Calgary Region Airshed Zone
Air Quality Management Plan

August 2019

Executive Summary

The Calgary Region Airshed Zone (CRAZ) Air Quality Management Plan (AQMP) is a comprehensive, multi-stakeholder plan outlining the Objectives for air quality management in the CRAZ Region as well as the Strategies and Actions required to achieve the Objectives.

The CRAZ AQMP was first developed in 2008 (then referred to as the *CRAZ PM and Ozone Management Plan)* by a multi-stakeholder committee led by CRAZ. The plan was subsequently updated in 2014 to ensure its continued relevance for air quality management in the CRAZ Region. This 2019 update represents the third version of the CRAZ AQMP.

CRAZ committees are responsible for the implementation of the CRAZ AQMP. Achievement reports are published regularly to report on progress made under the AQMP. The most recent achievement report is available on the CRAZ website.

Table of Contents

Introduction

The Calgary Region Airshed Zone (CRAZ) Air Quality Management Plan (AQMP) is an action plan for managing air quality in the CRAZ region. The Plan was originally developed in 2008 in collaboration with area stakeholders including Alberta Environment, industry, municipalities, non-governmental organizations, First Nations and Alberta residents.

Since 2008, the Plan has been reviewed and updated on a regular basis to assess progress made under the Plan and to ensure the continued relevance of the Objectives, Actions, Steps and Performance Indicators set out in the Plan. The first progress review of the Plan was completed in 2011 (CRAZ, 2011). A subsequent progress review and an update of the Plan took place in 2014 (SNC Lavalin, 2014). The Plan was reviewed for a third time in 2018. The outcomes of the 2018 review are summarized in the CRAZ Air Quality Management Plan Achievement Report (CRAZ, 2018). This 2019 update to the Plan incorporates the recommendations from the 2018 review as well as other comments brought forward during the 2019 engagement on the updated Plan.

This 2019 update to the Plan also includes a name change. Originally named the CRAZ Particulate Matter and Ozone Management Plan, the Plan will now be called the CRAZ Air Quality Management Plan. This new name was adopted to broaden the scope of the Plan to include air contaminants of concern other than $PM_{2.5}$ and O_3. The Objectives, Actions, Steps and Performance Indicators in the Plan have also been updated to reflect this change in scope.

Vision

The vision for the 2019 AQMP remains the same as the 2008 Plan with minor changes made to reflect the change in scope to include air contaminants of concern other than $PM_{2.5}$ and O_3. The vision of the AQMP is as follows:

> *"The [Air Quality] Management Plan for the [CRAZ region] will provide the necessary tools, resources and regional technical framework for inter-municipal cooperation for measuring, assessing and sharing emission information on [air contaminants of concern] and will promote efforts to decrease measured ambient levels of [air contaminants of concern] using continuous improvement principles."*

Continuous Improvement

The CRAZ AQMP operates on a principle of continuous improvement. The regular progress reviews and updates to the Plan support the continuous improvement cycle. The steps in the continuous improvement approach utilized by CRAZ are outlined in Figure 1.

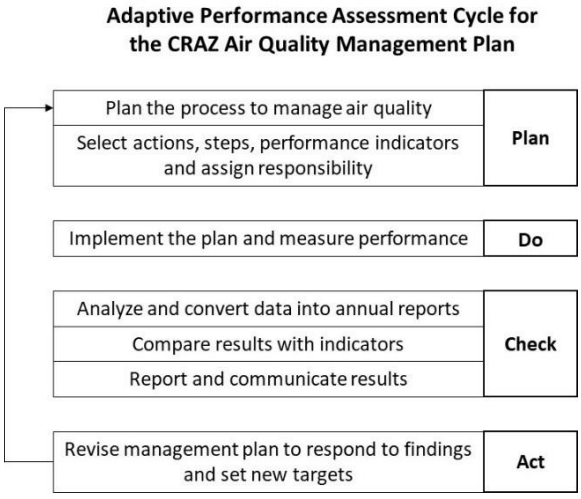

Figure 1: CRAZ Continuous Improvement Approach (CRAZ PM&O3 Management Plan 2008)

Background

The CRAZ Region

The CRAZ region boundary approximately follows the Alberta Health Services Calgary Zone boundary with the exception of the northern border which is defined by the southern border of the Parkland Air Management Zone (PAMZ).

This area includes the cities of Calgary and Airdrie, the towns of Okotoks, Cochrane, Chestermere, Strathmore, High River, Granum, Turner Valley, Black Diamond, Claresholm, Vulcan, Nanton and Canmore and many villages, the Municipal Districts of Bighorn and Foothills, the Counties of Willow Creek, Rocky View, Vulcan and Wheatland, the Improvement Districts of Kananaskis and Banff, and the Siksika, Eden Valley, Tsuu T'ina and Stoney First Nations.

There are four continuous monitoring stations currently operating in the CRAZ region. The Calgary Central-Inglewood Station is located on 9th Ave SE in Calgary adjacent to the Inglewood Bird Sanctuary and has been operational since 2015. The Calgary Varsity station is located at 32 Ave NW and 37th St NW in Calgary on the grounds of the Geological Survey of Canada building and has been operational since 2018. The Calgary Southeast monitoring station is located at 110th Ave SE and 46th St SE in Calgary adjacent to the Calgary Humane Society and has been operational since 2014. The Airdrie monitoring station, operated by Alberta Environment and Parks, is located at the Chinook Winds Ball Park in Airdrie and has been operational since 2017.

A historical network of passive monitors, currently discontinued, were also deployed in CRAZ. A map of the CRAZ boundary including the continuous monitoring stations and historical passive stations in the region is shown in Figure 2.

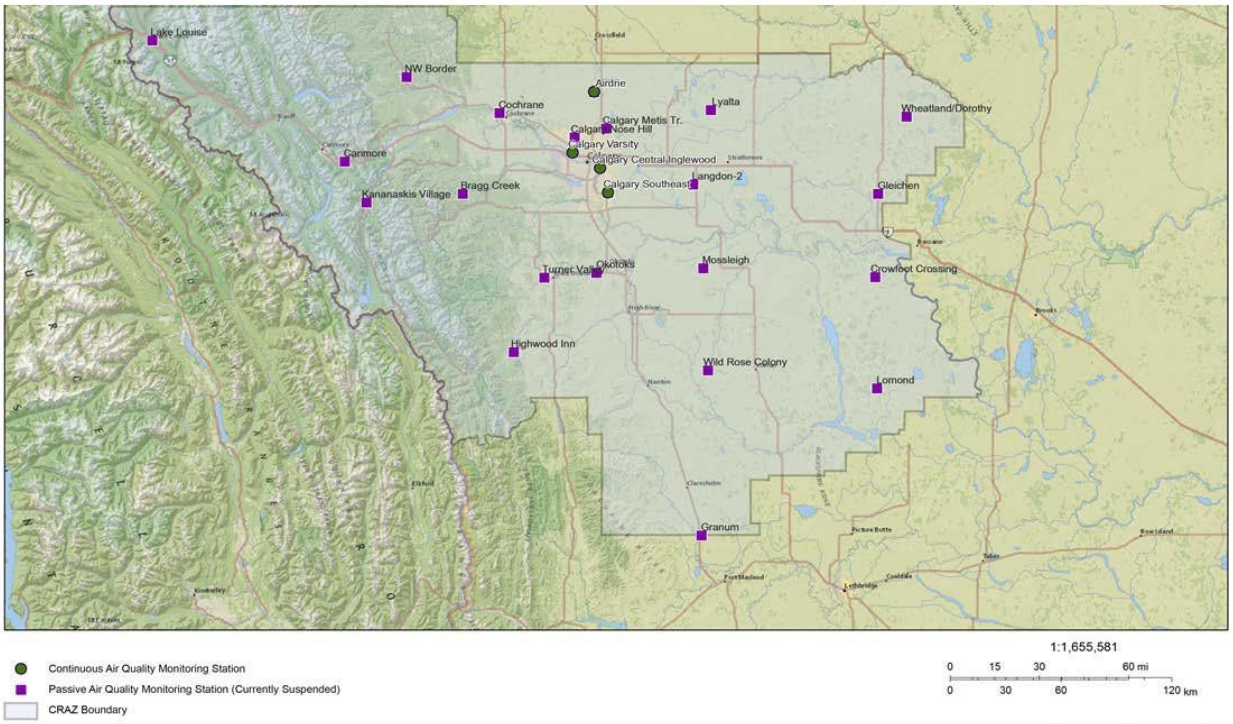

Figure 2: The CRAZ boundary including the continuous and historical passive monitoring stations in the region.

History of the CRAZ AQMP

CRAZ was established on January 16, 2007 to serve as a coordinating body to manage air quality issues in the Calgary Census Metropolitan Area (CMA) in response to an ozone exceedence for the Calgary CMA under the Clean Air Strategic Alliance (CASA) Particulate Matter and Ozone (PMO_3) Management Framework.

The CASA PMO_3 Management Framework, established in 2003, was a guidance document for ensuring achievement in Alberta of the Canada Wide Standards (CWS) which were numeric air quality standards for particulate matter and ozone developed by the Canadian Council of Ministers of the Environment (CCME). The CASA PMO_3 Management Framework established "action triggers", based on the CWS, against which ambient monitoring data was to be compared on an annual basis. Each year, an "action level" was assigned to each station based on the status of ambient air quality in comparison to the action triggers. Differing levels of management actions were required for each level assigned. The action levels, as defined under the CASA PMO_3 Framework were: baseline monitoring and data gathering, surveillance actions, management plans and mandatory plans to reduce below the CWS.

During the 2001-2003 reporting period, the Calgary CMA was placed in the "management plan" action level for ozone, triggering the need for the development of an air quality management plan for the region. CRAZ was formed to lead the collaborative development of the CRAZ Particulate Matter and Ozone Management Plan which was released in 2008. The inclusion of $PM_{2.5}$ in the Plan was proactive given that the "management plan" action level had not been triggered for $PM_{2.5}$ at the time.

Implementation of the Plan is an ongoing and collaborative effort between CRAZ, its various committees and its members.

In the interest of continuous improvement, the Plan is regularly reviewed and updated. The first review of the Plan took place in 2011 and the findings were documented in an achievement report (CRAZ, 2011). During the 2008-2010 and 2009-2011 reporting periods, the Calgary CMA triggered the "management plan" action level for $PM_{2.5}$. Therefore, the 2014 review of the Plan included consideration of whether $PM_{2.5}$ was adequately addressed in the Plan. An updated version of the CRAZ Particulate Matter and Ozone Management Plan was released in 2014 (SNC Lavalin, 2014).

Evolving Air Quality Management Systems

In 2012, the CCME replaced the Canada Wide Standards with new Canadian Ambient Air Quality Standards (CAAQS) and introduced the national Air Quality Management System (AQMS). The AQMS has strong similarities with the CASA PMO_3 Management Framework in that it identifies numerical triggers and limits and assigns a management "level" based on the status of ambient air quality in relation to the triggers and limits. To date, CAAQS have been established for fine particulate matter, ozone, sulphur dioxide, and nitrogen dioxide.

Alberta has chosen to implement the national AQMS through its regional plans as defined under the Alberta Land Use Framework (LUF), thus replacing the former CASA PM and O_3 Management Framework. The CRAZ region falls within the South Saskatchewan Region (SSR) under this system.

In 2014 the South Saskatchewan Regional Plan (SSRP) and the accompanying Air Quality Management Framework (SSR AQMF) were established for the SSR. The SSR AQMF provides guidance for managing $PM_{2.5}$, O_3 and NO_2 in the region. The CAAQS for particulate matter and ozone were adopted directly into the SSR AQMF as "triggers" and "limits". The NO_2 "triggers" and "limits" were derived from Alberta Ambient Air Quality Objectives (AAAQOs) but will be replaced by the CAAQS values in the first update to the Framework after the NO_2 CAAQS come into effect in 2020.

Reporting under the SSR AQMF and the CAAQS have indicated that the monitoring data in the Calgary region is still triggering the need for both $PM_{2.5}$ and NO_2 management planning. As a part of the 2018 review and this 2019 update to the AQMP, the Objectives, Actions, Steps and Performance Indicators in the Plan were considered and updated if necessary to ensure that the updated Plan considers air contaminants of concern in addition to $PM_{2.5}$ and O_3, such as NO_2.

A timeline summarizing the history of air quality management in the CRAZ region is summarized in Figure 4. Figure 5 is a schematic illustrating how air quality management has evolved in Alberta since 2000.

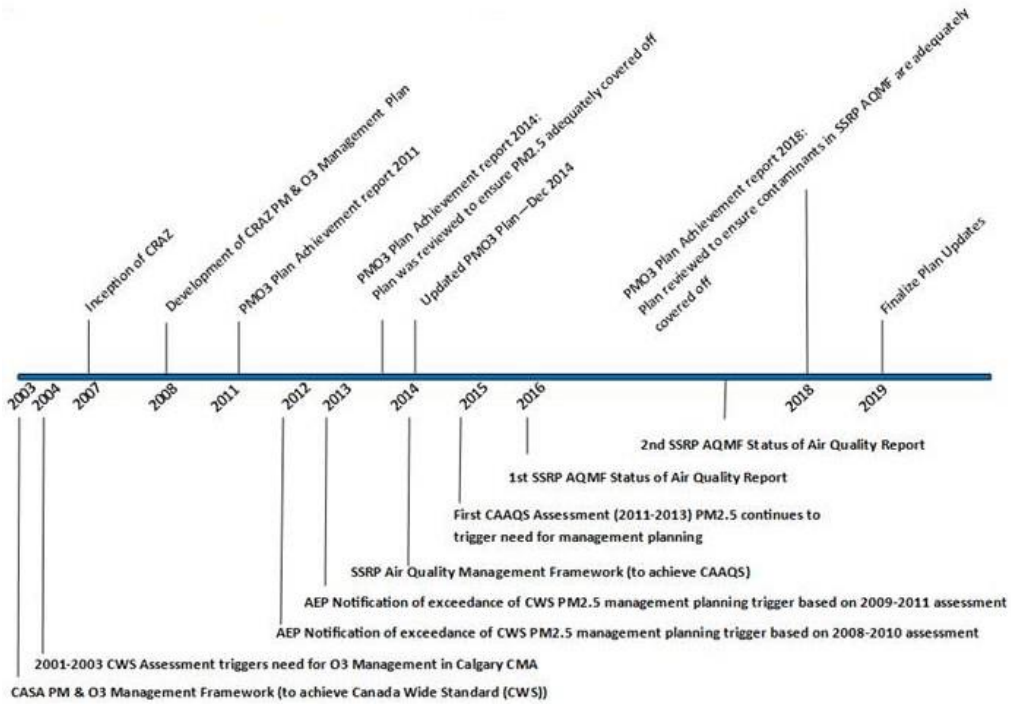

Figure 4: A timeline summarizing the history of the CRAZ AQMP.

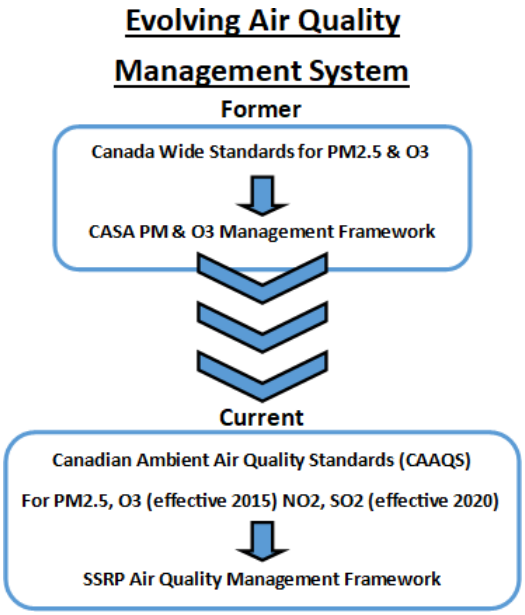

Figure 5: Schematic illustrating how air quality management has evolved in Alberta.

Air Contaminants of Concern in the CRAZ Region

The CRAZ AQMP addresses air contaminants of concern in the CRAZ region including fine particulate matter ($PM_{2.5}$), ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) volatile organic compounds (VOCs), carbon monoxide (CO) and hydrogen sulphide (H_2S).

Particulate Matter

Particulate matter (PM) is a mixture of both solid particles and liquid droplets suspended in the atmosphere including aerosols, smoke, fumes, dust, ash and pollen (MECP, 2010a). Particle diameter is often used to characterize particulate matter since different particle sizes have different effects on human health (AEP, 2018). Inhalable particulate matter (PM_{10}) has a particle size diameter of less than or equal to 10 µm while fine particulate matter ($PM_{2.5}$) has a particle size diameter of less than or equal to 2.5 µm (CRAZ, 2008). $PM_{2.5}$ penetrates deeper into the lungs than PM_{10}, irritating the respiratory system, reducing the surface area for oxygen exchange and transferring toxic compounds into the blood stream. Exposure to PM2.5 is associated with asthma, emphysema, bronchitis and cardiovascular effects and is linked to increased population morbidity (emergency room visits and hospitalization) and mortality (AEP 2018). Health Canada (2012), the World Health Organization (WHO 2006) and the United States Environmental Protection Agency (US EPA 2009) have indicated that there is no safe level of $PM_{2.5}$, that is, population based epidemiology studies have not identified a threshold below which there are no adverse health effects.

$PM_{2.5}$ can either be emitted directly from emission sources (primary $PM_{2.5}$) or can form in the atmosphere through transformations of other air contaminants of concern including NO_2, SO_2, VOCs and NH_3 (secondary $PM_{2.5}$) (AEP, 2018). Emission sources of $PM_{2.5}$ include, for example, dust from paved and unpaved roads, vehicular exhaust emissions, power plants and wood burning (CRAZ, 2008).

Ozone

Ozone (O_3) is a colourless, odourless gas that, when present at ground level, is a major constituent of smog (MECP, 2010b). Exposure to O_3 can constrict the airways, resulting in difficulty breathing, coughing, and aggravation of respiratory conditions such as asthma, emphysema and chronic bronchitis (USEPA, 2018). Health Canada (2012) has indicated that there is no safe level of O_3, that is, population based epidemiology studies have not identified a threshold below which there are no adverse health effects.

O_3 is not emitted directly into the atmosphere but is formed as a result of chemical reactions between NO_2 and VOCs in the presence of heat and sunlight (AEP, 2018).

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish-orange-brown gas with a pungent odour that contributes to a brown haze and smog formation (CRAZ, 2008). NO_2 can be irritating to the respiratory system, increase asthma-related respiratory symptoms and can lower resistance to respiratory infections (MECP, 2010c). Health Canada (2016) has indicated that there is no safe level of NO_2, that is, population based epidemiology studies have not identified a threshold below which there are no adverse health effects. Even if a safe threshold exists for the health effects of NO_2, it is likely to be near the lower limit of ambient NO_2 concentrations (HC, 2016).

NO_2 is emitted from a variety of combustion sources including vehicular traffic, air transportation, rail transportation, electric power generation, and industrial sources (CRAZ, 2008). It can also form from the conversion of other oxides of nitrogen (NO_x) to NO_2 (AEP, 2018).

Sulfur Dioxide

Sulfur dioxide (SO_2) is a colourless gas with a pungent odour (CRAZ, 2008). SO_2 can cause breathing problems and contribute to respiratory and cardiovascular diseases (MECP, 2010d). SO_2 contributes to acid rain (MECP, 2010d) and is a precursor to $PM_{2.5}$ (CRAZ, 2008).

SO_2 is emitted primarily from industrial sources (CRAZ, 2008).

Volatile Organic Compounds

Volatile Organic Compounds (VOCs) include several types of hydrocarbons such as alkanes, alkenes, alkynes, aromatics, aldehydes, ketones, alcohols, esters and some chlorinated compounds (CRAZ, 2008). Some VOCs are linked with elevated cancer risks (CRAZ, 2008). VOCs also contribute to the formation of O_3 and $PM_{2.5}$ (CRAZ, 2008).

VOCs are emitted by a variety of sources including agricultural operations, vehicular traffic, industrial activities and the industrial, commercial and home use of solvents.

Carbon Monoxide

Carbon monoxide is a colourless, odourless gas (CRAZ, 2008). When CO enters the blood stream, it reduces the delivery of oxygen to the organs and tissues (MECP, 2010e) resulting in headaches, drowsiness, dizziness, confusion and eventually death (CRAZ, 2008).

CO is formed by incomplete fuel combustion such as during idling of vehicles (CRAZ, 2008).

Hydrogen Sulphide

Hydrogen sulphide (H_2S) is a colourless gas with an odour of rotten eggs (ECCC, 2017). H_2S has a strong and foul smell and can cause tearing of the eyes, headaches, nausea and vomiting (CARB, 2019). At higher concentrations, H_2S can create serious adverse health effects but these exposures typically only take place in industrial settings (CARB, 2019).

Hydrogen sulphide originates mostly from natural sources but may also come from agricultural activities or industrial processes (ECCC, 2017).

A summary of the characteristics of each of the air contaminants of concern is included in Table 1.

Table 1: Summary of the characteristics of the air contaminants of concern considered in this Plan.

	$PM_{2.5}$	O_3	NO_2	SO_2	VOCs	CO	H_2S
Description	A mixture of both solid particles and liquid droplets suspended in the atmosphere	A colourless, odourless gas that contributes to smog	A reddish-orange-brown gas with a pungent odour that contributes to smog	Colourless gas with a pungent odour	Several types of hydrocarbons	A colourless, odourless gas	Colourless gas with an odour of rotten eggs
Health Effects of Chronic Exposure to Environmental Level	Irritates the respiratory system, exposure associated with asthma, emphysema, bronchitis and cardiovascular effects	Difficulty breathing, coughing, and aggravation of respiratory conditions such as asthma, emphysema and chronic bronchitis	Irritates the respiratory system, increases asthma-related respiratory symptoms and can lower resistance to respiratory infections	Can cause breathing problems and contribute to respiratory and cardiovascular diseases	Linked with elevated cancer risks	Reduces the delivery of oxygen to organs and tissues	Has an extremely strong smell and can cause tearing of the eyes, headaches, nausea and vomiting when exposed
Examples of Emission Sources	Construction dust, dust from paved and unpaved roads, agricultural dust, vehicular exhaust emissions, power plants and wood burning	Not directly emitted	Combustion sources including vehicular traffic, air transportation, rail transportation, electric power generation, and industrial sources or the conversion of other oxides of nitrogen (NO_x) to NO_2	Primarily industrial sources	Agricultural operations, vehicular traffic, industrial activities and the industrial, commercial and home use of solvents	Formed by incomplete fuel combustion such as idling of vehicles	Primarily natural sources but also agricultural activities and industrial processes
Atmospheric Processes	Also formed from transformations of NO_2, SO_2, VOCs and NH_3.	Formed as a result of chemical reactions between sunlight, NO2, and VOCs	Contributes to the formation of O_3 and $PM_{2.5}$	Contributes to the formation of $PM_{2.5}$	Contributes to the formation of O_3 and $PM_{2.5}$	n.a.	n.a.

Ambient Air Quality Trends at Stations in the CRAZ Region

Ambient air quality trends for $PM_{2.5}$, O_3, NO_2, SO_2, CO and H_2S at CRAZ monitoring stations are shown in Figure 6. VOCs are not shown because they are not continuously monitored at stations in the CRAZ region.

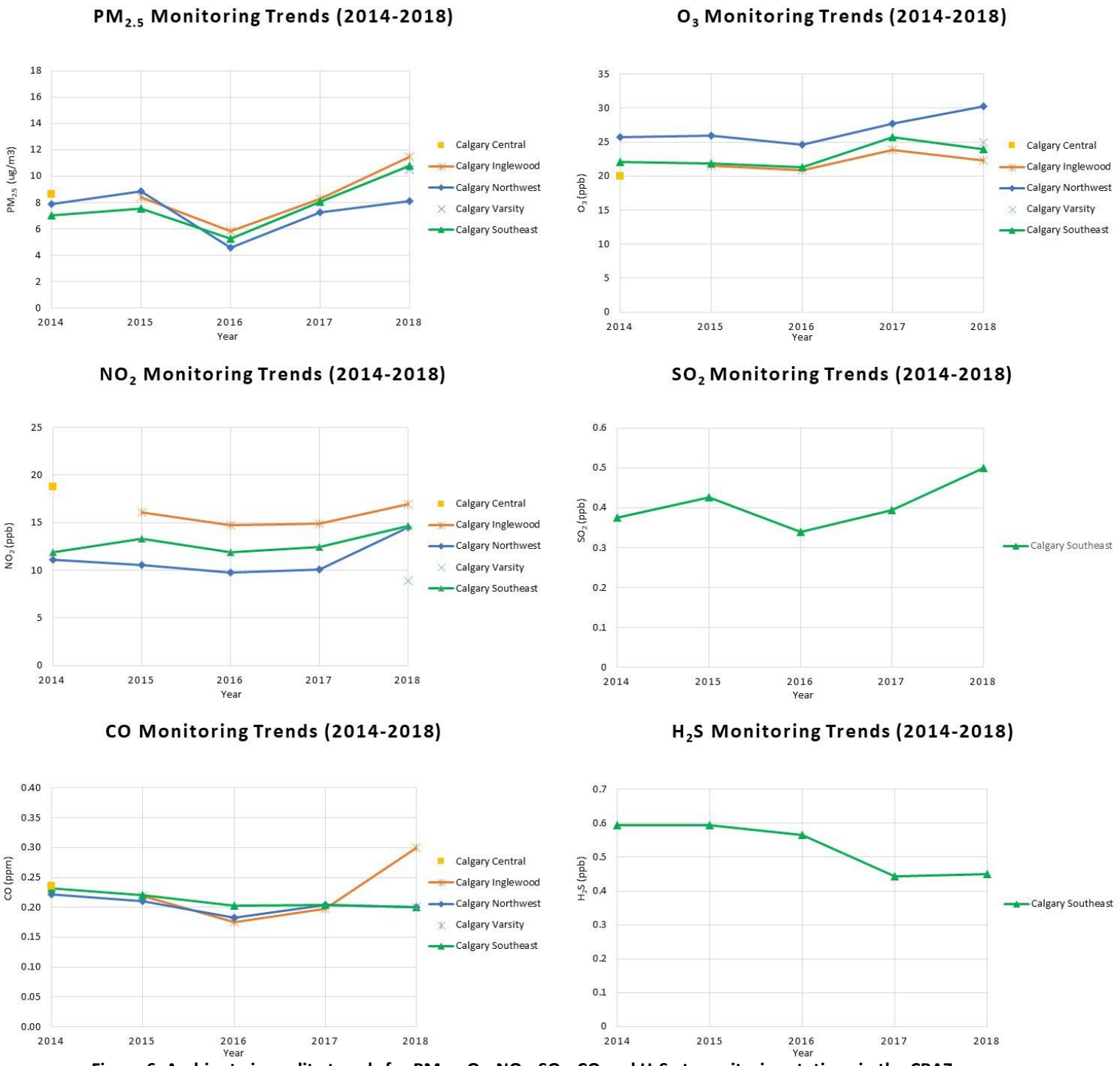

Figure 6: Ambient air quality trends for $PM_{2.5}$, O_3, NO_2, SO_2, CO and H_2S at monitoring stations in the CRAZ region.

Emission Sources in the CRAZ Region

In 2013, a spatially allocated emissions inventory for emissions of $PM_{2.5}$, NO_x, SO_2, VOCs and CO in the CRAZ Region was compiled using 2008 data (Novus Environmental, 2013). The CRAZ Emissions Inventory (CRAZ EI) can be used to identify key source sectors contributing to emissions of air contaminants of concern in the CRAZ Region.

The CRAZ emissions inventory aggregates emissions into several source sectors including:

- **Upstream Oil and Gas (UOG)** – includes all types of petroleum exploration and production.
- **Agriculture (AGR)** – includes agricultural anthropogenic activities, crop related fertilizing, field burning, stock burning, orchard heaters, food processing, livestock waste, etc.
- **Construction (CONS)** – includes all construction related fugitive emissions (commercial, residential and industrial constructions)
- **Transportation (TRANS)** – includes on-road and off-road mobile sources, airport and railways, marine, etc.
- **Commercial and Residential Heating (COMM)** – includes all types of commercial and residential heating, wood stove and fire place, gas, oil and coal-fired, etc.
- **General Solvent Use (SOL)** – includes industrial surface coating and solvent use, degreasing, dry cleaning and consumer & commercial solvent use.
- **Biogenic (BIOG)** – includes forest, agriculture vegetation, crops, grassland, dryland, urban and build-up land, range land, wetland, barren land, tundra, perennial snow and ice, and other natural emission sources
- **Other (OTHER)** – includes any emissions not included in the above categories.

A summary of the emission sources in the CRAZ Region is provided in Figure 7.

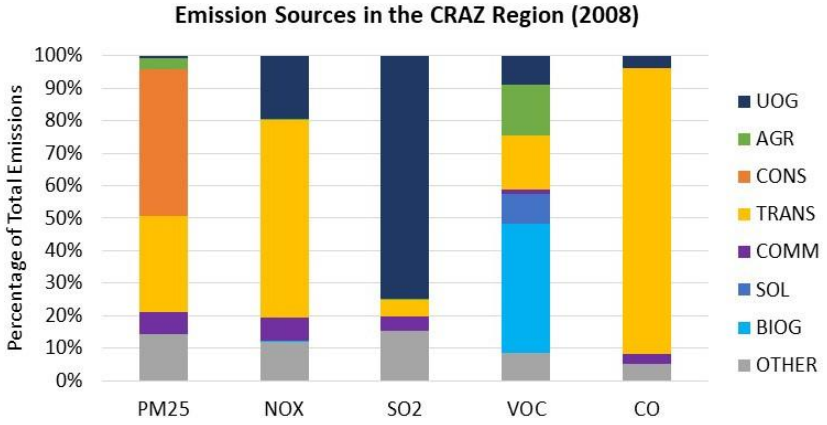

Figure 7: Emission sources in the CRAZ region based on the 2008 CRAZ EI.

The key source sectors contributing to primary $PM_{2.5}$ in the CRAZ region are *Construction* and *Transportation*. NO_x is contributed mostly by *Transportation* and *Upstream Oil and Gas*. SO_2 is contributed primarily by *Upstream Oil and Gas*. VOCs are contributed by a variety of sources including *Biogenic*, *Transportation*, *Agriculture, General Solvent Use* and *Upstream Oil and Gas*. CO is contributed primarily by *Transportation*.

These emission sources were taken into account when developing the CRAZ AQMP.

2019 CRAZ Air Quality Management Plan

The 2019 CRAZ AQMP consists 40 Steps that are contained within 16 Actions and 6 Objectives.

The 6 Objectives of the Plan are as follows:

Objective 1: CRAZ will consistently and transparently be one of the best managed air quality regions in Canada

Objective 2: Encourage strategic economic growth and foster sustainable business opportunities through improved understanding of air quality

Objective 3: Regional land use planning will encourage and promote improvements in air quality

Objective 4: Build and promote awareness of air quality issues

Objective 5: Stakeholders will work collaboratively to improve air quality and to share environmental responsibility

Objective 6: Encourage, pursue and support air quality science and research

The 16 Actions in the Plan each fall under one of the 6 Objectives. Similarly, the 40 Steps in the Plan each fall under one of the 16 Actions. The Steps were designed to be specific, measurable, achievable, reasonable and timely (SMART).

To achieve the SMART criteria, performance indicators were identified for each Step to support performance measurement. Time frames were also identified for each Step, represented as continuous (carried on indefinitely), short-term (within zero to two years), medium-term (within three to five years), or long-term (five years or more).

The 2011 review of the Plan (CRAZ, 2011) recommended that each Step should be assigned a lead and that the lead should be a CRAZ Committee (i.e. CRAZ Board, Administration, AQMP Committee, Technical Committee, Engagement Committee and Policy & Research Committee). In this update to the Plan, a lead CRAZ Committee was assigned to each Step. Assigned responsibilities for external partners were removed from the Plan as CRAZ has no direct control over the activities of these partners. For each step, the lead committee is indicated with bold formatting while the support committees are indicated with regular formatting.

As mentioned previously, the Plan was also updated to ensure that the Objectives, Actions, Steps and Performance Indicators in the Plan consider air contaminants of concern in addition to $PM_{2.5}$ and O_3. Some wording changes have been incorporated into the 2019 update of the Plan to reflect this change in scope.

The updated 2019 AQMP is shown on the following pages. A detailed summary of the changes made from the 2014 Plan is included in the Appendices. Appendix A includes the updates recommended by the CRAZ Air Quality Management Planning (AQMP) Committee during the 2018 review of the Plan.

Objective 1: CRAZ will consistently and transparently be one of the best managed air quality regions in Canada

Action	Step	Performance Indicator	Time Frame	Lead Committee
1. Continue to improve air quality monitoring and reporting for air contaminants of concern.	i) Air quality network will be rationalized and will include urban and rural considerations.	Existing network will be maintained Continuous monitoring data will be collected outside of the CMA.	C	**Technical**
	ii) Characterize PM from analysis of dichotomous and/or filter-based sampling data.	PM data used to help establish combustion versus fugitive source contributions.	ST	**AQMP**
2. Continuous improvement/ adaptive management approach for the Air Quality Management Plan.	iii) The Air Quality Management Plan will be reviewed and adjusted every 3 - 5 years through stakeholder consultation.	Air Quality Management Plan achieves informed updates every 3 to 5 years.	C	**AQMP**
	iv) Consultation regarding the Air Quality Management Plan will continue with stakeholders.	Formal records are kept by CRAZ of the s takeholder engagements.	C	**AQMP**
	v) Incorporate short term actions in the Air Quality Management Plan into CRAZ strategic plans on a 3-4 year cycle.	Strategic plans show good alignment with Air Quality Management Plan and sequential progress over time.	C	**Board/ Administration**
3. Air Quality Management Plan will be reviewed regularly to track implementation and to determine whether actions are successful	vi) Trend analysis of air contaminants of concern measurements to be conducted annually.	Trend analyses are completed and made publicly available.	C	**AQ Program Manager** AQMP
	vii) Complete regular reviews of the Air Quality Management Plan. Encourage dialogue with other airsheds as required.	Reviews are completed and made publicly available.	C	**AQMP**
	viii) Complete an 'Achievement Report' of the Air Quality Management Plan every 3-5 years.	Achievement Report will be written and published every 3-5 years.	C	**AQMP**
4. The Air Quality Management Plan will be consistently, fairly and equitably funded	ix) Endeavor to ensure the organization has adequate funding and that projects for AQMP receive funding. The accountability of the organization's finances will be reported to the Board by the Finance Committee.	Funding formula is created and periodically reviewed.	ST	**Finance/ Administration**
	x) Pursue opportunities for improving local air quality that do not require funding such as local policies and programs.	Local policies and programs are reviewed for opportunities to implement in the CRAZ region.	C	**AQMP** Engagement Policy & Research
	xi) Continue liaising with all levels of government and research potential outside funders.	Revenue is realized and programs are funded adequately.	C	**Administration/ Executive** Engagement

Time Frame: short-term (ST), medium-term (MT), long-term (LT) and continuous (C).

Objective 2: Encourage strategic economic growth and foster sustainable business opportunities through improved understanding of air quality.

Action	Step	Performance Indicator	Time Frame	Lead Committee
1. Incentives and deterrents will encourage area stakeholders to reduce emissions of air contaminants of concern.	i) Develop measures for creating incentives and deterrents.	List of existing and potential incentives and deterrents included in updates of the Air Quality Management Plan.	MT	**AQMP**
	ii) Support programs that promote emissions reduction from vehicles, lawnmowers, snowmobiles, etc. when available.	CRAZ website and/or promotional materials will list, when available, these types of programs.	C	**Engagement** AQMP Technical
2. Evaluate and promote green energy choices and products for consumers and commuters	iii) Evaluate the emissions intensity of energy use in CRAZ.	Emissions intensityvalues are made available to stakeholders. CRAZ emission intensity values are used to explore the impacts of green energy use.	MT	**AQMP** Technical
	iv) Investigate opportunities to partner with business and/or municipalities in the promotion of green energy and/or emission reduction technologies. Website content must be consistent with CRAZ's communication policy.	CRAZ website includes information on available green energychoices.	MT	**Engagement**
	v) Encourage small business opportunities whose activities promote decreasing emissions.	If available, promote on CRAZ website and promotional materials.	ST	**Engagement**

Time Frame: short-term (ST), medium-term (MT), long-term (LT) and continuous (C).

Objective 3: Regional land use planning will encourage and promote improvements in air quality

Action	Step	Performance Indicator	Time Frame	Lead Committee
1. Air quality management will be integrated into regional and municipal planning	i) Promote air qualityinitiatives within environmental management plans and municipal development plans or charters in the region (including SSRP and CMRB)	CRAZ will keep and up-to-date as possible list of municipal initiatives.	ST	**AQMP**
	ii) Develop templates for municipalities that promote/incentivize positive air qualityinitiatives for urban planning.	The relevance of the municipal toolkit is reviewed and development is continued, if required. Research opportunities to create further policy templates and tools with municipalities.	C	**Policy & Research**
2. Support multi- modal transportation systems	iii) Promote and develop programs for municipalities that promote/incentivize positive air qualityinitiatives for transportation.	Promote and develop programs/tools and/or policies to promote/incentivize positive air quality initiatives for transportation.	MT	**Engagement** Policy & Research
	iv) Evaluate the air quality impacts of transit/transportation initiatives.	Seek out and review available studies on the impacts of transit/transportation initiatives on air quality.	MT	**AQMP** Technical
3. Increase natural filters	v) Support and promote urban tree planting policies and programs for municipalities and individual residents.	Report back on results of policies and programs that increase the number of trees in the CRAZ region.	ST	**Engagement**
	vi) Encourage the implementation of green roofs policies	Report back on results of policies and programs that result in an increase in use of green roofs. Inclusion of green roof criteria in municipal building requirements/incentives.	MT	**Policy & Research** Engagement

Time Frame: short-term (ST), medium-term (MT), long-term (LT) and continuous (C).

Objective 4: Build and promote awareness of air quality issues

Action	Step	Performance Indicator	Time Frame	Lead Committee
1. Identify opportunities to advocate behavioural changes to stakeholders	i) Coordinate with the local school boards to support an air quality curriculum module in alignment with school curriculum.	Wider adoption of air quality module in CRAZ schools.	C	**Engagement**
	ii) Cross-promote with other appropriate area events and link to other relevant initiatives on the CRAZ website.	Wider array of events noted on CRAZ website. Increased CRAZ website hits.	C	**Administration**
	iii) Develop strategic, targeted behavioural campaigns to promote reduced vehicle use.	Promote plan on CRAZ website and through other forums. Engage drivers through interactive program development.	ST	**Engagement**
	iv) Partner with champions to develop and implement targeted behavioural campaigns within organizations.	Secure partner through semi-formal agreement.	C	**Administration**
2. Educate and outreach of regional stakeholders about area air emissions and reduction plans	v) Ensure a CRAZ communication and education strategy that includes tactics for addressing air contaminants of concern in the CRAZ Region.	Annual posting of a summary of ambient air quality highlighting changes, particularly reductions.	C	**Air Quality Program Manager** Engagement
	vi) Develop relationships with local media outlets (TV, radio, newspapers, billboards, train advertisements) to promote air qualityrelated issues.	Develop list of media outlets and send regular updates on CRAZ activities and events.	C	**Administration**
	vii) Prepare the public for legislated changes such as anti-idle and tailpipe testing.	Relevant information is included on CRAZ website. One or more CRAZ outreach efforts educating on the topic.	C	**Policy & Research** Engagement

Time Frame: short-term (ST), medium-term (MT), long-term (LT) and continuous (C).

Objective 5: Stakeholders will work collaboratively to improve air quality and to share environmental responsibility

Action	Step	Performance Indicator	Time Frame	Lead Committee
1. Coordinate with other stakeholders to identify opportunities for sharing of resources and knowledge	i) Collaborate with Alberta Transportation to identify effective vehicle policies and programs that could be implemented.	Review of policy options is completed. Strategic workshop occurs involving AEP, CRAZ and others.	MT	**AQMP**
	ii) Evaluate the feasibility of alternative fuels for municipal traffic.	Studyis conducted and posted or linked on CRAZ website.	MT	**AQMP**
2. Adopt voluntary reduction strategies, stewardship programs, corporate responsibility and individual responsibility to reduce air emissions	iii) CRAZ stakeholders will adopt a voluntarily commitment model that includes reduction activities suitable to their industry/municipality.	Strategic reduction programs are produced and supported. CRAZ will find opportunities to work with industries and municipalities.	MT	**AQMP**
	iv) Promote financial incentives for home owners such as rebates and free pick-up and disposal for old refrigerators and furnaces.	Program details are provided on municipal website. Track number of programs promoted.	LT	**Policy & Research** Engagement

Time Frame: short-term (ST), medium-term (MT), long-term (LT) and continuous (C).

Objective 6: Encourage, pursue and support air quality science and research

Action	Step	Performance Indicator	Time Frame	Lead Committee
1. Define local area poor air quality and predict poor air quality events	i) Support and review studies to locate poor air quality "hot spots".	Study is published to the CRAZ website but continuous effort is needed.	C	**AQMP**
	ii) Utilize air quality forecasting to predict poor air quality events (i.e. AQHI, BlueSkyRains).	Air quality forecasts are made available for the CRAZ region Forecasts and/or bulletins are posted on the CRAZ website and on social media.	C	**Administration**
	iii) Advocate for regular updating of the inventory and modelling of pollutants in the airshed to determine which management actions are most effective.	Modelling efforts show evaluation of different scenarios.	C	**AQMP**
2. Determine impact of poor air quality on CRAZresidents	iv) Conduct studies on local target groups (i.e. asthmatics or elderly) and associate air quality with health endpoints.	Develop and/or support a health effects working group.	ST	**AQMP**
	v) Study the potential for ozone damage to vegetation	Summary of findings included in annual reporting.	ST	**AQMP**
3. Develop and maintain an activity-based (bottom-up) CRAZemissions inventory (EI)	vii) Develop an activity-based CRAZ emissions inventory (EI).	CRAZ EI is developed and maintained/updated as new information is available CRAZ EI summaries are included in annual air quality reporting when applicable and available.	LT	**AQMP** Technical Administration
	viii) Investigate methods of linking the CRAZ EI with other relevant inventories and initiatives for the region.	Complete a review of relevant EI data Develop and/or support an emissions working group.	MT	**AQMP** Technical Finance

Time Frame: short-term (ST), medium-term (MT), long-term (LT) and continuous (C).

References

Alberta Environment and Parks (AEP), 2018. *South Saskatchewan Region Status of Management Response for Environmental Management Frameworks as of October 2017*. Government of Alberta. ISBN: 978-1-4601-3678-2 (PDF) Available at: https://open.alberta.ca/dataset/7fc8c948-edbf-402f-94ea-1ac5bcce10d7.

Calgary Region Airshed Zone (CRAZ), 2018. *2018 Achievement Report: CRAZ Particulate Matter and Ozone Management Plan.*

Calgary Region Airshed Zone (CRAZ), 2014. *Particulate Matter and Ozone (PM and O3) Management Plan December 2014.*

Calgary Region Airshed Zone (CRAZ), 2011. *2011 Achievement Report "The CRAZ Particulate Matter and Ozone Management Plan".*

Calgary Region Airshed Zone (CRAZ), 2008. *Particulate Matter and Ozone (PM and O3) Management Plan.*

California Air Resources Board (CARB), 2019. *Hydrogen Sulfide and Health*. Accessed May 9, 2019. <https://ww2.arb.ca.gov/resources/hydrogen-sulfide-and-health>

Environment and Climate Change Canada (ECCC). 2017. *Draft Screening Assessment Hydrogen Sulphide, Sodium Sulphide (Na(SH)) and Sodium Sulfide (Na_2S)*. Available at: http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=2C9C9061-1#toc-010.

Health Canada. 2016. Human Health Risk Assessment for Ambient Nitrogen Dioxide. Available at: http://publications.gc.ca/collections/collection_2016/sc-hc/H114-31-2016-eng.pdf.

Health Canada (HC), 2012. Canadian Smog Science Assessment Highlights and Key Messages. Available at: http://publications.gc.ca/site/archivee-archived.html?url=http://publications.gc.ca/collections/collection_2014/sc-hc/En88-5-2-2013-eng.pdf.

Novus Environmental, 2013. *All Source Pollutant Emissions Inventory for the Calgary Region Airshed Zone (CRAZ) – Spatial Allocation Project 2012-2013*.

Ontario Ministry of Environment, Conservation and Parks (MECP), 2010a. *Fine Particulate Matter.* Accessed May 9, 2019. <http://www.airqualityontario.com/science/pollutants/particulates.php>

Ontario Ministry of Environment, Conservation and Parks (MECP), 2010b. *Ground-Level Ozone.* Accessed May 9, 2019. <http://www.airqualityontario.com/science/pollutants/ozone.php>

Ontario Ministry of Environment, Conservation and Parks (MECP), 2010c. *Nitrogen Dioxide (NO_2).* Accessed May 9, 2019. <http://www.airqualityontario.com/science/pollutants/nitrogen.php>

Ontario Ministry of Environment, Conservation and Parks (MECP), 2010d. *Sulphur Dioxide (SO_2).* Accessed May 9, 2019. <http://www.airqualityontario.com/science/pollutants/sulphur.php>

Ontario Ministry of Environment, Conservation and Parks (MECP), 2010e. *Carbon Monoxide (CO).* Accessed May 9, 2019. <http://www.airqualityontario.com/science/pollutants/carbon.php>

United States Environmental Protection Agency (USEPA), 2018. Health Effects of Ozone Pollution. Accessed May 9, 2019. <https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution>

United States Environmental Protection Agency (USEPA) 2009. Integrated Science Assessment for Particulate Matter. National Center for Environmental Assessment-RTP Division, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, NC. December 2009. EPA/600/R-08/139F. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546.

World Health Organisation (WHO) 2006. Air Quality Guidelines. Global Update 2005. Particulate Matter, ozone, nitrogen dioxide and sulfur dioxide. ISBN 92 890 2192 6. World Health Organisation, Germany. 2006.

Appendix A: Summary of Changes from 2018 Review

The 2014 CRAZ Particulate Matter and Ozone Management Plan was reviewed and updated throughout 2018 by the CRAZ Air Quality Management Planning (AQMP) Committee. The Committee provided several recommendations for updates to the Plan to be incorporated into the 2019 CRAZ Air Quality Management Plan. More detail on the review and recommendations is provided in the 2018 CRAZ Air Quality Management Plan Achievement Report. The AQMP Committee also consulted and discussed the updated Plan with CRAZ stakeholders through the other working committees and board members. A summary of the changes that were incorporated into this updated version of the Plan is included in Table A1.

Table A1: Summary of changes to the CRAZ Air Quality Management Plan based on the 2018 review. More information is provided in the 2018 CRAZ Air Quality Management Plan Achievement Report.

2019 Objectives, Actions and Steps	2019 Performance Indicators	Changes Since 2014
Objective 1: CRAZ will consistentlyand transparentlybe one of the best managed air qualityregions in Canada		No change
Action 1: Continue to improve air quality monitoring and reporting for air contaminants of concern.		The wording in the Action was changed to "air contaminants of concern" from "PM, O3 and precursors".
Step i: Air quality network will be rationalized and will include urban and rural considerations	Existing network will be maintained Continuous monitoring data will be collected outside of the CMA	No change
Step ii: Characterize PM from analysis of dichotomous and/or filter-based sampling data	PM data used to help establish combustion versus fugitive source contributions	No change
Action 2: Continuous improvement/ adaptive management approach for the Air Quality Management Plan.		The wording in the Action was changed to "Air Quality Management Plan" from "PM and O3 Management Plan".
Step iii: The Air Quality Management Plan will be reviewed and adjusted every 3 - 5 years through stakeholder consultation.	Air Quality Management Plan achieves informed updates every 3 to 5 years	The wording in the Step was changed to "Air Quality Management Plan" from "PM and O3 Management Plan". The wording in the Indicator was changed to "Air Quality Management Plan" from "PMO3 Plan".
Step iv: Consultation regarding the Air Quality Management Plan will continue with stakeholders	Formal records are kept by CRAZ of the stakeholder engagements	The wording in the Step was changed to "Air Quality Management Plan" from "PM and O3 Plan".
Step v: Incorporate short term actions in the Air Quality Management Plan into CRAZ strategic plans on a 3-4 year cycle	Strategic plans show good alignment with Air Quality Management Plan and sequential progress over time	The wording in the Step was changed to "Air Quality Management Plan" from "PMO3 Plan". The wording in the Indicator was changed to "Air Quality Management Plan" from "PMO3 Plan".
Action 3: Air Quality Management Plan will be reviewed regularly to track implementation and to determine whether actions are successful		The wording in the Action was changed to "review" from "audit" and to "Air Quality Management Plan" from "PM and O3 Management Plan".
Step vi: Trend analysis of air contaminants of concern measurements to be conducted annually.	Trend analyses are completed and made publicly available	The wording in the Step was changed to "air contaminants of concern" from "ozone and PM2.5" and to "annually" from "every 5 years or less".
Step vii: Complete regular reviews of the Air Quality Management Plan. Encourage dialogue with other airsheds as required.	Reviews are completed and made publicly available	The wording in the Step was changed to "review" from "audit" and to "Air Quality Management Plan" from "PMO3 Management Plan". The second sentence in the Step was changed from "Review progress through dialogue with other airsheds". The wording in the Indicator was changed to "Reviews" from "Audits".
Step viii: Complete an 'Achievement Report' of the Air Quality Management Plan every 3-5 years	Achievement Report will be written and published every 3 to 5 years.	The wording in the Step was changed to "Air Quality Management Plan" from "PMO3 Plan". The Indicator was from "2014 Achievement Report is completed".

2019 Objectives, Actions and Steps	2019 Performance Indicators	Changes Since 2014
Action 4: The Air Quality Management Plan will be consistently, fairly and equitably funded		The wording in the Action was changed from "Air Quality Management Plan" from "PM and O3 Management Plan".
Step ix: Ensure the organization has adequate funding and that projects for AQMP receive funding.	Funding formula is created and periodically reviewed.	The wording in the Step was changed from "Implement and expand the CRAZ funding formula based on sector emissions." The wording in the Indicator was changed to "created and periodically reviewed" from "created and needs to be updated".
Step x: Pursue opportunities for improving local air qualitythat do not require funding such as local policies and programs	Local policies and programs are reviewed for opportunities to implement in the CRAZ region.	The Indicator was changed from "Review of policies is completed and published to CRAZ website".
Step xi: Continue liaising with all levels of government and research potential outside funders.	Revenue is realized and programs are funded adequately.	The wording in the Step was changed to "all levels of government and research potential outside funders" from "the AB government on funding". The wording in the Indicator was changed from "Meeting notes are prepared and archived at CRAZ".
Objective 2: Encourage strategic economic growth and foster sustainable business opportunities through improved understanding of air quality.		No change
Action 1: Incentives and deterrents will encourage area stakeholders to reduce emissions of air contaminants of concern.		The wording in the Action was changed to "emissions of air contaminants of concern" from "PM and O3 emissions".
Step i: Develop measures for creating incentives and deterrents	List of existing and potential incentives and deterrents included in updates of the Air Quality Management Plan	The wording in the Indicator was changed to "Air Quality Management Plan" from "PMO3 Management Plan".
Step ii: Support programs that promote emissions reduction from vehicles, lawnmowers, snowmobiles, etc. when available.	CRAZ website and promotional materials will list, when available, these types of programs.	This Step was moved to Action 1 from Action 3. Action 3 has now become Step v. The wording in the Step was changed from "Support vehicle scrappage/replacement programs". The wording in the Indicator was changed from "CRAZ website and educational materials include scrappage programs".
Action 2: Evaluate and promote green energy choices and products for consumers and commuters		No change
Step iii: Evaluate the emissions intensity of energy use in CRAZ	Emissions intensityvalues are made available to stakeholders. CRAZ emission intensity values are used to explore the impacts of green energy use	No change
Step iv: Investigate opportunities to partner with business and/or municipalities in the promotion of green energy	CRAZ website includes information on available green energychoices	The wording in the Step was changed to include "and/or municipalities".
Step v: Encourage small business opportunities whose activities promote decreasing emissions	If available, promote on CRAZ website and promotional materials	This item was moved to a Step from an Action and an indicator was developed.
Objective 3: Regional land use planning will encourage and promote improvements in air quality		No change
Action 1: Air quality management will be integrated into municipal urban planning		No change
Step i: Promote air quality initiatives within environmental management plans and municipal development plans or charters in the region (including SSRP)	CRAZ will keep and up-to-date as possible list of municipal initiatives.	The wording in the Step was updated to include "environmental management plans". The Indicator was changed from "List municipal initiatives in an annual update of the PMO3 Plan".
Step ii: Develop templates for municipalities that promote/incentivize positive air quality initiatives for urban planning	The relevance of the municipal toolkit is reviewed and development is continued, if required.	The indicator was changed from "Conduct a workshop with municipal staff on use of templates".
Action 2: Support multi-modal transportation systems		No change

2019 Objectives, Actions and Steps	2019 Performance Indicators	Changes Since 2014
Step iii: Develop programs for municipalities that promote/incentivize positive air quality initiatives for transportation	Develop programs and/or tools to promote/incentivize positive air quality initiatives for transportation.	The wording in the Step was changed to "programs" from "templates". The Indicator was changed from "Conduct a workshop with municipal staff on use of templates".
Step iv: Evaluate the air quality impacts of transit/transportation initiatives	Seek out and review available studies on the impacts of transit/transportation initiatives on air quality.	The wording in the Step was changed to "air quality impacts" from "PMO3 impacts". The Indicator was changed from "Complete scenario analysis and publish on CRAZ website".
Action 3: Increase natural filters		No change
Step v: Support and promote urban tree planting policies and programs for municipalities and individual residents.	Increase in number of trees in CRAZ urban areas	No change
Step vi: Encourage the implementation of green roofs policies	An increase in use of green roofs. Inclusion of green roof criteria in municipal building requirements/incentives	No change
Objective 4: Build and promote awareness of air qualityissues		No change
Action 1: Identify opportunities to advocate behavioural changes to stakeholders		No change
Step i: Coordinate with the local school boards to support an air quality curriculum module in alignment with school curriculum	Wider adoption of air quality module in CRAZ schools	No change
Step ii: Cross-promote with other appropriate area events and link to other relevant initiatives on the CRAZ website	Wider array of events noted on CRAZ website Increased CRAZ website hits	No change
Step iii: Develop strategic, targeted behavioural campaigns to promote reduced vehicle use	Promote plan on CRAZ website and through other forum s. Engage drivers through interactive program development	No change
Step iv: Partner with a champion to develop and implement targeted behavioural campaigns within organizations	Secure partner through semi-formal agreement	The wording in the Step was changed from "Partner with a champion with sufficient resources" to remove "with sufficient resources". The wording in the Indicator was changed from "Secure partner through memorandum of understanding or some other semi-formal agreement" to remove "memorandum of understanding".
Action 2: Educate and outreach of regional stakeholders about area PMand O3 emissions and reduction plans		No change
Step v: Ensure a CRAZ communication and education strategy that includes tactics for addressing air contaminants of concern in the CRAZ region	Post plan on CRAZ website	The wording in the Step was changed to "strategy" from "plan". The wording in the Step was changed to "air contaminants of concern in the CRAZ region" from "PM and O3".
Step vi: Develop relationships with local media outlets (TV, radio, newspapers, billboards, train advertisements) to promote air quality related issues	Develop list of media outlets and send regular updates on CRAZ activities and events	No change
Step vii: Prepare the public for legislated changes such as anti-idle and tailpipe testing	Relevant information is included on CRAZ website. One or more CRAZ outreach efforts educating on the topic	No change
Objective 5: Stakeholders will work collaboratively to improve air qualityand to share environmental responsibility		No change
Action 1: Coordinate with other stakeholders to identify opportunities for sharing of resources and knowledge		No change
Step i: Collaborate with Alberta Transportation to identify effective vehicle policies and programs that could be implemented	Review of policy options is completed Strategic workshop occurs involving AEP, CRAZ and others	No change

2019 Objectives, Actions and Steps	2019 Performance Indicators	Changes Since 2014
Step ii: Evaluate the feasibility of alternative fuels for municipal traffic	Studyis conducted and posted or linked on CRAZ website	No change
Step iii: Review relevant municipal Climate Change Action Plans for actions that may achieve co-benefits	Asummary is developed and included in CRAZ reporting	This Step was moved from Objective 2 Action 3. Action 3 has now become Objective 2, Action 2 Step v.
Action 2: Adopt voluntary reduction strategies, stewardship programs, corporate responsibility and individual responsibility to reduce air emissions		The wording in the Action was changed to "reduction" from "compliance".
Step iv: CRAZ stakeholders will adopt a voluntarily commitment model that includes reduction activities suitable to their industry/municipality	Strategic reduction programs are produced and supported	The wording in the Step was changed to "activities" from "targets". The wording in the Indicator was changed to "programs" from "plans".
Step v: Promote financial incentives for home owners such as rebates and free pick-up and disposal for old refrigerators and furnaces	Program details are provided on municipal website. Track number of programs promoted	The wording in the Step was changed to "Promote" from "Develop and/or support". The wording in the Indicator was changed to "programs promoted" from "appliances collected through program".
Objective 6: Encourage, pursue and support air qualityscience and research		No change
Action 1: Define local area poor air quality and predict poor air quality events		No change
Step i: Support and review studies to locate poor air quality "hot spots"	Study is published to the CRAZ website but continuous effort is needed	The wording in the Step was changed to "Support and review studies" from "Commission a study".
Step ii: Utilize air quality forecasting to predict poor air quality events (i.e. AQHI, BlueSkyRains)	Air quality forecasts are made available for the CRAZ region. Forecasts and/or bulletins are posted on the CRAZ website and on social media	The wording in the Step was changed to include AQHI. The wording in the Indicator was changed to include "and on social media".
Step iii: Advocate for regular updating of the inventory and modelling of pollutants in the airshed to determine which management actions are most effective	Modelling efforts show evaluation of different scenarios	The wording in the Step was changed to "Advocate for regular updating of the inventory and modelling" from "Ongoing air quality modelling".
Step iv: Conduct cumulative impact assessment to quantify the impact of ozone and particulate matter emissions	Publish assessment results in annual reporting.	This step was removed from the Plan because the committee feels that this action is addressed by modelling studies as well as health impact studies.
Action 2: Determine impact of poor air quality on CRAZresidents		No change
Step iv: Conduct studies on local target groups (i.e. asthmatics or elderly) and associate air quality with health endpoints.	Develop and/or support a health effects working group	The wording in the Step was changed to "Conduct studies" from "Determine the feasibility of conducting studies". The wording in the Step was also changed to "associate air quality with heath endpoints" from "the incidence of emergency room visits and mortality during exceedance events".
Step v: Study the potential for ozone damage to vegetation	Summary of findings included in annual reporting	No change
Action 3: Develop and maintain an activity- based (bottom-up) CRAZemissions inventory (EI)		No change
Step vii: Develop an activity-based CRAZ emissions inventory	CRAZ EI is developed and maintained/updated as new information is available. CRAZ EI summaries are included in annual air quality reporting when applicable and available	The wording of the Indicator was changed to "developed and maintained/updated as new information is available" from "developed and maintained/updated annually". The wording of the Indicator was also changed to "included in air quality reporting when applicable and available" from "included in annual air quality reporting".
Step viii: Investigate methods of linking the CRAZ EI with other relevant inventories and initiatives for the region	Complete a review of relevant EI data Develop and/or support an emissions working group	No change