Fort Air Partnership

2021

Ambient Air Quality Monitoring Annual Network Report And Data Summary

FORT AIR PARTNERSHIP

We Monitor the Air You Breathe

FAP Technical Working Group April 2022

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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	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, 2021, this department was Alberta Environment and Parks.

2021 Network Summary

Network Overview

During 2021 Fort Air Partnership (FAP) operated ten continuous ambient air quality monitoring stations. One of the stations, a portable monitoring station, operated in two locations during 2021. Table 1 describes the parameters measured at continuous stations as of the end of 2021.

In addition to the continuous network, FAP operated a 16-site passive monitoring network in 2021. Compounds measured in the passive network include sulphur dioxide (SO_2) and hydrogen sulphide (H_2S).

Table 1: FAP continuous monitoring stations and parameters 2021

	Bruderheim 1	Elk Island	Fort Sask.	Gibbons	Lamont County	Range Road 220	Redwater	Ross Creek	Scotford South	Keith Purves Portable*
Alberta Health Quality Index	✓	✓	✓	✓	✓		✓			✓
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 2021 (continued)

	Bruderheim 1	Elk Island	Fort Sask.	Gibbons	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 at Sturgeon County until April 2021 and then moved to the Town of Lamont from August through December 2021.*

Continuous Monitoring Performance Measures

In 2021 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.

There were five 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 root cause investigated.

Table 2: Data completeness 2021 (percent)

	Bruderheim1	Elk Island	Fort Sask.	Gibbons	Lamont County	Portable at Sturgeon Cty*	Portable at Lamont*	Range Road 220	Redwater	Ross Creek	Scotford South
Wind Speed & Direction	*99.6*	*99.6*	*58.3*	*99.6*	*99.8*	*100.0*	*100.0*	*99.8*	*99.2*	*99.6*	*100.0*
Sulphur Dioxide (SO_2)	*100.0*	*99.7*	*99.9*	*99.9*	*99.6*	*100.0*	*99.7*		*99.9*	*99.8*	*100.0*
Nitric Oxide (NO)	*99.7*	*99.6*	*99.4*	*99.2*	*99.5*	*100.0*	*99.8*	*99.9*	*99.1*	*99.0*	*98.4*
Nitrogen Dioxide (NO_2)	*99.7*	*99.6*	*99.4*	*99.2*	*99.5*	*100.0*	*99.8*	*99.9*	*99.1*	*99.0*	*98.4*
Oxides of Nitrogen (NOx)	*99.7*	*99.6*	*99.4*	*99.2*	*99.5*	*100.0*	*99.8*	*99.9*	*99.1*	*99.0*	*98.4*
Ammonia (NH_3)			*99.4*						*99.1*	*98.6*	
Ozone (O_3)	*99.3*	*99.8*	*96.8*	*99.7*	*99.7*	*100.0*	*99.8*				
Hydrogen Sulphide (H_2S)			*99.4*	*99.4*	*99.4*	*99.9*	*100.0*				*99.7*
Ethylene (C_2H_4)								*98.3*		*97.7*	
Total Hydrocarbon (THC)	*61.3*		*99.0*		*95.8*	*99.9*	*98.7*	*99.4*			
Methane (CH_4)	*61.3*		*99.0*		*95.8*	*99.9*	*98.7*	*99.4*			
Non-Methane Hydrocarbon (NMHC)	*61.3*		*99.0*		*95.8*	*99.9*	*98.7*	*99.4*			
Fine Particulates ($PM_{2.5}$)	*99.7*	*99.3*	*99.7*	*99.2*	*99.7*	*86.7*	*93.1*		*99.5*		
Carbon Monoxide (CO)			*99.5*								
Benzene (C_6H_6)											*98.3*
Toluene (C_7H_8)											*98.3*
Ethylbenzene (C_8H_{10})											*98.3*
Xylene ($C_{24}H_{30}$)											*98.3*
Styrene (C_8H_8)											*98.3*
Average Site	**88.2**	**99.6**	**96.0**	**99.4**	**98.6**	**98.7**	**98.9**	**99.5**	**99.3**	**99.0**	**98.8**

**The Keith Purves Portable station uptime does not include April through July 2021 when the station was not in operation.*

Monitoring Network Changes in 2021

FAP made the following changes to the continuous monitoring network in 2021, including improvements to infrastructure and equipment.

- The FAP portable station was renamed as the Keith Purves Portable to honour the service of a longtime public member of FAP.
- The Keith Purves Portable continuous monitoring station operated at Sturgeon County site until March 31, 2021. It was then moved to a new project in the Town of Lamont to begin operation as of August 1st, where it remained for the remainder of 2021.
- Trees infringing on the Ross Creek station, specifically the maximum angle allowable above the manifold intake, were trimmed back significantly in November.
- A new retractable and tip-over tower for the wind sensor was installed at the Fort Saskatchewan station.
- A new retractable tower for the wind sensor was installed at the Range Road 220 station.
- A new model ethylene analyzer with a different measurement principle was installed at the Range Road 220 station.
- New generation ozone and sulphur dioxide analyzers were installed at the Bruderheim station.
- A new generation hydrogen sulphide and a new oxides of nitrogen analyzer were installed at the Gibbons station.
- A new generation oxides of nitrogen analyzer was installed at the Range Road 220 station.
- A new generation sulphur dioxide and a new ammonia/oxides of nitrogen analyzer were installed at the Ross Creek station.
- New generation hydrogen sulphide and sulphur dioxide analyzers were installed at the Scotford South station.
- New temperature and relative humidity sensors with improved specifications were installed at 9 continuous stations (Ross Creek excluded).
- A new humidity probe installed at the Ross Creek station. The old temperature and relative humidity sensor on the station was removed. Ambient temperature is reported using the 2-meter sensor of the delta temperature system.
- Barometric pressure measurement was added at the Scotford South station in October.

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 2021 are listed in Table 3 and 4 respectively. Two significant wildfire smoke events occurred in Fort Air Partnership during 2021 that affected air quality in the Airshed. 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 reported exceedances.

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

Table 3: 2021 1-hour average exceedances of the AAAQO

One Hour Exceedances			
Parameter	**Exceedances**	**Dates**	**Attributed Cause**
Fine Particulate ($PM_{2.5}$)	1	January 29	Wintertime inversion
	1	April 16	Undetermined cause
	328	July 15, 17-20 August 14	Wildfire smoke
	3	August 28 September 5	Undetermined cause
	59	October 5 & 6	Wildfire smoke
	1	October 31	Multiple sources
Hydrogen Sulphide (H_2S)	2	June 4	Natural due to wetlands
	2	June 27 & 29	
	8	July 5, 9, 12, 28, 31	
	4	September 8, 13, 29	
Ozone (O_3)	3	July 8, 9	Summertime smog
Total	**412**		

Table 4: 2021 24-hour average exceedances of the AAAQO

24 Hour Exceedances			
Parameter	**Exceedances**	**Dates**	**Attributed Cause**
Fine Particulates ($PM_{2.5}$)	2	January 29	Wintertime inversion
	2	January 30	
	28	July 13-20	Wildfire smoke
	18	August 1-3, 14, 15	
	10	October 5 & 6	
Total	**60**		

2021 Summary of Exceedances

Table 5 provides the total exceedances for each compound FAP measures that has a respective AAAQO in 2021 and the previous 5 years.

Table 5: Summary of 2021 Exceedances and 5 years previous

Parameter Measured		2021	2020	2019	2018	2017	2016
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*	393	6	119	810	69	35
	24-hr	60	19	37	117	29	11
Hydrogen Sulphide (H_2S)	*1-hr*	16	7	9	20	-	-
	24-hr	-	1	1	4	-	-
Nitrogen Dioxide (NO_2)	*1-hr*	-	-	-	-	-	-
	24-hr	-	-	-	-	-	-
	Annual	-	-	-	-	-	-
Ozone (O_3)	*1-hr*	3	-	23	6	-	-
Styrene (C_8H_8)	*1-hr*	-	-	-	-	-	-
Sulphur Dioxide (SO_2)	*1-hr*	-	-	-	-	38	51
	24-hr	-	-	-	-	9	9
	30-day	-	-	-	-	1	2
	Annual	-	-	-	-	-	-
Toluene (C_7H_8)	*1-hr*	-	-	-	-	-	-
Xylenes (o-, m- and p- isomers)	*1-hr*	-	-	-	-	-	-
Total Exceedances		**472**	**33**	**189**	**957**	**147**	**108**

Note: SO_2 exceedances in 2016 & 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 2021. The Keith Purves portable station operated at Sturgeon County from January through March and in the Town of Lamont from August through December 2021. 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 - 2021

		Risk Level (% of time)			
Station Name	Hours Monitored	Low Risk	Moderate Risk	High Risk	Very High Risk
Bruderheim 1	8448	93.84%	5.46%	0.53%	0.17%
Elk Island	8418	96.34%	2.82%	0.64%	0.20%
Fort Saskatchewan	8257	92.88%	6.20%	0.71%	0.21%
Gibbons	8420	93.24%	6.13%	0.55%	0.08%
Lamont County	8463	96.27%	3.19%	0.40%	0.14%
Redwater	8140	95.48%	3.66%	0.65%	0.21%
Sturgeon County*	1751	97.72%	2.28%	-	-
Town of Lamont*	2872	98.19%	1.60%	0.21%	-
Total hours	**54769**	**52008**	**2380**	**297**	**84**

***The Keith Purves portable station operated at two sites during 2021.*

Table 7: Air Quality Health Index in FAP region number of hours - 2021

		Risk Level (# of hours)			
Station Name	Hours Monitored	Low Risk	Moderate Risk	High Risk	Very High Risk
Bruderheim 1	8448	7928	461	45	14
Elk Island	8418	8110	237	54	17
Fort Saskatchewan	8257	7669	512	59	17
Gibbons	8420	7851	516	46	7
Lamont County	8463	8147	270	34	12
Redwater	8140	7772	298	53	17
Sturgeon County*	1751	1711	40	-	-
Town of Lamont*	2872	2820	46	6	-
Total hours	**54769**	**52008**	**2380**	**297**	**84**

***** *The Keith Purves portable station operated at two sites during 2021.*

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 2021 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		Portable*			
Air Quality Event Dates	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Very High Risk	High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Total Hrs.	Attributed Cause
Jan. 29	-	-	-	-	-	-	-	-	-	-	1	-	-	-	**1**	Wintertime inversion
Apr. 16	-	-	-	-	-	-	1	-	-	-	-	-	-	-	**1**	Undeter-mined
Jul. 9	-	-	1	-	-	-	-	-	-	-	-	-	-	-	**1**	Summer-time smog
Jul. 9	-	-	-	-	-	-	-	-	-	-	1	-	-	-	**1**	Natural, due to wetlands
Jul. 15-20	38	14	42	17	45	17	32	7	30	12	42	17	-	-	**313**	Wildfire smoke
Aug. 4 & 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	**3**	Summer-time smog
Aug. 14	-	-	-	-	4	-	1	-	-	-	1	-	-	-	**6**	Wildfire smoke
Aug. 28	-	-	-	-	-	-	2	-	-	-	-	-	-	-	**2**	Undeter-mined
Sept. 2 & 5	-	-	-	-	-	-	3	-	-	-	-	-	-	-	**3**	Undeter-mined
Sept. 8	-	-	-	-	-	-	-	-	-	-	1	-	-	-	**1**	Natural, due to wetlands
Oct. 5 & 6	4	-	11	-	10	-	6	-	4	-	6	-	6	-	**47**	Wildfire smoke
Oct. 31	-	-	-	-	-	-	1	-	-	-	-	-	-	-	**1**	Multiple Sources
Total hours	**45**	**14**	**54**	**17**	**59**	**17**	**46**	**7**	**34**	**12**	**52**	**17**	**6**	**-**	**380**	

** The Keith Purves portable station operated at two sites during 2021*

Overview

The FAP Organization (2021)

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 2021 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, a 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

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, 2021, 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 Alberta Government 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 access 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 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 and 16 passive 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 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 Parks. 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 study report was released in 2021.
- 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 as established in 2021 for the FAP network are as shown in Table 9 below:

Table 9: FAP 2021 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 Parks. This information is also accessed by Alberta Health 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 are listed in the 2021 Monitoring Results section later this report along with comparisons to FAP data for each substance.

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 2017-2019 Alberta Air Zones Report was released in November of 2021.

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.

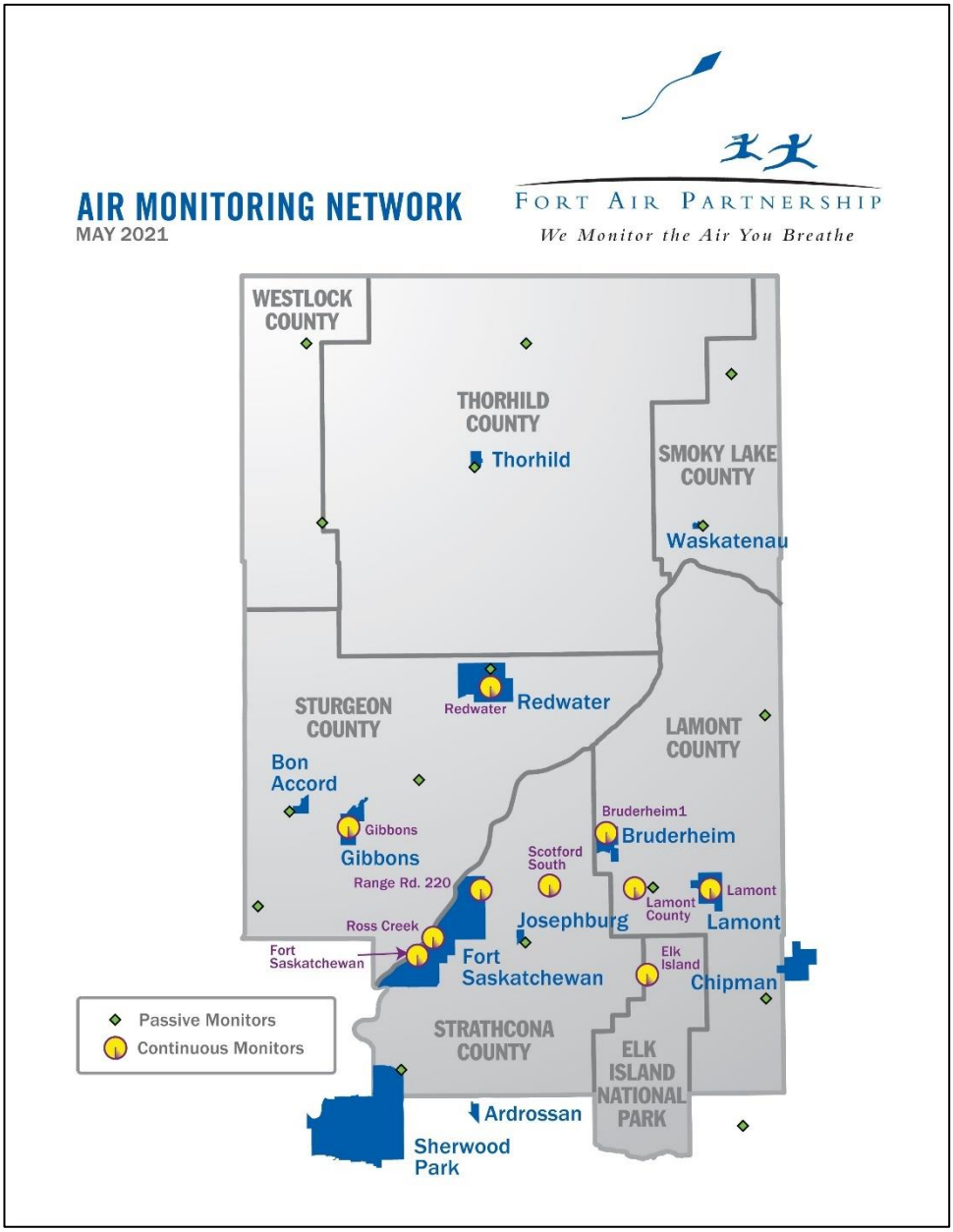
These federal "airsheds" are not to be confused with Alberta Airsheds, which are regional air monitoring and reporting organizations operating throughout Alberta. Alberta's 10 Airsheds operate extensive, integrated ambient air monitoring networks. Air quality data collected by the Airsheds is also used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

2021 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 2021.

Figure 1: FAP Monitoring sites on December 31, 2021



Monitoring Station Coordinates

Table 11 gives the longitude and latitude coordinates for the FAP monitoring stations active in 2021.

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	53.76036 N	-112.88017 W	727 m	Jan 2003	Agricultural
Keith Purves Portable at Sturgeon County	53.880597 N	-113.200518 W	647 m	July 2020 - March 31 2021	Agricultural
Keith Purves Portable at Lamont	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 data from that station was first reported to the Alberta Government Air Monitoring data warehouse.

2021 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 (2021):
New generation ozone and sulphur dioxide analyzers and a new temperature and relative humidity sensor with improved specifications were all installed at the Bruderheim 1 station in 2021.

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 (2021): A new temperature and relative humidity sensor with improved specifications was installed in 2021.

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.

Figure 5: Fort Saskatchewan Station

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.

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 18,000 vehicles per day in 2019. 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 Provincial Air Monitoring data warehouse. This station along with Elk Island is part of the NAPS network of stations across the country.

Fort Saskatchewan changes (2021):
A new retractable and tip over tower, and new temperature and relative humidity sensor with improved specifications, were installed in 2021.

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 (2021):
A new generation hydrogen sulphide and a new oxides of nitrogen analyzer were installed. A new temperature and relative humidity sensor with improved specifications was installed in 2021.

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.

Figure 7: Lamont County Station

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 (2021):
A new temperature and relative humidity sensor with improved specifications was installed in 2021.

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 8: Portable Station at Lamont

Site description - Sturgeon County: The Keith Purves portable operated at a Sturgeon County site to begin monitoring on January 1 to March 31, 2021. The site was on an unused farmstead along Range Road 223 approximately 1 kilometer. south of secondary highway 570.

Site description – Town of Lamont: In July 2021 the Keith Purves portable was moved to a site in the Town of Lamont to begin operation on August 1. It remained at the location as of Dec 31, 2021. 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.

Keith Purves Portable changes (2021): FAP renamed its portable station to the Keith Purves portable in 2021 in recognition of a long serving public member of the FAP organization. The monitoring project at Sturgeon County ended at the end of March 2021. A report on the findings of this project is available on the FAP website or by contacting FAP at info@fortairmail.org. The portable station was relocated to the Town of Lamont to address some local air quality questions and compare air quality in the community with other stations in FAP.
A new temperature and relative humidity sensor with improved specifications was installed on the Keith Purves portable in 2021.

Range Road 220 Station

Figure 9: 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 (2021):
A new generation oxides of nitrogen analyzer was installed in 2021. A new tip over tower and new temperature and relative humidity sensor with improved specifications were also installed in 2021.

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.

Figure 10: Redwater Station

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 (2021):
A new temperature and relative humidity sensor with improved specifications was installed in 2021.

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 (2021):
A new generation sulphur dioxide and a new ammonia/oxides of nitrogen analyzer were installed. A new relative humidity sensor with improved specifications was installed with the delta temperature system in 2021 while the old external temperature and relative humidity sensor was removed in favour of the 2-meter temperature and relative humidity outputs from the delta temperature system.

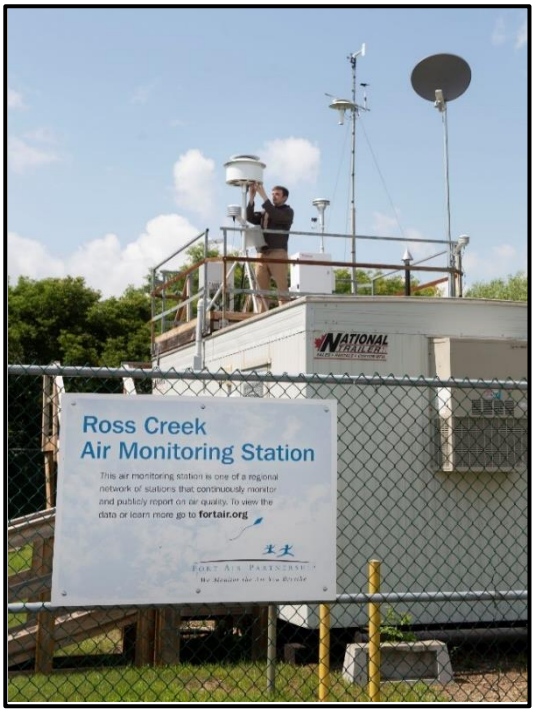


Figure 11: Ross Creek Station

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 12: Scotford South Station

Scotford South changes (2021):
New generation hydrogen sulphide and sulphur dioxide analyzers were installed. Barometric pressure measurement was added to the site in October. A new temperature and relative humidity sensor with improved specifications was installed in 2021.

2021 Capital Purchases for the Network

Life cycle replacement across the network:

In 2021 FAP owned approximately $2.2 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 2021 capital purchases totaled just over $100,000.

- Equipment purchased as part of the capital equipment replacement plan in 2021 for deployment in the network included two analyzers for SO_2, and one ozone analyzer.
- As well 7 meteorological sensors and 5 spare sensors were purchased to upgrade those already in the network.
- Support equipment included 2 data logger computers, a retractable tower for wind sensors and one hydrogen generator.
- In 2021 the Alberta Government supplied
    - A new wind tower and wind sensor for Fort Saskatchewan station
    - New temperature and relative humidity sensors for the Fort Saskatchewan and Elks Island stations

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.

2021 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 13: Passive monitoring site

Figure 14: 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, 2021

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
20	Range Rd 202	-112.880153	53.76029	1	1	Jan 1, 2006
34	C&C Tree Farm	-113.48362	53.74538	1	1	Aug 1, 2006
36	Galloway Seed	-113.22421	53.65760	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

2021 Monitoring Results

2021 Ambient Air Monitoring Data and Discussion

The following sections provide a brief analysis of the results of the 2021 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 2021 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 2021 data with data collected during the previous 5 years.

For substances used in AQHI calculations, data from FAP stations in 2021 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 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 2021.

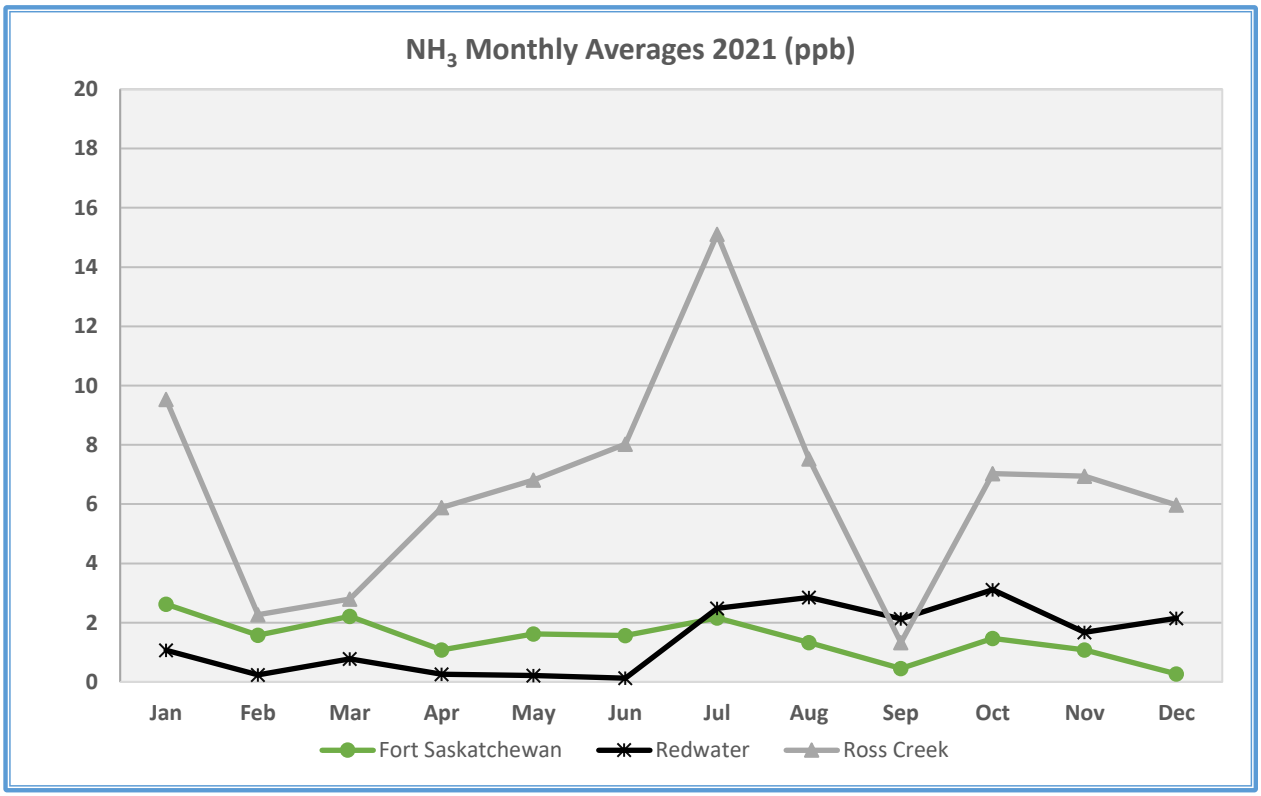
Table 13 below provides maximum 1-hour averages of NH_3 in 2021 with comparisons to the applicable AAAQO.

Table 13: 2021 maximum NH_3 averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time
Fort Saskatchewan	61.6	3.1%	Feb 7 16:00
Redwater	66.7	3.3%	Oct 5 16:00
Ross Creek	651.2	32.6%	Nov 4 10:00

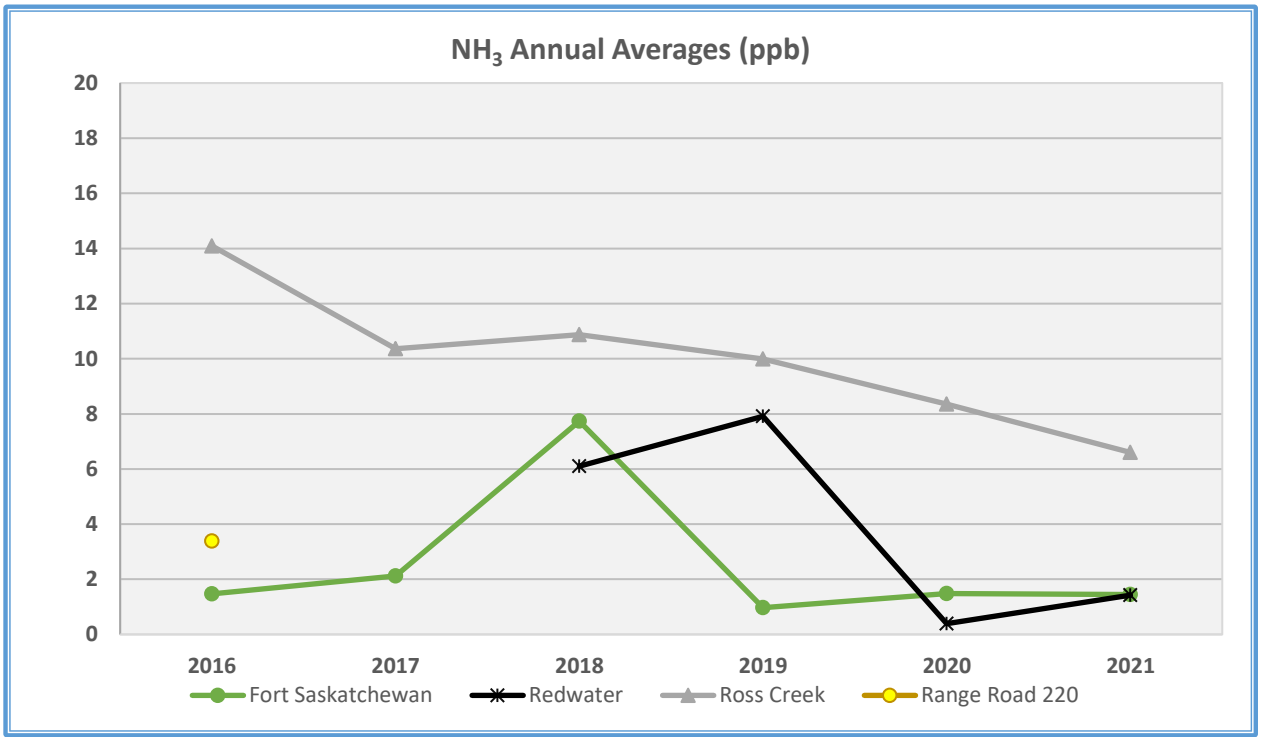
Figure 15 below presents a summary of NH_3 concentrations recorded in 2021 at individual stations while Figure 16 shows annual NH_3 averages for 2021 and the five years previous.

Figure 15: Monthly average NH_3 concentrations (ppb) in 2021



Ammonia (continued)

Figure 16: Annual average NH_3 concentrations at FAP stations (ppb)



Notes: - The Redwater station began operation October 2017.
- ammonia monitoring was stopped at Range Road 220 in January 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 2021 at the Fort Saskatchewan station, with comparisons to the applicable AAAQOs.

Table 14: 2021 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	2.4	18.7%	Jul 17 18:00	2.3.	46%	July 18

The CO monthly average concentrations recorded at Fort Saskatchewan station is given in Figure 17 while Figure 18 provides a comparison of annual averages for 2021 and the five years previous.

Figure 17: Monthly average CO concentrations Fort Saskatchewan (ppm) in 2021

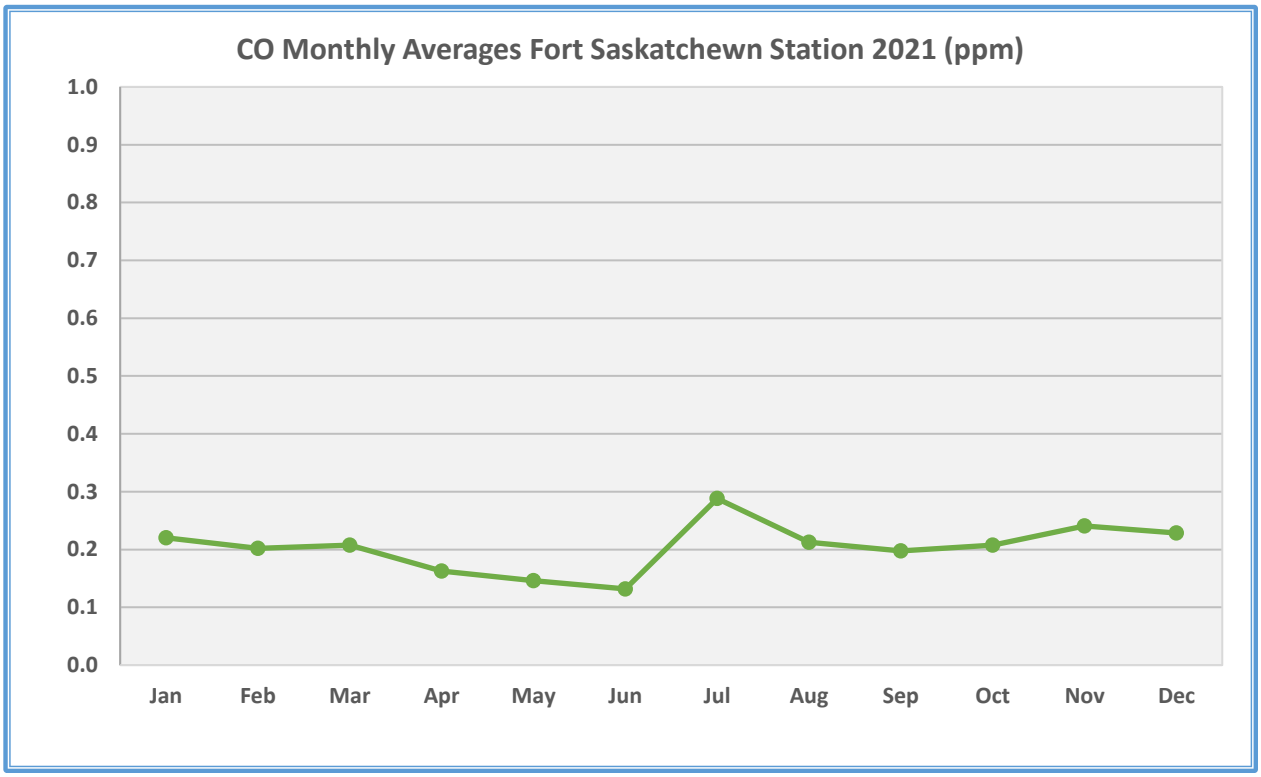
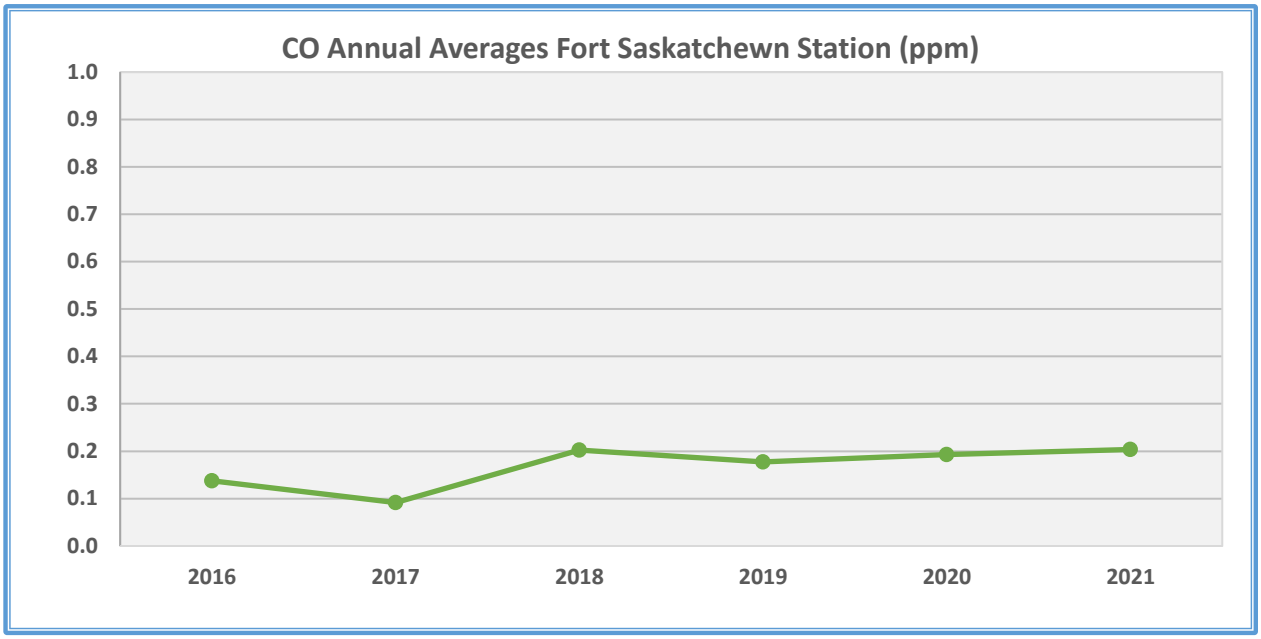


Figure 18: Annual average CO concentrations Fort Saskatchewan (ppm)



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.

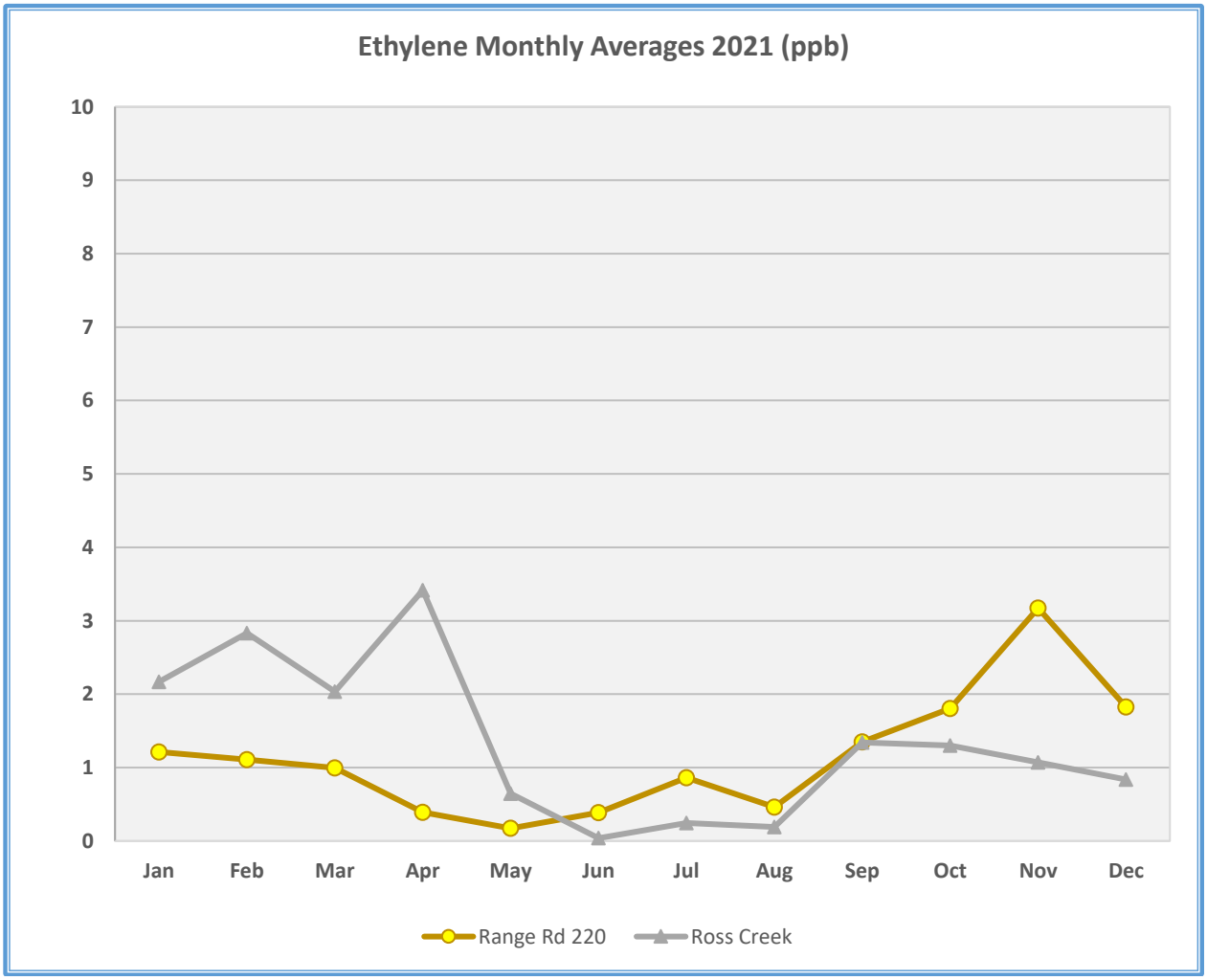
Table 15 below provides maximum 1-hour, 72-hour and annual averages of ethylene in 2021 with comparisons to the applicable AAAQOs.

Table 15: 2021 maximum ethylene averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 72-hour average (ppb)	% of AAAQO	Date	Annual average (ppb)	% of AAAQO
Range Road 220	133.8	12.7%	Mar 12 02:00	5.2	13.0%	Nov-23	1.3	5.0%
Ross Creek	158.8	15.1%	Jan 24 19:00	14.8	37.0%	Mar-28	1.1	4.2%

Figure 19 gives a summary of average ethylene concentrations recorded each month in 2021 at the two FAP stations where it is measured.

Figure 19: Monthly average ethylene concentrations (ppb) in 2021



Ethylene (continued)

Figure 20: Annual average ethylene concentrations at FAP stations (ppb)

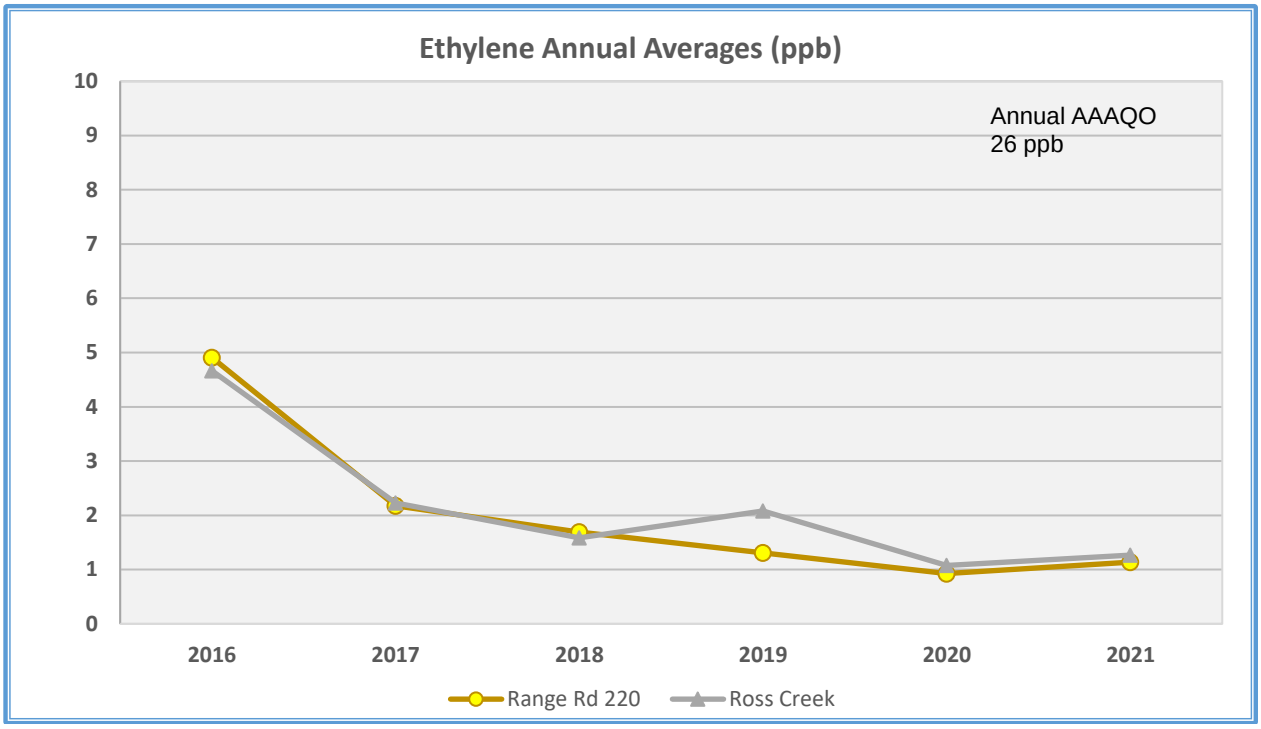


Figure 20 shows the annual ethylene averages at the two stations for 2021 and the five years previous. The downward trend in annual ethylene averages since 2016 is largely due to reduced flaring activities at a nearby industrial facility.

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 2021 against the Alberta ambient guideline and objectives (AAAQG/AAAQO), there were 328 1-hour Guideline exceedances and 60 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 2021

Station	Highest 1-hour average ($\mu g/m^3$)	Exceedances	Date(s)	Attributed Cause
Redwater	81.9	1	January 29	Wintertime inversion
Gibbons	112.6	1	April 16	Undetermined cause
*7 stations	391.1 (Elk Island)	328	July 15, 17-20 August 14	Wildfire smoke
Gibbons	144	3	August 28 September 5	Undetermined cause
*7 stations	164.6 (Redwater)	59	October 5 & 6	Wildfire smoke
Gibbons	84.3	1	October 31	Multiple sources

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

Fine Particulates (continued)

Table 17: Exceedances of the 24-hour average AAAQO for $PM_{2.5}$ in 2021

24 Hour Exceedances				
Station	Highest 24-hour average ($\mu g/m^3$)	Exceedances	Dates	Attributed Cause
Gibbons, Redwater	34.0 (Redwater)	2	January 29	Wintertime inversion
Gibbons, Ft. Saskatchewan	31.3 (Ft. Saskatchewan)	2	January 30	
*7 stations	201.3 (Elk Island)	28	July 13-20	Wildfire smoke
Bruderheim 1, Elk Island, Ft. Saskatchewan, Gibbons, Lamont County, Redwater	44.1 (Ft. Saskatchewan)	18	August 1-3, 14, 15	
*7 stations	69.8 (Redwater)	10	October 5 & 6	

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

Table 18: 2021 maximum $PM_{2.5}$ averages compared with applicable AAAQO(G)

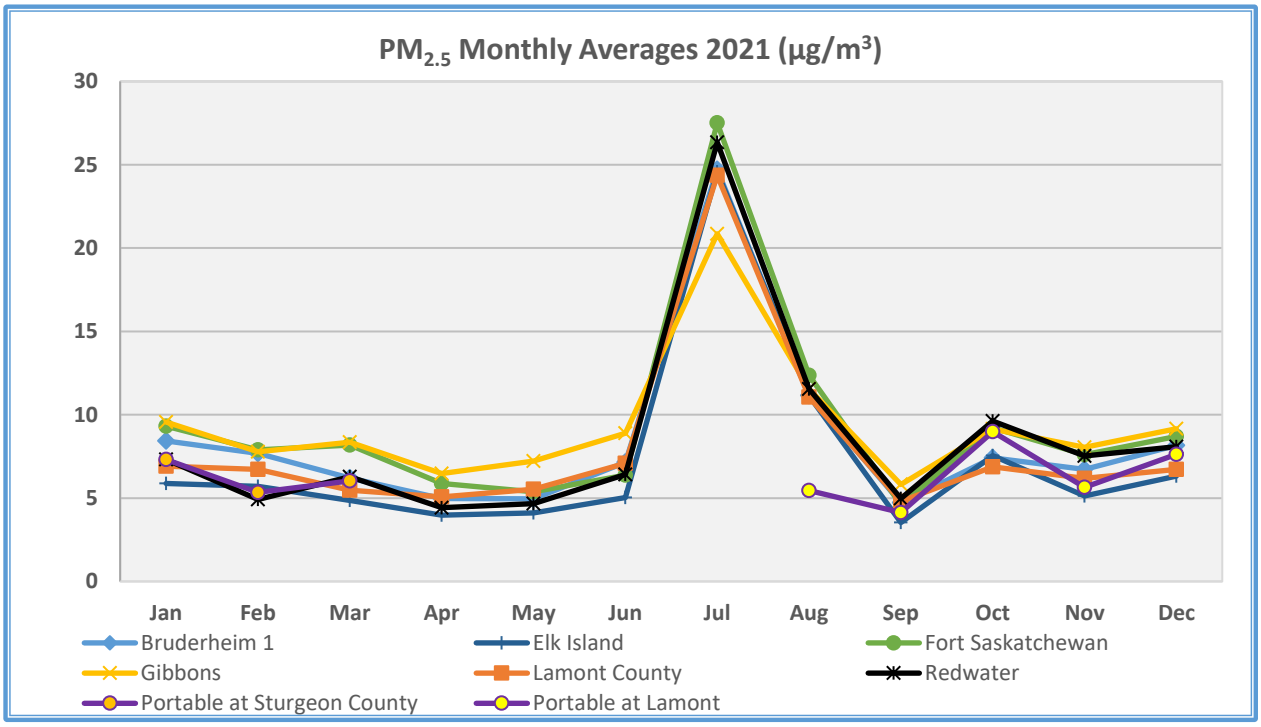
Station	Highest 1-hour average ($\mu g/m^3$)	% of AAAQG	Date Time	Highest 24-hour average ($\mu g/m^3$)	% of AAAQO	Date
Bruderheim 1	285.7	357	Jul 17 22:00	166.4	574	Jul 17
Elk Island	391.1	489	Jul 17 17:00	201.3	694	Jul 17
Fort Saskatchewan	387.9	474	Jul 17 18:00	199.2	687	Jul 17
Gibbons	335.3	419	Jul 17 17:00	150.9	520	Jul 17
K.P. Portable at Sturgeon County	45.4	56	Jan 29 18:00	23.9	82	Jan 29
K.P. Portable at Lamont	142.4	178	Oct 5 17:00	66.2	228	Oct 5
Lamont County	289.5	362	Jul 17 17:00	163.9	565	Jul 17
Redwater	381.6	477	Jul 17 22:00	195.9	676	Jul 17

Figure 21 below shows monthly average $PM_{2.5}$ concentrations recorded in 2021 at individual FAP monitoring stations. Figure 22 shows the annual average at each station in 2021 and the five years previous. Figure 23 shows annual averages at FAP stations compared to others across Alberta for the past 3 years.

Fine Particulates (continued)

As shown in Figure 21, a week-long wildfire smoke event was measured at all FAP stations in mid July 2021 causing an elevated monthly average. Other shorter events occurred in August and again in early October. As seen in Figure 22, 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.

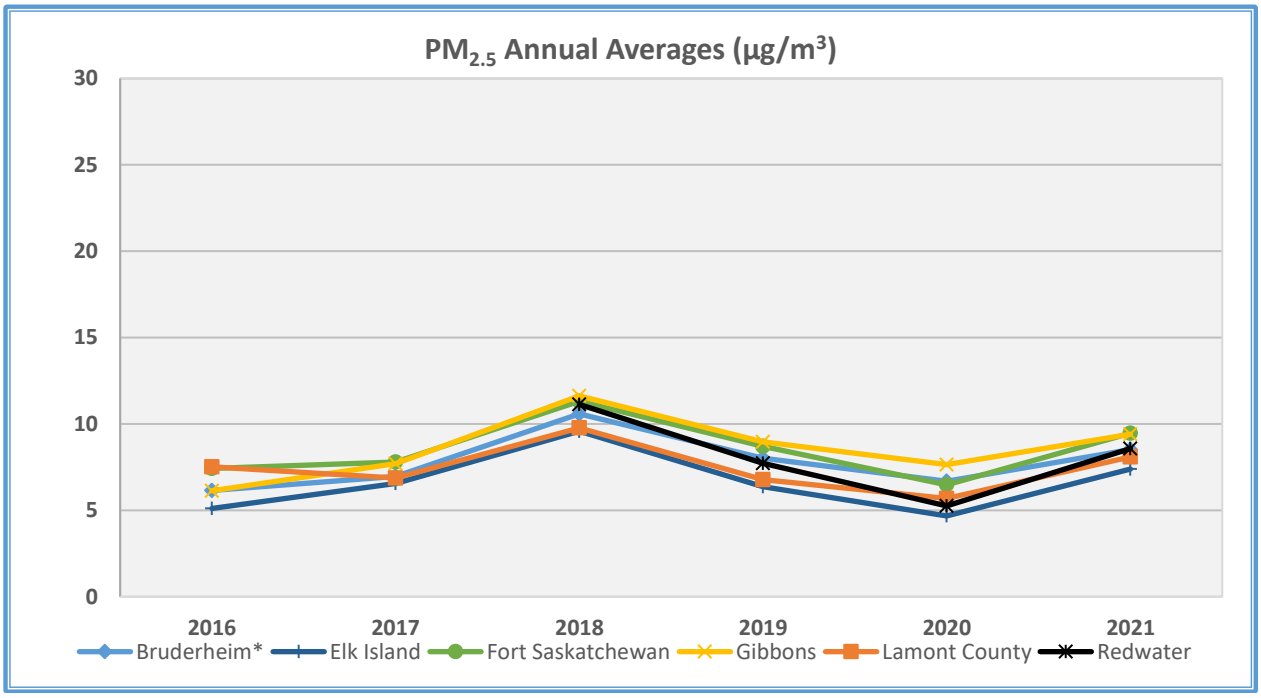
Figure 21: Monthly average $PM_{2.5}$ concentrations ($\mu g/m^3$) in 2021



Note: The Keith Purves Portable stopped operating at Sturgeon County in March and began again in the town of Lamont in August 2021.

Fine Particulates (continued)

Figure 22: Annual average $PM_{2.5}$ concentrations at FAP stations (µg/m^3)

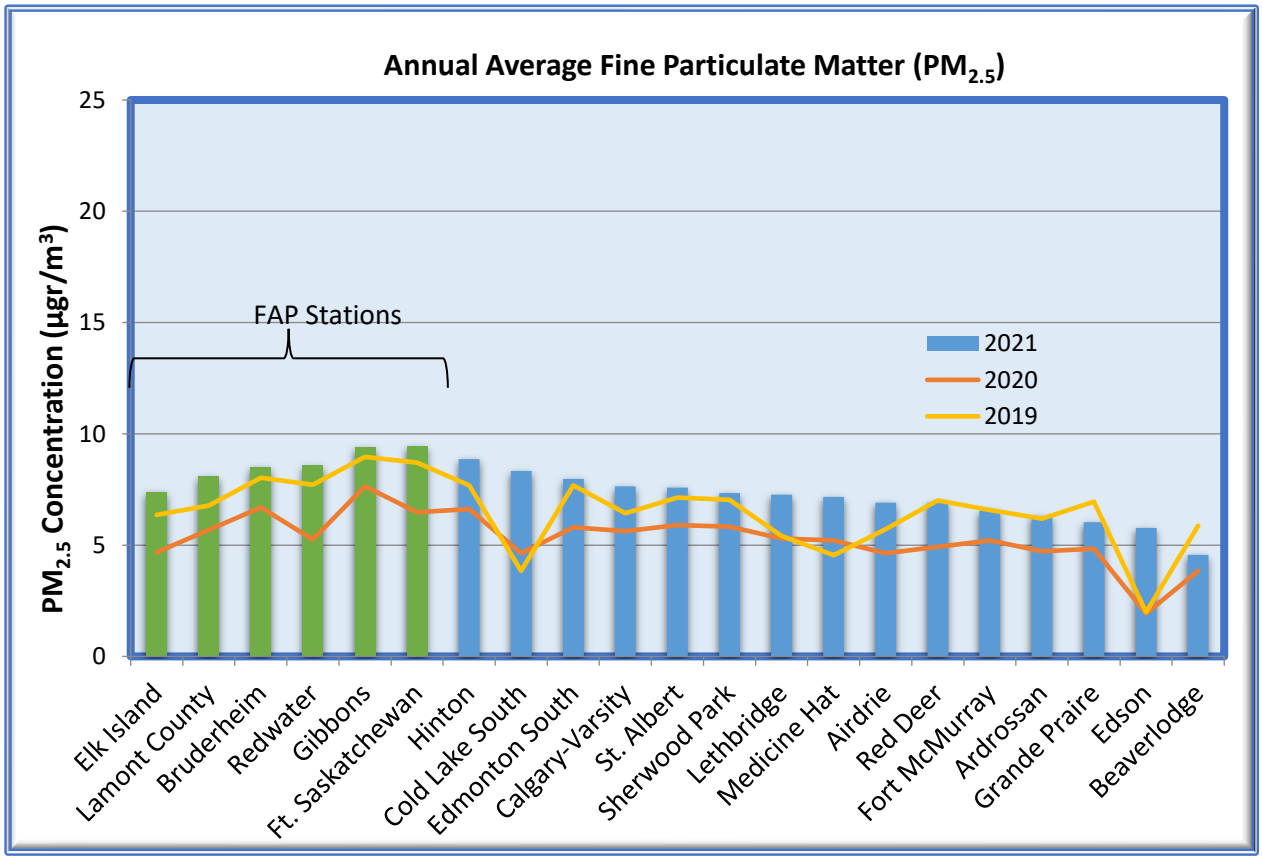


Notes:

- **The Bruderheim station was moved in 2016 and renamed Bruderheim 1. Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations.*
- *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.*

Fine Particulates (continued)

Figure 23: Annual average $PM_{2.5}$ concentrations in Alberta (µg/m³)



Significant wildfire smoke episodes across Alberta in both 2019 and 2021 contributed to overall higher annual average $PM_{2.5}$ values in those years as seen in Figure 23 above when compared to the 2020 annual average.

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.

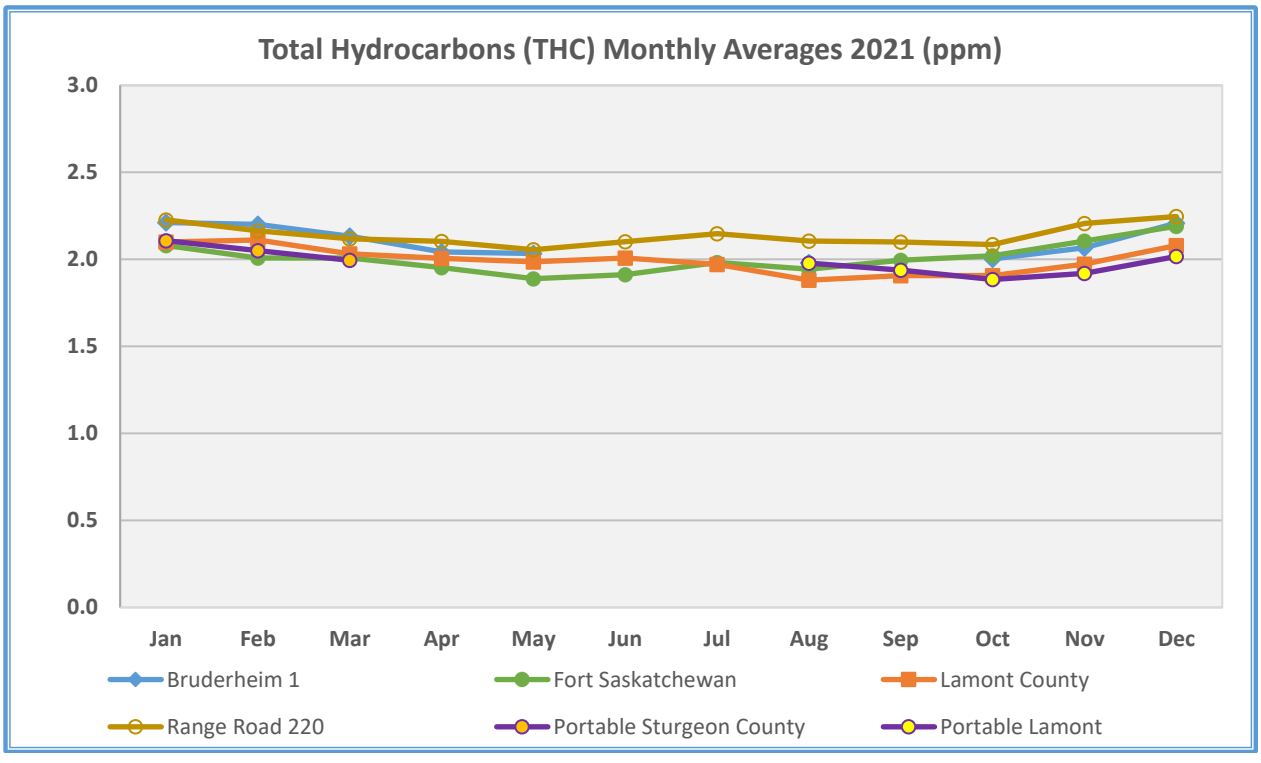
The major reactive hydrocarbon in the atmosphere is methane. Major worldwide sources of atmospheric methane include wetlands, ruminants such as cattle, energy use, landfills, and burning biomass such as wood. Methane is the primary component of natural gas.

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 2021 at individual stations is presented in Figure 24 though Figure 26 below. Note that for these plots, the Portable stopped operating at Sturgeon County in April and began again at a location in town of Lamont in August 2021. The hydrocarbon at the Bruderheim 1 station malfunctioned for over 25% of the hours in the months of June, July and September and did not permit viable monthly average calculations for total and non-methane hydrocarbons in those months.

Plots showing 2021 along with the previous 5 years are presented in Figure 27 through Figure 29 below. The portable data 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 24: Monthly average Total Hydrocarbons (ppm) in 2021



Hydrocarbons (continued)

Figure 25: Monthly average Methane concentrations (ppm) in 2021

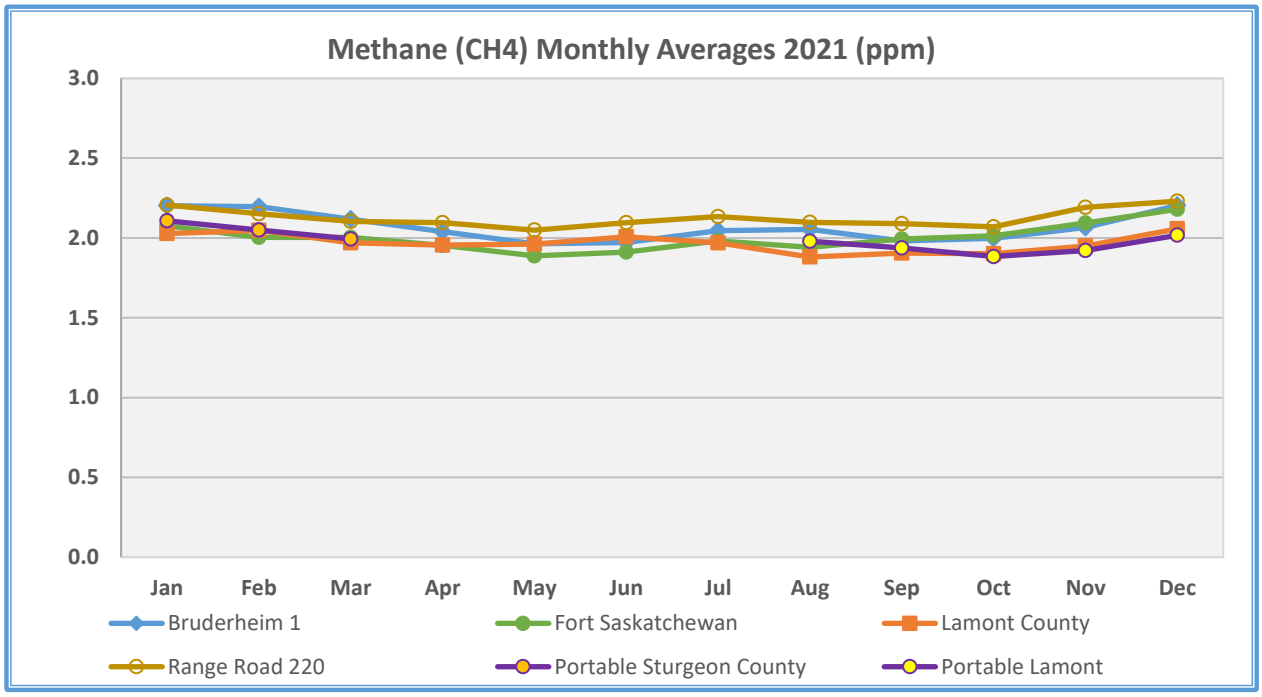
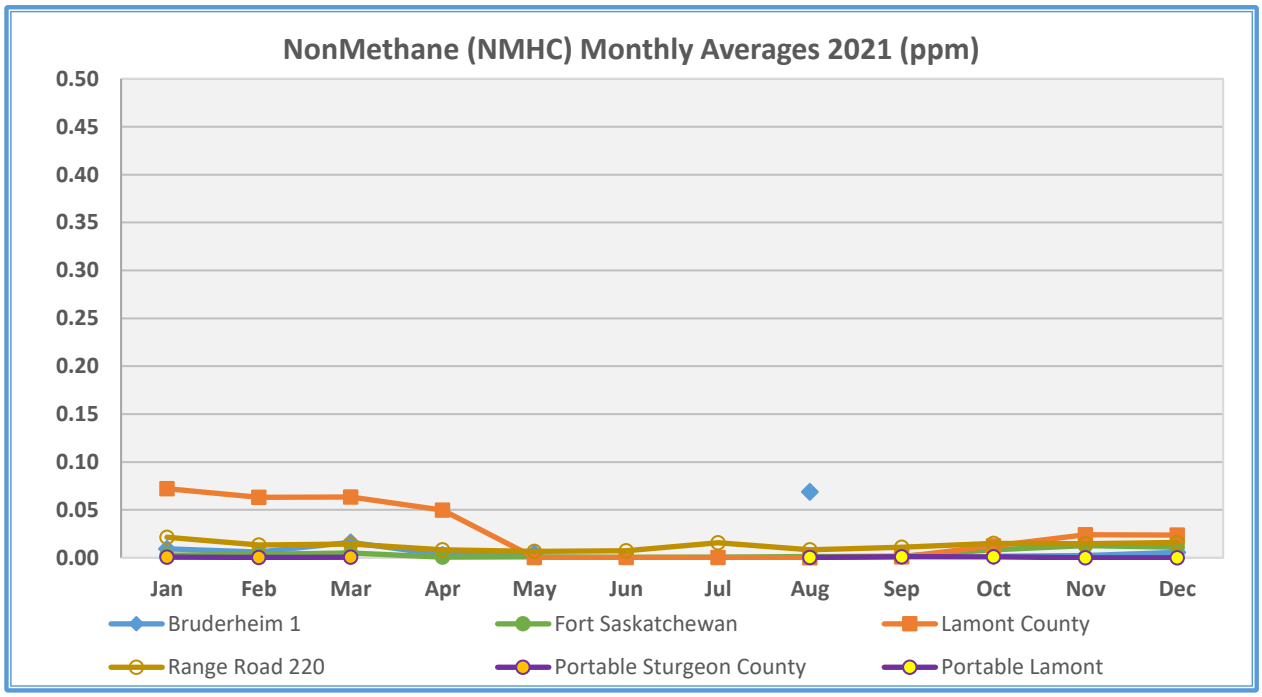
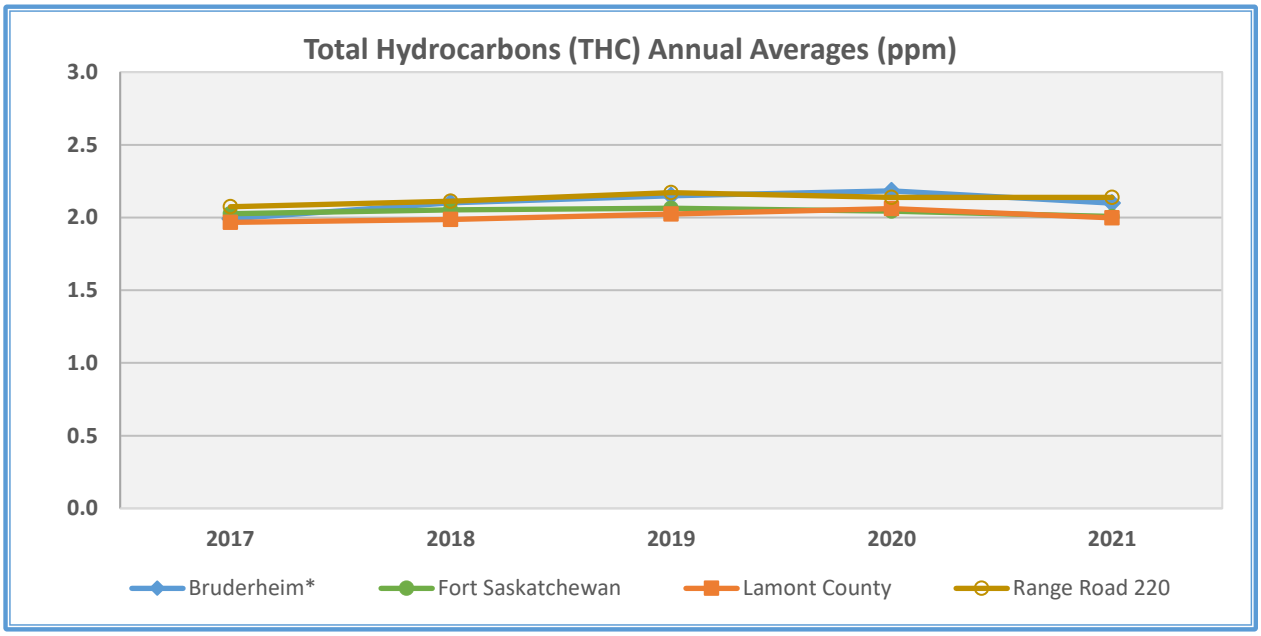


Figure 26: Monthly average Non-Methane Hydrocarbon concentrations (ppm) in 2021



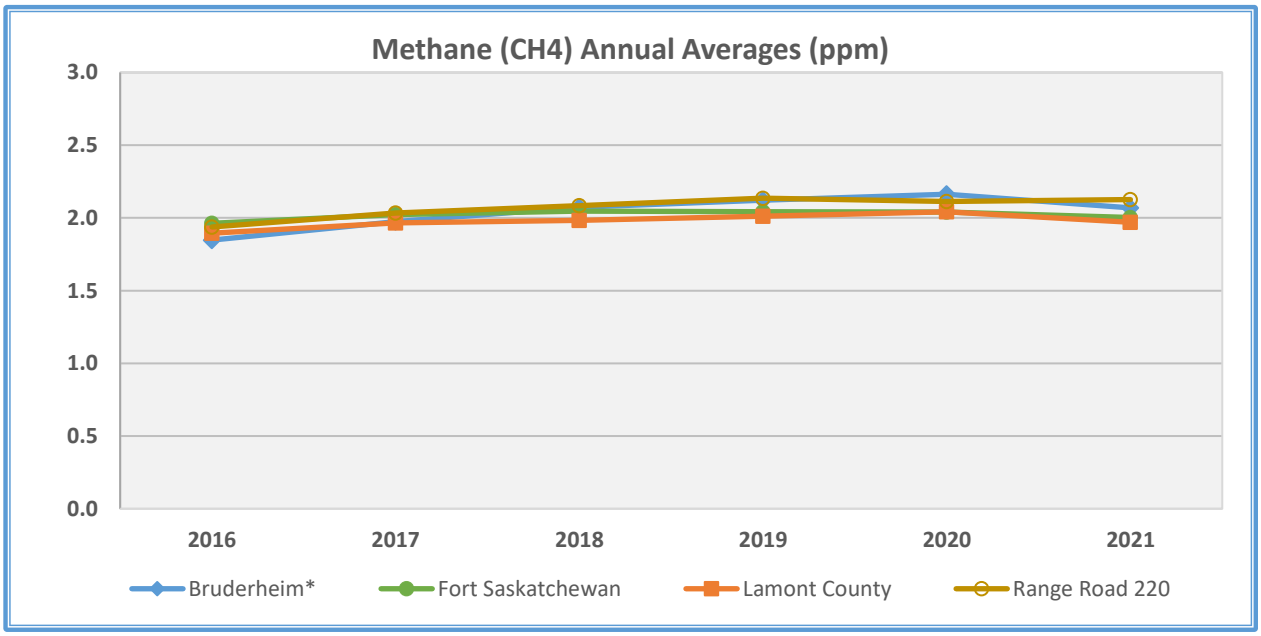
Hydrocarbons (continued)

Figure 27: Annual average THC concentrations at FAP stations (ppm)



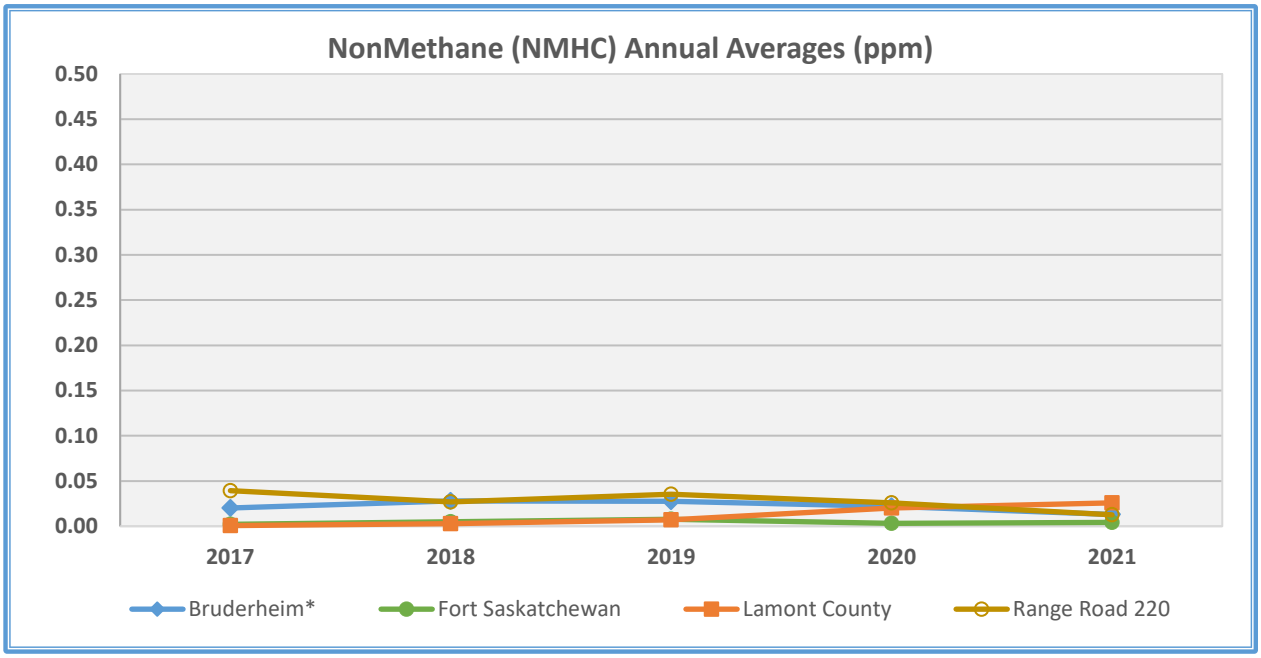
*Note: *The Bruderheim station was moved in 2016 and renamed Bruderheim 1. The Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations.*

Figure 28: Annual average CH_4 concentrations at FAP stations (ppm)



*Note: *The Bruderheim station was moved in 2016 and renamed Bruderheim 1. The Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations.*

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



*Note: *The Bruderheim station was moved in 2016 and renamed Bruderheim 1. The Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations.*

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 2021 as measured at each FAP station each month.

Table 19: 2021 Maximum 1-hour average hydrocarbon concentrations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Hydrocarbons THC (PPM)												
Bruderheim 1	4.1	3.8	4.0	4.0	2.6	--	--	4.1	--	3.3	3.5	4.5
Fort Saskatchewan	2.7	2.7	2.6	2.6	2.7	2.4	2.5	2.6	2.7	2.7	2.8	2.9
K.P. Portable at Sturgeon County	3.1	3.0	2.4	--	--	--	--	--	--	--	--	--
K.P. Portable at Lamont	--	--	--	--	--	--	--	2.7	2.6	2.4	2.3	2.8
Lamont County	2.6	2.8	2.5	2.5	2.4	2.4	2.5	2.4	2.5	2.9	2.4	2.8
Range Road 220	4.1	2.8	3.8	4.0	2.8	3.2	3.7	3.5	3.2	3.0	3.2	3.3
Methane CH_4 (PPM)												
Bruderheim 1	3.7	3.6	3.6	3.1	3.3	4.0	3.9	3.4	--	3.0	3.3	4.1
Fort Saskatchewan	2.7	2.5	2.5	2.6	2.3	2.3	2.5	2.5	2.6	2.5	2.7	2.7
K.P. Portable at Sturgeon County	3.1	2.9	2.4	--	--	--	--	--	--	--	--	--
K.P. Portable at Lamont	--	--	--	--	--	--	--	2.7	2.6	2.4	2.3	2.8
Lamont County	2.5	2.3	2.3	2.2	2.4	2.4	2.5	2.4	2.5	2.8	2.3	2.7
Range Road 220	3.0	2.7	2.6	3.0	2.6	3.1	2.9	3.3	2.6	2.7	2.8	3.0
Non-Methane Hydrocarbons NMHC (PPM)												
Bruderheim 1	0.4	0.3	0.6	0.1	0.0	--	--	0.9	-	0.3	0.3	0.4
Fort Saskatchewan	0.5	0.2	0.6	0.1	0.6	0.1	0.1	0.2	0.1	0.6	0.6	0.4
K.P. Portable at Sturgeon County	0.1	0.1	0.3	--	--	--	--	--	--	--	--	--
K.P. Portable at Lamont	--	--	--	--	--	--	--	0.04	1.0	0.8	0.8	0.6
Lamont County	0.3	0.2	0.2	0.2	0.1	0.0	0.1	0.0	0.0	0.2	0.2	0.3
Range Road 220	1.4	0.8	1.6	1.9	0.6	0.6	1.0	0.4	1.0	0.8	0.8	0.6

--the parameter was not measured in the month

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 16 exceedances of the 1-hour AAAQO and no 24-hour exceedances of the AAAQO for H_2S in 2021. Details of the H_2S exceedances recorded in 2021 are listed in Table 20.

Table 20: Exceedances of the 1-hour average AAAQO for H_2S in 2021

Station	Highest 1 hour average (ppb)	Exceedances	Date	Attributed Cause
Scotford South	10.2	2	June 4	Natural due to wetlands
Gibbons, Redwater	11.2	2	June 24	Natural due to wetlands
Redwater	23.2	8	July 5,9,12,28,31 5	Natural due to wetlands
Redwater	12.7	4	Sep 8,13,29	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 2021 with comparisons to the applicable AAAQOs.

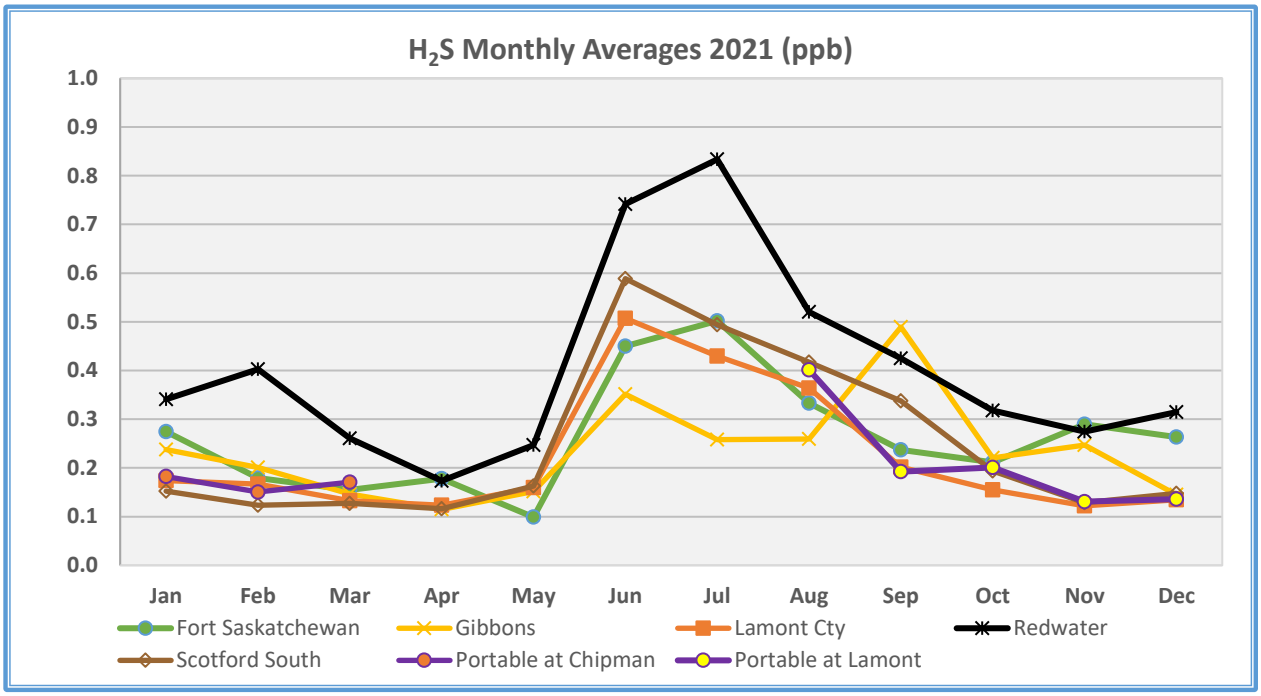
Table 21: 2021 maximum H_2S averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 24-hour average (ppb)	% of AAAQO	Date
Fort Saskatchewan	5.9	59%	Apr 16 04:00	1.5	50.0%	Jun 29
Gibbons	10.1	101%	Jun 29 06:00	1.5	50.0%	Jun 29
Keith Purves Portable at Sturgeon County	2.7	27%	Mar 5 14:00	0.6	20%	Jan 29
Keith Purves Portable at Lamont	9.7	97%	Aug-06 06:00	2.3	77%	Aug 6
Lamont County	4.7	47%	Aug 7 07:00	1.5	50.0%	Jun 30
Redwater	22.4	224%	Jul 31 01:00	2.5	83.3%	Jun 29
Scotford South	10.3	103%	Jun 4 05:00	1.8	60.0%	Jun 4

A summary of the monthly average H_2S concentrations recorded in 2021 at individual stations and annual averages for 2021 with the 5 years previous is shown in Hydrogen Sulphide (continued)
Figure 30 and Figure 31 below.

Hydrogen Sulphide (continued)

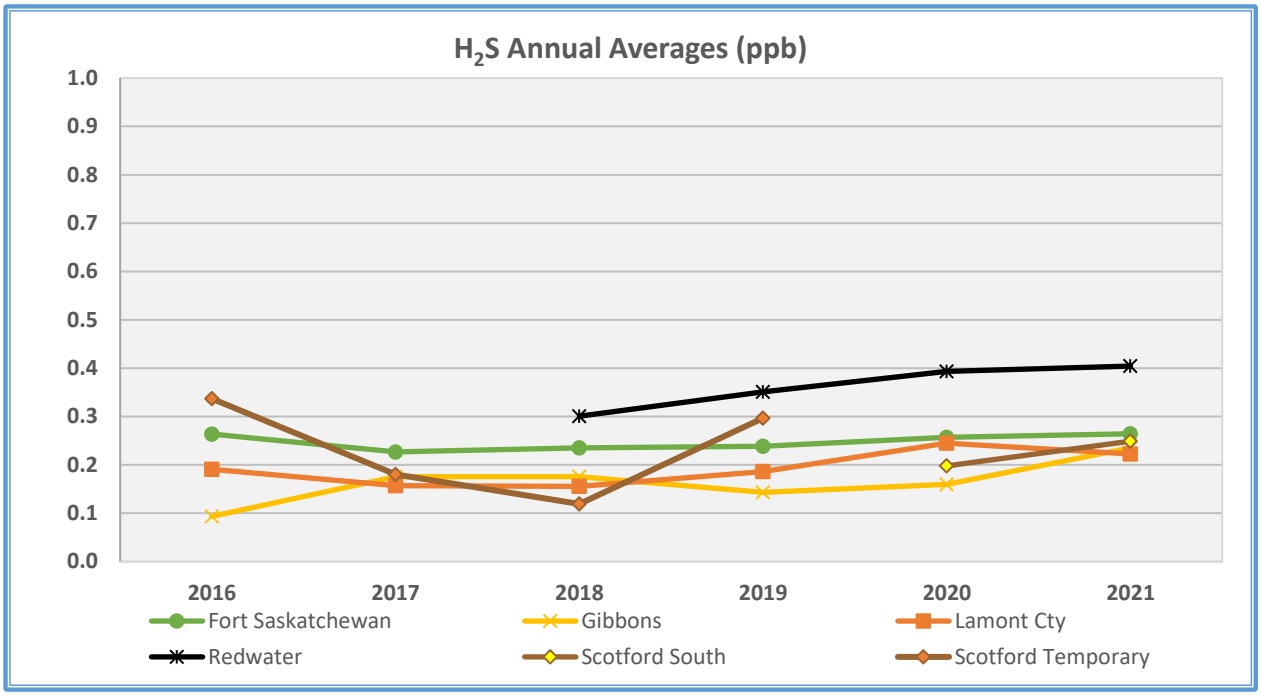
Figure 30: Monthly average H_2S concentrations (ppb) in 2021



Note: The Keith Purves Portable stopped operating at Sturgeon County in March and began again in the town of Lamont in August 2021.

Hydrogen Sulphide (continued)

Figure 31: Annual average H_2S concentrations at FAP stations (ppb)



Notes:

- *The Redwater station began operations late in 2017.*
- *The Gibbons station began operations in February 2016.*
- *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 2021.

Table 22 below provides the maximum 1-hour and annual NO_2 averages in 2021 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 2021 at either location to calculate a valid annual average.

Nitrogen Dioxide (continued)

Table 22: 2021 maximum NO_2 averages compared with applicable AAAQO

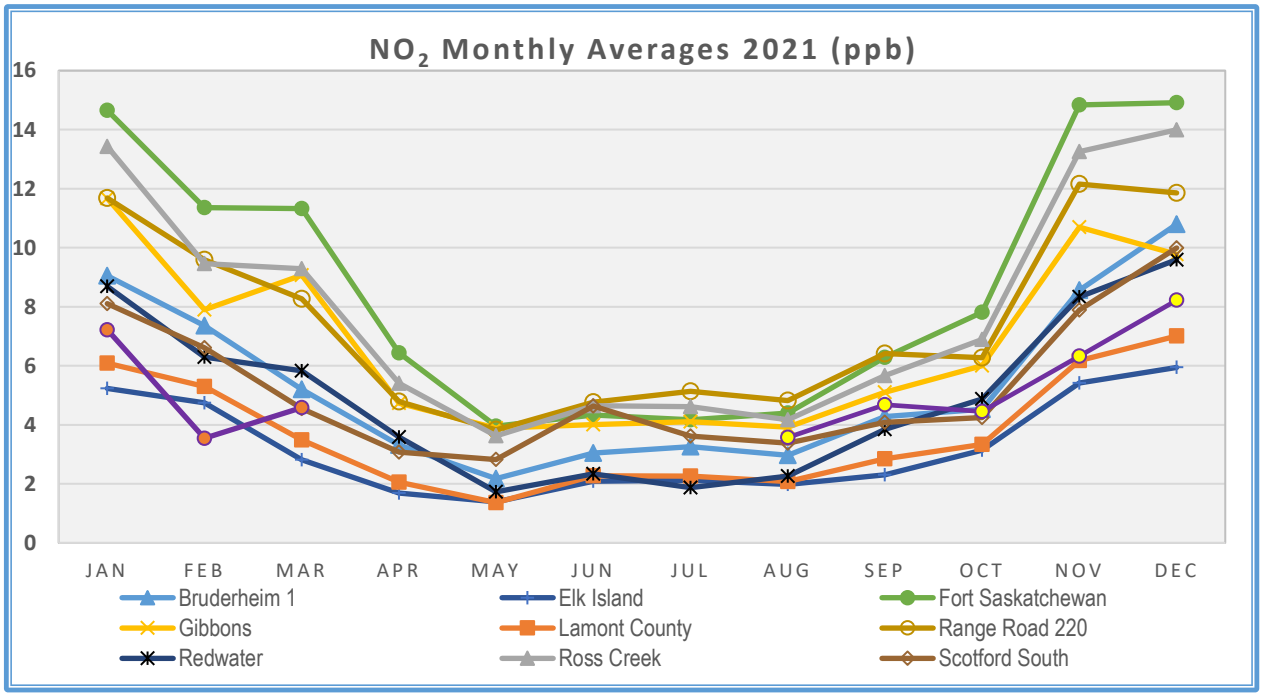
Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Annual average (ppb)	% of AAAQO
Bruderheim 1	56.4	35.5%	Dec 31 17:00	5.38	22%
Elk Island	38.2	24.0%	Nov 18 18:00	3.24	13%
Fort Saskatchewan	49.1	30.9%	Jan 7 18:00	8.71	36%
Gibbons	47.2	29.7%	Jan 9 19:00	6.74	28%
K.P. Portable at Sturgeon County	38.3	24.1%	Jan-08 01:00	-	N/A
K.P. Portable at Lamont	35.7	22.4%	Nov-18 23:00	-	N/A
Lamont County	36.5	23.0%	Dec 20 17:00	3.69	15%
Range Road 220	45.8	28.8%	Feb 18 03:00	7.46	31%
Redwater	38.4	24.1%	Feb 18 08:00	4.94	21%
Ross Creek	47.7	30.0%	Feb 18 06:00	7.87	33%
Scotford South	45.7	28.7%	Feb 18 00:00	5.25	22%

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 32. 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 32 and Figure 33 below respectively. Figure 34 is a chart of the annual averages in 2021 and the previous 2 years recorded at FAP stations compared with averages from a cross section of other monitoring sites around Alberta.

Nitrogen Dioxide (continued)

Figure 32: Monthly average NO_2 concentrations (ppb) in 2021

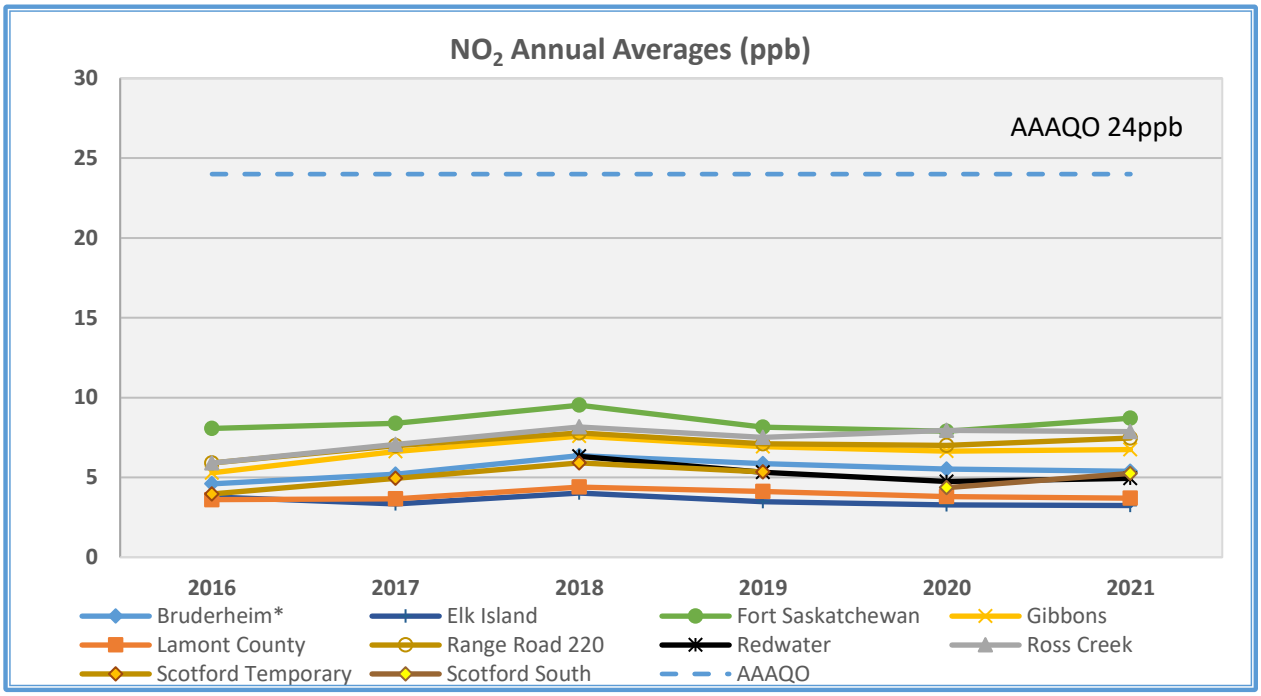


Notes:

- *The Scotford Temporary station was moved in March 2020 and became Scotford South.*
- *The Keith Purves Portable station stopped operating at Sturgeon County in March and began again at the Lamont location in August 2021.*

Nitrogen Dioxide (continued)

Figure 33: Annual average NO_2 concentrations at FAP stations (ppb)

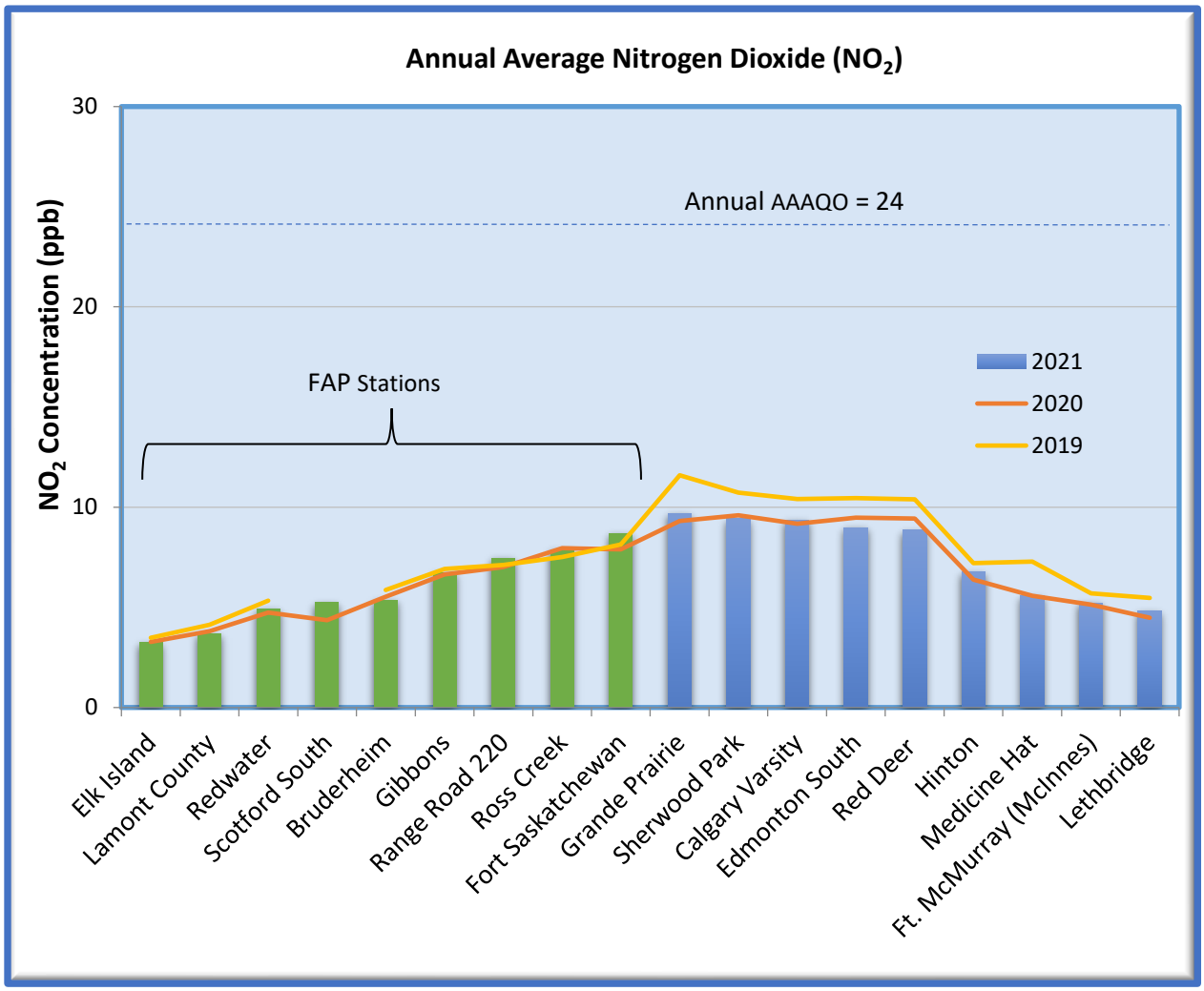


Notes:

- **The Bruderheim station was moved in 2016 and renamed Bruderheim 1. The Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations.*
- *The Gibbons station began operations in February 2016.*
- *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 here as it is not at any location for the minimum 75% of a calendar year required to calculate an annual average.*

Nitrogen Dioxide (continued)

Figure 34: Annual average NO_2 concentrations in Alberta (ppb)



Note: The Scotford South station began operation in 2020.

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 Government of Alberta 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 2021 this occurred during warm weather in July as shown in Table 23. 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 2021 as seen in Figure 35, 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 2021.

Table 23 below provides the maximum 1-hour O_3 averages in 2021 with comparison to the applicable AAAQO.

Ozone (continued)

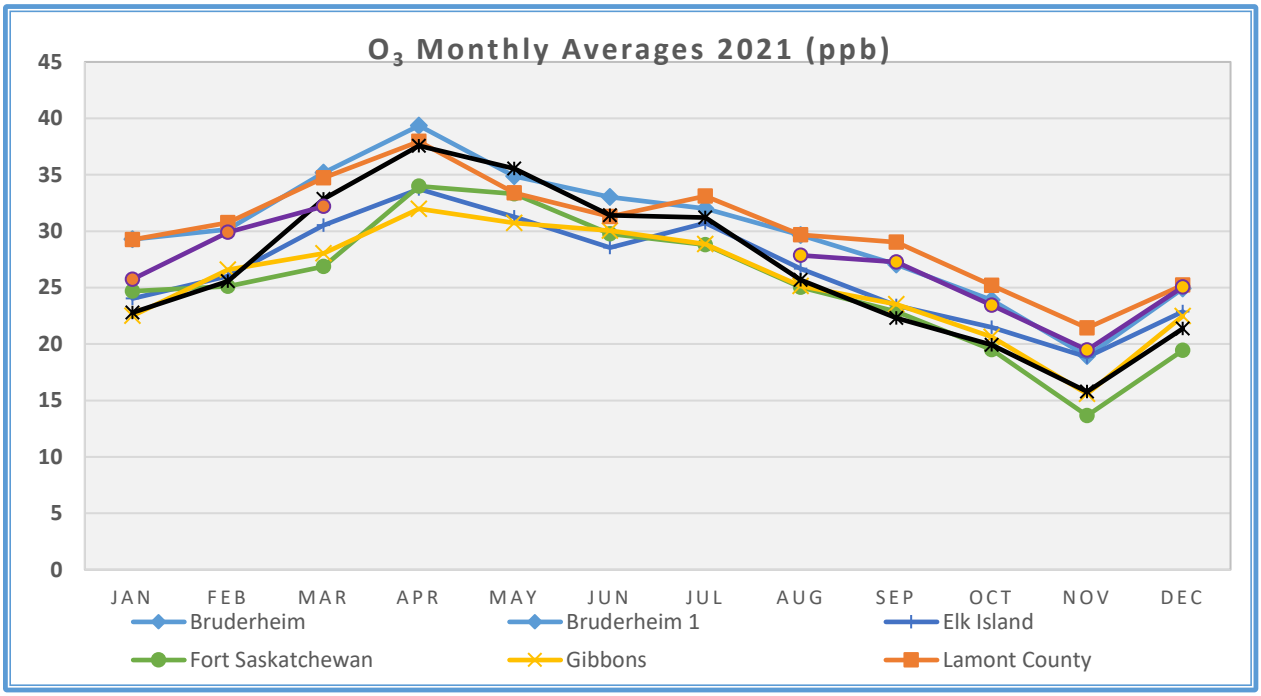
Table 23: 2021 maximum O_3 averages compared with applicable AAAQO

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time
Bruderheim 1	83.9	110.4%	Jul 8 13:00
Elk Island	82.4	108.5%	Jul 9 13:00
Fort Saskatchewan	74.0	97.4%	Jul 9 13:00
Gibbons	69.3	91.1%	Aug 5 16:00
K.P. Portable at Sturgeon County	50.8	66.8%	Mar-19 17:00
K.P. Portable at Lamont	68.2	89.8%	Aug 4 13:00
Lamont County	73.9	97.2%	Jul 9 14:00
Redwater	78.2	102.9%	Jul 9 16:00

A summary of monthly average O_3 concentrations recorded at individual stations is shown in Figure 35 below while Figure 36 shows the annual average O_3 concentrations in the FAP network in 2021 and the 5 years previous. Figure 37 plots annual averages at FAP sites alongside selected stations across Alberta for the last 3 years.

Ozone (continued)

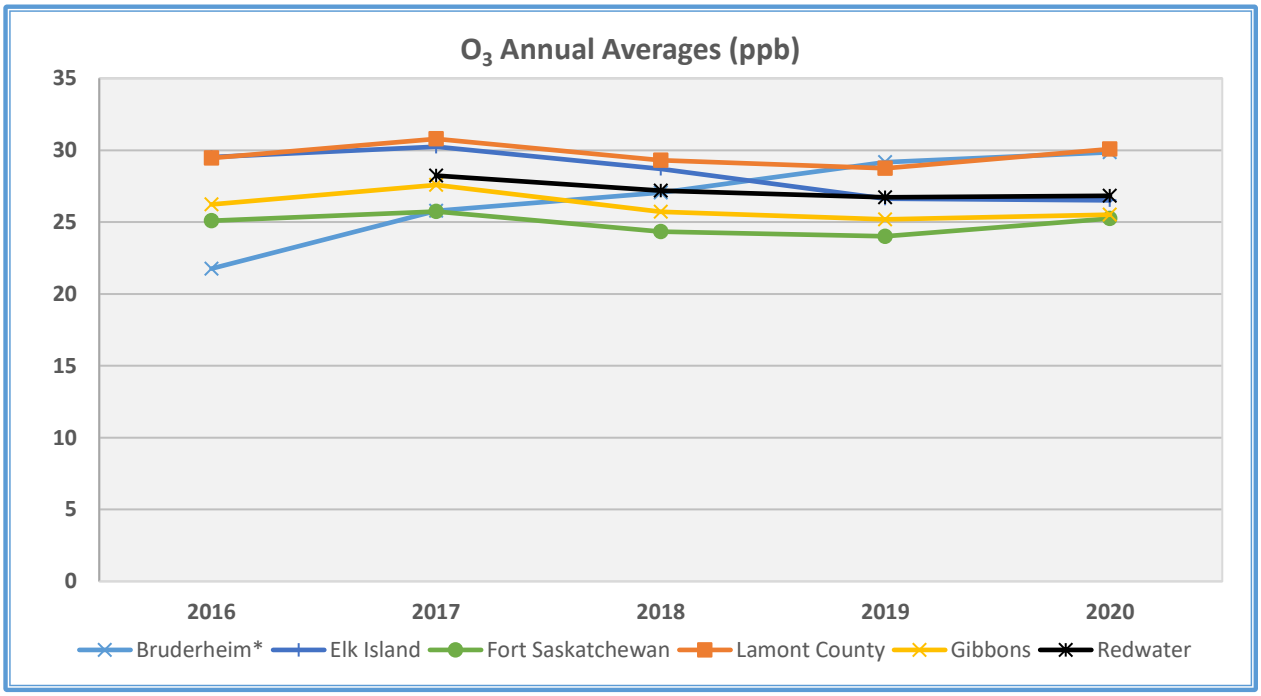
Figure 35: Monthly average O_3 concentrations (ppb) in 2021



Note: The Keith Purves Portable stopped operating at Sturgeon County in March and began again at Lamont in August 2021.

Ozone (continued)

Figure 36: Annual average O_3 concentrations at FAP stations (ppb)

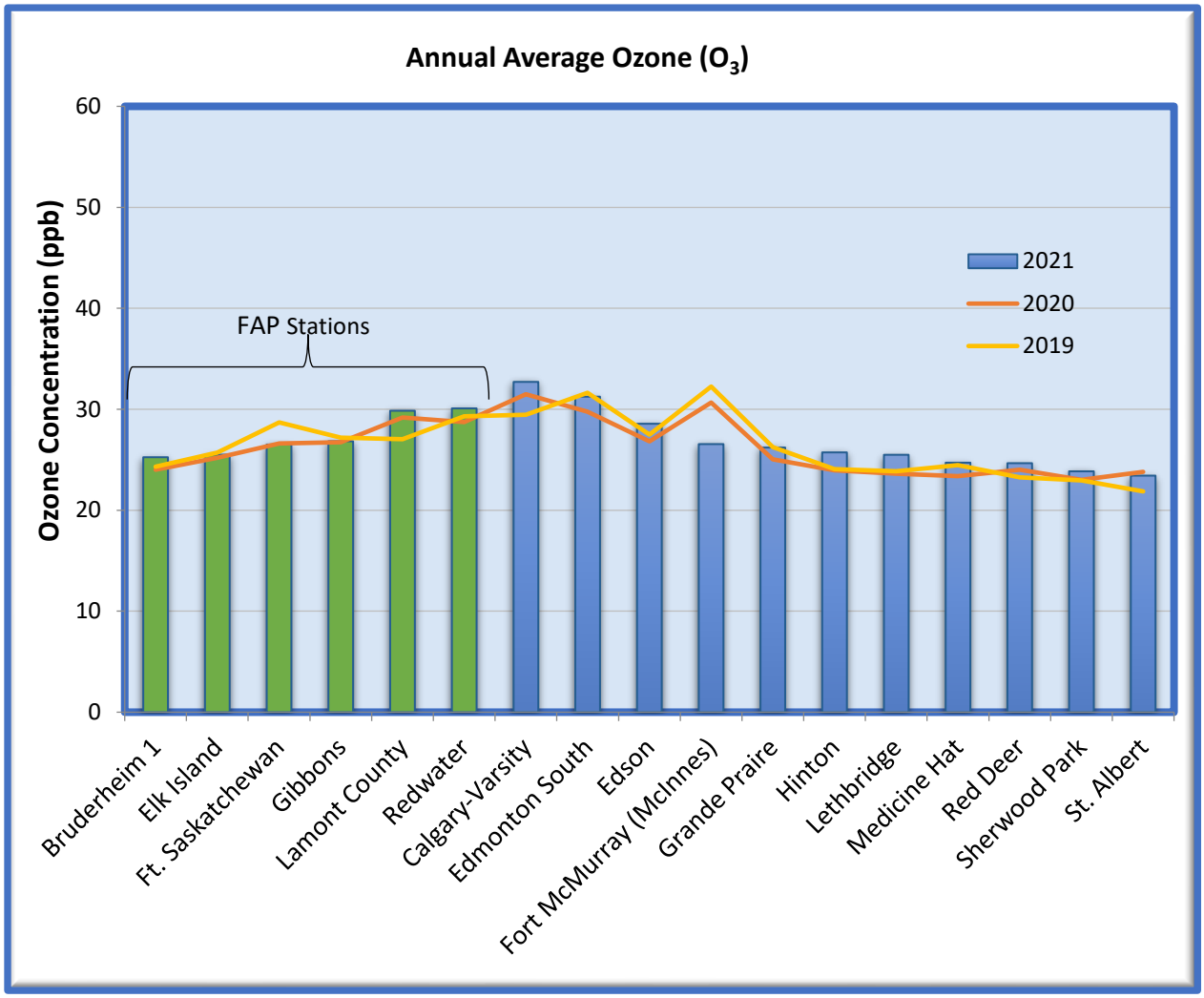


Notes:

- **The Bruderheim station was moved in 2016 and renamed Bruderheim 1. Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations.*
- *The Gibbons station began operations in February 2016.*
- *The Redwater station began operations late in 2017.*
- *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.*

Ozone (continued)

Figure 37: Annual average O_3 concentrations in Alberta (ppb)



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 2021.

Table 24 below provides the maximum 1-hour, 24-hour, 30 day and annual SO_2 averages in 2021 with comparison to the applicable AAAQOs. For the purposes of this comparison, FAP uses the monthly averages as the 30-day average.

Table 24: 2021 maximum SO_2 averages compared with applicable AAAQO

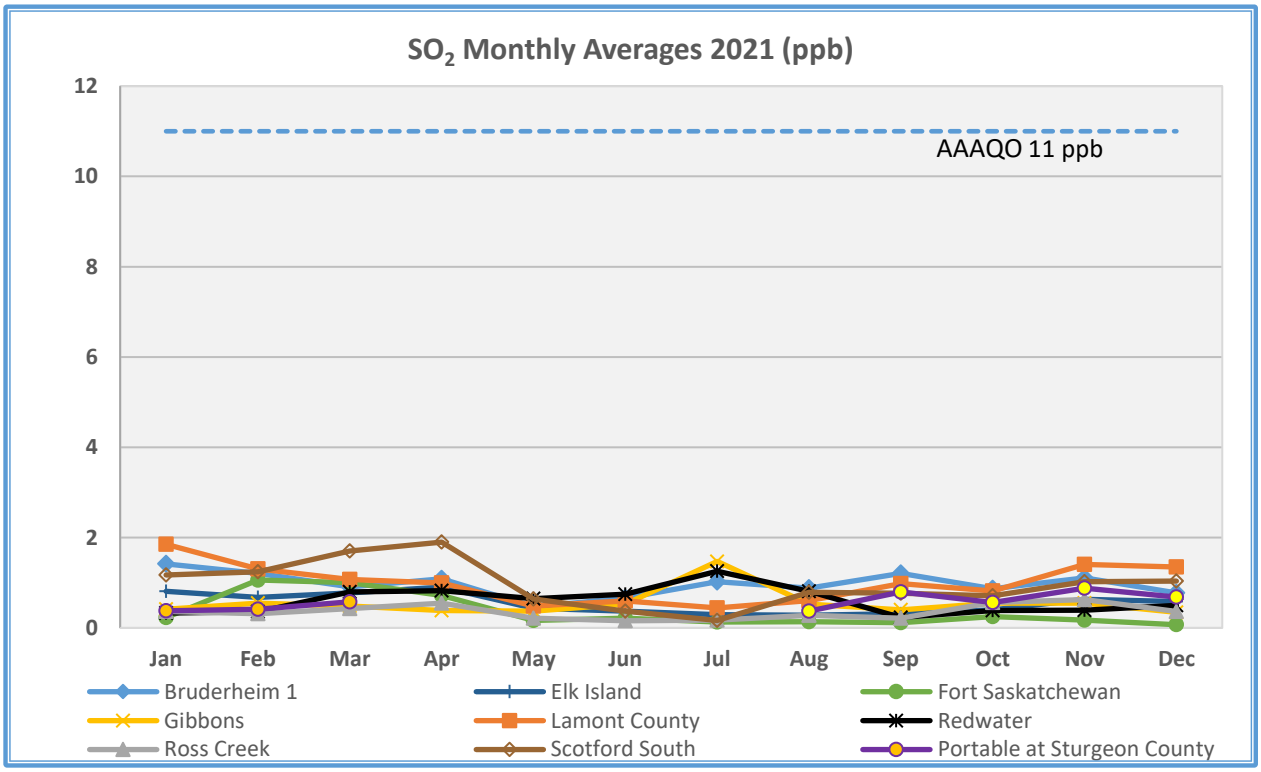
Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 24-hour average (ppb)	% of AAAQO	Date	Highest 30-day average (ppb)	% of AAAQO	Month	Annual average (ppb)	% of AAAQO
Bruderheim 1	45.6	26.5%	Apr 2 10:00	5.5	11.5%	Apr-21	1.42	13%	Jan	0.97	12%
Elk Island	36.7	21.4%	Jan 28 00:00	5.5	11.5%	Mar-29	0.90	8%	Apr	0.54	7%
Fort Saskatchewan	25.8	15.0%	Apr 17 11:00	3.4	7.1%	Apr-17	1.06	10%	Feb	0.36	4%
Gibbons	20.2	11.8%	Oct 12 10:00	5.6	11.7%	Jul-19	1.47	13%	Jul	0.55	7%
K.P. Portable at Sturgeon County	27.2	15.8%	Mar-03 14:00	2.5	5.2%	Feb-18	1.85	17%	Jan	0.99	12%
K.P. Portable at Lamont	29.9	17.4%	Sep 29 10:00	3.5	7.3%	Nov-05	1.25	11%	Jul	0.61	8%
Lamont County	40.9	23.8%	Mar 30 11:00	6.4	13.3%	Jan-28	0.63	6%	Nov	0.35	4%
Redwater	27.3	15.9%	Mar 7 15:00	4.3	9.0%	Apr-13	1.90	17%	Apr	0.96	12%
Ross Creek	31.1	18.1%	Apr 17 10:00	4.6	9.6%	Apr-17	0.58	5%	Mar	N/A	N/A
Scotford South	98.5	57.3%	Apr 16 12:00	23.4	48.8%	Mar-29	0.88	8%	Nov	N/A	N/A

Sulphur Dioxide (continued)

A summary of monthly average SO_2 concentrations recorded in 2021 at individual stations is presented in Figure 38 below.

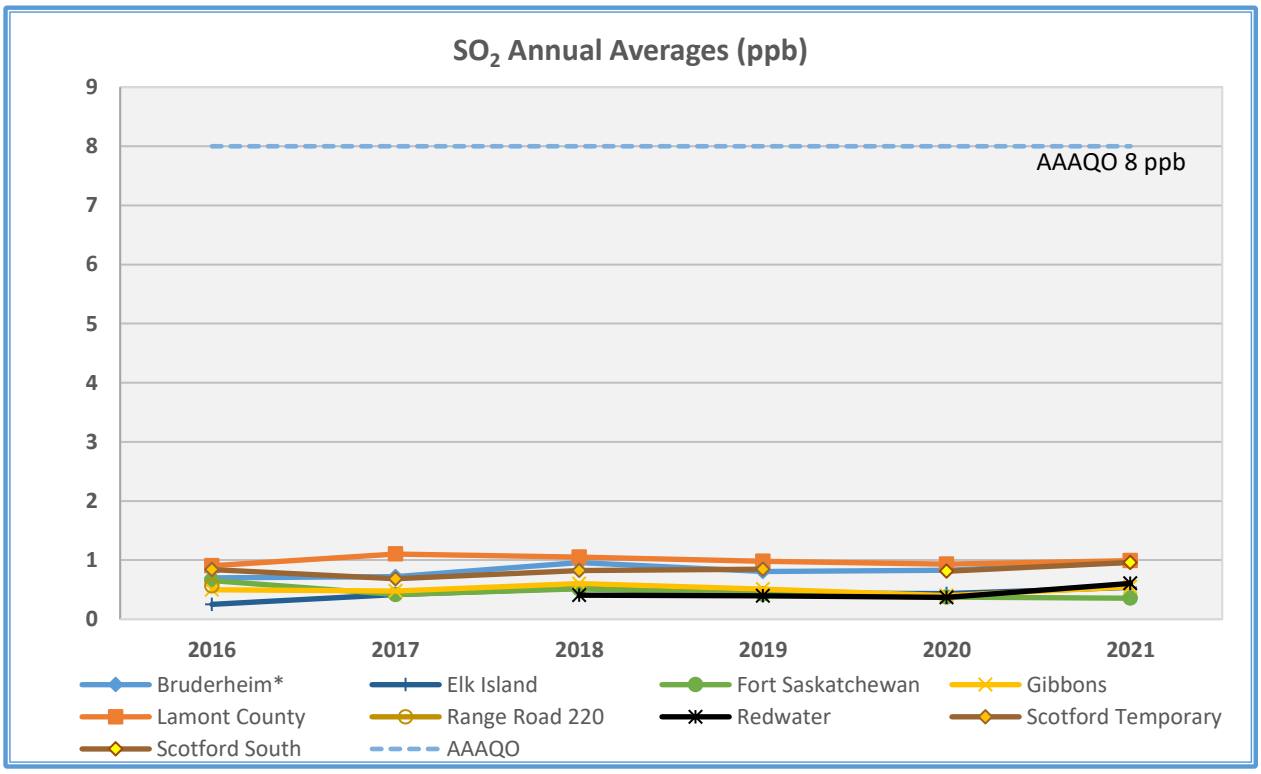
A comparison of annual averages for 2021 and the five years previous is shown in Figure 39. Figure 40 shows the annual averages of SO_2 at FAP stations and with a cross section of other stations in Alberta.

Figure 38: Monthly average SO_2 concentrations (ppb) in 2021



Sulphur Dioxide (continued)

Figure 39: Annual average SO_2 concentrations at FAP stations (ppb)

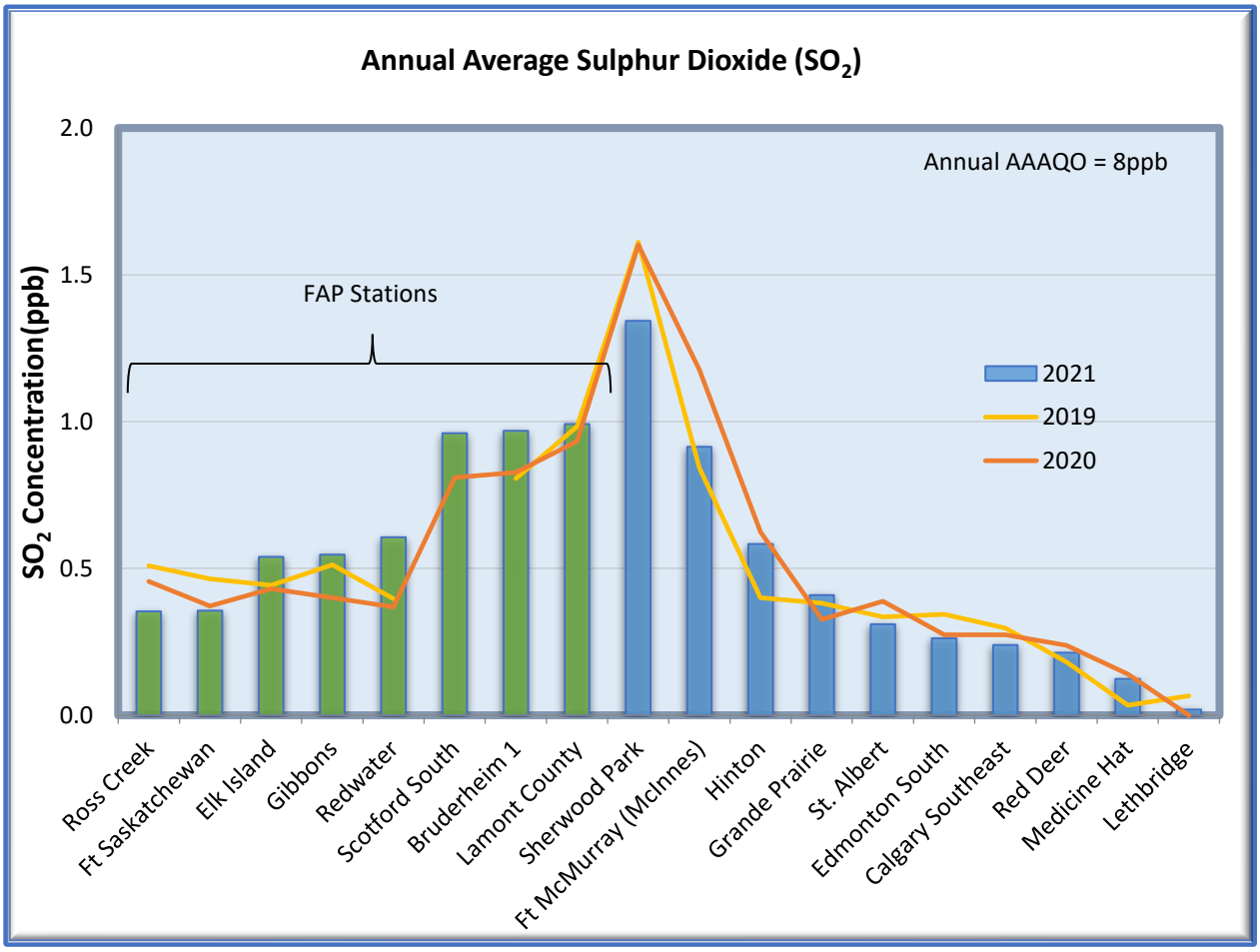


Notes:

- **The Bruderheim station was moved in 2016 and renamed Bruderheim 1. The Bruderheim 2016 annual average includes data from both Bruderheim and Bruderheim1 stations.*
- *SO_2 monitoring was stopped at Range Road 220 in January 2017.*
- *The Redwater station began operation October 2017.*
- *The Scotford South station replaced Scotford Temporary in March 2020.*
- *The Portable station is not shown here as it was not at a location for the minimum 75% of a calendar year required to calculate an annual average.*

Sulphur Dioxide (continued)

Figure 40: Annual average SO_2 concentrations in Alberta (ppb)



Note: The Scotford South station was installed in March 2020.

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 at Scotford Temporary 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 2021.

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 2021. The annual average of 0.01 ppb benzene in 2021 represents approximately 1% of the AAAQO.

Volatile Organic Compounds (continued)

Table 25: 2021 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	5.5	60.9%	Oct 18 07:00	1.8	Jul-17	N/A
Toluene	19.7	3.9%	Jun 4 08:00	2.4	Jul-17	2.3%
Ethylbenzene	2.0	0.4%	Apr 13 09:00	0.2	Aug-24	N/A
m, p-Xylene	16.7	3.2%	Apr 13 09:00	1.6	Apr-13	1.0%
o-Xylene	16.7	3.2%	Apr 13 09:00	5.8	Aug-04	3.6%
Styrene	23.2	44.6%	Aug 4 11:00	1.9	Sep-30	N/A

A plot of the monthly average BTEX/S concentrations recorded in 2021 at the Scotford South station is presented in Figure 41. A comparison of 2021 annual average BTEX/S concentrations with the five years previous is shown in Figure 42 below. Due to the proximity of the two station locations, data from both the Scotford Temporary and Scotford South stations is used in Figure 42. The increase of toluene the 2017 annual average as shown in Figure 42 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 41: Monthly average BTEX/S concentrations (ppb) in 2021

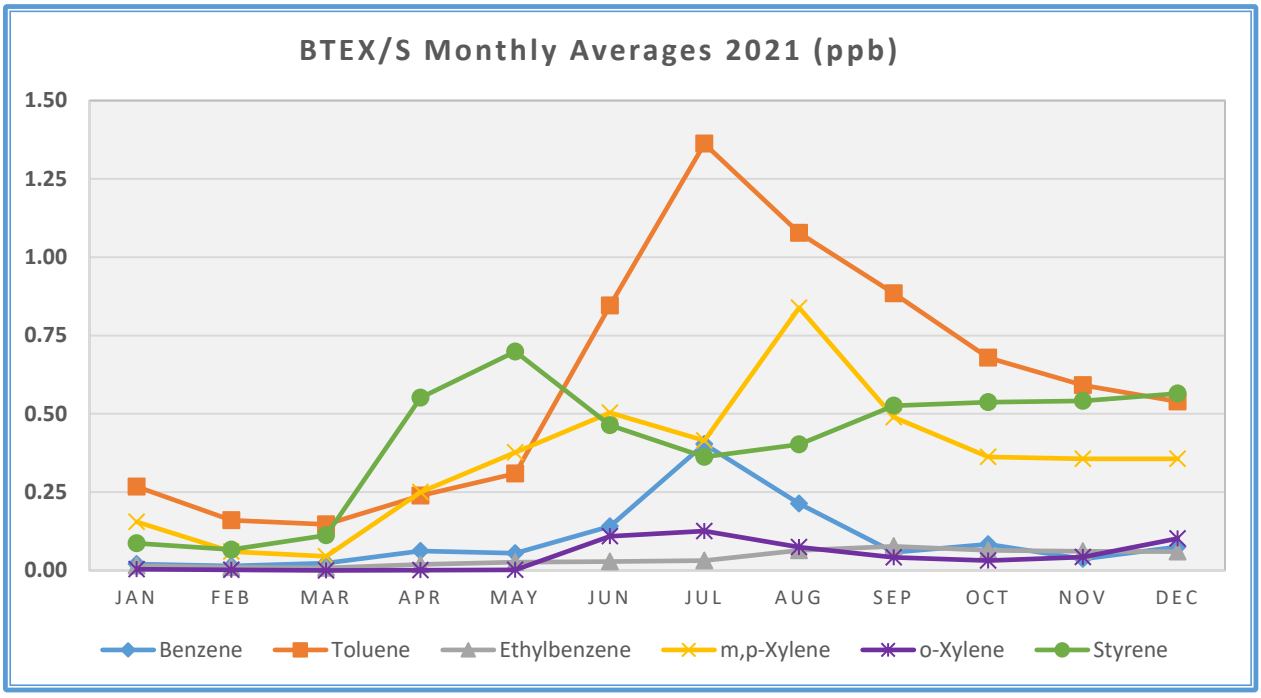
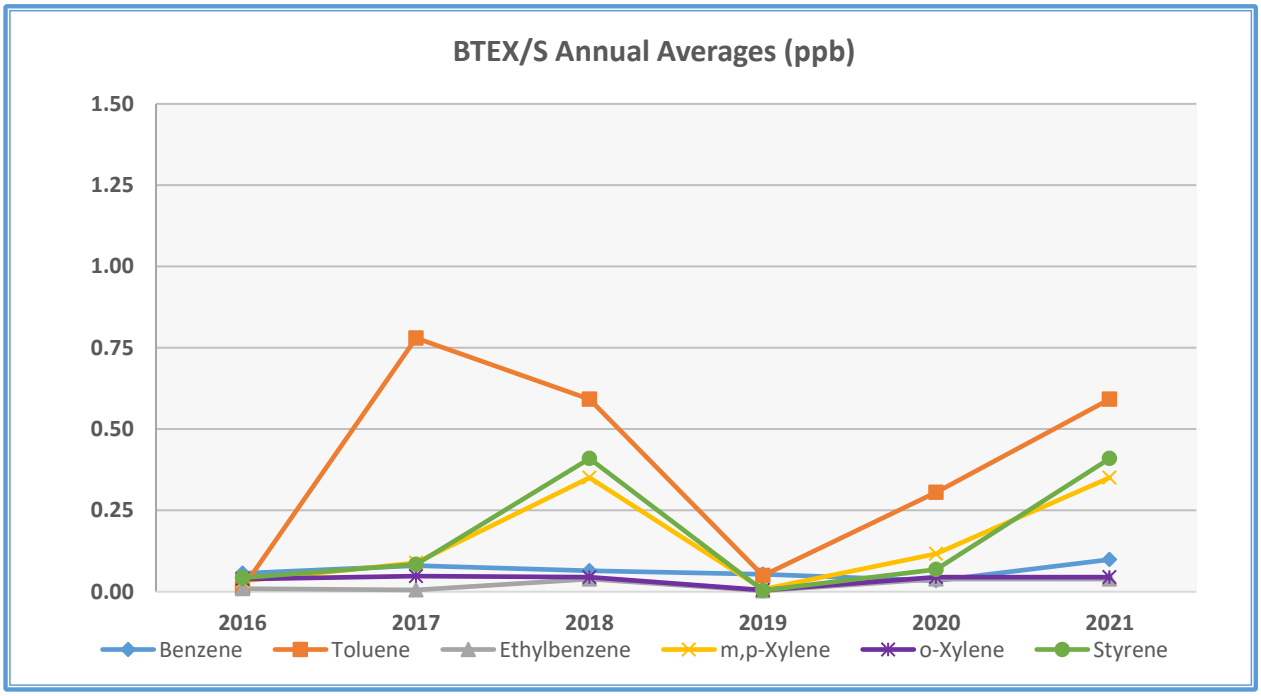


Figure 42: Annual average BTEX/S concentrations (ppb)

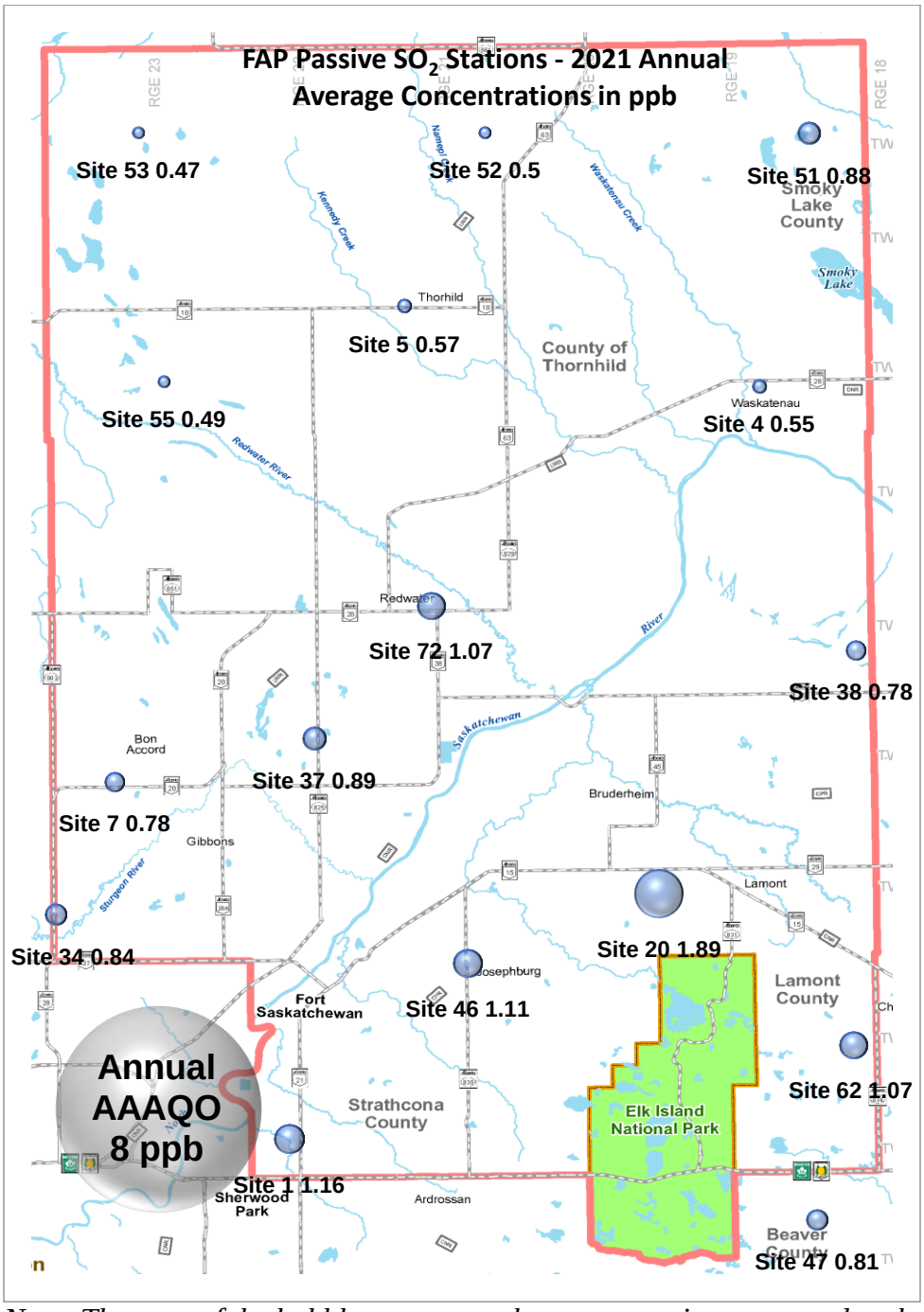


2021 Passive Monitoring Results

The following four figures show results from the passive monitoring sites. Figure 43 and Figure 45 are bubble charts showing annual average concentrations of SO_2 and H_2S respectively at each site geographically with the size of the bubble relative to the concentration measured. Figure 44 and Figure 46 chart the 2021 annual average concentrations as bars with line charts showing the annual average concentrations in the previous 5 years. Some sites were added the in 2020 so do not show prior averages.

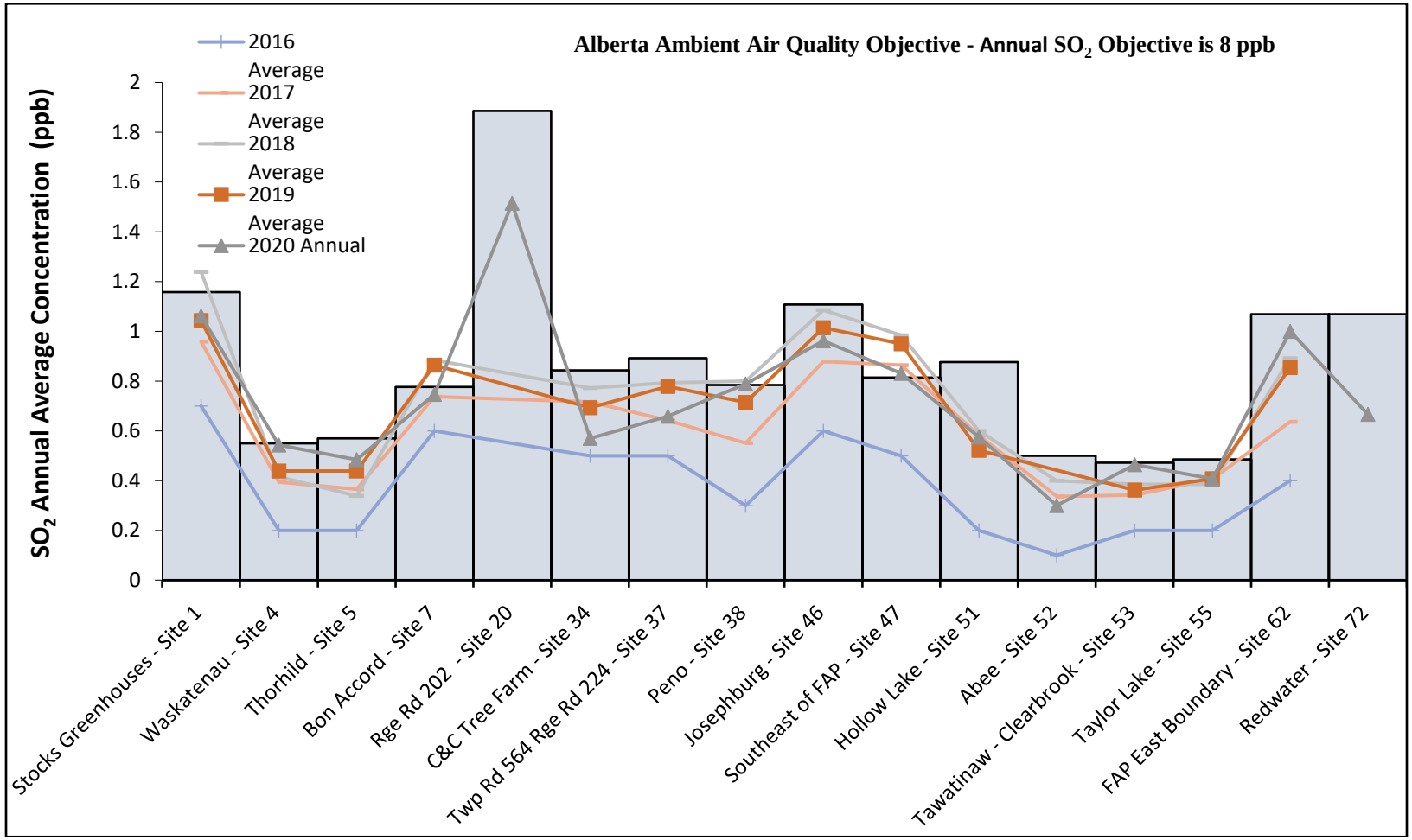
Sulphur Dioxide

Figure 43: 2021 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.

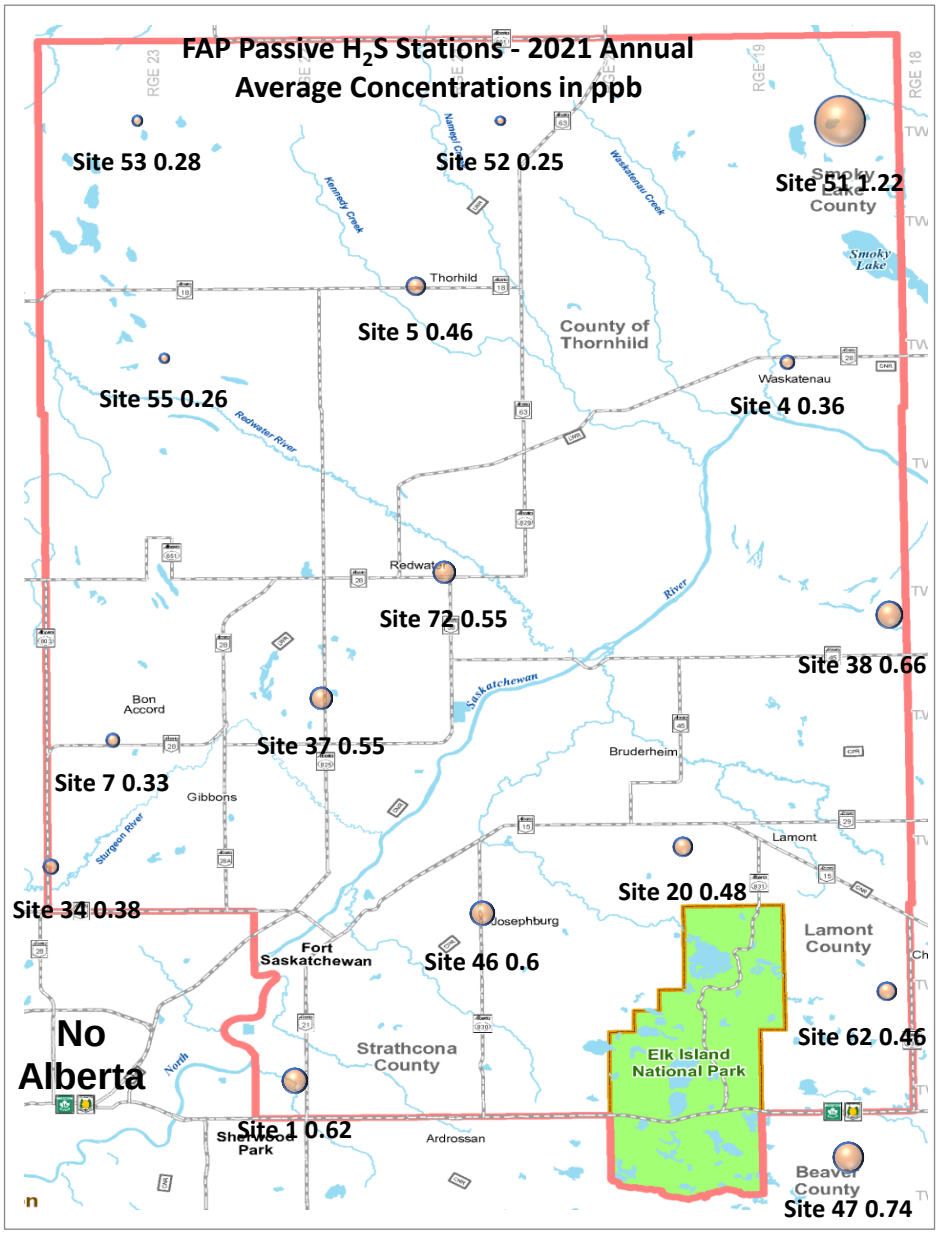
Figure 44: Passive monitoring annual averages: SO_2 (ppb) – historical



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

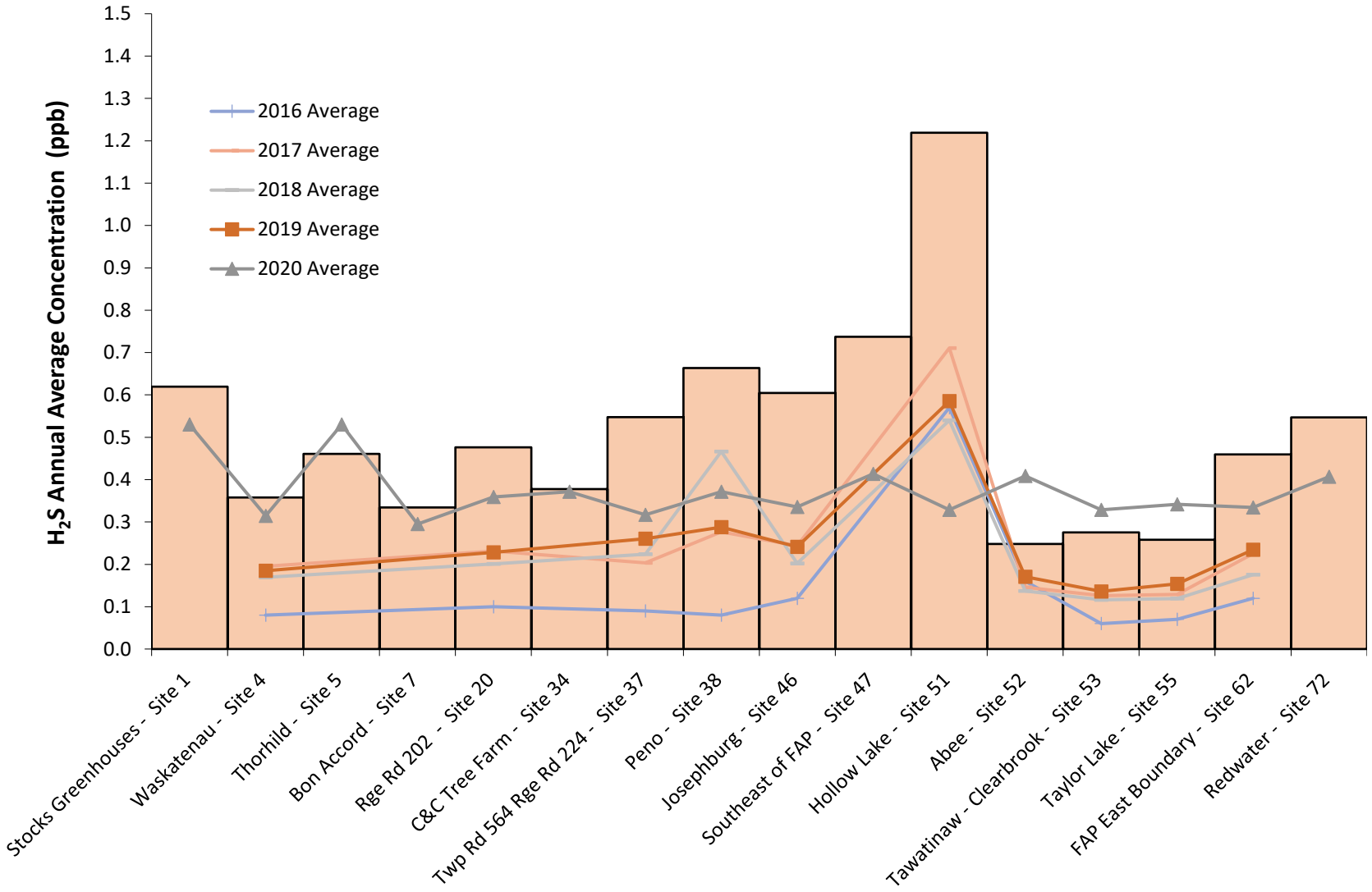
Hydrogen Sulphide

Figure 45: 2021 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 46: Passive monitoring annual averages: H_2S (ppb)



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

Small Sensor Network

In 2021 FAP added PurpleAir sensors to its monitoring program. These sensors were installed in Waskatenau, Bon Accord and Josephburg 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 component in the calculation of the AQHI.

Figure 47 through Figure 49 show one-hour averages of PurpleAir sensors in each community since they were installed in mid-2021. 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. The two episodes of wildfire smoke in mid-July and again in early October are evident at all three sites.

Figure 47: 1-hour $PM_{2.5}$ averages from Bon Accord small sensor

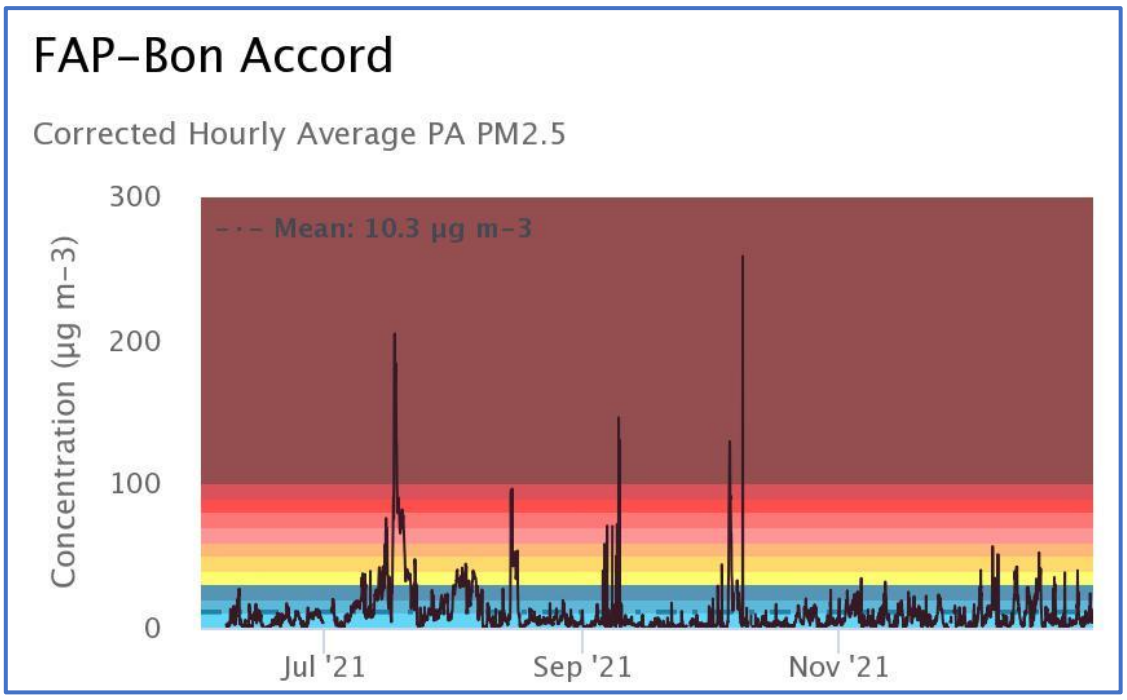


Figure 48: 1-hour $PM_{2.5}$ averages from Josephburg small sensor

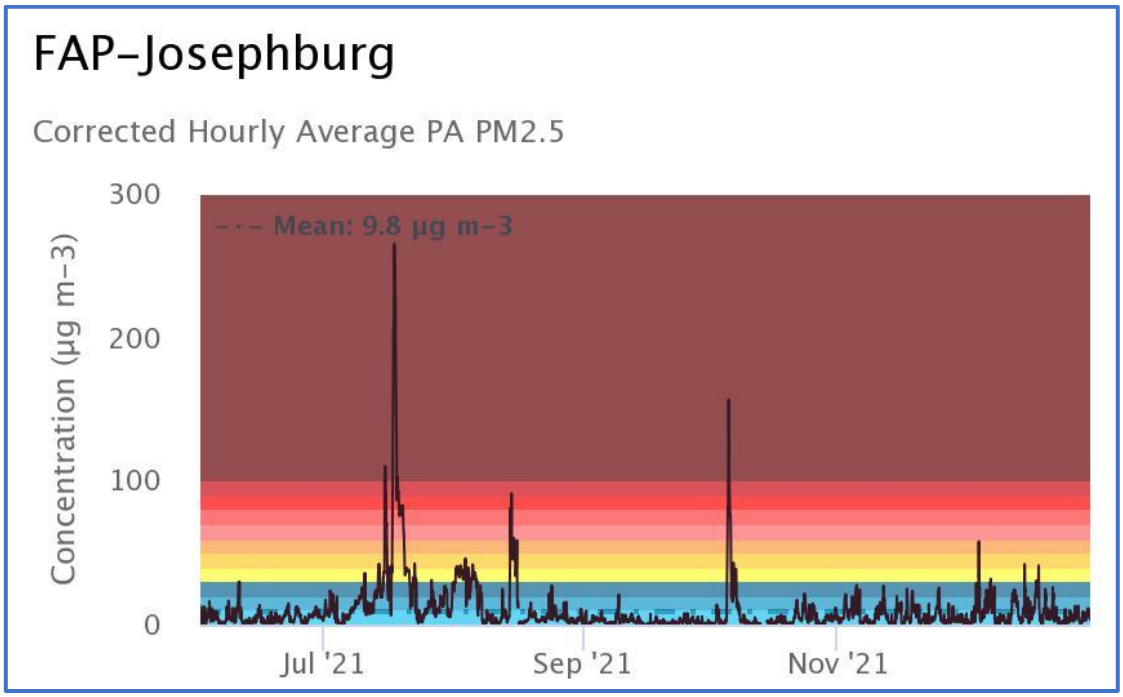
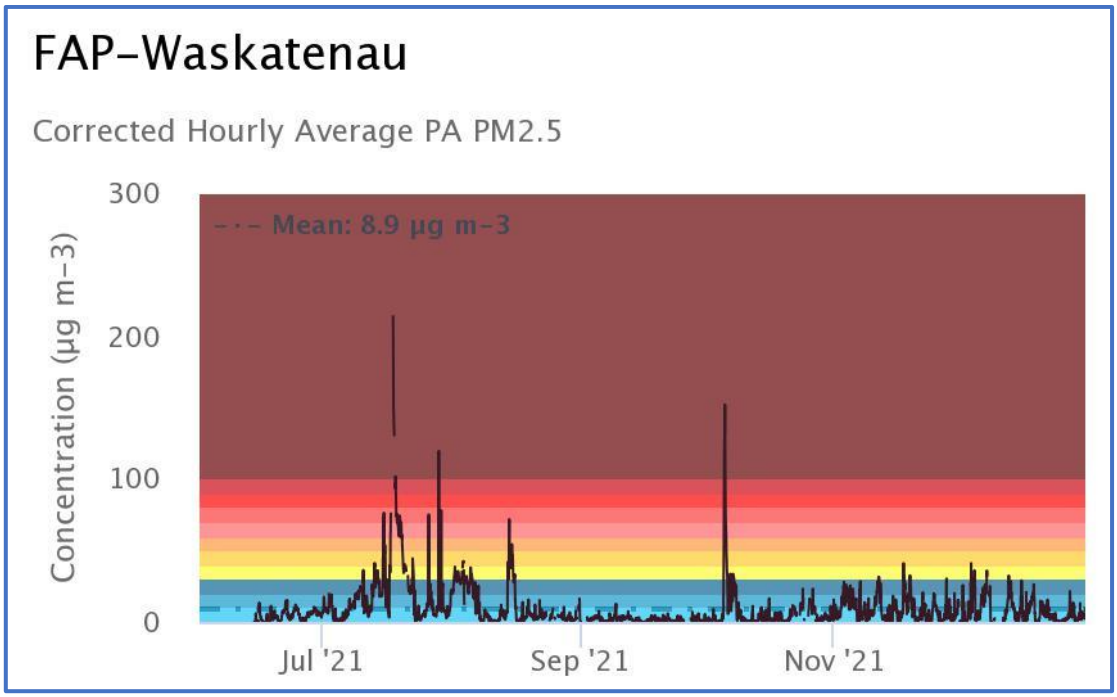


Figure 49: 1-hour averages from $PM_{2.5}$ averages from Waskateneau small sensor



Other Technical Airshed Programs and Activities

Monitoring Plan

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. With the completion of all monitoring projects in the 2015 plan by 2020, the FAP Technical Working Group (TWG) determined a new monitoring plan was warranted to guide the further development of the air monitoring network. This plan is under development as of the date of this report.

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 50 through Figure 52 below. As the distribution in Figure 50 shows, almost all 1-hour averages (about 90%) every year are below 0.1ppm. Figure 51 shows the distribution of measurements above 0.1ppm. While, as shown in Figure 52, only less than 1% of all readings are greater than 0.5ppm.

Figure 50: NMHC Relative Distribution

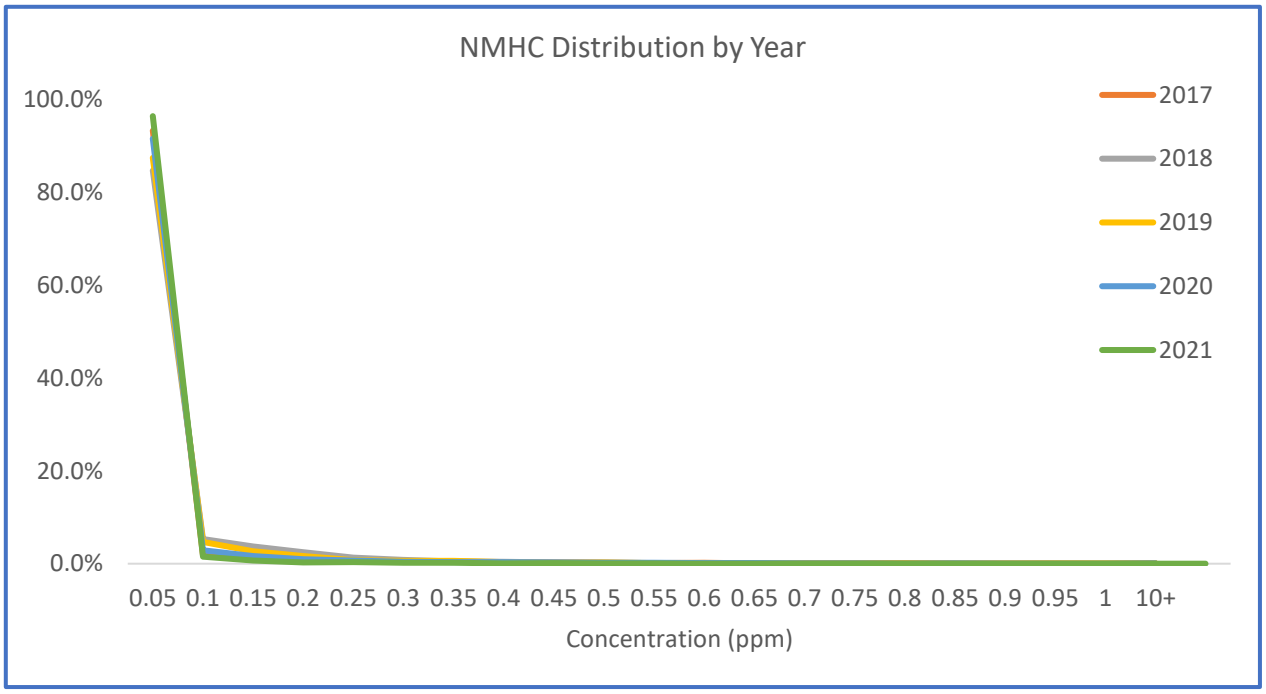


Figure 51: NMHC Relative Distribution above 0.1ppm

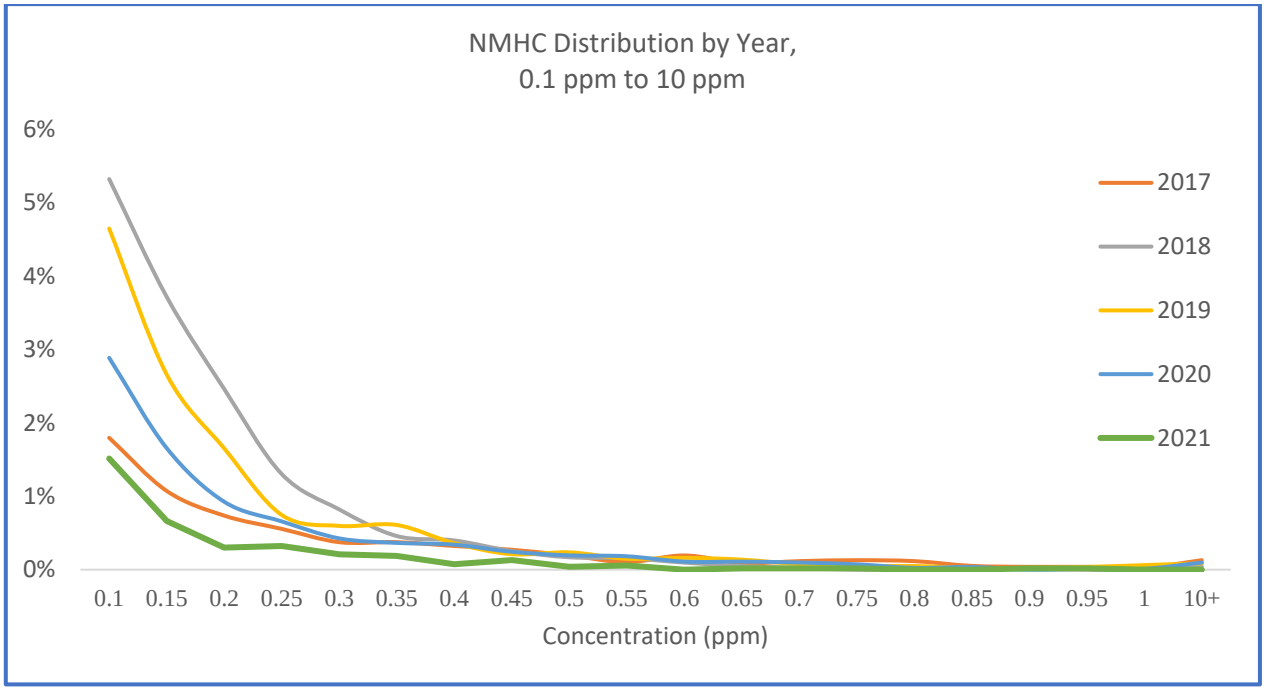
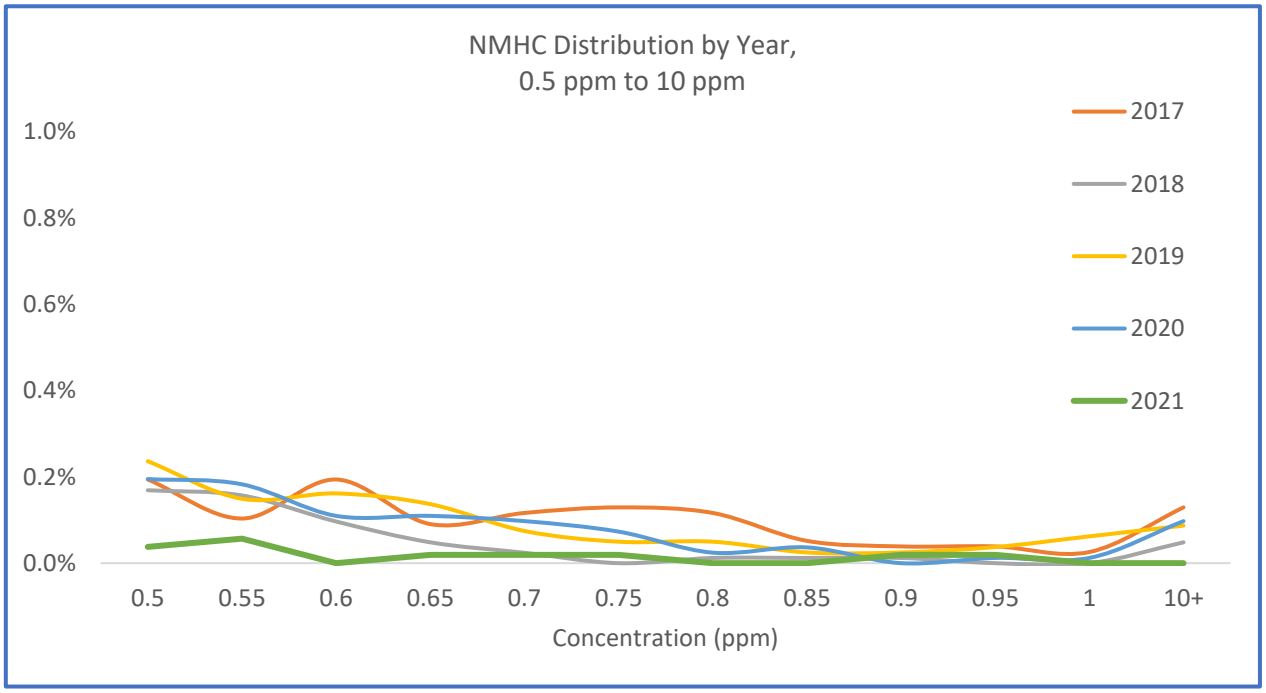


Figure 52: NMHC Relative Distribution above 0.5ppm



Fine Particulates Speciation Project

FAP began a 3-year fine particulate matter speciation project in Fort Saskatchewan in 2018. This speciation work was initiated to partially address a recommendation for a permanent "superstation" (a station that includes monitoring to address all monitoring questions in the network) in the 2012 network assessment.

The sampling portion of this project was completed in April 2021. A scientific report on the results was released in spring of 2022.

Results from this project will add an additional piece of information that can help to inform the Capital Region Particulate Matter Response Plan of which FAP is a participating organization.

Fine Particulate Matter Response Plan

Fort Air Partnership continued to support the Capital Region Oversight Advisory Committee implementation of a Fine Particulate Matter Response Plan throughout 2021. 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 Capital Region
- 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, 2021)

Harry Benders
(Chair)
Network Manager
Fort Air Partnership

Patrick Andersen B.Sc.
Andersen Science Consulting

Farron Bibby
Air Monitoring Technologist
Alberta Environment and Parks

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

Jeff Cooper C. Tech.
AQM Operations Manager
WSP

Scott Hillier
Cenovus

Doug Hurl
EHS Supervisor
Chemtrade Logistics

Stephanie Kozey B.Sc.
EH&S Regulatory Specialist
Dow Chemical Canada ULC

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

Maxwell Mazur M.Sc.
Senior Air Quality Specialist
Alberta Environment and Parks

Christophe Nayet
Air Quality Technician
Environment and Climate Change Canada

Clementina Okoro P.Eng.
Environmental Advisor
Inter Pipeline Ltd.

Moe Ouellet
Environmental Specialist
Pembina Pipeline Corp.

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

Ali Schweitzer B.Sc. G.I.T.
Environmental Advisor
Inter Pipeline Ltd.

Karlee Searle
Environmental Advisor
Nutrien

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

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

Kathryn Dragowska
Chemtrade Logistics

Jeff Hamilton
Pembina Pipeline Corp.

Appendix B: Industry Participants in FAP

Industry Participants in FAP (Dec. 31, 2021)

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.
- North West Redwater Partnership
- Nutrien
- Pembina Pipeline Corp.
- Shell Scotford (Shell Chemicals, Shell Refinery and Shell Upgrader)
- Sherritt International Corp.
- Oerlikon Metco (Canada) Inc.

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
- 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: 2021 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	1.4	1.1	1.0	0.8	1.1	1.1	1.3	0.9	0.9	1.6	1.4	1.2	1.6
4	Waskatenau	0.8	0.6	0.8	0.5	0.6	0.7	0.5	0.3	0.4	0.4	0.5	0.5	0.6	0.8
5	Thorhild	0.3	0.5	0.6	0.5	0.8	1.1	0.7	0.4	0.4	0.6	0.3	0.4	0.6	1.1
7	Bon Accord	1.0	0.8	0.8	0.6	1.0	0.6	0.8	0.5	0.5	0.6	1.0	0.9	0.8	1.0
20	Rge Rd 202	4.1	2.4	1.5	1.6	1.0	1.5	1.5	1.2	1.4	1.4	2.9	2.2	1.9	4.1
34	C&C Tree Farm	0.7	1.2	1.0	0.7	0.8	0.7	1.2	1.0	0.4	0.7	0.8	0.8	0.8	1.2
37	Twp Rd 564 Rge Rd224	0.9	1.0	1.0	0.8	1.5	0.9	0.8	1.0	0.4	1.1	0.7	0.6	0.9	1.5
38	Peno	1.2	0.9	0.8	0.8	0.7	0.9	0.9	0.6	0.7	0.6	0.6	0.7	0.8	1.2
46	Josephburg	1.2	1.7	1.1	1.2	1.0	1.0	0.8	0.9	0.7	0.7	1.4	1.3	1.1	1.7
47	Southeast of FAP	1.2	1.2	0.8	1.0	0.5	0.9	0.9	0.7	0.5	0.5	0.8	0.9	0.8	1.2
51	Hollow Lake	0.7	0.9	0.8	0.5	0.5	1.5	1.8	1.3	0.5	0.3	0.3	0.5	0.9	1.8
52	Abee	0.5	0.6	0.9	0.5	0.5	1.1	0.4	0.3	0.2	0.2	0.5	0.5	0.5	0.5
53	Tawatinaw - Clearbrook	0.6	0.5	0.7	0.4	0.5	0.7	0.4	0.3	0.3	0.4	0.5	0.5	0.5	0.7
55	Taylor Lake	0.4	0.7	0.6	0.4	0.9	0.5	0.7	0.4	0.2	0.4	0.4	0.4	0.5	0.9
62	FAP East Boundary	1.6	1.6	0.7	1.1	0.9	1.3	0.8	0.8	0.7	0.8	1.2	1.7	1.1	1.7
72	Redwater (co-locate)	1.0	1.0	1.5	1.1	0.9	1.2	0.9	1.0	0.7	1.0	1.4	1.2	1.1	1.4
	Average	1.1	1.1	0.9	0.8	0.8	1.0	0.9	0.7	0.6	0.7	0.9	0.9	0.9	
	Max	4.1	2.4	1.5	1.6	1.5	1.5	1.8	1.3	1.4	1.4	2.9	2.2		4.1

Reportable Detection Limit: 0.2 ppb

Table 27: 2021 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	0.4	0.2	0.3	0.4	1.5	1.6	1.0	0.8	0.5	0.3	0.4	0.6	1.6
4	Waskatenau	0.2	0.3	0.2	0.1	0.3	1.0	0.7	0.6	0.3	0.2	0.2	0.3	0.4	1.0
5	Thorhild	0.2	0.3	0.2	0.3	0.4	1.5	1.2	0.5	0.5	0.3	0.2	0.2	0.5	1.5
7	Bon Accord	0.3	0.3	0.2	0.4	0.3	0.7	0.6	0.5	0.3	0.2	0.2	0.3	0.3	0.7
20	Rge Rd 202	0.3	0.4	0.2	0.2	0.2	1.0	0.7	0.9	0.5	0.3	0.2	0.4	0.5	1.0
34	C&C Tree Farm	0.2	0.4	0.2	0.2	0.2	0.6	0.6	0.5	0.5	0.3	0.2	0.4	0.4	0.6
37	Twp Rd 564 Rge Rd224	0.2	0.4	0.2	0.2	0.4	1.4	1.3	1.2	0.7	0.4	0.2	0.3	0.5	1.4
38	Peno	0.4	0.4	0.2	0.2	0.4	1.8	1.6	1.0	1.0	0.6	0.3	0.3	0.7	1.8
46	Josephburg	0.2	0.4	0.2	0.2	0.3	1.6	1.3	0.9	0.6	0.3	0.3	0.3	0.6	1.6
47	Southeast of FAP	0.2	0.3	0.1	0.1	0.4	2.1	1.7	1.0	0.7	0.3	0.2	MS	0.7	2.1
51	Hollow Lake	0.3	0.9	0.2	0.2	0.6	1.8	7.0	3.2	1.5	0.4	0.2	0.4	1.2	7.0
52	Abee	0.2	0.3	0.1	0.1	0.2	0.5	0.5	0.4	0.2	0.2	0.2	0.3	0.2	0.5
53	Tawatinaw - Clearbrook	0.2	0.3	0.2	0.1	0.1	0.5	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.5
55	Taylor Lake	0.2	0.3	0.1	0.1	0.2	0.4	0.6	0.3	0.2	0.2	0.2	0.3	0.3	0.6
62	FAP East Boundary	0.2	0.4	0.1	0.2	0.3	1.4	1.0	0.9	0.6	0.3	0.2	0.3	0.5	1.0
72	Redwater (co-locate)	0.3	0.4	0.2	0.2	0.3	1.4	1.5	0.9	0.6	0.4	0.3	0.5	0.5	1.5
	Average	0.2	0.4	0.2	0.2	0.3	1.2	1.4	0.9	0.6	0.3	0.2	0.3	0.5	
	Max	0.4	0.9	0.2	0.4	0.6	2.1	7.0	3.2	1.5	0.6	0.3	0.5		7.0

MS - missing 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, 2021)

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 averaging time)	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 is greater)	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 N/A	Not available

Table 2828: Continuous monitoring methods, limits, and sampling details (Dec 31, 2021) - 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 detector	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 detector	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, 2021) - 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 averages	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, 2021) - 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	$\alpha = 0.00385 \pm 0.00002\ \Omega/°C$
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, 2021) - 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	Vaisala HMP60	%RH	1-second samples averaged to 1-min & 1-hr	0 – 100%	Not available	capacitive relative humidity sensor	Against traceable standard(s)	Not available	0°to +40°C ±3% (0 to 90% RH) ±5% (90 to 100% RH) -40° to 0°C and +40° to +60°C: ±5% (0 to 90% RH) ±7% (90 to 100% RH)
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

Table 28: Continuous monitoring methods, limits, and sampling details (Dec 31, 2021) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
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 performed.

- Gas analyzers are automatically subjected to a daily zero and single high-point test.
- The data acquisition system automatically flags analyzer operational parameters that are outside normal operating ranges.
- Daily review of the daily 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 AEP, 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 AEP. Calibration factors arising from this calibration may be applied to the data as appropriate.
- Alberta Environment and Parks 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 AEP 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 AEP audit lab prior to use in the network.
  - Annual calibration system verifications at the AEP audit lab against AEP 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 AEP verification, 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 AEP.
  - 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 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 Technical Working Group (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.

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 Government 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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