Fort Air Partnership

2022

Ambient Air Quality Monitoring Annual Network Report And Data Summary

FORT AIR PARTNERSHIP

We Monitor the Air You Breathe

FAP Technical Working Group April 2023

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Table of Contents

List of Tables

List of Figures

Abbreviations and Acronyms

24-hours	A calendar day, beginning at midnight
AAAQG	Alberta Ambient Air Quality Guideline
AAAQO	Alberta Ambient Air Quality Objective
AER	Alberta Energy Regulator
AMD	Air Monitoring Directive
AQM	Air Quality Monitoring
BTEX/S	Benzene, toluene, ethylbenzene, xylenes and styrene
CAAQS	Canadian Ambient Air Quality Standards
Calm	1-hour average wind speed is lower than 5 km/hour
CASA	Clean Air Strategic Alliance
CH_4	Methane
EPEA	Alberta's Environmental Protection and Enhancement Act
FAP	Fort Air Partnership
H_2S	Hydrogen sulphide
MST	Mountain Standard Time
NAPS	National Air Pollution Surveillance
NMHC	Non-methane hydrocarbons
NH_3	Ammonia
NO_2	Nitrogen dioxide
NO	Nitric oxide
NO_X	Oxides of nitrogen
O_3	Ozone (present at ground level)
$PM_{2.5}$	Particulate matter with aerodynamic diameter less than 2.5 µm, Also referred to as fine particles
QA/QC	Quality assurance / quality control
SO_2	Sulphur dioxide
THC	Total hydrocarbons
TWG	FAP Technical Working Group
VOC	Volatile organic compound
WD or WDR	Wind direction
WS or WSP	Wind speed

Units of Measurement

µg/m^3	micrograms per cubic meter
km/hr or kph	kilometers per hour
ppb	parts per billion by volume
ppm	parts per million by volume

Note: Where the Alberta Government is mentioned in this report, the reference is to the Department that has authority over and regulates the industrial approvals of air monitoring and reporting. As of December 31, 2022, this department was Alberta Environment and Protected Areas.

2022 Network Summary

Network Overview

During 2022 Fort Air Partnership (FAP) operated ten continuous ambient air quality monitoring stations. One of the stations, the Keith Purves Portable monitoring station, operated for eight months of the year at one location. Table 1 describes the parameters measured at continuous stations as of the end of 2022. The Lamont County Station was moved to Lamont in November of 2022

In addition to the continuous network, FAP operated a 16-site passive monitoring network in 2022. Compounds measured in the passive network include sulphur dioxide (SO_2) and hydrogen sulphide (H_2S).

Table 1: FAP continuous monitoring stations and parameters 2022

	Bruderheim 1	Elk Island	Fort Sask.	Gibbons	Lamont and Lamont County	Range Road 220	Redwater	Ross Creek	Scotford South	Keith Purves Portable*
Air Quality Health Index (AQHI)	✓	✓	✓	✓	✓		✓			✓
Ammonia (NH_3)			✓				✓	✓		
Carbon Monoxide (CO)			✓							
Ethylene (C_2H_4)						✓		✓		
Ozone (O_3)	✓	✓	✓	✓	✓		✓			✓
Total Hydrocarbons (THC)	✓		✓		✓	✓				✓
Non-methane Hydrocarbons (NMHC)	✓		✓		✓	✓				✓
Methane (CH_4)	✓		✓		✓	✓				✓
Hydrogen Sulphide (H_2S)			✓	✓	✓		✓		✓	✓
Oxides of Nitrogen (NO_X)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nitric Oxide (NO)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 1: FAP continuous monitoring stations and parameters 2022 (continued)

	Bruderheim 1	Elk Island	Fort Sask.	Gibbons	Lamont and Lamont County	Range Road 220	Redwater	Ross Creek	Scotford South	Keith Purves Portable*
Nitrogen Dioxide (NO_2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fine Particulates ($PM_{2.5}$)	✓	✓	✓	✓	✓		✓			✓
Sulphur Dioxide (SO_2)	✓	✓	✓	✓	✓		✓	✓	✓	✓
Benzene (C_6H_6)									✓	
Ethylbenzene (C_8H_{10})									✓	
Styrene (C_8H_8)									✓	
Toluene (C_7H_8)									✓	
Xylene ($C_{24}H_{30}$)									✓	
Air Temperature @ 2 meters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Air Temperature @ 10 meters								✓		
Delta Temperature								✓		
Barometric Pressure							✓	✓	✓	
Relative Humidity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Solar Radiation								✓		
Vertical Wind Speed								✓		
Wind Speed and Wind Direction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

*The Keith Purves Portable station operated in the town of Lamont from January through August prior to the move of the Lamont County station.

Continuous Monitoring Performance Measures

In 2022 the average monthly uptime of all continuous monitoring equipment in the network was **99.2%.** FAP's overall average uptime target is 98.5% or better, while the Alberta Government requires that monitoring equipment be fully operational a minimum of 90% of each month. Table 2 below lists the uptimes for the gas and particulate analyzers as well as horizontal wind speed and direction. Other meteorological parameters such as temperature are not included in the table.

There were seven instances where operational uptime of an ambient air monitor or meteorological sensor fell below the minimum 90% in a month as required by the Alberta Government. Each of these were reported to the Alberta Government, the issue promptly resolved, and the cause investigated.

Table 2: Data completeness 2022 (percent)

	Bruderheim1	Elk Island	Fort Sask.	Gibbons	Lamont County	Lamont	Portable at Lamont*	Range Road 220	Redwater	Ross Creek	Scotford South
Wind Speed & Direction	*99.7*	*99.3*	*98.9*	*99.6*	*99.9*	*96.7*	*100.0*	*99.7*	*99.7*	*99.3*	*99.6*
Sulphur Dioxide (SO_2)	*100.0*	*99.6*	*99.7*	*99.9*	*99.8*	*100.0*	*98.9*		*99.7*	*99.7*	*99.5*
Nitric Oxide (NO)	*99.5*	*100.0*	*99.2*	*99.8*	*99.6*	*99.0*	*99.6*	*99.9*	*97.6*	*98.5*	*98.4*
Nitrogen Dioxide (NO_2)	*99.5*	*100.0*	*99.2*	*99.8*	*99.6*	*99.0*	*99.6*	*99.9*	*97.6*	*98.5*	*98.4*
Oxides of Nitrogen (NOx)	*99.5*	*100.0*	*99.2*	*99.8*	*99.6*	*99.0*	*99.6*	*99.9*	*97.6*	*98.5*	*98.4*
Ammonia (NH_3)			*91.7*						*97.3*	*98.5*	
Ozone (O_3)	*99.8*	*99.8*	*99.9*	*99.9*	*99.8*	*99.6*	*99.7*				
Hydrogen Sulphide (H_2S)			*99.9*	*99.9*	*98.7*	*80.9*	*99.6*				*99.3*
Ethylene (C_2H_4)								*99.5*		*99.5*	
Total Hydrocarbon (THC)	*97.2*		*97.7*		*98.8*	*99.9*	*99.2*	*98.7*			
Methane (CH_4)	*97.2*		*97.7*		*98.8*	*99.9*	*99.2*	*98.7*			
Non-Methane Hydrocarbon (NMHC)	*97.2*		*97.7*		*98.8*	*99.9*	*99.2*	*98.7*			
Fine Particulates ($PM_{2.5}$)	*99.5*	*99.9*	*99.3*	*99.8*	*89.5*	*97.6*	*97.6*		*99.9*		
Carbon Monoxide (CO)			*99.9*								
Benzene (C_6H_6)											*96.4*
Toluene (C_7H_8)											*96.4*
Ethylbenzene (C_8H_{10})											*96.3*
Xylene ($C_{24}H_{30}$)											*96.1*
Styrene (C_8H_8)											*96.1*
Average Site	**98.89**	**99.80**	**98.45**	**99.82**	**98.45**	**97.4**	**99.30**	**99.35**	**98.46**	**98.94**	**97.73**

*The Keith Purves Portable station, Lamont County station and the new Lamont station uptime calculation does not include periods when the station was not in service.

Monitoring Network Changes in 2022

FAP made the following changes to the continuous monitoring network in 2022, including improvements to infrastructure and equipment.

- The Keith Purves Portable continuous monitoring station operated at Lamont until early September at which time it was dismantled in preparation for the next project near Newbrook.
- The Lamont County Station was decommissioned October 31. Analyzers and equipment were all moved to a new shelter in Lamont which commenced operation in November.
- New generation ozone analyzer was installed at the Lamont County station in January.

Air Quality Events and Exceedances Summary

The data Fort Air Partnership collects is compared to Alberta Ambient Air Quality Objectives (AAAQOs) established by the Government of Alberta. Exceedances of AAAQOs are reported to the Alberta Government and the cause of the exceedance investigated. Follow up information with attribution if determined, is then provided to the Alberta Government within seven days. One-hour and 24-hour average exceedances in 2022 are listed in Alberta Ambient Air Quality Objectives (AAAQO)

Table 3 and 4 respectively. Two significant wildfire smoke events occurred in Fort Air Partnership during 2022. Smoke from wildfires predominately outside of the province blanketed the Airshed over several days in July and again in early October, causing the bulk of the exceedances reported.

A complete listing of the AAAQO compounds and values can be found at:
Alberta Ambient Air Quality Objectives (AAAQO)

Table 3: 2022 1-hour average exceedances of the AAAQO

One Hour Exceedances			
Parameter	**Exceedances**	**Dates**	**Attributed Cause**
Fine Particulate ($PM_{2.5}$)	1	June 3	Undetermined
	14	August 22	Wildfire smoke
	1	September 1	Harvest dust
	31	September 4, 5	Wildfire smoke
	45	September 10, 11	Wildfire smoke
	3	October 8,18	Local fire pit
	12	October 18,19	Controlled burn (Elk Island Park)
	3	October 19	Regional meteorological conditions
	3	November 11	Wintertime inversion
	1	December 15	Brush burning
	4	December 30, 31	Wintertime inversion
Hydrogen Sulphide (H_2S)	2	July 14, 18	Natural, due to wetlands
	1	July 23	Industry responsible
	14	August 3, 16, 18, 22, 23, 24, & 31 September 18	Natural, due to wetlands

	1	August 25	Undetermined
	1	October 3	Natural, due to wetlands
Ozone (O_3)	3	August 20	Summertime smog
Total	**140**		

Table 4: 2022 24-hour average exceedances of the AAAQO

24 Hour Exceedances			
Parameter	**Exceedances**	**Dates**	**Attributed Cause**
Fine Particulates ($PM_{2.5}$)	9	August 22, 23	Wildfire smoke
	8	September 3, 4	
	11	September 10, 11	
	1	October 18	Local fire pit
	2	October 18,19	Controlled burn (Elk Island Park)
	8	October 18,19	Regional meteorological conditions
	5	November 10,11	Wintertime inversion
	1	November 14	Undetermined
	1	December 15	Brush burning
	7	December 30, 31	Wintertime inversion
Hydrogen Sulphide (H_2S)	1	August 23	Natural, due to wetlands
Total	**54**		

2022 Summary of Exceedances

Table 5 provides the total exceedances for each compound FAP measures that has a respective AAAQO in 2022 and the previous 5 years.

Table 5: Summary of 2022 Exceedances and 5 years previous

Parameter Measured		2022	2021	2020	2019	2018	2017
Ammonia (NH_3)	*1-hr*	-	-	-	-	-	1
Benzene (C_6H_6)	*1-hr*	-	-	-	-	-	-
Carbon Monoxide (CO)	*1-hr*	-	-	-	-	-	-
	8-hr	-	-	-	-	-	-
Ethyl Benzene (C_8H_{10})	*1-hr*	-	-	-	-	-	-
Ethylene (C_2H_4)	*1-hr*	-	-	-	-	-	-
	3-day	-	-	-	-	-	-
	Annual	-	-	-	-	-	-
Fine Particulate Matter ($PM_{2.5}$)	*1-hr*	118	393	6	119	810	69
	24-hr	53	60	19	37	117	29
Hydrogen Sulphide (H_2S)	*1-hr*	19	16	7	9	20	-
	24-hr	1	-	1	1	4	-
Nitrogen Dioxide (NO_2)	*1-hr*	-	-	-	-	-	-
	24-hr	-	-	-	-	-	-
	Annual	-	-	-	-	-	-
Ozone (O_3)	*1-hr*	3	3	-	23	6	-
Styrene (C_8H_8)	*1-hr*	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	*1-hr*	-	-	-	-	-	38
	24-hr	-	-	-	-	-	9
	30-day	-	-	-	-	-	1
	Annual	-	-	-	-	-	-
Toluene (C_7H_8)	*1-hr*	-	-	-	-	-	-
Xylenes (o-, m- and p- isomers)	*1-hr*	-	-	-	-	-	-
Total Exceedances		**194**	**472**	**33**	**189**	**957**	**147**

Note: SO_2 exceedances in 2017 occurred at a station that FAP no longer operates.

Air Quality Health Index Summary

The Air Quality Health Index (AQHI) was reported from seven FAP stations in 2022. The Keith Purves portable station operated at Lamont from January through August. AQHI results for the two sites are listed separately. The AQHI is calculated by the Government of Alberta using FAP collected data. In Alberta the AQHI is calculated using fine particulate matter ($PM_{2.5}$), ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and hydrogen sulphide (H_2S) data.

Table 6: Air Quality Health Index in FAP region by percent - 2022

		Risk Level (% of time)			
Station Name	Hours Monitored	Low Risk	Moderate Risk	High Risk	Very High Risk
Bruderheim	8303	94.65%	5.25%	0.10%	0.00%
Elk Island	8513	96.99%	2.64%	0.24%	0.13%
Fort Saskatchewan	8189	91.45%	8.27%	0.28%	0.00%
Gibbons	8550	92.95%	6.48%	0.54%	0.03%
Lamont County	6933	97.00%	2.94%	0.06%	0.00%
Redwater	8215	95.87%	3.91%	0.22%	0.00%
Town of Lamont*	6908	95.87%	4.13%	0.00%	0.00%
Total hours	55611	52776	2702	119	14

***The Town of Lamont includes the Keith Purves Portable till September, then the new permanent station beginning in November.*

Table 7: Air Quality Health Index in FAP region number of hours - 2022

		Risk Level (# of hours)			
Station Name	Hours Monitored	Low Risk	Moderate Risk	High Risk	Very High Risk
Bruderheim	8303	7859	436	8	0
Elk Island	8513	8257	225	20	11
Fort Saskatchewan	8189	7489	677	23	0
Gibbons	8550	7947	554	46	3
Lamont County	6933	6725	204	4	0
Redwater	8215	7876	321	18	0
Lamont (Town)	6908	6623	285	0	0
Total hours	**55611**	**52776**	**2702**	**119**	**14**

***The Town of Lamont includes the Keith Purves Portable till September, then the new permanent station beginning in November.*

The higher the AQHI number, the greater the health risk. The index describes the level of health risk associated with the AQHI number as 'low', 'moderate', 'high' or 'very high', and suggests steps people can take to reduce exposure. Table 8 details the occurrence of air quality events in 2022 and the number of hours with a high or very-high risk AQHI rating at each station.

Table 8: Distribution of hours with an AQHI High or Very-High Risk rating

	FAP Continuous Air Quality Monitoring Station															
	Bruder-heim 1		Elk Island		Fort Sask.		Gibbons		Lamont County		Redwater		Town of Lamont*			
Air Quality Event Dates	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Total Hrs.	Attributed Cause
Aug 20-22			5		4		4		1		2				**16**	Wildfire smoke
Sep 2-5			1		4		18				8				**31**	Wildfire smoke
Sep 10-11	3		10		15		23	3	1						**55**	Wildfire smoke
Oct 9											1				**1**	Local campfire
Oct 19	1		2	11					2		7				**23**	Regional met conditions and controlled burn at Elk Island Park
Nov 11							1								**1**	Wintertime inversion
Dec 31	4		2												**6**	Wintertime inversion
Total Hours	**8**	-	**20**	**11**	**23**	-	**46**	**3**	**4**	-	**18**	-	-	-	**133**	

** The Town of Lamont includes the Keith Purves Portable till September, then the new permanent station beginning in November.*

Overview

The FAP Organization (2022)

The Fort Air Partnership (FAP) is a registered not-for-profit society established in 1997 to operate an air quality monitoring network in a 4,500-square kilometer area northeast of Edmonton, Alberta that includes the city of Fort Saskatchewan, the communities of Gibbons, Bon Accord, Bruderheim, Lamont, Redwater, Waskatenau, Thorhild, and Elk National Island Park. In November 2000, FAP became the fourth Airshed in Alberta recognized by the Clean Air Strategic Alliance (CASA) of Alberta.

FAP is a multi-stakeholder group with members from industry, provincial and municipal government, and the public. FAP members see the benefit of working collaboratively to meet the organization's vision and mission.

The FAP Board holds regular meetings that are open to the public. Decisions of the Board and its committees are made by consensus.

The FAP Vision:

"*Public, industry and government have a clear shared understanding of ambient air quality in the region".*

The FAP Mission:

"To operate a regional network to monitor and report credible and comprehensive ambient air quality information".

FAP uses a governance organizational structure, such that the Board of Directors establishes policy and strategic direction for the organization, and contracted staff and committees manage the operational details in accordance with the set direction. In 2022 FAP continued to operate with several committees including an Executive Committee, a Technical Working Group (TWG) and related subcommittees, an External Relations Committee, a Finance Committee and a Governance Committee, which all make recommendations to the FAP Board of Directors. FAP operations were managed by an Executive Director, with contracted staff consisting of a Network Manager, Communications Director, and an Administrative Assistant. FAP contracts air monitoring service providers who perform monitoring equipment operation, maintenance, calibration, and data validation and reporting.

Fort Air Partnership's monitoring and communications programs are funded by:

- Northeast Capital Industrial Association
- Alberta Government

- Alberta's Industrial Heartland Association
- Environment and Climate Change Canada provides monitoring equipment for two continuous monitoring stations and PurpleAir® sensors.

FAP ambient air monitoring and reporting activities are accomplished under its comprehensive Quality Assurance Program as required by the Alberta Government. FAP has developed the following quality statement to guide its work:

"Dependable, impartial collection of high-quality data."

FAP works with other Airsheds provincially as part of the Alberta Airsheds Council. Airsheds in Alberta collaborate with both the provincial and federal government to implement successful air monitoring, reporting, and education within Alberta. Multi-stakeholder oversight of monitoring, data and analysis through Alberta's Airshed organizations is critical to ensuring a credible, science-based approach to understanding air quality in Alberta. Stakeholders include all levels of government, industry, non-governmental organizations and the public. Timely execution of environmental monitoring, and the provision of scientifically credible monitoring data to the public and policy makers for informed decision making, are critical functions provided by Airsheds. An important aspect to this collaborative work is sharing of technical expertise and information through the Alberta Airsheds Council Technical Committee.

Fort Air Partnership Technical Working Group (TWG)

FAP's TWG is primarily responsible for oversight of the implementation and operation of the monitoring network and provides technical guidance to FAP. The TWG meets monthly, except in summer, to review the data and network operations. The TWG operates under the leadership of the FAP Network Manager to ensure that appropriate protocols are in place to ensure data quality and guidance on air monitoring projects.

TWG members represent a wide range of technical air quality expertise from industry, the Environment Ministries of the Alberta and Canadian Governments, FAP's primary monitoring and data validation contractors, and members of the public. Committee members have substantial combined experience including monitoring technology, data analysis, laboratory analysis, quality systems, engineering, air quality modeling, environmental health and safety and regulatory reporting. Additionally, the TWG membership draws upon outside expertise from industry, air quality consultants, academia and government. Members of the TWG collaborate with other air monitoring agencies in Alberta and Canada. The FAP TWG chair also plays a leading role as a member of the Alberta Airsheds Council Technical Committee, consisting of technical leads from all Airsheds in Alberta. A list of TWG committee members as of December 31, 2022, can be found in Appendix A. Lists of industry approval holders participating in FAP, as required in many cases by Environmental and Protection Enhancement Act (EPEA) operating approval clauses can be found in Appendix B.

FAP Air Quality Results Reporting:

FAP Data

FAPs air monitoring data is reported and available in several ways:

- FAP maintains a near-real-time live data site with 90 days of raw un-validated data for use by its members and the public at Live Air Quality Data – Fort Air Partnership. Live, un-validated data is also reported hourly to the Alberta Government and retained for 1 year on the real-time website at:
  AQHI - Map (alberta.ca)
- Validated historical data, suitable for use in analysis and reports, is available from the Provincial air monitoring data warehouse. at:
  Access air quality and deposition data | Alberta.ca
- Passive monitoring data tables are available upon request at: info@fortairmail.org

Live Data Site

FAP continues to provide a free, on-line live data feed that allows anyone to check out air quality readings at any time. Users can search by station, or by substance, and get hour-by-hour current or past raw data in an easy-to-understand format. The technical sister to this public service allows regulators, technical group users and emergency responders to receive minute-by-minute data in near real time.

The data available on the FAP live data site are raw numbers but quality controls ensure the data is validated before being permanently stored in the Alberta Government air data monitoring warehouse.

The public site features an interactive map with pop-up legends showing the substances monitored at each of our 10 continuous air monitoring stations, 16 passive sites and five PurpleAir® sites. Hourly measurements from the continuous stations are available in near real time. The site also enables measurement comparisons to one-hour provincial objectives for substances where an objective exists. Passive sampler data is updated monthly.

FAP Reports

AQHI Reporting

Weekly charts of the AQHI calculated at FAP stations are published on the FAP website, social media platforms and distributed to local media.

If the Air Quality Health Index approaches the *High Risk* to health category, medical officers from the local health authority are notified by Alberta Environment and Protected Areas. Alberta Government medical officers may then decide whether to issue a public health or air quality advisory.

Public Reports

The following public reports are available on the FAP website or by emailing info@fortairmail.org

- Reports such as this one, prepared annually for public release.
- Reports of the findings for each location and project for the Keith Purves Portable station.
- Quarterly summaries of AQHI statistics and AAAQO exceedances.
- Scientific reports with findings of special sampling projects carried out by FAP from time to time. The Bruderheim VOC speciation and Ross Creek fine particulate speciation study reports were released in 2021 and 2022 respectively.
- A report detailing long term trends at the Fort Saskatchewan station as compared to other stations in Alberta, Canada and internationally.

Reports to Government

- Reports from all continuous stations are submitted monthly to the Alberta Government with the content as prescribed by the AMD
- Annual reports, also submitted to Alberta Government.

More details on the FAP reporting protocol are provided in Appendix E of this report.

The FAP Monitoring Objectives

FAP identified specific objectives for its ambient air monitoring operations as early as 2001 when the first monitoring plan was developed. These objectives were revised in 2011 to guide a 3rd party network assessment at that time. In 2021 the FAP TWG struck a subcommittee to develop a new monitoring plan. One of the first tasks of this subcommittee was to review and revise the monitoring objectives and to ensure they still met FAP's mission and vision. While

the FAP monitoring network is designed to meet the FAP monitoring objectives, it is operated following the regulatory requirements as set out by the Alberta Government.

The monitoring objectives established in 2021 for the FAP network are as shown in **Error! Reference source not found.** below:

Table 9: FAP Monitoring Objectives

The FAP air monitoring network shall collect the data required to:
Provide information for evaluating population exposure to ambient air quality
Provide information required to understand air quality impacts on the ambient environmental condition
Understand spatial distribution of pollutants in the region
Identify regional air quality trends
Respond to emerging issues
Effectively identify and apportion pollutant sources-for purposes of air quality management

Alberta Ambient Air Quality Objectives

Alberta Ambient Air Quality Objectives (AAAQO) are set by the Alberta Government and intended to provide protection of the environment and human health to an extent technically and economically feasible, as well as socially and politically acceptable. Fort Air Partnership continuously compares the data it collects to these provincial Ambient Air Quality Objectives. This information is used to inform policy and management decisions by government and other organizations.

When air quality standards are exceeded, FAP alerts Alberta Environment and Protected Areas. This information is also accessed by Alberta Health Services to determine if a health advisory should be issued. The cause of each exceedance is investigated and whenever possible attributed to a source or combination of sources. Often, natural causes lead to exceedances, including weather events such as temperature inversions, or smoke from wildfires.

The AAAQO concentrations set by the Government for each substance are listed in the 2022 Monitoring Results section later this report along with comparisons to FAP data.

Canadian Ambient Air Quality Standards

FAPs data is also compared to national standards known as Canadian Ambient Air Quality Standards (CAAQS). These standards are in place for fine particulate matter ($PM_{2.5}$), ozone (O_3), nitrogen dioxide (NO_2) and Sulphur dioxide (SO_2).

Table 10 summarizes the CAAQS threshold and management levels for these four substances. Alberta is divided into six separate air zones. Each is assessed separately for achievement against these values. Fort Air Partnership falls within the North Saskatchewan Air Zone.

Table 10: Air Quality Management System Thresholds

Pollutant	Averaging Time	Numerical Value			Statistical Form
		2015	2020	2025	
Fine Particulate Matter ($PM_{2.5}$)	24-hour	28 µg/m^3	27 µg/m^3		The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations
	Annual	10.0 µg/m^3	8.8 µg/m^3		The 3-year average of the annual average of all 1-hour concentrations
Ozone (O_3)	8-hour	63 ppb	62 ppb	60 ppb	The 3-year average of the annual 4th highest of the daily maximum 8-hour average ozone concentrations
Sulphur Dioxide (SO_2)	1-hour		70 ppb	65 ppb	The 3-year average of the annual 99th percentile of the SO_2 daily maximum 1-hour average concentrations
	Annual		5 ppb	4 ppb	The average over a single calendar year of all 1-hour average SO_2 concentrations
Nitrogen Dioxide (NO_2)	1-hour		60 ppb	42 ppb	The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations
	Annual		17 ppb	12 ppb	The average over a single calendar year of all 1-hour average concentrations

All provinces and territories including Alberta must annually report the status of air quality as compared to these national standards. The 2018-2020 Alberta Air Zones Report was released in September of 2022.

There are two levels of planning areas under CAAQS, larger federally defined airsheds that consist of six broad geographic regions for the entire country, and smaller Air Zones within, which enable a place-based approach to managing local air quality. Provinces and territories delineate and manage Air Zones within their boundaries with the goal of driving continuous improvements in air quality and preventing exceedances of CAAQS. Alberta has aligned the Air Zones in the Province with the Land Use Framework regional boundaries. Fort Air Partnership Airshed is entirely within the North Saskatchewan Air Zone, one of 6 Air Zones in Alberta.

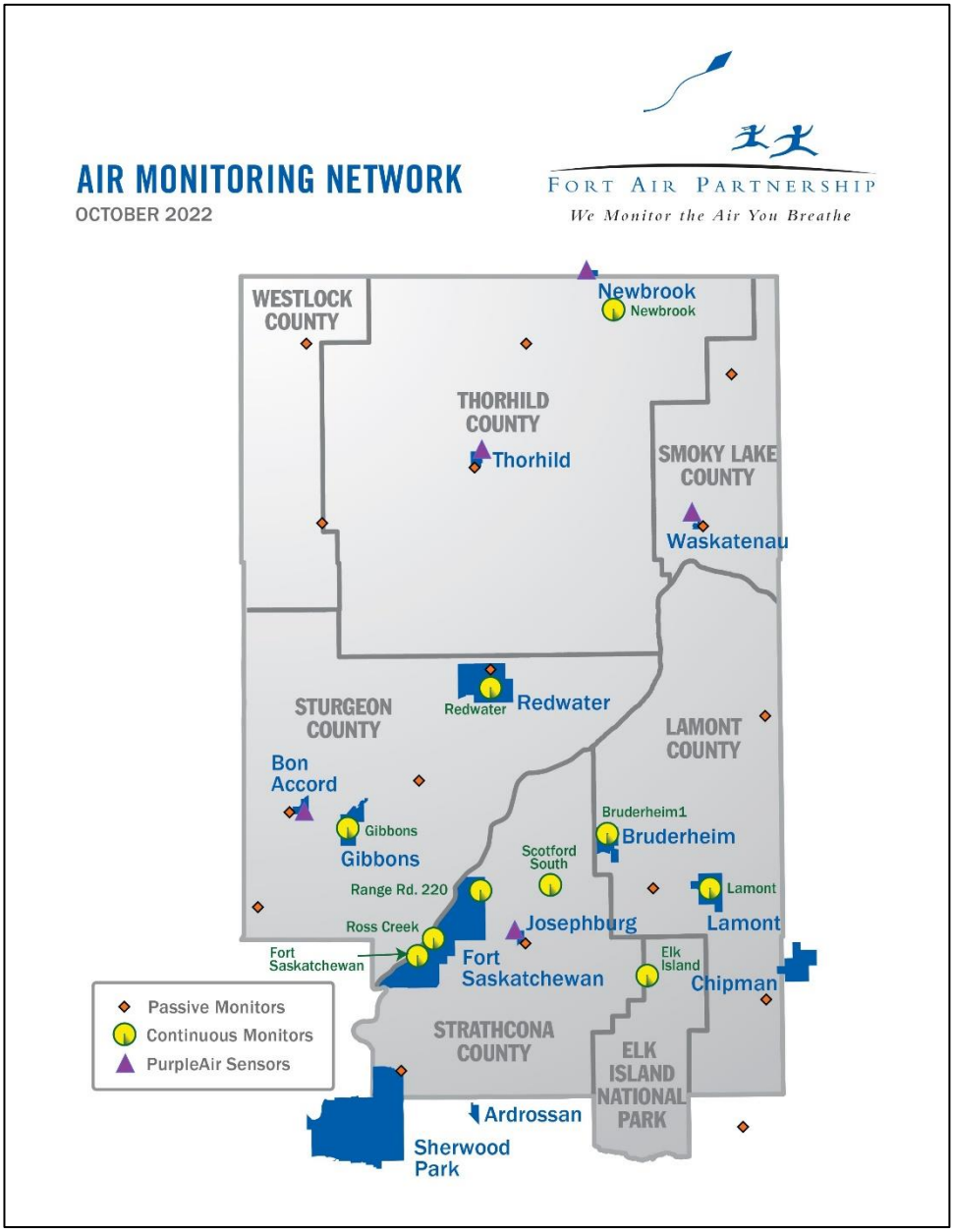
These federal "airsheds" are not to be confused with Alberta Airsheds, which are regional air monitoring and reporting organizations operating throughout Alberta. Alberta's 10 Airsheds operate extensive, integrated ambient air monitoring networks. Air quality data collected by the Airsheds is also used by the province of Alberta to report against the federal CAAQS for each of the six Alberta air zones.

2022 Air Quality Monitoring Program

FAP Monitoring Sites

The FAP Airshed map in Figure 1 shows the locations of the continuous and passive air monitoring sites in the network as of the end of December 2022.

Figure 1: FAP Monitoring sites on December 31, 2022



Monitoring Station Coordinates

Table 11 gives the longitude and latitude coordinates for the FAP continuous monitoring stations active in 2022.

Table 11: Continuous monitoring station locations

Station	Latitude	Longitude	Elevation	Year Established	Land Use
Bruderheim 1	53.805629 N	-112.925851 W	630 m	Mar 2016	Residential
Elk Island	53.68236 N	-112.86806 W	711 m	2003	Parkland
Fort Saskatchewan	53.69883 N	-113.22319 W	629 m	Jan 2003	Residential
Gibbons	53.827241 N	-113.327174W	673 m	Feb 2016	Residential
Lamont County (to Oct. 2022)	53.76036 N	-112.88017 W	727 m	Jan 2003	Agricultural
Lamont (Began Nov. 2022)	53.757334 N	-112.778004 W	652 m	August 1, 2021	Residential
Keith Purves Portable at Lamont (to Sept. 2022)	53.757334 N	-112.778004 W	652 m	August 1, 2021	Residential
Range Road 220	53.75245 N	-113.12582 W	625 m	Jan 2003	Industrial
Redwater	53.951834 N	-113.105857 W	627 m	Oct 2017	Residential
Ross Creek	53.71622 N	-113.19994 W	624 m	Jan 2003	Industrial
Scotford South	53.759684 N	-113.027247 W	626 m	March 2020	Agricultural

Note: The year established reflects the date when FAP began reporting data from that station to the Provincial air monitoring data warehouse.

2022 Continuous Monitoring

Continuous Monitoring Description

A continuous air monitoring station is a temperature-controlled shelter typically housing several different continuous ambient air analyzers and sensors. Continuous analyzers, as the name implies, run continuously, and store data in one-minute averages. Continuous analyzers are designed to measure ambient air for specific compounds. FAP uses different combinations of these analyzers and sensors at the various stations depending on the monitoring objectives of each station.

Every FAP station has a wind sensor atop a tower that is at least 10 meters tall. Stations also measure several meteorological conditions including wind speed and direction and ambient temperature.

Data acquisition and data quality control at these stations is discussed elsewhere in this report.

Figure 2: Continuous air monitoring station interior

The FAP continuous monitoring network is composed of nine fixed continuous monitoring stations along with a tenth, the Keith Purves portable station. These stations measure 18 different air quality parameters along with several meteorological conditions. The nine permanent continuous monitoring stations are all located in the southern portion of the Airshed around population centres, industrial facilities, or downwind of these source areas. These stations each met one or more of the FAP monitoring objectives as detailed earlier in this report. The Keith Purves portable station moves around the Airshed to attend to areas without continuous monitoring stations, deal with short term projects or emerging issues. FAP monitoring and reporting protocols are structured to meet the requirements of the Alberta Government Air Monitoring Directive.

Several industrial facilities hold Environmental Protection and Enhancement Act (EPEA) operating approvals, or authorizations, and are required to either fund or conduct ambient air quality monitoring through participation in FAP.

FAP Continuous Monitoring Site Details

Bruderheim 1 Station

Primary Monitoring Objective:
To monitor ambient air quality where people live. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous Parameters Monitored:
Methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, ambient temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index.

Figure 3: Bruderheim 1 Station

Site Description:
FAP has been operating a station in Bruderheim and reporting data to the Provincial air monitoring data warehouse since 2010. This station, formerly named Bruderheim was moved to the northwest corner of the Bruderheim school sports fields in 2016 and renamed Bruderheim 1. Bruderheim population is listed as 1,395 in the most recent census available 2018.

Bruderheim 1 changes (2022):
There were no changes to the Bruderheim 1 station in 2022.

Elk Island Station

Primary monitoring objective: Understand the air quality impacts of a large Canadian city and concentrated heavy industry on a protected area. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored: $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. A wet deposition (precipitation quality) sampler is also at the site part of a program run by the Alberta Government. This station collects the data required to calculate the Air Quality Health Index.

Figure 4: Elk Island Station

Site Description: This station is located within the boundaries of Elk Island National Park, between the administration building and Astotin Lake, near the west entrance to the park at Township Road 544 near Range Road 203. FAP has been operating this station and reporting data to the Provincial air monitoring data warehouse since January 2003. This station was designated a National Air Pollution Surveillance (NAPS) station in 2008 and part of the national network.

Elk Island changes (2022):
There were no changes to the Elk Island station in 2022.

Fort Saskatchewan Station

Primary monitoring objective: Monitor air quality where people live and to establish air quality compliance to the AAAQOs. With the longest operational history and data record in the FAP network, it is an important station for understanding historical trends. It is a designated NAPS station. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored: Ammonia, carbon monoxide, H_2S, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index.

Figure 5: Fort Saskatchewan Station

Site description: This station is in the Airshed's largest population center (26,942 in 2019 census). It is located adjacent to a residential area of the City of Fort Saskatchewan near 92nd Street and 96th Avenue, 80 meters west of Highway 15, a major traffic artery, with an annual average daily traffic count of over 17,000 vehicles per day in 2021. FAP has been operating this station and reporting data to the Provincial air monitoring data warehouse since January 2003. Data from this site goes back to 1993 in the data warehouse. This station along with Elk Island is part of the NAPS network of stations across the country.

Fort Saskatchewan changes (2022):
There were no changes to the Fort Saskatchewan station in 2022.

Gibbons Station

Primary monitoring objective:
To monitor ambient air quality where people live. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous Parameters Monitored:
H_2S, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index.

Figure 6: Gibbons Station

Site Description:
This station began operating and reporting data to the Provincial air monitoring data warehouse in February 2016. Alberta Environment and Parks has loaned FAP a $PM_{2.5}$ analyzer to enable the collection of data required to calculate the AQHI for this station. This station is at the rear of the Gibbons Town office located on 50th Avenue at 48th Street. The most recent census available (2016) lists the Gibbons population as 3,159.

Gibbons changes (2022):
There were no changes to the Gibbons station in 2022.

Lamont Station

The new permanent Lamont station began operation in November 2022. It was outfitted with the analyzers from the decommissioned Lamont County station.

Primary monitoring objective:
To monitor ambient air quality where people live. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored:
H_2S, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index. FAP began operating this station and reporting data to the Provincial air data monitoring warehouse in November 2022.

Site description: The station is located behind the community recreation center complex at 4848-49 Street. It is along the west side of Secondary Highway 831 (48 St.) and approximately 400 meters north of Highway 15. Highway 831 has an average annual daily traffic count (AADT) of 1420 vehicles per day. The Highway 15 AADT is 1550 vehicles per day. The population of the Town of Lamont is 1774 as of May 2016.

Lamont changes (2022):
The Lamont station started up in November 2022.

Lamont County Station

The Lamont County station was decommissioned October 31, 2022.

Figure 8: Lamont County Station

Primary monitoring objective:
Understand impacts of multiple pollutant sources in the region, which may include sources from Alberta's Industrial Heartland and from Strathcona industrial area, as well as from other sources in the City of Edmonton. This site was selected because modeling indicated that this elevated area of the region may experience higher concentrations of SO_2. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored:
H_2S, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index. FAP has been operating this station and reporting data to the Provincial air monitoring data warehouse since January 2003.

Site description: This station is in a rural area located in a hay field, several kilometers away from industrial facilities and other large pollutant sources, approximately 6 km west of the town of Lamont. The station is on a hill, 1.5 kilometers south of Highway 15, about 250 meters west of Range Road 202.

Lamont County changes (2022):
A new generation ozone analyzer was installed at the station in January 2022. All analyzers were moved to the new station in the town of Lamont, starting up there in November 2022.

Keith Purves Portable Station

Primary monitoring objective: The portable is used to meet various objectives depending on the specific location and/or project. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored: H_2S, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. Other parameters can be added as required to meet project monitoring objectives.

Figure 9: Portable Station at Lamont

Site description – Town of Lamont: The Keith Purves portable began operation in Lamont in August 2021. It remained at the location until shutdown in early September 2022. The portable was located behind the community recreation center complex at 4848-49 Street, at the same location as the new permanent Lamont station. The site is along the west side of Secondary Highway 831 (48 St.) and approximately 400 meters north of Highway 15. Highway 831 has an average annual daily traffic count (AADT) of 1420 vehicles per day. The Highway 15 AADT is 1550 vehicles per day. The population of the Town of Lamont is 1774 as of May 2016.

Keith Purves Portable changes (2022): FAP shut down the Keith Purves portable station at Lamont in early September of 2022. This was to prepare it for the next project near Newbrook on the FAP northern border, but also to make room for the new permanent station (see Lamont) at the same location in November. A report on the findings of the Lamont portable project and how the data compared to the Lamont County station is available on the FAP website or by contacting FAP at info@fortairmail.org.

Range Road 220 Station

Primary monitoring objective: Monitor the impacts of local industrial emissions on air quality. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored:
Ethylene, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, barometric pressure, outdoor temperature and relative humidity, wind speed and direction.

Site description: The station is located off Range Road 220 in an open area along the facility fence line east of the Dow Chemical ethylene production facilities. FAP has been operating this station and reporting data to the Provincial air monitoring data warehouse since January 2003.

Range Road 220 changes (2022):
There were no changes to the Range Road 220 station in 2022.

Figure 10: Range Road 220 Station

Redwater Station

Figure 11: Redwater Station

Primary monitoring objective: To monitor ambient air quality where people live. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored:
Ammonia, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction and barometric pressure.

Site description: The Redwater air quality monitoring station was established in October 2017, replacing the Redwater Industrial station. The station is located near the center of the town of Redwater at 47th street and 49th avenue, just south of the town administration offices. The most recent census available (2016), lists the town of Redwater population of 2053.

Redwater changes (2022):
There were no changes to the Redwater station in 2022.

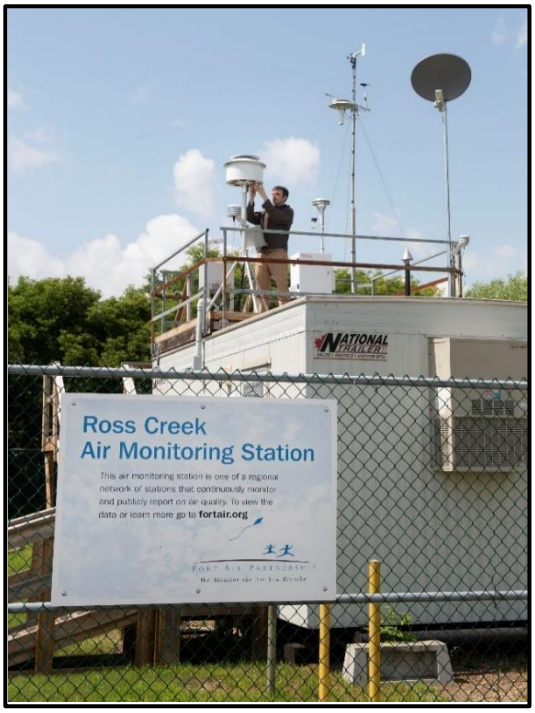
Ross Creek Station

Primary monitoring objective: To monitor the impacts of local industrial emissions on air quality. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored: Ammonia, ethylene, $NO/NO_X/NO_2$, SO_2, barometric pressure, solar radiation, relative humidity, temperature at 2 meters and 10 meters, vertical wind speed and horizontal wind speed and direction.

Site description: The station is located west of the Sherritt Fort Saskatchewan site, between the industrial facility and the City of Fort Saskatchewan. FAP has been operating this station and reporting data to the Provincial air monitoring data warehouse since January 2003.

Ross Creek changes (2022):
There were no changes to the Ross Creek station in 2022.



Scotford South Station

Primary objective: The station is intended to monitor the impacts of local industrial emissions on air quality. A complete list of FAP monitoring objectives is given elsewhere in this report.

Continuous parameters monitored: H_2S, $NO/NO_X/NO_2$, SO_2, benzene, toluene, ethylbenzene, xylenes (o-, m- and p- isomers), styrene, outdoor temperature and relative humidity, wind speed and direction and barometric pressure.

Site description: The Scotford South site is located to the southeast of industrial facilities on Range Road 212, approximately 2 kilometers south of Highway 15. The site is in a cultivated field approximately 100 meters west of Range Road 212.

Figure 13: Scotford South Station

Scotford South changes (2022):
There were no changes to the Scotford South station in 2022.

2022 Capital Purchases for the Network

Life cycle replacement across the network:

In 2022 FAP owned approximately $2.4 M in equipment and shelters at the 8 stations it owned. Spare and backup equipment was valued at approximately an additional $0.8M. The capital replacement plan target is for purchases equaling approximately 8% to 10% of the total value of the active monitoring and support equipment within FAP each year. The 2022 capital purchase was almost $110,000.

- The new shelter for the Lamont station was the only capital purchase in 2022.

Continuous Monitoring Methods

Analytical methods allowed for ambient air monitoring in Alberta are prescribed by the Alberta Government's Air Monitoring Directive. Details of the monitoring methods used by FAP are summarized in Appendix E.

2022 Passive Monitoring

Passive Monitoring Description

Passive monitoring is a cost-effective solution for monitoring air quality at locations where continuous monitoring is not practical. Passive sampling devices can monitor air pollutants without the need for electricity, data loggers or pumps. Passive sampling devices are lightweight, portable and relatively simple to operate. No active movement of air through the sampler is necessary.

Passive sampling involves the exposure of a reactive surface to the air. Transfer of the pollutant occurs by diffusion from the air to the surface via naturally occurring air movement. The surface consists of a membrane that is impregnated with a reactive solution. The sampling devices are mounted under a hood to protect it from rain or snow. Samplers are exposed for one month the sent to a laboratory for analysis.

A major advantage of using a passive sampling system is that several samplers can be used over a large area to assess the spatial variation of pollutant levels. Passive samplers are also useful to examine longer-term trends of air pollutants at specific locations. However, since a sample is exposed for a month, events that last for a short time may be "averaged out".

Figure 14: Passive monitoring site

Figure 15: Changing passive monitoring devices

FAP Passive Monitoring Network

Since FAP was established in 2003, the passive network grew as FAP assumed operation of several individual passive networks from industrial sites within the Airshed established as a requirement in their EPEA operating approvals. Two network reviews undertaken in 2012 and 2018 reduced the number of sites to 47 by the beginning of 2020. FAP undertook a wholistic review and extensive rationalization of the passive network in 2020. With the increased number of continuous stations in the FAP network since 2012 the passive sampler network was further reduced in 2020. There are now 14 sites in FAP that measure both SO_2 and H_2S. Two additional sites serve as co-located stations with continuous monitors. Passive devices are no longer specifically identified within the EPEA operating approvals of FAP's industry partners, however FAP must still obtain Government approval for changes to the passive monitoring network.

Passive sampling devices are exchanged within three days of the end of each month and sent to a laboratory for analysis. Results from the passive monitors are submitted each month to the Alberta Government.

Passive Monitoring Network Site Descriptions

Passive samplers are intended to gather information over a broad spatial area and to measure trends over time. The majority of FAP passive monitoring sites are not selected based on a high likelihood of impingement, but rather on a spatial grid to establish a picture of comparative air quality throughout the Airshed.

The site coordinates and parameters measured at each passive monitoring site are listed in Table 12.

Table 12: FAP passive monitoring sites as December 31, 2022

Site	Location	Longitude	Latitude	SO_2	H_2S	Date Started
1	Stocks Greenhouses	-113.246659	53.596325	1	1	Jul 1, 2005
4	Waskatenau	-112.77622	54.09875	1	1	Jul 1, 2005
5	Thorhild	-113.1331	54.15233	1	1	Jul 1, 2005
7	Bon Accord	-113.42423	53.83382	1	1	Jul 1, 2005
34	C&C Tree Farm	-113.48362	53.74538	1	1	Aug 1, 2006
37	Township Rd 564 & Range Rd 224	-113.22356	53.86307	1	1	Aug 1, 2006
38	Peno	-112.67866	53.92182	1	1	Aug 1, 2006
46	Josephburg	-113.0693	53.71279	1	1	Nov 1, 2007
47A	Southeast of FAP	-112.705296	53.54175	1	1	Sept 1, 2020
51	Hollow Lake	-112.72578	54.238822	1	1	Aug 1, 2008
52	Abee	-113.05062	54.268211	1	1	Aug 1, 2008
53A	Tawatinaw - Clearbrook	-113.40057	54.268146	1	1	Sept 1, 2020
55	Taylor Lake	-113.37483	54.10185	1	1	Aug 1, 2008
62	FAP East Boundary	-112.68102	53.65779	1	1	Jun 1, 2010
72	Redwater	-113.105857	53.95183	1	1	Sept 1, 2020
73	Lamont	-112.778004	53.757334	1	1	Nov 1, 2022

2022 Monitoring Results

2022 Ambient Air Monitoring Data and Discussion

The following sections provide a brief analysis of the results of the 2022 monitoring data compound by compound. Not all stations measure every substance. The sections below provide information on all current stations, as well as some historical decommissioned stations. Annual averages are calculated for stations in operation for at least nine months (75%) of the calendar year. Data from the portable station is given in each section but not included in annual average plots since the portable has not been at one location for the required percentage (75%) of the calendar year to calculate a valid annual average. Data in 2022 is compared to Alberta Ambient Air Quality Objectives where applicable. Monthly averages and maximum 1-hour averages are shown in charts and tables. Also provided are comparisons of 2022 data with the previous 5 years.

For substances used in AQHI calculations, data from FAP stations in 2022 is compared to selected stations across Alberta. For longer term trend analysis and comparison of FAP stations with Canadian sites and others around the world back as far as 1991, refer to the 2019 FAP Air Quality Trending and Comparison Report. The report is available for download on the FAP website library.

Continuous Monitoring Results by Compound

Ammonia

Ammonia (NH_3) is a colourless gas with the well-known pungent odour often found in household cleaners. NH_3 can be produced by both natural and anthropogenic sources. Some natural sources of NH_3 include the decay of plant material and animal waste. A small portion is also released during respiration. In Alberta, the fertilizer industry is the main industrial source of NH_3. This industry produces synthetic NH_3 for either direct application to soil as a fertilizer, or as a raw material for use in the production of other high nitrogen fertilizer products. The other significant source of NH_3 in Alberta is commercial livestock feedlots, specifically from their large amounts of animal waste.

Sources of ammonia in the Airshed are primarily from industrial sources in the production of fertilizer but can also be formed from natural sources such as the decay of plant material and animal waste.

The AAAQO for ammonia is:

- 1-hour average concentration 2000 ppb

Ammonia is measured at three stations in FAP. There were no exceedances of the NH_3 AAAQO recorded at any FAP stations in 2022.

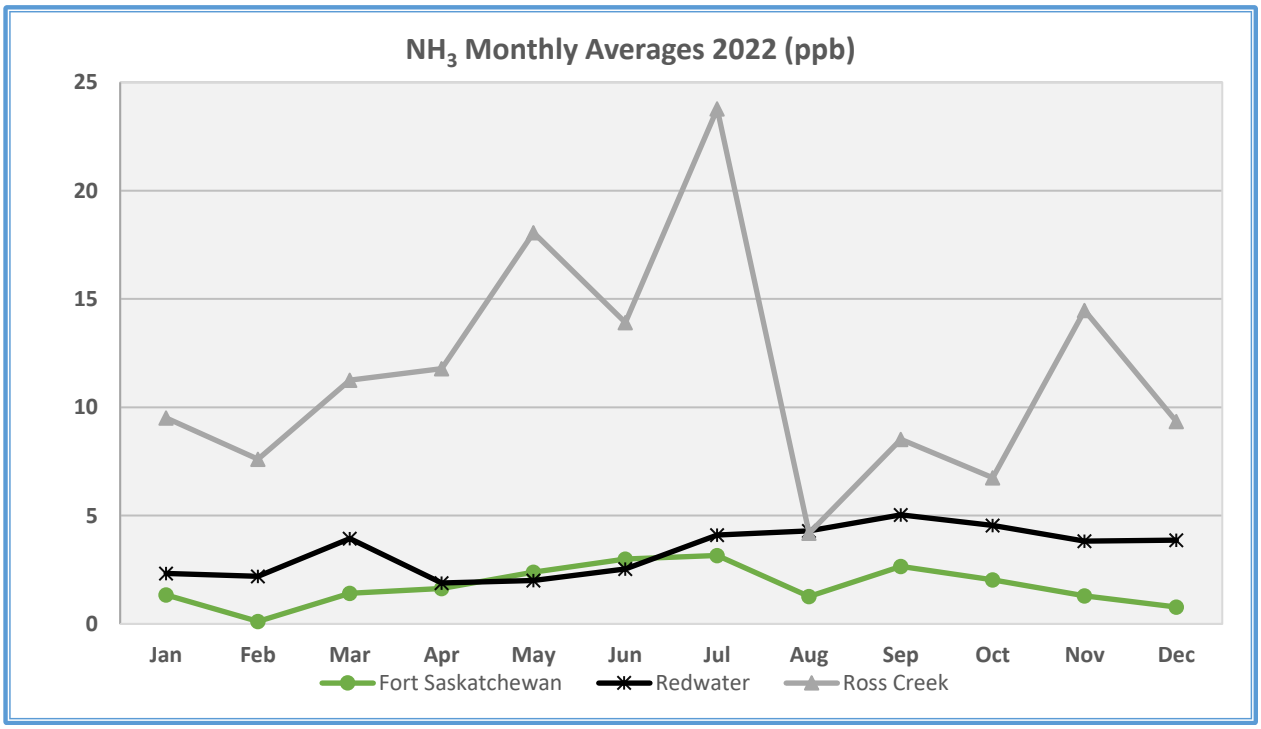
Table 13 below provides maximum 1-hour averages of NH_3 in 2022 with comparisons to the applicable AAAQO.

Table 13: 2022 maximum NH_3 averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time
Fort Saskatchewan	42.7	2.1%	Jan 1 21:00
Redwater	78.9	3.9%	Sep 10 04:00
Ross Creek	552.5	27.6%	May 27 20:00

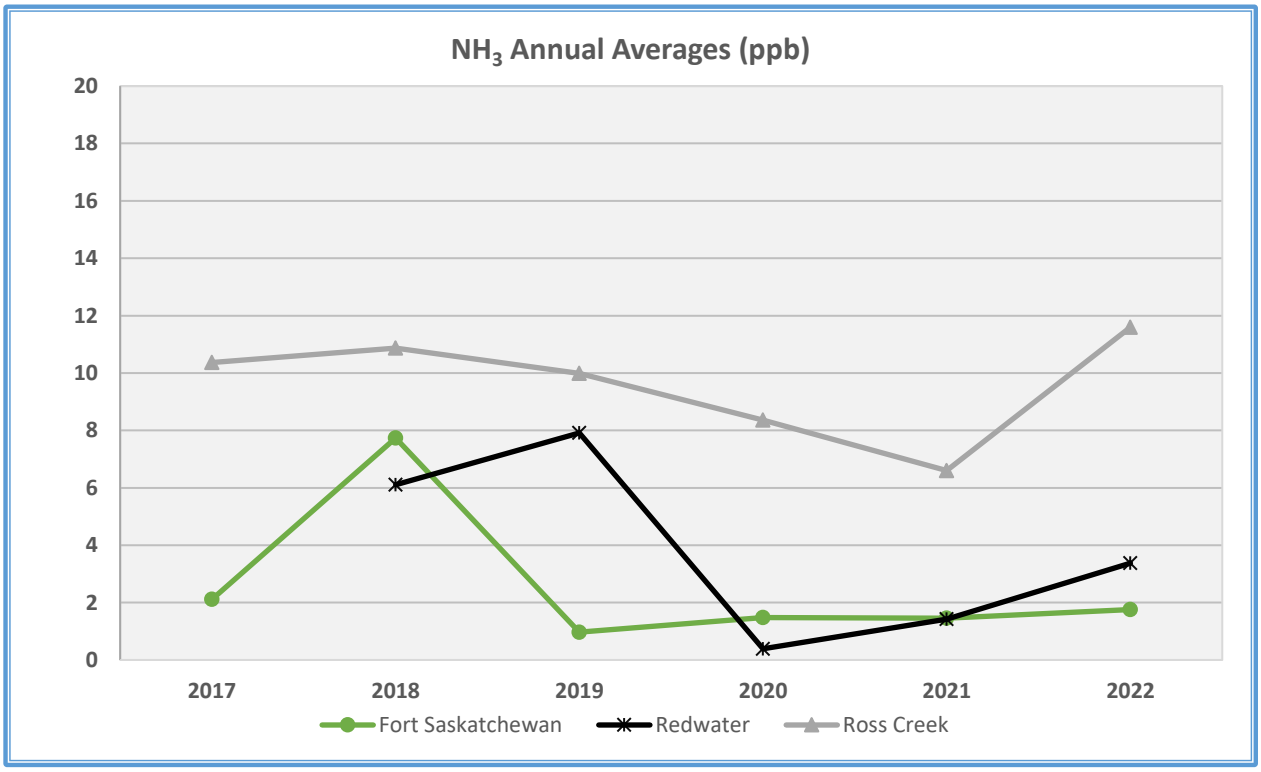
Figure 16 below presents a summary of NH_3 concentrations recorded in 2022 at individual stations while Figure 17 shows annual NH_3 averages for 2022 and the five years previous.

Figure 16: Monthly average NH_3 concentrations (ppb) in 2022



Ammonia (continued)

Figure 17: Annual average NH_3 concentrations at FAP stations (ppb)



Notes: - The Redwater station began operation October 2017..

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas present in small amounts in the atmosphere primarily from incomplete combustion of carbon-based fuels such as gasoline, oil and wood. The major source of CO in urban locations is motor vehicle exhaust emissions. Minor sources include fireplaces, industry, aircraft and natural gas combustion. Wildfires are also a significant natural source of CO.

The AAAQOs for carbon monoxide are:

- 1-hour average concentration 13 ppm
- 8-hour average concentration 5 ppm

In FAP only the Fort Saskatchewan station measures CO.

Table 14 below provides maximum 1-hour and 8-hour averages of CO in 2022 at the Fort Saskatchewan station, with comparisons to the applicable AAAQOs.

Table 14: 2022 maximum CO averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 8-hour average (ppb)	% of AAAQO	Date
Fort Saskatchewan	1.4	11.1%	Dec 31 22:00	1.1	21.4%	December 31

The CO monthly average concentrations recorded at Fort Saskatchewan station is given in Figure 18 while Figure 19 provides a comparison of annual averages for 2022 and the five years previous.

Figure 18: Monthly average CO concentrations Fort Saskatchewan (ppm) in 2022

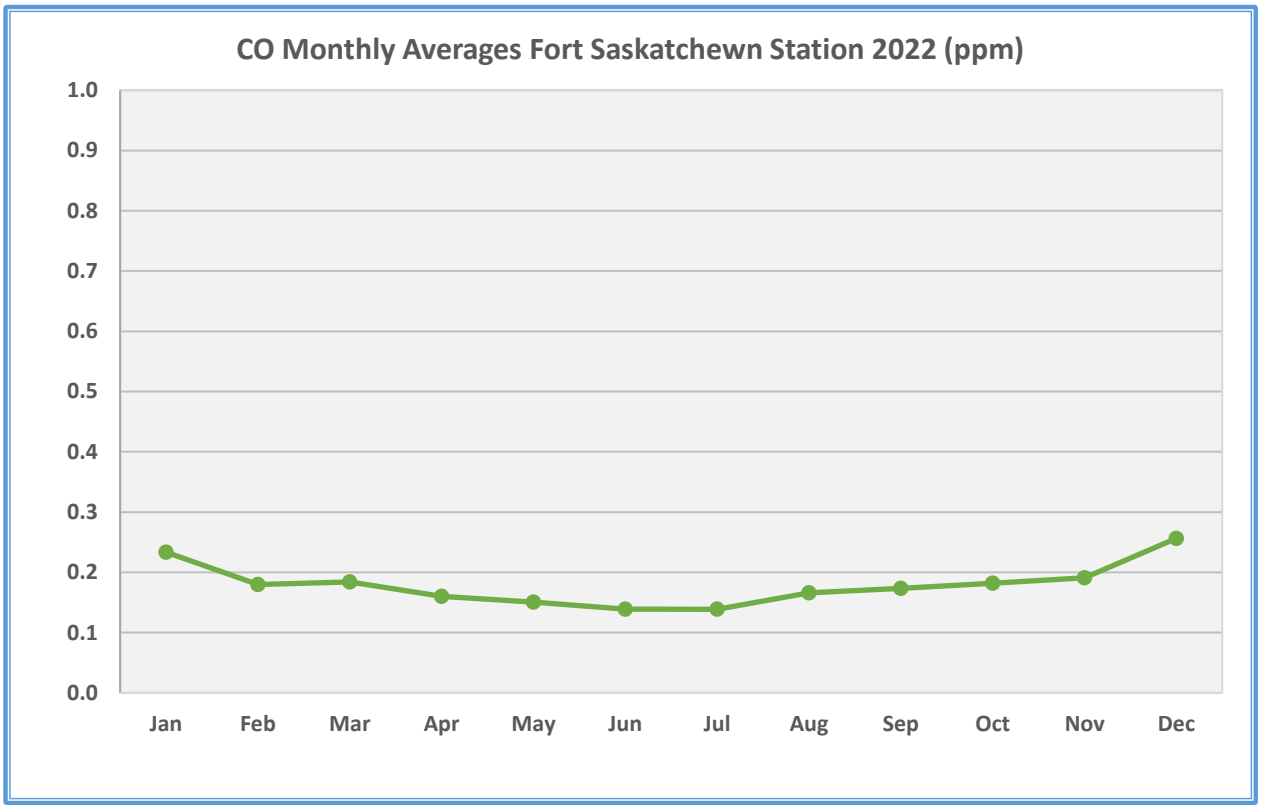
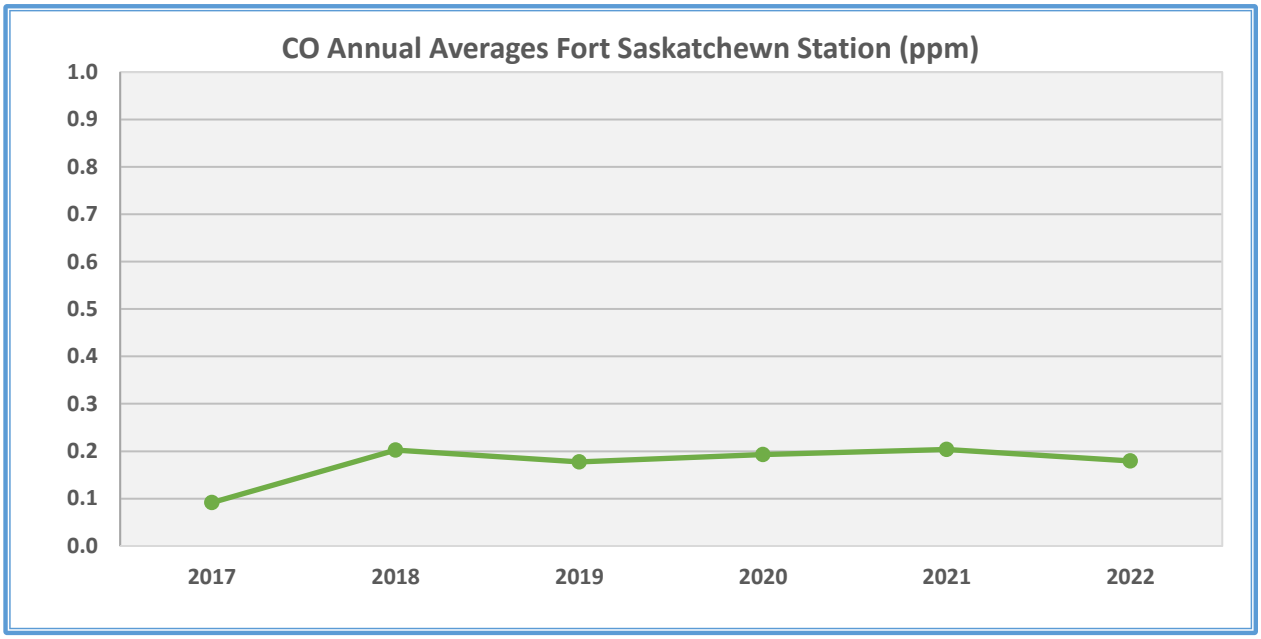


Figure 19: Annual average CO concentrations Fort Saskatchewan (ppm)



Ethylene

Ethylene is a naturally occurring compound in ambient air. It is produced at low levels by soil microorganisms, algae, lichens and plants. Other natural sources of ethylene include volcanic activity and combustion in forest and grass fires. In Alberta, the concentration in ambient air resulting from these natural sources is typically low.

Anthropogenic sources of ethylene include combustion of fossil fuels, and processing of natural gas in petrochemical facilities (e.g., production of plastics).

The AAAQOs for ethylene are:

- 1-hour average concentration 1050 ppb
- 3-day average 40 ppb
- Annual mean 26 ppb

Ethylene is measured at two stations in FAP. There were no exceedances of any of the three AAAQO average periods for ethylene.

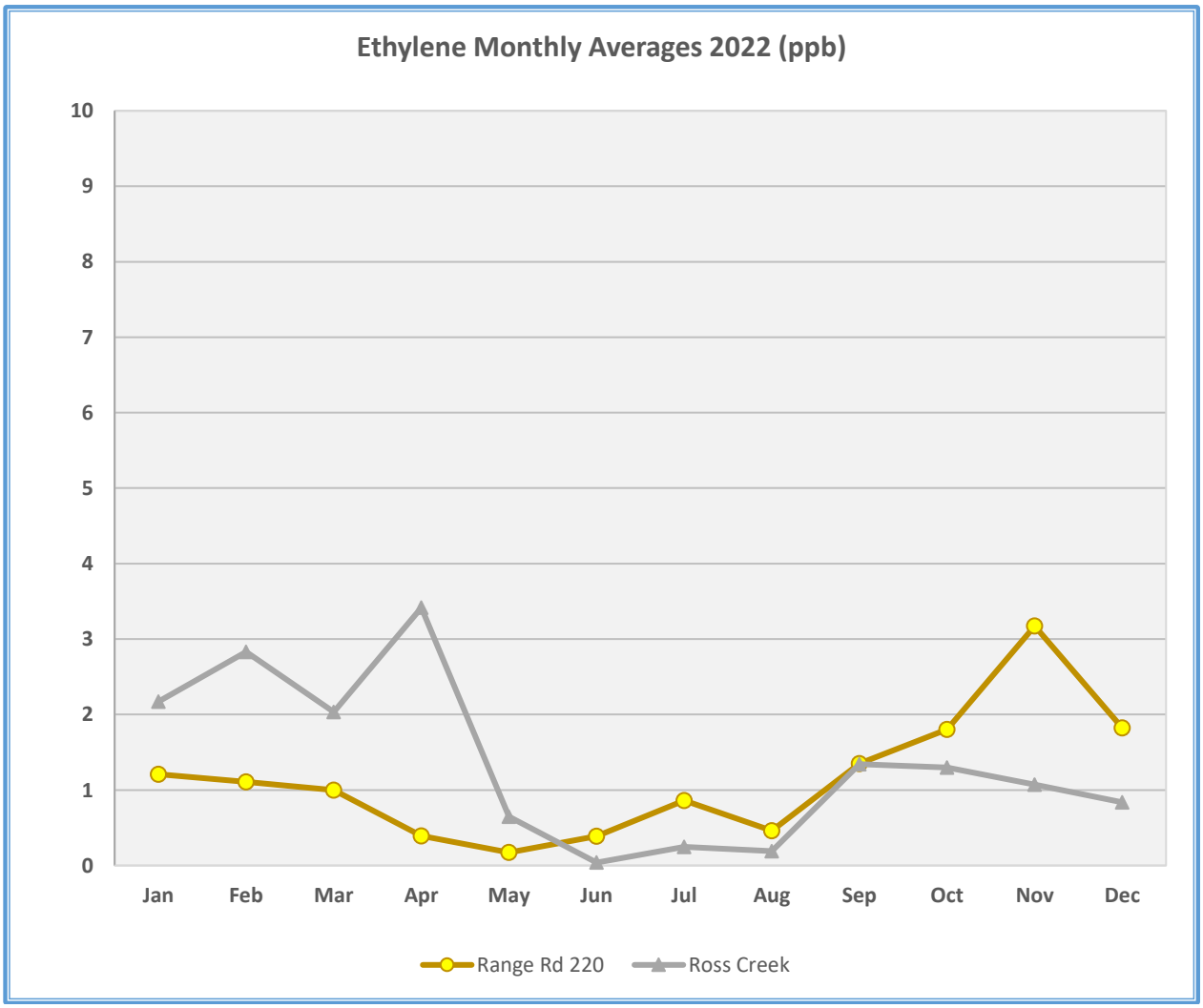
Table 15 below provides maximum 1-hour, 72-hour and annual averages of ethylene in 2022 with comparisons to the applicable AAAQOs.

Table 15: 2022 maximum ethylene averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 3-day average (ppb)	% of AAAQO	Date	Annual average (ppb)	% of AAAQO
Range Road 220	311	29.6%	Sep 28 11:00	31.9	79.8%	Sep 29	1.1	4.4%
Ross Creek	187	17.8%	Sep 28 08:00	29.7	74.2%	Sep 30	1.3	5.2%

Figure 20 gives a summary of average ethylene concentrations recorded each month in 2022 at the two FAP stations where it is measured.

Figure 20: Monthly average ethylene concentrations (ppb) in 2022



Ethylene (continued)

Figure 21: Annual average ethylene concentrations at FAP stations (ppb)

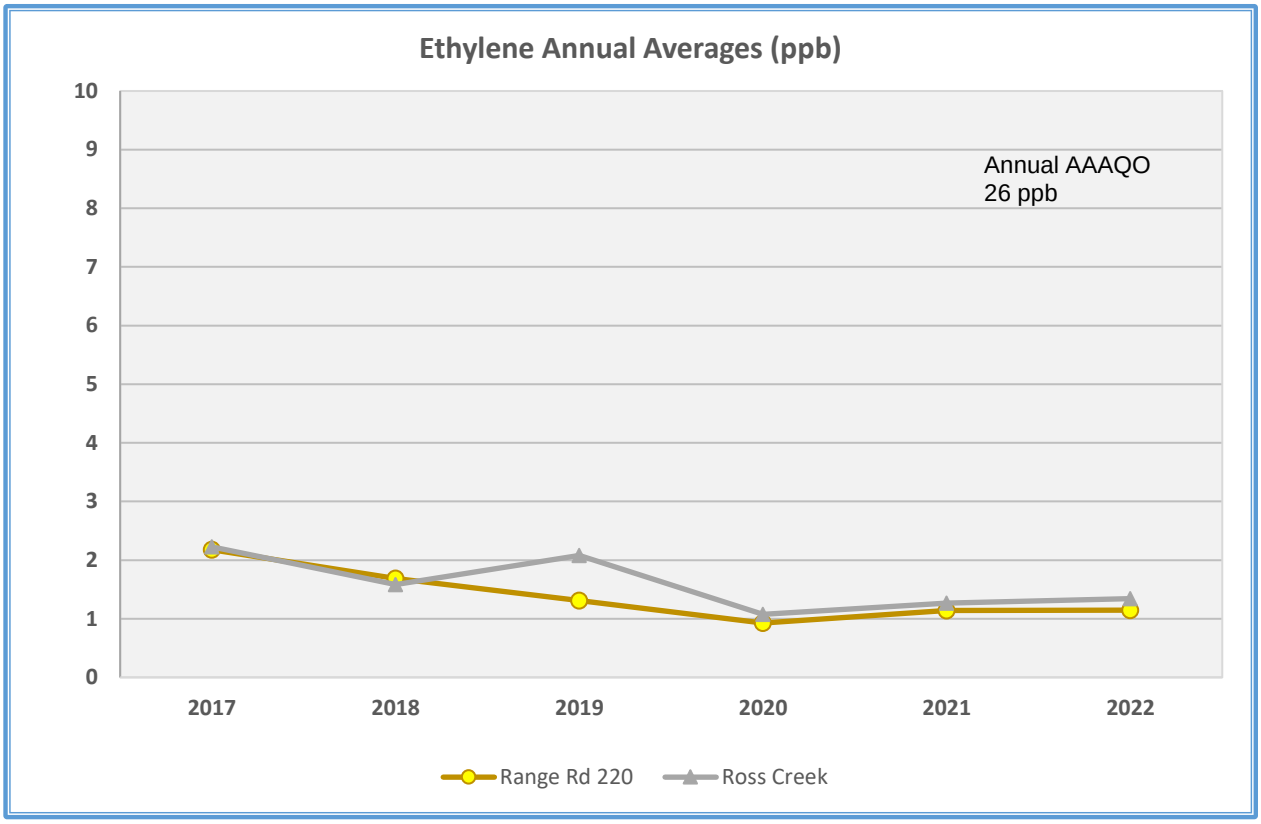


Figure 21 shows the annual ethylene averages at the two stations for 2022 and the five years previous. The downward trend in annual ethylene averages since 2017 is largely due to reduced flaring activities at a nearby industrial facility.

Fine Particulates ($PM_{2.5}$)

Fine particulate matter ($PM_{2.5}$) consists of tiny particles, 2.5 microns in size and smaller. In comparison, a strand of human hair is about 70 microns in width. Sources of $PM_{2.5}$ include soil, roads, agricultural dust, vehicles, industrial emissions, smoke from forest fires, cigarettes, household heating, fireplaces and barbecues. Secondary particulate matter may also be produced in the atmosphere through complex chemical processes involving other substances. Particulates can come from both solid matter and liquid aerosols.

In high concentrations, suspended particulates may lead to human health problems. Inhaling particulate matter can make breathing more difficult or may aggravate existing lung and heart problems. Smaller particles can travel deep into the lungs where they may cause permanent lung damage.

Higher values of $PM_{2.5}$ typically occur during winter temperature inversions when air movement is limited, or in summer with impact from long range transport of forest fire smoke often coupled with warm weather and little or no wind.

The AAAQO for $PM_{2.5}$ is:

- 24-hour average concentration 29 $\mu g/m^3$

There is also an Air Quality Guideline for $PM_{2.5}$:

- 1-hour average concentration 80 $\mu g/m^3$

A one-hour average concentration of 80$\mu g/m^3$ will trigger an AQHI in the “High Risk' category.

Fine Particulates (continued)

Comparing air quality monitoring data in the Fort Air Partnership region in 2022 against the Alberta ambient guideline and objectives (AAAQG/AAAQO), there were 118 1-hour Guideline exceedances and 53 24-hour AAAQO exceedances of fine particulates ($PM_{2.5}$) experienced throughout the network.

Table 16 and Table 16Table 17 group the exceedances by date and station with the attributed causes.

Fine particulate matter is measured at seven continuous monitoring stations in FAP. Table 18 below provides the maximum 1-hour and 24-hour $PM_{2.5}$ averages in 2021 at each station with the applicable AAAQO and AAAQG.

Table 16: Exceedances of the 1-hour average AAAQG for $PM_{2.5}$ in 2022

Station	Highest 1-hour average (µg/m³)	Exceedances	Date(s)	Attributed Cause
Gibbons	80.1	1	Jun 3	undetermined
*6 stations	112.7	14	Aug 22	wildfire smoke
Redwater	108.2	1	Sep 1	harvest dust
*6 stations	157.7	31	Sep 4-5	wildfire smoke
Elk Island Ft. Sask. Gibbons	181.6	45	Sep 10-11	wildfire smoke
Redwater	112	3	Oct 8,18	Local fire pit
Elk Island	1151	12	Oct 18,19	Controlled burn in the park
Bruderheim 1 Lamont Cnty	112	3	Oct 18,19	Regional meteorological conditions
Gibbons, Redwater	97.8	3	November 11	Winter inversion
Redwater	91.7	1	December 15	Brush burning
Bruderheim 1, Lamont	90.7	4	December 31	Winter inversion

*6 FAP stations recorded exceedances of the AAAQO these dates: Bruderheim 1, Elk Island, Fort Saskatchewan, Gibbons, Lamont County and Redwater. The Keith Purves Portable also measures fine particulates but did not record any exceedances these on dates.

Fine Particulates (continued)

Table 17: Exceedances of the 24-hour average AAAQO for $PM_{2.5}$ in 2022

	24 Hour Exceedances			
Station	Highest 24-hour average ($\mu g/m^3$)	Exceedances	Dates	Attributed Cause
*7 stations	53.3 (Elk Island)	9	August 22,23	Wildfire smoke
Gibbons, Ft. Saskatchewan	95.3 (Gibbons)	8	September 3,4	
Bruderheim 1, Elk Island, Ft. Saskatchewan, Gibbons, Lamont County, Redwater	114.6 (Gibbons)	11	September 10,11	Wildfire smoke
Redwater	46.2	1	October 18	Local campfire
Elk Island	199	2	October 18,19	Controlled burn
Bruderheim 1, Ft. Saskatchewan, Gibbons, Lamont County, Redwater	44.5	8	October 18,19	Wildfire smoke
Bruderheim 1, Ft. Saskatchewan, Gibbons, Lamont, Redwater	44.9	5	November 10,11	Winter inversion
Lamont	30.1	1	November 14	Undetermined
Redwater	34.9	1	December 15	Brush burning
Bruderheim 1, Elk Island, Ft. Saskatchewan, Gibbons, Lamont, Redwater	56.3	7	December 30,31	Winter inversion

*7 FAP stations measured fine particulates in August: Bruderheim 1, Elk Island, Fort Saskatchewan, Gibbons, Lamont County, Redwater and the Keith Purves Portable at Lamont.

Table 18: 2022 maximum $PM_{2.5}$ averages compared with applicable AAAQO(G)

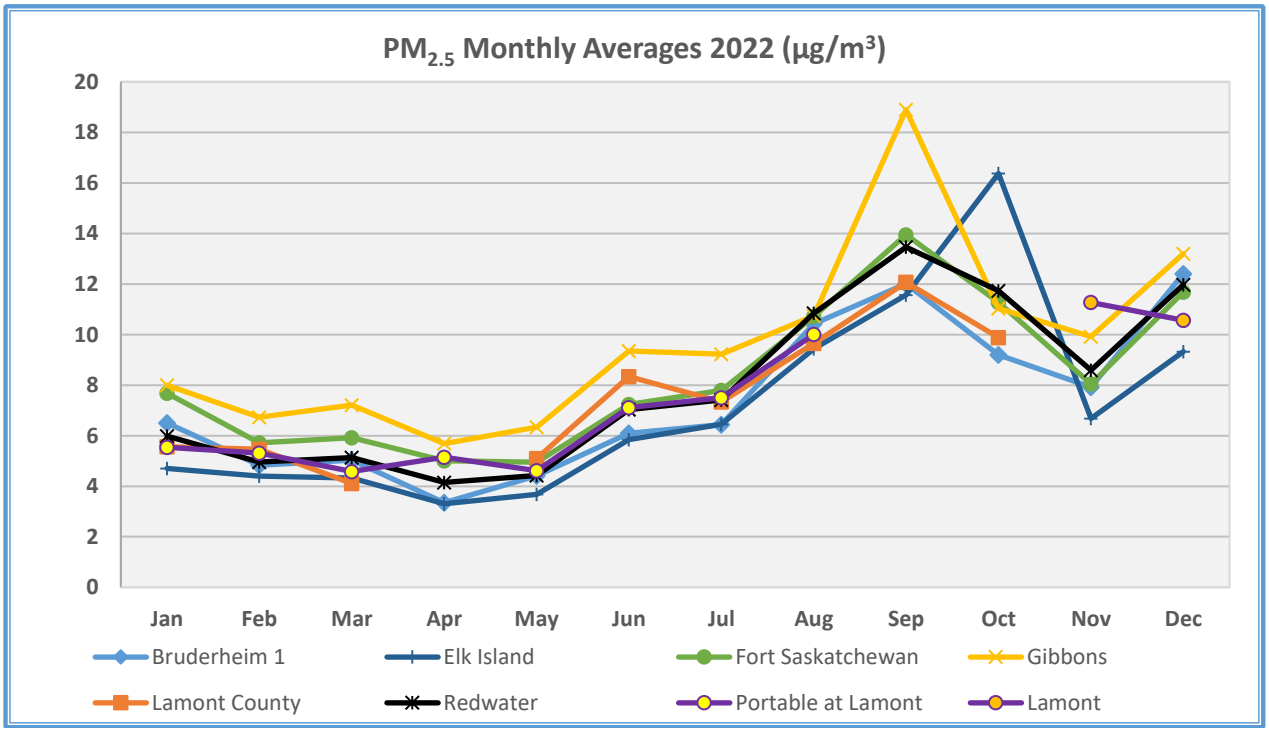
Station	Highest 1-hour average ($\mu g/m^3$)	% of AAAQG	Date Time	Highest 24-hour average ($\mu g/m^3$)	% of AAAQO	Date
Bruderheim 1	90.7	113.4%	Dec 31 10:00	56.3	194%	Dec 31
Elk Island	1151.3	1439.1%	Oct 19 01:00	199.0	686%	Oct 19
Fort Saskatchewan	109.3	136.6%	Sep 11 00:00	60.1	207%	Sep 11
Gibbons	199.2	249.0%	Sep 11 04:00	114.6	395%	Sep 11
K.P. Portable at Lamont	77.0	96.3%	Aug 22 08:00	47.3	163%	Sep 11
Lamont County	91.7	114.6%	Oct 19 05:00	45.1	156%	Sep 4

Lamont	82.1	102.7%	Dec 31 11:00	39.7	137%	Dec 31
Redwater	111.5	139.4%	Oct 18 06:00	56.8	196%	Sep 4

Figure 22 below shows monthly average $PM_{2.5}$ concentrations recorded in 2022 at individual FAP monitoring stations. Figure 23 shows the annual average at each station in 2022 and the five years previous. Figure 24 shows annual averages at FAP stations compared to others across Alberta for the past 3 years.

As shown in Figure 22, wildfire smoke events were measured at all FAP stations in September 2022 causing an elevated monthly average. Other shorter events occurred in October (due to regional meteorological conditions and brush burning at Elk Island Park) and again in late December (due to a wintertime inversion). As seen in Figure 23, the $PM_{2.5}$ annual averages in 2018 were higher than other years. This was due to wildfire smoke from British Columbia for most of August that year.

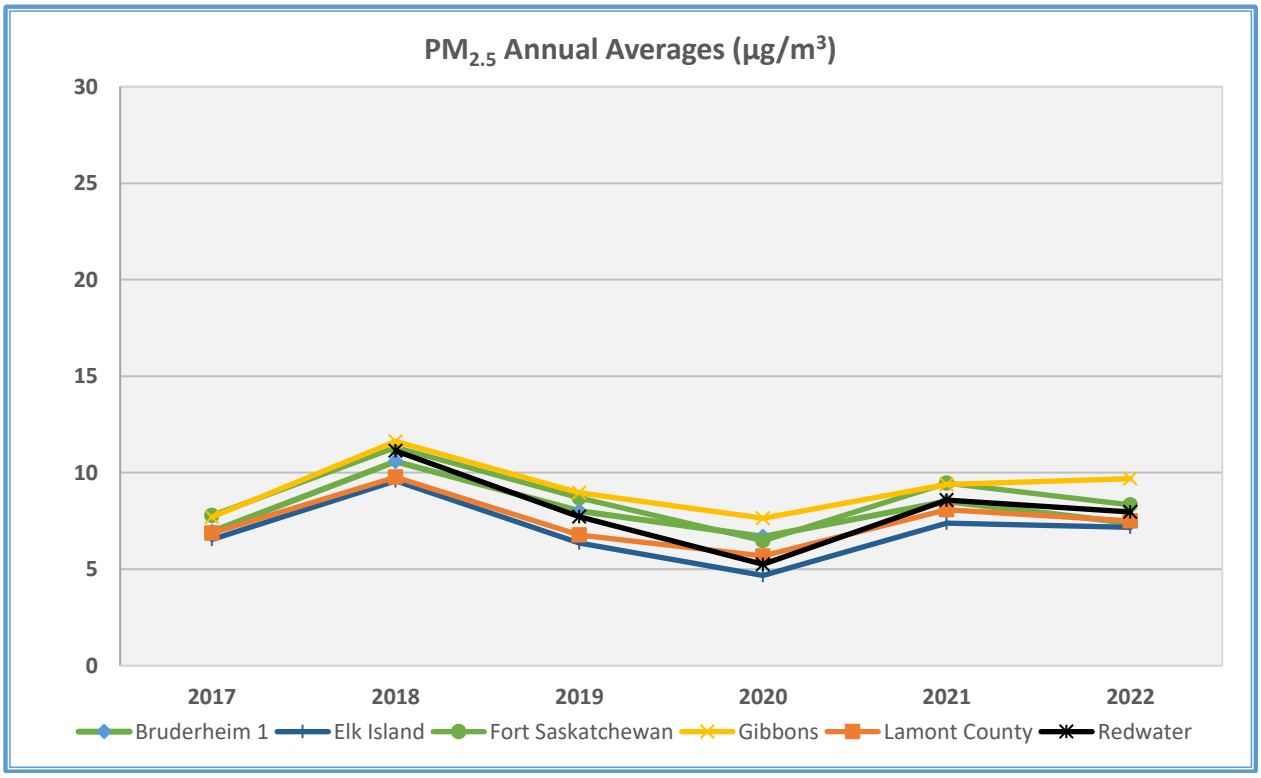
Figure 22: Monthly average $PM_{2.5}$ concentrations (µg/m^3) in 2022



Notes:
- The Keith Purves portable stopped operating at Lamont in early September 2022.
- The new Lamont station began operating November 2022.
- The Lamont County station was decommissioned at the end of October 2022.

Fine Particulates (continued)

Figure 23: Annual average $PM_{2.5}$ concentrations at FAP stations (µg/m^3)

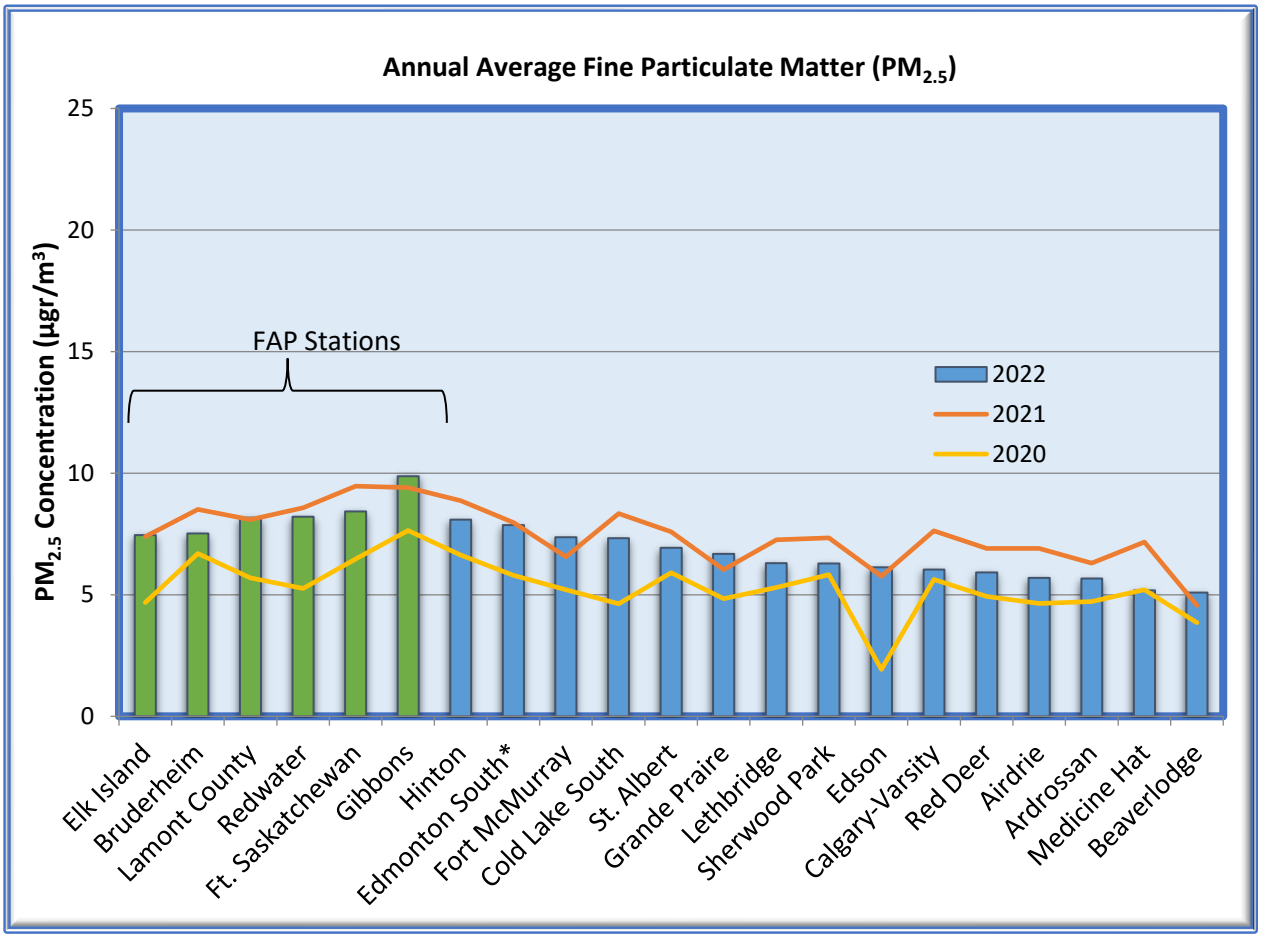


Notes:

- *The Redwater station began operations in late 2017.*
- *The Keith Purves Portable station is not shown in this plot as it was not at any location for the minimum 75% of a calendar year required to calculate an annual average.*
- *The new Lamont station, began November 2022, had insufficient data to calculate an annual average.*

Fine Particulates (continued)

Figure 24: Annual average $PM_{2.5}$ concentrations in Alberta (µg/m³)



**Edmonton South was decommissioned. 2022 data is from the Edmonton Lendrum station.*

Significant wildfire smoke episodes across Alberta in 2021 contributed to overall higher annual average $PM_{2.5}$ values in those years as seen in Figure 24 above when compared to the 2020 or 2022 annual averages.

Hydrocarbons

Total hydrocarbons (THC) refer to a broad family of chemicals that contain carbon and hydrogen atoms. Total hydrocarbons are the sum of non-reactive and reactive hydrocarbons.

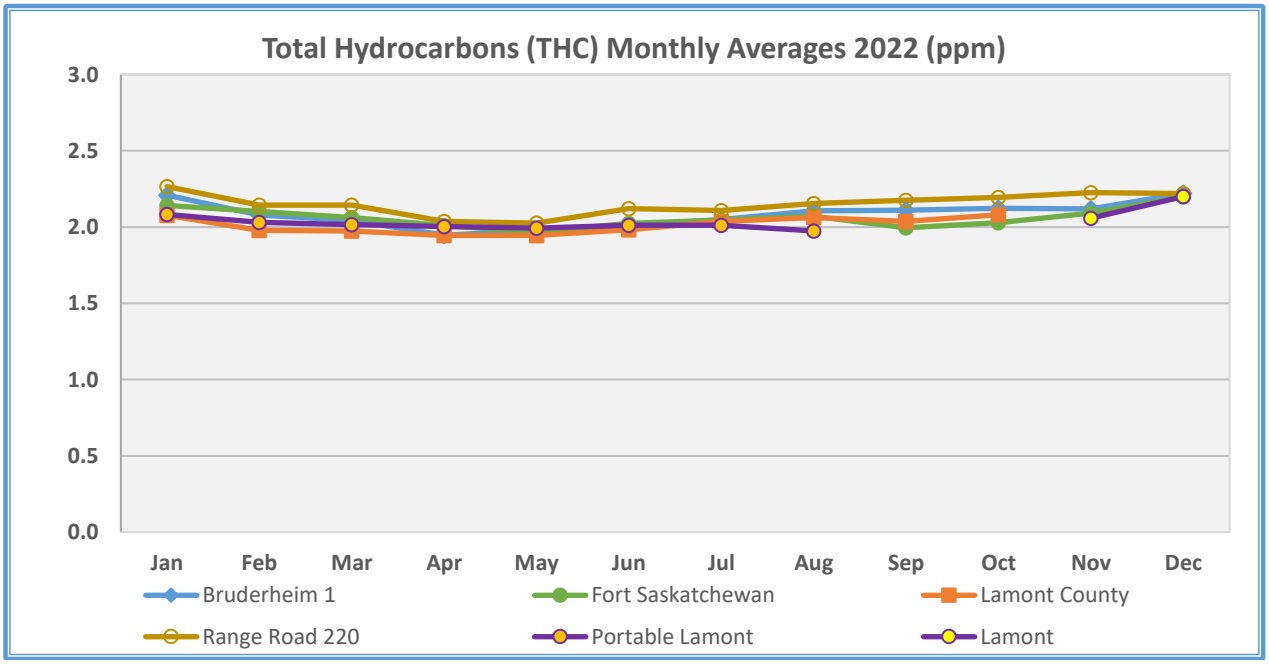
The major reactive hydrocarbon in the atmosphere is methane. Major worldwide sources of atmospheric methane include wetlands, ruminants such as cattle, energy use, landfills, and burning biomass such as wood. Methane is the primary component of natural gas.

The reactive (or non-methane) hydrocarbons consist of many volatile organic compounds (VOC's), some of which react with oxides of nitrogen in the atmosphere to form ozone. FAP measures a group of these non-methane or VOC hydrocarbons at one station. These are detailed later in this section under Volatile Organic Compounds. While Alberta does not have ambient air quality objectives (AAAQO) for total hydrocarbons, methane or non-methane hydrocarbons, the oxidation of hydrocarbons in the atmosphere contributes to an increased amount of nitrogen oxides and ozone, which do have objectives. Additionally, there are objectives for some specific reactive hydrocarbons such as benzene, toluene, ethylbenzene, xylenes, styrene and ethylene.

A summary of hydrocarbon concentrations recorded in 2022 at individual stations is presented in Figure 25 though Figure 27 below. Note that for these plots, the Keith Purves Portable station stopped operating at Lamont in early September 2022. And the new Lamont station, began in November 2022, had insufficient data to calculate an annual average.

Plots showing 2022 along with the previous 5 years are presented in Figure 28 through Figure 30 below. Data from the Keith Purves portable station is not shown in annual averages since each year spans two distinct sites and not at any location for the minimum 75% of a calendar year required to calculate an annual average.

Figure 25: Monthly average Total Hydrocarbons (ppm) in 2022



Hydrocarbons (continued)

Figure 26: Monthly average Methane concentrations (ppm) in 2022

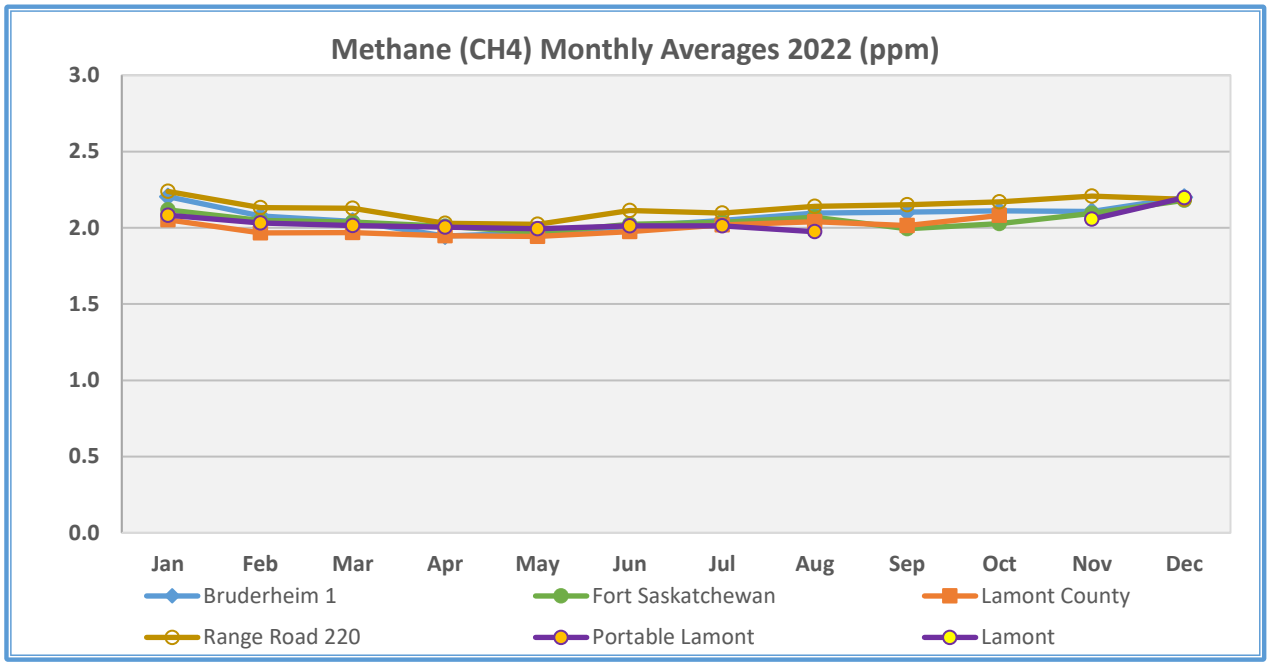
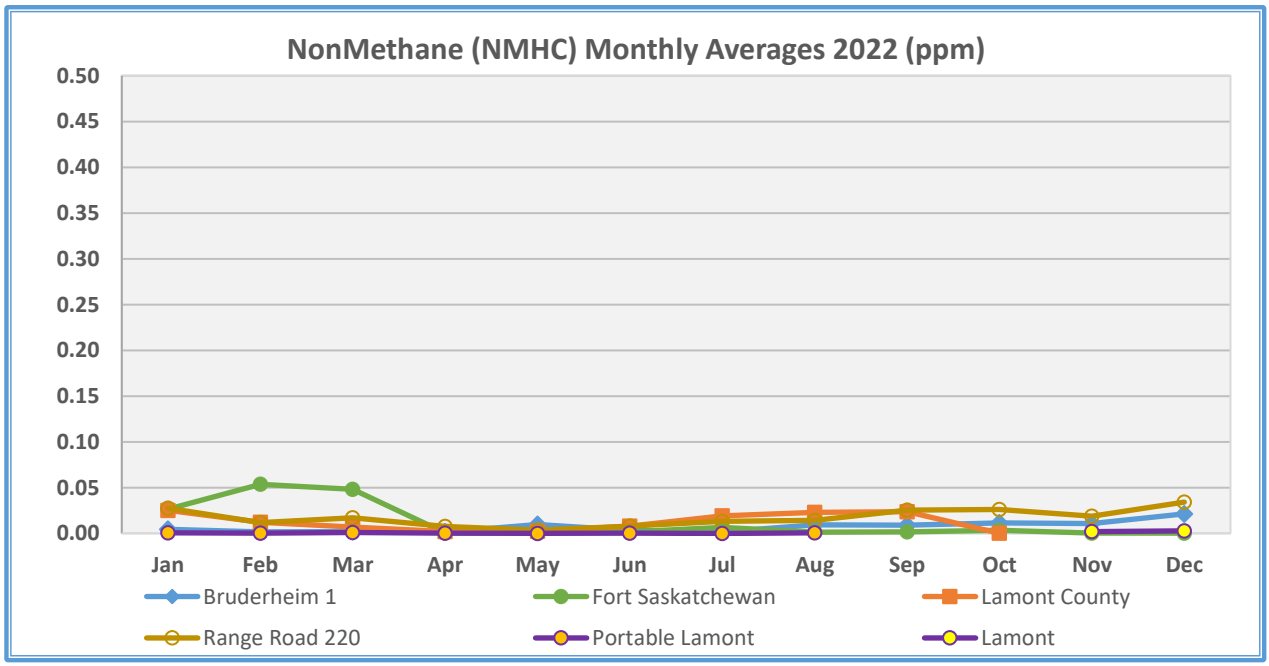


Figure 27: Monthly average Non-Methane Hydrocarbon concentrations (ppm) in 2022



Hydrocarbons (continued)

Figure 28: Annual average THC concentrations at FAP stations (ppm)

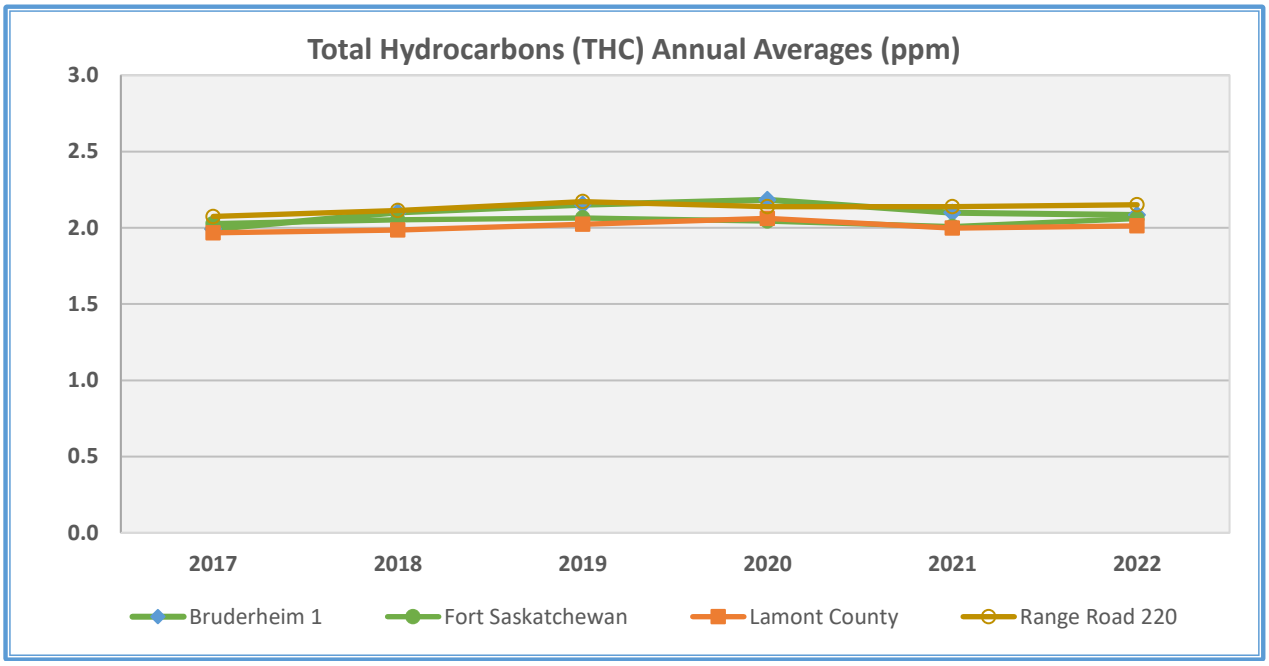


Figure 29: Annual average CH_4 concentrations at FAP stations (ppm)

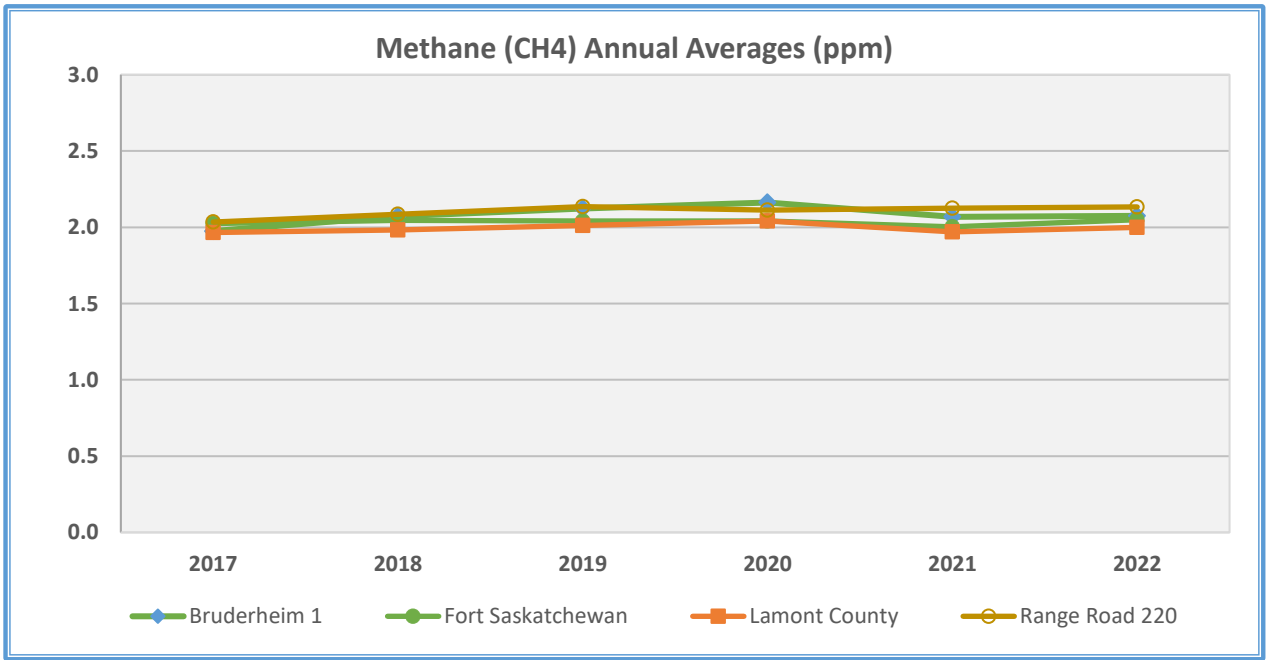
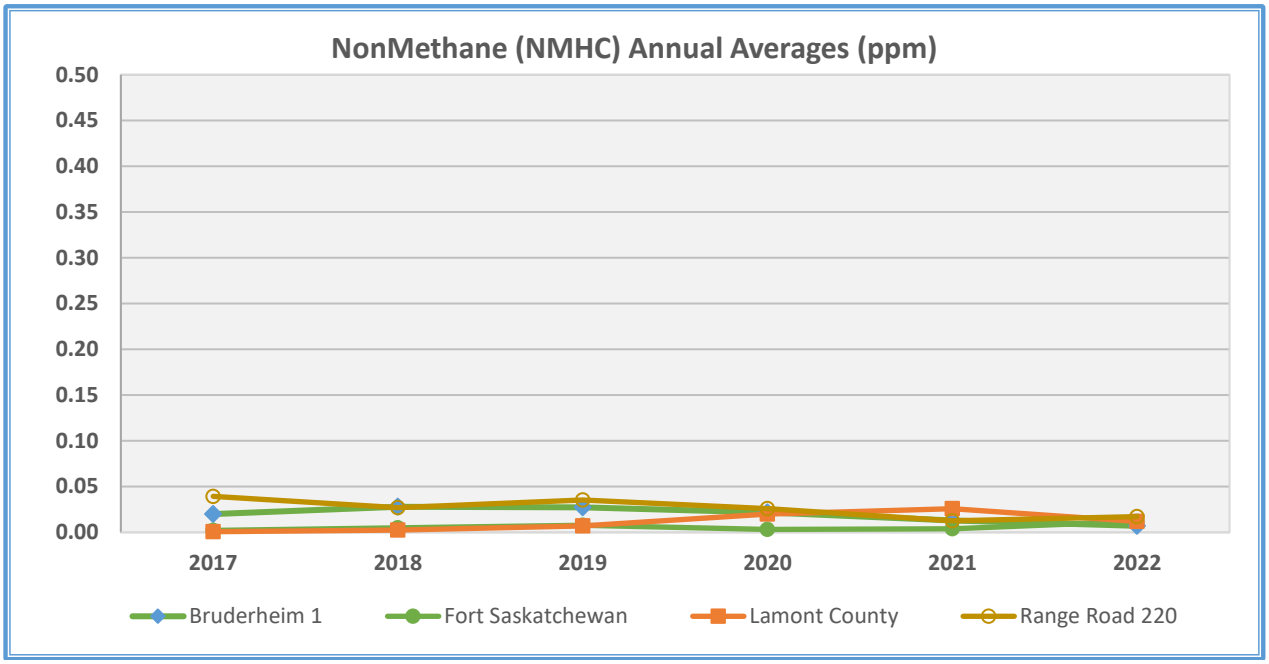


Figure 30: Annual average NMHC concentrations at FAP stations (ppm)



Hydrocarbons (continued)

Although the average and maximum hydrocarbon values recorded are similar at the various monitoring sites, it should be noted that the Bruderheim 1 and Range Road 220 station has historically measured brief hydrocarbon measurements that other stations have not. The source(s) have not been determined but are likely relatively nearby due to the short duration of these events and the volatile nature of hydrocarbons.

Table 19 below provides the maximum 1-hour average for each hydrocarbon species in 2022 as measured at each FAP station each month.

Table 19: 2022 Maximum 1-hour average hydrocarbon concentrations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Hydrocarbons THC (PPM)												
Bruderheim 1	3.81	3.41	4.76	3.44	3.72	3.77	2.99	3.77	3.84	3.87	5.37	4.57
Fort Saskatchewan	3.12	2.81	2.68	2.45	2.32	2.84	5.76	2.66	2.77	3.06	3.71	3.15
Lamont County	2.81	2.91	2.36	2.81	2.21	2.31	2.46	2.74	2.67	2.79	-	-
Range Road 220	4.55	3.06	3.96	2.61	3.70	3.30	3.29	3.57	4.12	4.00	4.18	4.03
K.P. portable at Lamont	2.70	2.29	2.44	2.79	2.25	2.65	2.59	2.74	2.27	-	-	-
Lamont	-	-	-	-	-	-	-	-	-	-	2.62	2.99
Methane CH_4 (PPM)												
Bruderheim 1	3.55	2.93	4.07	3.04	3.15	3.20	2.94	3.29	3.30	3.24	4.33	3.57
Fort Saskatchewan	2.69	2.56	2.46	2.45	2.32	2.31	2.47	2.60	2.51	3.04	3.71	3.12
Lamont County	2.56	2.80	2.30	2.75	2.13	2.27	2.37	2.73	2.58	2.79	-	-
Range Road 220	3.01	2.90	3.05	2.50	3.43	3.05	2.64	2.94	2.93	3.19	3.05	3.60
K.P. portable at Lamont	2.69	2.29	2.31	2.71	2.25	2.63	2.59	2.74	2.27	-	-	-
Lamont	-	-	-	-	-	-	-	-	-	-	2.62	2.80
Non-Methane Hydrocarbons NMHC (PPM)												
Bruderheim 1	0.37	0.48	0.69	0.40	1.51	0.57	0.17	0.51	0.55	0.63	1.05	1.58
Fort Saskatchewan	0.94	0.37	0.37	0.29	0.11	0.82	2.09	0.35	0.61	1.02	0.09	0.12
Lamont County	0.25	0.22	0.17	0.12	0.10	0.12	0.15	0.20	0.75	0.01	-	-
Range Road 220	2.12	0.65	1.42	0.50	0.30	0.45	1.18	1.00	1.59	1.62	1.45	1.41
K.P. portable at Lamont	0.20	0.04	0.43	0.12	0.01	0.06	0.01	0.28	0.01	-	-	-
Lamont	-	-	-	-	-	-	-	-	-	-	0.25	0.78

Notes:

- *The Keith Purves portable stopped operating at Lamont in early September 2022.*
- *The new Lamont station began operating November 2022.*
- *The Lamont County station was decommissioned at the end of October 2022.*

Hydrogen Sulphide

Hydrogen sulphide (H_2S) is a colourless gas with a rotten egg odour. Industrial sources of H_2S include fugitive emissions (leakages) from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, sewage treatment facilities, and animal feedlots. Natural sources of H_2S include sloughs, marshes, and lakes.

The AAAQOs for H_2S are:

- 1-hour average concentration 10ppb
- 24-hour average concentration 3ppb

There were 19 exceedances of the 1-hour AAAQO and one 24-hour exceedance of the AAAQO for H_2S in 2022. Details of the 1-hour H_2S exceedances recorded in 2022 are listed in Table 20.

The single 24-hour exceedance of 4.1ppb occurred on August 23rd at the Redwater station. Also caused by natural processes in nearby wetlands.

Table 20: Exceedances of the 1-hour average AAAQO for H_2S in 2022

Station	Highest 1 hour average (ppb)	Exceedances	Date	Attributed Cause
Redwater	15.4	3	July 14,18,23	Natural due to wetlands
Redwater	34.5	12	August 3,16,18,22,23,24,31	Natural due to wetlands
Scotford South	21.8	1	August 25	Undetermined
Redwater	13.3	2	September 18, 29	Natural due to wetlands
Redwater	10.5	1	October 3	Natural due to wetlands

Hydrogen sulphide is measured at six continuous monitoring stations in FAP. Table 21 below provides the maximum 1-hour and 24-hour H_2S averages in 2022 with comparisons to the applicable AAAQOs.

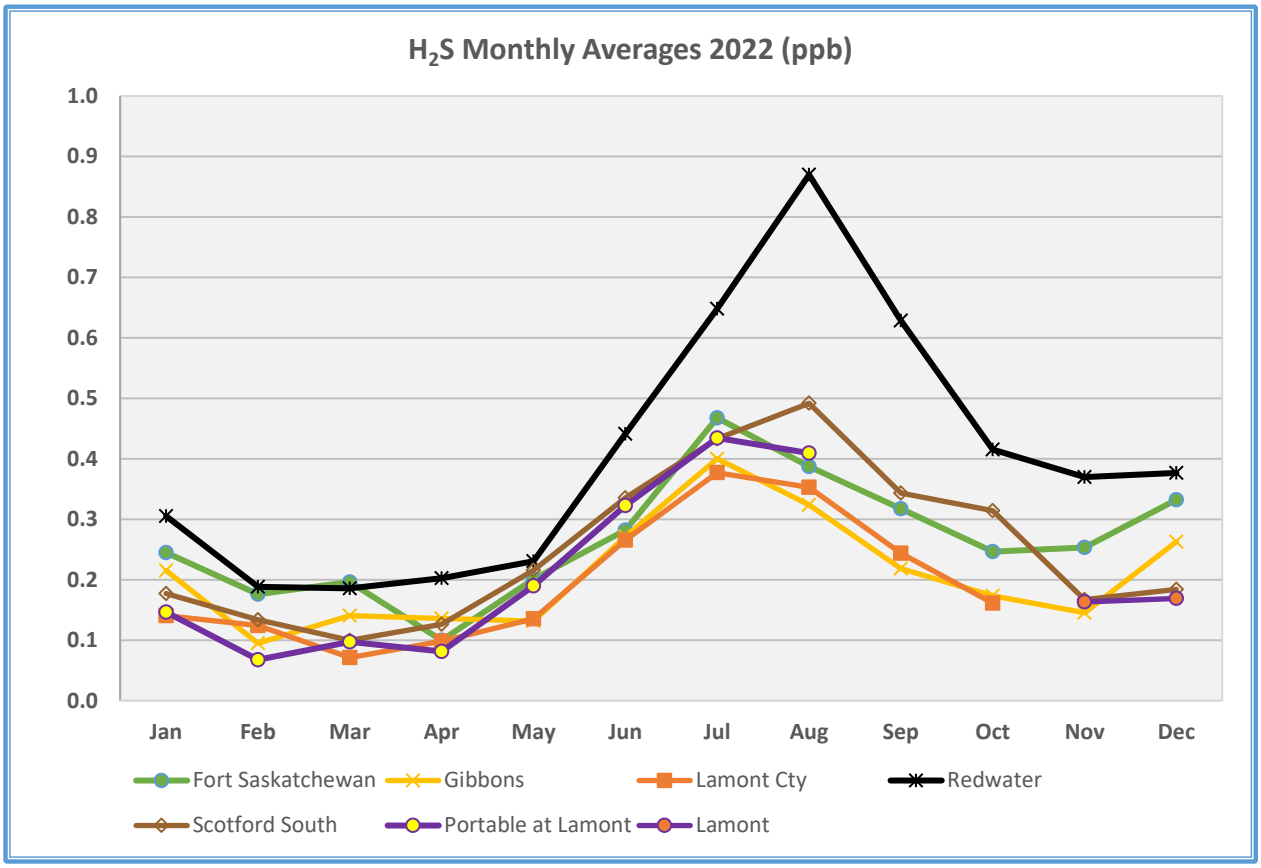
Table 21: 2022 maximum H_2S averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 24-hour average (ppb)	% of AAAQO	Date
Fort Saskatchewan	3.8	38.2%	Jul 23 07:00	1.0	33.3%	Jul 23
Gibbons	8.6	85.5%	Jul 18 04:00	1.1	36.7%	Jun 11
Keith Purves portable at Lamont	5.6	55.7%	Jun 11 06:00	1.5	50.0%	Jul 18
Lamont County	4.1	41.0%	Jul 18 06:00	0.8	26.7%	Jul 18
Lamont	1.7	16.7%	Dec 31 11:00	0.6	20.0%	Dec 31
Redwater	34.4	343.5%	Aug 23 02:00	4.5	150.0%	Aug 23
Scotford South	22.1	220.6%	Aug 25 21:00	1.8	60.0%	Aug 25

A summary of the monthly average H_2S concentrations recorded in 2022 at individual stations and annual averages for 2022 with the 5 years previous is shown in Hydrogen Sulphide (continued)
Figure 31 and Figure 32 below.

Hydrogen Sulphide (continued)

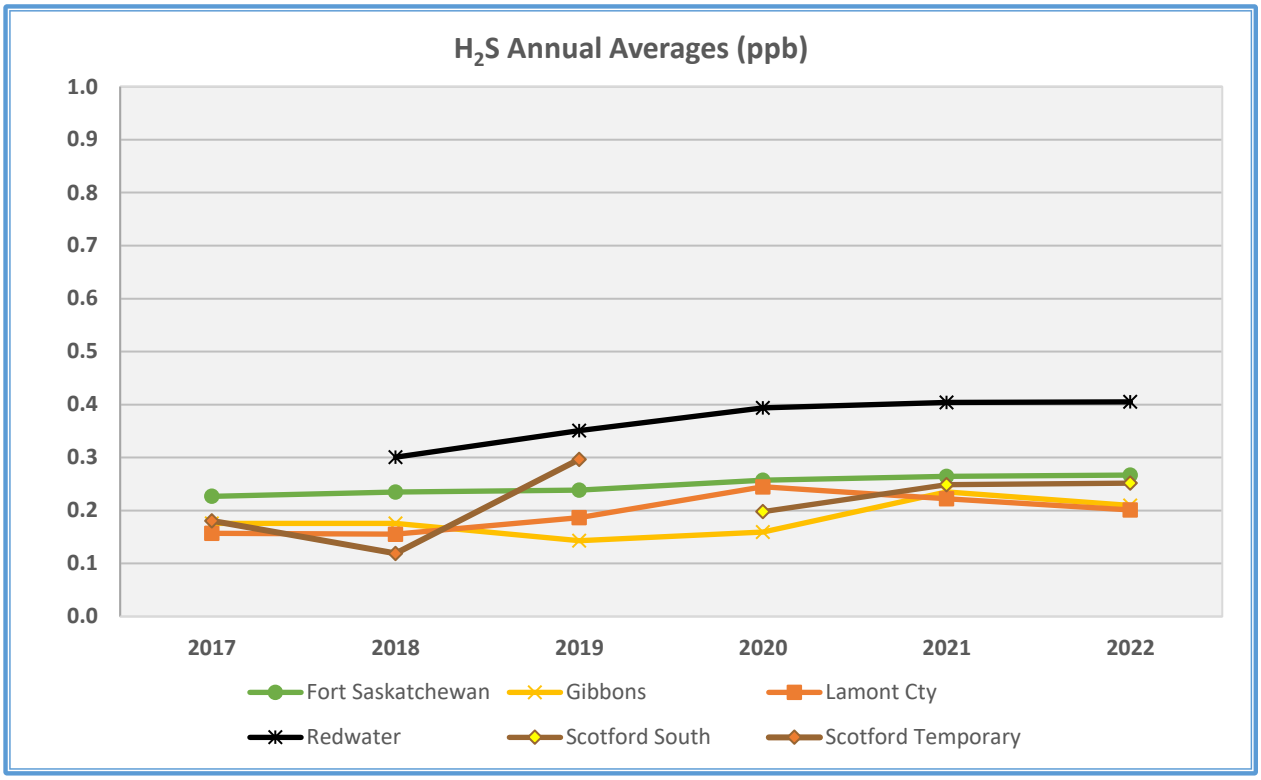
Figure 31: Monthly average H_2S concentrations (ppb) in 2022



Notes:
- The Keith Purves portable stopped operating at Lamont in early September 2022.
- The new Lamont station began operating November 2022.
- The Lamont County station was decommissioned at the end of October 2022.

Hydrogen Sulphide (continued)

Figure 32: Annual average H_2S concentrations at FAP stations (ppb)



Notes:

- *The Redwater station began operations late in 2017.*
- *The Scotford Temporary station was moved in March 2020 and became Scotford South.*
- *The Portable station is not shown here as it is not at any location for the minimum 75% of a calendar year required to calculate an annual average.*

Nitrogen Dioxide

Oxides of nitrogen (NO_x) are the total of nitrogen dioxide (NO_2) and nitric oxide (NO). During high temperature combustion, such as burning of natural gas, coal, oil and gasoline, atmospheric nitrogen may combine with molecular oxygen to form NO. NO is colourless and odourless. Most NO in the ambient air will readily react with O_3 to form NO_2. NO_2 is a reddish-brown gas with a pungent odour and is partially responsible for the "brown haze" sometimes observed near large cities.

Transportation (automobiles, locomotives and aircraft) is the major source of NO_x in Alberta. Other significant sources include industrial sources (oil and gas industries). Smaller sources of NO_x include natural gas combustion, heating fuel combustion, and forest fires.

The AAAQOs for NO_2 are:

- 1-hour average concentration 159 ppb
- Annual average concentration 24 ppb

NO_2 is measured at all ten continuous monitoring stations in FAP. There were no exceedances of either the NO_2 1-hour or annual average AAAQO at any of the FAP stations in 2022.

Table 22 below provides the maximum 1-hour and annual NO_2 averages in 2022 with comparisons to the applicable AAAQO. Due to the timing of station moves, the Keith Purves Portable station did not record the minimum 75% data in 2022 at its location to calculate a valid annual average.

Nitrogen Dioxide (continued)

Table 22: 2022 maximum NO_2 averages compared with applicable AAAQO

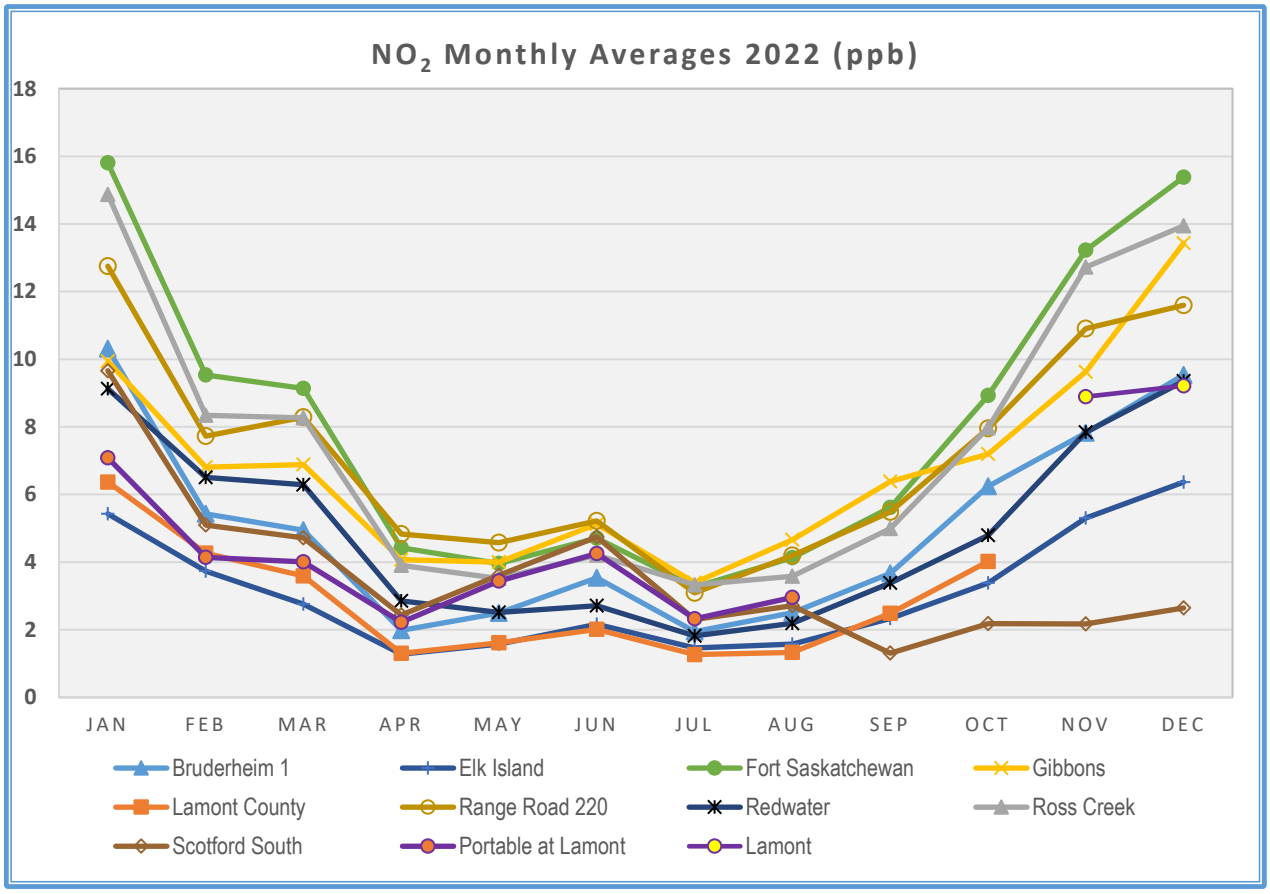
Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Annual average (ppb)	% of AAAQO
Bruderheim 1	55.5	34.9%	Jan 11 20:00	5.03	21%
Elk Island	37.5	23.6%	Nov 23 00:00	3.11	13%
Fort Saskatchewan	50.8	31.9%	Jan 10 18:00	8.18	34%
Gibbons	44.9	28.3%	Dec 10 01:00	6.79	28%
K.P. Portable at Lamont	38.2	24.0%	Jan 10 20:00		
Lamont County	41.6	26.2%	Jan 10 20:00	2.83	12%
Lamont	35.1	22.0%	Nov 17 19:00		
Range Road 220	53.8	33.8%	Jan 11 19:00	7.22	30%
Redwater	44.2	27.8%	Jan 28 04:00	4.95	21%
Ross Creek	51.1	32.1%	Jan 11 19:00	7.47	31%
Scotford South	55.8	35.1%	Nov 22 23:00	3.63	15%

While there is no AAAQO for monthly average concentrations of NO_2, the monthly averages values are useful to show that variation in NO_2 concentrations is seasonal. The maximum monthly NO_2 values occur during the winter months of November to February as seen in Figure 33. This normally occurs due to lower atmospheric mixing heights during colder weather where emissions tend to accumulate near the ground and not disperse as readily. This is meteorological phenomenon is commonly referred to as a temperature inversion.

A summary of monthly average NO_2 concentrations recorded at individual stations and a comparison with the previous 5 years are presented in Figure 33 and Figure 34 below respectively. Figure 35 is a chart of the annual averages for the last 3 years recorded at FAP stations compared with averages from a cross section of other monitoring sites around Alberta.

Nitrogen Dioxide (continued)

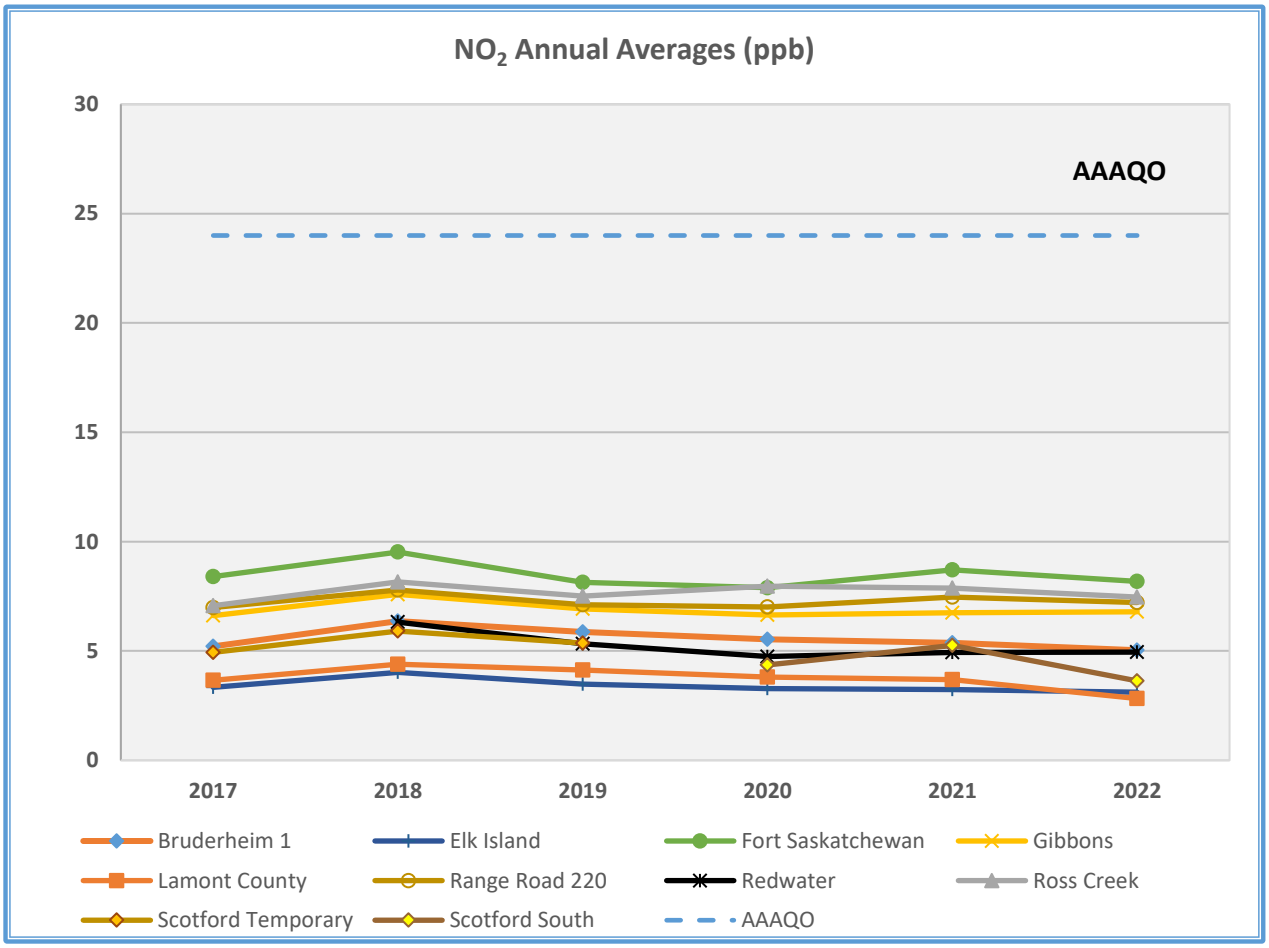
Figure 33: Monthly average NO_2 concentrations (ppb) in 2022



Notes:
- The Keith Purves portable stopped operating at Lamont in early September 2022.
- The new Lamont station began operating November 2022.
- The Lamont County station was decommissioned at the end of October 2022.

Nitrogen Dioxide (continued)

Figure 34: Annual average NO_2 concentrations at FAP stations (ppb)

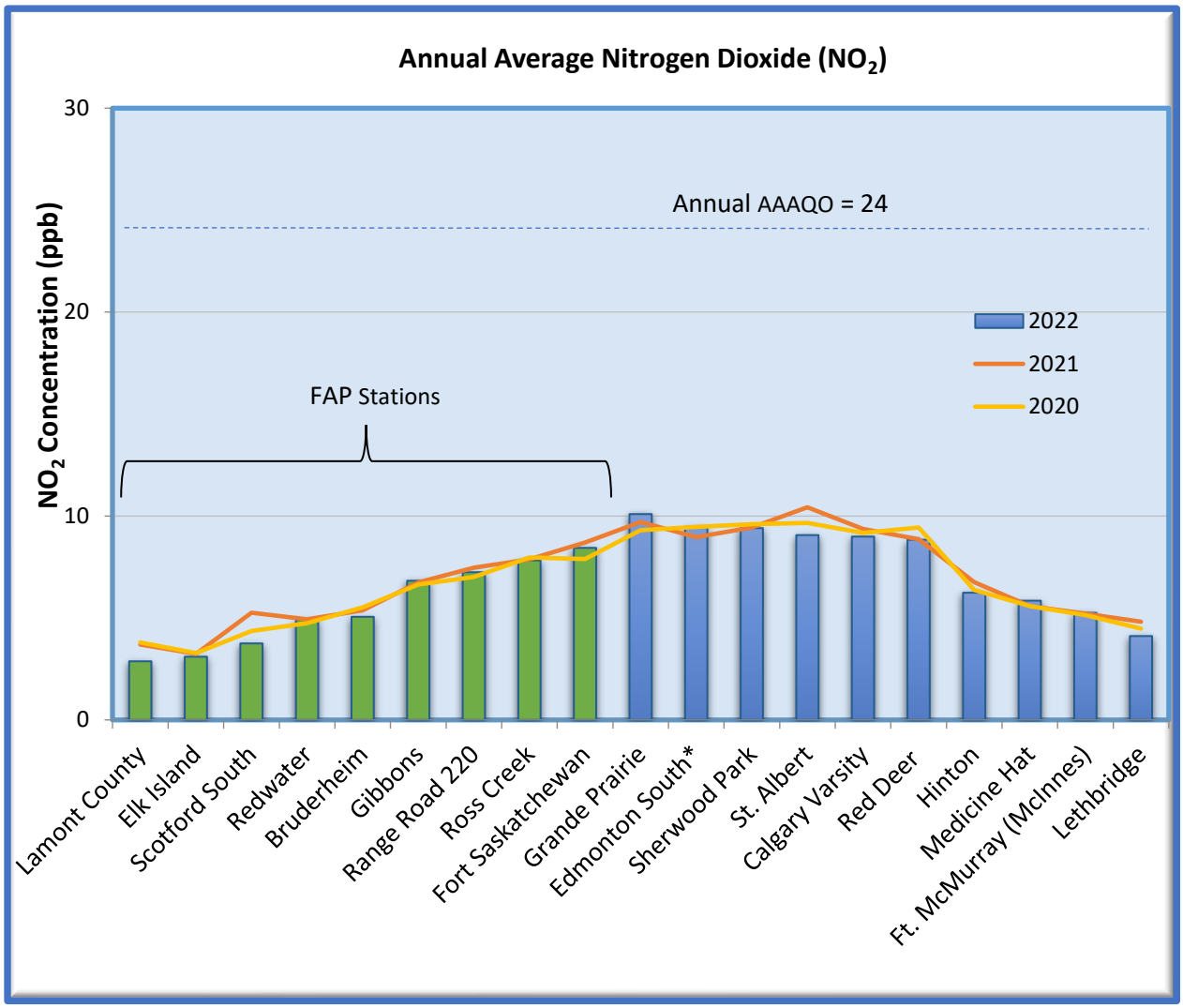


Notes:

- *The Redwater station began operations late in 2017.*
- *The Scotford Temporary station was moved in March 2020 and became Scotford South.*
- *The Keith Purves Portable station is not shown in this plot as it was not at any location for the minimum 75% of a calendar year required to calculate an annual average.*
- *The new Lamont station, began November 2022, had insufficient data to calculate an annual average.*

Nitrogen Dioxide (continued)

Figure 35: Annual average NO_2 concentrations in Alberta (ppb)



**Edmonton South was decommissioned. 2022 data is from the Edmonton Lendrum station.*

Nitric oxide (NO) and oxides of nitrogen (NO_x) are also measured and reported at FAP monitoring stations. Data for these parameters are available through the Provincial air monitoring data warehouse.

Ozone

Unlike other pollutants, ozone (O_3) is not emitted directly by anthropogenic activities. O_3 in the lower atmosphere is produced by a complicated set of chemical reactions involving oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. O_3 is also transported to the ground from the "ozone rich" upper atmosphere by natural weather processes. O_3 and its precursors, such as NO_x and VOCs, may also be carried from upwind sources such as urban centers and industrial complexes. This phenomenon can be observed particularly in summer in Alberta when warm temperatures (~30 °C) coupled with light winds and abundant sunshine result in an air quality condition referred to as summertime smog.

O_3 concentrations are generally lower at urban locations than at rural locations. This is due to the destruction of O_3 by nitric oxide (NO) that is emitted by the combustion of fossil fuels. A significant natural source of VOCs in remote and rural areas in Alberta is emissions from trees and vegetation. O_3 levels are usually higher during the spring and summer months due to increased transport from the upper atmosphere and more sunlight, which allows O_3 forming chemical reactions to occur more rapidly.

At normal outdoor concentrations, O_3 is a colourless, odourless gas. However, O_3 does have a characteristic sharp ‘very fresh air’ odour at very high concentrations, such as that experienced immediately after lightning storms. The highest maximum one-hour values tend to occur in the summer, during hot afternoons and under low wind conditions, a condition often referred to as summertime smog. In 2022 this occurred during warm weather predominantly in August as shown in Table 23**Error! Reference source not found.**. Peak concentrations for ozone are relevant because of potential health effects. However, the highest monthly average concentrations tend to occur during the spring months as shown in April 2022 as seen in Figure 36, when the overall background ozone levels are highest.

The AAAQO for ozone is:

- 1-hour average concentration 76 ppb

O_3 is measured at seven continuous monitoring stations in FAP. There were three exceedances of the O_3 1-hour average AAAQO at any of the FAP stations in 2022. All occurred at the Fort Saskatchewan station during a summertime smog event on the afternoon of August 22. The highest concentration recorded that day is given in the table below.

Table 23 below provides the maximum 1-hour O_3 averages in 2022 with comparison to the applicable AAAQO.

Ozone (continued)

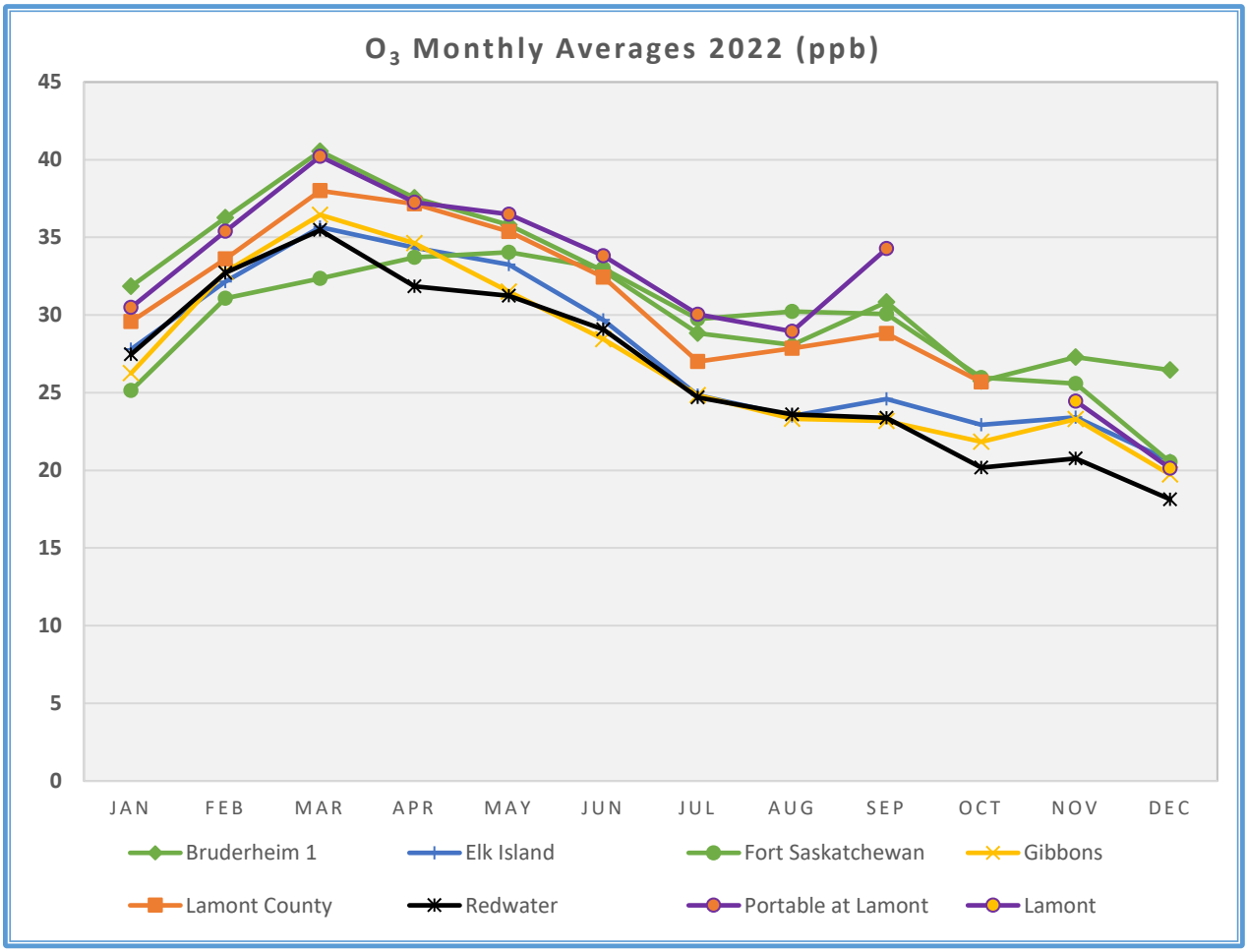
Table 23: 2022 maximum O_3 averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time
Bruderheim 1	73.7	97.0%	Aug 15 17:00
Elk Island	72.1	94.9%	Sep 11 17:00
Fort Saskatchewan	82.6	108.6%	Aug 20 17:00
Gibbons	66.7	87.7%	Jul 12 14:00
K.P. Portable at Lamont	76.0	99.9%	Aug 20 15:00
Lamont County	69.1	90.9%	Sep 11 13:00
Lamont	40.2	52.9%	Nov 20 13:00
Redwater	64.5	84.8%	Aug 26 15:00

A summary of monthly average O_3 concentrations recorded at individual stations is shown in Figure 36 below while Figure 37 shows the annual average O_3 concentrations in the FAP network in 2022 and the 5 years previous. Figure 38 plots annual averages at FAP sites alongside selected stations across Alberta for the last 3 years.

Ozone (continued)

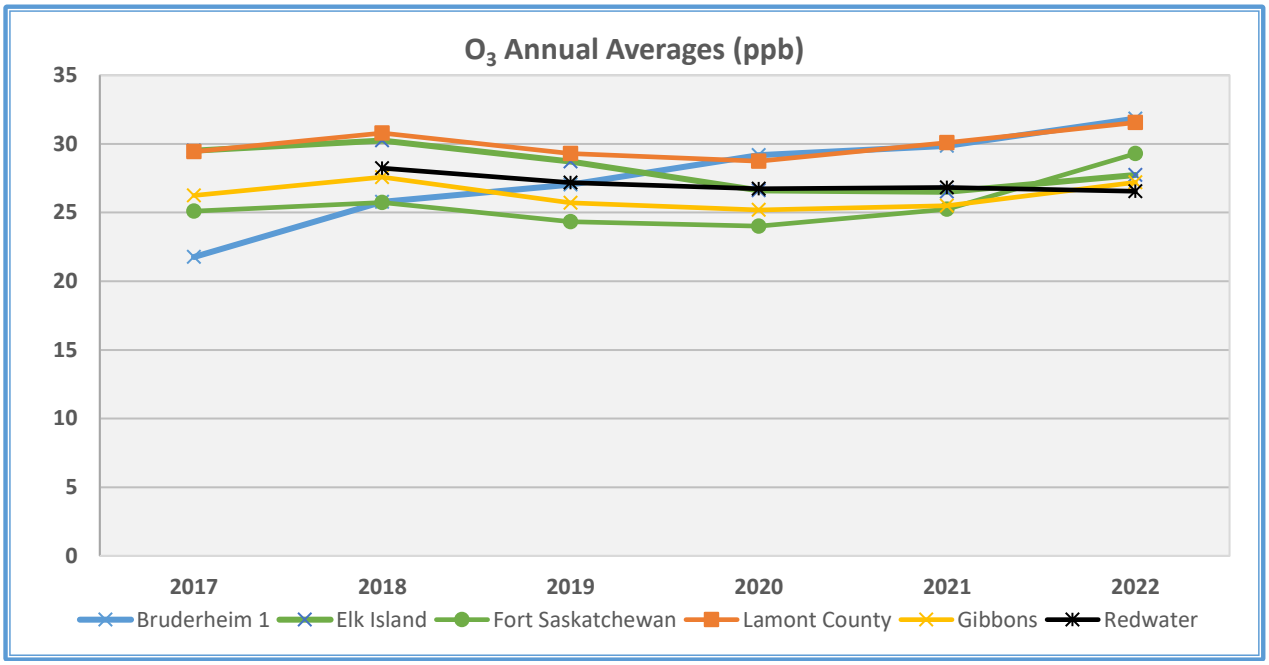
Figure 36: Monthly average O_3 concentrations (ppb) in 2022



Notes:
- The Keith Purves portable stopped operating at Lamont in early September 2022.
- The new Lamont station began operating November 2022.
- The Lamont County station was decommissioned at the end of October 2022.

Ozone (continued)

Figure 37: Annual average O_3 concentrations at FAP stations (ppb)

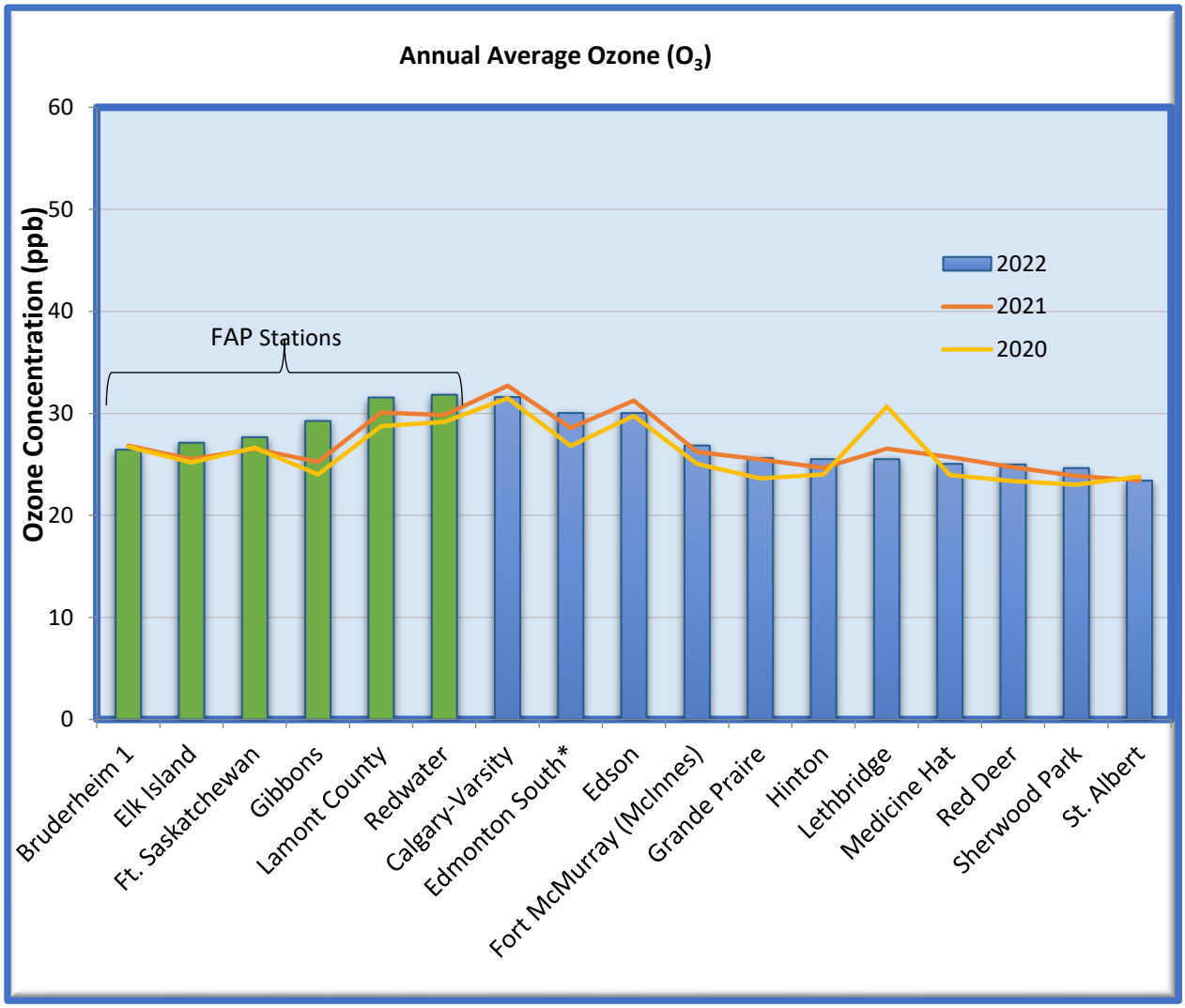


Notes:

- *The Redwater station began operations late in 2017.*
- *The Scotford Temporary station was moved in March 2020 and became Scotford South.*
- *The Keith Purves Portable station is not shown in this plot as it was not at any location for the minimum 75% of a calendar year required to calculate an annual average.*
- *The new Lamont station, began November 2022, had insufficient data to calculate an annual average.*

Ozone (continued)

Figure 38: Annual average O_3



**Edmonton South was decommissioned. 2022 data is from the Edmonton Lendrum station.*

Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a pungent odour. In Alberta, natural gas processing plants are responsible for close to half of the SO_2 emissions in the province. SO_2 measured in the Airshed is primarily from industrial sources, from both within and outside the FAP boundary.

The AAAQOs for sulphur dioxide are:

- 1-hour average concentration 172 ppb
- 24-hour average concentration 48 ppb
- 30-day average concentration 11 ppb
- Annual average concentration 8 ppb

There were no exceedances of any of the AAAQOs for SO_2 at any of the FAP monitoring stations in 2022.

Table 24 below provides the maximum 1-hour, 24-hour, 30 day and annual SO_2 averages in 2022 with comparison to the applicable AAAQOs. For the purposes of this comparison, FAP uses the monthly averages as the 30-day average.

Table 24: 2022 maximum SO_2 averages compared with applicable AAAQO

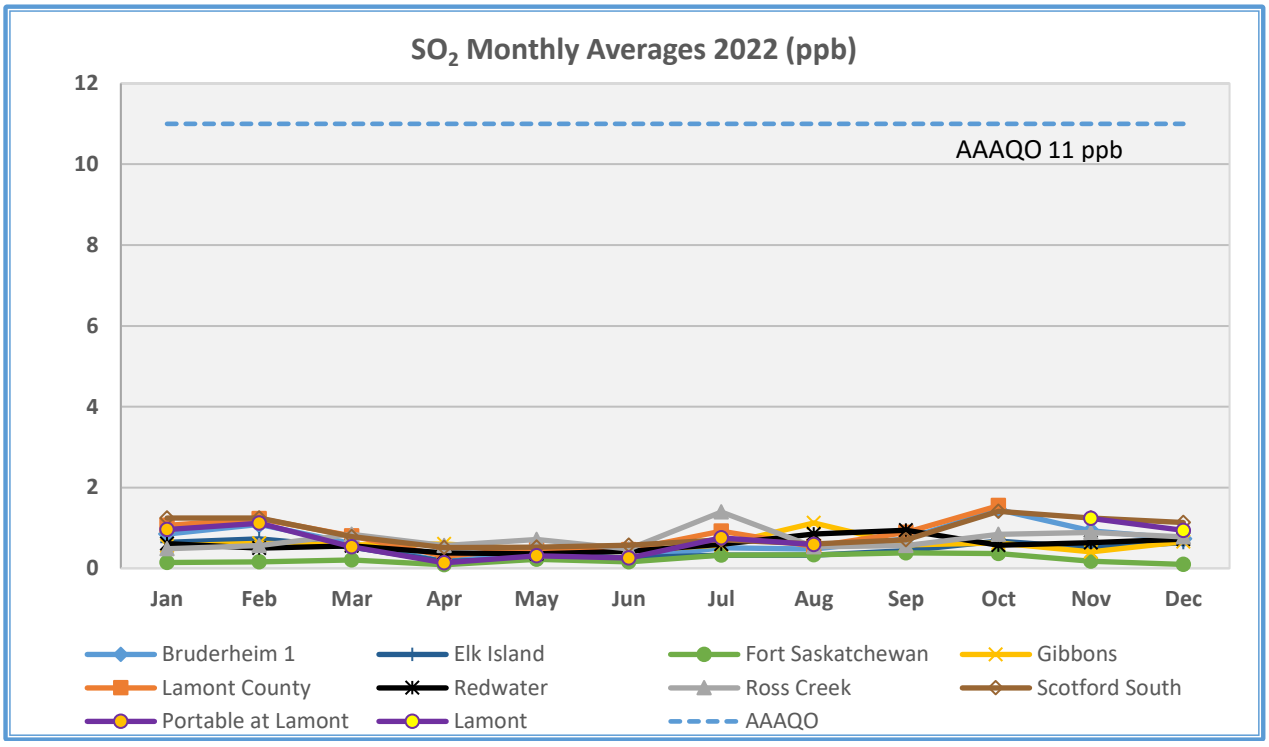
Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 24-hour average (ppb)	% of AAAQO	Date	Highest 30-day average (ppb)	% of AAAQO	Month	Annual average (ppb)	% of AAAQO
Bruderheim 1	37.9	22.0%	Feb 7 16:00	5.9	12.3%	Feb 7	1.45	13%	Jan	0.68	9%
Elk Island	41.5	24.1%	Jul 16 11:00	5.0	10.4%	Feb 26	0.73	7%	Apr	0.46	6%
Fort Saskatchewan	41.0	23.8%	Sep 2 12:00	3.9	8.1%	Oct 17	0.38	3%	Feb	0.22	3%
Gibbons	24.8	14.4%	Oct 15 15:00	4.3	9.0%	Aug 12	1.12	10%	Jul	0.60	8%
K.P. Portable at Lamont	27.7	16.1%	Feb 7 19:00	6.9	14.4%	Feb 8	1.12	10%	Mar	N/A	N/A
Lamont County	38.5	22.4%	Feb 7 22:00	3.2	6.7%	Nov 19	1.55	14%	Jan	0.83	10%
Lamont	21.2	12.3%	Dec 2 13:00	6.2	12.9%	Feb 7	1.24	11%	Nov	N/A	N/A
Redwater	20.8	12.1%	Sep 3 13:00	2.8	5.8%	Jul 12	0.94	9%	Jul	0.60	7%
Ross Creek	47.3	27.5%	Oct 17 13:00	8.0	16.7%	Oct 5	1.39	13%	Nov	0.72	9%
Scotford South	61.6	35.8%	Oct 26 15:00	6.5	13.5%	Oct 17	1.41	13%	Apr	0.89	11%

Sulphur Dioxide (continued)

A summary of monthly average SO_2 concentrations recorded in 2022 at individual stations is presented in Figure 39 below.

A comparison of annual averages for 2022 and the five years previous is shown in Figure 40. Figure 41 shows the annual averages of SO_2 in the past three years at FAP stations with a cross section of other stations in Alberta.

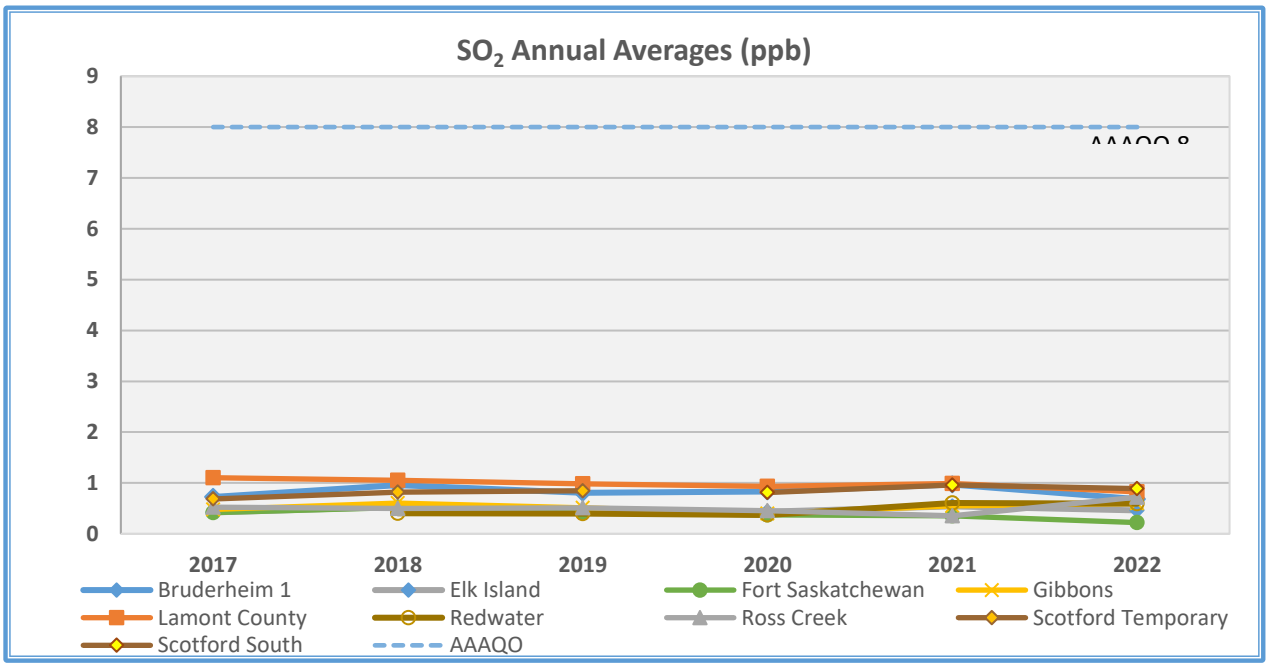
Figure 39: Monthly average SO_2 concentrations (ppb) in 2022



Notes:
- The Keith Purves portable stopped operating at Lamont in early September 2022.
- The new Lamont station began operating November 2022.
- The Lamont County station was decommissioned at the end of October 2022.

Sulphur Dioxide (continued)

Figure 40: Annual average SO_2 concentrations at FAP stations (ppb)

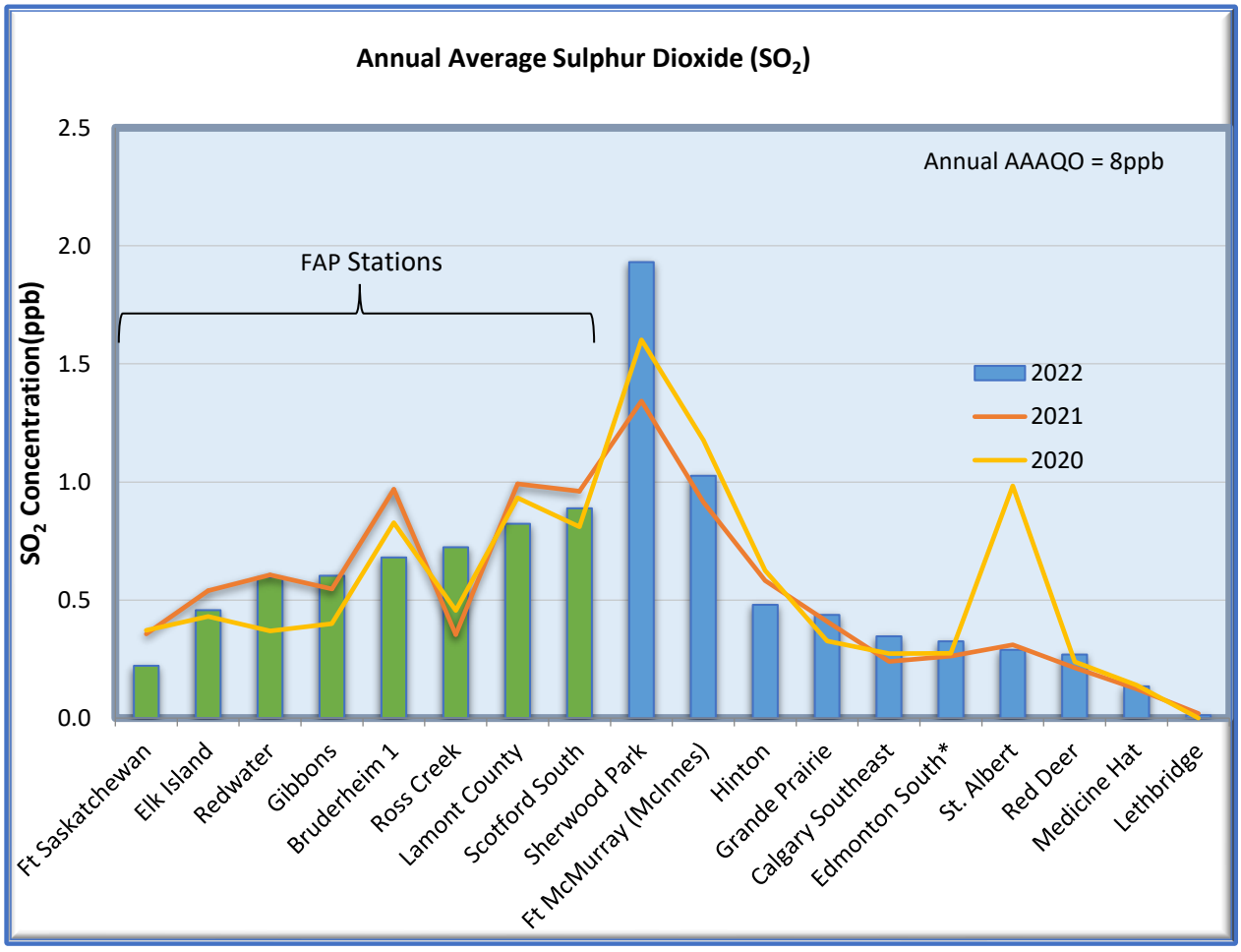


Notes:

- *The Redwater station began operations late in 2017.*
- *The Scotford Temporary station was moved in March 2020 and became Scotford South.*
- *The Keith Purves Portable station is not shown in this plot as it was not at any location for the minimum 75% of a calendar year required to calculate an annual average.*
- *The new Lamont station, began November 2022, had insufficient data to calculate an annual average.*

Sulphur Dioxide (continued)

Figure 41: Annual average SO_2 concentrations in Alberta (ppb)



**Edmonton South was decommissioned. 2022 data is from the Edmonton Lendrum station.*

Volatile Organic Compounds (VOCs)

Benzene, toluene, ethylbenzene, o-xylene, mp-xylenes, and styrene (BTEX/S) fall into the group of compounds known as VOC's. These compounds are typically found in petroleum products, such as gasoline and diesel fuel with each having a characteristic strong odour. Significant sources of VOCs in Alberta are vegetation, automobile emissions, gasoline dispensing and storage tanks, petroleum and chemical industries, dry cleaning, fireplaces and natural gas combustion. The major source of VOCs in most urban areas is vehicle exhaust emissions.

BTEX/S has been measured on a semi-continuous (up to four samples per hour) basis at the Scotford 2 and subsequently the Scotford Temporary and Scotford South stations since January 2007.

The AAAQOs for the following VOCs are:

- Benzene
  - 1-hour average concentration 9 ppb
  - Annual average concentration 0.9 ppb
- Toluene
  - 1-hour average concentration 499 ppb
  - 24-hour average concentration 106 ppb
- Ethylbenzene
  - 1-hour average concentration 460 ppb
- Xylenes (all isomers)
  - 1-hour average concentration 530 ppb
  - 24-hour average concentration 161 ppb
- Styrene
  - 1-hour average concentration 52 ppb

There were no exceedances of any AAAQO for any of the BTEX/S compounds in 2022.

Table 25 below provides the maximum 1-hour and 24-hour BTEX/S averages with comparison to the applicable AAAQOs. The tables and charts below combine data from both the Scotford Temporary and Scotford South locations for the monitoring station in 2022. The annual average of 0.1 ppb benzene in 2022 represents approximately 11% of the AAAQO.

Volatile Organic Compounds (continued)

Table 25: 2022 maximum BTEX/S averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	Date Time	% of AAAQO	Highest 24-hour average (ppb)	Date	% of AAAQO
Benzene	6.9	77.1%	Oct 19 07:00	1.2	Oct 19	N/A
Toluene	5.4	1.1%	Apr 6 12:00	1.6	Jan 11	1.5%
Ethylbenzene	2.2	0.5%	Oct 14 22:00	0.4	Jul 28	N/A
m, p-Xylene	8.7	1.6%	Sep 6 12:00	1.1	Jan 11	0.7%
o-Xylene	5.1	1.0%	Apr 6 12:00	1.1	Jul 9	0.7%
Styrene	4.3	8.3%	Apr 6 12:00	0.8	Jan 11	N/A

A plot of the monthly average BTEX/S concentrations recorded in 2022 at the Scotford South station is presented in Figure 42. The somewhat higher toluene concentrations of May through July were unexplained. A comparison of 2022 annual average BTEX/S concentrations with the five years previous is shown in Figure 43 below. Due to the proximity of the two station locations, data from both the Scotford Temporary and Scotford South stations is used in Figure 43. The increase of toluene the 2017 annual average as shown in Figure 43 was due to inadvertent application of a sealant to repair the roof of the monitoring station shelter itself, then off-gassing during warmer temperatures.

Volatile Organic Compounds (continued)

Figure 42: Monthly average BTEX/S concentrations (ppb) in 2022

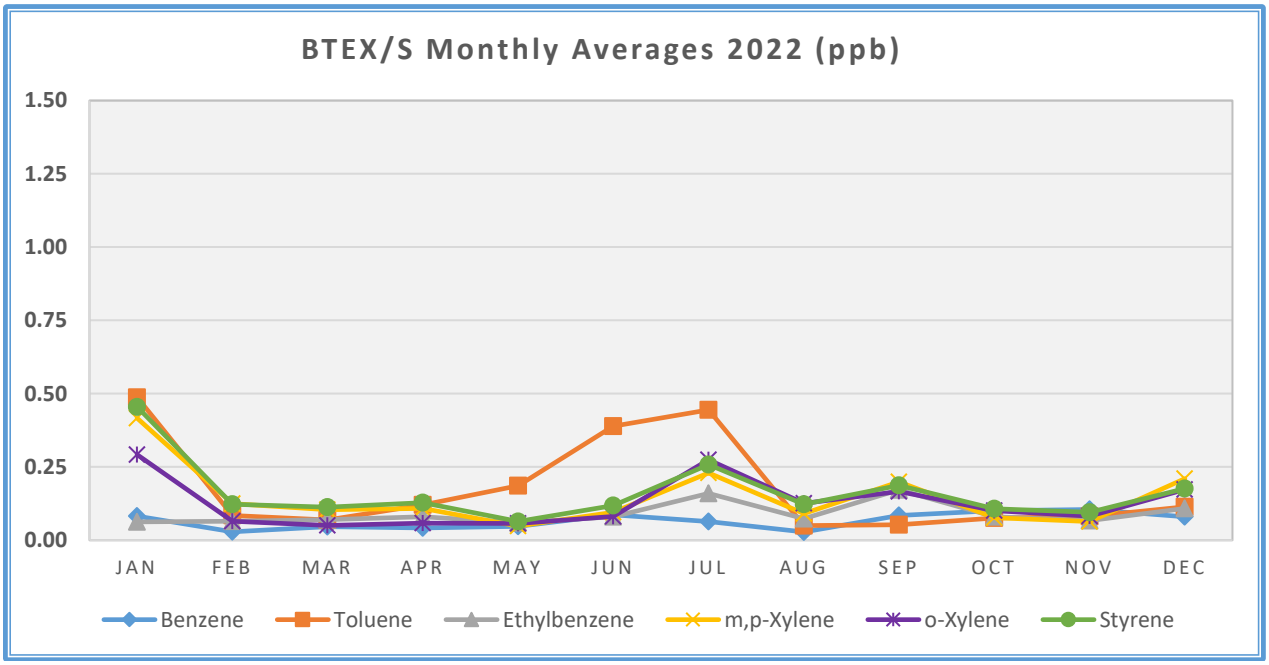
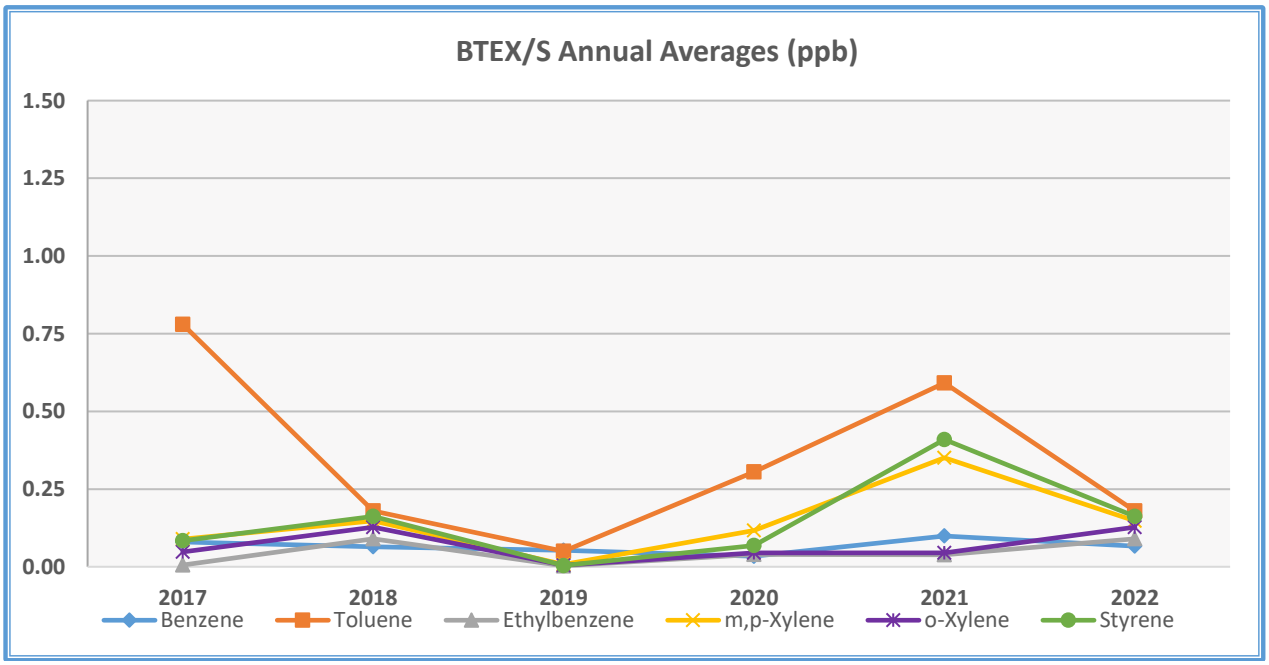


Figure 43: Annual average BTEX/S concentrations (ppb)

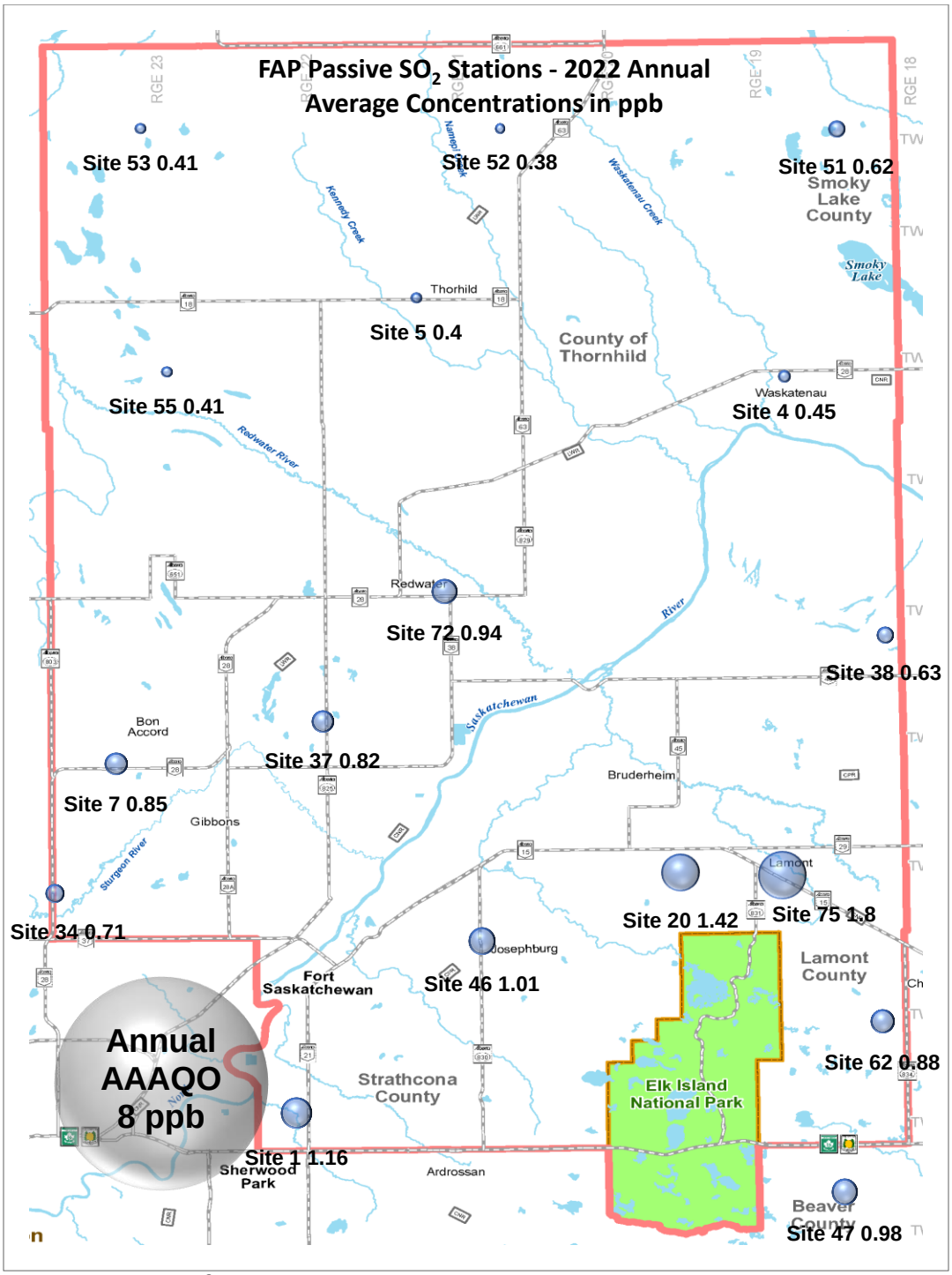


2022 Passive Monitoring Results

The following four figures show results from the passive monitoring sites in 2022. Figure 44 and Figure 46 are bubble charts showing annual average concentrations of SO_2 and H_2S respectively at each site geographically. The size of the bubble is relative to the measured annual average concentration. Figure 45 and Figure 47 chart the 2022 annual average concentrations as bars with line charts showing the annual average concentrations in the previous 5 years. Some sites were added in 2019 and 2020 so do not show prior year averages.

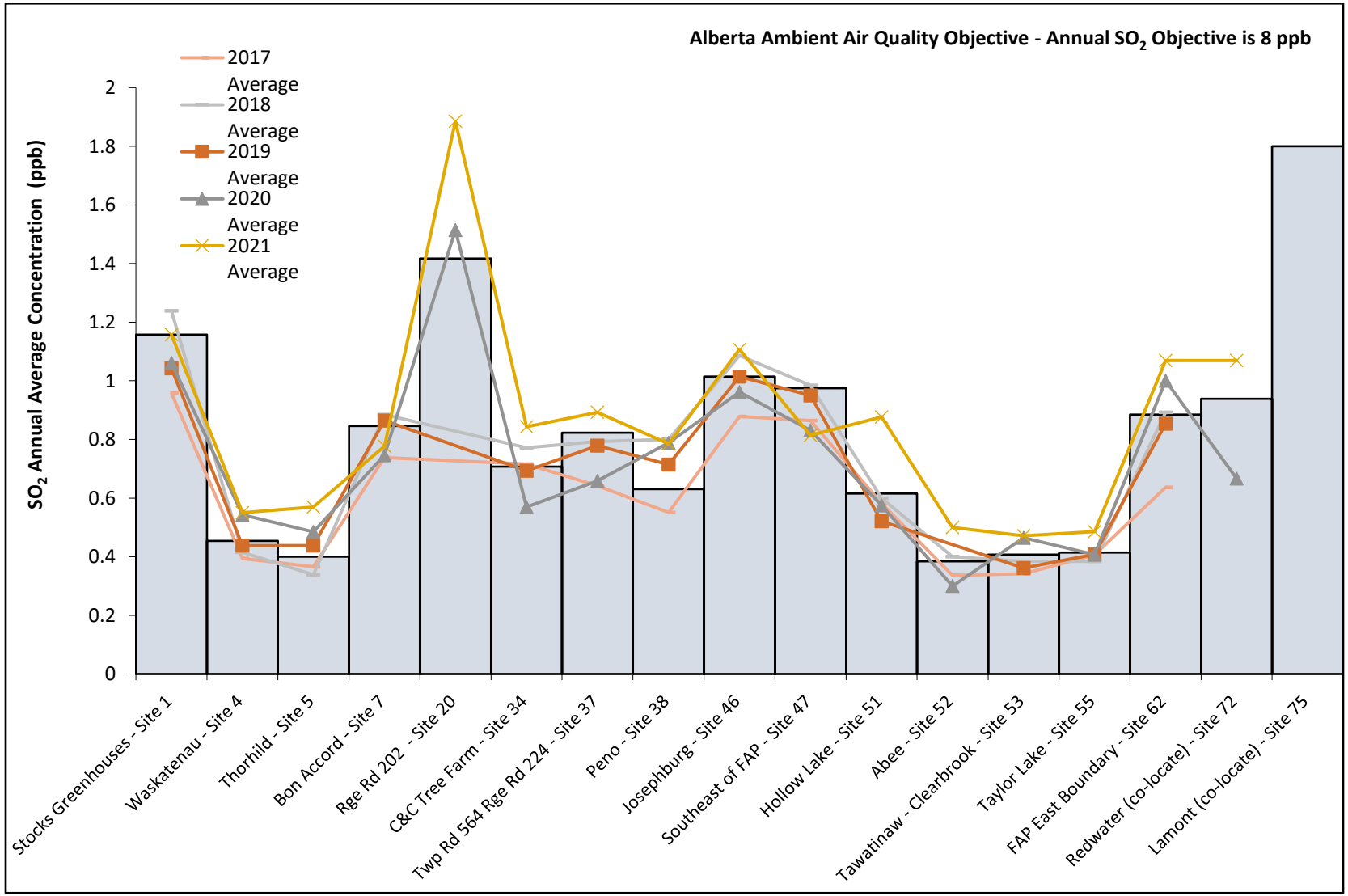
Sulphur Dioxide

Figure 44: 2022 Map of Annual average SO_2 concentrations (ppb)



Note: The area of the bubble represents the concentration measured at the geographic center of the bubble, not the geographic area affected.

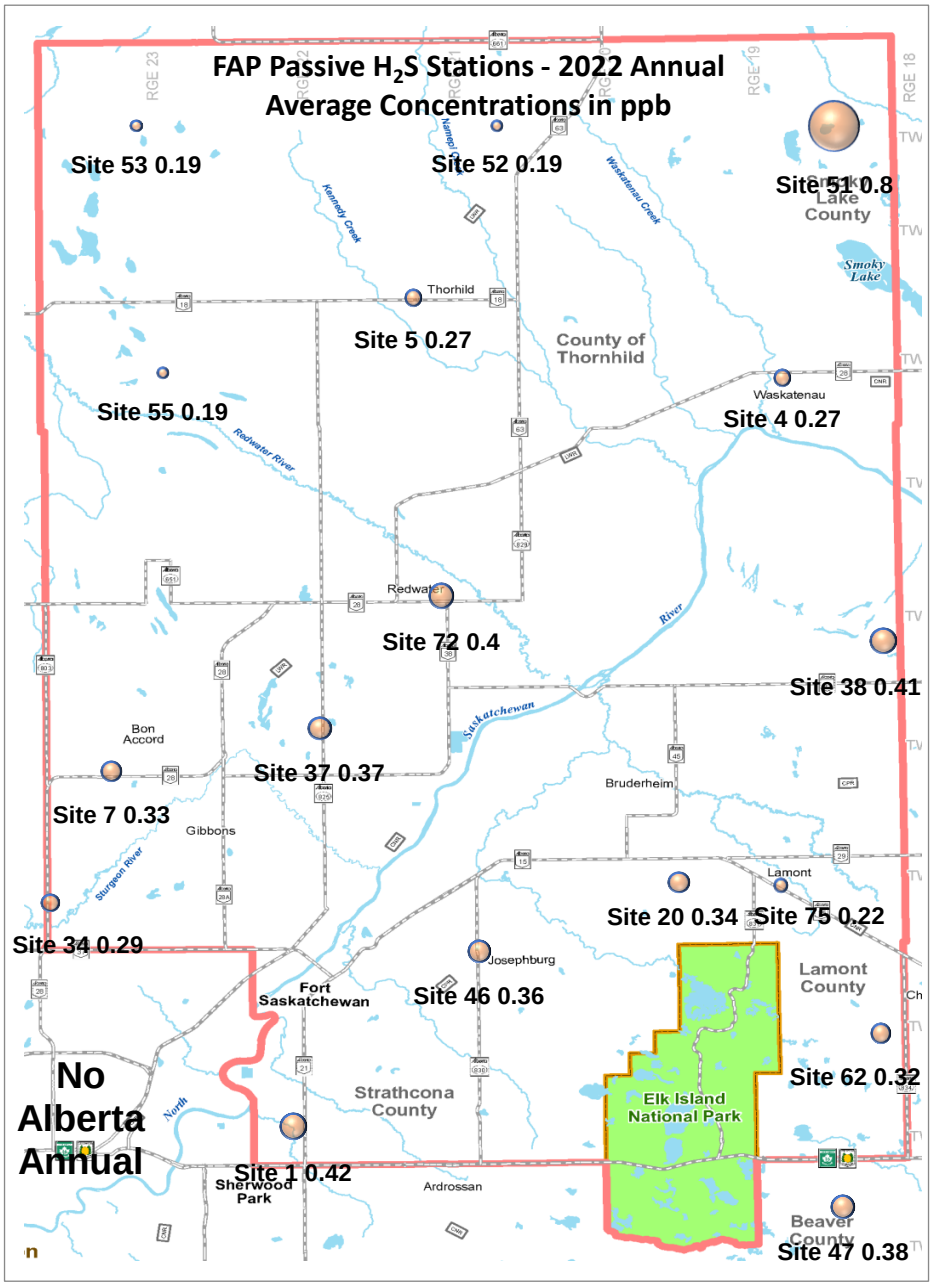
Figure 45: Passive monitoring annual averages: SO_2 (ppb) – historical



Note: Sites added to the network in 2019 or 2020 do not show previous data.

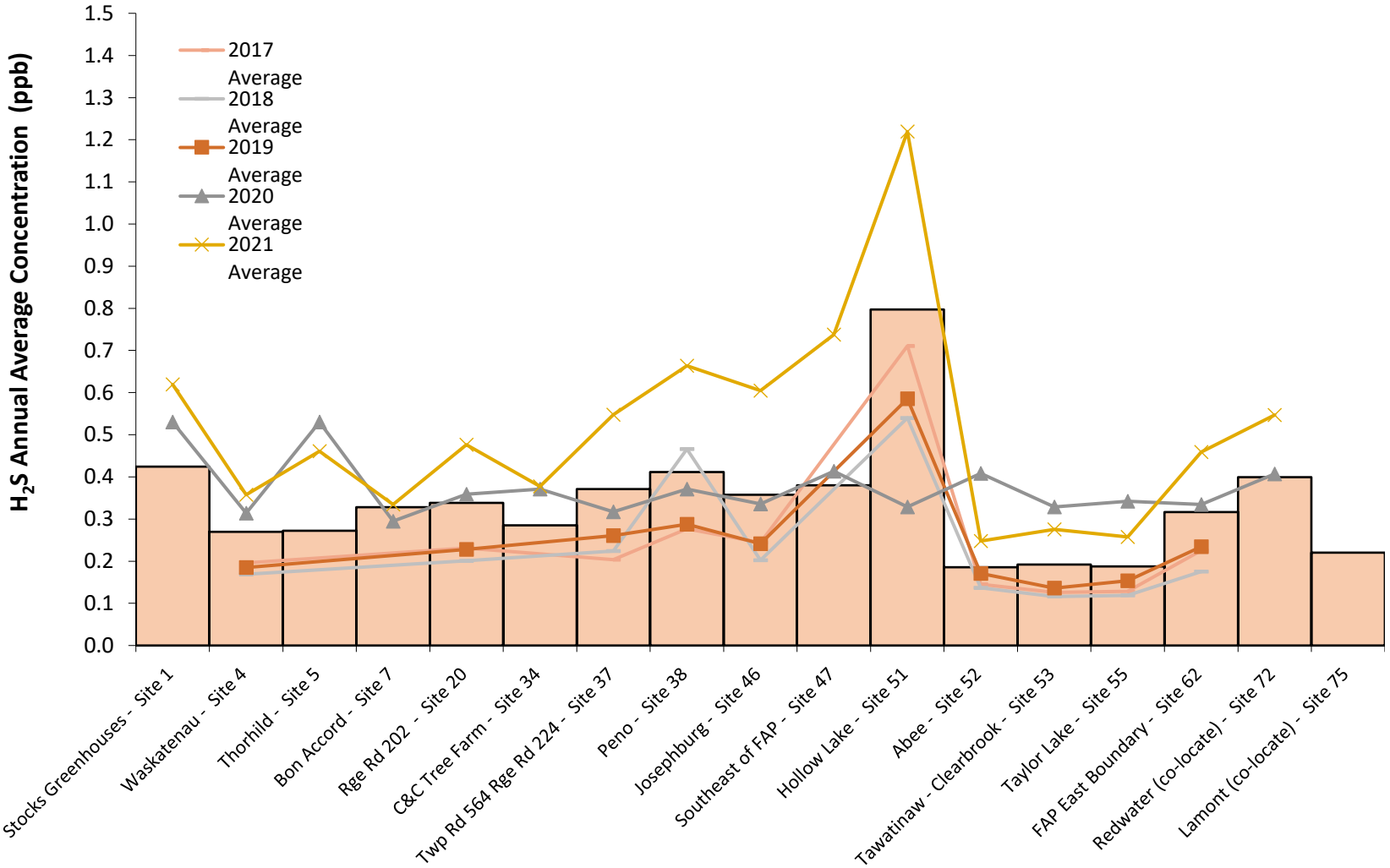
Hydrogen Sulphide

Figure 46: 2022 Map of Annual average H_2S concentrations (ppb)



Note: The area of the bubble represents the concentration measured at the geographic center of the bubble, not the geographic area affected.

Figure 47: Passive monitoring annual averages: H_2S (ppb)



Note: Sites added to the network in 2019 do not show previous data.

Small Sensor Network

FAP recently added PurpleAir® sensors to its monitoring program. These sensors were installed in Bon Accord, Josephburg, Newbrook, Thorhild and Waskatenau to address gaps in fine particulate matter ($PM_{2.5}$) air monitoring in the Airshed. While not as accurate as continuous air monitors, the PurpleAir® sensors provide a valuable assessment of the levels of particulate matter in these communities, particularly during extreme events such as the presence of wildfire smoke in the region. The PurpleAir® sensors, donated by Environment and Climate Change Canada, were deployed in place of continuous air monitoring stations in these communities since they are inexpensive to install and operate, and can be a useful indicator of air quality based on particulate matter, a primary component in the calculation of the Air Quality Health Index.

Information collected by the PurpleAir® sensors is available on Fort Air Partnership's website: fortair.org.

While of public interest, data from PurpleAir® sensors does not meet Government of Alberta or Government of Canada regulatory standards for measurement devices. As a result, data from the sensors is not used to make regulatory decisions, report against AAAQOs, or in issuing air quality advisories.

The $PM_{2.5}$ concentrations reported by PurpleAir® sensors while not used to calculate and report Air Quality Health Index, can however be compared to AQHI risk ratings, since $PM_{2.5}$ is a primary driver in the calculation of AQHI in FAP.

Figure 48 through Figure 52 show one-hour averages of PurpleAir® sensors in each community in 2022. The one-hour averages have an automatic correction formula applied that has been derived from co-locations between PurpleAir® sensors and continuous $PM_{2.5}$ monitors to further improve comparability. The 1-hr average charts have background colour bands consistent with the AQHI colour scheme for the various risk levels corresponding to the measured $PM_{2.5}$ concentrations. Episodes of wildfire smoke in August and September are evident. Not all sensors were operational the entire year.

Figure 48: 1-hour $PM_{2.5}$ averages from Bon Accord small sensor

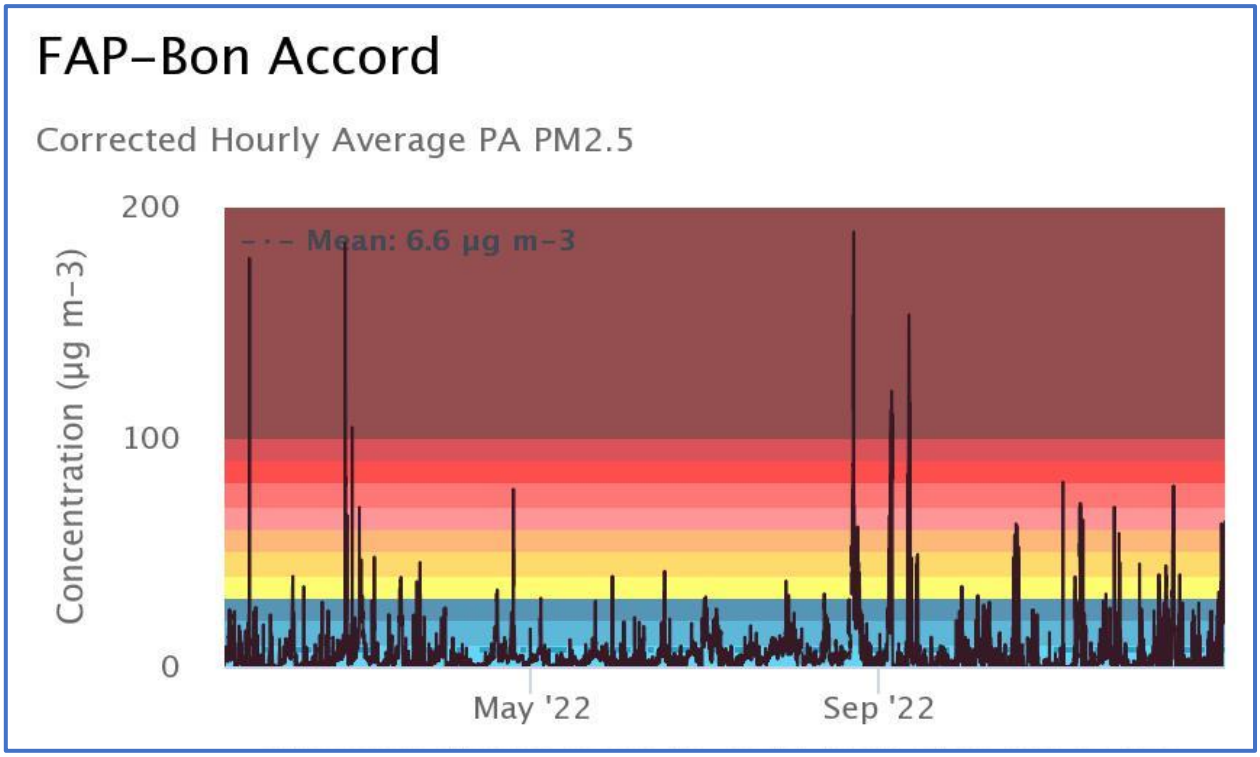


Figure 49: 1-hour $PM_{2.5}$ averages from Josephburg small sensor

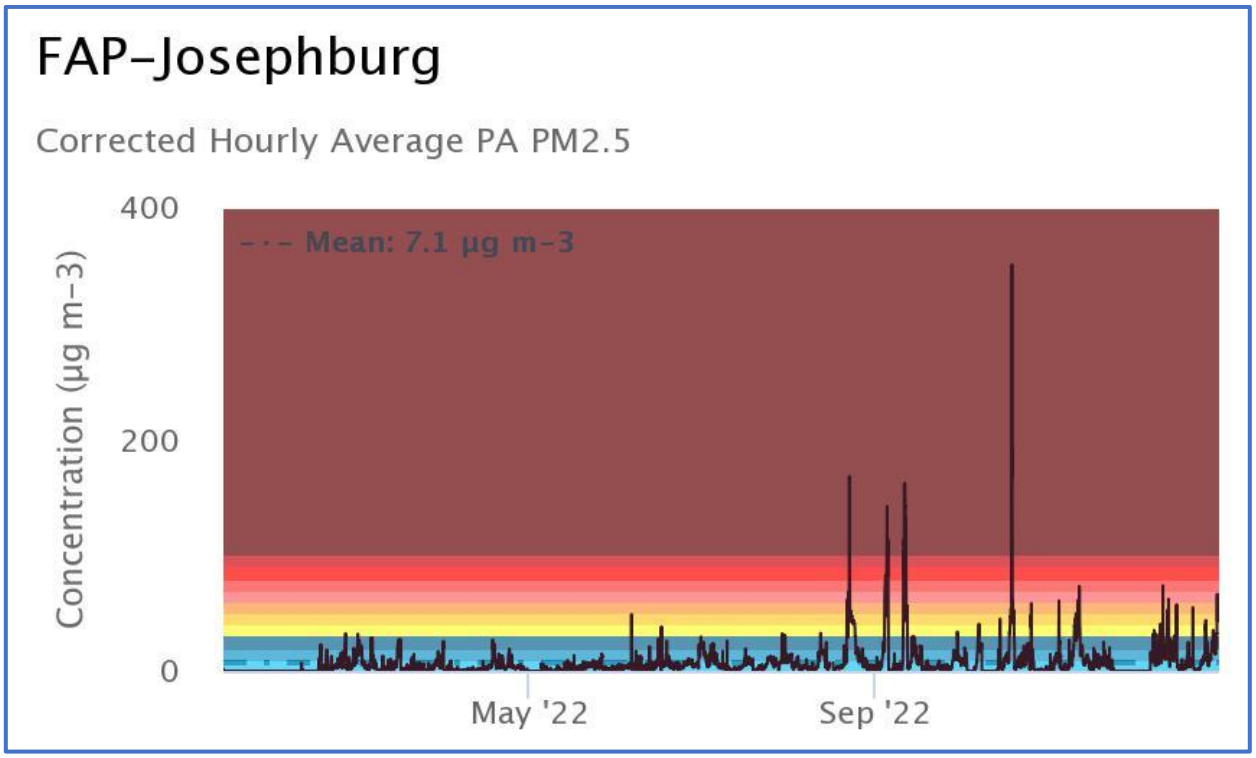


Figure 50: 1-hour averages from $PM_{2.5}$ averages from Newbrook small sensor

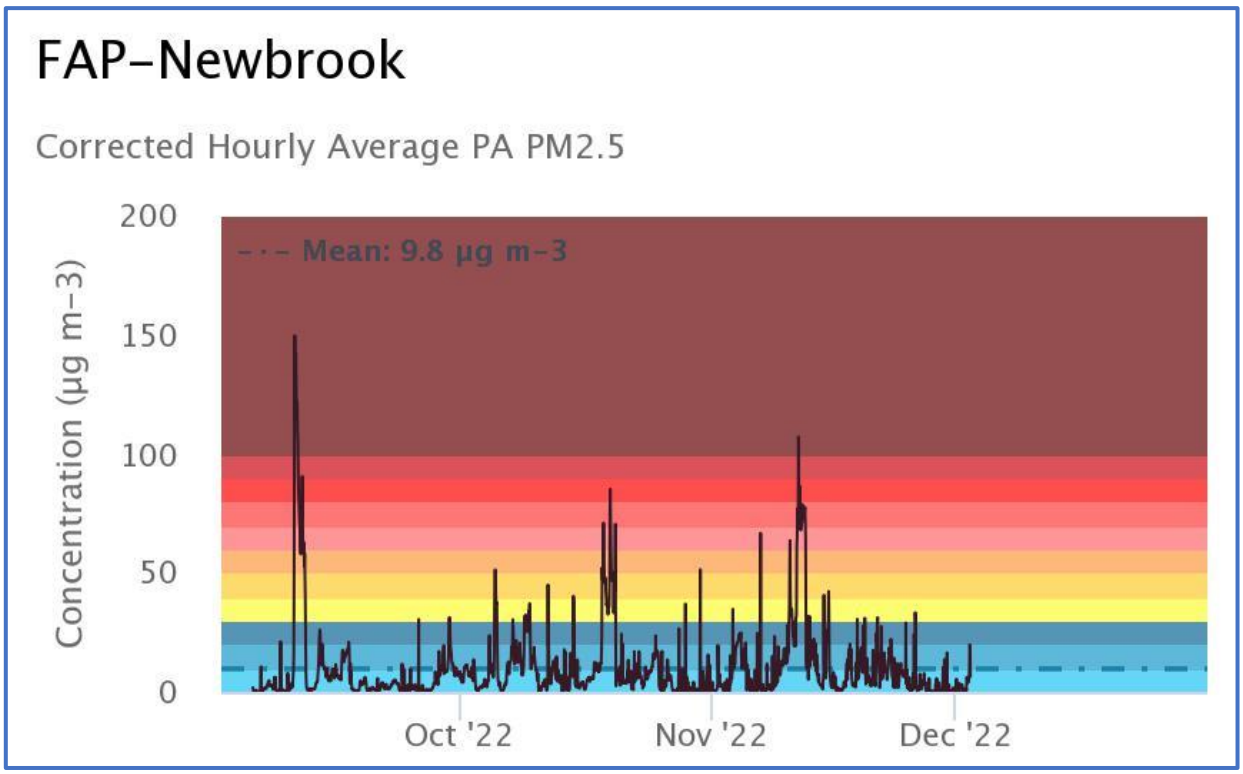


Figure 51: 1-hour averages from $PM_{2.5}$ averages from Thorhild small sensor

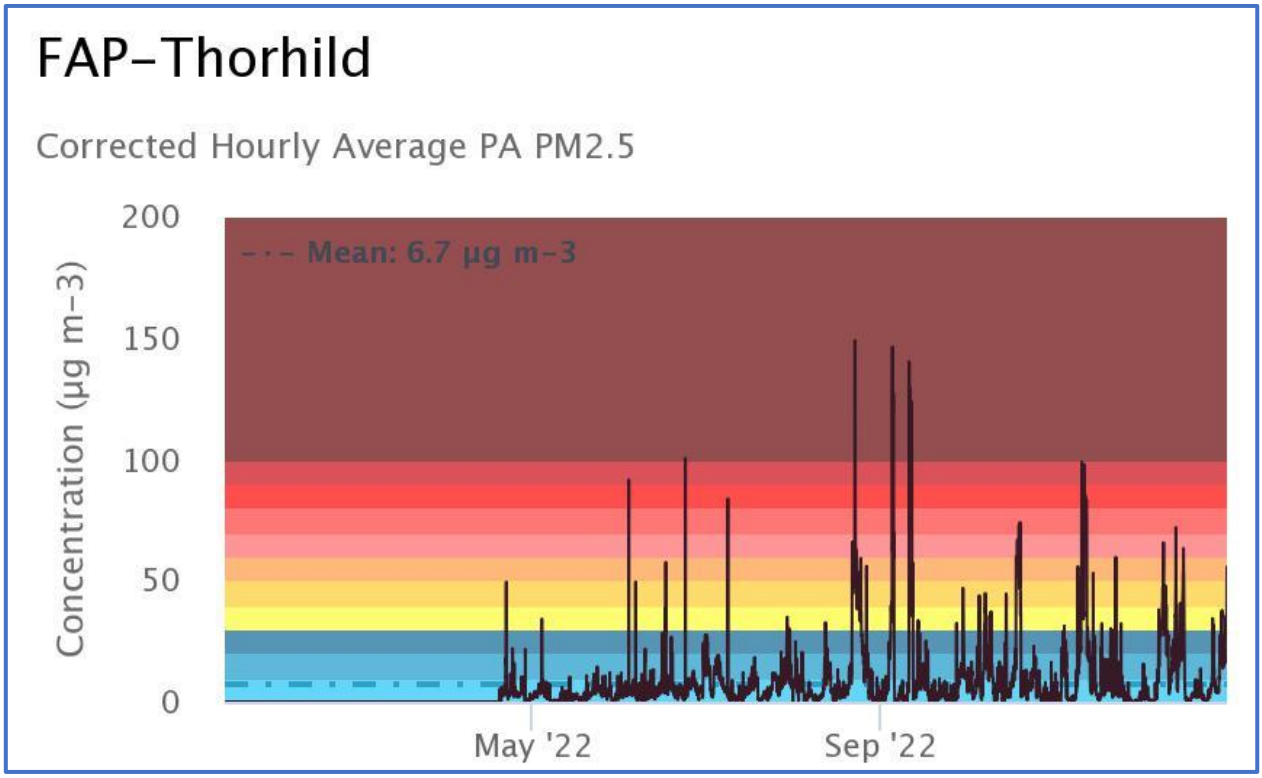
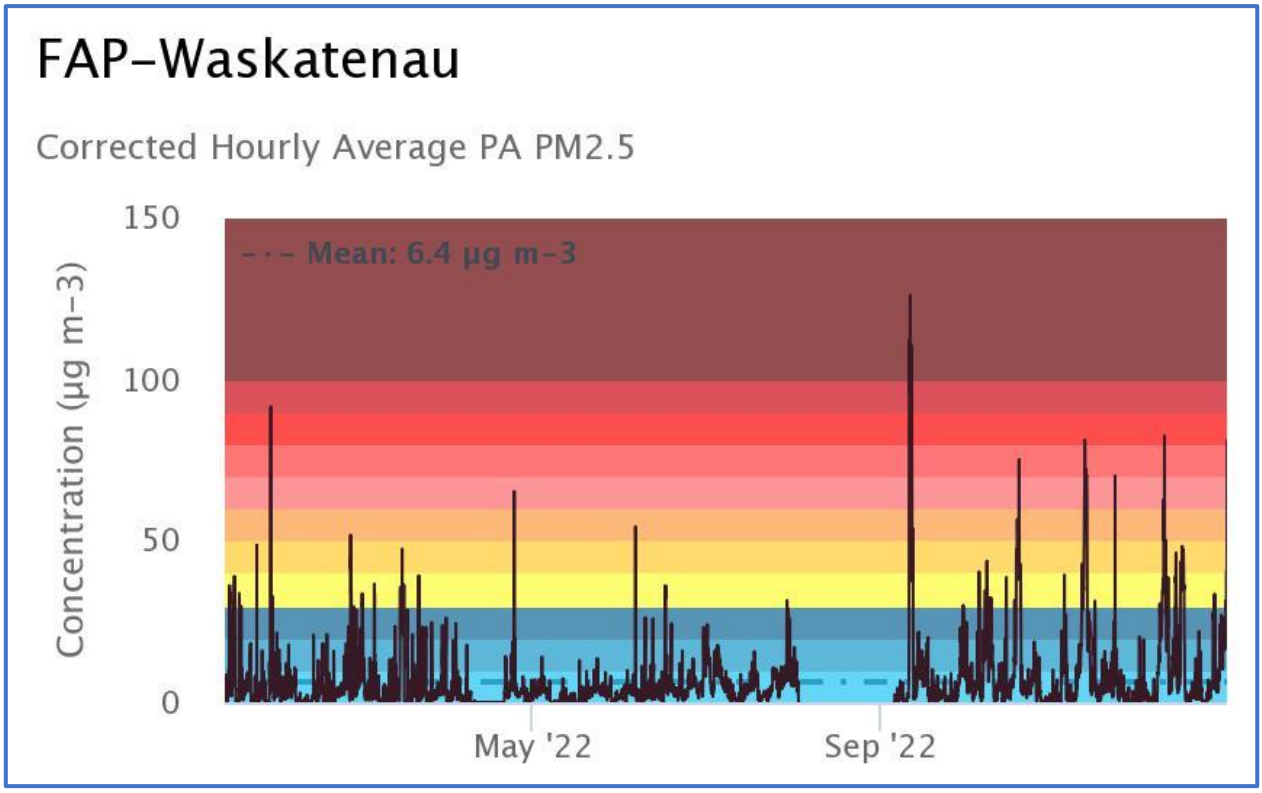


Figure 52: 1-hour averages from $PM_{2.5}$ averages from Waskateneau small sensor



Other Technical Airshed Programs and Activities

Monitoring Plan

The newest FAP monitoring plan was approved as of the date of this report in early 2023.

The first FAP monitoring plan in 2001 strove to create "a regional air quality monitoring program for Fort Saskatchewan" with a five-year implementation plan. The plan outlined the perceived air quality issues at the time, regional emissions, and existing monitoring and made recommendations on an ambient monitoring network with proposed sites and parameters.

By 2010 FAP recognized that the monitoring network of mainly legacy fence-line monitoring to meet industrial operating approval requirements, was not adequate to meet the shifting focus in Alberta towards a more regional approach to understanding air quality. Therefore, in 2011, FAP undertook an independent network assessment to determine how best to maximize the ability of the monitoring network to generate meaningful data to meet FAP's monitoring objectives.

This network evaluation informed the development of the 2015 FAP Monitoring Plan to meet FAPs monitoring objectives. Monitoring projects and changes identified in the 2015 plan were all completed by 2020. The FAP TWG determined a new monitoring plan was warranted to guide the further development of the air monitoring network.

Volatile Organics Speciation Project

FAP completed a Volatile Organic Compound (VOC) speciation project at the Bruderheim 1 station in 2018. VOC Speciation was recommended in a network assessment completed for the FAP network in 2012 and included as a project in the 2015 FAP Monitoring Plan. The full report on this project is available on the FAP website Reports – Fort Air Partnership.

The report recommended that NMHC measurements at the Bruderheim 1 station be tracked over future years to determine whether there was a notable trend, either up or down. A sufficient increasing trend could warrant consideration for a repeated VOC speciation project.

Several plots of the 1-hour average concentration distribution since 2017 are provided in Figure 53 through Figure 55 below. As the distribution in Figure 53 shows, almost all 1-hour averages (about 90%) every year are below 0.1ppm. Figure 54 shows the distribution of measurements above 0.1ppm. While, as shown in Figure 55, only less than 1% of all readings are greater than 0.5ppm.

Figure 53: NMHC Relative Distribution

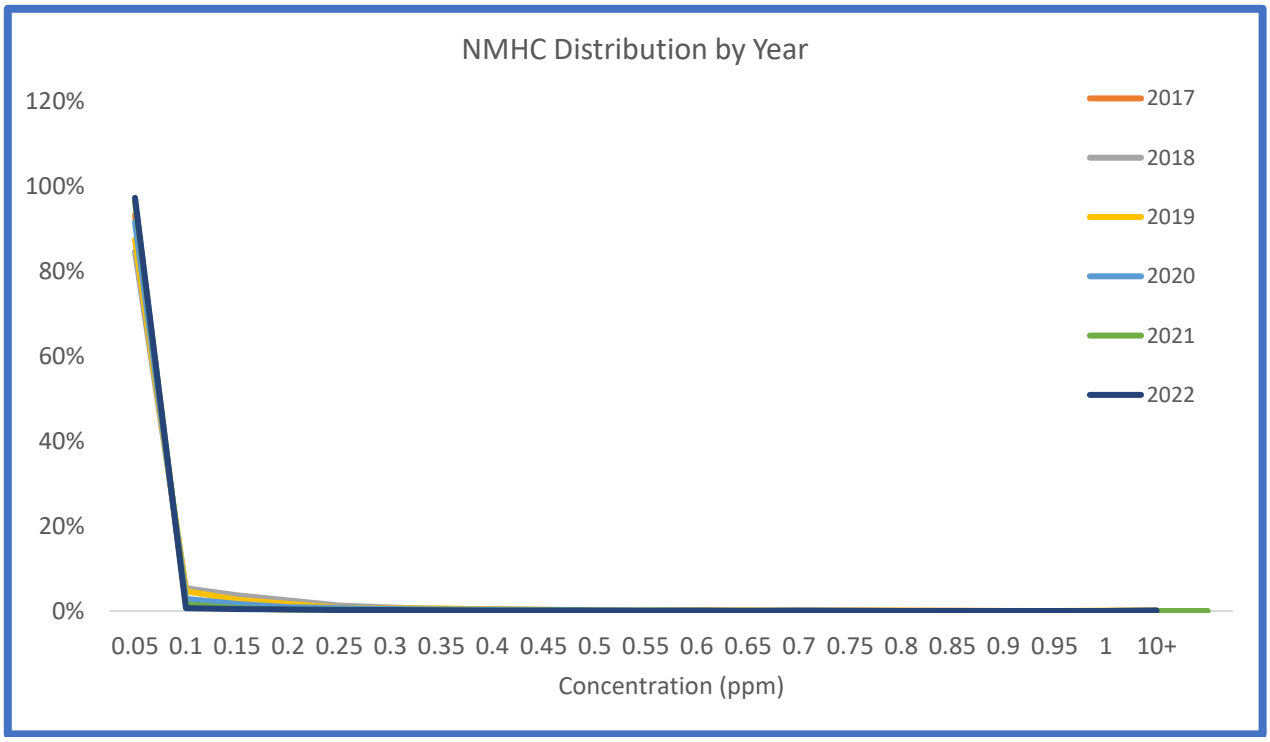


Figure 54: NMHC Relative Distribution above 0.1ppm

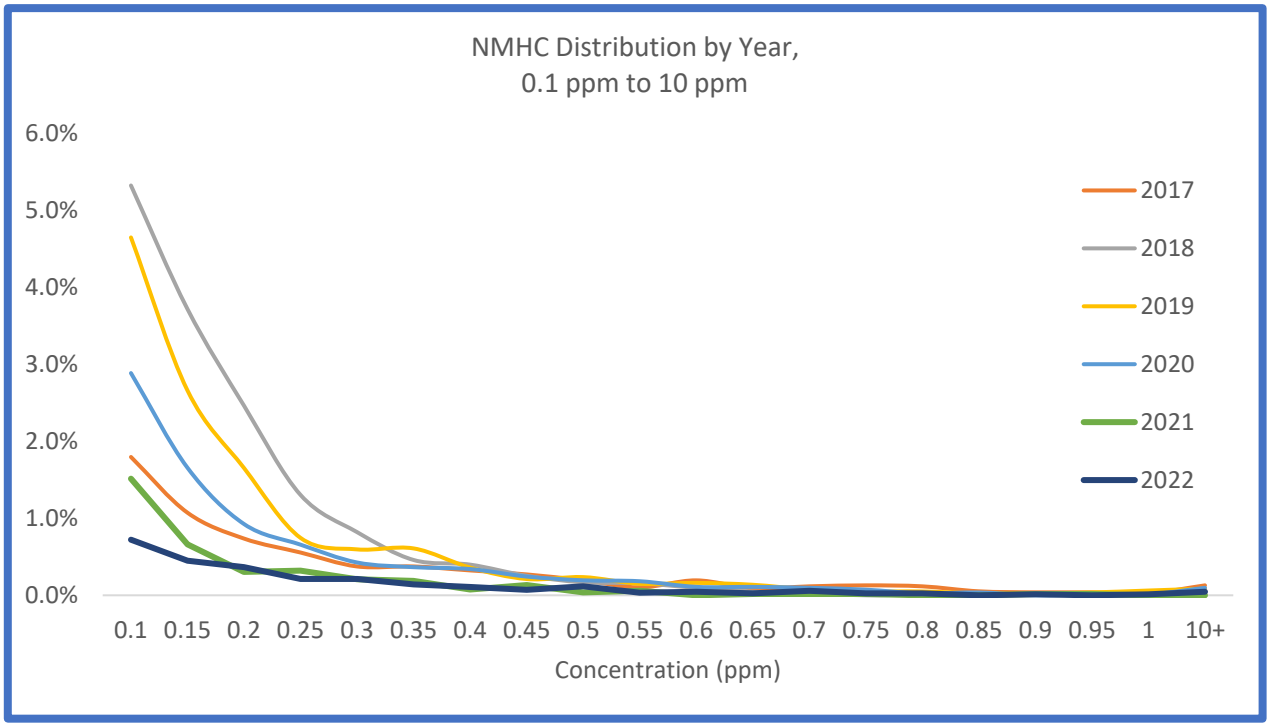
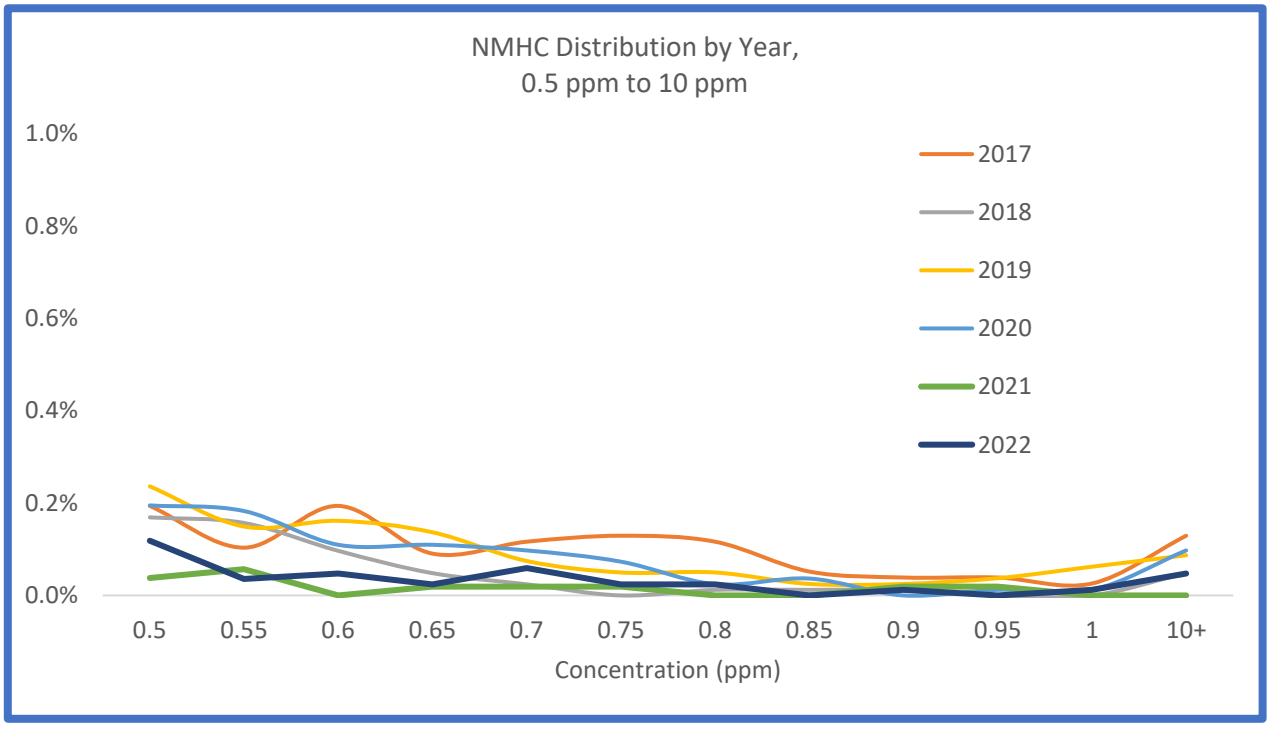


Figure 55: NMHC Relative Distribution above 0.5ppm



Fine Particulate Matter Response Plan

Fort Air Partnership continued to support the dmonton Metropolitan Area Oversight Advisory Committee implementation of a Fine Particulate Matter Response Plan throughout 2022. The Fine Particulate Matter Response Plan includes recommended actions to:

- reduce $PM_{2.5}$ concentrations in the outside air
- improve knowledge of $PM_{2.5}$ in the Edmonton Metropolitan Area
- engage with people about their responsibilities to reduce ambient $PM_{2.5}$

Implementation of the Fine Particulate Matter Response Plan will be evaluated and reported against the new Canadian Ambient Air Quality Standards (CAAQS) that have been adopted nationally for $PM_{2.5}$. Measurements of $PM_{2.5}$ taken by Fort Air Partnership and other Airsheds are compared annually to the CAAQS.

Fort Air Partnership's air monitoring stations measure the amount of fine particulate matter in the air. Higher measurements are often recorded in cold winter months and during wildfire season. Cold temperatures and stagnant air can create a build-up of pollutants near the ground, particularly during a weather phenomenon called a temperature inversion where cold air is trapped near the ground by a layer of warm air. The warm air acts like a lid, holding these pollutants down until wind, rain or snow storms helps to disperse them. Some examples of actions that people can take during the wintertime to reduce their contribution to $PM_{2.5}$ include carpooling, not idling their cars when parked and working from home if possible.

Appendices

Appendix A: Technical Working Group Members

(As of December 31, 2022)

Harry Benders
(Chair)
Network Manager
Fort Air Partnership

Patrick Andersen B.Sc.
Andersen Science Consulting

Graham Aitken
EHS&S Specialist
Dow Chemical Canada

Robert Annett
Environmental Advisor
Keyera

Nadine Blaney, B.Sc.
Executive Director
Fort Air Partnership

Jeff Cooper C. Tech.
AQM Operations Manager
WSP

Scott Hillier
Cenovus Energy

Cynthia Huppie
Environmental Specialist
Inter Pipeline

Doug Hurl
EHS Supervisor
Chemtrade Logistics

Eric Isberg
Environment Advisor
Pembina Pipeline

Gerry Mason CRSP
Manager, EHS
Oerlikon Metco (Canada) Inc.

Matt McClelland, P.Ag.
Senior Advisor, Environment
Sherritt International Corporation

Christophe Nayet
Air Quality Technician
Environment and Climate Change Canada

Jamie Peters M.Sc. P.Ag.
Manager, Regulatory Affairs and Projects
Wolf Midstream

Keith Purves
FAP Vice Chair and Public Member
Fort Air Partnership

Marianne Quimpere EP
Environmental Advisor
Sherritt International Corporation

Stephen Raye BET (Environmental)
Regulatory and Advocacy Focal
Shell Scotford

Michelle Renaud P.Ag.
Sr. Specialist, Environment
Plains Midstream Canada

Karlee Searle
Environmental Advisor
Nutrien

Laura Tabor
Air Monitoring Technologist
Alberta Environment and Parks

Jocelyn Thrasher-Haug M.Sc., P.Ag., P.Biol.
Manager, Environmental Planning
Strathcona County

Graham Tyler, P. Eng.
Senior Air Quality Specialist
Alberta Environment and Parks

Darcy Walberg
Operations Environmental Specialist
Northwest Redwater
Partnership

Alan Wesley
Public Member
Fort Air Partnership

Gerry Zulyniak, P.Eng.
Environment Lead
Conifer Energy Inc.

Technical Working Group Corresponding Members

Laurie Danielson, PhD., P. Chem.
Executive Director
Northeast Capital Industrial Association

Moe Ouellet
Environmental Specialist
Pembina Pipeline Corp.

Lorrie Wooden
Umicore Canada

Appendix B: Industry Participants in FAP

Industry Participants in FAP (Dec. 31, 2022)

A.
As funders of FAP through Northeast Capital Industrial Association and participation on the FAP Board of Directors

- Sherritt International Corp.
- Dow Chemical Canada ULC

B.
As funders of FAP through Northeast Capital Industrial Association and participation in the Technical Working Group

- Cenovus Energy
- Chemtrade Logistics
- Conifer Energy Inc
- Dow Chemical Canada ULC
- Inter Pipeline Ltd.
- Keyera Energy
- North West Redwater Partnership
- Nutrien
- Oerlikon Metco (Canada) Inc.
- Pembina Pipeline Corp.
- Plains Midstream Canada
- Shell Scotford (Shell Chemicals, Shell Refinery and Shell Upgrader)
- Sherritt International Corp.
- Wolf Midstream

C. As funders of FAP through Northeast Capital Industrial Association

- Air Liquide Canada Inc.
- Aux Sable Canada
- Bunge Canada
- Cenovus Energy
- Chemtrade Logistics (CSC)
- Chemtrade Logistics (Sulphides)
- Conifer Energy Inc.
- Dow Chemical Canada ULC
- Enbridge
- Evonik
- Inter Pipeline Ltd.
- Keyera Energy
- Linde Canada
- ME Global Canada Inc.
- MEG Energy
- North West Redwater Partnership
- Nutrien Fort Saskatchewan
- Nutrien Redwater
- Oerlikon Metco (Canada)
- Pembina NGL Corp.

- Plains Midstream Canada
- Praxair Canada Inc.
- Shell Canada Ltd. (Shell Chemicals, Shell Refinery and Shell Upgrader)
- Sherritt International Corp.
- Umicore Canada Inc.
- Wolf Midstream

Appendix C: Passive Data Summary Tables

Table 26: 2022 Passive monitoring monthly averages: SO_2 (ppb)

Site	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Max
1	Stocks Greenhouses	1.4	1.2	0.9	0.5	0.7	0.9	0.7	0.9	1.4	1.9	1.5	1.5	1.2	1.9
4	Waskatenau	0.5	0.6	0.4	0.2	0.1	0.3	0.5	0.6	0.5	MS	0.6	0.6	0.5	0.6
5	Thorhild	0.4	0.5	0.4	0.3	0.3	0.4	0.5	0.6	0.5	0.3	0.3	0.5	0.4	0.6
7	Bon Accord	1.0	1.3	1.0	0.6	0.7	0.7	0.8	1.1	0.6	0.8	0.7	1.0	0.8	1.3
20	Rge Rd 202	1.6	2.2	1.3	0.7	0.7	0.8	1.1	1.0	1.3	2.1			1.4	2.2
34	C&C Tree Farm	0.7	1.0	0.7	0.4	0.5	0.5	0.6	0.8	0.6	0.7	0.8	1.1	0.7	1.1
37	Twp Rd 564 Rge Rd224	0.7	0.8	0.7	1.0	0.5	0.9	0.8	1.5	0.7	0.7	0.5	1.1	0.8	1.5
38	Peno	1.1	0.9	0.5	0.2	0.3	0.5	0.5	0.6	0.5	1.1	0.8	0.8	0.6	1.1
46	Josephburg	1.3	1.1	0.7	0.7	0.7	1.0	0.8	0.9	0.9	1.1	1.4	1.6	1.0	1.6
47	Southeast of FAP	0.9	1.1	0.6	0.2	0.3	MS	0.8	MS	0.6	2.3	1.6	1.2	1.0	2.3
51	Hollow Lake	1.0	0.5	0.4	0.3	0.1	0.8	0.9	1.1	0.6	0.6	0.4	0.5	0.6	1.1
52	Abee	0.2	0.5	0.5	0.2	0.2	0.3	0.4	0.4	0.5	0.3	0.4	0.7	0.4	0.7
53	Tawatinaw - Clearbrook	0.5	0.6	0.4	0.2	0.2	0.4	0.2	0.5	0.5	0.3	0.3	0.7	0.4	0.7
55	Taylor Lake	0.5	0.5	0.4	0.3	0.2	0.5	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.6
62	FAP East Boundary	1.0	1.3	0.6	0.3	0.6	0.6	0.9	0.8	0.7	1.1	1.1	1.7	0.9	1.7
72	Redwater (co-locate)	0.9	0.8	1.0	0.6	0.5	0.7	0.9	1.3	1.3	0.8	1.1	1.0	0.9	1.3
75	Lamont (co-locate)											1.9	1.7	1.8	1.9
	Average	0.9	0.9	0.7	0.4	0.4	0.6	0.7	0.8	0.7	1.0	0.8	1.0	0.8	
	Max	1.6	2.2	1.3	1.0	0.7	1.0	1.1	1.5	1.4	2.3	1.6	1.7		2.3

MS - missing or damaged sample
Reportable Detection Limit: 0.2 ppb

Table 27: 2022 Passive monitoring monthly averages: H_2S (ppb)

Site	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Max
1	Stocks Greenhouses	0.3	0.2	0.2	0.2	0.4	0.7	0.5	1.0	0.6	0.4	0.2	0.4	0.4	1.0
4	Waskatenau	0.2	0.2	0.2	0.1	0.2	0.3	0.7	0.5	0.3	0.2	0.1	0.3	0.3	0.7
5	Thorhild	0.2	0.2	0.1	0.2	0.3	0.6	0.4	0.4	0.3	0.2	0.1	0.2	0.3	0.6
7	Bon Accord	0.3	0.2	0.1	0.1	0.3	0.6	1.0	0.4	0.3	0.2	0.2	0.3	0.3	1.0
20	Rge Rd 202	0.3	0.3	0.2	0.2	0.2	0.4	0.8	0.4	0.4	0.2			0.3	0.8
34	C&C Tree Farm	0.3	0.2	0.2	0.2	0.2	0.4	0.5	0.3	0.3	0.2	0.1	0.3	0.3	0.5
37	Twp Rd 564 Rge Rd224	0.3	0.2	0.2	0.2	0.3	0.8	0.8	0.7	0.5	0.3	0.2	0.4	0.4	0.8
38	Peno	0.3	0.2	0.2	0.1	0.3	0.6	1.0	0.9	0.8	0.4	0.2	0.3	0.4	1.0
46	Josephburg	0.3	0.2	0.2	0.1	0.3	0.7	0.6	0.5	0.5	0.2	0.2	0.3	0.4	0.7
47	Southeast of FAP	0.2	0.1	0.1	0.1	0.3	0.2	1.2	MS	0.4	0.2	0.1	0.3	0.4	1.2
51	Hollow Lake	2.3	0.3	0.2	0.3	0.2	1.4	1.7	1.8	1.6	0.6	0.1	0.3	0.8	2.3
52	Abee	0.2	0.2	0.1	0.1	0.1	0.2	0.4	0.2	0.3	0.2	0.1	0.2	0.2	0.4
53	Tawatinaw - Clearbrook	0.2	0.2	0.1	0.1	0.1	0.2	0.3	0.3	0.2	0.1	0.1	0.2	0.2	0.3
55	Taylor Lake	0.2	0.2	0.1	0.1	0.2	0.2	0.4	0.2	0.2	0.1	0.1	0.2	0.2	0.4
62	FAP East Boundary	0.2	0.2	0.2	0.2	0.2	0.6	0.8	0.5	0.5	0.2	0.2	0.3	0.3	0.8
72	Redwater (co-locate)	0.3	0.3	0.2	0.2	0.3	0.7	0.9	1.0	0.1	0.4	0.2	0.4	0.4	1.0
75	Lamont (co-locate)											0.2	0.3	0.2	0.3
	Average	0.4	0.2	0.2	0.2	0.2	0.5	0.7	0.6	0.5	0.3	0.2	0.3	0.3	
	Max	2.3	0.3	0.2	0.3	0.4	1.4	1.7	1.8	1.6	0.6	0.2	0.4		2.3

MS - missing or damaged sample
Reportable Detection Limit: 0.02 ppb

Appendix D: Continuous Monitoring Methods, Limits and Sampling Details

Table 28: Continuous monitoring methods, limits, and sampling details (Dec 31, 2022)

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Sulphur Dioxide (SO_2)	Thermo 43i Thermo 43iQ	ppb	1-second samples averaged to 1-min & 1-hr	0 - 500 ppb	43i 0.5, 1, 2 ppb (300, 60, 10 second averaging time) 43iQ 0.25, 1, 2 ppb (300, 60, 10 second	Pulsed fluorescence	Dynamic dilution of compressed gas standard	43i 1% of reading or 1ppb (whichever is greater) 43iQ +- 1% FS	Not available
Hydrogen Sulphide (H_2S)	Thermo 450i Thermo 450iQ	ppb	1-second samples averaged to 1-min & 1-hr	0 - 100 ppb	0.5, 1, 2 ppb (300, 60, 10 second avg time)	Pulsed fluorescence with converter	Dynamic dilution of compressed gas standard	450i 1% of reading or 1ppb (whichever	Not available
Nitric Oxide, Oxides of Nitrogen, Nitrogen Dioxide (NO, NO_x, NO_2)	Thermo 42i Thermo 42iQ Thermo 17i	ppb	1-second samples averaged to 1-min & 1-hr	0 - 500 ppb	42i & iQ 0.4 ppb 17i & iQ 1.0ppb	Chemi-luminescence	Dynamic dilution of compressed gas standard	42i ± 0.4ppb (500 ppb range) 17i & 42iQ	Not available

Table 2828: Continuous monitoring methods, limits, and sampling details (Dec 31, 2022) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Ammonia (NH_3)	Thermo17i	ppb	1-second samples averaged to 1-min & 1-hr	0 - 5000 ppb	1.0 ppb	Chemi-luminescence with total nitrogen converter	Dynamic dilution of compressed gas standard	± 0.4ppb 500 ppb range	Not available
Ozone (O_3)	Thermo 49i Thermo 49iQ	ppb	1-second samples averaged to 1-min & 1-hr	0 - 500 ppb	0.50 ppb	Ultraviolet photometry	O_3 Reference Bench	49i 1.0ppb 49 iQ Not available	Not available
Ethylene	Peak Performer	ppb	200 seconds (18 samples per hour)	0 - 2000 ppb	1 ppb	Gas chromatography with flame ionization	Dynamic dilution of compressed gas standard	Not available	Not available
Ethylene	AMA GC 3000	ppb	Samples taken every 3 minutes	0-1000 ppb	Specific to method	Gas chromatography with photo ionization	Dynamic dilution of compressed gas standard	Specific to method	Specific to method
Carbon Monoxide (CO)	Thermo 48i	ppm	1-second samples averaged to 1-min & 1-hr	0 - 50 ppm	0.04 ppm	Gas filter correlation	Dynamic dilution of compressed gas standard	±1% or 0.02 ppm	±1% or 0.02 ppm
Hydrocarbons (methane-NMHC or THC)	Thermo 55C Thermo 55i	ppm	2.5 minutes with 24 samples per hour	0 - 20 ppm methane 0 - 20 ppm NMHC 0 - 40 ppm THC	20 ppb Methane 50 ppb NMHC (as propane)	Gas chromatography with flame ionization detector	Dynamic dilution of compressed gas standard	±2% of measured value	±2% of measured value

Table 2828: Continuous monitoring methods, limits, and sampling details (Dec 31, 2022) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Particulates $PM_{2.5}$	SHARP 5030 SHARP 5030i	µg/m^3	Continuous sampling data stored in 1-min & 1-hr	0 - 1000 µg/m^3	0.2 µg/m^3	Hybrid beta attenuation and nephelometer	Light transmitting foils	±2 µg/m^3<80 µg/m^3 ±5 µg/m^3>80 µg/m-3	±5% (compared to 24-hr FRM)
Particulates $PM_{2.5}$	Grimm 180	µg/m^3	Continuous sampling data stored in 1-min & 1-hr averages	0 - 1000 µg/m^3	0.2 µg/m^3	Spectrometry	Factory	±5%	±2%
Particulates $PM_{2.5}$	API T640	µg/m^3	1-second samples averaged to 1-min & 1-hr	10,000 µg/m^3	<0.1 µg/m^3 (1-hour average)	Scattered light spectrometry	Calibrated SpanDust ™	± 0.5µg/m^3 (1-hour average)	Not available
Benzene, Toluene, Ethylbenzene, Xylene, Styrene	AMA GC 5000	ppb	Samples taken every 15 minutes	Benzene & Ethylbenzene 0 – 20ppb Toluene, Styrene Xylene 0-100ppb or all at 0-1000 ppb	Specific to method	Gas chromatography with FID detection	Dynamic dilution of compressed gas standard	Specific to method	Specific to method

Table 28: Continuous monitoring methods, limits, and sampling details (Dec 31, 2022) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Wind Speed Wind Direction (WS / WD)	RM Young 5305	km/hr	1-second samples averaged to 1-min & 1-hr	0 – 100 km/hr 0 - 360 degrees	WSP 0.4 m/s WDR 0.5 m/s	3 cup anemometer and wind vane	Known RPM Standard or Factory	Not available	Not available
Temperature	Vaisala HMP60	°C	1-second samples	-40 to +60°C	Not available	Platinum resistance detector	Comparison to Reference Standard	Not available	±0.6°C
Temperature	Campbell Scientific HC2-S3-L	°C	1-second samples	-40 to +60°C	Not available	Platinum resistance detector	Comparison to Reference Standard	Not available	±0.1°C (at 23°C)
Delta Temperature	Met One T-200	°C	1-second samples averaged to 1-min & 1-hr	-50 to +100	Not applicable	Platinum resistance detector	Comparison to Reference Standard	Not available	α = 0.00385 ± 0.00002 Ω/°C
Barometric Pressure	Setra 270	mmHg	1-second samples averaged to 1-min & 1-hr	500 - 900 mmHg	±2 mmHg	Ceramic sensing capsule coupled with capacitive sensor	Comparison to Reference Standard	±0.01	±0.05%

Table 28: Continuous monitoring methods, limits, and sampling details (Dec 31, 2022) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Relative Humidity	Campbell Scientific HC2-S3-L	%RH	1-second samples averaged to 1-min & 1-hr	0 – 100%	Not available	Capacitive sensor	Against traceable standard(s)	Not available	± 0.8% at 23°C
Relative Humidity	Met One 083E	%RH	1-second samples averaged to 1-min & 1-hr	0 – 100%	Not available	Thin film polymer capacitor. With internally compensated temperature coefficient. Mounted in aspirated radiation shield.	Against traceable standard(s)	Not available	± 2.0% from 0 to 100% RH
Solar Radiation	Kipp and Zonen SP Lite	watts/m^2	1-second samples averaged to 1-min & 1-hr	400-1100 nm spectral range	60 to 100 µV/W/m^2 (Sensitivity)	Photodiode detector	Factory	Not available	Not available
Vertical Wind Speed	Gill Model 27106	km/hr	1-second samples averaged to 1-min & 1-hr	1	0.3 m/s	Helicoid propeller with tech-generator transducer	Mechanical RPM Standard	Not available	Not available

Appendix E: Data Acquisition, Validation and Reporting Procedures

Air quality monitoring instrumentation is connected digitally to a data logger at each station. The data logger stores monitoring information in engineering units each second. One-minute and one-hour average values are calculated by the data logger. These one-minute and hourly-average data packets along with operational information on each sensor and the site itself are retrieved every minute from the data logger via automatic polling through dedicated communications channels.

Automatic alarm set points trigger a notification to technicians of any data that is above a predetermined set point, (including levels that exceed the AAAQOs). The technician assesses the analyzer and data prior to notifying the Alberta Government and FAP. Other alarms such as rate of change or standard deviation alert technicians to investigate data that is outside what is normally expected.

Operation alarms are also configured so technicians get automatic alerts if the operational parameters of an analyzer are outside set points. These alarms also automatically invalidate the data. The operator can then verify these operational alarms and confirm the corrective actions.

Data Quality Control Procedures

To assure data collection quality and operational uptime, the following procedures are implemented.

- Gas analyzers are automatically subjected to a zero and single high-point test each day.
- The data acquisition system automatically flags key analyzer operational parameters that are outside normal operating ranges.
- Daily review of the zero and single-point tests from each analyzer is completed by FAP's contractors, with technicians dispatched to investigate/correct as necessary.
- Daily review of the data, including inspection for anomalies and any flags that may have been applied automatically by the data logger, with technicians dispatched to investigate/correct as necessary.
- Daily data review includes cross-network comparison of measurements of the same substances or meteorological conditions to look for anomalies at one station that might indicate a problem.
- For compounds that are subject to Alberta Guidelines or Objectives, alarm set-points are automatically triggered when ambient concentrations exceed the Guidelines or Objectives. This initiates a reporting protocol to the Alberta Government, including an investigation into the likely cause.

- Each analyzer is subjected to an up scale and zero as-found test and at least a 4-point calibration each month. BTEX and ethylene analyzers that are non-linear by design are tested with a zero and 5 upscale points. Calibration reports are retained, and copies are submitted to AEP monthly. Calibration forms use automatic formatting to highlight results that approach the limits set by the Alberta Government. Calibration factors arising from this calibration may be applied to the data as appropriate.
- Alberta Government personnel conduct performance audits of analyzers once a year, verifying that each analyzer is working properly and in accordance with the AMD. Auditors also make suggestions for improvements to monitoring operations at the stations. Follow-up actions to the audit, if necessary, are defined and implemented by FAP per the Alberta Government Audit Follow-up Protocol.
- FAP uses a subcommittee of the TWG to review data validation outcomes at selected stations for selected months at least every three years. FAP also may contract an independent data validation contractor to run a parallel data validation on selected months and stations.
- Technicians of the operations contractor are observed performing calibrations. The procedure they use is compared to the AMD and their own applicable SOPs. Where noted, corrections are recorded and made and reported to the TWG.
- FAP uses a process to verify operation and validity of the in-situ calibrators and dedicated gases used at each continuous monitoring station. This includes:
  - Calibration gas standards used in FAP network certified by the manufacturer to +/- 2% or better. These gases are subject to a further verification by the Alberta Government audit lab prior to use in the network.
  - Annual calibration system verifications at the AEP audit lab against Alberta Government standards.
  - Replacement of calibration cylinders before manufacturer posted expiry dates even if they are not empty. If a replacement cylinder is not available due to delays in shipping or verification by the Alberta Government, the as-found high scale point concentrations are tracked each month to ensure the expired cylinder concentration is still within specifications.
  - Verifications of photometers used for gas phase titration (GPT) calibrations of NO_2 and O_3 is carried out by the Alberta Government.
  - Regular flow measurements, flow calibrations and calibration system maintenance is carried out as specified by the AMD and manufacturer specifications, or if flow anomalies are suspect.
- Test equipment such as flow, and temperature measurement devices used by the FAP contractor have current calibration certificates.

Data Validation Processes

Preliminary data validation is carried out daily by technicians for FAP's principal operations contractor. Primary data validation for FAP continuous data is conducted by an independent contractor in preparation of each monthly report. Secondary checks of data plots are done by a data review committee of the FAP Network Manager, the operations contractor lead technician and data validation contractor each month in advance of the TWG meeting, where it is again reviewed by the group as a whole. Validated data and daily span tests are also reviewed by the data review committee and holistically by the Technical Working Group monthly to identify any possible anomalies and trends that may warrant another look. Every three months a Data Subcommittee of the Technical Working Group reviews and tracks daily spans on key analyzers as compared to the expected and calculated span concentrations going back up to 12 months previous with the intention to explain or investigate any sudden changes or prolonged negative or positive trends.

The following data validation procedures are performed by the Data Validation Contractor to FAP every month.

- One-minute, 60-minute, 24-hr, and monthly averages are calculated from 1-second data the data logger gathers from each sensor.
- Data is baseline-corrected by interpolation between consecutive valid zero points.
- Several statistical tests are performed each month comparing data against historical norms at the same station to help discern anomalies.
- Data is reviewed in several ways:
  - Data is plotted and examined together, comparing complementary or related parameters within a station.
  - Information in operational logs, the daily zeroes and spans, and calibration reports are considered.
  - Outliers, flat lines, and other data irregularities are investigated.
  - Data flags are applied as required.

The Alberta Government also performs an annual review of data in the Provincial database. The review subjects data from continuous stations to several statistical tests. Any anomalies found are reviewed by FAP , the data is corrected or reflagged as necessary and reposted to the database.

Raw data is maintained unaltered within the central database in parallel with the validated data.

The FAP Network Manager conducts the final validation and report review monthly by for all stations in in the network, with an additional validation step by TWG members for some stations, prior to submitting reports or posting data to the Provincial air monitoring data warehouse. Annual reports are primarily a compilation of monthly reports and also reviewed by the FAP Network Manager and TWG members.

Reporting Protocol

Reporting of FAP's continuous and passives data and monitoring operations is required by the Alberta Government is accomplished in a number of ways:

- Near real time raw un-verified data is sent hourly to the Alberta Government website for public availability. This data undergoes basic automatic error checking before being used for AQHI reporting and forecasting. The data is also available in near real time on several subsequent websites/platforms across Canada, North America, and even globally.

- Exceedances of AAAQOs are reported to Alberta Government's Environmental Service Response Centre as per timelines FAP has established and are followed up with further information within 7 days.

- Instrument operational time below 90% in a month is reported to Alberta Government's Environmental Service Response Centre as soon as it is known and followed up with further information and a corrective action letter within 7 days.

- An ambient air quality monitoring report is prepared summarizing the validated data for each continuous monitoring station and submitted monthly to the Alberta Government. Also submitted each month are calibration reports for each station for the month in question and a laboratory report with analytical results of all passive devices. The report's contents are prescribed by the Air Monitoring Directive.

- Validated data is posted to the Alberta Government ambient air quality database each month.

- Validated data from FAP stations is downloaded from the Alberta Government database annually by Environment and Climate Change Canada and incorporated into the national database managed for use in national trend analysis and policy construct.

- A summary report is prepared for each monitoring station and all passive sites and submitted annually to the Alberta Government. The report's contents are prescribed by the Air Monitoring Directive.

- This Technical Annual Report provides additional information. It documents the status of the monitoring network and summarizes the regional air monitoring results with historical comparisons and details of AAAQO exceedances as well as comparisons of key parameters over time and with other locations across Alberta.

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