PHILLIPS ALASKA, INC.
NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
ANNUAL DATA REPORT
APRIL 2000 THROUGH MARCH 2001

Prepared for:

PHILLIPS ALASKA, INC.
Anchorage, Alaska

Prepared by:

SECOR INTERNATIONAL INCORPORATED
Fort Collins, Colorado

May 2001

SECOR
International Incorporated

May 21, 2001

Mr. Mike Stahl
Phillips Alaska, Inc.
700 G Street
Anchorage, AK 99510-0360

Re: *Nuiqsut Ambient Air Quality Monitoring Program Annual Data Report April 2000 Through March 2001*

Dear Mike,

Enclosed for your review and distribution are ten copies of the *Nuiqsut Ambient Air Quality Monitoring Program Annual Data Report: April 2000 Through March 2001*. We expect that copies of the report will be distributed as follows:

- six copies to the North Slope Borough (no data diskettes),
- one copy to the village of Nuiqsut (no data diskette),
- one copy to the ADEC (with data diskette), and
- two copies for PAI's records (with data diskettes).

Please contact either me or Sims Duggins via phone at (970) 226-4040 or via e-mail (pmiller@secor.com or sduggins@secor.com) if you have any questions or comments regarding this report or any other aspect of the project. We appreciate the opportunity to assist you with this project.

Sincerely,
SECOR ***International Incorporated***

Peter P. Miller II, CCM
Project Manager

PPM/

ref: 012.11311.007
enc: as stated

EXECUTIVE SUMMARY

This report summarizes the second year of data collected at the Nuiqsut Ambient Air Quality Monitoring Station from April 1, 2000 through March 31, 2001. The monitoring station is operated by Phillips Alaska, Inc. (PAI) with the assistance of SECOR International Incorporated (SECOR). The ambient monitoring program was established to address air quality concerns raised by the village of Nuiqsut and the North Slope Borough. The project monitoring plan (SECOR 2000) fully describes the protocols used to collect dispersion meteorology and ambient air quality data which meet the quality assurance and data recovery requirements of the United States Environmental Protection Agency (EPA) Prevention of Significant Deterioration (PSD) program as administered by the Alaska Department of Environmental Conservation (ADEC) and other specific ADEC quality assurance requirements.

Though the program is primarily designed to characterize ambient air quality at Nuiqsut, it also fulfills permit requirements imposed on PAI by ADEC as described in Condition IV(C) of the Alpine Development Project construction permit No. 0073-AC060. Simply stated, the permit requires PAI to collect at least one year of ambient NO_x, SO_2, PM_{10}, and dispersion meteorology data at Nuiqsut. The end of the month of November 2000 marked the successful collection of the first complete year of ambient data at Nuiqsut.

The monitoring station is instrumented and equipped to continuously measure the following parameters:

- nitrogen oxides (NO, NO_2, and NO_x),
- sulfur dioxide (SO_2),
- inhalable particulate matter less than 10 μm in diameter (PM_{10}),
- 10-meter wind speed, wind direction, and wind direction standard deviation (σ_θ), and
- 2-meter ambient temperature.

Official data collection began on April 9, 1999 for all parameters except PM_{10}, which began on April 25, 1999.

On July 14, 2000 the monitoring program was expanded to include measurement of PM_{10} using a Partisol sequential air sampler. This sampler is designated as a Federal Reference Method (FRM) for measuring ambient PM_{10} concentrations. A draft addendum to the project monitoring plan, which describes the purpose of the additional particulate monitoring as well as proposed data management and quality assurance procedures, was submitted to ADEC for review and comment in June 2000 (SECOR 2000b). A final addendum to the project monitoring plan addressing all of the ADEC concerns was submitted to the ADEC in January 2001 (SECOR 2001). ADEC review and approval of the final addendum is pending.

Air quality data recovery exceeded project goals for all quarters except the first quarter of 2001. Meteorological data recovery exceeded project goals for all months except January 2001. Data recovery was particularly affected by the following events:

- Freezing precipitation in January 2001.
- An extreme blowing snow event in February 2001.
- A degraded mirror assembly in the SO_2 analyzer in March 2001.

Equivalent National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS) have been established for NO_2, SO_2, and PM_{10}. These standards represent thresholds above which risk to public health and welfare becomes an issue. The term AAAQS is used to refer to both the AAAQS and NAAQS since they are identical.

Monitored NO_2, SO_2, and PM_{10} concentrations were well below the AAAQS for the reporting period. Figure 1 and Tables 1 and 2 provide summaries of the ambient air quality data collected during the monitoring year compared to the appropriate AAAQS. As shown in these figures and tables, measured concentrations of all monitored pollutants were well below the applicable AAAQS.

The data show that the annual average NO_2 concentration was just above instrument detection, and well below applicable AAAQS. Summer seasonal averages were lower than winter seasonal averages as a result of increases in local NO_2 producing activities during the winter. The highest impacts were measured when winds transport air from the village to the monitoring site.

Annual SO_2 data show that there was no single near-field or far-field source of measurable SO_2 identified in the data collected, which indicates that measured concentrations are representative of a regional background signature, consistent with the rural environment of the site.

Despite some high daily impacts that occurred during the summer, the annual average PM_{10} concentration was low compared to the AAAQS. In general, the data collected this year again show that the airshed is very clean and the particulate that is present is a result of naturally

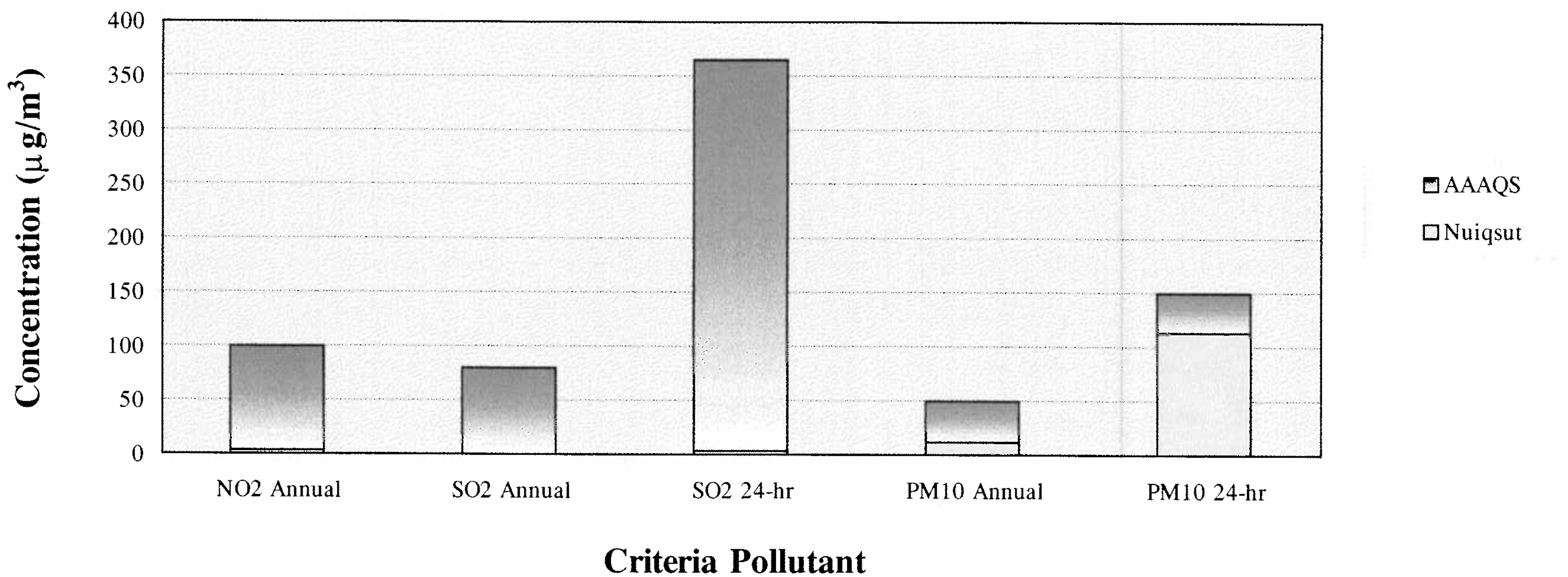


FIGURE 1: SUMMARY OF AMBIENT AIR QUALITY DATA APRIL 2000 THROUGH MARCH 2001

TABLE 1

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
MEASURED GASEOUS POLLUTANT CONCENTRATIONS COMPARED TO ALASKA AMBIENT AIR QUALITY STANDARDS
APRIL 2000 THROUGH MARCH 2001

Pollutant	Averaging Period	Maximum Period Average Concentration (ppm)	AAAQS (ppm)	Percent of AAAQS
NO_2	Annual	0.003[1]	0.053	5.7
SO_2	3-hour	0.003	0.500	0.6
	24-hour	0.001	0.140	0.7
	Annual	0.000[1]	0.030	0.0

[1] Average concentration for the period April 1, 2000 through March 31, 2001.

TABLE 2

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM MEASURED PARTICULATE CONCENTRATIONS COMPARED TO ALASKA AMBIENT AIR QUALITY STANDARDS APRIL 2000 THROUGH MARCH 2001

Pollutant	Averaging Period	Maximum Period Average Concentration[1] (μg/m³)	AAAQS (μg/m³)	Percent of AAAQS
PM_{10}	24-hour[2]	113.4	150	75.6
	24-hour[3]	83.2	150	26.7
	Annual	8.4	50	16.8

[1] Standard conditions
[2] Maximum 24-hour average concentration
[3] Second highest 24-hour average concentration

occurring wind blown fugitive dust from exposed areas local to the monitoring site. Exposed areas identified this monitoring year were the exposed bank of the Nechelik channel east of the station, local construction activities east and south of the station, and to a much lesser degree, dirt roads within the village. When fugitive dust from these sources is not present (i.e., during winter), hourly concentrations are at or below the instrument detection limit.

At the time this report was written, Partisol data were available through February 12 only. An objective comparison between data collected with the Partisol monitor and the TEOM monitor showed the Partisol data systematically biased lower than the TEOM data up through the January 25, 2001 sample. Samples analyzed since that time have shown no bias. It is assumed that the bias has been corrected by improving filter shipping procedures starting with the January 31, 2001 sample. The improved procedures have apparently corrected the mass loss problem observed to occur during shipping. More samples need to be analyzed to know for sure if the bias has been corrected, but the revised procedures appear to have a positive affect.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Background/History

On January 31, 2001, Phillips Alaska, Inc. (PAI) was issued a construction permit (Permit #0073-AC060) to establish an oil and gas exploration and production complex approximately 14 kilometers (km) north of Nuiqsut on the North Slope of Alaska. The project, called the Alpine Development Project, consists of a main site which includes a production facility, an operating camp, and a temporary drilling operation, and a second drilling site approximately 5 km to the west of the main production facility.

In anticipation of the proposed Alpine Development Project, representatives of Nuiqsut expressed an interest in characterizing the baseline ambient air quality conditions in Nuiqsut before and after the Alpine Development Project. In response to citizen concerns, PAI offered direct assistance to implement the Nuiqsut Ambient Air Quality Monitoring Program in cooperation with the Alaska Department of Environmental Conservation (ADEC), the North Slope Borough, and Nuiqsut. The spirit of this commitment is to better understand local ambient air quality in Nuiqsut. The spatial relation between the major North Slope oil fields and Nuiqsut is shown in Figure 1-1.

Though the program is primarily designed to characterize ambient air quality at Nuiqsut, it also fulfills permit requirements imposed on PAI by ADEC as described in Condition IV(C) of the Alpine Development Project Construction Permit No. 0073-AC060. Simply stated, the permit requires PAI to collect at least one year of ambient NO_x, SO_2, PM_{10}, and dispersion meteorology data at Nuiqsut. The end of the month of November 2000 marked the successful collection of the first complete year of ambient data at Nuiqsut. On March 27, 2001, PAI informed ADEC by letter (PAI 2001) that the ambient monitoring requirement contained in the Alpine construction permit had been met.

To address citizen concerns and fulfill the permit requirements, PAI retained the services of SECOR International Incorporated (SECOR) to implement the Nuiqsut Ambient Air Quality Monitoring Program. The program consists of a single ambient air quality and dispersion meteorology monitoring station within Nuiqsut, with data analysis and support provided from SECOR's Fort Collins, Colorado office with the aid of locally hired on-site technical support. The station was installed in the spring of 1999, and brought online in two phases: continuous

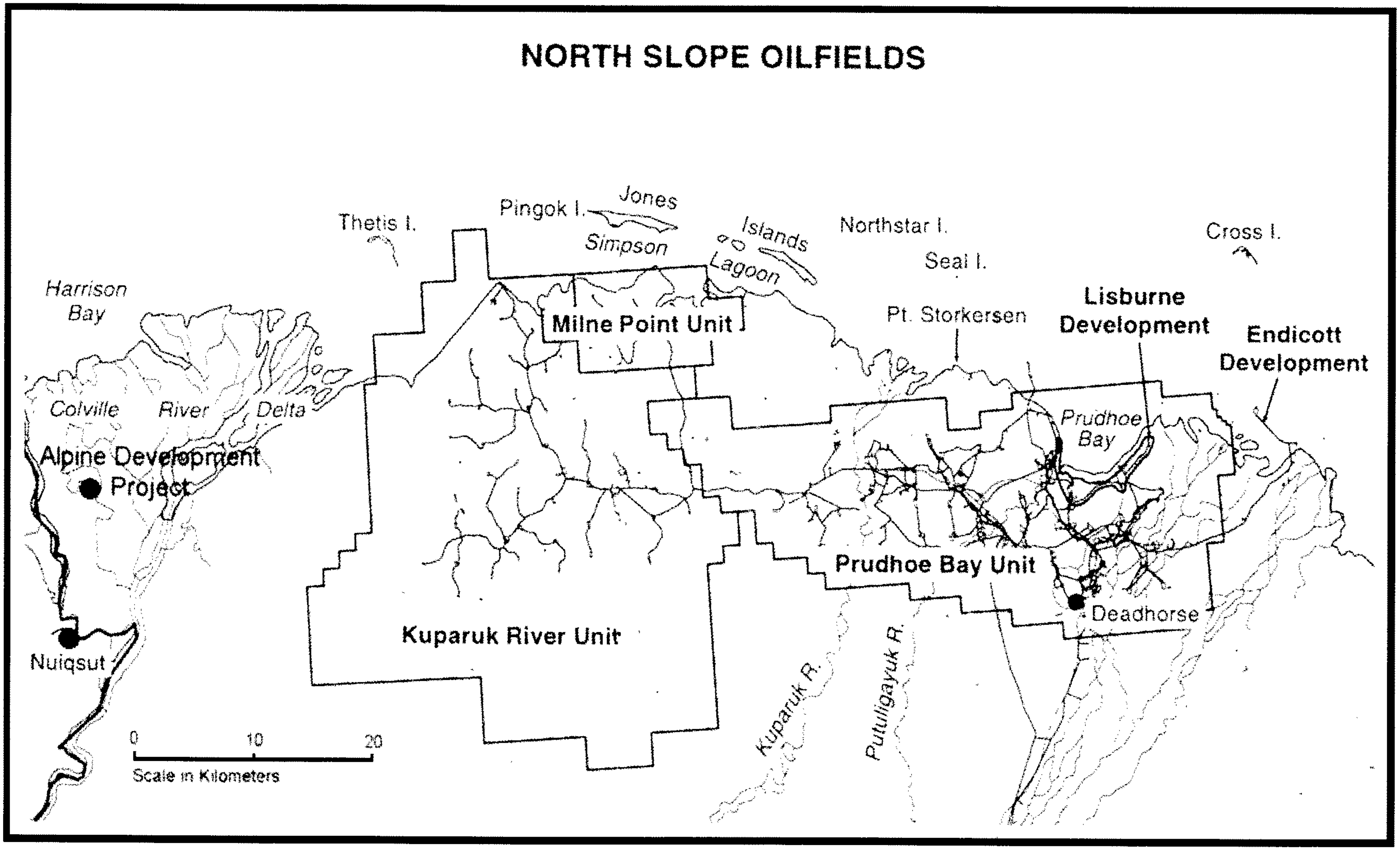


FIGURE 1-1: LOCATION OF REGIONAL NORTH SLOPE OIL FIELDS RELATIVE TO NUIQSUT

meteorology, ambient NO_x, and ambient SO_2 collection began on April 9, 1999, while ambient PM_{10} sampling began on April 25, 1999.

On July 14, 2000 the monitoring program was expanded to include measurement of PM_{10} using a Partisol sequential air sampler. This sampler is designated as a Federal Reference Method (FRM) for measuring ambient PM_{10} concentrations. A draft addendum to the project monitoring plan, which describes the purpose of the additional particulate monitoring as well as proposed data management and quality assurance procedures, was submitted to ADEC for review and comment in June 2000 (SECOR 2000b). A final addendum to the project monitoring plan was submitted to the ADEC in January 2001 (SECOR 2001).

1.2 Project Implementation

Consistent with the goals of the Nuiqsut Ambient Air Quality Monitoring Program, the specific technical objectives of the program are to:

- document current baseline air quality conditions in Nuiqsut prior to operation of the Alpine complex,
- document air quality conditions after the Alpine facility becomes operational, and
- meet the ambient air quality and meteorological monitoring requirements set forth in the Alpine Development Project Construction Permit No. 0073-AC060.

To meet these objectives, the air quality monitoring station is instrumented and equipped to continuously measure the following parameters:

- nitrogen oxides (NO, NO_2, and NO_x),
- sulfur dioxide (SO_2),
- inhalable particulate matter less than 10 μm in diameter (PM_{10}),
- 10-meter wind speed, wind direction, and wind direction standard deviation (σ_θ), and
- 2-meter ambient temperature.

Table 1-1 shows the methods and instruments used to measure these parameters.

1.2.1 Nuiqsut Station Location

The station has been sited so that impacts due to oil and gas operations to the north and east can be distinguished from near-field impacts due to Nuiqsut located to the south and west. The

TABLE 1-1

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM MEASUREMENT METHODS

Parameter	Suggested Manufacturer/Model	Sample Frequency	Averaging Period	Measurement Range	Lower Detection Limit	Method
Nitrogen oxides (NO_x, NO_2, NO)	Thermo Environmental Instruments (TECO) Model 42C	Continuous	1-hour	0-500ppb	0.5 ppb	Chemiluminescence (EPA reference method RFNA-1289-074)
Sulfur Dioxide (SO_2)	Thermo Environmental Instruments (TECO) Model 43C	Continuous	1-hour	0 – 500 ppb	2 ppb	Pulsed Fluorescence (EPA equivalent method EQSA-0486-060)
Particulate Matter (PM_{10})	Rupprecht & Patashnick (R&P) Model 1400a TEOM PM_{10}	Continuous	1-hour	<5 μg/m^3 to several g/m^3	<5 μg/m^3	Tapered Element Oscillating Microbalance (EPA equivalent method EQPM-1090-079)
Particulate Matter (PM_{10})	Rupprecht & Patashnick (R&P) Model 2025 Sequential Air Sampler	Daily[1]	24-hour	<5 μg/m3 to several g/m^3	<5 μg/m^3	Gravimetric (EPA reference method RFPS-1298-127)
Wind Speed (10 m)	R.M. Young Wind Monitor AQ - 05305	Continuous	1-hour	0 to 50 m/s	0.2 m/s	Propeller/Magnetically Induced AC
Wind Direction (10 m)	R.M. Young Wind Monitor AQ - 05305	Continuous	1-hour	0 to 360°	N/A	Vane/Potentiometer
Sigma-Theta (σ_θ) (10 m)	Computed by Data Logger	Continuous	1-hour	0 to 100°	N/A	Single Pass Estimator of Wind Direction Standard Deviation Yamartino (1984)
Temperature (2 m)	R.M. Young 41342	Continuous	1-hour	-50°C to 50°C	N/A	Motor aspirated/shielded platinum RTD

[1] Daily samples from June-October; every 6-day samples from November-May

location of the air quality monitoring station relative to Nuiqsut and major oil and gas operations is shown in Figure 1-2. A detailed site specific map is included in Figure 1-3 to show the site relative to Nuiqsut and near-field sources. This map is augmented by an aerial photo shown in Figure 1-4. This photo was taken in August 2000.

1.2.2 Project Monitoring Plan

The original monitoring plan for this project (SECOR 1999) was submitted to ADEC in February 1999 and was approved by ADEC with comments (ADEC 1999) on April 7, 1999. A revised monitoring plan (hereafter referred to as the Monitoring Plan) was approved by ADEC in April 2000 (SECOR 2000a). The revised Monitoring Plan incorporates changes and additions recommended by ADEC. The Monitoring Plan describes the protocols used to collect dispersion meteorology and ambient air quality data which meet the quality assurance (QA) and data recovery requirements of the EPA Prevention of Significant Deterioration (PSD) program as administered by the ADEC and other specific ADEC QA requirements. A draft addendum to the Monitoring Plan was submitted to ADEC on June 15, 2000 (SECOR 2000b) to include a collocated Federal Reference Method (FRM) particulate monitor at the station. A final addendum was submitted to the ADEC in January 2001 (SECOR 2001). ADEC review and approval of the final addendum is pending. Guideline documents cited by the project Monitoring Plan are:

- *Alaska Quality Assurance Manual for Ambient Air Quality Monitoring* (ADEC 1996),
- *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* (EPA 1987),
- *On-Site Meteorological Program Guidance for Regulatory Modeling Applications (Revised August 1995)* (EPA 1987a),
- *Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Specific Methods (Interim Edition)* (EPA 1994),
- *Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Specific Methods (Interim Edition) Section 2.10: Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere (Dichotomous Sampler Method)* (EPA 1990),

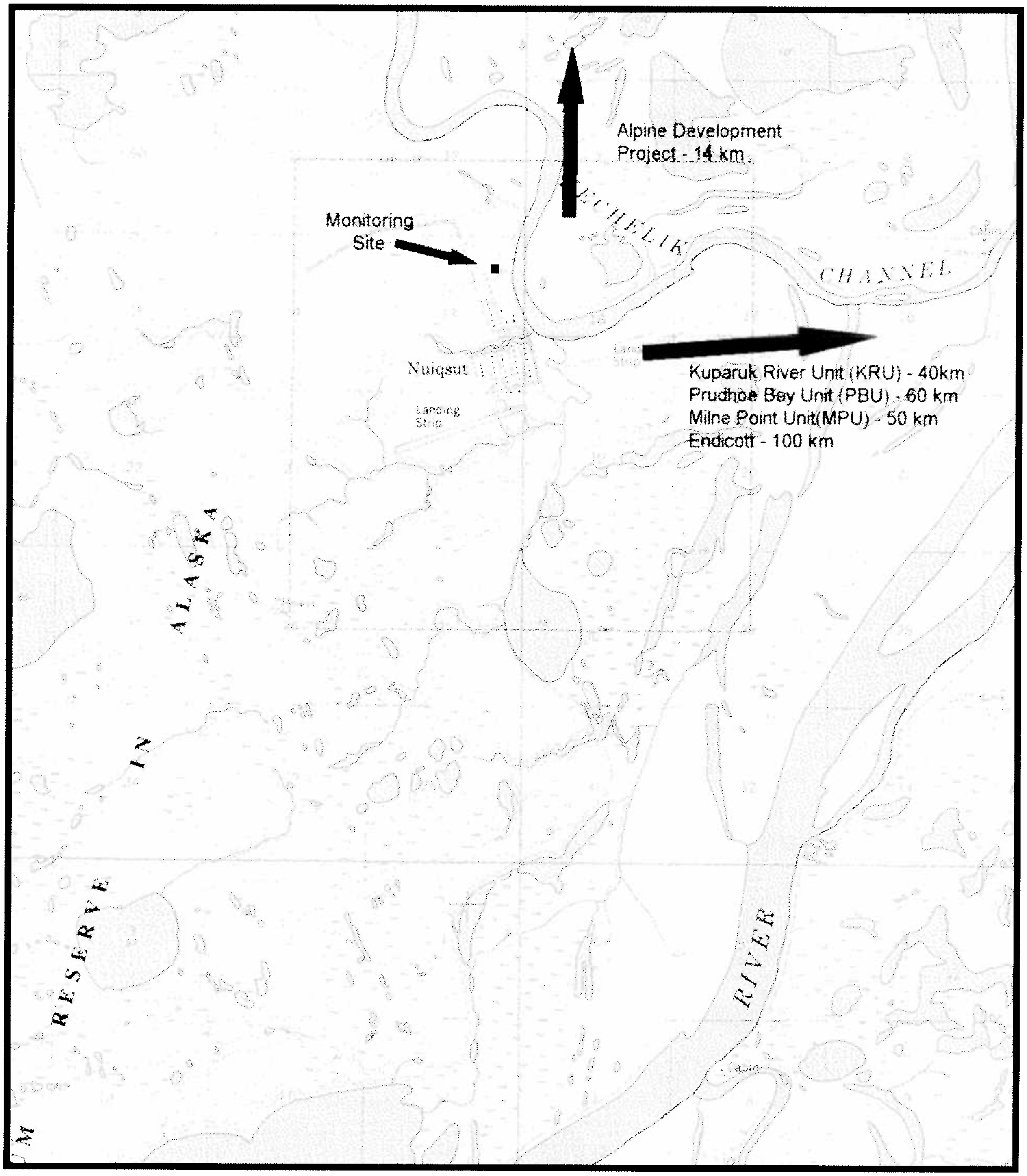


FIGURE 1-2: REGIONAL MAP

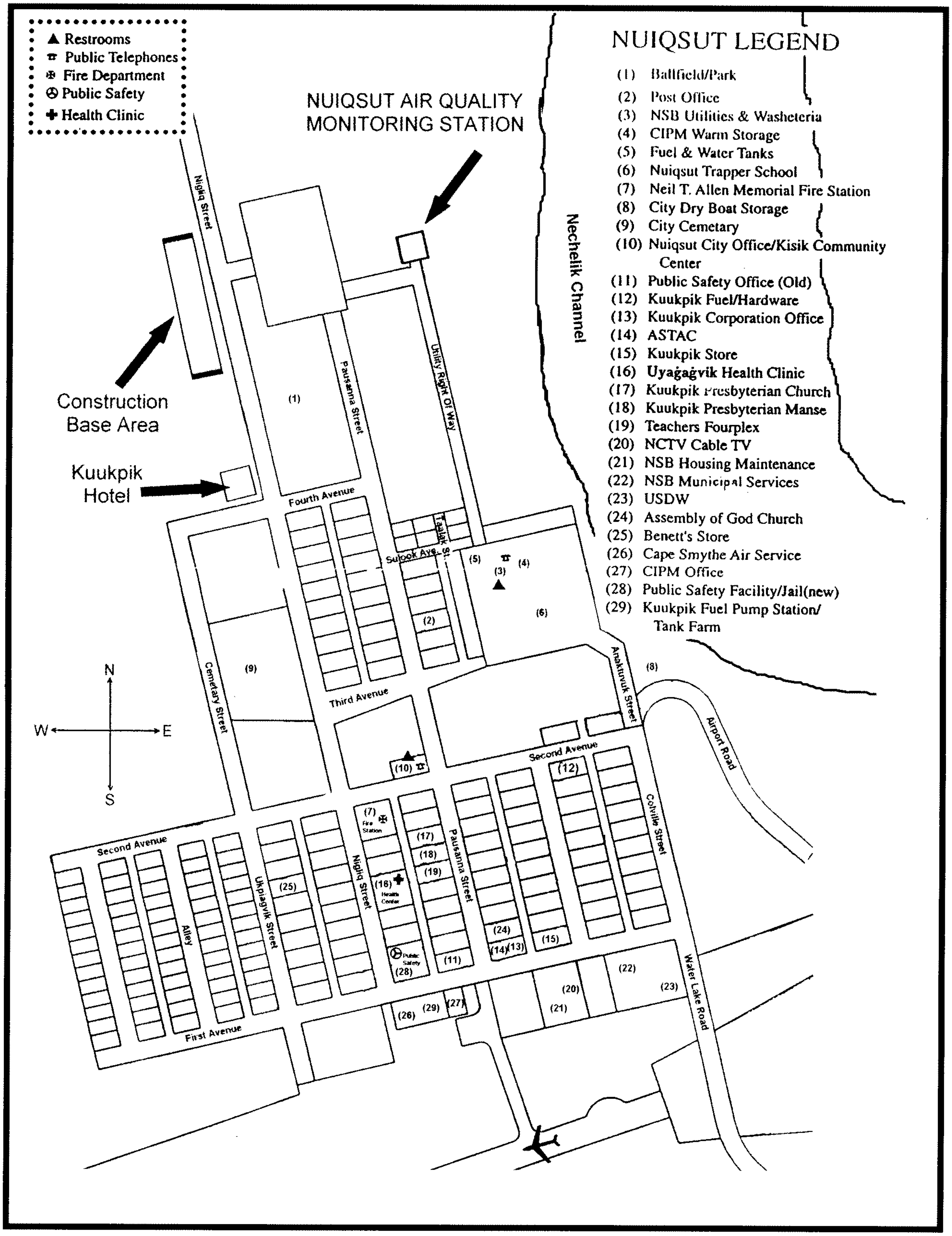


FIGURE 1-3: LOCAL MAP

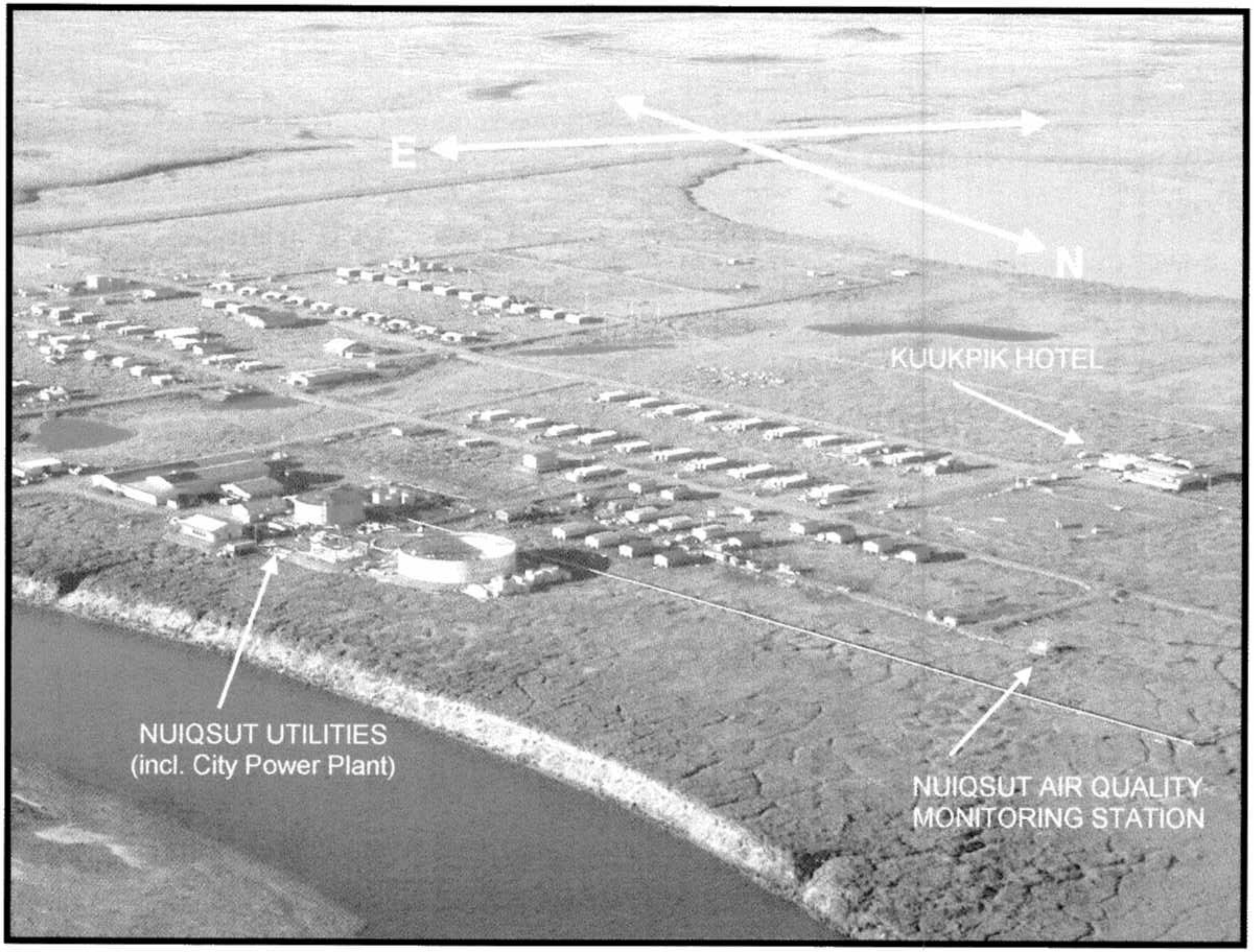


FIGURE 1-4: AERIAL PHOTO OF NUIQSUT

- *Quality Assurance Handbook for Air Pollution Measurement Systems. Volume IV: Meteorological Measurements* (EPA 1995), and

- Code of Federal Regulations 40 CFR Part 58–Ambient Air Quality Surveillance:

  Appendix A - *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*
  Appendix B - *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*
  Appendix C - *Ambient Air Quality Monitoring Methodology*
  Appendix E - *Probe Siting Criteria for Ambient Air Quality Monitoring*

1.3 Monitoring Report Overview

The report summarizes and documents the operation of the monitoring station and data collected during the second year of monitoring conducted at the village of Nuiqsut, defined by the 12-month monitoring period from April 1, 2000 through March 31, 2001, with the exception of data collected by Partisol Sampler. At the time of this report Partisol data were available through February 12, 2001 only. The report has been subdivided into several chapters. Chapter 2 discusses the performance of the monitoring network. Chapter 3 summarizes the air quality and meteorological data collected during the period. Appendix A contains the various statistical formulae used to determine data precision, accuracy, and recovery statistics. Appendix B contains a description of blowing snow events which have caused a significant loss of TEOM measured particulate data during the reporting period. Appendix C contains additional data related to particulate concentration accuracy and precision as reported by the Partisol sampler. Appendix D summarizes the contents of the diskette containing validated hourly data for the reporting period.

2.0 STATION PERFORMANCE SUMMARY

This chapter presents a summary of events significant to station performance and contributing to data completeness, precision, and accuracy. Specific goals for data completeness, precision, and accuracy established in the Monitoring Plan are listed in Tables 2-1 through 2-5 for reference. Data recovery for most parameters exceeded project goals. The exceptions were wind speed, wind direction, and σ_θ in January 2001, PM_{10} as measured by the TEOM in February and March 2001, and SO_2 in March 2001. These exceptions are discussed in detail in Section 2.2 and in the appropriate quarterly reports. Data accuracy and precision goals for all parameters were exceeded during the reporting period.

2.1 Significant Project Events

Table 2-6 summarizes the significant project events for the monitoring period. In addition to these significant events, data were lost during routine maintenance visits, power failures, and due to extreme blowing snow events which affected wind speed, wind direction, σ_θ, and PM_{10} data recovery. Since extreme blowing snow events were responsible for a considerable amount of lost TEOM data, a detailed discussion of these events and their effect on the monitor is included in Appendix B.

2.2 Missing, Invalid, and Adjusted Data

Several routine adjustments have been made to the air quality data during the monitoring year to increase the quality of the data. These data processing procedures are discussed below, and are detailed in Appendix A and in the Monitoring Plan.

- All hourly SO_2 and NO_x data are adjusted according to the procedure outlined in EPA (1998) and described in Appendix A. The adjustment procedure corrects data based on daily Level 1 zero/span and/or calibration results to eliminate instrument zero/span drift as completely as possible from the data. Without adjustment, zero or span drift of the instrumentation could be misinterpreted as low-level concentrations of NO_x or SO_2.

- All hourly SO_2 and NO_X data less than 0.000 ppm but greater than or equal to -0.001 ppm have been set to 0.000 ppm to conservatively remove negative biases from the data set that may remain after instrument drift corrections are applied. Values less than -0.001 ppm are also adjusted to 0.000 ppm but only after investigating for correctness.

TABLE 2-1

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM MINIMUM PRECISION, ACCURACY, AND COMPLETENESS GOALS METEOROLOGY DATA

Parameter	Accuracy [1]	Completeness
Horizontal Wind Speed	± (0.2 m/s + 5% of observed)	90% per month
Horizontal Wind Direction	± 5 compass degrees (total system accuracy) ± 3 degrees relative to the sensor mount (sensor linearity)	90% per month
Temperature	± 0.5°C	90% per month

[1] Based on calibrations and independent quality assurance performance audits.

TABLE 2-2

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM MINIMUM PRECISION, ACCURACY, AND COMPLETENESS GOALS CONTINUOUS AIR QUALITY ANALYZER DATA

Parameter	Precision [1]	Accuracy [2]	Completeness
Nitrogen Oxides and Sulfur Dioxide	±15% of input value Quarterly reported 95% probability limits less than ±15%	±15% of input value Slope ≥ 0.85 and ≤ 1.15 Intercept ≤ ±3% of FS $R^2 > 0.995$ NO_2 converter efficiency > 96%	80% per calendar quarter

1 Based on precision checks.
2 Based on calibrations and independent quality assurance performance audits.

TABLE 2-3

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
MINIMUM PRECISION, ACCURACY, AND COMPLETENESS GOALS
CONTINUOUS PARTICULATE MONITORING DATA

Parameter	Precision [1]	Accuracy [2]	Completeness
PM_{10}	Main and auxiliary flow rate within ±2% of set points as indicated on monitor display	Main and auxiliary flow rate within ±2% of set points as indicated on monitor display Main (auxiliary) flow rate within ±7% of 3.0 l/min (13.67 l/min) as indicated by reference flow device Total flow rate within ±10% of 16.67 l/min as indicated by reference flow device Mass transducer calibration constant within ±2.5% of factory-set value Temperature within ±1.0°C of actual Pressure within ±1.5% of actual	80% per calendar quarter

1 Based on precision checks.
2 Based on calibrations and independent quality assurance performance audits.

TABLE 2-4

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM MINIMUM PRECISION, ACCURACY, AND COMPLETENESS GOALS 24-HOUR INTEGRATED PARTICULATE MONITORING DATA

Parameter	Precision [1]	Accuracy [2]	Completeness
PM_{10}	Flow rate within ±5% of set point as indicated on monitor display	Flow rate within ±5% as indicated on monitor display Flow rate within ±10% of 16.7 l/min as indicated by reference flow device Time within ±5 minutes of actual time Ambient temperature within ±2.0°C of actual Ambient pressure within ±10 mm Hg of actual	80% per calendar quarter

[1] Based on precision checks.
[2] Based on calibrations and independent quality assurance performance audits.

TABLE 2-5

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
MINIMUM PRECISION AND ACCURACY GOALS
ANALYTICAL LABORATORY

Parameter	Precision	Accuracy
Filter mass analysis	±20 μg (exposed and unexposed duplicates)	±10 μg (laboratory balance)
Field and laboratory blanks	±20 μg	
Filter conditioning temperature	15°C ≤ T ≤ 30°C (±3°C)	(±1°C)
Filter conditioning relative humidity	20% ≤ RH ≤ 45% (±5%)	(±5%)

TABLE 2-6

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
SIGNIFICANT PROJECT EVENTS
APRIL 1, 2000 THROUGH MARCH 31, 2001

Date	Event/Comment
May 2, 2000 through May 3, 2000	Second quarter 2000 calibration of the air quality and meteorological monitoring systems. The calibration showed all systems to be operating within acceptable limits.
May 31, 2000 through June 2, 2000	Second quarter 2000 independent quality assurance audit of the air quality and meteorological monitoring systems. The audit showed all systems to be operating within acceptable limits.
July 14, 2000	Partisol Sequential Air Sampler installed and calibrated. First sample collected July 16, 2000.
July 15, 2000	Third quarter 2000 calibration of the air quality monitoring system. The calibration showed all analyzers to be operating within acceptable limits.
July 21, 2000 through August 2, 2000	All NO_x data corrected for an approximate 17% span drift caused by a failing NO_x analyzer pump.
August 2, 2000 through August 21, 2000	All NOx data corrected for an approximate 17% span drift caused by a poor post- repair analyzer adjustment.
August 28, 2000	Third quarter 2000 independent quality assurance audit of the air quality monitoring system. The audit showed all analyzers to be operating within acceptable limits.
October 10, 2000 through October 11, 2000	Fourth quarter 2000 calibration of the air quality and meteorological monitoring systems calibration. The calibration showed all systems to be operating within acceptable limits.
November 15, 2000 through November 17, 2000	Fourth quarter 2000 independent quality assurance audit of the air quality and meteorological monitoring systems. The audit showed all systems to be operating within acceptable limits.
December 1, 2000 through January 11, 2001 (0300 each day)	Invalid SO_2 data. Calibration gas contaminated the measurement made during the hour containing the last half of the nightly Level I calibration. Ambient concentration measurements at other times were not affected. The analyzer pump was re-built on January 11, and the problem was corrected.

[1]All times are Alaska Standard Time and refer to the hour ending a one-hour block.

TABLE 2-6 (continued)

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
SIGNIFICANT PROJECT EVENTS
APRIL 1, 2000 THROUGH MARCH 31, 2001

Date	Event/Comment
January 31, 2001 through February 1, 2001	First quarter 2001 calibration of the air quality monitoring system. The calibration showed all analyzers to be operating within acceptable limits.
February 22, 2001	First quarter 2001 independent quality assurance audit of the air quality monitoring system. The audit showed all analyzers to be operating within acceptable limits.
February 28, 2001 through March 31, 2001	SO_2 data invalid due to analyzer failure.

[1]All times are Alaska Standard Time and refer to the hour ending a one-hour block.

On occasion, reported hourly average PM_{10} values are slightly less than zero (usually between 0 $\mu g/m^3$ and -5 $\mu g/m^3$). Negative PM_{10} concentrations usually occur in conjunction with precipitation events or abrupt changes in the weather. As described in Appendix A-1 of this report, and Appendix A-1 of the Monitoring Plan, measured PM_{10} concentrations greater than -10 $\mu g/m^3$ are considered valid unless there is a documented reason to invalidate the data. Measured concentrations of -10 $\mu g/m^3$ or less are considered invalid.

The following sub-sections summarize non-routine data losses for each specific portion of the monitoring network. Additional data losses include those due to routine network operation and maintenance, calibrations, audits, and precision checks. Additional details pertaining to each event are included in the quarterly data reports.

2.2.1 NO_x and SO_2 Data

On August 1, 2000 the NO_x analyzer pump failed. It was promptly repaired on August 2, 2000 and the analyzer returned to normal operation. As a precursor to the failure, on July 21, the analyzer daily Level I spans dropped, and remained 17 percent low. Several hours were invalidated during the period from July 21 through the pump failure while the on-site technician diagnosed the problem causing the span drift. The routine adjustment procedures documented in Section 2.2 removed the span drift from the data for the aforementioned period. Though the analyzer was properly repaired on August 2, 2000, it was left in a state with spans consistently 17 percent high until August 21, 2000 when the instrument was adjusted and a calibration was done by the on-site technician to verify instrument operation. During the period following the pump repair, the data were adjusted for the span drift by the procedure described in Section 2.2.

During the month of December and the first part of January, SO_2 concentrations measured between 0200 and 0300 were invalidated because they were contaminated with calibration gas input to the analyzer for the daily Level I zero/span check. The contamination resulted from low analyzer sample flow, which was corrected on January 11, 2000 by rebuilding the sample pump.

Premature degradation of the surface of the mirrors comprising the mirror assembly in the SO_2 analyzer caused the analyzer to fail performance limits on February 28, 2001. A replacement analyzer was shipped from SECOR and was installed, calibrated and brought on-line April 13, 2001.

2.2.2 Continuous PM_{10} Data (TEOM)

A total of 1146 hours of continuous PM_{10} data were lost during the winter of 2000-2001 due to what has been labeled extreme blowing snow events. Unlike typical blowing snow events, the extreme events affected the operation of the TEOM particulate monitor and data recovery. Because these events have caused a significant amount of data loss this monitoring year, Appendix B has been included to detail these events and data losses.

Except for the problems associated with extreme blowing snow events, there were no other major losses of PM_{10} data during the monitoring year.

2.2.3 24-Hour Integrated Particulate Data (Partisol)

A total of 119 of 133 scheduled Partisol samples were collected since sampling began on July 16, 2000. Samples were lost due to instrument filter scheduling errors and filters not being loaded into the instrument on time. Except for these minor events, no other losses of Partisol data occurred.

As designated in the monitoring plan, Partisol samples were collected from July 16, 2000 through October 31, 2000 every day. From November 1, 2000 through March 31, 2001 samples were collected every six days on the EPA designated sampling schedule.

At the time of this report, samples collected at the station from February 18, 2001 through March 31, 2001 (7 samples) had been collected but not shipped from Nuiqsut. Since this data is not available for analysis, it has not been included in this report.

2.2.4 Meteorological Data

A total of 260 hours of wind speed data, and 189 hours of wind direction and σ_θ data, were lost because of a frozen sensor.

Losses were high this winter because of the large number of freezing precipitation events (snow, freezing fog, and ground blizzards) that occurred. When the sensor did freeze, the on-site technician responded when possible to free the sensor, but the frequent occurrences of extreme weather coupled with unsafe travel conditions led to unavoidable data losses. There were no other significant losses of meteorological data during the monitoring year.

2.3 Network Data Recovery

Data recovery percentages for each continuous air quality and meteorological parameter have been calculated based on the total number of hours of valid data collected versus the total number of possible hours in the period. Data missing due to routine maintenance, calibrations, quality assurance audits, and data which did not satisfy program criteria for accuracy and quality assurance were considered invalid when calculating data recovery. During the monitoring year, data recovery for all meteorological parameters exceeded the minimum project goal of 90 percent per month for all months except January 2001. Data recovery for all air quality parameters exceeded the minimum goal of 80 percent per calendar quarter for all but the first quarter of 2001.

Table 2-7 provides a summary of monthly data recovery for each parameter.

2.4 Precision Statistics

Precision statistics have been calculated for the NO_x and SO_2 analyzers based on the method outlined by the EPA (1993a) and summarized in Appendix A of this report.

The average percent differences ($\bar{d}_j$) between known input concentrations and the observed analyzer responses for the NO_x and SO_2 analyzers have been calculated along with the standard deviation of the percent differences (S_j), and the upper and lower 95 percent probability limits (U_{95}, L_{95}) based on the total number of precision checks (N) performed during the period. The NO_2, NO, and SO_2 precision results, shown in Table 2-8 and Table A-1 in Appendix A, indicate that the air quality analyzers operated within the tolerances listed in Table 2-2. SO_2 precision statistics do not include days when the analyzer was affected by a faulty sample pump (December 1 through January 11, 2001) because precision data collected during that time was contaminated with calibration zero air.

Precision of the PM_{10} monitors is evaluated each business day by determining whether the main and bypass flow rates are correct to within ±2 percent of the respective set points (±5 percent for the Partisol sampler). This method of determining the monitor precision is recommended as an alternate procedure (EPA 1995a), provided that the flow meter inside the instrument is stable, reliable, and accurate, and that the flow meter is audited with a flow rate transfer standard at least once every six months. All flow checks for the period indicate that the monitors operated within project specifications, and all quarterly calibrations and audits confirm proper operation of the internal flow meters.

2.4.1 Analytical Lab Quality Assurance Results

Duplicate Samples, Field Blanks, and Laboratory Blanks

Measurement precision between successive weights of the same filter (duplicate samples) indicates that laboratory balance performance and procedures do not introduce a data bias. Cumulative laboratory duplicate statistics are listed in Appendix C, Table C-1. Prior to

TABLE 2-7
NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
CONTINUOUS AIR QUALITY AND METEOROLOGICAL
DATA RECOVERY STATISTICS
APRIL 1, 2000 THROUGH MARCH 31, 2001

PARAMETER	APR 2000 (%)	MAY 2000 (%)	JUN 2000 (%)	JUL 2000 (%)	AUG 2000 (%)	SEP 2000 (%)	OCT 2000 (%)	NOV 2000 (%)	DEC 2000 (%)	JAN 2001 (%)	FEB 2001 (%)	MAR 2001 (%)	Q2 2000 (%)	Q3 2000 (%)	Q4 2000 (%)	Q1 2001 (%)	Annual 2000 (%)
Meteorological																	
10-m Wind Speed	100.0	99.5	100.0	100.0	100.0	100.0	96.0	92.8	90.3	86.8	98.7	99.2	99.8	100.0	93.0	94.8	96.9
10-m Wind Direction	100.0	99.5	100.0	100.0	100.0	100.0	96.9	94.0	98.0	86.8	98.7	99.2	99.8	100.0	96.3	94.8	97.7
10-m Sigma-Theta (σ_θ)	100.0	99.5	100.0	100.0	100.0	100.0	96.9	93.9	98.0	86.7	98.7	99.1	99.8	100.0	96.3	94.7	97.7
2-m Temperature	100.0	99.2	98.8	100.0	100.0	100.0	99.6	99.7	100.0	100.0	100.0	100.0	99.3	100.0	99.8	100.0	99.8
Air Quality																	
Nitrogen Dioxide (NO_2)	99.4	94.8	98.2	97.7	95.8	99.4	98.7	98.5	99.5	98.1	97.3	99.5	97.4	97.6	98.9	98.3	98.1
Nitric Oxide (NO)	99.4	94.8	98.2	97.7	95.8	99.4	98.7	98.5	99.5	98.1	97.3	99.5	97.4	97.6	98.9	98.3	98.1
Sulfur Dioxide (SO_2)	99.4	98.0	98.2	97.7	98.9	99.4	98.7	98.6	95.3	96.2	95.8	0.0	98.5	98.7	97.5	63.0	89.5
Particulate (PM_{10}) (TEOM)	100.0	99.3	99.4	99.6	99.6	100.0	99.5	80.7	66.8	83.6	50.0	42.7	99.6	99.7	82.3	59.1	85.3
Particulate (PM_{10}) (Partisol)	na[1]	na[1]	na[1]	100.0	93.5	73.3	100.0	40.0	100.0	100.0	75.0	100.0	na[1]	87.0	92.7	93.3	89.5
Meteorological Only	100.0	99.4	99.7	100.0	100.0	100.0	97.3	95.1	96.6	90.1	99.0	99.4	99.7	100.0	96.4	96.1	98.0
Air Quality Only	99.6	96.7	98.5	98.4	96.7	94.3	99.1	91.9	90.6	94.3	84.8	62.0	98.2	96.5	94.2	80.2	92.5
ALL PARAMETERS	99.8	98.1	99.1	99.1	98.2	96.9	98.3	93.5	93.5	92.2	91.8	80.3	99.0	98.1	95.2	88.0	95.1

1 na= not applicable

TABLE 2-8

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
NO_2, NO, AND SO_2 PRECISION STATISTICS
APRIL 1, 2000 THROUGH MARCH 31, 2001

Analyzer	Number of Precision Checks (N)	Average Percent Difference ($\bar{d}_j$)	Standard Deviation (S_j)	Upper 95% Probability Limit (U_{95})	Lower 95% Probability Limit (L_{95})
NO	60	2.0	5.5	12.8	-8.8
NO_2	57	1.0	5.1	10.9	-8.9
SO_2	49	0.3	2.1	4.3	-3.8

contracting with IML Air Science (IML) to perform gravimetric analysis, 57 percent of the duplicate samples analyzed exceeded the precision goal of 20 μg. Since that time, all duplicate samples have met the minimum precision goal.

Measurement precision of a filter which has been handled exactly like sampled filters, except that it is not sampled (field blank), indicates potential problems with filter handling procedures. Cumulative field blank statistics are listed in Appendix C, Table C-2. In general, field blank statistics have indicated that filter handling procedures caused mass loss. Starting on January 31, 2001 exposed filters were shipped in individual well packed anti-static bags instead of in the filter magazine. Since then statistics have shown a positive change.

Measurement precision of a filter weighed before and after the laboratory conditioning process (laboratory blank) indicates problems with conditioning procedures. Cumulative laboratory blank statistics are listed in Appendix C, Table C-3. Prior to contracting with IML to perform gravimetric analysis, none of the laboratory blanks met the minimum precision goal of 20 μg. Since that time, all duplicate samples have met the minimum precision goal. This indicates that the current procedures are acceptable.

Filter Conditioning Environment

Filter conditioning statistics are listed in Appendix C, Table C-4. These statistics show that generally filters have been equilibrated within the ranges and control tolerances listed in Table 2-5. When ranges and tolerances have not been met, corrective action has been taken by the lab, and the problem was corrected.

2.5 Data Accuracy

The meteorological and ambient air quality monitoring systems are subjected to periodic calibrations and independent quality assurance performance audits. All calibration and audit equipment is documented as traceable to authoritative standards. The purpose of these calibration and audit checks is to challenge the monitoring systems with known inputs and to verify that each instrument response is accurate to within EPA-established tolerances. Consistent with the goals of the project Monitoring Plan, four quarterly calibrations of the air quality monitoring system, and two semi-annual calibrations of the meteorological monitoring system, were performed. In addition to these quality assurance activities performed by SECOR, four quarterly independent performance audits of the air quality monitoring system, two semi-annual independent performance audits of the meteorological monitoring system, one annual independent field systems audit, one systems audit of the data handling, validation, processing, and reporting procedures at the Fort Collins SECOR office and an independent systems audit of IML labs, where Partisol filter gravimetric analysis is conducted, were performed by AMSTech during the period.

Specific calibration and independent quality assurance audit details, including data forms, can be found in the respective quarterly data reports.

3.0 MONITORING NETWORK DATA SUMMARY

This chapter provides a summary and analysis of the air quality and meteorology data collected at the Nuiqsut monitoring station during the reporting period.

It is useful to discuss seasonal trends when analyzing annual data sets. The notion of seasons as it is typically understood at mid-latitudes loses meaning when applied to latitudes as far north as Nuiqsut. The ambiguity in defining seasons is linked to the fact that at high northern latitudes days of 24-hour darkness rapidly give way to days of 24-hour daylight, and freezing temperatures can be experienced during any month of the year. Instead of defining four seasons, the Barrow National Weather Service office suggests that this area experiences two seasons, winter and summer, separated by a month of rapid transition in May and October. Therefore, for the remainder of this report, winter is defined as November through April, and summer as June through September.

3.1 Air Quality Data

The criteria pollutants monitored as part of the Nuiqsut Ambient Air Quality Monitoring Program are nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and respirable particulate less than 10 μm in diameter (PM_{10}). Criteria pollutants are those air pollutants for which the ADEC has established Alaska Ambient Air Quality Standards (AAAQS). These standards provide a threshold above which risk to public health and welfare may become an issue. The applicable AAAQS, along with ambient concentrations measured at the site, are presented in Table 3-1 and summarized by pollutant below.

3.1.1 Nitrogen Dioxide

Table 3-1 and Figures 3-1 through 3-4 present summaries of the NO_2 data collected during the monitoring year. During the monitoring year, nearly one-quarter of the hourly measurements were below instrument detection. The annual average NO_2 concentration was 0.003 ppm, compared to the annual NO_2 AAAQS of 0.053 ppm. The annual average NO_2 concentration is just above instrument detection and only 5.7 percent of the NO_2 AAAQS.

Winter seasonal averages were higher than summer seasonal averages, as a result of increases in local NO_2-producing activities during the winter. Highest concentrations were measured when winds transport air from the village toward the monitoring site. This trend is a result of the

TABLE 3-1

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM
MEASURED NO_2, SO_2, AND PM_{10} CONCENTRATIONS APRIL 1, 2000 THROUGH MARCH 31, 2001

Monitoring Period	Period Average NO_2 Concentration (ppm)	Maximum 3-Hour SO_2 Concentration (ppm)	Maximum 24-Hour SO_2 Concentration (ppm)	Period Average SO_2 Concentration (ppm)	Maximum 24-Hour PM_{10} Concentration[2] ($\mu g/m^3$)		Period Average PM_{10} Concentration[2] ($\mu g/m^3$)	
					Standard	Actual	Standard	Actual
Apr-00	0.003	0.003	0.001	0.000	40.0	49.0	11.9	14.1
May-00	0.001	0.000	0.000	0.000	15.2	16.6	7.4	8.4
Jun-00	0.001	0.000	0.000	0.000	26.6	27.2	9.4	9.8
Jul-00	0.001	0.000	0.000	0.000	73.8	75.0	11.4	11.9
Aug-00	0.003	0.001	0.001	0.000	83.2	85.4	13.4	14.1
Sep-00	0.003	0.000	0.000	0.000	113.4	126.2	11.7	12.7
Oct-00	0.003	0.001	0.000	0.000	8.1	9.1	4.4	4.9
Nov-00	0.005	0.001	0.000	0.000	10.8	12.5	4.9	5.8
Dec-00	0.002	0.000	0.000	0.000	22.2	25.8	5.5	6.6
Jan-01	0.004	0.000	0.000	0.000	9.4	10.9	4.5	5.4
Feb-01	0.006	0.001	0.000	0.000	11.8	6.8	13.3	7.9
Mar-01	0.003	-	-	-	2.8	3.5	2.4	3.0
Reporting Period	0.003	0.003	0.001	0.000	113.4	126.2	8.4	8.7
AAAQS	**0.053** [1]	**0.5**	**0.14**	**0.03** [1]	**150**	**n/a**	**50** [1]	**n/a**

[1] Annual average
[2] Based on continuous particulate (TEOM) data

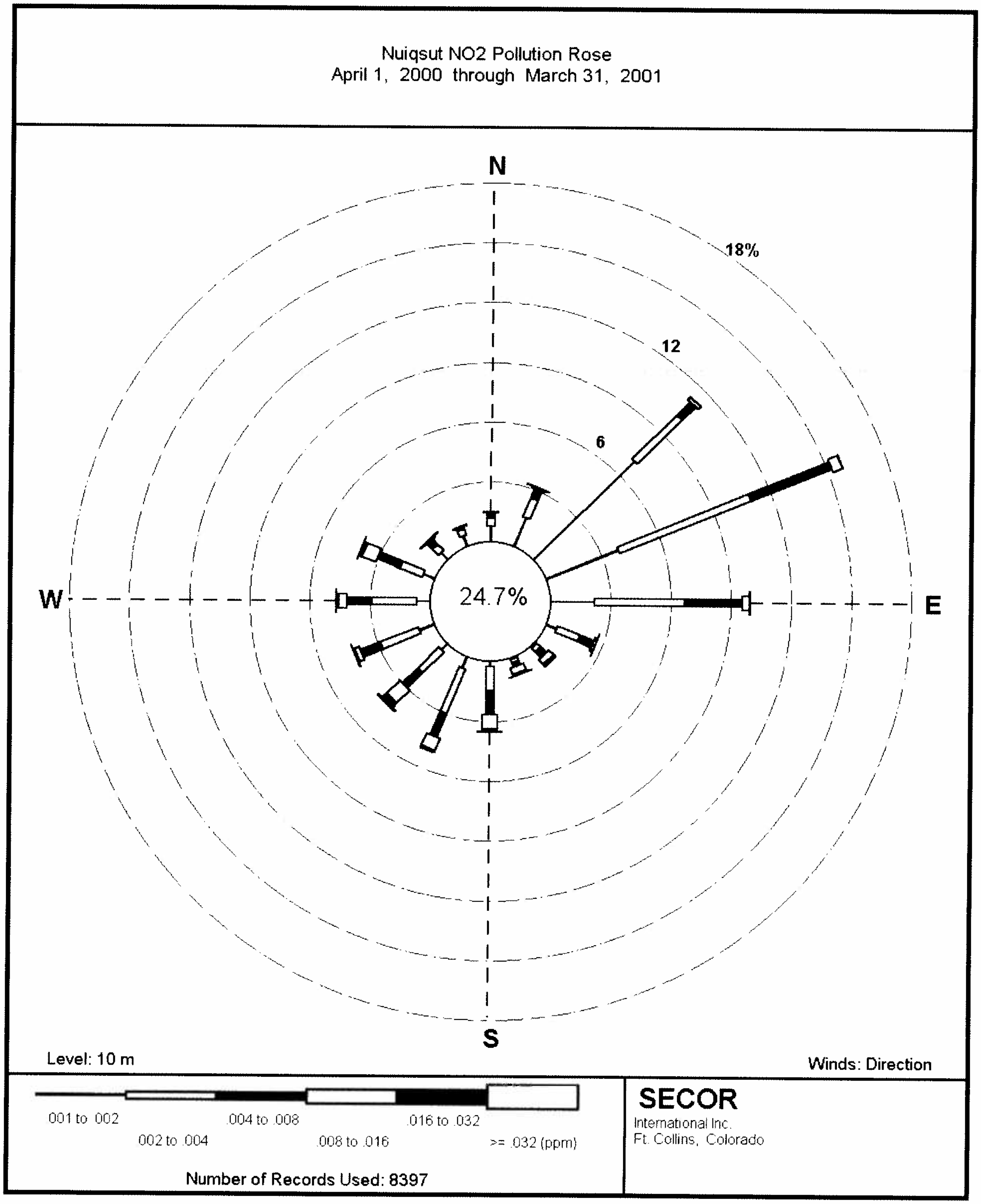


FIGURE 3-1: NO_2 FREQUENCY ANALYSIS BY WIND DIRECTION

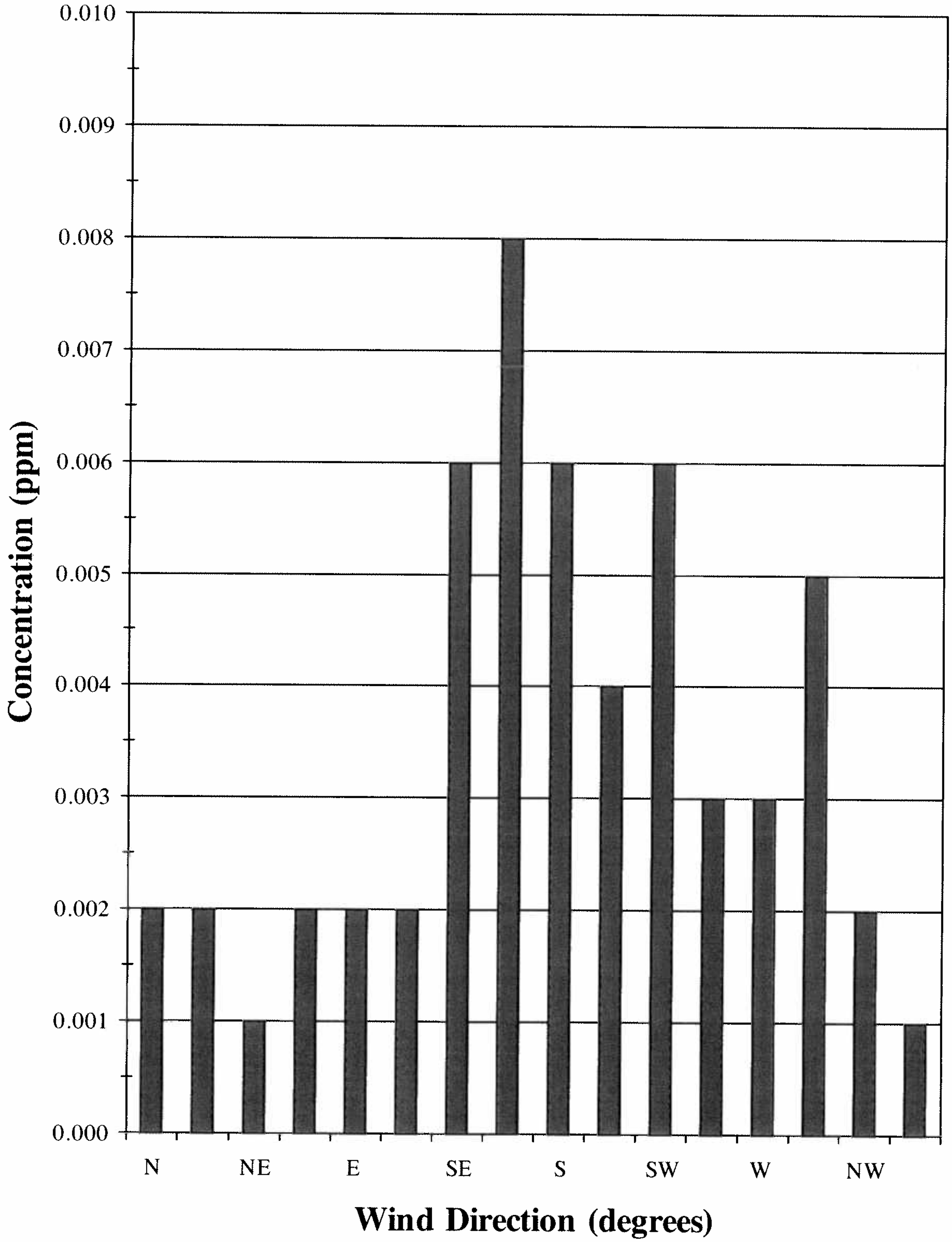


FIGURE 3-2: AVERAGE HOURLY NO_2 CONCENTRATION BY WIND DIRECTION

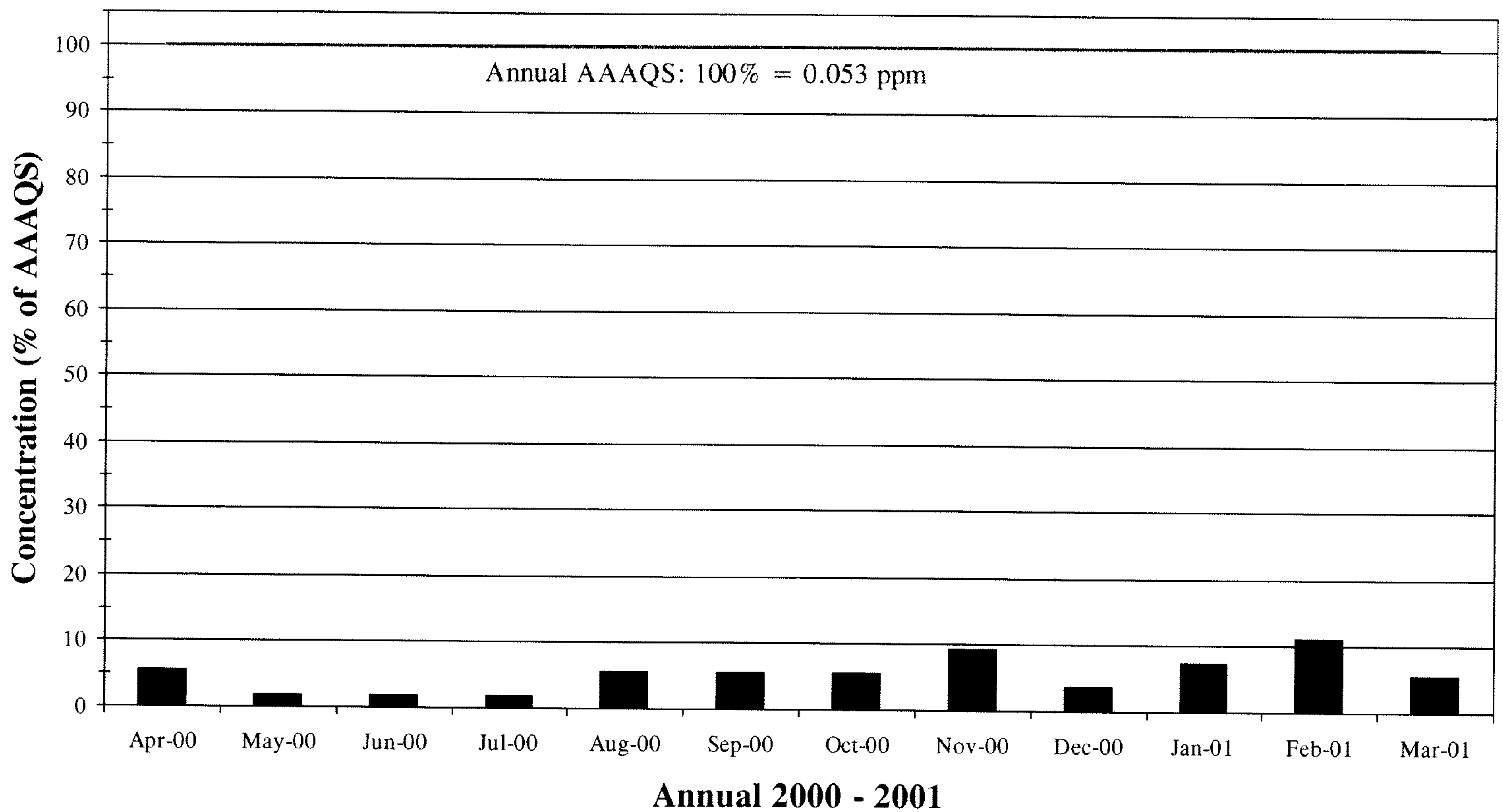


FIGURE 3-3: AVERAGE NO_2 CONCENTRATION BY MONTH

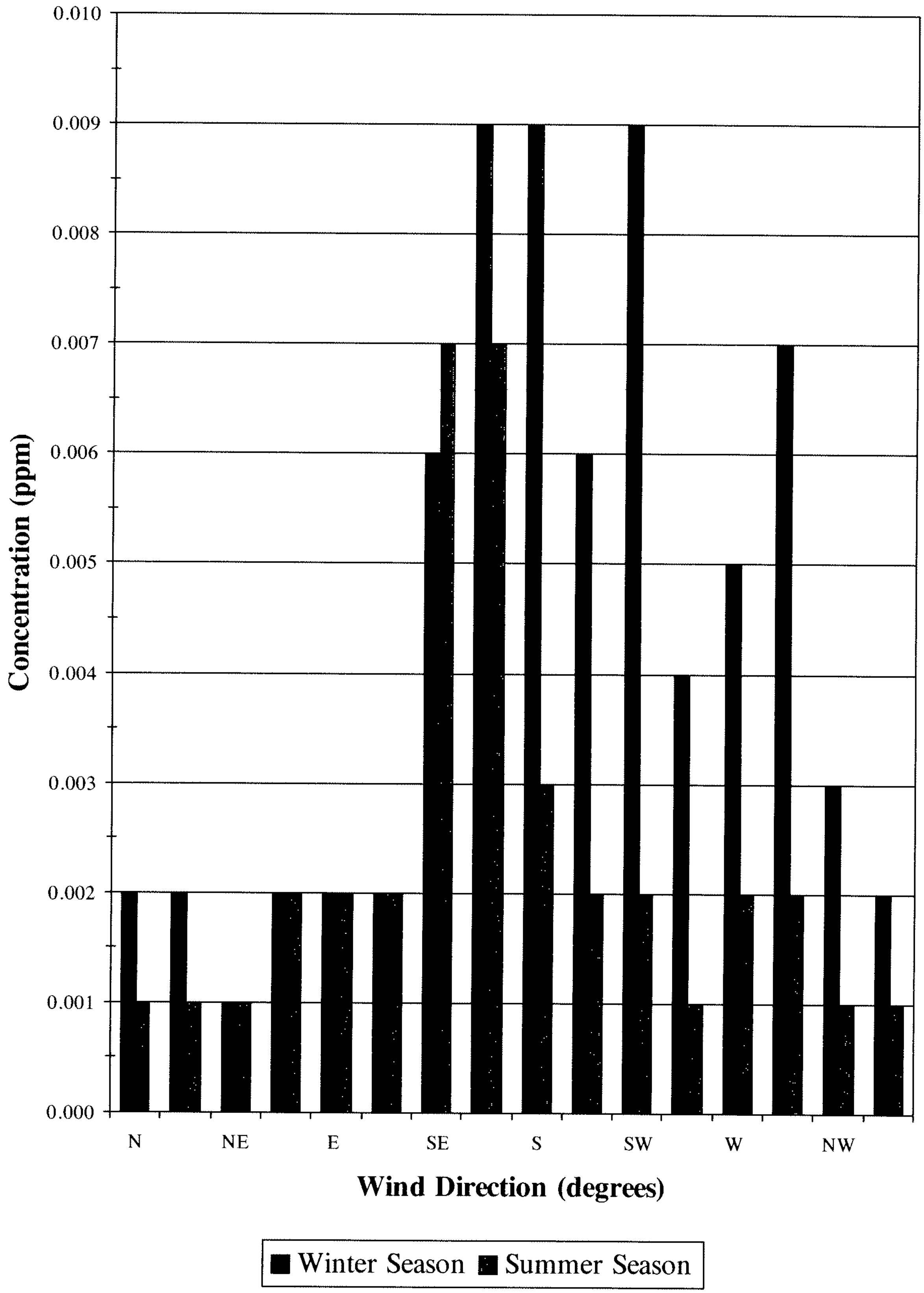


FIGURE 3-4: AVERAGE HOURLY NO_2 CONCENTRATION BY WIND DIRECTION AND SEASON

proximity of the village sources to the monitoring site and is not likely an indication of the amount of NO_2 produced or the number of sources in the village.

The highest hourly concentration measured during the monitoring year was 0.065 ppm and was measured under conditions of light winds from the southwest in the late morning of November 16, 2000. Based on the direction, magnitude, and timing of the concentration, this measurement probably resulted from a parked but running vehicle or construction equipment in the village.

A frequency analysis of hourly NO_2 measurements by wind direction is shown in Figure 3-1. This analysis shows the following characteristics of the ambient NO_2 concentrations measured at Nuiqsut:

- One quarter of the hourly measurements (24.7 percent) were below 0.001 ppm, as shown in the center ring of the plot.

- The highest concentrations (reflected in the width of the plot spokes) were measured from all directions which transport air from the village to the monitoring site. These directions have been defined as southeasterly through west-northwesterly (SE-WNW)

- A brief high concentration is observed on the north-northeasterly wind direction spoke. Closer examination of the hourly data shows that this is a result of a single elevated measurement observed in the evening of November 7, 2000. The origin of this measured concentration is unknown, but the magnitude indicates a local source.

The average NO_2 concentrations plotted as a function of wind direction for the monitoring year is presented in Figure 3-2. Average concentrations by wind direction show slightly higher values when winds are from the direction of the village (SE-WNW). The average hourly concentration measured from the village was 0.005 ppm; averaging over all other directions yields a concentration of only 0.002 ppm.

Monthly average NO_2 concentrations for the monitoring year are presented in Figure 3-3. This figure shows that with the exception of the winter months (designated as November through April), monthly averages are just above instrument detection (0.001 ppm). During the winter months the average hourly concentration was 0.004 ppm, and during the summer months (designated as June through September) the average hourly concentrations were 0.002 ppm. This doubling of average concentrations during the winter results from an increase in local NO_2-producing activities within the village. Local NO_2 producing activities that are known to increase during the winter include residential heating activities, idling automobiles, snow machines, etc.

The differences between summer and winter seasonal averaged hourly impacts as a function of wind direction are shown in Figure 3-4. This figure shows that average concentrations measured while winds transported background air toward the village [northwest (NW) through east-southeast (ESE)] during the winter were almost equal to concentrations measured during the summer, indicating a stable background air source to the village during the entire monitoring year. Though the background airshed contains NO_2-producing sources which may increase during the winter, they are far enough away that the seasonal changes are not observed in the data. Seasonally averaged hourly impacts measured when winds were from the village (SE through WNW) show much higher concentrations during the winter as compared to the summer.

3.1.2 Sulfur Dioxide

There were only 13 hours during the monitoring year when measured SO_2 concentrations were 0.002 ppm or higher. None of these measurements was higher than 0.005 ppm. There was no single near-field or far-field source of measurable SO_2 indicated by the data collected. Without identifiable sources, measured concentrations are representative of a regional background signature. The low average concentrations measured are consistent with an airshed containing little industry and few sources.

Table 3-1 lists the measured maximum 3-hour (running) and 24-hour (midnight-to-midnight) average SO_2 concentrations for each month, as well as the annual average SO_2 concentration. Concentrations for all three averaging periods were near the instrument detection limit and are well below the applicable AAAQS.

3.1.3 Respirable Particulate Matter (PM_{10}) - TEOM Data

Table 3-1 and Table 3-2, and Figures 3-5 through 3-7 summarize the PM_{10} data collected during this monitoring year. The highest measured particulate levels are the result of naturally occurring wind blown fugitive dust from exposed or disturbed areas local to the monitoring site. Exposed areas identified this monitoring year were the exposed bank of the Nechelik channel east of the station, disturbed ground due to house building along the utility right-of-way east and south of the station, and to a much lesser degree, disturbed ground associated with dirt roads within the village. When fugitive dust from these sources is not present (i.e., during winter), hourly concentrations are at or below the instrument detection limit.

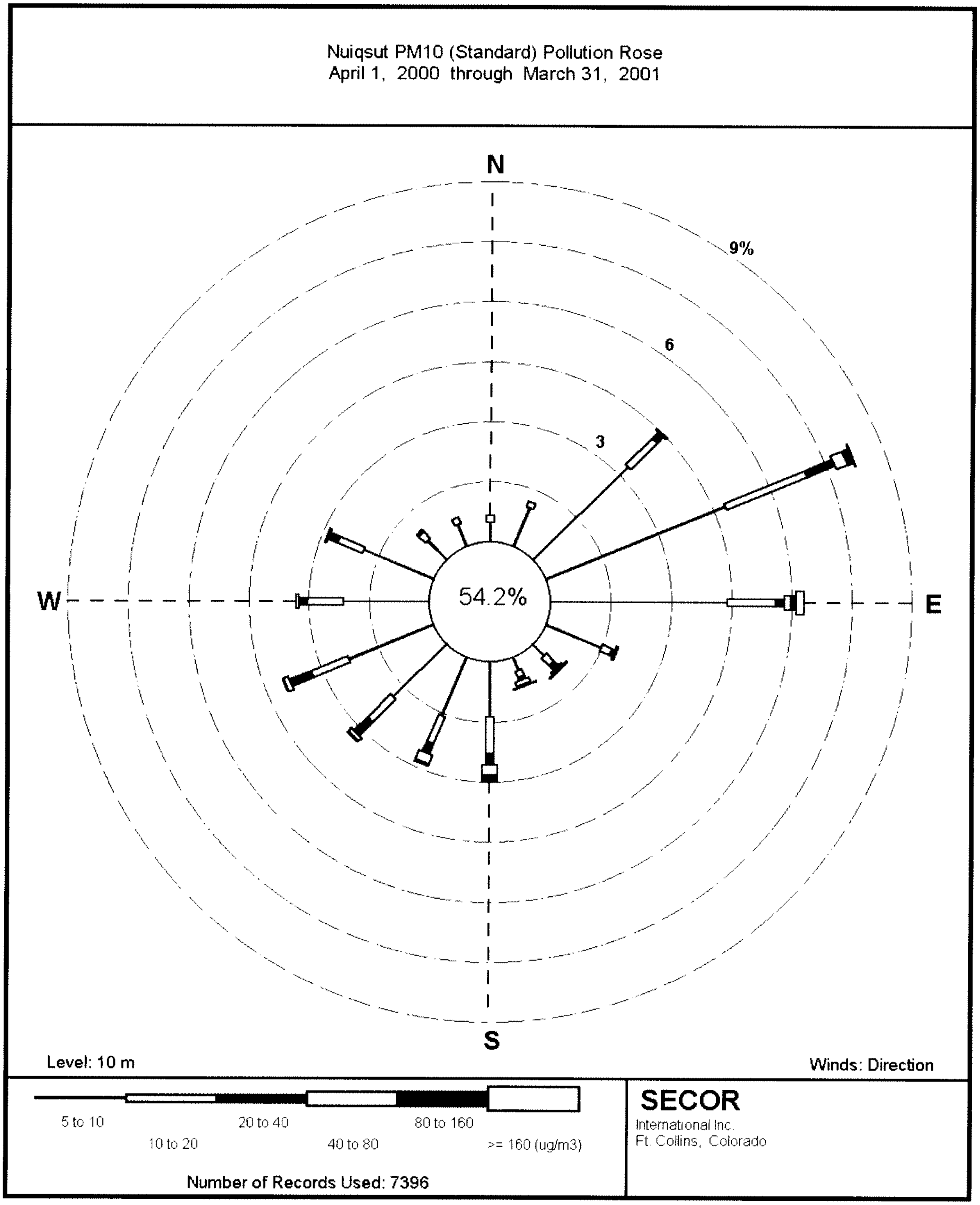


FIGURE 3-5: PM_{10} FREQUENCY ANALYSIS BY WIND DIRECTION

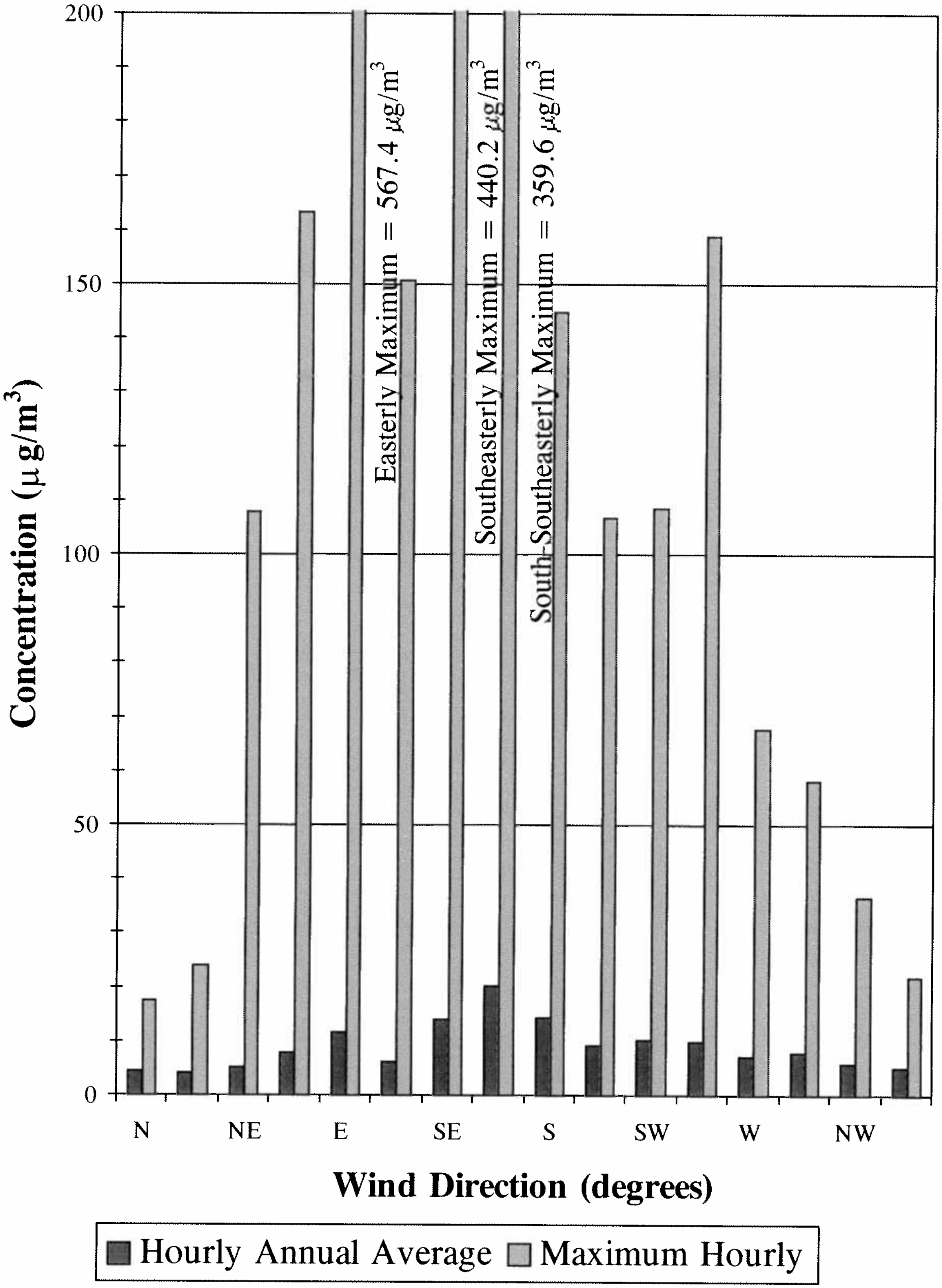


FIGURE 3-6: ANNUAL AVERAGE AND MAXIMUM PM_{10} CONCENTRATION BY WIND DIRECTION

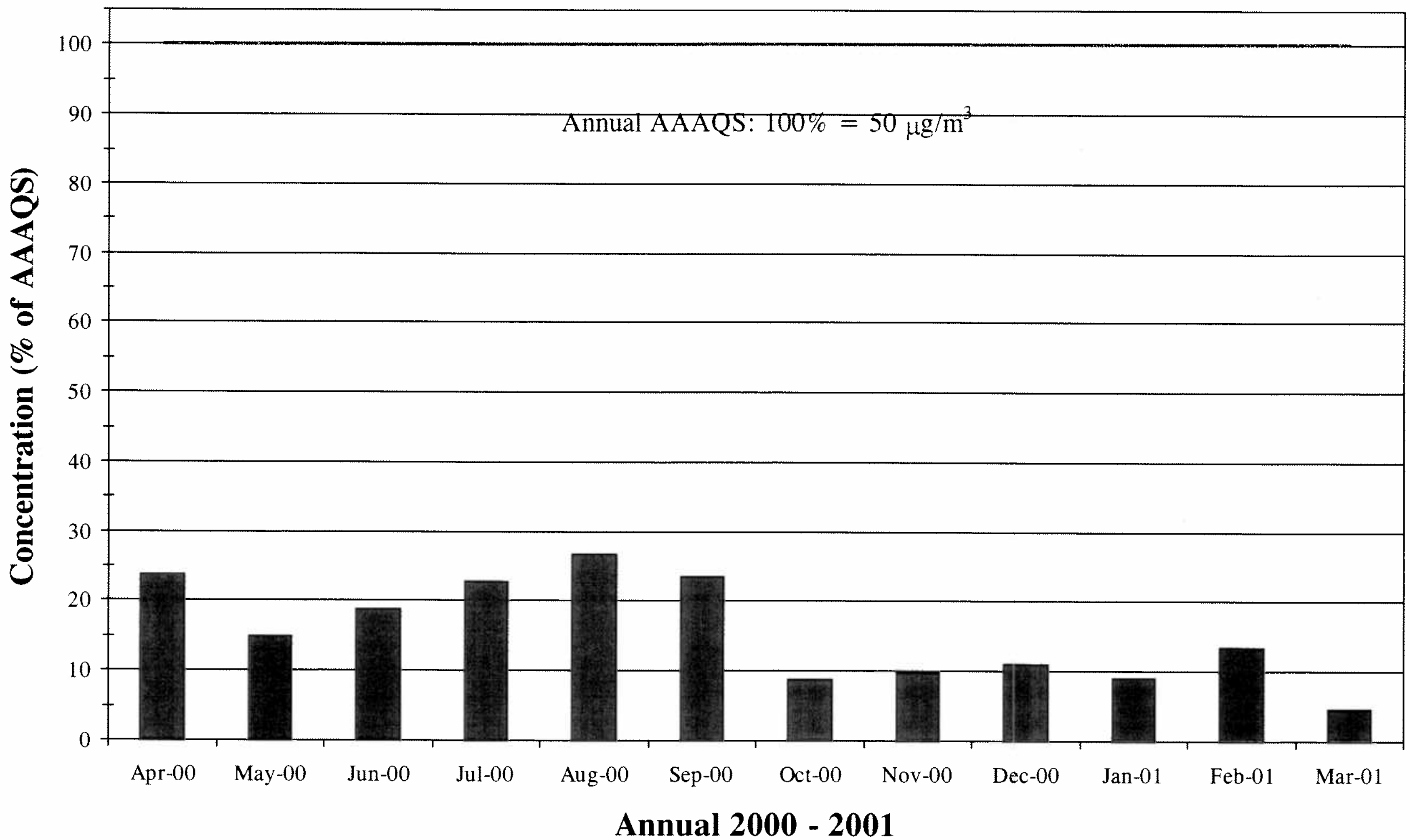


FIGURE 3-7: AVERAGE PM_{10} CONCENTRATION BY MONTH

PM_{10} has a 24-hour (midnight-to-midnight) AAAQS of 150 $\mu g/m^3$, and an annual AAAQS of 50 $\mu g/m^3$ measured at standard temperature and pressure conditions. As listed in Table 3-1, the maximum 24-hour PM_{10} concentration measured during the monitoring period was 113.4 $\mu g/m^3$, which is 76 percent of the 24-hour AAAQS. The second highest 24-hour concentration was 83.2 $\mu g/m^3$, which is just over half the AAAQS. The annual average PM_{10} concentration was 8.3 $\mu g/m^3$, which is only 16.6 percent of the annual AAAQS.

The highest 24-hour PM_{10} concentration occurred on September 24, 2000, a day with east-northeasterly through easterly winds and hourly wind speeds in excess of 10 m/s. Elevated measured particulate concentrations on this date resulted from high easterly winds transporting dust from the thawed, exposed Nechelik channel bank to the monitoring station. This conclusion is supported by discussions with Nuiqsut residents and is consistent with the developing data set.

A frequency analysis of 1-hour average PM_{10} measurements by wind direction is shown in Figure 3-5. This analysis shows the following characteristics of the ambient PM_{10} measured at Nuiqsut this monitoring period:

- 54 percent of the measurements (an equal number to the last monitoring year) were below the instrument detection limit of 5 $\mu g/m^3$, as shown in the center ring of the plot. The high percentage of low measurements is explained by the rural environment of the site combined with the absence of wind blown fugitive dust during a large part of the year when the ground is frozen and or snow covered.

- The highest hourly measurements (reflected in the width of the spokes) were measured during east-northeast through easterly winds. These winds are known to transport particulate from the bank of the Nechelik channel to the monitoring site.

- Additional elevated hourly measurements (reflected in the width of the spokes) were measured during southeast through southerly winds. Based on on-site observations, these elevated measurements are most likely a result of wind blown fugitive dust originating from disturbed ground to the southeast of the monitoring site. The disturbed ground is a result of house building which was occurring along the utility right-of-way leading to the monitoring station.

Average PM_{10} concentrations as a function of wind direction over the monitoring year are shown in Figure 3-6. This figure indicates that regardless of the wind direction, average concentrations measured are at or just above the instrument detection limit. Two exceptions to this are concentrations measured when winds are easterly and when they are southeasterly through southerly. As was discussed, on-site observations document that easterly winds are responsible for producing and transporting fugitive dust from the exposed Nechelik Channel bank to the monitoring station. On-site observations also document that southeasterly through southerly winds are responsible for producing and transporting fugitive dust from exposed and disturbed areas southeast of the station. Possible sources in this direction, in order of importance, include disturbed areas associated with the house construction along the utility right-of-way and the unvegetated utility right-of-way itself.

Maximum hourly PM_{10} concentrations as a function of wind direction are also shown in Figure 3-6. This figure shows that the highest maximums as a function of wind direction are associated with easterly winds. Again, these winds are responsible for producing and transporting wind blown fugitive dust from the exposed bank of the Nechelik channel to the station. High hourly maximum concentrations were also measured when winds were blowing from the direction of the utility right-of-way. Additional high hourly maximum concentrations were measured when winds were blowing from the general direction of the village. A possible particulate source distributed throughout the village responsible for these maximums could be fugitive dust associated with the village dirt roads. The sources associated with these maximums discussed above are neither strong enough nor persistent enough to affect yearly averages, and do not cause violations of the 24-hour AAAQS.

Figure 3-7 shows the average monthly PM_{10} concentrations measured during the monitoring year. PM_{10} impacts are correlated to season. Concentrations measured from June 2000 through September 2000 are nearly double those measured during any other time of the monitoring year (with the exception of April). This doubling is related to the wind blown fugitive dust origin of the PM_{10} measured. About one month after the mean temperature rises above freezing (mid-June), the ground has thawed and starts drying. With the ground exposed and dry, the normally high regional winds are able to produce wind blown fugitive dust through erosion, and to transport particulate to the monitoring site. This results in an increase in measured particulate concentrations. Similarly, about a month after the mean temperature drops below freezing (mid-October), the ground becomes frozen and snow covered, and average monthly impacts once again drop to around 10 $\mu g/m^3$.

The exception to the general seasonal trend of average monthly PM_{10} concentrations is the month of April. In April 2000, there were 4 days when the 24-hour average exceeded 20 $\mu g/m^3$. Wind directions on these days averaged approximately 65 degrees, and wind speeds were no higher than 7 m/s. These conditions are not entirely consistent with the conditions necessary to produce and transport fugitive dust from the Nechelik channel bank to the station because the temperature was so cold and wind speeds were slightly low. During April, the temperature was still consistently well below freezing, implying that the ground should have been frozen. With no on-site observations, there is no obvious explanation for this anomaly except that though the ground was frozen, it must have remained disturbed enough to become a source of particulate under high winds.

Table 3-2 lists all 24-hour (midnight to midnight) averaged PM_{10} concentrations measured over 20 $\mu g/m^3$ during the monitoring year and compares them to the average wind speed and wind direction for the same period. During the prior monitoring year, a similar table was dominated by concentrations measured when winds were from the northeast through easterly directions, which was related to the exposed Nechelik channel bank. Contrary to the last monitoring year, Table 3-2 shows that during this monitoring year no particular source dominated the top measured hourly concentrations. The top concentrations were instead well balanced from the three fugitive sources identified in this report section. [The bank of the Nechelik Channel (ENE-E), construction to the south of the station (SE-S) and the village at large (SSW-NW)]. Though impacts were well distributed, the highest are still associated with the exposed bank of the Nechelik channel.

3.1.4 Respirable Particulate Matter (PM_{10}) - Partisol Data

A summary of 24-hour integrated PM_{10} data collected by the Partisol sampler is presented by quarter in Figures 3-8 through 3-10. Data processing procedures used to generate the reported 24-hour average concentrations are discussed in Appendix A. One purpose of installing the Partisol sampler is to use data collected by this Federal Reference Method (FRM) to generate comparison statistics with data collected by the TEOM continuous monitor. The discussion of the two data sets focuses on a qualitative comparison of the data.

Figures 3-8 through Figure 3-10 show that up until February 6, 2001, the disagreement between concentrations measured by the two methods generally increases as the ambient concentration (as measured by the TEOM) increases. The two instruments also show identical trends, indicating a systematic bias between the two instruments up until that time. The TEOM has consistently shown higher, more conservative results than the Partisol. Starting with the sample collected on February 6, 2001 the bias between the measurements disappears. This is a very positive observation since filter handling and shipping procedures were changed starting with the January 31, 2001 sample. The recent results are positive, but many more samples will have to be collected before it is known for sure that the bias between the two instruments has been eliminated.

TABLE 3-2

NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM MEASURED PM_{10} CONCENTRATIONS GREATER THAN 20 $\mu g/m^3$

Ranking	24-hour PM_{10} Concentration ($\mu g/m^3$)	24-hour Period		Average Wind Speed (m/s)	Dominant Wind Direction
		Year	Date		
1	113.4	2000	September 24	7.6	E
2	83.2	2000	August 2	7.1	E-ESE
3	73.8	2000	July 15	3.5	E and SSE-S
4	50.9	2000	August 29	9.4	E
5	50.4	2000	August 16	3.8	SSE-SW
6	42.3	2000	July 13	8.2	ENE
7	42.2	2000	September 20	3.2	S-WSW
8	40.0	2000	April 3	2.5	NE-ENE
9	37.9	2000	July 22	2.9	E-ESE and S-SSW
10	28.7	2000	April 5	4.8	ENE
11	28.2	2000	September 1	4.0	SSE-SSW
12	27.8	2000	April 6	2.1	NE-E
13	27.5	2000	August 30	3.3	ENE-SE
14	26.6	2000	June 22	4.6	SW-WSW
15	25.5	2000	July 14	7.6	ENE-E
16	22.8	2000	April 7	1.9	SSE-SSW
17	22.2	2000	December 5	14.3	ENE
18	20.1	2000	August 10	10.3	S-W

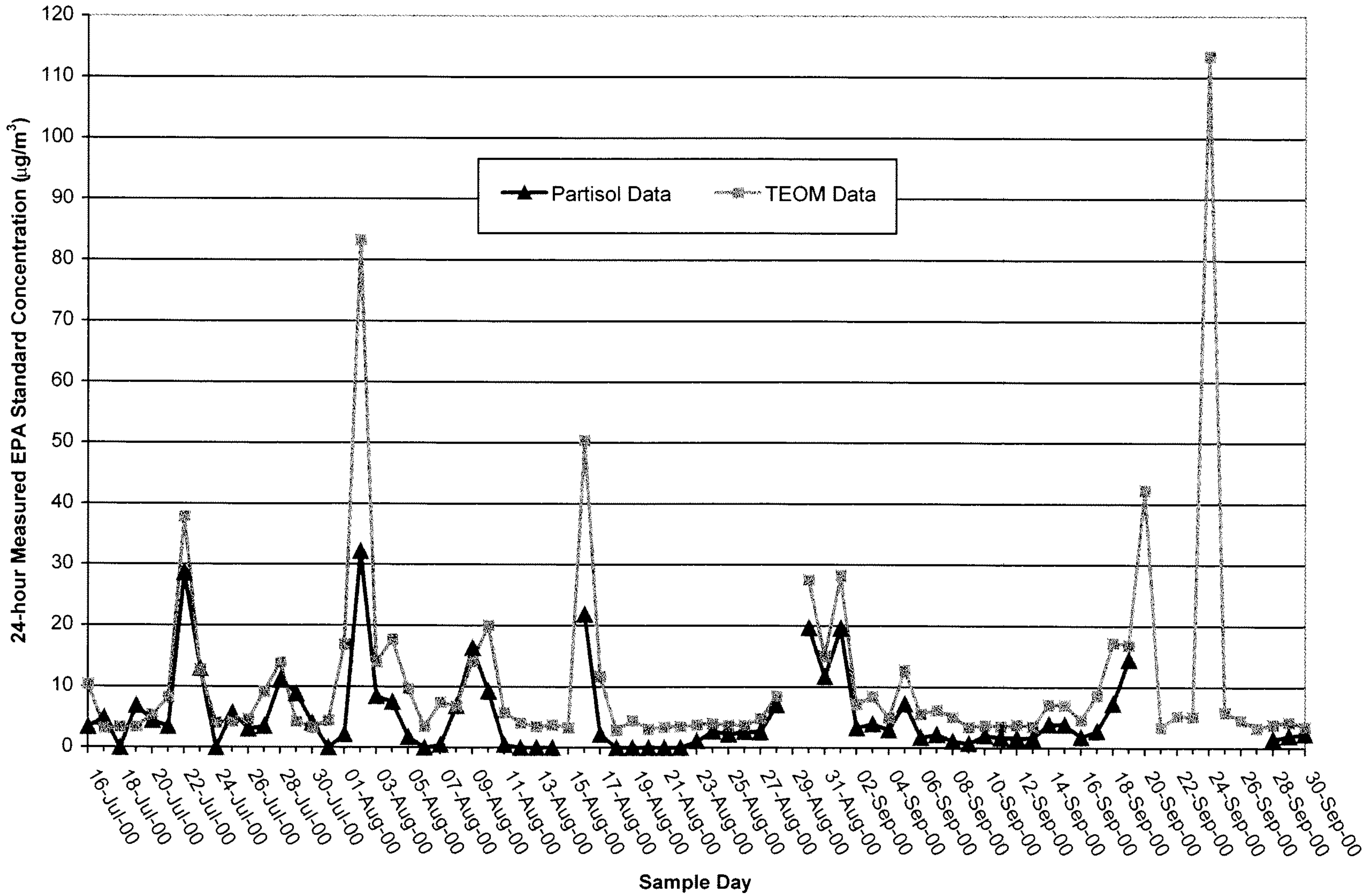


FIGURE 3-8: COMPARISON BETWEEN PARTISOL AND TEOM PM_{10} DATA - THIRD QUARTER 2000

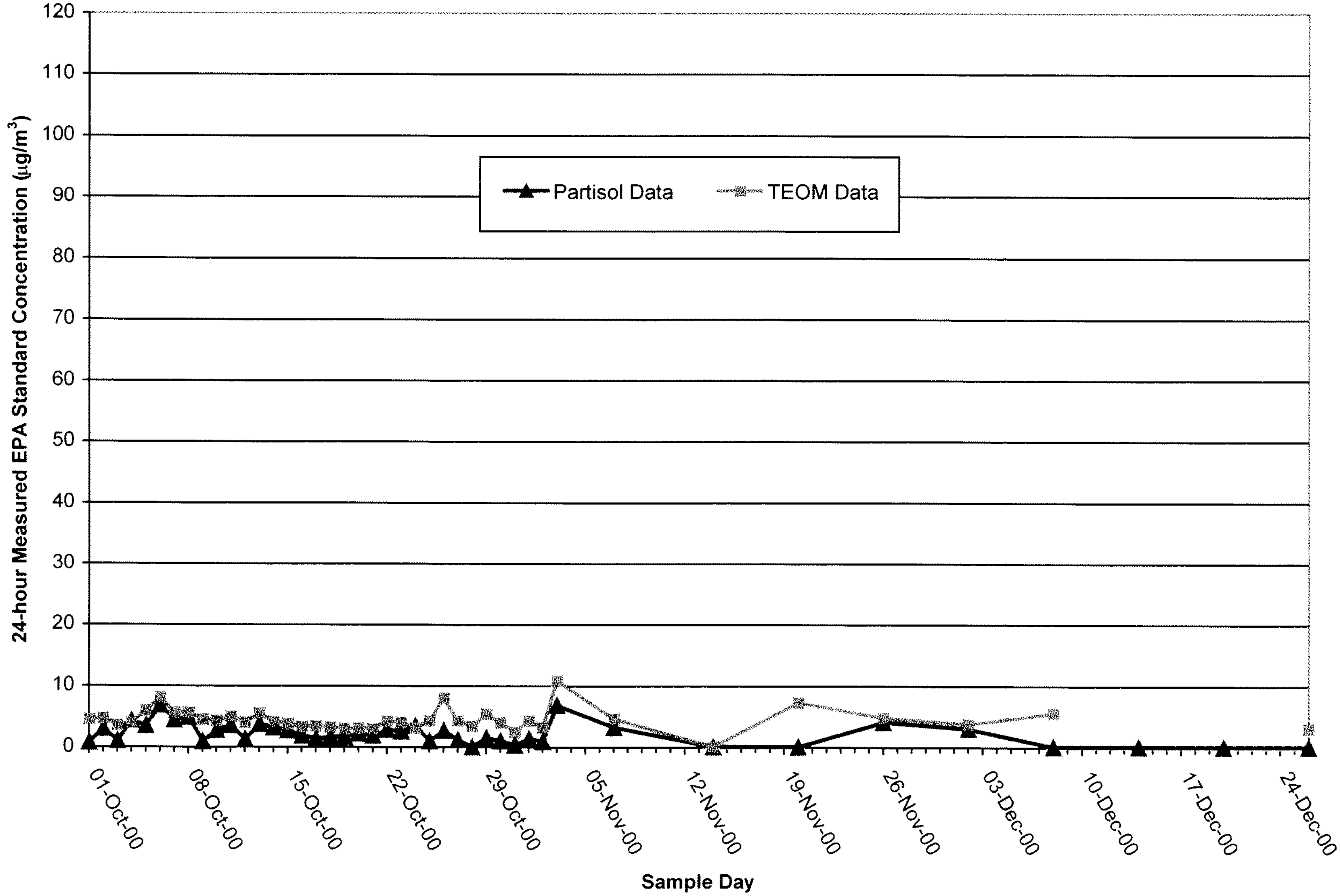


FIGURE 3-9: COMPARISON BETWEEN PARTISOL AND TEOM PM_{10} DATA - FOURTH QUARTER 2000

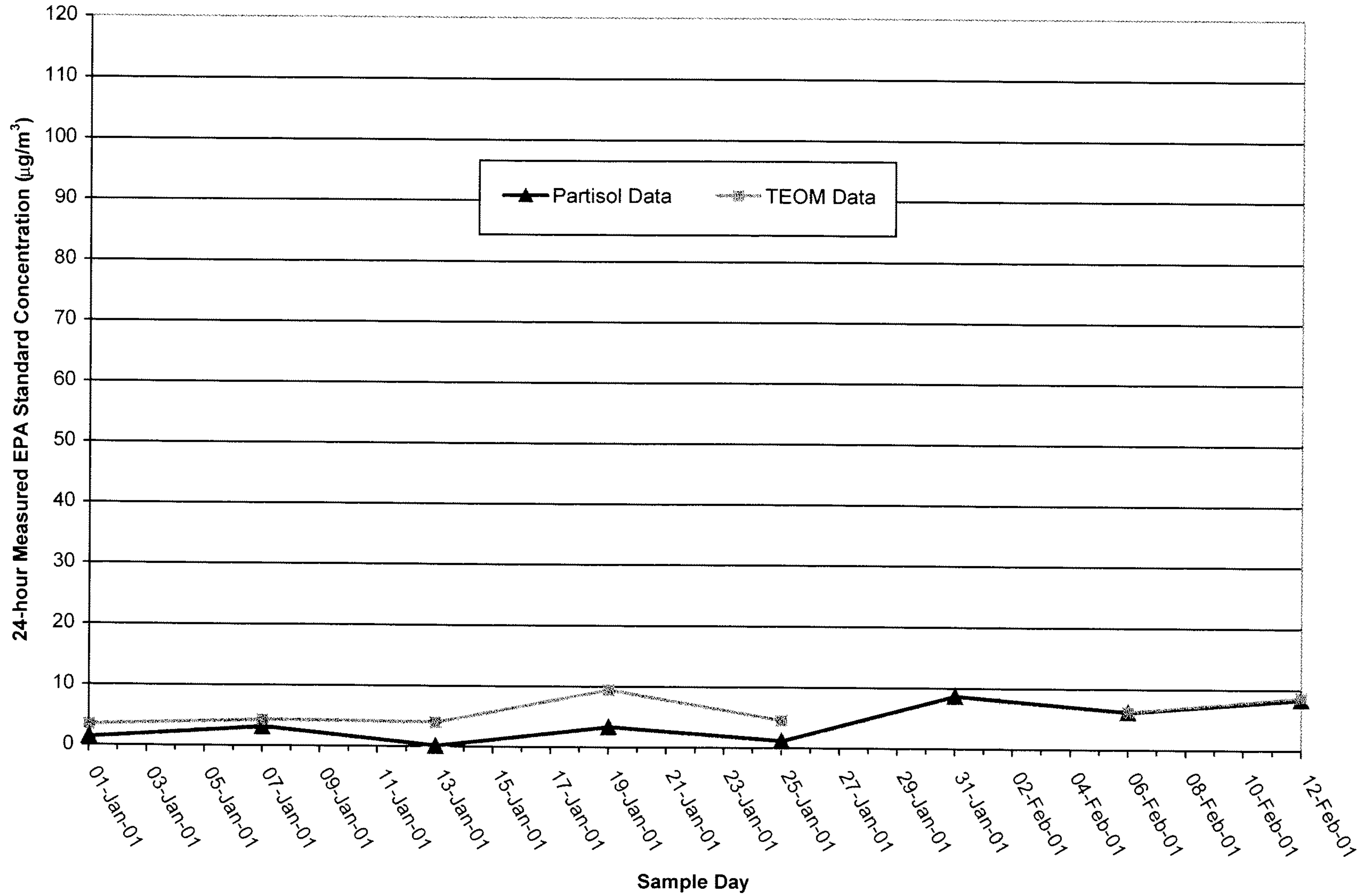


FIGURE 3-10: COMPARISON OF PARTISOL AND TEOM PM_{10} DATA - FIRST QUARTER 2001

3.2 Meteorological Data

Meteorological data collected at the Nuiqsut monitoring station includes temperature, wind speed, and wind direction.

3.2.1 Wind Speed and Direction Climatology

The annual Nuiqsut bivariate wind frequency distribution is presented in Figure 3-11. This figure shows that winds during the monitoring year were bi-modal, dominated by northeasterly (NE) through easterly (E) winds and by south-southwesterly (SSW) through westerly (W) winds. From the table presented with Figure 3-11, and tabulated below, the NE-E winds average slightly higher speeds than the SSW-W winds. Over all wind directions, the mean 10-meter wind speed for the monitoring year was 5.0 m/s while the maximum was 23.7 m/s. Combining the information from Figure 3-11 with the statistics gathered during the last monitoring year yields the following comparison:

Wind Speed/ Wind Direction Parameter	Current Monitoring Year April 2000 through March 2001	Prior Monitoring Year April 1999 through March 2000
Frequency of NE - E Winds	50.7 %	53.8 %
Frequency of SSW-W Winds	22.7 %	22.9 %
Mean Wind Speed over NE - E Winds	6.0 m/s	6.6 m/s
Mean Wind Speed over SSW-W Winds	4.6 m/s	4.6 m/s
Mean Hourly Wind Speed	5.0 m/s	5.3 m/s
Maximum Hourly Wind Speed	23.7 m/s	20.1 m/s

It is very clear from these statistics that there has been very little change in the wind climatology over the last two monitoring years. This climatology reflects the persistence of regional seasonal weather patterns which remain uninfluenced by flat terrain as they move through the Alaska North Slope Coastal Plain surrounding Nuiqsut.

Figure 3-12 shows the seasonal differences in the Nuiqsut wind rose between summer and winter. As was observed during the last monitoring year, the seasonal wind roses collected this monitoring year indicate that there is a persistence of northeasterly through easterly winds all year long. During the last monitoring year, an increase in southwesterly through westerly winds

Nuiqsut Air Quality Monitoring Program - Nuiqsut, AK
WIND ROSE ANALYSIS (PERCENT)
4/ 1/2000 through 3/31/2001
All Hours

WIND DIRECTION	WIND SPEED (M/S) <= 1.5	<= 3.1	<= 5.1	<= 8.2	<=10.8	>10.8	TOTAL	AVG SPEED
N	0.26	0.97	0.78	0.09	0.00	0.00	2.10	2.94
NNE	0.41	1.78	2.19	0.33	0.06	0.00	4.77	3.28
NE	0.65	2.26	5.16	6.11	2.29	0.67	17.14	5.67
ENE	0.78	2.85	6.01	5.57	2.53	2.71	20.45	6.35
E	0.68	2.01	3.63	3.57	1.86	1.33	13.09	5.97
ESE	0.27	1.30	1.61	0.85	0.18	0.04	4.24	3.98
SE	0.38	0.62	0.38	0.13	0.00	0.00	1.51	2.71
SSE	0.26	0.49	0.38	0.00	0.00	0.00	1.13	2.51
S	0.29	1.06	2.05	0.72	0.00	0.00	4.12	3.67
SSW	0.39	1.26	3.19	0.80	0.02	0.00	5.67	3.78
SW	0.25	0.98	2.01	1.31	0.29	0.04	4.88	4.59
WSW	0.27	1.20	1.93	2.05	0.45	0.18	6.08	5.12
W	0.34	1.26	2.25	1.58	0.35	0.33	6.11	5.00
WNW	0.35	1.33	1.74	0.79	0.21	0.02	4.45	3.98
NW	0.33	1.12	0.59	0.22	0.08	0.00	2.34	3.15
NNW	0.19	0.91	0.54	0.16	0.02	0.00	1.83	3.11
CALM	0.09						0.09	
TOTAL	6.20	21.40	34.44	24.29	8.35	5.31	100.00	

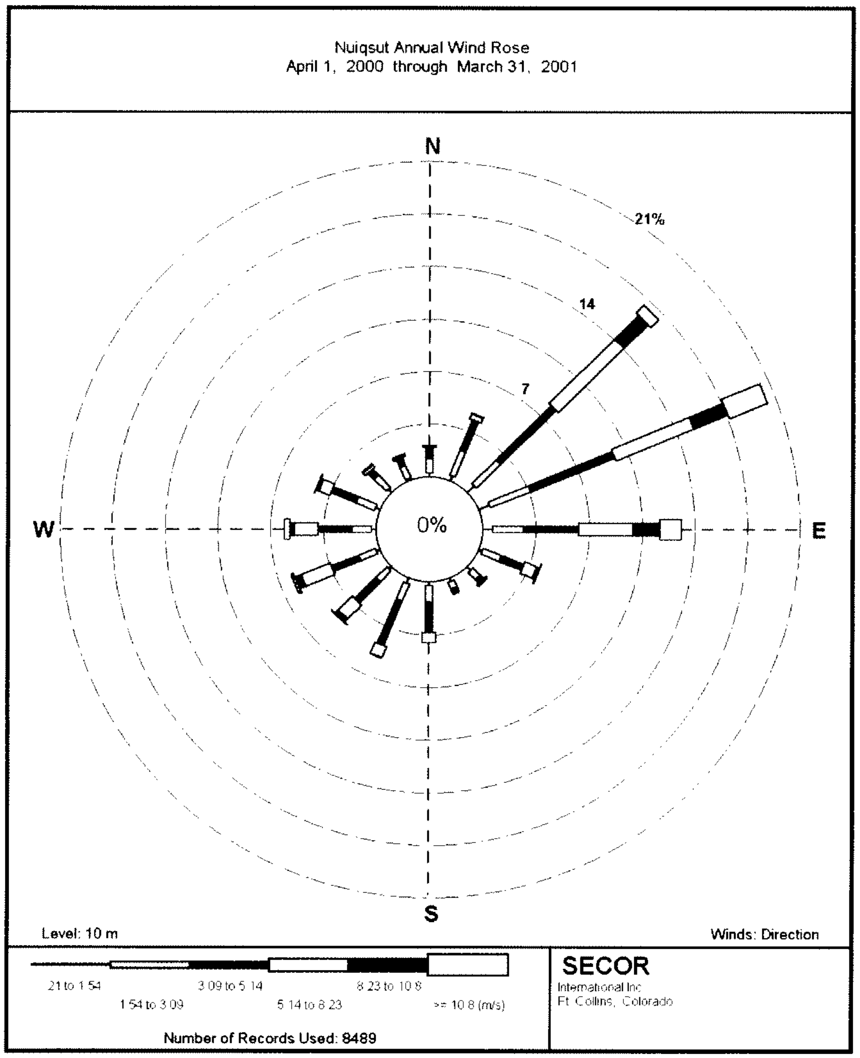
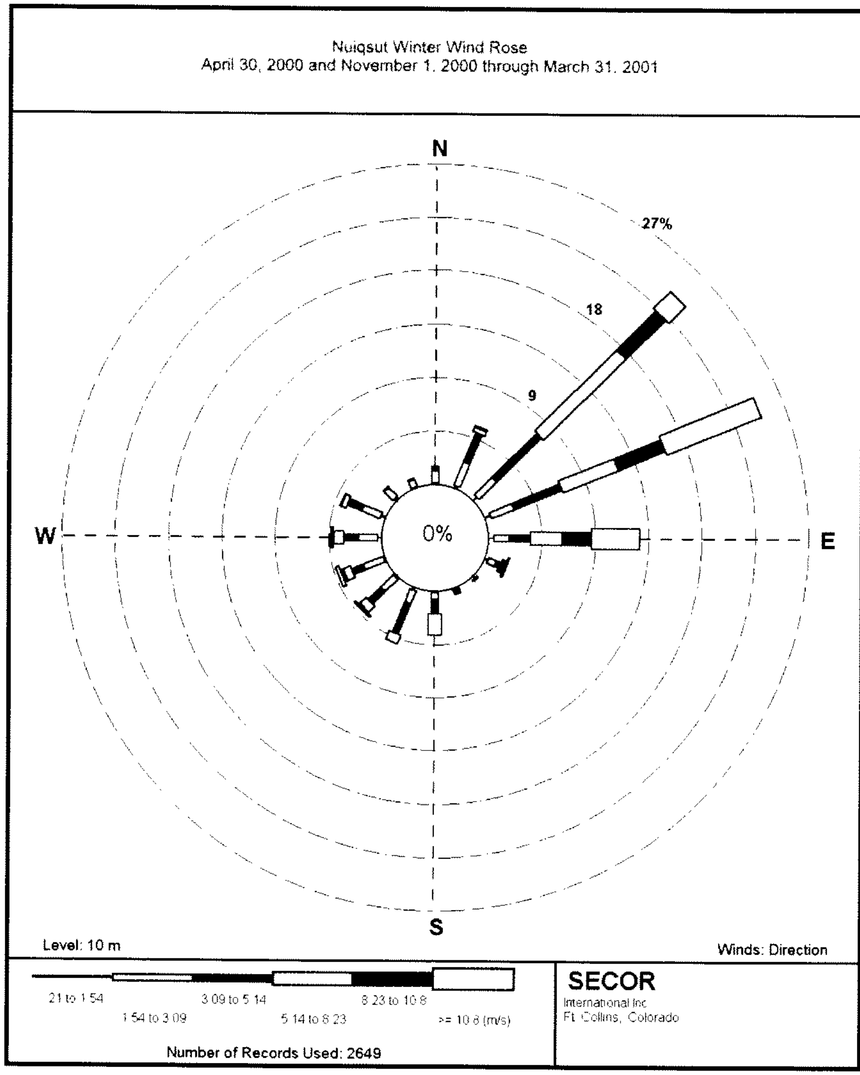


FIGURE 3-11: ANNUAL BIVARIATE WIND ANALYSIS



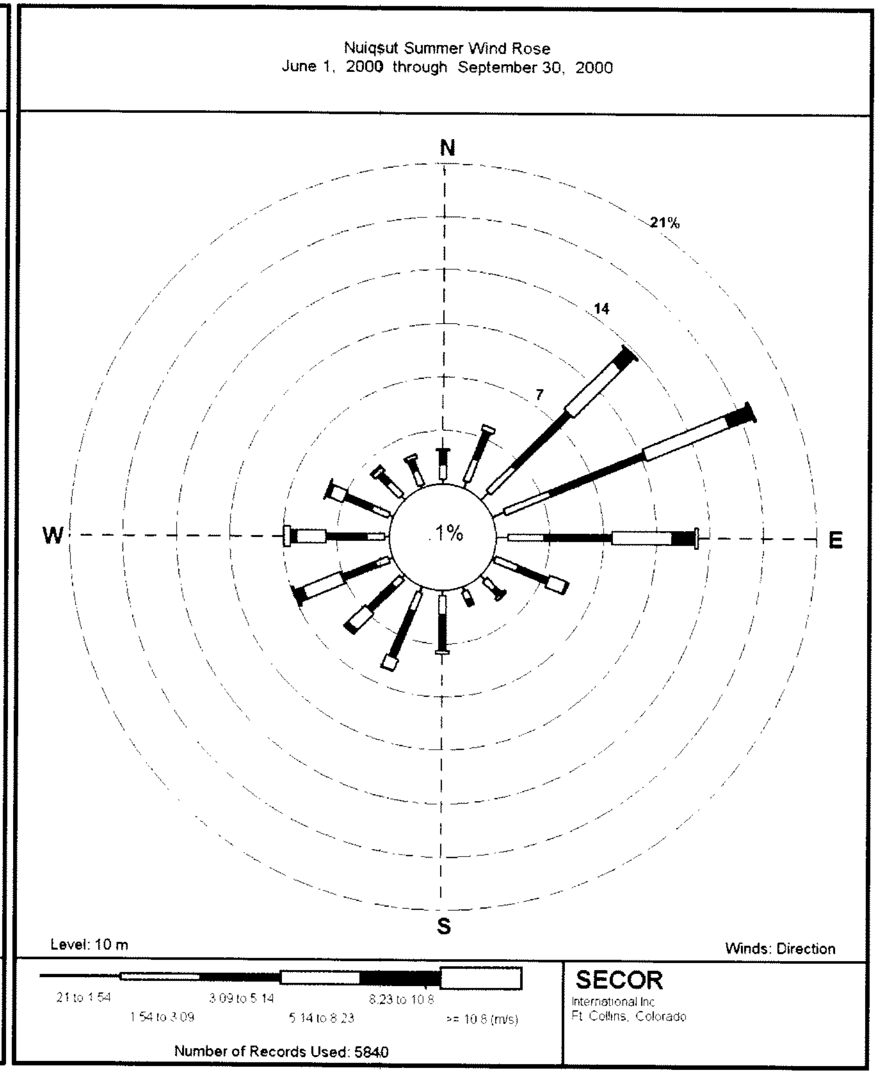


FIGURE 3-12: SEASONAL BIVARIATE WIND ANALYSIS

developed during the winter. This monitoring year, what little increase there was between seasons from these directions appears to have developed in the summer, not the winter.

3.2.2 Stability Frequencies

The Pasquill-Gifford stability class distribution derived for the reporting period is presented in Figure 3-13. The stability classes were calculated based on the observed wind speed and wind direction standard deviation (sigma-theta, or σ_θ) according to the method presented in Appendix A. Neutral stability conditions occurred approximately 67 percent of the time, with unstable and stable conditions rarely occurring. Combining this information from the statistics gathered during the last monitoring year yields the following comparison:

Stability Parameter	Current Monitoring Year April 2000 through March 2001	Prior Monitoring Year April 1999 through March 2000
Frequency of Neutral Conditions	66.9 %	70.0 %

It is very clear from these statistics that there has been very little change in the stability climatology over the last two monitoring years. This is consistent with the regional climatology and is due to typically high wind speeds in the area creating a well-mixed surface layer. This stability class distribution has been persistent throughout the year, and shows little seasonal variability.

3.2.3 Temperature Climatology

During the monitoring year, the hourly averaged near-surface ambient temperature reached a maximum of 27.1°C (80.8°F) on the evening on July 22, 2000 and a minimum of -43.0°C (–45.4°F) in the early morning of February 25, 2001. Combining this information from the statistics gathered during the last monitoring year yields the following comparison:

Temperature	Current Monitoring Year April 2000 through March 2001	Prior Monitoring Year April 1999 through March 2000
Maximum Hourly Temperature	27.1°C	27.8°C
Minimum Hourly Temperature	-43.0°C	-41.5°C

NUIQSUT AIR QUALITY MONITORING SITE

April 1, 2000 - March 31, 2001

Stability Class	Percent Occurrence
Extremely Unstable	4.6
Unstable	4.2
Slightly Unstable	12.5
Neutral	66.9
Slightly Stable	9.2
Stable	2.6

(Calculated Using the Sigma-Theta Method)

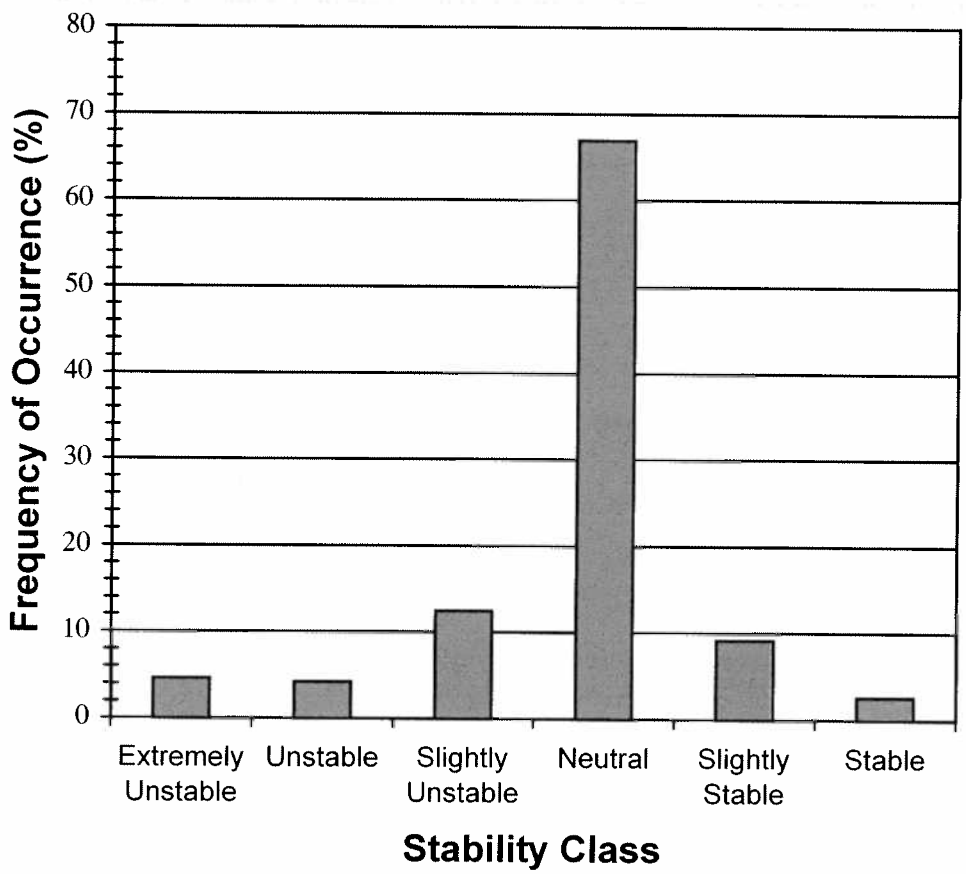


FIGURE 3-13: NUIQSUT STABILITY CLASS FREQUENCY DISTRIBUTIONS

The Nuiqsut temperature climatology shown in Figure 3-14 does not follow the nearby (55 km) Kuparuk River Unit (KRU) temperature climatology as well as might be expected. In general, Nuiqsut temperatures this monitoring year were two to three degrees Celsius higher than at KRU. Though a trend is developing which indicates that the temperatures measured at Nuiqsut are higher than at DS1F, neither dataset is long enough to indicate if both climatologies show typical trends, or if one or both climatologies are influenced by an anomalous year.

Comparing the longer term Barrow climatology to the temperatures measured at Nuiqsut, and accounting for differences mentioned above, it is still clear from Figure 3-14 that February and March indicate deviations from the normals. February was abnormally warm, and March was cooler than normal. Though the trends were not the same, temperatures measured during February and March during the last monitoring year were anomalous as well. Taking the two monitoring years together, this would tend to indicate that the temperatures during these two months are easily influenced, possibly due to the return of sunlight and solar forcing to the area.

The developing temperature climatology presented in Table 3-3 shows that with very few exceptions, several extreme temperature records were broken this year for data collected at the Nuiqsut air quality monitoring station. The winter was slightly cooler than was observed last year, and the summer slightly warmer.

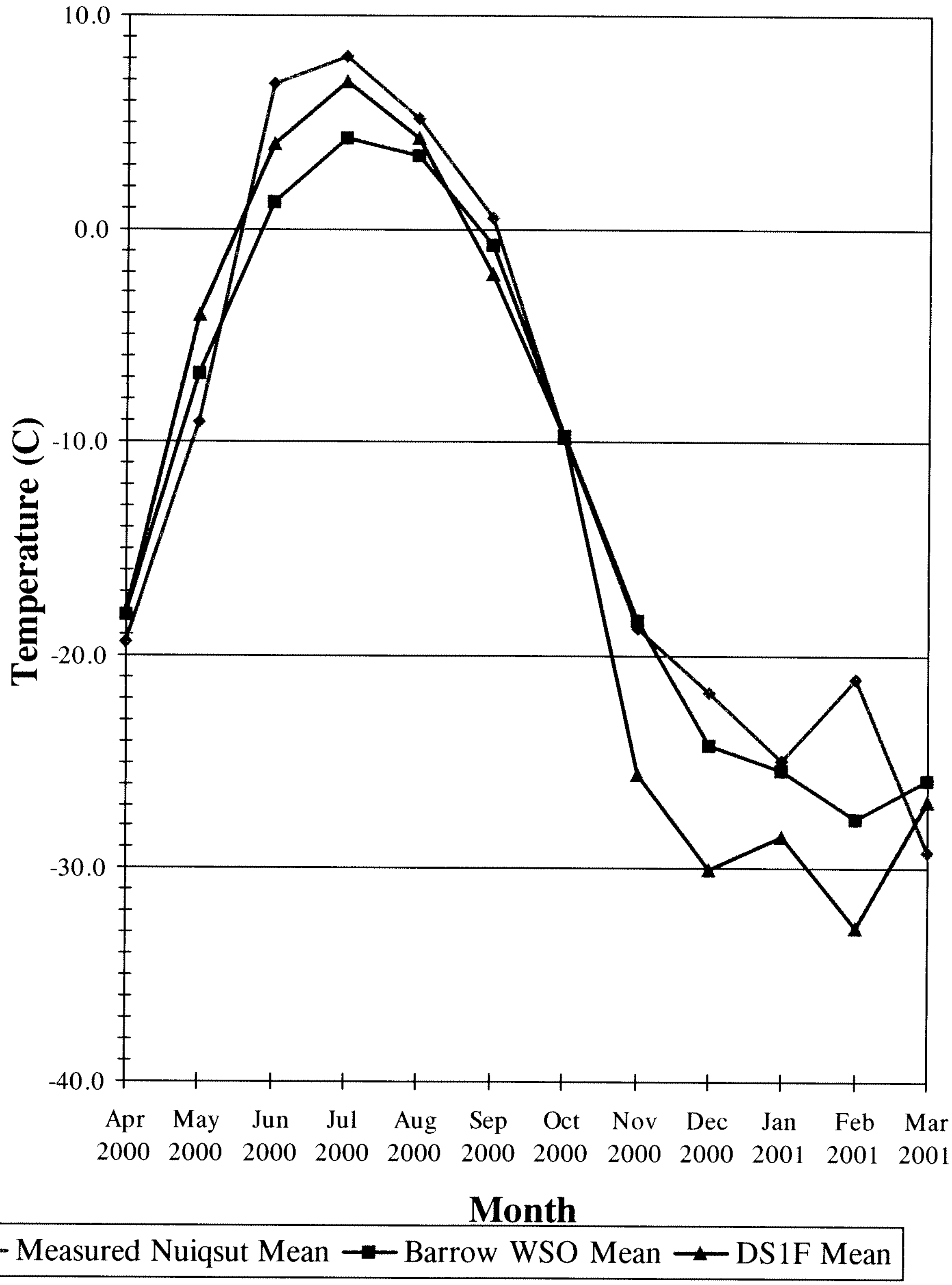


FIGURE 3-14: NUIQSUT TEMPERATURE CLIMATOLOGY

TABLE 3-3
NUIQSUT AIR QUALITY PROGRAM
TEMPERATURE CLIMATE SUMMARY
PERIOD OF RECORD APRIL 9, 1999 THROUGH MARCH 31, 2001

Month	Temperature (C)								
	Mean			Extreme					
	Daily Maximum	Daily Minimum	Monthly	Record Highest	Year	Day	Record Lowest	Year	Day
April 2000	-15.0	-23.0	-19.0	0.8	2000	30	-34.0	2000	4
May 2000	-6.0	-7.7	-5.2	3.7	2000	29	-23.0	2000	14
June 2000	11.0	2.3	6.8	24.0	2000	25	-5.0	2000	5
July 2000	27.1	-0.7	8.1	27.1	2000	22	-0.7	2000	14
August 2000	19.6	-3.3	5.4	27.8	1999	5	-3.3	2000	27
September 2000	8.2	-11.2	0.5	18.2	2000	1	-13.6	1999	30
October 2000	-7.1	-13.4	-9.8	-1.2	1999	7	-27.2	1999	31
November 2000	-15.3	-22.2	-19.1	-2.7	2000	15	-35.5	1999	5
December 2000	-19.6	-23.9	-21.8	-11.5	2000	8	-42.1	1999	18
January 2001	-21.8	-28.1	-24.9	-6.6	2001	16	-42.0	2001	7
February 2001	-17.3	-25.6	-21.1	-5.4	2001	15	-43.0	2001	25
March 2001	-26.0	-32.8	-29.2	-17.6	2001	3	-39.4	2000	23
Monitoring Year	-4.8	-15.8	-9.9	27.8	1999		-43.0	2001	

4.0 REFERENCES

Alaska Department of Environmental Conservation (ADEC). 1996. Alaska Quality Assurance Manual for Ambient Air Quality Monitoring. Revised August 21, 1996.

_____. 1999. Nuiqsut Ambient Air Quality Monitoring QA Plan Review. Letter from J. Baumgartner (ADEC) to M. Stahl (AAI), dated April 3, 1999.

SECOR International Incorporated (SECOR). 1995. Analysis of Data Applicability for the Alaska North Slope Air Quality Management Program - Badami Development Project. Prepared for BP Exploration (Alaska), Inc. by SECOR International Incorporated. March 1995.

_____. 1999. ARCO Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Plan. February 1999.

_____. 2000a. ARCO Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Plan (Revised). April 2000.

_____. 2000b. Phillips Alaska Inc. Nuiqsut Ambient Air Quality Monitoring Project Addition of Federal Reference Method Particulate Monitoring. June 2000.

_____. 2001. Phillips Alaska inc. Nuiqsut Ambient Air Quality Monitoring Project Addition of Federal Reference Method Particulate Monitoring - Final Addendum. January 2001.

Phillips Alaska, Inc. (PAI). 2001. Letter from M. Stahl (PAI) to J. Baumgartner (ADEC) notifying ADEC that the ambient monitoring requirement contained in the Alpine Construction Permit had been met. Submitted March 27, 2001.

United States Environmental Protection Agency (EPA). 1987. Ambient Monitoring Guidelines for Prevention of Significant Deterioration. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA-450/4-87-007.

_____. 1987a. On-Site Meteorological Program Guidance for Regulatory Modeling Applications (Revised August 1995). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA-450/4-87-013.

_______. 1990. Quality Assurance Handbook for Air Pollution Measurement Systems. Volume II: Ambient Air Specific Methods (Interim Edition) Section 2.10: Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere (Dichotomous Sampler Method). Office of Research and Development, Research Triangle Park, North Carolina. EPA-600/R-94/038b. April 1990.

_____. 1994. Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Ambient Air Specific Methods (Interim Edition). Office of Research and Development, Research Triangle Park, North Carolina. EPA-600/R-94/038b. April 1994.

_____. 1995. Quality Assurance Handbook for Air Pollution Measurement Systems. Volume IV: Meteorological Measurements. Office of Research and Development, Research Triangle Park, North Carolina. EPA-600/R-94/038d. Revised March 1995.

_____. 1995a. Supplemental Interim Guidance for Quality Assessment of Continuous PM_{10} Analyzers. Memorandum from W. Mitchell and F. McElroy, Quality Assurance Branch, Air Measurements Research Division, Research Triangle Park, North Carolina. November 3, 1995.

_____. 1998. Quality Assurance Handbook for Air Pollution Measurement Systems Volume II: Part 1. Ambient Air Quality Monitoring Program Quality System Development. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA-454/R-98-004. August 1998.

Yamartino, R. J. 1984. A Comparison of Several "Single-Pass" Estimators of the Standard Deviation of Direction. J. Climate Appl. Meteorology, Vol. 23, pp. 1362-1366.