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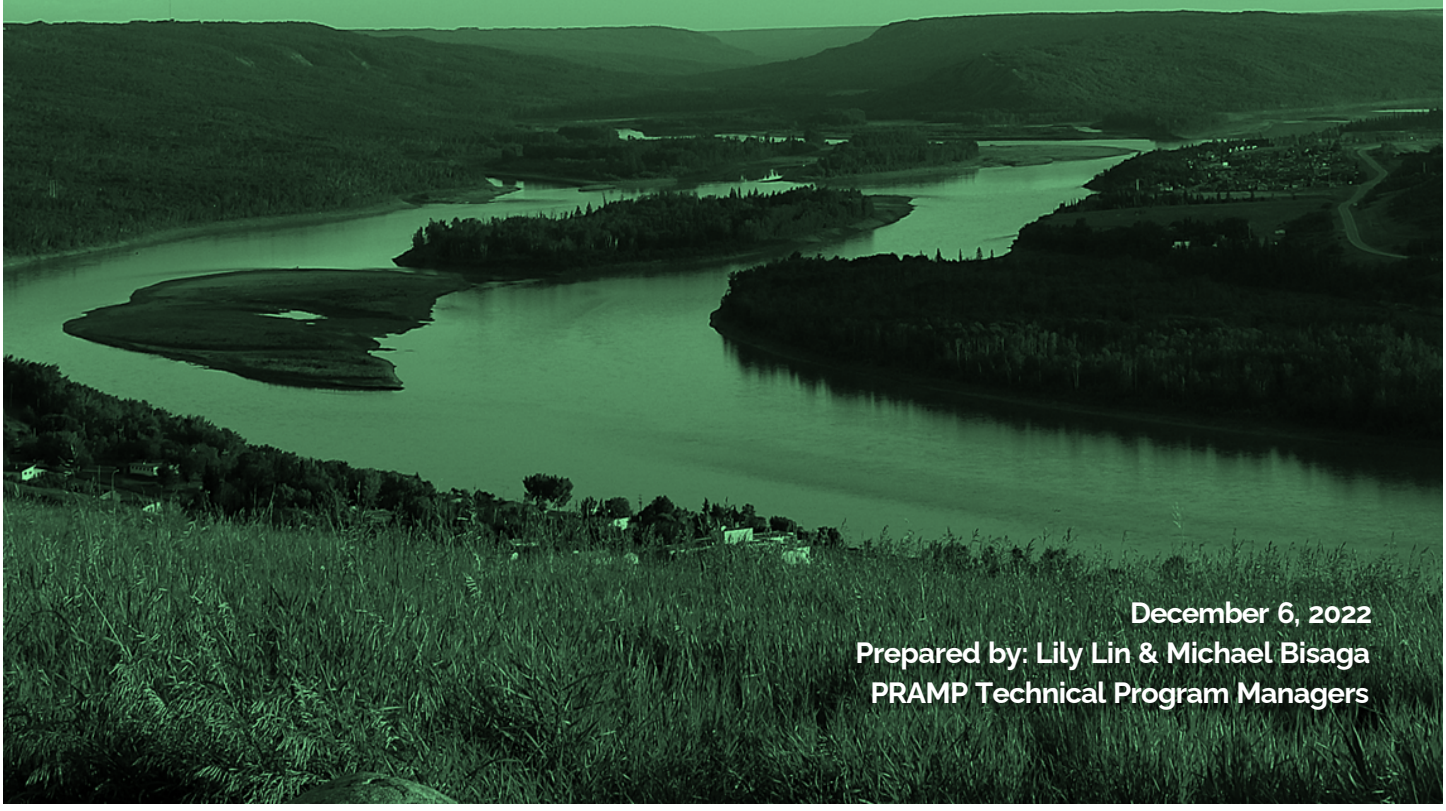
PEACE RIVER AREA MONITORING PROGRAM

2021 Annual Data Review



December 6, 2022

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PRAMP Technical Program Managers

Executive Summary

The Peace River Area Monitoring Program (PRAMP) was created to satisfy air quality monitoring and modelling recommendations released following a proceeding called by the Alberta Energy Regulator (AER) in 2014. On March 31, 2014, the panel released its report titled Report of Recommendations on Odours and Emissions in the Peace River Area. The recommendations in the report included called for regulatory change, regional air monitoring, and ongoing stakeholder engagement in the Peace River Area.

PRAMP collected concentration data of methane (CH_4), non-methane hydrocarbons (NMHC), total reduced sulphurs (TRS), and sulphur dioxide (SO_2) at Station 986-C, 842-B, and Reno continuous monitoring stations in 2021; these parameters plus ozone (O_3), nitrogen dioxide (NO_2) and nitric oxide (NO), and fine particulate matter ($PM_{2.5}$) were also collected at the AQHI Station in the community of Cadotte Lake. This report summarizes and presents the data using different visualizations and summary statistics. Wind speed and direction were also monitored to further understand the potential sources of substances. Triggered volatile organic compound (VOC) sampling events provide additional concentration data for a variety of hydrocarbon species.

Hourly measurements of CH_4, NMHC, and SO_2, concentrations generally show incremental changes in the year-over-year summary statistics. Between 2020 and 2021, CH_4 showed a slight decrease which is in-line with ongoing efforts to reduce fugitive emissions from upstream oil and gas operations while NMHC showed a slight increase due to protracted wildfire smoke episodes in the summer. For the first half of 2021, the AQHI-Cadotte Lake Station recorded frequent elevated NMHC concentrations due to the use of heavy construction equipment on land adjacent to the monitoring station. Like previous years' analyses, it should be noted that hydrocarbon concentrations remain low especially considering the historically elevated concentrations of Station 986 and 842.

All stations showed a pattern of elevated TRS concentrations during the summer months; these elevated concentrations begin to decrease as cooler, fall weather arrives. This observation may be attributed to a few factors including sulphur compounds being released by shallow sloughs and wetlands that contain decaying vegetation or sulphur compounds released by asphalt paving during the summer construction period. At the AQHI-Cadotte Lake station, the occurrence of elevated concentrations of TRS in the late winter and early spring validates odour observations by local residents; these elevated concentrations may be caused when local lakes and waterways thaw and release hydrogen sulphide (a reduced sulphur compound) that has been trapped under ice over the winter months.

In 2021, there were no odour complaints recorded by the AER across the entire network; this is the lowest number of complaints to the AER since PRAMP began compiling these data in 2010. Volatile organic compound (VOC) sampling with canister devices were triggered 9 times in 2021 however concentrations of VOC species were below Alberta Ambient Air Quality Objectives where applicable.

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1. Introduction

1.1. Historical Context

The Peace River Area Monitoring Program (PRAMP) was created to satisfy air quality monitoring and modelling recommendations released following a proceeding called by the Alberta Energy Regulator (AER). The proceeding was called to address odour and emissions generated by heavy oil operations in the Peace River Area of Alberta (AER 2014a). The oral proceeding started on January 21 and ended on January 31, 2014, in Peace River, Alberta. On March 31, 2014, the panel released its report titled Report of Recommendations on Odours and Emissions in the Peace River Area. The recommendations in the report included calls for regulatory change, regional air monitoring, and ongoing stakeholder engagement in the Peace River Area.

1.2. Monitoring Program Overview

PRAMP has a well-established monitoring program that is critical to understanding the state of air quality in the Peace River Area. The monitoring program has been active at Station 986 since 2010, Station 842 since 2012, and the Reno Station since 2014. PRAMP's Air Quality Health Index (AQHI) station was deployed for the first time in 2019 in the community of Cadotte Lake. The AQHI Station determines the AQHI risk level, *hence its name*. The AQHI risk level relates air quality to health on a scale from 1 to 10. The higher the number, the greater the health risk associated with the air quality. The AQHI risk level is calculated based on the relative risks of a combination of common air pollutants that are known to harm human health. These pollutants are: ozone, particulate matter, and nitrogen dioxide. The AQHI station is intended to be a portable monitoring unit; it is similar in construction and layout to other PRAMP continuous air monitoring stations, but it is moved regularly as the need and issues arise, approximately every 18-24 months. The AQHI station was moved to the Town of Grimshaw in late 2021. More information about the AQHI is in Section 3 of this report.

Station 986 and 842 have been relocated 3 and 2 times, respectively, during their deployment in the region. With each relocation event, PRAMP maintained a consistent naming convention by annotating an alphabetic identifier; Station 986 is currently 986-C and Station 842 is currently 842-B. Despite moving the stations, the new monitoring sites are reasonably close to their original locations and are therefore considered to be representative of their earliest deployment locale.

Sulphur dioxide (SO_2), total reduced sulphur (TRS), methane (CH_4), and non-methane hydrocarbons (NMHC) concentrations are monitored continuously at Station 986-C, Station 842-B, Reno Station, and the Air Quality Health Index (AQHI) Station. The AQHI Station also measures particulate matter ($PM_{2.5}$), oxides of nitrogen (NO_2, NO), and ozone (O_3).

PRAMP's monitoring stations are located at:

- Station 842 (or 842-B) at 16-07-084-19 W5M
- Station 986 (or 986-C) at 5-15-085-19 W5M
- Reno Station at 01-28-079-20 W5M
- AQHI Station (Cadotte Lake) at 16-27-86- 16 W5M

The locations of the four monitoring stations are shown on the map in Figure 1. The map also shows nearby industrial activities in the Peace River Area and surrounding regions including compressor stations, oil batteries, gas gathering and processing facilities, terminals, pulp mills, and waste facilities (industrial and domestic). This figure assists in the identification of potential emission sources around each station.

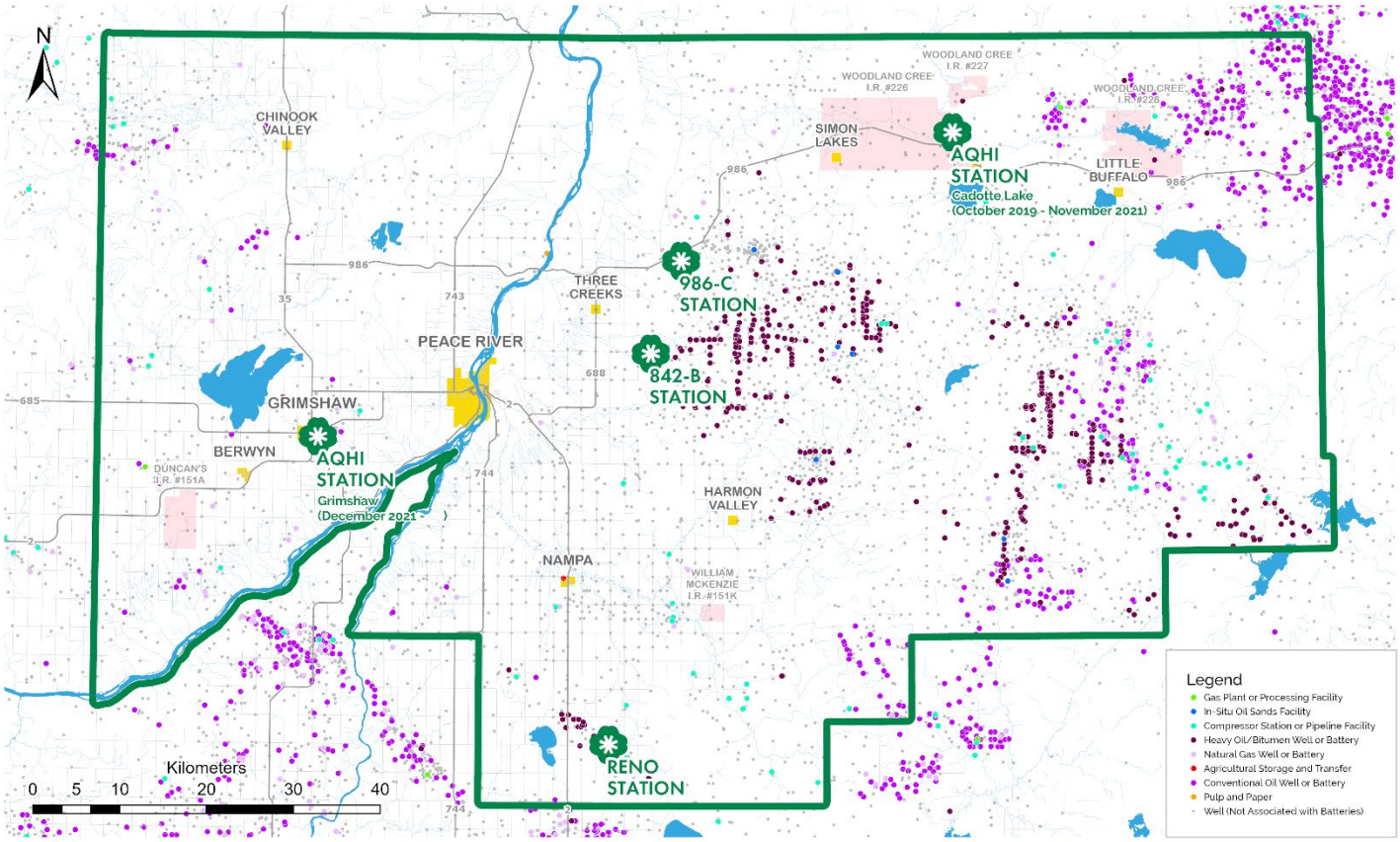

Figure 1: Map of the PRAMP Area

1.3. Air Quality Monitoring Goals

In 2021, PRAMP held strategic planning sessions and as a result, established a new set of goals. The goals that are directly related to delivery of the air quality monitoring program are as follows:

Goal 1: Evidence-driven verification that air quality in the Peace River area is at acceptable levels and that emissions are being minimized.

Goal 2: Residents and stakeholders have timely access to air quality data and information in a manner that is readily understood.

Goal 3: Educators, community groups and citizens can access resources to increase understanding of and promote healthy air quality.

Goal 4: Recognized as an independent not-for-profit organization and Airshed that is focused on continuous improvement and responsible leadership in air quality monitoring.

There are several strategies associated with achieving these goals including:

- Maintain operation of all PRAMP air monitoring stations to achieve the objectives of the OSM contract and in compliance with the Air Monitoring Directive.
- Data reporting meets or exceeds provincial requirements and regulatory compliance commitments
- Data is analyzed to confirm that results do not exceed Alberta Ambient Air Quality Objectives and Guidelines and Canadian Ambient Air Quality Standards where applicable
- Deliver timely, relevant and accessible air quality data so that residents can make informed choices in support of human health and the environment.

To accomplish PRAMP's goals, air quality in the Peace River Area was monitored through continuous and triggered canister samples.

Continuous monitoring stations use substance-specific technology to detect concentrations in a sample stream of ambient air that is taken by the

instrument at a set time interval. Wind speed and direction data are also collected at the continuous monitoring stations. Assessing concentration and wind data together allows investigation into the potential sources of substances affecting the local air quality. Different visualizations of data also assist in understanding the spatial and temporal patterns and distribution of the data.

Discrete, 1-hour canister samples can be automatically collected at Station 986-C, 842-B and Reno when the continuously monitored NMHC concentration data exceeds a set pre-determined value. The current value is 0.3 ppm based on real-time NMHC concentrations averaged over a 5-minute period. After the 1-hour sample is collected, a field technician is notified, and the canister is sent to a laboratory for speciated hydrocarbon analysis.

The provincial government develops the Alberta Ambient Air Quality Objectives and Guidelines (AAAQO/AAAQG; AEP 2019) to protect the environment and human health. AAAQO/Gs are developed through a mulit-stakeholder process lead by Alberta Environment and Protected Areas under Section 14 of Environmental Protection and Enhancement Act. The AAAQOs and AAAQGs are used as threshold values for comparing substance concentrations (at appropriate averaging periods) to assess potential impacts.

2. Monitoring Results

2.1. Interpretation Key

This section provides interpretation guidance for the standalone charts and dashboard-style layouts of data that are presented later in the report.

In 2021, Alberta's Airsheds collectively operated over 80 continuous monitoring stations across the province. Airsheds monitor a variety of pollutants and meteorological parameters. Each Airshed operates a monitoring program that is designed to meet local objectives including long-term trend analysis, air quality health index reporting, and compliance assurance.

Box plots are used to present summary statistics for 2021 continuous monitoring data collected by Alberta's Airsheds. Each monitoring location has a label that includes an acronym for the Airshed that operates the station; Airsheds' acronyms and their geographic location can be found on the map on this page. In some cases, Alberta Environment and Parks (AEP) also operates monitoring stations. Note in 2022, AEP changed its name to Environment and Protected Areas.

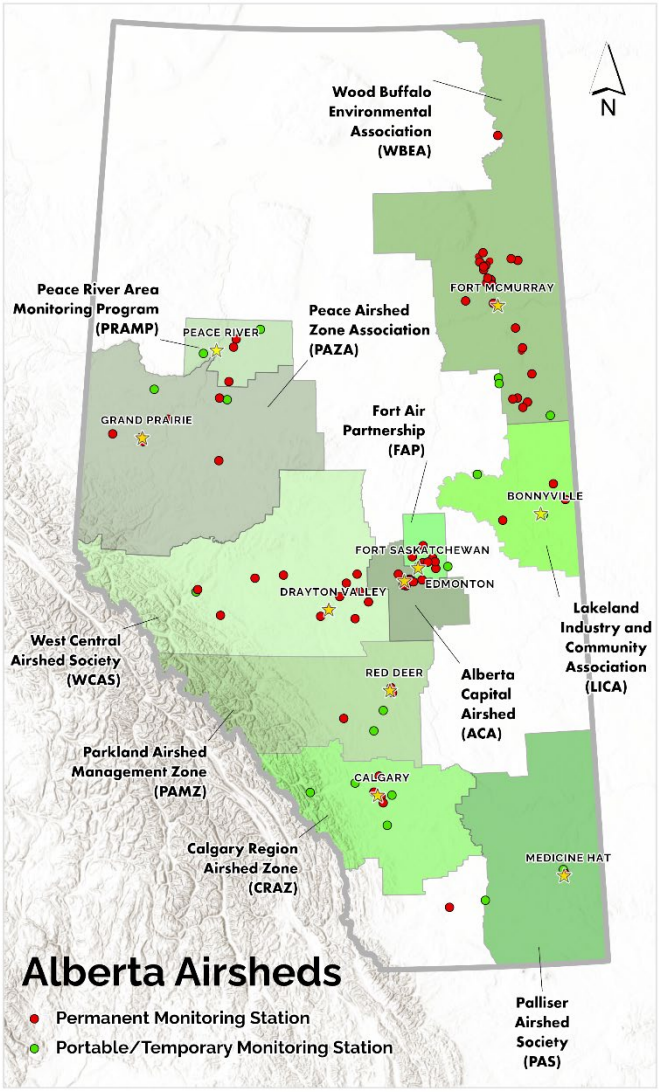

Figure 2: Alberta's Airshed Zones

For each box plot, a series of concentration values are presented. The lower and upper 'whiskers' represent the 5th and 95th percentile respectively, while the lower and upper end of each bar represents 1st quartile (or 25th percentile) and 3rd quartile (or 75th percentile) respectively. The vertical line between the 1st and 3rd quartile in each bar represents the media average

concentration; monitoring locations are sorted by annual median. In statistics, the most common definition of a percentile is a value below which a certain percentage of scores fall. For example, the 25th percentile is the value below which 25% of the scores (in this case, concentrations) in the distribution may be found. Similarly, the median is the middle number in a sorted list of numbers and can be more descriptive of that data set than the average. The median is sometimes used instead of the mean (or average) when there are outliers in the sequence that might skew the average of the values. The box plots presented in this section, provide a useful indication of "data spread" while excluding potential outlier data points collected during extreme events such as forest fires, facility upsets, and unique weather phenomenon (data below 5% and above 95% in this presentation of results are considered outliers).

If available, the relevant threshold (the acceptable provincial or federal levels) for the guideline or standard for the pollutant is presented below each pollutant summary in an information box.

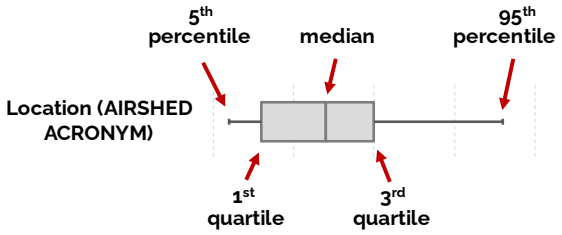

Figure 3: Box plot interpretation key

This section also presents wind roses formatted to present pollutant concentrations; when concentration data are presented this way, the resulting diagram is called a pollution rose. These pollutions roses show the frequency of contaminant concentrations travelling with winds blowing from a particular direction over a specified period. The length of each 'spoke' around the circle is related to the frequency of that concentration of the contaminant occurring. Pollution roses will have the same shape as wind roses; the focus is on which direction the higher concentrations come from.

Each parameter in the following sections has a dashboard-style data summary presentation. Each dashboard contains 20 smaller charts. The rows of charts in the dashboard present different summary statistics or frequency distributions to help elucidate patterns and other observations in the monitoring data; each column of charts in the dashboard represents a monitoring station in the PRAMP network.

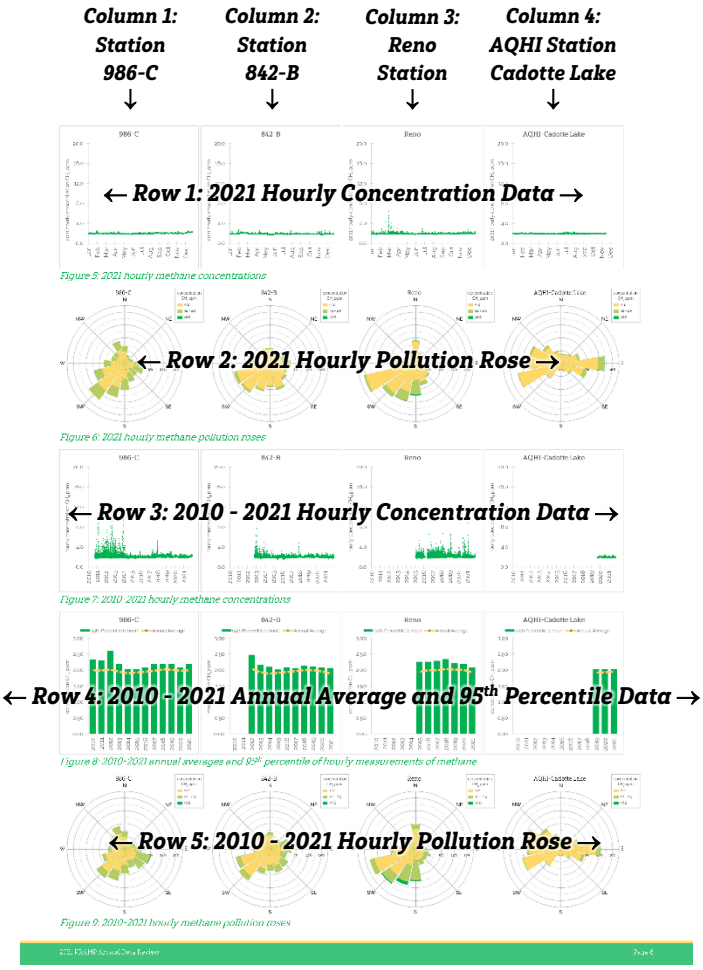

Figure 4: Dashboard Report interpretation key

2.2. Methane

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices, land use, and by the decay of organic waste in municipal solid waste landfills. While there is no AAAQO for methane, background levels are typically around 1.8 ppm.

There is an overall decrease in the frequency of elevated methane events at Stations 986-C and 842-B, and Reno, especially when compared to the early monitoring record at both sites. In 2021, the Reno monitoring station had slightly elevated concentrations of methane relative to the other monitoring station in the PRAMP network; the Reno monitoring station is closer to active well sites and upstream oil and gas sources than the other stations in the PRAMP network and is likely detecting fugitive emissions of methane gas from nearby operations. Both the annual and long-term wind roses indicate that the source of methane detected at the Reno location could be oil and gas operations immediately south of the monitoring station. The 842-B station measured the lowest overall concentrations of methane in the PRAMP network while the Cadotte Lake station had the lowest number of elevated methane events; compared to PRAMP's other stations, the Cadotte Lake monitoring location is much further away from typical methane sources such as upstream oil and gas and agriculture which cause short-term *spikes* of methane.

In 2021, the highest concentrations of hydrocarbons were measured near the industrial complexes east of Edmonton as well as oilsands mining areas north of Fort McMurray. PRAMP's monitoring stations have concentrations that are very close to the natural background for rural Alberta, with all sites being among the lowest in Alberta (see Figure 5).

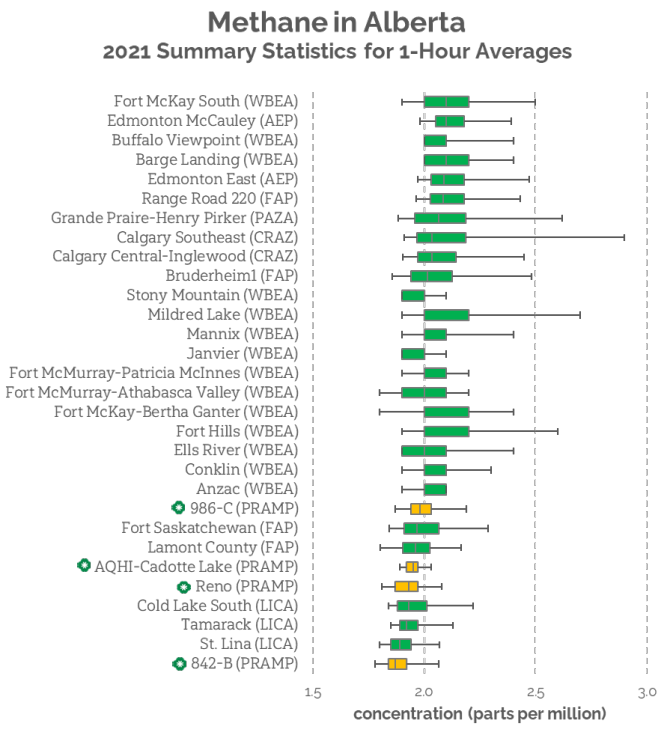

Figure 5: 2021 Methane in Alberta

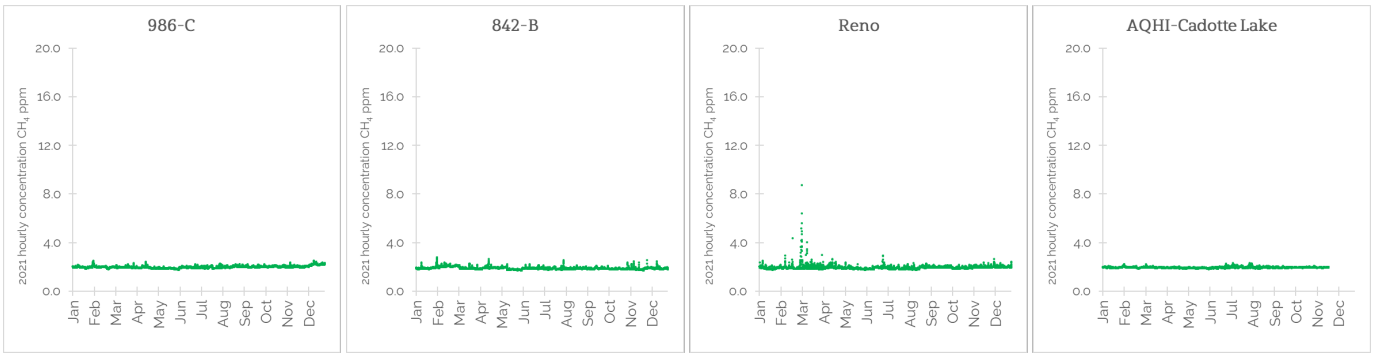

Figure 6: 2021 hourly methane concentrations

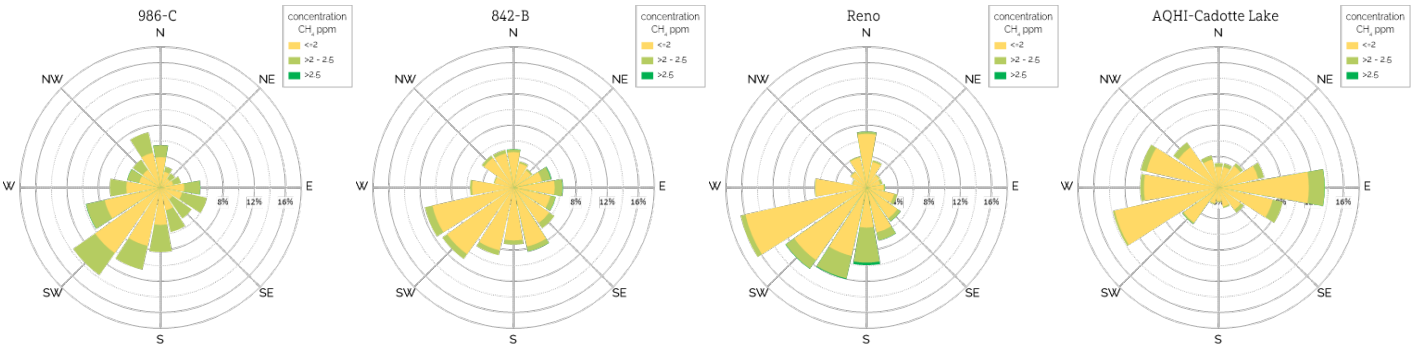

Figure 7: 2021 hourly methane pollution roses

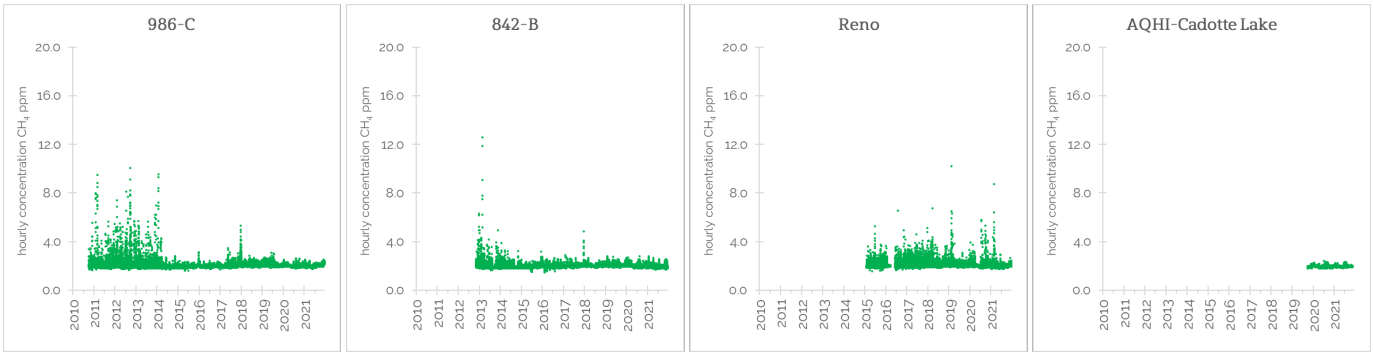

Figure 8: 2010-2021 hourly methane concentrations

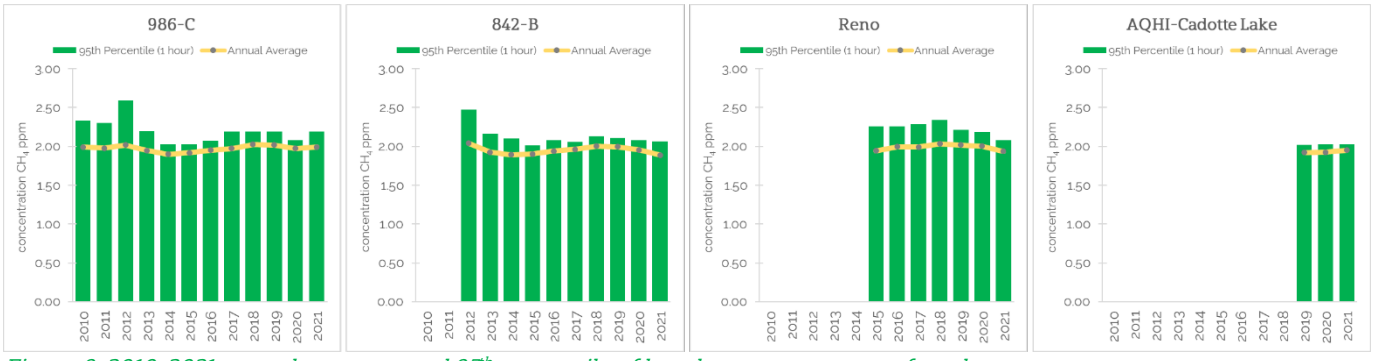

Figure 9: 2010-2021 annual averages and 95th percentile of hourly measurements of methane

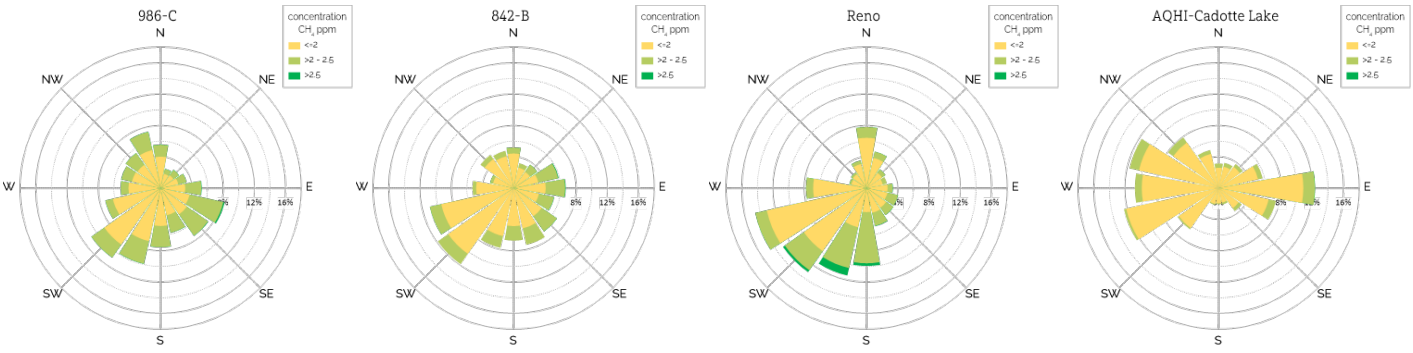

Figure 10: 2010-2021 hourly methane pollution roses

2.3. Non-Methane Hydrocarbons

Non-methane hydrocarbons (NMHCs) are a set of organic compounds that are typically photochemically reactive in the atmosphere; this group of hydrocarbons – as the name implies – is marked by the exclusion of methane. NMHCs are generally formed by a wide range of natural (e.g., vegetation, forest fires) and anthropogenic sources, including traffic, industrial complexes, and manufacturing.

In the PRAMP network, there were two distinct network wide elevated NMHC events in 2021 associated with forest fire smoke episodes; these events occurred in late June and late July. For the first half of 2021, the Cadotte Lake Station also recorded frequent elevated NMHC concentrations due to the use of heavy construction equipment on land adjacent to the monitoring station. Generally, Stations 986-C, 842-B, and Reno saw a decrease in the magnitude and frequency of elevated NMHC since monitoring began in the PRAMP area.

Since non-methane hydrocarbons are not detected very often, most concentrations throughout the year are found to be zero (0) parts per million at nearly all monitoring locations across Alberta. The summary statistics figure for NMHC in Alberta therefore only shows a 95th percentile indicator while all other metrics are zero ppm when Provincial monitoring data are plotted and presented in this way (See Figure 11).

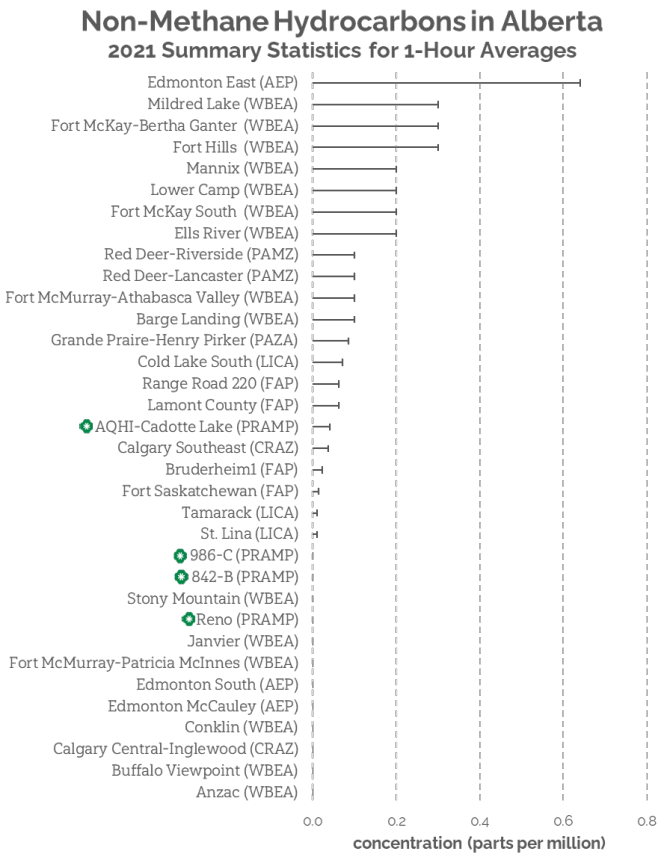

Figure 11: 2021 Non-Methane Hydrocarbons in Alberta

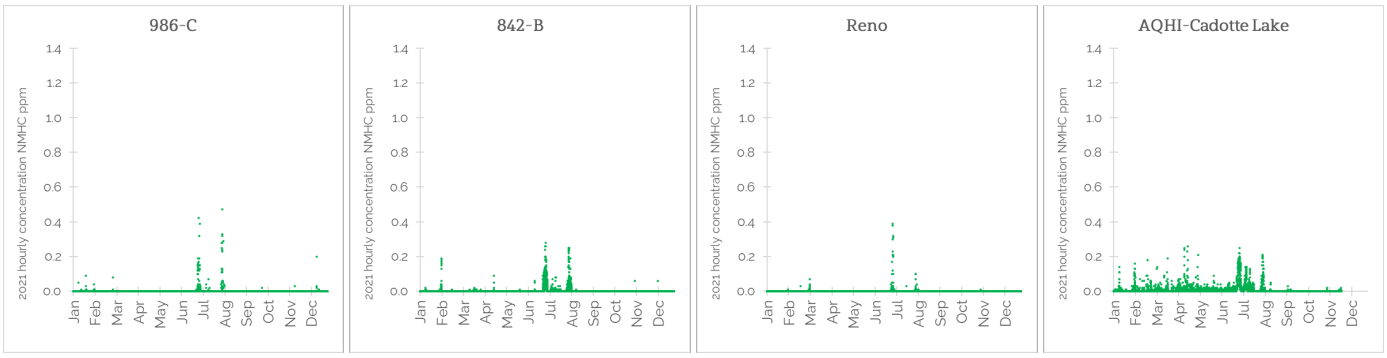

Figure 12: 2021 hourly non-methane hydrocarbons concentrations

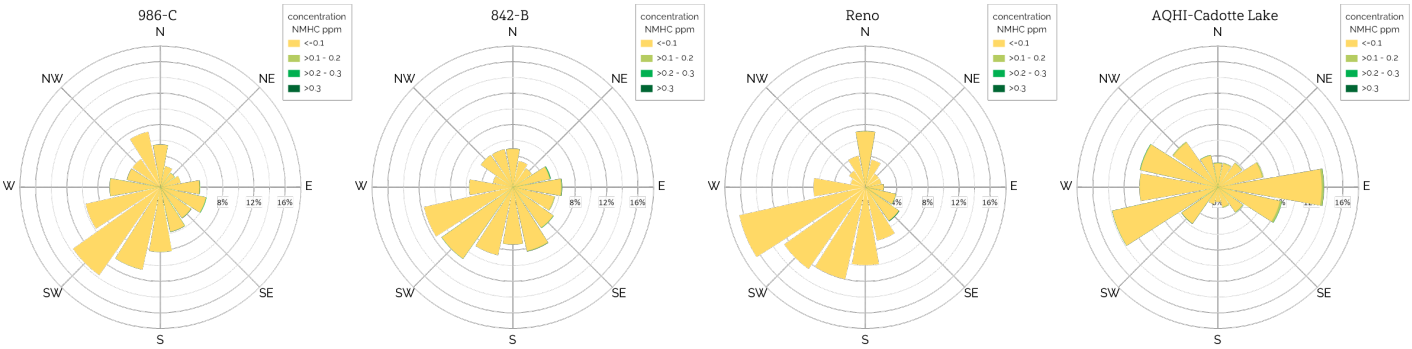

Figure 13: 2021 hourly non-methane hydrocarbons concentration wind roses

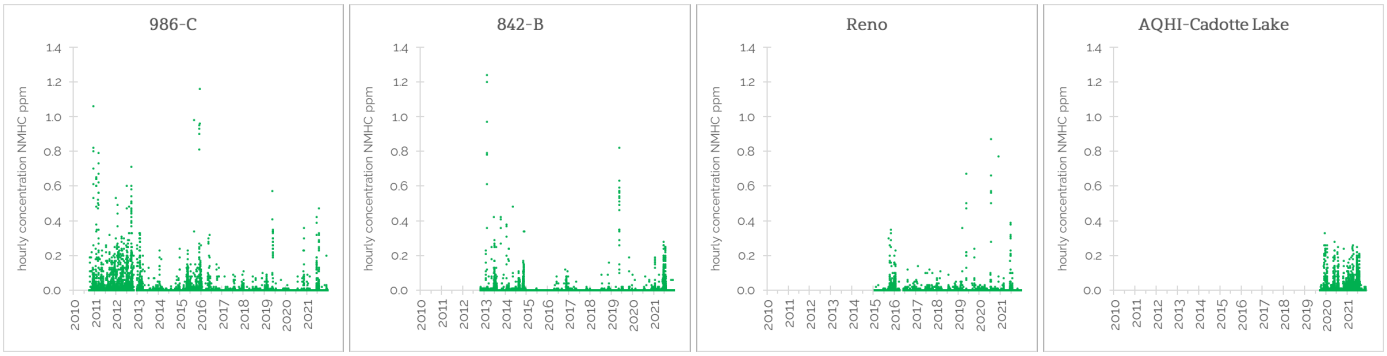

Figure 14: 2010-2021 hourly non-methane hydrocarbons concentrations

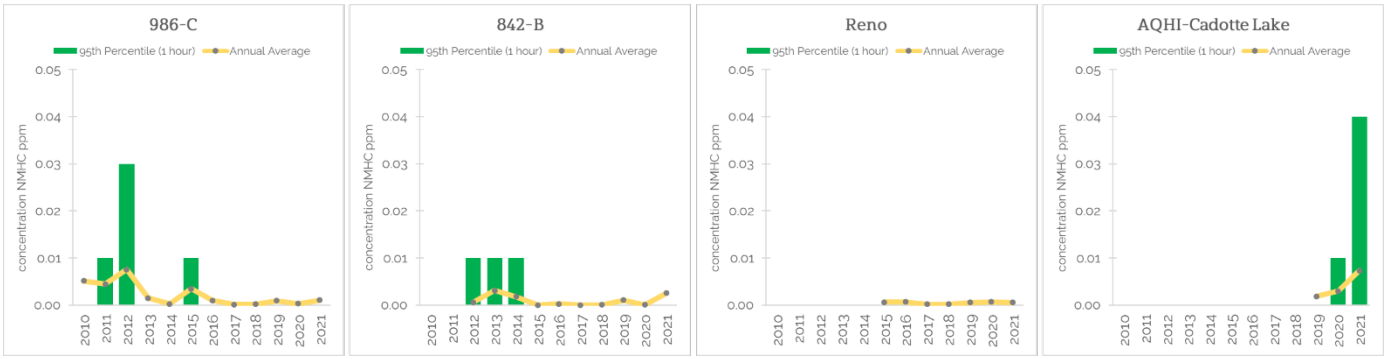

Figure 15: 2010-2021 annual averages and 95th percentile of hourly measurements of non-methane hydrocarbons

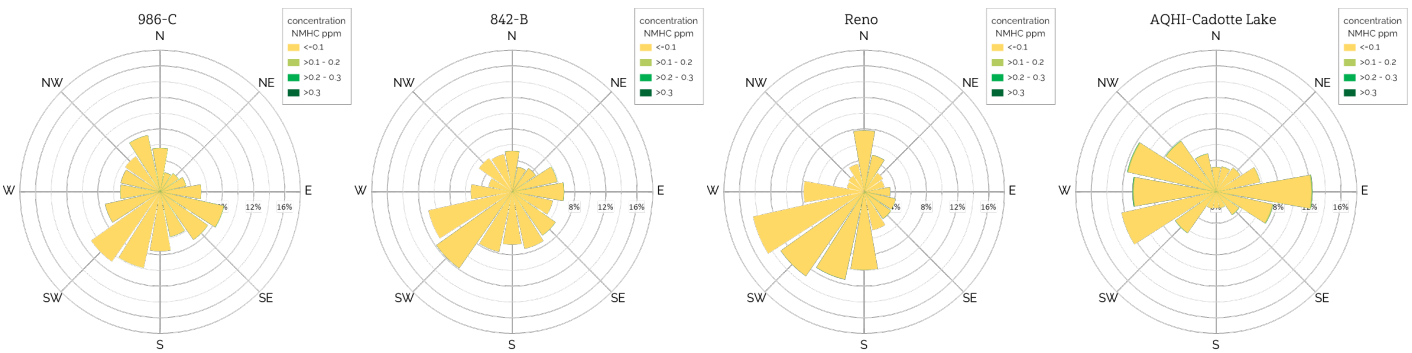

Figure 16: 2010-2021 hourly non-methane hydrocarbons concentration wind roses

2.4. Sulphur Dioxide

Sulphur dioxide (SO_2) results from the combustion of sulphur compounds in fuel and flared/incinerated gas. In Alberta, oil and gas operations and their associated sulphur dioxide emissions range from relatively small (small, distributed well sites) to very large (oilsands operations or sour gas processing); many operations can be, and typically are, located close together resulting in higher localized concentrations of sulphur dioxide. This pattern of elevated concentrations near major sources or clusters of facilities is evident it the monitoring data. In 2021, the highest annual concentrations of sulphur dioxide were measured north of Fort McMurray near oilsands mines, east of Edmonton near refineries, and near Fort Saskatchewan's petrochemical operations.

AAAQO's for sulphur dioxide 172 ppb (1 hour), and 8.0 parts per billion (annual); all of PRAMP's monitoring stations are well below these concentrations and there are no discernable trends in the monitoring data.

In 2021, all of PRAMP's monitoring stations had annual average concentrations in the lower 50% of all stations that monitor sulphur dioxide in Alberta.

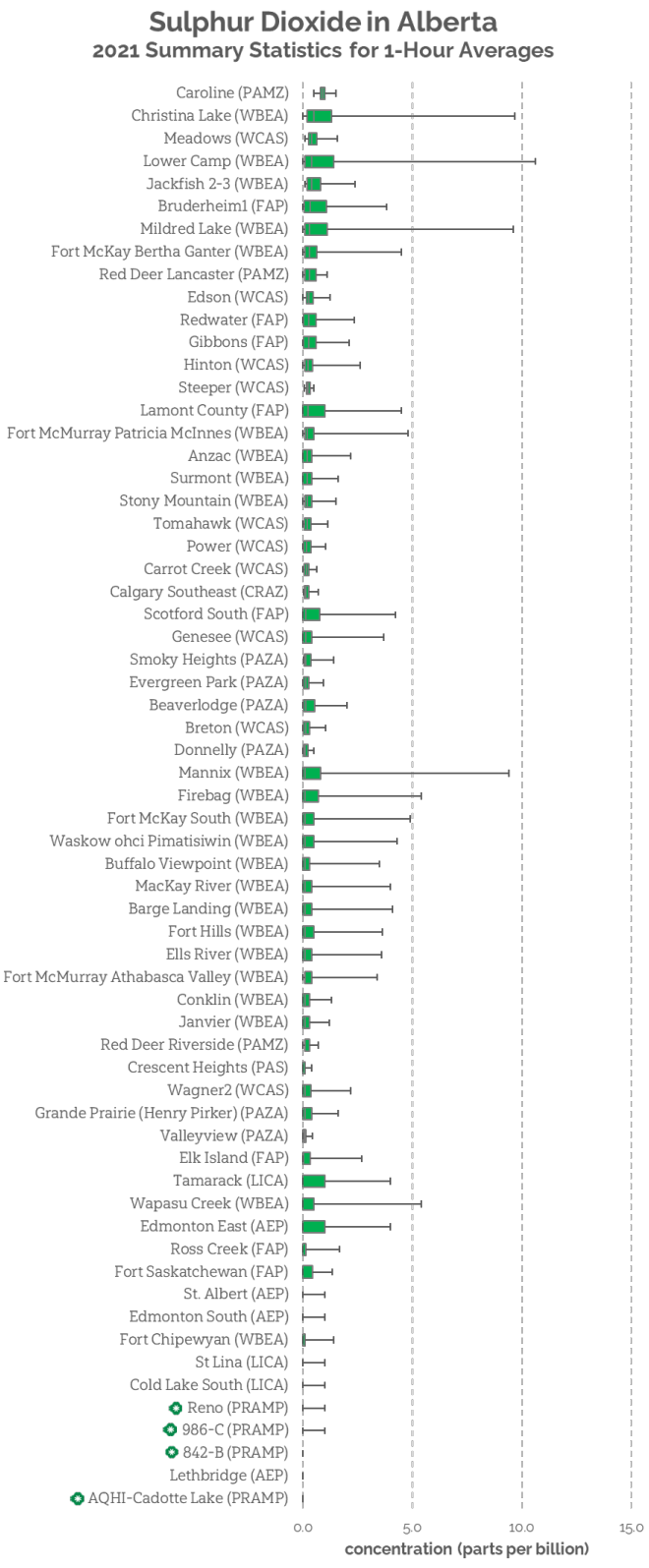

Figure 17: 2021 Sulphur Dioxide in Alberta

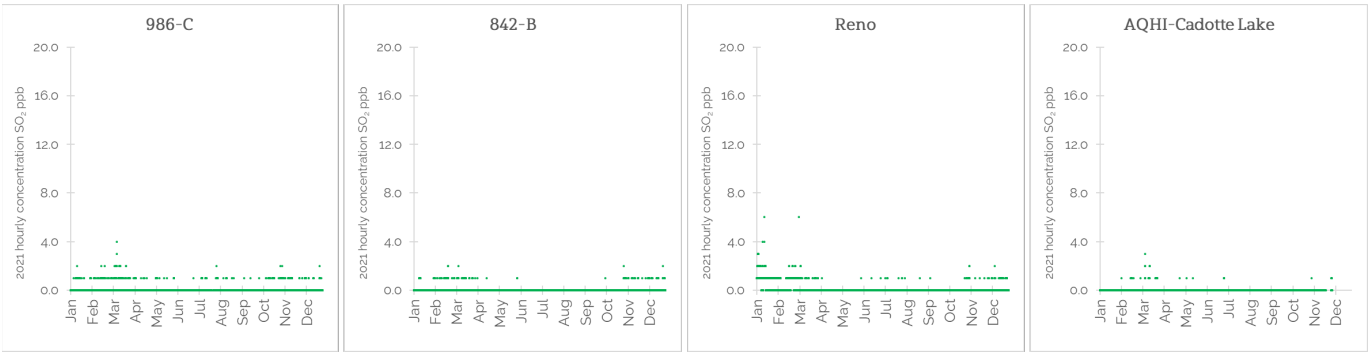

Figure 18: 2021 hourly sulphur dioxide concentrations

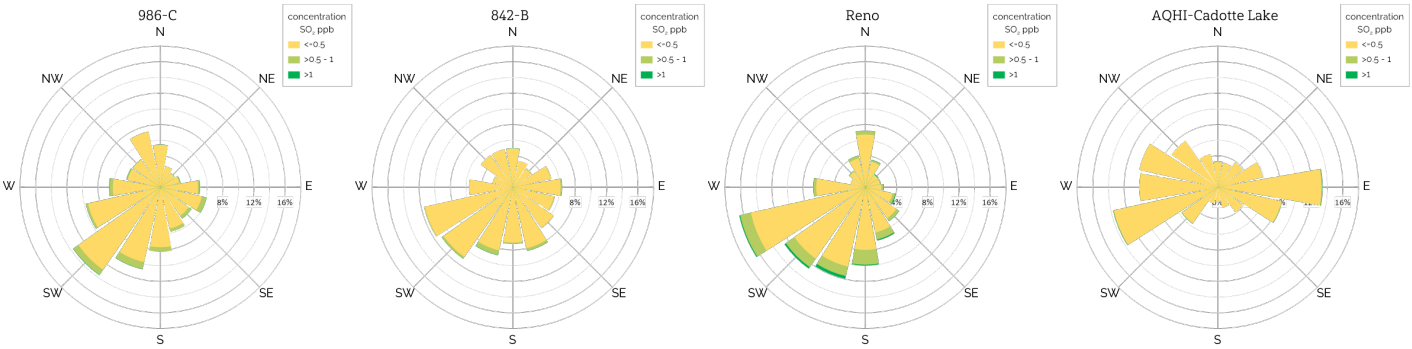

Figure 19: 2021 hourly sulphur dioxide concentration wind roses

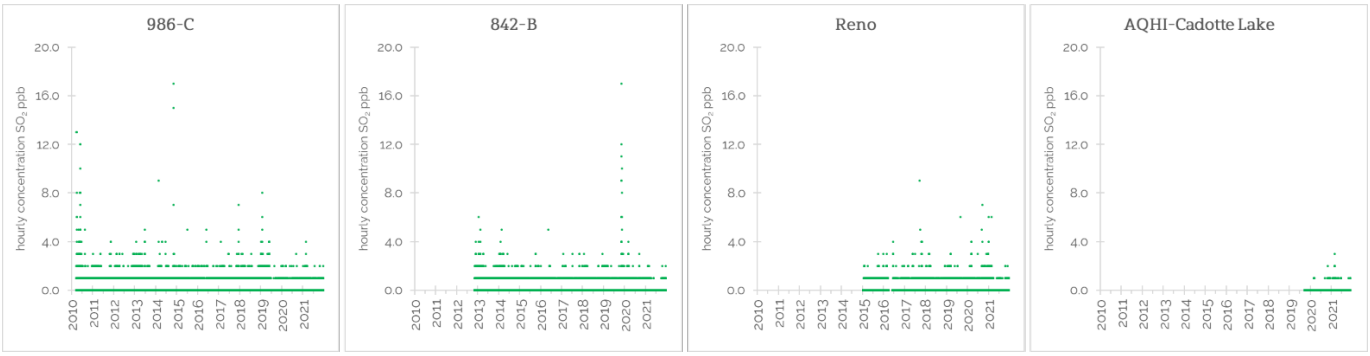

Figure 20: 2010-2021 hourly sulphur dioxide concentrations

Figure 21: 2010-2021 annual averages and 95th percentile of hourly measurements of sulphur dioxide

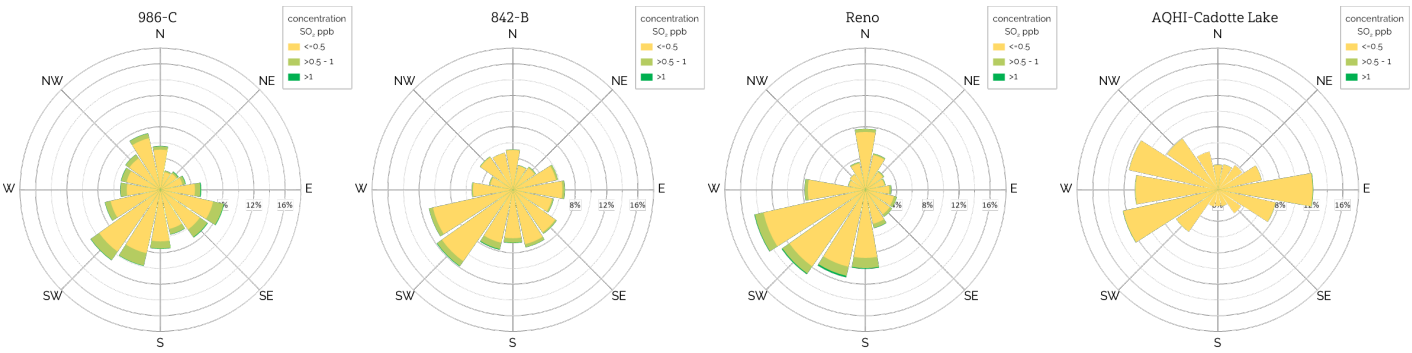

Figure 22: 2010-2021 hourly sulphur dioxide concentration wind roses

2.5. Total Reduced Sulphur Compounds

Total reduced sulphur (TRS) compounds is a gaseous mixture of pollutants that contain sulphur (S) in its reduced state. There is no AAAQO for TRS but the AAAQO for hydrogen sulphide and carbon disulphide are both 10 ppb; both of these substances are members of the total reduced sulphur group of compounds.

From 2020 to 2021, there is a slight decrease in the overall hourly and annual TRS concentrations at all stations. Elevated measurements of TRS may be caused by local industrial sources but other sources may include agriculture and natural features such as shallow lakes and sloughs. All stations show a pattern of elevated concentrations during the summer months which begin to decrease as cooler, fall weather arrives. This observation may be attributed to a few factors including sulphur compounds being released by shallow sloughs and wetlands that contain decaying vegetation and/or sulphur compounds released by asphalt paving during the summer construction period. At the AQHI-Cadotte Lake station, the occurrence of elevated concentrations of TRS in the late winter and early spring validates odour observations by local residents; these elevated concentrations may be caused when local lakes and waterways thaw and release hydrogen sulphide (a reduced sulphur compound) that has been trapped under ice over the winter months.

In Alberta, monitoring locations that had elevated TRS concentrations were Hinton due to pulp mill operations, Caroline due to sour gas facilities, and the oil sands mining area north of Fort McMurray.

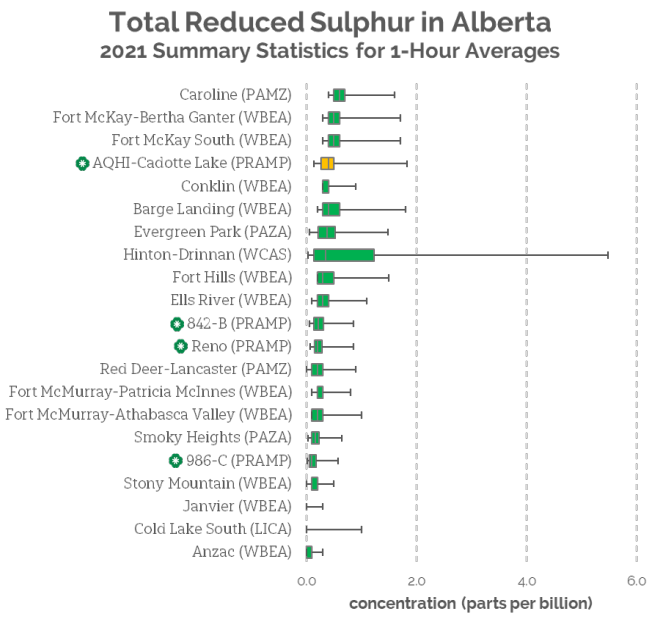

Figure 23: 2021 Total Reduced Sulphur in Alberta

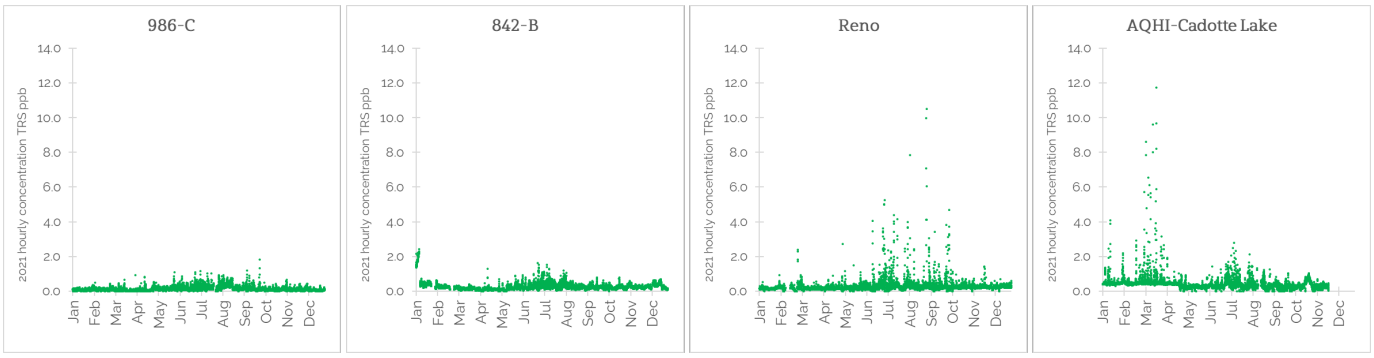

Figure 24: 2021 hourly total reduced sulphurs concentrations

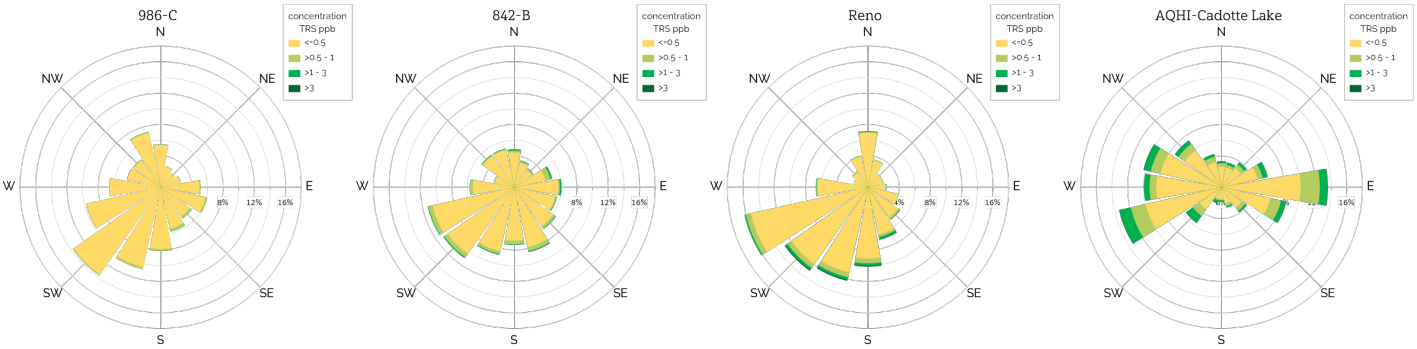

Figure 25: 2021 hourly total reduced sulphurs concentration wind roses

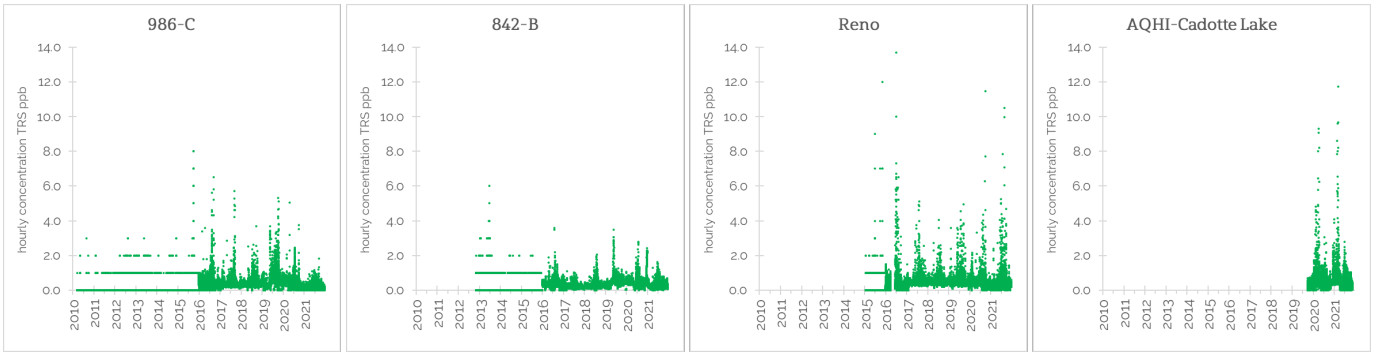

Figure 26: 2010-2021 hourly total reduced sulphurs concentrations

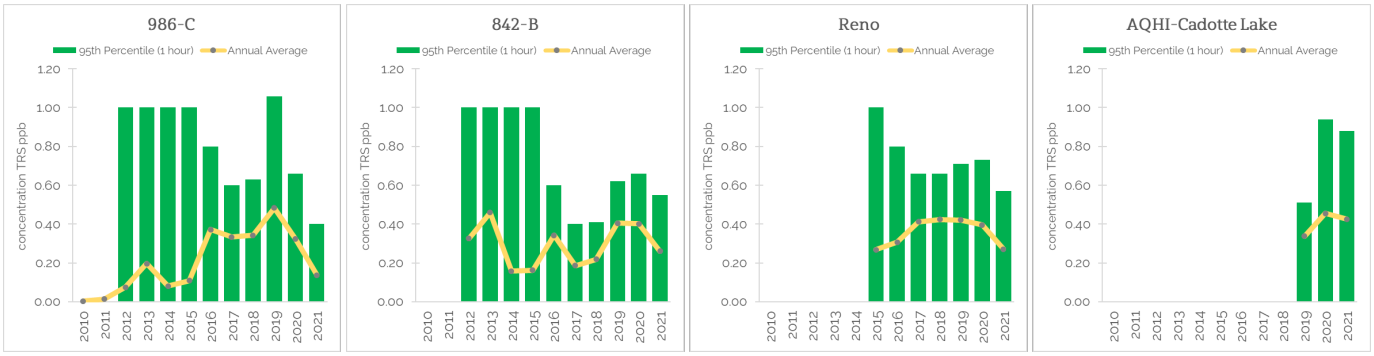

Figure 27: 2010-2021 annual averages and 95th percentile of hourly measurements of total reduced sulphurs

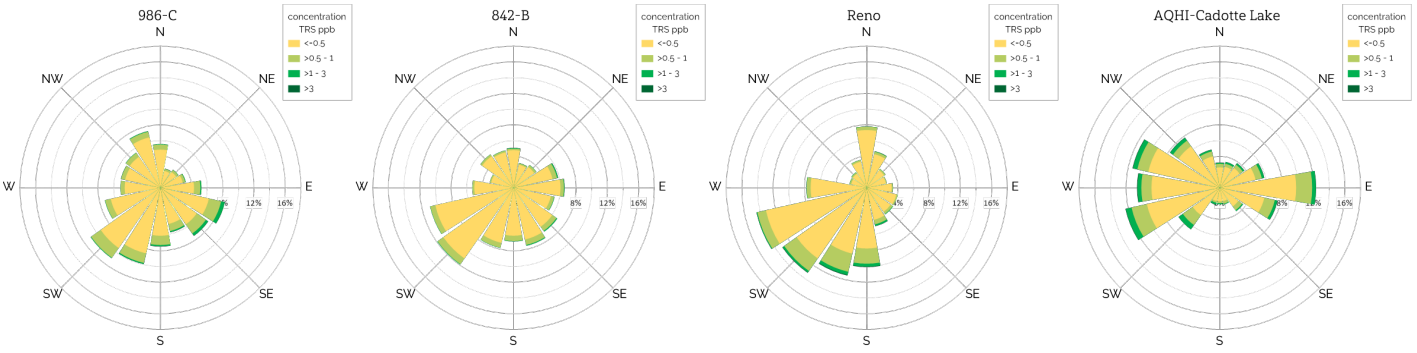

Figure 28: 2010-2021 hourly total reduced sulphurs concentration wind roses

2.6. Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish-brown gas with a pungent, acrid odour and one of the several oxides of nitrogen. Nitrogen dioxide is a oxide of nitrogen which is a family of pollutants produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures. Nitrogen dioxide is produced from fuel combustion in mobile and stationary sources. The combustion of gasoline in automobiles emits nitrogen dioxide into the atmosphere (mobile source). Stationary emissions sources include power plants, refineries, and pulp mills. The 1-hour nitrogen dioxide AAAQO is 159 ppb and annual AAAQO for dioxide is 24 ppb.

In 2021, PRAMP monitored nitrogen dioxide at the Cadotte Lake station. PRAMP's monitoring data show that NO_2 has a distinct season pattern with higher concentrations occurring in the winter due to greater use of gas appliances for heating, vehicle idling; pollutants from these sources tend to accumulate at ground level in the winter due to cold, stagnant metrological conditions.

The highest annual average concentrations in Alberta occur almost exclusively in Alberta's large cities including Edmonton, Calgary, St. Albert, Red Deer, and Grande Prairie. Elevated concentrations are also generally measured at smaller urban centers and monitoring stations in the vicinity of large industrial operations.

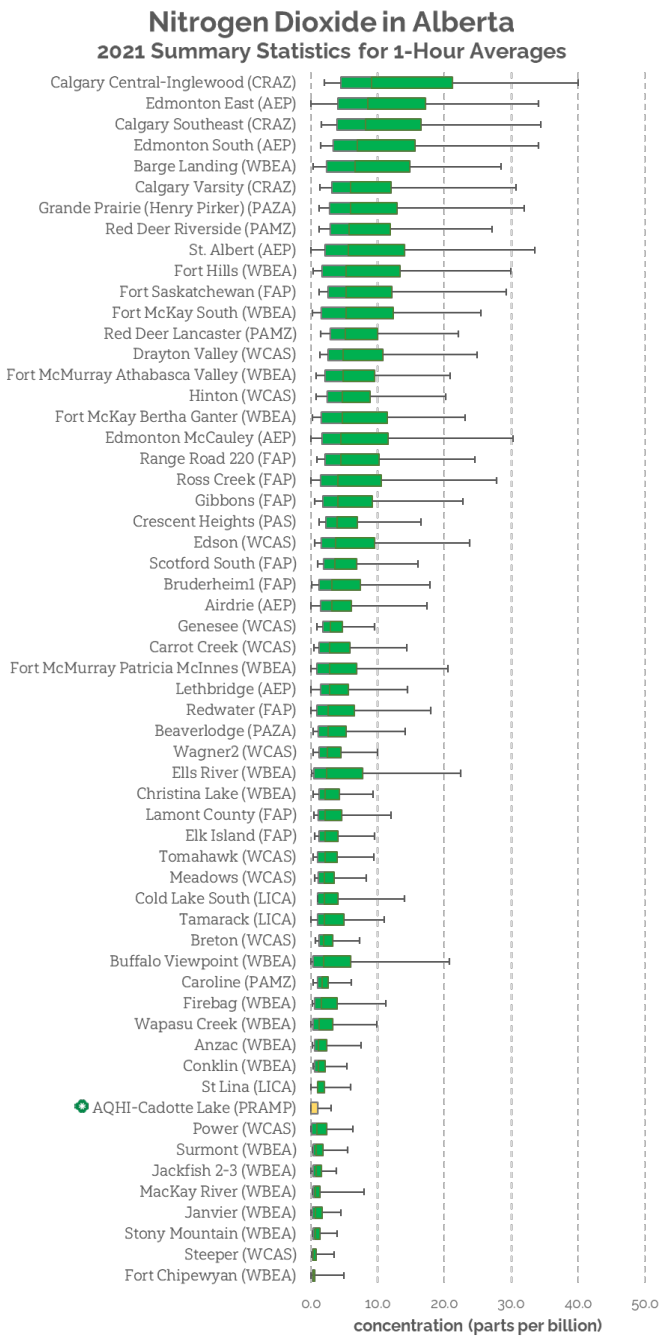

Figure 29: Nitrogen dioxide in Alberta

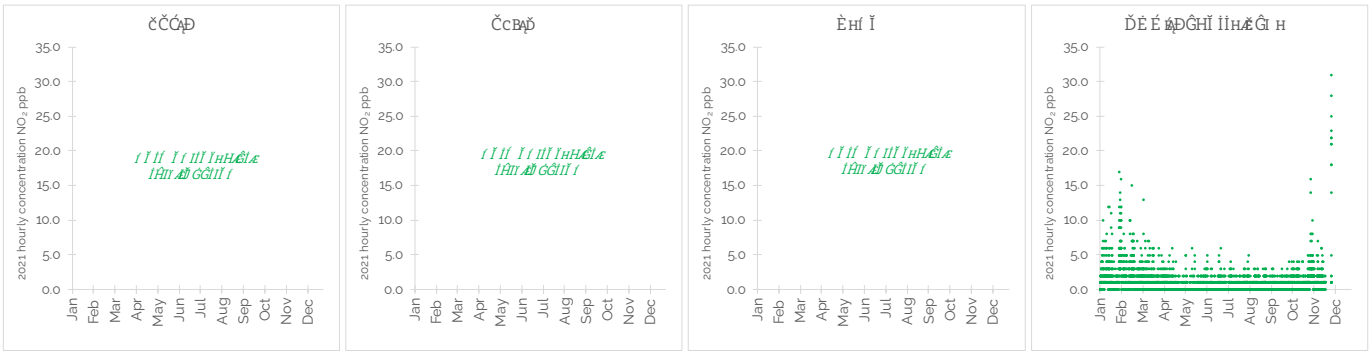

Figure 30: 2021 hourly nitrogen dioxide concentrations

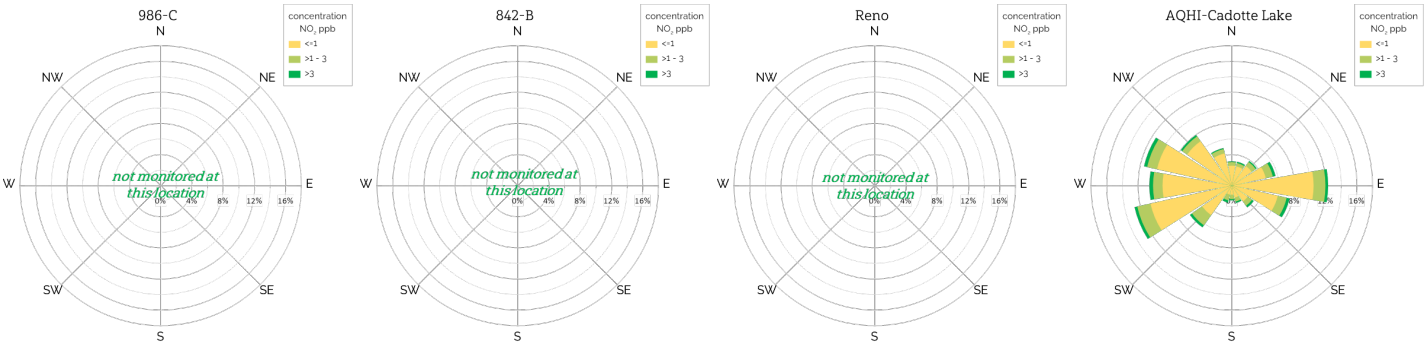

Figure 31: 2021 hourly nitrogen dioxide concentration wind roses

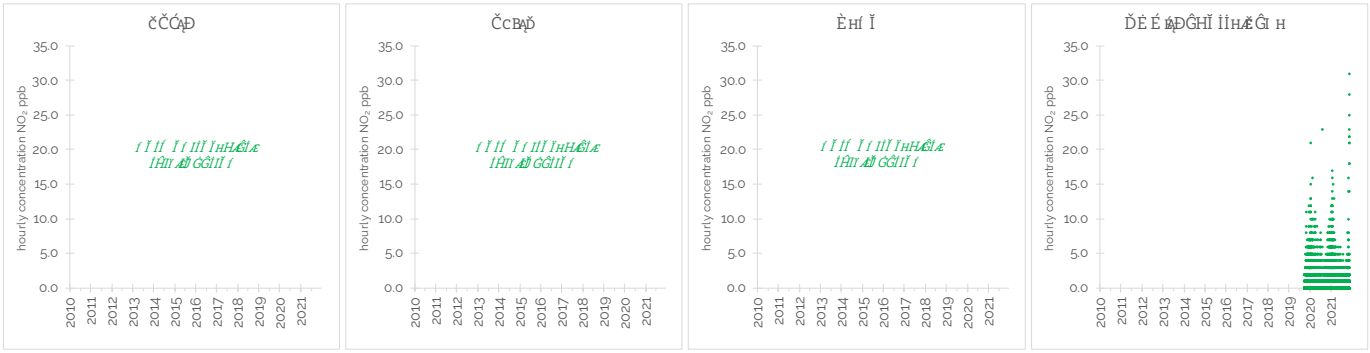

Figure 32: 2010-2021 hourly nitrogen dioxide concentrations

Figure 33: 2010-2021 annual averages and 95th percentile of hourly measurements of nitrogen dioxide

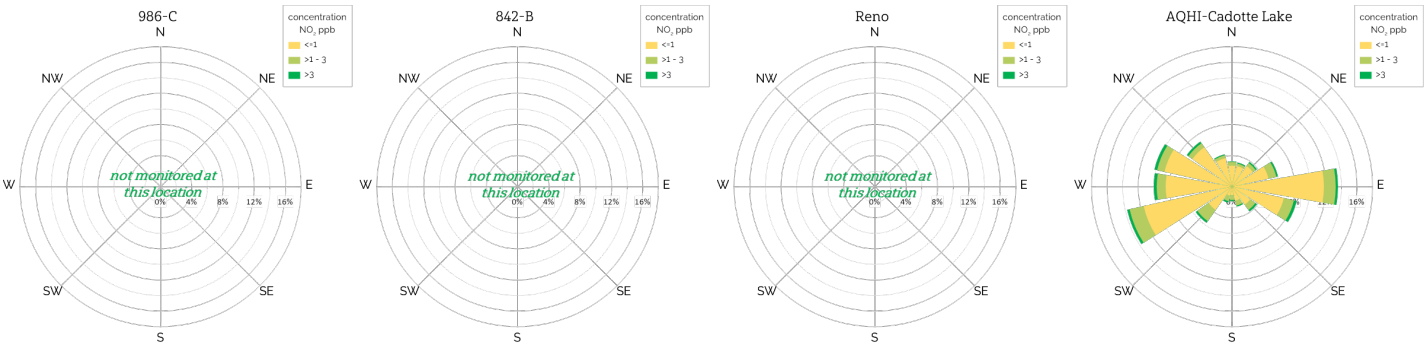

Figure 34: 2010-2021 hourly nitrogen dioxide concentration wind roses

2.7. Nitric Oxide

Like nitrogen dioxide, nitric oxide is also a oxide of nitrogen. It is a colorless gas with the formula NO. The observations in PRAMP's monitoring data for nitric oxide are effectively the same as those for nitrogen dioxide, both in terms of annual and across-Alberta comparisons. There are no AAAQOs for nitric oxide.

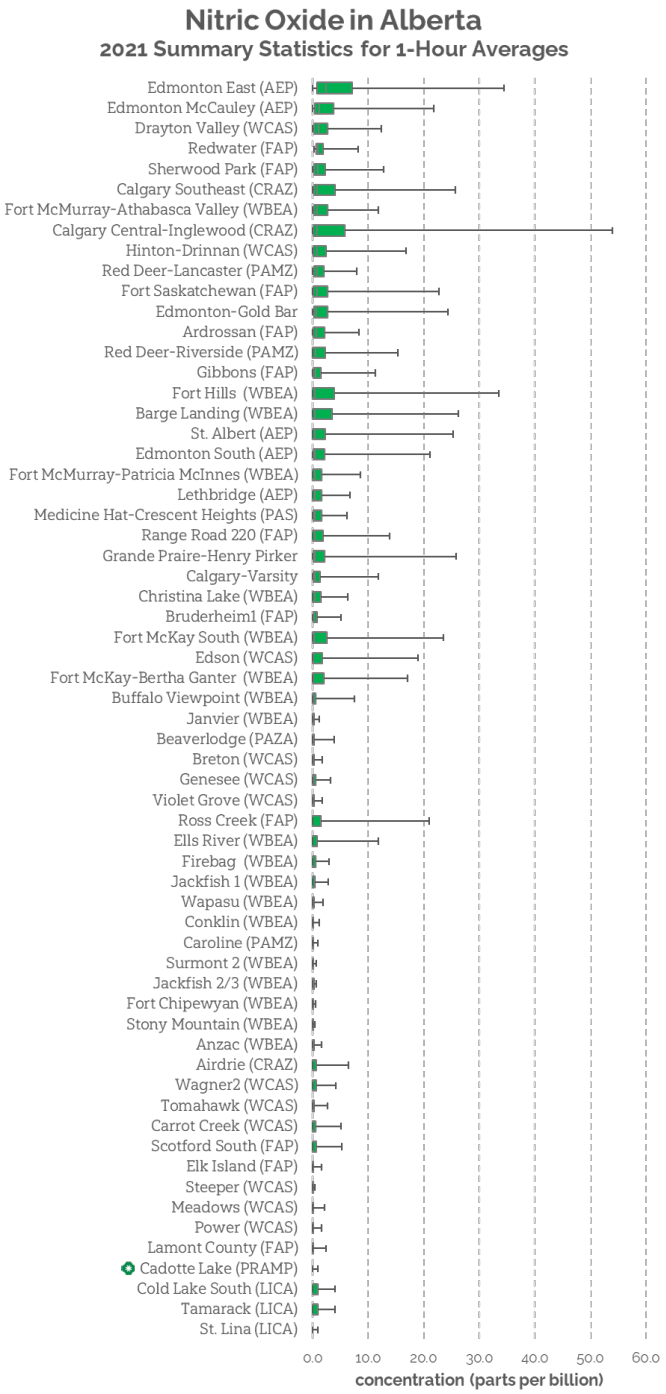

Figure 35: Nitric oxide in Alberta

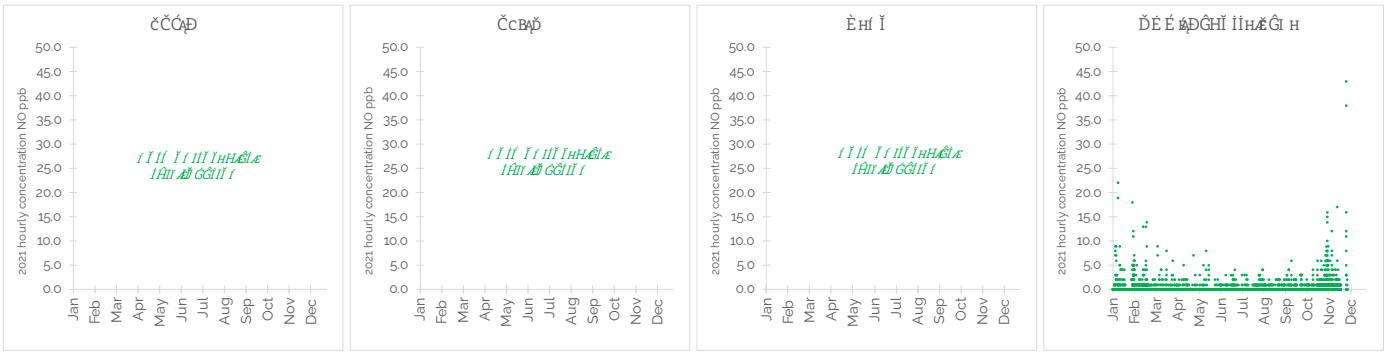

Figure 36: 2021 hourly nitric oxide concentrations

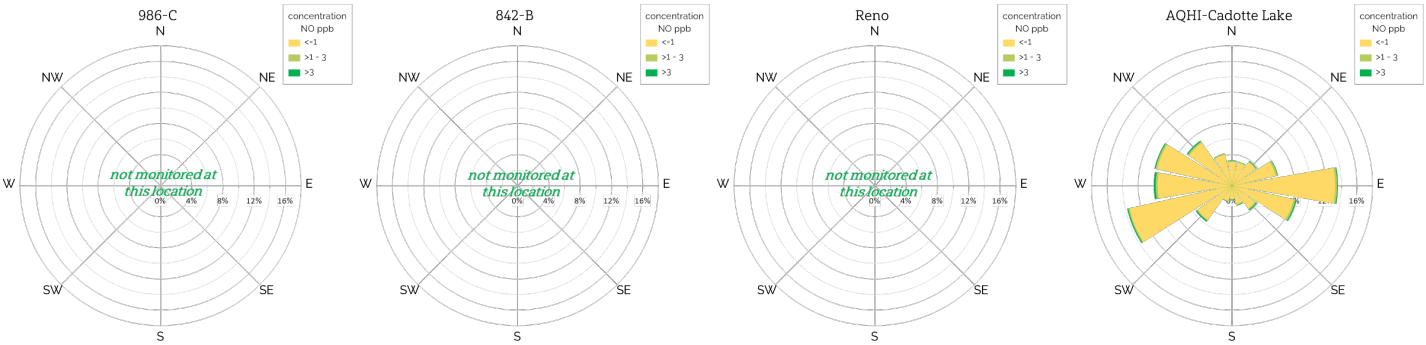

Figure 37: 2021 hourly nitric oxide concentration wind roses

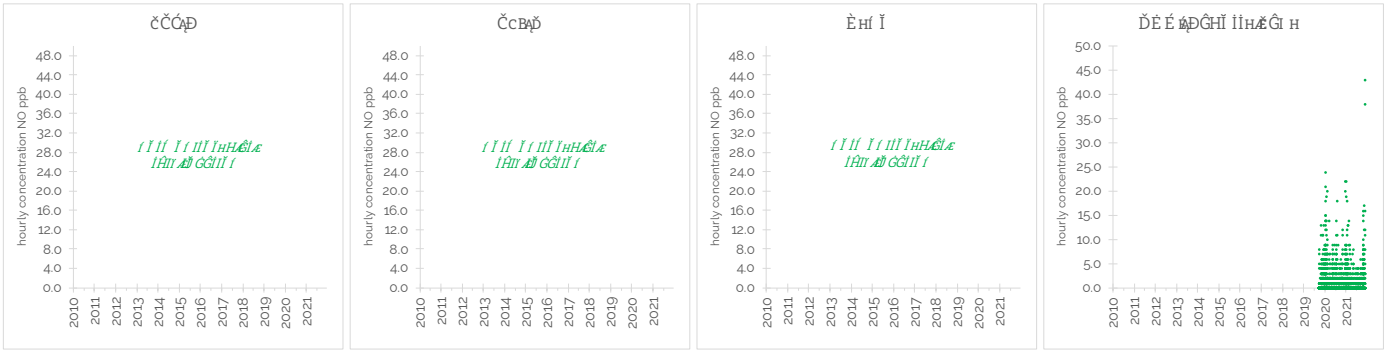

Figure 38: 2010-2021 hourly nitric oxide concentrations

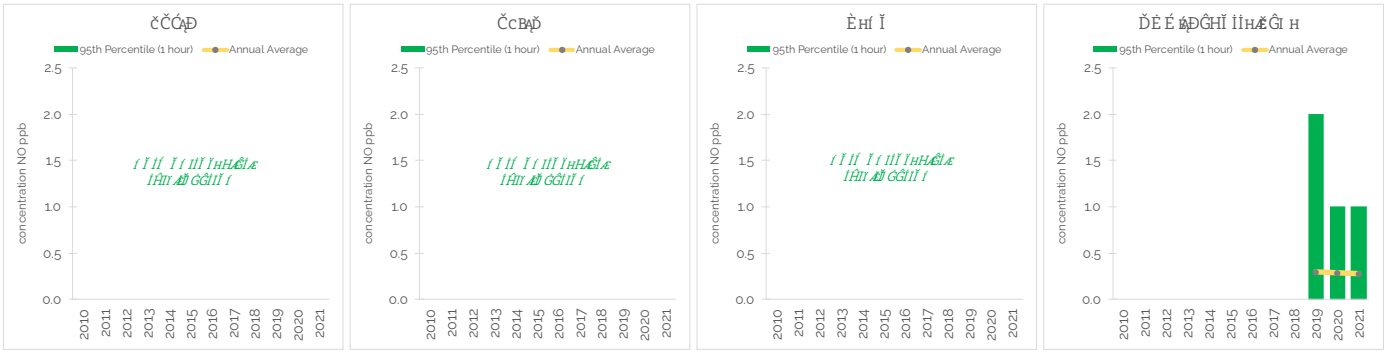

Figure 39: 2010-2021 annual averages and 95th percentile of hourly measurements of nitric oxide

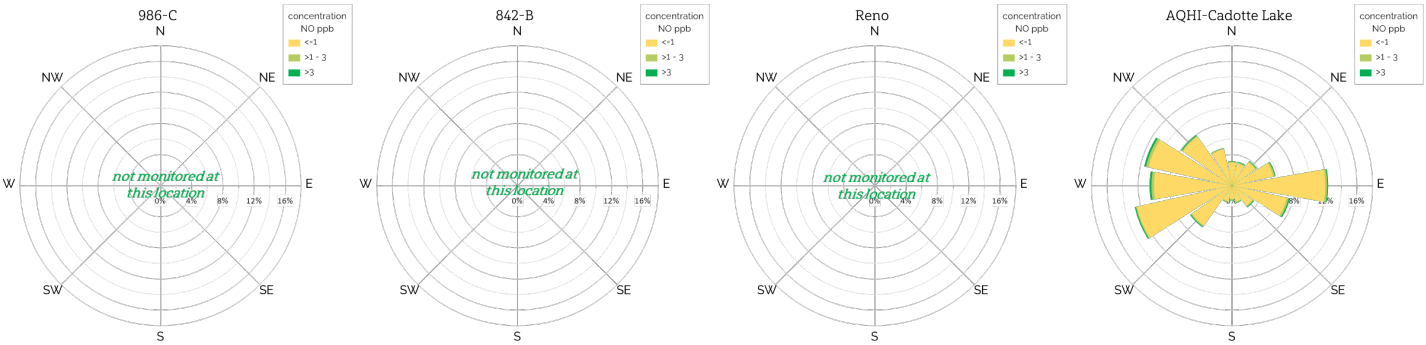

Figure 40: 2010-2021 hourly nitric oxide concentration wind roses

2.8. Ozone

Ozone is a colourless, odourless gas at ambient concentrations and is a major component of smog. While ozone in the upper atmosphere (the ozone layer) plays an important role protecting life on the planet from harmful ultraviolet radiation, ozone produced near the surface (ground level ozone) of the earth has environmental, health, and economic impacts.

The 1-hour AAAQO for ozone is 76 parts per billion.

Ground-level ozone is a secondary pollutant which means it is not directly emitted by industry or vehicles. It forms and degrades by complex atmospheric processes. Ozone is formed when nitrogen oxides and volatile organic compounds, the "precursor" chemicals, react in the presence of sunlight. However, under certain conditions, ozone can be degraded by some of the compounds by which it is also formed. This degradation occurs more often in cities than in rural areas because of the increased presence of key precursor compounds, namely nitric oxide. In Alberta, rural areas often have higher concentrations of ozone than urban areas. This is because ozone levels are generally higher downwind of ozone precursor sources such as cities, at distances of hundreds or even thousands of kilometers.

PRAMP measured higher concentrations at the AQHI station in Cadotte Lake relative to about half of the other stations in the Alberta network. This is due to the station being in a relatively rural and remote area and downwind of precursor sources.

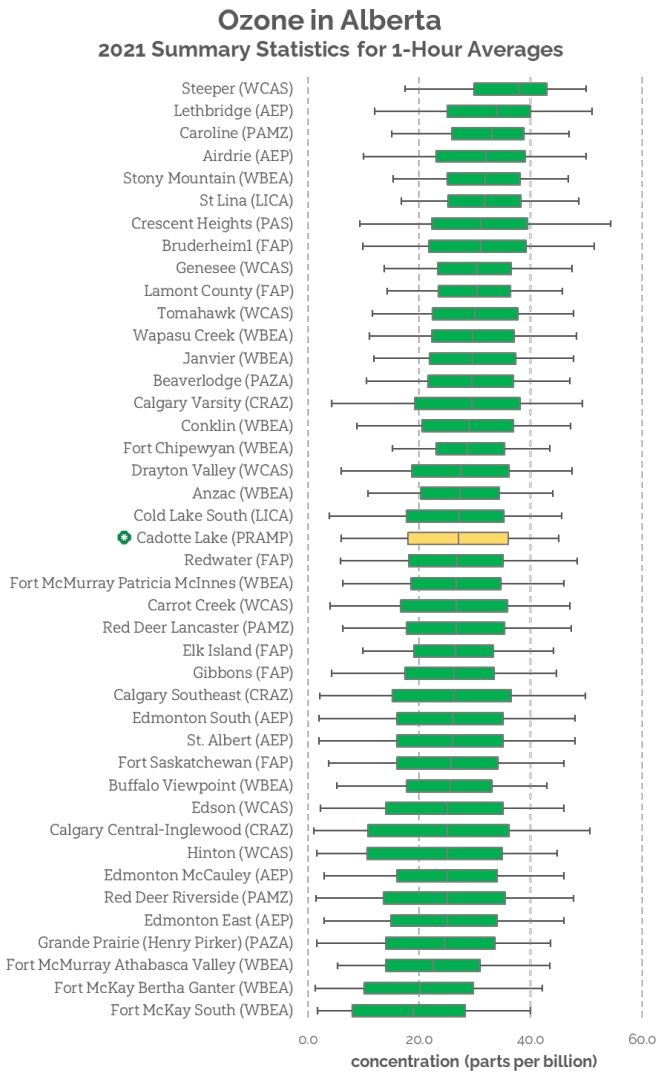

Figure 41: 2021 Ozone in Alberta

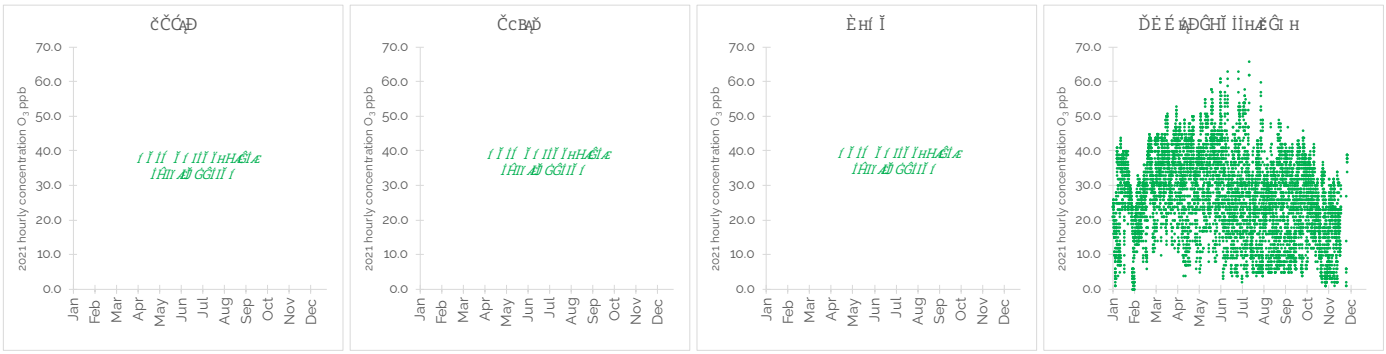

Figure 42: 2021 hourly ozone concentrations

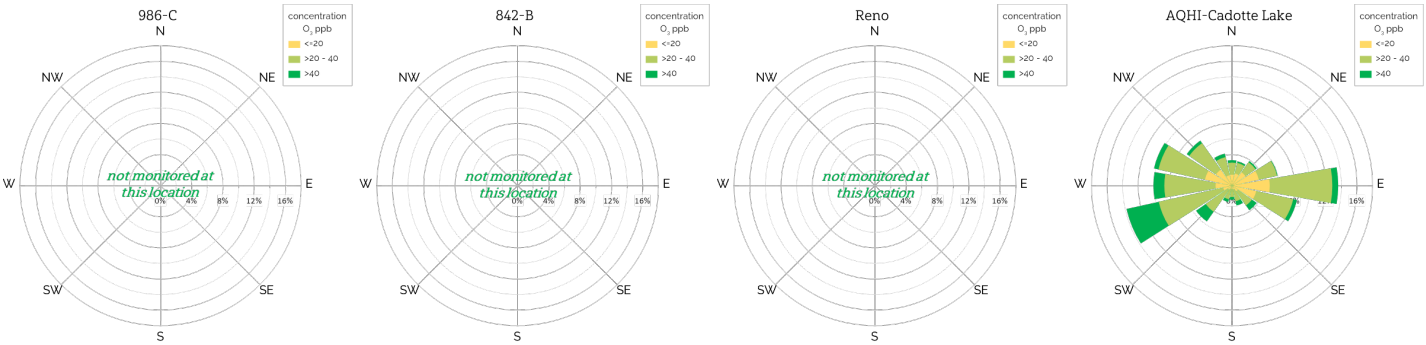

Figure 43: 2021 hourly ozone concentration wind roses

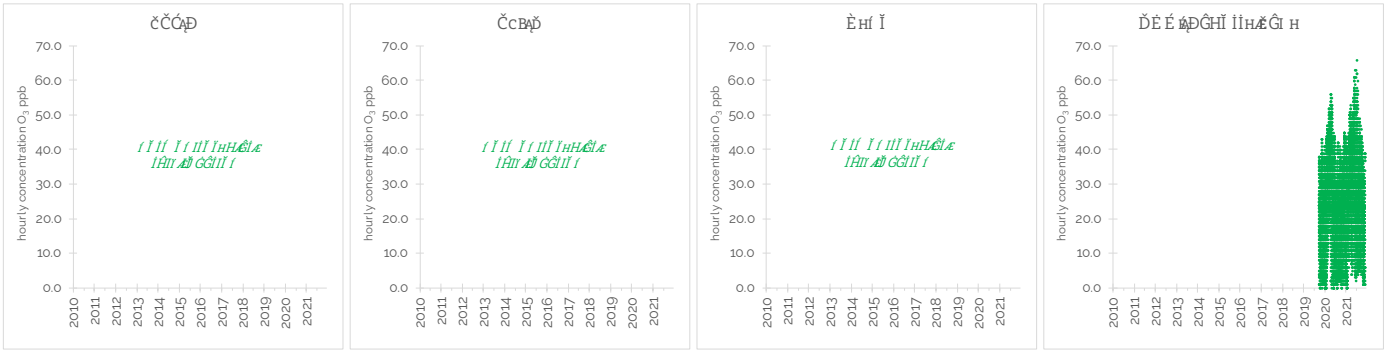

Figure 44: 2010-2021 hourly ozone concentrations

Figure 45: 2010-2021 annual averages and 95th percentile of hourly measurements of ozone

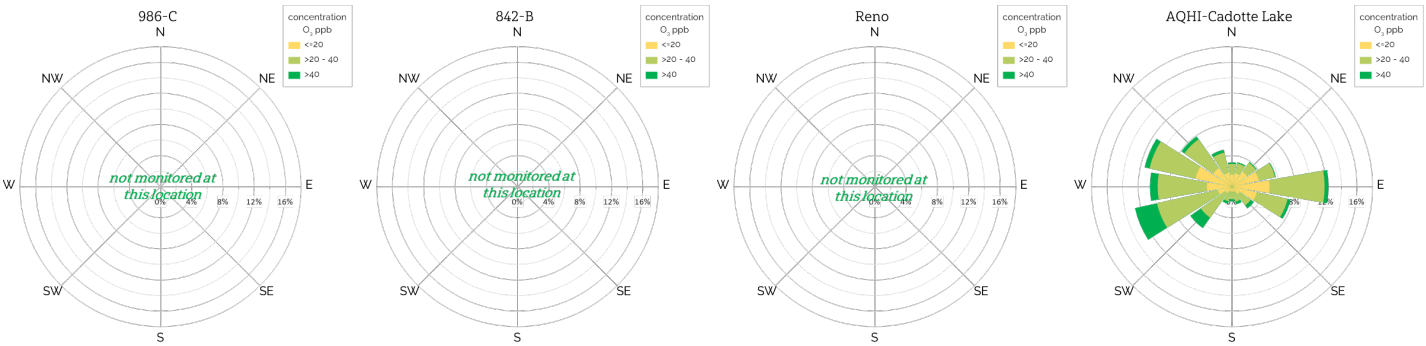

Figure 46: 2010-2021 hourly ozone concentration wind roses

2.9. Particulate Matter

Particulate matter is characterized according to size - mainly because of the different health effects associated with particles of different diameters. Particulate matter is the general term used for a mixture of solid particles and liquid droplets in the air. It includes smoke, dust, ash, and pollen. The composition of particulate matter varies with place, season, and weather conditions. This chart presents fine particulate matter. Fine particulate matter is 2.5 microns in diameter and less; in comparison, a human hair is about 70 microns in diameter. It is also known as PM2.5 or respirable particles because it penetrates further into the respiratory system than larger particles. Fine particulate matter is primarily formed from chemical reactions in the atmosphere and through fuel combustion. Major sources of fine particulate matter in Alberta include forest fires, vehicles, power plants, oil and gas facilities, residential fireplaces and wood stoves, and agricultural burning.

In 2021, the highest overall concentrations were generally measured in Alberta's large cities and urban centres (Edmonton, Calgary Fort Saskatchewan, Red Deer) and the areas downwind of them (Gibbons, Lamont County). Past studies have determined that this is largely the result of secondary fine particulate matter formation; there are a greater frequency of days with fine particulate matter events between January and March driven by weather conditions associated with calm winds and temperature inversions. The other notable area that has elevated particulate matter concentrations is the oil sands mining area north of Fort McMurray; this is likely caused by dust from mining operations.

In the PRAMP network, particulate matter was monitored at the AQHI-Cadotte Lake station in 2021. The highest concentrations were measured when smoke was carried into the area from fires burning in British Columbia. Throughout the year however, the wind rose diagrams also indicate that in there is a higher frequency of particulate matter concentrations coming from the east; this is due to the unpaved Haig Lake Road which is on the east side of the land on which the station is located.

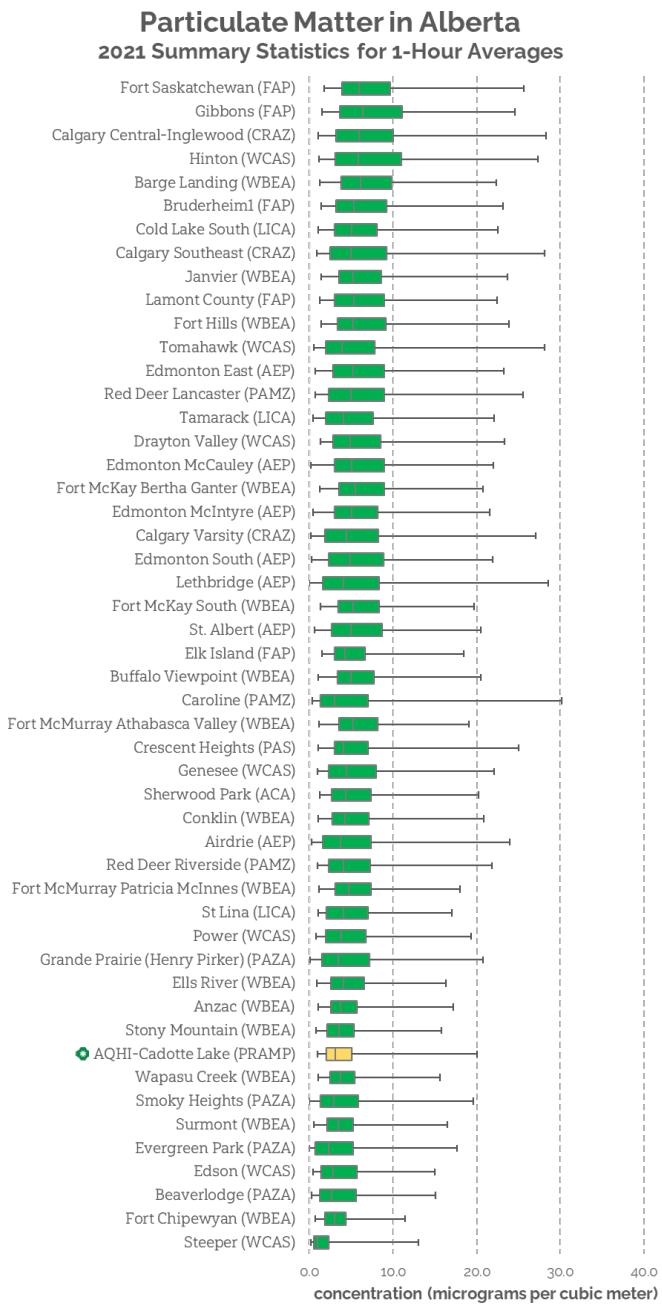

Figure 47: 2021 Ozone in Alberta

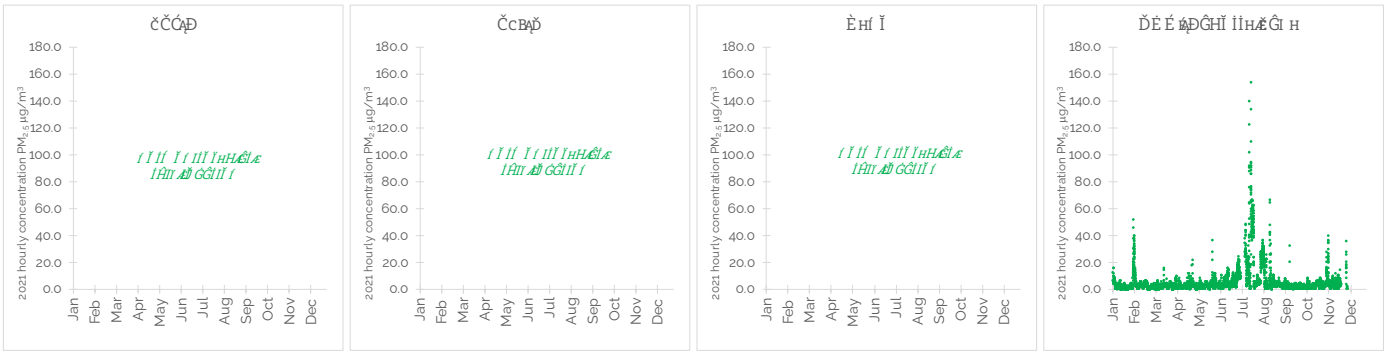

Figure 48: 2021 hourly fine particulate matter concentrations

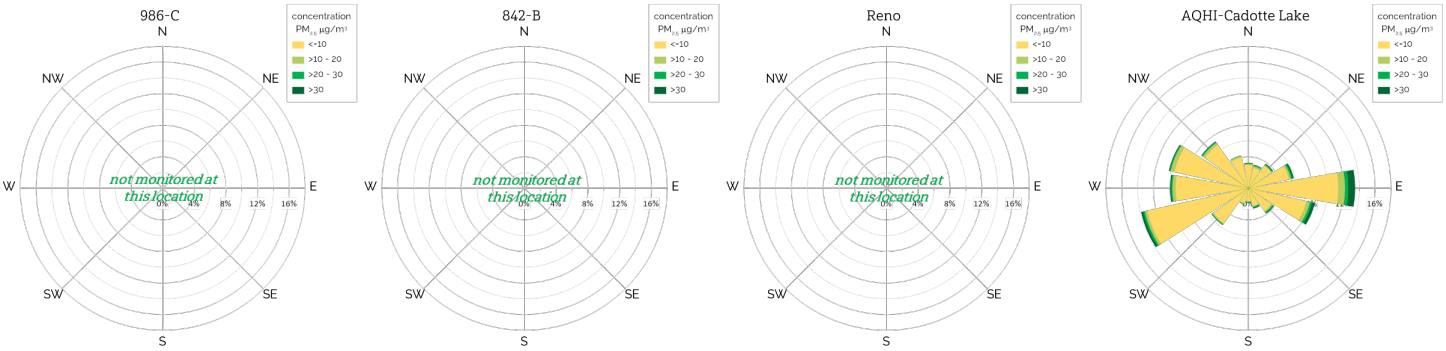

Figure 49: 2021 hourly fine particulate matter concentration wind roses

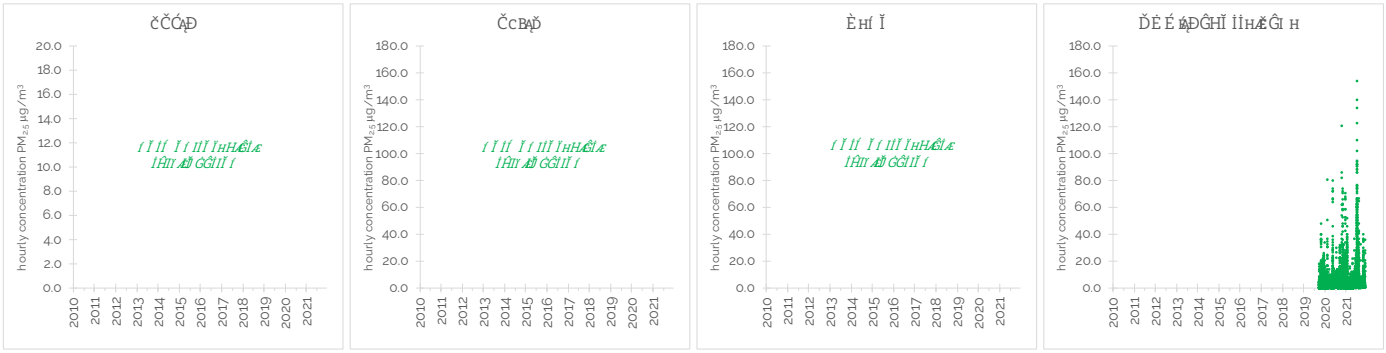

Figure 50: 2010-2021 hourly fine particulate matter concentrations

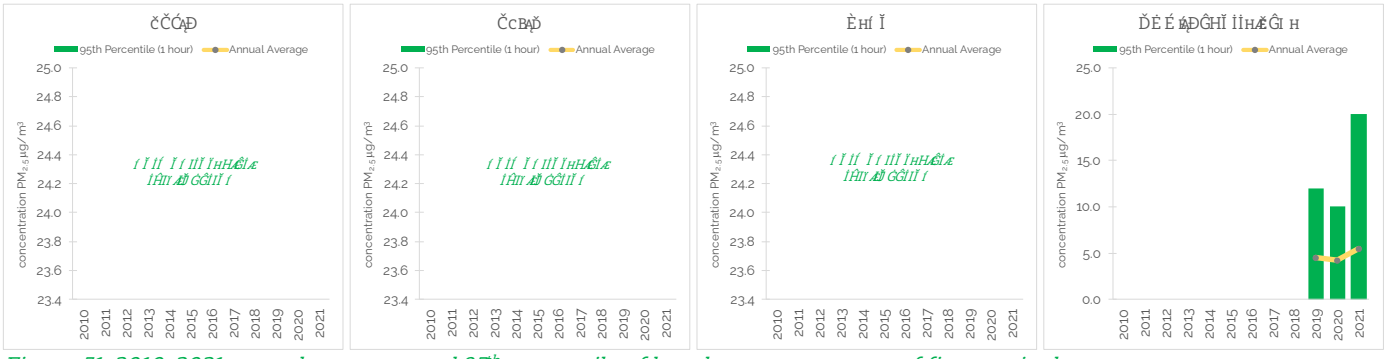

Figure 51: 2010-2021 annual averages and 95th percentile of hourly measurements of fine particulate matter

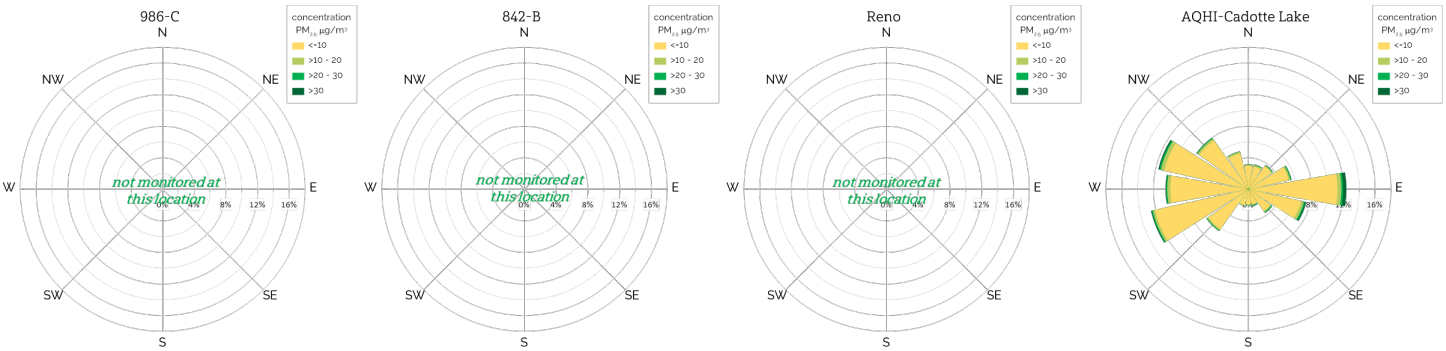

Figure 52: 2010-2021 hourly fine particulate matter concentration wind roses

2.10. Triggered Volatile Organic Compound Sampling

The volatile organic compound (VOC) canister sampling program collects a 1-hour sample of air when the continuously measured non-methane hydrocarbons concentration reaches a specified trigger point; the current trigger point is 0.3 ppm. The trigger point is based on real-time monitoring data that are averaged over a 5-minute period. Canisters sample collection systems are in place at Station 986-C, 842-B, and the Reno Station; a canister sample collection system is not part of the suite of instruments currently deployed at the AQHI-Cadotte Lake Station.

All canister samples were taken to a laboratory for analysis of over 140 VOC compounds and total reduced sulphur compounds. Time and date of the canister sampling was recorded and used to cross reference the sample to the monitored data and retrieve the associated wind direction and speed.

Nine triggered samples were collected across the entire PRAMP network in 2021; this is among the lowest total number of canisters collected since this program began.

A high-level summary of 2021 triggered canister VOC sampling results is presented in the table below; this table includes a summary of compounds that are commonly found above the method detection. A complete list of species for each of the samples is provided in Appendix 1.

Table 1: Summary of 2021 VOC Sample Results for PRAMP Stations (842-B, 986-C, and Reno)

Station		AAAQO	986c	986c	842	Reno	986c	842	986c	986c	986c
Sampled Date (MM/DD/YYYY)			08-Jan	26-Feb	28-Jun	29-Jun	29-Jun	29-Jun	01-Aug	04-Aug	15-Dec
Sampled Time			11:30	9:10	19:35	18:50	19:55	20:30	20:20	6:10	17;00
Triggered Concentration (ppm)			0.30	0.30	0.31	0.32	0.32	0.30	0.35	0.34	0.50
Parameter	Unit		Result	Result	Result	Result	Result	Result	Result	Result	Result
Acetone	ppb	**2400**	5.00	5.90	9.20	12.6	15.70	12.20	13.80	6.0	2.4
Acrolein	ppb	**1.9**	0.90	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	1.00	< 0.4	< 0.5
Benzene	ppb	**9**	0.42	0.34	0.13	0.13	0.12	0.10	0.22	0.47	0.91
Ethanol	ppb	**none**	397.00	9.40	9.50	6.9	8.50	7.10	10.70	4.4	2.2
Ethylbenzene	ppb	**460**	< 0.01	< 0.01	< 0.04	0.28	0.18	< 0.04	0.18	< 0.04	0.26
Freon-113	ppb	**none**	0.21	0.17	0.07	0.07	0.07	0.07	0.05	0.04	0.05
Isobutane	ppb	**none**	3.04	2.26	1.02	1.34	1.38	1.23	< 0.04	1.08	1.16
Isopentane	ppb	**none**	7.68	5.11	0.38	0.59	0.47	0.78	0.61	8.49	5.92
o-Xylene	ppbv	**530**	< 0.01	< 0.01	0.27	0.42	0.26	< 0.04	< 0.04	< 0.04	0.23
m,p-Xylene	ppb	**530**	< 0.04	< 0.04	0.39	0.73	0.37	< 0.06	0.34	0.28	0.52
Methane	ppm	**none**	2.0	2.4	1.8	1.9	1.8	1.5	0.2	2.5	2.6
n-Butane	ppb	**none**	2.67	2.56	0.52	0.52	0.57	0.50	0.55	3.08	3.62
n-Pentane	ppb	**none**	7.30	4.60	0.24	0.2	0.23	0.26	0.29	8.58	6.9
Toluene	ppb	**499**	< 0.01	0.21	0.24	0.53	0.21	0.19	0.36	0.59	0.71

3. Air Quality Health Index Summary

Monitoring data can be used to determine the Air Quality Health Index. The Air Quality Health Index (AQHI) provides a rating to indicate the level of relative health risk associated with local air quality using a colour-coded scale with associated values from 1 to 10. The index describes the level of health risk associated with each number as low (1-3), moderate (4-6), high (7-10) or very high (10+) and suggests exposure mitigation steps for each risk level.

The AQHI communicates four primary things;

- It measures the air quality in relation health on a scale from 1 to 10. The higher the number, the greater the health risk associated with the air quality. When the amount of air pollution is very high, the number will be reported as 10+.
- A category that describes the level of health risk associated with the index reading (e.g. Low, Moderate, High, or Very High Health Risk).
- Health messages customized to each category for both the general population and the 'at risk' population.
- Current hourly AQHI readings and at some locations, maximum forecast values for 'today', 'tonight', and 'tomorrow'.

The AQHI is designed to give the above information along with some suggestions on how to adjust activity levels depending on individual health risk from air pollution.

The AQHI is calculated based on the relative risks of a combination of common air pollutants that is known to harm human health. These pollutants are:

- Ozone at ground level,
- Particulate Matter ($PM_{2.5}$)
- Nitrogen Dioxide

The figure on this page helps illustrate the AQHI observations for different locations across Alberta in 2021, including the AQHI-capable air quality monitoring station in the PRAMP network. Each location on the chart has approximately 8500 hours of AQHI readings. Data are sorted in acsending order by the percentage of low-risk air quality datas (the sum of risk rateings 1, 2, and 3).

In general, large Alberta's large cities (Edmonton, Calgary, etc.) had fewer days with low-risk AQHI days than more remote, sparsely populated locations (Fort Chipeweyan, Beaverlodge, etc.). In 2021, PRAMP measured the AQHI in the community of Cadotte Lake. Cadotte Lake Commuinty had a low risk AQHI rating over 98% of the time and in Alberta, is among the locations that had the highest freqency of low-risk AQHI rating.

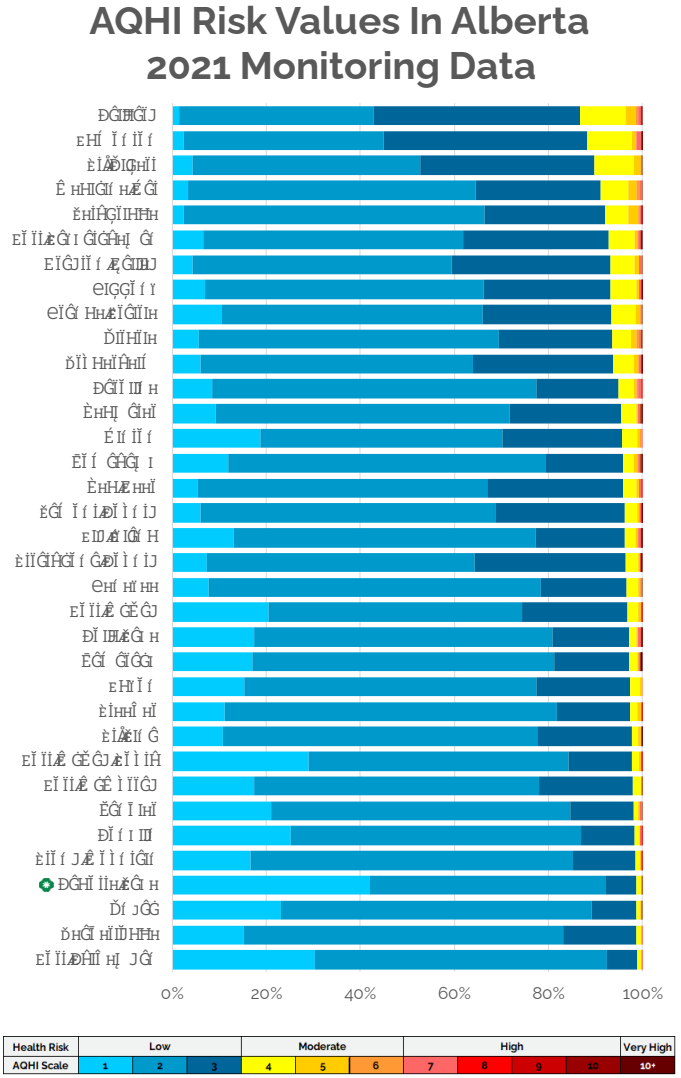

Figure 53: 2021 Air Quality Health Index in Alberta

4. Odour Complaints

Albertans are encouraged to contact the AER's Emergency 24-Hour Response Line with energy and environmental concerns including odour complaints.

Each year, PRAMP tracks the number of odour complaints that have been recorded by the AER for the Peace River Cold Heavy Oil Production areas (Three Creeks, Reno, Seal, Walrus). Odour complaints related to any industrial, agricultural, or commercial operations may be received by a range of other government departments or agencies. PRAMP only has access to data about complaints recorded by the AER. It should be noted that with the current network design, it is not possible to monitor all areas of the airshed at all times, however it is possible for area residents to detect odours at any place at any time.

In 2021, there were no odour complaints recorded by the AER for the Peace River Cold Heavy Production areas; this is the lowest number of complaints to the AER since PRAMP began compiling these data.

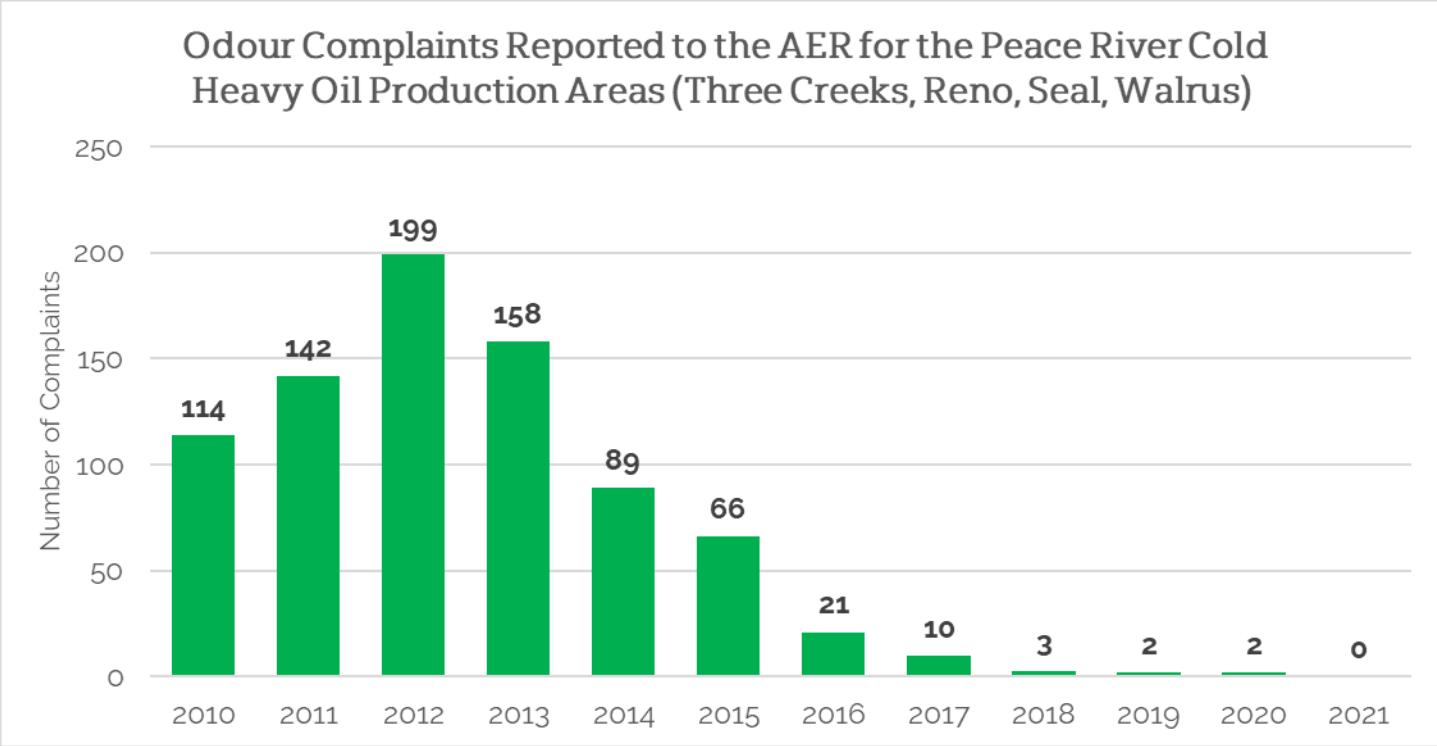

Figure 54: 2010-2021 Odour Complaints in the Peace River Cold Heavy Oil Production Area

If you need to report a complaint related to energy development, or its impact on the environment, please call the Alberta Energy Regulator's Energy and Environmental 24-hour Response Line at:

1-800-222-6514

5. Summary

PRAMP collected concentration data for CH_4, NMHC, TRS, and SO_2 at Station 986-C, 842-B, and the Reno Station in 2021; these parameters plus O_3, NOx, and $PM_{2.5}$ were also collected at the AQHI. The data was summarized and presented using different visualizations and summary statistics. Wind speed and direction were also monitored to further understand the potential sources of substances detected by the monitoring. Triggered sampling events provided additional concentration data.

Hourly measurements of CH_4, NMHC, and SO_2, concentrations generally show incremental changes in the year-over-year summary statistics. Between 2020 and 2021, CH_4 showed a slight decrease which is in-line with ongoing efforts to reduce fugitive emissions from upstream oil and gas operations. NMHC showed a slight increase due to protracted wildfire smoke episodes during the summer months. For the first half of 2021, the AQHI-Cadotte Lake Station recorded frequent elevated NMHC concentrations due to the use of heavy construction equipment on land adjacent to the monitoring station. Like previous years' analyses, it should be noted that hydrocarbon concentrations remain low especially considering the historically elevated concentrations of Station 986 and 842.

All stations continue to show a pattern of elevated TRS concentrations during the summer months which begin to decrease as cooler, fall weather arrives. This observation may be attributed to a few factors including sulphur compounds being released by shallow sloughs and wetlands that contain decaying vegetation or sulphur compounds released by asphalt paving during the summer construction period. At the AQHI-Cadotte Lake station, the occurrence of elevated concentrations of TRS in the late winter and early spring validates odour observations by local residents; these elevated concentrations may be caused when local lakes and waterways thaw and release hydrogen sulphide (a reduced sulphur compound) that has been trapped under ice over the winter months.

O_3, NO_2, $PM_{2.5}$, and O_3 were only measured at the AQHI-Cadotte Lake station in 2021. Except for $PM_{2.5}$, concentrations of these pollutants were very or at values expected given that Cadotte Lake is a small, rural community. $PM_{2.5}$ had sustained elevated concentrations during 2021's wildfire season which saw smoke transported into Alberta from wildfires burning in British Columbia.

The triggered canister program collected 9 samples in 2021. While a number of VOC species were detected in the samples collected, no AAAQOs were exceeded (where comparisons can be made); the overall number of canisters triggered is among the lowest since PRAMP being this sampling program.

In 2021, there were no odour complaints recorded by the AER across the entire network; this is the lowest number of complaints to the AER since PRAMP began compiling these data.

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6. References

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Appendix A: Triggered Canister Sample Data (All VOC Species)

Station		986-C	986-C	842-B	Reno	986-C	842-B	986-C	986-C	986c
Sampled Date		08-Jan	26-Feb	28-Jun	29-Jun	29-Jun	29-Jun	01-Aug	04-Aug	15-Dec
Sampled Time		11:30	9:10	19:35	18:50	19:55	20:30	20:20	6:10	17:00
Triggered Concentration (ppm)		0.30	0.30	0.31	0.32	0.32	0.30	0.35	0.34	0.50
Parameter	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
1-Butene	ppmv	< 0.14	< 0.14	< 0.15	< 0.16	< 0.15	< 0.14	< 0.14	< 0.14	< 0.14
Acetylene	ppmv	< 0.11	< 0.11	< 0.12	< 0.13	< 0.12	< 0.11	< 0.11	< 0.11	< 0.11
cis-2-Butene	ppmv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06
Ethane	ppmv	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Ethylacetylene	ppmv	< 0.08	< 0.08	< 0.09	< 0.10	< 0.09	< 0.08	< 0.08	< 0.08	< 0.08
Ethylene	ppmv	< 0.10	< 0.10	< 0.10	< 0.11	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Isobutane	ppmv	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Isobutylene	ppmv	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Methane	ppmv	2.0	2.4	1.8	1.9	1.8	1.5	0.2	2.5	2.6
n-Butane	ppmv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
n-Propane	ppmv	< 0.10	< 0.10	< 0.10	< 0.11	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Propylene	ppmv	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Propyne	ppmv	< 0.1	< 0.1	< 0.2	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
trans-2-Butene	ppmv	< 0.12	< 0.12	< 0.14	< 0.14	< 0.13	< 0.12	< 0.12	< 0.13	< 0.12
2,5-Dimethylthiophene	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
2-Ethylthiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4
2-Methylthiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4
3-Methylthiophene	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Butyl mercaptan	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Carbon disulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	1.60	1.60	< 0.4
Carbonyl sulphide	ppbv	1.20	1.50	< 0.4	< 0.5	0.70	< 0.4	< 0.4	< 0.4	2.5
Dimethyl disulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4
Dimethyl sulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4
Ethyl mercaptan	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Ethyl sulphide	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Hydrogen sulphide	ppbv	1.50	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	3.8
Isobutyl mercaptan	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Isopropyl mercaptan	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Methyl mercaptan	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4
Pentyl mercaptan	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.5	< 0.6	< 0.7
Propyl mercaptan	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.5	< 0.6	< 0.7
tert-Butyl mercaptan	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Thiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.4
1,1,1-Trichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
1,1,2,2-Tetrachloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
1,1,2-Trichloroethane	ppbv	< 0.03	0.08	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
1,1-Dichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
1,1-Dichloroethylene	ppbv	< 0.06	< 0.06	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
1,2,3-Trimethylbenzene	ppbv	< 0.07	< 0.07	0.28	0.27	0.16	< 0.07	0.17	< 0.07	0.16
1,2,4-Trichlorobenzene	ppbv	< 1.1	< 1.1	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5

Station		986-C	986-C	842-B	Reno	986-C	842-B	986-C	986-C	986c
Sampled Date		08-Jan	26-Feb	28-Jun	29-Jun	29-Jun	29-Jun	01-Aug	04-Aug	15-Dec
Sampled Time		11:30	9:10	19:35	18:50	19:55	20:30	20:20	6:10	17:00
Triggered Concentration (ppm)		0.30	0.30	0.31	0.32	0.32	0.30	0.35	0.34	0.50
1,2,4-Trimethylbenzene	ppbv	< 0.07	< 0.07	0.50	0.52	0.32	0.19	0.34	< 0.04	0.28
1,2-Dibromoethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
1,2-Dichlorobenzene	ppbv	< 0.04	< 0.04	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
1,2-Dichloroethane	ppbv	< 0.01	< 0.01	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
1,2-Dichloropropane	ppbv	< 0.01	< 0.01	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
1,3,5-Trimethylbenzene	ppbv	< 0.03	< 0.03	0.24	0.24	0.19	< 0.04	< 0.04	< 0.04	0.23
1,3-Butadiene	ppbv	< 0.03	< 0.03	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
1,3-Dichlorobenzene	ppbv	< 0.4	< 0.4	< 0.6	< 0.6	< 0.6	< 0.6	< 0.5	< 0.6	< 0.7
1,4-Dichlorobenzene	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.5	< 0.6	< 0.7
1,4-Dioxane	ppbv	< 0.6	< 0.6	< 0.8	< 0.8	< 0.7	< 0.7	< 0.7	< 0.7	< 0.9
1-Butene	ppbv	1.74	3.39	1.37	1.72	1.59	1.07	2.24	0.89	0.83
1-Hexene	ppbv	0.26	0.34	< 0.10	< 0.11	< 0.10	< 0.10	0.16	< 0.10	0.25
1-Pentene	ppbv	0.75	1.21	0.21	0.23	0.30	0.19	0.61	0.14	0.41
2,2,4-Trimethylpentane	ppbv	< 0.01	< 0.01	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
2,2-Dimethylbutane	ppbv	0.31	0.21	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.28	0.29
2,3,4-Trimethylpentane	ppbv	< 0.01	< 0.01	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
2,3-Dimethylbutane	ppbv	< 0.03	0.24	0.96	1.91	1.60	1.47	1.01	0.35	0.32
2,3-Dimethylpentane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.05	0.20	0.24
2,4-Dimethylpentane	ppbv	< 0.01	< 0.01	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	0.11	0.2
2-Methylheptane	ppbv	< 0.01	< 0.01	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.28	0.46
2-Methylhexane	ppbv	< 0.01	0.19	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	0.76	0.55
2-Methylpentane	ppbv	0.82	0.74	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	1.32	1.16
3-Methylheptane	ppbv	< 0.03	< 0.03	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	0.20	0.24
3-Methylhexane	ppbv	0.24	< 0.03	< 0.03	0.08	0.08	0.07	< 0.03	0.61	0.56
3-Methylpentane	ppbv	0.60	0.38	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	1.21	1.19
Acetone	ppbv	5.00	5.90	9.20	12.6	15.70	12.20	13.80	6.0	2.4
Acrolein	ppbv	0.90	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	1.00	< 0.4	< 0.5
Benzene	ppbv	0.42	0.34	0.13	0.13	0.12	0.10	0.22	0.47	0.91
Benzyl chloride	ppbv	< 0.6	< 0.6	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Bromodichloromethane	ppbv	< 0.03	< 0.03	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
Bromoform	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Bromomethane	ppbv	< 0.01	< 0.01	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Carbon disulfide	ppbv	< 0.01	0.19	< 0.03	< 0.03	0.31	< 0.03	0.35	0.26	0.22
Carbon tetrachloride	ppbv	< 0.01	0.15	0.08	0.07	0.07	0.07	0.07	0.05	0.1
Chlorobenzene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Chloroethane	ppbv	0.30	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Chloroform	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Chloromethane	ppbv	1.52	1.45	0.60	0.67	0.71	0.67	0.94	0.52	0.56
cis-1,2-Dichloroethene	ppbv	< 0.01	< 0.01	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
cis-1,3-Dichloropropene	ppbv	< 0.06	< 0.06	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
cis-2-Butene	ppbv	< 0.03	< 0.03	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
cis-2-Pentene	ppbv	< 0.03	0.17	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04

Station		986-C	986-C	842-B	Reno	986-C	842-B	986-C	986-C	986c
Sampled Date		08-Jan	26-Feb	28-Jun	29-Jun	29-Jun	29-Jun	01-Aug	04-Aug	15-Dec
Sampled Time		11:30	9:10	19:35	18:50	19:55	20:30	20:20	6:10	17:00
Triggered Concentration (ppm)		0.30	0.30	0.31	0.32	0.32	0.30	0.35	0.34	0.50
Cyclohexane	ppbv	< 0.03	< 0.03	< 0.06	0.12	0.11	0.10	< 0.05	0.72	1.07
Cyclopentane	ppbv	< 0.01	0.28	< 0.03	< 0.03	< 0.03	3.54	< 0.03	0.24	0.51
Dibromochloromethane	ppbv	< 0.01	< 0.01	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Ethanol	ppbv	397.00	9.40	9.50	6.9	8.50	7.10	10.70	4.4	2.2
Ethyl acetate	ppbv	< 0.6	< 0.6	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Ethylbenzene	ppbv	< 0.01	< 0.01	< 0.04	0.28	0.18	< 0.04	0.18	< 0.04	0.26
Freon-11	ppbv	0.47	0.37	0.20	0.2	0.19	0.21	0.21	0.19	0.31
Freon-113	ppbv	0.21	0.17	0.07	0.07	0.07	0.07	0.05	0.04	0.05
Freon-114	ppbv	0.07	0.04	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
Freon-12	ppbv	0.92	0.78	0.46	0.52	0.55	0.54	0.53	0.47	0.45
Hexachloro-1,3-butadiene	ppbv	< 0.69	< 0.69	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Isobutane	ppbv	3.04	2.26	1.02	1.34	1.38	1.23	< 0.04	1.08	1.16
Isopentane	ppbv	7.68	5.11	0.38	0.59	0.47	0.78	0.61	8.49	5.92
Isoprene	ppbv	< 0.01	< 0.01	55.80	56.5	63.90	49.50	42.70	3.59	< 0.04
Isopropyl alcohol	ppbv	2.30	2.90	0.90	1.3	1.10	0.70	0.80	< 0.4	0.6
Isopropylbenzene	ppbv	< 0.01	< 0.01	< 0.06	< 0.06	< 0.06	< 0.06	< 0.05	< 0.06	< 0.07
m,p-Xylene	ppbv	< 0.04	< 0.04	0.39	0.73	0.37	< 0.06	0.34	0.28	0.52
m-Diethylbenzene	ppbv	< 0.06	< 0.06	0.21	0.16	< 0.03	0.17	< 0.03	< 0.03	< 0.04
m-Ethyltoluene	ppbv	< 0.11	< 0.11	0.20	0.19	0.16	0.17	< 0.04	< 0.04	< 0.05
Methyl butyl ketone	ppbv	< 0.69	< 0.69	< 0.6	< 0.6	< 0.6	< 0.6	< 0.5	< 0.6	< 0.7
Methyl ethyl ketone	ppbv	< 0.4	< 0.4	1.10	1.2	1.30	0.90	1.20	0.50	< 0.5
Methyl isobutyl ketone	ppbv	< 0.6	< 0.6	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Methyl methacrylate	ppbv	< 0.10	< 0.10	< 0.12	< 0.13	< 0.12	< 0.11	< 0.11	0.35	< 0.14
Methyl tert butyl ether	ppbv	< 0.04	< 0.04	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
Methylcyclohexane	ppbv	0.23	< 0.01	0.12	0.13	0.11	0.11	0.08	0.84	0.82
Methylcyclopentane	ppbv	< 0.03	0.21	0.11	0.1	0.09	0.09	0.08	0.57	0.98
Methylene chloride	ppbv	< 0.4	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
n-Butane	ppbv	2.67	2.56	0.52	0.52	0.57	0.50	0.55	3.08	3.62
n-Decane	ppbv	< 0.08	< 0.08	< 0.09	< 0.10	< 0.09	< 0.08	< 0.08	< 0.08	0.2
n-Dodecane	ppbv	< 0.6	< 0.6	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
n-Heptane	ppbv	0.36	0.32	< 0.06	< 0.06	< 0.06	< 0.06	0.18	1.41	1.11
n-Hexane	ppbv	1.36	0.84	< 0.04	< 0.05	< 0.04	< 0.04	0.16	3.55	3.29
n-Nonane	ppbv	< 0.01	0.14	< 0.06	< 0.06	< 0.06	< 0.06	< 0.05	0.16	0.25
n-Octane	ppbv	0.22	0.20	< 0.03	0.17	< 0.03	0.14	0.17	0.32	0.43
n-Pentane	ppbv	7.30	4.60	0.24	0.2	0.23	0.26	0.29	8.58	6.9
n-Propylbenzene	ppbv	< 0.07	< 0.07	< 0.09	< 0.10	< 0.09	< 0.08	< 0.08	< 0.08	< 0.10
n-Undecane	ppbv	< 0.7	< 0.7	< 0.8	< 0.8	< 0.7	< 0.7	< 0.7	< 0.7	< 0.9
Naphthalene	ppbv	< 0.7	< 0.7	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
o-Ethyltoluene	ppbv	< 0.01	< 0.01	0.18	0.18	0.14	< 0.03	< 0.03	< 0.03	< 0.04
o-Xylene	ppbv	< 0.01	< 0.01	0.27	0.42	0.26	< 0.04	< 0.04	< 0.04	0.23
p-Diethylbenzene	ppbv	< 0.06	< 0.06	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
p-Ethyltoluene	ppbv	< 0.10	< 0.10	< 0.06	< 0.06	< 0.06	< 0.06	< 0.05	< 0.06	< 0.07

Station		986-C	986-C	842-B	Reno	986-C	842-B	986-C	986-C	986c
Sampled Date		08-Jan	26-Feb	28-Jun	29-Jun	29-Jun	29-Jun	01-Aug	04-Aug	15-Dec
Sampled Time		11:30	9:10	19:35	18:50	19:55	20:30	20:20	6:10	17:00
Triggered Concentration (ppm)		0.30	0.30	0.31	0.32	0.32	0.30	0.35	0.34	0.50
Styrene	ppbv	< 0.06	< 0.06	0.33	0.4	0.33	< 0.06	< 0.05	< 0.06	0.41
Tetrachloroethylene	ppbv	< 0.06	< 0.06	0.20	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Tetrahydrofuran	ppbv	< 0.6	< 0.6	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Toluene	ppbv	< 0.01	0.21	0.24	0.53	0.21	0.19	0.36	0.59	0.71
trans-1,2-Dichloroethylene	ppbv	0.56	0.69	3.15	31.40	0.86	0.26	3.50	0.20	0.22
trans-1,3-Dichloropropylene	ppbv	< 0.06	< 0.06	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
trans-2-Butene	ppbv	< 0.01	< 0.01	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.04	< 0.05
trans-2-Pentene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Trichloroethylene	ppbv	< 0.06	< 0.06	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04
Vinyl acetate	ppbv	< 0.6	0.70	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.4	< 0.5
Vinyl chloride	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.04