transboundary Flows and Exceptional Events for Air Zone Management,*[28] developed by the CCME, provides guidance to provinces and territories on the procedures for assessing the influences of TF-EE on CAAQS exceedances and management levels. The guide also helps ensure consistent procedures across Canada to account for TF-EE influences.

1.4.2 Canada-United States Air Quality Agreement

The Canada-United States Air Quality Agreement[29] was signed by Canada and the United States in 1991 to originally address transboundary air pollution leading to acid rain. Both countries agreed to reduce emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_x), the primary precursors to acid rain, and to work together on acid rain-related scientific and technical cooperation.

The Ozone Annex was added to the Canada-United States Air Quality Agreement in 2000 to address the transboundary air pollution leading to high air quality levels of ground-level ozone, a major component of smog. The Ozone Annex identifies regions in both countries where decreases in NO_x and VOCs would reduce transboundary ozone pollution in the other country and it sets out emission requirements within those regions. The long-term goal of the Ozone Annex is the attainment of the ozone air quality standards

28 https://ccme.ca/en/res/guidancedocumentontransboundaryflowsandexceptionalevents_secured.pdf

29 https://www.canada.ca/en/environment-climate-change/services/air-pollution/issues/transboundary/canada-united-states-air-quality-agreement.html

in both countries. The Ozone Annex commits both countries to reduce their emissions of nitrogen oxides and VOCs, the precursor pollutants to ground-level ozone.[30]

The United States and Canadian governments have asked the International Joint Commission (IJC) to address transboundary air pollution issues between Canada and the USA in boundary regions. As well, under the 1991 Canada-United States Air Quality Agreement, the IJC is required to collect and synthesize public comments on the air quality progress report published by the governments every two years.

1.5 Air Zone Management Framework

The National Air Zone Management Framework (AZMF) is described in the *Guidance Document on Air Zone Management* (GDAZM) (CCME, 2019). The guiding principles of the AZMF, including "Keeping Clean Areas Clean" and "Continuous Improvement", are intended to ensure that air quality does not deteriorate, but is maintained or improved to the extent practicable.

The AZMF was developed to guide monitoring, reporting, and management actions to be implemented in air zones. Management levels were developed for each substance and each of the four colour-coded management levels are associated with a range of monitoring, reporting, and management actions that are described in the GDAZM.

Alberta has described the overall process for implementing the national management levels in the document titled *Air Zone Management Framework in Alberta's Implementation of the National Air Zone Management Framework* (2015).

1.5.1 Alberta's Air Zones

One of the principal aspects of the AZMF is that each province or territory delineate air zones, the unit of management planning, which would cover the entire jurisdiction. Alberta has aligned air zone boundaries with the Land-use Framework regional boundaries, except the Lower and Upper Peace regions, which were combined into one air zone called Peace, as illustrated in Figure 2.

Alberta Environment and Parks annually produces reports to summarize the air zones' CAAQS status and assigned management levels based on both three-year and annual metrics. These reports are available on the Alberta Air Quality website.[31]

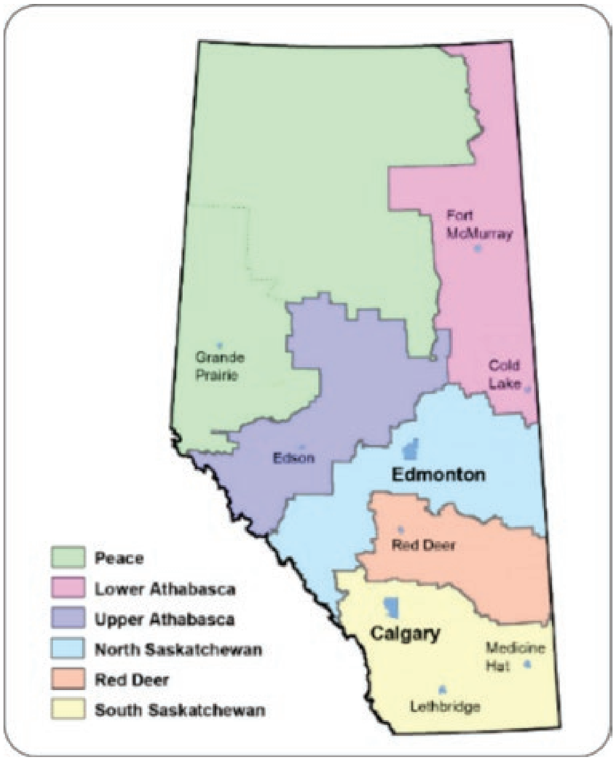


Figure 2: Map of Alberta's Air Zones

Alberta Environment and Parks produces annual reports on the CAAQS, one of the measures used to provide Albertans with an assessment of their air quality. The reports provide information on:

- The air quality in each air zone compared with CAAQS for individual ambient air monitoring stations which meet the criteria in section 1.3 of the AZMF.
- The designated management level for each air zone.
- A summary of any management plans in place.
- Any other relevant information.

The fifth annual report on the CAAQS for Alberta, titled "*Air Zones Report 2016–2018*", assessed levels of $PM_{2.5}$ and ozone measured in the years 2016, 2017, and 2018, and determined air quality management

30 http://publications.gc.ca/site/eng/9.506241/publication.html
31 https://www.alberta.ca/canadian-ambient-air-quality-standards.aspx

levels for each air zone for the 2016–2018 assessment period.[32] The final report is not yet available online, however, the $PM_{2.5}$ and ozone raw[33] data used in this report can be accessed online.[34]

For the 2016–2018 assessment period, the 2015 CAAQS were achieved in all six air zones for both $PM_{2.5}$ and ozone for the reporting year. The ozone management levels in all air zones remained unchanged between the 2016–2018 reporting period and the previous assessment (2015–2017). The $PM_{2.5}$ management levels in all air zones, except the South Saskatchewan Air Zone, have remained consistent with those assigned in the previous assessment and reporting year. The South Saskatchewan Air Zone has moved from the yellow management level (Actions for Preventing Air Quality Deterioration) to the orange management level (Actions to Improve Air Quality through Active Air Management and Prevent Exceedance of the CAAQS).[35] The air zone was also in the orange management level in the 2012–2014 and 2013–2015 assessment periods. It is important to note that these results removed TF/EE only for stations in red and the orange management levels.

1.5.2 CAAQS Response: Government of Alberta Action Plans

Alberta's Implementation of the National Air Zone Management Framework (2015) requires air zones that are in orange and red management levels create a management plan within two years following the assessment.

The CCME document titled *Guidance document on Air Zone Management* also indicates that each province is responsible for assigning each air zone their management level and implementing necessary management actions, with the following exception:[36]

> *"... [e]mission sources and lands that fall under federal authority (such as transportation sources, federal lands and national parks), the federal government will collaborate with provinces and territories on air quality management."*

If an air zone is assigned orange or red management levels for several pollutants that have more than one averaging period (e.g., hourly and annual), only the highest management level will be assigned to that air zone.

Developing and implementing action plans in a particular air zone can span numerous years. Sometimes an air zone can change management levels while a plan is being developed. Alberta's policy for an air zone that goes from one management level to a lower management level (e.g., red to orange or orange to yellow) requires that it must be at the lower level for three consecutive assessments, following which:

- The management plan should be reviewed following the management planning steps to determine if any changes to management actions are required and appropriate, and
- All contextual factors should be considered, along with any other information brought forward when reviewing the management actions.

Since assessments began, all Alberta Air Zones have reached an orange management level at some point since CAAQS have been developed. CAAQS Response-Action Plans have been developed as a result and can be accessed online under "Management Plans."[37]

32 Annual Alberta air zone reports can be found here: https://open.alberta.ca/dataset?q=%22Alberta%20air%20zones%20annual%20report%22

33 The raw data goes through significant processing to calculate the CAAQS. The CCME has published documents on its website which outlines guidance on the monitoring, procedures and methodologies for Provinces and Territories to report on CAAQS achievement status for each pollutant. The documents for NO_2 and SO_2 is called the "Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Nitrogen Dioxide and the Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Sulphur Dioxide (2021).

34 https://www.alberta.ca/access-air-quality-and-deposition-data.aspx

35 For the 2014–2016 and 2015–2017 reporting year assessment periods, the South Saskatchewan Air Zone was assessed to be in the yellow CAAQS levels. Note there is a distinction between the Air Zones Reports report the "reporting-year" management level obtained for the reporting period under consideration, compared to "effective" management level, as outlined in the Alberta's Implementation of the National Air Zone Management Framework. For an effective management level to be lowered, an air zone requires the "reporting-year" management level to be at the lower level for three consecutive assessment periods, before changes in management actions are required. Since the previous assessment periods of 2012–2014 and 2013–2015 South Saskatchewan had an orange management level, it cannot be changed to yellow, despite being within that CAAQS threshold.

36 https://ccme.ca/en/res/guidancedocumentonairzonemanagement_secured.pdf

37 https://www.alberta.ca/canadian-ambient-air-quality-standards.aspx#toc-1

1.5.3 Preliminary CAAQS NO_2 Forecasts for Alberta based on 2017–2019 data

The first formal achievement determination of the 1-hour NO_2 2020 CAAQS occurs in 2021 and will be based on metric values for the 3-year period from 2018 to 2020. For the 2025 standard, it will be based on metric values for the period 2023 to 2025. For the annual standard, the first formal achievement determination will be based on the annual average of NO_2 1-hour measurements in 2020 for the 2020 standard and in 2025 for the 2025 standard. However, preliminary NO_2 CAAQS achievement forecasts (for both the 1-hour and annual metrics) can be completed using 2017–2019 data.[38]

Results from a preliminary analysis using 2017–2019 data show the 1-hour NO_2 metric stations in the South Saskatchewan Air Zone could potentially exceed the 2020 CAAQS (60 ppb) and all other Air Zones in the province could reach the orange management level (which means actions need to be taken to improve air quality through active air management and prevent CAAQS exceedances) (Figure 3). The two stations in the South Saskatchewan Air Zone that are estimated to exceed the 1-hour CAAQS are Calgary Central-Inglewood (64 ppb) and Airdrie (62 ppb). Stations in the North Saskatchewan and Peace Air Zones had metric values up to the mid-50 ppb range, and other regions of the province had metric values up to the 40–45 ppb range.

These estimates are preliminary, as only the 2018 and 2019 data in this analysis are relevant for the 2020 CAAQS determination. Also, the analysis did not consider possible TF and EE impacts.

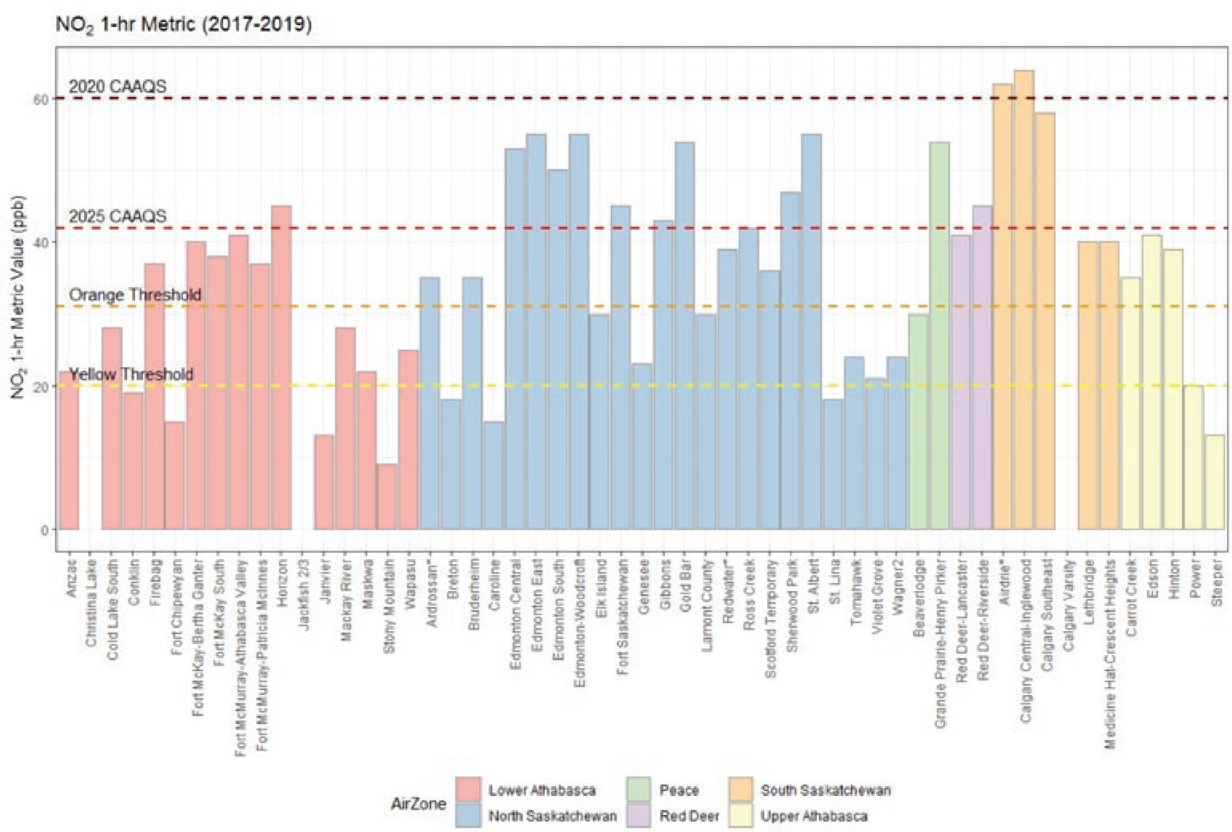


Figure 3: Comparison of Alberta's 2017–2018 1-hour NO_2 levels against the 2020 and 2025 1-hour CAAQS (Note: stations with an asterisk* had only two years of data available to calculate the metric value instead of three)

38 Note that there are three stations that only had two years of data available to calculate the metric value and they are indicated with an asterisk next to the station name (e.g., Ardrossan, Airdrie, and Redwater).

Based on 2019 data for the annual NO_2 CAAQS (17.0 ppb), all regions of the province are estimated to reach the orange management level (Figure 4). In 2019, the highest annual average NO_2 concentrations were measured at the Calgary Central-Inglewood and Edmonton Central stations, with metric values of 15.5 ppb and 14.9 ppb, respectively, which places these stations close to the NO_2 annual CAAQS for 2020.

The 2025 NO_2 CAAQS are more stringent, and at least one station in every Air Zone, except for the Upper Athabasca Air Zone, is estimated to exceed the 1-hour NO_2 CAAQS (42 ppb). Once again, this is based on 2017–2019 data only. In the Lower Athabasca Air Zone, the station that would exceed the 2025 1-hour CAAQS is the Horizon station, which has been relocated and renamed. It is unknown if the new Horizon location (Ells River) would have similar levels of NO_2. According to the 2019 data, the annual 2025 CAAQS (12.0 ppb) is projected to be exceeded in both the North Saskatchewan Air Zone and the South Saskatchewan Air Zone, and at Edmonton area stations (Central, East, Woodcroft, and Gold Bar) and Calgary stations (Inglewood and Southeast), respectively.

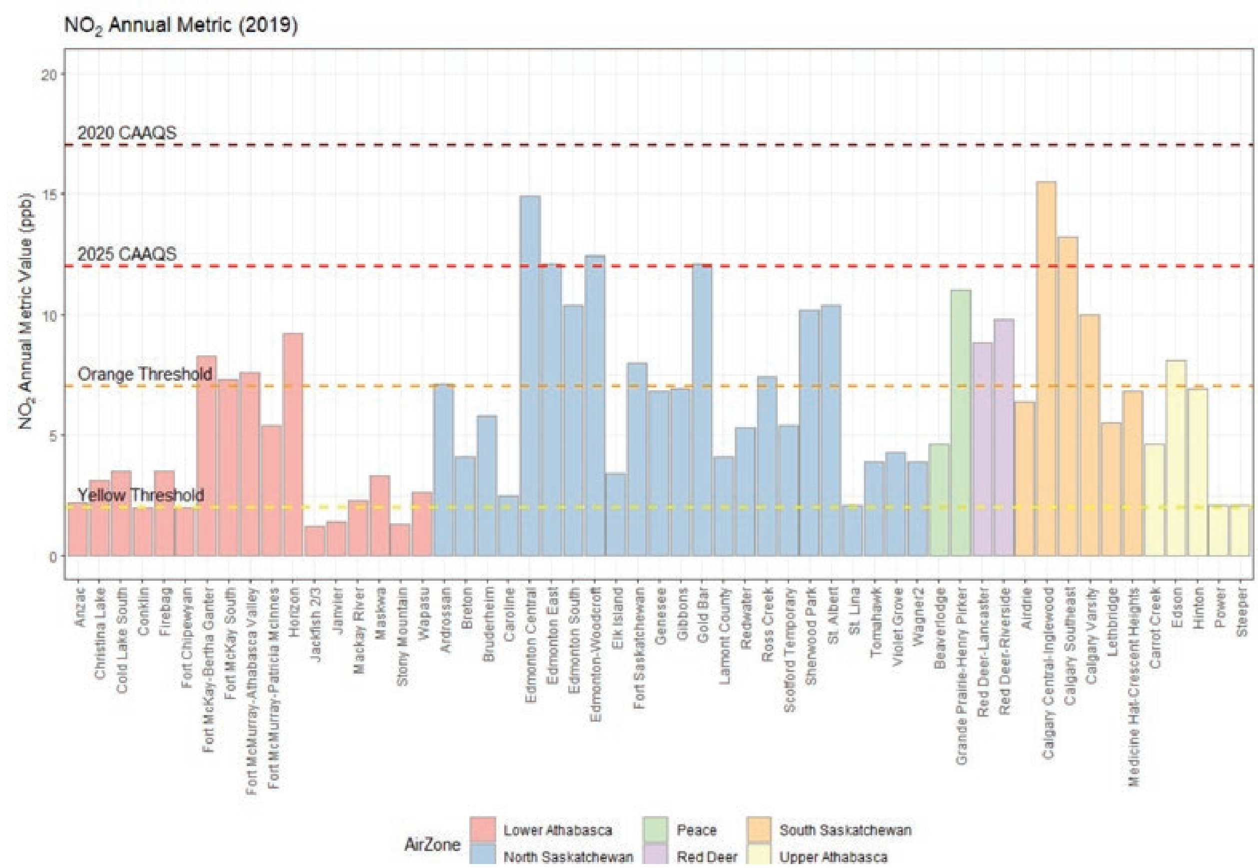


Figure 4: Comparison of Alberta's 2017–2019 annual NO_2 levels against the 2020 and 2025 annual CAAQS (Note: stations with an asterisk* had only two years of data available to calculate the metric value instead of three)

2.0 Overview of Air Management in Alberta

Alberta's air management system consists of several components that work together to protect human health and the environment. The major components of the overall Air Quality Management System for Alberta are described in the following sections. For a full list of current regulatory and non-regulatory mechanisms for managing air emissions, see Appendix B.

2.1 Air Quality Legislation

Air quality in Alberta is primarily managed through the *Environmental Protection and Enhancement Act* (EPEA), its regulations and related legislation (i.e., directives, standards, policies, objectives, guidelines, monitoring codes, Codes of Practice, and management frameworks).

In addition, the *Alberta Land Stewardship Act* (ALSA) also plays an important role in managing air quality in Alberta.

Section 1(2) of the ALSA states:

"The purposes of this Act are:

(a) To provide a means by which the government can give direction and provide leadership in identifying the objectives of the province of Alberta, including economic, environmental and social objectives;

(b) To provide a means to plan for the future, recognizing the need to manage activity to meet the reasonably foreseeable needs of current and future generations of Albertans, including [A]boriginal [P]eoples;

(c) To provide for the co-ordination of decisions by decision-makers concerning land, species, human settlement, natural resources and the environment;

(d) To create legislation and policy that enable sustainable development by taking account of and responding *to the cumulative effect of human endeavor and other events;*

(e) To enable various tools to support land conservation and effective management of private property and public lands."[39]

ALSA is the legal basis for Regional Plans. The Stewardship Minister, Stewardship Commissioner, and Land Use Secretariat (LUS) oversee the development of each regional plan.

The Stewardship Minister is designated as the minister responsible for ALSA and carries numerous responsibilities which are outlined in the act. The Stewardship Commissioner is responsible for overseeing the development, implementation, review, and amendment of regional plans, and for reviewing complaints. The Stewardship Commissioner has the authority to investigate complaints about non-compliance and may issue Interpretation Bulletins if further explanation or clarification of the act or regional plan is needed.[40]

The LUS reports to the Stewardship Commissioner and works independently of any department. The LUS also supports Regional Advisory Councils that provide advice to the Alberta government during development of the regional plans. The LUS is subject only to directives issued by the Stewardship Minister and fulfills the following responsibilities:

- supports development of the terms of reference for regional plans
- leads development of regional plans in conjunction with departments with an interest in land-use (regional planning teams) and in consultation with the Regional Advisory Councils
- communicates with local planning bodies to clarify and interpret plans
- supports policy reconciliation
- provides advice to regional bodies on provincial policy
- ensures effective management of cross-regional infrastructure and policy matters
- assists provincial departments, municipalities, and other local authorities in reconciling their respective roles to the Land-use Framework (LUF)
- provides administration infrastructure and support to Regional Advisory Councils
- ensures application of cumulative effects assessments

39 https://www.qp.alberta.ca/documents/Acts/A26P8.pdf

40 Details regarding the administration of ALSA and the definitions provided can be found online: https://landuse.alberta.ca/Governance/Administration/Pages/default.aspx

2.2 Land-use Framework, Regional Planning & Air Quality Management Frameworks

Alberta's Regional Plans consider the cumulative effects of all activities in a region, and with input from Albertans establishes a regional vision, and defines regional outcomes and objectives in conjunction with strategies and actions to accomplish the outcomes and objectives.

Environmental Management Frameworks are a key instrument for implementing strategies under regional plans. They build on existing environmental policy, legislation, and regulation, and provide an understanding of the current state of the environment, as well as emerging trends, challenges, and opportunities.[41]

Each management framework includes:

- regional desired objectives
- regional limits and triggers for key indicators (or plans to set them)
- approaches/actions to achieve objectives
- an approach to monitoring, evaluation, and reporting including how to communicate the results to Albertans

Since the frameworks are based on the Regional Plans, they have regulatory backing from ALSA; however, the frameworks do not replace existing regulatory processes.[42] Currently, only two Regional Plans exist (LAR and SSR). For further information on the regulatory details of the Air Quality Management Framework (AQMF), please refer to Appendix D for the SSR, which are similar to LAR.

2.3 Air Quality Management Frameworks

AQMFs are specific types of Environmental Management Frameworks that provide a transparent, systematic, and consistent approach to ambient air quality management in air zones. The CAAQS for NO_2 and SO_2 will be incorporated as regional limits and triggers into the AQMFs. In addition, other identified air quality parameters can be included, monitored, and reported on in the region.

Air Quality Ambient Condition reports and *Status of Management Response* reports associated with the Environmental Management Frameworks and AQMFs are released on a regular basis and can be found on the Alberta government website.[43]
Air Quality Ambient Condition reports provide information on annual monitoring of air indicators compared to established limits and triggers outlined in the AQMF. *Status of Management Response* reports for each Regional Plan are created to provide an update on the activities undertaken by AEP and stakeholders as part of the management response for trigger and limit exceedances under the specific region's air quality and surface water quality management frameworks.

2.4 Acid Deposition Management Framework

Acid deposition takes place when acidifying substances are deposited on the earth's surface. Sulphur dioxide and nitrogen oxides are the main acidifying substances. Deposition of these substances, and their reactive products, to terrestrial or aquatic ecosystems may result in acidification and damage to the ecosystem. Management of acidic deposition requires an integrated approach that includes measurement, estimation of emissions and deposition, and evaluation of the effects of deposition on recipient ecosystems.

Alberta has an Acid Deposition Management Framework (ADMF), which is based on four levels of acid deposition (Appendix A). Each level corresponds to specific management practices. The framework includes regular acid disposition assessments in the province roughly every five years. AEP is revising the ADMF through a multi-stakeholder process. This revision considers all relevant, current scientific research on assessing acidic deposition.

Alberta also conducts and regularly reviews precipitation chemistry and soil acidification monitoring. AEP has an email distribution list for circulating acid deposition-related information to subscribers.[44]

41 https://landuse.alberta.ca/PlanforAlberta/DevelopingFramework/Pages/default.aspx
42 https://landuse.alberta.ca/CumulativeEffects/EnvronmentalMgmtFrameworks/Pages/default.aspx
43 https://www.alberta.ca/environment-and-land-use-planning.aspx
44 https://www.alberta.ca/acid-deposition.aspx

2.4.1 Saskatchewan-Alberta Memorandum of Understanding (MoU)

The current MoU between Alberta and Saskatchewan commits both provinces to work together to:

- understand the state of transboundary air quality
- collaborate to address transboundary issues
- share relevant data and information
- work together to develop and implement a work plan

The first MoU with Saskatchewan, the *Saskatchewan-Alberta Memorandum of Understanding on Acid Deposition*, was signed on June 11, 2002, and expired March 31, 2007. Following its expiry in 2007 several publications and news articles highlighted the need for a revised memorandum to initiate acid deposition data and knowledge exchange between the two ministries. A revised MoU was signed on May 25, 2011, which provided a framework for cooperation between Saskatchewan and Alberta on the understanding and coordination of action on acid-forming substances subject to aerial transport between the two provinces.

In 2017, Alberta and Saskatchewan renewed the MoU until December 31, 2021. The amended 2017 MoU expanded the scope to include understanding the state of transboundary air quality, collaborating on addressing transboundary issues, and sharing relevant data and information.

As outlined in Section 1.4 (Airshed Coordination), the National AQMS includes broad geographical areas called Regional Airsheds, which have been established to coordinate efforts to reduce transboundary air pollution flows and report on regional air quality. Alberta and Saskatchewan are within the Prairie Airshed and both jurisdictions have renewed their focus on the potential effects of acidifying emissions (which includes NO_2 and SO_2 emissions).

2.5 Airshed Organizations

Airshed organizations (Airsheds) are regional multi-stakeholder not-for-profit societies responsible for ambient air monitoring across Alberta, and collectively represent a variety of stakeholders including municipalities, industry, Indigenous communities, federal and provincial governments, community members, and environmental groups.

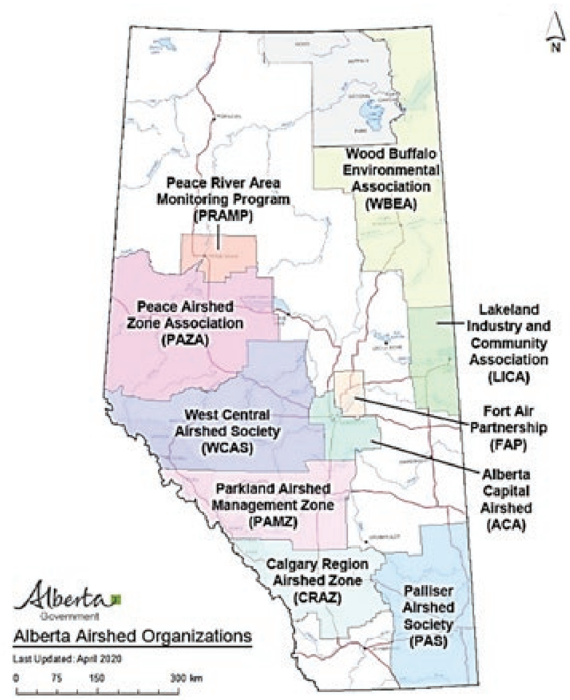


Figure 5: Map of Alberta's Airsheds

Ten Airsheds formed in Alberta between 1996 and 2017. Airsheds currently operate more than 88 air monitoring stations across the province. Each Airshed works within a designated area to monitor, analyze, and provide transparent, credible air quality information available freely through a central data warehouse.[45] A map of Alberta's Airsheds is provided in Figure 5.

Collectively, Airsheds play a significant role in Alberta's overall AQMS and most have well-established regional networks for responding to local and regional air quality concerns. Airsheds also raise awareness, educate, and engage with communities on ambient air quality, and frequently facilitate multi-stakeholder dialogue around air quality issues. Note that Alberta Airsheds should not be confused with air zones nor the Regional Airsheds that are part of the national AQMS described in Section 1.0.

45 Data has undergone quality control and can be searched by station name or parameter, either by multiple parameters one station or one parameter multiple stations. The Alberta Airsheds Council also provides an air quality report, which can be accessed here: https://static1.squarespace.com/static/587f8bd6414fb56f5c11053a/t/5fda4c1a7626c821f275e096/1608141899037/AAC_2019AR_LR.pdf

2.6 Ambient Air Quality Objectives and Guidelines

Alberta's Ambient Air Quality Objectives (AAAQOs) are primarily intended for use by AEP and the AER to:

- determine adequacy of facility design for EPEA approvals, considering all sources in the area (via Air Quality Dispersion Modelling) [46]
- establish required stack heights and other release conditions
- assess compliance and evaluate facility performance

They may also be used to:

- report to Albertans on the quality of the air through the provincial Air Quality Index (AQI)
- enhance the national Air Quality Health Index (AQHI) to include additional pollutants[47]
- guide special ambient air quality surveys
- assess Alberta's air quality through the continuous monitoring network
- plan and manage airsheds
- assess local concerns

In 2000, Alberta Environment (the department) initiated a process for the development and review of AAAQOs as recommended by CASA with participation by industry, government, and public interest groups. Substances for which objectives may be required are prioritized at a multi-stakeholder workshop which are held as needed. Three-year work plans are then developed and implemented for the new or updated ambient air quality objectives or guidelines.

As work progressed, it became clear that there was a distinction between guidelines and objectives, the latter having a different role in the management system than the former.[48] To be consistent with the terminology in EPEA, the understanding at the time was that environmental science-derived numbers were to be called "air quality objectives" while numbers developed as empirical indicators would be called "guidelines." By 2010, the department had grown its set of air quality objectives to include 46 substances.

In 2017 a CASA "Ambient Air Quality Objectives Project Team" was formed to provide AEP with recommendations for new and/or revised AAAQOs for fine particulate matter, ozone, sulphur dioxide, nitrogen dioxide, and hydrogen sulphide/total reduced sulphur, with consideration of: scientific information, health and ecosystem effects, technological factors, and economic factors.

In 2018, consensus recommendations were made for lowering fine particulate matter and ozone AAQOs. CASA transmitted the recommendations to AEP, who then implemented them.

For H_2S and TRS, the AAQO Project Team reached consensus in the following areas:

1. The current 24-hour and 1-hour AAQOs for H_2S are protective of health.
2. The current 24-hour and 1-hour AAQOs for H_2S are not adequate to address odour.
3. Odour issues in Alberta can be a concern and there is a gap in the management tools available to address this issue. A TRS Guideline could potentially bridge this gap.
4. A 30-minute TRS Guideline of 5 ppb (7 µg/m^3) would be useful as an odour management tool.
5. Application of the TRS guideline was outside the mandate of the team and was a barrier to full consensus.

For NO_2, the AAQO Project Team agreed the science supports lowering the AAAQOs for nitrogen dioxide from the current levels to be more protective of human and environmental health; however, consensus could not be reached on revised AAAQO values.

For SO_2, the AAQO Project Team agreed the science supports lowering the 1-hour AAAQO for sulphur dioxide from the current levels to be more protective of human health; however, consensus could not be reached on revised AAAQO values. CASA also provided advice to AEP on how to prioritize substances for review for the next AAAQO work plan.[49]

46 Air quality dispersion models provide estimates of pollutant concentration in ambient air resulting from current or projected future emissions. An air quality dispersion model is a set of mathematical relationships or physical/chemical models that are based on scientific principles. For further information about how AAQOs are used in air dispersion modelling, refer to the guideline "Using Ambient Air Quality Objectives in Industrial Plume Dispersion Modelling and Individual Industrial Site Monitoring" 2013. https://open.alberta.ca/publications/9781460112922

47 The AAAQOs are used in the AQHI to do two things: 1) override the AQHI numerically when AQOs for $PM_{2.5}$, NO_2, O_3, SO_2, and CO are exceeded, and 2) display an odour/visibility message if the AQO for H_2S is exceeded. There is also an odour/visibility message triggered for $PM_{2.5}$ and SO_2, but at concentrations lower than the AAAQO. For information about how the AAAQO goes into the AQHI calculation refer to the website: https://www.alberta.ca/air-quality-health-index--calculation.aspx

48 https://www.researchgate.net/publication/309462681_Dust_Smoke_and_Sour_Gas_The_First_65_years_of_Air_Quality_Management_in_the_Alberta_Government_1945-2010

49 https://www.casahome.org/past-projects/ambient-air-quality-objectives-project-team-52/

2.7 Ambient Air Quality Standards/Indicators/Instruments Comparison

The table below is a comparison of ambient air quality standards, indicators, and instruments applied in Alberta. More information on the Air Quality Index is provided in Appendix C.

	Canadian Ambient Air Quality Standards (CAAQS)	Land-use Framework/ Air Quality Management Framework (LUF/ AQMF)	Alberta Ambient Air Quality Objectives (AAAQO)	Air Quality Index (AQI)	Air Quality Health Index (AQHI)
Purpose	Long-term regional air zone air quality management to improve protection of human health and the environment. Corresponding to each air zone management levels, action plans are published outlining recommended air quality management actions.	Manage air quality regionally with cumulative effects approach. Regions align with LUF planning boundaries, with management responses being place-based. Triggers management response and actions.	Manage air quality provincially and at facility level. Inform *Environmental Protection and Enhancement Act* (EPEA) approvals – model facility impact on ambient air quality.	Evaluate AEP's performance in achieving air quality in its annual report. Inform AEP business planning.	Communicate the health risks of air pollution with the public in real-time to enable planning of daily activities.
Reporting	Annual – through Air Zones reports.	Annual – through Status of Ambient Condition and Status of Management Response reports.	Immediately upon exceedance of an objective and in monthly and annual reports.	Annual – in GoA and AEP annual reports.	Real-time – through web page, smartphone apps, and other services.
Authority	Federal: *Canadian Environmental Protection Act* (CEPA)	*Alberta Land Stewardship Act* (ALSA) Stewardship Minister	Provincial: EPEA Regional Director (if in an approval)	AEP Based on AAAQOs	Federal program: Health Canada; Alberta has a unique role in administering the program.
Number of Pollutants	Four pollutants ($PM_{2.5}$, O_3, NO_2, SO_2)	Varies by LUF region. To date, has included $PM_{2.5}$, O_3, NO_2, SO_2. Others such as non-methane hydrocarbon (NMHC) and total reduced sulphur (TRS) may be included in the future.	57 pollutants	Five pollutants ($PM_{2.5}$, O_3, NO_2, SO_2, CO) Minimum four to five, must include $PM_{2.5}$	Three pollutants ($PM_{2.5}$, O_3, NO_2) across Canada, except Alberta + (SO_2, CO, H_2S, TRS) for Alberta only

	Canadian Ambient Air Quality Standards (CAAQS)	Land-use Framework/ Air Quality Management Framework (LUF/ AQMF)	Alberta Ambient Air Quality Objectives (AAAQO)	Air Quality Index (AQI)	Air Quality Health Index (AQHI)
Data used/ measured	Measured QA/QC data. For each CAAQS pollutant, the highest management level of the two metrics (except O_3) determines the management level for the air zone for that specific pollutant (e.g., hourly or annual for NO_2 and SO_2; 24-hour or annual for $PM_{2.5}$). Stations used are in populated areas (using *Population Improvement Approach*[A]) and areas with significant monitored pollutant sources, or near sensitive ecosystems for NO_2 and SO_2.[B]	In the Lower Athabasca Region (LAR), NO_2 and SO_2 are based on AAAQOs. In the South Saskatchewan Region (SSR), NO_2 is based on AAAQO; $PM_{2.5}$ and O_3 are based on CAAQS. No other regions have LUF/AQMFs.	Real-time data. Reported both before and after QA/QC.[C] Point Source (community and fence line stations). Includes exceptional events – hard limit. Modelled. Not all substances are monitored.	Calculated hourly, based on the previous hour. Single pollutant driven (the pollutant that gives the highest AQI measure for each hour determines the AQI for that hour at that station).	Calculated hourly based on previous 3-hour average. Uses a weighted equation[D] of NO_2, $PM_{2.5}$, and O_3 combined. For Alberta only, there is a substance-specific override: if the 1-hour average AQI is greater than 6 (high or very high)[E] and greater than the AQHI, then AQI-like value is used instead. Real-time data that are not QA/QC.
Metrics	Substance-specific but most include an annual average and a three-year average of short-term peak concentrations. May exclude transboundary flows and exceptional events (e.g., pollution that originated from beyond Alberta's geographic boundaries, forest fires[F]).	Initially based on annual averages and 99th percentiles but moving to adopt CAAQS. May include secondary indicators in future with unique metrics.	Short-, medium-, and long-term averages. Any value in excess of AAAQO is an exceedance.	Percentage of cumulative days of good, fair, poor, or very poor air quality.	Scale 1-10+.
Data Source	Stations that measure the pollutants above (~44 stations in Alberta)[G]	Appropriate stations depending on the region and sources monitored.	All stations in Alberta (>100 stations), including industrial.	~18 stations in urban areas as of 2018.[H]	Community stations measuring the pollutants above (~33). Can include short-term portable sites.

	Canadian Ambient Air Quality Standards (CAAQS)	Land-use Framework/ Air Quality Management Framework (LUF/ AQMF)	Alberta Ambient Air Quality Objectives (AAAQO)	Air Quality Index (AQI)	Air Quality Health Index (AQHI)
A performance indicator[I]	YES and NO Not effective as a short-term air quality indicator because results are only available when the annual assessment is completed and do not account for significant meteorology variation affecting the formation of secondary pollutants like $PM_{2.5}$.	NO AQMFs could be performance indicators but have similar issues to CAAQS and are not currently available for all regions.	YES Only at a facility level.	YES Only for AEP.	NO The risk value reported is related to the pollutant mixture in the AQHI formula rather than an individual pollutant.

A. Population Improvement approach combines ambient air quality data with population distribution. For instance, if a CAAQS is set at x concentration using 10% PIA, and that CAAQS is reached across the country, 10% of the population will experience better air quality.

B. CAAQS for the NO_2 and SO_2 also consider the impacts these pollutants have on acid deposition and critical load acidity in an area. Impacts from acid deposition can include stress or damage to sensitive species of vegetation, such as lichen. Lichen are often used as biological indicators of long-term atmospheric pollution.

C. Exceedances are reported before QA/QC, and all other reporting is QA/QC'd as per the Air Monitoring Directive.

D. AQHI = 1000/10.7 [(exp0.000871[NO_2]-1) + (exp0.000537[O_3] – 1) + (exp0.000487[$PM_{2.5}$] – 1)]

E. Since AQI is on a 1-100 scale and the AQHI is on a 1-10 scale, AEP has updated the AQI formulas in anticipation of an update to the AQI, which would have brought it to a 1-10 scale, and it is these formulas that are used for the overrides.

F. Transboundary flow and exceptional events calculations are optional. Jurisdictions do not have to do these calculations if they do not want to.

G. The CCME Guidance Document on Achievement Determination (GDAD) provides guidance on the stations that should be used for CAAQS reporting. However, the GDAD acknowledges that the number of reporting stations in an air zone will vary depending on several factors. Jurisdictions have the flexibility to use stations they deem appropriate if the associated monitors satisfy the monitoring technology requirements outlined in the GDADs.

H. Stations must have 75% of hourly data per year to be reported on; if not, they are excluded. For this reason, the number of stations used might vary per year if, for example, a station is not functioning.

I. A performance indicator measures the success of management actions the government takes to improve the environment. These performance indicators are monitored to see if the actions have produced the desired changes in condition (e.g., ambient pollutant concentration), pressure (e.g., air emissions) or response (e.g., recycling program efficacy) indicators.

2.7.1 Management of AAAQO Exceedances

Exceedances of AAQOs must be reported as outlined in the Air Monitoring Directive.[50] In addition, whenever an AAAQO is exceeded, AEP is notified by either the monitoring organization or industry, as appropriate. AEP then assesses the possible cause(s) of the exceedance. If corrective action is required, the appropriate regulator (AEP, AER, municipality) ensures this compliance function takes place. Actions include determining and notifying the responsible sources, affected parties, and communities, and determining any requirements to prevent a reoccurrence. If an AAAQO (hourly, daily, or annual) is exceeded, the parties responsible for the identified source or sources (if industrial) are required to submit details of management actions aimed at preventing the event from happening again. In some situations, remedial and preventative actions may be needed to reduce releases from anthropogenic sources.

3.0 PM & Ozone Management Plans

3.1 The Relationship Between PM, Ozone, NO_x, and SO_x

Particulate matter, also known as PM, can be directly emitted from industrial and non-industrial sources, and this is termed primary particulate matter. However, PM can also be formed in the atmosphere from chemical and photochemical reactions with precursor pollutants including ozone, NO_x, and SO_x; this PM is referred to as secondary particulate matter.

The particle size of PM influences the transport of these small pollutants and its inhalation into the respiratory system. PM can be coarse particles (<10 µm/PM_{10}) or fine (<2.5 µm/$PM_{2.5}$).

PM is comprised of millions of different chemical compounds, such as dust, pollen, elemental and organic carbon, and inorganic salts. Amongst the most concerning PM compounds are inorganic salts, such as ammonium nitrates, ammonium sulphates, and secondary organic aerosols as these particulates contribute to smog and acid deposition.[51]

3.2 CASA PM and Ozone Management Framework

In June 2000, the CWS for PM and ozone were published. These new national ambient air quality standards committed governments to reduce PM and ground-level ozone through jurisdiction-specific air quality management plans. Alberta Environment asked CASA to assemble a multi-stakeholder team to develop a framework to achieve the CWS by the 2010 target date. The framework required stakeholders to develop a management plan to prevent future exceedances of CWS.[52]

50 https://open.alberta.ca/dataset/0d2ad470-117e-410f-ba4f-aa352cb02d4d/resource/4ddd8097-6787-43f3-bb4a-908e20f5e8f1/download/aaqo-summary-jan2019.pdf

51 https://www.encyclopedie-environnement.org/en/air-en/air-pollution-particles-what-are-they/

52 https://www.researchgate.net/publication/309462681_Dust_Smoke_and_Sour_Gas_The_First_65_years_of_Air_Quality_Management_in_the_Alberta_Government_1945-2010

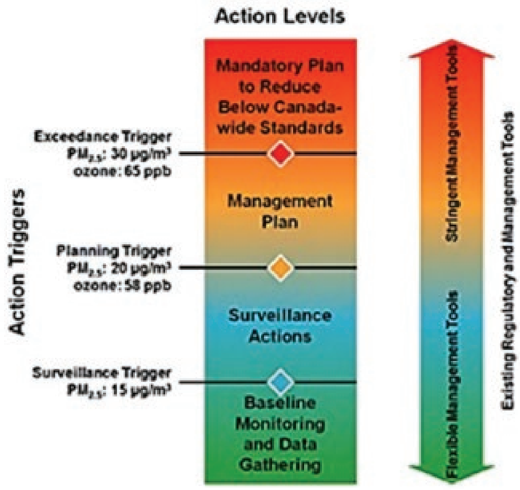


Figure 6: PM and Ozone Management Framework action levels and triggers

The PM and Ozone Management Framework set out four action levels (Figure 6). Each level represented a continuum of analysis and management activities based on measured ambient concentrations in the province:

- baseline monitoring and data gathering
- surveillance
- management plans
- mandatory plans to reduce below the CWS

It took three years to complete the framework, which was developed by representatives from eight industry sectors, four Government of Alberta departments, Environment and Climate Change Canada, municipal governments, Airshed organizations, and key environmental and health organizations.[53]

The Framework established a tiered air quality management system similar to what was subsequently adopted under the AQMS for the CAAQS. The Framework identified the GoA as the lead agency but with Airshed zones also playing a key role in the development of management plans and emitting sources/sectors also having a role in management plan development and implementation.

As such, experience from the application of this Framework has relevance to the possible management approach(es) applicable to addressing the CAAQS NO_2 issue.

Following the development of the framework, data from monitoring stations in the following Airsheds had $PM_{2.5}$ and/or ozone levels that triggered the requirement to develop management plans:

- West Central Airshed Society (WCAS)
- Fort Air Partnership (FAP)
- Parkland Airshed Management Zone (PAMZ)
- Calgary Region Airshed Zone (CRAZ)
- Alberta Capital Airshed (ACA)

AEP hosted several workshops to assist the Airsheds in developing these plans and produced a *Particulate Matter and Ozone Management Plan Guidance* document to provide an understanding of what elements should be included in a PM and Ozone Management Plan.[54] A policy tools document was also developed to inform Airsheds of potential actions that could be taken to reduce $PM_{2.5}$ and ozone called *Air Quality Management Policy Tools Leading Practice Research*.[55]

All plans and frameworks were developed using a multi-stakeholder collaborative process. The multi-stakeholder processes were facilitated either by CASA, Airsheds, or an AEP department. Another characteristic of the plans is that they all used a proactive approach of linking actions to ambient air quality for each contaminant of concern.

3.3 Example: The CRAZ Air Quality Management Plan

In 2001–2003, the assessment of PM and ozone in the Calgary Census Metropolitan Area (CMA) triggered the red action level outlined in the CASA PM & Ozone Framework. This meant that an air quality management plan had to be developed.

53 https://www.researchgate.net/publication/309462681_Dust_Smoke_and_Sour_Gas_The_First_65_years_of_Air_Quality_Management_in_the_Alberta_Government_1945-2010

54 https://open.alberta.ca/dataset/81a5ecb9-734b-4b6a-bf23-823fb6f8b85b/resource/af395d90-f3ed-46ea-a766-9db1a7d8e2ed/download/2007-particulatematterozoneguidance-2007.pdf

55 https://open.alberta.ca/dataset/27147ba3-d6cf-46c6-b720-e764df5e76aa/resource/fabbe8c7-529f-4ed3-8f11-ed4cf7d26d77/download/2007-airqualitymanagementtools-dec2007.pdf

To meet this requirement, the Calgary Region Airshed Zone (CRAZ) was formed in 2007 to lead the collaborative development and implementation of the Particulate Matter and Ozone Management Plan (the Plan). The Plan was submitted to AEP in December 2008 and was approved by the department in early 2009.

3.3.1 CRAZ PM and Ozone and Air Quality Management Plan Implementation

The CRAZ Particulate Matter and Ozone Management Plan is an ongoing plan that is being implemented, reviewed, and updated as required. In 2020, the scope of the plan was expanded to include additional CAAQS indicators (nitrogen dioxide) and the document was rebranded as the "Air Quality Management Plan." The CRAZ Air Quality Management Plan is implemented by the CRAZ Air Quality Management Planning (AQMP) Committee. A few examples of some of the actions led and coordinated by CRAZ AQMP include:

- air quality monitoring and evaluation (led by the CRAZ Technical Committee)
- air quality engagement, education, and outreach (led by the CRAZ Engagement Committee)
- air quality policy review and recommendations (led by the CRAZ Policy & Research Committee)[56]

Figure 7: CRAZ Airshed boundary in relation to the established South Saskatchewan LUF boundary

In addition, the CRAZ AQMP Committee continuously reviews progress made under the Plan and works with stakeholders to update the Plan regularly to ensure its continued relevance for managing air quality in the CRAZ region. For instance, the plan was reviewed and updated in 2011, 2014, and 2019. In addition, CRAZ also regularly publishes an Achievement Report[57], which assesses:

- the achievements since the last Plan
- whether the actions listed in the Plan remain relevant
- whether emerging priority pollutants such as NO_2 are adequately addressed in the Plan
- if the Plan remains in alignment with current provincial policy, such as Air Quality Management Frameworks and their corresponding Regional Plans

The CRAZ Air Quality Management Plan supports the implementation of the SSR AQMF; Figure 7 outlines the CRAZ boundary in relation to the South Saskatchewan Regional Plan boundary.

3.4 Evolution of Alberta Air Management

In 2012, Alberta decided to implement the national AQMS through its Regional Plans as defined under the Alberta LUF, thus replacing the former CASA PM and O_3 Management Framework (Figure 8).

The LUF Regional Air Quality Management Frameworks have strong similarities with the CASA PM and Ozone Management Framework in that they identify numerical triggers and limits and assign a management "level" based on the status of ambient air quality in relation to them.

Nevertheless, it has been recognized that previous management plans (e.g., CRAZ and Capital Region PM and Ozone management plans) that were already underway prior to LUF need to continue to support the implementation of the new Regional Plan Air Quality Management Frameworks and the CAAQS.

56 For examples of the CRAZ proposed actions and recommendations, refer to their 2019 "CRAZ Air Quality Management Plan." The plan outlines the six objectives of the airshed, along with actions under each objective. Actions begin on page 14. For example, under Objective 3, action 1 is to "Develop templates for municipalities that promote/incentivize positive air quality initiatives for urban planning."

57 To see the latest plan and updates, as well as plans and reports, visit the CRAZ website: https://craz.ca/air-quality-management-plan/

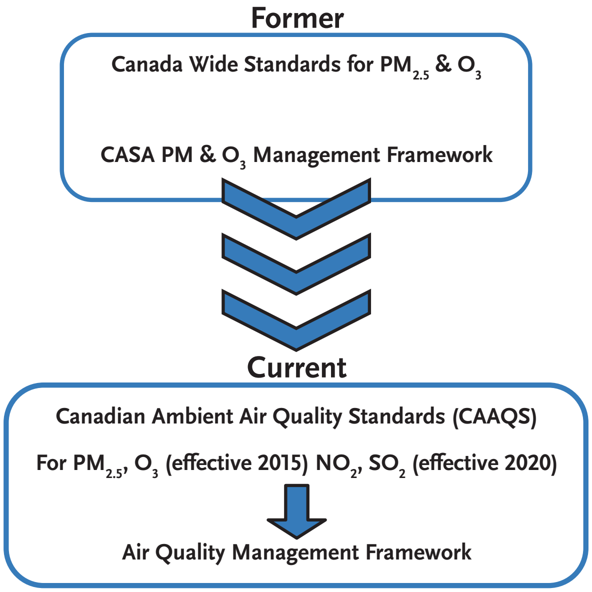


Figure 8: Evolution of air management in Alberta

For management plans that were developed under the previous CASA PM and Ozone Management Framework (e.g., CRAZ and Capital Region PM and Ozone Management Plan[58]), there was no criteria outlining when a CWS/CAAQS related air quality management plan is no longer required, nor evaluation metrics determining if the plans had successfully accomplished its air quality management goals. There is a risk that these plans will continue unnecessarily and/or inappropriately as a legacy of previous, but no longer relevant, policies. Nevertheless, some of the components of previous PM and ozone plans and the associated approaches to managing ambient air quality in the sub-region may be incorporated into future Air Quality Management Frameworks (e.g., the North Saskatchewan Regional Air Quality Management Framework).

3.5 Air Quality Management Frameworks for the Lower Athabasca and South Saskatchewan Regions

In 2012, the Lower Athabasca Regional Plan (LARP) and its associated Air Quality Management Framework (AQMF) were developed, while the South Saskatchewan Regional Plan (SSRP) and AQMF was established in 2014. The Plans apply a cumulative effects approach to managing air quality, along with surface water quality and hydrology (in the case of the LAR). The AQMF provides context for development and related regulatory processes and facilitates sustainable resource management. It is intended to add to and complement, not replace, existing policies, legislation, regulations, and management tools.

Similar to the previous management plans outlined in the CASA PM and O_3 Framework, and the plans developed by Airsheds, the LAR and SSR AQMF has trigger and limit levels with corresponding management actions, increasing in stringency with each level. In the LARP AQMF, the limits and triggers apply to SO_2 and NO_2 and were based on the AAAQO and refers to the process outlined in the CASA PM & O_3 Framework. However, the LARP AQMF does not have triggers for PM or O_3.

Regarding the SSR AQMF, the limits and triggers for PM and O_3 are based on the CAAQS, and the NO_2 limits and triggers are based on AAAQOs, because NO_2 CAAQS had not been established at that time. Unlike the LARP AQMF, SSR does not include SO_2 in its AQMF as it is not a significant concern in the region. Process was intended to provide a proactive air quality management approach which would allow time to address increasing ambient concentrations, before reaching the annual air quality limits for NO_2, SO_2, $PM_{2.5}$, and O_3.[59]

As outlined in the LUF Regional Plans, regions are required to report on Status of Ambient Condition, which includes Status of Air Quality reports. These reports can be found online for both LARP and SSRP.[60]

58 Note, these are two separate plans developed years apart. The ozone plan was developed and lead by a coalition of Airsheds in 2008. The PM response was developed by AEP and released in 2015.

59 Note: the upper range of the hourly data is not a limit, and these levels are used to trigger investigation if higher than normal data is observed.

60 LAR Status of Air Quality report can be accessed here: https://www.alberta.ca/lower-athabasca-regional-planning.aspx and SSR status reports can be viewed here: https://www.alberta.ca/south-saskatchewan-regional-planning.aspx

According to the LAR and SSR AQMFs, it is intended that the CAAQS associated air zone management threshold will be incorporated into the regional air quality management framework.[61]

Management Response
Monitoring and Verification Collect and assess ambient air quality data
Preliminary Assessment Assess each monitoring station against the ambient air quality levels described in this framework
Investigation Assess current and future scenarios of trends in the region
Select Mitigative Management Actions Determine appropriate actions and who needs to act
Delivery of Management Actions Select and apply the most effective management tool(s)
Evaluation Assess implementation of management actions and the performance of each component of the framework
Communication/Reporting Report on the effectiveness of the framework and management tools to stakeholders in the region

3.5.1 Managing Exceedances

Management response and management action have distinct meanings in the context of AQMFs, which are outlined in the following subsections.

Management Response

The management response is a set of steps that will be undertaken (all or in part) if air quality data shows that an ambient air quality trigger or limit has been exceeded (see inset). Part of the management response is determining the need for management actions. Management actions become more stringent as stations are assigned to higher ambient air quality action levels.

The management response begins with verifying whether an ambient air quality trigger or limit has been exceeded. Once this is confirmed, an assessment and investigation is undertaken to identify the source(s) contributing to the trigger level exceedance and the need for management actions. When a need for management action is confirmed, options for action are considered, depending on the trigger exceeded and the trend over consecutive years.

As part of the Management Response process in the environmental management frameworks, regions are required to report on the *Status of Management Response*.[62]

Management Actions

Management actions are specific place-based actions designed to avoid exceeding the limit or maintain or improve air quality. If an ambient trigger is exceeded, steps must be taken to maintain conditions below the limit. If an ambient limit is exceeded, there is a commitment that steps will be taken to return to conditions below the ambient limit. To confirm that desired outcomes are met, AEP is responsible for providing oversight of management actions, evaluating the effects of implementation, and communicating progress toward meeting regional outcomes.

3.5.2 Summary

The CAAQS are used to manage air quality within defined air zones, while under the former CWS management areas were not predefined. Air zone boundaries in Alberta are designed to align with the Land-use Framework regions.

61 Reference to this action can be found is section 4.3.2. in the SSR AQMF: *"The federal government has also set hourly, 24-hour and annual National Ambient Air Quality Objectives (NAAQOs) for NO_2. CAAQS are currently being developed for NO_2 that will replace the NAAQOs and will be phased into this framework's approach as they become available."*

62 LAR Status of Management report can be accessed here: https://www.alberta.ca/lower-athabasca-regional-planning.aspx and SSR status reports can be viewed here: https://www.alberta.ca/south-saskatchewan-regional-planning.aspx

Potential Management Actions and Tools: From least to most stringent

- Education and awareness
- Additional regional monitoring is optional (assessed collaboratively by the environmental and community associations and Alberta Environment and Parks)
- Approval conditions to participate in Airsheds, regional initiatives
- Air quality modelling
- Ambient air quality management plan
- Monitoring networks (continuous, passive)
- First Nations bylaws
- Municipal programs, planning, and policies
- Vehicle emission programs for in-use vehicles
- Memorandum of understanding
- Facility continuous improvement plans
- Economic instruments, including tools to incent
- Municipal bylaws
- Codes of practice
- Revise policies, plans, and performance standards for new or existing sources
- Environmental protection orders
- Enforcement orders and fines
- Approval conditions or restrictions
- Regional planning: mechanisms for managing non-regulated sources
- Emission reduction plans
- Regional growth plans
- Regional emissions or concentration limits for specified substances
- More stringent performance standards or regulations
- Director-initiated approval amendments (in accordance with authority under EPEA)
- Emission reduction requirements
- Restrictions on further industrial emission sources

Reference: Capital Region Air Quality Management Framework, 2012

AQMFs under Land-use Framework Plans currently vary from region to region in terms of which pollutants are covered, and whether CAAQS are incorporated, or if triggers and limits are based on the AAAQOs. The reason for this variation is due to the time difference between when the Regional Plan was developed and when the CAAQS were developed for the various pollutants. It is the intent that the CAAQS associated air zone management thresholds will be incorporated into future regional air quality management frameworks.[63] Land-use Framework AQMFs aim to provide both the structure and mechanisms to assist in managing CAAQS air quality issues.

Each regional plan is at a different stage of development. AEP plans to advance air quality management frameworks developed within each region.

63 Reference to this action can be found is section 4.3.2. in the SSR AQMF: *"The federal government has also set hourly, 24-hour and annual National Ambient Air Quality Objectives (NAAQOs) for NO_2. CAAQS are currently being developed for NO_2 that will replace the NAAQOs and will be phased into this framework's approach as they become available."*

4.0 CAAQS/CWS Management in Other Jurisdictions

4.1 Jurisdictional Review of CAAQS exceedances:

According to the CCME website, numerous provinces' air zones have exceeded the following CAAQS as of 2015:[64]

- $PM_{2.5}$ 24-hr (see Figure 9[65])
  - British Columbia
  - Alberta
  - Quebec
- $PM_{2.5}$ annual
  - Alberta
  - Quebec
- Ozone 8-hr maximum
  - Quebec
  - Ontario

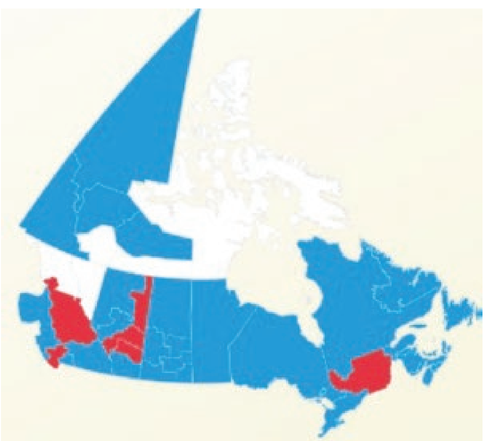


Figure 9: CAAQS exceedances (red) across Canada for $PM_{2.5}$ (24-hour) in 2015

Note that:

- Blue areas = air zones that achieved the 2015 CAAQS.
- Red areas = air zones that exceeded the 2015 CAAQS.
- White areas = insufficient data to determine achievement.

In 2016, AEP contracted Ramboll Environ to conduct an international jurisdictional review of air quality Non-Attainment Areas, called International Review of Non-Attainment Area (NAA) Air Quality Management Tools and Techniques.[66] The conclusions of the study indicated the following:

> *"The federalist system of government in the U.S. is compatible with strong, centralized and uniform national "top down" air quality regulation. Historically, this system developed in response to concerns that many states do not have the political will to impose costly regulations on their own, in part because such states could be placed at an economic disadvantage relative to neighboring states. Nevertheless, states carry much of the burden of implementing the U.S. national regulations and are free to enact more stringent regulations if they so choose".*

The report indicated that the US had the most "extensive, rigorous and rigorously enforced" system for managing air quality. They attribute US success to its legal framework, such as *The Clean Air Act*, and its regulations for implementing the National Ambient Air Quality Standards (NAAQS) that include pollutant-specific monitoring requirements, and clear consequences of NAAQS violations (which was not found in other jurisdictions).

According to the review of international NAA air quality management practices, the recommendations were that Alberta consider the following management system elements in its NAA management system:

- *"Clearly and fully specified (as to level and form) ambient air quality standards (goals, while potentially useful, are generally not in themselves sufficient to drive emission reductions unless coupled to a clear path to achieving attainment);*
- *A firm set of deadlines for achieving attainment;*
- *An open and fair combination of incentives and penalties for missing attainment deadlines;*

64 According to the CCME State of the Air website, "these concentrations can be influenced by human activities originating outside of the province or territory and by exceptional events such as forest fires. Jurisdictions may account for these sources when determining the management levels in the air zones."

65 https://www.ccme.ca/en/air-quality-report#slide-7

66 https://open.alberta.ca/publications/9781460130148

- *A structured set of planning requirements and deadlines for achieving the use of appropriate air pollution prevention/control methods and technologies;*
- *Mandatory, rigorous and transparent data collection and reporting systems, including regularly updated comprehensive emission inventories;*
- *Data analysis (including modelling) programs that meet strict scientific criteria (including peer review) and are sufficient to fully quantify emissions from all sources and identify key source-receptor linkages;*
- *Full public accounting of costs and benefits of air quality regulations;*
- *A strong public outreach program including extensive opportunities for public participation in the decision-making process."*

These, and other, air quality management system elements will need to be assessed and considered when developing recommended strategies to address the NO_2 management plans required under the CAAQS.

4.1.1 United States

The Ramboll review included leading jurisdictions around the world that have well-established, advanced air quality management programs in place, including jurisdictions in Australasia, North America, Asia, and Europe. Below is an excerpt from the report related to the USA.

3.1.14 Summary of the US National Program

As described above, air quality management in the US for non-attainment areas is based on provisions of the Clean Air Act which require that:

1. USEPA develop science-based ambient air quality standards (the NAAQS) adequate to protect public health and welfare;
2. USEPA establish national emission performance standards for new sources (and also for existing sources of hazardous air pollutants for which NAAQS have not been developed) and a requirement that states develop stationary source permitting programs;
3. States develop "infrastructure" SIPs (State Implementation Plans) which establish sufficient regulatory structures and capability (monitoring, permitting programs, etc.) to maintain acceptable air quality;
4. USEPA identify areas in which ambient air quality does not meet the NAAQS;
5. States develop non-attainment area SIPs which include sufficient federally enforceable measures for reducing emissions to a level which will result in attainment as demonstrated by technical analyses (including modelling) within the attainment deadlines specified by the USEPA as required under the CAA; and
6. Enforcement mechanisms to be used in the case that deadlines are not achieved, including required incremental emission reductions and economic sanctions. It should be noted that developing and maintaining the US air quality management program described above has required a considerable investment in technical and regulatory resources needed to support full implementation of the CAA provisions.

3.1.15 Overall Assessment of the US National Program

Overall, the US air quality program has resulted in significant improvement in air quality throughout the country.

A few highlights from the EPA website are:[67]

- Experience with the *Clean Air Act* since 1970 has shown that protecting public health and building the economy can go hand in hand.
- *Clean Air Act* programs have lowered levels of six common pollutants—particles, ozone, lead, carbon monoxide, nitrogen dioxide, and sulfur dioxide—as well as numerous toxic pollutants.
- From 1970 to 2017, aggregate national emissions of the six common pollutants alone dropped an average of 73 percent while gross domestic product grew by 324 percent. This progress reflects efforts by state, local and tribal governments, EPA, private sector companies, environmental groups, and others.
- The emissions reductions have led to dramatic improvements in the quality of the air that people breathe. Between 1990 and 2017, national concentrations of air pollutants improved 80 percent for lead, 77 percent for carbon monoxide, 88 percent for sulfur dioxide (1-hour), 56 percent for nitrogen dioxide (annual), and 22 percent for ozone. Fine particle concentrations/$PM_{2.5}$ (24-hour) improved

67 https://gispub.epa.gov/air/trendsreport/2019/#naaqs

40 percent and coarse particle concentrations/ PM10 (24-hour) improved 34 percent between 2000 (when trends data begins for fine particles) and 2015. (For more trends information, see EPA's Air Trends site.[68])

- These air quality improvements have enabled many areas of the country to meet national air quality standards set to protect public health and the environment. For example, all 41 areas that had unhealthy levels of carbon monoxide in 1991 now have levels that meet the health-based national air quality standard. A key reason is that the motor vehicle fleet is much cleaner because of *Clean Air Act* emissions standards for new motor vehicles.
- Airborne lead pollution, a widespread health concern before EPA phased out lead in motor vehicle gasoline under *Clean Air Act* authority, now meets national air quality standards in most areas of the country.
- State emission control measures to implement the act, as well as EPA's national emissions standards, have contributed to air quality improvements.

4.2 British Columbia (BC)

According to the *Air Zone Management Response for British Columbia* 2019 report, two air zones have exceeded the CAAQS $PM_{2.5}$ in BC since 2012.[69] Figure 10 is a map of the air zones in BC, and Table 6 and Table 7 highlight the CAAQS $PM_{2.5}$ and Ozone levels for each of the air zones.

In addition to the federal government regulations, standards and guidelines that manage emissions from vehicles, engines, fuel, marine vessels, rail, and transboundary issues,[70] the province uses several activities to address red air zone management areas. As outlined in the *Air Zone Management Response for British Columbia 2017* document, the provincial approach to air zone management is to:

- Build upon existing regulations and programs to protect air quality across BC.
- Support additional activities at the local level, with a priority on those areas that exceed the CAAQS (i.e., are at the "red" management level).
- Support local action through early engagement, technical support, and strategic funding to support local initiatives. Local air management plans are a key element of this response.

Figure 10: Map of CAAQS air zones in British Columbia

68 https://www.epa.gov/air-trends

69 https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/air-zone-reports/air_zone_management_response_09-2017.pdf

70 Transboundary emissions are addressed as part of the Georgia Basin – Puget Sound International Airshed strategy as well as through Transboundary project reviews, referrals, and sharing of information across the border.

Table 6: Summary of BC air zone management levels for ozone CAAQS

Air Zone	Three-year Reporting Periods				
	2015-2017	2014-2016	2013-2015	2012-2014	2011-2013
Central Interior	Prince George	Prince George Quesnel	Prince George Quesnel	Prince George Quesnel	Several sites
Coastal	Terrace	Terrace	N/A	N/A	N/A
Georgia Strait	Duncan Whistler	Duncan Whistler	Duncan Whistler	Whistler	Whistler
Lower Fraser Valley	Agassiz Hope Maple Ridge	Agassiz Hope	Hope	Hope	Burnaby Chilliwack Hope
Northeast	Fort St. John Taylor	Fort St. John	N/A	N/A	N/A
Northwest	N/A	N/A	N/A	N/A	N/A
Southern Interior	Kamloops Kelowna	Kamloops Kelowna	Kelowna Vernon	Kelowna Vernon	Kelowna

Table 7: Summary of BC air zone management levels for $PM_{2.5}$ CAAQS

Air Zone	Three-year Reporting Periods				
	2015-2017	2014-2016	2013-2015	2012-2014	2011-2013
Central Interior	Houston Vanderhoof (Valemount – based on 2 years of data)	Houston Vanderhoof	Smithers Vanderhoof	Smithers Vanderhoof	Smithers Vanderhoof
Coastal	Kitimat site	Kitimat sites	Kitimat sites	Kitimat sites[3]	Kitimat Terrace
Georgia Strait	Courtenay	Courtenay Port Alberni	Courtenay Duncan Port Alberni	Courtenay Duncan	Courtenay Duncan
Lower Fraser Valley	Several sites	Several sites	Langley Abbotsford	Several sites	Several sites
Northeast	Fort St John	N/A	N/A	N/A	N/A
Northwest	N/A	N/A	N/A	N/A	N/A
Southern Interior	Several sites	Several sites	Several sites	Several sites	Castlegar Kamloops Vernon

4.2.1 Provincial Responsibilities/ Initiatives

The BC government has several regulatory and non-regulatory tools that support Airshed management and improving air quality throughout the province.

Regulatory:

- *Environmental Management Act*
  - The province primarily regulates air emissions for industrial sources and emissions through this act. This enabling legislation also has several regulations that govern the release of air contaminants in BC. These regulations cover asphalt plants, agricultural waste, fuel

and gasoline, motor vehicle emissions, oil and gas waste, open burning, ozone depleting substance, solid fuels burning appliances, and wood residue incinerators.

- Solid Fuel Burning Domestic Appliance Regulation sets standards for wood burning appliances and helps manage $PM_{2.5.}$
- Open Burning Smoke Control Regulation governs the burning of vegetative material resulting from activities such as land clearing and forestry operations. The regulation encourages vegetative reuse and sets conditions to minimize smoke releases.

Non-Regulatory:

- BC Air Quality Objectives[71]
  - Set air quality standards for common air contaminants and provides air quality data to the public through the BC Air Quality website; a list of the Air Quality Objectives is available online.[72]
    - In 2020, BC published a "Provincial Framework for Developing Air Quality Objectives"[73] which outlines how it plans to set provincial AQOs where CAAQS exist:
      - Where CAAQS exist, CAAQS and supporting science assessments provide the basis from which provincial AQOs are developed. The Ministry will then assess the need to adopt more or less stringent AQOs than the CAAQS provide, based on BC-specific factors that include: vulnerable populations and other sensitive receptors in BC, achievability, and how AQOs are or will be applied in the province.
      - Where CAAQS do not exist, criteria from leading Canadian/US jurisdictions and supporting documentation provide a practical starting point for provincial AQO review or development.
- Woodstove Exchange Program
  - A provincial initiative available to communities. The program is designed to encourage the change-out of older wood stoves for appliances with lower emissions.
- Municipal bylaw model for backyard burning[74]
  - This document helps local government efforts to control smoke. The government also created an inventory of air quality bylaws that exist in BC.
- Other
  - Diesel bus retrofits, setting emission reductions for heavy duty vehicles, reducing fleet emissions, phasing out beehive burners, working toward improved emission technologies for industry, and developing biomass burning emission limits for electricity generation and industrial operations.

Additional examples of actions taken (listed in the Cowichan's Regional Air Protection Strategy) are:[75]

- Raise public awareness on the health impacts of wood smoke, the alternatives, best practices, and rules.
- Develop consistent Airshed-wide regulatory approach for open burning.
- Contribute to provincial efforts to control wood smoke through participation in wood smoke strategy discussions.
- Explore options for a curbside pickup of yard and garden materials to overcome barriers to open burning alternatives.

4.3 Ontario

Consistent with the national AQMS, Ontario delineated air zones as part of managing air quality in the province (see Figure 13 for a map of Ontario's air zones). The delineation of air zones was based on factors such as air emissions sources, geography/topography, population density, rural/urban considerations, existing local actions impacting air quality, and pollution levels. This led to the creation of the following category system for delineating air zones:

- Category/Air Zone 1 – Areas with limited pollution from either point or non-point sources

71 Metro Vancouver has also established air quality objectives that apply within its region.

72 https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/prov_aqo_fact_sheet.pdf

73 https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/provincial_framework_for_developing_provincial_air_quality_objectives_-_info_sheet.pdf

74 https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/prov_air_qual_objectives_fact_sheet.pdf

75 https://www.northcowichan.ca/assets/Departments/Engineering/PDFs/CVRD%20Airshed%20Protection%20Strategy.pdf

or transboundary influence where the air quality management activities are focused on maintaining good air quality.

- Category/Air Zone 2 – Areas under pressure from multiple sources including non-point sources, smaller point sources, individual large industrial point sources, and transboundary influences, where air quality management activities are focused on multiple broad-based initiatives targeting many sources.
- Category/Air Zone 3 – Areas with a concentration of large industrial sources where air quality management activities are focused on the abatement of local industrial emissions as well as non-industrial sources.

According to Ontario's 2017 Air Quality Report, over the period of 2008–2017, the province had decreased its NO_x emissions by approximately 33%.[76]

Table 8 summarizes additional air quality and emission trends in Ontario. The primary reductions have been from emissions reductions in the transportation sector.

Despite these reductions, only 5 of 23 CAAQS designated areas meet the CAAQS for ozone in 2017. The report states:

> *"... while ambient concentrations have improved, the province continues to experience high levels of ozone due to transboundary air pollution, increasing global background levels, and reduced scavenging effect which has contributed to exceedances of the ozone CAAQS."*[77]

Table 8: Trends in Ontario's ambient air concentrations and air emissions from 2008–2017 (APEI)

Pollutant	Concentrations	Emissions
NO_2/NO_x	↓25%	↓33%
SO_2	↓46%	↓52%
$PM_{2.5}$	↓11%	↓16%

4.3.1 Management of NO_x emissions in Ontario

According to the Air Pollutant Emissions Inventory (APEI) 1990–2017 data, approximately 70% of Ontario's NO_x emissions come from the transportation sector, as illustrated in Figure 14. The Ontario government attributes most of these NO_x reductions to numerous management actions the province has taken over the years; however, the transportation initiatives of the federal government likely also contributed to the emission reductions. For further details on specific subsectors listed in Figure 11, refer to Appendix E.

76 https://www.ontario.ca/document/air-quality-ontario-2016-report

77 Although NO_x is a precursor to ozone, studies have shown that significant decreases of NO_x, under certain environmental conditions, can also increase ozone concentrations, by "[reducing] the amount of O_3 quenched through NO_x titration." For more information, see https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4988408/.

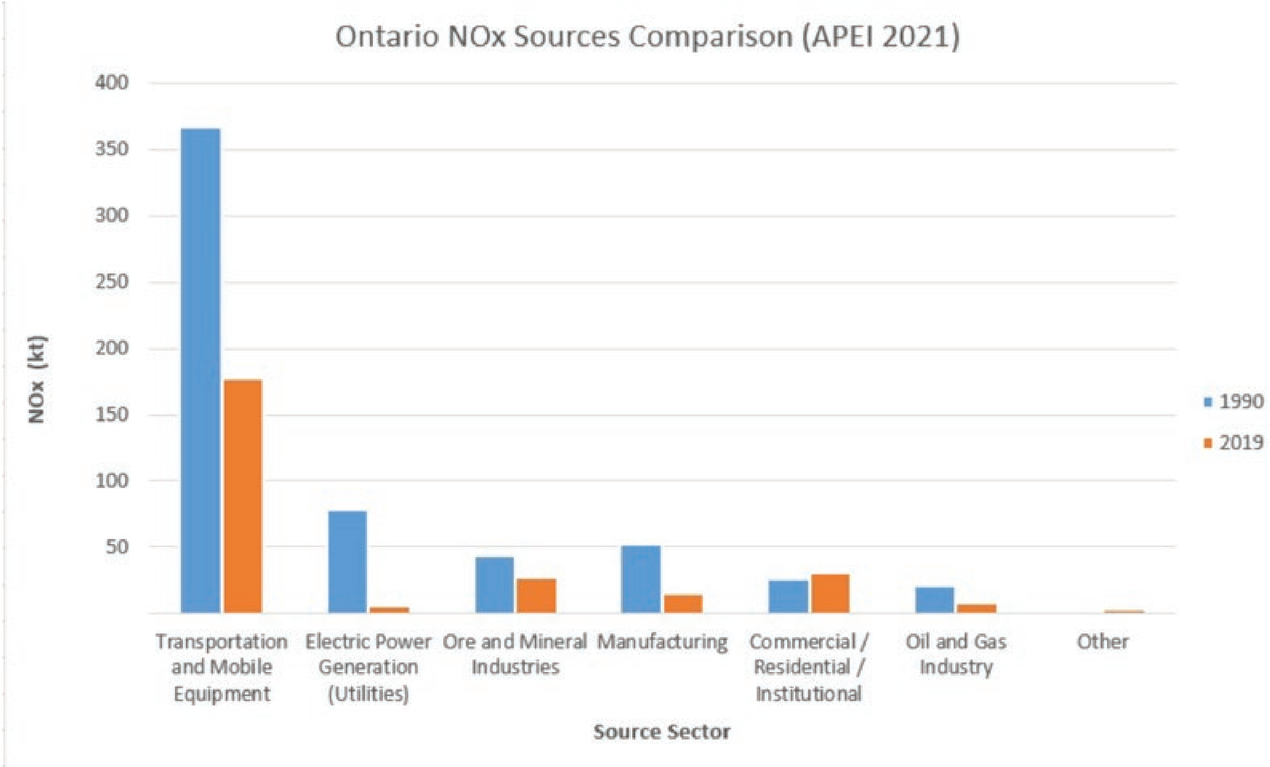


Figure 11: Ontario's NO_x emission estimates by sector in 1990 and 2019

Some examples of the management actions that Ontario implemented include:

- The phase-out and banning of coal-fired generating stations.
- Nitrogen oxides and sulphur dioxide emissions cap and trade regulations (O. Reg. 397/01 and O. Reg. 194/05). Note: this regulation was repealed in February 2021.
- This program was introduced in 2000 and resulted in a large reduction in emissions in the early years of the program.
- Setting new and updated air standards through the local air quality regulation (O. Reg. 419/05).
- Regulating industrial emissions through the site-specific standard and technical standard compliance options under O. Reg. 419/05.
- Establishing emissions controls at Ontario smelters through site-specific standards under O. Reg. 419/05.
- Drive Clean testing of vehicle emissions.
  - This program succeeded in reducing NO_x by requiring regular emission testing for heavy-duty vehicles, commercial trucks, buses, and regular passenger vehicles. This program was regularly enforced by on-road enforcement officers. However, after 20 years, the program was cancelled in April 2019 for passenger vehicles, while heavy diesel commercial motor vehicles continue to require an emissions test.[78]
- The Air Contaminants Benchmarks List itemizes approximately 5,100 contaminants with corresponding benchmarks (standards, guidelines, or screening levels) used by facilities to assess their contributions of a contaminant to air. This information is primarily used to complete an Emission Summary and Dispersion Modelling (ESDM) report under *Ontario Regulation 419/05 or Ontario Regulation 1/17.*[79]

78 https://www.ontario.ca/page/vehicle-emissions-test

79 If a B1 value is exceeded, the facility is required to carry out specific actions. See section 28 of *Ontario Regulation 419/05* for actions. If a B2 value is exceeded, or if no B2 value is available, the regulations require potential adverse effects to be assessed.

Table 9 highlights anticipated additional management activities for each of Ontario's air zones, as outlined in a 2016 presentation.[80]

Table 9: Anticipated management activities for Ontario's three Air Zones

Zone	Anticipated Types of Management Activities
Zone 1	Proactive air management measures, such as: • Ongoing regional and locally focused air quality monitoring • Implementation of regulatory framework for air emissions (including O. Reg. 419) • Public education and reporting
Zone 2	Early and ongoing actions for continuous quality improvement, as well as targeted, active efforts such as: • Ongoing programs and initiatives (e.g. Drive Clean) and targeted compliance and inspection efforts • Collaborative work with other jurisdictions (U.S. & Quebec in particular) • Site specific orders and standards • Emissions inventories • Stakeholder engagement and community involvement
Zone 3	Advanced air zone management actions and strategies, such as: • Implementation of the Local Integrated Air Strategy • Community-specific action plans and activities • Public education and reporting on status and progress • Frequent, proactive inspection of facilities

4.4 Quebec

According to the CCME website:

> *"Although Québec supports the general objectives of the AQMS, it will not implement the system since it includes federal industrial emission requirements that duplicate Québec's regulation. However, Québec is collaborating with jurisdictions on developing other elements of the system, notably air zones and airsheds."*

The 2018 Quebec NCQAA (CAAQS) air report (roughly translated) outlines initiatives Quebec has implemented to control the sources of $PM_{2.5}$ emissions and precursors of O_3 on its territory. Note there may have been subsequent changes or updates to these policies since this 2018 document was released:[81]

- The 2013–2020 Climate Change Action Plan with more than half of the funds from the action plan reserved for the promotion of public and alternative transport by improving supply, developing infrastructure, and facilitating sustainable choices.[82]
- The Heavy Motor Vehicle Inspection and Maintenance Program (PIEVAL) aims to improve air quality, particularly in urban areas, by reducing air quality emissions of particulate, volatile organic compounds (VOCs) and carbon monoxide (CO) produced by heavy vehicles.[83]
- The Wood Heating Devices Regulations (ERRs), which came into force on September 1, 2009, stipulate that only high-efficiency wood stoves meeting the design criteria of the Canadian Standards Association (CSA) or United States Environmental Protection Agency (USEPA) can be manufactured, distributed, sold, or offered for sale in Quebec.[84]

80 https://cleanairpartnership.files.wordpress.com/2016/01/20160401-azd-gtacac.pdf
81 https://www.environnement.gouv.qc.ca/air/particules_ozone/rapport2018.pdf
82 www.environnement.gouv.qc.ca/changements/plan_action/pacc2020.pdf
83 www.environnement.gouv.qc.ca/air/pieval/index.htm
84 https://www.environnement.gouv.qc.ca/air/chauf-bois/index.htm

- The Clean Air Regulations (RAA), which came into force on June 30, 2011, is a framework, or more precisely, a multi-sector regulation, targeting several industrial sectors. It includes emission standards and standards for ambient air quality (concentration in ambient air).[85]
- The Industrial Waste Reduction Program (RRIP) aims to make releases consistent with the ability of the receiving media to accommodate, gradually reduce releases, and move towards sustainable industrial production. It is aimed at major industrial establishments covered by regulations and is a continuous improvement process.[86]
- Finally, Quebec publishes on an annual basis an update of this report to communicate on the state of ambient air quality.

5.0 Inventories of NO_x Emission Sources

5.1 Federal Air Pollutant Emissions Inventory (APEI)

The APEI is a comprehensive inventory of air pollutant emissions at the national and provincial/territorial levels. The first national inventory of air pollutant emissions in Canada was compiled in 1973. The APEI is prepared and published by Environment and Climate Change Canada (ECCC) on an annual basis.[87] Facility emissions data captured in the APEI originate primarily from the National Pollutant Release Inventory (NPRI). However, unlike the NPRI, it is also supplemented with data provided by provincial governments (Alberta, Manitoba, New Brunswick, Newfoundland and Labrador, Ontario, and Quebec) and includes non-industrial sources like transportation.

The following results from 2019 data were outlined in the APEI 2021 report:

- Approximately 1.6 Mt of NO_x were released in Canada in 2019.
- Transportation and mobile equipment were the largest contributors, accounting for 48% (778 kt) of total NO_x emissions.
  - Heavy-duty diesel vehicles, marine transportation, and off-road diesel vehicles and equipment were the largest emitters, collectively contributing 31% (506 kt) of total NO_x emissions.
- The oil and gas industry accounted for 30% (481 kt) of total NO_x emissions in 2019, with the upstream oil and gas industry accounting for nearly all the oil and gas industry total (466 kt).
- Electric power generation (utilities) contributed 8% (125 kt) of total NO_x emissions, with coal-fired generation contributing 5% (88 kt) of the national total.
- The remaining 14% of NO_x emissions were distributed across multiple sources.

The APEI 2021 report illustrates the four major contributors to Canada's NO_x emissions. Overall, national NO_x emissions decreased by 29% (657 kt) from 1990 to 2019, mainly due to a decrease in emissions from light-duty gasoline trucks and vehicles. However, as Figure 16 and the report indicates:

> *"The upstream oil and gas industry and Domestic Marine Navigation, Fishing and Military are the only major contributors to NO_x emissions that experienced an increase in emissions across the time series. This increase is attributed to expansion and growth in the oil and gas industry and an increase in marine activity."*

85 https://www.environnement.gouv.qc.ca/air/atmosphere/raa.htm
86 https://www.environnement.gouv.qc.ca/programmes/prri/index.htm
87 http://publications.gc.ca/collections/collection_2021/eccc/En81-30-2019-eng.pdf

Table 10: Most significant changes in national NO_x emissions from 1990 to 2019 (APEI, 2021)

Contributor	% change (kt)
Transportation and mobile equipment	40% decrease (511 kt)
Off-road diesel vehicles and equipment	54% decrease (180 kt)
Light-duty gasoline trucks and vehicles	58% decrease (170 kt)
Rail transportation	42% decrease (70 kt)
Electric power generation (utilities)	51% decrease (132 kt)
Coal-fired generation	57% decrease (155 kt)
Oil and gas	39% decrease (135 kt)
Upstream oil and gas	50% increase (155 kt)
Downstream oil and gas	56% decrease (20 kt)

According to the 2021 APEI data, Alberta contributed to 42% of Canada's total NO_x emissions in 2019, followed by Ontario (16%), British Columbia (13%), and Quebec (10%) (Figure 12). Since 1990, the largest NO_x reductions have been from New Brunswick (64%), Ontario (54%), and Nova Scotia (51%), while Alberta and Saskatchewan are the only provinces that saw NO_x emission increase since 1990 (AB 3%, SK 5%).

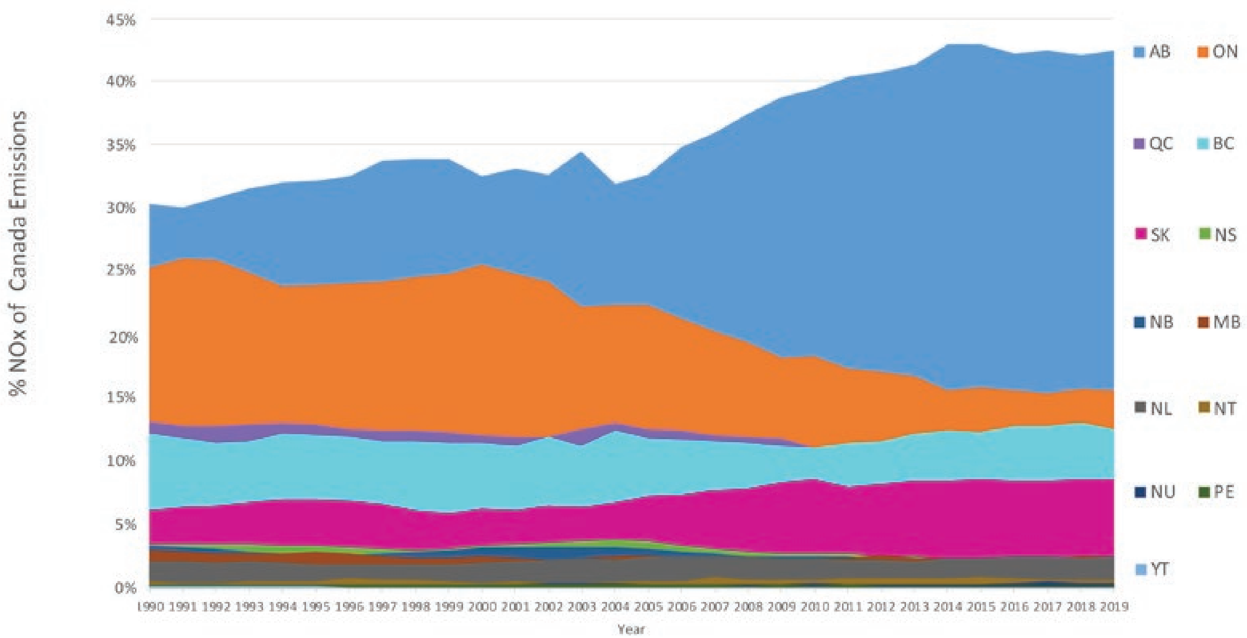


Figure 12: Annual NO_x emissions by province (APEI 2021)

Figure 13 and Figure 14 show the breakdown of NO_x emissions in Alberta. Industrial sources account for 74% of NO_x emissions in Alberta, while non-industrial sources account for 26% of emissions. Looking at individual sectors, the conventional oil and gas sector was the largest source of NO_x emissions in Alberta, with 45% of emissions. The transportation sector was the second largest source of NO_x emissions in Alberta, with 24% of emissions. The oil sands and electric power sectors were the next largest sources of NO_x emissions in Alberta, with 17% and 7% respectively. Various other industrial and non-industrial sectors together made up the remaining 7% of 2019 NO_x emissions in Alberta.

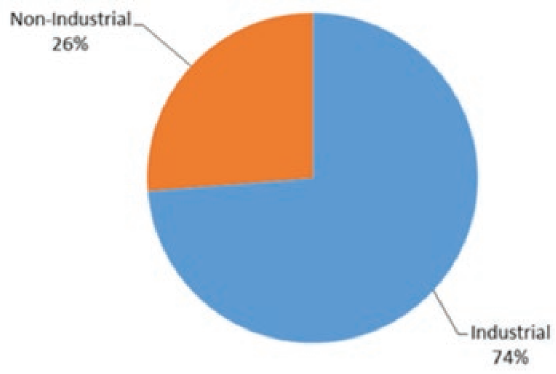


Figure 13: Percentage of NO_x emissions in Alberta from industrial vs. non-industrial sources (2019 APEI and AEP data)

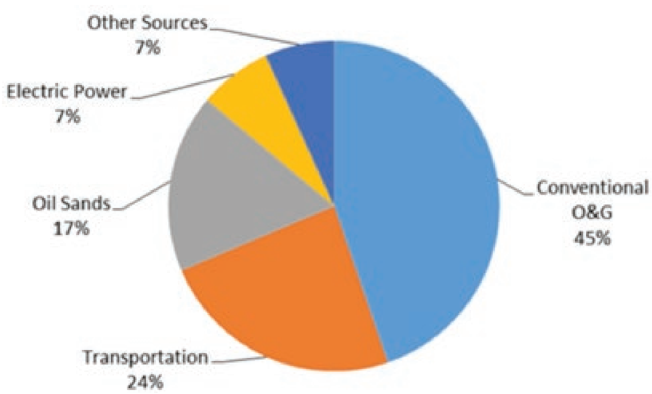


Figure 14: NO_x emission sources in Alberta (2019 AEP and APEI data)

5.2 Federal National Pollutant Release Inventory (NPRI)

Since 1993, the NPRI has collected data from Canadian industrial, commercial, and institutional facilities on the pollution they release to the air, water, and land. The NPRI also collects data about the disposal, transfer, and recycling of pollutants. Facilities that meet specific reporting requirements must submit a report each year.

Based on 2019 data from the NPRI, Alberta accounted for over 50% of the facilities that reported NO_x emissions for all of Canada and for the amount of NO_x reported to be released to the atmosphere (Table 7).

Table 11: Number of facilities and NO_x emission data reported to the NPRI for Canada and Alberta (2019)

	Canada	Alberta
Number of facilities that reported to the NPRI	7,632	3,029 (40%)
Number of facilities that reported NO_x emissions	3,513	2,005 (57%)
NO_x reported to be released to the atmosphere (kt)	560	294 (52%)

As shown in Figure 15, facilities in the oil and gas sector accounted for 44% of all Canadian NO_x emissions reported to the NPRI for 2019. The manufacutring and electric power sectors were the second and third largest sources of reported Canadian NO_x emissions with 23% and 22%. Various other setors emitted the remaining 11% of reported Canadian NO_x emissions.

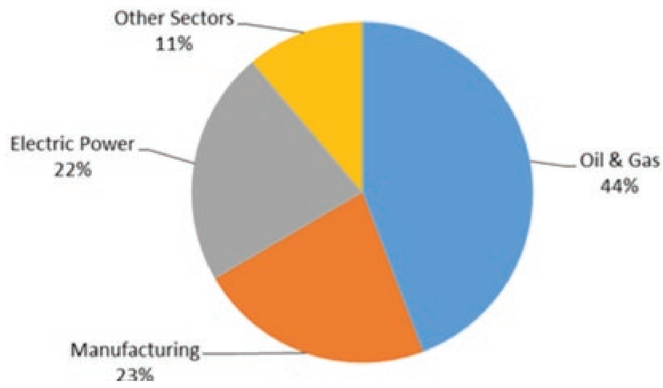


Figure 15: NO_x emission sources in Canada (2019 NPRI data)

5.3 Alberta Annual Emissions Inventory Reporting (AEIR) Program

The Government of Alberta requires reporting on air emissions from industrial facilities that exceed set reporting thresholds. The AEIR Program has been specifically designed to capture detailed source-level emissions data and other required information for large emitting industrial facilities in Alberta. The AEIR is intended for regulatory management in Alberta, as well as for:

- policy development
- air quality modelling
- scientific assessments
- regional planning
- responding to specific Alberta air quality issues

For the 2018 inventory year, 301 of the 335 AEIR facilities reported non-zero amounts of NO_x emissions. Together these facilities reported a total of 203 kt of NO_x emissions. The average reported facility total for NO_x emissions was 673 tonnes/year. 32 facilities reported emitting greater than 1,000 tonnes/year of NO_x in 2018, with these 32 facilities together emitting about 76% of the total AEIR facility NO_x emissions reported in Alberta.

The AEIR Program differs significantly from national inventories like the APEI and NPRI, in terms of both purpose and scope. The APEI and NPRI are not intended for specific provincial regulatory purposes, or for air management within specific jurisdictions. The purposes of the NPRI and the APEI are to be public sources of pollutant release information for Canada and to satisfy various international reporting obligations.[88]

The APEI covers all anthropogenic sources, but only provides air emission totals for entire provinces and territories. The NPRI also has a broader scope than the AEIR Program. For instance, it includes emissions from non-EPEA regulated sectors, covers many additional substances, and goes beyond just releases to air.[89] However, regarding industrial air emissions, the NPRI collects less detailed information in the form of facility total annual emissions. Therefore, no source specific information is available on equipment, pollution control technologies, or minimum and maximum emission rates. The AEIR program collects annual emissions data from a variety of point and non-point sources at each reporting facility. Three types of emission rates are captured by the AEIR Program:

- annual actual air emission rates (in tonnes/year for each source for the specific inventory year)
- normal air emission rates (in tonnes/day and representing normal operation for the source)
- maximum air emission rates (in kg/hour and representing maximum potential operation/emission for the source)

The AEIR Program does not collect air emissions data of individual substances for a specific hour nor monthly; however, facilities with source monitoring requirements do separately submit source monitoring results to the Government of Alberta, as per their EPEA approval requirements. Some on-site sources are also excluded from NPRI reporting and consequently, in some instances, the NPRI under-reports a facility's emissions that the AEIR Program captures. It is estimated that the 2018 AEIR dataset accounts for 90% of total Alberta SO_2 emissions and 30% of total NO_x emissions. Table 12 compares the AEIR Program to the NPRI in terms of scope, source, and modelling information.

88 According to the ECCC website, NPRI and APEI intended for the following purposes:
"Contributing to tracking and quantifying air pollutants in accordance with Canada's domestic and international reporting obligations; supporting the development of domestic air quality management strategies, policies and regulations; informing Canadians about pollutants that affect their health and the environment; and providing data to support air quality forecasting."

89 See link for further information about which facilities need to report to the NPRI, what data is collected and the methods used: https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/frequently-asked-questions.html

Table 12: Comparison of AEIR and NPRI scope, source, and modelling information

Category	NPRI	AEIR
Scope		
Alberta facilities covered	~3,000	350-400 EPEA approved
Reportable substances	320	71
Type of releases	Aggregate air, water, land	Disaggregated air
Transfers and disposals	On- and off-site	Not required
Provincial IDs	Voluntary and incomplete/incorrect	EPEA approval and AER
Equipment information	None	Identification, make, model, year
Pollution controls	Only identification of any new pollution reduction efforts at the facility	Installed pollution controls, make, model, year, targeted pollutants, effectiveness
Employee threshold criteria	Some only need to report emissions from combustion sources if <10 employees	No employee threshold
Facility definition	NPRI program-specific	Individual approval specific
Responsible party	Operator	Owner (approval holder)
Source Information		
Stack level of detail	Aggregated facility total, stacks >50 m	Disaggregated (all individual stacks and non-point sources)
Stack parameters	Only for stacks > 50 m	All stacks
Spatial information	Facility location and any stacks > 50 m	Locations for individual stacks, polygon/line for non-point sources
Non-point level of detail	4 combined non-point categories	24 non-point categories
Non-point description	None	Type, shape, area, height, release temperature
Special non-point source breakdowns	None	Storage tanks, storage piles, mine fleet, mine face, and tailings ponds
Sources excluded	On-site transportation	None, but can exclude some small sources deemed negligible
Modelling Information		
Individual stacks, parameters, locations	Only stacks > 50 m	Individual stacks and non-point sources
SCCs	None, defaults assigned by ECCC to > 50 m stacks and to the combined entire facility	Individual stacks and non-point sources
Temporal information	Facility only	Individual sources different from facility and typical frequencies
Building dimensions	None	Yes, for facilities potentially causing downwash
Types of modelling	Only large-scale regional, cannot be used to represent the proponent facility's sources and emissions when doing regulatory dispersion modelling in Alberta	Yes, intended for both dispersion and photochemical modelling at various levels

5.4 AEP 2016 Provincial Emissions Analysis for CASA NPS Project

As part of CASA's 2018 report *Recommendations to Reduce Non-Point Source Air Emissions in Alberta* an additional technical report was completed called *A Knowledge Synthesis of Non-Point Source Air Emissions and their Potential Contribution to Air Quality in Alberta: Final Technical Report to the Non-Point Source Project Team*. Both are within the final report, available on the CASA website.[90]

The technical report highlights some of the findings from a 2016 AEP analysis of major non-point sources in Alberta. Specifically, the study aimed to synthesize what is known about point and non-point source emission inventories, retrospective trends in emissions for 2000–2014, and emissions forecasting in relation to non-achievement of ambient $PM_{2.5}$ and O_3 CAAQS standards in Alberta's Air Zones.

The 2016 AEP analysis focused specifically on directly emitted (primary) fine particulate matter emissions ($PM_{2.5}$) and did not include information on quantities of secondary fine particulate matter or ozone that are formed in the atmosphere. The report did provide information on emissions of precursor substances that contribute to the formation of secondary fine particulate matter and ozone. This included emissions of nitrogen oxides (NO_x), sulphur dioxide (SO_2), total non-methane volatile organic compounds (VOCs), and ammonia (NH_3).

According to the 2016 study, which relied on 2014 inventory data,[91] industrial sources accounted for 70% of the province's total anthropogenic NO_x emissions in 2014. Transportation sources were the second largest source of NO_x emissions, representing 28% of Alberta's anthropogenic emissions.

The 10 largest NO_x emitting sources in Alberta accounted for over 94% of 2014 total Alberta anthropogenic NO_x emissions, which are listed and ranked in Table 13. The table includes several non-industrial source categories (non-industrial off-road use of diesel, heavy-duty diesel vehicles, rail transportation, light-duty gasoline trucks, air transportation, and light-duty gasoline vehicles). The list of largest NO_x sources also includes four industrial source categories: upstream petroleum (including oil sands), electric power generation, chemicals, and petroleum product transportation and distribution.

Table 13: Ten largest sources of NO_x emissions in Alberta

Rank	Sector Category	2014 AB NO_x Emissions (kt)	% of 2014 AB Anthropogenic Total
1	Upstream Petroleum Industry (including oil sands)	343.3	50.1%
2	Electric Power Generation	82.1	12.0%
3	Off-road use of diesel	56.7	8.3%
4	Heavy-duty diesel vehicles	51.0	7.4%
5	Rail Transportation	50.9	7.4%
6	Light-duty gasoline trucks	17.2	2.5%
7	Chemicals Industry	13.5	2.0%
8	Petroleum Product Transportation and Distribution	10.2	1.5%
9	Air Transportation	9.4	1.4%
10	Light-duty gasoline vehicles	8.9	1.3%

90 https://www.casahome.org/past-projects/non-point-source-project-team-37/

91 Data sources include: 2014 APEI, 2000-2014 EPEA Industrial approvals for oil sands mining, 2008 Alberta Emissions Inventory, 2011 Clearstone oil and gas emissions inventory, 2014 NPRI for industrial source vs. non-point source comparison.

Total Alberta anthropogenic NO_x emissions are estimated to have decreased by 9% between 2000 and 2014 and were projected to remain fairly constant over the next 20 years. However, some individual air zones, such as those with oil sands development, may see increases in NO_x emissions associated with additional industrial development. Figure 16 shows the total Alberta NO_x emissions from transportation sources for 2000 to 2014 and the projected NO_x emissions from 2015 to 2035.[92]

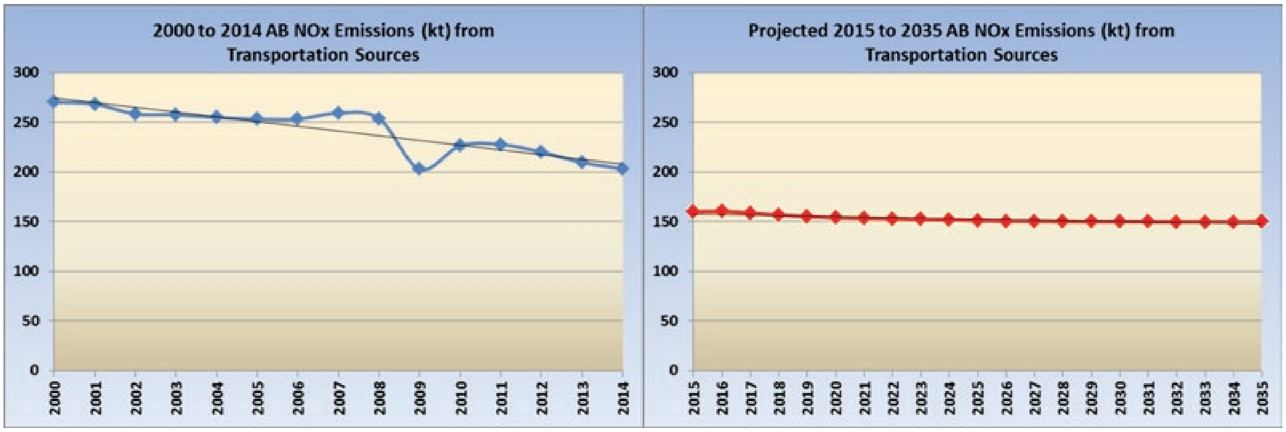


Figure 16: Historical time series and projections of Alberta's NO_x emissions from transportation sources

5.5 Provincial Acid Deposition Management Framework Assessments

NO_x and SO_2 emissions represent the major sources of acidifying emissions in Alberta. Future provincial ADMF assessments can potentially provide information on possible priorities for NO_x emission management from the standpoint of acid deposition.

Provincial acid deposition management assessments are conducted to answer the following questions (AEP, 2008):[93]

- What is the current provincial situation regarding acid deposition?
- Are large areas of the province at risk due to deposition of acidifying substances?
- Are there changes in acid deposition patterns over the long-term that indicate that harmful effects may occur in some areas of the province in the foreseeable future?
- Are activities in Alberta negatively impacting the environment in the neighbouring jurisdictions?

The framework prescribes a five-year assessment cycle involving:

- model estimation of Potential Acid Input (PAI) in each 1° latitude by 1° longitude grid cell
- evaluation of the model-based PAI predictions
- review and revision (if needed) of the receptor sensitivity database
- comparison of PAI to receptor sensitivity
- review of science gaps and recommendations

The Acid Deposition Assessment Group (ADAG) was established by AEP to guide the assessment and review the framework. The ADAG consists of representatives from government, industry, and environmental organizations. The most recent assessment was in 2011 and published in 2014. The acid deposition assessment report and results can be found online.[94]

The draft revised Acid Deposition Management Framework (2021 ADMF) public comment period was closed on September 14, 2020. AEP is currently reviewing the feedback received during the public review of the revised Framework. A document is being prepared which contains responses to the comments and questions from the review and identifies any changes made in response to feedback.

92 Note that there is a 50 kt discrepancy between 2014 NO_x emissions from transportation and projected 2015 to 2035 NO_x emissions levels. This may be the result of a different base year and inventory dataset being used for the projections, or potentially due to differences in the source categories used in the inventory and projections.

93 https://open.alberta.ca/publications/9780778567264

94 https://open.alberta.ca/dataset/9eddc860-9121-4b0b-a919-a2c7d72badf8/resource/b1b0255d-3a37-4eb5-a728-946e6450959e/download/2014-2011aciddepositionassessment-jul2014.pdf

5.6 Provincial Air Quality Photochemical Modelling Report

The Community Multi-scale Air Quality model (CMAQ) is a photochemical grid model that is capable of predicting ground-level concentrations of both primary and secondary pollutants. CMAQ has been used in numerous photochemical modelling studies in Alberta in the past (Cho et al., 2012 A&B). Three recent CMAQ studies (two by Alberta Environment and Parks [2014, 2015] and one by the Parkland Airshed Management Zone, 2017) were used to parameterize CMAQ for operation in central Alberta's climate using the best available emissions inventory.

Recently, this type of modelling was conducted by AEP in 2018 via a consultant. This particular CMAQ study looked to predict ground-level concentrations of O_3, $PM_{2.5}$, SO_2, NO_2, and VOCs. Fine particulate matter concentrations were further speciated into the components of nitrate (NO_3), sulphate (SO_4), elemental carbon (EC), organic carbon (OC), ammonium (NH_4), and other particulate matter (OPM; e.g., soil). The study also included developing the most complete emissions inventory in Alberta to date, for the purposes of modelling. Full details of source emissions and the improvements made with respect to past studies can be found in the study's final report, available online.[95] Photochemical modelling (using CMAQ) has also been conducted to assess the impact of existing and future oil sands development on acid deposition (Cho et al., 2017).[96]

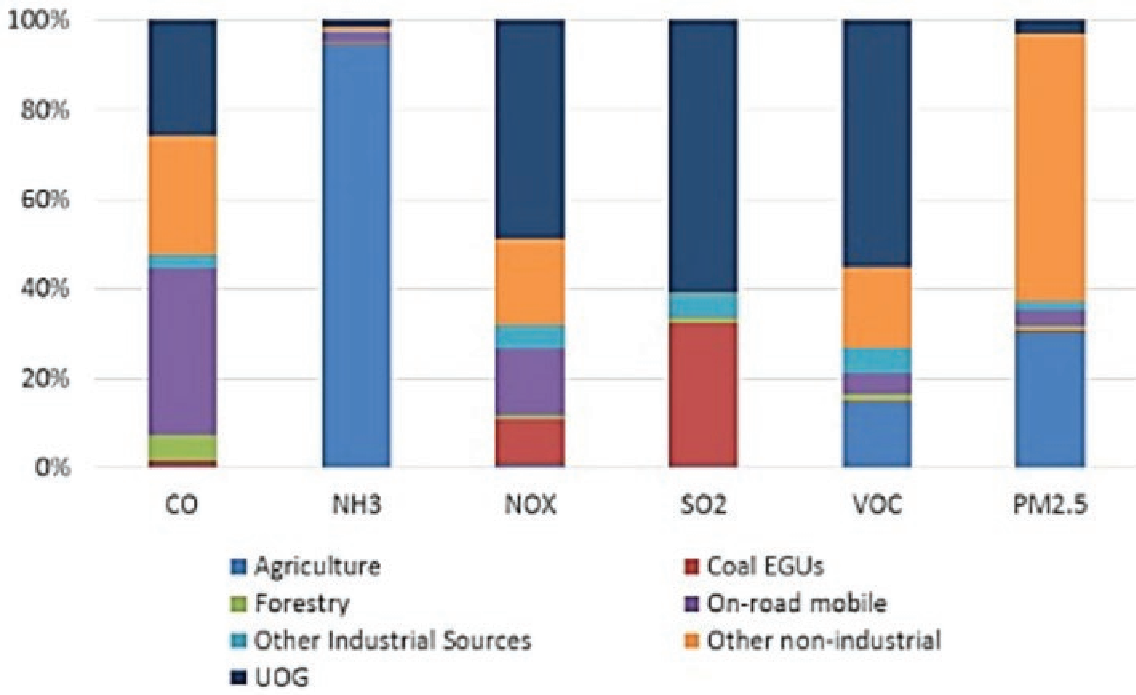


Figure 17: Alberta-wide 2013 anthropogenic emissions (percentage of total emissions) by sector

95 https://open.alberta.ca/dataset/6780b709-6a9b-4a25-bdc2-2196a8e4f215/resource/a55d2d3e-ccda-451b-9699-690a5eaf6426/download/public-facing-summary-final-w-attachments.pdf

96 The CMAQ model was used to estimate acid deposition using four emission scenarios in the oil sands area. Predicted gross Potential Acid Input (PAI) deposition in the AOSR increases from historical to existing case with further increases predicted in two future cases due to the projected increase in NO_x emissions. On average, the total predicted PAI deposition in the AOSR is approximately 40% sulphur deposition and 60% nitrogen deposition.

Air Quality Photochemical Modelling studies allow analysts to explore the contribution of various sectors to the total emissions of air contaminants, using a prediction analysis called "source apportionment" using a zero-out scenario (Figure 18). A zero-out scenario compares a base case, with all emission sources active, to a scenario with a specific sector turned off or "zeroed-out." The difference in predicted concentrations between the base case and the zero-out scenario is indicative of the contribution of that sector to the air contaminant of concern. Source apportionment does not represent a sector contribution exactly, due to the non-linear nature of the photochemical reactions involved, but it does provide a good relative measure of a sector's contribution to pollution in the modelling domain.

The results of this study help individuals to identify how each of the seven major sectors in Alberta impact ambient air contaminant levels.[97] Ultimately, this analysis can help inform decision makers to prioritize air quality management action to the appropriate sector. Figure 17 highlights the study's results of Alberta's sector emission contribution for each of the target air pollutants.

In terms of NO_2 contribution, the study identified the Upstream Oil and Gas (UOG) sector to be one of the key NO_x sources in Alberta and noted that:

> *"As expected, widespread reductions of annual average NO_2 concentrations, mostly ranging 1.5-3 ppb and up to 18 ppb, occur when eliminating emissions from UOGs. Many UOG facilities are located just east of the Rockies where hot spots of NO_2 are predicted."*[98]

NO_x contributions from other sectors were predicted as follows:

- On-road mobile sources contribute more than 1 ppb across Alberta and up to 2 ppb in Edmonton and Calgary. Larger contributions (> 5 ppb) from on-road sources are seen in smaller cities including Red Deer (up to 16 ppb), Lethbridge, and Medicine Hat.
- Coal EGUs contribute up to 2 ppb near power plants west of Edmonton and less than 0.5 ppb in most areas.
- Similarly, contributions to NO_x emissions from forestry and agriculture sources were mostly less than 0.5 ppb.
- Emissions from other industrial point sources are mostly affecting annual average NO_2 concentrations near sources. Reductions are generally lower than 1.5 ppb near railways and unpaved roads were mostly less than 2 ppb and more than 5 ppb (up to 11 ppb) in Edmonton, Calgary, and near Fort McMurray. Note: The findings on relative source contributions for the 98th percentile 1-hour NO_2 CAAQS were similar to those found for the annual NO_2 CAAQS results.

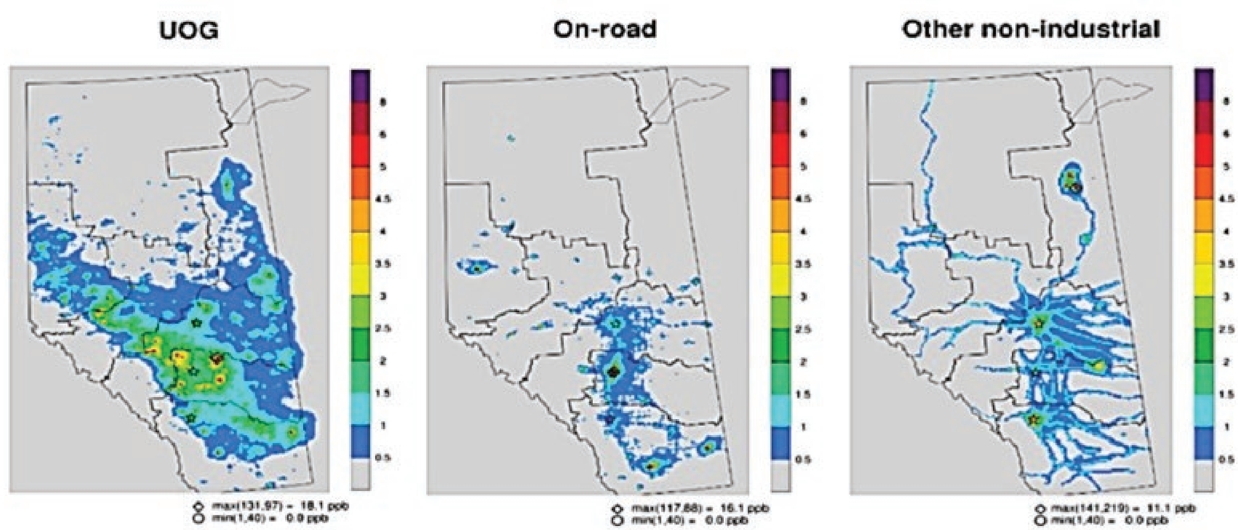


Figure 18: The source contribution from three primary sectors to annual average NO_2 concentration (ppb) for 2013 calendar year (Base-scenario) — other sector contribution can be found in the final report.

97 The seven sectors include: Agriculture; Coal-fired Power Plants (EGU); Forestry; Upstream Oil and Gas (UOG); Other Industrial Sources; On-road mobile; Other non-industrial sources.

98 Note that the upstream oil and gas activities generally take place in rural areas, however the stations used to report on CAAQS are predominately urban.

5.7 Effect of the COVID-19 Public Health Emergency on Urban Air Quality in Alberta

On March 17, 2020, Alberta declared a public health emergency and took action to limit the spread of COVID-19, including the closure of schools and daycares, the restriction of gatherings to 15 or fewer people, and mandating physical distancing and work from home requirements. Some of these measures had the effect of reducing the ambient concentrations of certain air pollutants due to reduced road traffic in Alberta's urban centres. On June 12, 2020, these restrictions were eased.

During the public health emergency, air quality monitoring continued. Results from the analysis of data collected during the first five weeks of the health emergency are presented below. AEP continues this data analysis to further investigate the effect of the COVID-19 response on air quality.

5.7.1 Measuring the Air Quality Impacts of COVID-19

NO_2 is one in a group of oxides of nitrogen compounds. NO_2 and nitrogen oxide (NO), which in the atmosphere is converted to NO_2, are emitted by many sources including motor vehicles and industrial activity. Because motor vehicles are generally a major source of NO_2, particularly in cities, NO_2 is a useful metric to understand how reduced traffic in urban areas affects air quality.

5.7.2 Pandemic response and traffic volume

The actions taken by Albertans to prevent the spread of COVID-19, including working from home and limiting non-essential travel, reduced weekday traffic on urban thoroughfares by 30–40% during March 23–April 24, 2020 (Figure 19).

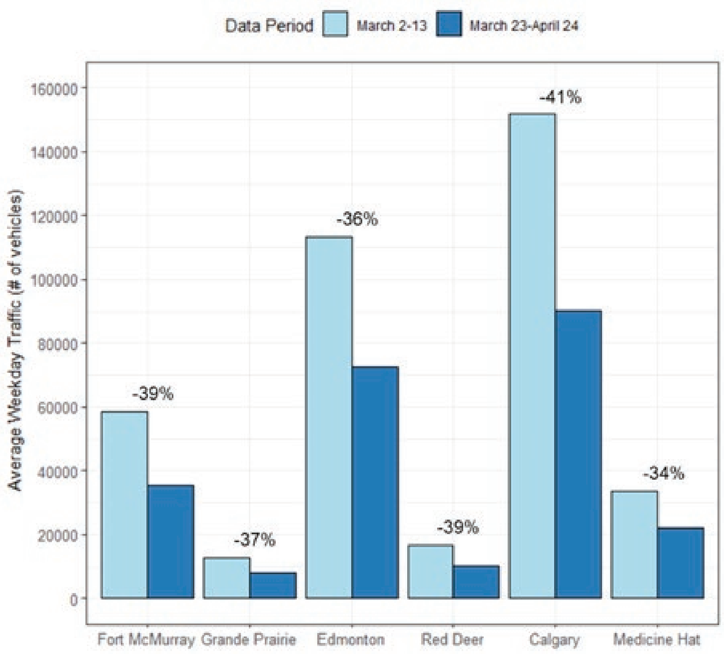
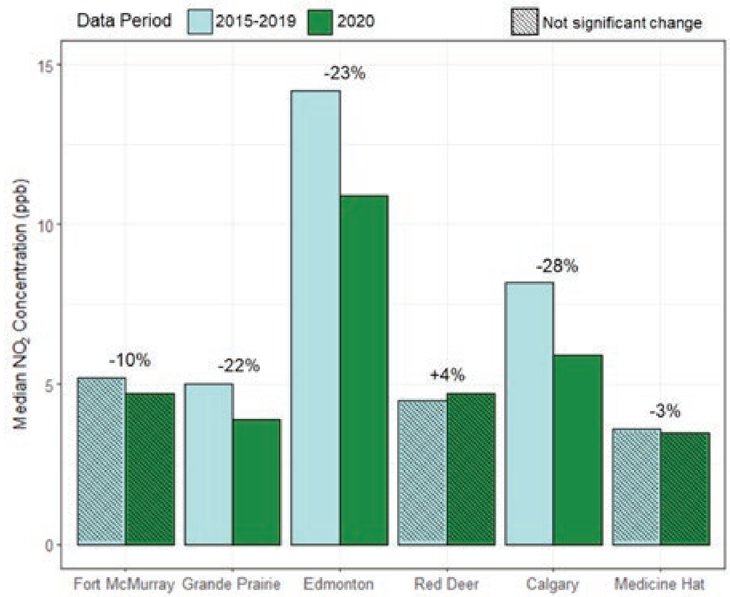


Figure 19: Changes in weekday traffic on major highways in Alberta cities in March/April 2020 (data from Alberta Transportation)

5.7.3 Effect of the pandemic response on air quality in large Alberta cities

Larger cities experience higher concentrations of NO_2 owing to higher vehicle traffic volumes. Calgary and Edmonton saw median NO_2 concentrations decrease by 23–28% or 2–3 ppb during the public health emergency when compared to similar periods between 2015 and 2019 (Figure 20).

In Alberta's smaller cities like Fort McMurray, Grande Prairie, Red Deer, and Medicine Hat, concentrations of NO_2 are normally lower than in Edmonton and Calgary. The lower concentrations of NO_2 within smaller cities can make it more difficult to detect change. No significant change in NO_2 was detected for concentrations in Fort McMurray, Red Deer, or Medicine Hat between March 22 and April 25. In Grande Prairie, a decrease in NO_2 of 22% (1 ppb) was observed.



Data period 2020 includes sample days between March 22- April 25 (excluding weekends and holidays)
Data period 2015-2019 include sample days between March 22- April 25 (excluding weekends and holidays)
Significance was tested using *Mann Whitney u test* (p-value ≤0.05)

Figure 20: Concentrations of NO_2 in Alberta cities in 2015–19 vs. 2020

5.7.4 A more detailed examination of NO_2 over time

Examining NO_2 concentrations in urban centers for each week during the period of March 22–April 25, 2020, shows that decreasing NO_2 concentrations are observed for most weeks in Edmonton and Calgary (Figure 21). However, no significant changes were observed for the week of April 5–11 compared to previous years. In Alberta's smaller cities, such as Grande Prairie, there is larger variability in changes, including weeks in which NO_2 concentrations increased compared to previous years.

The changes in NO_2 observed in a given week depends on the number of emissions released into the air, proximity of the air monitoring station to the emission source(s), and the weather which determines how pollutants disperse. For example, temperature inversions in combination with light winds may lead to a layer of cold, stagnant air settling near the ground, limiting pollutant dispersion. Such events are common during the winter months, and as a result vehicle emissions are often trapped close to the surface. Several days in late March and early April were unseasonably cold in 2020, with the average temperature for April 5–11 in Edmonton recorded at -1.7 °C in 2020, while the average temperature for the same dates over the previous 20 years (1999–2019) was 3.3°C. These temperature differences complicate assessing air quality impacts associated with the pandemic response.

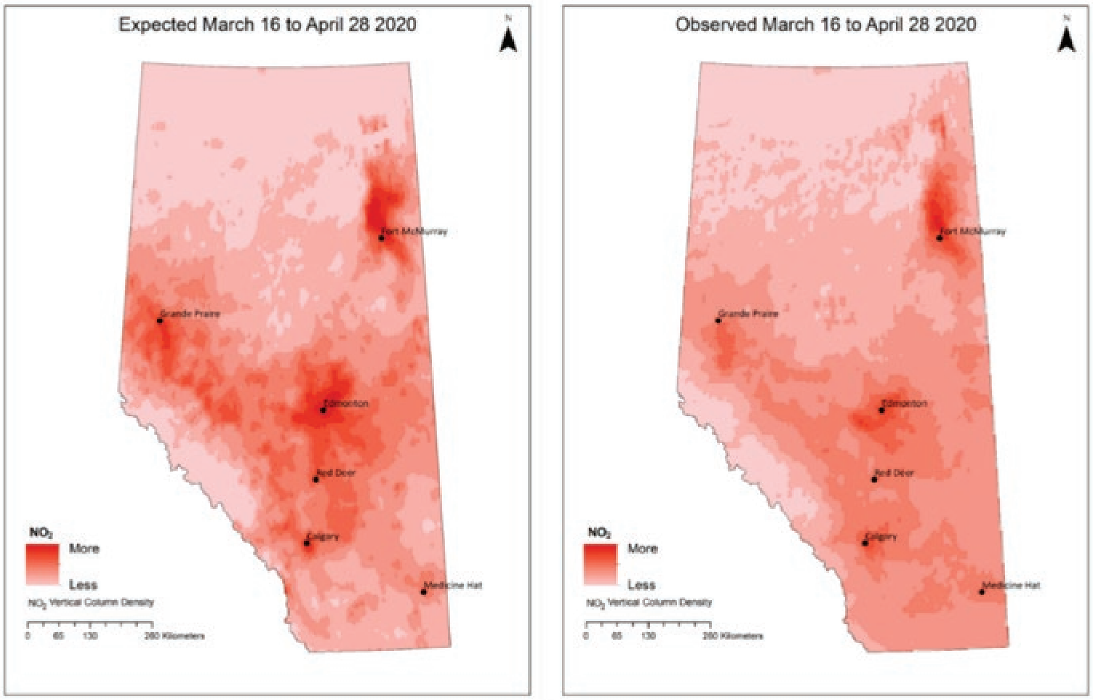
Weekly median values are calculated using only weekday sample period.
Significance was tested using *Mann Whitney u test* (p-value ≤0.05)

Figure 21: Concentrations of NO_2 by week in Alberta cities in 2015–19 vs. 2020

5.7.5 NO_2 Satellite Measurements

Levels of NO_2 measured by satellite during the public health emergency are also lower than would be expected under typical conditions for urban areas across Alberta (Figure 22). Work is ongoing to quantify the change in ambient NO_2 levels based on the satellite measurements.

Satellite data has shown likely pandemic-related decreases in air pollution in other Canadian urban areas.



Produced by the Air Quality Research Division at Environment and Climate Change Canada (ECCC) using satellite observations from the European Space Agency's Tropospheric Monitoring Instrument (TROPOMI) with post-processing performed by ECCC. The expected NO_2 levels (left panel) are based on observations prior to public health emergency, seasonally adjusted to represent expected observations and the observed NO_2 levels (right panel) are data for days after the public health emergency.

Figure 22: NO_2 concentrations in Alberta, March–April 2020 measured by satellite

5.7.6 Air quality monitoring, evaluation, and reporting continue during the public health emergency

Other indicators of air quality (O_3 and $PM_{2.5}$) appear to also have been affected, and additional work is ongoing to better understand air quality changes during the public health emergency.[99]

5.7.7 Summary of Preliminary Results

- Nitrogen dioxide (NO_2) is a common indicator of air quality because of its effect on respiratory health, its ability to react in the atmosphere to form secondary pollutants such as O_3 and $PM_{2.5}$, and its contribution to acid rain and transportation, which can be a major contributor to NO_2 levels in urban centres.
- Weekday traffic on urban thoroughfares decreased by 30–40% during March 23–April 24, 2020.
- Between March 22 and April 24, 2020, ambient concentrations of NO_2 in Alberta's two largest cities, Calgary and Edmonton, were approximately 25% lower than in previous years.
- Satellite measurements of NO_2 showed lower levels than would be expected under typical conditions for urban areas across Alberta.

99 For current information on air quality in Alberta, visit Alberta's Air Quality Health Index website.

Appendix A: Acid Deposition Management Framework

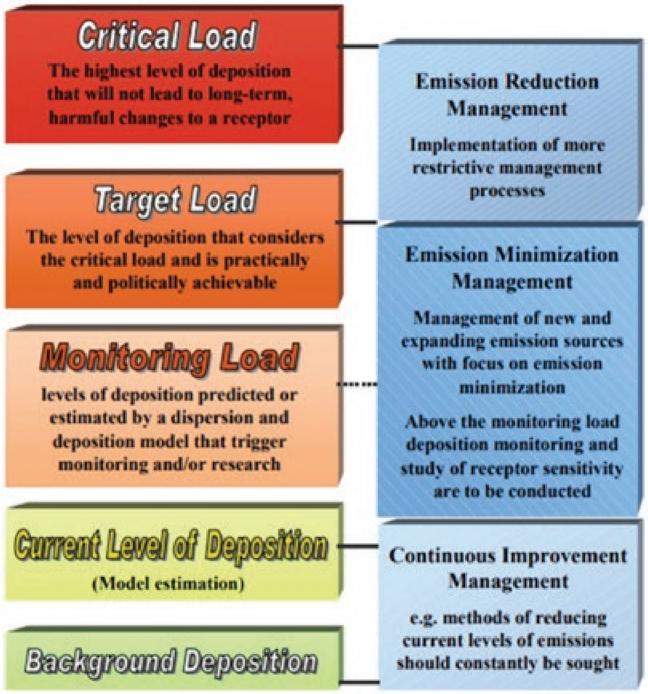


Figure 23: Action levels for Alberta's Acid Deposition Management Framework

Alberta Environment adopted the Acid Deposition Management Framework (ADMF) developed by the Clean Air Strategic Alliance (CASA) for management of acid deposition effects in Alberta in 1999. The framework was described in the report Application of Critical, Target, and Monitoring Loads for Evaluation and Management of Acid Deposition (AENV, 1999). In 2008, AEP updated the framework to identify potential acidification issues at an early stage and establish a tiered approach to addressing these issues depending on their magnitude (AEP, 2008).

The AMDF outlined four defined levels of acid deposition: pre-industrial deposition (background), the current level of deposition, the target load, and the critical load. These four levels define three management zones (Figure 23). The critical load is a numerical expression of the highest level of deposition that will not lead to long-term, harmful changes to a receptor. Also, the target load is defined as the maximum level of acidic atmospheric deposition that affords long-term protection from adverse ecological consequences, and that is politically and practically achievable (Target Loading Subgroup, 1996).

Continuous improvements are employed in the lowest management zone, defined by background deposition (pre-industrial deposition) at the bottom level and current deposition levels at the top. Current emissions are not deemed as being simply acceptable, but rather methods of reducing current levels of emissions, and hence, deposition should constantly be sought and pursued. Above the emissions minimization management zone is the emissions reduction management zone that is set by the target load. Entry into this zone results in implementation of more restrictive management processes. Once deposition in a grid cell[100] exceeds the target load, a strategy to reduce deposition to below the target load is to be developed. Used in this manner, the target load becomes an environmental objective as defined in Section 14.1 of the EPEA for the management of acidifying emissions and acid deposition.

Once a draft revised ADMF is finalized, the current ADMF (2008 ADMF) will be replaced by the revised ADMF and it will be available online.[101]

100 *Grid cells* are part of an environment-independent spatial coordinate system that integrates a variety of data and information (e.g., air quality, soil pH, meteorology etc.), to that specific location/grid cell on a map.

101 https://www.alberta.ca/acid-deposition.aspx

Appendix B: Current Regulatory and Non-regulatory Mechanisms for Managing Air Emissions

Note: Information below was obtained from what has been published on Alberta's Open Government website.

Mechanisms	Jurisdiction	Date	Description
Provincial			
Acts			
Environmental Protection and Enhancement Act (EPEA)	Alberta	1993	The Act's individual regulation covers a range of activities, including beverage container recycling, pesticide sales, and storm drainage. It regulates several aspects of environment protection, including the process for environment assessments, approvals, and registrations.
Alberta Land Stewardship Act (ALSA)	Alberta	2013	The Act enables government to provide direction and leadership in identifying current and future land-use objectives of the Province, including economic, environmental, and social objectives, while respecting private property rights. The Act provides for the coordination of decisions concerning land, species, human settlement, natural resources, and the environment, while taking into account cumulative effects of human endeavors and other events.
Responsible Energy Development Act (REDA)	Alberta	2012	The Responsible Energy Development Act (REDA) was proclaimed in part on June 17, 2013. Further parts of REDA were proclaimed on November 6, 2013 and March 29, 2014. After the Act was proclaimed, the AER became the single regulator for upstream oil, gas, oil sands and coal projects in Alberta.
Oil and Gas Conservation Act	Alberta	2000	This Act establishes a regulatory regime administered by the Alberta Energy Regulator for the development of oil and gas resources and related facilities in Alberta.
Regulations			
Substance Release Regulation	Alberta (EPEA)	1993	The regulation sets opacity (the degree to which visible emissions obstruct the passage of light) limits for visible emissions, maximum concentrations of particulate matter from the effluent streams of manufacturing or industrial processes, and the maximum concentrations of vinyl chloride releases into the air from polyvinyl chloride plants. It identifies the types of industries to which Codes of Practice under a registration apply.
Release Reporting Regulation	Alberta (EPEA)	2018	The regulation provides rules, provisions, and stipulations related to environmental monitoring in the event of a release. This includes who, when, and how reporting is to be completed. Reporting must include the location and time of release, the circumstances leading up to the release, and the type and quantity of the substance released.

Mechanisms	Jurisdiction	Date	Description
Mercury Emissions from Coal-Fired Power Plants Regulation	Alberta (EPEA)	2006	Presents regulatory requirements for mercury emissions from coal-fired power plants in Alberta.
Emissions Trading Regulation	Alberta (EPEA)	2006	The Emission Trading Regulation encourages power stations to reduce their nitrogen oxide & sulphur dioxide emissions prior to mandatory improvements required in their *Environmental Protection and Enhancement Act* industrial approvals.
Oil Sands Environmental Monitoring Program Regulation	Alberta (EPEA)	2013	The regulation establishes the Oil Sands Environmental Monitoring Program and provides rules, provisions, and stipulations enabling the collection of monitoring fees from oil sands operators, access to the land for monitoring, and for providing records necessary for the determination of an assessment.
Environmental Assessment Regulation	Alberta (EPEA)	1993	The Environmental Assessment (Mandatory and Exempted Activities) Regulation lists those activities that must undergo environmental impact assessments.
Environmental Assessment (Mandatory and Exempted Activities) Regulation	Alberta (EPEA)	1993	Identifies mandatory and exempted activities for an environmental impact assessment.
Environmental Appeal Board Regulation	Alberta (EPEA)	1993	The regulation identifies the formal requirements of an appeal to decisions made under the *Environmental Protection and Enhancement Act*, and the Environmental Appeal Board's responsibilities when an appeal is received.
Approvals and Registrations Procedure Regulation	Alberta (EPEA)	1993	The regulation provides a clear set of rules, provisions, and stipulations regarding information that must be submitted with a registration application.
Activities Designation Regulation	Alberta (EPEA)	2003	The regulation identifies activities affecting the environment for which approval, registration, or notifications are required.
Code of Practice for Asphalt Paving Plants	Alberta (EPEA)	1996	The Code outlines the minimum operating requirements that asphalt paving plants that produce hot or cold asphalt must meet to ensure environmental protection including: persons responsible for the plant are to complete a registration form and submit it to the director; plants must be equipped with pollution control technology meeting Code requirements for opacity, particulate concentrations, odour, and fugitive dust; operational requirements for plants using wet scrubbers or baghouse systems to control particulate emissions; record keeping, such as environmental logs; and reporting of contraventions to the director.

Mechanisms	Jurisdiction	Date	Description
Code of Practice for Compressor and Pumping Stations and Sweet Gas Processing Plants	Alberta (EPEA)	1996	The Code outlines the design and operating requirements for compressor and pumping stations and sweet gas processing plants in order to protect the environment, and requires: submission of a registration form; natural gas engines and combustion turbines to meet requirements for low nitrogen dioxide emission technology; dispersion modelling; storage and effective containment systems for industrial wastewater for systems installed prior to 1996; groundwater monitoring when industrial wastewater or process liquids are stored in a pond or impoundment constructed before the Code came into effect; minimization of runoff from the facility, and when an industrial runoff point is used, the Code sets quality parameters and a frequency of sampling; yearly groundwater monitoring reports; records to be kept for five years; and reporting of contraventions to the Code.
Code of Practice for Concrete Producing Plants	Alberta (EPEA)	1996	The Code outlines the minimum operating requirements for concrete producing plants including: persons responsible for the concrete producing plant are to complete a registration form and submit it to the director before commencing operations; plants must be equipped with pollution control technology meeting Code requirements for opacity, particulate concentrations, fugitive dust, industrial run-off and washings from concrete truck operations; operational requirements, including fugitive dust, disposal of baghouses, disposal of lubricating oil, waste disposal, and inspections; record keeping, such as environmental logs of baghouse inspections; and reporting of contraventions to the director.
Code of Practice for Forage Drying Facilities	Alberta (EPEA)	2006	The Code: requires air and water monitoring to be done in accordance with recognized standards/methodologies; sets out information for registration applications; lists sources from which air effluents may be released and prohibits fugitive emissions that may cause environmental or health problems; describes operational requirements for process, monitoring, and pollution abatement equipment; sets air emissions limits according to criteria such as type of drying operation (dryers and kilns with conveyor chain vs. others) location of the forage dryer (urban vs. rural), size of urban location (50,000 population) and date (before or after January 1, 2015); and prohibits industrial wastewater releases, controls industrial runoff into nearby surface water and requires domestic wastewater to be treated; wastes to be disposed of at approved waste management facilities, and to prepare and retain records of waste management; reclamation of disturbed lands to equivalent land capability, preparation, and submission of reclamation plans and reports; contraventions to be reported; and records to be kept (e.g., performance of air pollution abatement equipment, equipment operation, and maintenance).

Mechanisms	Jurisdiction	Date	Description
Code of Practice for Foundries	Alberta (EPEA)	1996	The Code outlines minimum operating requirements for foundries not requiring an approval under the *Environmental Protection and Enhancement Act*: persons responsible are to complete a registration form and forward it to the director; foundries are to use pollution control technology and operating practices for control of opacity of air emission sources, particulate concentration, fugitive dust emissions, and industrial run-off; sets out monitoring and inspections of baghouses, or wet scrubber dust collectors; requires persons responsible to keep an environmental log of all actions to comply with the Code and to make monthly logs available for inspection; and contraventions are to be reported to the director.
The Code of Practice for Sawmill Plants	Alberta (EPEA)	2006	The Code of Practice for Sawmill Plants: stipulates the information requirements for an application for registration and for installation of a new thermal energy system at the sawmill plant; stipulates air, wastewater, waste management, and reclamation requirements and effective dates of air emission limits for existing sawmill plants, those with a major expansion, and new sawmill plants; prohibits the operation of wood waste incinerators at sawmill plants in urban areas and rural areas as of January 1, 2008 and January 1, 2015, respectively; and requires record keeping and contraventions to be reported to the director.
Code of Practice for Small Incinerators	Alberta (EPEA)	2005	The Code lists the requirements for mobile or small incinerator facilities that incinerate less than 10 tonnes of non-hazardous waste per month. It is enabled by the Waste Control Regulation (AR 192/96). The Code lists requirements for sampling, design, construction, and installation requirements such as primary and secondary combustion chambers. Mobile and small facilities that wish to incinerate waste are required to complete a registration form and submit it to the Director.
Directives		**Alberta (*EPEA*)**	
Sulphur Recovery project ID 2001-03	Alberta (REDA) AER	2001	The Alberta Energy and Utilities Board (EUB) and Alberta Environment (AENV) have completed a review of the sulphur recovery guidelines for sour gas plants in Alberta. This interim directive (ID) sets out the guidelines and provides details on how the EUB and AENV will implement the findings of the review and apply the revised sulphur recovery guidelines to sour gas plants, other upstream petroleum facilities, and downstream petroleum operations, including refineries and heavy oil and bitumen upgraders. For ease of use, a contents to the guidelines follows this introduction.

Mechanisms	Jurisdiction	Date	Description
Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Alberta Venting	Alberta (REDA) AER	2011	This directive sets out requirements for flaring, incinerating, and venting in Alberta at all upstream petroleum industry wells and facilities. These requirements also apply to pipeline installations that convey gas (e.g., compressor stations, line heaters) licensed by the AER in accordance with the Pipeline Act. With the exception of oil sands mining schemes and operations, Directive 060 applies to all schemes and operations approved under section 10 of the Oil Sands Conservation Act.
Directive 071: Emergency Preparedness and Response Requirements Alberta for the Petroleum Industry	Alberta (REDA) AER	2009	Part A sets out planning requirements for emergency response plan (ERP) development that licensees are required to meet in order to gain AER approval for the ERP. Part A also contains the requirements for a corporate-level ERP. Part B sets out the requirements that licensees are required to meet in order to effectively implement their plans and respond to an incident or emergency. Part B will be assessed through the AER's Emergency Response Assessment Program, exercise involvement, post-incident investigations, and field inspections.
Air Monitoring Directive Chapter 1 Introduction	Alberta (EPEA)	2019	Chapter 1 contains all the definitions for the Air Monitoring Directive, lists components that make up the directive and provide general requirements for monitoring and reporting of air quality by industry and airsheds in Alberta.
Air Monitoring Directive Chapter 2 Ambient Monitoring Program Planning	Alberta (EPEA)	2016	Chapter 2 requires airsheds to develop a monitoring plan and submit it to Environment and Parks for approval. Monitoring plans describe all airshed monitoring programs in place, including some linked to approval requirements.
Air Monitoring Directive Chapter 3 Ambient Monitoring Site Selection Siting Criteria and Sampling System Requirements	Alberta (EPEA)	2016	Chapter 3 applies to industrial approval holders and airsheds conducting ambient monitoring. It sets out requirements for siting ambient monitoring stations and equipment.
Air Monitoring Directive Chapter 4 Monitoring Requirements and Equipment Technical Specifications	Alberta (EPEA)	2017	Chapter 4 outlines the minimum requirements for air monitoring methods and equipment specifications to ensure that monitoring is conducted consistently across the province, using robust methods, resulting in representative data that are comparable and of known quality.
Air Monitoring Directive Chapter 5 Quality System	Alberta (EPEA)	2016	Chapter 5 specifies requirements for industrial approval holders and airsheds to develop a Quality System for air quality monitoring and reporting and to document it in a Quality Assurance Plan.
Air Monitoring Directive Chapter 6 Ambient Data Quality	Alberta (EPEA)	2016	Chapter 6 applies to industrial approval holders and airsheds conducting ambient monitoring. It sets out requirements for ambient air quality data collection and the verification and validation of continuous, ambient data.

Mechanisms	Jurisdiction	Date	Description
Air Monitoring Directive Chapter 7 Calibration	Alberta (EPEA)	2018	Chapter 7 applies to industrial approval holders and airsheds conducting ambient monitoring. It sets out requirements for calibrating ambient air monitoring analyzers and equipment.
Air Monitoring Directive Chapter 8 Ambient Audit	Alberta (EPEA)	2018	Chapter 8 applies to industrial approval holders and airsheds conducting ambient monitoring. It sets out requirements for auditing of continuous ambient air monitoring stations and equipment.
Air Monitoring Directive Chapter 9 Reporting	Alberta (EPEA)	2016	Chapter 9 specifies requirements for industrial approval holders and airsheds to submit air quality data (source emissions and ambient) and reports to Environment and Parks and the Alberta Energy Regulator.
Continuous Emissions Monitoring System Code	Alberta (EPEA)	1998	Requirements for installation, operation, maintenance & certification of continuous emission monitoring systems to ensure effective measurement, recording & standardized reporting. Requirements for alternative monitoring systems and QA/QC of data.
Guidelines			
Alberta Ambient Air Quality Objectives	Alberta (EPEA)	NA	
Air Quality Model Guideline	Alberta (EPEA)	2013	Provides detailed guidance on methods & approaches to assess air quality from emission sources. Sets out statutory authority, overview of approach, guidance on appropriate technical methods & the info required to demonstrate that a source meets the AAAQO.
Alberta Air Emission Standards for Electricity Generation and Alberta Air Emission Guidelines for Electricity Generation	Alberta (EPEA)	2005	Alberta air emission standards and guidelines for electricity generation.
Annual Emissions Inventory Report Standard and Guidance Document	Alberta (EPEA)	2018	The purpose of the Annual Emissions Inventory Report Standard and Guidance Document (AEIR Standard) is to assist EPEA approved industrial operations with meeting the annual emissions inventory reporting requirements set out in the Air Monitoring Directive Reporting Chapter and the Substance Release Regulation. Although mainly a guidance document, the AEIR Standard is also a reporting standard and does have some mandatory requirements that are required to be met or followed.
Alberta Real-time Ambient Air Data Submitter's Guide	Alberta (EPEA)	2017	The Alberta Real-time Ambient Air Data Submitter's Guide instructs airsheds on how to submit their ambient data in real-time, as required by the Air Monitoring Directive, Chapter 9 Reporting.

Mechanisms	Jurisdiction	Date	Description
Emission Guidelines for Oxides of Nitrogen (NO_x) for New Boilers, Heaters and Turbines Based on a Review of Best Available Technology Economically Achievable (BATEA)	Alberta (EPEA)	2007	Interim policy, specifies emission requirements for new gas-fired equipment in the oil sands area north of Fort McMurray.
Guidance on Air Emissions and Monitoring Requirements During the Combustion of Non-Gaseous Fuels	Alberta (EPEA)	2011	The purpose of this document is to guide project proponents and regulators on air emissions and monitoring expectations where non-gaseous fuels are the proposed fuel source for specified types of equipment.
Non-Routine Flaring Management – Modelling Guidance	Alberta (EPEA)	2014	Replaces Emergency/Process Upset Flaring Management: Modelling Guidance. Provides guidance to modellers when they do air dispersion modelling assessments for non-routine flaring situations.
Precipitation chemistry data handling and preparation	Alberta (EPEA)	2016	Outlines the best practices for compiling, verifying, and analyzing precipitation chemistry laboratory results. The practices outlined in this handbook have been adopted from the Global Atmosphere Watch (GAW) manual for the GAW Precipitation Chemistry Programme. This guidance document should be used to prepare data for submission into Alberta's Ambient Air Quality Data Warehouse and the NAtChem database.
Guide for Responding to Potential "Hot Spots" Resulting From Air Emissions From the Thermal Electric Power Generation Sector – Nov 2005	Alberta (EPEA)	2019	This guide is designed to help stakeholders—including the public, non-governmental groups and government officials—to identify and manage potential hot spots caused or potentially caused by air emissions from thermal electrical generation facilities.
Particulate matter and ozone management plan guidance document	Alberta (EPEA)	2007	This document was developed in response to a need expressed by airsheds to be provided with a base level of information to support the development of Particulate Matter (PM) and Ozone Management Plans. The purpose of this document is to provide airsheds with an understanding of the elements of a PM and Ozone Management Plan as well as a conceptual framework that could be included in the plan development process. The process and content suggestions contained in this document are not meant to be templates that airsheds must follow, but as tools that airsheds could use to build their management plans.
Policies			

Mechanisms	Jurisdiction	Date	Description
Alberta Implementation of the Air Zone Management Framework for Fine Particulate Matter and Ozone	Alberta (EPEA)	2015	This document is a general procedure document (guidance) for Alberta's implementation of air zone management planning for Canadian Ambient Air Quality Standards for particulate matter and ozone.
Land-use Framework	*Alberta Land Stewardship Act* (ALSA)	2008	The Land-use Framework sets out an approach to manage public and private lands and natural resources to achieve Alberta's long-term economic, environmental, and social goals. It provides a blueprint for land-use management and decision-making that addresses Alberta's growth pressures.
Clean Air Strategic Alliance Particulate Matter and Ozone Management Framework	CASA	2003	The CASA Particulate Matter and Ozone Management Framework is Alberta's jurisdictional implementation plan to achieve the Canada-Wide Standards (CWS) for particulate matter ($PM_{2.5}$) and ozone by the 2010 target date. The framework is based on a consensus agreement reached by stakeholders representing the government, industry, municipal, and public sectors. Under the framework, Alberta Environment has committed to conduct an annual assessment of ambient $PM_{2.5}$ and ozone data for all air monitoring stations in Alberta that meet the CWS data availability criteria. Under the CWS process, Alberta is only required to report for the Edmonton and Calgary Census Metropolitan Areas (CMAs)
Lower Athabasca Air Quality Management Framework	*Alberta Land Stewardship Act* (ALSA)	2012	The Air Quality Management Framework for the Lower Athabasca Region was developed as part of the Lower Athabasca Regional Plan. It is designed to maintain flexibility in the management of the cumulative effects of development on air quality within the Region.
South Saskatchewan Region air quality management framework: for nitrogen dioxide (NO_2), Ozone (O_3), and fine particulate matter ($PM_{2.5}$)	*Alberta Land Stewardship Act* (ALSA)	2014	Cumulative effects management frameworks seek to balance anticipated development with environmental protection by using a triple bottom line approach to support the environmental and social and economic objectives in the region. The Air Quality Management Framework (the framework) develops ambient triggers and limits for specific substances which become the indicators for ambient air quality.
Capital Region Air Quality Management Framework for Nitrogen Dioxide, Sulphur Dioxide, Fine Particulate Matter, and Ozone	Alberta (EPEA)	2012	Focuses on the achievement of outcomes, understanding the effects of multiple developments and assessing risk. It sets air quality triggers and limits with associated adaptive management actions for air quality parameters in the Edmonton Capital Region.
Alberta Acid Deposition Management Framework	Alberta (EPEA)	2013	Intended to identify potential acidification issues at an early stage and establishes a tiered approach to addressing these issues depending on their magnitude.

Mechanisms	Jurisdiction	Date	Description
Industrial Release Limits Policy	Alberta (EPEA)	2000	Policy on broad considerations used by Environment & Sustainable Resource Development when setting emission standards & guidelines, overview of principles & procedures used to develop industrial release limits in AB.
Ambient audit program protocol	Alberta (EPEA)	1995	This document outlines the procedures used in the Ambient Air Audit Program. Field and laboratory audit procedures, audit failure criteria and consequences are covered in this document. Also included are quality assurance measures and the maintenance of standards for the ambient air audit program.
Strategies			
Clean Air Strategy and Action Plan	Alberta	2012	Clean Air Strategy reaffirms Alberta's commitment to air quality and outlines its vision and desired outcomes. The action plan outlines short, medium, and long-term actions for the next ten years that will enhance Alberta's Air Quality Management System.

Federal	
Acts	
Canadian Environmental Protection Act	Canada
Regulations	
On-Road Vehicle and Engine Emission Regulations	Canada (CEPA)
Multi-Sector Air Pollutant Regulation	Canada (CEPA)
Export of Substances on the Export Control List Regulations	Canada
Sulphur in Gasoline Regulations	Canada
Products Containing Mercury Regulations	Canada
Renewable Fuels Regulations	Canada
Off-Road Compression-Ignition Engine Emission Regulations	Canada
Sulphur in Diesel Fuel Regulations	Canada
Benzene in Gasoline Regulations	Canada
Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emission Regulations	Canada
Gasoline Regulations	Canada
Volatile Organic Compound (VOC) Concentration Limits for Automotive Refinishing Products Regulations	Canada
Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations	Canada
Off-Road Small Spark-Ignition Engine Emission Regulations	Canada

Federal	
Regulations	
Gasoline and Gasoline Blend Dispensing Flow Rate Regulations	Canada
Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations	Canada
Contaminated Fuel Regulations	Canada
Secondary Lead Smelter Release Regulations	Canada
Regional Plans	
LARP	Alberta
SSRP	Alberta
Place-based	
Growing Forward: Capital Region Growth Plan	Capital Region
Capital Region Ozone Management Plan	Capital Region
Odour Management Protocol	Industrial Heartland
Municipal	
Strategies	
Municipal sustainability plans	Municipalities
Incentives, public education, communication, and awareness programs	Municipalities
Transportation planning	Municipalities
Acts	
Municipal Government Act	Municipalities
Bylaws	
Community standards bylaws	Municipalities
Zoning bylaws	Municipalities
Traffic bylaws	Municipalities

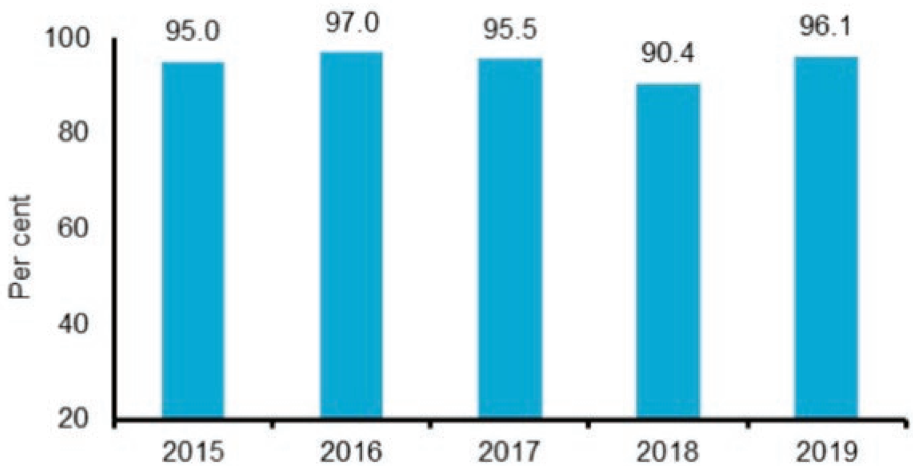
Appendix C: Alberta Air Quality Index

In addition to CAAQS and AAAQOs, Alberta also has an Air Quality Index (AQI) as a performance indicator for AEP's management of air quality (Figure 24). It reflects the total number of hours of good air quality divided by the total number of hours with an AQI value for all stations in Alberta for the year. The annual AQI results are calculated based on a minimum of four and a maximum of five major pollutants: carbon monoxide, nitrogen dioxide, ozone, sulphur dioxide, and fine particulate matter ($PM_{2.5}$), which are measured hourly. The pollutant that gives the highest AQI value for each hour determines the AQI for that timeframe. The hourly AQI number is then compared to AQI ranges that represent good (0–25), fair (26–50), poor (51–100) and very poor (>100) air quality.

These categories are based on Alberta's AAAQOs and guidelines under the EPEA and the National Ambient Air Quality Objectives[102] (which have been completely replaced with CAAQS) as of 2020. Stations with a valid AQI value for at least 75% of hours in the year are included in the calculation. AEP and Airsheds monitor the pollutants.

Performance Indicator: Percentage of good air quality days in urban areas

The air quality index reflects the overall provincial air quality based on ambient air quality objectives and guidelines of five major pollutants: fine particulate matter, ozone, carbon monoxide, nitrogen dioxide and sulphur dioxide.



Source: Parkland Airshed Management Zone, Calgary Region Airshed Zone, Fort Air Partnership, Peace Airshed Zone Association, Palliser Airshed Society, Wood Buffalo Environmental Association, Lakeland Industry and Community Association, Alberta Capital Airshed, Environment and Parks.

Note: The Canadian Ambient Air Quality Standards focus on long-term ambient levels of fine particulate matter and ozone in the province's six air zones and complement the air quality index by guiding air quality management actions.

Figure 24: Example of the Alberta Air Quality Index

102 Further information about the NAAQO can be found here: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/air-quality/national-ambient-air-quality-objectives-particulate-matter-executive-summary-part-1-science-assessment-document.html and here https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/naaqo-onqaa/particulate_matter_matieres_particulaires/summary-sommaire/98ehd220.pdf

	NO_2	SO_2	CO	O_3	$PM_{2.5}$	H_2S/TRS
Alberta 1-hr objective	159 ppb	172 ppb	13 ppm	82 ppb	80 µg m-3	10 ppb
Alberta AQI *good*	<50 ppb	<100 ppb	<13 ppm	<50 ppb	<30 µg m-3	<10 ppb

Figure 25: Alberta's AQI for the last five years

Figure 25 highlights the AQI results for the last 5 years, published in AEP's 2019 Annual Report which can be found online.[103] The 2019 results are based on data from 18 stations, located in Edmonton (three stations), Calgary (three stations), Fort McMurray (two stations), Red Deer (two stations), Airdrie, Grande Prairie, Cold Lake, Fort Saskatchewan, Sherwood Park, Medicine Hat, Lethbridge, and St. Albert.

The AQI differs from the widely known AQHI, as well as CAAQS, AAAQOs and regional AQMF triggers and limits. To see the comparison of the various ambient air quality standards, refer to Appendix A.

Note: The number of stations may change from year to year as stations are added, relocated, or if operational difficulties result in less than 75% of AQI values being available.

103 The most recent annual report (2019) and AQI results can be found on pg.23 at: https://open.alberta.ca/dataset/40c2fab1-e757-49f1-b403-e42c0239158a/resource/6eaf21e0-fd79-4c57-a951-de47bedce8c4/download/aep-annual-report-2019-2020.pdf

Appendix D: South Saskatchewan Regional Plan Regulatory Details

"Part 2: Air Quality

Designated Minister

9 For the purposes of this Part, the Minister designated under section 16 of the *Government Organization Act as the Minister responsible for the Environmental Protection and Enhancement Act is the Designated Minister.*

Definitions

10 In this Part,

(a) "framework" means the "South Saskatchewan Region Air Quality Management Framework (ESRD 2014)" as amended or replaced from time to time;

(b) "limit" means the applicable limit specified in Table A-1 or A-3 of Schedule "A";

(c) "official'' means any person within the Designated Minister's department as duly authorized by the Designated Minister;

(d) "person responsible" has the same meaning as in the *Environmental Protection and Enhancement Act*;

(e) "trigger" means the applicable trigger specified in Table A-1, A-2 or A-3 of Schedule "A".

Designated Minister's determination final and binding

11(1) The Designated Minister in the exercise of the Designated Minister's powers and duties under this Part may determine:

(a) the measurements of substances of concern at monitoring stations established and maintained under a program referred to in section 12,

(b) whether a trigger or limit has been exceeded for the purposes of this Part,

(c) whether a trigger or limit exceeded in one or more sub-areas in the planning region is of concern to other sub-areas or the planning region as a whole, and

(d) the duration of an exceedance of a trigger or limit as determined under clause (b).

(2) The Designated Minister's determination is final and binding on

(a) the Crown,

(b) decision-makers,

(c) local government bodies, and

(d) subject to section15.1 of the Act, all other persons.

Programs to manage effects

12 In respect of the framework, the Designated Minister shall establish and maintain programs

(a) managing ambient air quality triggers and limits for substances that in the opinion of the Designated Minister are indicators of the air quality effects of concern for the planning region, monitoring and evaluating the ambient air quality in the planning region, and

(b) evaluating the effectiveness of the framework in meeting the air quality objective stated in the SSRP Implementation Plan.

b.7.8 Notice respecting limits

13(1) In respect of one or more limits that, if, in the opinion of the Designated Minister, have been exceeded, the Designated Minister shall issue a notice specifying all of the following:

(a) the applicable limit or limits in respect of the activity or activities referred to in clause (b) that, in the opinion of the Designated Minister, have been exceeded;

(b) the activity or activities, or type or class of activities, that in the opinion of the Designated Minister are reasonably expected to have or have had, a direct or indirect, effect on the exceedance of the limit or limits;

(c) the area of the planning region affected by the exceedance of the limit or limits;

(d) the decision-maker or decision-makers affected by the notice;

(e) the local government body or local government bodies affected by the notice;

(f) the anticipated duration of the effect of the exceedance of the limit or limits on the activity or activities, type or class of activities, area, decision-makers, or local government bodies;

(g) the action to be taken by affected decision-makers and affected local government bodies in response to the exceedance of the limit;

(h) the direction that no statutory consent in respect of a proposed activity referred to in clause (b) shall be issued.

(2) Notwithstanding subsection (1), if in the opinion of the Designated Minister, a non-point source is reasonably expected to have, or have had a significant effect on the exceedance of a limit, the Designated Minister is not required to issue a notice pursuant to subsection (1).

(3) All affected decision-makers and local government bodies referred to in subsection (1)(d) and (e) shall be served with the notice by personal service, registered mail, or fax.

(4) Upon receiving a notice referred to in subsection (1), all affected decision makers and local government bodies shall comply with the notice.

(5) A notice referred to in subsection (1) shall be publicly available.

Management response

14(1) If the Designated Minister determines that a trigger or limit has been exceeded, an official shall initiate a management response consistent with the framework.

(2) The Designated Minister may specify actions to be taken by affected decision makers in respect of a management response referred to in subsection (1).

(3) A person responsible shall comply with the lawful directions of an official in respect of a management response referred to in subsection (1).

(4) An official referred to in subsection (1), shall as soon as practicable report to the Designated Minister in writing the details and the effect of the management response.

(5) A report referred to in subsection (4) shall be publicly available.

Designated Minister's considerations

15 For greater clarification, in reaching an opinion under sections 13 and 14, the Designated Minister may consider such information as in the Designated Minister's opinion is material to any or all of the following:

(a) a particular activity or activities or type or class of activity or types or classes of activities that are being undertaken or that are reasonably expected to occur in the planning region;

(b) the relevant area or relevant part of the area in the planning region in which the activity is to occur;

(c) the relevant area or relevant part of the area in the planning region in which an effect or effects of the activity or activities are reasonably expected to occur;

(d) the reasonably expected, relevant period or duration of the effect or effects of the activity or activities;

(e) any other matter that in the Designated Minister's opinion is advisable under a program referred to in Section 12."

Appendix E: Air Pollutant Emissions Inventory 2021 Data Tables Used

Ontario's NO_x (t) emissions data from the APEI 2021 emissions inventory.

Sector and Subsector	1990	2019
Transportation and Mobile Equipment	**367,278**	**177,965**
Heavy-Duty Diesel Vehicles	83,109	59,584
Off-Road Diesel Vehicles and Equipment	83,507	30,741
Light-Duty Gasoline Vehicles	72,159	14,311
Rail Transportation	42,385	19,555
Light-Duty Gasoline Trucks	32,233	24,375
Off-Road Gasoline/LPG/NG Vehicles and Equipment	21,758	11,757
Heavy-Duty Gasoline Vehicles	13,576	8,910
Heavy-Duty LPG/NG Vehicles	11,670	7
Domestic Marine Navigation, Fishing and Military	3,463	4,654
Air Transportation (LTO)	1,890	3,127
Light-Duty Diesel Vehicles	616	284
Light-Duty Diesel Trucks	145	424
Light-Duty LPG/NG Trucks	564	0
Motorcycles	97	234
Light-Duty LPG/NG Vehicles	107	0
Tire Wear and Brake Lining		
Electric Power Generation (Utilities)	**78,202**	**5,996**
Coal	74,981	125
Natural Gas	2,461	4,498
Diesel	39	1,003
Other (Electric Power Generation)	690	214
Waste Materials	32	155
Ore and Mineral Industries	**44,197**	**27,234**
Cement Manufacturing	18,469	12,783
Primary (Blast Furnace and DRI)	15,317	7,525
Metal Mining	3,052	2,308
Lime Manufacturing	630	2,474
Primary Ni, Cu, Zn, Pb	1,456	606
Secondary (Electric Arc Furnaces)	1,654	308
Other (Mining and Rock Quarrying)	1,454	25

Sector and Subsector	1990	2019
Other (Mineral Products Industry)	749	95
Rock, Sand, and Gravel	184	637
Asphalt Paving Industry	238	132
Concrete Batching and Products	346	0
Other (Non-Ferrous Refining and Smelting Industry)	140	95
Ferrous Foundries	117	63
Gypsum Product Manufacturing	90	89
Iron Ore Mining	168	
Brick Products		75
Clay Products	54	
Non-ferrous Foundries	41	
Limestone		19
Secondary Pb, Cu	17	
Die Casting	13	0
Steel Recycling	8	
Pelletizing		
Potash		
Secondary Aluminium Production (Includes Recycling)		
Alumina (Bauxite Refining)		
Silica Production		
Primary Aluminium Smelting and Refining		
Coal Mining Industry		
Other (Iron and Steel Industry)		
Manufacturing	**52,633**	**14,850**
Pulp and Paper Product Manufacturing	12,390	4,218
Other (Manufacturing)	15,248	421
Chemical Manufacturing	8,580	4,394
Glass Manufacturing	5,842	352
Plastics and Synthetic Resins Fabrication	2,468	306
Vehicle Manufacturing (Engines, Parts, Assembly, Painting)	2,025	605
Petrochemical Industry	614	1,379
Food Preparation	887	460
Metal Fabrication	1,187	78
Sawmills	777	467
Grain Processing	613	616

Sector and Subsector	1990	2019
Panel Board Mills	442	745
Fertilizer Production	489	686
Plastics Manufacturing	792	
Other (Chemical Industry)	7	120
Electronics	104	
Other (Wood Products)	56	
Textiles	37	0
Paint and Varnish Manufacturing	26	4
Cleaning Compound Manufacturing	24	
Warehousing and Storage	15	
Abrasives Manufacturing	6	
Bakeries	4	
Biofuel Production		
Converted Paper Product Manufacturing		
Commercial/Residential/Institutional	**26,048**	**30,938**
Residential Fuel Combustion	13,698	15,729
Commercial and Institutional Fuel Combustion	8,072	11,244
Home Firewood Burning	3,058	3,289
Construction Fuel Combustion	1,220	676
Commercial Cooking		
Service Stations		
Human		
Other (Miscellaneous)		
Oil and Gas Industry	**21,786**	**7,779**
Petroleum Refining	14,101	4,302
Natural Gas Transmission and Storage	5,374	2,894
Other (Downstream Oil and Gas Industry)	1,148	
Refined Petroleum Products Bulk Storage and Distribution	900	0
Natural Gas Production and Processing	57	561
Natural Gas Distribution	204	21
Light/Medium Crude Oil Production	2	0
Petroleum Liquids Transportation	0	0
Petroleum Liquids Storage		
Disposal and Waste Treatment		
Oil Sands Mining, Extraction, and Upgrading		

Sector and Subsector	1990	2019
Refined Petroleum Product Pipelines		
Heavy Crude Oil Cold Production		
Well Drilling/Servicing/Testing		
Accidents and Equipment Failures		
Oil Sands In-Situ Extraction		
Other	**2,603**	**3,833**
Fuel Use	660	1,236
Municipal Water and Wastewater Treatment	351	1,319
Prescribed Burning	899	20
Landfills	40	352
Residential Waste Burning	136	225
Other (Waste Incineration)	106	252
Sewage Sludge Incineration	134	195
Municipal Incineration	174	139
Specialized waste treatment and remediation	25	52
Printing	56	20
Structural Fires	17	8
Crematoriums	3	8
Biological Treatment of Waste		3
Surface Coatings	0	2
Dry Cleaning	1	
Construction Operations		
Unpaved Roads		
Animal Production		
Paved Roads		
Coal Transportation		
General Solvent Use		
Marine Cargo Handling		
Harvesting		
Tillage Practices		
Wind Erosion		
Waste Sorting and Transfer		
Mine Tailings		
Inorganic Fertilizer Application		
Sewage Sludge Application		

Appendix 4b:
Summarized Background Document

Summarized Background Document

Clean Air Strategic Alliance
September 2021

Contents

1 Executive Summary

The current and potential cumulative impacts associated with existing and planned emission sources represent significant air zone stresses, especially where air pollutants cannot or are not being effectively dispersed. Forecasts and recent data presented by Alberta Environment and Parks (AEP) to the project team indicate that all Alberta air zones will likely approach or exceed CAAQS when the 2020 CAAQS are first reported, based on 2018-20 data.

The intent of this document is to provide context on this issue and to facilitate future discussions on options and approaches to reduce NO_2 emissions for achieving the NO_2 Canadian Ambient Air Quality Standards (CAAQS).

It is important for stakeholders to not only understand the current policies and requirements used to manage air emissions but also understand why such policies have not been sufficient to prevent CAAQS non-achievement in certain areas of the province. Some of the challenges in managing emissions regionally include the mobile nature of some emissions sources that extend beyond a region or local authority to manage and fall under federal or provincial jurisdiction, the intensive development that continues to occur in areas where the local meteorology exacerbates the air quality impacts of air emissions, and the time lag that can exist between implementation of policies and resultant emission reductions.

The hope is that this document will inform and help guide discussions on how to address the current challenges through the development and implementation of innovative, yet practical, emission management recommendations.

Data on NO_x[104] emissions were summarized from three emissions inventories (including provincial and federal data) and results taken from recent studies to understand which sectors contribute the most to NO_x emissions in Alberta and to identify historical and future trends. While the numbers varied by inventory and study, Alberta is the largest contributor to Canada's total NO_x emissions by province and territory (~40% in 2019) and was one of two provinces that saw NO_x emission increase since 1990 (3%). Industrial sources account for most provincial NO_x emissions (~70% in 2019): conventional oil and gas was the largest single-sector contributor of NO_x emissions (~45%) followed by transportation (~24%).

As a starting point to begin discussions on potential policy approaches and solutions, information was compiled from previous management frameworks, management practices, policies, and studies from Alberta and other jurisdictions. The intent is to use this information to highlight potential gaps and opportunities in addressing the NO_x issue in the province.

104 This document refers to both NO_x (nitrogen oxides) and NO_2 (nitrogen dioxide). Readers should note that while NO_x and NO_2 are related, they are not equivalent: nitrogen oxides are a family of compounds with NO_2 being the most prevalent form generated by human activities. The CAAQS are based on NO_2. Studies and data referenced in this document vary depending on which substance was reported on, but for the purposes of this report, NO_x is used as a surrogate for NO_2.

2 Introduction

Ongoing scientific research has linked air emissions, including NO_2, to a range of human health and environmental impacts. Worldwide, air pollution is estimated to cause approximately seven million premature deaths per year, mainly in low- and middle-income countries.[105] Canada benefits from relatively good air quality although adverse health impacts are still found; Health Canada estimates ambient air pollution (specifically, fine particulate matter, ozone, and nitrogen dioxide) from human sources contributes to 15,300 premature deaths per year in Canada, with 1,400 of those deaths in Alberta.[106]

Likewise, air pollution can cause adverse impacts to environmental systems. For example, acid deposition occurs when acidifying substances are deposited on the earth's surface.[107] Sulphur dioxide and nitrogen oxides are the main acidifying substances. Deposition of these substances, and their reactive products on terrestrial or aquatic ecosystems may result in eutrophication and damage to the ecosystem. As such, there are clear benefits to managing and reducing emissions from a public health and environmental perspective.

3 Purpose of this document

In 2019, a statement of opportunity from the Government of Alberta (GoA) was brought to the Clean Air Strategic Alliance (CASA), which identified a need to generate dialogue and ideas from a wide array of stakeholders to inform policy options for managing air quality in consideration of anticipated exceedances of NO_2 Canadian Ambient Air Quality Standards (CAAQS) that may occur if no action is taken to reduce emissions.

CASA established a project team in 2020 to investigate solutions to the NO_2 CAAQS issue by identifying and exploring stakeholder perspectives through a webinar series and set of subsequent workshops. As a result of this project, the GoA hopes to capture a range of innovative policy and regulatory recommendations to address the CAAQS NO_2 challenge efficiently, effectively, and equitably.

The information in this document is meant to inform and guide discussions in the webinar series and workshops. Additional information regarding this project, including the scope, goal, and objectives, can be found on the CAAQS project page of the CASA website,[108] as well as the project team's project charter.[109]

4 Canadian Ambient Air Quality Standards (CAAQS)

In 2012, the ministers of environment from all provinces and territories, except Quebec, agreed to implement the Air Quality Management System (AQMS) to manage air emissions nationwide.[110,111] The CAAQS were established under the AQMS as non-binding objectives under the *Canadian Environmental Protection Act* for contaminants of concern with targets for outdoor air quality across the country in

105 https://www.who.int/health-topics/air-pollution#tab=tab_1

106 https://www.canada.ca/en/health-canada/services/publications/healthy-living/2021-health-effects-indoor-air-pollution.html#a1

107 https://www.epa.gov/acidrain/what-acid-rain

108 https://www.casahome.org/past-projects/canadian-ambient-air-quality-standards-project-team-59/

109 https://www.casahome.org/uploads/source/CAAQS_Project_Charter_(Approved_September_2020).pdf

110 https://www.ccme.ca/en/air-quality-report

111 According to the Canadian Council of Minsters of the Environment (CCME), Quebec supports the general objectives of the AQMS but will not implement the system due to an overlap with industrial emission requirements that duplicate the province's existing regulations. Québec is still adopting elements of the system, including implementation of air zones and airsheds.

order to protect human health and the environment. More information on other elements of the AQMS can be found in Appendix B.

The CAAQS replaced existing national air quality standards, called Canada-Wide Standards (CWS), for $PM_{2.5}$ and ozone in 2013 by setting stricter targets and introducing an annual standard for $PM_{2.5}$. They were developed to drive continuous improvement in air quality. Provinces and territories were formally required to report ambient air quality measurements against the CAAQS starting in 2015.

CAAQS include four management levels: green, yellow, orange, and red, from least to most stringent. The CAAQS management levels and the associated objectives associated with each are shown in Table 11.

Table 14: Alberta CAAQS management levels and associated air quality objectives

Management level	Air quality objective
Green	To maintain good air quality through proactive air management measures to keep clean areas clean.
Yellow	To improve air quality using early and ongoing actions for continuous improvement.
Orange	To improve air quality through active air management and prevent exceedance of the CAAQS.
Red	To reduce pollutant levels below the CAAQS through advanced air management actions.

Table 15 outlines the NO_2 CAAQS thresholds that apply in Alberta; the information for the other CAAQS parameters ($PM_{2.5}$, O_3, and SO_2) can be found on the CAAQS page of the GoA website.[112]

Table 15: Alberta CAAQS management levels and associated NO_2 thresholds

	Nitrogen Dioxide (NO_2)			
	1-Hour		Annual	
	Effective 2020	Effective 2025	Effective 2020	Effective 2025
Action	Actions for Achieving Air Zone CAAQS			
Standard	60 ppb	42 ppb	17.0 ppb	12.0 ppb
Action	Actions for Preventing CAAQS Exceedances			
Threshold	31 ppb		7.0 ppb	
Action	Actions for Preventing Air Quality Deterioration			
Threshold	20 ppb		2.0 ppb	
Action	Actions for Keeping Clean Areas Clean			

112 https://www.alberta.ca/canadian-ambient-air-quality-standards.aspx

Figure 26: Map of Alberta's air zones

Each province is responsible for assigning each air zone their management level and implementing necessary management actions, except for emission sources and lands under federal jurisdiction (e.g., national parks); in these areas, the federal government collaborates with provinces and territories to manage air quality.

The CAAQS are reported on in Alberta by geographic areas called air zones. There are six air zones in Alberta, which align with the Land-use Framework (LUF) regional boundaries, except the Lower and Upper Peace regions, which were combined into one air zone called Peace (Figure 26).[113]

AEP annually produces reports to summarize the air zones' CAAQS status and assigned management levels based on both three-year and annual metrics. These reports are available on the Alberta Air Quality website.[114]

Since assessments began, every Alberta air zone has reached an orange management level at least once since the CAAQS were developed. The corresponding CAAQS Response – Action Plans for Alberta air zones can be accessed online under "Management Plans."[115]

Current ambient air quality assessments for 2021 show that most Alberta air zones are in the "orange" CAAQS management level for both hourly and annual nitrogen dioxide. Forecasts and recent data presented by AEP to the project team indicate that all Alberta air zones will likely approach or exceed CAAQS when the 2020 CAAQS are first reported, based on 2018-20 data. Data and information on the Alberta forecasts can be found in Appendix A.

5 Alberta's Air Management System

This section provides a brief overview of Alberta's current air quality management. Some broad lessons learned from experience in implementation of air management frameworks in the province are also provided.

6 Evolution of Alberta's Air Management System

In 2000, the Canadian Council of Ministers of the Environment (CCME) set air quality standards, called Canada-Wide Standards (CWS) for ozone and particulate matter, which were to be achieved by 2010. All provinces and territories, except Quebec, agreed to implement the CWS.

113 Note there are differences in terminology between regional airsheds, air zones and airsheds in Alberta. Regional airsheds and air zones are terms to describe geographic areas, whereas in Alberta, Airsheds are not-for-profit organizations that monitor air quality within a certain area.

114 https://www.alberta.ca/canadian-ambient-air-quality-standards.aspx

115 https://www.alberta.ca/canadian-ambient-air-quality-standards.aspx

To meet Alberta's commitment to the CWS, CASA was approached by former Alberta Environment (now known as AEP) to convene a project team, with the aim of providing recommendations as to how the province could achieve the standards. A CASA PM and O_3 Management Framework was developed and completed in 2003.

In 2012, the CCME transitioned to implementation of the national AQMS, which included the CAAQS. The establishment of the AQMS and CAAQS led to the dissolution of the CASA PM and O_3 Management Framework (Figure 27).[116] Alberta committed to implementing the AQMS and CAAQS through regional plans and the associated air quality management frameworks (AQMFs).[117]

As mentioned in the previous section, Alberta designated air zones under the AQMS. These boundaries coincide with the land-use planning regions defined under the Alberta Land-use Framework and *Alberta Land Stewardship Act*.

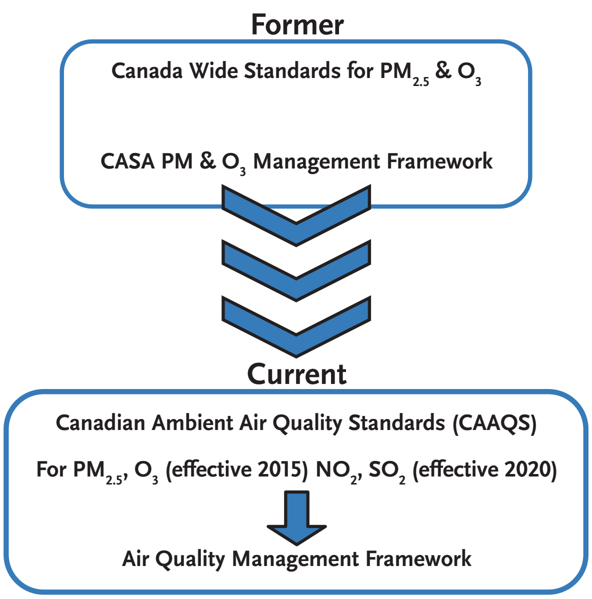


Figure 27: Evolution of air management in Alberta

The AQMFs have strong similarities with the previous CASA PM and O_3 Management Framework in that they identify numerical triggers and limits and assign a management "level" based on the status of ambient air quality in relation to the triggers and limits.

AQMFs under LUF plans vary from region to region and in terms of which pollutants are covered and whether the CAAQS are incorporated. These variations are due to the time difference between when the regional plan was developed and when the CAAQS were developed for the various pollutants. CAAQS-associated air zone management thresholds are intended to be incorporated into future regional air quality management frameworks.[118]

Previous management plans (e.g., CRAZ and Capital Region PM and Ozone management plans) that were already underway before the LUF need to continue to support implementing the new Regional Plan Air Quality Management Frameworks and the CAAQS (e.g., the North Saskatchewan Regional Air Quality Management Framework).

Table 16 summarizes and compares the various Ambient Air Quality Standards applied in Alberta and their role in the air quality management system.

For management plans developed under the previous CASA PM and Ozone Management Framework (e.g., CRAZ and Capital Region PM and Ozone Management Plan[119]) there were no criteria outlining when a CWS/CAAQS related air quality management plan is no longer required nor evaluation metrics determining if the plans had successfully accomplished their air quality management goals. There is a risk that future similar management plans may lack similar criteria and evaluation metrics and therefore continue a legacy of previous, but no longer relevant, policies. AQMFs hope to mitigate some of these risks by being supported with legislation and maintained by regular reporting.

116 https://craz.ca/downloads/craz-documents/Documents/Air%20Quality%20Management%20Plan%202019/Air%20Quality%20Management%20Plan%202019/2019%20CRAZ%20Air%20Quality%20Management%20Plan_final.pdf

117 The Regional Plans in Alberta are under various stages of development. For more information, please visit the Land-use Framework website: https://landuse.alberta.ca/Pages/default.aspx

118 Reference to this action can be found in section 4.3.2. in the SSR AQMF "The federal government has also set hourly, 24-hour and annual National Ambient Air Quality Objectives (NAAQOs) for NO_2. The CAAQS are currently being developed for NO_2 that will replace the NAAQOs and will be phased into this framework's approach as they become available."

119 Note that these are two separate plans developed years apart. The ozone plan was developed and led by a coalition of airsheds in 2008. The PM response was developed by AEP and released in 2015.

Table 16: Comparison of Ambient Air Quality Standards applied in Alberta

	Canadian Ambient Air Quality Standards (CAAQS)	Land-use Framework/ Air Quality Management Framework (LUF/ AQMF)	Alberta Ambient Air Quality Objectives (AAAQO)	Air Quality Index (AQI)	Air Quality Health Index (AQHI)
Purpose	Long-term regional air zone air quality management to improve protection of human health and the environment. Corresponding to each air zone management levels, action plans are published outlining recommended air quality management actions.	Manage air quality regionally with cumulative effects approach. Regions align with LUF planning boundaries, with management responses being place-based. Triggers management response and actions.	Manage air quality provincially and at facility level. Inform *Environmental Protection and Enhancement Act* (EPEA) approvals – model facility impact on ambient air quality.	Evaluate AEP's performance in achieving air quality in its annual report. Inform AEP business planning.	Communicate the health risks of air pollution with the public in real-time to enable planning of daily activities.
Reporting	Annual – through Air Zones reports.	Annual – through Status of Ambient Condition and Status of Management Response reports.	Immediately upon exceedance of an objective and in monthly and annual reports.	Annual – in GoA and AEP annual reports.	Real-time – through web page, smartphone apps, and other services.
Authority	Federal: *Canadian Environmental Protection Act* (CEPA)	*Alberta Land Stewardship Act* (ALSA) Stewardship Minister	Provincial: EPEA Regional Director (if in an approval)	AEP Based on AAAQOs	Federal program: Health Canada; Alberta has a unique role in administering the program.
Number of Pollutants	Four pollutants ($PM_{2.5}$, O_3, NO_2, SO_2)	Varies by LUF region. To date, has included $PM_{2.5}$, O_3, NO_2, SO_2. Others such as non-methane hydrocarbon (NMHC) and total reduced sulphur (TRS) may be included in the future.	57 pollutants	Five pollutants ($PM_{2.5}$, O_3, NO_2, SO_2, CO) Minimum four to five, must include $PM_{2.5}$	Three pollutants ($PM_{2.5}$, O_3, NO_2) across Canada, except Alberta + (SO_2, CO, H_2S, TRS) for Alberta only

	Canadian Ambient Air Quality Standards (CAAQS)	Land-use Framework/ Air Quality Management Framework (LUF/ AQMF)	Alberta Ambient Air Quality Objectives (AAAQO)	Air Quality Index (AQI)	Air Quality Health Index (AQHI)
Data used/ measured	Measured QA/QC data. For each CAAQS pollutant, the highest management level of the two metrics (except O_3) determines the management level for the air zone for that specific pollutant (e.g., hourly or annual for NO_2 and SO_2; 24-hour or annual for $PM_{2.5}$). Stations used are in populated areas (using *Population Improvement Approach*[A]) and areas with significant monitored pollutant sources, or near sensitive ecosystems for NO_2 and SO_2.[B]	In the Lower Athabasca Region (LAR), NO_2 and SO_2 are based on AAAQOs. In the South Saskatchewan Region (SSR), NO_2 is based on AAAQO; $PM_{2.5}$ and O_3 are based on CAAQS. No other regions have LUF/AQMFs.	Real-time data. Reported both before and after QA/QC.[C] Point Source (community and fence line stations). Includes exceptional events – hard limit. Modelled. Not all substances are monitored.	Calculated hourly, based on the previous hour. Single pollutant driven (the pollutant that gives the highest AQI measure for each hour determines the AQI for that hour at that station).	Calculated hourly based on previous 3-hour average. Uses a weighted equation[D] of NO_2, $PM_{2.5}$, and O_3 combined. For Alberta only, there is a substance-specific override: if the 1-hour average AQI is greater than 6 (high or very high)[E] and greater than the AQHI, then AQI-like value is used instead. Real-time data that are not QA/QC.
Metrics	Substance-specific but most include an annual average and a three-year average of short-term peak concentrations. May exclude transboundary flows and exceptional events (e.g., pollution that originated from beyond Alberta's geographic boundaries, forest fires[F]).	Initially based on annual averages and 99th percentiles but moving to adopt CAAQS. May include secondary indicators in future with unique metrics.	Short-, medium-, and long-term averages. Any value in excess of AAAQO is an exceedance.	Percentage of cumulative days of good, fair, poor, or very poor air quality.	Scale 1-10+.
Data Source	Stations that measure the pollutants above (~44 stations in Alberta)[G]	Appropriate stations depending on the region and sources monitored.	All stations in Alberta (>100 stations), including industrial.	~18 stations in urban areas as of 2018.[H]	Community stations measuring the pollutants above (~33). Can include short-term portable sites.

	Canadian Ambient Air Quality Standards (CAAQS)	Land-use Framework/ Air Quality Management Framework (LUF/ AQMF)	Alberta Ambient Air Quality Objectives (AAAQO)	Air Quality Index (AQI)	Air Quality Health Index (AQHI)
A performance indicator[I]	YES and NO Not effective as a short-term air quality indicator because results are only available when the annual assessment is completed and do not account for significant meteorology variation affecting the formation of secondary pollutants like $PM_{2.5}$.	NO AQMFs could be performance indicators but have similar issues to CAAQS and are not currently available for all regions.	YES Only at a facility level.	YES Only for AEP.	NO The risk value reported is related to the pollutant mixture in the AQHI formula rather than an individual pollutant.

A. Population Improvement approach combines ambient air quality data with population distribution. For instance, if a CAAQS is set at x concentration using 10% PIA, and that CAAQS is reached across the country, 10% of the population will experience better air quality.

B. CAAQS for the NO_2 and SO_2 also consider the impacts these pollutants have on acid deposition and critical load acidity in an area. Impacts from acid deposition can include stress or damage to sensitive species of vegetation, such as lichen. Lichen are often used as biological indicators of long-term atmospheric pollution.

C. Exceedances are reported before QA/QC, and all other reporting is QA/QC'd as per the Air Monitoring Directive.

D. $AQHI = 1000/10.7\ [(\exp 0.000871[NO_2]-1) + (\exp 0.000537[O_3] - 1) + (\exp 0.000487[PM_{2.5}] - 1)]$

E. Since AQI is on a 1-100 scale and the AQHI is on a 1-10 scale, AEP has updated the AQI formulas in anticipation of an update to the AQI, which would have brought it to a 1-10 scale, and it is these formulas that are used for the overrides.

F. Transboundary flow and exceptional events calculations are optional. Jurisdictions do not have to do these calculations if they do not want to.

G. The CCME Guidance Document on Achievement Determination (GDAD) provides guidance on the stations that should be used for CAAQS reporting. However, the GDAD acknowledges that the number of reporting stations in an air zone will vary depending on several factors. Jurisdictions have the flexibility to use stations they deem appropriate if the associated monitors satisfy the monitoring technology requirements outlined in the GDADs.

H. Stations must have 75% of hourly data per year to be reported on; if not, they are excluded. For this reason, the number of stations used might vary per year if, for example, a station is not functioning.

I. A performance indicator measures the success of management actions the government takes to improve the environment. These performance indicators are monitored to see if the actions have produced the desired changes in condition (e.g., ambient pollutant concentration), pressure (e.g., air emissions) or response (e.g., recycling program efficacy) indicators.

7 Data and information on NO_x emissions in Alberta

Developing potential approaches and solutions for NO_2 CAAQS achievement requires knowledge of the amount and sources of Alberta's NO_x emissions. The following sections describe NO_x trends from publicly available datasets and reports.

8 Inventories of NO_x emissions in Alberta

This section provides a summary of NO_x emissions data from federal and provincial emission inventories, as well as an overview of NO_x data for Alberta from publicly available reports. It should be noted that the data presented in this section cover a variety of sectors, geographic areas, and years. Further, historical trends and results may not reflect current conditions.

There are three main sources of NO_x emissions data for Alberta:

- the Air Pollutant Emissions Inventory (APEI)
- the National Pollutant Release Inventory (NPRI)
- the Annual Emissions Inventory Report (AEIR)

A description of each inventory and key results from each inventory are provided in Table 17 below.

Table 17: Inventories of NO_x emissions in Alberta

Inventory	Description	Key results
Air Pollutant Emissions Inventory (APEI)	• Provides air emission total for numerous pollutants for entire provinces and territories, not by air zone. • Annually prepared and published by Environment and Climate Change Canada, using facility emissions data collected from the NPRI as well as emissions data provided by provinces. • Includes all anthropogenic sources, both industrial and non-industrial data (e.g., transportation).	• A total of 1.6 Mt of NO_x was released in Canada in 2019 of which ○ 48% were from transportation and mobile equipment. ○ 30% were from the oil and gas industry (97% upstream; 3% downstream). • National NO_x emissions decreased by 29% (657 kt) from 1990 to 2019, mainly due to a decrease in emissions from light-duty vehicles. The Upstream Oil and Gas industry and Domestic Marine Navigation, Fishing and Military were the only major contributors to NO_x emissions that experienced an increase in emissions across this time series. • Alberta and Saskatchewan are the only provinces that saw NO_x emission increase since 1990 (3% and 5%, respectively). • Alberta contributed 42% of Canada's total NO_x emissions in 2019 from which conventional oil and gas was the largest source of NO_x emissions (45%), followed by transportation (24%) and oil sands (17%).
National Pollutant Release Inventory (NPRI)	• Data reported from specific industrial, commercial, and institutional facilities that are required to submit reports annually to the federal government. • Inventory includes water and land pollution in addition to air, as well as disposal, transfer, and recycling of pollutants. • Data reported excludes some on-site facility sources. • Emissions reported are aggregated by facility totals. • Data can only be used for large-scale regional photochemical modelling, not local scale.	• A total of 560 kt of NO_x was reported as being released to the atmosphere for 2019 across Canada, with 294 kt being emitted by facilities in Alberta (~53%). • Facilities in the oil and gas sector accounted for 44% of all Canadian NO_x emissions reported to the NPRI for 2019, followed by manufaturing (23%) and electric power (22%).

Alberta Annual Emissions Inventory Report (AEIR)	The AEIR Program is designed to capture detailed source-level emissions for large industrial facilities in Alberta. Collected facility data includes both point and non-point sources. Data is disaggregated and detailed to include equipment information, pollution controls, emission rates, and all facility stacks. Data can be used for both local and large-scale dispersion and photochemical modelling.	According to the 2018 AEIR data: • 301 of the 335 AEIR facilities (~90%) reported non-zero volumes of NO_x emissions. • The average reported facility total for NO_x emissions was 673 tonnes/year. • A total of 32 facilities reported NO_x emissions greater than 1,000 tonnes/year. • These 32 facilities emitted ~76% of the total AEIR facility NO_x emissions.

9 Studies outlining NO_x emissions sources in Alberta

Several publicly available reports include data on NO_x emissions in Alberta, in some cases including forecasts into the future. A summary of the NO_x-related data for Alberta from each report is provided in Table 18 below.

Table 18: Results from reports that include NO_x emissions in Alberta

Report name	Report context	Key results
A Knowledge Synthesis of Non-Point Source Air Emissions and their Potential Contribution to Air Quality in Alberta: Final Technical Report to the Non-Point Source Project Team	A technical report prepared for CASA's Non-Point Source project. The technical report highlights some of the findings from an analysis AEP conducted of major non-point sources in Alberta. The analysis aimed to synthesize what is known about point and non-point source emission inventories, retrospective trends in emissions for 2000-2014, and emissions forecasting in relation to non-achievement of ambient $PM_{2.5}$ and O_3 CAAQS standards in Alberta's air zones.	• In 2014, industrial sources accounted for 70% of the province's total anthropogenic NO_x emissions, and transportation sources were the second largest NO_x emission source, representing 28% of Alberta's anthropogenic emissions. • Total Alberta anthropogenic NO_x emissions are estimated to have decreased by 9% between 2000 and 2014 and were projected to remain constant over the next 20 years. • Some Alberta air zones, such as those with oil sands development, may see increases in NO_x emissions associated with additional industrial development.

Provincial Air Quality Photochemical Modelling Report[120]	In 2018, AEP hired a consultant to complete a study using the Community Multi-Scale Air Quality model (CMAQ) to predict ground-level concentrations of both primary and secondary pollutants. The results of the study allow the province to identify how major sectors in Alberta impact ambient air contaminant levels to prioritize air quality management action for the appropriate sector.	• The study identified the Upstream Oil and Gas (UOG) sector as a key source of NO_x in Alberta. • Widespread reductions of annual average NO_2 concentrations, ranging from 1.5-3 ppb and up to 18 ppb, occur when eliminating emissions from the UOG sector from the model. • Other sectors with notable NO_x contributions included on-road mobile sources, coal electric generating units, agriculture and forestry, and other industrial point sources.
Effect of the COVID-19 public health emergency on urban air quality in Alberta	Alberta Environment and Parks completed preliminary data analysis to investigate the potential for improved air quality due to reduced vehicular transportation associated with COVID-19 as part of CASA's ongoing project, "Impacts of Reduced Transportation on Air Quality in Alberta Associated with COVID-19." The project is ongoing, and the results of the study will be published once complete.	• Satellite measurements of NO_2 showed lower levels than would typically be expected for urban areas across Alberta suggesting transportation can be a major contributor to NO_2 levels in urban centres. • Weekday traffic on urban thoroughfares decreased by 30 to 40% from March 23 to April 24, 2020. • Between March 22 and April 24, 2020, ambient concentrations of NO_2 in Alberta's two largest cities, Calgary and Edmonton, were approximately 25% lower than in previous years.

10 Experience from outside Alberta to inform approaches and solutions

Included in this section is a brief review of what other jurisdictions have done to manage air quality and reduce emissions.

This jurisdictional review is not meant to be comprehensive nor suggest that such actions could or should solve Alberta's issue because there are differences in policy, regulations, economics, etc. Further, the effectiveness of these management actions in reducing emissions in the jurisdictions in which the actions were implemented is unknown. Instead, this information is intended to be used as a starting point to understand the types of management actions that could be undertaken and which could inform future workshop discussions. Further information from other jurisdictions will be shared in the CAAQS achievement webinar series.

120 https://open.alberta.ca/dataset/6780b709-6a9b-4a25-bdc2-2196a8e4f215/resource/a55d2d3e-ccda-451b-9699-690a5eaf6426/download/public-facing-summary-final-w-attachments.pdf

11 Learnings from other jurisdictions

The project team identified four jurisdictions for this preliminary review: British Columbia (BC), Ontario, Quebec, and the USA. Table 19 outlines several examples of management actions being undertaken by these jurisdictions to manage air quality and reduce emissions.

The provinces of BC and Ontario were selected because they have also exceeded CAAQS (for $PM_{2.5}$ and O_3), and the actions they have taken may be relevant for Alberta NO_2 CAAQS exceedances.[121] Quebec is included as a point of comparison with Ontario and BC as a jurisdiction within Canada that does not follow the AQMS. The USA was selected because it has a longer history of air quality management than Canada, and their experience may help inform what could be done in Alberta.

For readers interested in other jurisdictions, a 2016 report was contracted by AEP to conduct an international review of air quality non-attainment areas.[122] The report includes a review of air management systems from Europe, Australia, and Asia.

Table 19: Jurisdictional review of air quality management issues and associated management actions to reduce emissions

Jurisdiction	Air emissions issue	Examples of management actions undertaken to reduce emissions
British Columbia[123]	$PM_{2.5}$ CAAQS exceeded (annual and/or hourly) in four three-year reporting periods between 2011 and 2016 in the Central Interior Air Zone.	• Developed a Regional Air Protection Strategy to identify actions to allow the region to respond to air quality issues. • Created a woodstove exchange program to provide funding to communities to support replacing old inefficient woodstoves. • Built awareness of local air quality issues and published in local newspapers. • Developed public outreach materials and partnerships, such as an emissions inventory and regional air quality study. • Installed additional air quality monitoring station to identify possible air quality hot spots. • Created bylaws to regulate backyard burning.
	$PM_{2.5}$ CAAQS exceeded (annual and/or hourly) in four three-year reporting periods between 2011 and 2016 in the Georgia Strait Air Zone.	• Hosted a forum on air quality attended by experts and elected officials. • Participated in the provincial woodstove exchange program. • Developed educational programs to increase communication about air issues in the region. • Considered bylaws related to open burning. • Developed an air quality report for the region.

121 https://www.ontario.ca/document/air-quality-ontario-2018-report
122 https://open.alberta.ca/publications/9781460130148
123 https://www2.gov.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/air-zone-reports/air_zone_management_response_09-2017.pdf

Ontario[124]	Ontario reduced NO_x emissions ~26% between 2009 and 2019; ambient air concentrations decreased by ~21%. ~66% of Ontario's NO_x emissions came from the transportation sector in 2018.	• Combined provincial management actions and federal-level transportation initiatives. • Phased-out and banned coal-fired generating stations. • Implemented nitrogen oxides and sulphur dioxide emissions cap and trade regulations (O. Reg. 397/01 and O. Reg. 194/05). This program was introduced in 2000 and resulted in a large reduction in emissions in the early years of the program. Note that this regulation was repealed in February 2021. • Set new and updated air standards through the local air quality regulation (O. Reg. 419/05). • Regulated industrial emissions through the site-specific standard and technical standard compliance options under O. Reg. 419/05. • Established emissions controls at Ontario smelters through site-specific standards under O. Reg. 419/05. • Promoted Drive Clean testing of vehicle emissions.[125] • Required regulated facilities to produce Emission Summary and Dispersion Modelling reports under *Ontario Regulation 419/05* or *Ontario Regulation 1/17*.[126]
Quebec	Quebec has not implemented the AQMS but has taken measures to control sources of $PM_{2.5}$ and O_3.	• Reserved funds from a 2013-2020 Climate Change Action Plan for the promotion of public and alternative transport by improving supply, developing infrastructure, and facilitating sustainable choices. • Implemented a Heavy Motor Vehicle Inspection and Maintenance Program (PIEVAL) to improve air quality, particularly in urban areas, by reducing air quality emissions of particulate, volatile organic compounds (VOCs) and carbon monoxide (CO) produced by heavy vehicles. • Required that only high-efficiency wood stoves can be manufactured, distributed, or sold in Quebec under Wood Heating Devices Regulations.

124 https://www.ontario.ca/document/air-quality-ontario-2018-report

125 This program succeeded in reducing NO_x by requiring regular emission testing for heavy-duty vehicles, commercial trucks, buses, and regular passenger vehicles. This program was regularly enforced by on-road enforcement officers. However, after 20 years, the program was cancelled in April 2019 for passenger vehicles while heavy diesel commercial motor vehicles continue to require an emissions test.

126 https://www.ontario.ca/document/guideline-10-procedure-preparing-emission-summary-and-dispersion-modelling-esdm-report

USA	The USA has several air quality management system elements that could be considered when developing strategies to address the NO_2 issue in Alberta.	• *The Clean Air Act* (CAA) is the comprehensive federal law that regulates air emissions from stationary and mobile sources. • One of the goals of the act was to set and achieve National Ambient Air Quality Standards (NAAQS) in every state by 1975.[127] States were also directed to develop State Implementation Plans (SIPs) to achieve these standards. • In general, the SIP consists of air quality monitoring, air quality modelling, emission inventories, emission control strategies, contingency measures, and policies that the state uses to attain and maintain the NAAQS. • The CAA requires states with non-attainment areas to adopt additional regulatory programs designed to achieve and maintain attainment of the relevant NAAQS.

12 Webinar series and workshops to identify potential approaches and solutions

Through the CAAQS achievement webinar series and subsequent workshops, the project team will be developing potential approaches and solutions to the NO_x issue in Alberta. Stakeholders are encouraged to bring innovative policy and regulatory recommendations to address this issue practically and effectively.

The GoA is looking for recommendations from stakeholders from this project that:

- Target key emission sources while recognizing that uncertainties exist and that, in some cases, improved knowledge and understanding of key emission sources and their air quality impacts is required.
- Are realistic in terms of what current and/or modified regulatory and non-regulatory policies and programs can achieve.
- Consider the economic implications to the province and targeted sectors.
- Can be implemented and are measurable. For example, the action identified is specific enough to establish an associated measurable performance measure(s). This will allow the implemented action to be monitored and evaluated to see if it has been effective in achieving the desired air quality outcomes.

127 The Act was amended in 1977 and 1990 primarily to set new goals and dates for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines.

Appendices

Appendix A: CAAQS Achievement Forecasts for Alberta

The first formal achievement determination of the 1-hour NO_2 2020 CAAQS occurs in 2021 and will be based on metric values for the three-year period from 2018 to 2020. For the 2025 standard, the formal achievement will be based on metric values for the period 2023 to 2025. For more information on how the CAAQS are calculated, please visit the CCME's *Guidance Document on Air Zone Management*[128] for national guidelines and *Alberta's Implementation of the National Air Zone Management Framework* for Alberta-specific information.[129]

For the annual NO_2 standard, the first formal achievement determination will be based on the annual average of NO_2 1-hour measurements in 2020 for the 2020 standard and in 2025 for the 2025 standard.

For this project, AEP conducted preliminary NO_2 CAAQS achievement forecasts (for both the 1-hour and annual metrics) using 2017–2019 data.[130] These estimates are preliminary, as only the 2018 and 2019 data in this analysis are relevant for the 2020 CAAQS determination. For this analysis, transboundary flow and exceptional event (TF and EE) impacts were not considered.

Key results from the analysis are as follows (shown in Figure 28 and Figure 29):

2020 1-Hour NO_2 CAAQS (Standard 60 ppb)

- The 1-hour NO_2 metric stations in the South Saskatchewan Air Zone could potentially exceed the 2020 CAAQS (red management level).
    - The two stations in the South Saskatchewan Air Zone that are estimated to exceed the 1-hour CAAQS are Calgary Central-Inglewood (64 ppb) and Airdrie (62 ppb).
- All other air zones in the province could reach the orange management level.
    - Stations in the North Saskatchewan and Peace Air Zones had metric values up to the mid-50 ppb range, and other regions of the province had metric values up to the 40–45 ppb range.

2025 1-Hour NO_2 CAAQS (Standard 42 ppb)

- At least one station in every air zone, except for the Upper Athabasca Air Zone, is estimated to exceed the 1-hour NO_2 CAAQS.
- In the Lower Athabasca Air Zone, the station that would exceed the 2025 1-hour CAAQS is the Horizon station, which has been relocated and renamed. It is unknown at the time this document was created if the new Horizon location (Ells River) will have similar levels of NO_2.

2020 Annual NO_2 CAAQS (Standard 17.0 ppb)

- All regions of the province are estimated to reach the orange management level for the 2020 Annual NO_2 CAAQS.
    - In 2019, the highest annual average NO_2 concentrations were measured at the Calgary Central-Inglewood and Edmonton Central stations, with metric values of 15.5 ppb and 14.9 ppb, respectively, which places these stations close to the NO_2 Annual CAAQS for 2020.

2025 Annual NO_2 CAAQS (12.0 ppb)

- Projected to be exceeded in both the North Saskatchewan Air Zone and the South Saskatchewan Air Zone at Edmonton area stations (Central, East, Woodcroft, and Gold Bar) and Calgary stations (Central-Inglewood and Southeast).

128 https://ccme.ca/en/res/guidancedocumentonairzonemanagement_secured.pdf

129 https://open.alberta.ca/dataset/2baa091e-2b5e-4d12-9da7-4c5e89bef71d/resource/5f87b061-e049-4549-8fde-b077cf0207fd/download/implementationframework-pm-ozone-sep2015.pdf

130 Note that there are three stations that only had two years of data available to calculate the metric value, and they are indicated with an asterisk next to the station name (e.g., Ardrossan, Airdrie, Redwater).

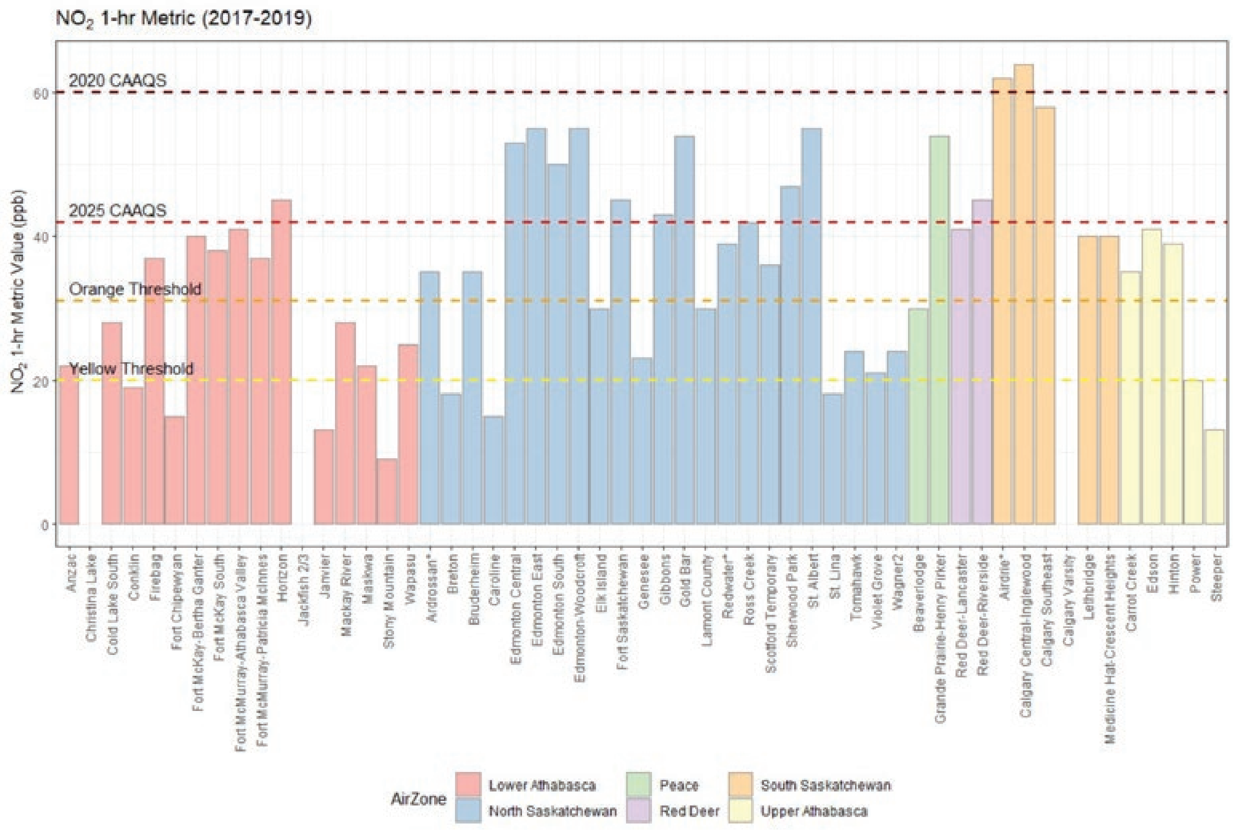


Figure 28: Comparison of Alberta's 2017–2019 1-hour NO_2 levels against the 2020 and 2025 1-hr CAAQS (Note: Stations with an asterisk* had only two years of data available to calculate the metric value instead of three.)

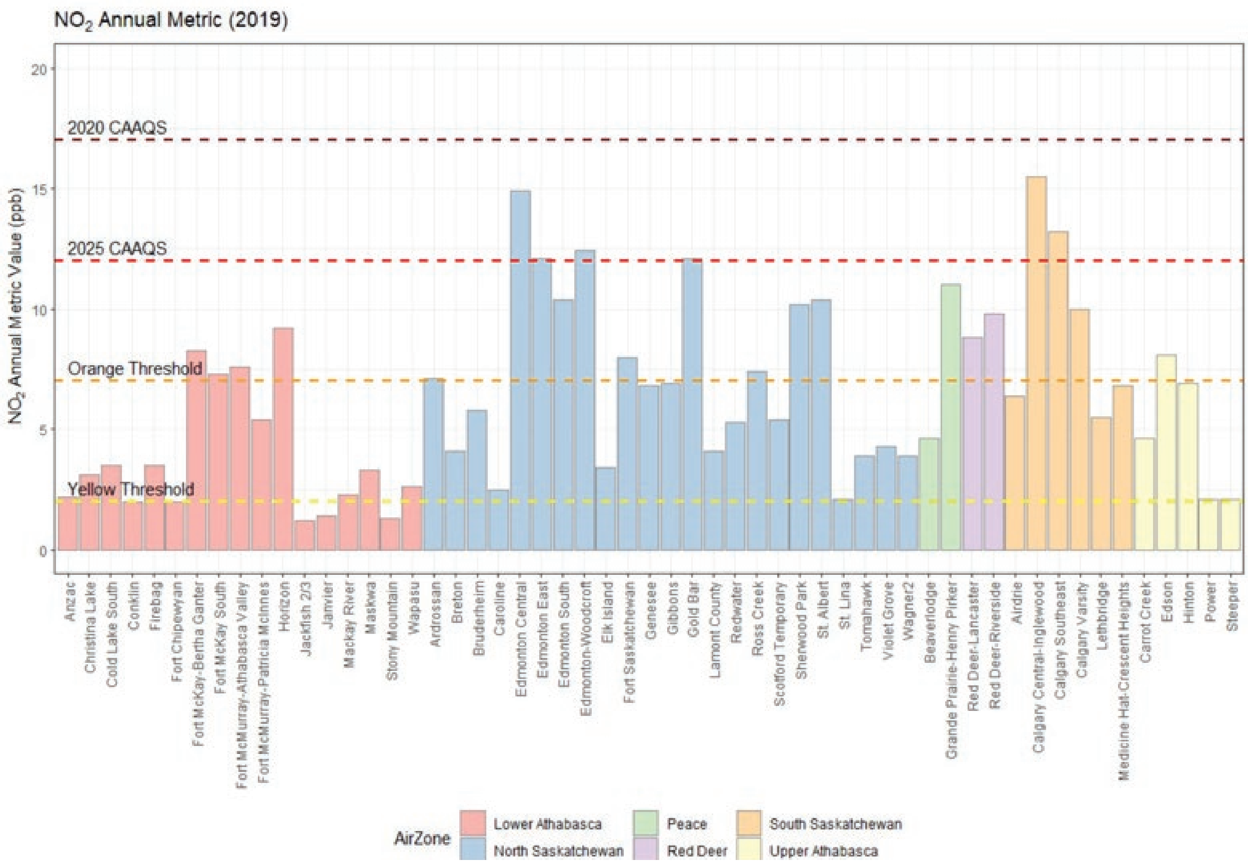


Figure 29: Comparison of Alberta's 2017–2019 annual NO_2 levels against the 2020 and 2025 annual CAAQS (Note: Stations with an asterisk* had only two years of data available to calculate the metric value instead of three.)

Appendix B: Resources for further reading

Table 20 includes a brief list and description of resources on air quality management at the federal and provincial level. These resources provide additional context about the CAAQS issue for those interested in learning more.

Table 20: Air quality management resources for further reading

Topic	Resource name	Description
Federal		
Pre-CAAQS federal air quality standards	National Ambient Air Quality Objectives[131,132]	Published in 1976, covering SO_2, suspended particulates, CO, O_3, NO_2. Consisted of three tiers identifying ranges of air quality.
	Canada-Wide Standards (CWS) for particulate matter and ground-level ozone[133]	CWS environmental standards for ambient air quality covering fine particulate matter and ground-level ozone. CWS were a single value (no steps or levels). Included determination and reporting procedures. In June 2000, the CWS for PM and ozone were published. These new national ambient air quality standards committed governments to reduce PM and ground-level ozone through jurisdiction-specific air quality management plans.

131 https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/naaqo-onqaa/particulate_matter_matieres_particulaires/summary-sommaire/98ehd220.pdf

132 https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/air-quality/national-ambient-air-quality-objectives-particulate-matter-executive-summary-part-1-science-assessment-document.html

133 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/agreements/related-federal-provincial-territorial/standards.html

Topic	Resource name	Description
Air Quality Management System	Canadian Ambient Air Quality Standards[134]	Driver for air quality improvement across Canada. See Sections 4 and 5 of this document for more information on CAAQS and how they are applied in Alberta.
	Base-Level Industrial Emissions Requirements (BLIERs)[135]	Set emissions standards for major industrial sectors and equipment types in Canada to ensure facilities achieve a base level of performance. BLIERs must be considered by provinces and territories when developing provincial source emission requirements and industrial approvals.
	Air Zone Management Framework[136]	A framework for air management that allows provinces and territories to manage emissions to achieve CAAQS within air zones.
	Regional airsheds[137]	Provide a framework to coordinate and address air quality issues for transboundary air pollution.
	Mobile sources	An intergovernmental Mobile Sources Working Group building on existing federal, provincial, and territorial initiatives to reduce transportation sector emissions.
Provincial		
Pre-CAAQS provincial implementation of national standards	CASA PM and Ozone Management Framework[138]	Alberta Environment asked CASA to assemble a multi-stakeholder team to develop a framework to achieve the CWS in Alberta by the 2010 target date. The framework established a tiered air quality management system similar to the CAAQS. At the most stringent management levels, the framework required development of management plans. A policy tools document was also developed to inform airsheds of potential actions that could be taken to reduce $PM_{2.5}$ and ozone called the “Air Quality Management Policy Tools Leading Practice Research”[139] which may apply to the current NO_2 problem.
Implementation of Canada’s AQMS in Alberta	*Alberta’s Implementation of the National Air Zone Management Framework for Fine Particulate Matter and Ozone*[140]	Describes the overall process for how the GoA is implementing O_3 and $PM_{2.5}$ CAAQS in the province.

134 https://ccme.ca/en/air-quality-report

135 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/overview-multi-sector-air-pollutants-regulations.html

136 https://ccme.ca/en/res/guidancedocumentonairzonemanagement_secured.pdf

137 https://ccme.ca/en/air-quality-report

138 https://open.alberta.ca/dataset/c7cf3235-6024-4e79-ad2a-f991db337d3b/resource/c7a65d60-901c-4260-ad36-aff62a7aff63/download/pm-ozonemanagementhistory-mar01-2017.pdf

139 https://open.alberta.ca/dataset/27147ba3-d6cf-46c6-b720-e764df5e76aa/resource/fabbe8c7-529f-4ed3-8f11-ed4cf7d26d77/download/2007-airqualitymanagementtools-dec2007.pdf

140 https://open.alberta.ca/dataset/2baa091e-2b5e-4d12-9da7-4c5e89bef71d/resource/5f87b061-e049-4549-8fde-b077cf0207fd/download/implementationframework-pm-ozone-sep2015.pdf

Topic	Resource name	Description
Legislation	*Environmental Protection and Enhancement Act*[141]	Primary legislation to manage air quality in Alberta and includes several related directives, standards, policies, objectives, guidelines, monitoring codes, Codes of Practice, and management frameworks.
	Alberta Land Stewardship Act[142]	The legal basis for regional plans. See Table 2.
Implementation of Canada's AQMS in Alberta	Lower Athabasca Regional Plan and South Saskatchewan Regional Plan Air Quality Management Frameworks[143,144]	In 2012, the Lower Athabasca Regional Plan and its associated AQMF were developed while the South Saskatchewan regional plan and AQMF was established in 2014. The plans apply a cumulative effects approach to managing air quality, along with surface water quality and hydrology (in the case of the LAR).
Air monitoring	Airshed organizations (airsheds)[145]	Regional multi-stakeholder not-for-profit societies responsible for air monitoring. There are ten airsheds, operating more than 88 air monitoring stations. Help respond to local and regional air quality concerns; facilitate multi-stakeholder dialogue on air quality issues; and educate and engage with communities on ambient air quality.
Acid deposition	Acid Deposition Management Framework (ADMF)[146]	Developed in 1999 by CASA for management of acid deposition effects in Alberta, and later updated in 2008. The framework is based on four levels of acid deposition, with corresponding management practices. The framework includes regular acid deposition assessments in the province roughly every five years. AEP is currently revising the ADMF through a multi-stakeholder process. Once complete, the revised ADMF will replace the current ADMF and will be found on the Alberta Air website.[147]

141 https://www.qp.alberta.ca/documents/Acts/E12.pdf
142 https://www.qp.alberta.ca/documents/Acts/A26P8.pdf
143 https://landuse.alberta.ca/LandUse%20Documents/Lower%20Athabasca%20Regional%20Plan%202012-2022%20Approved%202012-08.pdf
144 https://open.alberta.ca/dataset/13ccde6d-34c9-45e4-8c67-6a251225ad33/resource/e643d015-3e53-4950-99e6-beb49c71b368/download/south-saskatchewan-regional-plan-2014-2024-may-2018.pdf
145 https://www.albertaairshedscouncil.ca/
146 https://open.alberta.ca/dataset/8c64b5ab-23f5-4250-8bbc-8bea779853b3/resource/c1fc29fa-549e-4fb7-9423-6a06ad240018/download/2008-aciddepositionmanagementframework-feb2008.pdf
147 https://www.alberta.ca/acid-deposition.aspx

Appendix 5a:
Webinar Proceedings

Webinar Proceedings

Clean Air Strategic Alliance

March 2022

About these proceedings

These proceedings contain synopses of the presentations, panel discussions, opening and closing remarks, and Q&A sessions. The synopses were prepared by the Clean Air Strategic Alliance based on recordings of the speakers' presentations and on their slides. Note: for webinar 6, a recording is not available, so the proceedings are based on project team members' notes and input from the presenters. Speakers have had the opportunity to review the proceedings and edit their synopses for accuracy. The feedback provided was almost exclusively minor clarifications, but in a small number of cases the information delivered at the webinar was incorrect and has been amended for this document. Therefore, where differences exist between this document and the presentations, this document contains what should be considered the best available information.

Contents

Webinar #1: Setting the context for the issue of NO_2 CAAQS Achievement in Alberta

Alberta's Air Quality Management System and the challenge of NO_x emissions management moving forward

Hamid Namsechi
Alberta Environment and Parks (AEP)

The focus of the presentation was on why Alberta has a nitrogen oxides (NO_x) air quality issue; past, current, and possible future NO_x levels in Alberta relative to the 2020 and 2025 Canadian Ambient Air Quality Standards (CAAQS); and sources of NO_x emissions by both sector and geographic area.

Presentation Highlights

The main driver for NO_x management is the risk to human health. Acute exposure to NO_x causes 0.9% of non-accidental deaths in Canada. Nitrogen dioxide (NO_2) is also a precursor for secondary particulate matter (PM) and ozone (O_3).

Alberta has a high concentration of industrial sources of NO_x compared to other provinces; it also emits more NO_x than British Columbia, Ontario, and Quebec combined. With respect to industrial sources of NO_x, conventional oil and gas is the largest emissions source, followed by transportation. Alberta's NO_x emissions increased greatly in the late 1990s, and it remains high because of increased industrial activity.

NO_x concentration is an ambient air quality issue, but it has been trending downwards in Alberta due to tightening emission controls on vehicles and other NO_x sources. Three major changes that contribute to the decrease in NO_2 are:

1. Removing older vehicles from the road,
2. The economic downturn in 2018 and subsequent reduced industrial activity, and
3. The COVID-19 pandemic causing reduced commuting.

For the 2020 CAAQS assessment, most Alberta air zones are expected to be in the "orange" management level for NO_2 CAAQS. When looking at the 2025 threshold, most of Alberta (except Upper Athabasca) is expected to be in the "red" management level, thus requiring urgent action to reduce levels to orange or lower.

Air policy tools used to manage air quality are in layers, which range from international to place-based scales, and include, but are not limited to:

- International: Canada-USA Accord
- National: Canadian Ambient Air Quality Standards (CAAQS)
- Provincial: Ambient Air Quality Objectives/ Standards (AAQOs), source emission standards
- Regional: Land-Use Plans
- Sub-regional: Capital Regional Air Emissions Framework
- Municipal: anti-idling bylaws, transportation plans, building codes
- Industrial: facility approvals

There are two pillars of Alberta's Air Quality Management System (AQMS): i) source emission standards and ii) the Ambient Air Quality Management System.

Source emission standards aim to reduce emissions from industrial sources, which are regulated through legislation or approvals. AAQOs are benchmarks for assessing air quality and involve air monitoring and reporting air quality changes. Industry approvals are used as the primary industry regulatory tool, and it highlights how ambient and source emission standards come together. Approval applications incorporate source emission standards, while the AAQOs are used in plume dispersion modelling to assess a facility's impacts to the environment. Requirements in approvals are based on best available technology, ambient conditions, and can also involve monitoring and reporting, and other factors.

The challenge moving forward is that the Government of Alberta (GoA) needs to develop a new policy, framework, and/or supporting regulatory tools to facilitate development in new areas that have already exceeded the NO_2 CAAQS.

Canada's Air Quality Management System and Canadian Ambient Air Quality Standards for nitrogen dioxide

Brian Asher and Patrick Hamel, MD
Environment and Climate Change Canada (ECCC)

The focus of the presentation was on AQMS, with a focus on the CAAQS The development of the CAAQS for NO_2 was discussed, including the collaborative process for their development, the human health, and environmental effects of NO_2, as well as the main analyses used to develop the standards.

Presentation Highlights

The AQMS is a harmonized jurisdictional approach to improving air quality in Canada using collaboration between the federal government, provinces, and territories. This approach is supported by extensive research and modelling. The key elements of the federal AQMS include:

- CAAQS: Led by the federal government and an integral part of the AQMS. CAAQS are the driver for air quality improvements across Canada and provide reference points for measuring progress and taking action.
- Base-level Industrial Emissions Requirements (BLIERs): Set for major sectors and equipment types.
- Regional airsheds: Coordinate action on transboundary air pollution.
- Provincial and territorial action: Manage emissions to attain CAAQS within delineated air zones.
- Mobile Sources Working Group: Reduce vehicle emissions among jurisdictions.
- Monitoring and reporting: Public reporting on national State of the Air Reports using provincial and territorial inputs.

The CAAQS are not a "pollute up to level;" they are adopted by the Canadian Council of Ministers of the Environment (CCME) based on the recommendation of the CAAQS Development and Review Working Group (CDRWG). The four management levels (green, yellow, orange, and red) are meant to provide guidance to jurisdictions on the level of monitoring, reporting, and management actions to implement in air zones depending on the level of prevailing concentrations. Actions become progressively more rigorous as air quality deteriorates from the green to the red management level. The main stages of the CAAQS Assessment Approach are:

1. An Air Quality Assessment Report is completed, which uses current science on human health and environmental impacts, and projections for pollutants.
2. The CCME agrees on a range of concentrations as the basis for future CAAQS.
3. The CAAQS Development and Review Working Group selects values for future CAAQS using a collaborative and consensus-based process.
4. The CCME considers the CDRWG's recommendations.
5. Environment and Climate Change Canada establishes the CAAQS and AAQOs under the *Canadian Environmental Protection Act, 1999*.

Some notable environmental impacts of NO_2 include:

- Decreased transpiration, photosynthesis, and biosynthesis of lipids in plants
- Contribution to acidification and eutrophication of ecosystems
- Precursor to O_3 and PM, which have significant implications for human and environmental health

Prior to development of the CAAQS, there were National AAQOs (NAAQOs), however, these were outdated (developed in 1976) and not stringent enough to protect human health. The literature included in the last Human Health Risk Assessment (Health Canada, 2016) shows that NO_2 causes a wide range of adverse outcomes at levels well below the NAAQO.

Short-term exposure to NO_2 causes, or likely causes:

- Adverse respiratory effects
- Premature mortality

Long-term exposure likely causes:

- Adverse respiratory effects
- The evidence is also suggestive of cardiovascular, reproductive, and developmental effects, as well as cancer

The relationship between exposure to NO_2 and respiratory and cardiovascular effects and mortality is linear, with no evidence of a threshold. Population subgroups at increased risk of effects include those with pre-existing conditions and older adults. The range for CAAQS for non-threshold pollutants (i.e., NO_2, O_3, and $PM_{2.5}$) is established using the population improvement approach (PIA). The PIA identifies a population-based air quality target representing an incremental improvement from current conditions. Improvements in population exposure between 5 and 20% resulted in a range of concentration values used to select the future standards. It supports the AQMS principle of continuous improvement and can be viewed as minimum benefit, since it would not account for any reductions in exposure in populations living in areas that already met the target.

The changing landscape of NO_2 (decreases in national emissions and average ambient concentrations) are also considered when assessing the need for a more stringent set of standards. Projected ambient concentrations are used to assess feasibility of the CAAQS, which includes the "business as usual" emissions scenario for 2025 and the 2012 emission inventory and energy forecast for 2025.

The 2025 CAAQS are based on the premise of reducing negative impacts on human health and the environment associated with NO_2. Steady and continued decreases in NO_x emissions and projected ambient levels of NO_2 resulted in a realistic target of achievement that will have health and environmental benefits for Canadians.

Working together to achieve NO_x reduction

Gerald Palanca
Alberta Energy Regulator (AER)

This presentation provided an overview of NO_x non-achievement risks as they relate to the upstream oil and gas industry. The causes and sources of exceedances are due to a variety of challenges, including regulatory gaps. Getting access to more reliable data and developing stronger data management tools will improve capacity to identify major sources and realistic solutions.

Presentation Highlights

The Alberta Energy Regulator (AER) is committed to supporting AEP's management responses under the air and surface water quality management frameworks as well as the GoA's commitment to CAAQS achievement. Gas plant facilities in Alberta are subject to provincial and federal regulations and reporting requirements. For example, the regulator may use out-of-date publicly available data to determine appropriate pollution limits for facility applications. The AER's inability to verify emission from federally regulated facilities makes it challenging to ensure approval conditions are sufficient to protect the airshed. It is possible exceedances in emissions could be solely from one of the facilities that is regulated federally, which could result in excessive costs to the facility under provincial jurisdiction because of the fragmented policy and regulatory system.

The causes of exceedances are the cumulative effects of oil and gas development, emissions from non-AER regulated sources, and policy and regulations that have gaps and are fragmented. Some exceedances of air quality objectives can be directly attributed to AER regulated facilities, but there is a lack of surveillance to verify compliance on the ground. The impacts of CAAQS non-achievement are significant, including:

- impacts to public health
- delays in facility approvals, resulting in higher capital/operating costs and deterring investment
- disruption in AER operations
- damage to Alberta's reputation for sustainable resource development
- the possibility of federal intervention due to CAAQS non-achievement

Standardizing air quality models and tools can reduce the complexity of air assessments and approvals. An air emissions inventory is also critical. Centralizing real-time information would support operator facility applications and AER approvals to ensure adequate pollution prevention controls. In the event of a CAAQS exceedance, an inventory is required to implement management responses and to attribute emissions to operators and facilities.

The AER predicts that federal multi-sector air pollution regulations (MSAPR) requirements are not enough to prevent CAAQS non-achievement risk, and that certain prolific oil and gas development areas of the province are high risk due to the cumulative effects of development. There have been some NO_x reductions (7%) because of declining natural gas development; however, to achieve CAAQS, emissions need to drop 55% from 2019 levels to prevent crossing the exceedance threshold. It is expected that NO_x emissions will increase by about 20% by 2025, mainly because of oil and gas development.

You can only manage what you measure. Airshed accountability requires overseeing measurement, reporting, and source limit enforcement. A real-time database of existing and future emissions is needed to inform facility approval conditions and streamline management response when monitored exceedances occur. Enforcement will reduce costs by holding operators accountable and reducing the impacts to air quality from large industrial facilities.

NO_2 Monitoring

Dr. Bob Myrick
Alberta Environment and Parks (AEP)

The presentation focused on NO_2 monitoring approaches in Alberta. Specifically, how it is conducted, governed (i.e., Air Monitoring Directive and how it influences how monitoring is done), and how it represents different areas and populations.

Presentation Highlights

Air monitoring is delivered through a distributed model across various scales: airsheds, AEP, ECCC, and industry. AEP owns 20 monitoring stations, but only operates seven. The others are operated by airsheds, who also run about 50–60 other stations. ECCC provides data, equipment, and technical information through the National Air Pollutant Surveillance Program. ECCC also has a large role in the Oil Sands Monitoring Program. Industry is required to conduct monitoring near their facilities for compliance purposes.

AEP ensures consistent data and sharing of this data publicly via the Air Data Warehouse and Data Management Program, which is set by the Air Monitoring Directive. AEP also conducts routine audits on monitoring stations.

Traditional continuous monitors can overestimate concentration of NO_x due to other reactive nitrogen compounds in the air. This can result in a bias, although it is usually less than 10%. There are commercially available single-channel instruments that continuously measure "true NO_2." Some US Environmental Protection Agency (USEPA) monitoring sites require a "true NO_2" measurement at each site. In Alberta, "true NO_2" could be used to support environmental management.

Nitrogen dioxide monitoring stations are classified in accordance with the criteria indicated in the AEP Five-Year Monitoring, Evaluation, and Reporting (MER) Plan. There are 35 community monitoring stations, 15 regional monitoring stations, and 12 near industrial facilities monitoring stations, resulting in a provincial network of 62 monitoring stations, 57 of which currently meet the CAAQS.

The CCME Guidance Document on Achievement Determination (GDAD) for NO_2 provides guidance on the stations that should be used for CAAQS reporting and those that should not be used, such as monitoring stations within and very near to industrial activity. Community, regional, and near industrial facility monitoring stations are included in the GDAD with specific guidance on placement of stations based on proximity to communities, local sources of NO_2, and capturing variability. Governments and organizations undertaking air quality monitoring are encouraged to include enough stations to capture variability of NO_2 levels in air zones where it is known that levels are non-uniform.

The "near industrial facility" monitoring stations are one of the more controversial station classifications. They must be located near an industrial site and near a population centre or sensitive ecosystem to be included as a CAAQS station. The caveat that stations near industrial activity should not be used for CAAQS reporting is limited by the location of people and sensitive ecosystems. An example of the kind of sensitivity analysis that is used to make decisions is the use of a critical load of acidity map to identify stations that might be located near sensitive ecosystems.

Question and answer session

Q: How does Alberta account for transportation emissions? Does the transportation sector report to AEP?

A: *When setting emission limits for transportation, Alberta collaborates with the federal government to help set the standards, which become more stringent over time. It is the federal government that has jurisdiction on vehicle emissions. Vehicle emissions estimates also come from the federal government.*

Q: Can AEP please comment on whether and how they are working with AER on NO_x emission reductions for the oil sands sector in the context of the *Environmental Protection and Enhancement Act* (EPEA) approval process and policy/regulation updates?

A: *AEP is the policy arm while AER is the regulatory arm—AEP sets policy, and the AER implements it. The organizations work collaboratively to set emission standards and they strive to find collective agreement on strategies. However, there is still much to improve on.*

Q: Are biogenic sources removed from the dataset before modelling or are they accounted for differently?

A: *Only anthropogenic sources are included in the modelling. ECCC does not model biogenic sources.*

Q: If the CAAQS were established under the AQMS as non-binding objectives, then how is Alberta adopting them as AAQOs that are then used for permitting and compliance?

A: *The AER is adhering to the minimum air quality objectives and standards as it relates to their EPEA approval. Dispersion modelling is conducted, and subsequent adjustments are made to source limits. The challenge is potential non-achievement of CAAQS in the future. AER does not have an answer for this yet and is here today to explore options with fellow stakeholders.*

Q: When we do modelling, we are estimating emissions. For example: MSAPR and the stationary spark emission engine limit for modern engines—we know they will emit twice as high. What do you think is the best way to estimate current and future emissions? What are the appropriate NO_x emissions to use? Because this information will guide us as to the actions we must take to reduce NO_x.

A: *Modelling is based on theory and estimates. There needs to be a solid ground presence to verify actual emissions; the theory of what the emissions are must match the reality. The first step is surveillance and holding industry accountable to meeting their requirements. Investing in more research and satellite monitoring to bridge the gap between theory and reality.*

A: *It is not just modelling; AEP has also used monitored data and calculations for current NO_2 CAAQS for various areas compared against 2025 levels. There are 10 years of valuable ambient monitoring data to use for getting answers about emissions criteria.*

Q: Was the five-kilometre buffer also applied to stations near population centre?

A: *Assuming this question is regarding determining industry stations and if they are accessed by the public, AEP did not use a five-kilometre buffer. AEP worked with regional managers who are connected with local specialists to determine if the station was located on public land or if they had used the land for a specific purpose. If there was public access or use, then that station would be included in analysis. This was one of the trickier ones to determine public access and AEP opted to include the monitoring stations. There are also criteria to determine community and community hotspot monitoring stations, which is detailed in AEP's Five-Year MER Plan. An update on this plan will be provided to CASA's members in a separate webinar later this fall.*

Q: Is there a timeline on when we need to show comparison to the CAAQS as well as AAQOs in air quality assessments?

A: *There is not necessarily a timeline. AEP reports annually on CAAQS and the most recent report should be ready in draft form at the end of the calendar or fiscal year.*

Q: For Hamid: Your presentation identified the challenge ahead as how to deal with new applications where CAAQS are not being met. Is the key challenge ahead how to meet the CAAQS in those red areas? Is this still the objective for the GoA?

A: *The GoA seeks to balance economic, social, and environmental requirements. We need to accommodate new sources of emissions while ensuring good air quality. Closing off airsheds in Alberta to new forms of development is not the signal the province would like to send.*

Q: Were all these 57 stations used in the CAAQS determination by the CAAQS Development and Review Working Group? My recollection is that only very few stations near the industries in Alberta were used for CAAQS determination.

A: *CAAQS metric values from 40 stations in Alberta were used to inform the development of NO_2 CAAQS. These stations did include some stations that were located near industrial activity. Stations in the highly populated areas around the downtown cores of Edmonton and Calgary experience comparable (or even higher) metric values to those stations near industry. The inclusion of a few industrial stations was not expected to impact the results.*

Q: Mr. Myrick, are you stating that the instruments used to measure NO_x are inaccurate? This seems to have major implications for all the modelling and monitoring? Could this issue bring us under the 2025 CAAQS red management level province-wide?

A: *The traditional equipment used to monitor NO_2 can overestimate the measured concentration due to the presence of other reactive nitrogen species (e.g., NOy) in the sampled air. The level of interference can vary and will depend on the amount of other reactive nitrogen species that are present in the sampled air, which in turn will depend on proximity of the monitoring station to the NO_2 source(s) and the amount of atmospheric processing/reaction the sampled air has undergone. For example, the level of interference will differ between samples collected at an urban site (closer to NO_2 sources) and downwind or regional sites.*

Trial CAAQS assessments conducted using 2017 to 2019 data collected at urban stations show levels that exceed the 2025 CAAQS for NO_2. It is difficult to determine if monitoring "true NO_2" at these urban locations would lower NO_2 values enough to bring them below the CAAQS red management level. Over the next few years, AEP will work with Airshed organizations to investigate the impact of "true NO_2" monitoring at selected CAAQS reporting stations.

Q: The measurement bias for NO_2 concentrations between the conventional chemiluminescence vs. "true NO_2" instrument was shown to potentially change CAAQS classification by several management levels. This was based upon relatively limited measurements. Given that this has potential to significantly change the assessment of where we are today, does AEP plan to deploy "true NO_2" stations?

A: *The difference between conventional and "true NO_2" measurements will likely differ between stations. Factors that can affect this difference include proximity to source and the level of atmospheric processing the sampled air has undergone. As a result, it is difficult to know exactly how the change in monitoring technology may affect the assessment. Deploying "true NO_2" monitors at CAAQS reporting stations likely would not change the CAAQS assessment by "several management levels." The assessed NO_2 would likely change but the magnitude of this change is not known at this time. It is recommended that AEP work with Airsheds to develop a plan to potentially deploy "true NO_2" monitoring at selected locations to help further understand this issue.*

Q: Hamid, with 2020 being a unique year, was there a significant improvement in the impact on NO_x in regions that were previously in red?

A: *We have not yet completed the CAAQS assessment for 2018–2020 data. However, based on preliminary results, NO_2 levels at large urban centres were lower at the start of the pandemic (March–April 2020). These differences were not as notable later in 2020.*

Q: Bob, do you have an idea of the investment required to migrate to new NO_2 instruments if proven to be more accurate?

A: *We have not looked at the full cost of adding "true NO_2" monitoring to the ambient air monitoring network yet. Prior to doing this, we will need to determine if we want to add "true NO_2" monitors at existing stations and, if so, how many stations. AEP will work with Airsheds in making these monitoring decisions.*

Webinar #2: Theoretical overview of pollution costs and impacts, benefits, and equitable sharing of emission reductions

Scientific, engineering, and economic underpinnings of air quality controls

Dr. Daniel Vallero
Duke University

This presentation was focused on the nitrogen system, pollution sources, factors, and risks, and how scientific, engineering, and economic factors influence air quality, and in turn, management decisions.

Presentation Highlights

Nitrogen is an important component of our environment and air quality. It has implications for environmental and human health, with impacts including eutrophication and cancer. Using "systems thinking" means considering nitrogen at several levels, such as the microbial level in nutrients, watersheds, and airsheds, and as a part of the climate and its role in climate change. When talking about nitrogen and airsheds, the different forms of nitrogen compounds need to be considered. Chemical speciation of nitrogen has become very important when talking about things like climate change and NO_x.

Combustion is a part of the nitrogen cycle, which be from stationary and mobile sources, and is what creates NO_x in the atmosphere. Because nitrogen is involved in chemical processes in the atmosphere as well as on and within the earth (i.e., soil), it has a major role in localized issues like indoor air quality and global issues like climate change. Movement and heat exchange determines the amount of NO_x that enters the air. The laws of thermodynamics, such as mass balance and entropy, help determine the movement of nitrogen. A Bayesian Leaf Network, which is similar to critical path thinking, can be used to assess the factors that influence NO_x in our atmosphere and to identify the causal chain of influential factors. This can then be used to identify opportunities for mitigating sources of nitrogen.

Nitrogen dioxide is one of the most studied nitrogen oxides, often with a focus on human health and chemical properties of nitrogen. Yet actions taken to reduce the impact are very limited. Reliable information is required to make sound decisions to reduce NO_x emissions, but often there are gaps in data and information that hinder the process. For example, we need more economic assessment of the costs and benefits. More localized data is needed, as the variables used in modelling vary greatly depending on the region and context.

Bayesian Networks are utilized when data and resources are limited. Human and ecological factors can help propagate and plan for potential risks. Ecological systems usually fall under secondary air pollutant standards, and those tend to be more stringent.

Risk is a function of both hazard and exposure; air quality decision-makers tend to focus on exposure. Pollution decisions are often risk-based by nature although some countries, such as Canada, assume a precautionary approach to managing pollution. Most regulations are tied to risk. Factors of safety depend on the receptor: humans, ecosystems, or resources. The larger the factor of safety, the greater the reduction of risk from the status quo. Understanding exposure is complex and requires modelling of various factors.

Reductionism is important, but science needs to be put together in a systemic way or "systems engineering" to achieve desired results. Trade-offs should be considered when attempting reductionism. It is a challenge but can be done with time.

Environmental Justice: What does it mean and how do we build inclusivity?

Chúk Odenigbo
Future Ancestors

This presentation was designed to provide an overview of environmental justice in a Canadian context through building a shared understanding of environmental racism. Environmental justice was then explored as a framework through which systemic racism, and other systemic inequities that shape the environment Canadians of various identities experience, could be addressed and solved.

Presentation Highlights

Defining nature is difficult; nature is a part of who we are. As people who identify as Canadian, it is our responsibility to get to know the nature around us and to protect it. To understand how environmental racism perpetuates, it is first important to delve into how people view nature and the barriers that prevent them from connecting with the environment and sharing this "natural heritage" with others.

Historical examples of environmental racism in Canada include:

- Refusing municipal services to racialized communities.
- Minimizing the land sovereignty of Indigenous peoples.
- Forcing Chinese workers into more dangerous living conditions than their White co-workers.

For example, people enslaved from Africa often associated water with pain, suffering, and death because of how treacherous the journey across the Atlantic Ocean was, and the symbolism of being led to a life being treated as subhuman. The danger associated with the ocean was then passed down through their genes as a means of protecting the next generation, thereby manifesting as intergenerational trauma where Black people today who descend from these stolen peoples have an instinctual fear of the ocean/large bodies of water.

Current examples of environmental racism include:

- Access to green spaces tend to be connected to affluent neighbourhoods.
- Heat islands and poor air quality disproportionately impact racialized and low-income communities.
- Pipelines are built through Indigenous communities and landfills near Black communities, but rarely through White communities.

Canada has ongoing challenges with ensuring a healthy environment for all, and the burden of proof has been placed on the communities experiencing environmental racism. Canada is behind the rest of the world in terms of environmental equity and honouring the right of people to live in a healthy environment away from the hazards of landfills, mines, and other dangers. Bill C-230 is an attempt to develop a national strategy for redressing the harm caused by environmental racism.

Representation in natural spaces is another challenge. We have branded nature, and right now it is primarily portrayed as a space for White people. For example, until 2015, Mountain Equipment Co-op did not have any images or marketing with a person of colour in their branding. There is danger in branding nature because people may feel the need to fit into the image. If we design nature for certain people, we should not be surprised when other people are not showing up and taking an interest.

Intersectionality is an important aspect of environmental justice. Certain issues affect some people more than others. Climate change, for example, does not impact everyone equally; as such climate justice should involve human rights.

There is a myth that only white people care about the environment, but studies have demonstrated that this is just simply not true. This incorrect belief is based on White people having the privilege of time and energy to commit to certain environmental causes whereas racialized people are often on the front lines of other human rights violations that they do not have the energy to also fight for the environment, regardless of how important it is to them. Environmental justice acknowledges these imbalances. Environmental justice recognizes that we do not all enter the fight for the environment on equal footing, and oftentimes, Black, Indigenous and other racialized and marginalized people are so busy fighting for their lives that they do not have the additional energy to give to the environment.

Nature is often feminized and in media representation nature is often personified as Indigenous or Black. In a society that still systematically treats women and people of colour with less respect, it is perhaps not surprising that there can also be inadequate respect for nature. This perhaps highlights why our environmentalism must be intersectional and why environmentalists should be on the forefront of social justice/equity movements.

Addressing air pollution exposure inequities: Tools for policy analysis

Dr. Amanda Giang
University of British Columbia

The focus of the presentation was air pollution and environmental justice and its key concepts, as well as what they mean in the Canadian context and the opportunities to integrate them into air pollution decision-making processes.

Presentation Highlights

Air pollution is not equally distributed in space or time— this is true at a global scale, and also at a more local one. For instance, in Calgary there are measurable variations in air quality across the city from inner-city areas to suburban areas. Even seemingly small variations at low levels can lead to large differences in health outcomes.

These variations in the distribution of air pollution in space and time can also lead to differences in who is exposed to air pollution. Decades of research have demonstrated distributional injustices, meaning inequities in the distribution of environmental health harms among low-income, Black, Indigenous, and other racialized communities, including in Canada. A study[148] found that in Canada's three largest cities, neighbourhoods with a greater proportion of residents who do not speak English or French had greater exposures of ambient NO_2.

Inequality means differences in exposure to environmental hazards between population groups. Inequity is a subset of inequalities that reflect social and historical factors that reinforce inequality for certain groups that already experience disadvantage or vulnerability, including racialized communities, Indigenous communities, low-income communities, etc. What is considered inequitable, or unjust, may differ depending on social and historical context, and groups such as the Public Health Agency of Canada have identified priorities in the context of health disparities in a Canadian context, for instance.

Traffic-related pollution is a core focus for air pollution exposure studies because it is a key driver to variability and concentrations of pollutants. Energy, industrial, and extractive industries' hot spots are also relevant for both urban and rural communities, and past research has shown that they tend to exist in lower income, immigrant, racialized, and Indigenous communities. Canada has its own unique history of colonization, racialization, and industrialization that influences environmental justice. For example, Sarnia and the surrounding region in southern Ontario is known as "chemical valley" and has close to 60 refineries and industrial facilities. This area is traditional territory of the Anishinabek people and home to the Aamjiwnaang First Nation. Living in the area means tangible daily exposure to air pollution.

There are opportunities to incorporate equity lenses to improve decision-making and reduce environmental injustices. But this must be a thoughtful and collaborative process. Some methods include:

- Using screening tools to ensure that a lens of equity can be considered when planning.
- Completing a policy impact analysis ahead of a project that can improve policy design by incorporating measures for environmental injustice (e.g., distributional inequity).
- Conducting a post-evaluation of policy.

Metrics and indicators for environmental injustice can be factored into the policy-making process at each stage. Measuring equality requires looking at distribution (e.g., Gini coefficient); measuring equity requires making a values-based judgment about which inequalities matter. Environmental injustices bear multiple dimensions (e.g., social, economic) and each should be carefully considered when developing policy.

A multi-faceted understanding of social marginalization is critical. For instance, it is important to unpack the differences in air quality exposure between racialized groups, rather than just looking at categories like "visible minority" as a whole. Socio-economic status also displays multiple dimensions, such as household income, employment status, and educational attainment. We need to be aware that using quantitative data, such as census data, does not necessarily tell the whole story. Census variables and categories may not capture all the dimensions of marginalization. Participation is core to procedural and distributive justice; choosing what data is used and who is involved should be important considerations for policy development.

148 Pinault, L., Crouse, D., Jerrett, M., Brauer, M., & Tjepkema, M. (2016). Spatial associations between socioeconomic groups and NO_2 air pollution exposure within three large Canadian cities. Environmental research, 147, 373-382.

Question and answer session

Q: With the growing understanding that for the criteria air contaminants like $PM_{2.5}$, O_3, and NO_2 there is no ambient threshold level below which there are health impacts, how or does this alter the approaches you might use to manage these contaminants from an air quality perspective?

A: *While we have a set level for individual pollutants, we need a systems approach to rectifying this challenge.*

Q: How was the PM measured in Calgary by postal code?

A: *This was not originally measured by postal code. These are monitoring estimates (e.g., satellite, ground) based on modelling inputs that provide a spatial distribution in terms of actual grids, so for each grid box there is a concentration. These were matched with postal codes to draw connections with other data we have.*

The NO_2 data by postal code is accessible in an online map viewer here: https://www.canuedata.ca/map.php# . Underlying data from:

- *Hystad, P., Setton, E., Cervantes, A., Poplawski, K., Deschenes, S., Brauer, M., van Donkelaar, A., Lamsal, L., Martin, R., Jerrett, M. and Demers, P., 2011. Creating national air pollution models for population exposure assessment in Canada. Environmental health perspectives, 119(8), pp.1123-1129. https://doi.org/10.1289/ehp.1002976*
- *Weichenthal S, Pinault L, Burnett RT. (2017) Impact of Oxidant Gases on the Relationship Between Outdoor Fine Particulate Air Pollution and Nonaccidental, Cardiovascular, and Respiratory Mortality. Scientific Reports 7, Article number: 16401. Doi:10.1038/s41598-017-16770-y*

Q: Have you found environmental injustice in terms of where or how air quality and exposure is monitored?

A: *This is true globally and within Canada. The areas of the world that have the most known air pollution are also the areas that most often lack complete data and likely have much worse pollution than is recorded. Disparities exist due to the lack of monitoring data. Community activists are advocating for increased monitoring and data in these areas that could in turn provide a bigger picture.*

A: *Citizen science is a powerful tool that is often bypassed. The technology for citizen science is increasing; this could be an opportunity to fill data gaps.*

Q: What are some examples of "non-classified/other" sources in Amanda's presentation? It showed 65%—a very significant overall contribution.

A: *That study used ambient air pollution that is not linked to a certain source, the concentrations reflect a variety of sources. Not all sources are attributed in the study.*

Q: Could you give examples of how different pollutants affect certain marginal groups? It would be great if one of the examples could be NO_2.

A: *There are many sources of NO_2, particularly vehicular traffic sources. These were found to be linked to low-income and inner-city communities.*

Additional information can be found in the following resources:

Clark, L.P., Millet, D.B. and Marshall, J.D., 2014. National patterns in environmental injustice and inequality: outdoor NO_2 air pollution in the United States. PloS one, 9(4), pp.e94431. https://doi.org/10.1371/journal.pone.0094431

Pinault, L., Crouse, D., Jerrett, M., Brauer, M. and Tjepkema, M., 2016. Spatial associations between socioeconomic groups and NO_2 air pollution exposure within three large Canadian cities. Environmental research, 147, pp.373-382. https://doi.org/10.1016/j.envres.2016.02.033

Giang, A. and Castellani, K., 2020. Cumulative air pollution indicators highlight unique patterns of injustice in urban Canada. Environmental Research Letters, 15(12), pp.124063. https://doi.org/10.1088/1748-9326/abcac5

Harper, S., Ruder, E., Roman, H.A., Geggel, A., Nweke, O., Payne-Sturges, D. and Levy, J.I., 2013. Using inequality measures to incorporate environmental justice into regulatory analyses. International journal of environmental research and public health, 10(9), pp.4039-4059.

Doiron, D., Setton, E.M., Shairsingh, K., Brauer, M., Hystad, P., Ross, N.A. and Brook, J.R., 2020. Healthy built environment: Spatial patterns and relationships of multiple exposures and deprivation in Toronto, Montreal and Vancouver. Environment International, 143, pp.106003.

Cooper, M.J., Martin, R.V., McLinden, C.A. and Brook, J.R., 2020. Inferring ground-level nitrogen dioxide concentrations at fine spatial resolution applied to the TROPOMI satellite instrument. Environmental Research Letters, 15(10), pp.104013.

Q: The US Environmental Protection Agency compensated people close to a pollution source. Does that have the unintended consequence of creating an incentive for people to move towards a source?

A: *It is not compensation but targeted investment of dollars. Some federal funds could be invested into communities that have historically been underinvested in leading to the disparities. This could be one way to addresses historical patterns.*

A: *It is a challenge to pinpoint and document environmental injustices. Highways are often built close to low-income communities, unlike affluent communities. Black Canadians are the most urbanized people in Canada leading to heavy population concentrations in major cities. This is a result of the stereotypes and reactions to those stereotypes, which can perpetuate environmental injustices.*

Q: Are there situations where trade-offs must be made between reducing absolute numbers of health impacts (such as mortalities) and improving inequalities in those same outcomes between disadvantaged groups? (Thinking about policy options such as the routing of truck routes example you had showed.)

A: *The use of an equity lens in the decision-making process can help to clarify when trade-offs need to happen. Decisions must be made through a collective, deliberative political process. Decisions should be made with consideration for historical and social impacts, including considering what harms the communities have experienced in the past.*

Webinar #3: Cost-benefit analysis for air policy options

Modelling the benefits from air pollution control: Methods and recent results

Dr. Nick Muller
Carnegie Mellon University

This presentation was focused on how various models are used to predict the benefits from air pollutions controls. Specific methods, examples, and results were shared to express the potential for benefit-cost analyses (BCA) as a decision-making tool.

Presentation Highlights

Federal regulators in the US use BCA and regulatory impact analysis, which employ the damage function approach. The damage function approach uses environmental damage as a way of measuring the impact of environmental policy on a certain contaminant.

Integrated Assessment Models (IAMs) are used to connect anthropogenic and economic activity to an environmental consequence. This presentation focuses on the Air Pollution Emission Experiments and Policy analysis version 3 (AP3) model, which is one IAM among many. The AP3 model starts with economic activity which causes emissions and connects the various logical components of how those emissions ultimately impact society. For example, looking at an increase in demand for power from a fossil fuel-powered plant, emissions (e.g., $PM_{2.5}$, SO_2) are modelled using emission data from the US Environmental Protection Agency (USEPA) federal emissions inventories from individual and spatially aggregate sources. One challenge with the data is that some are measured, and some are modelled. Measured emissions tend to come from point sources and modelled emissions come from mobile and inconsistent sources, such as vehicles and wildfires.

The AP3 uses an air quality model (Gaussian Plume) that estimates atmospheric chemistry, which links primary emissions to secondary $PM_{2.5}$. This model is limited in its spatial accuracy. It emulates the essential aspects of the Chemical Transport Model but does not include complete spatial data. However, this also makes the model much more efficient, allowing for thousands of model-runs every day.

For the power plant case study used, the model seeks to plot out an emissions concentration profile. It shows it changes due to weather profiles and distances from the source. Knowing the ambient concentrations coming from a given source comes from the air quality model, the next step is to understand the impact on the human population using spatial and age-based information. The AP3 model has vital statistics data built in that is used for measuring human exposure to emissions.

The impact of emissions exposure on human health is measured using peer-reviewed epidemiological research; this power plant example uses premature mortality associated with $PM_{2.5}$. In the US, it has been found that this health metric contributes the largest share to total benefits of pollution control. AP3 uses two primary $PM_{2.5}$ dose response functions from the American Cancer Society Cohort and Harvard Six Cities studies. These functions link changes in ambient concentrations to changes in premature mortality risk. Country-level vital statistics data are then used to estimate deaths associated with emissions and avoided deaths due to reduced emissions.

The next step is valuation. This example is focusing on the valuation of premature mortality risk. Other metrics can be used if considering morbidity including cost of illness, lost wages due to missed work, and emergency room visits for asthma. The most common measurement is the Value of Statistical Life, which is the marginal rate of substitution between changes (for example, changes in wages and in mortality risk associated with on-the-job risk of death). This is not about valuing known deaths or avoided deaths. Market prices and willingness to pay can also be used for valuation.

The AP3 Marginal Damage Algorithm uses all USEPA data to estimate baselines and compute changes to pollutants per ton. A map can then be generated to correlate the geographical impacts and its distribution relative to the location of the source.

IAMs are commonly employed to connect emissions to monetary damage.

Question and Answer Session

Q: What differentiates the AP3 model from the BenMAP model?

A: *BenMAP begins at pollutant concentrations and uses health impact functions to estimate physical health effects and then values those effects. BenMAP does not link emissions from sources to concentrations, whereas AP3 does make that connection.*

Q: Do dose response curves change over time?

A: *For the cohort studies the USEPA uses, the estimated coefficient that links $PM_{2.5}$ exposure to premature mortality has stayed stable over time; however, there has been more recent work looking at race-specific coefficients for premature mortality and $PM_{2.5}$ that are quite different from one another and from the coefficients in the cohort studies being discussed.*

Q: Is AP3 applicable to assessing attainment?

A: *Yes, but only for the annual standards. There are usually primary and secondary standards—often the secondary standards are calibrated to daily maximum readings and a model like AP3 is unable to model those because it is modelling seasonal and annual averages. However, we are in the process of building up from an AP3 model to AP4 that would have daily distributions of pollution, which means it will be able to assess both primary and secondary emissions.*

Q: Has any of this been used to determine siting of new major pollutant sources (i.e., away from/downwind rather than upwind of major population locations?

A: *Yes, in published academic research, but not in terms of the permitting decision the USEPA would undertake. This is due to the limited ability of the USEPA to model daily fluctuations and how that pertains to secondary standards.*

Q: Have you used, or plan to use, AP3 for regulatory attainment analysis, rather than benefit-cost analysis?

A: *As a part of academic research, changes in annual concentrations are used, so in that sense, yes. I have not worked with the USEPA to undertake such analysis. There are some examples of the use of AP3, such as the state of Minnesota using ambient concentrations to determine the new siting for fossil fuel generated power plants.*

Q: Do you have any thoughts on how we can/should use an IAM to assist Alberta in identifying NO_x emission management priorities?

A: *The ideal process would be assessing the health impact per tonne, conditional on compliance of sources, and prioritize locations inversely proportional to the impact per tonne. This can be assessed with a reduced form model to determine the sources of concern across the province.*

Q: In the beginning, you mentioned the "damage function approach" to cost-benefit analysis, but what are the other approaches for cost-benefit analysis of air policies?

A: *One that is not used by the USEPA but is used by academic researchers is hedonics. For example, regressing residential house prices on various controls in addition to measures of ambient air pollution, then assess the impacts on residential real estate values to assess the monetary value and damages as they manifest in a market.*

Q: Are the processes included in AP3, including the added chemistry, all linear?

A: *The source receptor matrixes are linear by design, using linear algebraic calculations. There are also non-linear regression models that track the formation of pollutants such as nitrate. These are represented non-linearly, but are not necessarily non-linear; it depends on the emission concentrations.*

Q: Can AP3 also be used to take an integrated air and climate approach? Has it been used by the EPA in that way?

A: *It does not have greenhouse gas (GHG) emissions in the model itself as AP3 is a near-term air pollution model. It has been used in co-benefit analyses, where there is some change in economic activity. For example, a coal power plant's closure and the changes in CO_2 emissions and in turn GHGs.*

Benefit-cost analysis for air policy options in Europe

Dr. Mike Holland
Ecometrics Research and Consulting

The focus of the presentation was on benefit-cost analysis (BCA) methods and models used for determining regulations and standards in Europe. Case studies and examples were used to illustrate European applications of BCA, and extension of methods to consider factors including deprivation.

Presentation Highlights

BCA is a valuable tool to support environmental and natural resource management decisions. It is widely used for environmental policy decisions in Europe. The following models make up the main framework for air quality policy analysis for the European Union (EU):

- European Monitoring and Evaluation Programme (EMEP) – models pollutant concentrations across Europe
- Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) – processes pollutant data, assesses top level impacts (ecosystem risk and mortality), and describes cost-effective strategies for control to externally defined targets for improvement
- Atmospheric Long-range Pollution Health/environment Assessment (ALPHA) Riskpoll – quantifies various impacts (e.g., health, crops, macroeconomic impacts), monetizes impacts, and compares costs and benefits of different policy scenarios
- Others – e.g., PRIMES-TREMOVE, Common Agricultural Policy Regionalized Impact, provide information on future trends in activity (and hence emissions) in the transport, energy, and agriculture sectors

The European models used in air quality policy analysis provide long-term projections (now to 2050 or beyond), dispersion modelling, estimates for costs of reducing emissions, and cost-effective ways of meeting air quality improvements. These models have and are being used to inform the development of legislation on various environmental policies including:

- National emission ceilings (limits) for NO_x, SO_2, NH_3, $PM_{2.5}$ and VOCs (describing the maximum amount of each pollutant that each country is permitted to emit)
- Ambient concentration standards
- Emission limits for various activities, from industry to transport to the use of domestic sectors
- Climate policies, through exploring the co-benefits and trade-offs with air policy

The impact pathway approach is used for quantification of impacts and their valuation. This tracks the evolution of harm from the generation of emissions, dispersion and atmospheric chemistry, exposure of the population, health responses (mortality, disease), through to valuation. Modelling of atmospheric chemistry accounts for the formation of and exposure to important secondary pollutants—ozone and secondary organic and inorganic aerosols formed following the release of NO_x, SO_2, NH_3, and VOCs. Modelling has been extended in recent years to also account for effects of toxic metals (As, Cd, Cr, Hg, Ni, Pb) and some organics (dioxins/furans, benzene, formaldehyde, and polycyclic aromatic hydrocarbons). This has required extension of the modelling framework to also include exposure via consumption of seafood, milk, meat, and water for several pollutants that are passed through various environmental media following their release to air. Most of the early work on the impacts of air pollutants on human health focused on mortality and hospitalizations, however, there has been more discussion about other measurements, such as bronchitis and other respiratory illnesses, cardiovascular disease, stroke, diabetes, and birth outcomes. Further research is needed to validate the response functions used for some parts of the extended analysis.

The "damage cost approach" is a simpler approach used to quantify damage directly from emissions data. It uses estimates of damage per unit of pollutant mass and is generally not location specific. The damage costs vary country to country in Europe, linked to differences in population density and proximity to industrial and transportation activities. The information is used to prioritize future air quality management decisions. A recent development is that pollution mapping has been overlaid with population and indicators of deprivation to understand inequalities linked to pollution exposure. Communities that experience low income, poor health, and other deprivation tend to experience worse air pollution and more severe health impacts.

Question and Answer Session

Q: What was the source for Figure 1.10, the U.K. results with significant morbidity damages?

A: *IIASA, Holland 2021: 2nd Clean Air Outlook main report: https://iiasa.ac.at/web/home/research/researchPrograms/air/policy/CAO2-MAIN-final-21Dec20.pdf . IIASA, Holland 2021: 2nd Clean Air Outlook annexes: https://iiasa.ac.at/web/home/research/researchPrograms/air/policy/CAO2-ANNEX-final-21Dec20.pdf*

Q: GAINS is a global model, though seems most applied in Europe. How applicable do you think the marginal costs/benefits are to Alberta's NO_x problem? What barriers exist to its application to this problem?

A: *GAINS has been widely used in Europe and parts of Asia. North America has not been a priority area for the GAINS model to be used. There are other models for health impact assessment that can be used in Canada such as the ALPHA Riskpoll, AirQ+, and ClimatH.*

Q: What do the measures look like within GAINS? Would they be applicable in the Canadian context?

A: *Many measures are applicable in a Canadian context. GAINS covers all sources including domestic, transport, and industry. Some Alberta-specific sectors may need to be factored into GAINS.*

Q: Does the damage map you showed for Europe only include damage to the same country where emissions happen, or is cross-border transport implied in those maps (i.e., does the impact capture exposure in the entirety of Europe)?

A: *The work for the European Commission includes emissions and their effects across the whole of Europe and not just EU member states, including the U.K., Turkey, and more recently moving further east into parts of Asia. Some countries have adopted country-specific parameters that are factored into BCA exercises. Limitation of quantification to impacts within one's own borders runs counter to the polluter-pays principle.*

Q: How challenging is it to assess the emission control options and costs for the 204 facilities causing 50% of the health impacts?

A: *To be clear, this is 50% of the impacts of the 14,000 facilities reporting emissions to the European Pollutant Release and Transfer Register. The 204 facilities concerned are largely coal-fired plant, including many power stations, steelworks, etc. Abatement measures for these facilities are well understood and cost data are available. A detailed assessment for each plant would clearly take more time but is reasonably straight forward to do.*

Application of cost-benefit analysis to air quality regulations in Canada

Dr. Edward Olale
Environment and Climate Change Canada

The focus of the presentation was on the use of cost-benefit analysis (CBA) by the federal government and the application of CBA for air quality regulations in Canada. There are various models and processes that are used in decision making at the federal level that are described in detail.

Presentation Highlights

All federal departments and agencies are required to use the Canadian CBA Guide for undertaking CBA regulatory proposals. The proponents are required to use the most suitable policy instrument and show the distributional impacts on society. There are 10 principles from the CBA guide that must be followed:

1. The proposal should be assessed based on incremental welfare impacts to society.
2. Incremental impacts should reflect various angles between baseline and regulatory scenarios.
3. Methodology should be clearly defined.
4. It should be guided by principles of proportionality.
5. It should demonstrate total benefits, costs, and net benefits.
6. It should show the distribution of impacts.
7. Benefits and costs should be discounted to present value.
8. Market price and discount rates should be in real value.
9. The proponent should perform a sensitivity analysis to account for risk and uncertainty.
10. Non-monetized or unquantifiable benefits and costs should be included.

Measuring benefits requires rigorous modelling and there are many models that can be used, including direct market estimation, revealed preferences, stated preferences, and benefit transfer methods. There is also the damage function approach. These methods use specific values and functions that should be considered when selecting a method.

Measuring costs of resources is often used in implementing the regulatory proposal. These can be either direct costs (e.g., administration and compliance), which are generally incurred by the private sector and government, or indirect costs (e.g., reduced welfare of producers and/or consumers), which most often results in costs to consumers.

Net benefits are computed using incremental benefits and costs that have been quantified and monetized. The net present value is calculated using a social discount rate, which is set to 3% in the Canadian CBA Guide.

Distribution analysis strives to allocate the benefits or losses due to proposed regulation. This would indicate which groups will bear costs and by how much. It captures a wide range of factors from demographics to economic ones, including impacts on industry, consumers, and Indigenous people as well as gender-based analysis and other groups.

The federal government requires that a CBA be conducted on regulatory proposals with significant costs, defined as more than $1 million annually or $10 million over a period of 10 years.

An impact pathway analysis process is used when analyzing benefits. It includes modelling with:

- Global Environmental Multiscale – Modelling Air Quality and Chemistry (GEM-MACH) – assesses the change in ambient air concentration levels and provides an air quality forecast.
- Air Quality Benefits Assessment Tool (AQBAT) – estimates human health benefits because of ambient air quality using data from GEM-MACH.
- Air Quality Valuation Model 2 (AQVM2) estimates the economic value of the environmental impacts associated with changes in air quality, including changes to crop productivity, visibility, and surface soiling.

There is also the Energy, Emissions and Economy Model for Canada (E3MC), which is an energy and macroeconomic model developed by Environment and Climate Change Canada (ECCC).

In 2018, new amendments to air quality regulations required all coal-fired generating units to meet new emissions standards. The framework for understanding costs and benefits incorporated multiple pathways, such as compliance costs leading to higher retail prices, and reduced GHGs improving air quality. The results showed $2,687 million net benefit.

Question and Answer Session

Q: How are emissions and equipment inventories developed for the CBAs/Regulatory Impact Analysis Statement (RIAS)? Just federal data (e.g., National Pollutant Release Inventory) or are other jurisdictions' data used?

A: *We use data from a variety of sources, not just federal. For example, methane and RIASs provide examples where data collected from industry, provincial data, and/or third-party analysis are used to inform equipment inventory counts.*

Q: What's the process for estimating the financial cost of regulatory implementation? Does industry generally inform those values?

A: *Yes, we take industry cost data when provided. We also take costing data from independent studies and sometimes contract these studies out to experts.*

Q: How is regulatory duplication (e.g., federal overlapping with a provincial/municipal requirement) handled?

A: *Duplication is accounted for. Establishing a correct baseline is a key part of the CBA process. Equivalency Agreements with provinces and territories are also allowed under the Canadian Environmental Protection Act and Fisheries Act.*

Q: Is the CBA process revisited during regulatory review to test the accuracy of the original predictions?

A: *Yes, the input received following publication of the draft regulation and RIAS is reviewed, assessed, and integrated.*

A: *The CBA process is not re-visited after publication of the final regulation. If amendments are proposed following final publication, a new CBA would be conducted on those amendments.*

Q: How are positive health outcomes, ideally that have been realized, assessed during the review of a regulation?

A: *ECCC does not do ex-post analysis of health outcomes after publishing in the Canada Gazette.*

A: *If amendments are proposed following final publication, health outcomes would be assessed at that time.*

Q: Does business as usual account for emerging parallel regulations? For example, would refinery VOC reg phase 2 RIAS account for refinery VOC reg phase 1, although it's not in effect yet?

A: *The business as usual accounts for regulations that have been published in the Canada Gazette, so any regulations that are drafted but have not been published will not be covered in the business as usual.*

Q: Is AQVM2 a publicly available model?

A: *It is not publicly available due to intellectual property agreements.*

Q: Are there sensitivity analyses conducted as part of these modelling efforts (e.g., in respect of the assumptions used in the modelling)?

A: *We use this analysis to estimate environmental and human health impacts and damages. It is a process that follows rigorous steps and takes about six months to do, so a sensitivity analysis is not completed for air quality impacts, but it is done for CBA.*

Q: Can ECCC share industry-provided emission control costs information or is it deemed confidential?

A: *ECCC typically does not share this information. ECCC can share some data based on specific requests and cases, but the information is considered confidential and decisions about data sharing are made based on intellectual property agreements.*

Q: What type of environmental information is not publicly available?

A: *What is available is what has been published. ECCC strives to be comprehensive in what it published.*

Q: How was it determined that a firm polluting the environment is deemed confidential? How is a model that is developed by the federal government using taxpayers' money not publicly available?

A: *Generally, the data is not confidential unless there is a sharing agreement.*

Q: Are ECCC control costs data significantly different than USEPA cost model? The USEPA provides a list of technologies and associated pollution on a public database, which allows for interpretation and association of pollutant levels from certain facilities or industries. There is total transparency in the values of the control costs.

A: *ECCC specifically asks for the costs associated by the regulated community to have a full understanding of influential factors to inform a robust CBA. USEPA has more extensive resources for ECCC to draw upon unlike Canada (e.g., supplemental data). This is due to more densely populated areas in the US and the need for more modelling and analysis in Canada; right now, ECCC uses supplemental data from contractors and other sources.*

Health Canada's Air Quality Benefits Assessment Tool

Dr. Dave Stieb
Health Canada

The focus of the presentation was on the applications of Health Canada's AQBAT and the various factors used for analysis. An example of forest fires was used to discuss the use of AQBAT for assessing $PM_{2.5}$.

Presentation Highlights

The two primary applications of AQBAT are estimating the burden of disease and conducting cost-benefit analysis. Several health outcomes are associated with air pollution, including respiratory and cardiovascular disease, and death. Health Canada estimated that in 2020 there were 14,600 premature deaths due to air pollution.

Economic evaluations are required by Canada's Treasury Board to inform management decisions (e.g., Canada's Greenhouse Gas Regulations for the Electricity Sector). For example, the Greenhouse Gas Regulations for the Electricity Sector were estimated to result in $2.2 billion in industry compliance costs vs. $3.6 billion in benefits of GHG reductions and $1.3 billion in co-benefits of air quality improvements, and the 1990 US Clean Air Act amendments were associated with $65 billion in costs and $2 trillion in benefits.

The analysis scheme is as follows:

> (Change in exposure)*(Concentration response function)*(Baseline outcome rate)*(Population)* (Economic valuation) = (Estimated change in frequency of health outcome and associated economic valuation)

Change in exposure is measured using ground monitoring stations, which are scattered across the country and increasingly using air quality models and satellite monitoring. The pollutants included in AQBAT are CO, NO_2, O_3, SO_2, and $PM_{2.5}$.

The concentration response function is the slope relating changes in exposure to changes in health impacts, based on epidemiological research. Health Canada mostly employs linear concentration response functions but can also look at mortality impacts employing non-linear concentration response functions. Health Canada keeps updated on the latest studies and evidence to inform its work and derives concentration response functions through a detailed search of current literature.

Health outcome rates are the baseline incidence of each outcome per population. Generating accurate rates is a non-trivial task, requiring quality-checking and analysis of large datasets from multiple sources, and mapping them to census boundaries. Projecting impacts into the future requires projecting baseline rates. Life expectancy has been increasing over time, resulting in an aging population, and this needs to be accounted for when projecting impacts of changes in air quality.

Economic valuation is implicit in any decision. It looks at direct costs (for health care), indirect costs (lost productivity), and intangible costs (pain and suffering). Values are assigned to these costs as part of the exercise. The current value associated with mortality is $65 per 1/100,000 risk change.

Application of AQBAT to assess the health impacts of wildfires on air quality and health in Canada was used as an example to illustrate the methodology. Mortality and morbidity attributable to wildfire smoke and their economic valuation were estimated for 2013–15, 2017, and 2018. Changes to air quality in BC were the most severe compared to other provinces/territories in Canada for this period, as wildfires were most prevalent in that area.

Question and Answer Session

Q: Open source means having something be completely accessible anytime, anywhere, and being able to use the versions of the tool at any time. In that case, why was the decision made to make AQBAT public but not open?

A: *There are federal government IT constraints on the ability to make AQBAT immediately downloadable. As a first step, the AQBAT web page provides basic information on AQBAT and information about accessing it. Health Canada is currently working to make an R-based app where the code would be open for public use.*

The AQBAT webpage (https://science.gc.ca/eic/site/063.nsf/eng/h_97170.html) provides the contact information needed to obtain AQBAT. The VBA code within AQBAT is openly available.

Q: So great to hear about the R-based app. Is there a way to make sure we are notified of this new app (e.g., mail list)? Any chance that the web version would be open-source?

A: *The current version is open source in the sense that users can freely access the underlying VBA code. We hope to make the code for the new version available through GitHub. All announcements are made on the webpage (https://science.gc.ca/eic/site/063.nsf/eng/h_97170.html).*

Q: In the new version, will you stay with census divisions or are there plans to go to a finer resolution?

A: *At this point Health Canada is planning to go with census divisions, however the R platform completes calculations more efficiently and may allow use of other more highly spatially resolved geographies. A limitation will be that the baseline health outcome rates are the key parameters, and there is a limit on geographic resolution possible with the health outcomes due to confidentiality concerns.*

Q: Dave mentioned two values in his presentation: $50 and $65 for the social cost of avoidable death. Can you elaborate on the difference between the two values?

A: *These values were only for illustrative purposes. The $50 was to have a simpler round number. The $65 is the Treasury Board Secretariat recommended value. The information and rationale behind this are included in the model. The numbers are also adjusted to the applicable currency year based on the consumer price index.*

Q: Will long-term health impacts to people that had COVID change the population's susceptibility to air pollutants? In other words, does COVID change the dose response curves?

A: *Epidemiologists are actively working on understanding this, but time will be needed before this factor can be integrated into the model.*

Webinar #4: Compare and contrast air policy options with other jurisdictions for the purposes of informing workshop discussions

Combining innovative science and policy to improve air quality in cities with refining and chemicals manufacturing: The case study of Houston, Texas

Dr. David Allen
University of Texas at Austin

This presentation covered air quality improvements seen in Houston, Texas through learning about the unique air quality challenges, measuring the sources and spread, and identifying emissions of concern and ways to mitigate them.

Presentation Highlights

Houston is the fourth largest city in the US with extensive chemical manufacturing and refining, and historic issues with ozone coming from industrial sources. The existing State Implementation Plan (SIP) called for significant reductions to NO_x emissions (about 70%, 90%+ for point sources) and about a 25% reduction in VOC emissions. The cost of controlling emissions was about US$5 billion per year, which was enough to prompt the first study of the impacts of emission in Houston.

This study, called TEXAQS, started in 2000 and involved measuring NO_x for a month in the summer. Measurements were taken using an aircraft flying about at an altitude of about 1,000–1,500 m with a downward facing LIDAR instrument to map ozone concentrations as a function of height. The findings showed that there were transient spikes in ozone concentrations occurring throughout the day. Highly concentrated areas of ozone were found to disperse over the city. These pockets of ozone concentration were found to have reactive hydrocarbons, indicating that the cause of the ozone pockets was not due to reactions with atmospheric NO_x.

This research spurred the Texas Commission on Environmental Quality to create a new category of VOCs, known as highly reactive VOCs (including ethylene, propylene, butenes, and butadiene). This led to a search for unintended emissions to understand where the highly reactive VOCs were coming from. Unreported and intermittent events were found to be a major cause.

TEXAQS informed regulations that were completely novel in Texas at the time. The regulations included highly reactive VOCs and required reporting on emission events. It allowed for a trading system for reactive hydrocarbons and put new caps on episodic emissions.

Prior to the study, underreporting was a major issue with understanding emissions and their impacts. Providing the data gave policy makers more concrete information for decision making and allowed cost-effective management strategies. Policy benefited from the science that explained the cause of the emissions and subsequent ozone pockets, and as a result Houston has greatly reduced emissions and is no longer an area with a major ozone concentration.

Question and Answer Session

Q: How did the tackling of the ozone issue in the Houston area affect NO_x emissions from industrial point sources?

A: *NO_x was still included in the emissions control requirements, and although it was less stringent than when it was the only emission type being targeted, it still achieved a reduction at a much lower overall cost.*

Q: Was industry supportive of the accelerated science evaluation process?

A: *Industry recognized the problem and wanted to solve the emissions problem effectively. There was also confidence in the science, so they were in support of the research. There was involvement from environmental groups as well who supported the work and were happy with the research. It was a remarkable confluence of interests.*

Q: Are there examples of the highly reactive VOCs that you can share?

A: *In Alberta, flaring is a major issue. An efficiency issue was identified in the flaring process, in that flares were not operating at full capacity and it was resulting in incomplete combustion, which equates to more air pollutants. The solution was to improve flaring efficiency. Highly reactive VOCs need more attention in areas where there are not necessarily high concentrations.*

Q: Do you think the 90% NO_x reduction path would have solved the issue or would those investments have been wasted?

A: *They would not have been wasted, but it would not have been enough to solve the air quality problem. Recognizing the role of the highly reactive VOCs along with the* NO_x *was the only way to achieve the national air quality standard in the US.*

California State Implementation Plan

Stephanie Parent
California Air Resources Board

This presentation was about air quality management in California and the accomplishments and challenges addressed by the California Air Resources Board (CARB).

Presentation Highlights

The California SIP is a living document that is consistently updated and reactive to changes in federal requirements.

CARB works with local air districts to improve air quality in California. California has significantly improved air quality since the creation of CARB over 50 years ago, when there were lead, NO_2, CO, SO_2, O_3, and other contaminants at dangerously high levels in Los Angeles.

Federal, state, and local authorities work together to regulate emissions and improve air quality. The USEPA regulates interstate travel (trains, planes, and ships), CARB regulates mobile sources of air pollution (cars, trucks, and buses) and consumer products, and local air districts regulate stationary and local pollution sources (fireplaces, factories, refineries, and power plants). The USEPA sets the National Ambient Air Quality Standards (NAAQS) and the SIPs. CARB is legally responsible for SIP development and works collaboratively with local air districts; there are 35 in the state of California, which adopt SIPs into their local plan and send to CARB for review.

The *Federal Clean Air Act* (1970) was a major shift in the federal government's role in air pollution control. It authorized the development of federal and state level regulations on stationary and mobile sources of pollution and resulted in the NAAQS. Currently there are six criteria pollutants (lead, CO, NO_2, PM, O_3, and SO_2) in NAAQS, which must be included in the SIPs. The standards and criteria in NAAQS are reviewed every five years. NAAQS have become more stringent since they were introduced, requiring lower emissions levels with every updated standard. CARB is currently focused on ozone and PM.

In California, areas are determined to be either in attainment/unclassified (the latter referring to working towards attainment) of standards for ozone and $PM_{2.5}$ or they are classified as non-attainment. There are 19 ozone non-attainment areas in California, which are required to submit attainment plans by 2022. For $PM_{2.5}$, there are five non-attainment areas in the 24-hour standard and four areas for the annual standard. These areas are in valleys where PM settles.

SIPs address identifying air pollution problems and the sources, as well as the emission reduction requirements. They are legally required plans that must be submitted by a certain date and are enforceable by federal courts. Ambient air monitoring and modelling are used to ensure the NAAQS are being met. An emissions inventory is used to gather seasonal and time-specific estimates that help demonstrate attainment of standards.

Control standards must be feasible and enforceable, and developed in collaboration with industry. Some current examples include the Heavy-Duty Omnibus Regulation and Clean Miles Standard. Failure to submit an SIP or failure to attain the emissions measures can result in a Federal Implementation Plan and other contingency measures that will address the emissions.

Air quality improvements since the creation of CARB have resulted in avoiding 29,000 premature deaths annually.

Along with the contaminants identified in NAAQS, there are greenhouse gases and other emissions that must be considered when planning for improving air quality.

Question and Answer Session

Q: Could you provide examples of policies or programs outlined in the SIP that were found to be effective in reducing the target emission sources?

A: *On the mobile side, the Truck and Bus Regulation required upgrading engines to a 2010 standard, thereby reducing NO_x and diesel PMs. On the stationary side, the Regional Clean Air Incentives Market cap-and-trade program has been successful. Looking forward, CARB is hoping to increase the number of lower-emission cars on the road.*

Q: Are any of the 300 monitoring stations from industrial sites (fence line monitors)?

A: *Yes, in 2017 legislation changed to allow CARB to have more direct connection communities and local monitoring programs, including fence line monitoring. The Significant New Alternatives Policy program involves fence line monitoring as well.*

Q: Overall in your experience, is there one element in the SIPs that has really been effective in reducing air pollutants?

A: *There is a lot of variation across the state, and the programs are evolving to address a changing landscape. Modelling and measuring has been important in identifying what is needed and building the inventory of emissions data.*

Q: Do SIPs consider climate change policy initiatives and the co-benefits for air emissions improvements?

A: *SIPs are specific to clean air pollutants and are focused on those pollutants. Co-benefits are accounted for and included in the SIP through the emissions inventory (which includes greenhouse gasses [GHGs] and other co-benefits), as well as through programs that target GHGs along with the criteria pollutants.*

Managing air quality and greenhouse gases in the Metro Vancouver region

John Lindner
Metro Vancouver

This presentation described Metro Vancouver's role in regional air quality and greenhouse gas management and provided an overview of their recent initiatives to improve air quality and reduce greenhouse gases in the region.

Presentation Highlights

Metro Vancouver is a regional district that covers 23 local governments, including the Tsawwassen First Nation. Decisions are made by the Metro Vancouver Board of Directors, which is comprised of mayors, councillors, and other leaders from each of the 23 governments which make up Metro Vancouver. The Government of British Columbia delegated authority to Metro Vancouver to control air contaminants and manage air quality, which has included developing plans, strategies, and regulations, as well as issuing permits, monitoring air quality, and increasing awareness and incentives. Recent actions have included implementing limits on $PM_{2.5}$ from residential wood burning, increasing fees for industrial facilities and older non-road diesel engines, and updating VOC requirements for autobody shops.

Metro Vancouver establishes ambient air quality objectives for air contaminants. Their standards tend to be stringent, given the region is in a valley and there is high population density. Monitoring sites are located across the region, including a near-road monitoring station. An inventory of the regional emissions over time is used to monitor changes and identify key sources of emissions. Emission estimates look at GHGs, $PM_{2.5}$, NO_x, SO_x, CO, VOCs, and other contaminants from all sectors, including transportation, agriculture, and other industries. This provides the information needed to make regional plans. The Metro Vancouver Board has adopted 2030 targets for GHG reduction and air quality improvement.

The Clean Air Plan incorporates targets that will result in positive health and economic impacts. The combined reductions in VOCs, NO_x, $PM_{2.5}$, and SO_x could result in $1.6 billion in health benefits. Some of the "Big Moves" the Clean Air Plan addresses include implementing road/mobility pricing and emissions requirements for on-road vehicles and mandating GHG performance requirements for buildings and industry.

Integrating equity is a work in progress, focusing on working with communities in impacted areas. There is work to build community engagement into the tools and monitoring processes.

Interorganizational collaboration among provincial and federal governments, industry, and non-profits is needed to achieve the greatest possible impact. Some challenges have been aligning with other jurisdictions and integrating equity. As well, balancing air quality improvements and GHG reductions is a challenge, given that sometimes reducing GHGs can result in localized air quality impacts that need to be understood and addressed.

Question and Answer Session

Q: How is Metro Vancouver collecting emissions data—especially from mobile sources like shipping, rail, and heavy-duty vehicles?

A: *For shipping and rail, this involves working with both the Port of Vancouver (the local port authority) and Environment and Climate Change Canada using data from the Port's emission inventories, since most marine and rail emissions are port-related goods movement. Additional estimates are generated for personal transportation by boat (e.g., BC Ferries) and rail (e.g., commuter rail such as West Coast Express). For heavy-duty vehicles, Metro Vancouver develops emission estimates using insurance, inspection, and other data, as well as an emissions model developed by the US Environmental Protection Agency.*

Q: With the potential impact on air quality regarding the Clean Air Plan, was there one pollutant that had a larger impact on health benefits then other pollutants?

A: *Yes, all the data suggests that* $PM_{2.5}$ *has the largest impact on health, followed by ground-level ozone and* NO_2.

Q: Does Metro Vancouver have any direct regulatory authority over emissions from ocean-going vessels?

A: *No, marine vessels are regulated federally. However, Metro Vancouver works with the Port of Vancouver and other agencies to ensure regulations and objectives are aligned as much as possible.*

Q: Can you elaborate on your Big Moves for non-road engines (e.g., what sectors are these engines from, why are they being targeted)?

A: *The primary target right now is diesel engines and diesel particulate matter, with goods movement at the port (cranes, loaders) and local construction industry being the biggest contributors. There is a tiered fee based on the age and size of the engine, because older and larger units are known to be greater emitters. There are also rebate programs for retiring older engines. This fee structure might change to continue to target getting older engines out of use.*

Q: The Clean Air Plan shows an impressive $1.6 billion in health benefits by 2030. Has Metro Vancouver done any detailed analysis on the cost of the actions needed to achieve this benefit?

A: *We have not assessed those costs yet, but there is a project underway that will assess the costs based on some of the actions outlined in the Plan.*

Q: What actions would low carbon procurement plans include?

A: *For low carbon procurement, Metro Vancouver is looking to develop and implement regional guidance on procurement to prioritize low carbon products, equipment and services for construction, and other projects. The guidance could outline best practices, available certifications, methods for life cycle emission calculations, circular economy considerations (e.g., disposal), greenhouse gas targets and emission disclosure requirements. Products covered by the guidance could include, for example, low carbon cement and concrete products.*

Q: Curious about cannabis regulation, is this related to indoor use (so more individual focus) or production at a commercial or industrial style facility? Is this in an indoor air quality focus or ambient air quality focus on cannabis?

A: *The concerns around cannabis regulation relate to cannabis production and processing facilities (i.e., businesses) rather than to individual use. Thus, this is an ambient air quality issue.*

Q: How are agricultural emissions addressed?

A: *There are 10 different actions in the Clean Air Plan to address agricultural emissions, including outreach programs, incentives, pilot projects, and regulations. The two Big Moves for agriculture in the Plan focus on reducing* NO_x *and GHG emissions from greenhouses and reducing* $PM_{2.5}$ *emissions from open-burning of agricultural vegetative waste.*

Webinar #5: Integrated Assessment Models

GLIMPSE: Supporting air and climate decision making

Dr. Dan Loughlin and Dr. Chris Nolte
United States Environmental Protection Agency

This presentation was focused on discussing the complex connections between air, climate, water, and energy and how GLIMPSE can support navigation of energy technologies and policies on air pollution with consideration of the environment.

Presentation Highlights

The term "energy system" refers to the processes that extend from the extraction of energy to the end uses, meaning the full system that produces and provides energy to people, including natural gas wells, refineries, lightbulbs, and cars. The energy system contributes over half of known air pollutants in the US GLIMPSE allows users to explore the interplay between air, climate, water, and energy while considering the economy, land use, and other relevant factors that impact energy consumption and subsequent air pollution.

GLIMPSE uses the Global Change Analysis Model (GCAM) for computations. GCAM is an open source, public domain resource that was originally developed by the Pacific Northwest National Laboratory. Its base or "core" version divides the globe into 32 regions, where each region is a large country or a grouping of similar smaller countries. Additionally, more detailed versions exist for Canada, the US, China, etc., in which those countries are subdivided into their constituent states or provinces. GCAM can be cumbersome for users to learn and use; GLIMPSE is a graphical user interface for GCAM.

GLIMPSE provides a library of scenarios (e.g., air quality goals) for the user to choose from or the user can create their own scenario. Outputs from GLIMPSE can include visual comparisons and graphical representation of modelling results, including energy and environmental impacts.

A demonstration was provided of how GLIMPSE operates using an example of assessing electric vehicle emissions based on four scenarios and looking at the potential for market penetration and the future of electricity production. The output demonstrated emissions (e.g., CO_2, SO_2, NO_x, VOCs) are reduced when electric vehicle use increased.

GLIMPSE can be used to model the impact of multi-pollutant control strategies as well as to assess the impact of policy, technology, and other emerging innovations on emissions.

GLIMPSE will be publicly available in 2022.

Question and Answer Session

Q: What is the applicability of GLIMPSE outside the US?

A: *GLIMPSE is a graphical user interface for managing GCAM inputs, so it can be used with the global version of GCAM or other versions of GCAM that are region-specific.*

Q: Where do you get your abatement technologies and the costs? Is the inventory made public?

A: *Almost everything (except for some raw data) is open-source. The data come from publicly available inventories.*

Q: Much of the data showed total pollutant emissions. Can GCAM use population-weighted exposures as an output?

A: *That could be calculated after the modelling, however, GCAM does not currently have a module that can calculate concentrations based on region or population.*

Q: Can air quality impacts (e.g., from reduced form models) be used in the optimizations within GCAM?

A: *Yes, in principle. It has been done as a prototype but there is more work to be done.*

Q: Do you have any guidance for the number/type of Community Multiscale Air Quality Modelling System (CMAQ) runs that would be required to get a good handle on developing policy options?

A: *The number and type of runs would be dependent on the policy question. With that said, GCAM is less computationally intensive than CMAQ, so more simulations can be run—this is beneficial in screening the scenarios and identifying options for further analysis in CMAQ.*

Integrated assessment modelling in support of European air pollution policies

Dr. Stefan Åström
IVL Swedish Environmental Research Institute

The focus of the presentation was describing the use of Integrated Assessment Models (IAMs) in Europe, including the models and inputs used in European IAMs and the positive impacts on policy.

Presentation Highlights

Both the climate change research and air pollution communities use IAM. The presentation focused on the air pollution IAM.

The air pollution IAM integrates various aspects of air pollution that need to be considered for policy. For example, IAM can incorporate atmospheric, agricultural, health, and ecosystem models. The general steps of IAM are:

1. Emissions projections from various sources (e.g., emission dispersion data, ecosystem sensitivity) are used as inputs to the model.
2. Emission control options or policies can be applied (or not) to reduce emissions, which have associated costs.
3. The model can apply an atmospheric dispersion model to simulate how pollutants move over space.
4. The model outputs the impacts of air pollution.
5. The model can be used to find the lowest cost solution to meet environmental targets (though there are other ways of optimizing within the model).

The European IAM is set to be transboundary and transdisciplinary. There is one IAM model for policy support, hosted by an internationally independent institute with input from United Nations Economic Commission for Europe Air Convention experts. In Europe, there are several international groups working on modelling and solution-finding. The European IAM allows these groups to provide transdisciplinary and interdisciplinary inputs and produces synthesized information to inform decision making.

The presentation outlined some examples of application of the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model for policy. The policy was applied in Europe in the early 1990s in relation to a sulphur issue. The original international protocol had costs of reducing emissions shared in similar amounts by the different countries involved; the GAINS model instead was used to find the most cost-effective emissions reductions. This allowed some countries to increase emissions compared to the previous protocol in place. Other examples of application include the Air Convention 2012 Amended Multi-Pollutant, Multi-Effect Protocol, and the EU 2016 National Emission Reduction Commitments Directive.

Newer IAM analysis is moving towards welfare-maximizing analysis from cost-effectiveness, where the marginal costs equal the marginal benefits of new policies or other measures.

Question and Answer Session

Q: Are impact matrices, for example those from the European Monitoring and Evaluation Programme (EMEP), considered to be static in time for long-term analysis?

A: *It depends on the purpose of the analysis; the typical use is taking the average over time. In principle, it is static. There is not year-specific modelling at this time.*

Q: Are you aware of any Canadian applications of the GAINS model? Are you aware of the applicability of the technologies or performance of EMEP emission-concentration relationships in Canada?

A: *The Northern hemisphere version of the EMEP Model is available and used for research purposes but is still in development for other purposes. A GAINS model for Canada would be useful as it is a large country. As mentioned, the model is used in Europe to measure transboundary air pollution among European states; given Canadian provinces are similar in size to European states, the model could be applied in a similar fashion as it has in Europe.*

Q: What approach do you use to standardize emission control and cost inputs?

A: *Consultant companies are working on developing and analyzing technologies, and a European techno-economic task force works on testing applications and monitoring the costs. Those who offer these technologies on the market report back to the task force.*

Additional resources

GAINS: https://gains.iiasa.ac.at/gains4/EUN/index.login?logout=1

EMEP: https://www.emep.int/mscw/

Integrated Assessment Modelling: Insights for air quality policy

Dr. Rebecca Saari
University of Waterloo

This presentation focused on the application of IAM in policy and the use of various models and streamlined data in IAM that result in specific policy implications.

Presentation Highlights

The goal of IAM modelling for air pollution is to link policy to its impacts (air quality, human health, economic benefits). IAM can capture the uncertainty in the pathways from policy to impact and are specific to different locations, scales, types of emissions, timeframes, and policy questions. There are many different types of IAMs for different purposes.

IAMs can be used to estimate how climate policy effects air quality and air quality-related co-benefits. The cost of air pollution can be offset by understanding the sources of emissions and implementing informed policies that target cost-effective emission reductions. Accounting for the sources of emissions and their resulting economic impacts can result in economic co-benefits. IAM offers multi-component analysis and can thus provide insight into welfare-maximizing solutions, long-run impacts, unintended effects, and distributional effects.

The Massachusetts Institute of Technology Integrated Global System Model (MIT IGSM) is MIT's IAM and is a computationally efficient system that uses both the Economic Projection and Policy Analysis model and the MIT Earth System Model. MIT IGSM couples the global economic model with the global earth system model. Similar to GLIMPSE, the MIT IGSM does not estimate air quality-related concentrations or impacts automatically. The outputs need to be connected to traditional air quality impact assessments. The IAM can estimate policy costs, the impacts of climate, and climate-relevant pollutant emissions. A Global Chemical Transport Model can be used with the IAM to understand how the air pollutant concentrations will respond to policy changes.

An example of the application of IAM is modelling the impacts of climate change on air pollution in Canada. It was found that if emissions are not reduced by the year 2100, the costs could be over $100 billion annually and human health will be at significant risk.

The results of IAM can be used to inform climate policy and international agreements, such as the Paris Climate Agreement. It can be used to evaluate climate and air pollution policy options to determine health, economic, and welfare-maximizing solutions across regions. Because IAM cannot estimate air quality concentrations, employing a regional chemical emissions/transport model and a health impact model provides insight on regional differences, which can then be linked back to an economic model to close the loop.

IAM has been used to examine the effect of different policy designs for capping air pollution, and findings showed there are health and economic co-benefits for all policy options. Transboundary impacts of policy can be modelled and demonstrate nationwide benefits offered by regional policies.

IAM can be configured for distributional analysis of the impact of policy on different demographics. Dr. Saari's research found that lower income households experience the greatest exposure to ozone and that although there was some improvement to this (measured by percent welfare change) under new equity-focused policy, underlying economic inequity mattered more.

IAM can be streamlined based on data needed for policy decision making. A streamlined IAM study focusing on the transportation sector in Ontario demonstrated that each Green Freight truck on the road can save $80,000 in climate and air quality costs.

IAMs give quantitative results that provide insights and should be used with the understanding that further information is needed to calculate actual targets.

Question and Answer Session

Q: Were the estimates used Canadianized or did you use original values?

A: *The estimates used were impacts to US receptors.*

Q: How do you locate low-income people that get air quality benefits?

A: *Using census data.*

Incorporating source impacts into integrated assessment models

Dr. Amir Hakami
Carleton University

The focus of the presentation was on incorporating air quality models into IAM, thus augmenting air quality models for a trans- and interdisciplinary approach that makes them applicable for decision making.

Presentation Highlights

Multiple pollutants and multiple endpoints are used in IAM to measure the impact of emission sources on air quality. The advantage of the model is being able to identify the impact of different sources on different areas and among different sectors.

Marginal Benefits (also called Marginal Damage, Benefit Per Tonne [BPT]) refers to monetized societal benefits and can be used as decision metrics.

Reverse influence modelling starts with source impacts (receptors) and traces back to individual sources. The change in concentration and the change in emissions can be traced to the change in mortality, which is linked to the valuation of emissions and public health impact. It is useful as a complementary tool that contributes to understanding the costs associated with emissions and the marginal benefit of reducing emissions. Using reverse influence modelling can show the impact of emission reduction in one area on the greater region, for example the impacts of changes in Edmonton on Canada.

IAM can be used to compare the effect of multiple pollutants on each other, for example the increased presence of NO_2 as a result of NO_x. A study assessing the coal phase-out in Alberta showed the impact of multiple pollutants on human health extend beyond Alberta, where coal power plants are concentrated.

In Canada, there is a political decision priority hierarchy that depends on political will. At this time the priority is climate mitigation; using IAM can demonstrate the impact beyond climate mitigation to health impacts, environmental justice, and other priorities.

Using IAM to understand co-benefits of changes to diesel heavy-duty vehicles shows that there are fewer co-benefits in newer vintages because the drop in criteria contaminant emissions has changed faster than the drop in CO_2 emissions. Even so, comparing the newest vintage of heavy-duty diesel that resulted in the fewest co-benefits with fossil fuel burning electricity generating units, IAM shows that removing diesel heavy-duty vehicles will have a greater impact on co-benefits.

Impacts of emissions reductions can be modelled with health impacts in mind; for example, modelling the impact of emissions reduction in New York City with monetized health impact metrics shows that in some areas the inequities will be exacerbated.

Question and Answer Session

Q: Benefit per tonne analysis indicated that depending on the pollutants, there are either positive or negative benefits. In terms of co-benefit analyses among various pollutants, what would be the best way to apply those scientific findings to policymaking (suggestions, recommendations)?

A: *We do not see negative co-benefits because even when there are negatives in some respects, the overall benefit is positive. Considering co-benefits along with total cost can help with prioritizing in decision making.*

Q: With respect to inequality and the case of New York, does your preliminary result indicate that a congestion charge would be undesirable?

A: *From an air pollution equity perspective the answer is likely yes, although more information is needed.*

Q: Will increasingly strict CAAQS greatly reduce likely co-benefits of CO_2 reductions?

A: *Co-benefits depend on source impacts and BPTs associated with the criteria contaminants that come with CO_2, and in turn the BPTs depend on population distribution, epidemiology, and atmospheric composition, which are not directly related to standards.*

Webinar #6: Industry Perspectives on Alberta's NO_2 Challenges and Opportunities

Panel Discussion[149]

Moderator: Danielle Smith, Alberta Enterprise Group

Panellists:

Craig Werner, Alberta Forest Products Association (Forestry Sector)

Jim Hackett, Heartland Generation Ltd. (Electricity Sector)

Don McCrimmon, Canadian Association of Petroleum Producers (Oil and Gas Sector)

Greg Moffatt, Chemistry Industry Association of Canada (Chemistry Sector)

Dr. Laurie Danielson, Northeast Capital Industrial Association (Cross-Sector)

Background and Introductions

Danielle Smith opened the webinar with a reminder of the Alberta NO_2 CAAQS challenge, noting that ambient air quality assessments conducted in 2021 show that most Alberta air zones are in the orange management level for annual NO_2. In addition, forecasts for the 2025 NO_2 CAAQS assessments show most Alberta air zones will be in the red management level; under the National Air Quality Management Framework, provinces in the red management level would be required to take action to reduce emissions in those air zones.

She noted two key elements for industry's perspective — first, that in some instances there is a trade-off in reducing NO_x and greenhouse gasses (GHGs), and second, the transportation sector is also a notable contributor to NO_x emissions.

The discussion began with introductions of the panellists, their organizations, and the sectors they represent.

Q: Please introduce the sector you represent and the sector's contribution to air quality in Alberta.

Forestry Sector

The forestry sector is an important part of Alberta's economy, and the sector continues to grow and develop. Forestry includes lumber, pulp and paper, panelboard, and secondary manufacturing. The forestry sector creates 40,000 jobs, directly and indirectly, across 70 communities in the province. Climate change discussions and priorities have had a significant influence on the sector, and the interplay between climate policy and air quality policy is of interest and is necessary to consider going forward. Manufacturing of forestry products that involve combustion (e.g., boilers, kilns) are the major concern for impacting air quality. The sector has some flexibility with the fuels used in manufacturing, including fossil fuel, natural gas, and biomass, which has implications for NO_x emissions.

Electricity Sector

The panellist noted they would be speaking specifically to the electricity sector and not all utilities in Alberta. In Alberta, there are 26,000 km of high-voltage transmission lines, more than 200,000 km of distribution lines to homes and businesses, and 235 electricity generating stations. The point source emissions from the electricity sector come from fuel combustion to generate electricity. Alberta is unique for electricity generators in that it has a competitive market for electricity providers, with over 200 participants in that market. From CASA's Electricity Framework Review[150]: in 2019, Alberta's electricity sector had 85 terawatt hours of electricity generated, and of that, 55% was generated by natural gas, 35% by coal, and 10% by renewables. Currently, renewables make up about 20% of installed capacity, but due to its intermittent nature, it is only about 10% of actual energy delivered. In 2018, the electricity sector contributed 8% of NO_x emissions in Alberta, 31% of sulphur dioxide emissions, 29% of mercury, 4.6% of $PM_{2.5}$, and 24% of GHGs. Emissions data often has a lag between when it is recorded versus when it is published, and given the transition the electricity sector is undergoing, there has been reductions in emissions from what was reported in 2018. The ongoing coal phase-out will reduce NO_x as a co-benefit.

149 Note: For webinar 6, a recording is not available, so the proceedings are based on project team members' notes and input from the presenters.
150 https://www.casahome.org/attachments/2018%20EFR%20Project%20-%20Final%20Draft%20Report%20(with%20appendices).pdf

Oil and Gas Sector

The Canadian Association of Petroleum Producers (CAPP) represents oil and gas producers, which represent about 80% of oil and gas production and contributes approximately $116 billion per year to the Canadian economy. The oil and gas sector is a large source of provincial NO_x and NO_2 emissions, but the sources are distributed throughout the province, so the regional impacts vary. Combustion is a component of upstream oil and gas, and that creates NO_2 emissions. There is a tie between NO_x production and oil and gas production, however the link is not linear. There have been efforts to decouple NO_x production and oil and gas production over the last few years, but certainly the engines, boilers, and heaters (and flares to a certain degree) produce NO_2. The sector is working to minimize the emissions, but it is a concern. As NO_2 is a byproduct of combustion, it is unavoidably produced by the sector.

Chemistry Sector

The Chemistry Industry Association of Canada (CIAC) represents companies that produce industrial chemicals that are the essential building blocks for the broader manufacturing sector. In Canada, the chemical sector is growing, with close to 82,000 people employed in Canada and $6.5 billion in wages. In Alberta, the CIAC represents about 40% of Canada's industrial chemical and resins manufacturing and 25% of the broader chemical sector. Chemical producers use products and co-products of the energy sector as raw materials and inputs as energy and heat to produce value-added goods that are important inputs to oil and gas, forestry, construction, and more. The CIAC exports over $8 billion in product and employs close to 7,300 Albertans, representing about $800 million in wages, and there is potential for growth. Using Alberta's energy resources for feedstock or heat and energy, the chemistry sector finds itself in the nexus of GHG aspirations. For more than 35 years, Canada's chemistry sector has led the way in responsible and sustainable chemical manufacturing through its United Nations recognized Environmental, Social and Governance (ESG) initiative, Responsible Care®, which was founded in 1985 and is now practiced by 73 countries and by 96 of the 100 largest chemical producers in the world. The ESG covers all aspects of the company, business, employees, communities, and environment over the entire lifecycle of the products. This highlights responsible care and commitment to sustainability and improvement. Members continue to invest in pollution prevention, energy efficiency, and resource conservation. The National Emissions Reduction Master Plan is a part of CIAC members' responsible care commitment, and the results are published and available publicly. CIAC members have an obligation to maintain an active and ongoing dialogue with their communities and a requirement to report. Chemical manufacturing in Alberta is a significant contributor to air pollutants and the sector is continuously taking initiative to improve the situation.

Cross-Sector

The Northeast Capital Industrial Association (NCIA) is concentrated in Alberta's industrial heartland with 23 members involved in chemical and petrochemical companies. There are many members in common with CAPP and CIAC. NCIA employs 8,500 people with $850 million in payroll, resulting in 30,000 indirect jobs. NCIA members spend over $2 billion annually on goods and services in the region, invest over $43 billion in manufacturing plants and infrastructure, and pay $141.4 million in municipal taxes (plus $8.6 million in education taxes). There is $14 billion in output and $7.4 billion in GDP. The point source issues related to NO_x comes from generating steam, generating heat by burning natural gas, and generating hydrogen which requires burning natural gas; those are the largest concerns.

Q: What has your sector done to reduce NO_x emissions recently, and what are your sector's current and emerging plans to reduce NO_x emissions?

Forestry Sector

Environmental aspects are included in board decision making on capital investments. (For example, a member company introducing on-site electricity generation to power the facilities and produce electricity using technology that reduces NO_x emissions.) It requires thinking about keeping the facility relevant and sustainable and bringing that into board decisions and investments and recognizing that the sector is competing in an international market. Compliance with provincial regulations is a priority for forest companies and customers in the international market expect this of their suppliers. The stringent regulations in Alberta allow for accountability to members and consumers. There is a need to consider for each facility where improvements can be made (e.g., is there an opportunity to reduce fuel use). The sector is always looking for technology opportunities and other ways to reduce emissions. In some cases, it can be challenging to reduce emissions due to the need for specialized machinery and retrofitting existing sites has its own challenges. However, there are ongoing discussions about opportunities to electrify where possible.

Electricity Sector

Regarding coal phase-out, Heartland Generation has already completed the phase-out at two generating stations, almost 10 years ahead of the coal phase-out schedule. There will be emission reductions from this, almost 50% NO_x and 45% GHG emission reductions, and SO_2, primary PM, and mercury have been eliminated. Overall, the electricity sector has been reducing emissions and has seen significant reductions over the past decade. Climate change policy is driving the change, shifting the source of energy to natural gas from coal. In 2018, for the first time, natural gas provided more power generation than coal; this will continue to improve. These coal to gas conversions will be the single largest emission reduction in Alberta's history. That means the 31% SO_2 emissions will go to 0%. Alternative energy sources are also being increased and will have a positive impact on emissions. Although alternative energy sources can be useful, there need to be options to fill the gaps in power supply, possibly using batteries or supplemented with natural gas power. Hydrogen could be a replacement for natural gas. Carbon capture and storage (CCS) is also a possibility for lowering emissions. More non-emitting renewables are coming, and the future is looking to smaller, regionally-specific solutions.

Oil and Gas Sector

Upstream oil and gas emissions have been on a steady decline while production is increasing. The NO_x emissions in the oil and gas sector come from combustion of either a fuel that industry needs to purchase or our gas product we could sell, so there is a built-in economic incentive to minimize combustion during production. This will save money and reduce NO_x emissions. Some solutions involve trade-offs between which contaminants are emitted—a selective catalytic reduction system can reduce NO_2 at a significant cost and can result in the release of ammonia.

In response to a pointed question from the moderator regarding the potential use of CCS to mitigate NO_2: CCS requires planning and prioritizing, and the costs are high. The historic focus of CCS has been on GHGs, which is understandable given the potential impacts and priority placed on climate change. I don't believe as much research has been done on the potential capture of NO_x, but aside from technology challenges, I have not seen evidence of the relative priority of NO_x capture to warrant the significant cost—especially in areas where CAAQS are being achieved or where there may be more cost-efficient ways to CAAQS achievement.

Chemistry Sector

Emissions went up in 2005–2020, including a spike in 2011 due to a new facility in Medicine Hat. The sector is very diverse and therefore requires planning based on specific requirements and capacity. Methanex installed low-NO_x emitting technology at some facilities, which has reduced NO_x by 70%. NO_x is understood from a chemical viewpoint, however the facilities where NO_x can be an issue have to be considered in context, including the physical structure (e.g., can the building hold the weight of a new technology) and the economic components. We should want more facilities here in Alberta for economic reasons and we need to consider the value added. There are competing priorities and we need to consider the balance between economic development, reducing emissions, and human health.

Cross-Sector

While the rapid growth of industrial facilities in the Edmonton Metropolitan Region (including Alberta's Industrial Heartland) has not happened at the rate expected, there has nonetheless been growth. That growth includes new facilities and expansions of existing facilities. There have also been continuous improvements made to existing facilities. Most of these improvements have largely been related to upgrading lower NO_x burners for boilers and power-generating equipment. Consequently, the overall NO_x emission profile for the region has remained relatively unchanged for the last decade or so.

Q: If we are trying to reduce emissions and combustion is the major source, taking a holistic approach that takes into account the contribution of the transportation sector and other sectors, what challenges does your sector face in achieving NO_x emissions reductions?

Cross-Sector

There is a need to consider the primary sources of emissions and allow for flexibility in solution-making. Industry needs to operate with regulations and capital costs in mind, and it is better to let industry decide how to meet requirements while remaining accountable to stakeholders. The best approach it to give industry flexibility in which technology and other solutions could be implemented.

Chemistry Sector

The facilities in the chemistry sector are complex, and changes can be challenging for reasons already discussed. There is a need to consider policy that is outcome-focused and flexible, allowing industry to be flexible and creative with the solutions. Incentives to improve can work, particularly in cases where the economic cost of changing outweighs the perceived benefits. Compensation and pricing can allow for trading and mutual benefit.

Oil and Gas Sector

In response to a previous comment about a pricing model: The implementation of a pricing system can be complicated and can create unintended trade-offs between competing priced emissions (NO_2 vs. GHG, for example).

The federal multi-sector air pollution regulations (MSAPR) requirements just entered into effect for engines—requiring them to meet a 2021 standard. We expect these changes to have a significant impact on our industry's NO_2 emissions, but we're unlikely to get those results until 2022/2023 (2022 will be the first full year that the requirement has been in place for engines, and emissions reporting will not occur until 2023). Until we have a good idea of where we are, we should be cautious about where we need to go next. In addition, the upstream oil and gas sector is frequently challenged to retrofit major emissions controls—there is always a desire to efficiently design facilities, and this has resulted in existing facilities often lacking the physical space to add certain emissions controls such as selective catalytic reduction equipment. The cost of retrofits is high to begin with and requirements to significantly modify or move existing equipment amplify those costs.

In response to a direct question regarding the potential electrification of operators' maintenance and inspection vehicles: There are some transportation-related emissions coming from transportation within the sector (e.g., pick-up trucks going to site visits) but those are not the main contributor to NO_x emissions from the sector. These are also a highly dispersed source of emissions that are unlikely to relate to CAAQS achievement—especially in urban centres.

Forestry Sector

There is a need to be realistic about where the problem areas are and where it is possible to make changes (e.g., economically and technologically). An outcomes-focused approach to policy is a practical way to manage risk while still achieving environmental benefits. We are all in this together and need to collaborate on solutions.

Question and Answer Session

Q: Industry has made great strides to reduce NO_x emissions in the province. What opportunities does industry see to address NO_x emissions from older, existing sources in the province?

Forestry Sector

The sector is always looking for opportunities to make improvements and will do so where feasible, considering cost, technical requirements, and the environmental benefit that can be achieved. Earlier I mentioned the interesting interplay between climate policy and air policy. Actions to reduce GHG emissions may result in co-benefits of NO_2 reductions but some approaches may also result in a net increase in NO_2 emissions. These two policies' spaces are connected. We find ourselves at a crucial time where the focus on climate is unprecedented and given that the Department of Environment and Parks is committed to transforming the regulatory system in Alberta, it is an ideal opportunity to take a close look at our approach to air policy and evaluate if that approach is still appropriate given the changes that are occurring globally on the climate agenda.

Electricity Sector

CASA's framework has created the standards for the sector.

Oil and Gas Sector

It depends on the part of the industry; the challenges exist in bigger facilities and the timing matters. Retrofitting existing facilities can be incredibly challenging.

Chemical Sector

Respect the capital lifecycle and provide flexibility to comply.

Cross-Sector

In some cases, older units cannot be retrofitted, they need to be replaced. As such, the costs to comply can be high both to re-engineer to accommodate the replacement technology and for the capital investment in the new equipment. However, cost and design considerations are not necessarily an impediment to progress. We know that achieving compliance to the Federal MSAPR by our members is being progressed and will achieve an 18% reduction in NO_x emissions, with most of that coming from the older facilities.

Subsequent follow-up from Electricity Sector

The coal to gas conversions in the electricity sector will reduce NO_x emissions on those older existing units by 50%. In the future, climate change policy will bring new technologies, like CCS and fuels like hydrogen that may offer NO_x reduction opportunities for older equipment.

Subsequent follow-up from Cross-Sector

As noted during the webinar, the federal MSAPR will continue to drive NO_x improvements in all facilities, including older ones. For boilers and heaters, which is the most relevant to the NCIA membership, compliance must be achieved by 2026. Based on our analysis, we anticipate an 18% reduction in NO_x emissions from our members, with the older facilities contributing most of those reductions. I believe that these measures, once fully implemented, will allow CAAQS achievement by industry. The challenge will be the large urban areas, and given how the CAAQS are calculated it will be very difficult for airsheds with large urbans to achieve the 2025 CAAQS for NO_x.

Q: There is currently the Alberta Emissions Trading Regulation for NO_x—why has this economic instrument not been sufficient in reducing NO_x from the electricity sector in Alberta in your perspective?

Electricity Sector

The electricity sector has achieved significant reductions in NO_x emissions and continues to deliver NO_x emissions reductions. The recent coal to gas conversions target GHG emissions reductions but also have the co-benefit of reducing priority air contaminants including reducing NO_x emissions by 50% from those generating units. Much of the emissions reduction have been driven by climate change policy but there has also been continuous improvement to reduce emissions. The Emissions Trading Regulation encourages continuous improvement through the opportunity to create emissions credits for performance better than baseline values. It also offers some compliance flexibility for units that have reached their end of design life milestone to allow time to plan for installation of abatement control or to retire the unit. The emissions trading registry indicates that over 100,000 NO_x credits have been created by the program which corresponds to the amount of NO_x tonnes reduced from baseline conditions.

Q: What are the challenges in industry providing detailed information on abatement options and costs for policy discussions? And potential production implications of abatement investments? Is such information useful?

Electricity Sector

There can be significant cost and effort associated with assessing abatement options and providing detailed information including project economics. Policy discussion should have clear direction of intended objectives justified by the outcomes to ensure that any requests for information appropriately support the initiative.

Chemistry Sector

In many cases it can be difficult to disclose the comprehensive costs and impacts on existing infrastructure and/or production as competitiveness and confidentiality considerations must be respected. External cost estimations can lack appropriate consideration of the supplemental costs which are incurred in addition to the upfront capital investment. Items such as the design and engineering of the equipment need to be accounted for. An often-overlooked consideration is the indirect impacts to existing infrastructure. An example seen in other jurisdictions is the requirement to expand existing wastewater treatment facilities to accommodate new waste streams coming from newly installed air emissions control equipment. The costs of subsequent operation of new equipment should also be factored in. Continued engagement between stakeholders is likely the best way to better illustrate fulsome costs and impacts, however we must acknowledge that the constraints noted above will remain.

Cross-Sector

Industry has a long history of working with the Alberta government on this topic. Discussions about technologies, capital costs, capital stock turnover and lifespan are part of the conversation with government. There is no "one size fits all" technology solution as large industrial sites are complex. Adding in a new technology in one part of a facility has implications (that may not be positive) for other parts of a facility. That is why industry requires flexibility to achieve the desired outcomes.

Webinar #7: Air policy opportunities in the transportation sector

Measuring traffic-related air pollution

Dr. Greg Evans
University of Toronto

This presentation was about the impact of traffic on air quality using monitoring at roadways; Dr. Evans highlights that diesel trucks make a disproportionate contribution to emissions and that the types of vehicles on the road can be more important than the volume.

Presentation Highlights

Dr. Evans conducted a study using near-road monitoring to measure NO_x in six sites in two cities (Vancouver and Toronto). In Vancouver, there was on-site monitoring by a heavy truck route and one away from the highway. In Toronto, there was a site by Highway 401, one downtown (ground level and roof), and two background sites: one in the north and one in the south of the city.

The measurements beside major roads showed four times the ultrafine particles (UFP; particles smaller than 100 nanometers) beside highways indicating that 75% of these UFP where originating from emissions of vehicles on this highway. The fraction of other pollutants from these local vehicles ranged from barium (90%), NO (90%), black carbon (BC, 60%), CO (30%) to CO_2 (<10%) CO. The low faction for CO_2 does not indicate a minimal vehicle contribution of CO_2 from vehicles; it reflects the long atmospheric lifetime and hence high global background level of CO_2.

Diesel trucks are a major contributor to emissions of many key pollutants (e.g., NO_x, BC, UFP). The truck route and highway sites showed significantly more NO and black carbon concentrations than downtown. This shows that it is not the traffic volume, but the fraction of diesel trucks on the roadway that determines the concentrations of these pollutants. During weekdays, when there are more trucks on the road, there is much more black carbon emission compared to Saturdays and Sundays. NO_x emissions also increased in winter as the temperature gets colder as the diesel emission treatment systems do not work as well, causing a rise by about a factor of four. Black carbon emissions increased in the summer in Ontario, but not in Vancouver. Fuel composition matters and has an impact on emissions at different temperatures.

When a vehicle passes the monitoring site there is an approximately two-minute spike in emissions, making it possible to measure the emissions from each vehicle as well as total emissions from all vehicles. Emissions on a road depend on the number of trucks on that road. As soon as there is a certain percentage of trucks, they dominate the emissions.

A mobile lab can be used to follow trucks while driving and measure the pollutants in transit, capturing real-time emissions. So far, using this equipment they have found some trucks are within the regulated limits while others significantly exceeded limits.

Air pollutant levels were measured during the COVID-19 pandemic and compared to pre-pandemic levels. Comparing the levels of NO_x before the pandemic and throughout shows that NO_x concentrations were lower during lockdowns by about 40% depending on the location. However, given the increase in demand for delivery, more trucks were on the roadway; so, while there was a 50% decrease in vehicles on the road, there was a lesser decrease in emissions.

Fine particulate matter showed more lower reduction during the COVID-19 lockdown period, as it also depends on regional and seasonal changes. Measuring local $PM_{2.5}$ showed tailpipe emissions, brake dust, and non-tailpipe emission dropped significantly during lockdowns.

Tailpipe emissions from vehicles have improved significantly since 2004; however, more large passenger vehicles (e.g., SUVs and pick-up trucks) are on the road, and as a result, non-tailpipe emissions have increased and greatly exceed tailpipe emissions.

A third of Canadians live within 250 m of a major roadway—this matters for public health given the emissions that occur from vehicles on these roadways.

Question and Answer Session

Q: When talking about trucks, are you referring to diesel trucks?

A: *Yes, not referring to pick-up trucks, but cube vans, tractors trailers, and other diesel trucks.*

Q: Why the focus on ultrafine particles instead of $PM_{2.5}$, which there are air quality criteria for?

A: *The contribution of vehicles to $PM_{2.5}$ is more difficult to resolve because loss of the mass is formed in the atmosphere rather than directly emitted. Ultrafine particles are much more sensitive and localized, making the contribution from traffic easier to detect.*

Q: What proportion of trucks' emissions management systems are tampered with?

A: *I have heard speculation that about 25% in Ontario are tampered with. There are challenges with unregulated vehicles crossing the border from the United States. Ontario recently changed from a program that focuses on cars to focusing on trucks, which was supported by results from this research. The challenge is that the only way to catch people who have disconnected their system is to catch them on the roadway.*

Q: What are some next steps from your study? Are there recommended actions for the Ontario government or federal government? What might the province be able to do to address vehicle emissions?

A: *Regular checks on trucks would help. It is also important to account for the reality that often the testing for emissions-reducing systems is done in warmer climates and that has an impact on emissions. As well, ensuring the developers and construction projects are contracting work to companies with low-emitting vehicles. This might involve including emissions standards in the tendering process. Another possibility would be having emission standards for large warehouses, such as Amazon, in populated regions so trucks coming to and from the warehouse are required to be low emitting. We also need better standards for products related to our vehicles such as brake pads. Microplastics from tires also need to be addressed.*

Q: Are there air policies provincially or regionally for emissions controls on vehicles, i.e., anti-tampering or removal? Or having to pass emissions tests?

A: *It is currently being redone in Ontario; BC also had a program. Unsure of the rest of the country.*

Q: Have you conducted analyses of fuel samples or discussed with fuel providers to assess differences in fuel composition?

A: *We have seen higher aromatic content from gasoline in the summer but have not been including diesel fuel yet. Getting the mix right between the winter and summer fuel is an art, and the content of aromatics may differ between refineries.*

Q: Non-tailpipe emissions are the wearing down of brakes, tires, and road surfaces. Which emission type is dominant?

A: *Currently the brakes seem to be the dominant issue, but it is difficult to characterize the contribution from tires. The road dust has two components: wear of the roadway and dust from tires, brakes, or soil that deposited on the road. What goes on the road matters (e.g., salt in winter). Brakes also matter and are currently the focus because there are metal rich particles in the brake, such as copper. Some research has shown that these brake emissions could deplete antioxidants in human lungs.*

Q: Why would a truck disconnect the emissions abatement system? Does it have impacts on fuel efficiencies?

A: *Fuel efficiency is one aspect. Another challenge has been difficulties with the technology as it is relatively new and not many people are trained to fix the technology, so if it malfunctions it is easier to disconnect than repair it.*

Q: To what extent are the non-tailpipe emissions along College Street affected by the streetcars?

A: *Still working on the data collection. We believe that emissions from streetcars are mostly just from steel and thus contain iron and manganese. There is lots of barium present. Barium is a main component of brakes, so it appears that brakes are a larger source than the streetcars.*

Q: You mentioned that ultrafine particulate reduces as you move away from the road. What distance is typical for seeing the effect of the roadway diminish?

A: *It varies depending on the urban topography, wind conditions, and directions. It tends to be about 250 m. In many cities it is difficult to find houses further away than that from the road.*

Q: How do you see non-tailpipe emissions changing over time with electric vehicles (EVs) coming into the fleet mix?

A: *We do not know. Abrasion is a factor, as EVs are heavier which means more abrasion but also have a less-abrasive "regenerative" brake system. There is reason to believe that EVs will reduce non-tailpipe emissions.*

Q: Any comments on how design of intersections impact local air quality— signal lights vs. roundabouts vs. cloverleaf interchanges?

A: *Less braking or stop-and-go traffic should reduce emissions. We don't yet know by how much.*

Q: You referenced local traffic strongly affecting local air quality and mentioned a distance of 250 m. What was the 250 m intentional? Is so, what is this distance mentioned based on?

A: *We have measured pollutant concentrations at different distances downwind of major roads. By 250 m the concentration approaches but still exceeds the upwind concentration. Thus, within this 250 m buffer a contribution of the vehicle emissions to the air pollutant concentrations is evident.*

Urban transportation and air quality: Climate and health benefits of cleaner vehicles

Dr. Laura Minet
University of Victoria

This presentation was on modelling changes to the transportation system in the Greater Toronto and Hamilton Area (GTHA), focusing on health and social impacts of transitioning to fewer and cleaner vehicles on the road.

Presentation Highlights

The main source of emissions in cities is on-road transportation, with NO_x and black carbon (BC) making up most of the emissions. Two case studies were the focus of the presentation: 1) the health burdens of on-road vehicles in the GTHA, and 2) the climate and health benefits of getting cleaner vehicles (both passenger and commercial) on the roads in the GTHA.

The study area included the six regional municipalities in the GTHA, as well as surrounding regions, going up to New York State, which power plant and industrial emissions affect the GTHA air quality.

A modelling framework was created for the study that uses the Chemical Transport Model, which simulates the dispersion and chemical reactions of air pollutants. Inputs for the model include natural and anthropogenic emissions, land use, and meteorology. The outcome is air pollutant concentrations. The emissions modelling used in this work looked at hourly power plant emissions, hourly traffic emissions, hourly emissions from other anthropogenic sources, and hourly natural emissions. The traffic modelling required for this work required detailed traffic information. A private household data survey and a commercial travel survey were used to populate a travel demand model providing traffic flow information which, combined with emission factors from the Motor Vehicle Emission Simulator (MOVES) model, were used to generate a detailed traffic emissions inventory. The health outcomes used in the model used changes in years of life lost and number of premature deaths. Concentration Response Functions (CRFs) define the relationship between exposure and increased risk of disease. The economic valuation uses Value of Statistical Life (VSL) to measure socio-economic benefits, which puts a value on how much people are willing to pay to reduce their risk of death.

Trucks account for most NO_x and BC emissions, compared with private passenger vehicles (cars and SUVs) and public transit buses; however, passenger vehicles contribute the majority of greenhouse gas (GHG) emissions. The research modelled the impact of each of the three vehicle categories (trucks, private vehicles, and transit buses) on annual number of years of life lost per 100,000 population. The findings were that trucks, and to a lesser extent, private vehicles, have a significant negative impact on years of life lost. The 401 highway and the airport areas had the highest concentration of impact. Premature deaths were calculated for each scenario, finding that trucks could be associated with 407 per 100,000 premature deaths, private vehicles with 332, and transit buses with 143.

The research modelled three scenario and their results are as follows:

- Scenario 1: Private vehicles are 100% electric
  - Results: Largest reduction in GHG emissions (70%), even when including the electricity needed to fuel the vehicles. It saved 23,640 tonnes of CO_2 equivalent per day, prevented 313 premature deaths, and the social benefits were $9,850 per electric car or SUV.
- Scenario 2: Transit buses are 100% electric
  - Results: It saved 970 tonnes CO_2 equivalent per day and prevented 143 premature deaths.
- Scenario 3: Cleaner trucks (2008 technology standards)
  - Results: It saved 185 tonnes of CO_2 equivalent per day, prevented 275 premature deaths, and the social benefits were $308,000 per truck.

Even in scenarios where there is only partial electrification of the private passenger fleet, there was an appreciable impact on reducing GHG emissions and improving air quality, and the social benefits are the same $10,000 per car or SUV in all scenarios.

Electricity in Ontario is primarily hydroelectric and from uranium, whereas in Alberta electricity comes from natural gas and coal, so the impact of EVs will be different. It depends on where the oil and gas production is located in relation to population centres.

Question and Answer Session

Q: What type of emissions were associated with the various forms of electricity generations (natural gas, hydro, nuclear)?

A: *We considered all sources of electricity, but in terms of air quality, nuclear and hydro were considered to have no air pollutant emissions. The work focused on emissions from natural gas power plants.*

Q: Based on Dr. Greg Evans's presentation, depending on the emission factors used, modelling could underestimate the transportation impact on different pollutant parameters based on his findings of actual vs. expected. Does your modelling use standard emission factors, or do you have another way of estimating transportation emissions?

A: *We did not use standard emissions; we used a model called Motor Vehicle Emission Simulator (MOVES) developed by the United States Environmental Protection Agency (USEPA) that has aggregated emission factors from maintenance tests, mainly in the US, but over a wide range of vehicles. The model is providing emissions factors for different speeds and different types of vehicles; the emissions factors are averages over the many types of vehicles that have been tested under quasi-real-world conditions. Because averages are being used, it is possible the research could be underestimating, but it is difficult to be sure. It is however considered a more accurate method than simply using standard emission factors that do not depend on speed.*

Q: I understand that hydro has significant methane emissions thus does it make sense for it to be excluded?

A: *We considered methane emissions in GHG emissions, but methane is not necessarily attributed to air pollution. As well, hydro power plants are located far away from the GTHA. Methane emissions were associated with GHG quantification but not directly with air quality.*

Q: Could you elaborate on which model was used for emission modelling and air quality modelling? Which baseline year was modelled? And what is the source and resolution of the emissions data?

A: *Traffic emissions were based on emission factors from MOVES; for power plant emissions we used data from NPRI (National Pollutant Release Inventory), aggregated with data specific to Ontario and New York State. The rest of the anthropogenic emissions were based on a global emissions inventory called EDGAR (Emissions Database for Global Atmospheric Research). The Chemical Transport Model used is called Polyphemus. The baseline year was 2016 because emissions factors were from 2016 and before.*

Q: Which chemistry-transport model was used for this analysis, and can you mention some of the CRFs/ risk factors that were considered for the health burden analysis? Was the VSL approximately $7.6M per death? Was POLAIR the chemistry-transport model used?

A: *Yes, the CTM POLAIR3D was from the Polyphemus suite developed by the Centre d'Enseignement et de Recherche en Environnement Atmosphérique (CEREA, France). The CRF and risk factors that were considered were extracted from literature in Canada. $PM_{2.5}$, NO_2, black carbon, and ozone were the pollutants considered. That is the correct VSL, these data were provided by Statistics Canada.*

Q: Can you please provide some insight by how much the modelling results would be underestimating emissions from transportation? For example, 80% underestimation.

A: *This is very difficult to know. The model was validated against measurements at monitoring stations to ensure the concentrations being modelled aligned with what is measured. The model tended to overestimate ozone. NO_x and other emissions were quite similar to what was measured, but it is difficult to validate.*

Q: Is the method of estimating "years of life lost" the same as "number of premature mortalities" and just reported differently? Is it possible to assess the typical age of persons experiencing years lost or premature mortality?

A: *Years of Life Lost and Premature Death was chosen based on the age of the population and a recommendation from Health Canada. There is a lot of controversy around associating health outcomes and social costs with mortality and disease based on age. The costs were estimated to be the same for a population of different ages.*

Q: We have been using the Air Quality Benefits Assessment Tool (AQBAT) on- and off-road diesel and gasoline emissions as a guide to look at the health impacts of vehicle emissions. Are your results generally consistent with these?

A: *They are a bit different because the research did not use the same CRF, especially for NO_2. AQBAT only looks at long-term effects of NO_2 and we considered the cumulative effects of NO_2 exposure as well. The biggest difference is that AQBAT is at a low spatial resolution. In this research, there were data from 1x1 km grids, so it was at a much higher spatial resolution that enabled us to work at the dissemination area level, which is the smallest geographical unit where census data in Canada is available.*

Overview of key transportation-related regulations to reduce air pollution in Canada

Sandra Bayne and Sean Hornsby
Environment and Climate Change Canada

This presentation was about the role of the Transportation Division in Environment and Climate Change Canada (ECCC) in addressing air pollutants and GHGs using regulations that align with the USEPA.

Presentation Highlights

ECCC is responsible for the development, administration, and compliance testing of regulations for air pollutants and GHGs. Federal regulations set the standards for new vehicles and engines, and ECCC coordinates consultations during regulatory development, as well as collecting data and information from other sources. ECCC has been recognized as a world-class regulator.

The regulations administered by the Transportation Division under the *Canadian Environmental Protection Act* (CEPA) include:

1. The *On-Road Vehicle and Engine Emission Regulations* established emission standards for new on-road vehicles, including passenger vehicles, sport utility vehicles, motorcycles, and heavy-duty vehicles. These regulations introduced standards to reduce smog-forming emissions for 2004 and later model year on-road vehicles.
2. The *Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations* establish greenhouse gas emission standards for new on-road heavy-duty vehicles and engines of the 2014 and later model years.
3. The *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* establish greenhouse gas emission standards for new 2011 and later model year light-duty on-road vehicles offered for sale in or imported into Canada.
4. The *Off-road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations* repeal and replace the *Off-Road Compression-Ignition Engine Emission Regulations*, combining the previous mobile diesel engine standards together with the new large spark-ignition engine and stationary diesel engine standards into one consistent framework. Emission standards for mobile diesel engines are unchanged, although some new administrative and compliance flexibilities are introduced for certain applications. These regulations apply to large spark-ignition engines and stationary diesel engines manufactured after June 4, 2021. Mobile diesel engines of the 2006 and later model years must meet the applicable emissions standards in place at their time of manufacture.
5. The *Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emission Regulations* introduced emission standards for 2012 and later inboard and outboard marine engines, personal watercraft, all-terrain vehicles, snowmobiles, and off-road motorcycles.
6. The *Off-Road Small Spark-Ignition Engine Emission Regulations* introduced emission standards for 2006 and later model year small engines with a gross power rating of 19 kW or less, such as those typically found in lawn and garden equipment.

As part of the implementation of the various vehicle and engine emissions regulations, the Transportation Division administers a comprehensive compliance program. Part of this compliance program includes emissions testing in a laboratory setting.

In Canada, proposed regulations are published in the Canada Gazette, Part I, and ECCC notifies stakeholders. Following this publication, there is a comment period during which stakeholders can submit comments to ECCC about the proposed regulations. In addition to the official consultation period, significant effort is put into stakeholder engagement prior to the first publication. Final regulations are published in the Canada Gazette, Part II. A Regulatory Impact Analysis Statement is included with both the proposed and final versions. This document contains information about the regulatory objective, pertinent background information, a description of the regulations, cost-benefit analysis, consultation summary, instrument choice justification, and some details about implementation, compliance/enforcement, and performance measurement.

Given the highly integrated nature of the North American vehicle and engine industry, Canadian regulations incorporate the emission standards and test procedures of the USEPA. Consequently, EPA certification is recognized in Canada as one method to demonstrate compliance with the standards. This approach to harmonization preserves the competitiveness of the manufacturing sector in Canada, maximizes regulatory efficiencies, and assures significant environmental and economic benefits for both countries.

Question and Answer Session

Q: Are these small engine (snow blowers, chain saws, etc.) emissions regulated at the consumer level? If so, how is this achieved? Or is the regulation only at the manufacturer level?

A: *The SSI regulation applies to Canadian manufacturers and importers as defined in CEPA and sets emissions-based performance standards that must be complied with throughout the useful life of the engines. This ensures that products sold at the retail level comply with the regulations. When products do not comply, due to defects in the design, construction or functioning of an engine, companies are required to submit a Notice of Defect to ECCC and owners. The company must outline the affected engines, defect, pollution risk, and how to bring the engines back into compliance and report on progress in subsequent reports. Provinces and territories are responsible for any regulations after the first retail sale.*

Q: It is my understanding that certification of engines is to be based on testing that reflects representative in-use conditions. What if in-use, on-board testing of fleets indicates that emission greater than 750 hp emission limits? Limited in-use, on-board monitoring of heavy haulers in the oil sands indicates that this may be the case.

A: *ECCC is aligned with EPA vehicle and engine standards and test methods to facilitate harmonization in the integrated North American market and to take advantage of the regulatory efficiencies and environmental and economic benefits for both countries. However, there is ongoing work examining other testing cycles that might be more representative of real-world scenarios. In addition, the Transportation Division's compliance team performs enhanced testing, such as using portable emission measurement systems outside of a laboratory setting.*

Q: Regarding the Regulatory Impact Analysis Statement (RIAS) modelling of the transportation emissions reduction, would it be possible to get the data specifically for Alberta?

A: *The data and cost-benefit analysis used for the RIAS modelling is publicly available on the CEPA Registry. There is also a list of regulations in the CEPA Registry: https://pollution-waste.canada.ca/environmental-protection-registry/regulations. For emissions data specific to Alberta, the Alberta government should be able to provide this data.*

Q: Where does Alberta fit in the regulation of emission from small consumer engines? Or what are the provinces doing to complement the efforts to reduce emissions from small engines?

A: *ECCC regulates import at a national level. Provinces and territories are responsible for any regulations after the first retail sale. Provinces can complement ECCC efforts by implementing trade-in programs to switch out gas-powered small engine equipment.*

Q: Is it problematic to be linked to the US regarding vehicle emissions, based on the significant political swings in approaches and some of the missteps the US has made (e.g., the emission limits for greater than 750 hp off-road mobile compression-ignition engines)?

A: *Several policy options are considered during the regulatory process. As a recent example, with respect to on-road vehicles, in the recent Healthy Economy, Healthy Environment announcement there is a commitment that would increase the stringency of Canada's GHG emissions standards and increase zero-emission vehicles, in alignment with the most stringent standards at the US federal or state level. Given the integrated nature of the road transport, maritime, and aviation sectors, the US and Canada agreed to take aligned and accelerated policy actions, including efforts to achieve a zero-emissions vehicle future. Historically, stakeholders have been supportive of harmonization with the US due to the highly integrated nature of the market. Environment and Climate Change Canada reviews EPA rulemakings and evaluates the decision of alignment while addressing unique Canadian considerations.*

Q: What is the participation of provinces in development or amendment of federal regulations?

A: *All entities that are affected by federal regulations are identified and included in stakeholder consultations during the regulatory process. This includes the provinces* *and territories, Indigenous Groups, industry associations, NGOs, and companies in the industry. Following publication in the Canada Gazette, Part I, stakeholders are notified of the publication and invited to submit comments during the consultation period. Provinces are welcome to provide comments using data from their province, and unique issues can be voiced during the consultation process.*

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Webinar #8: The role and perspectives of NGOs in managing air quality in Alberta

Panel Discussion

Moderator: Rita Stagman, Alberta Environment and Parks
Panellists:

Gary Redmond, Alberta Capital Airshed and West Central Airshed Society
Dan Jackson, Strathcona Residents Association
Jill Bloor, Calgary Region Airshed Zone
Dr. Elaine MacDonald, Healthy Communities – Ecojustice
Chris Chavez, Coalition for Clean Air, California

Background and Introductions

Rita Stagman opened the discussion by briefly introducing the panellists.

Gary Redmond is the executive director of both the Alberta Capital Airshed (ACA)and the West Central Airshed Society (WCAS). In each of these roles, Gary leads a team of professionals who monitor, analyze, and report on ambient air, as well as engage community stakeholders, support educational initiatives, and lead public awareness programs.

Dan Jackson is the president of the Strathcona Residents Association (SRA) in Vancouver, BC. The SRA is a volunteer, non-profit society dedicated to promoting the health, safety, and well-being of all residents living in our diverse urban neighbourhood. In 2020, we began working with the Port of Vancouver on a Community-Led Air Quality Monitoring Project.

Elaine MacDonald joined Ecojustice in 1999 and is a PhD level environmental engineer who applies her expertise to work related to air quality, water pollution, and toxic substances, including pesticides. Elaine leads the Healthy Communities team, where she's challenging all levels of government to protect every Canadian's right to a healthy environment—especially the most vulnerable.

Chris Chavez joined Coalition for Clean Air (CCA) as Deputy Policy Director in 2017. Since joining CCA, he has successfully advocated for significant environmental laws at the California State Capitol and landmark clean air protections in southern California. Chris has also worked to prioritize disadvantaged communities for billions of dollars in public and private clean transportation investments. Chris also was CCA's lead staff on successful state and local ballot measures, including the No on Prop 71 (June 2018) and Yes on Measure US (November 2020) campaigns.

Jill Bloor has been the executive director of the Calgary Region Airshed Zone (CRAZ) since April 2008. She came to the organization after many years in the social service sector, all with non-profit organizations. She has a BA from York University and a Masters of Non-Profit Administration (MNA) from North Park University in Chicago. She is a Registered Social Worker. Jill brings her experience in program development, stakeholder engagement, conflict resolution, and organizational development, to name a few, to CRAZ.

Q: Please tell us about your organization.

Strathcona Residents Association

Strathcona is a small and diverse neighbourhood in Vancouver. The SRA serves as a voice for the community as issues come up. The SRA became involved in air quality when a member who is an environmental analyst asked the nearby Port of Vancouver, which is expanding a terminal adjacent to Strathcona, for a grant to run a community-based air quality monitoring project. The SRA represents the citizens' perspectives, with involvement from Metro Vancouver, University of British Columbia professors, and Vancouver Coastal Health. The project is relatively new and in early stages.

Healthy Communities – Ecojustice

Ecojustice is a national environmental law organization with offices across the country. The organization works to protect the environment through law reform and litigation, including issues of climate change, protecting biodiversity, and protecting people. The Healthy Communities branch in Ontario has been working on air quality issues that affect people.

Coalition for Clean Air, California

The Coalition for Clean Air is an advocacy-based non-profit working on clean air and climate change in California. Most of the work is in southern California where there is poor air quality and there are massive environmental injustices that affect low-income communities and communities of colour. This includes communities that live downwind of the ports of Long Beach and Los Angeles and the corresponding transportation corridors and refineries. The Coalition for Clean Air primarily works on finding ways to make the transportation sector cleaner.

In addition to the initial question, airsheds, please explain how your organization is different than other NGOs.

ACA and WCAS

West Central Airshed started in the 1990s to bring all stakeholders to the table to oversee ambient air quality monitoring, including government, community, and industry. The West Central Airshed spans from Wabamun Lake to the British Columbia (BC) border. The ACA includes Edmonton and the surrounding area, excluding Fort Saskatchewan, representing urban air quality issues. Airsheds are not advocacy organizations, but they are non-government.

Calgary Region Airshed Zone

Formed in 2007, CRAZ covers from the Alberta–BC border with Banff National Park to Woodland County, and includes Rocky View County and Municipal District of Big Horn, down to the Municipal District of Willow Creek. CRAZ is the largest airshed zone in Alberta by population with 1.6 million people. The stakeholders involved in CRAZ come from all levels of government, industry, and the public. CRAZ operates three ambient air monitoring stations in Calgary, as well as a portable monitoring station for outlying small communities. There is also education and community outreach and a policy committee that researches frameworks and policies that have an impact on air quality in CRAZ. CRAZ does not advocate or lobby.

Q: What are some of the local air quality or air quality-related issues your organization is concerned about or currently facing?

Coalition for Clean Air, California

The focus is on the transportation sector; about half the greenhouse gas emissions and 80% of smog-forming emissions (e.g., NO_x, SO_x) in California come from transportation. According to the American Lung Association, the Los Angeles–Long Beach area has the worst air quality in the United States and there is a significant presence of transportation-related emissions. Diesel particulate matter is a major challenge due to freeways that are heavily used by trucks, in addition to the emissions coming from ships at the ports. The California Air Resources Board (CARB) is the state-wide air quality regulator; CARB detected a 20-tonne per day increase in NO_x and 0.5-tonne per day increase in diesel particulate matter. The US equivalent of CAAQS is the National Ambient Air Quality Standards (NAAQS). In southern California, the air quality does not meet the NAAQS and will likely not be able to reach the targets by the deadline in 2023. There is the possibility of meeting the 2031 and 2037 standards, but it will take investment and energy from the public and private sectors. Along with the transportation sector, there are stationary source issues and refineries contributing to poor air quality. There continues to be disproportionately poor air quality in low-income, Black, and Latino communities, in part due to discriminatory housing policies.

Strathcona Residents Association

The SRA became engaged in the air quality conversation when an adjacent container port announced it would be doubling the capacity, which would mean an increase in trains or trucks going through Strathcona. This led to the community questioning how the change will impact their air quality and what their air quality was at the time. Working with the port, the community has set up monitoring systems throughout the neighbourhood to measure air quality at baseline and over the next two years.

Healthy Communities – Ecojustice

Healthy Communities in Ontario has been focusing on old industrial hot spots. For example, there is a refinery community in southwestern Ontario in an area known as chemical valley, which is a pollution hotspot because of the refineries and chemical plants. As well, in Hamilton there are steel refineries and in Sudbury, there are smelters. These air pollution hotspots are the primary focus, and a challenge has been that the Ontario government does not look at cumulative effects; each facility is permitted as though it existed on its own, disregarding what is around it. There is ongoing work to get a cumulative effects policy that accounts for the entire airshed. Ontario's approach to regulating air pollution focuses on point of impingement and modelling, rather than air quality monitoring. As such, the focus has been on the industrial hot spots to understand the impact on air quality. In Ontario, there is no regulated buffer zone between industry and community, leading to situations like a First Nation sharing a fence line with a refinery. In some areas, there are high levels of air toxics such as benzene, which is another area of interest for Healthy Communities. Ecojustice uses law reform, and at times litigation, to address these issues, as well as looking at technical standards and ways to reduce the emissions. There is also work on the impact of the transportation sector; for example, a proposal to increase highways in the Greater Toronto Area. As well, there are transboundary issues across the Great Lakes and along the St. Lawrence River.

Calgary Region Airshed Zone

CRAZ has the largest city in the province, with major highways and the largest airport, as well as rural areas and a national park. The largest source of emissions is from the transportation sector. The region is becoming a logistics hub, resulting in considerable transportation traffic.

ACA and WCAS

ACA encompasses a population of about 1.3 million people and includes heavy industry and refinery row, as well as having a winter city which means wintertime smog. In Western Canada generally, wildfire smoke is an issue, as well as woodburning for home heating and recreational use. WCAS encompasses a large rural area with four towns of about 10,000 people. It is a site for upstream oil and gas, forestry, coal, and power generation. Three of the four major population centres exist in bowls, which means emissions are trapped, resulting in similar air quality issues to urban centres.

Q: What is an initiative that has been the most successful or effective in addressing air quality issues in your area? What were the drivers? And what are challenges your organization has faced?

Healthy Communities – Ecojustice

There has been success in trying to get Ontario air standards updated; in some cases, the province is using standards from the 1970s. So far, there have been two updated standards, SO_2 and benzene. The NO_x standard in Ontario is about four or five times higher than CAAQS, and it has been challenging to get the Ontario government to update the standard. Without a driver such as a health-based standard, it is hard to make progress in reducing industrial emissions. There has been mixed success in getting cumulative effects standards, with some changes for specific pollutants. In emission hot spots, there needs to be ways to assess the cumulative effects to understand the impact on communities that are already disproportionately impacted. As governments change, there is different access to making policy change; the previous government provided more opportunity to engage but since 2018, Ecojustice has not been engaged to work with government.

ACA and WCAS

WCAS has been around for quite a while; ambient air quality monitoring with multi-stakeholder oversight has been conducted since the mid-1990s. This has resulted in the airshed becoming a trusted platform and a voice for the community. A challenge in this airshed is that some of the towns are industry towns and are not looking for air quality solutions, however, having representatives at the table helps. For the ACA, there is not the same platform for ambient air monitoring; it is still retained by government and industry in the region. There is still opportunity to bring forward concerns to larger forums. The airshed has a large presence on social media and has done presentations at conferences and clean air forums, as well as at schools. There is also interest from municipalities on entrenching air quality into the decision making and in urban planning.

Calgary Region Airshed Zone

CRAZ was instrumental in developing the 2009 Particulate Matter and Ozone Management Plan. In 2019, the plan was broadened to include other contaminants of concern including NO_2. CRAZ has increased awareness that air quality is an issue in the communities, including more rural areas. The plan is cited in the South Saskatchewan Regional Air Quality Management Framework, which is considered a success because the government recognized a multi-stakeholder solution. In the Particulate Matter and Ozone Management Plan there are strategies, timelines, and actions, much of which are focused on outreach. An example of outreach is the Commuter Connect Program, which encourages employers to reach out to employees and find ways to get to work in ways other than single occupant vehicles. There is also an idle-free campaign which involves reaching out to schools. The challenges include wanting to do more but needing more funding.

Strathcona Residents Association

The project is in an early stage, so there have not been initiatives with successful outcomes yet. One initial success has been the community bringing the stakeholders together. The plan is to get the data and bring the stakeholders together to discuss actions that will have an impact on air quality.

Coalition for Clean Air, California

There are common challenges among the panellist organizations, including overcoming political will, lack of funding, and trying to encourage community collaboration. In terms of successes, 2021 has been a remarkable year for air quality legislation at the local level, specifically focusing on southern California. This year, two significant rules were passed, one related to warehouses, which hold the goods being carried to and from the ports and which are based about 80 miles from the ports, thus requiring trucks to take the highway through the neighbourhoods in the area. The newly instated rule requires warehouses to ensure clean goods movement, which can mean mandating the use of zero-emission trucks, deploying air filtration for the schools and residences in the areas around the warehouses, and other things that will reduce the emissions impact. The other new rule focuses on refineries that produce smog-forming emissions, requiring emissions limits on about 300 different pieces of equipment. This rule was put in place to supplement an emissions cap-and-trade system that was put in place in the 1990s and had been increasingly failing to limit emissions. Getting this rule instated took coordination and collaboration with other local environmental groups, environmental justice organizations, and community organizations, and being able to support the case with the science and legal precedent. The challenges include addressing the ports as the largest source of emissions; environmental advocates are pushing for an indirect source rule for the ports, however, the ports are pushing for a memorandum of understanding on emission reductions, which would be a voluntary agreement. The ports recently submitted a proposal for this, which are not to the standard the Coalition for Clean Air is looking for and as such, the coalition continues to push for overcoming political will and instating a rule that will bring emissions reductions to the community.

Q: From an NGO perspective, how do you see air pollution (especially NO_x emissions) being managed/reduced in the future and what are the roles for other organizations (e.g., government and industry)?

Coalition for Clean Air, California

In the past, much of the focus has been on voluntary compliance and voluntary emissions reductions. The deadline for meeting the NAAQS is coming up and many standards will not be adhered to in time, indicating a failure of the voluntary compliance approach. There has been a push for actual regulations, however, there is still a political preference for incentives, such as incentives to replace trucks. While incentives have a role, they need to be used in conjunction with rules. Recently, there has been a stronger effort to work with the local community. In 2017, a law was passed (AB 617) that requires air regulators to identify highly polluted communities and form a collaborative process with the local community, including business stakeholders, residential stakeholders, non-governmental actors, and local governments to develop an emission reductions and monitoring plan for these communities. The new rules mentioned previously were tied to the AB 617 process. There is starting to be recognition that rules need to be enacted for air quality, as well as rules and programs in conjunction with communities that have suffered the most from pollution.

Healthy Communities – Ecojustice

There has not been a big focus on NO_x within Healthy Communities. Ontario closed coal plants over 10 years ago, which had a significant impact on air quality, including almost complete disappearance of smog in the Greater Toronto Area. The major challenges are related to localized air pollution in industrial hot spots and the need for the NO_x standard to be updated so it can be used a pressure point for areas where there are higher pollutant levels. There are many urban hot spots along the golden horseshoe in Ontario and solutions include increasing the use of public transportation, getting more vehicles off the road, and moving people away from major transportation routes. The issues of people moving further away from urban centres and travelling further, along with larger vehicles becoming more popular, are minimizing the positive impacts of removing coal power plants. Ozone is a major issue in the Greater Toronto Area, which is a precursor to NO_x.

ACA and WCAS

It will be hard and at times expensive, as such we need to focus on broader initiatives that use more than the regulatory levers and use broader stakeholder engagement beyond air quality practitioners, because it needs to be entrenched at all levels of government and decision making. Urban planning for public transportation is key. There needs to be more engagement and enforcement at all levels, including the local level. The ACA has been working on neighbourhood level monitoring, bringing in community education and locally based actions. Those initiatives, if supported by broader actions, are beneficial.

Calgary Region Airshed Zone

There needs to be a conversation with surrounding areas and that is where airsheds can support the work. CRAZ already has a broad base of stakeholders, including industry and the public, as well as an airshed plan that could be more broadly implemented. There needs to be a mix of voluntary actions and regulatory actions. For example, the anti-idling campaign that focuses on increasing public awareness.

Strathcona Residents Association

The SRA is in a unique situation, in that it is a distinct community working directly with the port to identify data and actions that will decrease pollution. The port is already thinking about solutions, such as handling diesel emissions on the rail line. The conversation is being had in a non-combative way with the air quality regulators at the port, and the hope is that as these changes have a positive impact it will be replicated at other ports. Having a citizen-based awareness of the problem seems to have more political leverage. The hope is that through a collaboration with the port, solutions can be identified and implemented. The bottom-up approach seems to be working well.

Question & Answer Session

Q: Transportation emissions have come up as a challenge for all panellists. Gary and Jill, what would you like to see as the main actions to combat transportation emissions in Edmonton and Calgary?

ACA and WCAS

The City of Edmonton is a leader in this, along with the surrounding municipalities that make up the ACA. Public awareness and education are important; we need to improve people's understanding of pollution from cars and the intent of anti-idling initiatives, and the impact of air quality on human health. We learned that Instagram is the best way to reach young people. Another approach is talking to individual employers and finding ways to avoid single occupancy vehicles commuting to the same office. Air quality should also be included in urban planning so there are walkable and bikeable cities whenever possible. Energy transition support is also needed, particularly moving away from idling diesel engines.

Calgary Region Airshed Zone

Before talking about actions, we need to engage stakeholders and bring everyone to the table. CRAZ has tried to get industry, such as trucking and construction, with minimal success. Having these industries at the table shows a willingness to think about alternatives and actions. CRAZ has a Commuter Connect Program that works with employers to address single occupant vehicles going to the office. A success story from this program is a company in downtown Calgary that identified the employees' desire to bike to work but concerns about bike storage, resulting in two executives giving up their parking spots for bike storage. CRAZ also has an idle-free program for trucking fleets, which resulted in one company reducing their incidents of idling over 10 minutes from 600 to 30 in three months. We know voluntary actions work, but we need to get people to the table first so they understand what the actions are. The solutions also need to be informed by those who would implement it. For example, rural areas do not have public transit, so that solution is not relevant to them.

Q: Question for Elaine and Chris: There are several approaches that NGOs have with respect to addressing air quality issues which include collaboration which, while desirable, doesn't always get results, lobbying government, using the media to influence public opinion and increase pressure on government and/or industry, and legal action. What are your perspectives on when and how to use these different approaches?

Healthy Communities – Ecojustice

Ecojustice uses all the mentioned approaches; it depends on the context. Going to court is the last option, because there is a lot of uncertainty in what the outcome will be, and it is very expensive. Working directly with community groups and other involved parties to negotiate solutions is usually the first step, depending on the political context.

Coalition for Clean Air, California

As a small organization, the coalition tries to use all those approaches in different regards. Similar to Ecojustice, legal action is not preferable as it is expensive, and a loss means paying the other sides fees. There has been success from working collaboratively with the state legislature and creating positive working relationships with elected officials at the local and state level and with regulators and using direct and transparent communication with politicians and the public. There needs to be honesty about issues and intent, and open communication about the goals. It is important to be at the table where decisions are being made, as well as connecting with and educating the public. Working with businesses and labour unions represent polluting industries also matters. Finally, connecting with the media and presenting on concerns and ideas as often as possible.

Q: For Chris and Dan: What are your organizations' experiencing in navigating the various regulators involved in transportation?

Coalition for Clean Air, California

The coalition works with transportation-related agencies, primarily CARB. In the US, the USEPA has general authority over environmental policies including air quality, CARB addresses mobile sources of emissions, and there are local air districts that work on stationary sources of emissions. A recent example of working with these agencies was creating a bill that went through the California legislature that requires smog checks for heavy-duty trucks. In this example, CARB developed a regulatory framework for the truck smog check program and the coalition worked with CARB to strengthen the bill. Working directly with those agencies has been successful, including having the president of the coalition as a member of the California Transportation Commission. It is also important to work with local government and be involved in land use and planning.

Strathcona Residents Association

When the port announced it would expand, the SRA initially tried to go through the BC Ministry of Environment and request an environmental assessment for the expansion. There was minimal success; the SRA has had much more success dealing directly with the polluter, which enabled more conversation about the opportunities and challenges perceived by both sides. There seems to be real world solutions in this situation because the polluters and those directly affected can talk about solutions together.

Q: Elaine mentioned that the access to government waxes and wanes depending the government in power. However, industry always has the ear of government. What are your thoughts or suggestions on how to effectively engage industry recognizing that there will be times when you have to battle with industry when pushing for more stringent pollution control regulations?

Strathcona Residents Association

Trying to get the port to react to legal and regulatory push resulted in response from a communications team that wanted to shut it down. Finding the individual within the organization that cared about the problem and was willing to be a partner resulted in a beneficial connection to the organization and created an opportunity to generate mutual understanding of the complex issue. This resulted in the SRA being able to present concerns to the port with credibility. The recommendation then is to find the person within the organization who cares about the problem and is willing to be a partner in figuring out a solution to realistically address the problem.

Coalition for Clean Air, California

The federal government administration has a major impact on connection to regulators. For example, the coalition has heard from the Biden Administration since inauguration this year more than they heard from the Trump Administration throughout the four years of the term. Getting access to political officials can be very difficult and there is a point you need to bypass them and go to those who can make change, such as the public or industry; try to find an ally. A major part of advocacy is working with both political sides. When possible, take your case to the media and discuss the issue in advance of political involvement and decision making.

Healthy Communities – Ecojustice

There was a time Ecojustice was working with government and industry, but that is no longer the situation. When government is not inviting stakeholders to the table, another approach is to support the local community. The local community has the ear of industry because industry needs to answer to the local community. Providing legal support, technical reports, and other tools to communities has helped give them a voice when talking to industry. Another approach is taking a more visible stance through media to influence the political conversation about the issue.

Calgary Region Airshed Zone

Finding the right person to work with within industry is invaluable; the challenge with this has been when people transition out of the role, it can mean losing the seat at the table. The same goes for finding an ally within government. Some of the best success has been with working directly with an ally to get a seat at the table and collaborate on solutions. Talking to the media also helps, but you must find the right person.

ACA & WCAS

Both ACA and WCAS have industry is at the table, it is built into the airshed model. Some are involved because of regulatory requirements, and some are there voluntarily. Neither airshed pushes for tighter pollution controls, instead they push for government to accept Alberta's airshed model which means having large emitters at the table alongside the other stakeholders and making sure the airsheds are managing the ambient air monitoring so that there is multi-stakeholder oversight, public transparency of data, and full community engagement.

Q: What kind of rules does California have with respect to vehicle emission control anti-tampering and/or regular vehicle inspections? Thoughts on the best ways to ensure that emissions from existing vehicles are being managed or controlled as best they can.

Coalition for Clean Air, California

California is unique because it creates its own emissions standards for passenger vehicles, which other states use, as outlined in the *Federal Clean Air Act*. This is in part because California was regulating automobile emissions before the federal government. There are penalties for tampering with pollution control devices, whether at the user level such as with catalytic converters or at the company level, such as the diesel gate scandal with Volkswagen. In the Volkswagen example, CARB and the University of West Virginia was involved in detecting incorrect data and finding that the Volkswagen vehicles were emitting at a much higher level in real world conditions. Volkswagen faced massive penalties and prosecution in Germany. From that, Volkswagen has become involved in the EVs space; the Electrify America program was a spinoff of the Volkswagen settlement, in that Volkswagen has become one of the largest providers of electric vehicle charging. There are still many issues with tampering and emissions control, and not everything is being taught. It takes both community and academic involvement directly from communities that are experiencing poor air quality because of non-compliance. For example, a recent issue with hydrogen sulphide being detected at high levels was properly addressed when the local community identified the source and demanded answers.

Healthy Communities – Ecojustice

Tailpipe emissions standards are set federally under the *Canadian Environmental Protection Act* to match the USEPA. While the USEPA acted quickly on the Volkswagen issue, Environment Canada did not act and resulted in Ecojustice suing Environment Canada to get action on the issue. Years after the USEPA had completed collecting fines from Volkswagen, Environment Canada followed through in suing and collecting fines as well. There is not a strong enforcement culture in Canada federally, it required forcing the regulator through legal action.

Q: Many of you have mentioned the issue that the true impacts of air quality on health and quality of life are often not well defined, understood or considered whereas the cost of emission reduction controls is relatively easy to define and use as an argument against additional controls. Any thoughts on how to better incorporate the health impact context in promoting better air quality?

Calgary Region Airshed Zone

Health Canada develops a report '*Health Impacts of Air Pollution in Canada*'. Their staff was able to pull figures for the three Census Districts that CRAZ falls into. From the 2019 version of that report, 1,359,699 million respiratory and asthma symptom days per year, 234 emergency room visits per year and a total economic cost of $2.94 billion per year and there were 490,855 restricted activity days per year. These are real costs that the governments, employers, families, and individual's shoulder. CRAZ incorporates this kind of information into our presentations to potential members as well as shares it through our social media channels. The entire report is for Canada.

Strathcona Residents Association

Great question. Because the negative consequences of poor air quality are diffuse and distributed over time — and causal connections difficult to make — "showing the problem" is difficult. We're doing some public engagement workshops this summer that aim to address this. But we've yet to find a good solution. We'd love to hear from people who have

Coalition for Clean Air, California

Ultimately, it's the air quality standards that need to consider health needs. From there, rules can be developed to meet air quality standards. While it's hard to design a rule around specific health outcomes, it is easier for a rule to help meet specific air quality standards. By meeting those standards, public health will be improved.

Another area of concern is that many agencies use health-risk assessments in the rulemaking process. This is problematic, however, as health-risk assessments can be easily manipulated to minimize the apparent impacts on communities.

CARB is in the process of improving their assessments of health costs to make them more complete. Agencies should always consider the number of avoided premature deaths, hospitalizations and work and school absences due to rules.

ACA and WCAS

It would be helpful to have some research done within the Airshed linking air quality data and health metrics for both short term events (wildfires, wintertime smog, etc.) and chronic exposure, with consideration to factors such as socio-economic indicators, housing, proximity to emissions, etc. Such empirical data would be helpful in battling the notion that poor air quality is a concern only in larger urban areas abroad and could be used to influence local planning.

Q: Chris — Are California's new vehicle on- and off-road diesel engine emission limits the same as the USEPA's limits? One of the concerns and major vehicle emission issues we have in Alberta relates to the Tier 4 limit emission limits for large off-road diesel vehicles which are not stringent. Have you had to try and deal with an issue like this?

Coalition for Clean Air, California

California does have on- and off-road vehicle emissions standards that exceed the United States Environmental Protection Agency's (US EPA) standards. In the case of on-road heavy-duty vehicles, these standards were part of the Heavy-Duty Omnibus rule. For off-road, CARB takes a sector-by-sector approach, such as with the just passed rules on commercial harborcraft. There are also rules relating to locomotives and construction equipment; however, some of these rules are due to be updated.

Additionally, the California Air Resources Board specifies which model years are allowed to operate within the state. For example, starting in 2023, all port drayage trucks will need to have a model year 2010 engine or newer. Additionally, trucks are prohibited from idling more than 5 minutes unless the truck meets “clean idle certification” – emitting less than 30 grams of NO_x.

CARB also has an Advanced Clean Trucks Rule, which applies to truck manufacturers.

Governor Newsom also issued Executive Order N-79-20, which creates a policy goal of requiring all medium- and heavy-duty trucks to meet a zero-emissions standard by 2045, where feasible. This executive order, however, will need rules and possibly laws to actually make effective.

We actively support alternatives to diesel-powered vehicles and equipment, where feasible. This includes zero-emissions technology, as well as near-zero emissions technology fuelled by renewable fuels where zero-emissions is not feasible.

Q: For Chris and Dan: What is your organization’s experience in navigating the various regulators involved in transportation?

Strathcona Residents Association

As a residents association, our contacts with regulators (mostly provincial ministries) is via letters that get polite replies and occasional polite meetings that seem to have little impact. Our most effective links have been with polluters themselves (the Port of Vancouver is funding a two-year community air quality monitoring project).

Coalition for Clean Air, California

Coalition for Clean Air works extensively with California’s agencies, including the California Air Resources Board (CARB), the California State Transportation Agency and the California Transportation Commission (CTC.) We have developed a strong relationship with the Board Members and principal executives for each of those agencies, and our President/CEO is an appointee to the CTC. We also work heavily with regional and local agencies that either have direct or indirect involvement with transportation, including local transportation agencies (Los Angeles Metropolitan Transportation Authority) and air districts (the South Coast Air Quality Management District.)

Our involvement with federal agencies, such as USEPA and the National Highway Traffic Safety Administration (NHTSA) is limited as we do not have a lobbying presence in Washington, DC. Despite this, we were actively engaged in the effort to protect California’s automotive emissions standards from being rolled back by the Trump Administration.

Q: Transportation emissions have come up as a challenge for all panellists. Gary and Jill, what would you like to see as main actions to combat transportation emissions in Edmonton and Calgary?

Calgary Region Airshed Zone

CRAZ has developed a Commuter Connect Program that we promote to employers for them to survey their employers on ways they commute to work and how they’d like to commute, barriers to the changes, etc. The guidebook offers tips, techniques, and templates to assist with breaking down those barriers. We acknowledge for the CRAZ region that program isn’t always feasible as we have urban and rural areas. CRAZ also promotes idle-free programs for fleets, parents waiting to drop off/pick up at schools. The Alberta Airshed Council has a video on this. The airshed zone organizations and the Council have educational/awareness materials that we all share in our regions. We need to continue to talk to drivers and remind them that just stopping needless idling is a way for them to improve the ambient air quality and reduce emissions. Behaviour change is often the hardest to get people to do.

ACA & WCAS

1. Good measurements that are easily understood by the general populace would be helpful alongside key messages to influence behaviours (driving, purchasing, idling, etc.)
2. The ACA area would benefit from a cooperative approach amongst monitoring stakeholders to better strategize what is monitored and where, in order to include transportation emissions as a key element of understanding the air quality of the region
3. Exploration of new technology to better track the emissions along major routes, in order to influence transportation and urban planning
4. Financial investment in air monitoring stemming from transportation non-point sources. This could be used for new programs or existing ones, such as the ACA community host and citizen science programs
5. Emission testing and vehicle buy-back programs
6. Municipal and industrial fleet transition to electric (or at least away from diesel)

Q: Question for Chris: What kind of rules does California have with respect to vehicle emission control anti-tampering and/or regular vehicle inspections? Any thoughts on the best ways to ensure that emissions from existing vehicles are being managed or controlled as best they can?

Coalition for Clean Air, California

The state's smog check program (which Coalition for Clean Air helped create in the 1980s) is the state's main tool regarding emissions control tampering. California requires passenger vehicles over six years old to be "smogged" every two years.

Until the passage of California Senate Bill 210 in 2019, medium- and heavy-duty trucks were not required to go through any pollution testing. Instead, trucks were subject to a visual opacity test—in other words, trucks would only be checked to see if they were billowing out excessive amounts of black exhaust. Starting in 2024, however, medium- and heavy-duty trucks will be subject to a vehicle maintenance and inspection program. These inspections will be done with On-Board Diagnostics (OBD) tools.

Monitoring by CARB and the University of West Virginia were crucial in uncovering Volkswagen's actions in the "Dieselgate" scandal nearly a decade ago.

Appendix A: Webinar Series Program

Clean Air Strategic Alliance Webinar Series: Approaches and Solutions for Canadian Ambient Air Quality Standards (CAAQS) Achievement in Alberta

TIME	TOPIC	SPEAKERS & MODERATORS
September 27, 2021 1:00 – 3:00 p.m. MT	Setting the context for the issue of NO_2 CAAQS Achievement in Alberta	Hamid Namsechi, Alberta Environment and Parks Brian Asher, Environment and Climate Change Canada Patrick Hamel, Health Canada Gerald Palanca, Alberta Energy Regulator Bob Myrick, Alberta Environment and Parks
October 8, 2021 9:00 – 11:00 a.m. MT	Theoretical overview of pollution costs and impacts, benefits, and equitable sharing of emission reductions	Daniel Vallero, Duke University Chúk Odenigbo, Future Ancestors Amanda Giang, University of British Columbia
October 19, 2021 9:00 – 11:45 a.m. MT	Cost/benefit analyses for air policy options	Nick Muller, Carnegie Mellon University Mike Holland, Ecometrics Research and Consulting Edward Olale, Environment and Climate Change Canada Dave Stieb, Health Canada
November 3, 2021 10:00 a.m. – noon MT	Integrated Assessment Models	Dan Loughlin, US Environmental Protection Agency Stefan Åström, IVL Swedish Environmental Research Institute Rebecca Saari, University of Waterloo Amir Hakami, Carleton University
November 9, 2021 9:00 – 11:00 a.m. MT	Compare and contrast air policy options with other jurisdictions for the purposes of informing workshop discussions	Dave Allen, University of Texas (Austin) John Lindner, Metro Vancouver Stephanie Parent, California Air Resources Board
November 17, 2021 9:00 – 11:00 a.m. MT	Industry Perspectives on Alberta's NO_2 Challenges & Opportunities	Moderator: Danielle Smith, Alberta Enterprise Group Craig Werner, Alberta Forest Products Association Jim Hackett, Heartland Generation Ltd. Don McCrimmon, Canadian Association of Petroleum Producers Greg Moffatt, Chemistry Industry Association of Canada Laurie Danielson, Northeast Capital Industrial Association
November 30, 2021 9:00 – 11:00 a.m. MT	Air policy opportunities in the transportation sector	Greg Evans, University of Toronto Laura Minet, University of Victoria Sandra Bayne and Sean Hornsby, Environment and Climate Change Canada
December 14, 2021 1:00 – 3:00 p.m. MT	The role and perspective of NGOs in managing air quality in Alberta	Moderator: Rita Stagman, Alberta Environment and Parks Gary Redmond, ACA/WCAS Dan Jackson, Strathcona Residents Association Jill Bloor, Calgary Region Airshed Zone Elaine MacDonald, Ecojustice Chris Chavez, Coalition for Clean Air (California)

Appendix B: Speaker Biographies

Webinar 1 – Setting the context for the issue of NO_2 CAAQS achievement in Alberta

Hamid Namsechi is the Director of the Air Policy section, Policy Division in Alberta Environment and Parks. His team is responsible for developing policies, frameworks, standards, and objectives to support air quality management in Alberta. The responsibility includes updating the *Environmental Protection and Enhancement Act* (EPEA) to deal with emerging issues such as achievement of national air quality standards (CAAQS). Hamid has been responsible for leading the Air Policy team for the past 12 years.

Brian Asher is a senior policy advisor in the Air Emissions Priorities Division within Environment and Climate Change Canada. He works on ambient air quality issues including the implementation of the Air Quality Management System in collaboration with provinces and territories. He is currently leading the review of the Canadian Ambient Air Quality Standards for $PM_{2.5}$.

Patrick Hamel is a senior scientific evaluator in the Ambient Air Quality Section (AQAS) of the Water and Air Quality Bureau of Health Canada. His team is responsible for establishing and quantifying the relationships between air pollution and health.

Gerald Palanca is the manager of the Alberta Energy Regulator's Emissions Management Team. His team is responsible for ensuring that the implementation and maintenance of the air emissions framework is achieved through regulatory development, stakeholder engagement, surveillance, and related enforcement process activities.

Bob Myrick is the Director of the Airshed Sciences section, Resource Stewardship Division in Alberta Environment and Parks. His team is responsible for evaluation and reporting on air quality and deposition in the province. This includes providing data and information to manage air quality and deposition within environmental limits, providing real-time air quality information to the public and emergency response personnel, and sharing technical information on new monitoring methods and emerging air quality issues with stakeholders. One specific responsibility is reporting against the Canadian Ambient Air Quality Standards following the guidance of the Canadian Council of Ministers of the Environment. Bob has led the Airshed Sciences team since its formation in 2015.

Webinar 2 – Theoretical overview of pollution costs and impacts, benefits, and equitable sharing of emission reductions

Daniel A. Vallero is an internationally recognized author and expert in environmental science and engineering. He has devoted decades to conducting research, teaching, and mentoring future scientists and engineers. He is currently developing tools and models to predict potential exposures to chemicals in consumer products. He is a full adjunct professor of civil and environmental engineering at Duke University's Pratt School of Engineering and is a senior research physical scientist in the United States government's executive branch. He received his Ph.D. from Duke University, and master's degrees from the University of Kansas and Southern Illinois University. Dr. Vallero has authored over 60 peer-reviewed journal articles and more that 100 book chapters.

Chúk Odenigbo is a Franco-Albertain from Calgary, and is incredibly passionate about the interactions between culture, health, and the environment. This passion manifests itself in his three primary roles as (1) Founding Director for Future Ancestors Services Inc., an Indigenous and Black-owned, youth-led professional services social enterprise and start-up that advances climate justice and equity with a lens of anti-racism and ancestral accountability; (2) Co-founder of The Poison and The Apple, a Albertan born bilingual non-profit organisation that seeks to change the way in which Canadians interact with nature at a sociocultural level in order to diversify outdoor spaces and make nature truly for all; and (3) PhD Candidate in Medical Geography where his research looks at the relationships between human health, the environment, geographic factors, society, and healthcare to shed light on public health policies and strategies.

Amanda Giang is an Assistant Professor in the Institute for Resources, Environment and Sustainability and the Department of Mechanical Engineering at the University of British Columbia. Her research address environmental policy analysis challenges through an interdisciplinary lens, with a focus on pollution, climate, and energy. Topics of current interest include developing better tools and methods for assessing and addressing air pollution and environmental injustice in Canada, and understanding the links between air quality and decarbonization to inform policy and planning decisions. She serves as an editorial board member for the journal Environmental Research Communications and as an Early Career Editorial Advisory Board Member for Environmental Science & Technology.

Webinar 3 – Cost/benefit analyses for air policy options

Nick Muller is the Lester and Judith Lave Associate Professor of Economics, Engineering, and Public Policy in the Department of Engineering and Public Policy and the Tepper School of Business at Carnegie Mellon University. Muller joined the National Bureau of Economic Research as a Faculty research Fellow in 2012 and was promoted to Research Associate in the fall of 2013. Dr. Muller teaches microeconomics, benefit-cost analysis, environmental and natural resource economics, and energy policy. Broadly, his research focuses on measuring air pollution damage and market-based policy design. Dr. Muller has published papers in leading economics and natural science journals. He served on the US Environmental Protection Agency's Scientific Advisory Board from 2015 to 2017.

Mike Holland is a freelance consultant who has worked on the development and application of methods for cost-benefit analysis of air quality policies for over 30 years. He has worked at all scales from the development of local air quality plans in the UK, China, Romania, and other countries, through national planning to the development of international (particularly European) agreements and legislation. He is vice chair of EMEP, the scientific body for the UN Economic Commission for Europe Convention on Long-Range Transboundary Air Pollution, a member of the UK's Committee on the Medical Effects of Air Pollutants (COMEAP) and a member of the evaluation panel for the Green Bonds issued by Agence France de Trésor.

Edward Olale is a Senior Economic Advisor at Environment and Climate Change Canada (ECCC). He provides advice on the methodology and best practices of Cost-Benefit Analysis and contributes the development of CBAs and Regulatory Impact Analysis Statements (RIASs) for submission to the Treasury Board Secretariat. As well, he works with departmental policy leads to address comments raised by Indigenous organizations, provincial and territorial authorities, as well as stakeholders from environmental non-governmental organizations, industry, and industry associations on CBAs and RIASs. Edward is passionate about CBA methodology and best practices. He is part of an interdepartmental team developing a CBA certification program for the Community of Federal Regulators to be delivered via the University of Ottawa beginning Nov 2021. Before joining ECCC, Edward worked as a Senior Economist at the Government of New Brunswick and a Part-time Professor at both the University of New Brunswick and St. Thomas University for over eight years. On the research front, Edward is interested in environmental and natural resource policy analysis. His research is published in peer-reviewed journals such as Climatic Change, Regional Environmental Change, Journal of Cleaner Production, Food Policy, Canadian Journal of Agricultural Economics, Journal of Soil and Water Conservation, Agronomy Journal, Fisheries Research, Forest Policy and Economics, and Forest Science.

Dave Stieb is a public health physician and epidemiologist at Health Canada and an adjunct professor in the School of Epidemiology and Public Health at the University of Ottawa. His main interests are air pollution epidemiology and application of epidemiologic evidence to risk analysis and risk communication, employing systematic evidence synthesis and quantitative risk analysis methods. He has worked in the area for nearly thirty years and published over 100 peer-reviewed papers.

Webinar 4 – Integrated Assessment Models

David Allen is the Gertz Regents Professor of Chemical Engineering, and the Director of the Center for Energy and Environmental Resources, at the University of Texas at Austin. Dr. Allen has been a lead investigator for multiple air quality measurement studies, including studies that made some of the first measurements of methane emissions from unconventional oil and gas production. He directs the Air Quality Research Program for the State of Texas, and he is the founding Editor-in-Chief of the American Chemical Society's journal ACS Sustainable Chemistry & Engineering. He has served on a variety of governmental advisory panels and from 2012 to 2015 chaired the US Environmental Protection Agency's Science Advisory Board. In 2017, he was elected to the US National Academy of Engineering. Dr. Allen received his B.S. degree in Chemical Engineering, with distinction, from Cornell University in 1979. His M.S. and Ph.D. degrees in Chemical Engineering were awarded by the California Institute of Technology in 1981 and 1983. He has held visiting faculty appointments at the California Institute of Technology, the University of California, Santa Barbara, and the US Department of Energy.

Stephanie Parent has a breadth of experience that covers ambient, as well as indoor, air quality and is currently an Air Pollution Specialist at the California Air Resources Board. She collaborates with colleagues at local, regional, and federal governments to prepare State Implementation Plans to improve air quality and public health for the people of California. She earned her master's degree in Environmental Science and Policy from Clark University and her bachelor's degree in Environmental Policy Analysis and Planning from the University of California, Davis. Stephanie was born in Montreal and grew up in Southern California.

John Lindner is an air quality planner with Metro Vancouver, where he has worked since 2016. He lead the development of the Clean Air Plan, Metro Vancouver's 10-year management plan to address regional air quality and greenhouse gas emissions. At Metro Vancouver, John has also worked on bylaw development, policy reviews, and updates to Metro Vancouver's ambient air quality objectives. Prior to Metro Vancouver, John worked in consulting for 10 years, conducting air quality, noise and climate assessments, along with geophysical mining exploration. He has a Masters in physics and lives in Vancouver with his wife, 2 young daughters, and a never-ending list of house renos.

Webinar 5 – Compare and contrast air policy options with other jurisdictions for the purposes of informing workshop discussions

Dan Loughlin has been a Research Scientist at the United States Environmental Protection Agency for 18 years. His specialties include energy system modelling, technology assessment, estimating air pollutant and greenhouse gas emissions for technology and policy scenarios, and sensitivity and uncertainty analyses. Dan is the co-lead of the GLIMPSE project with Chris Nolte. Previously, Dan was involved with EPA's MARKAL database development and applications, focusing on the electric and transportation sectors. He is also an adjunct professor at Duke University's Nicholas School of the Environment where he teaches a course on Integrated Assessment Modeling.

Stefan Åström has been a senior researcher and project manager at IVL Swedish Environmental Research Institute for the past 17 years. Most of Stefan's research is oriented towards the integrated area of economics and air pollution with a special focus on co-benefits and trade-offs between air pollution policies and climate change policies. Stefan has a broad education from Chalmers University of Technology and Gothenburg University, including a PhD in Energy and Environment, a Masters' degree in Environmental Science and a Bachelors' degree in Economics. In addition to his role as researcher, he is currently co-chair of the United Nations Economic Commission for Europe CLRTAP Task Force on Integrated Assessment Modelling (TFIAM).

Rebecca Saari is an Assistant Professor in Civil and Environmental Engineering at the University of Waterloo. She completed her Ph.D. at the Massachusetts Institute of Technology after working as a professional air quality engineer and as a government scientist with Environment and Climate Change Canada. Dr. Saari is an internationally recognized expert in quantifying the health and economic impacts of air pollution. She develops novel, interdisciplinary, integrated modelling tools to understand the impacts of harmful emissions and benefits of policy solutions. Dr. Saari has published in leading journals in environmental engineering, environmental health, and sustainable policy analysis.

Her analysis of air quality-related impacts of climate policy has been requested by White House staff, cited by the US Environmental Protection Agency (USEPA) administrator in the press, and used to support climate legislation in federal court.

Amir Hakami is an Associate Professor at the Department of Civil and Environmental Engineering, and the Associate Dean - Research in the Faculty of Engineering and Design at Carleton University. He is an internationally recognized expert in air quality modelling and over the last two decades has significantly contributed to the development of tools and models that inform air quality decision-making. His research is multidisciplinary and at the intersection of atmospheric modelling, population health, environmental and climate policy, air pollution economics, and environmental justice. He has led a number multi-institutional, national, and international projects and is funded by various agencies in Canada and the US.

Webinar 6 – Industry Perspectives on Alberta's NO_2 Challenges and Opportunities

Moderator

Danielle Smith is the President of the Alberta Enterprise Group and is a regular columnist with PostMedia.

Panelists

Don McCrimmon has worked at the Canadian Association of Petroleum Producers for 4.5 years, representing the upstream oil and gas industry on various environmental issues. He currently sits on the CASA board as the representative for Large Oil and Gas Producers. He also represents oil and gas producers on the CAAQS Development and Review Working Group. Don has a background in civil engineering as well as international human rights and environmental law.

Greg Moffat joined the Chemistry Industry Association of Canada (CIAC) in July 2016 and is responsible for analysis and advocacy improving business and economic competitiveness of CIAC members across Canada. He is also the lead for government and stakeholder relations in Western Canada. Prior to joining CIAC, Greg held positions with Penn West, TransCanada, the University of Alberta, CN, and the Government of Alberta. He has worked extensively in all four western provinces, at the federal level, and in a number of US states. He holds an Executive MBA from the University of Alberta and BA in Political Science from the University of Calgary.

Craig Werner is the Director for Environment and Regulatory Affairs at the Alberta Forest Products Association. His portfolio includes air, climate and water policy and he works closely with engineers, environment, and mill managers to find solutions to policy challenges and opportunities. Craig has worked in both the private and public sector in a variety of global locations including South Africa, the United Kingdom, Saudi Arabia, and Canada.

Jim Hackett is currently Senior Advisor, Environment & Policy for Heartland Generation Ltd. He is a chemical engineer with over 30 years' experience working through environment and climate change challenges in the electricity space. No stranger to CASA or air quality, Jim represents the electricity sector on the CASA Board, has co-chaired the CASA Electricity Framework Review 3 times, and currently serves as industry VP on the CASA Executive.

Laurie Danielson joined the Northeast Capital Industrial Association as the Executive Director in 2007 following a lengthy career with Sherritt Inc., Viridian Inc. and The Westaim Corporation. Dr. Danielson holds a doctorate in chemistry from the University of Alberta, and has extensive experience in regulatory compliance, government relations, and regional issues management. A long-time resident of Fort Saskatchewan, he is a member of the Association of the Chemical Profession of Alberta, a board member of the Fort Air Partnership and the North Saskatchewan Watershed Alliance.

Webinar 7 – Air policy opportunities in the transportation sector

Greg Evans P.Eng., FCAE, FAAAS, FCEEA, is an Engineering Professor at the University of Toronto. He is the Director of the Southern Ontario Centre for Atmospheric Aerosol Research, a multidisciplinary centre investigating the impacts of air pollution on the environment, climate, and health. Prof. Evans was recently awarded the 2021 NSERC Brockhouse Prize for Interdisciplinary Research and has previously been widely recognized for both his research and teaching.

Laura Minet is a postdoctoral research associate at the University of Victoria, where she will start a position of Assistant Professor in Civil Engineering in January 2022. Her research addresses issues of traffic-related air pollution and its impact on population health. Current topics of interest include the impact of climate change and climate change mitigation strategies on urban air quality, and the design of sustainable transportation systems that minimize population exposure to air pollution.

Sandra Bayne is the Section Head - Regulatory Administration, Heavy-Duty Vehicles and Large Engines Section, Transportation Division at ECCC. Sandra has over 20 years' experience working for the Government of Canada relating to technologies and programs for reducing emissions from the transportation sector, including light-duty vehicles, heavy-duty vehicles and off-road engines and equipment. She started her career in the Transportation Division of ECCC where she spent over 16 years working on the regulatory development and administration of the suite of on- and off-road vehicle and engine emission regulations. Sandra spent almost 5 years at Natural Resources Canada where she worked on transportation R,D&D and gained experience in program development and delivery in both the transportation and forestry sectors, including work on the Electric Vehicle Infrastructure Demonstration (EVID) Program. She returned to the ECCC to lead the regulatory administration for heavy-duty vehicles under both the On-Road Vehicle and Engine Emission Regulations and the Heavy-duty Vehicle and Engine Greenhouse Gas Emissions Regulations.

Sean Hornsby is the Program Engineer, Regulatory Development, Heavy-Duty Vehicles and Large Engines Section, Transportation Division at ECCC. Sean has over 10 years' experience working for Environment and Climate Change Canada in the transportation sector, focused on reducing emissions from vehicles and engines. He spent 7 years working in the compliance field for on-road motorcycles. This involved selecting, acquiring, and emissions testing for on-road motorcycles. Sean was involved in hosting several manufacturer visits at the test lab, a correlation program with the US EPA and multiple manufacturers, and a research project examining test cycles and their effect on emissions from on-road motorcycles. Most recently, Sean has shifted to regulatory development and was part of the team responsible for the recent publication of the Off-road Compression-Ignition (Mobile and Stationary) and Large Spark-Ignition Engine Emission Regulations.

Webinar 8 – The role and perspective of NGOs in managing air quality in Alberta

Moderator

Rita Stagman is an Engagement and Education Specialist with Alberta Environment and Parks. She is part of a team that encourages Albertans' participation in conversations that provide opportunities to hear diverse perspectives on topics and to contribute to decisions that affect our environment. The goal is to encourage environmental stewardship of Alberta's air, land, water, and biodiversity through education and engagement.

Panelists

Gary Redmond is the Executive Director of both the ACA and the WCAS. In each of these roles, Gary leads a team of professionals who monitor, analyze, and report on ambient air, as well as engage community stakeholders, support educational initiatives, and lead public awareness programs.

Dan Jackson is the president of the Strathcona Residents Association (SRA) in Vancouver, BC. The SRA is a volunteer, non-profit society dedicated to promoting the health, safety, and well-being of all residents living in our diverse urban neighbourhood. In 2020, we began working with the Port of Vancouver on a Community-Led Air Quality Monitoring Project.

Jill Bloor has been the Executive Director of CRAZ since April 2008. She came to the organization after many years in the social service sector, all with non-profit organizations. She has a B.A. from York University and a Masters of Non-Profit Administration (M.N.A.) from North Park University in Chicago. She is a Registered Social Worker. Jill brings her experience in program development, stakeholder engagement, conflict resolution and organizational development, to name a few, to CRAZ.

Elaine MacDonald is the Program Director - Healthy Communities with Ecojustice. Elaine joined Ecojustice in 1999 and is a PhD level environmental engineer who applies her expertise to work related to air quality, water pollution, and toxic substances, including pesticides. Elaine leads the Healthy Communities team, where she's challenging all levels of government to protect every Canadian's right to a healthy environment — especially the most vulnerable.

Chris Chavez is the Deputy Policy Director, Coalition for Clean Air (CCA), located in California. Chris joined Coalition for Clean Air as Deputy Policy Director in 2017. Since joining CCA, he has successfully advocated for significant environmental laws at the California State Capitol and landmark clean air protections in Southern California. Chris has also worked to prioritize disadvantaged communities for billions of dollars in public and private clean transportation investments. Chris also was CCA's lead staff on successful state and local ballot measures, including the No on Prop 71 (June 2018) and Yes on Measure US (November 2020) campaigns.

Appendix 5b:
Webinar Survey Responses Summary

Webinar Survey Responses Summary

Clean Air Strategic Alliance

March 2022

Contents

Background

New national air quality standards (CAAQS) require that Alberta reduce emissions from current levels to ensure achievement. This is a complex issue due to the cumulative effects from numerous emissions sources which affect stakeholders and Albertans across the province. Current ambient air quality assessments for 2021 show that most Alberta air zones are in the “orange” CAAQS management level for both hourly and annual NO_2. In addition, forecasts for the 2025 NO_2 CAAQS assessment indicate that most Alberta air zones will be in the “red” management level. Under the national Air Quality Management Framework, provinces are required to take action to reduce emissions in air zones that are in the red management level.

To help advance identification of approaches and solutions to address the NO_x issue in Alberta, CASA hosted a series of webinars from September to December 2021. The webinar content was geared towards stakeholders with an expertise in areas related to air quality management. These virtual information sessions were intended to provide general information on air quality management topics and more focused information relevant to NO_x emissions to facilitate discussions on approaches and measures that warrant exploration. A more detailed exploration of options will occur at a set of workshops in 2022.

This report summarizes responses to a survey that was distributed electronically to participants of the CAAQS Achievement webinar series. There were 201 unique participants across the eight webinars and 41 responses to the surveys.

Notes on interpreting survey results

The findings presented in this report reflect the diverse perspectives of the individuals and organizations who participated in the webinar survey. The findings are not intended to be statements of consensus or representative of a specific organization or all organizations. Instead, this report presents a general perspective on what is considered by participants to be possible and desirable to reduce emissions to achieve CAAQS in Alberta.

The survey was only made available to those who attended the webinars. Invitations to the webinar were extended to the CASA board and those who specifically reached out with interest in attending the webinar; other participants were included based on referral by the network of CASA members. Therefore, the results may be skewed towards the views of CASA’s membership and their network, which may not be representative of all stakeholders.

Participation in the survey was voluntary, which may mean that those who felt strongly about the issue responded to the survey and may not reflect the full set of attendees or stakeholders generally.

The responses were anonymous; therefore, the answers likely reflect a mix of individuals’ personal views and those on behalf of a larger organization, sector, or other group.

While 40 surveys were submitted, not every respondent answered every question. The number of responses for each question is noted in parentheses in the header of each question.

Survey responses

There were eight survey questions. For the purposes of this summary, related questions were organized into three groups. The first group is the "profile of participants" - three questions were aimed at gathering information on the participants and their interest in the project. The "webinar takeaways and gaps" covers questions 4 and 5, which were related to the webinar topics—what participants learned and what gaps they saw in the webinar content. The final three questions were designed to gather stakeholder thoughts and perspectives on approaches and solutions to achieve CAAQS and are found under the header, "stakeholder perspectives on options and approaches to achieve CAAQS in Alberta."

1. Profile of Participants

The following subsections summarize information about the survey respondents.

Sectors represented (41 responses)

Of the 41 responses, 32 were from industry, government, or non-government organizations (Figure 30), mirroring the broad sector membership of CASA. It is possible that those more familiar with CASA were more likely to respond. The remaining responses were from other governments or regulators (4) and consultants (5). Several educational/academic representatives were in attendance and presented at the webinars, though none responded to the survey.

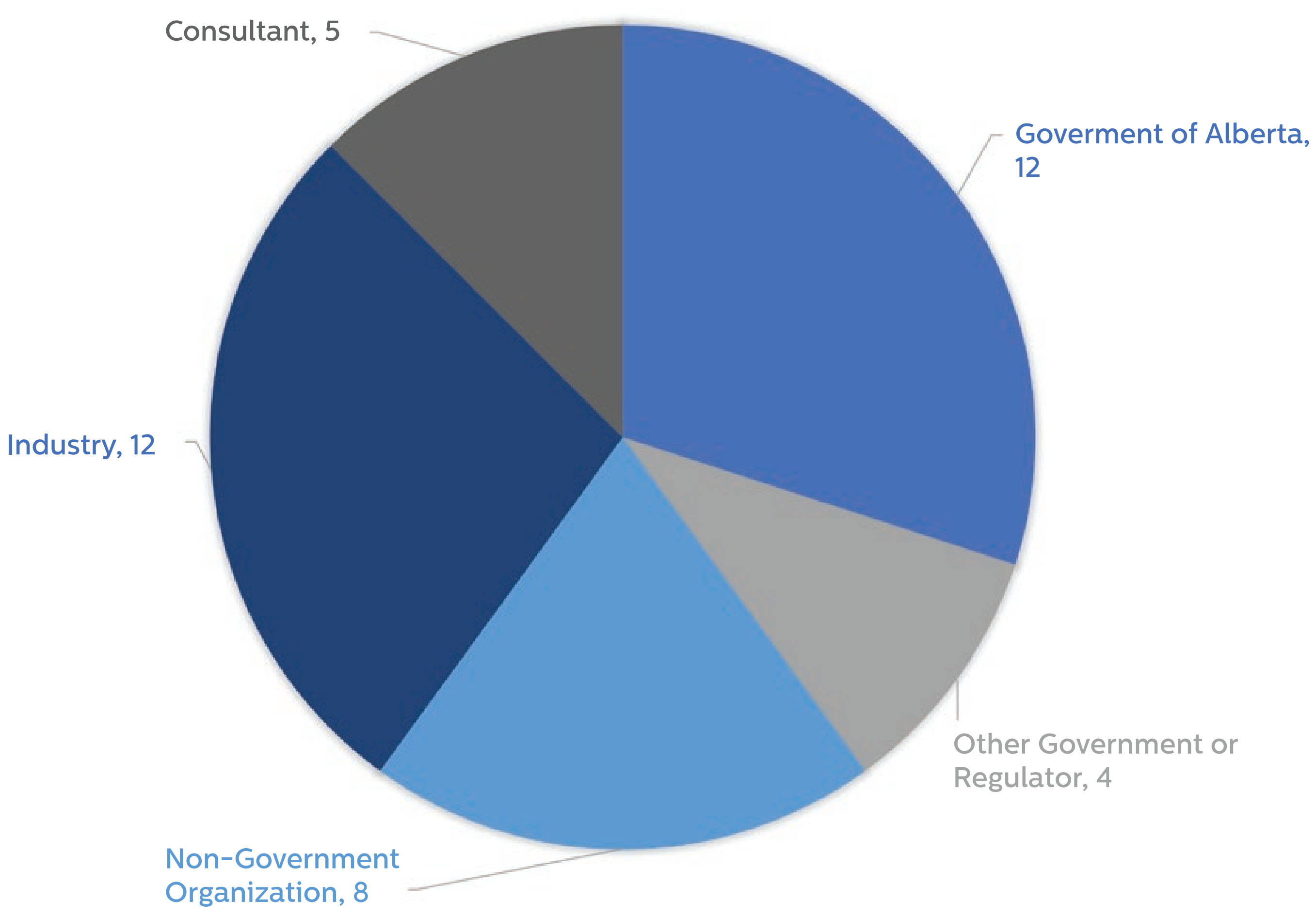

Figure 30: The sectors of survey respondents

Main reasons for attending (40 responses)

By far the most common reason for attending was professional growth and development (26 participants; 63%), followed by personal interest (13 participants; 32%).

All other responses were custom entries. Common custom entries included a desire to gain background to contribute to the results of this project; to hear other perspectives and ideas for taking action; and, potential implications to operations and awareness of risks and benefits of different approaches.

These results suggest that most respondents were attending to learn more about the topic area, which is consistent with the intent of the webinars.

How respondents heard about the webinar series (39 responses)

About 45% of the respondents heard of the series directly from CASA (through a meeting or event), the rest received referrals. A couple respondents listed who they were referred by.

These results were not surprising given that the event was not open to the public and the only way to receive an invitation was through CASA communications or being referred to by a CASA member.

2. Webinar takeaways and gaps

The following subsections are focused on the webinar content—what participants learned and what gaps they saw.

Key insights gained from attending the webinar(s) (38 responses)

The participants identified a range of takeaways from the webinars, most of which fall into two categories: learning about other sector perspectives and learning more about specific topic areas (see Table 21 below).

Table 21: Participant takeaways from webinars

Learning about other sectors' perspectives	Topic areas
• Industry perspectives and concerns • Provincial and federal government perspectives and processes, where they are headed/what their thinking is • Non-profits: barriers, what is working • Indigenous or other marginalized groups: impacts on their communities, environmental racism	• Cost-benefit analysis: how human life is valued, how to measure and analyze benefits and costs • Alberta's air monitoring network • The contribution of point vs. non-point sources to NO_x emissions • Similarities/differences between Alberta and other jurisdictions in managing air quality • Links between air emissions and human health • How to balance economic, social, and environmental goals

Topics or concepts not covered in the CAAQS Achievement webinar series that respondents would have found interesting (29 responses)

Generally, the responses were either related to diving deeper into topics that were covered at a high level during the webinars and topics that were truly not covered in the webinars (Table 22).

Table 22. Topics or concepts not covered in the webinar series that participants would have found interesting

Areas where a deeper dive on existing topics was desired	New topic areas of interest
• Detailed discussion of regulatory processes between provincial and federal government • Experiences and solutions of air quality improvement from other jurisdictions • Cost/benefit analyses: how costs/benefits are derived, calculating the value of human life • Causes of CAAQS exceedances in airsheds across the province (what are the sources, where are they located) • Treatment of transboundary emissions • Analysis of the economic impact of CAAQS on industry • Risk/receptor relationships (e.g., CAAQS measured on airshed basis and limits are the same, but population is concentrated in urban centres)	• Impacts of climate change policy on potential CAAQS policies – impact of carbon pricing, relationship between CO_2, NO_x, SO_x, VOCs, GHGs • How to build trust when working with other sectors • Municipal perspectives • Historical approaches in Alberta to address air quality issues and successes/challenges • Provincial government's current perspective on policy and tools in the absence of this project • Litigation case studies from industrial or other polluters • Transportation emissions: what are others doing to manage unregulated urban emissions, status of CCME work on mobile sources

3. Stakeholder perspectives on options and approaches to achieve CAAQS in Alberta

This section outlines the responses to questions that were intended to generate responses that incorporate perspectives, experiences, and desires in achieving CAAQS in Alberta.

Considerations from sector/organizations' perspectives in assessing air management policy options to reduce NO_x emissions (36 responses)

There were a wide range of considerations that participants identified, organized into themes below.

1. Desire for government to do due diligence in development of policy
   (a) Ensure options achieve desired outcomes
   (b) Solutions are practical to implement
   (c) Align with other government levels and agencies
   (d) Options should be developed with stakeholder input
   (e) Consider timelines and temper expectations (i.e., 2025 is not far away)
   (f) Fairness among sectors—not general or blanket regulations or policy applied across several sectors
2. Data
   (a) Solutions should be based on data not politics
   (b) Gather new or additional data and model before implementing policy
      (i) Monitor/model in cities to determine where NO_x emissions are prevalent (e.g., buildings, speciation to determine where emissions are coming from)
      (ii) Consider fence-line vs. community monitoring
      (iii) Understand emissions from intensive agricultural areas (from trucks and farm equipment)
      (iv) Consider options for management of sources not regulated by AEP/AER (e.g., stationary combustion engines, heaters, and boilers)
   (c) Recognize that modelling and data are limited and understand limitations
3. Consider impacts beyond economics
   (a) Human health
   (b) Impacts to marginalized communities

4. Make effective use of technology/innovation where possible, recognizing that there are limitations in technology and potential trade-offs (i.e., increases in other emissions to reduce NO_x)

Options that sectors see to reduce NO_x emissions in a fair and equitable way (30 responses)

Most of the responses were not about specific options but how to identify the options. The most common answer was the need to understand the contribution of NO_x sources by sector, facility, and airshed to prioritize areas for management action or policy. Another suggested that stakeholders in the workshops will need to define what fair and equitable means and agree on that first before further discussion.

Some of the responses were specific options:

- Further limits on diesel trucks and old reciprocating compressors
- More stringency on vehicle emissions controls and enforcement of retaining controls
- Fuel conversion, where possible
- Transition to lower emission vehicles
- Regulation of compressor stations
- Update to newer air pollution control technology

Some responses were about characteristics of potential options:

- There should be flexibility to implement approaches for whoever/wherever stricter emission limits will apply
- Funding should be applied to implement emissions reductions similar to GHGs
- Policy/regulation developed should be aligned with what is existing or planned
- Targets should be comparable across sectors or industries

Barriers to reducing NO_x emissions (28 responses)

The most common barriers to reduce NO_x emissions were:

- Lack of a detailed emissions inventory of NO_x emissions (point and non-point source)
- Technology is inherently limited and will only reduce emissions so far
- Proliferation of outdated technology (e.g., personal vehicles and various industrial technologies)
- Fragmentation of policy (for both measurement and reporting provincially and federally)
- Lack of desire/political unwillingness of government to make difficult decisions where impacts to some sectors could be significant
- Transportation sector: lack of regulation, emission limits for the sector not consistent with standards in other jurisdictions such as the USA
- Lack of desire of industry to go beyond government requirements
- Alberta government does not regulate many of the source contributors, which limits what total emissions reductions can be achieved
- Cost of implementing potential solutions is high
  - Industry capital cost to upgrade equipment, cost of longer turnaround time to retrofit
  - Would need to provide incentives for consumers to upgrade to low or zero emission vehicles

Additional comments/ suggestions (12 responses)

There was an opportunity to provide additional feedback or thoughts. Responses were:

- Webinar format worked well, learned lots, thanks for arranging
- Public education and information are crucial; most Albertans are not aware of the problem
- Whether AEP is investing in true NO_2 instruments (i.e., instruments using chemiluminescent absorbance with photolytic conversion of NO_2 to nitric oxide (NO) or cavity attenuated phase shift (CAPS)) to minimize potential positive bias in NO_2 measurement. Additional side-by-side studies of existing and new instrumentation should be performed at CAAQS NO_2 hotspot stations to confirm or refute findings.

Appendix 6:
Communications Plan

CAAQS Achievement Project Team

Communications Plan

Clean Air Strategic Alliance

March 2022

BACKGROUND

Communications Plans are developed as part of Clean Air Strategic Alliance (CASA) projects to guide communications during or upon completion of the work. This communications plan supports the Canadian Ambient Air Quality Standards (CAAQS) Achievement Project (2020–2022) that had the goal of identifying potential options to reduce NO_x emissions and ambient NO_2 concentrations in Alberta, as well as gathering stakeholder perspectives on those potential options.

GOAL

The goal of the communications plan as part of the overall project is to: a) describe how to communicate the work of the project team, and b) describe the NO_2 CAAQS issue in Alberta.

AUDIENCES & PROPOSED APPROACH

The target audiences for the communications plan are: a) the CASA board, including Government, Industry, and Non-Governmental Organizations (NGO) partners, b) the CAAQS Achievement Project Team, c) the participants of the webinar series, d) media outlets (e.g., newspapers), and e) the public. The proposed approaches for reaching the target audiences are shown in the table below.

Target Audience	Proposed Approach

CASA Board, CAAQS Achievement Project Team, webinar participants, media outlets, the public	Make effective use of the CASA website and social media:
	• Post the project documentation on the CASA website.
	• Provide links or references to existing online resources related to the CAAQS, such as:
	  ○ Canadian Council of Ministers of the Environment (CCME) webpages: overview of the CAAQS and Air Quality Management System
	  ○ Alberta Environment and Parks webpages: CAAQS overview, assessment results, and management plans
	• Share the project outcomes on CASA's social media platforms.
	• Provide the webinar recordings upon request.

CASA Board, CAAQS Achievement Project Team	Make effective use of existing partnerships: • Use partner networks and social media to share the CAAQS Achievement project documents where appropriate. • Determine which partners/networks to reach out to and request they share the website link to the project.
CASA Board, CAAQS Achievement Project Team	Develop presentations and briefing notes: • Presentations and briefing notes will be developed by CASA staff for use in board updates, CASA newsletters, and stakeholder communications.

BUDGET

The communications plan and any related project documentation will be made available electronically. Hard copies of project documentation will be provided upon request to CASA. The number of requests is expected to be low, with minimal budget implications (likely under $500 for printing hard copies).

No other expenses are expected to be incurred by CASA in delivering the communications plan.

Clean Air Strategic Alliance

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