Peace Airshed Zone Association
Box 21135 Grande Prairie, AB, T8V 6W7
P: 780-833-4343
www.paza.ca

POPLAR

AIR QUALITY SUMMARY REPORT

OCTOBER 2021 TO APRIL 2024

Date: January 27, 2025

Prepared by Mandeep Dhaliwal
PAZA Program Manager
mandeep@paza.ca

Data Statistics, Charts, and Maps Prepared by
KRM Environmental Consulting Inc.
kevinmcc@myaccess.ca

Executive Summary

The Poplar air quality monitoring station was located about 30 kilometers northwest of Grande Prairie in a rural region of mainly oil and gas, and agriculture activity. The Peace Airshed Zone Association (PAZA) conducted an air quality survey at the Poplar station from October 2021 to April 2024. The air quality survey was undertaken to collect baseline data before any increase in industrial activities and was identified as an area of interest in PAZA's 2013 and 2019 Network Assessments.

The PAZA roving monitoring station was used to continuously measure the following data during that period:

- Total reduced sulphur compounds (TRS);
- Sulphur dioxide (SO_2):
- Oxides of nitrogen (NO, NO_2, and NO_x);
- Ozone (O_3);
- Fine particulate matter ($PM_{2.5}$);
- Hydrocarbons (Total hydrocarbons (THC), Methane (CH_4) and Non-methane Hydrocarbons (NMHC); and
- Meteorology (Wind speed and Direction, and Temperature)

The results are summarized as follows:

- There were no exceedances of Alberta Ambient Air Quality Objectives (AAAQO) for TRS components. The overall TRS measurements may be infrequently influenced by local industry or agriculture but in general measurements are indicative of low background levels.
- There were no exceedances of AAAQO for SO_2. The data indicates that SO_2 levels in the area are generally low inferring that there are no significant sources of SO_2 in the local area. The bias of higher average concentrations toward certain wind directions may be a sign of influence from long range transport from other industrial sources in the region.
- There were no exceedances of AAAQO for NO_2. Of the oxides of nitrogen, only NO_2 has an AAAQO. The ambient NO_2 data measured at the Poplar station appears to suggest that emissions from Grand Prairie could be the main contributor to the measurements which is not unexpected given the location of the monitor. However, measurements are low and are considered to be reflective of a typical rural setting.
- Exceedances of the 1-hour AAAQO for O_3 were measured on 3 and 4 consecutive hours on two hot sunny summer afternoons, and are not considered to be indicative of on-going air quality problems. Measurements are comparable with other areas in the province. A typical diurnal profile is present in the O_3 measurements and relates with the diurnal patterns of NO and NO_2. This pattern shows slight photo-chemical formation and

destruction of O_3 through complex reactions with NO_x and volatile organic compounds (VOCs).

- Exceedances of the 1-hour $PM_{2.5}$ AAAQG were measured which in turn, led to calculated exceedances of the 24-hour AAAQO. These elevated measurements were due to wildfires and do not indicate on-going air quality problems in the region. In general, $PM_{2.5}$ measurements were slightly lower than other areas in the province.
- Ambient measurements of THC in the area indicate the levels are slightly lower than other monitors in the province for the same time period. Very infrequent elevated concentrations of NMHC were measured; however the majority of NMHC measurements were zero suggesting the elevated measurements are not indicative of any air quality issues. Concentrations of specific hydrocarbons cannot be inferred from the data collected. For the most part when data were available, the THC and CH_4 measurements were essentially equal, and hence, the analysis focused on the THC measurements.
- Meteorology measurements indicate that the most frequent winds and highest wind speeds occur from the westerly directions. Measured temperatures were typical of central Alberta.

The summary of the air quality survey at the Poplar site is limited to the parameters measured in this study. Air quality surrounding the monitor may be affected by other compounds that PAZA was not equipped to measure such as speciated hydrocarbons, VOCs, ammonia or other complex odorous compounds.

The volume of data collected indicates that the air quality in this area is relatively good and is comparable to other rural areas in Alberta. The main contributors to the ambient air are likely local and regional oil and gas facilities, agriculture and the City of Grande Prairie.

Concentrations of $PM_{2.5}$ in excess of the AAAQO and AAAQG are due to exceptional events (wildfires) and do not necessarily indicate poor air quality in the area but do suggest that there are events and emissions sources that can influence the quality of the local air from time to time.

Although the very infrequent elevated NMHC measurements are not necessarily a cause for concern, canister sampling for specific hydrocarbons or VOCs such as benzene, may provide further helpful information.

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1. INTRODUCTION

The Peace Airshed Zone Association (PAZA) is a nonprofit, multi-stakeholder organization that conducts ambient air quality monitoring in northwestern Alberta. PAZA is an unbiased, open and transparent organization, and our members collaborate to provide local solutions to local air quality concerns.

PAZA was formed in March 1999 in response to air quality concerns in the Peace region. As an independent third-party, PAZA has invested ten years into building trust among members of the public, industry, non-governmental organizations, Alberta Environment and Protected Areas (AEPA), Alberta Energy Regulator (AER), and Alberta Health Services. The PAZA boundary is shown in Figure 1-1

The air quality monitoring program is a resource for the public to become informed about local air quality. Members work collaboratively to produce scientifically defensible data that can be used by stakeholders to ensure continuous improvement of regional air quality, protect environmental health, and influence public policy.

In 2003, PAZA became the fifth airshed zone in Alberta recognized by the Clean Air Strategic Alliance (CASA). PAZA operates under the guidelines developed in the *CASA Airshed Zone Guidelines*. These guidelines include management by consensus, representation from affected stakeholders and public accessibility to data and information from monitoring activities.

Consensus is reached when there is unanimous agreement among our stakeholders, ensuring each one can live with the outcome of the decision. Stakeholders may not achieve all their goals, but the objective is to find the optimal solution that includes something for everyone. Decisions made through consensus processes are likely to be more innovative and longer lasting than those reached through traditional negotiation or top-down hierarchy.

Airshed zones are a key component in Alberta's strategy for the management of air quality within Alberta.

PAZA is funded by compulsory and voluntary membership through a funding mechanism which is based on calculated relative impacts to air quality within the PAZA boundaries. For more information about PAZA and regional air quality, please visit PAZA's web site[1].

PAZA currently operates a network of eight continuous monitoring stations and 61 passive monitoring stations that collectively monitor air quality across the airshed (see Figure 1-2). One of these continuous stations is a portable or roving continuous monitoring station that is used to respond to various concerns. This roving station was setup from October 2021 to April 2024 at approximately 30 kilometres northwest of Grande Prairie, Alberta, to collect baseline data before any increase in industrial activities and was identified as an area of interest in PAZA's 2013 Network Assessment.

[1] https://www.paza.ca/

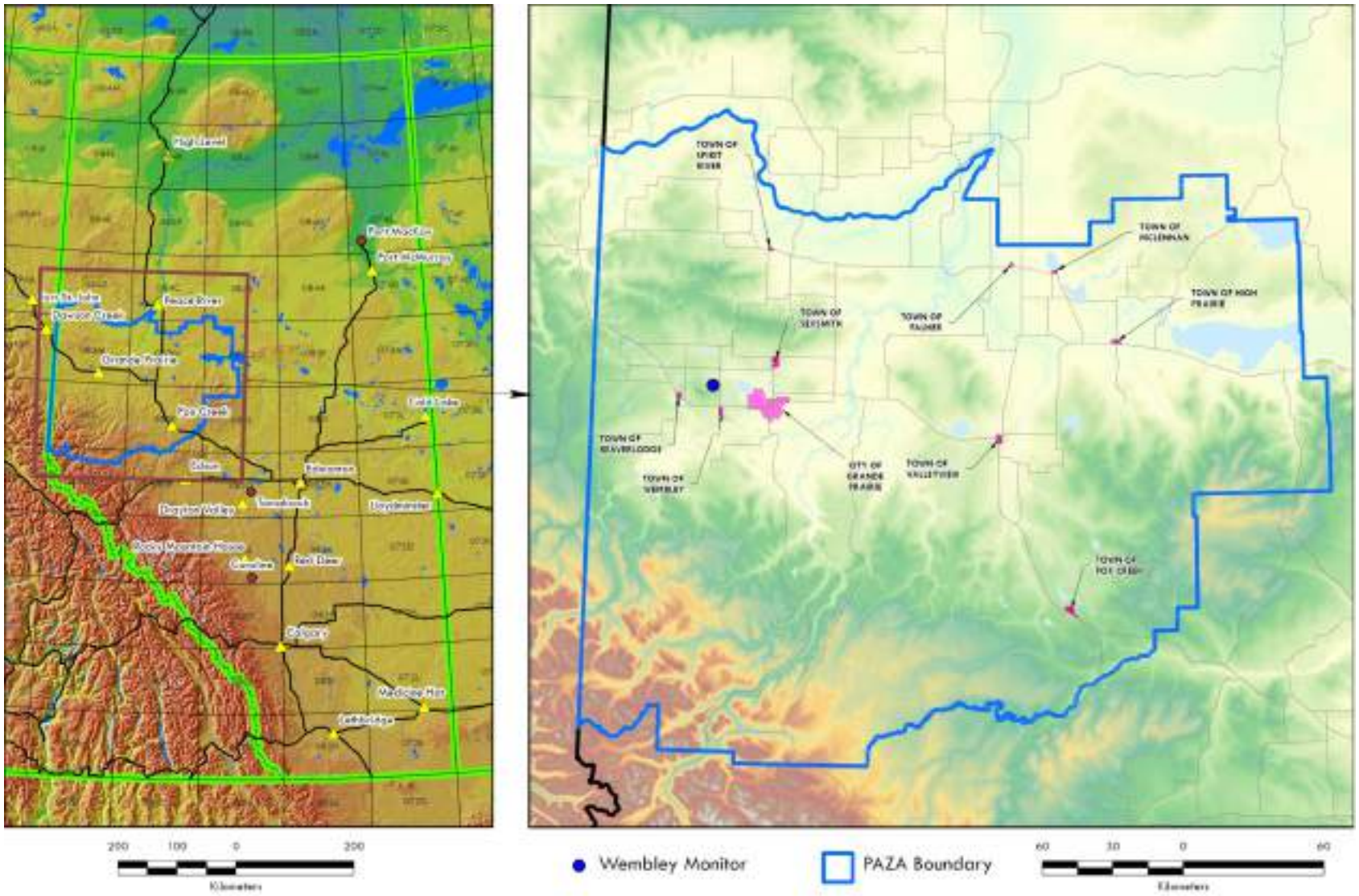


Figure 1-1 Provincial Area Map showing location Poplar and PAZA

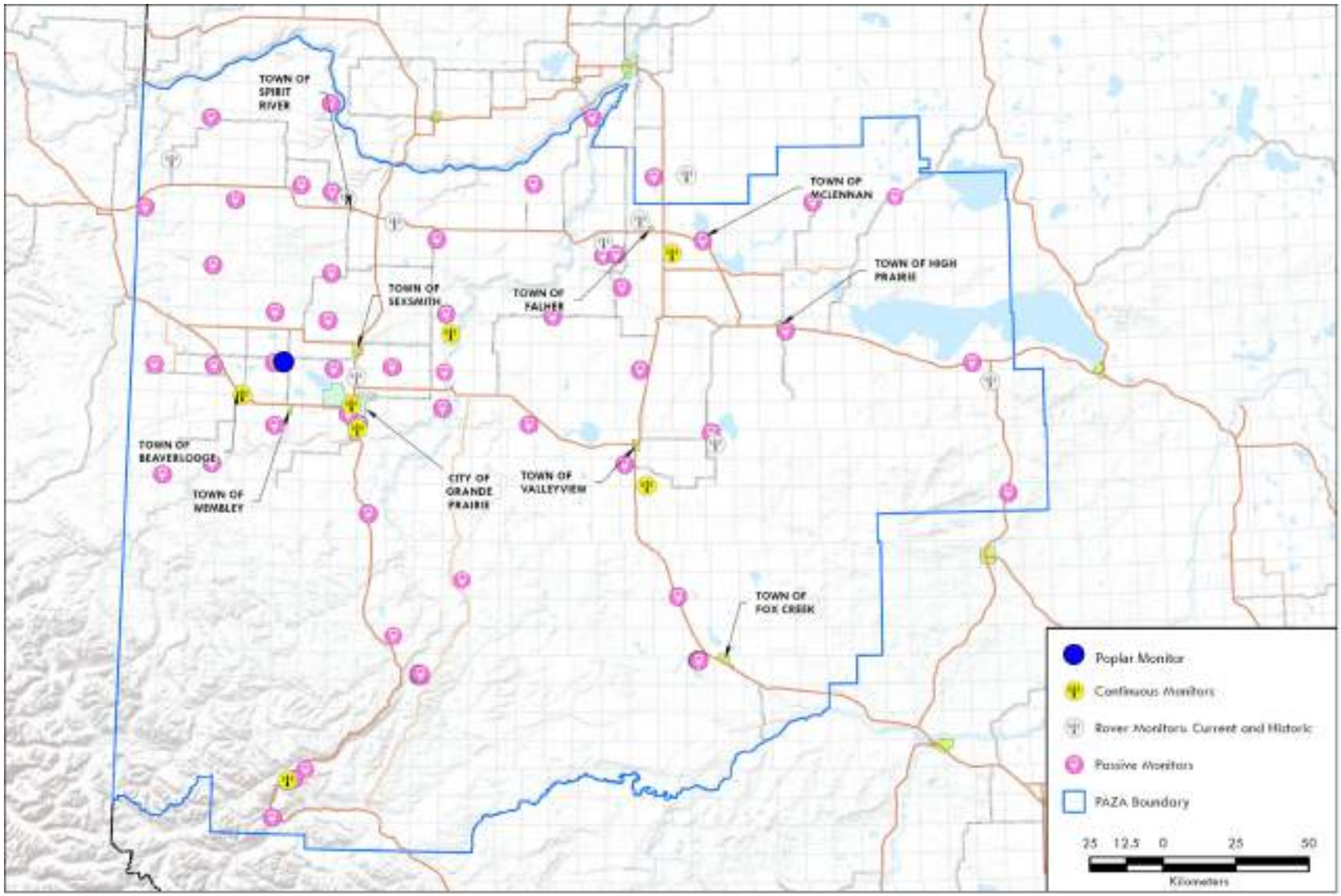


Figure 1-2 PAZA Monitoring Locations .

2. SITE SETTING

The air quality monitoring station was proposed to be located near north of Wembley and the final site location was based on the following considerations while accounting for AEPA's siting criteria. The siting criteria can be obtained from PAZA.

- Considerations
  - Current and future landowner(s)
  - Potential future land use change (avoid roads and right-of-ways)
  - All weather access
  - Power availability
  - Maximum security
- AEPA Air Monitoring Directive (AMD) Siting Criteria
  - Away from nearby emission sources such as roads, oil and gas wells/batteries, gas processing plants, maintenance/fueling areas, etc.
  - Avoid low-lying areas and high areas to prevent local air flow biases
  - An open area away from buildings and tree canopies to ensure representative flows are recorded and to ensure passive samplers are appropriately exposed
  - Stations cannot be located in pastures because of potential damage

Accounting for the above criteria and considerations, the monitor that was used for the air quality survey was placed on CNRL property by one of the pump jacks in Poplar Hill area just west of Range Road 84 and approximately 0.8 kilometres north of Highway 672. The geographic and projected coordinates of the site are:

- 55°18'15.5"N 119°11'06.8"W (NAD 83)
- 55.323310° N, 119.192517° W (NAD 83)
- 360,889 m E, 6,132,959 m N (UTM Zone 11 – NAD 83)
- Elevation:749.0 m above sea level

The monitor was located at about 30 km west-northwest of Grande Prairie and about 19 km northeast of Beaverlodge. A regional area map is shown in Figure 2-1. The terrain in the area is shown in Figure 2-2. Figure 2-3 shows the major industrial emitters in the area. There is oil and gas activity in the local area but mostly small facilities and wells. Agriculture is also a major activity in the local area.

The closest major roads are Highway 43 which runs east/west about 17 km to the south, and Highway 672 which runs east/ west about 1 km south. As well, the Canadian National railway mainline runs parallel with Highway 43. The amount of the rail traffic is not readily available.

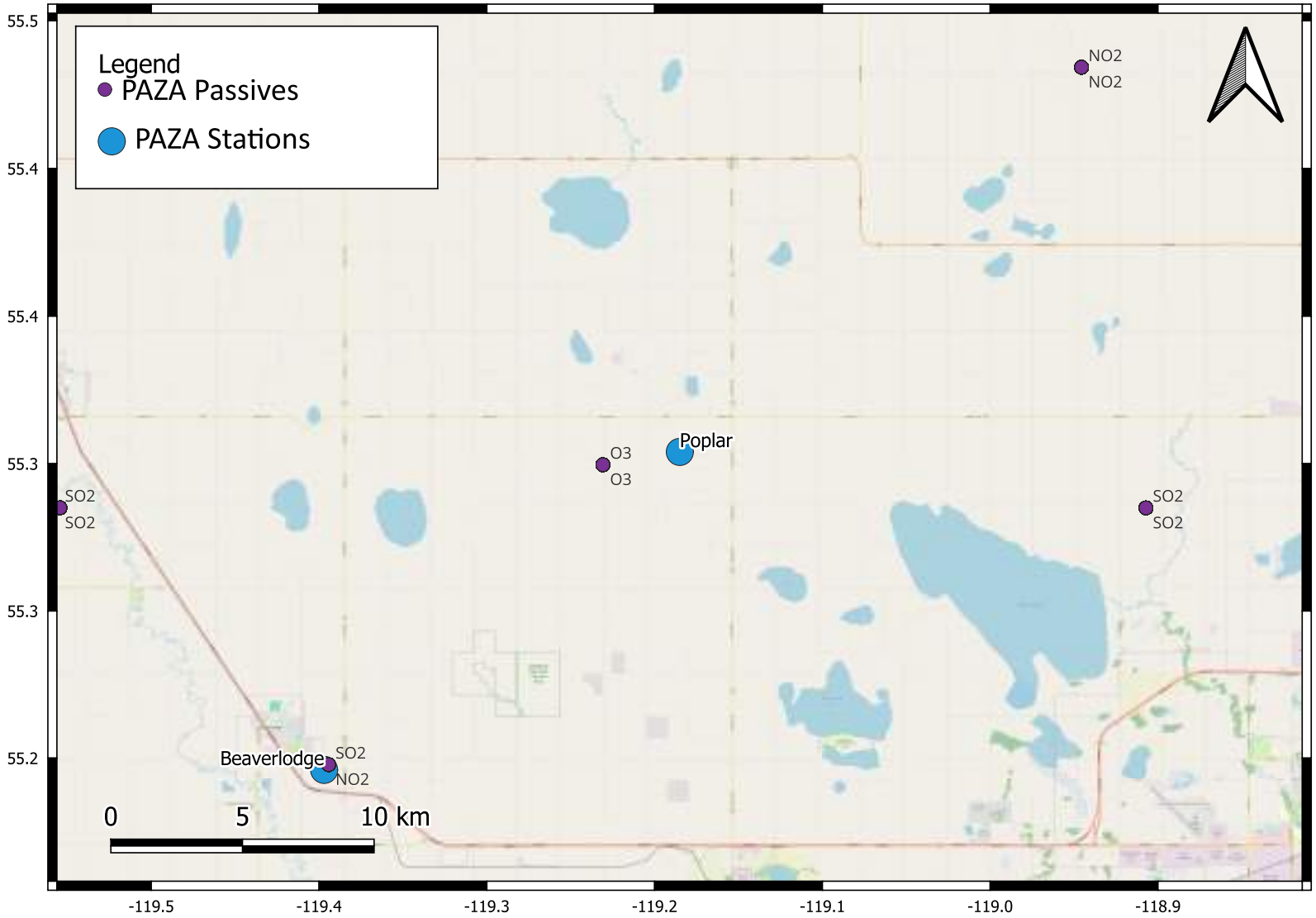


Figure 2-1 Regional setting around Poplar Monitor

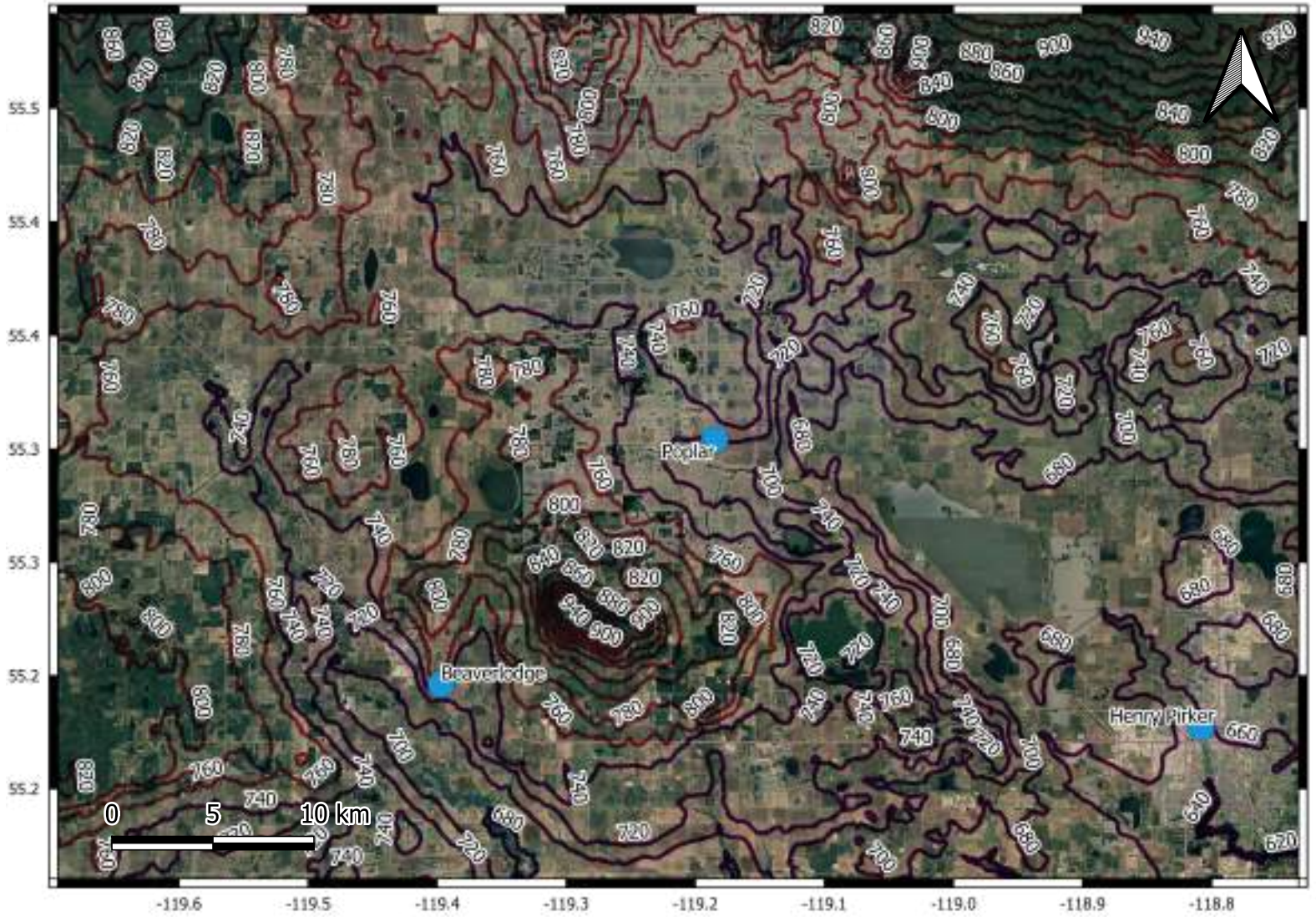


Figure 2-2 Terrain around Poplar Monitor

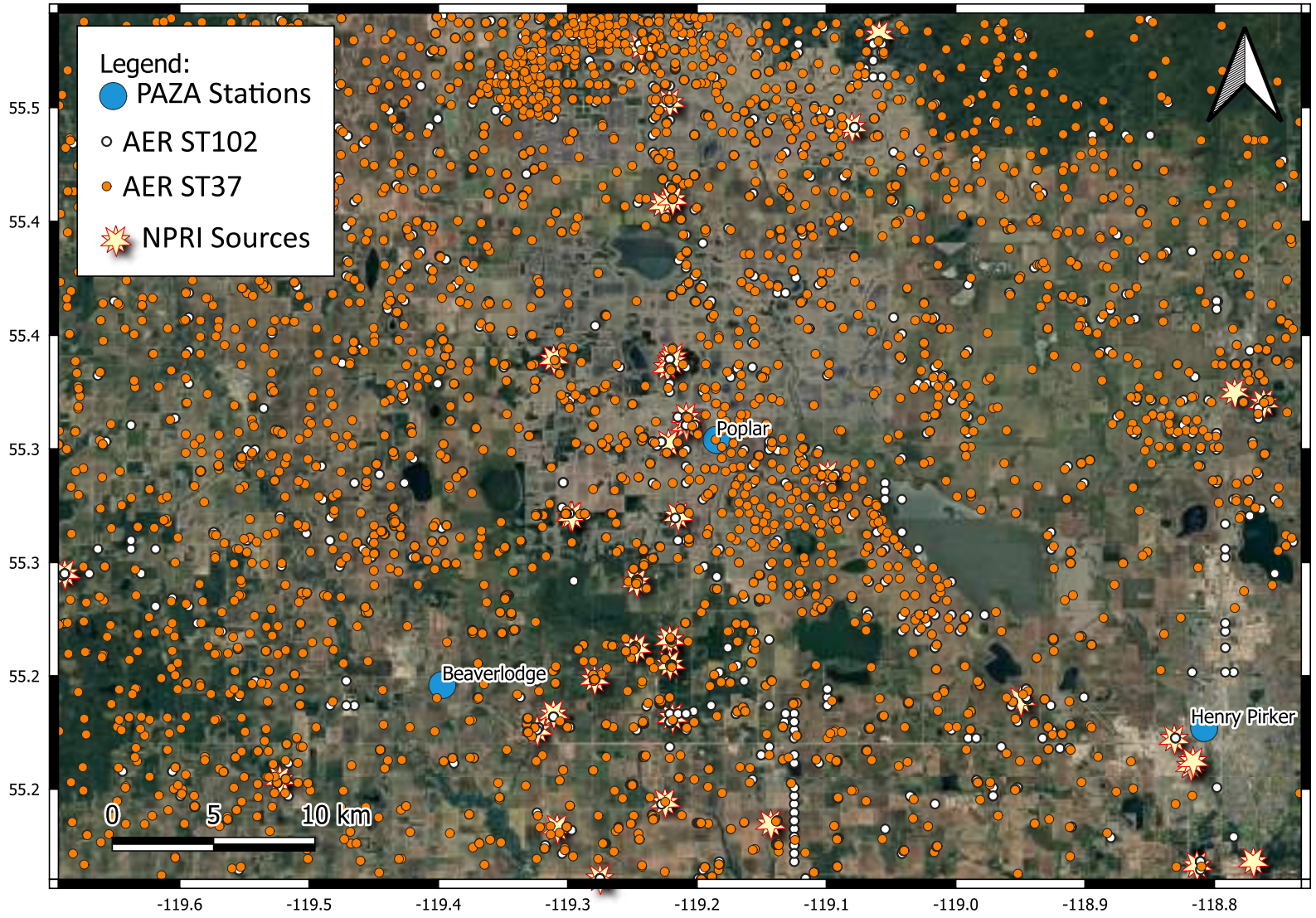


Figure 2-3 Emission Sources around the Poplar Monitoring Station

3. AIR MONITORING (PARAMETERS, EQUIPMENT, ETC)

The monitoring station equipment is described in Table 3.1. The continuous monitoring station sampled for total reduced sulphur (TRS), sulphur dioxide (SO_2), total oxides of nitrogen (NO_x), nitric oxide (NO), nitrogen dioxide (NO_2), ozone (O_3), fine particulate matter ($PM_{2.5}$), total hydrocarbons (THC), methane (CH_4), non-methane hydrocarbons (NMHC) and meteorology (wind speed, wind direction, and ambient temperature). Sampling occurred every second and 1-hour averages were calculated from the 1 second samples. The data acquisition system used was the CR3000. The monitoring station operated from October 2, 2021 08:00 to April 30, 2024 13:00 (22,589 hours).

The continuous monitoring equipment was operated according to the AEPA Air Monitoring Directive[2] (AMD) including daily instruments checks, monthly multipoint calibrations, and annual audits conducted by AEPA.

The Contractor's Standard Operating Procedures (SOPs) contain information on completeness, lower detection limits, ranges, accuracy, detection and calibration methods, and zero and span deviations.. SOPs for each of the parameters measured are listed in Table 3.1. For more information on SOPs please contact PAZA.

Continuous monitoring equipment uptime and downtime during the Poplar air quality monitoring survey is presented in Table 3.2. All parameters had uptimes of greater than 90%, except for CH_4/NMHC (18.2%). A figure showing the local area around the site is shown in Figure 3-1. Photos of the monitoring station and views from it are shown in Figure 3-2.

[2] https://www.alberta.ca/air-monitoring-directive.aspx

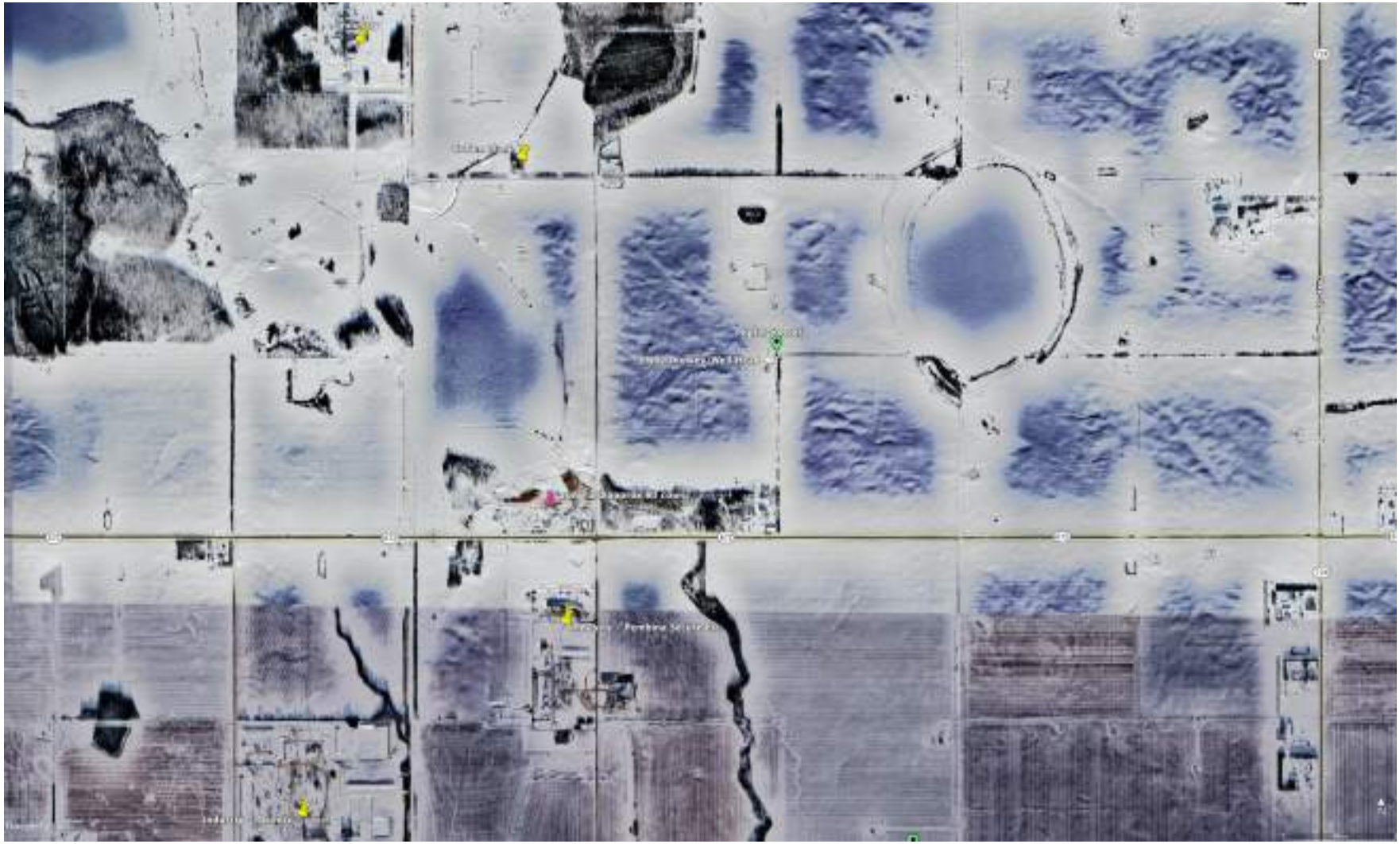
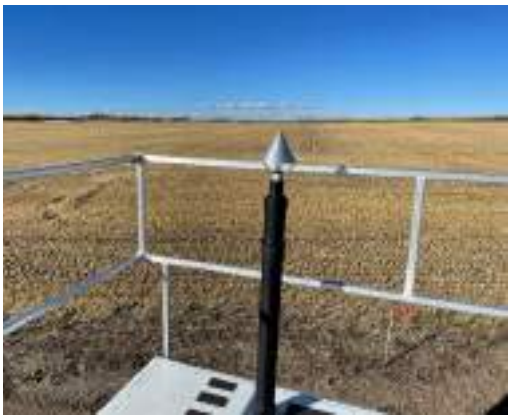
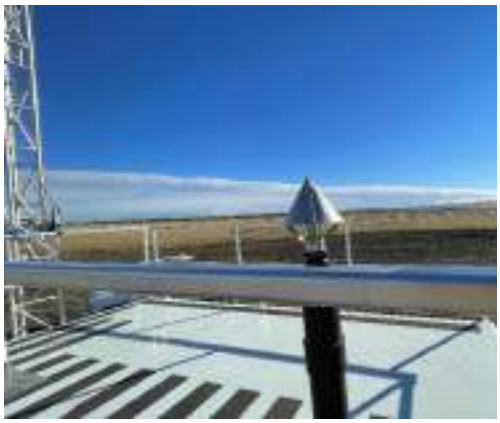
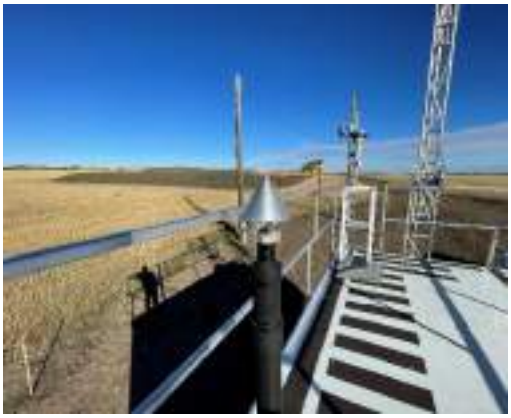


Figure 3-1 Local Area around Monitoring Site


Looking North


Looking South


Looking East


Looking West


Monitoring Trailer

Figure 3-2 Views from and of Poplar Monitoring Station

Table 3.1 Monitoring Station Equipment Description

Parameter	Instrument Make and Model	Units of Measure	Sampling Height (m)	Standard Operating Procedures Document
TRS	TEI / 43-I with oxidizer(s/n:536)	Parts per billion (ppb)	4	WAQP-1.002
SO_2	TECO/43i	ppb	4	WAQP-1.001
Oxides of Nitrogen (NO, NO_2, NO_x)	TECO/42i	ppb	4	WAQP-1.003
O_3	TECO/49i	ppb	4	WAQP-1.004
$PM_{2.5}$	TEOM, Thermo/ 1400AB; Sensor Unit (Removed on September 7, 2023) API T640 (installed on September 7, 2023)	$\mu g/m^3$	4	WAQP-1.011
Hydrocarbons (THC, CH_4, NMHC)	TEI 55i-A3PHAA (removed on February 14, 2022) TEI 51Li-LT (installed on March 8, 2022)	Parts per million (ppm)	4	WAQP-1.006
Wind Speed	Met One 50.5H Sonic	km/hr	10	WAQP-2.002
Wind Direction	Met One 50.5H Sonic	Degrees direction from	10	WAQP-2.002
Temperature	Met One 064-2	°C	4	WAQP-2.006

Table 3.2 Monitoring Equipment Measurement Uptime

	TRS	SO_2	NO_x	$PM_{2.5}$	O_3	THC	CH_4 and NMHC	Temperature	Wind Speed	Wind Direction
Start Date	10/02/21	10/02/21	10/02/21	10/02/21	10/02/21	10/02/21	10/02/21	10/02/21	10/02/21	10/02/21
End Date	04/30/24	04/30/24	04/30/24	04/30/24	04/30/24	04/30/24	12/12/22	04/30/24	04/30/24	04/30/24
Valid Measurement	22,251	22,428	22,324	21,868	22,370	20,944	4,105	22,411	22,183	22,183
No Measurement	339	162	266	722	220	1646	18,463	179	407	407
Uptime (%)	98.5%	99.3%	98.8%	96.8%	99.0%	92.7%	18.2%	99.2%	98.2%	98.2%

4. AMBIENT AIR QUALITY OBJECTIVES

4.1 Alberta

The Alberta Ambient Air Quality Objectives (AAAQOs) and Guidelines (AAAQGs) for the pollutants that were measured are shown Table 4.1[3]. Objectives are used to determine adequacy of facility design, to establish required stack heights and other emission release conditions, and to assess compliance and evaluate facility performance. Guidelines may be used for airshed planning and management, as a general performance indicator, and to assess local concerns. There are currently no AAAQOs for TRS. However, hydrogen sulphide (H_2S) and carbon disulphide (CS_2) are classified as reduced sulphur compounds and have AAAQOs. Of the oxides of nitrogen compounds measured, only NO_2 has AAAQOs.

There are no AAAQOs for CH_4, THC (or some of its other main constituents such as ethane or propane) nor NMHC. AAAQOs do exist for specific NMHCs such as benzene. However, concentrations of specific hydrocarbon concentrations cannot be inferred from the data collected.

Except for O_3, the AAAQO are directly comparable to measured or modelled concentrations.

Table 4.1 Alberta Ambient Air Quality Objectives (AAAQO)and Guidelines (AAAQG).

Pollutant	Averaging Period				
	1-hr (ppb)	8-hr (ppb)	24-hr (ppb)	30 day (ppb)	Annual (ppb)
TRS[1]	10 (H_2S) 10 (CS_2)	-	3 (H_2S)		
SO_2	172	-	48	11	8
NO_2	159	-	-	-	24
O_3	76[2]		-	-	-
$PM_{2.5}$ ($\mu g/m^3$)	80 (AAAQG)	-	29	-	

Note
1. At the time of this deployment, there were no AAAQO or AAAQG for TRS
2. The 1-hour daily maximum.

[3] https://open.alberta.ca/publications/9781460134856

5. MONITORING RESULTS

This report provides an overall summary of the monitoring data; the detailed one-hour monitoring data results are available on the PAZA website, monthly and annual reports and at the AEPA Air Data Warehouse[4].

In the sections that follow, several summary statistics are used in the discussion of monitoring results including the average, maximum, minimum, and percentile concentrations. An n^{th} percentile concentration indicates that n percent of data are less than that concentration, and (100 – n) percent of data are greater than that concentration. For example, a dataset with a 90^{th} percentile concentration of 50 ppb indicates that 90 % of the data will be less than 50 ppb and 10 % percent of the data will be greater than 50 ppb.

Frequency distributions and data distributions by wind direction known as wind, pollution or data roses (depending on the data being analyzed) are presented to help identify potential sources of pollutants.

Comparison with other areas of the province was undertaken using ambient measurements from other air monitoring locations for the same time period as the Poplar monitoring.

Also included is a comparison of monthly averages from the closest PAZA passive monitoring station for SO_2 and NO_2. The closest passive station to the Poplar monitoring location is the Poplar passive station which is approximately 3.5 km to the southwest.

[4] http://airdata.alberta.ca/

5.1 Meteorology

The following figures illustrate the meteorological conditions recorded at the Poplar monitoring station during the period October 2, 2021 16:00 to April 30, 2024 12:00. Figure 5-1 shows that the most frequent winds were from the westerly sector. This pattern is consistent with the terrain in the region. Figure 5-2 shows the monthly temperature and wind speed distributions. Figure 5-3 displays a scatter plot of wind speed versus standard deviation of wind direction which shows a typical pattern of the lower wind direction variance at higher wind speeds and vice versa. Overall, the data is considered to provide a good representation of the meteorology for that area of the province.

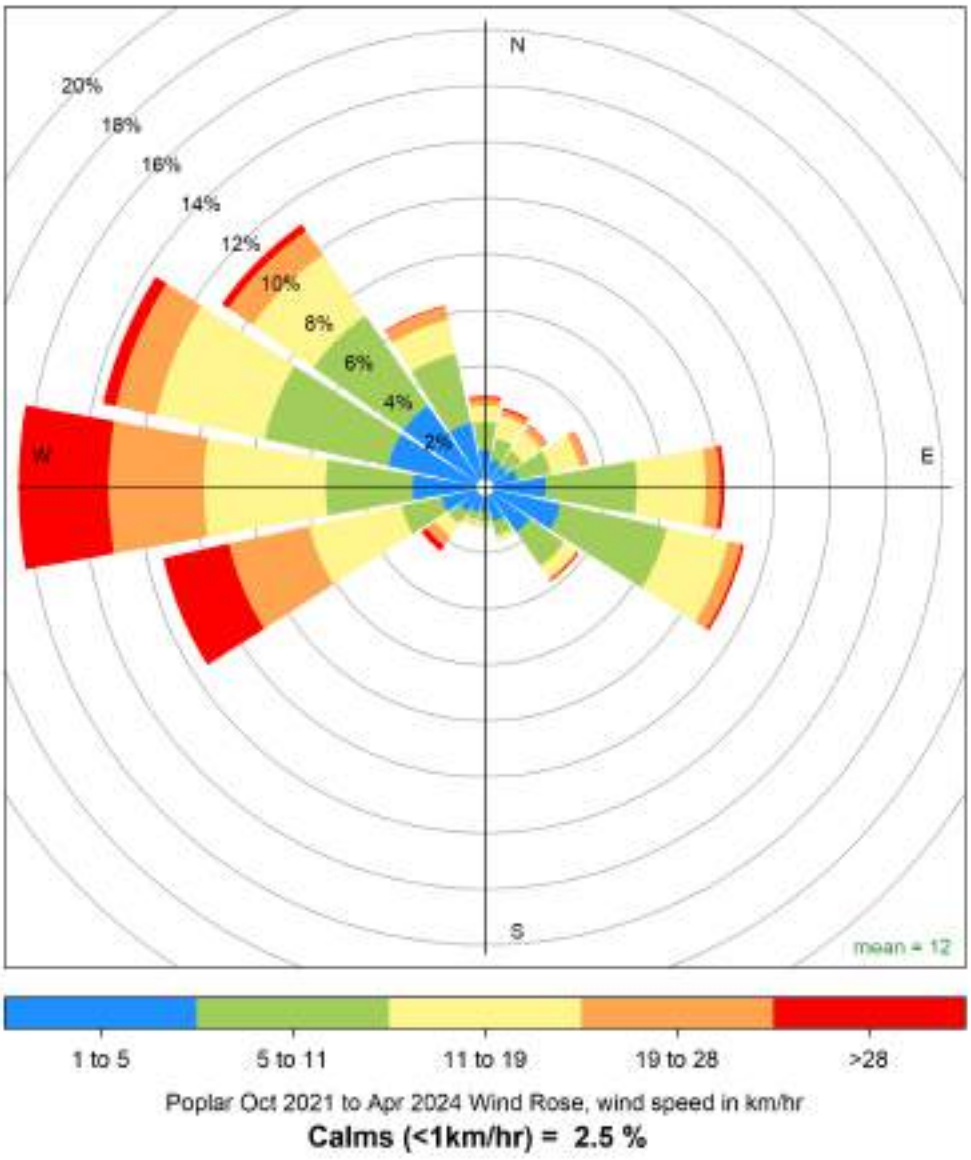


Figure 5-1 Wind Frequency Distribution at Poplar Monitoring Station

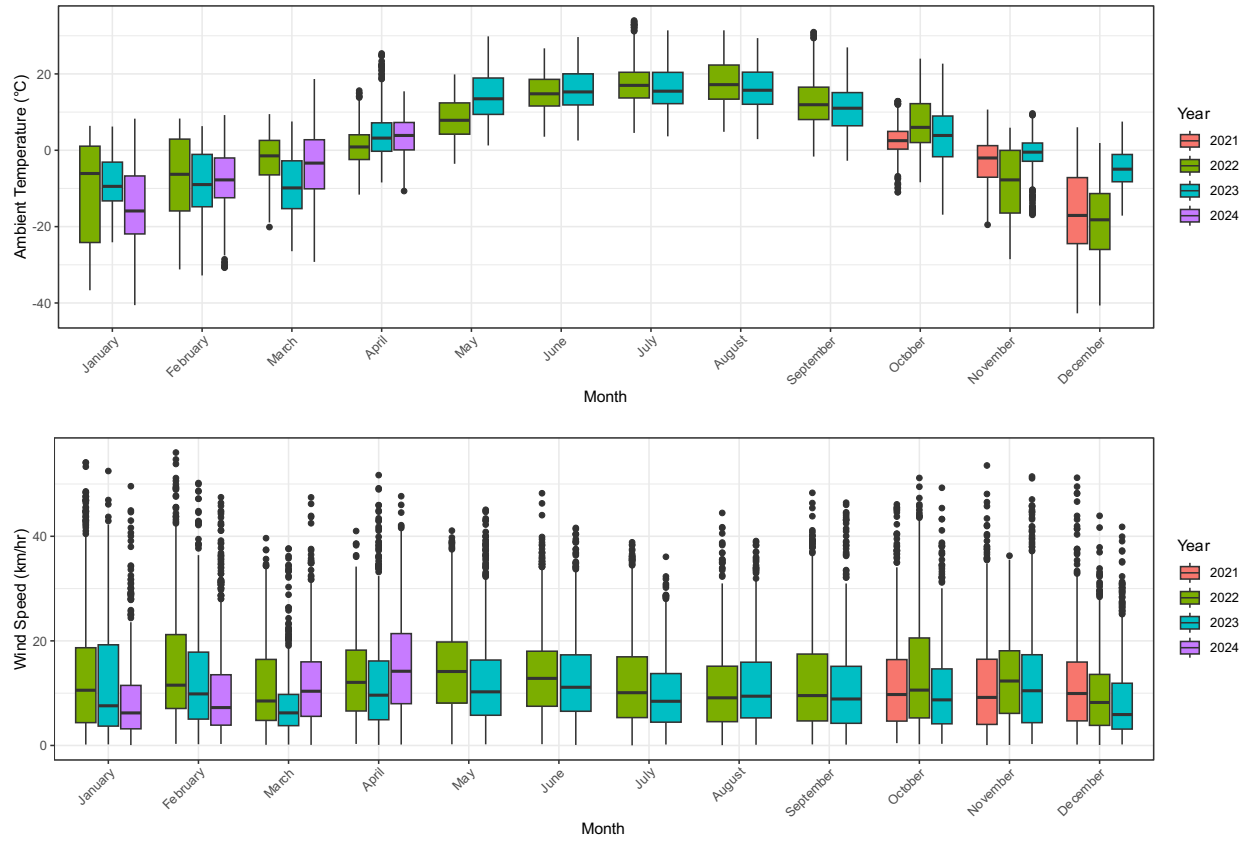


Figure 5-2 Monthly Temperature and Wind Speed Distribution Measured at Poplar Monitoring Station

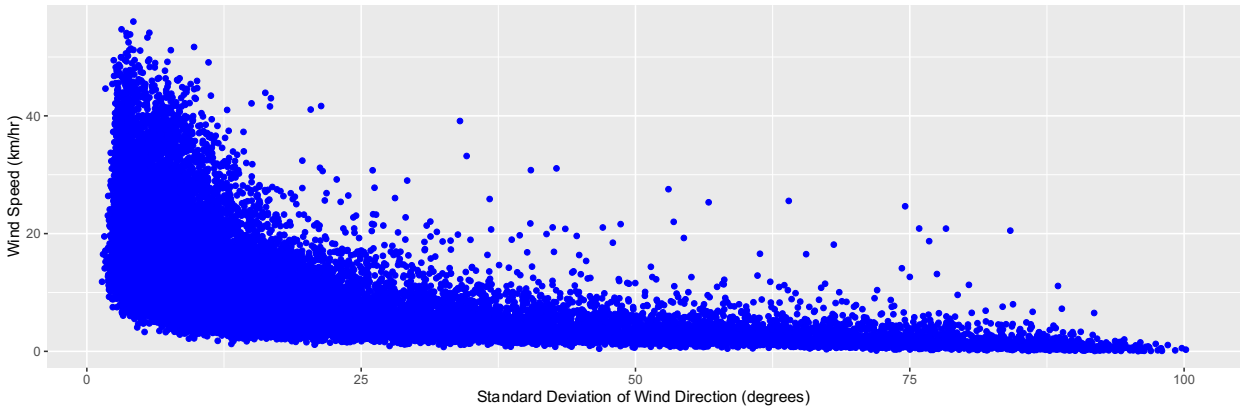


Figure 5-3 Wind Speed versus Standard Deviation of Wind Direction

5.2 Total Reduced Sulphur Compounds

Reduced sulphur compounds are a complex family of substances. They are defined by the presence of sulphur in a reduced state and are generally characterized by strong odours at relatively low concentrations. Total reduced sulphur compounds (TRS) includes hydrogen sulphide (H_2S), carbon disulphide (CS_2), mercaptans, dimethyl sulphide, dimethyl disulphide and other compounds. Sulphur dioxide (SO_2) is not a reduced sulphur compound.

As noted earlier in Table 4.1, during the monitoring period there were no AAAQO for TRS. However, there are AAAQOs for H_2S and CS_2 which are based on odour thresholds. H_2S is known to have highly toxic properties, and can cause negative health effects at even low concentrations.

Natural sources of reduced sulphur compounds in air include volcanoes and sulphur springs, oceans and estuaries, and exposed faces of sulphur-containing oil and coal deposits. The primary anthropogenic sources include sour oil and gas processing facilities, kraft pulp mills, chemical manufacturing plants, and livestock operations. TRS can be produced when manure undergoes anaerobic (absence of oxygen) fermentation.

In the area around the monitor, the main local sources of TRS emissions would likely be the oil and gas industry and agricultural practices. Municipal sources such as landfills and sewage lagoons can also emit TRS; however, the existence of such sources near the monitor was not investigated. As well, swamps and sloughs can be natural sources of TRS. A map of facilities with reported National Pollutant Release Inventory (NPRI) TRS emissions of greater than 0.5 t/y is shown in Figure 5-4.

A summary of TRS measurements are shown in Table 5.1 and the time series of measurements are shown in Figure 5-5. The measurements show that the AAAQO (H_2S and CS_2) were not exceeded during the monitoring period. Only nine occurrences in excess of 2 ppb were measured. Figure 5-6 presents a time series of the data with statistics of the 1-hour measurements shown for each month.

Figure 5-7 and Figure 5-8 show the statistical concentrations as a function of wind direction (not including winds of less than 1 m/s). The highest measurements occurred for winds from northwest and southeast directions indicating that this location may be affected from many different sources. Overall, the measurements indicate that TRS appears to be fairly ubiquitous in the area with winds from the southeast giving the highest average measurements.

Figure 5-9 presents the TRS measurements as a function of hour of day. In general, TRS measurements tended to be higher in the early morning hours and lower during the day which tend to suggest impacts that of ground level sources.

Figure 5-10 provides a comparison of TRS measurements from other monitoring stations in the province for the same time period. TRS is not a commonly measured suite of pollutants and would usually be measured in areas where TRS compounds are present and considered important from a local perspective. The figure shows that the measurements at Poplar station are similar to other areas where TRS are measured. The ambient TRS data measured at Poplar station appears

to adequately reflect the general rural setting with a minor influence from local and distant industry.

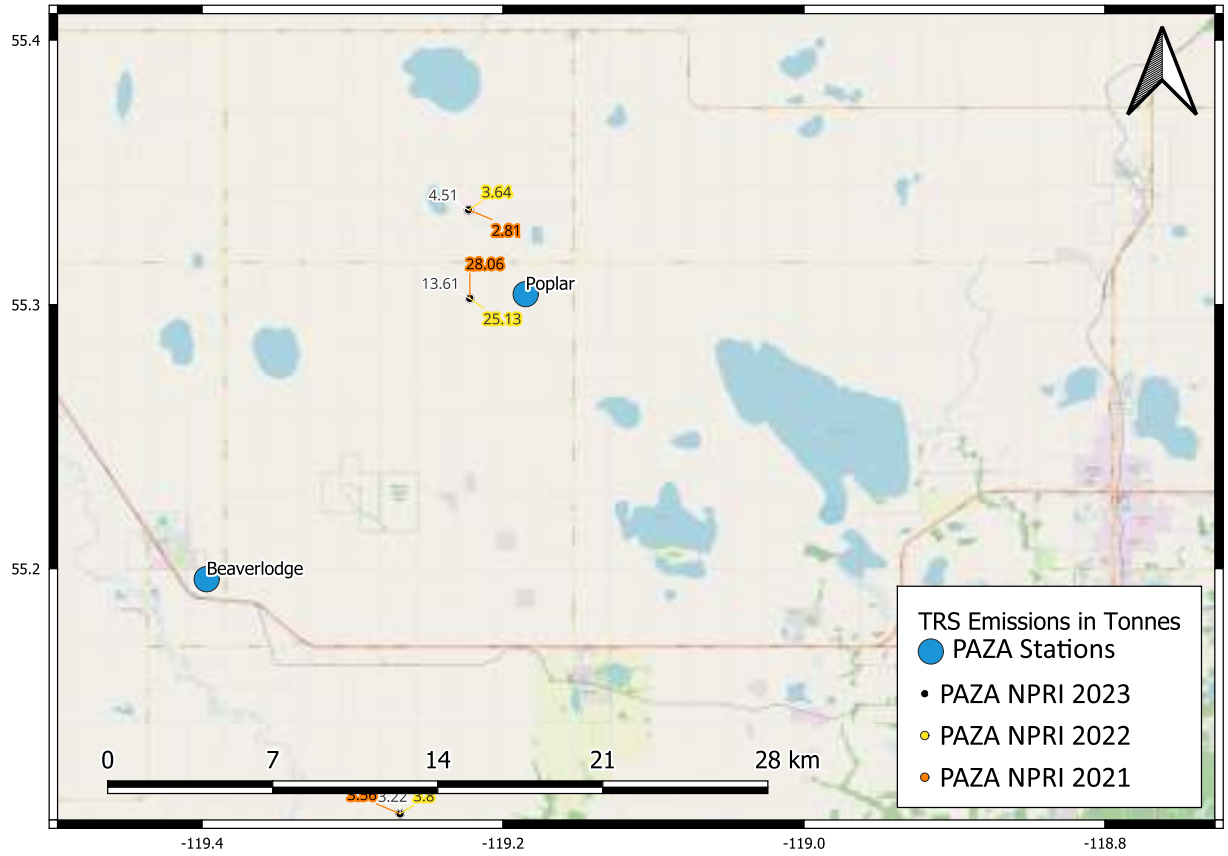


Figure 5-4 Facilities with NPRI Reported TRS Emissions greater than 0.5 t/y

Table 5.1 Summary of TRS Measurements (ppb) at Poplar Monitoring Station

	2021[a]	2022	2023	2024[b]	Period
Maximum 1-hour Measurement	20.1	16.9	26.6	17.2	26.6
95th Percentile Measurement	1.0	1.2	1.2	1.2	1.2
Median (50th Percentile) Measurement	0.4	0.4	0.4	0.6	0.4
Average Measurement	0.5	0.5	0.5	0.7	0.5
Maximum 24-hour Average Measurement	2.5	3.5	1.9	1.7	3.5
Counts above AAAQO					
1-hour AAAQO (using H_2S, 10 ppb)	1	11	4	1	17
24-hour AAAQO (using H_2S, 3 ppb)	0	1	0	0	1

a. October 2, 2021 to December 31, 2021

b. January 1, 2024 to April 30, 2024

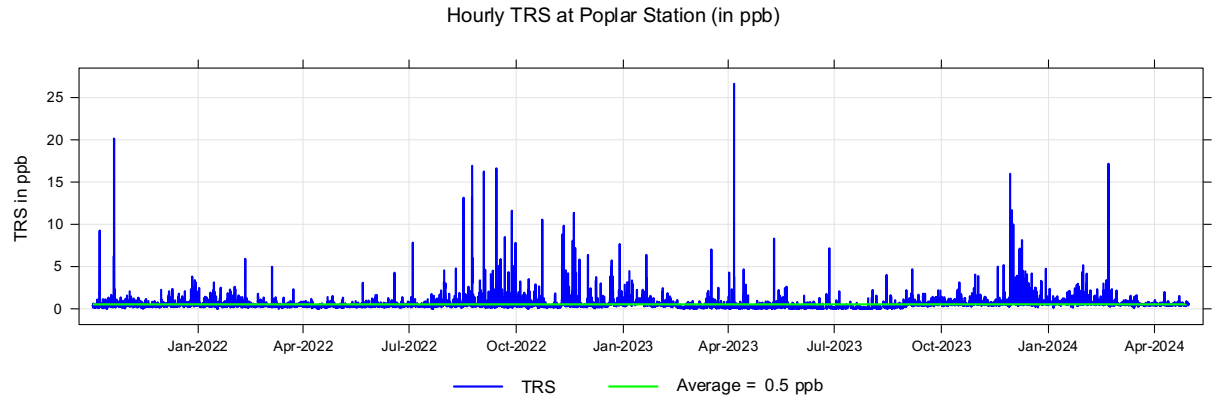


Figure 5-5 Time Series of the Hourly TRS Measurements

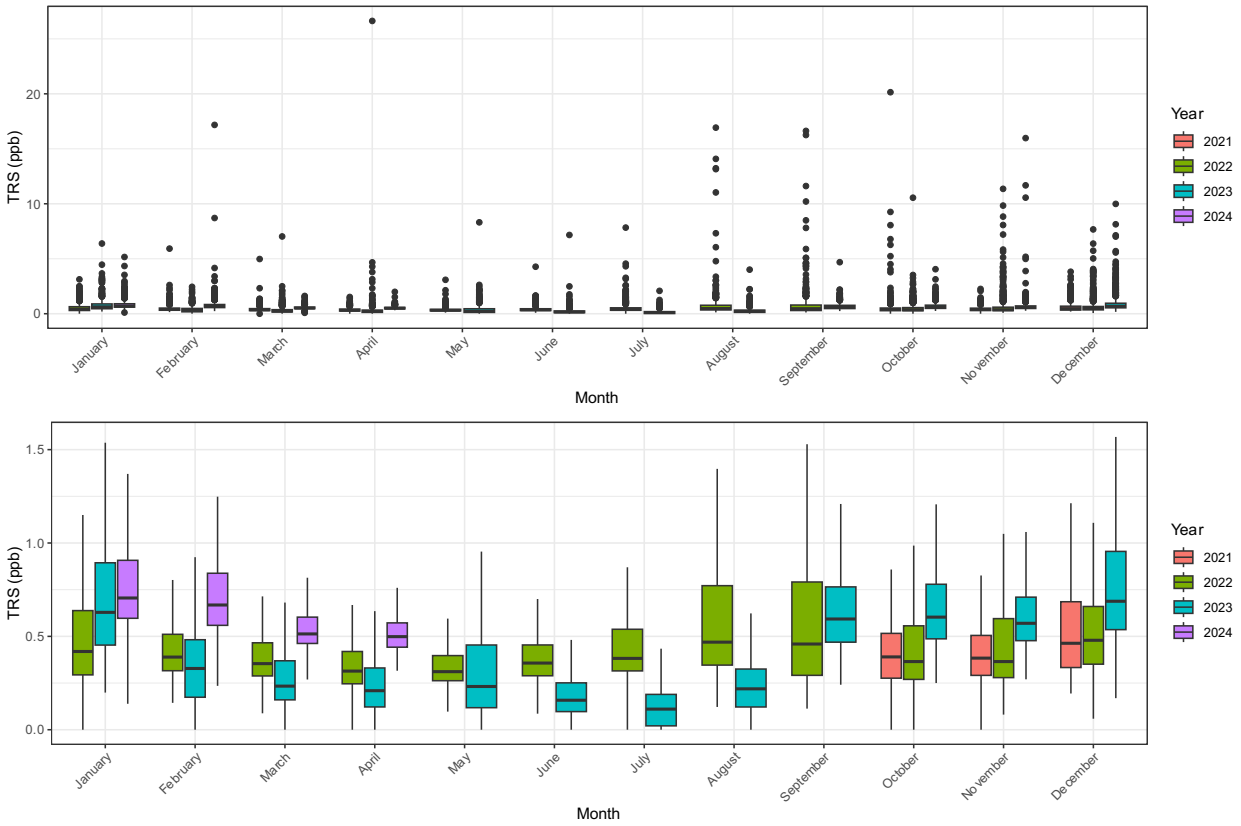


Figure 5-6 Monthly Time Series of the Hourly TRS Measurements

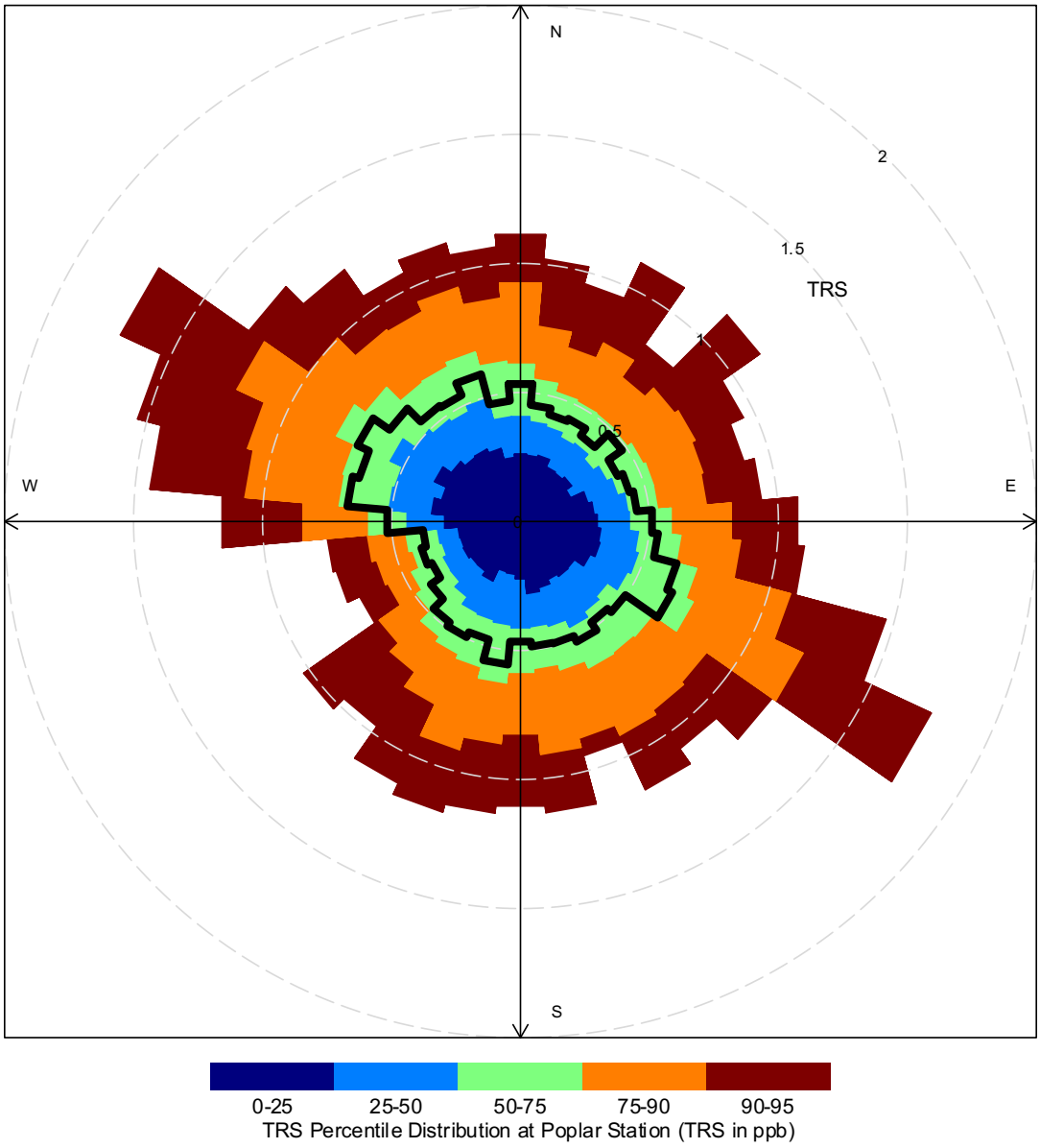


Figure 5-7 TRS Measurements by Wind Direction

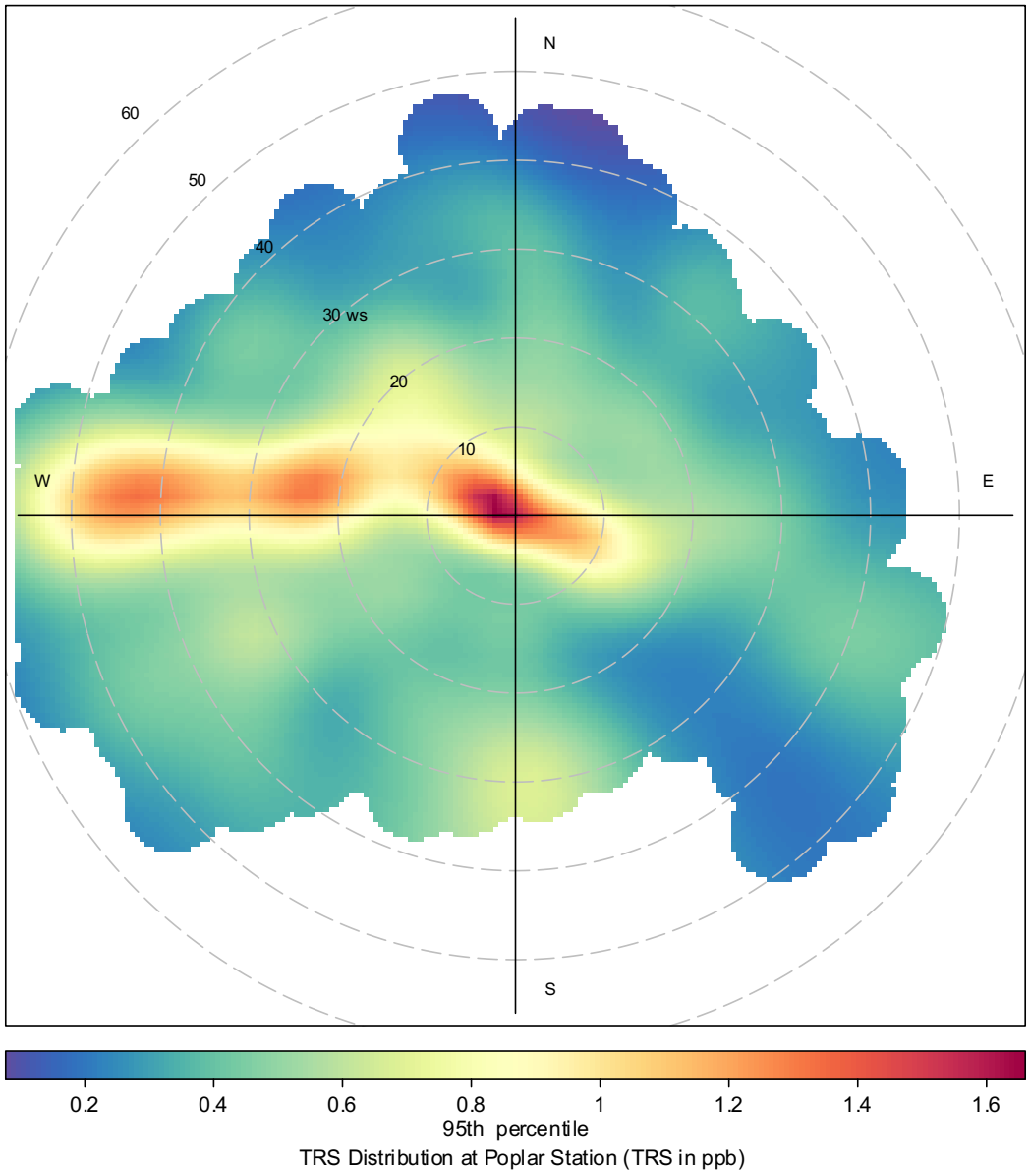


Figure 5-8 TRS Measurements by Wind Direction

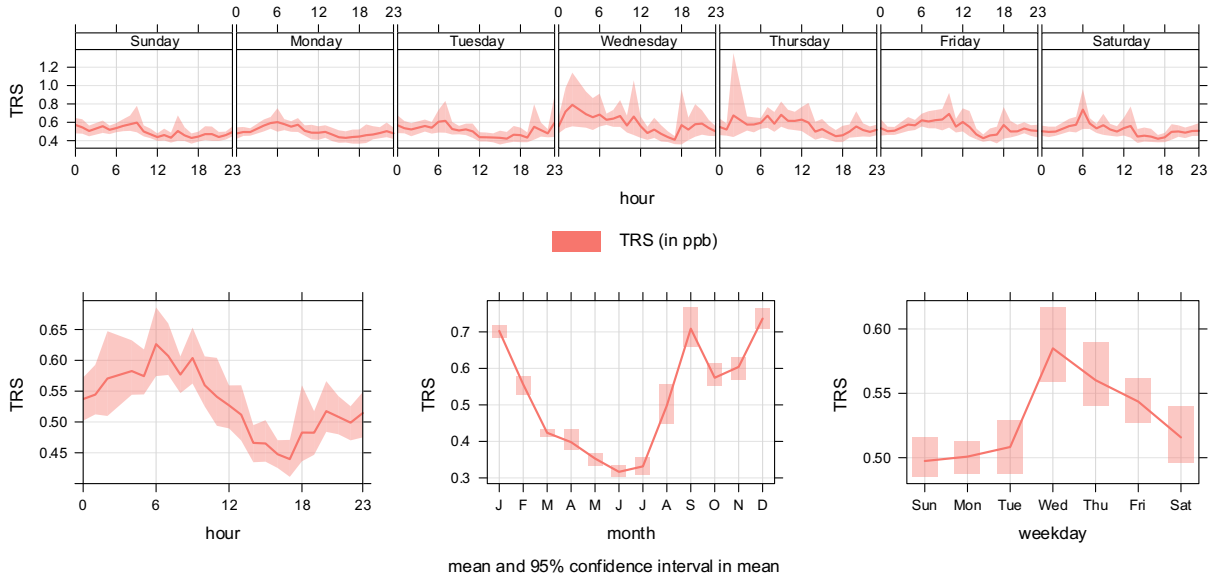


Figure 5-9 TRS Measurements by Hour of Day

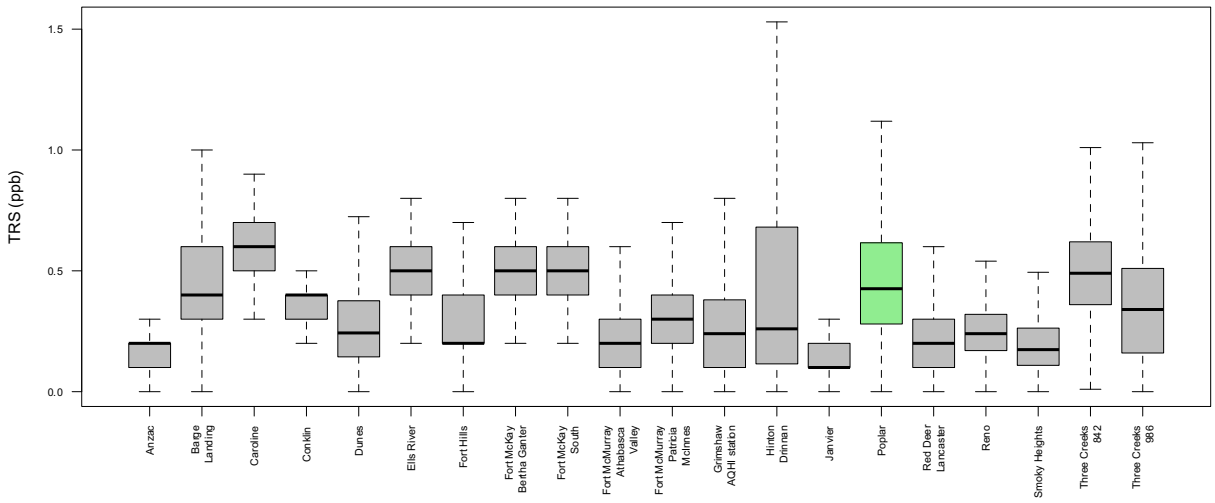


Figure 5-10 Comparison of TRS/H_2S Measurements from other Continuous Monitoring Stations (Mean values shown).

5.3 Sulphur Dioxide

Sulphur dioxide is a colourless, non-flammable gas with a sharp, pungent odour. Natural sources include volcanoes, decaying organic matter and solar action on seawater. The most significant anthropogenic emission sources of sulphur dioxide are from combustion of sulphur-containing fossil fuels, smelting sulphide ores, and petroleum refining. Other less significant sources include chemical and allied products manufacturing, metal processing, other industrial processes, and vehicle emissions.

Once sulphur dioxide is released into the atmosphere, it may be converted to other compounds and/or removed from the atmosphere by various mechanisms. Processes such as oxidation, wet deposition, dry deposition, absorption by vegetation and by soil, dissolution into water and other processes contribute to the removal of sulphur dioxide from the atmosphere. Exposure to high enough concentrations of SO_2 can affect human and environmental health.[5] A map of facilities with reported NPRI SO_2 emissions of greater than 1 t/d is shown in Figure 5-11.

A summary of SO_2 measurements are shown in Table 5.2. The measurements were well below the SO_2 AAAQO in all instances. The time series of measurements are shown in Figure 5-12. Figure 5-13 presents a time series of the data with statistics of the 1-hour measurements shown for each month. A slight increase in concentrations during the colder months is noted.

Figure 5-14 and Figure 5-15 shows the statistical concentrations as a function of wind direction. The highest measurements are occurring under winds from west-northwest and north directions. Overall, the highest average concentrations are occurring under winds from west-northwest.

Figure 5-16 presents the SO_2 measurements as a function of hour of day. In general, SO_2 measurements tended to be higher in the day and lower during the night. This tends to suggest that elevated sources may be the main contributor.

Figure 5-17 shows the average monthly SO_2 concentrations with the closest passive station (Poplar). The figure shows that for the most part the average monthly concentrations are noticeably higher, but follow a similar trend with the measurements from the closest passive monitor. For a few months, the passive monitor measured significantly higher levels. The reasons for this were not investigated.

Figure 5-18 provides a comparison of SO_2 measurements from other monitoring stations in the province for the same time period. The figure shows that the measurements at Poplar were comparable to other areas where SO_2 is measured.

The data indicates that SO_2 levels around Poplar are generally low inferring that there are no significant local sources of SO_2. The slight bias of higher concentrations toward certain wind directions may be a sign of influence from major SO_2 emitters in the regional area as seen in Figure 5-11.

[5] https://open.alberta.ca/publications/ambient-air-quality-objectives-sulphur-dioxide

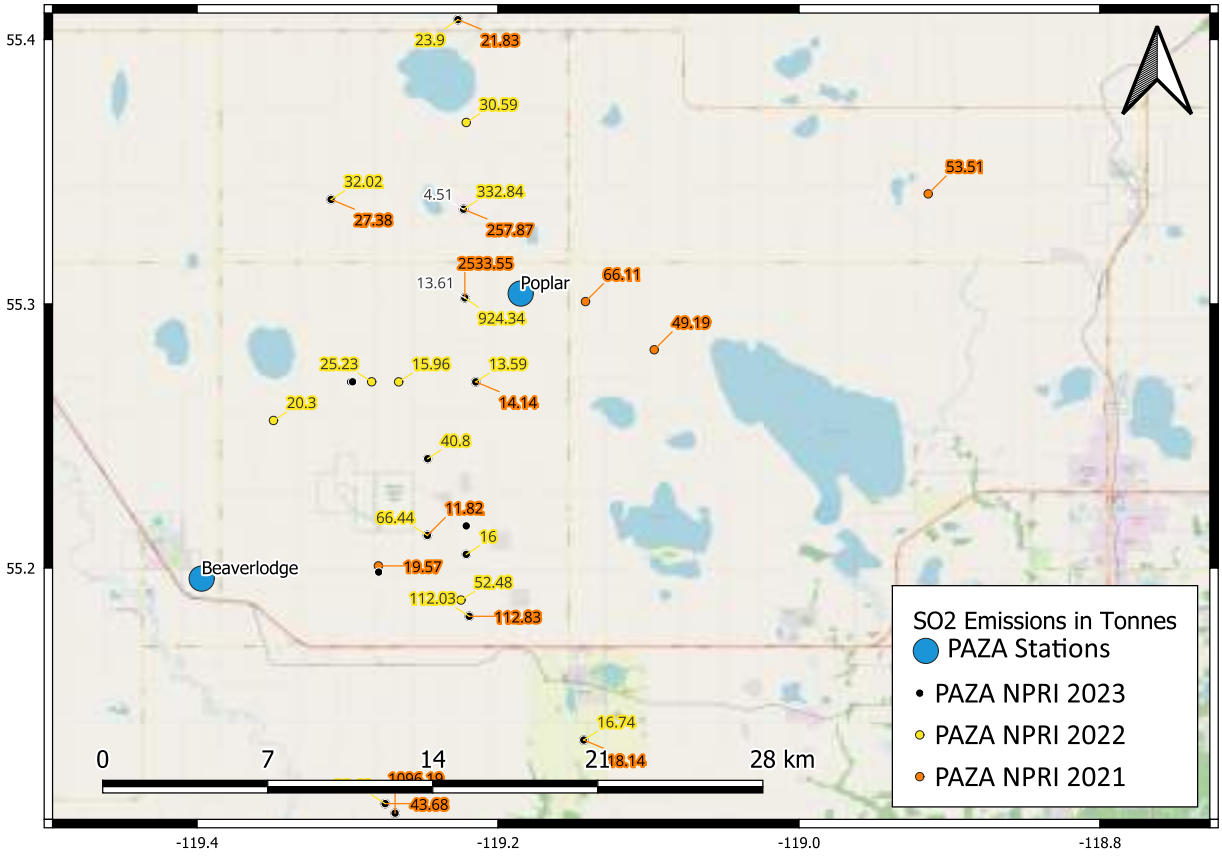


Figure 5-11 Facilities with NPRI Reported SO_2 Emissions greater than 1 t/d

Table 5.2 Summary of SO_2 Measurements (ppb) at Poplar Monitoring Station

	2021[a]	2022	2023	2024[b]	Period
Maximum 1-hour Measurement	26.0	76.7	58.0	42.4	76.7
95th Percentile Measurement	3.2	3.8	4.2	3.9	3.9
Median (50th Percentile) Measurement	0.5	0.5	0.6	0.7	0.6
Average Measurement	1.0	1.1	1.2	1.2	1.1
Maximum 24-hour Average Measurement	3.4	11.0	6.3	3.5	11.0
99th Percentile of Daily 1-hour Maximums[c]	1.1	1.8	1.8	1.6	1.8
Maximum Month Average	26.0	76.7	58.0	42.4	76.7
Counts above AAAQO					
1-hour AAAQO (172 ppb)	0	0	0	0	0
24-hour AAAQO (48 ppb)	0	0	0	0	0
30-day AAAQO (11 ppb)	0	0	0	0	0
Annual AAAQO (8 ppb)	0	0	0	0	0

a. October 2, 2021 to December 31, 2021

b. January 1, 2024 to April 30, 2024

c. Based on 3-year average of the annual 99th percentile of daily maximum 1-hour average concentrations

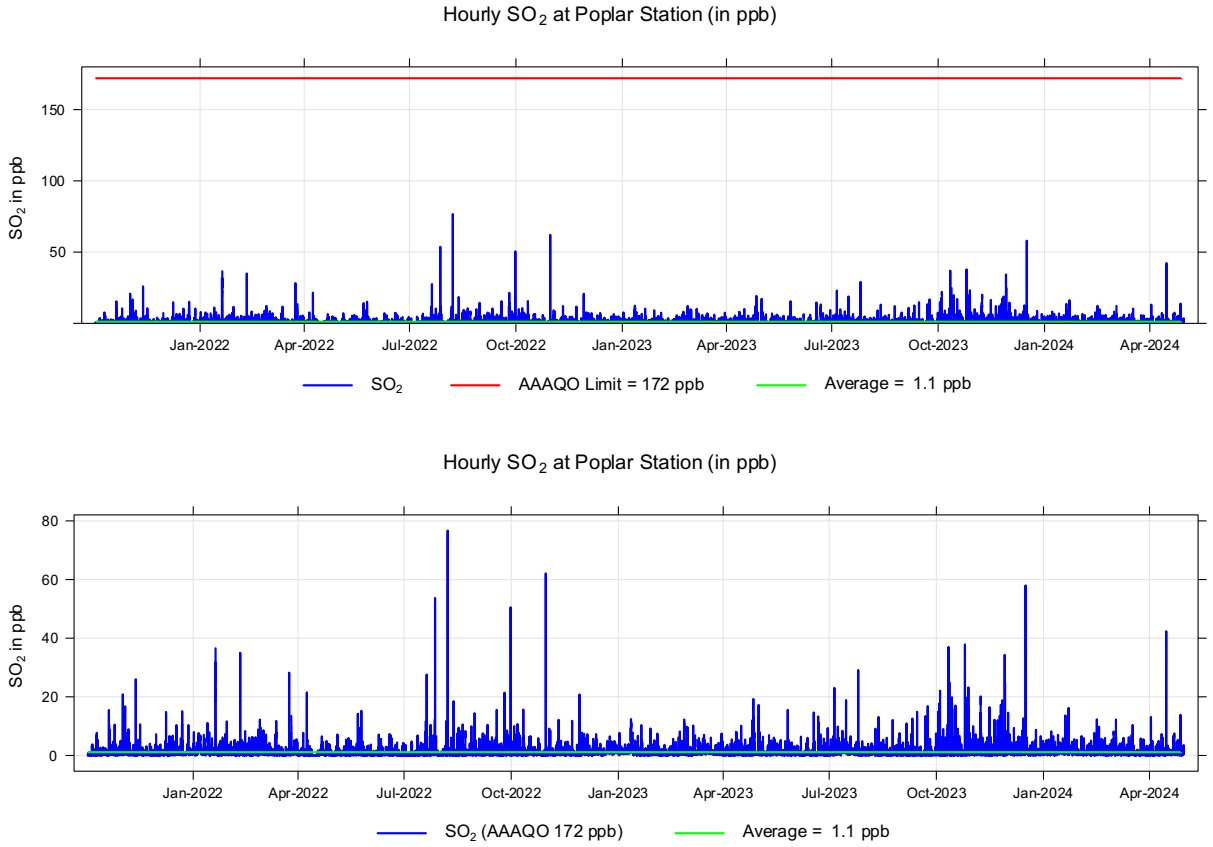


Figure 5-12 Time Series of the Hourly SO_2 Measurements

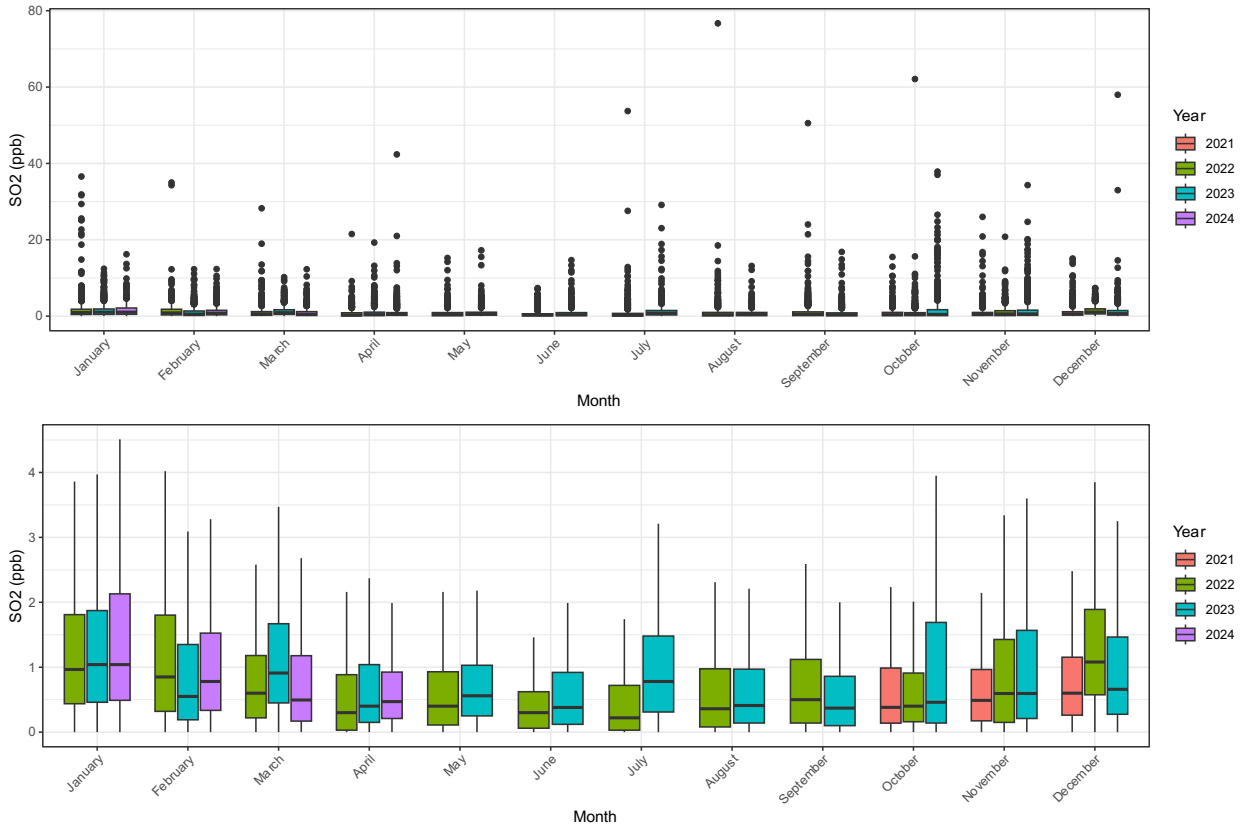


Figure 5-13 Monthly Time Series of the Hourly SO_2 Measurements

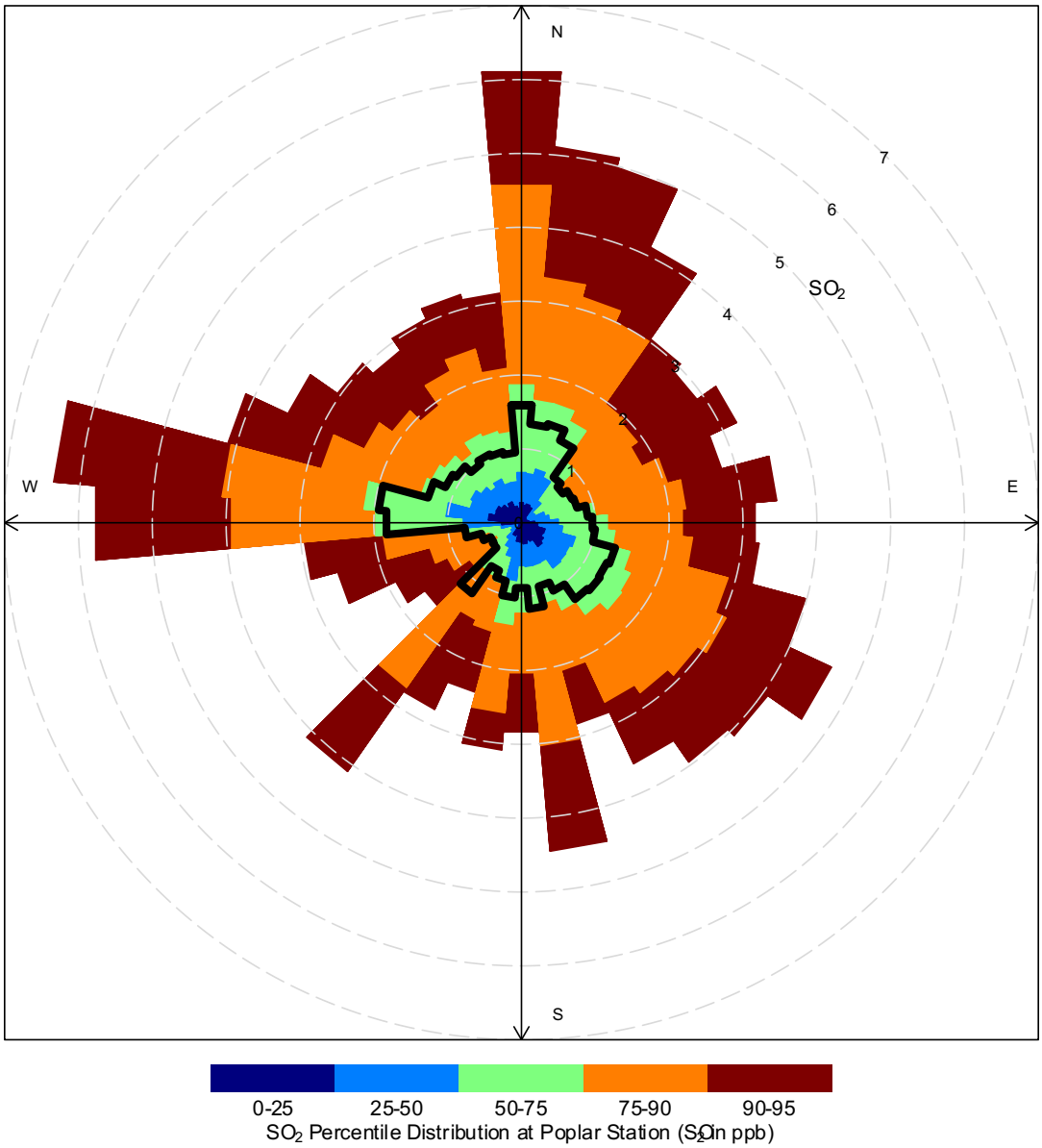


Figure 5-14 SO_2 Measurements by Wind Direction

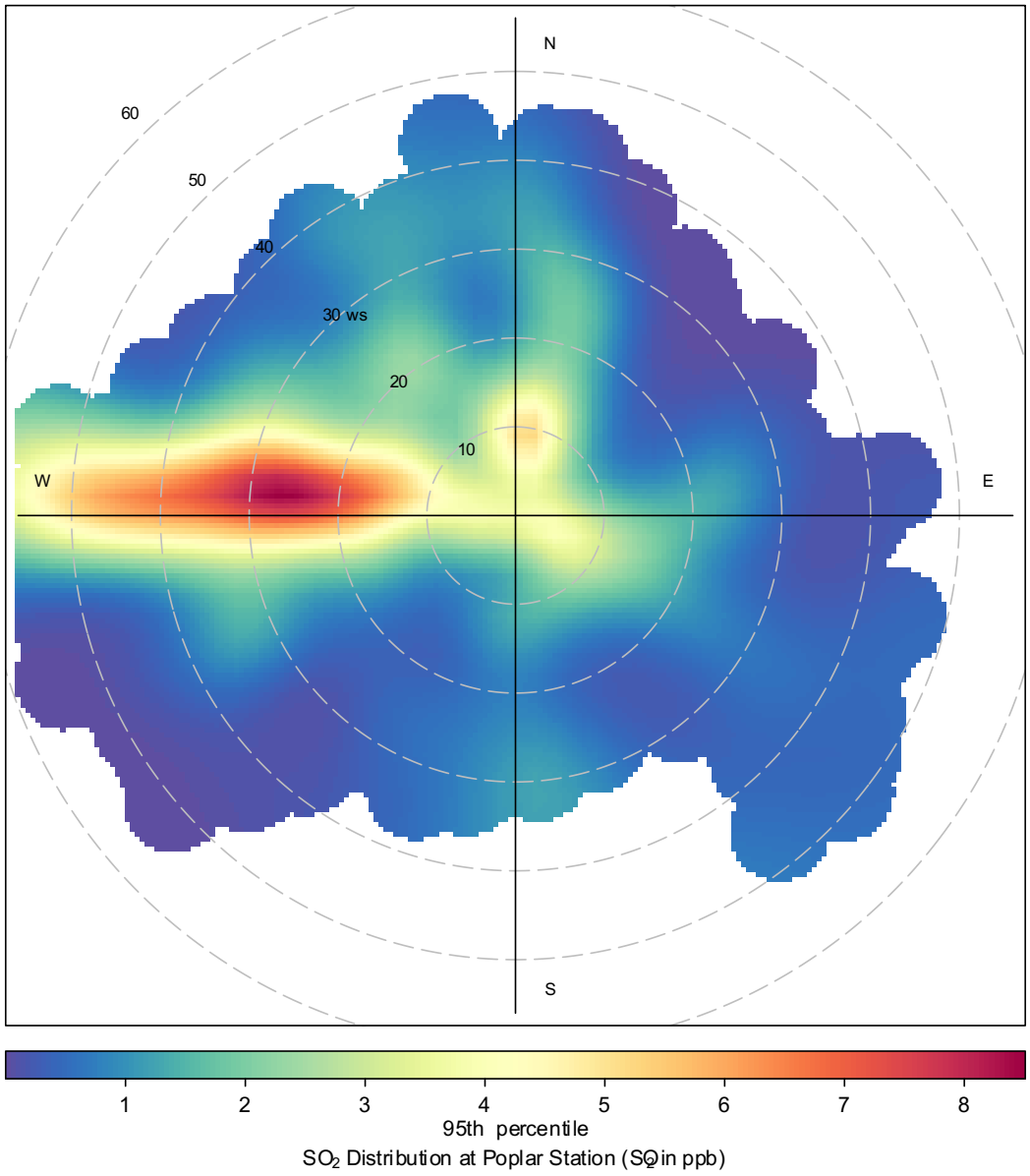


Figure 5-15 SO_2 Measurements by Wind Direction

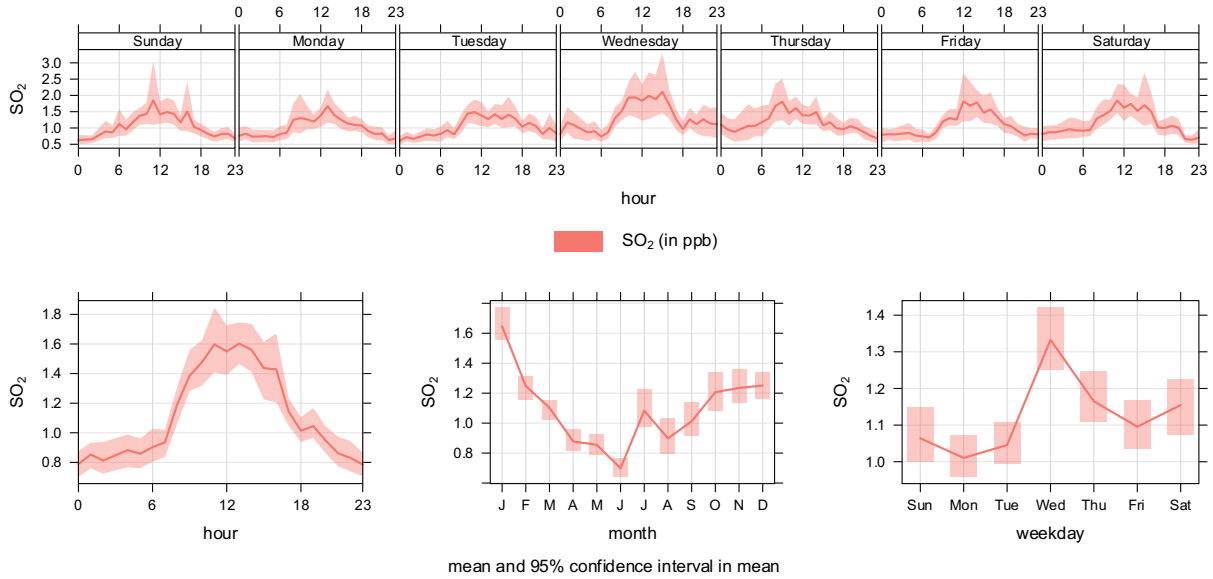


Figure 5-16 SO_2 Measurements by Hour of Day

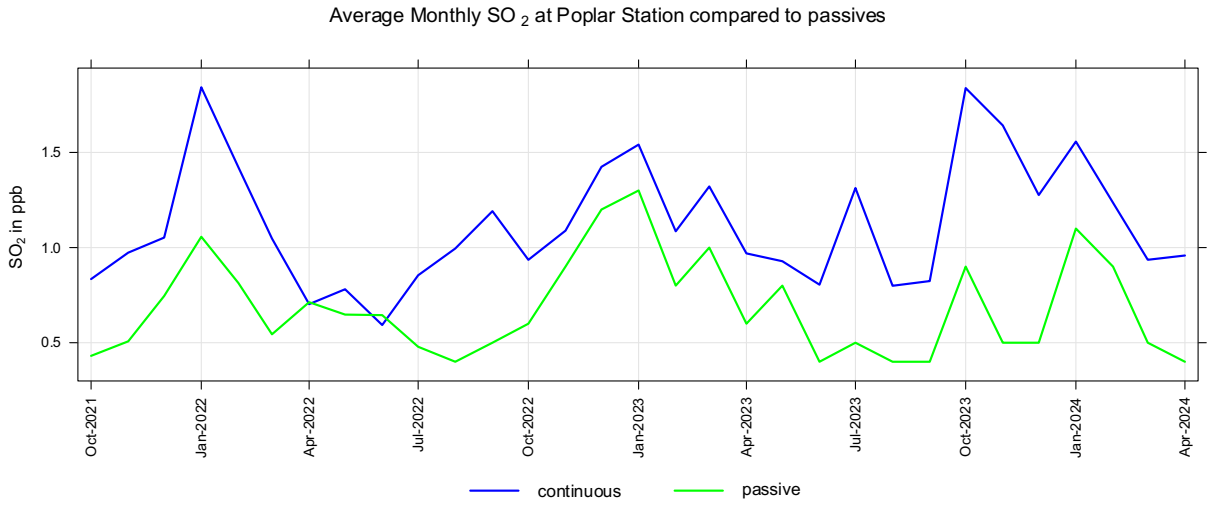


Figure 5-17 Average Monthly SO_2 Concentrations compared to closest Passive monitor

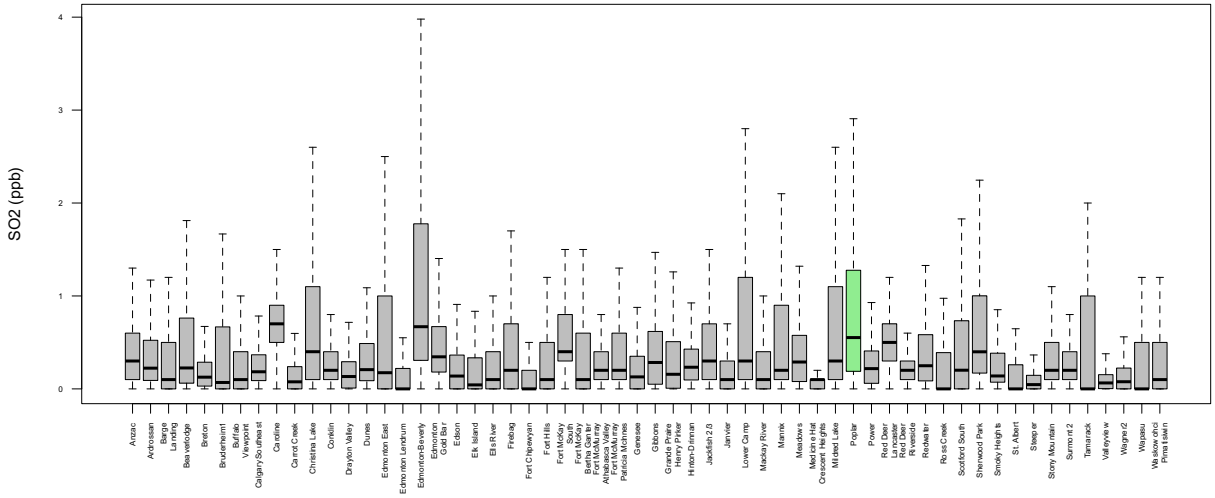


Figure 5-18 Comparison of SO_2 Measurements from other Continuous Monitoring Stations (Mean values shown).

5.4 Nitrogen Oxides

Nitrogen dioxide (NO_2) and nitric oxide (NO) are known collectively as oxides of nitrogen (NO_x). NO_x occurs naturally in the environment as a result of forest fires, atmospheric lightning discharges and biogenic oxidation of nitrogen containing compounds present in soil. Anthropogenic NO_x emissions are mainly the result of combustion processes, such as the combustion of fuel for vehicles or the combustion of coal, oil and natural gas for industrial processes. Emissions of NO_x from combustion processes are initially about 90 to 95% NO and about 5 to 10% NO_2. NO is oxidized to NO_2 in the atmosphere, and through further complex atmospheric chemical reactions can lead to the formation of ozone (see next section), nitric acid and nitrate-containing particles.

Of the NO_x species, an AAAQO exists for NO_2 only. Therefore, a summary of the NO_x measurements is restricted to NO_2. NO_2 is a reddish-orange-brown gas with an irritating, acrid, characteristic pungent odour. It is corrosive, highly oxidizing and non-combustible. At high enough concentrations, NO_2 can have respiratory effects on humans on which the 1-hour AAAQO is based. On a long term basis, NO_2 can have detrimental effects on vegetation which is reflected in the annual AAAQO.[6] A map of facilities with reported NPRI NO_x emissions of greater than 1 t/d is shown in Figure 5-19.

A summary of NO_2 measurements are shown in Table 5.3. The measurements were below the NO_2 AAAQO in all instances.

The time series of measurements are shown in Figure 5-20. Figure 5-21 presents a time series of the data with statistics of the 1-hour measurements shown for each month. The figures show that the highest measurements occur during the colder months.

Figure 5-22 and Figure 5-23 show the statistical concentrations as a function of wind direction. Overall, the measurements indicate that NO_2 appears to be fairly ubiquitous in the area with winds from the north-northwest, south-southwest, and east giving the highest average measurements.

Figure 5-24 presents the statistics of the NO_2 measurements as a function of hour of day. In general, NO_2 measurements tended to be higher in the night and lower during the day. This diurnal pattern suggests that complex atmospheric processes (discussed in the ozone section) may be occurring.

Figure 5-25 shows the average monthly NO_2 concentrations with the closest passive station (Poplar). The figure shows that for the most part the average monthly concentrations are noticeably higher, but follow a similar trend with the measurements from the closest passive monitor. For the colder months, it is noted that the continuous data for most months is significantly higher than the passive data. The reasons for this were not investigated.

[6] https://open.alberta.ca/publications/ambient-air-quality-objectives-nitrogen-dioxide

Figure 5-26 provides a comparison of NO_2 measurements from other monitoring stations in the province for the same time period. The figure shows that NO_2 levels at Poplar were lower relative to other areas in the province.

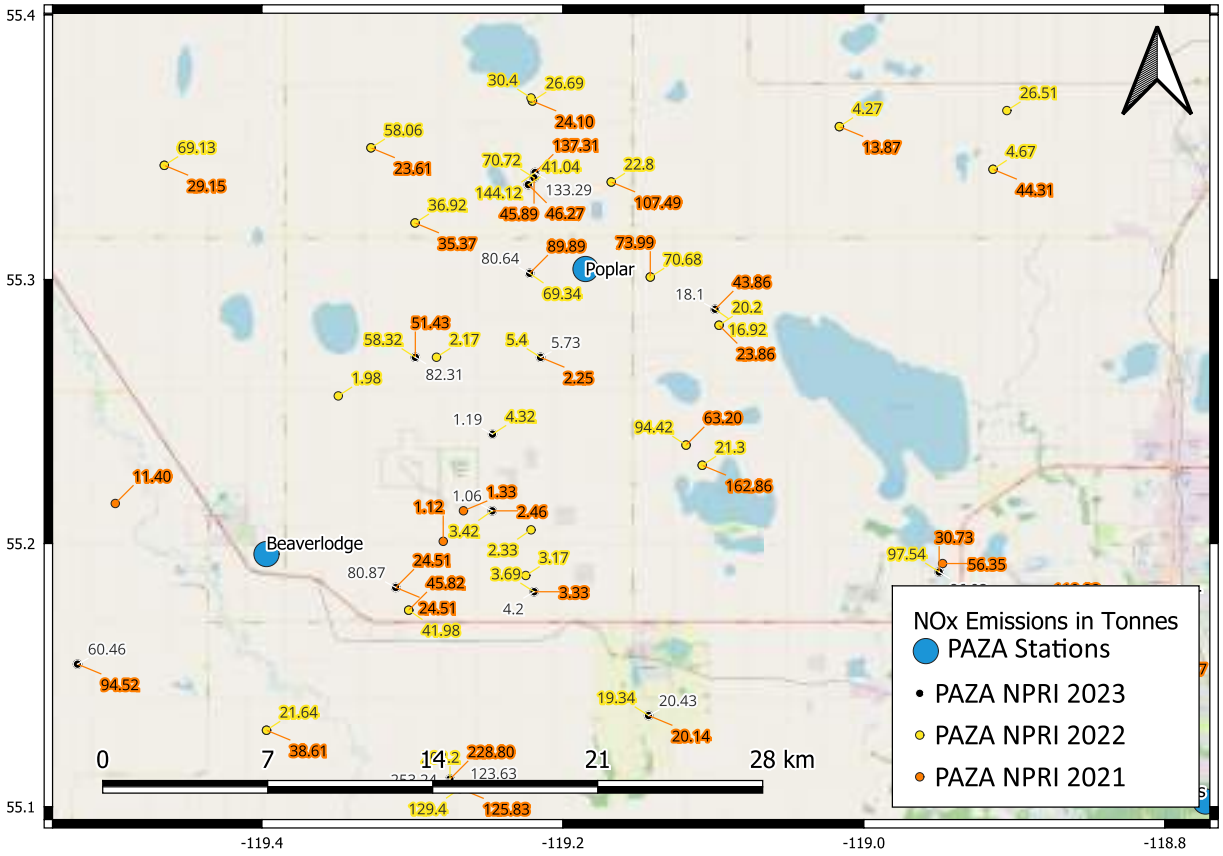


Figure 5-19 Facilities with NPRI Reported NO_x Emissions greater than 1 t/d

Table 5.3 Summary of NO_2 Measurements (ppb) at Poplar Monitoring Station

	2021[a]	2022	2023	2024[b]	Period
Maximum 1-hour Measurement	40.1	38.4	35.0	36.8	40.1
95th Percentile Measurement	21.7	16.4	18.7	19.2	18.1
Median (50th Percentile) Measurement	4.5	2.8	4.0	4.7	3.6
Average Measurement	6.9	5.0	6.1	6.6	5.8
Counts above AAAQO					
1-hour AAAQO (159 ppb)	0	0	0	0	0
Annual AAAQO (24 ppb)	0	0	0	0	0

a. October 2, 2021 to December 31, 2021

b. January 1, 2024 to April 30, 2024

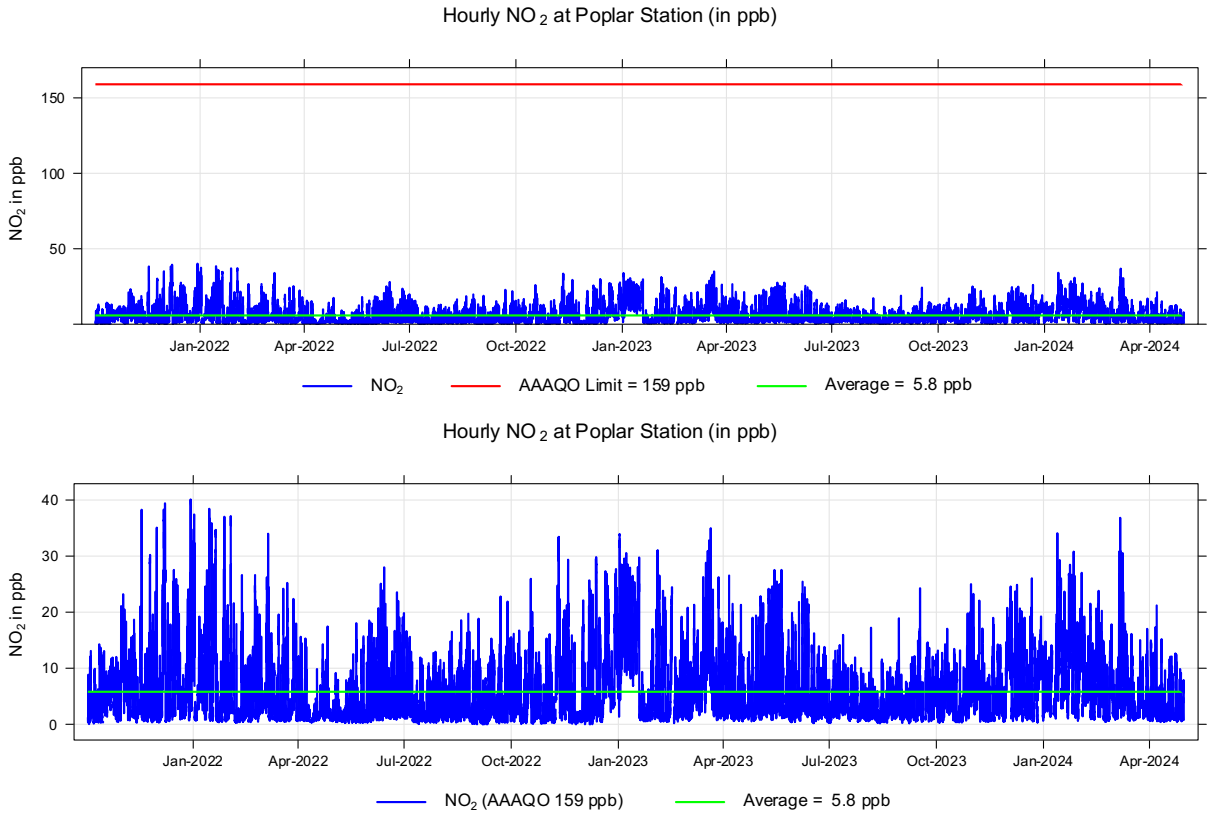


Figure 5-20 Time Series of the Hourly NO_2 Measurements

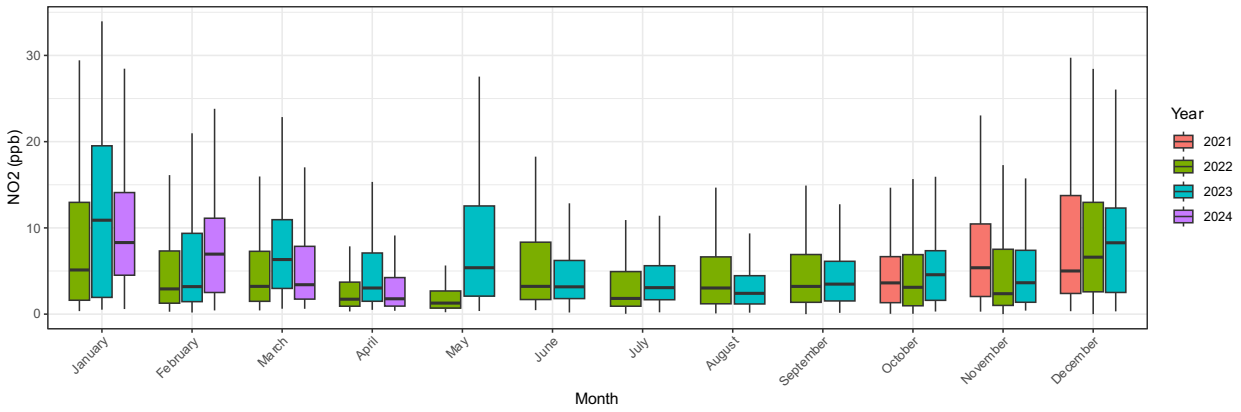


Figure 5-21 Monthly Time Series of the Hourly NO_2 Measurements

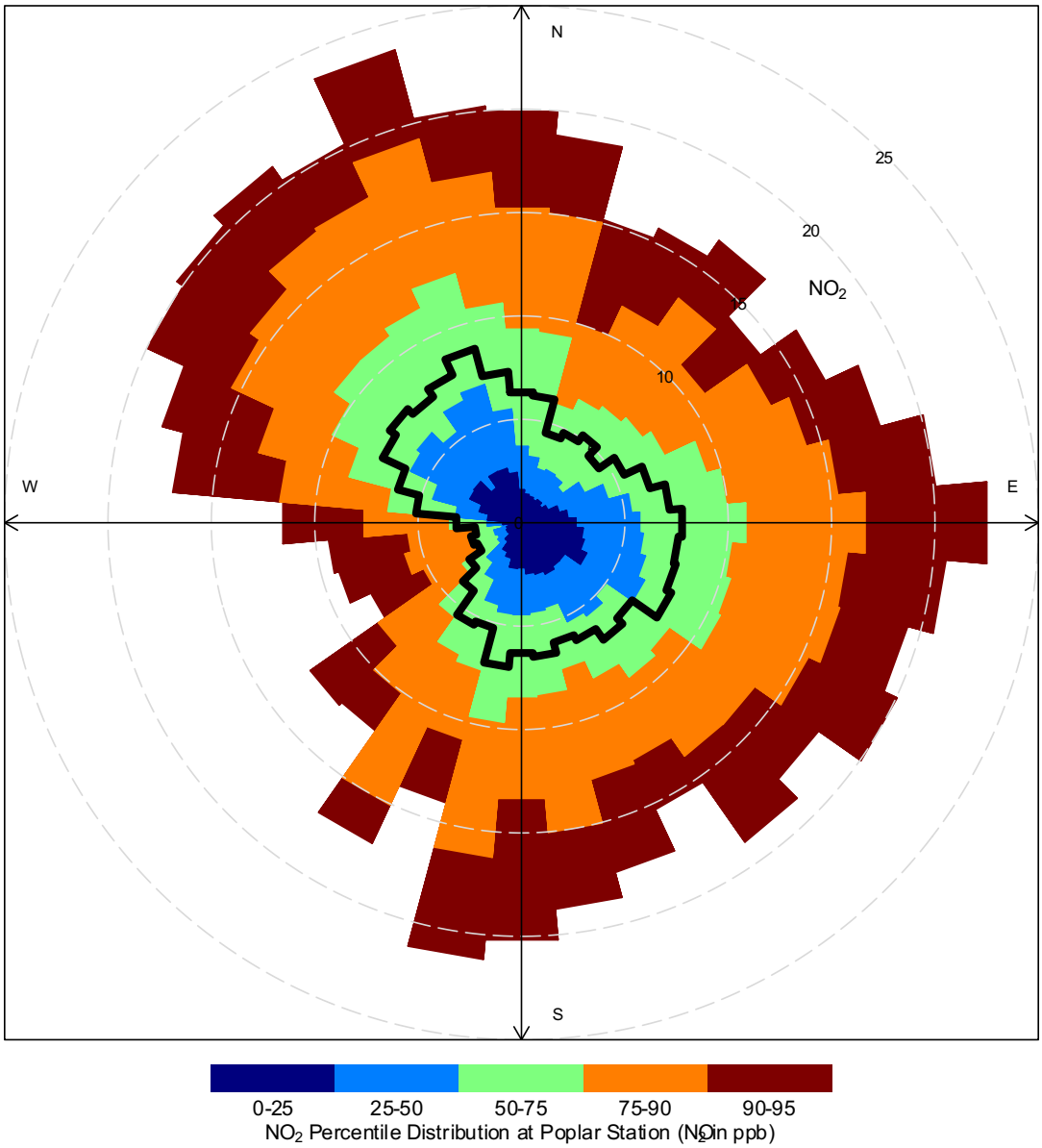


Figure 5-22 NO_2 Measurements by Wind Direction

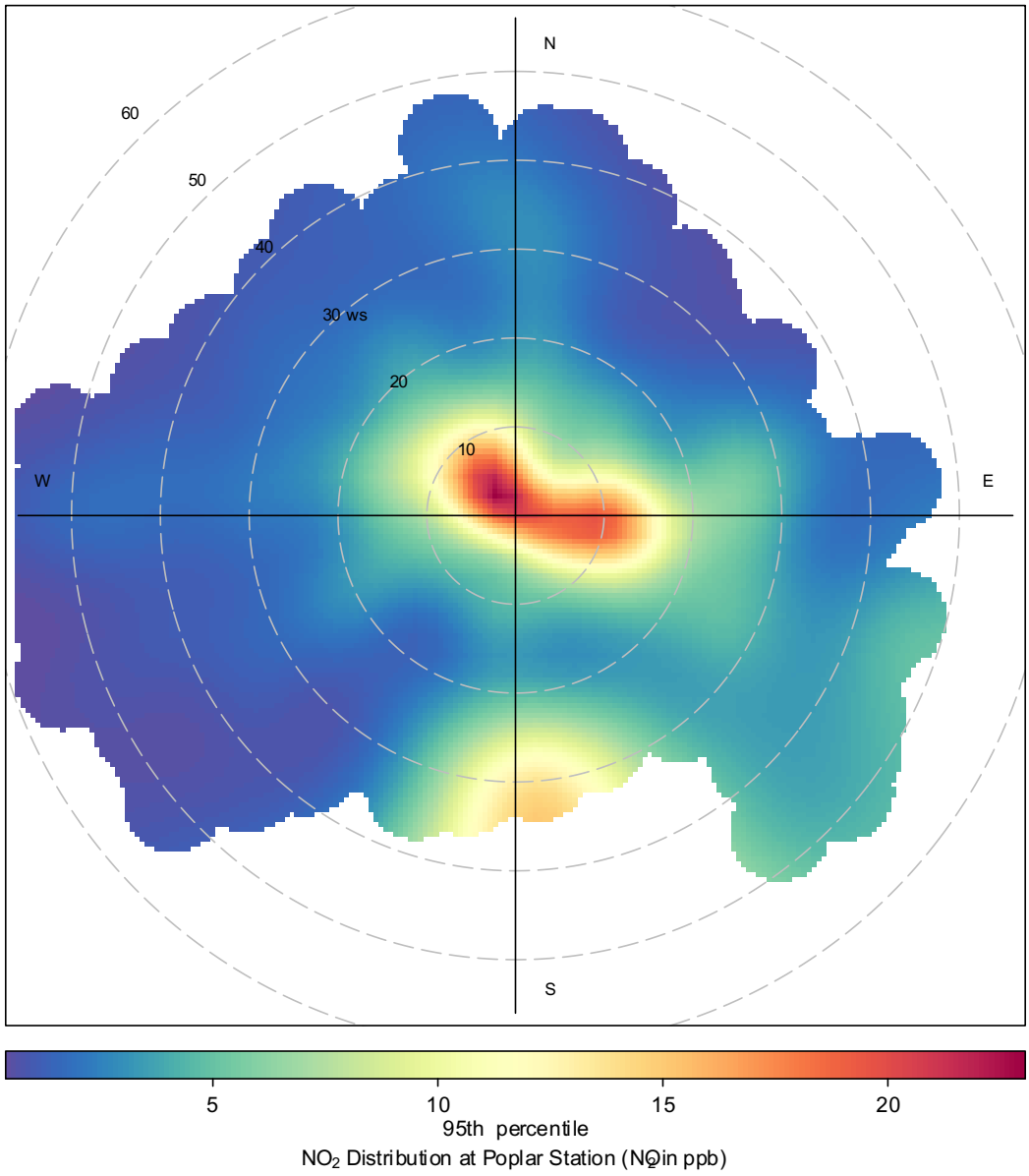


Figure 5-23 NO_2 Measurements by Wind Direction

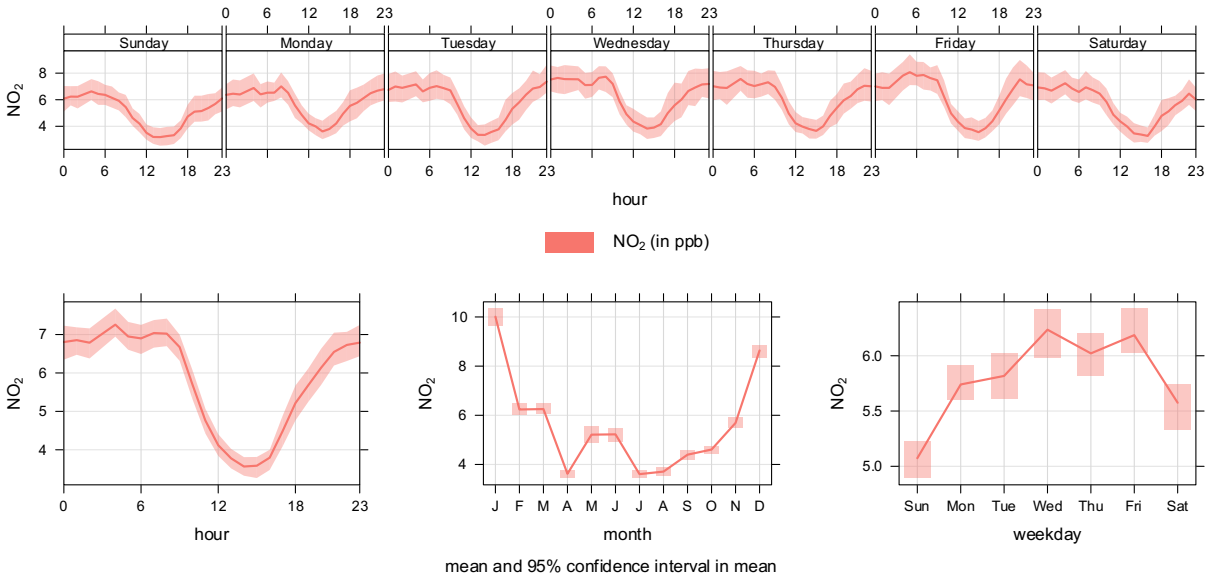


Figure 5-24 NO_2 Measurements by Hour of Day

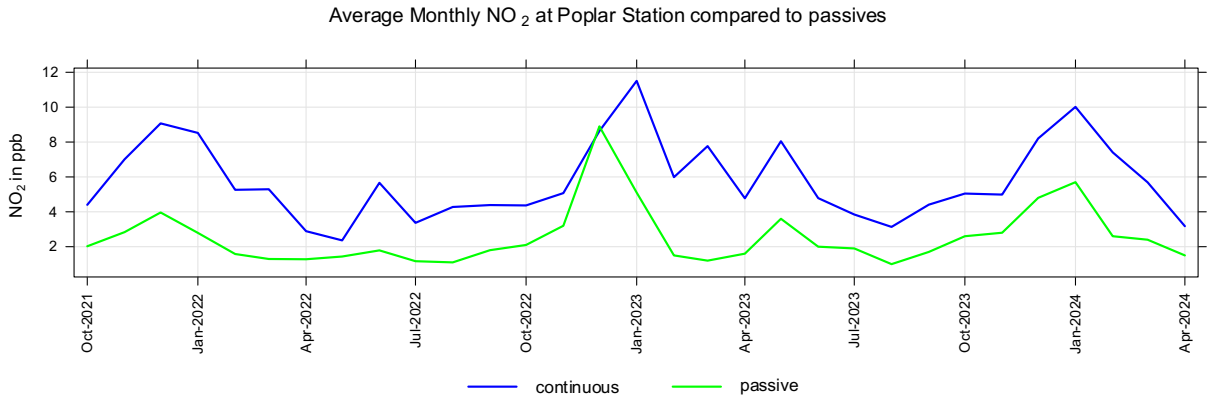


Figure 5-25 Average Monthly NO_2 Concentrations compared to the closest Passive monitor

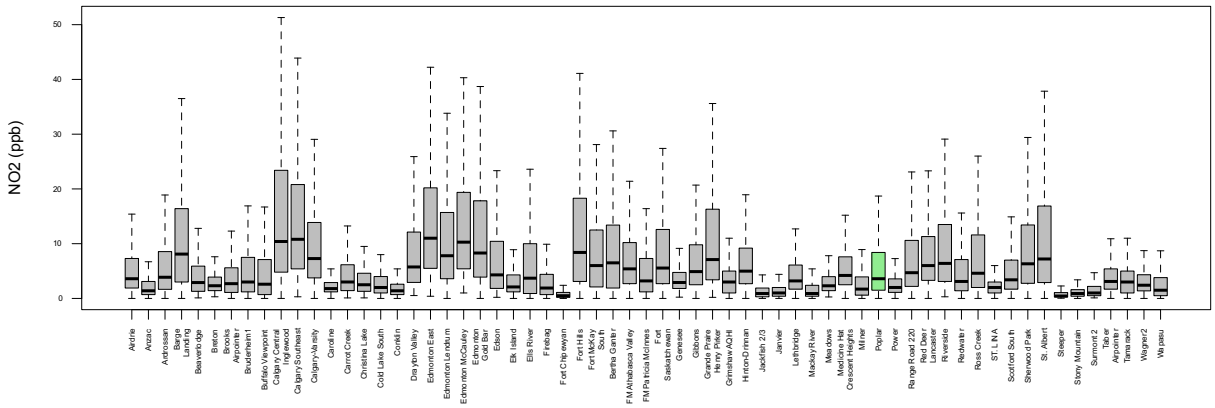


Figure 5-26 Comparison of NO_2 Measurements from other Continuous Monitoring Stations (Mean values shown).

5.5 Ozone

Ozone is a chemical whose effect on the environment is either beneficial or detrimental depending on where it occurs. Stratospheric ozone protects us from the sun's ultraviolet light, but can be toxic in the troposphere (atmospheric layer encompassing ground level). Ozone is a highly reactive, colourless gas. It has a sharp, clean odour that can often be detected around running electric motors, after lightning storms, and around new mown hay.

Ozone is not emitted by anthropogenic or natural processes. It is normally present in the troposphere as a result of naturally occurring photochemical and meteorological processes. Ground level ozone is formed through complex chemical reactions between precursor emissions of volatile organic compounds (VOCs) and NO_x in the presence of heat and sunlight. Combustion exhausts emit both VOCs and NO_x and in rural areas, trees and other vegetation naturally emit VOCs that can contribute to ozone formation. Changing weather patterns contribute to yearly differences in ozone concentrations from city to city. Ozone and its precursor substances can be transported into an area from distant pollution sources.

Extensive scientific studies indicate that there can be significant health and environmental effects associated with ozone. Potential short-term effects include pulmonary function reductions, increased airway sensitivities, and airway inflammation on which the 1-hour AAAQO for ozone is based. [7]

A summary of O_3 measurements are shown in Table 5.4. Measurements above the 1-hour AAAQO were recorded on 3 and 4 consecutive hours on the afternoon of May 15 and May 20, 2023 during the season of wildfires and a period of extremely hot and stagnant air.

The time series of measurements are shown in Figure 5-27. Figure 5-28 presents a time series of the data with statistics of the 1-hour measurements shown for each month. A usual pattern of higher average measurements occurring during the spring is noted. Typically, the highest measurements tend to occur on hot sunny summer days but overall averages are higher in the spring.

Figure 5-29 presents statistics of the measured O_3 concentrations as a function of hour of day. Also seen is a typical diurnal pattern of O_3 where O_3 is decomposed to O_2 through a reaction with NO in the early morning and then created during the day in complex reactions with VOCs and NO_2 in the presence of sunlight.

Figure 5-30 provides a comparison of O_3 measurements from other monitoring stations in the province for the same time period. The figure shows that O_3 levels at Poplar were comparable to other areas in the province.

[7] https://open.alberta.ca/publications/9781460142769

Figure 5-31 presents the diurnal relationships between NO, NO_2, and O_3 at the Poplar monitoring station for the entire period, and for the months of December, April and August. The figures show the complex relationship between these pollutants that lead to O_3 formation.

The ambient O_3 data measured in Poplar appears to adequately reflect the general rural setting; however, the ozone measurements may be affected by local NO_x emissions as the data is showing ozone formation and decomposition due to complex relationship with atmospheric NO_x and VOCs. Measurements above the AAAQO were recorded on two hot summer afternoons during the wildfires season, but are not indicative of an on- going problem.

Table 5.4 Summary of O_3 Measurements (ppb) at Poplar Monitoring Station

	2021[a]	2022	2023	2024[b]	Period
Maximum 1-hour Measurement	47.4	69.5	89.0	62.2	89.0
95th Percentile Measurement	39.1	46.0	48.6	46.6	46.5
Median (50th Percentile) Measurement	24.0	29.1	28.1	28.9	28.2
Average Measurement	22.4	27.8	27.1	27.6	27.0
Counts above AAAQO					
1-hour AAAQO (76 ppb)	0	0	7	0	7

a. October 2, 2021 to December 31, 2021

b. January 1, 2024 to April 30, 2024

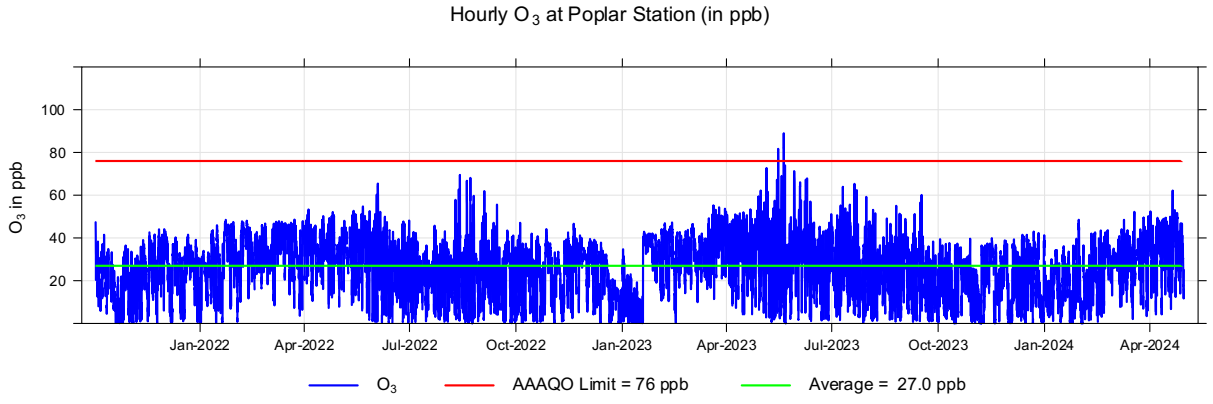


Figure 5-27 Time Series of the Hourly O_3 Measurements

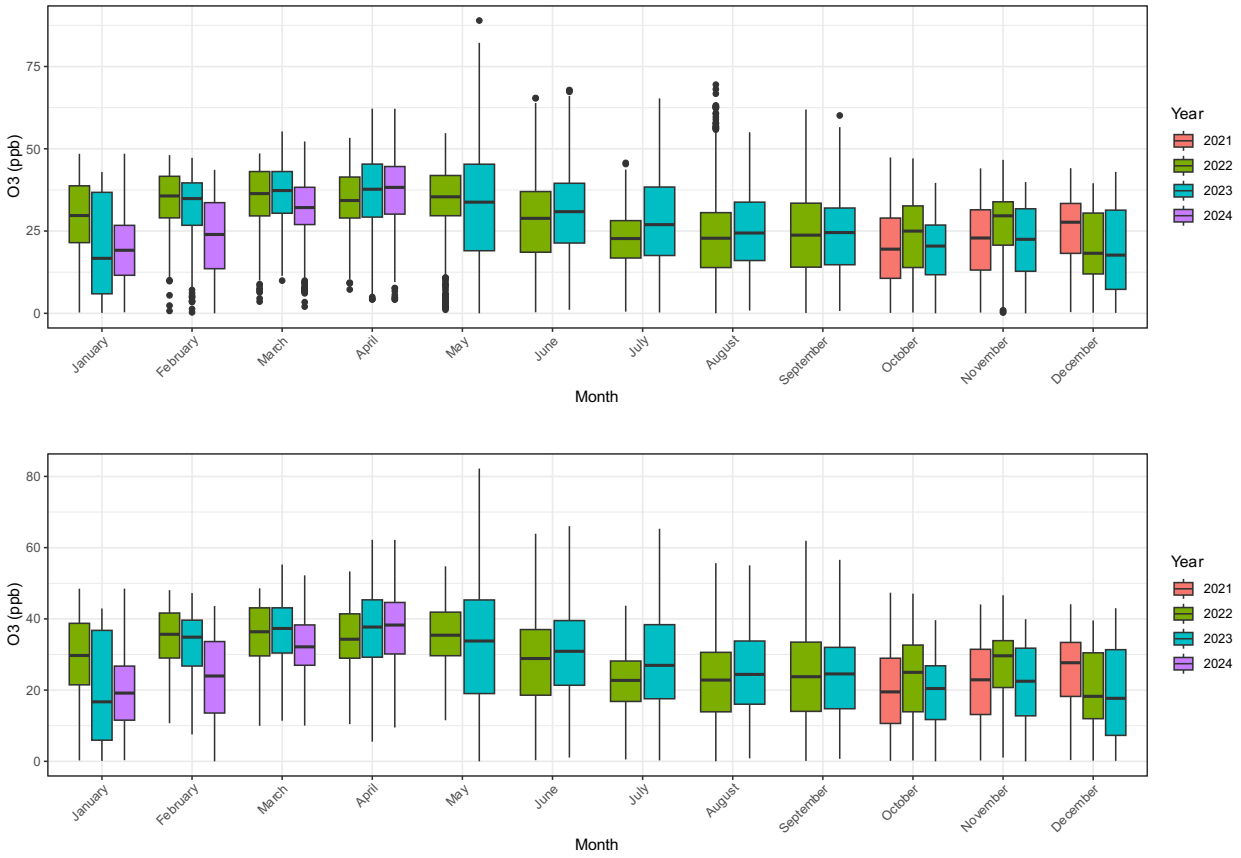


Figure 5-28 Monthly Time Series of O_3 Measurements

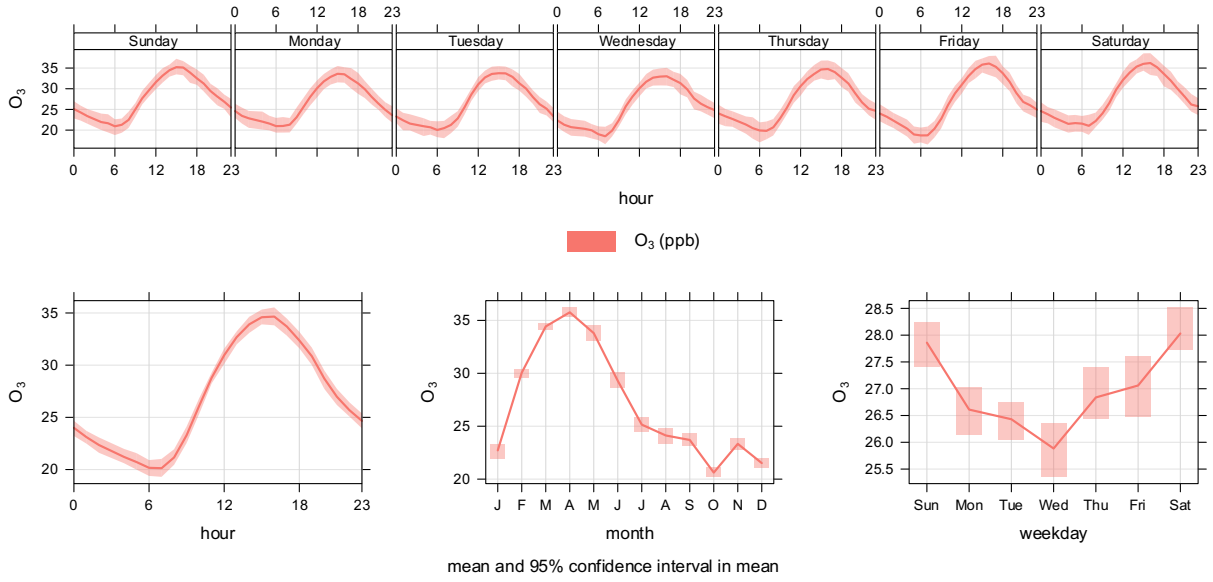


Figure 5-29 O_3 Measurements by Hour of Day

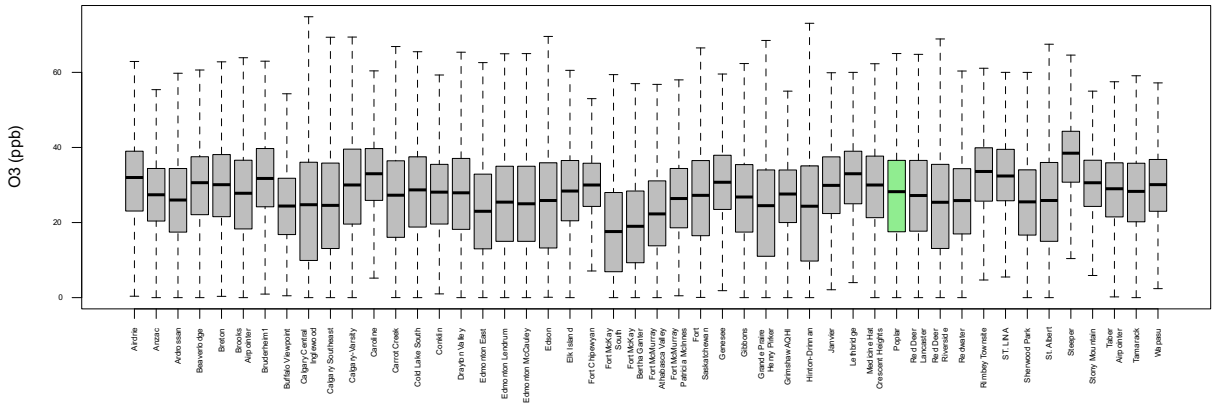


Figure 5-30 Comparison of O_3 Measurements from other Continuous Monitoring Station (Mean values shown).

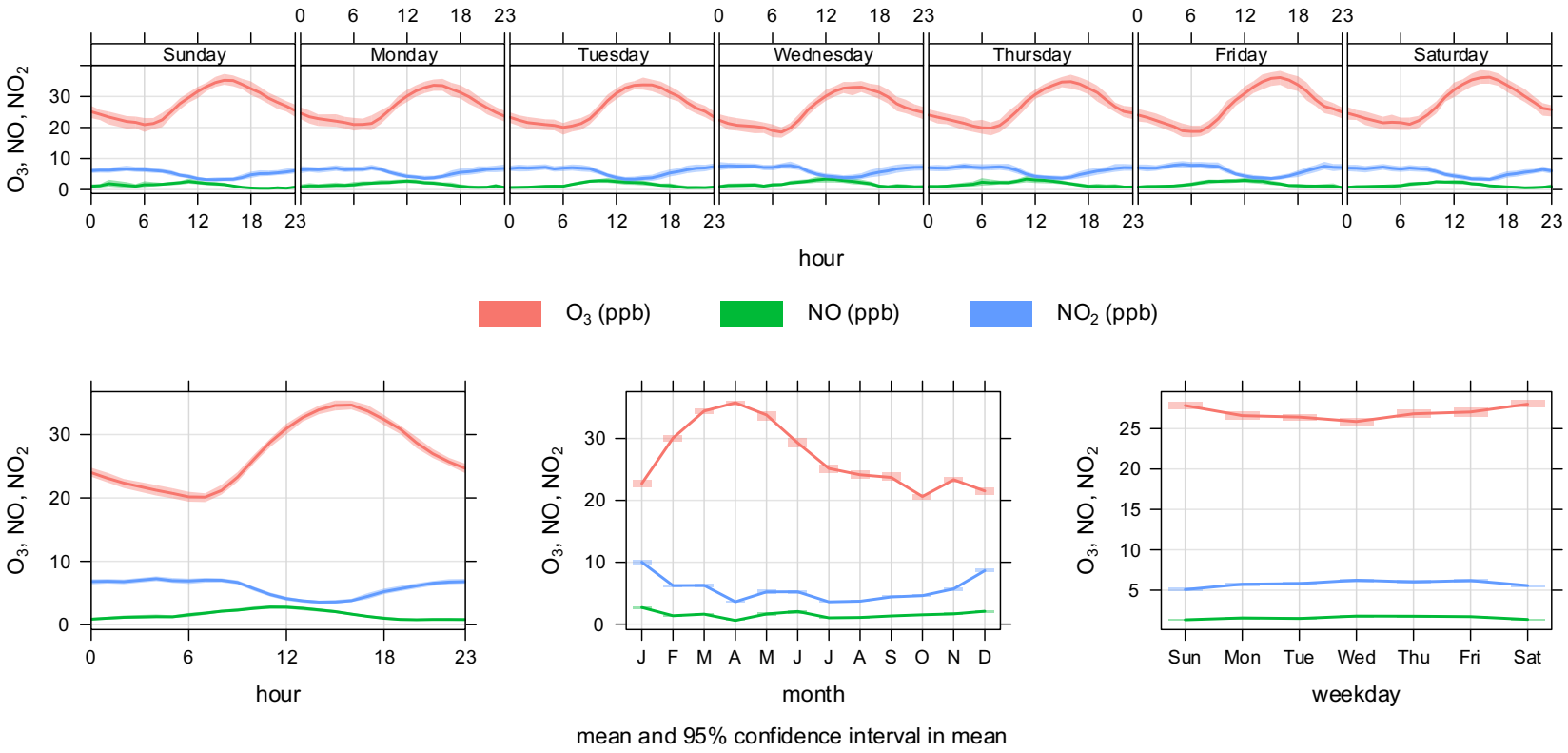


Figure 5-31 Diurnal Relationship between Average Measured O3, NO, and NO2 concentrations for entire period and selected months.

5.6 Fine Particulate Matter ($PM_{2.5}$)

Fine particulate matter ($PM_{2.5}$) refers to airborne solid or liquid particles that are 2.5×10^{-6}m (microns) or less in diameter. It is either emitted directly (primary PM) or formed in the atmosphere from precursor emissions (secondary PM). Important precursors of secondary PM are nitrogen oxides, sulphur dioxide, ammonia, and volatile organic compounds. The chemical composition of particles can vary widely and depends on location, time of year, and weather. Primary $PM_{2.5}$ is formed by combustion processes including: forest fires or residential wood fires; burning of fossil fuels in motor vehicles, furnaces, boilers, and heaters; and certain industrial processes. Secondary fine particles are created when chemicals react in the atmosphere and grow through particle-particle or gas-particle interactions.[8]

A summary of $PM_{2.5}$ measurements are shown in Table 5.5. The maximum measurements in 2022 and 2023 exceeded the 1-hr AAAQG. The maximum 24-hr measurement in 2022 and 2023 exceeded the 24-hr AAAQO. These exceedances are due to wildfires.

The time series of measurements are shown in Figure 5-32. Figure 5-33 presents a time series of the data with statistics of the 1-hour measurements shown for each month. The measurements show a fairly low background level interspersed with very infrequent extremely high measurements due to wildfires.

Figure 5-34 and Figure 5-35 show statistics of the $PM_{2.5}$ measurements as a function of wind direction. For lower percentile statistics and the mean, the measurements show higher measurements for winds from the southeast, northwest quadrants. High measurements of $PM_{2.5}$ are from the south-southwest and southeast directions. Outside the wildfires season, there seems to be some impact from Grande Prairie.

Figure 5-36 shows the statistics of the measured $PM_{2.5}$ concentrations as a function of hour of day and day of week. There is a slight trend of the highest median and mean measurements occurring on Saturday.

Figure 5-37 provides a comparison of $PM_{2.5}$ measurements from other monitoring stations in the province for the same time period. The figure shows $PM_{2.5}$ levels at Poplar were slightly lower when compared to other areas in the province.

The ambient $PM_{2.5}$ data measured in Poplar appears to adequately reflect the general rural setting that is slightly influenced by the City of Grande Prairie in the warmer months and by exceptional events (wildfires) infrequently in the summer and fall months.

[8] https://open.alberta.ca/publications/aaqo-fine-particulate-matter

Table 5.5 Summary of $PM_{2.5}$ Measurements (µg/m^3) at Poplar Monitoring Station

	2021[a]	2022	2023	2024[b]	Period
Maximum 1-hour Measurement	27.9	96.9	448.7	65.0	448.7
95th Percentile Measurement	7.5	11.6	59.4	13.7	27.7
Median (50th Percentile) Measurement	1.6	1.6	4.4	3.4	2.8
Average Measurement	2.4	3.3	14.8	4.8	7.7
Maximum 24-hour Average Measurement	6.8	30.9	292.9	25.0	292.9
Counts above AAAQO					
1-hour AAAQG (80 µg/m³)	0	4	272	0	276
24-hour AAAQO (29 µg/m³)	0	1	48	0	49

a. October 2, 2021 to December 31, 2021

b. January 1, 2024 to April 30, 2024

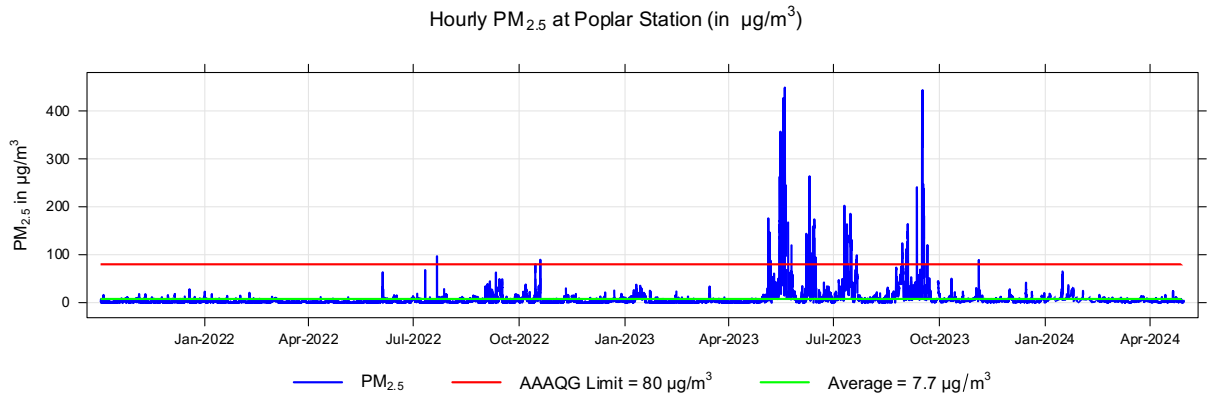


Figure 5-32 Time Series of the Hourly $PM_{2.5}$ Measurements

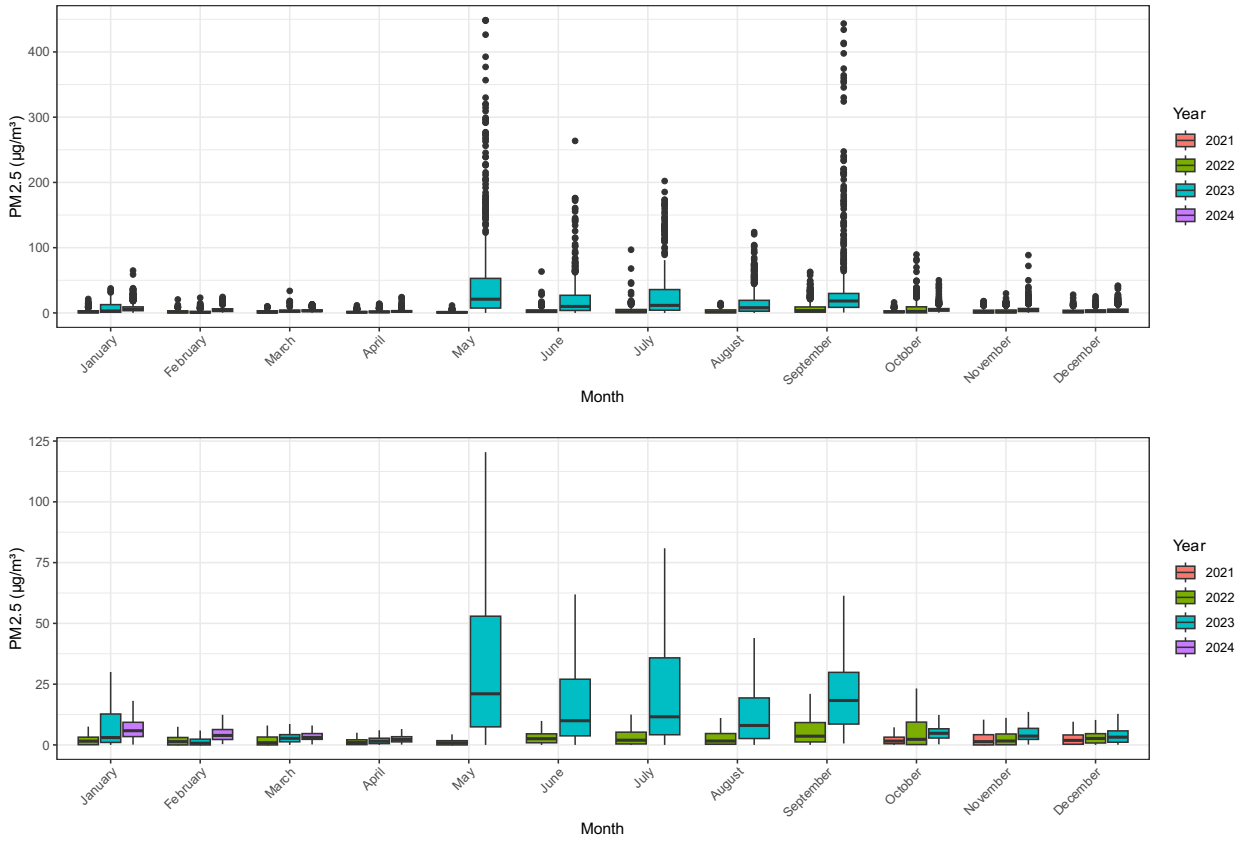


Figure 5-33 Monthly Time Series of $PM_{2.5}$ Measurements

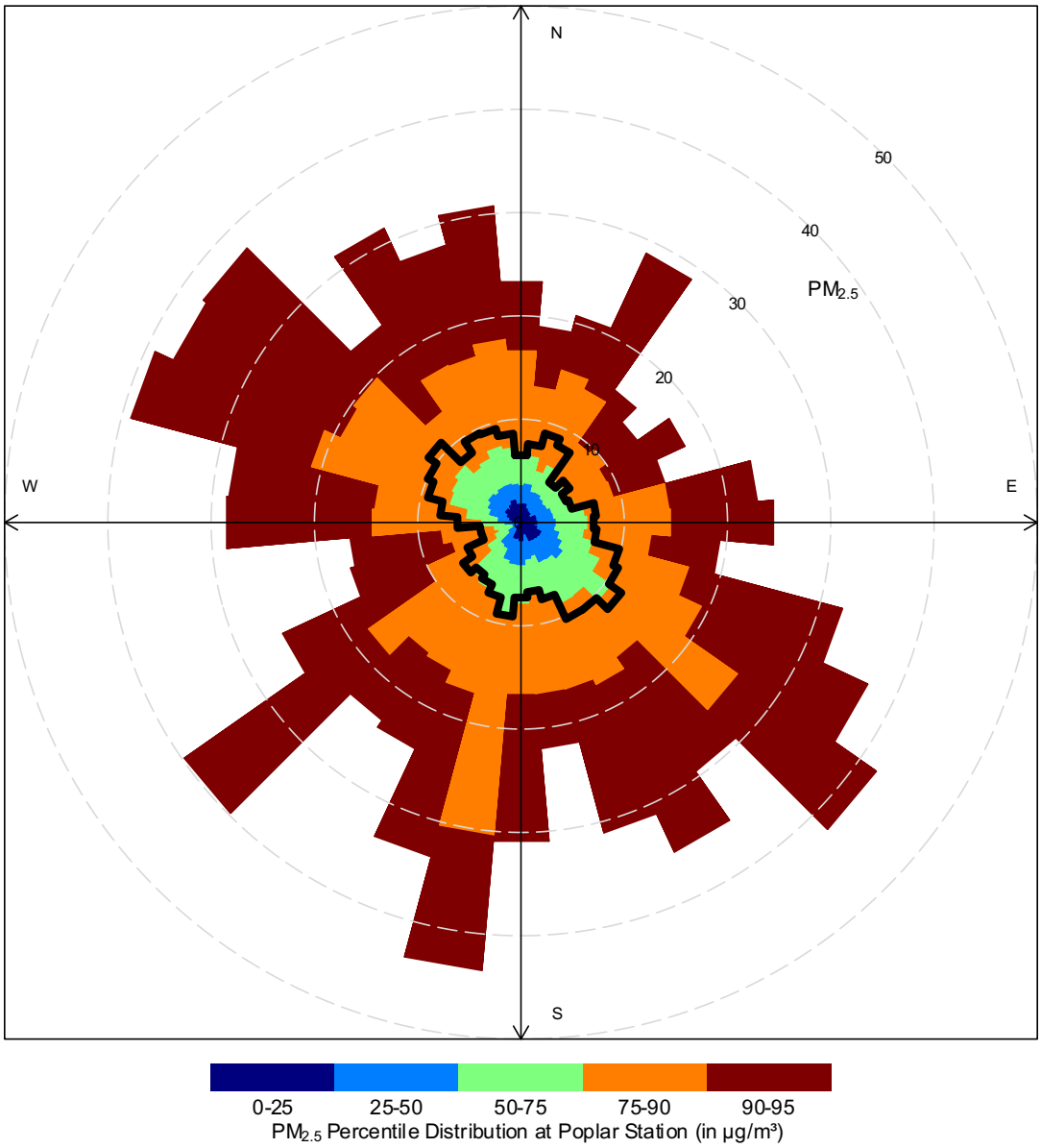


Figure 5-34 $PM_{2.5}$ Measurements by Wind Direction

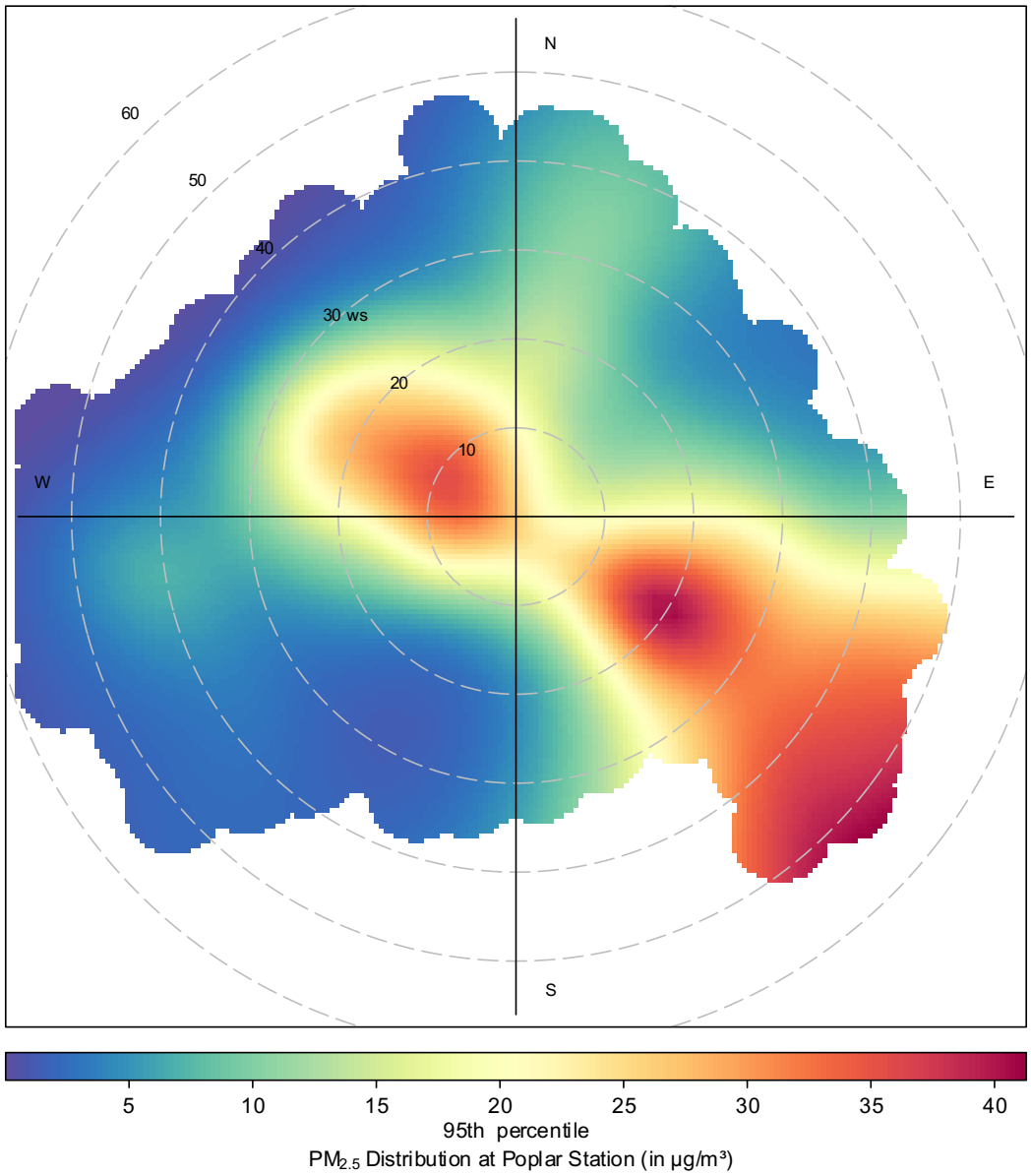


Figure 5-35 $PM_{2.5}$ Measurements by Wind Direction

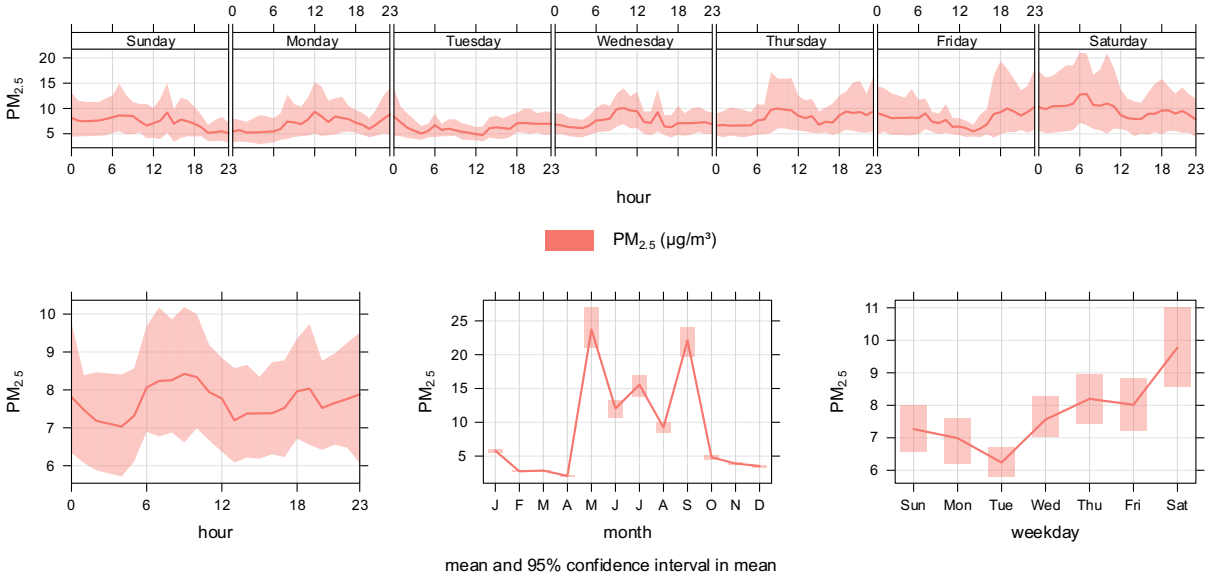


Figure 5-36 $PM_{2.5}$ Measurements by Hour of Day

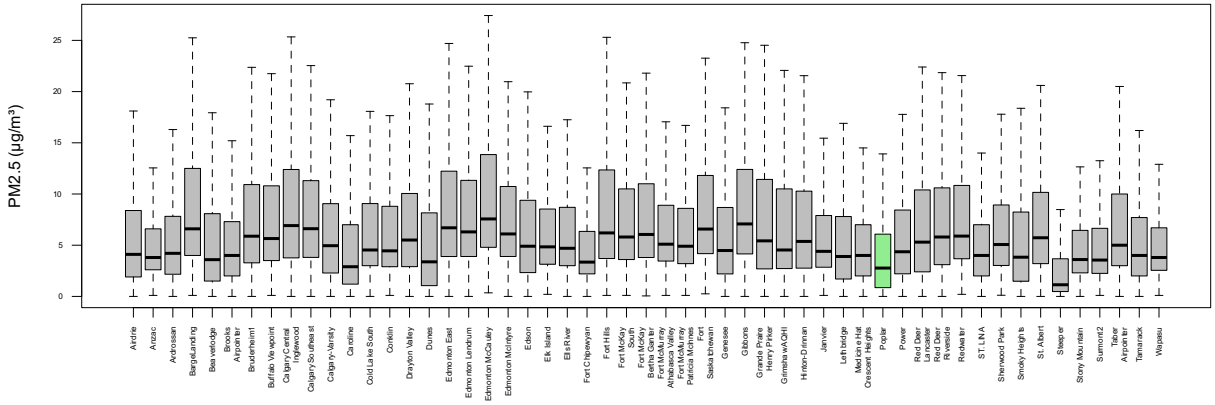


Figure 5-37 Comparison of $PM_{2.5}$ Measurements from other Continuous Monitoring Stations (Median values shown).

5.7 Hydrocarbons

THC is a broad term used to describe compounds which contain hydrogen and carbon atoms. Anthropogenic sources of hydrocarbons include vehicle emissions, oil and gas facilities (combustion and fugitive sources), chemical industries, dry cleaning, and natural gas combustion. Natural sources of hydrocarbons include decomposition of organic material, and livestock.

Hydrocarbons are divided into two broad categories, "non-reactive" and "reactive" hydrocarbons. The major non-reactive hydrocarbon in the atmosphere is methane, which is a naturally occurring colourless, odourless gas recognized as a major contributor to the greenhouse effect. The reactive hydrocarbons consist of many VOCs, some of which react with oxides of nitrogen in the atmosphere to form ozone. They generally occur at much lower concentrations than methane. THC include both reactive and non-reactive hydrocarbons.

There are no AAAQOs for methane, THC (or the major constituents of THC) nor NMHC. However, AAAQOs do exist for specific NMHC such as benzene. However, concentrations of specific hydrocarbons cannot be inferred from the data collected. Background THC are primarily composed of methane (1.8 – 2.0 ppm in rural Alberta) and a small contribution from NMHC.

A summary of THC, methane, and NMHC measurements are shown in Table 5.6. As can be seen, most of the NMHC measurements were zero, for the time period methane and NMHC data were available. As a result, most of the THC and methane measurements were essentially identical. Hence, further analysis focussed on the THC measurements only.

The time series of measurements are shown in Figure 5-38. Figure 5-39 presents a time series of the data with statistics of the 1-hour THC measurements shown for each month. It is noted that the higher measurements are occurring during the colder months.

Figure 5-40 and Figure 5-41 present statistics of the THC measurements as a function of wind direction. As THC is ubiquitous in the air, the radius scales have been exaggerated to highlight even small changes in the calculated statistics. The data appears to show that the higher measurements are occurring for winds from the northwest sector. However, overall average and median measurements show a greater contribution from winds from the northwest.

Figure 5-42 presents the statistics of the THC measurements as a function of hour of day. Diurnal profiles indicate a slight trend for THC measurements to peak in mid-morning and gradually decline to the late afternoon before gradually increasing to mid-morning. This may indicate some of the THCs are involved in the formation of ground level ozone; however, further investigation into that possibility is beyond the scope of this report.

Figure 5-43 shows a comparison of THC measurements from other monitoring stations in the province for the same time period. The figure shows that THC levels at Poplar were slightly lower than other areas in the province.

The hydrocarbon data measured appears to be consistent with the rural setting of the monitor. Overall, there appears to be a slight contribution from the City of Grande Prairie. The highest THC measurements are associated with northwest winds suggesting an impact from industry. A few high measurements of NMHC were measured and would be cause for concern if they were more frequent; however, the majority of the NMHC readings were zero suggesting that the high readings could be anomalies assuming the monitoring equipment were working properly.

Table 5.6 Summary of Hydrocarbon Measurements (ppm) at Poplar Monitoring Station

THC	2021[a]	2022	2023	2024[b]	Period
Maximum 1-hour Measurement	4.3	8.9	10.2	4.8	10.2
95th Percentile Measurement	2.8	2.9	3.0	3.0	3.0
Median (50th Percentile) Measurement	2.1	2.1	2.2	2.2	2.2
Average Measurement	2.2	2.2	2.3	2.4	2.3
CH4					
Maximum 1-hour Measurement	3.3	3.5	-	-	3.5
95th Percentile Measurement	2.7	2.6	-	-	2.6
Median (50th Percentile) Measurement	2.1	2.0	-	-	2.1
Average Measurement	2.2	2.0	-	-	2.1
NMHC					
Maximum 1-hour Measurement	1.99	5.43	-	-	5.43
95th Percentile Measurement	0.07	0.21	-	-	0.13
Median (50th Percentile) Measurement	0.00	0.00	-	-	0.00
Average Measurement	0.02	0.04	-	-	0.03

a. October 2, 2021 to December 31, 2021

b. January 1, 2024 to April 30, 2024

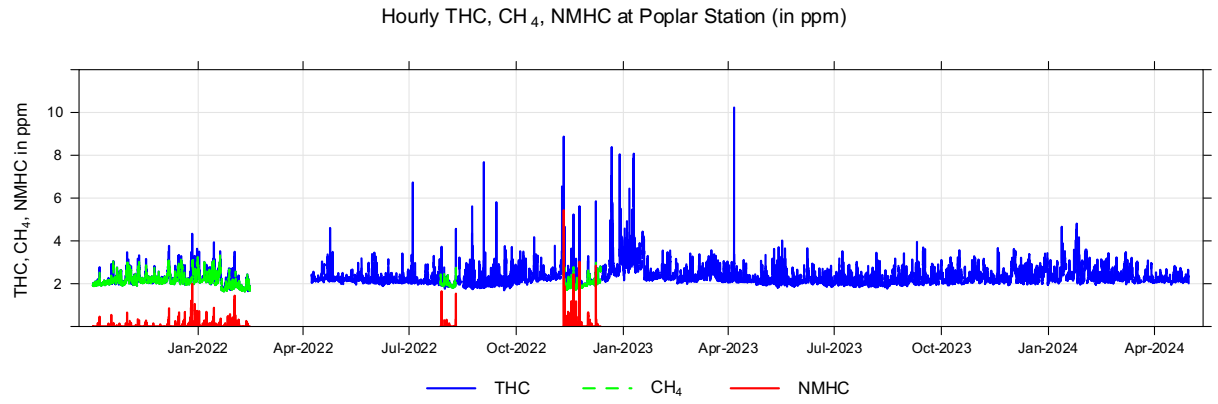


Figure 5-38 Time Series of the Hourly Hydrocarbon Measurements

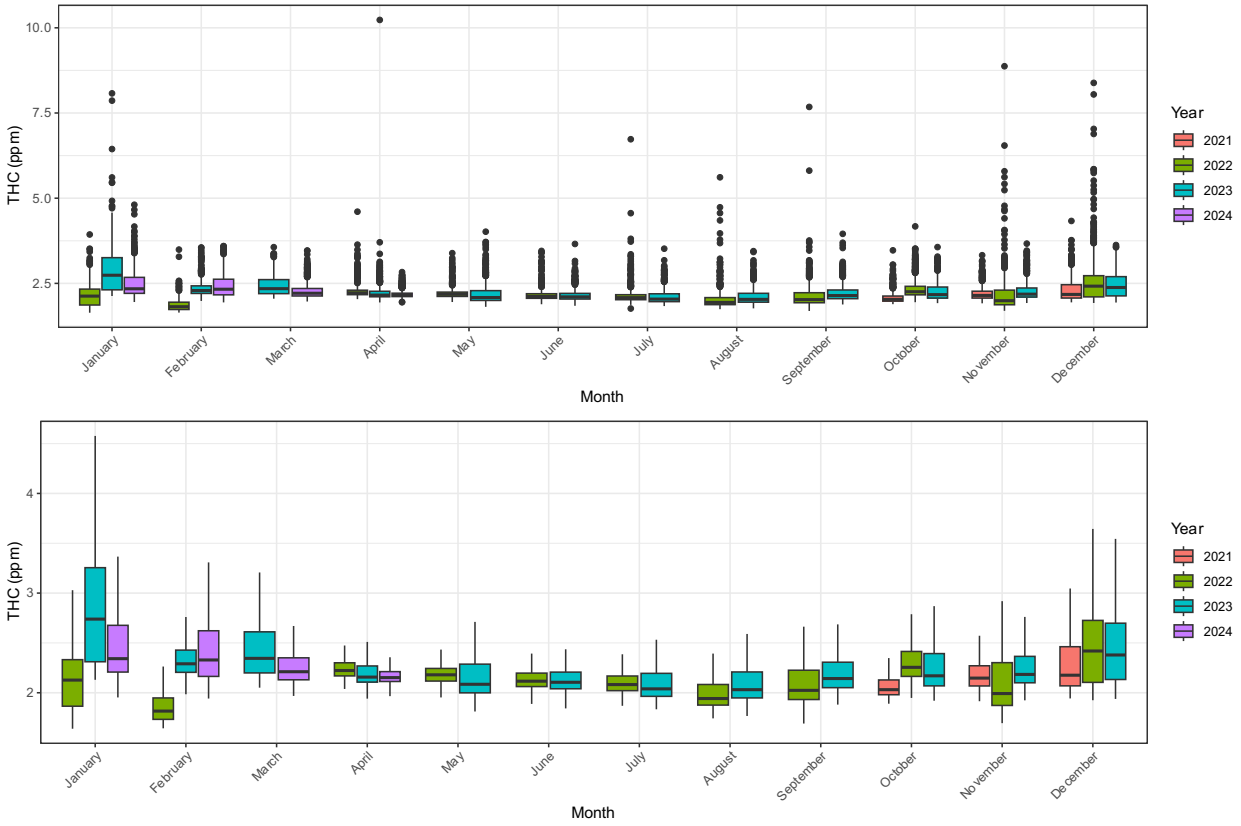


Figure 5-39 Monthly Time Series of the Hourly Hydrocarbon Measurements

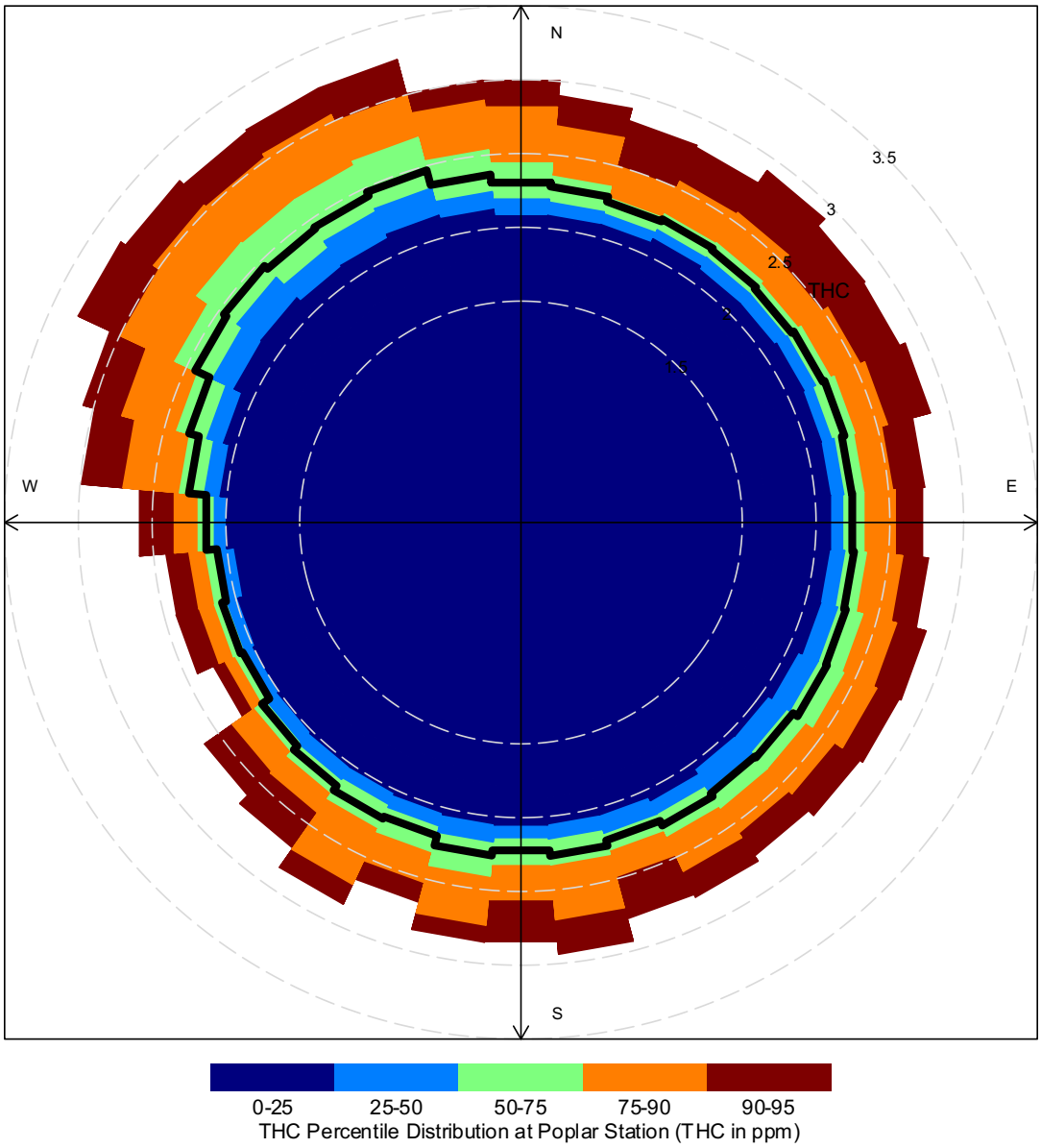


Figure 5-40 THC Measurements by Wind Direction

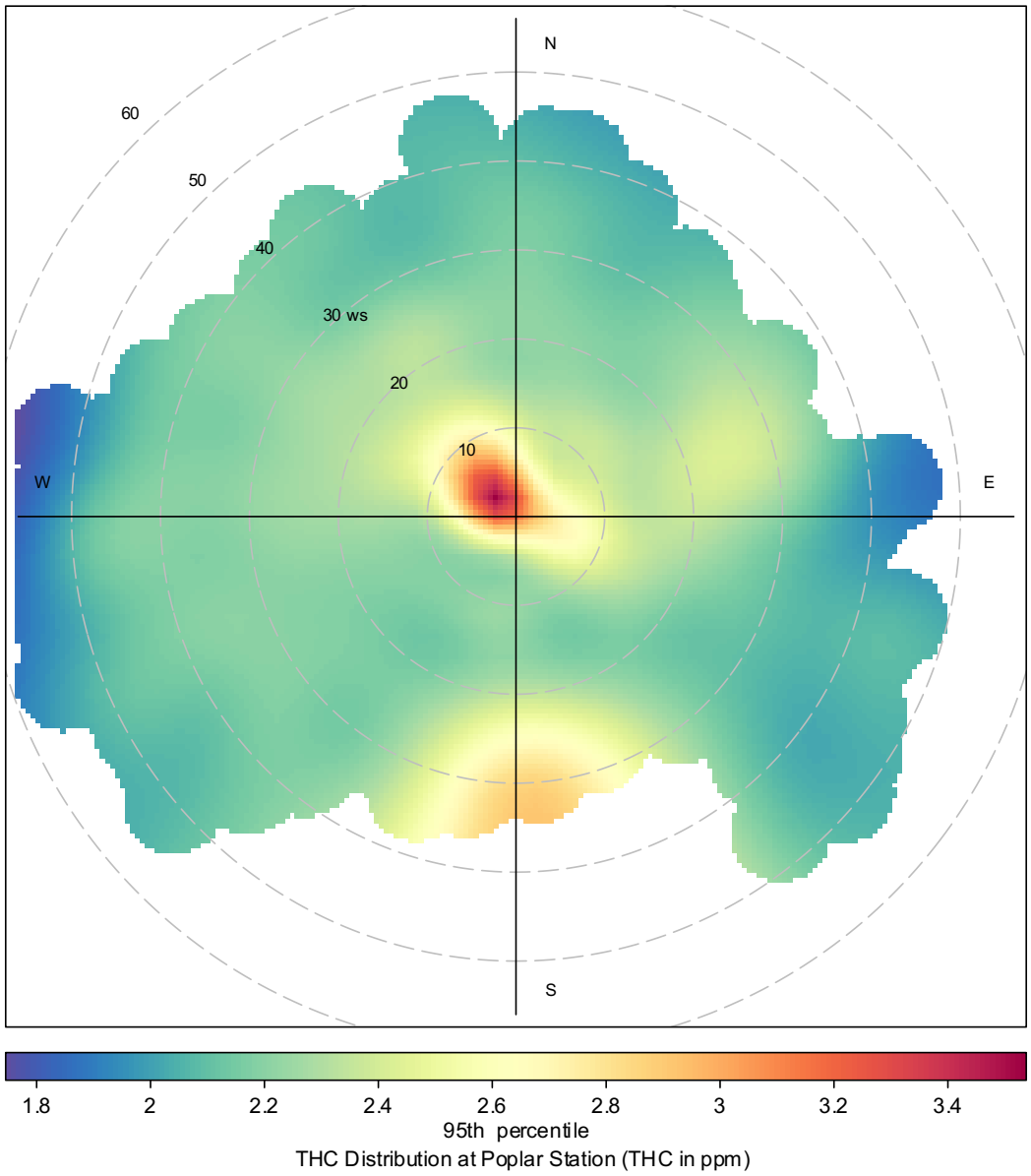


Figure 5-41 THC Measurements by Wind Direction

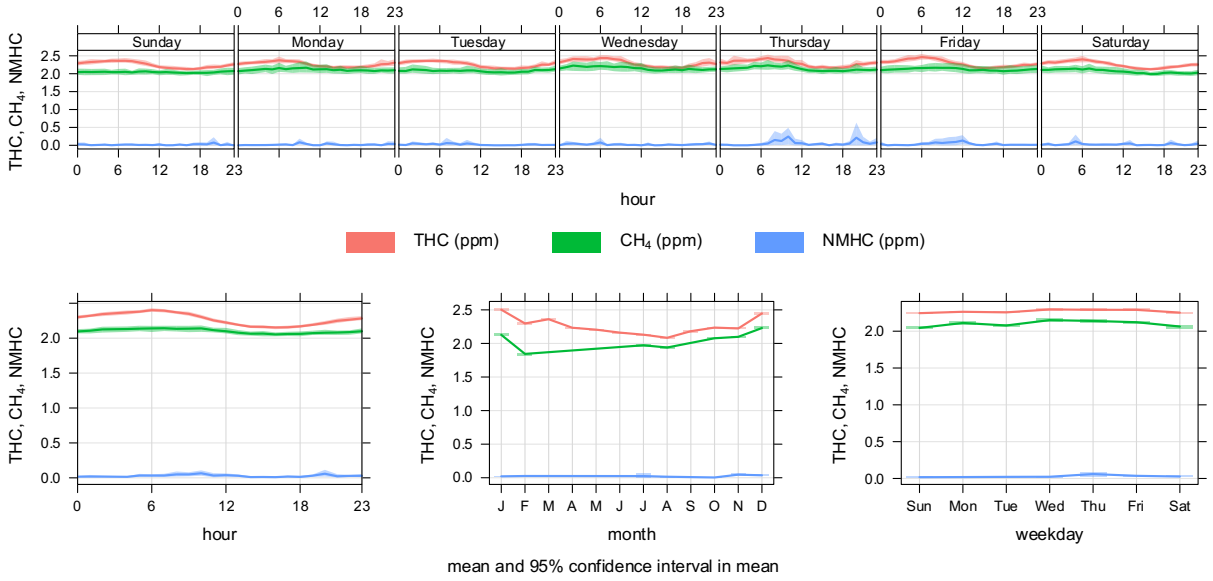


Figure 5-42 THC Measurements by Hour of Day

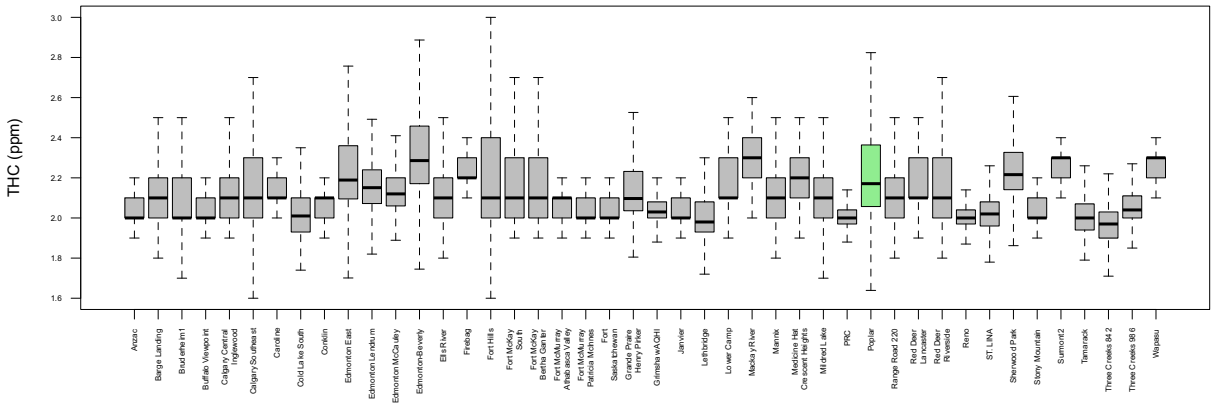


Figure 5-43 Comparison of THC Measurements from other Continuous Monitoring Stations (Mean values shown).

6. SUMMARY AND RECOMMENDATIONS

The monitoring data that PAZA collected through the Poplar monitoring project suggests that the air quality in the area is relatively good. Measured concentrations of TRS, SO_2, and NO_2 were below the applicable or other representative AAAQOs. Diurnal profiles of O_3 and NO_2 measurements appear to show slight photo-chemical O_3 formation and decomposition.

Measurements of $PM_{2.5}$ indicated that the AAAQG and AAAQO were exceeded infrequently during the monitoring period which were due to wildfires and did not appear to be reminiscent of general poor air quality.

The AAAQO for O_3 was exceeded on 3 and 4 consecutive hours on two different hot sunny summer days in 2023, which also happened to be during the days impacted by wildfires. These exceedances do not appear to be indicative of an on-going air quality problems in the area but it is a sign that elevated O_3 levels can occur under the correct conditions.

Emissions from the City of Grande Prairie and industry appeared to be the main contributor to NO_2 measurements. Emissions from industry appeared to be the main contributor to SO_2 measurements. Measurements of TRS and THC showed influence from both municipal and industrial sources. Although measurements of $PM_{2.5}$ were heavily influenced by natural sources (wildfires), a slight influence from municipal and industrial sources was noted.

Concentrations of THCs measured in the area were slightly lower than other areas in province for the same monitoring period. Very infrequent elevated concentrations of NMHC were measured but are not necessarily a cause for concern as the majority of NMHC measurements were zero. However, canister sampling for specific hydrocarbons or VOCs such as benzene would provide further helpful information as concentrations of specific hydrocarbons or VOCs cannot be inferred from the data collected.

The summary of the Poplar air quality survey is limited to the parameters measured in this study. Air quality in the area may be affected by other compounds some of which PAZA was not equipped to measure such as speciated hydrocarbons, volatile organic compounds (VOCs) or ammonia.