Nuiqsut Ambient Air Quality and Meteorological Monitoring Program

January 1, 2016 – December 31, 2016

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Nuiqsut, Alaska

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2016 Annual Data Report

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This document has been prepared by SLR International Corporation (SLR). The material and data in this report were prepared under the supervision and direction of the undersigned.

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EXECUTIVE SUMMARY

On behalf of ConocoPhillips Alaska, Inc. (CPAI), SLR International Corporation (SLR) is collecting ambient air and meteorological data in the village of Nuiqsut, Alaska. Since April 9, 1999 (prior to construction of the Alpine Central Processing Facility), CPAI has operated an ambient air quality and dispersion meteorology monitoring station in Nuiqsut, Alaska, which is located on the Alaskan North Slope. The Nuiqsut Ambient Air Quality and Meteorological Monitoring Program is comprised of one station located at the northern edge of Nuiqsut approximately 400 meters north-northwest of the community electrical generators. The Nuiqsut Monitoring Program is being conducted to document air quality in Nuiqsut and data may also be used to support various ambient air quality impact analyses conducted for oil field development in the Colville Delta region.

The Nuiqsut monitoring program is designed and operated in accordance with applicable Environmental Protection Agency (EPA) Prevention of Significant Deterioration (PSD) regulations and guidance documents. This report provides details of ambient air and meteorological measurements collected during the 2016 monitoring year, spanning from January 1, 2016, to December 31, 2016, at the Nuiqsut monitoring station.

Table E-1 details Quality Assurance Project Plan (QAPP) variations documented for this project during the monitoring year. Any QAPP variations are explained in more detail in Section 1. The Nuiqsut QAPP Revision 2.1 was approved by the Alaska Department of Environmental Conservation (ADEC) in September 2012. Table E-2 provides a summary of quarterly and annual measured data for the monitored pollutants and the respective ratios of measured pollutants to National Ambient Air Quality Standards and Alaska Ambient Air Quality Standards (NAAQS/AAAQS). Tables E-3 and E-4 provide monthly, quarterly, and annual valid hours and percent data capture for the Nuiqsut meteorological monitoring station. Data not meeting QAPP and PSD precision and accuracy criteria were invalidated and are discussed in Section 2.

Table E-1: QAPP Variation Table

Item / Procedure	Summary of QAPP Variation	Reason for Variation
Vertical wind speed audit	A vertical wind speed sensor audit was not conducted during the December 2016 semi-annual meteorological audit.	The vertical wind sensor had been damaged by frequent icing events in November-December 2016 and was not operational at the time of the audit. The sensor will be repaired and calibrated and audits will be conducted at the next opportunity.

Table E-2: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Nitrogen Dioxide (NO_2)	53 ppb (100 µg/m^3)	Annual	Average of Period	2	1	1	2	1	**1.9%**
	100.0 ppb (190 µg/m^3)	1-Hour (2)	Daily Max 1-Hour Averages (98th Percentile)	--	--	--	--	18.0	**18.0%**
			1st Highest, 1-Hour Average	29.2	17.0	16.2	29.0	29.2	**29.2%**
			2nd Highest, 1-Hour Average	28.6	15.1	15.4	21.7	29.0	**29.0%**
Ozone (O_3)	0.075 ppm (150 µg/m^3)	8-Hour (3)	4th Highest, 8-Hour Average	0.041	0.041	0.028	0.037	0.043	**57.3%**
			1st Highest, 8-Hour Average	0.044	0.044	0.030	0.038	0.044	**58.7%**
			2nd Highest, 8-Hour Average	0.043	0.044	0.029	0.037	0.044	**58.7%**
Carbon Monoxide (CO)	35 ppm (40,000 µg/m^3)	1-Hour (1)	1st Highest, 1-Hour Average	1	1	0	1	1	**2.9%**
			2nd Highest, 1-Hour Average	1	1	0	0	1	**2.9%**
	9 ppm (10,000 µg/m^3)	8-Hour (1)	1st Highest, 8-Hour Average	0	1	0	1	1	**11.1%**
			2nd Highest, 8-Hour Average	0	1	0	1	1	**11.1%**

[1] Not to be exceeded more than once each year.
[2] To attain this standard, the 3-year average of the 98th percentile of the annual daily maximum 1-hour average must not exceed 100 ppb.
[3] To attain this standard, the 3-year average of the annual fourth-highest daily maximum 8-hour average must not exceed 0.075 ppm.

Table E-2 (Continued): Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Sulfur Dioxide (SO_2)	0.030 ppm (80 μg/m^3)	Annual	Average of Period	0.001	0.002	0.001	0.000	0.001	**3.3%**
	0.14 ppm (365 μg/m^3)	24-Hour [5]	1st Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
			2nd Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
	0.5 ppm (1,300 μg/m^3)	3-Hour [5]	1st Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
			2nd Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
	75.0 ppb (196 μg/m^3)	1-Hour [4]	Daily Max 1-Hour Averages (99th Percentile)	--	--	--	--	3.2	**4.3%**
			1st Highest, 1-Hour Average	1.8	3.6	2.2	0.8	3.6	**4.8%**
			2nd Highest, 1-Hour Average	1.8	3.5	2.2	0.8	3.5	**4.7%**

[4] To attain this standard, the 3-year average of the 99th percentile of the annual daily maximum 1-hour average must not exceed 75.0 ppb.
[5] Not to be exceeded more than once each year.

Table E-2 (Continued): Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Particulate Matter <2.5 microns ($PM_{2.5}$)	12.0 μg/m^3	Annual [7]	Average of Period	1.9	1.4	1.1	0.9	1.3	**10.8%**
	35 μg/m^3	24-Hour [6]	98th Percentile, 24-Hour Average	--	--	--	--	6	**15.7%**
			1st Highest, 24-Hour Average	9	5	9	6	9	**25.1%**
			2nd Highest, 24-Hour Average	6	5	6	6	9	**24.3%**
Particulate Matter <10 microns (PM_{10})	150 μg/m^3	24-Hour (8,9)	1st Highest, 24-Hour Average	20	40	150	130	150	**100.0%**
			2nd Highest, 24-Hour Average	10	40	120	60	130	**86.7%**

[6] To attain this standard, the 3-year average of the 98th percentile of the 24-hour concentration must not exceed 35.0 μg/m^3.
[7] To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentration must not exceed 12.0 μg/m^3.
[8] Not to be exceeded more than once per year on average over three years.
[9] 40 CFR Appendix K requires that reportable concentrations of PM_{10} be rounded to the nearest 10 μg/m^3; actual measurement results are within Appendix C.

Table E-3: Meteorological Data Capture – Valid Hours per Month

Period	Meteorological Parameters – Valid Hours per Month [1]								
	Vertical Wind Speed	Vertical Wind Speed Std. Dev. (Sigma Omega)	Horizontal Wind Speed [2]	Horizontal Wind Direction [2]	Wind Direction Std. Dev. (Sigma Theta) [2]	2-M Temp	10-M Temp	Delta-Temp	Solar Radiation
January	741	741	671	671	671	741	741	741	741
February	672	672	631	631	631	695	695	695	692
March	743	743	737	737	737	743	743	743	741
1st Quarter	**2156**	**2156**	**2039**	**2039**	**2039**	**2179**	**2179**	**2179**	**2174**
April	715	715	715	715	715	715	715	715	702
May	738	738	744	744	744	744	744	744	744
June	716	716	716	716	716	716	716	716	716
2nd Quarter	**2169**	**2169**	**2175**	**2175**	**2175**	**2175**	**2175**	**2175**	**2162**
July	744	744	744	744	744	744	744	744	744
August	744	744	744	744	744	744	744	744	744
September	720	720	720	720	720	720	720	720	720
3rd Quarter	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**	**2208**
October	724	724	744	744	744	734	734	734	734
November	**286** [3]	**286** [3]	**534** [4]	**534** [4]	**534** [4]	720	720	720	720
December	**0** [3]	**0** [3]	721	721	721	739	739	739	744
4th Quarter	**1010** [3]	**1010** [3]	**1999**	**1999**	**1999**	**2193**	**2193**	**2193**	**2198**
Annual	**7543**	**7543**	**8421**	**8421**	**8421**	**8755**	**8755**	**8755**	**8742**

[1] EPA PSD-quality meteorological monitoring standards require data capture of 90 percent or greater per quarter for four consecutive quarters.
[2] Due to the primary (Set A) wind speed / direction sensor failing audit criteria during the December 13 audit, wind speed and direction data are reported from the primary sensor as well as the secondary (Set B) wind speed / direction sensor. Data from the first quarter is from the Set A sensor and data from Set B data is used for the second, third and fourth quarters.
[3] Vertical wind data were invalidated due to the buildup of snow and ice on the sensor and subsequent damage. DQOs were not met for the vertical wind speed for the fourth quarter.
[4] Snow and ice buildup on the horizontal wind speed and direction sensor resulted in significant data loss in November. Despite the data loss, DQOs were met for the fourth quarter for horizontal wind speed and direction.

Table E-4: Meteorological Data Capture – Percent Data Capture

Period	Meteorological Parameters – Data Recovery [1]								
	Vertical Wind Speed	Vertical Wind Speed Std. Dev. (Sigma Omega)	Horizontal Wind Speed [2]	Horizontal Wind Direction [2]	Wind Direction Std. Dev. (Sigma Theta) [2]	2-M Temp	10-M Temp	Delta-Temp	Solar Radiation
January	100%	100%	90%	90%	90%	100%	100%	100%	100%
February	97%	97%	91%	91%	91%	100%	100%	100%	99%
March	100%	100%	99%	99%	99%	100%	100%	100%	100%
1st Quarter	**99%**	**99%**	**93%**	**93%**	**93%**	**100%**	**100%**	**100%**	**100%**
April	99%	99%	99%	99%	99%	99%	99%	99%	98%
May	99%	99%	100%	100%	100%	100%	100%	100%	100%
June	99%	99%	99%	99%	99%	99%	99%	99%	99%
2nd Quarter	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**99%**
July	100%	100%	100%	100%	100%	100%	100%	100%	100%
August	100%	100%	100%	100%	100%	100%	100%	100%	100%
September	100%	100%	100%	100%	100%	100%	100%	100%	100%
3rd Quarter	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
October	97%	97%	100%	100%	100%	99%	99%	99%	99%
November	40% [3]	40% [3]	74% [4]	74% [4]	74% [4]	100%	100%	100%	100%
December	0% [3]	0% [3]	97%	97%	97%	99%	99%	99%	100%
4th Quarter	**46%** [3]	**46%** [3]	**91%**	**91%**	**91%**	**99%**	**99%**	**99%**	**100%**
Annual	**86%**	**86%**	**96%**	**96%**	**96%**	**100%**	**100%**	**100%**	**100%**

[1] EPA PSD-quality meteorological monitoring standards require data capture of 90 percent or greater per quarter for four consecutive quarters.
[2] Due to the primary (Set A) wind speed / direction sensor failing audit criteria during the December 13 audit, wind speed and direction data are reported from the primary sensor as well as the secondary (Set B) wind speed / direction sensor. Data from the first quarter is from the Set A sensor and data from Set B data is used for the second, third and fourth quarters.
[3] Vertical wind data were invalidated due to the buildup of snow and ice on the sensor and subsequent damage. DQOs were not met for the vertical wind speed for the fourth quarter.
[4] Snow and ice buildup on the horizontal wind speed and direction sensor resulted in significant data loss in November. Despite the data loss, DQOs were met for the fourth quarter for horizontal wind speed and direction.

1. INTRODUCTION

1.1 PROJECT SUMMARY

Since April 9, 1999 (prior to construction of the Alpine Central Processing Facility), CPAI has operated an ambient air quality and meteorology monitoring station in Nuiqsut, Alaska, which is located on the Alaska North Slope. One station located at the northern edge of Nuiqsut, approximately 400 meters north-northwest of the community electrical generators, comprises the Nuiqsut Ambient Air Quality and Meteorological Monitoring Program. Currently, the Nuiqsut Monitoring Program is being conducted to document air quality in Nuiqsut and the data may also be used to support various ambient air quality impact analyses conducted for oil field development in the Colville Delta region.

The monitoring program consists of an ambient air quality monitoring station and a meteorological monitoring tower directly mounted to the air quality monitoring structure. The program is designed and operated in accordance with applicable PSD regulations and guidance documents. The specific project objectives of the Monitoring Program are to:

- Collect data to document Nuiqsut air quality and address community concerns related to regional oilfield development.
- Establish a monitoring system to measure, with known accuracy and precision, meteorological parameters at the project site from ground level up to 10 meters.
- Provide required and relevant optional meteorological data for American Meteorological Society/EPA Regulatory Model Improvement Committee Model (AERMOD) modeling system.
- Establish a monitoring system to measure, with known bias and precision, the ambient concentrations of the criteria air quality pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}), and particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$) to establish National Ambient Air Quality Standards (NAAQS) compliance status for the monitoring location.

The Nuiqsut station collects the following ambient air data:

- Carbon monoxide (CO)
- Oxides of nitrogen (NO_2, NO_X, and NO)
- Ozone (O_3)
- Sulfur dioxide (SO_2)
- Inhalable particulate matter less than 2.5 microns ($PM_{2.5}$)
- Inhalable particulate matter less than 10 microns (PM_{10})

The Nuiqsut station measures the following meteorological parameters:

- Horizontal wind speed (meters per second [m/s])
- Horizontal wind direction (degrees [°])
- Vertical wind speed (meters per second [m/s])
- Air temperature, two and ten meters above ground level (degrees Celsius [°C])
- Solar radiation (Watts per square meter [W/m^2])

The Nuiqsut station calculates the following meteorological parameters:

- Horizontal wind direction standard deviation (Sigma Theta [σ_θ])
- Vertical wind speed standard deviation (Sigma Omega [σ_ω])
- Temperature difference ((ΔT, "Delta T" (degrees Celsius [°C]), is calculated as temperature at 10 meters minus temperature at 2 meters)

Data review and validation procedures and monitoring program data and measurement quality objectives (MQO's) are provided in the Nuiqsut Ambient Air Quality and Meteorological Monitoring Station Quality Assurance Project Plan Revision 2.1 approved by ADEC in September 2012.

The community of Nuiqsut is located in the Colville River Delta region of the North Slope of Alaska. Figure 1-1 shows a detailed map of Nuiqsut while Figure 1-2 provides an aerial view of the Nuiqsut village and depicts the location of the monitoring station. Figure 1-3 depicts the general location of the project area.

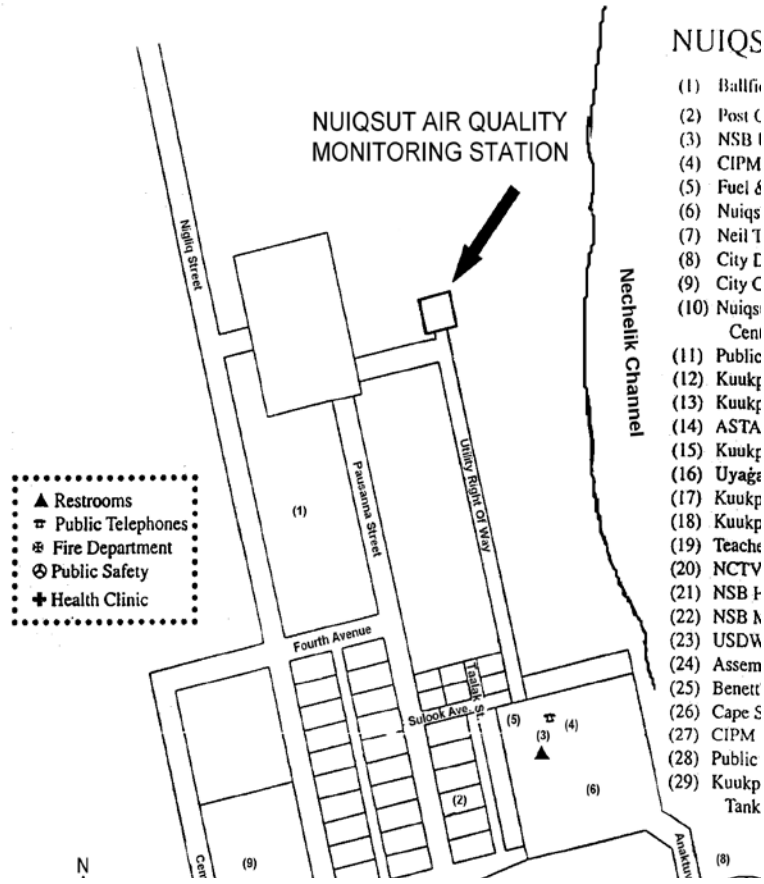


Figure 1-1: Local Map of Nuiqsut

Figure 1-2: Aerial Photo Showing Site Location

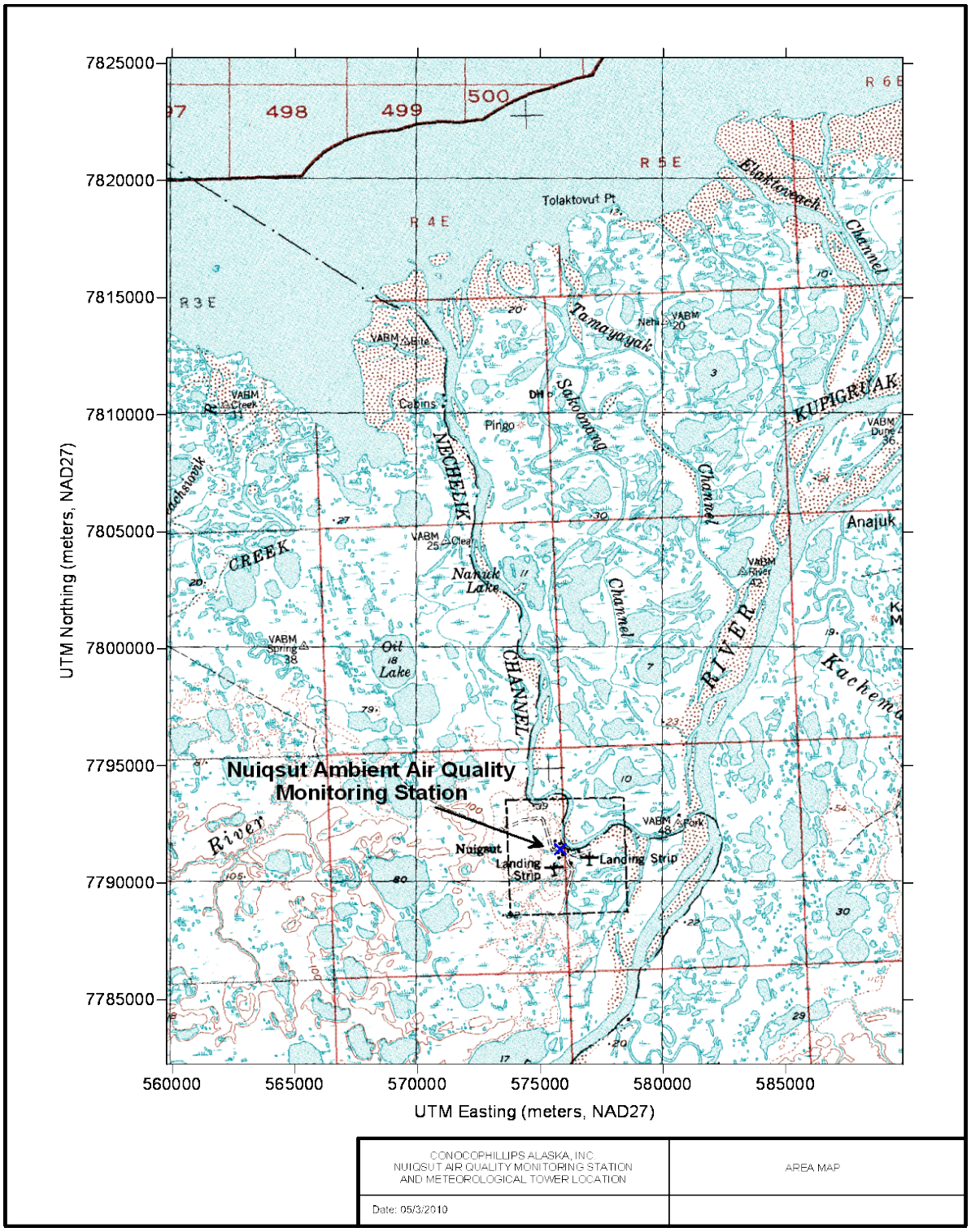


Figure 1-3: Map of Nuiqsut Project Area

1.2 MEASUREMENT METHODS TABLE

All instruments meet or exceed the U.S. Environmental Protection Agency (EPA) PSD requirements for range accuracies, thresholds, response times, resolutions, damping ratios, and other measures of instrument performance.

1.2.1 CONTINUOUS NO_2, O_3, CO AND SO_2 MONITORING

The gas analyzers used for the Nuiqsut Air Monitoring Station have been designated by EPA as either a Federal Equivalent Method (FEM) or Federal Reference Method (FRM) as defined in 40 CFR 53. Table 1-1 provides a summary of the measurement methods and parameters used for the Nuiqsut Ambient Air Monitoring Program.

Table 1-1: Gaseous Pollutant Measurement Parameters

Parameter	Instrument	References	Units	Sampling Frequency	Sample Averaging
Carbon Monoxide (CO)	Thermo 48i Gas filter correlation analyzer	EPA reference method RFCA-0981-054	Parts per million (ppm)	Continuous	1-hour
Nitrogen Dioxide (NO_2) [1,2]	Thermo Scientific 42i Chemiluminescent NO_X gas analyzer	EPA reference method RFNA-1289-074	Parts per billion (ppb)		
	API T200U Chemiluminescent NO_X gas analyzer	EPA reference method RFNA-1194-099			
Ozone (O_3)	API T400 UV Photometric Ozone analyzer	EPA equivalent method EQOA-0992-087			
Sulfur Dioxide (SO_2)	Thermo 43i Pulsed fluorescence SO_2 gas analyzer	EPA equivalent method EQSA-0486-060			

[1] Total oxides of nitrogen (NO_X) and nitrogen oxide (NO) are also measured.
[2] Thermo instrument was used January 1- July 12, 2016. API instrument was used July 12-December 31, 2016.

1.2.2 CONTINUOUS PM_{10} AND $PM_{2.5}$ MONITORING

Monitoring for PM_{10}/$PM_{2.5}$ data was conducted in accordance with the requirements and guidance in 40 CFR Parts 50, 53, and 58. PM_{10} and $PM_{2.5}$ monitoring were conducted using Met One Instruments, Inc. Model BAM-1020 Beta Attenuation Mass Monitors, which continuously measure ambient particulate concentrations using beta ray attenuation. The US EPA designations for these units are PM_{10}: FEM EQPM-0798-122 and $PM_{2.5}$ Class III FEM EQPM-0308-170. For EPA reference method sampling, the $PM_{2.5}$ sampler inlet system was configured with a BGI VSCC™ (Very Sharp Cut Cyclone) particle size separator.

CPAI participates in the North Slope air monitoring network that contains a $PM_{2.5}$ collocation station in Deadhorse, Alaska. As such, filter-based samplers for assessing precision were not run at Nuiqsut. Network precision statistics were evaluated using samples collocated at Deadhorse.

Block daily averages (24-hours) were obtained from the hourly measurements with the BAM-1020 samplers. Table 1-2 lists the particulate matter parameters measured and the frequency at which samples collected and recorded.

Table 1-2: PM Monitoring Measurement Parameters

Parameter	Units	Sampling Schedule	Sample Period	Averaging Time
$PM_{2.5}$	Micrograms per cubic meter ($\mu g/m^3$)	Continuous	1-Hour [(1)]	24-Hour (Average) [(1)]
PM_{10}	Micrograms per cubic meter ($\mu g/m^3$)	Continuous	1-Hour [(1)]	24-Hour (Average) [(1)]
Sample Volume	Cubic meters (m^3)	Every sampling event	Continuously up to 30 days (hourly checks)	Total volume over sample period
Flow Rate	Liters per min (LPM)			Average over sampling period
Ambient Temperature	Degrees Celsius (°C)			
Barometric Pressure	Millimeters of mercury (mm Hg)			

[1] 24-hour averages are obtained from the 1-hour measurements each day. A minimum of 18 hours must be available for a valid 24-hr average to be calculated.

1.2.3 METEOROLOGICAL MONITORING

The meteorological monitoring (wind speed, wind direction, vertical wind speed, ambient air temperature, and solar radiation) were conducted in a manner consistent with PSD criteria for surface meteorological data collection. The meteorological sensors meet or exceed the performance specifications stated in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005). Table 1-3 lists the parameters measured, their reported units, sampling frequency, and sample averaging time.

Table 1-3: Meteorological Measurement Methods

Parameter	Measurement Method	Sensor Manufacturer/ Model Number	Range	Accuracy	Resolution	Sampling Frequency	Averaging Period
Ambient Temperature	Triple element thermistor	Climatronics Model 100093-2	-50 to +50°C	± 0.10°C	0.01°C	1 second	1 hour
Horizontal Wind Speed	Propeller, magnetically induced AC sine wave	RM Young Co. 05305-AQ	0 to 50 m/s	0.2 m/s and three upscale points over sensor range, ±(0.2 m/s + 5% of actual), Starting torque ≤0.25 m/s	0.1 m/s	1 second	1 hour
Wind Direction	Light-weight vane, Low torque potentiometer	RM Young Co. 05305-AQ	0 to 360°	Alignment within ±5°, Starting torque ≤0.5 m/s, Normalized linearity within ±3° (every 30 or 45 degrees)	1.0°	1 second	1 hour
Vertical Wind Speed	Propeller anemometer	Climatronics Model 102236-G0	0 to 49 m/s	±(0.2 m/s + 5% of actual), Starting torque ≤0.25 m/s	0.1 m/s	1 second	1 hour
Solar Radiation	Thermopile sensing element	Kipp & Zonen CMP 11	0 to 2,800 W/m^2	± 2%	10 W/m^2	1 second	1 hour

1.3 VARIATIONS FROM THE QAPP

During the 2016 monitoring year, one variation from the approved Nuiqsut Ambient Air Quality and Meteorological Monitoring Quality Assurance Project Plan (QAPP) occurred. Any QAPP variations that have occurred throughout the monitoring year are discussed in Table 1-4 and below.

Table 1-4: QAPP Variation Table

Item / Procedure	Summary of QAPP Variation	Reason for Variation
Vertical wind speed audit	A vertical wind speed sensor audit was not conducted during the December 2016 semi-annual meteorological audit.	The vertical wind sensor had been damaged by frequent icing events in November-December 2016 and was not operational at the time of the audit. The sensor will be repaired and calibrated and audits will be conducted at the next opportunity.

The vertical wind sensor was not audited as part of the fourth quarter performance audits. The sensor was damaged by the icing events and was inoperable at the time the audit was conducted in December 2016. The sensor will be repaired and calibrated to restore valid data collection. The sensor will be audited on the next scheduled audit visit.

2. STATION PERFORMANCE SUMMARY

2.1 SIGNIFICANT PROJECT EVENTS

Table 2-1 summarizes the significant events that occurred at the Nuiqsut station relevant to the 2015 ambient air and meteorological monitoring year.

Table 2-1: Chronology of Significant Events

Date	Event
January 1, 2016	Start of the monitoring year.
January 8 – 9, 29 – 30, and 31, 2016	Horizontal wind data invalidated due to snow and ice buildup on the sensor. 69 hours of horizontal wind speed and wind direction data invalidated.
January 11, 12, and 31, 2016	PM_{10} data invalidated due to 24-hour average concentration less than -2 µg/m^3.
January 18, 2016	Multipoint calibration performed on NO_X analyzer. Five hours of gas pollutant data invalidated during calibrations.
January 28, 2016	Multipoint calibrations, QC Checks and independent performance audit of ambient air analyzers and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits. Ozone transfer standard replaced. Seven hours of gas pollutant data invalidated during checks.
February 1, 20 – 21, and 22 – 23, 2016	Horizontal wind data invalidated due to snow and ice buildup on the sensor. 64 hours of horizontal wind speed and wind direction data invalidated.
February 4, 5, and 16, 2016	PM_{10} data flagged as invalid due to 24-hour average concentration less than -2 µg/m^3.
February 10, 2016	Multipoint calibration performed on NO_X analyzer. Six hours of gas pollutant data invalidated during calibrations.
February 17, 18, and 22, 2016	$PM_{2.5}$ data flagged as invalid due to 24-hour average concentration less than -2 µg/m^3.
February 20 – 21, 2016	Vertical wind speed data invalidated due to snow and ice buildup on the sensor. 23 hours of data invalidated.
February 22 – 24, 2016	Abbreviated zero background check performed on PM_{10} analyzer to verify electrical grounding and sampler zero set point; 51 hours of PM_{10} data invalidated.
February 24, 2016	Monthly QC checks performed on PM samplers; all passed acceptance criteria.
March 11, 2016	Multipoint calibration performed on CO analyzer; instrument passed.
March 19, 2016	Horizontal wind data invalidated due to snow and ice buildup on the sensor. Five hours of horizontal wind speed and wind direction data invalidated.
March 21, 2016	Monthly QC checks and multipoint calibrations performed on PM samplers; all passed acceptance criteria.
April 16, 2016	Daily average PM_{10} concentration less than -2 µg/m^3. 24 hours of BAM PM_{10} data invalidated.

Date	Event
April 20-21, 2016	Multipoint calibrations of ambient air analyzers, meteorological sensors, and PM samplers as well as monthly QC checks on PM samplers conducted by SLR. Independent performance audit of ambient air analyzers, meteorological sensors, and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits with the exception of the primary solar sensor. Post-calibration and audit investigation revealed frost buildup on the primary solar sensor that adversely affected the results for the later portion of the calibration and audit. The audit and calibration results were considered invalid and a follow-up audit and calibration were performed May 26-27. 8 hours of gas data invalidated and 4 hours of meteorological data invalidated during calibrations and audits. No as-found calibration check was conducted on the NOx analyzer prior to repairs. 161 hours of NOx data invalidated back to last passing automatic precision check on April 14.
April 20-29, 2016	Abnormal zero responses were observed on calibration verifications following the April 20, 2016 ozone sampler calibration. The analyzer was recalibrated on April 29 and acceptable performance restored. Ozone data from April 20 through April 29, 2016 (220 hours) were invalidated.
April 20-29, 2016	SO_2 data invalidated due to analyzer malfunction. SO_2 analyzer was replaced on April 29, 2016 with S/N 10020059. 220 hours of SO_2 data invalidated.
April 22, 2016	Six hours NO_x and CO data invalidated during maintenance work related to the SO_2 analyzer.
April 22, 2016	18 hours of primary solar data invalidated due to frost buildup on sensor.
April 27, 2016	BAM $PM_{2.5}$ instrument malfunction resulted in 4 hours of invalid data.
May 2-3, 2016	Power failure resulted in calibrator malfunction. 18 hours of gas data invalidated.
May 20, 2016	Ice buildup on sensor resulted in 6 hours of invalid vertical wind speed data.
May 24, 2016	SO_2 calibration performed, calibration passed, 4 hours gas data invalidated.
May 24-27, 2016	Broken filter tape on both BAM units resulted in 72 hours of invalid BAM PM_{10} data and 45 hours of invalid BAM $PM_{2.5}$ data.
May 26, 2016	Follow-up solar calibration and audit performed; instruments passed. Monthly QC checks performed on PM samplers. All instruments passed.
June 16, 2016	SO_2 calibration performed, calibration passed. 4 hours gas data invalidated.
June 21, 2016	Monthly QC checks performed on PM samplers. All instruments passed. Maintenance conducted on samplers. SO_2 pump failed after maintenance. 27 hours of SO_2, 8 hours of NO_x, CO, and O_3 data invalidated and 4 hours of $PM_{2.5}$ data invalidated.
June 22, 2016	Replaced ozone transfer standard, SO_2 analyzer pump replaced and analyzer recalibrated; 5 hours of gas data invalidated.
July 6 – 12, 2016	SO_2 data invalidated due to analyzer malfunction. SO_2 analyzer (S/N 10020059) was replaced on July 12, 2016 with S/N 0920039. 143 hours of SO_2 data invalidated.

Date	Event
July 12, 2016	NO_X analyzer (S/N 1008241339) replaced with API T200U S/N 194. Calibrations performed on CO, NO_X, and SO_2 analyzer; all passed. Seven hours of gas data invalidated during calibrations.
July 12, 2016	Monthly QC checks performed on PM samplers. All instruments passed.
July 24, 2016	High, gusty winds were observed coming from the Colville River toward the station. High PM_{10} observations were recorded during the wind event and likely caused by dust originating from the exposed river bank.
July 26, 2016	Calibrations performed on all gas analyzers. Monthly QC checks performed on PM samplers. All instruments passed. Four hours of gas data invalidated during calibrations.
August 5, 2016	High, gusty winds were observed coming from the Colville River toward the station. High PM_{10} observations were recorded during the wind event and likely caused by dust originating from the exposed river bank.
August 16, 2016	Monthly QC checks performed on PM samplers. All instruments passed.
September 14, 2016	Monthly QC checks on PM samplers. All instruments passed. Independent performance audit of ambient air analyzers and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits.
September 22, 2016	Daily average $PM_{2.5}$ concentration less than -2 µg/m^3. 24 hours of BAM $PM_{2.5}$ data invalidated.
September 30, 2016	Calibrations performed on SO_2 analyzer; analyzer passed. Four hours of gas data invalidated during calibration.
October 6, 2016	Icing on the vertical wind speed sensor, 10 hours invalidated.
October 24, 2016	Monthly QC checks performed on PM samplers; all passed acceptance criteria.
October 28, 2016	The BAM $PM_{2.5}$ 24 hour average concentration was reported as less than -2 µg/m^3. 24 hours of BAM data invalidated.
November 3, 2016	High, gusty winds were observed coming from the Colville River toward the station. High PM_{10} observations were recorded during the wind event and likely caused by dust originating from the exposed river bank.
November 6, 2016	The BAM $PM_{2.5}$ 24 hour average concentration was reported as less than -2 µg/m. 24 hours of BAM data invalidated.
November 12 – December 31, 2016	Icing and subsequent damage to the vertical wind speed sensor, 1178 hours invalidated.
November 16-24, 26-27, December 2-4, 2016	205 hours of wind speed and direction data were invalidated for times when the sensor was knowingly impacted by ice and during periods where measurements indicated calm conditions but not verifiable by other sources.
November 15, 2016	Ozone Transfer Standard exchanged Old: 87, New: 220, Monthly QC checks performed on PM samplers; all passed acceptance criteria.
November 26-27, 2016	The BAM $PM_{2.5}$ 24 hour average concentration was reported as less than -2 µg/m^3 for two consecutive days. 48 hours of BAM data invalidated.

Date	Event
November 28-29, 2016	The BAM PM_{10} 24 hour average concentration was reported as less than -2 µg/m^3 for two consecutive days. 48 hours of BAM data invalidated.
December 1, 2016	The BAM PM_{10} 24 hour average concentration was reported as less than -2 µg/m. 24 hours of BAM data invalidated.
December 13-15, 2016	BAM $PM_{2.5}$ tape broke. 36 hours invalid.
December 13-15, 2016	Multipoint calibrations of ambient air analyzers, meteorological sensors, and PM samplers as well as monthly QC checks on PM samplers conducted by SLR. Independent performance audit of ambient air analyzers, meteorological sensors, and PM samplers conducted by AMS Tech, LLC. All instruments found to be operating within EPA PSD measurement quality limits with the exception of the vertical wind speed sensor, which was not audited due to damage to the instrument prior to the audit and the wind direction A torque. Wind speed and direction A data invalidated back to previous passing calibration. 5 hours of ambient gas data 4 hours of met data invalidated.
December 20, 2016	Remote calibration verifications and stability checks. 4 hours ambient gas data invalidated.
December 31, 2016	End of the monitoring year.

2.2 MISSING, INVALID AND ADJUSTED DATA

The data collected at the Nuiqsut station were carefully reviewed during the quality assurance process. Some data were removed as a result of planned site activities, including data collected during station system and performance audits and calibrations. Data known or suspected to be invalid have been removed from the data set after verifying that the removed data values do not represent actual ambient air quality conditions at the sampling station.

Periods of 4 or fewer records that were invalidated are considered to be due to routine operations and maintenance activities and are generally not described in detail. Events impacting larger periods of time are described above in Table 2-1: Chronology of Significant Events. Additionally, those events meriting more detailed explanation of data validation decisions are as follows:

Manufacturer specifications for $PM_{2.5}$ and PM_{10} measurements indicate that the uncertainty for 24-hour average concentrations is +/- 2 $\mu g/m^3$. Accordingly, 24-hour average concentrations less than -2 $\mu g/m^3$ result in the invalidation of data for the entire day. PM_{10} data were invalidated for the entire day on January 11, 12, and 31, February 4, 5, and 16, April 16, November 28 and 29, and December 1, 2016 and $PM_{2.5}$ data were invalidated for the entire day on February 17, 18 and 22, September 22, October 28, and November 6, 26, and 27, 2016. A total of 240 hours of PM_{10} data and 192 hours of $PM_{2.5}$ data were affected during the monitoring period.

39 hours of vertical wind speed data were invalidated due to snow and ice buildup on the sensor throughout 2016. Damage to the sensor was discovered prior to a calibration and performance audit on December 13, 2016. 1178 hours of suspect vertical wind speed data were subsequently invalidated.

On 5 hours of gas data were invalidated on January 18, 7 hours on January 28, and 6 hours on February 10, 2016, for calibrations and a quarterly performance audit for ambient air analyzers.

Horizontal wind speed and direction sensors A and B had snow and ice buildup periodically throughout 2016. A total of 138 hours of wind direction and speed A and 450 hours of wind direction and speed B data were invalidated for this reason (205 hours of which occurred during the period in April 1-December 31 for which the B wind is reported).

An abbreviated, non-required zero background check on the BAM-1020 PM_{10} sampler was conducted February 22 – 24, 2016 to verify sampler grounding and offset set points. 51 hours of PM_{10} data were invalidated.

On April 20 and 21, 2016, quarterly calibration and performance audits were performed. Four hours of meteorological data and 8 hours of ambient gas data was invalidated. Prior to the NO_x calibration, a mechanical problem was discovered and corrected on that analyzer. The site operator was unable to perform an as-found calibration prior to maintenance and so all NO_X data were invalidated back to the most recent passing automatic precision check (161 hours). On April 22, 2016, 18 hours of primary solar data were invalidated because of frost buildup on the sensor.

Abnormal zero responses were observed on calibration verifications following the April 20, 2016 ozone sampler calibration. While the data met all other critical and operational validation criteria SLR concluded that the zero calibration conducted on April 20 introduced measurement error. The sampler was recalibrated on April 29, 2016. 220 hours of ozone data between April 20 and April 29, 2016 were invalidated.

Malfunctions of the BAM units resulted in invalidation of four hours of $PM_{2.5}$ data on April 27, 2016, 45 hours of $PM_{2.5}$ data and 72 hours of PM_{10} data between May 24 and 27, 2016.

The SO_2 analyzer was replaced on April 29, 2016, after a malfunction. SO_2 data was invalidated from the time of repair back to the most recent calibration on April 20, 2016 for a total of 220 hours invalid. 6 hours of gas data were invalidated on April 22, 2016 during maintenance related to the SO_2 analyzer malfunction. Other maintenance and calibrations on the SO_2 analyzer resulted in invalidation of four hours of all gases on May 24, 2016, of all gases four hours on June 16, 2016 and 27 hours of SO_2 and 8 hours of other gases on June 21, 2016.

On May 2, 2016, a power failure at the station resulted in calibration gas continually flowing into the sampling inlet until the calibrator was manually reset. 18 hours of gas data were invalidated.

Four hours of $PM_{2.5}$ data were invalidated on June 21, 2016 in relation to the monthly QC checks and instrument maintenance.

Five hours of ozone data were invalidated as part of an ozone transfer standard replacement on June 22, 2016.

143 hours of SO_2 data were invalidated July 6, 2016 through July 12, 2016 due to analyzer malfunction. SO_2 analyzer (S/N 10020059) was replaced on July 12, 2016 with S/N 0920039.

The NO_X analyzer (S/N 1008241339) was replaced with API T200U S/N 194 on July 12, 2016. Calibrations were performed on the CO, NO_X, and SO_2 analyzer; all passed. Seven hours of gas data were invalidated during calibrations.

Calibrations of the gas analyzers also occurred on July 26 and September 30, 2016. Four hours of gas data on each day were invalidated during the calibrations.

BAM $PM_{2.5}$ data was invalidated for 36 hours between December 13 and 15, 2016 due to a tape break.

Between December 13 and 15, 2016, a calibration and performance audit were performed on meteorological sensors and ambient air analyzers. Prior to either being completed, the vertical wind speed sensor was discovered damaged. An audit was not performed on this sensor and vertical wind speed data was invalidated from the time of damage through the end of the monitoring year. 1178 hours affected. Wind direction sensor A failed the performance torque test. Wind speed and direction B data were invalidated back to the previous passing audit on April 20, 2016. 5653 hours affected.

On December 20, 2016, a remote calibration of the ozone and NO_x analyzers resulted in 4 hours of gas data invalidation.

Table 2-2 lists the quantities of data that were flagged according to EPA criteria, yet not removed from the refined final data set. All flagged data were carefully examined, but generally remained in the reduced data unless dictated by certain circumstances, including: values outside the normal range of variation; consecutive repetitive values recorded for an unidentified reason; maintenance activity at the site, and impairing damage to sensors.

Table 2-2: Percentage of Final Data Set Flagged

Parameter	Flagging Criteria[(1)]	Percent Flagged
Wind Speed	Value is < 0 m/s	0.0%
	Value is > 25 m/s	0.0%
	< 0.1 m/s variation for 3 consecutive hours	1.9%
	< 0.5 m/s variation for 12 consecutive hours	0.5%
Wind Direction	Value is < 0°, > 360°	0.0%
	< 1° variation over 3 consecutive hours	0.0%
	< 10° variation over 18 consecutive hours	3.6%
Temperature (2 meters)	> 5°C variation from previous hour	0.1%
	< 0.5°C variation for 12 consecutive hours	1.0%
	Value is > record high, < record low	0.0%
Temperature (10 meters)	> 5°C variation from previous hour	0.1%
	< 0.5°C variation for 12 consecutive hours	1.4%
	Value is > record high, < record low	0.0%
Temperature Difference, ΔT	Value is > 0.8°C during the daytime	0.4%
	Value is < -0.8°C during the night	0.0%
	Value is > 5°C, < -3°C	0.0%
Solar Radiation	> 0 w/m^2 at night	1.6%
	Greater than the maximum possible value for date and latitude	0.1%

[1] Based upon Table 8-4: Suggested Data Screening Criteria in *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (EPA-454/R-99-005).

2.3 NETWORK DATA COMPLETENESS

Data completeness is a measure of the amount of data actually collected compared to the amount of data that could have been collected. Data completeness was calculated by dividing the number of valid hours of data by the total number of hours during the monitoring period. The data quality objective (DQO) for data completeness for air quality data is 80 percent per calendar quarter, and 90 percent for meteorological data per calendar quarter. The Nuiqsut ambient air and meteorological monitoring station met all PSD requirements during the monitoring year.

Quarterly and annual data completeness for ambient air and meteorological parameters are provided in Tables 2-3 and 2-4, respectively. Calculations for determining data completeness are provided in Appendix A. Fully validated data for all parameters are provided in Appendix D.

Table 2-3: Ambient Air Quality Data Capture Percent

Period	Pollutants – Data Recovery [1]					
	CO	NO_2	O_3	SO_2	$PM_{2.5}$ [2]	PM_{10} [2]
January	98%	98%	98%	98%	100%	90%
February	99%	99%	99%	99%	90%	79% [3]
March	99%	99%	99%	99%	100%	100%
1st Quarter	**98%**	**98%**	**98%**	**98%**	**97%**	**90%**
April	97%	76% [4]	69% [4]	69% [4]	100%	97%
May	97%	97%	97%	97%	94%	90%
June	97%	97%	97%	95%	100%	100%
2nd Quarter	**97%**	**90%**	**88%**	**87%**	**98%**	**96%**
July	98%	98%	98%	80% [5]	100%	100%
August	99%	99%	99%	99%	100%	100%
September	98%	98%	98%	98%	97%	100%
3rd Quarter	**99%**	**99%**	**98%**	**92%**	**99%**	**100%**
October	99%	99%	99%	99%	97%	100%
November	99%	99%	99%	99%	90%	93%
December	98%	97%	97%	98%	94%	97%
4th Quarter	**99%**	**98%**	**98%**	**99%**	**93%**	**97%**
Annual	**98%**	**96%**	**96%**	**94%**	**97%**	**96%**

[1] EPA PSD-quality ambient air monitoring standards require data capture of 80 percent or greater per quarter for four consecutive quarters.
[2] Data recovery for PM monitors is based on the number of valid 24-hour average particulate matter samples collected divided by the total number of 24-hour periods during the sampling period. 24-hour average data recovery percentages in Table 2-2 differ from the 1-hour average data recovery percentage summaries presented in Appendix C.
[3] An abbreviated non-required zero background check was performed on the PM_{10} analyzer. Despite the data loss, DQOs were met for the first quarter for all ambient parameters.
[4] Data for the NO_x, O_3 and SO_2 analyzers was invalidated for unrelated instrument performance issues in April. Despite the data loss, DQOs were met for the second quarter for all ambient parameters.
[5] The SO_2 analyzer failed on July 6, 2016. The failure was remedied on July 12, 2016. Despite the data loss, DQOs were met for the third quarter for all ambient parameters.

Table 2-4: Meteorological Data Capture Percent

Period	Meteorological Parameters – Data Recovery [1]								
	Vertical Wind Speed	Vertical Wind Speed Std. Dev. (Sigma Omega)	Horizontal Wind Speed [2]	Horizontal Wind Direction [2]	Wind Direction Std. Dev. (Sigma Theta) [2]	2-M Temp	10-M Temp	Delta-Temp	Solar Radiation
January	100%	100%	90%	90%	90%	100%	100%	100%	100%
February	97%	97%	91%	91%	91%	100%	100%	100%	99%
March	100%	100%	99%	99%	99%	100%	100%	100%	100%
1st Quarter	**99%**	**99%**	**93%**	**93%**	**93%**	**100%**	**100%**	**100%**	**100%**
April	99%	99%	99%	99%	99%	99%	99%	99%	98%
May	99%	99%	100%	100%	100%	100%	100%	100%	100%
June	99%	99%	99%	99%	99%	99%	99%	99%	99%
2nd Quarter	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**99%**
July	100%	100%	100%	100%	100%	100%	100%	100%	100%
August	100%	100%	100%	100%	100%	100%	100%	100%	100%
September	100%	100%	100%	100%	100%	100%	100%	100%	100%
3rd Quarter	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
October	97%	97%	100%	100%	100%	99%	99%	99%	99%
November	40% [3]	40% [3]	74% [4]	74% [4]	74% [4]	100%	100%	100%	100%
December	0% [3]	0% [3]	97%	97%	97%	99%	99%	99%	100%
4th Quarter	**46%** [3]	**46%** [3]	**91%**	**91%**	**91%**	**99%**	**99%**	**99%**	**100%**
Annual	**86%**	**86%**	**96%**	**96%**	**96%**	**100%**	**100%**	**100%**	**100%**

[1] EPA PSD-quality meteorological monitoring standards require data capture of 90 percent or greater per quarter for four consecutive quarters.
[2] Due to the primary (Set A) wind speed / direction sensor failing audit criteria during the December 13 audit, wind speed and direction data are reported from the primary sensor as well as the secondary (Set B) wind speed / direction sensor. Data from the first quarter is from the Set A sensor and data from Set B data is used for the second, third and fourth quarters.
[3] Vertical wind data were invalidated due to the buildup of snow and ice on the sensor and subsequent damage. DQOs were not met for the vertical wind speed for the fourth quarter.
[4] Snow and ice buildup on the horizontal wind speed and direction sensor resulted in significant data loss in November. Despite the data loss, DQOs were met for the fourth quarter for horizontal wind speed and direction.

2.4 PRECISION STATISTICS

2.4.1 MONITORING NETWORK PRECISION STATISTICS

Precision statistics were determined using the methods outlined in Title 40 Code of Federal Regulations, Part 58 (40 CFR 58), Appendix A. Valid precision data for ambient air monitors (CO, NO_2, O_3, and SO_2) were collected at least once every two weeks, meeting the critical validation criteria outlined in the monitoring program QAPP. Quarterly precision statistics for each criteria pollutant are provided in Tables 2-5 through 2-20.

Continuous PM_{10} monitors are not required to have collocated precision comparisons. Precision statistics for the continuous $PM_{2.5}$ monitor were determined using the monitoring network QA station located in Deadhorse, Alaska. EPA recommends that precision statistics for $PM_{2.5}$ should only be calculated for collocated samples if both the collocated and the primary sample concentrations are greater than or equal to 3 $\mu g/m^3$. As proposed in the Deadhorse $PM_{2.5}$ Monitoring Program QAPP, precision statistics for this monitoring project were calculated for collocated samples if both the collocated and the primary sample concentrations were greater than or equal to 2 $\mu g/m^3$. Quarterly network $PM_{2.5}$ precision statistics are presented in Table 2-21.

Table 2-5: 1st Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound (1)
1/7/2016	8.1	7.8	4.1	17	4.22	2.01	8.16	0.28	2.64
1/14/2016	8.2	7.8	5.1						
1/18/2016	8.2	8.0	3.0						
1/21/2016	8.3	7.8	6.2						
1/28/2016	8.4	7.8	7.4						
1/28/2016	8.1	8.0	0.9						
2/4/2016	8.1	7.8	4.2						
2/10/2016	8.1	8.0	1.4						
2/10/2016	8.2	8.0	2.7						
2/11/2016	8.2	7.8	4.6						
2/18/2016	8.2	7.8	5.3						
2/25/2016	8.2	7.8	5.6						
3/3/2016	8.3	7.8	6.4						
3/10/2016	8.4	7.8	7.1						
3/17/2016	8.0	7.8	2.9						
3/24/2016	8.1	7.8	3.5						
3/31/2016	8.1	8.0	1.3						

[1]Acceptance criteria: ≤ 10%

Table 2-6: 2nd Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
4/7/2016	8.2	8.0	2.6	23	1.71	1.65	4.94	-1.52	2.06
4/14/2016	8.2	8.0	2.3						
4/20/2016	8.2	8.0	1.6						
4/21/2016	8.1	8.0	1.0						
4/22/2016	8.1	8.0	1.0						
4/22/2016	8.1	8.0	0.6						
4/28/2016	8.1	8.0	0.7						
4/29/2016	8.1	8.0	1.3						
5/5/2016	8.1	8.0	1.7						
5/12/2016	8.1	8.0	0.8						
5/19/2016	8.3	8.0	3.2						
5/24/2016	8.3	8.0	3.0						
5/24/2016	8.2	8.0	1.9						
5/26/2016	8.2	8.0	2.5						
6/2/2016	8.3	8.0	3.3						
6/9/2016	8.3	8.0	3.4						
6/16/2016	8.3	8.0	3.4						
6/16/2016	8.3	8.0	3.5						
6/16/2016	8.3	8.0	3.2						
6/21/2016	8.3	8.0	3.4						
6/22/2016	7.8	8.0	-2.1						
6/23/2016	7.9	8.0	-1.1						
6/30/2016	7.9	8.0	-1.7						

[1]Acceptance criteria: ≤ 10%

Table 2-7: 3rd Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound (1)
7/7/2016	7.9	8.0	-1.6	17	0.76	1.41	3.53	-2.01	1.85
7/12/2016	7.8	8.0	-3.5						
7/14/2016	7.9	8.0	-1.7						
7/21/2016	7.9	8.0	-1.2						
7/26/2016	7.9	8.0	-1.2						
7/28/2016	7.9	8.0	-1.7						
8/4/2016	7.9	8.0	-1.8						
8/11/2016	7.9	8.0	-1.2						
8/18/2016	7.8	8.0	-2.1						
8/25/2016	7.8	8.0	-1.9						
9/1/2016	7.8	8.0	-2.1						
9/8/2016	7.8	8.0	-2.6						
9/15/2016	7.8	8.0	-2.2						
9/22/2016	7.8	8.0	-2.2						
9/29/2016	7.9	8.0	-1.0						
9/30/2016	7.9	8.0	-1.6						
9/30/2016	7.9	8.0	-1.2						

[1]Acceptance criteria: ≤ 10%

Table 2-8: 4th Quarter CO Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/6/2016	7.9	8.0	-0.9	16	0.59	1.18	2.90	-1.72	1.56
10/14/2016	8.0	8.0	0.1						
10/20/2016	8.0	8.0	0.4						
10/27/2016	8.1	8.0	0.6						
11/3/2016	8.1	8.0	1.3						
11/10/2016	8.1	8.0	1.6						
11/17/2016	8.2	8.0	2.0						
11/24/2016	8.3	8.0	3.5						
12/1/2016	7.9	8.0	-0.8						
12/8/2016	8.0	8.0	-0.3						
12/12/2016	8.0	8.0	-0.7						
12/15/2016	8.0	8.0	0.3						
12/20/2016	8.1	8.0	0.8						
12/20/2016	8.1	8.0	1.0						
12/22/2016	8.1	8.0	1.0						
12/29/2016	8.0	8.0	-0.6						

[1]Acceptance criteria: ≤ 10%

Table 2-9: 1st Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
1/7/2016	76.3	80.0	-4.6	17	-0.32	3.43	6.41	-7.05	4.50
1/14/2016	76.2	79.9	-4.6						
1/18/2016	81.6	81.8	-0.2						
1/21/2016	82.0	80.8	1.5						
1/28/2016	83.0	77.7	6.8						
1/28/2016	77.2	77.0	0.3						
2/4/2016	76.9	79.9	-3.8						
2/10/2016	76.2	80.3	-5.1						
2/10/2016	81.3	82.3	-1.2						
2/11/2016	81.9	79.9	2.5						
2/18/2016	81.4	77.8	4.6						
2/25/2016	81.3	79.1	2.8						
3/3/2016	80.2	81.3	-1.4						
3/10/2016	81.3	79.3	2.5						
3/17/2016	78.7	81.3	-3.2						
3/24/2016	80.1	80.7	-0.7						
3/31/2016	79.5	80.8	-1.6						

[1]Acceptance criteria: ≤ 10%

Table 2-10: 2nd Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
4/7/2016	80.1	79.8	0.4	16	-0.02	1.87	3.63	-3.68	2.47
4/14/2016	78.3	80.6	-2.9						
4/20/2016	82.2	81.6	0.7						
4/21/2016	83.2	83.0	0.2						
4/22/2016	81.5	78.7	3.6						
4/28/2016	82.5	80.1	3.0						
5/5/2016	81.8	81.1	0.9						
5/12/2016	80.3	81.7	-1.7						
5/19/2016	81.3	81.1	0.3						
5/26/2016	80.3	81.8	-1.8						
6/2/2016	79.1	80.2	-1.4						
6/9/2016	79.4	80.5	-1.4						
6/16/2016	79.2	81.4	-2.7						
6/22/2016	82.4	81.6	1.0						
6/23/2016	82.4	81.1	1.6						
6/30/2016	81.4	81.5	-0.1						

[1]Acceptance criteria: ≤ 10%

Table 2-11: 3rd Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
7/7/2016	80.0	79.6	0.5	14	0.65	2.38	5.32	-4.01	3.23
7/12/2016	78.7	79.0	-0.4						
7/14/2016	77.5	80.2	-3.4						
7/21/2016	76.8	80.0	-4.0						
7/28/2016	76.2	76.1	0.1						
8/4/2016	78.0	78.5	-0.6						
8/11/2016	79.7	79.1	0.8						
8/18/2016	79.9	79.1	1.0						
8/25/2016	80.4	79.3	1.4						
9/1/2016	81.3	80.5	0.9						
9/8/2016	81.2	79.4	2.3						
9/15/2016	83.3	79.5	4.8						
9/22/2016	81.3	78.2	4.0						
9/29/2016	82.0	80.5	1.9						

[1]Acceptance criteria: ≤ 10%

Table 2-12: 4th Quarter NO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/6/2016	81.7	81.1	0.7	15	2.45	2.09	6.55	-1.66	2.81
10/14/2016	[2]	[2]	[2]						
10/20/2016	82.7	78.8	5.0						
10/27/2016	82.6	79.2	4.3						
11/3/2016	82.1	79.5	3.3						
11/10/2016	83.6	80.1	4.4						
11/17/2016	83.6	81.7	2.3						
11/24/2016	83.3	80.7	3.2						
12/1/2016	82.9	79.5	4.3						
12/8/2016	84.2	82.9	1.6						
12/12/2016	81.9	80.1	2.3						
12/15/2016	83.3	81.6	2.1						
12/20/2016	83.2	78.9	5.5						
12/20/2016	79.5	79.6	-0.1						
12/22/2016	79.2	80.2	-1.3						
12/29/2016	80.4	81.0	-0.7						

[1] Acceptance criteria: ≤ 10%

[2] A calibrator malfunction resulted in an invalid precision check on 10/14/2016. After a review of the previous and following precision checks and daily zero/span checks, it was determined that data validity was not affected.

Table 2-13: 1st Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
1/7/2016	89.2	90.0	-0.9	13	1.47	2.09	5.56	-2.63	2.88
1/14/2016	89.0	90.0	-1.1						
1/21/2016	88.4	90.0	-1.8						
1/28/2016	89.2	90.0	-0.9						
2/4/2016	91.8	90.0	2.0						
2/11/2016	92.2	90.0	2.5						
2/18/2016	92.2	90.0	2.5						
2/25/2016	91.4	90.0	1.5						
3/3/2016	90.4	90.0	0.4						
3/10/2016	92.9	90.0	3.2						
3/17/2016	93.1	90.0	3.4						
3/24/2016	93.9	90.0	4.3						
3/31/2016	83.0	79.9	3.9						

[1]Acceptance criteria: ≤ 7%

Table 2-14: 2nd Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound (1)
4/7/2016	81.8	79.9	2.4	16	0.67	2.51	5.58	-4.25	3.32
4/14/2016	81.5	79.9	2.0						
4/20/2016	80.9	79.9	1.3						
4/21/2016	81.0	79.9	1.4						
4/28/2016	76.4	80.9	-5.6						
4/29/2016	81.7	79.9	2.3						
5/5/2016	80.8	79.9	1.1						
5/12/2016	80.8	79.9	1.2						
5/19/2016	80.7	79.9	1.0						
5/26/2016	79.3	79.9	-0.8						
6/2/2016	80.5	79.9	0.8						
6/9/2016	78.8	79.9	-1.4						
6/16/2016	79.3	79.9	-0.7						
6/21/2016	77.7	80.0	-2.9						
6/23/2016	82.7	80.0	3.4						
6/30/2016	84.0	80.0	5.0						

[1]Acceptance criteria: ≤ 7%

Table 2-15: 3rd Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
7/7/2016	83.0	80.0	3.8	14	0.70	1.49	3.61	-2.21	2.02
7/14/2016	81.9	80.0	2.4						
7/21/2016	81.8	80.0	2.3						
7/28/2016	79.3	80.0	-0.9						
8/4/2016	79.5	80.0	-0.6						
8/11/2016	78.6	80.0	-1.7						
8/12/2016	79.9	80.0	-0.1						
8/18/2016	79.9	80.0	-0.1						
8/25/2016	79.6	80.0	-0.6						
9/1/2016	80.9	80.0	1.2						
9/8/2016	80.6	80.0	0.7						
9/15/2016	81.0	80.0	1.3						
9/22/2016	80.7	80.0	0.9						
9/29/2016	80.9	80.0	1.2						

[1]Acceptance criteria: ≤ 7%

Table 2-16: 4th Quarter O_3 Precision Statistics Summary

Period	Analyzer Response (ppm)	Precision Gas Concentration (ppm)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/6/2016	81.0	80.0	1.2	16	-0.23	1.44	2.59	-3.05	1.91
10/14/2016	80.9	80.0	1.2						
10/20/2016	81.4	80.0	1.7						
10/27/2016	81.1	80.0	1.3						
11/3/2016	81.1	80.0	1.4						
11/10/2016	81.2	80.0	1.5						
11/17/2016	77.8	80.0	-2.8						
11/24/2016	79.1	80.0	-1.1						
12/1/2016	78.2	80.0	-2.3						
12/8/2016	79.1	80.0	-1.2						
12/12/2016	78.9	80.0	-1.4						
12/15/2016	79.3	80.0	-0.8						
12/20/2016	79.0	80.0	-1.3						
12/20/2016	79.7	80.0	-0.4						
12/22/2016	79.6	80.0	-0.5						
12/29/2016	79.8	80.0	-0.2						

[1] Acceptance criteria: ≤ 7%

Table 2-17: 1st Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
1/7/2016	79.8	78.0	2.4	17	1.43	0.78	2.97	-0.11	1.03
1/14/2016	79.2	78.0	1.6						
1/18/2016	79.0	77.8	1.5						
1/21/2016	79.1	78.0	1.4						
1/28/2016	79.4	78.0	1.8						
1/28/2016	79.3	78.0	1.6						
2/4/2016	78.9	78.0	1.2						
2/10/2016	77.9	77.8	0.1						
2/10/2016	80.6	77.8	3.6						
2/11/2016	78.8	78.0	1.1						
2/18/2016	79.1	78.0	1.4						
2/25/2016	78.3	78.0	0.4						
3/3/2016	78.7	78.0	0.9						
3/10/2016	78.7	78.0	0.9						
3/17/2016	79.5	78.0	1.9						
3/24/2016	79.0	78.0	1.3						
3/31/2016	78.8	77.7	1.4						

[1]Acceptance criteria: ≤ 10%

Table 2-18: 2nd Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
4/7/2016	79.5	77.7	2.3	23	-0.21	3.08	5.82	-6.24	3.85
4/14/2016	79.7	78.0	2.2						
4/20/2016	80.9	78.2	3.4						
4/21/2016	84.4	78.3	7.9						
4/22/2016	77.2	78.2	-1.3						
4/22/2016	77.1	78.2	-1.4						
4/28/2016	75.7	78.2	-3.2						
4/29/2016	78.6	78.2	0.5						
5/5/2016	76.0	78.3	-2.9						
5/12/2016	77.7	78.4	-0.8						
5/19/2016	77.0	78.0	-1.3						
5/24/2016	79.5	78.1	1.8						
5/24/2016	76.0	78.4	-3.0						
5/26/2016	76.7	78.4	-2.2						
6/2/2016	75.9	78.2	-3.0						
6/9/2016	77.0	78.2	-1.4						
6/16/2016	79.3	78.4	1.1						
6/16/2016	78.7	78.2	0.7						
6/16/2016	79.0	78.2	1.0						
6/21/2016	80.1	78.1	2.5						
6/22/2016	71.8	78.0	-8.0						
6/23/2016	78.5	78.0	0.6						
6/30/2016	77.9	78.0	-0.1						

[1] Acceptance criteria: ≤ 10%

Table 2-19: 3rd Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
7/7/2016	78.6	78.0	0.7	17	0.76	1.41	3.53	-2.01	1.85
7/12/2016	81.7	78.3	4.3						
7/14/2016	77.2	78.0	-1.0						
7/21/2016	77.8	78.0	-0.3						
7/26/2016	78.0	78.1	-0.1						
7/28/2016	77.0	78.0	-1.3						
8/4/2016	77.9	78.0	-0.1						
8/11/2016	77.6	78.0	-0.5						
8/18/2016	78.1	78.0	0.1						
8/25/2016	78.7	78.0	0.9						
9/1/2016	79.0	78.0	1.2						
9/8/2016	78.8	78.0	1.0						
9/15/2016	80.1	78.0	2.7						
9/22/2016	79.7	78.0	2.2						
9/29/2016	79.3	78.0	1.7						
9/30/2016	79.0	78.2	1.0						
9/30/2016	78.4	78.2	0.3						

[1] Acceptance criteria: ≤ 10%

Table 2-20: 4th Quarter SO_2 Precision Statistics Summary

Period	Analyzer Response (ppb)	Precision Gas Concentration (ppb)	Percent Difference (%)	Number of Checks	Average Percent Difference	Standard Deviation	Upper 95% Limit	Lower 95% Limit	CV Upper Bound [1]
10/6/2016	77.7	78.0	-0.3	16	-0.51	1.06	1.57	-2.59	1.41
10/14/2016	77.3	78.0	-0.8						
10/20/2016	78.7	78.0	0.8						
10/27/2016	77.6	78.0	-0.6						
11/3/2016	77.3	78.0	-0.9						
11/10/2016	78.7	78.0	0.9						
11/17/2016	78.6	78.0	0.8						
11/24/2016	78.9	78.0	1.1						
12/1/2016	77.1	78.0	-1.1						
12/8/2016	77.3	78.0	-0.8						
12/12/2016	76.0	78.2	-2.8						
12/15/2016	76.8	78.0	-1.5						
12/20/2016	76.6	78.0	-1.8						
12/20/2016	77.6	78.0	-0.5						
12/22/2016	78.0	78.0	0.0						
12/29/2016	77.4	78.0	-0.7						

[1]Acceptance criteria: ≤ 10%

Table 2-21: Network $PM_{2.5}$ Monitoring Precision

Period	Samplers	Concentration Levels	Number of Collocated Samples	Average Percent Difference	Standard Deviation [1] ($\mu g/m^3$)	Precision [2] ($\mu g/m^3$)	Bias [3] ($\mu g/m^3$)
1st Quarter (January 1 – March 31)	Primary FEM against Secondary FEM	≥2 $\mu g/m^3$	33	23.7	1.19	0.60	1.38
		All [4]	71	54.7	1.25	0.62	1.65
	Primary FEM against Collocated FRM	≥2 $\mu g/m^3$	10	-16.8	0.65	0.32	1.08
		All [4]	14	-146.1	1.29	0.65	1.55
2nd Quarter (April 1 – June 30)	Primary FEM against Secondary FEM	≥2 $\mu g/m^3$	15	-9.7	0.69	0.35	0.84
		All [4]	41	-23.3	0.79	0.39	0.91
	Primary FEM against Collocated FRM	≥2 $\mu g/m^3$	5	-28.3	1.17	0.58	1.54
		All [4]	11	-84.5	1.04	0.52	1.82
3rd Quarter (July 1 – September 30)	Primary FEM against Secondary FEM	≥2 $\mu g/m^3$	16	-24.1	1.51	0.75	2.34
		All [4]	40	-2.4	1.48	0.74	1.85
	Primary FEM against Collocated FRM	≥2 $\mu g/m^3$	3	-20.2	0.99	0.49	1.17
		All [4]	8	-74.1	1.45	0.72	1.66
4th Quarter (October 1 – December 31)	Primary FEM against Secondary FEM	≥2 $\mu g/m^3$	9	-3.9	0.88	0.44	1.44
		All [4,5]	25	8.4	0.82	0.41	1.18
	Primary FEM against Collocated FRM	≥2 $\mu g/m^3$	0	--	--	--	--
		All [4,5]	2	-47.3	0.64	0.32	0.75
Year to Date (January 1 – December 31)	Primary FEM against Secondary FEM	≥2 $\mu g/m^3$	73	2.9	1.24	0.62	1.49
		All [4]	177	17.2	1.21	0.61	7.28
	Primary FEM against Collocated FRM	≥2 $\mu g/m^3$	18	-20.6	0.84	0.42	1.22
		All [4]	35	-104.6	1.21	0.60	1.61

[1] Standard deviation of the absolute concentration differences for the population.
[2] Standard deviation of the absolute concentration difference for the population divided by 2 with a goal of ≤ 3 $\mu g/m^3$ per quarter.
[3] Average over the population of the absolute value of the individual pair concentration difference with a goal of ≤ 4 $\mu g/m^3$ per quarter.
[4] BAM concentrations can be slightly negative and still be valid, however these results are excluded from the precision statistics calculations.
[5] Due to mechanical failures, fewer precision samples were collected during the fourth quarter than planned. Despite the failures, the project met $PM_{2.5}$ collocation DQOs.

2.4.2 ANALYTICAL LABORATORY PRECISION STATISTICS

Not applicable.

2.4.3 ANALYTICAL LABORATORY PRECISION STATISTICS FOR LEAD ANALYSIS OF PARTICULATE SAMPLES

Not applicable.

2.5 ACCURACY STATISTICS

The ambient air and meteorological monitoring systems are subjected to periodic calibrations and independent quality assurance performance audits. All calibration and audit equipment are documented as traceable to authoritative standards. The purpose of these calibration and audit checks is to challenge the monitoring systems with known inputs or collocate traceable authoritative standards with them to verify that each instrument response is accurate to within established tolerances.

Tables 2-22 through 2-39 summarize the accuracy statistics obtained during the project.

2.5.1 INSTRUMENT CALIBRATION STATISTICS

Single-point calibration verifications were performed on a daily basis on all gas pollutant analyzers throughout the monitoring year. The single-point calibration verifications consisted of challenging each instrument response with air scrubbed of all pollutants ("zero air") and air containing a National Institute of Standards and Technology (NIST) traceable standard gas concentration equal to 80 percent (span check) of the instrument's upper range limit (URL). If zero or span drift limits are exceeded, ambient measurements are invalidated back to the most recent point in time where such measurements were known to be valid. Single-point calibration verification data for each parameter are provided in Appendix C.

Multi-point calibrations were performed on a biannual basis as recommended by the EPA (EPA-454/R-98-004). Additionally, multi-point calibrations were conducted under specific circumstances including: indication of analyzer malfunction, repairs or service that affected its calibration, and following significant interruptions in station operations. Multi-point calibrations consisted of challenging each instrument response with air scrubbed of all pollutants ("zero air") and at least four concentrations spanning 80 to 90 percent of the URL. The NO_2 converter efficiency was determined following the guidelines provided in the 40 CFR 50 – Appendix F.

Tables 2-22 through 2-25 include calibration statistical summaries for CO, NO_2, O_3, and SO_2 analyzers, respectively. Tables 2-26 and 2-27 summarize the monthly quality control checks of the particulate samplers. These manual QC checks are conducted by SLR or on-site personnel and the data are transmitted to the SLR Anchorage office.

Meteorological calibration is assessed at least semi-annually. Each sensor is assessed by collocating calibration sensors of NIST-traceable accuracy. Calibration results are presented in Tables 2-28 through 2-29. Refer to Appendix C for detailed calibration records for meteorological sensors.

If calibration checks reveal a sampler is operating outside of established quality control criteria, data is invalidated as far back as the most recently passed calibration. Refer to Section 2 for a discussion of any data that was invalidated due to failing accuracy.

Table 2-22: Calibration Summary – CO

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [(1)]
1/28/2016	0.0	0.0	-	0.68%	0.9972	0.1085	0.9999	PASS
	8.0	8.1	0.8%					
	17.5	17.6	0.6%					
	30.0	30.3	1.2%					
	40.0	40.1	0.1%					
	45.2	44.9	-0.7%					
3/11/2016	0.0	0.3	-	1.73%	1.0050	0.2838	0.9999	PASS
	8.0	8.1	2.0%					
	17.5	17.9	2.2%					
	29.9	30.6	2.3%					
	40.0	40.7	1.6%					
	45.2	45.4	0.4%					
4/20/2016	0.0	0.1	-	0.74%	0.9868	0.2314	0.9999	PASS
	8.0	8.1	1.2%					
	17.5	17.6	0.4%					
	30.0	30.1	0.2%					
	40.0	39.8	-0.7%					
	45.0	44.5	-1.2%					
6/21/2016	0.0	0.3	-	1.59%	0.9968	0.3724	0.9998	PASS
	8.0	8.2	2.2%					
	17.4	17.8	2.3%					
	29.8	30.4	2.2%					
	39.7	40.1	1.0%					
	45.0	44.9	-0.3%					
7/12/2016	0.0	0.0	-	2.90%	0.9725	0.0151	0.9999	PASS
	8.1	7.7	-4.4%					
	17.6	17.1	-2.6%					
	30.0	29.5	-1.6%					
	40.1	39.0	-2.8%					
	45.0	43.6	-3.1%					
7/26/2016 (As Found)	0.0	0.1	-	1.41%	0.9861	0.0378	0.9999	PASS
	8.0	7.8	-2.7%					
	17.5	17.3	-1.0%					
	30.0	29.9	-0.3%					
	40.0	39.4	-1.6%					
	45.0	44.3	-1.5%					

Table 2-22 Continued: Calibration Summary – CO

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [(1)]
7/26/2016 (As Left)	0.0	0.0	-	0.19%	0.9971	0.0416	1.0000	PASS
	8.0							
	17.5	17.5	0.2%					
	30.0	30.0	0.0%					
	40.0	39.9	-0.3%					
	45.0							
12/13/2016	0.0	0.1	-	1.04%	0.9777	0.2254	0.9999	PASS
	8.0	8.0	-0.4%					
	17.5	17.5	-0.4%					
	30.0	29.8	-0.6%					
	40.1	39.4	-1.8%					
	45.0	44.1	-2.1%					

[1]Acceptance criteria:

1. Measured and audit point difference ≤ ±10%
2. Slope ≥ 0.90 and ≤ 1.10
3. R2 ≥ 0.9955
4. Y-intercept ≤ ±2% of full scale

Table 2-23: Calibration Summary – NO_2

Period	Calibration Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Converter Efficiency	Pass/Fail [(1)]
1/18/2016 (As Found)	0.000	0.000	-	6.31%	0.9254	0.0019	0.9997	99.4%	PASS
	0.080	0.076	-5.6%						
	0.171	0.163	-4.9%						
	0.334	0.310	-7.1%						
	0.391	0.368	-5.9%						
	0.427	0.393	-8.0%						
1/18/2016 (As Left)	0.000	0.000	-	1.04%	0.9795	0.0017	0.9997	98.9%	PASS
	0.082	0.082	-0.4%						
	0.175	0.175	-0.2%						
	0.336	0.333	-0.7%						
	0.396	0.392	-1.0%						
	0.428	0.416	-2.9%						
1/28/2016 (As Found)	0.000	0.000	-	5.39%	1.0474	0.0009	0.9999	99.7%	PASS
	0.078	0.083	6.0%						
	0.165	0.175	6.1%						
	0.279	0.294	5.3%						
	0.376	0.393	4.4%						
	0.411	0.432	5.2%						
1/28/2016 (As Left)	0.000	0.000	-	0.84%	0.9982	-0.0003	0.9999	100.4%	PASS
	0.074	0.076	1.4%						
	0.166	0.163	-1.8%						
	0.285	0.284	-0.5%						
	0.398	0.399	0.2%						
	0.430	0.428	-0.4%						
2/10/2016 (As Found)	0.000	0.001	-	6.90%	0.9249	0.0010	1.0000	98.6%	PASS
	0.081	0.076	-5.8%						
	0.174	0.163	-6.6%						
	0.336	0.310	-7.6%						
	0.424	0.393	-7.4%						
	0.456	0.424	-7.0%						
2/10/2016 (As Left)	0.000	0.000	-	1.17%	0.9745	0.0023	0.9998	98.4%	PASS
	0.081	0.082	0.1%						
	0.174	0.173	-0.6%						
	0.305	0.304	-0.2%						
	0.425	0.413	-2.7%						
	0.456	0.446	-2.2%						

Table 2-23 Continued: Calibration Summary – NO_2

Period	Calibration Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Converter Efficiency	Pass/Fail [(1)]
4/20/2016	0.000	0.000	-	0.97%	0.9950	0.0018	0.9999	98.3%	PASS
	0.081	0.083	2.2%						
	0.171	0.174	2.1%						
	0.309	0.308	-0.2%						
	0.422	0.421	-0.3%						
	0.461	0.461	0.0%						
7/12/2016 (As Found)	0.000	0.000	-	1.81%	0.9718	0.0015	0.9999	98.5%	PASS
	0.079	0.079	-0.9%						
	0.169	0.167	-1.1%						
	0.300	0.295	-1.6%						
	0.417	0.406	-2.7%						
	0.452	0.440	-2.7%						
7/12/2016 (As Left)	0.000	0.000	-	2.80%	0.9689	0.0003	1.0000	99.7%	PASS
	0.081	0.080	-1.9%						
	0.173	0.168	-2.9%						
	0.305	0.295	-3.2%						
	0.418	0.404	-3.1%						
	0.452	0.439	-2.9%						
7/26/2016	0.000	0.000	-	2.71%	0.9709	0.0001	0.9999	99.8%	PASS
	0.075	0.075	-0.9%						
	0.159	0.152	-4.7%						
	0.313	0.307	-1.9%						
	0.407	0.395	-3.0%						
	0.436	0.423	-3.1%						
12/13/2016	0.000	0.000	-	2.88%	1.0302	-0.0002	1.0000	100.6%	PASS
	0.080	0.082	2.5%						
	0.170	0.175	3.1%						
	0.353	0.362	2.7%						
	0.446	0.462	3.4%						
	0.479	0.492	2.8%						

Table 2-24: Calibration Summary – O_3

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [(1)]
1/28/2016	0.000	-0.001	-	0.17%	1.0027	-0.0008	1.0000	PASS
	0.081	0.081	-0.5%					
	0.176	0.176	0.0%					
	0.301	0.301	-0.1%					
	0.400	0.401	0.2%					
	0.451	0.451	0.0%					
4/20/2016	0.000	0.000	-	0.96%	0.9865	0.0011	1.0000	PASS
	0.080	0.081	1.1%					
	0.176	0.175	-0.6%					
	0.300	0.298	-0.8%					
	0.402	0.398	-1.1%					
	0.452	0.446	-1.3%					
4/29/2016	-0.002	0.000	-	0.75%	0.9947	0.0025	1.0000	PASS
	0.080	0.082	2.0%					
	0.175	0.176	0.8%					
	0.300	0.302	0.6%					
	0.400	0.401	0.2%					
	0.450	0.450	-0.2%					
6/21/2016 (As Found)	0.000	-0.002	-	3.18%	0.9644	0.0001	0.9999	PASS
	0.080	0.078	-2.8%					
	0.175	0.170	-2.8%					
	0.300	0.291	-2.9%					
	0.400	0.386	-3.5%					
	0.450	0.432	-4.0%					
6/21/2016 (As Left)	0.000	0.000	-	1.05%	1.0063	0.0005	0.9999	PASS
	0.080	0.082	2.3%					
	0.175	0.177	1.0%					
	0.300	0.302	0.6%					
	0.400	0.401	0.3%					
	0.450	0.455	1.2%					
7/26/2016 (As Found)	0.000	0.002	-	2.73%	1.0145	0.0021	1.0000	PASS
	0.079	0.083	5.1%					
	0.176	0.180	2.5%					
	0.301	0.308	2.2%					
	0.401	0.410	2.1%					
	0.451	0.459	1.8%					

Table 2-24 Continued: Calibration Summary – O_3

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [(1)]
7/26/2016 (As Left)	0.000	0.000	-	0.08%	0.9985	0.0002	1.0000	PASS
	0.080	0.080	0.1%					
	0.175	0.175	0.1%					
	0.300	0.300	0.0%					
	0.400	0.400	0.0%					
	0.449	0.448	-0.2%					
12/13/2016	0.000	0.000	-	0.49%	1.0064	-0.0012	1.0000	PASS
	0.080	0.079	-1.4%					
	0.175	0.175	-0.2%					
	0.300	0.300	0.0%					
	0.398	0.399	0.3%					
	0.447	0.449	0.5%					

[1]Acceptance criteria:

1. Measured and audit point difference ≤ ±7%
2. Slope ≥ 0.93 and ≤ 1.07
3. R^2 ≥ 0.9955

Y-intercept ≤ ±2% of full scale

Table 2-25: Calibration Summary – SO_2

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [(1)]
1/28/2016	0.000	0.001	-	0.82%	0.9954	-0.0002	0.9999	PASS
	0.078	0.078	0.3%					
	0.170	0.168	-1.6%					
	0.292	0.288	-1.4%					
	0.390	0.391	0.2%					
	0.441	0.438	-0.6%					
4/20/2016 (As Found)	0.000	0.002	-	9.11%	1.0937	0.0003	1.0000	PASS
	0.078	0.084	7.6%					
	0.171	0.187	9.3%					
	0.292	0.320	9.6%					
	0.391	0.429	9.8%					
	0.439	0.479	9.2%					
4/20/2016 (As Left)	0.000	-0.001	-	3.95%	1.0396	-0.0003	1.0000	PASS
	0.078	0.081	4.1%					
	0.171	0.178	4.3%					
	0.292	0.303	3.5%					
	0.390	0.404	3.6%					
	0.439	0.457	4.2%					
4/22/2016 (As Found)	0.000	-0.001	-	1.30%	0.9871	-0.0001	0.9999	PASS
	0.078	0.077	-2.0%					
	0.171	0.169	-0.8%					
	0.292	0.289	-1.1%					
	0.390	0.388	-0.7%					
	0.438	0.430	-2.0%					
4/22/2016 (As Left)	0.000	-0.001	-	3.95%	1.0396	-0.0003	1.0000	PASS
	0.078	0.081	4.1%					
	0.171	0.178	4.3%					
	0.292	0.303	3.5%					
	0.390	0.404	3.6%					
	0.439	0.457	4.2%					
4/29/2016	0.000	0.001	-	0.37%	1.0036	0.0002	1.0000	PASS
	0.078	0.078	0.2%					
	0.171	0.171	0.1%					
	0.292	0.295	0.8%					
	0.390	0.392	0.3%					
	0.438	0.440	0.4%					

Table 2-25 Continued: Calibration Summary – SO_2

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [(1)]
5/24/2016 (As Found)	0.000	0.004	-	1.38%	0.9752	0.0035	1.0000	PASS
	0.078	0.080	1.9%					
	0.171	0.170	-0.3%					
	0.292	0.288	-1.5%					
	0.390	0.385	-1.4%					
	0.439	0.431	-1.8%					
5/24/2016 (As Left)	0.000	0.000	-	1.96%	0.9763	0.0006	1.0000	PASS
	0.078	0.077	-1.0%					
	0.171	0.167	-2.0%					
	0.292	0.286	-2.3%					
	0.390	0.381	-2.3%					
	0.439	0.429	-2.1%					
6/16/2016 (As Found)	0.000	0.003	-	1.33%	0.9733	0.0031	1.0000	PASS
	0.078	0.079	0.9%					
	0.171	0.170	-0.6%					
	0.292	0.289	-1.2%					
	0.390	0.384	-1.6%					
	0.439	0.429	-2.3%					
6/16/2016 (As Left)	0.000	0.001	-	1.12%	1.0075	0.0007	1.0000	PASS
	0.078	0.079	1.4%					
	0.171	0.173	1.1%					
	0.292	0.297	1.5%					
	0.390	0.394	1.0%					
	0.439	0.442	0.7%					
6/21/2016 (As Found)	0.000	0.002	-	1.84%	1.0070	0.0021	0.9999	PASS
	0.078	0.080	2.8%					
	0.169	0.173	2.1%					
	0.290	0.296	2.0%					
	0.387	0.394	1.7%					
	0.439	0.442	0.6%					
6/21/2016 (As Left)	0.000	-0.001	-	0.67%	1.0055	-0.0001	0.9999	PASS
	0.078	0.078	-0.2%					
	0.169	0.171	1.3%					
	0.290	0.293	1.1%					
	0.387	0.389	0.5%					
	0.439	0.440	0.2%					

Table 2-25 Continued: Calibration Summary – SO_2

Period	Calibration Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Slope	Y-Intercept	R^2	Pass/Fail [1]
7/12/2016 (As Found)	0.000	0.001	-	3.50%	1.0284	0.0013	1.0000	PASS
	0.079	0.082	4.2%					
	0.171	0.178	3.8%					
	0.292	0.301	3.0%					
	0.391	0.405	3.5%					
	0.439	0.452	3.0%					
7/12/2016 (As Left)	0.000	0.000	-	0.53%	1.0031	0.0003	0.9999	PASS
	0.079	0.079	0.9%					
	0.171	0.171	0.1%					
	0.292	0.296	1.3%					
	0.391	0.391	0.1%					
	0.439	0.440	0.3%					
7/26/2016	0.000	0.002	-	0.85%	0.9997	-0.0002	0.9998	PASS
	0.078	0.077	-1.6%					
	0.171	0.170	-0.2%					
	0.292	0.290	-0.8%					
	0.390	0.387	-0.8%					
	0.438	0.442	0.9%					
9/30/2016 (As Found)	0.000	0.002	-	1.37%	1.0070	0.0015	0.9999	PASS
	0.078	0.079	1.4%					
	0.171	0.174	2.0%					
	0.292	0.297	1.6%					
	0.390	0.392	0.4%					
	0.438	0.445	1.4%					
9/30/2016 (As Left)	0.000	0.000	-	1.30%	1.0017	0.0009	0.9998	PASS
	0.078	0.081	3.4%					
	0.171	0.173	1.4%					
	0.292	0.291	-0.6%					
	0.390	0.390	-0.1%					
	0.438	0.443	1.0%					
12/13/2016	0.000	-0.001	-	0.69%	0.9973	-0.0008	0.9999	PASS
	0.078	0.078	-0.1%					
	0.171	0.169	-1.2%					
	0.293	0.290	-0.8%					
	0.391	0.387	-1.1%					
	0.439	0.440	0.2%					

[1]Acceptance criteria:

1. Measured and audit point difference ≤ ±10%
2. Slope ≥ 0.90 and ≤ 1.10
3. $R^2 \geq 0.9955$
4. Y-intercept ≤ ±2% of full scale

Table 2-26: Quality Control Checks $PM_{2.5}$

Date	Ambient Temperature [1] (˚C)			Barometric Pressure [2] (mmHg)			Time (hh:mm:ss)			Flow Rate [3] (L/min)		
	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff
1/28/2016 [4]	-14.5	-13.8	-0.7	735	733	2	12:30:00	12:28:00	0:02:00	16.7	16.85	-0.9%
2/24/2016	-16.7	-16.2	-0.5	749	747	2	17:20:45	17:19:06	0:01:39	16.7	16.88	-1.1%
3/21/2016[4]	-16.6	-15.6	-1.0	762	760	2	17:34:51	17:33:00	0:01:51	16.7	17.00	-1.8%
4/21/2016	-1.6	-2.2	0.6	759	764	-5	15:26:50	15:25:00	0:01:50	16.7	16.77	-0.4%
5/26/2016	5.0	4.6	0.4	763	767	-4	10:23:00	10:21:00	0:02:00	16.7	16.74	-0.2%
6/21/2016	1.4	1.2	0.2	758	763	-5	10:14:30	10:12:28	0:02:02	16.7	16.61	0.5%
7/12/2016	20.4	18.9	1.5	758	763	-5	19:15:11	19:13:23	0:01:48	16.7	16.67	0.2%
7/26/2016	14.5	13.5	1.0	754	753	1	11:25:46	11:23:40	0:02:06	16.7	16.80	-0.6%
8/16/2016	2.9	3.7	-0.8	761	762	-1	12:43:42	12:41:52	0:01:50	16.7	16.76	-0.4%
9/14/2016	-0.4	-0.5	0.1	759	759	0	10:53:00	10:51:00	0:02:00	16.7	16.70	0.0%
10/24/2016	-10.4	-9.1	-1.3	764	760	4	12:17:27	12:15:20	0:02:07	16.7	16.93	-1.4%
11/15/2016	-17.2	-16.3	-0.9	756	754	2	12:47:00	12:45:00	0:02:00	16.7	16.99	-1.7%
12/15/2016	-20.1	-20.6	0.5	767	768	-1	8:05:00	8:04:00	0:01:00	16.7	16.40	1.8%

[1] Acceptable criteria ±2°C
[2] Acceptable criteria ±10 mmHg
[3] Acceptable criteria ±4% of reference
[4] QC check and multipoint calibration performed; the multipoint form and results are included in Appendix C.

Table 2-27: Quality Control Checks PM_{10}

Date	Ambient Temperature [1] (˚C)			Barometric Pressure [2] (mmHg)			Time (hh:mm:ss)			Flow Rate [3] (L/min)		
	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff	Sampler	QC Check	Diff
1/28/2016 [4]	-14.2	-13.8	-0.4	734	733	1	12:30:00	12:28:00	0:02:00	16.7	16.84	-0.8%
2/24/2016	-16.6	-16.2	-0.4	749	747	2	17:21:24	17:19:06	0:02:18	16.7	16.90	-1.2%
3/21/2016 [4]	-16.4	-15.6	-0.8	762	760	2	17:35:11	17:33:00	0:02:11	16.7	17.10	-2.3%
4/21/2016	-2.1	-2.2	0.1	760	764	-4	15:27:03	15:25:00	0:02:03	16.7	16.83	-0.8%
5/26/2016	4.8	4.6	0.2	763	767	-4	10:23:00	10:21:00	0:02:00	16.7	16.76	-0.4%
6/21/2016	1.5	1.6	-0.1	759	763	-4	9:59:00	9:57:02	0:01:58	16.7	16.72	-0.1%
7/12/2016	20.7	18.9	1.8	767	763	4	19:15:45	19:13:13	0:02:32	16.7	16.71	-0.1%
7/26/2016	15.4	13.5	1.9	752	753	-1	11:25:30	11:23:25	0:02:05	16.7	16.78	-0.5%
8/16/2016	4.1	3.7	0.4	760	762	-2	12:43:41	12:41:52	0:01:49	16.7	16.85	-0.9%
9/14/2016	-0.7	-0.5	-0.2	757	759	-2	10:53:00	10:51:00	0:02:00	16.7	16.90	-1.2%
10/24/2016	-10.8	-9.1	-1.7	762	760	2	12:17:29	12:15:20	0:02:09	16.7	16.84	-0.8%
11/15/2016	-16.7	-16.3	-0.4	757	754	3	12:47:00	12:45:00	0:02:00	16.7	16.97	-1.6%
12/15/2016	-21.0	-20.6	-0.4	764	768	-4	8:05:00	8:03:00	0:02:00	16.7	16.66	0.2%

[1] Acceptable criteria ±2°C
[2] Acceptable criteria ±10 mmHg
[3] Acceptable criteria ±4% of reference
[4] QC check and multipoint calibration performed; the multipoint form and results are included in Appendix C.

Table 2-28: April 21, 2016 Meteorological Calibration Summary

Parameter	Limit	Units	Max Error	Status
Time	≤ ±05:00	mm:ss	-00:07	PASS
2-m Temperature Accuracy	≤ ±0.50	°C	0.15	PASS
10-m Temperature Accuracy	≤ ±0.50	°C	0.11	PASS
Air Temperature Difference	≤ ±0.10	°C	0.04	PASS
Wind Speed A Accuracy	≤ ±0.20 ± 5% known input	m/s	0.00	PASS
Wind Speed A Torque	≤ 1.0	g-cm	0.4	PASS
Wind Direction A Alignment	≤ ±5	Degree	3	PASS
Wind Direction A Accuracy	≤ ±5	Degree	3.5	PASS
Wind Direction A Linearity	≤ ±3	Degree	1.7	PASS
Wind Direction A Torque	≤ 11.0	g-cm	8	PASS
Wind Speed B Accuracy	≤ ±0.20 ± 5% known input	m/s	0.00	PASS
Wind Speed B Torque	≤ 1.0	g-cm	0.3	PASS
Wind Direction B Alignment	≤ ±5	Degree	1	PASS
Wind Direction B Accuracy	≤ ±5	Degree	2.7	PASS
Wind Direction B Linearity	≤ ±3	Degree	1.7	PASS
Wind Direction B Torque	≤ 11.0	g-cm	9	PASS
Vertical Wind Speed Accuracy	≤ ±0.20 ± 5% known input	m/s	0.20	PASS
Vertical Wind Speed Torque	≤ 0.310	g-cm	0.1	PASS
Solar Radiation Accuracy	≤ ±5	%	0.6 [1]	PASS [1]

[1] Results from the April 21, 2016 meteorological calibration for Solar Radiation were determined to be invalid after frost build-up was discovered on the sensor upon retrieval. Results shown are from the follow-up calibration and audit performed on May 26, 2016.

Table 2-29: December 13, 2016 Meteorological Calibration Summary

Parameter	Limit	Units	Error	Status
Time	≤ ±05:00	mm:ss	0:00	PASS
2-m Temperature Accuracy	≤ ±0.50	°C	0.22	PASS
10-m Temperature Accuracy	≤ ±0.50	°C	0.19	PASS
Air Temperature Difference	≤ ±0.10	°C	0.08	PASS
Wind Speed A Accuracy	≤ ±0.20 ± 5% known input	m/s	0.20	PASS
Wind Speed A Torque	≤ 1.0	g-cm	0.2	PASS
Wind Direction A Alignment	≤ ±5	Degree	3.2	PASS
Wind Direction A Accuracy	≤ ±5	Degree	2.2	PASS
Wind Direction A Linearity	≤ ±3	Degree	1.8	PASS
Wind Direction A Torque	≤ 11.0	g-cm	15	FAIL
Wind Speed B Accuracy	≤ ±0.20 ± 5% known input	m/s	0.00	PASS
Wind Speed B Torque	≤ 1.0	g-cm	0.2	PASS
Wind Direction B Alignment	≤ ±5	Degree	4	PASS
Wind Direction B Accuracy	≤ ±5	Degree	1.9	PASS
Wind Direction B Linearity	≤ ±3	Degree	1.5	PASS
Wind Direction B Torque	≤ 11.0	g-cm	9	PASS
Vertical Wind Speed Accuracy	≤ ±0.20 ± 5% known input	m/s	0.20	PASS
Vertical Wind Speed Torque	≤ 0.310	g-cm	0.1	PASS [(1)]
Solar Radiation Accuracy	≤ 10	W/m^2	0.1	PASS

[1] The vertical wind speed sensor was found damaged and unable to be calibrated. Calibration findings are for the replacement sensor. Shortly after the replacement sensor was installed, it too experienced malfunction.

2.5.2 INDEPENDENT QUALITY ASSURANCE AUDITS

Gas analyzer performance audits involve challenging the analyzer with known concentrations of pollutants. For each concentration challenge, the difference between the audit gas concentration and analyzer response is assessed and compared to PSD limits. Results of the gas analyzer audits conducted during the monitoring year are presented in Tables 2-30 to 2-33.

The gas analyzers performance audit acceptance criterion for an individual analyzer is that the mean absolute difference between the audit gas concentration and analyzer response is equal to or less than 15 percent for CO, NO_2, and SO_2 and equal to or less than 10 percent for O_3.

The performance audits of $PM_{2.5}$ and PM_{10} samplers challenge the flow rate of the monitors against independent instruments that are calibrated and traceable to National Institute of Standards and Technology (NIST) transfer standards. Audits of the $PM_{2.5}$ and PM_{10} samplers are conducted using an audit orifice transfer standard (BGI Delta Cal or equivalent). Results of the PM sampler audits are presented in Tables 2-34 and 2-35.

Meteorological performance audits involve challenging the sensors with known inputs or by using calibrated instruments collocated with the sensor. For each reading, the difference between the station value and the expected value is compared with established PSD limits to assess the accuracy of the sensor. Results of the meteorological audits conducted throughout the monitoring year are presented in Tables 2-36 to 2-37.

AMS Tech LLC completed performance audits on all station monitors. All meteorological sensors and ambient air analyzers were found to be operating within acceptable criteria throughout the monitoring year. Complete performance audit findings and details are provided in Appendix C.

Conoco requested and was granted a waiver from ADEC to reduce the network frequency of $PM_{2.5}$ Performance Evaluation Program (PEP) audits to one every three years. The last PEP-like audit was conducted in monitoring year 2015 at the Nuiqsut station. Accordingly, no PEP audit was conducted during the reporting period. Data from the 2015 $PM_{2.5}$ PEP audit are provided in Table 2-38.

EPA recommends that a technical systems audit (TSA) be conducted to serve as a qualitative review of all aspects of a monitoring program. The systems audit includes a review of the program plan, station site, facilities, equipment, personnel, procedures, record keeping, data validation and data reporting. An annual TSA was performed in December 2016 at the Nuiqsut monitoring station. The audit indicated that the monitoring project is staffed with experienced personnel with a defined organization, and that the station is well-planned and properly sited according to criteria recommended by the EPA. Appendix C contains the complete technical systems audit report.

Table 2-30: Performance Audit Summary – CO

Period	Audit Point	Audit Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Pass/Fail [(1)]
						Slope	Y-Intercept	R2	
1/28/2016	0	0.00	0.00	-	0.3	0.9998	0.016	1.0000	Pass
	1	2.10	2.10	0.0					
	2	6.83	6.89	0.9					
	3	21.70	21.70	0.0					
4/20/2016	0	0.00	0.20	-	1.8	0.9897	0.162	1.0000	Pass
	1	2.10	2.17	3.3					
	2	6.81	6.94	1.9					
	3	23.18	23.10	-0.3					
9/14/2016	0	0.00	0.20	-	0.9	0.9836	0.101	1.0000	Pass
	1	2.05	2.03	-1.0					
	2	6.82	6.78	-0.6					
	3	21.84	21.60	-1.1					
12/13/2016	0	0.00	0.09	-	1.7	1.0022	0.065	1.0000	Pass
	1	2.05	2.01	-2.0					
	2	6.82	7.00	2.6					
	3	24.90	25.00	0.4					

[1]Acceptance criteria: Measured and audit point difference ≤ ±15%

Table 2-31: Performance Audit Summary – NO_2

Period	Audit Point	Audit Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Converter Efficiency	Pass/Fail [(1)]
						Slope	Y-Intercept	R2		
1/28/2016	0	0	0	-	4.6	1.0557	-0.365	1.0000	100.0%	Pass
	1	47	48	2.1						
	2	79	84	6.3						
	3	241	254	5.4						
4/20/2016	0	0	0	-	5.4	0.9485	-0.137	1.0000	100.0%	Pass
	1	51	48	-5.9						
	2	96	91	-5.2						
	3	308	292	-5.2						
9/14/2016	0	0	0	-	0.7	1.0109	-0.208	1.0000	100.0%	Pass
	1	61	61	0.0						
	2	91	92	1.1						
	3	293	296	1.0						
12/13/2016	0	0	0	-	2.2	1.0195	-0.134	1.0000	100.0%	Pass
	1	55	56	1.8						
	2	74	76	2.7						
	3	253	258	2.0						

[1]Acceptance criteria: Measured and audit point difference ≤ ±15%

Table 2-32: Performance Audit Summary – O_3

Period	Audit Point	Audit Gas Concentration (ppm)	Analyzer Response (ppm)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Pass/Fail [(1)]
						Slope	Y-Intercept	R2	
1/28/2016	0	0.000	-0.001	-	1.9	1.0049	0.001	1.0000	Pass
	1	0.030	0.031	3.3					
	2	0.075	0.077	2.7					
	3	0.148	0.151	2.0					
	4	0.401	0.403	0.5					
4/20/2016	0	0.000	0.000	-	1.9	1.0119	0.000	1.0000	Pass
	1	0.031	0.032	3.2					
	2	0.075	0.076	1.3					
	3	0.150	0.152	1.3					
	4	0.401	0.406	1.2					
9/14/2016	0	0.000	0.000	-	1.2	0.9989	0.000	1.0000	Pass
	1	0.030	0.029	-3.3					
	2	0.075	0.074	-1.3					
	3	0.150	0.150	0.0					
	4	0.401	0.400	-0.2					
12/13/2016	0	0.000	-0.002	-	4.1	1.0045	-0.003	1.0000	Pass
	1	0.030	0.027	-10.0					
	2	0.075	0.071	-5.3					
	3	0.150	0.147	-2.0					
	4	0.400	0.399	-0.3					

[1]Acceptance criteria: Measured and audit point difference ≤ ±10%

Table 2-33: Performance Audit Summary – SO_2

Period	Audit Point	Audit Gas Concentration (ppb)	Analyzer Response (ppb)	Percent Difference (%)	Mean Absolute Percent Difference (%)	Linear Regression Statistics			Pass/Fail [(1)]
						Slope	Y-Intercept	R2	
1/28/2016	0	0	1	-	1.0	0.9803	0.779	1.0000	Pass
	1	40	40	0.0					
	2	74	73	-1.4					
	3	248	244	-1.6					
4/20/2016	0	0.0	0	-	5.4	0.9571	-0.404	1.0000	Pass
	1	39	36	-7.7					
	2	73	70	-4.1					
	3	247	236	-4.5					
9/14/2016	0	0.0	0	-	2.1	0.9844	-0.293	1.0000	Pass
	1	39.7	38.9	-2.0					
	2	74	72	-2.7					
	3	247	243	-1.6					
12/13/2016	0	0.0	1	-	4.9	0.9766	-0.818	0.9998	Pass
	1	39.7	37	-6.8					
	2	74	70	-5.4					
	3	247	241	-2.4					

[1]Acceptance criteria: Measured and audit point difference ≤ ±15%

Table 2-34: Performance Audit Summary – $PM_{2.5}$

Period	External Leak Check Error (LPM)	Ambient Temperature Error (°C)	Ambient Pressure Error (mmHg)	Flow Rate		Pass/Fail [1]
				Flow Rate Accuracy Percent Error (%)	Design Flow Test Percent Error (%)	
1/28/2016	0.0	0.0	-4	0.6	-0.6	Pass
4/20/2016	0.1	0.8	-5	1.2	-1.2	Pass
9/14/2016	0.6	-0.4	0	0.0	0.0	Pass
12/13/2016	0.0	-0.2	-2	-1.2	1.2	Pass

[1] Acceptance criteria:
1. Leak check ≤ ±1.0 LPM
2. Temperature ≤ ±2.0 °C
3. Pressure ≤ ± 10 mmHg
4. Flow rate error ≤ ± 4% audit standard
5. Design flow test ≤ ± 5% design flow rate

Table 2-35: Performance Audit Summary – PM_{10}

Period	External Leak Check Error (LPM)	Ambient Temperature Error (°C)	Ambient Pressure Error (mmHg)	Flow Rate		Pass/Fail [1]
				Flow Rate Accuracy Percent Error (%)	Design Flow Test Percent Error (%)	
1/28/2016	0.0	0.3	-4	0.6	-0.6	Pass
4/20/2016	0.1	0.3	-4	-0.6	0.6	Pass
9/14/2016	0.4	-0.8	-2	0.6	-0.6	Pass
12/13/2016	0.1	0.7	-1	1.8	-1.8	Pass

[1] Acceptance criteria:
1. Leak check ≤ ±1.0 LPM
2. Temperature ≤ ±2.0 °C
3. Pressure ≤ ± 10 mmHg
4. Flow rate error ≤ ± 4% audit standard
5. Design flow test ≤ ± 5% design flow rate

Table 2-36: April 20, 2016 Meteorological Performance Audit Summary

Parameter	Limit	Units	Max Error	Status
Wind Speed A Accuracy	≤ ±0.20 + 5% known input	m/s	0.00	Pass
Wind Speed A Torque	≤ 0.5	m/s	0.28	Pass
Wind Direction A Accuracy	≤ ±5	Degree	0.5	Pass
Wind Direction A Linearity	≤ ±3	Degree	2	Pass
Wind Direction A Torque	≤ 0.5	m/s	0.49	Pass
Wind Speed B Accuracy	≤ ±0.20 + 5% known input	m/s	0.00	Pass
Wind Speed B Torque	≤ 0.5	m/s	0.16	Pass
Wind Direction B Accuracy	≤ ±5	Degree	1.8	Pass
Wind Direction B Linearity	≤ ±3	Degree	-3	Pass
Wind Direction B Torque	≤ 0.5	m/s	0.33	Pass
Vertical Wind Speed Accuracy	≤ ±0.20 + 5% known input	m/s	0.02	Pass
Vertical Wind Speed Torque	≤ 0.25	m/s	0.14	Pass
2-m Temperature Accuracy	≤ ±0.50	°C	-0.10	Pass
10-m Temperature Accuracy	≤ ±0.50	°C	-0.09	Pass
Air Temperature Difference	≤ ±0.10	°C	0.03	Pass
Solar Radiation Accuracy > 200 W/m^2	≤ 5%	%	-0.9	Pass [(1)]

[1] Results from the April 21, 2016 meteorological calibration for Solar Radiation were determined to be invalid after frost build-up was discovered on the sensor upon retrieval. Results shown are from the follow-up calibration and audit performed on May 26, 2016.

Table 2-37: December 13, 2016 Meteorological Performance Audit Summary

Parameter	Limit	Units	Max Error	Status
Wind Speed B Accuracy	≤ ±0.20 + 5% known input	m/s	0.00	Pass
Wind Speed B Torque	≤ 0.5	m/s	0.16	Pass
Wind Direction B Accuracy	≤ ±5	Degree	3.5	Pass
Wind Direction B Linearity	≤ ±3	Degree	1	Pass
Wind Direction B Torque	≤ 0.5	m/s	0.33	Pass
Vertical Wind Speed Accuracy	≤ ±0.20 + 5% known input	m/s	N/A	N/A [(1)]
Vertical Wind Speed Torque	≤ 0.25	m/s	N/A	N/A
2-m Temperature Accuracy	≤ ±0.50	°C	-0.09	Pass
10-m Temperature Accuracy	≤ ±0.50	°C	-0.08	Pass
Air Temperature Difference	≤ ±0.10	°C	0.03	Pass
Solar Radiation Accuracy < 200 W/m^2	≤ ±10	W/m^2	0.1	Pass

[1] The vertical wind speed sensor was found damaged and was not performance tested.

Table 2-38: 2015 $PM_{2.5}$ PEP Audit Results

Date	PEP Audit Results (µg/m3)	BAM 1020 Results (µg/m3)	Difference (µg/m3)	Bias [1] (µg/m3)
25-Aug-2015	0.26	2.60	2.34	1.13
27-Aug-2015	1.54	2.00	0.46	
28-Aug-2015	0.25	1.60	1.35	
29-Aug-2015	0.12	1.20	1.08	
30-Aug-2015	1.54	2.00	0.46	

[1] Average over the population of the absolute value of the individual pair concentration differences with a goal of ≤ 4 µg/m3 per quarter.

3. MONITORING DATA NETWORK SUMMARY

3.1 AIR QUALITY DATA SUMMARY

Table 3-1 provides quarterly and annual averages of the criteria pollutant concentrations measured from January 1, 2016, through December 31, 2016, and compared to national and Alaska air quality standards (NAAQS/AAAQS). The highest and second highest critical pollutant concentrations are also provided in Table 3-1 and compared to the respective primary and secondary air quality standards. Figures 3-1 through 3-9 provide plots of annual averages of the criteria pollutant concentrations at the Nuiqsut station along with respective NAAQS/AAAQS standards for comparison.

Table 3-1: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Nitrogen Dioxide (NO_2)	53 ppb (100 µg/m^3)	Annual	Average of Period	2	1	1	2	1	**1.9%**
	100.0 ppb (190 µg/m^3)	1-Hour [2]	Daily Max 1-Hour Averages (98th Percentile)	--	--	--	--	18.0	**18.0%**
			1st Highest, 1-Hour Average	29.2	17.0	16.2	29.0	29.2	**29.2%**
			2nd Highest, 1-Hour Average	28.6	15.1	15.4	21.7	29.0	**29.0%**
Ozone (O_3)	0.075 ppm (150 µg/m^3)	8-Hour [3]	4th Highest, 8-Hour Average	0.041	0.041	0.028	0.037	0.043	**57.3%**
			1st Highest, 8-Hour Average	0.044	0.044	0.030	0.038	0.044	**58.7%**
			2nd Highest, 8-Hour Average	0.043	0.044	0.029	0.037	0.044	**58.7%**
Carbon Monoxide (CO)	35 ppm (40,000 µg/m^3)	1-Hour [1]	1st Highest, 1-Hour Average	1	1	0	1	1	**2.9%**
			2nd Highest, 1-Hour Average	1	1	0	0	1	**2.9%**
	9 ppm (10,000 µg/m^3)	8-Hour [1]	1st Highest, 8-Hour Average	0	1	0	1	1	**11.1%**
			2nd Highest, 8-Hour Average	0	1	0	1	1	**11.1%**

[1] Not to be exceeded more than once each year.
[2] To attain this standard, the 3-year average of the 98th percentile of the annual daily maximum 1-hour average must not exceed 100 ppb. 3 To attain this standard, the 3-year average of the annual fourth-highest daily maximum 8-hour average must not exceed 0.075 ppm.

Table 3-1 Continued: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Sulfur Dioxide (SO_2)	0.030 ppm (80 μg/m^3)	Annual	Average of Period	0.001	0.002	0.001	0.000	0.001	**3.3%**
	0.14 ppm (365 μg/m^3)	24-Hour [5]	1st Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
			2nd Highest, 1-Hour Average	0.00	0.00	0.00	0.00	0.00	**0.0%**
	0.5 ppm (1,300 μg/m^3)	3-Hour [5]	1st Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
			2nd Highest, 3-Hour Average	0.0	0.0	0.0	0.0	0.0	**0.0%**
	75.0 ppb (196 μg/m^3)	1-Hour [4]	Daily Max 1-Hour Averages (99th Percentile)	--	--	--	--	3.2	**4.3%**
			1st Highest, 1-Hour Average	1.8	3.6	2.2	0.8	3.6	**4.8%**
			2nd Highest, 1-Hour Average	1.8	3.5	2.2	0.8	3.5	**4.7%**

[4] To attain this standard, the 3-year average of the 99th percentile of the annual daily maximum 1-hour average must not exceed 75.0 ppb.
[5] Not to be exceeded more than once each year.

Table 3-1 Continued: Nuiqsut Ambient Air Monitoring Summary Data

Pollutant	National and Alaska Ambient Air Quality Standards (NAAQS/AAAQS)		Nuiqsut Ambient Air Monitoring – Pollutant Data						
	Concentration	Averaging Period	Averaging Period	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual	YTD % of NAAQS/ AAAQS
Particulate Matter <2.5 microns ($PM_{2.5}$)	12.0 μg/m^3	Annual [7]	Average of Period	1.9	1.4	1.1	0.9	1.3	**10.8%**
	35 μg/m^3	24-Hour [6]	98th Percentile, 24-Hour Average	--	--	--	--	6	**15.7%**
			1st Highest, 24-Hour Average	9	5	9	6	9	**25.1%**
			2nd Highest, 24-Hour Average	6	5	6	6	9	**24.3%**
Particulate Matter <10 microns (PM_{10})	150 μg/m^3	24-Hour [8,9]	1st Highest, 24-Hour Average	20	40	150	130	150	**100.0%**
			2nd Highest, 24-Hour Average	10	40	120	60	130	**86.7%**

[6] To attain this standard, the 3-year average of the 98th percentile of the 24-hour concentration must not exceed 35.0 μg/m3.
[7] To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentration must not exceed 12.0 μg/m3.
[8] Not to be exceeded more than once per year on average over three years.
[9] 40 CFR Appendix K requires that reportable concentrations of PM10 be rounded to the nearest 10 μg/m3; actual measurement results are within Appendix C.

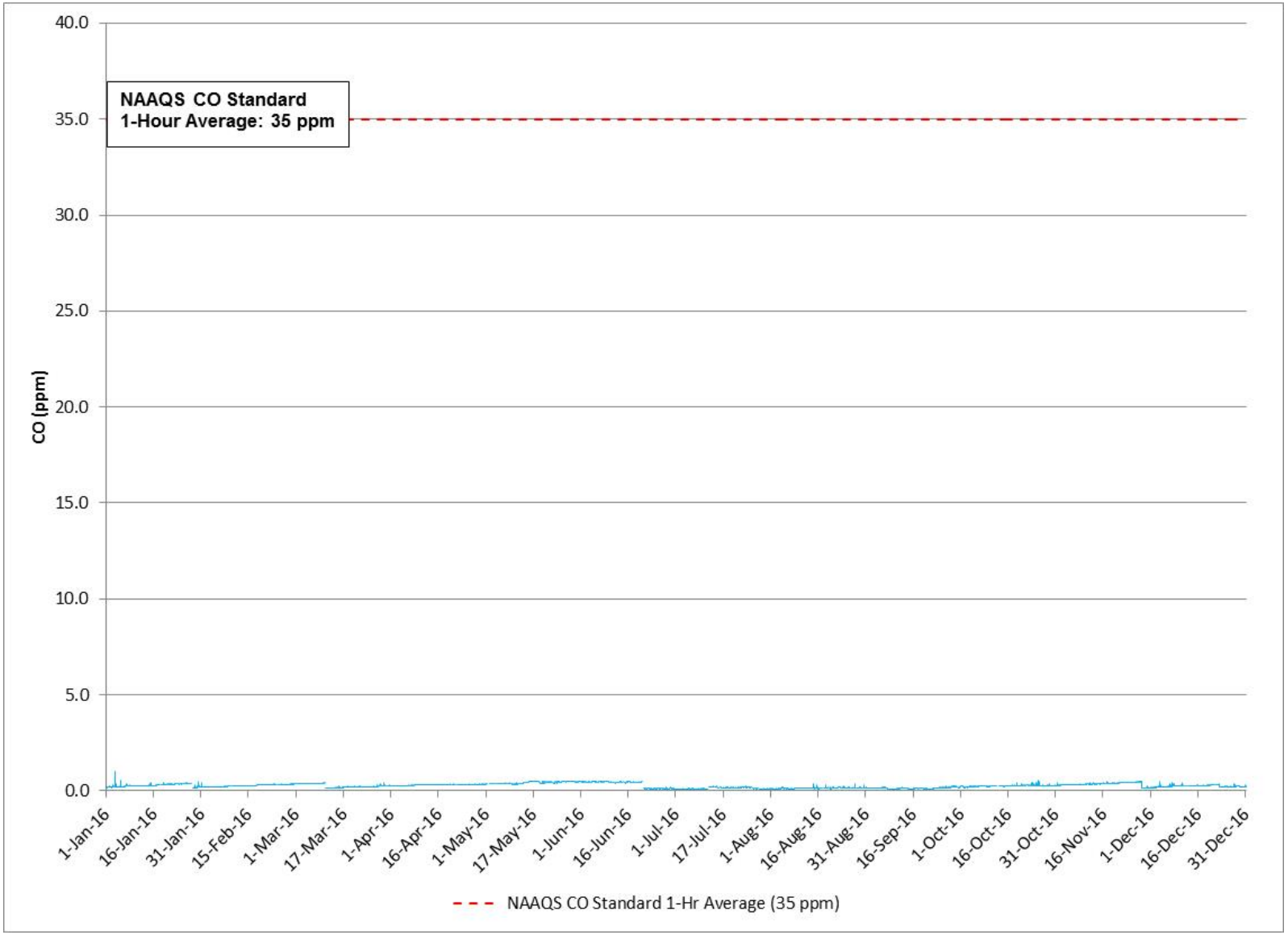


Figure 3-1: 1-Hour Average CO and NAAQS/AAAQS Standard

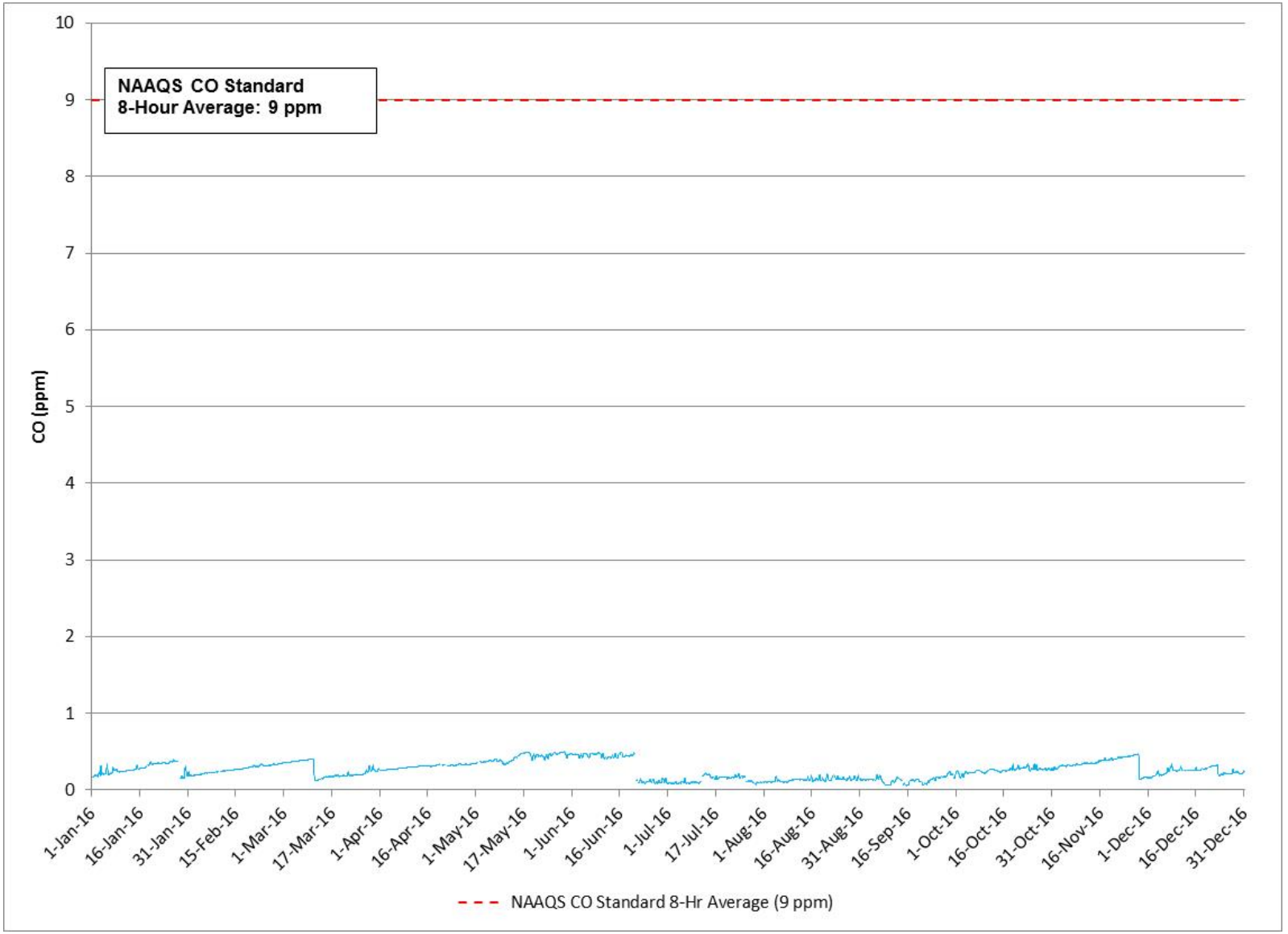


Figure 3-2: 8-Hour Average CO and NAAQS/AAAQS Standard

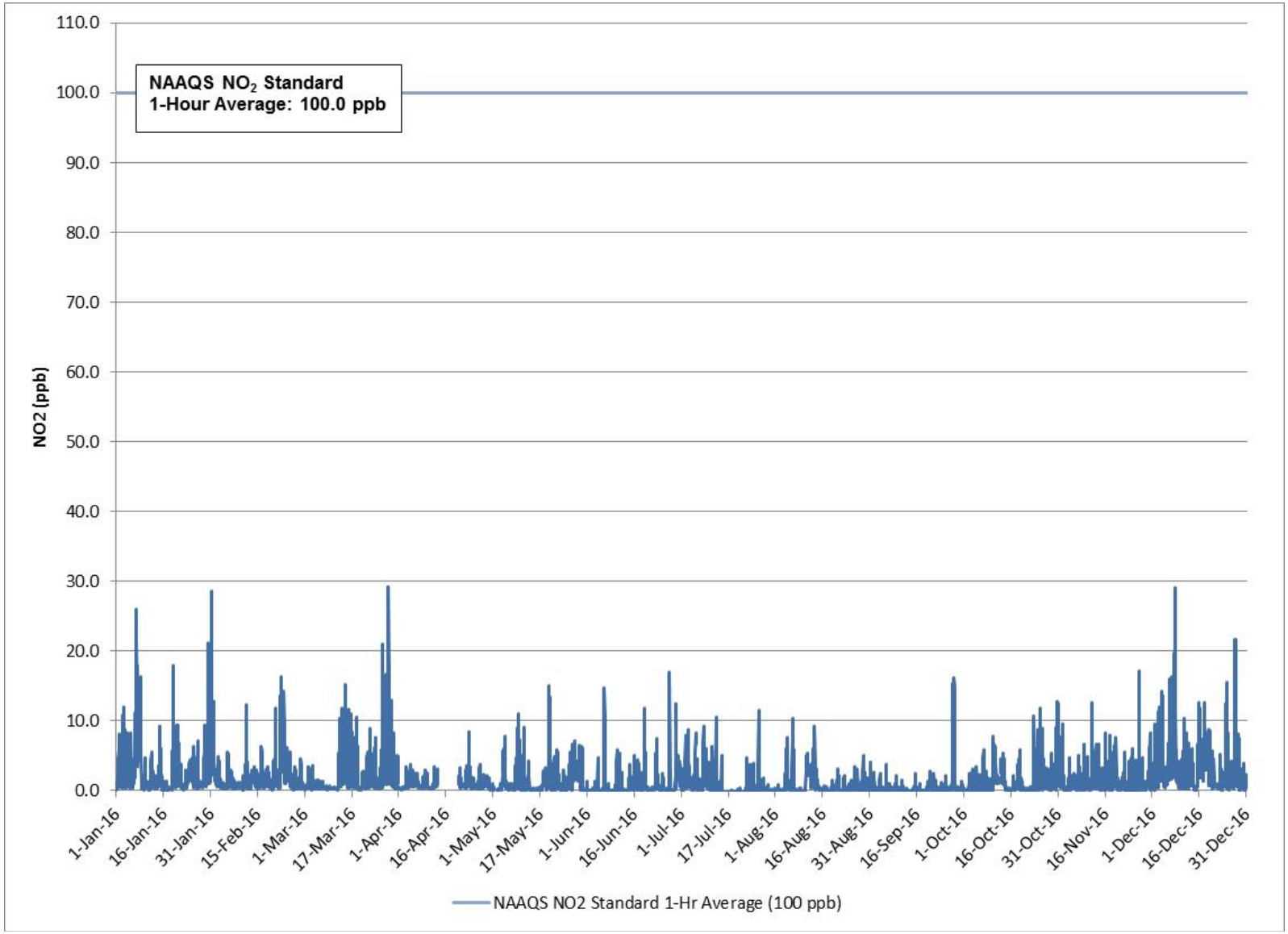


Figure 3-3: 1-Hour Average NO_2 and NAAQS Standard

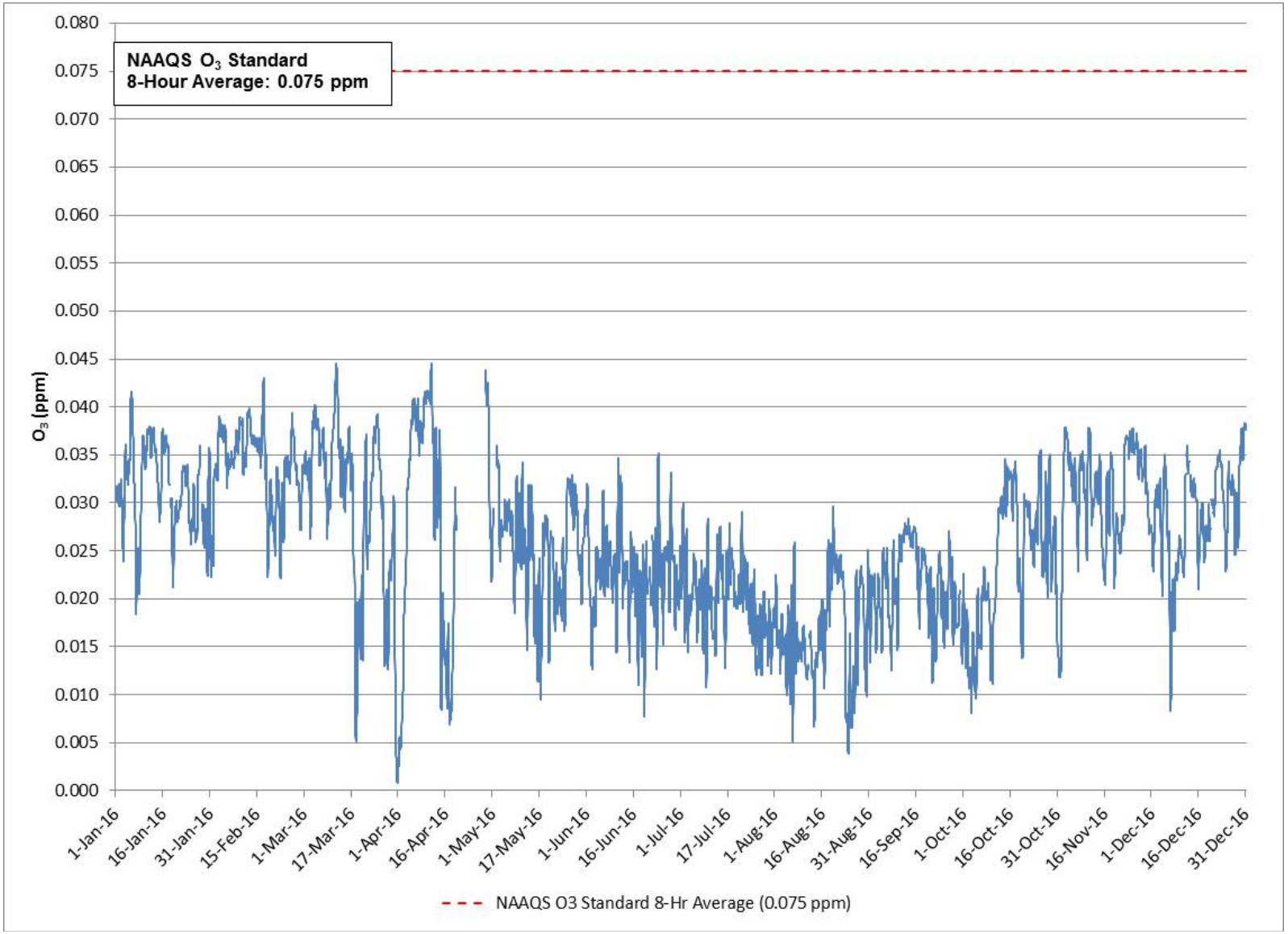


Figure 3-4: 8-Hour Average O_3 and NAAQS/AAAQS Standard

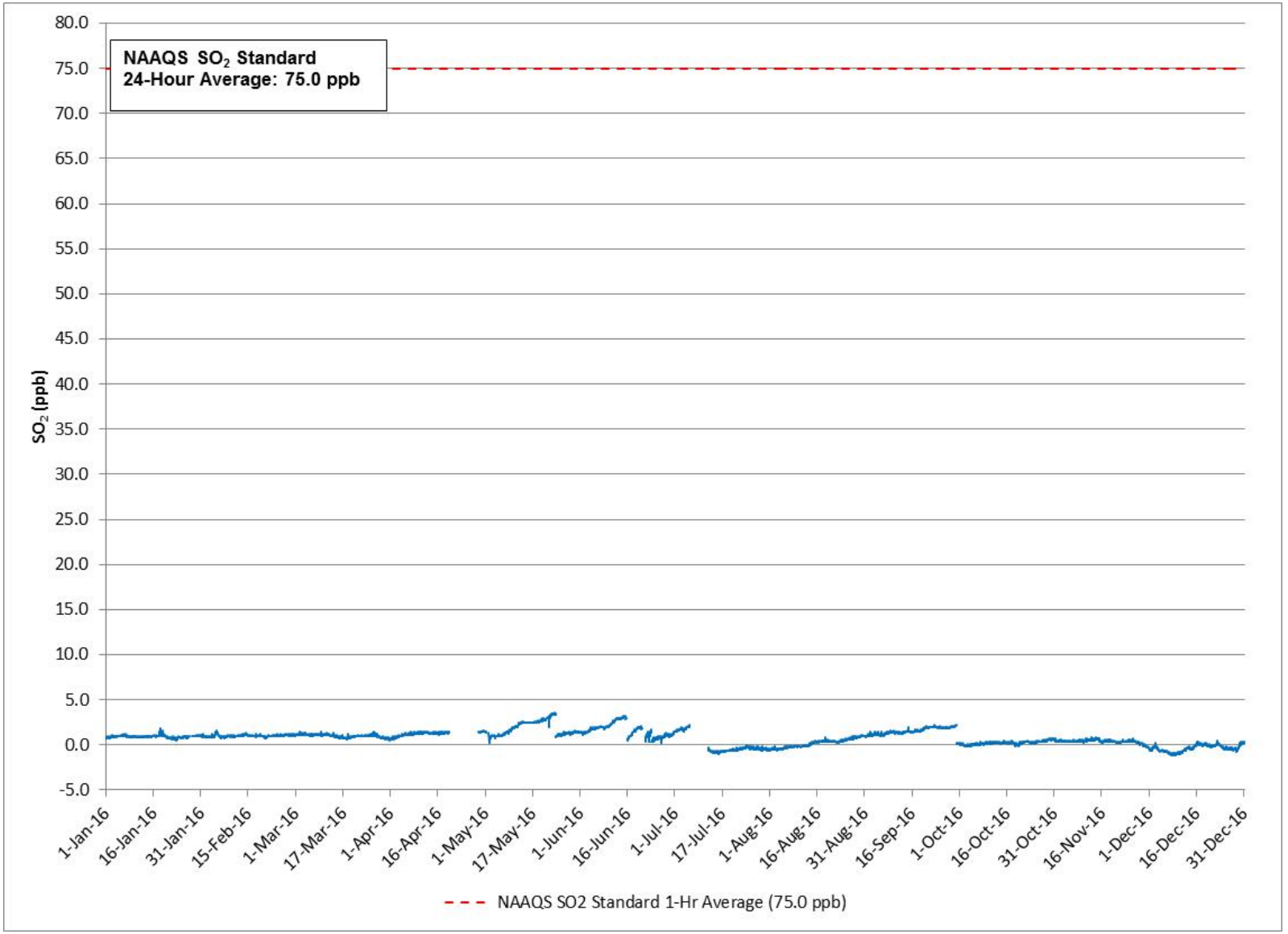


Figure 3-5: 1-Hour Average SO_2 and NAAQS/AAAQS Standard

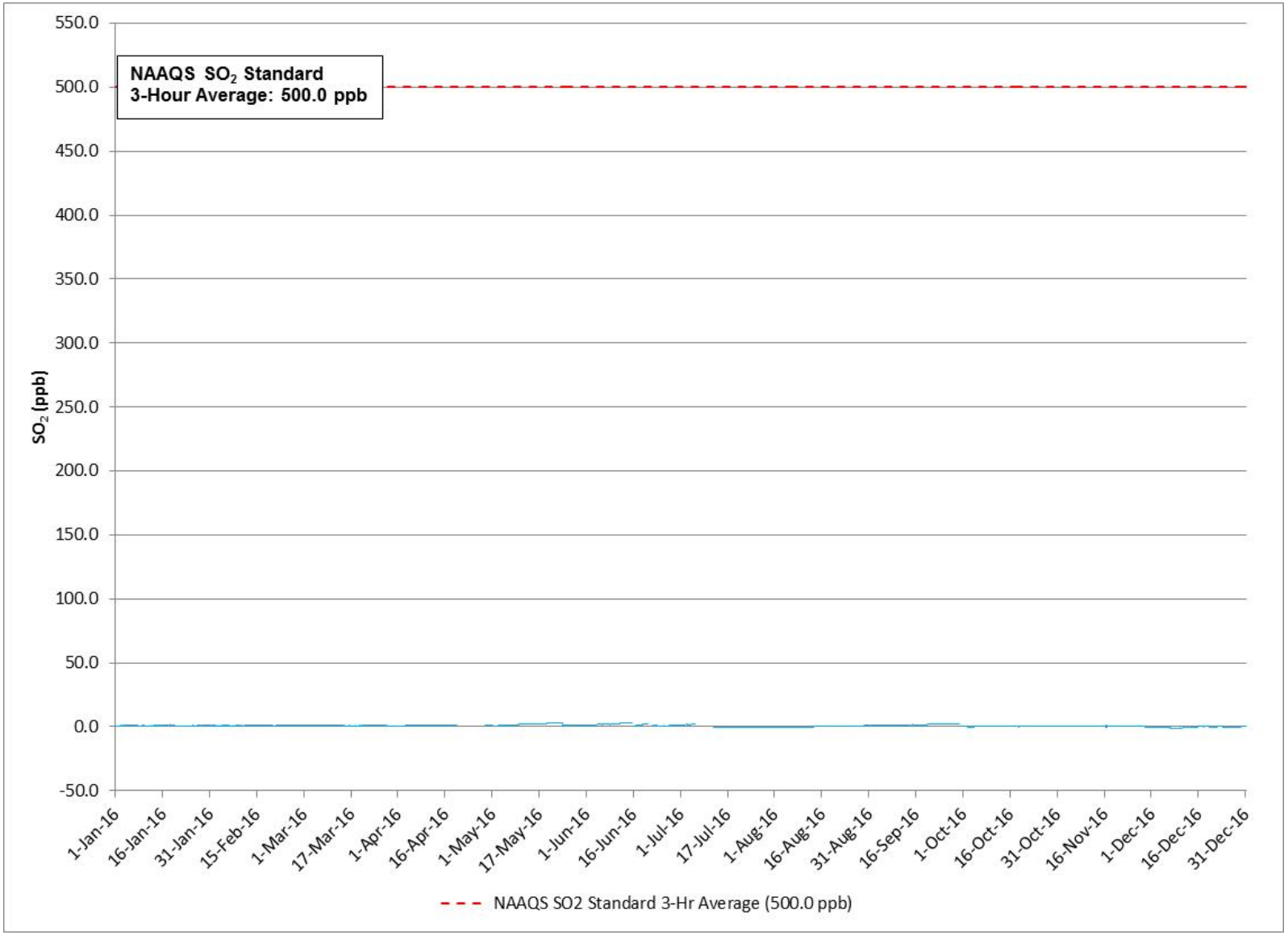


Figure 3-6: 3-Hour Average SO_2 and NAAQS/AAAQS Standard

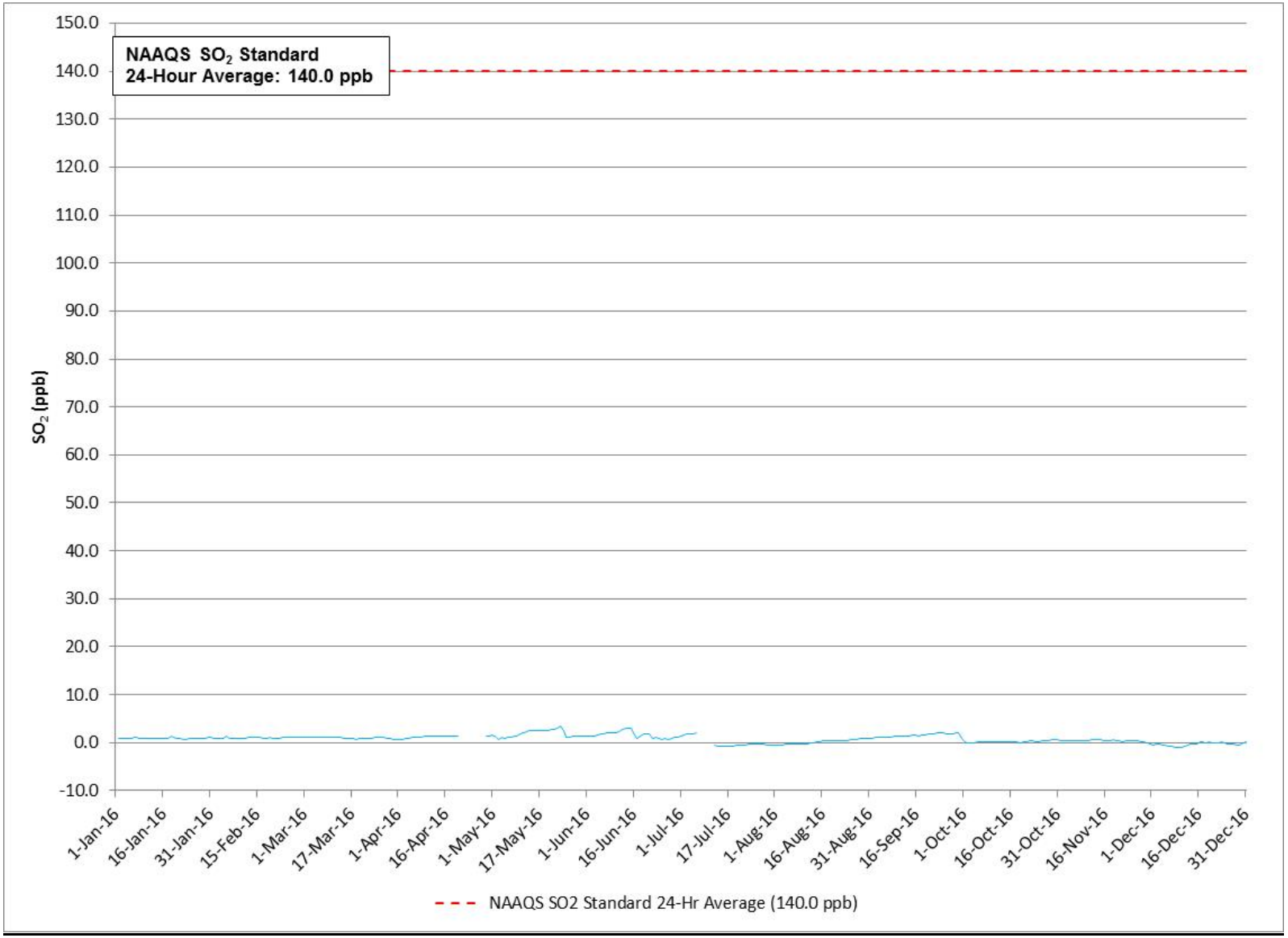


Figure 3-7: 24-Hour Average SO_2 and NAAQS/AAAQS Standard

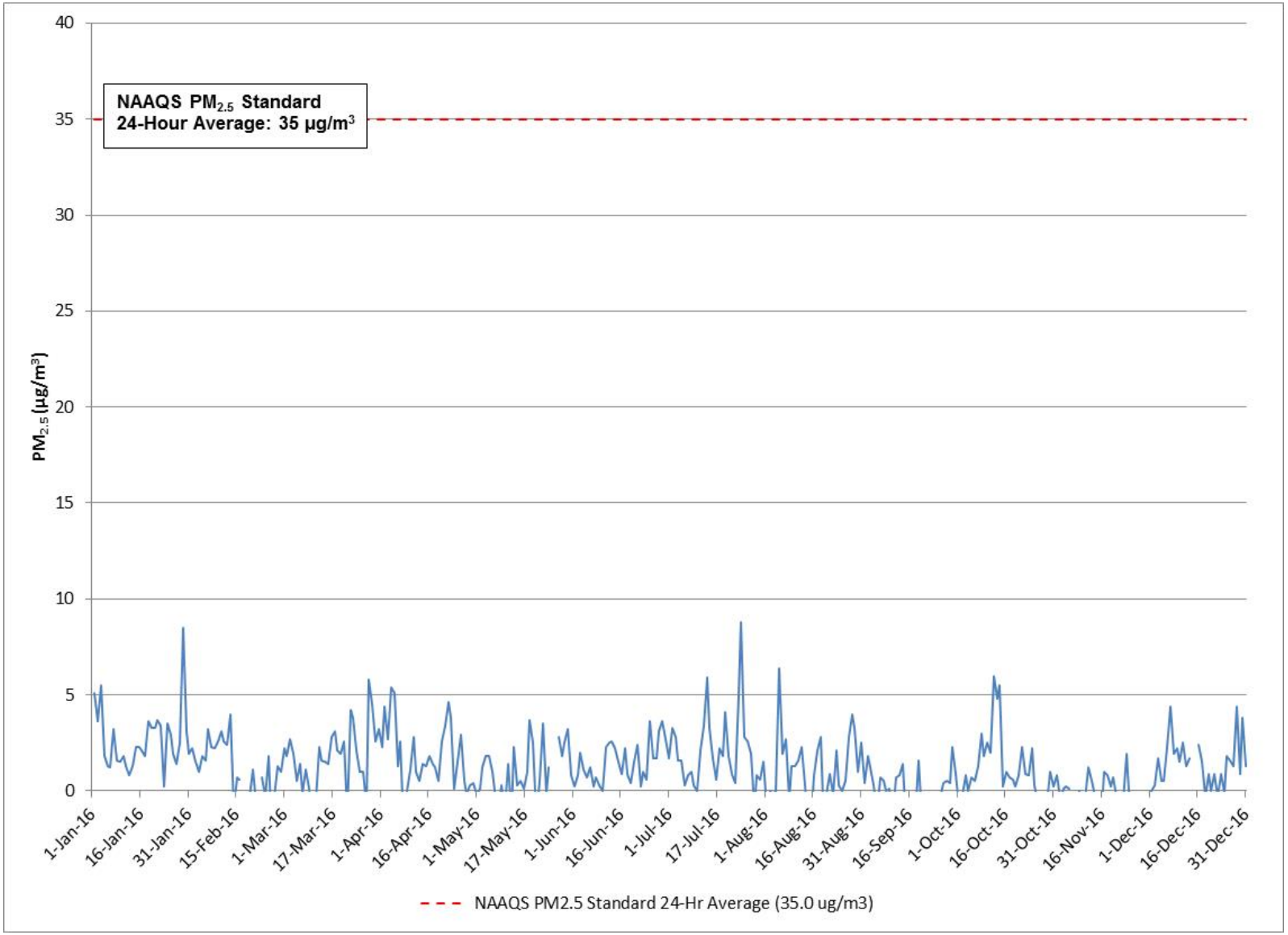


Figure 3-8: 24-Hour Average $PM_{2.5}$ and NAAQS/AAAQS Standard

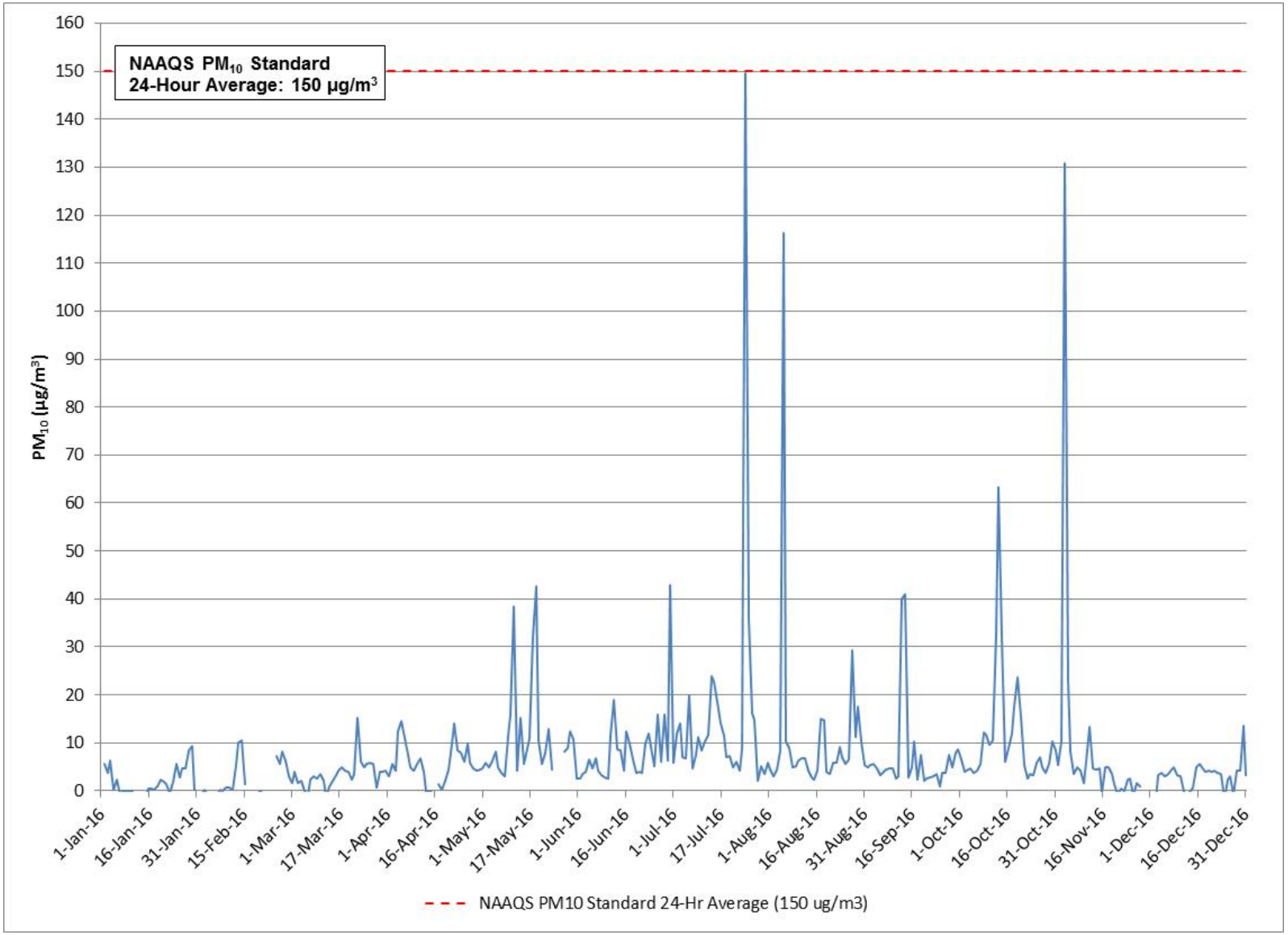


Figure 3-9: 24-Hour Average PM_{10} and NAAQS/AAAQS Standard

3.2 METEOROLOGICAL DATA SUMMARY

3.2.1 WIND SPEED (WS) AND WIND DIRECTION (WD) CLIMATOLOGY

Due to the primary (Set A) wind speed / direction sensor failing audit criteria during the December 13 audit, wind speed and direction data are reported from the primary sensor as well as the secondary (Set B) wind speed / direction sensor. Data from the first quarter is from the Set A sensor and data from Set B data is used for the second, third and fourth quarters. Valid performance audits and calibrations for both sensors are provided in Appendix C to demonstrate data were valid and bracketed by acceptable QA verifications for the entire period reported.

Table 3-2 provides the mean and maximum hourly wind speeds at the nearby Nuiqsut Airport meteorological station, operated by the National Weather Service and located approximately one mile southwest of the Nuiqsut meteorological monitoring station. The summary in Table 3-2 provides summary statistics for data collected at the Nuiqsut airport. Table 3-3 provides a statistical summary of measurements obtained at the Nuiqsut station.

Figure 3-10 provides an annual wind rose for the Nuiqsut station and Figure 3-11 provides quarterly wind roses. Table 3-4 is the annual wind analysis table and Tables 3-5 to 3-8 are the quarterly wind analysis tables. Figure 3-12 provides the annual wind rose superimposed over a Nuiqsut area map, centered at the approximate location of the monitoring station.

Table 3-2: Average and Maximum Wind Speeds at the Nuiqsut Airport

Monitoring Period	Mean Hourly Average Wind Speed (m/s)	Maximum Hourly Average Wind Speed (m/s)
1st Quarter	5.89	18.01
2nd Quarter	6.00	21.61
3rd Quarter	4.66	16.46
4th Quarter	4.08	17.49
Monitoring Year	**4.70**	**21.61**

Table 3-3: Average and Maximum Wind Speeds at Nuiqsut Station

Monitoring Period	Mean Hourly Average Horizontal Wind Speed (m/s)	Maximum Hourly Average Horizontal Wind Speed (m/s)	Mean Hourly Average Vertical Wind Speed (m/s)	Maximum Hourly Average Vertical Wind Speed (m/s)
1st Quarter	5.95	17.81	0.33	1.26
2nd Quarter	5.67	18.71	0.28	1.80
3rd Quarter	4.66	13.44	0.17	0.88
4th Quarter	3.78	15.62	0.16	0.51
Monitoring Year	**5.02**	**18.71**	**0.24**	**1.80**

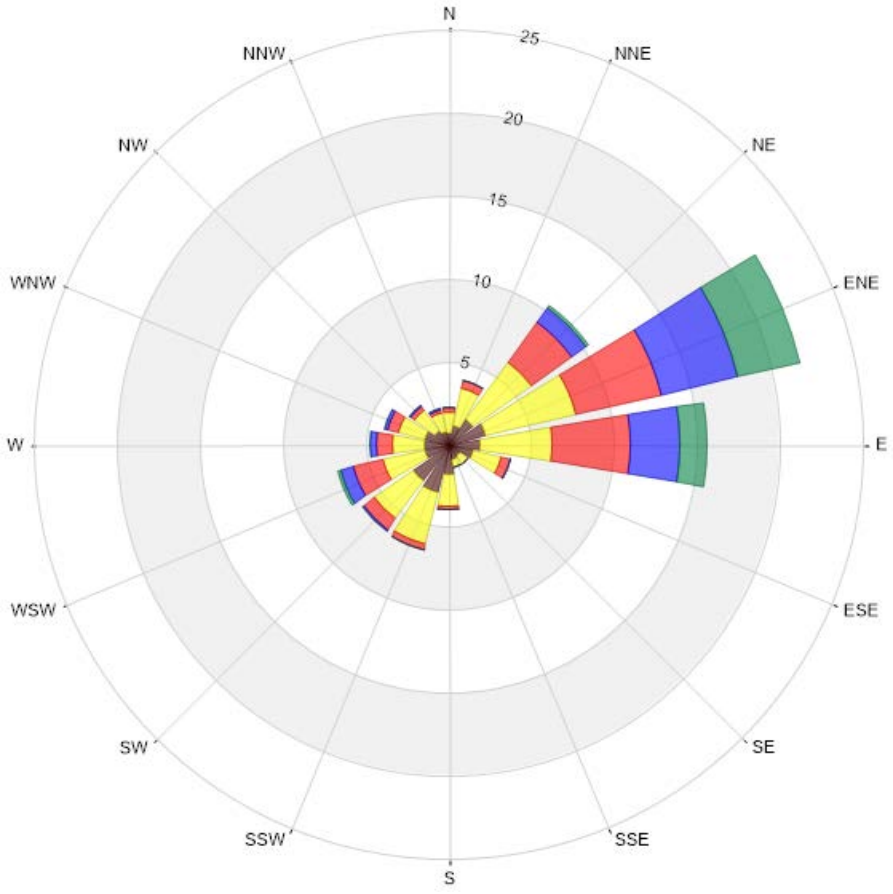


Figure 3-10: Nuiqsut Annual Wind Rose

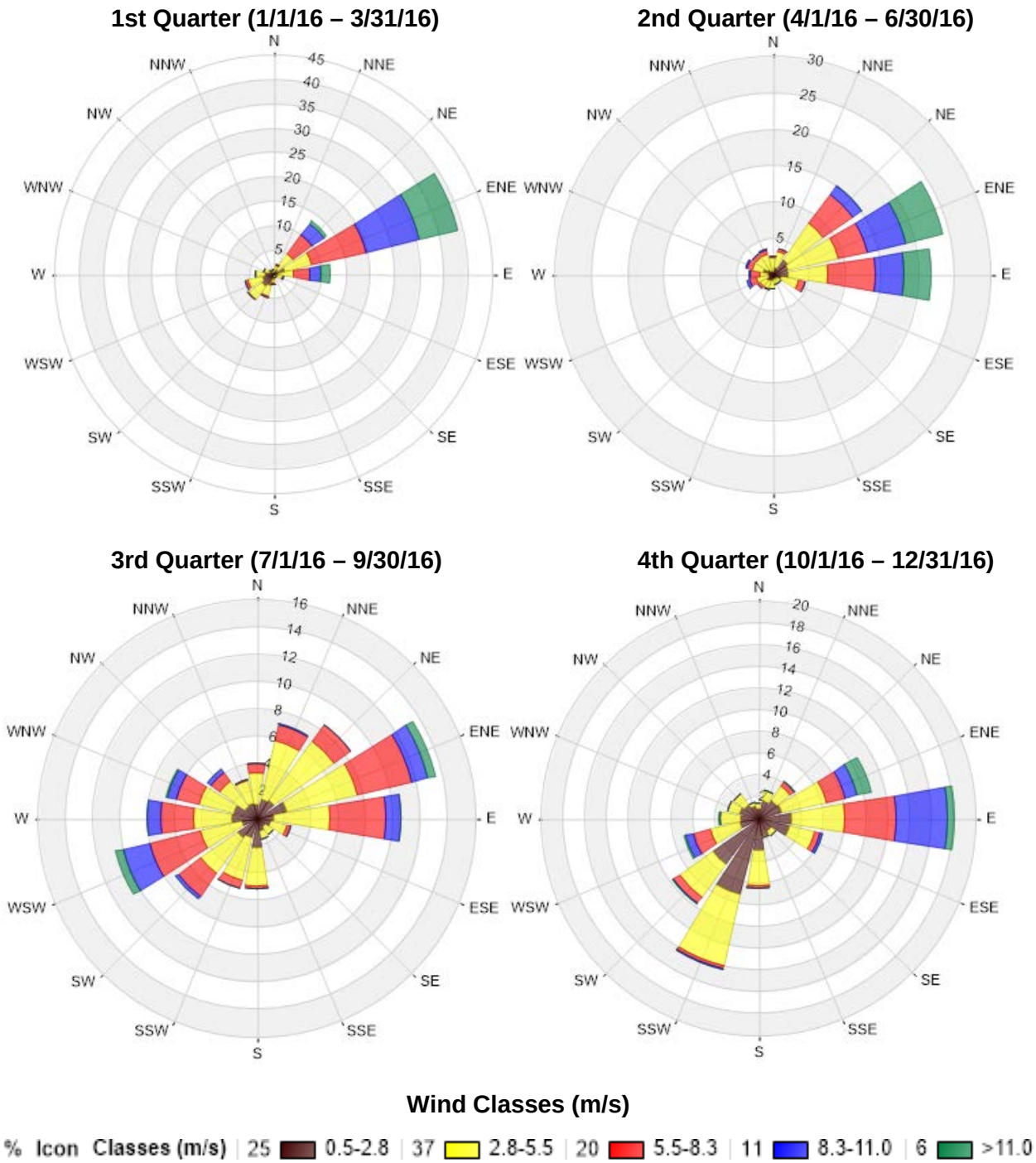


Figure 3-11: Nuiqsut Quarterly Wind Roses

Table 3-4: Annual Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	0.75	1.25	0.27	0	0	2.27
NNE	1.24	2.24	0.48	0.01	0	3.97
NE	1.86	4.29	2.96	1.10	0.19	10.40
ENE	2.32	5.59	5.28	4.75	3.81	21.75
E	1.91	4.38	4.70	3.00	1.58	15.57
ESE	1.54	1.73	0.56	0.06	0.01	3.90
SE	0.89	0.53	0	0	0	1.42
SSE	1.00	0.45	0	0	0	1.45
S	1.79	2.01	0.18	0	0	3.98
SSW	2.98	3.21	0.34	0.01	0	6.54
SW	2.68	2.85	0.82	0.08	0.01	6.44
WSW	1.50	2.57	1.84	0.81	0.19	6.91
W	1.52	1.90	0.95	0.38	0.02	4.77
WNW	1.50	1.59	0.67	0.21	0.02	3.99
NW	1.00	1.52	0.34	0.08	0	2.94
NNW	0.86	1.16	0.19	0.07	0	2.28
Summary	25.34	37.27	19.58	10.56	5.83	98.58 [(1)]

[1] The remaining 1.42 percent of data were calms (below 0.5 m/s).

Table 3-5: First Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	0.54	0.34	0	0	0	0.88
NNE	0.69	1.23	0.25	0	0	2.17
NE	1.13	3.92	4.86	2.89	0.74	13.54
ENE	2.40	5.74	11.38	11.43	8.04	38.99
E	1.13	3.19	3.24	2.31	2.01	11.88
ESE	0.88	1.03	0.29	0.05	0.05	2.30
SE	0.59	0.20	0	0	0	0.79
SSE	0.59	0.20	0	0	0	0.79
S	1.23	0.74	0.25	0	0	2.22
SSW	2.50	2.21	0.25	0	0	4.96
SW	3.04	3.38	0.10	0	0	6.52
WSW	2.45	2.89	0.74	0	0	6.08
W	1.96	1.72	0.10	0.05	0	3.83
WNW	0.98	1.08	0.15	0	0	2.21
NW	0.64	0.25	0	0	0	0.89
NNW	0.54	0.15	0	0	0	0.69
Summary	21.29	28.27	21.61	16.73	10.84	98.74 [(1)]

[1] The remaining 1.26 percent of data were calms (below 0.5 m/s).

Table 3-6: Second Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	0.55	1.70	0.32	0	0	2.57
NNE	1.06	2.21	0.41	0	0	3.68
NE	2.57	6.07	4.92	1.56	0	15.12
ENE	2.30	7.13	3.95	5.43	5.33	24.14
E	2.16	5.52	6.48	4	3.63	21.79
ESE	1.29	2.48	0.97	0	0	4.74
SE	0.69	0.83	0	0	0	1.52
SSE	0.78	0.74	0	0	0	1.52
S	0.87	1.20	0.05	0	0	2.12
SSW	0.97	1.10	0.09	0	0	2.16
SW	1.06	1.06	0.32	0.05	0	2.49
WSW	0.74	1.56	0.97	0.46	0	3.73
W	0.64	1.20	1.20	0.32	0	3.36
WNW	1.47	1.52	0.74	0.05	0	3.78
NW	0.87	2.07	0.51	0.09	0	3.54
NNW	0.51	2.30	0.60	0.28	0	3.69
Summary	18.53	38.69	21.53	12.24	8.96	100

Table 3-7: Third Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	1.00	2.31	0.72	0	0	4.03
NNE	1.49	4.39	1.18	0.05	0	7.11
NE	1.63	5.34	1.49	0	0	8.46
ENE	2.26	5.30	4.08	1.22	0.59	13.45
E	1.31	4.08	4.12	1.09	0	10.6
ESE	1.13	1.13	0.36	0	0	2.62
SE	0.77	0.68	0	0	0	1.45
SSE	0.95	0.63	0	0	0	1.58
S	2.17	2.85	0.14	0	0	5.16
SSW	1.54	3.13	0.63	0	0	5.30
SW	1.77	3.26	2.04	0.23	0	7.30
WSW	1.13	3.08	3.85	1.99	0.54	10.59
W	1.86	2.81	2.31	1.04	0	8.02
WNW	1.77	2.54	1.68	0.77	0.09	6.85
NW	1.04	2.31	0.82	0.23	0	4.40
NNW	1.18	1.63	0.14	0	0	2.95
Summary	23.00	45.47	23.56	6.62	1.22	100

Table 3-8: Fourth Quarter Wind Rose Frequency Distribution Table

Frequency Distribution (Percent)						
Direction	**Speed (m/s)**					
	0.5-2.8	**2.8-5.5**	**5.5-8.3**	**8.3-11.0**	**>11.0**	**Total**
N	0.95	0.45	0	0	0	1.40
NNE	1.70	0.95	0	0	0	2.65
NE	2.10	1.55	0.5	0	0.05	4.20
ENE	2.25	4.20	1.75	1.15	1.35	10.70
E	3.10	4.90	4.70	4.80	0.60	18.10
ESE	2.95	2.35	0.55	0.20	0	6.05
SE	1.55	0.40	0	0	0	1.95
SSE	1.75	0.15	0	0	0	1.90
S	2.95	3.25	0.30	0	0	6.50
SSW	7.25	6.65	0.35	0.05	0	14.30
SW	5.20	3.75	0.70	0.05	0.05	9.75
WSW	1.80	2.70	1.70	0.70	0.20	7.10
W	1.70	1.80	0.05	0.05	0.10	3.70
WNW	1.75	1.15	0	0	0	2.90
NW	1.50	1.30	0	0	0	2.80
NNW	1.15	0.45	0	0	0	1.60
Summary	39.65	36.00	10.60	7.00	2.35	95.60 [(1)]

[1] The remaining 4.40 percent of data were calms (below 0.5 m/s).

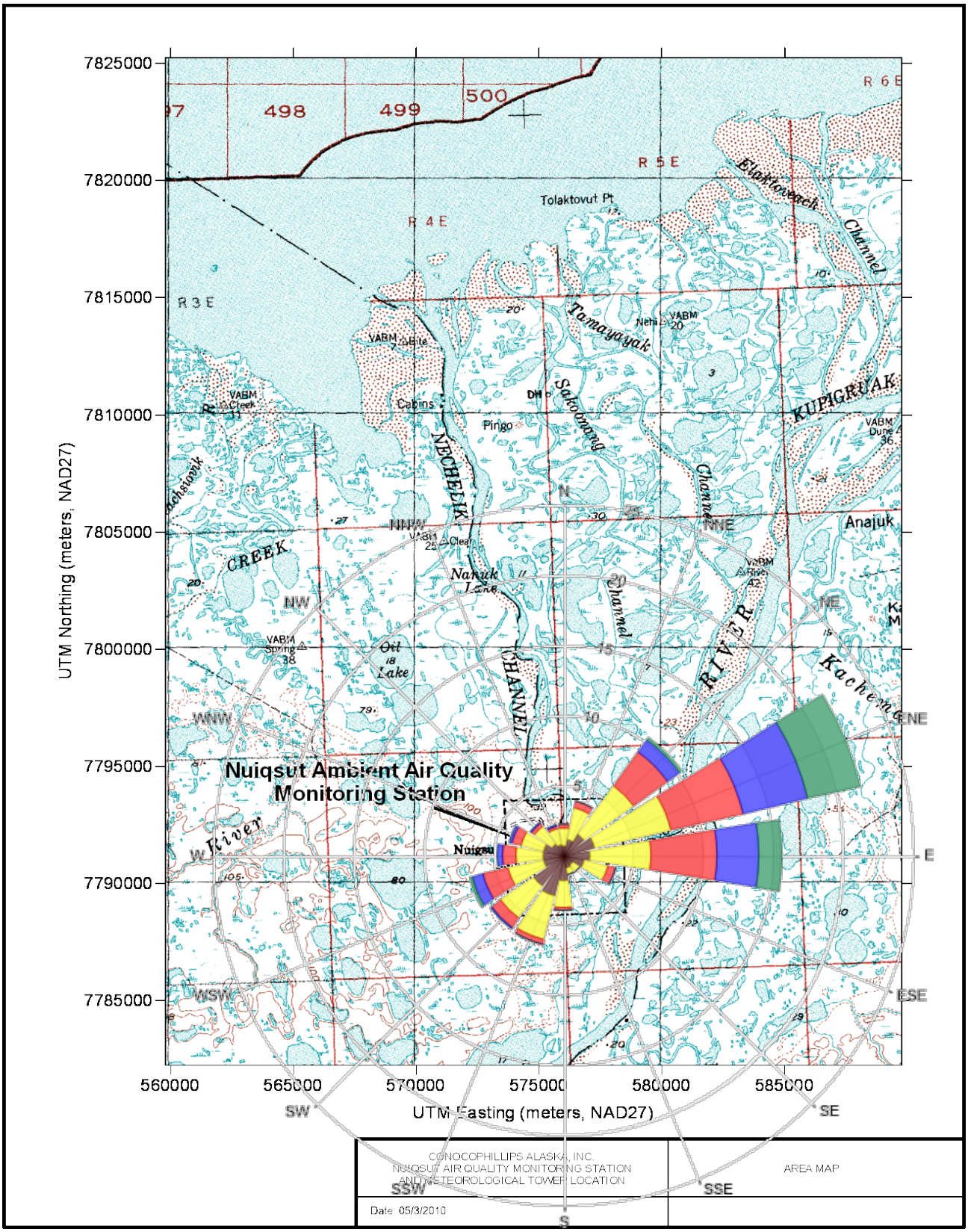


Figure 3-12: Annual Wind Rose Superimposed on Site Map

3.2.2 TEMPERATURE CLIMATOLOGY

Tables 3-9 and 3-10 provide the maximum and minimum daily mean temperatures, monthly mean temperatures, and maximum and minimum hourly average temperatures for the 2-meter and 10-meter temperature measurements, respectively. Figure 3-13 provides a graph of the 2-meter and 10-meter hourly average temperatures at the Nuiqsut station, as well as temperature data from the Nuiqsut Airport for comparative purposes only. Figure 3-14 shows a plot of vertical temperature difference (the difference between 10-meter and 2-meter temperature values) during the monitoring year.

Table 3-9: 2-Meter Temperature Summary

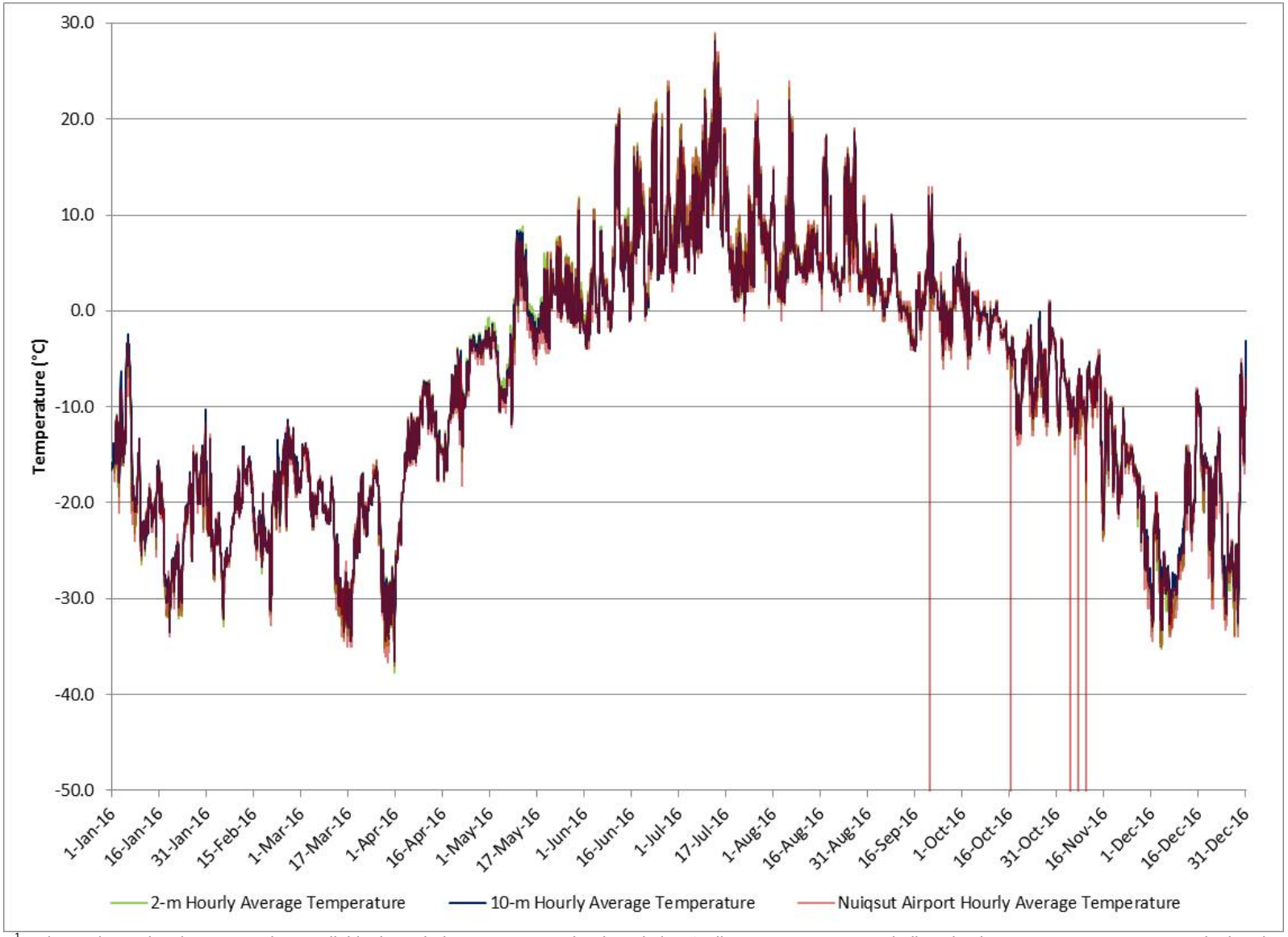
Period	Maximum Daily Mean Temperature (°C)	Minimum Daily Mean Temperature (°C)	Mean Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	-5.5	-31.0	-19.9	-2.8	-33.4
February	-14.3	-28.1	-21.0	-11.6	-32.9
March	-14.5	-31.8	-22.9	-13.8	-35.2
1st Quarter	**-5.5**	**-31.8**	**-21.3**	**-2.8**	**-35.2**
April	-2.7	-30.0	-11.3	-1.5	-37.7 [(2)]
May	5.3	-8.7	-0.2	11.9	-11.6
June	15.8	-1.4	6.4	23.4	-3.8
2nd Quarter	**15.8**	**-30.0**	**-1.7**	**23.4**	**-37.7** [(2)]
July	21.0	3.5	10.3	28.8 [(1)]	0.0
August	13.5	2.9	6.7	23.3	0.8
September	6.2	-3.0	1.7	12.3	-5.1
3rd Quarter	**21.0**	**-3.0**	**6.3**	**28.8** [(1)]	**-5.1**
October	1.5	-11.3	-3.6	5.6	-12.9
November	-5.1	-27.4	-13.1	-3.0	-29.3
December	-9.2	-32.5	-22.8	-3.2	-35.2
4th Quarter	**1.5**	**-32.5**	**-13.2**	**5.6**	**-35.2**
Monitoring Year	**21.0**	**-32.5**	**-7.4**	**28.8** [(1)]	**-37.7** [(2)]

[1] The maximum hourly average temperature occurred on July 13, 2016.
[2] The minimum hourly average temperature occurred on April 1, 2016.

Table 3-10: 10-Meter Temperature Summary

Period	Maximum Daily Mean Temperature (°C)	Minimum Daily Mean Temperature (°C)	Mean Temperature (°C)	Maximum Temperature (°C)	Minimum Temperature (°C)
January	-4.6	-30.2	-19.5	-2.5	-33.5
February	-14.2	-27.9	-20.8	-11.3	-32.1
March	-14.6	-31.3	-22.8	-13.8	-34.4
1st Quarter	**-4.6**	**-31.3**	**-21.1**	**-2.5**	**-34.4**
April	-3.0	-29.7	-11.4	-2.1	-36.6 [(2)]
May	5.2	-9.1	-0.7	10.5	-11.8
June	15.7	-2.0	6.0	22.9	-3.9
2nd Quarter	**15.7**	**-29.7**	**-2.0**	**22.9**	**-36.6** [(2)]
July	20.8	2.9	9.9	28.2 [(1)]	-0.1
August	13.6	2.6	6.6	21.9	0.8
September	6.4	-3.2	1.6	12.1	-4.6
3rd Quarter	**20.8**	**-3.2**	**6.1**	**28.2** [(1)]	**-4.6**
October	1.5	-11.2	-3.5	5.4	-12.9
November	-5.2	-26.4	-13.0	-3.0	-28.7
December	-9.0	-30.8	-22.1	-3.2	-33.3
4th Quarter	**1.5**	**-30.8**	**-12.9**	**5.4**	**-33.3**
Monitoring Year	**20.8**	**-31.3**	**-7.4**	**28.2** [(1)]	**-36.6** [(2)]

[1] The maximum hourly average temperature occurred on July 13, 2016.
[2] The minimum hourly average temperature occurred on April 1, 2016.



[1] Nuiqsut airport data is presented as available through the mesowest.utah.edu website. Outlier measurements are believed to be erroneous measurements in that dataset

Figure 3-13: Hourly Average 2-Meter and 10-Meter Temperatures

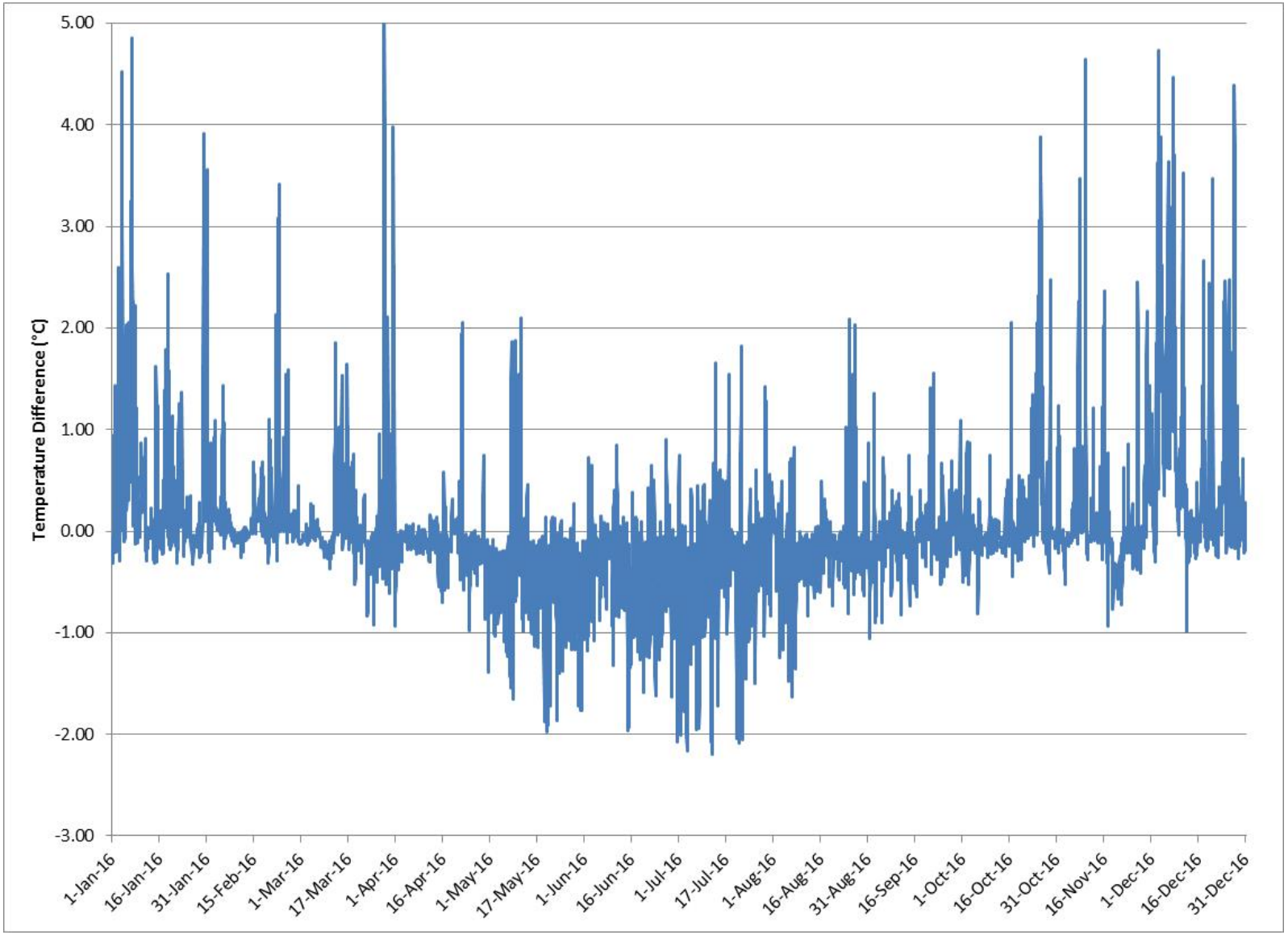


Figure 3-14: Hourly Average Vertical Temperature Difference

3.2.3 OTHER METEOROLOGICAL PARAMETERS

Table 3-11 provides a summary of solar radiation measurements obtained for the 2016 monitoring year. Figure 3-15 is a plot of annual hourly average solar radiation. The solar radiation data are available in monthly tabular format in Appendix D.

Table 3-11: Solar Radiation Summary

Period	Mean Solar Radiation (W/m^2)	Maximum Solar Radiation (W/m^2)
January	1	52
February	18	275
March	66	415
1st Quarter	**28**	**415**
April	153	643
May	201	761
June	231	751
2nd Quarter	**196**	**761**
July	226	723
August	108	615
September	54	435
3rd Quarter	**130**	**723**
October	22	383
November	2	58
December	0	1
4th Quarter	**8**	**383**
Monitoring Year	**90**	**761**

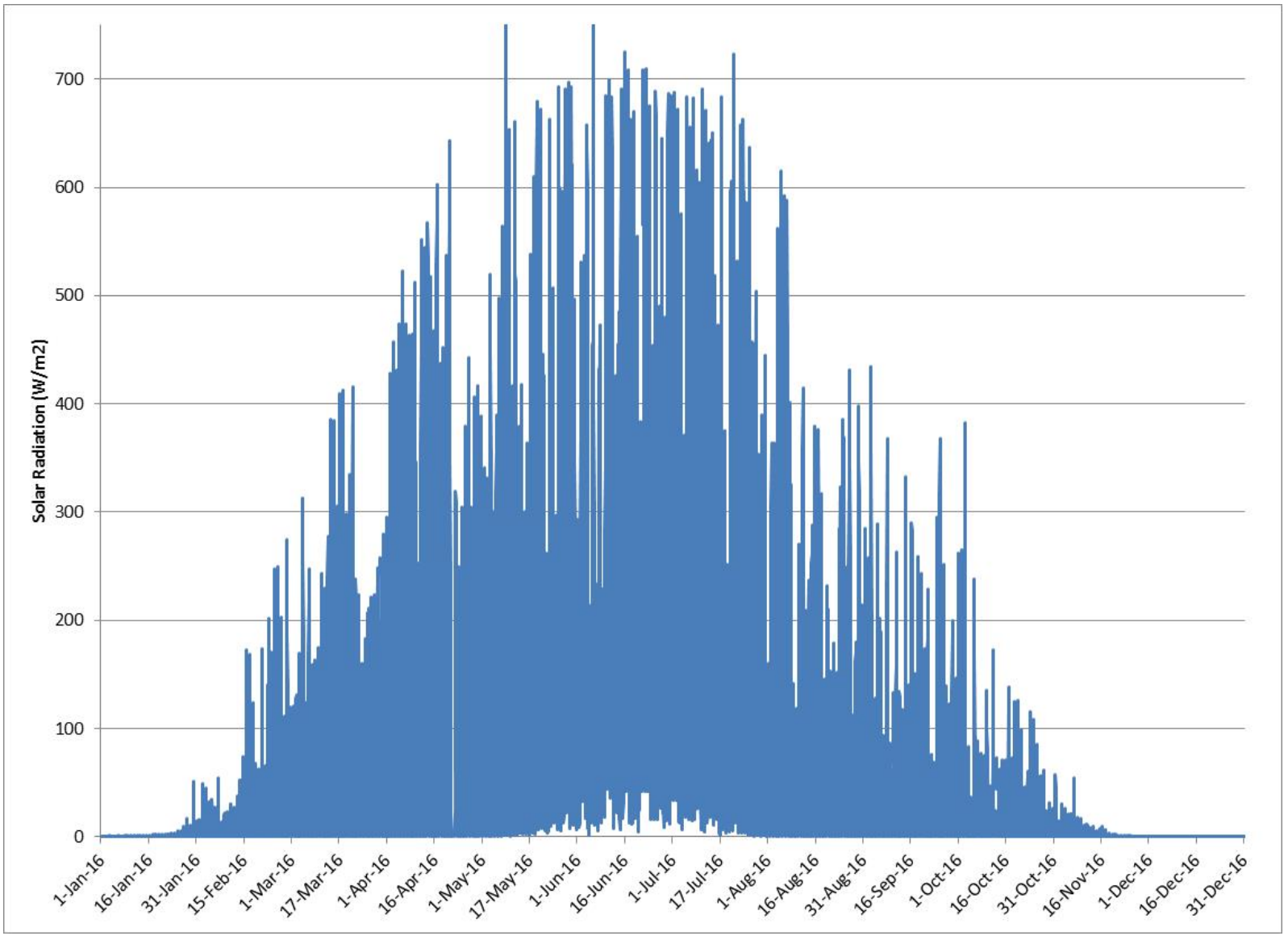


Figure 3-15: Hourly Average Solar Radiation

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