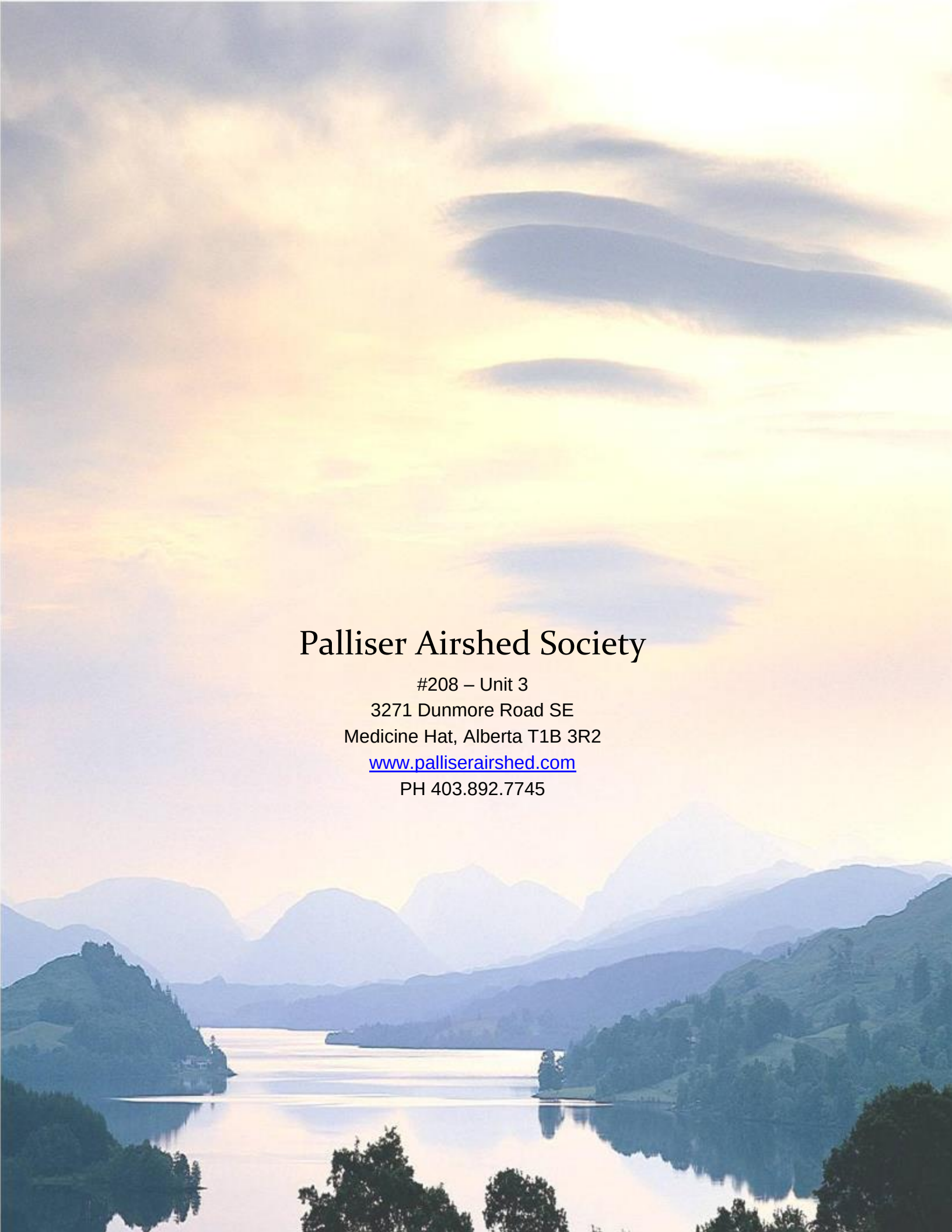
A Year in the Palliser Airshed

2018 Annual Report

palliser airshed society



Palliser Airshed Society

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Introduction

The Palliser Airshed Society (PAS) is a multi-stakeholder, not-for-profit organization consisting of industry, local government, environmental organizations, in partnership with Alberta Environment and Parks. PAS was formed in 2003 in response to concerns over air quality in the Medicine Hat region. In 2007, the PAS expanded its borders to the boundaries of the former Palliser Health Region. The airshed zone was expanded again in 2011, when the southwest border was extended to Highway 4 and Highway 36. Figure 1 illustrates the boundaries of the area monitored by the Palliser Airshed Society.

The current airshed boundaries encompass an area greater than 44,000 km^2. Approximately 130,000 people live and work in this area. The major industries include oil and gas processing, power generation, manufacturing, agriculture, ranching and tourism.

The PAS air monitoring network uses a combination of both continuous and passive monitoring technologies. The network is designed to provide reliable information to a wide range of stakeholders, including those involved in developing strategies to maintain environmental quality through sound management.

In 2018, PAS operated two continuous monitoring stations, and up to 22 passive sampling sites. The Crescent Heights continuous monitoring station has been in operation since 2003. A new *airpointer+PM*® continuous monitoring station was in operation at a site adjacent to the City of Brooks until August 31, 2016. The *airpointer+PM*® was relocated to a site near the Medicine Hat Airport beginning September 9, 2016, where it remained until July 2018. The *airpointer+PM*® moved to a new home near the Medicine Hat Trap Club and began full operation in October 2018.

Vision

Air quality is known and valued to ensure clean, healthy air for today and tomorrow.

Mission

Collecting and communicating credible ambient air quality data to all stakeholders.

Principles

Through the development and achievement of a consensus based, multi-disciplinary stakeholder group, the Palliser Airshed Society (PAS) is committed to collecting and communicating credible ambient air quality data to all stakeholders. Through this open communication, PAS is committed to achieving the following:

- Maintain an open, relaxed forum for all stakeholders to express their concerns;
- Create an understanding of air quality issues prevalent in the airshed and the potential effects to human, animal and vegetative health;
- Educate the public with respect to interactions, generation and dispersion of common air contaminates;
- Serve as an avenue for members of the public to confirm industry commitment to environmental health; and
- Strive to have the Palliser Airshed Society recognized as a credible, committed and responsible organization which contributes real value in supporting effective environmental monitoring and stewardship.

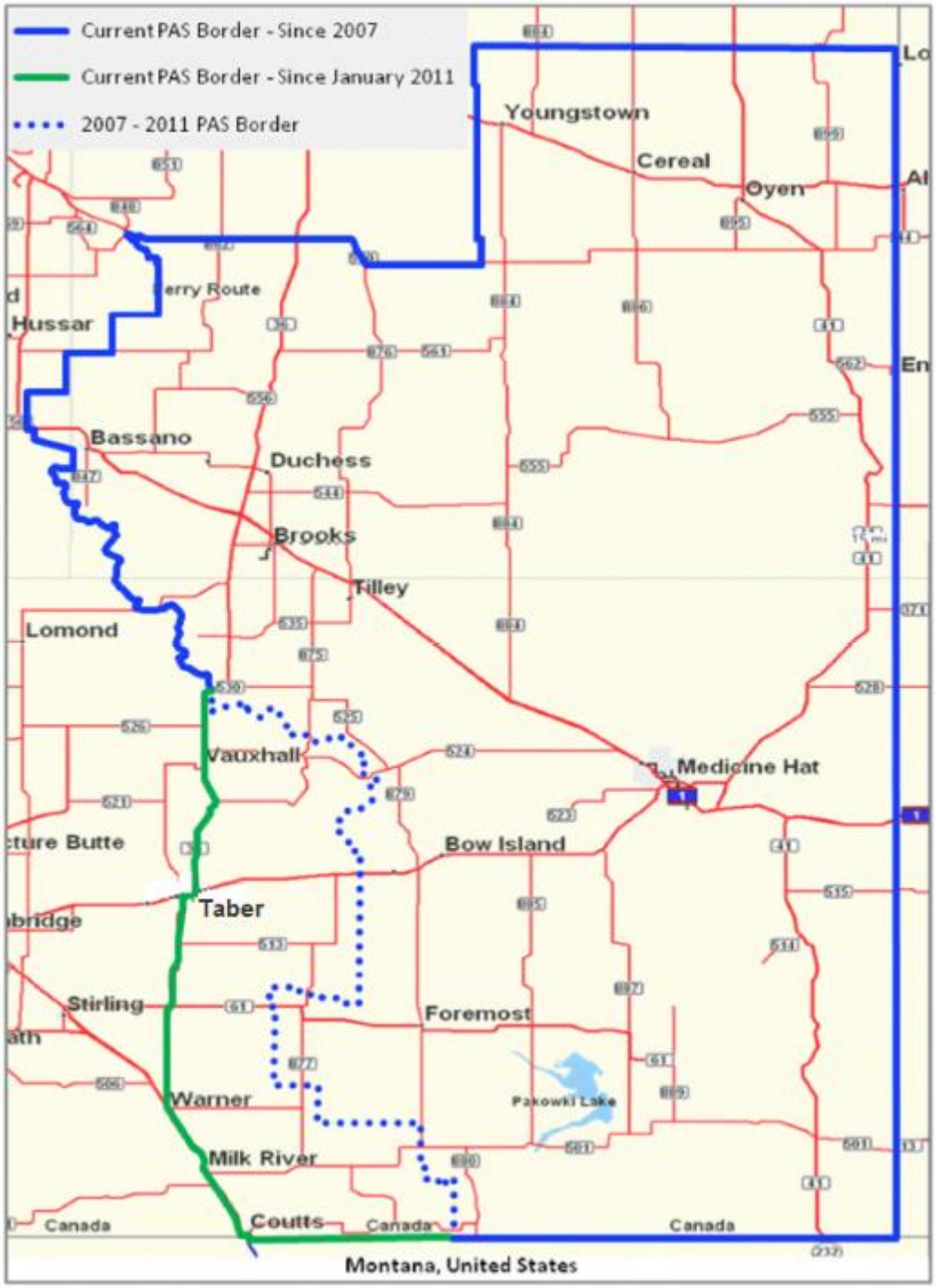


Figure 1. Boundaries of the Palliser Airshed

Year in Review

PAS Air Monitoring Network

The Crescent Heights and Medicine Hat Airport/Trap Club continuous air monitoring stations met the operations criteria defined by the Alberta Ambient Air Monitoring Directive (AMD) throughout 2018, with the exception of one uptime non-compliances, due to analyzer malfunctioning (<90% operational within a month) for relative humidity at the Crescent Heights Station. The measured air quality was within the Alberta Ambient Air Quality Objectives (AAAQO) for 2018, with the exception of twenty 1-hour O_3 exceedances, twenty-five 1-hour and fifteen 24-hour $PM_{2.5}$ exceedance events attributed to wildfire smoke and high wind speed events in the region. Measurement of NO, NO2 and NOx parameters resumed with the *airpointer+PM*® in July. THC measurement was resumed at the Crescent Heights station in October.

All passive sampling sites yielded more than 90% valid samples for SO_2, and NO_2.

Contact Information

Please visit the PAS website for additional information: www.palliserairshed.com. If you have any comments or suggestions, please contact Lorna Morishita at (403) 512-0085 or lmorishita@shaw.ca.

Consultants

The PAS Board contracts Wood (formerly Amec Foster Wheeler) to operate and manage the monitoring equipment as well as reporting of data representative of the airshed. Wood's primary goal is to ensure high quality data is collected while maintaining efficient operations of the monitoring network.

Figure 2. PAS Continuous Air Quality Monitoring Stations

Message from the Chair

On behalf of the Palliser Airshed Society (PAS), it is my pleasure to present the 2018 Annual Report. 2018 was our fourteenth full year of air quality monitoring in south eastern Alberta. The current zone covers the south eastern corner of Alberta, an area of approximately 57,000 square kilometers and includes about 130,000 people who work and live in the area.

In 2018 we moved our portable Airpointer monitoring system to a location that will help provide data to validate air modelling that has been done for the area for NOX. The system continues to operate very well and gives PAS the flexibility to move the system to monitor specific areas of concern.

In 2018 we entered into long term contracts with AEP, this has provided PAS with the financial stability that will allow us to make long term plans for the airshed.

I want to thank AEP, industry and municipalities for their commitment to airsheds in the province. Without their support our airshed would not be sustainable.

I look forward to an interesting and exciting 2019 and years ahead.

Russ Golonowski
Chairman

Membership - Board of Directors

Position	Name	Association
Chair	Russ Golonowski	CF Industries
Vice-Chair	Brian Strandlund	City of Medicine Hat Electric Utility
Treasurer	Pamela Hodgkinson	Alberta Health Services
Executive Director	Lorna Morishita	Palliser Airshed Society
Director	Susan McIntosh	Alberta Environment and Parks
Director	Ed Rahn	Alberta Energy Regulator
Director	Jason Sweeney	Cancarb Ltd.
Director	David Gue	Grasslands Naturalists
Director	Wendy Lyka	City of Medicine Hat
Director	Mark Grant	Torxen Energy Ltd
Director	Kim Schacher	International Petroleum Corp.
Director	Ryan Hornung	Methanex

Membership – Funding Members

GOVERNMENT & MUNICIPALITIES

Alberta Environment and Parks, Evaluation Monitoring and Science Division	City of Medicine Hat
Cypress County	Town of Redcliff
Newell County	

INDUSTRY

ARC Resources	JBS Foods Canada
Belltrix Exploration Ltd	Lamb Weston Canada
Black Pearl Resources	Lance Exploration Corp
CF Industries	Marquee Energy Ltd
Canadian Natural Resources Limited	Methanex
Cancarb	NAT-1 Ltd Partnership
Cardinal Energy Ltd	Pine Cliff Energy Ltd
CertainTeed Corp - Insulation Group	Porocel of Canada Ltd
COR4 Oil Corp	Prairie Gold Produce Ltd
City of Medicine Hat Electric Utility	Prairie Provident Resources
City of Medicine Hat Gas Utility	TORC Oil & Gas Ltd
Crescent Point Energy	Torxen Energy
Hemisphere Energy Corp	TransCanada Pipeline Ltd
International Petroleum Corporation	West Lake Energy Corp

History and Outlook of the Palliser Airshed Network

The PAS air quality monitoring network design was approved by the Board prior to the fall of 2003. A continuous monitoring station was placed within the Airshed to collect representative, scientifically credible air quality data for the area. In addition, a passive monitoring network of six stations was implemented to augment the data collected at the continuous station.

The continuous monitoring station was established across from the McCoy High School in the Crescent Heights region of Medicine Hat (Figure 3). This station monitors sulphur dioxide (SO_2), nitrogen oxides (NO, NO_2, NOx), ozone (O_3), total hydrocarbons (THC), carbon monoxide (CO), and fine particulate matter ($PM_{2.5}$). The station also collects meteorological data, including wind speed, wind direction, ambient temperature, relative humidity, and solar radiation data. Meteorological data is used to assist in interpretation of air quality parameter readings and source investigation.

In 2007, the Palliser Airshed expanded its borders. The airshed was expanded to encompass approximately 40,000 km^2, and included a population of approximately 100,000 people. The borders were aligned with the boundaries of the former Palliser Health Region. A new monitoring plan was developed based on the expansion. As a result, the network added a portable air monitoring station and fourteen passive sampling stations.

In 2010, the Palliser Airshed Society faced serious financial stress. To resolve the circumstances, the passive sampling program was modified by monitoring ten sites for six months and then switching to the other ten sites for the remainder of the year. The portable monitoring program was downsized to a two-month program at the Jenner Station.

In 2011, the southwest border was extended to the junction of Highway 4 and Highway 36. The current airshed encompasses an area of greater than 44,000 km^2, with approximately 130,000 people living and working in this area. The portable monitoring station was decommissioned in October following the Hays monitoring program. Two passive sites at Hays were added to the passive network, forming a total of twenty-two passive stations, as shown in Figure 3.

In July 2015, an *airpointer+PM*® was commissioned for operation at a location adjacent to the City of Brooks. The *airpointer+PM*® is intended for use as a portable monitoring station, and was relocated to a site near the Medicine Hat Airport in September 2016, where it operated through to July 2018. The *airpointer+PM*® was moved to a site located nearby the Medicine Hat Trap Club, full operation resumed in October 2018.

Due to financial constraints in 2017, PAS completed a rationalization of the passive monitoring network with the technical help of AEP. As a result of the study, O_3 passive monitoring was discontinued in March 2017. Seven sites were discontinued completely, and SO_2 monitoring was discontinued at an additional seven sites in June 2017. A new NO_2 site was established in December 2017 near Milk River.

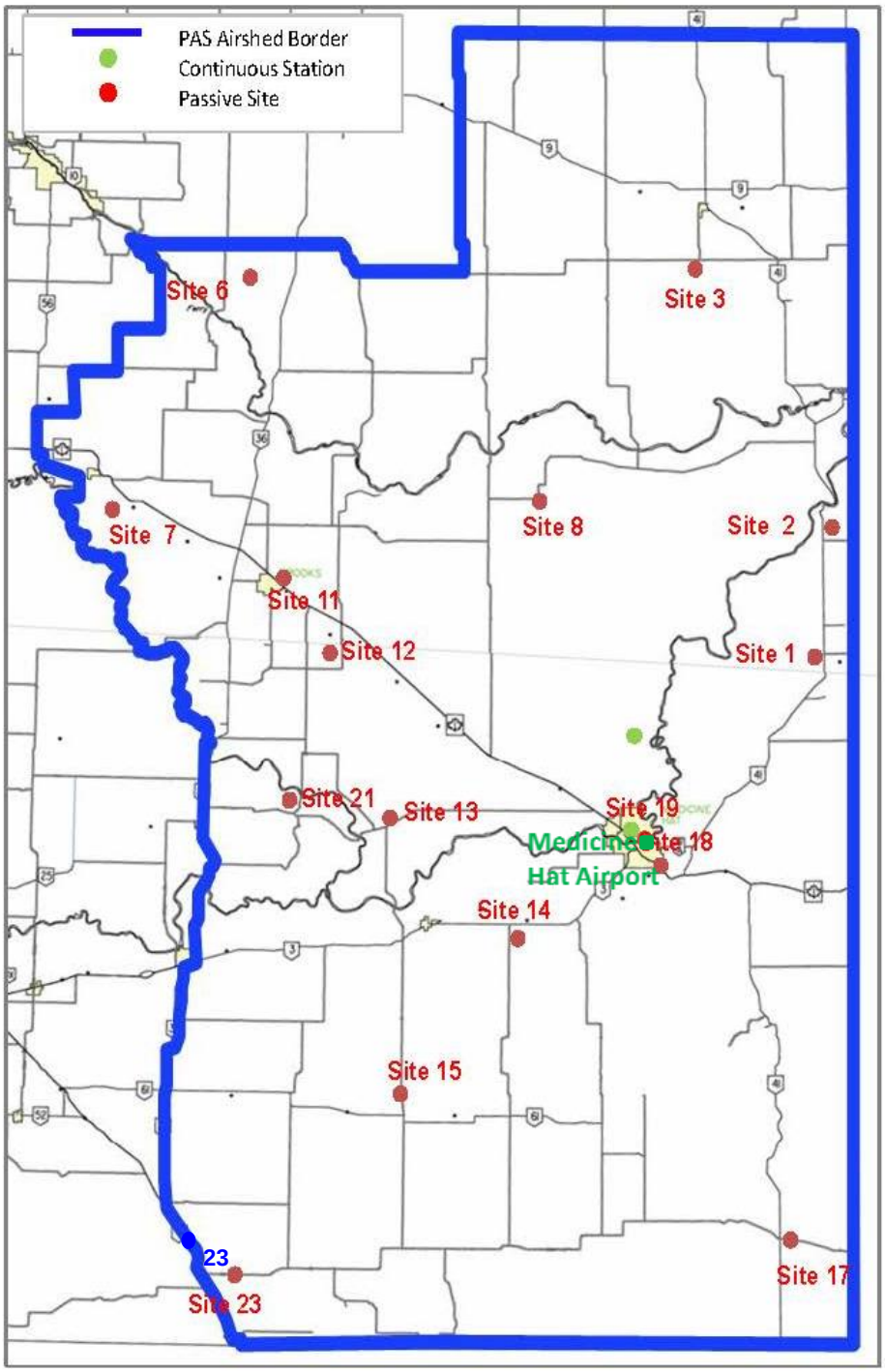


Figure 3. PAS Air Quality Monitoring Network for 2018

Continuous Air Quality Monitoring Program

The Palliser Airshed Society operates two continuous air monitoring stations which are monitoring ambient air quality in the City of Medicine Hat. The Crescent Heights station is a stationary air monitoring station, which began monitoring operations in December 2003. The Medicine Hat Airport site is monitored by a portable *airpointer+PM*® station which began operations on September 9, 2016. The *airpointer*® is a compact monitoring system, and as such, it can be mobilized to address special air monitoring needs within the airshed.

Near real-time data from the continuous air monitoring stations has been available on the PAS website since the spring of 2004, allowing public access to this data and providing an indication of the ambient air quality.

Environment Canada, as a stakeholder, provided a TEOM fine particulate analyzer and a carbon monoxide analyzer for the Crescent Heights station when the PAS airshed began operations. Donation of the equipment was made through a partnership program with Alberta Environment and Parks, and the National Air Pollution Surveillance program (NAPS) of Environment Canada. In 2013, AEP provided a SHARP $PM_{2.5}$ monitor to replace the TEOM. This instrument enables the Crescent Heights station to report the Air Quality Health Index (AQHI). The AQHI is a public health tool used to provide advice to the general population and at-risk groups on how to reduce health risk by adjusting daily activities according to the status of air quality. In Alberta, the AQHI is measured and forecast for 27 communities. Near real-time AQHI data is available on the AEP website: http://www.environment.alberta.ca/apps/aqhi/aqhi.aspx

In 2016, electronic billboards displaying the current AQHI value were introduced in major population centers. For Medicine Hat, the AQHI value is derived from data provided by PAS.

Continuous Air Quality Monitoring Results

Oxides of Nitrogen

Oxides of nitrogen (NO_X) are present in the air primarily in the form of nitric oxide (NO) and nitrogen dioxide (NO_2). These emissions are produced from the reaction of nitrogen and oxygen gases during combustion, especially at high temperatures. In atmospheric chemistry, oxides of nitrogen refer to the total concentration of nitric oxide and nitrogen dioxide.

Oxides of nitrogen (NOx) are produced from both natural and anthropogenic sources. Forest fires, lightning, and nitrogen fixation microorganisms are the primary natural contribution sources. Anthropogenic emissions are primarily from fuel combustions, such as transportation sources (automobiles, trucks, and trains), industrial sources (oil and gas industries), power generation plants, and space heating. The largest urban source of oxides of nitrogen is motor vehicles.

Nitrogen dioxide is a major component of photochemical reactions in the atmosphere that leads to smog formation, acid rain, and ground-level ozone formation and scavenging. High concentrations of oxides of nitrogen can damage plants, causing leaf discoloring and impairment of leaf function. Nitrogen dioxide, at higher concentrations, is an irritating gas that can constrict airways of asthmatics, and may increase the susceptibility of infection in the general population.

Alberta Environment and Parks sets air quality objectives for NO_2 among the nitrogen oxides compounds. The Alberta Ambient Air Quality Objectives for nitrogen dioxide are:

- 1-hour average AAAQO = 159 ppb
- Annual average AAAQO = 24 ppb

The Crescent Heights station was greater than 90% operational for 2018. The NOx analyzer at the Medicine Hat Airport station resumed operations in July. There were no exceedances of the 1-hour and annual AAAQO values. The annual average concentration of NO_2 at the Crescent Heights, Medicine Hat Airports and Medicine Hat Trap Club stations was recorded as 7.2 ppb, 4.3 ppb (July only), 5.5 ppb (Oct- Dec) respectively. The maximum 1-hour average concentration of 49.3 ppb at the Crescent Heights station was detected in January. The maximum 1-hour average concentration of 33.8 ppb at the Medicine Hat Trap Club station was detected in November.

Figure 4 compares annual average concentrations of NO_2 for the Air Monitoring Stations (AMS) in Alberta. The concentration at the Crescent Heights and Medicine Hat Airport stations was comparable to other cities of similar size. Higher concentrations of nitrogen dioxide tend to be recorded in large cities, such as Calgary and Edmonton, due to traffic and space heating. A higher concentration of NO_2 is also detected in energy resource operation regions, e.g. Wood Buffalo area.

Parameter	Annual Average Concentration – Nitrogen Oxides (NO/NO_2/NOx, ppb)										
	Crescent Heights							Medicine Hat Airport			Medicine Hat Trap Club
	2018	2017	2016	2015	2014	2013	2012	2018 (July)	2017 (Jan-Apr)	2016 (Sept-Dec)	2018 (Oct- Dec)
NOx	9.6	7.2	7.4	8.4	8.4	9.0	9.2	8.3	6.9	7.3	8.4
NO_2	7.2	5.7	5.6	6.4	6.4	7.0	6.9	4.1	4.7	4.9	5.5
NO	2.3	1.4	1.7	2.0	2.0	2.0	2.2	4.3	2.2	2.4	3.0

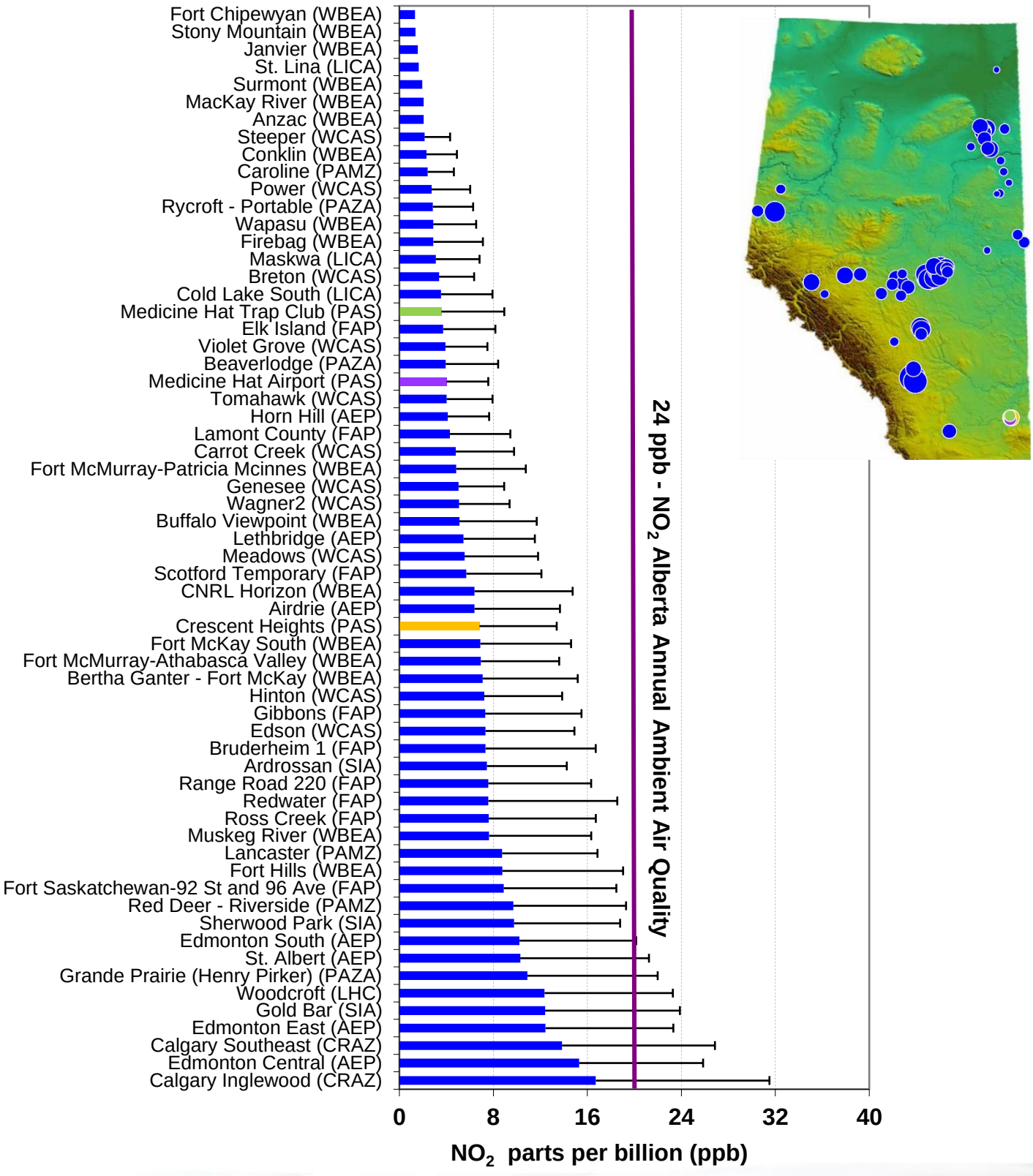


Figure 4. Nitrogen Dioxide (NO_2) – 2018 Annual Average

Ozone

Ozone (O_3) is most commonly known as the "ozone layer" in the upper atmosphere (stratosphere) which shields the Earth against harmful radiation from the sun, particularly ultraviolet B radiation. However, ozone is considered a pollutant at ground level as it is involved with photochemical production of many secondary air pollutants (such as smog). Ozone is described as "Good up high; Bad nearby".

Ozone is a bluish colored gas that has a distinctive sharp odour at higher concentrations, such as that generated from lightning storms or near photocopiers indoors. At normal outdoor concentrations, ozone tends to be odourless. At higher concentrations, ozone can reduce lung function, aggravate existing respiratory illness, and irritate eyes, nose and throats.

Ozone is a reactive gas. It tends to react rapidly in the presence of oxides of nitrogen. In Alberta, ozone concentrations are generally lower in urban areas. The trend is likely due to scavenging of ozone by nitric oxide emitted by traffic emissions and residential/commercial heating. Ozone concentration is typically highest between late spring and summer. Research in the Edmonton Capital Region found that high concentrations of ozone could be associated with contributions from the upper air ozone and photochemical reaction of biogenic emissions. More research is underway to investigate ozone formation mechanisms.

The Alberta Ambient Air Quality Objective for ozone is 82 ppb for the daily maximum concentration averaged over a one-hour period.

The Crescent Heights, Medicine Hat Airport and Medicine Hat Trap Club stations were greater than 90% operational for 2018. There were twenty exceedances of the 1-hour AAAQO recorded at the Medicine Hat Airport Station. The annual average concentration at the stations was 30 ppb, 30 ppb (Jan-July), 20 ppb (Oct-Dec) respectively. The maximum 1-hour average concentration of 81 ppb at the Crescent Heights station was detected in May. The maximum 1-hour average concentration of 97 ppb at the Medicine Hat Airport station was detected in July. The historical annual average concentrations for the past 12 years are summarized in the table below. There is no apparent yearly trend at the Crescent Heights station.

Figure 5 compares 2018 annual average concentrations of O_3 for the AMS located in Alberta. The concentrations at the Crescent Heights and Medicine Hat Airport stations tend to be lower than at rural monitoring stations, and higher than the large cities, such as Edmonton and Calgary. The spatial trend indicates ozone scavenging is likely an important ozone chemistry mechanism in Alberta.

Monitoring Station	Annual Average Concentration - Ozone (O_3, ppb)											
	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Crescent Heights	30	32	27	27	28	28	29	30	26	29	25	28
Medicine Hat Airport	30 [a]	29	21[b]	-	-	-	-	-	-	-	-	-
Medicine Hat Trap Club	20 [c]	-	-	-	-	-	-	-	-	-	-	-

[a] 2018 Data collected January 1 – July 31.

[b] 2016 data for the Medicine Hat Airport station was collected September 1 to December 31.

[C] 2018 Data collected October 1 – December 31.

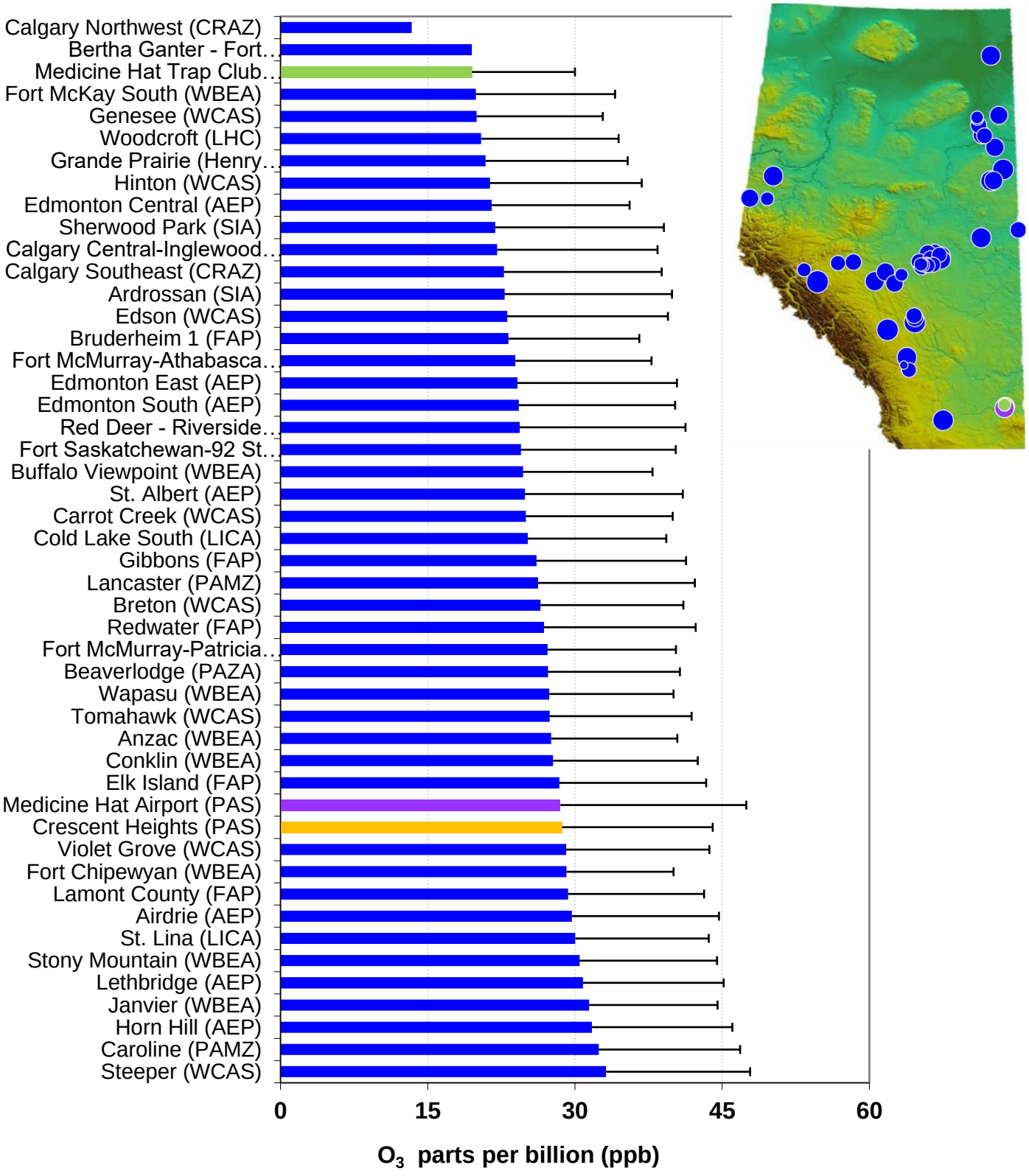


Figure 5. Ozone (O_3) – 2018 Annual Average

Total Hydrocarbons

Hydrocarbons are divided into two categories, "reactive" and "non-reactive". The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms and includes both reactive and non-reactive hydrocarbons. Reactive hydrocarbons include many volatile organic compounds such as alkenes, alkynes, benzene, toluene, ethylbenzenes, xylenes, and other aromatics. Reactive hydrocarbons are important because they can react with oxides of nitrogen in the presence of sunlight to form ozone and may be toxic to humans, animals, or vegetation.

Trees and plants are natural emitters of reactive hydrocarbons. Other significant contribution sources include livestock operations, vehicle emissions, fireplaces, natural gas combustion, and fugitive emissions from fuel storage tanks, petroleum and chemical industries, as well as dry cleaning. Motor vehicles are the primary source of hydrocarbons in urban areas.

The primary non-reactive hydrocarbon in the atmosphere is methane, which is a naturally occurring, colorless, odourless gas. Methane is regarded as a major contributor to the greenhouse effect. Large amounts of methane are produced naturally from bogs, shallow lakes and soils through anaerobic decay of vegetation. The global background concentration of total hydrocarbons is approximately 1.8 to 2.1 ppm, consisting primarily of methane.

Alberta does not have an ambient air quality objective for total hydrocarbons. Some reactive hydrocarbons such as benzene and styrene are specified in the air quality objectives.

The THC analyzer at the Crescent Heights station has an operational uptime of 98.9% for October – December 2018. The maximum 1-hour average concentration of 4.4 ppm was detected in October, and the annual average concentration was 2.1 ppm. The historical annual average concentrations for the past 12 years are summarized in the table below. There is no apparent yearly trend for total hydrocarbons at the Crescent Heights station.

Figure 6 compares the annual average concentrations of THC for the Alberta AMS. The annual average concentration of THC at the Crescent Heights station ranks in the middle among the reviewed stations. In Alberta, a slightly higher concentration is detected in intensive energy operation regions, e.g. Wood Buffalo area.

Monitoring Station	Annual Average Concentration - Total Hydrocarbons (THC, ppm)											
	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Crescent Heights	2.1	2.1	2.1	2.1	2.2	2.2	2.2	2.1	2.1	1.9	2.1	2

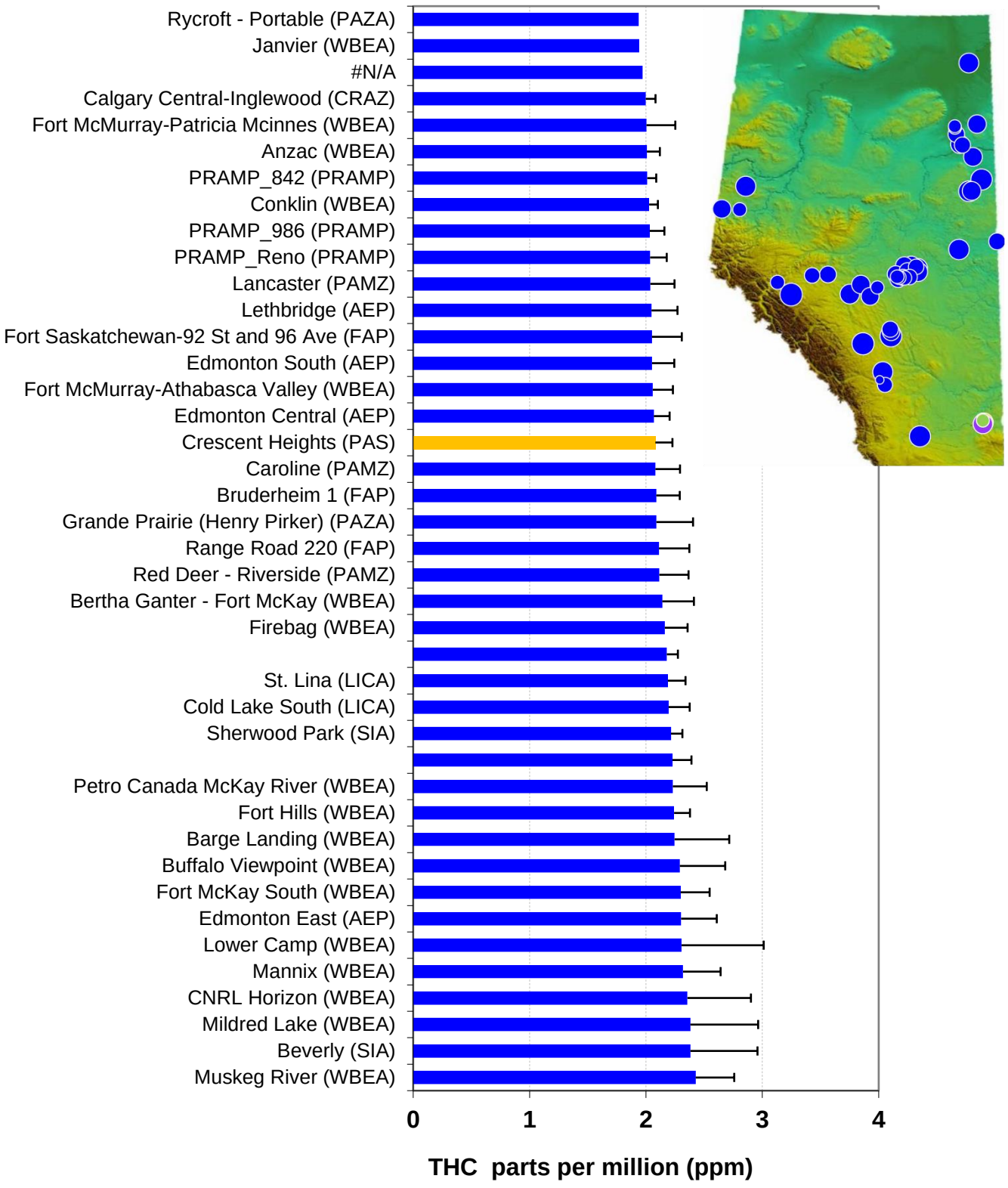


Figure 6. Total Hydrocarbons (THC) – 2018 Annual Average

Fine Particulate Matter

Particulate matter (PM) is unique among air pollutants for it is identified by its size rather than by its composition. The major health concerns for particulate matter are for small particles, which are referred to as inhalable particulate, or PM_{10}. PM_{10} is defined for particles which have an aerodynamic diameter less than 10 microns (or 0.01 mm). The small particles can be emitted directly into the air from sources or be generated through physical and chemical reactions in the atmosphere. They can remain airborne for a long period of time and can travel a long distance.

PM_{10} can be divided into two groups based on particle sizes: fine particles and coarse particles. The fine particles are those particles which have an aerodynamic diameter smaller than 2.5 microns (0.0025 mm) and are identified as $PM_{2.5}$ (respirable particulate matter). In contrast, coarse particles are defined as those that are greater than 2.5 microns and smaller than 10 microns in aerodynamic diameter.

Generally, fine particles pose a greater health risk because these particles can be inhaled deep into the lungs, bringing with them potential chemicals that may be harmful. In the atmosphere, fine particles are the main contributors to reduction of visibility (haze). Exposure to harmful particulate matter can cause eye, nose, and throat irritation. In addition, studies have linked respirable particulate matter to aggravated heart and lung diseases such as asthma, bronchitis, and emphysema.

The Alberta Ambient Air Quality Objectives for $PM_{2.5}$ are:

- 1-hour average AAAQO = 80 µg/m^3
- 24-hour average AAAQO = 29 µg/m^3

Major particulate emission sources in Alberta include soil erosion, road dust as well as dust resulting from other human activities, smoke from forest fires and from recreational sources, vehicle exhaust emissions, and industrial sources, e.g. power plants, cement manufacturing, mining, and forest products industry.

The Crescent Heights and Medicine Hat Airport stations were greater than 90% operational for 2018. There were 25 exceedances of the 1-hour AAAQO, and 18 exceedances of the 24-hour AAAQO, attributed to wildfire smoke and high wind speed events.

The historical annual average concentrations for the past 13 years are summarized in the table below. An increased concentration was observed between 2009 and 2010 due to an analyzer upgrade. A Filter Dynamics Measurement System (FDMS) was installed on the TEOM in 2009. The FDMS enables the TEOM to measure volatile particulate matter, causing an increased concentration. The TEOM-FDMS was replaced with a SHARP analyzer in November, 2013. The SHARP analyzer combines light scattering photometry and beta radiation attenuation. It is believed to provide a better detection limit and data quality than the TEOM-FDMS.

Figure 7 compares the annual average concentrations for the Alberta AMS. The concentration at the Crescent Heights and Medicine Hat Airport stations is low to average among the reviewed stations. A higher concentration of $PM_{2.5}$ tends to be detected in large cities, energy resource exploration areas, and industrial areas.

Monitoring Station	Annual Arithmetic Average - Fine Particulate Matter ($PM_{2.5}$, µg/m^3)												
	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Crescent Heights	7	6	4	7	5	8	9	8	8	6	3	4	3
Medicine Hat Airport	7 [a]	7	4 [b]	-	-	-	-	-	-	-	-	-	-
Medicine Hat Trap Club	4 [c]	-	-	-	-	-	-	-	-	-	-	-	-

[a] 2018 data for the Medicine Hat Airport station was collected January 1 to July 31.

[b] 2016 data for the Medicine Hat Airport station was collected September 1 to December 31.

[c] 2018 data for the Medicine Hat Trap Club station was collected October 1 to December 31.

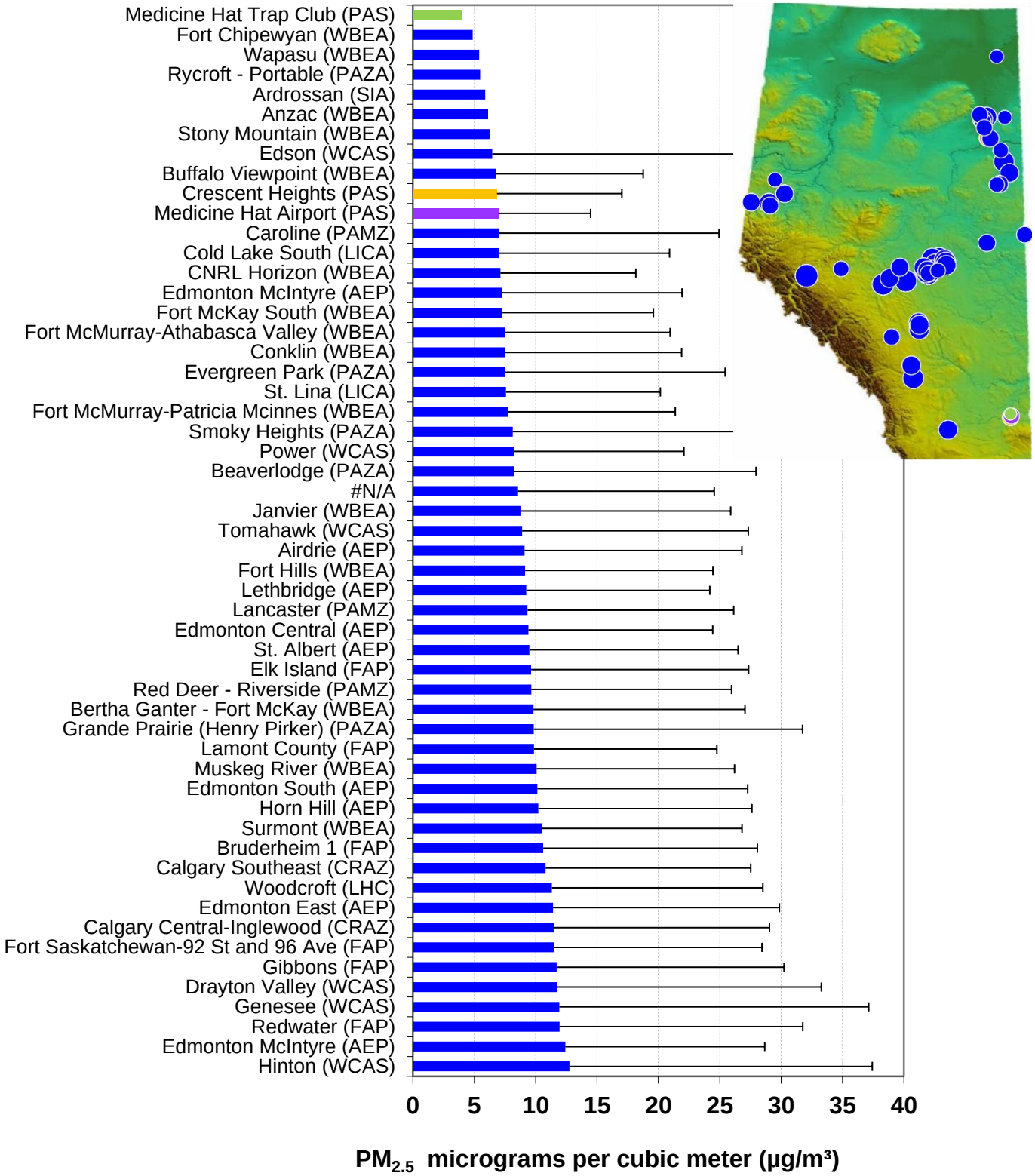


Figure 7. Fine Particulate Matter ($PM_{2.5}$) – 2018 Annual Arithmetic Average

Carbon Monoxide

Carbon Monoxide (CO) is a colourless and odourless gas. It is the most commonly inhaled poisonous substance. CO occurs naturally in the atmosphere, but the major causes of CO poisoning are from vehicles idling in closed ventilated areas, blocked fireplaces, and charcoal grills used in a confined space.

Carbon monoxide is produced from partial oxidation of carbon during fuel combustion. The major anthropogenic emission sources include traffic emissions (automobiles, trucks, and trains), industrial sources (incomplete combustion), space heating, gas stoves, and cigarette smoke. The largest urban source of CO is from motor vehicle emissions. The major natural emission sources include forest fires and volcanic activities.

Alberta Environment and Parks sets up air quality objectives based on the protection of human health and life. As CO is inhaled, it combines with the hemoglobin in the red blood cell inhibiting the oxygen carrying capability of the red blood cells. At low concentrations, acute exposure may cause fatigue in healthy people and cause chest pain in people with heart disease.

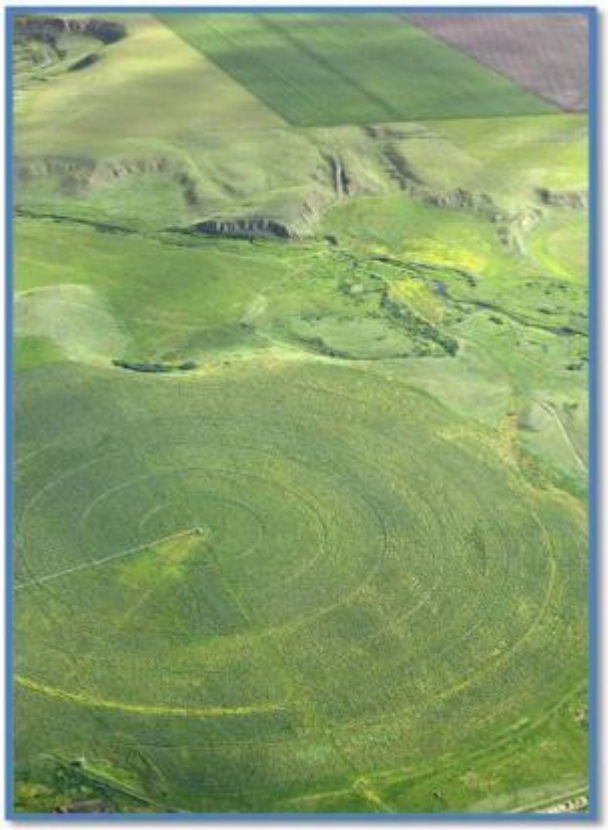
The Alberta Ambient Air Quality Objectives for carbon monoxide are:

- 1-hour average AAAQO = 13 ppm
- 8-hour average AAAQO = 5 ppm

The CO analyzer was greater than 90% operational for the year 2018. There were no exceedances of the AAAQO values at the Crescent Heights station. The maximum 1-hour average concentration of 0.9 ppm was detected in August.

The historical annual average concentrations for the past 12 years are summarized in the table below. There is no apparent yearly trend at the Crescent Heights station.

Figure 8 compares annual average concentrations for Alberta AMS. The concentration at the Crescent Heights station was the lowest among the reviewed AMS. Large cities, such as Calgary and Edmonton, tend to detect a higher concentration, attributed to traffic emissions and other combustion sources.



Parameter	Annual Average – Crescent Heights Station (ppm)												
	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Carbon Monoxide	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2

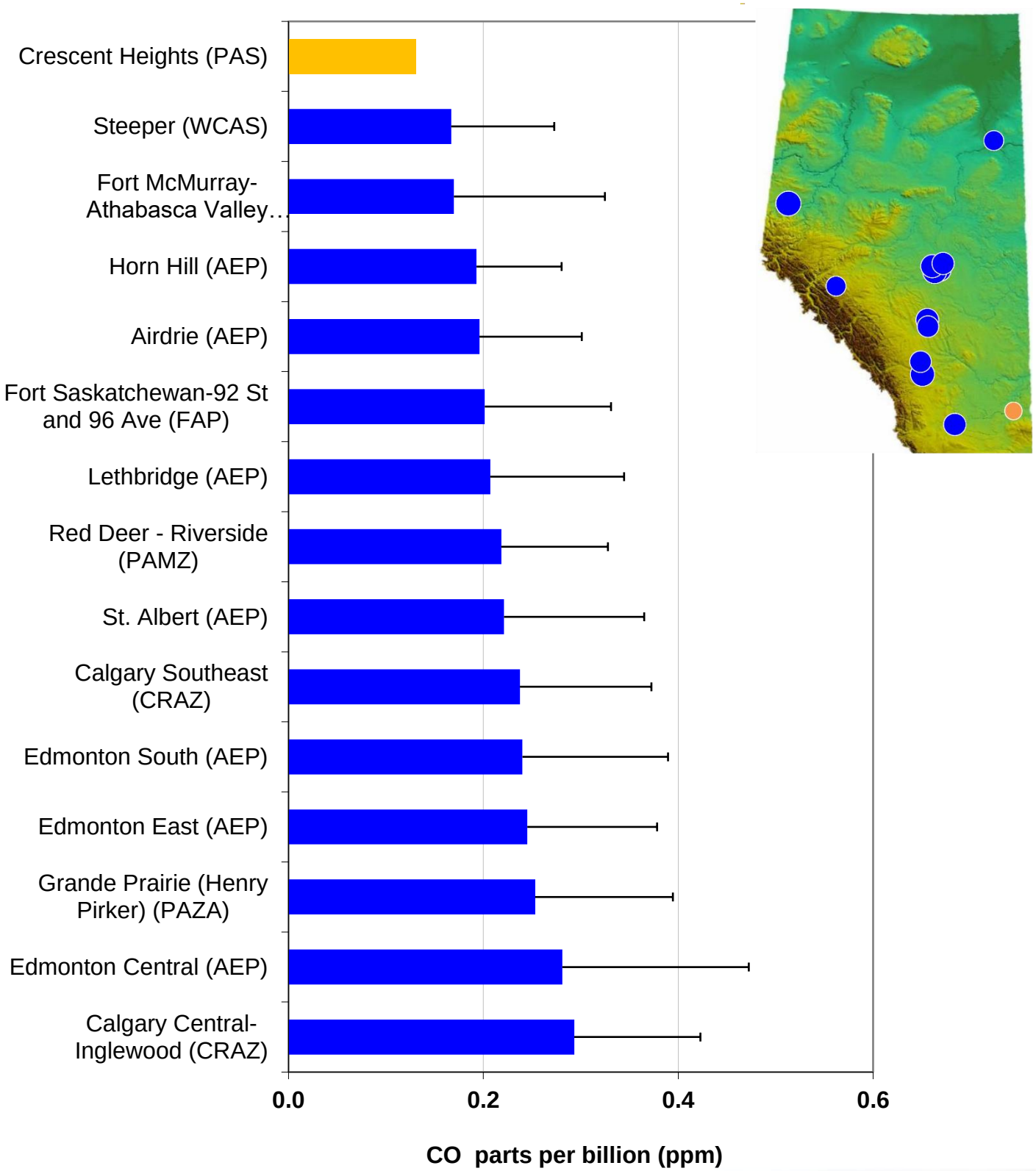


Figure 8. Carbon Monoxide (CO) – 2018 Annual Average

Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a strong, pungent odour. At concentrations as low as 300 ppb, it can be tasted and smelled. Acute exposure to high concentration SO_2 can lead to constricted airways, which can be especially troublesome for people with asthma. Children may experience an increase in respiratory tract infections. Healthy people may experience sore throats, coughing, and breathing difficulties. Chronic exposure to high concentrations of SO_2 has been associated with an increased risk of mortality from respiratory or cardiovascular disease.

Sulphur dioxide is formed during processing and combustion of fossil fuels containing sulphur, such as gasoline, natural gas, oil, coal, and oil sands. On a global basis, volcanic eruptions are the major natural source of sulphur dioxide into the atmosphere.

Sulphur dioxide, once emitted into the atmosphere, can persist for days, allowing for wide spatial distribution of the gas. In the atmosphere, some SO_2 can be oxidized by ozone and hydrogen peroxide to form sulfur trioxide (SO_3). Both SO_2 and SO_3 are soluble in water; hence, if they are present in the atmosphere when condensation occurs, droplets of sulfuric acid (acid rain) are formed.

The Alberta Ambient Air Quality Objectives (AAAQO) for sulphur dioxide:

- 1-hour average AAAQO = 172 ppb
- 24-hour average AAAQO = 48 ppb
- Annual average AAAQO = 8 ppb

The SO_2 analyzer at the Crescent Heights station was greater than 90% operational for 2018. There were no exceedances of the 1-hour, 24-hour, or annual AAAQO values. The measured concentration was typically quite low, with an annual average of 0.1 ppb. The maximum 1-hour average concentration of 8.4 ppb was detected in August.

The historical annual average concentrations for the past 9 years are summarized in the table below. There is no apparent yearly trend at the Crescent Heights station.

Figure 9 compares the annual average concentrations for Alberta AMS. The concentration at the Crescent Heights station is among the lowest in Alberta. A higher concentration of sulphur dioxide tends to be measured in the energy operation regions, e.g. the Wood Buffalo area and Fort Air Partnership area.

Monitoring Station	Annual Average – Sulphur Dioxide (ppb)									
	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009
Crescent Heights	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3

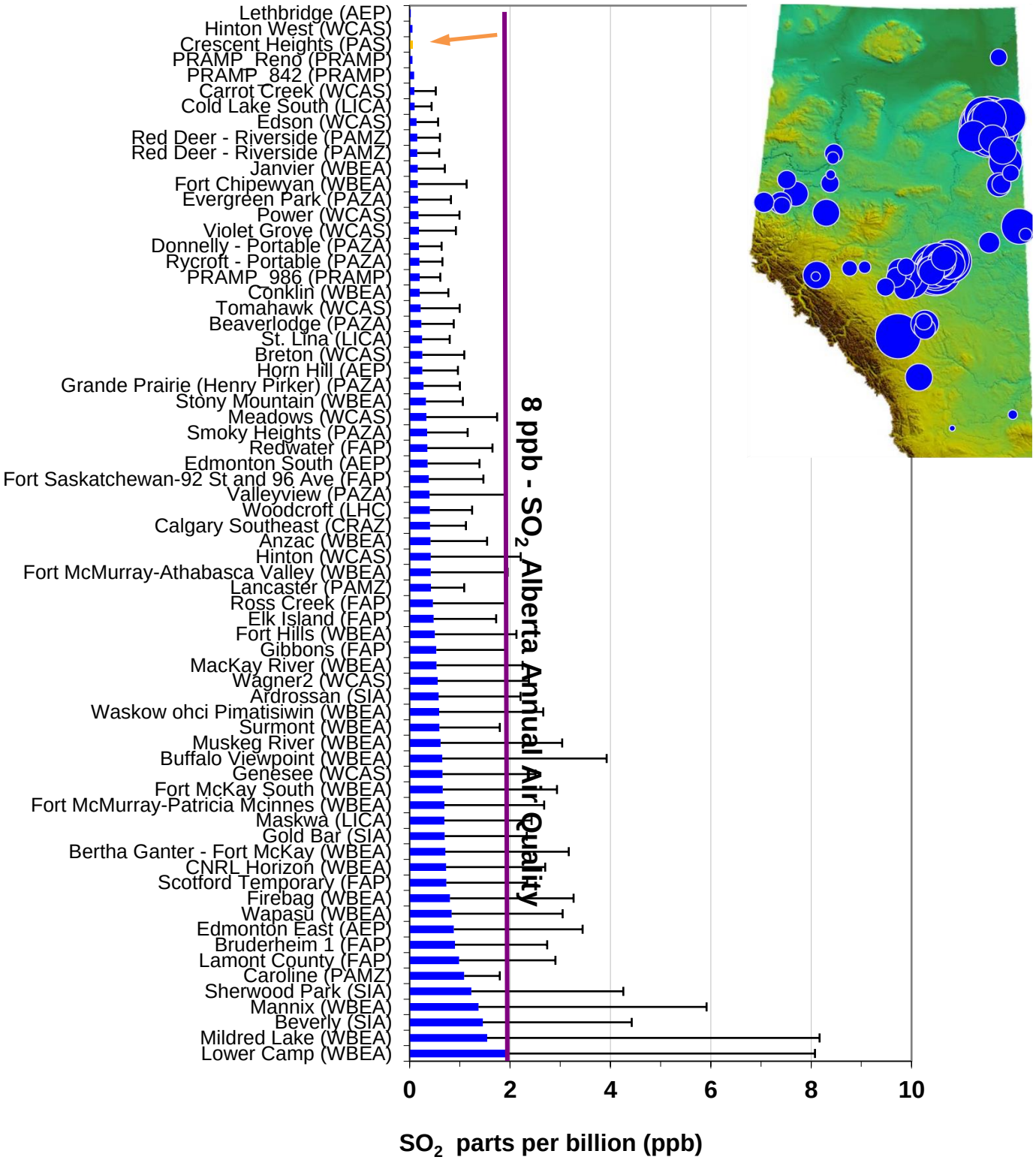


Figure 9. Sulphur Dioxide (SO_2) – 2018 Annual Average

Air Quality Health Index

The Air Quality Health Index (AQHI) is a health protection tool that is designed to help the public make decisions to protect their health by limiting short-term exposure to air pollution, and adjusting their activity levels during increased levels of air pollution. The AQHI uses concentration data for three air pollutants to calculate a single numerical value to evaluate the health risk associated with air pollution. The three air pollutants are fine particulate matter, nitrogen dioxide, and ozone. All three pollutants are required to calculate the AQHI. If one or more of the pollutants is missing data, the AQHI index cannot be reported.

The following scale illustrates the risk categories and health messages for the AQHI system (AEP, 2011). The health risk is classified in four categories: Low (1 to 3), Moderate (4 to 6), High (7 to 10), and Very High (greater than 10).

Figure 10 compares the AQHI ratings for 21 communities in Alberta. For the City of Medicine Hat, air quality was rated Low Risk 89.2% of the time, Moderate Risk 10.4% of the time, and High Risk 0.4% of the time. The Moderate and High Risk air quality events were primarily attributed to wildfire smoke in the region. Large forest fires in British Columbia created high concentrations of fine particulate matter in the region.

Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population	General Population
Low Risk	1 – 3	**Enjoy** your usual outdoor activities.	**Ideal** air quality for outdoor activities.
Moderate Risk	4 – 6	**Consider** reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	**No need to modify** your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High Risk	7 – 10	**Reduce or reschedule** strenuous activities outdoors. Children and the elderly should also take it easy.	**Consider** reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High Risk	Above 10	**Avoid** strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	**Reduce or reschedule** strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

Source: http://esrd.alberta.ca/air/programs-and-services/air-quality-health-index/about-AQHI.aspx

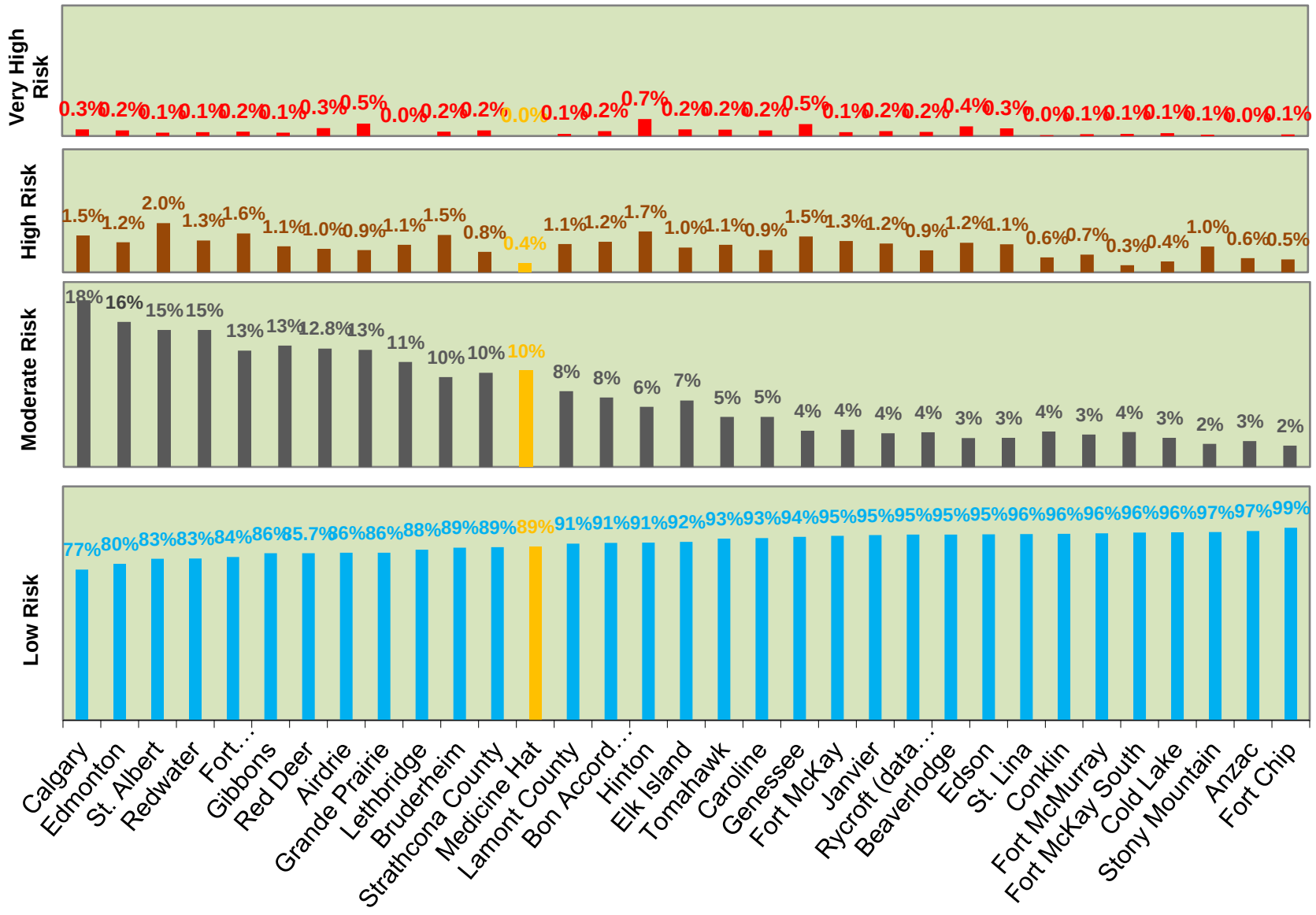
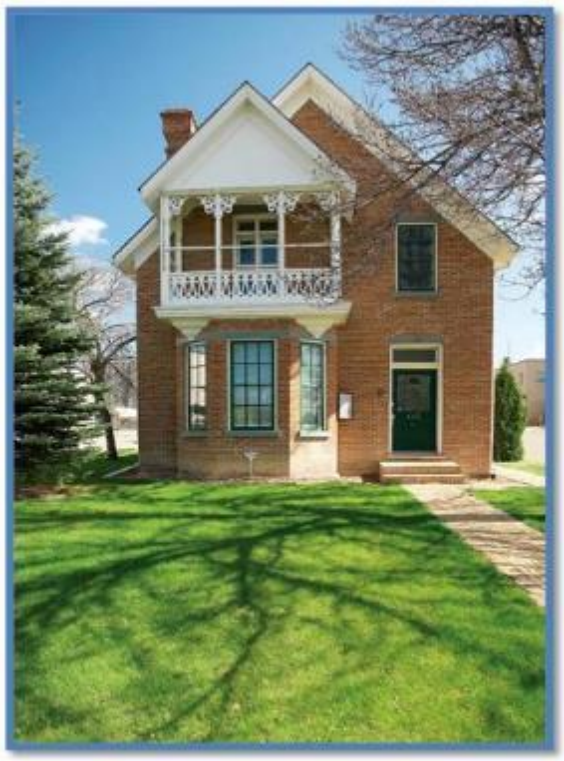


Figure 10. 2018 Air Quality Health Index for Alberta Communities

Passive Air Quality Monitoring Results

The PAS Air Quality Monitoring Program uses passive samplers as a cost-effective method to monitor air quality throughout the airshed. The results are used to assess the spatial distribution trend of air pollutants in the region. The monitoring objective is to ensure the air quality is in compliance with Alberta's Ambient Air Quality Objectives (AAAQO), as well as to provide monitoring of long-term trends.

The advantages of passive sampling devices include simple sampler design, low operation costs, and ease of use. Passive samplers require no power, making them suitable for monitoring air quality in remote areas. Passive samplers are designed to monitor long-term average concentrations. The disadvantage of the passive sampling devices is that short-duration events cannot be identified.



Passive sampling devices rely on the principles of permeation and diffusion to uptake the specific compound being sampled. Air pollutants diffuse through a semi-permeable membrane or tube to a sampling medium which has been chemically treated to absorb or react with the target air pollutant. After being exposed in the field for a predetermined period of time, the sampler is analyzed in a certified laboratory. An average concentration is calculated based on the duration of exposure and accounting for the effects of environmental conditions, e.g. temperature, humidity, and wind speed.

Initially, the PAS passive sampling program included 6 passive monitoring stations that were located based on airshed modeling predictions of high impact areas, and to gather data in sensitive areas within the airshed (e.g. hospitals, schools). Passive Network Rationalization resulted in changes to the passive network in early 2017. The current network is made up of 8 SO_2 sites and 16 NO_2 sites.

The PAS passive network provides 30-day samples to be analyzed for sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3) (January and February only). These parameters are the priority air quality concerns and remain consistent with those being monitored by other Alberta airsheds. A Multi-Gas Passive Sampler was used for the PAS passive program until May 2014, when it was replaced with the Ogawa Ozone sampler and the Radiello sampler tube for sulphur dioxide and nitrogen dioxide. The samplers were changed again in November 2017, to the Maxxam Passive Air Sampling System (PASS).

Nitrogen Dioxide

The annual average concentration of nitrogen dioxide ranged from 0.3 ppb to 3.8 ppb, which is substantially less than the annual AAAQO of 24 ppb. The maximum 30-day average concentration of 10.7 ppb was detected in December at Site 19 (Crescent Heights), while the lowest 30-day average concentration of 0.2 ppb was detected at Site 17 (Onefour) in March.

Figure 11 illustrates the historical data for monthly network average concentrations for passive NO_2. The histogram exhibits a seasonal trend: higher concentrations tend to occur in the winter months. In winter, the Palliser airshed region is characterized by low atmospheric ceilings and thermal inversions such that air pollutants are trapped near the ground level. Emissions from space heating may be another factor contributing to the seasonal trend.

Figure 14 illustrates the annual average concentrations across the PAS airshed. A spatial trend seems to exist: a higher concentration tends to occur in the cities and near major highways. Traffic emissions and space heating could be the potential causes. Within the passive network, the maximum annual average concentration of 3.8 ppb was detected at Site 19 (Crescent Heights), while the minimum concentration of 0.3 ppb was detected at Site 17 (Onefour).

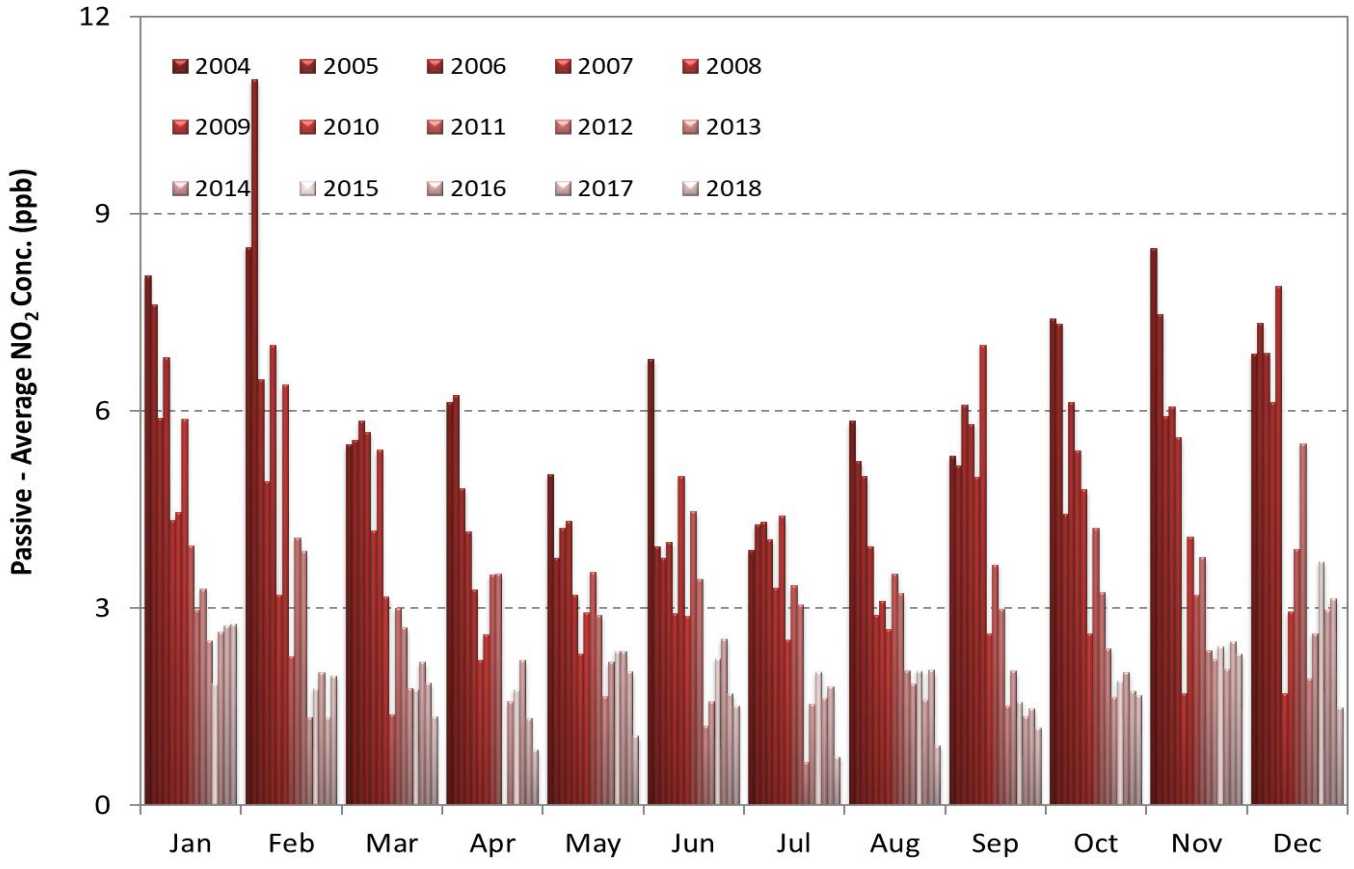


Figure 11. Passive Nitrogen Dioxide (NO_2) – Annual and Monthly Trends

Sulphur Dioxide

The concentration of sulphur dioxide generally is quite low in the PAS airshed zone. The annual average concentration of SO_2 ranged from 0.3 to 0.7 ppb, with no exceedances of the annual AAAQO of 8 ppb or of the 30-day AAAQO of 11 ppb.

The annual average concentration in 2018 was 0.4 ppb. The maximum 30-day average concentration of 3.0 ppb was detected in August at Site 8 (Jenner), while the lowest concentration was less than the detection limit (detected at all monitoring sites).

Figure 13 illustrates historical data for the monthly average concentrations of the passive SO_2 network. Given the low concentration of SO_2, data uncertainty may be too high to comment on a monthly, seasonal or yearly trend.

Figure 14 illustrates the annual average concentrations across the PAS airshed zone. Given the low concentration of SO_2, data uncertainty may be too high to comment on a spatial trend. The maximum annual average concentration of 0.7 ppb was detected at Site 8 (Jenner).

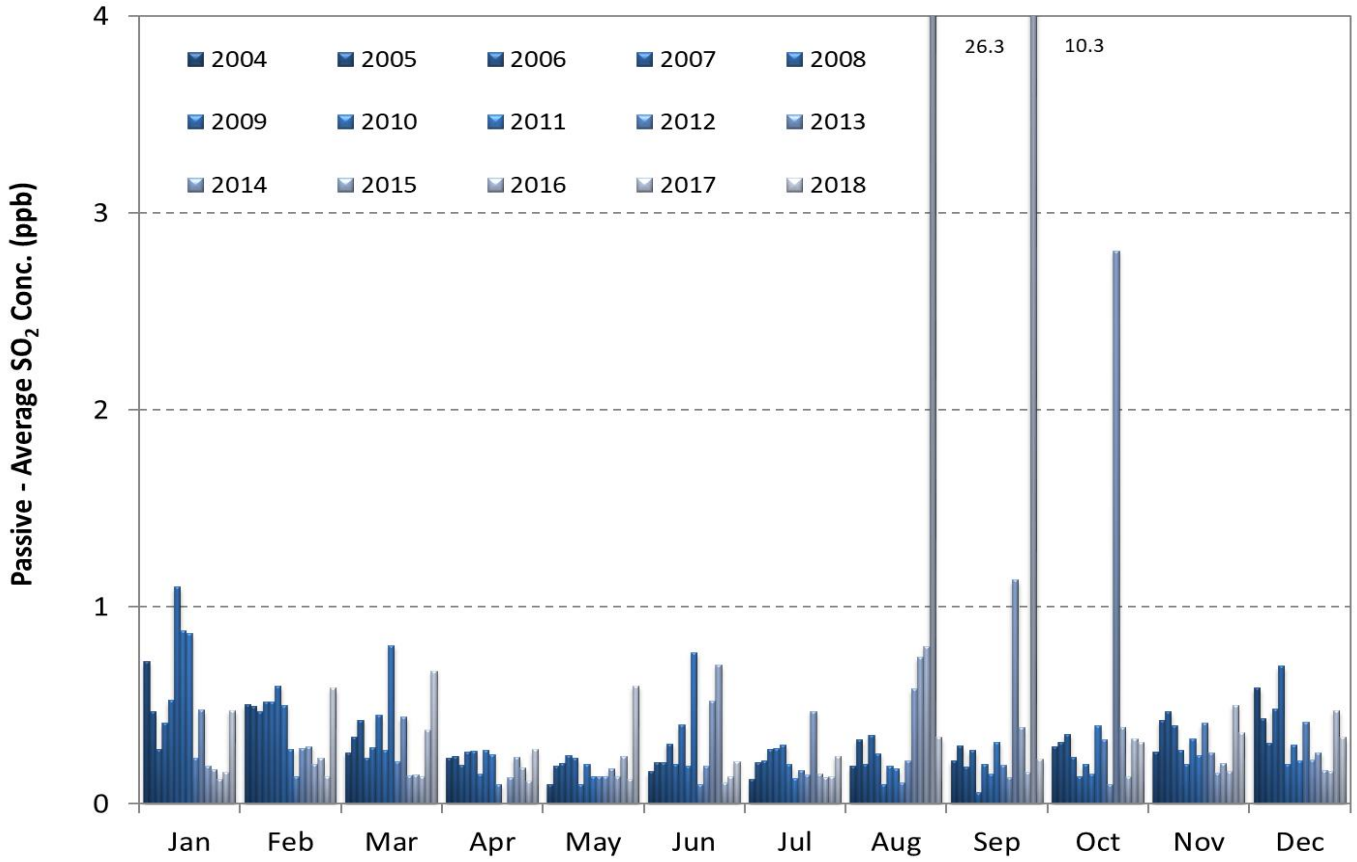


Figure 13. Passive Sulphur Dioxide (SO_2) –Annual and Monthly Trends

2018 Annual Averages For the Passive Program

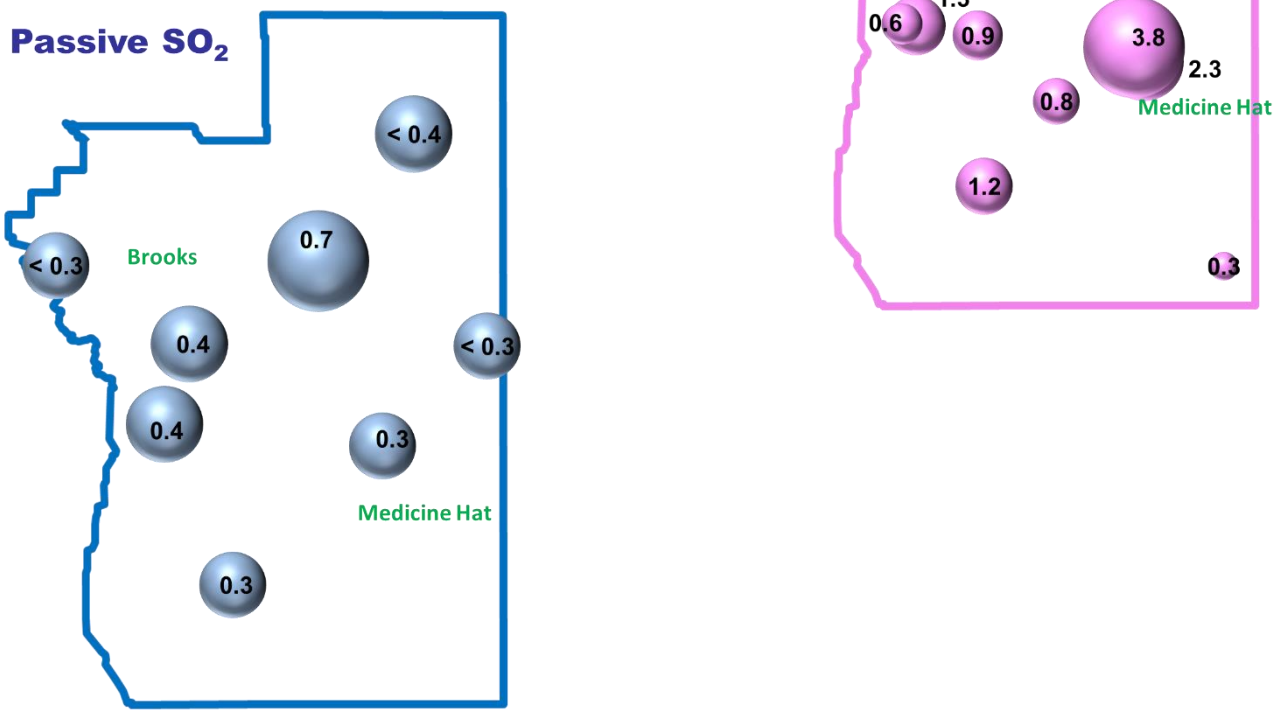


Figure 14. Passive Concentrations in the PAS Airshed – 2018 Annual Averages

PAS Financial Statements – Reviewer's Report

Palliser Airshed Society

Financial Statements

December 31, 2018

Palliser Airshed Society
Index to Financial Statements
For the Year Ended December 31, 2018

SEAN D. MILLER
PROFESSIONAL CORPORATION
CHARTERED PROFESSIONAL ACCOUNTANT

Independent Practitioner's Review Engagement Report

To the Members of Palliser Airshed Society

I have reviewed the accompanying financial statements of Palliser Airshed Society which comprise the statement of financial position as at December 31, 2018 and the statements of operations, changes in net assets and cash flows for the year then ended, and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation and fair presentation of these financial statements in accordance with Canadian accounting standards for not-for-profit organizations, and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

Practitioner's Responsibility for the Financial Statements

My responsibility is to express a conclusion on the accompanying financial statements based on my review. I conducted my review in accordance with Canadian generally accepted standards for review engagements, which require me to comply with relevant ethical requirements.

A review of financial statements in accordance with Canadian generally accepted standards for review engagements is a limited assurance engagement. The practitioner performs procedures, primarily consisting of making inquiries of management and others within the entity, as appropriate, and applying analytical procedures, and evaluates the evidence obtained.

The procedures performed in a review are substantially less in extent than, and vary in nature from, those performed in an audit conducted in accordance with Canadian generally accepted auditing standards. Accordingly, I do not express an audit opinion on these financial statements.

Conclusion

Based on my review, nothing has come to my attention that causes me to believe that these financial statements do not present fairly, in all material respects, the financial position of Palliser Airshed Society as at December 31, 2018, and the results of its operations and its cash flows for the year then ended in accordance with Canadian accounting standards for not-for-profit organizations.

Medicine Hat, Alberta
May 9, 2019

Sean D. Miller Professional Corporation
Chartered Professional Accountant

P 403.580.7400 / F 403.580.7404 / #5 - 3295 Dunmore Road SE, Medicine Hat, AB T1B 3R2 / www.millercpa.ca

Palliser Airshed Society
Statement of Financial Position
December 31, 2018

	2018	2017
ASSETS		
CURRENT		
Cash	**$ 123,411**	$ 128,258
Contributions and grants receivable *(Note 4)*	**29,828**	43,248
Goods and services tax recoverable	**6,678**	4,897
Prepaid expenses	**5,170**	5,072
	165,087	181,475
CAPITAL ASSETS *(Note 5)*	**82,874**	89,751
	$ 247,961	$ 271,226
LIABILITIES AND NET ASSETS		
CURRENT		
Accounts payable and accrued liabilities	**$ 5,418**	$ 5,001
NET ASSETS		
Unrestricted net assets	**159,669**	176,474
Invested in capital assets	**82,874**	89,751
	242,543	266,225
	$ 247,961	$ 271,226

On behalf of the Board

RK Johnson _____ *Chairperson*

R Wadden _____ *Treasurer*

See notes to financial statements
Sean D. Miller Professional Corporation

Palliser Airshed Society
Statement of Operations
For the Year Ended December 31, 2018

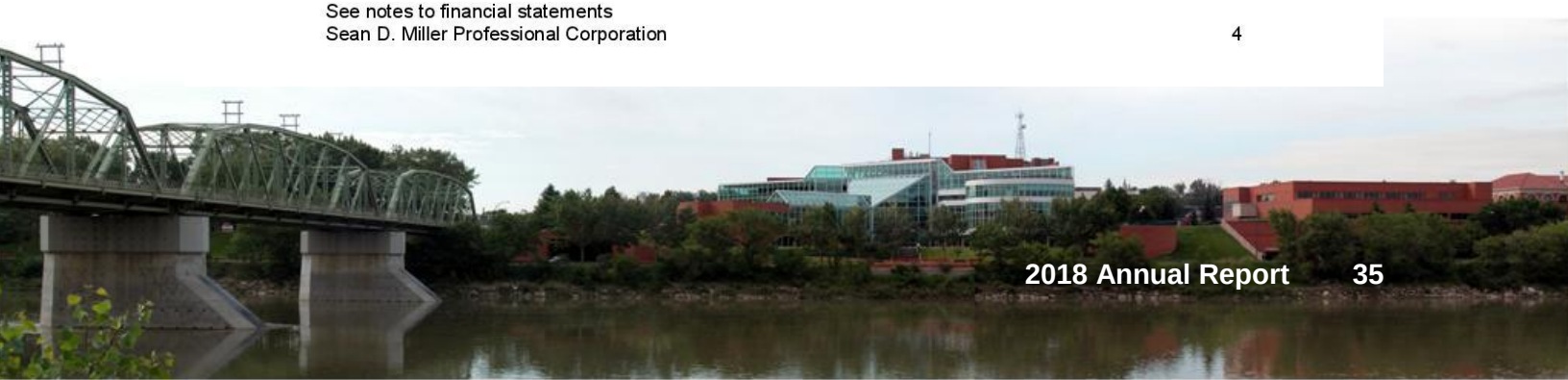
	2018	2017
REVENUE		
Member contributions	**$ 108,516**	$ 101,381
Government contracts - Alberta Environment & Parks	**128,320**	168,580
	236,836	269,961
EXPENSES		
Insurance	**7,471**	7,364
Interest and bank charges	**103**	101
Meals and entertainment	**82**	1,335
Meetings and conventions	**731**	694
Memberships and subscriptions	**1,960**	1,000
Monitoring and program management fees	**210,820**	194,627
Office	**1,774**	1,931
Professional fees	**5,825**	5,513
Travel and honorarium	**2,330**	1,549
Amortization	**17,900**	22,438
	248,996	236,552
EXCESS (DEFICIENCY) OF REVENUE OVER EXPENSES FROM OPERATIONS	**(12,160)**	33,409
OTHER EXPENSE		
Loss on disposal of capital assets	**11,522**	-
EXCESS (DEFICIENCY) OF REVENUE OVER EXPENSES	**$ (23,682)**	$ 33,409

See notes to financial statements
Sean D. Miller Professional Corporation

Palliser Airshed Society
Statement of Changes in Net Assets
For the Year Ended December 31, 2018

	Unrestricted Net Assets	Invested in Capital Assets	**2018**	2017
NET ASSETS - BEGINNING OF YEAR	$ 176,474	$ 89,751	**$ 266,225**	$ 232,816
Excess (deficiency) of revenue over expenses	5,740	(29,422)	**(23,682)**	33,409
Transfer from Unrestricted Net Assets to Invested in Capital Assets *(Note 10)*	(22,545)	22,545	**-**	-
NET ASSETS - END OF YEAR	$ 159,669	$ 82,874	**$ 242,543**	$ 266,225

See notes to financial statements
Sean D. Miller Professional Corporation



Palliser Airshed Society
Statement of Cash Flows
For the Year Ended December 31, 2018

	2018	2017
OPERATING ACTIVITIES		
Excess (deficiency) of revenue over expenses	**$ (23,682)**	$ 33,409
Items not affecting cash:		
Amortization	**17,900**	22,438
Loss on disposal of assets	**11,522**	-
	5,740	55,847
Changes in non-cash working capital:		
Contributions and grants receivable	**13,420**	17,559
Goods and services tax recoverable	**(1,781)**	1,302
Prepaid expenses	**(98)**	(61)
Accounts payable and accrued liabilities	**417**	(7,795)
	11,958	11,005
Cash flow from operating activities	**17,698**	66,852
INVESTING ACTIVITY		
Purchase of capital assets	**(22,545)**	-
INCREASE (DECREASE) IN CASH FLOW	**(4,847)**	66,852
CASH - BEGINNING OF YEAR	**128,258**	61,406
CASH - END OF YEAR	**$ 123,411**	$ 128,258
CASH CONSISTS OF:		
Cash	**$ 123,411**	$ 128,258

See notes to financial statements
Sean D. Miller Professional Corporation

Palliser Airshed Society
Notes to Financial Statements
For the Year Ended December 31, 2018

1. PURPOSE OF THE SOCIETY

Palliser Airshed Society (the "society") is a not-for-profit organization incorporated provincially under the Societies Act of Alberta. The society is exempt from the payment of income tax under Section 149(1) of the Income Tax Act.

The society's principal business activity is to monitor air quality using a combination of both continuous and passive monitoring technologies. The society is committed to collecting and communicating credible ambient air quality data back to all stakeholders.

2. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Basis of presentation

The financial statements were prepared in accordance with Canadian accounting standards for not-for-profit organizations (ASNFPO).

Fund accounting

Palliser Airshed Society follows the deferral method of accounting for contributions.

The Unrestricted Net Assets Fund reports the revenue and expenses related to the day to day monitoring activities and operations.

The Invested in Capital Assets Fund reports the assets, liabilities, revenues, and expenses related to the society's capital assets.

Financial instruments policy

Financial instruments are recorded at fair value when acquired or issued. In subsequent periods, financial assets with actively traded markets are reported at fair value, with any unrealized gains and losses reported in income. All other financial instruments are reported at amortized cost, and tested for impairment at each reporting date. Transaction costs on the acquisition, sale, or issue of financial instruments are expensed when incurred.

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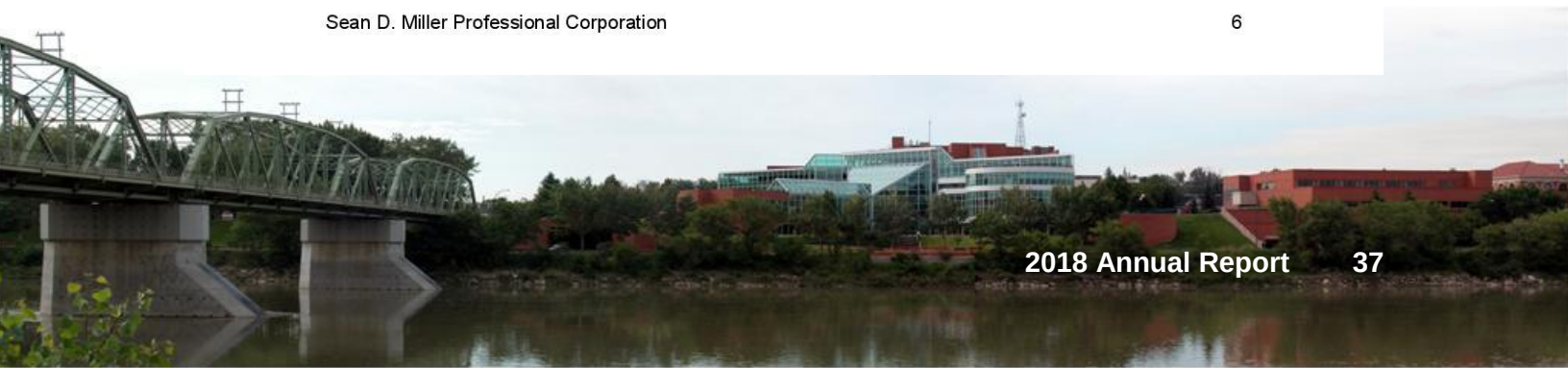

Palliser Airshed Society
Notes to Financial Statements
For the Year Ended December 31, 2018

2. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES *(continued)*

Revenue recognition

Palliser Airshed Society follows the deferral method of accounting for contributions.

Restricted contributions are recognized as revenue in the year in which the related expenses are incurred. Unrestricted contributions are recognized as revenue when received or receivable if the amount to be received can be reasonably estimated and collection is reasonably assured.

Restricted contributions consist of grant revenue received from Alberta Environment and Parks and are designated to be spent on executive director fees, office operations, and board expenses. These amounts are included in "Monitoring and program management fees".

Unrestricted contributions consist of member contributions in the year and are not designated for a specific purpose. Membership contributions consist of both mandatory and voluntary memberships.

Mandatory membership fees are received from companies who are regulated and mandated by the jurisdiction to be a local airshed member. These contributions are recognized as revenue at the time of billing.

Voluntary membership fees are received from companies who are regulated but not mandated by the jurisdiction to be a local airshed member. Municipalities also make contributions through voluntary membership. These contributions are recognized as revenue when received instead of at the time of billing due to the fact that these membership fees are voluntary and depend solely on the contributors' decision to renew their annual membership.

Restricted investment income is recognized as revenue in the year in which the related expenses are incurred. Unrestricted investment income is recognized as revenue when earned.

Capital assets

Capital assets are stated at cost or deemed cost less accumulated amortization and are amortized over their estimated useful lives at the following rates and methods:

Equipment	20%	diminishing balance method

The society regularly reviews its capital assets to eliminate obsolete items.

Capital assets acquired during the year but not placed into use before the end of the year are not amortized until they are placed into use.

Measurement uncertainty

The preparation of financial statements in conformity with Canadian accounting standards for not-for-profit organizations requires management to make estimates and assumptions that affect the reported amount of assets and liabilities, disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the period. Such estimates are periodically reviewed and any adjustments necessary are reported in earnings in the period in which they become known. Actual results could differ from these estimates.

Palliser Airshed Society
Notes to Financial Statements
For the Year Ended December 31, 2018

3. FINANCIAL INSTRUMENTS

Fair Value

The society's carrying value of cash, contributions and grants receivable, goods and services tax recoverable, prepaid expenses and accounts payable and accrued liabilities approximates its fair value due to the immediate or short term maturity of these instruments.

4. CONTRIBUTIONS AND GRANTS RECEIVABLE

	2018	2017
Alberta Environment and Parks	**$ 28,725**	$ 42,145
Mandatory memberships	**1,103**	1,103
	$ 29,828	$ 43,248

5. CAPITAL ASSETS

	Cost	Accumulated amortization	**2018 Net book value**	2017 Net book value
Equipment	$ 273,077	$ 190,203	**$ 82,874**	$ 89,751

6. RELATED PARTY TRANSACTIONS

The following is a summary of the society's related party transactions:

	2018	2017
Membership Contributions		
Contributions received from companies represented on the Board of Directors	**$ 47,115**	$ 51,819
Government Contracts		
Contributions received from governments represented on the Board of Directors	**128,320**	168,580
	$ 175,435	$ 220,399

Contributions receivable include $28,725 (2017 - $42,145) due from members of the society represented on the Board of Directors.

These transactions are in the normal course of operations and are measured at the exchange amount, which is the amount of consideration established and agreed to by the related parties.

Palliser Airshed Society
Notes to Financial Statements
For the Year Ended December 31, 2018

7. CONTRACTUAL OBLIGATIONS

The agreement between the society and Wood PLC (formerly AMEC Foster Wheeler) has been extended for July 1, 2018 - June 30, 2019. The agreement states that Wood PLC will provide the following services to the society:

Monitoring Network Operations and Maintenance	$11,134.20/month

The society has budgeted a nominal 3% cost increase to secure a monitoring and maintenance operations contractor beginning July 1, 2019 for a multiyear period.

The society has had a contract in place for Executive Director services for the period January 1, 2015 to December 31, 2018 as follows:

Executive Director Services:	$ 4,847.85/month

The society has a new contract in place for Executive Director services for the period January 1, 2019 to December 31, 2021 as follows:

Executive Director Services:	$ 4,900.35/month

8. ECONOMIC DEPENDENCE

The society derives all of its income from member contributions and Alberta Government contracts and grants. The society's ability to continue viable operations is dependant upon continuing to receive funding from these sources.

9. SUBSEQUENT EVENT

Subsequent to year end, the society has received Core Grant funding from the Community Engagement Branch of AEP to cover a portion of the administration and overhead costs associated with the airpointer and the Passive Monitoring Network for a value of $31,520 per annum. The application was submitted to cover the shortfall from the new EMSD-AEP contract.

10. INTERFUND TRANSFER

The interfund transfer of $22,545 from the Unrestricted Net Assets fund to the Invested in Capital Assets fund represents the cost associated with the purchase of a replacement NOx analyzer for the airpointer (air monitoring equipment) during the year.

Acknowledgements

The Palliser Airshed Society would like to acknowledge the hard work and contributions of all stakeholders and contractors in partnership with the association. PAS has made significant strides towards achieving the stated goals in 2018. Our member companies and municipalities have continued to provide experience and financial stability to PAS, even in times of less than ideal economic conditions.

We are looking forward to a successful 2019

Palliser Airshed Society

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