PRAMP 2015 - 2016

Annual Report

peace river area monitoring program

pramp

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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 second annual data review and compares 2015 and 2016 monitoring results; the first review, which compares 2014 and 2015 data is 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 2016; Figure 1). Operators in the Three Creeks area with Cold Heavy Oil Production with Sand (CHOPS) 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, the impacts on air quality at three monitoring locations are presented for review.

1.2. Meteorology

This report outlines data collected during 2015-2016 at three monitoring locations (Figure 1a). The measurements collected at the monitoring sites confirm that temporal and spatial meteorological variations occur in the Peace River Area.

- The wind directions have a systematic diurnal trend with west-southwesterly and southwesterly winds occurring during the day. During the night, more southerly and south-easterly winds occur.
- The wind speeds have a systematic trend with lower winds occurring during the night and increasing wind speeds during the day. From a spatial perspective, the following are noted:
    - The predominant wind direction at the 842 and Reno stations is from the southwest for the period of monitoring and at Station 986 is from the southeast.

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 the 842 and 986 stations since 2010 and at the Reno station since 2014. This is PRAMP's second annual report and data analysis was completed on the two most recent annual datasets.

Observations were made from data and trend analysis that will be discussed throughout the report. Three types of monitored data were analyzed for this report. Continuous sampling monitored Sulphur dioxide (SO_2), total reduced sulphur (TRS), total hydrocarbon (THC), methane (CH_4), non-methane hydrocarbons (NMHC) concentrations as well as meteorological parameters (wind speed, wind direction, temperature, pressure, and relative humidity) from the three continuous ambient air quality monitoring stations in the region.

Triggered samples were collected when the NMHC concentration reached a threshold of 0.3 parts per million by volume (ppmv) averaged over 5 minutes. In total, 14 and 12 triggered events were sampled using canisters and analyzed in 2015 and 2016 respectively for over 140 volatile organic compounds (VOC). In 2016, 12 canister events were triggered in 2016, but only 11 samples were collected for analyses; one event was missed by the operator and the sample was discarded. AER complaints were collected and analyzed for the correlations to monitored data.

The methods used to analyze the monitored 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 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:

- 14 and 12 triggered events were sampled using canisters and analyzed in 2015 and 2016 respectively for over 140 volatile organic compounds (VOC). In 2016, 12 canister events were triggered in 2016, but only 11 samples were collected for analyses; one event was missed by the operator and the sample was discarded. 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 2015 and 2016. Observations of increased THC concentrations at Stations 986 toward the end of 2015 may be due to brush burning activities happening near the monitoring stations. 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 among the lowest in the Province. The 99th percentile decreased at the Reno Station between 2015 and 2016 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 particularly when the full record of monitoring is considered. This pattern of improvement is particularly evident when examining data from the beginning of monitoring record at Station 986 and 842; further investigation of data collected at the Reno station is required to determine potential causes for elevated concentrations relative to the two other stations in the PRAMP network.

1.4. Complaints

Complaints filed with the AER are presented in a timeline with THC and NMHC concentrations (continuous), and canister-triggered events. AER complaints were collected and analyzed as follows:

- Station 842 showed a decrease in the number of complaints from 39 in 2015 to 15 in 2016
- Station 986 showed a decrease in the number of complaints from 6 in 2015 to 4 in 2016
- Reno Station showed a decrease in the number of complaints from 11 in 2015 to 2 in 2016

The number of complaints decreased from 2015 to 2016 for the Peace River Area. Complaints were correlated to monitored concentrations with wind direction and speed taken into consideration.

2. BACKGROUND

The Peace River Area is defined as the Three Creeks, Reno, Seal Lake, and Walrus areas (Figure 1a). 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 2015). 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 2015). 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 2015)
- 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 emission and odours in the area (PRAMP 2017)

A review and analysis of the 2015 - 2016 annual air monitoring data collected by PRAMP is included in this report. The data includes the continuous monitoring of the 1-hour averaged TRS, CH_4, NMHC, THC, and SO_2 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 monitorin 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 contribution of nearby sources to the monitoring data. The heavy oil facilities in the area, operated by Baytex Energy Ltd., Murphy Oil Company Ltd., Penn West Petroleum Ltd., and Shell Canada Ltd. are selectively shown on Figures 2 through 5.

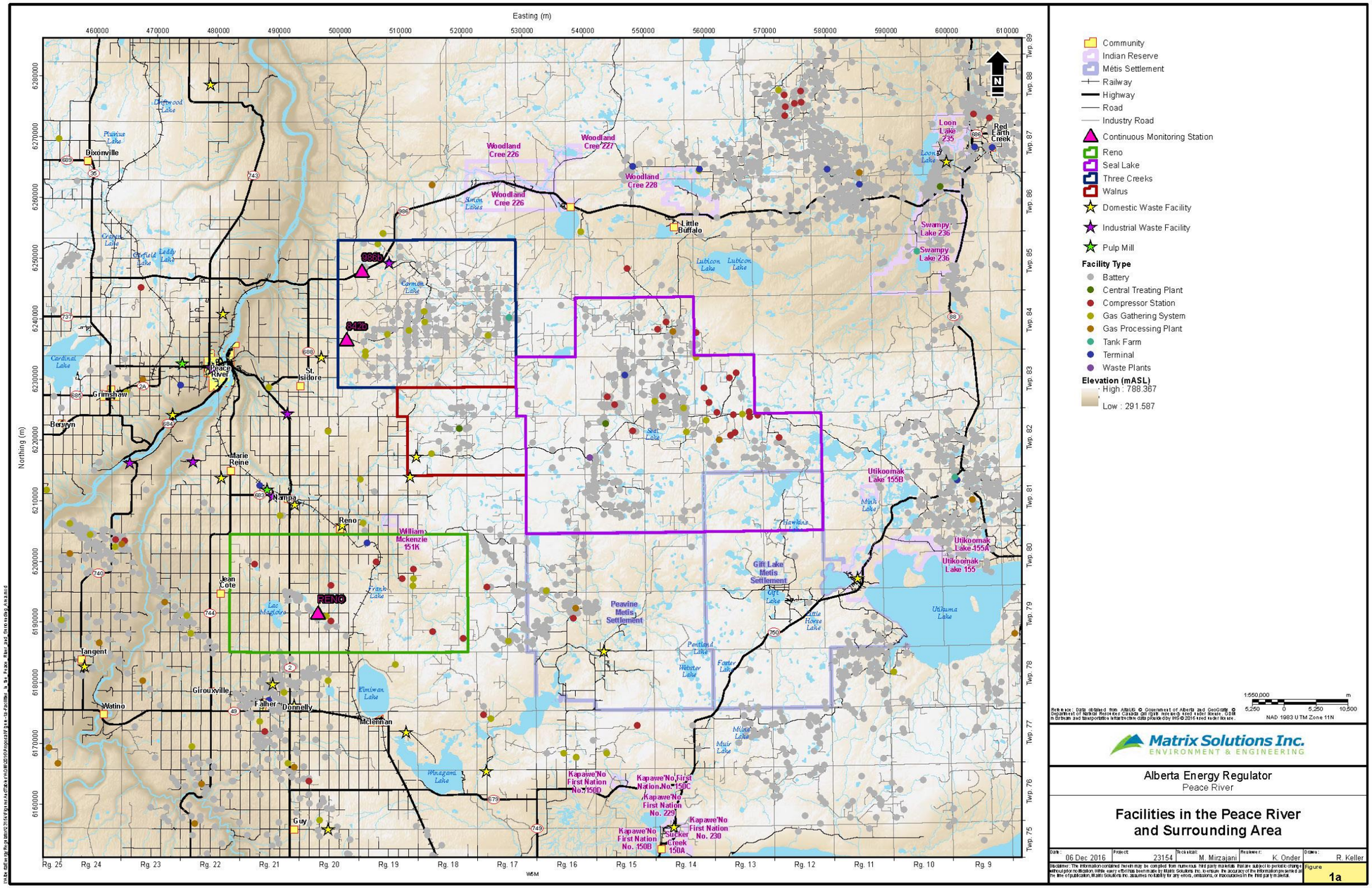


Figure 1: Facilities in the Peace River and Surrounding Area

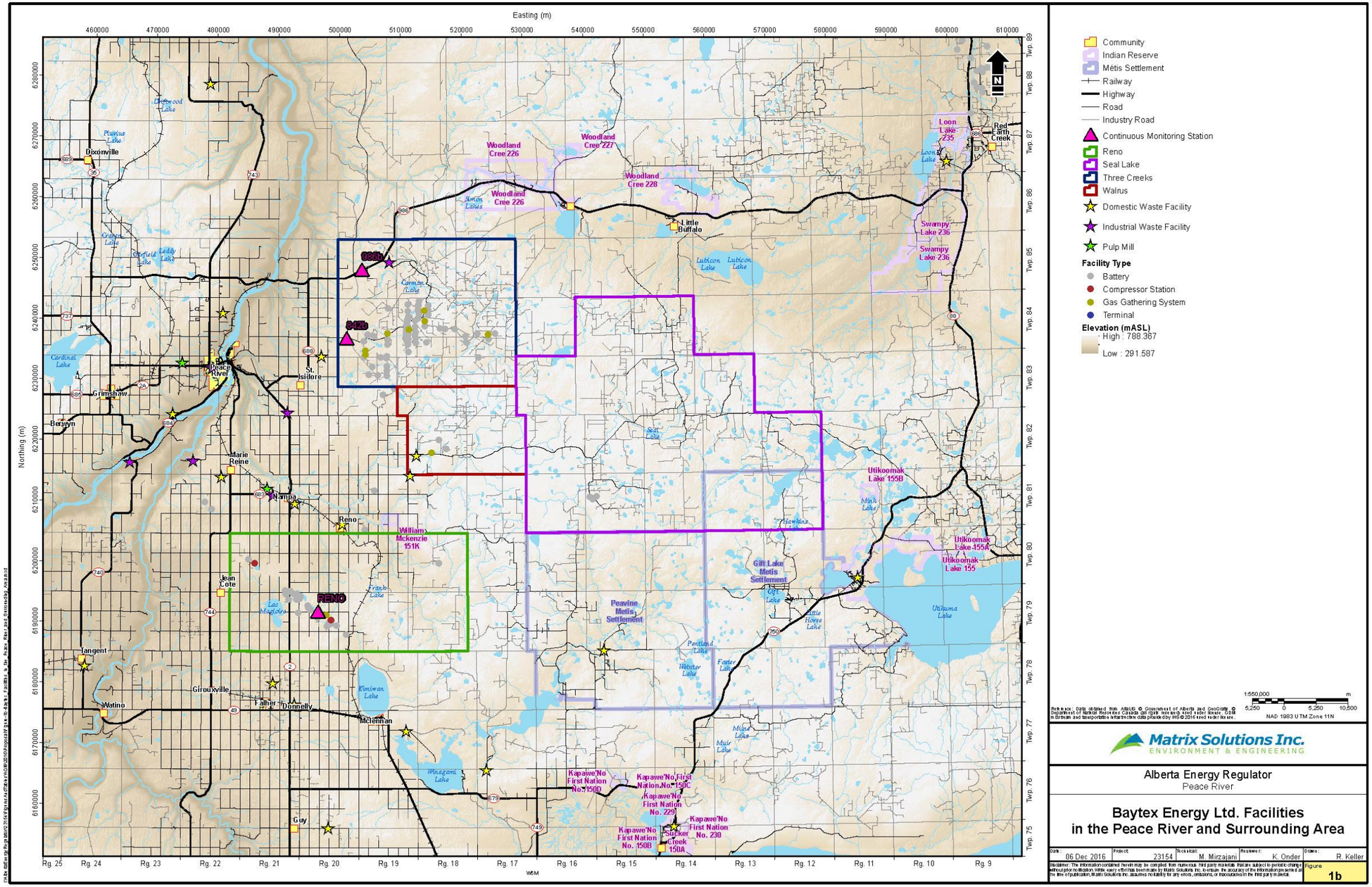


Figure 2: Baytex Energy Ltd. Facilities in the Peace River and Surrounding Area

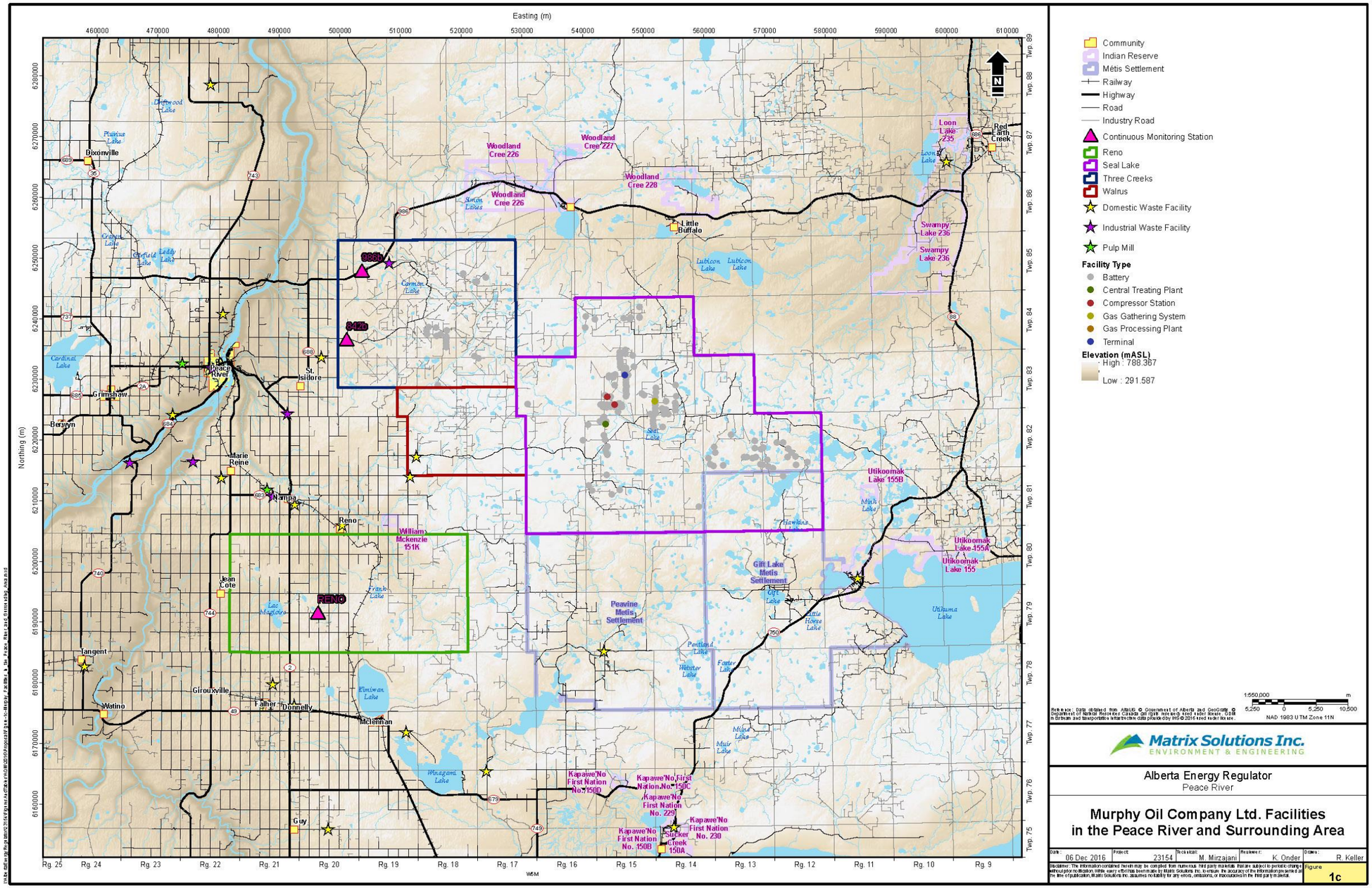


Figure 3: Murphy Oil Company Ltd. Facilities in the Peace River and Surrounding Area

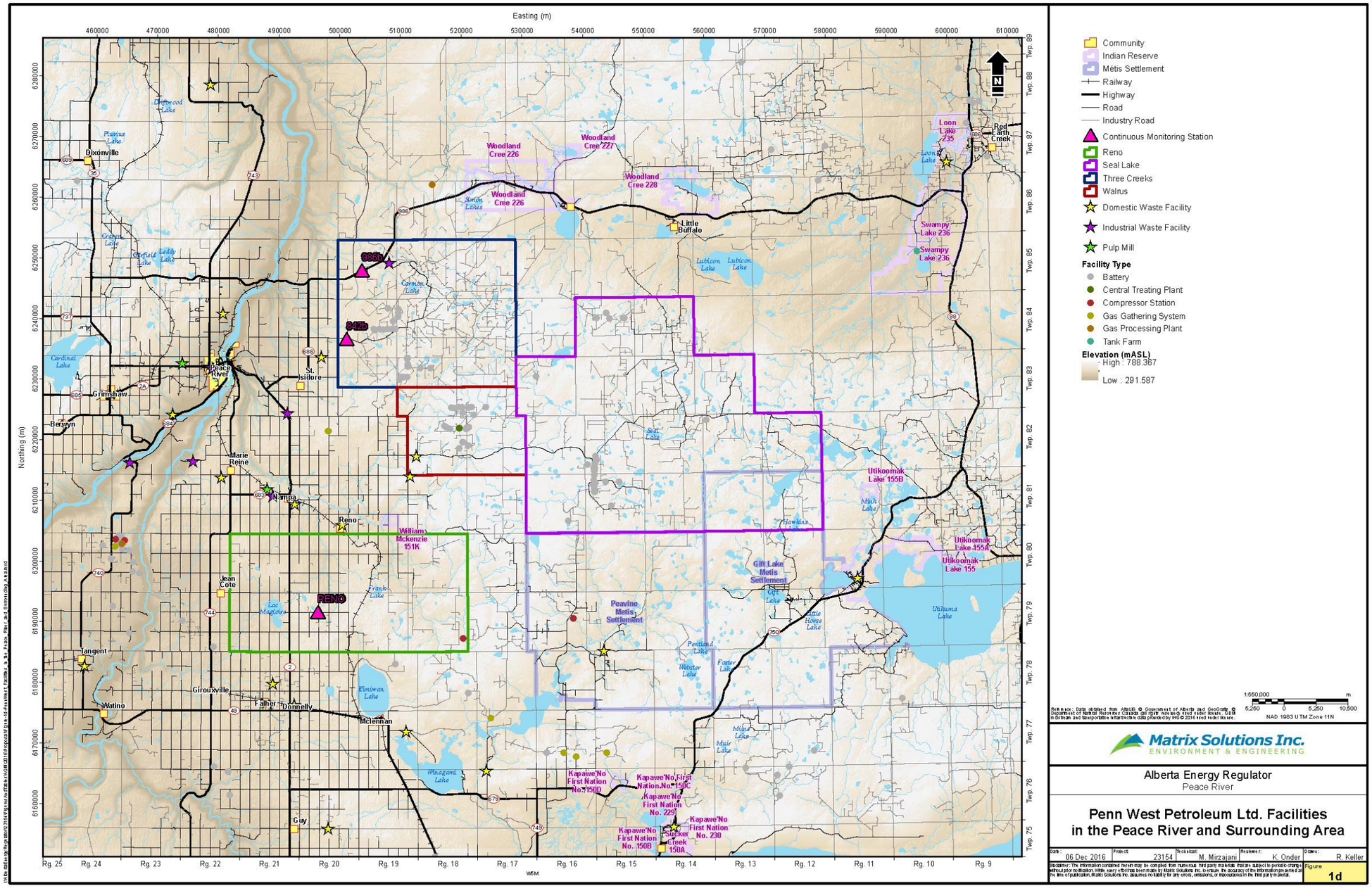


Figure 4: Penn West Petroleum Ltd. Facilities in the Peace River and Surrounding Area

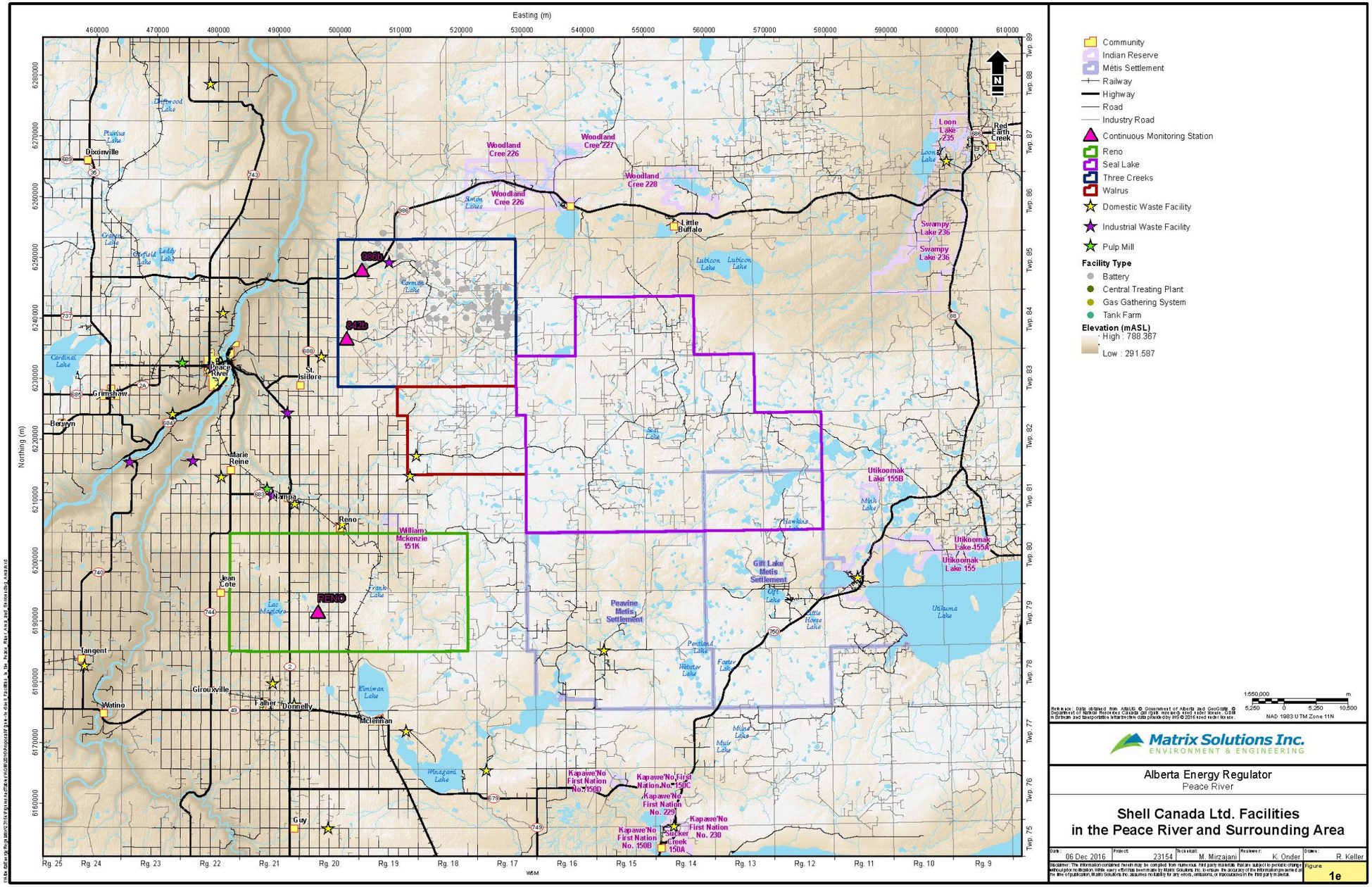


Figure 5: Shell Canada Ltd. Facilities in the Peace River and Surrounding Area

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 by the laboratory in charge, to understand the distribution of the data.

Individual 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.

PRAMPs objectives include the comparison of monitored data to toxic thresholds (PRAMP 2015). The provincial government developed the Alberta Ambient Air Quality Objectives and Guidelines Summary (AAAQO; AEP 2016) 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 100th (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

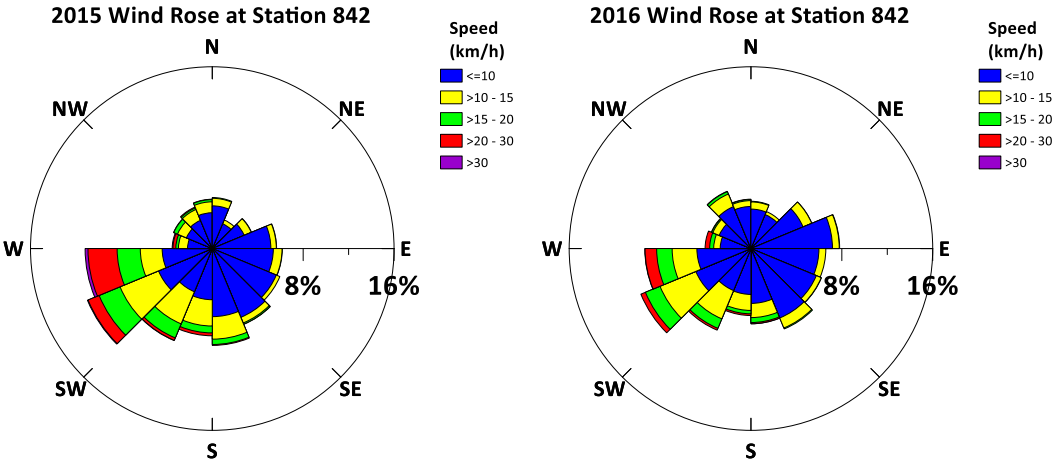
This data and statistical analysis has been presented with interpretation in Sections 3.2 to 3.5. An annual audit was completed by Alberta Environment and Parks of the three monitoring stations and the audits are available in Appendix A.

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 2015 and 2016. More than 73% 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 2015 and 2016. Approximately 91% 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. Approximately 89% of hours annually were below 10 km/hour.



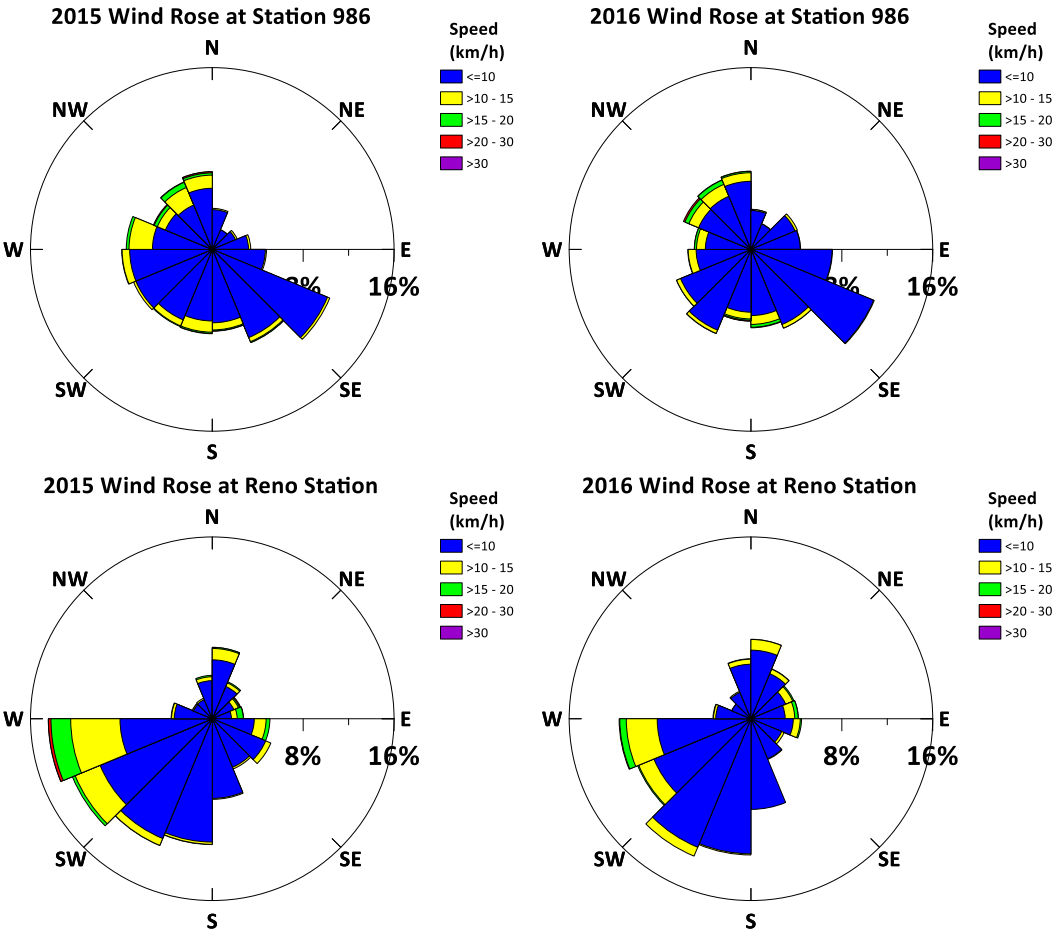


Figure 6: Wind Roses at Stations 842, 986 and Reno

3.3. Hourly Concentration Data

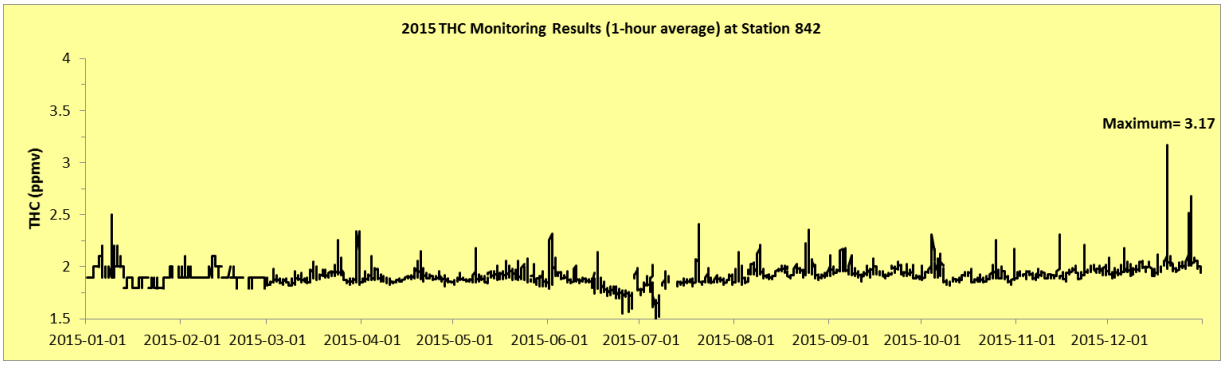
Hourly concentration data is presented to show all concentration data collected at the three stations for each year. Hourly concentrations are presented for total hydrocarbon (THC), non-methane hydrocarbons (NMHC), total reduced sulphur (TRS), sulphur dioxide (SO_2) and methane (CH_4) in this section. 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).

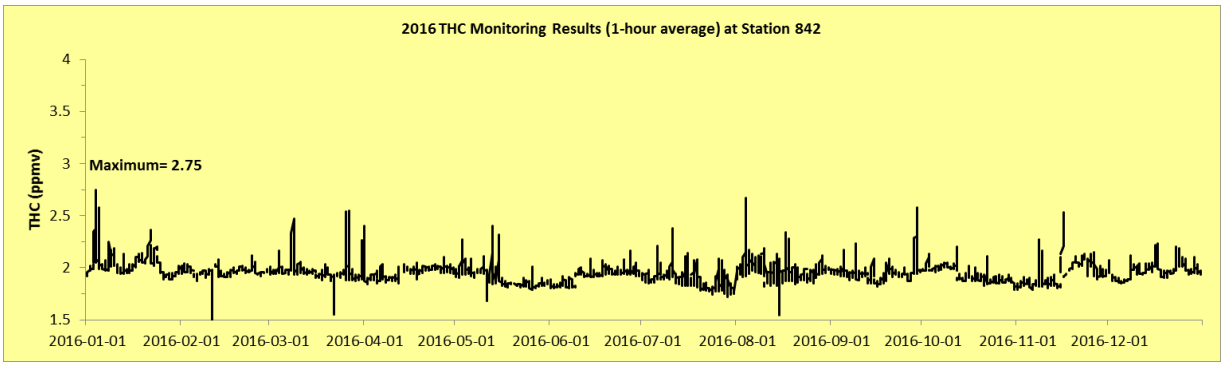
TRS compounds include hydrogen sulphide, carbonyl sulphide, carbon disulphide, and other hydrocarbon-sulphur compounds such as mercaptans and thiophenes. Some TRS compounds may have a strong offensive odour at concentrations below 1 ppbv. There are natural sources of TRS but they can also be emitted 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 3).

The maximum hourly THC data for both Station 842 and Reno Station are incrementally higher in 2016 than they were in 2015; the maximum hourly THC concentration at Station 986 was lower in 2016 than in 2015. The elevated THC concentrations, observed from October to November 2015, may be due to brush burning activities occurring south of the Reno Station monitoring trailer. There may also be sources south and southwest of the station (outside of the PRAMP area) influencing elevated measurements at this site given the proximity of the station to the boundary of study area and the density of oil and gas activity just beyond the boundary. A significant producer in the Reno area shut down operations in early 2016 and resumed production by that summer. It is not known if the break in operations included other producers in the area.





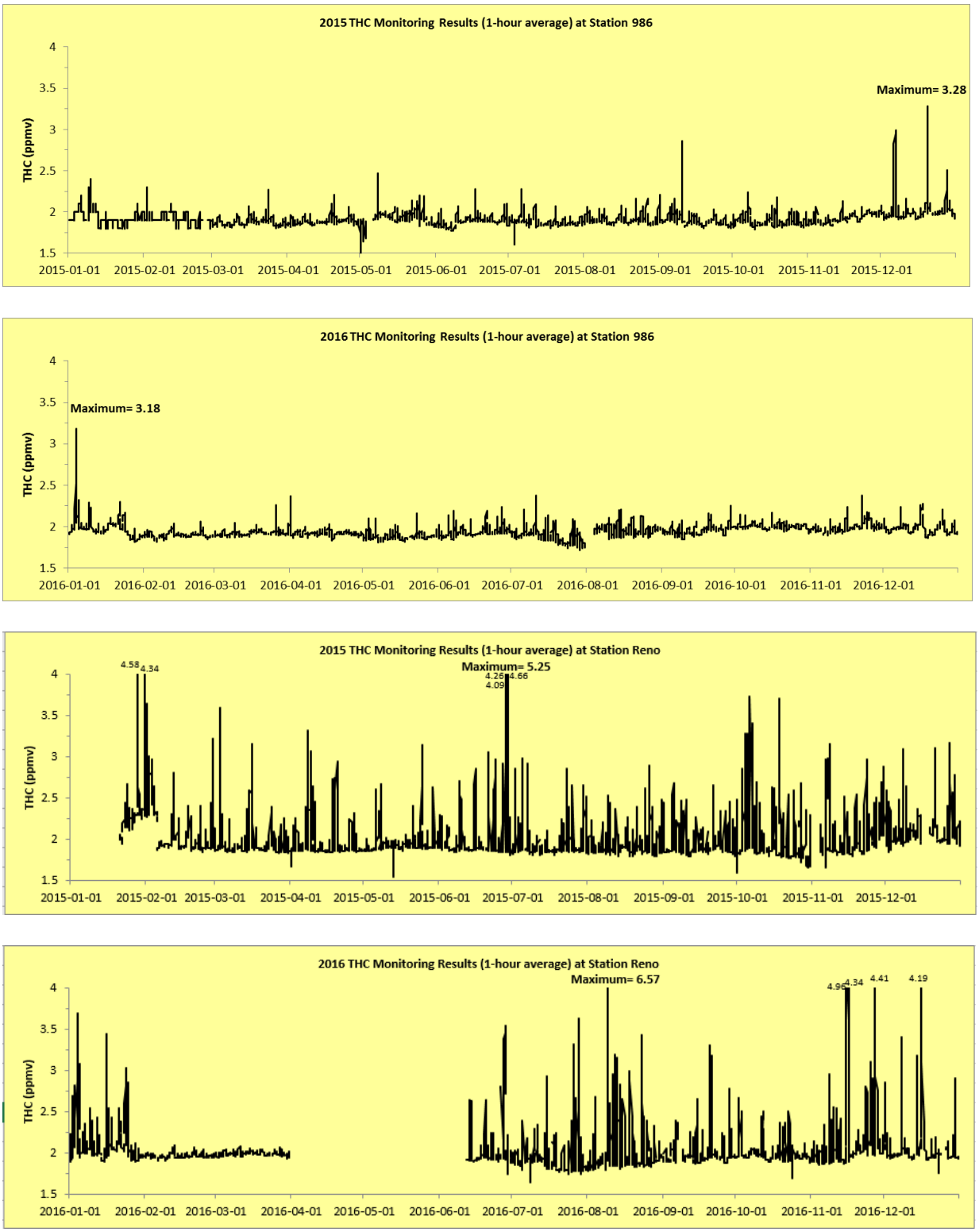


Figure 7: Hourly Monitored Total Hydrocarbons Data

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.

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 2015-2016. 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.

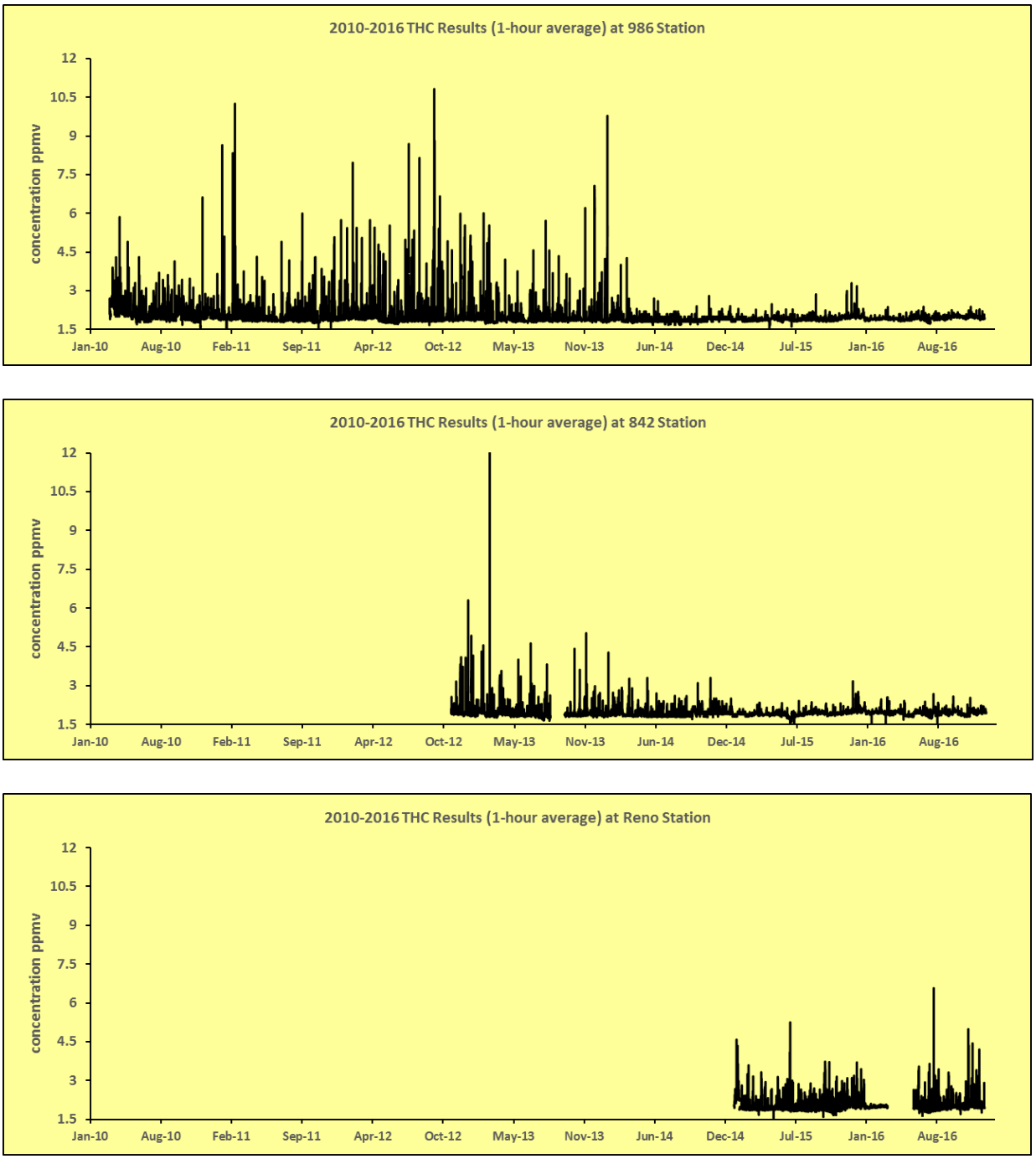
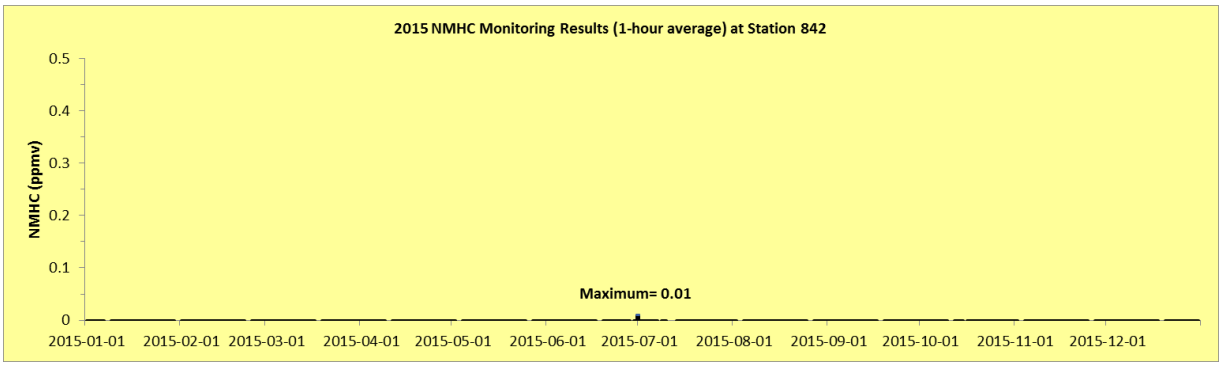


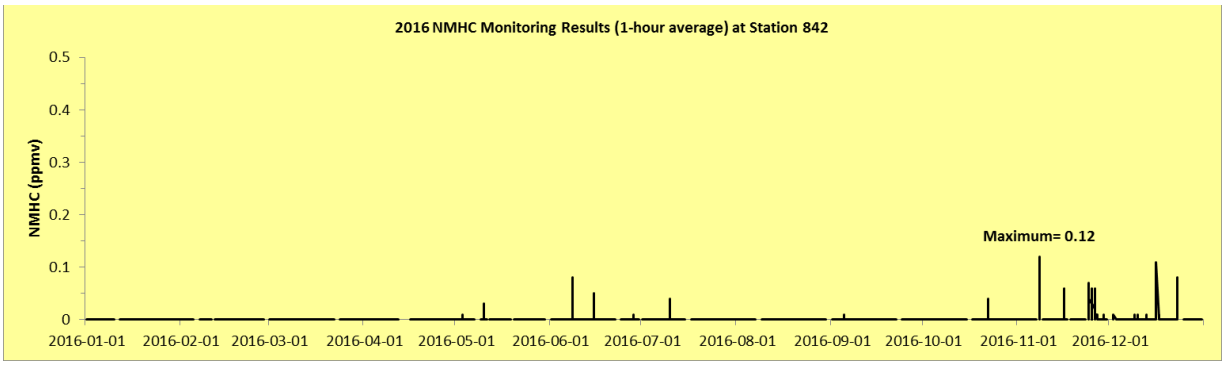
Figure 8: Hourly Monitored Total Hydrocarbon Data from 2010-2016

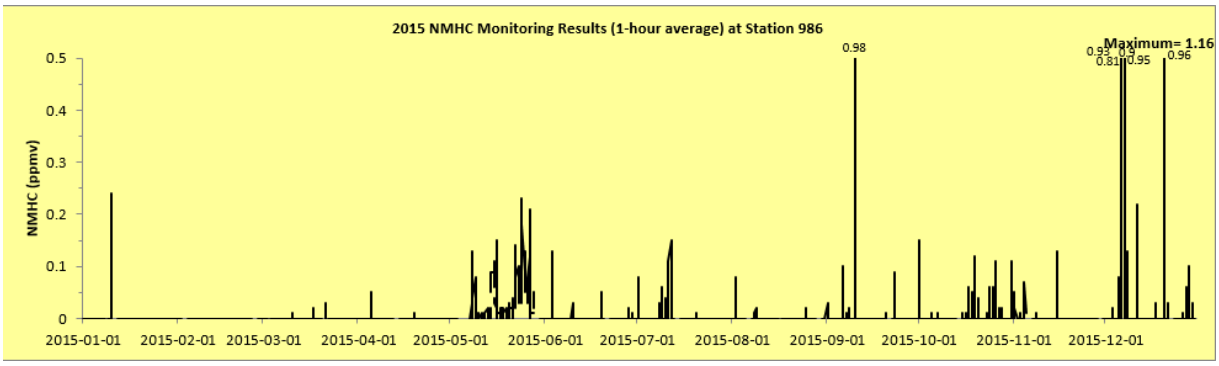
3.3.2. Non-methane Hydrocarbons

Hourly NMHC data NMHC for the three stations is shown in the charts below (Figure 4). There is no AAAQO for NMHC.

The maximum hourly NMHC data for Station 842 increased incrementally from 2015 to 2016. In 2015 all the data reported at Station 842 were zero except for four occurrences of 0.01 ppmv. The maximum hourly NMHC concentration for Station 986 decreased between 2015 to 2016 from 1.16 ppmv to 0.32 ppmv and overall shows a lower frequency of occurrences of elevated measurements of NMHC. The Reno Station recorded maximum NMHC concentrations of up to 0.35 ppmv in 2015 and 0.23 ppbv in 2016; overall, the magnitude and frequency of elevated NHMC events decreased in 2016 compared to 2015.







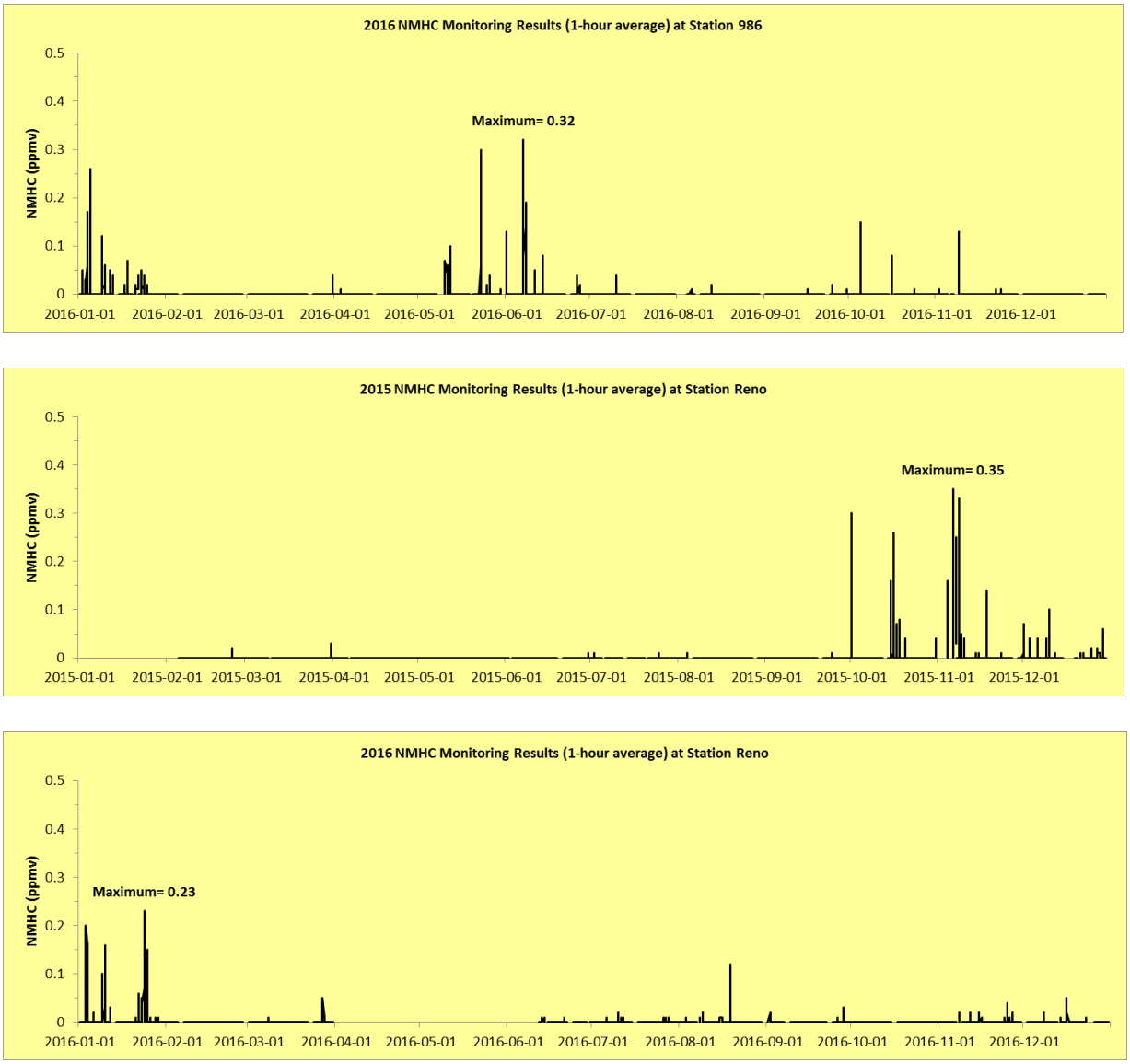
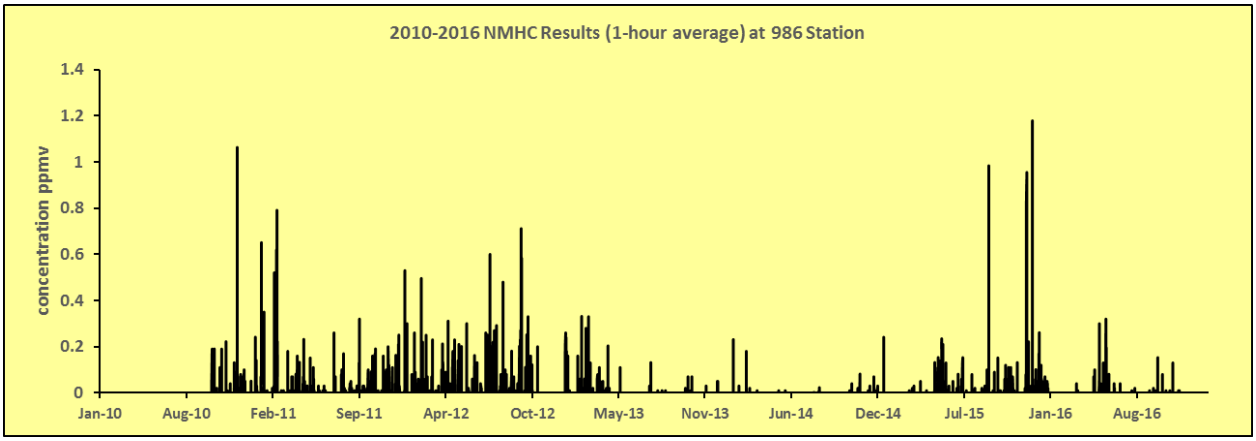
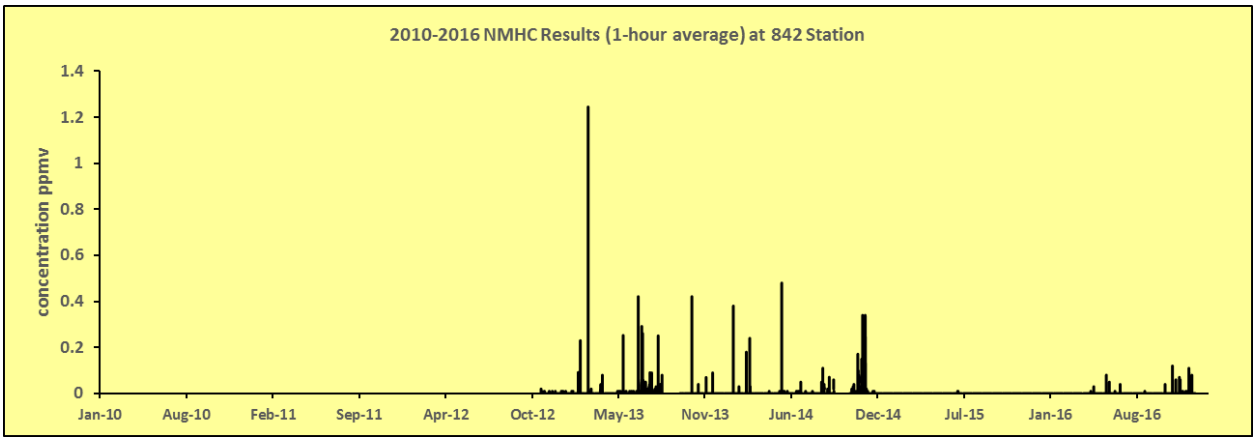


Figure 9: Hourly Monitored Non-methane Hydrocarbons Data

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.





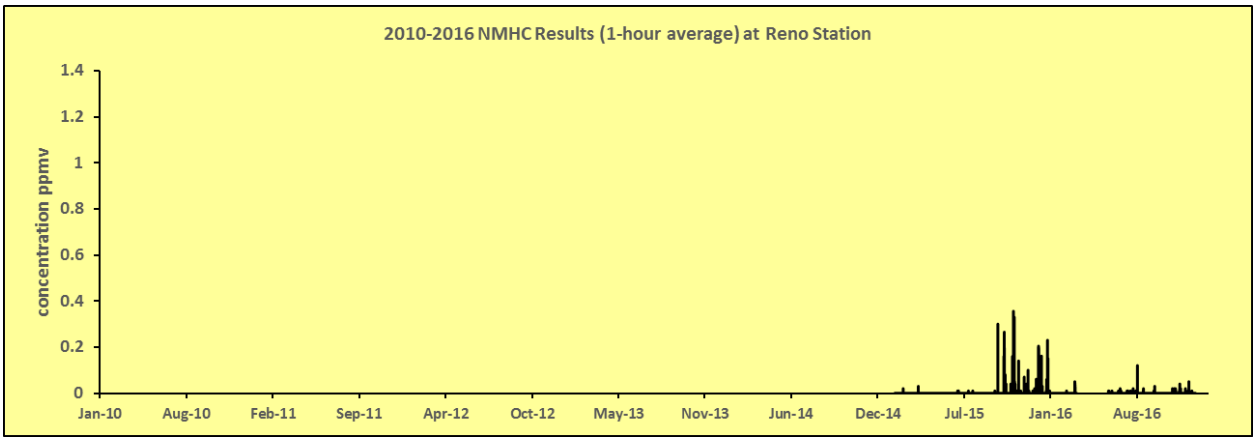
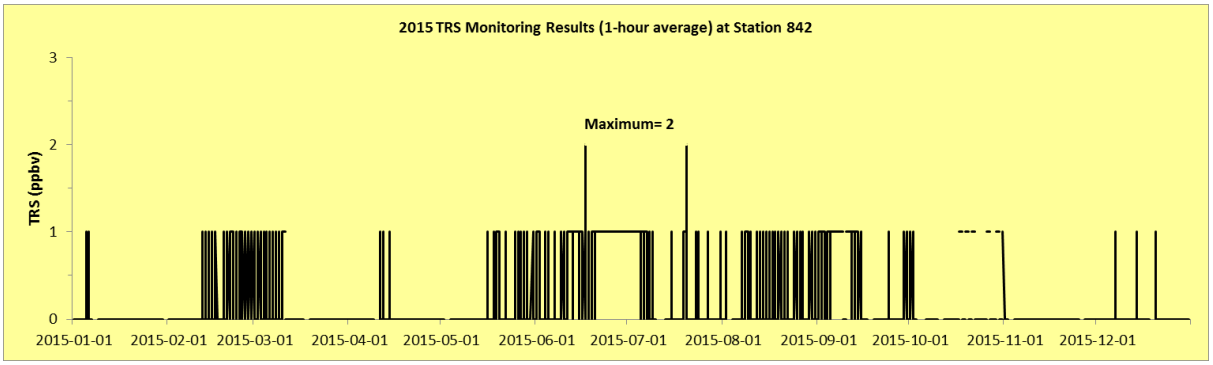


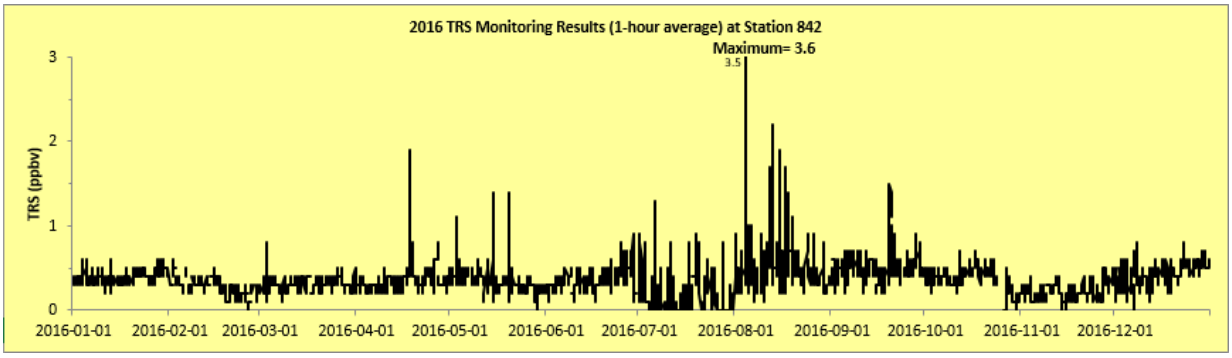
Figure 10: Hourly Monitored Non-Methane Hydrocarbons from 2010-2016

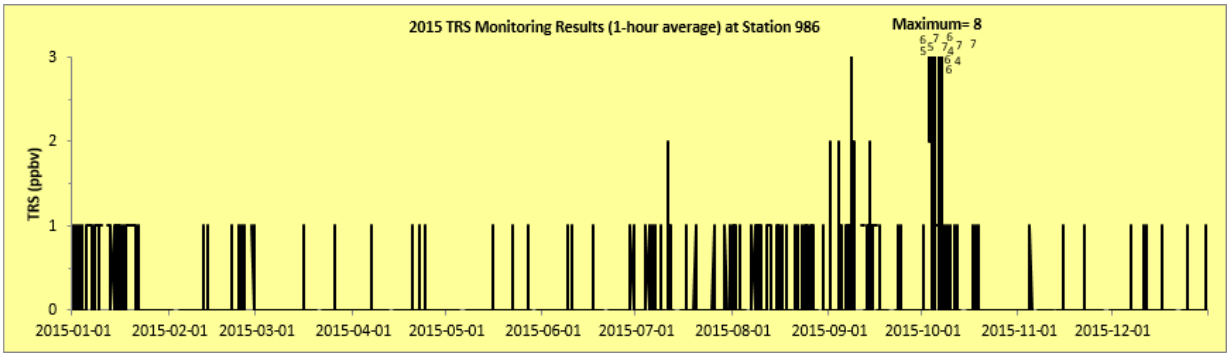
3.3.3. Total Reduced Sulphur

Hourly data for TRS for the three stations is shown in the charts below (Figure 5). 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 increase in the maximum hourly TRS concentration from 2015 to 2016 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 other may also include agriculture and natural sources such as shallow lakes and sloughs.







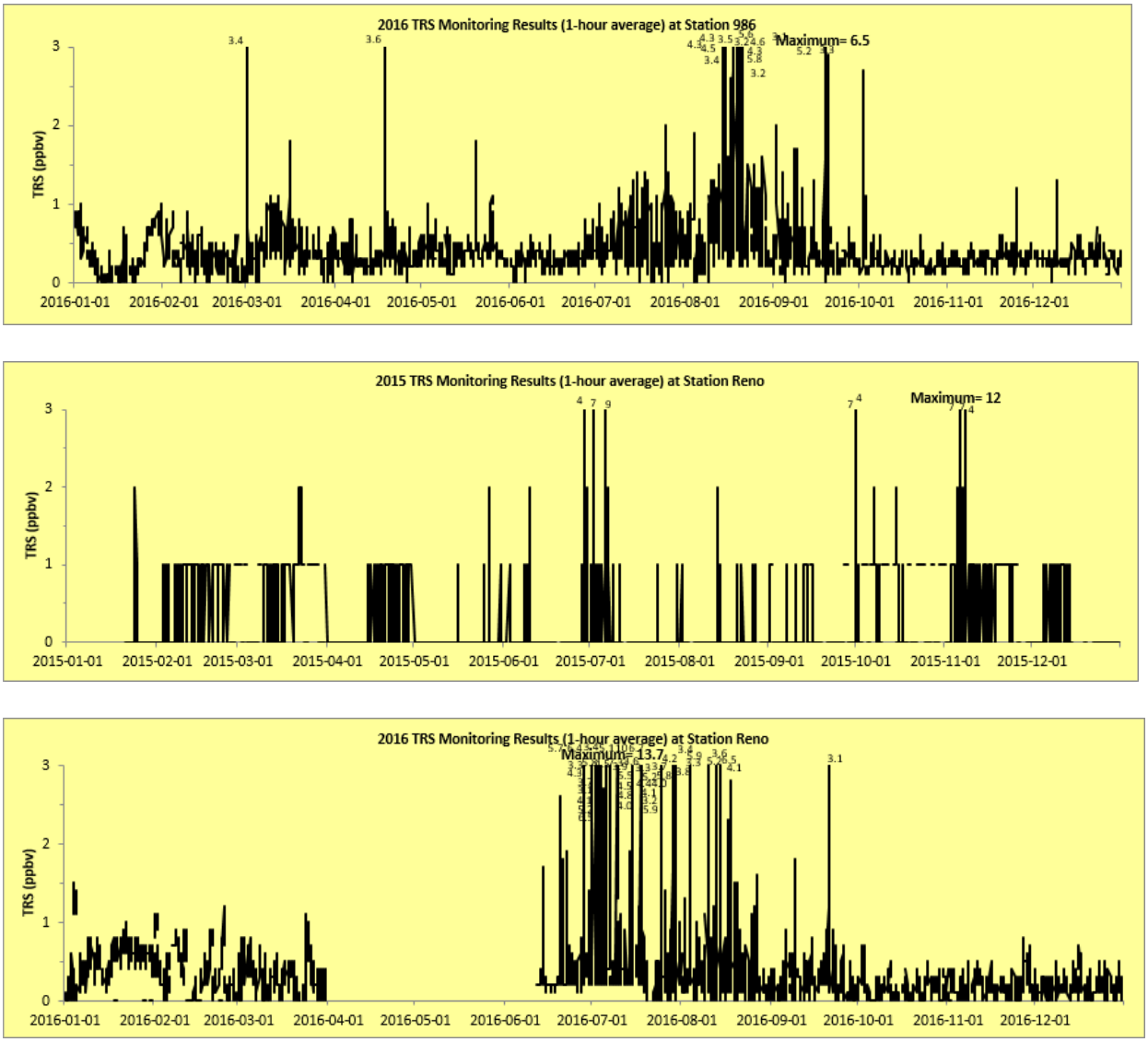


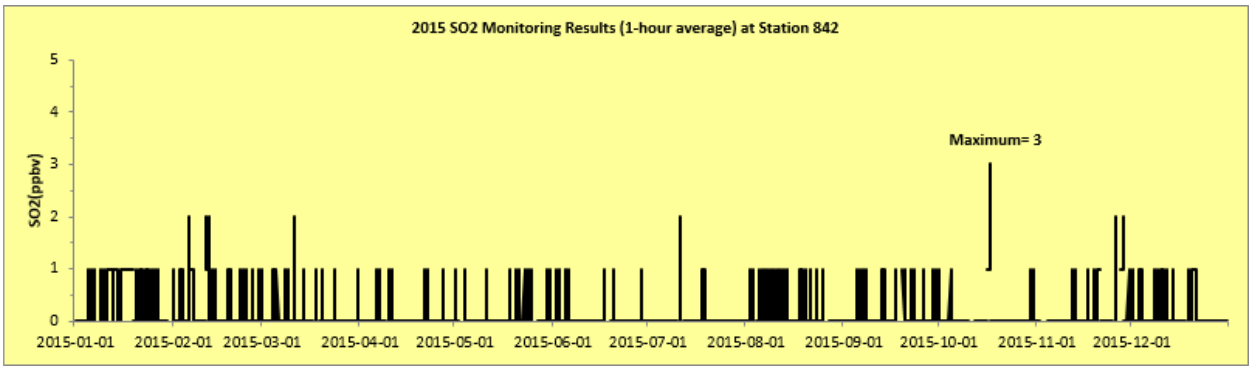
Figure 11 Hourly Monitored Total Reduced Sulphur Data

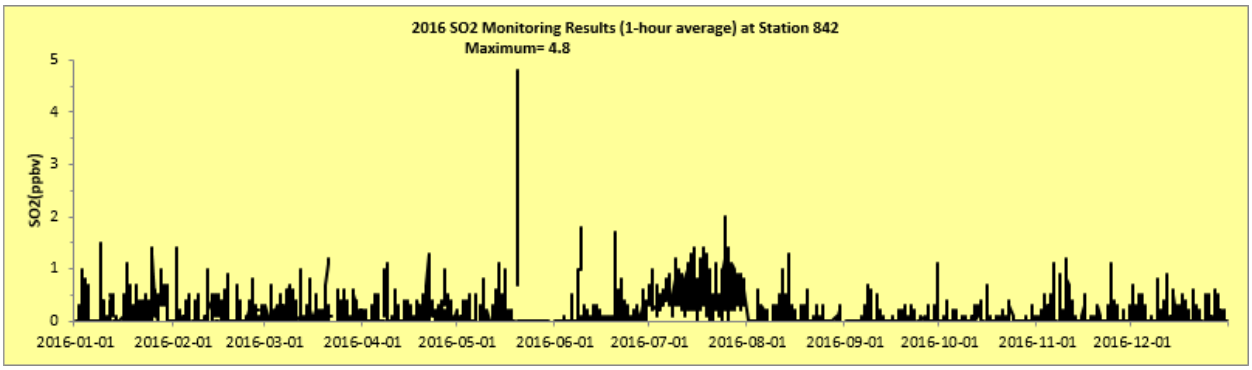
3.3.4. Sulphur Dioxide

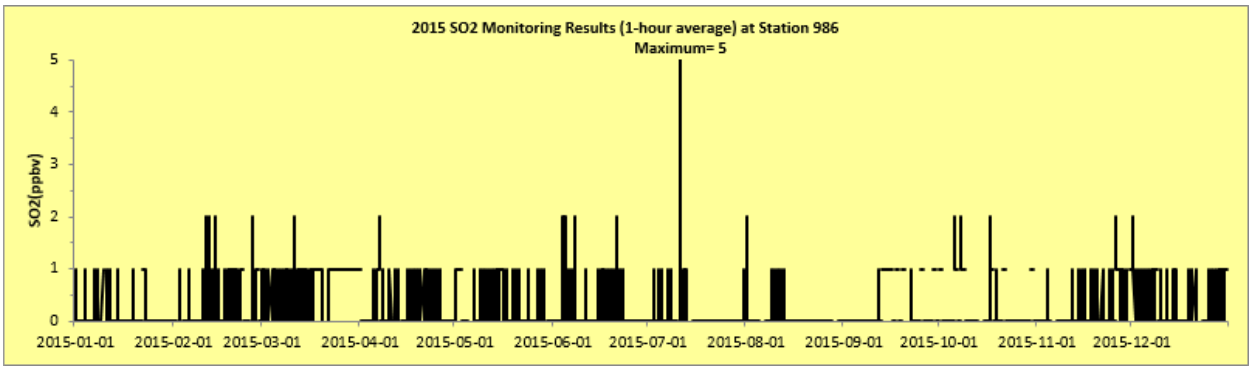
Hourly data for SO_2 for the three stations is shown in the charts below (Figure 6). The AAAQO for SO_2 is 172 ppbv.

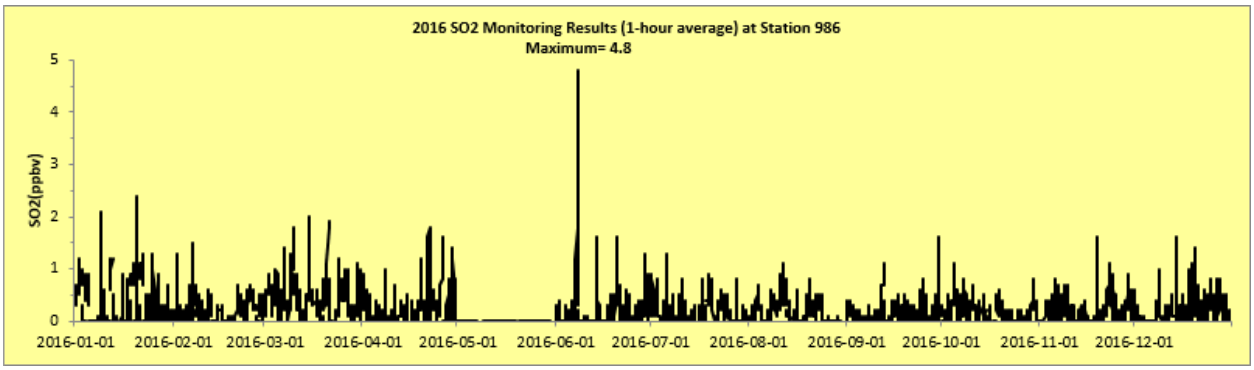
The maximum hourly SO_2 data for Station 842 increased from 2015 to 2016. The maximum hourly SO_2 data for Station 986 decreased from 2015 to 2016. At this station, the maximum 1-hour average SO_2 is similar to Station 842. Overall, it is difficult to comment on the relative change in the year-over-year frequency of elevated measurements at the Reno Station and Stations 986 and 842 because the measurement technology changed in 2016 to one that has a higher

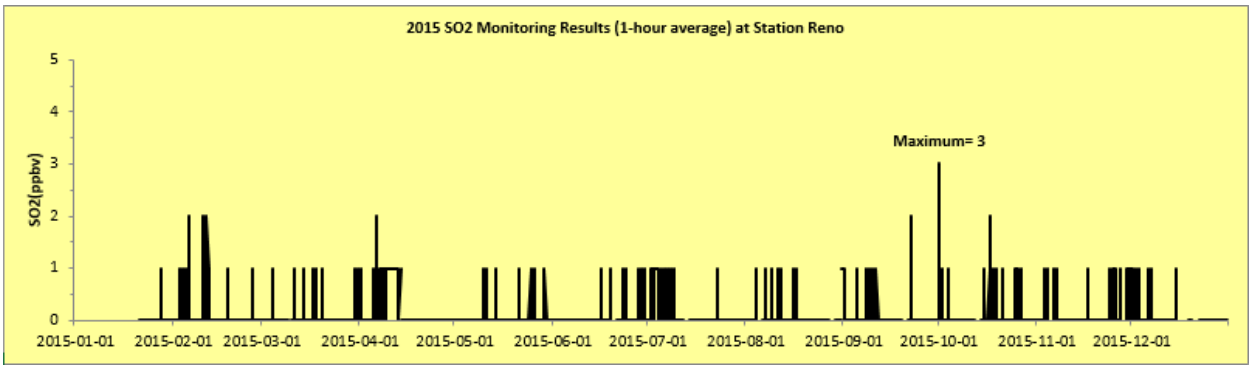
resolution. It should be noted that the elevated SO_2 concentrations at all stations and years are far below the Alberta Ambient Air Quality Objective (AAAQO) (AEP 2017).











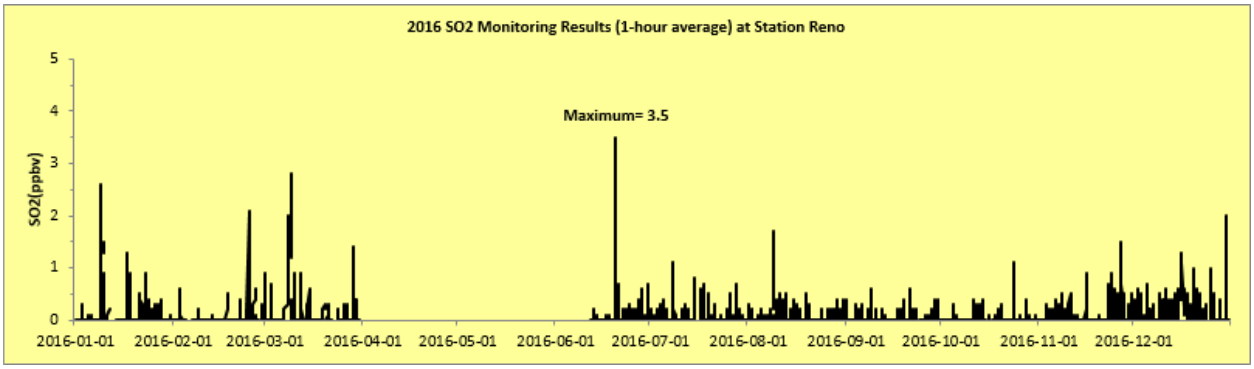
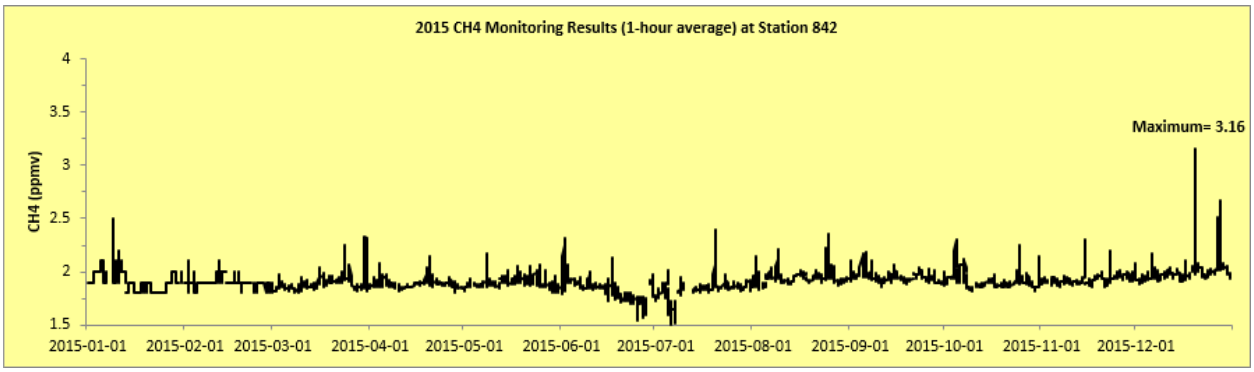


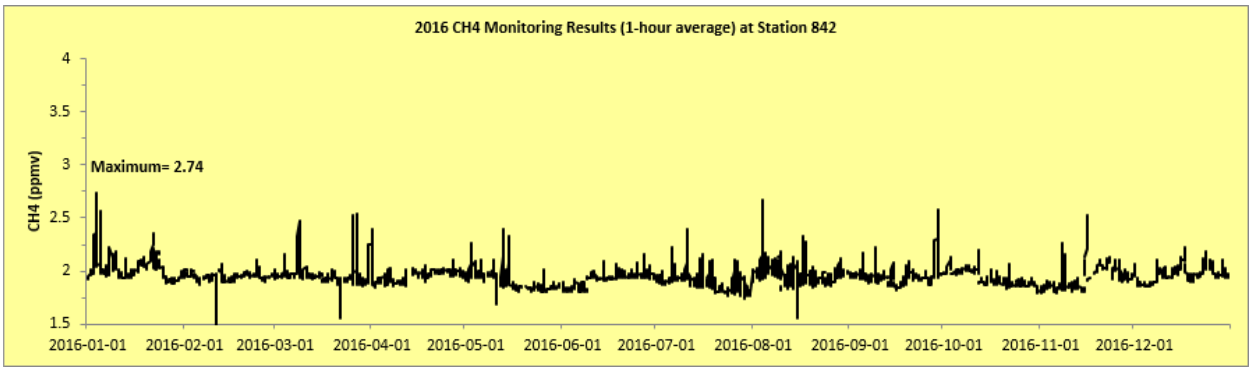
Figure 12: Hourly Monitored Sulphur Dioxide Data

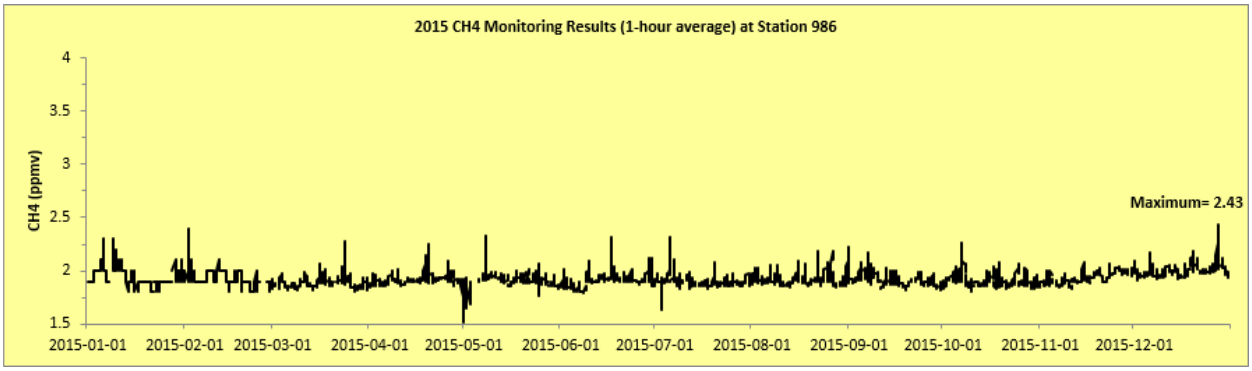
3.3.5. Methane

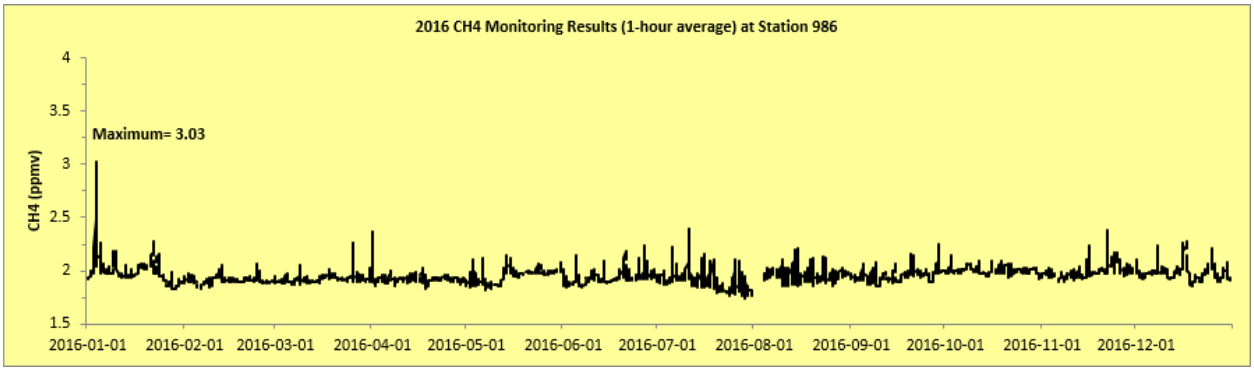
Hourly data for CH_4 for the three stations is shown in the charts below (Figure 11). There is no AAAQO for CH_4.

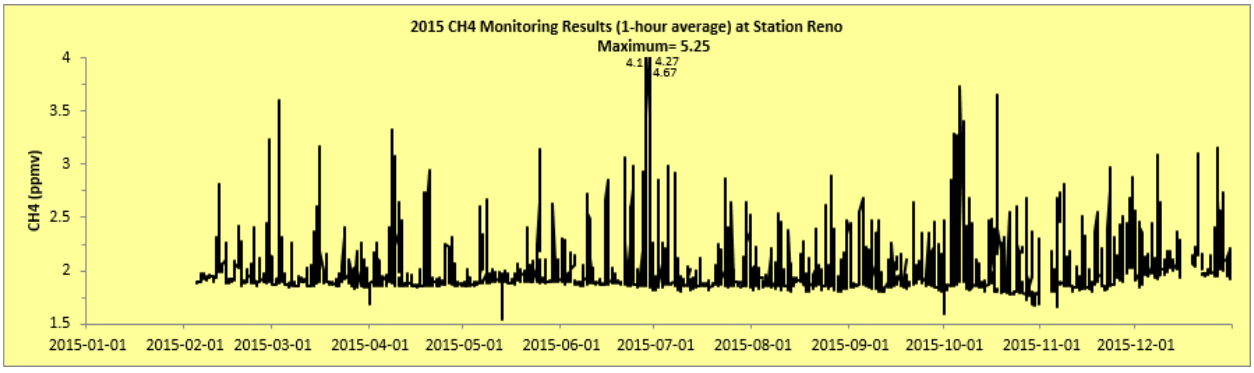
The maximum hourly CH_4 data for Station 842 decreased from 2015 to 2016. The maximum hourly CH_4 data for Station 986 increased slightly from 2015 to 2016. Reno station shows the highest frequency of occurrence of elevated measurements of CH_4 for both 2015 and 2016.




2016 CH4 Monitoring Results (1-hour average) at Station 842
CH4 (ppmv)
Maximum= 2.74
4
3.5
3
2.5
2
1.5
2016-01-01
2016-02-01
2016-03-01
2016-04-01
2016-05-01
2016-06-01
2016-07-01
2016-08-01
2016-09-01
2016-10-01
2016-11-01
2016-12-01


2015 CH4 Monitoring Results (1-hour average) at Station 986
CH4 (ppmv)
Maximum= 2.43
4
3.5
3
2.5
2
1.5
2015-01-01
2015-02-01
2015-03-01
2015-04-01
2015-05-01
2015-06-01
2015-07-01
2015-08-01
2015-09-01
2015-10-01
2015-11-01
2015-12-01


2016 CH4 Monitoring Results (1-hour average) at Station 986
CH4 (ppmv)
Maximum= 3.03
4
3.5
3
2.5
2
1.5
2016-01-01
2016-02-01
2016-03-01
2016-04-01
2016-05-01
2016-06-01
2016-07-01
2016-08-01
2016-09-01
2016-10-01
2016-11-01
2016-12-01


2015 CH4 Monitoring Results (1-hour average) at Station Reno
Maximum= 5.25
4.1
4.27
4.67
CH4 (ppmv)
4
3.5
3
2.5
2
1.5
2015-01-01
2015-02-01
2015-03-01
2015-04-01
2015-05-01
2015-06-01
2015-07-01
2015-08-01
2015-09-01
2015-10-01
2015-11-01
2015-12-01

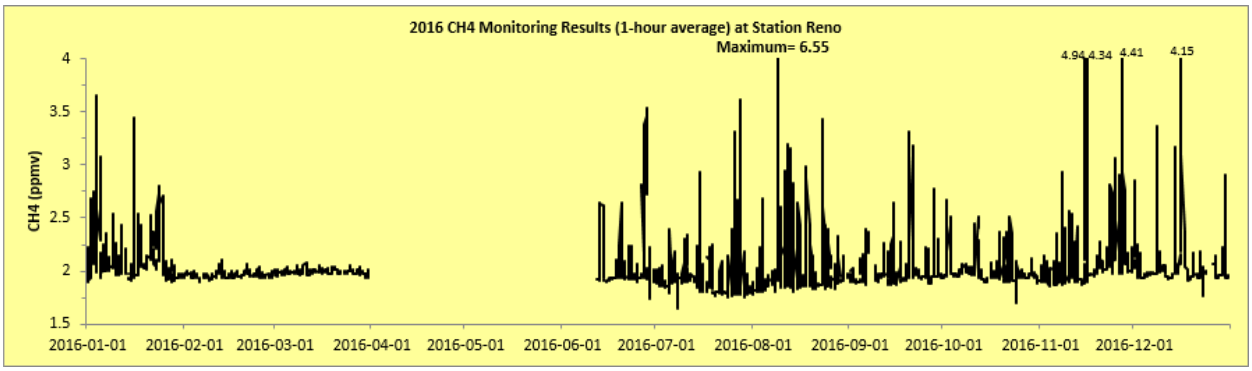


Figure 13: Hourly Monitored Methane Data

3.4. Monthly Data Analysis

The hourly data presented in Section 3.3 was 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 2015 to December 2016 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 (2015 and 2016)

Station	2015		2016	
	Minimum (ppmv)	Maximum (ppmv)	Minimum (ppmv)	Maximum (ppmv)
842	2.05	2.52	2.06	2.45
986	2.06	2.51	2.02	2.56
Reno	2.40	3.49	2.05	3.34

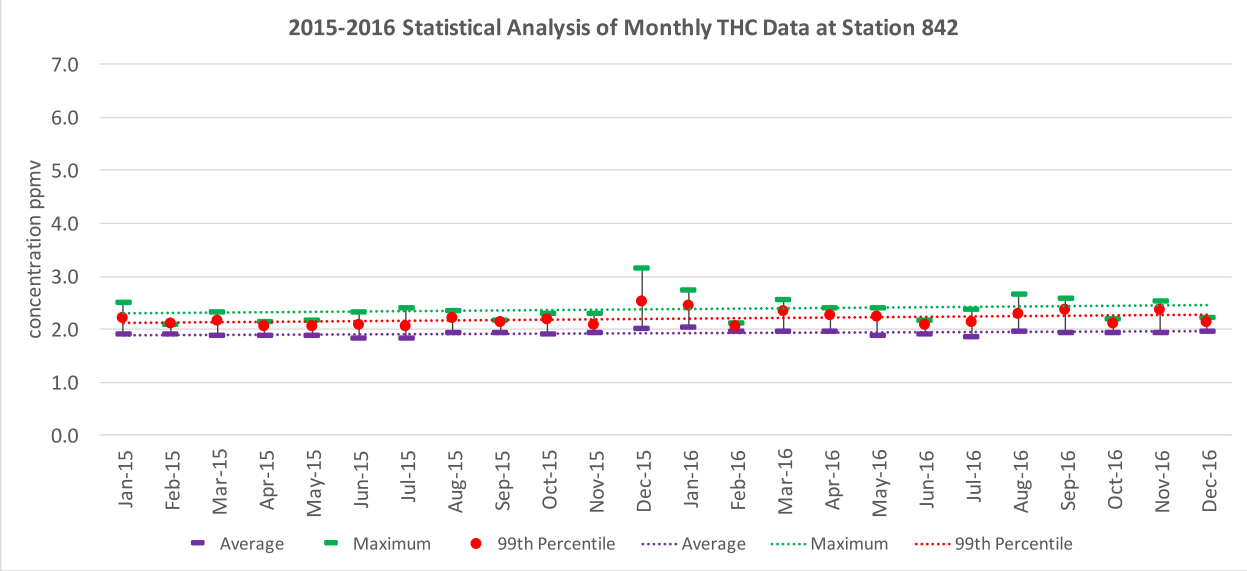


Figure 14: Total Hydrocarbons Data and Trends at Station 842

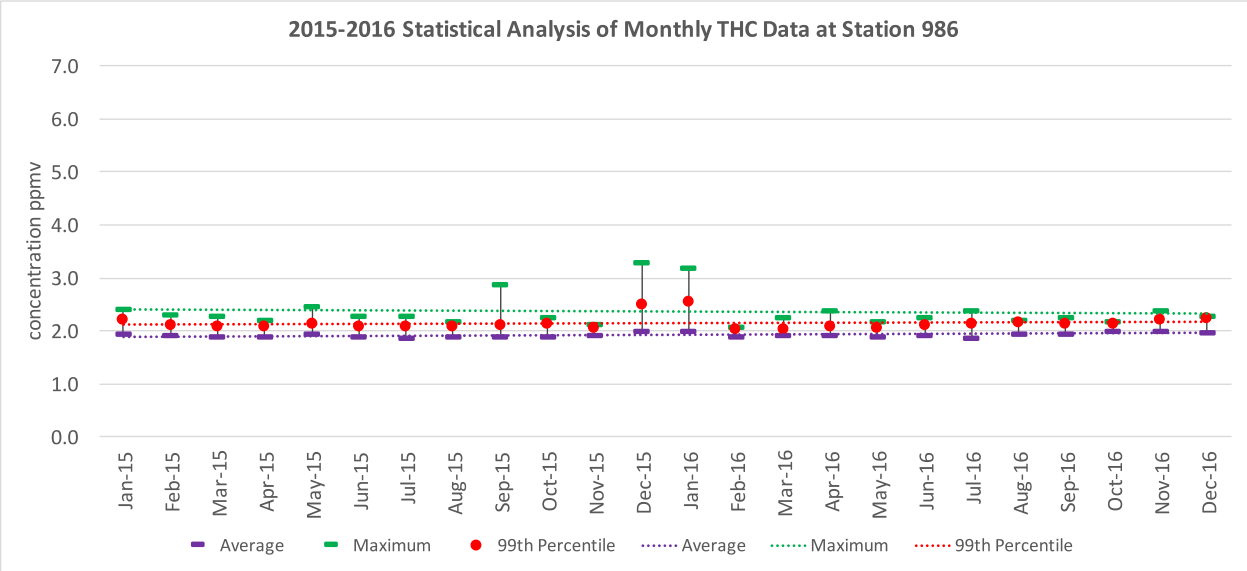


Figure 15: Total Hydrocarbons Data and Trends at Station 896

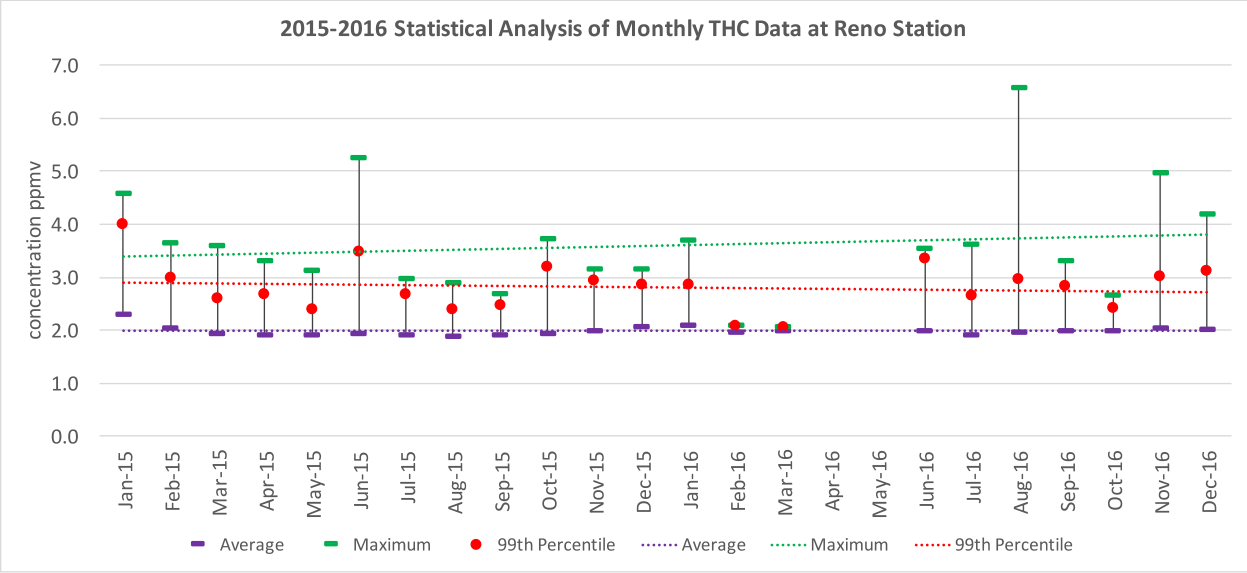


Figure 16: Total Hydrocarbons Data and Trends at Reno Station

3.4.2. 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.

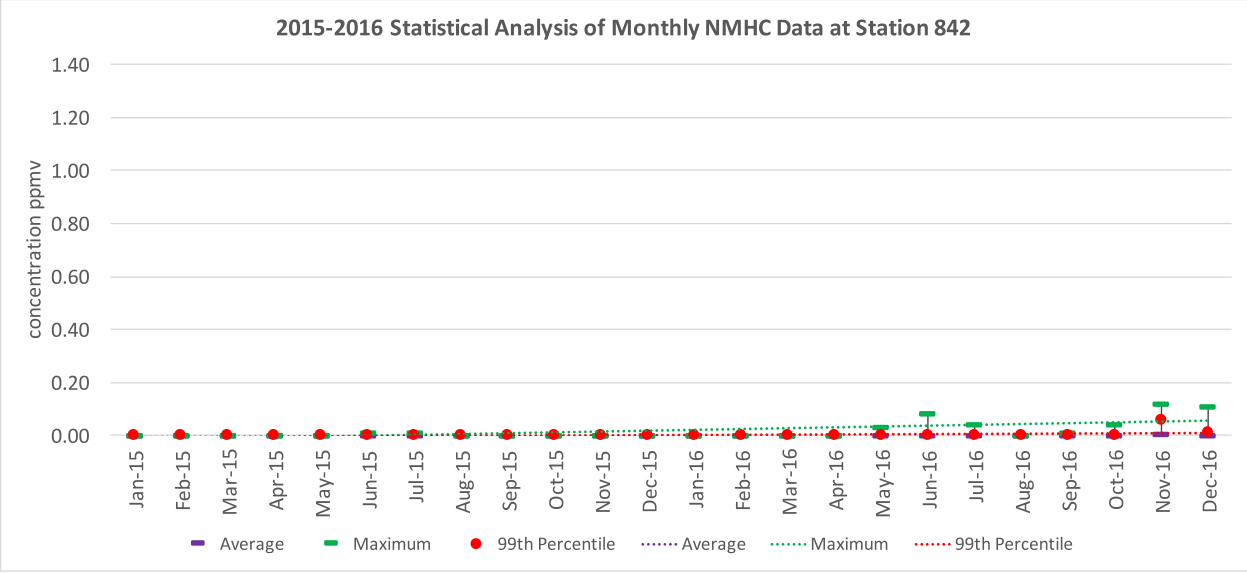


Figure 17: Non-methane Hydrocarbon Data and Trends at Station 842

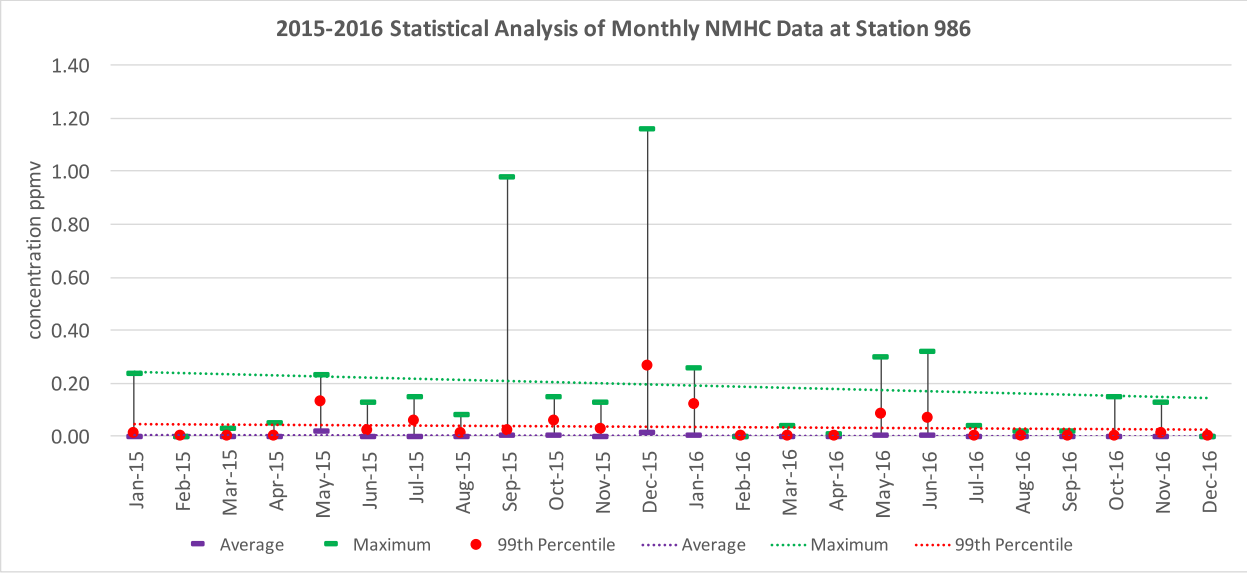


Figure 18: Non-methane Hydrocarbon Data and Trends at Station 986

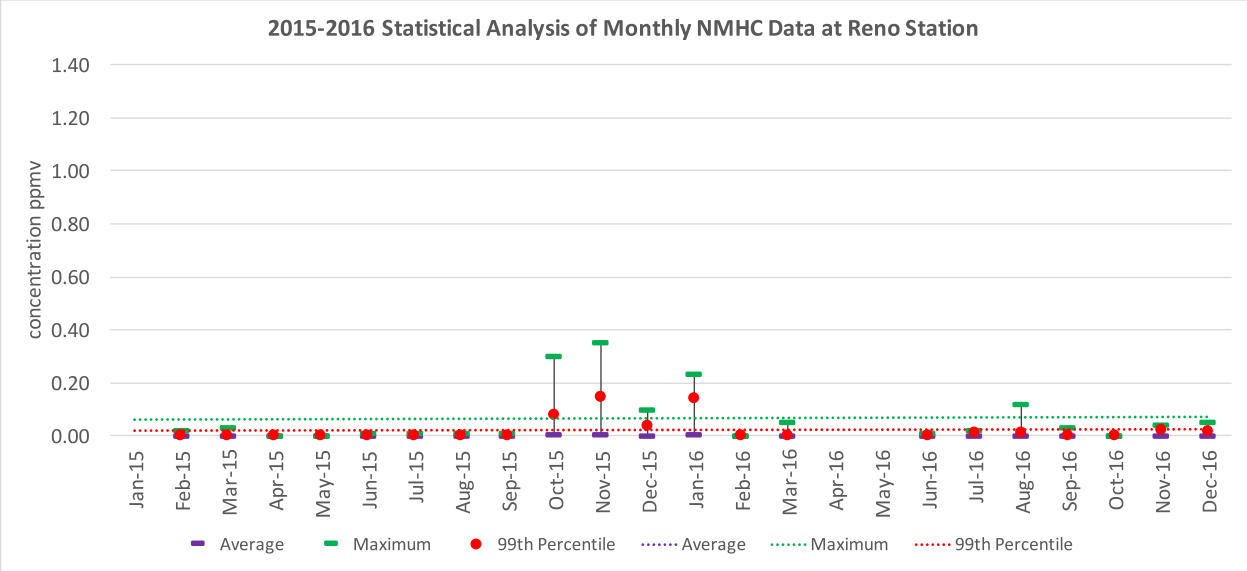


Figure 19: Non-methane Hydrocarbon Data and Trends at Reno Station

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.

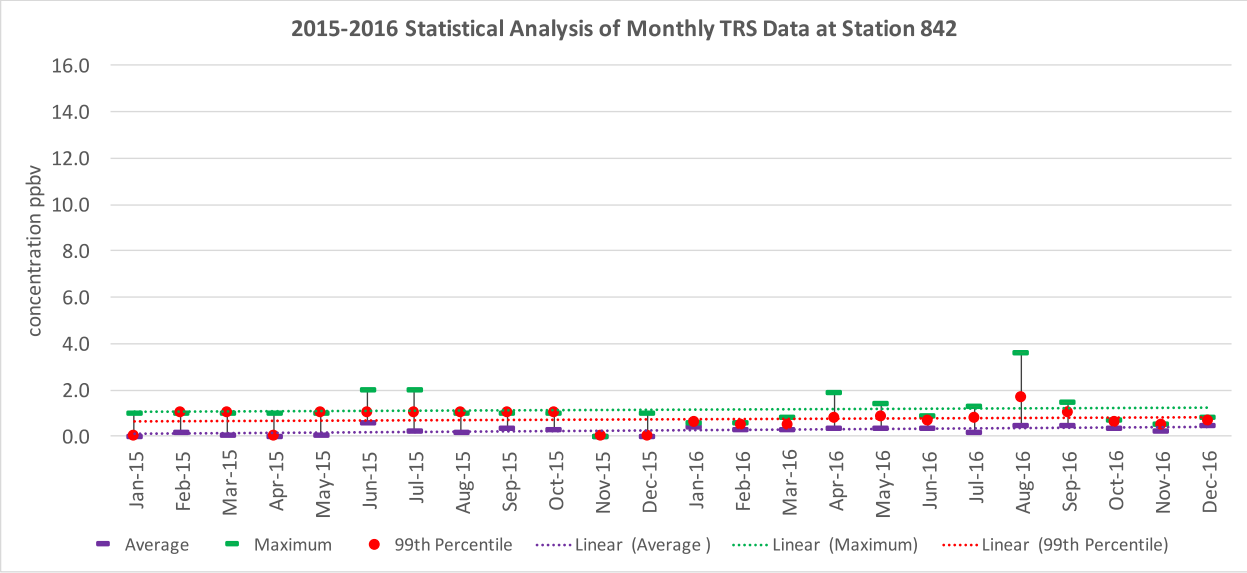


Figure 20: Total Reduced Sulphur Data and Trends at Station 842

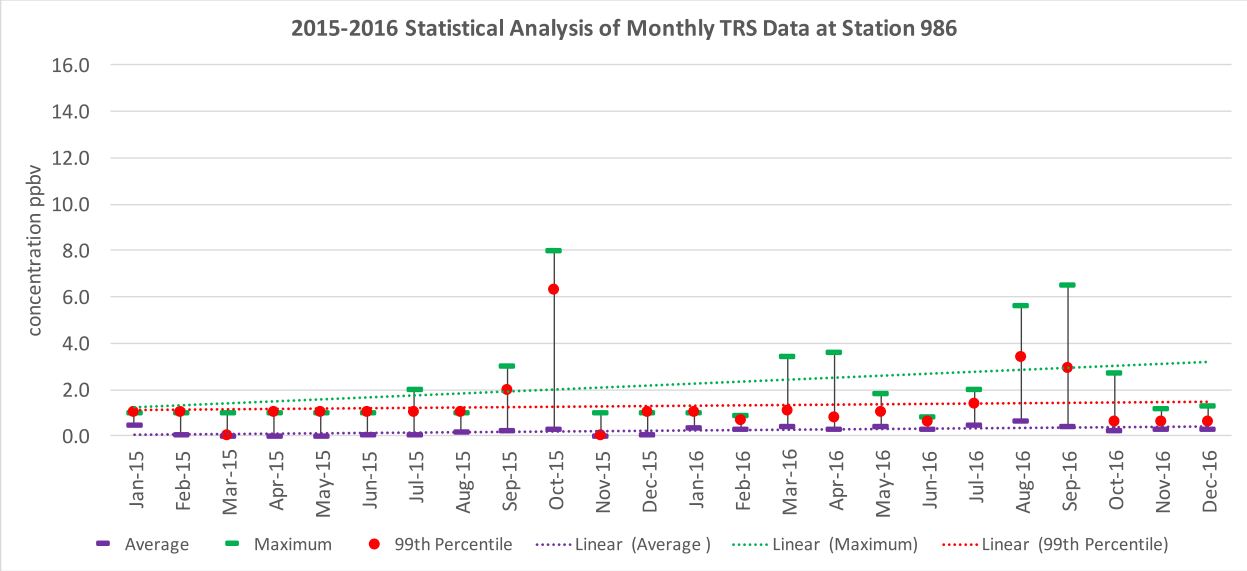


Figure 21: Total Reduced Sulphur Data and Trends at Station 986

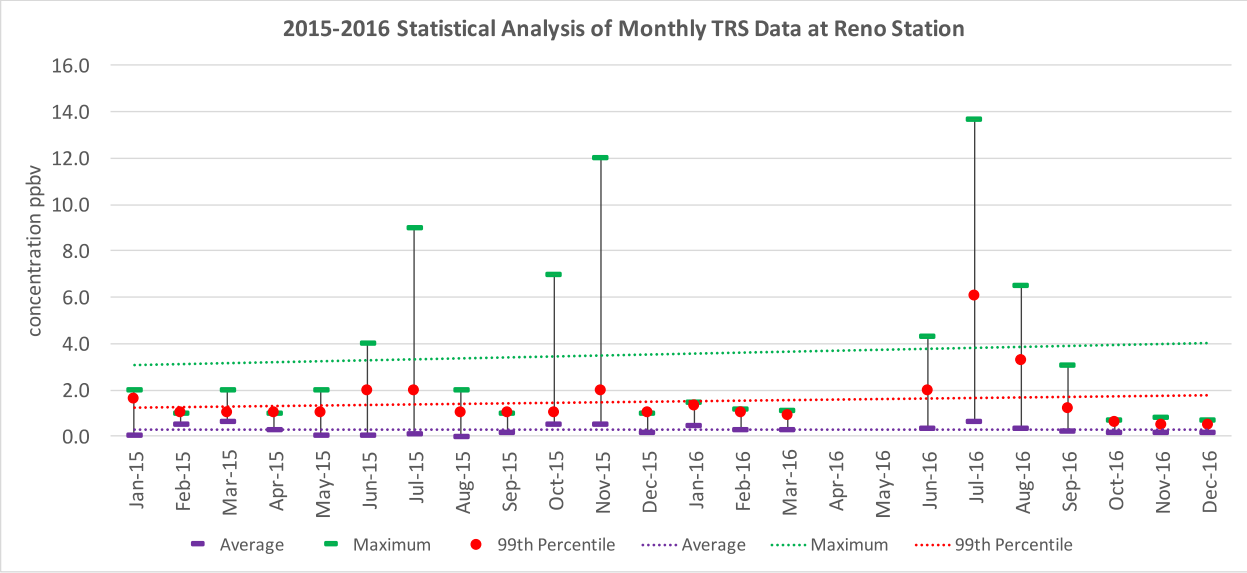


Figure 22: Total Reduced Sulphur Data and Trends at Reno Station

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.

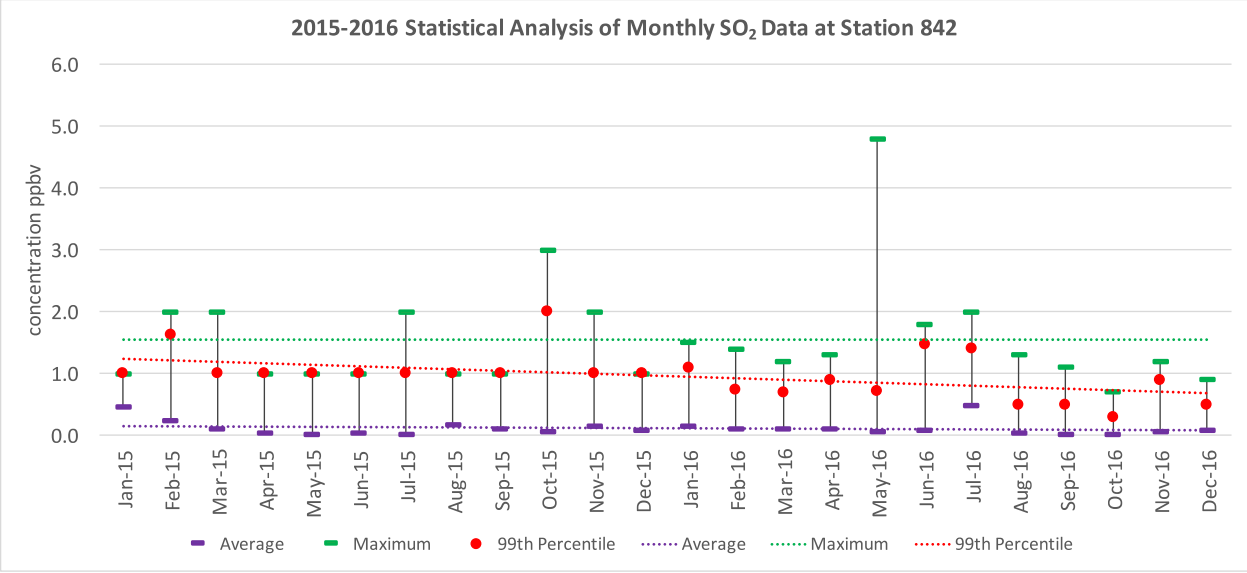


Figure 23: Sulphur Dioxide Data and Trends at Station 842

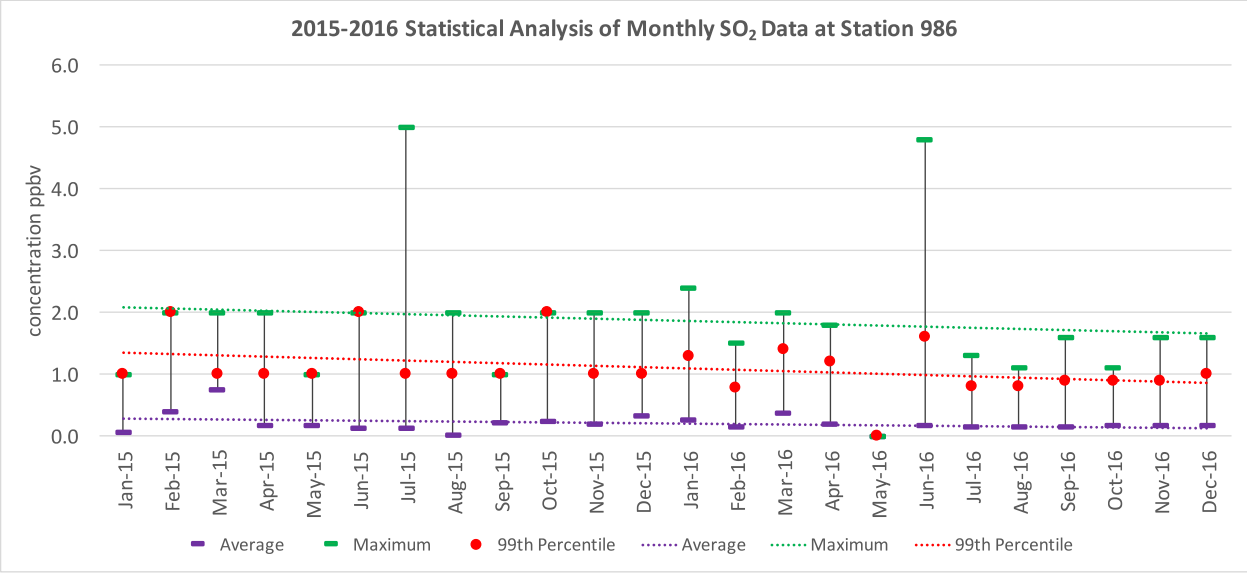


Figure 24: Sulphur Dioxide Data and Trends at Station 986

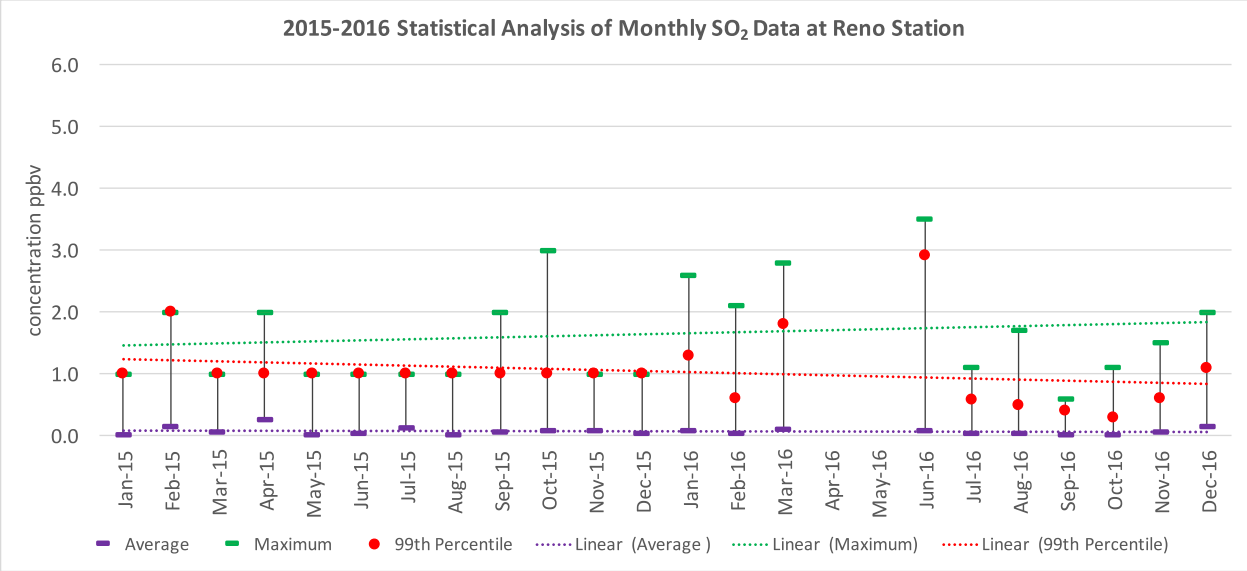


Figure 25: Sulphur Dioxide Data and Trends at Reno Station

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.

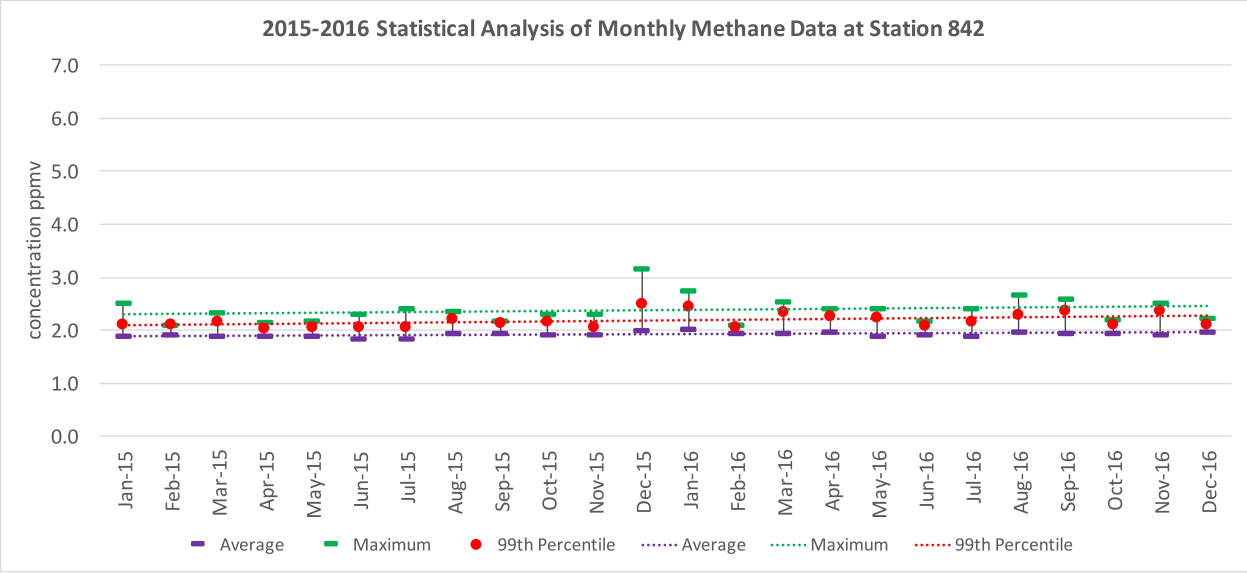


Figure 26: Methane Data and Trends at Station 842

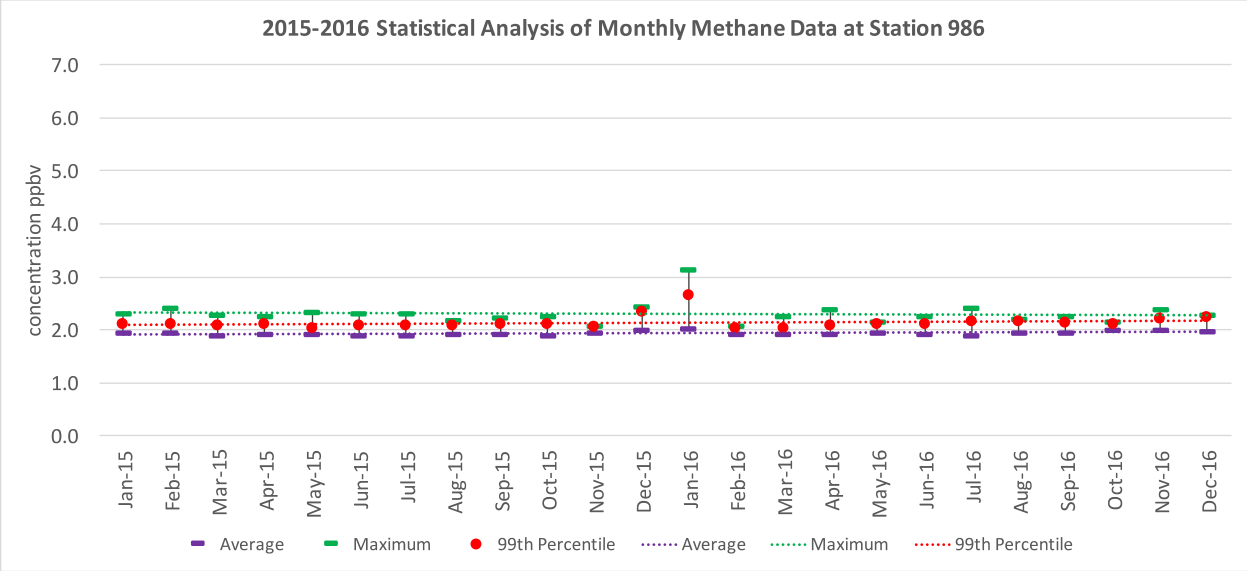


Figure 27: Methane Data and Trends at Station 986

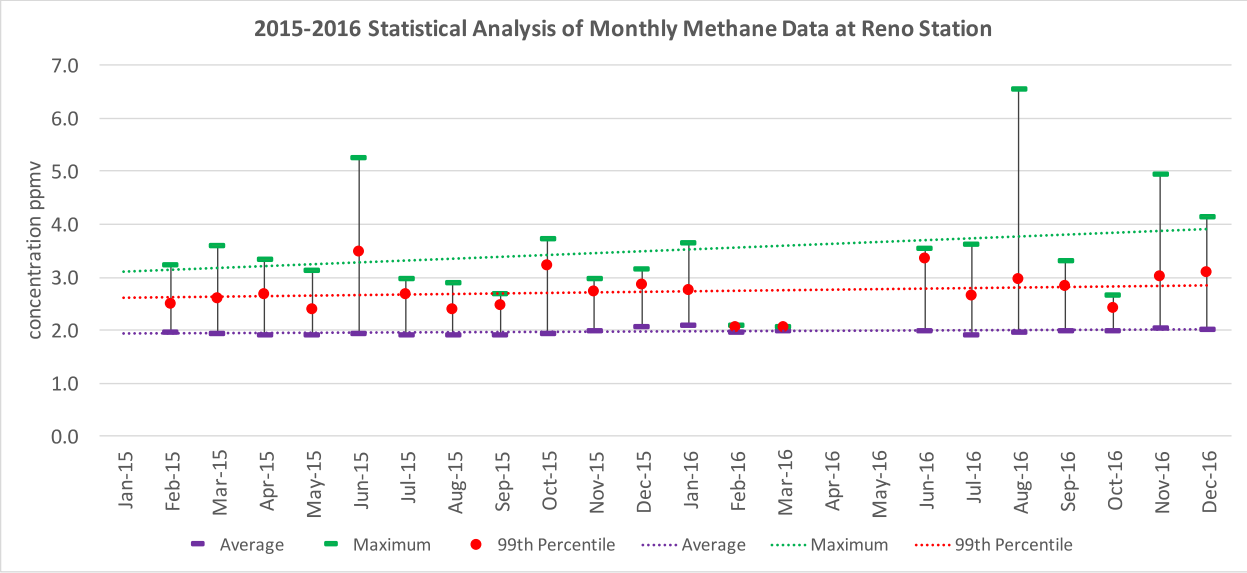


Figure 28: Methane Data and Trends at the Reno Station

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 986 showed THC, SO_2, and CH_4, NMHC all showed decreasing trends over time.

The trending for the Reno Station showed variability; measurements for SO_2 and THC showed decreasing trends at different metrics, CH_4 showed increasing trends while NMHC remained relatively constant.

The correlation between values and wind directions are presented in the concentration roses (Section 3.7), which will assist in identifying from where predominant winds are carrying pollutants.

3.5. Annual Data Analysis

Analysis was completed for each station for 2015 (where available) and 2016 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 all stations were incrementally higher in 2016 than 2015.

Table 2: 2015 Monitoring Data Percentiles

Location	Rank	THC (ppmv)	NMHC (ppmv)	TRS (ppbv)	SO2 (ppbv)	CH4 (ppmv)
Station 842	Average	1.91	0.00	0	0	1.90
	Maximum	3.17	0.01	2	3	3.16
	99th percentile	2.15	0.00	1	1	2.14
	90th percentile	1.97	0.00	1	1	1.96
	50th percentile	1.90	0.00	0	0	1.90
	Minimum	1.50	0.00	0	0	1.50
Station 986	Average	1.91	0.00	0	0	1.92
	Maximum	3.28	1.16	8	5	2.43
	99th percentile	2.12	0.08	1	1	2.10
	90th percentile	2.00	0.00	0	1	2.00
	50th percentile	1.90	0.00	0	0	1.90
	Minimum	1.51	0.00	0	0	1.51
Reno	Average	1.96	0.00	0	0	1.95
	Maximum	5.25	0.35	12	3	5.25
	99th percentile	2.75	0.01	1	1	2.68
	90th percentile	2.20	0.00	1	0	2.10
	50th percentile	1.89	0.00	0	0	1.89
	Minimum	1.54	0.00	0	0	1.54
AAAQO*	1-hour	-	-	-	172	-

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

Table 3: 2016 Monitoring Data Percentiles

Location	Rank	THC (ppmv)	NMHC (ppmv)	TRS (ppbv)	SO2 (ppbv)	CH4 (ppmv)
Station 842	Average	1.94	0	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	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	2.00	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)

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

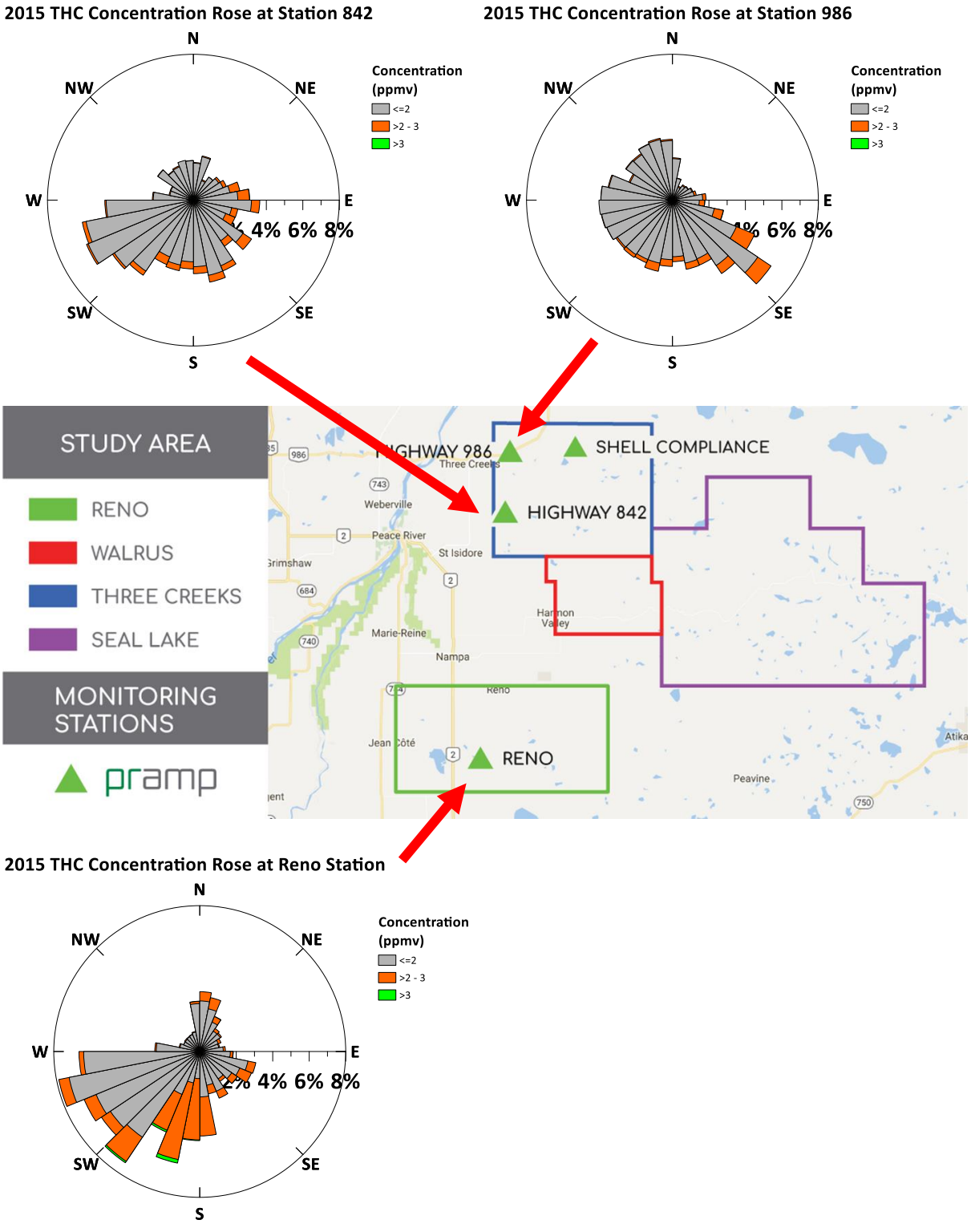


Figure 29: Total Hydrocarbons Concentration Roses for 2015 at Station 842(left), Station 986 (right), and Reno Station (bottom)

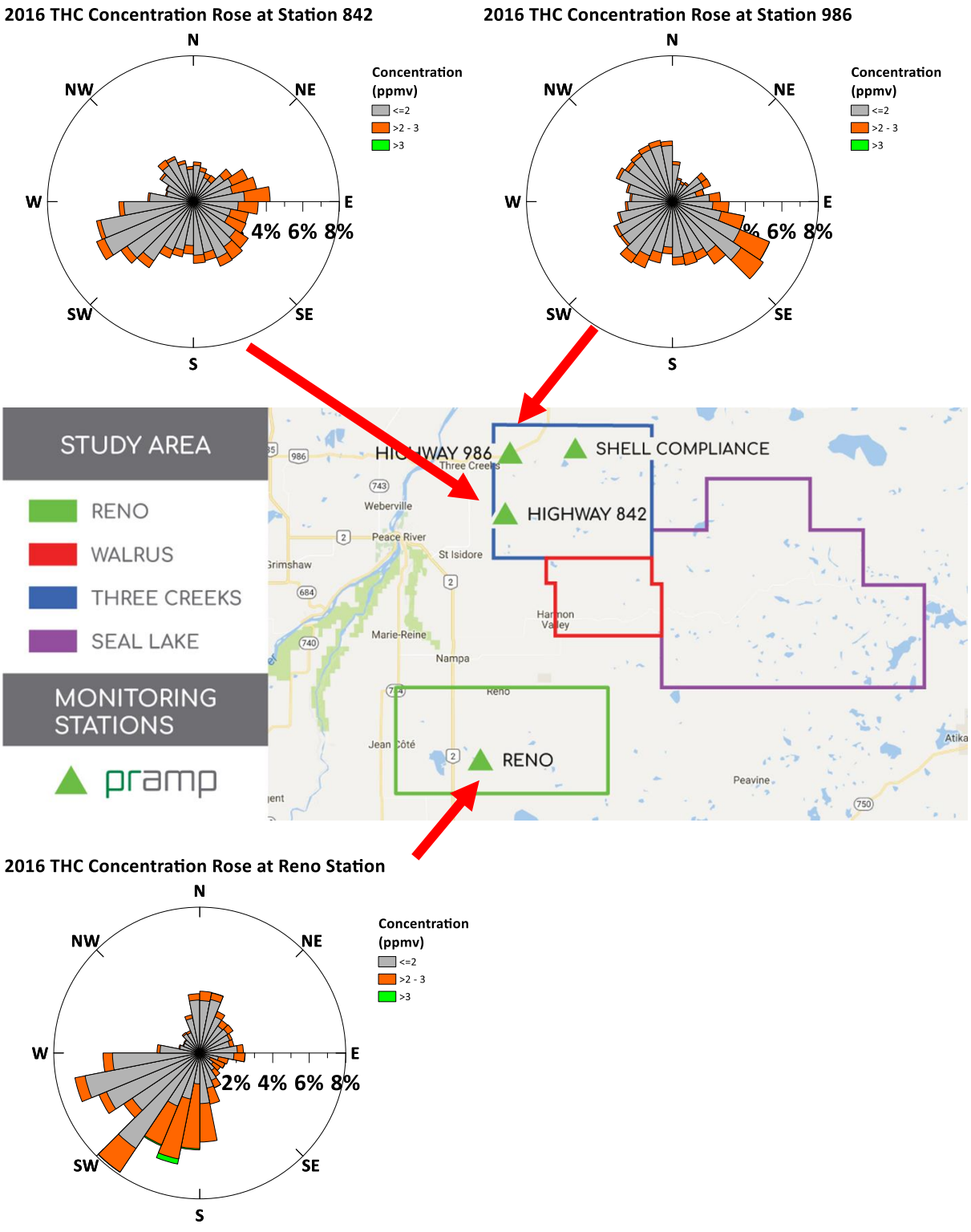


Figure 30: Total Hydrocarbons Concentration Roses for 2015 at Station 842(left), Station 986 (right), and Reno Station (bottom)

3.6.2. 3.6.2 Non-methane Hydrocarbons

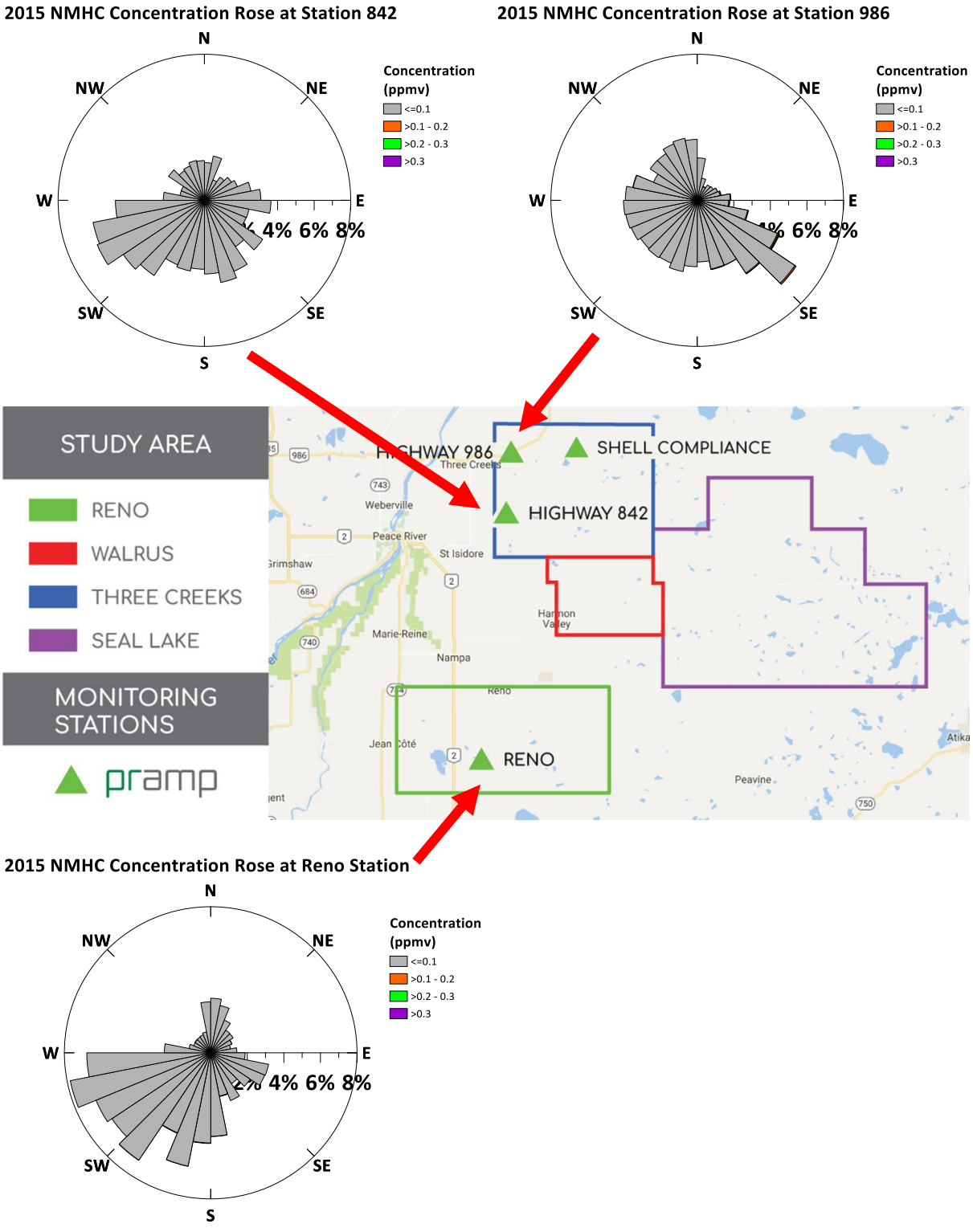


Figure 31: Non-methane Hydrocarbons Concentration Roses for 2015 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

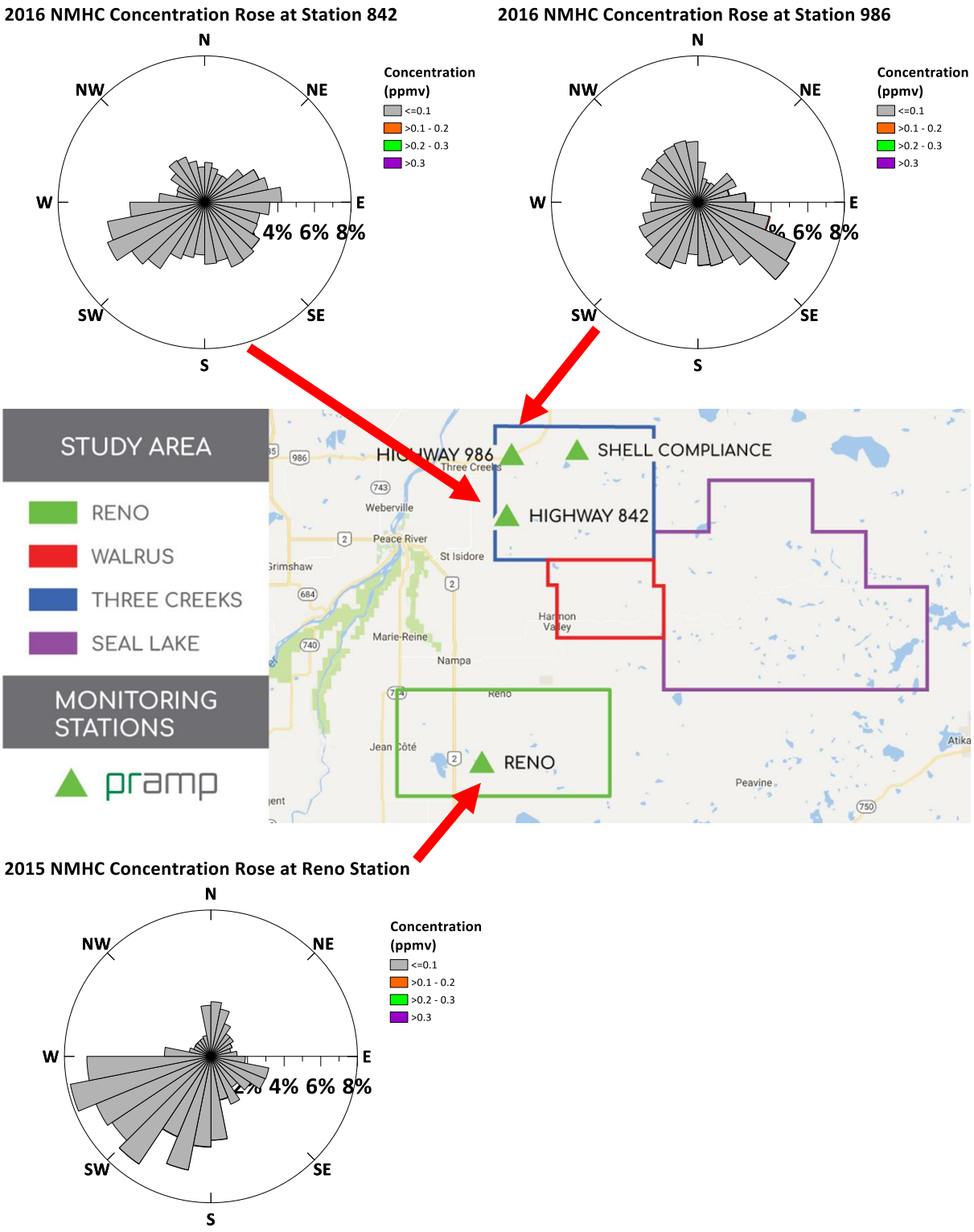


Figure 32: Non-methane Hydrocarbons Concentration Roses for 2016 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

3.6.3. Total Reduced Sulphur

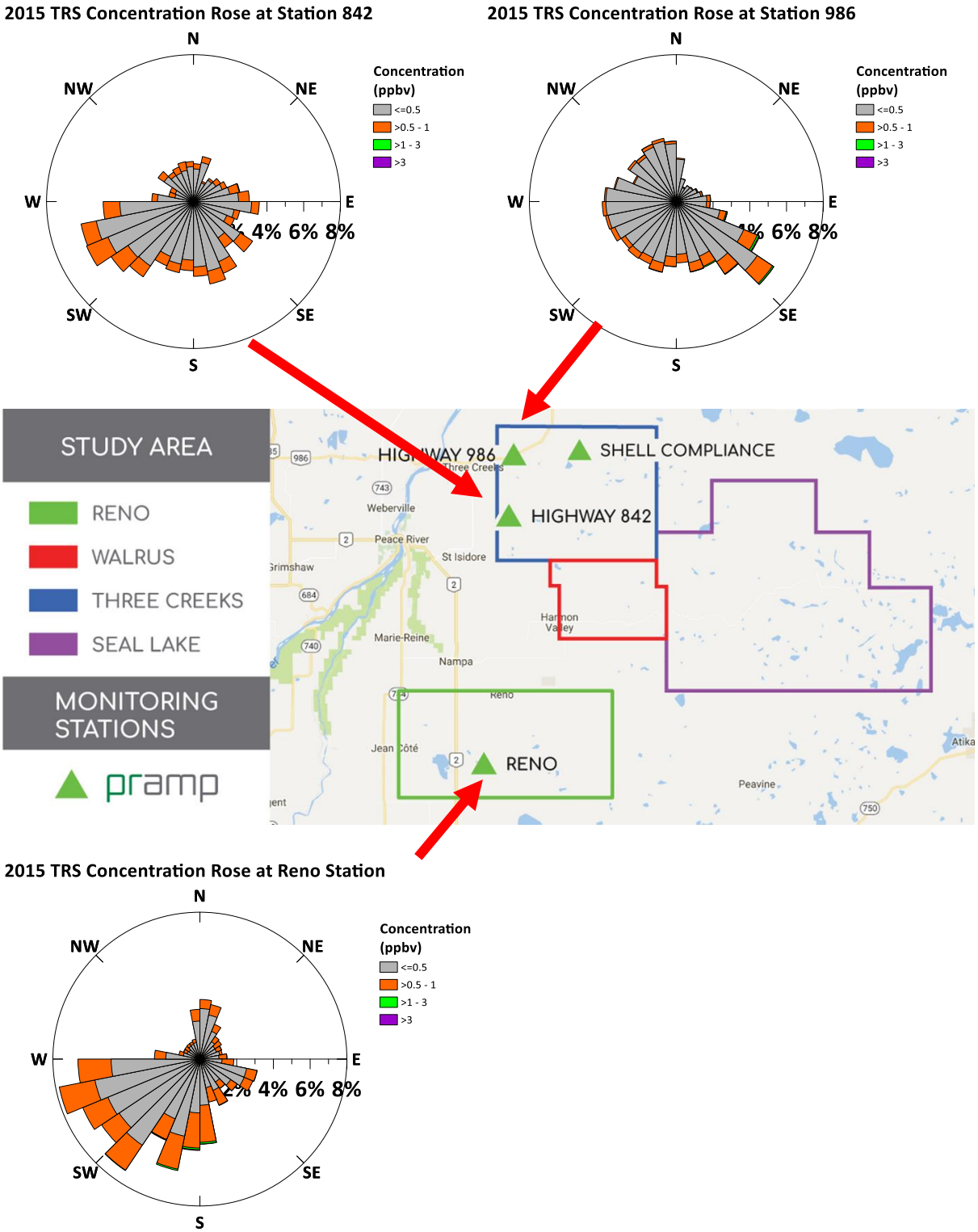


Figure 33: Total Reduced Sulphur Concentration Roses for 2015 at Station 842 (left), Station 986(right), and Reno Station (bottom)

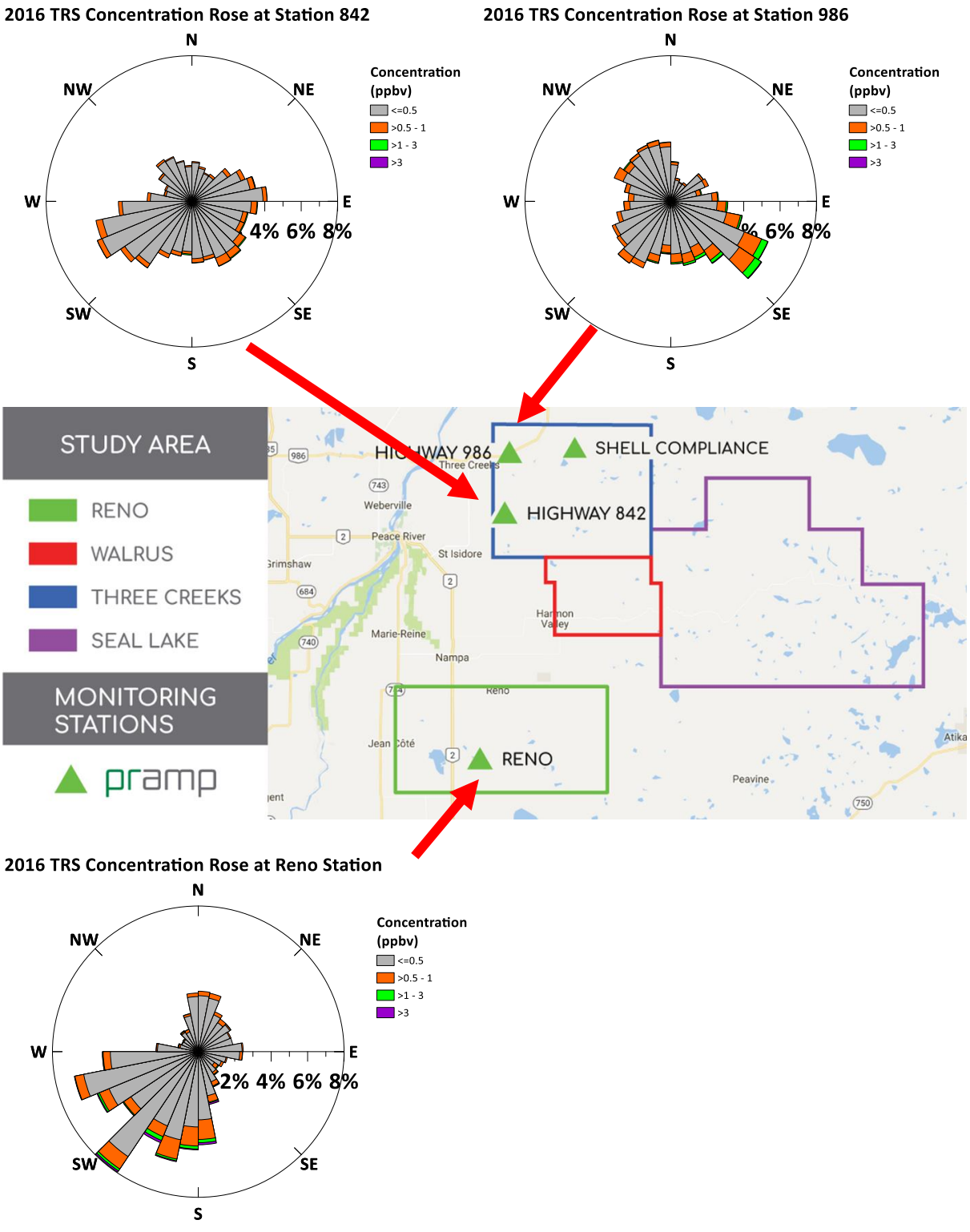


Figure 34: Total Reduced Sulphur Concentration Roses for 2016 at Station 842 (left), Station 986(right), and Reno Station (bottom)

3.6.4. Sulphur Dioxide

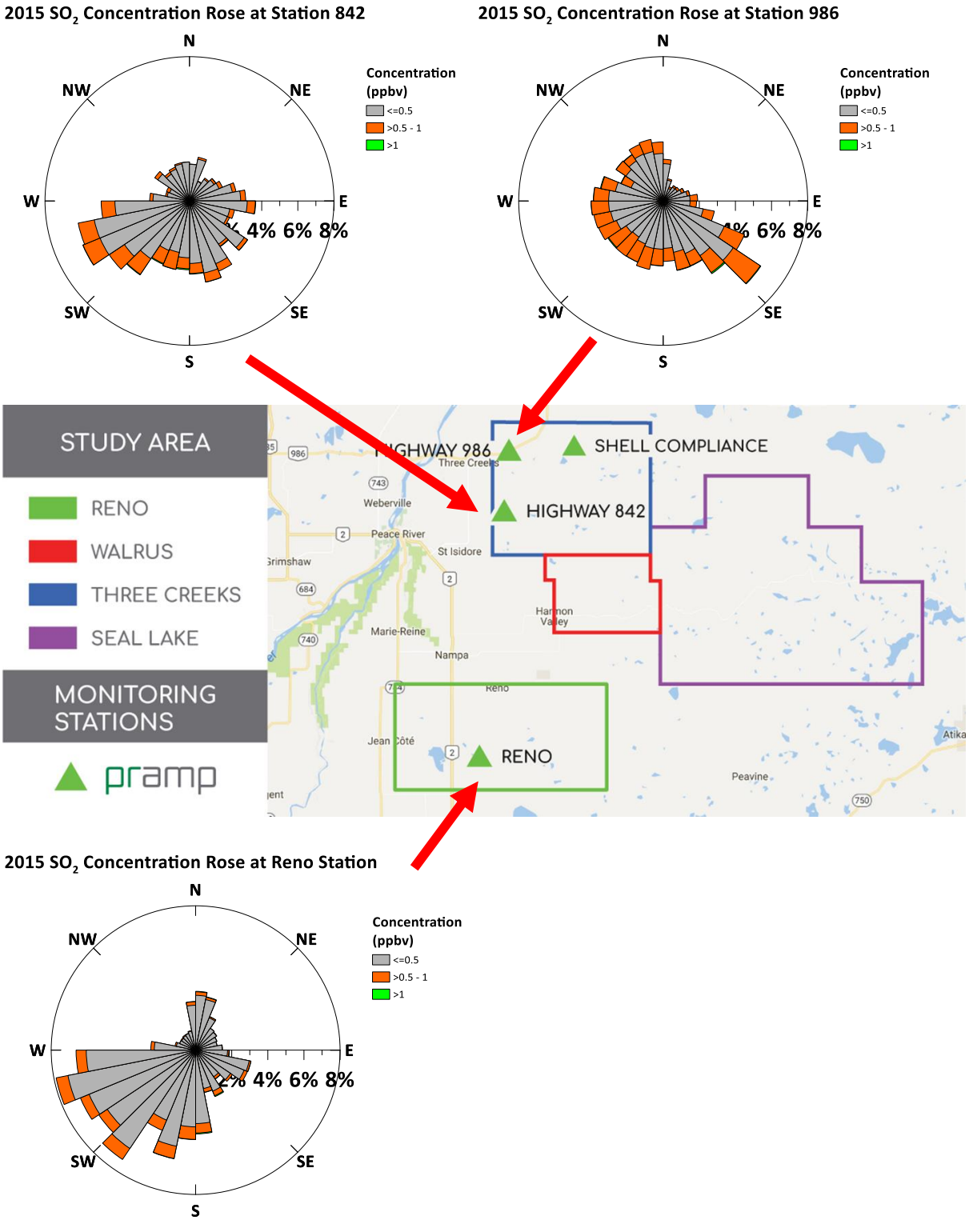


Figure 35: Sulphur Dioxide Concentration Roses for 2015 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

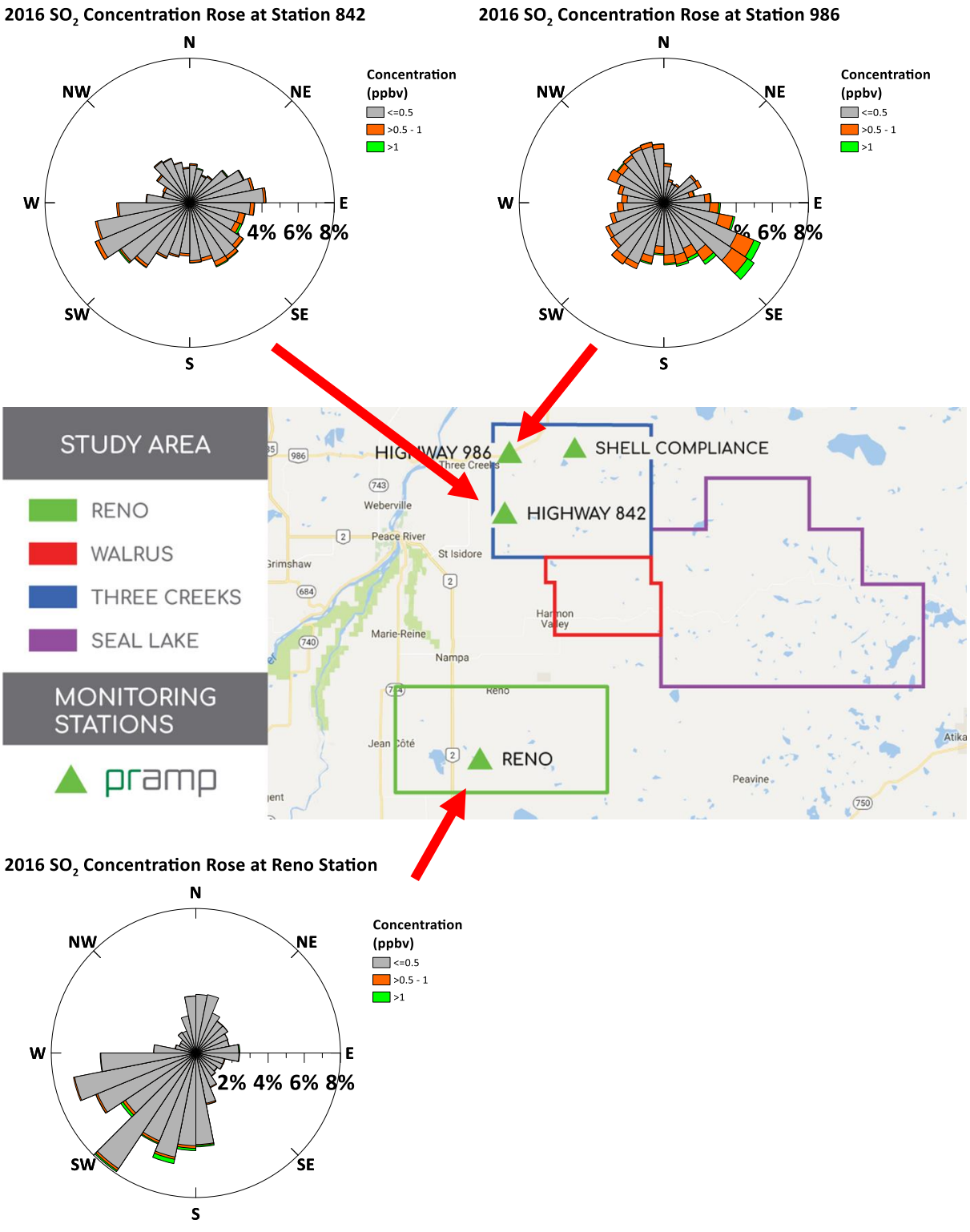


Figure 36: Sulphur Dioxide Concentration Roses for 2016 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

3.6.5. Methane

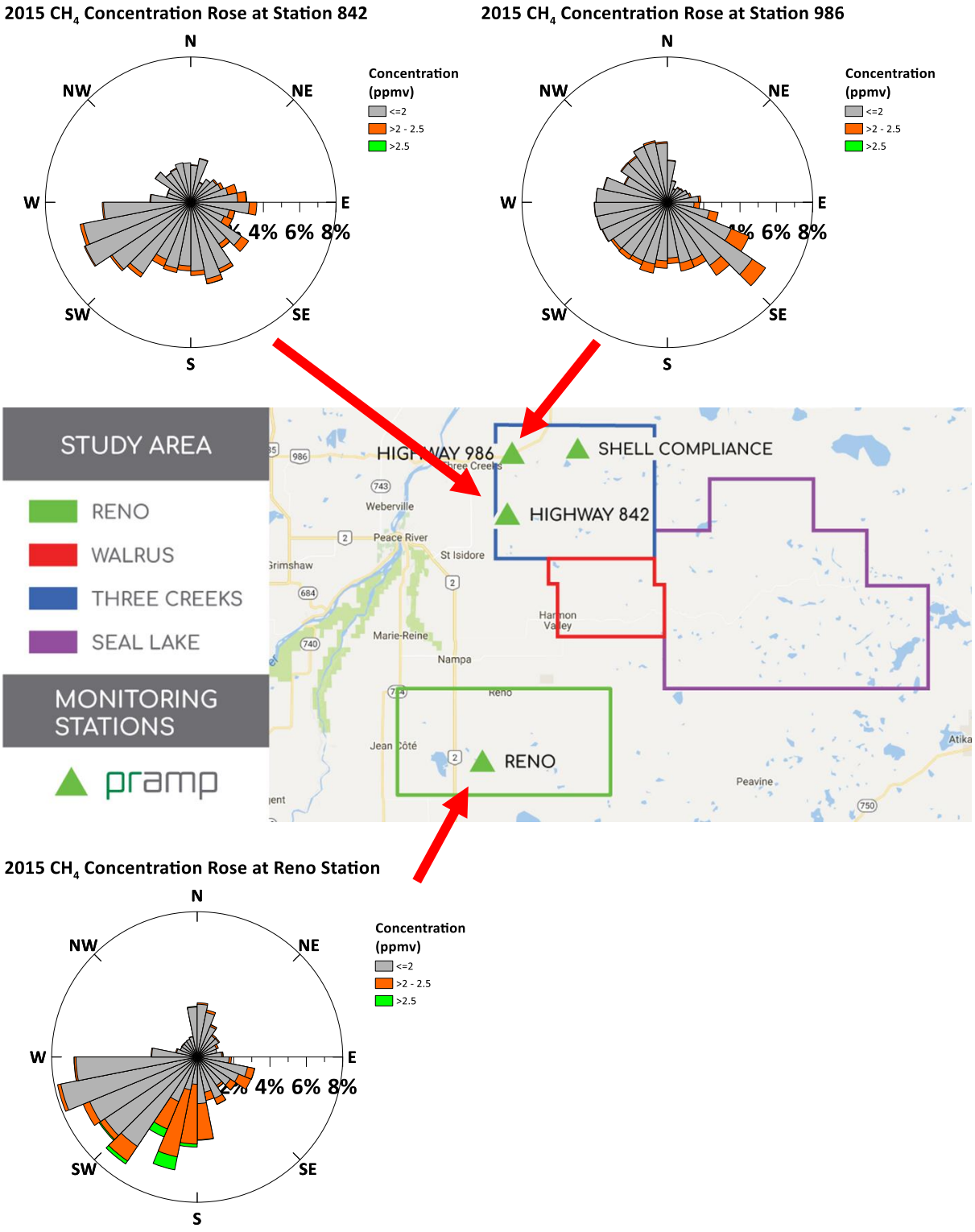


Figure 37: Methane Concentration Roses for 2015 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

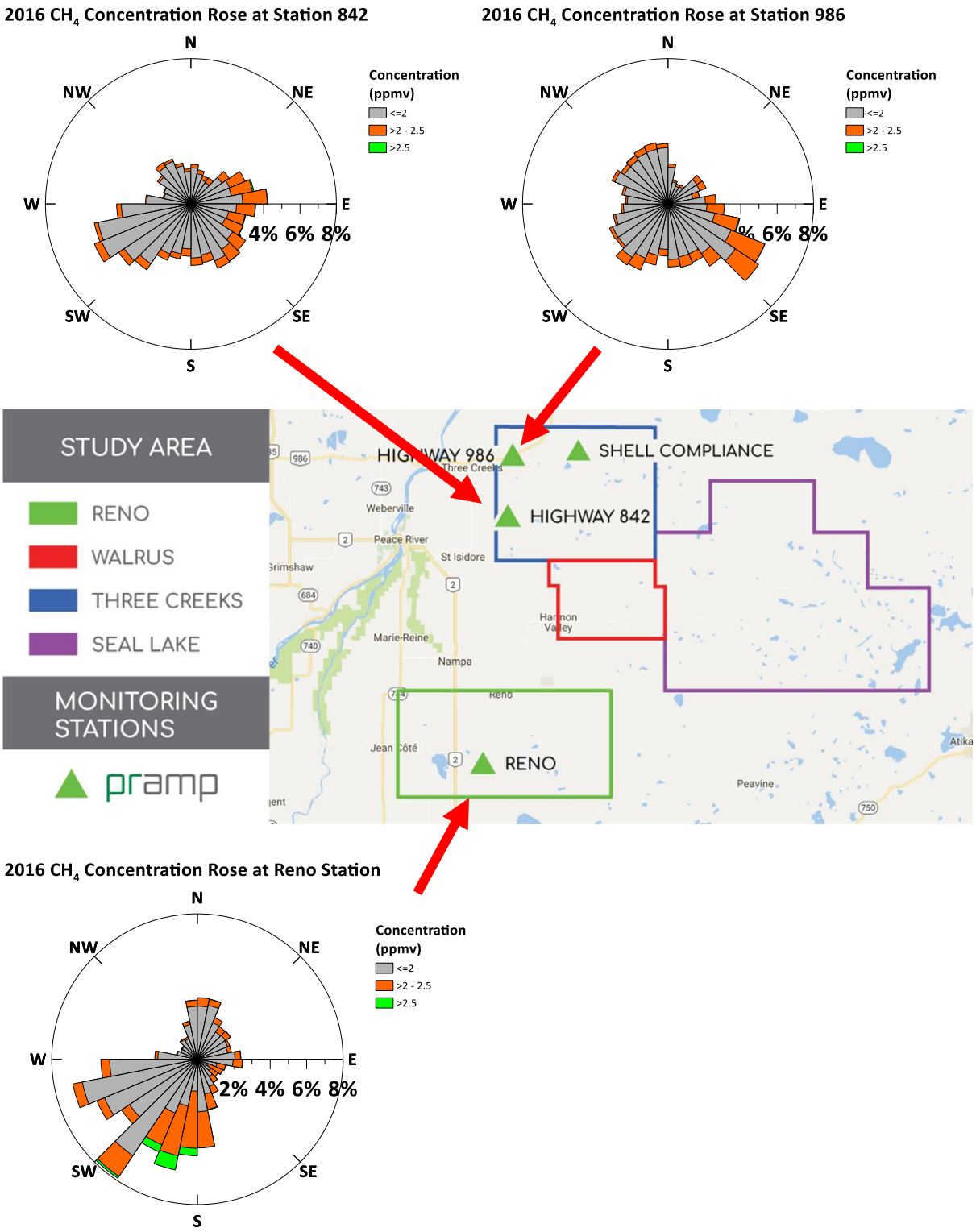


Figure 38: Methane Concentration Roses for 2016 at Station 842 (left), Station 986 (right), and Reno Station (bottom)

3.6.6. Summary

The concentration rose from Reno Station indicates that the identifiable sources for most contaminants are likely the nearby heavy oil operations in the Reno area but there are also potential sources outside of the Reno area to the southwest of the Reno area boundary (see Figure 1a). Further study work is needed to verify the sources. Likewise, for Station 986, the heavy oil operations appear to be major contributors to the monitored concentrations. However there appears to be sources not related to heavy oil operations contributing to elevated readings particularly when examining the frequency distribution of SO_2 at both Station 986 and 842. There are two landfill stations close by and upwind of Station 842 and Station 986 is relatively close to a pulp mill.

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 2016 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 2016 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
986	2016/01/02	11:45	8.3	180	0.36	3100	6.2	< 0.4	0.26	< 0.4	0.11	1.79	1.16	n/a	4.29	1.5	0.32	n/a
986	2016/01/05	18:30	1.2	141	0.35	3200	1.8	< 0.4	0.66	< 0.4	0.11	6.16	7.57	n/a	15.5	7.3	0.41	n/a
986	2016/01/12	18:55	6	153	0.49	2100	2.5	< 0.4	0.45	0.4	0.09	0.64	0.39	n/a	1.29	0.6	0.15	n/a
986	2016/01/13	16:55	2.6	201	0.46	2300	5	< 0.4	0.47	1.2	0.18	1.46	0.92	n/a	3.05	1.4	0.38	n/a
986	2016/01/24	15:50	3.5	206	0.48	2000	2.6	< 0.4	0.32	0.5	0.09	1.62	0.85	n/a	3.11	0.9	0.21	n/a
986	2016/03/31	08:55	6.9	161	0.55	2100	3.2	< 0.4	0.05	0.5	0.1	0.55	0.53	n/a	0.56	0.2	0.02	n/a
986	2016/05/23	02:25	2.1	152	0.33	2100	3.7	< 0.4	5.47	1.1	0.08	5.09	17.9	n/a	16.5	21.9	1.89	n/a
986	2016/06/07	22:25	1.4	85	0.34	2400	<0.5	< 0.3	5.03	1.8	0.06	0.25	10.4	n/a	4.87	13.4	1.77	n/a
986	2016/10/05	18:40	3	77	0.43	2200	4.9	< 0.5	0.93	0.9	0.05	1.07	13.8	n/a	7.73	11.9	0.16	n/a
Reno	2016/01/03	23:35	3.4	14	0.31	3700	9.1	< 0.4	3.25	2.4	0.11	3.41	2.08	n/a	8.14	2.9	1.83	n/a
Reno	2016/01/24	00:10	2.4	196	0.33	2500	3.3	< 0.4	0.47	0.6	0.09	2.77	1.38	n/a	5.63	1.4	0.86	n/a
Reno**	2016/08/19	08:55	4.1	173	0.46	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

* 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
** Canister was not sent to the lab for analysis due to operator error. No analytical result is available.

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 2015 to 2016. 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 would be 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 2015 and 2016. 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 2015 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 19 and Table 5 compare the CH_4 1-hour average measurements in Alberta in 2015 and 2016 for 22 stations. Seventeen sites had a full year of CH_4 data in 2015. The number of months of available data is shown in brackets for the following stations missing data in 2015:

- PRAMP Reno [11]
- Edmonton Central [11]
- Calgary Central-Inglewood [9]
- Stony Mountain [Conklin Lookout] [4]
- Calgary Central 2 [3]

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:

- Lethbridge [9]
- PRAMP Reno [9]
- Elk Point [5]
- Bruderheim [2]
- Calgary Central 2 [0]

The annual averages for 2015 versus 2016 are consistent and do not show increasing or decreasing trends at the majority of the stations. The annual 99th percentile of the 2015 data for Station 986 was 2.10 ppmv, 2.13 ppmv for Station 842, and 2.68 ppmv for the Reno Station. For 2016, the annual 99th percentile was 2.17 ppmv for Station 986, 2.26 ppmv for Station 842, and 3.80 for the Reno station. These all represent small increases

CH_4 readings in the Three Creeks area are among the lowest in the province. CH_4 99th percentile annual readings in the Reno area ranked 13 out of 22 compared to other stations in the province. Note the annual average CH_4 is typically less than 2 ppmv across the province, which is about the natural background concentration.

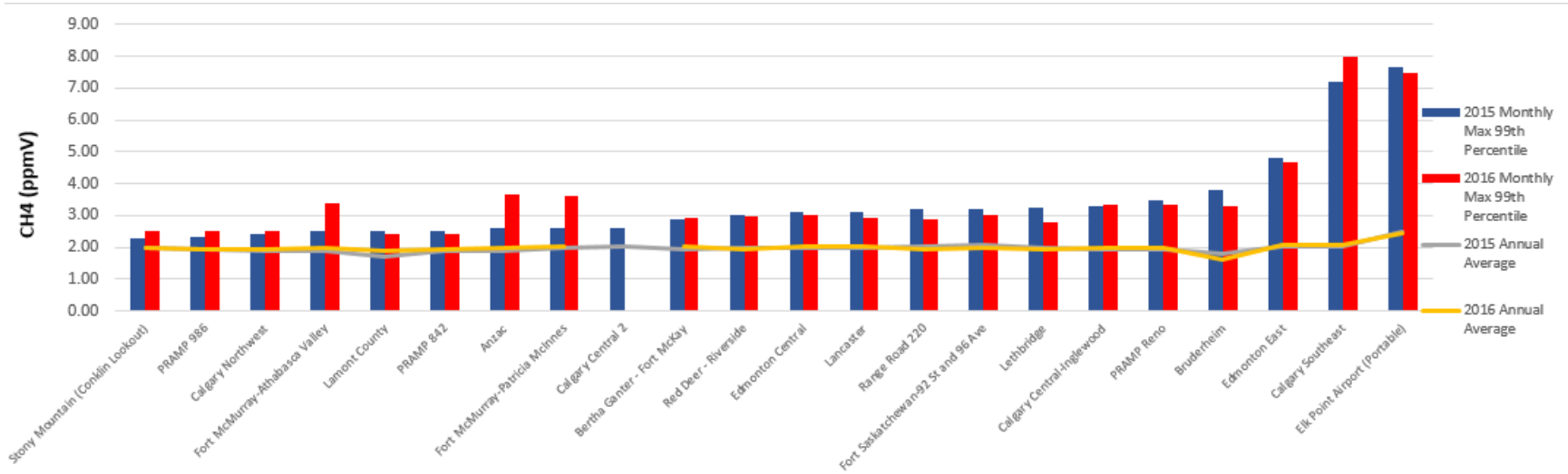


Figure 39: CH4 1-hour Average Measurements in Alberta in 2015 and 2016

Table 5: CH4 1-hour Average Measurements in Alberta for 2015 and 2016 (ppmv)

Sorted Results	Stony Mountain (Conklin Lookout)	PRAMP 986	Calgary Northwest	Fort McMurray-Athabasca Valley	Lamont County	PRAMP 842	Anzac	Fort McMurray-Patricia McInnes	Calgary Central 2	Bertha Ganter - Fort McKay	Red Deer - Riverside	Edmonton Central	Lancaster	Range Road 220	Fort Saskatchewan-92 St and 96 Ave	Lethbridge	Calgary Central-Inglewood	PRAMP Reno	Bruderheim	Edmonton East	Calgary Southeast	Elk Point Airport (Portable)
2015 Monthly Max 99th Percentile	2.30	2.33	2.40	2.49	2.50	2.50	2.60	2.60	2.60	2.90	3.00	3.10	3.11	3.19	3.20	3.26	3.29	3.49	3.80	4.82	7.18	7.68
2016 Monthly Max 99th Percentile	2.49	2.52	2.50	3.39	2.41	2.44	3.66	3.60	n/a	2.92	2.97	3.00	2.93	2.90	3.00	2.80	3.36	3.34	3.30	4.66	7.97	7.50
2015 Annual 99th Percentile	2.30	2.10	2.20	2.30	2.20	2.13	2.30	2.30	2.50	2.50	2.80	2.60	2.70	2.70	3.00	2.60	2.80	2.68	3.10	3.20	4.50	5.80
2016 Annual 99th Percentile	2.30	2.17	2.21	2.70	2.30	2.26	2.30	2.61	n/a	2.70	2.70	2.50	2.60	2.60	2.60	2.50	2.90	2.80	2.70	3.10	4.16	5.20
2015 Annual Average	197	192	188	191	171	190	190	196	2.04	194	197	199	199	2.01	2.08	199	194	195	179	2.03	2.04	2.48
2016 Annual Average	196	195	193	197	189	194	197	2.04	n/a	2.04	195	2.02	2.03	194	196	194	199	199	162	2.05	2.07	2.42

6.2. Non-methane Hydrocarbons

Figure 20 and Table 6 compare the NMHC 1-hour average measurements in Alberta in 2015 and 2016 for 20 stations. Sixteen sites had a full year of NMHC data for 2015. The number of months of available data is shown in brackets for the following stations missing data in 2015:

- PRAMP Reno [11]
- Edmonton Central [11]
- Calgary Central-Inglewood [9]
- Stony Mountain (Conklin Lookout) [4]
- Calgary Central 2 [3]

Seventeen 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 2015:

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]
- Elk Point [5]
- Bruderheim [2]
- Lancaster [0]
- Calgary Central 2 [0]
- Lethbridge [0]

Figure 20 shows that the maximum monthly 99th percentile values for 8 of the 22 stations were equal or lower in 2016 compared to 2015 with a few notable exceptions in Fort McMurray likely the result of the large forest fire event. Annual averages are very close for 2015 and 2016 at most of the stations. Annual averages are very close for 2015 and 2016 at most of the stations.

NMHC readings in the Peace River Area are amongst the lowest in the province. The annual 99th percentile of the 2015 data for Station 842 was 0.00 ppmv, 0.01 ppmv for the Reno Station, and 0.08 ppmv for Station 986.

The annual 99th percentile of the 2016 data for Station 842 was 0.00 ppmv, 0.02 ppmv for the Reno Station, and 0.03 ppmv for Station 986.

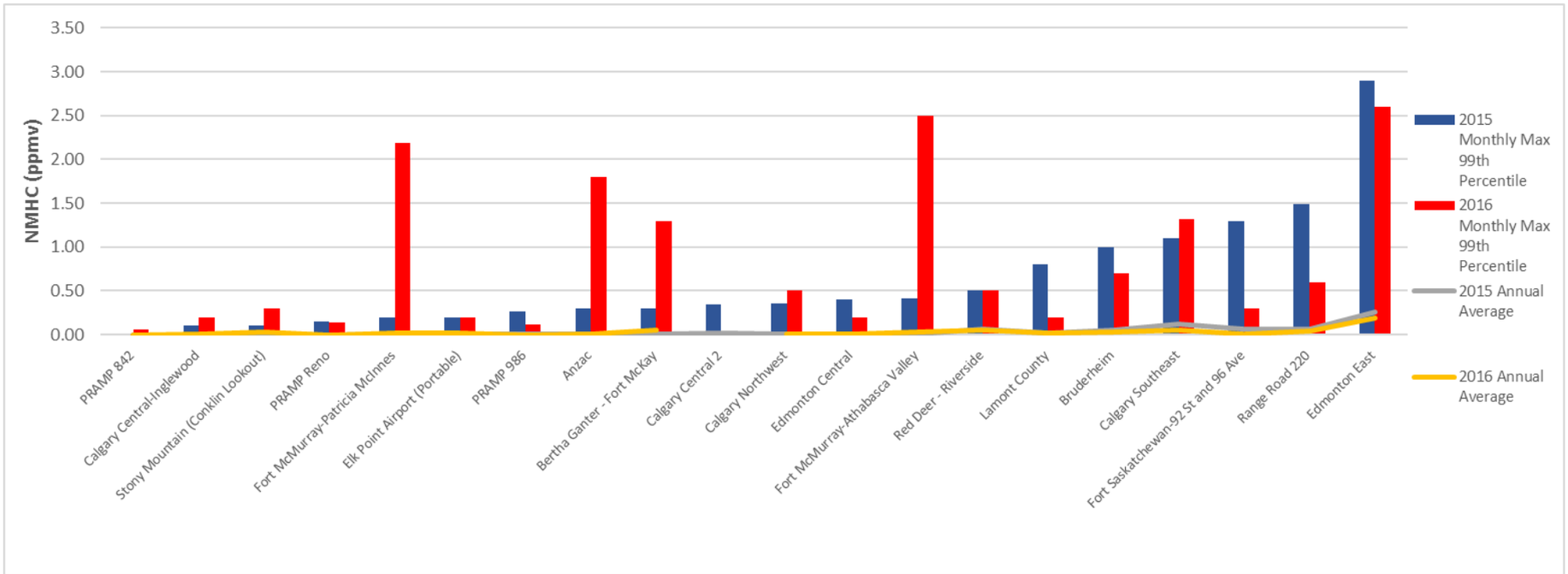


Figure 40: NMHC 1-hour Average Measurements in Alberta in 2015 and 2016

Table 6: NMHC 1-hour Average Measurements in Alberta for 2015 and 2016 (ppmv)

Sorted Results	PRAMP 842	Calgary Central-Inglewood	Stony Mountain (Conklin Lookout)	PRAMP Reno	Fort McMurray-Patricia McInnes	Elk Point Airport (Portable)	PRAMP 986	Anzac	Bertha Ganter - Fort McKay	Calgary Central 2	Calgary Northwest	Edmonton Central	Fort McMurray-Athabasca Valley	Red Deer - Riverside	Lamont County	Bruderheim	Calgary Southeast	Fort Saskatchewan-92 St and 96 Ave	Range Road 220	Edmonton East
2015 Monthly Max 99th Percentile	0.00	0.10	0.10	0.15	0.20	0.20	0.27	0.30	0.30	0.35	0.36	0.40	0.42	0.50	0.80	1.00	1.10	1.30	1.49	2.90
2016 Monthly Max 99th Percentile	0.06	0.20	0.30	0.14	2.19	0.20	0.12	1.80	1.30	n/a	0.50	0.20	2.50	0.50	0.20	0.70	1.31	0.30	0.60	2.60
2015 Annual 99th Percentile	0.00	0.00	0.10	0.01	0.00	0.20	0.08	0.20	0.20	0.20	0.10	0.20	0.20	0.40	0.40	0.70	0.67	0.80	0.50	1.80
2016 Annual 99th Percentile	0.00	0.10	0.10	0.02	0.30	0.20	0.03	0.20	0.50	n/a	0.20	0.10	0.80	0.30	0.20	0.60	0.50	0.20	0.30	1.60
2015 Annual Average	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.06	0.02	0.05	0.12	0.07	0.07	0.25
2016 Annual Average	0.00	0.00	0.02	0.00	0.01	0.02	0.00	0.01	0.05	n/a	0.01	0.00	0.03	0.05	0.02	0.03	0.05	0.01	0.04	0.19

6.3. Total Hydrocarbons

Figure 21 and Table 7 compare the THC 1-hour average measurements in 2015 and 2016 for 50 stations in Alberta. Of the 40 stations with data in both 2015 and 2016, 22 stations showed equal or lower maximum 99th monthly percentile in 2016 than in 2015. The THC annual averages values are lower for 2016 at 17 of the 40 stations with data for both years.

Thirty-three sites had a full year of THC data in 2015. The number of months of available data is shown in brackets for the following stations missing data in 2015:

- Edmonton Central [11]
- Clairmont Portable [9]
- Calgary Central-Inglewood [9]
- Millennium Mine [8]
- Beverly [8]
- Sherwood Park [New] [8]
- Stony Mountain (Conklin Lookout) [4]
- Rimbey Townsite [4]
- Eagle Hills South [3]
- Crossfield-Carstairs (Portable) [3]
- Calgary Central 2 [3]
- Rimbey-Simpson [2]
- Sundre Northeast [2].

Thirty-one 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:

- Beverly - 1 [10]
- Violet Grove [10]
- Sherwood Park (New) - 1 [10]
- PRAMP Reno [10]
- Lethbridge - 1 [9]
- Edmonton South - 1 [9]
- Millennium Mine [8]
- Bonnyville Station (Portable) [7]
- Bruderheim [2]
- Rimbey-Simpson (Portable) [0]
- Rimbey Townsite [0]
- Millennium Mine [0]
- Clairmont-Portable [0]
- Crossfield-Carstairs (Portable) [0]
- Sundre Northeast (Portable) [0]
- Lamont County [0]
- Eagle Hills South (Portable) [0]

- Calgary Central 2 [0].

Note that the additional sites with THC monitoring compared to NMHC and CH_4 monitoring have a single instrument that measure THC only.

Figure 20 shows that the maximum monthly 99th percentile values for 8 of the 22 stations were equal or lower in 2016 compared to 2015. Annual averages are very close for 2015 and 2016 at most of the stations.

The annual 99th percentile of the 2015 data for Station 986 was 2.12 ppmv, 2.16 ppmv for Station 842, and 2.75 ppmv for the Reno Station. THC readings in the Three Creeks area are amongst the lowest in the province. THC 99th percentile annual readings in the Reno area rank 18 out of 49 stations in the province.

The annual 99th percentile of the 2015 data for Station 986 was 2.12 ppmv, 2.16 ppmv for Station 842, and 2.75 ppmv for the Reno Station. THC readings in the Three Creeks area are amongst the lowest in the province. THC 99th percentile annual readings in the Reno area rank 18 out of 49 stations in the province.

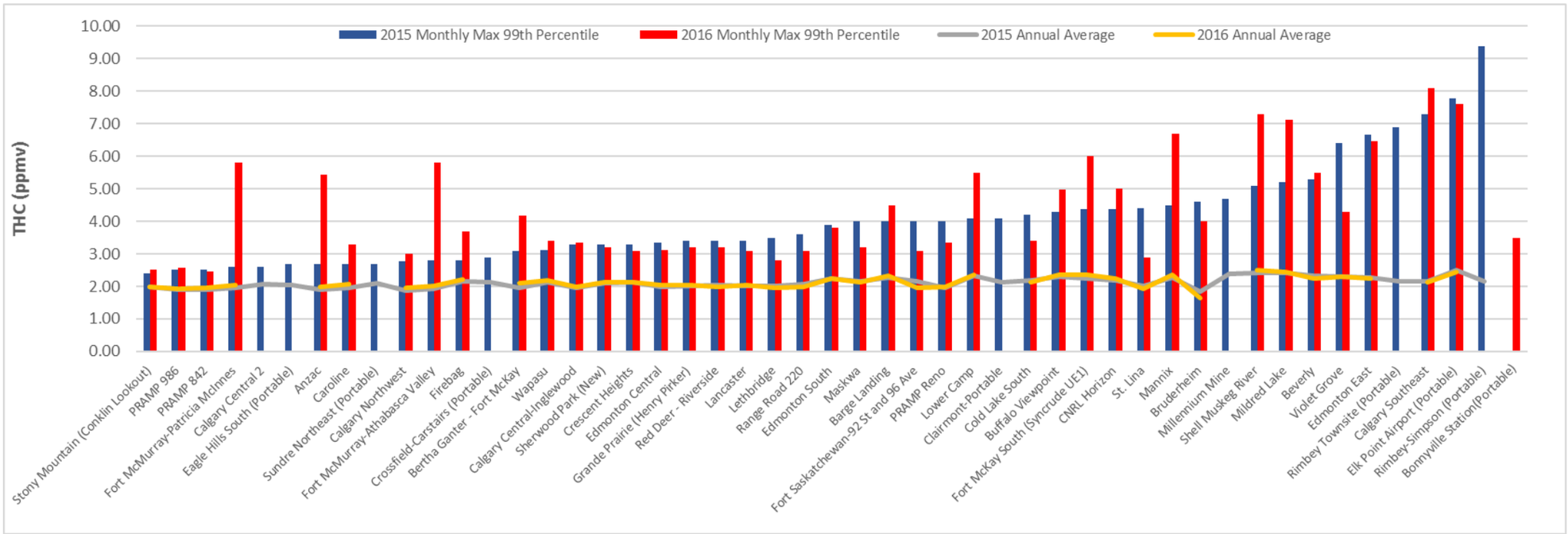


Figure 41: THC 1-hour Average Measurements in Alberta in 2015 and 2016

Table 7: THC 1-hour Average Measurements in Alberta in 2015 and 2016 (ppmv)

Sorted Results	Stony Mountain (Conklin Lookout)	PRAMP 986	PRAMP 842	Fort McMurray-Patricia McInnes	Calgary Central 2	Eagle Hills South (Portable)	Anzac	Caroline	Sundre Northeast (Portable)	Calgary Northwest	Fort McMurray-Athabasca Valley	Firebag	Crossfield-Carstairs (Portable)	Bertha Ganter - Fort McKay	Wapasu	Calgary Central-Inglewood	Sherwood Park (New)	Crescent Heights	Edmonton Central	Grande Prairie (Henry Pirker)	Red Deer - Riverside	Lancaster	Lethbridge	Range Road 220	Edmonton South	Maskwa	Barge Landing	Fort Saskatchewan-92 St and 96 Ave	PRAMP Reno	Lower Camp	Clairmont-Portable	Cold Lake South	Buffalo Viewpoint	Fort McKay South (Syncrude UE1)	CNRL Horizon	St. Lina	Mannix	Bruderheim	Millennium Mine	Shell Muskeg River	Mildred Lake	Beverly	Violet Grove	Edmonton East	Rimbey Townsite (Portable)	Calgary Southeast	Elk Point Airport (Portable)	Rimbey-Simpson (Portable)	Bonnyville Station(Portable)
2015 Monthly Max 99th Percentile	2.40	2.51	2.52	2.60	2.60	2.69	2.70	2.70	2.70	2.76	2.80	2.80	2.90	3.10	3.12	3.29	3.30	3.30	3.34	3.40	3.40	3.41	3.50	3.59	3.90	3.99	4.00	4.00	4.01	4.09	4.10	4.20	4.29	4.38	4.38	4.40	4.48	4.59	4.70	5.09	5.20	5.28	6.39	6.66	6.90	7.30	7.78	9.40	n/a
2016 Monthly Max 99th Percentile	2.50	2.56	2.45	5.79	n/a	n/a	5.44	3.30	n/a	3.00	5.80	3.70	n/a	4.19	3.40	3.36	3.20	3.10	3.11	3.20	3.20	3.09	2.80	3.10	3.80	3.20	4.49	3.09	3.34	5.49	n/a	3.40	4.99	6.00	5.00	2.90	6.70	4.00	n/a	7.30	7.14	5.50	4.30	6.46	n/a	8.08	7.60	n/a	3.50
2015 Annual 99th Percentile	2.30	2.12	2.16	2.30	2.50	2.51	2.30	2.50	2.60	2.30	2.40	2.50	2.80	2.70	2.59	2.80	2.90	2.90	2.70	2.90	3.10	2.90	2.90	3.00	3.20	3.20	3.20	3.70	2.75	3.40	3.40	3.20	3.50	3.30	3.50	2.70	3.40	3.80	4.30	4.00	4.00	4.00	4.23	4.70	5.70	4.80	5.90	5.70	n/a
2016 Annual 99th Percentile	2.30	2.18	2.27	2.90	n/a	n/a	2.40	2.80	n/a	2.40	3.30	2.70	n/a	3.00	2.70	2.90	2.80	2.70	2.60	2.70	3.00	2.70	2.60	2.70	3.10	2.70	3.50	2.60	2.82	3.70	n/a	3.00	3.70	3.70	3.70	2.50	4.10	3.34	n/a	4.30	4.30	3.60	3.70	4.50	n/a	4.60	5.30	n/a	3.10
2015 Annual Average	1.97	1.91	1.91	1.96	2.06	2.05	1.91	1.95	2.09	1.88	1.92	2.15	2.12	1.95	2.12	1.95	2.09	2.12	1.99	2.02	2.04	2.01	2.01	2.08	2.25	2.16	2.28	2.15	1.96	2.33	2.13	2.18	2.31	2.25	2.18	2.00	2.28	1.84	2.39	2.40	2.40	2.34	2.30	2.28	2.17	2.16	2.49	2.17	n/a
2016 Annual Average	1.98	1.94	1.94	2.05	n/a	n/a	1.99	2.06	n/a	1.94	2.00	2.22	n/a	2.09	2.19	1.99	2.13	2.14	2.03	2.06	1.99	2.04	1.95	1.97	2.25	2.12	2.34	1.97	2.00	2.37	n/a	2.13	2.35	2.35	2.24	1.94	2.37	1.65	n/a	2.50	2.45	2.23	2.30	2.24	n/a	2.13	2.44	n/a	2.11

6.4. Total Reduced Sulphur

Figure 22 and Table 8 compare the TRS 1-hour average measurements in 2015 and 2016 for 25 stations in Alberta. Of the 19 sites with data in both 2015 and 2016, 15 stations showed equal or lower. Some stations show reduction in TRS maximum monthly 99th percentile values in 2016 than in 2015. The TRS annual averages values are lower for 2016 at 12 of the 19 stations with data for both years.

Seventeen sites had a full year of TRS data in 2015. The number of months of available data is shown in brackets for the following stations missing data in 2015:

- Clairmont Portable [9]
- Millennium Mine [8]
- Stony Mountain (Conklin Lookout) [5]
- Rimbey Townsite [4]
- Eagle Hills South [3]
- Crossfield-Carstairs (Portable) [3]
- Rimbey-Simpson [2]
- Sundre Northeast [2]

Fifteen 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]
- PRAMP Reno [10]
- Hinton [4]
- Millennium Mine [0]
- Clairmont-Portable [0]
- Rimbey Townsite [0]
- Sundre Northeast [0]
- Crossfield-Carstairs (Portable) [0]
- Eagle Hills South [0]

The 99th percentile of the 2016 data for stations 986 and 842 was 1 ppbv and did not change from 2015 to 2016. The 99th percentile of the 2015 data for the Reno station was also 1 ppbv. The resolution of the TRS instrument is 1 ppbv which is the most common 99th percentile value for all of the stations.

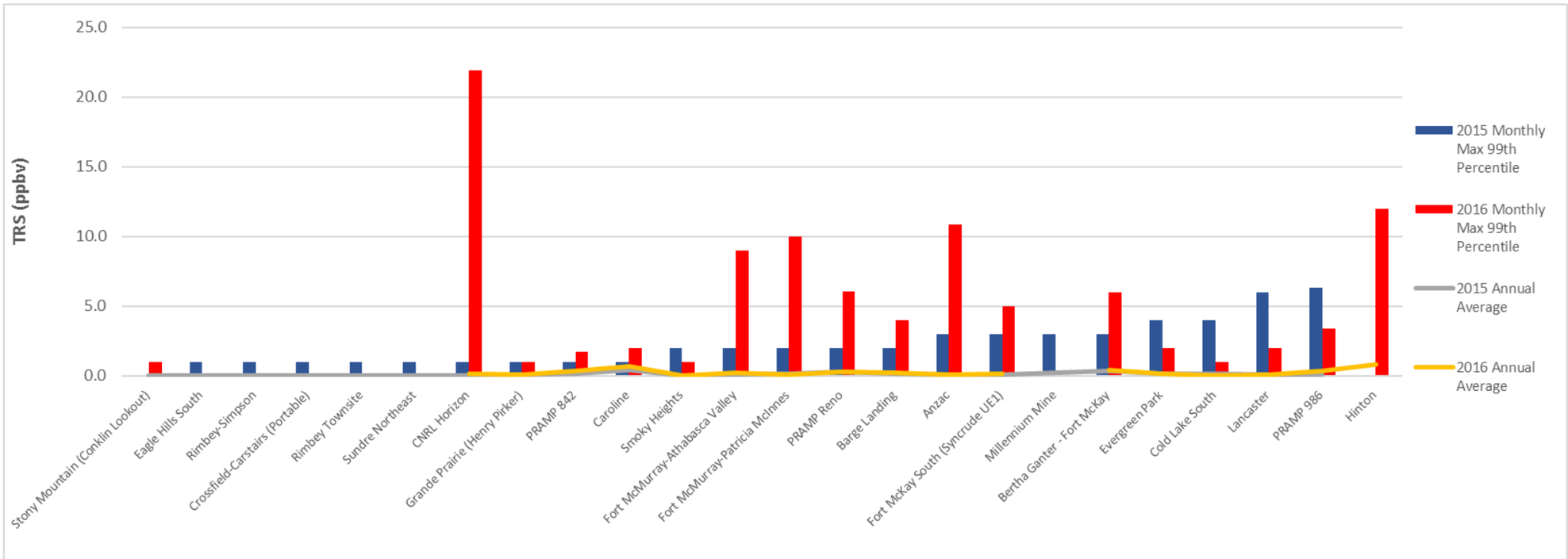


FIGURE 22: TRS 1-hour Average Measurements in Alberta in 2015 and 2016

Table 8: TRS 1-hour Average Measurements in Alberta in 2015 and 2016 (ppbv)

Sorted Results	Stony Mountain (Conklin Lookout)	Eagle Hills South	Rimbey-Simpson	Crossfield-Carstairs (Portable)	Rimbey Townsite	Sundre Northeast	CNRL Horizon	Grande Prairie (Henry Pirker)	PRAMP 842	Caroline	Smoky Heights	Fort McMurray-Athabasca Valley	Fort McMurray-Patricia McInnes	PRAMP Reno	Barge Landing	Anzac	Fort McKay South (Syncrude UE1)	Millennium Mine	Bertha Ganter - Fort McKay	Evergreen Park	Cold Lake South	Lancaster	PRAMP 986	Hinton
2015 Monthly Max 99th Percentile	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0	4.0	4.0	6.0	6.3	n/a
2016 Monthly Max 99th Percentile	1.0	n/a	n/a	n/a	n/a	n/a	21.9	1.0	1.7	2.0	1.0	9.0	10.0	6.1	4.0	10.8	5.0	n/a	6.0	2.0	1.0	2.0	3.4	12.0
2015 Annual 99th Percentile	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0	1.0	2.0	2.0	1.0	2.0	1.0	1.0	n/a
2016 Annual 99th Percentile	1.0	n/a	n/a	n/a	n/a	n/a	2.0	1.0	0.8	1.0	1.0	4.0	2.0	1.8	2.0	1.0	2.0	n/a	2.0	1.0	1.0	1.0	1.4	7.0
2015 Annual Average	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.0	0.1	0.2	0.3	0.2	0.1	0.1	0.2	0.4	0.2	0.1	0.1	0.1	n/a
2016 Annual Average	0.0	n/a	n/a	n/a	n/a	n/a	0.2	0.1	0.3	0.7	0.0	0.3	0.1	0.3	0.2	0.1	0.1	n/a	0.4	0.1	0.0	0.1	0.4	0.8

7. COMPLAINTS AND 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 842 showed a decrease in the number of complaints from 39 in 2015 to 15 in 2016
- Station 986 showed a decrease in the number of complaints from 6 in 2015 to 4 in 2016
- Reno Station showed a decrease in the number of complaints from 11 in 2015 to 2 in 2016

The associated time, meteorological data (wind speed and wind direction), THC reading, and triggered canister event were all correlated against each complaint. If the complaint did not occur on the clock hour (for example, complaint time is recorded as 21:30), meteorological data and concentrations from both bordering clock hours were considered in the correlation assessment.

Based on the latitude and longitude of the complaint, meteorological data (wind speed and wind direction), and THC concentration, are recorded for 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. Appendix C has a complete record of complaints for 2015-16.

Each chart in Sections 7.1 to 7.3 shows the THC readings on the primary Y axis. Complaints are shown in the legend. Complaints without elevated THC present may suggest that concentrations of sulphur compounds are responsible. However, a correlation between complaints, TRS, and SO_2 concentrations was also assessed but no relationship was found.

7.1. Station 842

Figure 40 shows the correlation between the complaints and the monitored data for THC Station 842. Complaints reported for this station include formal complaints received from the AER.

In 2016, there is a marked decrease in the number of complaints received with some of the complaints occurring during hours with marginally elevated THC concentrations. The complaint record dating back to 2014 shows an overall decrease in the number of complaints received by the AER.

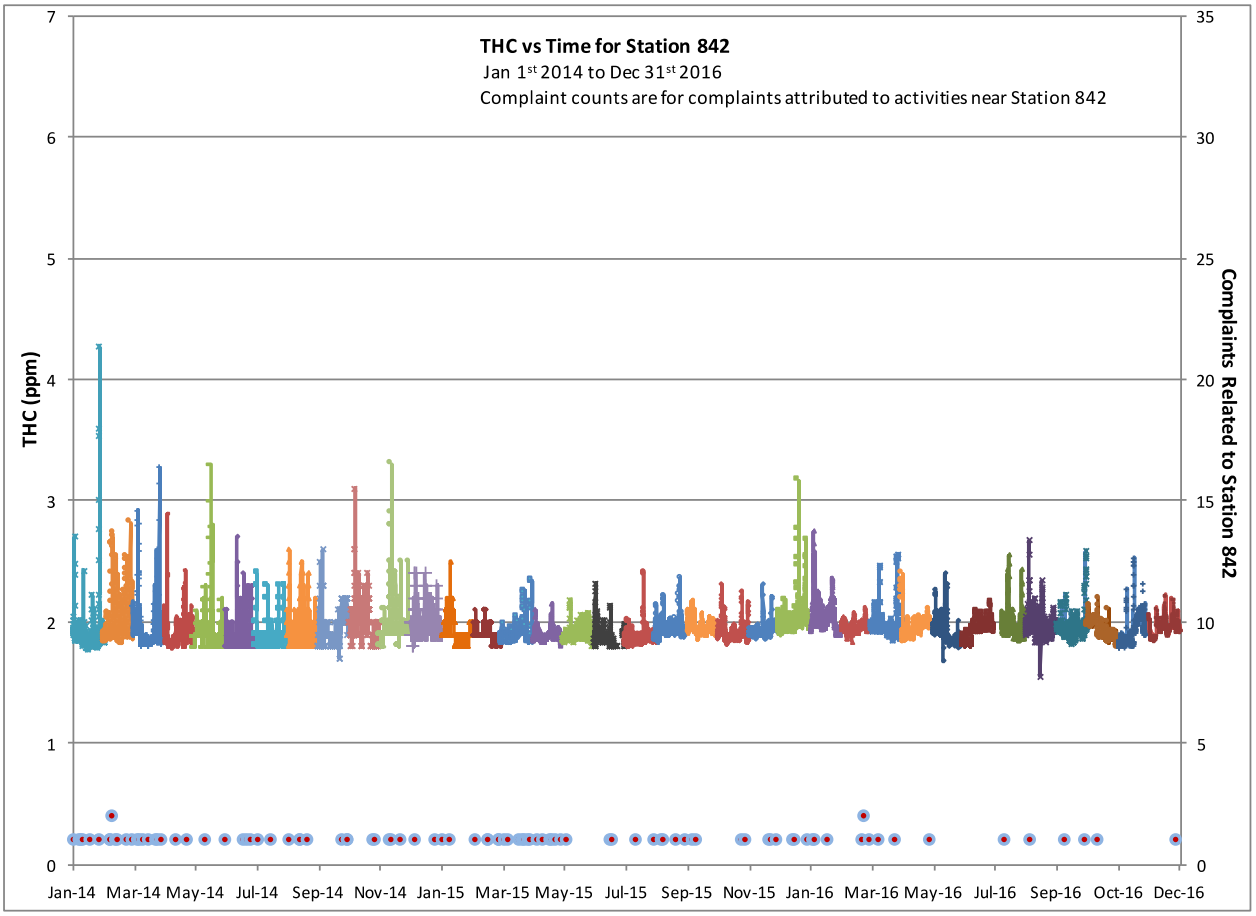


Figure 42: THC and Complaints Correlation at Station 842

7.2. Station 986

Figures 41 shows the correlation between the complaints and the monitored data for THC at Station 986. There were fewer complaints recorded around this station than Station 842. The complaint record dating back to 2014 shows an overall decrease in the number of complaints received by the AER.

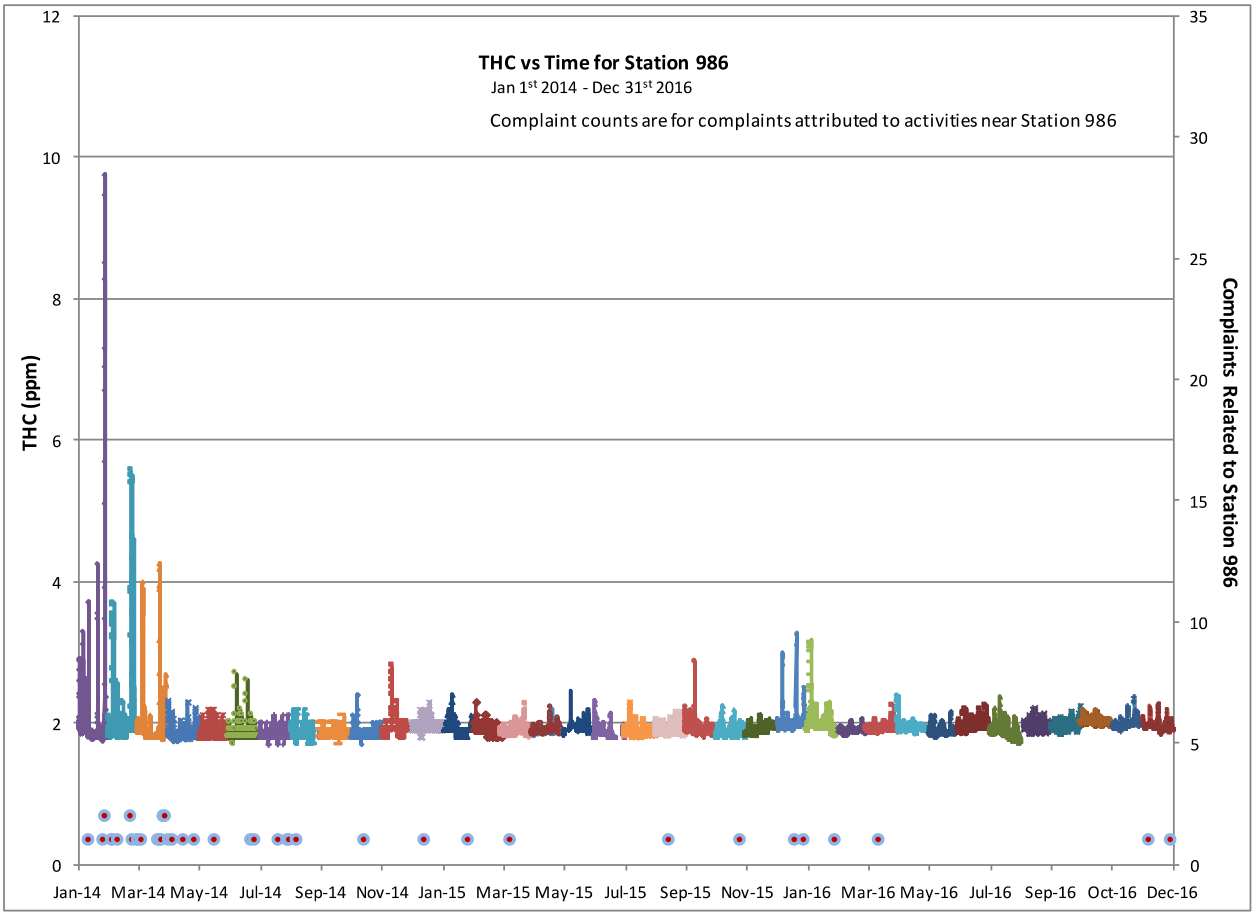


Figure 43: THC and Complaints Correlation for Station 986

7.3. Reno Station

Figures 42 shows the correlation between the complaints and the monitored data for THC at Reno Station. Other contaminants do not appear to have correlation with complaints. Similar to the other stations in the PRAMP network, the complaint record dating back to 2014 shows an overall decrease in the number of complaints received by the AER.

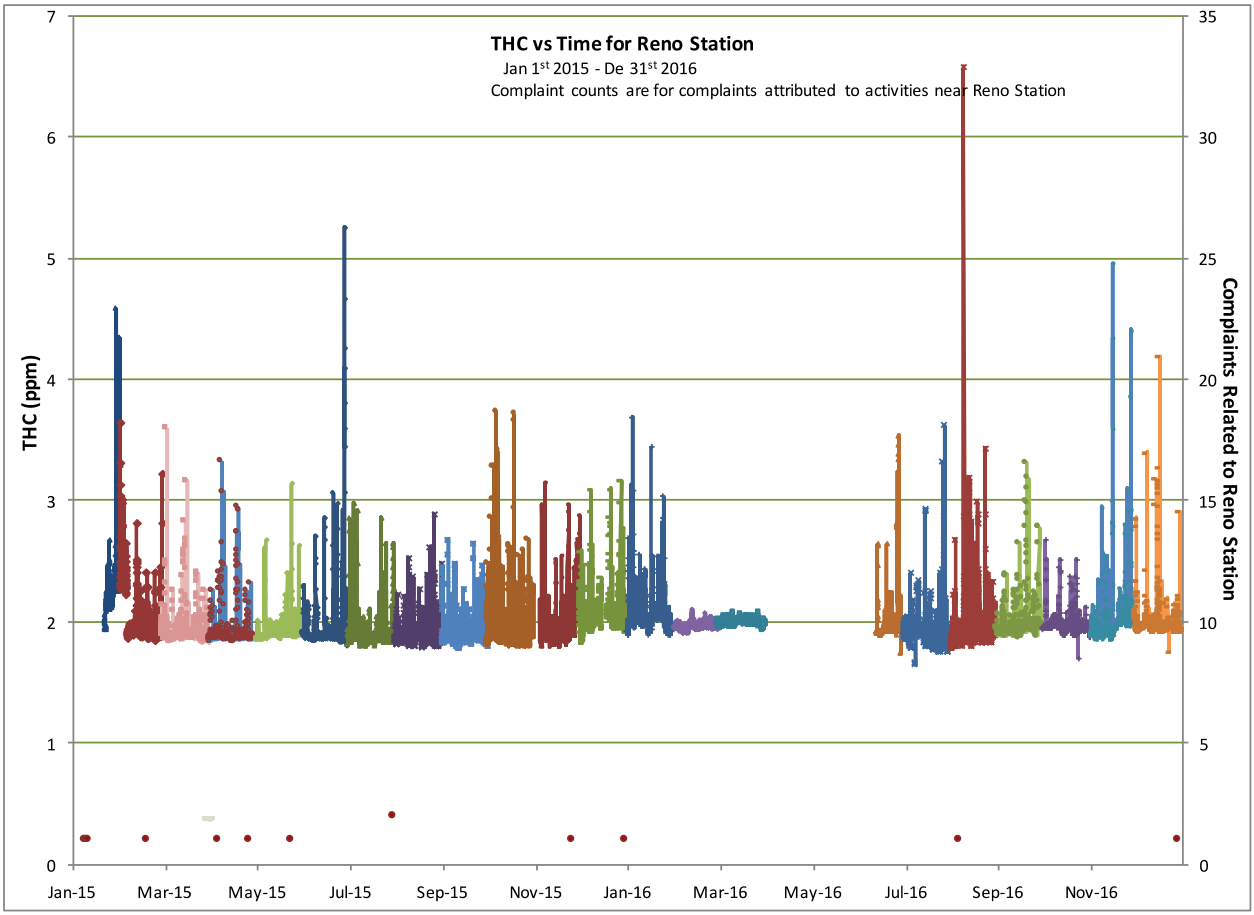


Figure 44: THC and Complaints Correlation for Reno Station

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 2015 and 2016. 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 2015 and 2016 depending on the metric examined (average, 99^{th} percentile, 90^{th} percentile, etc.). 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 lower than the historical maximums at 986 and 842. To improve the collective understanding of air quality in the region, PRAMP is investigating the potential causes for these elevated measurements and sporadic 'spikes'. This ongoing investigation may include additional monitoring, credible third-party data sources, further study of existing PRAMP data in 2017-18, and field surveillance. The extent of the production shutdown in the Reno area in 2016 (noted in section 3.1) and the potential influence it had on air quality is also being investigated.

Although the number of canister events has decreased over time, further analysis of the historical analytical data is required to understand the changes-over-time in ambient concentrations of hydrocarbon species of interest. In 2015, AEP completed a preliminary assessment of the hydrocarbon species measured through PRAMP's canister program; that study may serve as a template for PRAMP to complete an updated analysis of new data.

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 is currently underway to ensure that appropriate corrective actions are implemented to eliminate data loss.

9. REFERENCES

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APPENDIX A
Monitoring Station Audit

measure. assess. inform.

Alberta Environmental Monitoring, Evaluation and Reporting Agency

aemera.org

AEMERA Monitoring
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Edmonton, AB, T6E 5K1
Telephone: 780.427.7888
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April 15, 2016

Ms. Allison Fisher
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Senior Environmental Coordinator
Baytex Energy Limited
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Calgary, Alberta, T2P 0R3

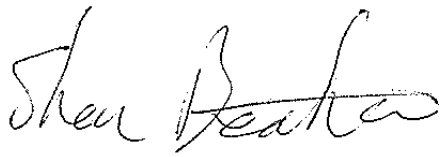
Dear Ms. Fisher, Ms. Friesen, and Mr. Travers:

Subject: PRAMP Ambient Air Monitoring Station Audits

AEMERA has received and reviewed the Shell Peace River In-situ response letter dated April 15, 2016. Based on the content of the letter and timelines provided, although AEMERA has not yet verified the findings, AEMERA is satisfied that all items noted have or are being addressed.

Should you have any questions or concerns please contact the undersigned via email at shea.beaton@aemera.org or via telephone at 780 427-7888.

Yours truly,



Shea Beaton
Monitoring Systems Auditor

Attachments - None
cc: Karla Reesor – Pramp Facilitator
Kate Humphreys, Robyn Kutz Semeniuk – Shell Canada
Anthony Traverse - Baytex
Bob Myrick - AEMERA
Doug Wong – AER, Michael Zelensky – AER, Wally Qiu – AER, Yan Liu – AEP
Trina Whitsitt – Maxxam Analytics

Audit Summary

Facility / Zone	PRAMP
Total # of parameters that passed	9
Total # of parameters audited in the network	9
Date(s) of the audit	March 8, 2016
Issue Date of Audit Summary	March 15, 2016

Station Name	PRAMP Three Creeks 986b		
Auditor	Shea Beaton / Al Clark		
Audit Date	March 8, 2016		
Critical	**Pass**	**Fail**	
H_2S	x		
SO_2	x		
TRS	x		
NMHC	x		
Wind Speed / Wind Direction	x		
Wind head Orientation	x		
Manifold Fan	x		
Zero/Span Systems Operational	x		

Inspection Items	**OK**	**Need for Improvement**	
Sample pump venting/scrubbing	x		
Heating / Air Conditioning	x		
Manifold		**x**	Dusty
Sample Lines	x		
Safety	x		
Site Conditions	x		

Non-critical	**OK**	**Opportunity for Improvement**	
RH	x		
Station Temperature		**x**	+/- 1˚C
Ambient Temperature		**x**	+/- 1˚C
Station Condition	x		
Station Documentation		**x**	Needs review / or missing

Not monitored at this location

Audit Summary

Facility / Zone	PRAMP
Total # of parameters that passed	9
Total # of parameters audited in the network	9
Date(s) of the audit	March 8, 2016
Issue Date of Audit Summary	March 15, 2016

Station Name	PRAMP Three Creeks 842b		
Auditor	Shea Beaton / Al Clark		
Audit Date	March 8, 2016		
Critical	**Pass**	**Fail**	
H_2S	x		
SO_2	x		
TRS	x		
NMHC	x		
Wind Speed / Wind Direction	x		
Wind head Orientation	x		
Manifold Fan	x		
Zero/Span Systems Operational	x		

Inspection Items	**OK**	**Need for Improvement**	
Sample pump venting/scrubbing	x		
Heating / Air Conditioning	x		
Manifold		**x**	Dirty
Sample Lines	x		
Safety	x		
Site Conditions	x		

Non-critical	**OK**	**Opportunity for Improvement**	
RH	x		
Station Temperature	x		
Ambient Temperature	x		
Station Condition	x		
Station Documentation		**x**	Needs review / or missing

Not monitored at this location

Audit Summary

Facility / Zone	PRAMP
Total # of parameters that passed	9
Total # of parameters audited in the network	9
Date(s) of the audit	March 8, 2016
Issue Date of Audit Summary	March 15, 2016

Station Name	PRAMP Reno		
Auditor	Shea Beaton / Al Clark		
Audit Date	March 8, 2016		
Critical	**Pass**	**Fail**	
H_2S	x		
SO_2	x		
TRS	x		
NMHC	x		
Wind Speed / Wind Direction	x		
Wind head Orientation	x		
Manifold Fan	x		
Zero/Span Systems Operational	x		

Inspection Items	**OK**	**Need for Improvement**	
Sample pump venting/scrubbing	x		
Heating / Air Conditioning	x		
Manifold		**x**	Dusty
Sample Lines	x		
Safety	x		
Site Conditions	x		

Non-critical	**OK**	**Opportunity for Improvement**	
RH	x		
Station Temperature		**x**	+/- 1˚C
Ambient Temperature	x		
Station Condition	x		
Station Documentation		**x**	Needs review / or missing

Not monitored at this location

STATION AUDIT

File No. 2015 - 155A/157A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: PRAMP Reno Location: Reno

Facility/Zone: PRAMP Operator: Maxxam

Temp: 21.8 C Barometric Press: 700mmHg

Location

Latitude N 55°, 52', 10.7"

Longitude W 117°, 03', 27.1"

Elevation 641m

Status of Site Documentation **On Site - Incomplete**

Manifold Material Glass

Manifold Condition Good

Meteorological

	Observed	Audit Value
Wind Speed Direction	193° 2.6 Km/H	SSW 3-5 Km/H
Station Temperature	**16.4 C**	18.4 C
Relative Humidity	59.1%	59.3%
Ambient Temperature	3.7 C	3.3 C
Solar Radiation	NA	NA
Precipitation	NA	NA

Remarks:

- Site documents missing maps, site plan view and cross section view. Needs review and update.
- Station temp sensor reading 2 °C low

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SO_2 ANALYZER AUDIT

File No. 2015 - 155A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: PRAMP Reno Location: Reno

Facility/Zone: PRAMP Operator: Maxxam

Temp. 21.8 C Barometric Press. 700 mmHg

Monitor

Make/Model: API 100A Serial No: 1298

Inlet flow (sccm): 584 Full Scale Range ppm: 0.5

Last cal. Date: February 11, 2016 Old Correction Factor: 0.999

Zero/Bkg 67.5

Span Coef 0.935

Calibrator

Calibration Method: GAS DILUTION

Make/Model: R&R MFC 201 AMU # : 1698

Cylinder # : CAL016720 SO_2 Concentration PPM: 98.57

Calibrator Flow (sccm)			Calculated Conc. (ppm)	Indicated Concentration (ppm)	% Difference	
Air	Gas	Total			vs Audit Gas	Limits
4976	0.0	4976	0.000	0.001		
4993	19.9	5013	0.391	0.388	-1%	± 10%
4995	9.8	5005	0.192	0.192	-1%	± 10%
4996	4.9	5001	0.096	0.095	-2%	± 10%
				Absolute Average Percent Difference	1%	

Linear Regression Analysis:

y=mx+b (where x=calculated concentration, y=indicated concentration)

		LIMITS
Correlation Coeff.=	1.0000	**≥ 0.995**
m (Slope)=	0.9912	**0.85-1.15**
b (Intercept as % of full scale)=	0.1227	**± 3% F.S.**

Remarks:

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TRS ANALYZER AUDIT

File No. 2015 - 156A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: PRAMP Reno Location: Reno

Facility/Zone: PRAMP Operator: Maxxam

Temp. 21.8 C Barometric Press. 700 mmHg

Monitor

Make/Model: Thermo 43C Serial No: 43C-59358 - 322

Inlet flow (sccm): 829 Full Scale Range ppm: 0.1

Last cal. Date: February 11, 2016 Old Correction Factor: 1.001

Zero/Bkg 71

Span Coef 1.06

Calibrator

Calibration Method: GAS DILUTION

Make/Model: R&R MFC 201 AMU # : 1698

Cylinder # : CAL015106 H_2S Concentration PPM: 20.43

Calibrator Flow (sccm)			Calculated Conc. (ppm)	Indicated Concentration (ppm)	% Difference	
Air	Gas	Total			vs Audit Gas	Limits
4976	0.0	4976	0.0000	0.0003		
4995	18.5	5013	0.0752	0.0765	1%	± 10%
4996	9.1	5005	0.0372	0.0380	1%	± 10%
4996	4.6	5001	0.0189	0.0194	1%	± 10%
				Absolute Average Percent Difference	1%	

Linear Regression Analysis:

y=mx+b (where x=calculated concentration, y=indicated concentration)

		LIMITS
Correlation Coeff.=	1.0000	**≥ 0.995**
m (Slope)=	1.0135	**0.85-1.15**
b (Intercept as % of full scale)=	0.2839	**± 3% F.S.**

Remarks:

aemera.org

Non Methane Analyzer Audit

File No. 2015 - 157A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station:

Name: PRAMP Reno Location: Reno Operator: Maxxam

Facility/Zone: PRAMP Temp. 21.8 C BP: 700 mmHg

Monitor:

Make/Model: Thermo 55i Serial No. 1505664392

Inlet flow (sccm): CH_4 Range ppm: 20

Last cal. Date: February 11, 2016 Non CH_4 Range ppm: 20

THC Range ppm: 40

Old Correction Factor: CH_4: 0.999

Non CH_4: 1.004

THC: 1.001

Calibration Method: Gas Dilution

Calibrator: Make/Model R&R MFC 201 AMU# 1698

HC cylinder # FF27932 CH_4 conc. (ppm) 500.0 CH_4 Equiv (Propane only) (ppm) 550.0

Propane conc. (ppm) 200.0 Total CH_4 Equiv. (ppm) 1050.0

Calibrator Flows			Calc. Conc.			Indicated Concentration			% Difference vs Audit Gas		
			CH_4	Non CH_4	THC	CH_4	Non CH_4	THC	Limit ± 10%		
Air	Gas	Total	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	CH_4	Non CH_4	THC
2986	0.0	2986	0.00	0.00	0.00	0.00	0.00	0.00			
2989	80.6	3070	13.13	14.45	27.58	12.79	14.00	26.79	-3%	-3%	-3%
3016	40.4	3056	6.62	7.28	13.89	6.56	7.08	13.68	-1%	-3%	-2%
3037	20.5	3057	3.35	3.68	7.03	3.37	3.65	7.02	1%	-1%	0%
					Absolute Average Percent Difference				1%	2%	2%

Linear Regression Analysis: *y=mx+b (where x=calculated concentration, y=indicated concentration)*

	CH_4	**Non CH_4**	**THC**	**LIMITS**
Correlation Coeff.=	0.9999	1.0000	1.0000	**≥ 0.995**
m (Slope)=	0.9720	0.9673	0.9697	**0.85-1.15**
b (Intercept as % of FS)=	0.3373	0.1920	0.2844	**± 3% F.S.**

Remarks:

aemera.org

Station Performance Audit Summary

Company: PRAMP Facility Name: NA

Approval No.: NA Site Name: PRAMP Reno

Region: Upper Peace District:

Parameters audited:

H_2S		SO_2	x	NO_X		NH_3		O_3	
CO		CH_4	x	NonCH4	x	THC	x	Ethylene	
$PM_{2.5}$		PM_{10}		TSP		BTEX		Wind Speed	x
Wind Dir	x	Amb. Temp	x	Stn.Temp	x	RH	x	Solar Radiation	
Rainfall		Precip		VWS		Other	TRS		
All parameters monitored as per approval: Yes_____ No _____ N/A___x___									

	YES	NO	N/A
GENERAL			
Has the location remained unchanged from previous audit?			x
Is site secure?	x		
Are station operating conditions adequate?	x		
DATA ACQUISITION			
Are strip charts in use?		x	
Is a telemetry system for data acquisition in use?	x		
SYSTEM COMPONENTS			
Is a glass sampling manifold installed?	x		
Is sampling manifold clean?	x		
Is a manifold trap in place?	x		
Are spare manifold ports capped	x		
Is manifold oriented so it is not exactly horizontal?	x		
Are manifold ports situated to prevent water entering monitors?	x		
Is manifold pump properly installed and operative?	x		
Do sample lines extend at least 3/4"into manifold?	x		
Are monitor sampling lines connected to manifold?	x		
Are sampling lines clean?	x		
Are monitors properly mounted and secure?	x		
Are monitors properly exhausted from room or scrubbed?	x		
Are zero and span systems operational?	x		
WIND EQUIPMENT			
Is wind sensor properly oriented?	x		
Does wind equipment appear to be functioning properly?	x		
Date of last calibration. Date: September 15, 2015			

COMMENTS: Wind Speed range incorrect on wind system cal form, correct in DAS

AUDITOR: Shea Beaton / Al Clark DATE: March 8, 2016

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STATION AUDIT

File No. 2015 152A/154A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: Three Creeks 842 Location: Peace River - Three Creeks

Facility/Zone: PRAMP Operator: Maxxam

Temp: 21.1 C Barometric Press: 700 mmHg

Location

Latitude N 56°, 16', 26.9"
Longitude W 116°, 58', 52.8"
Elevation 615m
Status of Site Documentation **Incomplete; needs update**

Manifold Material Glass
Manifold Condition **Dusty - Cracked at Tee**

Meteorological

	Observed	Audit Value
Wind Speed Direction	202° 9.1 km/H	SSW 5-10 Km/H
Station Temperature	23.1 C	23.7 C
Relative Humidity	92.4%	86.6%
Ambient Temperature	-2.7	-2.1
Solar Radiation	NA	NA
Precipitation	NA	NA

Remarks:

- Site documents need update; station & analyzer information.
- Glass manifold tee has a crack on the sintered sealing surface connecting to water knock-out.

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SO_2 ANALYZER AUDIT

File No. 2015 - 152A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: Three Creeks 842 Location: Peace River - Three Creeks

Facility/Zone: PRAMP Operator: Maxxam

Temp. 21.1 C Barometric Press. 700 mmHg

Monitor

Make/Model: API 100A Serial No: 1502

Inlet flow (sccm): 617 Full Scale Range ppm: 0.5

Last cal. Date: February 17, 2016 Old Correction Factor: 1.001

Zero/Bkg 48.0

Span Coef 1.008

Calibrator

Calibration Method: GAS DILUTION

Make/Model: R&R MFC 201 AMU # : 1698

Cylinder # : CAL016720 SO_2 Concentration PPM: 98.57

Calibrator Flow (sccm)			Calculated Conc. (ppm)	Indicated Concentration (ppm)	% Difference	
Air	Gas	Total			vs Audit Gas	Limits
4988	0.0	4988	0.000	0.000		
5005	20.0	5025	0.391	0.386	-1%	± 10%
4991	9.8	5001	0.193	0.190	-2%	± 10%
5000	4.9	5005	0.096	0.093	-3%	± 10%
				Absolute Average Percent Difference	2%	

Linear Regression Analysis:

y=mx+b (where x=calculated concentration, y=indicated concentration)

		LIMITS
Correlation Coeff.=	1.0000	**≥ 0.995**
m (Slope)=	0.9880	**0.85-1.15**
b (Intercept as % of full scale)=	-0.1727	**± 3% F.S.**

Remarks:

aemera.org

TRS ANALYZER AUDIT

File No. 2015 - 153

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: Three Creeks 842 Location: Peace River - Three Creeks

Facility/Zone: PRAMP Operator: Maxxam

Temp. 21.1 C Barometric Press. 700 mmHg

Monitor

Make/Model: Thermo 43i Serial No: 1314057761

Inlet flow (sccm): 433 Full Scale Range ppm: 0.1

Last cal. Date: 17-Feb-16 Old Correction Factor: 1.000

Zero/Bkg 8.4

Span Coef 0.996

Calibrator

Calibration Method: GAS DILUTION

Make/Model: R&R MFC 201 AMU # : 1698

Cylinder # : CAL015106 H_2S Concentration PPM: 20.43

Calibrator Flow (sccm)			Calculated Conc. (ppm)	Indicated Concentration (ppm)	% Difference	
Air	Gas	Total			vs Audit Gas	Limits
4988	0.0	4988	0.0000	0.0001		
5007	18.5	5025	0.0750	0.0742	-1%	± 10%
4992	9.0	5001	0.0369	0.0368	-1%	± 10%
5000	4.6	5005	0.0187	0.0181	-4%	± 10%
				Absolute Average Percent Difference	2%	

Linear Regression Analysis:

y=mx+b (where x=calculated concentration, y=indicated concentration)

		LIMITS
Correlation Coeff.=	1.0000	**≥ 0.995**
m (Slope)=	0.9905	**0.85-1.15**
b (Intercept as % of full scale)=	-0.0576	**± 3% F.S.**

Remarks:

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Non Methane Analyzer Audit

File No. 2015 - 154A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station:

Name: Three Creeks 842 Location: Peace River - Three Creeks Operator: Maxxam

Facility/Zone: PRAMP Temp. 21.1 C BP: 700 mmHg

Monitor:

Make/Model: Thermo 55i Serial No. 12236656188

Inlet flow (sccm):

Last cal. Date: February 17, 2016

CH_4 Range ppm: 20

Non CH_4 Range ppm: 20

THC Range ppm: 40

Old Correction Factor: CH_4: 1.001

Non CH_4: 0.999

THC: 1.000

Calibration Method: Gas Dilution

Calibrator: Make/Model R&R MFC 201 AMU# 1698

HC cylinder # FF27932 CH_4 conc. (ppm) 500.0 CH_4 Equiv (Propane only) (ppm) 550.0

Propane conc. (ppm) 200.0 Total CH_4 Equiv. (ppm) 1050.0

Calibrator Flows			Calc. Conc.			Indicated Concentration			% Difference vs Audit Gas		
									Limit ± 10%		
Air	Gas	Total	CH_4 (ppm)	Non CH_4 (ppm)	THC (ppm)	CH_4 (ppm)	Non CH_4 (ppm)	THC (ppm)	CH_4	Non CH_4	THC
2993	0.0	2993	0.00	0.00	0.00	0.00	0.00	0.01			
2992	81.1	3073	13.20	14.52	27.72	12.78	13.97	26.75	-3%	-4%	-4%
3019	40.0	3059	6.54	7.20	13.74	6.54	7.08	13.63	0%	-2%	-1%
3032	20.2	3052	3.30	3.63	6.94	3.31	3.60	6.92	0%	-1%	0%
								Absolute Average Percent Difference	1%	2%	2%

Linear Regression Analysis: *y=mx+b (where x=calculated concentration, y=indicated concentration)*

	CH_4	Non CH_4	THC	LIMITS
Correlation Coeff.=	0.9998	0.9999	0.9999	**≥ 0.995**
m (Slope)=	0.9670	0.9608	0.9634	**0.85-1.15**
b (Intercept as % of FS)=	0.4276	0.3612	0.4244	**± 3% F.S.**

Remarks:

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Station Performance Audit Summary

Company: PRAMP Facility Name: Three Creeks

Approval No.: NA Site Name: 842b

Region: Lower Peace District:

Parameters audited:

H_2S		SO_2	X	NO_X		NH_3		O_3	
CO		CH_4	X	NonCH4	X	THC	X	Ethylene	
$PM_{2.5}$		PM_{10}		TSP		BTEX		Wind Speed	X
Wind Dir	X	Amb. Temp	X	Stn.Temp	X	RH	X	Solar Radiation	
Rainfall		Precip		VWS		Other	TRS		
All parameters monitored as per approval: Yes_____ No _____ N/A__X____									

	YES	NO	N/A
GENERAL			
Has the location remained unchanged from previous audit?	x		
Is site secure?	x		
Are station operating conditions adequate?	x		
DATA ACQUISITION			
Are strip charts in use?		x	
Is a telemetry system for data acquisition in use?	x		
SYSTEM COMPONENTS			
Is a glass sampling manifold installed?	x		
Is sampling manifold clean?		**x**	
Is a manifold trap in place?	x		
Are spare manifold ports capped	x		
Is manifold oriented so it is not exactly horizontal?	x		
Are manifold ports situated to prevent water entering monitors?	x		
Is manifold pump properly installed and operative?	x		
Do sample lines extend at least 3/4"into manifold?	x		
Are monitor sampling lines connected to manifold?	x		
Are sampling lines clean?	x		
Are monitors properly mounted and secure?	x		
Are monitors properly exhausted from room or scrubbed?	x		
Are zero and span systems operational?	x		
WIND EQUIPMENT			
Is wind sensor properly oriented?	x		
Does wind equipment appear to be functioning properly?	x		
Date of last calibration. Date: July 9, 2015			

COMMENTS: - Wind speed output range wrong on wind cal form but correct in DAS
- Sampling manifold and inlet dirty - crack in glass TEE on sintered sealing surface connecting to water knock-out

AUDITOR: Shea Beaton / Al Clark DATE: March 8, 2016

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STATION AUDIT

File No. 2015 149A/151A

Date: March 8, 2016 Performed by: Shea Beaton/Al Clark

Station

Name: Three Creeks 986b Location: Peace River Three Creeks

Facility/Zone: PRAMP Operator: Maxxam

Temp: 23.3 C Barometric Press: 702mmHg

Location

Latitude N 56.3760

Longitude W -116.9406

Elevation 599m

Status of Site Documentation **On Site - Incomplete**

Manifold Material Glass

Manifold Condition Dusty

Meteorological

	Observed	Audit Value
Wind Speed Direction	165deg / 5 Km/H	SSE / 5-10 Km/H
Station Temperature	**24.3 C**	22.0 C
Relative Humidity	82%	90%
Ambient Temperature	**-1.2**	-2.7
Solar Radiation	NA	NA
Precipitation	NA	NA

Remarks:

Ambient temperature Sensor reading 1.5C higher than audit standard - Recommend sensor calibration. Station temperature sensor 2.3 C higher than audit standard.

Site Documents need to be updated; photos showing previous station installation and interior Plan and cross section view as required by SS 4-D (b & c) missing.

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SO_2 ANALYZER AUDIT

File No. 2015-149A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: Three Creeks 986b Location: Peace River - Three Creeks

Facility/Zone: PRAMP Operator: Maxxam

Temp. 23.3 Barometric Press. 702mmHg

Monitor

Make/Model: Thermo 43C Serial No: 43C-62339-335

Inlet flow (sccm): 720 Full Scale Range ppm: 0.5

Last cal. Date: February 10, 2016 Old Correction Factor: 1.000

Zero/Bkg 65.4

Span Coef 0.907

Calibrator

Calibration Method: GAS DILUTION

Make/Model: R&R MFC 201 AMU # : 1698

Cylinder # : CAL016720 SO_2 Concentration PPM: 98.57

Calibrator Flow (sccm)			Calculated Conc. (ppm)	Indicated Concentration (ppm)	% Difference	
Air	Gas	Total			vs Audit Gas	Limits
5009	0.0	5009	0.0000	0.001		
5036	19.9	5056	0.3880	0.393	1%	± 10%
5009	9.8	5019	0.1923	0.193	0%	± 10%
5008	4.9	5013	0.0956	0.095	-2%	± 10%
			Absolute Average Percent Difference		0%	

Linear Regression Analysis:

y=mx+b (where x=calculated concentration, y=indicated concentration)

		LIMITS
Correlation Coeff.=	1.0000	**≥ 0.995**
m (Slope)=	1.0120	**0.85-1.15**
b (Intercept as % of full scale)=	-0.0965	**± 3% F.S.**

Remarks:

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TRS ANALYZER AUDIT

File No. 2015-150A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station

Name: Three Creeks 986b Location: Peace River - Three Creeks

Facility/Zone: PRAMP Operator: Maxxam

Temp. 23.3 Barometric Press. 702

Monitor

Make/Model: Thermo 43i Serial No: 1314057760

Inlet flow (sccm): 408 Full Scale Range ppm: 0.1

Last cal. Date: February 23, 2016 Old Correction Factor: 1.001

Zero/Bkg 9.5

Span Coef 0.915

Calibrator

Calibration Method: GAS DILUTION

Make/Model: R&R MFC 201 AMU # : 1698

Cylinder # : CAL015106 H_2S Concentration PPM: 20.43

Calibrator Flow (sccm)			Calculated Conc. (ppm)	Indicated Concentration (ppm)	% Difference	
Air	Gas	Total			vs Audit Gas	Limits
5009	0.0	5009	0.0000	-0.0001		
5038	18.4	5056	0.0744	0.0726	-2%	± 10%
5010	9.0	5019	0.0368	0.0349	-5%	± 10%
5008	4.6	5013	0.0187	0.0178	-4%	± 10%
				Absolute Average Percent Difference	4%	

Linear Regression Analysis:

y=mx+b (where x=calculated concentration, y=indicated concentration)

		LIMITS
Correlation Coeff.=	0.9999	**≥ 0.995**
m (Slope)=	0.9776	**0.85-1.15**
b (Intercept as % of full scale)=	-0.4474	**± 3% F.S.**

Remarks:

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Non Methane Analyzer Audit

File No. 2015-151A

Date: March 8, 2016 Performed by: Shea Beaton / Al Clark

Station:

Name: Three Creeks 986b Location: Peace River - Three Creeks Operator: Maxxam

Facility/Zone: PRAMP Temp. 23.3 BP: 701mmHg

Monitor: Make/Model: Thermo 55i Serial No. 1022143392

Inlet flow (sccm): CH_4 Range ppm: 20

Last cal. Date: February 10, 2016 Non CH_4 Range ppm: 20

THC Range ppm: 40

Old Correction Factor: CH_4: 1.001

Non CH_4: 1.001

THC: 1.001

Calibration Method: Gas Dilution

Calibrator: Make/Model R&R MFC 201 AMU# 1698

HC cylinder # FF27932 CH_4 conc. (ppm) 500.0 CH_4 Equiv (Propane only) (ppm) 550.0

Propane conc. (ppm) 200.0 Total CH_4 Equiv. (ppm) 1050.0

Calibrator Flows			Calc. Conc.			Indicated Concentration			% Difference vs Audit Gas		
			CH_4	Non CH_4	THC	CH_4	Non CH_4	THC	Limit ± 10%		
Air	Gas	Total	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	CH_4	Non CH_4	THC
3030	0.0	3030	0.00	0.00	0.00	0.00	0.00	0.01			
3030	80.0	3110	12.86	14.15	27.02	12.52	13.68	26.22	-3%	-3%	-3%
3024	40.0	3064	6.53	7.18	13.71	6.40	6.94	13.33	-2%	-3%	-3%
3036	20.2	3056	3.31	3.64	6.95	3.27	3.51	6.75	-1%	-4%	-3%
					Absolute Average Percent Difference				2%	3%	3%

Linear Regression Analysis: *y=mx+b (where x=calculated concentration, y=indicated concentration)*

	CH_4	**Non CH_4**	**THC**	**LIMITS**
Correlation Coeff.=	1.0000	1.0000	1.0000	**≥ 0.995**
m (Slope)=	0.9724	0.9669	0.9703	**0.85-1.15**
b (Intercept as % of FS)=	0.1410	-0.0235	0.0290	**± 3% F.S.**

Remarks:

aemera.org

Station Performance Audit Summary

Company: PRAMP Facility Name: Three Creeks

Approval No.: NA Site Name: 986b

Region: Lower Peace District:

Parameters audited:

H_2S		SO_2	X	NO_X		NH_3		O_3	
CO		CH_4	X	NonCH4	X	THC	X	Ethylene	
$PM_{2.5}$		PM_{10}		TSP		BTEX		Wind Speed	X
Wind Dir	X	Amb. Temp	X	Stn.Temp	X	RH	X	Solar Radiation	
Rainfall		Precip		VWS		Other	TRS		
All parameters monitored as per approval: Yes_____ No _____ N/A__X____									

	YES	NO	N/A
GENERAL			
Has the location remained unchanged from previous audit?		X	
Is site secure?	X		
Are station operating conditions adequate?	X		
DATA ACQUISITION			
Are strip charts in use?		X	
Is a telemetry system for data acquisition in use?	X		
SYSTEM COMPONENTS			
Is a glass sampling manifold installed?	X		
Is sampling manifold clean?		X	
Is a manifold trap in place?	X		
Are spare manifold ports capped	X		
Is manifold oriented so it is not exactly horizontal?	X		
Are manifold ports situated to prevent water entering monitors?	X		
Is manifold pump properly installed and operative?	X		
Do sample lines extend at least 3/4"into manifold?	X		
Are monitor sampling lines connected to manifold?	X		
Are sampling lines clean?	X		
Are monitors properly mounted and secure?	X		
Are monitors properly exhausted from room or scrubbed?	X		
Are zero and span systems operational?	X		
WIND EQUIPMENT			
Is wind sensor properly oriented?	X		
Does wind equipment appear to be functioning properly?	X		
Date of last calibration. Date: June 9, 2015			

COMMENTS: - Sampling manifold dusty

- Tubing behind instrument rack messy; recommend tidying tubing.

AUDITOR: Shea Beaton / Al Clark DATE: March 8, 2016

aemera.org

Shell Canada Limited
400 – 4th Avenue S.W.
P.O. Box 100, Station M
Calgary, Alberta, T2P 2H5
Tel: (403) 691-3111
Internet www.shell.ca

April 15, 2016

Alberta Environmental Monitoring, Evaluation, and Reporting Agency
Main Floor Bldg 3 McIntyre Center, 4946 – 89th Street
Edmonton, AB, T6E 5K1

Attention: Shea Beaton (Email: shea.beaton@aemera.org)
Monitoring Systems Auditor

Re: **AEMERA Audit of the Peace River Area Monitoring Program (PRAMP) Ambient Air Monitoring Stations**

The Alberta Environmental Monitoring, Evaluation, and Reporting Agency (AEMERA) conducted an audit on the Peace River Area Monitoring Program (PRAMP) ambient air monitoring stations on March 8, 2016. This audit included three community-based continuous air monitors (986b, 842b, and Reno). Although AEMERA was satisfied that the instruments in the stations were operating properly and considers the audit closed, there were a number of audit finding recommendations for improvement put forward by AEMERA.

The Peace River multi-industry Air Quality Working Group (AQWG; which includes the local industry operators on PRAMP who manage the monitoring services contractor) evaluated the AEMERA audit finding recommendations. Table 1 below provides a summary of the AEMERA audit findings, as well as the actions that are being taken to address each recommendation. Expected completion dates to close off each action are also given.

Table 1: Summary of Actions to Address AEMERA Audit Finding Recommendations

Station	AEMERA Audit Finding Recommendation	Response / Action	Expected Completion Date
986b	The station site documents were found to be incomplete and require updating; pursuant to AMD Chapter 3 sections SS 4-D(b) and SS 4-D(c) both a plan view sketch and a cross sectional sketch must be added to the site documents and available at the station.	The necessary data will be gathered by Maxxam Analytics during the next scheduled site visit (currently set for April 19), and then the relevant sections of the site documents will be updated. The station site documents will be physically replaced during the Maxxam Analytics May site visit.	End of May, 2016
986b	The photos and instrument list need to be updated; these items have not been updated since the new shelter was put in place.	The necessary data will be gathered during the next scheduled site visit (currently set for April 19), and then the relevant sections of the site documents will be updated. The	End of May, 2016

Station	AEMERA Audit Finding Recommendation	Response / Action	Expected Completion Date
		station site documents will be physically replaced during the Maxxam Analytics May site visit.	
986b	The ambient temperature sensor was reading 1.5°C higher than the audit standard; it is recommended that the ambient temperature/RH sensor be serviced and calibrated.	During the next scheduled site visit (currently set for April 19), the temperature sensor will be removed for service/calibration and replaced with an alternate unit.	End of April, 2016
986b	The station temperature sensor was reading 2.3°C higher than the audit standard; correcting this issue is regarded as an opportunity for improvement.	The read-out was corrected by Maxxam Analytics based on this audit finding.	March 21, 2016 (Complete)
986b	The sample manifold was observed to be dusty and requires cleaning.	The manifold was cleaned by Maxxam Analytics, and will be routinely cleaned at subsequent visits.	March 21, 2016 (Complete)
842b	The station site documents were found to be incomplete and require updating; pursuant to AMD Chapter 3 sections SS 4-D(b) and SS 4-D(c) both a plan view sketch and a cross sectional sketch must be added to the site documents and available at the station.	The necessary data will be gathered by Maxxam Analytics during the next scheduled site visit (currently set for April 20), and then the relevant sections of the site documents will be updated. The station site documents will be physically replaced during the Maxxam Analytics May site visit.	End of May, 2016
842b	The photos and instrument list needs to be updated.	The necessary data will be gathered during the next scheduled site visit (currently set for April 20), and then the relevant sections of the site documents will be updated. The station site documents will be physically replaced during the Maxxam Analytics May site visit.	End of May, 2016
842b	The glass TEE installed in the manifold inlet system has a crack on the sintered sealing surface connecting the water knock-out to the manifold and inlet pipe. This crack does not appear to be compromising the integrity of the glass manifold inlet system but the TEE should be repaired or replaced to prevent the possibility of further damage to the manifold inlet system.	Maxxam Analytics is presently taking steps to identify whether the affected part(s) can be repaired or if they must be replaced. If replacement is required, the target completion date may extend into May, 2016.	End of May, 2016
842b	The manifold was observed to be dirty and requires cleaning.	The manifold was cleaned by Maxxam Analytics, and will be routinely cleaned at subsequent visits.	March 16, 2016 (Complete)
Reno	The station site documents were found to be incomplete and require updating; pursuant to AMD Chapter 3 sections SS 4-D(b) and SS 4-D(c) both a plan view sketch and a cross sectional sketch must be added to the site documents and available at the station.	This station ceased operation on March 31, 2016 and will be removed in April. No action required.	March 31, 2016 (Complete)

Station	AEMERA Audit Finding Recommendation	Response / Action	Expected Completion Date
Reno	A site description (SS 4-B (j)) and an area map (SS 4-D (a)) are also required.	This station ceased operation on March 31, 2016 and will be removed in April. No action required.	March 31, 2016 (Complete)
Reno	The station temperature sensor is reading 2°C lower than the audit standard – correcting this issue is regarded as an opportunity for improvement	The read-out was corrected by Maxxam Analytics based on this finding.	March 21, 2016 (Complete)
All	As an ambient air monitoring network PRAMP is required to have current network site documentation that meets the requirements of AMD Chapter 3 SS 4-C. This document will need to be completed and made available to AEMERA's audit team for inspection.	This audit recommendation has been put on the agenda for the next PRAMP Committee meeting, set for April 18, 2016. The PRAMP Committee has an existing Monitoring Plan Report, which may assist in satisfying this request for site documentation and network details. However, this audit recommendation shall be addressed via separate cover from the PRAMP Committee following the April 18, 2016 meeting.	End of May, 2016 (via PRAMP Committee)

We trust that the above information meets your current requirements. If you have any questions, please do not hesitate to contact PRAMP (Karla Reesor; 403-807-2995; karlareesor@movingfwd.ca) or the AQWG (Allison Fisher; 403-691-4536; allison.fisher@shell.com)

Sincerely,

Allison Fisher, B.Sc. Hons., M.A.Sc.
Peace River Industry Air Quality Working Group Chair
Regional Specialist – Air, Noise, and Environmental Reporting
Shell Canada Limited

cc: Karla Reesor – PRAMP Facilitator
Anthony Traverse – Baytex
Stephanie Nielson – Murphy
Kenda Friesen - Pennwest
Robyn Kutz Semeniuk, Kate Humphreys – Shell Canada
Bob Myrick – AEMERA
Michael Zelensky, Wally Qiu – AER
Yan Liu – AEP
Trina Whitsett - Maxxam Analytics

APPENDIX B
Triggered Sample Results

APPENDIX B
TRIGGERED SAMPLE RESULTS

TABLE B-1 Triggered Sample Results at all PRAMP Stations (842, 986, and Reno) for the year of 2016

Station		986	986	986	986	986	986	986	986	986	Reno	Reno
Sampled Date (MM/DD/YYYY)		2016/01/02	2016/01/05	2016/01/12	2016/01/13	2016/01/24	2016/03/31	2016/05/23	2016/06/07	2016/10/05	2016/01/03	2016/01/24
Sampled Time		11:45	18:30	18:55	16:55	15:50	08:55	02:25	22:25	18:40	23:35	00:10
Parameter	Unit	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
1-Butene	ppmv	< 0.13	< 0.14	< 0.13	< 0.12	< 0.13	< 0.12	< 0.13	< 0.12	< 0.18	< 0.12	< 0.12
Acetylene	ppmv	< 0.3	< 0.3	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 0.4	< 0.2	< 0.2
cis-2-Butene	ppmv	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
Ethane	ppmv	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
Ethylacetylene	ppmv	< 0.08	< 0.08	< 0.08	< 0.07	< 0.08	< 0.07	< 0.08	< 0.07	< 0.11	< 0.07	< 0.07
Ethylene	ppmv	< 0.3	< 0.3	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 0.4	< 0.2	< 0.2
Isobutane	ppmv	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
Isobutylene	ppmv	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
Methane	ppmv	3.1	3.2	2.1	2.3	2.0	2.1	2.1	2.4	2.2	3.7	2.5
n-Butane	ppmv	< 0.3	< 0.3	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 0.4	< 0.2	< 0.2
n-Propane	ppmv	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	0.37	< 0.08	< 0.13	< 0.09	< 0.09
Propylene	ppmv	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
Propyne	ppmv	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1
trans-2-Butene	ppmv	< 0.11	< 0.12	< 0.12	< 0.11	< 0.12	< 0.11	< 0.12	< 0.10	< 0.16	< 0.11	< 0.11
2,5-Dimethylthiophene	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 1.6	< 0.4	< 0.4
2-Ethylthiophene	ppbv	md	md	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 1.8	< 0.2	< 0.2
2-Methylthiophene	ppbv	md	md	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 1.4	< 0.2	< 0.2
3-Methylthiophene	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 0.9	< 0.4	< 0.4
Butyl mercaptan	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 1.4	< 0.4	< 0.4
Carbon disulphide	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	0.4	< 1.1	< 0.4	< 0.4
Carbonyl sulphide	ppbv	md	md	1.6	0.9	1.2	5.6	1.8	3.5	8.1	< 0.2	< 0.2
Dimethyl disulphide	ppbv	md	md	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 1.4	< 0.2	< 0.2
Dimethyl sulphide	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 1.3	< 0.4	< 0.4
Ethyl mercaptan	ppbv	md	md	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 1.1	< 0.2	< 0.2
Ethyl sulphide	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 1.6	< 0.4	< 0.4
Hydrogen sulphide	ppbv	md	md	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 1.3	< 0.2	< 0.2
Isobutyl mercaptan	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 1.4	< 0.4	< 0.4
Isopropyl mercaptan	ppbv	md	md	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 1.6	< 0.1	< 0.1
Methyl mercaptan	ppbv	md	md	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 1.6	< 0.2	< 0.2
Pentyl mercaptan	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 3.6	< 0.4	< 0.4

Station		986	986	986	986	986	986	986	986	986	Reno	Reno
Sampled Date (MM/DD/YYYY)		2016/01/02	2016/01/05	2016/01/12	2016/01/13	2016/01/24	2016/03/31	2016/05/23	2016/06/07	2016/10/05	2016/01/03	2016/01/24
Sampled Time		11:45	18:30	18:55	16:55	15:50	08:55	02:25	22:25	18:40	23:35	00:10
Parameter	Unit	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Propyl mercaptan	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 1.8	< 0.4	< 0.4
tert-Butyl mercaptan	ppbv	md	md	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 1.6	< 0.4	< 0.4
Thiophene	ppbv	md	md	< 0.3	< 0.2	< 0.3	< 0.2	< 0.3	< 0.2	< 1.3	< 0.2	< 0.2
1,1,1-Trichloroethane	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
1,1,2,2-Tetrachloroethane	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
1,1,2-Trichloroethane	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
1,1-Dichloroethane	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
1,1-Dichloroethylene	ppbv	< 0.05	< 0.05	< 0.05	0.08	< 0.05	< 0.05	< 0.05	< 0.05	< 0.07	< 0.05	< 0.05
1,2,3-Trimethylbenzene	ppbv	< 0.06	< 0.07	< 0.07	< 0.06	< 0.06	< 0.06	< 0.06	0.09	< 0.09	< 0.06	< 0.06
1,2,4-Trichlorobenzene	ppbv	< 1.0	< 1.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 0.9	< 1.4	< 1.0	< 1.0
1,2,4-Trimethylbenzene	ppbv	< 0.04	< 0.04	< 0.04	0.09	< 0.04	< 0.04	0.05	0.07	0.06	0.07	0.08
1,2-Dibromoethane	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
1,2-Dichlorobenzene	ppbv	< 0.04	< 0.04	< 0.04	0.06	< 0.04	< 0.04	< 0.04	< 0.03	< 0.05	< 0.04	< 0.04
1,2-Dichloroethane	ppbv	0.03	0.03	0.02	0.09	< 0.01	0.02	0.03	0.01	0.03	0.03	< 0.01
1,2-Dichloropropane	ppbv	0.02	0.02	0.02	0.10	0.02	< 0.01	0.01	< 0.01	< 0.02	0.02	0.02
1,3,5-Trimethylbenzene	ppbv	< 0.03	< 0.03	< 0.03	0.09	< 0.03	< 0.02	0.04	< 0.02	< 0.04	0.03	< 0.02
1,3-Butadiene	ppbv	< 0.03	< 0.03	< 0.03	< 0.02	< 0.03	< 0.02	0.08	0.04	< 0.04	< 0.02	< 0.02
1,3-Dichlorobenzene	ppbv	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 0.5	< 0.4	< 0.4
1,4-Dichlorobenzene	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
1,4-Dioxane	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
1-Butene	ppbv	0.42	0.17	0.35	0.67	0.27	0.24	0.43	0.32	0.55	2.07	0.16
1-Hexene	ppbv	< 0.03	< 0.03	< 0.03	0.39	< 0.03	< 0.02	0.03	0.03	< 0.04	0.20	< 0.02
1-Pentene	ppbv	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.03	0.02	0.24	< 0.01
2,2,4-Trimethylpentane	ppbv	0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
2,2-Dimethylbutane	ppbv	0.02	0.11	< 0.01	< 0.01	0.02	< 0.01	0.50	0.28	0.15	0.06	0.03
2,3,4-Trimethylpentane	ppbv	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	0.02	< 0.01
2,3-Dimethylbutane	ppbv	0.05	0.19	< 0.03	0.08	0.03	< 0.02	1.05	0.66	0.38	0.19	0.08
2,3-Dimethylpentane	ppbv	< 0.03	0.08	< 0.03	0.12	0.03	< 0.02	0.50	0.43	0.06	0.07	0.05
2,4-Dimethylpentane	ppbv	0.02	0.11	0.02	0.06	0.03	< 0.01	0.26	0.16	0.03	0.07	0.04
2-Methylheptane	ppbv	0.01	0.10	< 0.01	0.08	0.02	< 0.01	0.41	0.32	< 0.02	0.04	0.03
2-Methylhexane	ppbv	0.04	0.26	0.02	0.56	0.08	0.06	1.33	0.99	0.13	0.10	0.12
2-Methylpentane	ppbv	0.23	1.36	0.12	0.51	0.24	< 0.01	6.14	4.40	1.93	0.52	0.40
3-Methylheptane	ppbv	< 0.03	0.05	< 0.03	0.07	< 0.03	< 0.02	0.20	0.14	< 0.04	0.03	< 0.02
3-Methylhexane	ppbv	0.06	0.28	0.04	0.74	0.08	0.08	1.26	0.94	0.09	0.20	0.15

Station		986	986	986	986	986	986	986	986	986	Reno	Reno
Sampled Date (MM/DD/YYYY)		2016/01/02	2016/01/05	2016/01/12	2016/01/13	2016/01/24	2016/03/31	2016/05/23	2016/06/07	2016/10/05	2016/01/03	2016/01/24
Sampled Time		11:45	18:30	18:55	16:55	15:50	08:55	02:25	22:25	18:40	23:35	00:10
Parameter	Unit	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
3-Methylpentane	ppbv	0.12	0.82	0.08	0.20	0.14	0.06	3.62	2.58	0.76	0.29	0.23
Acetone	ppbv	6.2	1.8	2.5	5.0	2.6	3.2	3.7	< 0.5	4.9	9.1	3.3
Acrolein	ppbv	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.3	< 0.5	< 0.4	< 0.4
Benzene	ppbv	0.26	0.66	0.45	0.47	0.32	0.05	5.47	5.03	0.93	3.25	0.47
Benzyl chloride	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
Bromodichloromethane	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
Bromoform	ppbv	< 0.03	< 0.03	< 0.03	0.06	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
Bromomethane	ppbv	0.02	0.02	< 0.01	0.09	0.01	< 0.01	< 0.01	< 0.01	< 0.02	0.02	< 0.01
Carbon disulfide	ppbv	< 0.01	< 0.01	0.04	0.13	0.13	0.04	0.08	0.59	0.05	< 0.01	0.03
Carbon tetrachloride	ppbv	0.10	0.11	0.12	0.19	0.12	0.11	0.11	0.09	0.12	0.11	0.12
Chlorobenzene	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
Chloroethane	ppbv	< 0.03	< 0.03	< 0.03	0.10	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02
Chloroform	ppbv	0.03	0.03	< 0.03	0.10	0.03	< 0.02	< 0.03	< 0.02	< 0.04	0.03	0.03
Chloromethane	ppbv	0.97	0.79	0.88	0.97	0.74	0.94	0.67	0.56	0.41	0.95	0.72
cis-1,2-Dichloroethene	ppbv	< 0.01	< 0.01	< 0.01	0.07	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
cis-1,3-Dichloropropene	ppbv	< 0.05	< 0.05	< 0.05	0.07	< 0.05	< 0.05	< 0.05	< 0.05	< 0.07	< 0.05	< 0.05
cis-2-Butene	ppbv	0.05	< 0.03	< 0.03	0.03	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	0.42	0.03
cis-2-Pentene	ppbv	< 0.03	< 0.03	< 0.03	< 0.02	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	0.07	< 0.02
Cyclohexane	ppbv	0.11	0.62	0.08	0.23	0.11	< 0.02	5.14	4.46	0.53	0.34	0.19
Cyclopentane	ppbv	0.06	0.28	0.03	0.07	0.05	0.01	3.16	2.05	31.2	0.15	0.08
Dibromochloromethane	ppbv	< 0.01	< 0.01	< 0.01	0.07	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
Ethanol	ppbv	< 0.4	< 0.4	0.4	1.2	0.5	0.5	1.1	1.8	0.9	2.4	0.6
Ethyl acetate	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
Ethylbenzene	ppbv	0.02	0.02	0.03	0.13	0.04	< 0.01	0.12	0.11	< 0.02	0.15	0.09
Freon-11	ppbv	0.38	0.38	0.34	0.41	0.33	0.35	0.32	0.25	0.33	0.35	0.33
Freon-113	ppbv	0.11	0.11	0.09	0.18	0.09	0.10	0.08	0.06	0.05	0.11	0.09
Freon-114	ppbv	0.03	0.03	0.03	0.11	0.03	0.03	0.03	< 0.02	< 0.04	0.03	0.03
Freon-12	ppbv	0.77	0.81	0.70	0.77	0.71	0.73	0.57	0.20	0.65	0.67	0.71
Hexachloro-1,3-butadiene	ppbv	< 0.64	< 0.68	< 0.66	< 0.62	< 0.65	< 0.62	< 0.64	< 0.58	< 0.90	< 0.62	< 0.62
Isobutane	ppbv	1.79	6.16	0.64	1.46	1.62	0.55	5.09	0.25	1.07	3.41	2.77
Isopentane	ppbv	1.16	7.57	0.39	0.92	0.85	0.53	17.9	10.4	13.8	2.08	1.38
Isoprene	ppbv	0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	0.62	2.54	0.07	0.18	< 0.01
Isopropyl alcohol	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
Isopropylbenzene	ppbv	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.01	0.01	< 0.02	0.02	< 0.01

Station		986	986	986	986	986	986	986	986	986	Reno	Reno
Sampled Date (MM/DD/YYYY)		2016/01/02	2016/01/05	2016/01/12	2016/01/13	2016/01/24	2016/03/31	2016/05/23	2016/06/07	2016/10/05	2016/01/03	2016/01/24
Sampled Time		11:45	18:30	18:55	16:55	15:50	08:55	02:25	22:25	18:40	23:35	00:10
Parameter	Unit	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
m,p-Xylene	ppbv	0.07	0.10	0.11	0.31	0.12	< 0.04	0.39	0.66	0.07	0.26	0.22
m-Diethylbenzene	ppbv	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.07	< 0.05	< 0.05
m-Ethyltoluene	ppbv	< 0.10	< 0.11	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.09	< 0.14	< 0.10	< 0.10
Methyl butyl ketone	ppbv	< 0.64	< 0.68	< 0.66	< 0.62	< 0.65	< 0.62	< 0.64	< 0.58	< 0.90	< 0.62	< 0.62
Methyl ethyl ketone	ppbv	< 0.4	< 0.4	< 0.4	0.5	< 0.4	< 0.4	< 0.4	0.6	< 0.5	1.3	< 0.4
Methyl isobutyl ketone	ppbv	1.6	< 0.5	1.9	< 0.5	0.8	2.0	1.6	2.5	3.0	< 0.5	< 0.5
Methyl methacrylate	ppbv	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.08	< 0.13	< 0.09	< 0.09
Methyl tert butyl ether	ppbv	< 0.04	< 0.04	< 0.04	0.09	< 0.04	< 0.04	< 0.04	< 0.03	< 0.05	< 0.04	< 0.04
Methylcyclohexane	ppbv	0.09	0.58	0.08	0.97	0.09	0.13	2.79	2.48	0.18	0.29	0.20
Methylcyclopentane	ppbv	0.09	0.47	0.09	0.20	0.11	0.03	4.53	3.67	0.63	0.25	0.20
Methylene chloride	ppbv	< 0.4	< 0.4	< 0.4	1.6	< 0.4	< 0.4	0.5	0.7	0.6	< 0.4	< 0.4
n-Butane	ppbv	4.29	15.5	1.29	3.05	3.11	0.56	16.5	4.87	7.73	8.14	5.63
n-Decane	ppbv	< 0.08	< 0.08	< 0.08	< 0.07	< 0.08	< 0.07	< 0.08	< 0.07	< 0.11	0.11	< 0.07
n-Dodecane	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
n-Heptane	ppbv	0.09	0.50	0.06	1.82	0.10	0.08	2.45	2.10	0.13	0.25	0.15
n-Hexane	ppbv	0.29	1.84	0.22	0.74	0.28	0.04	8.59	6.59	1.59	0.77	0.43
n-Nonane	ppbv	0.02	0.03	0.02	0.07	0.02	< 0.01	0.09	0.10	0.03	0.07	0.04
n-Octane	ppbv	< 0.03	0.16	< 0.03	< 0.02	0.06	< 0.02	0.48	0.45	0.04	0.14	0.06
n-Pentane	ppbv	1.5	7.3	0.6	1.4	0.9	0.2	21.9	13.4	11.9	2.9	1.4
n-Propylbenzene	ppbv	< 0.06	< 0.07	< 0.07	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.09	< 0.06	< 0.06
n-Undecane	ppbv	< 0.6	< 0.7	< 0.7	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.9	< 0.6	< 0.6
Naphthalene	ppbv	< 0.6	< 0.7	< 0.7	< 0.6	< 0.6	< 0.6	3.0	1.0	< 0.9	< 0.6	< 0.6
o-Ethyltoluene	ppbv	< 0.01	< 0.01	< 0.01	0.02	< 0.01	< 0.01	0.01	0.01	< 0.02	0.03	0.02
o-Xylene	ppbv	0.01	0.02	0.02	0.13	0.03	< 0.01	0.10	0.09	0.03	0.12	0.08
p-Diethylbenzene	ppbv	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.20	< 0.07	< 0.05	< 0.05
p-Ethyltoluene	ppbv	< 0.09	< 0.09	< 0.09	0.09	< 0.09	< 0.09	< 0.09	< 0.08	< 0.13	< 0.09	< 0.09
Styrene	ppbv	< 0.05	< 0.05	< 0.05	0.08	< 0.05	< 0.05	0.05	< 0.05	< 0.07	0.08	< 0.05
Tetrachloroethylene	ppbv	< 0.05	< 0.05	< 0.05	0.14	< 0.05	< 0.05	< 0.05	< 0.05	< 0.07	< 0.05	< 0.05
Tetrahydrofuran	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
Toluene	ppbv	0.32	0.41	0.15	0.38	0.21	0.02	1.89	1.77	0.16	1.83	0.86
trans-1,2-Dichloroethylene	ppbv	< 0.01	< 0.01	< 0.01	0.07	< 0.01	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
trans-1,3-	ppbv	< 0.05	< 0.05	< 0.05	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.07	< 0.05	< 0.05
trans-2-Butene	ppbv	0.08	< 0.01	< 0.01	0.04	0.04	< 0.01	0.03	0.02	< 0.02	0.59	0.05
trans-2-Pentene	ppbv	< 0.03	< 0.03	< 0.03	< 0.02	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	0.11	< 0.02

Station		986	986	986	986	986	986	986	986	986	Reno	Reno
Sampled Date (MM/DD/YYYY)		2016/01/02	2016/01/05	2016/01/12	2016/01/13	2016/01/24	2016/03/31	2016/05/23	2016/06/07	2016/10/05	2016/01/03	2016/01/24
Sampled Time		11:45	18:30	18:55	16:55	15:50	08:55	02:25	22:25	18:40	23:35	00:10
Parameter	Unit	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
Trichloroethylene	ppbv	< 0.05	< 0.05	< 0.05	0.10	< 0.05	< 0.05	< 0.05	< 0.05	< 0.07	< 0.05	< 0.05
Vinyl acetate	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.7	< 0.5	< 0.5
Vinyl chloride	ppbv	< 0.03	< 0.03	< 0.03	0.08	< 0.03	< 0.02	< 0.03	< 0.02	< 0.04	< 0.02	< 0.02

APPENDIX C

Complaints with Monitored Data Correlation

APPENDIX C
COMPLAINTS AND RESIDENT REPORTS WITH MONITORED DATA CORRELATION

Table C-1: Correlation AER Reported Complaints to Monitored Data at all PRAMP Stations (842, 986, and Reno)

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	01/03/2015	17:24	17:00	0	0	4.4	WSW	2	1.9	0	0.02
842	01/09/2015	07:01	07:00	1	0	1.1	ESE	2.1	2.1	0	0
842	02/03/2015	07:01	07:00	0	0	3.6	SSE	1.9	1.9	0	0
842	02/16/2015	06:15	06:00	0	1	8	N	1.9	1.9	0	0
842	02/17/2015	21:00	21:00	0	0	6.5	S	1.9	1.9	0	0
842	02/27/2015	06:15	06:00	0	1	0.8	NE	1.9	1.9	0	0
842	02/28/2015	06:30	06:00	0	1	3.2	W	1.9	1.9	0	0
842	03/05/2015	07:01	07:00	0	0	3.8	SSW	1.86	1.85	0	0.01
842	03/09/2015	06:01	06:00	1	0	0.8	E	1.82	0.81	0	0
842	03/19/2015	09:00	10:00	0	0	8.6	ENE	n/a	n/a	n/a	n/a
842	03/23/2015	06:30	07:00	0	0	2.8	E	1.95	1.94	0	0
842	03/24/2015	23:00	0:00*	0	0	7.9	SSE	1.95	1.94	0	0
842	03/28/2015	06:30	05:00	0	0	2.9	WSW	1.86	1.85	0	0
842	03/30/2015	22:30	23:00	0	0	5.6	ENE	2.34	2.33	0	0
842	04/06/2015	06:01	07:00	0	0	5.6	ESE	1.94	1.93	0	0
842	04/11/2015	04:00	05:00	0	0	5.2	SE	1.86	1.85	0	0
842	04/19/2015	07:00	08:00	0	0	8.2	SW	1.92	1.9	0	0.01
842	04/20/2015	06:01	07:00	0	0	2.7	S	2.06	2.05	0	0
842	04/24/2015	05:30	06:00	0	0	13.5	ENE	1.89	1.88	0	0
842	04/29/2015	06:01	07:00	0	0	11.8	SW	1.86	1.86	0	0
842	05/05/2015	07:10	08:00	0	0	13.3	ENE	1.87	1.87	0	0
842	06/17/2015	08:01	09:00	0	1	5.6	ESE	1.84	1.83	0	0
842	06/19/2015	01:00	02:00	0	1	6.2	ENE	1.8	1.8	0	0
842	07/12/2015	08:00	09:00	0	n/a	8.3	SW	n/a	n/a	n/a	n/a
842	07/31/2015	22:50	23:00	0	0	4.3	NNE	1.86	1.85	0	0
842	08/07/2015	23:30	0:00*	0	0	4.5	ESE	1.95	1.95	0	0
842	08/09/2015	23:00	0:00*	0	0	1	SSE	1.94	1.94	0	0
842	08/21/2015	23:30	0:00*	0	0	0.6	E	1.98	1.98	0	0
842	08/30/2015	23:30	0:00*	0	0	14.7	SSW	1.92	1.92	0	0
842	09/06/2015	06:00	07:00	0	1	3.2	ENE	2.18	2.18	0	0
842	09/10/2015	00:36	01:00	0	0	3.4	SE	1.94	1.94	0	0
842	10/25/2015	08:00	09:00	n/a	n/a	1.4	ESE	n/a	n/a	n/a	n/a
842	10/29/2015	00:36	01:00	0	0	12.9	SSW	1.91	1.9	0	0
842	11/22/2015	20:17	20:00	0	0	0.7	SW	1.93	1.92	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)
842	11/23/2015	08:35	08:00	0	0	3.1	ENE	2.21	2.2	0	0
842	11/29/2015	01:00	01:00	0	0	11.5	SW	1.95	1.94	0	0.02
842	12/15/2015	09:02	09:00	0	0	7.1	W	1.94	1.94	0	0
842	12/17/2015	22:00	22:00	0	0	4.7	E	2.01	2	0	0
842	12/29/2015	07:16	07:00	0	0	7.8	SSW	2.04	2.03	0	0
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	0:00*	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
986	01/27/2015	11:05	11:00	0	0	9.9	NE	1.9	1.9	0	0
986	03/10/2015	09:31	10:00	0	0	5.6	SE	1.89	1.9	0	0
986	08/16/2015	03:00	04:00	0	1	0.8	ESE	2.03	2.04	0	0
986	10/26/2015	08:00	09:00	0	0	2.6	SE	1.88	1.89	0	0
986	12/20/2015	05:30	05:00	0	0	1.4	ESE	3.12	2.18	0.96	1.46
986	12/28/2015	04:45	04:00	0	0	1.3	NE	2.36	2.32	0.05	0.17
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
Reno	01/09/2015	10:00	10:00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reno	01/10/2015	22:10	22:00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reno	01/11/2015	16:00	16:00	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reno	02/18/2015	17:00	17:00	1	1	3.3	S	2.41	2.42	0	0
Reno	04/06/2015	18:00	19:00	0	0	3.9	SSE	1.94	1.94	0	0
Reno	04/27/2015	20:00	21:00	0	1	2	S	2.32	2.32	0	0
Reno	05/24/2015	12:00	13:00	0	0	5.3	SE	1.89	1.9	0	0.02

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	07/30/2015	22:30	23:00	0	0	2.1	SSW	2.37	2.37	0	0.04
Reno	11/26/2015	18:00	18:00	0	0	9.3	SW	1.93	1.92	0	0
Reno	12/30/2015	21:30	21:00	0	0	4.9	S	2.1	2.09	0	0.02
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
Note:											
n/a: Valid data is not available											
***: Monitored Date is Reported Date plus 1 day due to conversion from DST to MST**											