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VILLAGE OF KINUSO

AIR QUALITY SUMMARY REPORT

APRIL 2009 TO JUNE 2010

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Executive Summary

The Village of Kinuso, Alberta is located on the eastern edge of the Peace Airshed Zone in an area of mainly agriculture activity. The Peace Airshed Zone Association (PAZA) conducted an air quality survey just outside Kinuso from April 2009 to June 2010. The reasons for this air quality survey were as follows:

- To collect continuous air quality data in an area of PAZA lacking continuous data (data gap); and,
- To collect continuous air quality data in an area of PAZA that could be representative of air quality entering or leaving PAZA (background conditions).

A continuous monitoring station was used to monitor total reduced sulphur compounds (TRS), sulphur dioxide (SO_2), nitric oxide (NO), nitrogen dioxide (NO_2), total oxides of nitrogen (NO_x), ozone (O_3) and meteorology during that period.

There were no exceedances of Alberta Ambient Air Quality Objectives (AAAQO) measured at the monitoring station except for O_3. Of NO, NO_2 and NO_x, only NO_2 has an AAAQO. The results are summarized as follows:

- Measurements suggest that TRS is ubiquitous in the area at fairly low levels. Fugitive emissions from agricultural operations may be the main contributor to the measurements which are comparable to other areas in the province.
- The SO_2 measurements suggest there were no significant sources of SO_2 in the area during the measurement period and were low compared to other areas in the province. Long range transport from Edmonton appears to be influencing the results.
- Due to the proximity of the monitor station to Highway 33, the NO_2 measurements may have been influenced by vehicle emissions However, data indicated NO_2 levels were lower than other areas of the province.
- An episode in the late afternoon on August 29 2009 lead to exceedances of the O_3 AAAQO. This was a single episode related to a forest fire.The O_3 measurements cannot be directly compared to the CWS.
- Other than the August 29 2009 episode, O_3 are comparable with other areas in province. A typical diurnal profile is present in the ozone measurements and relates with the diurnal patterns of NO and NO_2. This pattern shows the photo-chemical formation and destruction of ozone through complex reactions with NO_x and volatile organic compounds. Long range transport from Edmonton appears to be influencing the results as well.
- Meteorology measurements indicate that coldest months resulted in the highest average measurements of TRS, SO_2, and NO_2. This likely due to stagnant, poor dispersion conditions including atmospheric inversions that occur more frequently in the colder months.

- The most frequent winds are from the south and south-southeast directions and appear to be influenced by the local terrain.

The volume of data collected indicates that this area is comparable of air quality in other rural areas of Alberta. Exceedances of the AAAQO for O_3 are due to forest fire activity and are not an indication of poor air quality in the area.

The summary of the air quality monitoring data is limited to the parameters measured in this study. Air quality surrounding the Village of Kinuso may be affected by other compounds associated with other activities some of which PAZA was not equipped to measure such as volatile organic compounds (VOCs) and fine particulate matter.

The results do not necessarily support further continuous monitoring in the area. However, if PAZA chooses to conduct additional monitoring in the Kinuso area, it is recommended that PAZA consider passive hydrogen sulphide monitoring to determine trends,

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1. INTRODUCTION

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

PAZA was formed in March 1999 in response to air quality concerns in the Peace region. As an independent third-party, PAZA has invested ten years into building trust among members of the public, industry, non-governmental organizations, Alberta Environment and Sustainable Resource Development (AESRD), Energy Resources Conservation Board, and Alberta Health Services.

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

In 2003, PAZA became the fifth airshed zone in Alberta recognized by the Clean Air Strategic Alliance (CASA).

PAZA operates under the guidelines developed in the *CASA Airshed Zone Guidelines*. These guidelines include management by consensus, representation from affected stakeholders and public accessibility to data and information from monitoring activities.

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

Air Quality Management Zones are a key component in Alberta's strategy for the management of air quality within Alberta.

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

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

2. SITE SETTTING

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

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

Accounting for the above criteria and considerations, the monitor that was used for the air quality survey was placed on the west side of Highway 33 in a farmer's field about 10 km south-southeast of the Village of Kinuso within SE 9-19-72-9 W5M. The geographic and projected coordinates of the site are:

- 55° 15' 8.83" N, 115° 21' 49.71" W (NAD 83)
- 55.252453° N, 115.363808° W (NAD 83)
- 604002 m E, 6124105 m N (UTM Zone 11 – NAD 83)

A regional area map is shown in Figure 2.1. The PAZA monitoring network is shown in Figure 2.2.

Photos of monitoring station and views from it are shown in Figure 2.3. Although no airflow restrictions were noted, the photos show a stand of trees to the west and a few small sheds to the east. The nearest trees to the station are about 20 m distance with a height of 8 m.

Figure 2.4 shows the local setting around the Village of Kinuso and the monitoring station. The major industry in the area is agriculture. The Environment Canada National Pollution Release Inventory for 2008 noted only one small oil and gas facility (8-19-72-8 W5M pad site) in the local area as shown in Figure 2.3 located about 10 km to the east. The closest road is Secondary Highway 33 located about 200 m to the east. According to Alberta Transportation, the Average Annual Daily Traffic Volume on that section of Highway 33 in 2010[2] was 710 vehicles/day .

[2] http://www.transportation.alberta.ca/Content/docType181/production/HTVH2001-2010.pdf

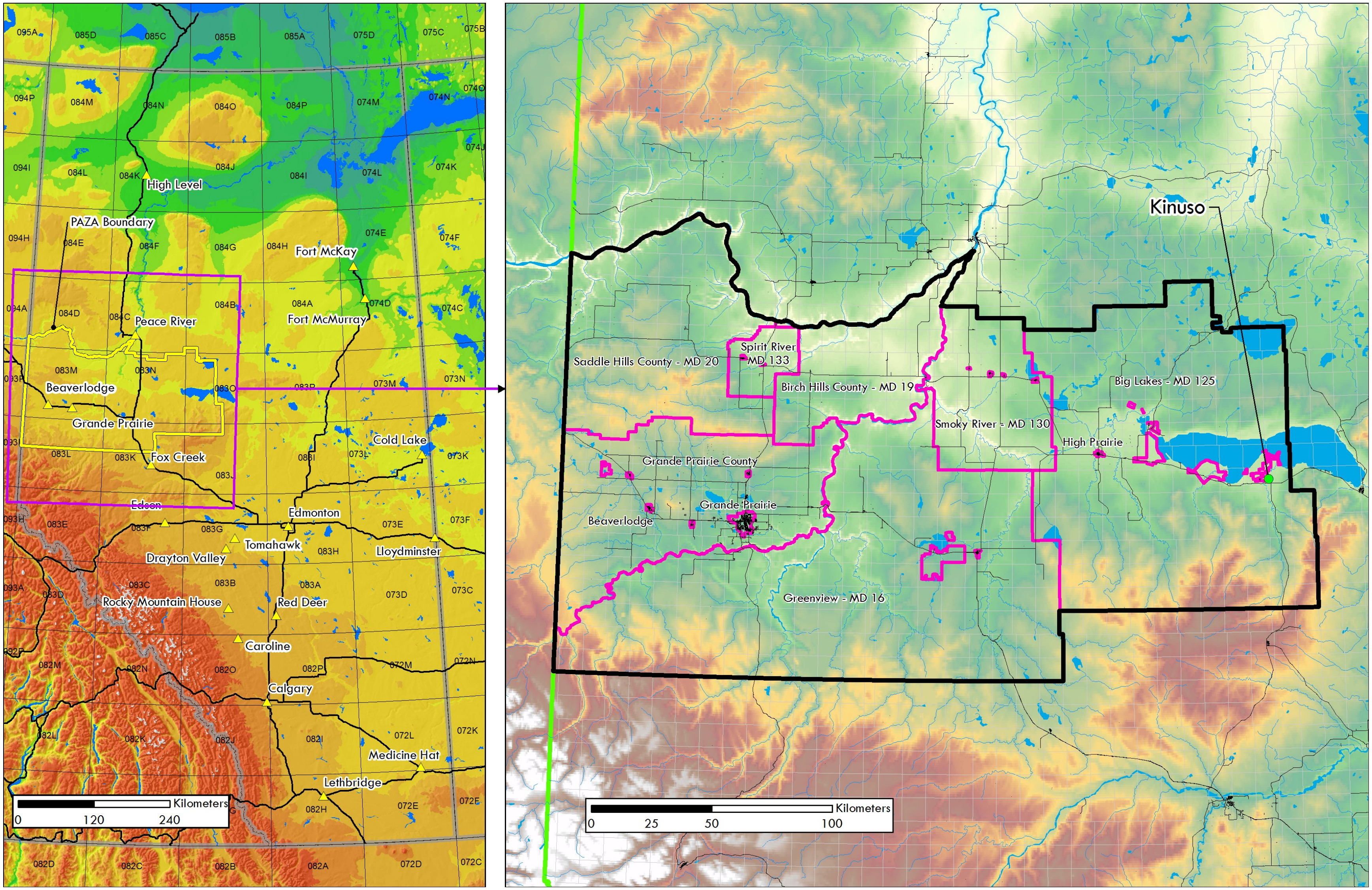


Figure 2.1 Regional Area Map showing location Kinuso and PAZA

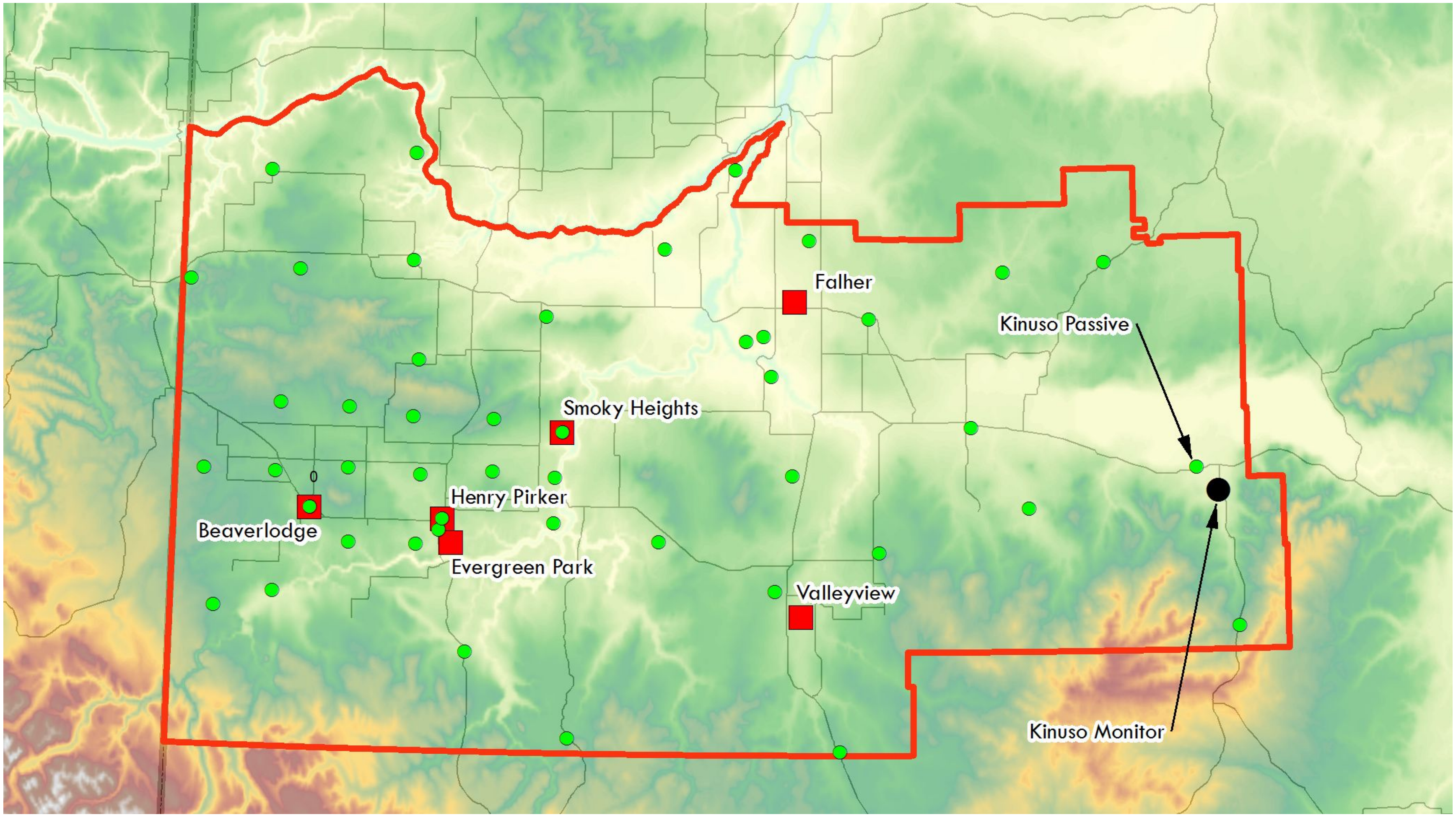


Figure 2.2 PAZA Monitoring Network

Looking North

Looking South

Looking East

Looking West

Monitoring Trailer

Analyzers

Figure 2.3 Views from and of Kinuso Monitoring Station

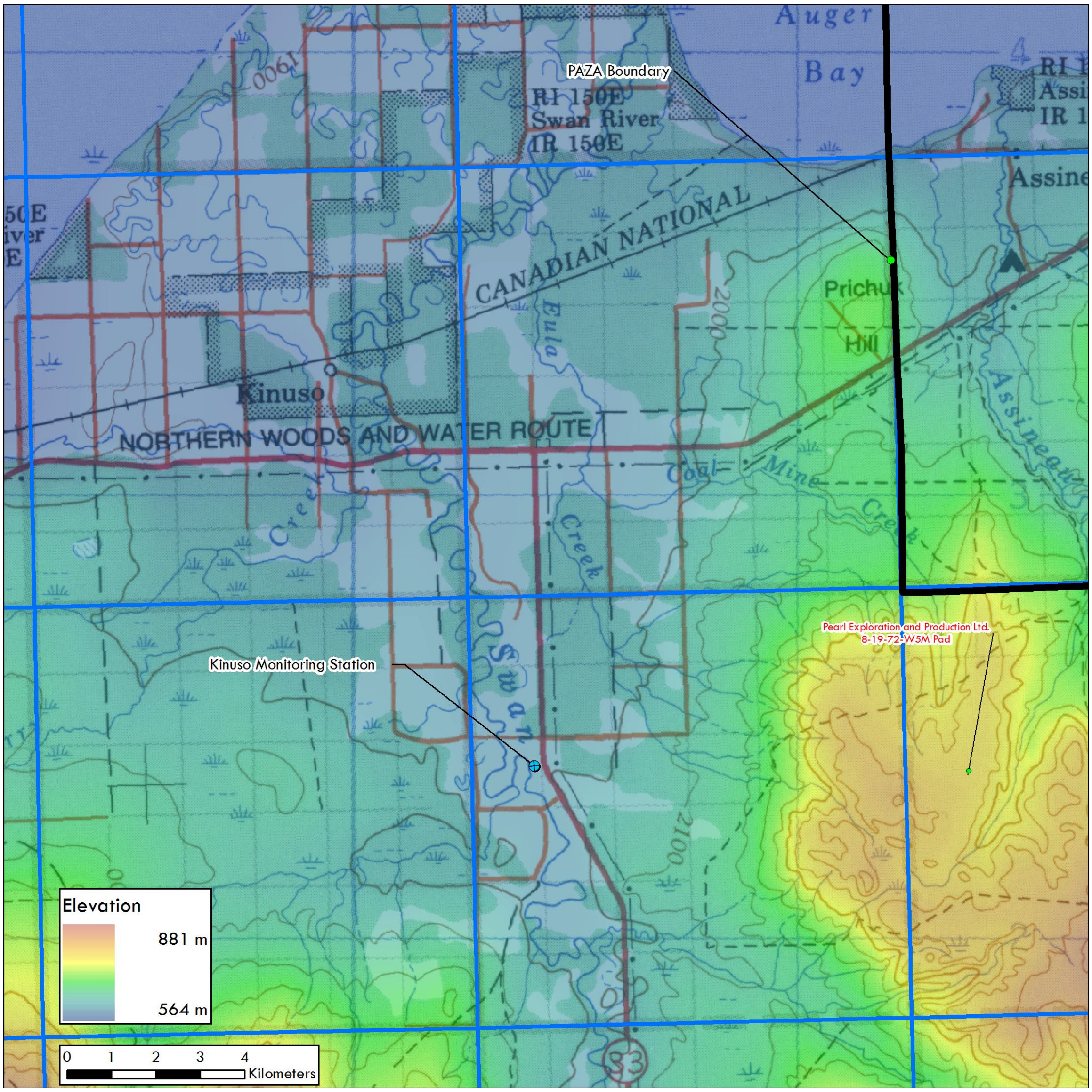


Figure 2.4 Local setting around Kinuso Monitor

3. AIR MONITORING (PARAMETERS, EQUIPMENT, ETC)

The monitoring station equipment is described in Table 3.1. The continuous monitoring station sampled for TRS, SO_2, NO_x (including NO and NO_2), O_3, and meteorology (wind speed, wind direction, and ambient temperature). Sampling occurred every second and 1-hour averages were calculated from the 1 second samples. The data acquisition system used was the Focus DACS-AP1000. The monitoring station operated from April 2, 2009 0900 to June 17, 2010 16:00 (10592 hours). The continuous monitoring equipment was operated according to the Alberta Environment Air Monitoring Directive[3] (AMD) including daily instruments checks, monthly multipoint calibrations, and annual audits conducted by AESRD. The monitoring station was audited on September 17, 2009 and May 13, 2010 by AESRD while located in Kinuso.

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

Continuous monitoring equipment uptime and downtime during the Kinuso air quality monitoring survey is presented in Table 3.2.

[3] http://environment.alberta.ca/0996.html

Table 3.1 Monitoring Station Equipment Description

Parameter	Instrument Make and Model	Units of Measure	Sampling Height (m)	Standard Operating Procedures Document
TRS	TEI/43C with converter	Parts per billion (ppb)	4	FAQP-1.002
SO_2	TECO/43C	ppb	4	FAQP-1.001
NO_x	TECO/42i	ppb	4	FAQP-1.003
O_3	TECO/49c	ppb	4	FAQP-1.004
Wind Speed	Met One 010C	km/hr	10	FAQP-2.001
Wind Direction	Met One 020C	Degrees direction from	10	FAQP-2.001
Temperature	Met One 062	°C	4	FAQP-2.006

Table 3.2 Monitoring Equipment Uptime

Measurement	TRS	SO_2	NO_x	O_3	Temperature	Wind Speed	Wind Direction
Valid Reading	92.80%	92.77%	92.53%	88.00%	97.31%	97.24%	97.24%
Not in Service	0.06%	0.05%	0.02%	5.27%	0.30%	0.09%	0.09%
Daily Automated Zero/Span Sequence	4.26%	4.27%	4.28%	3.93%	0.00%	0.00%	0.00%
Calibration	0.50%	0.51%	0.78%	0.41%	0.00%	0.00%	0.00%
Not Valid[a]	0.63%	0.63%	0.63%	0.64%	0.64%	0.87%	0.87%
Maintenance	0.00%	0.01%	0.01%	0.00%	0.00%	0.05%	0.05%
Span (Used for Manual Span)	0.01%	0.02%	0.00%	0.01%	0.00%	0.00%	0.00%
Power Failure	0.26%	0.26%	0.26%	0.26%	0.26%	0.26%	0.26%
Data Acquistion Failure	1.48%	1.48%	1.48%	1.48%	1.48%	1.48%	1.48%

a) Not Valid is defined as data collected when the instrument is operating outside normal conditions.

4. ALBERTA AMBIENT AIR QUALITY OBJECTIVES

The AAAQOs for the pollutants that were measured are shown in Table 4.1. There are currently no AAAQOs for TRS. However, hydrogen sulphide (H_2S) and carbon disulphide (CS_2) are classified as reduced sulphur compounds and have AAAQOs. Of the NO_x compounds measured, only NO_2 has AAAQOs. Although there is currently a 1-hour AAAQO for O_3, compliance or achievement is usually determined by the Canada-Wide Standards for O_3 which is an 8-hour average of 65 ppb based on the 4th highest daily 8-hr measurement annually, averaged over 3 consecutive years. Since the Kinuso monitoring station only measured O_3 for just over 14 months, direct comparison to the CWS cannot be made. Also included in the CWS for O_3 are provisions for “Keeping Clean Areas Clean and Continuous Improvement” that apply at ambient concentrations below the numeric CWS, as well as provisions on monitoring and reporting of progress and activities.

Table 4.1 Alberta Ambient Air Quality Objectives.

Pollutant	Averaging Period				
	1-hr (ppb)	8-hr (ppb)	24-hr (ppb)	30 day (ppb)	Annual (ppb)
TRS	10 (H_2S) 10 (CS_2)	-	3 (H_2S)		
SO_2	172	-	48	11	8
NO_2	159	-	-	-	24
O_3	82	65 (CWS)[1] 58 (CWS)[1]	-	-	-

Note: 1 CWS Exceedance Trigger is 65 ppb, CWS Planning Trigger is 58 ppb, both based on the 4th highest 8-hour daily measurement annually, averaged over 3 years

5. MONITORING RESULTS

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

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

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

Comparison with other areas of the province was undertaken using ambient measurements from the following locations for the same time period as the Kinuso monitoring. The locations of these stations are shown in Figure 2.1 and Figure 2.2.

- Beaverlodge (PAZA)
  - Small urban
- Evergreen Park (PAZA) (TRS only)
  - Small urban
- Henry Pirker (PAZA) (TRS only)
  - Small urban
- Caroline
  - Rural
- Calgary NW
  - Urban
- Cold Lake South
  - Small urban
- Fort McKay
  - Rural – near oil sands
- Tomahawk
  - Rural

Also included is a comparison of monthly averages from the closest PAZA passive monitoring station for SO_2, NO_2, and O_3. The closest passive station to the Kinuso monitoring location is the Kinuso passive monitoring station which is 9 km northwest. The closest current passive monitor

[4] http://www.casadata.org/Reports/SelectCategory.asp

that measures TRS or H_2S is located 70 km north-northwest and was not included in the comparison as it was not operating at the time of the Kinuso monitor.

5.1 Meteorology

The following figures illustrate the meteorological conditions recorded at the Kinuso monitoring station during the period April 2, 2009 0900 to June 17, 2010 16:00. Figure 5.1 shows that the most frequent winds are from the south and south-southeast quadrants. As seen in Figure 2.3, the monitor is located in a gentle rolling valley that influenced the wind flow at the monitor. It is also noted that winds above 30 km/hr were not recorded during the monitoring period. Figure 5.2 shows the monthly temperature and wind speed distributions. These figures show that the coldest weather occurred in the month of December.

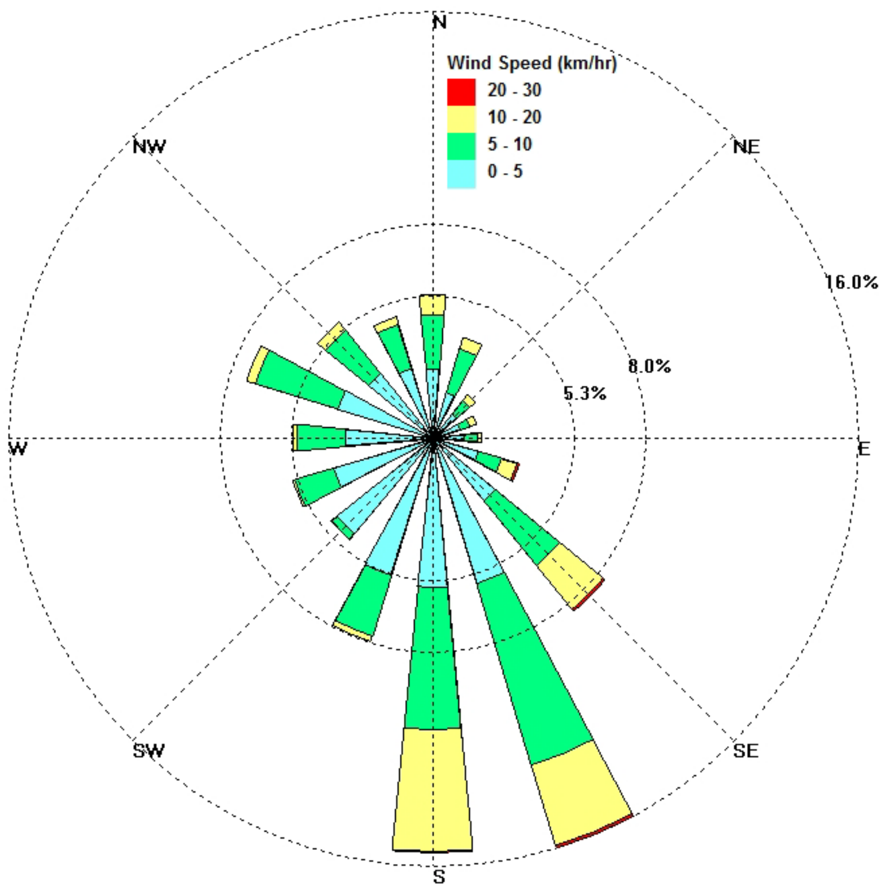
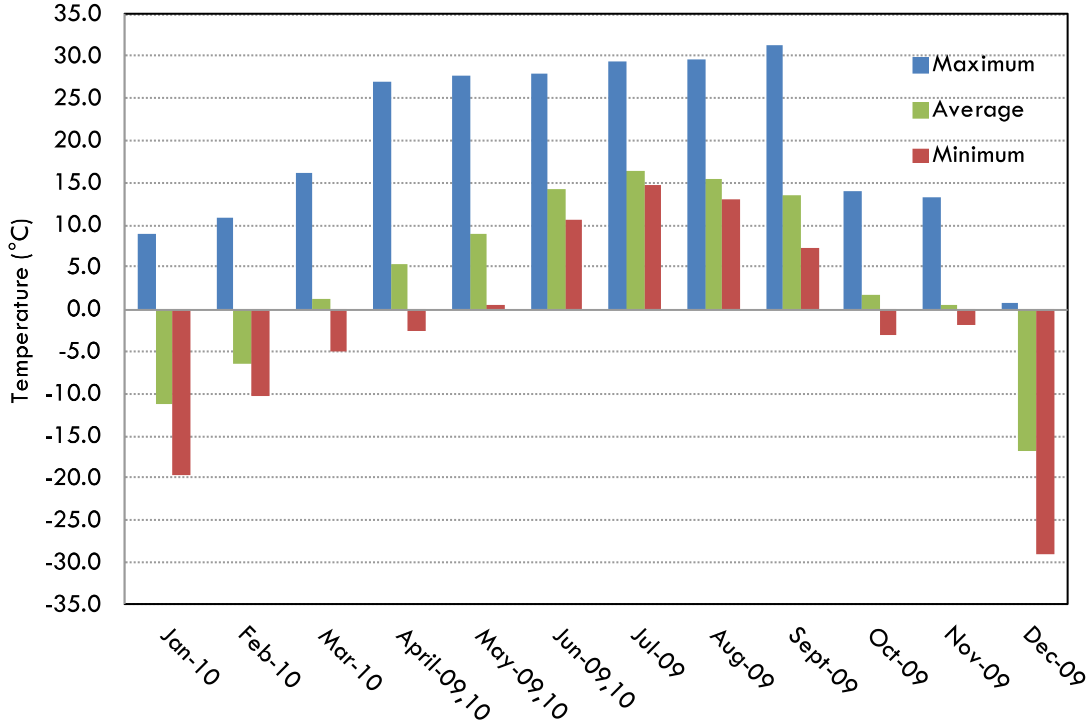


Figure 5.1 Wind Frequency Distribution at Kinuso Monitoring Station



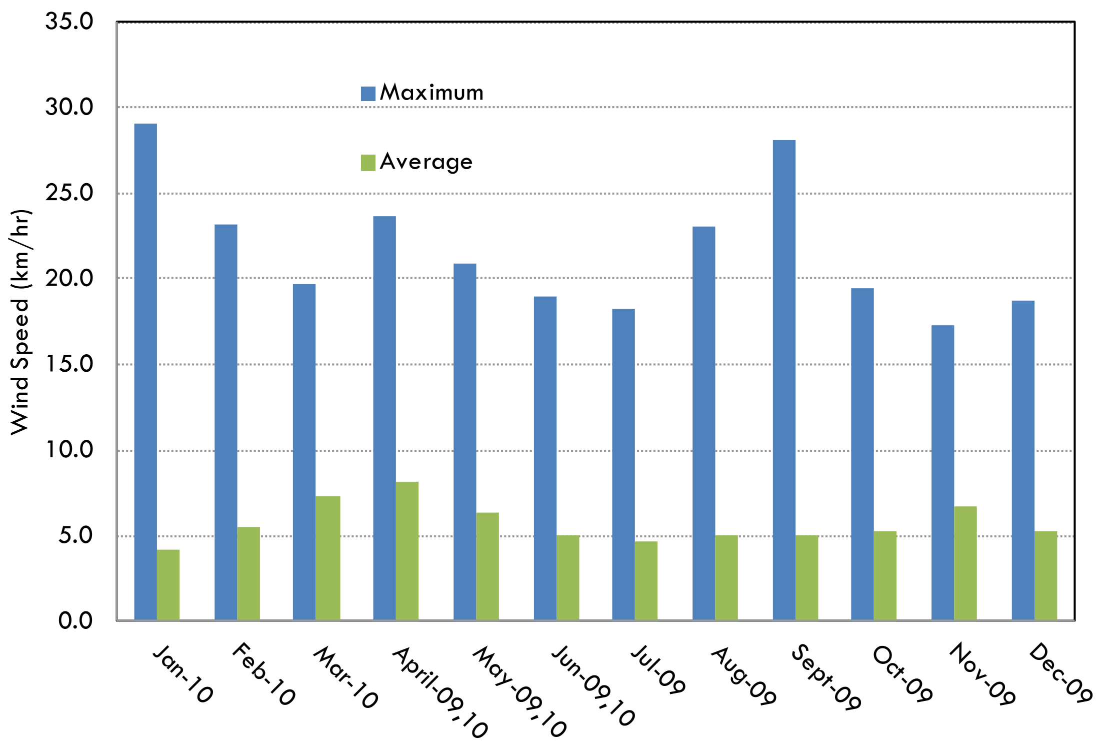


Figure 5.2 Monthly Temperature and Wind Speed Distribution Measured at Kinuso Monitoring Station

5.2 Total Reduced Sulphur Compounds

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

As noted earlier in Table 4.1, currently there are no AAAQO for TRS. However, there are AAAQOs for H_2S and CS_2 which are based on odour thresholds. H_2S is known to have highly toxic properties, and can cause negative health effects at low concentrations.[5]

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

In the area around the Kinuso monitor, the main sources of TRS emissions would be agricultural operations, landfill, and sewage lagoons. As well, swamps and sloughs can be natural sources of TRS. It is noted in Figure 2.3 that there is a pond located directly to the west of the monitor whose purpose is not clear.

A summary of TRS measurements are shown in Table 5.1 and the time series of measurements are shown in Figure 5.3. It shows that TRS measurements were consistently in 0.4 ppb range throughout the monitoring period without much deviation.

The measurements indicate that the AAAQO for H_2S and CS_2 were not exceeded during the monitoring period. Figure 5.4 shows that concentrations above 1 ppb were not frequently recorded (only 6 times) and all those measurements occurred during the early morning of May 4, 2010 when the winds were light from the northwest. At this time, the source or sources contributing to those measurements is not known. Figure 5.5 shows that the maximum average recorded TRS concentrations occurred for winds from the northwest but the average TRS concentrations do not show a distinctive trend for any particular wind direction.

Figure 5.5 presents the maximum and average measured TRS concentrations as a function of month and hour of day. The figures show a slight bias toward higher concentrations in the colder months and at sunrise but the bias is not considered significant.

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[5] http://environment.gov.ab.ca/info/library/6664.pdf

Figure 5.6 provides a comparison of TRS measurements from other monitoring stations in the province for the same time period. TRS is not a commonly measured suite of pollutants and would usually measured in areas where TRS compounds are present and considered important from an air quality perspective. The figure shows that the measurements at Kinuso are comparable to other areas where TRS are measured.

Overall, measurements taken at the Kinuso monitor show that TRS is rather ubiquitous in the area, showing very little deviation by wind direction, time of day or time of year. Concentrations measured can be considered typical for Alberta.

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

1-hour AAAQO	10 (H_2S and CS_2)
Maximum 1-hour Measurement	2.83
99.9th Percentile Measurement	0.74
99th Percentile Measurement	0.61
90th Percentile Measurement	0.52
Median Measurement	0.41
Average Measurement	0.41
24-hour AAAQO	3 (H_2S)
Maximum 24-hour Average Measurement	0.61

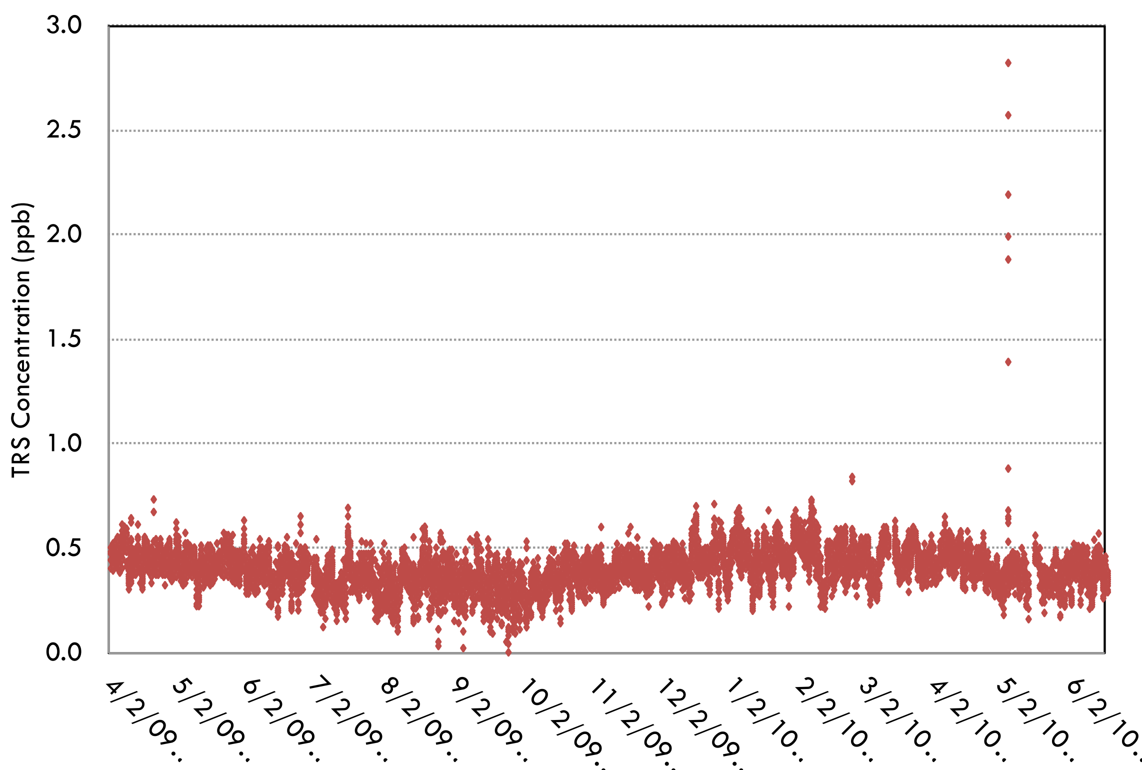


Figure 5.3 Time Series of the Kinuso TRS Measurements (non-zero values)

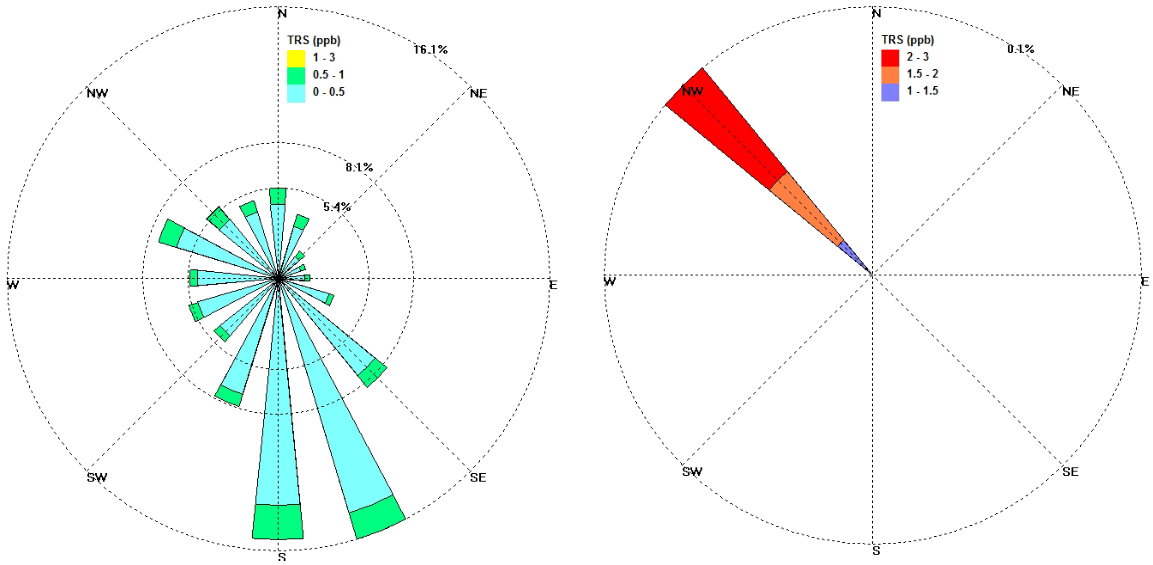


Figure 5.4 Frequency Distribution of TRS Measurements by Wind Direction

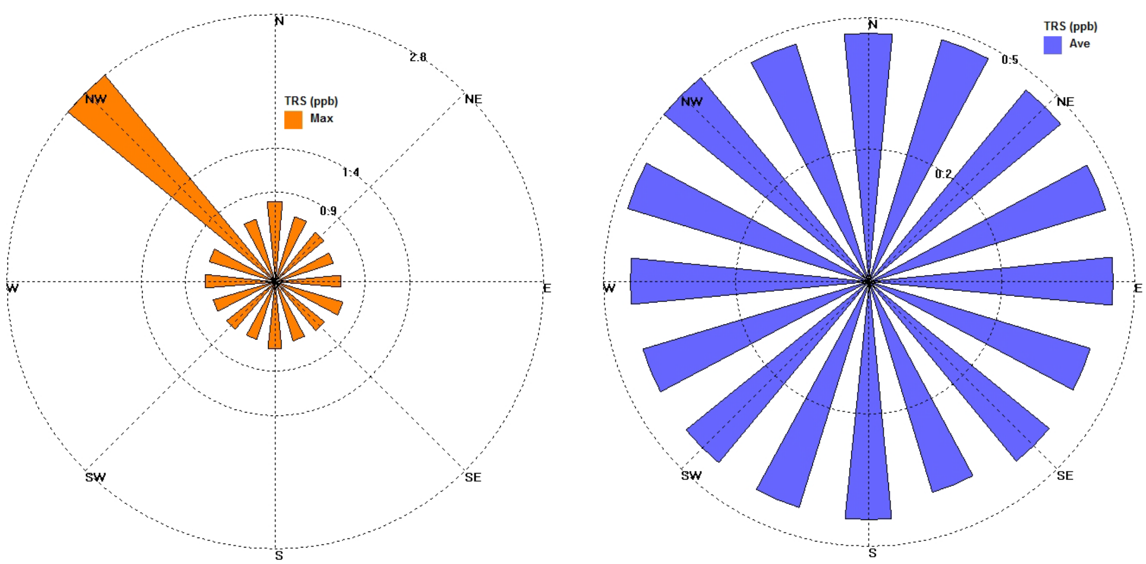
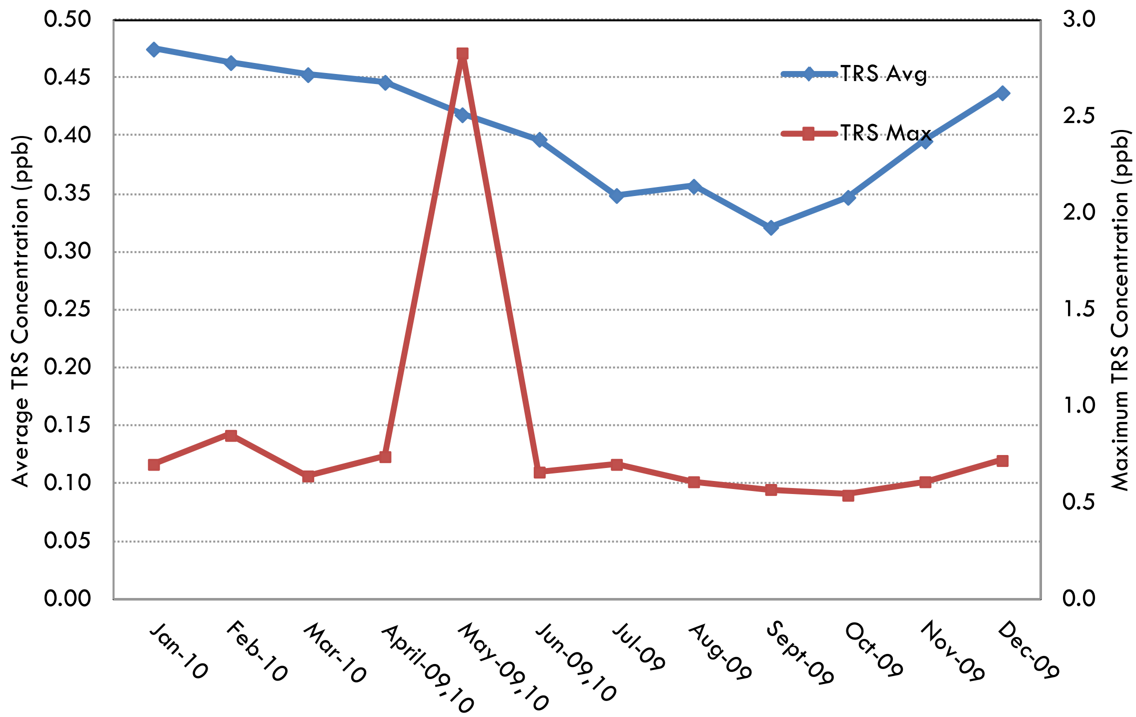


Figure 5.5 Maximum and Average TRS measurements by Wind Direction



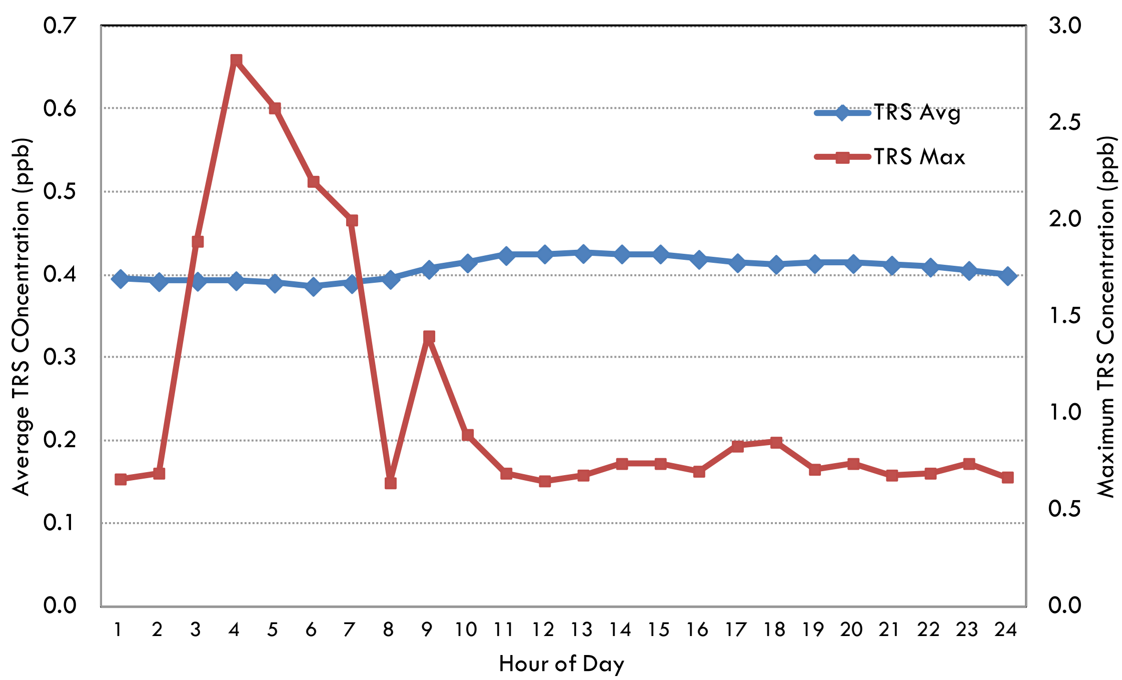


Figure 5.6 Maximum and Average TRS Measurements by Month and Hour of Day

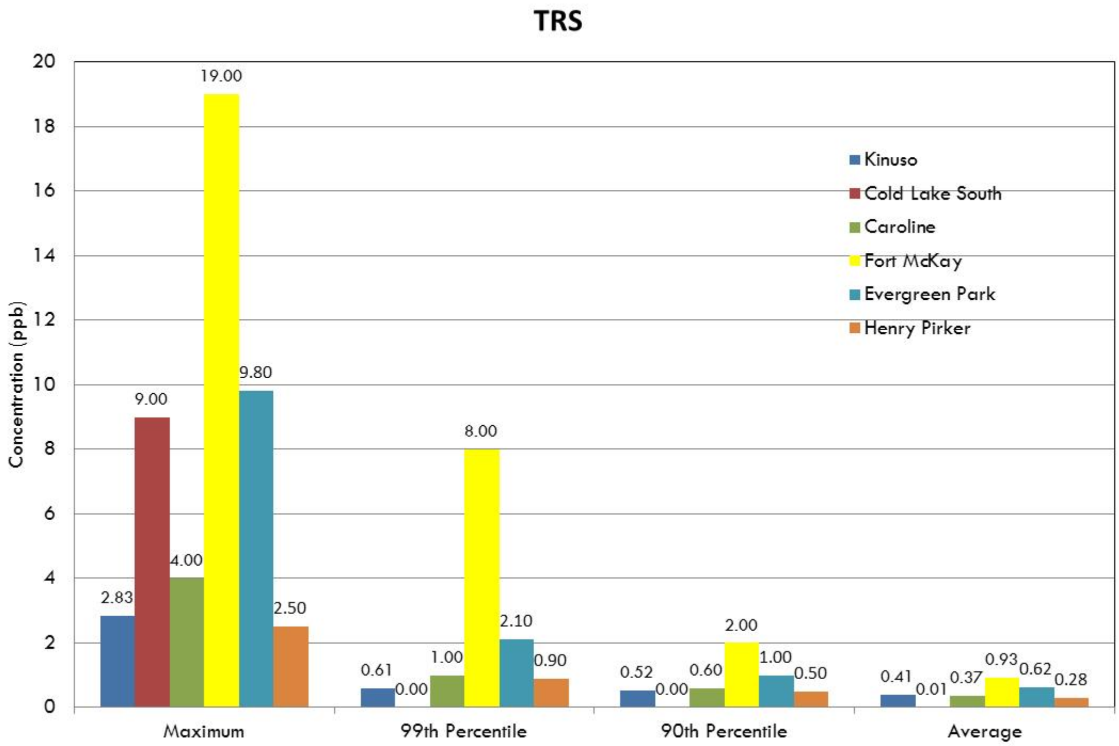


Figure 5.7 Comparison of TRS Measurements from other Continuous Monitoring Stations

5.3 Sulphur Dioxide

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

Once sulphur dioxide is released into the atmosphere, it may be converted to other compounds and/or removed from the atmosphere by various mechanisms. Processes such as oxidation, wet deposition, dry deposition, absorption by vegetation and by soil, dissolution into water and other processes contribute to the removal of sulphur dioxide from the atmosphere. Exposure to high enough concentrations of SO_2 can affect human and environmental health.[6]

[6] http://environment.gov.ab.ca/info/library/8304.pdf

A summary of SO_2 measurements are shown in Table 5.2 and the time series of measurements are shown in Figure 5.8. Unlike the TRS measurements, the SO_2 measurements more variability over time which is revealed in the differences in the median and average measurements. Nevertheless, the measurements were well below the SO_2 AAAQO in all instances.

Figure 5.9 shows that most concentrations were less than 1 ppb. Figure 5.9 and Figure 5.10 indicate that the maximum measured SO_2 concentrations occur for winds from the south to southeast sector. Highest average SO_2 concentrations show a trend to the southeast quadrants.

Figure 5.11 presents the maximum and average measured SO_2 concentrations as a function of month and hour of day. The figures show the average concentrations have a slight bias toward higher concentrations in the midday. The highest average monthly concentrations occurred in January to March 2010 period. The highest SO_2 measurements by do not show a particular trend. The figure shows that for the most part the average monthly concentrations are higher than the measurements from the closest passive monitor. The close proximity to Highway 33 may partly explain the difference.

Figure 5.12 provides a comparison of SO_2 measurements from other monitoring stations in the province for the same time period. The figure shows that the measurements at Kinuso were slightly lower when compared to other areas where SO_2 is measured.

The data indicates that SO_2 levels around Kinuso are generally low inferring that there are no significant sources of SO_2 in the area. The bias of higher concentrations from the southeast may be a sign of long range transport from the Edmonton area. Further, more thorough analysis of the measured data coupled with detailed information about activity in the area may yield more definitive conclusions in regard to the main emission contributors.

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

1-hour AAAQO	172
Annual AAAQO	20
Maximum 1-hour Measurement	11.22
99.9th Percentile Measurement	5.90
99th Percentile Measurement	2.23
90th Percentile Measurement	0.52
Median Measurement	0.10
Average Measurement	0.23
24-hour AAAQO	48
Maximum 24-hour Average Measurement	3.21

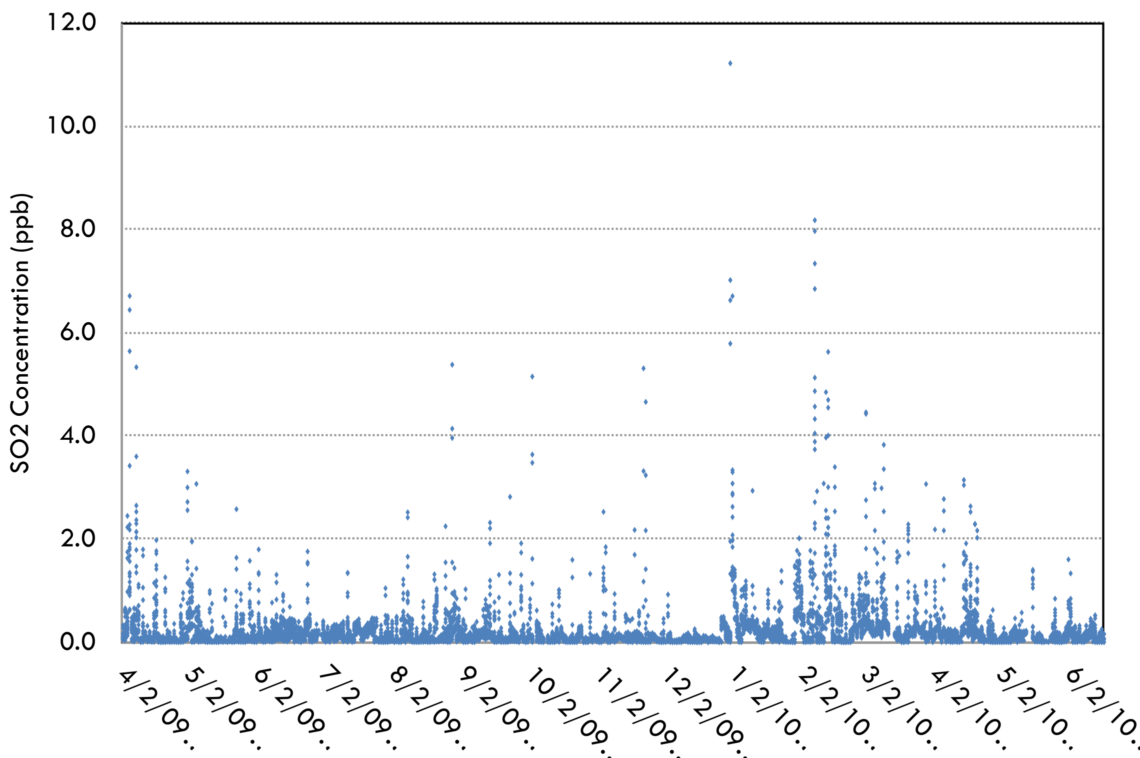
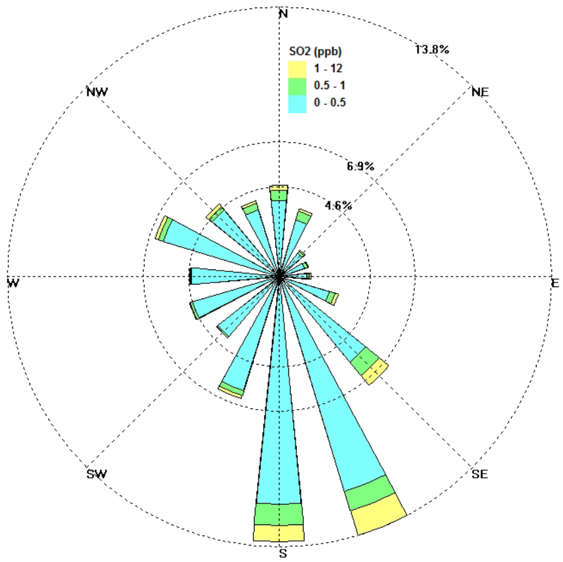


Figure 5.8 Time Series of the Kinuso SO_2 Measurements (non-zero values)



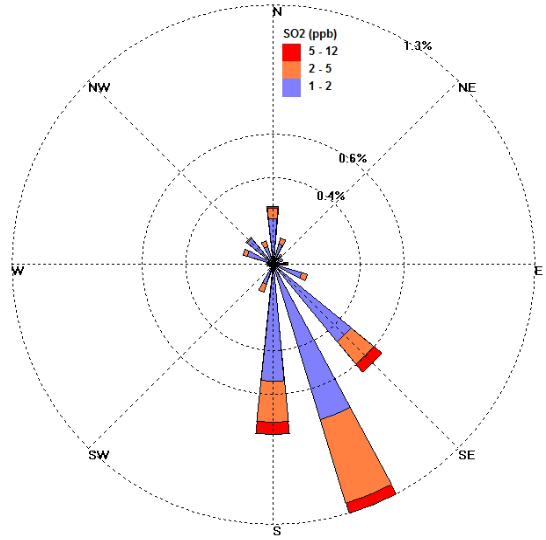
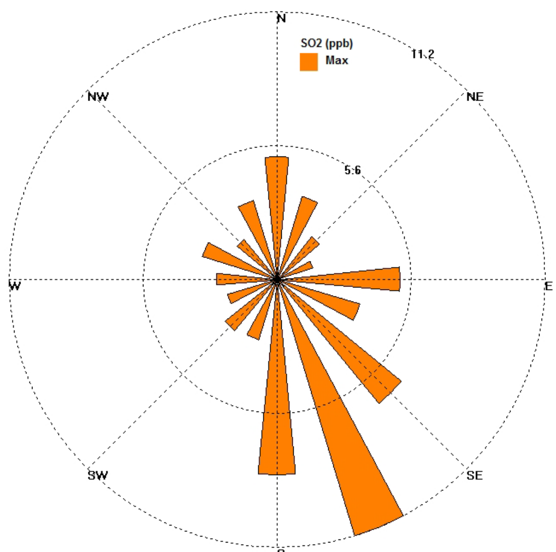


Figure 5.9 Frequency Distribution of SO_2 Measurements by Wind Direction



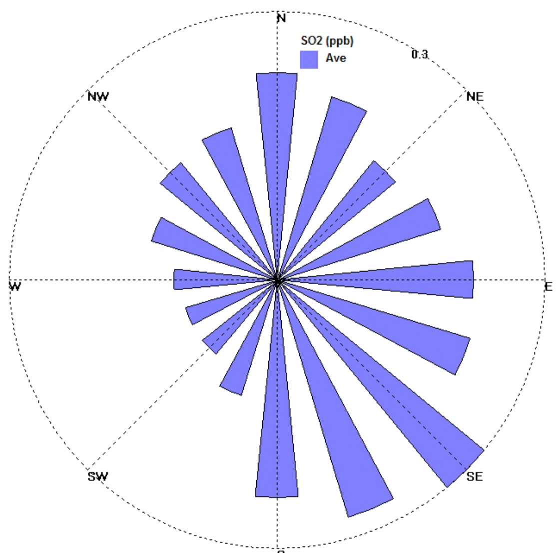


Figure 5.10 Maximum and Average SO_2 measurements by Wind Direction

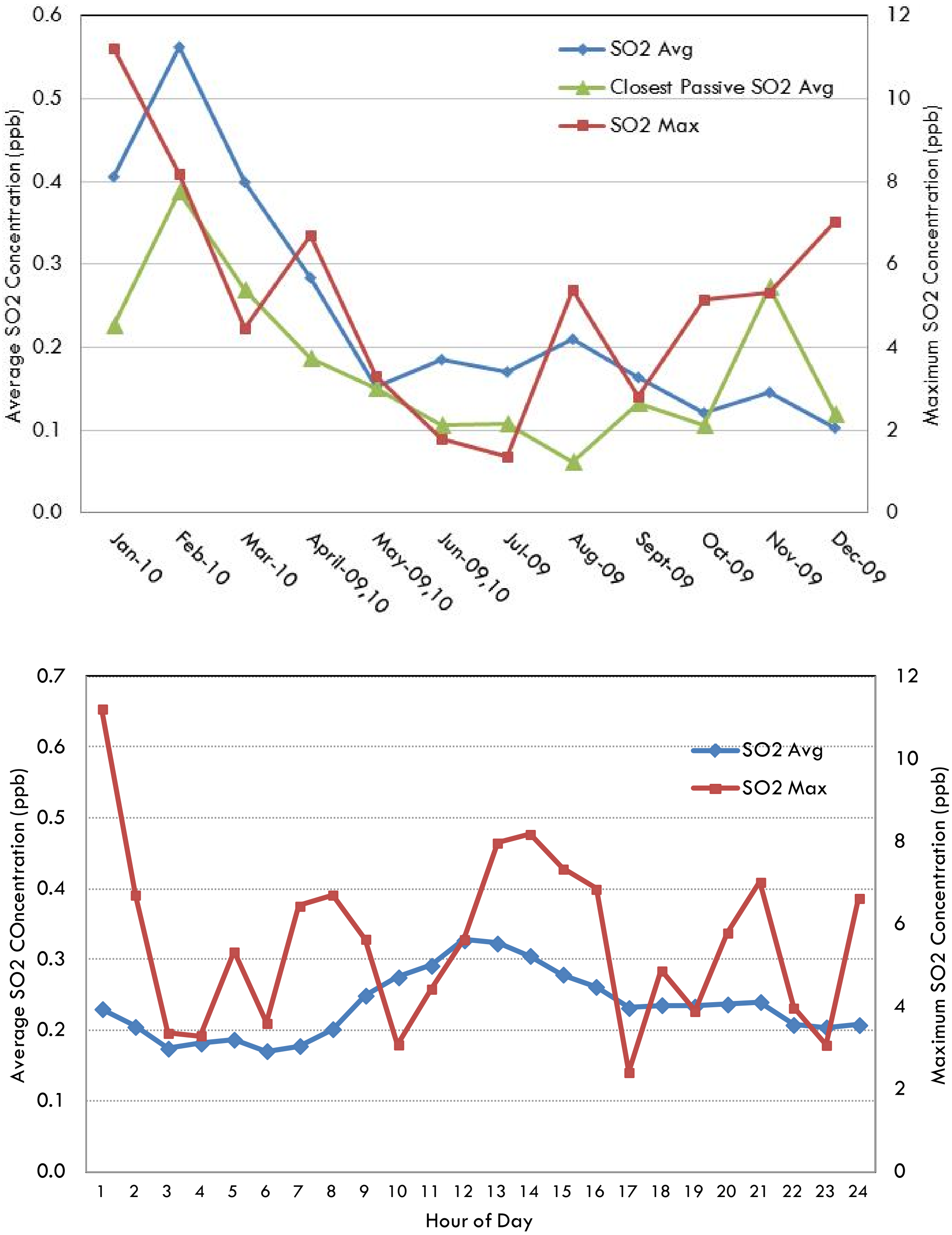


Figure 5.11 Maximum and Average SO_2 Measurements by Month and Hour of Day

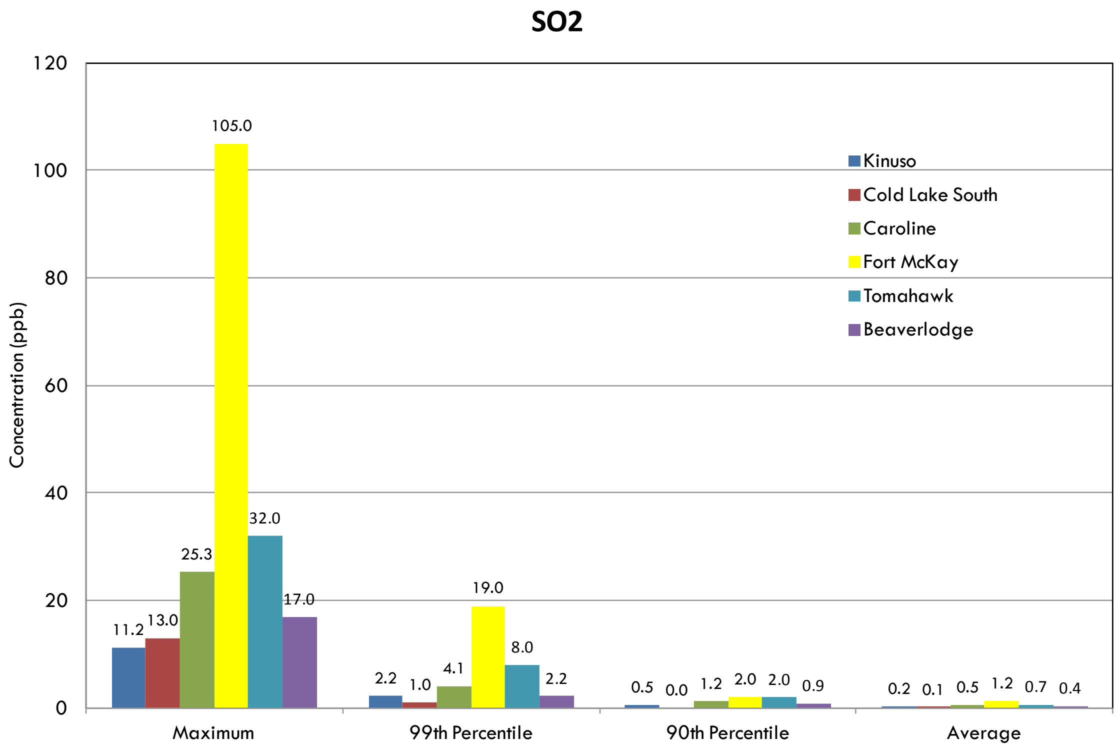


Figure 5.12 Comparison of SO_2 Measurements from other Continuous Monitoring Stations

5.4 Nitrogen Oxides

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

Of the NO_x species, an AAAQO exists for NO_2 only. Therefore, a summary of the NO_x measurements is restricted to NO_2. NO_2 is a reddish-orange-brown gas with an irritating, acrid, characteristic pungent odour. It is corrosive, highly oxidizing and non-combustible. At high enough concentrations, NO_2 can have respiratory effects on humans on which the 1-hour

AAAQO is based. On a long term basis, NO_2 can have detrimental effects on vegetation which is reflected in the annual AAAQO.[7]

A summary of NO_2 measurements are shown in Table 5.3 and the time series of measurements are shown in Figure 5.13. The figure shows that the measurements were all in the 2 ppb area except for a spike in concentrations in the December 2009 to February 2010 period. However, the measurements were below the NO_2 AAAQO in all instances.

Figure 5.14 shows that most concentrations were less than 5 ppb. Figure 5.14 and Figure 5.15 indicate that the highest NO_2 concentrations are occurring for winds from all directions, although there is a bias for winds from the east sector giving the highest average concentrations. This appears to show the influence from Highway 33.

Figure 5.16 presents the maximum and average measured NO_2 concentrations as a function of month and hour of day. The figures show the average concentrations have a slight bias toward higher concentrations in the colder months of December to February in which dispersion of ground based sources (vehicles which are the main emission sources) would be poor. There is also a diurnal pattern for average and maximum NO_2 values showing a very small peak in the morning, followed by a decline due to decreased emissions and complex atmospheric processes in sunlight (discussed in the ozone section), followed by an increase in the afternoon as the sun goes down, and a steady average during the night. The figure also shows that for the most part the average monthly concentrations are higher than the measurements from the closest passive monitor. The close proximity of the monitor to Highway 33 is the likely explanation for the difference.

Figure 5.17 provides a comparison of NO_2 measurements from other monitoring stations in the province for the same time period. The figure shows that NO_2 levels at Kinuso were lower when compared to other areas in the province.

The ambient NO_2 data measured in Kinuso appears to adequately reflect the general rural setting with a close proximity to a secondary highway. Further, more thorough analysis of the measured data coupled with detailed information about activity in the area may yield more definitive conclusions.

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[7] http://environment.gov.ab.ca/info/library/8303.pdf

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

1-hour AAAQO	159
Annual AAAQO	24
Maximum 1-hour Measurement	25.26
99.9th Percentile Measurement	21.70
99th Percentile Measurement	16.11
90th Percentile Measurement	4.84
Median Measurement	1.65
Average Measurement	2.46

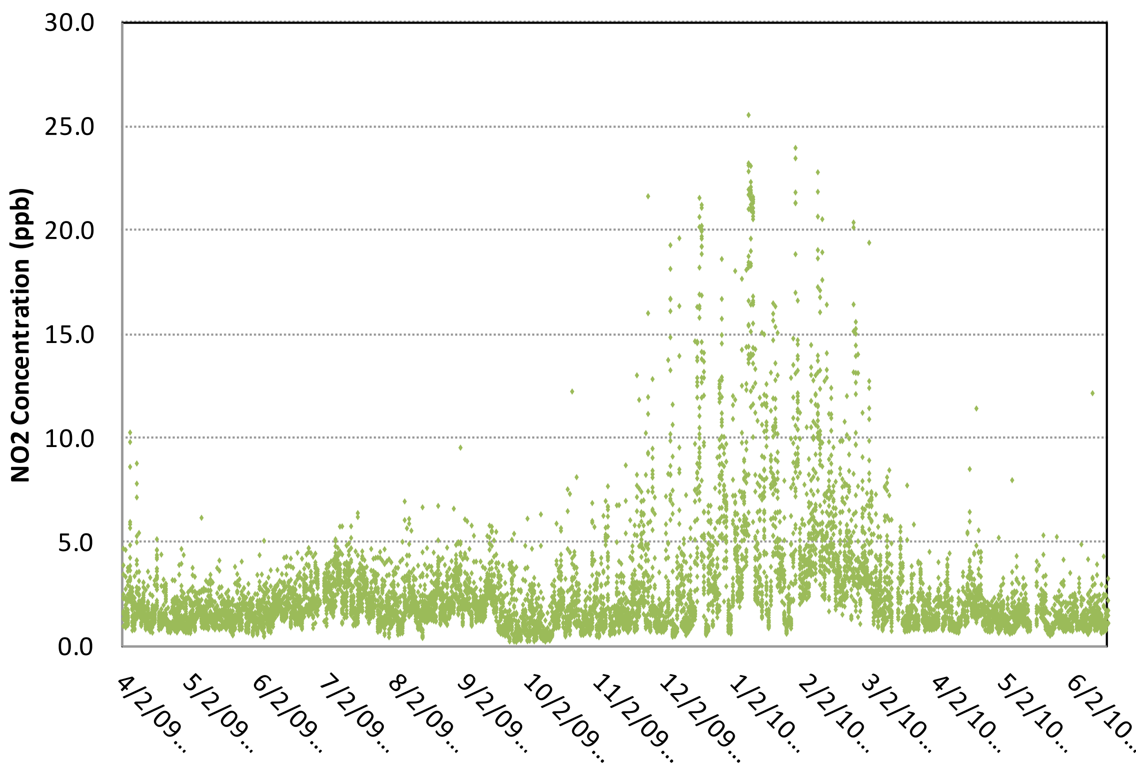


Figure 5.13 Time Series of the Kinuso NO_2 Measurements (non-zero values)

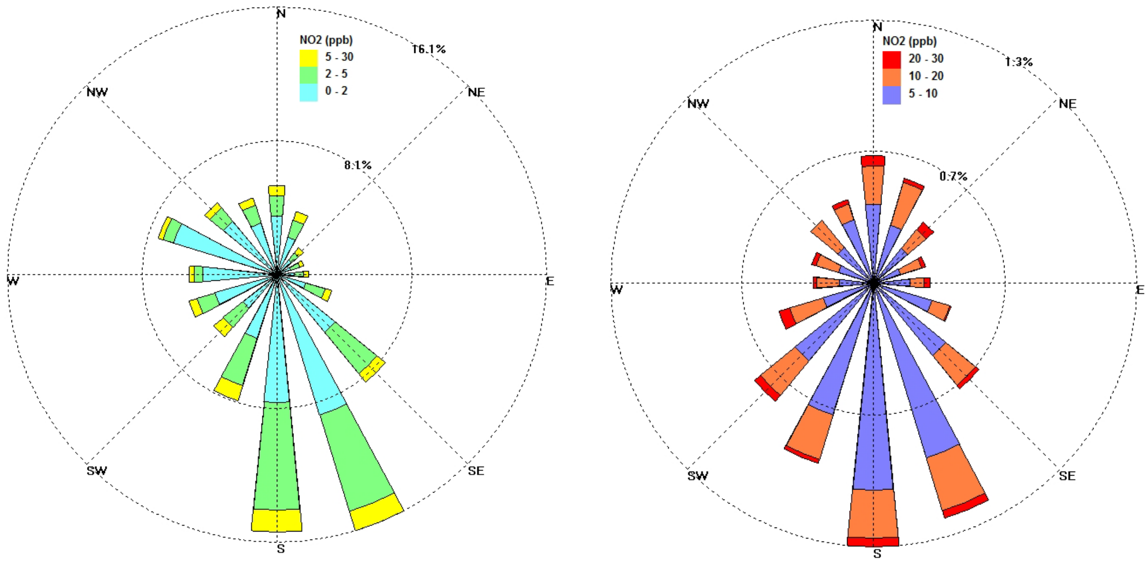


Figure 5.14 Frequency Distribution of NO_2 Measurements by Wind Direction

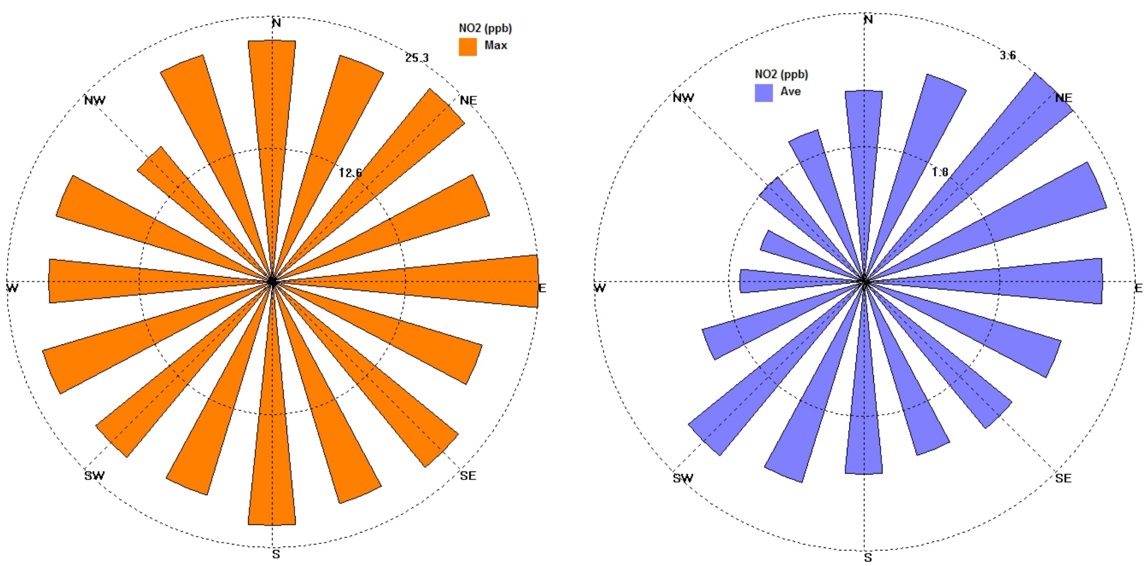
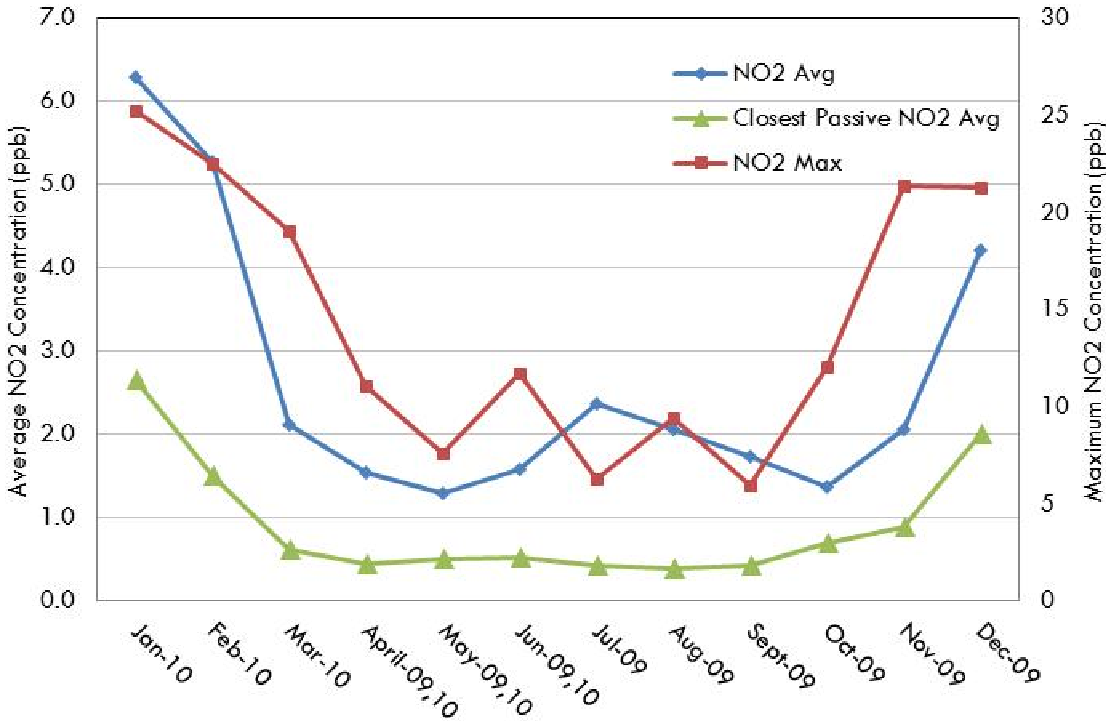


Figure 5.15 Maximum and Average NO_2 measurements by Wind Direction



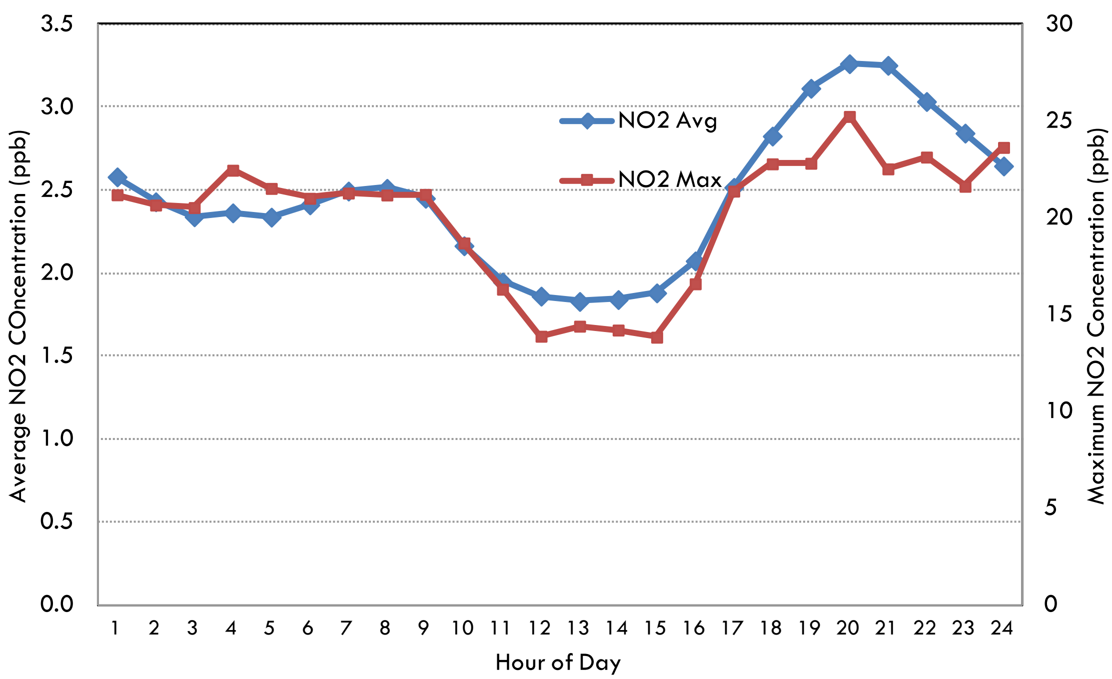


Figure 5.16 Maximum and Average NO_2 Measurements by Month and Hour of Day

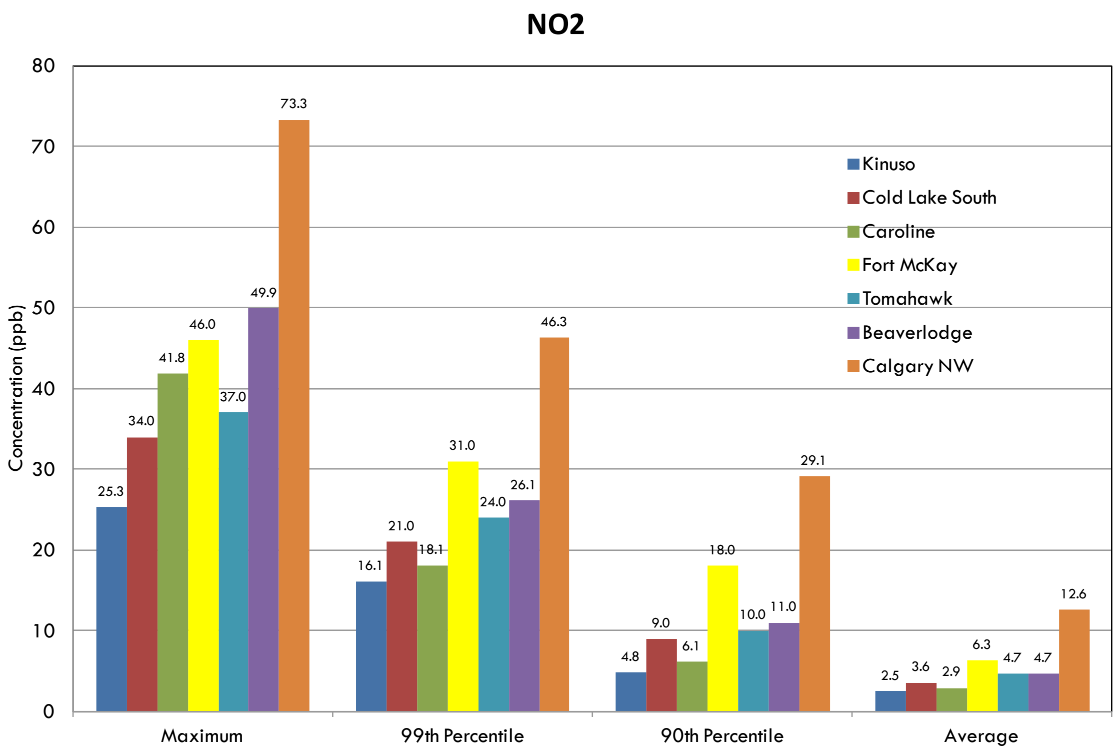


Figure 5.17 Comparison of NO_2 Measurements from other Continuous Monitoring Stations

5.5 Ozone

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

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

Extensive scientific studies indicate that there can be significant health and environmental effects associated with ozone. Potential short-term effects include pulmonary function reductions, increased airway sensitivities, and airway inflammation on which the 1-hour AAAQO for ozone is based. [8]

A summary of O_3 measurements are shown in Table 5.4 and the time series of measurements are shown in Figure 5.18. The data indicates that for the most part O_3 levels were below 60 ppb; however, there were 3 exceedances of the 1-hour AAAQO and although the CWS are not directly comparable, the 4th highest 8-hr daily average over the monitoring period is greater than CWS planning trigger of 58 ppb. All the exceedances of the AAAQO occurred in the late afternoon of August 29, 2009 during hot conditions with light and variable winds. It is likely that the effects from a forest fire lead to these very high measurements.

Figure 5.19 presents the frequency distribution of O_3 measurements by wind direction. Figure 5.20 presents the maximum and average O_3 measurements by wind direction. Although there is no apparent bias of maximum and average values by wind direction, the data is skewed to the high measurements in August 2009. The most frequent O_3 concentrations above 50 ppb are occurring during winds from the south-southeast which might suggest long range transport from the Edmonton area and forest fire activity.

Figure 5.21 presents the maximum and average measured O_3 concentrations as a function of month and hour of day. The figures show a definite pattern of the highest average and maximum values in the spring and lowest in the fall except for August 2009 period as noted. Also seen in the average concentrations is a typical diurnal pattern of O_3 where O_3 is decomposed to O_2 through a reaction with NO in the early morning and then created during the day in complex reactions with VOCs and NO_2 in the presence of sunlight. The figure also shows that the average monthly concentrations are fairly consistent with the measurements from the closest passive monitor.

Figure 5.22 provides a comparison of O_3 measurements from other monitoring stations in the province for the same time period. Other than the peak measurement, the figure shows that O_3 levels at Kinuso were comparable to other areas in the province.

Figure 5.23 presents the diurnal relationships between NO, NO_2, and O_3 at the Kinuso monitoring station for the entire period, and for the months of December, April and August. The figures show the complex relationship between these pollutants that lead to O_3 formation. Although the formation of O_3 can be seen in all four figures, it is most pronounced in August which has the highest temperatures and sunlight.

The ambient O_3 data measured in Kinuso appears to adequately reflect the general rural setting. The data is showing ozone formation and destruction due to NO_x and VOC emissions and other than the August 29, 2009 episode, ozone levels are below the AAAQO.

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[8] http://environment.gov.ab.ca/info/library/7808.pdf

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

1-hour AAAQO	82
Maximum 1-hour Measurement	104.69
99.9th Percentile Measurement	63.29
99th Percentile Measurement	54.94
90th Percentile Measurement	41.01
Median Measurement	25.56
Average Measurement	25.84
8-hour CWS Exceedance Trigger	65
8-hour CWS Planning Trigger	58
4th Highest Daily 8-hour Measurement[a]	60.9
a. This value was calculated for presentation purposes only and cannot be directly compared to the CWS	

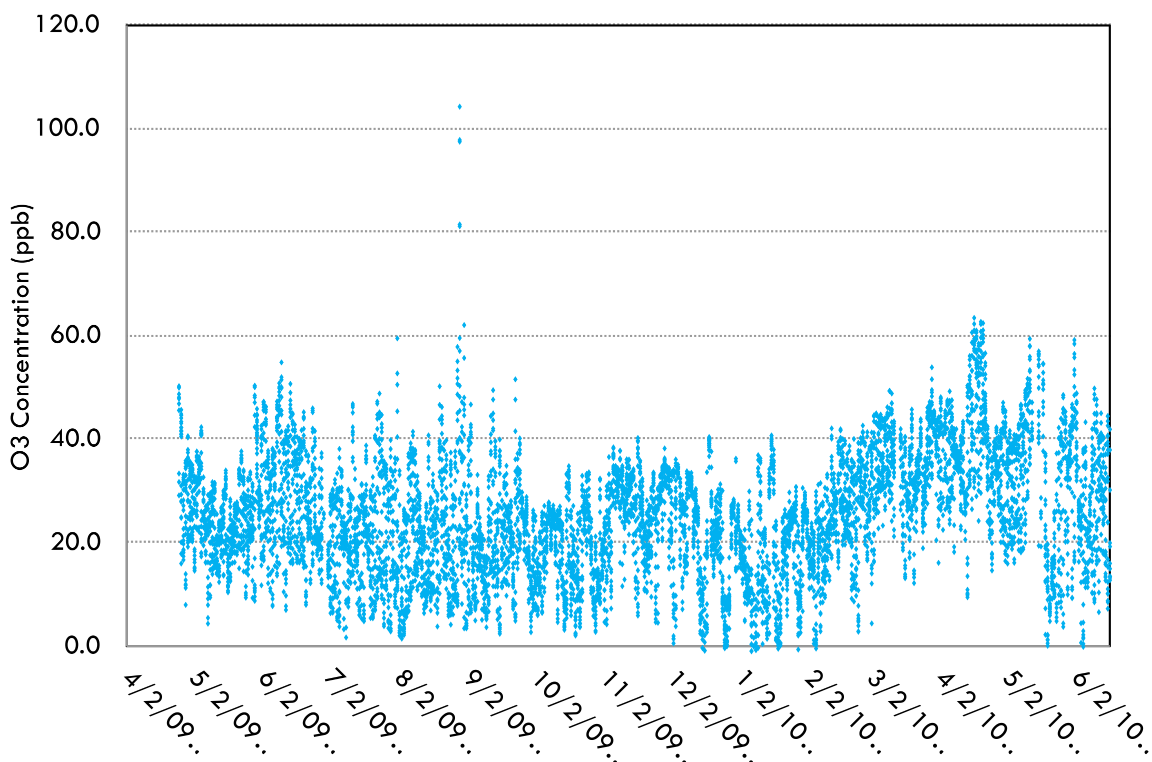


Figure 5.18 Time Series of the Kinuso O_3 Measurements (non-zero values)

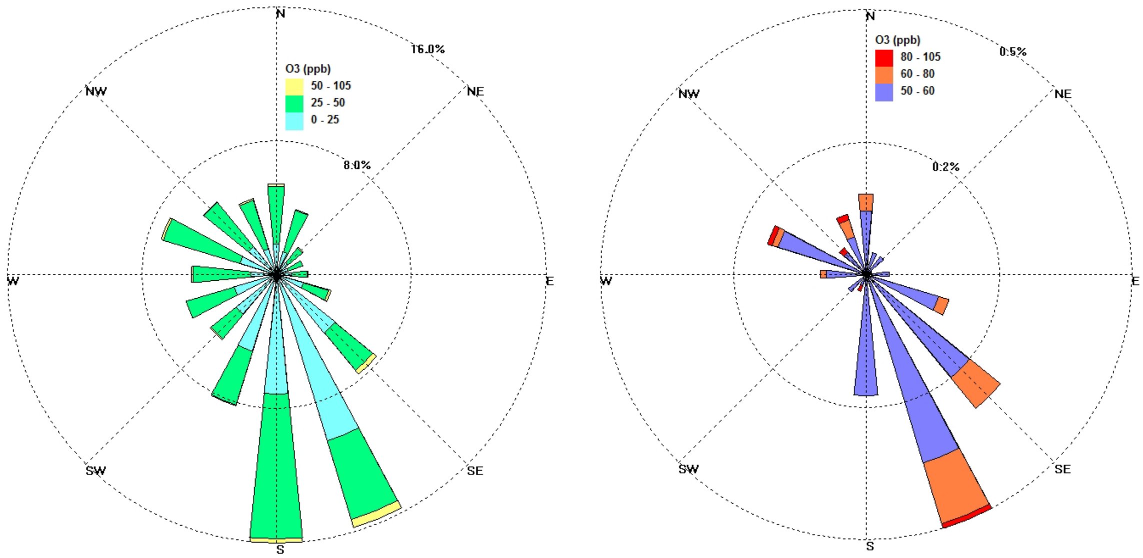


Figure 5.19 Frequency Distribution of O_3 Measurements by Wind Direction

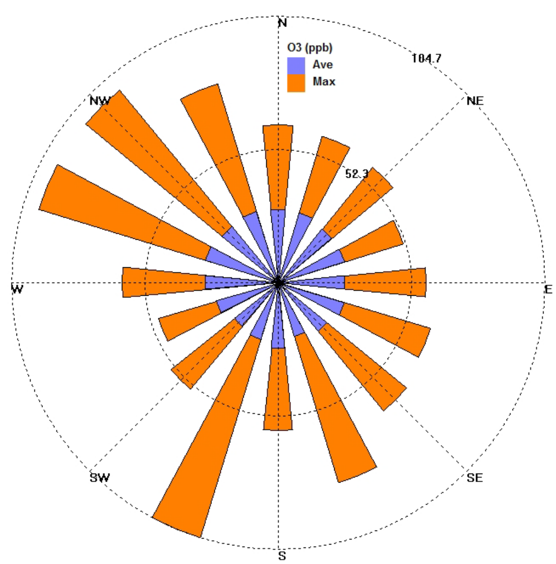
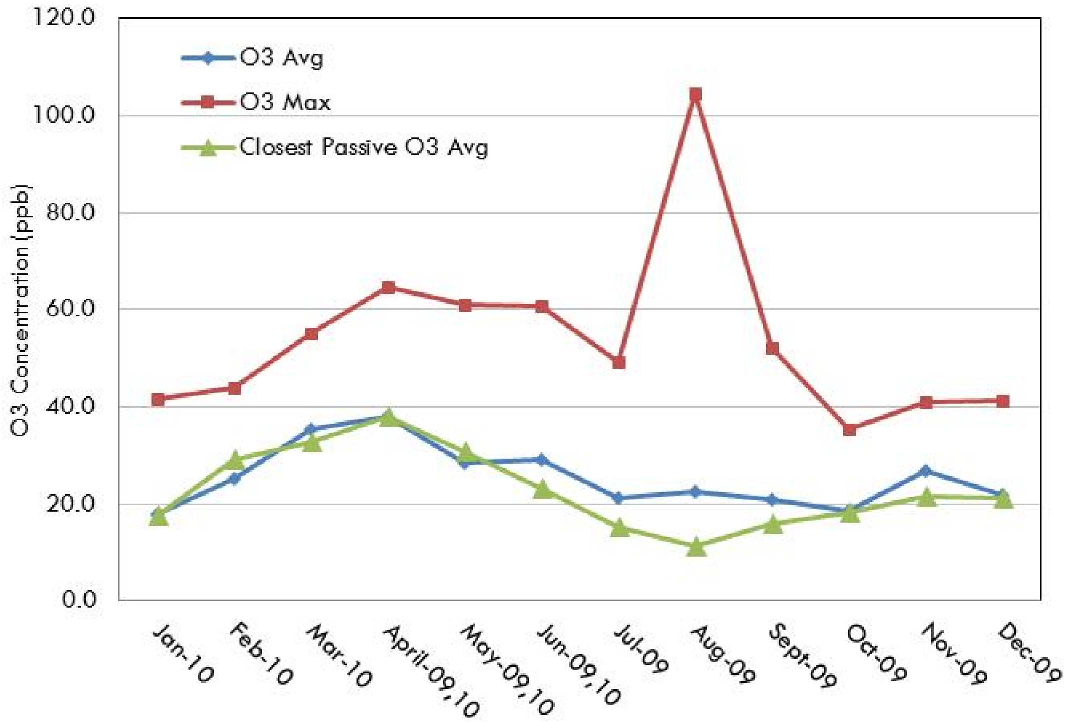


Figure 5.20 Maximum and Average O_3 Measurements by Wind Direction



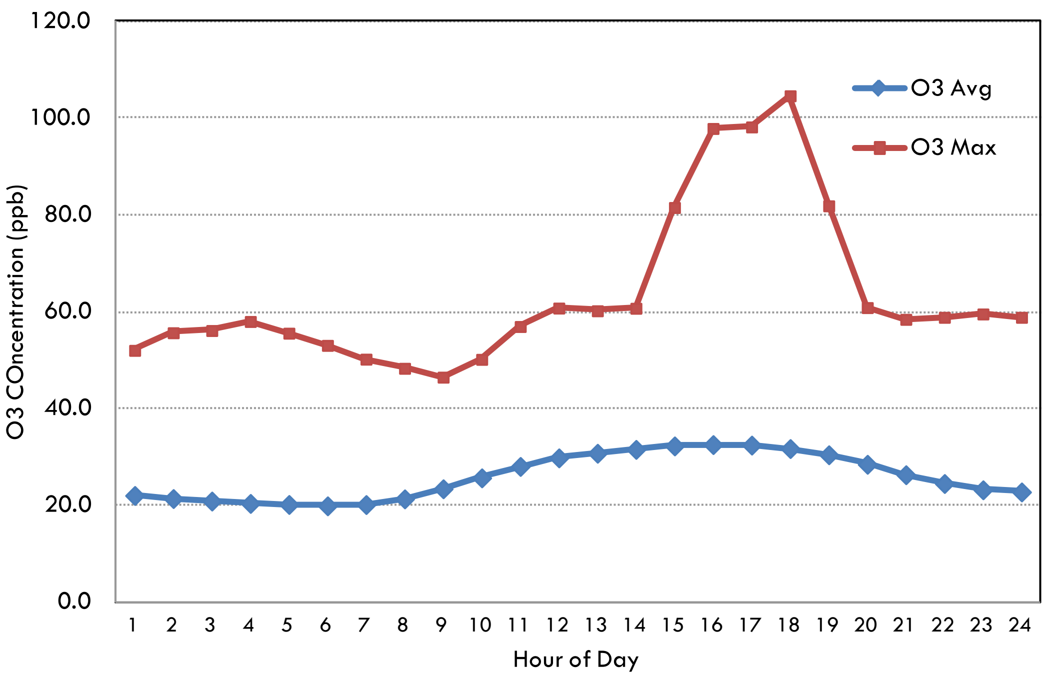


Figure 5.21 Maximum and Average O_3 Measurements by Month and Hour of Day

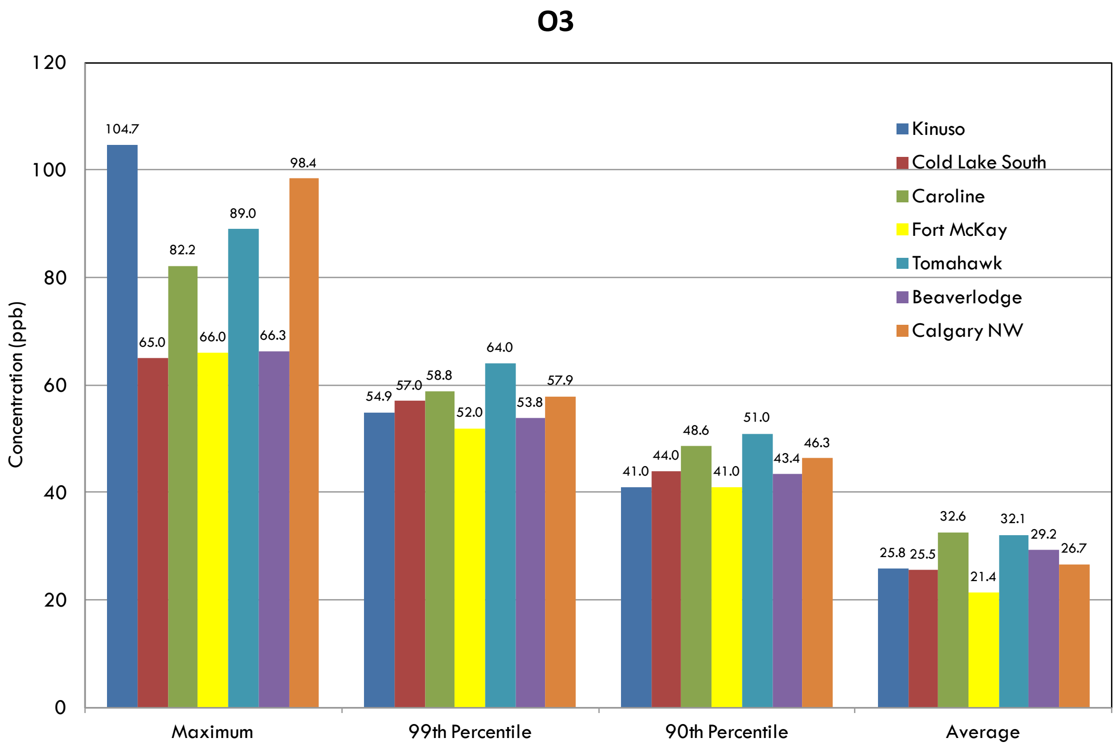


Figure 5.22 Comparison of O_3 Measurements from other Continuous Monitoring Stations

PAZA
Peace Airshed Zone Association

www.paza.ca

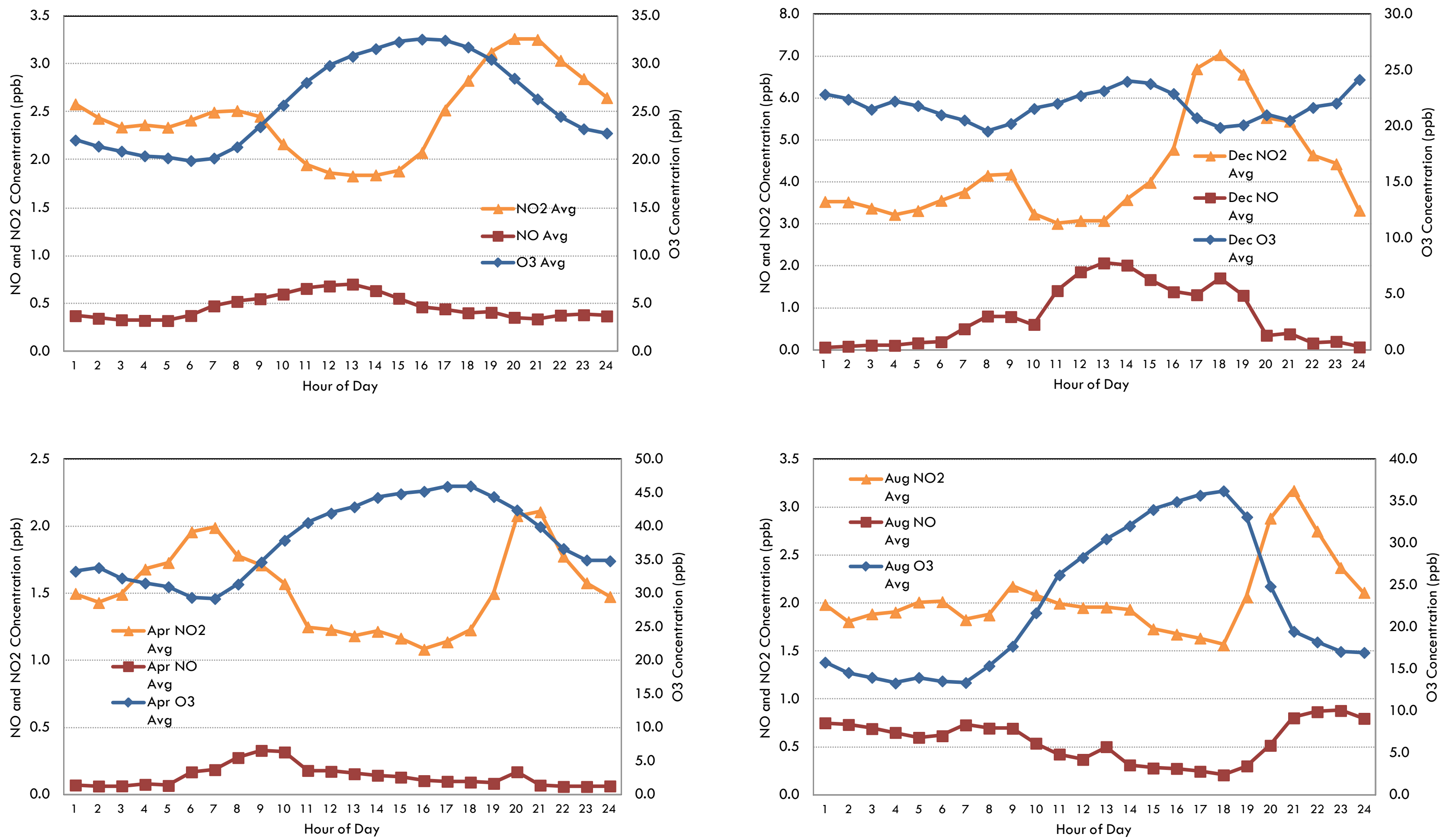


Figure 5.23 Diurnal Relationship between Measured O_3, NO, and NO_2 concentrations for entire period and selected months.

6. SUMMARY AND RECOMMENDATIONS

The monitoring data that PAZA collected through the Kinuso monitoring project suggests that the air quality is relatively good. Measured concentrations of TRS, SO_2 and NO_2, were below the applicable or other representative AAAQOs. Diurnal profiles of O_3 and NO_2 measurements appear to show photo-chemical O_3 formation and destruction. Measurements of O_3 and SO_2 may be influenced by long range transport from the Edmonton area

For the most part O_3 levels were below the AAAQO and CWS triggers, however an episode on August 29 2009 lead to exceedances of the AAAQO. The episode was linked to forest fire activity and is not indicative of an on-going air quality problem in the area.

The summary of the air quality monitoring data is limited to the parameters measured in this study. Air quality in the area around the Village of Kinuso may be affected by other compounds associated with local activities some of which PAZA was not equipped to measure such as volatile organic compounds (VOCs) and fine particulate matter.

Although the monitoring results do not necessarily support further continuous monitoring in the area, if PAZA chooses to conduct additional monitoring in the Kinuso area, it is recommended to consider passive hydrogen sulphide monitoring to determine trends and perhaps assist in determining source contributions.