PEACE RIVER AREA MONITORING PROGRAM

2016–2017 ANNUAL REPORT

pramp

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Cover Photo: *Amanda Monette Photography*
"Canola Field"

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1. 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).

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. This report outlines the results of air monitoring in the area as a result of these recommendations.

In particular, the monitoring requirements in Paragraph 178(1) of the report recommendations accepted by the AER state, "The AER accepts this recommendation and will immediately engage with industry, residents and stakeholders to establish a regional air quality monitoring program for the Peace River Area" (AER 2014b). This report is the third annual data review and compares 2016 and 2017 monitoring results; the first and second reviews, which compare 2014 and 2015, and 2015 and 2016, data are available on the PRAMP website.

1.1. Emissions

In the region, there are about 4,000 industrial facilities and installations including gas plants, flare stacks, wells, storage facilities, and pipeline infrastructure with the potential to emit hydrocarbons (IHS 2017; Figure 1). Operators in the Peace River area (Three Creeks, Reno, Walrus, Seal) with Cold Heavy Oil Production (CHOP) facilities are required to have emission control devices in place to mitigate or eliminate potential releases of hydrocarbons (AER 2017). Typical hydrocarbon emissions result from fugitive and combustion sources that tend to occur on a continuous basis. Emissions also occur on an episodic basis from truck filling and tank cleaning operations. While emission sources are not characterized at all locations, the impacts on air quality at three monitoring locations are presented for review.

1.2. Meteorology

This report outlines data collected during 2016-2017 at three monitoring locations (Figure 1). The measurements collected at the monitoring sites confirm that temporal and spatial meteorological variations occur in the Peace River Area.

1.3. Station Data and Trends

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.

This is PRAMP's third annual report and data analysis was completed on the two most recent annual datasets (2016 – 2017). Three types of data were analyzed: continuous monitoring, meteorological measurements, and discrete canister samples.

Continuous sampling monitored Sulphur dioxide (SO_2), total reduced sulphur (TRS), total hydrocarbon (THC), methane (CH_4), and non-methane hydrocarbons (NMHC) concentrations.

Meteorological parameters (wind speed, wind direction, temperature, pressure, and relative humidity) were also monitored at the three continuous ambient air quality monitoring stations in the region.

Discrete, triggered canister samples were collected when the NMHC concentration reached a threshold of 0.3 parts per million by volume (ppmv) averaged over 5 minutes. Canisters are analyzed for over 140 volatile organic compounds (VOC). In 2016, 12 canister events were triggered, but only 11 samples were collected for analyses; one event was missed by the network operations contractor and the sample was discarded. In 2017, 6 canister events were triggered but only 4 samples were sent for analyses; 2 events were missed by the network operator and the samples were discarded.

AER complaints were collected and analyzed for the correlations to monitored data.

The methods used to analyze data are outlined below.

Continuous sampling:

- continuous measured meteorology parameters (wind speed and wind direction) are presented in wind roses
- continuous measured ambient SO_2, TRS, THC, CH_4, and NMHC concentrations are present in vertical bar charts, line plots, and concentration roses
- continuous measured ambient SO_2, TRS, THC, CH_4, and NMHC concentrations (maximum, 99^{th} percentile, and average by month) are presented in vertical bar charts with statistical analysis

Triggered sampling canister events:

- 11 triggered canister events in 2016 and 4 triggered canister events in 2017 were analyzed for over 140 volatile organic compounds (VOC). These data are presented in tables.

AER complaints:

- AER complaints are presented in a timeline with THC concentrations (continuous)

Based on hourly measurement data, maximum THC, NMHC, SO_2, and CH_4 concentrations generally show some incremental variability in trends at Stations 986 and 842 between 2016 and 2017. Observations of increased THC and CH4 concentrations at Station 986 toward the end of 2017 are likely due to cattle in the vicinity of the station. TRS data at Stations 986, 842, and Reno show an incremental increasing trend over the two years of applicable data. Analysis of the monitored data on a monthly basis resulted in varied trends over time for each substance.

Stations 986 and 842 monitoring results showed that the 99th percentile concentrations of THC were similar to other areas of the Province. The 99th percentile increased while the maximum decreased at the Reno Station between 2016 and 2017 however it remains elevated relative to Station 986 and 842 for both years. The Reno station measurements are higher; however, they are at about the average of other stations in the province.

Data for Three Creeks suggests that PRAMP is meeting the goal of verifying that air quality is improving and odours are being minimized as a result of operational and regulatory improvements; this is particularly evident when the full record of monitoring from Station 986 and 842 are considered. Recent spatial analysis of wells and their associated infrastructure suggests the close proximity of CHOP facilities may be influencing hydrocarbon concentrations more at the Reno Station than at Stations 986 and 842.

1.4. Complaints

The AER recorded odour complaints from residents and assigned the location of the complaint to each of the three stations. AER complaints were collected and analyzed as follows:

- Station 986 showed a decrease in the number of complaints from 5 in 2016 to 4 in 2017 (down from a historical maximum of 33 in 2014)
- Station 842 showed a decrease in the number of complaints from 16 in 2016 to 4 in 2017 (down from a historical maximum of 44 in 2014)
- Reno Station showed an increase in the number of complaints from 3 in 2016 to 5 in 2017 (down from a historical maximum of 11 in 2015)

While odour complaints attributed to Reno Station showed a slight increase, all stations show a marked decline compared to historical maximums in the Three Creeks Area.

2. BACKGROUND

The Peace River Area is defined as the Three Creeks, Reno, Seal Lake, and Walrus areas (Figure 1). The air quality monitoring program operated by PRAMP is designed to operate collaboratively and transparently including representation from industry, the AER, government agencies, residents of Three Creeks and Reno areas, and environmental non-governmental organizations (AER 2014b).

PRAMP's vision is that the "Peace River Area heavy oil and bitumen operations' emissions will not cause odours that affect human health" (PRAMP 2016). The mission statement maintained by PRAMP is the "Peace River Area will have an air quality monitoring program that provides credible and comprehensive data to permit the identification and appropriate response to odour and emission-related issues" (PRAMP 2016). An overview of PRAMP's goals and objectives are listed below. PRAMP defines odours and emissions as the following:

- odours: detected in the ambient air by the people in the area
- emissions: at a source are defined by the concentration and flow rate of each compound released; upon release from the source the emissions disperse downwind and may be measured as a concentration in the ambient air by a monitoring device

PRAMP's goals are to:

- assist in verifying that air quality is improving and odours are being minimized as a result of operational and regulatory improvements
- operate transparently and give residents and stakeholders timely access to data and information in a manner that is readily understood
- demonstrate that oil and gas operators have effective control mechanisms
- verify that air quality is at acceptable levels and that emissions residents are exposed to are below toxic thresholds (PRAMP 2016)
- maintain its status as an independent Not-for-Profit Organization and Airshed that is focused on continuous improvement and responsible growth

To accomplish the goals the program would:

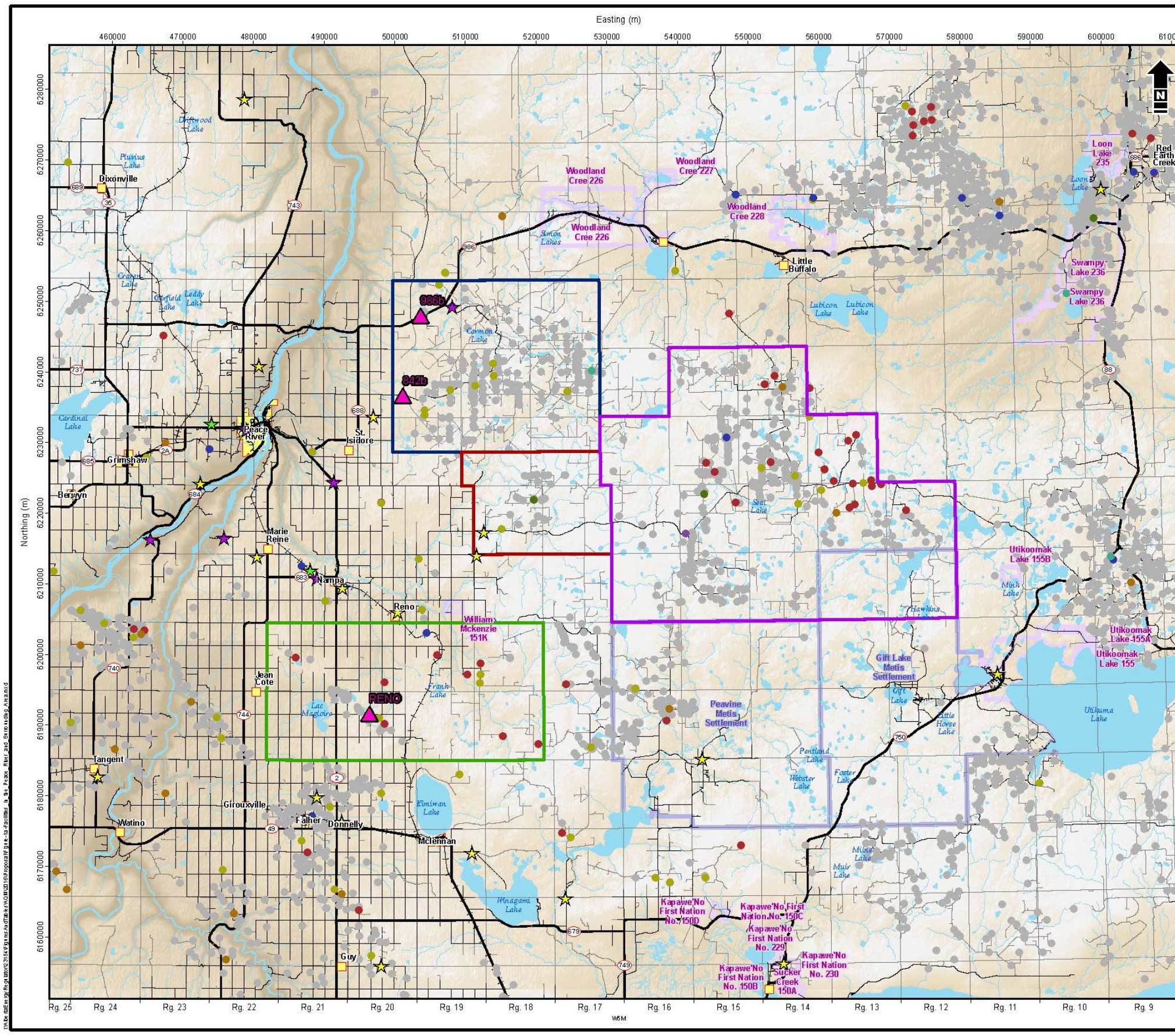
- characterize emissions and odours associated with industrial activity, with a focus on oil and gas operations
- identify and measure dominant sources of emissions in the area
- give timely, real-time data on ambient emissions and odours in the area (PRAMP 2017)

A review and analysis of the 2016 - 2017 annual air monitoring data collected by PRAMP is included in this report. The data includes the continuous monitoring of the 1-hour averaged TRS, CH4, NMHC, THC, and SO2 concentrations. Additionally, VOCs monitored using 1-hour event canisters triggered by NMHC concentrations exceeding a threshold of 0.3 ppmv were also assessed.

All monitoring was conducted at the three community stations located within PRAMP's monitoring network:

- Station 842 is located at 16-07-084-19 W5M
- Station 986 is located at 14-16-085-19 W5M
- Reno Station is located at 01-28-079-20 W5M

The locations of the three monitoring stations are shown on Figure 1, which also shows nearby industrial activities in the Peace River Area and surrounding regions including compressor stations, oil batteries, tank farms, gas gathering and processing facilities, terminals, pulp mills, and waste facilities (industrial and domestic). This figure assists in the identification of the emission sources around each station as well as the potential influence of nearby sources to the monitoring data. The heavy oil facilities in the area, operated by Baytex Energy Ltd., Murphy Oil Company Ltd. (now owned by Baytex), Penn West Petroleum Ltd. (now Obsidian Energy), and Shell Canada Ltd. (now Canadian Natural Resources Limited) are selectively shown on Figures 2 through 5.



igure 1: Facilities in the Peace River and Surrounding Area

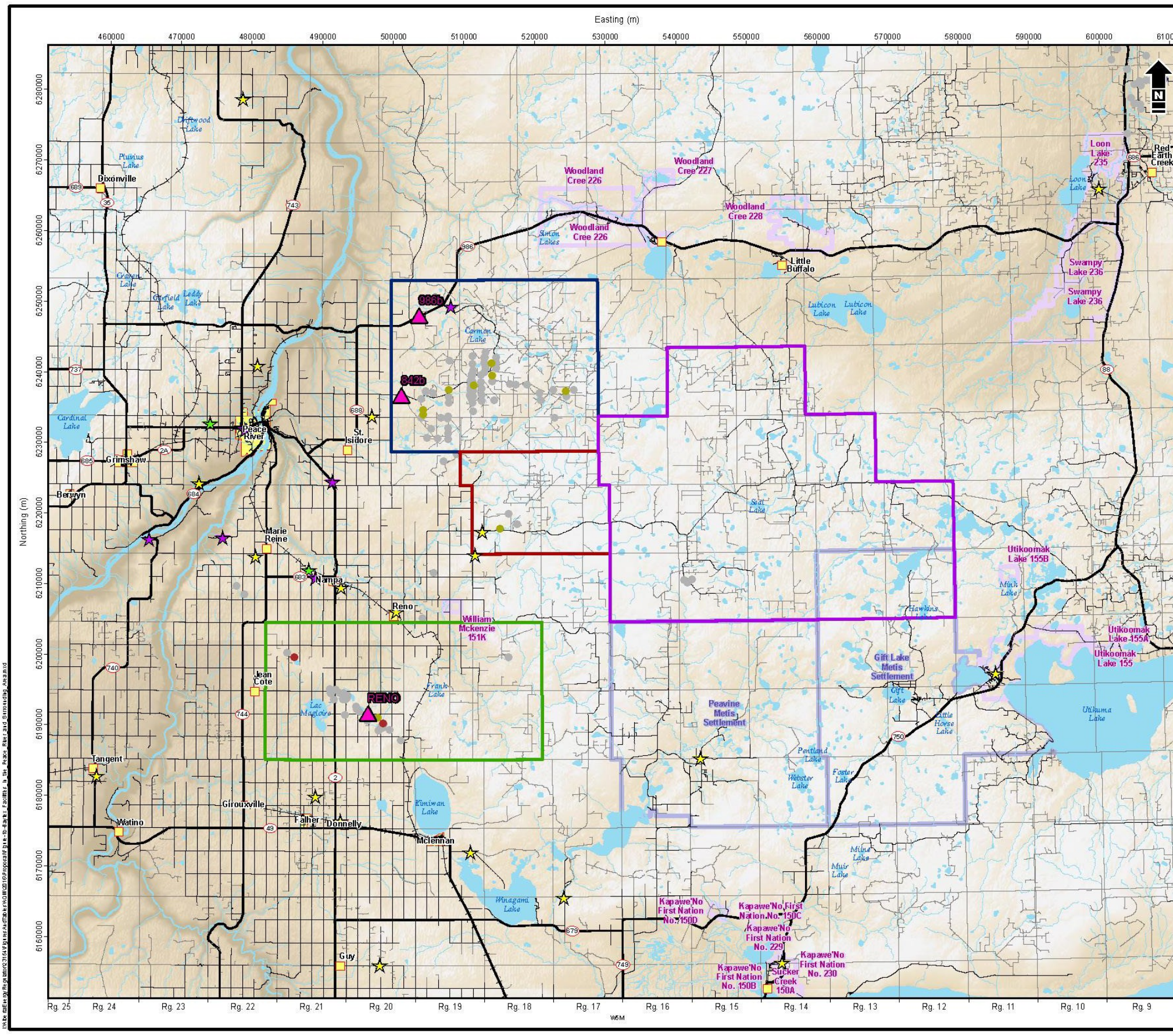


Figure 2: Baytex Energy Ltd. Facilities in the Peace River and Surrounding Area

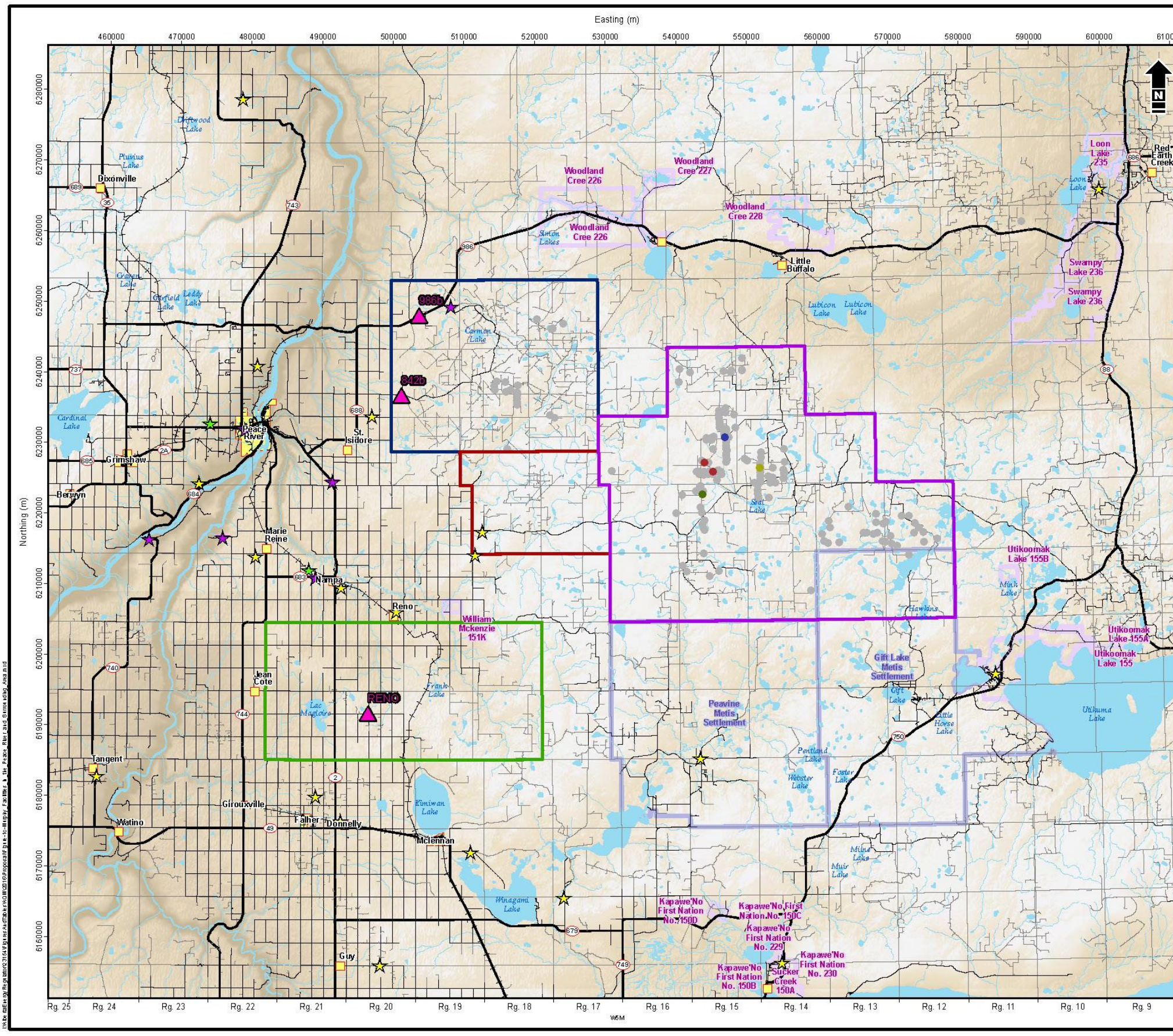


Figure 3: Murphy Oil Company Ltd. (now Baytex) Facilities in the Peace River and Surrounding Area

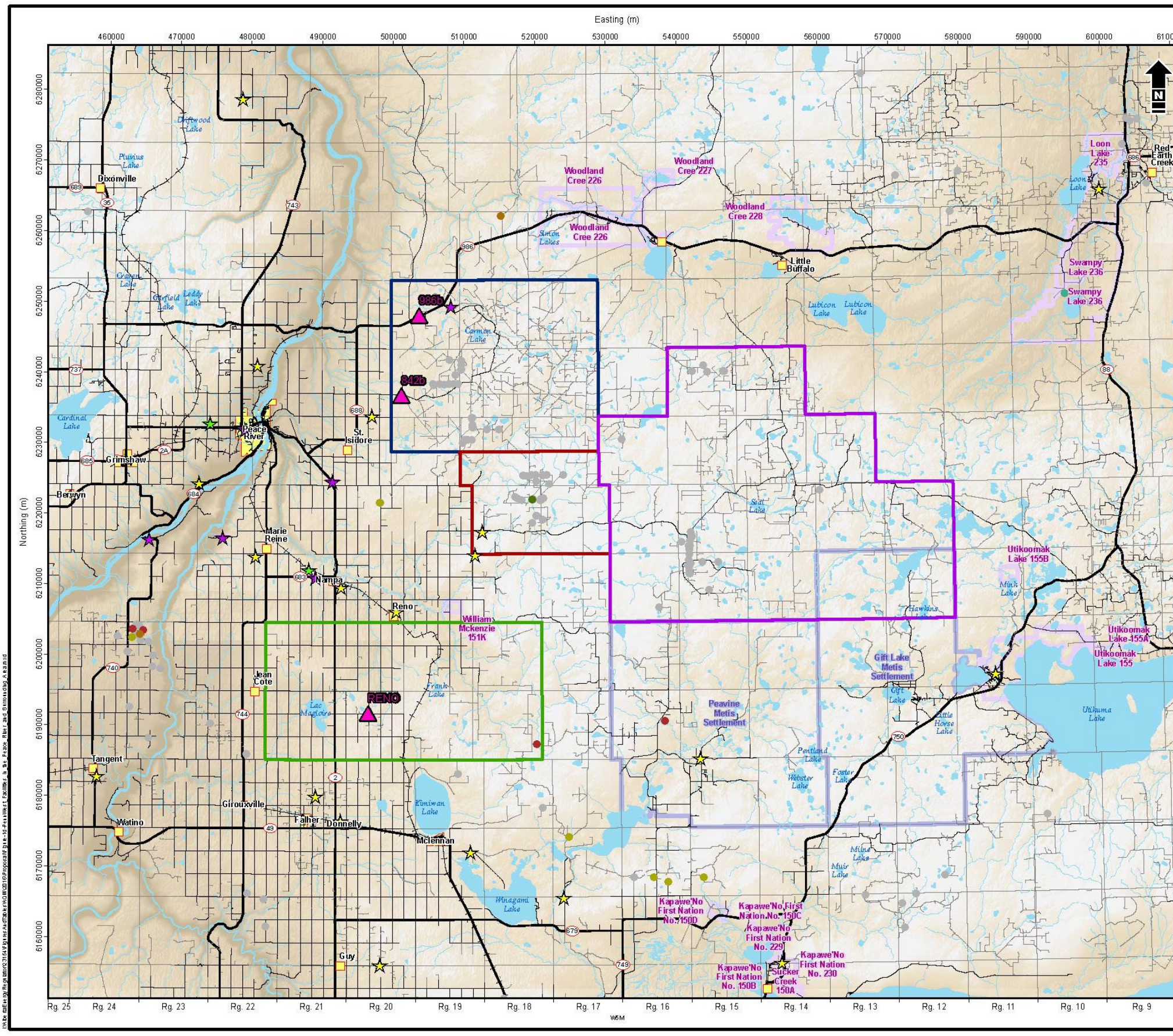


Figure 4: Penn West Petroleum Ltd. (now Obsidian Energy) facilities in the Peace River and Surrounding Area

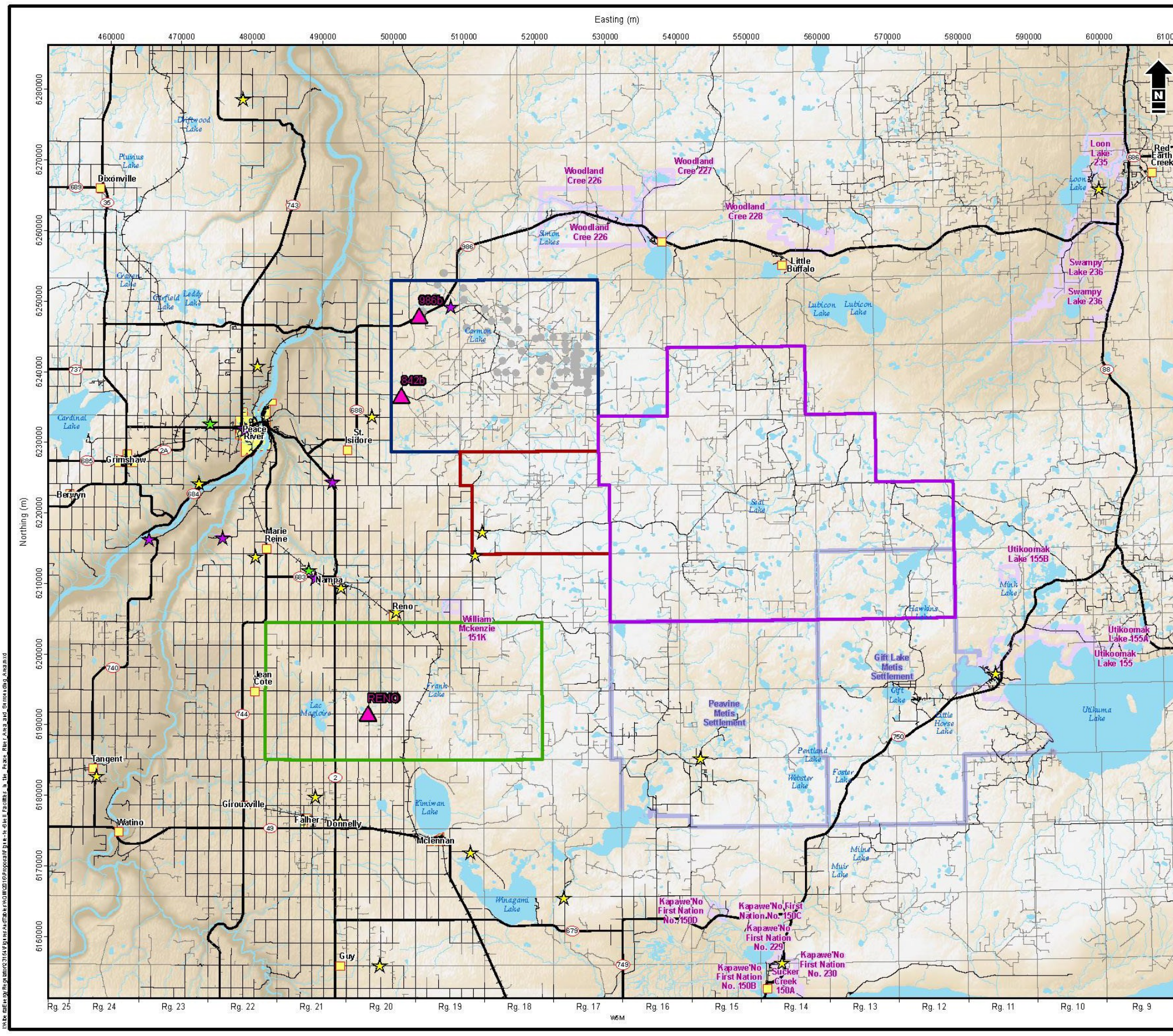


Figure 5: Shell Canada Ltd. (now Canadian Natural Resources Limited) facilities in the Peace River and Surrounding Area

2.1. Air Quality Monitoring Overview

To accomplish PRAMP's goals and to be in alignment with its mission statement, 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 are also collected at the continuous monitoring stations and used in this monitoring program. Assessing concentration and wind data together allows investigation into the potential sources of substances affecting the local air quality. Statistical analysis, such as the calculation of percentiles, is performed on the data, which has undergone quality assurance, to understand the distribution of the data.

Discrete canister sampling events were triggered when continuous monitored data exceeded set thresholds. Triggered sampling events were completed using canisters to capture ambient air samples. The samples are then taken to a laboratory for analysis.

PRAMP's objectives include the comparison of monitored data to toxic thresholds (PRAMP 2016). The provincial government developed the Alberta Ambient Air Quality Objectives and Guidelines Summary (AAAQO; AEP 2017) to protect the environment and human health. The AAAQOs are used as threshold values for comparing substance concentrations (at appropriate averaging periods) to assess impacts.

3. CONTINUOUS MONITORING STATION DATA AND TRENDS

The following subsections describe the results of the monitoring, analysis, and methods used to complete this report.

3.1. Station Data and Trends Methodology

All hourly data collected at the three stations was compiled and interpreted. Hourly data for meteorology, THC, NMHC, TRS, SO_2, and CH_4 concentrations have been presented as follows:

- wind roses displaying the wind speed and direction for each year and at each station
- hourly data with maximum values identified for each year and station
- monthly measurement trends for the 100^{th} (maximum) and 99^{th} percentiles by month for each station for all time periods
- time series results for the maximum, 99^{th}, 90^{th}, and 50^{th} percentiles and minimum readings collected at each station and year

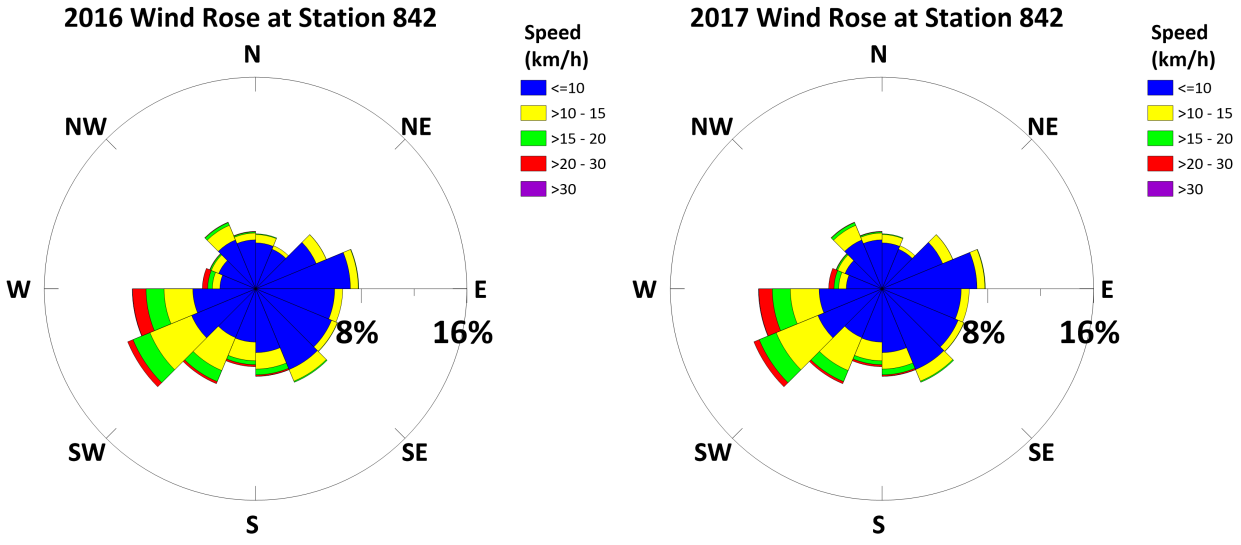
This data and statistical analysis has been presented with interpretation in Sections 3.2 to 3.5.

3.2. Wind Roses

Presented in a circular format, wind roses show the frequency of winds blowing from particular directions over a specified period. The length of each 'spoke' around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each concentric circle represents a different frequency, emanating from zero at the center to increasing frequency at the outer circles. Each spoke is broken down into colour-coded bands to show the range of wind speeds that occurred in that particular direction.

Wind roses created from meteorological measurement data for each station and year are presented to understand the predominant wind conditions at each of the three station locations (Figure 2). Trends for each station are noted as follows:

- Station 842: Winds are primarily from the southwest. Wind speeds largely range from less than 10 to 30 km/hour with minimal wind speeds over 30 km/hour in both 2016 and 2017. More than 70% of hours annually were below 10 km/hour.
- Station 986: Wind direction varies, with a higher frequency of winds coming from the southeast and minimal winds coming from the northeast. Wind speeds largely range from less than 10 to 15 km/hour with minimal wind speeds over 15 km/hour in both 2016 and 2017. More than 85% of hours were below 10 km/hour.
- Reno Station: Winds were primarily from the southwest. Wind speeds largely range from less than 10 to 20 km/hour with minimal wind speeds over 20 km/hour. More than 85% of hours annually were below 10 km/hour.



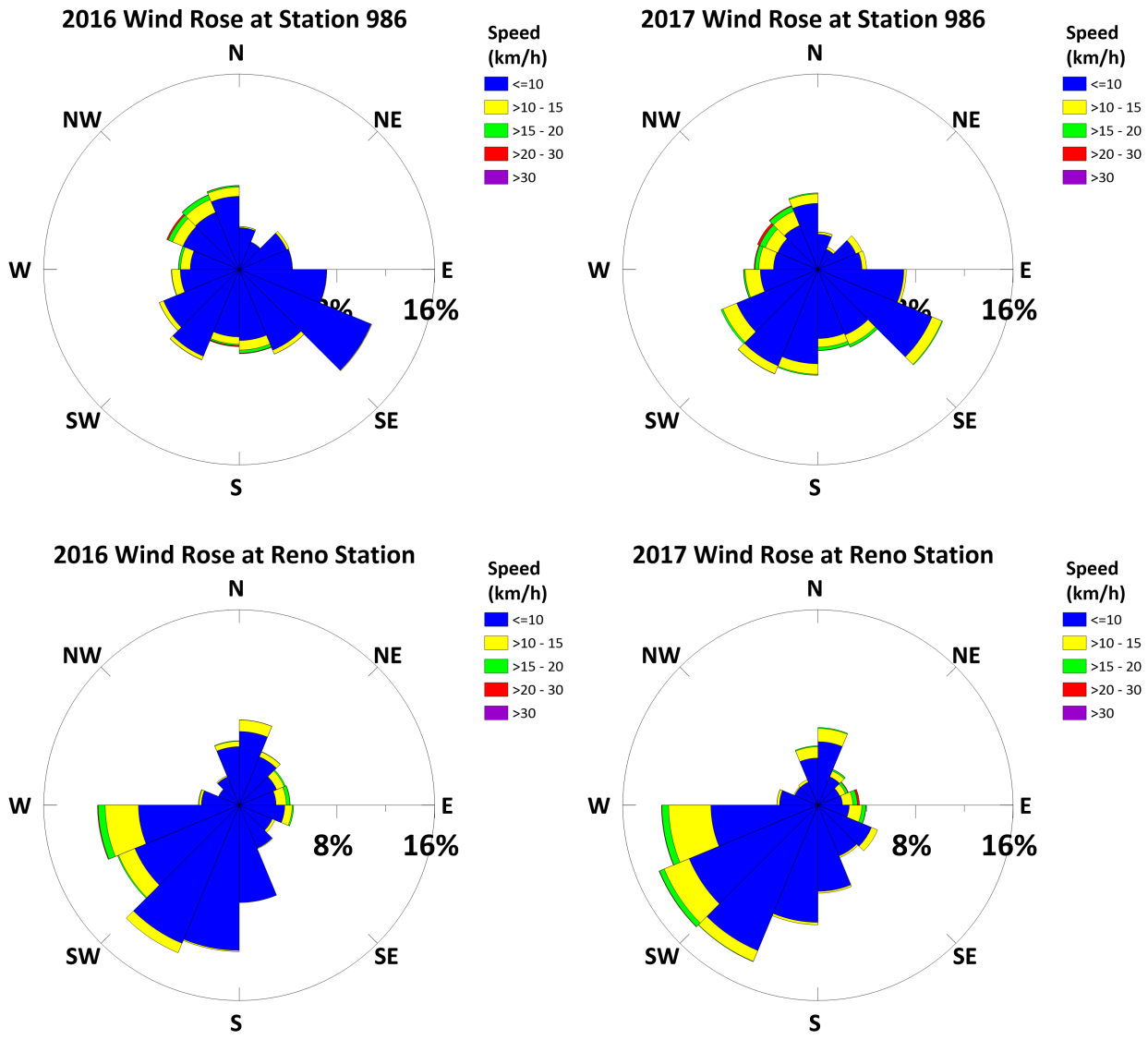


Figure 6: Wind Roses at Stations 842, 986 and Reno

3.3. Hourly Concentration Data

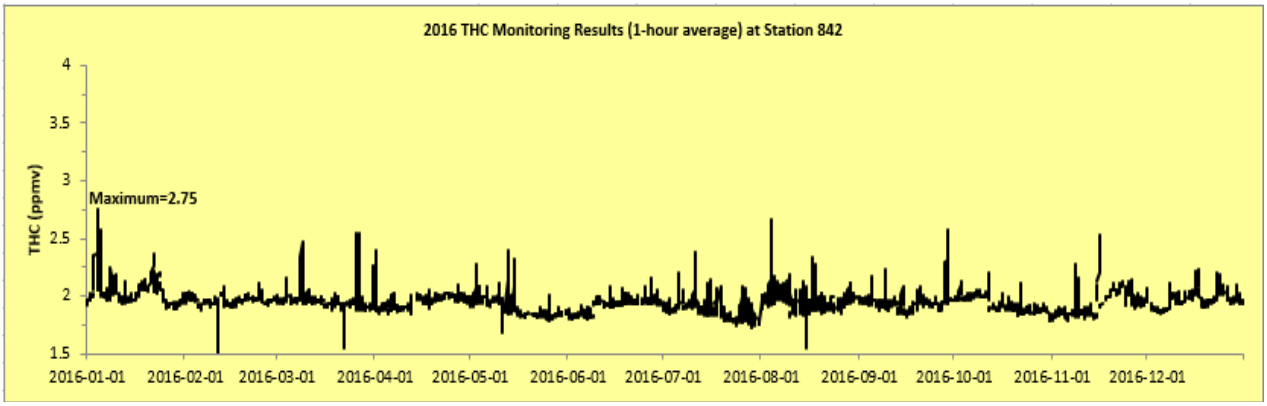
Hourly concentration data is presented to show all concentration data collected at the three stations for each year. Hourly concentrations are presented for total hydrocarbon (THC), non-methane hydrocarbons (NMHC), total reduced sulphur (TRS), sulphur dioxide (SO_2) and methane (CH_4) in this section. THCs are the sum of CH_4 and NMHC. NMHC may be emitted with methane from the man-made sources and are likely to have an odour. NMHC measurements include volatile organic compounds (VOC).

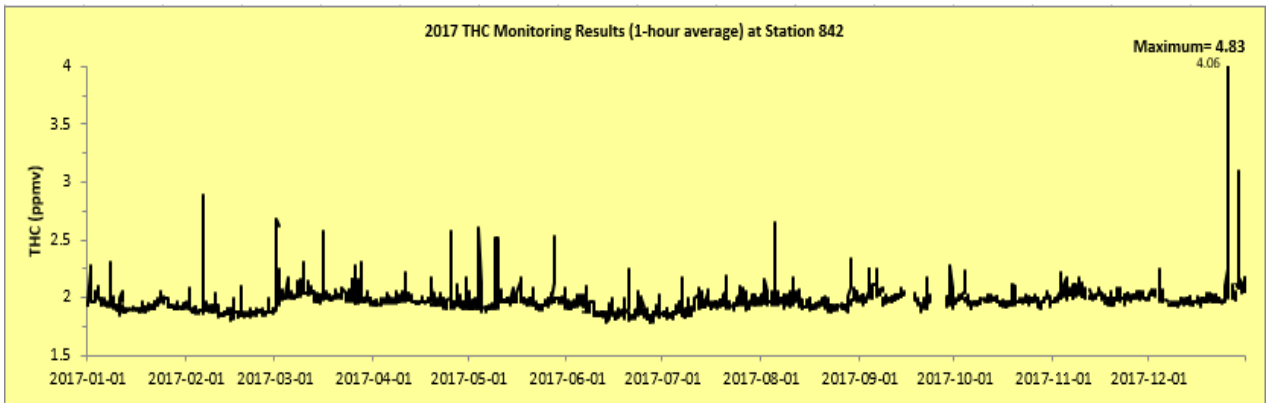
TRS compounds include hydrogen sulphide, carbonyl sulphide, carbon disulphide, and other hydrocarbon-sulphur compounds such as mercaptans and thiophenes. Some TRS compounds may have a strong offensive odour at concentrations below 1 ppbv. There are natural sources of TRS but they can also be emitted from bitumen facilities. SO_2 results from the combustion of sulphur compounds in fuel and flared/incinerated gas. CH_4 comes from natural and man-made sources and has a background concentration of typically less than 2 ppmv, depending on season and time of day. CH_4 does not have an odour or health effects at these low concentrations.

3.3.1. Total Hydrocarbons

THC concentrations include all NMHC and methane concentrations. There is no AAAQO for THC. Hourly data for THC from the three stations is presented in the charts below (Figure 7).

The maximum hourly THC data for the Reno Station was lower in 2017 than in 2016; the maximum hourly THC concentration at Station 986 was higher in 2017 than in 2016 due to cattle grazing near the station. The elevated THC concentrations, observed from October to November 2016, may be due to brush burning activities occurring south of the Reno Station monitoring trailer. A significant producer in the Reno area shut down operations in early 2017 and resumed production by that summer.





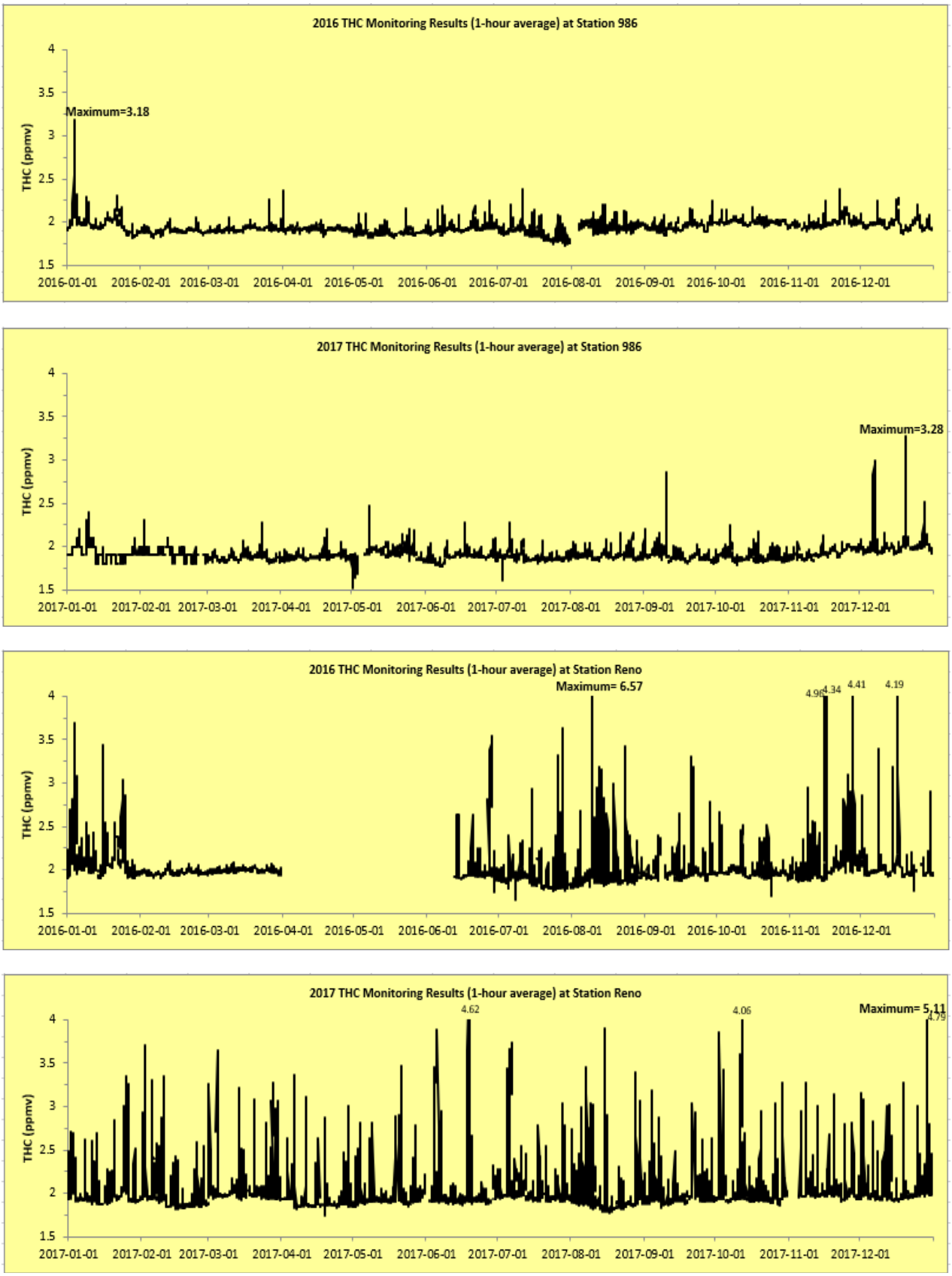


Figure 7: Hourly Monitored Total Hydrocarbons Data

For historical comparison purposes, Figure 8 shows the complete record of monitoring for THC at all stations. There is a clear decrease in ambient THC concentrations at Stations 986 and 842; the presence of cattle and their associated hydrocarbon emissions is noted in the up-tick in concentrations towards the end of 2017. Note that the scale of these charts is different than the previous series because the historical concentrations of THC have been higher than measured in 2016-2017. Reno continues to show elevated THC relative to the other stations however the concentrations are not as high as historical values measured at the other PRAMP sites.

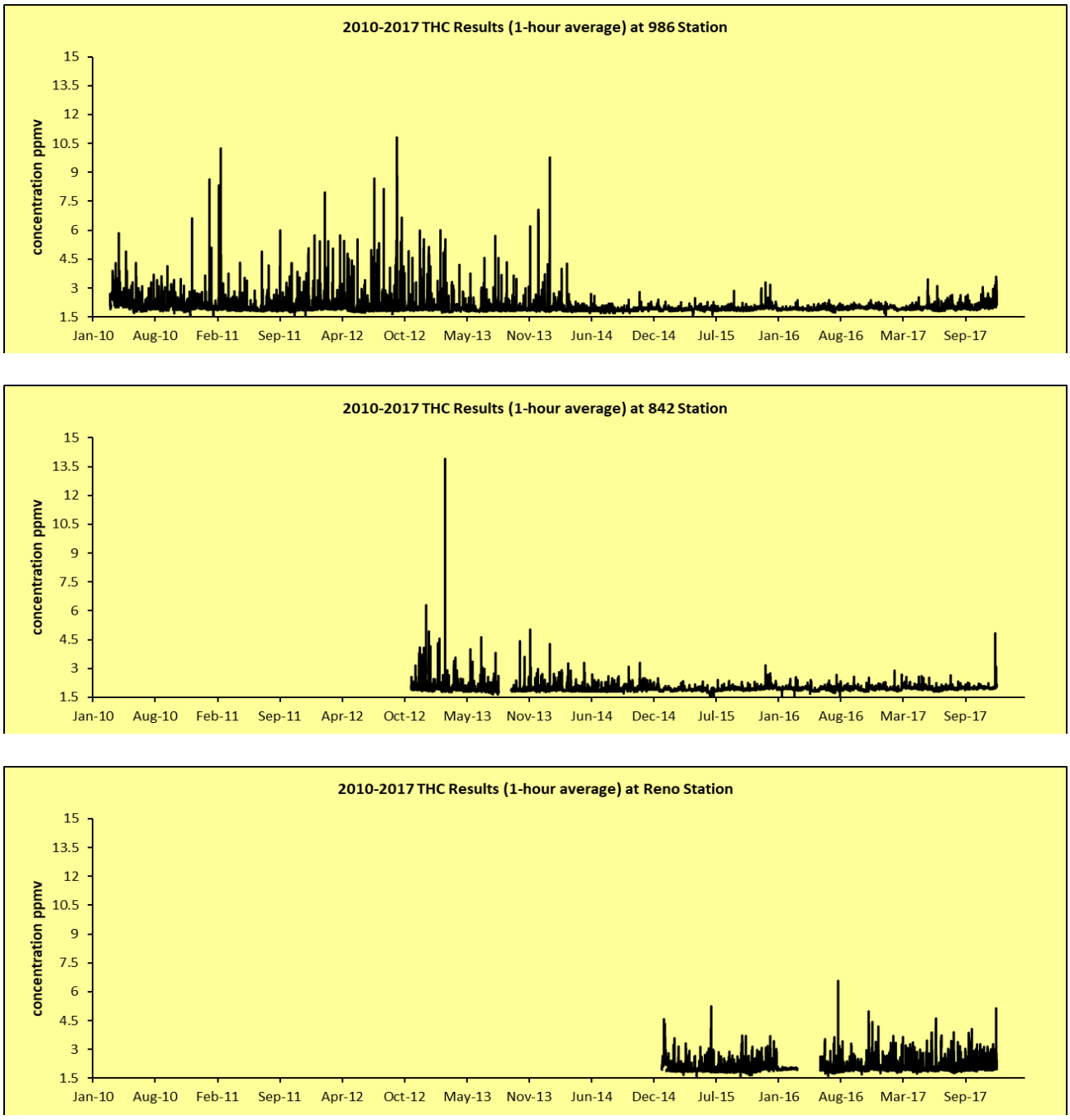
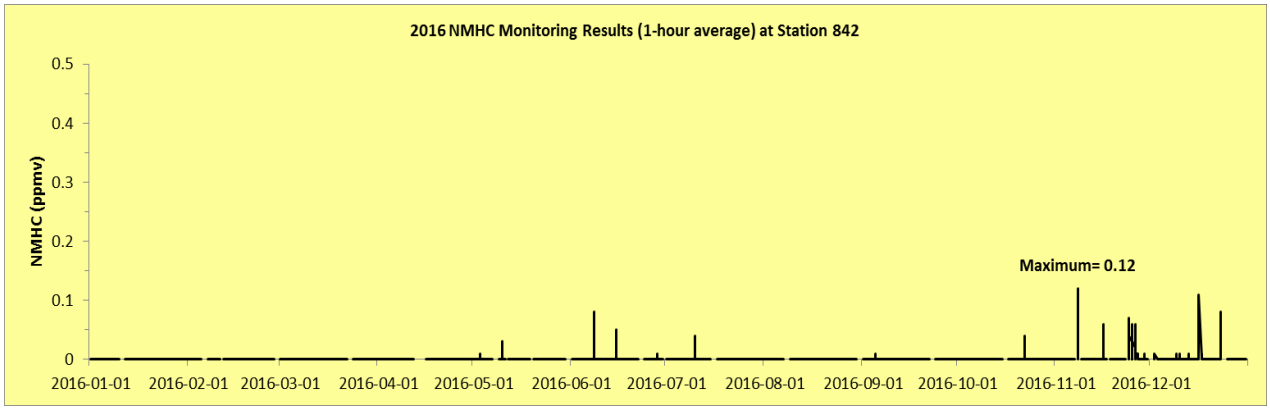
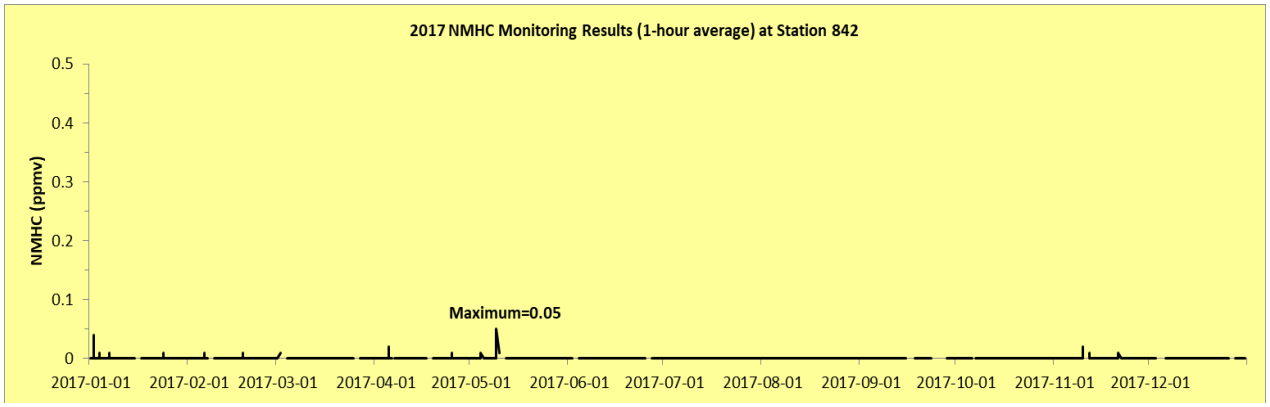


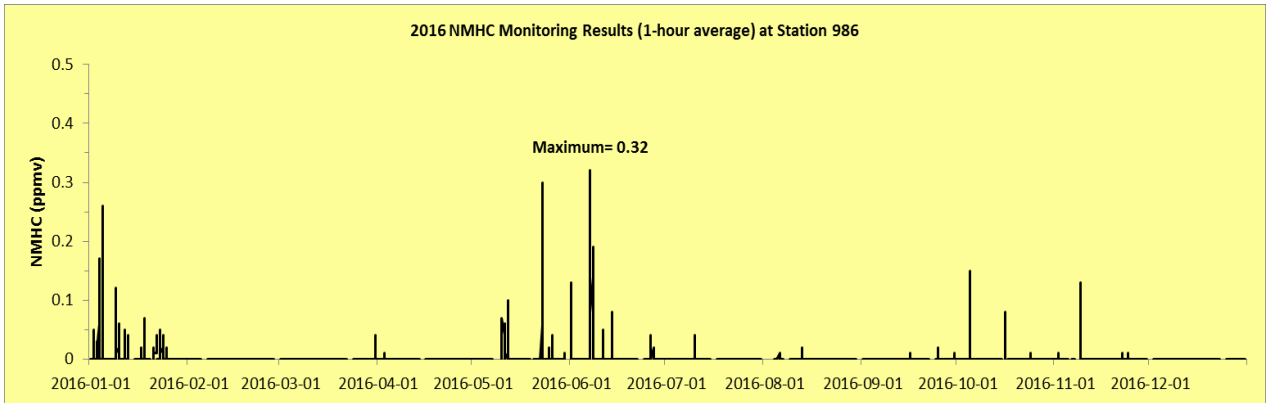
Figure 8: Hourly Monitored Total Hydrocarbon Data from 2010-2017

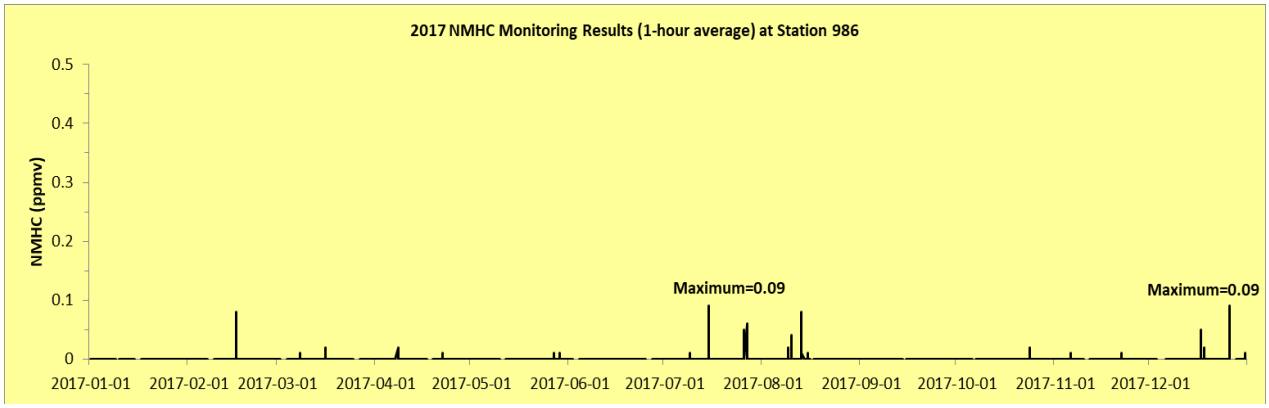
3.3.2. Non-methane Hydrocarbons

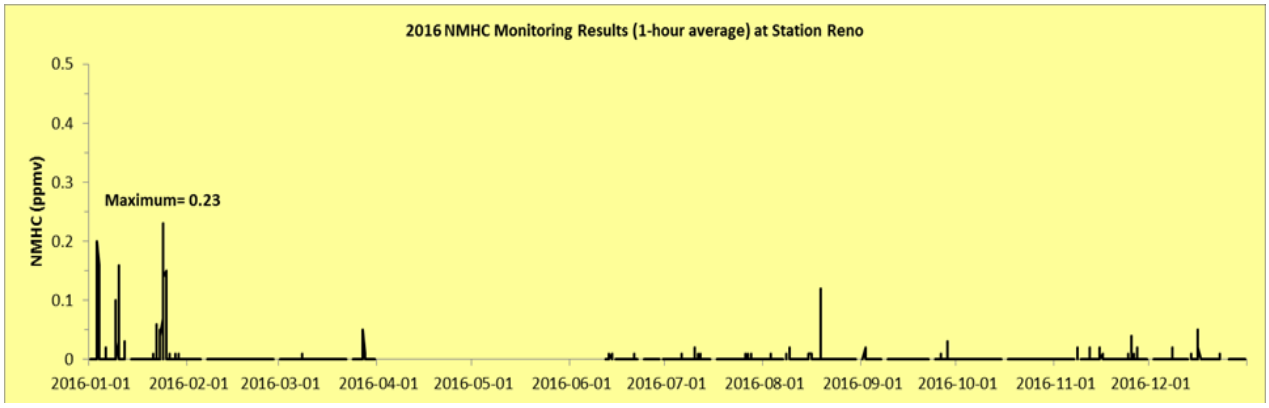
Hourly NMHC data NMHC for the three stations is shown in the charts below (Figure 9). There is no AAAQO for NMHC. The maximum hourly NMHC data for Station 842 decreased incrementally from 2016 to 2017. In 2016 all the data reported at Station 842 were less than 0.05. The maximum hourly NMHC concentration for Station 986 decreased between 2016 to 2017 from 0.32 ppmv to 0.09 ppmv and overall shows a lower frequency of occurrences of elevated measurements of NMHC. The Reno Station recorded maximum NMHC concentrations of up to 0.23 ppmv in 2016 and 0.14 ppbv in 2017; overall, the magnitude and frequency of elevated NHMC events decreased in 2017 compared to 2016.











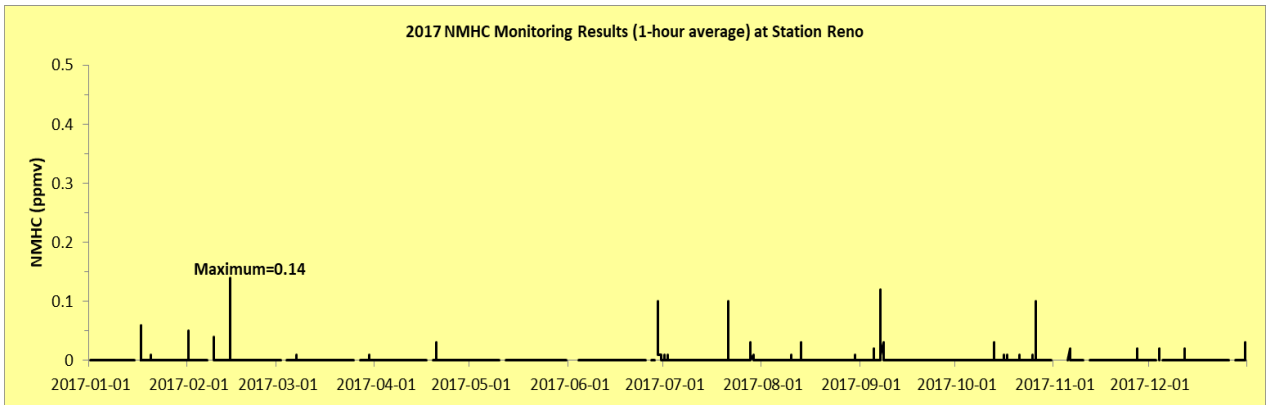


Figure 9: Hourly Monitored Non-methane Hydrocarbons Data

For historical comparison purposes, Figure 10 shows the complete record of monitoring for NMHC at all stations. There is a decrease in frequency of elevated NMHC events at Stations 986 and 842. Reno shows a decrease in the magnitude and frequency of elevated NMHC since monitoring began at that site in 2014.

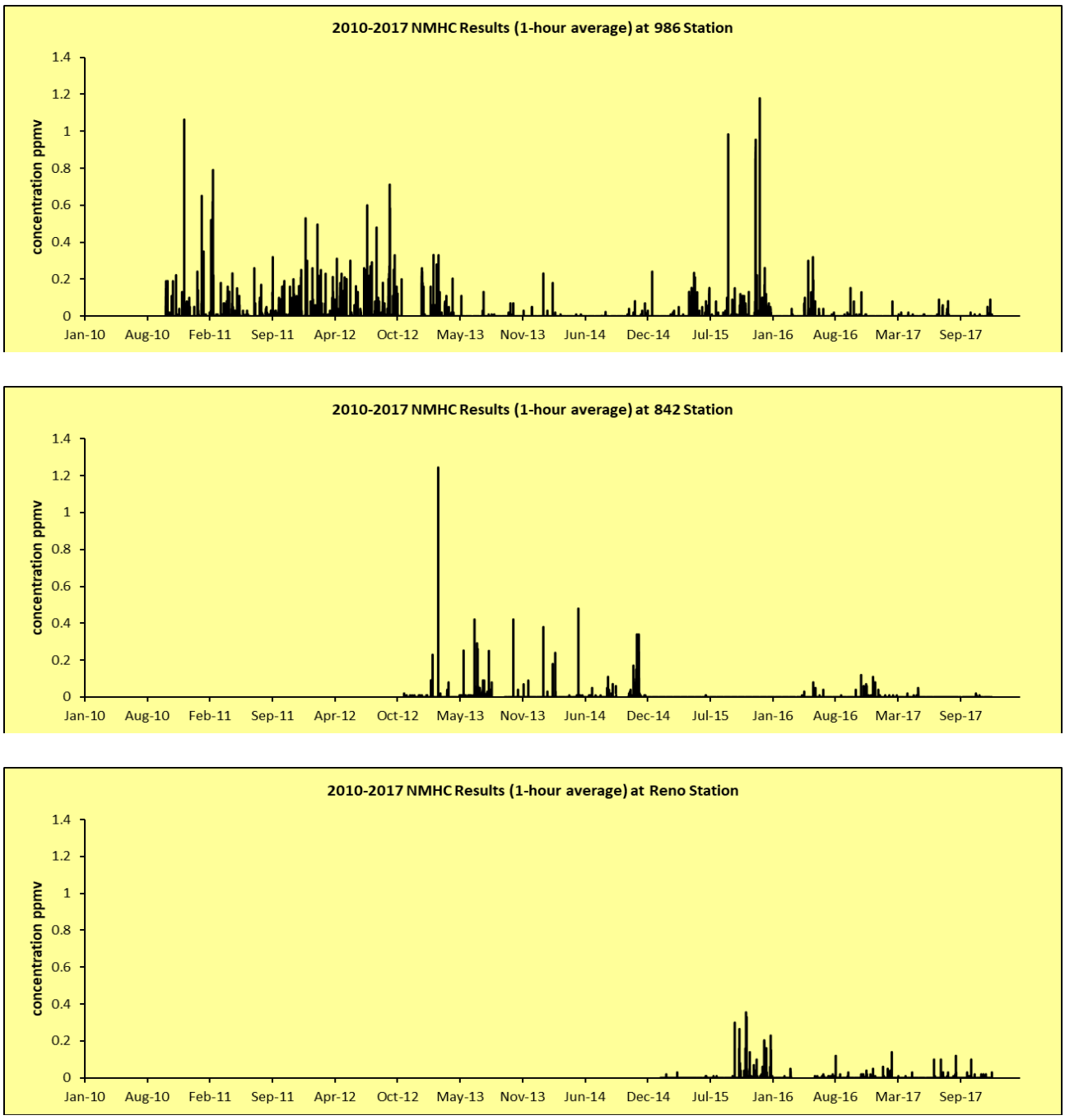
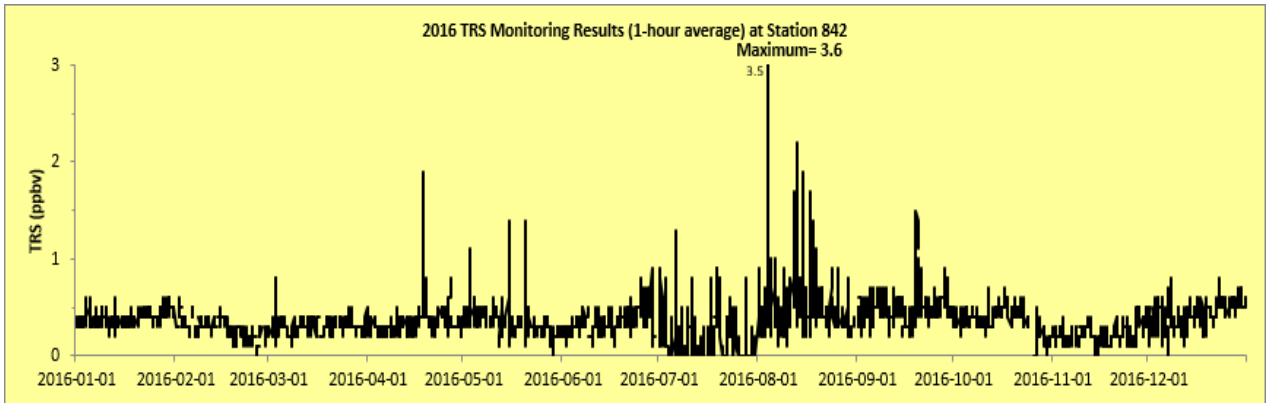


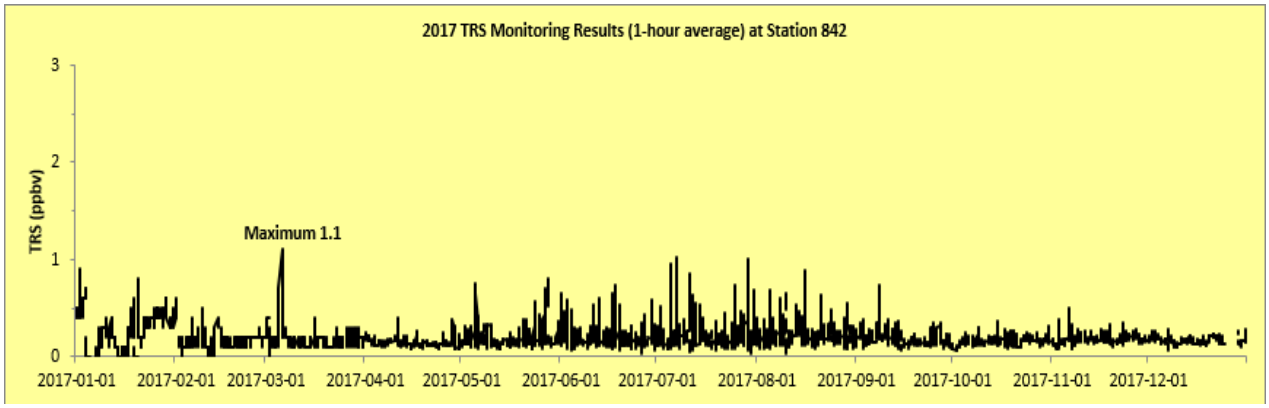
Figure 10: Hourly Monitored Non-Methane Hydrocarbons from 2010-2017

3.3.3. Total Reduced Sulphur

Hourly data for TRS for the three stations is shown in the charts below (Figure 11). The resolution of the reported results was 1 parts per billion (ppbv). There is no AAAQO for TRS but the AAAQO for hydrogen sulphide and carbon disulphide are both 10 ppbv.

There is a slight decrease in the maximum hourly TRS concentration from 2016 to 2017 at both Station 842 and 986. The Reno Station shows the highest hourly value overall and the highest frequency of elevated measurements of TRS. Elevated measurements of TRS may be caused by local industrial sources but others may also include agriculture and natural sources such as shallow lakes and sloughs. Despite the elevated values at Reno, there was a marked decrease in the maximum concentration measured between 2016 and 2017.





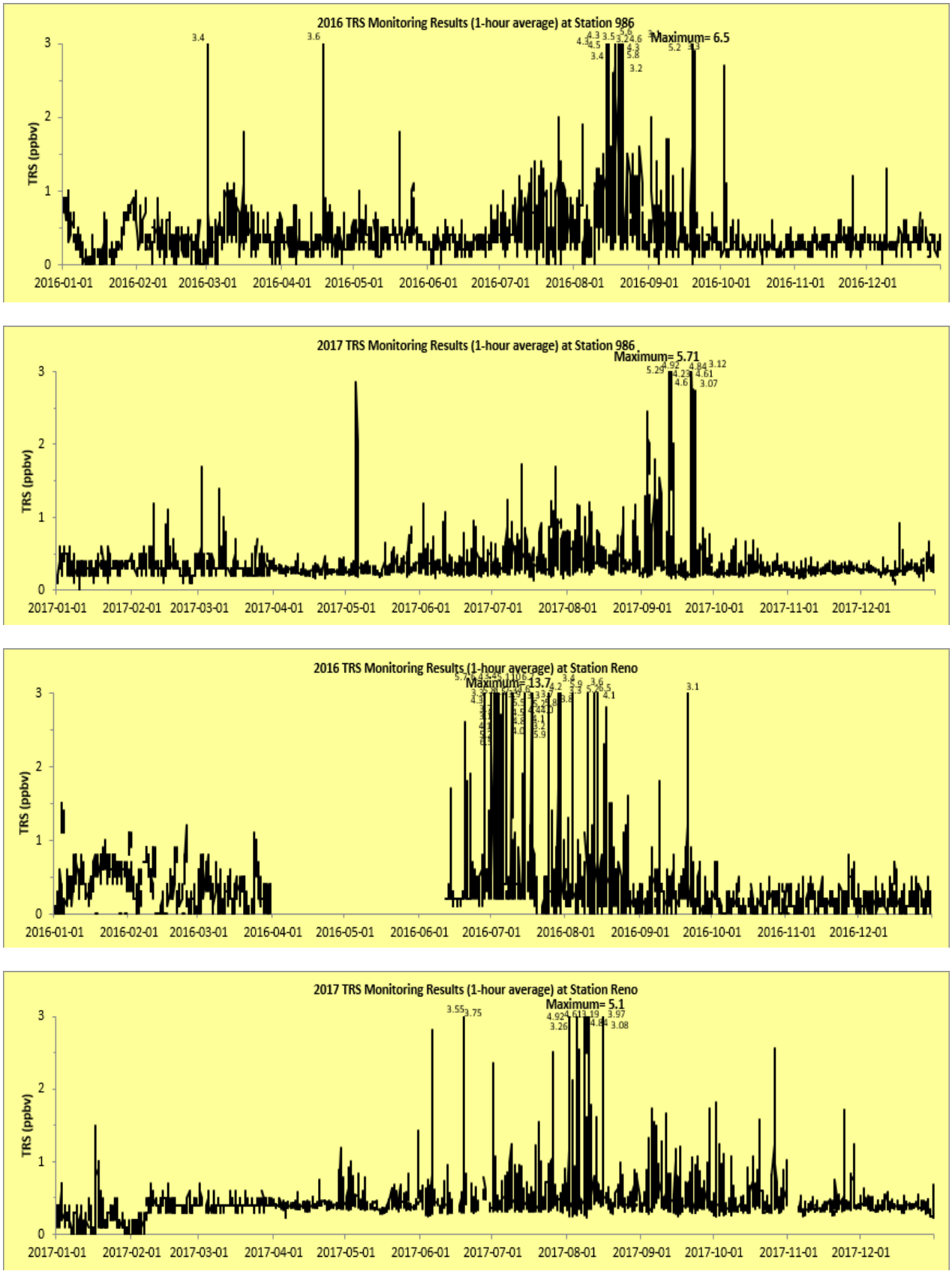
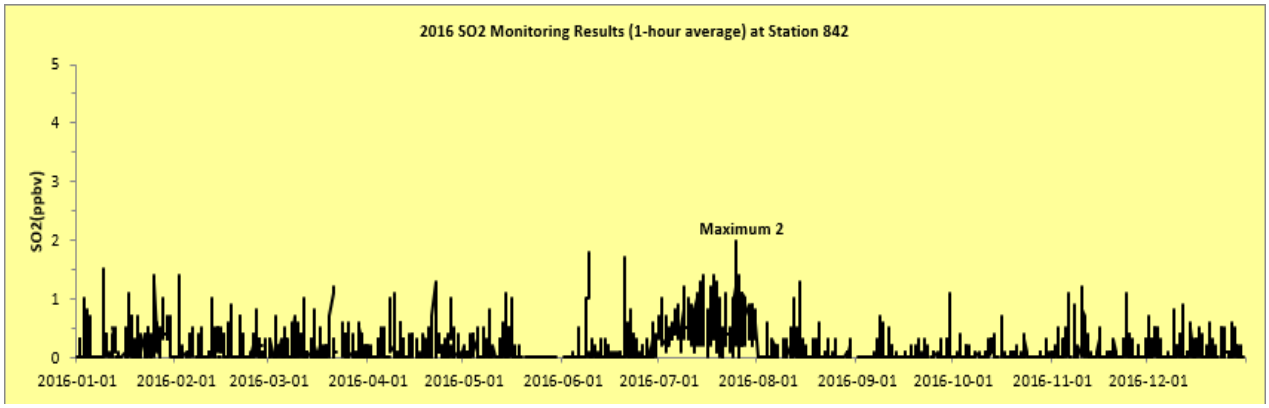


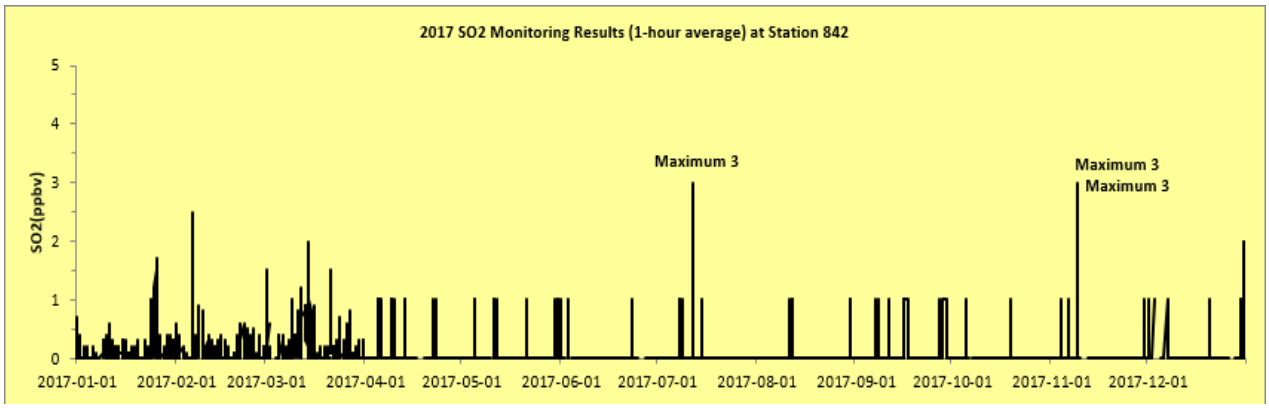
Figure 11: Hourly Monitored Total Reduced Sulphur Data

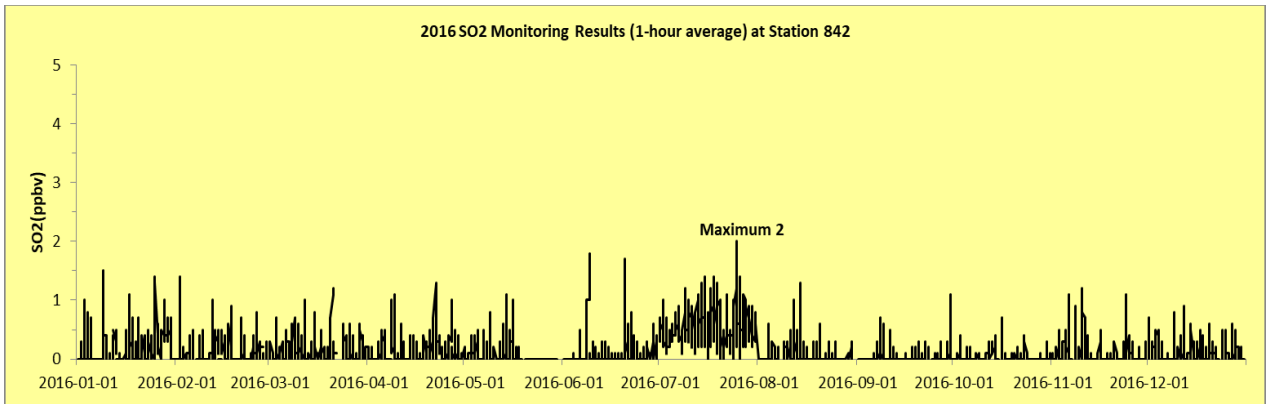
3.3.4. Sulphur Dioxide

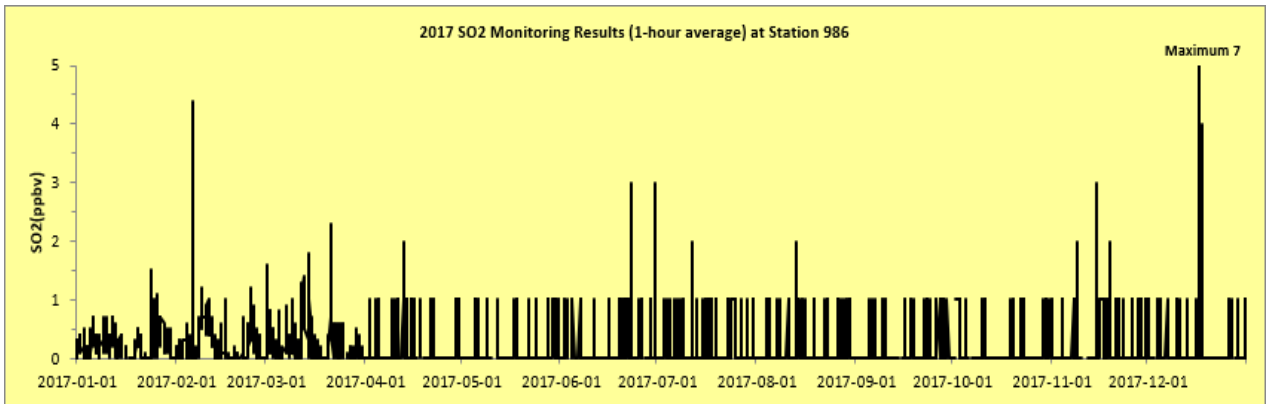
Hourly data for SO_2 for the three stations is shown in the charts below (Figure 12). The AAAQO for SO_2 is 172 ppbv.

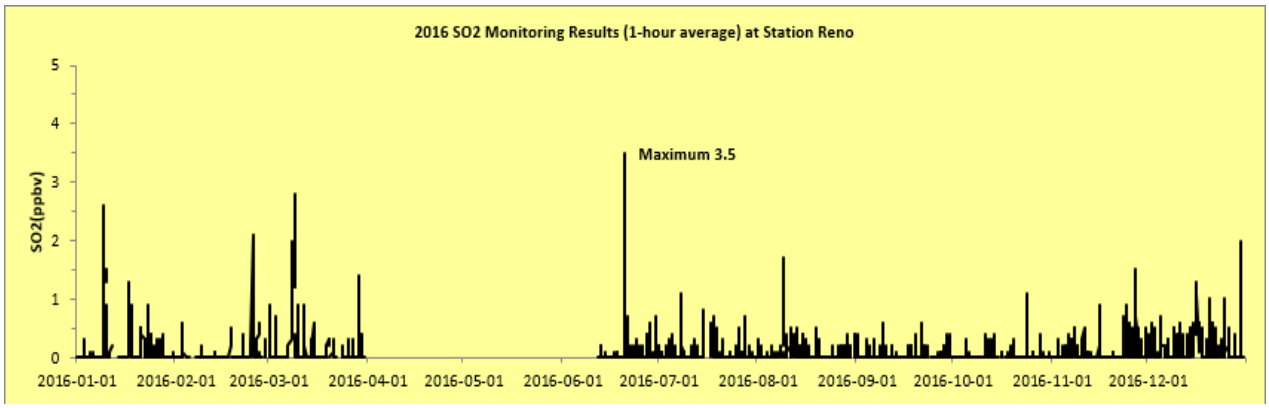
The maximum hourly SO_2 data for Station 842, 986, and Reno increased incrementally from 2016 to 2017. It should be noted that although there was an increase, elevated concentrations at all stations and years were well below the Alberta Ambient Air Quality Objective.











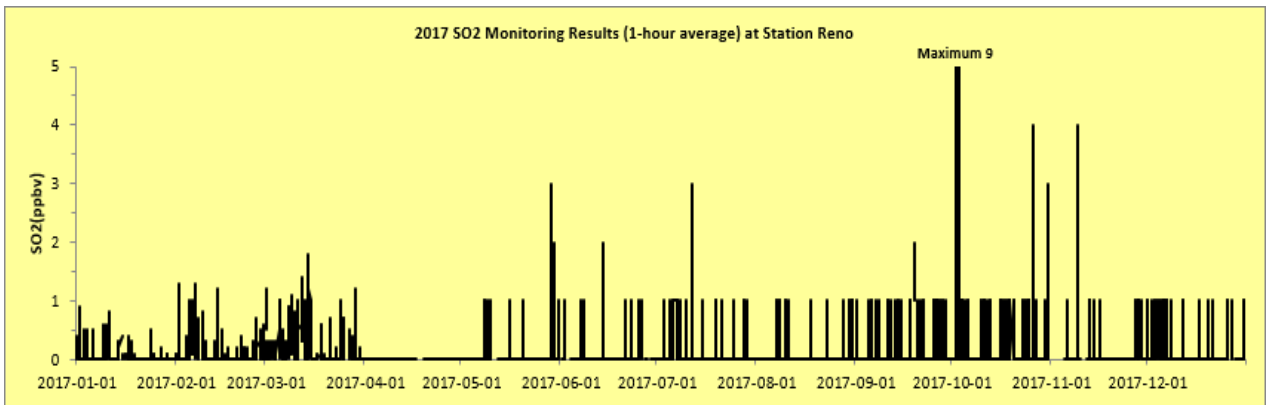
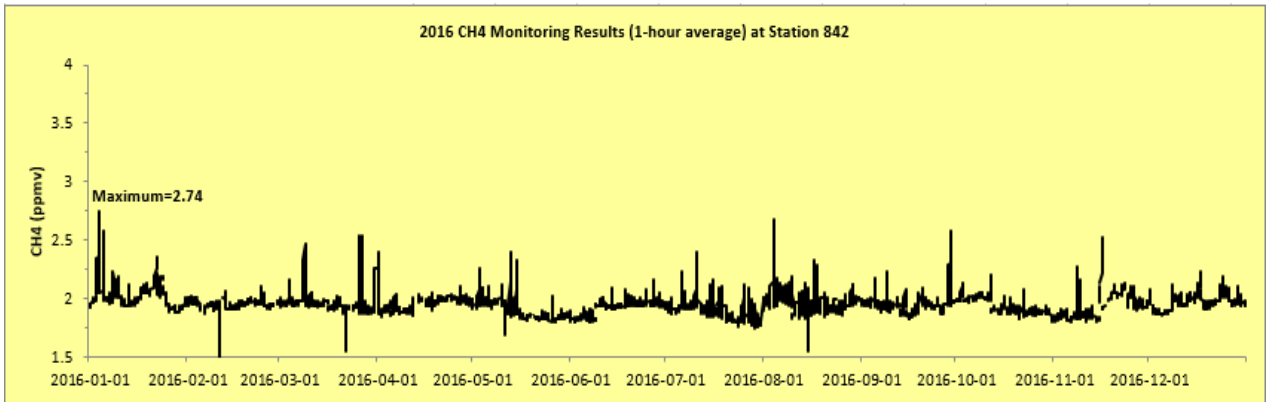


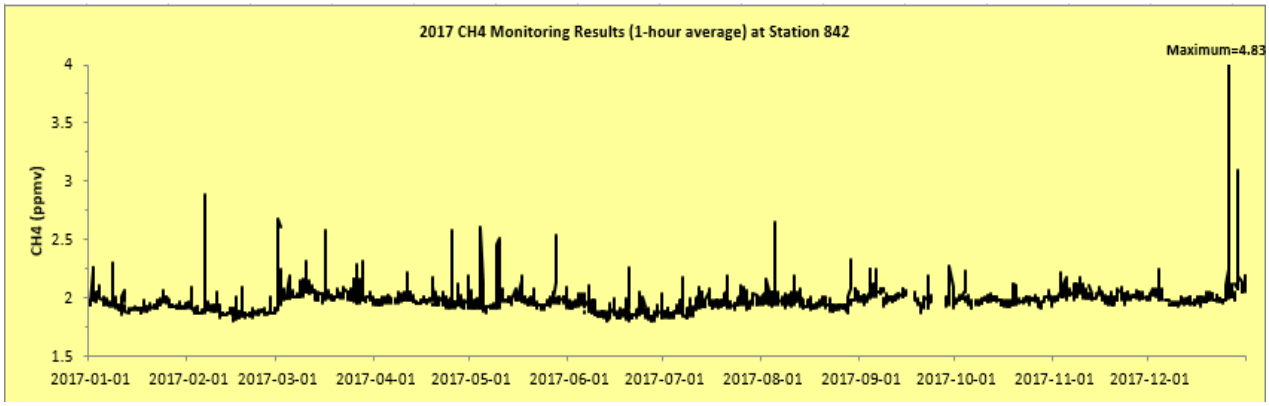
Figure 12: Hourly Monitored Sulphur Dioxide Data

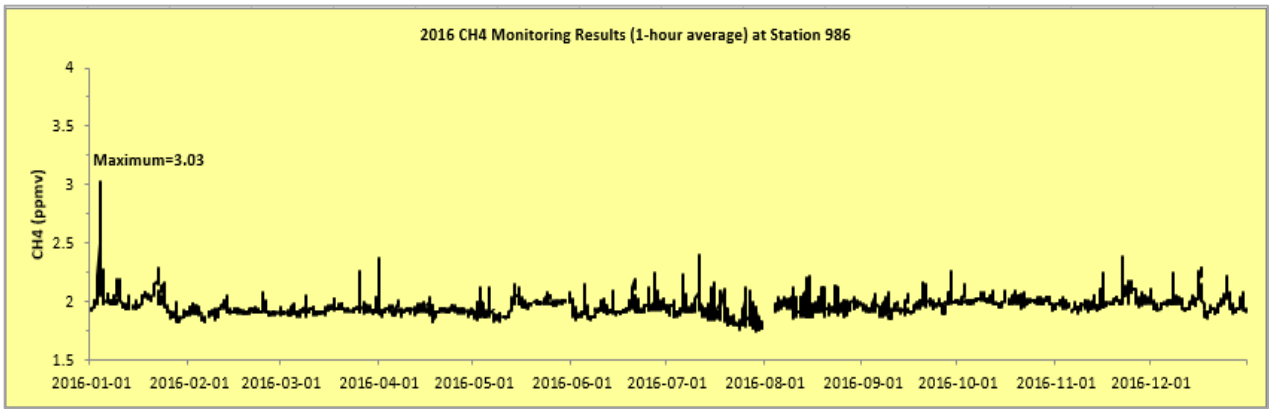
3.3.5. Methane

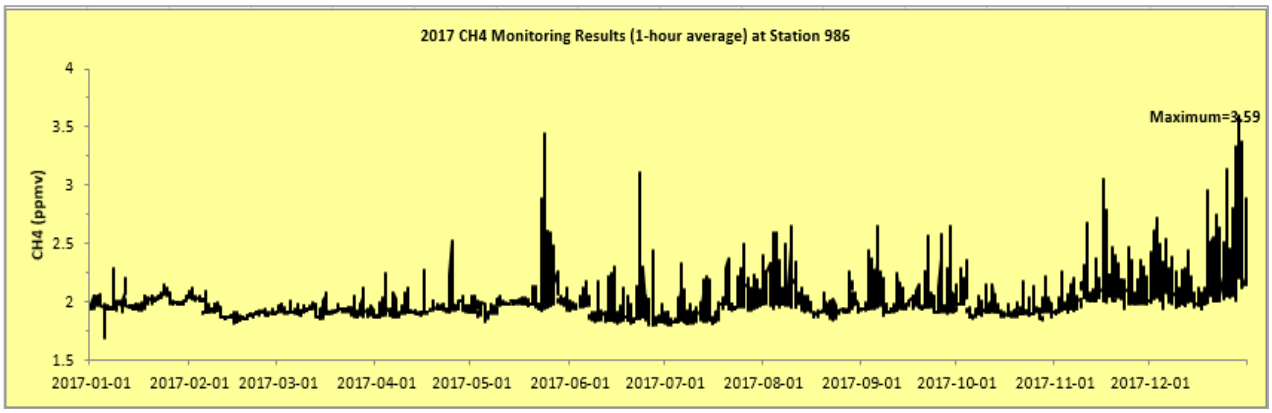
Hourly data for CH_4 for the three stations is shown in the charts below (Figure 13). There is no AAAQO for CH_4.

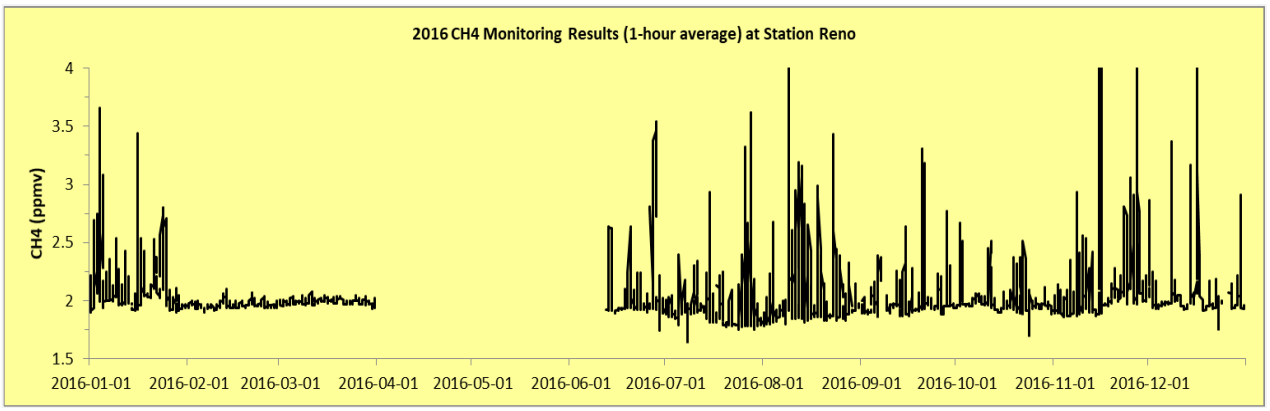
The maximum hourly CH_4 data for Station 842 increased from 2016 to 2017. The maximum hourly CH_4 data for Station 986 increased slightly from 2016 to 2017 due to cattle grazing nearby. Reno station shows the highest frequency of occurrence of elevated measurements of CH_4 for both 2016 and 2017 however there was a decrease in the maximum measured value.











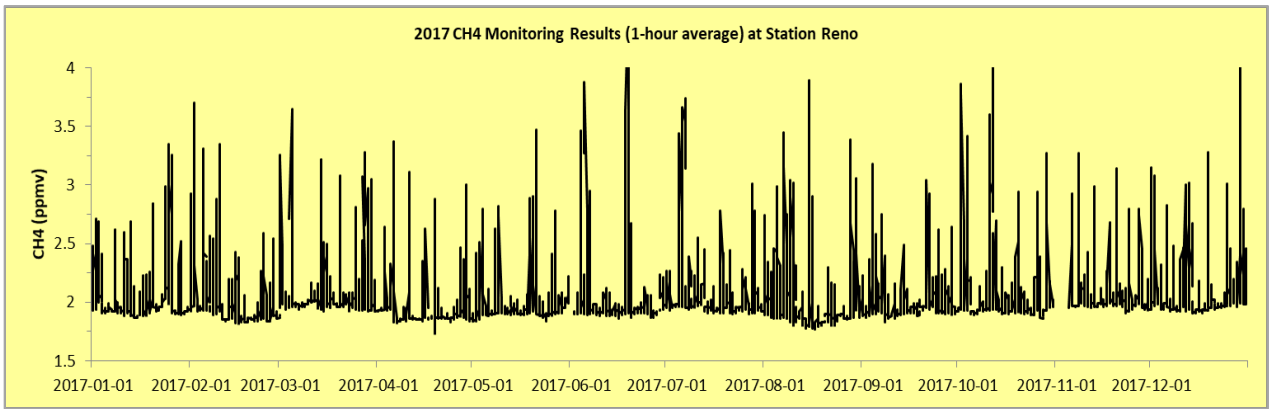


Figure 13: Hourly Monitored Methane Data

3.4. Monthly Data Analysis

The hourly data presented in this section were analyzed to determine the maximum, 99th percentile, and average of hourly concentrations for each month of data. Calculating percentiles allows data to be grouped based on the percentage of values that fall below a specific value. Arranging the data into percentile ranks can provide insight to the distribution of data and is helpful for understanding outlying values. For example, the 99th percentile value represents the value at which 99% of the data falls below.

Analyses are often carried out using a higher percentile instead of the true maximum as it is a more representative value of the full dataset and is less likely to be impacted by extreme data points. Trend lines of the non-zero series are presented to examine if the series have an increasing or decreasing behaviour from January 2016 to December 2017 for all stations. Variation between the seasons is expected due to the impacts of climate on ambient concentration.

3.4.1. Total Hydrocarbons

The THC trends for the maximum, 99th percentile and average by month for each site are shown on the following figures. Table 1 presents the minimum and maximum monthly 99th percentile THC for each year.

Table 1: Minimum and Maximum of 99th Percentile in Each Month of THC Concentrations (2016 and 2017)

Station	2016		2017	
	Minimum (ppmv)	Maximum (ppmv)	Minimum (ppmv)	Maximum (ppmv)
842	2.06	2.45	2.03	3.08
986	2.02	2.56	2.06	3.14
Reno	2.05	3.34	2.79	3.44

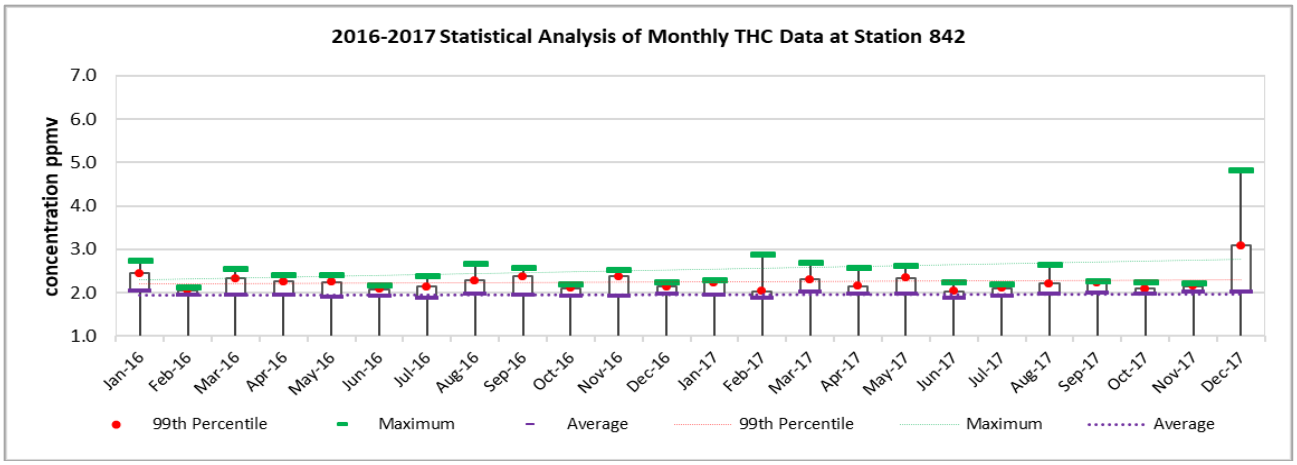


Figure 14: Total Hydrocarbons Data and Trends at Station 842

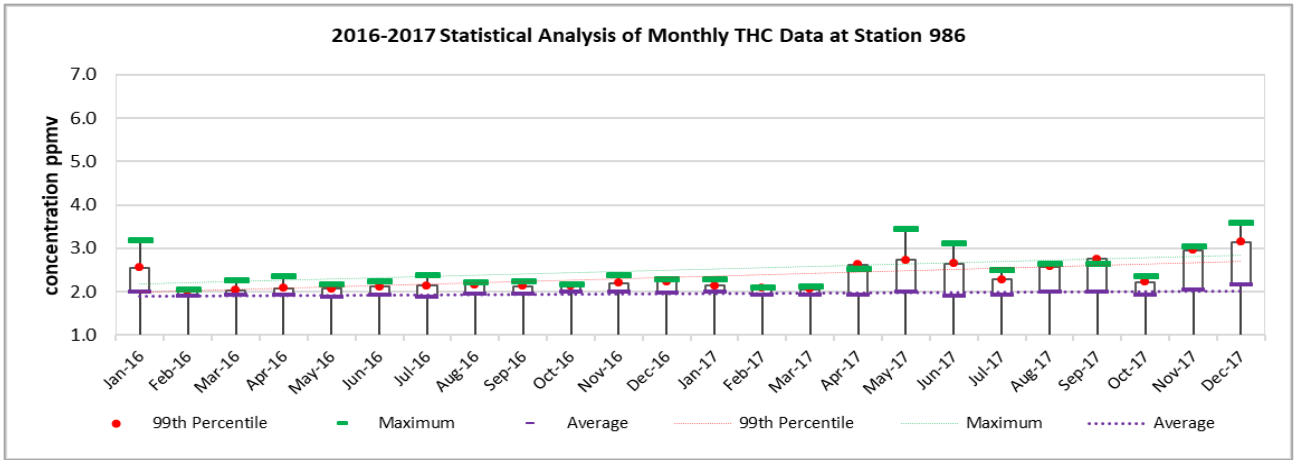


Figure 15: Total Hydrocarbons Data and Trends at Station 896

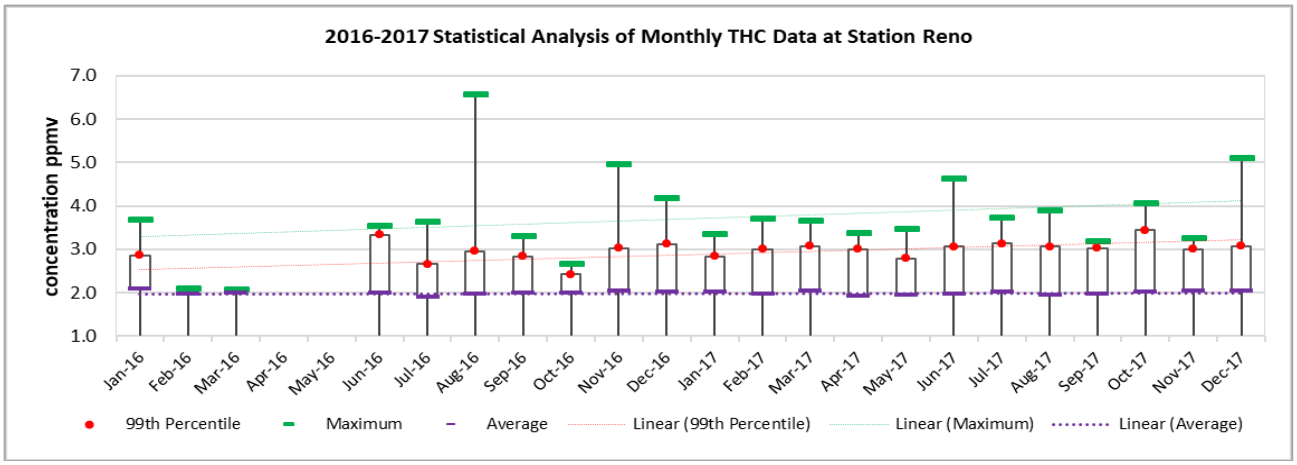


Figure 16: Total Hydrocarbons Data and Trends at Reno Station

3.4.2. Non-Methane Hydrocarbons

The NMHC trends for the maximum, 99th percentile, and average by month for each site are shown on the following figures.

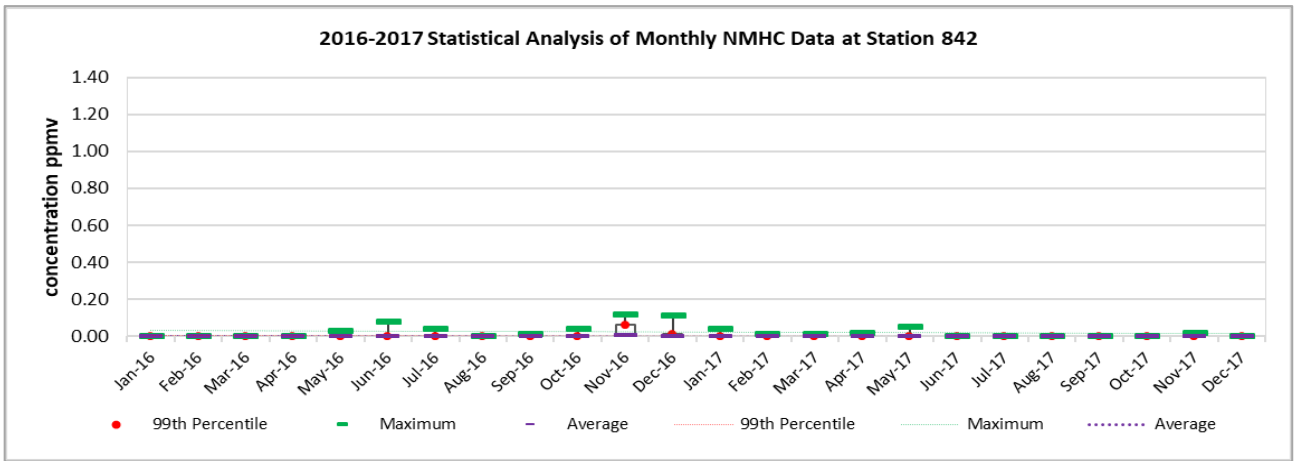


Figure 17: Non-methane Hydrocarbon Data and Trends at Station 842

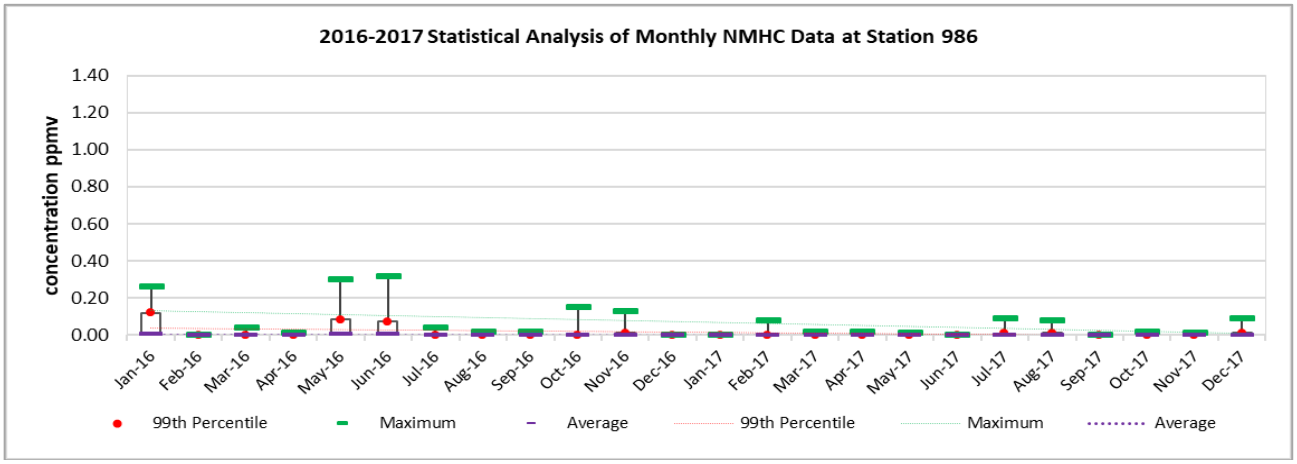


Figure 18: Non-methane Hydrocarbon Data and Trends at Station 986

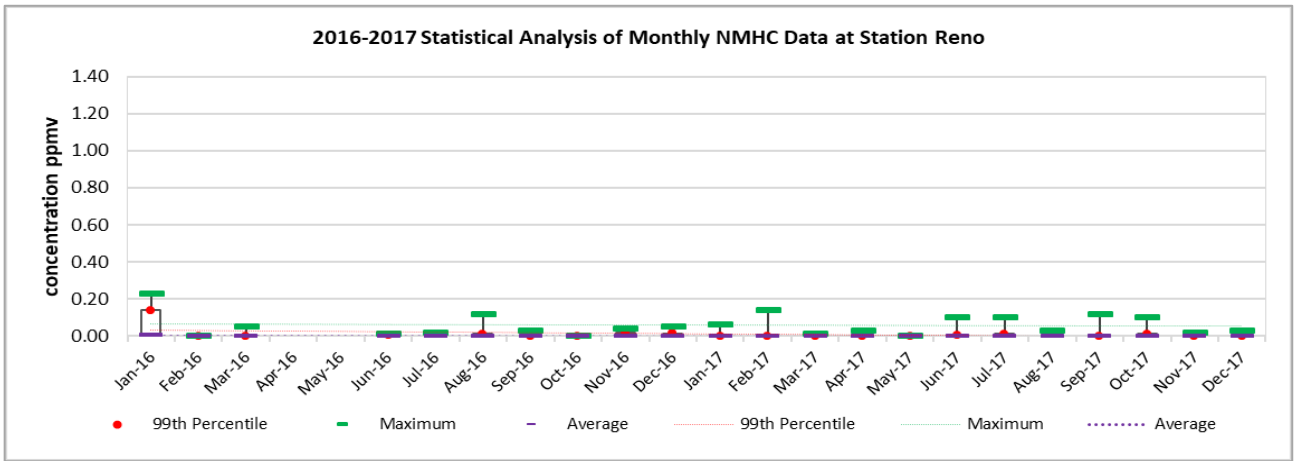


Figure 19: Non-methane Hydrocarbon Data and Trends at Reno Station

3.4.3. Total Reduced Sulphur

The TRS trends for the maximum, 99th percentile and average by month for each site are shown on the following figures.

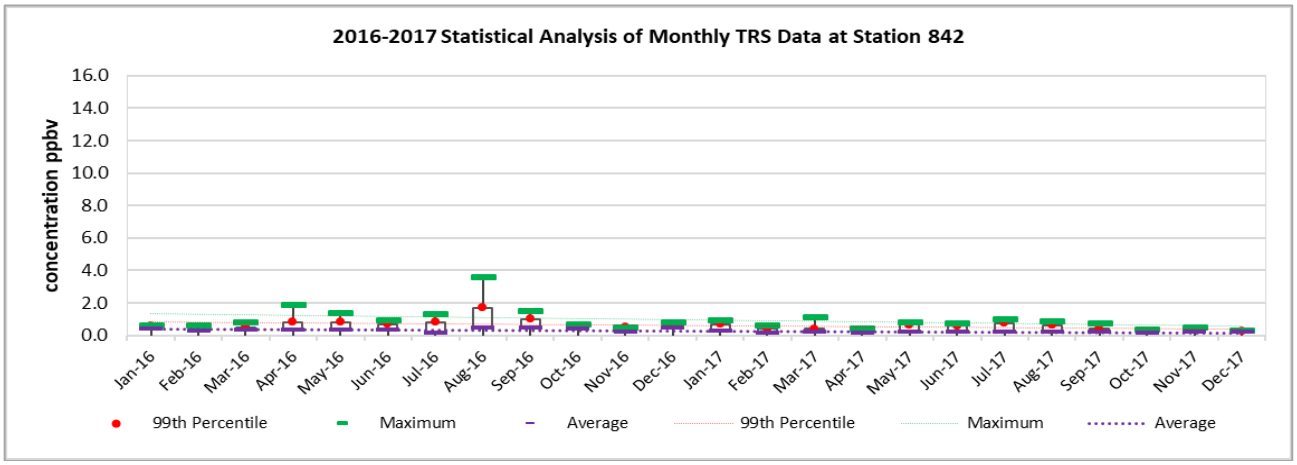


Figure 20: Total Reduced Sulphur Data and Trends at Station 842

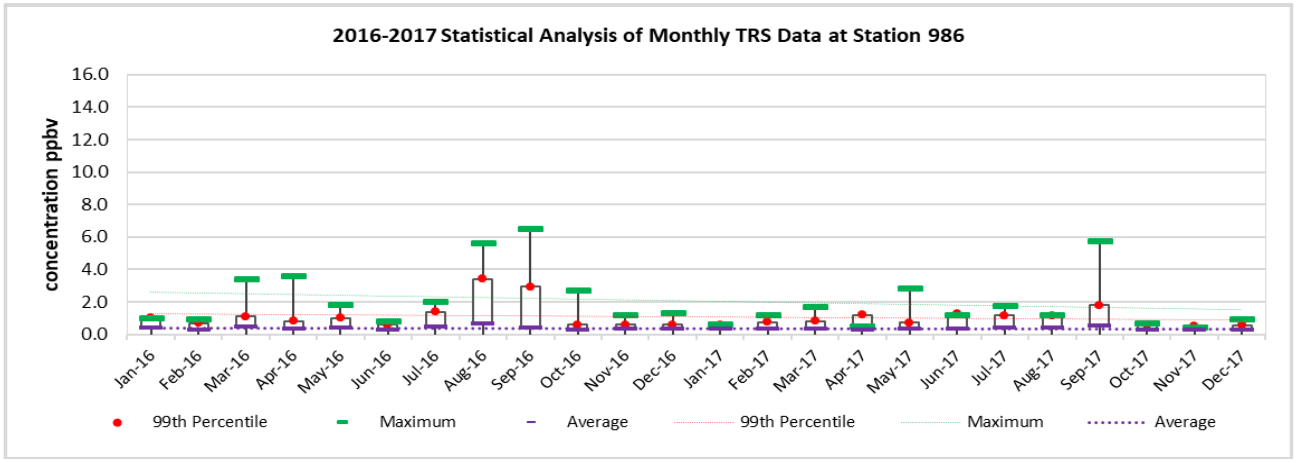


Figure 21: Total Reduced Sulphur Data and Trends at Station 986

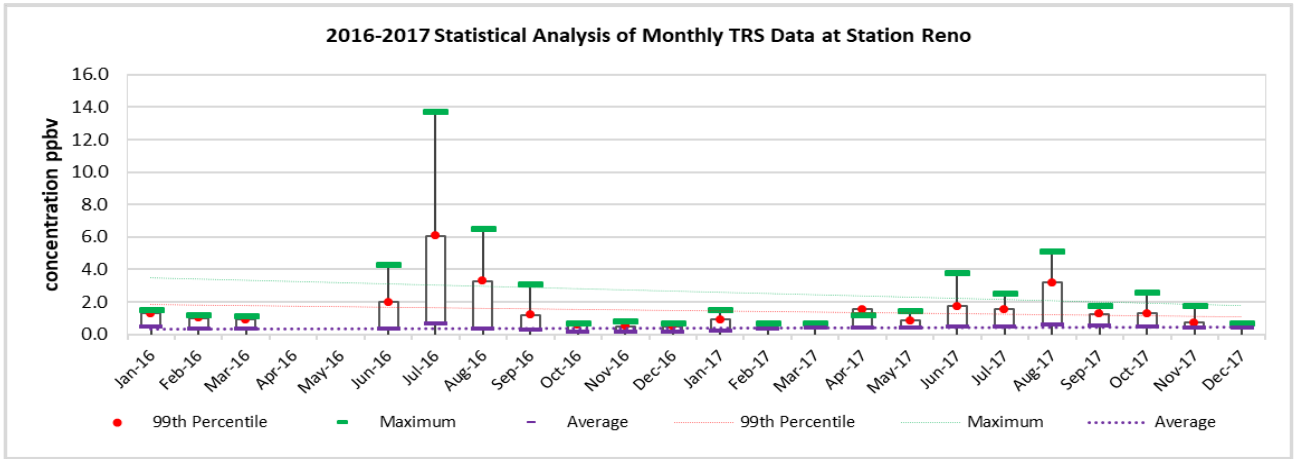


Figure 22: Total Reduced Sulphur Data and Trends at Reno Station

3.4.4. Sulphur Dioxide

The SO_2 trends for the maximum, 99th percentile and average by month for each site are shown on the following figures.

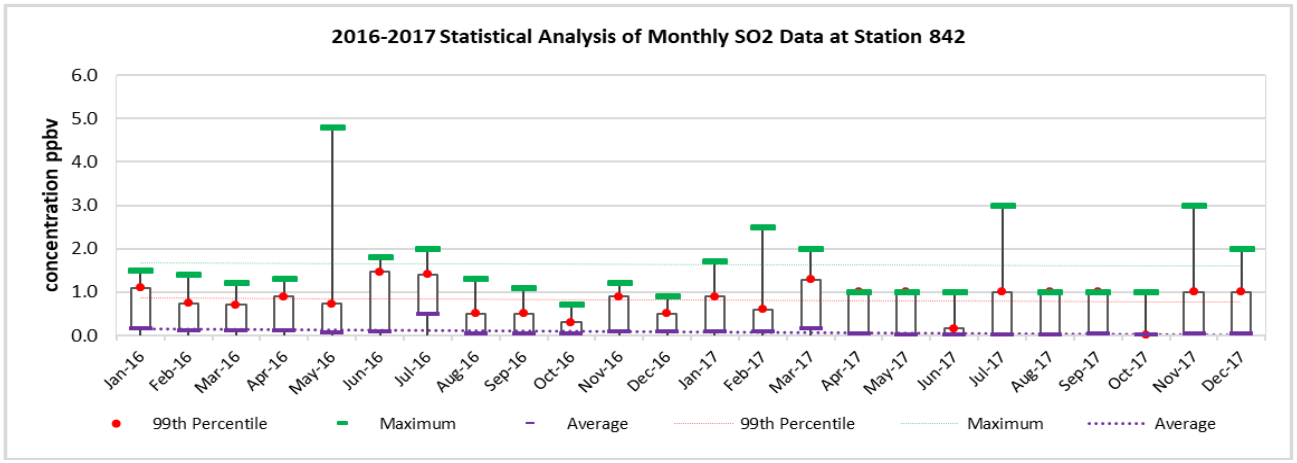


Figure 23: Sulphur Dioxide Data and Trends at Station 842

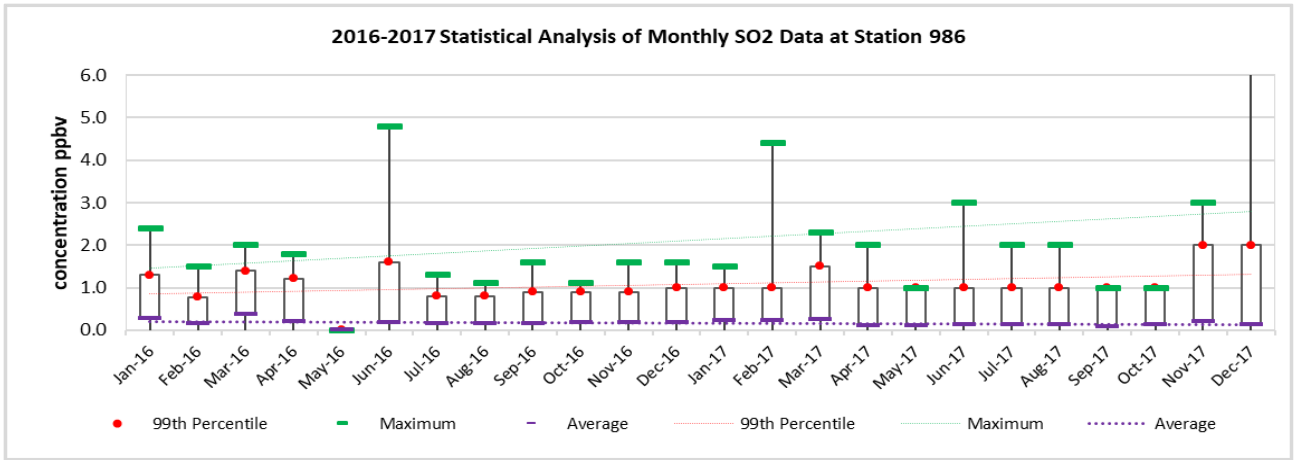


Figure 24: Sulphur Dioxide Data and Trends at Station 986

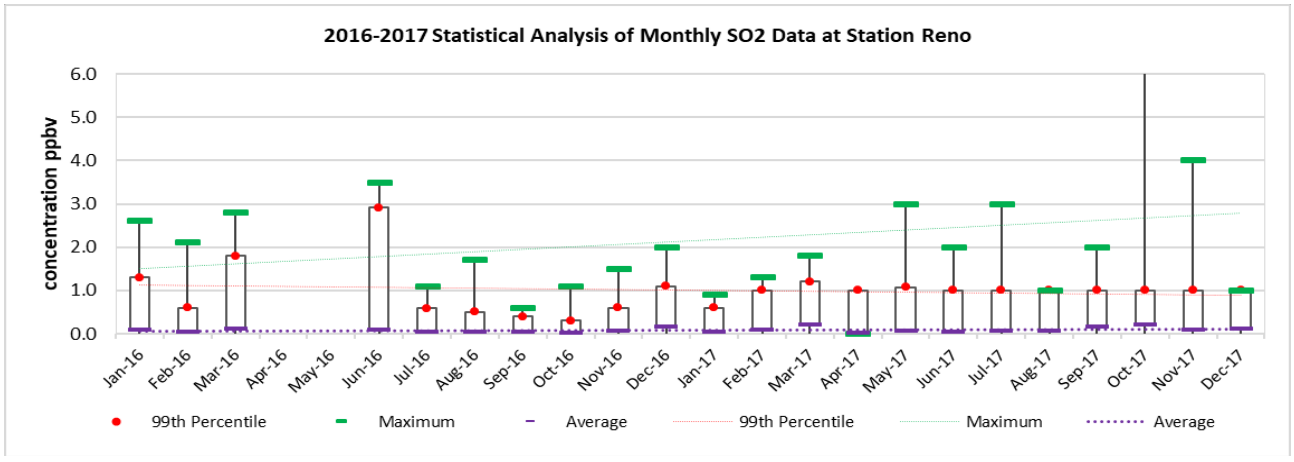


Figure 25: Sulphur Dioxide Data and Trends at Reno Station

3.4.5. Methane

The CH4 trends for the maximum, 99th percentile and average by month for each site are shown on the following figures.

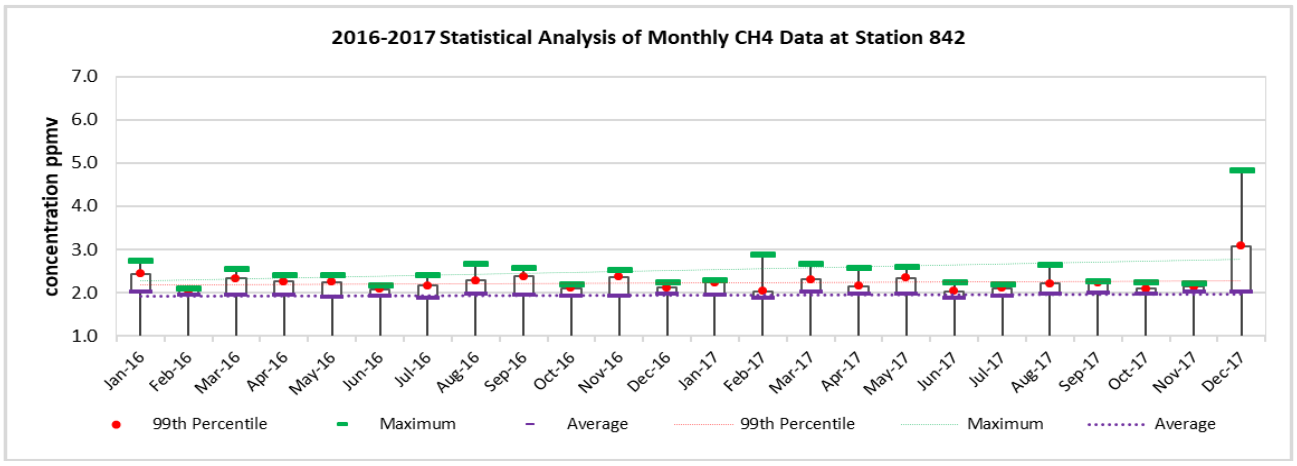


Figure 26: Methane Data and Trends at Station 842

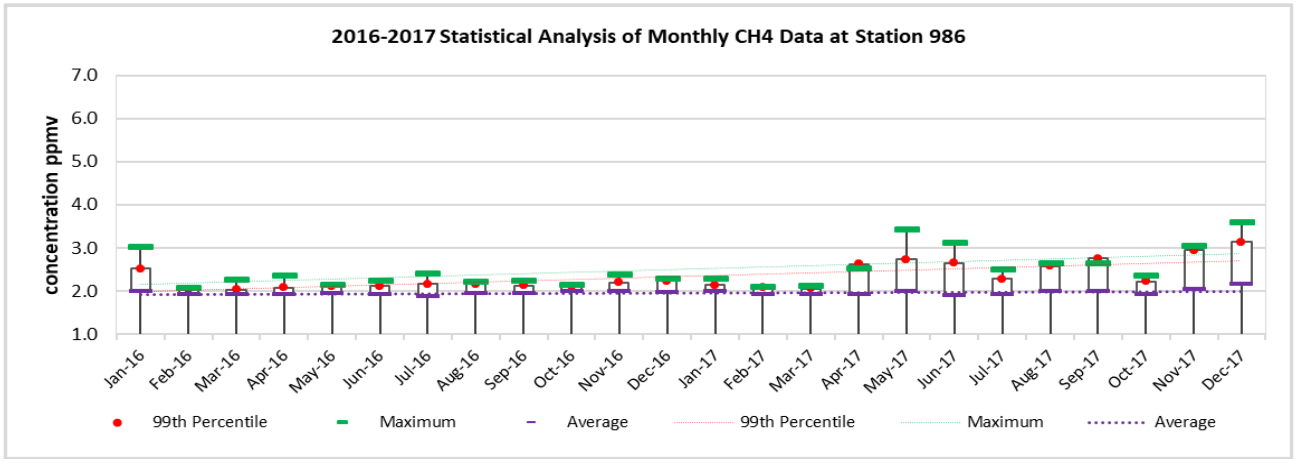


Figure 27: Methane Data and Trends at Station 986

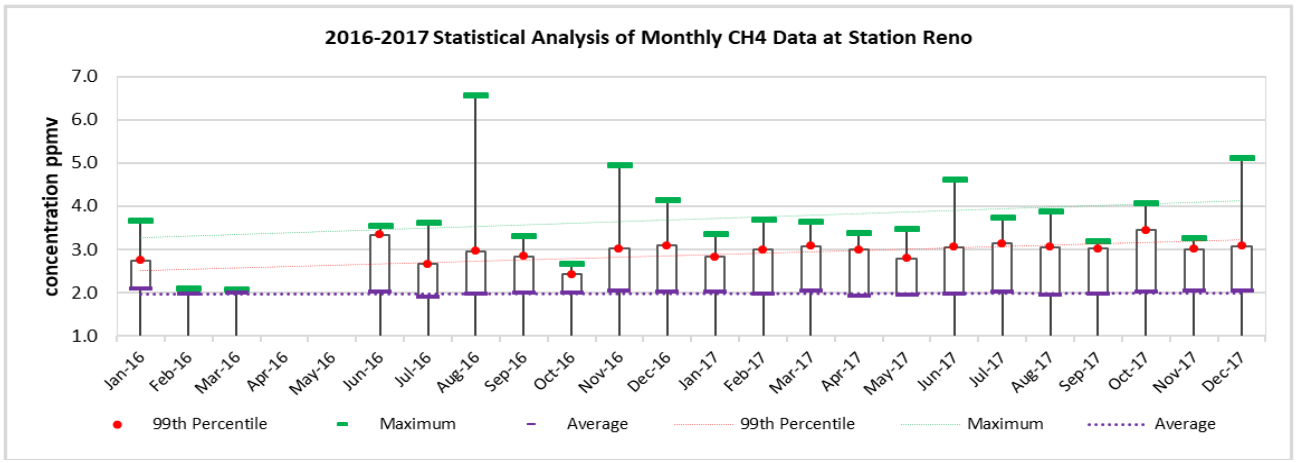


Figure 28: Methane Data and Trends at the Reno Station

3.4.6. Summary

In general, maximum and average values provide useful statistics but are often an over-simplified and inadequate representation of a dataset. For the measured results, the maximum values tend to fluctuate greatly and the average concentrations stay relatively stable and close to 0 ppmv or ppbv, for NMHC, and TRS and SO_2, respectively. However, as the 99th percentile is influenced by the distribution of the data, it provides a useful statistic for analyzing trends in a dataset.

The monthly data analysis for Station 842 shows that the 99th percentile data for different substances have varying trends over the reporting periods. Some pollutant concentrations increased over the reporting period, but overall, the data showed in air quality remaining relatively constant over the two-year monitoring period.

Data collected at Station 842 showed THC, SO_2, and CH_4, all showed incremental increases in the last two years while NMHC remained relatively constant.

The trending for the Reno Station showed variability; measurements for TRS showed decreasing trends at different metrics, THC and SO_2 showed increasing trend.

The correlation between values and wind directions are presented in the concentration roses (Section 3.6), which will assist in identifying from where predominant winds are carrying pollutants.

3.5. Annual Data Analysis

Analysis was completed for each station for 2016 (where available) and 2017 by calculating the maximum, 99th, 90th, 50th percentiles and minimum value of the 1-hour concentrations for each year for THC, NMHC, TRS, SO_2, and CH_4. Similar to the 99th percentile measure, 90th percentile and 50th percentile metrics indicate that 90% and 50% of data fall below that value respectively. Calculating percentiles allow data to be grouped based on the percentage of values that fall below a specific value. Arranging the data into percentile ranks can provide insight to the distribution of data and is helpful for understanding outlying values. By definition, the 50th percentile represents the median of the dataset. The results of this analysis are shown in Tables 2 and 3. The annual 99th percentile concentrations for Stations 986 and 842 were incrementally lower in 2017 compared to 2016; some metrics for the Reno Station had an incremental increase over the last two years.

Table 2: 2016 Monitoring Data Percentiles

Location	Rank	THC (ppmv)	NMHC (ppmv)	TRS (ppbv)	SO2 (ppbv)	CH4 (ppmv)
Station 842	Average	1.94	0.00	0	0	1.94
	Maximum	2.75	0.12	4	5	2.74
	99th percentile	2.27	0.00	1	1	2.26
	90th percentile	2.03	0.00	1	0	2.03
	50th percentile	1.94	0.00	0	0	1.94
	Minimum	1.53	0.00	0	0	1.53
Station 986	Average	1.94	0.00	0	0	1.95
	Maximum	3.18	0.32	7	5	3.12
	99th percentile	2.18	0.03	1	1	2.19
	90th percentile	2.02	0.00	1	1	2.03
	50th percentile	1.93	0.00	0	0	1.94
	Minimum	1.72	0.00	0	0	1.74
Reno	Average	2	0.00	0	0	1.99
	Maximum	6.57	0.23	14	4	6.55
	99th percentile	2.82	0.02	2	1	2.80
	90th percentile	2.12	0.00	1	0	2.11
	50th percentile	1.96	0.00	0	0	1.96
	Minimum	1.65	0.00	0	0	1.65
AAAQO*	1-hour	-	-	-	172	-

* Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2017)

Table 3: 2017 Monitoring Data Percentiles

Location	Rank	THC (ppmv)	NMHC (ppmv)	TRS (ppbv)	SO2 (ppbv)	CH4 (ppmv)
Station 842	Average	1.96	0.00	0	0	1.96
	Maximum	4.83	0.05	1	3	4.83
	99th percentile	2.25	0.00	0	1	2.25
	90th percentile	2.01	0.00	0	0	2.01
	50th percentile	1.95	0.00	0	0	1.95
	Minimum	1.79	0.00	0	0	1.79
Station 986	Average	1.97	0.00	0	0	1.97
	Maximum	3.59	0.09	6	7	3.59
	99th percentile	2.52	0.00	1	1	2.52
	90th percentile	2.06	0.00	0	1	2.06
	50th percentile	1.95	0.00	0	0	1.95
	Minimum	1.69	0.00	0	0	1.69
Reno	Average	1.99	0.00	0	0	1.99
	Maximum	5.11	0.14	5	9	5.11
	99th percentile	3.04	0.00	1	1	3.04
	90th percentile	2.12	0.00	1	0	2.12
	50th percentile	1.94	0.00	0	0	1.94
	Minimum	1.74	0.00	0	0	1.74
AAAQO*	1-hour	-	-	-	172	-

* Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2017)

3.6. Concentration Roses for Continuous Monitoring Data

Much the same as wind roses, concentration roses show the frequency of contaminant concentrations travelling with winds blowing from particular directions over a specified period. The length of each 'spoke' around the circle is related to the frequency of that concentration of the contaminant occurring.

Concentration roses will have the same shape as wind roses. The focus is on which direction the higher concentrations come from.

3.6.1. Total Hydrocarbons

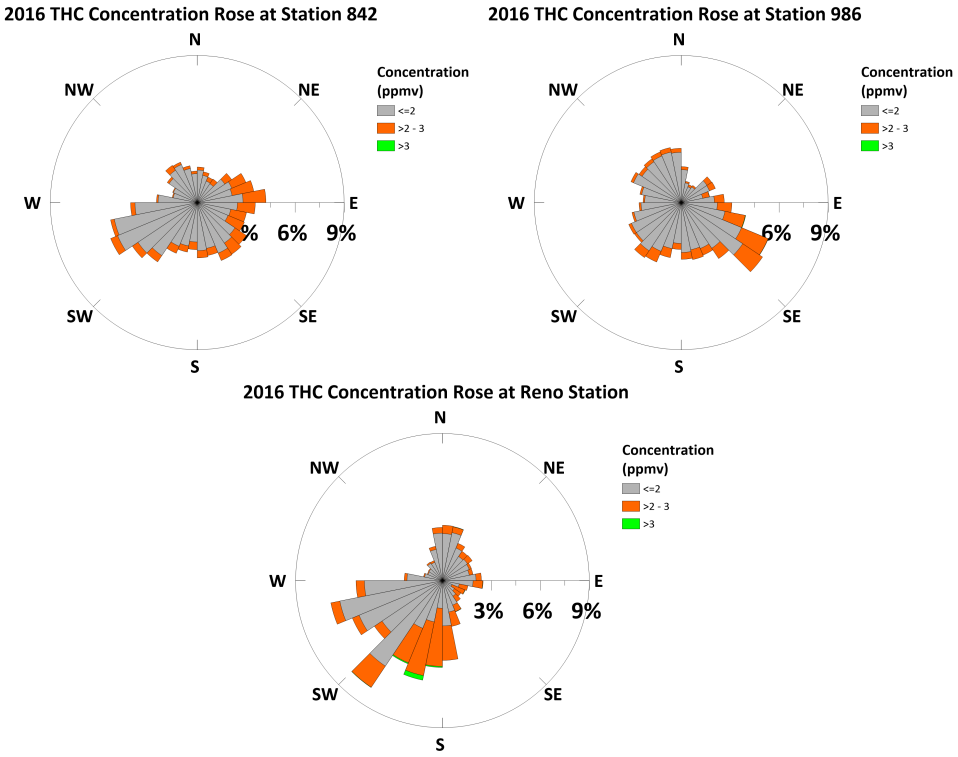
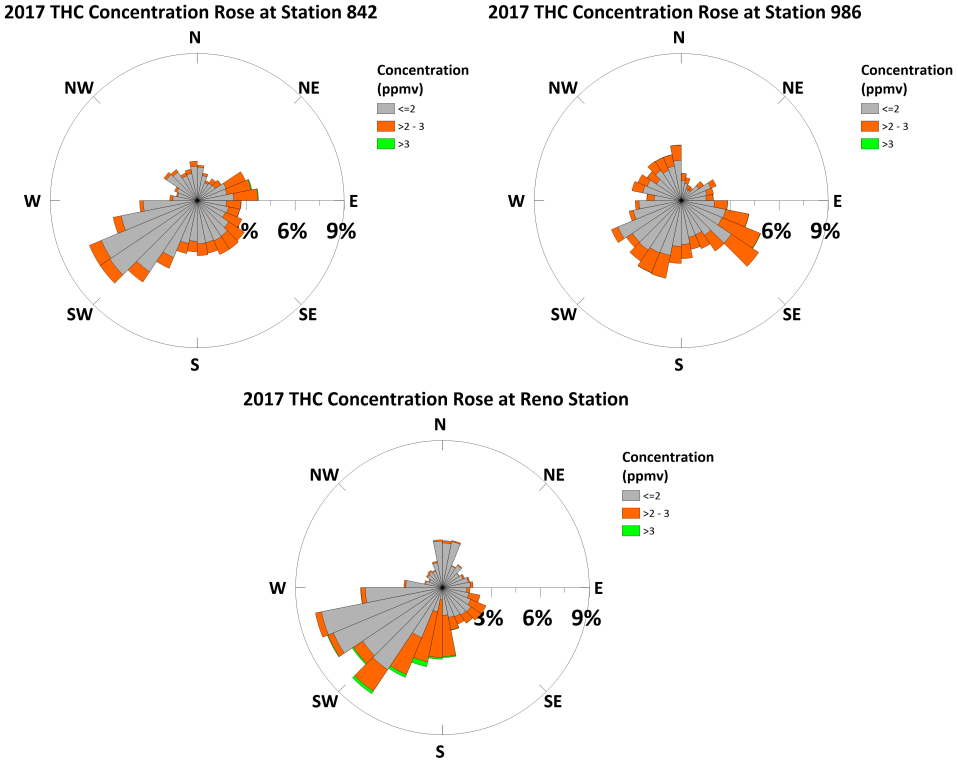


Figure 29: Total Hydrocarbons Concentration Roses for 2016 at Station 842(left), Station 986 (right), and Reno Station (bottom)



-Figure 30: Total Hydrocarbons Concentration Roses for 2017 at Station 842(left), Station 986 (right), and Reno Station (bottom)

3.6.2. Non-methane Hydrocarbons

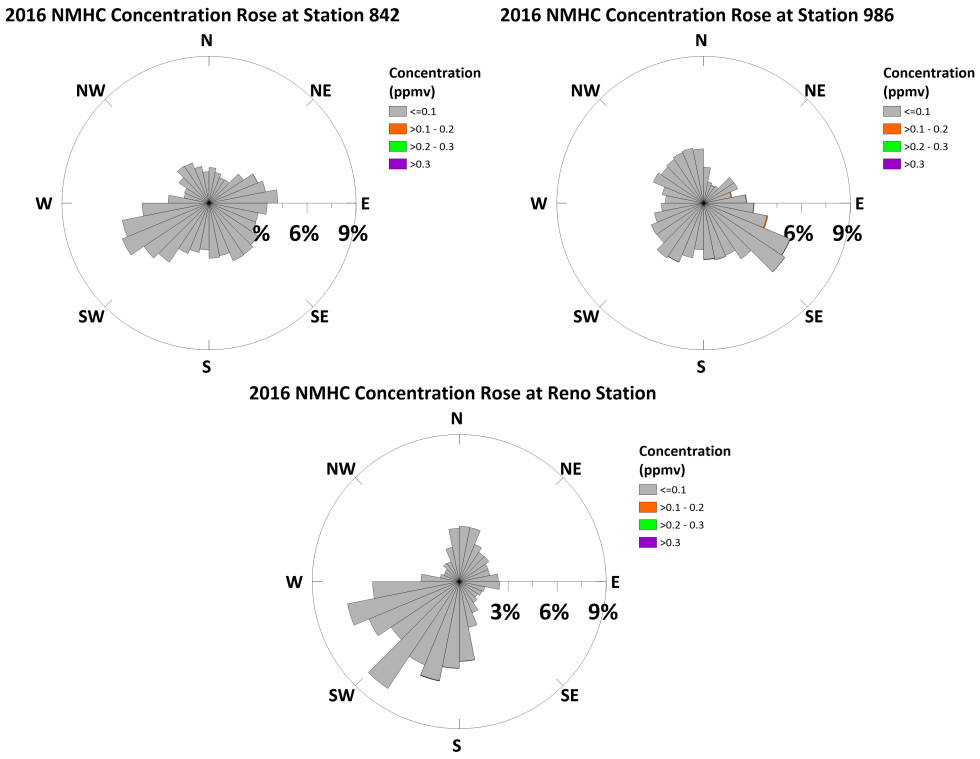


Figure 31: Non-methane Hydrocarbons Concentration Roses for 2016 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

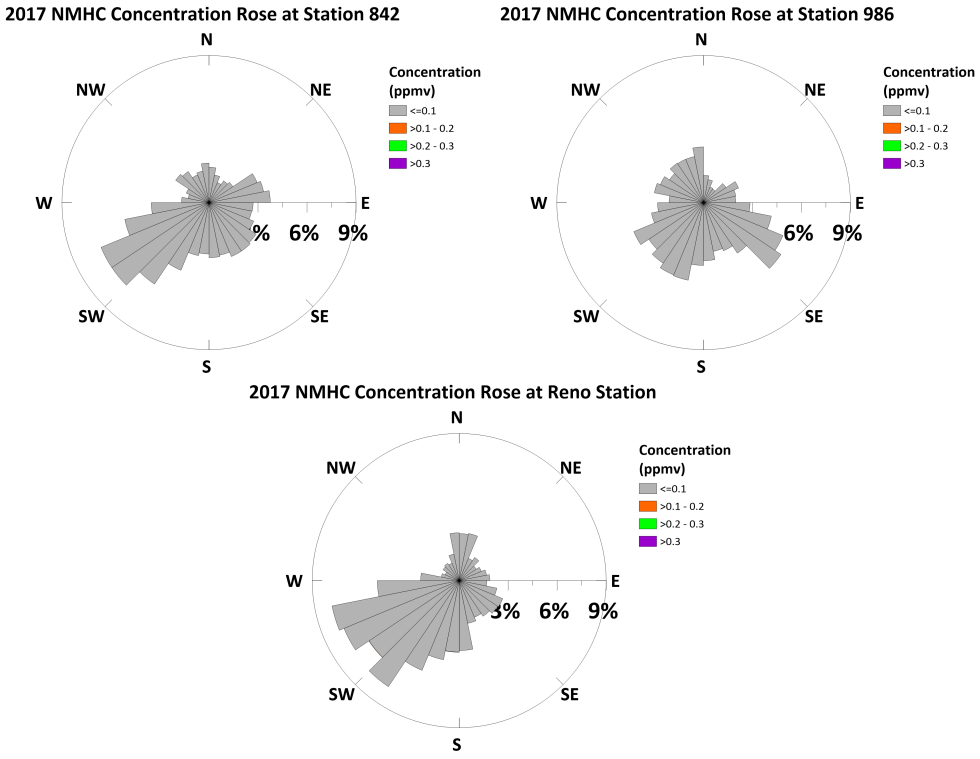


Figure 32: Non-methane Hydrocarbons Concentration Roses for 2017 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

3.6.3. Total Reduced Sulphur

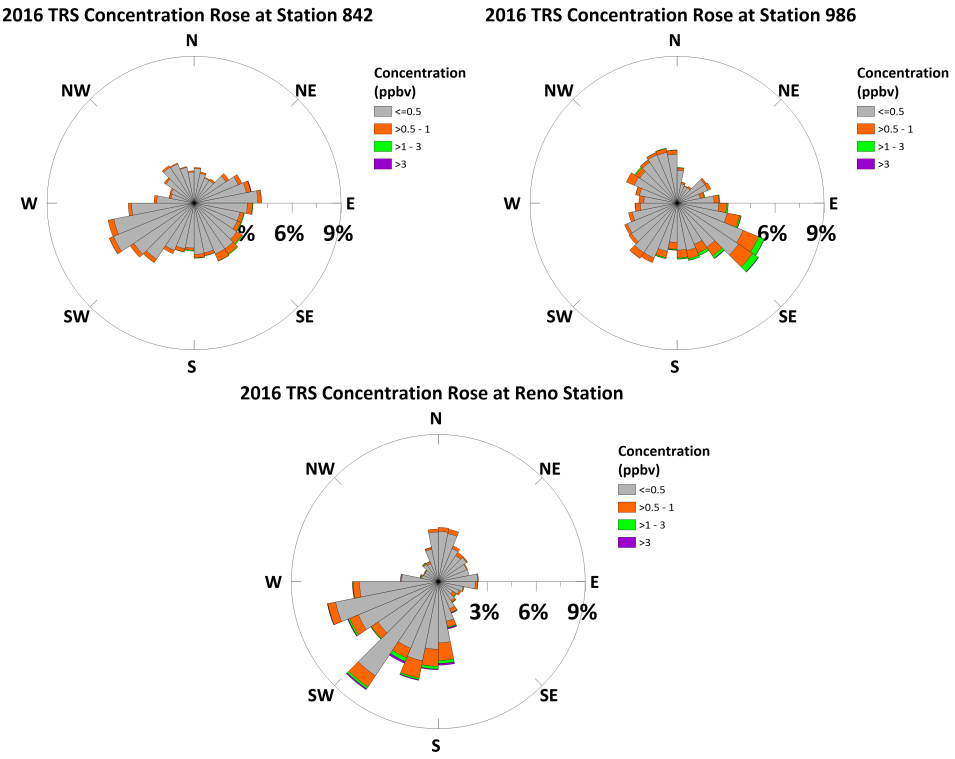


Figure 33: Total Reduced Sulphur Concentration Roses for 2016 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

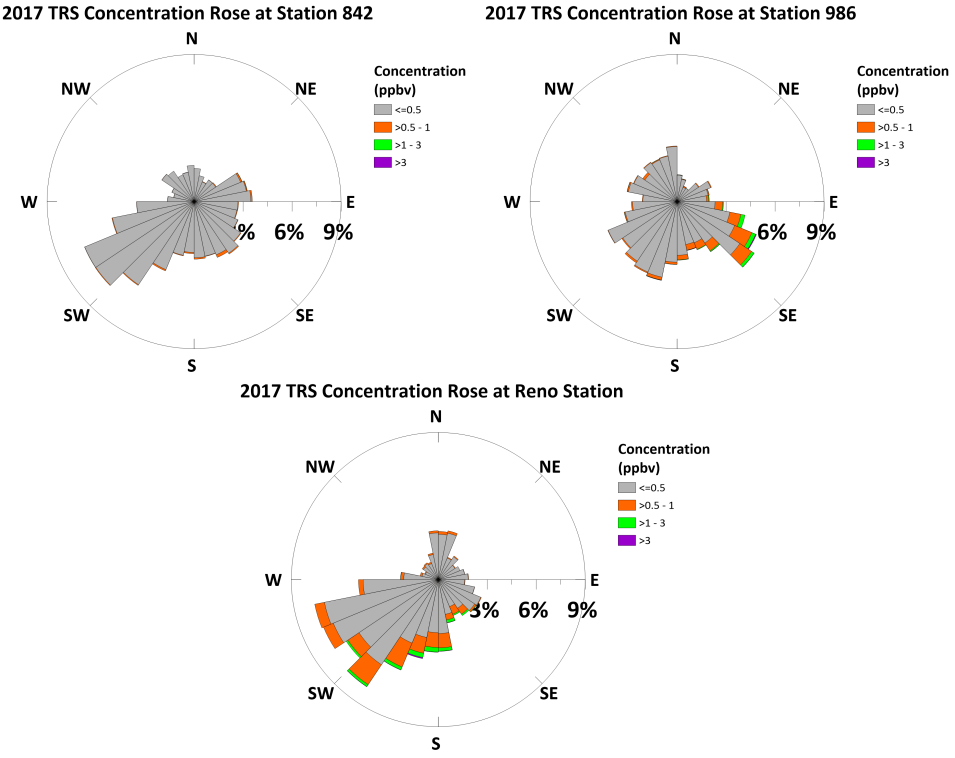


Figure 34: Total Reduced Sulphur Concentration Roses for 2017 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

3.6.4. Sulphur Dioxide

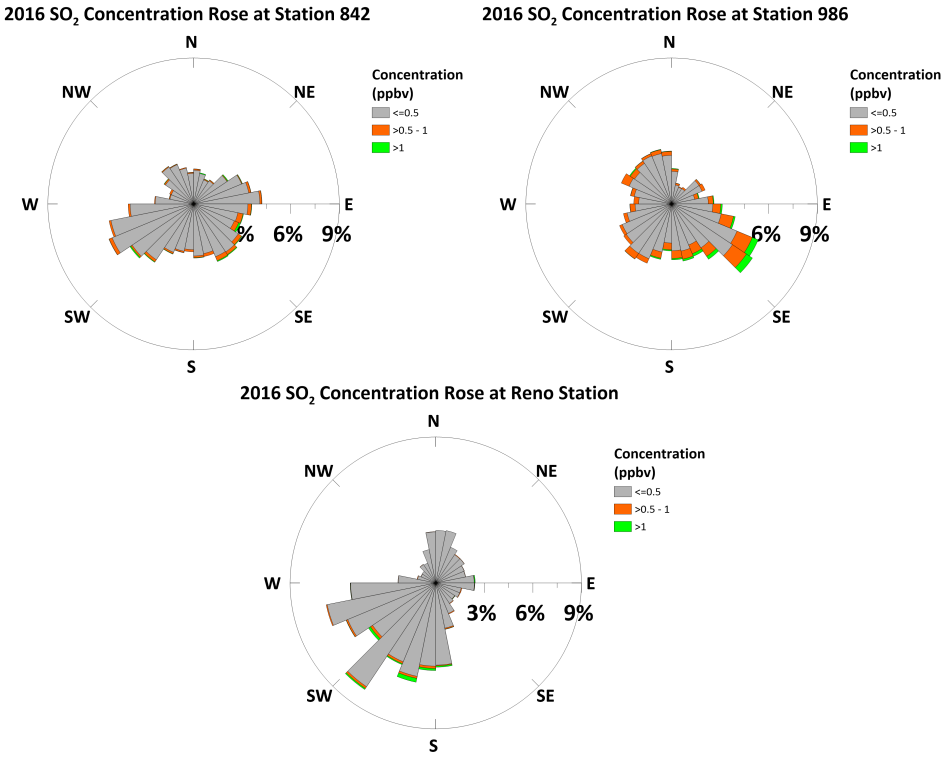


Figure 35: Sulphur Dioxide Concentration Roses for 2016 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

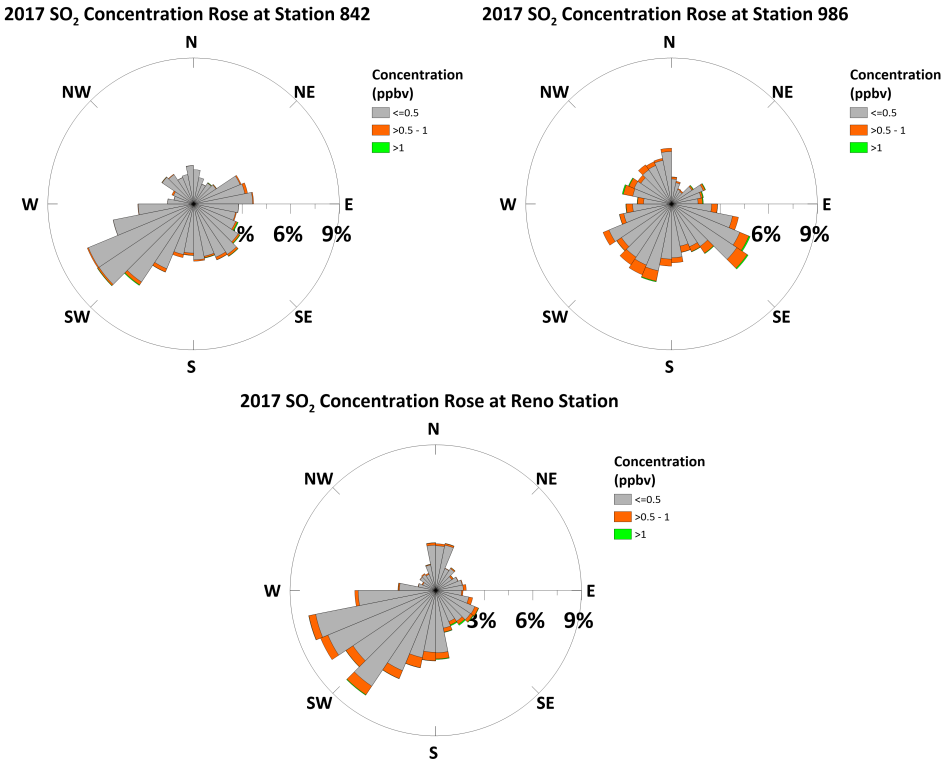


Figure 36: Sulphur Dioxide Concentration Roses for 2017 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

3.6.5. Methane

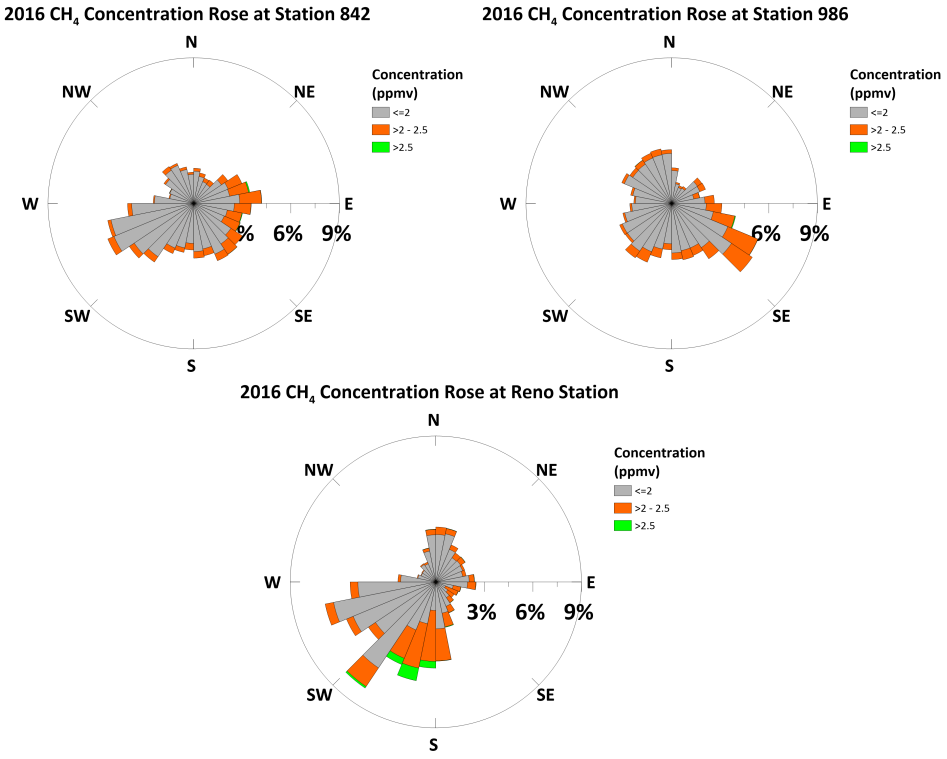


Figure 37: Methane Concentration Roses for 2016 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

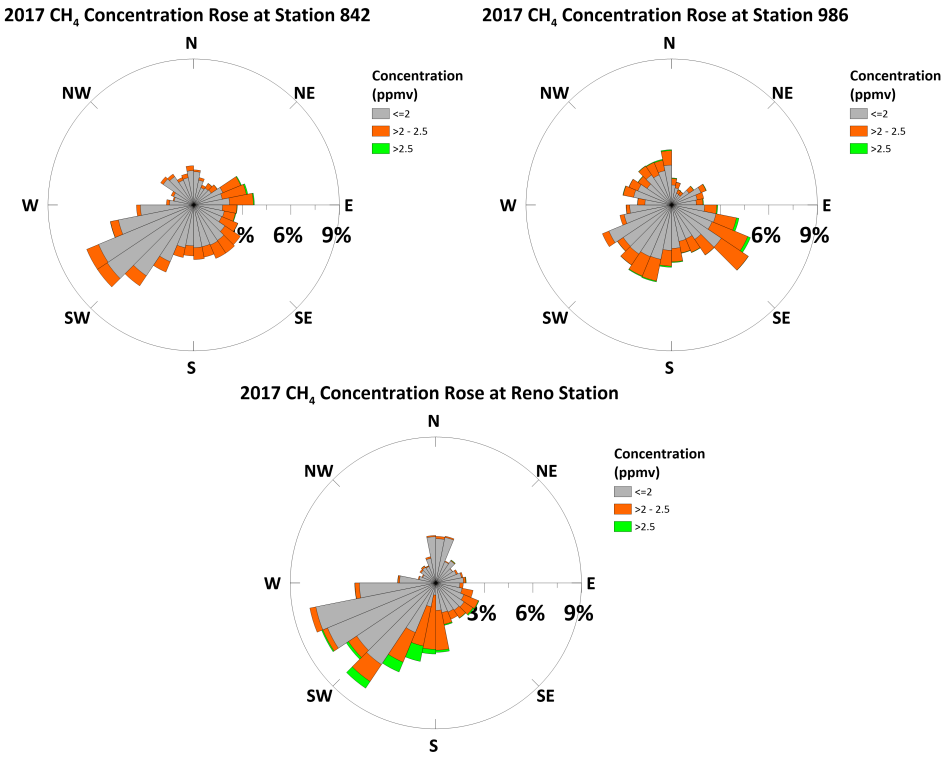


Figure 38: Methane Concentration Roses for 2017 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

3.6.6. Summary

The concentration rose from the Reno Station, 986 Station, and 842 Station indicate that the identifiable sources for most contaminants are likely the nearby heavy oil operations. Further study work is required to verify the sources, however the initial analysis suggests that proximity of wells and associated infrastructure are likely influences, particularly for hydrocarbons. The proximity of infrastructure to the Reno Station, is much closer compared to Station 986 and 842. The facilities nearest Station 986 and 842 are approximately 6km and 4km away; however at the Reno Station, similar facilities are 300 - 500m away which represents an order of magnitude difference. There appears to be other sources not related to heavy oil operations contributing the elevated readings when examining the frequency distribution of other pollutants including SO; other industry in the vicinity includes non-heavy oil facilities, land fill stations, agricultural operations and a relatively close pulp mill operation.

4. TRIGGERED VOLATILE ORGANIC COMPOUND SAMPLING

Canister sampling events are triggered when NMHC concentrations at a station measure a 0.3 ppmv averaged over 5 minutes. The canister samples were collected and 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.

The 2017 triggered canister VOC sampling results at the three stations are presented in Table 4. The top twelve compounds, of the 140 compounds sampled, with highest concentrations were selected and presented in Table 4. A comparison of the data to the available AAAQO (AEP 2017) was conducted as screening health exposure thresholds for all compounds were not available for comparison while preparing this report. Methane (CH_4) is also presented in Table 4. A complete list of species for each of the samples is provided in Appendix B, Table B-1.

4.1. Volatile Organic Compound Results Compared to AAAQO

There were no exceedances of the AAAQOs in 2017 however it should be noted that there are few hydrocarbon species that have an associated AAAQO.

Table 4: Volatile Organic Compound Canister Sample 1-hour Average Concentrations (ppbv)

Station ID	Sampled Date (YYYY/MM/DD)	Sampled Time (MST)	WS (km/hr)	WD	NMHC triggered concentration (ppmv)	CH4	Acetone	Acrolein	Benzene	Ethanol	Freon-113	Isobutane	Isopentane	Butane	n-Butane	n-Pentane	Toluene	Pentane
AAAQO*	n/a	n/a	n/a	n/a	n/a	n/a	2400	1.9	9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	499	n/a
Reno	2017-02-14	16:40	5.3	182	0.99	4600	2.5	< 0.4	0.15	1.9	0.12	1.36	0.95	n/a	1.34	0.5	0.41	n/a
986	2017-02-16	20:10	1.2	331	0.31	< 200	4.7	< 0.6	0.29	1.6	0.12	1.02	2.91	n/a	6.03	2.6	0.09	n/a
Reno[1]	2017-03-26	16:20	4.8	65	0.45	< 100	3.4	< 0.4	0.14	< 0.4	0.09	8.37	3.59	n/a	13.4	2.9	0.08	n/a
Reno	2017-07-21	21:00	8.5	235	0.38	2100	3.3	< 0.4	0.09	< 0.4	0.08	0.30	0.17	n/a	0.32	< 0.1	0.06	n/a
Reno	2017-09-07	20:00	0.9	215	0.32	3100	6.4	< 0.4	0.39	2.2	0.08	2.38	2.50	n/a	2.90	1.0	0.54	n/a
Reno[2]	2017-10-26	20:20	1.4	204	0.33	3000	4.1	0.8	1.57	0.6	0.08	0.95	0.49	n/a	1.47	0.5	0.66	n/a

* Alberta Ambient Air Quality Objectives and Guidelines Summary (bolded values exceed)
(a) Data Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2017)
n/a – data not available
1. Canister collected on March 26 is not considered a valid event due to an anomalous spike.
2. Caniter sample passed sample hold time. Results may be compromised.

5. BACKGROUND CONCENTRATIONS OF METHANE

A background concentration is the combination of naturally occurring chemical substances and ambient concentrations of man-made chemical substances in the environment that is representative of the surrounding area. The statistical analysis of the 1-hour concentrations for each year is presented in Tables 2 and 3.

The 50th percentile reading from each station was found to be consistent from 2016 to 2017. This suggests that the 50th percentile represents the background concentration as it remains unchanged regardless of year and location. It is reasonable to conclude that a suitable background methane (CH_4) concentration is approximately 1.90 ppmv for the region.

6. COMPARISONS OF RESULTS ACROSS ALBERTA

The following analysis was conducted for all monitoring sites in Alberta (including Stations 842, 986, and Reno) that monitored for CH_4, NMHC, THC, and TRS during 2016 and 2017. The 99th percentile is often used as an indicator of elevated concentrations that are exceeded 1% of the time. A maximum value could be used but it occurs only once. Alberta air quality management frameworks use the annual 99th percentile as an indicator of prolonged exposures or of multiple episodes to high concentrations. For example, the annual 99th percentile target for SO_2 for a regional plan is set by reviewing past monitoring data.

The station data was downloaded from the Alberta Environment and Parks air data site (http://airdata.alberta.ca/aepContent/Reports/DataDownloadMain.aspx) using the one parameter at multiple stations reporting option. Additional station information reports including the airshed, location, start date, status and parameters monitored are available on the Alberta Environment and Parks air data site (http://airdata.alberta.ca/aepContent/Reports/StationInformationMain.aspx). The locations of many of the stations is shown on the air quality technical map (http://maps.srd.alberta.ca/AQHI).

Not all stations had a full year of data, the minimum was two months. The 99th percentile for each month was calculated along with the annual or data set 99th percentile and average for each station for the available data. For ease of viewing, only the maximum 99th percentile for each month and annual averages are presented on the figures. All of the calculated statistics are presented in the tables.

In the following figures, station values were sorted from the lowest to highest annual or data set 99th percentile and then on the annual or data set average value if the annual 99th percentile were the same based on 2016 values. The annual 99th percentile is exceeded about 88 hours (1% of the time) if a full year of data is available. Higher values are indicative of more emissions in the area and higher potential for odours and complaints. Note the annual average CH_4 is typically less than 2 ppmv across the province, which is about the natural background concentration.

6.1. Methane

Figure 39 and Table 5 compare the CH_4 1-hour average measurements in Alberta in 2016 and 2017 for 22 stations.
Three new stations were added in the province in 2017: Horn Hill 1, Horn Hill 2 and Janvier. Three stations were decommissioned in 2017: Bruderheim, Elk Point Airport (Portable) and Lethbridge 1.

Seventeen sites had a full year of data in 2016. The number of months of available data is shown in brackets for the following stations missing data in 2016:

- PRAMP Reno [9]
- Lethbridge 1 [9]
- Bruderheim1 [9]
- Conklin Community [9]
- Bonnyville station (Portable) [7]
- Elk Point [5]
- Lethbridge 2 [3]
- Edmonton South [3]
- Bruderheim [2]

Twenty-two sites had a full year of data in 2017. The number of months of available data is shown in brackets for the following stations missing data in 2017:

- Stony Mountain (Conklin Lookout) [11]
- Bonnyville station (Portable) [7]
- Horton Hill 1 [6]
- Horton Hill 2 [2]

The annual averages for 2016 versus 2017 are consistent and do not show increasing or decreasing trends at the majority of the stations. Most stations saw incremental increases in 2017.

CH_4 readings in the Three Creeks area are comparable to other locations in Alberta. Note the annual average CH_4 is typically less than 2 ppmv across the province, which is about the natural background concentration.

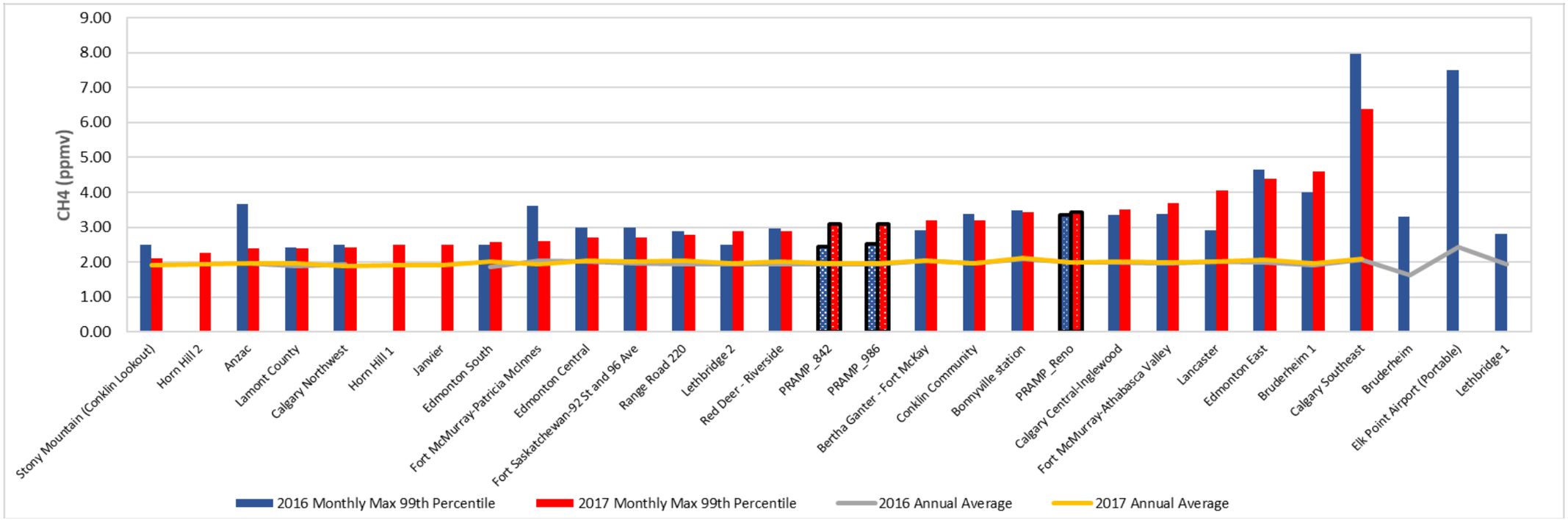


Figure 39: CH4 1-hour Average Measurements in Alberta in 2016 and 2017

Table 5: CH4 1-hour Average Measurements in Alberta for 2016 and 2017 (ppmv)

Sorted Results	Stony Mountain (Conklin Lookout)	Horn Hill 2	Anzac	Lamont County	Calgary Northwest	Horn Hill 1	Janvier	Edmonton South	Fort McMurray-Patricia McInnes	Edmonton Central	Fort Saskatchewan-92 St and 96 Ave	Range Road 220	Lethbridge 2	Red Deer - Riverside	PRAMP_842	PRAMP_986	Bertha Ganter - Fort McKay	Conklin Community	Bonnyville station	PRAMP_Reno	Calgary Central-Inglewood	Fort McMurray-Athabasca Valley	Lancaster	Edmonton East	Bruderheim	Calgary Southeast	Bruderheim	Elk Point Airport (Portable)	Lethbridge 1
2016 Monthly Max 99th Percentile	2.49	n/a	3.66	2.41	2.50	n/a	n/a	2.50	3.60	3.00	3.00	2.90	2.50	2.97	2.44	2.52	2.92	3.39	3.49	3.34	3.36	3.39	2.93	4.66	3.99	7.97	3.30	7.50	2.80
2017 Monthly Max 99th Percentile	2.12	2.26	2.39	2.40	2.43	2.50	2.50	2.57	2.60	2.70	2.70	2.79	2.90	2.90	3.10	3.11	3.19	3.20	3.42	3.43	3.51	3.70	4.06	4.39	4.59	6.38	n/a	n/a	n/a
2016 Annual 99th Percentile	2.30	n/a	2.30	2.30	2.21	n/a	n/a	2.50	2.61	2.50	2.60	2.60	2.40	2.70	2.26	2.17	2.70	2.60	3.00	2.80	2.90	2.70	2.60	3.10	3.44	4.16	2.70	5.20	2.50
2017 Annual 99th Percentile	2.10	2.20	2.20	2.30	2.10	2.20	2.10	2.40	2.30	2.50	2.50	2.53	2.44	2.70	2.20	2.60	2.70	2.60	3.00	3.00	2.80	2.50	2.70	3.00	3.50	4.71	n/a	n/a	n/a
2016 Annual Average	1.96	n/a	1.97	1.89	1.93	n/a	n/a	1.87	2.04	2.02	1.96	1.94	1.94	1.95	1.94	1.95	2.04	1.96	2.10	1.99	1.99	1.97	2.03	2.00	1.90	2.07	1.62	2.42	1.94
2017 Annual Average	1.92	1.95	1.96	1.97	1.88	1.93	1.92	2.01	1.95	2.05	2.02	2.04	1.97	2.01	1.96	1.97	2.06	1.96	2.12	1.99	2.01	2.00	2.02	2.08	1.98	2.10	n/a	n/a	n/a

6.2. Non-methane Hydrocarbons

Figure 40 and Table 6 compare the NMHC 1-hour average measurements in Alberta in 2016 and 2017 for 29 stations.

Three new stations were added in the province in 2017: Horn Hill 1, Horn Hill 2 and Janvier. Three stations were decommissioned in 2017: Bruderheim, Elk Point Airport (Portable) and Lethbridge 1.

Sixteen sites had a full year of NMHC data for 2016. The number of months of available data is shown in brackets for the following stations missing data in 2016:

- Edmonton Central [11]
- PRAMP Reno [9]
- Lethbridge 1 [9]
- Bruderheim 1 [9]
- Conklin Community [9]
- Bonnyville station [7]
- Elk Point [5]
- Edmonton South [3]
- Lethbridge 2 [3]
- Bruderheim [2]

Twenty-two sites had a full year of NMHC data for 2016. The number of months of available data is shown in brackets for the following stations missing data in 2016:

- Stony Mountain (Conklin Lookout) [11]
- Bonnyville Station (Portable) [7]
- Horton Hill 1 [6]
- Horton Hill 2 [2]

Figure 40 shows the maximum monthly 99th percentile values for station across Alberta. Many of the stations were lower in 2017 compared to 2016 with a few notable decreases in Fort McMurray likely the result of a large forest fire event. Annual averages are very close for 2016 and 2017 at most of the stations. Annual averages are very close for 2016 and 2017 at most of the stations.

NMHC readings in the Peace River Area are amongst the lowest in the province.

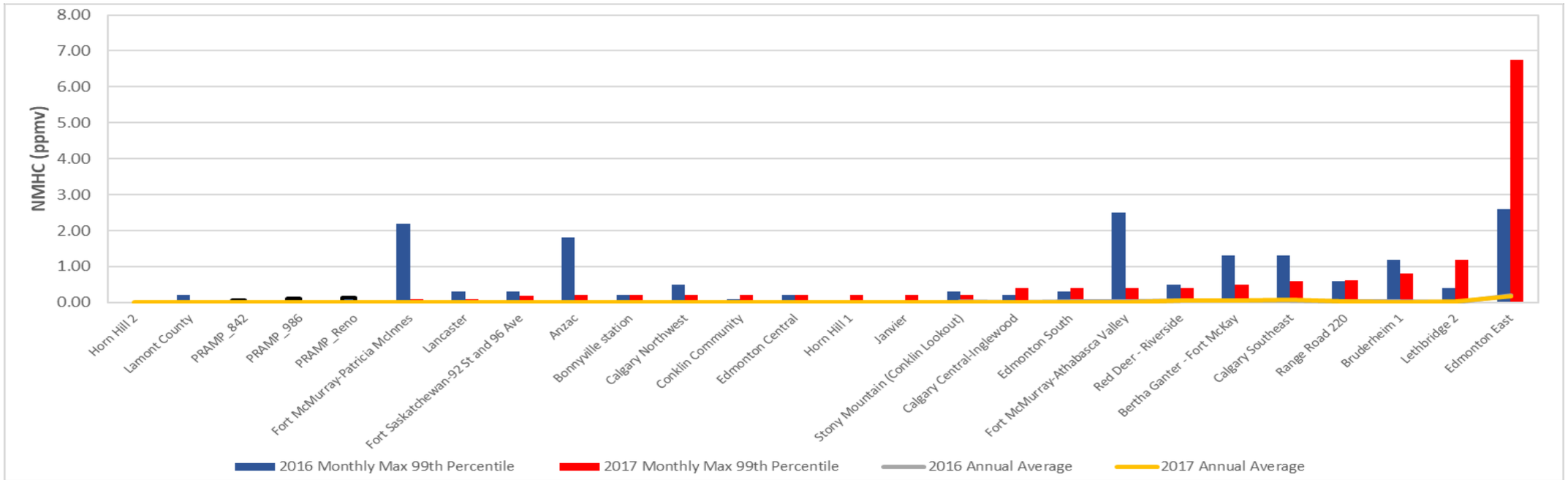


Figure 40: NMHC 1-hour Average Measurements in Alberta in 2016 and 2017

Table 6: NMHC 1-hour Average Measurements in Alberta for 2016 and 2017 (ppmv)

Sorted Results	Horn Hill 2	Lamont County	PRAMP_842	PRAMP_986	PRAMP_Reno	Fort McMurray-Patricia McInnes	Lancaster	Fort Saskatchewan-92 St and 96 Ave	Anzac	Bonnyville station	Calgary Northwest	Conklin Community	Edmonton Central	Horn Hill 1	Janvier	Stony Mountain (Conklin Lookout)	Calgary Central-Inglewood	Edmonton South	Fort McMurray-Athabasca Valley	Red Deer - Riverside	Bertha Ganter - Fort McKay	Calgary Southeast	Range Road 220	Bruderheim 1	Lethbridge 2	Edmonton East	Bruderheim	Elk Point Airport (Portable)	Lethbridge 1
2016 Monthly Max 99th Percentile	n/a	0.20	0.06	0.12	0.14	2.19	0.30	0.30	1.80	0.20	0.50	0.10	0.20	n/a	n/a	0.30	0.20	0.30	2.50	0.50	1.30	1.31	0.60	1.20	0.40	2.60	0.70	0.20	0.46
2017 Monthly Max 99th Percentile	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.40	0.40	0.40	0.40	0.50	0.60	0.62	0.80	1.20	6.74	n/a	n/a	n/a
2016 Annual 99th Percentile	n/a	0.20	0.00	0.03	0.02	0.30	0.10	0.20	0.20	0.10	0.20	0.00	0.10	n/a	n/a	0.10	0.10	0.30	0.80	0.30	0.50	0.50	0.30	0.70	0.30	1.60	0.60	0.20	0.30
2017 Annual 99th Percentile	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.10	0.10	0.20	0.10	0.10	0.10	0.00	0.10	0.20	0.30	0.30	0.30	0.40	0.50	0.40	0.50	0.50	1.74	n/a	n/a	n/a
2016 Annual Average	n/a	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	n/a	n/a	0.02	0.00	0.02	0.03	0.05	0.05	0.05	0.04	0.04	0.02	0.19	0.03	0.02	0.01
2017 Annual Average	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.01	0.05	0.05	0.07	0.04	0.02	0.03	0.17	n/a	n/a	n/a

6.3. Total Hydrocarbons

Figure 41 and Table 7 compare the THC 1-hour average measurements in 2016 and 2017 for 65 stations in Alberta.

Ten new stations were added in the province in 2017: Brion MacKay River, Fort Hills, Harmattan 2, Horn Hill, Janvier, Nordegg, Red Deer Range Road 272, South McDougal Flats, Surmont and Three Hills (Portable).

Thirteen stations were decommissioned in 2017: Beiseker, Bentley-Town, Beverly 1, Brion MacKay River, Bruderheim, Caprona, Edmonton South 1, Elk Point Airport (Portable), Innisfail Southwest, Lethbridge 1, Sherwood Park (New) 1, Sundre Northeast and Sylvan Lake Townsite.

Thirty sites had a full year of THC data in 2016. The number of months of available data is shown in brackets for the following stations missing data in 2016:

- Edmonton Central [11]
- St. Lina [11]
- Beverly - 1 [10]
- Violet Grove [10]
- Sherwood Park (New) - 1 [10]
- PRAMP Reno [10]
- Grande Prairie (Henry Pirker) [10]
- Rycroft-Portable [10]
- Lethbridge - 1 [9]
- Edmonton South - 1 [9]
- Bruderheim 1 [9]
- Conklin Community [9]
- Bonnyville Station (Portable) [7]
- Elk Poin [5]
- Edmonton Sounth-2 [3]
- Innisfail Southwest [3]
- Lethbridge-2 [3]
- Sylvan Lake Townsite [3]
- Beiseker [3]
- Beverly-2 [2]
- Bruderheim [2]
- Sherwood Park (New)-2 [2]
- Caprone [2]
- Bentley-Town [2]
- Sundre Northeast [1]

Thirty-eight sites had a full year of THC data in 2017. The number of months of available data is shown in brackets for the following stations missing data in 2017:

- Cresent Heights [11]
- Maskwa [11]
- Rycroft-Portable [11]
- Shell Muskeg River [11]
- Stony Mountain (Conklin Lookout) [11]
- Horn Hill [8]
- Bonnyville station [7]
- Fort Hills [7]
- Surmont [4]
- Three Hills (portable) [3]
- Harmttan-2 [3]
- Nordegg [3]
- South McDougal Flats [2]
- Red Deer Range Road 272 [2]

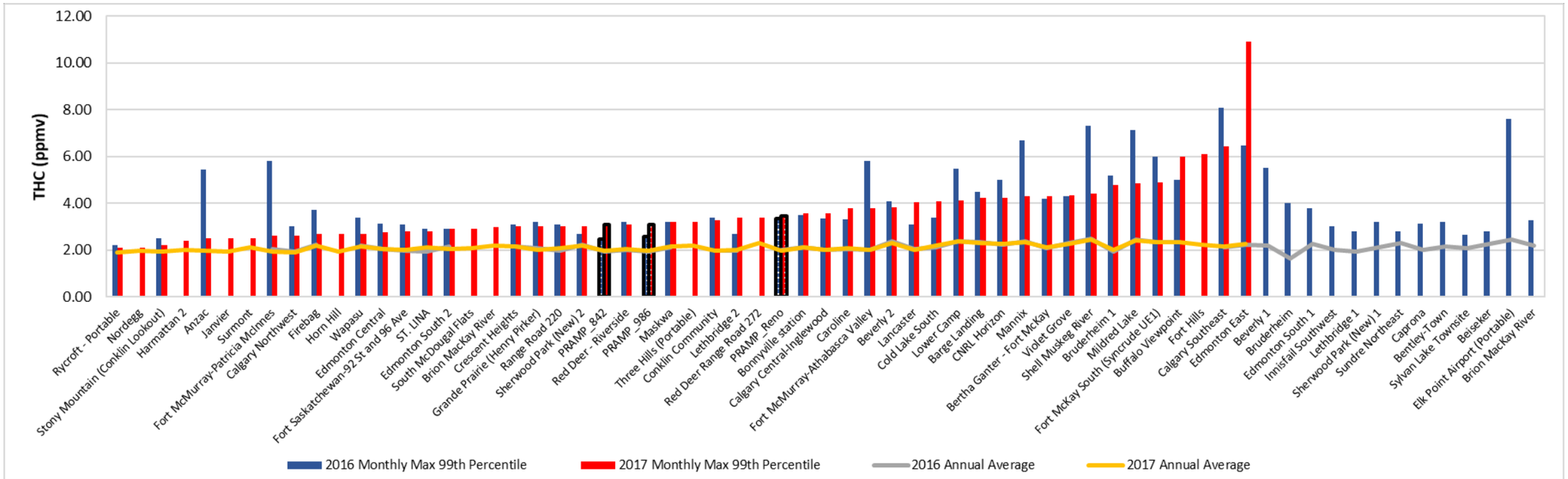


Figure 41: THC 1-hour Average Measurements in Alberta in 2016 and 2017

Table 7: THC 1-hour Average Measurements in Alberta in 2016 and 2017 (ppmv)

Sorted Results	Rycroft - Portable	Nordegg	Stony Mountain (Conklin Lookout)	Harmattan 2	Anzac	Janvier	Surmont	Fort McMurray-Patricia McInnes	Calgary Northwest	Firebag	Horn Hill	Wapasu	Edmonton Central	Fort Saskatchewan-92 St and 96 Ave	ST. LINA	Edmonton South 2	South McDougal Flats	Brion MacKay River	Crescent Heights	Grande Prairie (Henry Pirker)	Range Road 220	Sherwood Park (New) 2	PRAMP_842	Red Deer - Riverside	PRAMP_986	Maskwa	Three Hills (Portable)	Conklin Community	Lethbridge 2	Red Deer Range Road 272	PRAMP_Reno
2016 Monthly Max 99th Percentile	2.20	n/a	2.50	n/a	5.44	n/a	n/a	5.79	3.00	3.70	n/a	3.40	3.11	3.09	2.90	2.90	n/a	n/a	3.10	3.20	3.10	2.70	2.45	3.20	2.56	3.20	n/a	3.39	2.70	n/a	3.34
2017 Monthly Max 99th Percentile	2.10	2.10	2.20	2.40	2.50	2.50	2.50	2.60	2.63	2.70	2.70	2.70	2.76	2.80	2.80	2.90	2.90	2.99	3.00	3.00	3.00	3.00	3.10	3.10	3.11	3.20	3.20	3.29	3.37	3.39	3.44
2016 Annual 99th Percentile	2.10	n/a	2.30	n/a	2.40	n/a	n/a	2.90	2.40	2.70	n/a	2.70	2.60	2.60	2.50	2.70	n/a	n/a	2.70	2.70	2.70	2.70	2.27	3.00	2.18	2.70	n/a	2.60	2.60	n/a	2.82
2017 Annual 99th Percentile	2.10	2.10	2.20	2.40	2.30	2.10	2.50	2.30	2.30	2.50	2.20	2.50	2.60	2.50	2.70	2.70	2.75	2.60	2.70	2.60	2.73	2.70	2.20	2.90	2.60	2.90	3.00	2.60	2.80	3.30	3.00
2016 Annual Average	1.88	n/a	1.98	n/a	1.99	n/a	n/a	2.05	1.94	2.22	n/a	2.19	2.03	1.97	1.93	2.15	n/a	n/a	2.14	2.07	1.97	2.22	1.94	1.99	1.94	2.12	n/a	1.96	1.96	n/a	2.00
2017 Annual Average	1.90	1.97	1.94	2.02	1.97	1.92	2.10	1.95	1.89	2.18	1.94	2.15	2.06	2.03	2.11	2.03	2.07	2.19	2.14	2.00	2.07	2.19	1.96	2.06	1.97	2.16	2.20	1.97	2.00	2.29	1.99

Sorted Results	Bonnyville station	Calgary Central-Inglewood	Caroline	Fort McMurray-Athabasca Valley	Beverly 2	Lancaster	Cold Lake South	Lower Camp	Barge Landing	CNRL Horizon	Mannix	Bertha Ganter - Fort McKay	Violet Grove	Shell Muskeg River	Bruderheim 1	Mildred Lake	Fort McKay South (Syncrude UE1)	Buffalo Viewpoint	Fort Hills	Calgary Southeast	Edmonton East	Beverly 1	Bruderheim	Edmonton South 1	Innisfail Southwest	Lethbridge 1	Sherwood Park (New) 1	Sundre Northeast	Caprona	Bentley-Town	Sylvan Lake Townsite	Beiseker	Elk Point Airport (Portable)	Brion MacKay River
2016 Monthly Max 99th Percentile	3.50	3.36	3.30	5.80	4.08	3.09	3.40	5.49	4.49	5.00	6.70	4.19	4.30	7.30	5.16	7.14	6.00	4.99	n/a	8.08	6.46	5.50	4.00	3.80	3.00	2.80	3.20	2.80	3.12	3.20	2.66	2.80	7.60	3.29
2017 Monthly Max 99th Percentile	3.56	3.58	3.80	3.80	3.82	4.06	4.07	4.14	4.22	4.24	4.29	4.29	4.34	4.40	4.78	4.84	4.89	5.99	6.09	6.43	10.92	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2016 Annual 99th Percentile	3.10	2.90	2.80	3.30	3.41	2.70	3.00	3.70	3.50	3.70	4.10	3.00	3.70	4.30	4.10	4.30	3.70	3.70	n/a	4.60	4.50	3.70	3.34	3.20	2.80	2.60	2.80	2.80	3.00	3.10	2.50	2.70	5.30	2.70
2017 Annual 99th Percentile	3.10	2.90	2.80	2.70	3.46	2.70	3.20	3.60	3.30	3.69	3.70	3.00	3.30	4.00	3.90	4.10	3.60	3.40	4.00	5.00	4.30	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2016 Annual Average	2.11	1.99	2.06	2.00	2.36	2.04	2.13	2.37	2.34	2.24	2.37	2.09	2.30	2.50	1.94	2.45	2.35	2.35	n/a	2.13	2.24	2.21	1.65	2.28	1.99	1.95	2.11	2.32	2.01	2.15	2.07	2.26	2.44	2.19
2017 Annual Average	2.13	2.02	2.09	2.01	2.32	2.02	2.19	2.36	2.29	2.26	2.34	2.11	2.27	2.44	2.00	2.42	2.34	2.34	2.21	2.17	2.25	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

6.4. Total Reduced Sulphur

Figure 42 and Table 8 compare the TRS 1-hour average measurements in 2016 and 2017 for 34 stations in Alberta.

Eight new stations were added in the province in 2017: Janvier, Lancaster, Three Hills (Portable), Harmattan-2, South MacDougal Flats, Fort Hills, Nordegg and Red Deer Range Road 272.

Seven stations were decommissioned in 2017: Innisfail Southwest, Lancaster, Sundre Northeast, Caprona, Bentley-Town, Sylvan Lake Tosnsite and Beiseker.

Thirteen sites had a full year of TRS data in 2016. The number of months of available data is shown in brackets for the following stations missing data in 2016:

- Fort McMurray-Athabasca Valley [11]
- Grande Prairie (Henry Pirker) [10]
- Smoky Heights [10]
- Rycroft - Portable [10]
- PRAMP Reno[10]
- Conklin Community [9]
- Hinton[4]
- Innisfail Southwest [3]
- Sylvan Lake Townsite [3]
- Caprona [2]
- Bentley-Town [2]
- Beiseker [2]
- Sundre Northeast [1]

Twenty sites had a full year of TRS data in 2017. The number of months of available data is shown in brackets for the following stations missing data in 2017:

- Stony Mountain (Conklin Lookout) [11]
- Fort Fills [7]
- Three Hills (Portable) [3]
- Harmattan-2 [3]
- Nordegg [3]
- South McDougal Flats [2]
- Red Deer Range Road 272 [2]

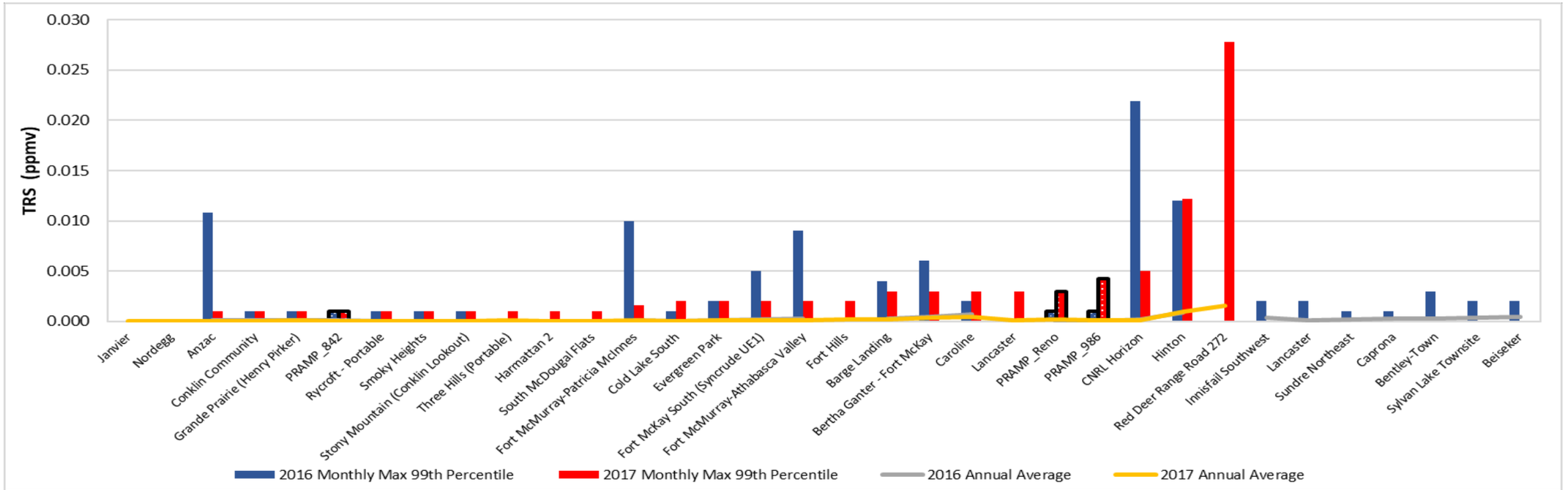


Figure 42: TRS 1-hour Average Measurements in Alberta in 2016 and 2017

Table 8: TRS 1-hour Average Measurements in Alberta in 2016 and 2017 (ppmv)

Sorted Results	Janvier	Nordegg	Anzac	Conklin Community	Grande Prairie (Henry Pirker)	PRAMP_842	Rycroft - Portable	Smoky Heights	Stony Mountain (Conklin Lookout)	Three Hills (Portable)	Harmattan 2	South McDougal Flats	Fort McMurray-Patricia McInnes	Cold Lake South	Evergreen Park	Fort McKay South (Syncrude UE1)	Fort McMurray-Athabasca Valley	Fort Hills	Barge Landing	Bertha Ganter - Fort McKay	Caroline	Lancaster	PRAMP_Reno	PRAMP_986	CNRL Horizon	Hinton	Red Deer Range Road 272	Innisfail Southwest	Lancaster	Sundre Northeast	Caprona	Bentley-Town	Sylvan Lake Townsite	Beiseker
2016 Monthly Max 99th Percentile	n/a	n/a	0.011	0.001	0.001	0.001	0.001	0.001	0.001	n/a	n/a	n/a	0.010	0.001	0.002	0.005	0.009	n/a	0.004	0.006	0.002	n/a	0.001	0.001	0.022	0.012	n/a	0.002	0.002	0.001	0.001	0.003	0.002	0.002
2017 Monthly Max 99th Percentile	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.004	0.005	0.012	0.028	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2016 Annual 99th Percentile	n/a	n/a	0.001	0.001	0.001	0.001	0.001	0.001	0.001	n/a	n/a	n/a	0.002	0.001	0.001	0.002	0.004	n/a	0.002	0.002	0.001	n/a	0.000	0.001	0.002	0.007	n/a	0.001	0.001	0.001	0.001	0.003	0.002	0.002
2017 Annual 99th Percentile	0.000	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.008	0.019	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2016 Annual Average	n/a	n/a	0.000	0.000	0.000	0.000	0.000	0.000	0.000	n/a	n/a	n/a	0.000	0.000	0.000	0.000	0.000	n/a	0.000	0.000	0.001	n/a	0.000	0.000	0.000	0.001	n/a	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2017 Annual Average	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	n/a	n/a	n/a	n/a	n/a	n/a	n/a

7. COMPLAINTS AND THC MONITORING RESULTS

The AER recorded complaints from residents and assigned the location of the complaint to each of the three stations. AER complaints were collected and analyzed as follows:

- Station 986 showed a decrease in the number of complaints from 5 in 2016 to 4 in 2017 (down from a historical maximum of 33 in 2014)
- Station 842 showed a decrease in the number of complaints from 16 in 2016 to 4 in 2017 (down from a historical maximum of 44 in 2014)
- Reno Station showed an increase in the number of complaints from 3 in 2016 to 5 in 2017 (down from a historical maximum of 11 in 2015)

Based on the latitude and longitude of the complaint, each complaint was assigned the station closest to where the complaint was logged. 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. Therefore, when a complaint is assigned to a monitoring station, it is considered to be reasonably close for correlation analysis of the complaint and wind speed, wind direction, THC concentrations, and other parameters; the complaint was not necessarily logged at the exact location of the monitoring station.

Over time, there have been fewer odour complaints. While fewer complaints is a likely outcome of the reduction in ambient hydrocarbon concentrations, however PRAMP recognizes that there may be other factors involved including residents moving out of the area and complainant fatigue.

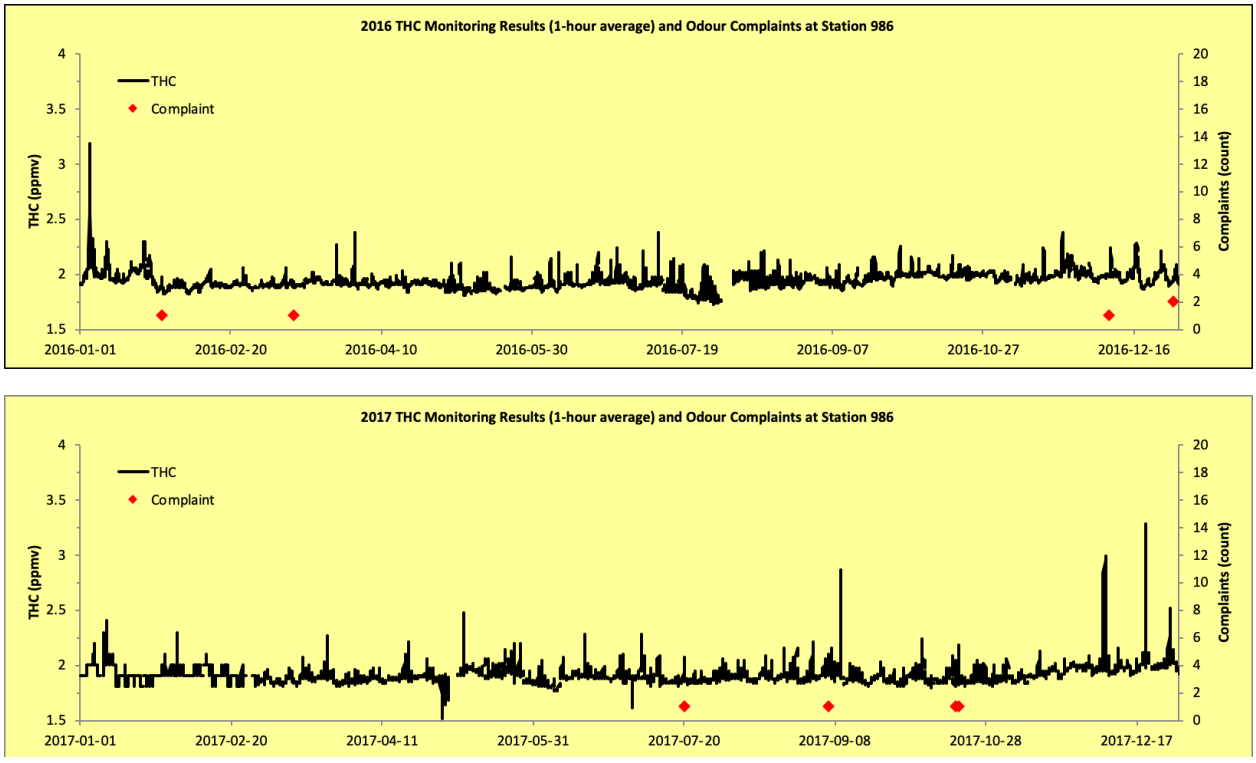


Figure 43: THC and Complaints Correlation at Station 986

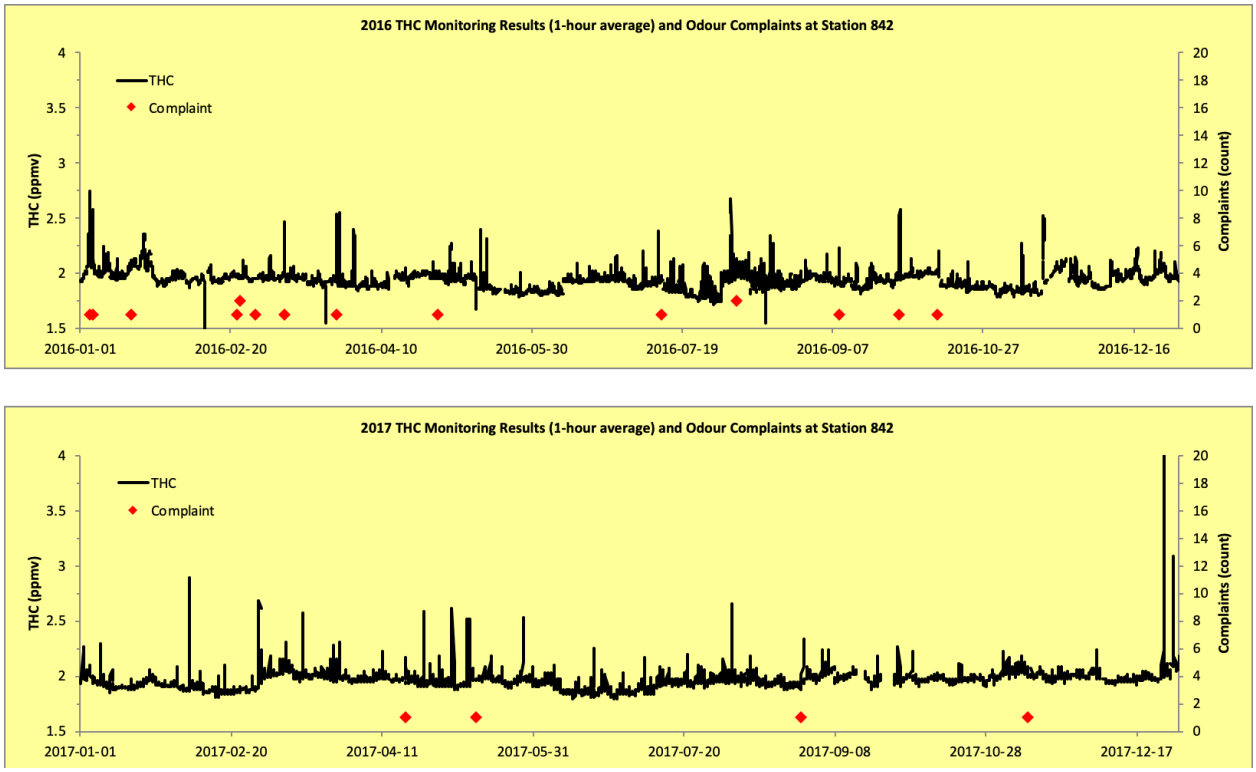


Figure 44: THC and Complaints Correlation for Station 842

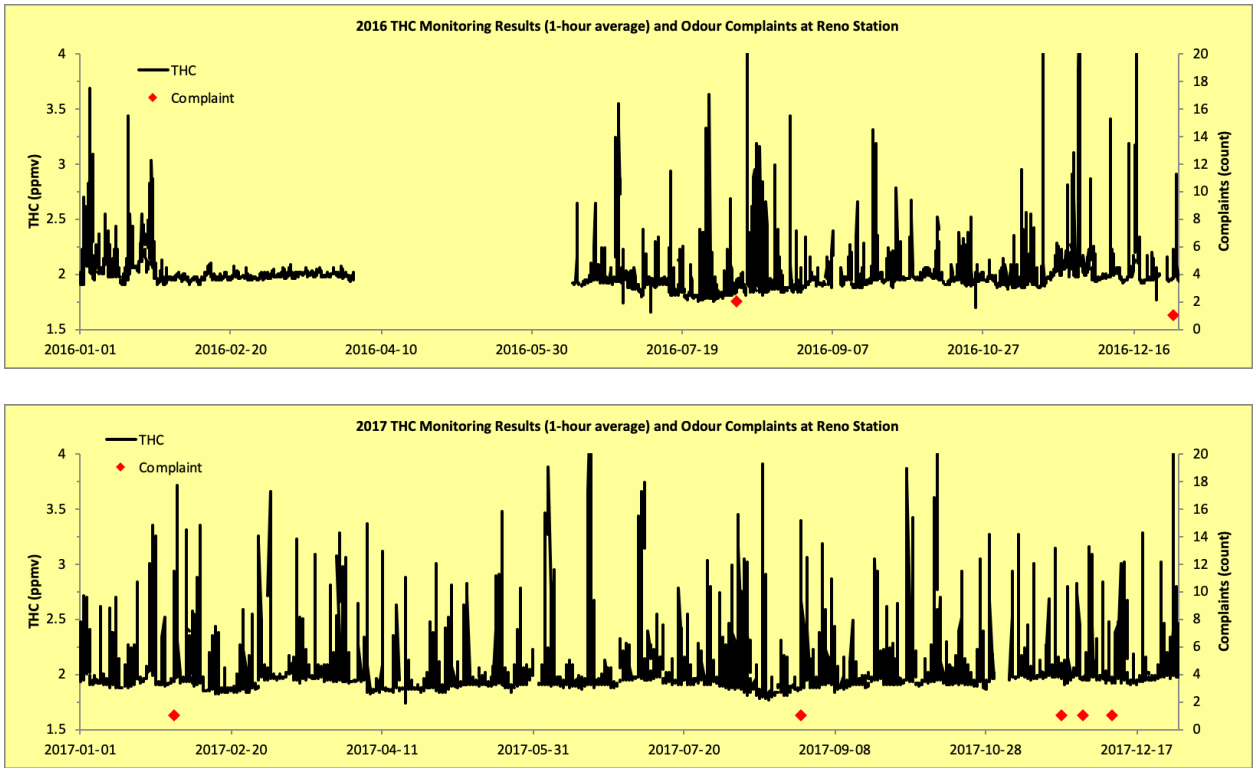


Figure 45: THC and Complaints Correlation for Reno Station

8. CONCLUSIONS

PRAMP collected concentration data of THC, NMHC, TRS, SO_2, and CH_4 at three continuous monitoring stations in the Peace River Area throughout 2016 and 2017. The data was summarized and analyzed using statistical methods to quantify the air quality in the area. Wind speed and direction was also monitored to further understand the potential sources of substances detected by the monitoring. Triggered sampling events provided additional concentration data.

Based on hourly measurement data, THC, NMHC, SO_2, TRS, and CH_4 concentrations show increasing and decreasing trends or patterns between 2016 and 2017 depending on the metric examined (average, 99th percentile, 90th percentile, etc.). Similar to previous years' analysis, it should be noted that all of the changes are incremental, particularly when considering the historically elevated concentrations of hydrocarbons at station 986 and 842. The existing monitoring program should continue with the same measurement parameters to continue to examine trends in concentrations.

The Reno monitoring station continues to see elevated hydrocarbon concentrations relative to current measurements at the other PRAMP sites; despite being elevated, measurements at Reno are generally lower than the historical maximums at 986 and 842. To improve the collective understanding of air quality in the region, PRAMP has investigated the potential causes for these elevated measurements and sporadic 'spikes'. The initial results of this ongoing investigation suggest that CHOP infrastructure is much closer to the Reno Station compared to Station 986 and 842 and is a strong influence on the elevated measurements at that site. The CHOP facilities nearest Station 986 and 842 are approximately 6km and 4km away; however, at the Reno Station, the same types of facilities are 300-500m away which represents an order of magnitude difference.

In general, the PRAMP Airshed has a disbursed, low-density rural population. However, much like the differences described above with respect to monitoring station proximity to industrial sources, so too are there differences in the population distribution throughout the PRAMP area. Compared to Station 986 and 842, there are more heavy oil installations and private residences in close proximity to each other in the Reno area; this supports PRAMP's ongoing monitoring efforts in this area and additional efforts to analyze the air monitoring data from the Reno Station.

The production shutdown in the Reno area in 2016 (noted in section 3.1) and the influence it had on air quality also suggests that the nearby CHOP infrastructure is an influencing factor on hydrocarbon concentrations.

Additional study work is required to account for the influence of all "human activities" on the air quality throughout the PRAMP airshed which may include non-heavy oil oil and gas activities, trans-loading operations, agricultural activities, forestry and urban centers.

The canister program is a high-profile element of PRAMP's overall monitoring program. Although a more rigorous sample handling protocol was implemented, contractor error has resulted in lost data. With fewer canisters being collected, each sample is all that more valuable in telling the ongoing story of the ambient concentration of hydrocarbon species in the Peace River Area. A thorough review of the canister sample handling protocol was completed in 2017 and an electronic alarm system was installed to reduce the occurrence of missed sampling events and the associated data loss.

9. REFERENCES

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APPENDIX A

TRIGGERED SAMPLE RESULTS

APPENDIX A TRIGGERED SAMPLE RESULTS

Station		Reno	986	Reno[1]	Reno[2]	Reno	Reno
Sampled Date (MM/DD/YYYY)		2017-02-14	2017-02-16	2017-03-26	2017-07-21	2017-09-07	2017-10-26
Sampled Time		16:40	20:10	16:20	21:00	20:00	20:20
Parameter	Unit	Result	Result	Result	Result	Result	Result
1-Butene	ppmv	0.18	< 0.19	< 0.13	< 0.13	< 0.14	< 0.14
Acetylene	ppmv	0.3	< 0.4	< 0.3	< 0.3	< 0.3	< 0.3
cis-2-Butene	ppmv	0.6	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Ethane	ppmv	0.4	< 0.2	0.2	< 0.1	< 0.1	< 0.1
Ethylacetylene	ppmv	0.42	< 0.11	< 0.08	< 0.08	< 0.08	< 0.08
Ethylene	ppmv	< 0.3	< 0.4	< 0.3	< 0.3	< 0.3	< 0.3
Isobutane	ppmv	0.5	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Isobutylene	ppmv	0.4	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Methane	ppmv	4.6	< 0.2	< 0.1	2.1	3.1	3.0
n-Butane	ppmv	1.1	< 0.4	< 0.3	< 0.3	< 0.3	< 0.3
n-Propane	ppmv	0.47	< 0.13	< 0.09	< 0.09	< 0.10	< 0.09
Propylene	ppmv	0.4	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
Propyne	ppmv	0.5	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1
trans-2-Butene	ppmv	0.41	< 0.17	< 0.12	< 0.12	< 0.12	< 0.12
2,5-Dimethylthiophene	ppbv	< 1.2	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
2-Ethylthiophene	ppbv	< 1.4	< 0.4	< 0.3	< 0.3	< 0.3	< 0.3
2-Methylthiophene	ppbv	< 1.1	< 0.4	< 0.3	0.7	< 0.3	< 0.3
3-Methylthiophene	ppbv	< 0.7	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
Butyl mercaptan	ppbv	< 1.1	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
Carbon disulphide	ppbv	< 0.8	< 0.4	< 0.3	< 0.3	0.3	< 0.3
Carbonyl sulphide	ppbv	< 1.4	10.3	< 0.4	6.8	1.3	1.9
Dimethyl disulphide	ppbv	< 1.1	< 0.4	< 0.3	< 0.3	< 0.3	< 0.3
Dimethyl sulphide	ppbv	< 1.0	< 0.4	< 0.3	< 0.3	0.9	< 0.3

Station		Reno	986	Reno[1]	Reno[2]	Reno	Reno
Sampled Date (MM/DD/YYYY)		2017-02-14	2017-02-16	2017-03-26	2017-07-21	2017-09-07	2017-10-26
Sampled Time		16:40	20:10	16:20	21:00	20:00	20:20
Parameter	Unit	Result	Result	Result	Result	Result	Result
Ethyl mercaptan	ppbv	< 0.8	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
Ethyl sulphide	ppbv	< 1.2	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
Hydrogen sulphide	ppbv	< 1.0	< 0.2	1	1.4	< 0.1	0.4
Isobutyl mercaptan	ppbv	< 1.1	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
Isopropyl mercaptan	ppbv	< 1.2	< 0.6	1.3	< 0.4	< 0.4	< 0.4
Methyl mercaptan	ppbv	< 1.2	< 0.4	< 0.3	< 0.3	< 0.3	< 0.3
Pentyl mercaptan	ppbv	< 0.05	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
Propyl mercaptan	ppbv	< 1.4	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
tert-Butyl mercaptan	ppbv	< 1.2	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
Thiophene	ppbv	< 1.0	< 0.4	0.6	< 0.3	< 0.3	< 0.3
1,1,1-Trichloroethane	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
1,1,2,2-Tetrachloroethane	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
1,1,2-Trichloroethane	ppbv	< 0.03	0.17	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethane	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethylene	ppbv	< 0.05	< 0.08	< 0.05	< 0.05	< 0.06	< 0.05
1,2,3-Trimethylbenzene	ppbv	< 0.07	< 0.09	< 0.07	< 0.07	< 0.07	< 0.07
1,2,4-Trichlorobenzene	ppbv	< 1.1	< 1.5	< 1.1	< 1.1	< 1.1	< 1.1
1,2,4-Trimethylbenzene	ppbv	< 0.07	< 0.09	< 0.07	0.29	0.09	< 0.07
1,2-Dibromoethane	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
1,2-Dichlorobenzene	ppbv	< 0.04	< 0.06	< 0.04	< 0.04	< 0.04	< 0.04
1,2-Dichloroethane	ppbv	0.02	0.02	0.02	< 0.01	0.02	< 0.01
1,2-Dichloropropane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
1,3,5-Trimethylbenzene	ppbv	0.04	< 0.04	< 0.03	< 0.03	0.04	< 0.03
1,3-Butadiene	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	0.28
1,3-Dichlorobenzene	ppbv	< 0.4	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4

Station		Reno	986	Reno[1]	Reno[2]	Reno	Reno
Sampled Date (MM/DD/YYYY)		2017-02-14	2017-02-16	2017-03-26	2017-07-21	2017-09-07	2017-10-26
Sampled Time		16:40	20:10	16:20	21:00	20:00	20:20
Parameter	Unit	Result	Result	Result	Result	Result	Result
1,4-Dichlorobenzene	ppbv	< 0.5	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
1,4-Dioxane	ppbv	< 0.5	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
1-Butene	ppbv	0.45	0.50	0.08	< 0.03	0.07	0.73
1-Hexene	ppbv	< 0.03	0.09	< 0.03	< 0.03	< 0.03	0.08
1-Pentene	ppbv	< 0.01	0.02	< 0.01	0.02	< 0.01	0.12
2,2,4-Trimethylpentane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
2,2-Dimethylbutane	ppbv	0.04	0.03	0.05	< 0.01	0.12	< 0.01
2,3,4-Trimethylpentane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	0.02	< 0.01
2,3-Dimethylbutane	ppbv	0.10	< 0.04	0.07	0.04	0.35	0.04
2,3-Dimethylpentane	ppbv	0.10	< 0.04	0.04	< 0.03	0.29	< 0.03
2,4-Dimethylpentane	ppbv	0.03	< 0.02	0.02	< 0.01	0.10	< 0.01
2-Methylheptane	ppbv	0.06	< 0.02	0.03	< 0.01	0.06	< 0.01
2-Methylhexane	ppbv	0.10	< 0.02	0.12	< 0.01	0.21	< 0.01
2-Methylpentane	ppbv	0.30	0.39	0.53	0.02	0.97	0.06
3-Methylheptane	ppbv	0.04	< 0.04	< 0.03	< 0.03	0.06	< 0.03
3-Methylhexane	ppbv	0.14	0.04	0.13	< 0.03	0.32	< 0.03
3-Methylpentane	ppbv	0.27	0.30	0.3	< 0.01	0.74	0.04
Acetone	ppbv	2.5	4.7	3.4	3.3	6.4	4.1
Acrolein	ppbv	< 0.4	< 0.6	< 0.4	< 0.4	< 0.4	0.8
Benzene	ppbv	0.15	0.29	0.14	0.09	0.39	1.57
Benzyl chloride	ppbv	< 0.5	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
Bromodichloromethane	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
Bromoform	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
Bromomethane	ppbv	< 0.01	< 0.02	0.01	0.01	0.02	< 0.01
Carbon disulfide	ppbv	< 0.01	0.22	0.04	1.09	0.46	0.02

Station		Reno	986	Reno[1]	Reno[2]	Reno	Reno
Sampled Date (MM/DD/YYYY)		2017-02-14	2017-02-16	2017-03-26	2017-07-21	2017-09-07	2017-10-26
Sampled Time		16:40	20:10	16:20	21:00	20:00	20:20
Parameter	Unit	Result	Result	Result	Result	Result	Result
Carbon tetrachloride	ppbv	0.12	0.11	0.08	0.09	0.09	0.08
Chlorobenzene	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
Chloroethane	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
Chloroform	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
Chloromethane	ppbv	0.57	0.60	0.63	0.34	0.55	0.59
cis-1,2-Dichloroethene	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
cis-1,3-Dichloropropene	ppbv	< 0.05	< 0.08	< 0.05	< 0.05	< 0.06	< 0.05
cis-2-Butene	ppbv	0.04	0.05	< 0.03	< 0.03	< 0.03	0.13
cis-2-Pentene	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	0.04
Cyclohexane	ppbv	0.25	0.10	0.17	< 0.03	0.69	0.05
Cyclopentane	ppbv	0.09	0.15	0.13	< 0.01	0.21	0.04
Dibromochloromethane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01
Ethanol	ppbv	1.9	1.6	< 0.4	< 0.4	2.2	0.6
Ethyl acetate	ppbv	< 0.5	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
Ethylbenzene	ppbv	0.05	< 0.02	< 0.01	< 0.01	0.05	0.06
Freon-11	ppbv	0.35	0.31	0.23	0.29	0.31	0.29
Freon-113	ppbv	0.12	0.12	0.09	0.08	0.08	0.08
Freon-114	ppbv	< 0.03	< 0.04	< 0.03	< 0.03	< 0.03	< 0.03
Freon-12	ppbv	0.74	0.64	0.41	0.60	0.66	0.58
Hexachloro-1,3-butadiene	ppbv	< 0.68	< 0.94	< 0.67	< 0.66	< 0.69	< 0.68
Isobutane	ppbv	1.36	1.02	8.37	0.30	2.38	0.95
Isopentane	ppbv	0.95	2.91	3.59	0.17	2.50	0.49
Isoprene	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	3.18	0.07
Isopropyl alcohol	ppbv	< 0.5	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
Isopropylbenzene	ppbv	0.02	< 0.02	< 0.01	< 0.01	< 0.01	< 0.01

Station		Reno	986	Reno[1]	Reno[2]	Reno	Reno
Sampled Date (MM/DD/YYYY)		2017-02-14	2017-02-16	2017-03-26	2017-07-21	2017-09-07	2017-10-26
Sampled Time		16:40	20:10	16:20	21:00	20:00	20:20
Parameter	Unit	Result	Result	Result	Result	Result	Result
m,p-Xylene	ppbv	0.31	0.06	< 0.04	< 0.04	0.09	0.10
m-Diethylbenzene	ppbv	< 0.05	< 0.08	< 0.05	< 0.05	< 0.06	< 0.05
m-Ethyltoluene	ppbv	< 0.4	< 0.15	< 0.11	< 0.11	< 0.11	< 0.11
Methyl butyl ketone	ppbv	< 0.68	< 0.94	< 0.67	< 0.66	< 0.69	< 0.68
Methyl ethyl ketone	ppbv	< 0.4	< 0.6	< 0.4	0.4	0.7	0.5
Methyl isobutyl ketone	ppbv	< 0.5	4.8	< 0.5	< 0.5	< 0.6	< 0.5
Methyl methacrylate	ppbv	< 0.10	< 0.13	< 0.09	< 0.09	< 0.10	< 0.09
Methyl tert butyl ether	ppbv	< 0.04	0.13	< 0.04	< 0.04	< 0.04	< 0.04
Methylcyclohexane	ppbv	0.26	0.06	0.18	< 0.01	0.80	0.04
Methylcyclopentane	ppbv	0.36	0.42	0.24	< 0.03	0.74	0.07
Methylene chloride	ppbv	< 0.4	< 0.6	< 0.4	< 0.4	< 0.4	< 0.4
n-Butane	ppbv	1.34	6.03	13.4	0.32	2.90	1.47
n-Decane	ppbv	< 0.08	< 0.11	< 0.08	< 0.08	< 0.08	< 0.08
n-Dodecane	ppbv	< 0.5	< 0.8	< 0.5	< 0.5	< 0.6	< 0.5
n-Heptane	ppbv	< 0.01	0.05	0.17	< 0.01	0.11	0.06
n-Hexane	ppbv	0.25	1.04	0.55	0.02	0.38	0.11
n-Nonane	ppbv	0.07	< 0.02	0.02	< 0.01	0.03	0.02
n-Octane	ppbv	0.12	< 0.04	0.05	< 0.03	0.04	0.03
n-Pentane	ppbv	0.5	2.6	2.9	< 0.1	1.0	0.5
n-Propylbenzene	ppbv	< 0.07	< 0.09	< 0.07	< 0.07	< 0.07	< 0.07
n-Undecane	ppbv	< 0.7	< 0.9	< 0.7	< 0.7	< 0.7	< 0.7
Naphthalene	ppbv	< 0.4	< 0.9	< 0.7	< 0.7	< 0.7	< 0.7
o-Ethyltoluene	ppbv	0.02	< 0.02	< 0.01	< 0.01	0.02	0.02
o-Xylene	ppbv	0.10	0.10	0.06	0.02	0.04	0.06
p-Diethylbenzene	ppbv	< 0.05	< 0.08	< 0.05	< 0.05	< 0.06	< 0.05

APPENDIX B

COMPLAINTS WITH MONITORED DATA CORRELATION

APPENDIX B COMPLAINTS WITH MONITORED DATA CORRELATION

Station	Reported Date (MM/DD/YYYY)	Reported Time (MDT,HH:MM)	Monitored Time (MST, HH:MM)	SO2 (ppb)	TRS (ppb)	WSP (km/h)	WD	THC (ppm)	CH4 (ppm)	NMHC (ppm)	NMHC_max (ppm)
842	01/04/2016	00:00	00:00	0	0.4	2.1	E	2.37	2.36	0	0.03
842	01/05/2016	00:00	00:00	0	0.4	2.1	E	2.08	2.06	0	0
842	01/18/2016	00:00	00:00	0.2	0.4	0.6	SSE	2.1	2.09	0	0
842	02/22/2016	07:20	07:00	n/a	n/a	11.3	SW	n/a	n/a	n/a	n/a
842	02/23/2016	04:30	04:00	0	0.2	9.1	WSW	1.98	1.96	0	0
842	02/23/2016	23:10	23:00	0	0.2	2.2	E	1.96	1.95	0	0
842	02/28/2016	00:20	00:00	0.2	0.3	8.1	NNW	1.96	1.95	0	0.02
842	03/09/2016	00:00	00:00	0.7	0.4	1.7	E	2.47	2.47	0	0
842	03/26/2016	00:00	01:00	0	0.3	2.9	E	1.97	1.95	0	0.01
842	04/29/2016	23:39	00:00*	0	0.3	7.2	WSW	1.98	1.98	0	0.01
842	07/12/2016	00:00	01:00	0.5	0	4.4	N	1.92	1.94	0	0
842	08/06/2016	00:00	01:00	0.1	0.7	5.4	ENE	2.09	2.09	0	0
842	09/09/2016	00:00	01:00	0	0.6	1	E	1.96	1.96	0	0
842	09/29/2016	00:00	01:00	0	0.7	4.4	ENE	2.38	2.38	0	0
842	10/12/2016	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
842	12/29/2016	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
842	04/19/2017	23:20	00:00*	0	0.14	4.3	E	1.96	1.96	0	0
842	05/12/2017	11:55	12:00	0	0.14	13	E	1.98	1.98	0	0
842	08/28/2017	08:28	09:00	0	0.26	5.8	SW	1.93	1.93	0	0
842	11/11/2017	16:40	16:00	0	0.26	3	SW	2.05	2.05	0	0.06
986	01/28/2016	00:00	00:00	0	0.6	5.1	SSE	1.88	1.89	0	0
986	03/12/2016	00:00	01:00	0.3	0.3	3.6	E	1.9	1.9	0	0
986	12/08/2016	12:00	12:00	0.4	0.4	0.1	W	2.2	2.2	0	0
986	12/29/2016	12:00	12:00	0.1	0.2	2.3	ESE	1.98	1.98	0	0
986	07/20/2017	21:48	22:00	0	0.77	1.3	ESE	2.14	2.14	0	0
986	09/06/2017	11:29	12:00	0	0.33	6	S	1.97	1.97	0	0
986	10/18/2017	05:38	06:00	0	0.38	3.3	S	1.9	1.9	0	0
986	10/19/2017	13:01	14:00	0	0.26	9.3	SSW	1.86	1.86	0	0
Reno	08/06/2016	00:00	01:00	0	0.2	7.6	E	1.88	1.88	0	0.1
Reno	12/29/2016	12:00	12:00	0	0.2	3.8	S	2.11	2.11	0	0
Reno	02/01/2017	14:00	14:00	0	0.1	2.9	W	1.95	1.95	0	0
Reno	08/28/2017	08:28	09:00	1	0.45	6.7	WSW	1.87	1.87	0	0
Reno	11/22/2017	08:30	08:00	0	0.42	4.6	SSE	2.03	2.03	0	0

Station	Reported Date (MM/DD/YYYY)	Reported Time (MDT,HH:MM)	Monitored Time (MST, HH:MM)	SO2 (ppb)	TRS (ppb)	WSP (km/h)	WD	THC (ppm)	CH4 (ppm)	NMHC (ppm)	NMHC_max (ppm)
Reno	11/29/2017	08:16	08:00	0	0.39	7.2	SW	1.95	1.95	0	0
Reno	12/09/2017	16:20	16:00	0	0.36	9.4	WSW	1.93	1.93	0	0

Note:

n/a: Valid data is not available

***: Monitored Date is Reported Date plus 1 day due to conversion from DST to MST**