2005 Urban Air Toxics Monitoring Program (UATMP)

December 2006
Final Report

EPA-454/R-07-001
December 2006

2005 Urban Air Toxics Monitoring Program (UATMP)

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Contract No. 68-D-03-049
Delivery Orders 03 and 04

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emissions, Monitoring and Analysis Division
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LIST OF ACRONYMS

AIRS	Aerometric Information and Retrieval System
AQS	Air Quality Subsystem (of the Aerometric Information and Retrieval System)
BTEX	benzene, toluene, ethylbenzene, and xylenes (*o*-, *m*-, and *p*-xylene)
CAA	Clean Air Act
CFR	Code of Federal Regulations
CV	coefficient of variation
DNPH	2,4-dinitrophenylhydrazine
EPA	U.S. Environmental Protection Agency
FID	flame ionization detection
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
HAP	hazardous air pollutant
HPLC	high-performance liquid chromatography
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
MEK	methyl ethyl ketone
MDL	method detection limit
MTBE	methyl *tert*-butyl ether
NAAQS	National Ambient Air Quality Standards
NATA	National Air Toxics Assessment
NATTS	National Air Toxics Trends Site
NA	not applicable
ND	Nondetect
NEI	National Emissions Inventory
NMOC	Nonmethane Organic Compounds
NOAA	National Oceanic and Atmospheric Administration
NO_x	oxides of nitrogen
ppbC	parts per billion carbon
ppbv	parts per billion (by volume)
PM	particulate matter
RfC	Reference Concentration
RPD	relative percent difference
SIC	Standard Industrial Classification
SNMOC	Speciated Nonmethane Organic Compound
SVOC	Semivolatile Organic Compounds
UATMP	Urban Air Toxics Monitoring Program
VOC	Volatile Organic Compound(s)
TNMOC	Total Nonmethane Organic Compound(s)
tpy	tons per year
TSP	Total Suspended Particulate

URE	Unit Risk Estimate
VMT	vehicle miles traveled
WBAN	Weather Bureau/Army/Navy ID

Monitoring Stations

APMI	Allen Park in Detroit, Michigan
AZFL	Azalea Park in St. Petersburg, Florida
BAPR	Barceloneta, Puerto Rico
BOMA	Boston, Massachusetts
BTUT	Bountiful, Utah
CANC	Candor, North Carolina
CANJ	Camden, New Jersey
CHNJ	Chester, New Jersey
CUSD	Custer, South Dakota
DEMI	Dearborn in Detroit, Michigan
DITN	Dickson, Tennessee
ELNJ	Elizabeth, New Jersey
ETAL	East Thomas in Birmingham, Alabama
FLFL	Davie, Florida
GAFL	Gandy in Tampa, Florida
GPCO	Grand Junction, Colorado
GPMS	Gulfport, Mississippi
GRMS	Grenada, Mississippi
INDEM	Gary, Indiana
ITCMI	Sault Sainte Marie, Michigan
LDTN	Loudon, Tennessee
MAWI	Madison, Wisconsin
MIMN	Minneapolis, Minnesota
MUTX	Murchison Middle School in Austin, Texas
NBAL	North Birmigham, Alabama
NBIL	Northbrook in Chicago, Illinois
NBNJ	New Brunswick, New Jersey
ORFL	Orlando, Florida
PCOK	Site 1 in Ponca City, Oklahoma
PGMS	Pascagoula, Mississippi
PITX	Pickle Research Center in Austin, Texas
POOK	Site 2 in Ponca City, Oklahoma
PVAL	Providence, Alabama
RRTX	Round Rock, Texas
RTPNC	Research Triangle Park, North Carolina
S4MO	St. Louis, Missouri (Site #4)
SFSD	Sioux Falls, South Dakota

SIAL	Sloss Industries in Birmingham, Alabama
SJPR	San Juan, Puerto Rico
SKFL	Pinellas Park, Florida
SMFL	Simmons Park in Tampa, Florida
SPIL	Schiller Park in Chicago, Illinois
SYFL	Plant City, Florida
TRTX	Travis High School in Austin, Texas
TUMS	Tupelo, Mississippi
WETX	Webberville Road in Austin, Texas
YDSP	El Paso, Texas
YFMI	Yellow Freight in Detroit, Michigan

Abstract

This report presents the results and conclusions from the ambient air monitoring conducted as part of the 2005 Urban Air Toxics Monitoring Program (UATMP)—a program designed to characterize the magnitude and composition of potentially toxic air pollution in, or near, urban locations. The 2005 UATMP included 47 monitoring stations that collected 24-hour air samples, typically on a 6- or 12-day schedule plus special monitoring in the aftermath of Hurricane Katrina. Forty-six sites analyzed ambient air samples for concentrations of 60 volatile organic compounds (VOC) and/or 15 carbonyl compounds. Thirteen sites also analyzed for 80 speciated nonmethane organic compounds (SNMOC). Six sites analyzed for 19 semivolatile compounds (SVOC) while fifteen sites analyzed 11 metal compounds. Overall, nearly 170,000 ambient air concentrations were measured during the 2005 UATMP. An additional 34,000 ambient air concentrations were added due to Hurricane Katrina sampling. The summary presented in this report uses various graphical, numerical, and statistical analyses to put the vast amount of ambient air monitoring data collected into perspective.

Not surprisingly, the ambient air concentrations measured during the program varied significantly from city to city and from season to season. This report describes and interprets these spatial and temporal variations separately for halogenated hydrocarbons, hydrocarbons, polar compounds, and carbonyls.

The ambient air monitoring data collected during the 2005 UATMP serve a wide range of purposes. Not only do these data characterize the nature and extent of urban air pollution close to the 47 monitoring stations participating in this study, but they also indicate some trends and patterns that may be common to all urban environments. Therefore, this report presents some results that are specific to particular monitoring locations and presents other results that are apparently common to urban environments. These results should ultimately provide additional insight into the complex nature of urban air pollution. The final data are also included in the appendices to this report.

1.0 Introduction

Air pollution in urban locations incorporates many components that originate from a wide range of stationary, mobile, and natural emissions sources. Because some of these components include toxic compounds known or suspected to be carcinogenic, the U.S. Environmental Protection Agency (EPA) continues to encourage state, local, and tribal agencies to understand and appreciate the nature and extent of potentially toxic air pollution in urban locations. To achieve this goal, EPA sponsors the Urban Air Toxics Monitoring Program (UATMP) to characterize the composition and magnitude of urban air pollution through extensive ambient air monitoring. Since the inception of the UATMP in 1987, many environmental and health agencies have participated in the program to assess the causes and effects of air pollution within their jurisdictions. This report summarizes and interprets the 2005 UATMP monitoring effort, which includes up to twelve months of 1-in-6 and 1-in-12 day measurements of ambient air quality at 47 monitoring sites in or near 28 urban/rural locations including 22 metropolitan statistical areas (MSAs). Much of the analysis and data interpretation in this report focuses on pollutant-specific data trends.

The contents of this report provide both a qualitative overview of air pollution at selected urban and rural locations and a quantitative analysis of the factors that appear to affect urban and rural air quality most significantly. This report also focuses on data trends at each of the 47 different air sampling locations, a site-specific approach that allows for much more detailed analyses of the factors (e.g., stationary sources, mobile sources, natural sources) that affect air quality differently from one location to the next.

In the wake of Hurricane Katrina's devastation to the Gulf Coast in late August 2005, EPA, state, and local agencies in Mississippi and Louisiana developed and implemented an intensive sampling initiative to evaluate air, water, and sediment quality during the clean-up and recovery process. To evaluate air quality, a network of nearly 30 ambient monitoring sites was instituted in Louisiana and Mississippi. Two of those sites participated in the 2005 UATMP prior to Hurricane Katrina's landfall. At the request of the State of Mississippi, post-Katrina

data from the Pascagoula, MS and Gulfport, MS are also presented and compared to pre-Katrina data in a special analysis section in the Mississippi state analysis (Chapter 12).

The contents of this report offer participating agencies useful insights into important air quality issues. For example, participating agencies can use trends and patterns in the UATMP monitoring data to determine whether levels of air pollution present public health concerns, to identify which emissions sources contribute most to air pollution, or to forecast whether proposed pollution control initiatives might significantly improve air quality. Since 2001, EPA has been actively conducting the National Air Toxics Assessment (NATA), which uses air toxics emissions to model ambient monitoring concentrations across the nation. UATMP monitoring data may be used to compare modeling results, such as NATA. Policy-relevant questions may include:

- Which pollutants contribute the greatest risk on a short-term, intermediate-term, and long-term basis?
- Have pollutant concentrations decreased as a result of regulations?
- What anthropogenic sources contribute to air quality?

The data analyses in this report are applied at every participating UATMP monitoring site, where applicable, and present a comprehensive account of urban air pollution. However, state and local environmental agencies are encouraged to perform additional analyses of the monitoring data so that the many factors that affect their specific ambient air quality can be understood fully.

To facilitate examination of the 2005 UATMP monitoring data, the complete set of measured concentrations is presented in appendices of this report. In addition, these data are publicly available in electronic format from the Air Quality Subsystem (AQS) of EPA's Aerometric Information Retrieval System (AIRS) at http://www.epa.gov/ttn/airs/airsaqs/.

The remainder of this report is organized into 25 text sections and 12 appendices. Table 1-1 highlights the contents of each section. As with previous UATMP annual reports, all figures and tables in this report appear at the end of their respective sections (figures first, followed by tables).

Table 1-1. Organization of the 2005 UATMP Report

Report Section	Section Title	Overview of Contents
1	Introduction	Introduction to the history and scope of the UATMP.
2	The 2005 UATMP	This section provides background information on the scope of the 2005 UATMP and includes information about the: • Monitoring locations • Pollutants selected for monitoring • Sampling and analytical methods • Sampling schedules • Completeness of the air monitoring program.
3	Summary of the 2005 UATMP	This section, which presents and discusses significant trends and relationships in the UATMP data, characterizes how ambient air concentrations varied with monitoring location and with time, then presents an interpretation of the significance of the observed spatial and temporal variations.
4	Sites in Alabama	Monitoring results for Birmingham, AL MSA (ETAL, NBAL, PVAL, and SIAL)
5	Site in Colorado	Monitoring results for Grand Junction, CO MSA (GPCO)
6	Sites in Florida	Monitoring results for Orlando, FL MSA (ORFL), Miami-Ft. Lauderdale-Miami Beach, FL MSA (FLFL), and Tampa-St. Petersburg-Clearwater, FL MSA (AZFL, GAFL, SKFL, SMFL, and SYFL)
7	Sites in Illinois	Monitoring results for Chicago-Naperville-Joliet, IL-IN-WI MSA (NBIL and SPIL)
8	Site in Indiana	Monitoring results for Chicago-Naperville-Joliet, IL-IN-WI MSA (INDEM)
9	Site in Massachusetts	Monitoring results for Boston-Cambridge-Quincy, MA-NH MSA (BOMA)
10	Sites in Michigan	Monitoring results for Detroit-Warren-Livonia, MI MSA (APMI, DEMI, and YFMI), and Sault Sainte Marie, MI (ITCMI)
11	Site in Minnesota	Monitoring results for Minneapolis-St.Paul-Bloomington, MN MSA (MIMN)
12	Sites in Mississippi	Monitoring results for Grenada, MS (GRMS), Pascagoula, MS MSA (PGMS), and Tupelo, MS (TUMS). Post-Katrina monitoring results for Gulfport-Biloxi, MS MSA (GPMS) and Pascagoula, MS MSA (PGMS)

Table 1-1. Organization of the 2005 UATMP Report (Continued)

Report Section	Section Title	Overview of Contents
13	Site in Missouri	Monitoring results for St. Louis, MO-IL MSA (S4MO)
14	Sites in New Jersey	Monitoring results for New York-Newark-Edison, NY-NJ-PA MSA (CHNJ, ELNJ, and NBNJ) and Philadelphia-Camden-Wilmington, PA-NJ-DE-ND MSA (CANJ)
15	Sites in North Carolina	Monitoring results for Durham-Chapel Hill, NC MSA (RTPNC) and Candor, NC (CANC)
16	Sites in Oklahoma	Monitoring results for Ponca City, OK (PCOK and POOK)
17	Sites in Puerto Rico	Monitoring results for San Juan-Caguas-Guaynabo, PR MSA (BAPR and SJPR)
18	Sites in South Dakota	Monitoring results for Custer, SD (CUSD) and Sioux Falls, SD MSA (SFSD)
19	Sites in Tennessee	Monitoring results for Knoxville, TN MSA (LDTN) and Nashville-Davidson-Murfreesboro, TN MSA (DITN)
20	Sites in Texas	Monitoring results for Austin-Round Rock, TX MSA (MUTX, PITX, RRTX, TRTX, and WETX) and El Paso, TX MSA (YDSP)
21	Site in Utah	Monitoring results for Ogden-Clearfield, UT MSA (BTUT)
22	Site in Wisconsin	Monitoring results for Madison, WI MSA (MAWI)
23	Data Quality	This section defines and discusses the concepts of precision and accuracy. Based on quantitative and qualitative analyses, this section comments on the precision and accuracy of the 2005 UATMP ambient air monitoring data.
24	Conclusions and Recommendations	This section summarizes the most significant findings of the report and makes several recommendations for future projects that will involve ambient air monitoring in urban locations.
25	References	This section lists the references cited throughout the report.

2.0 The 2005 UATMP

The 2005 UATMP included 47 monitoring sites that collected 24-hour integrated ambient air samples for up to 12 months, at six or twelve day sampling intervals. Section 2.5 provides further details on each of the sampling methodologies. All UATMP samples were analyzed in a central laboratory for concentrations of selected hydrocarbons, halogenated hydrocarbons, and polar compounds from canister samples (TO-15), carbonyl compounds from cartridge samples (TO-11A), semivolatile organic compounds from XAD-2® thimbles (TO-13), and metals from filters (IO-3.5). The following discussion reviews the monitoring locations, pollutants selected for monitoring, sampling schedules, sampling and analytical methods, and completeness of the 2005 UATMP dataset.

2.1 Monitoring Locations

Although EPA sponsors the UATMP, EPA does not dictate the location of its monitoring stations. Rather, representatives from the state, local, and tribal agencies that voluntarily participate in the program and contribute to the overall monitoring costs select the monitoring locations based on specific siting criteria. Some monitors were placed near the centers of heavily populated cities (e.g., Chicago, IL and Philadelphia, PA), while others were placed in moderately populated areas (e.g., Candor, NC and Custer, SD).

Figure 2-1 shows the 28 urban and rural areas participating in the 2005 program. The site descriptions in Tables 2-1 and 2-2 and in Appendix A provide detailed information on the surroundings near the 2005 UATMP monitoring locations. Monitoring sites that are designated as part of EPA's National Air Toxic Trend Station (NATTS) network are indicated by bold type in Table 2-1. The NATTS network, consisting of 23 monitoring sites located in different geographical areas with varying population densities, was designed to allow EPA to evaluate the current state of air toxics, reduce emissions of these toxics, which will reduce the risk of cancer and other health effects, and to evaluate concentrations trends over time. The monitoring sites participating in previous UATMP programs are listed in Table 2-3, and are discussed further in Section 3.3.4, Site Trends Analysis. Sections 4 through 22 are state-specific breakdowns of the data analysis, and each contains topographic maps for each of the sites. Stationary source facilities within 10 miles of the monitoring sites are provided in these sections as well. The

location and category descriptions of these emissions sources were retrieved from the 2002 National Emission Inventory (NEI) (US EPA, 2006a).

As Figure 2-1 shows, the 2005 UATMP monitoring sites are distributed across the country. The monitoring data from these sites may indicate certain air quality trends that are common to all urban environments, but may also show distinct geographic trends. The analyses in this report differentiate those trends that appear to be site-specific from those that appear to be common to most urban environments.

Chemical concentrations measured during the 2005 UATMP varied significantly from monitoring site to monitoring site. As discussed throughout this report, the proximity of the monitoring locations to different emissions sources, especially industrial facilities and heavily traveled roadways, often explains the observed spatial variations in ambient air quality. To provide a first approximation of the contributions of stationary source emissions on ambient air quality at each site, Table 2-2 lists the number of people living within 10 miles of each monitoring location, as well as the stationary source emissions in the monitor's residing county, according to the 2002 NEI.

At every UATMP monitoring site, the air sampling equipment was installed in a temperature-controlled enclosure (usually a trailer or a shed) with the sampling inlet probe exposed to the ambient air. With this common setup, every UATMP monitoring site sampled ambient air at heights approximately 5 to 20 feet above local ground level.

For record keeping and reporting purposes, each of these sites was assigned:

- A unique UATMP site code – used to track samples from the monitoring sites to the laboratory; and
- A unique nine-digit AQS site code – used to index monitoring results in the AQS database.

This report often cites these codes when presenting selected monitoring results.

2.2 Pollutants Selected for Monitoring

Urban air pollution typically contains hundreds of components, including, but not limited to, volatile organic compounds (VOCs), carbonyl compounds, metals, and particulate matter. Because the sampling and analysis required to monitor for every component of air pollution has been prohibitively expensive, the UATMP instead focuses on measuring ambient levels of 60 VOCs (14 hydrocarbons, 37 halogenated hydrocarbons, and 9 polar compounds), 80 Speciated Nonmethane Organic Compounds (SNMOC), 15 carbonyl compounds, 19 Semivolatile Organic Compounds (SVOC), and 11 metals. Tables 2-4 through 2-8 identify the specific target pollutants and their corresponding experimentally-determined average method detection limits (MDL).

2.3 Sampling Schedules

Table 2-9 presents the dates on which sampling began and ended for each monitoring location. The UATMP monitoring locations started sampling in January 2005 and stopped sampling in December 2005, with the following exceptions. Sixteen sites began sampling after January 2005:

- Barceloneta and San Juan, PR sites (BAPR and SJPR) started in February 2005;
- Birmingham, AL sites (ETAL, NBAL, PVAL, SIAL) started in July 2005;
- Davie, FL site (FLFL) started in October 2005;
- Minnesota, MN site (MIMN) started in March 2005;
- Austin, TX sites (MUTX, PITX, RRTX, and WETX) started in June 2005;
- Travis High School in Austin, TX site (TRTX) started in July 2005;
- Ponca City, OK sites (PCOK and POOK) started in May 2005;
- El Paso, TX site (YDSP) started in March 2005;
- Northbrook, IL site (NBIL) started carbonyl sampling in March 2005 and Schiller Park, IL site (SPIL) started carbonyl sampling in February 2005;

Six sites ended sampling before December 2005:

- Allen Park in Detroit, MI site (APMI) ended in November 2005;
- Grenada, MS site (GRMS) ended in May 2005;
- Sault St. Marie, MI site (ITCMI) ended VOC sampling in August 2005 and SVOC sampling in September 2005;
- Ponca City, OK site (PCOK and POOK) ended in July 2005;
- Yellow Freight in Detroit, MI site (YFMI) ended in October 2005;

According to the UATMP schedule, 24-hour integrated samples were to be collected at every monitoring site approximately once every 6- or 12-days (dependent upon location) and each sample collection began and ended at midnight, local standard time. At each site, VOC and carbonyl samples were collected concurrently, except for the following sites:

- North Carolina sites (CANC and RTPNC) - carbonyls only;
- El Paso, TX (YDSP) – VOC only;
- Florida sites (AZFL, FLFL, GAFL, ORFL, SKFL, SMFL, and SYFL) - carbonyls only;
- Gary, IN (INDEM) - carbonyls only;
- Intertribal Council site in Sault Sainte Marie, MI (ITCMI) - VOC only;
- Ponca City sites (PCOK & POOK) – VOC only; and
- Yellow Freight site in Detroit, MI (YFMI) - VOC only.

Of the 47 sites, only one did not sample for VOCs and/or carbonyls - BOMA in Boston, MA. The following six sites sampled SVOCs:

- Birmingham, AL sites (ETAL, NBAL, PVAL, and SIAL);
- Intertribal Council site in Sault Sainte Marie, MI (ITCMI);
- Yellow Freight site in Detroit, MI (YFMI).

The following thirteen sites also collected SNMOC samples:

- Austin, TX (MUTX, PITX, RRTX, TRTX, and WETX) – Total NMOC only;
- Bountiful, UT (BTUT);
- Custer, SD (CUSD);
- Northbrook site in Chicago, IL (NBIL);
- Pascagoula, MS (PGMS);
- Ponca City, OK (PCOK & POOK);
- Sioux Falls, SD (SFSD); and
- St. Louis, MO (S4MO).

Finally, fifteen sites collected metal samples:

- Austin, TX (MUTX, PITX, RRTX, TRTX, and WETX);
- Birmingham, AL (ETAL, NBAL, PVAL, and SIAL);
- Boston, MA (BOMA);
- Bountiful, UT (BTUT);
- Madison, WI (MAWI);
- Minneapolis, MN (MIMN);
- Northbrook in Chicago, IL (NBIL); and
- St. Louis, MO site 4 (S4MO).

As part of the sampling schedule, site operators were instructed to collect duplicate samples on roughly 10% of the sampling days. Sampling calendars were distributed to help site operators schedule the collection of samples, duplicates, and field blanks. In cases where monitors failed to collect valid samples on a scheduled sampling day, site operators sometimes rescheduled samples for other days. This practice explains why some monitoring locations periodically strayed from the 6- or 12-day sampling schedule. The State of Michigan prepared a schedule that allowed Michigan's Department of Environmental Quality's laboratory to share samples with ERG's laboratory.

The 6- or 12-day sampling schedule permits cost-effective data collection for trends characterization (annual-average concentrations) of toxic compounds in ambient air and ensures that sampling days are evenly distributed among the seven days of the week to allow weekday/weekend comparison of air quality.

2.4 Completeness

Completeness refers to the number of valid samples collected compared to the number of samples expected from a 6- or 12-day sampling cycle. Monitoring programs that consistently generate valid results have higher completeness than programs that consistently invalidate samples. The completeness of an air monitoring program, therefore, can be a qualitative measure of the reliability of air sampling equipment and laboratory analytical equipment and a measure of the efficiency with which the program was managed. Appendix B identifies samples that were invalidated and lists the specific reasons why the samples were invalidated.

Table 2-9 summarizes the completeness of the monitoring data sets collected during the 2005 UATMP:

- For VOC sampling, the completeness ranged from 68 to 100%, with an overall completeness of 92%;
- For carbonyl sampling, the completeness ranged from 68 to 100% with an overall completeness of 95%;

- For SNMOC sampling, the completeness ranged from 50 to 100% with an overall completeness of 92% for all sites;

- For SVOC sampling, the completeness was 88 to 100% with an overall completeness of 93% for all sites; and

- For metals sampling, the completeness for all sites and the overall completeness was 100%.

The UATMP data quality objectives are based on the 2005 EPA-approved Quality Assurance Project Plan (QAPP), where 85-100% of samples collected at a given monitoring station must be analyzed successfully to be considered sufficient for data trends analysis. The data in Table 2-9 shows that 11 data sets (from a total of 110 data sets) for the 2005 UATMP monitoring stations did not meet this data quality objective. These data sets were lower than the 85% criteria for a number of reasons. One site did not meet the objective because sampling ended before they made up their required make-up samples (APMI). Other sites were having sampling issues that would not allow make-up samples to be performed (CHNJ, MUTX, SIAL, SJPR, WETX). One hundred percent completeness was achieved for five carbonyl monitoring sites, six VOC monitoring sites, three SNMOC monitoring sites, one SVOC monitoring site, and fifteen metals monitoring sites.

2.5 Sampling and Analytical Methods

During the 2005 UATMP, four EPA-approved methods were used to characterize urban air pollution:

- *Compendium Method TO-15* was used to measure ambient air concentrations of 60 VOC and 80 SNMOC;

- *Compendium Method TO-11A* was used to measure ambient air concentrations of 15 carbonyl compounds;

- *Compendium Method TO-13A* was used to collect ambient air concentrations of 19 SVOC; and

- *Compendium Method IO-3.5* was used to collect ambient concentration of 11 metals.

The following discussion presents an overview of these sampling and analytical methods. For detailed descriptions of the methods, readers should refer to EPA's original documentation of the Compendium Methods (US EPA, 1998b; US EPA, 1999a; US EPA, 1999b; US EPA, 1999c; US EPA, 1999d).

2.5.1 VOC Sampling and Analytical Method

As specified in the EPA method, ambient air samples for VOC analysis were collected in passivated stainless steel canisters. The central laboratory distributed the prepared canisters (i.e., cleaned and evacuated) to the UATMP monitoring sites before each scheduled sampling event, and site operators connected the canisters to air sampling equipment prior to each sampling day. Before their use in the field, the passivated canisters had internal pressures much lower than atmospheric pressure. Because of this pressure differential, ambient air naturally flowed into the canisters once they were opened, and pumps were not needed to collect ambient air for VOC analysis. A flow controller on the sampling device ensured that ambient air entered the canister at a constant rate across the collection period. At the end of the 24-hour sampling period, a solenoid valve automatically stopped ambient air from flowing into the canister, and site operators returned the canisters to the central laboratory for analysis.

By analyzing each sample with gas chromatography incorporating mass selective detection and flame ionization detection (GC/MS-FID), laboratory staff determined ambient air concentrations of 60 VOC (14 hydrocarbons, 37 halogenated hydrocarbons, and nine polar compounds), 80 SNMOC, and total NMOC (TNMOC), which is the sum of all hydrocarbon concentrations within the sample. Because isobutene and 1-butene elute from the GC column at the same time, the VOC analytical method reports only the sum of the concentrations for these compounds, and not the separate concentrations for each compound. The same situation applies to *m*-xylene and *p*-xylene.

A note regarding samples of acetonitrile: laboratory analysts indicated that the values may be artificially high (or nonexistent) due to site conditions and potential cross-contamination with concurrent sampling of carbonyl compounds. At the time of the report, studies are being

conducted to determine the validity of these values, and readers must exercise caution when interpreting acetonitrile monitoring data.

Table 2-4 summarizes the MDLs for the laboratory analysis of the VOC samples and Table 2-5 summarizes the MDLs for the SNMOC samples. Although the sensitivity of the analytical method varies from pollutant to pollutant, the detection limit for VOC reported for every pollutant is lower than 0.25 parts per billion by volume (ppbv). Speciated Nonmethane Organic Compound (SNMOC) detection limits are expressed in parts per billion carbon (ppbC). All of the detection limits were less than 0.82 ppbC.

Due to analytical technique modifications to incorporate acrolein to the VOC analyses, detection limits were improved and the following pollutants were detected at higher frequencies: Dichlorotetrafluoroethane, vinyl chloride, 1,3-butadiene, bromomethane, chloroethane, acetonitrile, acrolein, acrylonitrile, methy tert-butyl ether, methyl ethyl ketone, bromodichloromethane, trichloroethyelene, methyl isobutyl ketone, dibromochloromethane, n-octane, chlorobenzene, *p*-dichlorobenzene, 1,2,4-trichlorobenzene, and hexachloro-1,3-butadiene.

Appreciating Detection Limits

All detection limits of the analytical methods must be considered carefully when interpreting the corresponding ambient air monitoring data. By definition, detection limits represent the lowest concentrations at which laboratory equipment have been experimentally determined to reliably quantify concentrations of selected pollutants to a specific confidence level. If a chemical concentration in ambient air does not exceed the method sensitivity (as gauged by the detection limit), the analytical method might not differentiate the pollutant from other pollutants in the sample or from the random "noise" inherent in laboratory analyses. Therefore, when samples contain concentrations at levels below their respective detection limits, multiple analyses of the same sample may lead to a wide range of results, including highly variable concentrations or "nondetect" observations. Data analysts must exercise caution when interpreting monitoring data with many reported concentrations at levels near or below the corresponding detection limits.

MDLs are determined at the ERG analytical laboratory using 40 CFR, Part 136 Appendix B procedures. This procedure involves analyzing at least seven replicate standards prepared on/in the appropriate sampling media (per analytical method). Instrument detection

limits are not determined (replicates of standards only) because sample preparation procedures are not considered.

Because nondetect results significantly limit the range of data interpretations for ambient air monitoring programs, participating agencies should note that the approach for treating nondetects may slightly affect the magnitude of the calculated central tendency concentrations, especially for compounds with a low detection rate. The nondetect is treated as a valid data point that can be used, in conjunction with back trajectories, for validation of nearby emission sources. For calculations of seasonal and annual averages, nondetects were substituted with one-half of the MDL per pollutant.

Similar to 2005, the reportable SNMOC analysis option was combined with the standard VOC sampling. These data are presented in Appendix H and I.

2.5.2 Carbonyl Sampling and Analytical Method

Following the specifications of EPA Compendium Method TO-11A, ambient air samples for carbonyl analysis were collected by passing ambient air over silica gel cartridges coated with 2,4-dinitrophenylhydrazine (DNPH), a compound known to react selectively and reversibly with many aldehydes and ketones. Carbonyl compounds in ambient air remain within the sampling cartridge, while other compounds pass through the cartridge without reacting with the DNPH-coated matrix. As with the VOC sampling, the central laboratory distributed the silica gel cartridges to the monitoring sites, and site operators connected the cartridges to the air sampling equipment. After each 24-hour sampling period, site operators returned the cartridges to the central laboratory for chemical analysis.

To quantify concentrations of carbonyls in the sampled ambient air, laboratory analysts eluted the exposed silica gel cartridges with acetonitrile. This solvent elution liberated a solution of DNPH derivatives of the aldehydes and ketones collected from the ambient air. High-performance liquid chromatography (HPLC) analysis and ultraviolet detection of these solutions determined the relative amounts of individual carbonyls present in the original air sample. Because butyraldehyde/isobutyraldehyde elute from the HPLC column at the same time, the

carbonyl analytical method can report only the sum of the concentrations for these compounds, and not the separate concentrations for each compound. For the same reason, the analytical method reports only the sum of the concentrations for the three tolualdehydes isomers, as opposed to reporting separate concentrations for the three individual compounds.

Table 2-6 lists the MDLs reported by the analytical laboratory for measuring concentrations of 15 carbonyl compounds. Although the sensitivity of the analytical method varies from pollutant to pollutant and from site to site, the detection limit reported by the analytical laboratory for every pollutant is less than or equal to 0.02 ppbv with a 1000L sample volume. The treatment of nondetects for carbonyl compounds is similar to the procedure described for VOCs, with the substitution of a zero for calculating seasonal and annual averages.

2.5.3 Semivolatile Sampling and Analytical Method

Semivolatile sampling was performed by the sites in accordance with EPA Compendium Method TO-13A. ERG supplies prepared sampling media and receives the samples from the sites for analysis only. Semivolatile sampling modules containing polyurethane foam (PUF) and petri dishes containing filters, together with Chain of Custody forms and all associated documentation, were shipped to the ERG laboratory from the field. Upon receipt at the laboratory, sample preparation and analysis procedures are based on Compendium Method TO-13A.

Table 2-7 lists the MDLs for the laboratory analysis of the SVOC samples. MDLs for semivolatile organic compounds ranged from 0.08 to 0.49 pg/m^3, in an average sample volume of 200 m^3. The treatment of nondetects for semi-volatile organic compounds is similar to the procedure described for VOCs and carbonyls, with the substitution of a zero for calculating seasonal and annual averages.

2.5.4 Metals Sampling and Analytical Data

Metals sampling was performed by the sites in accordance with EPA Compendium Method IO-3.5 for inorganic compounds (metals). Metals filters, together with Chain of Custody forms and all associated documentation, were shipped to the ERG laboratory from the field. Upon receipt, filters were analyzed by the ERG laboratory.

Table 2-8 lists the MDLs for the laboratory analysis of the metal samples. Two types of filters were utilized. The BTUT sites used a small round 47mm filter (assuming a 20 m^3 volume) while the remaining sites used a large 8 X 10 inch Quartz filter (assuming a 2000 m^3 volume). Therefore, there are two sets of MDLs listed in Table 2-8. The MDLs ranged from 0.101 to 1.03 ng/m^3 for the 47mm filters and from 0.0172 to 1.26 ng/m^3 for the 8 X 10 filters. The treatment of nondetects for metals is similar to the procedure described for VOCs, carbonyls, and semivolatiles, with the substitution of a zero for calculating seasonal and annual averages.

Figure 2-1. Monitoring Sites and Associated MSAs for the 2005 UATMP

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
APMI	Allen Park, Detroit, MI	Commercial	Suburban	60,000	Unknown	The Allen Park site is an intermediate site located in a residential neighborhood 300 feet away from I-75. Historically, this site has been used to detect impacts from mobile sources. There are no major industrial sources within a half-mile of the site. Of all the population-oriented sites in the Detroit MSA, Allen Park has the highest PM_{10} levels. Therefore, Allen Park has been selected as the $PM_{2.5}$ trend speciation site and the collocated site for the federal reference method (FRM) monitors. Other criteria pollutant measurements that are collected at Allen Park include CO, O_3, SO_2, and $PM_{10.}$
AZFL	Azalea Park, St. Petersburg, FL	Residential	Suburban	51,000	Unknown	A neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay pilot project. This monitor is sited in an area of high population density with uniform mixed land use, consisting of residential, commercial, and industrial properties. Major point sources are located approximately 2 to 10 miles from the monitoring site. In addition, this site is at least 150 meters from major roadways. However, given the proximity of motor vehicle traffic it is expected that mobile sources will contribute appreciably to the measured samples.
BAPR	Barceloneta, PR	Residential	Rural	10	1994	The Barceloneta site is a residential area surrounded by 5 pharmaceutical plants. The greater area outside the city is rural in character and the city itself is within 2 miles of the Atlantic Ocean.
BOMA	**Boston, MA**	Commercial	Urban	27,287	2000	The Boston site is located in a residential neighborhood on Harrison Avenue in Dudley Square. Its purpose is to measure population exposure for a city bus terminal which is located across the street from the monitor and other urban sources.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
BTUT	**Bountiful, UT**	Residential	Suburban	33,310	2002	The Bountiful Viewmont site is located in a suburban area of the Ogden-Clearfield MSA, at 171 West 1370 North in Bountiful, Utah. This site is a relocation of the BOUT site, which was about 1.1 miles south of the new site. The site is located on the grounds of Viewmont High School, adjacent to a parking lot, tennis courts, and a football field. The surrounding neighborhood is made up of residential properties. BTUT is a SLAMS neighborhood-scale site for monitoring population exposure to SO_2, CO, NO_2, and $PM_{2.5}$; and a NAMS neighborhood-scale site for monitoring maximum ozone concentrations. Speciated $PM_{2.5}$ sampling, meteorological monitoring, and NATTS air toxics sampling are also done at the Bountiful Viewmont site. Several petroleum refineries are located two to five miles away from the site, as are several sand and gravel mining operations.
CANC	Candor, NC	Forest	Rural	100	1999	The Candor, NC, site is in rural Montgomery Co., at the end of a private dead end road named Perry Dr. The site sits approximately 1.5 miles off a main road (McCallum Rd.). There is not a pollution source within 5 miles of the site. EPA also monitors next to this site.
CANJ	Camden, NJ	Residential	Suburban	62,000	1986	Although this monitoring site in Camden, NJ, is in a residential area, numerous industrial facilities and busy roadways are located within a 10 mile radius. The monitors are situated in a parking lot of a business complex.
CHNJ	Chester, NJ	Agricultural	Rural	12,623	1995	The Chester, NJ, site is located in a rural-agricultural, residential section and is topographically rolling. The site is located near Lucent Laboratory Building #1. There is potential population exposure to ozone, NO_2, and SO_2.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
CUSD	Custer, SD	Residential	Suburban	1,940	2002	The site is located on the edge of an urban area, in a pasture across the road from the last housing development on the east side of the City of Custer. The city has a population of 1,860 and is the largest city in the county. The city is located in a river valley in the Black Hills with pine covered hills on the north and south sides of the valley. The site is located in the center of the valley on the east side of the city. Major sources near the site include vehicles (highest traffic counts from May through September), forest fires (mainly during July through September), wood burning for heat, and wildland heath fires (during the winter months). The main industries in the area include tourism, logging, and mining of feldspar/quartz.
DEMI	**Dearborn in Detroit, MI**	Industrial	Suburban	12,791	1990	The Dearborn, MI site is located in a residential neighborhood with industrial impacts. An auto and steel manufacturing plant is located in close proximity to the monitoring site. Previous violations of the PM_{10} standard have also occurred at this site. The site lies between I-75 and I-94. This site is expected to show some of the highest levels of air toxics in the Detroit Pilot program area. The SO_2 and PM_{10} measurements are also made there.
DITN	Dickson, TN	Commercial	Urban	4,420	2003	The Dickson, TN site was set up due to public concern about air emissions from several sources in an industrial park. Among these sources is one that cast aluminum engine blocks, one that reclaims scrap metal, and a large printing company.
ELNJ	Elizabeth, NJ	Industrial	Suburban	170,000	Unknown	The Elizabeth site is located in Union County, NJ, at an urban-industrial site where the topography is relatively smooth. The monitoring site is located 75 yards away from the Toll Plaza and about one mile from Bayway Refinery. The neighborhood scale is at maximum concentration. The location has a PM_{10} filter analyzer for sulfates and nitrates as well as the UATMP site.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
ETAL	East Thomas, Birmingham, AL	Residenital	Suburban	30,000	Unknown	This SLAMS microscale roadway site (located at the intersection of Finley Avenue and Arkadelphia Road) has a thirty-five year history of ambient air monitoring. This site is used mainly to monitor vehicle emissions. It is also an environmental justice site in that most of the residences in the area are owned and occupied by minorities. It is also located in a valley that is heavily industrialized. This site has also yielded some of the county's highest reported particulate levels. There have been several special roadway emission studies performed at this site over the past few years, the latest of which was pertaining to the contribution of $PM_{2.5}$ particles from roadway emissions.
FLFL	Davie, FL	Commercial	Suburban	8000	Unknown	The site is located on the campus of the University of Florida, Agricultural Research Center in Davie, Florida. It is located in a generally residential area that is surrounded by 4 major thoroughfares in the county (~1 mile from I-595, ~2 miles from the Florida Turnpike, ~6 miles from I-95, and ~6 miles from I-75). It is located ~ 6 miles from the Ft. Lauderdale-Hollywood International Airport and ~9 miles from Port Everglades. It is in an area generally representative of the ambient air conditions experienced throughout the county. It is expected that this site will become an NCORE type II site in the near future.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
GAFL	Gandy in Tampa, FL	Commercial	Suburban	81,460	Unknown	A neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay Region Air Toxics Study Monitoring Stations (TBRATS) pilot project. This monitor is sited in an area of high population density with uniform mixed land use, consisting of residential, commercial, and industrial properties. Major point sources are located greater than one mile from the monitoring site. Since the emission points from these sources are elevated and not proximate to the monitor, concentrations measured during this study should not be dominated by a single source. In addition, this site is at least 150 meters from major roadways. However, given the proximity of motor vehicle traffic, mobile sources are expected to contribute appreciably to the measured samples.
GPCO	**Grand Junction, CO**	Commercial	Urban	19,572	2000-2002	This site is a small 1-story shelter that houses the VOC/carbonyl sampler. The inlet for this sampler is 13' above the ground and 35' south of Pitkin Avenue. This site also has meteorological sensors (WS, WD, T, RH) on a 10 meter tower, a carbon monoxide sampler and a continuous PM_{10} sampler. Monitoring is being conducted on the southeast side of the downtown area. The area is very mixed usage, with commercial business to the west, northwest and north, residential to the northeast and east, and industrial to the southeast, south and southwest. The location is next to one of the major east-west roads in Grand Junction.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
GRMS	Grenada, MS	Agricultural	Rural	1,100	2000	The Grenada County monitoring site was established because it was identified by Region IV's Air Toxics Monitoring Network planning effort as a county where toxic emissions concentrations were expected to be higher and pose a higher than normal risk to residents. There are several major industries in the area that are primarily involved in the surface coating industry. The area is moderately populated but the area itself would be considered rural.
INDEM	Gary, IN	Industrial	Urban	42,950	1990	This site is located on property now owned by the Dunes National Lakeshore. It is approximately one-half to three-quarters of a mile south west of the USX coking battery for their mill. The site is part of the Chicago PAMS network. It is considered a Type 2 or source site. Monitoring for ozone, NO/NO_x, ozone precursors, and carbonyls began in 1995 as the network was deployed in Wisconsin, Illinois, Indiana, and Michigan. Other parameters monitored at this location are SO_2, PM_{10}, $PM_{2.5}$, speciated $PM_{2.5}$, and several meteorological parameters.
ITCMI	Sault Sainte Marie, MI	Residential	Rural	100,000	1990	Tribal members had issued complaints arising from the smell and clouds being produced from a steel plant and paper mill located on the other side of the Saint Mary's River. The site is located on Lake Superior State University campus, which is a residential area. This site includes two sequential $PM_{2.5}$ filter based FRM monitors (primary and a collocated), a $PM_{2.5}$ speciation monitor, a $PM_{2.5}$ TEOM monitor, an AVOCS monitor, a PAH monitor, a meteorological station, and a large particulate matter collector (dustfall monitor).

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
LDTN	Loudon, TN	Residential	Suburban	13,360	2003	The site was set up due to public concern about air emissions from several sources in an industrial park. Among these sources is a very large facility that processes corn to make corn syrup, A.E. Staley, a sausage casing manufacturer, boat manufacturer, paper products manufacturer, waste metal reclamation, waste paper reclamation, and others.
MAWI	Madison, WI	Residential	Urban	23,750	1993	The Madison monitoring site is located on the East High School's Killiher Athletic field, near the corner of Hoard and Fifth Street. The monitoring site was originally established in 1992 as an ozone monitoring site. Air toxics monitoring was added in 2002 as part of the Region 5 State and Local Regional Air Toxics Monitoring Strategy. The site was selected to provide new monitoring data for a midsize city experiencing urban growth.
MIMN	Minneapolis, MN	Commercial	Urban	10,000	2000	This site is used to characterize urban air mass in Minneapolis. The site resides in an urban business district, primarily offices and retail shops, city government and warehouses. Nearby sources (less than 1.5 miles from) include Hennepin Energy Recovery Center (HERC) (which uses mass burn technology to convert 365,000 tons of garbage a year into electricity), NRG Energy Center Minneapolis LLC Steam and Air-Conditioning Supply, and Hennepin County Medical Center. There is also a high density of mobile sources and some light manufacturing industries.
MUTX	Murchison MS in Austin, TX	Residential	Suburban	4,374	2002	This site is located between a parking lot and the athletic fields at Murchison Middle School. The site is also located fairly close to the roadway running in front of the school.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
NBAL	North Birmingham, AL	Commercial	Urban	2,000	1994	This NAMS neighborhood scale site (located in North Birmingham) is a super site with a thirty-five year history of ambient air monitoring. It is an environmental justice site in that most of the residences in the area are owned and occupied by minorities. It is located in a valley that is heavily industrialized. This site yields the one of county's highest reported particulate levels.
NBIL	**Northbrook in Chicago, IL**	Residential	Suburban	29,600	2001	The village of Northbrook is located in northeast Cook County. This monitoring site is located at the Northbrook Water Filtration Station at 750 Dundee Road. A forest preserve is located immediately south with residential areas farther south (southeast to southwest). Residential areas are also immediately to the west. Commercial areas are located along Dundee Road and to the east. A major expressway (I-94) is located 1 km to the east and north. O'Hare Airport is located 18 km to the southwest and the Chicago Loop is located 32 km to the southeast.
NBNJ	New Brunswick, NJ	Agricultural	Rural	63,000	Unknown	The New Brunswick site is located in a suburban-agricultural, residential area and is topographically smooth. The actual site location is in Rutgers University's Horticultural Farm.
ORFL	Winter Park, FL	Commercial	Urban	59,000	Unknown	The site is an Urban/Neighborhood spatial scale site to determine the concentrations of the EPA Criteria pollutants (and now Air Toxics) to which the area population may be exposed. The primary emission source is motor vehicles with some commercial businesses also in the area.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
PCOK	Site 1 in Ponca City, OK	Commercial	Urban	8,100	2004	Based on a joint OkDEQ and EPA Region 6 project using the RAIMI (Regional Air Impact Modelling Initiative) techniques to identify and map the cancer risks from inhalable pollutants for Ponca City, OK, the highest risk not on the Conoco-Phillips property was a narrow strip directly north of the refinery. The PCOK site is located in this area, just across the highway from the refinery. Possible influences would include the refinery itself, and the highway (US 77) on the south side of the site location.
PGMS	Pascagoula, MS	Commercial	Urban	8,600	2000	The Pascagoula site is in a mostly commercial area in proximity to perhaps the largest industrial area in Mississippi. The industries near the Pascagoula site include chemical processes, petroleum refining, and ship building.
PITX	Pickle Research Center, Austin, TX	Residential	Suburban	33,936	2005	The Pickle Research Center is located in close proximity to MOPAC (Loop 1), a major Austin-specific north—south thoroughfare. It is also bounded on one side by Braker Lane, a four to six lane east—west road in Austin.
POOK	Site 2 in Ponca City, OK	Residential	Urban	3,800	2004	This site was established in 1995 in Ponca City. This source-oriented site also operates SO_2, $PM_{2.5}$, and PM_{10} monitors. This north-central Oklahoma site is used to monitor nearby refineries.
PVAL	Providence, AL	Residential	Rural	Unknown	Unknown	This SLAMS urban scale general background site (located in the western-most corner of Jefferson County) was established in the fall of 1999 to monitor background levels of ozone and $PM_{2.5}$ in the county, to get a better idea of what concentrations were entering the county, and to give better resolution at that time for the ozone mapping program. It is a rural site in that there are not many residences in the area and most of the land use is agricultural. It is located on a rural mountaintop on the edge of a field used for horse grazing. It is an excellent site for a background air toxics monitor.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
RRTX	Round Rock, TX	Commercial	Suburban	20,900	2004	The RRTX site is located in Round Rock, TX, north of Austin. The site is located south of FM 3406 and east of the I-35 corridor, at the deadend of Commerce Blvd. It was selected for an emphasis on a variety of factors: upwind of industrial facilities, population density (weighed heavily), and mobile source traffic (this location is fairly close to I-35, the north—south corridor through Austin into Round Rock).
RTPNC	Research Triangle Park, NC	Commercial	Suburban	12,000	2003	The RTP site is located on the north side of the EPA campus. It is approximately 600 meters south of interstate I-40. There are trees to the east of the site, sloping down from the site to the trees. The height of the tallest tress (relative to the sampling port) to the east is less than 2 times the distance to the trees. The site has at least 270E clearance around the site.
S4MO	**St. Louis, MO**	Residential	Urban	22,840	1995	Blair Street has some industry around it and a fair amount of industry to the east. The site is also only about 250 meters from I-70 (at its closest point).
SFSD	Sioux Falls, SD	Residential	Urban	4,320	1999	The SFSD monitoring site is located in Sioux Falls, SD, the largest city in the state, near two grade schools north of the site and residential areas on the west, east, and south. The area within 1 mile of the site is mostly residential with a few retail businesses. The main industrial area of the city is about 3 miles northwest and 2 miles to the west of the site. The site was selected because it represents population exposure to chemical and particulate emissions from the industrial parts of the city. The predominant wind direction is northwest for most of the year with southeast winds during the summer months.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
SIAL	Sloss Industries, Birmingham, AL	Residential	Urban	2,700	1993	This SPM neighborhood scale site (located between North Birmingham and Tarrant) has been in operation since 1994. It was established as an environmental justice site to monitor the emissions of a slag wool plant and a coke plant and is located next door to several residences in a residential area directly across the street from the plants.
SJPR	San Juan, PR	Industrial	Suburban	250	1992	The San Juan site is located at Bayamón Municipio, in the Regional Jail. The San Juan Metropolitan Area (SJMA) is affected by the emissions from stationary sources and by the heavy daily traffic. This geographical area is one of the Island's most polluted areas. The selected location is an open area representing a neighborhood scale in which the industrial area merges with the residential areas. The incidence of respiratory diseases is one of the general concerns (for the community and for the government). In general, the concentrations for the criteria pollutants are under the standards. But air toxics were not sampled for previously.
SKFL	**Skyview in Pinellas Park, FL**	Residential	Suburban	50,500	2003	This air monitoring site is located in south central Pinellas County at Skyview Elementary School, 8601 60th St. N., Pinellas Park, Florida. This site is a NATTS and samples for all pollutants/parameters required by NATTS, including VOCs, carbonyls, metals, PM-2.5 speciation, and black carbon. In addition, measurements are made for wind speed, wind direction, ambient pressure, and ambient temperature. Site spatial scale is neighborhood. This is a population-oriented site.
SMFL	Simmons Park in Tampa, FL	Unknown	Unknown	18,700	Unknown	Neighborhood spatial scale of representativeness characterizes this monitoring site selected for the Tampa Bay pilot project. East Lake monitor is in an area of low population density and it is representative of urban background concentrations for the Tampa Bay metro area. Major point sources are located approximately 8 to 15 km and at 150 m from major roadways.

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
SPIL	Schiller Park in Chicago, IL	Mobile	Suburban	214,900	2001	This monitoring site is located on a trailer at 4743 Mannheim Road just south of Lawrence Ave. and between Mannheim Road and I-294. The closest runway at O'Hare Airport is 0.5 km to the northwest. The immediate vicinity is mostly commercial. Residential areas are located east across I-294.
SYFL	**Sydney in Plant City, FL**	Residential	Rural	5,142	2002	The site in Sydney is a NATTS neighborhood/rural site. Monitoring has been occurring at Sydney for 5 years as a background site. Current development in the area warranted it becoming a NATTS site. The Sydney site is also being used for an intercomparison of the port of Tampa as compared to a neighbor/rural site.
TRTX	Travis HS in Austin, TX	Residential	Suburban	27,114	2004	This site is wedged between a parking lot, tennis courts, and the baseball field at Travis High School. The site was selected for an emphasis on a variety of factors: upwind of industrial facilities, population density (weighed heavily), and mobile source traffic (this location is fairly close to I-35 north—south corridor through Austin into Round Rock). The Travis High School site is approximately two miles south of Town Lake/the Colorado River.
TUMS	Tupelo, MS	Commercial	Suburban	4,900	1995/1997	The Tupelo site is in a light commercial and residential area. This site was selected because this area is believed to have high ambient air toxic concentrations based upon information from the NATA study and Mississippi's major source emission inventories.
WETX	Webberville Road in Austin, TX	Residential	Urban	5,733	2003	The WETX site is located in a parking lot near the intersections of Webberville Rd and Northwestern Ave and Webberville Rd and Pedermales St. Railroad tracks run parallel with Northwestern Ave. The site was selected for an emphasis on a variety of factors: upwind of industrial facilities, population density (weighed heavily), and mobile source traffic (this location is fairly close to I-35 north—south corridor through Austin into Round Rock).

Table 2-1. Text Descriptions of the 2005 UATMP Monitoring Sites (Continued)

UATMP Code	Monitoring Site	Land Use	Location Setting	Estimated Traffic (# vehicles)	Traffic Year Estimate	Description of the Immediate Surroundings
YDSP	El Paso, TX	Residential	Suburban	12,400	2003	This site is located in a vacant lot adjacent to the YDSP Tribal Courthouse. According to a 2003 traffic count conducted by TxDOT, this portion of Socorro Road averages 10,200 vehicles per work day. The site is approximately 50 meters northwest of the Old Reservation subdivision.
YFMI	Yellow Freight in Detroit, MI	Industrial	Urban	500	Unknown	The Yellow Freight site currently collects SO_2 measurements and is located in the center of a highly industrialized area. The primary influence is from a nearby car battery plant. The site is about 2.25 miles away from the Dearborn site. Its inclusion in the study provides information about the degree of heterogeneity of toxic air contaminants across a small scale.

BOLD = EPA-designated National Air Toxics Trend System (NATTS) site.

Table 2-2. Site Descriptions for the 2005 UATMP Monitoring Sites

2005 UATMP Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI[b] (tpy)	Closest National Weather Service Station
APMI	26-163-0001	Allen Park in Detroit, MI	964,194	9,319	Detroit/Metropolitan Airport
AZFL	12-103-0018	Azalea Park in St. Petersburg, FL	572,722	2,826	St. Petersburg/Whitted Airport
BAPR	72-017-0003	Barceloneta, PR	Unknown	410	San Juan, PR, Luis Munoz Marin Int'l Airport
BOMA	25-025-0042	Boston, MA	1,589,367	1,646	General Logan Int'l. Airport
BTUT	49-011-0004	Bountiful, UT	243,462	955	Salt Lake City International
CANC	37-123-0001	Candor, NC	11,014	180	Moore County Airport
CANJ	34-007-0003	Camden, NJ	2,030,976	1,399	Philadelphia International Airport
CHNJ	34-027-3001	Chester, NJ	234,148	1,265	Somerville, NJ,Somerset Airport
CUSD	46-033-0003	Custer, SD	4,449	23	Custer County Airport
DEMI	26-163-0033	Dearborn in Detroit, MI	1,201,847	9,319	Detroit Metropolitan Airport
DITN	47-043-0010	Dickson, TN	29,214	1,216	Outlaw Field Airport
ELNJ	34-039-0004	Elizabeth, NJ	2,179,781	2,069	Newark Int'l Airport

Table 2-2. Site Descriptions for the 2005 UATMP Monitoring Sites (Continued)

2005 UATMP Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI[b] (tpy)	Closest National Weather Service Station
ETAL	01-073-0028	East Thomas in Birmingham, AL	399,149	4,934	Birmingham Int'l Airport
FLFL	12-011-1002	Davie, FL	1,312,485	7,298	Ft Lauderdale, FL, Hollywood Int'l Airport
GAFL	12-057-1065	Gandy in Tampa, FL	462,119	7,247	Tampa, FL Int'l Airport
GPCO	08-077-0018	Grand Junction, CO	106,900	555	Walker Field Airport
GRMS	28-043-0001	Grenada, MS	21,446	487	Greenwood-Leflore Airport
INDEM	18-089-0022	Gary, IN	404,545	3,311	Lancing Municipal Airport
ITCMI	26-033-0901	Sault Sainte Marie, MI	22,188	194	Sault Ste. Marie Municipal Airport
LDTN	47-105-0108	Loudon, TN	46,750	1,551	McGhee Tyson Airport
MAWI	55-025-0041	Madison, WI	356,676	2,879	Dane County Regional-Traux Field Airport
MIMN	27-053-0966	Minneapolis, MN	1,146,484	3,455	Minneapolis-St. Paul Int'l Airport
MUTX	48-453-7001	Murchison MS in Austin, TX	679,750	2,379	Camp Mabry Army National Guard
NBAL	01-073-0023	North Birmingham, AL	394,649	4,934	Birmingham Int'l Airport
NBIL	17-031-4201	Northbrook in Chicago, IL	883,969	23,496	Palwaukee Municipal Airport

Table 2-2. Site Descriptions for the 2005 UATMP Monitoring Sites (Continued)

2005 UATMP Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI[b] (tpy)	Closest National Weather Service Station
NBNJ	34-023-0006	New Brunswick, NJ	787,380	2,725	Somerville, NJ, Somerset Airport
ORFL	12-095-2002	Winter Park, FL	962,938	4,836	Orlando Executive Airport
PCOK	40-071-0603	Ponca City, OK	33,081	320	Ponca City Regional Airport
PGMS	28-059-0006	Pascagoula, MS	56,235	2,815	Pascagoula, MS, Lott International Airport
PITX	48-453-703	Pickle Research Center, Austin, TX	649,314	2,379	Camp Mabry Army National Guard
POOK	40-071-0602	Ponca City, OK	33,081	320	Ponca City Regional Airport
PVAL	01-073-1009	Providence, AL	28,665	4,934	Tuscaloosa Municipal Airport
RRTX	48-491-7004	Round Rock, TX	365,870	772	Georgetown Municipal Airport
RTPNC	37-063-0014	Research Triangle Park, NC	380,541	884	Raleigh-Durham Int'l Airport
S4MO	29-510-0085	St. Louis, MO	822,941	2,245	St. Louis Downtown Airport
SFSD	46-099-0007	Sioux Falls, SD	154,472	538	Joe Foss Field Airport
SIAL	01-073-6004	Birmingham, AL	394,649	4,934	Birmingham Int'l Airport

Table 2-2. Site Descriptions for the 2005 UATMP Monitoring Sites (Continued)

2005 UATMP Code	AQS Site Code	Location	Population Residing Within 10 Miles of the Monitoring Site [a]	County-level Stationary Source HAP Emissions in the 2002 NEI[b] (tpy)	Closest National Weather Service Station
SJPR	72-021-0006	San Juan, PR	Unknown	227	San Juan, PR, Luis Munoz Marin Int'l Airport
SKFL	12-103-0026	Skyview in Tampa, FL	698,981	2,826	St. Petersburg-Clearwater International Airport
SMFL	12-057-0081	Simmons Park in Tampa, FL	58,222	7,247	Tampa Int'l Airport
SPIL	17-031-3103	Schiller Park in Chicago, IL	2,087,514	23,495	O'Hare Int'l Airport
SYFL	12-057-3002	Sydney in Plant City, FL	259,538	7,247	Winter Haven's Gilbert Airport
TRTX	48-453-7002	Travis HS in Austin, TX	553,117	2,379	Austin-Bergstrom Int'l Airport
TUMS	28-081-0005	Tupelo, MS	70,215	1,018	Tupelo Municipal Airport
WETX	48-453-7000	Webberville Road in Austin, TX	666,062	2,379	Austin-Bergstrom Int'l Airport
YDSP	48-141-9001	El Paso, TX	430,692	2,435	El Paso Int'l Airport
YFMI	26-163-0027	Yellow Freight in Detroit, MI	1,154,934	9,319	Detroit City Airport

[a] Reference: http://zipnet.htm
[b] Reference: EPA, 2006a.

Table 2-3. Current UATMP Monitoring Sites with Past Participation

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004
Allen Park, Detroit, MI (APMI)												T	T	T	T
Azalea Park, St. Petersburg, FL (AZFL)				T								T	T	T	T
Barceloneta, PR (BAPR)												T	T	T	
Boston, MA (BOMA)														T	T
Bountiful, UT (BTUT)														T	T
Camden, NJ (CANJ)	T		T	T			T	T	T	T	T	T	T	T	T
Candor, NC (CANC)														T	T
Chester, NJ (CHNJ)												T	T	T	T
Custer, SD (CUSD)													T	T	T
Dearborn, Detroit, MI (DEMI)												T	T	T	T
Dickson, TN (DITN)														T	T
Elizabeth, NJ (ELNJ)											T	T	T	T	T
Gandy, Tampa, FL (GAFL)												T	T	T	T
Gary, IN (INDEM)															T

Table 2-3. Current UATMP Monitoring Sites with Past Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004
Grand Junction, CO (GPCO)															T
Grenada, MS (GRMS)														T	T
Inter-Tribal Council, Sault Ste. Marie, MI (ITCMI)														T	T
Knoxville, TN (LDTN)														T	T
Madison, WI (MAWI)															T
New Brunswick, NJ (NBNJ)												T	T	T	T
Northbrook, Chicago, IL (NBIL)														T	T
Pascagoula, MS (PGMS)												T	T	T	T
Ponca City, Site 2 (POOK)														T	
Research Triangle Park, NC (RTPNC)															T
Schiller Park, Chicago, IL (SPIL)														T	T
Simmons Park in Tampa, FL (SMFL)												T			

Table 2-3. Current UATMP Monitoring Sites with Past Participation (Continued)

Monitoring Site	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999/ 2000[a]	2001	2002	2003	2004
Sioux Falls, SD (SFSD)											T	T	T	T	T
Skyview in Tampa, FL (SKFL)															T
St. Louis, MO (S4MO)													T	T	T
Sydney in Plant City, FL (SYFL)															T
Tupelo, MS (TUMS)												T	T	T	T
Winter Park, FL (ORFL)			T											T	T
Yellow Freight, Detroit, MI (YFMI)												T	T		T

[a] The time period for the 1999/2000 UATMP covers October 1999 to December 2000.

Table 2-4. VOC Method Detection Limits

Pollutant	Method Detection Limit (ppbv)[1]
Hydrocarbons	
Acetylene	0.05
Acrolein	0.03
Benzene	0.04
1,3-Butadiene	0.05
Ethylbenzene	0.03
n-Octane	0.05
Propylene	0.06
Styrene	0.03
Toluene	0.04
1,2,4-Trimethylbenzene	0.06
1,3,5-Trimethylbenzene	0.04
m-,*p*-Xylene[2]	0.04
o-Xylene	0.03
Halogenated Hydrocarbons	
Bromochloromethane	0.06
Bromodichloromethane	0.04
Bromoform	0.04
Bromomethane	0.05
Carbon Tetrachloride	0.05
Chlorobenzene	0.03
Chloroethane	0.08
Chloroform	0.04
Chloromethane	0.06
Chloromethylbenzene	0.04
Chloroprene	0.04
Dibromochloromethane	0.05
1,2-Dibromoethane	0.04
m-Dichlorobenzene	0.06
o-Dichlorobenzene	0.05
p-Dichlorobenzene	0.06
1,1-Dichloroethane	0.04
1,2-Dichloroethane	0.05
1,1-Dichloroethene	0.04
cis-1,2-Dichloroethylene	0.04
trans-1,2-Dichloroethylene	0.05
1,2-Dichloropropane	0.05
cis-1,3-Dichloropropene	0.04

Table 2-4. VOC Method Detection Limits (Continued)

Pollutant	Method Detection Limit (ppbv)[1]
Halogenated Hydrocarbons (Continued)	
trans-1,3-Dichloropropene	0.05
Dichlorodifluoromethane	0.02
Dichlorotetrafluoroethane	0.02
Hexachloro-1,3-butadiene	0.24
Dichloromethane	0.06
1,1,2,2-Tetrachloroethane	0.04
Tetrachloroethylene	0.04
1,2,4-Trichlorobenzene	0.16
1,1,1-Trichloroethane	0.04
1,1,2-Trichloroethane	0.05
Trichloroethylene	0.05
Trichlorofluoromethane	0.03
Trichlorotrifluoroethane	0.04
Vinyl Chloride	0.04
Polar Compounds	
Acetonitrile	0.08
Acrylonitrile	0.06
Ethyl Acrylate	0.06
Ethyl *tert*-Butyl Ether	0.05
Methyl Ethyl Ketone (MEK)	0.10
Methyl Isobutyl Ketone	0.07
Methyl Methacrylate	0.08
Methyl *tert*-Butyl Ether (MTBE)	0.07
tert-Amyl Methyl Ether	0.06

[1] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

[2] Because *m*-xylene and *p*-xylene elute from the GC column at the same time, the VOC analytical method can report only the sum of *m*-xylene and *p*-xylene concentrations and not concentrations of the individual compounds.

Table 2-5. SNMOC Method Detection Limits

Pollutant	Method Detection Limit[1] ppbC[2]	Pollutant	Method Detection Limit[1] ppbC[2]
Acetylene	0.06	3-Methyl-1-butene	0.32
Benzene	0.26	Methylcyclohexane	0.13
1,3-Butadiene	0.52	Methylcyclopentane	0.12
n-Butane	0.52	2-Methylheptane	0.39
cis-2-Butene	0.13	3-Methylheptane	0.28
trans-2-Butene	0.08	2-Methylhexane	0.18
Cyclohexane	0.29	3-Methylhexane	0.23
Cyclopentane	0.12	2-Methylpentane	0.28
Cyclopentene	0.32	3-Methylpentane	0.23
n-Decane	0.20	2-Methyl-1-pentene	0.29
1-Decene	0.26	4-Methyl-1-pentene	0.29
m-Diethylbenzene	0.26	*n*-Nonane	0.15
p-Diethylbenzene	0.16	1-Nonene	0.36
2,2-Dimethylbutane	0.29	*n*-Octane	0.25
2,3-Dimethylbutane	0.27	1-Octene	0.81
2,3-Dimethylpentane	0.43	*n*-Pentane	0.09
2,4-Dimethylpentane	0.28	1-Pentene	0.21
n-Dodecane	0.77	*cis*-2-Pentene	0.12
1-Dodecene	0.77	*trans*-2-Pentene	0.20
Ethane	0.20	α-Pinene	0.26
2-Ethyl-1-butene	0.29	β-Pinene	0.26
Ethylbenzene	0.19	Propane	0.18
Ethylene	0.07	*n*-Propylbenzene	0.17
m-Ethyltoluene	0.14	Propylene	0.12
o-Ethyltoluene	0.15	Propyne	0.18
p-Ethyltoluene	0.21	Styrene	0.81

Table 2-5. SNMOC Method Detection Limits (Continued)

Pollutant	Method Detection Limit[1] ppbC[2]	Pollutant	Method Detection Limit[1] ppbC[2]
n-Heptane	0.26	Toluene	0.35
1-Heptene	0.43	*n*-Tridecane	0.77
n-Hexane	0.09	1-Tridecene	0.77
1-Hexene	0.26	1,2,3-Trimethylbenzene	0.13
cis-2-Hexene	0.29	1,2,4-Trimethylbenzene	0.21
trans-2-Hexene	0.29	1,3,5-Trimethylbenzene	0.15
Isobutane	0.07	2,2,3-Trimethylpentane	0.81
Isobutene/1-Butene[3]	0.30	2,2,4-Trimethylpentane	0.43
Isopentane	0.32	2,3,4-Trimethylpentane	0.36
Isoprene	0.17	*n*-Undecane	0.59
Isopropylbenzene	0.36	1-Undecene	0.59
2-Methyl-1-Butene	0.32	*m*-,*p*-Xylene[3]	0.22
2-Methyl-2-Butene	0.32	*o*-Xylene	0.19

[1] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

[2] Concentration in ppbC = concentration in ppbv x number of carbon atoms in compound.

[3] Because isobutene and 1-butene elute from the GC column at the same time, the SNMOC analytical method can report only the sum of concentrations for these two compounds and not concentrations of the individual compounds. For the same reason, the *m*-xylene and *p*-xylene concentrations are reported as a sum.

Table 2-6. Carbonyl Method Detection Limits

Pollutant	Method Detection Limit (ppbv)[1,2]
Acetaldehyde	0.013
Acetone	0.008
Benzaldehyde	0.003
Butyr/Isobutyraldehyde[3]	0.005
Crotonaldehyde	0.004
2,5-Dimethylbenzaldehyde	0.003
Formaldehyde	0.016
Hexaldehyde	0.002
Isovaleraldehyde	0.003
Propionaldehyde	0.005
Tolualdehydes (*o-*, *n-*, *p-*)[3]	0.004
Valeraldehyde	0.003

[1] Assumes a 1000 L sample volume.

[2] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

[3] Because butyraldehyde/isobutyraldehyde elute from the HPLC column at the same time, the carbonyl analytical method can report only the sum of concentrations for these two compounds and not concentrations of the individual compounds. For the same reason, the analytical method also reports only the sum of concentrations for the three tolualdehydes isomers, as opposed to reporting separate concentrations for the three individual compounds.

Table 2-7. Semivolatile Organic Compound Method Detection Limits

Pollutant	Method Detection Limit[1,2] Total pg/m^3
Acenaphthene	0.08
Acenaphthylene	0.49
Anthracene	0.29
Benzo*(a)*anthracene	0.15
Benzo*(a)*pyrene	0.28
Benzo*(b)*fluoranthene	0.12
Benzo*(e)* pyrene	0.14
Benzo*(g,h,i)*perylene	0.11
Benzo*(k)*fluoranthene	0.11
Chrysene	0.08
Coronene	0.13
Dibenz(a,h)anthracene	0.12
Fluoranthene	0.13
Fluorene	0.11
Indeno(1,2,3-cd)pyrene	0.13
Naphthalene	0.08
Perylene	0.18
Phenanthrene	0.09
Pyrene	0.13

[1] Assumes a 200 m^3 sample volume.
[2] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

Table 2-8. Metals Method Detection Limits

Pollutant	Method Detection Limit (ng/m^3)[3]	
	47 mm Round[1]	8 X 10" Quartz[2]
Antimony	0.785	0.0267
Arsenic	0.155	0.0172
Beryllium	0.101	0.0234
Cadmium	0.112	0.0179
Chromium (total Chromium)	0.934	0.172
Cobalt	0.371	0.0246
Lead	0.458	1.26
Manganese	0.128	0.166
Mercury	0.354	0.151
Nickel	1.03	0.177
Selenium	0.174	0.0187

[1] Assumes 20 m^3 volume.
[2] Assumes 2000 m^3 volume.
[3] The MDLs in the table above represent the average MDL for each pollutant, as the MDL varies slightly based on sample volume.

Table 2-9. Sampling Schedules and Completeness

Site	Monitoring Location	Sampling Period[a]		Carbonyl			VOC			Metals			SNMOC/TNMOC			SVOC		
		Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
APMI	Allen Park in Detroit, MI	1/4/05	11/6/05	50	51	98	30	36	83	—	—	—	—	—	—	—	—	—
AZFL	Azalea Park in St. Petersburg, FL	1/4/05	12/30/05	57	61	93	—	—	—	—	—	—	—	—	—	—	—	—
BAPR	Barceloneta, PR	2/27/05	12/30/05	49	51	96	48	51	94	—	—	—	—	—	—	—	—	—
BOMA	Boston, MA	1/4/05	12/30/05	—	—	—	—	—	—	61	61	100	—	—	—	—	—	—
BTUT	Bountiful, UT	1/5/05	12/30/05	56	61	92	55	62	89	60	60	100	56	62	90	—	—	—
CANC	Candor, NC	1/4/05	12/30/05	27	28	96	—	—	—	—	—	—	—	—	—	—	—	—
CANJ	Camden, NJ	1/4/05	12/30/05	55	57	96	54	57	95	—	—	—	—	—	—	—	—	—
CHNJ	Chester, NJ	1/4/05	12/30/05	54	61	89	50	61	82	—	—	—	—	—	—	—	—	—
CUSD	Custer Park, SD	1/4/05	12/30/05	60	61	98	60	61	98	—	—	—	60	61	98	—	—	—
DEMI	Dearborn in Detroit, MI	1/4/05	12/30/05	56	58	97	52	58	90	—	—	—	—	—	—	—	—	—
DITN	Dickson, TN	1/10/05	12/24/05	28	29	97	28	29	97	—	—	—	—	—	—	—	—	—

[a] Begins with 1st valid sample and may include all five types.
[b] Pre-Katrina data only
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

Table 2-9. Sampling Schedules and Completeness (Continued)

Site	Monitoring Location	Sampling Period[a]		Carbonyl			VOC			Metals			SNMOC/TNMOC			SVOC		
		Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
ELNJ	Elizabeth, NJ	1/4/05	12/29/05	59	61	97	60	60	100	—	—	—	—	—	—	—	—	—
ETAL	East Thomas in Birmingham, AL	7/15/05	12/30/05	16	16	100	16	16	100	16	16	100	—	—	—	15	17	88
FLFL	Davie, FL	10/13/05	12/30/05	9	10	90	—	—	—	—	—	—	—	—	—	—	—	—
GAFL	Gandy in Tampa, FL	1/4/05	12/30/05	57	60	95	—	—	—	—	—	—	—	—	—	—	—	—
GPCO	Grand Junction, CO	1/4/05	12/30/05	62	63	98	59	53	94	—	—	—	—	—	—	—	—	—
GRMS	Grenada, MS	1/4/05	5/15/05	11	12	92	11	12	92	—	—	—	—	—	—	—	—	—
INDEM	Gary, IN	1/4/05	12/30/05	44	45	98	—	—	—	—	—	—	—	—	—	—	—	—
ITCMI	Sault Sainte Marie, MI	1/4/05	9/25/05	—	—	—	33	37	89	—	—	—	—	—	—	38	41	93
LDTN	Loudon, TN	1/10/05	12/24/05	27	30	90	27	30	90	—	—	—	—	—	—	—	—	—
MAWI	Madison, WI	1/4/05	12/30/05	59	63	94	60	63	95	30	30	100	—	—	—	—	—	—

[a] Begins with 1st valid sample and may include all five types.
[b] Pre-Katrina data only
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

Table 2-9. Sampling Schedules and Completeness (Continued)

Site	Monitoring Location	Sampling Period[a]		Carbonyl			VOC			Metals			SNMOC/TNMOC			SVOC		
		Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
MIMN	Minneapolis, MN	3/29/05	12/30/05	40	45	89	42	46	91	46	46	100	—	—	—	—	—	—
MUTX	Murchison MS in Austin, TX	6/15/05	12/24/05	13	16	81	16	16	100	17	17	100	16	16	100	—	—	—
NBAL	North Birmingham, AL	7/15/05	12/30/05	14	15	93	14	16	88	32	32	100	—	—	—	16	17	94
NBIL	Northbrook in Chicago, IL	1/4/05	12/30/05	35	40	88	53	59	90	61	61	100	52	59	88	—	—	—
NBNJ	New Brunswick, NJ	1/4/05	12/30/05	58	61	95	57	61	93	—	—	—	—	—	—	—	—	—
ORFL	Winter Park, FL	1/4/05	12/30/05	59	60	98	—	—	—	—	—	—	—	—	—	—	—	—
PCOK	Site 1 in Ponca City, OK	5/28/05	7/24/05	—	—	—	17	17	100	—	—	—	17	17	100	—	—	—
PGMS	Pascagoula, MS	1/4/05	10/1/05[b]	15	22	68	15	22	68	—	—	—	5	10	50	—	—	—
PITX	Pickle Research Center, Austin, TX	6/27/05	12/24/05	15	16	94	15	16	94	15	15	100	15	16	94	—	—	—

[a] Begins with 1st valid sample and may include all five types.
[b] Pre-Katrina data only
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

Table 2-9. Sampling Schedules and Completeness (Continued)

Site	Monitoring Location	Sampling Period[a]		Carbonyl			VOC			Metals			SNMOC/TNMOC			SVOC		
		Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
POOK	Site 2 in Ponca City, OK	5/28/05	7/24/05	—	—	—	15	17	88	—	—	—	15	17	88	—	—	—
PVAL	Providence in Birmingham, AL	7/15/05	12/30/05	15	15	100	15	16	94	16	16	100	—	—	—	16	16	100
RRTX	Round Rock, TX	6/15/05	12/24/05	16	16	100	15	16	94	18	18	100	15	16	94	—	—	—
RTPNC	Research Triangle Park, NC	1/4/05	12/18/05	27	28	96	—	—	—	—	—	—	—	—	—	—	—	—
S4MO	St. Louis, MO	1/4/05	12/30/05	60	62	97	61	62	98	61	61	100	—	—	—	—	—	—
SFSD	Sioux Falls, SD	1/4/05	12/30/05	59	62	95	59	62	95	—	—	—	58	61	95	—	—	—
SIAL	Sloss Industries in Birmingham, AL	7/15/05	12/30/05	15	16	94	13	16	81	16	16	100	—	—	—	15	16	94
SJPR	San Juan, PR	2/27/05	12/30/05	40	51	78	40	51	78	—	—	—	—	—	—	—	—	—

[a] Begins with 1st valid sample and may include all five types.
[b] Pre-Katrina data only
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

Table 2-9. Sampling Schedules and Completeness (Continued)

Site	Monitoring Location	Sampling Period[a]		Carbonyl			VOC			Metals			SNMOC/TNMOC			SVOC		
		Starting Date	Ending Date	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
SKFL	Skyview in Tampa, FL	1/4/05	12/30/05	61	61	100	—	—	—	—	—	—	—	—	—	—	—	—
SMFL	Simmons Park in Tampa, FL	1/28/05	12/30/05	56	57	98	—	—	—	—	—	—	—	—	—	—	—	—
SPIL	Schiller Park in Chicago, IL	1/10/05	12/30/05	46	49	94	58	60	97	—	—	—	—	—	—	—	—	—
SYFL	Sydney in Plant City, FL	1/4/05	12/30/05	59	60	98	—	—	—	—	—	—	—	—	—	—	—	—
TRTX	Travis HS in Austin, TX	7/9/05	12/24/05	14	15	93	15	15	100	15	15	100	15	15	100	—	—	—
TUMS	Tupelo, MS	1/4/05	12/30/05	37	37	100	38	38	100	—	—	—	—	—	—	—	—	—
WETX	Webberville Rd, Austin, TX	6/15/05	12/24/05	15	16	94	13	16	81	17	17	100	13	16	81	—	—	—
YFMI	Detroit, MI	1/4/05	10/1/05	—	—	—	43	43	100	—	—	—	—	—	—	42	46	91
YDSP	El Paso, TX	3/23/05	12/30/05	—	—	—	40	42	95	—	—	—	—	—	—	—	—	—
---	**Overall**	**---**	**—**	**1606**	**1699**	**95**	**1297**	**1405**	**92**	**481**	**481**	**100**	**337**	**366**	**92**	**142**	**153**	**93**

[a] Begins with 1st valid sample and may include all five types.
[b] Pre-Katrina data only
A = Valid Samples
B = Total Number of Samples
C = Completeness (%)

3.0 Summary of the 2005 UATMP Data

This section summarizes the data gathered during the 2005 UATMP reporting year. A total of 60 VOC (unlike previous years, acrolein was reported beginning in July), 15 carbonyl compounds, 19 SVOC, 80 SNMOC, and 11 metals were sampled during this program reporting year. These pollutants are discussed in greater detail in Sections 3.1 through 3.3.

A complete presentation of the data is found in Appendices C through L. Specifically:

- Appendix C: 2005 Summary Tables for VOC Monitoring;
- Appendix D: 2005 Summary Tables for SNMOC Monitoring;
- Appendix E: 2005 Summary Tables for Carbonyl Monitoring;
- Appendix F: 2005 Summary Tables for SVOC Monitoring;
- Appendix G: 2005 Summary Tables for Metals Monitoring;
- Appendix H: 2005 VOC Raw Monitoring Data;
- Appendix I: 2005 SNMOC/TNMOC Raw Monitoring Data;
- Appendix J: 2005 Carbonyl Raw Monitoring Data;
- Appendix K: 2005 SVOC Raw Monitoring Data; and
- Appendix L: 2005 Metals Raw Monitoring Data.
- Appendix M: 2005 Range of Detection Limits.

A total of 169,487 urban air toxics concentrations (including duplicate, replicate, and collocated samples) were collected at the 47 sites for the 2005 UATMP reporting year. Forty-one sites sampled for carbonyl compounds; 36 sites sampled for VOC; 15 sites sampled for metals; 7 sites sampled for SNMOC; and 6 sites sampled for SVOC. Additionally, five Austin area sites sampled for total NMOCs, using sampling methodology TO-15. These data were analyzed on a site-specific basis and results are presented in Sections 4.0 through 22.0. Samples from sites commissioned to the Hurricane Katrina monitoring effort account for an additional 33,932 concentrations.

3.1 Data Summary Parameters

The raw data tables in Appendices H through L were uploaded into a database for air quality statistical analysis. This section examines six different data summary parameters and reviews the basic findings determined from the statistical analysis: 1) number of sampling detects, 2) concentration ranges, 3) statistics, 4) risk screening, 5) non-chronic risk, and 6) correlation.

To better understand the following sections, it is important to know how the concentration data were treated. First, all duplicate and replicate (or collocated) samples were averaged in order to calculate one concentration for each pollutant for each sample day at each site. Second, *m,p*-xylene and *o*-xylene concentrations were summed together and are henceforth referred to as Atotal xylenes@ or Axylenes (total)@ throughout the remainder of this report, with the exception of Table 3-1 and Table 3-4, where results are broken down into *m,p*-xylene and *o*-xylene.

3.1.1 Number of Sampling Detects

Tables 3-1 through 3-5 summarize sampling detects for the VOC, carbonyl, SVOC, SNMOC, and metal concentrations, respectively. Less than 53 percent of the pollutants sampled were above the MDL. The percentages listed below represent the percent of samples that were above the MDL:

- 36.3 percent of VOC;
- 83.6 percent of carbonyl compounds;
- 66.2 percent of SNMOC;
- 95.9 percent of metals; and
- 82.6 percent of SVOC.

Similar to 2004, acetaldehyde, acetone, and formaldehyde had the greatest number of detectable values reported in samples (**$**1,600), while five pollutants (1,2-dichloropropane, bromoform, l-decene, l-tridecene, and propyne) had zero detects (see Tables 3-1 through 3-5).

Understanding the Units of Measure and When They are Used

In order to compare concentrations across multiple sampling methods, all concentrations have been converted to a common unit of measure, ($\mu g/m^3$). However, whenever a particular sampling method is isolated from others, such as in Tables 3-1 through 3-5, the statistical parameters are presented in the units of measure associated with the particular sampling method. It is important to pay very close attention to the unit of measure associated with each analysis discussed in this section of the report.

3.1.2 Concentration Range

As a means of comparing concentrations for all pollutant types, all concentrations were converted to $\mu g/m^3$. Approximately 72 percent of the detects had concentration values less than 1 $\mu g/m^3$, less than 4 percent had concentrations greater than 5 $\mu g/m^3$. VOC were observed in the highest number of samples with concentrations greater than 5 $\mu g/m^3$ (1,215); carbonyl compounds were observed the least (563); and SVOC and metals measured no concentrations greater than 5 $\mu g/m^3$. At least one pollutant sampled had a concentration greater than 5 $\mu g/m^3$ on 93 of 128 total sampling days. Forty-seven of the pollutants monitored never exceeded 1 $\mu g/m^3$. Twenty-two sites had maximum concentration values over 100 $\mu g/m^3$. BTUT had the greatest number of detects (5,283), as well as the greatest number of samples with concentrations greater than 5 $\mu g/m^3$ (353). The minimum and maximum concentration measured for each pollutant is also presented in Tables 3-1 through 3-5 (in respective pollutant group units).

3.1.3 Statistics

In addition to the number of detects and the concentrations ranges, Tables 3-1 through 3-5 also present a number of central tendency and data distribution statistics (arithmetic mean, geometric mean, median, mode, first and third quartiles, standard deviation, and coefficient of variation) for each of the pollutants sampled for during the 2005 UATMP by respective pollutant group units.

The Top 3 VOCs by average mass concentration as presented in Table 3-1 are acetonitrile (34.93 ppbv), acetylene (1.35 ppbv), and methyl ethyl ketone (1.22 ppbv). The Top 3 carbonyl compounds by mass concentration, as presented in Table 3-2, are formaldehyde (5.18 ppbv), acetaldehyde (1.33 ppbv), and acetone (0.87 ppbv). The Top 3 SVOC by mass concentration, as presented in Table 3-3, are naphthalene (161.22 ng/m^3), phenanthrene (22.82 ng/m^3), and fluorene (9.90 ng/m^3). The Top 3 SNMOC by mass concentration, as presented in Table 3-4, are propane (17.53 ppbC), *n*-butane (11.12 ppbC), and ethane (10.68 ppbC). Among the metals, the Top 3 pollutants for both PM10 and TSP fractions are manganese (TSP = 24.74 ng/m^3, PM_{10} = 9.81 ng/m^3), lead (TSP= 8.48 ng/m^3, PM_{10} = 7.48 ng/m^3), and chromium (TSP = 3.54 ng/m^3, PM_{10} = 2.06 ng/m^3).

3.1.4 Pollutants of Interest

Each year, a subset of pollutants is selected for further analyses (previously called "prevalent compounds"). In UATMPs prior to 2003, this subset was based on frequency and magnitude of concentrations. Since the 2003 UATMP, risk-based calculations were used to determine these pollutants. For the 2005 UATMP, the pollutants of interest are also based on risk potential, but the manner of identifying this subset has changed. For the 2005 UATMP, the following approach was used to determine the pollutants of interest:

1. The individual xylene concentrations (*o*-, *m*-, and *p*-) were summed together for each measurement day. For instances where a pollutant is measured by two separate methods, such as benzene with VOC and SNMOC methods, the two concentrations were averaged together. The purpose of this is to have one concentration per pollutant per day per site. The exception to this is the metals. One site, NBAL, sampled metals with both PM10 and TSP methods. These were reviewed separately.

2. Each 24-hour speciated measurement was compared against a screening value, as compiled by an EPA risk screening guidance document (EPA, 2006b). The purpose of this guidance is to provide a risk-based methodology for performing an initial screen of ambient air toxics monitoring data sets. It's important to note that not all UATMP pollutants have screening values. Concentrations that are greater than the screening value are described as "failing the screen."

3. The number of failed screens was summed for each applicable pollutant.

4. A total of 9,162 of 17,020 applicable concentrations (53.8%) failed the screen. The percent contribution of the number of failed screens was calculated for each applicable pollutant. The number of each metals failures were summed together.

5. The pollutants contributing to the Top 95% of the total failed screens were identified as pollutants of interest.

Table 3-6 identifies all of the pollutants that failed screens at least once, and summarizes the total number of detects, percentage failed, and percentage contributions. The program-wide pollutants of interest are as follows:

- Acetaldehyde
- Acrolein
- Arsenic
- Benzene
- 1,3-Butadiene
- Carbon Tetrachloride
- *p*-Dichlorobenzene
- Formaldehyde
- Hexachloro-1,3-butadiene
- Manganese
- Nickel
- Tetrachloroethylene
- Total Xylenes

As mentioned in Section 2.5.1, there is currently some question about the reliability of the acetonitrile data. Therefore, acetonitrile results were excluded from the "pollutants of interest" designation and analysis. It is also important to note that chromium was also excluded from this analysis due to problems with filter contamination.

Readers interested in closer examination of data trends for the other pollutants measured by the program should refer to the summary tables in Appendices C through G, and the raw monitoring data in Appendices H through L. However, readers should note the limitations posed by data sets with many nondetect observations.

3.1.5 Non-Chronic Risk

In addition to the risk screening described above, non-chronic risk was also evaluated using the ATSDR acute and intermediate minimal risk (MRL) factors and California EPA acute reference exposure limit (REL) factors (ATSDR, 2005; CARB, 2005). Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. It should be noted that the substitution of 1/2 MDLs for non-detects may have a significant impact on pollutants that are rarely detected at or above the detection limit and/or have a relatively high MDL. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. The spring season included concentrations from March, April, and May; summer includes June, July, and August; autumn includes September, October, and November; and winter includes January, February, and December. This analysis is still based on site-specific concentrations, but has been summed to the program-level.

Table 3-7 presents a summary of the program-wide acute risk analysis. Acrolein, formaldehyde, and benzene were the only pollutants with least one concentration exceeding the ATSDR and/or CalEPA risk factors. There were 30 exceedances of the ATSDR MRL for formaldehyde, but only 22 exceedances of the CalEPA REL. The ATSDR MRL is nearly half the CalEPA REL for formaldehyde (0.49 $\mu g/m^3$ vs. 0.94 $\mu g/m^3$, respectively). There were 283 exceedances of the ATSDR MRL for acrolein, and 279 exceedances of the CalEPA REL. The ATSDR MRL and the CalEPA REL for acrolein are more similar (0.11 $\mu g/m^3$ vs. 0.19 $\mu g/m^3$, respectively). Interestingly, every detect of acrolein during the 2005 UATMP was greater than 0.11 $\mu g/m^3$. Two concentrations of benzene, out of over 1300 detects, exceeded the ATSDR MRL. Benzene does not have a CalEPA acute risk factor. Exceedances of the acute risk factors will be discussed in further detail in Sections 4 through 22.

Also presented in Table 3-7 is a summary of the program-wide intermediate risk analysis. Only two seasonal averages of formaldehyde, both occurring during the summer season, exceeded the ATSDR intermediate MRL (40 $\mu g/m^3$). Nine seasonal acrolein averages exceeded the ATSDR intermediate MRL (0.09 $\mu g/m^3$). It is important to note that acrolein, as discussed in Section 3.0, was not sampled for until July, therefore, spring concentrations are not available. Additionally, based on the above definition of a seasonal average, winter and summer averages could not be calculated. A more complete picture of intermediate acrolein risk may be available in future UATMPs. Benzene does not have an intermediate risk factor, therefore, intermediate risk cannot be evaluated. Exceedances of the intermediate risk factors will also be discussed in further detail in Sections 4 through 22.

3.1.6 Pearson Correlations

This report uses Pearson correlation coefficients to measure the degree of correlation between two variables. By definition, Pearson correlation coefficients always lie between -1 and +1. Three qualification statements may be made:

- A correlation coefficient of -1 indicates a perfectly Anegative@ relationship, indicating that increases in the magnitude of one variable are associated with proportionate decreases in the magnitude of the other variable, and vice versa;
- A correlation coefficient of +1 indicates a perfectly Apositive@ relationship, indicating that the magnitudes of two variables both increase and both decrease proportionately.
- Data that are completely uncorrelated have Pearson correlation coefficients of 0.

Therefore, the sign (positive or negative) and magnitude of the Pearson correlation coefficient indicate the direction and strength, respectively, of data correlations. Generally, correlations greater than 0.75 or less than -0.75 are classified as very strong; correlation between 0.50 and 0.75 and -0.50 and -0.75 are classified as strong; and correlations between 0.25 and 0.50 and -0.25 and -0.50 are classified as moderately strong. Correlations between -0.25 and 0.25 are classified as weak.

When calculating correlations among the UATMP data, several measures were taken to identify spurious correlations and to avoid introducing bias to the correlations:

- $ Data correlations were calculated only for the program-wide pollutants of interest listed in this report.
- $ Correlations were calculated from the processed UATMP monitoring database in which each pollutant has just one numerical concentration for each successful sampling date. Non-detects (and their substituted value) were not included in this analysis.

Ambient air concentration tendencies often correlate favorably with ambient meteorological observations. The following three sections summarize how each of the pollutants of interest's concentrations correlated with eight meteorological parameters: maximum daily temperature; average daily temperature; average daily dew point temperature; average daily wet bulb temperature; average daily relative humidity; average daily sea level pressure; and average wind information.

3.1.6.1 Maximum and Average Temperature

Temperature is often a factor in high ambient air concentrations for some pollutants, such as ozone. Temperature helps speed up the kinetics as pollutants react with each other. According to Table 3-8, the program-wide pollutants of interest had mostly weak correlations with maximum temperature and average temperature. Acrolein exhibited the strongest positive correlation with maximum temperature (0.42) and average temperature (0.41), while nickel (PM_{10}) exhibited the strongest negative correlation with maximum and average temperature (-0.32 and -0.31, respectively). It should be noted that, although the correlations shown in Table 3-8 are low, they are mostly positive, which indicates that an increase in temperature is associated with a proportionate increase in concentration.

The poor correlation across the majority of the sites is not surprising due to the complex and diverse local meteorology associated with the monitoring sites. For this report, 47 sites are spread across 19 states. As discussed in Sections 4 through 22, the temperature parameters correlate much better at certain individual sites.

3.1.6.2 Moisture

Three moisture parameters were used in this study for correlation with the pollutants of interest. The *dew point temperature* is the temperature to which moist air must be cooled to reach saturation with respect to water. The *wet-bulb temperature* is the temperature to which moist air must be cooled by evaporating water into it at constant pressure until saturation is reached. The *relative humidity* is the ratio of the mixing ratio to its saturation value at the same temperature and pressure (Rogers and Yau, 1989). All three of these parameters provide an indication of how much moisture is presently in the air. Higher dew point and wet bulb temperatures indicate increasing amounts of moisture in the air, while relative humidity is expressed as a percentage with 100 percent indicating saturation. It should be noted that a high dew point and wet bulb temperature do not necessarily equate to a relative humidity near 100%, nor does a relative humidity near 100 percent equate to a high dew point or wet bulb temperature.

As illustrated in Table 3-8, the three moisture parameters had mostly weak correlations with the pollutants of interest. Again, acrolein and nickel (PM_{10}) had the strongest correlations with dew point and wet bulb temperatures. The strongest correlation with relative humidity was calculated for 1,3-butadiene and nickel (TSP), both -0.13. The sites participating in the 2005 program year were located in different climatic zones ranging from a desert climate (west Texas) to a very moist climate (Florida and Puerto Rico). As discussed in Sections 4 through 22, the moisture parameters correlate much better at certain individual sites.

3.1.6.3 Wind and Pressure Information

Surface wind observations include two primary components: wind speed and wind direction. *Wind speed*, by itself, is a scalar value and is usually measured in nautical miles or knots (1 knot = 0.5 meters per second = 1.15 miles per hour). *Wind direction* describes where the wind is coming from, and is measured in degrees where 0E is from the north, 90E is from the east, 180E is from the south, and 270E is from the west. Together, the wind speed and wind direction are described as a vector, and the hourly values can now be averaged.

The *u*-component of the wind is the vector value traveling along the x-axis in a Cartesian grid coordinate system. The u-component is calculated as follows:

u-component = -1* (wind speed) * sin(wind direction, degrees)

Similarly, the *v*-component of the wind is the vector value traveling along the y-axis in a Cartesian grid coordinate system. The *v*-component is calculated as follows:

v-component = -1* (wind speed) * cos(wind direction, degrees)

Using the *u*- and *v*-components of the wind allows averaging and correlation analyses with the measured concentrations.

As shown in Table 3-8, the *u*- and *v*-components of the wind have very weak correlations with the pollutants of interest across all sites, which is consistent with the temperature and moisture parameter observations. Geographical features such as mountains or valleys influence wind speed and wind direction. The sites used for sampling in the 2005 program year are located in different geographic zones ranging from a mountainous region (Colorado) to a plains region (South Dakota). Additionally, sites located downwind may correlate better with the measured concentrations than sites upwind. Acrolein concentrations had the strongest correlation with the *u*-component of the wind (-0.23), as well as the strongest correlation with the *v*-component of the wind speed (0.19). As discussed in Sections 4.0 through 22.0, the *u*- and *v*-components correlate much better at certain individual sites.

Wind is created through changes in pressure. The magnitude of the pressure difference (or pressure gradient) over an area is directly proportional to the magnitude of the wind speed. The direction of the wind flow is governed by the direction of the pressure gradient. Sea level pressure is the local station pressure corrected for elevation, in effect bringing all geographic locations down to sea-level, thus making different topographical areas comparable. Overall, sea

level pressure correlated weakly with ambient concentrations. The strongest correlations occurred with acrolein (-0.40) and formaldehyde (-0.33).

3.2 Additional Analyses of the 2005 UATMP

This section provides a summary of additional analyses performed on the 2005 UATMP dataset and discusses their results. Additional program-wide analyses include an examination into the impact of motor vehicles and a review of how concentrations vary among the sites themselves and from season to season.

3.2.1 The Impact of Mobile Source Emissions on Spatial Variations

Mobile source emissions from motor vehicles contribute significantly to air pollution in urban environments. Pollutants found in motor vehicle exhaust generally result from incomplete combustion of vehicle fuels. Although modern vehicles and, more recently, vehicle fuels have been engineered to minimize air emissions, all motor vehicles with internal combustion engines emit a wide range of chemical pollutants. The magnitude of these emissions in urban areas primarily depends on the volume of traffic, while the chemical profile of these emissions depends more on vehicle design and fuel content. This report uses four parameters to evaluate the impact of motor vehicle emissions on ambient air quality:

- Estimated motor vehicle ownership data;
- BTEX concentration profiles;
- Estimated daily traffic estimates; and
- Mobile source tracer analysis.

3.2.1.1 Motor Vehicle Ownership Data

As an indicator of motor vehicle emissions near the UATMP monitoring sites, Table 3-9 presents estimates of the number of vehicles owned by residents in the county in which the monitoring site is located. Where possible, actual county-level vehicle registration was obtained from the state or local agency. If data were not available, vehicle registration data are available at the state-level (EIA, 2005). Then the county proportion of the state population was applied to

the state registration count. For each UATMP county, a vehicle registration to population ratio was developed. Each ratio was then applied to the 10-mile populations surrounding the monitors (from Table 2-3). These estimated values are discussed in the individual state sections.

For purposes of comparison, both 10-mile motor vehicle ownership data and the arithmetic mean of hydrocarbons are presented in Table 3-9 and Figure 3-1. The data in the table and figure indicate a very slight positive linear correlation between motor vehicle ownership and ambient air concentrations of hydrocarbons. A Pearson correlation calculation from this data yields a weak positive correlation (0.14), where less than 0.25 is considered weak. However, readers should keep in mind other factors that might impact the reliability of motor vehicle ownership data as an indicator of ambient air monitoring data results:

- Estimates of higher car ownership surrounding a monitoring site do not necessarily imply increased motor vehicle use in the immediate vicinity of a monitoring site. Conversely, sparsely populated regions often contain heavily traveled roadways.
- Emissions sources in the area other than motor vehicles may significantly affect levels of hydrocarbons in the ambient air.

3.2.1.2 Estimated Traffic Data

When a site is being characterized, a parameter often recorded is the number of vehicles that pass the monitoring site on a daily basis. Traffic data were obtained from the site information provided on EPA=s Air Quality Subsystem (AQS) database, or by contacting state and local agencies. Table 3-9 contains the estimated daily traffic values, as well as county-level on-road and non-road HAP (hazardous air pollutant) emissions.

The highest traffic volume occurred at the SPIL and ELNJ sites, with over 214,900 and 170,000 vehicles passing by these monitoring sites, respectively. SPIL is located near Interstate 294 near the Chicago-O=Hare International Airport, and ELNJ is located near Exit 13 on Interstate 95. The average hydrocarbon (total) value at ELNJ was 8.05 ppbv, which is ranked 6th among sites that measured hydrocarbons. ETAL, PCOK, NBAL, SIAL, and WETX each had

average hydrocarbon concentrations greater than ELNJ, yet their traffic counts are ranked 14th, 30th, 41st, 39th, and 32nd highest, respectively. At SPIL, the average hydrocarbon (total) value was only 4.09 ppbv, which ranked 24th. Specific characterizations for these sites appear in the separate state sections.

Estimated on-road county emissions were highest in Wayne County, MI, which is the location of three UATMP sites (APMI, DEMI, and YFMI). The hydrocarbon averages for the sites in Wayne County, MI were fairly different from one another (6.13 ppbv at APMI; 4.90 ppbv at DEMI; and 7.25 ppbv at YFMI), where YFMI, with the highest average hydrocarbon concentration of the Wayne County sites, ranked 9th highest among all UATMP sites for 2005. Estimated non-road county emissions were highest in Cook County, IL. Non-road emission sources include, but are not limited to, activities from airplanes, construction vehicles, and lawn and garden equipment. As shown in Figure 3-2, there does not appear to be a direct correlation between traffic counts and average hydrocarbon concentrations. The calculated Pearson correlation was only -0.06, indicating a very weak relationship. Please refer to Table 3-9 and Figure 3-2 for a more detailed look at mobile source emissions and average hydrocarbon concentrations.

3.2.1.3 Mobile Source Tracer Analysis

Research has shown that acetylene can be used as a signature compound for automotive emissions (Warneck, 1988; NRC, 1991), as this VOC is not typically emitted from biogenic or stationary sources. As summarized in Table 3-9, many UATMP sites are located in high traffic areas (e.g., ELNJ and SPIL). Average acetylene concentrations at each site are also summarized in Table 3-9. As presented in Figure 3-3, there does not appear to be a direct correlation with daily traffic and acetylene concentrations. The calculated Pearson correlation was less than 0.01, indicating a very weak relationship. This observation might suggest that the site traffic counts may need to be updated, as many were recorded ten or more year ago.

Nearly all emissions of ethylene are due to automotive sources, with the exception of activities related to natural gas production and transmission. Ethylene is not detected as a VOC by the TO-15 sampling method, but is detected using the SNMOC method. For sites that chose

the SNMOC option, ethylene to acetylene concentration ratios were computed and compared to a ratio developed in numerous tunnel studies, and are presented in Table 3-10. An ethylene to acetylene ratio of 1.7 to 1 is indicative of mobile sources (TNRCC, 2002). Of the sites that sampled SNMOC, NBIL=s ethylene to acetylene ratio was the closest to the expected 1.7 to 1 ratio (1.77 to 1). These results are discussed further in the individual state sections.

3.2.1.4 BTEX Concentration Profiles

The *magnitude* of emissions from motor vehicles generally depends on the volume of traffic in urban areas, but the *composition* of these emissions depends more on vehicle design. Because the distribution of vehicle designs (i.e., the relative number of motor vehicles of different styles) is probably quite similar from one urban area to the next, the composition of air pollution resulting from motor vehicle emissions is not expected to exhibit significant spatial variations. In support of this hypothesis, previous air monitoring studies have observed relatively constant composition of ambient air samples collected along heavily traveled urban roadways (Conner et al., 1995). Roadside studies have found particularly consistent proportions of four hydrocarbons (benzene, toluene, ethylbenzene, and the xylene isomers - the ABTEX@ compounds) both in motor vehicle exhaust and in ambient air near roadways.

To examine the impact of motor vehicle emissions on air quality at the 2005 UATMP monitoring sites, Table 3-11 and Figure 3-4 compare concentration ratios for the BTEX compounds measured during the 2005 UATMP to the ratios reported in a roadside study (Conner et al., 1995). This comparison provides a qualitative depiction of how greatly motor vehicle emissions affect air quality at the UATMP monitoring sites: the more similar the concentration ratios at a particular monitoring site are to those of the roadside study, the more likely that motor vehicle emissions impact ambient levels of hydrocarbons at that location.

As presented in Figure 3-4, the concentration ratios for BTEX compounds measured at most UATMP monitoring sites bear some resemblance to the ratios reported in the roadside study. The BTEX ratios at the BAPR monitoring site appear to be the most similar to the roadside study profile. For all monitoring sites, the toluene-ethylbenzene ratio is the largest of the four ratios, with the exceptions of ITCMI, SIAL, and YFMI. The benzene-ethylbenzene ratio

is the smallest of the four ratios at 16 sites, while the xylenes-ethylbenzene ratio is the smallest at 18 sites. These observations suggest, though certainly do not prove, that emissions from motor vehicles significantly affect levels of hydrocarbons in urban ambient air.

3.2.2 Variability Analysis

Two types of variability are analyzed for this report. The first type examines the coefficient of variation analysis for each of the pollutants of interest across the UATMP sites. Seasonal variability is the second type of variability analyzed in this report. The UATMP concentration data were divided into the four seasons, as described in Section 3.1.5.

3.2.2.1 Coefficient of Variation

Figures 3-5 to 3-20 are graphical displays of site standard deviation versus average concentration. This analysis is best suited for comparing variability across data distributions for different sites and pollutants. Most of the pollutants of interest are either in a cluster (such as formaldehyde and tetrachloroethylene), exhibit a positive linear correlation (such as 1,3-butadiene and total xylenes), or are spread randomly (such as carbon tetrachloride). The coefficient of variation provides a relative measure of variability by expressing variations to the magnitude of the arithmetic mean.

3.2.2.2 Seasonal Variability Analysis

Figures 3-21 to 3-36 provide a graphical display of the average concentrations by season for the pollutants of interest. Recall how seasonal averages are calculated based on criteria specified in Section 3.1.5.

Many of the pollutants of interest, such as 1,3-butadiene, hexachloro-1,3-butadiene, *p*-dichlorobenzene, and tetrachloroethylene, were detected frequently in some seasons but not often in others. As a result of the seasonal average criteria, there are gaps in the figures for these pollutants for certain seasons. For example, Figure 3-12 shows that very few spring and winter averages are available, indicating that 1,3-butadiene is infrequently measured above the detection level in these seasons.

Other pollutants of interest, such as formaldehyde, benzene, and acetaldehyde, were detected year round. Comparing the seasonal averages for the sites with four valid seasonal averages often reveals a trend for these pollutants. For example, formaldehyde averages tended to be higher in the summer, as shown in Figure 3-28, while benzene averages tended to be higher in the winter, as shown in Figure 3-26. Other pollutants, such as acetaldehyde, do not exhibit as strong a trend.

Of the sites that sampled metals, most are located in Alabama and Texas. Unfortunately, these sites did not begin sampling until the summer, so only one or two seasonal averages are available. On a program-level, the same is true of acrolein as sampling began in the summer. Therefore, seasonal trends are only available for a small sample of sites, which makes a seasonal pattern difficult to discern at this time.

3.3 Additional Site-Specific Analyses

In addition to the analyses described in the preceding sections, the state-specific sections (4.0 through 22.0) contain additional analyses that do not lend themselves to review at a broader (program-wide) level. This section provides an overview of these analyses but does not discuss their results.

3.3.1 Emission Tracer Analysis

In this analysis, pollution roses for each of the pollutants of interest that exceeded the acute risk factors were created to help identify the geographical area where the emission sources of these pollutants may have originated. A pollution rose is a plot of the ambient concentration versus the unit vector of the wind direction; high concentrations are shown in relation to the direction of potential emissions sources.

3.3.2 Back Trajectory Analysis

A back trajectory analysis traces the origin of an air parcel in relation to the location where it is currently being measured. The method of constructing a back trajectory uses the Lagrangian frame of reference. In simplest terms, an air parcel can be traced back one hour to a new point of reference based on the current measured wind speed and direction. At this new point of reference that is now one hour prior to the current observation, the wind speed and direction are used again to determine where the air was one hour before. Each time segment is referred to as a Atime step.@ Typical back trajectories go 24 to 48 hours prior using surface and upper air meteorological observations. Back trajectory calculations are also governed by other meteorological parameters, such as pressure and temperature.

Gridded meteorological data and the model used for back trajectory analyses were prepared and developed by the National Oceanic and Atmospheric Administration (NOAA). The model used is the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT). More information on the model can be found at http://www.arl.noaa.gov/ready/hysplit4.html. The meteorological data represented the 2005 sampling year. Back trajectories were computed 24 hours prior to the sampling day (to match the 24-hour sample), and composite back trajectory maps were constructed for sampling days using GIS software. The value of the composite back trajectory maps is the determination of an airshed domain for air originating 24 hours prior to a sampling day. Agencies can use the airshed domain to evaluate regions where long-range transport may affect their monitoring site.

3.3.3 Wind Rose Analysis

In this analysis, wind roses were constructed for each site to help identify the predominant direction from which the wind blows. A wind rose shows the frequency of wind directions about a 16-point compass, and uses color or shading to represent wind speeds. Wind roses are constructed by uploading hourly wind data from the nearest weather station into a wind rose software program, WRPLOT (Lakes, 2006). A wind rose is often used in determining where to put an ambient monitoring site when trying to capture emissions from an upwind source. A wind rose may also be useful in determining whether high concentrations correlate with a specific

wind direction. While the composite back trajectory maps show where a parcel of air originated from on a number of days, the wind rose shows the frequency at which wind speed and direction are measured near the monitoring site. In other words, the back trajectory map focuses on long range transport, while the wind rose captures day to day fluctuations. Both are used to "capture" meteorological influences at the monitoring sites.

3.3.4 Site Trends Analysis

Table 2-1 presented past UATMP participation for sites participating in this years program. For sites that participated prior to 2004 and are still participants through the 2005 program year, a trends analysis was conducted. The trends analyzed are daily averages (refer to the definitions in Section 3.1.5) at each site for three pollutants: 1,3-butadiene, benzene, and formaldehyde. These daily averages are presented in the form of bar graphs. New to the site trends graphs this year is the confidence interval, represented by error bars extending from the top of each bar graph. The purpose of the confidence interval is to show the statistical significance of the relative increases or decreases shown over the years of participation. Although the average concentration for a particular year may appear to be much lower (or higher) than another year, if the confidence intervals overlap, the difference is not statistically significant. A large confidence interval correlates to a low confidence in a specific statistical parameter, in this case the daily average, and may indicate the presence of a few outliers driving the daily average in one direction or another.

At sites where all three pollutants were sampled, formaldehyde consistently measured the highest daily average concentration at all sites of the sites with at least 3 consecutive years of sampling, while 1,3-butadiene, with few exceptions, consistently measured the lowest. The site with the most years of participation is CANJ, having sampled consistently since 1994. It is important to note that not all sites sample the same pollutant types, therefore all three pollutants may not be represented for all years of participation.

3.3.5 1999 NATA Data Risk Assessment

In February 2006, the US EPA released the results of its national-scale air toxics assessment, NATA, for base year 1999 (EPA, 2006c). NATA uses the National Emissions Inventory (NEI) for hazardous air pollutants (HAPs) as its starting point, but also incorporates ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These concentrations are then applied to cancer unit risk estimates (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. The national-scale air toxics assessment (NATA) is a useful resource in helping federal and state/local/tribal agencies identify potential areas of air quality concern.

Several of the program-wide pollutants of interest are HAPs that have been identified as NATA risk driver pollutants (US EPA, 2006c): acrolein (national noncancer); arsenic (regional cancer and noncancer); benzene (national cancer); 1,3-butadiene (regional cancer and noncancer); carbon tetrachloride (regional cancer); formaldehyde (regional noncancer); manganese (regional noncancer); nickel (regional noncancer); and tetrachloroethylene (regional cancer).

Data from EPA's 1999 NATA were retrieved and are presented in this analysis. First, in sections 4.0 through 22.0, each site's respective census tract is identified and the percent of the home county population that resides in said census tract is calculated. Then the cancer and noncancer risk associated with the pollutants that "failed" screens (refer to Section 3.1.4) at each site is presented and discussed. Finally, an annual average, if available, is presented for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. An ***annual*** average is the average concentration of all detects and 1/2 MDL substituted values for non-detects. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Although EPA does not recommend comparing concentrations from different base years, it is useful to see if the concentration profile is similar.

Figure 3-1. Comparison of Average Hydrocarbon Concentration vs. 10-MileVehicle Registration

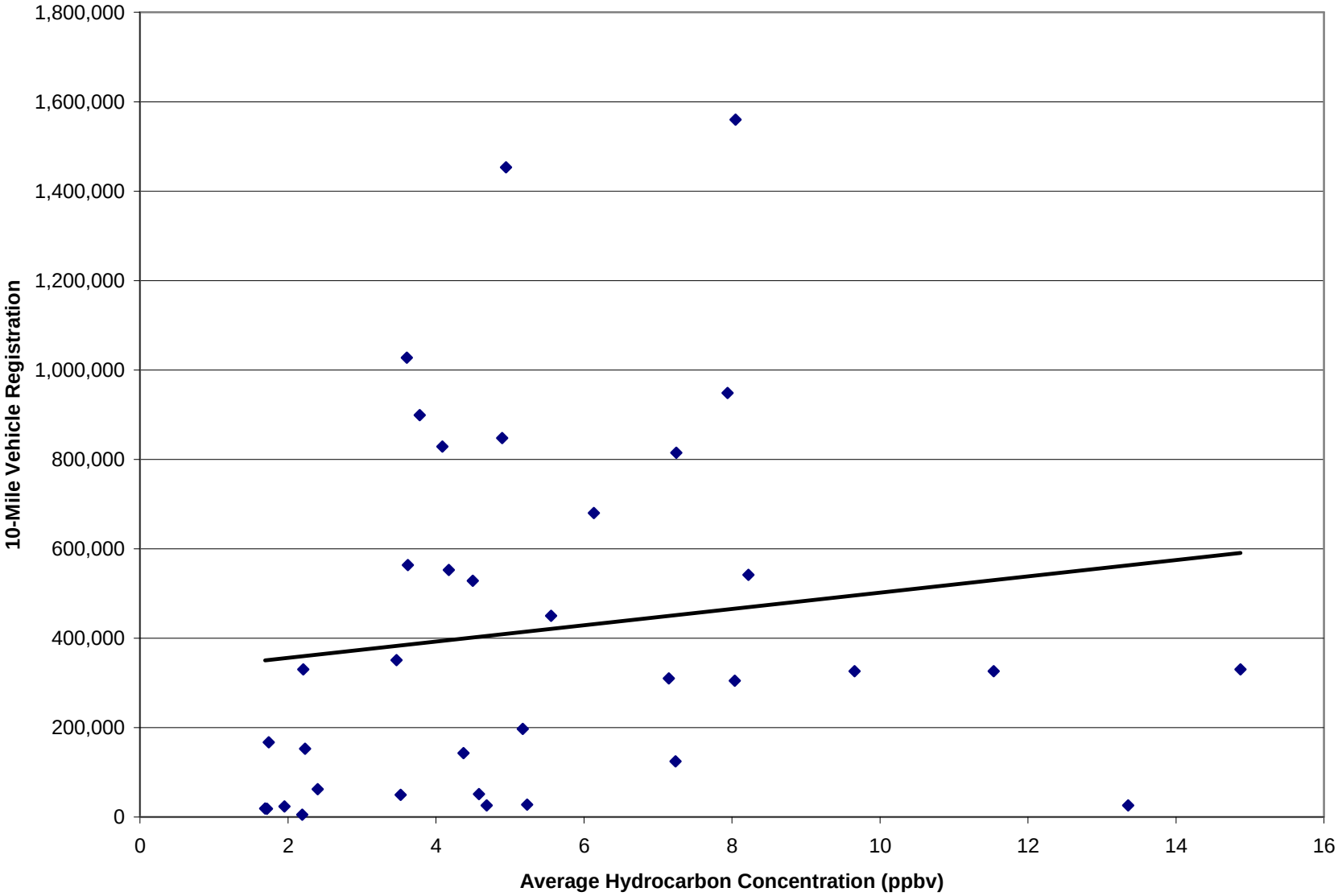


Figure 3-2. Comparison of Average Hydrocarbon Concentration vs. Daily Traffic Counts

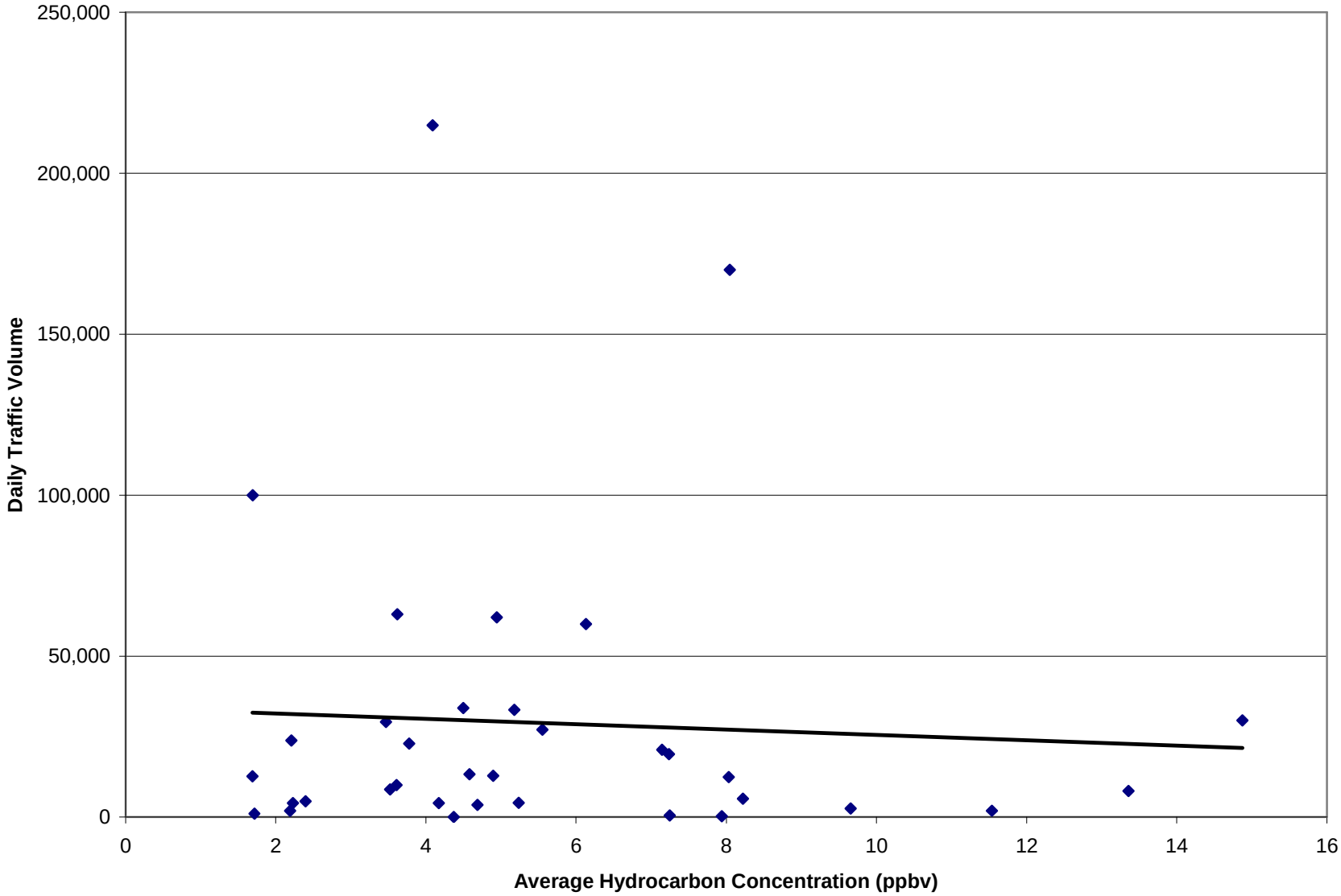


Figure 3-3. Comparison of Average Acetylene Concentration vs. Daily Traffic Counts

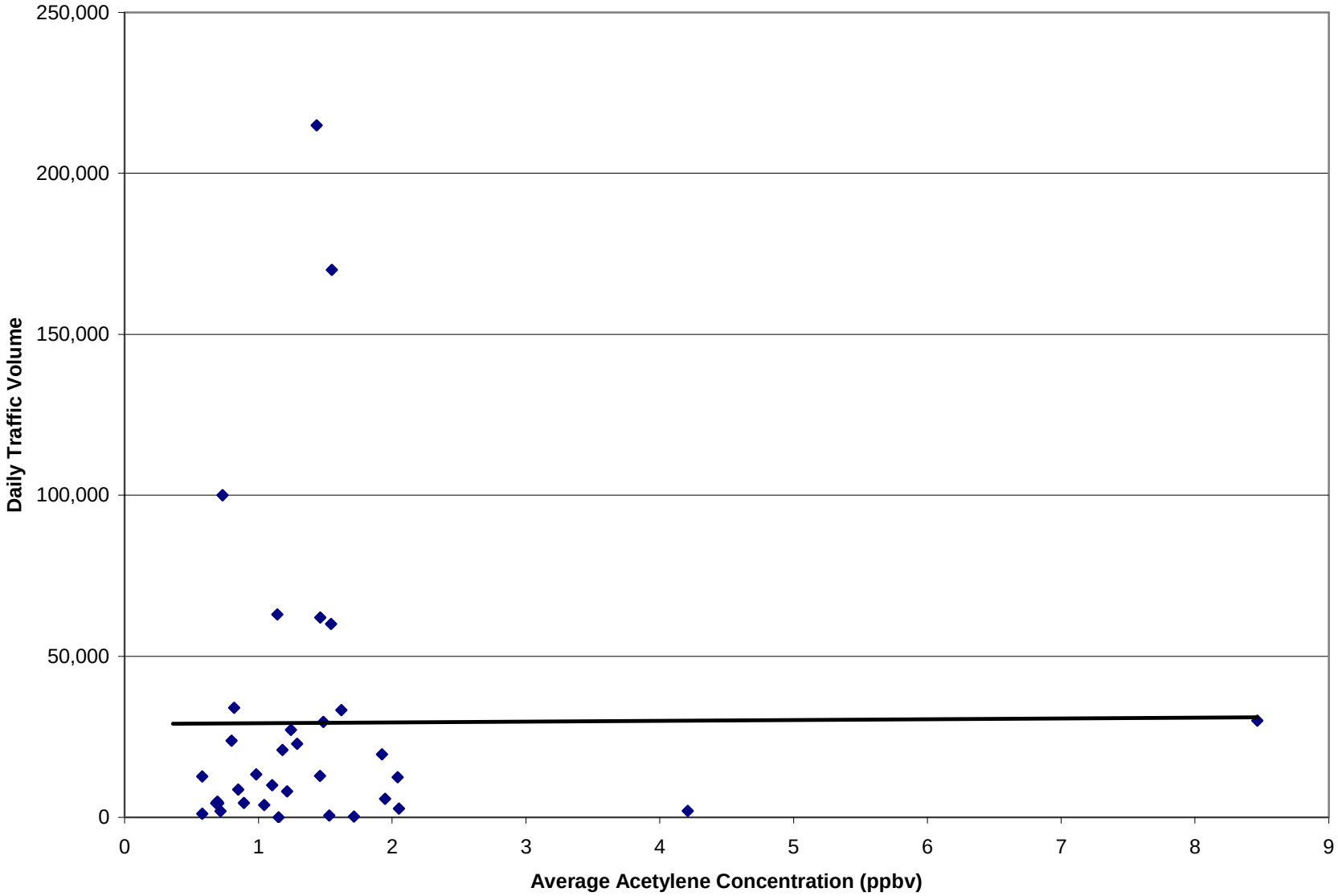


Figure 3-4. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study

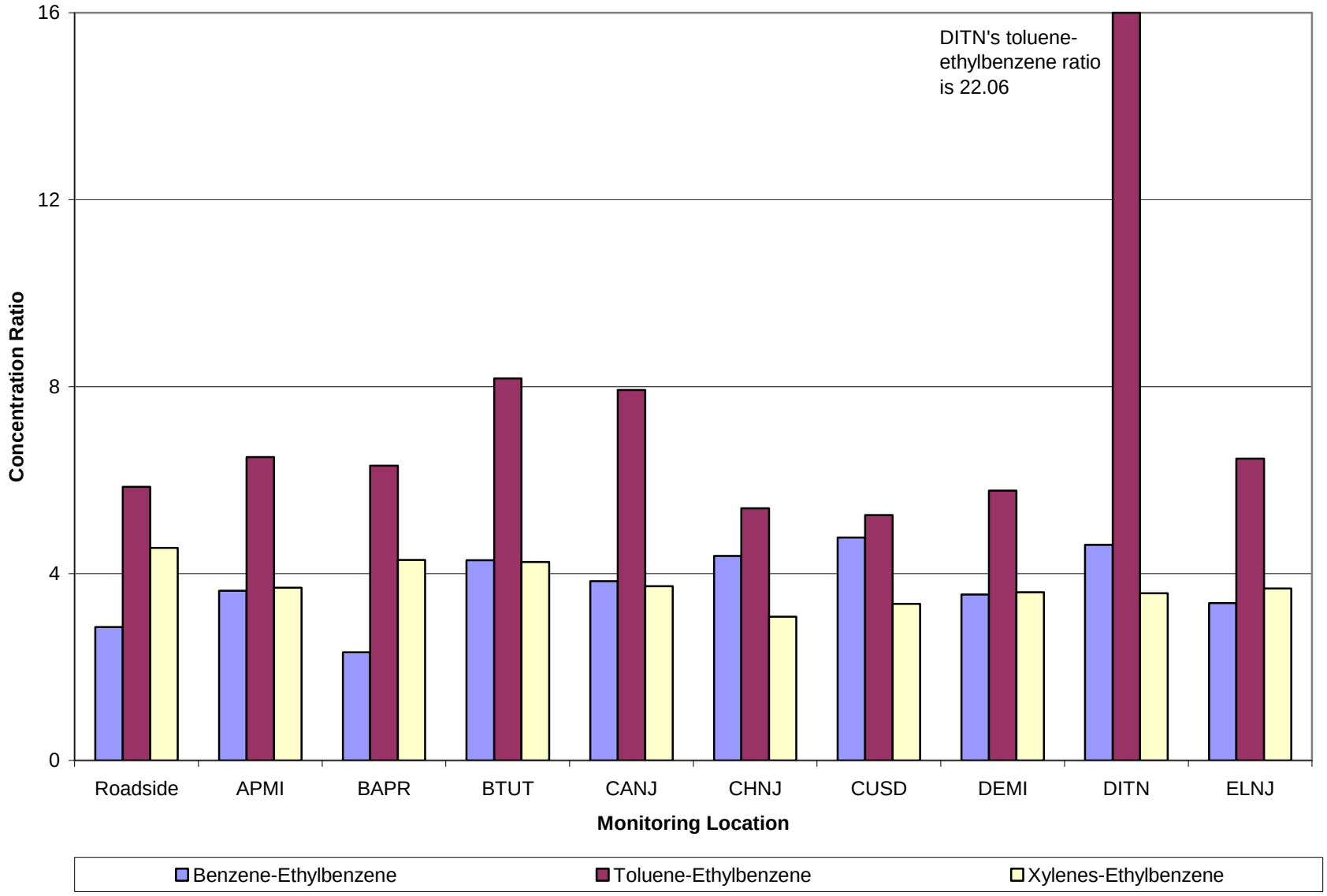


Figure 3-4. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study (Continued)

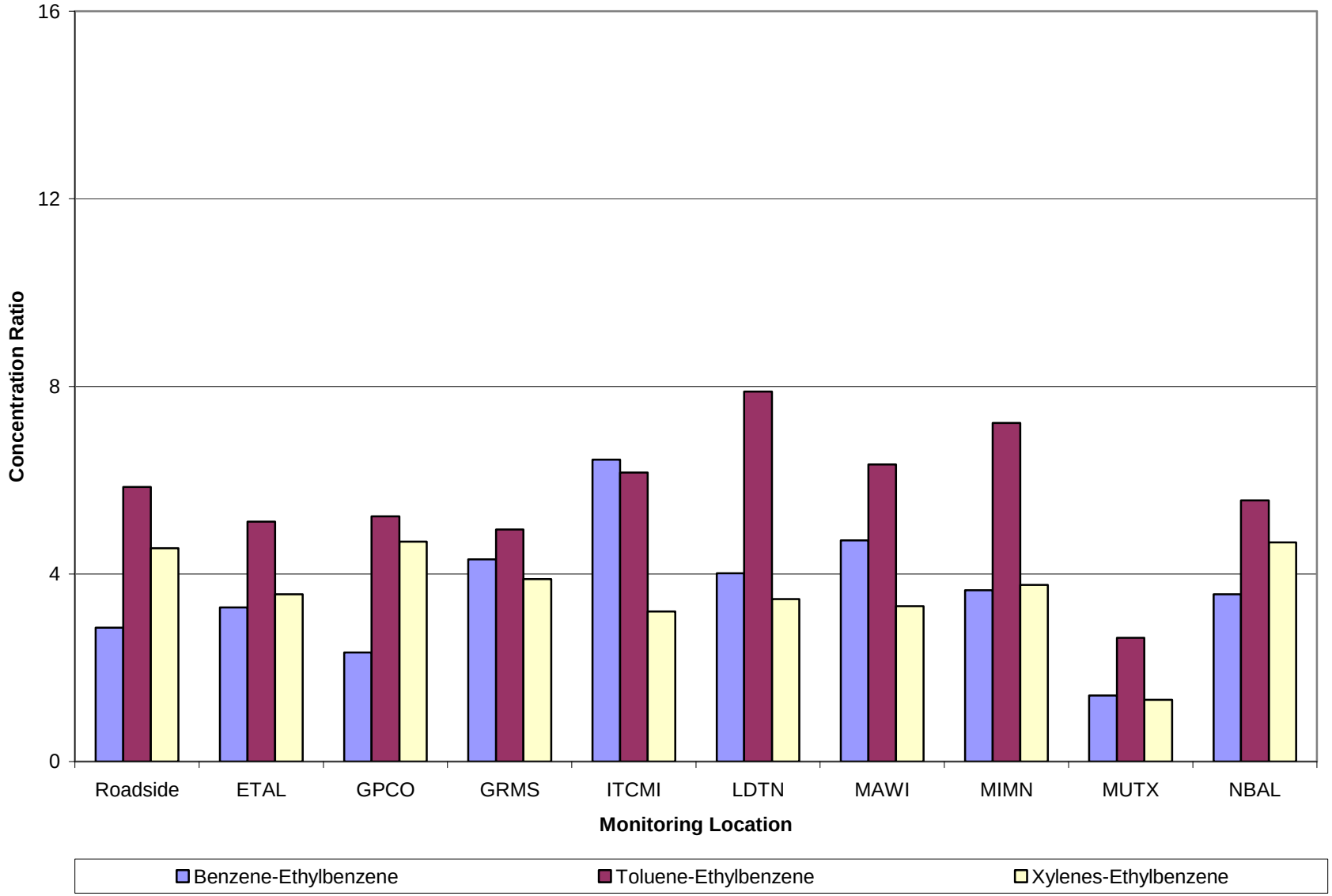


Figure 3-4. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study (Continued)

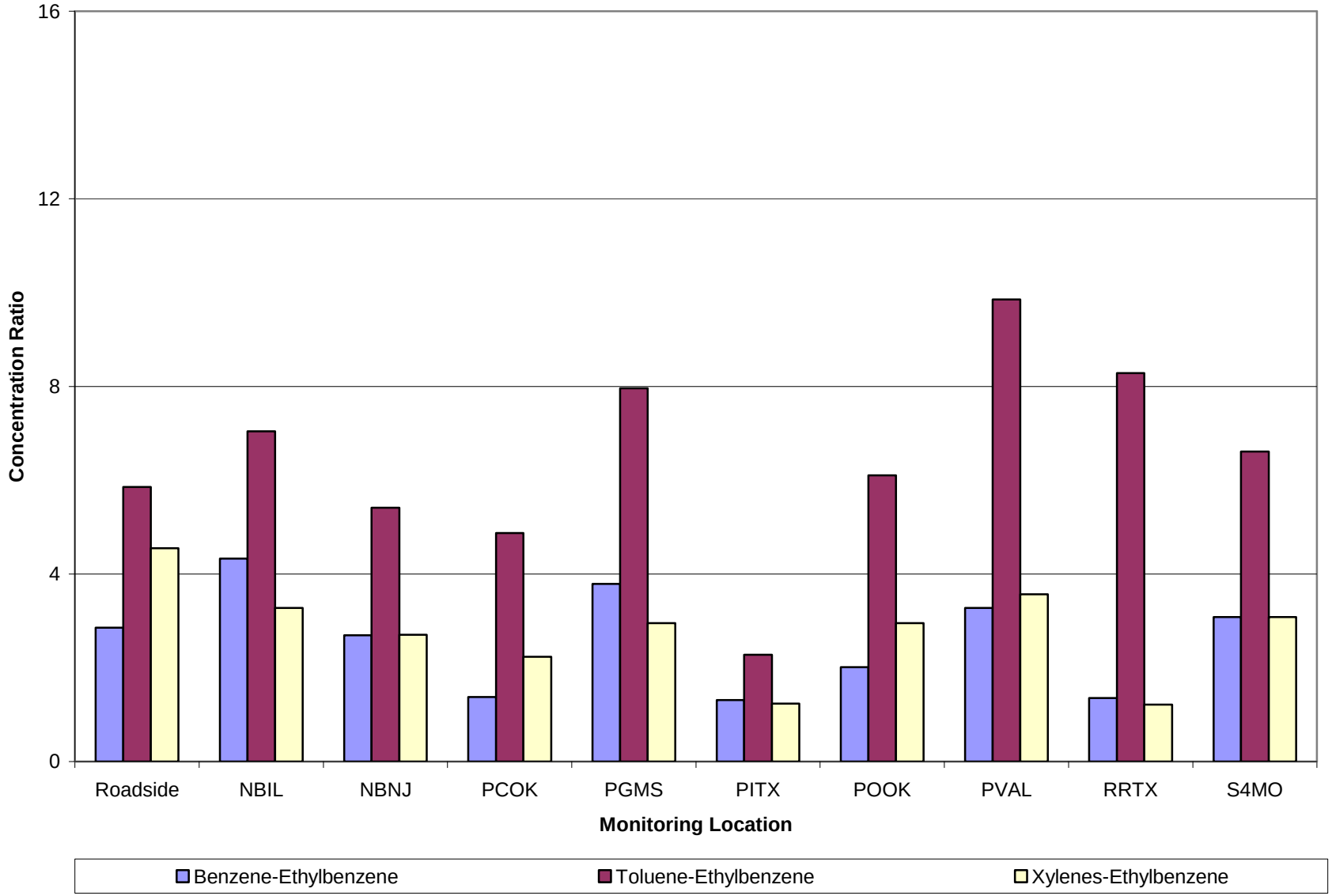


Figure 3-4. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study (Continued)

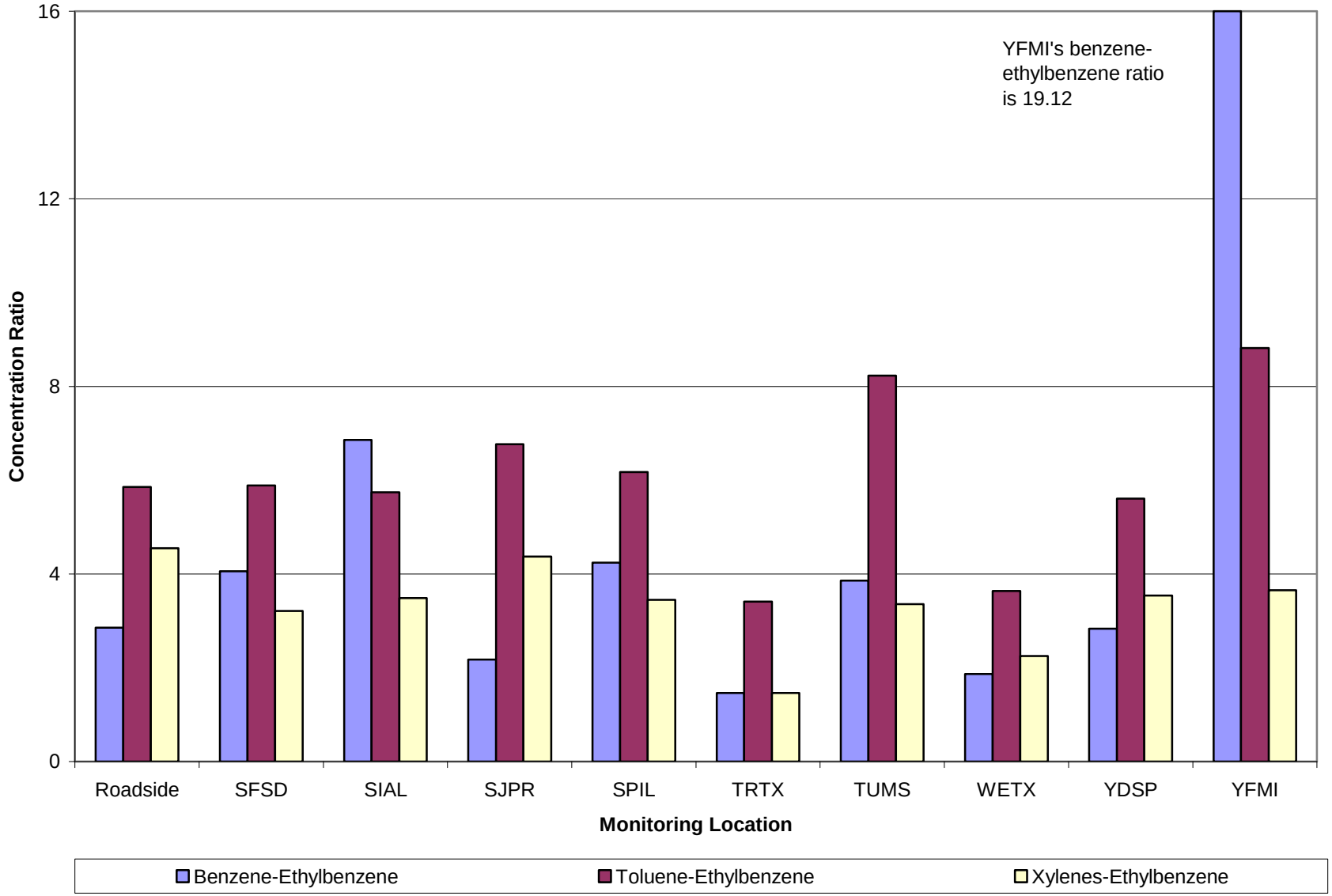


Figure 3-5. Coefficient of Variation Analysis of 1, 3-Butadiene Across 35 Sites

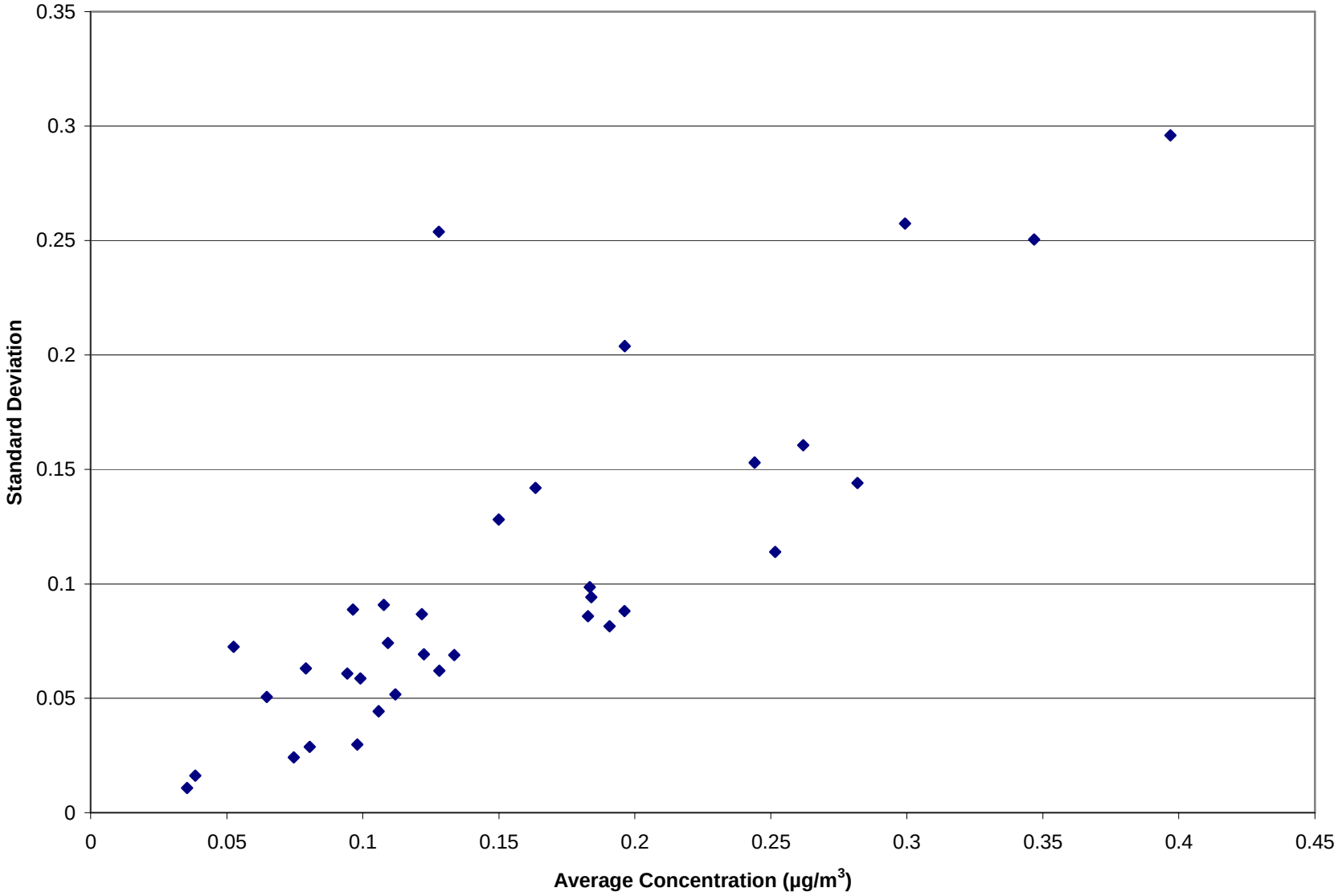


Figure 3-6. Coefficient of Variation Analysis of Acetaldehyde Across 41 Sites

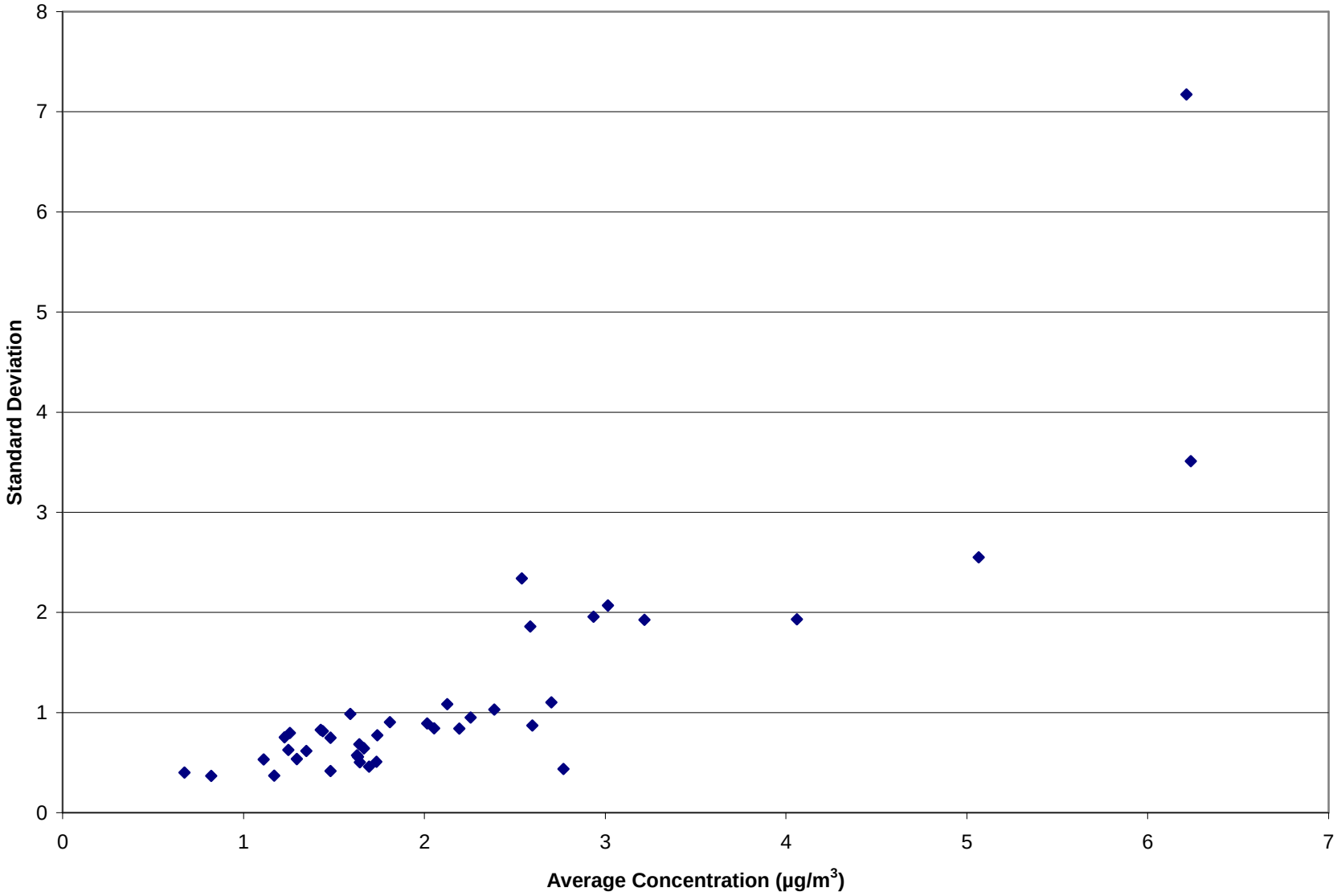


Figure 3-7. Coefficient of Variation Analysis of Acetonitrile Across 35 Sites

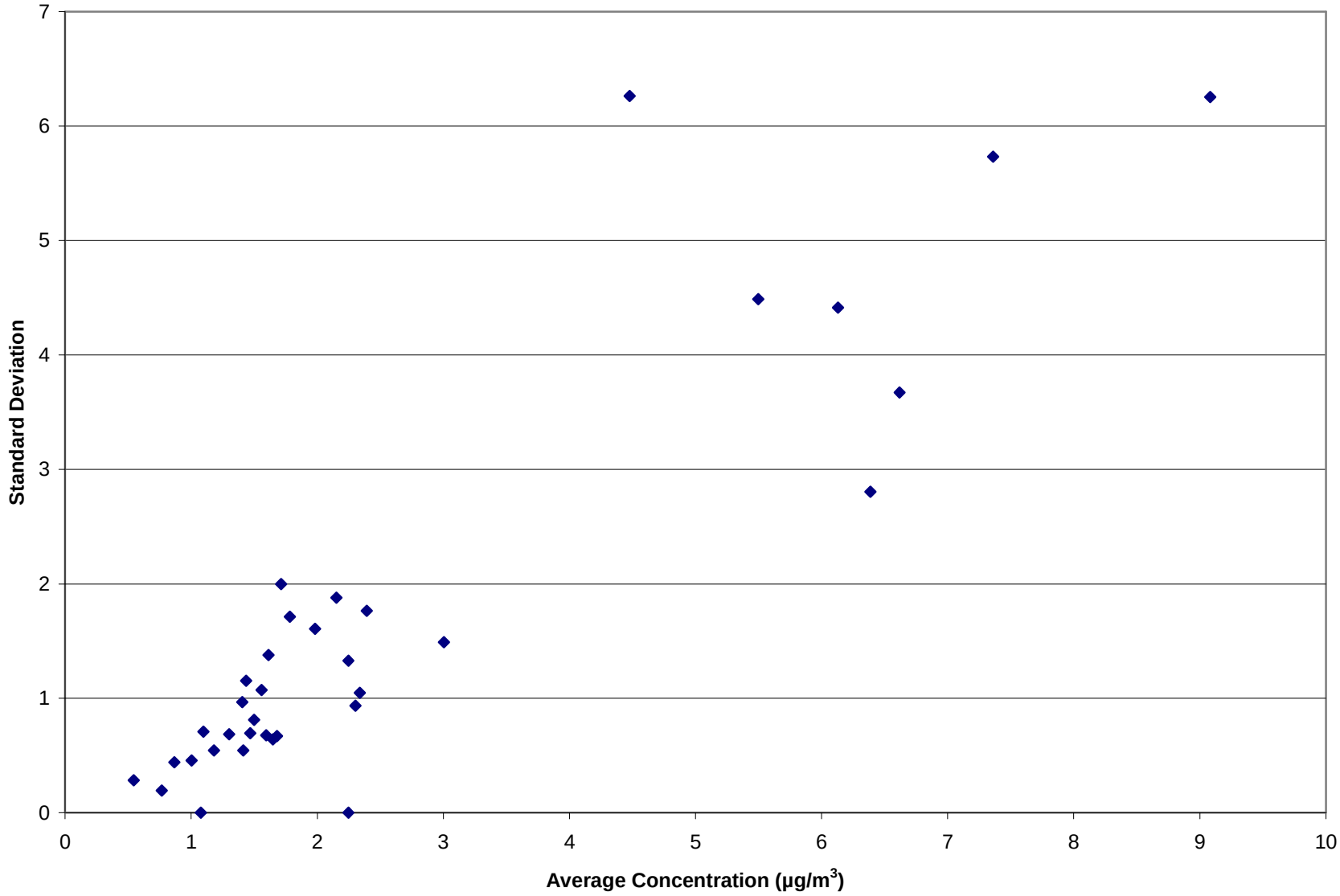


Figure 3-8. Coefficient of Variation Analysis of Benzene Across 36 Sites

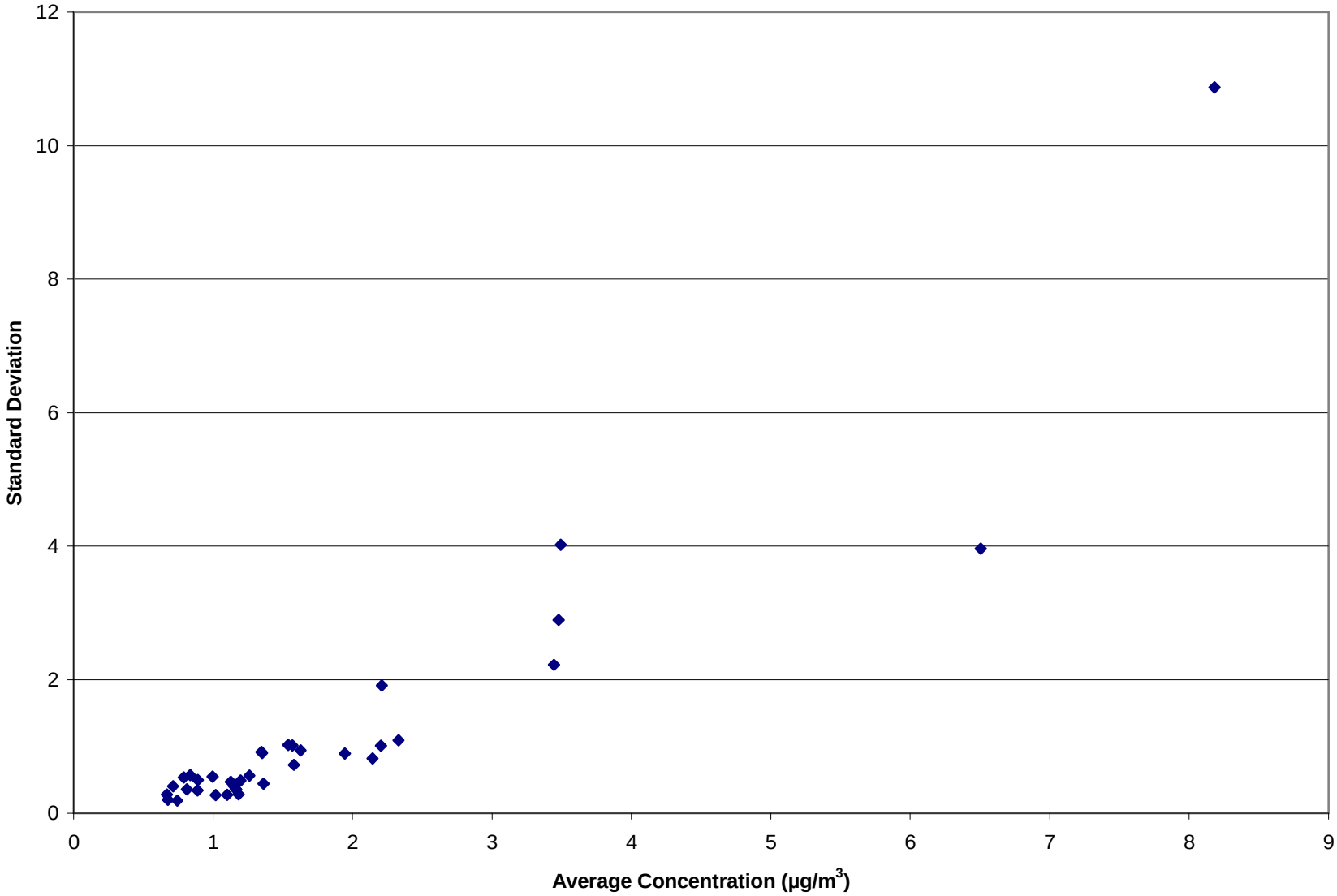


Figure 3-9. Coefficient of Variation Analysis of Carbon Tetrachloride Across 36 Sites

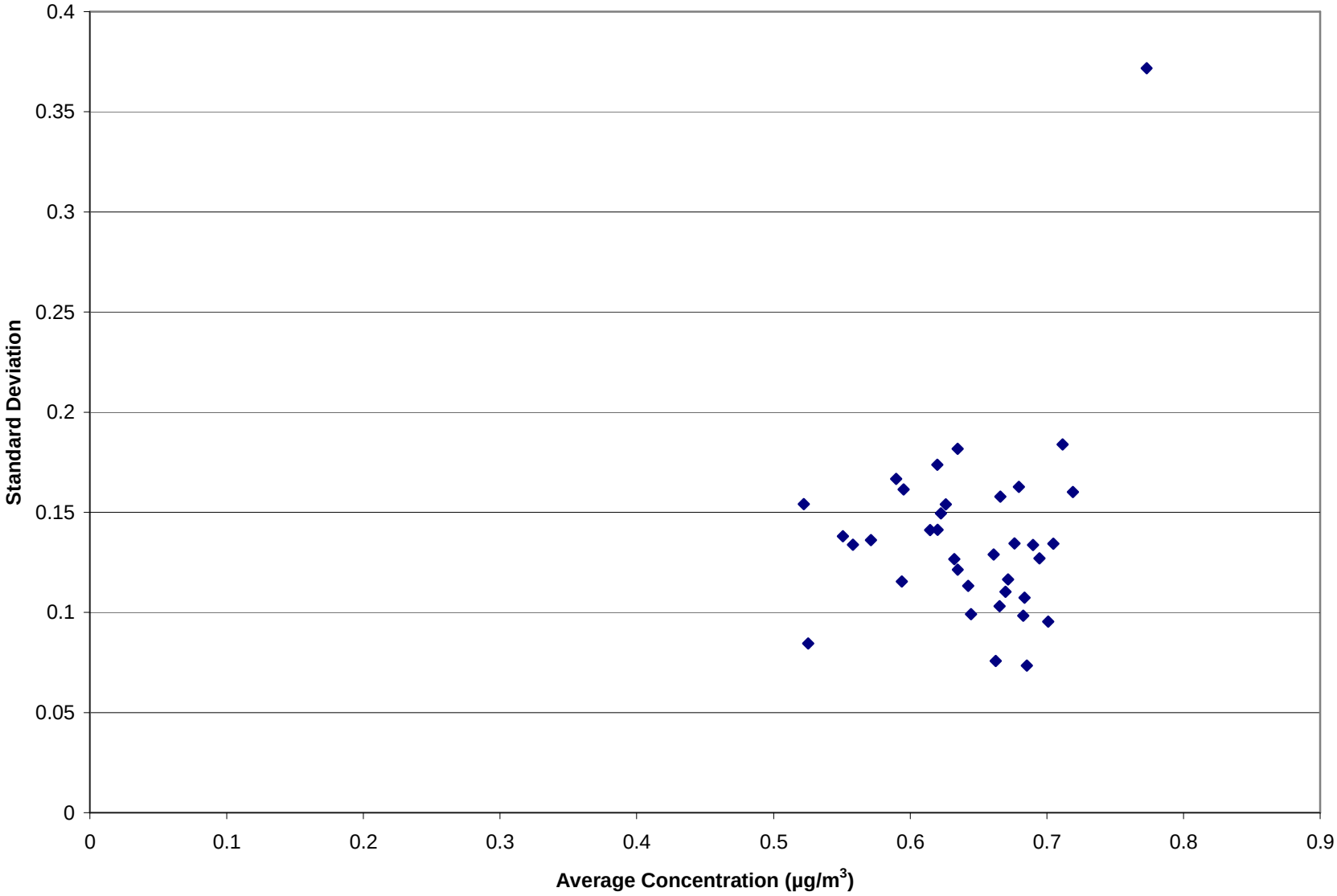


Figure 3-10. Coefficient of Variation Analysis of Formaldehyde Across 41 Sites

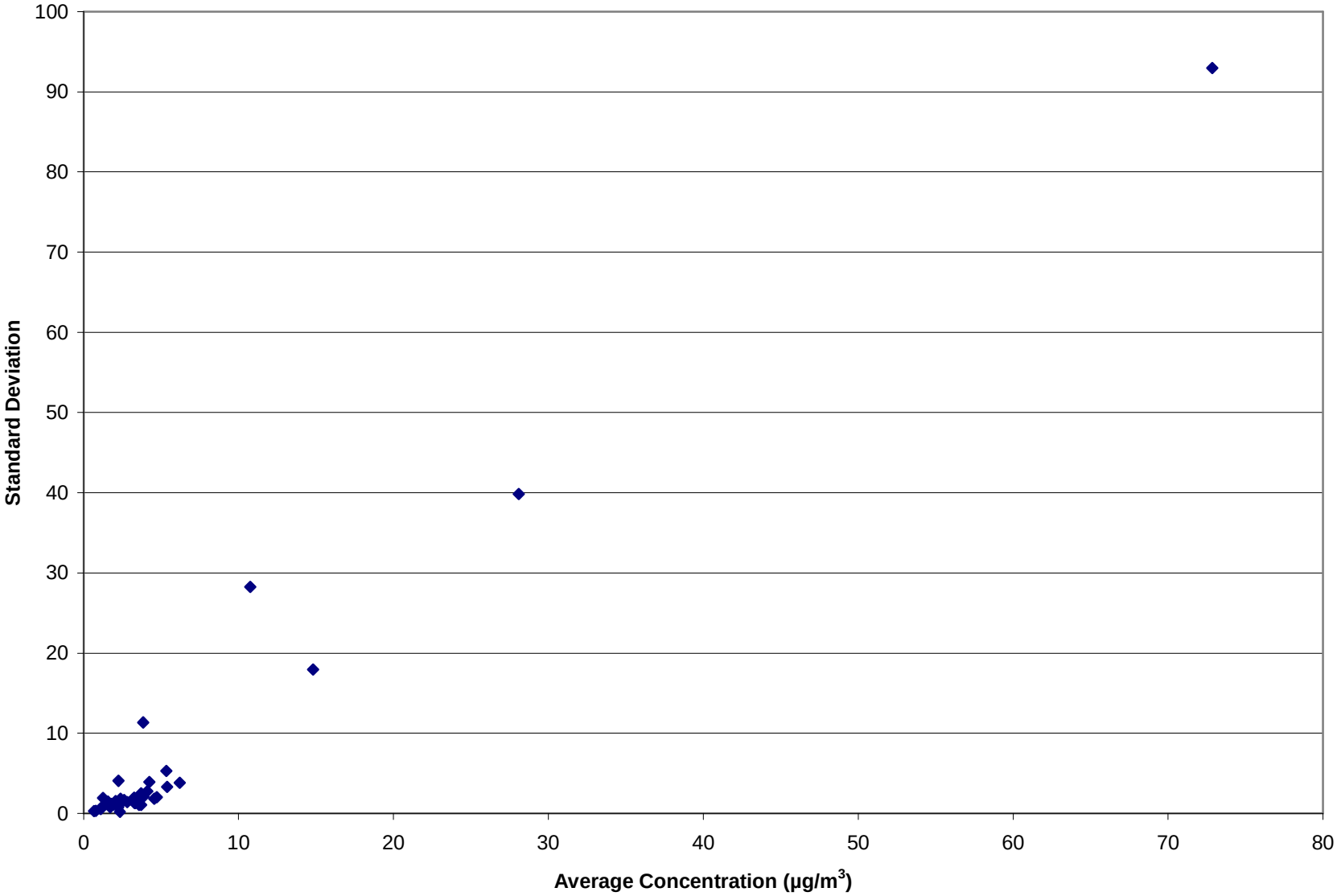


Figure 3-11. Coefficient of Variation Analysis of Hexachloro-1,3-Butadiene Across 31 Sites

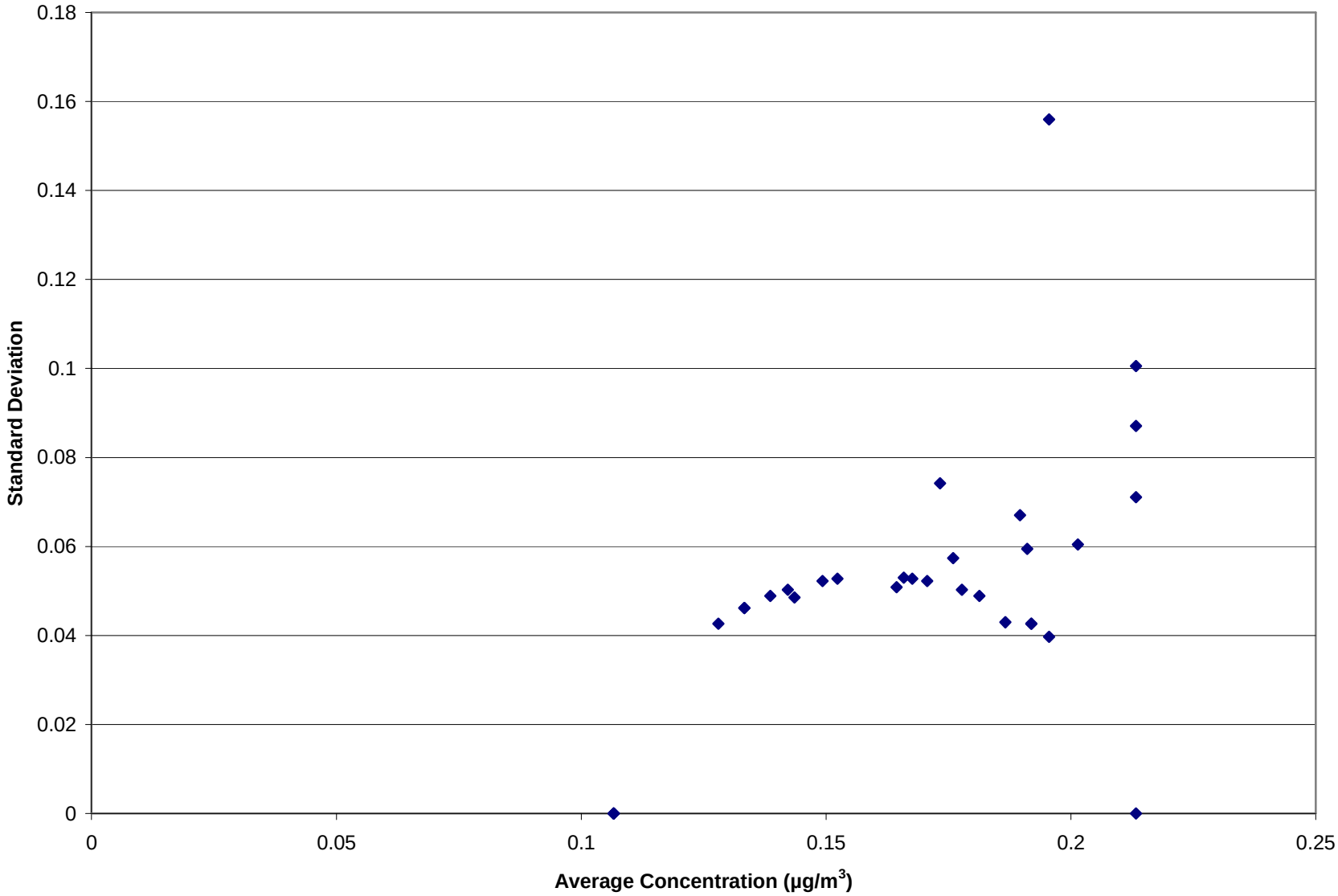


Figure 3-12. Coefficient of Variation Analysis of *p*-Dichlorobenzene Across 35 Sites

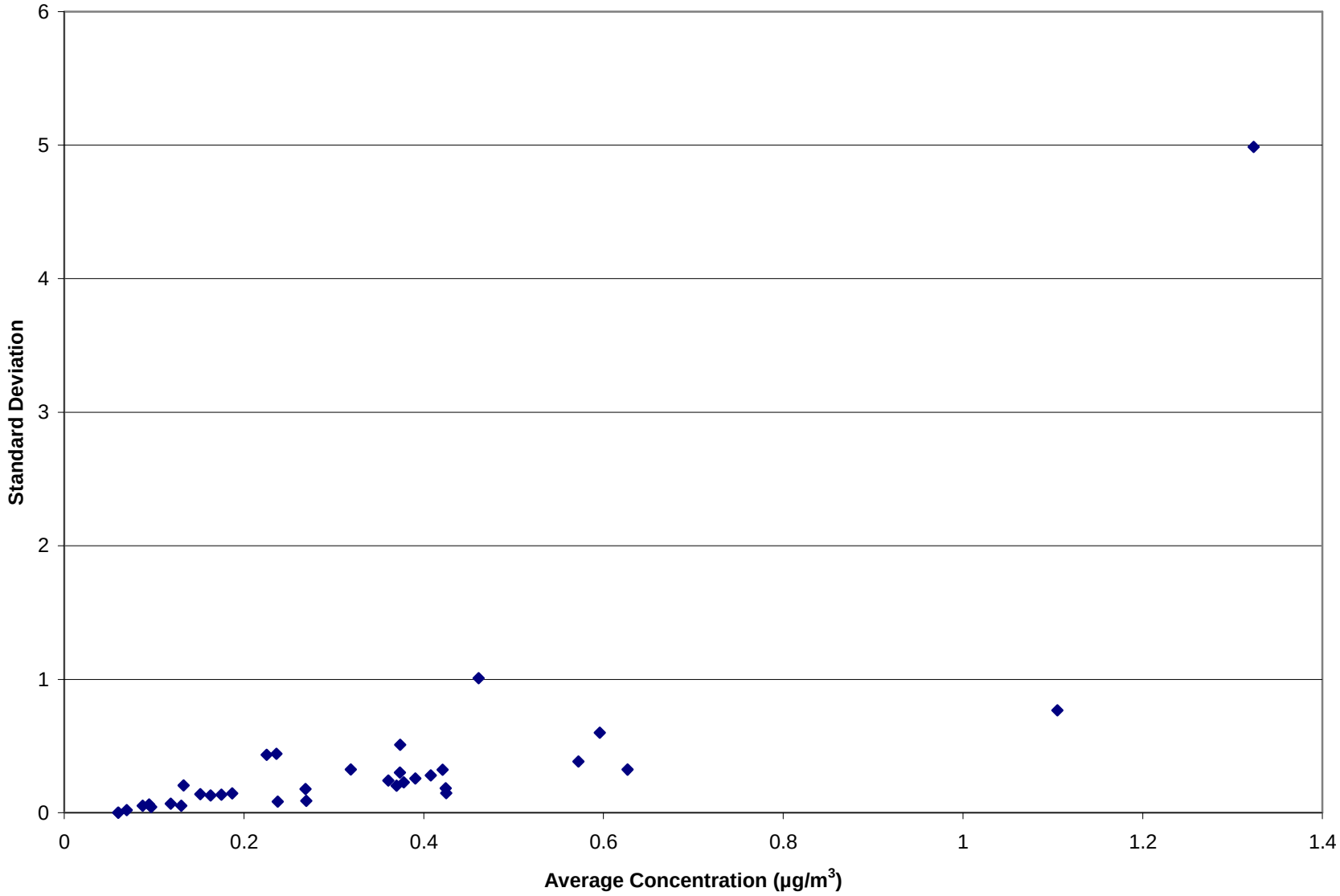


Figure 3-13. Coefficient of Variation Analysis of Tetrachloroethylene Across 35 Sites

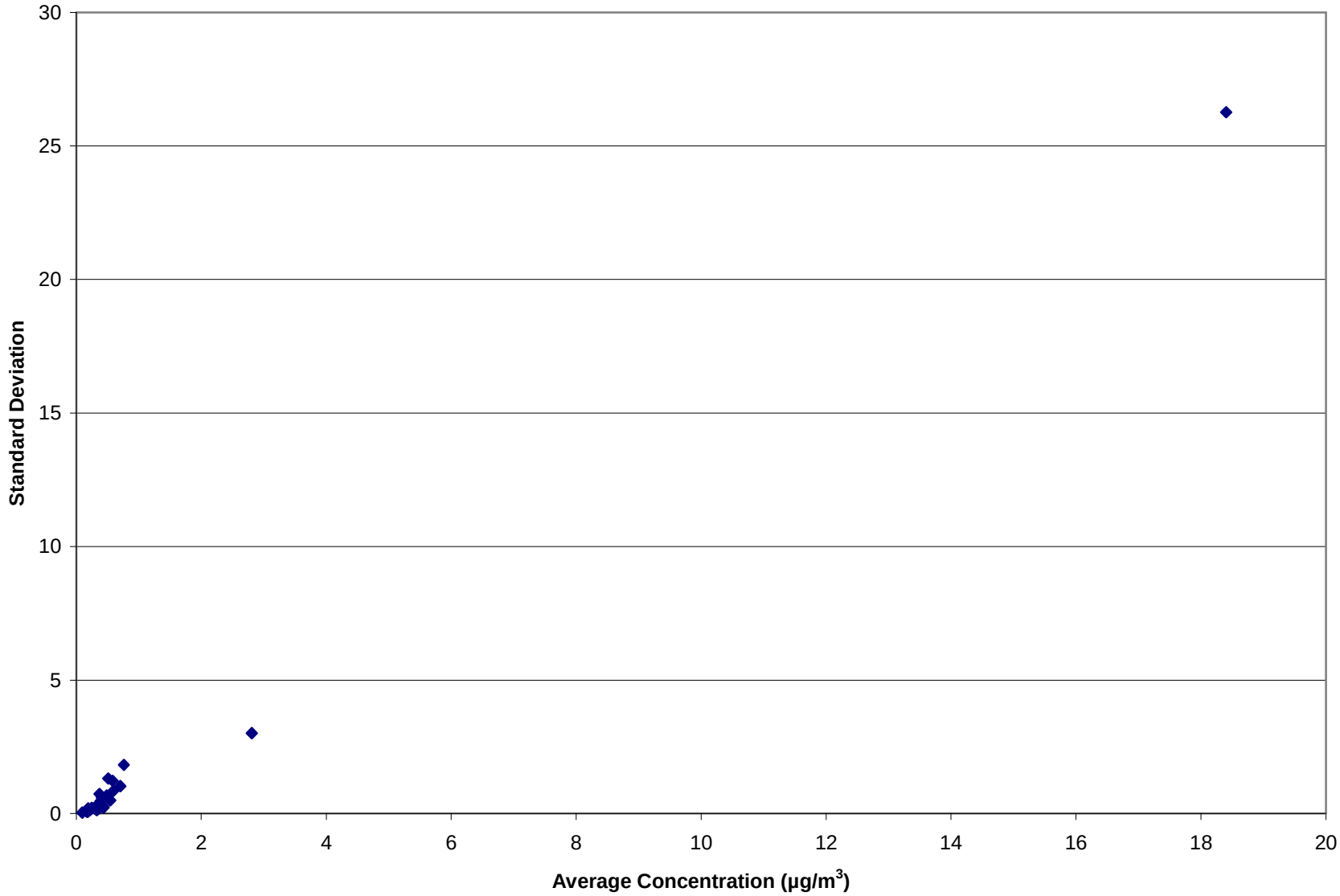


Figure 3-14. Coefficient of Variation Analysis of Xylene Across 36 Sites

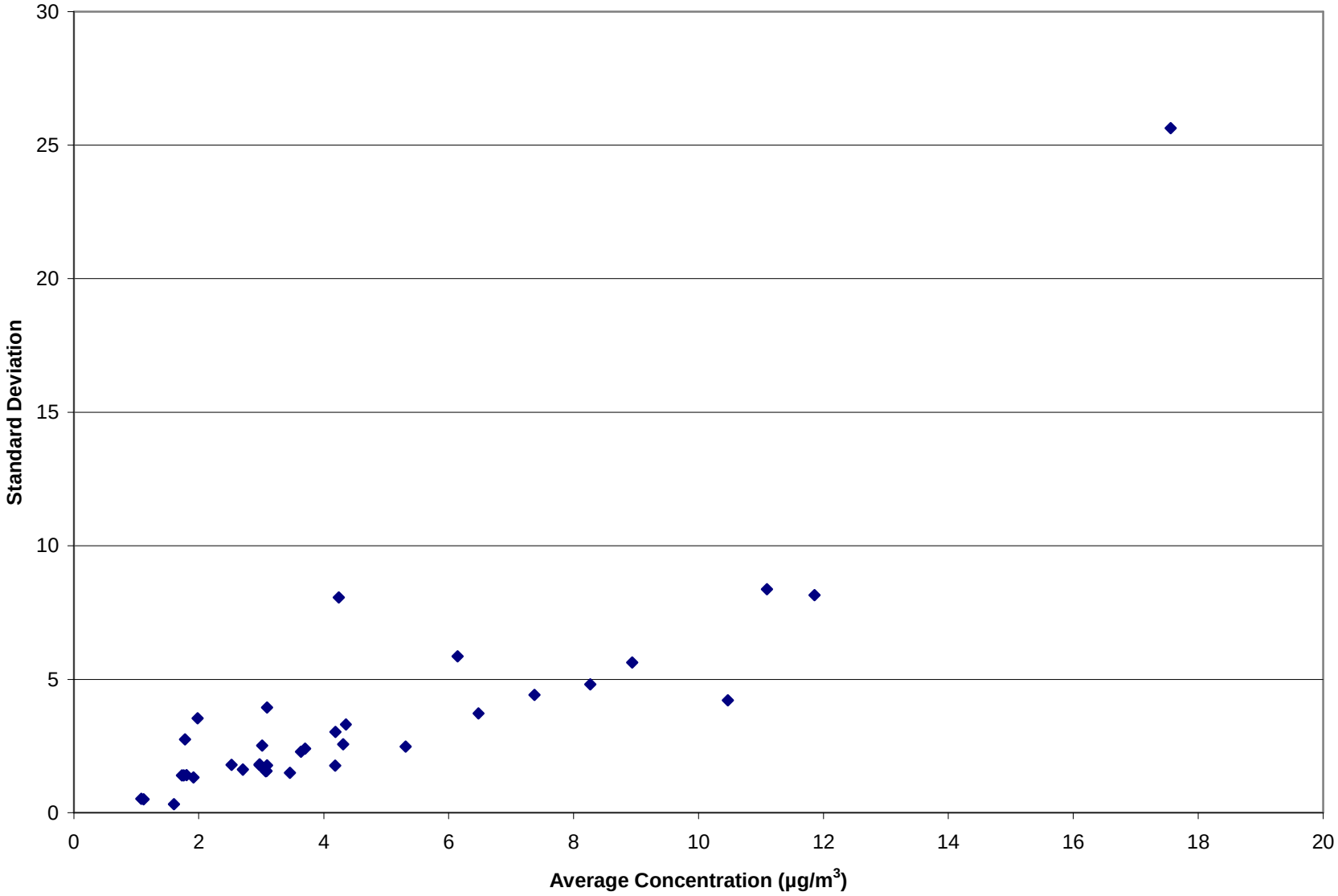


Figure 3-15. Coefficient of Variation Analysis of Arsenic-PM_{10} Across 8 Sites

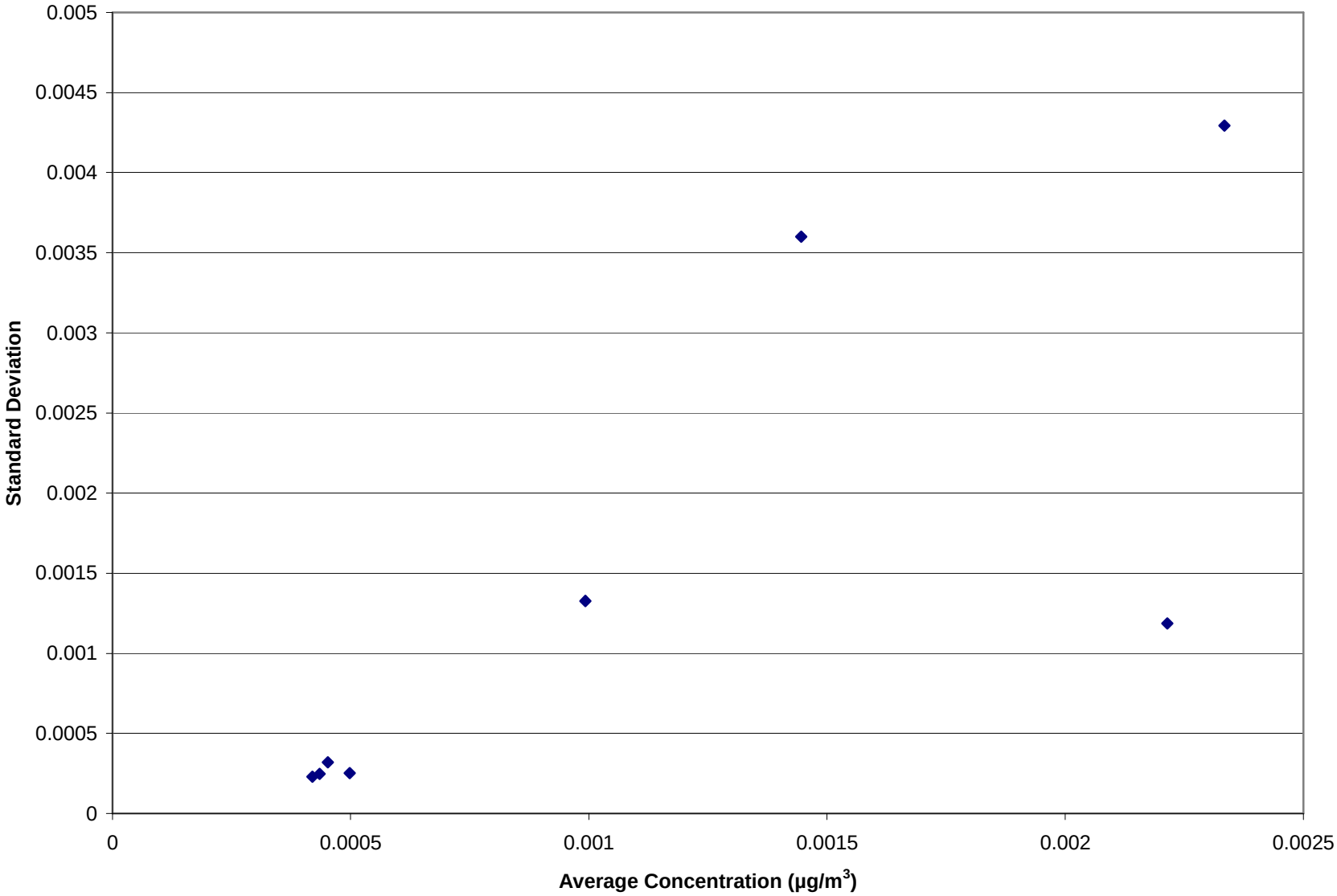


Figure 3-16. Coefficient of Variation Analysis of Manganese-PM_{10} Across 8 Sites

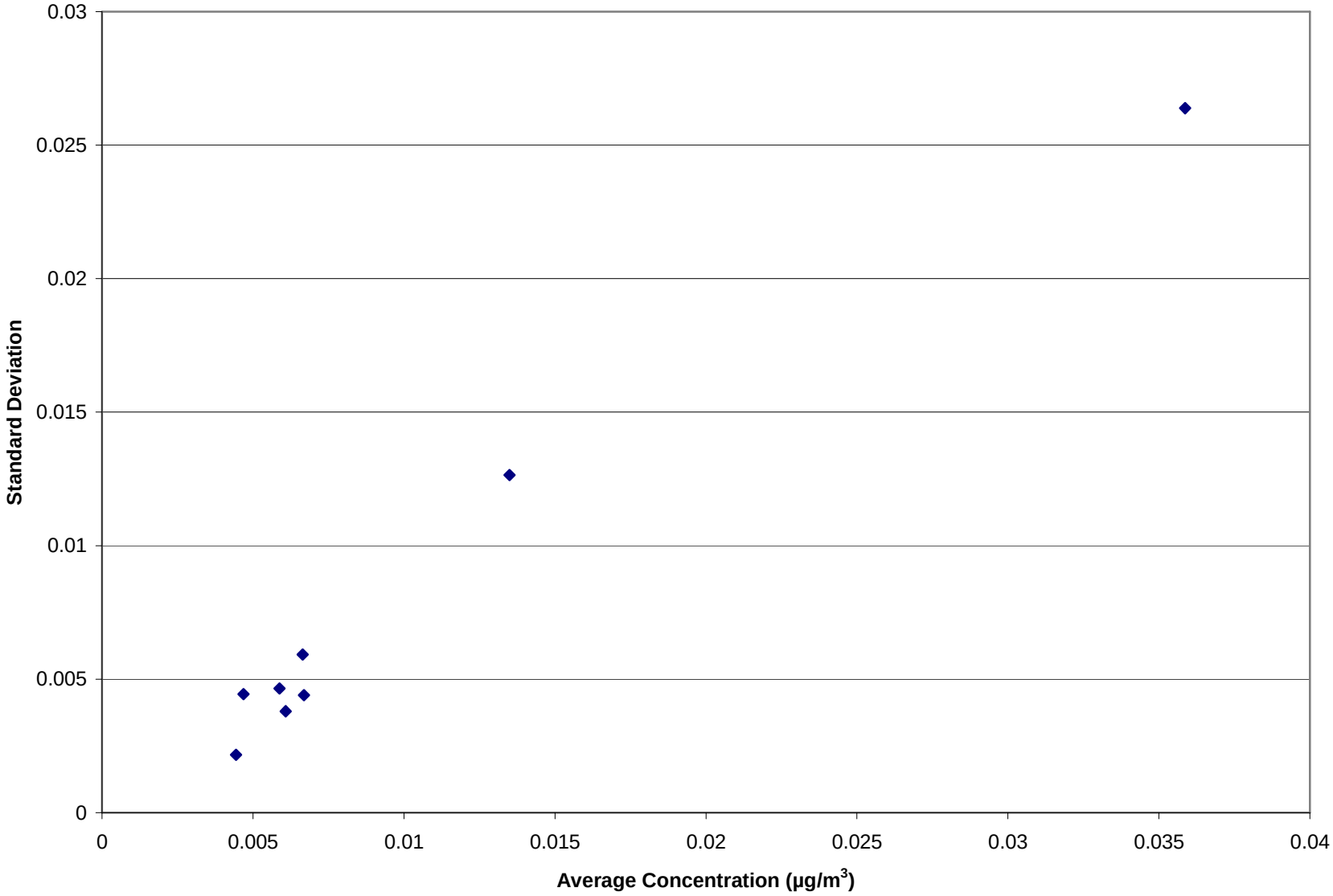


Figure 3-17. Coefficient of Variation Analysis of Nickel-PM_{10} Across 8 Sites

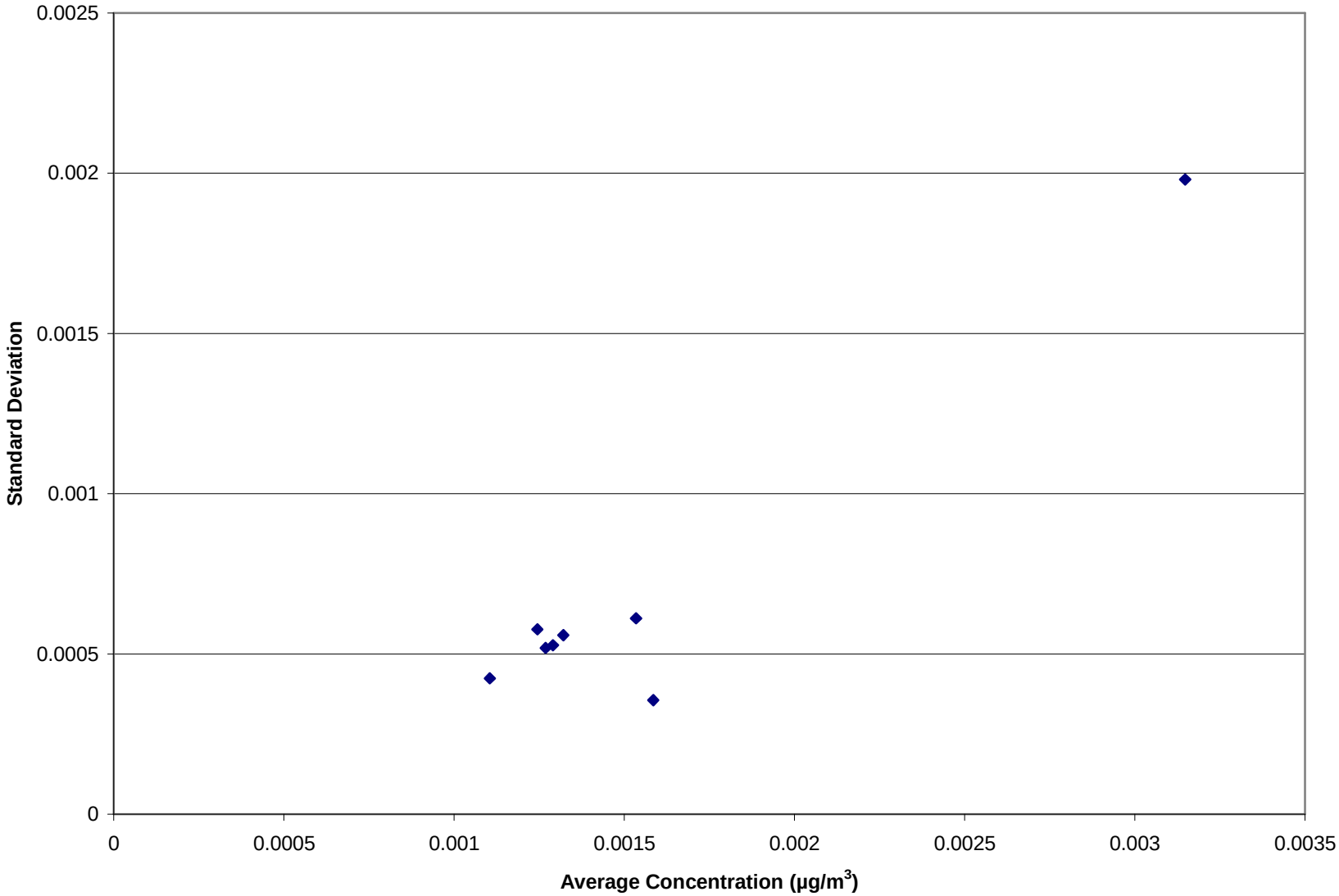


Figure 3-18. Coefficient of Variation Analysis of Arsenic-TSP Across 8 Sites

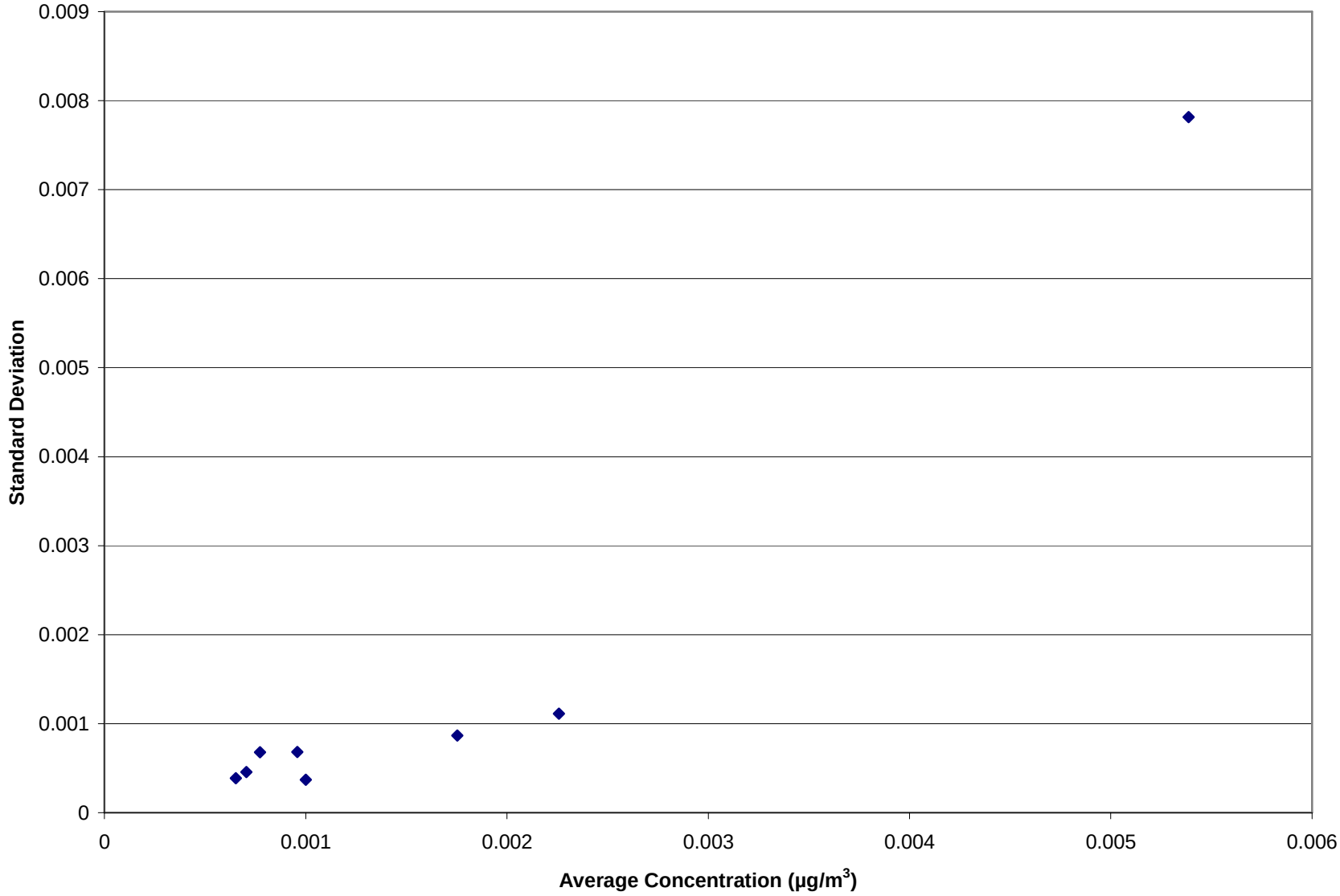


Figure 3-19. Coefficient of Variation Analysis of Manganese-TSP Across 8 Sites

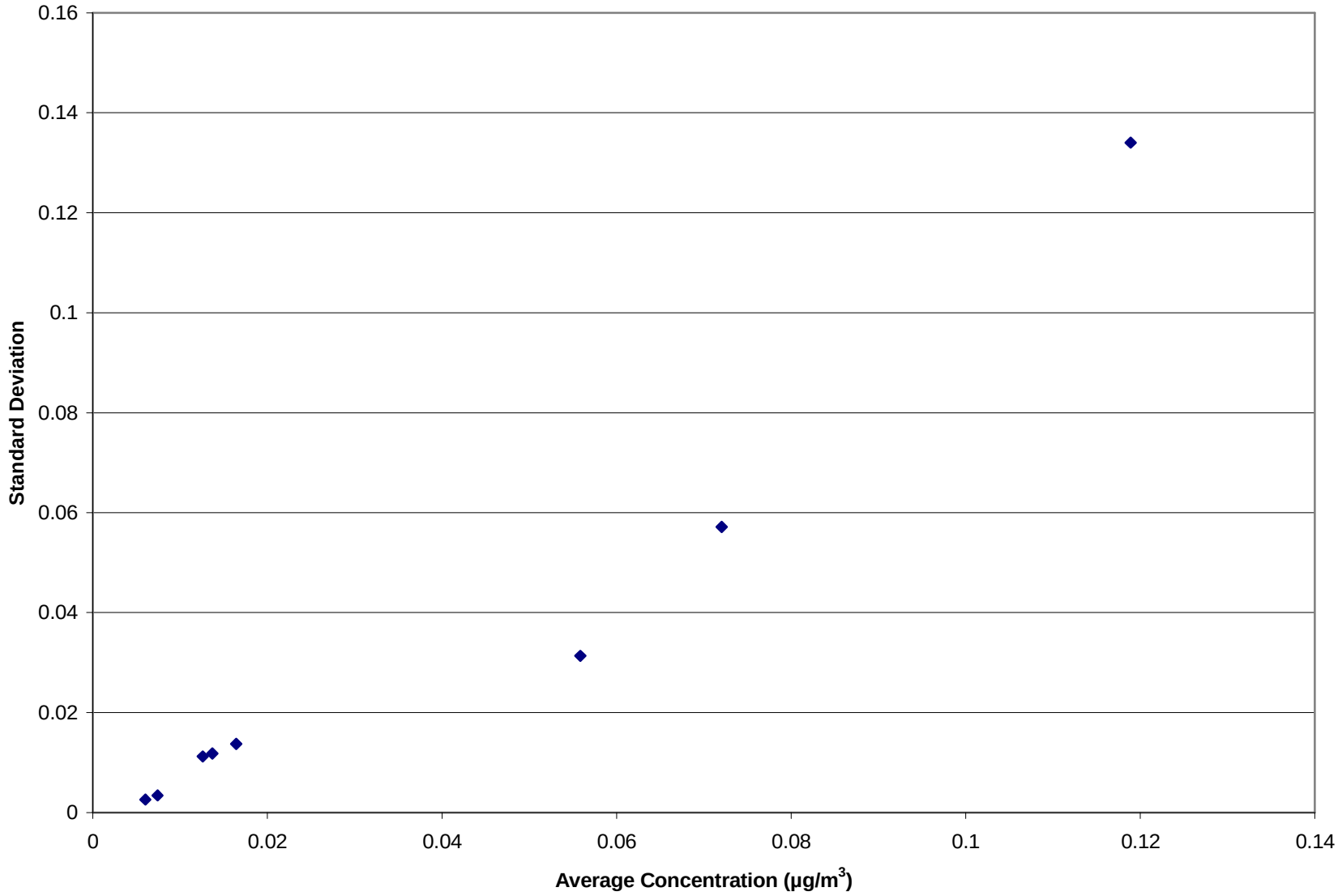


Figure 3-20. Coefficient of Variation Analysis of Nickel-TSP Across 8 Sites

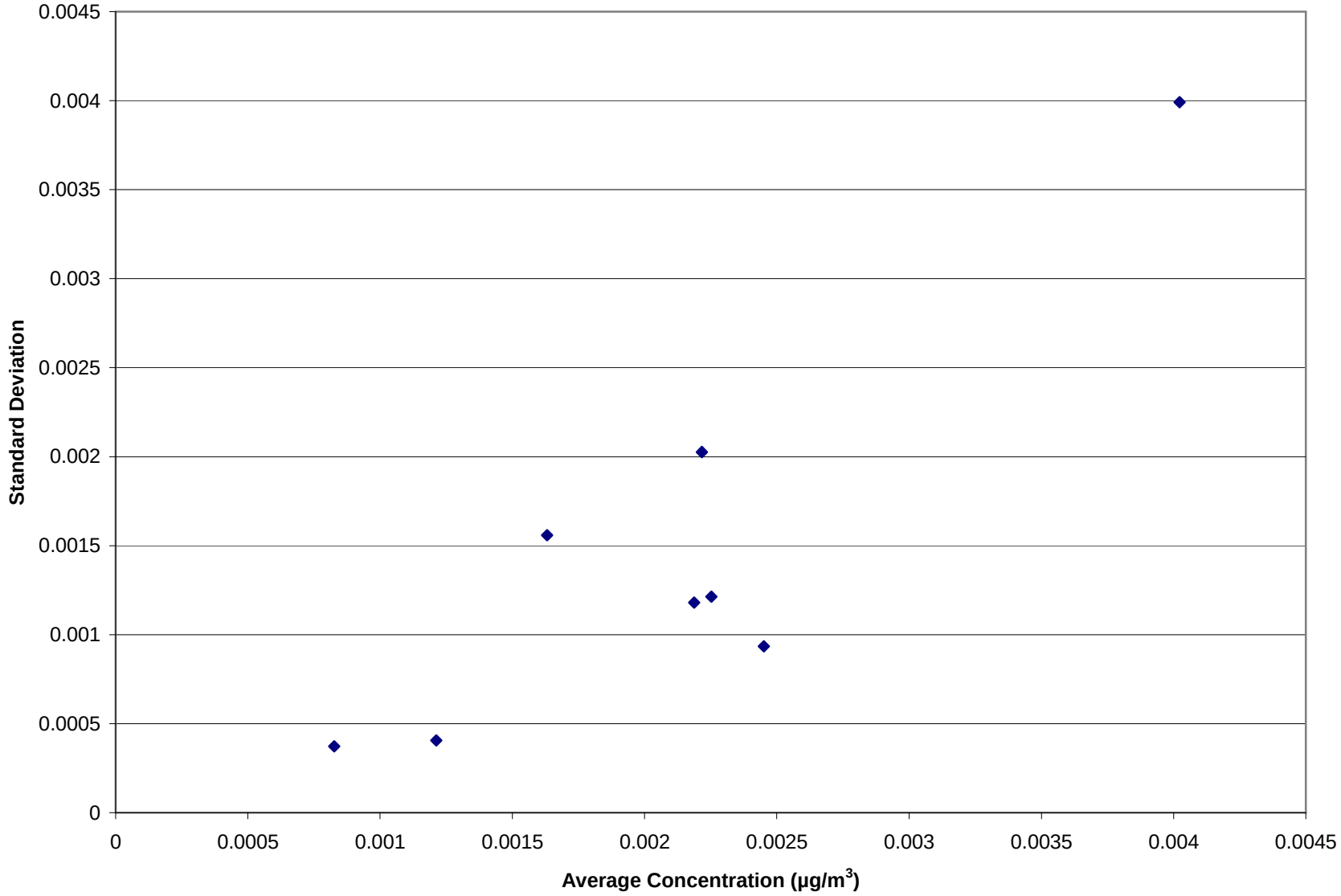


Figure 3-21a. Comparison of Average Seasonal 1,3-Butadiene Concentration by Season

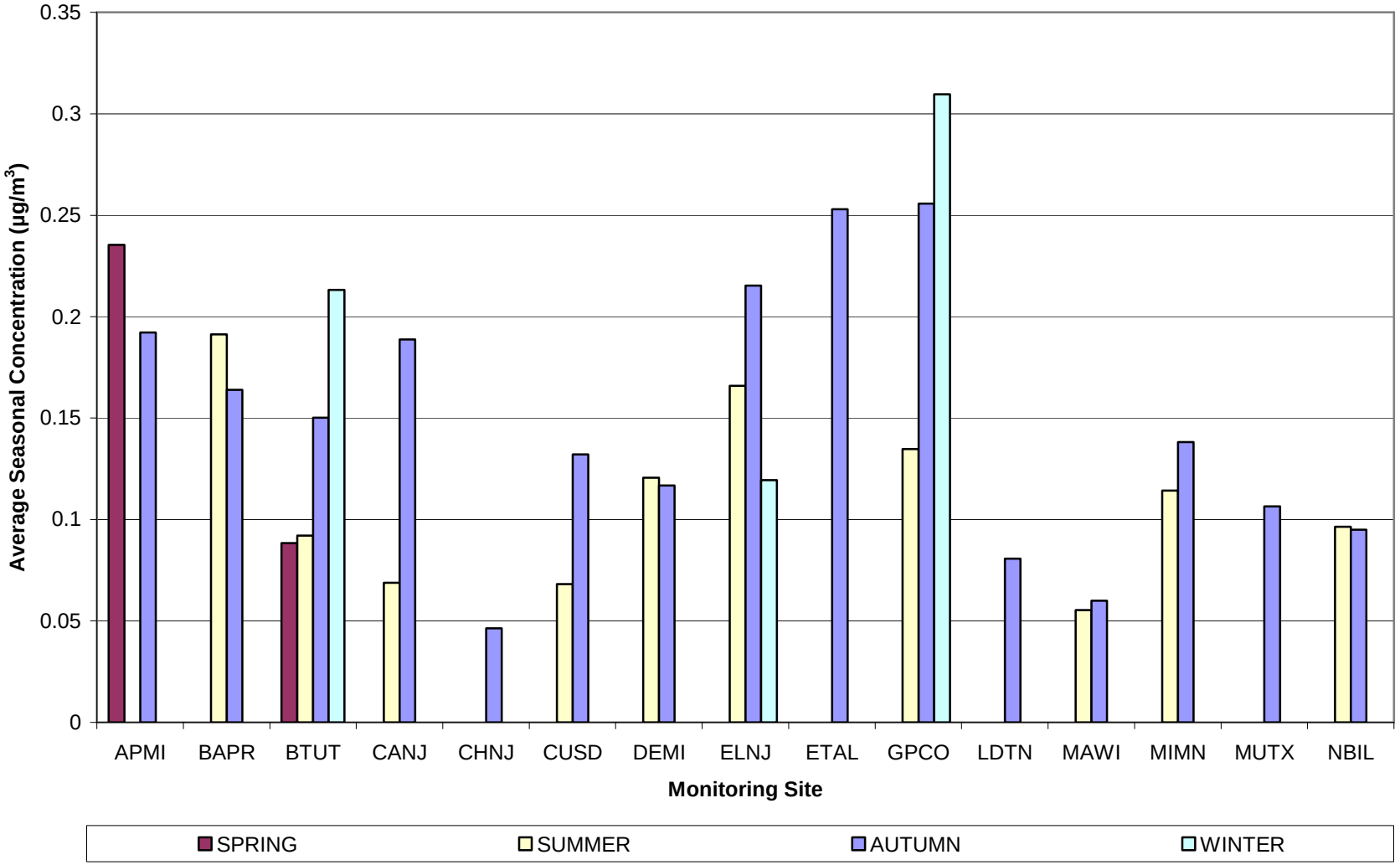


Figure 3-21b. Comparison of Average Seasonal 1,3-Butadiene Concentration by Season (Continued)

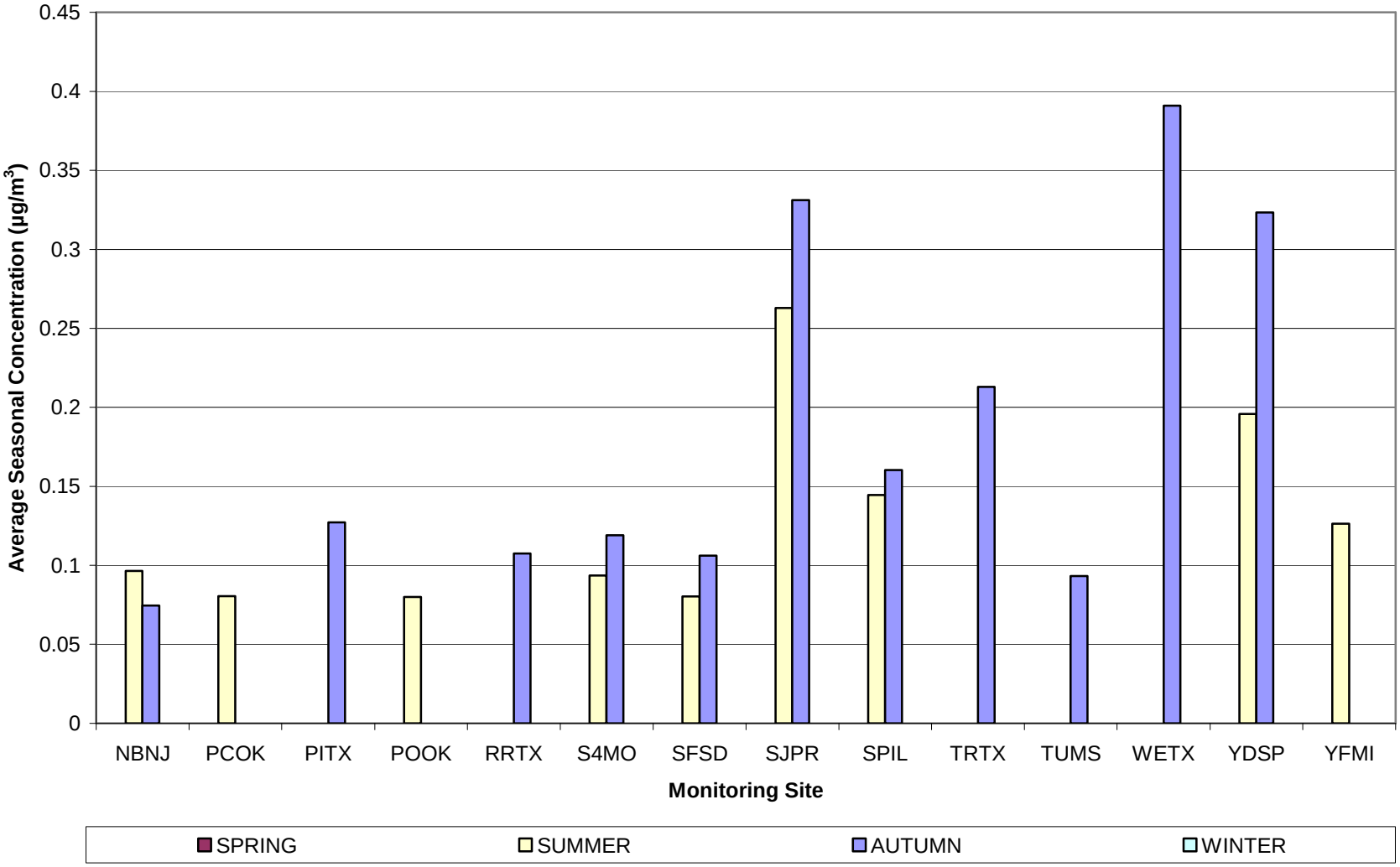


Figure 3-22a. Comparison of Average Seasonal Acetaldehyde Concentration by Season

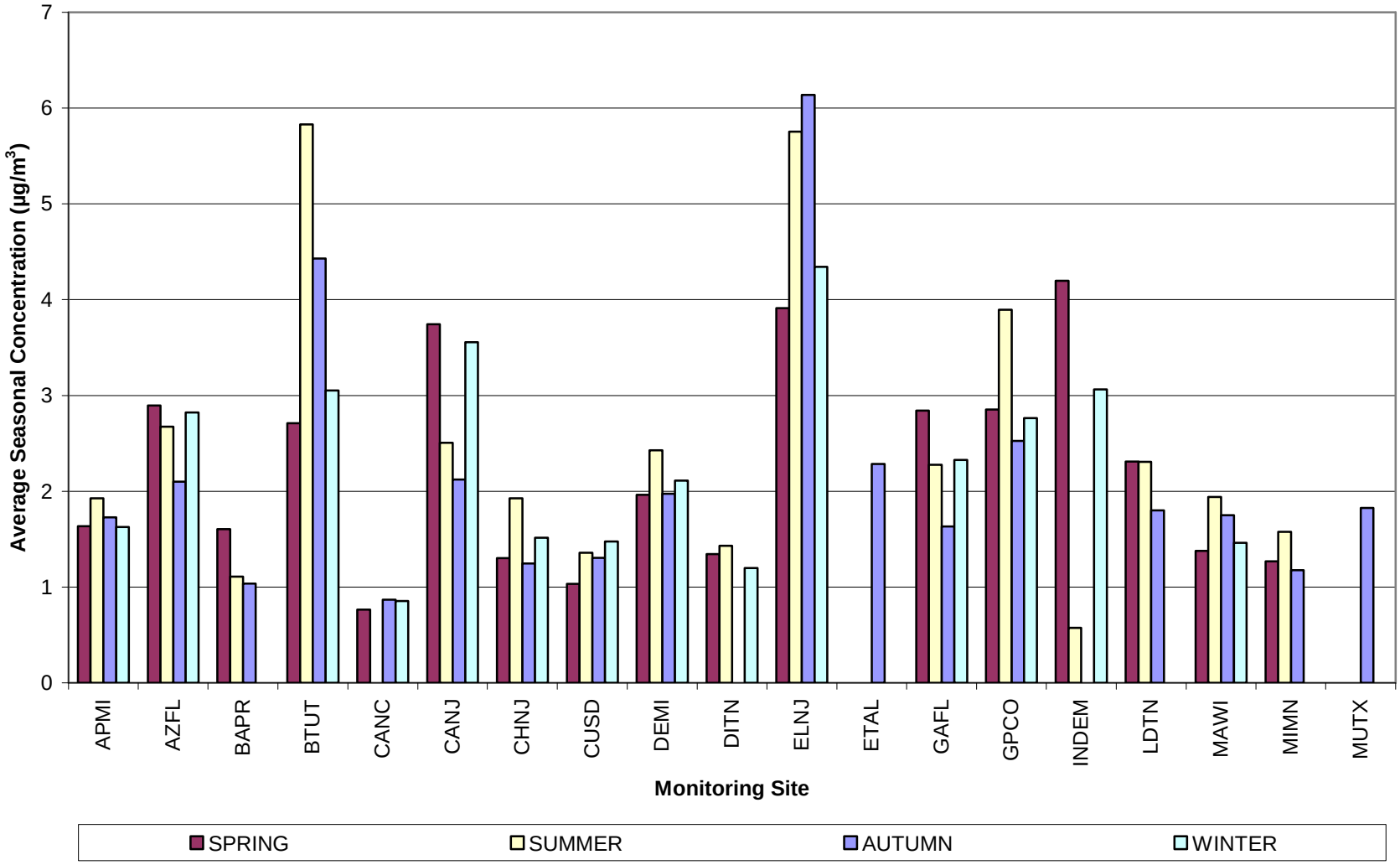


Figure 3-22b. Comparison of Average Seasonal Acetaldehyde Concentration by Season (Continued)

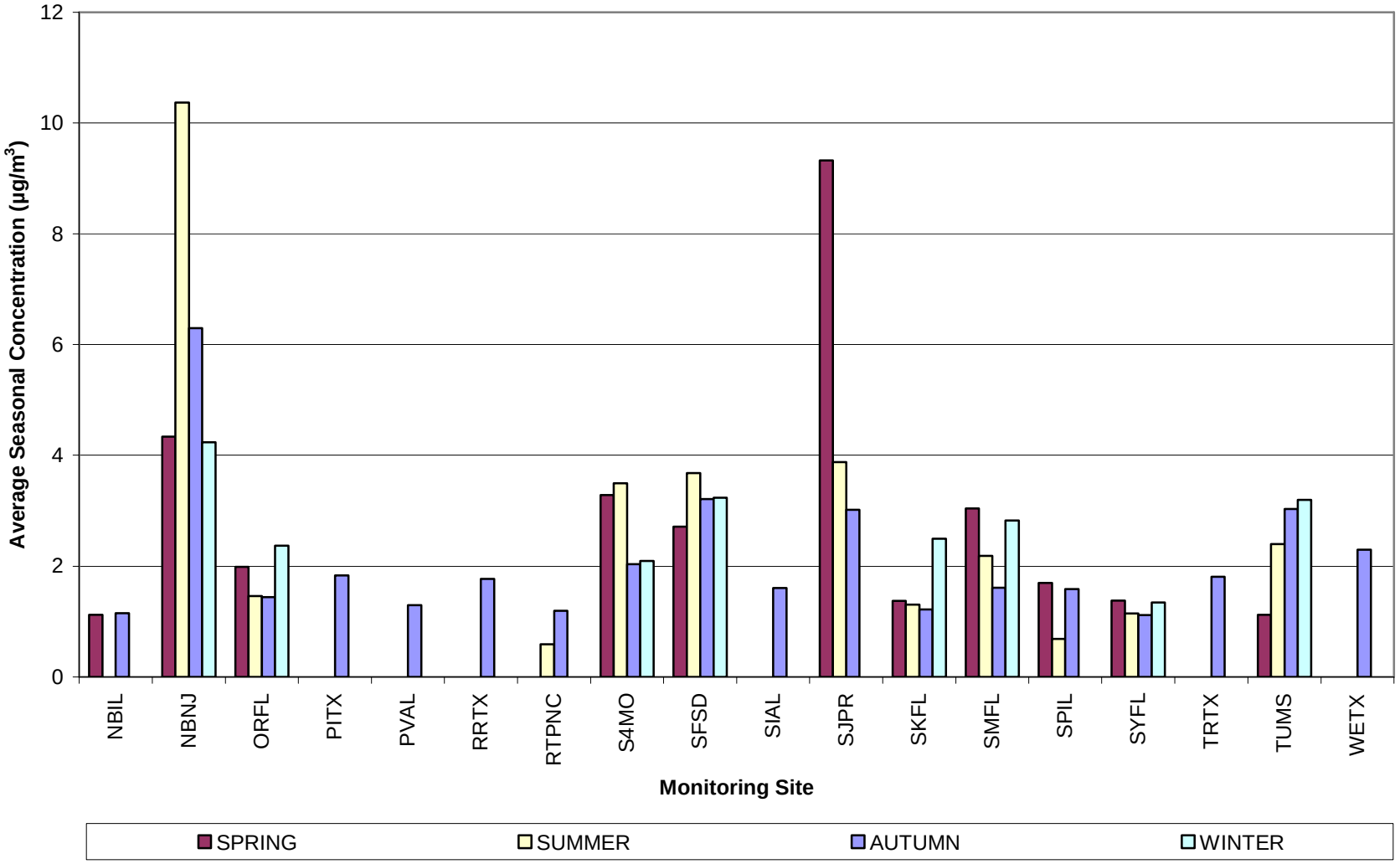


Figure 3-23. Comparison of Average Seasonal Acrolein Concentration by Season

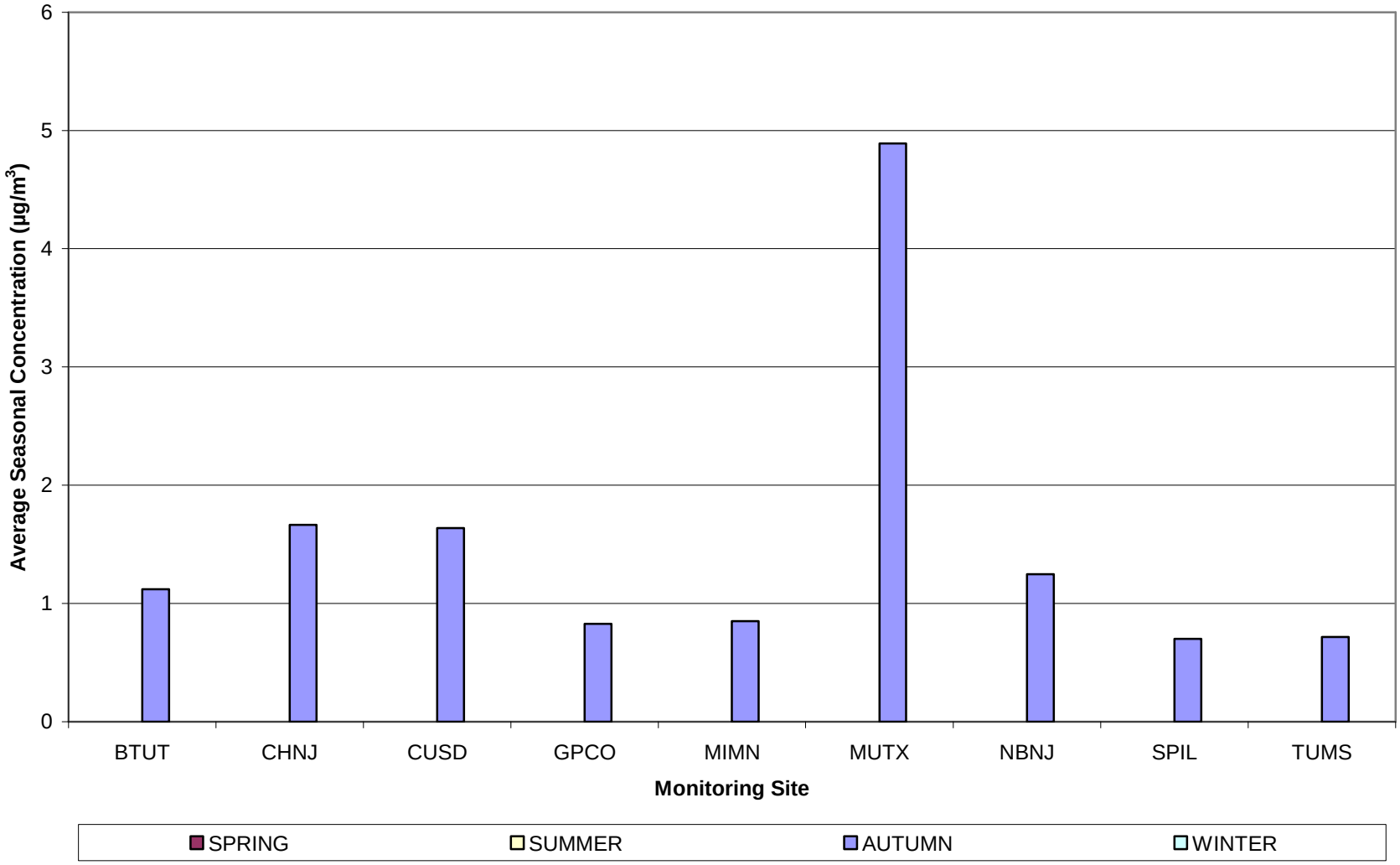


Figure 3-24. Average Seasonal Arsenic PM_{10} Concentration Comparison by Season

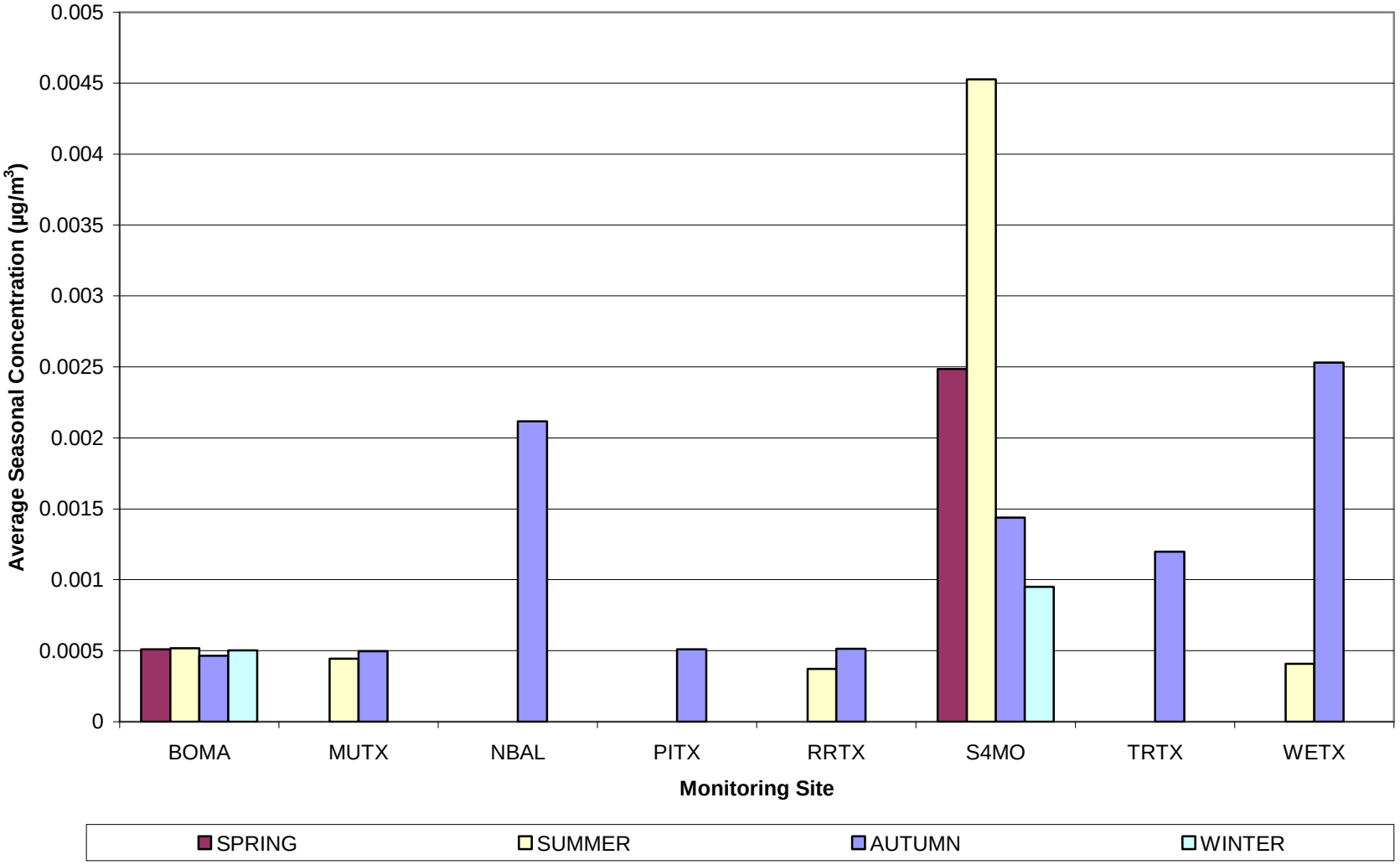


Figure 3-25. Comparison of Average Seasonal Arsenic TSP Concentration by Season

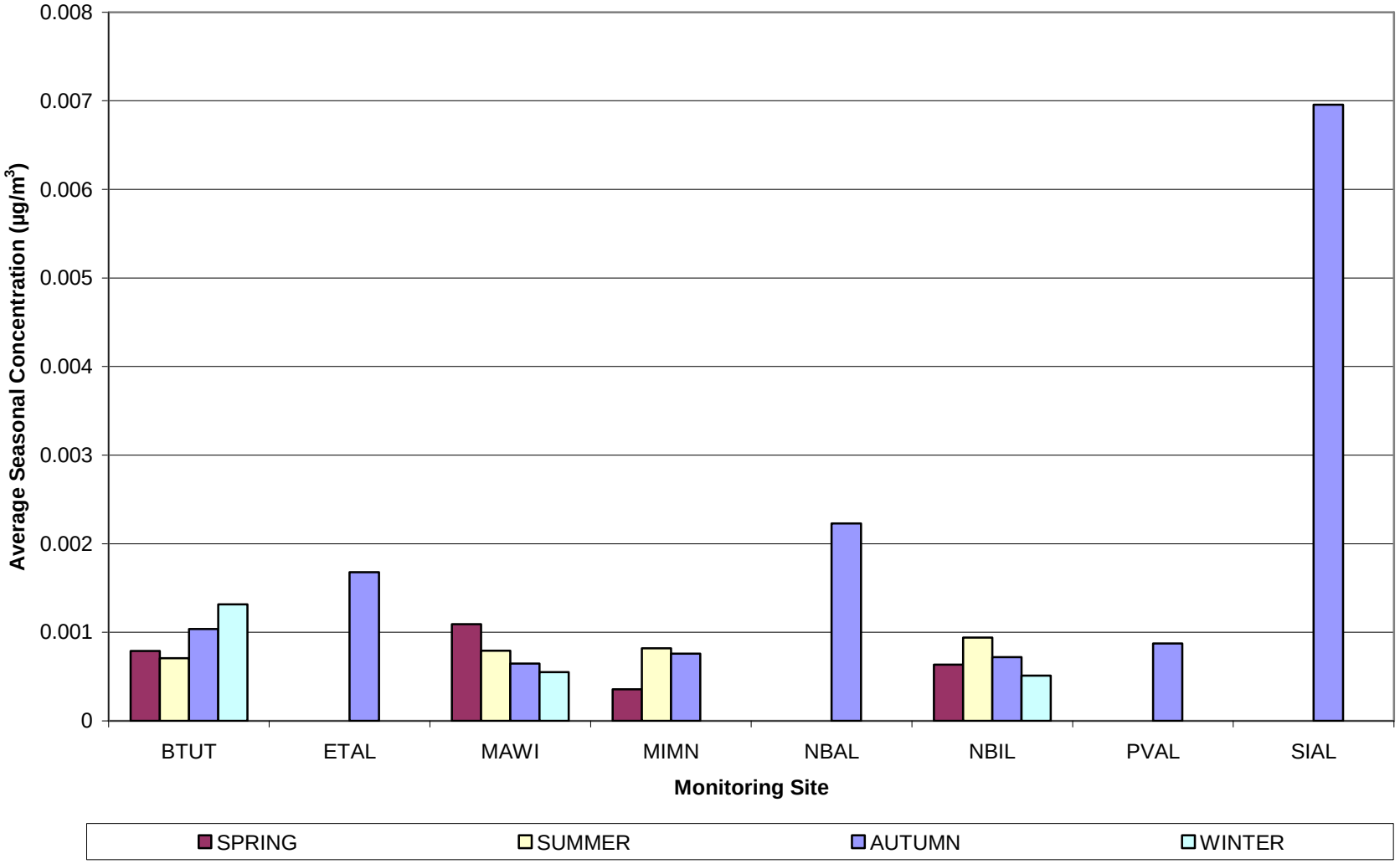


Figure 3-26a. Comparison of Average Seasonal Benzene Concentration by Season

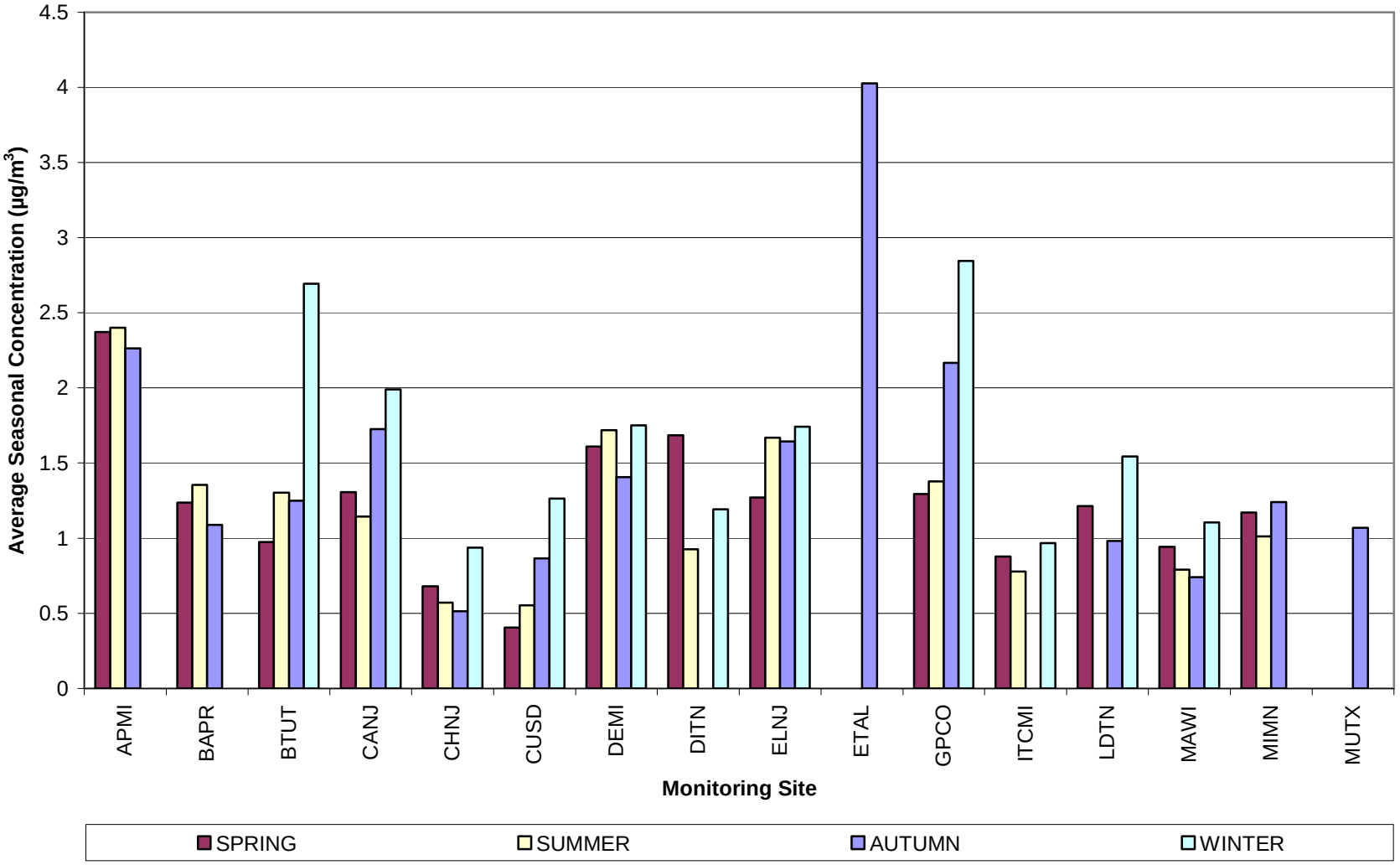


Figure 3-26b. Comparison of Average Seasonal Benzene Concentration by Season (Continued)

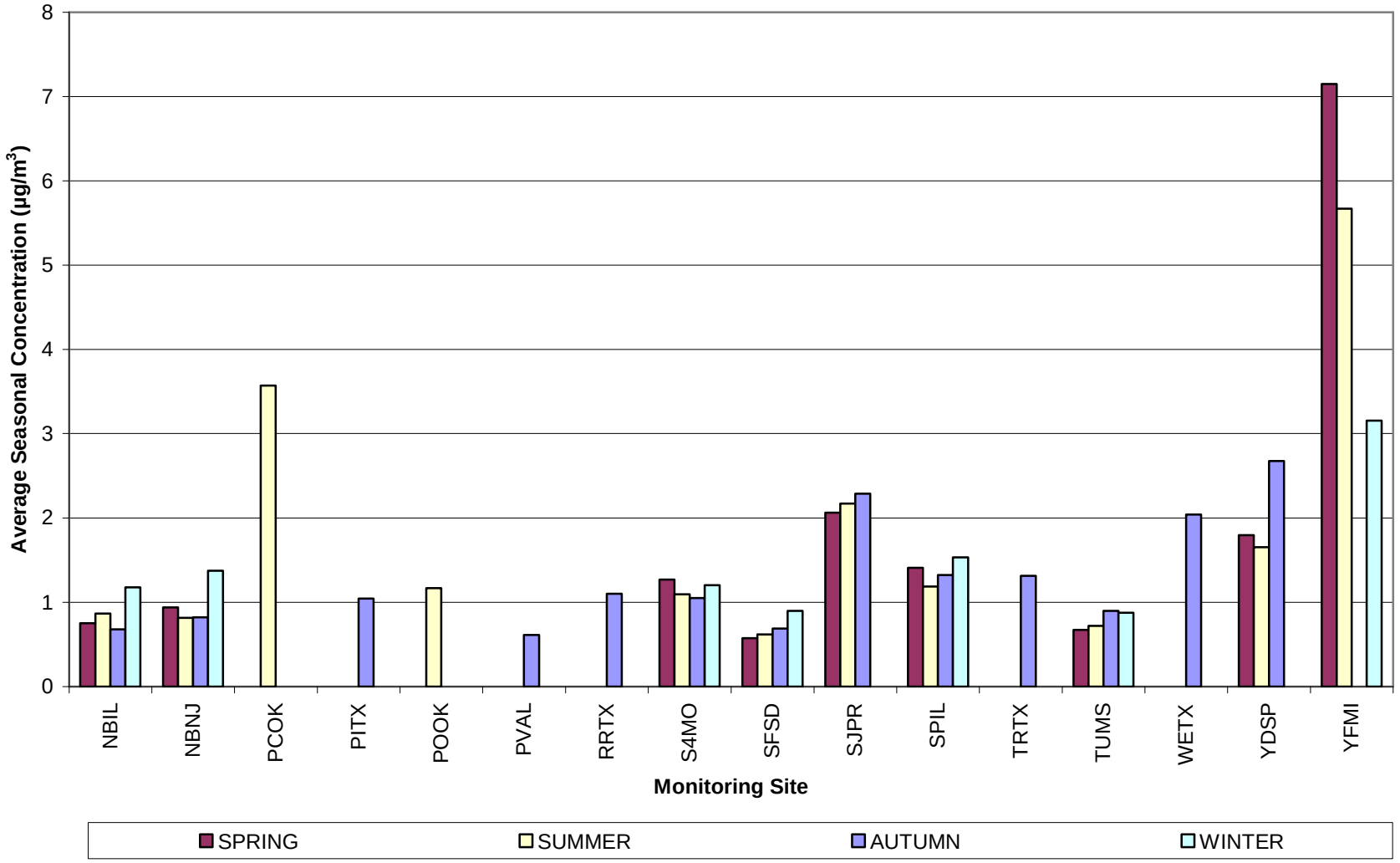


Figure 3-27a. Comparison of Average Seasonal Carbon Tetrachloride Concentration by Season

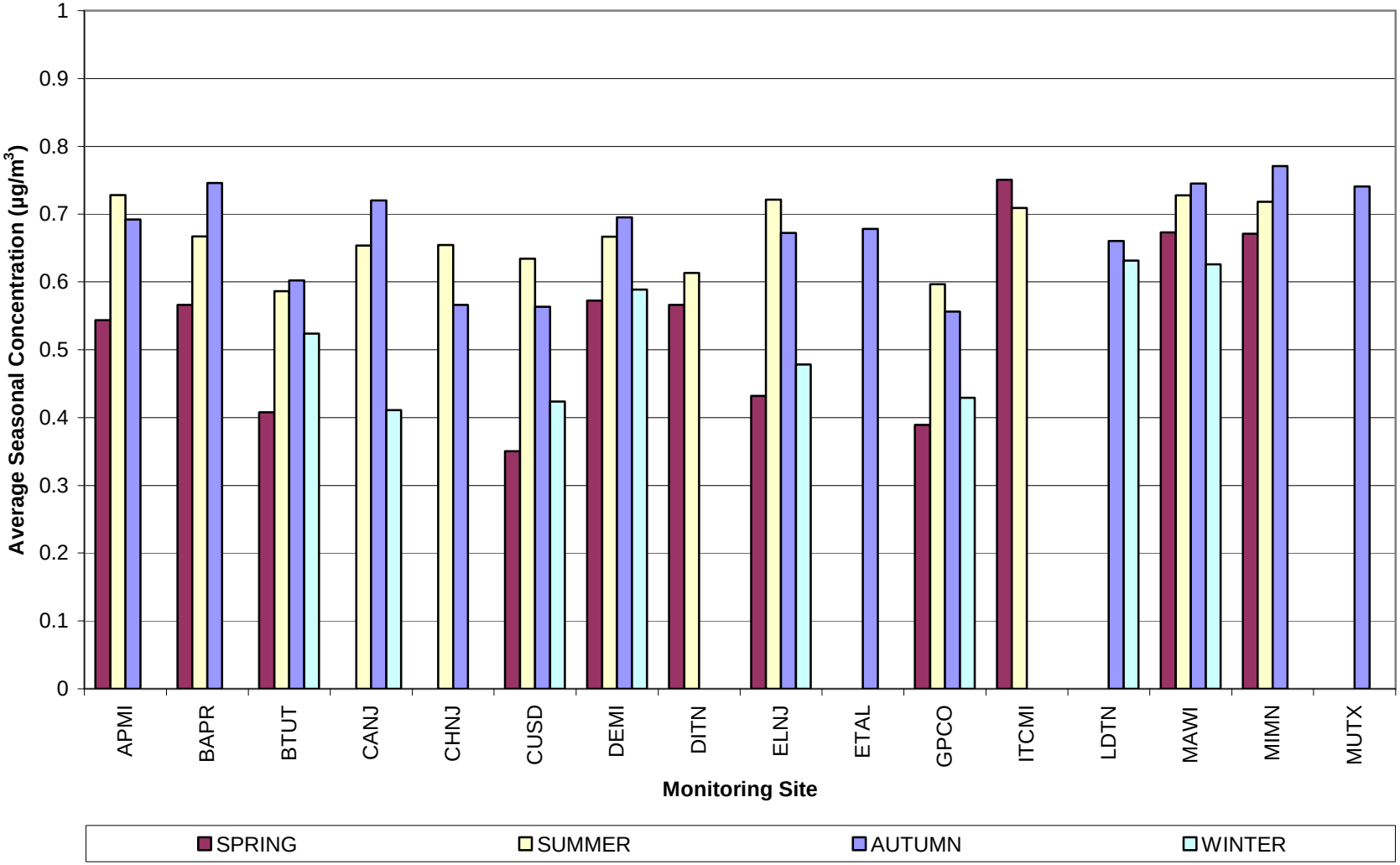


Figure 3-27b. Comparison of Average Seasonal Carbon Tetrachloride Concentration by Season (Continued)

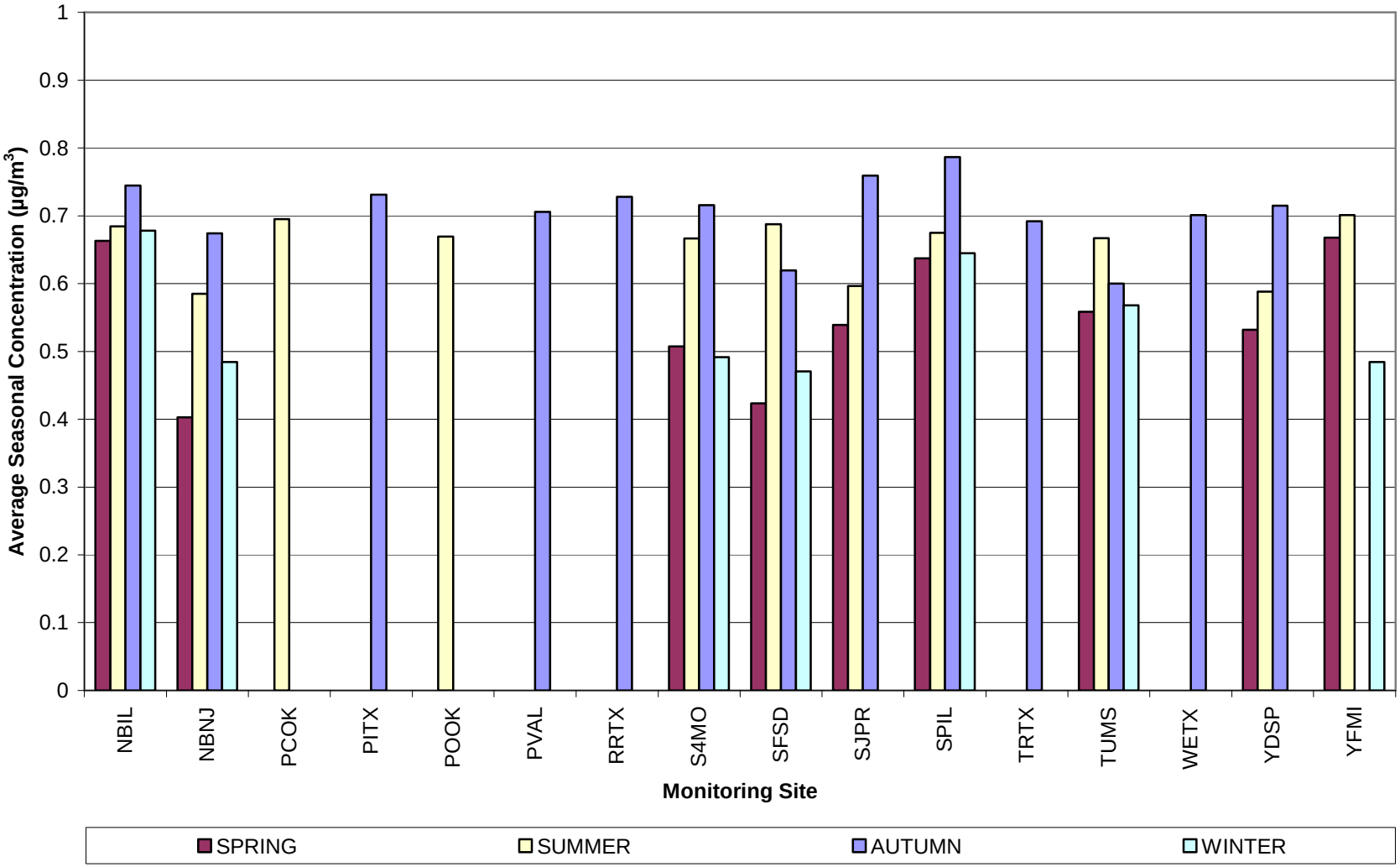


Figure 3-28a. Comparison of Average Seasonal Formaldehyde Concentration by Season

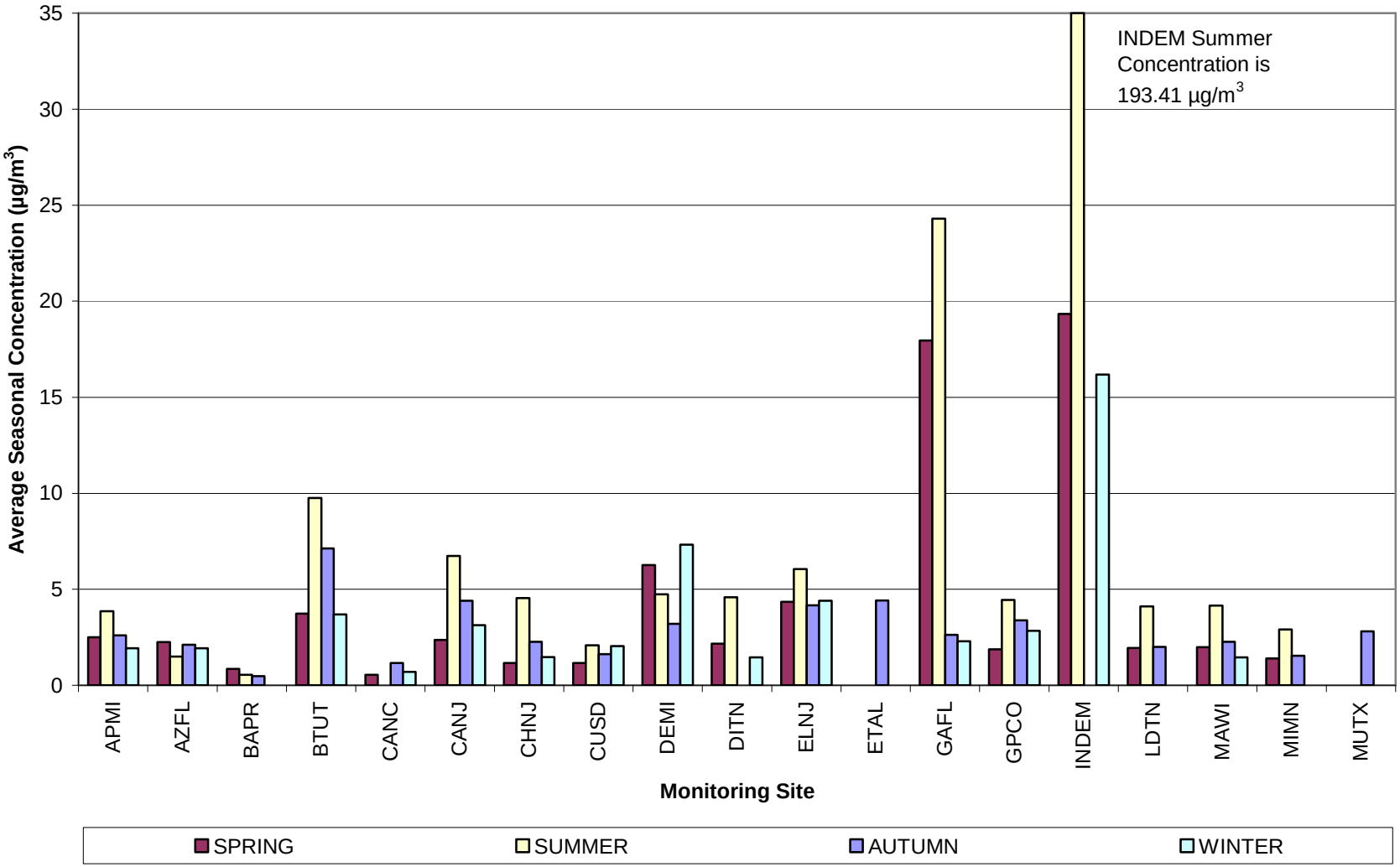


Figure 3-28b. Comparison of Average Seasonal Formaldehyde Concentration by Season (Continued)

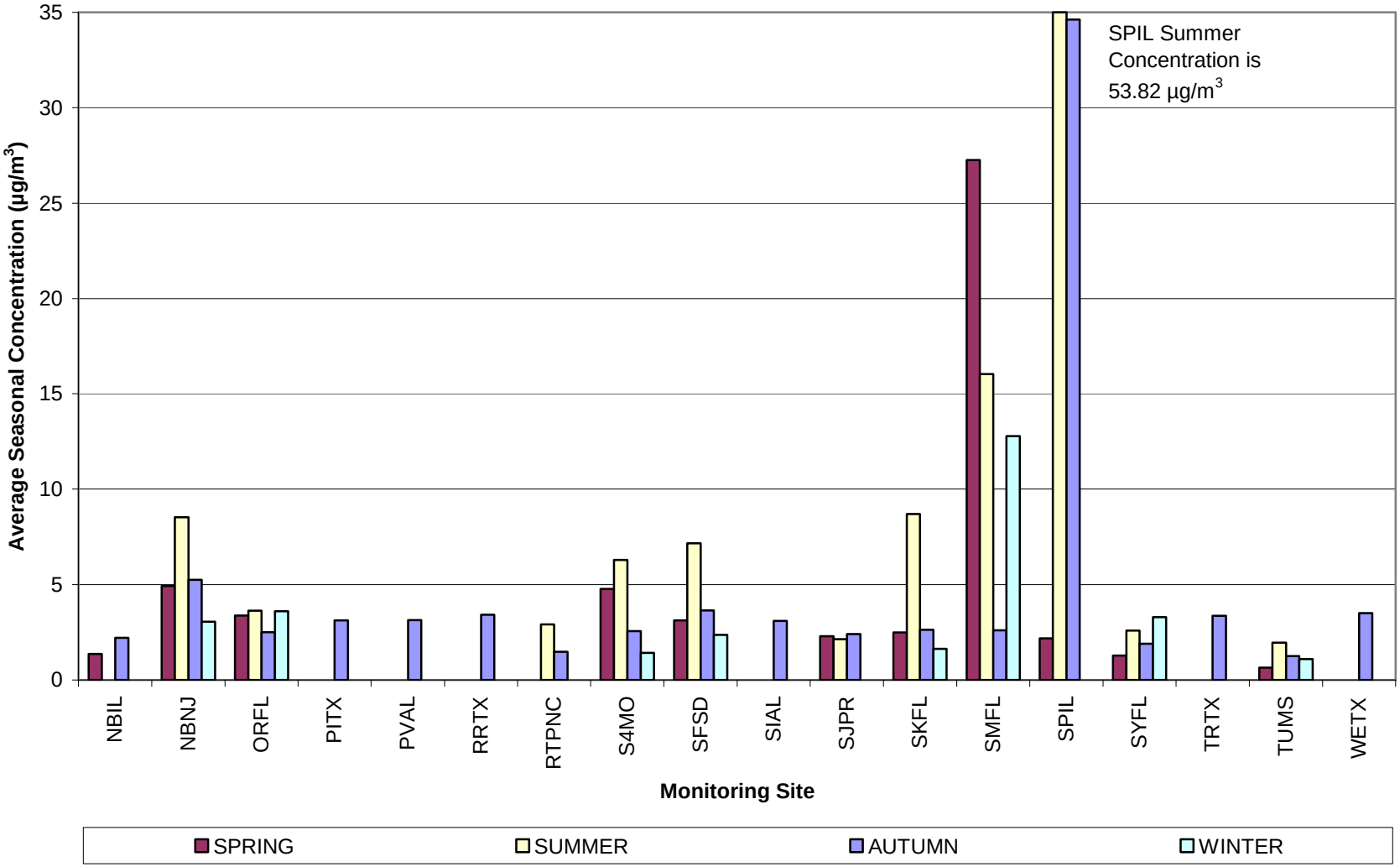


Figure 3-29. Comparison of Average Seasonal Hexachloro-1,3 Butadiene Concentration by Season

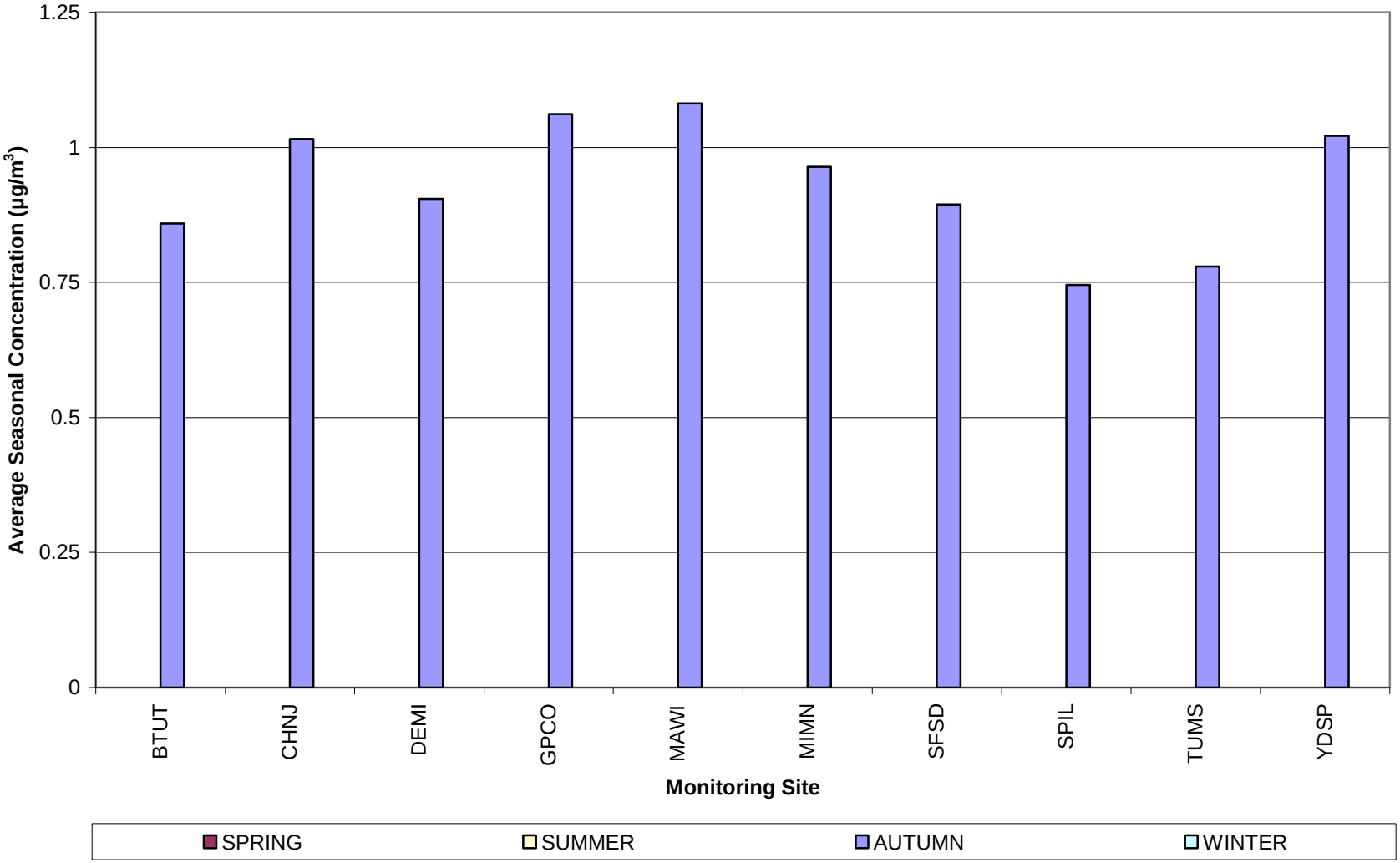


Figure 3-30. Comparison of Average Seasonal Manganese PM_{10} Concentration by Season

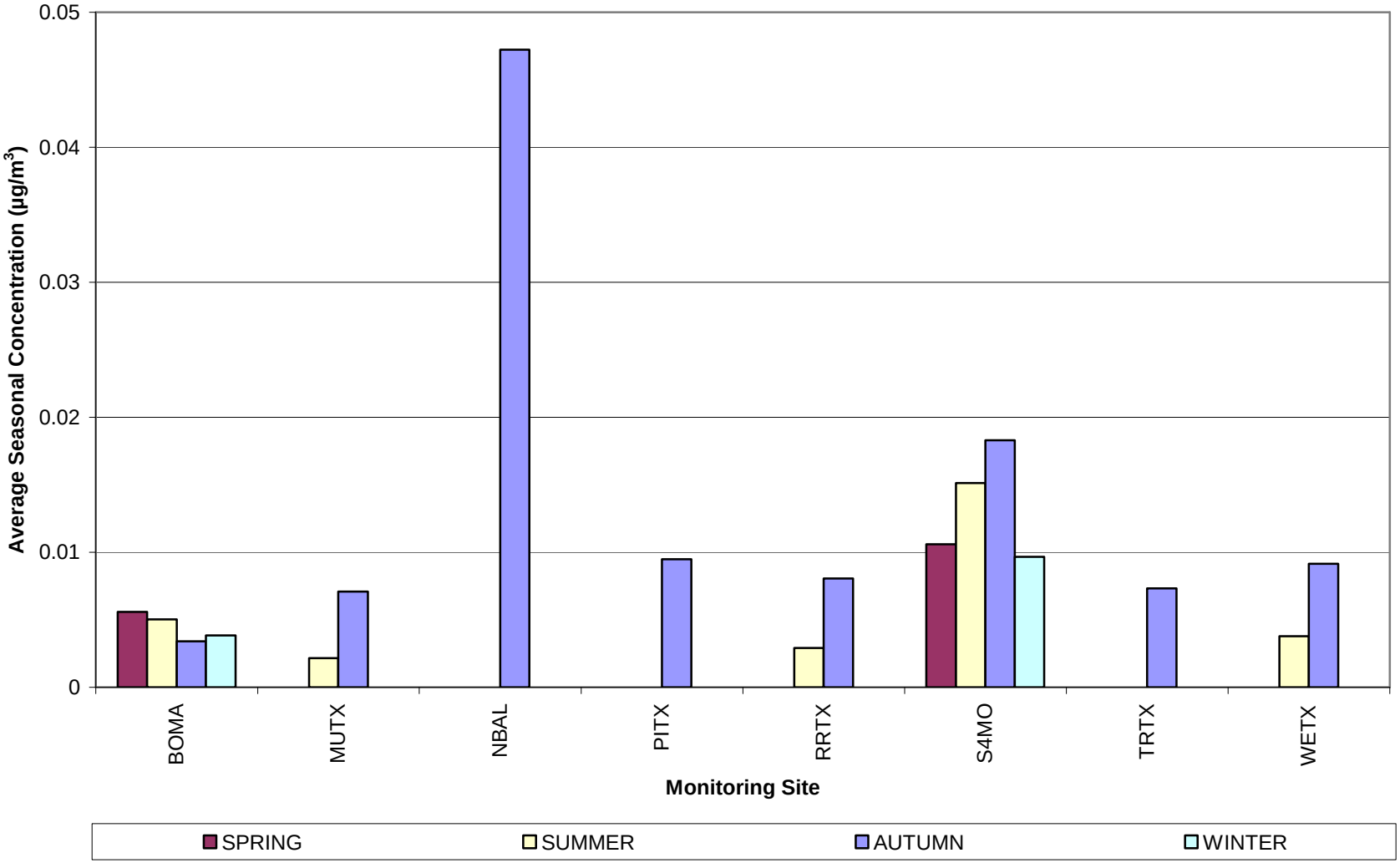


Figure 3-31. Comparison of Average Seasonal Manganese TSP Concentration by Season

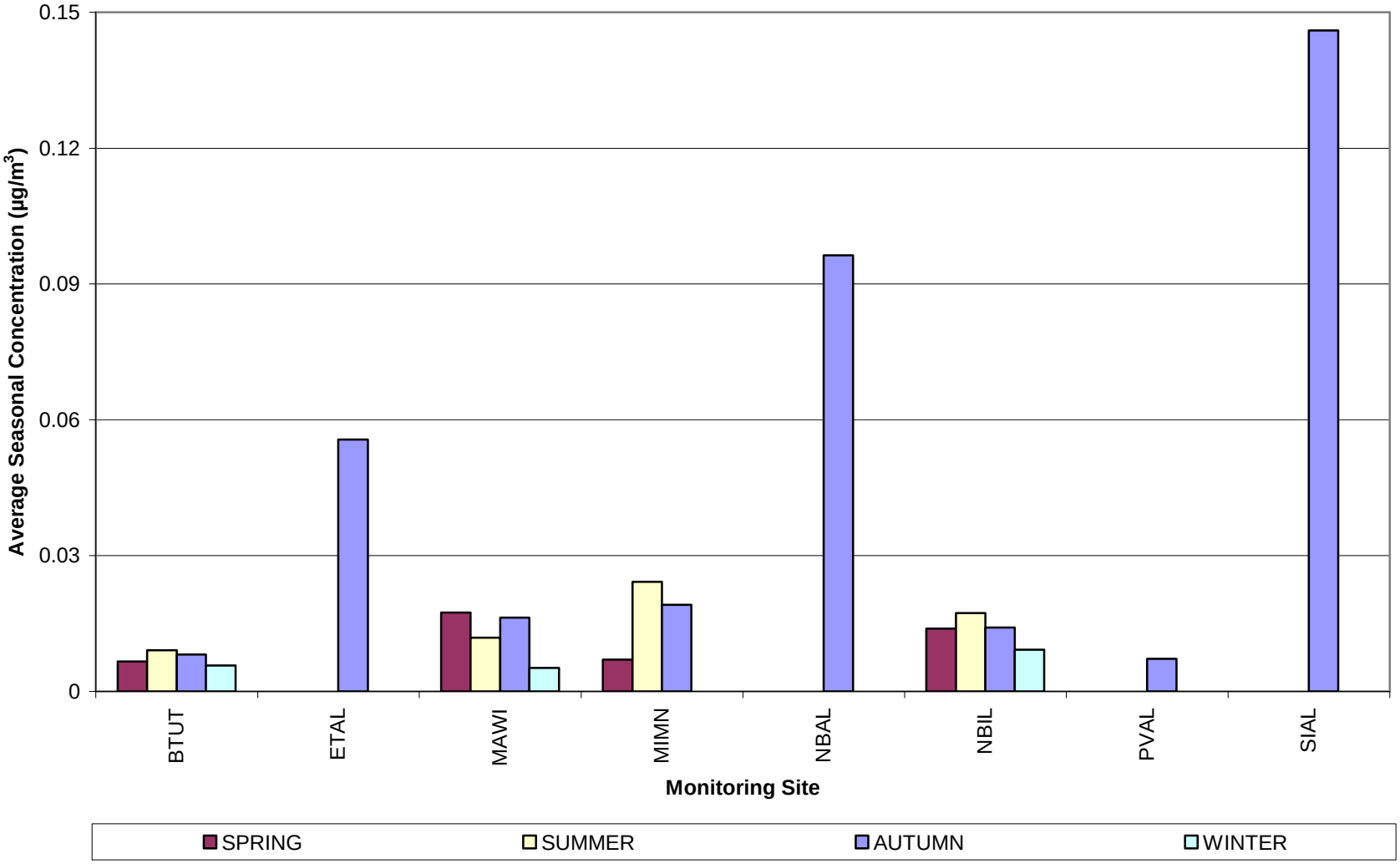


Figure 3-32. Comparison of Average Seasonal Nickel PM_{10} Concentration by Season

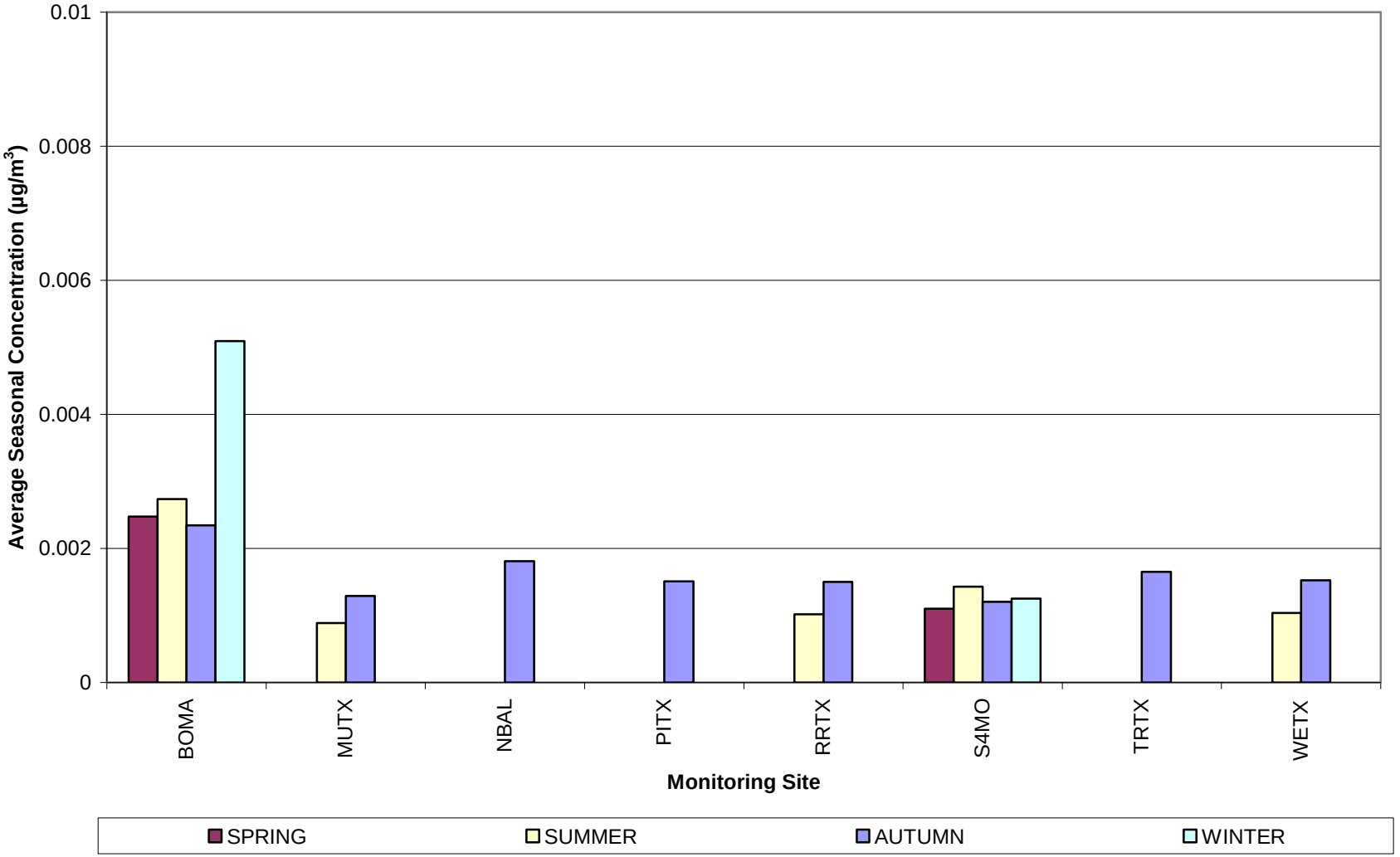


Figure 3-33. Comparison of Average Seasonal Nickel TSP Concentration by Season

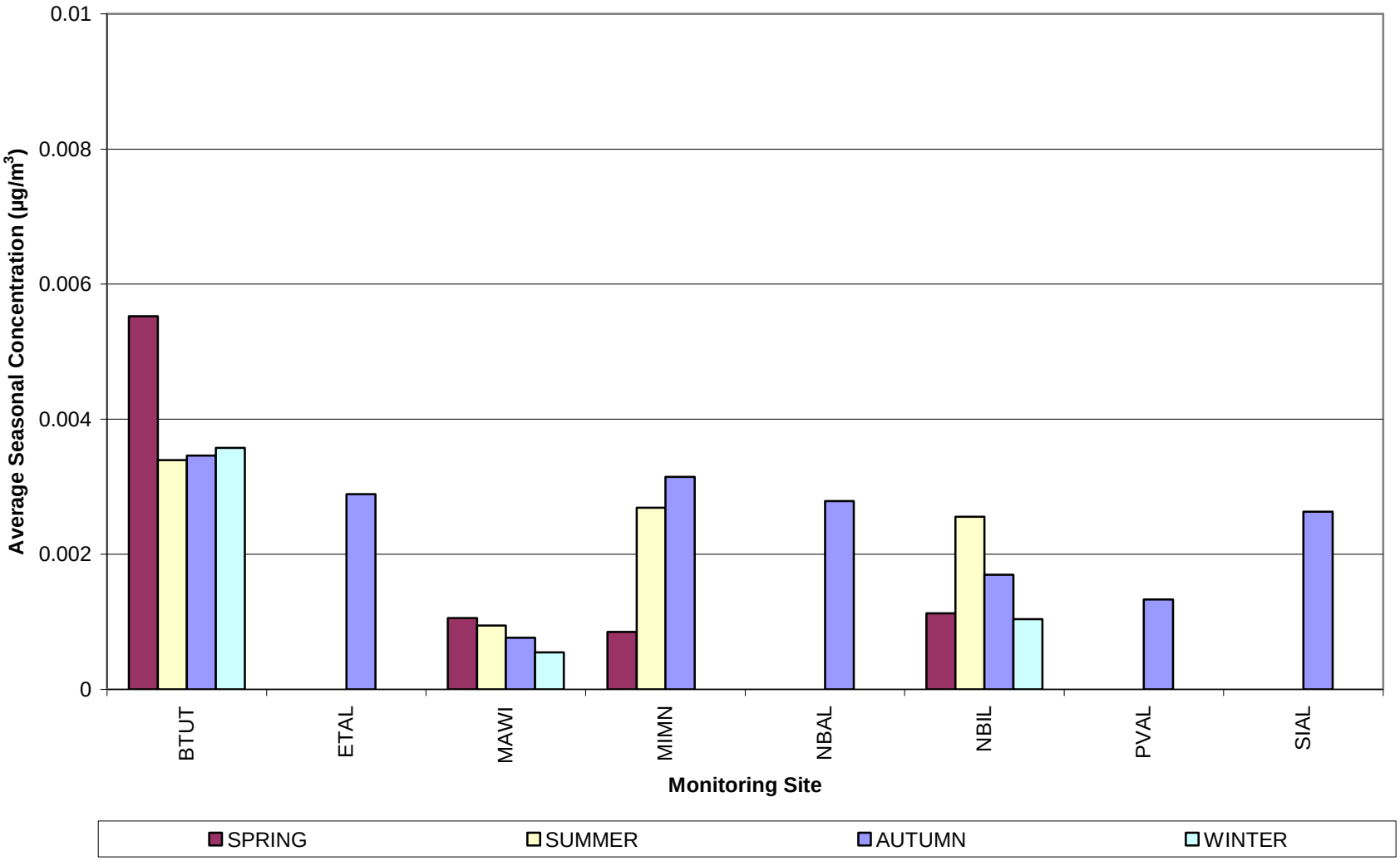


Figure 3-34a. Comparison of Average Seasonal *p*-Dichlorobenzene Concentration by Season

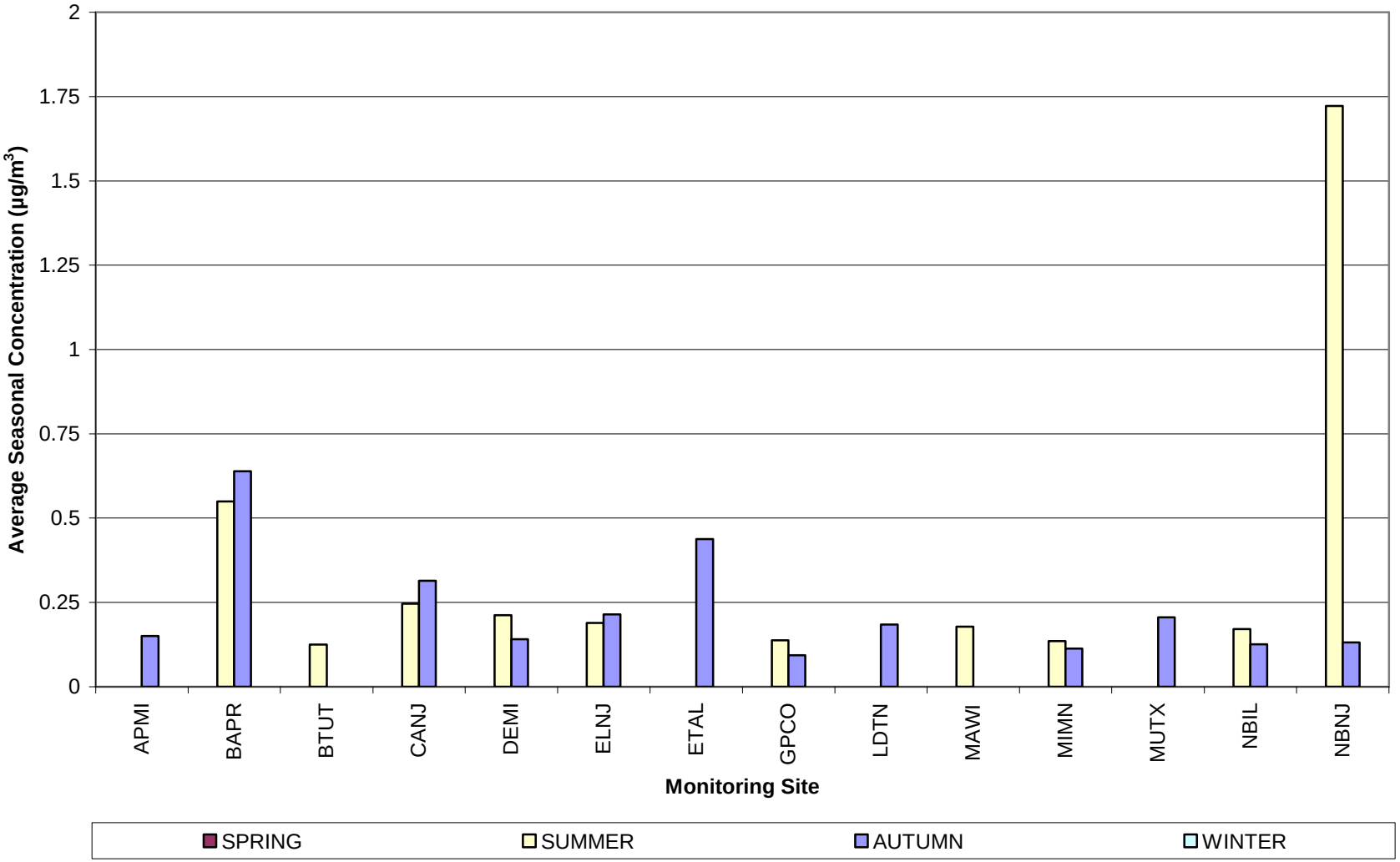


Figure 3-34b. Comparison of Average Seasonal *p*-Dichlorobenzene Concentration by Season (Continued)

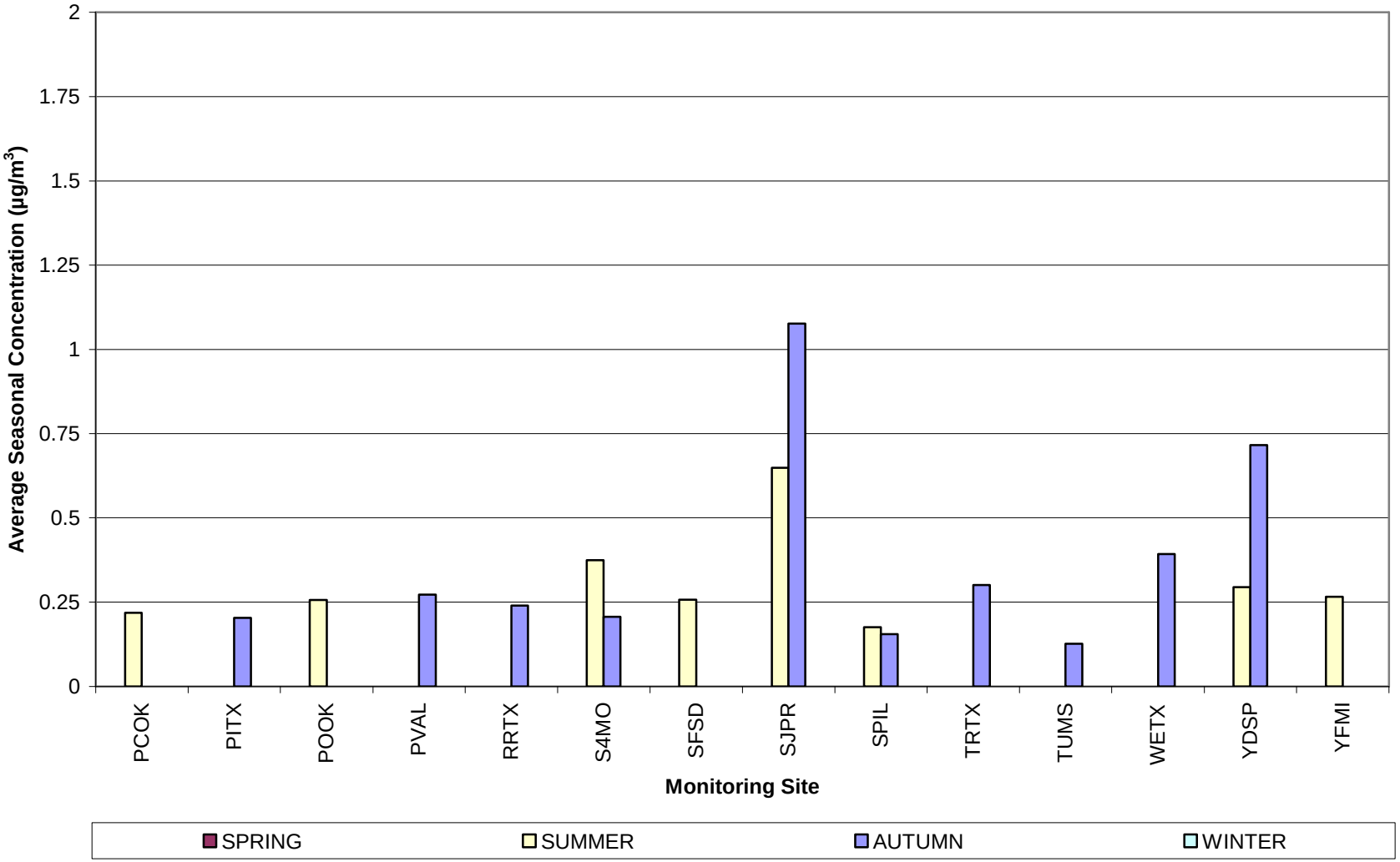


Figure 3-35a. Comparison of Average Seasonal Tetrachloroethylene Concentration by Season

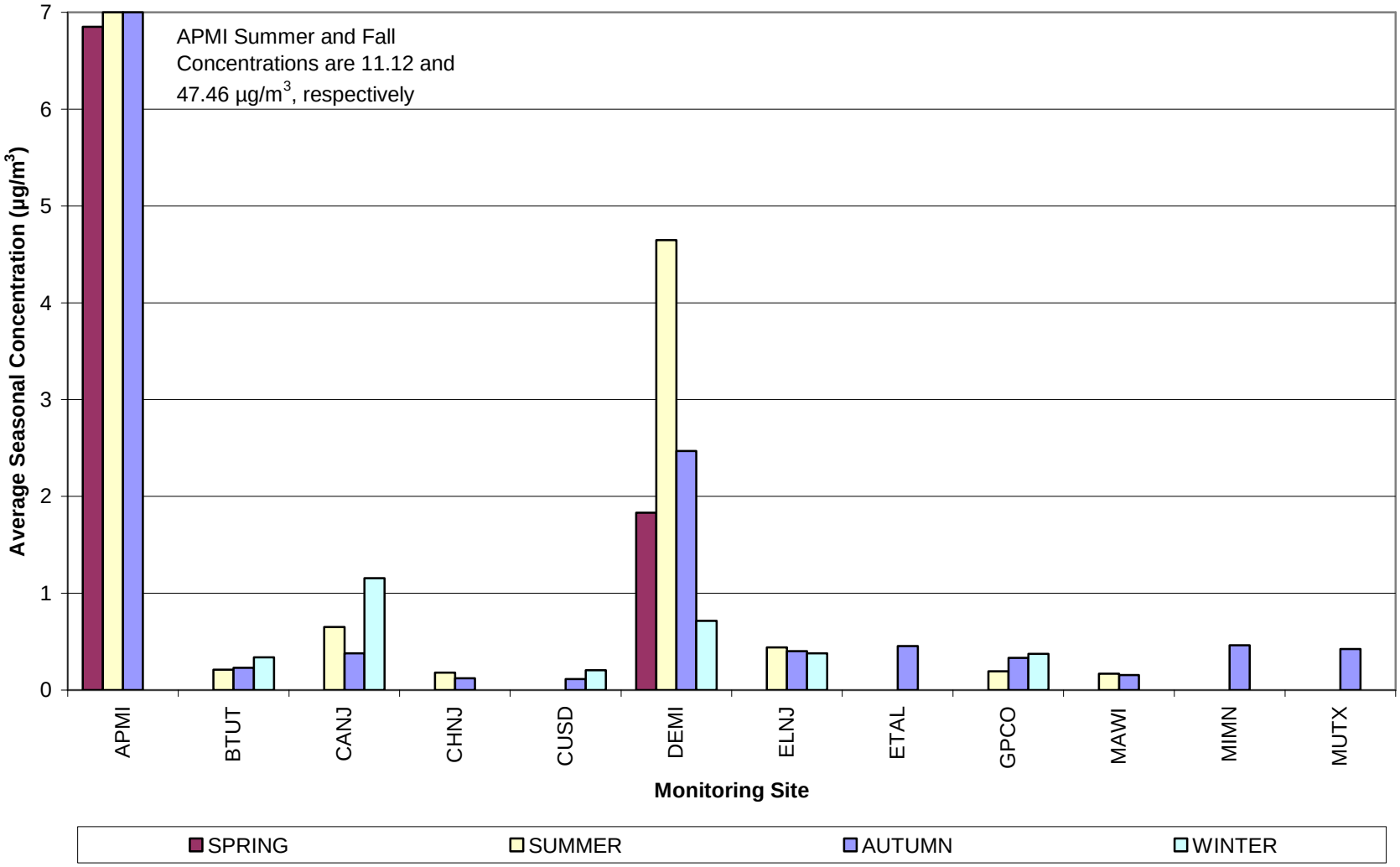


Figure 3-35b. Comparison of Average Seasonal Tetrachloroethylene Concentration by Season (Continued)

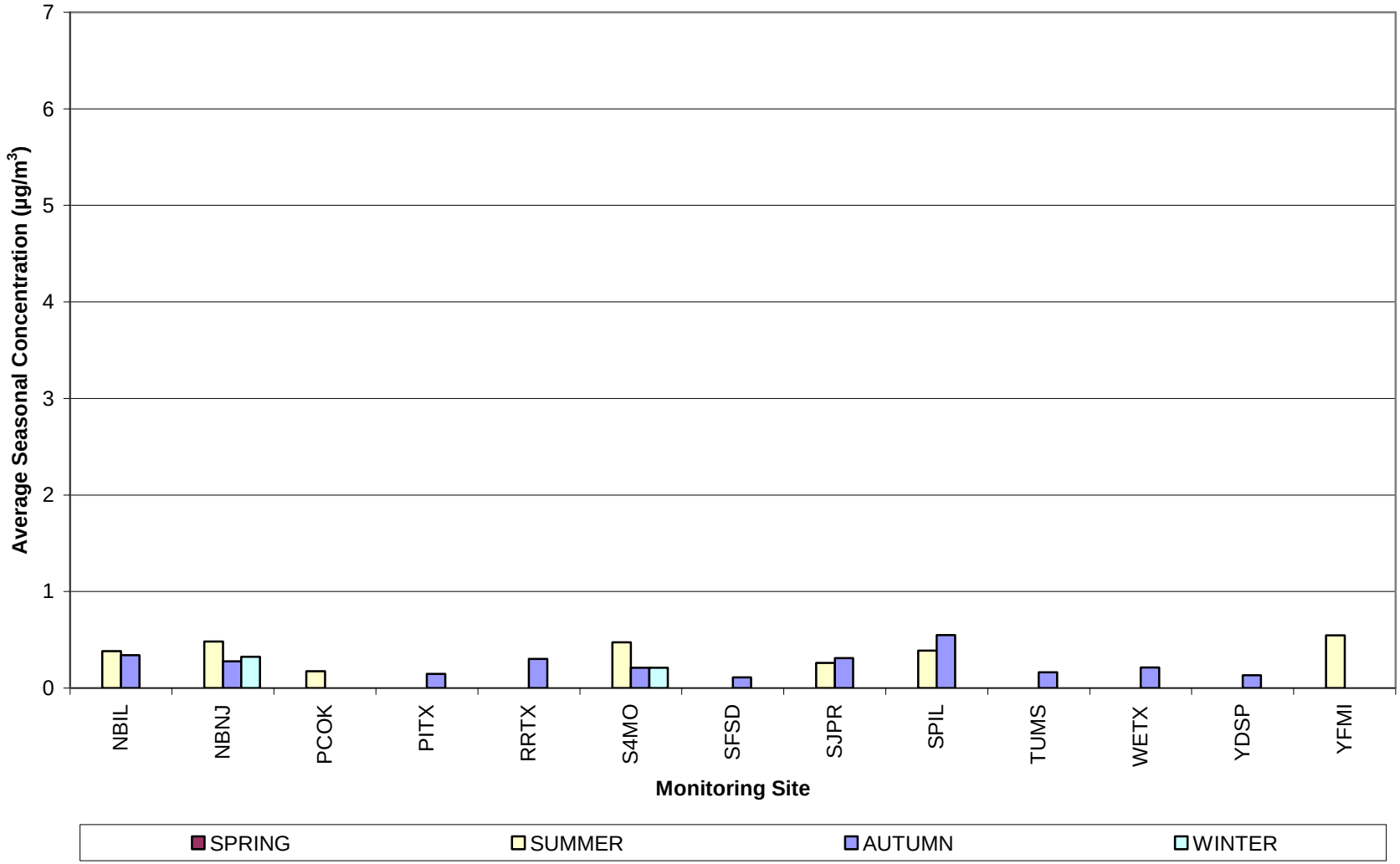


Figure 3-36a. Comparison of Average Seasonal Xylenes Concentration by Season

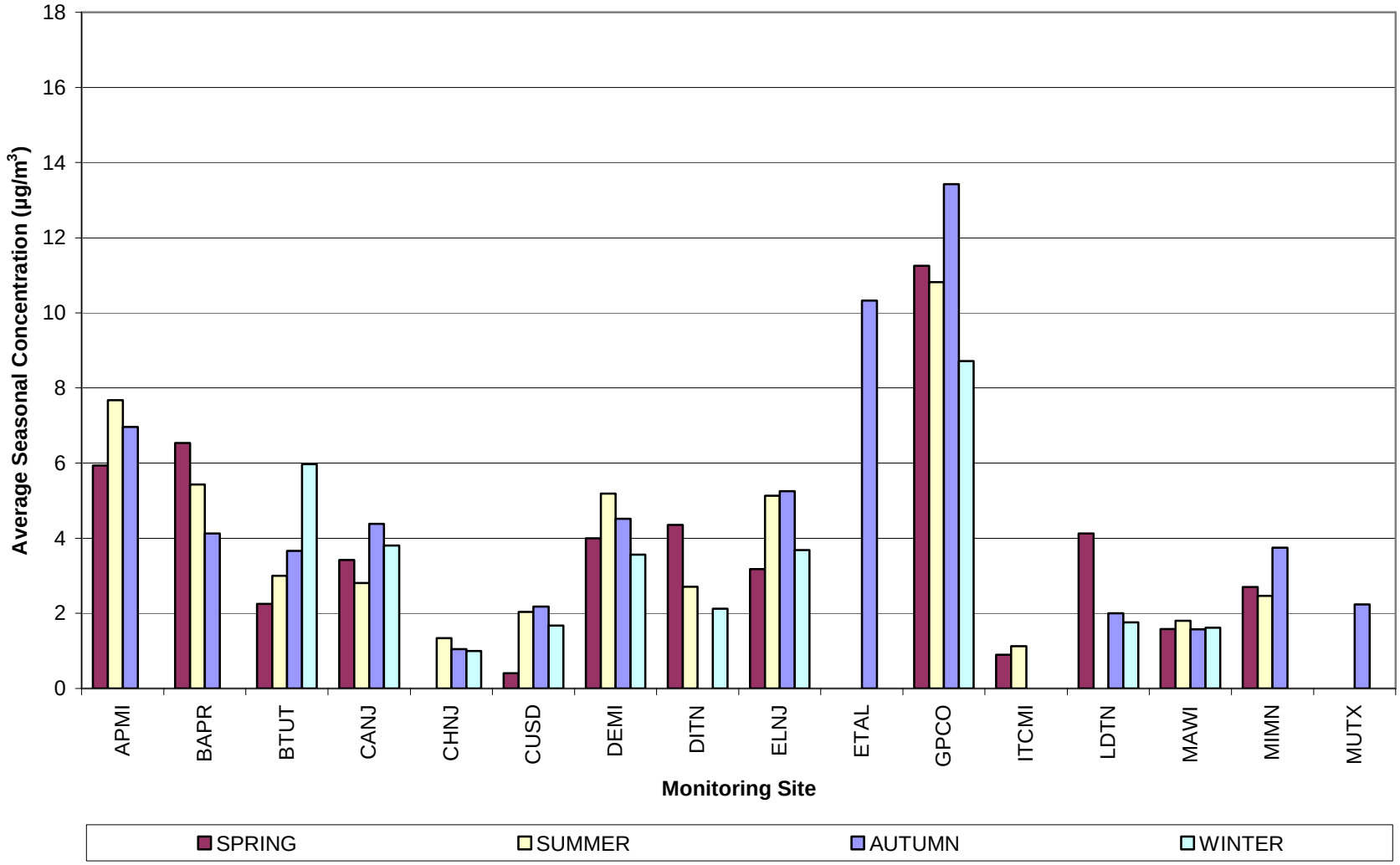


Figure 3-36b. Comparison of Average Seasonal Xylenes Concentration by Season

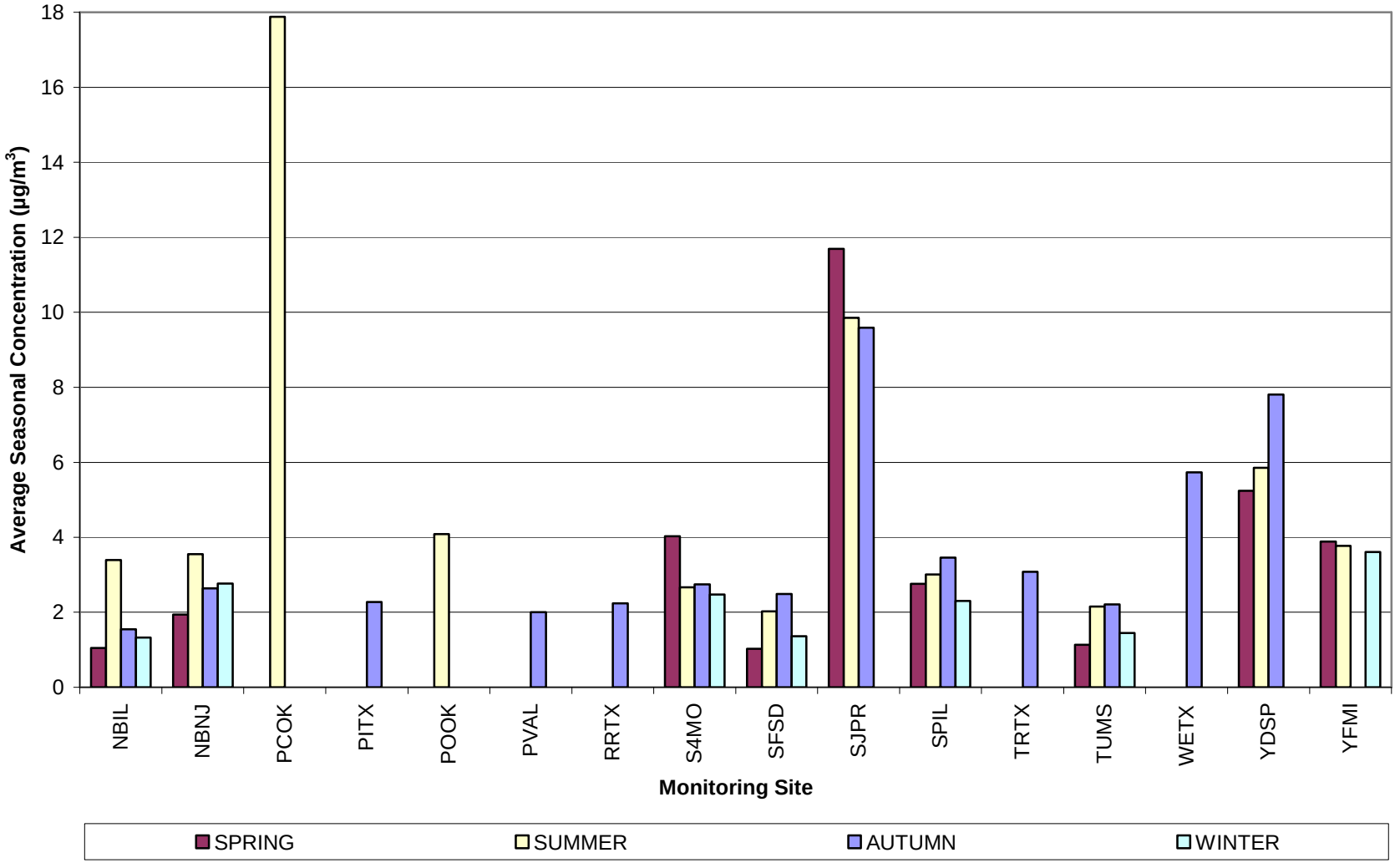


Table 3-1. Target Pollutant Detection Statistical Summaries of the VOC Concentrations

Pollutant	# Detects	Minimum (ppbv)	Maximum (ppbv)	Arithmetric Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
1,1,1-Trichloroethane	858	0.01	0.4	0.04	0.03	0.03	0.03	0.02	0.03	0.03	0.86
1,1,2,2-Tetrachloroethane	24	0.01	0.06	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.65
1,1,2-Trichloroethane	2	0.02	0.06	0.04	NA	0.04	0.03	0.03	0.05	0.02	0.5
1,1-Dichloroethane	14	0.01	0.07	0.03	0.02	0.02	0.02	0.02	0.03	0.01	0.55
1,1-Dichloroethene	7	0.02	0.21	0.08	NA	0.14	0.06	0.14	0.14	0.06	0.72
1,2,4-Trichlorobenzene	124	0.01	0.25	0.03	0.02	0.02	0.02	0.02	0.03	0.03	1.11
1,2,4-Trimethylbenzene	1003	0.01	2.99	0.16	0.09	0.12	0.11	0.07	0.2	0.19	1.15
1,2-Dibromoethane	3	0.04	0.06	0.05	NA	0.04	0.04	0.04	0.05	0.01	0.24
1,2-Dichloroethane	32	0.02	0.08	0.04	0.05	0.04	0.04	0.03	0.05	0.02	0.39
1,2-Dichloropropane	0	NA									
1,3,5-Trimethylbenzene	938	0.01	1.12	0.06	0.02	0.04	0.04	0.02	0.07	0.07	1.16
1,3-Butadiene	789	0.01	0.58	0.08	0.02	0.06	0.05	0.03	0.10	0.07	0.92
Acetonitrile	345	0.08	2670	34.93	9.16	4.53	5.61	1.33	20.8	156.65	4.48
Acetylene	1297	0.03	40.2	1.35	0.67	1.00	0.99	0.63	1.56	1.81	1.34
Acrolein	283	0.05	8.93	1.15	0.47	0.66	0.71	0.37	1.17	1.41	1.22
Acrylonitrile	17	0.03	0.53	0.19	0.25	0.17	0.15	0.07	0.25	0.14	0.71
Benzene	1291	0.05	15	0.53	0.26	0.35	0.38	0.24	0.52	0.84	1.59
Bromochloromethane	1	0.11	0.11	0.11	NA	0.11	0.11	0.11	0.11	NA	NA
Bromodichloromethane	23	0.01	0.06	0.04	0.03	0.03	0.03	0.03	0.05	0.01	0.38
Bromoform	0	NA									
Bromomethane	649	0.01	2.73	0.03	0.01	0.01	0.02	0.01	0.02	0.16	4.64
Carbon Tetrachloride	1222	0.01	0.34	0.10	0.10	0.10	0.10	0.09	0.11	0.03	0.25
Chlorobenzene	70	0.01	0.16	0.04	0.01	0.02	0.03	0.01	0.05	0.03	0.88
Chloroethane	563	0.01	0.45	0.03	0.01	0.02	0.02	0.01	0.03	0.05	1.37
Chloroform	542	0.01	1.44	0.05	0.02	0.03	0.04	0.02	0.06	0.08	1.52
Chloromethane	1295	0.04	2.00	0.69	0.6	0.66	0.67	0.58	0.76	0.19	0.27
Chloromethylbenzene	9	0.01	0.09	0.04	0.01	0.04	0.03	0.02	0.07	0.03	0.66

Table 3-1. Target Pollutant Detection Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# Detects	Minimum (ppbv)	Maximum (ppbv)	Arithmetric Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Chloroprene	3	0.01	0.10	0.07	NA	0.09	0.04	0.05	0.10	0.04	0.60
cis-1,2-Dichloroethylene	6	0.05	0.13	0.09	NA	0.09	0.08	0.07	0.10	0.02	0.29
cis-1,3-Dichloropropene	1	NA									
Dibromochloromethane	18	0.01	0.06	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.73
Dichlorodifluoromethane	1296	0.03	1.61	0.64	0.61	0.62	0.63	0.58	0.68	0.11	0.17
Dichloromethane	1055	0.02	9.73	0.23	0.08	0.10	0.12	0.07	0.17	0.61	2.63
Dichlorotetrafluoroethane	792	0.01	0.11	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.33
Ethyl Acrylate	1	NA									
Ethyl tert-Butyl Ether	6	0.01	0.06	0.03	0.01	0.02	0.02	0.01	0.03	0.02	0.67
Ethylbenzene	1223	0.01	3.49	0.18	0.05	0.11	0.12	0.07	0.21	0.25	1.38
Hexachloro-1,3-Butadiene	225	0.01	0.05	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.39
m,p-Xylene	1260	0.01	11.0	0.42	0.11	0.26	NA	0.14	0.48	0.59	1.42
m-Dichlorobenzene	41	0.01	0.18	0.03	0.01	0.02	0.02	0.01	0.02	0.03	1.19
Methyl Ethyl Ketone	497	0.05	12.60	1.22	0.25	0.59	0.65	0.32	1.18	1.77	1.45
Methyl Isobutyl Ketone	272	0.01	2.97	0.20	0.06	0.08	0.10	0.05	0.20	0.31	1.56
Methyl Methacrylate	35	0.01	3.43	0.47	0.01	0.16	0.16	0.08	0.39	0.81	1.72
Methyl tert-Butyl Ether	163	0.01	7.29	0.55	0.11	0.32	0.3	0.15	0.69	0.74	1.35
n-Octane	725	0.01	4.76	0.12	0.04	0.06	0.07	0.04	0.11	0.33	2.69
o-Dichlorobenzene	52	0.01	0.14	0.04	0.01	0.02	0.02	0.01	0.06	0.04	1.00
o-Xylene	1201	0.01	3.87	0.19	0.05	0.12	NA	0.07	0.21	0.23	1.26
p-Dichlorobenzene	596	0.01	3.64	0.06	0.01	0.03	0.03	0.01	0.07	0.16	2.72
Propylene	1293	0.01	27.48	0.86	0.24	0.54	0.56	0.32	0.87	1.39	1.62
Styrene	961	0.01	3.15	0.10	0.04	0.05	0.06	0.03	0.09	0.19	1.92
tert-Amyl Methyl Ether	12	0.01	0.38	0.07	0.06	0.05	0.04	0.02	0.06	0.10	1.34
Tetrachloroethylene	711	0.01	14.8	0.19	0.02	0.04	0.05	0.02	0.07	0.97	5.04
Toluene	1294	0.03	22.8	1.05	0.26	0.68	0.68	0.35	1.25	1.40	1.34
trans-1,2-Dichloroethylene	3	0.02	0.04	0.03	NA	0.03	0.03	0.03	0.04	0.01	0.27

Table 3-1. Target Pollutant Detection Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# Detects	Minimum (ppbv)	Maximum (ppbv)	Arithmetric Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
trans-1,3-Dichloropropene	2	0.04	0.06	0.05	NA	0.05	0.05	0.05	0.06	0.01	0.20
Trichloroethylene	389	0.01	1.28	0.06	0.01	0.03	0.03	0.02	0.05	0.12	1.95
Trichlorofluoromethane	1294	0.06	2.49	0.30	0.29	0.29	0.30	0.27	0.33	0.09	0.30
Trichlorotrifluoroethane	1294	0.04	0.88	0.12	0.09	0.10	0.11	0.09	0.14	0.06	0.46
Vinyl Chloride	105	0.01	0.13	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.99

Table 3-2. Target Pollutant Detection Statistical Summaries of the Carbonyl Compound Concentrations

Pollutant	# Detects	Minimum (ppbv)	Maximum (ppbv)	Arithmetric Mean (ppbv)	Mode (ppbv)	Median (ppbv)	Geometric Mean (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)	Coefficient of Variation
Acetaldehyde	1606	0.02	18.00	1.33	1.10	1.01	1.02	0.65	1.60	1.24	0.93
Acetone	1606	0.01	5.53	0.87	1.21	0.68	0.61	0.33	1.19	0.70	0.81
Benzaldehyde	1546	0.002	1.13	0.04	0.01	0.03	0.03	0.02	0.05	0.07	1.56
Butyraldehyde/Isobutyraldehyde	1590	0.01	2.11	0.10	0.05	0.07	0.07	0.05	0.12	0.10	1.05
Crotonaldehyde	1557	0.004	1.88	0.11	0.04	0.05	0.06	0.03	0.12	0.16	1.49
2,5-Dimethylbenzaldehyde	83	0.002	0.47	0.03	0.01	0.01	0.02	0.01	0.02	0.06	2.08
Formaldehyde	1600	0.01	287.00	5.18	1.34	2.04	2.18	1.19	3.55	17.75	3.43
Hexaldehyde	1551	0.002	1.32	0.05	0.02	0.03	0.03	0.02	0.04	0.08	1.81
Isovaleraldehyde	520	0.002	0.33	0.02	0.01	0.01	0.01	0.01	0.02	0.02	1.24
Propionaldehyde	1531	0.0003	2.02	0.12	0.07	0.10	0.09	0.06	0.15	0.12	1.00
Tolualdehydes	1409	0.002	0.77	0.03	0.01	0.02	0.02	0.01	0.04	0.05	1.40
Valeraldehyde	1519	0.004	1.79	0.04	0.02	0.03	0.03	0.02	0.04	0.08	1.80

Table 3-3. Target Pollutant Detection Statistical Summaries of the SVOC Concentrations

Pollutant	# Detects	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetric Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
Acenaphthene	142	0.02	86.00	9.82	16.70	2.67	2.41	0.51	10.73	15.78	1.61
Acenaphthylene	130	0.02	124.00	6.68	1.21	1.12	1.10	0.26	5.47	14.84	2.22
Anthracene	115	0.02	49.90	4.61	2.61	1.27	1.30	0.34	5.50	8.27	1.80
Benzo (a) anthracene	130	0.01	19.30	1.03	0.03	0.16	0.20	0.06	0.45	2.69	2.60
Benzo (a) pyrene	107	0.01	13.60	0.71	0.03	0.13	0.18	0.07	0.43	1.80	2.53
Benzo (b) fluoranthene	119	0.02	15.60	0.98	0.10	0.23	0.27	0.09	0.62	2.19	2.24
Benzo (e) pyrene	120	0.02	12.40	0.77	0.10	0.21	0.23	0.09	0.49	1.71	2.22
Benzo (g,h,i) perylene	107	0.02	6.66	0.56	0.23	0.20	0.24	0.11	0.50	1.04	1.85
Benzo (k) fluoranthene	129	0.02	15.90	0.87	0.13	0.22	0.27	0.10	0.58	2.05	2.34
Chrysene	141	0.02	24.50	1.36	0.17	0.31	0.37	0.13	0.79	3.20	2.36
Coronene	77	0.02	1.85	0.22	0.11	0.11	0.13	0.06	0.23	0.29	1.37
Dibenz (a,h) anthracene	40	0.02	3.38	0.41	0.03	0.18	0.18	0.06	0.48	0.62	1.51
Fluoranthene	142	0.17	62.30	6.98	6.49	3.18	3.17	1.29	8.56	9.72	1.39
Fluorene	141	0.13	83.90	9.90	1.08	3.73	3.91	1.19	12.00	14.53	1.47
Indeno(1,2,3-cd)pyrene	98	0.02	10.70	0.76	0.17	0.20	0.26	0.10	0.62	1.57	2.05
Naphthalene	142	0.12	1410.00	161.22	117.00	25.30	22.31	3.26	217.00	279.17	1.73
Perylene	65	0.01	4.06	0.31	0.04	0.07	0.10	0.03	0.25	0.67	2.19
Phenanthrene	142	0.10	186.00	22.82	2.81	9.91	10.09	3.63	29.03	30.82	1.35
Pyrene	142	0.09	41.80	4.37	2.11	1.94	1.92	0.77	4.96	6.37	1.46

Table 3-4. Target Pollutant Detection Statistical Summaries of the SNMOC Concentrations

Pollutant	# Detects	Minimum (ppbC)	Maximum (ppbC)	Arithmetric Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
1,2,3-Trimethylbenzene	133	0.09	3.91	0.39	0.62	0.27	0.28	0.18	0.38	0.51	1.33
1,2,4-Trimethylbenzene	192	0.13	19.30	1.22	1.41	0.80	0.81	0.50	1.21	2.07	1.69
1,3,5-Trimethylbenzene	175	0.10	7.71	0.50	0.22	0.33	0.34	0.21	0.51	0.84	1.70
1,3-Butadiene	125	0.06	1.03	0.18	0.12	0.15	0.16	0.11	0.21	0.12	0.68
1-Decene	0	NA									
1-Dodecene	54	0.08	6.33	0.42	0.12	0.20	0.24	0.13	0.34	0.86	2.06
1-Heptene	127	0.07	1.39	0.31	0.15	0.20	0.24	0.14	0.37	0.27	0.86
1-Hexene	179	0.09	1.54	0.36	0.52	0.31	0.30	0.19	0.45	0.22	0.62
1-Nonene	121	0.09	3.18	0.34	0.19	0.25	0.27	0.17	0.40	0.37	1.07
1-Octene	92	0.08	1.13	0.32	0.22	0.30	0.28	0.20	0.40	0.19	0.58
1-Pentene	173	0.09	21.10	0.74	0.24	0.36	0.38	0.23	0.51	2.22	3.00
1-Tridecene	0	NA									
1-Undecene	42	0.06	0.60	0.22	0.28	0.21	0.19	0.12	0.30	0.14	0.60
2,2,3-Trimethylpentane	128	0.08	17.00	0.97	0.16	0.32	0.42	0.17	0.73	2.08	2.15
2,2,4-Trimethylpentane	244	0.11	118.00	3.36	1.65	0.90	1.10	0.52	2.01	10.79	3.21
2,2-Dimethylbutane	217	0.07	7.58	0.61	0.21	0.43	0.44	0.25	0.70	0.70	1.16
2,3,4-Trimethylpentane	210	0.09	28.40	1.06	0.10	0.40	0.45	0.24	0.72	2.80	2.63
2,3-Dimethylbutane	233	0.10	10.90	1.01	1.27	0.54	0.62	0.33	1.16	1.38	1.37
2,3-Dimethylpentane	226	0.09	15.30	1.18	0.17	0.67	0.70	0.36	1.27	1.69	1.43
2,4-Dimethylpentane	223	0.09	15.50	0.83	0.36	0.42	0.47	0.25	0.86	1.49	1.80
2-Ethyl-1-butene	1	NA									
2-Methyl-1-butene	181	0.06	1.44	0.33	0.17	0.27	0.26	0.15	0.43	0.24	0.73
2-Methyl-1-pentene	21	0.09	126.00	6.16		0.15	0.21	0.11	0.22	26.80	4.35
2-Methyl-2-butene	185	0.08	1.69	0.35	0.11	0.27	0.28	0.16	0.46	0.27	0.77
2-Methylheptane	180	0.05	4.01	0.45	0.11	0.33	0.32	0.19	0.52	0.48	1.08
2-Methylhexane	215	0.08	20.20	1.01	1.07	0.54	0.56	0.27	1.05	1.91	1.89

Table 3-4. Target Pollutant Detection Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# Detects	Minimum (ppbC)	Maximum (ppbC)	Arithmetric Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
2-Methylpentane	260	0.10	37.80	2.88	3.20	1.51	1.58	0.69	3.40	3.90	1.36
3-Methyl-1-butene	16	0.10	0.48	0.22	NA	0.20	0.20	0.16	0.24	0.10	0.44
3-Methylheptane	183	0.07	5.09	0.41	0.12	0.27	0.30	0.18	0.44	0.56	1.35
3-Methylhexane	258	0.12	28.20	1.85	1.04	1.14	1.10	0.58	2.11	2.85	1.54
3-Methylpentane	260	0.13	14.70	1.63	2.99	0.93	1.04	0.53	1.99	2.02	1.24
4-Methyl-1-pentene	6	0.08	0.46	0.29	NA	0.32	0.24	0.16	0.42	0.15	0.50
Acetylene	262	0.13	25.90	2.52	1.97	1.81	1.78	1.04	2.81	2.90	1.15
a-Pinene	160	0.10	15.60	1.26	2.06	0.61	0.68	0.30	1.56	2.09	1.66
Benzene	263	0.23	23.00	1.80	1.24	1.32	1.33	0.78	2.07	2.15	1.19
b-Pinene	23	0.12	4.88	1.63	NA	0.61	0.82	0.30	3.17	1.60	0.98
cis-2-Butene	178	0.08	2.89	0.33	0.24	0.28	0.28	0.19	0.39	0.28	0.83
cis-2-Hexene	14	0.09	0.33	0.17	0.11	0.16	0.16	0.11	0.19	0.07	0.39
cis-2-Pentene	173	0.07	0.90	0.27	0.22	0.23	0.24	0.17	0.34	0.14	0.52
Cyclohexane	214	0.09	5.85	0.73	1.24	0.42	0.48	0.25	0.94	0.77	1.06
Cyclopentane	239	0.07	2.78	0.46	0.50	0.27	0.33	0.18	0.58	0.46	0.98
Cyclopentene	68	0.08	5.18	0.31	0.12	0.17	0.20	0.13	0.25	0.62	2.01
Ethane	262	0.42	150.00	10.68	6.14	7.01	7.63	4.65	10.78	12.54	1.17
Ethylbenzene	257	0.09	18.60	1.17	0.57	0.62	0.67	0.31	1.21	1.99	1.70
Ethylene	252	0.09	194.00	3.77	1.50	2.20	2.20	1.32	3.64	12.40	3.29
Isobutane	263	0.28	124.00	7.19	1.59	2.20	2.93	1.08	7.62	12.46	1.73
Isobutene/1-Butene	261	0.15	6.33	1.11	1.19	0.92	0.90	0.60	1.32	0.81	0.73
Isopentane	260	0.44	68.20	8.55	6.41	4.33	4.83	2.22	10.53	10.69	1.25
Isoprene	208	0.05	9.39	1.27	2.14	0.49	0.64	0.25	1.93	1.60	1.26
Isopropylbenzene	113	0.06	0.93	0.18	0.14	0.15	0.16	0.12	0.19	0.12	0.67
m-Diethylbenzene	117	0.06	1.87	0.40	0.11	0.25	0.29	0.16	0.50	0.37	0.92
Methylcyclohexane	234	0.09	6.18	0.87	0.11	0.46	0.53	0.23	1.23	0.94	1.08
Methylcyclopentane	259	0.10	6.14	1.03	0.29	0.57	0.67	0.33	1.44	1.07	1.04
m-Ethyltoluene	201	0.09	12.20	0.74	0.64	0.49	0.49	0.29	0.73	1.26	1.71

Table 3-4. Target Pollutant Detection Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# Detects	Minimum (ppbC)	Maximum (ppbC)	Arithmetric Mean (ppbC)	Mode (ppbC)	Median (ppbC)	Geometric Mean (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)	Coefficient of Variation
m-Xylene/*p*-Xylene	262	0.14	60.30	2.72	1.75	1.67	1.56	0.73	2.85	5.38	1.97
n-Butane	263	0.37	113.00	11.12	10.90	4.58	5.36	2.25	11.05	17.52	1.58
n-Decane	173	0.09	4.68	0.74	0.58	0.49	0.51	0.29	0.87	0.80	1.09
n-Dodecane	116	0.06	10.70	0.64	0.27	0.22	0.29	0.14	0.39	1.39	2.15
n-Heptane	248	0.09	13.10	1.10	1.02	0.56	0.64	0.31	1.30	1.56	1.43
n-Hexane	263	0.11	18.30	2.08	1.16	1.16	1.25	0.61	2.80	2.45	1.18
n-Nonane	201	0.09	4.77	0.47	0.30	0.35	0.36	0.22	0.57	0.46	0.99
n-Octane	237	0.08	4.97	0.60	0.33	0.40	0.42	0.25	0.69	0.65	1.09
n-Pentane	263	0.28	35.80	4.79	1.60	2.38	2.93	1.37	6.31	5.55	1.16
n-Propylbenzene	161	0.10	3.97	0.37	0.39	0.29	0.29	0.20	0.38	0.45	1.21
n-Tridecane	8	0.10	0.25	0.17	NA	0.17	0.17	0.14	0.22	0.05	0.27
n-Undecane	153	0.10	21.70	1.07	1.01	0.51	0.57	0.30	0.90	2.35	2.18
o-Ethyltoluene	161	0.08	4.21	0.45	0.49	0.32	0.34	0.21	0.52	0.49	1.09
o-Xylene	254	0.09	20.80	1.01	0.29	0.63	0.62	0.32	1.06	1.89	1.88
p-Diethylbenzene	120	0.06	7.45	0.64	0.19	0.22	0.33	0.17	0.57	1.15	1.79
p-Ethyltoluene	183	0.09	6.51	0.50	0.16	0.35	0.36	0.24	0.50	0.70	1.40
Propane	263	0.55	128.00	17.53	13.60	9.87	11.06	5.27	22.55	19.42	1.11
Propylene	263	0.15	13.90	1.57	1.68	1.18	1.17	0.66	1.84	1.51	0.96
Propyne	0	NA									
Styrene	199	0.08	5.99	0.96	0.16	0.35	0.49	0.18	1.31	1.16	1.21
Sum of Unknowns	263	2.16	393.00	64.22	25.20	44.30	43.00	23.35	84.45	62.65	0.98
Toluene	262	0.23	87.20	5.10	1.39	2.82	2.86	1.37	5.52	8.40	1.65
trans-2-Butene	180	0.06	3.83	0.31	0.25	0.24	0.25	0.16	0.35	0.34	1.08
trans-2-Hexene	31	0.05	0.55	0.18	NA	0.16	0.17	0.12	0.21	0.09	0.49
trans-2-Pentene	193	0.06	1.54	0.38	0.51	0.31	0.32	0.22	0.49	0.25	0.66
SNMOC (Sum of Knowns)	263	11.00	655.00	112.89	110.00	71.10	77.57	41.60	135.00	115.71	1.02
TNMOC (Total)	337	14.30	1600.00	233.30	172.00	159.00	162.68	91.60	275.00	231.26	0.99

Table 3-5. Target Pollutant Detection Statistical Summaries of the Metals Concentrations

PM Type	Pollutant	# Detects	Minimum (ng/m^3)	Maximum (ng/m^3)	Arithmetric Mean (ng/m^3)	Mode (ng/m^3)	Median (ng/m^3)	Geometric Mean (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)	Coefficient of Variation
PM_{10}	Antimony	220	0.04	12.10	1.07	0.59	0.90	0.82	0.59	1.26	1.03	0.97
PM_{10}	Arsenic	220	0.04	29.90	1.22	0.41	0.59	0.64	0.37	0.99	2.66	2.17
PM_{10}	Beryllium	215	0.0001	0.07	0.01	0.01	0.01	0.01	0.00	0.01	0.01	1.03
PM_{10}	Cadmium	220	0.01	4.99	0.51	0.10	0.27	0.27	0.12	0.61	0.65	1.27
PM_{10}	Chromium	220	0.14	5.09	2.06	2.75	2.07	1.90	1.70	2.42	0.65	0.32
PM_{10}	Cobalt	220	0.01	0.76	0.15	0.08	0.13	0.12	0.08	0.18	0.11	0.70
PM_{10}	Lead	220	0.19	67.70	7.48	12.60	3.96	4.52	2.54	9.84	8.56	1.14
PM_{10}	Manganese	220	0.33	104.00	9.81	10.70	5.68	6.06	3.48	9.96	13.09	1.33
PM_{10}	Mercury	125	0.0006	0.95	0.07	0.02	0.03	0.03	0.01	0.06	0.14	1.89
PM_{10}	Nickel	220	0.12	10.85	1.82	1.04	1.45	1.47	1.09	2.01	1.41	0.78
PM_{10}	Selenium	220	0.04	5.90	0.77	0.40	0.55	0.55	0.34	1.03	0.67	0.87
TSP	Antimony	261	0.05	4.42	1.00	0.41	0.84	0.76	0.45	1.31	0.74	0.74
TSP	Arsenic	261	0.04	34.30	1.23	0.52	0.79	0.80	0.48	1.26	2.33	1.90
TSP	Beryllium	249	0.0001	1.44	0.03	0.02	0.01	0.01	0.01	0.02	0.11	3.49
TSP	Cadmium	261	0.01	3.19	0.25	0.11	0.15	0.16	0.10	0.27	0.35	1.38
TSP	Chromium	261	0.24	11.60	3.54	2.19	3.02	2.99	2.18	4.72	1.92	0.54
TSP	Cobalt	261	0.01	20.30	0.37	0.06	0.16	0.16	0.09	0.25	1.50	4.10
TSP	Lead	261	0.37	115.00	8.48	4.03	4.93	5.43	3.29	8.86	11.49	1.36
TSP	Manganese	261	0.90	606.00	24.74	11.90	10.30	11.82	4.78	25.50	48.30	1.95
TSP	Mercury	156	0.0007	1.01	0.07	0.01	0.03	0.03	0.01	0.07	0.11	1.64
TSP	Nickel	261	0.10	29.60	2.29	0.88	1.73	1.65	1.04	2.56	2.51	1.10
TSP	Selenium	260	0.01	11.40	0.82	0.18	0.58	0.56	0.33	0.96	0.96	1.17

Table 3-6. Program–Wide Comparison of Measured Concentrations and EPA Screening Values

Pollutant	# Failed Screens	# Detects	% Failed	% Contribution	Cumulative %
Acetaldehyde	1563	1606	97.32	17.06	17.06
Formaldehyde	1393	1600	87.06	15.20	32.26
Benzene	1296	1296	100.00	14.15	46.41
Carbon Tetrachloride	1221	1222	99.92	13.33	59.74
1,3-Butadiene	777	821	94.64	8.48	68.22
Tetrachloroethylene	518	711	72.86	5.65	73.87
Arsenic	446	481	92.72	4.87	78.74
p-Dichlorobenzene	425	596	71.31	4.64	83.38
Manganese	324	481	67.36	3.54	86.91
Acrolein	283	283	100.00	3.09	90.00
Hexachloro-1,3-butadiene	225	225	100.00	2.46	92.46
Nickel	149	481	30.98	1.63	94.08
Xylenes	104	1280	8.13	1.14	95.22
Cadmium	89	481	18.50	0.97	96.19
Naphthalene	67	142	47.18	0.73	96.92
Dichloromethane	60	1055	5.69	0.65	97.58
Trichloroethylene	52	389	13.37	0.57	98.14
1,2-Dichloroethane	32	32	100.00	0.35	98.49
1,1,2,2-Tetrachloroethane	24	24	100.00	0.26	98.76
Methyl *tert*-Butyl Ether	23	163	14.11	0.25	99.01
Benzo (a) pyrene	19	107	17.76	0.21	99.21
Acrylonitrile	17	17	100.00	0.19	99.40
Bromomethane	15	649	2.31	0.16	99.56
Chloromethylbenzene	9	9	100.00	0.10	99.66
Vinyl chloride	6	105	5.71	0.07	99.73
Dibenz (a,h) anthracene	5	40	12.50	0.05	99.78
1,2-Dibromoethane	3	3	100.00	0.03	99.81
Benzo (a) anthracene	3	130	2.31	0.03	99.85
Beryllium	3	464	1.20	0.03	99.88
1,1,2-Trichloroethane	2	2	100.00	0.02	99.90
Benzo (b) fluoranthene	2	119	1.68	0.02	99.92
Benzo (k) fluoranthene	2	129	1.55	0.02	99.95
Toluene	2	1297	0.15	0.02	99.97
Cobalt	1	481	0.38	0.01	99.98
Ethyl Acrylate	1	1	100.00	0.01	99.99

Table 3-6. Program–Wide Comparison of Measured Concentrations and EPA Screening Values (Continued)

Pollutant	# Failed Screens	# Detects	% Failed	% Contribution	Cumulative %
Indeno(1,2,3-cd)pyrene	1	98	1.02	0.01	100.00
Total	9162	17020	53.83		

Table 3-7. Program-Wide Non-Chronic Risk Summary

Sampling Method	Pollutant	ATSDR Short-term MRL (µg/m^3)	Number of Exceedances	CAL EPA REL Acute (µg/m^3)	Number of Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Number of Winter Exceedances	Number of Spring Exceedances	Number of Summer Exceedances	Number of Autumn Exceedances
TO-11A	Formaldehyde	49	30	94	22	40	0	0	2	0
TO-15	Acrolein	0.11	283	0.19	279	0.09	--	--	--	9
TO-15	Benzene[1]	28.75	2	NA	--	NA	--	--	--	--

[1] Indicates the use of the ATSDR re-calculated acute risk factor

Table 3-8. Summary of Pearson Correlation Coefficients for Selected Meteorological Parameters and Pollutants of Interest

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
1,3-Butadiene	821	-0.07	-0.10	-0.15	-0.12	-0.13	-0.02	0.02	0.03
Acetaldehyde	1604	0.08	0.06	0.00	0.02	-0.11	-0.03	0.08	0.05
Acrolein	283	0.42	0.41	0.34	0.38	-0.12	-0.23	0.19	-0.40
Arsenic (PM_{10})	220	0.08	0.04	0.08	0.07	0.09	-0.09	0.09	0.07
Arsenic (TSP)	261	0.12	0.11	0.15	0.14	0.12	-0.07	-0.11	0.04
Benzene	1296	0.08	0.08	0.07	0.07	-0.01	-0.03	0.13	0.02
Carbon Tetrachloride	1222	0.13	0.14	0.20	0.18	0.14	-0.02	0.08	-0.02
Formaldehyde	1598	0.10	0.11	0.10	0.10	0.01	0.01	0.06	-0.35
Hexachloro-1,3-butadiene	225	-0.33	-0.34	-0.30	-0.32	0.08	0.09	0.02	0.14
Manganese (PM_{10})	220	0.05	0.01	0.03	0.02	0.04	-0.10	0.11	0.08
Manganese (TSP)	261	0.22	0.20	0.24	0.23	0.08	-0.08	-0.03	0.02
Nickel (PM_{10})	220	-0.32	-0.31	-0.27	-0.27	0.09	0.04	-0.12	0.13
Nickel (TSP)	261	0.13	0.11	0.04	0.07	-0.13	-0.06	0.09	-0.07
p-Dichlorobenzene	596	0.17	0.17	0.17	0.17	0.04	-0.08	-0.02	-0.01
Tetrachloroethylene	711	0.02	0.02	0.03	0.02	0.00	0.04	0.02	0.02
Xylenes	1280	0.21	0.20	0.15	0.18	-0.08	-0.16	0.09	0.02

Table 3-9. Summary of Mobile Source Information by Site

Site	County Motor Vehicle Registration	2005 Estimated County Population	Traffic Data Near Site (Daily Average)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Arithmetic Mean (ppbv)	Acetylene Arithmetic Mean (ppbv)
APMI	1,422,117	1,998,217	60,000	9,896	2,218	6.13	1.55
AZFL	1,030,672	928,032	51,000	4,831	1,822	NA	NA
BAPR	13,130	22,829	10	9	109	4.37	1.15
BOMA	566,351	654,428	27,287	1,136	1,962	NA	NA
BTUT	217,537	268,187	33,310	1,067	429	5.17	1.62
CANC	26,843	27,322	100	164	13	NA	NA
CANJ	369,412	518,249	62,000	1,106	704	4.94	1.46
CHNJ	349,299	490,593	12,623	1,737	1,396	1.69	0.58
CUSD	9,403	7,904	1,940	43	38	2.19	0.72
DEMI	1,422,117	1,998,217	12,791	9,896	2,218	4.89	1.46
DITN	43,784	45,894	4,420	345	16	5.23	0.89
ELNJ	380,628	531,457	170,000	1,399	664	8.05	1.55
ETAL	544,407	657,229	30,000	4,010	620	14.87	8.47
FLFL	1,140,365	1,777,638	8,000	7,629	2,363	NA	NA
GAFL	835,689	1,132,152	81,400	5,580	1,849	NA	NA
GPCO	148,158	129,872	19,572	543	223	7.24	1.92
GRMS	20,036	22,861	1,100	130	93	1.71	0.58
INDEM	393,034	493,297	42,950	1,519	957	NA	NA
ITCMI	33,580	38,780	100,000	181	507	1.69	0.73
LDTN	46,656	43,387	13,360	366	132	4.58	0.98
MAWI	420,070	458,106	23,750	1,761	1,024	2.21	0.80
MIMN	1,004,883	1,119,364	10,000	3,891	2,377	3.61	1.1
MUTX	707,976	888,185	4,374	2,955	1,311	4.17	0.7
NBAL	544,407	657,229	2,000	4,010	620	11.54	4.21
NBIL	2,115,353	5,303,683	29,600	8,734	5,510	3.47	1.49
NBNJ	561,754	789,516	63,000	2,343	1,330	3.62	1.14

Table 3-9. Summary of Mobile Source Information by Site (Continued)

Site ID	County Motor Vehicle Registration	2005 Estimated County Population	Traffic Data Near Site (Daily Average)	County-Level On-road Emissions (tpy)	County-Level Non-road Emissions (tpy)	Hydrocarbon Arithmetic Mean (ppbv)	Acetylene Arithmetic Mean (ppbv)
ORFL	735,120	1,023,023	59,000	5,588	2,017	NA	NA
PCOK	37,218	46,480	8,100	305	163	13.36	1.22
PGMS	119,796	135,940	8,600	668	997	3.52	0.85
PITX	707,976	888,185	33,936	2,955	1,311	4.50	0.82
POOK	37,218	46,480	3,800	305	163	4.69	1.05
PVAL	544,407	657,229	NA	4,010	620	1.95	0.36
RRTX	269,253	333,457	20,900	840	319	7.14	1.18
RTPNC	175,758	242,582	12,000	1,247	187	NA	NA
S4MO	189,295	344,362	22,840	1,377	482	3.78	1.29
SFSD	155,857	160,087	4,320	547	198	2.23	0.68
SIAL	544,407	657,229	2,700	4,010	620	9.66	2.05
SJPR	130,070	222,195	250	493	1,092	7.94	1.71
SKFL	1,030,672	928,032	50,500	4,831	1,822	NA	NA
SMFL	835,689	1,132,152	18,700	5,580	1,849	NA	NA
SPIL	2,115,353	5,303,683	214,900	8,734	5,510	4.09	1.44
SYFL	835,689	1,132,152	5,142	5,580	1,849	NA	NA
TRTX	707,976	888,185	27,114	2,955	1,311	5.55	1.24
TUMS	69,518	78,793	4,900	438	91	2.4	0.69
WETX	707,976	888,185	5,733	2,955	1,311	8.22	1.94
YDSP	505,459	721,598	2,200	2,209	524	8.04	2.04
YFMI	1,422,117	1,998,217	500	9,896	2,218	7.25	1.53

Table 3-10. Average Ethylene to Acetylene Ratios for Sites that Sampled SNMOC

Site	Average Ethylene to Acetylene Ratio	% Difference from 1.70 Ratio
BTUT	1.33 ± 0.22	-21.68
CUSD	1.58 ± 0.35	-6.77
NBIL	1.77 ± 0.34	3.99
PCOK	1.53 ± 0.21	-10.27
PGMS	1.41 ± 0.16	-17.18
POOK	1.25 ± 0.23	-26.28
SFSD	1.38 ± 0.21	-18.56

Table 3-11. Comparison of Concentration Ratios for BTEX Compounds vs. Roadside Study

Site	Benzene-Ethylbenzene Ratio	Toluene-Ethylbenzene Ratio	Xylenes-Ethylbenzene Ratio
Roadside Study	2.85	5.85	4.55
APMI	3.63 ± 0.52	6.49 ± 0.51	3.70 ± 0.18
BAPR	2.31 ± 0.13	6.31 ± 0.31	4.29 ± 0.14
BTUT	4.28 ± 0.30	8.17 ± 0.64	4.25 ± 0.18
CANJ	3.84 ± 0.28	7.92 ± 1.40	3.72 ± 0.12
CHNJ	4.37 ± 0.56	5.39 ± 0.36	3.07 ± 0.13
CUSD	4.77 ± 0.59	5.25 ± 0.47	3.35 ± 0.21
DEMI	3.55 ± 0.27	5.78 ± 0.40	3.59 ± 0.10
DITN	4.61 ± 0.67	22.06 ± 5.61	3.58 ± 0.18
ELNJ	3.37 ± 0.24	6.46 ± 0.37	3.68 ± 0.10
ETAL	3.28 ± 0.63	5.12 ± 0.28	3.56 ± 0.26
GPCO	2.33 ± 0.27	5.23 ± 0.49	4.69 ± 0.14
GRMS	4.31 ± 0.90	4.95 ± 0.69	3.89 ± 0.28
ITCMI	6.44 ± 1.26	6.16 ± 0.65	3.20 ± 0.19
LDTN	4.01 ± 0.66	7.89 ± 0.69	3.46 ± 0.17
MAWI	4.71 ± 0.40	6.34 ± 0.36	3.31 ± 0.18
MIMN	3.65 ± 0.30	7.22 ± 0.74	3.76 ± 0.10
MUTX	1.40 ± 0.42	2.64 ± 0.41	1.32 ± 0.25
NBAL	3.57 ± 1.14	5.57 ± 0.85	4.67 ± 0.53
NBIL	4.33 ± 0.53	7.04 ± 2.03	3.27 ± 0.13
NBNJ	2.69 ± 0.33	5.41 ± 1.23	2.70 ± 0.18
PCOK	1.38 ± 0.21	4.87 ± 0.87	2.23 ± 0.47
PGMS	3.79 ± 0.75	7.96 ± 0.79	2.95 ± 0.17
PITX	1.31 ± 0.50	2.27 ± 0.44	1.24 ± 0.26
POOK	2.01 ± 0.22	6.11 ± 0.57	2.95 ± 0.19
PVAL	3.27 ± 0.48	9.85 ± 2.09	3.56 ± 0.28
RRTX	1.36 ± 0.46	8.28 ± 1.73	1.21 ± 0.32
S4MO	3.08 ± 0.24	6.61 ± 1.10	3.08 ± 0.09
SFSD	4.06 ± 0.39	5.89 ± 0.47	3.21 ± 0.15
SIAL	6.86 ± 2.24	5.74 ± 0.68	3.49 ± 0.35
SJPR	2.17 ± 0.20	6.77 ± 0.56	4.37 ± 0.18
SPIL	4.24 ± 0.44	6.17 ± 0.44	3.45 ± 0.13
TRTX	1.46 ± 0.39	3.41 ± 0.64	1.46 ± 0.30
TUMS	3.86 ± 0.31	8.23 ± 1.24	3.35 ± 0.18
WETX	1.87 ± 0.31	3.63 ± 0.47	2.25 ± 0.33
YDSP	2.83 ± 0.18	5.61 ± 0.23	3.54 ± 0.10
YFMI	19.12 ± 8.76	8.81 ± 1.25	3.66 ± 0.14

4.0 Sites in Alabama

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Alabama (ETAL, NBAL, PVAL, and SIAL), located in or near the Birmingham area. Figures 4-1 thru 4-4 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 4-5 thru 4-6 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 4-5 shows, the three monitoring sites located within the city of Birmingham (ETAL, NBAL, and SIAL) are located relatively close to each other. Both the sites and nearby facilities are oriented along a diagonal line extending from northeast to southwest Birmingham. Surface coating processes and waste treatment and disposal facilities are the most prevalent industries near these monitoring sites. The PVAL monitoring site is located on the western edge of Jefferson County, with relatively few industrial sources nearby, as indicated in Figure 4-6.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the ETAL, NBAL, and SIAL monitoring sites is Birmingham International Airport (WBAN 13876), while the closest weather station to PVAL is Tuscaloosa Municipal Airport (WBAN 93806).

Birmingham, Alabama is about 300 miles inland from the Gulf of Mexico. This proximity allows the Gulf of Mexico to be a major influence in the city's climate. Winters are tempered and wet while summers are warm and humid. (Ruffner and Bair, 1987). Table 4-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average u- and v-components of the wind) for the entire year and on days samples were taken. As shown in Table 4-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

4.1 Pollutants of Interest at the Alabama Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total failed screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 4-2 presents the pollutants that failed at least one screen at the Alabama monitoring sites. The number of pollutants failing the screen varies by site, as indicated in Table 4-2. Seventeen pollutants with a total of 192 measured concentrations failed the screen at ETAL; 28 pollutants with a total of 231 measured concentrations failed the screen at NBAL; eleven pollutants with a total of 110 measured concentrations failed the screen at PVAL; and 19 pollutants with a total of 170 measured concentrations failed the screen at SIAL. The pollutants of interest also varied by site, yet the following nine pollutants contributed to the top 95% of the total failed screens at each Alabama monitoring site: arsenic, acrolein, formaldehyde, carbon tetrachloride, manganese, acetaldehyde, benzene, naphthalene, and *p*-dichlorobenzene. If PVAL is not included, the list of pollutants of interest is even more similar. It's important to note that the Alabama sites sampled for carbonyls, VOCs, SVOCs, and metals, and that this is reflected in each site's pollutants of interest.

Also listed in Table 4-2 are the total number of detects and the percent detects failing the screen. Of the nine pollutants that were the same among all four sites, five pollutants of interest, acrolein, acetaldehyde, benzene, carbon tetrachloride, and arsenic, had 100% of their detects fail the screening values.

4.2 Concentration Averages at the Alabama Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all

non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 4-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at ETAL, total xylenes measured the highest concentration by mass (8.94 ± 2.76 μg/m^3), followed by formaldehyde (4.56 ± 0.91 μg/m^3) and benzene (3.44 ± 1.09 μg/m^3). As the Alabama sites did not begin sampling until mid-July, no seasonal average is available for winter, spring, and summer. Total xylene concentrations measured the highest average autumn concentration at 10.33 ± 4.51 μg/m^3, again followed by formaldehyde (4.42 ± 1.21 μg/m^3) and benzene (4.03 ± 1.86 μg/m^3), none of which vary much from their respective daily averages, due to the high number of detects.

Similar to ETAL, the pollutants with the highest daily averages at NBAL were total xylenes (11.86 ± 4.26 μg/m^3), formaldehyde (3.86 ± 1.10 μg/m^3), and benzene (3.48 ± 1.52 μg/m^3). Only SVOCs and metals had enough samples in any season to calculate a valid seasonal average, therefore very few of the NBAL pollutants of interest have seasonal averages in Table 4-3.

The pollutants with the highest daily averages at PVAL were formaldehyde (3.28 ± 0.96 μg/m^3), acrolein (1.41 ± 1.09 μg/m^3), and acetaldehyde (1.17 ± 0.19 μg/m^3). Formaldehyde concentrations also measured the highest average autumn concentration (3.14 ± 1.07 μg/m^3) followed by acetaldehyde (1.29 ± 0.26 μg/m^3), both of which vary little from their respective daily averages. Acrolein has no autumnal seasonal average.

Similar to ETAL and NBAL, the pollutants with the highest daily averages at SIAL were total xylenes (8.27 ± 2.61 μg/m^3), benzene (6.50 ± 2.15 μg/m^3), and formaldehyde (3.29 ± 0.65

μg/m^3). Very few of the SIAL pollutants of interest have seasonal averages in Table 4-3. However, for the ones that do, the autumnal averages vary little from the daily averages.

4.3 Non-chronic Risk Evaluation at the Alabama Monitoring Sites

Non-chronic risk for the concentration data at Alabama monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein and manganese exceeded either the acute or intermediate risk values, and each site's non-chronic risk is summarized in Table 4-4.

All acrolein detects at the Alabama sites were greater than the ATSDR acute value of 0.11 μg/m^3 and the California REL value of 0.19 μg/m^3. The average detected concentration ranged from 1.41 ± 0.43 μg/m^3 (at NBAL) to 2.34 ± 0.92 μg/m^3 (at SIAL), which are an order of magnitude higher than either acute risk factor. No seasonal averages for acrolein could be calculated, therefore intermediate risk could not be evaluated.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. For all four Alabama monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 4-7 through 4-10 are pollution roses for acrolein at the Alabama sites. The pollution rose is a plot of concentration and wind direction. As shown in Figures 4-7 through 4-10, and discussed in Section 4.3, all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

Figure 4-7 is the acrolein pollution rose for the ETAL monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is characteristic of mobile sources. The highest concentration of acrolein occurred on July 27, 2005 with a westerly wind. The ETAL site is located near several

heavily traveled roadways, including I-20, which runs east to west and lies to the south of the monitoring site. Railroads are also located to the north and south of the site.

Figure 4-8 is the acrolein pollution rose for the NBAL monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is characteristic of mobile sources. The highest concentration of acrolein occurred on October 31, 2005 with a south-southeasterly wind. NBAL is located just east of I-65 and several railways transverse the area near the monitoring site.

Figure 4-9 is the acrolein pollution rose for the PVAL monitoring site. The pollution rose shows that the few measured concentrations occurred with winds originating from a several directions. The highest concentration of acrolein occurred on October 19, 2005 with a southwesterly wind. The PVAL site is located in a rural area beyond the Birmingham city limits.

Figure 4-10 is the acrolein pollution rose for the SIAL monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, characteristic of mobile sources. The highest concentrations of acrolein occurred on October 19, 2005 and July 27, 2005, both with a westerly wind. Interestingly, these dates correspond with ETAL and PVAL. SIAL is located just east of NBAL, near several heavily traveled roadways. A number of railways also transverse the area near SIAL.

4.4 Meteorological and Concentration Analysis at the Alabama Sites

The following sub-sections describe and discuss the results of the following three meteorological analyses: Pearson Correlation Coeffiencients between meteorological parameters (such as temperature) and the concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

4.4.1 Pearson Correlation Analysis

Table 4-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Alabama monitoring sites.

(Please refer to Section 3.1.6 for more information on Pearson Correlations.) Most of the correlations between the temperature and moisture variables and the pollutants of interest at ETAL were weak. However, formaldehyde and *p*-dichlorobenzene exhibited moderately strong to strong positive correlations with the temperature and moisture variables, indicating that concentrations tend to increase as temperature and humidity increase. Hexachloro-1,3-butadiene exhibited very strong negative correlations with these same parameters, indicating that concentrations tend to decrease as temperature and humidity increase. This pollutant also had the strongest correlations with the wind components and sea level pressure. However, it is important to note that hexachloro-1,3-butadiene was detected relatively few times.

Correlations between the pollutants of interest at NBAL and the temperature and moisture parameters were mostly positive, indicating the concentrations tend to increase as temperature and humidity increase. Formaldehyde exhibited the strongest of these correlations for maximum temperature (0.84), average temperature (0.79), dew point temperature (0.74), and wet bulb temperature (0.76). Six pollutants had moderately strong to very strong negative correlations with the *u*-component of the wind and moderately strong to strong negative correlations with the *v*-component of the wind (1,3-butadiene, carbon tetrachloride, hexachloro-1,3-butadiene, manganese (TSP and PM_{10}), and tetrachloroethylene). Acrolein, 1,3-butadiene, and hexachloro-1,3-butadiene each exhibited strong to very strong correlations with sea level pressure at the NBAL monitoring site.

Benzene and carbon tetrachloride had moderately strong to strong negative correlations with the temperature and moisture parameters at the PVAL monitoring site while formaldehyde and *p*-dichlorobenzene tended to have moderately strong to very strong positive correlations with the same parameters. Acrolein was detected fewer than four times at the PVAL site, therefore, no Pearson Correlations were calculated for this pollutant. Correlations with the wind parameters tended to be weak. Benzene exhibited a very strong positive correlation with sea level pressure (0.78), suggesting that concentrations of benzene increase as surface pressure increases.

Several pollutants exhibited strong positive correlations with the temperature and moisture variables at the SIAL monitoring site, of which dibenz (a,h) anthracene, formaldehyde, and acrolein had the strongest correlations. Many pollutants had moderately strong to strong positive correlations with the *u*-component of the wind, while almost all the pollutants exhibited moderately strong to strong negative correlations with the *v*-component of the wind. This indicates that ambient air concentrations at the SIAL are influenced greatly by which way and how strongly the wind blows. Several pollutants had moderately strong to strong correlations with sea level pressure, although the calculated correlations were both positive and negative.

4.4.2 Composite Back Trajectory Analysis

Figures 4-11 thru 4-14 are composite back trajectory maps for the Alabama monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day and each circle represents 100 miles.

As shown in Figure 4-11, the back trajectories originated from a variety of directions at ETAL. The 24-hour airshed domain is somewhat smaller than other UATMP sites, with trajectories originating as far away as southeast Kansas, or greater than 400 miles away. Nearly 56% of the trajectories originated within 200 miles of the site; and 78% within 300 miles from the ETAL monitoring site.

As shown in Figure 4-12, the back trajectories originated from a variety of directions at NBAL. The 24-hour airshed domain is somewhat smaller than other UATMP sites, with trajectories originating as far away as southeast Kansas, or greater than 400 miles away. Nearly 50% of the trajectories originated within 200 miles of the site; and 72% within 300 miles from the NBAL monitoring site.

As shown in Figure 4-13, the back trajectories originated from a variety of directions at PVAL. The 24-hour airshed domain is somewhat smaller than other UATMP sites, with trajectories originating as far away as southeast Kansas, or nearly 500 miles away. Nearly 53%

of the trajectories originated within 200 miles of the site; and 82% within 300 miles from the PVAL monitoring site.

As shown in Figure 4-14, the back trajectories originated from a variety of directions at SIAL. The 24-hour airshed domain is somewhat smaller than other UATMP sites, with trajectories originating as far away as southeast Kansas, or nearly 500 miles away. Over 56% of the trajectories originated within 200 miles of the site; and 88% within 300 miles from the SIAL monitoring site.

4.4.3 Wind Rose Analysis

Hourly wind data from the Birmingham International Airport and Tuscaloosa Municipal Airport stations were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 4-15 through 4-18 are the wind roses for the Alabama monitoring sites on days sampling occurred.

As indicated in Figure 4-15, hourly winds were predominantly out of the north (10% of observations), south-southeast (10%), and south (7%) on days samples were taken near ETAL. Calm winds (<2 knots) were recorded for 33% of the hourly measurements. For wind speeds greater than 2 knots, 27% of observations ranged from 7 to 11 knots.

As indicated in Figure 4-16, hourly winds were predominantly out of north (10%), south-southeast (8%), northwest (7%), and south (6%) on days samples were taken near NBAL. Similar to ETAL, calm winds were observed for 33% of the observations, and windspeeds of 7 to 11 knots were recorded for 28% of the wind measurements.

As shown in Figure 4-17, northerly (9%) and southerly (12%) winds were predominant near PVAL on days samples were taken. Wind speeds in the 7 to 11 knot range were most often recorded on days with northerly or southerly winds. Nearly 40 percent of hourly wind speed measurements were calm, or less than 2 knots.

Figure 4-18 shows that the SIAL windrose is very similar to the ETAL wind rose. Northerly winds occurred most frequently (11%), followed by south-southeasterly winds (10%), and southerly winds (7%). Wind speeds at SIAL were frequently less than 2 knots (33%), but when greater than 2 knots, tended to fall into the 7 to 11 knot range (29%).

4.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following two spatial analyses: population, vehicle ownership, and traffic volume comparisons; and BTEX analyses.

4.5.1 Population, Vehicle Ownership, and Traffic Volume Comparison

County-level vehicle registration and population in Jefferson County, AL were obtained from the Alabama Department of Revenue and the U.S. Census Bureau, and are summarized in Table 4-6. Table 4-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 4-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

As presented in Table 4-6, the PVAL monitoring site has a significantly lower population residing within 10 miles of it than the other sites, and therefore a significantly lower estimated 10 mile vehicle ownership. Traffic data for three Birmingham sites was obtained from the Alabama Department of Transportation, but no traffic data was available for PVAL. The ETAL site experiences a significantly higher daily traffic volume than NBAL and SIAL, and according to Figure 4-1, resides next to a major interstate. Compared to other UATMP locations, Jefferson County's population and vehicle registration are slightly above the middle of the range.

4.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information of this study, refer to Section 3.2.1.4). Table 3-11 presented

and Figure 3-4 depicted the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. Of the four Alabama sites, the NBAL monitoring site's ratios most resemble those of the roadside study, suggesting that mobile source emissions are a major influence at this site. At ETAL, the benzene-ethylbenzene (3.28 ± 0.63) and xylenes-ethylbenzene (3.56 ± 0.26) ratios are similar to each other, while the toluene-ethylbenzene ratio is the highest of the three (5.12 ± 0.28). At PVAL, the toluene-ethylbenzene ratio (9.85 ± 2.09) is significantly higher than the other two ratios, as well as the roadside study's ratios. The ratios at the SIAL monitoring site least resemble the roadside study. SIAL's benzene-ethylbenzene ratio (6.56 ± 2.24) is the highest, followed by the toluene-ethylbenzene ratio (5.74 ± 0.68) and the xylenes-ethylbenzene ratio (3.49 ± 0.35).

4.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 4-7 presents the 1999 NATA results for the census tracts where the Alabama monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 4-7. Pollutants of interest are bolded.

The ETAL monitoring site is located in census tract 01073001200 with a population of 3,603, which represents 0.5% of the county population in 2000. The NBAL monitoring site is located in census tract 01073000800, with a population of 5,387, which represents 0.8% of Jefferson County's 2000 population. PVAL is located in census tract 01073014102. The population in that census tract was 5,132, or just less than 0.8% of the county's 2000 population. Finally, SIAL is located in census tract 01073005500. In 2000, the population in this census tract was 2,689 or 0.4 % of the 2000 county population.

4.6.1 1999 NATA Summary

In terms of cancer risk, the Top 3 pollutants identified by NATA in the ETAL, NBAL, and SIAL census tracts are benzene (16.03, 19.77, and 19.41 in-a-million risk, respectively), 1,3-butadiene (4.81. 6.17, and 5.01 in-a-million, respectively), and acetaldehyde (4.48, 4.89, and 4.52 in-a-million, respectively). While these cancer risks are relatively low when compared to other urban areas, such as near the BAPR and MIMN monitoring sites (71.0 and 39.5 in-a-million, respectively), the NBAL and SIAL benzene cancer risk are both in the Top 10 cancer risks among all UATMP sites for the pollutants of interest. Acrolein was the only pollutant in the Alabama census tracts to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects), ranging from 6.81 at ETAL to 7.71 at NBAL. Most noncancer hazard quotients were less than 0.20, suggesting very little risk for noncancer health affects, with the exception of acrolein.

Cancer risk in the PVAL census tract tended to be lower than at the other Alabama census tracts. In terms of cancer risk, the Top 3 pollutants identified by NATA in the PVAL census tract are benzene (7.47 in-a-million risk), carbon tetrachloride (3.17 in-a-million), and acetaldehyde (2.79 in-a-million). Acrolein was the only pollutant in the PVAL census tract to have a noncancer hazard quotient greater than 1.0 (3.40), which may lead to adverse health effects. Most noncancer hazard quotients were less than 0.15, suggesting very little risk for noncancer health affects, with the exception of acrolein.

4.6.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 4.2 on how a valid annual average is calculated). Unfortunately, the Alabama sites did not begin sampling until July 2005, therefore, valid annual averages could not be calculated.

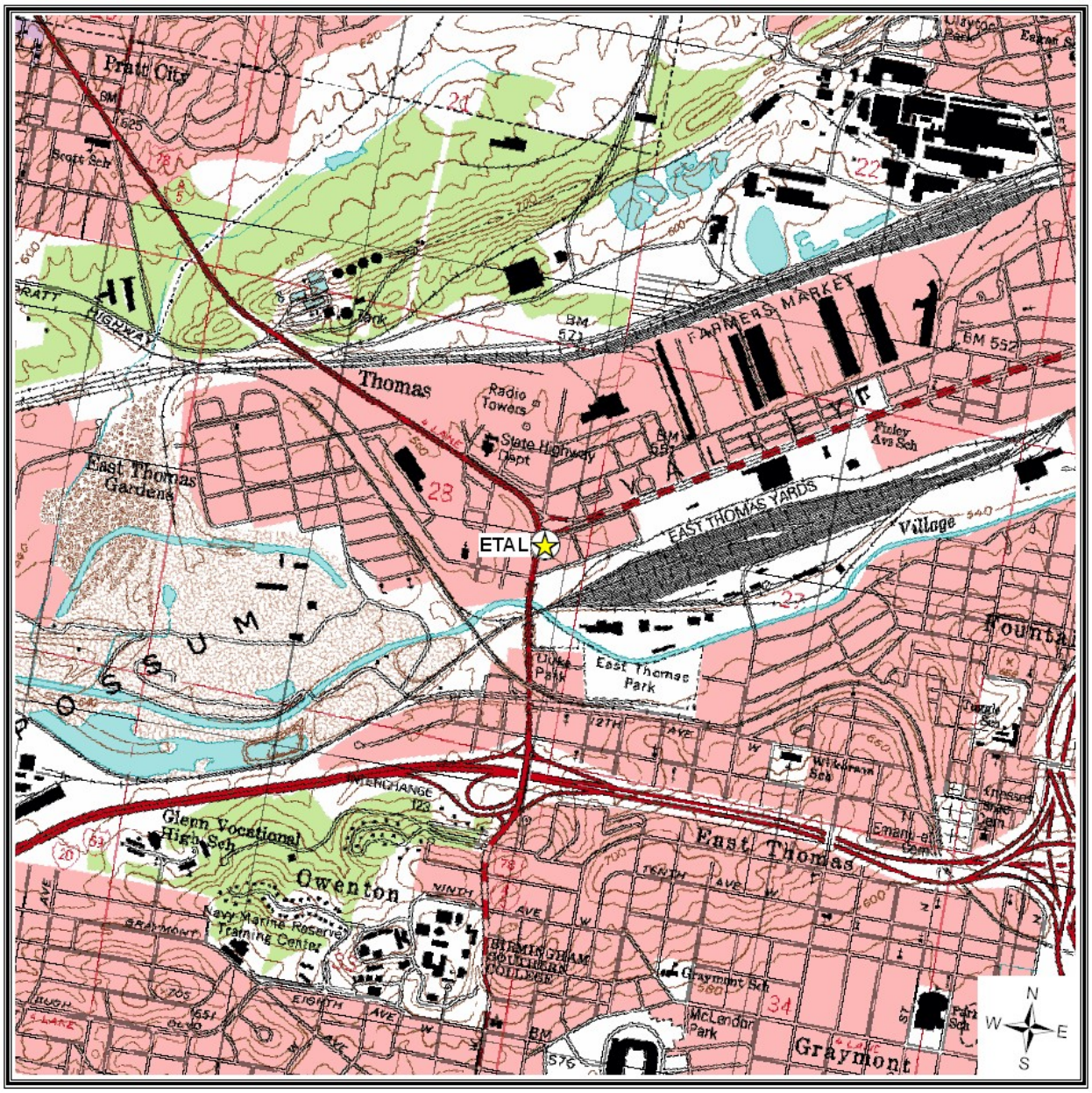
Alabama Pollutant Summary

- *The pollutants of interest common to each Alabama site are acetaldehyde, acrolein, arsenic, benzene, carbon tetrachloride, formaldehyde, manganese, naphthalene, and p-dichlorobenzene.*

- *Total xylenes measured the highest daily average at each of the three Birmingham sites (ETAL, NBAL, and SIAL), while formaldehyde had the highest daily average at PVAL.*

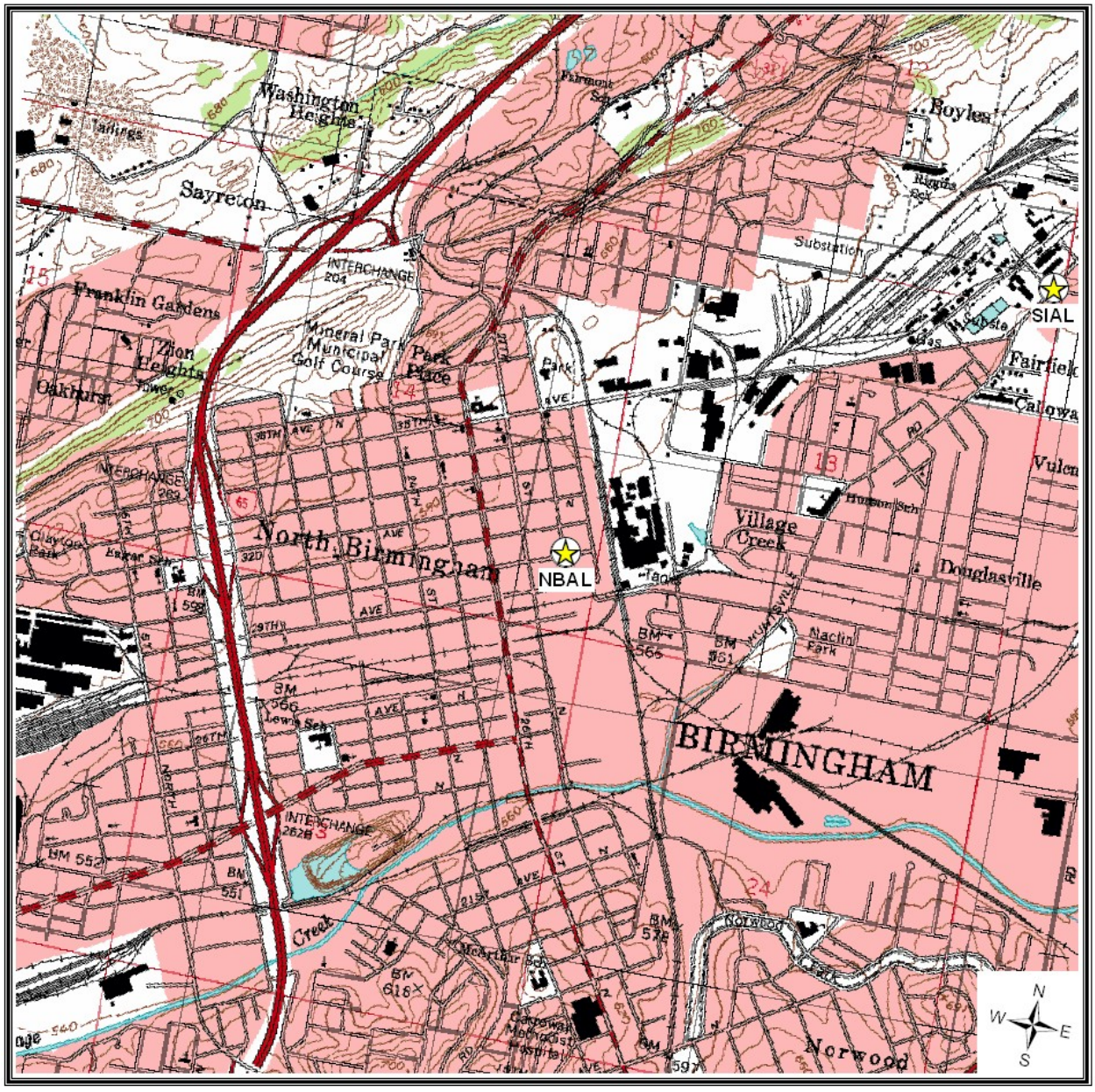
- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*

Figure 4-1. Birmingham, Alabama (ETAL) Monitoring Site



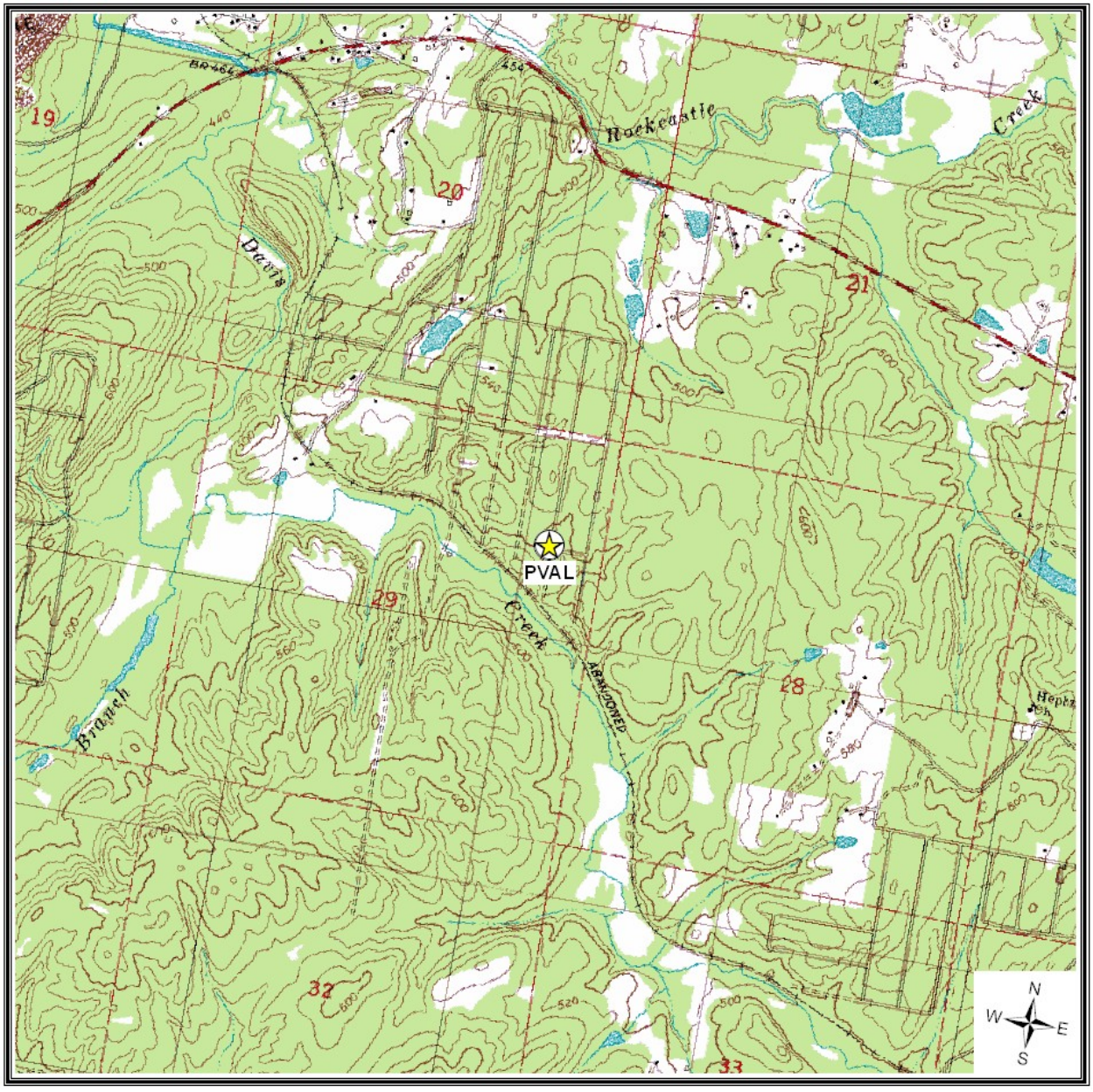
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-2. Birmingham, Alabama (NBAL) Monitoring Site



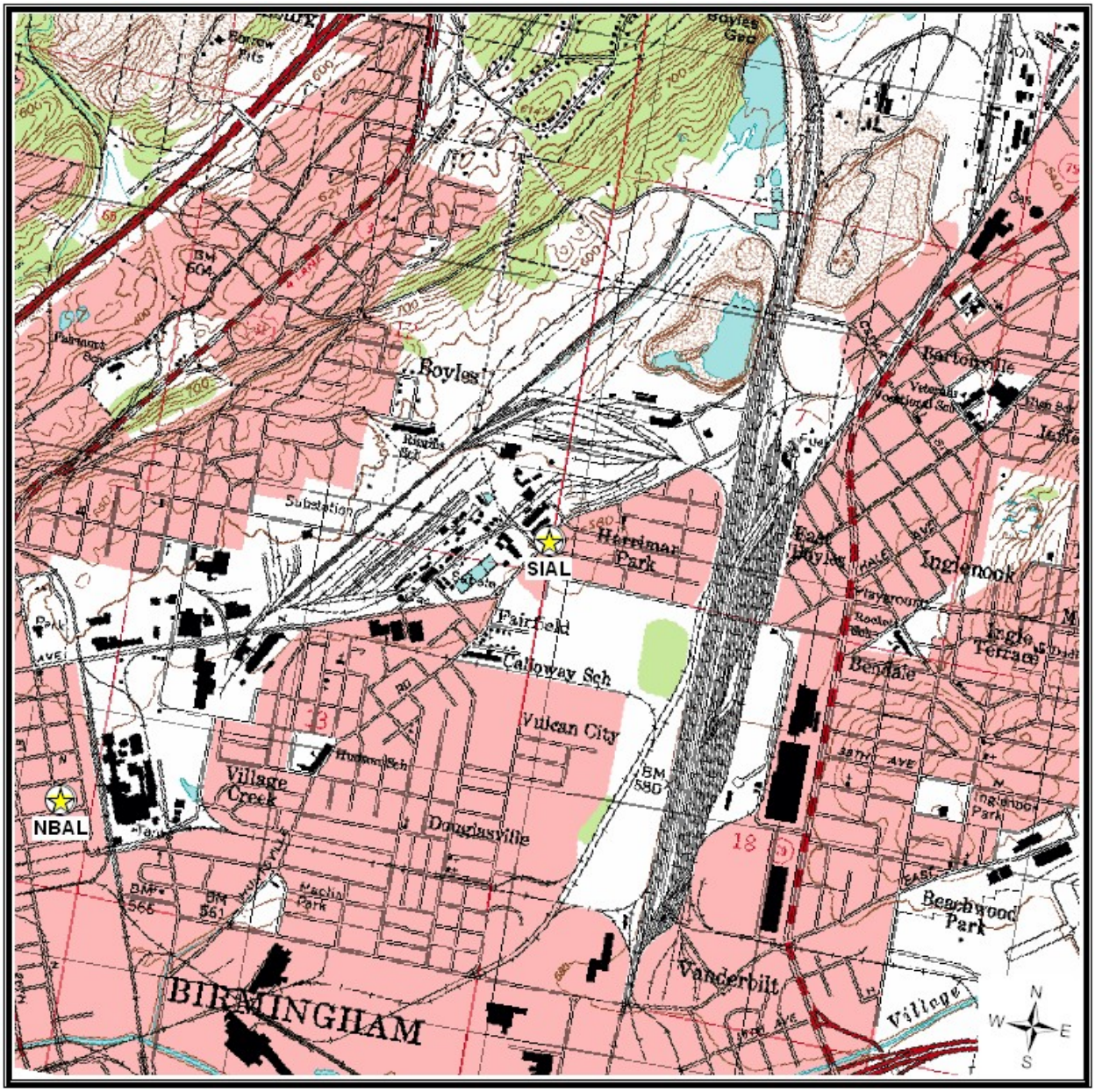
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-3. Birmingham, Alabama (PVAL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-4. Birmingham, Alabama (SIAL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 4-5. Facilities Located Within 10 Miles of the Birmingham, Alabama Sites ETAL, NBAL, and SIAL

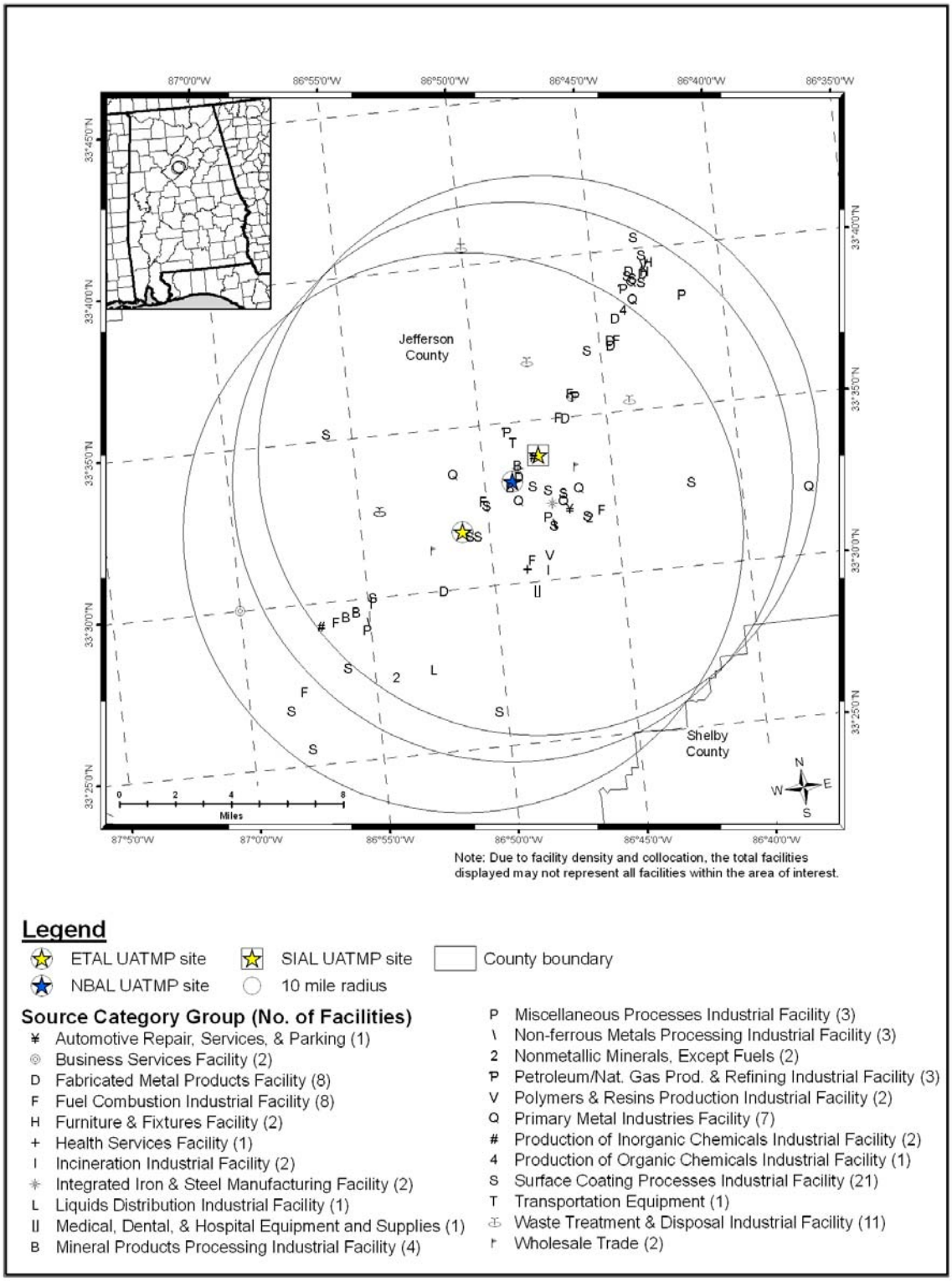


Figure 4-6. Facilities Located Within 10 Miles of PVAL

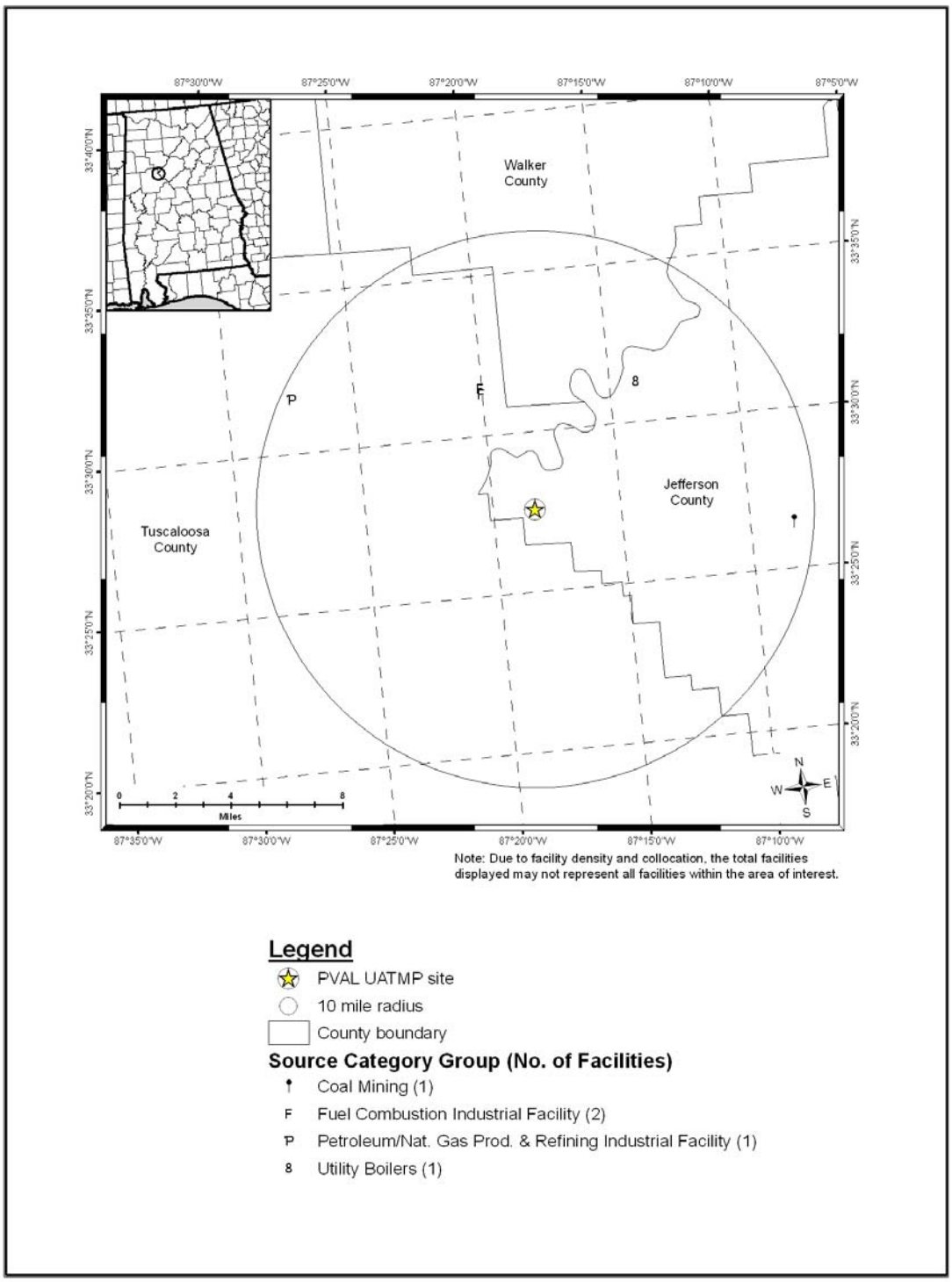


Figure 4-7. Acrolein Pollution Rose at ETAL

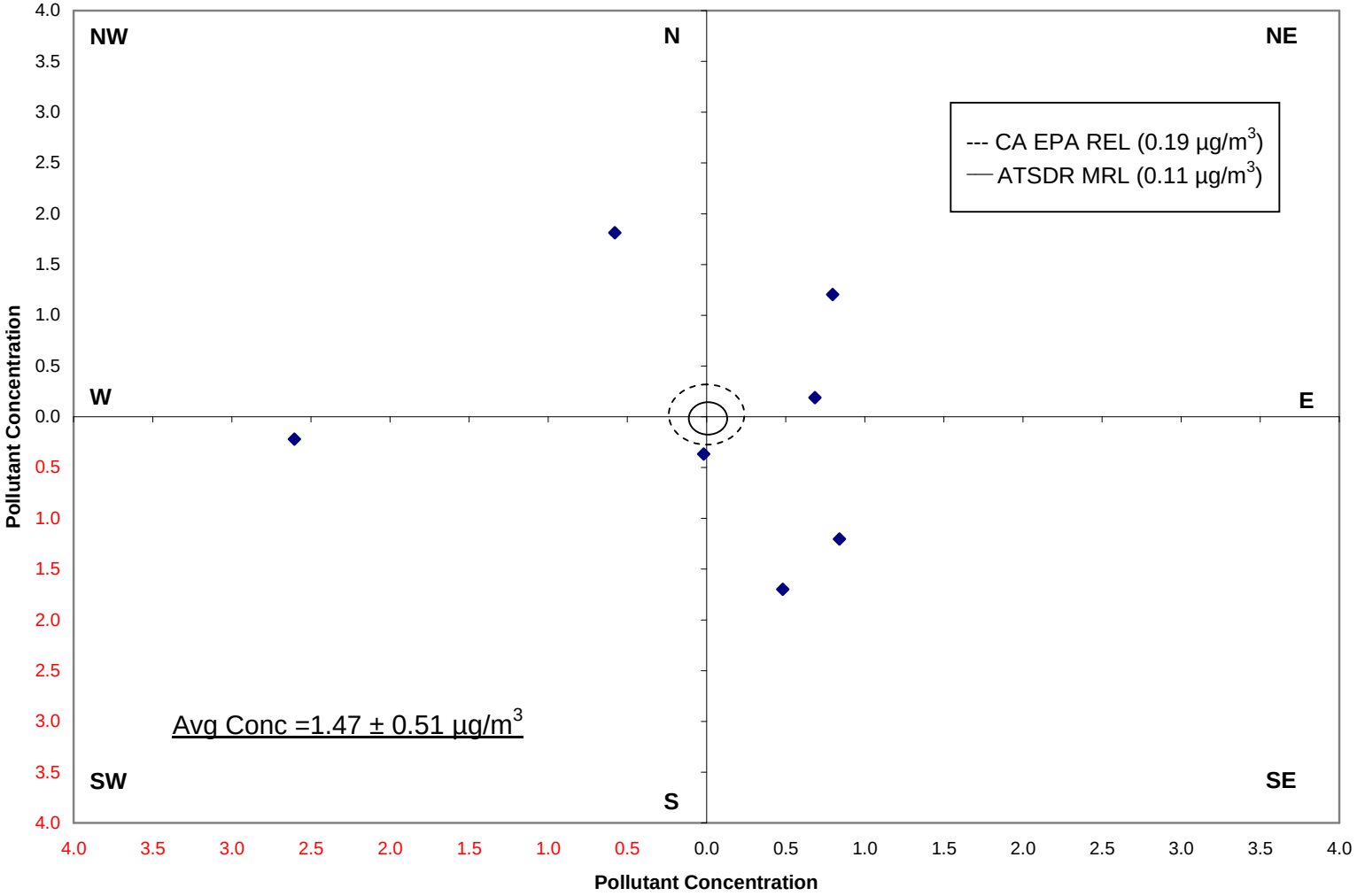


Figure 4-8. Acrolein Pollution Rose at NBAL

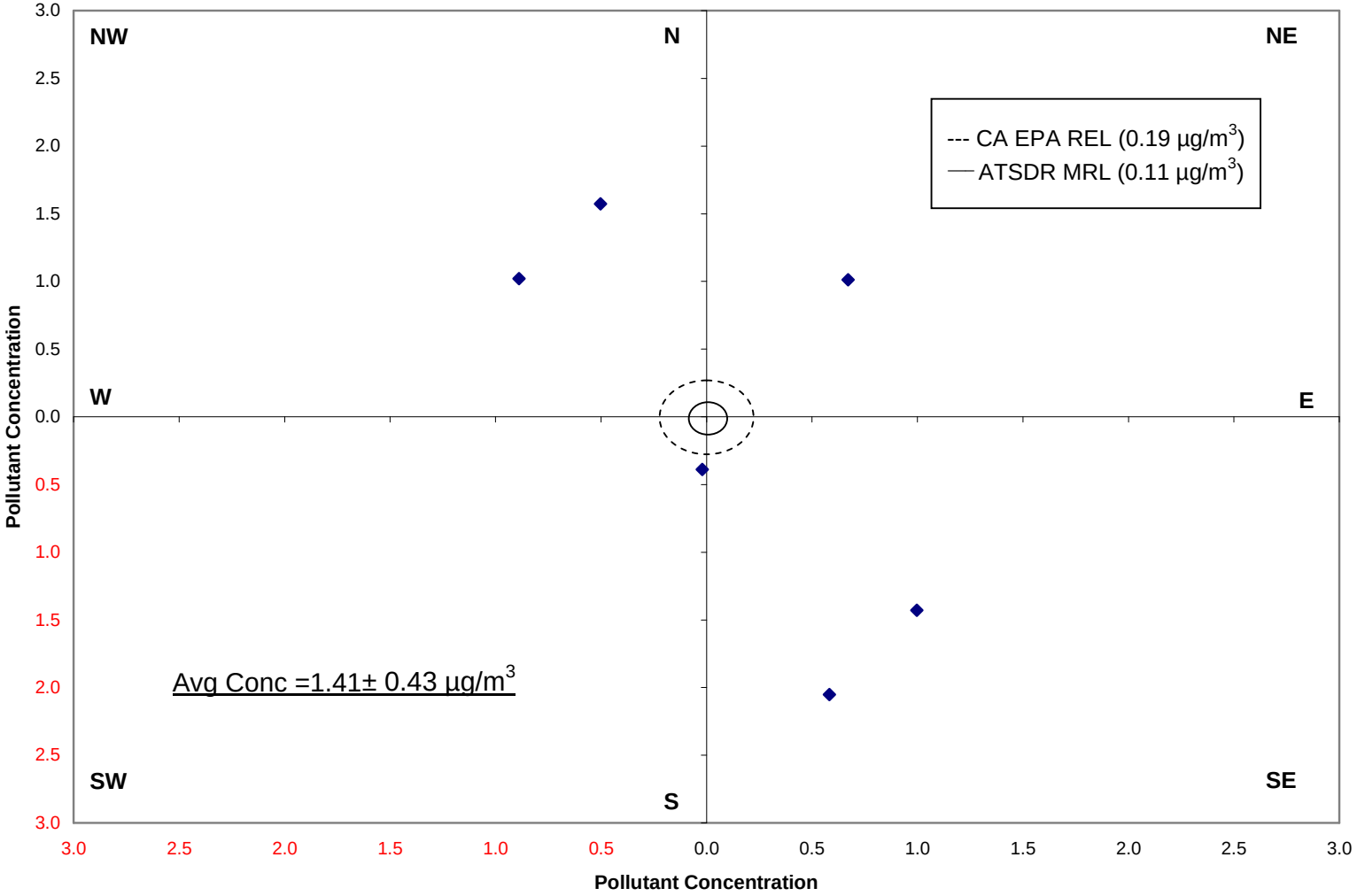


Figure 4-9. Acrolein Pollution Rose at PVAL

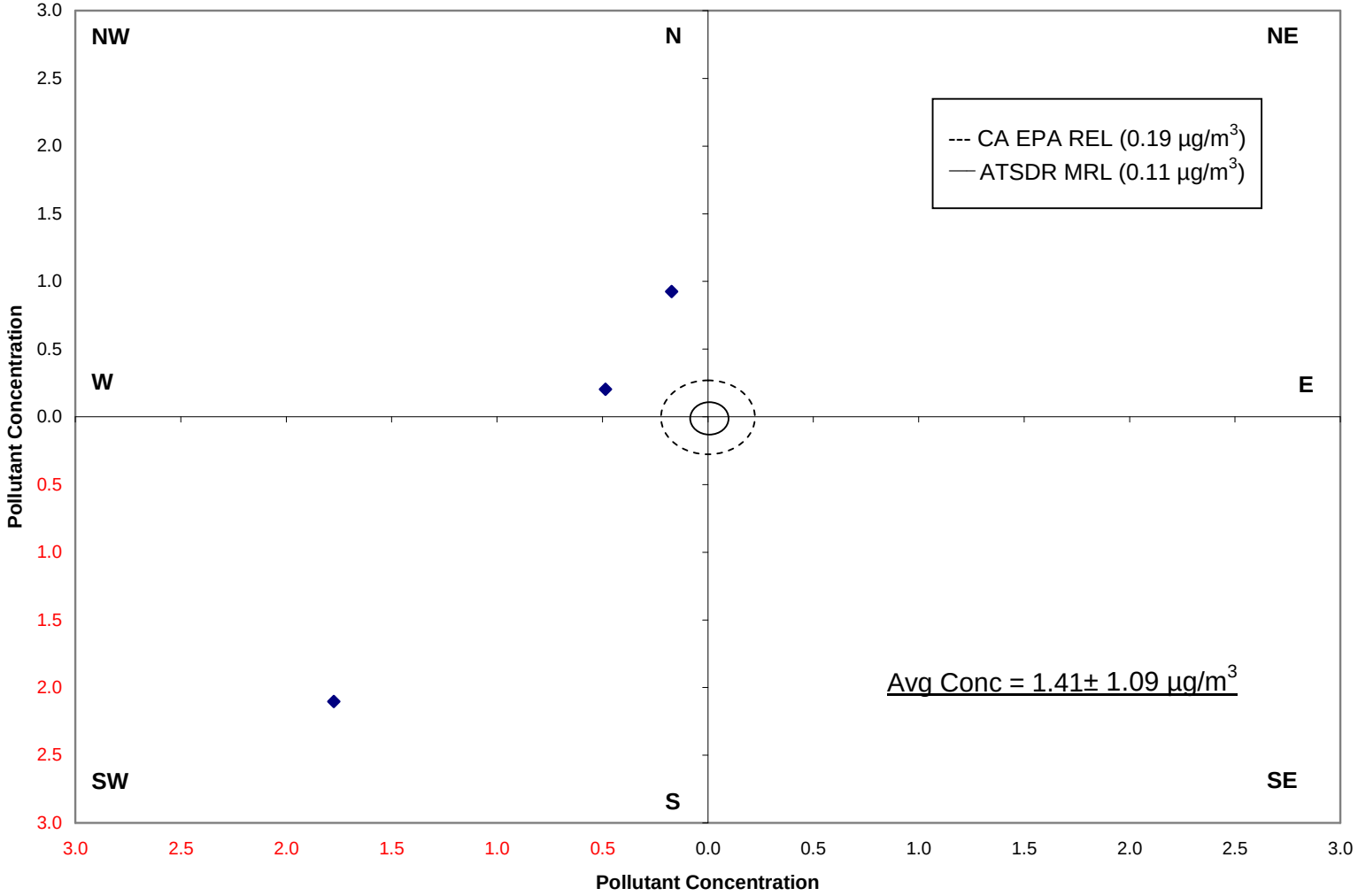


Figure 4-10. Acrolein Pollution Rose at SIAL

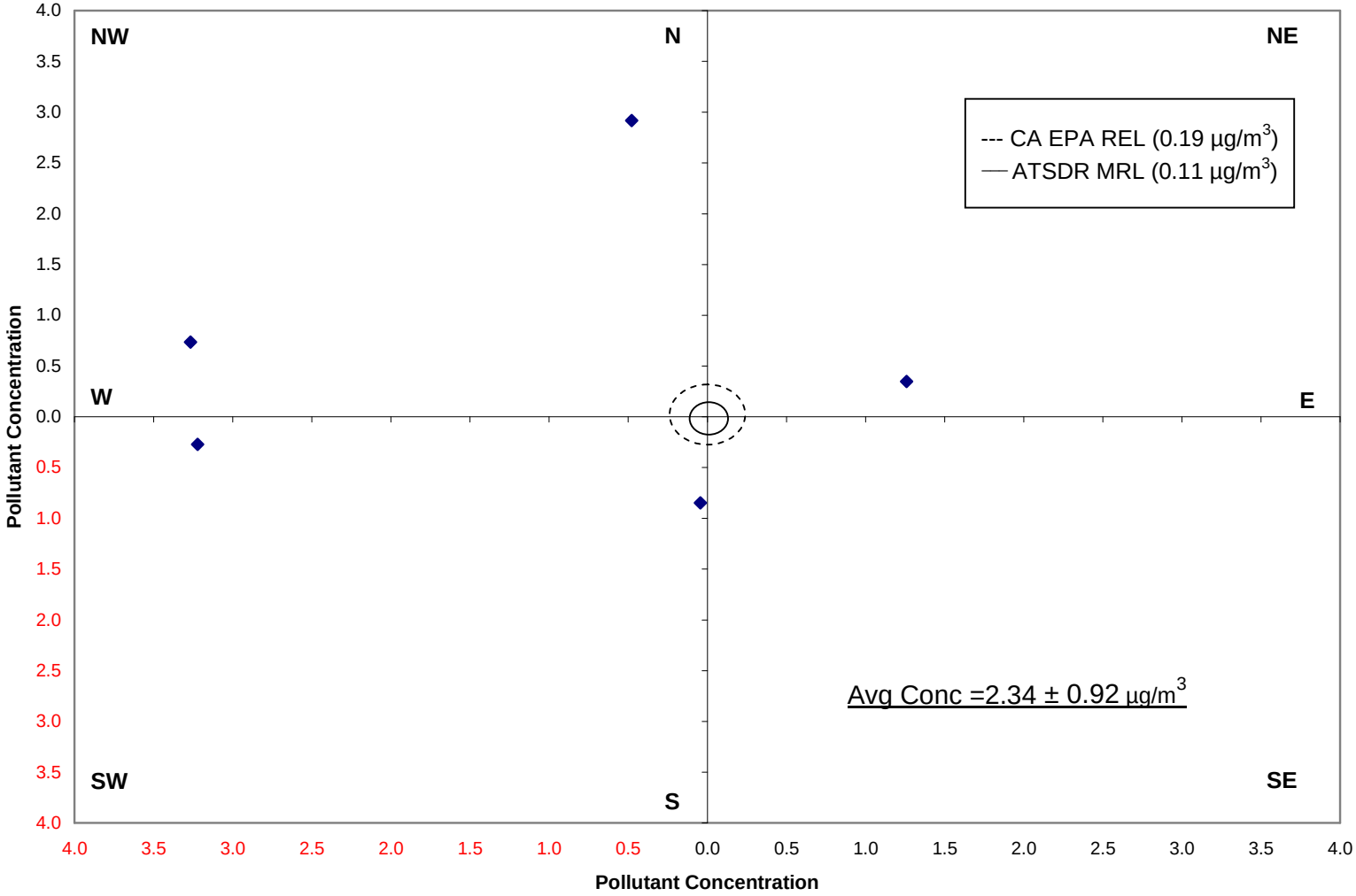


Figure 4-11. Composite Back Trajectory Map for ETAL

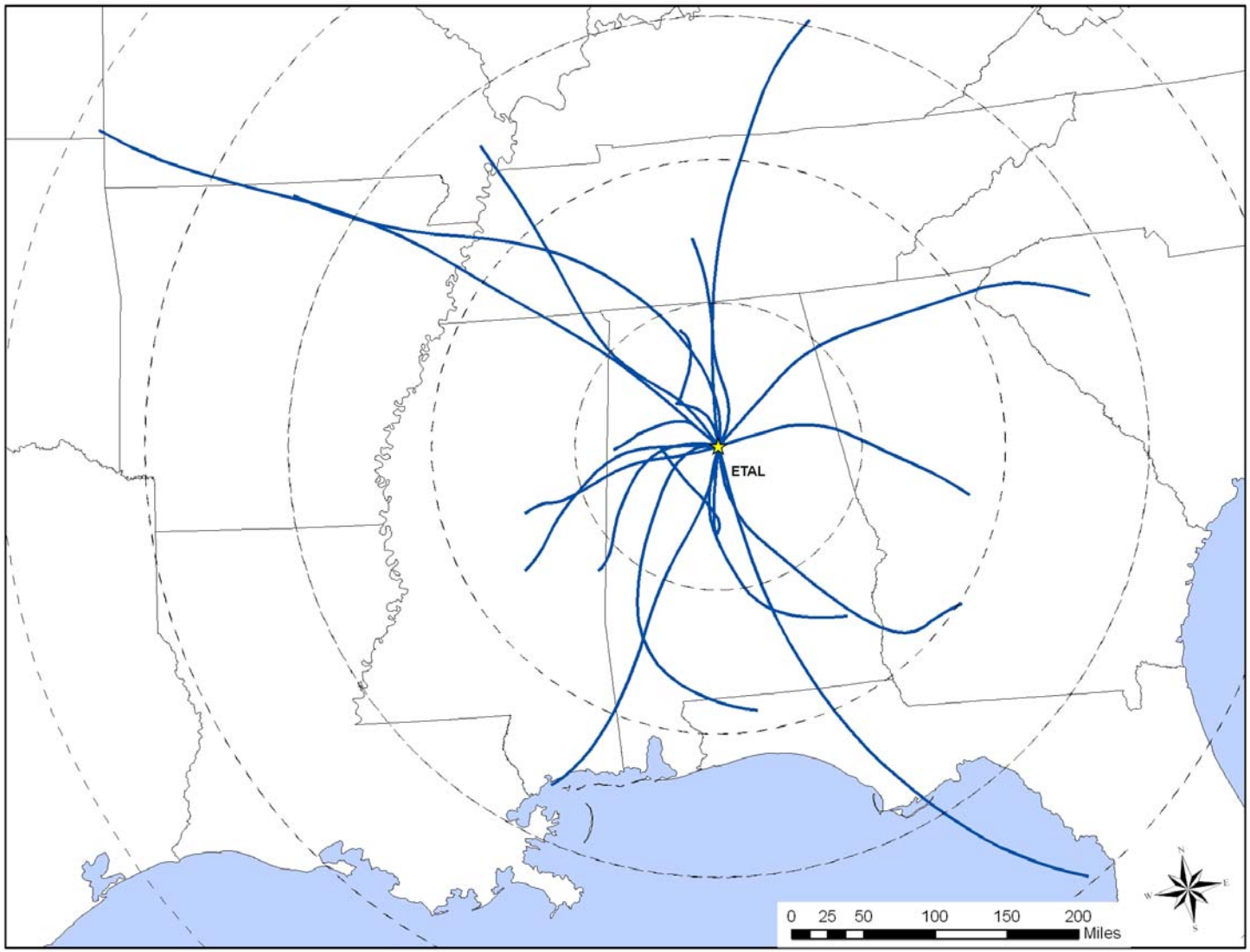


Figure 4-12. Composite Back Trajectory Map for NBAL

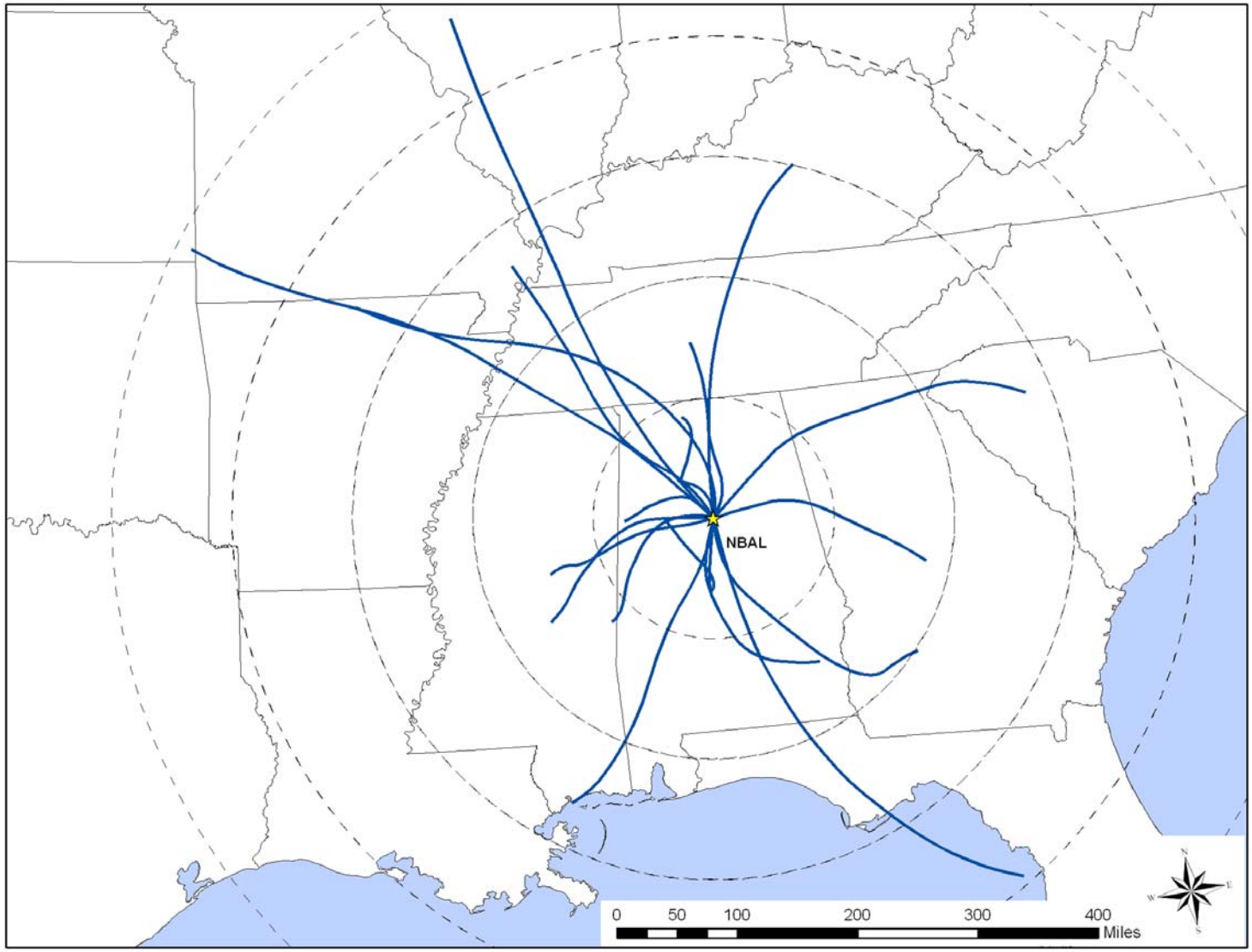


Figure 4-13. Composite Back Trajectory Map for PVAL

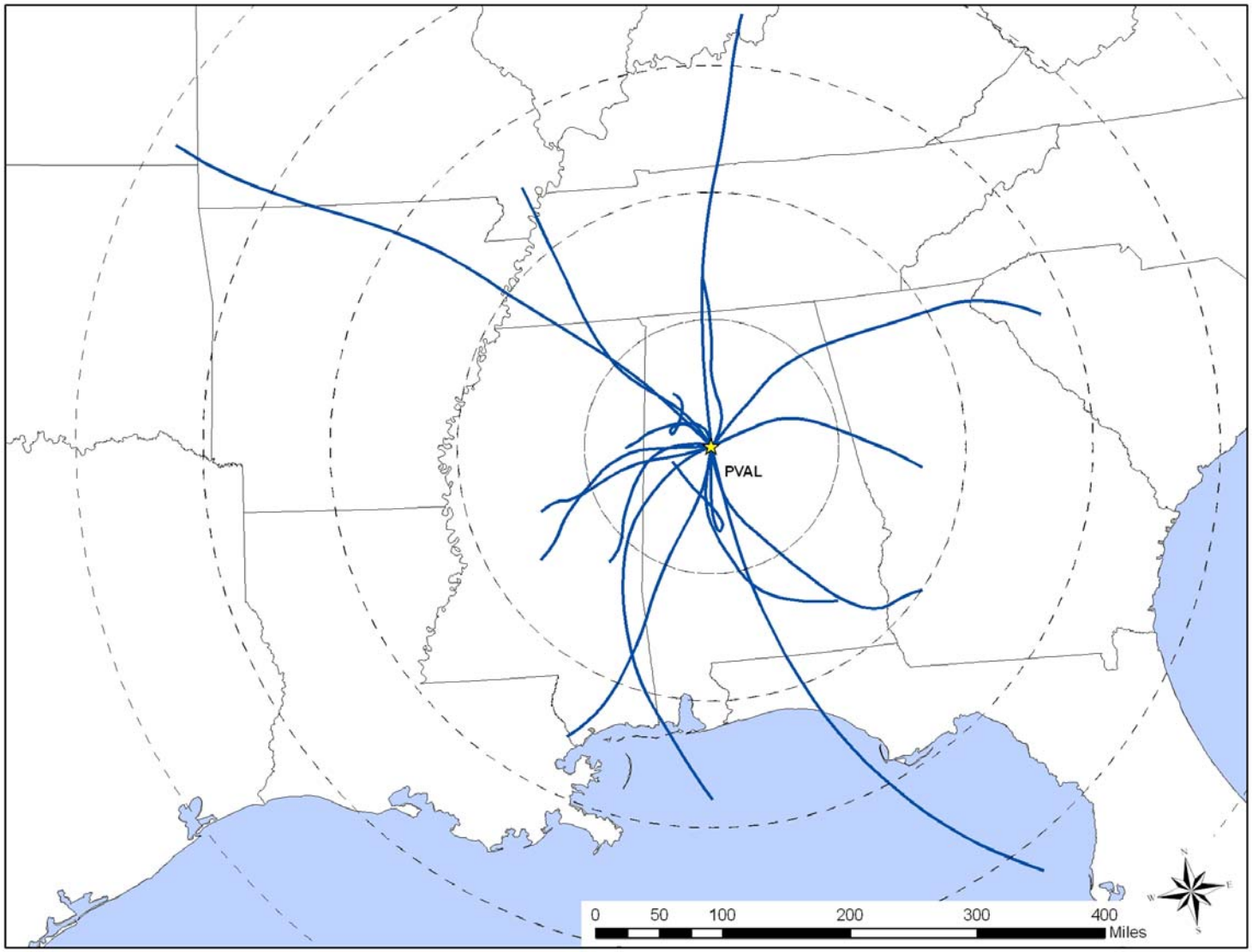


Figure 4-14. Composite Back Trajectory Map for SIAL

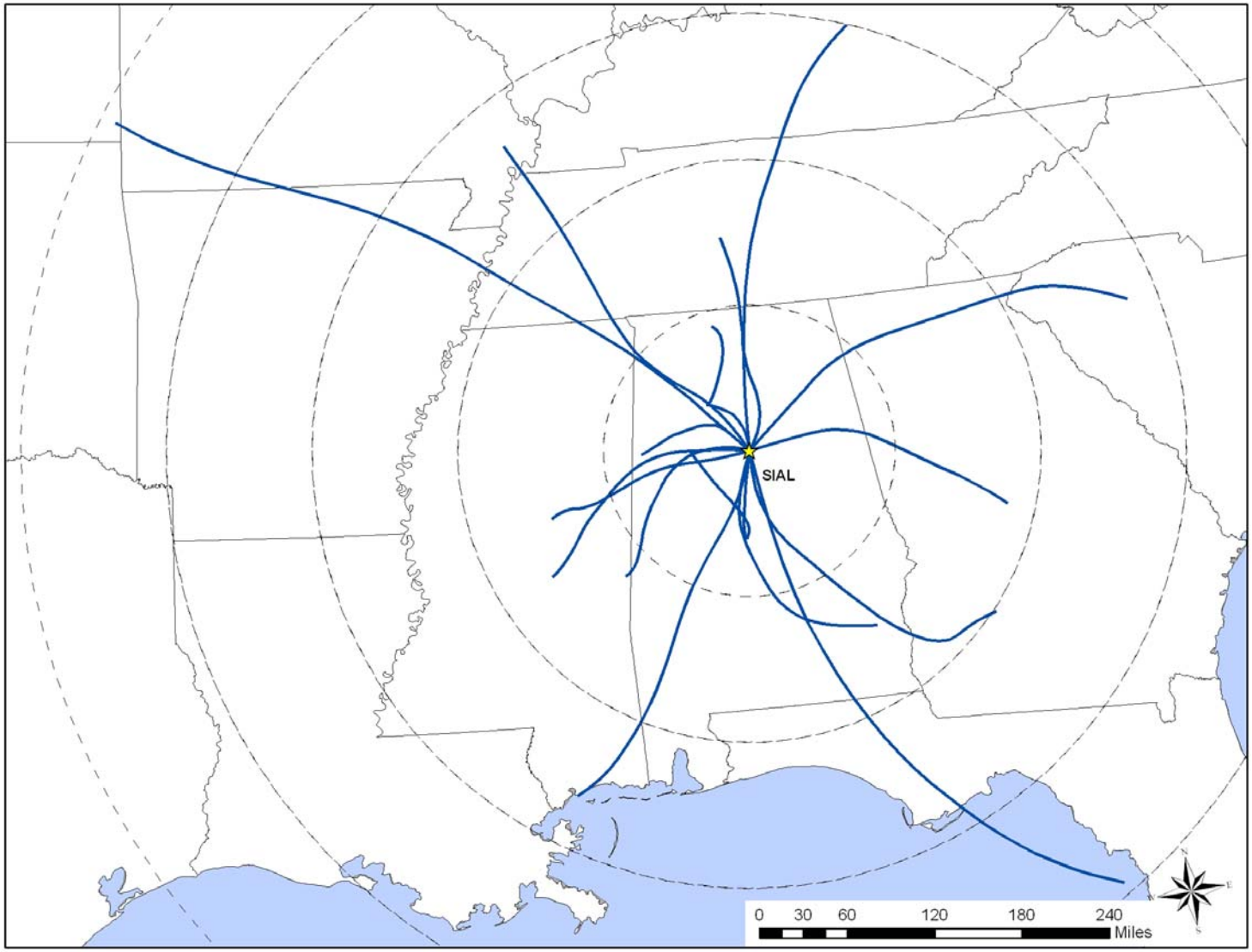


Figure 4-15. Wind Rose of Sample Days for the ETAL Monitoring Site

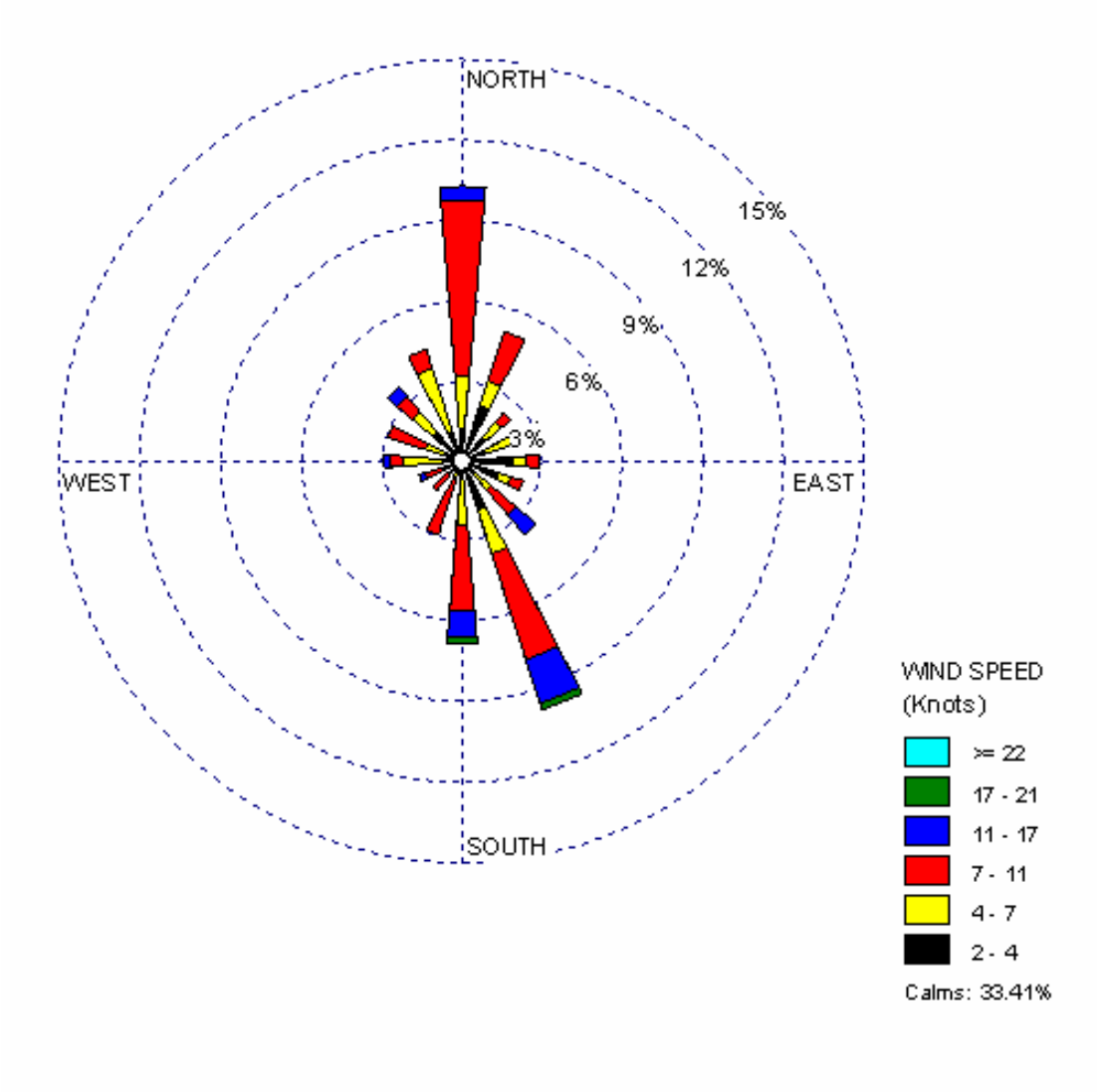


Figure 4-16. Wind Rose of Sample Days for the NBAL Monitoring Site

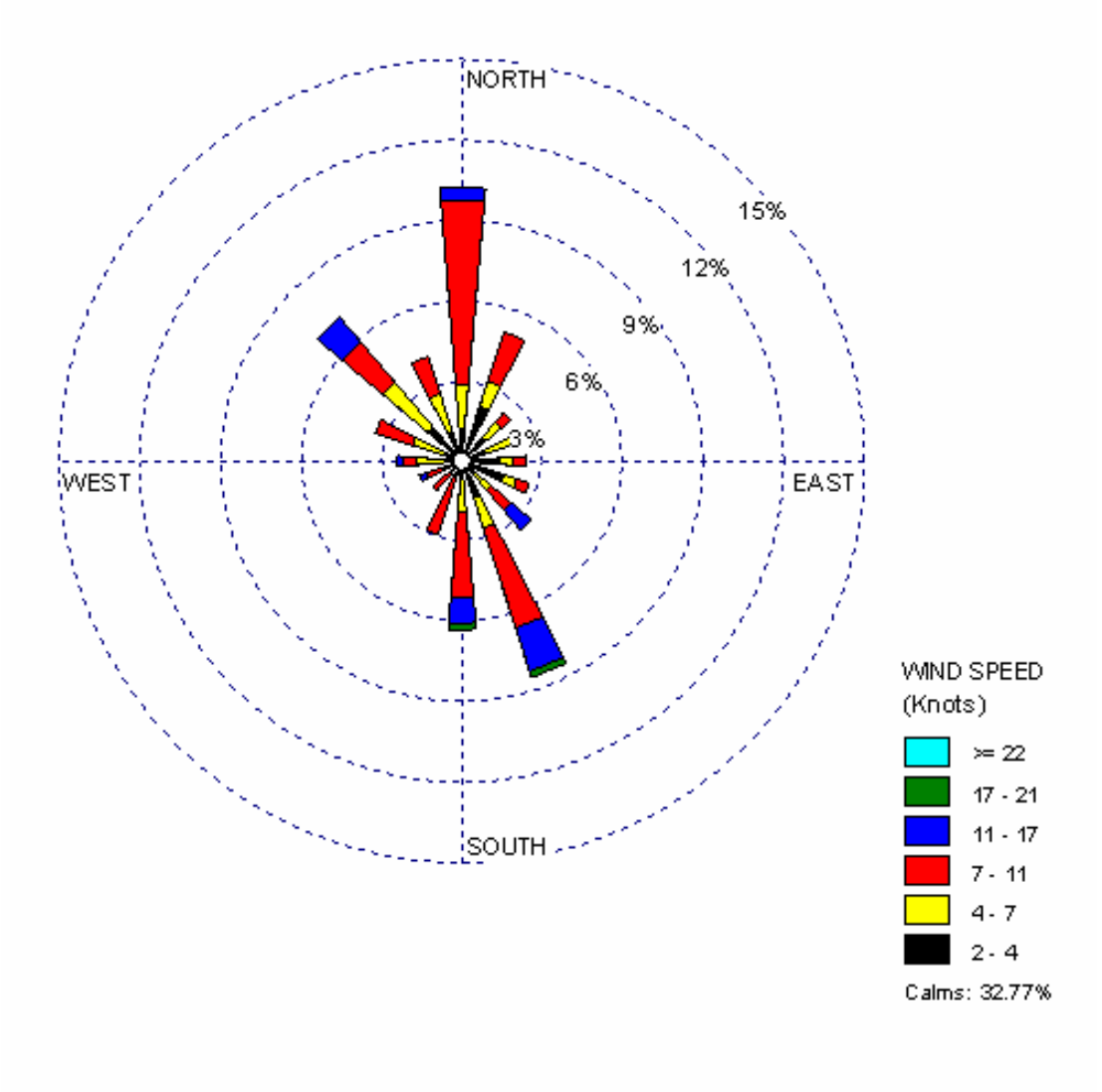


Figure 4-17. Wind Rose of Sample Days for the PVAL Monitoring Site

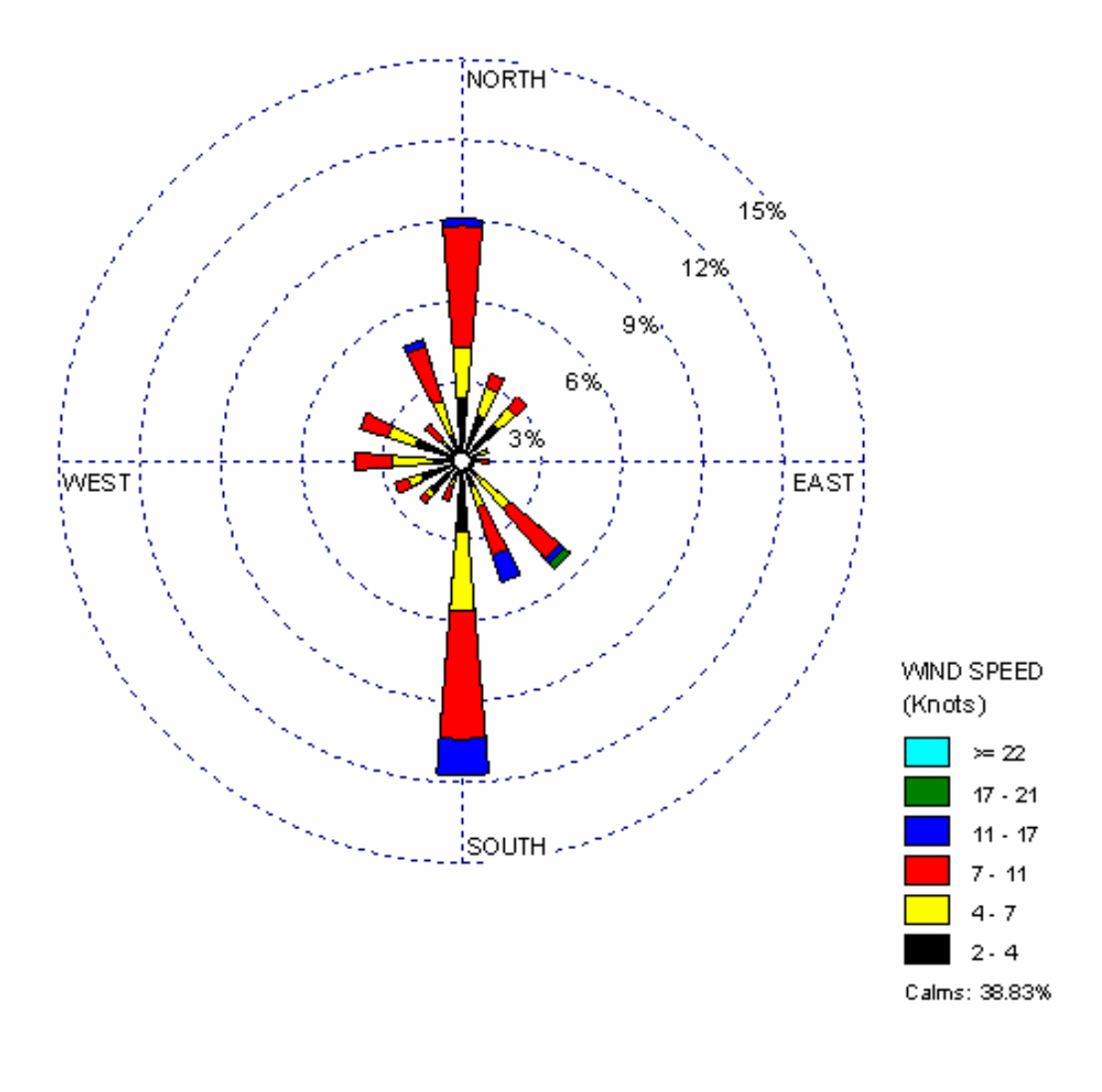


Figure 4-18. Wind Rose of Sample Days for the SIAL Monitoring Site

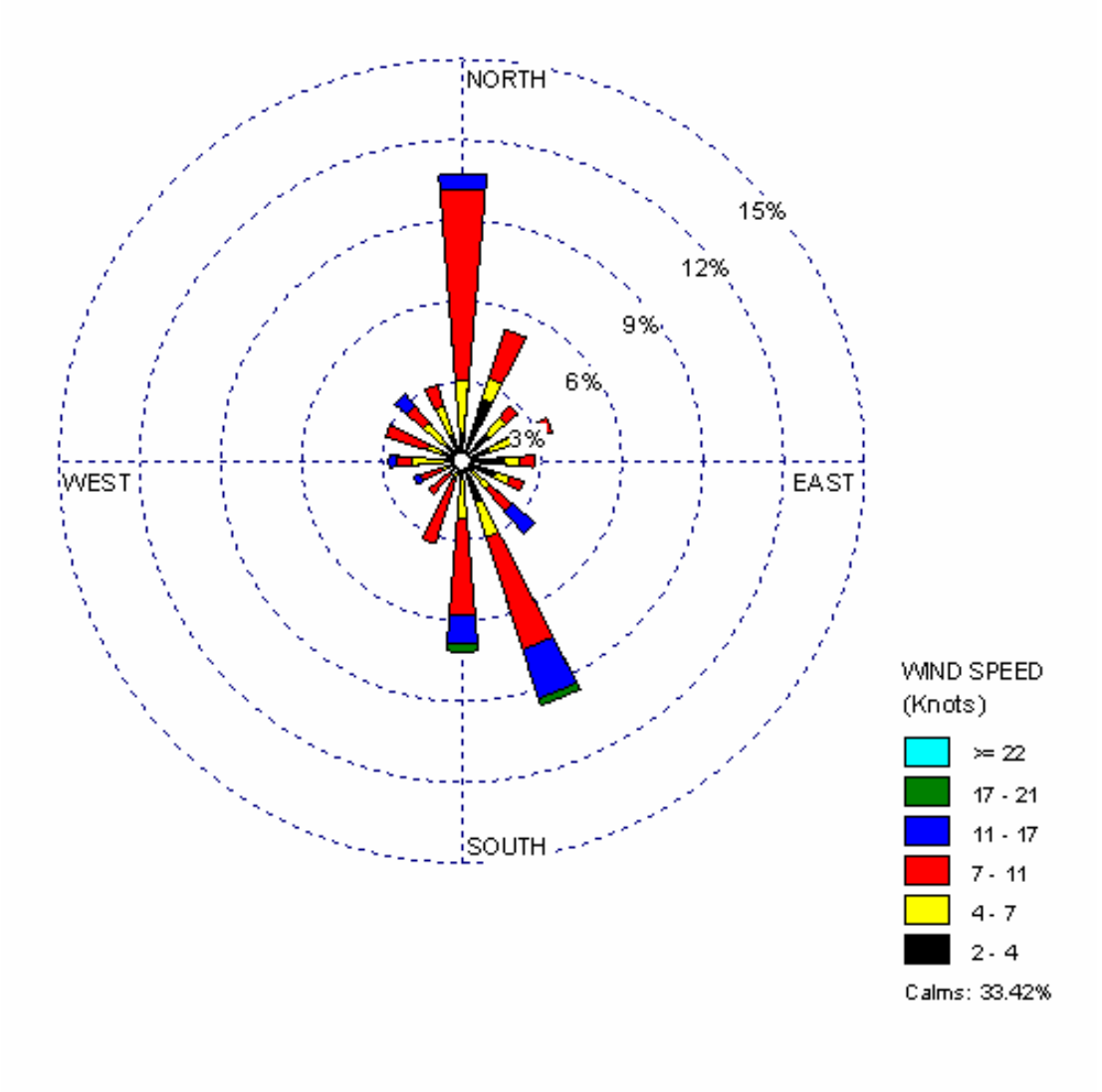


Table 4-1. Average Meteorological Parameters for Monitoring Sites in Alabama

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
ETAL	13876	All 2005	73.01 ± 1.50	63.18 ± 1.48	51.64 ± 1.71	56.98 ± 1.45	69.45 ± 1.29	1017.67 ± 0.57	-0.01 ± 0.36	-0.2 ± 0.37
		Sample Day	75.33 ± 6.45	64.75 ± 6.94	53.36 ± 8.25	58.58 ± 7.03	70.10 ± 5.87	1017.87 ± 2.35	-0.27 ± 0.99	0.25 ± 1.85
NBAL	13876	All 2005	73.01 ± 1.50	63.18 ± 1.48	51.64 ± 1.71	56.98 ± 1.45	69.45 ± 1.29	1017.67 ± 0.57	-0.01 ± 0.36	-0.2 ± 0.37
		Sample Day	74.89 ± 6.69	64.09 ± 7.16	52.44 ± 8.44	57.83 ± 7.23	69.39 ± 5.77	1017.82 ± 2.35	-0.03 ± 1.10	-0.03 ± 1.92
PVAL	93806	All 2005	75.24 ± 1.50	63.99 ± 1.48	53.34 ± 1.68	58.16 ± 1.45	71.69 ± 1.10	1017.32 ± 0.58	0.09 ± 0.26	-0.39 ± 0.33
		Sample Day	79.82 ± 5.90	67.42 ± 6.64	57.55 ± 7.78	61.77 ± 6.79	73.76 ± 4.01	1017.29 ± 2.43	-0.03 ± 0.83	0.35 ± 1.77
SIAL	13876	All 2005	73.01 ± 1.50	63.18 ± 1.48	51.64 ± 1.71	56.98 ± 1.45	69.45 ± 1.29	1017.67 ± 0.57	-0.01 ± 0.36	-0.20 ± 0.37
		Sample Day	77.63 ± 6.35	66.67 ± 7.08	55.06 ± 8.65	60.25 ± 7.29	69.89 ± 6.44	1017.65 ± 2.62	-0.31 ± 1.12	0.37 ± 2.07

Table 4-2. Comparison of Measured Concentrations and EPA Screening Values at the Alabama Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
East Thomas in Birmingham, Alabama - ETAL					
Arsenic (TSP)	16	16	100.0	8.3%	8.3%
Formaldehyde	16	16	100.0	8.3%	16.7%
Carbon Tetrachloride	16	16	100.0	8.3%	25.0%
Manganese (TSP)	16	16	100.0	8.3%	33.3%
Acetaldehyde	16	16	100.0	8.3%	41.7%
Benzene	16	16	100.0	8.3%	50.0%
Naphthalene	15	15	100.0	7.8%	57.8%
p-Dichlorobenzene	15	15	100.0	7.8%	65.6%
1,3-Butadiene	15	16	93.8	7.8%	73.4%
Tetrachloroethylene	12	14	85.7	6.3%	79.7%
Nickel (TSP)	9	16	56.3	4.7%	84.4%
Cadmium (TSP)	7	16	43.8	3.6%	88.0%
Xylenes	7	16	43.8	3.6%	91.7%
Hexachloro-1,3-butadiene	7	7	100.0	3.6%	95.3%
Acrolein	7	7	100.0	3.6%	99.0%
Benzo (a) pyrene	1	13	7.7	0.5%	99.5%
Acrylonitrile	1	1	100.0	0.5%	100.0%
Total	192	232	82.8		
North Birmingham, Alabama - NBAL					
Manganese (TSP)	16	16	100.0	6.9%	6.9%
Arsenic (PM_{10})	16	16	100.0	6.9%	13.9%
Arsenic (TSP)	16	16	100.0	6.9%	20.8%
Naphthalene	16	16	100.0	6.9%	27.7%
Manganese (PM_{10})	15	16	93.8	6.5%	34.2%
p-Dichlorobenzene	14	14	100.0	6.1%	40.3%
Formaldehyde	14	14	100.0	6.1%	46.3%
Benzene	14	14	100.0	6.1%	52.4%
Acetaldehyde	14	14	100.0	6.1%	58.4%
Carbon Tetrachloride	14	14	100.0	6.1%	64.5%
1,3-Butadiene	11	11	100.0	4.8%	69.3%
Cadmium (TSP)	10	16	62.5	4.3%	73.6%
Tetrachloroethylene	9	11	81.8	3.9%	77.5%
Xylenes	8	14	57.1	3.5%	81.0%
Cadmium (PM_{10})	8	16	50.0	3.5%	84.4%
Nickel (TSP)	6	16	37.5	2.6%	87.0%
Acrolein	6	6	100.0	2.6%	89.6%
Hexachloro-1,3-butadiene	5	5	100.0	2.2%	91.8%
Benzo (a) pyrene	4	12	33.3	1.7%	93.5%
Benzo (a) anthracene	3	16	18.8	1.3%	94.8%
Nickel (PM_{10})	2	16	12.5	0.9%	95.7%
Benzo (k) fluoranthene	2	15	13.3	0.9%	96.5%

Table 4-2. Comparison of Measured Concentrations and EPA Screening Values at the Alabama Monitoring Sites (Continued)

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Benzo (b) fluoranthene	2	13	15.4	0.9%	97.4%
Dibenz (a,h) anthracene	2	8	25.0	0.9%	98.3%
1,2-Dichloroethane	1	1	100.0	0.4%	98.7%
Acrylonitrile	1	1	100.0	0.4%	99.1%
Indeno(1,2,3-cd)pyrene	1	10	10.0	0.4%	99.6%
Trichloroethylene	1	11	9.1	0.4%	100.0%
Total	231	348	66.4		
Providence, Alabama – PVAL					
Arsenic (TSP)	16	16	100.0	14.5%	14.5%
Benzene	15	15	100.0	13.6%	28.2%
p-Dichlorobenzene	15	15	100.0	13.6%	41.8%
Acetaldehyde	15	15	100.0	13.6%	55.5%
Carbon Tetrachloride	15	15	100.0	13.6%	69.1%
Formaldehyde	14	15	93.3	12.7%	81.8%
Manganese (TSP)	10	16	62.5	9.1%	90.9%
Naphthalene	3	16	18.8	2.7%	93.6%
Acrolein	3	3	100.0	2.7%	96.4%
Hexachloro-1,3-butadiene	2	2	100.0	1.8%	98.2%
1,3-Butadiene	2	8	25.0	1.8%	100.0%
Total	110	136	80.9		
Sloss Industries in Birmingham, Alabama – SIAL					
Manganese (TSP)	16	16	100.0	9.4%	9.4%
Arsenic (TSP)	16	16	100.0	9.4%	18.8%
Formaldehyde	15	15	100.0	8.8%	27.6%
Acetaldehyde	15	15	100.0	8.8%	36.5%
Naphthalene	14	15	93.3	8.2%	44.7%
Carbon Tetrachloride	13	13	100.0	7.6%	52.4%
Benzene	13	13	100.0	7.6%	60.0%
1,3-Butadiene	12	12	100.0	7.1%	67.1%
p-Dichlorobenzene	12	13	92.3	7.1%	74.1%
Tetrachloroethylene	9	10	90.0	5.3%	79.4%
Nickel (TSP)	8	16	50.0	4.7%	84.1%
Benzo (a) pyrene	6	13	46.2	3.5%	87.6%
Acrolein	5	5	100.0	2.9%	90.6%
Xylenes	4	13	30.8	2.4%	92.9%
Hexachloro-1,3-butadiene	3	3	100.0	1.8%	94.7%
Dibenz (a,h) anthracene	3	8	37.5	1.8%	96.5%
Beryllium (TSP)	3	16	18.8	1.8%	98.2%
Cadmium (TSP)	2	16	12.5	1.2%	99.4%
Chloromethylbenzene	1	1	100.0	0.6%	100.0%
Total	170	229	74.2		

Table 4-3. Daily and Seasonal Averages for Pollutants of Interest at the Alabama Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
East Thomas in Birmingham, Alabama - ETAL												
1,3-Butadiene	16	16	0.24	0.07	NA	NA	NA	NA	NR	NR	0.25	0.13
Acetaldehyde	16	16	2.05	0.41	NA	NA	NA	NA	NR	NR	2.28	0.71
Acrolein	7	15	1.47	0.51	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (TSP)	16	16	0.0018	0.0004	NA	NA	NA	NA	NR	NR	0.0017	0.0007
Benzene	16	16	3.44	1.09	NA	NA	NA	NA	NR	NR	4.03	1.86
Cadmium (TSP)	16	16	0.0005	0.0002	NA	NA	NA	NA	NR	NR	0.0005	0.0002
Carbon Tetrachloride	16	16	0.70	0.05	NA	NA	NA	NA	NR	NR	0.68	0.07
Formaldehyde	16	16	4.56	0.91	NA	NA	NA	NA	NR	NR	4.42	1.21
Hexachloro-1,3-butadiene	7	16	0.17	0.04	NA	NA	NA	NA	NR	NR	NR	NR
Manganese (TSP)	16	16	0.06	0.02	NA	NA	NA	NA	NR	NR	0.06	0.02
Naphthalene	15	15	0.31	0.16	NA	NA	NA	NA	NR	NR	0.37	0.25
Nickel (TSP)	16	16	0.0025	0.0005	NA	NA	NA	NA	NR	NR	0.0029	0.0008
p-Dichlorobenzene	15	16	0.37	0.10	NA	NA	NA	NA	NR	NR	0.44	0.15
Tetrachloroethylene	14	16	0.43	0.15	NA	NA	NA	NA	NR	NR	0.45	0.23
Xylenes	16	16	8.94	2.76	NA	NA	NA	NA	NR	NR	10.33	4.51
North Birmingham, Alabama – NBAL												
1,3-Butadiene	11	14	0.18	0.06	NA	NA	NA	NA	NR	NR	NR	NR
Acetaldehyde	14	14	1.67	0.34	NA	NA	NA	NA	NR	NR	NR	NR
Acrolein	6	14	1.41	0.43	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (PM_{10})	16	16	0.0022	0.0006	NA	NA	NA	NA	NR	NR	0.002	0.001
Arsenic (TSP)	16	16	0.0023	0.0005	NA	NA	NA	NA	NR	NR	0.002	0.001
Benzene	14	14	3.48	1.52	NA	NA	NA	NA	NR	NR	NR	NR
Benzo (a) anthracene	16	16	0.0038	0.0030	NA	NA	NA	NA	NR	NR	0.006	0.005
Benzo (a) pyrene	12	16	0.0025	0.0024	NA	NA	NA	NA	NR	NR	NR	NR
Benzo (b) fluoranthene	13	16	0.003	0.003	NA	NA	NA	NA	NR	NR	0.004	0.004
Benzo (k) fluoranthene	15	16	0.003	0.002	NA	NA	NA	NA	NR	NR	0.004	0.007
Cadmium (TSP)	16	16	0.0010	0.0004	NA	NA	NA	NA	NR	NR	0.001	0.001

Table 4-3. Daily and Seasonal Averages for Pollutants of Interest at the Alabama Monitoring Sites (Continued)

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Cadmium (PM_{10})	16	16	0.0009	0.0004	NA	NA	NA	NA	NR	NR	0.001	0.001
Carbon Tetrachloride	14	14	0.69	0.04	NA	NA	NA	NA	NR	NR	NR	NR
Dibenzo(a,h) anthracene	8	16	0.0009	0.0008	NA	NA	NA	NA	NR	NR	NR	NR
Formaldehyde	14	14	3.86	1.10	NA	NA	NA	NA	NR	NR	NR	NR
Hexachloro-1,3-butadiene	5	14	0.19	0.04	NA	NA	NA	NA	NR	NR	NR	NR
Manganese (TSP)	16	16	0.07	0.03	NA	NA	NA	NA	NR	NR	0.096	0.049
Manganese (PM_{10})	16	16	0.04	0.01	NA	NA	NA	NA	NR	NR	0.047	0.021
Naphthalene	16	16	0.29	0.10	NA	NA	NA	NA	NR	NR	0.304	0.161
Nickel (TSP)	16	16	0.0022	0.0006	NA	NA	NA	NA	NR	NR	0.003	0.001
Nickel (PM_{10})	16	16	0.0015	0.0003	NA	NA	NA	NA	NR	NR	0.002	0.000
p-Dichlorobenzene	14	14	0.43	0.08	NA	NA	NA	NA	NR	NR	NR	NR
Tetrachloroethylene	11	14	0.32	0.08	NA	NA	NA	NA	NR	NR	NR	NR
Xylenes	14	14	11.86	4.26	NA	NA	NA	NA	NR	NR	NR	NR
Providence, Alabama – PVAL												
Acetaldehyde	15	15	1.17	0.19	NA	NA	NA	NA	NR	NR	1.29	0.26
Acrolein	3	14	1.41	1.09	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (TSP)	16	16	0.0010	0.0002	NA	NA	NA	NA	NR	NR	0.0009	0.0002
Benzene	15	15	0.68	0.10	NA	NA	NA	NA	NR	NR	0.61	0.12
Carbon Tetrachloride	15	15	0.68	0.05	NA	NA	NA	NA	NR	NR	0.71	0.08
Formaldehyde	15	15	3.28	0.96	NA	NA	NA	NA	NR	NR	3.14	1.07
Manganese (TSP)	16	16	0.0060	0.0013	NA	NA	NA	NA	NR	NR	0.0072	0.0021
Naphthalene	16	16	0.02	0.00	NA	NA	NA	NA	NR	NR	0.0131	0.0045
p-Dichlorobenzene	15	15	0.38	0.11	NA	NA	NA	NA	NR	NR	0.27	0.04
Sloss Industries in Birmingham, Alabama – SIAL												
1,3-Butadiene	12	13	0.25	0.06	NA	NA	NA	NA	NR	NR	NR	NR
Acetaldehyde	15	15	1.48	0.21	NA	NA	NA	NA	NR	NR	1.61	0.33
Acrolein	5	13	2.34	0.92	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (TSP)	16	16	0.005	0.004	NA	NA	NA	NA	NR	NR	0.007	0.007

Table 4-3. Daily and Seasonal Averages for Pollutants of Interest at the Alabama Monitoring Sites (Continued)

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Benzene	13	13	6.50	2.15	NA	NA	NA	NA	NR	NR	NR	NR
Benzo (a) pyrene	13	15	0.001	0.001	NA	NA	NA	NA	NR	NR	NR	NR
Beryllium (TSP)	16	16	0.0003	0.0002	NA	NA	NA	NA	NR	NR	0.0004	0.0003
Carbon Tetrachloride	13	13	0.67	0.06	NA	NA	NA	NA	NR	NR	NR	NR
Dibenz (a,h) anthracene	8	15	0.0006	0.0002	NA	NA	NA	NA	NR	NR	NR	NR
Formaldehyde	15	15	3.29	0.65	NA	NA	NA	NA	NR	NR	3.09	0.64
Hexachloro-1,3-butadiene	3	13	0.14	0.06	NA	NA	NA	NA	NR	NR	NR	NR
Manganese (TSP)	16	16	0.119	0.066	NA	NA	NA	NA	NR	NR	0.15	0.13
Naphthalene	15	15	0.38	0.14	NA	NA	NA	NA	NR	NR	0.44	0.23
Nickel (TSP)	16	16	0.002	0.001	NA	NA	NA	NA	NR	NR	0.003	0.001
p-Dichlorobenzene	13	13	0.57	0.21	NA	NA	NA	NA	NR	NR	NR	NR
Tetrachloroethylene	10	13	0.43	0.14	NA	NA	NA	NA	NR	NR	NR	NR
Xylenes	13	13	8.27	2.61	NA	NA	NA	NA	NR	NR	NR	NR

NA = Not Available due to short sampling duration.
NR = Not Reportable due to low number of detects.

Table 4-4. Non-Chronic Risk Summary at the Alabama Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
ETAL	TO-15	Acrolein	1.47 ± 0.51	0.11	7	0.19	7	0.09	NA	NA	NR	NR
NBAL	TO-15	Acrolein	1.41 ± 0.43	0.11	6	0.19	6	0.09	NA	NA	NR	NR
PVAL	TO-15	Acrolein	1.41 ± 1.09	0.11	3	0.19	3	0.09	NA	NA	NR	NR
SIAL	TO-15	Acrolein	2.34 ± 0.92	0.11	5	0.19	5	0.09	NA	NA	NR	NR

NA = Not Available due to short sampling duration.
NR = Not Reportable due to low number of detects.

Table 4-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Alabama Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
East Thomas in Birmingham, Alabama – ETAL									
1,3-Butadiene	16	0.07	-0.05	-0.08	-0.09	-0.08	0.41	-0.05	0.15
Acetaldehyde	16	0.27	0.11	0.00	0.03	-0.24	0.28	-0.21	0.18
Acrolein	7	0.16	0.14	0.14	0.14	0.13	0.39	-0.18	0.32
Arsenic (TSP)	16	0.30	0.18	0.20	0.17	0.18	0.11	-0.40	0.26
Benzene	16	0.08	-0.07	-0.12	-0.12	-0.14	0.16	-0.14	0.37
Cadmium (TSP)	16	0.18	0.04	0.06	0.04	0.10	0.10	-0.23	0.34
Carbon Tetrachloride	16	-0.19	-0.06	-0.03	-0.03	0.01	0.19	0.43	-0.06
Formaldehyde	16	0.68	0.58	0.47	0.51	0.03	0.24	-0.10	0.03
Hexachloro-1,3-butadiene	7	-0.71	-0.77	-0.95	-0.88	-0.70	-0.54	0.58	0.89
Manganese (TSP)	16	0.09	-0.03	0.03	-0.01	0.17	0.16	-0.27	0.22
Naphthalene	15	-0.04	-0.17	-0.26	-0.23	-0.31	0.00	0.10	0.53
Nickel (TSP)	16	0.03	0.03	0.15	0.09	0.42	0.09	-0.19	-0.30
p-Dichlorobenzene	15	0.56	0.42	0.31	0.34	-0.02	0.14	-0.02	-0.02
Tetrachloroethylene	14	0.35	0.21	0.15	0.16	-0.04	-0.04	0.01	0.17
Xylenes	16	0.18	0.03	0.00	-0.01	-0.05	0.23	-0.28	0.18
North Birmingham, Alabama – NBAL									
1,3-Butadiene	11	0.22	0.10	0.14	0.11	0.24	-0.36	0.27	0.63
Acetaldehyde	14	0.55	0.44	0.33	0.37	-0.01	0.05	-0.22	0.00
Acrolein	6	0.30	0.23	0.01	0.16	-0.34	-0.23	0.10	0.63
Arsenic (PM_{10})	16	0.29	0.14	0.14	0.12	0.09	0.06	-0.16	0.22
Arsenic (TSP)	16	0.31	0.18	0.20	0.17	0.19	-0.07	-0.13	0.13
Benzene	14	0.11	-0.02	-0.06	-0.06	-0.09	-0.09	-0.01	0.40
Benzo (a) anthracene	16	0.09	0.00	-0.08	-0.06	-0.19	-0.03	-0.02	0.20
Benzo (a) pyrene	12	0.16	0.12	0.09	0.10	0.01	-0.12	0.04	0.06
Benzo (b) fluoranthene	13	0.08	0.01	-0.02	-0.02	-0.06	-0.18	-0.03	0.18
Benzo (k) fluoranthene	15	0.10	0.02	-0.04	-0.03	-0.13	-0.08	-0.06	0.23
Cadmium (PM_{10})	16	0.57	0.44	0.38	0.39	0.10	0.04	-0.14	-0.07

Table 4-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Alabama Monitoring Sites (Continued)

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Cadmium (TSP)	16	0.52	0.40	0.33	0.35	0.07	-0.06	-0.10	-0.07
Carbon Tetrachloride	14	-0.11	-0.10	-0.08	-0.09	-0.03	-0.48	0.46	0.16
Dibenz (a,h) anthracene	8	0.33	0.30	0.28	0.28	0.15	-0.40	0.12	0.13
Formaldehyde	14	0.84	0.79	0.74	0.76	0.37	-0.03	-0.07	-0.21
Hexachloro-1,3-butadiene	5	0.34	0.07	-0.26	-0.04	-0.42	-0.89	0.63	0.79
Manganese (PM_{10})	16	0.29	0.18	0.06	0.11	-0.23	-0.32	0.37	0.06
Manganese (TSP)	16	0.20	0.14	0.03	0.07	-0.23	-0.59	0.66	0.09
Naphthalene	16	0.08	-0.07	-0.10	-0.10	-0.11	0.11	-0.07	0.27
Nickel (PM_{10})	16	0.28	0.26	0.32	0.29	0.37	-0.05	-0.09	-0.42
Nickel (TSP)	16	0.04	0.05	0.14	0.10	0.33	-0.07	-0.17	-0.41
p-Dichlorobenzene	14	0.51	0.39	0.32	0.34	0.06	0.04	-0.25	0.10
Tetrachloroethylene	11	0.33	0.24	0.33	0.28	0.47	-0.46	0.35	0.10
Xylenes	14	0.22	0.11	0.15	0.12	0.24	-0.14	-0.25	0.32
Providence, Alabama – PVAL									
Acetaldehyde	15	0.13	-0.10	-0.20	-0.17	-0.45	0.36	-0.19	0.15
Acrolein	3	0.25	0.04	0.03	0.03	0.21	-0.63	0.67	-0.59
Arsenic (TSP)	16	0.01	-0.01	-0.01	-0.01	-0.03	0.09	-0.26	0.39
Benzene	15	-0.56	-0.66	-0.64	-0.65	-0.42	0.24	-0.04	0.78
Carbon Tetrachloride	15	-0.37	-0.30	-0.28	-0.28	-0.17	-0.32	0.15	-0.11
Formaldehyde	15	0.78	0.64	0.55	0.59	0.15	0.13	0.04	-0.15
Manganese (TSP)	16	0.24	0.07	-0.02	0.00	-0.26	0.09	-0.20	0.00
Naphthalene	16	-0.27	-0.23	-0.19	-0.21	-0.05	-0.09	0.06	0.31
p-Dichlorobenzene	15	0.49	0.58	0.61	0.61	0.53	-0.01	0.28	-0.25
Sloss Industries in Birmingham, Alabama – SIAL									
1,3-Butadiene	12	0.01	-0.12	-0.12	-0.14	-0.04	0.48	-0.48	0.33
Acetaldehyde	15	0.28	0.15	0.02	0.06	-0.28	0.38	-0.52	-0.08
Acrolein	5	0.74	0.62	0.52	0.55	0.11	0.61	-0.57	0.60
Arsenic (TSP)	16	-0.20	-0.14	0.00	-0.06	0.37	0.02	-0.63	-0.24

Table 4-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Alabama Monitoring Sites (Continued)

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Benzene	13	0.49	0.35	0.23	0.27	-0.10	0.30	-0.48	0.10
Benzo (a) pyrene	13	0.63	0.55	0.40	0.46	-0.09	0.30	-0.32	-0.24
Beryllium (TSP)	16	0.05	0.07	0.19	0.13	0.42	0.04	-0.66	-0.29
Carbon Tetrachloride	13	-0.17	-0.08	-0.07	-0.06	-0.04	-0.05	0.52	-0.47
Dibenz (a,h) anthracene	8	0.78	0.81	0.75	0.78	0.47	0.09	-0.62	-0.18
Formaldehyde	15	0.77	0.71	0.68	0.69	0.40	0.23	-0.26	-0.36
Hexachloro-1,3-butadiene	3	NA							
Manganese (TSP)	16	-0.05	-0.01	0.13	0.07	0.46	0.08	-0.59	-0.30
Naphthalene	15	0.14	-0.04	-0.17	-0.13	-0.38	0.31	-0.17	0.33
Nickel (TSP)	16	-0.04	0.02	0.16	0.10	0.47	-0.01	-0.40	-0.32
p-Dichlorobenzene	13	0.27	0.12	0.06	0.07	-0.08	0.19	-0.28	0.17
Tetrachloroethylene	10	0.12	0.05	0.10	0.07	0.21	-0.43	0.17	0.32
Xylenes	13	0.34	0.19	0.12	0.13	-0.05	0.17	-0.34	0.17

Table 4-6. Motor Vehicle Information for the Alabama Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
ETAL	657,229	544,407	0.83	399,149	330,630	30,000
NBAL	657,229	544,407	0.83	394,649	326,902	2,000
PVAL	657,229	544,407	0.83	28,665	23,744	NA
SIAL	657,229	544,407	0.83	394,649	326,902	2,700

NA = Not available.

Table 4-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Alabama

Pollutant	2005 UATMP Annual Average ($\mu g/m^3$)	1999 NATA Modeled Concentration ($\mu g/m^3$)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
East Thomas in Birmingham, Alabama – ETAL, Census Tract 01073001200				
1,3-Butadiene	NA	0.16	4.81	0.08
Acetaldehyde	NA	2.04	4.48	0.23
Acrolein	NA	0.14	--	6.81
Acrylonitrile	NA	<0.01	0.13	<0.01
Arsenic (TSP)	NA	0.03	0.14	<0.01
Benzene	NA	2.06	16.03	0.07
Benzo (a) pyrene	NA	<0.01	0.07	--
Cadmium (TSP)	NA	0.18	0.32	0.01
Carbon Tetrachloride	NA	0.22	3.24	0.01
Formaldehyde	NA	1.81	0.01	0.18
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (TSP)	NA	5.94	--	0.12
Naphthalene	NA	0.09	2.98	0.03
Nickel (TSP)	NA	0.42	0.07	0.01
***p*-Dichlorobenzene**	NA	0.03	0.37	<0.01
Tetrachloroethylene	NA	0.17	1.03	<0.01
Xylenes	NA	3.32	--	0.03
North Birmingham, Alabama – NBAL, Census Tract 01073000800				
1,2-Dichloroethane	NA	0.03	0.83	<0.01
1,3-Butadiene	NA	0.21	6.17	0.10
Acetaldehyde	NA	2.22	4.89	0.25
Acrolein	NA	0.15	--	7.71
Acrylonitrile	NA	<0.01	0.16	<0.01
Arsenic (TSP)	NA	0.03	0.11	<0.01
Arsenic (PM_{10})	NA	0.03	0.11	<0.01
Benzene	NA	2.53	19.77	0.08
Benzo (a) anthracene	NA	<0.01	0.05	--
Benzo (a) pyrene	NA	<0.01	0.08	--
Benzo (b) fluoranthene	NA	<0.01	0.05	--
Benzo (k) fluoranthene	NA	<0.01	0.05	--
Cadmium (TSP)	NA	0.90	1.61	0.04
Cadmium (PM_{10})	NA	0.90	1.61	0.04
Carbon Tetrachloride	NA	0.21	3.19	<0.01
Dibenz (a,h) anthracene	NA	<0.01	0.08	--
Formaldehyde	NA	1.95	0.01	0.20
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Indeno(1,2,3-cd)pyrene	NA	<0.01	0.05	--
Manganese (PM_{10})	NA	10.74	--	0.21
Manganese (TSP)	NA	10.74	--	0.21

Table 4-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Alabama (Continued)

Pollutant	2005 UATMP Annual Average ($\mu g/m^3$)	1999 NATA Modeled Concentration ($\mu g/m^3$)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Naphthalene	NA	0.11	3.85	0.04
Nickel (PM_{10})	NA	0.75	0.12	0.01
Nickel (TSP)	NA	0.75	0.12	0.01
***p*-Dichlorobenzene**	NA	0.03	0.38	<0.01
Tetrachloroethylene	NA	0.18	1.04	<0.01
Trichloroethylene	NA	0.12	0.25	<0.01
Xylenes	NA	6.31	--	0.06
Providence, Alabama – PVAL, Census Tract 01073014102				
1,3-Butadiene	NA	0.07	2.18	0.04
Acetaldehyde	NA	1.27	2.79	0.14
Acrolein	NA	0.07	--	3.40
Arsenic (TSP)	NA	0.04	0.18	<0.01
Benzene	NA	0.96	7.47	0.03
Carbon Tetrachloride	NA	0.21	3.17	0.01
Formaldehyde	NA	1.31	0.01	0.13
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (TSP)	NA	2.74	--	0.05
Naphthalene	NA	0.03	1.05	0.01
***p*-Dichlorobenzene**	NA	0.01	0.12	<0.01
Sloss Industries in Birmingham, Alabama – SIAL, Census Tract 1073005500				
1,3-Butadiene	NA	0.17	5.01	0.08
Acetaldehyde	NA	2.05	4.52	0.23
Acrolein	NA	0.14	--	6.90
Arsenic (TSP)	NA	0.03	0.13	<0.01
Benzene	NA	2.49	19.41	0.08
Benzo (a) pyrene	NA	<0.01	0.08	--
Beryllium (TSP)	NA	0.01	0.01	<0.01
Cadmium (TSP)	NA	0.42	0.75	0.02
Carbon Tetrachloride	NA	0.21	3.15	0.01
Chloromethylbenzene	NA	<0.01	<0.01	--
Dibenz (a,h) anthracene	NA	<0.01	0.08	--
Formaldehyde	NA	1.84	0.01	0.19
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (TSP)	NA	10.65	--	0.21
Naphthalene	NA	0.09	3.12	0.03
Nickel (TSP)	NA	0.74	0.12	0.01
***p*-Dichlorobenzene**	NA	0.03	0.31	<0.01
Tetrachloroethylene	NA	0.17	1.00	<0.01
Xylenes	NA	5.80	--	0.06

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

5.0 Site in Colorado

This section presents meteorological, concentration, and spatial trends for the UATMP site in Colorado (GPCO), located in Grand Junction. Figure 5-1 is a topographical map showing the monitoring site in its urban location. Figure 5-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. The Grand Junction site is surrounded by numerous sources, mostly located to the north and east of the site. A large number of sources near GPCO fall into the liquids distribution source category.

Hourly meteorological data at a weather station near this site were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the GPCO monitoring site is Walker Field Airport (WBAN 23066).

Grand Junction is located in a mountain valley on the west side of the Rockies. This location can help protect the area from dramatic weather changes. The area tends to be rather dry and winds tend to flow out of the east-southeast on average, due to the valley breeze effect. Valley breezes occur as the sun heats up the side of a mountain. The warm air rises, creating a current that will move up the valley walls (Ruffner and Bair, 1987). Table 5-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 5-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

5.1 Pollutants of Interest at the Colorado Monitoring Site

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration

"failed the screen." A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 5-2 presents the fourteen pollutants that failed at least one screen at GPCO; a total of 366 measured concentrations failed screens. The pollutants of interest at GPCO were identified as the pollutants that contributed to the top 95% of the total failed screens, resulting in nine pollutants: acetaldehyde (62 failed screens), formaldehyde (61), benzene (59), carbon tetrachloride (54), 1,3-butadiene (41), tetrachloroethylene (29), xylenes (23), acrolein (15), and hexachloro-1,3-butadiene (10). It's important to note that the GPCO site sampled for carbonyls and VOCs only, and that this is reflected in the site's pollutants of interest.

Also listed in Table 5-2 are the total number of detects and the percent detects failing the screen. Of the nine pollutants of interest, acetaldehyde, benzene, carbon tetrachloride, acrolein, and hexachloro-1,3-butadiene had 100% of their detects fail the screening values.

5.2 Concentration Averages at the Colorado Monitoring Site

Three types of concentration averages were calculated for the nine pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 5-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at GPCO, total xylenes measured the highest concentration by mass (11.09 ± 2.14 μg/m^3), followed by formaldehyde (3.16 ± 0.44 μg/m^3) and acetaldehyde (3.02 ± 0.51 μg/m^3). Total xylene concentrations also measured the highest among each season, ranging from 8.72 ± 0.96 μg/m^3 in winter to 13.43 ± 3.31 μg/m^3 in autumn. Acetaldehyde,

benzene, formaldehyde, and total xylenes were detected in every sample taken at GPCO, while acrolein and hexachloro-1,3-butadiene were detected in less than one-half of the samples taken.

5.3 Non-chronic Risk Evaluation at the Colorado Monitoring Site

Non-chronic risk for the concentration data at GPCO was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the fourteen pollutants with at least one failed screen, only acrolein exceeded both the acute and intermediate risk values, and its non-chronic risk is summarized in Table 5-4.

All fifteen acrolein detects were greater than the ATSDR acute risk value of 0.11 $\mu g/m^3$ and the California REL risk value of 0.19 $\mu g/m^3$. The average detected acrolein concentration was 1.68 ± 0.34 $\mu g/m^3$, which is more than eight times the California REL value. For the intermediate acrolein risk, seasonal averages were compared to the ATSDR intermediate value of 0.09 $\mu g/m^3$. As discussed in Sections 3.1.5, acrolein concentrations could only be evaluated beginning July 2005, and a valid seasonal average could only be calculated for autumn. The autumn seasonal average was significantly greater than the ATSDR intermediate risk level.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Figure 5-3 is a pollution rose for acrolein at GPCO. The pollution rose is a plot of daily concentration and daily average wind direction. As indicated in Figure 5-3, all acrolein concentrations exceeded the acute risk factors, indicated by a dashed (CalEPA REL) and solid line (ATSDR MRL). The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources. The highest concentration of acrolein occurred on October 19, 2005 with a northerly wind, yet most of the concentrations were measured on a day with wind with an easterly component. GPCO is situated near several roadways and a railroad that runs east-northeast to west-southwest in relation to the monitoring site, and then curves northwestward just south of the site (Figure 5-1).

5.4 Meteorological and Concentration Analysis at the Colorado Monitoring Site

The following sub-sections describe and discuss the results of the following three meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

5.4.1 Pearson Correlation Analysis

Table 5-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the GPCO monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) Many of the pollutants of interest had moderately strong to very strong correlations with the temperature and moisture variables. The strongest correlations with temperature occurred with hexachloro-1,3-butadiene (-0.78 with maximum temperature and -0.81 with average temperature). However, it's important to note that this pollutant was detected only 10 times. Moderately strong positive correlations with temperature also occurred with acetaldehyde, acrolein, formaldehyde, and xylenes, while moderately strong negative correlations were calculated for 1,3-butadiene, benzene, and tetrachloroethylene. It is interesting to note that pollutants with higher averages in the summer (acetaldehyde, carbon tetrachloride, and formaldehyde) also exhibited positive correlations with maximum and average temperature. Conversely, benzene and 1,3-butadiene concentrations were highest in winter. This observation matches well with the negative correlation with average and maximum temperature for these two pollutants.

The strongest correlation with the dew point temperature occurred with acrolein (0.65) and the strongest correlation with wet bulb temperature occurred with hexachloro-1,3-butadiene (-0.73), yet both of these pollutants were detected fairly infrequently (15 and 10, respectively). Benzene, 1,3-butadiene, and tetrachloroethylene exhibited moderately strong negative correlations with the dew point and wet bulb temperatures, while carbon tetrachloride, acetaldehyde, and formaldehyde had moderately strong positive correlations with these parameters. Correlations with relative humidity tended to be slightly weaker.

Hexachloro-1,3-butdiene and benzene had moderately strong correlations with the *u*-component of the wind, indicating concentrations are significantly influenced by winds with an easterly or westerly component. However, most of the wind correlations were weak. Several pollutants of interest exhibited strong positive correlations with sea level pressure, indicating that as surface pressure rises, concentrations of these compounds tend to increase. Benzene, 1,3-butadiene, and tetrachloroethylene correlations were greater than 0.45, while hexachloro-1,3-butadiene had a moderately strong positive correlation (0.29) with pressure.

5.4.2 Composite Back Trajectory Analysis

Figure 5-4 is a composite back trajectory map for the GPCO monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site in Figure 5-4 represents 100 miles. As shown in Figure 5-4, the back trajectories originated from a variety of directions at GPCO. The 24-hour airshed domain is somewhat smaller at GPCO than at other UATMP sites, with trajectories originating as far away as central Idaho, or greater than 400 miles away. However, 65% of the trajectories originated within 200 miles of the site; and 83% within 300 miles from the GPCO monitoring site.

5.4.3 Wind Rose Analysis

Hourly wind data from the Walker Field Airport near the GPCO monitoring site was uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 5-5 is the wind rose for the GPCO monitoring site on days sampling occurred. As indicated in Figure 5-5, hourly winds were predominantly out of the east-southeast (16% of observations), east (11%), and southeast (10%) on sample days. Wind speeds tended to range from 7 to 11 knots on day samples were taken (34% of observations). Calm winds (<2 knots) were observed for 14% of the measurements.

5.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following two spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

5.5.1 Population, Vehicle Ownership, and Traffic Volume Comparison

County-level vehicle registration and population in Mesa County, CO were obtained from the Colorado Department of Revenue and the U.S. Census Bureau, and are summarized in Table 5-6. Table 5-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 5-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Compared to other UATMP sites, GPCO's population and vehicle registration count is low to mid-range; however, GPCO has one of the highest estimated vehicle registration-to-population ratios. The average daily traffic count falls in the middle of the range compared to other UATMP sites. The GPCO monitoring site is considered a commercial area and is located in an urban-city center setting.

5.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road or motor vehicle emissions. At the GPCO site, the toluene-ethylbenzene ratio (5.23 ± 0.49) and the xylenes-ethylbenzene ratio (4.69 ± 0.14), are closer together than the roadside study. Similar to the roadside study, the GPCO benzene-ethylbenzene ratio (2.33 ± 0.27) is the lowest concentration ratio, although slightly lower than that of the roadside study (2.85).

5.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 5-7 presents the 1999 NATA results for the census tract where the Colorado monitoring site is located. Only pollutants that "failed" the screens are presented in Table 5-7. Pollutants of interest are bolded.

5.6.1 1999 NATA Summary

The GPCO monitoring site is located in census tract 08077000800. The census tract population for the census tract where the GPCO monitoring site is located was 5,845, which represents about 5% of the county population in 2000. In terms of cancer risk, the Top 3 pollutants identified by NATA in the GPCO census tract are benzene (4.39 in-a-million risk), carbon tetrachloride (3.19), and 1,1,2,2-tetrachloroethane (2.13). These cancer risks are low when compared to other urban areas, such as near the BAPR and MIMN monitoring sites (71.0 and 39.5 in-a-million, respectively). Acrolein was the only pollutant in the GPCO census tract to have a noncancer hazard quotient greater than 1.0, which may lead to adverse health effects. Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

5.6.2 Annual Average Comparison

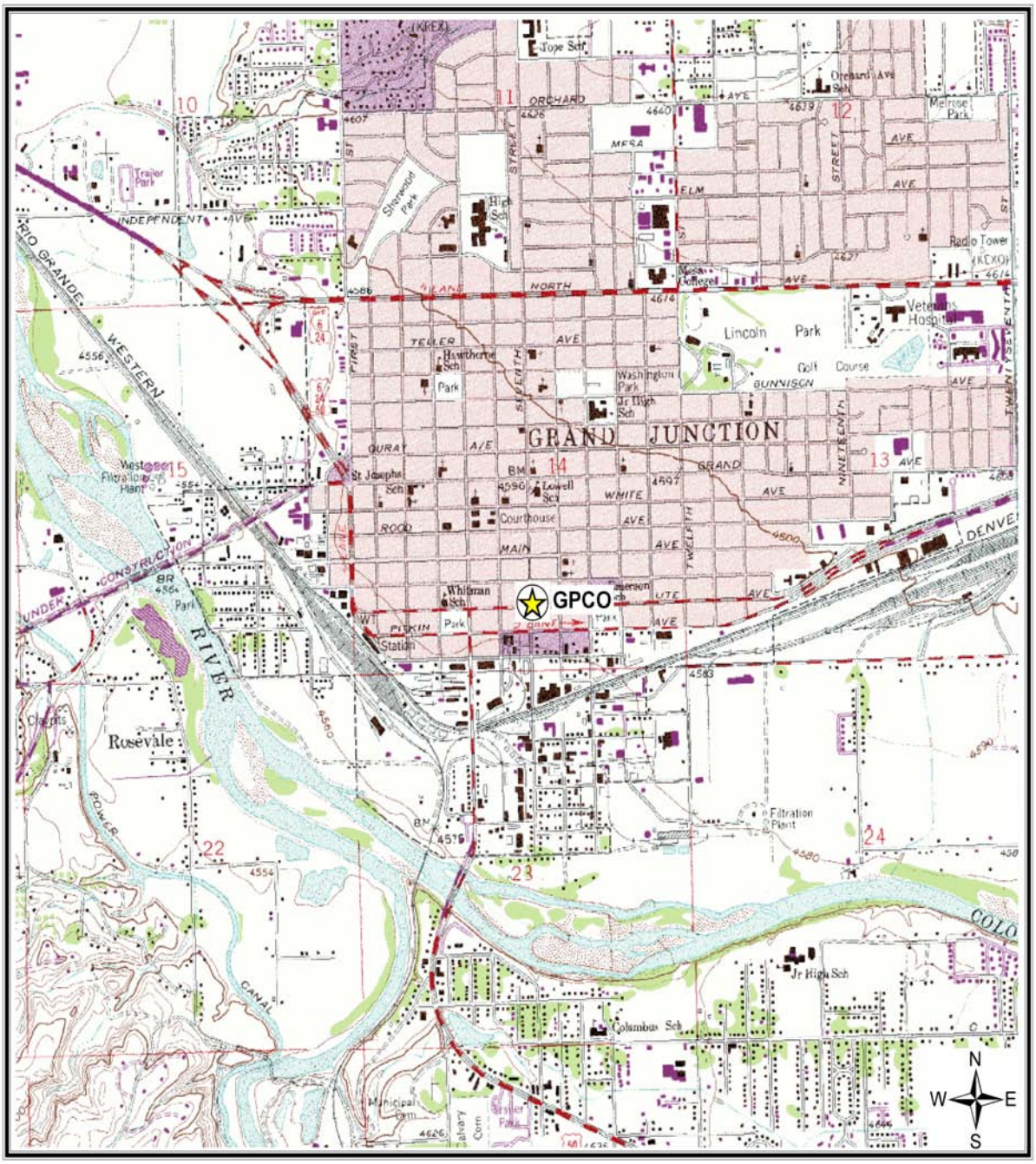
The Colorado monitoring site annual averages are also presented in Table 5-7 for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 5.2 on how a valid annual average is calculated). With the exception of hexachloro-1,3-butadiene and total xylenes, all the pollutants were within one order of magnitude from each other. Acetaldehyde, benzene, formaldehyde, and xylenes are identified as

the Top 4 pollutants by mass concentration from both the 1999 NATA-modeled and 2005 annual average concentrations.

Colorado Pollutant Summary

- *The pollutants of interest at the Colorado site are acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, tetrachloroethylene, and total xylenes.*
- *Total xylenes measured the highest daily average at GPCO.*
- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*

Figure 5-1. Grand Junction, Colorado (GPCO) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 5-2. Facilities Located Within 10 Miles of GPCO

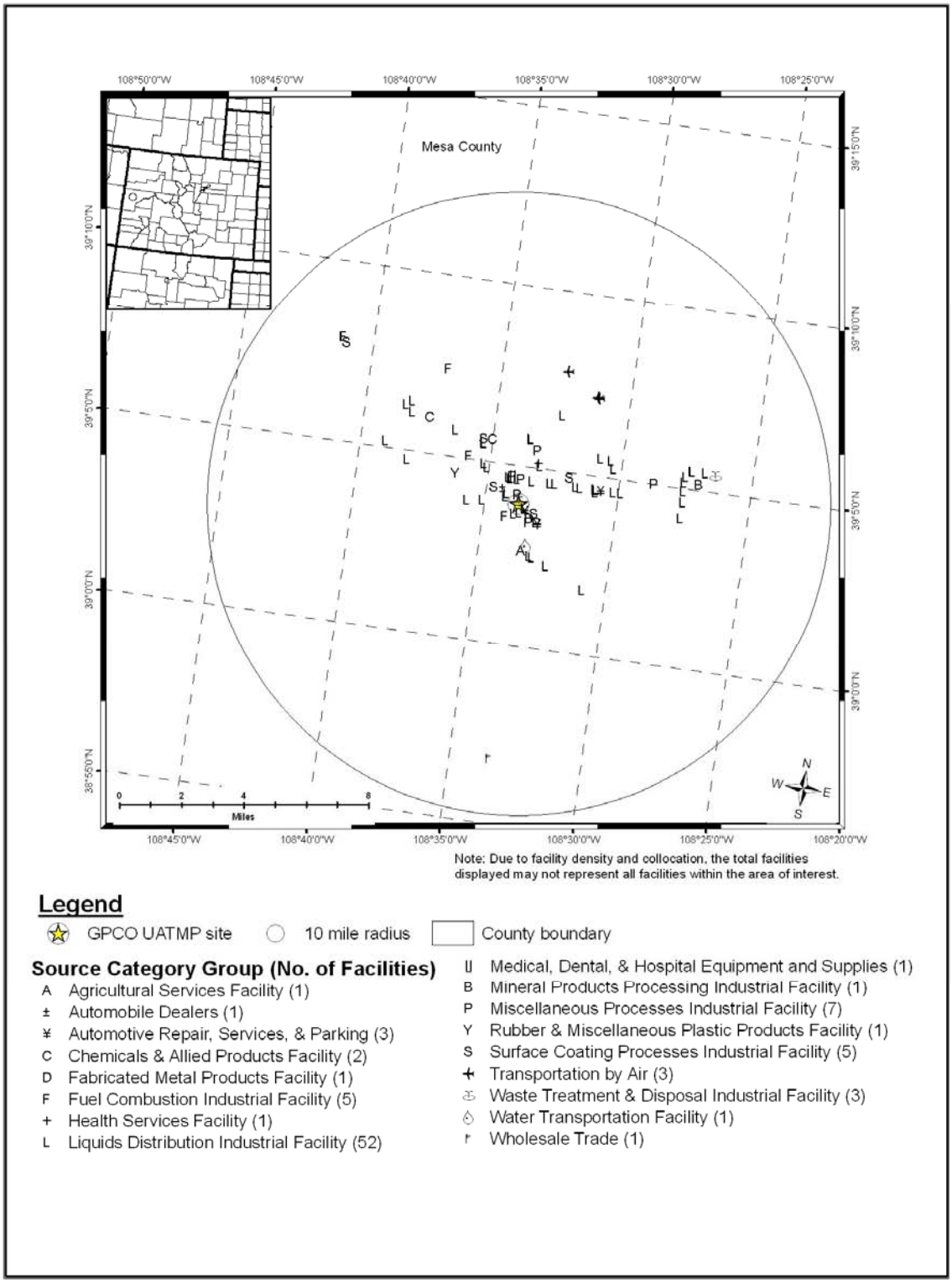


Figure 5-3. Acrolein Pollution Rose at GPCO

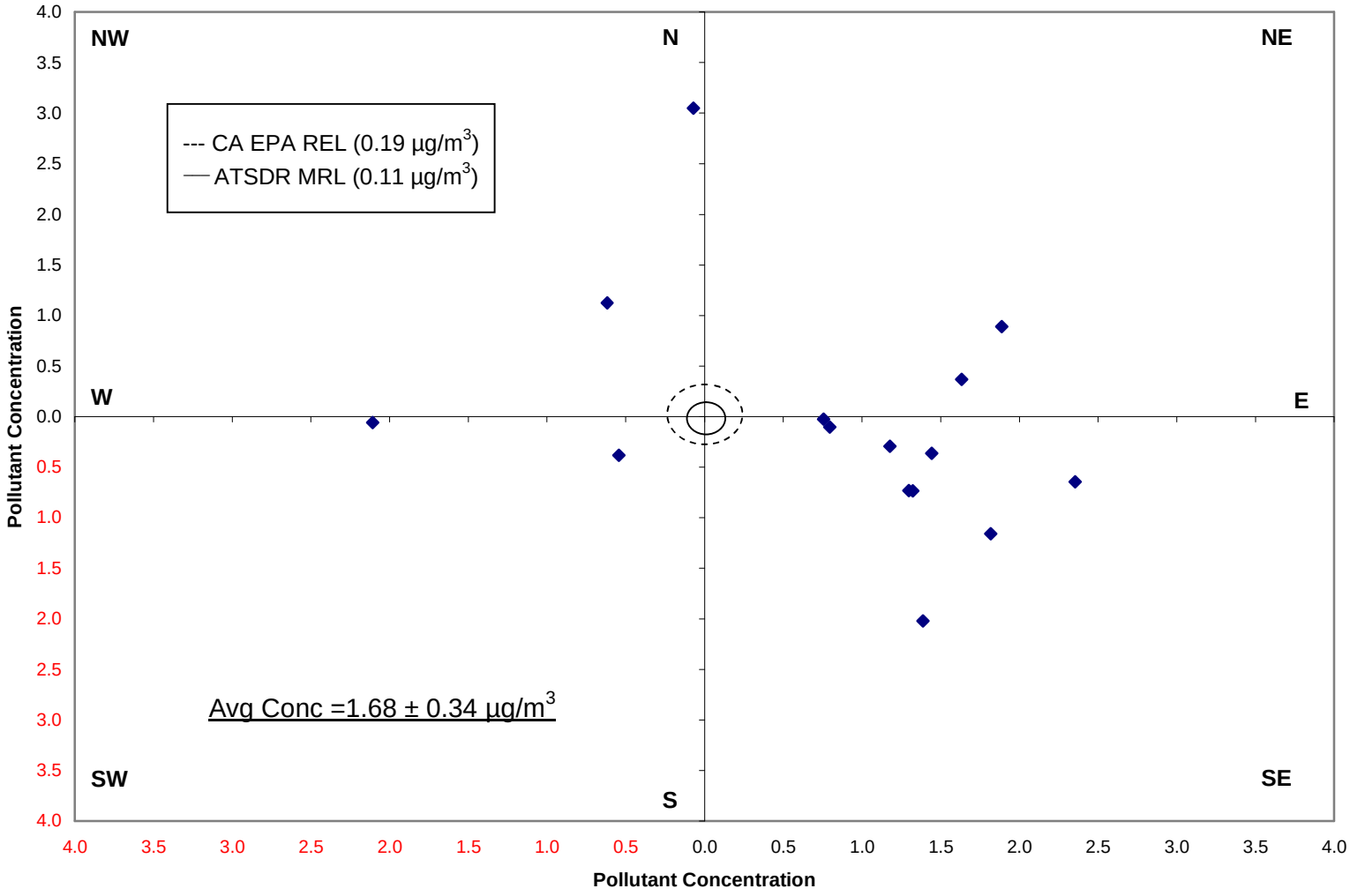


Figure 5-4. Composite Back Trajectory Map for GPCO

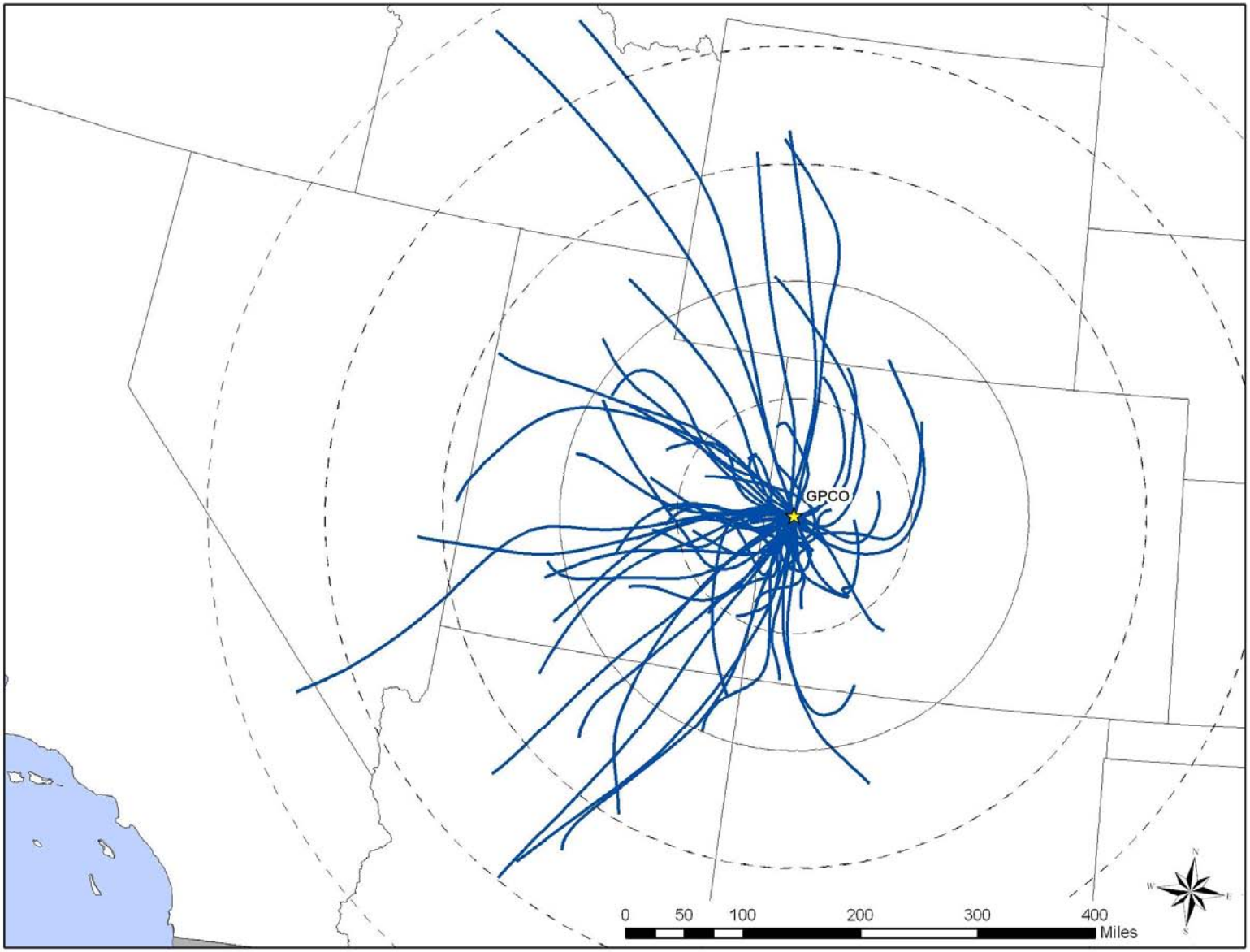


Figure 5-5. Wind Rose of Sample Days for the GPCO Monitoring Site

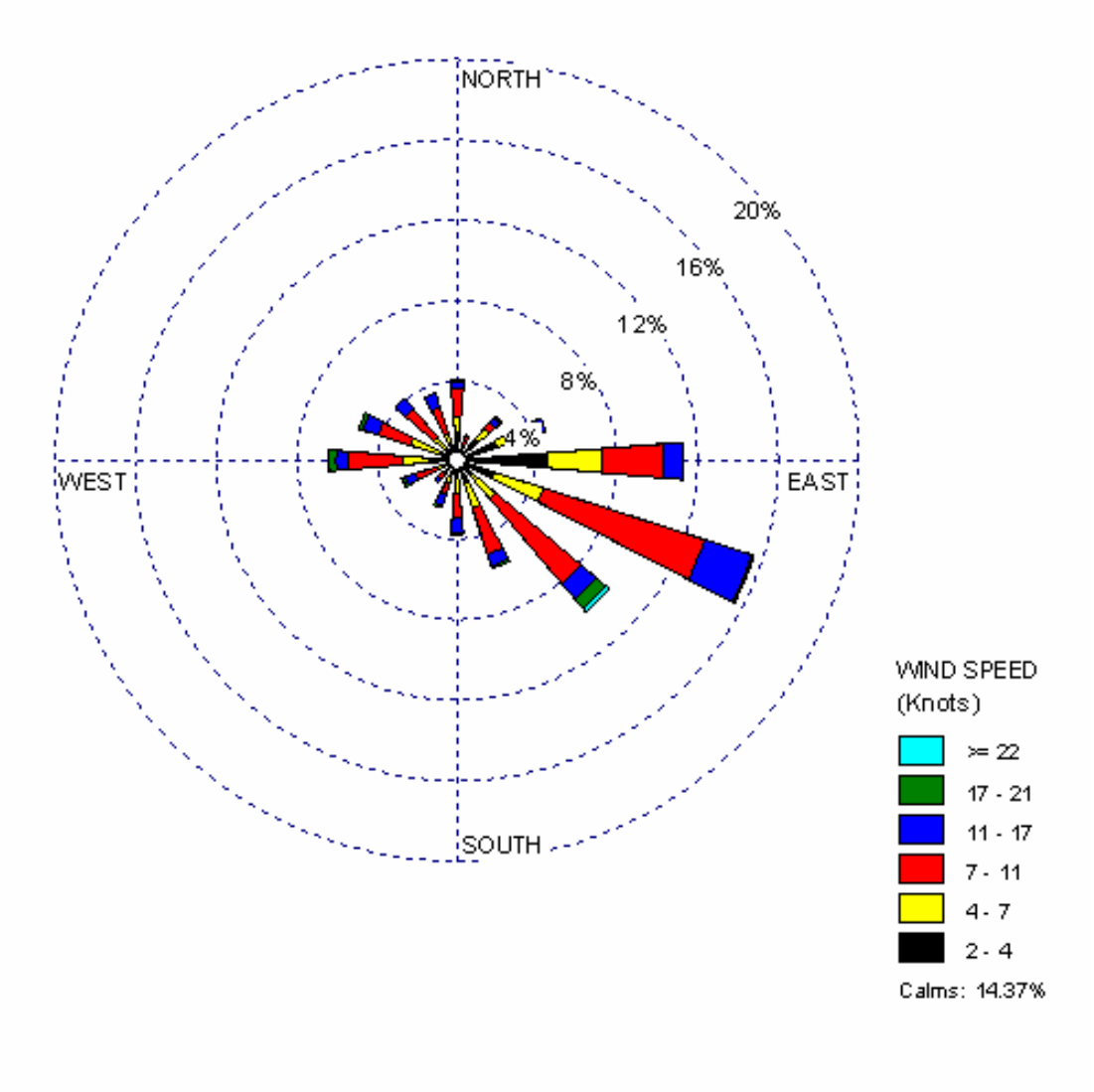


Table 5-1. Average Meteorological Parameters for the Monitoring Site in Colorado

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
GPCO	23066	All 2005	66.19 ± 1.99	53.85 ± 1.78	30.48 ± 1.12	42.50 ± 1.16	48.94 ± 2.05	1014.78 ± 0.76	-1.59 ± 0.23	0.75 ± 0.29
		Sample Day	66.83 ± 4.69	54.53 ± 4.15	29.95 ± 2.43	42.60 ± 2.60	46.80 ± 4.82	1014.50 ± 1.88	-1.43 ± 0.59	1.02 ± 0.68

Table 5-2. Comparison of Measured Concentrations and EPA Screening Values at the Colorado Monitoring Site

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Grand Junction, Colorado - GPCO					
Acetaldehyde	62	62	100.0	16.9%	16.9%
Formaldehyde	61	62	98.4	16.7%	33.6%
Benzene	59	59	100.0	16.1%	49.7%
Carbon Tetrachloride	54	54	100.0	14.8%	64.5%
1,3-Butadiene	41	42	97.6	11.2%	75.7%
Tetrachloroethylene	29	35	82.9	7.9%	83.6%
Xylenes	23	59	39.0	6.3%	89.9%
Acrolein	15	15	100.0	4.1%	94.0%
Hexachloro-1,3-butadiene	10	10	100.0	2.7%	96.7%
p-Dichlorobenzene	7	25	28.0	1.9%	98.6%
Acrylonitrile	2	2	100.0	0.5%	99.2%
1,2-Dichloroethane	1	1	100.0	0.3%	99.5%
Dichloromethane	1	49	2.0	0.3%	99.7%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.3%	100.0%
Total	366	476	76.9		

Table 5-3. Daily and Seasonal Averages for Pollutants of Interest at the Colorado Monitoring Site

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Acetaldehyde	62	62	3.02	0.51	2.76	0.25	2.85	0.73	3.89	1.75	2.53	0.36
Acrolein	15	32	1.68	0.34	NR	NR	NR	NR	NR	NR	0.83	0.48
Benzene	59	59	1.94	0.23	2.84	0.28	1.29	0.20	1.38	0.36	2.17	0.40
1,3-Butadiene	42	59	0.26	0.05	0.31	0.10	NR	NR	0.13	0.08	0.26	0.06
Carbon Tetrachloride	54	59	0.52	0.04	0.43	0.08	0.39	0.08	0.60	0.05	0.56	0.09
Formaldehyde	62	62	3.16	0.44	2.85	0.32	1.87	0.34	4.43	1.32	3.39	0.36
Hexachloro-1,3-butadiene	10	59	0.18	0.03	NR	NR	NR	NR	NR	NR	1.06	0.39
Tetrachloroethylene	35	59	0.36	0.06	0.37	0.09	NR	NR	0.19	0.06	0.33	0.10
Xylenes	59	59	11.09	2.14	8.72	0.96	11.25	6.21	10.82	4.88	13.43	3.31

NR = Not reportable due to low number of detects.

Table 5-4. Non-Chronic Risk Summary at the Colorado Monitoring Site

Site	Method	Pollutant	Daily Avg (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Avg (µg/m^3)	Spring Avg (µg/m^3)	Summer Avg (µg/m^3)	Autumn Avg (µg/m^3)
GPCO	TO-15	Acrolein	1.68 ± 0.34	0.11	15	0.19	15	0.09	NR	NR	NR	0.83 ± 0.48

NR = Not reportable due to low number of detects.

Table 5-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Colorado Monitoring Site

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Grand Junction, Colorado – GPCO									
Acetaldehyde	62	0.32	0.30	0.13	0.26	-0.27	0.01	<0.01	<0.01
Acrolein	15	0.24	0.31	0.65	0.48	0.16	0.02	-0.05	-0.08
Benzene	59	-0.36	-0.43	-0.32	-0.44	0.36	-0.26	-0.13	0.57
1,3-Butadiene	42	-0.46	-0.49	-0.27	-0.46	0.46	-0.16	-0.09	0.48
Carbon Tetrachloride	54	0.10	0.13	0.31	0.21	0.07	-0.18	0.03	-0.05
Formaldehyde	62	0.36	0.36	0.29	0.36	-0.20	-0.14	0.11	0.08
Hexachloro-1,3-butadiene	10	-0.78	-0.81	-0.51	-0.73	0.21	0.38	-0.19	0.29
Tetrachloroethylene	35	-0.40	-0.44	-0.31	-0.45	0.32	-0.23	-0.02	0.55
Xylenes	59	0.28	0.22	-0.03	0.17	-0.25	-0.13	0.02	0.08

Table 5-6. Motor Vehicle Information for the Colorado Monitoring Site

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
GPCO	129,872	148,158	1.14	106,900	121,952	19,572

Table 5-7. 1999 NATA Data Census Tract Summary for the Monitoring Site in Colorado

Pollutant	2005 UATMP Site Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Grand Junction, Colorado – GPCO, Census Tract ID 08077000800				
1,3-Butadiene	0.21 ± 0.04	0.04	1.25	0.02
Acetaldehyde	3.02 ± 0.51	0.58	1.28	0.06
Acrolein	NA	0.02	--	1.04
Acrylonitrile	0.07 ± 0.01	<0.01	0.15	<0.01
Benzene	1.94 ± 0.23	0.56	4.39	0.02
Carbon Tetrachloride	0.49 ± 0.04	0.21	3.19	0.01
1,2-Dichloroethane	0.09 ± 0.01	0.02	0.63	<0.01
Dichloromethane	0.43 ± 0.10	0.21	0.10	<0.01
Formaldehyde	3.16 ± 0.44	0.73	<0.01	0.07
Hexachloro-1,3-butadiene	0.98 ± 0.14	<0.01	0.03	<0.01
p-Dichlorobenzene	0.14 ± 0.01	0.01	0.14	<0.01
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	0.04	2.13	--
Tetrachloroethylene	0.27 ± 0.05	0.07	0.42	<0.01
Xylenes (total)	11.09 ± 2.14	0.53	--	0.01

BOLD indicates a pollutant of interest.
NA = Not available due to short sampling duration.

6.0 Sites in Florida

This section presents meteorological, concentration, and spatial trends for the five UATMP sites in and near the Tampa/St. Petersburg, FL area (AZFL, GAFL, SKFL, SMFL, and SYFL), one site in the Ft. Lauderdale area (FLFL), and one site near Orlando, FL (ORFL). Figures 6-1 through 6-7 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 6-8 through 6-10 identify point source emission sources within 10 miles of the sites and that reported to the 2002 NEI. In the Tampa/St. Petersburg area, three of these sites are located in Hillsborough County and two are located in Pinellas County. SKFL and AZFL are located on the Peninsula, with the bulk of the facilities to the north of the sites, and closest to SKFL. GAFL is located near the Gandy Bridge on Highway 92. A cluster of facilities is located near GAFL, but most are farther to the west of this site. SYFL is farther inland in Plant City. Most of the facilities within 10 miles are to the west or east of this site. SMFL is located in the southwest portion of Hillsborough County, with relatively few facilities nearby. A wide range of industries have facilities near these sites, of which surface coating processes and fuel combustion are the most numerous. FLFL (Figure 6-9) is located near Florida's east coast and nearby facilities are located mostly to the northeast and east of the monitoring site. Surface coating and liquids distribution industries are the major source types within the 10 mile radius. Several facilities surround ORFL (Figure 6-10), most of which are involved in waste treatment and disposal or fuel combustion.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the GAFL and SMFL monitoring sites is Tampa International Airport (WBAN 12842); closest to AZFL is St. Petersburg/Whitted Airport (WBAN 92806); closest to SKFL is St. Petersburg/Clearwater International Airport (WBAN 12873); closest to SYFL is Winter Haven's Gilbert Airport (WBAN 12876); closest to FLFL is Ft. Lauderdale/Hollywood International Airport (WBAN 12849); and closest to ORFL is Orlando Executive Airport (WBAN 12841).

Florida=s climate is subtropical, with very mild winters and warm, humid summers. The annual average maximum temperature is around 80EF for all locations and average relative humidity is near 70 percent. Although land and sea breezes affect each of the locations, wind generally blows from an easterly direction due to high pressure offshore (Ruffner and Bair, 1987). Table 6-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 6-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

6.1 Pollutants of Interest at the Florida Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contributed to the top 95% of the site's total failed screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 6-2 presents the pollutants that failed at least one screen at the Florida monitoring sites. It's important to note that these sites sampled for carbonyl compounds only and that only two carbonyls have risk screening values, acetaldehyde and formaldehyde. Both pollutants failed the screen at least once at each site, as indicated in Table 6-2, and both contributed almost equally to the number of failures. Therefore, acetaldehyde and formaldehyde are the two pollutants of interest at each Florida site. Also listed in Table 6-2 are the total number of detects and the percent detects failing the screen. Acetaldehyde failed 100% of the screens at all seven Florida sites and formaldehyde failed 100% of the screens at FLFL and SMFL.

6.2 Concentration Averages at the Florida Monitoring Sites

Three types of concentration averages were calculated for the compounds of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average

concentration of all detects. If there are at least seven detects within each season, then a *seasonal* average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no later than November. Daily and seasonal averages are presented in Table 6-3. Annual averages will be presented and discussed in further detail in later sections. With the exception of FLFL, all the Florida monitoring sites sampled year round.

Daily averages of acetaldehyde did not vary much among the sites, ranging from 1.25 ± 0.16 $\mu g/m^3$ at SYFL to 2.77 ± 0.29 $\mu g/m^3$ at FLFL. Seasonal acetaldehyde averages are available for each season at each site (except FLFL). Interestingly, the highest acetaldehyde seasonal averages occurred during the winter and spring at every site. However, most of the seasonal averages of acetaldehyde did not differ statistically. Only SKFL's acetaldehyde winter average was significantly higher than the other seasonal averages. The daily average concentration of formaldehyde at SMFL and GAFL were significantly higher than at the remaining sites (14.81 ± 4.71 $\mu g/m^3$ and 10.75 ± 7.33 $\mu g/m^3$, respectively). The remaining sites' daily average formaldehyde concentrations ranged from 1.94 ± 0.29 $\mu g/m^3$ at AZFL to 3.84 ± 2.85 $\mu g/m^3$ at SKFL. With the exception of FLFL, seasonal averages for formaldehyde are also available for each season at each site. The seasonal pattern observed for the acetaldehyde concentrations is not similar to the seasonal formaldehyde averages. Three sites measured their highest seasonal formaldehyde average during the summer (GAFL, ORFL, and SKFL), two during the spring (AZFL and SMFL), and one during the winter (SYFL). However, the large confidence intervals for the spring and summer GAFL formaldehyde averages, the SKFL summer formaldehyde average, and the winter and spring formaldehyde averages, indicate that a few outliers may be driving the formaldehyde averages upward.

6.3 Non-chronic Risk Evaluation at the Florida Monitoring Sites

Non-chronic risk for the concentration data at Florida monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only formaldehyde exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 6-4.

Of the 358 detects of formaldehyde at the Florida sites, only 6 exceeded the ATSDR Short-term MRL of 49 $\mu g/m^3$ (4 at GAFL, 1 at SKFL, and 1 at SMFL) and only 4 exceeded the CAL EPA REL of 94 $\mu g/m^3$ (3 at GAFL and 1 at SMFL). This represents less than 2% of formaldehyde samples. Also presented in Table 6-4 is the ATSDR Intermediate MRL and seasonal averages of formaldehyde. No seasonal averages for formaldehyde exceeded the ATSDR Intermediate MRL of 40 $\mu g/m^3$.

For the compounds that exceeded the short-term (acute) risk factors, the concentrations were further examined. Three Florida monitoring sites, GAFL, SKFL, and SMFL, sampled concentrations of formaldehyde that exceeded the acute risk factors. Figures 6-11 through 6-13 are pollution roses for formaldehyde at these sites. The pollution rose is a plot of concentration and wind direction. As shown in Figures 6-11 through 6-13, and discussed above, only a few formaldehyde concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL). At each one of these sites, the concentrations are generally dispersed around the center, suggesting a mobile source signature.

Figure 6-11 is the formaldehyde pollution rose for the GAFL monitoring site. The pollution rose shows that the few concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions. The highest concentration of formaldehyde occurred on May 16, 2005 with a west-southwesterly wind. However, on June 3, 2005, a concentration nearly as high as the one on May 16 was recorded with a southeasterly wind. The

GAFL site is located on a narrow strip of land near the Gandy Bridge, which spans westward across the Tampa Bay. A mixture of residential, commercial, and industrial areas are located to the east of the site.

Figure 6-12 is the formaldehyde pollution rose for the SKFL monitoring site. The pollution rose shows that only one concentration exceeded the acute risk factors, and occurred on July 9, 2005, with winds originating from the east-southeast. The SKFL site is surrounded by residential neighborhoods, and wedged in between several major roadways in the area.

Figure 6-13 is the formaldehyde pollution rose for the SMFL monitoring site. The pollution rose shows that only one concentration exceeded the acute risk factors, and occurred on May 10, 2005, with winds originating from the west-northwest. SMFL is located in E.G. Simmons Park, an estuary and nature preserve on the eastern short of the Tampa Bay.

6.4 Meteorological and Concentration Analysis at the Florida Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

6.4.1 Pearson Correlation Analysis

Table 6-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Florida monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) Most of the correlations between the meteorological variables and the pollutants of interest were weak. The strongest correlations occurred with acetaldehyde at FLFL. However, this site only sampled nine times, and this low number can skew the correlations. The ORFL monitoring site exhibited moderately strong negative correlations between acetaldehyde and the temperature and moisture variables, indicating that as temperature and humidity increase, concentrations of acetaldehyde decrease. In fact, many of the correlations with acetaldehyde and the temperature and moisture

variables were negative, albeit weak. With the exception of AZFL, formaldehyde exhibited positive correlations with maximum, average, dew point, and wet bulb temperatures.

6.4.2 Composite Back Trajectory Analysis

Figures 6-14 through 6-20 are composite back trajectory maps for the Florida monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the sites shown in these figures represents 100 miles.

As shown in Figures 6-14 through 6-18, the composite back trajectories at the Tampa/St. Petersburg monitoring sites look very similar. Back trajectories originated from a variety of directions from the sites. The 24-hour airshed domain is large, with trajectories originating as far away as Great Inagua Island, the southern-most island of the Bahamas, or greater than 700 miles away. Roughly 60% of the trajectories originated within 300 miles of the sites; and 80% within 400 miles from the monitoring sites.

As shown in Figure 6-19, the back trajectories originated from a variety of directions at FLFL. The 24-hour airshed domain is somewhat smaller than the other Florida sites, with the farthest trajectory originating several hundred miles off the South Carolina Coast, or greater than 400 miles away. Fifty percent of the trajectories originated within 300 miles of the site; and 80% within 400 miles from the FLFL monitoring site. It is important to note, however, that the FLFL monitoring site did not begin sampling until October. The composite back trajectory map might look much different under a longer sampling duration.

As shown in Figure 6-20, the back trajectories also originated from a variety of directions at ORFL. The 24-hour airshed domain is large, with trajectories originating as far away as southern Indiana, or greater than 700 miles away. Nearly 54% of the trajectories originated within 300 miles of the site; and 77% within 400 miles from the ORFL monitoring site.

6.4.3 Wind Rose Analysis

Hourly wind data from weather stations at Tampa International, Whitted, St. Petersburg/Clearwater International, Gilbert, Orland Executive, and Ft. Lauderdale/Hollywood International Airports were uploaded into a wind rose software program WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 6-21 thru 6-27 are wind roses for the Florida monitoring sites on days samples were taken.

As indicated in Figure 6-21, hourly winds at AZFL were predominantly out of the east (12% of observations), and winds from the north, northeast, and east account for nearly 50% of all wind direction observations on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (36% of observations). Interestingly, winds with north, northeasterly, and easterly components tended to be stronger than those from other directions. Calm winds (<2 knots) were observed for 7% of measurements.

As indicated in Figure 6-22, hourly winds at GAFL were predominantly out of the west (11% of observations) and east-northeast (10%) on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (43% of observations). Calm winds were observed for 14% of measurements.

As indicated in Figure 6-23, hourly winds at SKFL were predominantly out of the east (11% of observations) and east-northeast (10%) on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (43% of observations). However, winds from the east-southeast had the highest frequency of winds greater than 22 knots. Calm winds were observed for 10% of measurements.

Similar to GAFL, hourly winds at SMFL were predominantly out of the west (11% of observations) and east-northeast (10%) on sample days, as illustrated in Figure 6-24. Both of these sites are located in close proximity to Tampa Bay, which lies to the west of the monitoring

locations. Wind speeds tended to range from 7 to 11 knots on days samples were taken (42% of observations). Calm winds were observed for 14% of measurements.

As indicated in Figure 6-25, hourly winds at SYFL were predominantly out of the east (13% of observations) and north (10%) on sample days. Winds out of the north, northeast, and east account for nearly 43% of all wind direction observations on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (36% of observations). Calm winds were observed for 11% of measurements.

As indicated in Figure 6-26, hourly winds at FLFL were predominantly out of the east (11% of observations), south (11%), and northwest (11%) on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (41% of observations). Similar to AZFL, winds out of the east were recorded at higher speeds more frequently than other directions. Calm winds were observed for 8% of measurements.

As indicated in Figure 6-27, hourly winds at ORFL were predominantly out of the north (9% of observations) and east (9%) on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (36% of observations). Calm winds were observed for 16% of measurements.

6.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

6.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Pinellas, Hillsborough, Orange, and Broward Counties in Florida were obtained from the Florida Department of Highway Safety and Motor Vehicles and the U.S. Census Bureau, and are summarized in Table 6-6. Table 6-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle

registration ratio. Finally, Table 6-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Of the four Florida counties with monitoring sites in the UATMP, Broward County, where FLFL is located, is the most populous, while Pinellas County, where AZFL and SKFL are located, are the least populated. Yet, Broward County has the lowest estimated vehicles per person and Pinellas County has the highest. While FLFL has the highest number of people living within a 10 mile radius of the site, SMFL has the least. The GAFL monitoring site, located near the Gandy bridge between Tampa and St. Petersburg, experiences the highest daily traffic volume, while SYFL, located in the more rural outskirts of the Tampa area, experiences the least.

6.5.2 BTEX Analysis

A BTEX analysis could not be performed as the Florida sites sampled for carbonyl compounds only.

6.6 Site-Specific Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The Florida sites with enough data for a trends analysis are AZFL, GAFL, and ORFL. As previously mentioned, the Florida sites only sample for carbonyl compounds, and this is reflected in Figures 6-28 through 6-30.

- Concentrations of formaldehyde at the AZFL site have generally been decreasing over the last four years.

- Concentrations of formaldehyde in 2005 at the GAFL site appear to have doubled since 2004. However, the confidence interval for the 2005 formaldehyde average, illustrated by the error bars extending above and below the top of the bar, is quite large, indicating that the average may be biased by outliers.

- The formaldehyde concentration at the ORFL monitoring site appears to have increased slightly from 2003 to 2004, but when the confidence interval is taken into account, the formaldehyde concentration has changed very little.

6.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 6-7 presents the 1999 NATA results for the census tracts where the Florida monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 6-7, which includes acetaldehyde and formaldehyde only.

The Florida monitoring sites are located in different types of land use and location settings (i.e., rural vs. urban or residential vs. commercial). Some of the census tracts cover a large area with relatively few people, while others represent a small slice of the urban population. The census tracts for the Florida sites are as follows: 12103022402 for AZFL; 12011070204 for FLFL; 12057006500 for GAFL; 12095015901 for ORFL; 12103024905 for SKFL; 12057014107 for SMFL; and 12057012204 for SYFL. The 5,456 people residing in the AZFL census tract represent 0.6% of the 2000 Pinellas County population, while the 6,522 residents of the SKFL census tract represent 0.7% of the 2000 Pinellas County population. The 5,913 people residing in the GAFL census tract represent 0.6% of the 2000 Hillsborough County population; the 4,362 residents of the SYFL census tract represent 0.4% of the 2000 Hillsborough County population; and the 1,803 residents of the more rural SMFL census tract represent just less than 0.2% of the Hillsborough County population. The 2,083 people residing in the ORFL census tract represent 0.2% of the 2000 Orange County population. The 4,301 residents of the FLFL census tract represent 0.3% of the 2000 Broward County population.

6.7.1 1999 NATA Summary

According to NATA, the acetaldehyde risk in the Florida census tracts ranged from 2.33 in-a-million (SMFL) to 4.38 in-a-million (ORFL). Formaldehyde cancer risk is less than 0.01 in a million in each census tract. Noncancer risk for both acetaldehyde and formaldehyde are also low, with a hazard quotient of less than 0.25 for each pollutant in each census tract, suggesting very little risk for noncancer health affects.

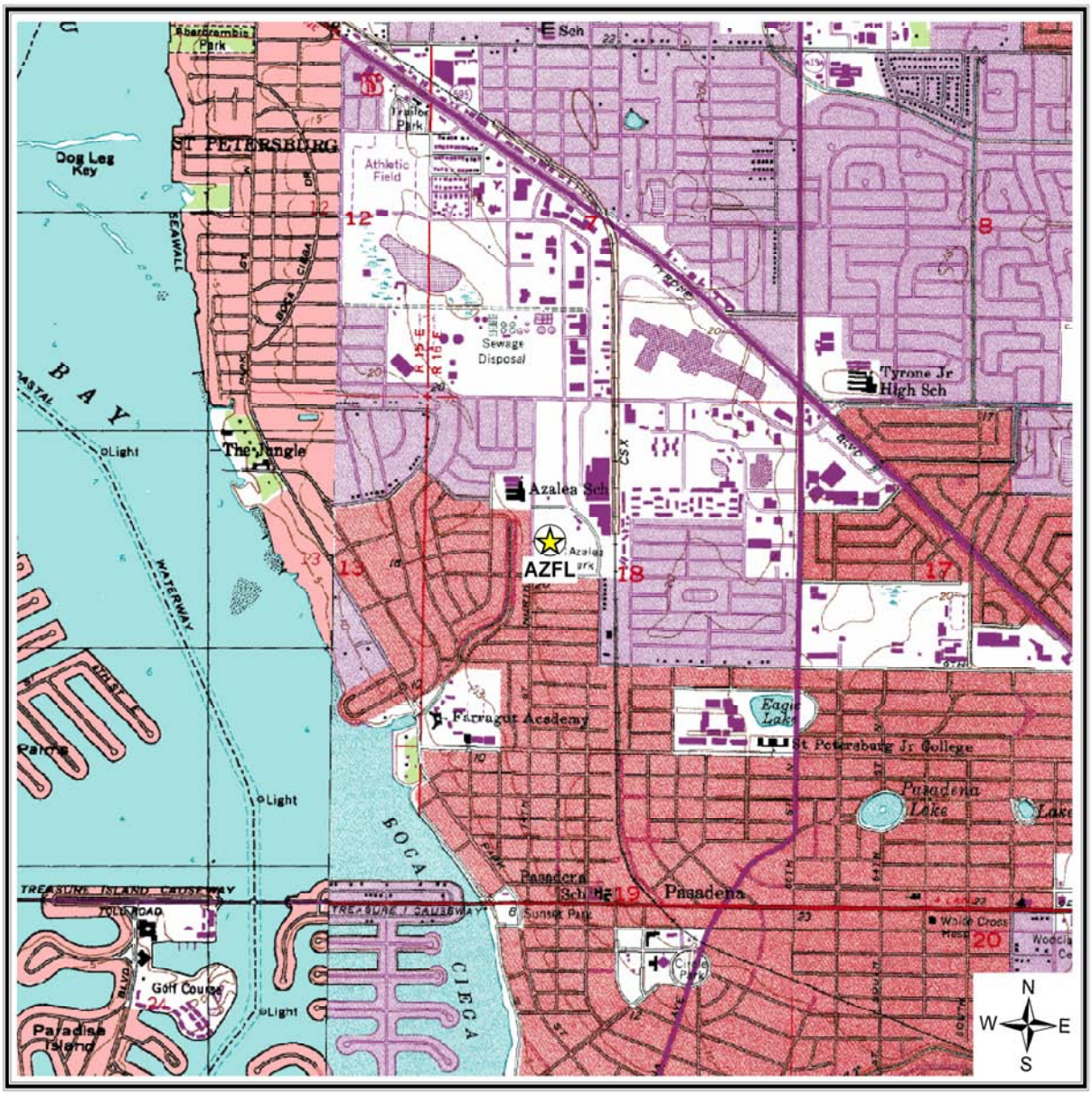
6.7.2 Annual Average Comparison

The Florida monitoring sites' annual averages are also presented in Table 6-7 for comparison to the 1999 NATA modeled concentrations. NATA modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 6.2 on how a valid annual average is calculated). The 1999 NATA and 2005 UATMP formaldehyde and acetaldehyde concentrations were very similar, usually within 1 or 2 micrograms of each other. It important to note that FLFL sampled only from October to December and therefore has no calculated annual averages. The highest predicted NATA concentration in the remaining six Florida census tracts is 1.99 $\mu g/m^3$ for both acetaldehyde and formaldehyde in the ORFL census tract. The 2005 UATMP annual acetaldehyde average at ORFL is 1.81 ± 0.23 $\mu g/m^3$, indicating very good agreement with the model. The 2005 UATMP annual formaldehyde average at ORFL is 3.25 ± 0.50 $\mu g/m^3$, which is slightly higher than the NATA modeled concentration. The 2005 UATMP formaldehyde concentrations at GAFL and SMFL are an order of magnitude higher than their 1999 NATA modeled concentrations.

Florida Pollutant Summary

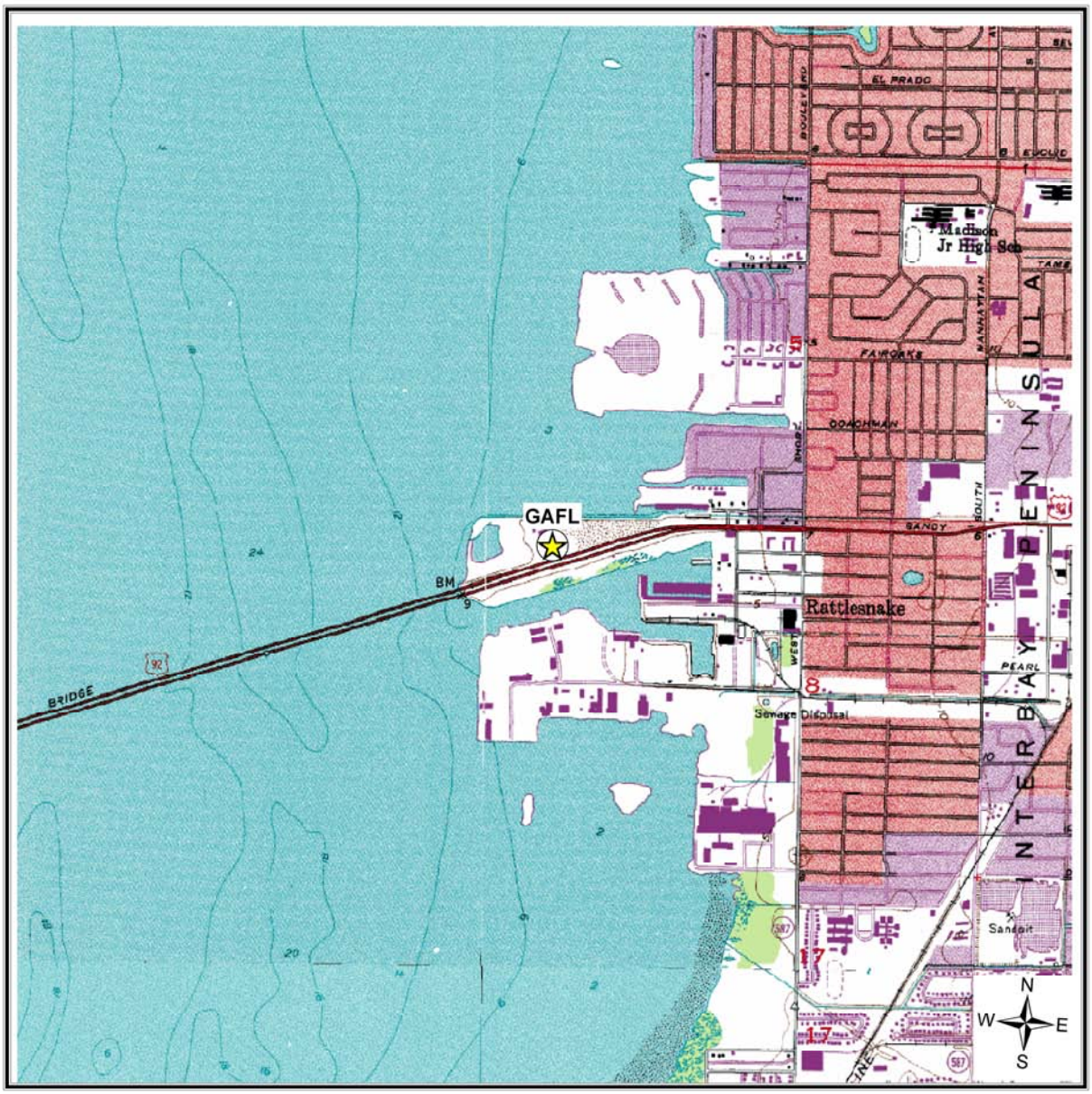
- *The pollutants of interest at all seven Florida sites are acetaldehyde and formaldehyde.*
- *The pollutant of interest with the highest daily average at GAFL, ORFL, SKFL, SMFL, and SYFL was formaldehyde, while acetaldehyde measured the highest daily average at AZFL and FLFL.*
- *Formaldehyde exceeded one or both of the short-term risk factors at GAFL, SKFL, and SMFL.*
- *A comparison of formaldehyde concentrations for all years of UATMP participation shows that formaldehyde concentrations decreased in 2002 and 2003 at AZFL and have been consistent since; formaldehyde decreased from 2002 to 2003 at GAFL, but increased in later years, although the confidence interval shows that the 2005 concentration may have been driven by a few outliers; and formaldehyde concentrations have changed little at ORFL since 2003.*

Figure 6-1. Tampa/St. Petersburg, Florida (AZFL) Monitoring Site



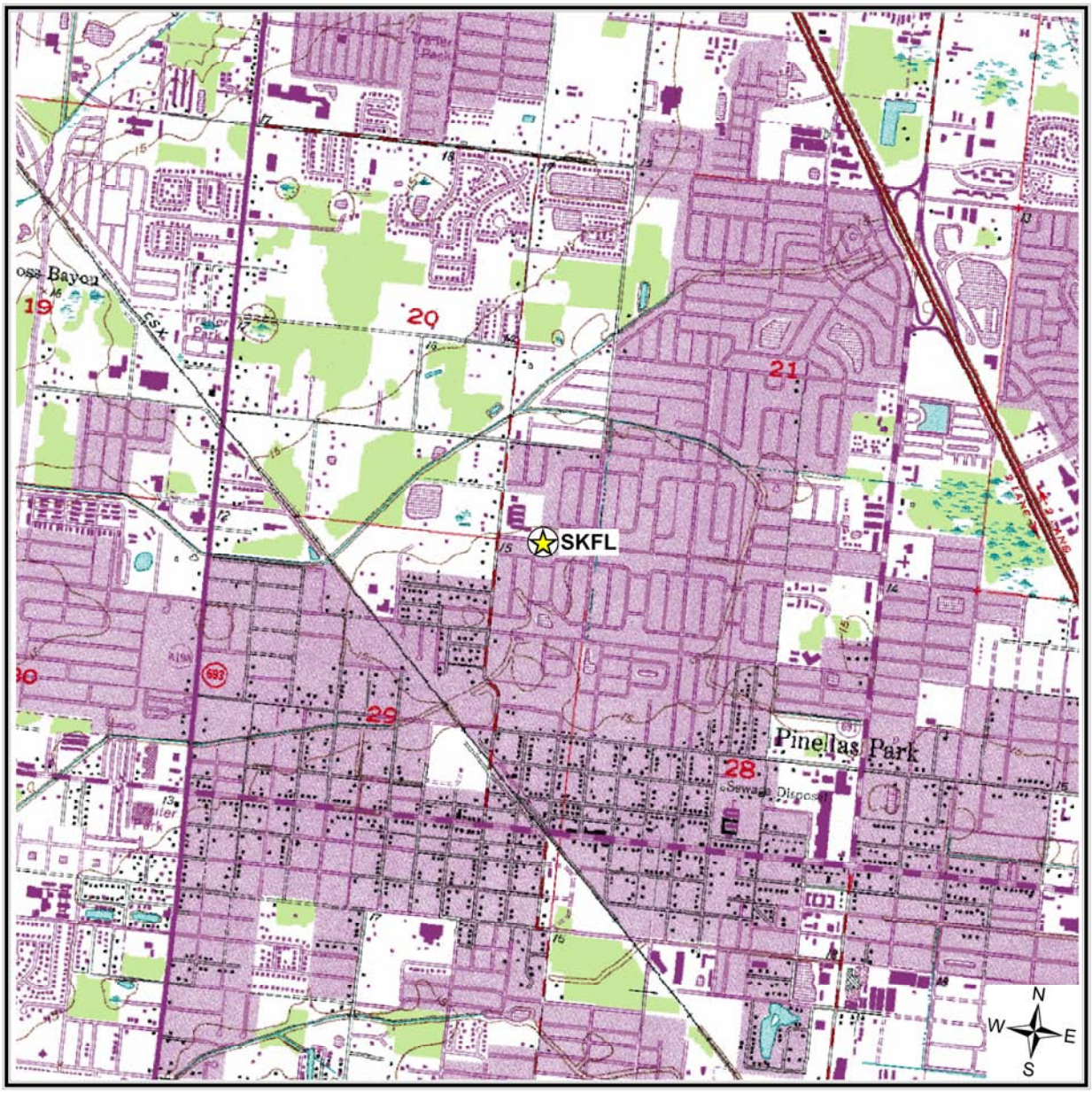
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 6-2. Tampa/St. Petersburg, Florida (GAFL) Monitoring Site



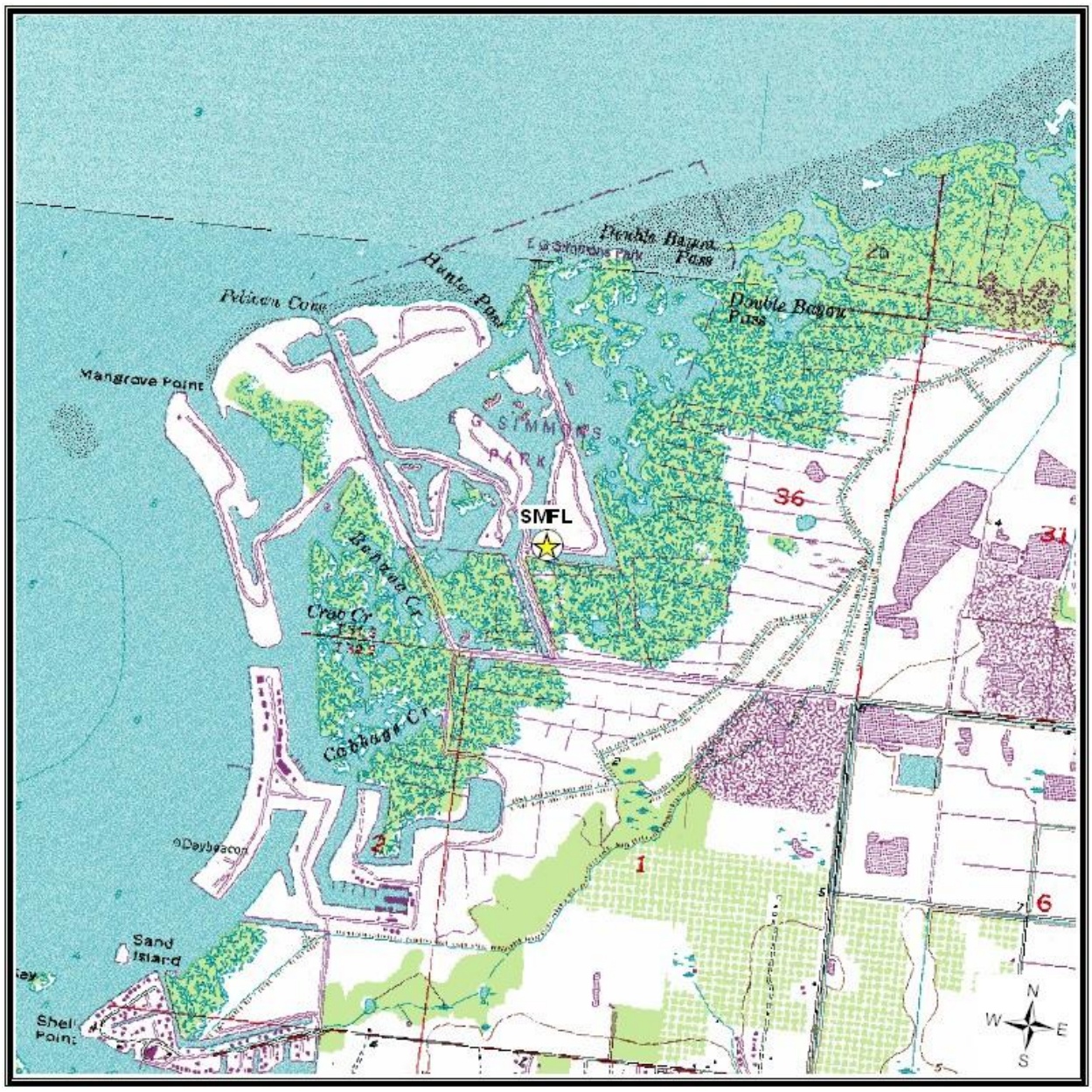
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 6-3. Tampa/St. Petersburg, Florida (SKFL) Monitoring Site



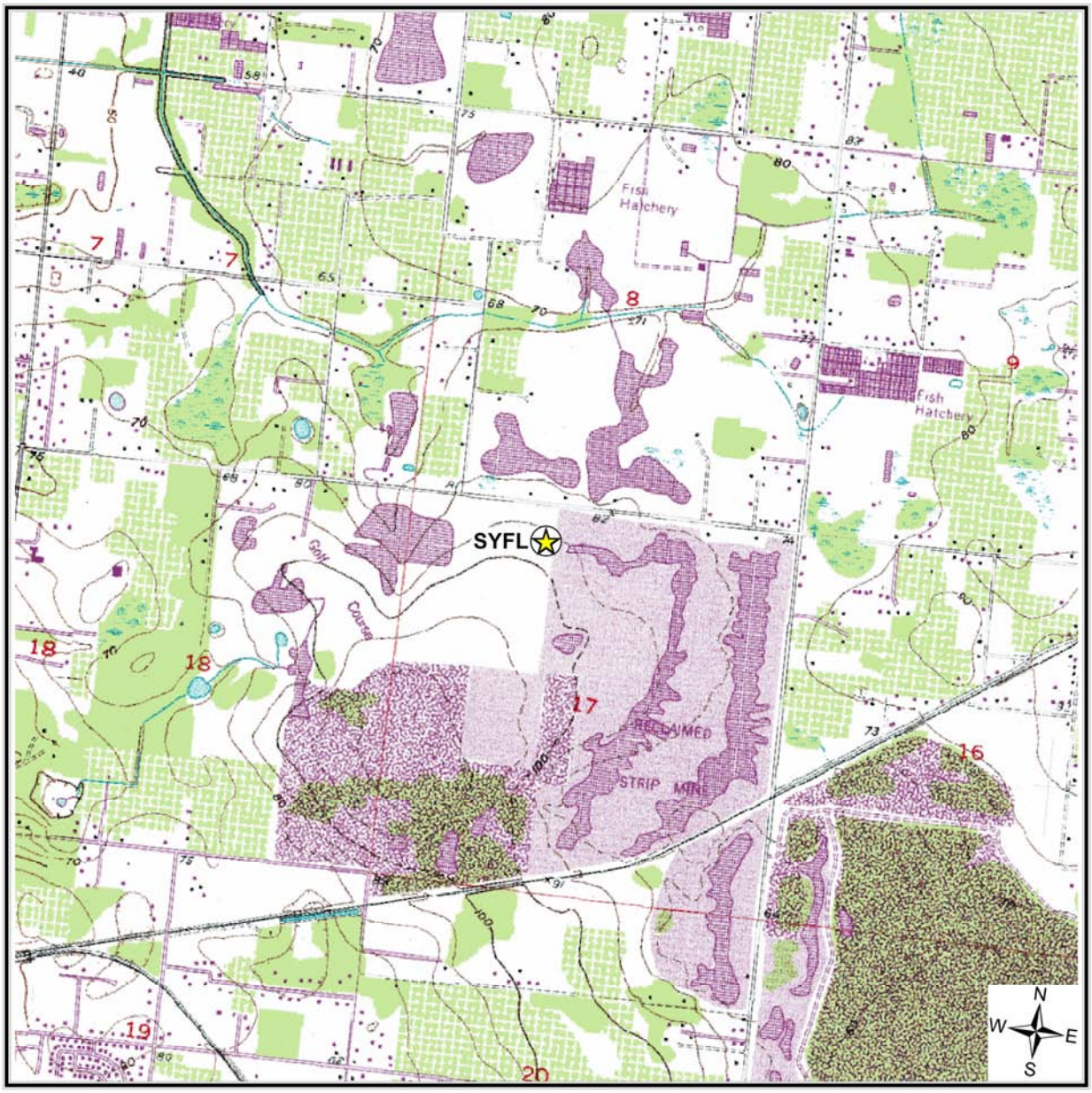
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 6-4. Tampa/St. Petersburg, Florida (SMFL) Monitoring Site



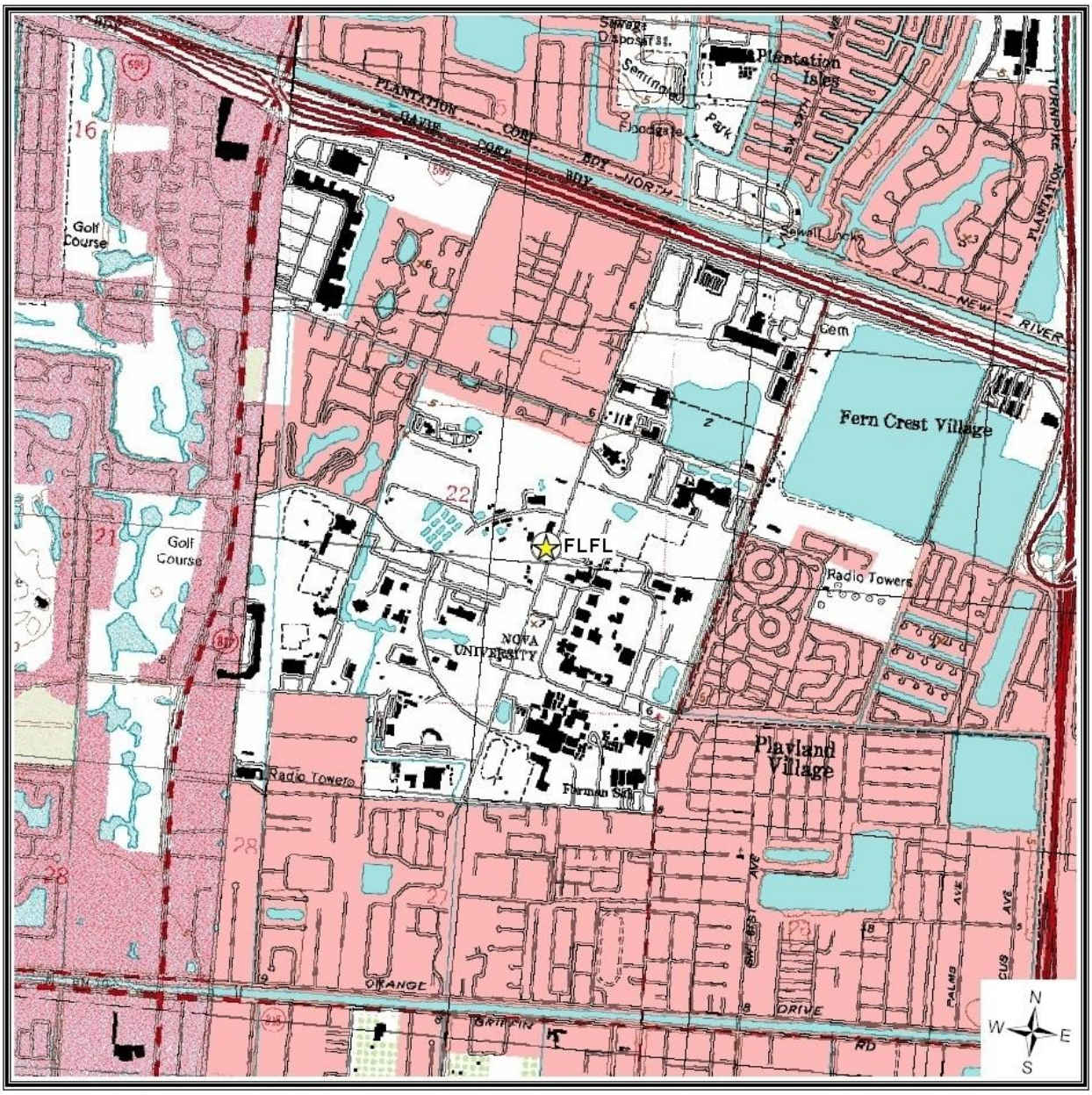
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 6-5. Tampa/St. Petersburg, Florida (SYFL) Monitoring Site



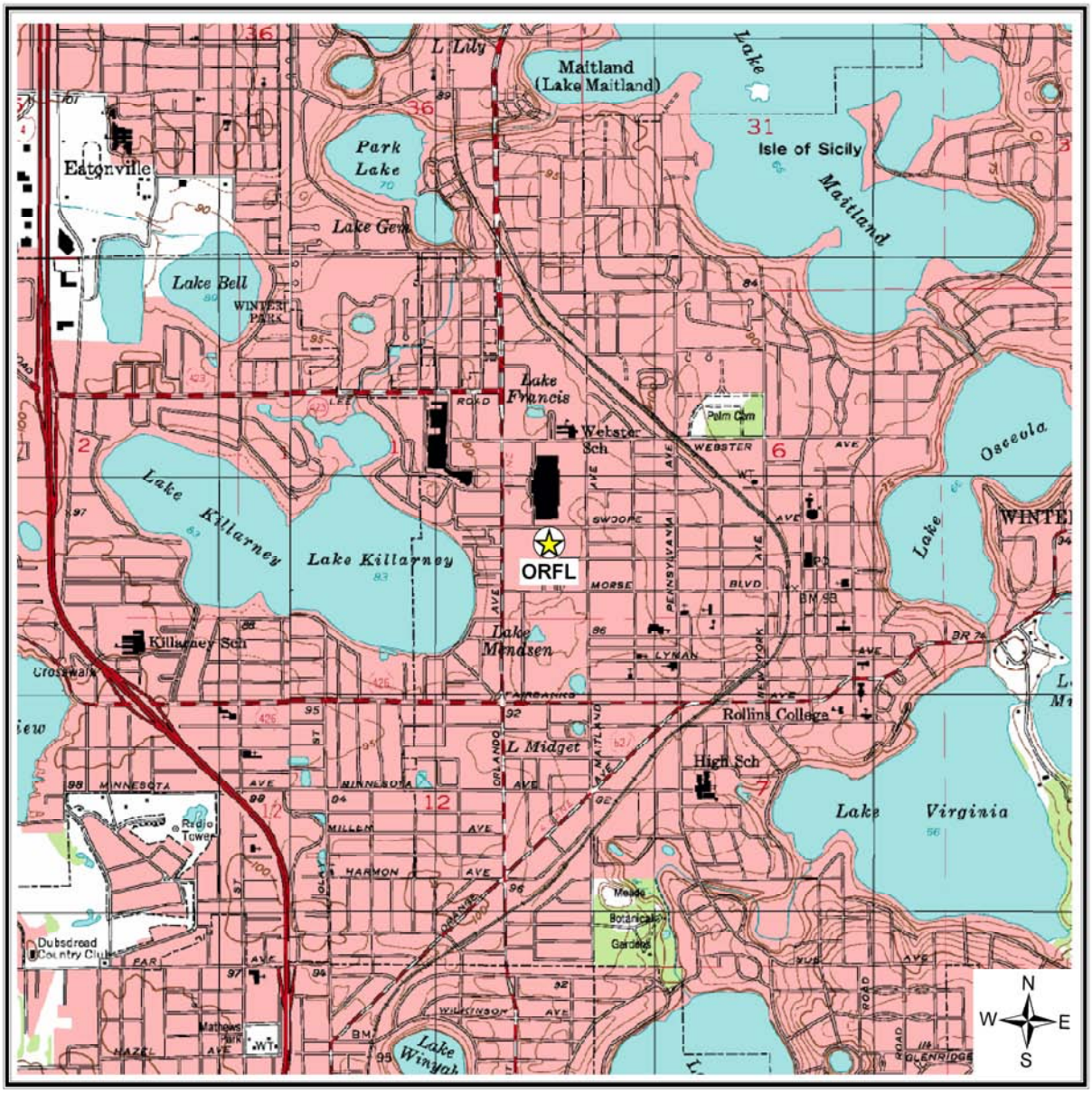
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 6-6. Ft. Lauderdale, Florida (FLFL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 6-7. Orlando, Florida (ORFL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 6-8. Facilities Located Within 10 Miles of the Tampa/ St. Petersburg, Florida Monitoring Sites

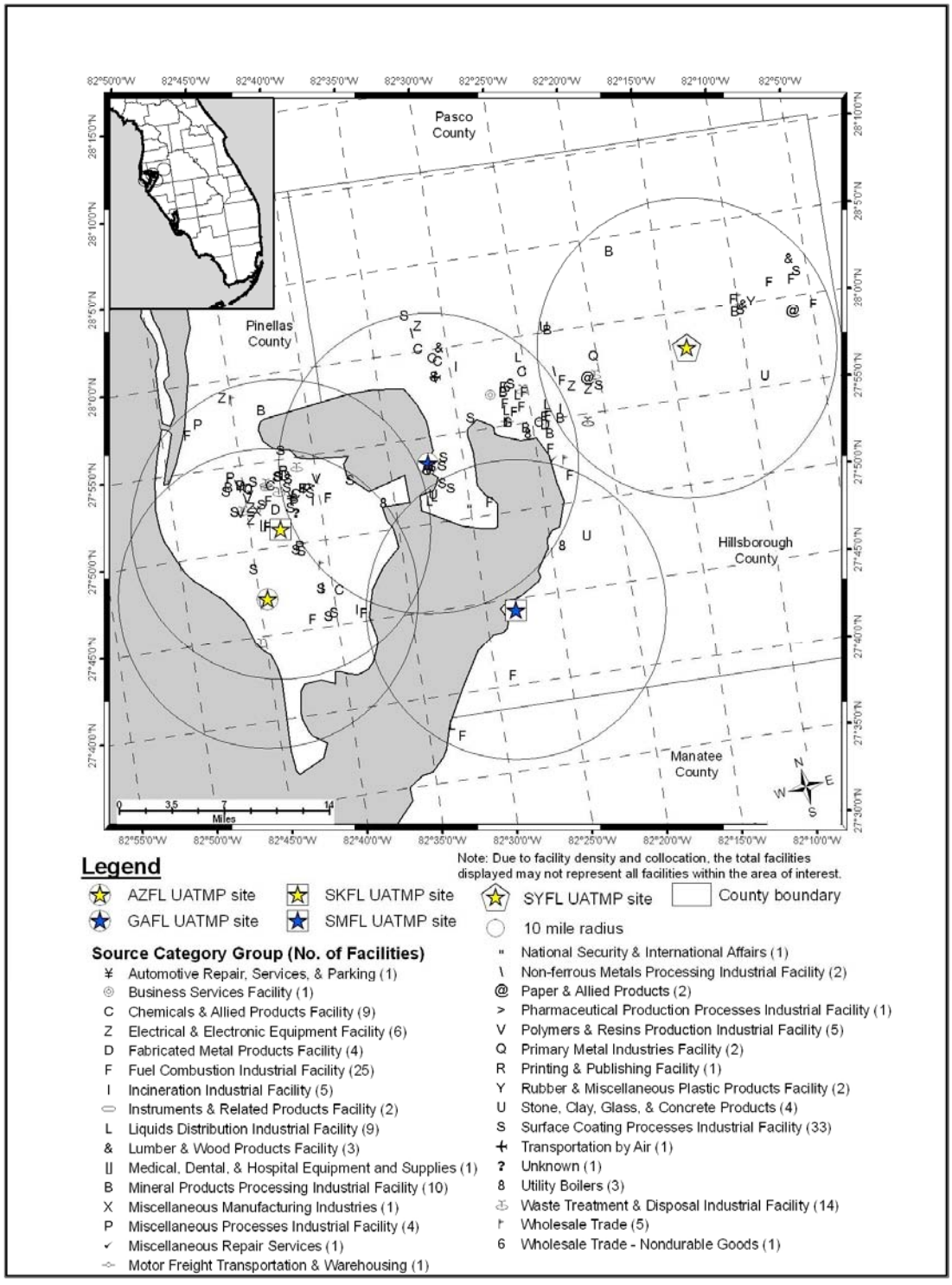


Figure 6-9. Facilities Located Within 10 Miles of FLFL

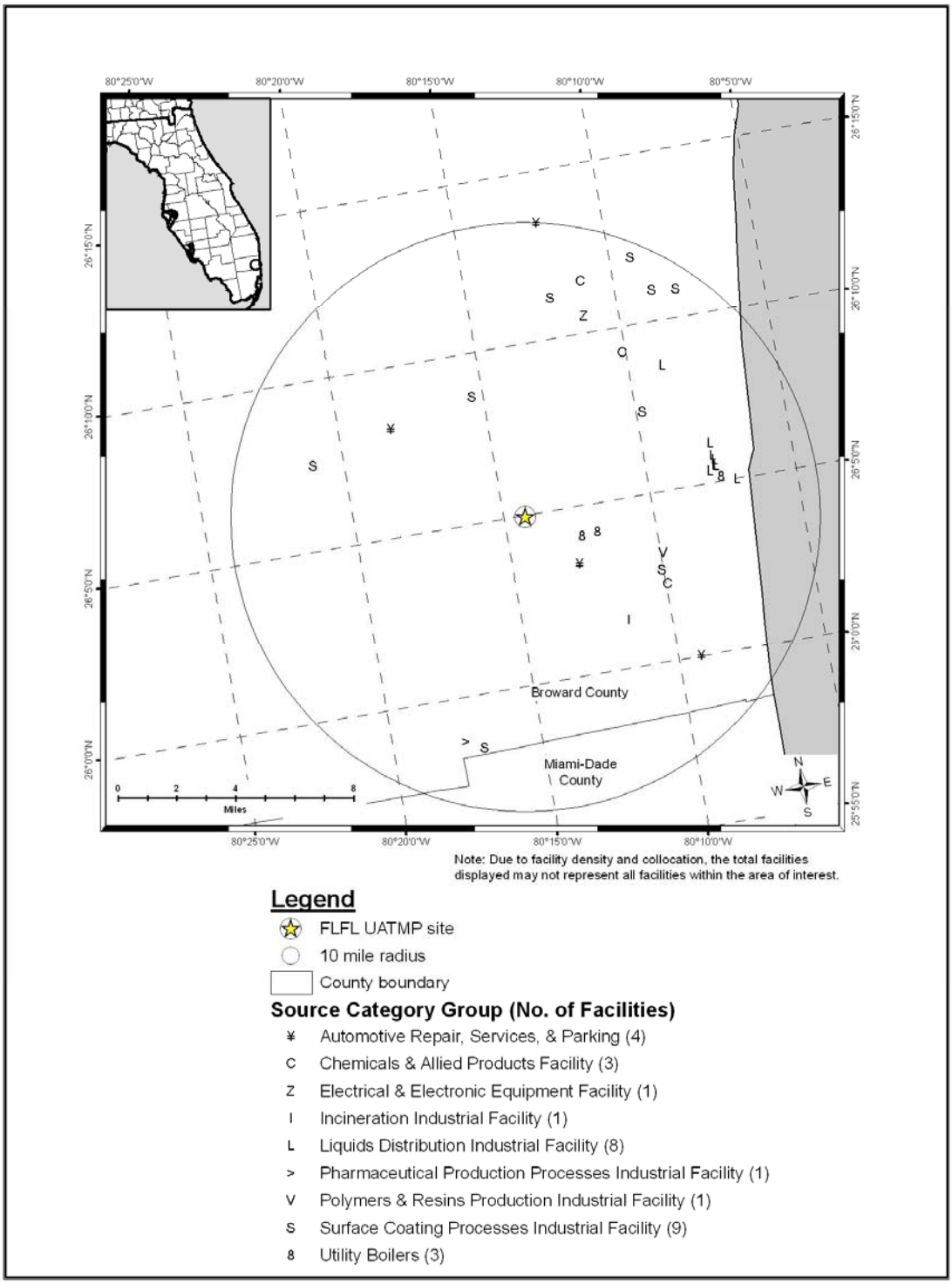


Figure 6-10. Facilities Located Within 10 Miles of ORFL

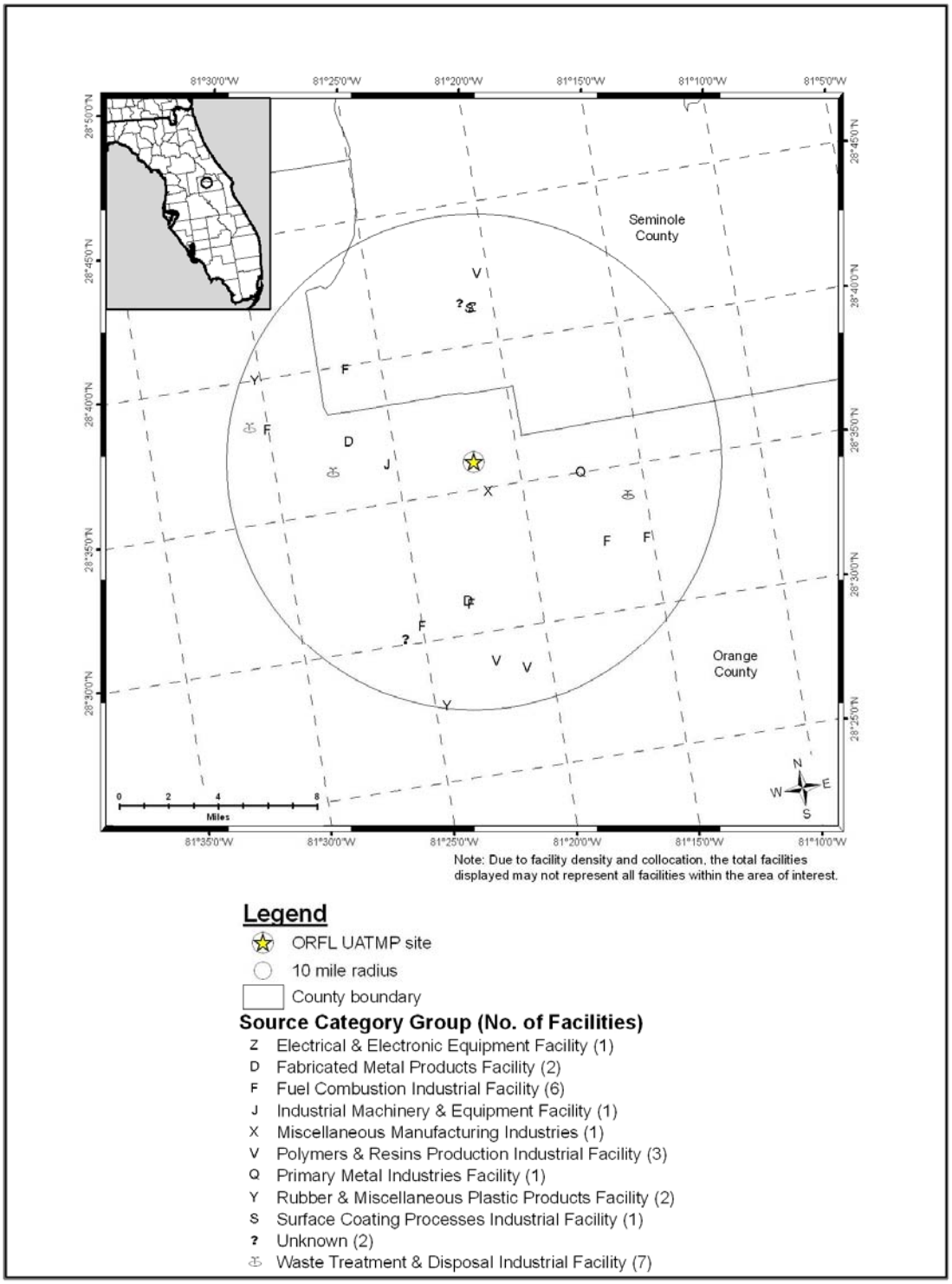


Figure 6-11. Formaldehyde Pollution Rose at GAFL

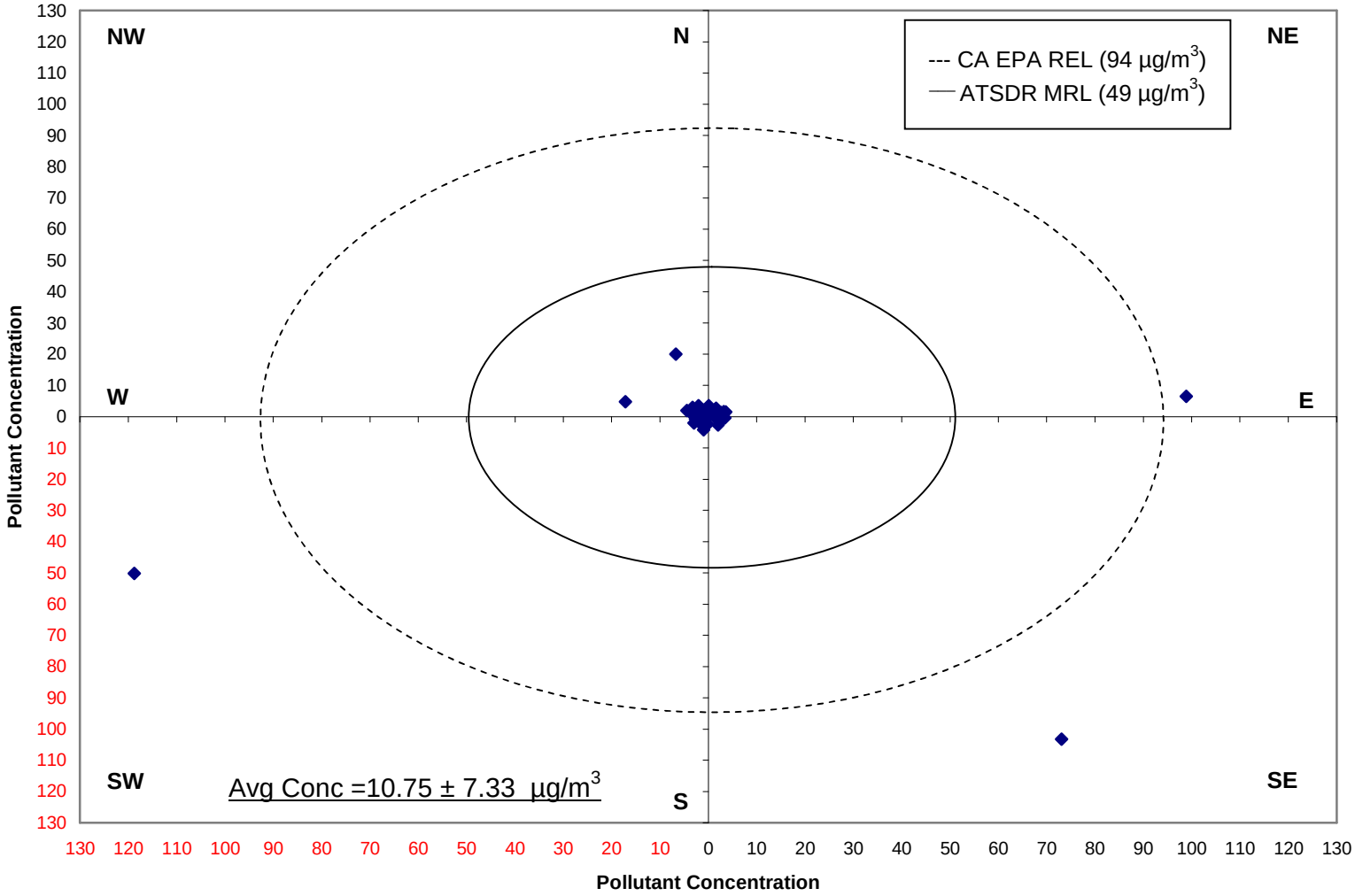


Figure 6-12. Formaldehyde Pollution Rose at SKFL

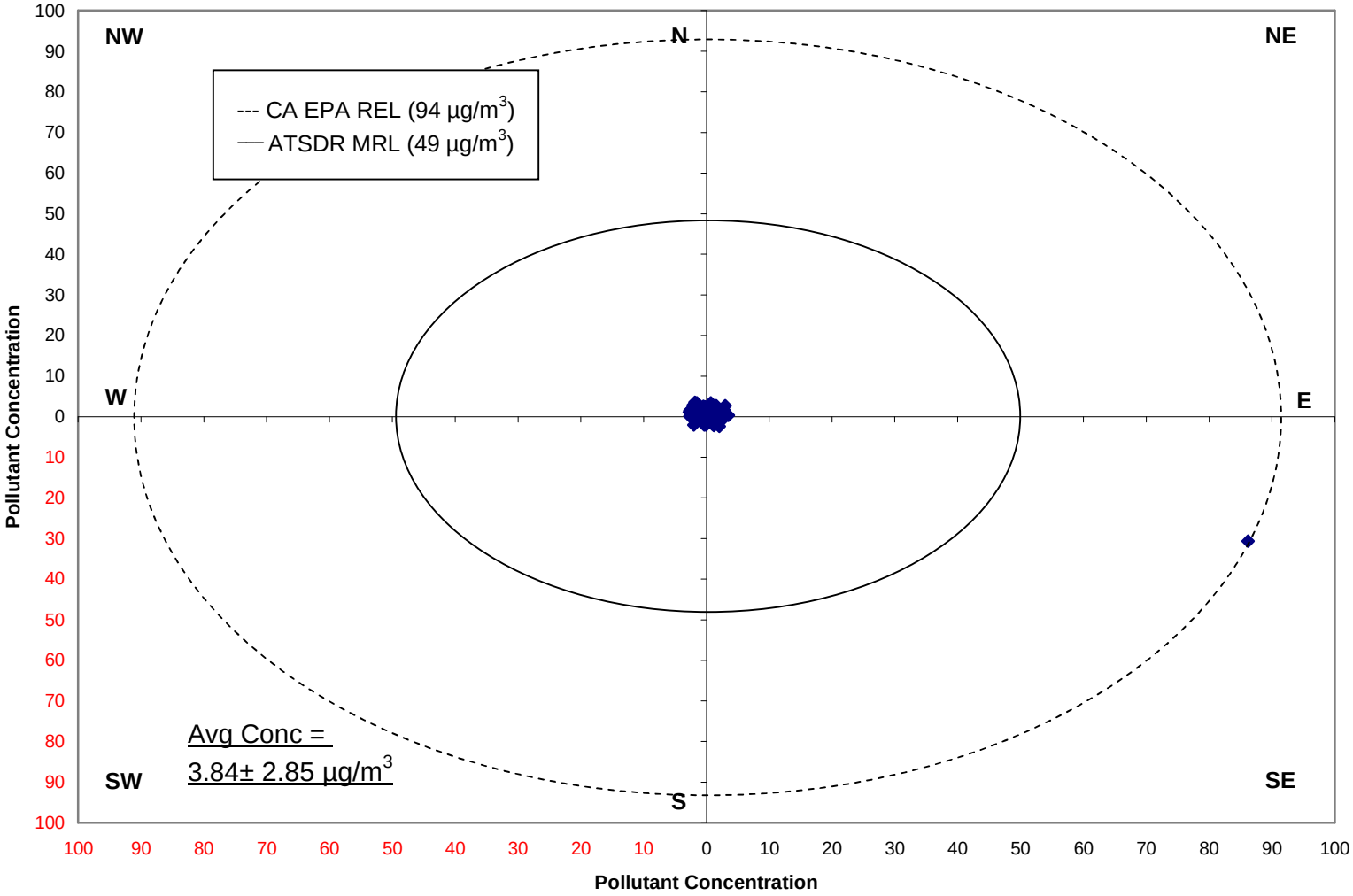


Figure 6-13. Formaldehyde Pollution Rose at SMFL

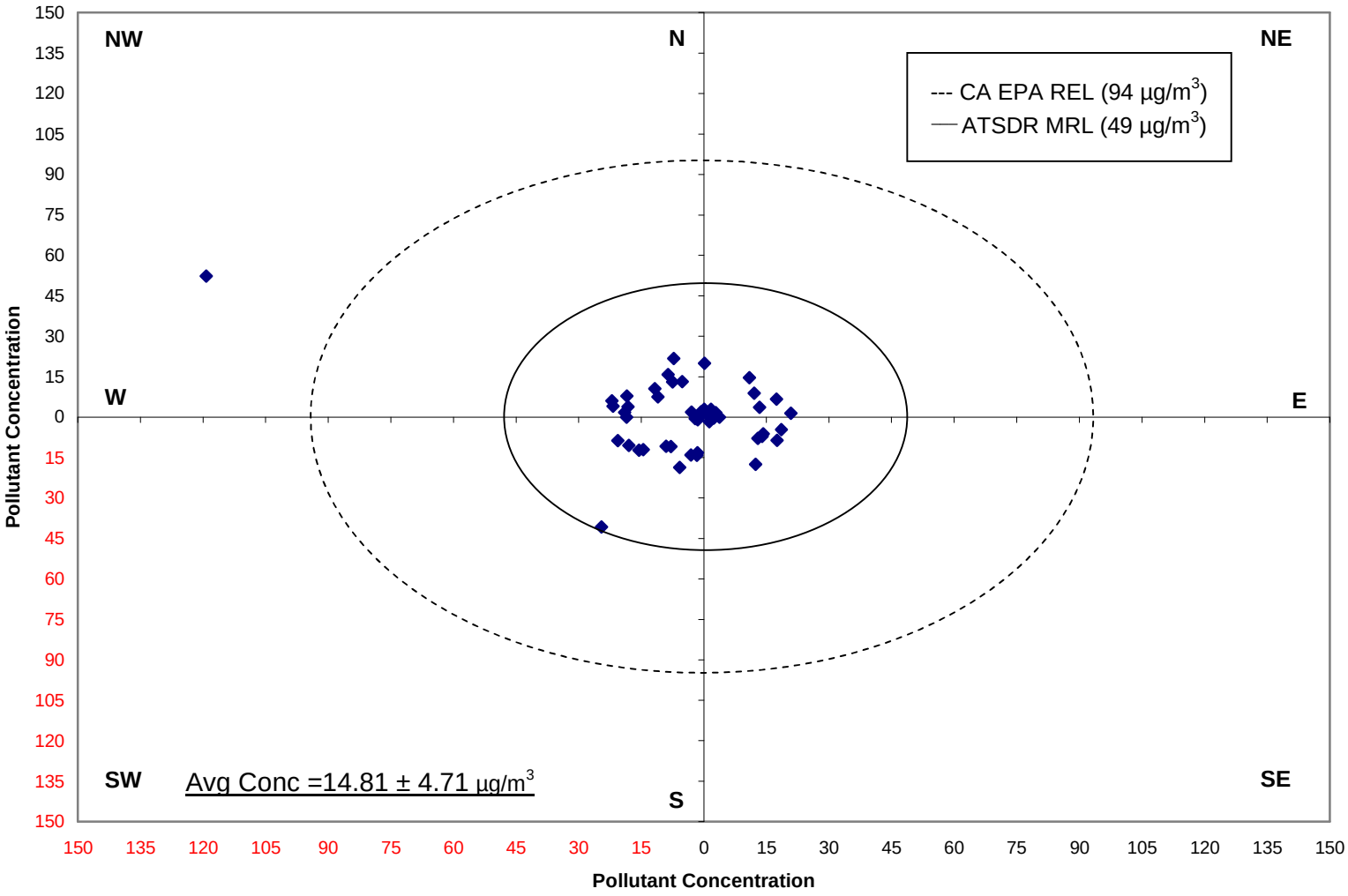


Figure 6-14. Composite Back Trajectory Map for AZFL

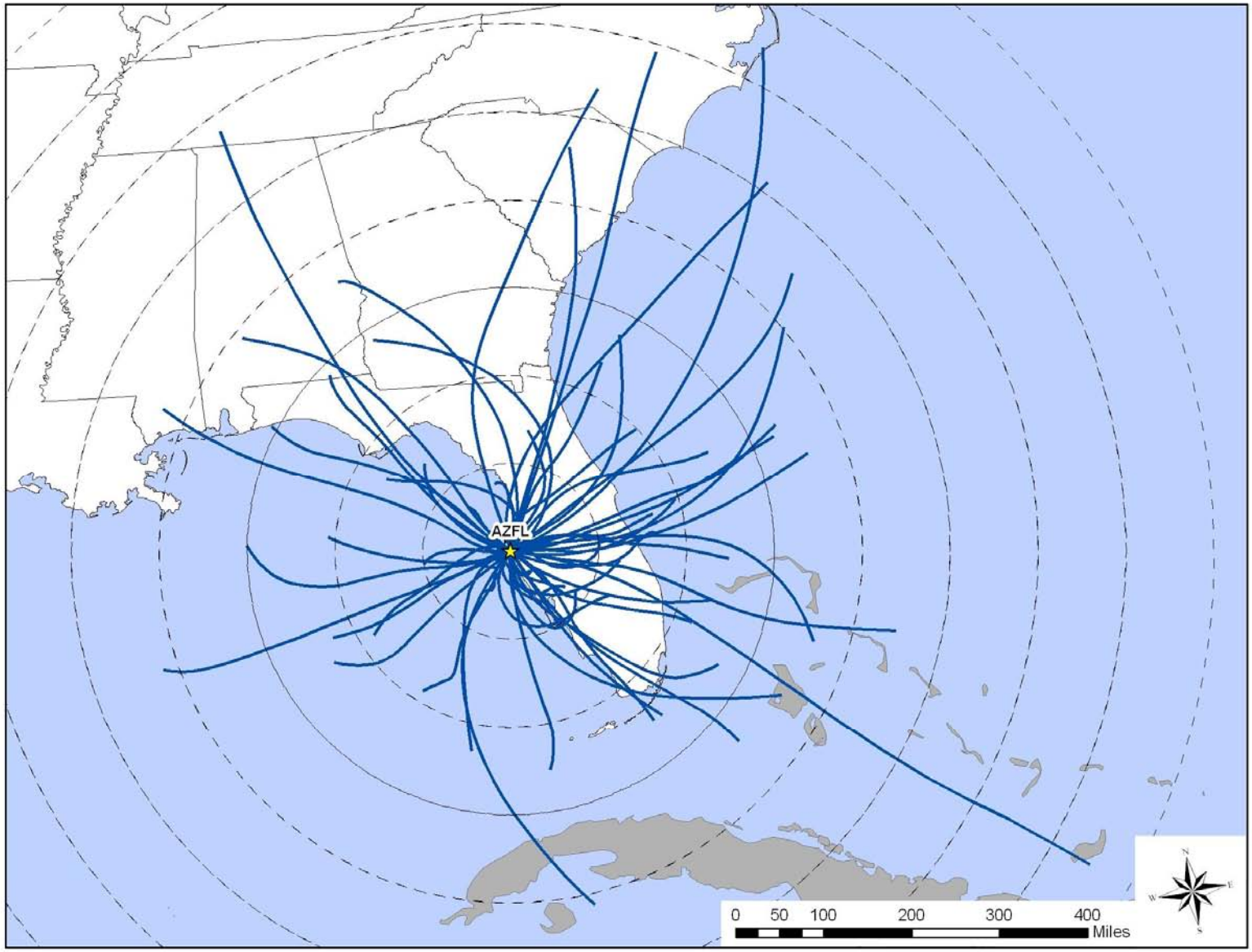


Figure 6-15. Composite Back Trajectory Map for GAFL

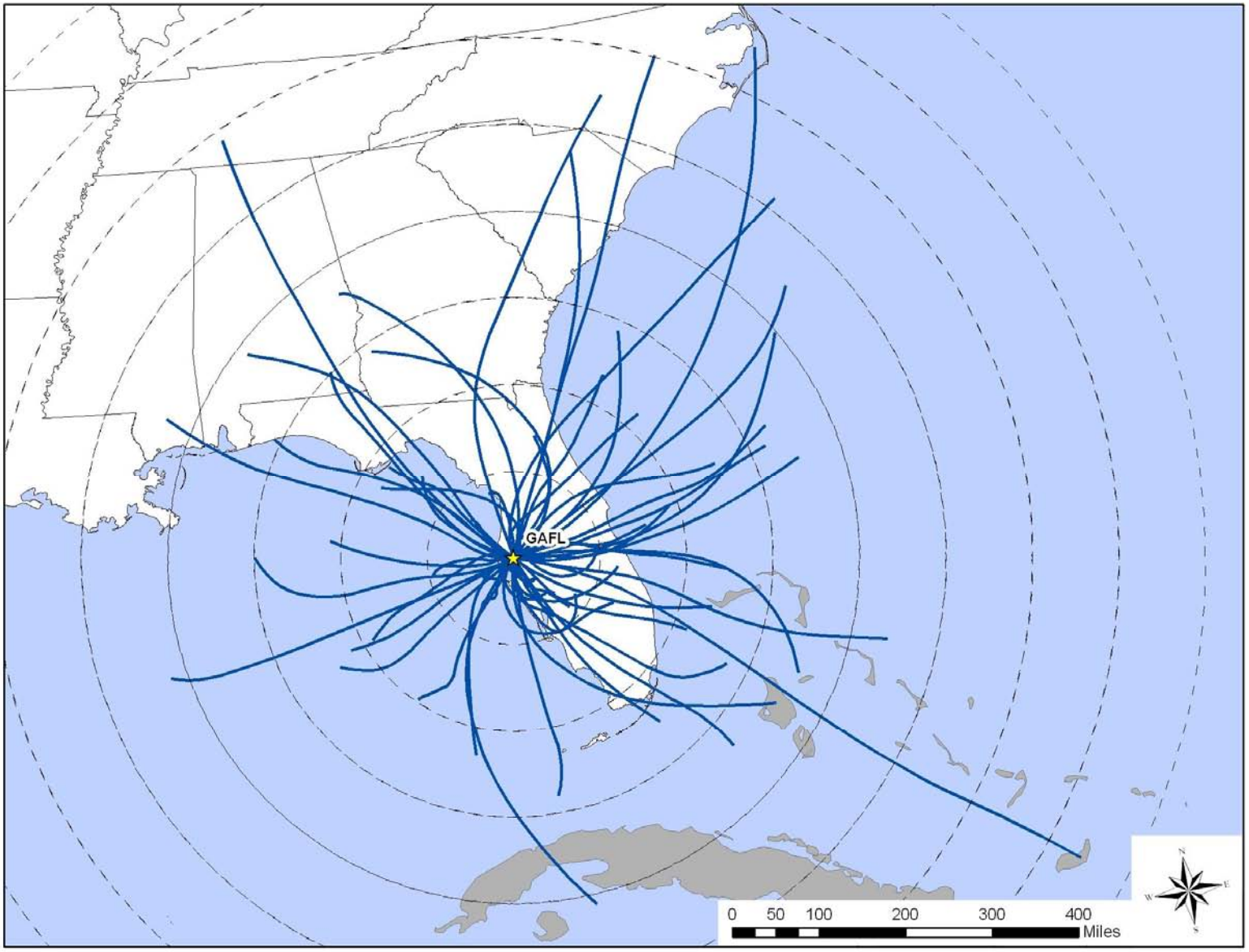


Figure 6-16. Composite Back Trajectory Map for SKFL

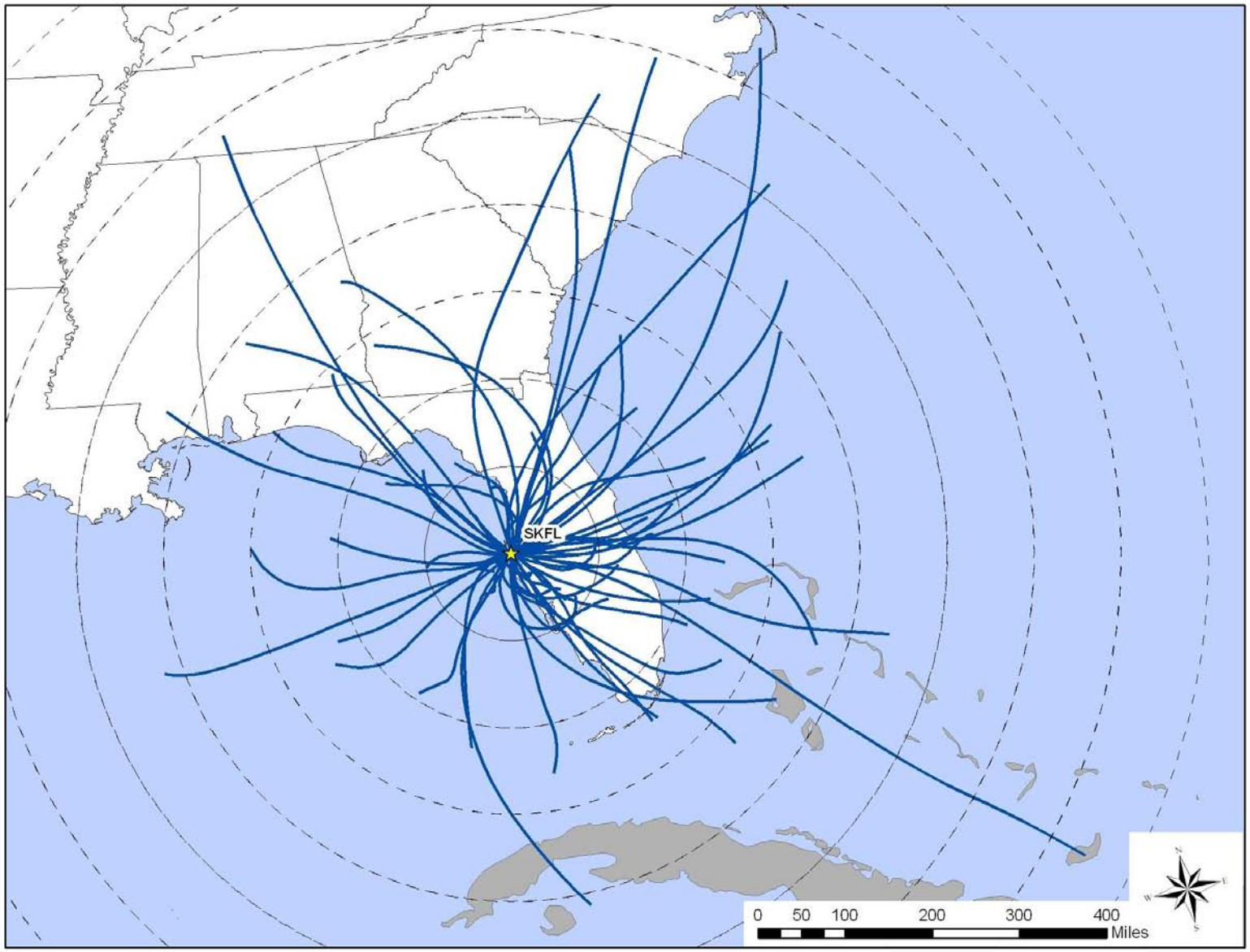


Figure 6-17. Composite Back Trajectory Map for SMFL

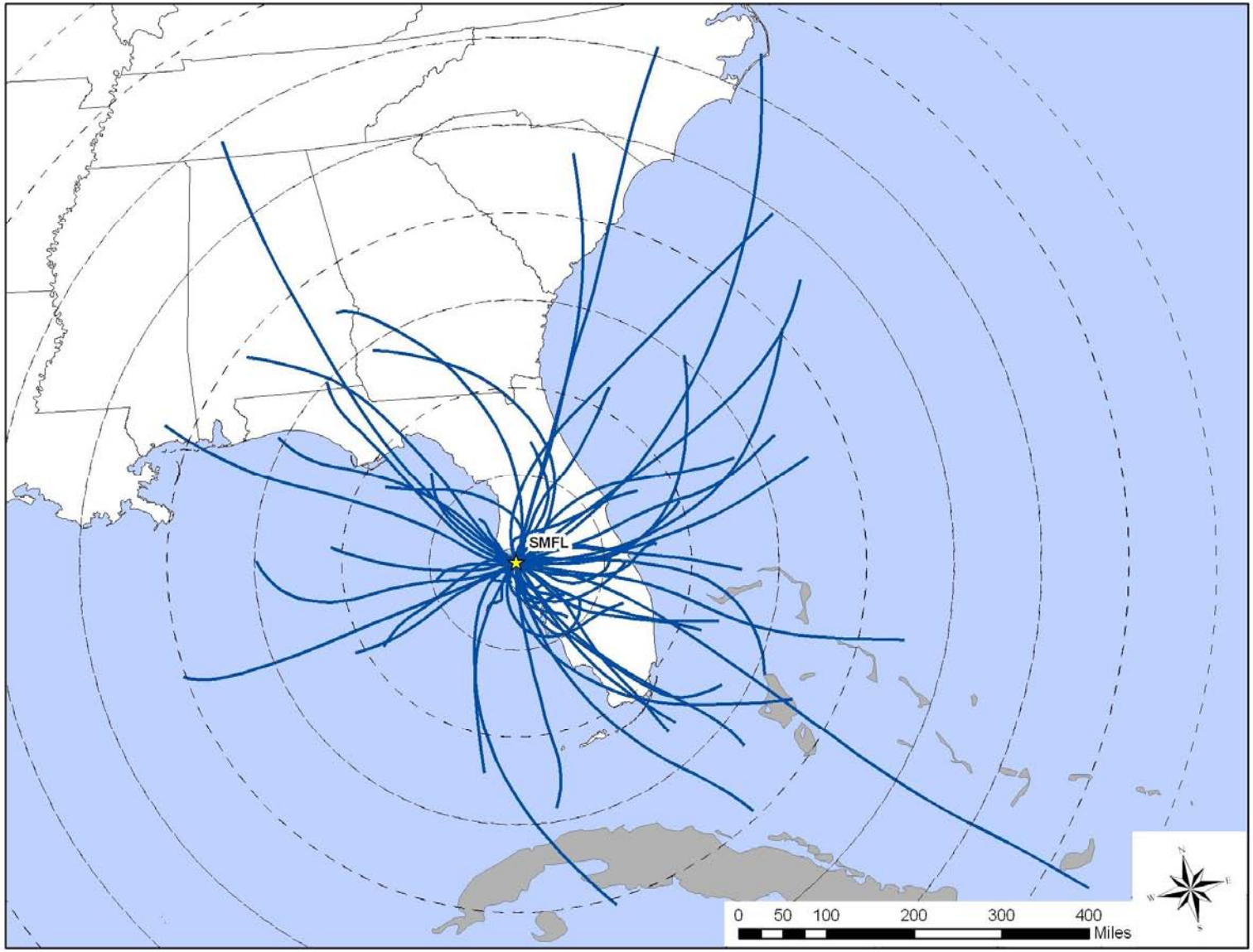


Figure 6-18. Composite Back Trajectory Map for SYFL

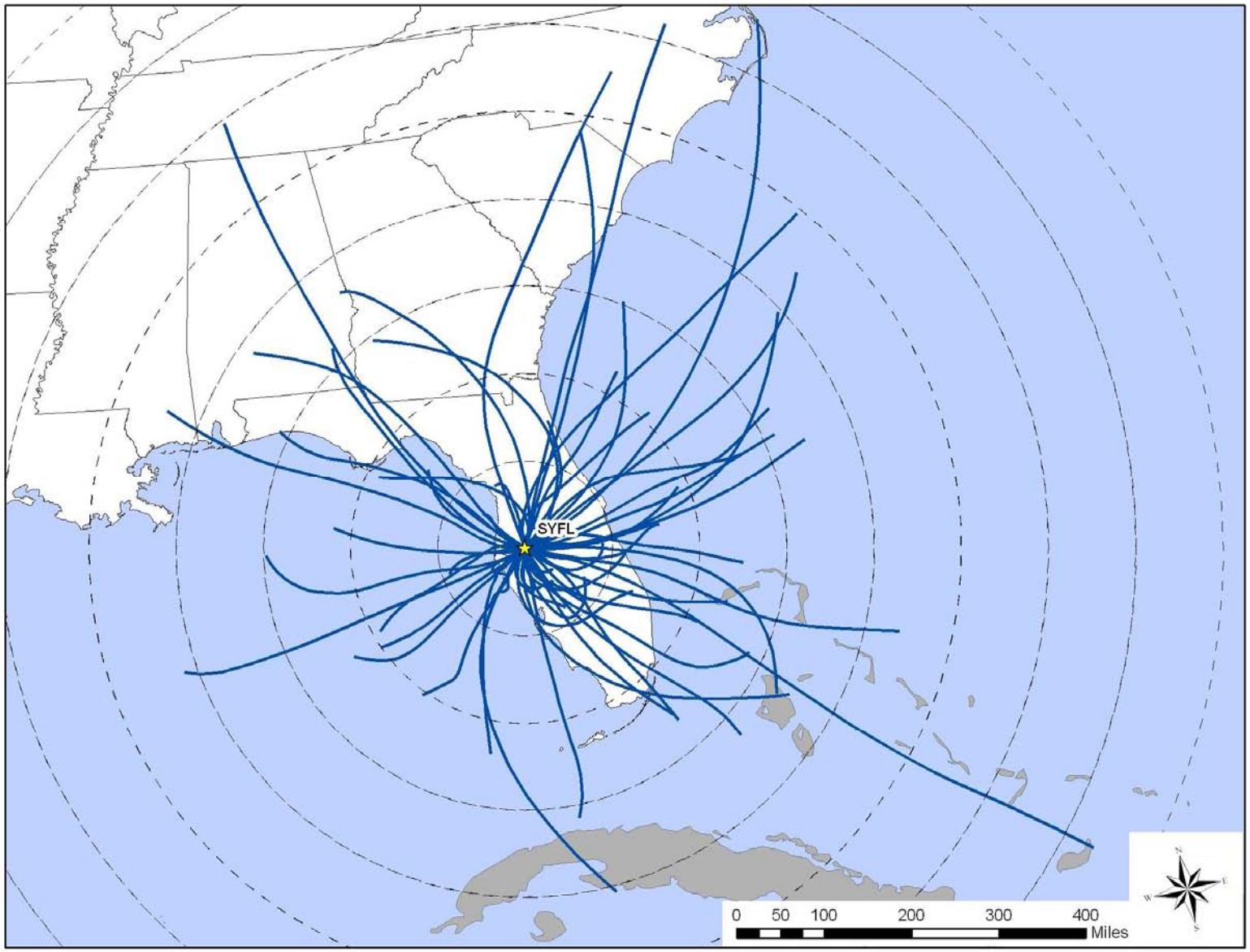


Figure 6-19. Composite Back Trajectory Map for FLFL

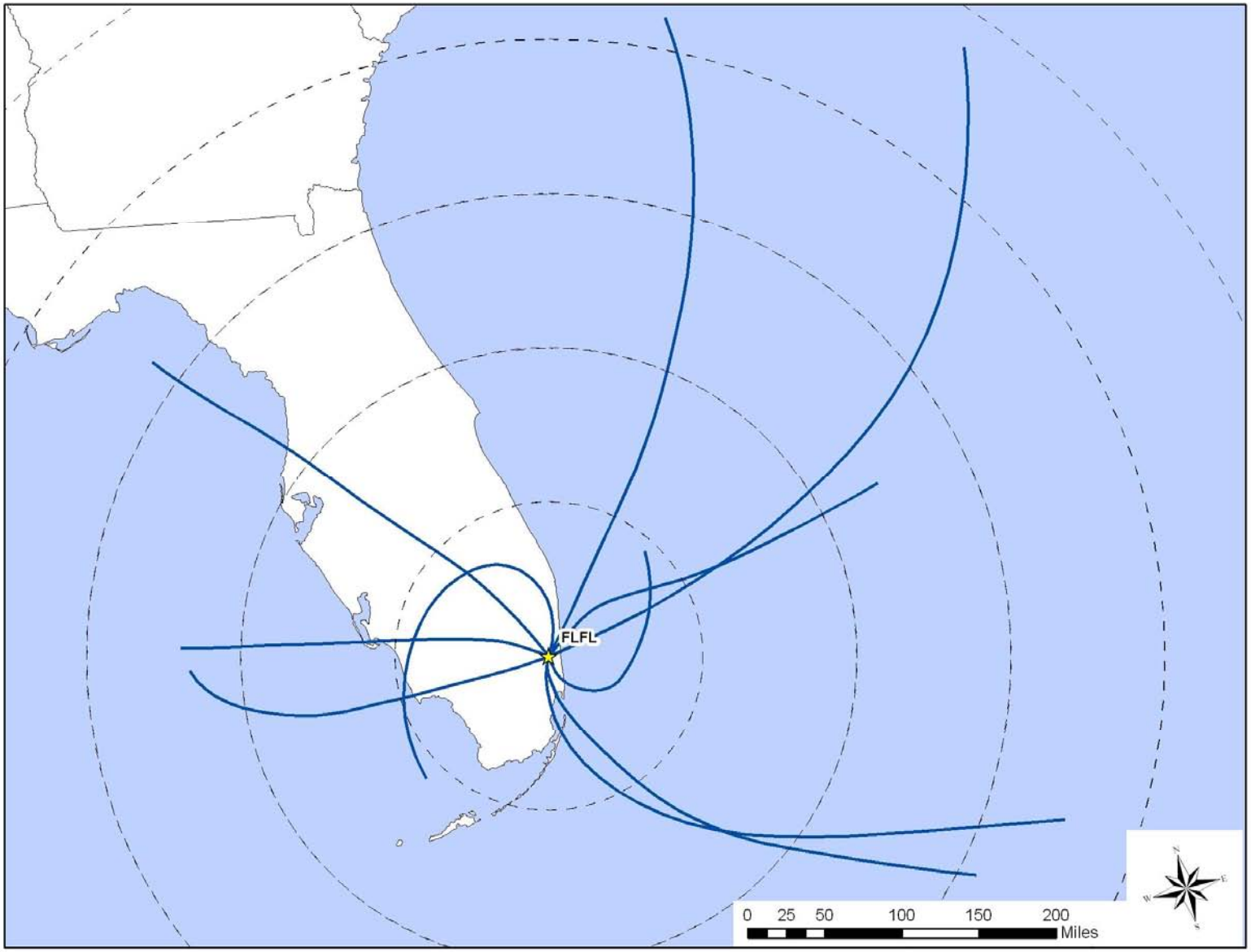


Figure 6-20. Composite Back Trajectory Map for ORFL

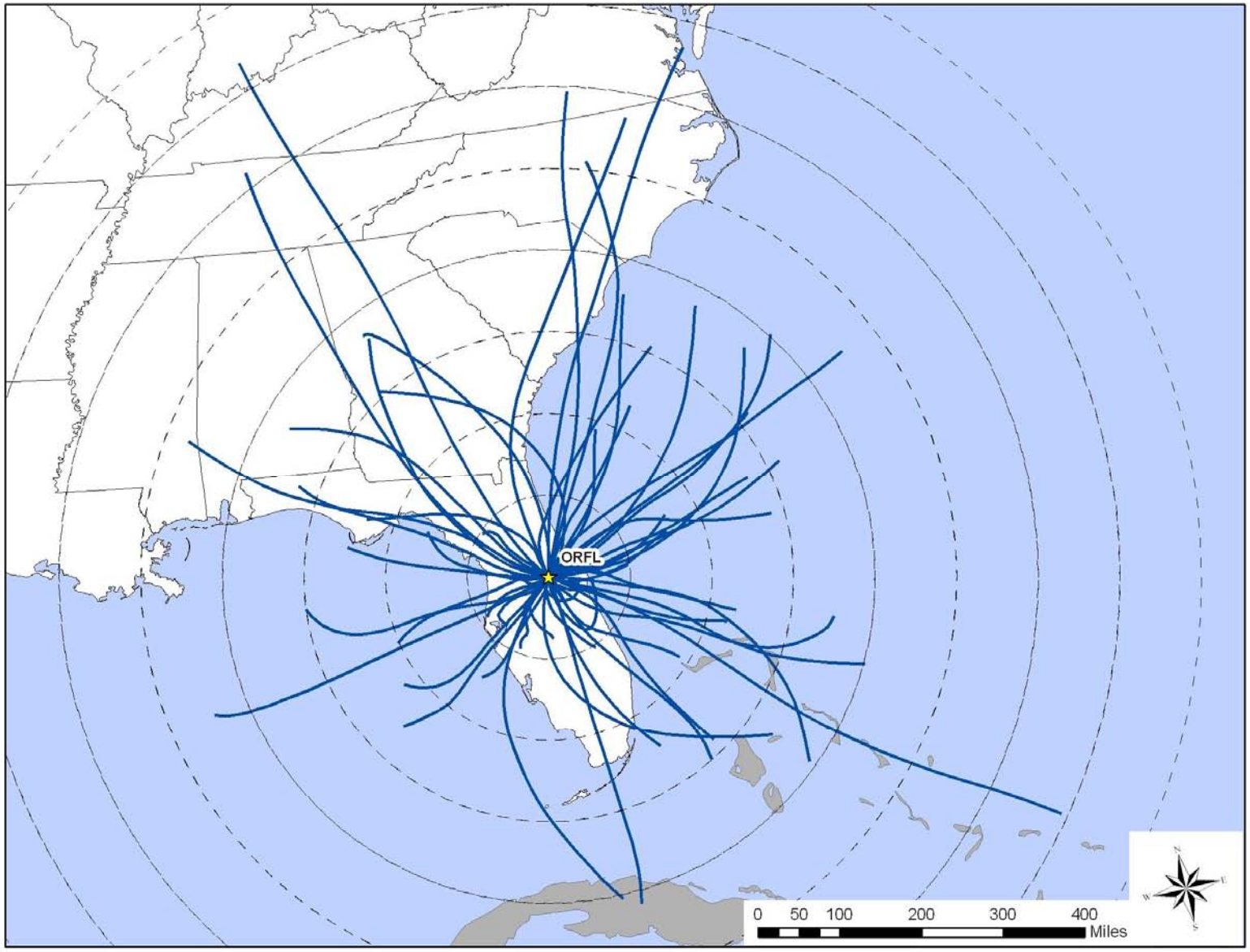


Figure 6-21. Wind Rose of Sample Days for the AZFL Monitoring Site

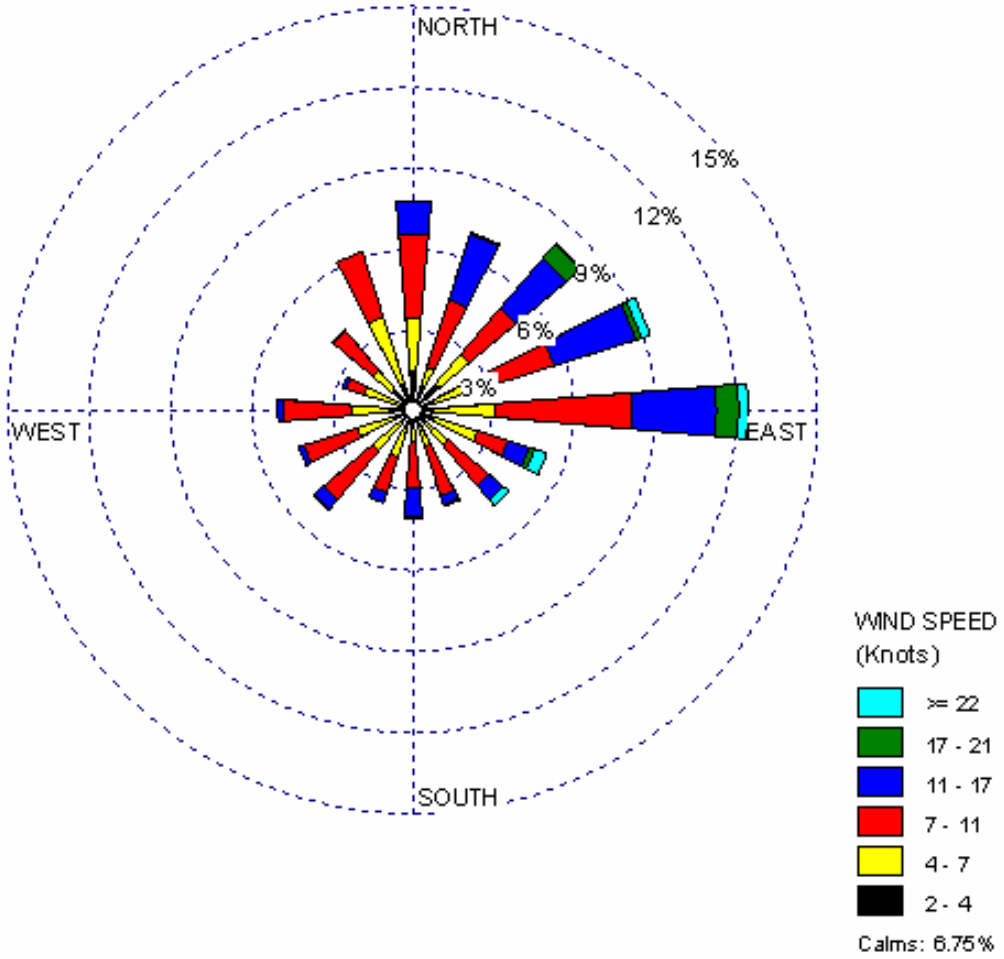


Figure 6-22. Wind Rose of Sample Days for the GAFL Monitoring Site

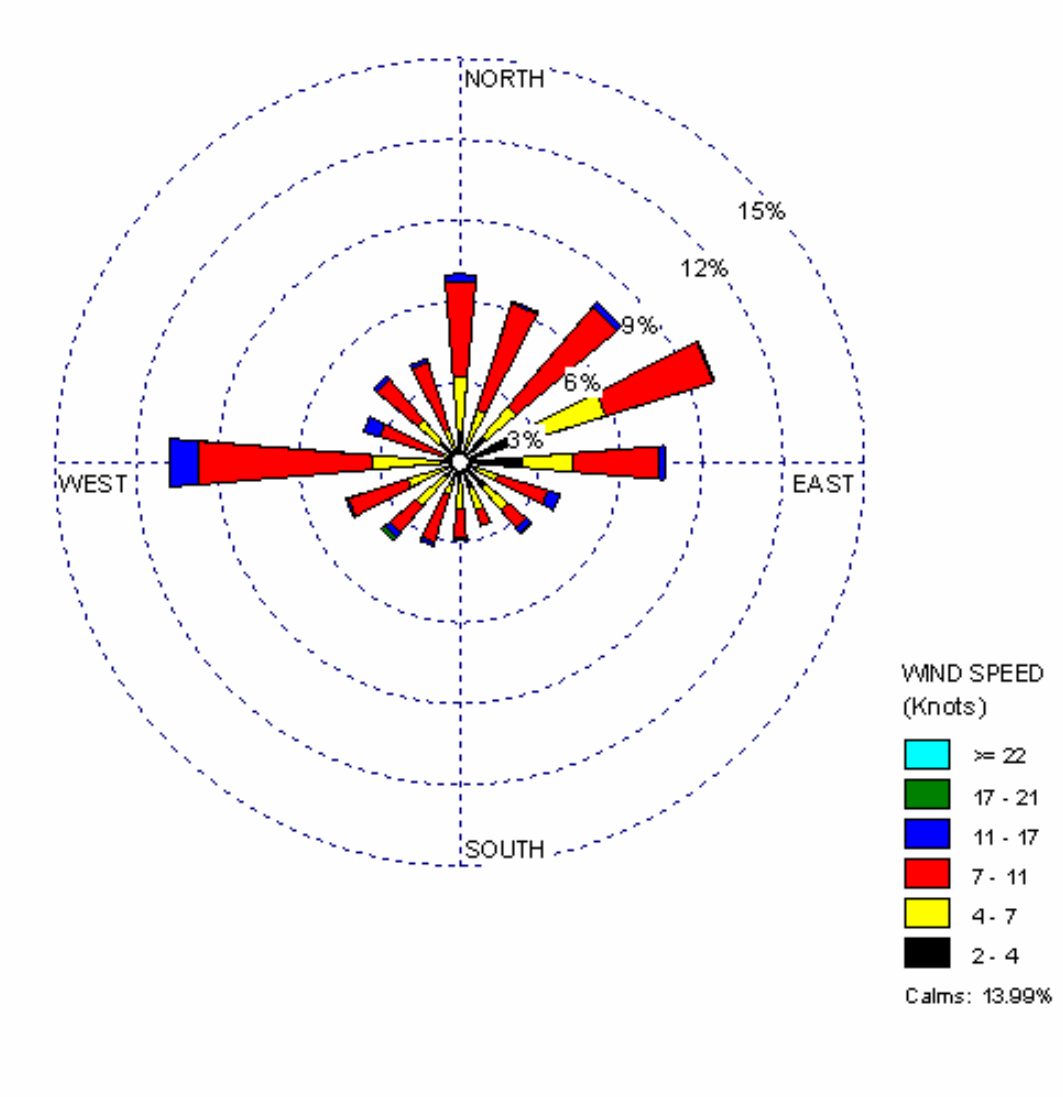


Figure 6-23. Wind Rose of Sample Days for the SKFL Monitoring Site

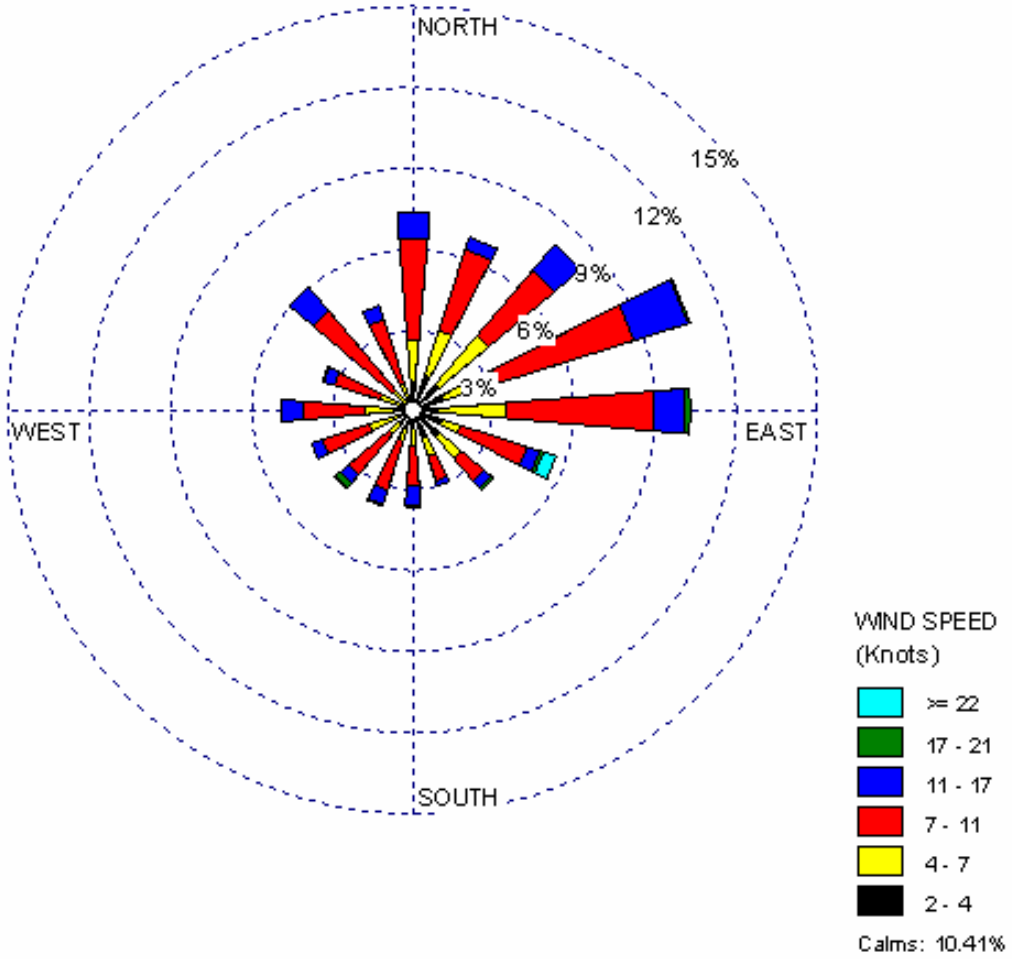


Figure 6-24. Wind Rose of Sample Days for the SMFL Monitoring Site

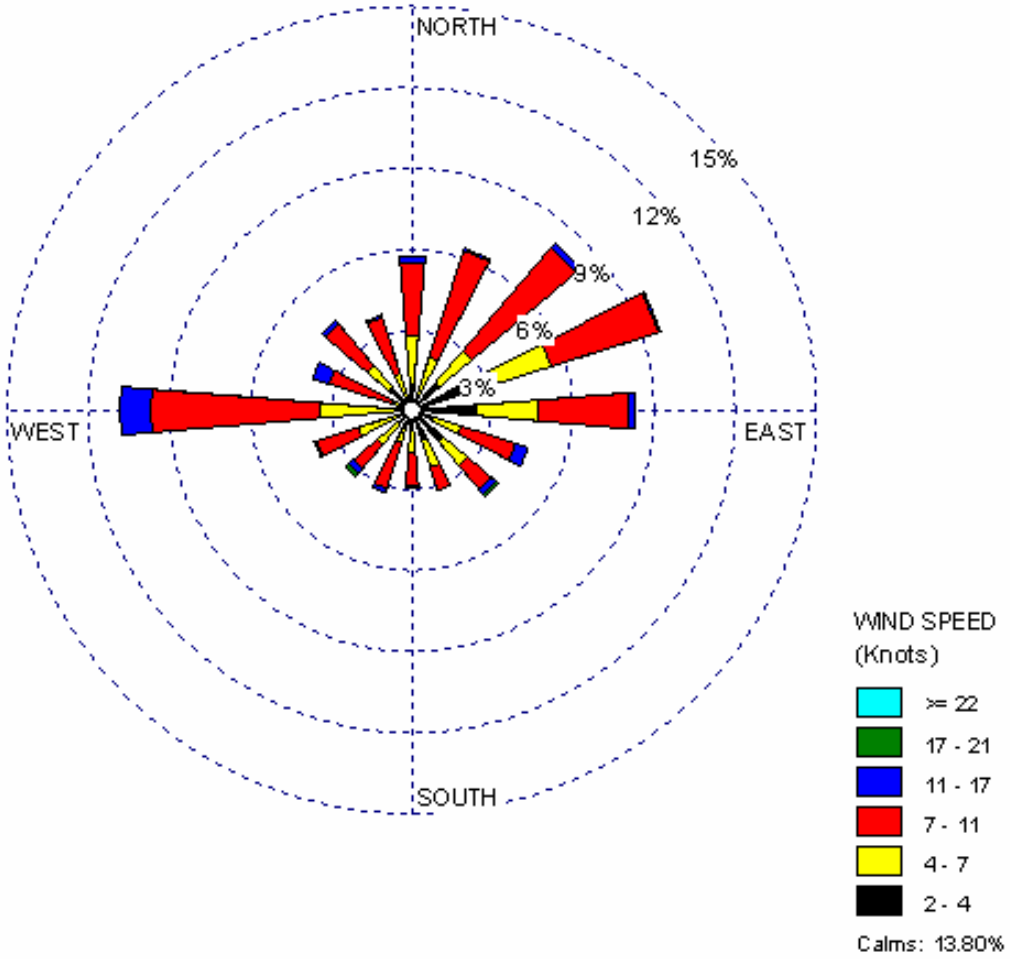


Figure 6-25. Wind Rose of Sample Days for the SYFL Monitoring Site

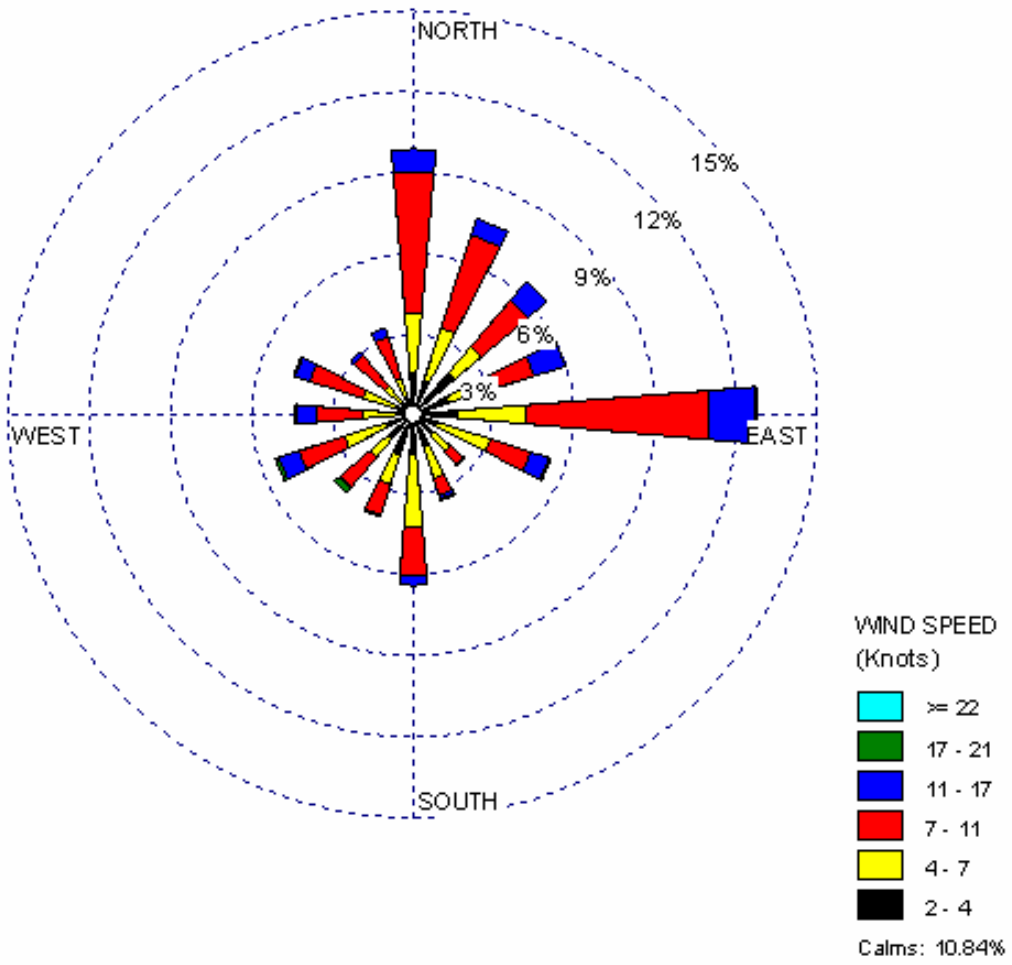


Figure 6-26. Wind Rose of Sample Days for the FLFL Monitoring Site

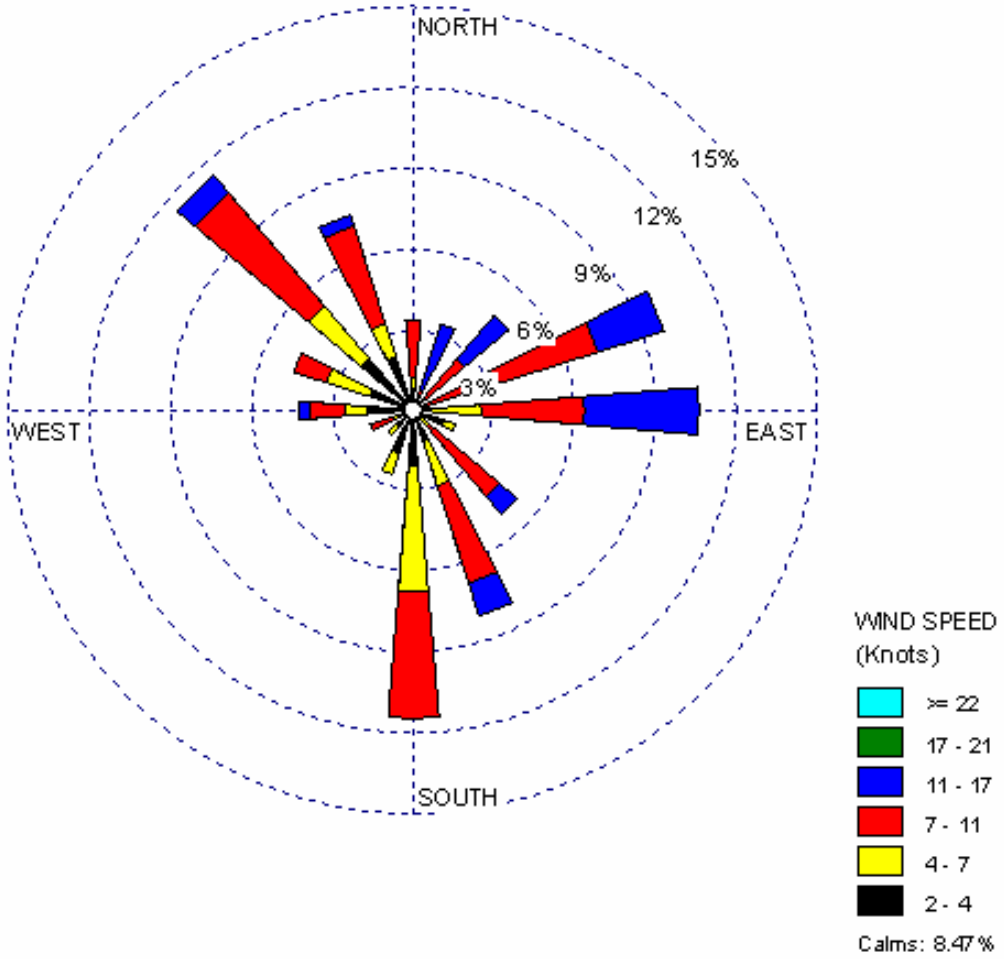


Figure 6-27. Wind Rose of Sample Days for the ORFL Monitoring Site

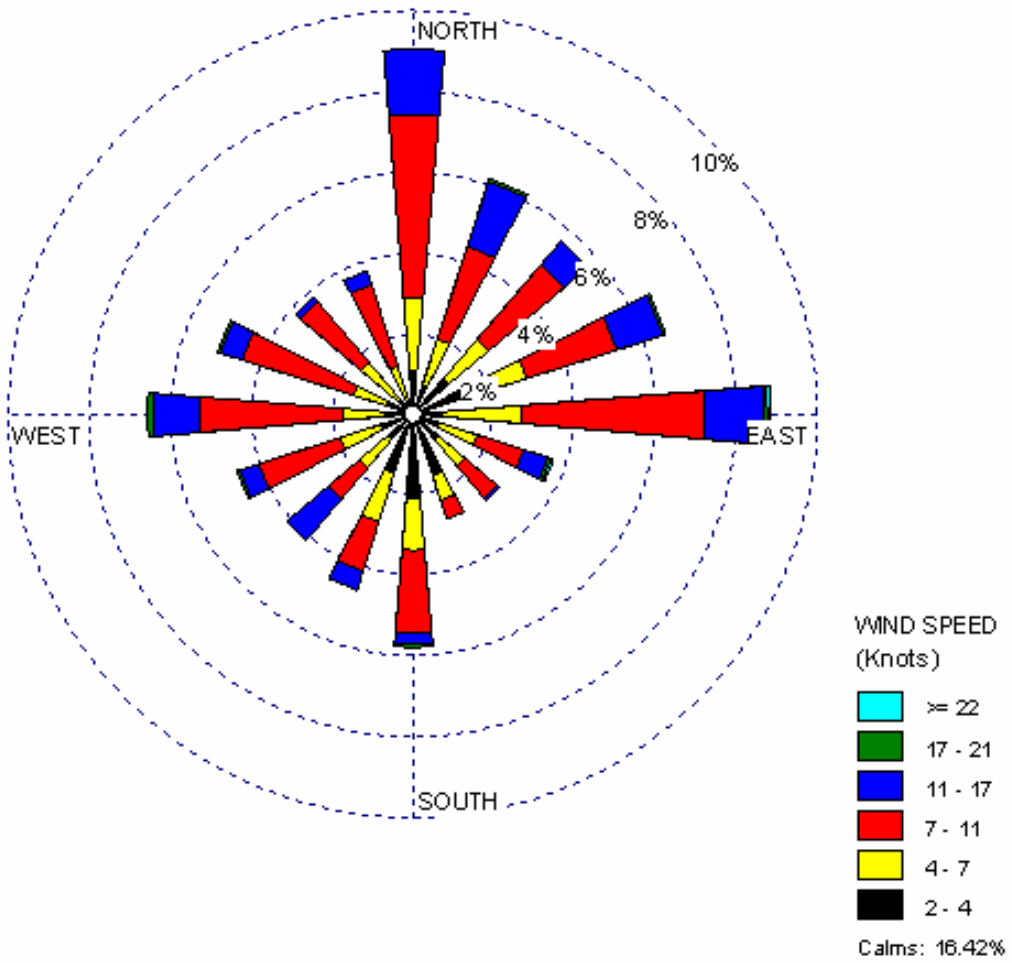


Figure 6-28. Comparison of Yearly Averages of the AZFL Monitoring Site

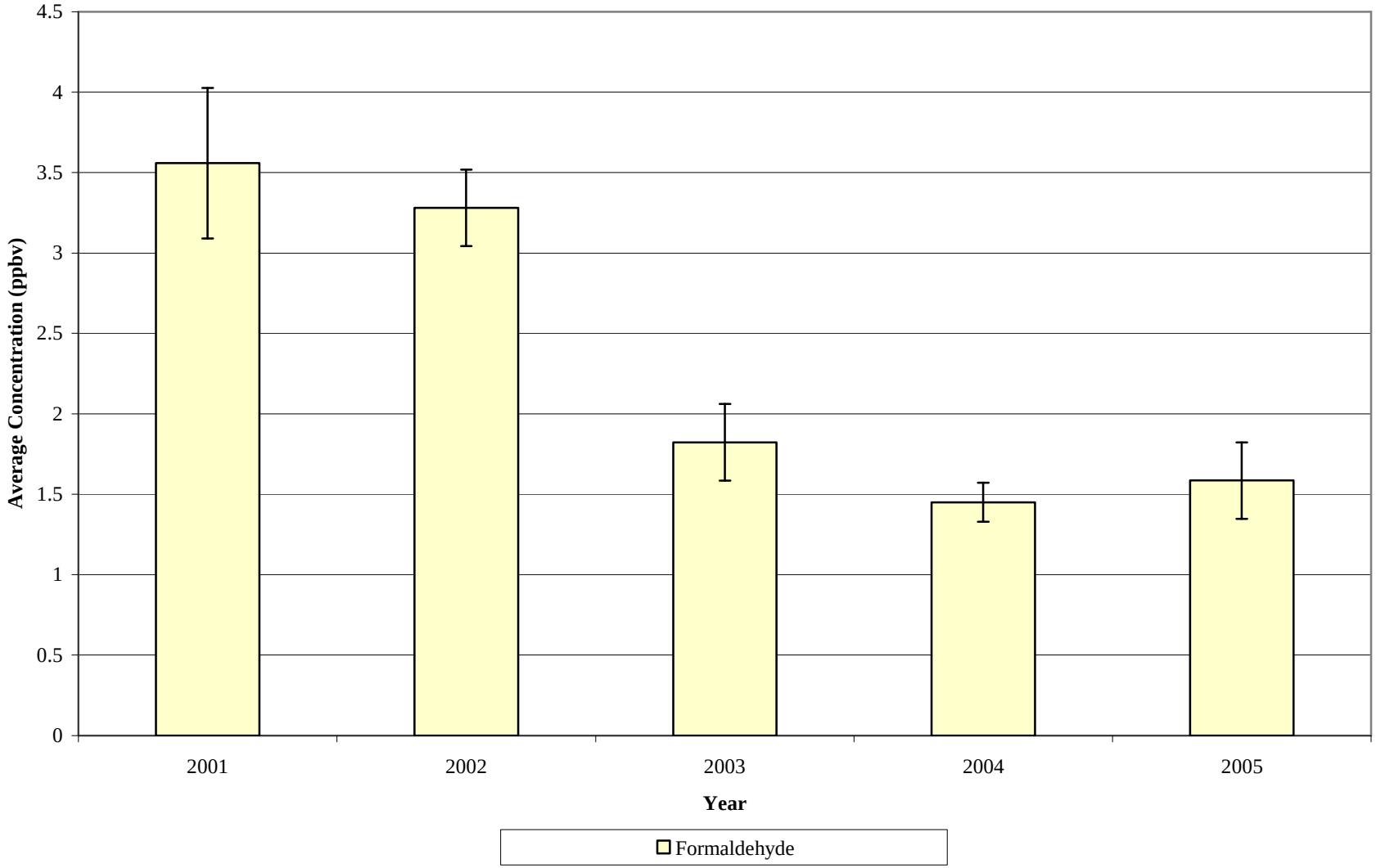


Figure 6-29. Comparison of Yearly Averages of the GAFL Monitoring Site

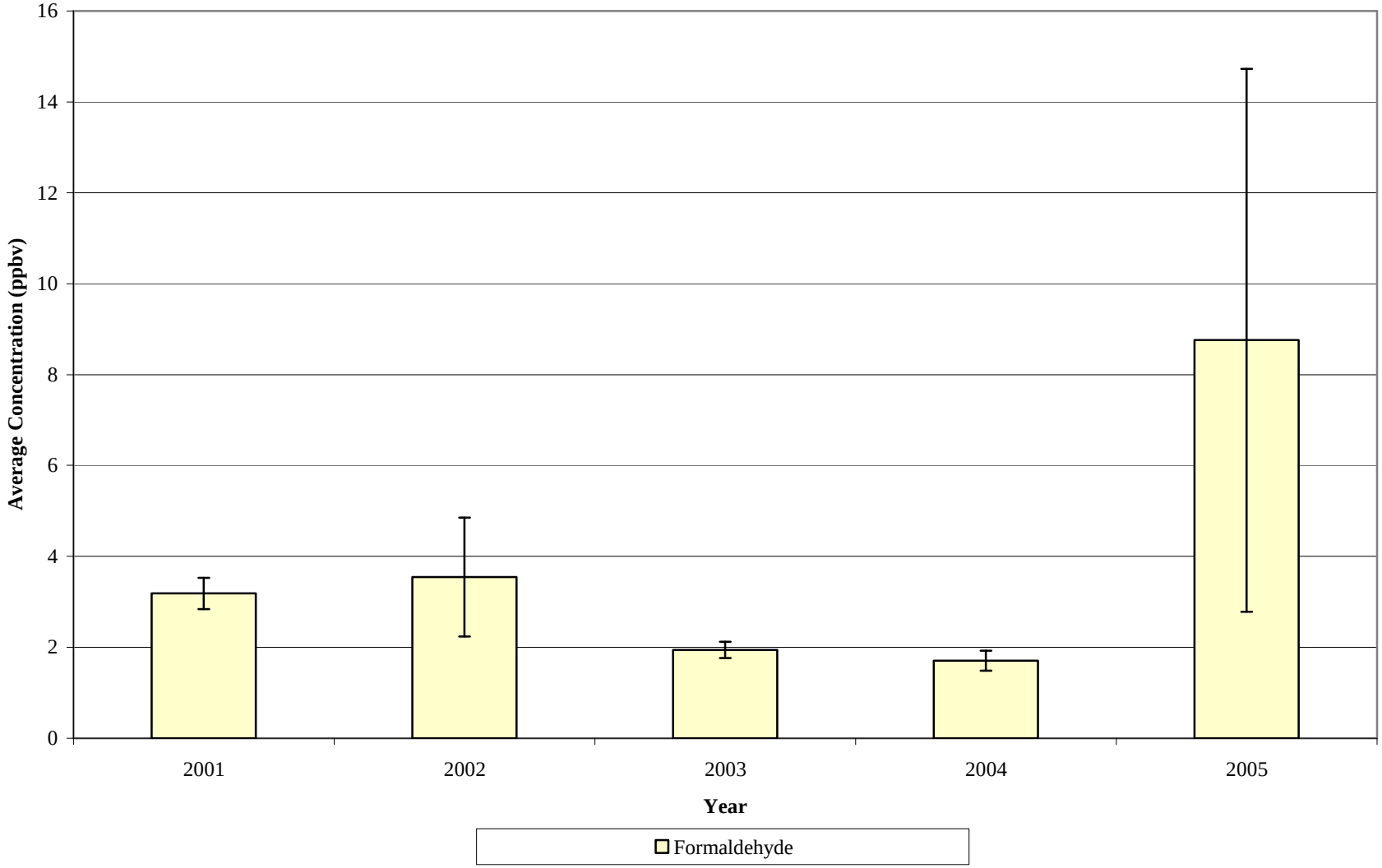


Figure 6-30. Comparison of Yearly Averages of the ORFL Monitoring Site

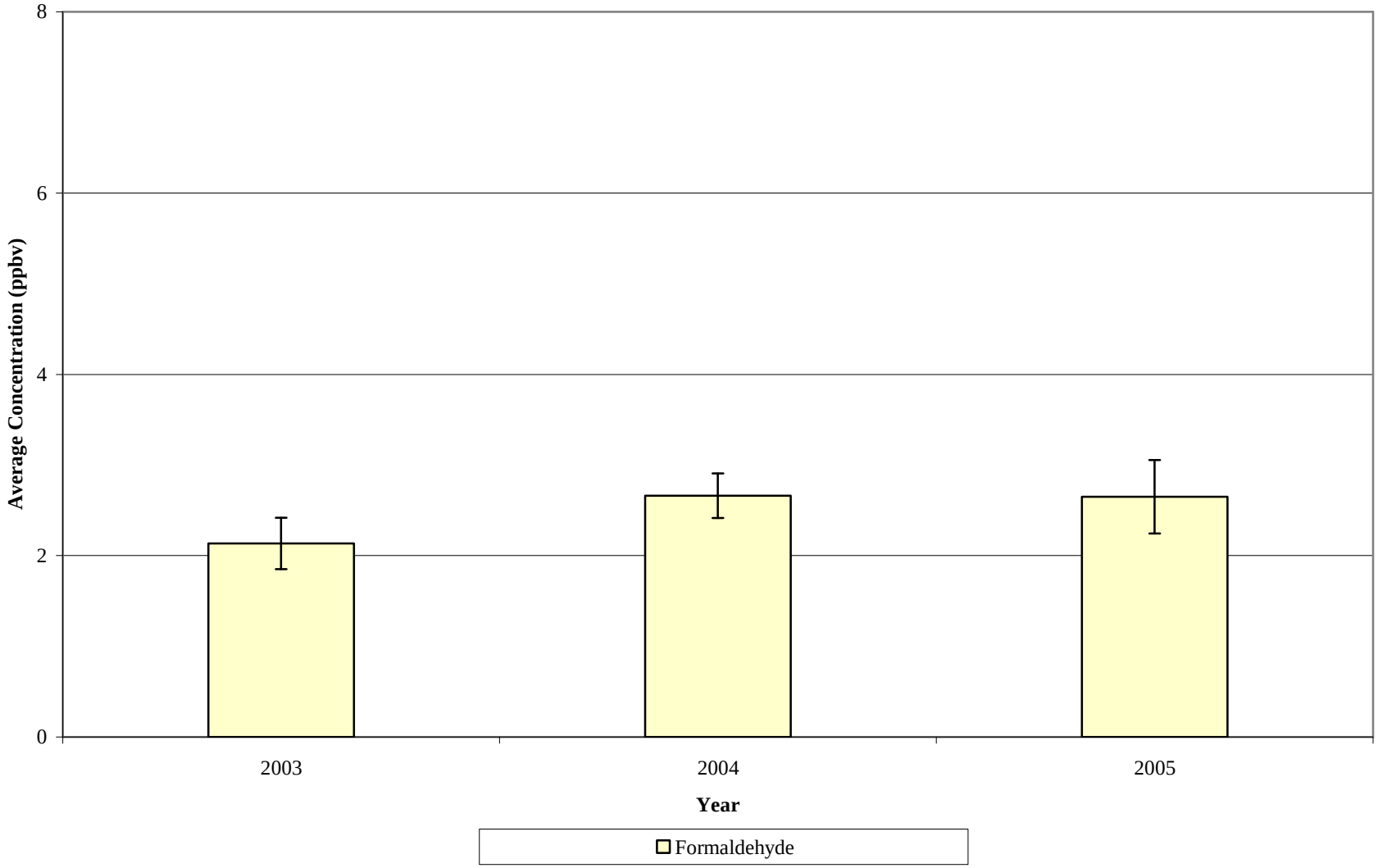


Table 6-1. Average Meteorological Parameters for Monitoring Sites in Florida

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
AZFL	92806	All 2005	81.30 ± 0.97	74.80 ± 1.00	63.78 ± 1.08	67.9 ± 0.94	69.80 ± 0.87	1016.00 ± 0.44	-2.06 ± 0.49	-0.83 ± 0.54
		Sample Day	81.08 ± 2.24	74.82 ± 2.27	63.95 ± 2.34	67.96 ± 2.08	70.18 ± 2.2	1016.05 ± 1.02	-2.38 ± 1.37	-1.01 ± 1.21
FLFL	12849	All 2005	81.58 ± 0.67	75.68 ± 0.76	65.89 ± 1.00	69.53 ± 0.82	73.10 ± 0.96	1015.64 ± 0.42	-2.94 ± 0.56	0.24 ± 0.47
		Sample Day	78.70 ± 2.29	71.91 ± 3.35	62.65 ± 4.91	66.28 ± 3.83	74.56 ± 6.35	1016.61 ± 1.73	-1.61 ± 2.67	-0.75 ± 2.77
GAFL	12842	All 2005	80.40 ± 0.93	72.17 ± 1.00	62.13 ± 1.16	66.06 ± 0.99	72.63 ± 0.95	1016.49 ± 0.44	-0.17 ± 0.39	-0.87 ± 0.37
		Sample Day	79.88 ± 2.26	71.97 ± 2.29	62.31 ± 2.48	66.01 ± 2.18	73.53 ± 2.30	1016.54 ± 1.03	-0.22 ± 1.01	-1.01 ± 0.84
ORFL	12841	All 2005	80.71 ± 0.97	71.86 ± 0.97	61.67 ± 1.20	65.75 ± 1.00	72.67 ± 1.08	1017.23 ± 0.45	-0.45 ± 0.45	-0.51 ± 0.4
		Sample Day	80.25 ± 2.43	71.58 ± 2.41	61.27 ± 2.99	65.41 ± 2.47	72.45 ± 2.91	1017.53 ± 1.03	-0.24 ± 1.16	-0.98 ± 1.02
SKFL	12873	All 2005	82.16 ± 0.95	74.12 ± 0.99	62.81 ± 1.12	67.13 ± 0.96	69.42 ± 0.87	1016.45 ± 0.44	-1.01 ± 0.46	-1.00 ± 0.50
		Sample Day	81.87 ± 2.21	74.07 ± 2.27	63.06 ± 2.41	67.19 ± 2.13	70.14 ± 2.08	1016.53 ± 1.02	-1.19 ± 1.19	-1.13 ± 1.09
SMFL	12842	All 2005	80.40 ± 0.93	72.17 ± 1.00	62.13 ± 1.16	66.06 ± 0.99	72.63 ± 0.95	1016.49 ± 0.44	-0.17 ± 0.39	-0.87 ± 0.37
		Sample Day	80.58 ± 2.26	72.73 ± 2.29	62.82 ± 2.55	66.60 ± 2.22	72.96 ± 2.35	1016.21 ± 0.99	-0.42 ± 1.05	-0.85 ± 0.84
SYFL	12876	All 2005	81.72 ± 0.96	72.08 ± 0.98	61.4 ± 1.17	65.63 ± 0.98	71.76 ± 0.98	1016.81 ± 0.44	-1.1 ± 0.44	-0.80 ± 0.40
		Sample Day	81.15 ± 2.31	71.92 ± 2.21	61.77 ± 2.57	65.73 ± 2.19	72.99 ± 2.49	1016.89 ± 1.01	-1.01 ± 1.07	-0.83 ± 0.96

Table 6-2. Comparison of Measured Concentrations and EPA Screening Values at the Florida Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
St. Petersburg, Florida – AZFL					
Acetaldehyde	57	57	100.0	50.9%	50.9%
Formaldehyde	55	57	96.5	49.1%	100.0%
Total	112	114	98.2		
Davie, Florida - FLFL					
Formaldehyde	9	9	100.0	50.0%	50.0%
Acetaldehyde	9	9	100.0	50.0%	100.0%
Total	18	18	100.0		
Gandy in Tampa, Florida - GAFL					
Acetaldehyde	57	57	100.0	50.4%	50.4%
Formaldehyde	56	57	98.2	49.6%	100.0%
Total	113	114	99.1		
Winter Park, Florida - ORFL					
Acetaldehyde	59	59	100.0	50.4%	50.4%
Formaldehyde	58	59	98.3	49.6%	100.0%
Total	117	118	99.2		
Pinellas Park, Florida - SKFL					
Acetaldehyde	61	61	100.0	50.4%	50.4%
Formaldehyde	60	61	98.4	49.6%	100.0%
Total	121	122	99.2		
Simmons Park in Tampa, Florida - SMFL					
Acetaldehyde	56	56	100.0	50.0%	50.0%
Formaldehyde	56	56	100.0	50.0%	100.0%
Total	112	112	100.0		
Plant City, Florida - SYFL					
Acetaldehyde	59	59	100.0	57.3%	57.3%
Formaldehyde	44	59	74.6	42.7%	100.0%
Total	103	118	87.3		

Table 6-3. Daily and Seasonal Averages for Pollutants of Interest at the Florida Monitoring Sites

Compound	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
St. Petersburg, Florida – AZFL												
Acetaldehyde	57	57	2.60	0.23	2.82	0.47	2.90	0.52	2.67	0.43	2.10	0.28
Formaldehyde	57	57	1.94	0.29	1.92	0.32	2.25	1.04	1.49	0.29	2.11	0.37
Davie, Florida – FLFL												
Acetaldehyde	9	9	2.77	0.29	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	9	9	2.33	0.13	NA	NA	NA	NA	NA	NA	NA	NA
Gandy in Tampa, Florida – GAFL												
Acetaldehyde	57	57	2.26	0.25	2.33	0.36	2.84	0.59	2.28	0.50	1.63	0.24
Formaldehyde	57	57	10.75	7.33	2.29	0.33	17.95	18.85	24.30	25.03	2.63	0.43
Winter Park, Florida – ORFL												
Acetaldehyde	59	59	1.81	0.23	2.37	0.64	1.98	0.34	1.46	0.28	1.44	0.28
Formaldehyde	59	59	3.25	0.50	3.60	1.58	3.37	0.67	3.63	0.66	2.50	0.54
Pinellas Park, Florida – SKFL												
Acetaldehyde	61	61	1.59	0.25	2.50	0.77	1.37	0.22	1.30	0.24	1.21	0.17
Formaldehyde	61	61	3.84	2.85	1.62	0.25	2.49	0.36	8.70	11.21	2.64	0.23
Simmons Park in Tampa, Florida – SMFL												
Acetaldehyde	56	56	2.39	0.27	2.82	1.02	3.04	0.16	2.19	0.27	1.61	0.22
Formaldehyde	56	56	14.81	4.71	12.79	7.86	27.27	13.94	16.03	1.50	2.60	0.34
Plant City, Florida – SYFL												
Acetaldehyde	59	59	1.25	0.16	1.35	0.51	1.38	0.22	1.15	0.22	1.12	0.16
Formaldehyde	59	59	2.25	1.04	3.30	3.95	1.28	0.28	2.59	0.56	1.90	0.43

NA = not available due to short sampling duration.

Table 6-4. Non-Chronic Risk Summary at the Florida Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
GAFL	TO-11A	Formaldehyde	10.75 ± 7.33	49	4	94	3	40	2.29 ± 0.33	17.95 ± 18.85	24.30 ± 25.03	2.63 ± 0.43
SKFL	TO-11A	Formaldehyde	3.84 ± 2.85	49	1	94	0	40	1.62 ± 0.25	2.49 ± 0.36	8.70 ± 11.21	2.64 ± 0.23
SMFL	TO-11A	Formaldehyde	14.81 ± 4.71	49	1	94	1	40	12.79 ± 7.86	27.27 ± 13.94	16.03 ± 1.50	2.60 ± 0.34

Table 6-5. Pollutant of Interest Concentration Correlations with Selected Meteorological Parameters at the Florida Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
St. Petersburg, Florida – AZFL									
Acetaldehyde	56	-0.01	-0.10	-0.16	-0.14	-0.14	-0.01	0.04	0.25
Formaldehyde	56	-0.06	-0.09	-0.14	-0.13	-0.14	-0.02	-0.07	-0.05
Davie, Florida – FLFL									
Acetaldehyde	9	-0.76	-0.80	-0.73	-0.79	-0.35	0.34	0.05	-0.17
Formaldehyde	9	0.24	0.20	0.12	0.15	-0.05	-0.02	-0.01	-0.55
Gandy in Tampa, Florida – GAFL									
Acetaldehyde	57	0.04	-0.02	-0.05	-0.05	-0.10	0.26	0.26	0.04
Formaldehyde	57	0.19	0.23	0.24	0.24	0.08	0.01	0.23	-0.21
Winter Park, Florida – ORFL									
Acetaldehyde	59	-0.24	-0.33	-0.40	-0.40	-0.32	0.31	0.04	0.33
Formaldehyde	59	0.15	0.09	0.02	0.03	-0.11	0.13	0.06	0.14
Pinellas Park, Florida – SKFL									
Acetaldehyde	61	-0.20	-0.29	-0.22	-0.26	0.16	0.13	0.10	0.41
Formaldehyde	61	0.08	0.13	0.14	0.14	0.06	-0.40	0.18	-0.18
Simmons Park in Tampa, Florida – SMFL									
Acetaldehyde	56	-0.16	-0.18	-0.15	-0.17	0.04	0.24	0.17	0.17
Formaldehyde	56	0.05	0.05	0.05	0.05	0.03	0.25	0.21	-0.09
Plant City, Florida – SYFL									
Acetaldehyde	59	0.00	-0.11	-0.27	-0.22	-0.38	0.24	0.01	0.10
Formaldehyde	59	0.07	0.02	-0.01	0.00	-0.06	0.09	0.07	0.02

Table 6-6. Motor Vehicle Information for the Florida Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
AZFL	928,032	1,030,672	1.11	572,722	636,065	51,000
FLFL	1,777,638	1,140,365	0.64	1,312,485	841,967	8,000
GAFL	1,132,152	835,689	0.74	462,119	341,109	81,400
ORFL	1,023,023	735,120	0.72	962,938	691,944	59,000
SKFL	928,032	1,030,672	1.11	698,981	776,288	50,500
SMFL	1,132,152	835,689	0.74	58,222	42,976	18,700
SYFL	1,132,152	835,689	0.74	259,538	191,576	5,142

Table 6-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Florida

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Azalea Park in St. Petersburg, Florida - AZFL, Census Tract 12103022402				
Acetaldehyde	2.60 ± 0.23	1.21	2.67	0.13
Formaldehyde	1.94 ± 0.29	1.31	0.01	0.13
Davie, Florida - FLFL, Census Tract 12011070204				
Acetaldehyde	NA	1.68	3.71	0.19
Formaldehyde	NA	2.30	0.01	0.23
Gandy in Tampa, Florida - GAFL, Census Tract 12057006500				
Acetaldehyde	2.26 ± 0.25	1.73	3.81	0.19
Formaldehyde	10.75 ± 7.33	1.72	0.01	0.18
Winter Park, Florida - ORFL, Census Tract 12095015901				
Acetaldehyde	1.81 ± 0.23	1.99	4.38	0.22
Formaldehyde	3.25 ± 0.50	1.99	0.01	0.20
Pinellas Park, Florida - SKFL, Census Tract 12103024905				
Acetaldehyde	1.59 ± 0.25	1.65	3.63	0.18
Formaldehyde	3.84 ± 2.85	1.73	0.01	0.18
Simmons Park in Tampa, Florida - SMFL, Census Tract 12057014107				
Acetaldehyde	2.39 ± 0.27	1.06	2.33	0.12
Formaldehyde	14.81 ± 4.71	1.26	0.01	0.13
Plant City, Florida - SYFL, Census Tract 12057012204				
Acetaldehyde	1.25 ± 0.16	1.25	2.75	0.14
Formaldehyde	2.25 ± 1.04	1.42	0.01	0.14

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

7.0 Sites in Illinois

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Illinois (NBIL and SPIL), located in the Chicago-Naperville-Joliet, IL-IN-WI metropolitan statistical area (MSA). Figures 7-1 and 7-2 are topographical maps showing the monitoring sites in their urban locations. Figure 7-3 identifies point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 7-3 shows, the NBIL and SPIL sites are within several miles of each other, and are surrounded by numerous point sources. Fuel combustion industries, surface coating facilities, and printing and publishing industries are the most numerous source category groups surrounding these sites.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The two weather stations are Palwaukee Municipal Airport and O'Hare International Airport (WBAN 4838 and 94846, respectively).

Daily weather fluctuations are common for the Chicago area due to its location near the Great Lakes. The proximity of Chicago to Lake Michigan offers moderating effects from the continental climate of the region. In the summertime, lake breezes can cool the city when winds from the south and southwest push temperatures upward. How much and what type of winter precipitation depends on the origin of the air mass. The largest snowfalls tend to occur when cold air masses flow southward over Lake Michigan. Wind speeds average around 10 mph, but can be greater due to the winds channeling between tall buildings downtown (Ruffner and Bair, 1987). Table 7-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 7-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

7.1 Polllutants of Interest at the Illinois Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total failed screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 7-2 presents the pollutants that failed at least one screen at the Illinois monitoring sites. The number of pollutants failing the screen varies by site, as presented in Table 7-2. Twenty-one pollutants with a total of 372 measured concentrations failed screens at NBIL while 16 pollutants with a total of 324 measured concentrations failed screens at SPIL. The pollutants of interest, which are highlighted in gray, also varied by site, yet the following nine pollutants were common to both sites: benzene, formaldehyde, carbon tetrachloride, 1,3-butadiene, acetaldehyde, tetrachloroethylene, hexachloro-1,3-butadiene, *p*-dichlorobenzene, and trichloroethylene. It's important to note that NBIL sampled for additional pollutant types compared to SPIL and that this is reflected in each site's pollutants of interest. Carbonyls, VOC, SNMOC, and metals were sampled at the NBIL monitoring site, while only carbonyls and VOCs were sampled at SPIL.

Also listed in Table 7-2 are the total number of detects and the percent detects failing the screen. Of the nine pollutants that were the same between the two sites, three pollutants of interest, benzene, carbon tetrachloride, and hexachloro-1,3-butadiene, had 100% of their detects fail the screening values.

7.2 Concentration Averages at the Illinois Monitoring Sites

Three types of concentration averages were calculated for the compounds of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average was not calculated for pollutants with less than seven detects in

a respective season. Finally, the *annual* average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 7-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at NBIL, formaldehyde measured the highest concentration by mass (2.07 ± 0.52 μg/m^3), followed by acrolein (1.50 ± 0.71 μg/m^3) and acetaldehyde (1.11 ± 0.18 μg/m^3). Valid seasonal averages for formaldehyde and acetaldehyde are only available in the spring and fall (NBIL did not begin sampling carbonyls until March), and are similar to the daily average. Acrolein has no valid seasonal averages. Most of the pollutants of interest's seasonal averages vary little from their daily averages.

At the SPIL monitoring site, the pollutant with the highest daily average was formaldehyde (28.09 ± 12.20 μg/m^3). This pollutant daily average concentration was significantly higher than any of the other pollutants of interest. The highest seasonal average of formaldehyde occurred in the summer (53.82 ± 30.52 μg/m^3), followed by the autumn average (34.62 ± 16.51 μg/m^3). The springtime average was significantly lower (2.17 ± 0.47 μg/m^3) and no winter average could be calculated (SPIL did not begin sampling carbonyls until February). The acetaldehyde summer average (0.68 ± 0.43 μg/m^3) was significantly lower than the spring or autumn averages (1.70 ± 0.38 and 1.59 ± 0.39 μg/m^3, respectively). The remaining seasonal averages did not vary much from season to season.

7.3 Non-chronic Risk Evaluation at the Illinois Monitoring Sites

Non-chronic risk for the concentration data at Illinois monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily

measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein and formaldehyde exceeded either the acute and/or intermediate risk values. Non-chronic risk is summarized in Table 7-4.

All acrolein detects at the Illinois sites were greater than the ATSDR acute MRL value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$. The average detected concentrations at NBIL and SPIL were 1.50 ± 0.71 $\mu g/m^3$ and 1.56 ± 0.79 $\mu g/m^3$, respectively. Both averages are an order of magnitude higher than either acute risk factor. No seasonal averages for acrolein could be calculated at NBIL, therefore intermediate risk could not be evaluated. Only one valid seasonal acrolein average could be calculated at SPIL. The autumn average of acrolein was 0.70 ± 0.51 $\mu g/m^3$ at SPIL, which is significantly higher than the intermediate risk factor of 0.09 $\mu g/m^3$.

Eleven formaldehyde detects at the SPIL site were greater than the ATSDR acute MRL of 49 $\mu g/m^3$ and five detects were greater than the California REL value of 94 $\mu g/m^3$. The average detected concentration at SPIL was 28.09 ± 12.20 $\mu g/m^3$. Valid seasonal formaldehyde averages were calculated for spring, summer, and autumn (SPIL did not begin sampling carbonyls until February). The summer seasonal average of formaldehyde (53.82 ± 30.52 $\mu g/m^3$) exceeded the ATSDR intermediate risk value of 40 $\mu g/m^3$.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Acrolein concentrations exceeded the acute risk factors at both NBIL and SPIL, and the acute risk factor for formaldehyde was exceeded at SPIL. Figures 7-4 and 7-5 are pollution roses for acrolein, and Figure 7-6 is a pollution rose for formaldehyde. A pollution rose is a plot of concentration and wind direction.

As shown in Figures 7-4 and 7-5, and discussed above, all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL). Figure 7-4 shows that high acrolein concentrations at NBIL occurred with

winds originating from a variety of directions. However, none of these high concentrations occurred with winds with an easterly component. The highest acrolein concentration at NBIL was recorded on December 18, 2005, with westerly winds. Major roadways and expressways surround the NBIL monitoring site, yet the area is primarily residential. Figure 7-5 shows that high acrolein concentrations at SPIL also occurred with winds originating from a variety of directions. However, none of these high concentrations occurred with winds with an easterly component. The highest acrolein concentration at SPIL was recorded on September 19, 2005, with southwesterly winds. Major roadways and highways are situated to the north, east, and south of the SPIL monitoring site, and Chicago O'Hare International Airport is located to the west.

Figure 7-6 shows that few detected formaldehyde concentrations exceeded the acute risk factor values. Only eleven formaldehyde detects at SPIL exceeded the ATSDR acute risk factor, and five exceeded the CAL EPA REL risk factor. While high concentrations of formaldehyde occurred with winds originating from a variety of directions, Figure 7-6 shows a cluster of high concentrations occurring with southwesterly winds. Yet, the highest formaldehyde concentration occurred with northerly winds on August 14, 2005.

7.4 Meteorological and Concentration Analysis at the Illinois Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

7.4.1 Pearson Correlation Analysis

Table 7-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Illinois monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) The strongest correlations at the NBIL site occurred with hexachloro-1,3-butadiene and most of the meteorological parameters, ranging from -0.88 to 0.94. However, it's important to note that this

pollutant was detected only eight times. Six pollutants (arsenic, manganese, nickel, *p*-dichlorobenzene, tetrachloroethylene, and trichloroethylene) exhibited moderately strong to strong positive correlations with the maximum, average, dew point, and wet bulb temperature, while three pollutants (acrolein, 1,3-butadiene, and hexachloro-1,3-butdiene) exhibited moderately strong to very strong negative correlations with the same parameters. Arsenic, benzene, manganese, *p*-dichlorobenzene, and tetrachloroethylene all had moderately strong negative correlations with the *u*-component of the wind, while acrolein had a strong positive correlation (0.62) with this same parameter. Acrolein was also detected very few times. Moderately strong positive correlations with the *v*-component of the wind were calculated for acetaldehyde, arsenic, formaldehyde, and manganese.

The strongest positive correlations at the SPIL monitoring site were exhibited between formaldehyde and maximum, average, dew point, and wet bulb temperatures, ranging from 0.62 to 0.65, while the strongest negative correlations were calculated between hexachloro-1,3-butadiene and the same parameters (-0.46 to -0.50). Pearson correlations for relative humidity, the wind components, and sea level pressure were generally weak. However, all the correlations with the *v*-component of the wind were positive, indicating that concentrations tend to increase as northerly and southerly winds increase in magnitude.

7.4.2 Composite Back Trajectory Analysis

Figures 7-7 and 7-8 are composite back trajectory maps for the Illinois monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. As shown, the back trajectories originated from a variety of directions at NBIL and SPIL, although less frequently from the east. Each circle around the sites in Figures 7-7 and 7-8 represents 100 miles.

The 24-hour airshed domain is rather large, with trajectories originating as far away as northern Manitoba, Canada, or over 1,000 miles away. Roughly 55% of the trajectories originated within 300 miles of the sites; and nearly 75% within 400 miles from the Illinois monitoring sites. The one trajectory originating from Manitoba occurred on a day when a strong

frontal system moved across the central and eastern US on November 24, 2005. This wind pattern is also evident on several composite trajectory maps from other sites in the region including the DEMI, INDEM, DITN, MIMN, and MAWI monitoring sites.

7.4.3 Wind Rose Analysis

Hourly wind data from the weather station at Pauwakee Municipal Airport near NBIL and Chicago O'Hare International Airport near SPIL were uploaded in a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 7-9 and 7-10 are the wind roses for the NBIL and SPIL monitoring sites on days sampling occurred.

As indicated in Figure 7-9, hourly winds at NBIL were predominantly out of the south (12% of observations) and west (10%) on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (39% of observations). Calm winds (< 2 knots) were recorded for 16% of measurements. As shown in Figure 7-10, hourly winds at SPIL resembled those of NBIL, although they were measured at separate weather stations. Winds were predominantly out of the west (12% of observations) and south (11%) on sample days. Wind speeds tended to range from 7 to 11 knots on days samples were taken (41% of observations). Calm winds were recorded for 10% of measurements.

7.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and acetylene-ethylene mobile tracer analysis.

7.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Cook County, IL were obtained from the Illinois Secretary of State and the U.S. Census Bureau, and are summarized in Table 7-6. Table 7-6 also includes a vehicle registration to county population ratio (vehicles per person). In

addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 7-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Table 7-6 shows that the SPIL monitoring site has more than twice the population residing within 10 miles of it than NBIL, and therefore a significantly lower estimated 10-mile vehicle ownership. The SPIL site experiences a significantly higher daily traffic volume than NBIL, as well as the highest traffic volume among all UATMP sites. Figure 7-2 shows that SPIL resides near a major interstate close to Chicago's O'Hare International Airport. Cook County also is the most populous of any UATMP county, and has the most vehicle registrations.

7.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. Like the roadside study, the toluene-ethylbenzene is the highest ratio for both NBIL and SPIL (7.04 ± 2.03 and 6.17 ± 0.44, respectively). However, the xylenes-ethylbenzene (3.27 ± 0.13 and 3.45 ± 0.13) and benzene-ethylbenzene (4.33 ± 0.53 and 4.24 ± 0.44) ratios are much closer to each other at NBIL and SPIL than the roadside study.

7.5.3 Mobile Tracer Analysis

As previously stated, NBIL sampled for SNMOC in addition to VOC. Acetylene is a compound that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile source emissions have found that ethylene and acetylene are typically

present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3) Listed in Table 3-10 is the ethylene-acetylene ratio for NBIL; as shown, NBIL's ethylene-acetylene ratio, 1.77 ± 0.34, is slightly higher than the 1.7 ratio. The similarities in these ratios suggest that mobile sources are influencing the air quality at the NBIL monitoring site. Because this ratio is slightly higher than the tunnel study, there may be other sources of ethylene contributing in small quantities to this area's air quality.

7.6 Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. Both Illinois sites have participated in the UATMP since 2003. Please refer to Figures 7-11 and 7-12.

- Prior to 2005, the Illinois sites only sampled VOCs, therefore no formaldehyde trend can be evaluated at this time.
- At NBIL, the average benzene and 1,3-butadiene concentration was higher in 2004 compared to 2003 and 2005.
- Although difficult to discern in Figure 7-12, the average concentrations of benzene and 1,3-butadiene at SPIL have changed little over the last three years.

7.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 7-7 presents the 1999 NATA results for the census tracts where the Illinois monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 7-7. Pollutants of interest are bolded.

The NBIL monitoring site is located in census tract 17031801500, while the SPIL monitoring site is located in 17031811600. The population for the census tract where the NBIL site is located was 6,227, which represents about 0.1% of the Cook County population in 2000. The population for the census tract where the SPIL site is located was 6,372, which also represents about 0.1% of the Cook County population in 2000.

7.7.1 1999 NATA Summary

In terms of cancer risk, the Top 3 pollutants identified by NATA in both the NBIL and SPIL census tracts are benzene (20.55 and 21.79 in-a-million risk, respectively), 1,3-butadiene (9.59 and 9.22 in-a-million, respectively), and acetaldehyde (5.99 and 7.32 in-a-million, respectively). These benzene cancer risks are the fifth and sixth highest cancer risks calculated for any of the UATMP sites. Acrolein was the only pollutant in the two Illinois census tracts to have a noncancer hazard quotient greater than 1.0 (8.98 at NBIL and 11.08 SPIL). A hazard quotient greater than 1.0 may lead to adverse health effects. The remaining noncancer hazard quotients were less than 0.30, suggesting very little risk for noncancer health affects.

7.7.2 Annual Average Comparison

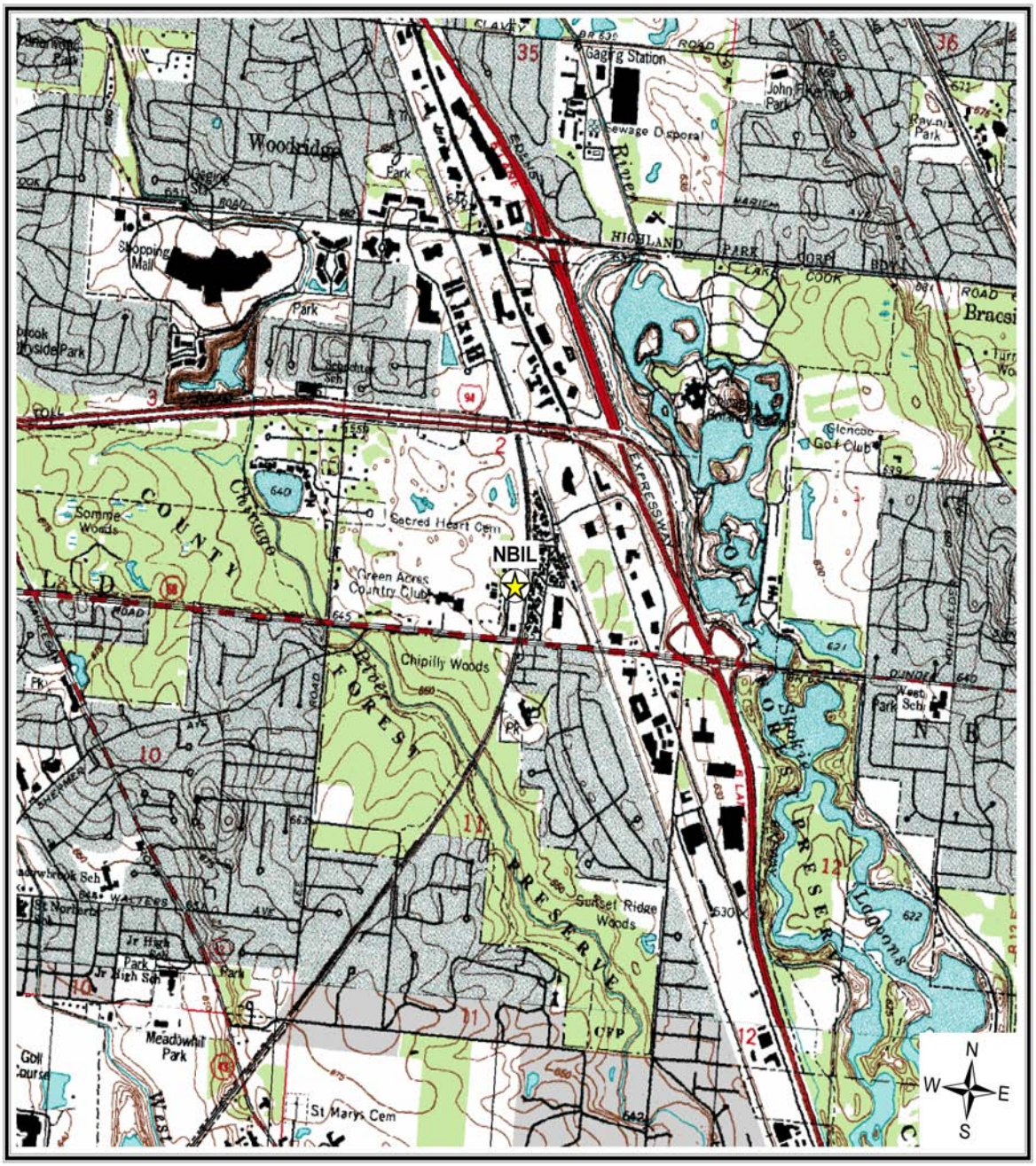
The Illinois monitoring sites' annual averages are also presented in Table 7-7 for comparison to the 1999 NATA modeled concentrations. NATA modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 7.2 on how a valid annual average is calculated). With few exceptions, the pollutants at NBIL and SPIL were within one order of magnitude from each other. The NATA modeled concentrations and the 2005 annual averages for some pollutants, such as trichloroethylene and tetrachloroethylene, were very similar. At NBIL, xylenes had the highest NATA-modeled and measured concentration (4.22 $\mu g/m^3$ and 1.90 ± 0.87 $\mu g/m^3$, respectively). Note that acetaldehyde and formaldehyde do not have reportable annual averages for this site. At SPIL, xylenes, formaldehyde, acetaldehyde, and benzene (not necessarily in that order) were identified by NATA and the UATMP as the Top 4 pollutants by mass concentration.

Xylenes had the highest NATA modeled concentrations at SPIL, while formaldehyde had the highest measured concentrations in 2005, followed by xylenes.

Illinois Pollutant Summary

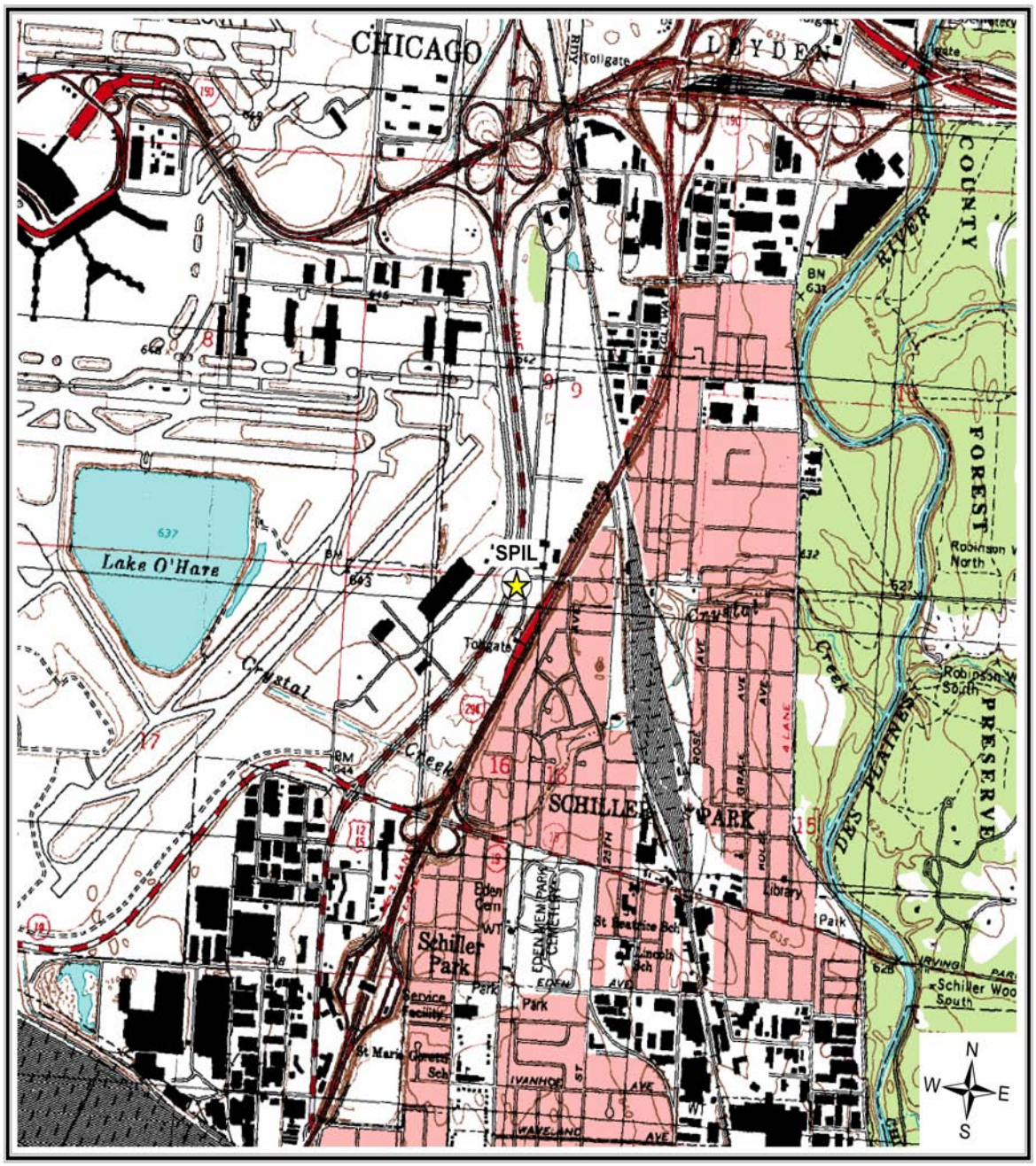
- *The pollutants of interest common to each Illinois site are acetaldehyde, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, p-dichlorobenzene, tetrachloroethylene, and trichloroethylene.*
- *Formaldehyde measured the highest daily average at each of the two Chicago sites (NBIL and SPIL).*
- *Acrolein exceeded the short-term risk factors at both Chicago sites, while formaldehyde exceeded the short-term risk factors at SPIL.*
- *A comparison of benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of these pollutants have not changed at either site since 2003.*

Figure 7-1. Chicago, Illinois (NBIL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 7-2. Chicago, Illinois (SPIL) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 7-3. Facilities Located Within 10 Miles of NBIL and SPIL

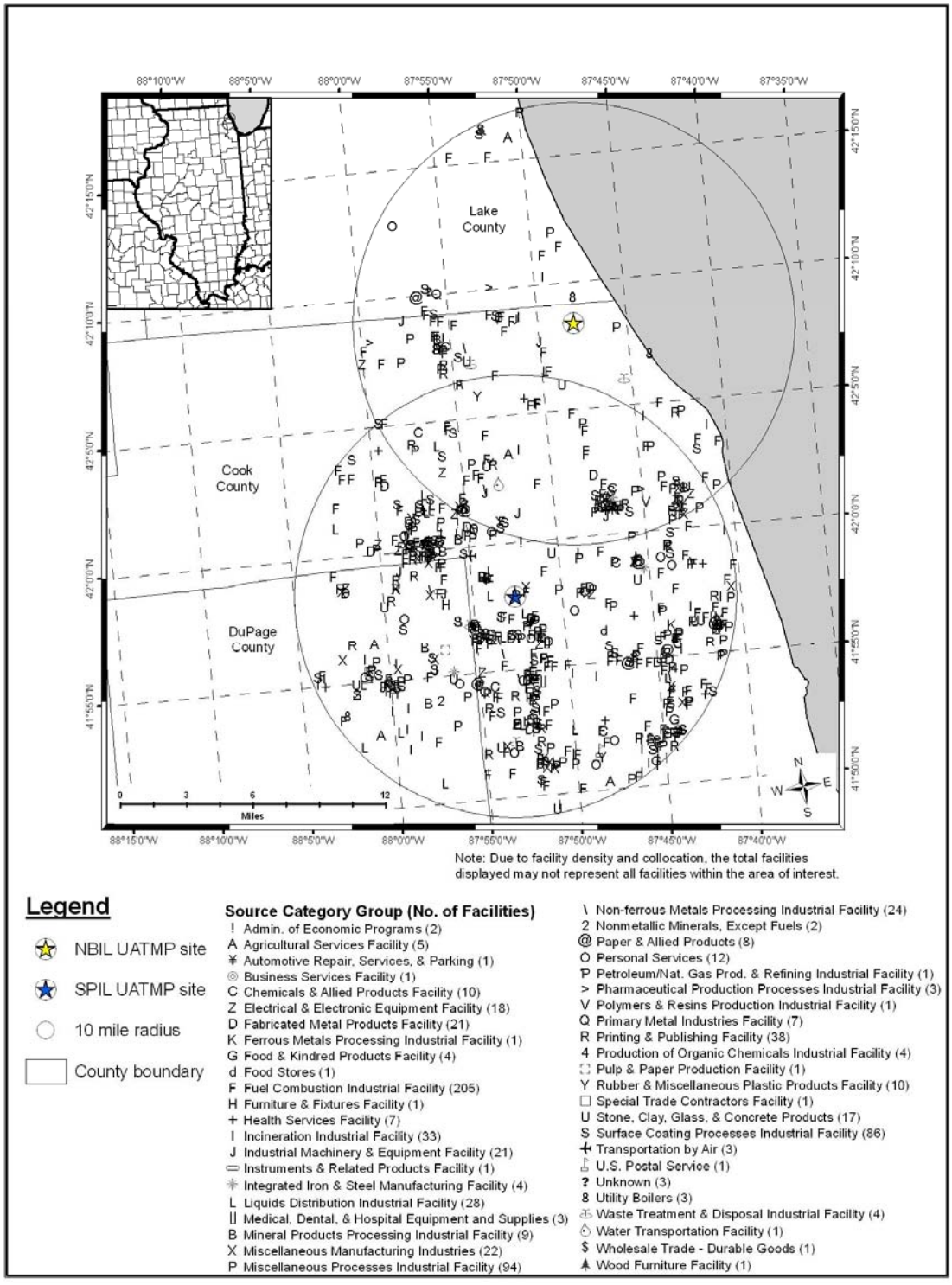


Figure 7-4. Acrolein Pollution Rose at NBIL

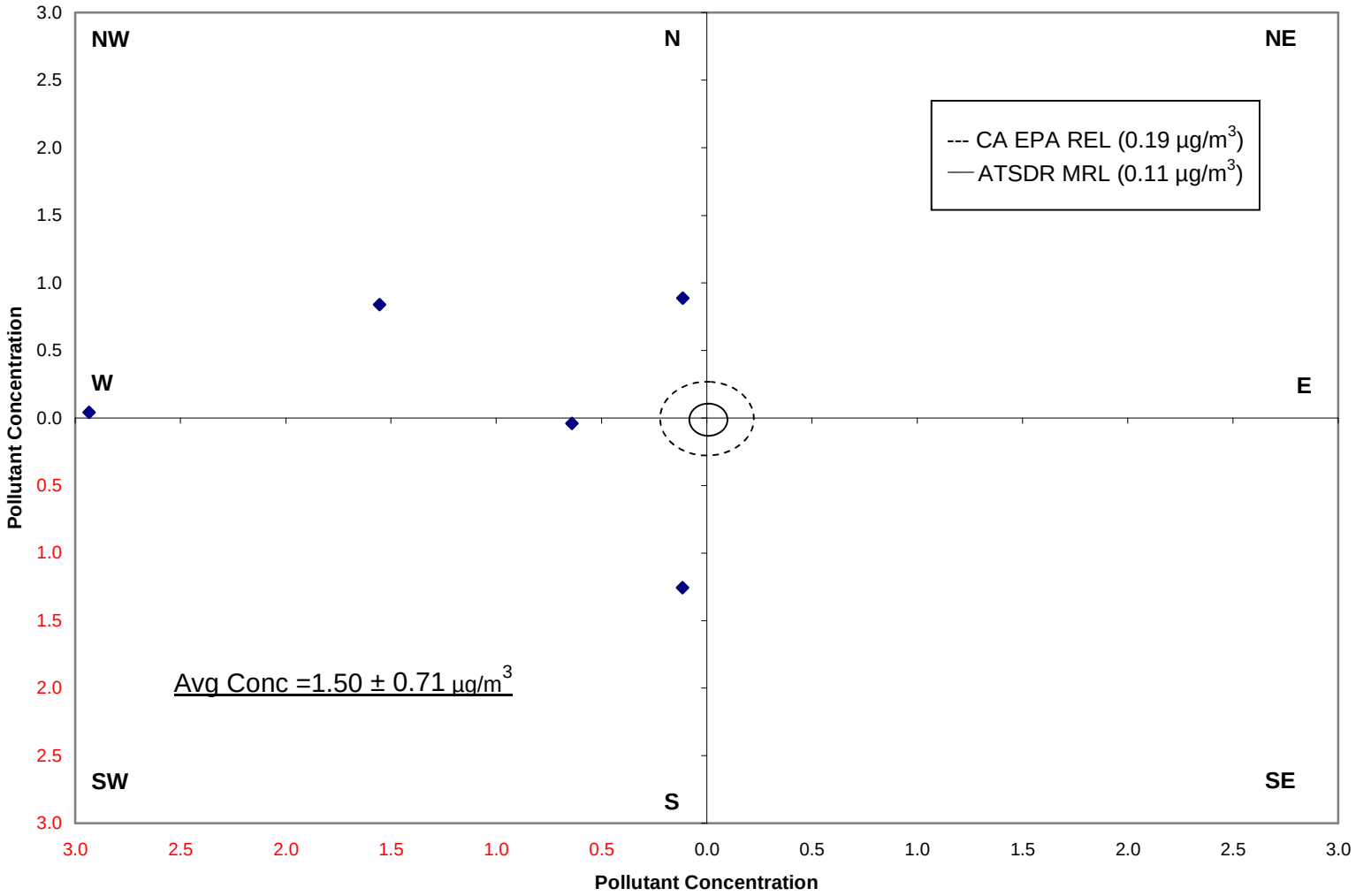


Figure 7-5. Acrolein Pollution Rose at SPIL

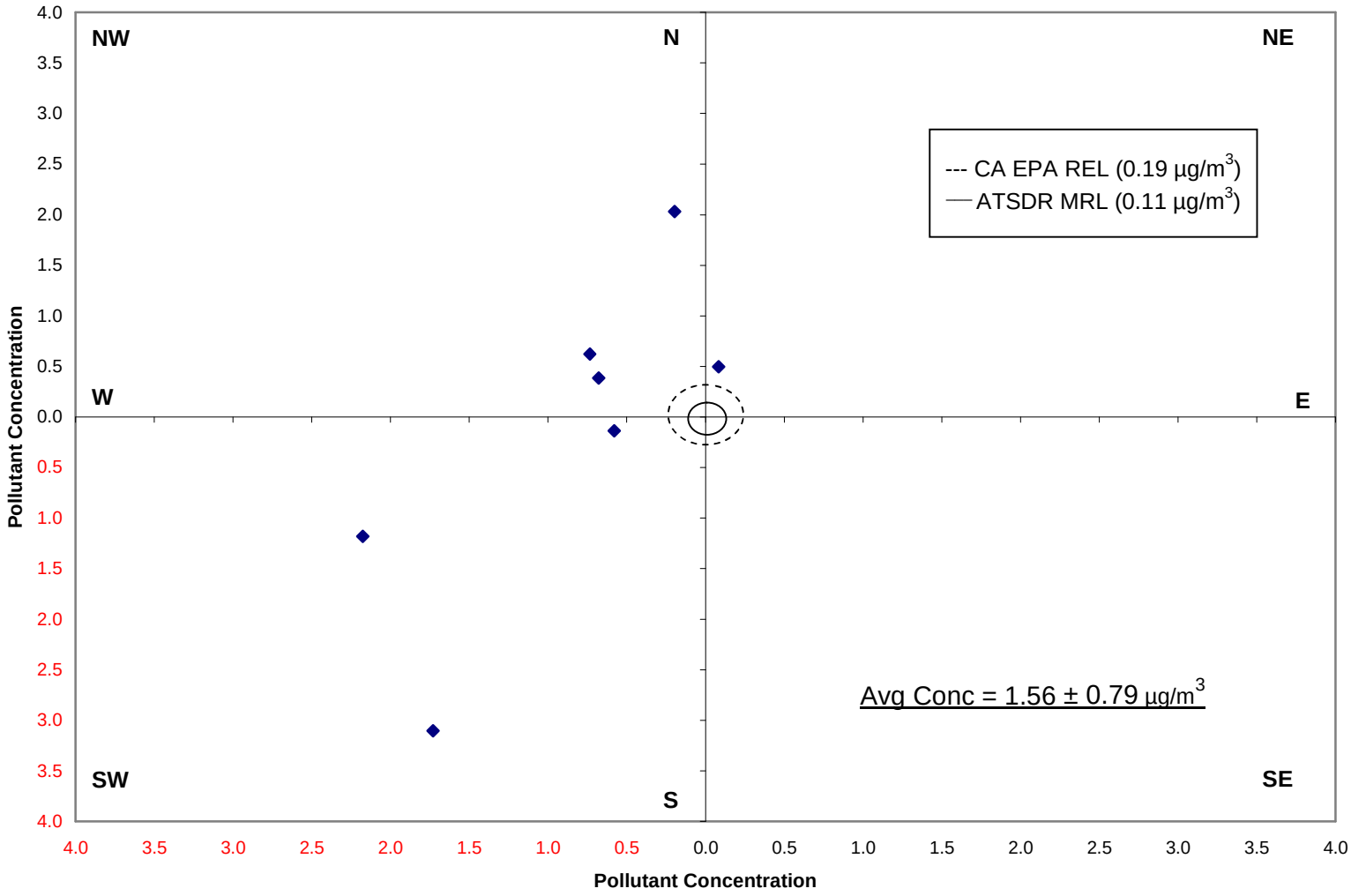


Figure 7-6. Formaldehyde Pollution Rose at SPIL

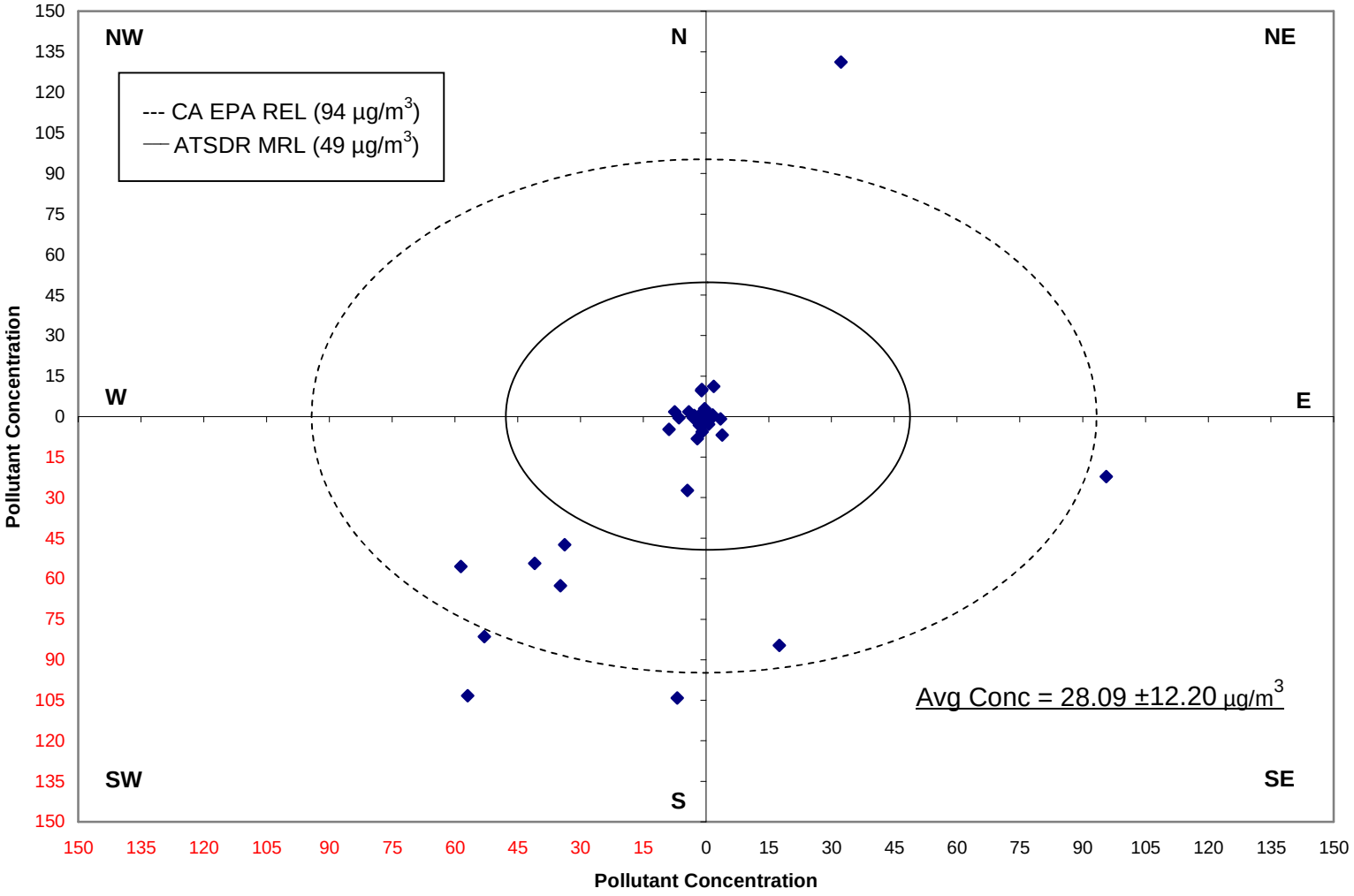


Figure 7-7. Composite Back Trajectory Map for NBIL

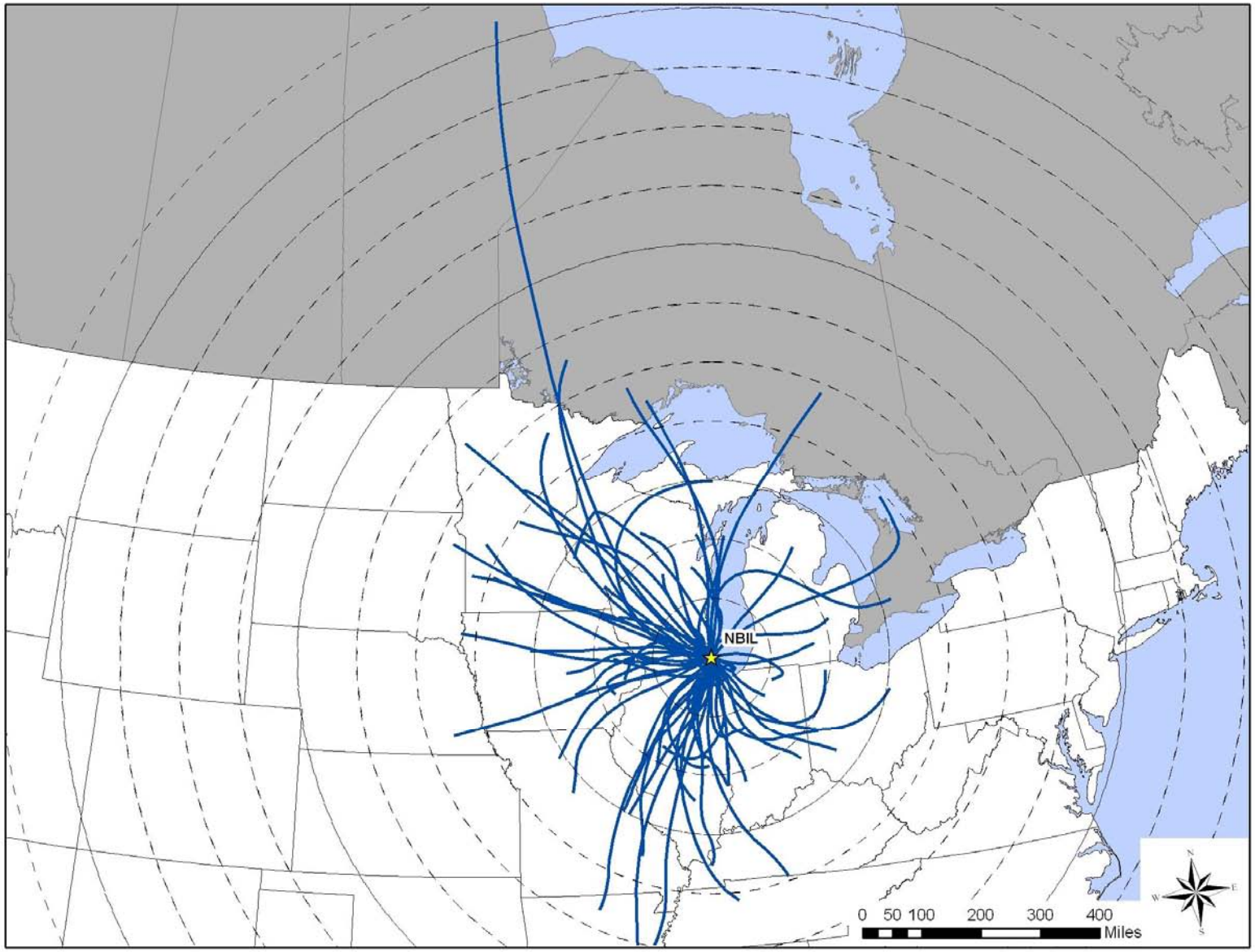


Figure 7-8. Composite Back Trajectory Map for SPIL

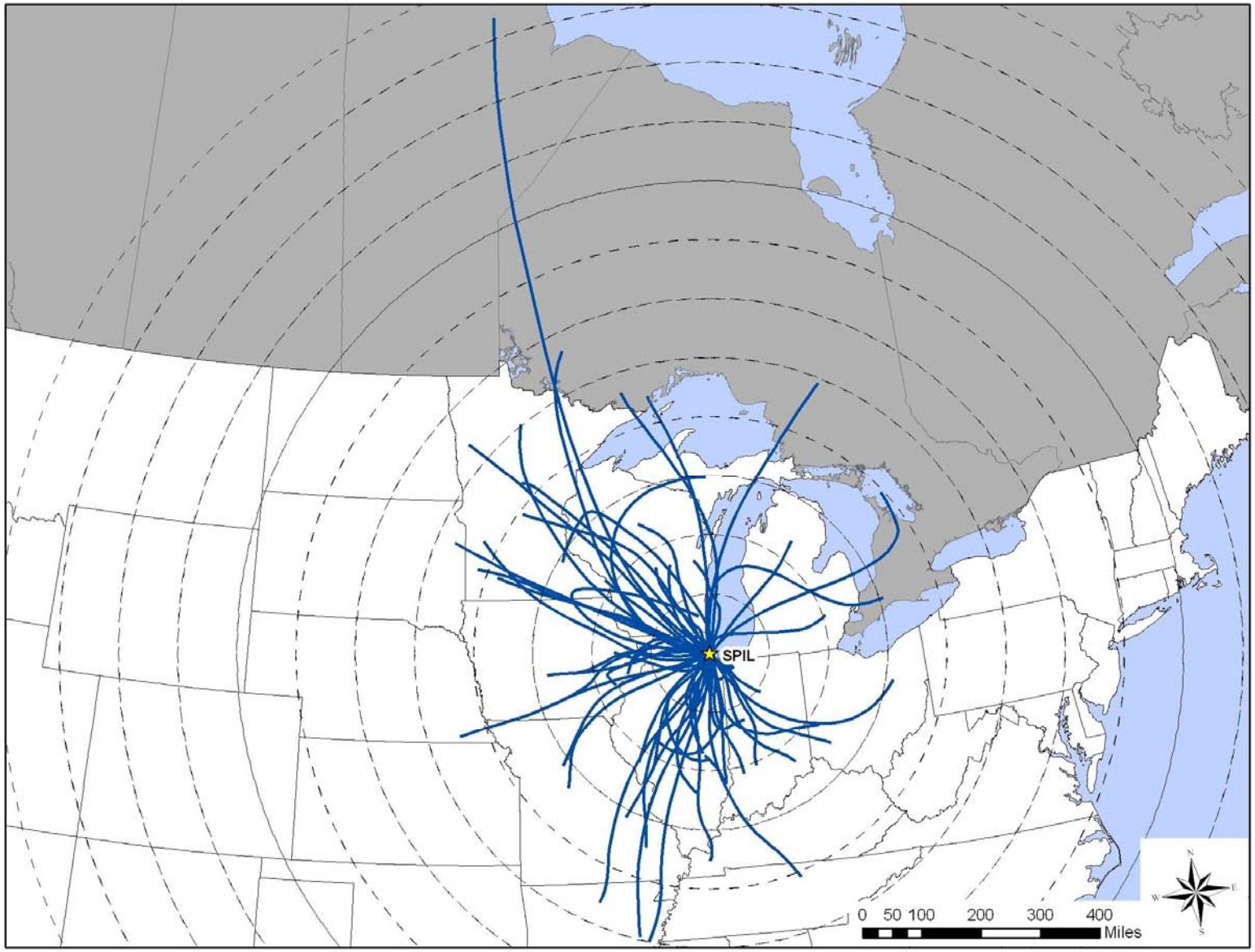


Figure 7-9. Wind Rose of Sample Days for the NBIL Monitoring Site

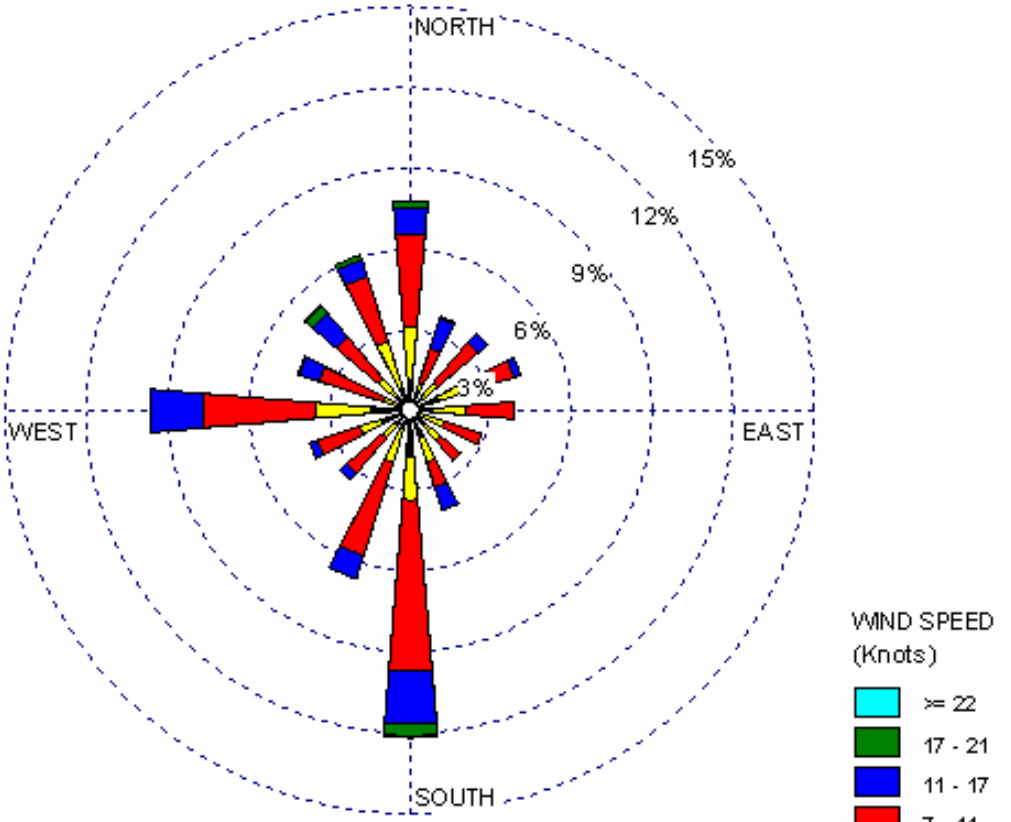


Figure 7-10. Wind Rose of Sample Days for the SPIL Monitoring Site

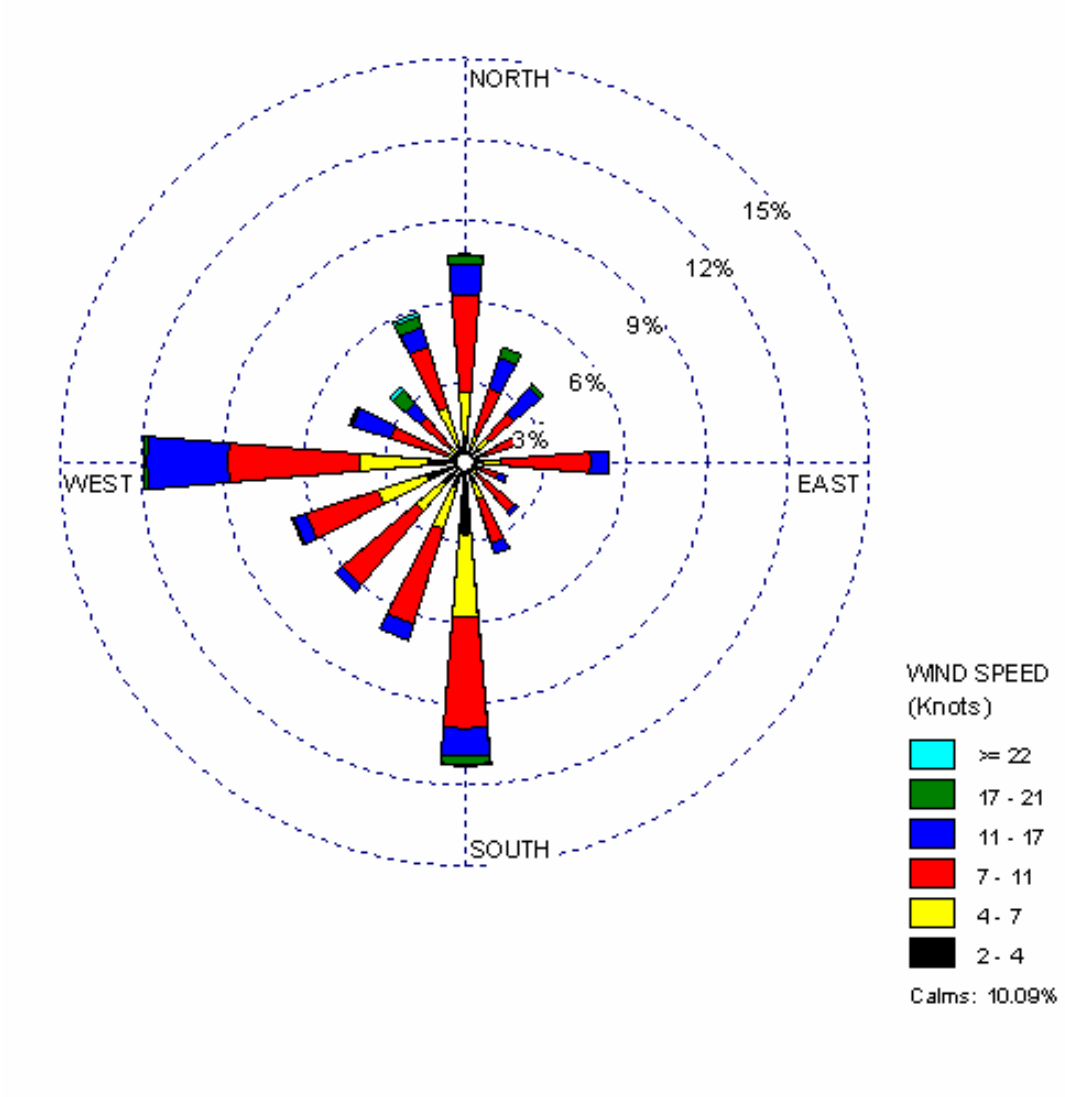


Figure 7-11. Comparison of Yearly Averages of the NBIL Monitoring Site

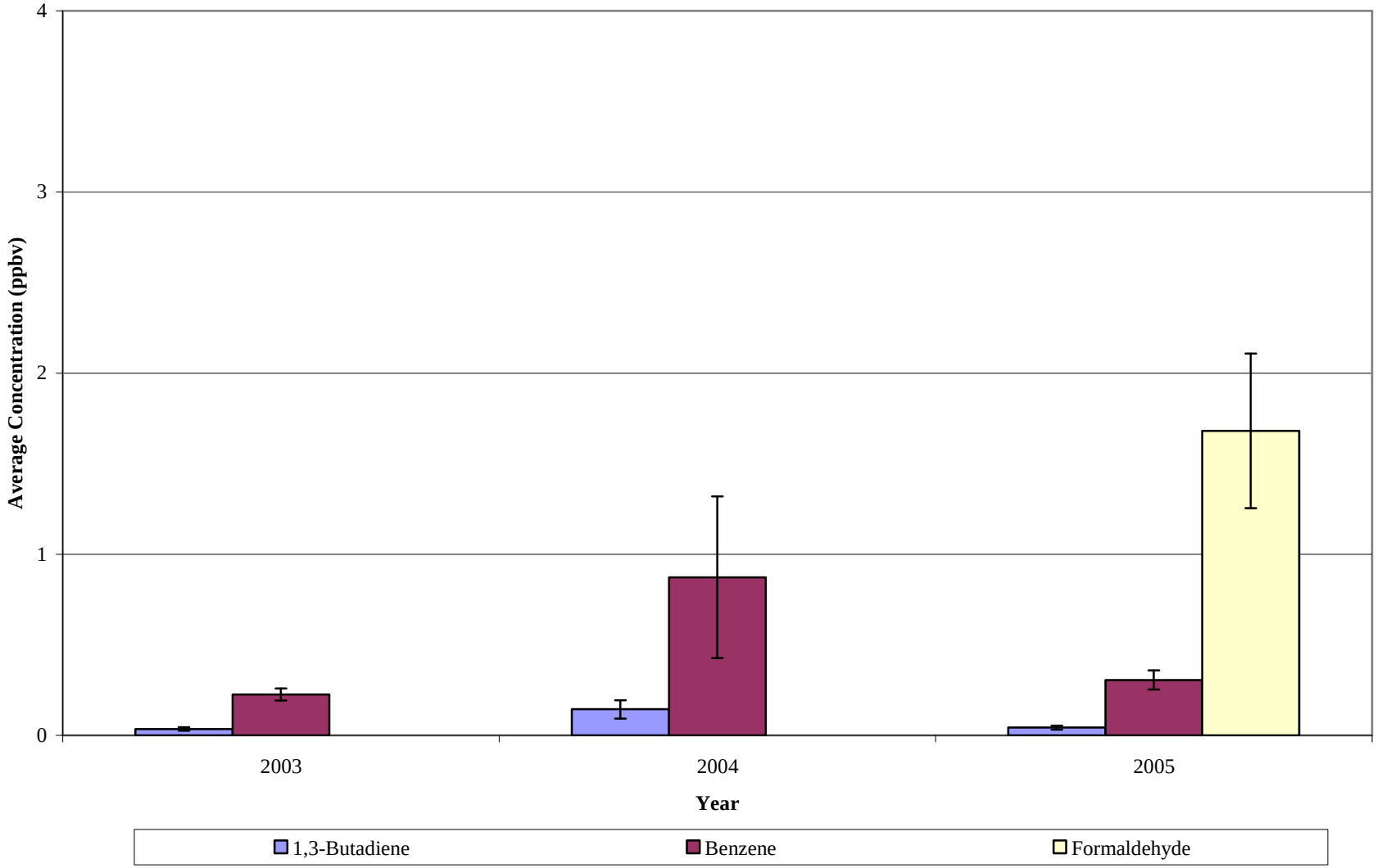


Figure 7-12. Comparison of Yearly Averages for the SPIL Monitoring Site

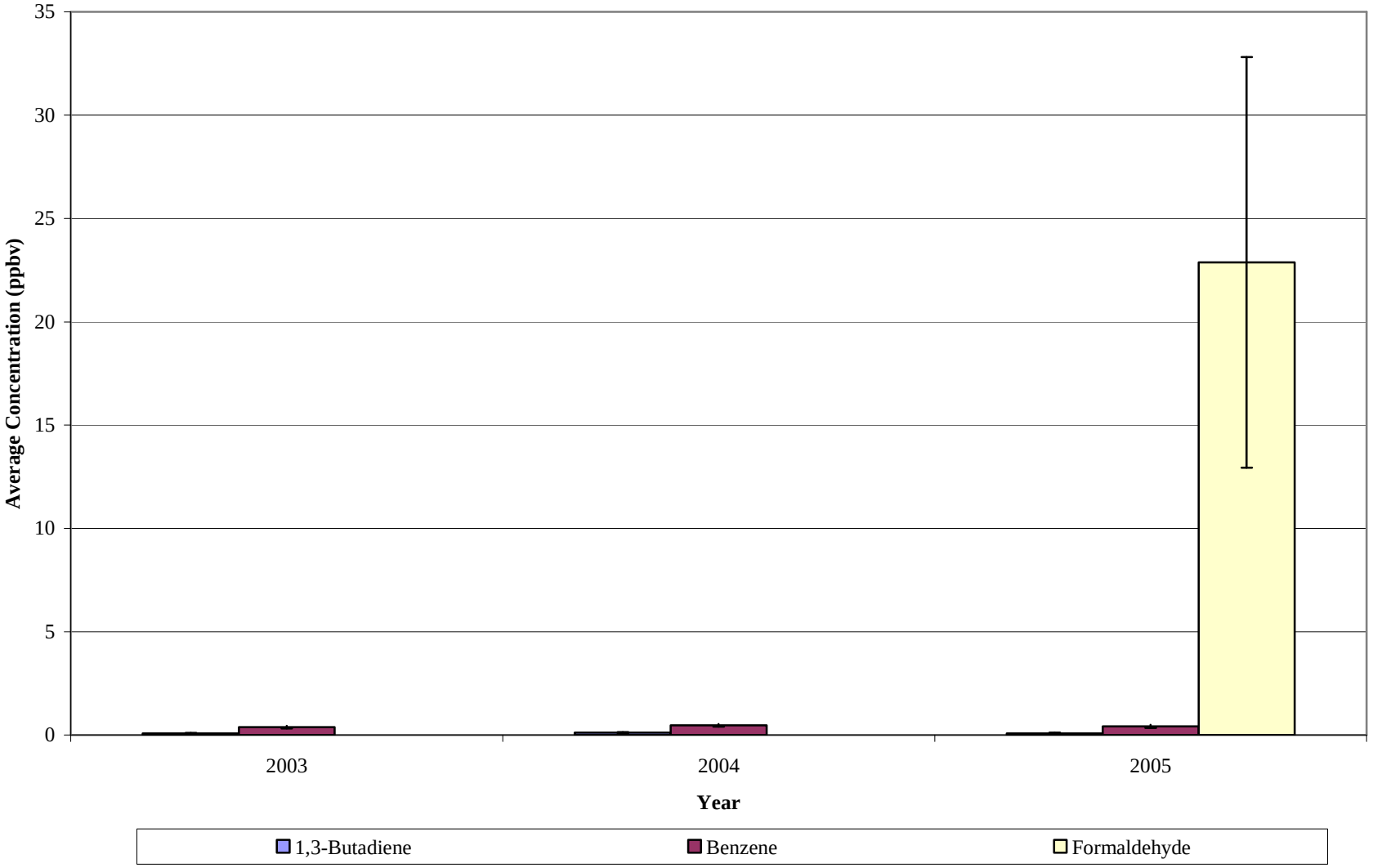


Table 7-1. Average Meteorological Parameters for Monitoring Sites in Illinois

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
NBIL	04838	All 2005	59.67 ± 2.27	51.53 ± 2.11	40.86 ± 1.88	46.12 ± 1.83	70.00 ± 1.27	1016.99 ± 0.74	1.12 ± 0.44	-0.03 ± 0.49
		Sample Day	59.98 ± 5.61	51.90 ± 5.09	41.15 ± 4.49	46.39 ± 4.39	70.24 ± 3.27	1016.78 ± 1.70	1.06 ± 0.89	0.06 ± 1.16
SPIL	94846	All 2005	59.91 ± 2.29	51.69 ± 2.11	39.61 ± 1.92	45.70 ± 1.84	66.56 ± 1.26	1016.40 ± 0.73	1.09 ± 0.53	-0.21 ± 0.51
		Sample Day	60.11 ± 5.73	51.96 ± 5.25	39.51 ± 4.81	45.79 ± 4.57	65.97 ± 3.36	1015.99 ± 1.79	1.43 ± 1.13	-0.11 ± 1.23

Table 7-2. Comparison of Measured Concentrations and EPA Screening Values at the Illinois Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Northbrook, Illinois - NBIL					
Arsenic (PM_{10})	56	61	91.80	15.1%	15.1%
Benzene	53	53	100.00	14.2%	29.3%
Carbon Tetrachloride	53	53	100.00	14.2%	43.5%
Manganese (PM_{10})	43	61	70.49	11.6%	55.1%
Acetaldehyde	32	35	91.43	8.6%	63.7%
1,3-Butadiene	30	34	88.24	8.1%	71.8%
Tetrachloroethylene	29	35	82.86	7.8%	79.6%
Formaldehyde	26	34	76.47	7.0%	86.6%
Nickel (PM_{10})	13	61	21.31	3.5%	90.1%
p-Dichlorobenzene	10	19	52.63	2.7%	92.7%
Hexachloro-1,3-butadiene	8	8	100.00	2.2%	94.9%
Trichloroethylene	5	30	16.67	1.3%	96.2%
Acrolein	5	5	100.00	1.3%	97.6%
Acrylonitrile	2	2	100.00	0.5%	98.1%
1,2-Dichloroethane	1	1	100.00	0.3%	98.4%
Bromomethane	1	26	3.85	0.3%	98.7%
1,1,2-Trichloroethane	1	1	100.00	0.3%	98.9%
Cobalt (PM_{10})	1	61	1.64	0.3%	99.2%
Cadmium (PM_{10})	1	61	1.64	0.3%	99.5%
1,1,2,2-Tetrachloroethane	1	1	100.00	0.3%	99.7%
Xylenes	1	53	1.89	0.3%	100.0%
Total	372	695			
Schiller Park, Illinois – SPIL					
Carbon Tetrachloride	58	58	100.00	17.9%	17.9%
Benzene	58	58	100.00	17.9%	35.8%
1,3-Butadiene	39	39	100.00	12.0%	47.8%
Formaldehyde	39	41	95.12	12.0%	59.9%
Acetaldehyde	37	46	80.43	11.4%	71.3%
Tetrachloroethylene	33	39	84.62	10.2%	81.5%
Trichloroethylene	22	40	55.00	6.8%	88.3%
p-Dichlorobenzene	12	23	52.17	3.7%	92.0%
Hexachloro-1,3-butadiene	10	10	100.00	3.1%	95.1%
Acrolein	7	7	100.00	2.2%	97.2%
Xylenes	2	56	3.57	0.6%	97.8%
1,2-Dichloroethane	2	2	100.00	0.6%	98.5%
1,1,2,2-Tetrachloroethane	2	2	100.00	0.6%	99.1%
Bromomethane	1	29	3.45	0.3%	99.4%
Vinyl chloride	1	3	33.33	0.3%	99.7%
Dichloromethane	1	48	2.08	0.3%	100.0%
Total	324	501			

Table 7-3. Daily and Seasonal Averages for Pollutants of Interest at the Illinois Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Northbrook, Illionois – NBIL												
1,3-Butadiene	34	53	0.09	0.02	NR	NR	NR	NR	0.10	0.01	0.09	0.01
Acetaldehyde	35	35	1.11	0.18	NR	NR	1.12	0.28	NR	NR	1.15	0.30
Acrolein	5	30	1.50	0.71	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (PM_{10})	61	61	0.001	0.000	0.0005	0.0001	0.0006	0.0003	0.0009	0.0002	0.0007	0.0002
Benzene	53	53	0.84	0.14	1.18	0.44	0.75	0.29	0.87	0.21	0.68	0.20
Carbon Tetrachloride	53	53	0.69	0.03	0.68	0.07	0.66	0.08	0.68	0.05	0.74	0.07
Formaldehyde	34	35	2.07	0.52	NA	NA	1.36	0.40	NR	NR	2.20	0.61
Hexachloro-1,3-butadiene	8	53	0.13	0.03	NR	NR	NR	NR	NR	NR	NR	NR
Manganese (PM_{10})	61	61	0.014	0.003	0.0092	0.0059	0.0139	0.0067	0.0173	0.0060	0.0141	0.0042
Nickel (PM_{10})	61	61	0.002	0.0004	0.0010	0.0004	0.0011	0.0002	0.0026	0.0012	0.0017	0.0004
p-Dichlorobenzene	19	53	0.12	0.03	NR	NR	NR	NR	0.17	0.03	0.13	0.03
Tetrachloroethylene	35	53	0.37	0.07	NR	NR	NR	NR	0.38	0.09	0.34	0.14
Trichloroethylene	30	53	0.31	0.08	NR	NR	NR	NR	0.27	0.09	0.27	0.13
Schiller Park, Illionois – SPIL												
1,3-Butadiene	39	58	0.20	0.06	NR	NR	NR	NR	0.14	0.03	0.16	0.06
Acetaldehyde	46	46	1.43	0.24	NR	NR	1.70	0.38	0.68	0.43	1.59	0.39
Benzene	58	58	1.35	0.23	1.53	0.63	1.41	0.38	1.19	0.23	1.32	0.54
Carbon Tetrachloride	58	58	0.69	0.03	0.64	0.06	0.64	0.05	0.68	0.05	0.79	0.08
Formaldehyde	41	46	28.09	12.20	NR	NR	2.17	0.47	53.82	30.52	34.62	16.51
Hexachloro-1,3-butadiene	10	58	0.14	0.03	NR	NR	NR	NR	NR	NR	0.75	0.38
p-Dichlorobenzene	23	58	0.15	0.06	NR	NR	NR	NR	0.18	0.04	0.15	0.07
Tetrachloroethylene	39	58	0.54	0.16	NR	NR	NR	NR	0.39	0.12	0.55	0.32
Trichloroethylene	40	58	1.05	0.44	0.41	0.21	1.09	0.83	0.70	0.27	0.79	0.80

NR = Not reportable due to low number of detects.
NA = Not available due to short sampling duration.

Table 7-4. Non-Chronic Risk Summary at the Illinois Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
NBIL	TO-15	Acrolein	1.50 ± 0.71	0.11	5	0.19	5	0.09	NA	NA	NR	NR
SPIL	TO-11A	Formaldehyde	28.09 ± 12.20	49	11	94	5	40	NR	2.17 ± 0.47	53.82 ± 30.52	34.62 ± 16.51
SPIL	TO-15	Acrolein	1.56 ± 0.79	0.11	7	0.19	7	0.09	NA	NA	NR	0.70 ± 0.51

NR = Not reportable due to low number of detects.
NA = Not available due to short sampling duration.

Table 7-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Illinois Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Northbrook, Illinois – NBIL									
1,3-Butadiene	34	-0.30	-0.32	-0.34	-0.33	0.06	0.07	-0.05	0.28
Acetaldehyde	35	0.15	0.11	0.01	0.06	-0.22	-0.03	0.32	0.22
Acrolein	5	-0.31	-0.34	-0.41	-0.37	-0.26	0.62	-0.16	0.63
Arsenic (PM_{10})	61	0.46	0.45	0.43	0.45	-0.17	-0.33	0.45	-0.09
Benzene	53	0.16	0.13	0.12	0.12	0.00	-0.29	0.24	0.10
Carbon Tetrachloride	53	0.04	0.01	0.00	0.01	-0.07	0.08	0.18	-0.04
Formaldehyde	34	-0.02	0.01	0.04	0.00	0.14	0.08	0.34	-0.26
Hexachloro-1,3-butadiene	8	-0.83	-0.87	-0.88	-0.88	0.21	0.94	-0.07	0.51
Manganese (PM_{10})	61	0.37	0.32	0.24	0.29	-0.38	-0.37	0.39	0.00
Nickel (PM_{10})	61	0.40	0.41	0.39	0.40	-0.14	-0.10	0.18	-0.08
p-Dichlorobenzene	19	0.51	0.51	0.41	0.46	-0.23	-0.49	-0.19	0.08
Tetrachloroethylene	35	0.44	0.42	0.41	0.41	-0.14	-0.37	0.06	-0.10
Trichloroethylene	30	0.42	0.38	0.33	0.35	-0.25	-0.21	0.22	-0.26
Schiller Park, Illinois - SPIL									
1,3-Butadiene	39	-0.15	-0.19	-0.18	-0.19	0.09	0.13	0.02	0.32
Acetaldehyde	46	-0.26	-0.32	-0.39	-0.35	-0.13	0.02	0.06	0.13
Benzene	58	0.12	0.08	0.06	0.06	-0.02	-0.15	0.24	0.15
Carbon Tetrachloride	58	0.04	0.04	0.08	0.06	0.09	0.19	0.23	-0.06
Formaldehyde	41	0.62	0.65	0.64	0.64	-0.18	-0.03	0.15	0.08
Hexachloro-1,3-butadiene	10	-0.50	-0.43	-0.46	-0.46	0.03	-0.16	0.16	-0.27
p-Dichlorobenzene	23	0.31	0.27	0.24	0.25	-0.10	-0.22	0.12	0.02
Tetrachloroethylene	39	-0.05	-0.09	-0.12	-0.10	-0.07	0.09	0.32	0.02
Trichloroethylene	40	0.17	0.13	0.06	0.10	-0.22	-0.14	0.17	0.11

Table 7-6. Motor Vehicle Information for the Illinois Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
NBIL	5,303,683	2,115,353	0.40	883,969	352,568	29,600
SPIL	5,303,683	2,115,353	0.40	2,087,514	832,597	214,900

Table 7-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Illinois

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Northbrook, Illinois – NBIL, Census Tract 17031801500				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	0.08	4.44	--
1,1,2-Trichloroethane	0.14 ± 0.02	<0.01	<0.01	<0.01
1,2-Dichloroethane	0.09 ± 0.01	0.05	1.25	<0.01
1,3-Butadiene	0.10 ± 0.01	0.32	9.59	0.16
Acetaldehyde	NA	2.72	5.99	0.30
Acrolein	NA	0.18	--	8.98
Acrylonitrile	0.07 ± 0.01	<0.01	0.06	<0.01
Arsenic (PM_{10})	<0.01	0.01	0.06	<0.01
Benzene	0.84 ± 0.14	2.64	20.55	0.09
Bromomethane	0.08 ± 0.02	0.14	--	0.03
Cadmium (PM_{10})	<0.01	0.24	0.44	0.01
Carbon Tetrachloride	0.69 ± 0.03	0.22	3.23	0.01
Cobalt (PM_{10})	<0.01	<0.01	--	<0.01
Formaldehyde	NA	2.73	0.02	0.28
Hexachloro-1,3-butadiene	1.05 ± 0.15	<0.01	0.03	<0.01
Manganese (PM_{10})	0.01	0.67	--	0.01
Nickel (PM_{10})	<0.01	0.36	0.06	0.01
***p*-Dichlorobenzene**	0.16 ± 0.01	0.04	0.44	<0.01
Tetrachloroethylene	0.30 ± 0.06	0.24	1.44	<0.01
Trichloroethylene	0.23 ± 0.05	0.26	0.52	<0.01
Xylenes	1.90 ± 0.87	4.22	--	0.04
Schiller Park, Illinois – SPIL, Census Tract 17031811600				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	0.08	4.36	--
1,2-Dichloroethane	0.09 ± 0.01	0.05	1.23	<0.01
1,3-Butadiene	0.15 ± 0.05	0.31	9.22	0.15
Acetaldehyde	1.43 ± 0.24	3.33	7.32	0.37
Acrolein	NA	0.22	--	11.08
Benzene	1.35 ± 0.23	2.79	21.79	0.09
Bromomethane	0.19 ± 0.21	0.20	--	0.04
Carbon Tetrachloride	0.69 ± 0.03	0.21	3.16	0.01
Dichloromethane	0.57 ± 0.19	1.15	0.54	<0.01
Formaldehyde	25.04 ± 11.16	2.99	0.02	0.30
Hexachloro-1,3-butadiene	0.96 ± 0.14	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.17 ± 0.02	0.06	0.64	<0.01
Tetrachloroethylene	0.42 ± 0.12	0.41	2.42	<0.01
Trichloroethylene	0.77 ± 0.32	1.73	3.45	<0.01
Vinyl chloride	0.05 ± 0.003	0.09	0.78	<0.01
Xylenes	2.92 ± 0.65	4.79	--	0.05

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

8.0 Site in Indiana

This section presents meteorological, concentration, and spatial trends for the UATMP site in Indiana (INDEM). This site is located in Gary, IN, in the Chicago-Naperville-Joliet, IL-IN-WI metropolitan statistical area (MSA). Figure 8-1 is a topographical map showing the monitoring site in its urban location. Figure 8-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. Due in part to INDEM's proximity to Lake Michigan, most of the facilities near INDEM are located in part to the east or west of the monitor. The bulk of these facilities are involved in fuel combustion, ferrous metal processing, or liquids distribution.

Hourly meteorological data at a weather station near this site were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The closest weather station is located at Lancing Municipal Airport (WBAN 04879).

Gary is located to the southeast of Chicago, and at the southern-most tip of Lake Michigan. Gary's proximity to Lake Michigan is an important factor controlling the weather of the area. In the summer, warm temperatures can be suppressed, while cold winter temperatures are often moderated. Winds that blow across Lake Michigan and over Gary in the winter can provide abundant amounts of lake-effect snow (Ruffner and Bair, 1987 and http://www.garychamber.com/geoclimate.asp). Table 8-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 8-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

8.1 Pollutants of Interest at the Indiana Monitoring Site

As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 8-2 presents the pollutants that failed at least one screen at INDEM. It's important to note that the INDEM site sampled for carbonyl compounds only, and that this is reflected in the site's pollutants of interest. A total of 76 measured concentrations of these pollutants failed screens. The pollutants of interest at INDEM were identified as the pollutants that contributed to the top 95% of the total failed screens, resulting in two pollutants: formaldehyde (42 failed screens) and acetaldehyde (34).

Also listed in Table 8-2 are the total number of detects and the percent detects failing the screen. Of the two pollutants of interest, formaldehyde failed nearly 96% of screens, and 77% of acetaldehyde detects failed screens.

8.2 Concentration Averages at the Indiana Monitoring Site

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 8-3. Annual averages will be presented and discussed in further detail in later sections.

Table 8-3 shows that both acetaldehyde and formaldehyde were detected in 100% of the samples taken at INDEM. The formaldehyde daily average concentration (72.85 ± 27.47 $\mu g/m^3$) was significantly higher than the acetaldehyde concentration (2.59 ± 0.55 $\mu g/m^3$). The seasonal averages show that the summer formaldehyde average (193.41 ± 44.41 $\mu g/m^3$) was an order of magnitude higher than the other seasons. Interestingly, the reverse is true for the acetaldehyde seasonal averages. The summer acetaldehyde average was an order of magnitude lower than the other seasons. Unfortunately, valid autumn seasonal averages could not be calculated, due to sampling issues occurring throughout much of the autumn season.

8.3 Non-chronic Risk Evaluation at the Indiana Monitoring Site

Non-chronic risk for the concentration data at INDEM was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Of the two pollutants with at least one failed screen, only formaldehyde exceeded both the acute and intermediate risk values, and its non-chronic risk is summarized in Table 8-4.

Thirteen formaldehyde detects exceeded the ATSDR acute risk value of 49 $\mu g/m^3$ and the California REL value of 94 $\mu g/m^3$. The average detected concentration was 72.85 ± 27.47 $\mu g/m^3$, which is more than the ATSDR MRL value, but less than the California REL value. For the intermediate formaldehyde risk, seasonal averages were compared to the ATSDR intermediate value of 40 $\mu g/m^3$. As discussed in Sections 8.2, a valid autumn average could not be calculated. For the remaining seasons, only the summer average exceeded the ATSDR intermediate MRL. However, this average is nearly five times the MRL (193.41 ± 44.41 $\mu g/m^3$).

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Figure 8-3 is a pollution rose for formaldehyde at INDEM. The pollution rose is a plot of daily concentration and daily average wind direction. As indicated in Figure 8-3, several concentrations exceeded the acute risk factors, indicated by a dashed (CalEPA REL) and solid line (ATSDR MRL). The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources. The highest concentration

of formaldehyde occurred on June 9, 2005 with a south-southwesterly wind. INDEM is situated in a fairly industrialized area, and major interstates are located just south of the monitoring site. In addition, several railways criss-cross the area surrounding the monitoring site (Figure 8-1).

8.4 Meteorological and Concentration Analysis at the Indiana Site

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

8.4.1 Pearson Correlation Analysis

Table 8-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the INDEM monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) As previously mentioned, the INDEM site sampled only for carbonyl compounds. The strongest correlation with acetaldehyde was with wet bulb temperature (-0.54). The acetaldehyde correlations with maximum, average, and dew point temperatures were moderately strong and also negative (-0.28, -0.33, and -0.44, respectively). This indicates that as temperature and humidity increase, acetaldehyde concentrations tend to decrease. Moderately strong to very strong positive correlations were computed for the temperature and moisture variables and formaldehyde (ranging from 0.29 to 0.73). This indicates that as temperature and humidity increase, formaldehyde concentrations also decrease. This correlates well when evaluating the seasonal averages for these two pollutants. Correlations with wind speeds were weak. The Lancing Municipal Airport weather station did not record sea level pressure.

8.4.2 Composite Back Trajectory Analysis

Figure 8-4 is a composite back trajectory map for the INDEM monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site in Figure 8-4 represents 100 miles. As shown in Figure 8-4, the back trajectories originated from a variety of directions at INDEM, although less frequently from the east.

The 24-hour airshed domain is rather large, with trajectories originating as far away as northern Manitoba, Canada, or greater than 500 miles away. Nearly 63% of the trajectories originated within 300 miles of the sites; and 79% within 400 miles from the INDEM monitoring site. The one trajectory originating from Manitoba occurred on a day when a strong frontal system moved across the central and eastern US on November 24, 2005. This wind pattern is also evident on several composite trajectory maps from other sites in the region including the DEMI, NBIL and SPIL, DITN, MIMN, and MAWI monitoring sites.

8.4.3 Wind Rose Analysis

Hourly wind data from the Lancing Municipal Airport near the INDEM monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 8-5 is the wind rose for the INDEM monitoring site on days sampling occurred. As indicated in Figure 8-5, hourly winds were predominantly out of the south (9% of observations) and west (9%). Wind speeds tended to range from 7 to 11 knots on day samples were taken (31% of observations). Calm winds (<2 knots) were observed for 25% of the measurements.

8.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

8.5.1 Population, Vehicle Ownership, and Traffic Volume Comparison

County-level vehicle registration and population in Lake County, IN were obtained from the Indiana Bureau of Motor Vehicles and the U.S. Census Bureau, and are summarized in Table 8-6. Table 8-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 8-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Compared to other UATMP sites, INDEM falls in the middle of the range in regards to population and vehicle registration; however, INDEM is on the higher end of average daily traffic counts. The INDEM monitoring site is considered an industrial area and is located in an urban-city center setting. As previously mentioned, several heavily traveled roadways are situated near the site.

8.5.2 BTEX Analysis

A BTEX analysis could not be performed as this site sampled for carbonyls only.

8.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 8-7 presents the 1999 NATA results for the census tract where the Indiana monitoring site is located. Only pollutants that "failed" screens are presented in Table 8-7. Pollutants of interest are bolded.

8.6.1 1999 NATA Summary

The INDEM monitoring site is located in census tract 18089010202. The population for the census tract where the INDEM monitoring site is located was 1,689, which represents about 0.3% of the county population in 2000. In terms of cancer risk, acetaldehyde cancer risk (4.32 in a million) was significantly higher than formaldehyde cancer risk (0.01). The noncancer hazard quotients for acetaldehyde and formaldehyde were similar to each other, and were both less than 0.25, suggesting very little risk for noncancer health affects.

8.6.2 Annual Average Comparison

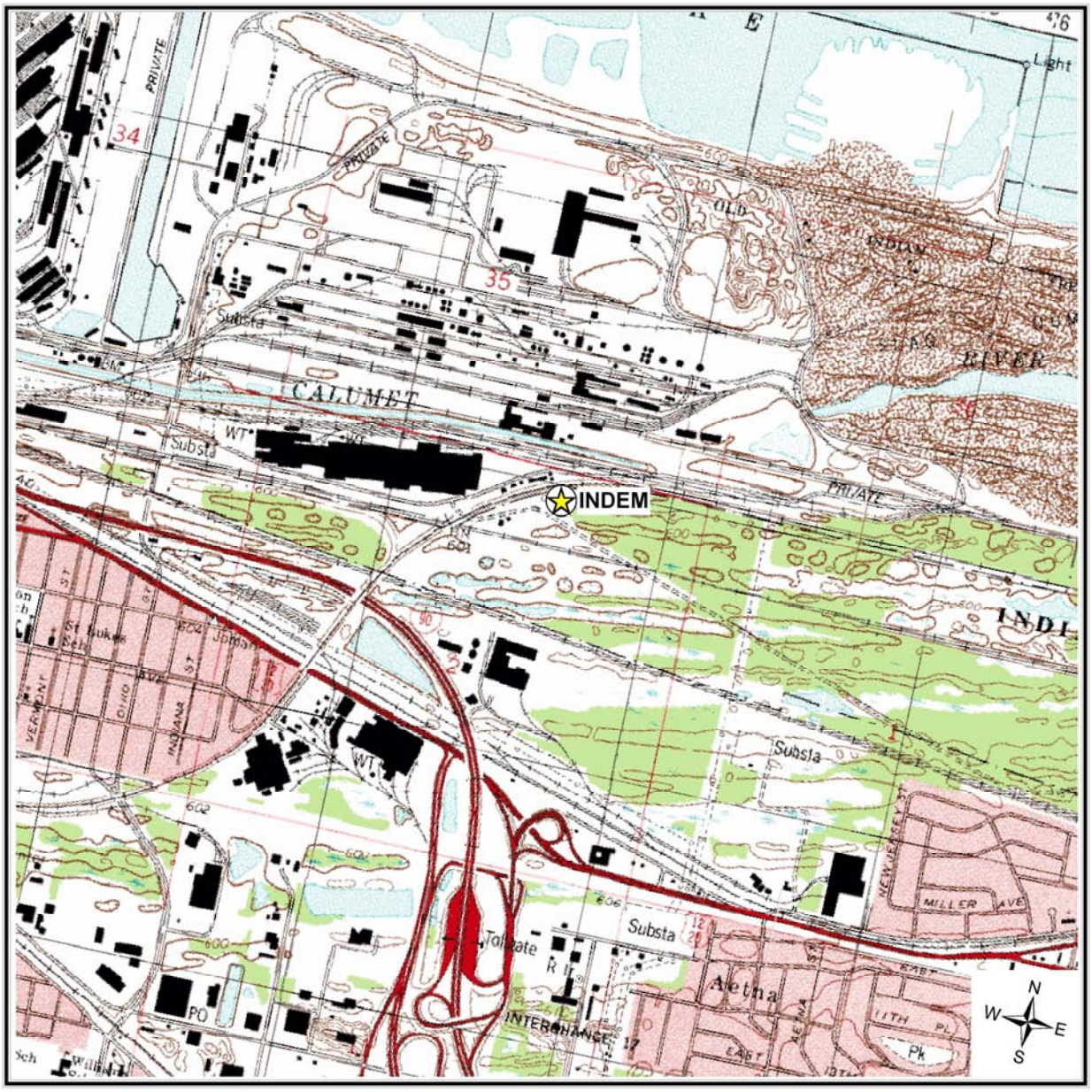
The Indiana monitoring site annual averages are also presented in Table 8-7 for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are

assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 8.2 on how a valid annual average is calculated). The annual averages of formaldehyde and acetaldehyde are the same as the daily averages of these pollutants because they were each detected in 100% of the samples taken. As mentioned in Section 8.2, the formaldehyde daily average concentration (72.85 ± 27.47 $\mu g/m^3$) was significantly higher than the acetaldehyde concentration (2.59 ± 0.55 $\mu g/m^3$). Table 8-7 shows that the acetaldehyde concentration is similar to the NATA modeled concentration. However, the formaldehyde annual concentration is significantly higher than the NATA modeled concentration (1.86 $\mu g/m^3$).

Indiana Pollutant Summary

- *The pollutants of interest at the Indiana site are acetaldehyde and formaldehyde.*
- *Formaldehyde measured the highest daily average at INDEM. Concentrations of formaldehyde were highest in summer, while acetaldehyde was highest in winter and spring.*
- *Formaldehyde exceeded both of the short-term risk factors, and the summer formaldehyde average exceeded the intermediate risk factor.*

Figure 8-1. Gary, Indiana (INDEM) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 8-2. Facilities Located within 10 Miles of INDEM

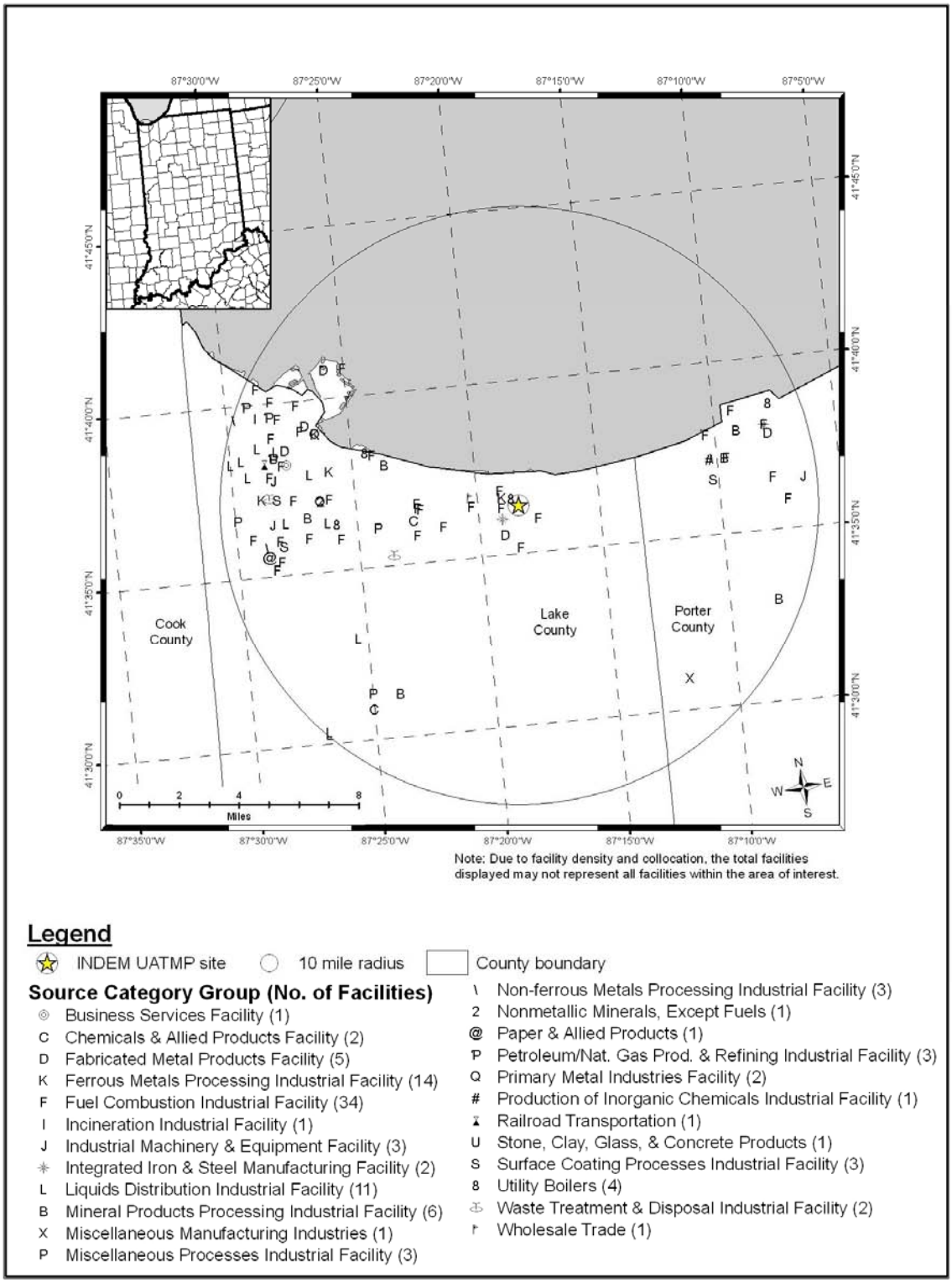


Figure 8-3. Formaldehyde Pollution Rose at INDEM

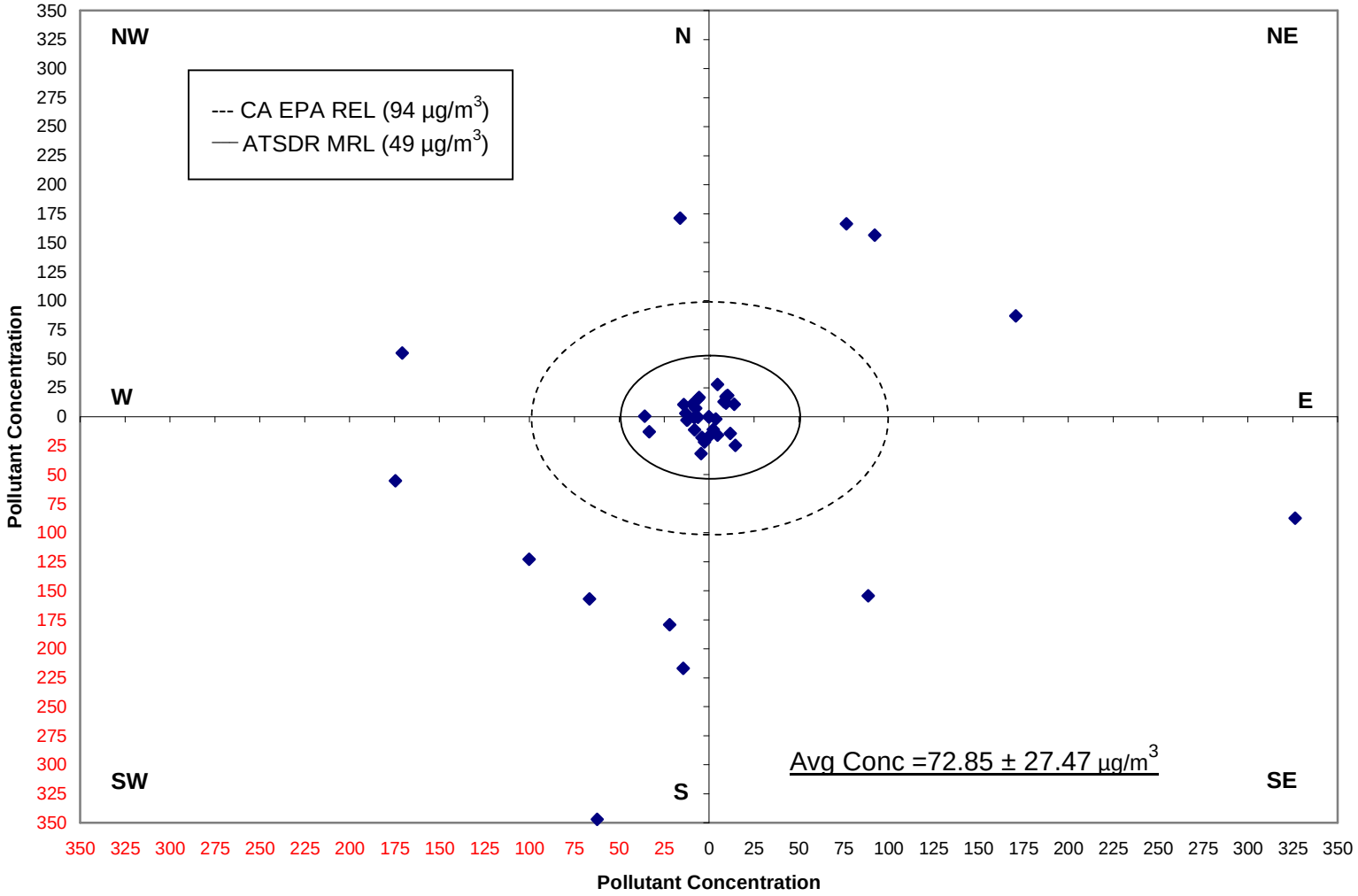


Figure 8-4. Composite Back Trajectory Map for INDEM

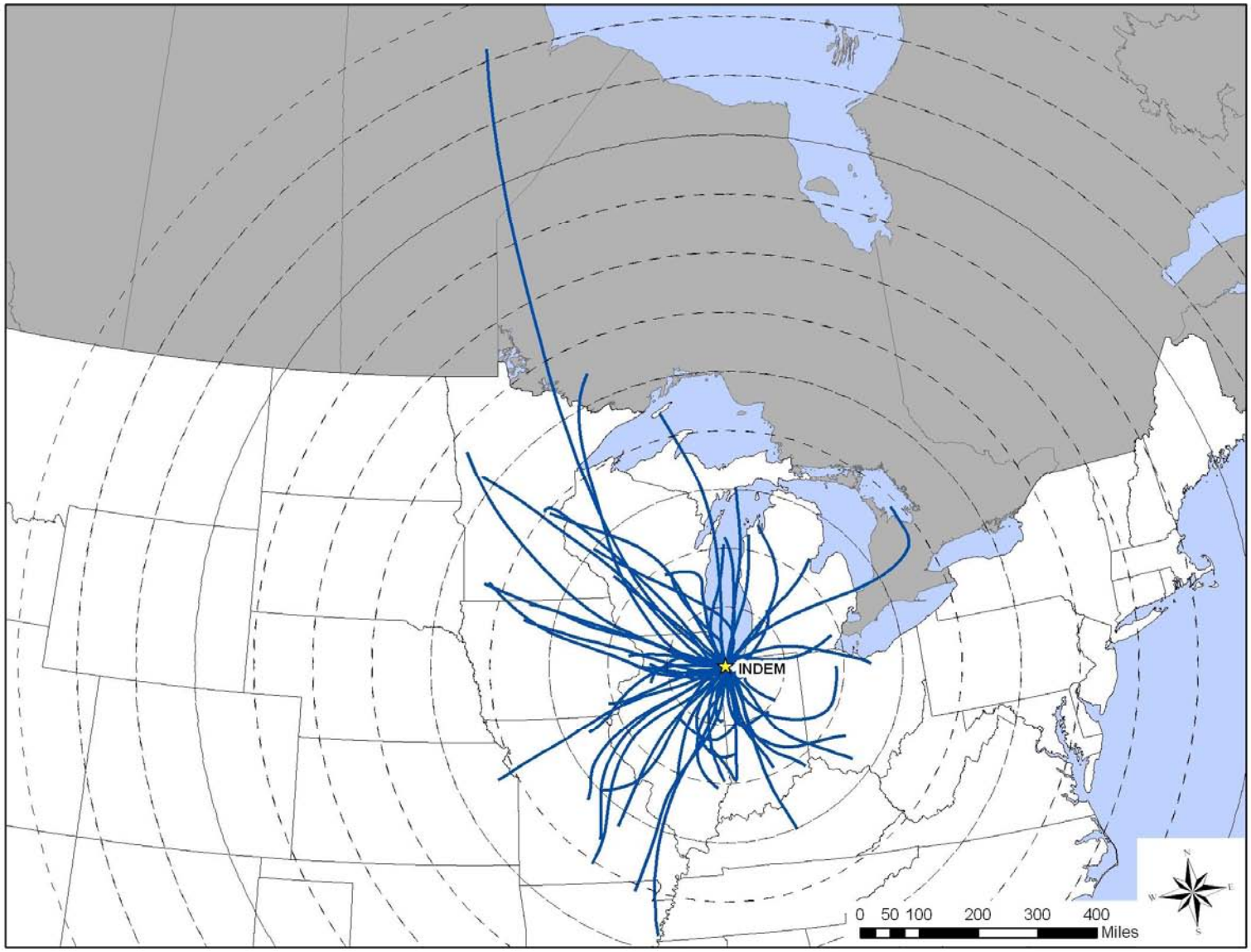


Figure 8-5. Wind Rose of Sample Days for the INDEM Monitoring Site

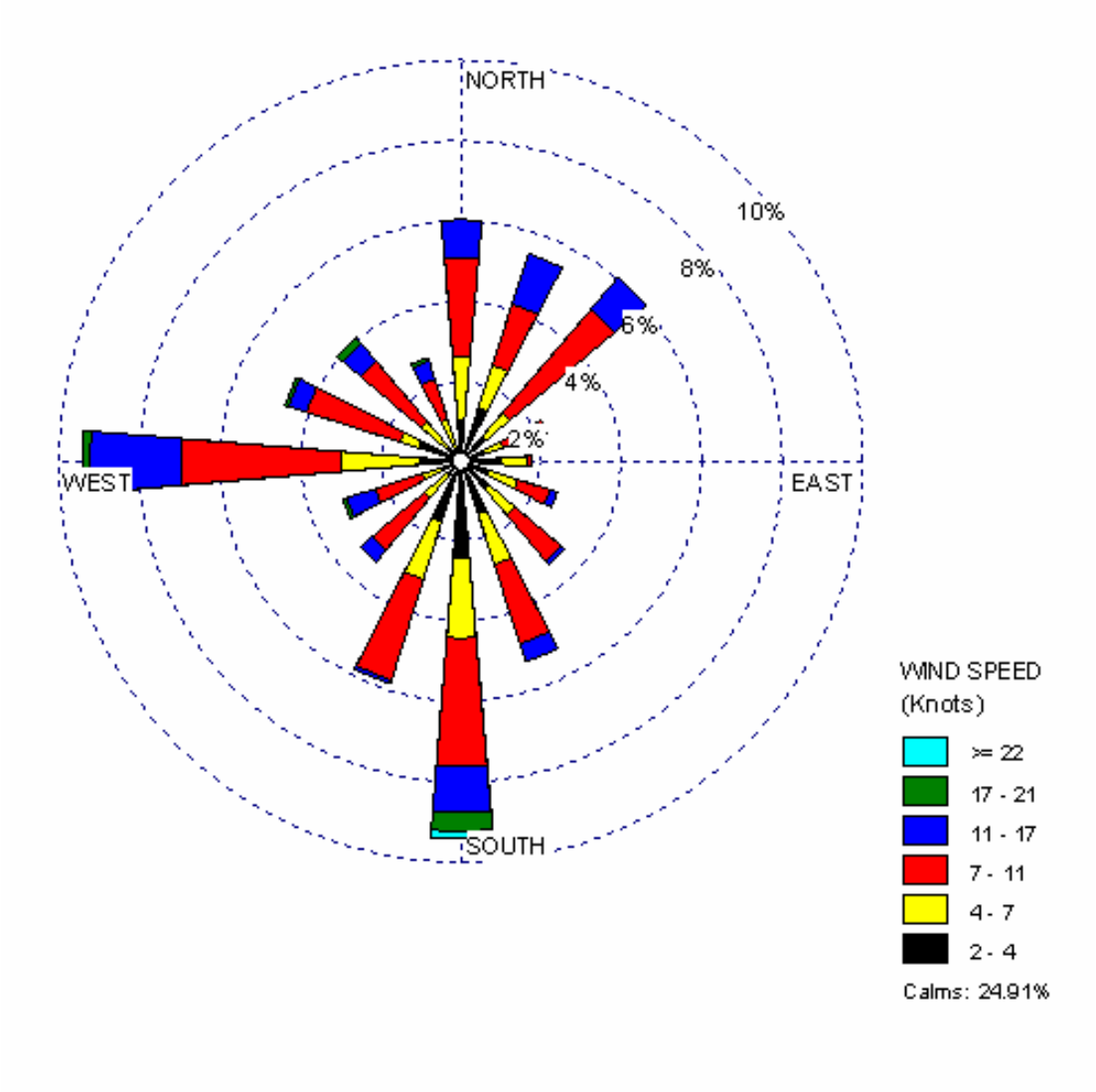


Table 8-1. Average Meteorological Parameters for Monitoring Site in Indiana

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
INDEM	4879	All 2005	60.35 ± 2.23	51.53 ± 2.04	41.87 ± 1.91	48.81 ± 1.97	71.58 ± 1.29	NA[1]	1.13 ± 0.44	0.52 ± 0.48
		Sample Day	59.33 ± 6.89	50.63 ± 6.18	40.04 ± 5.73	48.33 ± 5.82	69.02 ± 4.4	NA[1]	0.90 ± 1.11	0.14 ± 1.27

[1] Sea level pressure was not recorded at the Lancing Municipal Airport weather station.

Table 8-2. Comparison of Measured Concentrations and EPA Screening Values at the Indiana Monitoring Site

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Gary, Indiana - INDEM					
Formaldehyde	42	44	95.5	55.3%	55.3%
Acetaldehyde	34	44	77.3	44.7%	100.0%
Total	76	88	86.4		

Table 8-3. Daily and Seasonal Averages for Pollutants of Interest at the Indiana Monitoring Site

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Gary, IN – INDEM												
Acetaldehyde	44	44	2.59	0.55	3.06	0.28	4.20	0.98	0.57	0.21	NR	NR
Formaldehyde	44	44	72.85	27.47	16.18	3.36	19.34	5.39	193.41	44.41	NR	NR

NR = Not reportable due to low number of detects.

Table 8-4. Non-Chronic Risk Summary at the Indiana Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
INDEM	TO-11A	Formaldehyde	72.85 ± 27.47	49	13	94	13	40	16.18± 3.36	19.34 ± 5.39	193.41 ± 44.41	NR

NR = Not reportable due to low number of detects.

Table 8-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Indiana Monitoring Site

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Gary, Indiana - INDEM									
Acetaldehyde	44	-0.28	-0.33	-0.44	-0.54	-0.20	-0.02	0.07	NA[1]
Formaldehyde	44	0.61	0.66	0.73	0.66	0.29	-0.08	0.07	NA[1]

[1] Sea level pressure was not recorded at the Lancing Municipal Airport weather station.

Table 8-6. Motor Vehicle Information for the Indiana Monitoring Site

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
INDEM	493,297	393,034	0.80	404,545	322,321	42,950

Table 8-7. 1999 NATA Data Census Tract Summary for the Monitoring Site in Indiana

Pollutant	2005 UATMP Annual Average ($\mu g/m^3$)	1999 NATA Modeled Concentration ($\mu g/m^3$)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Gary, Indiana - INDEM, Census Tract 18089010202				
Acetaldehyde	2.59 ± 0.55	1.97	4.32	0.22
Formaldehyde	72.85 ± 27.47	1.86	0.01	0.19

BOLD = pollutant of interest.

9.0 Site in Massachusetts

This section presents meteorological, concentration, and spatial trends for the UATMP site in Massachusetts (BOMA). This site is located in the Boston-Lawrence-Worcester metropolitan statistical area (MSA). Figure 9-1 is a topographical map showing the monitoring site in its urban location. Figure 9-2 identifies point source emission locations within 10 miles of this site that reported to the 2002 NEI for point sources. BOMA is located near a number of sources, located mainly to the north and west of the site. A majority of the facilities are involved in fuel combustion industries.

Hourly meteorological data at a weather station near this site were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the BOMA monitoring site is at Logan International Airport (WBAN 14739).

Boston's location on the East Coast ensures that the city experiences a fairly active weather pattern. Most storm systems track across the Northeast, bringing ample precipitation to the area. The proximity to the Atlantic Ocean helps moderate cold outbreaks and hot spells, while at the same time allowing winds to gust higher than they would farther inland. Winds generally flow from the northwest in the winter and southwest in the summer (Ruffner and Bair, 1987). Table 9-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average u- and v-components of the wind) for the entire year and on days samples were taken. As shown in Table 9-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

9.1 Pollutants of Interest at the Massachusetts Monitoring Site

As described in Section 3.1.4, the methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 9-2 presents the four pollutants that failed at least one screen at BOMA; a total of 131 measured concentrations failed screens. The pollutants of interest at BOMA were identified as the pollutants that contributed to the top 95% of the total failed screens, resulting in four pollutants: arsenic (54 failed screens), nickel (42), manganese (22), and cadmium (13). It's important to note that the BOMA site sampled for metals only, and that this is reflected in the site's pollutants of interest. Also listed in Table 9-2 are the total number of detects and the percent detects failing the screen. The percent of detects failing screens ranged from 21% (cadmium) to 89% (arsenic).

9.2 Concentration Averages at the Massachusetts Monitoring Site

Three types of concentration averages were calculated for the four pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 9-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at BOMA, manganese measured the highest concentration by mass (0.0044 ± 0.0005 $\mu g/m^3$), followed by nickel (0.0031 ± 0.005 $\mu g/m^3$). The other two

pollutants were an order of magnitude less than these two pollutants. The seasonal averages of arsenic did not vary much while seasonal averages of nickel varied the most. Winter had the highest average concentration for both cadmium and nickel, while spring had the highest average for manganese.

9.3 Non-chronic Risk Evaluation at the Massachusetts Monitoring Site

Non-chronic risk for the concentration data at BOMA was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. Its is useful to compare daily measurement to the short-term MRL and REL factors, as well as compare the seasonal averages to the intermediate MRL. Of the four pollutants with at least one failed screen, none exceeded either the acute and intermediate risk values.

9.4 Meteorological and Concentration Analysis at the Massachusetts Site

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

9.4.1 Pearson Correlation Analysis

Table 9-4 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the BOMA monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) Both cadmium and nickel exhibited moderately strong negative correlations with maximum, average, dew point, and wet bulb temperatures, indicating that as temperatures increase, concentrations decrease. This correlates well with the seasonal averages of these pollutants. All of the correlations with pressure were positive and most were moderately strong, indicating that as pressure rises, so do concentrations of the pollutants of interest.

9.4.2 Composite Back Trajectory Analysis

Figure 9-3 is a composite back trajectory map for the BOMA monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site in Figure 9-3 represents 100 miles.

As shown in Figure 9-3, the back trajectories originated from a variety of directions at BOMA. The 24-hour airshed domain is large at BOMA, with trajectories originating as far away as the Gulf of St. Lawrence, north of New Brunswick, Canada, or greater than 600 miles away. However, 50% of the trajectories originated within 300 miles of the site; and 67% within 400 miles from the BOMA monitoring site.

9.4.3 Wind Rose Analysis

Hourly wind data from the Logan International Airport near the BOMA monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 9-4 is the wind rose for the BOMA monitoring site on days sampling occurred. As indicated in Figure 9-4, hourly winds were predominantly out of the west (12% of observations), west-northwest (9%), and southwest (9%) on sample days. Winds tended to be slightly breezier at BOMA than other UATMP sites. Wind speeds ranged from 7 to 11 knots on day samples were taken on 50% of observations, and ranged from 11 to 17 knots on 22% of sample days. Calm winds (<2 knots) were observed for only 2% of the measurements.

9.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

9.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration was not available in Suffolk County, MA. Thus, state-level vehicle registration from the Energy Information Administration (EIA) was allocated to the county-level using the county-level population proportion. County-level population information was obtained from the U.S. Census Bureau, and is summarized in Table 9-5. Table 9-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimate of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitors and the vehicle registration ratio. Finally, Table 9-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Compared to other UATMP sites, BOMA's county population, vehicle registration, estimated vehicles per person, and daily traffic volume are in the middle of the range. But BOMA's 10-mile population is on the high end, behind only sites in the New York City, Philadelphia, and Chicago areas. As a result, its estimated 10-mile vehicle ownership is also on the high end compared to other UATMP sites.

9.5.2 BTEX Analysis

A BTEX analysis could not be performed as BOMA sampled for metals only.

9.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 9-6 presents the 1999 NATA results for the census tract where the Massachusetts monitoring site is located. Only pollutants that "failed" the screens are presented in Table 9-6. Pollutants of interest are bolded.

9.6.1 1999 NATA Summary

The BOMA monitoring site is located in census tract 25025080400. The population for the census tract where the BOMA monitoring site is located was 723, which represents about 0.1% of the county population in 2000. In terms of cancer risk, arsenic had the highest risk of the BOMA pollutants of interest (0.28 in a million). However, none of the pollutants exhibited a cancer risk greater than 1 in a million. Similarly, no pollutants of interest had a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.01, suggesting very little risk for noncancer health affects.

9.6.2 Annual Average Comparison

The Massachusetts monitoring site annual averages are also presented in Table 9-6 for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 9.2 on how a valid annual average is calculated). Nickel was modeled to have the highest concentration of the pollutants of interest, but manganese actually measured the highest annual average in 2005. However, the BOMA annual average concentrations were all significantly less than the NATA modeled concentrations.

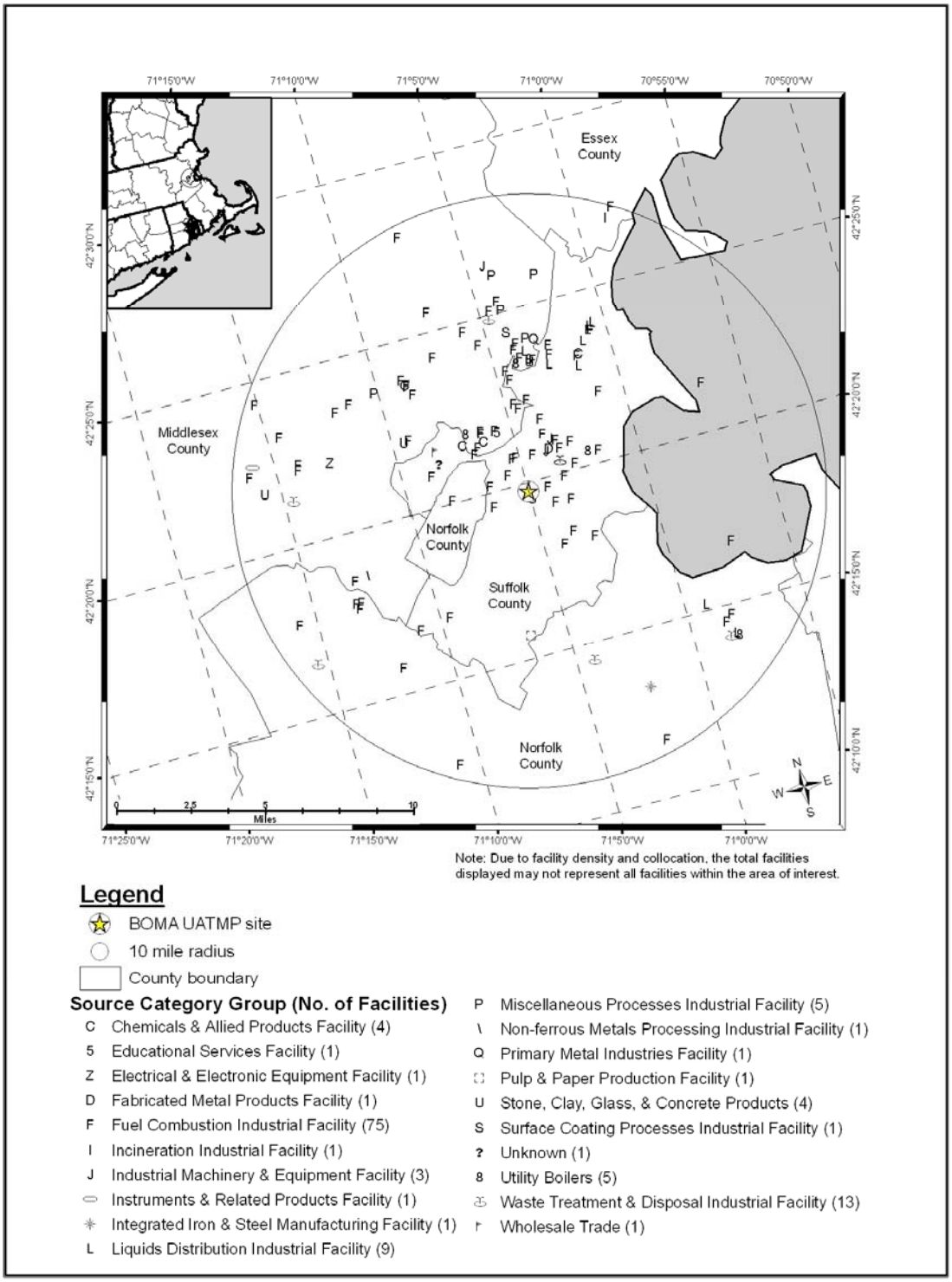
Massachusetts Pollutant Summary

- *The pollutants of interest at the Massachusetts site are arsenic, cadmium, manganese, and nickel.*
- *Manganese measured the highest daily average at BOMA. Concentrations of nickel were highest in winter.*

Figure 9-1. Boston, Massachusetts (BOMA) Monitoring Site

Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 9-2. Facilities Located Within 10 Miles of BOMA



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Legend

- BOMA UATMP site
- 10 mile radius
- County boundary

Source Category Group (No. of Facilities)

- C Chemicals & Allied Products Facility (4)
- 5 Educational Services Facility (1)
- Z Electrical & Electronic Equipment Facility (1)
- D Fabricated Metal Products Facility (1)
- F Fuel Combustion Industrial Facility (75)
- I Incineration Industrial Facility (1)
- J Industrial Machinery & Equipment Facility (3)
- Instruments & Related Products Facility (1)
- Integrated Iron & Steel Manufacturing Facility (1)
- L Liquids Distribution Industrial Facility (9)
- P Miscellaneous Processes Industrial Facility (5)
- \ Non-ferrous Metals Processing Industrial Facility (1)
- Q Primary Metal Industries Facility (1)
- Pulp & Paper Production Facility (1)
- U Stone, Clay, Glass, & Concrete Products (4)
- S Surface Coating Processes Industrial Facility (1)
- ? Unknown (1)
- 8 Utility Boilers (5)
- Waste Treatment & Disposal Industrial Facility (13)
- Wholesale Trade (1)

Figure 9-3. Composite Back Trajectory Map for BOMA

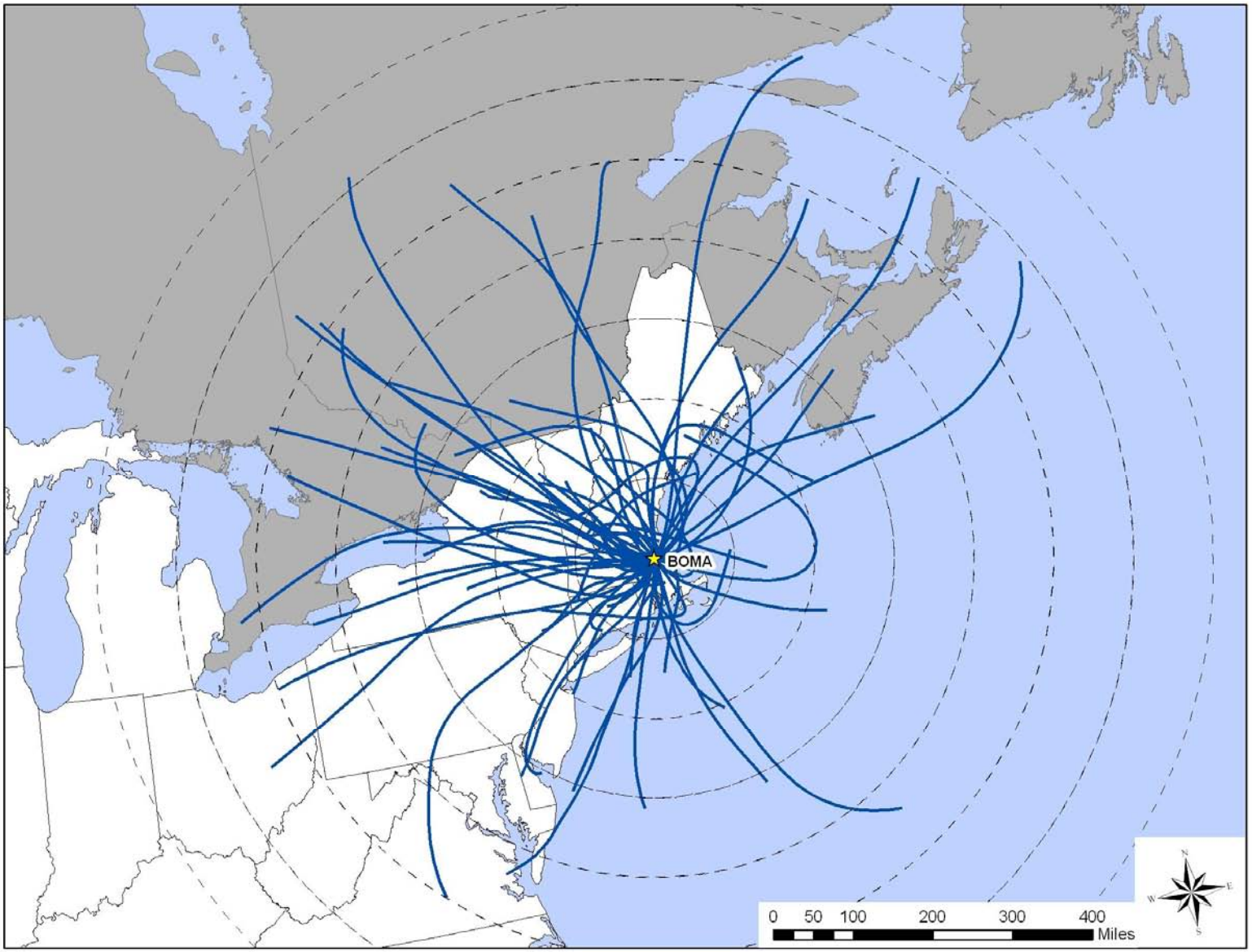


Figure 9-4. Wind Rose of Sample Days for the BOMA Monitoring Site

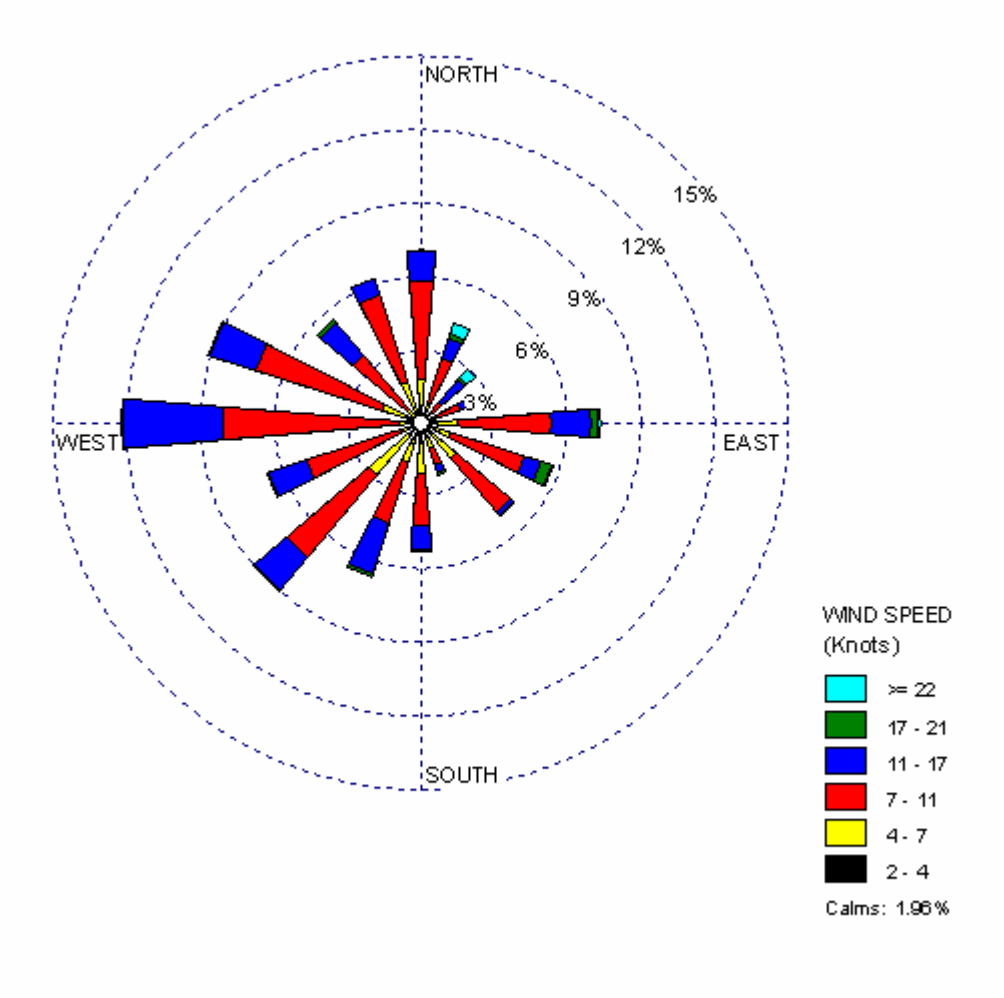


Table 9-1. Average Meteorological Parameters for Monitoring Site in Massachusetts

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*- component of the wind
BOMA	14739	All 2005	57.67 ± 1.95	50.98 ± 1.83	39.46 ± 1.97	45.80 ± 1.70	67.38 ± 1.57	1015.62 ± 0.89	2.11 ± 0.63	-0.63 ± 0.56
		Sample Day	58.78 ± 4.4	51.87 ± 4.20	40.3 ± 4.64	46.65 ± 3.97	67.26 ± 3.64	1016.09 ± 2.07	1.68 ± 1.40	-0.24 ± 1.26

Table 9-2. Comparison of Measured Concentrations and EPA Screening Values at the Massachusetts Monitoring Site

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Boston, Massachusetts - BOMA					
Arsenic (PM_{10})	54	61	88.5	41.2%	41.2%
Nickel (PM_{10})	42	61	68.9	32.1%	73.3%
Manganese (PM_{10})	22	61	36.1	16.8%	90.1%
Cadmium (PM_{10})	13	61	21.3	9.9%	100.0%
Total	131	244	53.7		

Table 9-3. Daily and Seasonal Averages for Pollutants of Interest at the Massachusetts Monitoring Site

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Arsenic (PM_{10})	61	61	0.0005	0.0001	0.0005	0.0001	0.0005	0.0001	0.0005	0.0001	0.0005	0.0001
Cadmium (PM_{10})	61	61	0.0005	0.0001	0.0008	0.0003	0.0004	0.0002	0.0002	0.0001	0.0005	0.0003
Manganese (PM_{10})	61	61	0.0044	0.0005	0.0038	0.0009	0.0056	0.0011	0.0050	0.0010	0.0034	0.0009
Nickel (PM_{10})	61	61	0.0031	0.0005	0.0051	0.0014	0.0025	0.0004	0.0027	0.0007	0.0023	0.0004

Table 9-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Massachusetts Monitoring Site

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Boston, Massachusetts - BOMA									
Arsenic (PM_{10})	61	0.17	0.12	0.03	0.07	-0.22	0.02	0.20	0.26
Cadmium (PM_{10})	61	-0.32	-0.32	-0.28	-0.30	-0.02	-0.08	-0.26	0.27
Manganese (PM_{10})	61	0.14	0.13	0.02	0.08	-0.31	-0.01	0.19	0.08
Nickel (PM_{10})	61	-0.42	-0.47	-0.39	-0.44	0.01	-0.13	-0.24	0.35

Table 9-5. Motor Vehicle Information for the Massachusetts Monitoring Site

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
BOMA	654,428	566,351	0.87	1,589,367	1,375,460	27,287

Table 9-6. 1999 NATA Data Census Tract Summary for the Monitoring Site in Massachusetts

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Boston, Massachusetts - BOMA, Census Tract 25025080400				
Arsenic (PM_{10})	<0.001	0.07	0.28	0.002
Cadmium (PM_{10})	<0.001	0.03	0.05	0.001
Manganese (PM_{10})	0.004 ± 0.0005	0.11	--	0.002
Nickel (PM_{10})	0.003 ± 0.0005	0.61	0.10	0.009

BOLD = pollutant of interest.

10.0 Sites in Michigan

This section presents meteorological, concentration, and spatial trends for the four UATMP sites in Michigan. Three sites, APMI, DEMI, and YFMI, are located in the Detroit area, while the ITCMI site is in Sault Saint Marie on the Upper Pennisula. Figures 10-1 through 10-4 are topographical maps showing the monitoring sites in their urban locations. Figures 10-5 and 10-6 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. The Detroit sites are within a few miles of each other. A number of facilities surround these sites, many of which are located just south of DEMI and YFMI. Most of these facilities are involved in fuel combustion or waste treatment and disposal. All of the industrial facilities within 10 miles of ITCMI are involved in waste treatment and disposal.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather stations closest to the Michigan monitoring sites are Detroit-Metropolitan Airport (APMI and DEMI), Detroit City Airport (YFMI), and Sault Ste. Marie International Airport (ITCMI), WBAN 94847, 14822, and 14847, respectively.

The Detroit area is located in the Great Lakes region, a place for active weather, as storm systems typically track across the region. Hence, winters can be cold and wet, while summers are generally mild. The urbanization of the area along with Lake St. Clair to the east are two major influences on the city=s weather. The lake tends to keep Detroit warmer in the winter and cooler in the summer than more inland areas. The urban heat island tends to keep the city warmer than outlying areas. Winds are often breezy and generally flow from the southwest on average. Sault Saint Marie is located on the northeast edge of Michigan=s Upper Pennisula. While this area also experiences an active weather pattern, its climate is somewhat tempered by the surrounding waters of Lakes Superior and Huron, as the city resides on the channel between the two lakes. This location experiences ample precipitation, especially during lake-effect snow

events (Ruffner and Bair, 1987). As shown in Table 10-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

10.1 Pollutants of Interest at the Michigan Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total failed screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 10-2 presents the pollutants that failed at least one screen at the Michigan monitoring sites. The number of pollutants failing the screen varies by site, as indicated in Table 10-2. Ten pollutants with a total of 219 measured concentrations failed screens at APMI; 12 pollutants with a total of 335 measured concentrations failed screens at DEMI; 7 pollutants with a total of 76 measured concentrations failed screens at ITCMI; and 11 pollutants with a total of 174 measured concentrations failed screens at YFMI. The pollutants of interest also varied by site, yet the following five pollutants contributed to the top 95% of the total failed screens at each Michigan monitoring site: benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene and tetrachloroethylene. It's important to note that the Michigan sites sampled for different pollutant types, and that this is reflected in each site's pollutants of interest. DEMI and APMI sampled for carbonyl compounds and VOC, while ITCMI and YFMI sampled for VOC and SVOC.

Also listed in Table 10-2 are the total number of detects and the percent detects failing the screen. Of the five pollutants of interest that were the same among all four sites, benzene and carbon tetrachloride had 100% of their detects fail the screening values.

10.2 Concentration Averages at the Michigan Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average

concentration of all detects. If there are at least seven detects within each season, then a *seasonal* average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the *annual* average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 10-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at APMI, tetrachloroethylene measured the highest concentration by mass (18.40 ± 9.40 μg/m^3), followed by formaldehyde (2.82 ± 0.39 μg/m^3) and benzene (2.21 ± 0.68 μg/m^3). Autumn tetrachloroethylene concentrations were significantly higher than the other valid seasonal averages, although there were not enough VOC samples taken in winter to calculate a winter seasonal average. Most of the other seasonal averages did not vary much at the APMI site. Among the daily averages at DEMI, formaldehyde measured the highest concentration by mass (5.35 ± 1.39 μg/m^3), followed by tetrachloroethylene (2.81 ± 0.87 μg/m^3) and acetaldehyde (2.13 ± 0.28 μg/m^3). Statistically, the seasonal averages did not vary much at the DEMI site. The benzene (8.18 ± 3.25 μg/m^3) and total xylenes (4.18 ± 0.91 μg/m^3) daily averages at YFMI were significantly higher than daily averages of the other pollutants of interest. The YFMI site sampled only through early October, and therefore has no autumn seasonal averages. For the remaining seasons, the seasonal averages did not vary much statistically at the YFMI site.

The averages at the Sault Ste. Marie site tended to be significantly less than those from the Detroit sites. Among the daily averages at ITCMI, benzene measured the highest concentration by mass (0.89 ± 0.12 μg/m^3), followed by carbon tetrachloride (0.77 ± 0.14 μg/m^3) and acrolein (0.54 ± 0.28 μg/m^3). The ITCMI site sampled only through September and most of ITCMI's pollutants of interest were not detected frequently enough to calculate seasonal

averages. However, benzene has three valid seasonal averages and carbon tetrachloride has two valid seasonal averages. Table 10-3 shows that seasonal averages of these pollutants did not vary much from season to season.

10.3 Non-chronic Risk Evaluation at the Michigan Monitoring Sites

Non-chronic risk for the concentration data at Michigan monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short term MRL and REL factors, as well as to compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein and benzene exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 10-4.

All acrolein detects at the Michigan sites were greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$. The average detected concentration ranged from 0.54 ± 0.28 $\mu g/m^3$ (at ITCMI) to 1.18 ± 0.34 $\mu g/m^3$ (at DEMI), which is an order of magnitude higher than either acute risk factor. No seasonal averages for acrolein could be calculated, therefore intermediate risk could not be evaluated.

Two benzene detects at the YFMI site were greater than the ATSDR acute risk value of 28.75 $\mu g/m^3$. However, the average detected benzene concentration was 8.18 ± 3.25 $\mu g/m^3$, and none of the three valid seasonal averages exceeded the ATSDR intermediate MRL of 20 $\mu g/m^3$. As previously mentioned, autumn seasonal averages could not be calculated for the YFMI site. Interestingly, the two exceedances of the ATSDR acute value occurred in autumn.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. For all four Michigan monitoring sites, at least one acrolein concentration exceeded the acute risk factors. Figures 10-7 through 10-10 are pollution roses for acrolein at the Michigan sites. A pollution rose is a plot of concentration and wind direction. As

shown in Figures 10-7 through 10-10, and discussed above, all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

Figure 10-7 is the acrolein pollution rose for the APMI monitoring site. The pollution rose shows that acrolein was detected only once during sampling at the APMI site. This concentration was recorded on October 25, 2005 with a northerly wind. However, there are not enough detects of acrolein to determine if a pattern between concentration and wind direction.

Figure 10-8 is the acrolein pollution rose for the DEMI monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, a pattern characteristic of mobile sources. The highest concentration of acrolein occurred on July 9, 2005 with a northwesterly wind. The DEMI site is located in a suburban, yet industrial area, and is surrounded by many railways and major interstates. I-94 is located to the west and north and I-75 is located to the south and east of the site. Major auto and steel manufacturers are located in close proximity to the site.

Figure 10-9 is the acrolein pollution rose for the ITCMI monitoring site. The pollution rose shows that four acrolein concentrations exceeded the acute risk factors. The exceedances occurred with winds originating from a variety of directions, a pattern characteristic of mobile sources. The highest concentration of acrolein occurred on July 3, 2005 with a south-southeasterly wind. ITCMI is located on the campus of Lake Superior State University, in a primarily residential area. Interstate 75 is located just west and north of the monitoring site, and ITCMI has one of the highest daily traffic volumes of all the UATMP sites.

Figure 10-10 is the acrolein pollution rose for the YFMI monitoring site. The pollution rose shows that two acrolein concentrations exceeded the acute risk factors. The exceedances occurred with winds originating from the east or the west. The highest concentration of acrolein occurred on July 15, 2005 with an east-northeastly wind. However, there are not enough detects of acrolein to determine if a pattern exists between concentration and wind direction.

Figure 10-11 is a pollution rose for benzene at the YFMI site. As shown in Figure 10-11, only two benzene concentrations exceeded the ATSDR acute risk factor, which is indicated by a dashed line. These exceedances occurred with south and south-southwesterly winds. Figure 10-3 shows numerous point sources are located to the south and southwest of the monitoring site. YFMI is located in a heavily industrialized area just west of the Detroit River. Interstate 75 is located to the north and west of the monitoring site. The two exceedances occurred on back-to-back sample days, September 19, 2005 and September 25, 2005.

10.4 Meteorological and Concentration Analysis at the Michigan Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

10.4.1 Pearson Correlation Analysis

Table 10-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Michigan monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) At APMI, acetaldehyde, carbon tetrachloride, formaldehyde, and *p*-dichlorobenzene exhibited moderately strong to strong positive correlations with maximum, average, dew point, and wet bulb temperatures. All of the correlations with the *v*-component of the wind were positive, indicating that northerly and/or southerly winds influence concentrations of the pollutants of interest at APMI.

At DEMI, acetaldehyde, acrolein, carbon tetrachloride, *p*-dichlorobenzene, and tetrachloroethylene exhibited moderately strong to strong positive correlations with maximum, average, dew point, and wet bulb temperatures. Hexachloro-1,3-butadiene exhibited strong negative correlations with these same parameters. With the exception of carbon tetrachloride, all of the correlations with the *u*-component of the wind were negative, indicating that easterly and/or westerly winds influence concentrations of the pollutants of interest at DEMI. Acrolein

and *p*-dichlorobenzene each exhibited moderately strong negative correlations with the *v*-component of the wind, while acetaldehyde exhibited a moderately strong positive correlation with the *v*-component. Moderately strong positive correlations with sea level pressure were calculated for acetaldehyde and acrolein.

Strong correlations were calculated between the various meteorological parameters and the pollutants of interest at ITCMI. However, the low number of detects shown in Table 10-5 may allow for exaggeration of the relationship between the concentrations and weather parameters. A moderately strong negative correlation exists between benzene and the maximum, average, dew point, and wet bulb temperatures. Correlations with the *v*-component of the wind were moderately strong for all of the pollutants, indicating that northerly and/or southerly winds influence concentrations of the pollutants of interest at ITCMI.

Moderately strong positive correlations were calculated between benzene, carbon tetrachloride, and naphthalene and maximum, average, dew point, and wet bulb temperatures at YFMI, while moderately strong negative correlations were calculated between 1,3-butadiene and tetrachloroethylene and these same parameters. With the exception of *p*-dichlorobenzene and tetrachloroethylene, all of the correlations with the *v*-component of the wind were moderately strong to strong and positive. This indicates that northerly and/or southerly winds are important factors in concentration of the pollutants of interest at YFMI. Tetrachloroethylene exhibited a strong positive correlation with sea level pressure (0.50).

10.4.2 Composite Back Trajectory Analysis

Figures 10-12 through 10-15 are composite back trajectory maps for the Michigan monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site represents 100 miles.

As shown in Figure 10-12, the back trajectories originated from a variety of directions at APMI. The 24-hour airshed domain is somewhat large, with trajectories originating as far away

as extreme northwest Iowa, over 600 miles away. Nearly 66% of the trajectories originated within 300 miles of the site; and 87% within 400 miles from the APMI monitoring site.

As shown in Figure 10-13, the back trajectories originated from a variety of directions at DEMI. The 24-hour airshed domain is large, with trajectories originating as far away as central Manitoba, Canada, or over 1000 miles away. Nearly 61% of the trajectories originated within 300 miles of the site; and 83% within 400 miles from the DEMI monitoring site. The one trajectory originating from Manitoba, Canada, occurred on a day when a strong frontal system moved across the central and eastern US on November 24, 2005. This wind pattern is also evident on several composite trajectory maps from other sites in the region including the INDEM, NBIL and SPIL, DITN, MIMN, and MAWI monitoring sites. This trajectory is not shown on the APMI, ITCMI, or YFMI composite trajectory maps because these sites stopped sampling prior to November 24, 2005.

As shown in Figure 10-14, the back trajectories originated from a variety of directions at ITCMI. The 24-hour airshed domain is somewhat large, with trajectories originating as far away as east-central Manitoba, Canada, nearly 600 miles away. Nearly 58% of the trajectories originated within 300 miles of the site; and 79% within 400 miles from the ITCMI monitoring site.

As shown in Figure 10-15, the back trajectories originated from a variety of directions at YFMI. The 24-hour airshed domain is large, with trajectories originating as far away as western Ontario, Canada, over 700 miles away. Nearly 70% of the trajectories originated within 300 miles of the site; and 93% within 500 miles from the YFMI monitoring site. Interestingly, the long trajectory originating in Ontario is for September 29, 2005, not November 24, 2005 as shown for DEMI in Figure 10-13. September 29 was a make-up day for the YFMI monitoring site, and samples were not taken on this date at other sites.

10.4.3 Wind Rose Analysis

Hourly wind data from the weather stations mentioned in Section 10.0 were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 10-16 through 10-19 are the wind roses for the Michigan monitoring sites on days sampling occurred.

As indicated in Figure 10-16, hourly winds at APMI originated from all directions. However, southerly, northerly, and westerly were most frequently measured (each representing 9% of the hourly observations). Calm winds (<2 knots) were recorded for 10% of the hourly measurements. For wind speeds greater than 2 knots, 36% of observations ranged from 7 to 11 knots. Wind speeds greater than 22 knots were most frequently recorded with southwesterly to westerly wind directions.

The wind rose for DEMI resembles the APMI wind rose. As indicated in Figure 10-17, hourly winds at DEMI originated from all directions. However, the mostly frequently measured wind directions were southerly, northerly, and westerly (10%, 8%, and 8%, respectively). Calm winds were recorded for 9% of the hourly measurements. For wind speeds greater than 2 knots, 37% of observations ranged from 7 to 11 knots. Wind speeds greater than 22 knots were most frequently recorded with southwesterly to northwesterly wind directions.

As indicated in Figure 10-18, hourly winds at ITCMI originated predominantly from the west-northwest (12% of the hourly observations), east (11%), west (9%), and northwest (9%). Calm winds were recorded for 11% of the hourly measurements. For wind speeds greater than 2 knots, 39% of observations ranged from 7 to 11 knots. Light winds (2-4 knots) were most frequently observed from the east-northeast and east.

The wind rose for YFMI shows that westerly winds were recorded most frequently (11 % of observations) as indicated in Figure 10-19, followed by southerly winds (9%), northerly winds

(8%), and easterly winds (7%). Calm winds were recorded for 14% of the hourly measurements. For wind speeds greater than 2 knots, 40% of observations ranged from 7 to 11 knots.

10.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

10.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Chippewa County and Wayne County, Michigan, were obtained from the Michigan Department of State and the U.S. Census Bureau, and are summarized in Table 10-6. Table 10-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 10-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

The Detroit sites are located in Wayne County, and ITCMI is located in Chippewa County. Wayne County has significantly more residents and registered vehicles than Chippewa County. In fact, this county has the highest population and vehicle registration of all the UATMP sites, except NBIL and SPIL in Cook County, in the Chicago area. However, the ITCMI site has a higher registration-population ratio than the Detroit sites. The Dearborn site (DEMI) has the highest estimated vehicle ownership within a 10-mile radius of the Michigan sites, although the ITCMI site has the highest daily traffic volume passing a Michigan monitor. The ITCMI monitoring site has the third highest traffic volume of all the UATMP sites.

10.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.14). Table 3-11 presented

and Figure 3-4 depicted the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle emissions. APMI and DEMI's ratios most resemble those of the roadside study, although both of their benzene-ethylbenzene and xylenes-ethylbenzene ratios are much closer together (3.63 ± 0.32 and 3.70 ± 0.18 for APMI and 3.55 ± 0.27 and 3.59 ± 0.10 for DEMI, respectively), and APMI's toluene-ethylbenzene ratio is somewhat higher (6.49 ± 0.51 for APMI vs. 5.85 for the roadside study) than the roadside study. ITCMI's benzene-ethylbenzene and toluene-ethylbenzene ratios are similar (6.44 ± 1.26 and 6.16 ± 0.65 for ITCMI vs. 2.85 and 5.85 for the roadside study). YFMI's benzene-ethylbenzene ratio (19.12 ± 8.76) is the highest and xylene-ethylbenzene ratio (3.66 ± 0.14) is the lowest, unlike the roadside study. These observations are very similar to those from 2004.

10.6 Site-Specific Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The Michigan sites with enough data for a trends analysis are APMI, DEMI, and ITCMI.

- Figure 10-20 shows that concentrations of 1,3-butadiene and benzene at APMI have changed little over the years (when factoring in the confidence intervals illustrated by the error bars). Concentrations of formaldehyde seem to have increased in 2005 after an initial decrease in 2002. However, the APMI site did not sample carbonyl compounds in 2003, so no formaldehyde concentration is provided.

- The DEMI monitoring site has consistently sampled VOC and carbonyls since 2001, as shown in Figure 10-21. After an initial decrease in formaldehyde concentrations in 2002, formaldehyde concentrations increased in 2003. The high 2004 formaldehyde concentration is probably skewed from a couple of high samples, as indicated by the confidence intervals represented by error bars. Concentrations of 1,3-butadiene and benzene have been fairly consistent throughout the period.

- The ITCMI monitoring site has sampled VOC since 2003. Although potentially misleading in Figure 10-22 due to the small range of concentrations, benzene concentrations have changed little statistically over the period. 1,3-Butadiene

concentrations appear to have increased in 2004, then decreased in 2005. However, the 2004 1,3-butadiene concentration is based on only one detect.

10.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 10-7 presents the 1999 NATA results for the census tracts where the Michigan monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 10-7. Pollutants of interest are bolded.

The APMI monitoring site is located in census tract 26163576600 with a population of 4,376, which represents 0.2% of the county population in 2000. The DEMI monitoring site is located in census tract 26163573500, with a population of 5,214, which represents 0.3% of Wayne County's 2000 population. YFMI is located in census tract 26163579000, which has a population of zero. Finally, ITCMI is located in census tract 26033970300. In 2000, the population in this census tract was 3,744 or 10% of the county population.

10.7.1 1999 NATA Summary

In terms of cancer risk at the Detroit sites, the Top 3 pollutants identified by NATA in the APMI and DEMI census tracts are benzene (20.04 and 29.55 in-a-million risk, respectively), 1,3-butadiene (6.47 and 10.06 in-a-million, respectively), and acetaldehyde (4.99 and 5.72 in-a-million, respectively). DEMI's benzene cancer risk is the third-highest calculated for a UATMP site, behind only BAPR and MIMN. Due to the lack of residents in the YFMI census tract, cancer risk is low. Acrolein was the only pollutant in the APMI and DEMI census tracts to have a noncancer hazard quotient greater than 1.0 (which may lead to adverse health effects), ranging from 8.08 at APMI to 9.52 at DEMI. Most noncancer hazard quotients were less than 0.20, suggesting very little risk for noncancer health affects, with the exception of acrolein. The Top 3

cancer risk pollutants identified by NATA at ITCMI are benzene (4.18 in a million), carbon tetrachloride (3.13), and tetrachloroethylene (1.23). Noncancer risk was low, with acrolein having the highest noncancer risk (0.38).

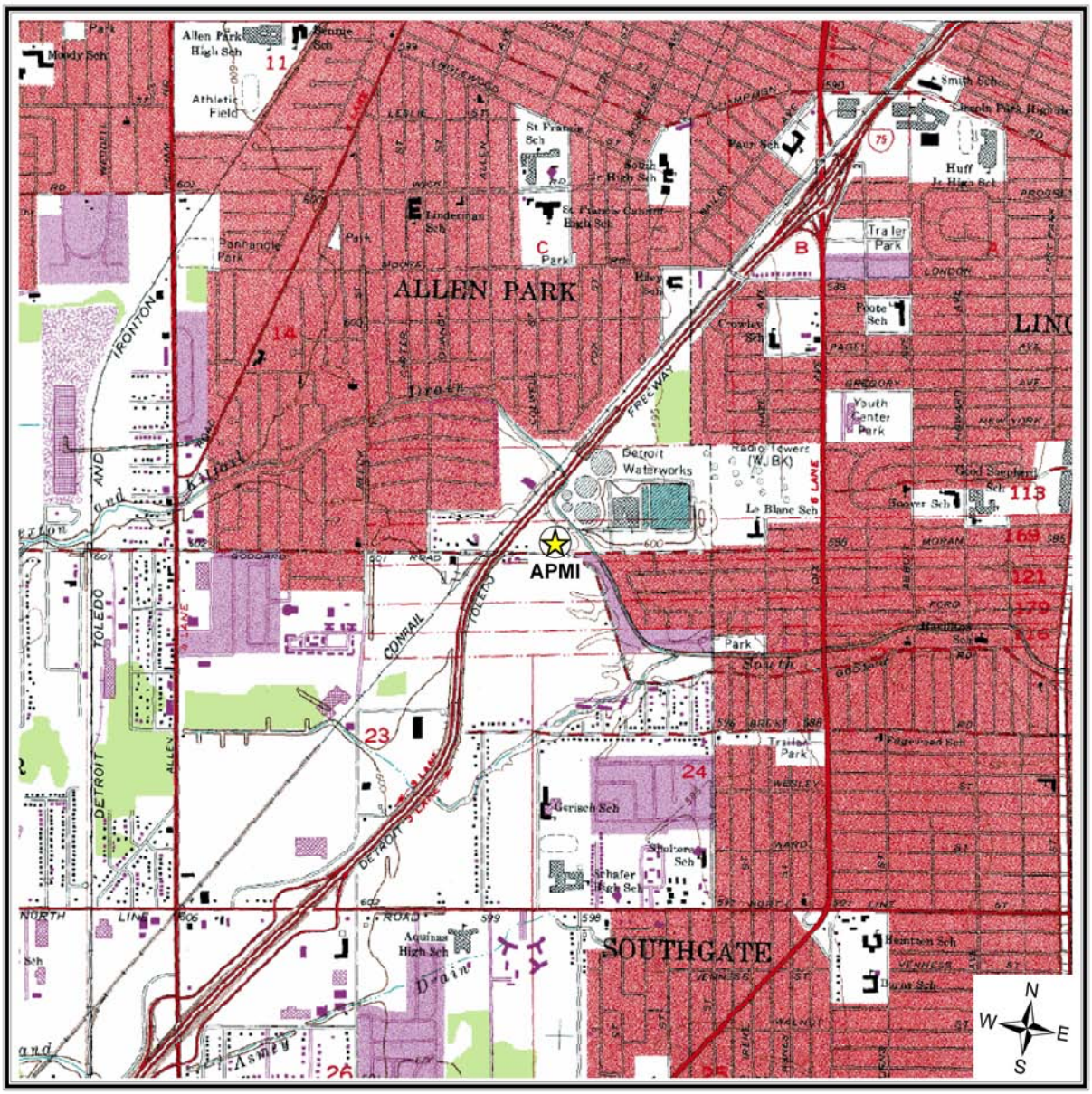
10.7.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 10.2 on how a valid annual average is calculated). Unfortunately, the ITCMI and YFMI sites ended sampling prior to November 2005, therefore, valid annual averages could not be calculated for those sites. For APMI, the NATA modeled concentrations are fairly similar to the annual averages, with the exception of tetrachloroethylene and total xylenes. The total xylenes annual average is slightly higher than the NATA modeled concentration, while the tetrachloroethylene annual average is significantly higher than the NATA modeled concentration. Tetrachloroethylene and formaldehyde annual averages at DEMI are somewhat higher than the NATA modeled concentrations, while the NATA modeled concentration for total xylenes is higher than the 2005 measured annual average.

Michigan Pollutant Summary

- *The pollutants of interest common to each Michigan site are benzene, 1,3-butadiene, carbon tetrachloride, p-dichlorobenzene, and tetrachloroethylene.*
- *Tetrachloroethylene measured the highest daily average at APMI; formaldehyde measured highest at DEMI; and benzene measured highest at ITCMI and YFMI.*
- *Acrolein exceeded the short-term risk factors at each of the Michigan sites, while benzene exceeded the short-term risk factor at YFMI.*
- *A comparison of formaldehyde, benzene, and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of formaldehyde increased in 2005 at APMI, while benzene and 1,3-butadiene have been holding steady. Formaldehyde appears to be increasing at DEMI although the low confidence interval in 2004 indicates the high 2004 concentration may have been driven by a few outliers. Little change is noted at ITCMI.*

Figure 10-1. Detroit, Michigan (APMI) Monitoring Site

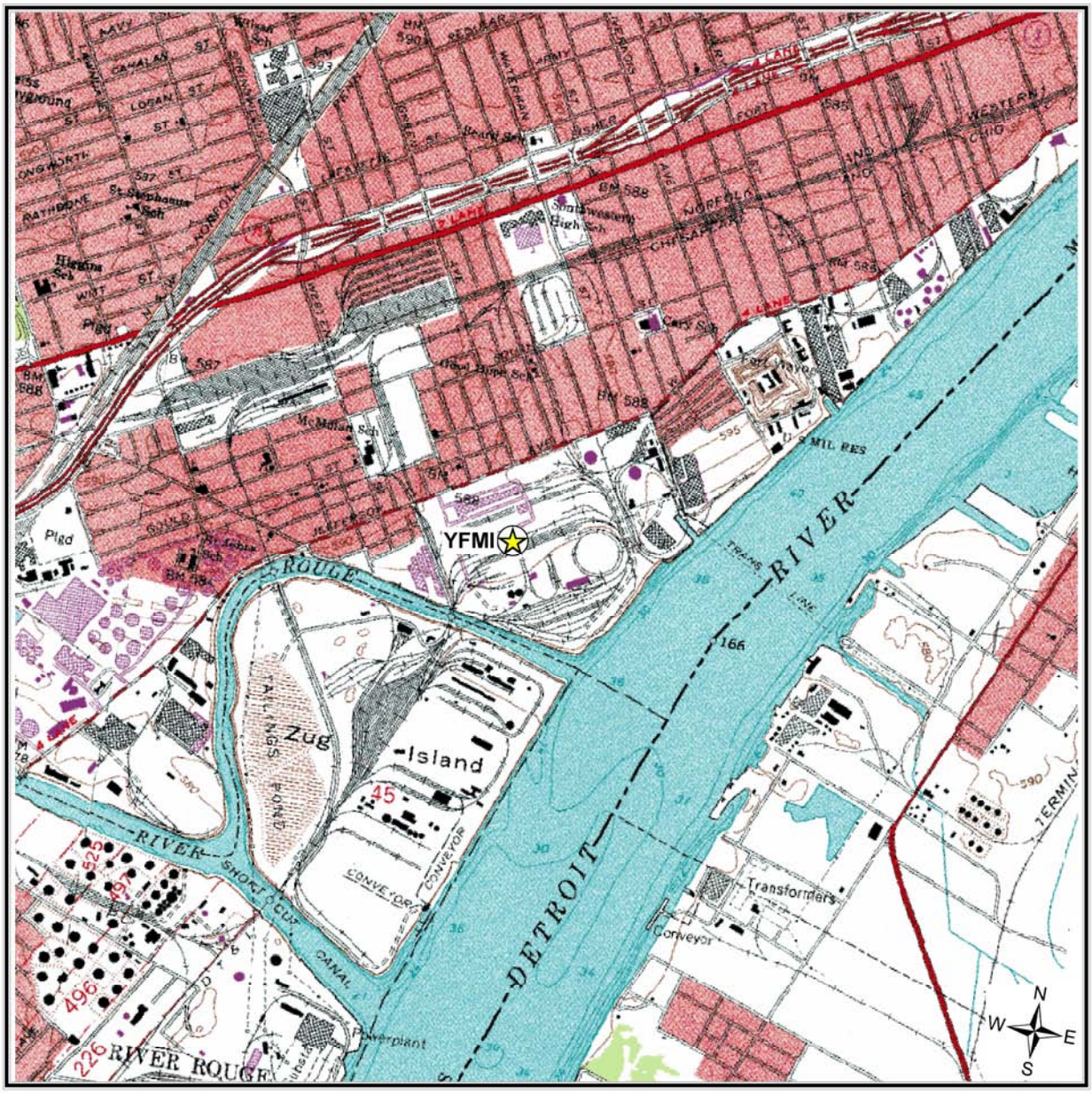


Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 10-2. Detroit, Michigan (DEMI) Monitoring Site

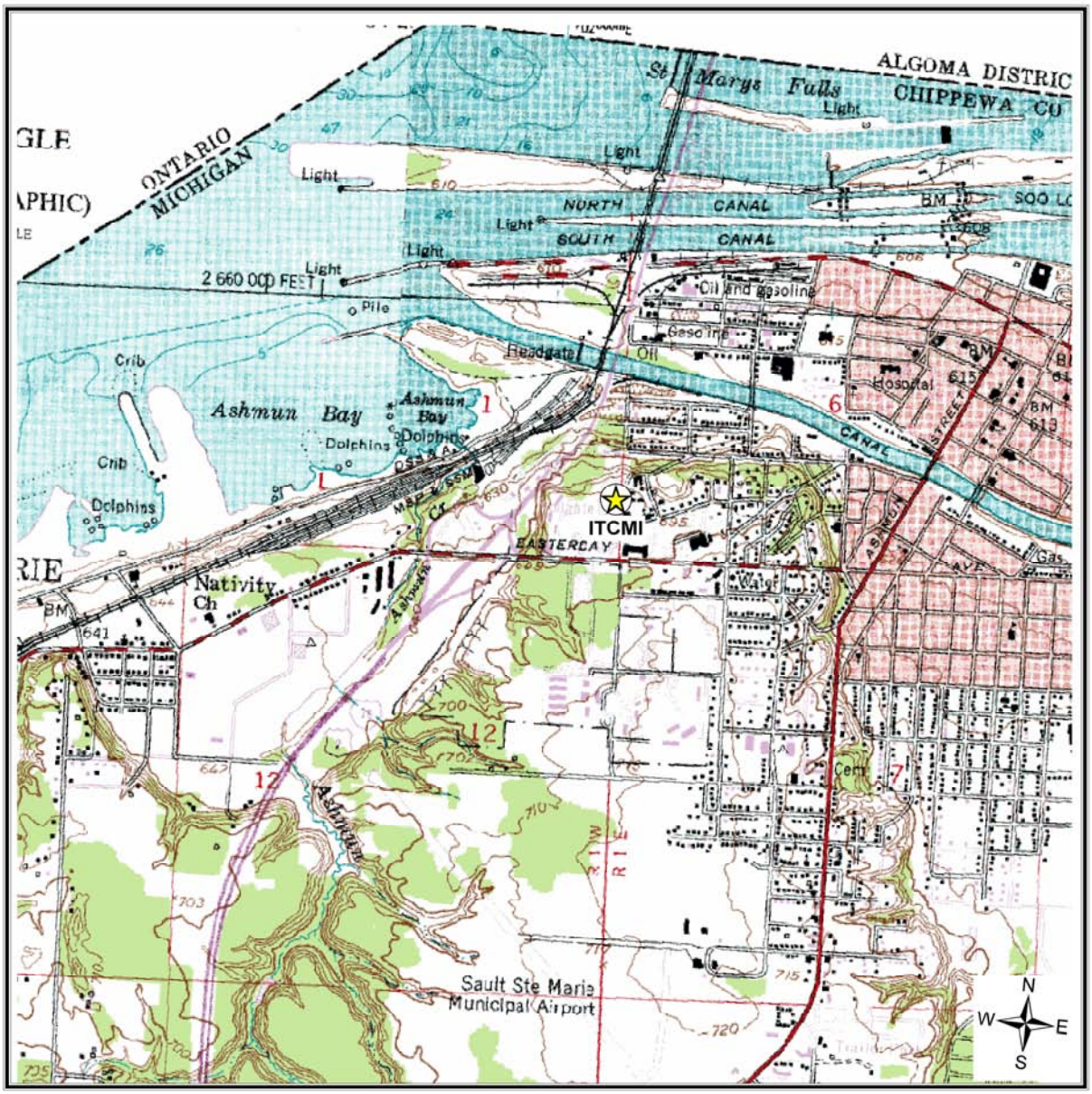
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 10-3. Detroit, Michigan (YFMI) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 10-4. Sault Saint Marie, Michigan (ITCMI) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 10-5. Facilities Located Within 10 Miles of the Detroit, Michigan Monitoring Sites (APMI, DEMI, YFMI)

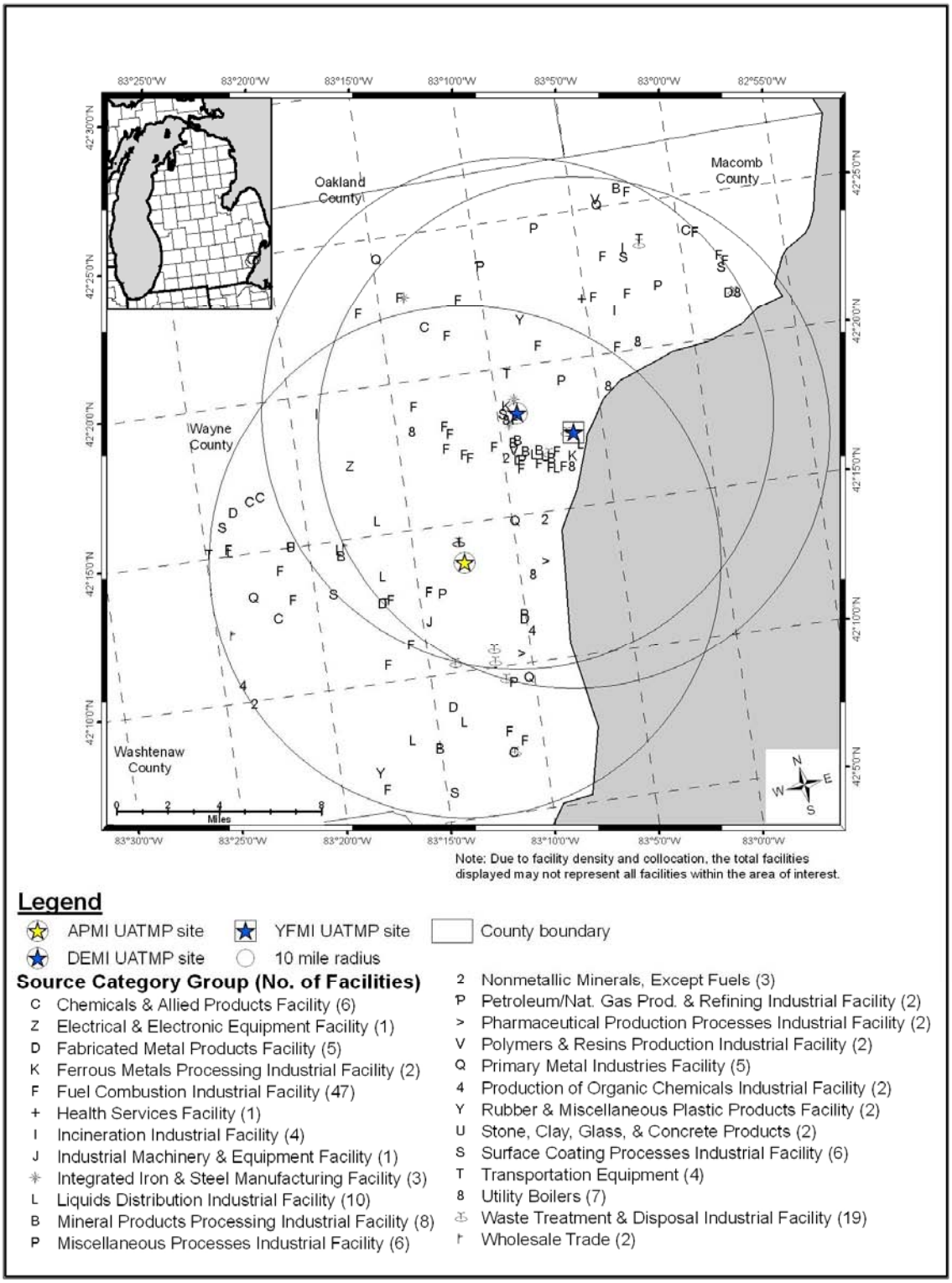


Figure 10-6. Facilities Located Within 10 Miles of ITCMI

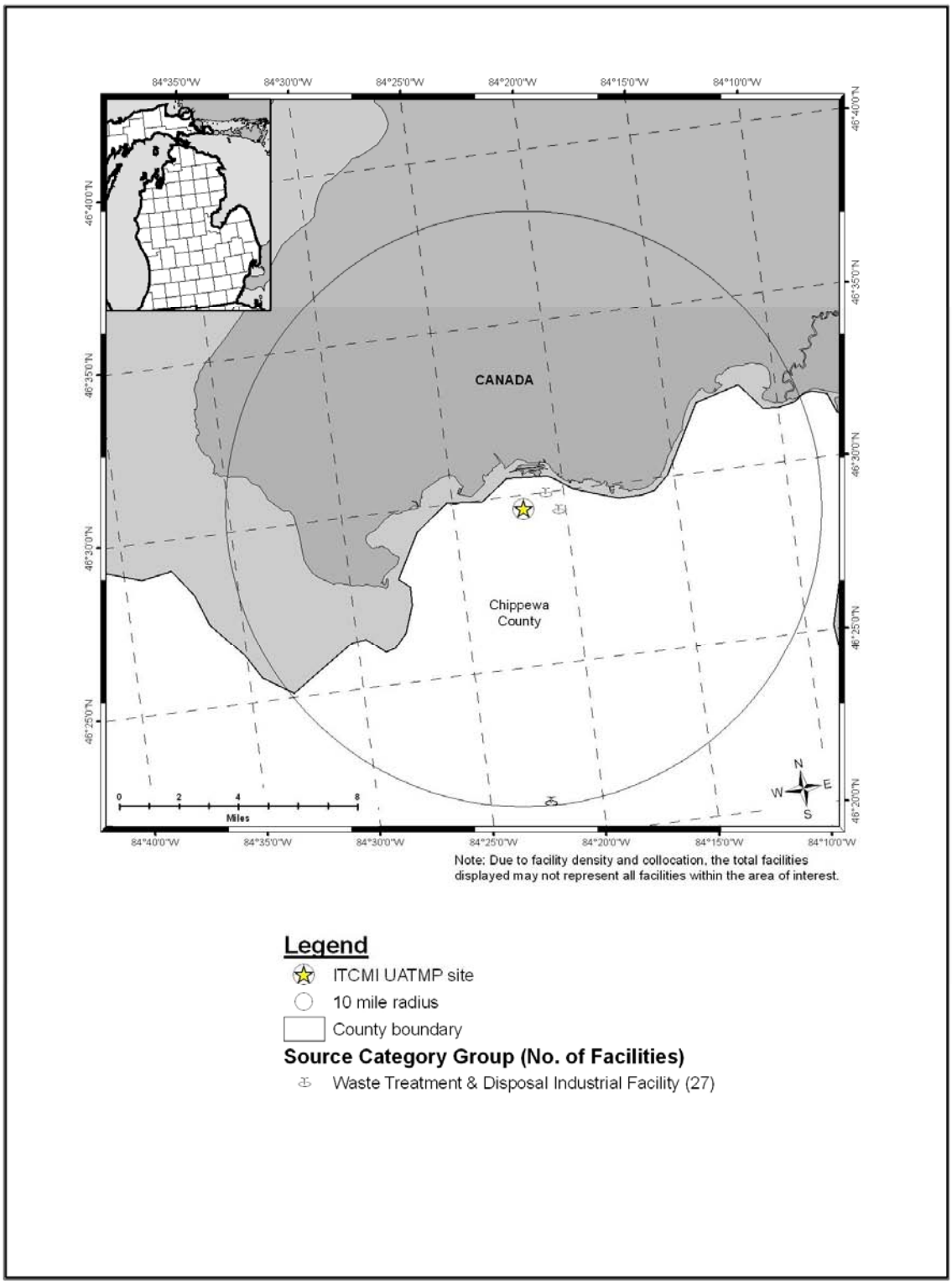


Figure 10-7. Acrolein Pollution Rose at APMI

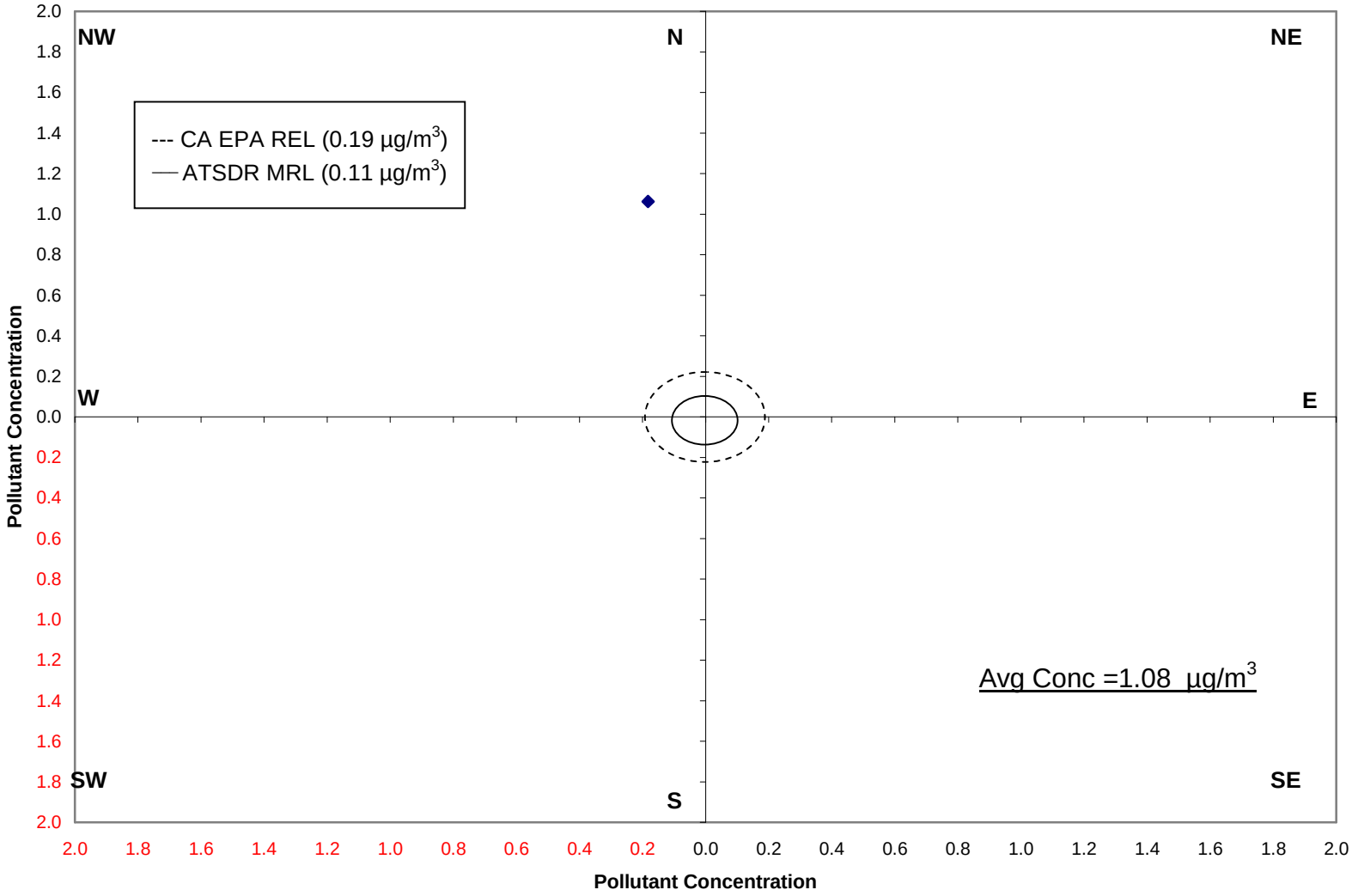


Figure 10-8. Acrolein Pollution Rose at DEMI

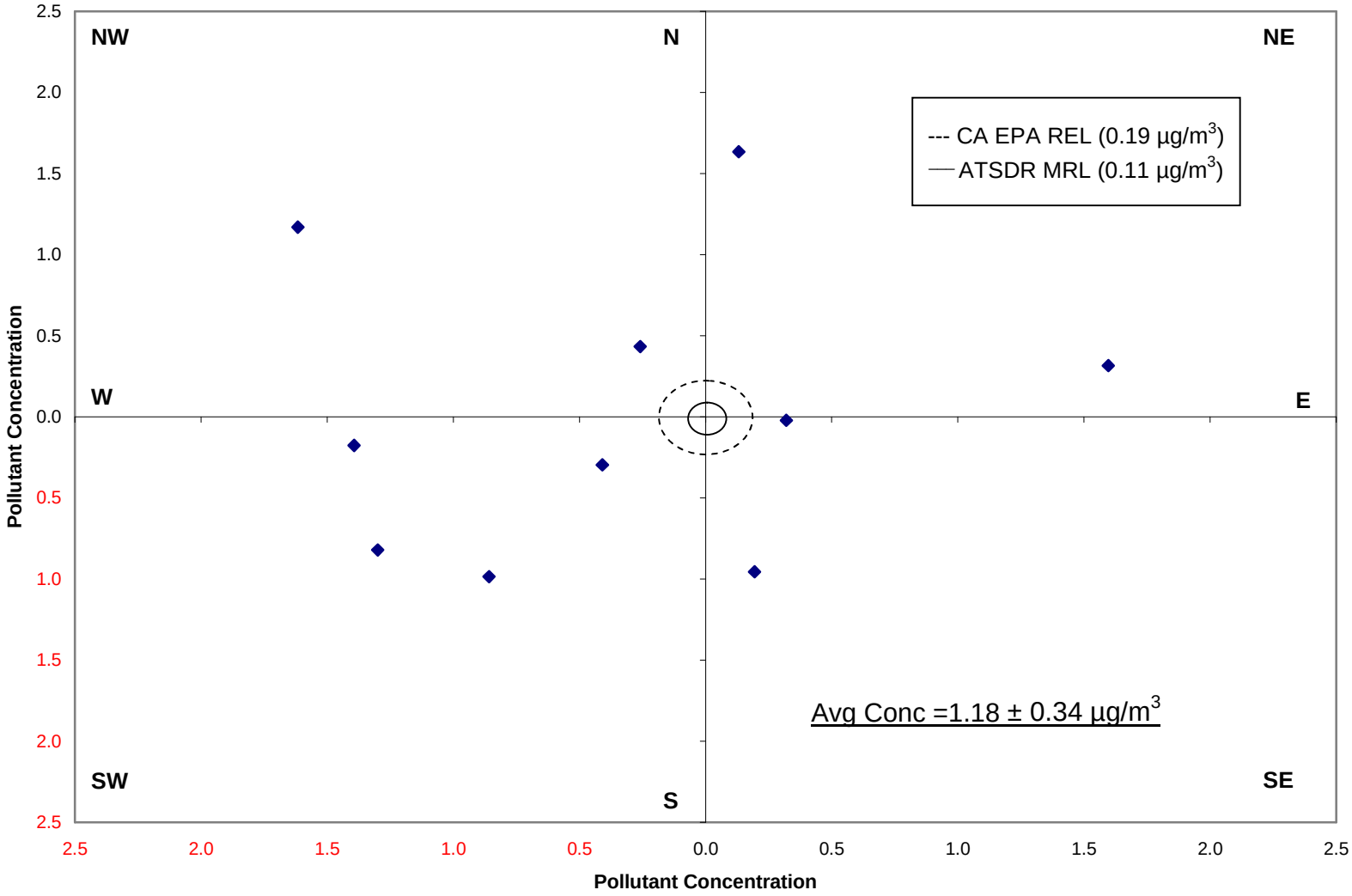


Figure 10-9. Acrolein Pollution Rose at ITCMI

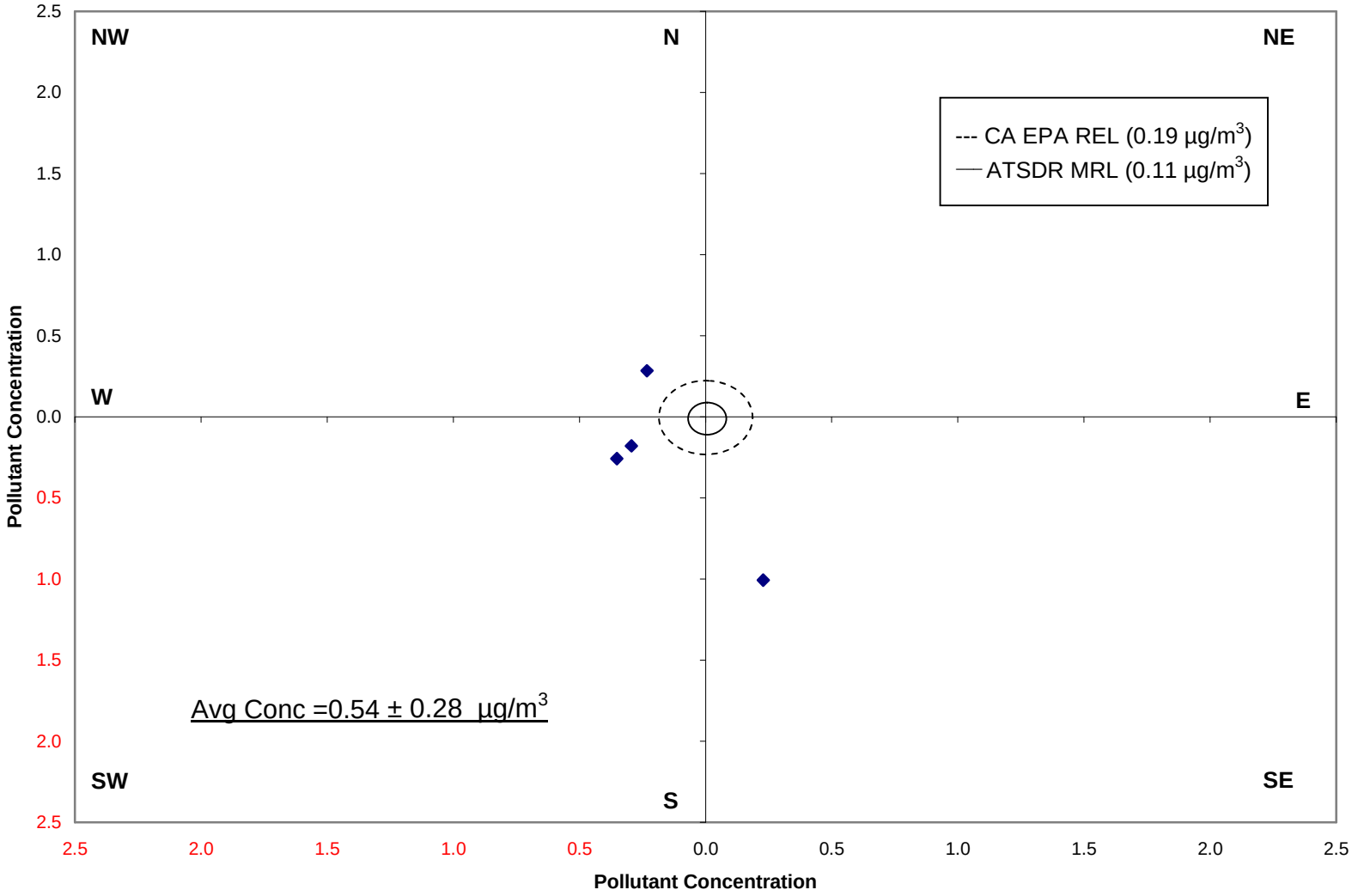


Figure 10-10. Acrolein Pollution Rose at YFMI

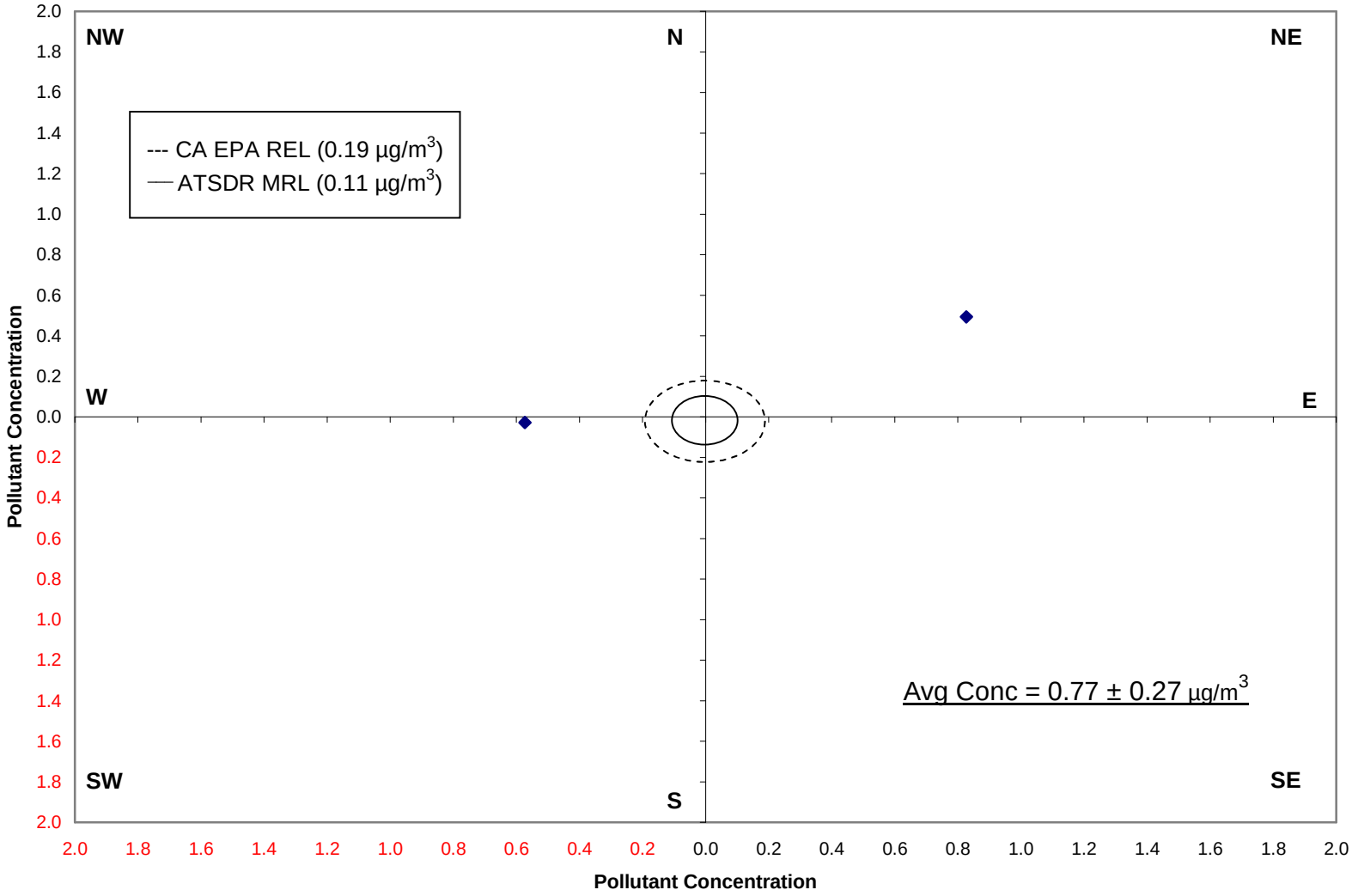


Figure 10-11. Benzene Pollution Rose at YFMI

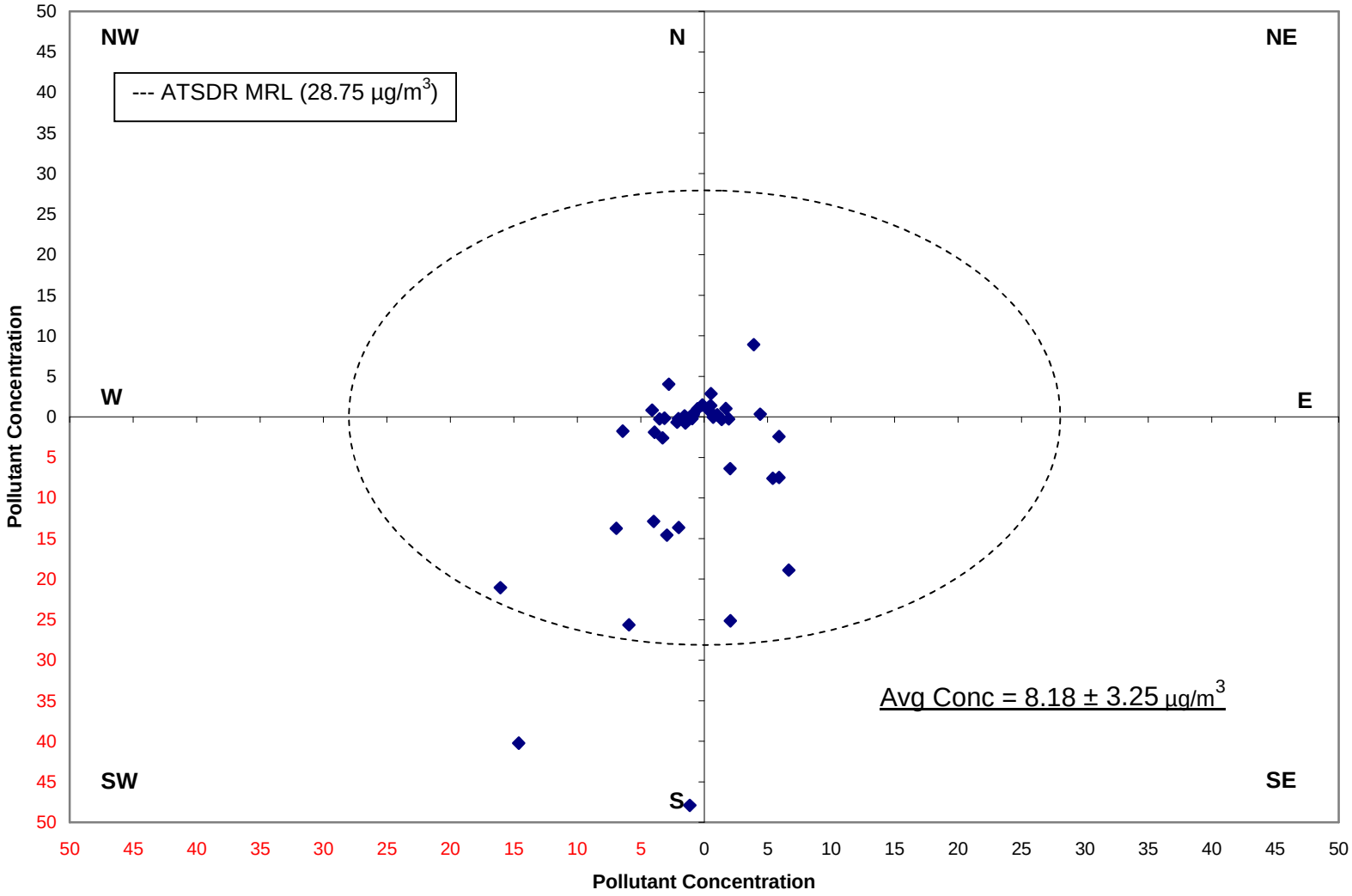


Figure 10-12. Composite Back Trajectory Map for APMI

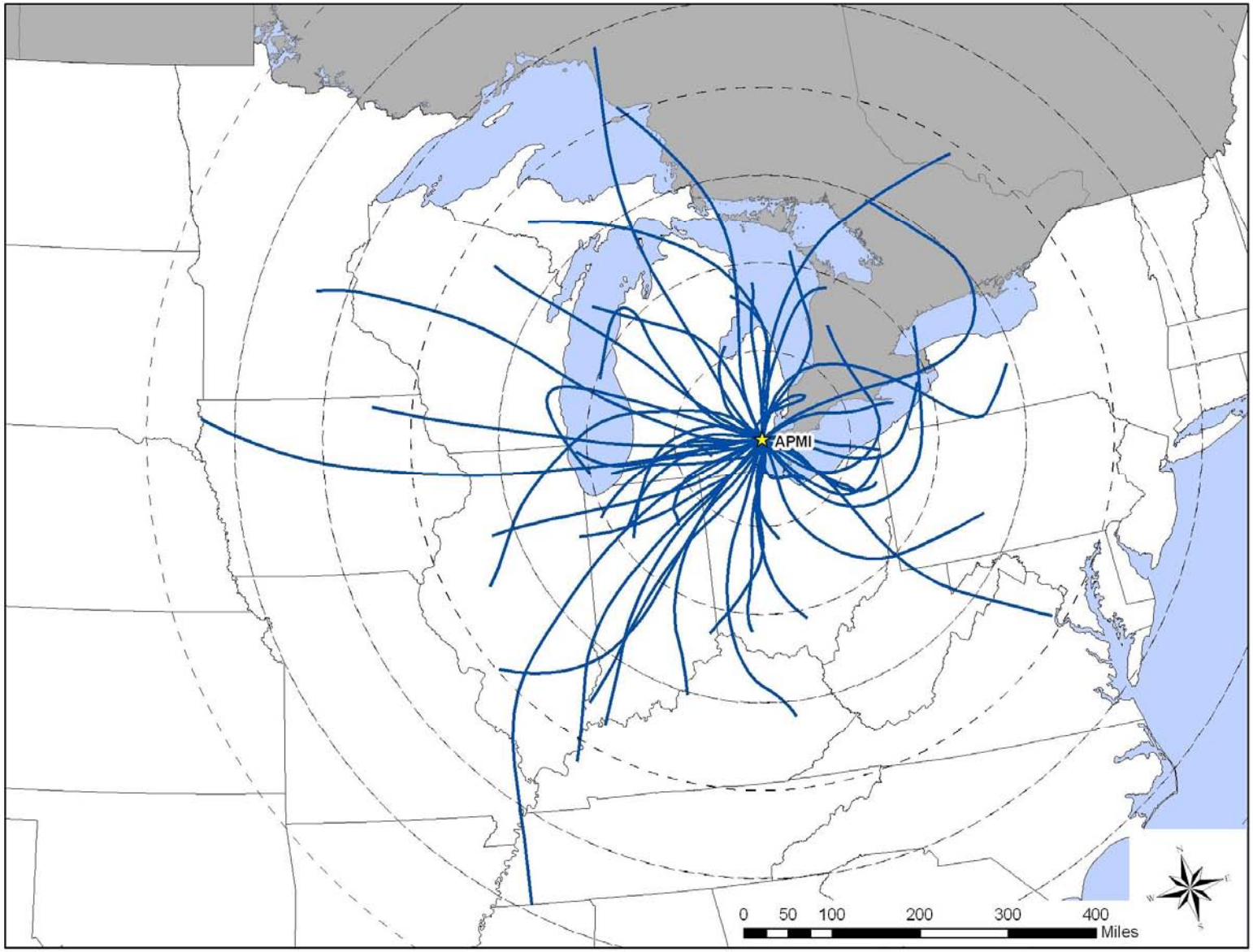


Figure 10-13. Composite Back Trajectory Map for DEMI

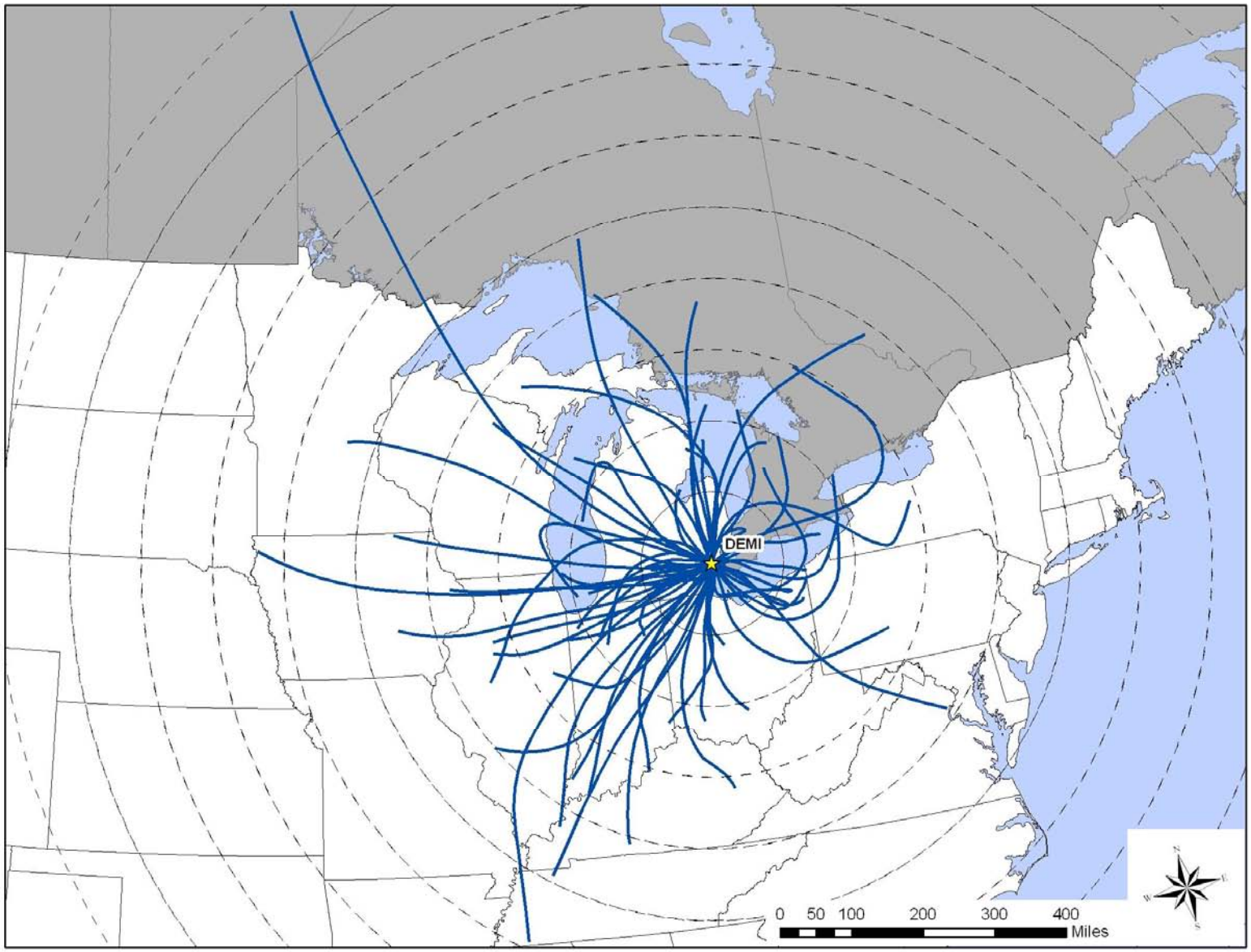


Figure 10-14. Composite Back Trajectory Map for ITCMI

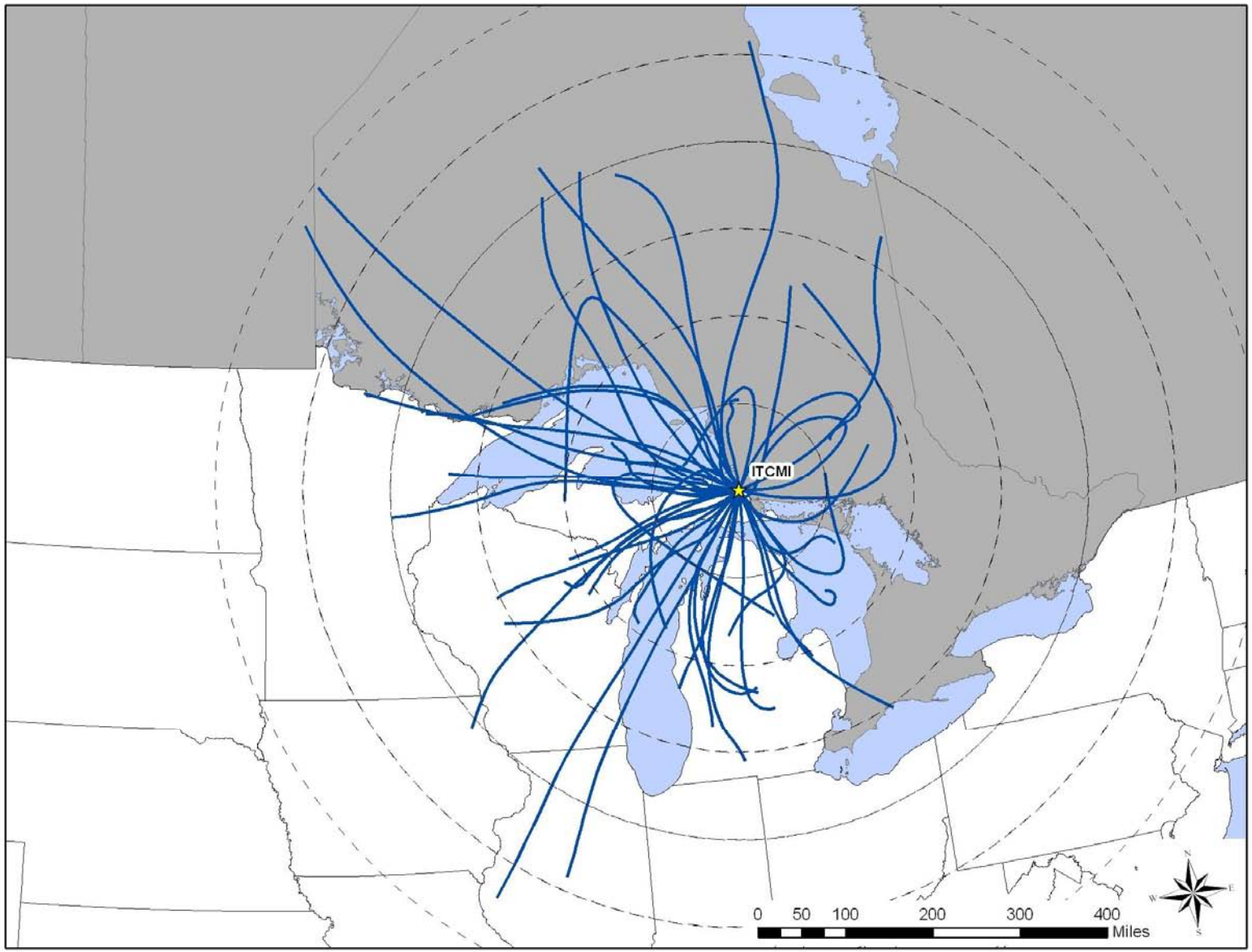


Figure 10-15. Composite Back Trajectory Map for YFMI

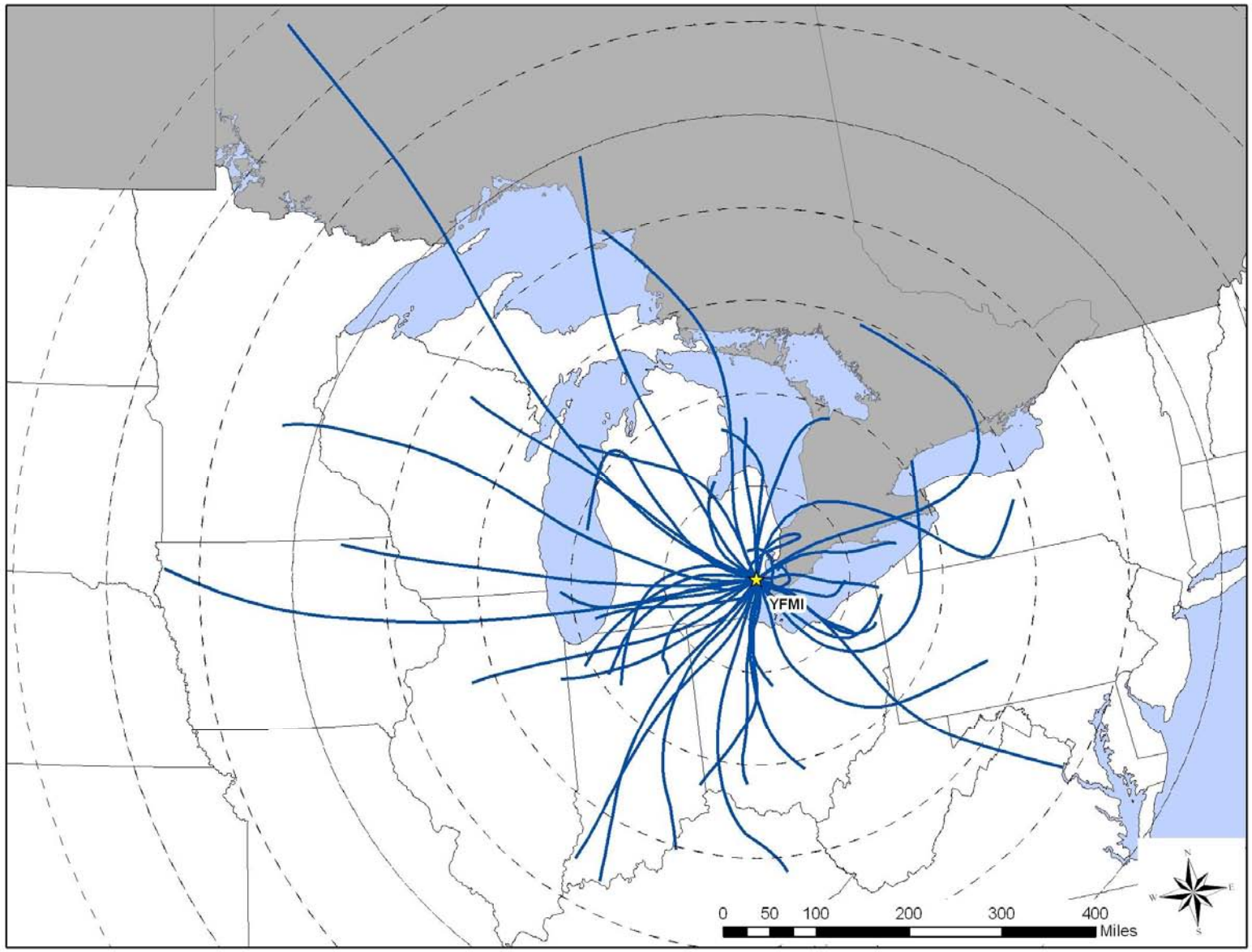


Figure 10-16. Wind Rose of Sample Days for the APMI Monitoring Site

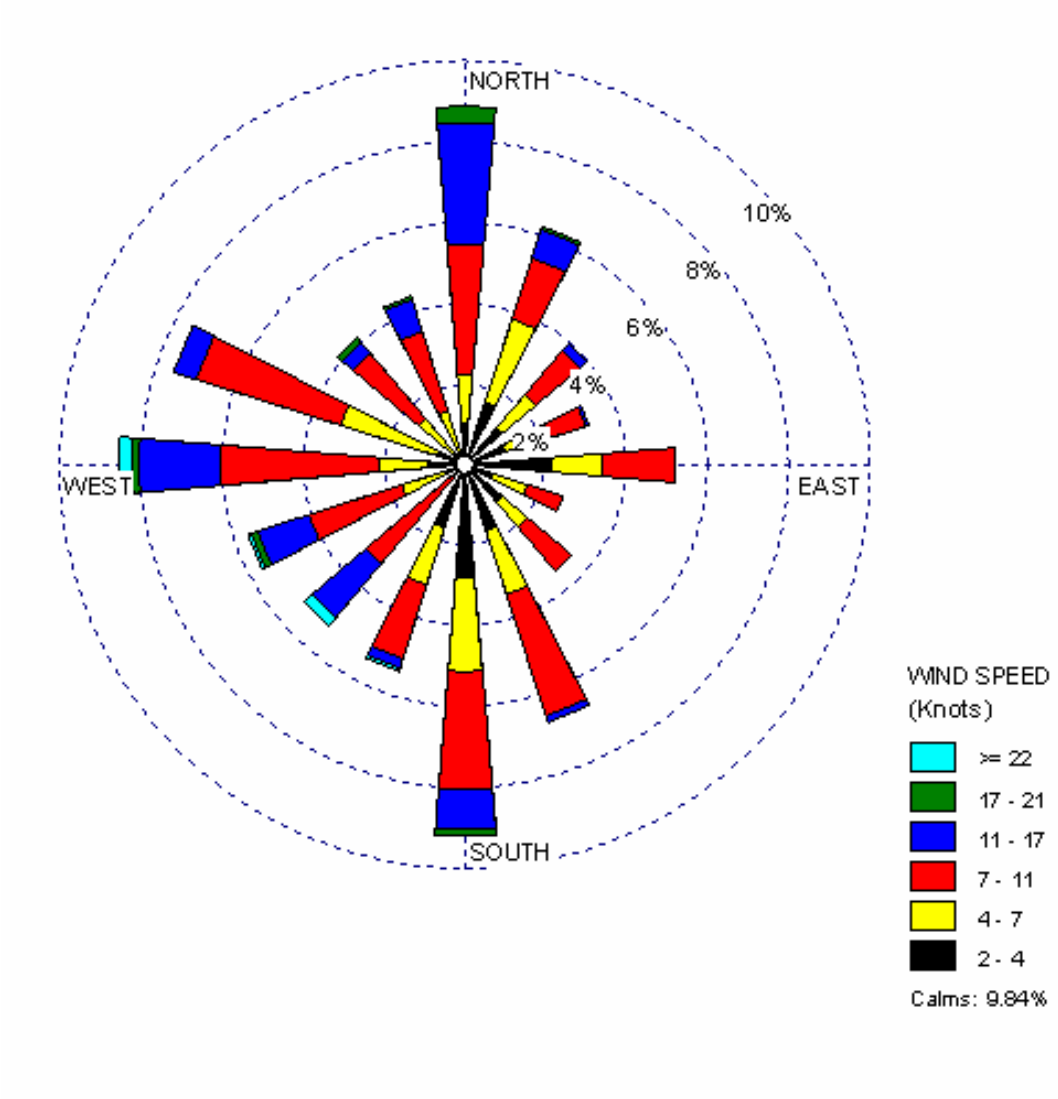


Figure 10-17. Wind Rose of Sample Days for the DEMI Monitoring Site

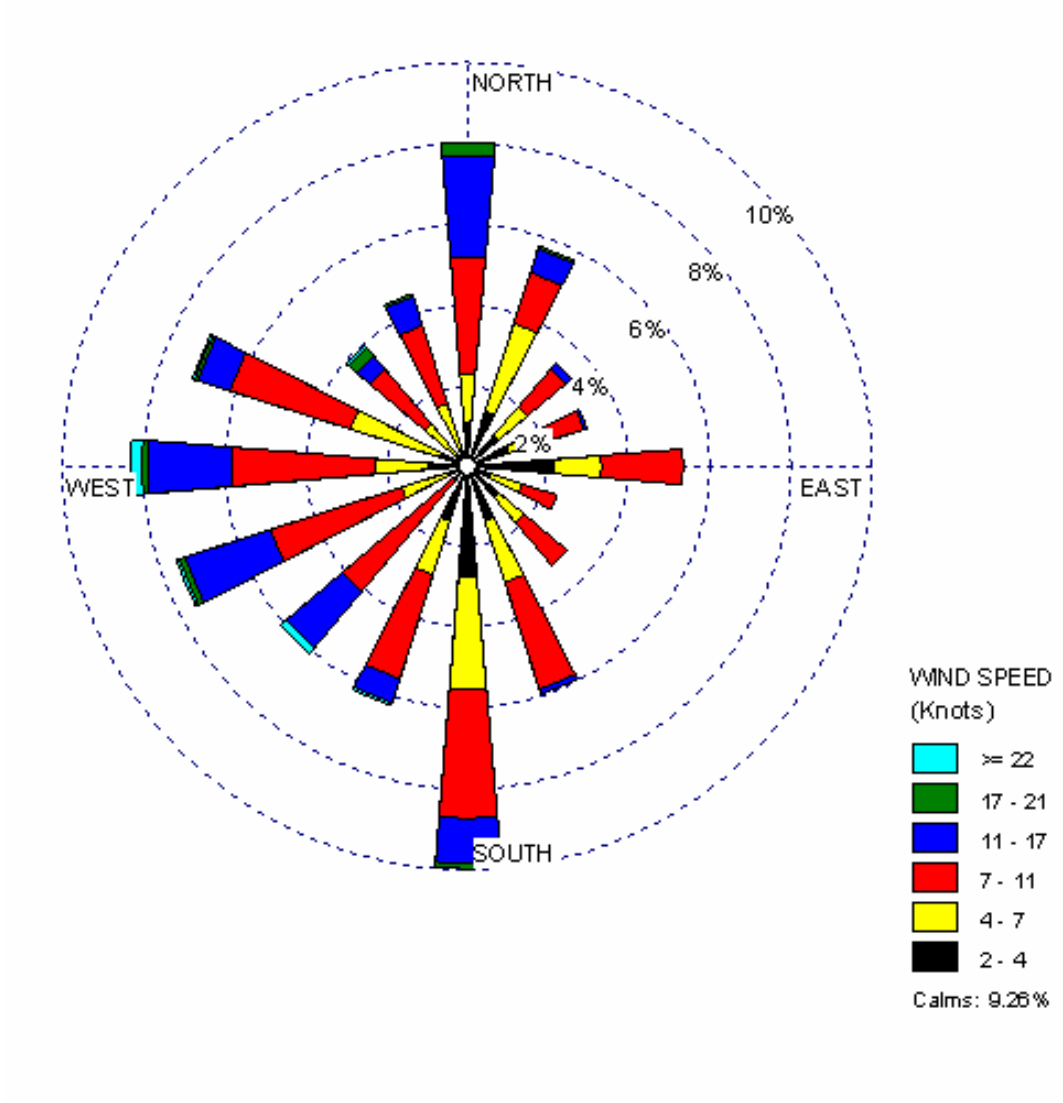


Figure 10-18. Wind Rose of Sample Days for the ITCMI Monitoring Site

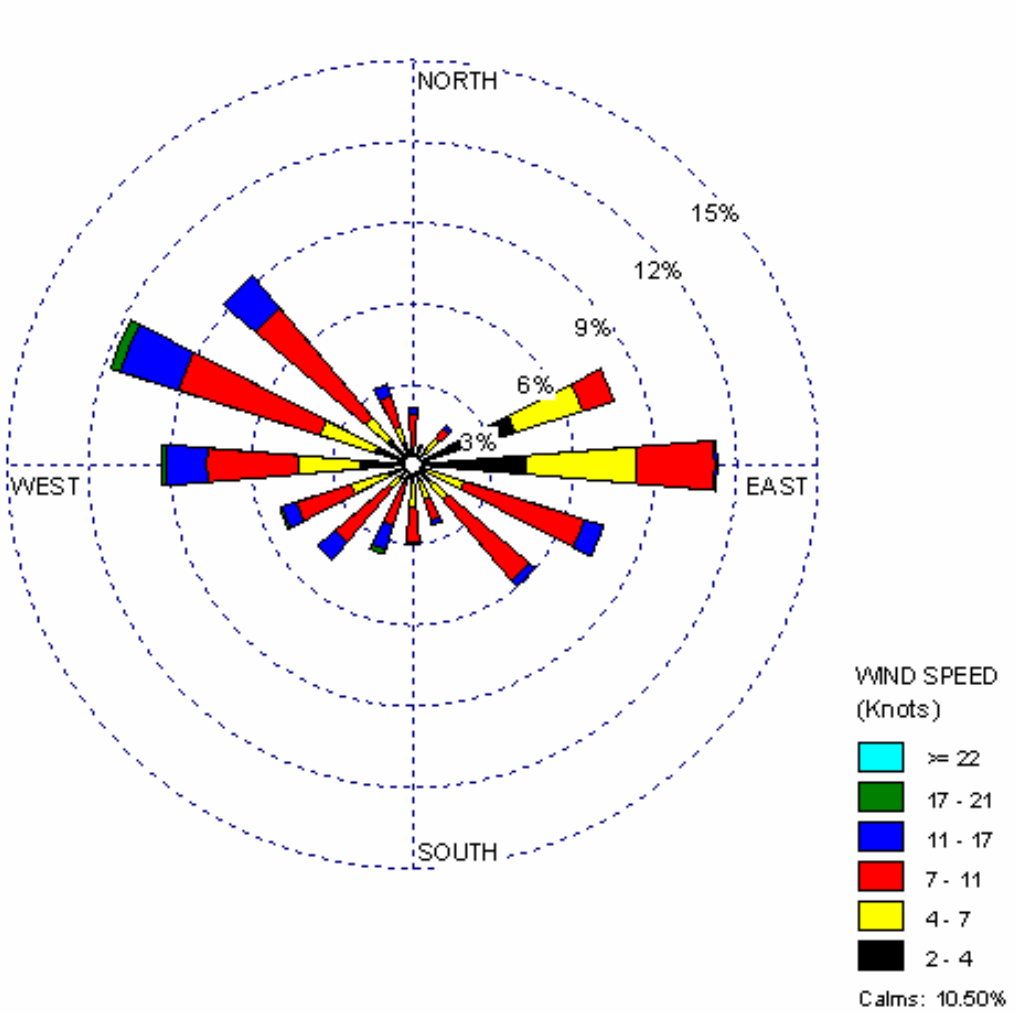


Figure 10-19. Wind Rose of Sample Days for the YFMI Monitoring Site

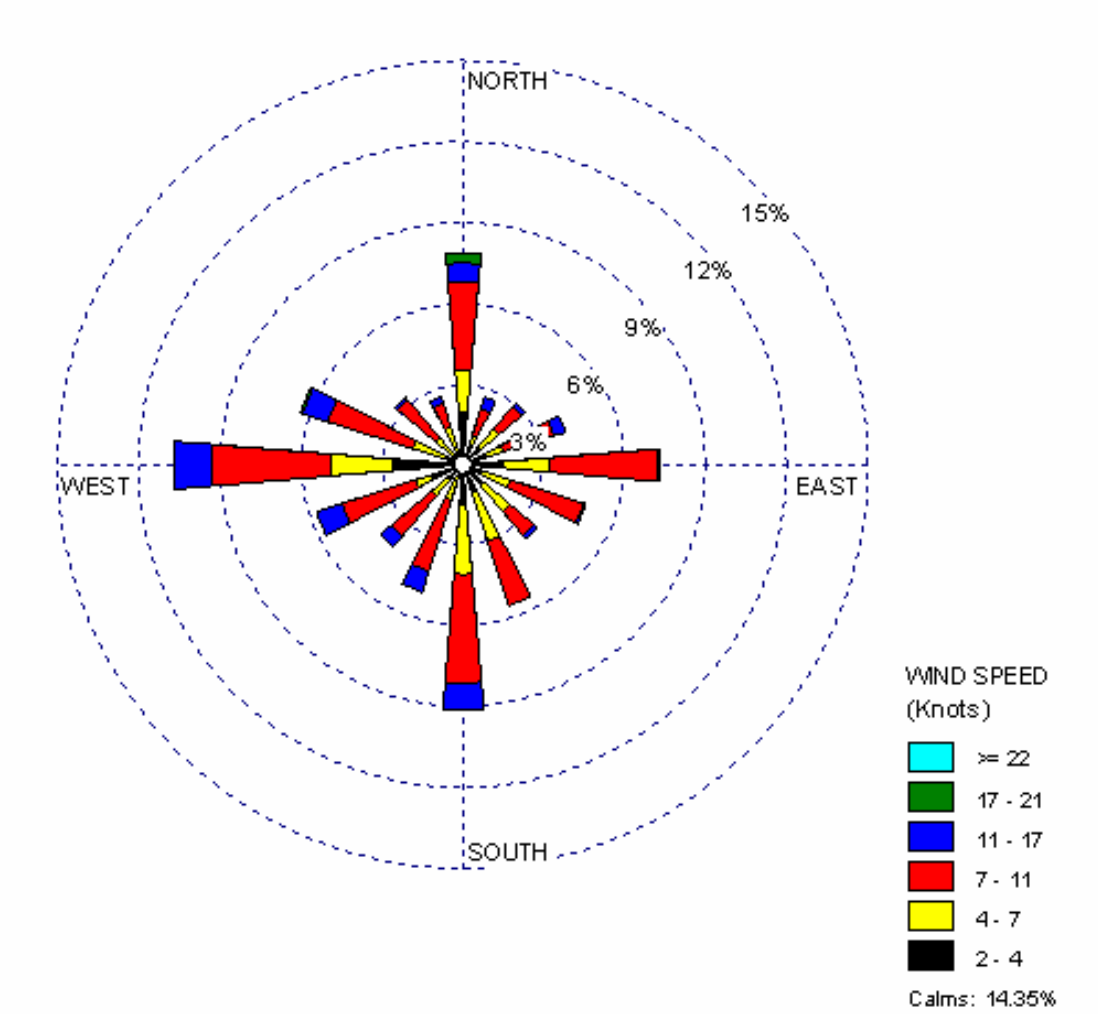


Figure 10-20. Comparison of Yearly Averages of the APMI Monitoring Site

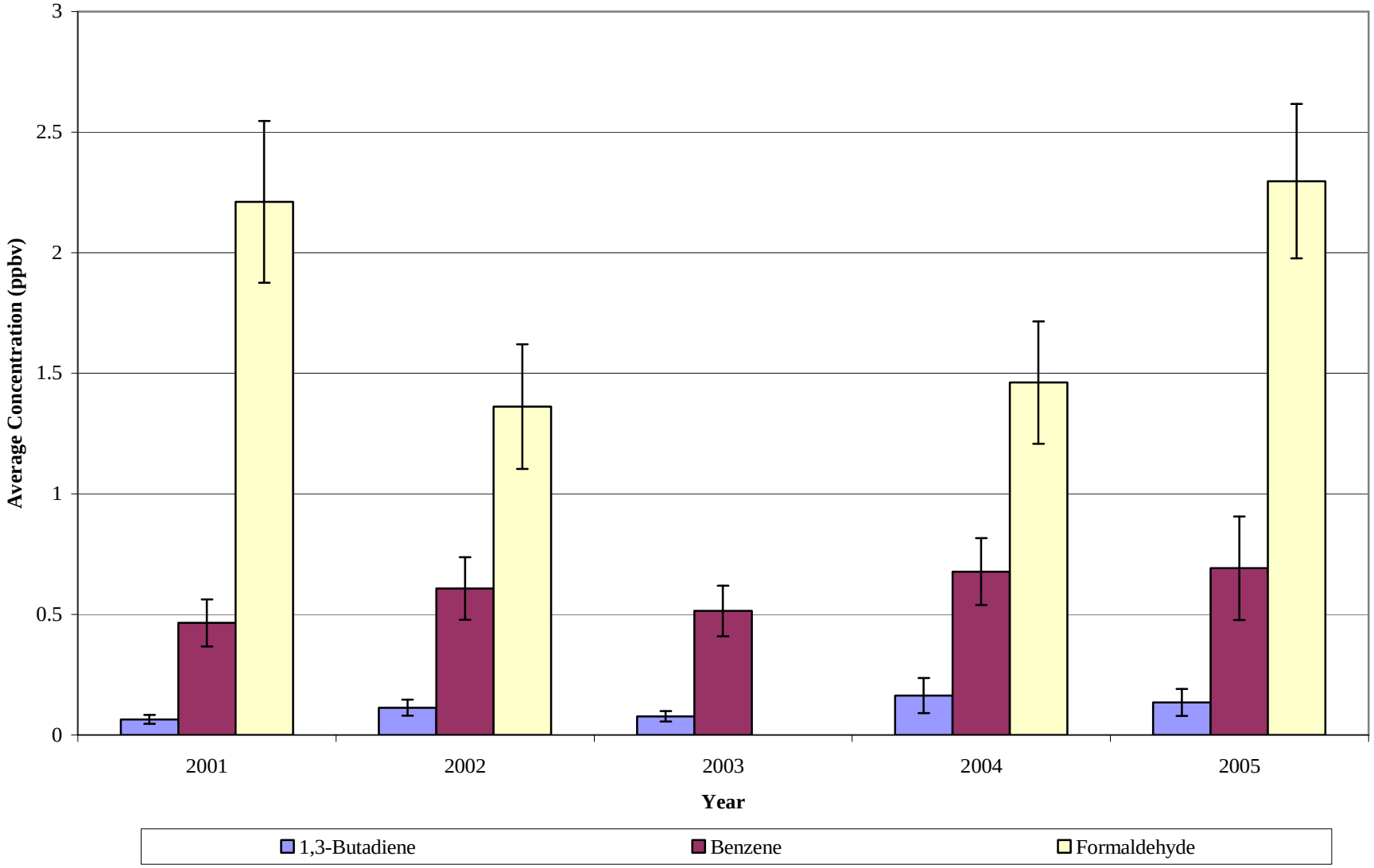


Figure 10-21. Comparison of Yearly Averages of the DEMI Monitoring Site

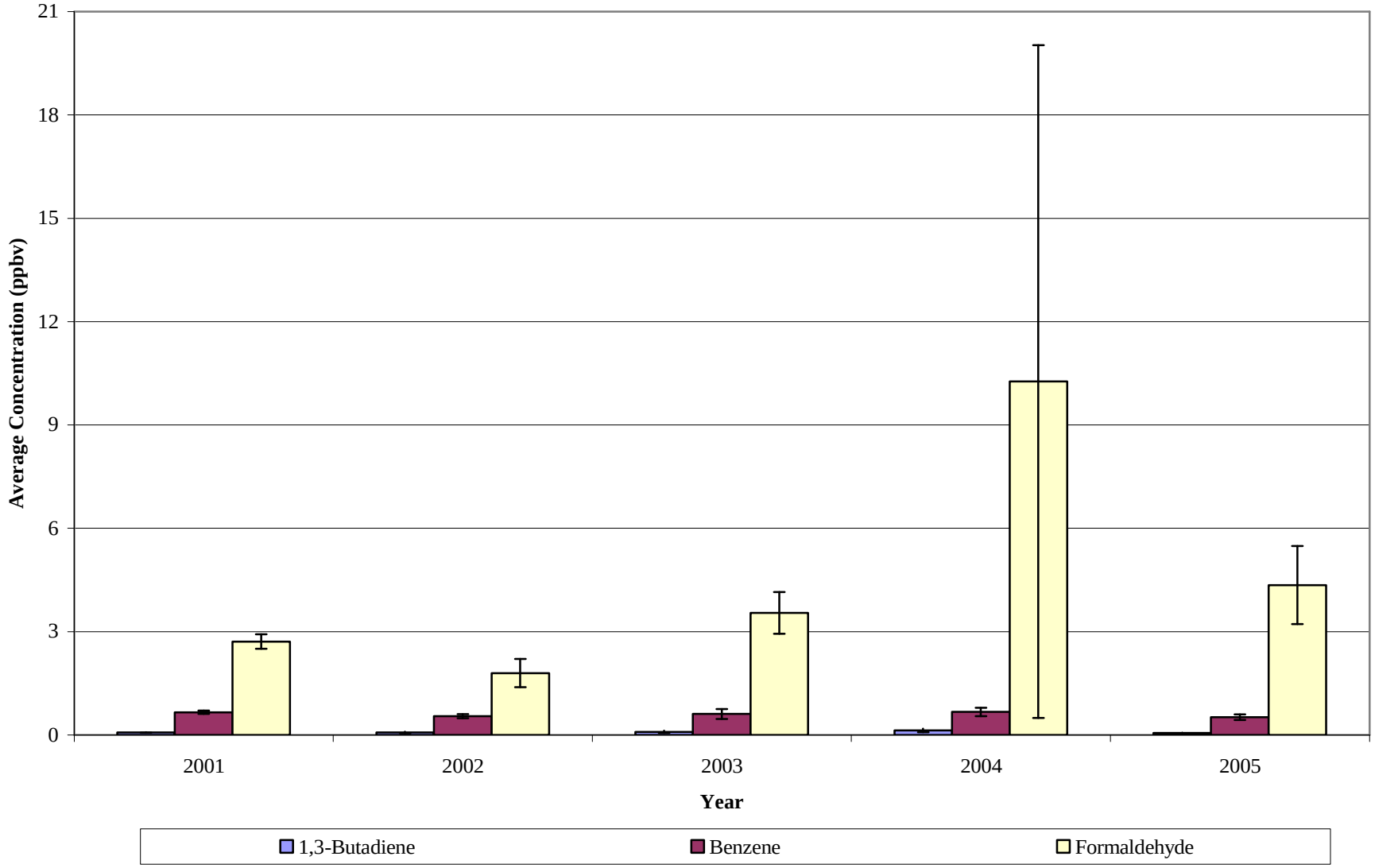


Figure 10-22. Comparison of Yearly Averages of the ITCMI Monitoring Site

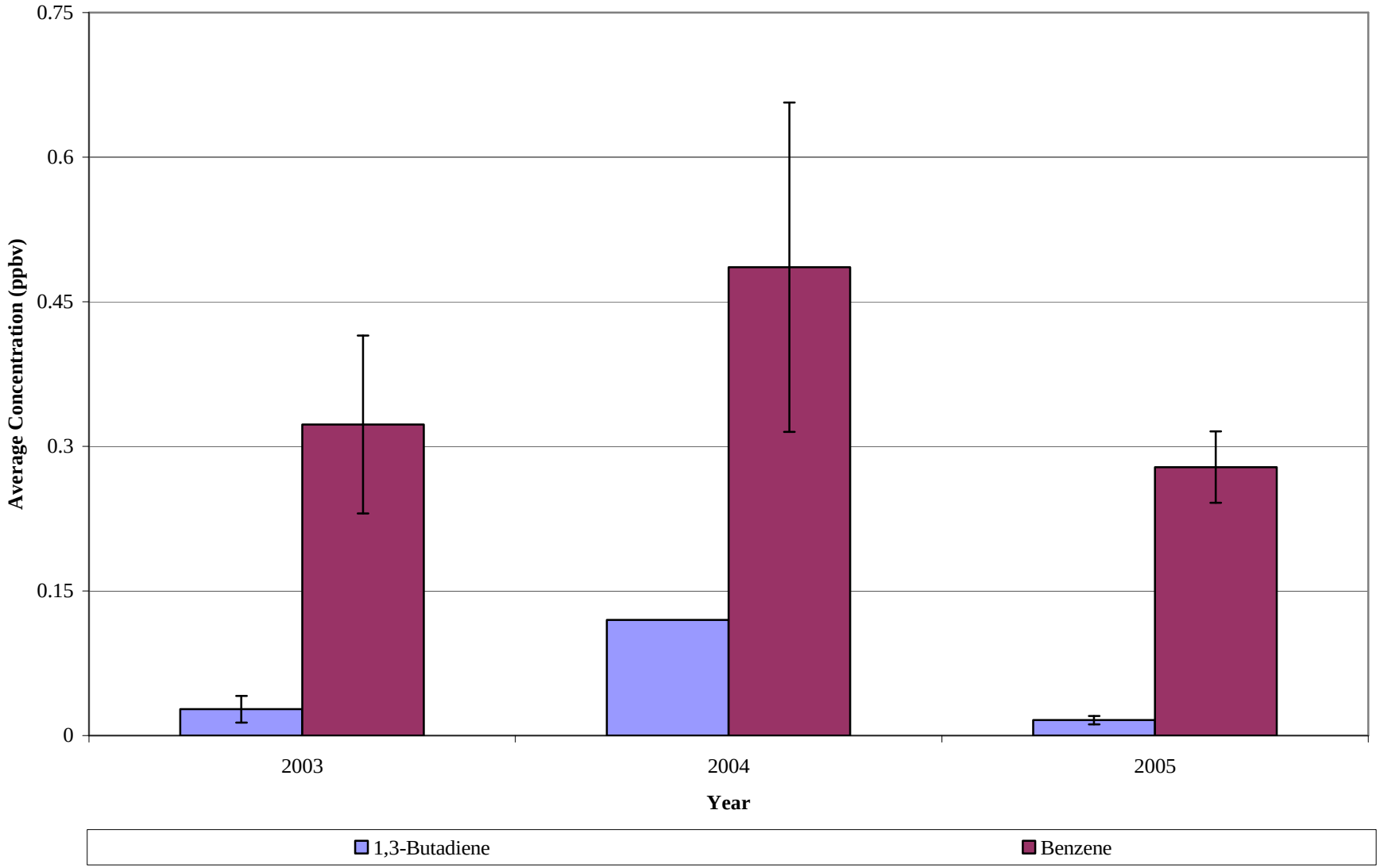


Table 10-1. Average Meteorological Parameters for Monitoring Sites in Michigan

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
APMI	94847	All 2005	58.86 ± 2.25	50.84 ± 2.07	39.75 ± 1.90	45.36 ± 1.84	68.75 ± 1.21	1016.78 ± 0.76	1.87 ± 0.49	0.19 ± 0.49
		Sample Day	62.88 ± 5.85	54.50 ± 5.31	43.35 ± 5.02	48.78 ± 4.78	68.90 ± 2.97	1016.64 ± 1.94	1.41 ± 1.11	-0.11 ± 1.26
DEMI	94847	All 2005	58.86 ± 2.25	50.84 ± 2.07	39.75 ± 1.90	45.36 ± 1.84	68.75 ± 1.21	1016.78 ± 0.76	1.87 ± 0.49	0.19 ± 0.49
		Sample Day	59.03 ± 5.67	50.88 ± 5.15	39.88 ± 4.83	45.46 ± 4.63	68.84 ± 2.73	1016.79 ± 1.85	1.78 ± 1.09	0.29 ± 1.17
ITCMI	14847	All 2005	51.27 ± 2.29	42.82 ± 2.12	34.23 ± 2.06	39.01 ± 1.95	74.32 ± 1.20	1015.49 ± 0.79	0.87 ± 0.49	-0.32 ± 0.34
		Sample Day	55.26 ± 6.70	45.64 ± 6.17	35.75 ± 6.10	41.15 ± 5.71	71.42 ± 3.46	1015.67 ± 2.13	1.02 ± 1.34	0.01 ± 0.83
YFMI	14822	All 2005	58.87 ± 2.27	51.47 ± 2.11	39.78 ± 1.88	45.63 ± 1.84	67.09 ± 1.18	1016.78 ± 0.77	1.24 ± 0.48	0.41 ± 0.48
		Sample Day	64.00 ± 6.43	55.86 ± 5.96	43.77 ± 5.35	49.48 ± 5.23	66.84 ± 3.17	1017.3 ± 2.06	0.68 ± 1.12	0.52 ± 1.09

Table 10-2. Comparison of Measured Concentrations and EPA Screening Values at the Michigan Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Allen Park in Detroit, Michigan – APMI					
Acetaldehyde	49	50	98.0	22.4%	22.4%
Formaldehyde	46	50	92.0	21.0%	43.4%
Tetrachloroethylene	30	30	100.0	13.7%	57.1%
Benzene	30	30	100.0	13.7%	70.8%
Carbon Tetrachloride	28	28	100.0	12.8%	83.6%
1,3-Butadiene	17	17	100.0	7.8%	91.3%
p-Dichlorobenzene	10	11	90.9	4.6%	95.9%
Xylenes	4	30	13.3	1.8%	97.7%
Hexachloro-1,3-butadiene	4	4	100.0	1.8%	99.5%
Acrolein	1	1	100.0	0.5%	100.0%
Total	219	251	87.3		
Dearborn in Detroit, Michigan - DEMI					
Formaldehyde	56	56	100.0	16.7%	16.7%
Acetaldehyde	55	56	98.2	16.4%	33.1%
Carbon Tetrachloride	52	52	100.0	15.5%	48.7%
Benzene	52	52	100.0	15.5%	64.2%
Tetrachloroethylene	46	46	100.0	13.7%	77.9%
1,3-Butadiene	32	33	97.0	9.6%	87.5%
p-Dichlorobenzene	16	26	61.5	4.8%	92.2%
Acrolein	10	10	100.0	3.0%	95.2%
Hexachloro-1,3-butadiene	10	10	100.0	3.0%	98.2%
Xylenes	3	52	5.8	0.9%	99.1%
Dichloromethane	2	41	4.9	0.6%	99.7%
1,2-Dichloroethane	1	1	100.0	0.3%	100.0%
Total	335	435	77.0		
Sault St. Marie, Michigan – ITCMI					
Benzene	32	32	100.0	42.1%	42.1%
Carbon Tetrachloride	28	28	100.0	36.8%	78.9%
p-Dichlorobenzene	5	6	83.3	6.6%	85.5%
Acrolein	4	4	100.0	5.3%	90.8%
Tetrachloroethylene	3	4	75.0	3.9%	94.7%
1,3-Butadiene	3	5	60.0	3.9%	98.7%
Chloromethylbenzene	1	1	100.0	1.3%	100.0%
Total	76	80	95.0		

Table 10-2. Comparison of Measured Concentrations and EPA Screening Values at the Michigan Monitoring Sites (Continued)

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Yellow Freight in Detroit, Michigan – YFMI					
Benzene	43	43	100.0	24.7%	24.7%
Carbon Tetrachloride	41	41	100.0	23.6%	48.3%
Tetrachloroethylene	23	26	88.5	13.2%	61.5%
1,3-Butadiene	23	23	100.0	13.2%	74.7%
Naphthalene	19	42	45.2	10.9%	85.6%
Benzo (a) pyrene	8	40	20.0	4.6%	90.2%
p-Dichlorobenzene	8	14	57.1	4.6%	94.8%
Xylenes	4	43	9.3	2.3%	97.1%
Hexachloro-1,3-butadiene	2	2	100.0	1.1%	98.3%
Acrolein	2	2	100.0	1.1%	99.4%
1,2-Dichloroethane	1	1	100.0	0.6%	100.0%
Total	174	277	62.8		

Table 10-3. Daily and Seasonal Averages for Pollutants of Interest at the Michigan Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Allen Park in Detroit, Michigan – APMI												
1,3-Butadiene	17	30	0.30	0.12	NR	NR	0.24	0.15	NR	NR	0.19	0.08
Acetaldehyde	50	50	1.74	0.21	1.63	0.70	1.63	0.33	1.92	0.36	1.73	0.40
Benzene	30	30	2.21	0.68	NR	NR	2.37	1.26	2.40	1.92	2.26	0.69
Carbon Tetrachloride	28	30	0.64	0.04	NR	NR	0.54	0.09	0.73	0.05	0.69	0.06
Formaldehyde	50	50	2.82	0.39	1.92	0.65	2.50	0.62	3.85	0.68	2.60	0.73
p-Dichlorobenzene	11	30	0.17	0.08	NR	NR	NR	NR	NR	NR	0.15	0.06
Tetrachloroethylene	30	30	18.40	9.40	NR	NR	6.85	1.65	11.12	4.29	47.46	25.74
Dearborn in Detroit, Michigan – DEMI												
1,3-Butadiene	33	52	0.13	0.02	NR	NR	NR	NR	0.12	0.03	0.12	0.04
Acetaldehyde	56	56	2.13	0.28	2.11	0.73	1.96	0.42	2.43	0.40	1.97	0.62
Acrolein	10	27	1.18	0.34	NR	NR	NR	NR	NR	NR	NR	NR
Benzene	52	52	1.63	0.26	1.75	0.56	1.61	0.63	1.72	0.36	1.41	0.50
Carbon Tetrachloride	52	52	0.63	0.03	0.59	0.05	0.57	0.09	0.67	0.05	0.70	0.05
Formaldehyde	56	56	5.35	1.39	7.32	4.37	6.27	2.93	4.73	0.80	3.20	0.96
Hexachloro-1,3-butadiene	10	52	0.19	0.03	NR	NR	NR	NR	NR	NR	0.90	0.43
p-Dichlorobenzene	26	52	0.16	0.05	NR	NR	NR	NR	0.21	0.07	0.14	0.05
Tetrachloroethylene	46	52	2.81	0.87	0.71	0.31	1.83	1.66	4.65	1.84	2.47	1.19
Sault Sainte Marie, Michigan – ITCMI												
1,3-Butadiene	5	33	0.04	0.01	NR	NR	NR	NR	NR	NR	NA	NA
Acrolein	4	6	0.54	0.28	NR	NR	NR	NR	NR	NR	NA	NA
Benzene	32	33	0.89	0.12	0.97	0.26	0.88	0.23	0.78	0.08	NA	NA
Carbon Tetrachloride	28	33	0.77	0.14	NR	NR	0.75	0.28	0.71	0.06	NA	NA
p-Dichlorobenzene	6	33	0.13	0.04	NR	NR	NR	NR	NR	NR	NA	NA
Tetrachloroethylene	4	33	0.31	0.18	NR	NR	NR	NR	NR	NR	NA	NA

Table 10-3. Daily and Seasonal Averages for Pollutants of Interest at the Michigan Monitoring Sites (Continued)

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Yellow Freight in Detroit, Michigan – YFMI												
1,3-Butadiene	23	43	0.18	0.04	NR	NR	NR	NR	0.13	0.04	NA	NA
Benzene	43	43	8.18	3.25	3.16	2.61	7.15	4.31	5.67	3.17	NA	NA
Benzo (a) pyrene	40	42	0.0005	0.0003	0.0002	0.0003	0.0008	0.0009	0.0003	0.0002	NA	NA
Carbon Tetrachloride	41	43	0.67	0.05	0.48	0.08	0.67	0.08	0.70	0.06	NA	NA
Naphthalene	42	42	0.18	0.11	0.02	0.02	0.18	0.21	0.16	0.14	NA	NA
p-Dichlorobenzene	14	43	0.24	0.23	NR	NR	NR	NR	0.27	0.23	NA	NA
Tetrachloroethylene	26	43	0.71	0.40	NR	NR	NR	NR	0.55	0.36	NA	NA
Xylenes	43	43	4.18	0.91	3.60	1.80	3.88	1.73	3.77	1.12	NA	NA

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 10-4. Non-Chronic Risk Summary at the Michigan Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
APMI	TO-15	Acrolein	NA[2]	0.11	1	0.19	1	0.09	NA	NA	NR	NR
DEMI	TO-15	Acrolein	1.18 ± 0.34	0.11	10	0.19	10	0.09	NA	NA	NR	NR
ITCMI	TO-15	Acrolein	0.54 ± 0.28	0.11	4	0.19	4	0.09	NA	NA	NR	NA
YFMI	TO-15	Acrolein	0.77 ± 0.27	0.11	2	0.19	2	0.09	NA	NA	NR	NA
YFMI	TO-15	Benzene[1]	8.18 ± 3.25	28.75	2	--	--	20	3.16 ± 2.61	7.15 ± 4.31	5.67 ± 3.17	NA

[1] Indicates a recalculated Short-term MRL
[2] Indicates only one detect
NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 10-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Michigan Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Allen Park in Detroit, Michigan – APMI									
1,3-Butadiene	17	0.06	0.07	0.11	0.10	0.13	-0.10	0.10	0.00
Acetaldehyde	50	0.35	0.31	0.29	0.29	-0.03	-0.12	0.46	0.16
Benzene	30	0.22	0.22	0.24	0.22	0.08	-0.12	0.15	-0.03
Carbon Tetrachloride	28	0.50	0.51	0.56	0.55	0.19	-0.04	0.27	-0.17
Formaldehyde	50	0.60	0.58	0.57	0.57	-0.06	0.04	0.46	-0.09
p-Dichlorobenzene	11	0.54	0.57	0.39	0.47	-0.38	0.39	0.01	0.06
Tetrachloroethylene	30	0.17	0.18	0.18	0.18	-0.04	0.13	0.06	-0.09
Dearborn in Detroit, Michigan – DEMI									
1,3-Butadiene	33	0.14	0.13	0.10	0.11	-0.14	-0.37	0.22	0.09
Acetaldehyde	56	0.33	0.28	0.28	0.28	0.01	-0.26	0.41	0.30
Acrolein	10	0.53	0.49	0.47	0.47	-0.23	-0.10	-0.28	0.47
Benzene	52	0.18	0.15	0.16	0.15	0.07	-0.38	0.17	0.21
Carbon Tetrachloride	52	0.29	0.27	0.32	0.30	0.16	0.23	0.23	-0.18
Formaldehyde	56	-0.11	-0.13	-0.09	-0.12	0.20	-0.19	-0.07	0.13
Hexachloro-1,3-butadiene	10	-0.53	-0.54	-0.48	-0.51	0.56	0.26	0.27	0.34
p-Dichlorobenzene	26	0.33	0.33	0.29	0.31	-0.24	-0.34	-0.32	0.10
Tetrachloroethylene	46	0.52	0.54	0.54	0.54	-0.15	-0.33	0.13	-0.16
Sault St. Marie, Michigan – ITCMI									
1,3-Butadiene	5	0.15	0.01	-0.05	-0.01	-0.15	0.24	0.26	0.64
Acrolein	4	-0.01	-0.18	-0.04	-0.10	0.28	-0.94	0.74	-0.90
Benzene	32	-0.24	-0.27	-0.31	-0.29	-0.15	0.12	-0.38	0.18
Carbon Tetrachloride	28	0.08	0.05	0.01	0.04	-0.15	0.17	-0.36	-0.33
p-Dichlorobenzene	6	-0.49	-0.47	-0.17	-0.32	0.61	0.28	0.29	-0.63
Tetrachloroethylene	4	-0.88	-0.95	-0.89	-0.98	0.10	-0.49	0.34	-0.36

Table 10-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Michigan Monitoring Sites (Continued)

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Yellow Freight in Detroit, Michigan - YFMI									
1,3-Butadiene	23	-0.24	-0.27	-0.29	-0.29	-0.06	-0.08	0.43	0.11
Benzene	43	0.38	0.36	0.35	0.36	-0.14	0.03	0.63	0.02
Benzo (a) pyrene	40	0.11	0.08	0.01	0.05	-0.31	0.06	0.44	0.17
Carbon Tetrachloride	41	0.47	0.46	0.43	0.45	-0.24	0.33	0.38	-0.22
Naphthalene	42	0.31	0.30	0.23	0.26	-0.33	-0.02	0.47	0.03
p-Dichlorobenzene	14	0.11	0.09	0.25	0.22	0.21	0.26	-0.01	-0.26
Tetrachloroethylene	26	-0.38	-0.40	-0.36	-0.39	0.22	-0.25	-0.05	0.50
Xylenes	43	0.24	0.23	0.21	0.22	-0.09	0.01	0.33	0.01

Table 10-6. Motor Vehicle Information for the Michigan Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
APMI	1,998,217	1,422,117	0.71	964,194	686,210	60,000
DEMI	1,998,217	1,422,117	0.71	1,201,847	855,346	12,791
ITCMI	38,780	33,580	0.87	22,188	19,213	100,000
YFMI	1,998,217	1,422,117	0.71	1,154,934	821,958	500

Table 10-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Michigan

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Allen Park in Detroit, Michigan – APMI, Census Tract 26163576600				
1,3-Butadiene	0.20 ± 0.08	0.22	6.47	0.11
Acetaldehyde	1.74 ± 0.21	2.27	4.99	0.25
Acrolein	NA	0.16	--	8.08
Benzene	2.21 ± 0.68	2.57	20.04	0.09
Carbon Tetrachloride	0.61 ± 0.06	0.21	3.14	0.01
Formaldehyde	2.82 ± 0.39	2.11	0.01	0.22
Hexachloro-1,3-butadiene	0.88 ± 0.15	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.18 ± 0.03	0.09	0.97	<0.01
Tetrachloroethylene	18.40 ± 9.40	0.41	2.43	<0.01
Xylenes	6.15 ± 2.10	3.70	--	0.04
Dearborn in Detroit, Michigan – DEMI, Census Tract 26163573500				
1,2-Dichloroethane	0.09 ± 0.01	0.04	1.07	<0.01
1,3-Butadiene	0.11 ± 0.02	0.34	10.06	0.17
Acetaldehyde	2.13 ± 0.28	2.60	5.72	0.29
Acrolein	NA	0.19	--	9.52
Benzene	1.63 ± 0.26	3.79	29.55	0.13
Carbon Tetrachloride	0.63 ± 0.03	0.21	3.14	0.01
Dichloromethane	0.54 ± 0.24	0.69	0.33	<0.01
Formaldehyde	5.35 ± 1.39	2.58	0.01	0.26
Hexachloro-1,3-butadiene	0.95 ± 0.14	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.17 ± 0.03	0.08	0.92	<0.01
Tetrachloroethylene	2.50 ± 0.80	0.37	2.16	<0.01
Xylenes	4.35 ± 0.90	6.69	--	0.07
Sault Sainte Marie, Michigan - ITCMI, Census Tract 26033970300				
1,3-Butadiene	NA	0.03	0.76	0.01
Acrolein	NA	0.01	--	0.38
Benzene	NA	0.54	4.18	0.02
Carbon Tetrachloride	NA	0.21	3.13	0.01
Chloromethylbenzene	NA	<0.01	<0.01	--
***p*-Dichlorobenzene**	NA	0.02	0.25	<0.01
Tetrachloroethylene	NA	0.21	1.23	<0.01

Table 10-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Michigan (Continued)

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Yellow Freight in Detroit, Michigan - YFMI, Census Tract 26163579000				
1,2-Dichloroethane	NA	<0.01	<0.01	<0.01
1,3-Butadiene	NA	<0.01	<0.01	<0.01
Acrolein	NA	<0.01	--	<0.01
Benzene	NA	<0.01	<0.01	<0.01
Benzo (a) pyrene	NA	<0.01	<0.01	--
Carbon Tetrachloride	NA	<0.01	<0.01	<0.01
Hexachloro-1,3-butadiene	NA	<0.01	<0.01	<0.01
Naphthalene	NA	<0.01	<0.01	<0.01
***p*-Dichlorobenzene**	NA	<0.01	<0.01	<0.01
Tetrachloroethylene	NA	<0.01	<0.01	<0.01
Xylenes	NA	<0.01	--	<0.01

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

11.0 Site in Minnesota

This section presents meteorological, concentration, and spatial trends for the UATMP site in Minnesota (MIMN), located in Minneapolis. Figure 11-1 is a topographical map showing the monitoring site in its urban location. Figure 11-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. The Minneapolis site is surrounded by numerous sources, of which a majority are involved in fuel combustion industries.

Hourly meteorological data at a weather station near this site were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the MIMN monitoring site is at Minneapolis-St. Paul International Airport (WBAN 14922).

The Mississippi River runs through the center of Minneapolis and connects with the Minnesota River in southwest St. Paul. The city is peppered with many small lakes throughout the city, which freeze in the winter. The city experiences a continental climate, generally cold in the winter and warm in the summer. Winds fluctuate seasonally, and tend to be out of the southeast in the summer and fall, and out of the northwest in the winter and spring. Although precipitation in the area isn't great, the spring thaw in conjunction with the river system can lead to flooding in the spring. (Ruffner and Bair, 1987). Table 11-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average u- and v- components of the wind) for the entire year and on days samples were taken. As shown in Table 11-1, average meteorological conditions on sample days are somewhat warmer and slightly windier than average weather conditions throughout the year. The site began sampling at the end of March, missing more than half of the winter months, which can attribute to this difference.

11.1 Pollutants of Interest at the Minnesota Monitoring Site

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 11-2 presents the nineteen pollutants that failed at least one screen at MIMN; a total of 351 measured concentrations failed screens. The pollutants of interest at MIMN were identified as the pollutants that contributed to the top 95% of the total failed screens, resulting in twelve pollutants: benzene (42 failed screens), carbon tetrachloride (42), arsenic (39), acetaldehyde (39), manganese (35), 1,3-butadiene (33), formaldehyde (32), tetrachloroethylene (19), nickel (18), acrolein (16), hexachloro-1,3-butadiene (12), and *p*-dichlorobenzene (12). It's important to note that the MIMN site sampled for carbonyls, VOC, and metals, and that this is reflected in the site's pollutants of interest.

Also listed in Table 11-2 are the total number of detects and the percent detects failing the screen. Of the twelve pollutants of interest, benzene, carbon tetrachloride, acrolein, and hexachloro-1,3-butadiene had 100% of their detects fail the screening values.

11.2 Concentration Averages at the Minnesota Monitoring Site

Three types of concentration averages were calculated for the twelve pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are

presented in Table 11-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at MIMN, formaldehyde measured the highest concentration by mass (1.78 ± 0.37 μg/m^3), followed by acetaldehyde (1.26 ± 0.25 μg/m^3) and benzene (1.13 ± 0.14 μg/m^3). The highest formaldehyde concentrations were measured in summer. Manganese and nickel were highest in summer and autumn. The remaining averages did not vary much from season to season. MIMN did not begin sampling until the end of March, and therefore has no valid winter seasonal averages. Acetaldehyde, arsenic, benzene, carbon tetrachloride, formaldehyde, manganese, and nickel were detected in every sample taken at MIMN, while acrolein and hexachloro-1,3-butadiene were detected in one-half or less of the samples taken.

11.3 Non-chronic Risk Evaluation at the Minnesota Monitoring Site

Non-chronic risk for the concentration data at MIMN was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the nineteen pollutants with at least one failed screen, only acrolein exceeded both the acute and intermediate risk values, and its non-chronic risk is summarized in Table 11-4.

All sixteen acrolein detects were greater than the ATSDR acute value of 0.11 μg/m^3 and fifteen exceeded the California REL value of 0.19 μg/m^3. The average detected concentration was 1.10 ± 0.35 μg/m^3, which is nearly six times the California REL value. For the intermediate acrolein risk, seasonal averages were compared to the ATSDR intermediate value of 0.09 μg/m^3. As discussed in Sections 3.1.5, acrolein concentrations could only be evaluated beginning July 2005, and a valid seasonal average could only be calculated for autumn. The autumn seasonal average was significantly greater than the ATSDR intermediate risk level.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Figure 11-3 is a pollution rose for acrolein at MIMN. The pollution rose

is a plot of daily concentration and daily average wind direction. As indicated in Figure 11-3, all acrolein concentrations exceeded the ATDSR acute risk factor, indicated by a solid line (ATSDR MRL). Although difficult to discern, all but one acrolein concentration exceeded the CalEPA acute risk factor, indicated by a dashed line (CalEPA REL). The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources, yet there is a cluster of concentrations measured on a day with winds from the west. The highest concentration of acrolein occurred on November 18, 2005 with a south-southwesterly wind. MIMN is located in downtown Minneapolis and is situated near several major roadways (Figure 11-1). The immediate vicinity is mostly shops and offices, although industrial sources are located within a mile of the monitoring site.

11.4 Meteorological and Concentration Analysis at the Minnesota Monitoring Site

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

11.4.1 Pearson Correlation Analysis

Table 11-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the MIMN monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) With the exception of hexachloro-1,3-butadiene, all the pollutants of interest at MIMN exhibited positive correlations with the maximum, average, dew point, and wet bulb temperatures, although actual correlations ranged from very weak to strong. This indicates that concentrations of the pollutants of interest tend to increase as temperatures increase. The strongest correlations with these parameters were computed for formaldehyde, which correlates well with its seasonal averages. Hexachloro-1,3-butadiene's correlations with these parameters were all strong and negative. The strongest correlation with relative humidity was computed for hexachloro-1,3-butadiene (0.55). The strongest correlation with a wind component was calculated for hexachloro-1,3-butadiene as well (0.43). Most of the remaining correlations were weak.

11.4.2 Composite Back Trajectory Analysis

Figure 11-4 is a composite back trajectory map for the MIMN monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site in Figure 11-4 represents 100 miles. As shown in Figure 11-4, the back trajectories originated from a variety of directions at MIMN, although there is an apparent lack of trajectories from the west and east. The 24-hour airshed domain is large, with trajectories originating as far away as northern Manitoba, Canada, over 900 miles away. Nearly 61% of the trajectories originated within 400 miles of the site; and 88% within 500 miles from the MIMN monitoring site. The one trajectory originating from Manitoba occurred on a day when a strong frontal system moved across the central and eastern US on November 24, 2005. This wind pattern is also evident on several composite trajectory maps from other sites in the region including the DEMI, INDEM, NBIL and SPIL, DITN, and MAWI monitoring sites.

11.4.3 Wind Rose Analysis

Hourly wind data from the Minneapolis-St. Paul International Airport near the MIMN monitoring site was uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 11-5 is the wind rose for the MIMN monitoring site on days sampling occurred. As indicated in Figure 11-5, hourly winds were predominantly out of the southeast (11% of observations), west (10%), and south-southeast (9%) on sample days. Wind speeds tended to range from 7 to 11 knots on day samples were taken (39% of observations). Calm winds (<2 knots) were observed for 7% of the measurements. The strongest winds (> 22 knots) were most frequently observed with winds from the west, northwest, and north.

11.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

11.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Hennepin County, MN were obtained from the Minnesota Department of Public Safety – Driver and Vehicle Services and the U.S. Census Bureau, and are summarized in Table 11-6. Table 11-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 11-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Hennepin County is one of the eleven counties with a population over 1 million. Accordingly, its vehicle registration count is also high compared to other UATMP sites and MIMN has one of the higher estimated vehicle registration-to-population ratios. MIMN's estimated 10 mile vehicle ownership is fourth behind sites from the New York, Philadelphia, and Boston areas. However, the average daily traffic count falls in the middle of the range compared to other UATMP sites. The MIMN monitoring site is considered a commercial area and is located in an urban-city center setting.

11.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area. For more information on this study, refer to Section 3.2.1.4. Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. At MIMN, the benzene-ethylbenzene and xylenes-ethylbenzene ratios (3.65 ± 0.30 and 3.76 ± 0.10, respectively) are closer together than those of the roadside study (2.85 and 4.55, respectively). The toluene-ethylbenzene ratio (7.22 ± 0.74) is also somewhat higher than those of roadside study (5.85).

11.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 11-7 presents the 1999 NATA results for the census tract where the Minnesota monitoring site is located. Only pollutants that "failed" the screens are presented in Table 11-7. Pollutants of interest are bolded.

11.6.1 1999 NATA Summary

The MIMN monitoring site is located in census tract 27053104600. The population for the census tract where the MIMN monitoring site is located was 3,082, which represents about 0.3% of the county population in 2000. In terms of cancer risk, the Top 3 pollutants identified by NATA in the MIMN census tract are benzene (39.5 in-a-million risk), 1,3-butadiene (14.18), and acetaldehyde (7.08). The cancer risk for benzene is the second highest cancer risk compared to other UATMP site census tracts. Acrolein was the only pollutant in the MIMN census tract to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.30, suggesting very little risk for noncancer health affects, with the exception of acrolein.

11.6.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 11.2 on how a valid annual average is calculated). Unfortunately, the MIMN started sampling in late March, and therefore, annual averages could not be calculated.

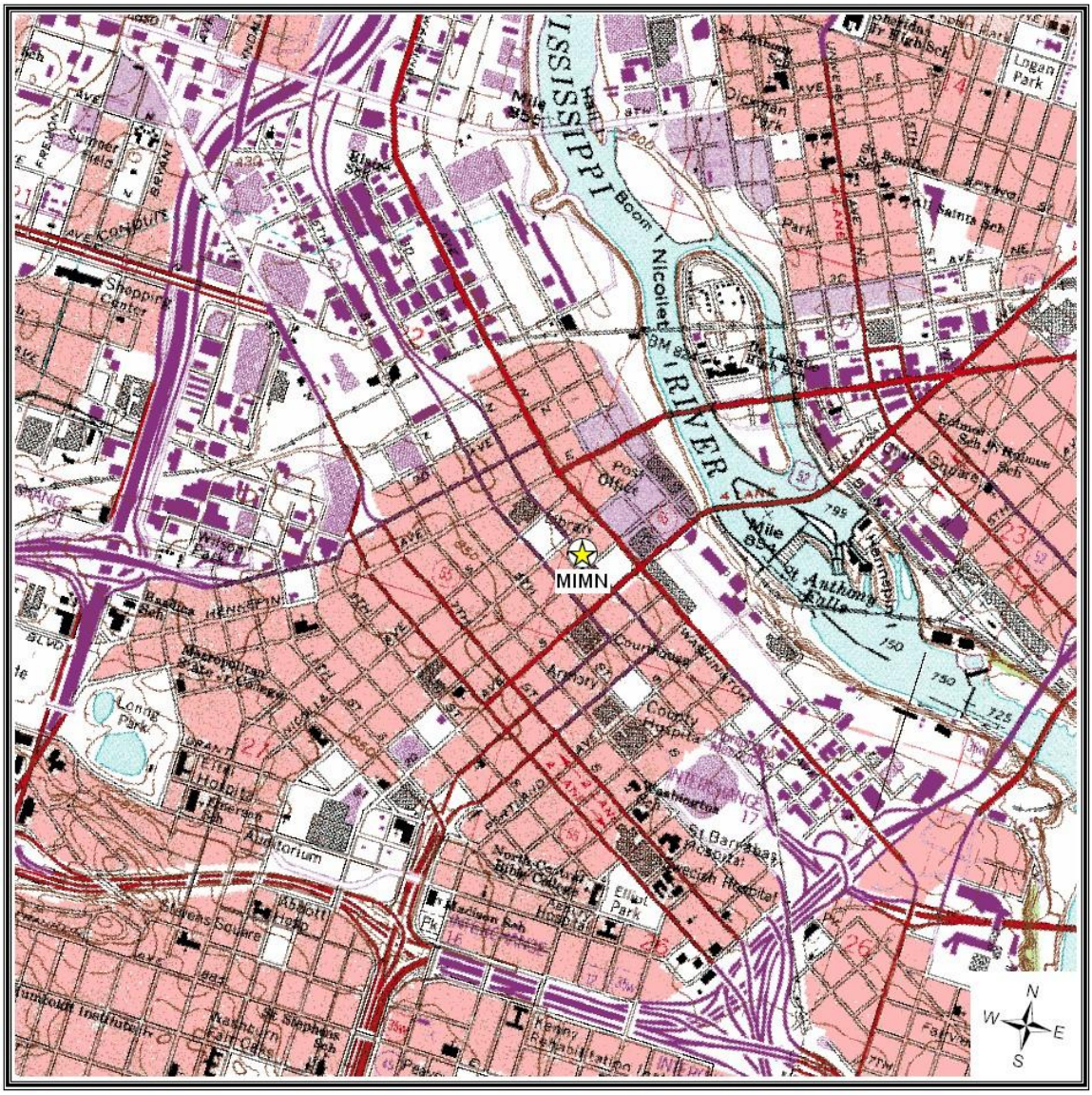
Minnesota Pollutant Summary

- *The pollutants of interest at the Minnesota site are acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, manganese, nickel, p-dichlorobenzene, and tetrachloroethylene.*

- *Formaldehyde measured the highest daily average at MIMN. Concentrations of formaldehyde were highest in summer, while nickel and manganese were highest in summer and autumn.*

- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*

Figure 11-1. Minneapolis, Minnesota (MIMN) Monitoring Site



Source: USGS 7.5 Minutes Series. Map Scale: 1:24,000

Figure 11-2. Facilities Located Within 10 Miles of MIMN

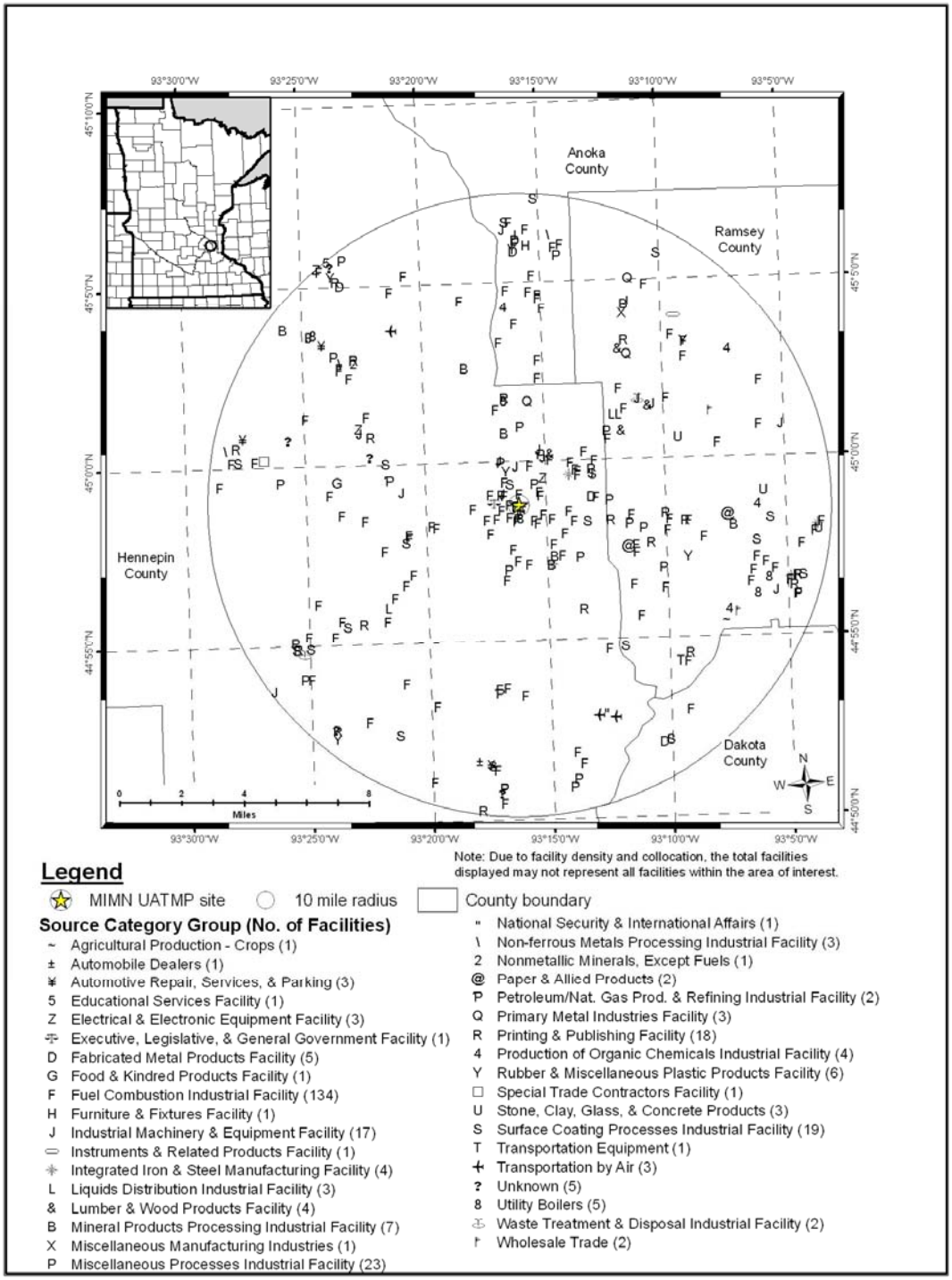


Figure 11-3. Acrolein Pollution Rose at MIMN

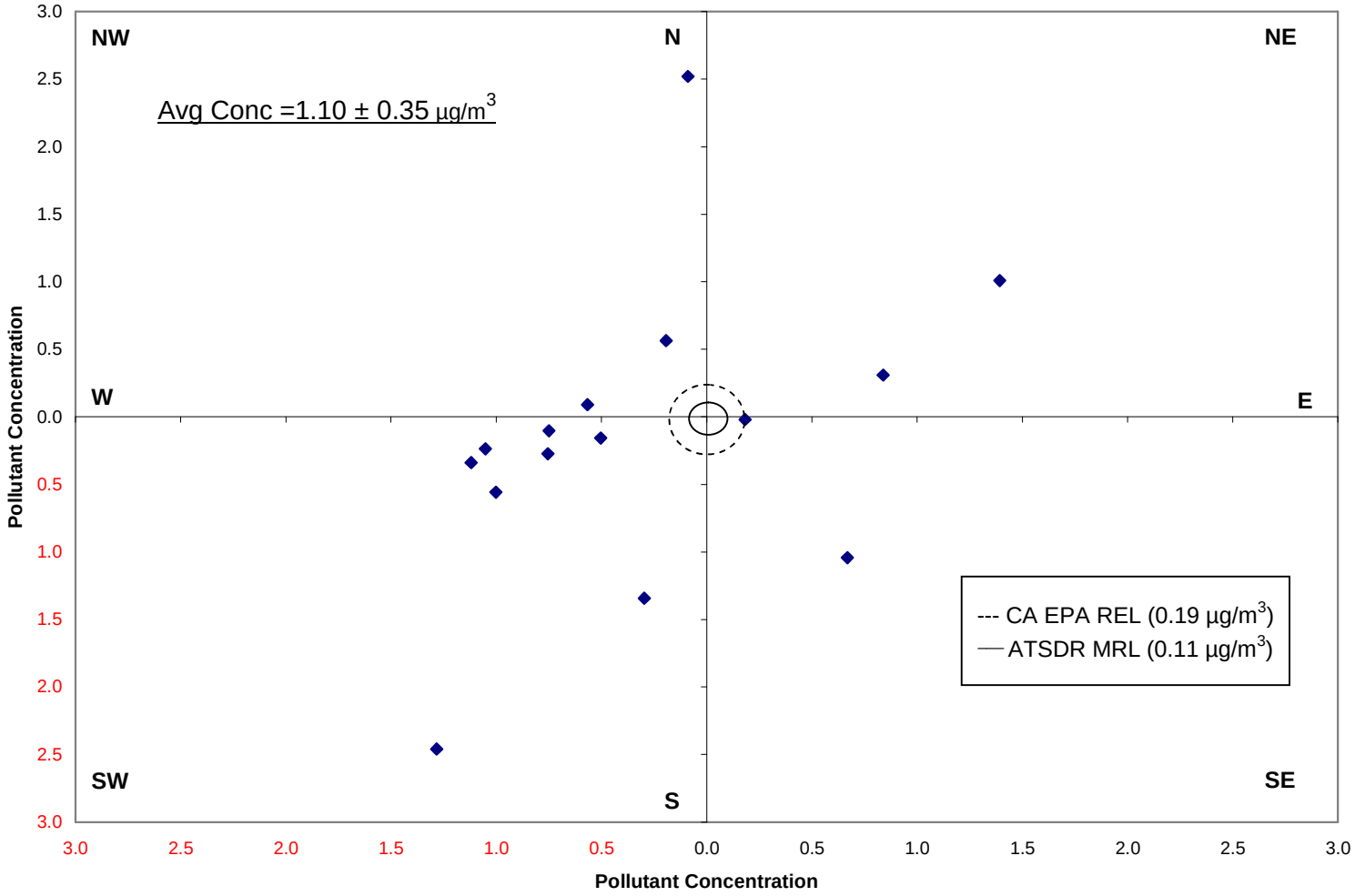


Figure 11-4. Composite Back Trajectory Map for MIMN

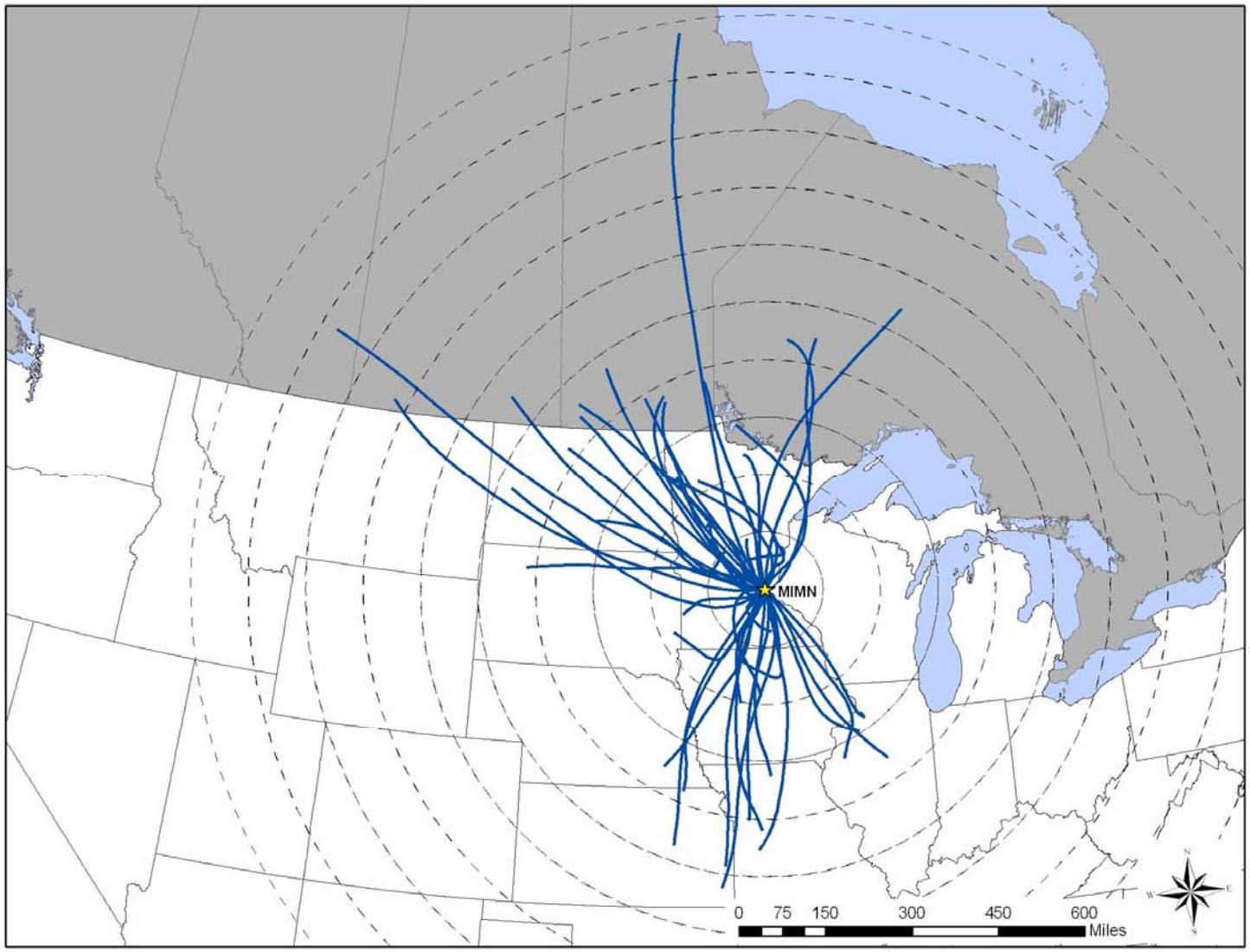


Figure 11-5. Wind Rose of Sample Days for the MIMN Monitoring Site

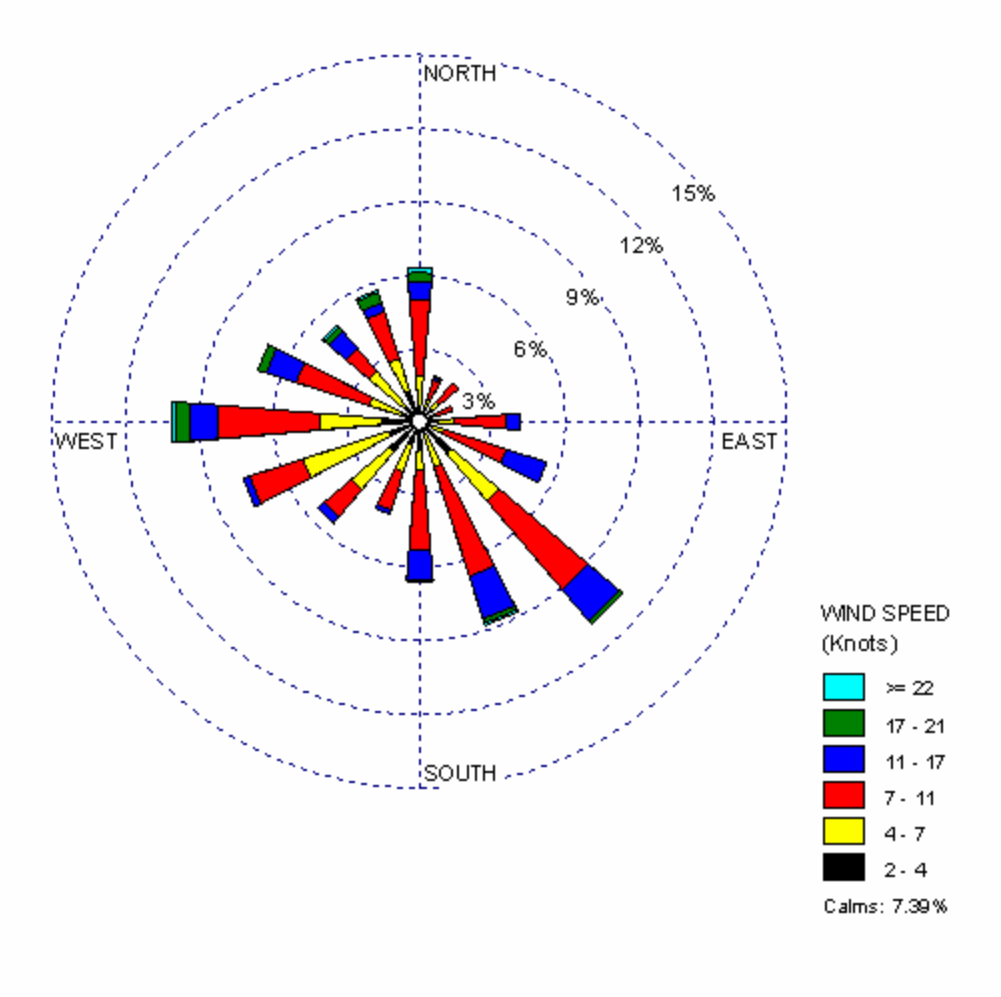


Table 11-1. Average Meteorological Parameters for Monitoring Site in Minnesota

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
MIMN	14922	All 2005	56.27 ± 2.44	48.41 ± 2.32	36.85 ± 2.10	42.8 ± 2.04	67.22 ± 1.23	1015.79 ± 0.79	0.41 ± 0.53	0.69 ± 0.52
		Sample Day	63.02 ± 6.06	55.57 ± 5.70	43.32 ± 5.27	49.22 ± 5.01	66.81 ± 4.09	1014.22 ± 2.03	0.64 ± 1.40	0.90 ± 1.36

Table 11-2. Comparison of Measured Concentrations and EPA Screening Values at the Minnesota Monitoring Site

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Minneapolis, MN - MIMN					
Benzene	42	42	100.0	12.0%	12.0%
Carbon Tetrachloride	42	42	100.0	12.0%	23.9%
Arsenic (TSP)	39	46	84.8	11.1%	35.0%
Acetaldehyde	39	40	97.5	11.1%	46.2%
Manganese (TSP)	35	46	76.1	10.0%	56.1%
1,3-Butadiene	33	34	97.1	9.4%	65.5%
Formaldehyde	32	40	80.0	9.1%	74.6%
Tetrachloroethylene	19	26	73.1	5.4%	80.1%
Nickel (TSP)	18	46	39.1	5.1%	85.2%
Acrolein	16	16	100.0	4.6%	89.7%
Hexachloro-1,3-butadiene	12	12	100.0	3.4%	93.2%
p-Dichlorobenzene	12	23	52.2	3.4%	96.6%
Trichloroethylene	4	23	17.4	1.1%	97.7%
Cadmium (TSP)	2	46	4.3	0.6%	98.3%
1,2-Dichloroethane	2	2	100.0	0.6%	98.9%
Acrylonitrile	1	1	100.0	0.3%	99.1%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.3%	99.4%
Bromomethane	1	25	4.0	0.3%	99.7%
Chloromethylbenzene	1	1	100.0	0.3%	100.0%
Total	351	512	68.6		

Table 11-3. Daily and Seasonal Averages for Pollutants of Interest at the Minnesota Monitoring Site

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Minneapolis, Minnesota – MIMN												
1,3-Butadiene	34	42	0.13	0.02	NA	NA	NR	NR	0.11	0.04	0.14	0.03
Acetaldehyde	40	40	1.26	0.25	NA	NA	1.27	0.27	1.58	0.72	1.18	0.30
Acrolein	16	28	1.10	0.35	NA	NA	NR	NR	NR	NR	0.85	0.42
Arsenic (TSP)	46	46	0.001	0.0001	NA	NA	0.0004	0.0003	0.0008	0.0001	0.0008	0.0002
Benzene	42	42	1.13	0.14	NA	NA	1.17	0.40	1.01	0.19	1.24	0.24
Carbon Tetrachloride	42	42	0.72	0.05	NA	NA	0.67	0.13	0.72	0.06	0.77	0.06
Formaldehyde	40	40	1.78	0.37	NA	NA	1.40	0.24	2.91	0.88	1.54	0.44
Hexachloro-1,3-butadiene	12	42	0.18	0.03	NA	NA	NR	NR	NR	NR	0.96	0.39
Manganese (TSP)	46	46	0.016	0.004	NA	NA	0.0070	0.0050	0.0242	0.0062	0.0192	0.0072
Nickel (TSP)	46	46	0.002	0.001	NA	NA	0.0009	0.0005	0.0027	0.0009	0.0031	0.0012
p-Dichlorobenzene	23	42	0.10	0.02	NA	NA	NR	NR	0.14	0.02	0.11	0.03
Tetrachloroethylene	26	42	0.39	0.18	NA	NA	NR	NR	NR	NR	0.46	0.28

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 11-4. Non-Chronic Risk Summary at the Minnesota Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
MIMN	TO-15	Acrolein	1.10 ± 0.35	0.11	16	0.19	15	0.09	NA	NA	NR	0.85 ±0.42

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 11-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Minnesota Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Minneapolis, MN – MIMN									
1,3-Butadiene	34	0.25	0.24	0.28	0.27	0.12	-0.27	-0.02	0.10
Acetaldehyde	40	0.42	0.40	0.39	0.40	-0.08	-0.26	0.00	-0.14
Acrolein	16	0.29	0.24	0.20	0.23	-0.35	-0.07	0.21	0.15
Arsenic (TSP)	46	0.24	0.24	0.30	0.26	0.07	0.03	0.00	0.05
Benzene	42	0.06	0.08	0.21	0.15	0.38	-0.14	0.08	0.20
Carbon Tetrachloride	42	0.09	0.12	0.22	0.17	0.26	-0.07	-0.07	-0.12
Formaldehyde	40	0.65	0.64	0.63	0.64	-0.11	-0.20	0.15	-0.21
Hexachloro-1,3-butadiene	12	-0.63	-0.62	-0.58	-0.60	0.55	0.43	0.15	0.02
Manganese (TSP)	46	0.56	0.53	0.47	0.49	-0.34	0.09	0.20	-0.06
Nickel (TSP)	46	0.19	0.19	0.27	0.23	0.14	0.08	0.28	-0.08
p-Dichlorobenzene	23	0.21	0.25	0.35	0.30	0.25	0.00	-0.22	0.00
Tetrachloroethylene	26	0.01	0.03	0.12	0.07	0.30	-0.02	-0.07	0.02

Table 11-6. Motor Vehicle Information for the Minnesota Monitoring Site

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
MIMN	1,119,364	1,004,883	0.90	1,146,484	1,029,229	10,000

Table 11-7. 1999 NATA Data Census Tract Summary for the Monitoring Site in Minnesota

Compound	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Minneapolis, MN - MIMN, Census Tract 27053104600				
1,1,2,2-Tetrachloroethane	NA	0.06	3.38	--
1,2-Dichloroethane	NA	0.04	0.97	<0.01
1,3-Butadiene	NA	0.47	14.18	0.24
Acetaldehyde	NA	3.22	7.08	0.36
Acrolein	NA	0.22	--	10.81
Acrylonitrile	NA	<0.01	0.12	<0.01
Arsenic (TSP)	NA	0.15	0.64	<0.01
Benzene	NA	5.06	39.50	0.17
Bromomethane	NA	0.21	--	0.04
Cadmium (TSP)	NA	0.14	0.25	0.01
Carbon Tetrachloride	NA	0.21	3.18	0.01
Chloromethylbenzene	NA	<0.01	<0.01	--
Formaldehyde	NA	3.12	0.02	0.32
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (TSP)	NA	0.36	--	0.01
Nickel (TSP)	NA	1.10	0.18	0.02
***p*-Dichlorobenzene**	NA	0.06	0.69	<0.01
Tetrachloroethylene	NA	0.35	2.04	<0.01
Trichloroethylene	NA	0.57	1.13	<0.01

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

12.0 Sites in Mississippi

This section presents meteorological, concentration, and spatial trends for the three UATMP sites in Mississippi (GRMS, PGMS, and TUMS). These sites are located in different cities in Mississippi: Grenada, Pascagoula, and Tupelo. Figures 12-1 through 12-3 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 12-4 through 12-6 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. Very few facilities are located near the GRMS site, which is located in central Mississippi. Most of the facilities are located to the south of the site and involved in a variety of industrial processes. The PGMS site is located along the Gulf Coast, near the Mississippi/Alabama border. Accordingly, a majority of the sources are located to the north and east of the monitoring site, and are mostly involved in surface coating industries. The industrial facilities within a ten mile radius of TUMS, which is located in northeast Mississippi, are mainly to the east and southeast of the site. A number of the sources near the TUMS site are involved in surface coating processes and chemical and allied products industries.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the GRMS monitoring site is Greenwood-Leflore Airport (WBAN 13978); the closest weather station to PGMS site is Pascagoula-Lott International Airport (WBAN 53858); and the closest weather station to TUMS site is Tupelo Municipal Airport (WBAN 93862).

Climatologically, all three of the Mississippi cities are warm and humid, especially Pascagoula, the site nearest the coast. High temperatures and humidity, due to proximity to the Gulf of Mexico, can make the climate in this region feel uncomfortable. Precipitation is distributed fairly evenly throughout the year, and thunderstorms are fairly common, especially in the summer and nearer to the coast (Ruffner and Bair, 1987). Table 12-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure

(average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 12-1, average meteorological conditions on sample days at PGMS and TUMS are fairly representative of average weather conditions throughout the year. The average meteorological conditions on sample days at GRMS are slightly different from the average weather conditions throughout the year. This is most likely because GRMS sampled from January through May only.

12.1 Pollutants of Interest at the Mississippi Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 12-2 presents the pollutants that failed at least one screen at the Mississippi monitoring sites. The number of pollutants failing the screen varies by site, as indicated in Table 12-2. Five pollutants with a total of 39 measured concentrations failed the screen at GRMS; 11 pollutants with a total of 57 measured concentrations failed the screen at PGMS; and 14 pollutants with a total of 193 measured concentrations failed the screen at TUMS. The pollutants of interest also varied by site, yet the following four pollutants contributed to the top 95% of the total failed screens at each Mississippi monitoring site: acetaldehyde, benzene, formaldehyde, carbon tetrachloride. It's important to note that GRMS and TUMS sampled for carbonyls and VOC, while PGMS sampled for SNMOC in addition to carbonyls and VOC, and that this is reflected in each site's pollutants of interest.

Also listed in Table 12-2 are the total number of detects and the percent detects failing the screen. Of the four pollutants that were the same among all three sites, two pollutants of interest, benzene and carbon tetrachloride, had all 100% of their detects fail the screening values.

12.2 Concentration Averages at the Mississippi Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 12-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at GRMS, acetaldehyde measured the highest concentration by mass (1.74 ± 0.30 μg/m^3), followed by formaldehyde (1.11 ± 0.32 μg/m^3). As the GRMS site ended in May and followed a 1-in-12 sampling schedule, no seasonal averages are available for this site.

At PGMS, the pollutants with the highest daily averages were benzene (1.19 ± 0.19 μg/m^3), formaldehyde (0.79 ± 0.17 μg/m^3), and acetaldehyde (0.67 ± 0.20 μg/m^3). The one detect of acrolein, however, was higher than the averages of any of the other pollutants of interest. PGMS started sampling every day beginning in October as part of the Hurricane Katrina monitoring effort. Therefore, only samples prior to October are being evaluated as UATMP data. (A post-Katrina analysis is presented at the end of this section). As a result of this and the 1 in 12 day sampling schedule, no seasonal averages are available for this site.

Finally, at TUMS, the pollutants with the highest daily averages were acetaldehyde (2.54 ± 0.75 μg/m^3), acrolein (1.30 ± 0.41 μg/m^3), and formaldehyde (1.21 ± 0.29 μg/m^3). TUMS was also part of the Hurricane Katrina monitoring effort. However, the TUMS site was used as a

background site. Sampling frequency increased from a 1-in-12 sampling schedule to a 1-in-6 schedule in October. This 1-in-6 schedule is the same as the schedule for most UATMP monitoring sites. Therefore, TUMS data sampled after October is still considered UATMP data, and seasonal averages are available for those pollutants with enough detects to meet the seasonal average criteria. For those meeting the criteria, the seasonal averages did not vary much from season to season, when the confidence interval is considered. For example, acetaldehyde seasonal averages varied from 1.12 ± 0.29 $\mu g/m^3$ in spring to 3.20 ± 2.62 $\mu g/m^3$ in winter.

12.3 Non-chronic Risk Evaluation at the Mississippi Monitoring Sites

Non-chronic risk for the concentration data at the Mississippi monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (CalEPA REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 12-4.

The lone acrolein detect at the PGMS site (2.25 $\mu g/m^3$) was an order of magnitude greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the CalEPA REL value of 0.19 $\mu g/m^3$. However, since no seasonal averages for acrolein could be calculated, intermediate risk could not be evaluated. All of the acrolein detects at TUMS exceeded the ATSDR acute value, and all but one acrolein detect exceeded the CalEPA REL value. An autumn seasonal acrolein average was able to be calculated for TUMS, and that average (0.71 ± 0.41 $\mu g/m^3$) is much greater than the ATSDR intermediate value (0.09 $\mu g/m^3$).

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Acrolein exceeded the acute risk factors at the PGMS and TUMS monitoring sites. Figures 12-7 through 12-8 are acrolein pollution roses for PGMS and TUMS. A pollution rose is a plot of concentration and wind direction. As shown in Figures 12-7 through

12-8, and discussed above, all acrolein concentrations exceeded at least one of the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

Figure 12-7 is the acrolein pollution rose for the PGMS monitoring site. The pollution rose shows that acrolein was detected only once at this site. This detect was sampled on July 15, 2005 with a south-southeasterly wind. Unfortunately, a concentration-wind direction pattern cannot be determined with only one concentration.

Figure 12-8 is the acrolein pollution rose for the TUMS monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is characteristic of mobile sources. The highest concentrations of acrolein occurred on July 27, 2005 with a northwesterly wind and on November 18, 2005, with a north-northeasterly wind. TUMS is located on the Tupelo Airport property on the west side of town. Several major roadways, such as Natchez Trace Parkway and Highway 278, border the airport property.

12.4 Meteorological and Concentration Analysis at the Mississippi Sites

The following sub-sections describe and discuss the results of the following three meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and the concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

12.4.1 Pearson Correlation Analysis

Table 12-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Mississippi monitoring sites. (Please refer to Section 3.1.6 for more information on understanding Pearson Correlations.) Many of the correlations between the pollutants of interest and the meteorological parameters at the GRMS site were strong. However, the low number of detects of each pollutant may make the correlations appear stronger than they would if the number of detects were larger. Readers should keep this in mind when evaluating the correlations at GRMS. Strong to very strong

positive correlations were calculated between formaldehyde and maximum, average, dew point, and wet bulb temperatures (0.75, 0.77, 0.57, and 0.68, respectively), while moderately strong to strong negative correlations were calculated between benzene and the same four parameters (-0.66, -0.62, -0.45, and -0.55, respectively). Acetaldehyde and carbon tetrachloride both exhibited moderately strong positive correlations with maximum temperature (0.34 and 0.38, respectively) and average temperature (0.26 and 0.29, respectively). The correlations with relative humidity were moderately strong to strong for all of the pollutants of interest at GRMS. The *v*-component of the wind exhibited stronger correlations than the *u*-component of the wind. Both formaldehyde and carbon tetrachloride has strong negative correlations with sea level pressure (-0.50 and -0.56, respectively).

Similar to GRMS, the correlations at PGMS between the pollutants of interest and maximum, average, dew point, and wet bulb temperatures were moderately strong to very strong. The strongest correlation was calculated between formaldehyde and average temperature (0.76). The correlations for relative humidity, the wind components, and sea level pressure were fairly weak, with the exception of 1,3-butadiene and the *u*-component of the wind (0.63), formaldehyde and relative humidity (0.31), and the *v*-component of the wind (0.47), and sea level pressure (-0.29). However, the same note of caution should be used with the 1,3-butadiene correlations, as the number of detects was also low. Correlations for 1,2-dibromoethane, acrylonitrile, *p*-dichlorobenzene, acrolein, chloromethylbenzene, and tetrachloroethylene could not be calculated due to the low detection rate (less than 4).

Tetrachloroethylene and *p*-dichlorobenzene exhibited moderately strong positive correlations with the maximum, average, dew point, and wet bulb temperatures at TUMS (ranging from 0.32 to 0.48 for both pollutants), while moderately strong negative correlations were calculated between 1,3-butadiene and these same parameters (ranging from -0.23 to -0.37). Acetaldehyde, hexachloro-1,3-butadiene, and *p*-dichlorobenzene exhibited moderately strong correlations with relative humidity. The correlations with the wind components and sea level pressure tended to be weak, with a few exceptions. Tetrachloroethylene exhibited a moderately strong positive correlation with the *v*-component of the wind (0.36), while 1,3-butadiene and

acrolein exhibited moderately strong positive correlations with sea level pressure (0.41 and 0.40, respectively).

12.4.2 Composite Back Trajectory Analysis

Figures 12-9 thru 12-11 are composite back trajectory maps for the Mississippi monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site in Figures 12-9 through 12-11 represents 100 miles.

As shown in Figure 12-9, the back trajectories originated from a variety of directions at GRMS. The 24-hour airshed domain is somewhat smaller than other UATMP sites, with trajectories originating as far away as South Carolina, or greater than 400 miles away. Nearly 42% of the trajectories originated within 300 miles of the site; and 92% within 400 miles from the GRMS monitoring site. It is important to note, however, that the GRMS monitoring site ended sampling in mid-May. The composite back trajectory map may look different if sampling continued throughout the year.

As presented in Figure 12-10, the back trajectories originated from a variety of directions at PGMS. The 24-hour airshed domain is somewhat smaller than other UATMP sites, with trajectories originating as far away as South Carolina, or greater than 400 miles away. Nearly 78% of the trajectories originated within 300 miles of the site; and 91% within 400 miles from the PGMS monitoring site. It is important to note, however, that the composite back trajectory for the PGMS monitoring site includes sampling days through the end of September only.

As presented in Figure 12-11, the back trajectories originated from a variety of directions at TUMS. The 24-hour airshed domain is larger than other Mississippi sites, with trajectories originating as far away as eastern Nebraska, or greater than 600 miles away. However, 63% of the trajectories originated within 300 miles of the site; and 87% within 400 miles from the TUMS monitoring site. The lone trajectory originating from Nebraska occurred on the same day a strong frontal system moved across the central and eastern US on November 24, 2005. This

wind pattern is also evident on several composite trajectory maps from other sites in the central U.S., including the DEMI, INDEM, NBIL and SPIL, DITN, MIMN, and MAWI monitoring sites.

12.4.3 Wind Rose Analysis

Hourly wind data from weather stations near these sites were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from submitted wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 12-12 through 12-14 are the wind roses for the Mississippi monitoring sites on days sampling occurred.

As presented in Figure 12-12, hourly winds were predominantly out of the north (14% of observations) and south (11%) on sample days near GRMS. Calm winds (<2 knots) were recorded for only 7% of the hourly measurements. For wind speeds greater than 2 knots, 47% of observations ranged from 7 to 11 knots. It is important to recall that GRMS sampled only through May, and that the wind rose for an entire year's worth of sample days might look differently.

As presented in Figure 12-13, hourly winds were predominantly out of the north (11% of observations) and north-northwest (10%) on sample days near PGMS. Unlike GRMS, calm winds (<2 knots) at PGMS were recorded for 41% of the hourly measurements. For wind speeds greater than 2 knots, 28% of observations ranged from 7 to 11 knots. Like GRMS, a wind rose for PGMS with an entire year's worth of sample days might look differently.

As presented in Figure 12-14, hourly winds were predominantly out of the north (15% of observations) and south (12%) on sample days near TUMS. The TUMS wind rose is somewhat similar to the GRMS wind rose. Interestingly, both sites are located in the northern half of the state. Unlike GRMS, calm winds (<2 knots) at TUMS were recorded for 19% of the hourly measurements. For wind speeds greater than 2 knots, 31% of observations ranged from 7 to 11 knots.

12.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following three spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and ethylene-acetylene ratio analysis.

12.5.1 Population, Vehicle Ownership, and Traffic Volume Comparison

County-level vehicle registration and population information for Grenada County, Jackson County, and Lee County, MS, were obtained from the Mississippi State Tax Commission and the U.S. Census Bureau, and are summarized in Table 12-6. Table 12-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 12-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

County population and vehicle registration are highest near PGMS, while the ten-mile population and vehicle ownership are highest near TUMS. Interestingly, the vehicles per person estimate is the same for all three sites. PGMS experiences the highest daily traffic volume of the three Mississippi sites, while GRMS experiences the lowest. In relation to other UATMP sites, the population and vehicle ownership counts for GRMS are among the lowest, while the counts for PGMS and TUMS are in the low to mid-range.

12.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort characterize the impact of on-road, or motor vehicle, emissions. At GRMS, the three ratios are fairly similar,

although the toluene-ethylbenzene ratio is highest (4.95 ± 0.69), the xylene-ethylbenzene ratio is lowest (3.89 ± 0.28), and the benzene-ethylbenzene ratio falls in-between (4.31 ± 0.90). The toluene-ethylbenzene is also highest at PGMS and TUMS (7.96 ± 0.79 and 8.23 ± 1.24), but is significantly higher than the toluene-ethylbenzene ratio at GRMS or the roadside study (5.85). At both PGMS and TUMS, the benzene-ethylbenzene is higher than the xylene-ethylbenzene ratio, which is the opposite of the roadside study.

12.5.3 Mobile Tracer Analysis

As previously stated, PGMS sampled for SNMOC in addition to VOC for a portion of the sampling period. Acetylene is a pollutant that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile sources have found that concentrations of ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3.) Listed in Table 3-10 is the ethylene to acetylene ratio for PGMS; as shown, PGMS's ethylene-acetylene ratio, 1.41 ± 0.16, is somewhat lower than the 1.7 ratio. This ratio suggests that while mobile sources may be influencing the air quality at the PGMS monitoring site, there may also be atmospheric chemical processes affecting the quantities of ethylene in this area's air quality. Known sinks of ethylene include reactions with ozone, as well as soil (National Library of Medicine).

12.6 Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The following observations were made:

- As presented in Figure 12-15, the GRMS monitoring site has participated in the UATMP since 2003. Concentrations of 1,3-butadiene have not been detected above the MDL at this site. Although it appears that the benzene concentration increased slightly in 2005,

the confidence intervals show that the apparent increase is not statistically significant. Formaldehyde concentrations, however, have decreased since the onset of sampling.

- As presented in Figure 12-16, the PGMS monitoring site has participated in the UATMP since 2001. Concentrations of 1,3-butadiene appear to have decreased through the years, but the confidence intervals show that the apparent decrease is not statistically significant. However, the large confidence interval in 2001 indicates that the high 2001 concentration may have been driven by a handful of outliers. Although difficult to discern, benzene concentrations decreased from 2001 to 2002, and then have been holding steady. Formaldehyde concentrations were lowest in 2005 at PGMS. The large 2004 confidence interval indicates that the 2004 formaldehyde concentration may have been driven by a handful of outliers.

- TUMS formaldehyde concentrations have been decreasing since 2001, as depicted in Figure 12-17. Benzene concentrations have decreased slightly over the sample period. The 1,3-butadiene concentrations have not changed significantly since 2001 at TUMS.

12.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 12-7 presents the 1999 NATA results for the census tracts where the Mississippi monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 12-7. Site-specific pollutants of interest are bolded.

The GRMS monitoring site is located in census tract 28043950200 with a population in 2000 of 5,038, which represents 21.7% of the county population. The PGMS monitoring site is located in census tract 28059042200, with a population in 2000 of 5,242, which represents 4.0% of the county population. TUMS is located in census tract 28081950600. The 2000 population in that census tract in 2000 was 7,862, or just less than 10.4% of the county's population.

12.7.1 1999 NATA Summary

In terms of cancer risk, the top two pollutants identified by NATA in all three of the Mississippi census tracts are benzene and carbon tetrachloride. In the GRMS census tract, the top 3 pollutants in regards to cancer risk are benzene (3.29 in-a-million risk), carbon tetrachloride (3.16 in-a-million), and acetaldehyde (1.28 in-a-million). The top 3 pollutants in regards to cancer risk in the PGMS census tract are benzene (10.47 in-a-million risk), carbon tetrachloride (4.00 in-a-million), and 1,3-butadiene (2.98 in-a-million). The top 3 pollutants in regards to cancer risk in the TUMS census tract are benzene (7.06 in-a-million risk), carbon tetrachloride (3.14 in-a-million), and dichloromethane (2.42 in-a-million). Acrolein was the only pollutant in the Mississippi census tracts to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

12.7.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated to provide comparisons (refer to Section 12.2 on how a valid annual average is calculated). Unfortunately, the GRMS site ended sampling in May 2005, therefore, valid annual averages could not be calculated. Annual averages for PGMS are also not provided due to the transition to daily (or 1-in-1) sampling in October in response to Hurricane Katrina.

The annual averages for the TUMS site are provided in Table 12-7. Nearly all of the pollutants were within one order of magnitude from each other. Some pollutants' NATA-modeled and measured concentrations, such as benzene, 1,3-butadiene, and tetrachloroethylene are in very good agreement, while others, such as dichloromethane, are less so. Dichloromethane, benzene, acetaldehyde, and formaldehyde are identified as the Top 4 pollutants by mass concentration for the 1999 NATA-modeled concentrations, while acetaldehyde, formaldehyde, hexachloro-1,3-butadiene, and benzene are the pollutants with the highest annual average concentrations.

Mississippi Pollutant Summary

- *The pollutants of interest common to each Mississippi site are acetaldehyde, benzene, carbon tetrachloride, and formaldehyde.*
- *Acetaldehyde measured the highest daily average at GRMS and TUMS, while benzene was highest at PGMS.*
- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*
- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of formaldehyde have been decreasing since the onset of program participation at GRMS, PGMS, and TUMS. Benzene has been decreasing at TUMS since 2002. Concentrations of 1,3-butadiene have been steady at PGMS and TUMS and have never been detected at GRMS.*

12.8 Post-Katrina Analysis

Analyses similar to those described in preceding sections (risk screening, non-chronic risk, and daily averages) were also prepared for the post-Katrina sampling data for GPMS and PGMS at the request of the State of Mississippi. GPMS was a UATMP monitoring site during the 2004 program-year, and is located in the coastal city of Gulfport, MS (AQS ID 28-047-0008). The Hurricane Katrina monitoring effort began in October and continued into 2006. However, only 2005 data will be discussed in this section. Data from GPMS and PGMS can be compared to each other to evaluate how concentrations may vary spatially; and pre- and post-Katrina data from PGMS can be compared to see how concentrations may have changed after Katrina's landfall and the conditions that resulted during recovery process.

12.8.1 Pollutants of Interest

Table 12-8 presents the pollutants that failed at least one screen at the GPMS and PGMS monitoring sites from October through December. The number of pollutants failing the screen varies by site, as indicated in Table 12-8. Twenty-eight pollutants with a total of 837 measured concentrations failed screens at GPMS while 23 pollutants with a total of 710 measured concentrations failed screens at PGMS. During the first 90 days of the monitoring effort, sampling took place everyday, which allows for the high number of detects. It's important to note that GPMS sampled for carbonyls, VOC, SVOC, SNMOC, and metals, while PGMS

sampled for carbonyls, VOC, and metals for the Hurricane Katrina monitoring effort; this is reflected in each site's pollutants of interest. Additionally, two sizes of metals were sampled: PM_{10} and $PM_{2.5}$. For purposes of this report, the two method types are viewed separately.

Although the pollutants of interest varied by site, the following fifteen pollutants contributed to the top 95% of the total failed screens at GPMS and PGMS post-Katrina: 1,2-dichloroethane, acetaldehyde, formaldehyde, benzene, beryllium (PM_{10} and $PM_{2.5}$), carbon tetrachloride, 1,3-butadiene, arsenic ($PM_{2.5}$ & PM_{10}), hexachloro-1,3-butadiene, acrolein, *p*-dichlorobenzene, manganese (PM_{10}), and tetrachloroethylene . Also listed in Table 12-8 are the total number of detects and the percent detects failing the screen. Of the fifteen pollutants that were common between both sites, six pollutants of interest, formaldehyde, benzene, carbon tetrachloride, acrolein, 1,2-dichloroethane, and hexachloro-1,3-butadiene had 100% of their detects fail the screening values.

The failure rate, or percent of detects failing screens, especially for the common pollutants of interest, is very similar for both sites (within 5% of each other), with a few expections: arsenic ($PM_{2.5}$), *p*-dichlorobenzene, nickel (PM_{10} & $PM_{2.5}$), and total xylenes. Arsenic ($PM_{2.5}$) and *p*-dichlorobenzene had higher failure rates at GPMS while nickel (PM_{10} & $PM_{2.5}$) and total xylenes had higher failure rates at PGMS.

Pre- and post- Katrina pollutants of interest and failure rates can also be compared for PGMS. Of the pollutants that failed at least one screen, 74% of those detects failed screens prior to Hurricane Katrina. Surprisingly, of the pollutants that failed at least one screen during the post-Katrina sampling, only 52% of detects failed screens. However, it's important to note that eleven pollutants failed screens prior to Hurricane Katrina, while twenty-three pollutants failed screens after Hurricane Katrina. If metals (which were sampled post-Katrina, but not before) are excluded, then thirteen pollutants failed screens after Hurricane Katrina. The lower percentage of failed screens post-Katrina may be a result of the numerous stationary and mobile sources not operating immediately after the storm.

Seven pollutants of interest are the same between the two time periods: benzene, carbon tetrachloride, acetaldehyde, formaldehyde, 1,3-butadiene, *p*-dichlorobenzene, and tetrachloroethylene. The failure rates of benzene and carbon tetrachloride are the same for both time periods (100%). Failure rates of 1,3-butadiene, *p*-dichlorobenzene, and tetrachloroethylene decreased after Hurricane Katrina. Failure rates of acetaldehyde and formaldehyde increased after Hurricane Katrina.

12.8.2 Concentration Averages

Daily averages of the post-Katrina pollutants of interest at the GPMS and PGMS monitoring sites are presented in Table 12-9. Due to the unique situation presented after the hurricane, calculation of seasonal averages is not appropriate. Rather, average concentrations from October through December, with 1/2 MDLs incorporated for non-detects (similar to seasonal or annual averages in previous sections), are presented as an intermediate average. Among the daily averages at GPMS, formaldehyde measured the highest concentration by mass (3.44 ± 0.33 μg/m^3), followed by acetaldehyde (2.43 ± 0.29 μg/m^3), and acrolein (1.55 ± 0.22 μg/m^3). Among the intermediate averages, formaldehyde exhibited the highest concentration (3.44 ± 0.33 μg/m^3), followed by acetaldehyde (2.43 ± 0.29 μg/m^3), and benzene (1.17 ± 0.20 μg/m^3). The daily and intermediate averages for these three pollutants are the same as these pollutants were detected in every post-Katrina sample taken.

Among the daily averages at PGMS, formaldehyde measured the highest concentration by mass (27.15 ± 13.99 μg/m^3), followed by acetaldehyde (2.73 ± 0.36 μg/m^3), and benzene (1.51 ± 0.27 μg/m^3). Among the intermediate averages, formaldehyde exhibited the highest concentration (26.80 ± 13.82 μg/m^3), followed by acetaldehyde (2.73 ± 0.36 μg/m^3), and benzene (1.51 ± 0.27 μg/m^3). The daily and intermediate averages for acetaldehyde and benzene are the same as these pollutants were detected in every post-Katrina sample taken, while formaldehyde had one non-detect.

Daily averages of the pre- and post- Katrina pollutants of interest can be compared for PGMS. In comparing the pre- and post-Hurricane Katrina daily averages of the common

pollutants of interest at PGMS, only formaldehyde and acetaldehyde are statistically different for the two time periods. Acetaldehyde and formaldehyde are higher after Hurricane Katrina (0.67 ± 0.20 $\mu g/m^3$ vs. 2.73 ± 0.36 $\mu g/m^3$ for acetaldehyde before and after, and 0.79 ± 0.17 $\mu g/m^3$ vs. 27.15 ± 13.99 $\mu g/m^3$ for formaldehyde before and after).

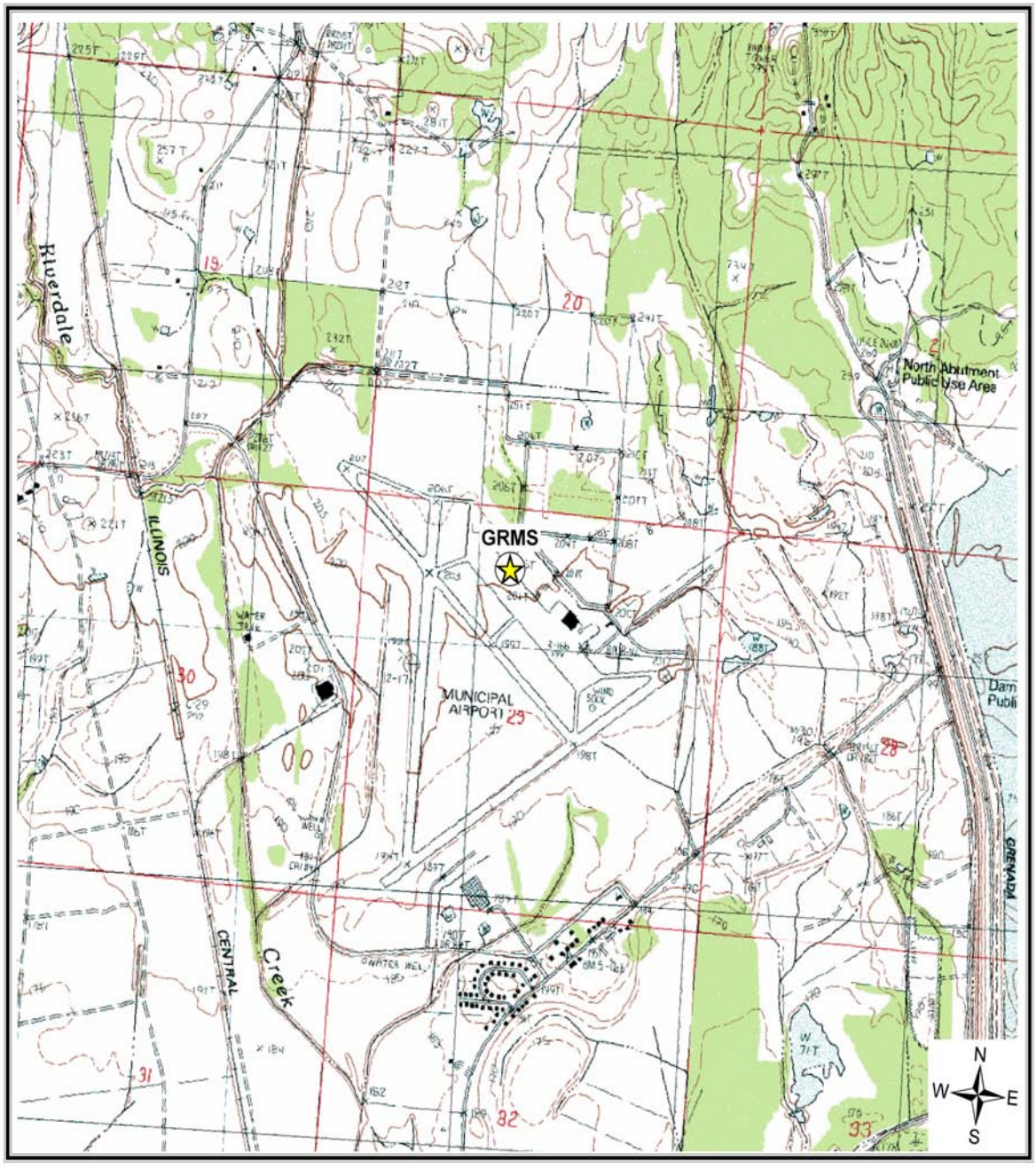
12.8.3 Non-Chronic Risk

Table 12-10 presents the summary of the post-Katrina non-chronic risk at GPMS and PGMS. Of the pollutants with at least one failed screen at these sites, only acrolein and formaldehyde exceeded either the acute and/or intermediate risk values. All detects of acrolein at both sites exceeded the acute risk factors. Daily acrolein averages at both sites were significantly greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$ (1.55 ± 0.22 $\mu g/m^3$ at GPMS and 1.42 ± 0.21 $\mu g/m^3$ at PGMS), and the intermediate averages at both sites exceeded the ATSDR intermediate value of 0.09 $\mu g/m^3$ (1.04 ± 0.21 $\mu g/m^3$ at GPMS and 1.06 ± 0.21 $\mu g/m^3$ at PGMS). The GPMS and PGMS daily acrolein averages were somewhat higher than their intermediate averages due to the number of non-detects.

Six formaldehyde concentrations at the PGMS site exceeded the acute risk factors, although the average daily formaldehyde average (27.15 ± 13.99 $\mu g/m^3$) is less than both risk factors. Five of the six exceedences of the acute risk values occurred in October, approximately one and half months after the hurricane made landfall. The intermediate formaldehyde average did not exceeded the ATSDR intermediate value of 40 $\mu g/m^3$ (26.80 ± 13.82 $\mu g/m^3$) at PGMS.

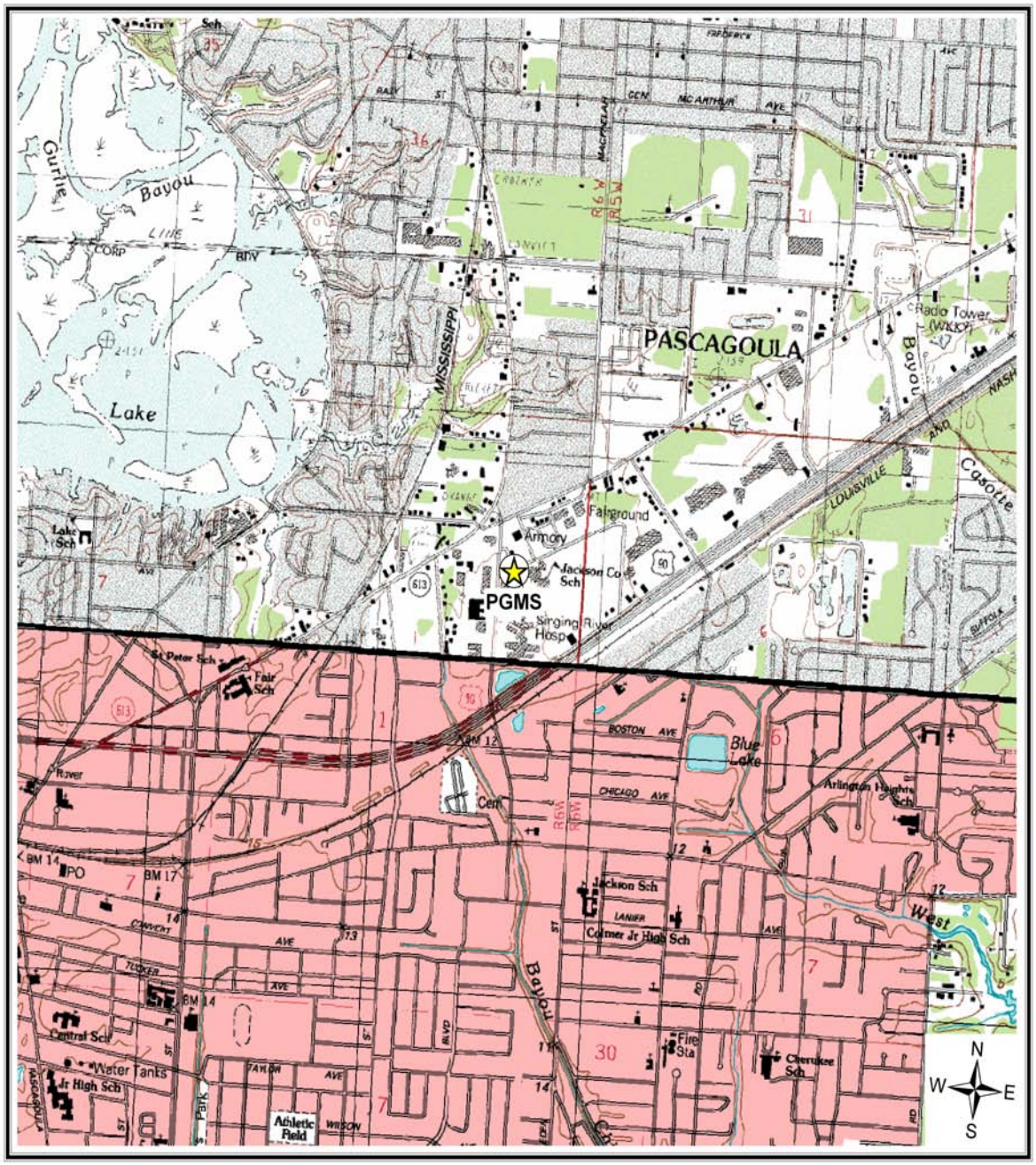
Prior to Hurricane Katrina, only one detect of acrolein at PGMS exceeded either the ATSDR MRL or California REL risk factors. Interestingly, from July (when acrolein sampling began) through the end of September (15 total samples), this pollutant was only detected once, representing a 7% detection rate. After Hurricane Katrina, this pollutant was detected 49 times in 66 samples, which represents a 74% detection rate. Out of fifteen samples, no formaldehyde concentrations exceeded the risk factors prior to Hurricane Katrina. Out of 78 samples, 6 formaldehyde concentrations exceeded the risk factors after Hurricane Katrina.

Figure 12-1. Grenada, Mississippi (GRMS) Monitoring Site



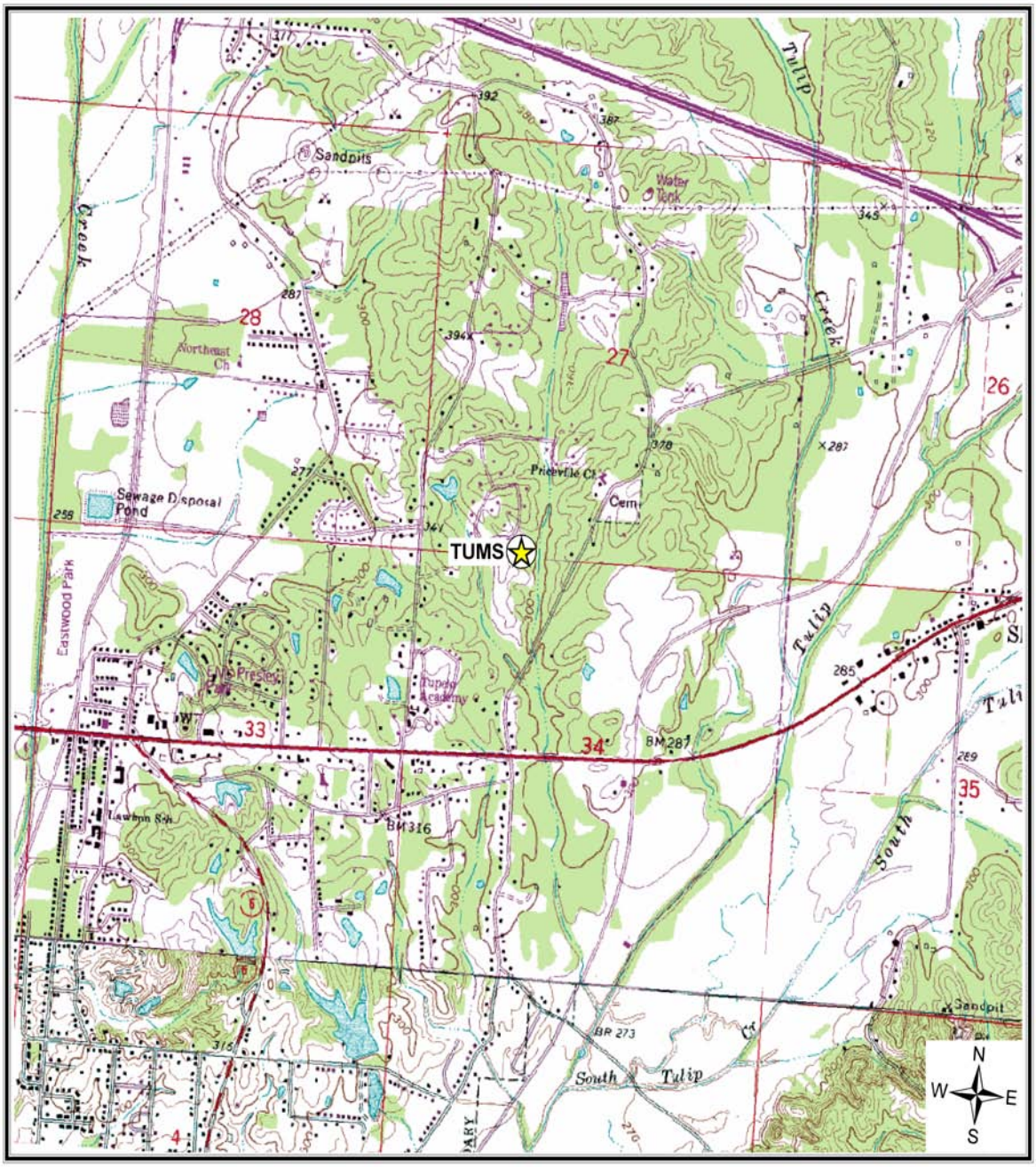
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 12-2. Pascagoula, Mississippi (PGMS) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 12-3. Tupelo, Mississippi (TUMS) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 12-4. Facilities Located Within 10 Miles of GRMS

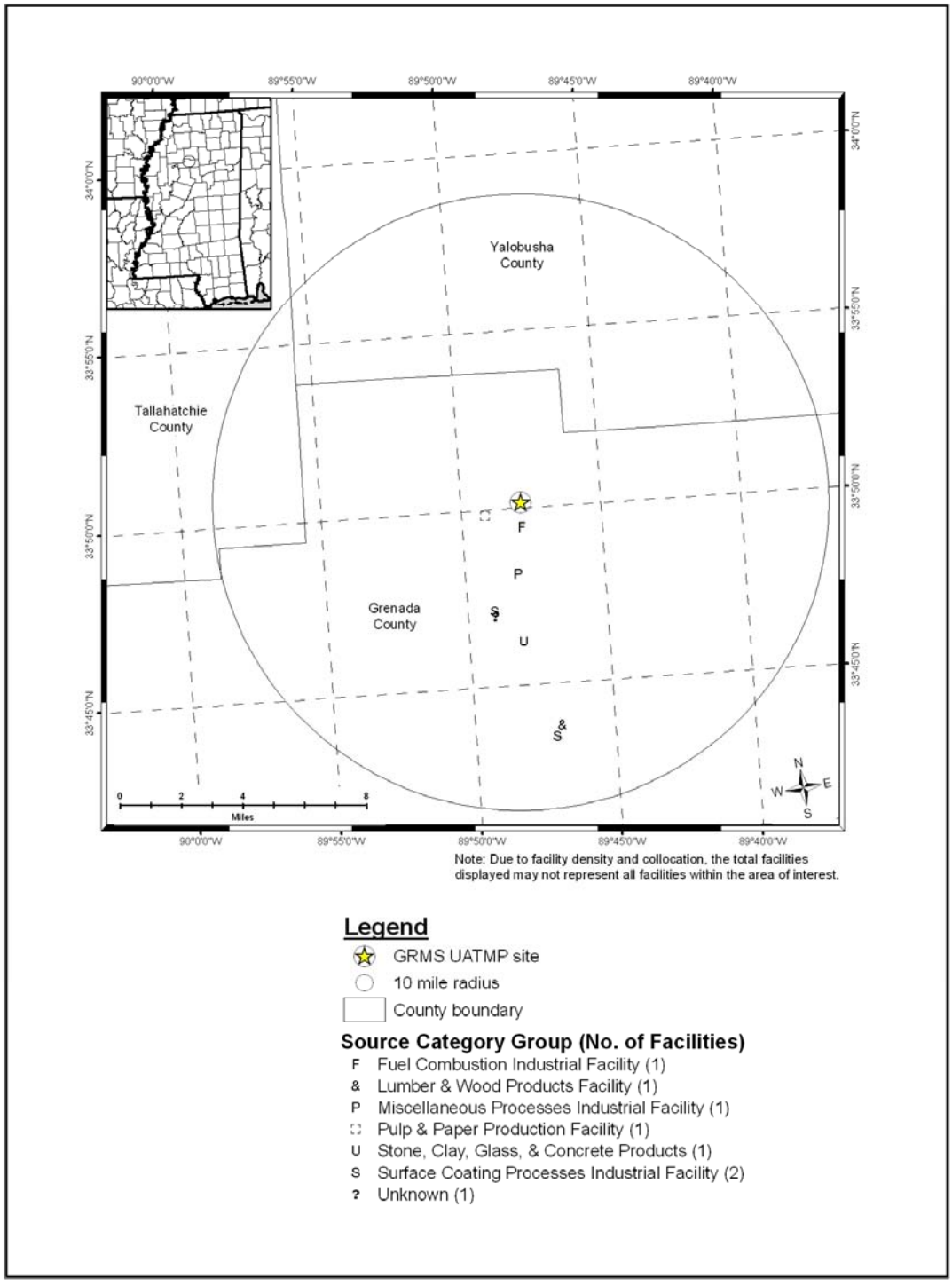


Figure 12-5. Facilities Located Within 10 Miles of PGMS

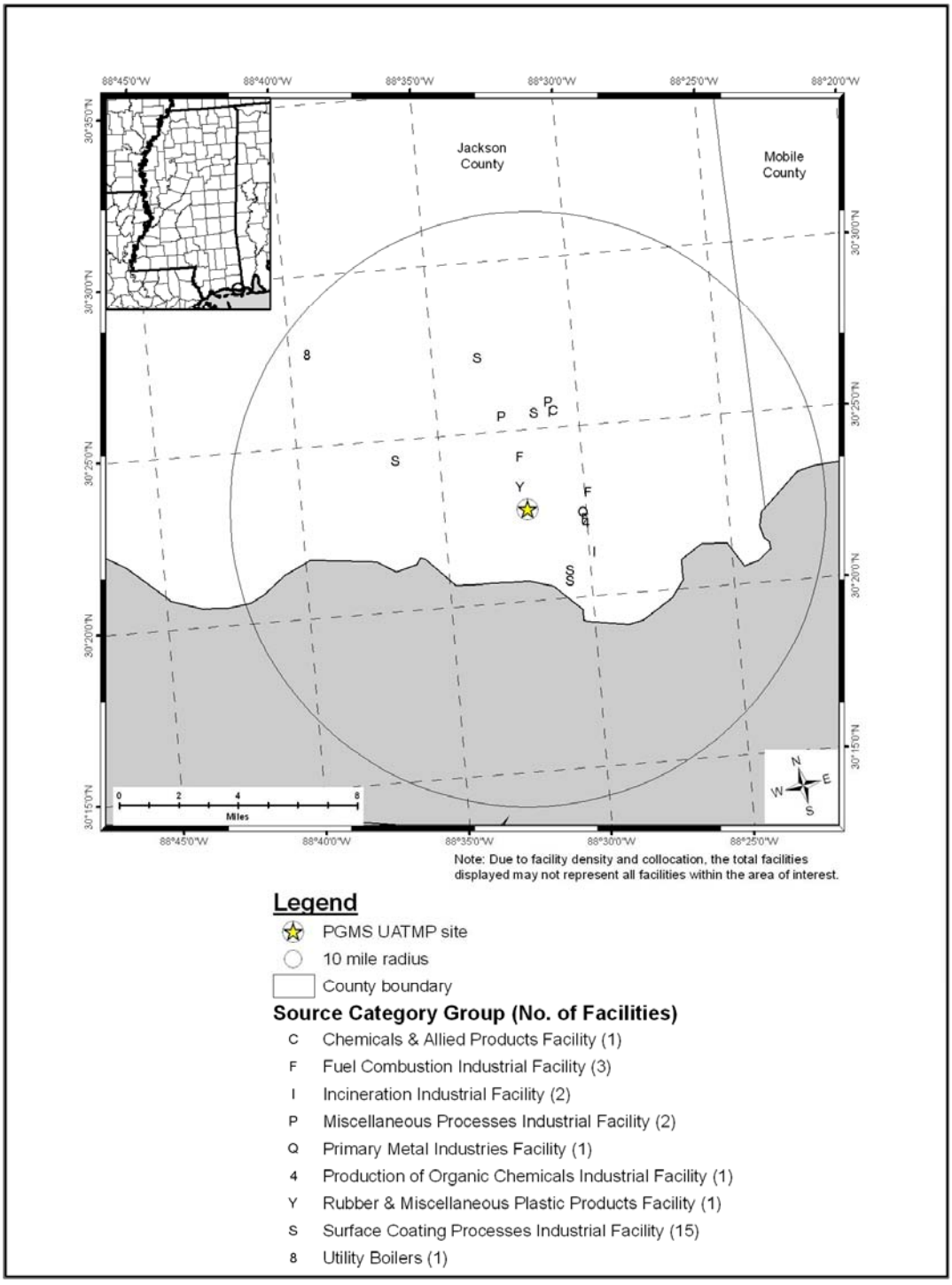


Figure 12-6. Facilities Located Within 10 Miles of TUMS

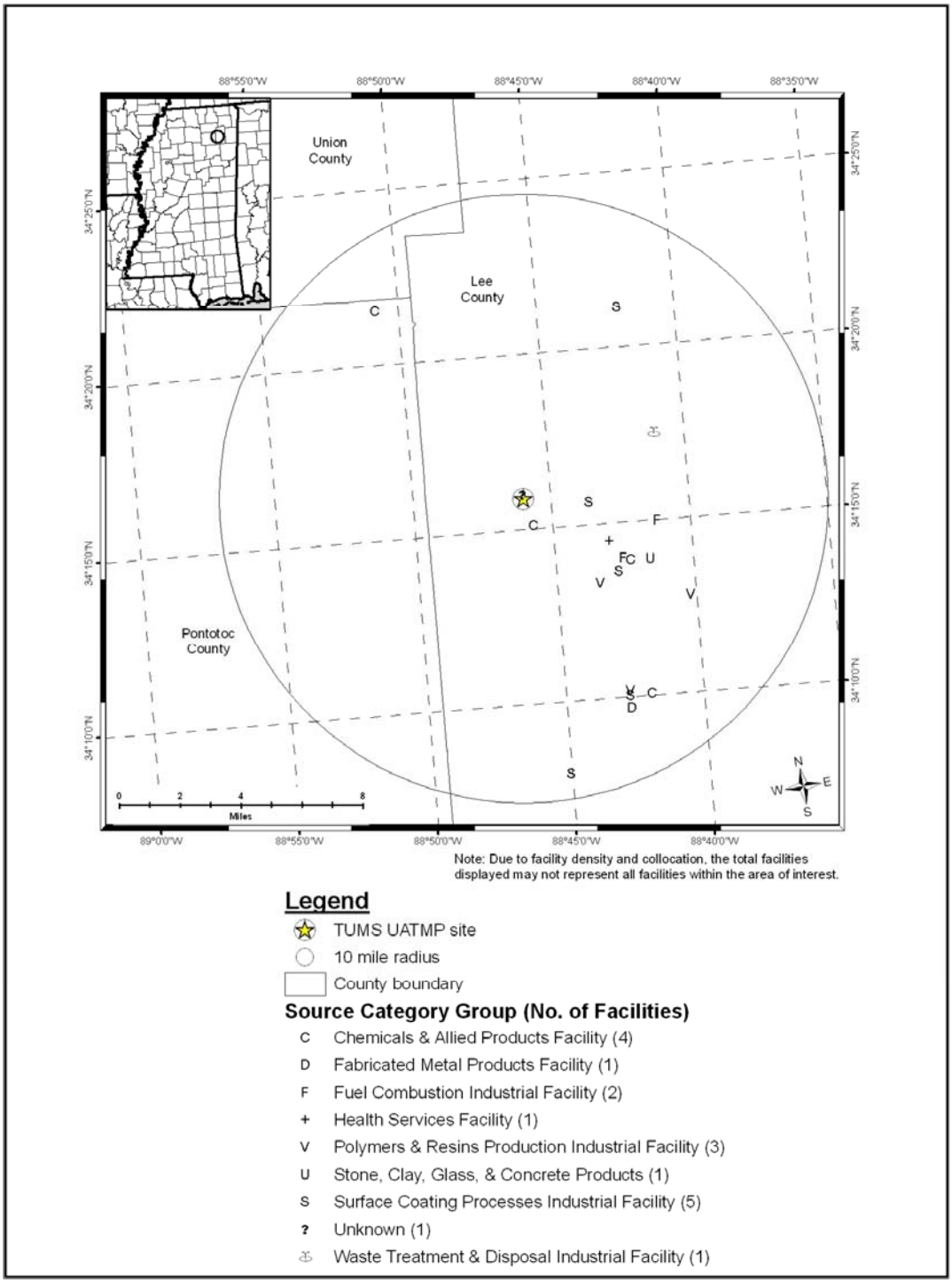


Figure 12-7. Acrolein Pollution Rose at PGMS

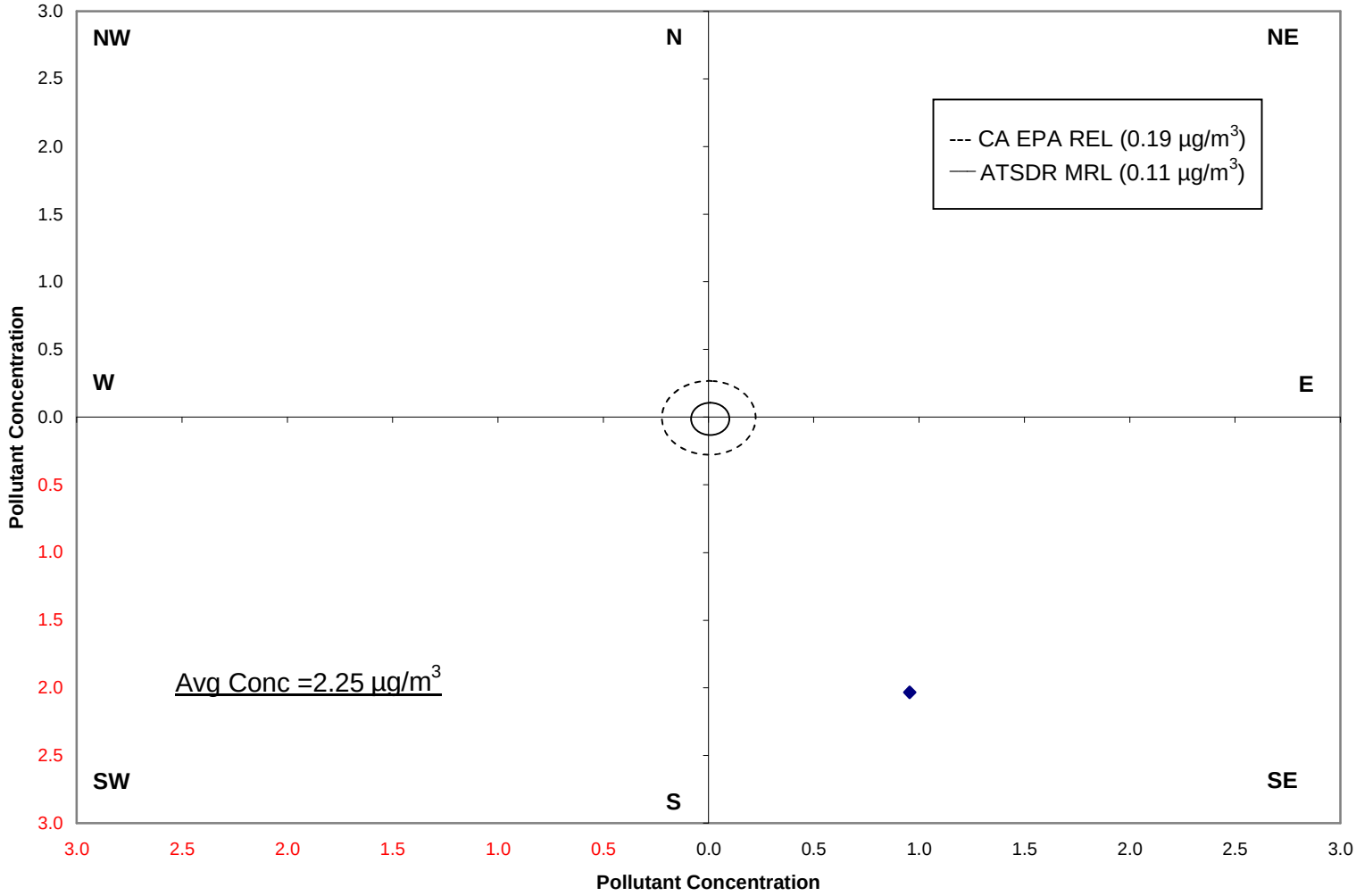


Figure 12-8. Acrolein Pollution Rose at TUMS

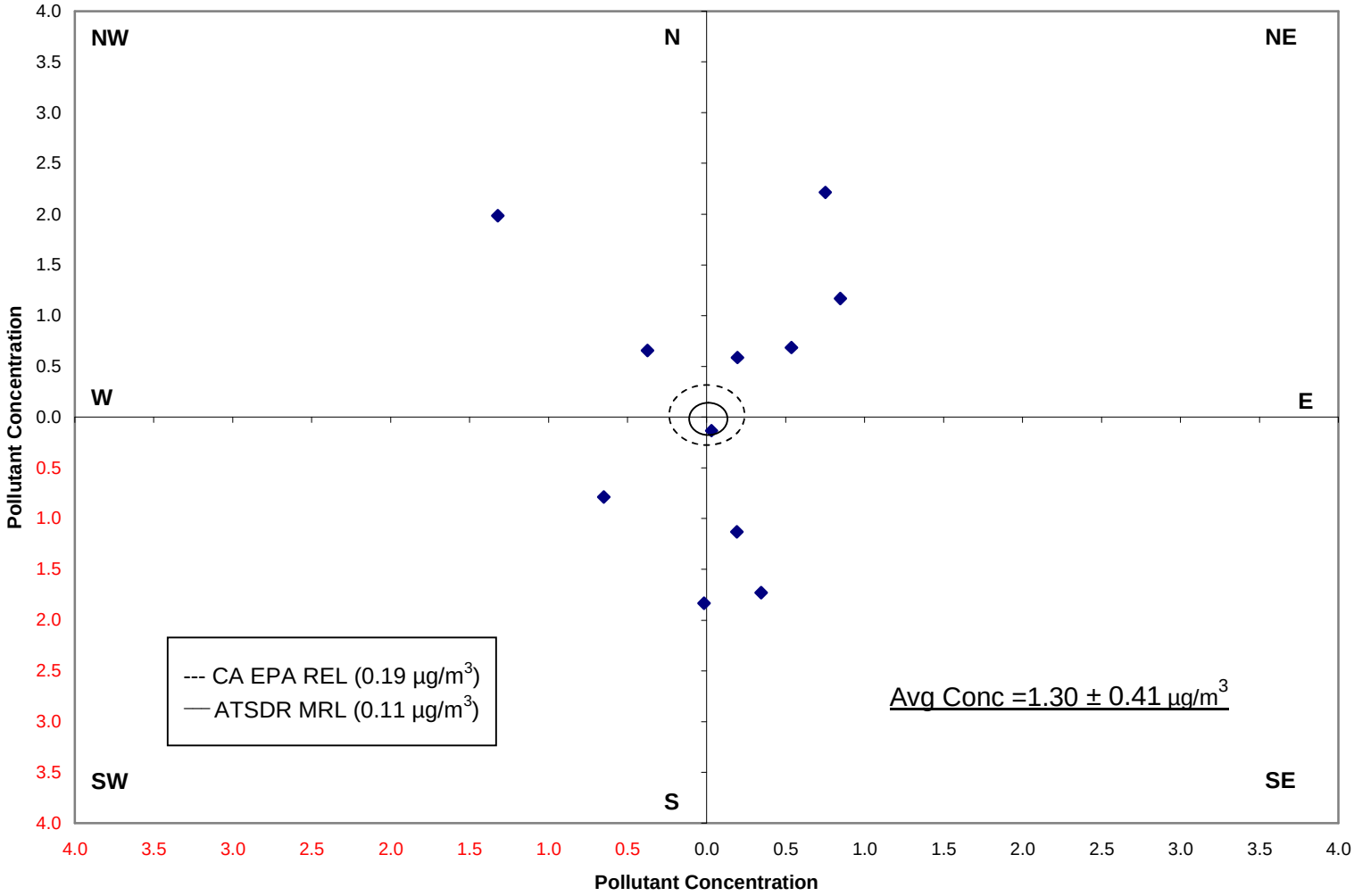


Figure 12-9. Composite Back Trajectory Map for GRMS

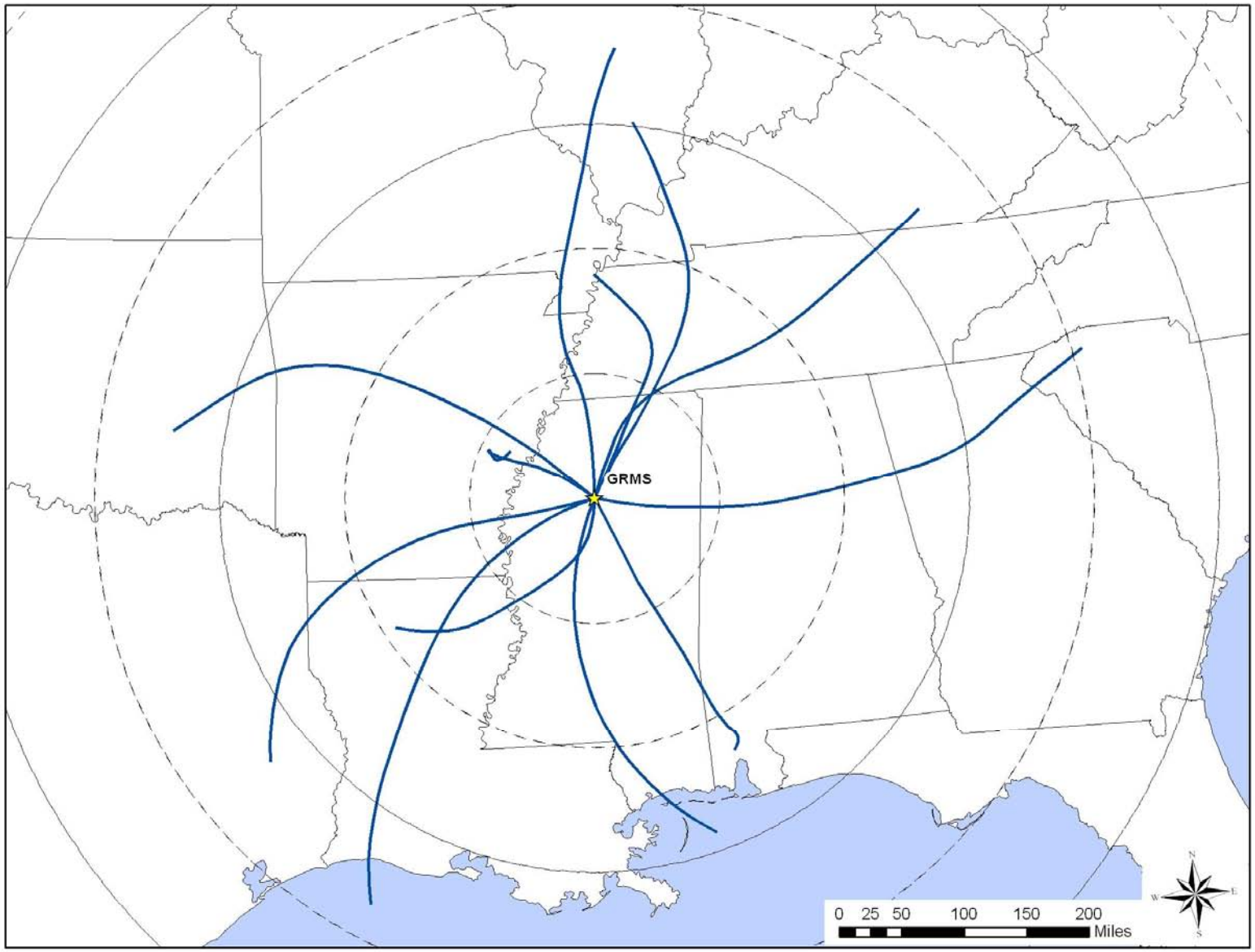


Figure 12-10. Composite Back Trajectory Map for PGMS

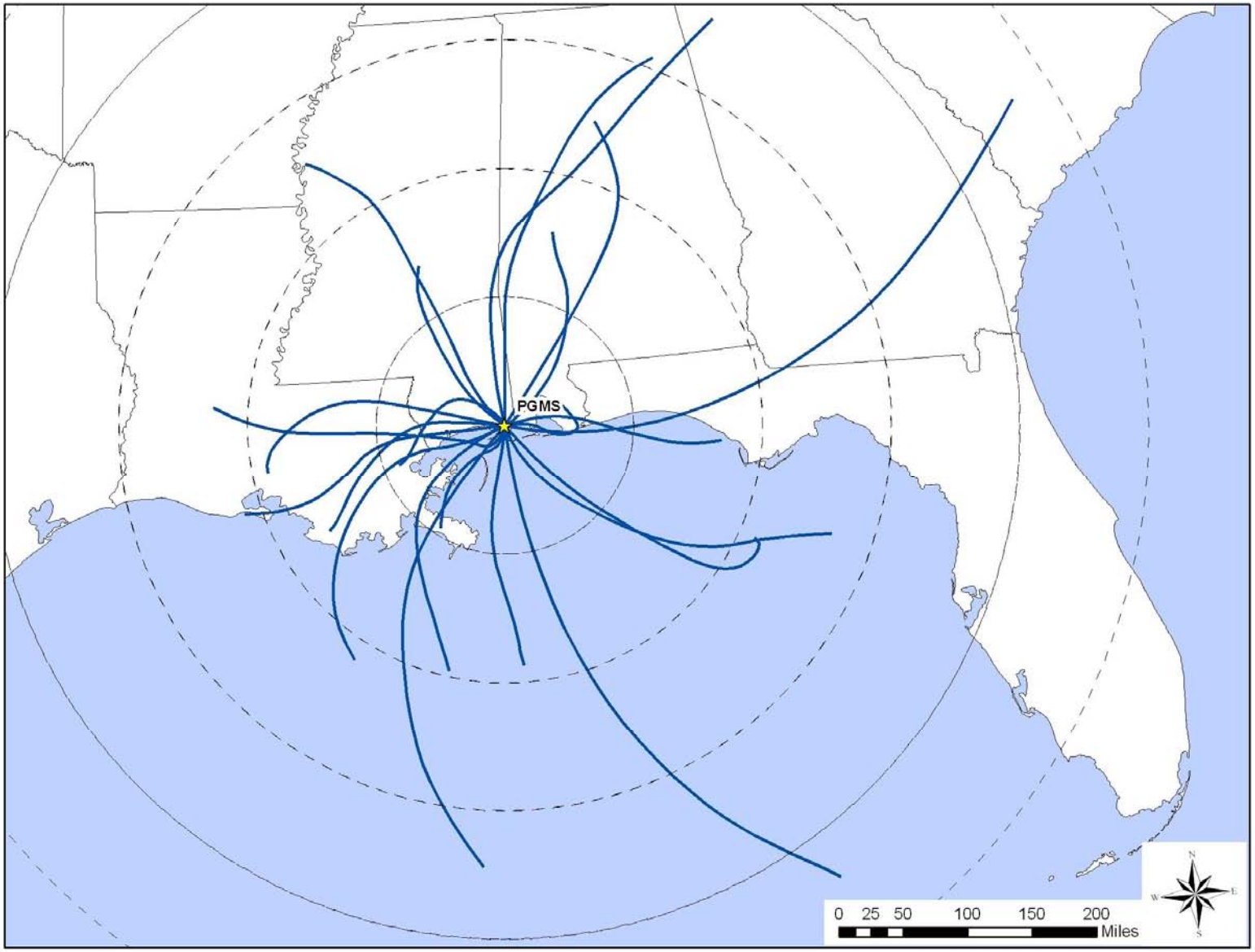


Figure 12-11. Composite Back Trajectory Map for TUMS

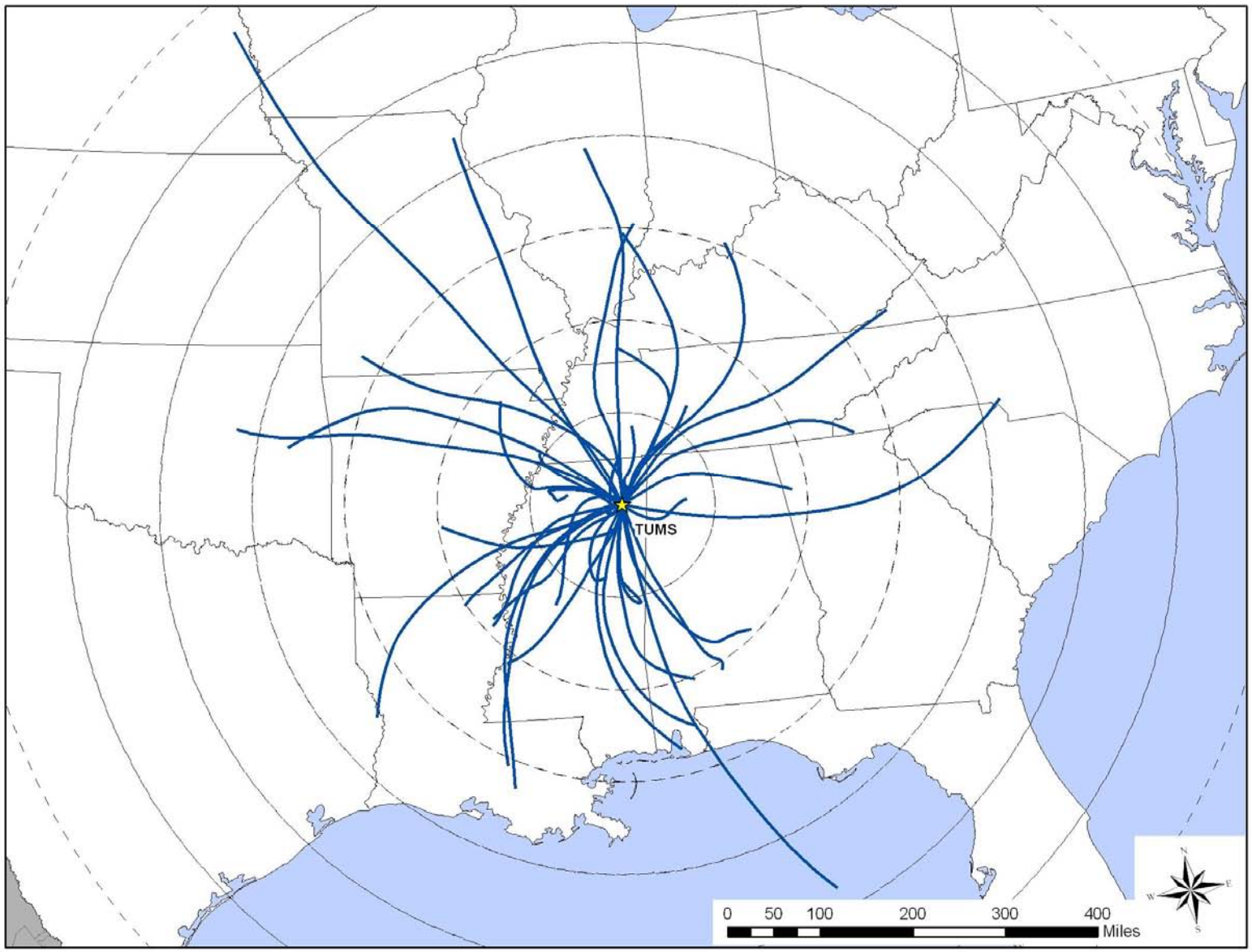


Figure 12-12. Wind Rose of Sample Days for the GRMS Monitoring Site

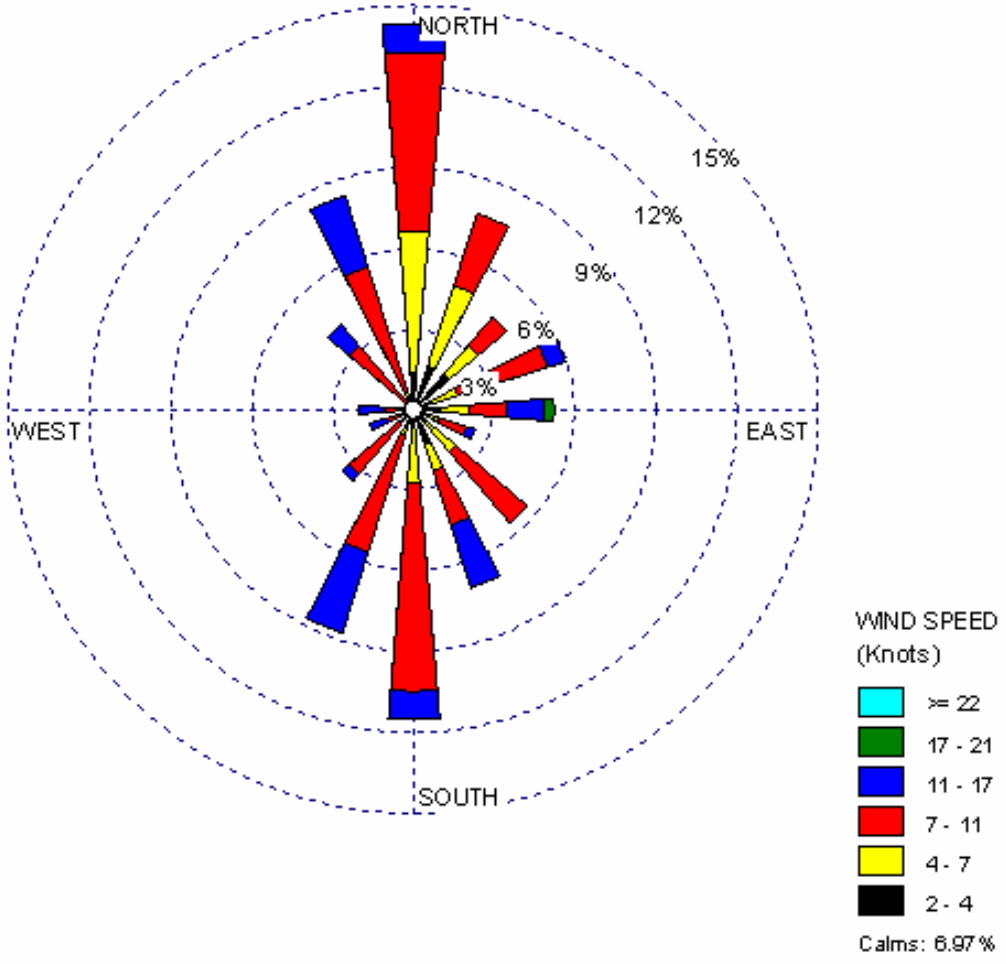


Figure 12-13. Wind Rose of Sample Days for the PGMS Monitoring Site

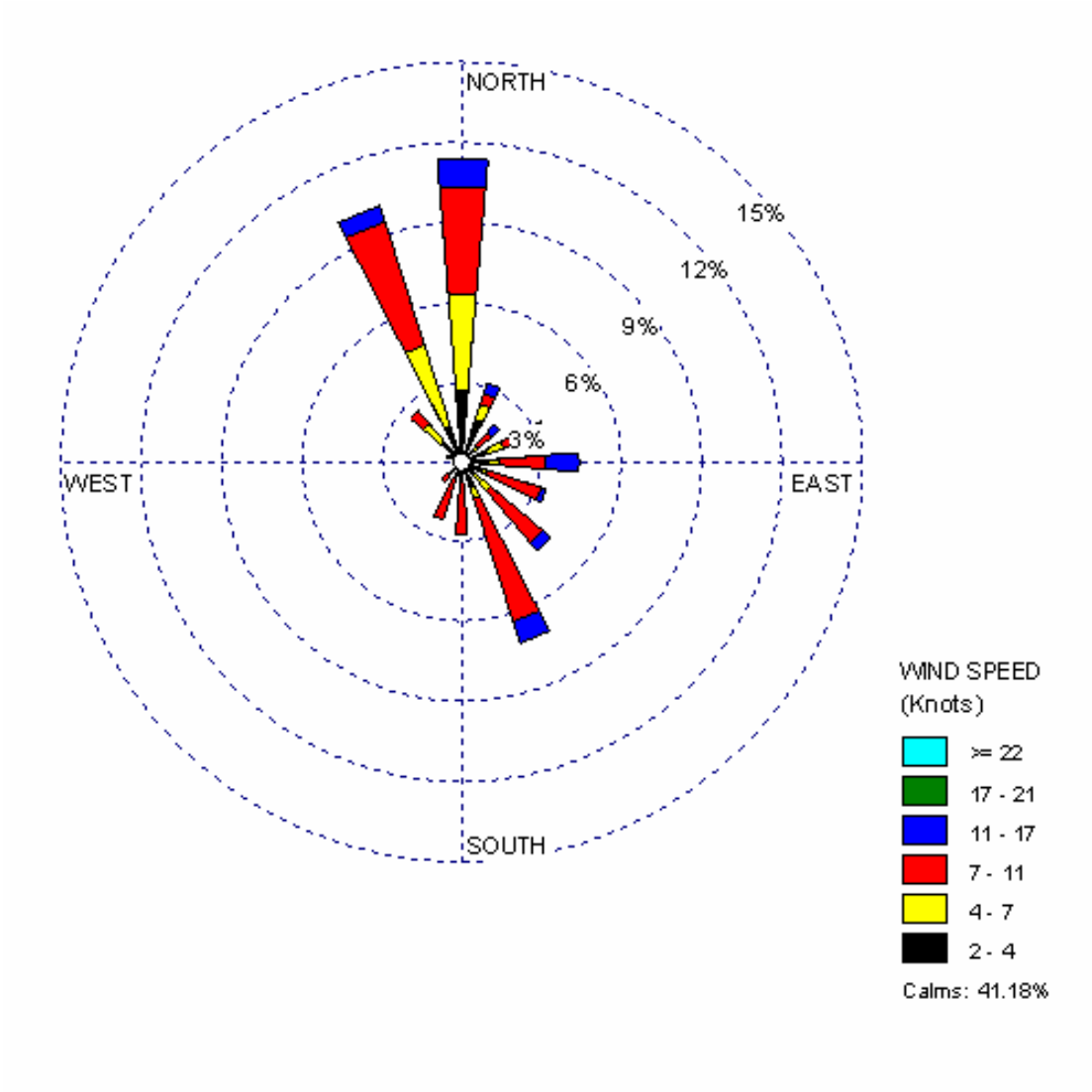


Figure 12-14. Wind Rose of Sample Days for the TUMS Monitoring Site

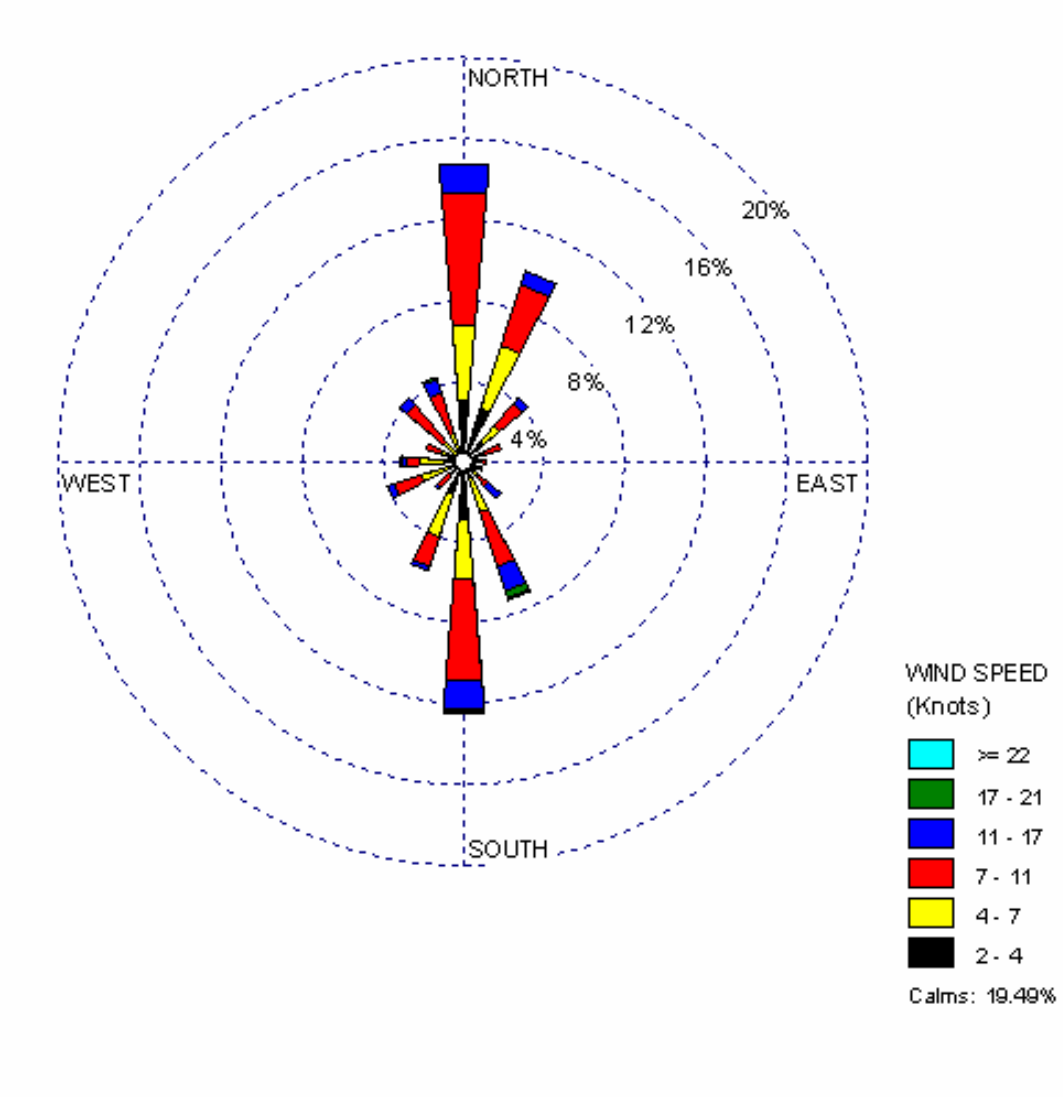


Figure 12-15. Comparison of Yearly Averages for the GRMS Monitoring Site

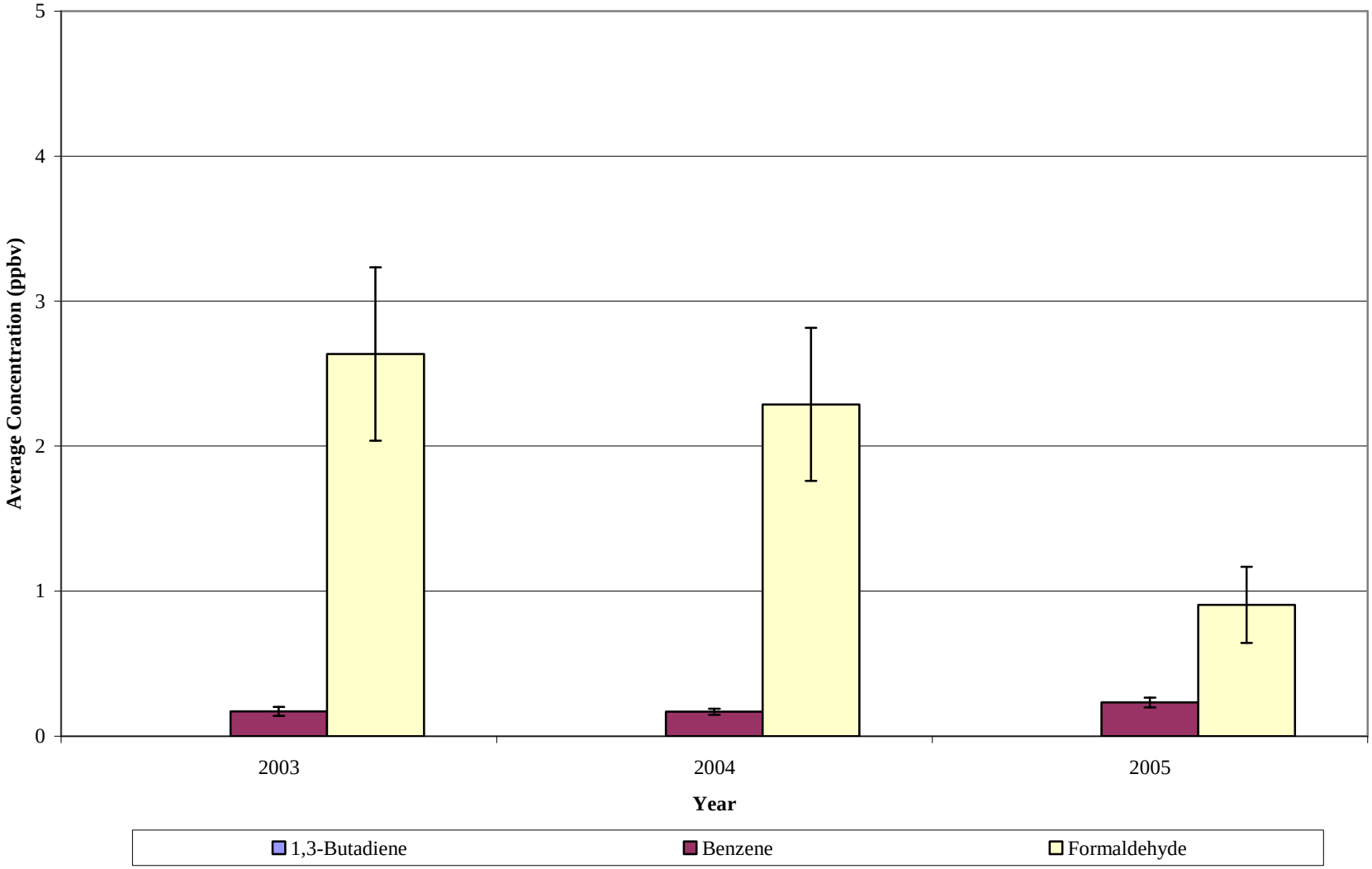


Figure 12-16. Comparison of Yearly Averages for the PGMS Monitoring Site

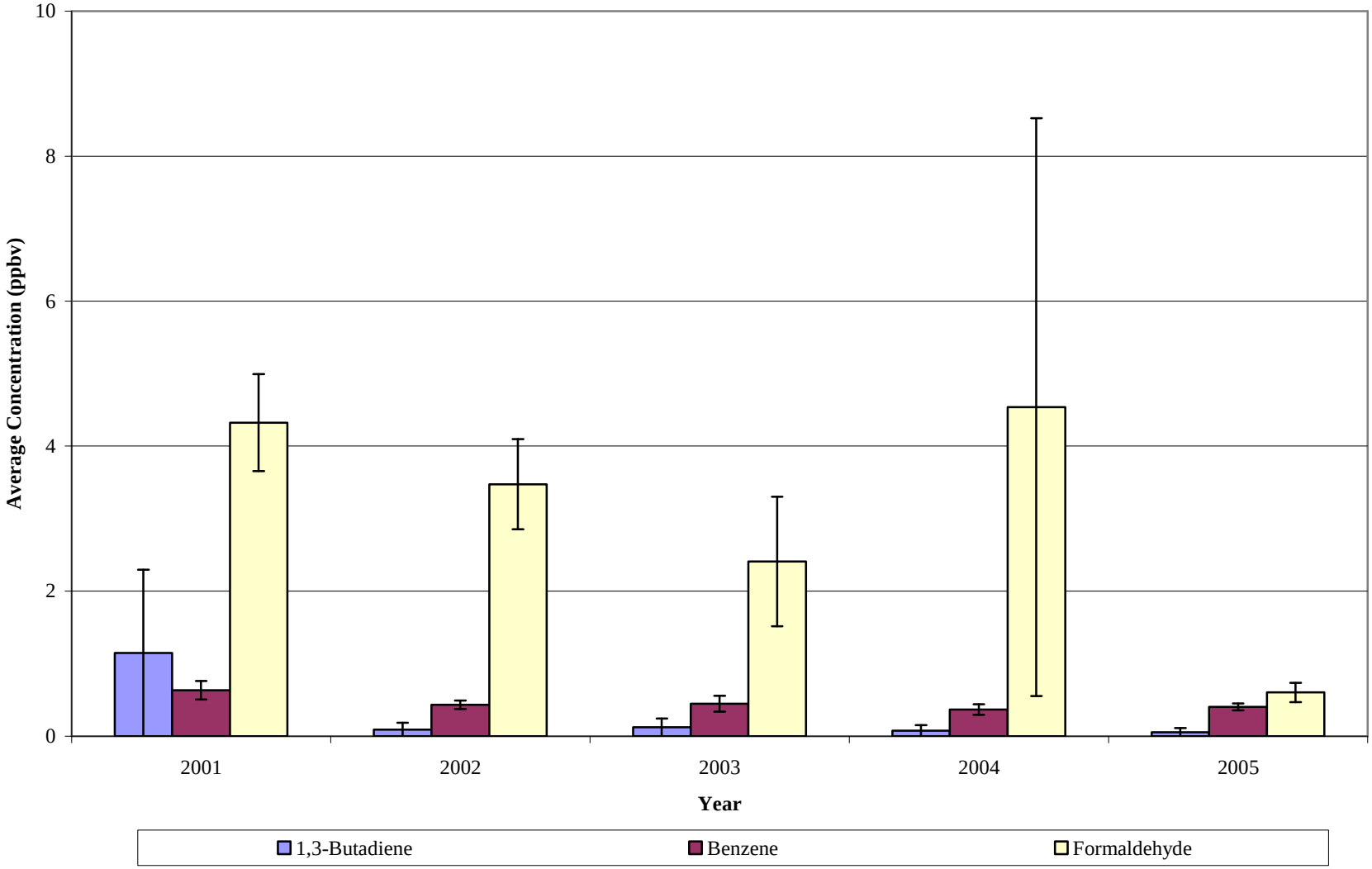


Figure 12-17. Comparison of Yearly Averages for the TUMS Monitoring Site

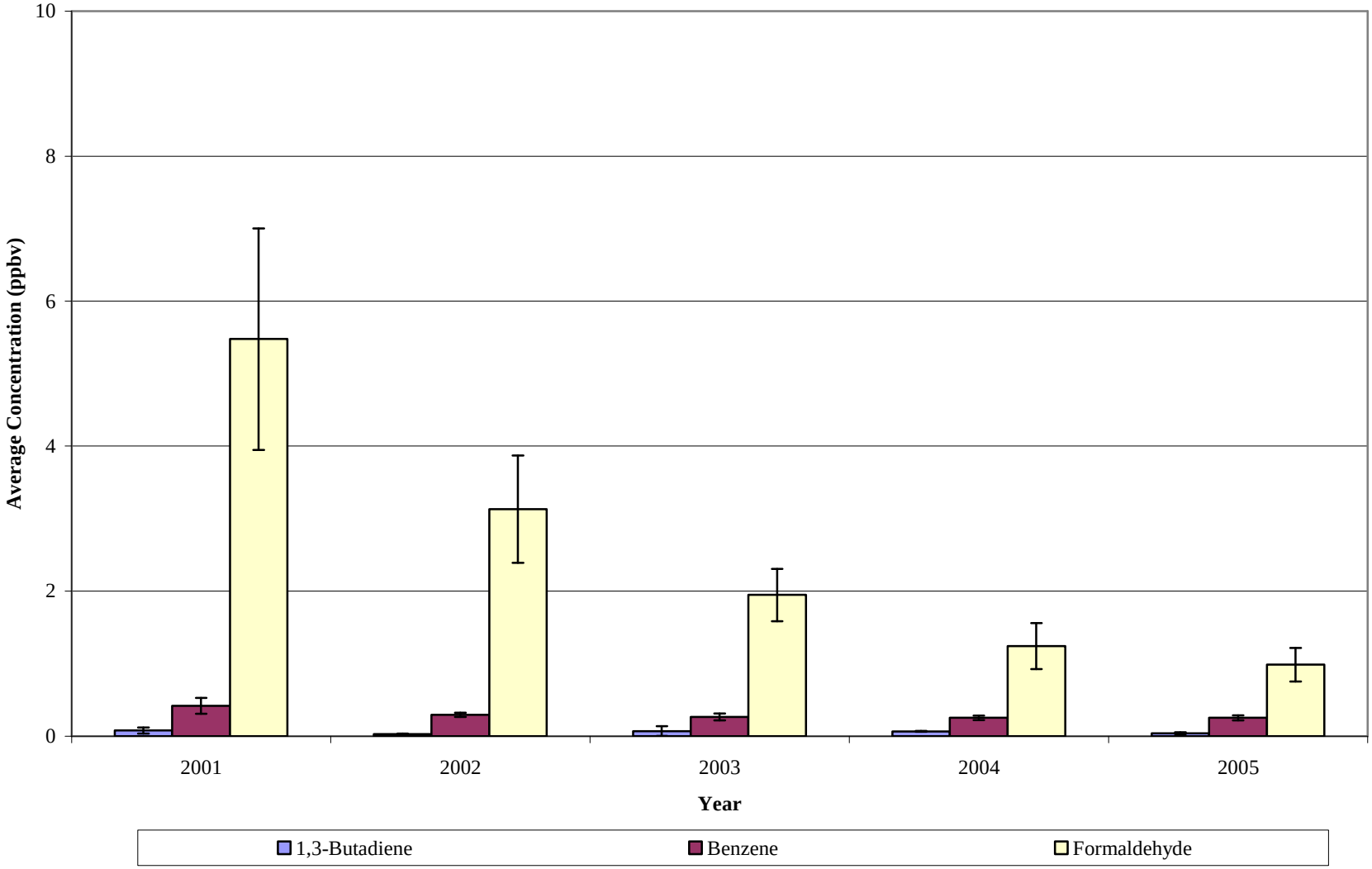


Table 12-1. Average Meteorological Parameters for Monitoring Sites in Mississippi

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
GRMS	13978	All 2005	74.98 ± 1.60	63.97 ± 1.55	53.13 ± 1.63	57.91 ± 1.46	71.06 ± 0.98	1017.06 ± 0.60	-0.41 ± 0.30	0.10 ± 0.46
		Sample Day	66.75 ± 7.42	57.01 ± 6.66	45.71 ± 6.01	51.17 ± 5.77	69.56 ± 6.09	1018.79 ± 4.05	-0.44 ± 2.43	-0.02 ± 3.16
PGMS	53858	All 2005	77.57 ± 1.22	66.52 ± 1.28	57.45 ± 1.49	61.34 ± 1.28	75.64 ± 1.10	1016.97 ± 0.54	-0.68 ± 0.27	-1.00 ± 0.34
		Sample Day	78.43 ± 4.94	68.44 ± 4.85	60.32 ± 5.44	63.58 ± 4.82	77.74 ± 3.49	1017.10 ± 1.79	-0.55 ± 1.05	-0.09 ± 1.58
TUMS	93862	All 2005	73.81 ± 1.63	63.27 ± 1.57	51.15 ± 1.69	56.67 ± 1.48	67.74 ± 1.05	1017.17 ± 0.61	-0.11 ± 0.27	-0.41 ± 0.46
		Sample Day	72.32 ± 4.86	61.51 ± 4.86	48.63 ± 5.17	54.64 ± 4.56	65.89 ± 3.15	1017.52 ± 1.96	-0.01 ± 0.85	-0.32 ± 1.52

Table 12-2. Comparison of Measured Concentrations and EPA Screening Values at the Mississippi Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Grenada, Mississippi – GRMS					
Benzene	11	11	100.0	28.2%	28.2%
Acetaldehyde	11	11	100.0	28.2%	56.4%
Carbon Tetrachloride	10	10	100.0	25.6%	82.1%
Formaldehyde	6	11	54.5	15.4%	97.4%
Dichloromethane	1	5	20.0	2.6%	100.0%
Total	39	48	81.3		
Pascagoula, Mississippi – PGMS					
Benzene	15	15	100	26.3%	26.3%
Carbon Tetrachloride	15	15	100	26.3%	52.6%
Acetaldehyde	9	15	60	15.8%	68.4%
1,3-Butadiene	8	8	100	14.0%	82.5%
Formaldehyde	3	15	20	5.3%	87.7%
p-Dichlorobenzene	2	2	100	3.5%	91.2%
Tetrachloroethylene	1	3	33	1.8%	93.0%
Acrylonitrile	1	1	100	1.8%	94.7%
1,2-Dibromoethane	1	1	100	1.8%	96.5%
Chloromethylbenzene	1	1	100	1.8%	98.2%
Acrolein	1	1	100	1.8%	100.0%
Total	57	77	74.0		
Tupelo, Mississippi – TUMS					
Benzene	38	38	100.0	19.7%	19.7%
Carbon Tetrachloride	38	38	100.0	19.7%	39.4%
Acetaldehyde	37	37	100.0	19.2%	58.5%
1,3-Butadiene	20	20	100.0	10.4%	68.9%
Formaldehyde	19	37	51.4	9.8%	78.8%
Hexachloro-1,3-butadiene	12	12	100.0	6.2%	85.0%
Acrolein	11	11	100.0	5.7%	90.7%
p-Dichlorobenzene	6	12	50.0	3.1%	93.8%
Tetrachloroethylene	6	17	35.3	3.1%	96.9%
1,2-Dichloroethane	2	2	100.0	1.0%	97.9%
Vinyl chloride	1	5	20.0	0.5%	98.4%
1,2-Dibromoethane	1	1	100.0	0.5%	99.0%
Chloromethylbenzene	1	1	100.0	0.5%	99.5%
Dichloromethane	1	29	3.4	0.5%	100.0%
Total	193	260	74.2		

Table 12-3. Daily and Seasonal Averages for Pollutants of Interest at the Mississippi Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Grenada, Mississippi – GRMS												
Acetaldehyde	11	11	1.74	0.30	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	11	11	0.74	0.11	NA	NA	NA	NA	NA	NA	NA	NA
Carbon Tetrachloride	10	11	0.53	0.05	NA	NA	NA	NA	NA	NA	NA	NA
Formaldehyde	11	11	1.11	0.32	NA	NA	NA	NA	NA	NA	NA	NA
Pascagoula, Mississippi – PGMS												
1,2-Dibromoethane	1	15	0.31	--	NA	NA	NR	NR	NR	NR	NA	NA
1,3-Butadiene	8	15	0.12	0.04	NA	NA	NR	NR	NR	NR	NA	NA
Acetaldehyde	15	15	0.67	0.20	NA	NA	NR	NR	NR	NR	NA	NA
Acrolein	1	4	2.25	--	NA	NA	NA	NA	NR	NR	NA	NA
Acrylonitrile	1	15	0.39	--	NA	NA	NR	NR	NR	NR	NA	NA
Benzene	15	15	1.19	0.19	NA	NA	NR	NR	NR	NR	NA	NA
Carbon Tetrachloride	15	15	0.63	0.06	NA	NA	NR	NR	NR	NR	NA	NA
Chloromethylbenzene	1	15	0.44	--	NA	NA	NR	NR	NR	NR	NA	NA
Formaldehyde	15	15	0.79	0.17	NA	NA	NR	NR	NR	NR	NA	NA
p-Dichlorobenzene	2	15	0.36	0.33	NA	NA	NR	NR	NR	NR	NA	NA
Tetrachloroethylene	3	15	0.25	0.24	NA	NA	NR	NR	NR	NR	NA	NA
Tupelo, Mississippi – TUMS												
1,3-Butadiene	20	38	0.09	0.03	NR	NR	NR	NR	NR	NR	0.09	0.02
Acetaldehyde	37	37	2.54	0.75	3.20	2.62	1.12	0.29	2.40	0.37	3.03	0.86
Acrolein	11	23	1.30	0.41	NA	NA	NA	NA	NR	NR	0.72	0.41
Benzene	38	38	0.81	0.11	0.88	0.19	0.67	0.17	0.72	0.16	0.90	0.25
Carbon Tetrachloride	38	38	0.60	0.05	0.57	0.10	0.56	0.08	0.67	0.07	0.60	0.11
Formaldehyde	37	37	1.21	0.29	1.09	0.69	0.64	0.18	1.95	0.74	1.25	0.34
Hexachloro-1,3-butadiene	12	38	0.19	0.03	NR	NR	NR	NR	NR	NR	0.78	0.42
p-Dichlorobenzene	12	38	0.46	0.57	NR	NR	NR	NR	NR	NR	0.13	0.04
Tetrachloroethylene	17	38	0.16	0.05	NR	NR	NR	NR	NR	NR	0.16	0.06

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 12-4. Non-Chronic Risk Summary at the Mississippi Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
PGMS	TO-15	Acrolein	2.25[1]	0.11	1	0.19	1	0.09	NA	NA	NR	NA
TUMS	TO-15	Acrolein	1.30 ± 0.41	0.11	11	0.19	10	0.09	NA	NA	NR	0.72 ± 0.41

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.
[1] This pollutant was detected only once.

Table 12-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Mississippi Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Grenada, Mississippi – GRMS									
Acetaldehyde	11	0.34	0.26	0.01	0.12	-0.58	0.02	0.16	-0.18
Benzene	11	-0.66	-0.62	-0.45	-0.55	0.49	-0.06	-0.46	0.08
Carbon Tetrachloride	10	0.38	0.29	0.07	0.18	-0.38	0.04	0.45	-0.56
Formaldehyde	11	0.75	0.77	0.57	0.68	-0.55	0.31	0.41	-0.50
Pascagoula, Mississippi – PGMS									
1,2-Dibromoethane	1	NA							
1,3-Butadiene	8	-0.56	-0.47	-0.43	-0.45	-0.11	0.63	0.24	-0.29
Acetaldehyde	15	0.53	0.50	0.48	0.49	0.22	0.05	0.19	-0.24
Acrolein	1	NA							
Acrylonitrile	1	NA							
Benzene	15	-0.29	-0.41	-0.43	-0.43	-0.17	0.23	0.16	0.12
Carbon Tetrachloride	15	0.25	0.34	0.36	0.36	0.18	-0.31	0.21	-0.10
Chloromethylbenzene	1	NA							
Formaldehyde	15	0.71	0.76	0.73	0.75	0.31	-0.14	0.47	-0.29
p-Dichlorobenzene	2	NA							
Tetrachloroethylene	3	NA							
Tupelo, Mississippi – TUMS									
1,3-Butadiene	20	-0.23	-0.33	-0.37	-0.36	-0.24	-0.10	0.20	0.41
Acetaldehyde	37	-0.08	-0.16	-0.25	-0.20	-0.40	0.25	-0.15	0.10
Acrolein	11	-0.12	-0.10	-0.12	-0.10	-0.07	-0.03	0.04	0.40
Benzene	38	0.02	-0.10	-0.12	-0.12	-0.05	0.04	0.19	0.23
Carbon Tetrachloride	38	0.08	0.08	0.08	0.09	0.02	0.12	-0.01	-0.09
Formaldehyde	37	0.33	0.26	0.17	0.22	-0.22	0.22	-0.08	-0.09
Hexachloro-1,3-butadiene	12	-0.07	0.04	0.17	0.12	0.32	-0.02	-0.19	-0.13
p-Dichlorobenzene	12	0.42	0.43	0.47	0.46	0.27	0.27	-0.26	-0.26
Tetrachloroethylene	17	0.48	0.41	0.32	0.35	-0.12	0.14	0.36	0.00

Table 12-6. Motor Vehicle Information for the Mississippi Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
GRMS	22,861	20,036	0.88	21,446	18,796	1,100
PGMS	135,940	119,796	0.88	56,235	49,557	8,600
TUMS	78,793	69,518	0.88	70,215	61,950	4,900

Table 12-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Mississippi

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Grenada, Mississippi - GRMS, Census Tract 28043950200				
Acetaldehyde	NA	0.58	1.28	0.06
Benzene	NA	0.42	3.29	0.01
Carbon Tetrachloride	NA	0.21	3.16	0.01
Dichloromethane	NA	0.15	0.07	<0.01
Formaldehyde	NA	0.53	<0.01	0.05
Pascagoula, Mississippi - PGMS, Census Tract 28059042200				
1,2-Dibromoethane	NA	0.01	2.68	0.02
1,3-Butadiene	NA	0.10	2.98	0.05
Acetaldehyde	NA	1.15	2.54	0.13
Acrolein	NA	0.08	--	4.11
Acrylonitrile	NA	<0.01	0.02	<0.01
Benzene	NA	1.34	10.47	0.04
Carbon Tetrachloride	NA	0.27	4.00	0.01
Chloromethylbenzene	NA	<0.01	<0.01	--
Formaldehyde	NA	1.06	0.01	0.11
***p*-Dichlorobenzene**	NA	0.02	0.27	<0.01
Tetrachloroethylene	NA	0.12	0.71	<0.01
Tupelo, Mississippi – TUMS, Census Tract 28081950600				
1,2-Dibromoethane	0.16 ± 0.01	0.01	1.26	0.01
1,2-Dichloroethane	0.09 ± 0.01	0.02	0.41	<0.01
1,3-Butadiene	0.08 ± 0.01	0.05	1.55	0.03
Acetaldehyde	2.54 ± 0.75	0.82	1.81	0.09
Acrolein	NA	0.04	--	2.06
Benzene	0.81 ± 0.11	0.90	7.06	0.03
Carbon Tetrachloride	0.60 ± 0.05	0.21	3.14	0.01
Chloromethylbenzene	0.11 ± 0.02	<0.01	<0.01	--
Dichloromethane	0.49 ± 0.50	5.15	2.42	0.01
Formaldehyde	1.21 ± 0.29	0.76	<0.01	0.08
Hexachloro-1,3-butadiene	0.86 ± 0.18	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.27 ± 0.18	0.02	0.22	<0.01
Tetrachloroethylene	0.15 ± 0.02	0.07	0.39	<0.01
Vinyl chloride	0.06 ± 0.01	0.01	0.11	<0.01

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

Table 12-8. Comparison of Measured Concentrations and EPA Screening Values at the Post-Katrina Mississippi Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Gulfport, Mississippi - GPMS					
Acetaldehyde	83	83	100.00	9.92	9.92
Formaldehyde	83	83	100.00	9.92	19.83
Benzene	77	77	100.00	9.20	29.03
Carbon Tetrachloride	77	77	100.00	9.20	38.23
1,3-Butadiene	68	75	90.67	8.12	46.36
Arsenic ($PM_{2.5}$)	64	67	95.52	7.65	54.00
Arsenic (PM_{10})	64	69	92.75	7.65	61.65
Hexachloro-1,3-butadiene	61	61	100.00	7.29	68.94
Naphthalene	58	83	69.88	6.93	75.87
Acrolein	51	51	100.00	6.09	81.96
p-Dichlorobenzene	38	68	55.88	4.54	86.50
Manganese (PM_{10})	36	87	41.38	4.30	90.80
Tetrachloroethylene	20	70	28.57	2.39	93.19
Cadmium (PM_{10})	8	80	10.00	0.96	94.15
1,2-Dichloroethane	7	7	100.00	0.84	94.98
Beryllium ($PM_{2.5}$)	7	45	15.56	0.84	95.82
Beryllium (PM_{10})	7	45	15.56	0.84	96.65
Cadmium ($PM_{2.5}$)	7	77	9.09	0.84	97.49
Benzo (a) pyrene	6	18	33.33	0.72	98.21
Nickel (PM_{10})	4	72	5.56	0.48	98.69
Xylenes	3	77	3.90	0.36	99.04
Nickel ($PM_{2.5}$)	2	68	2.94	0.24	99.28
Acrylonitrile	1	1	100.00	0.12	99.40
Antimony (PM_{10})	1	72	1.39	0.12	99.52
Antimony ($PM_{2.5}$)	1	66	1.52	0.12	99.64
Benzo (a) anthracene	1	60	1.67	0.12	99.76
Benzo (b) fluoranthene	1	41	2.44	0.12	99.88
Dichloromethane	1	74	1.35	0.12	100.00
Total	837	1754	47.72		
Pascagoula, Mississippi - PGMS					
Formaldehyde	77	77	100.00	10.85	10.85
Acetaldehyde	74	78	94.87	10.42	21.27
Benzene	66	66	100.00	9.30	30.56
Carbon Tetrachloride	66	66	100.00	9.30	39.86
Arsenic (PM_{10})	60	69	86.96	8.45	48.31
Arsenic ($PM_{2.5}$)	58	69	84.06	8.17	56.48
1,3-Butadiene	57	63	90.48	8.03	64.51
Hexachloro-1,3-butadiene	52	52	100.00	7.32	71.83

Table 12-8. Comparison of Measured Concentrations and EPA Screening Values at the Post-Katrina Mississippi Monitoring Sites (Continued)

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Acrolein	49	49	100.00	6.90	78.73
Manganese (PM_{10})	37	87	42.53	5.21	83.94
Nickel (PM_{10})	18	81	22.22	2.54	86.48
p-Dichlorobenzene	18	45	40.00	2.54	89.01
Tetrachloroethylene	15	53	28.30	2.11	91.13
Nickel ($PM_{2.5}$)	14	79	17.72	1.97	93.10
1,2-Dichloroethane	8	8	100.00	1.13	94.23
Beryllium ($PM_{2.5}$)	8	49	16.33	1.13	95.35
Beryllium (PM_{10})	8	52	15.38	1.13	96.48
Cadmium (PM_{10})	7	79	8.86	0.99	97.46
Xylenes	7	66	10.61	0.99	98.45
Cadmium ($PM_{2.5}$)	6	83	7.23	0.85	99.30
Acrylonitrile	2	2	100.00	0.28	99.58
Manganese ($PM_{2.5}$)	2	88	2.27	0.28	99.86
1,1,2,2-Tetrachloroethane	1	1	100.00	0.14	100.00
Total	710	1362	52.13		

Table 12-9. Daily and Intermediate-term Averages for Pollutants of Interest at the Post-Katrina Mississippi Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Intermediate	
			Avg ($\mu g/m^3$)	Conf. Int	Avg ($\mu g/m^3$)	Conf. Int
Gulfport, Mississippi - GPMS						
1,2-Dichloroethane	7	77	0.09	0.05	0.06	0.00
1,3-Butadiene	75	77	0.13	0.03	0.14	0.03
Acetaldehyde	83	83	2.43	0.29	2.43	0.29
Acrolein	51	77	1.55	0.22	1.04	0.21
Arsenic (PM_{10})	69	87	1.75E-03	4.61E-04	1.46E-03	3.85E-04
Arsenic ($PM_{2.5}$)	67	85	1.64E-03	4.20E-04	1.36E-03	3.50E-04
Benzene	77	77	1.17	0.20	1.17	0.20
Beryllium (PM_{10})	45	87	2.09E-04	4.63E-05	2.62E-04	2.66E-05
Beryllium ($PM_{2.5}$)	45	85	2.04E-04	4.43E-05	2.57E-04	2.64E-05
Cadmium (PM_{10})	80	87	2.89E-04	4.03E-05	2.69E-04	3.96E-05
Cadmium ($PM_{2.5}$)	77	85	2.88E-04	3.95E-05	2.65E-04	3.89E-05
Carbon Tetrachloride	77	77	0.68	0.02	0.68	0.02
Formaldehyde	83	83	3.44	0.33	3.44	0.33
Hexachloro-1,3-butadiene	61	77	0.18	0.01	0.51	0.14
Manganese (PM_{10})	87	87	4.76E-03	6.76E-04	4.76E-03	6.76E-04
Naphthalene	83	83	0.06	0.01	0.06	0.01
p-Dichlorobenzene	68	77	0.17	0.04	0.17	0.03
Tetrachloroethylene	70	77	0.18	0.06	0.17	0.06
Pascagoula, Mississippi - PGMS						
1,2-Dichloroethane	8	66	0.11	0.06	0.07	0.01
1,3-Butadiene	63	66	0.16	0.04	0.16	0.04
Acetaldehyde	78	78	2.73	0.36	2.73	0.36
Acrolein	49	66	1.42	0.21	1.06	0.21
Arsenic (PM_{10})	69	87	1.37E-03	3.34E-04	1.15E-03	2.80E-04
Arsenic ($PM_{2.5}$)	69	91	1.22E-03	3.21E-04	1.00E-03	2.56E-04
Benzene	66	66	1.51	0.27	1.51	0.27
Beryllium (PM_{10})	52	87	2.02E-04	4.14E-05	2.49E-04	2.75E-05
Beryllium ($PM_{2.5}$)	49	91	2.05E-04	4.32E-05	2.58E-04	2.60E-05
Carbon Tetrachloride	66	66	0.67	0.03	0.67	0.03
Formaldehyde	77	78	27.15	13.99	26.80	13.82
Hexachloro-1,3-butadiene	52	66	0.18	0.02	0.52	0.16
Manganese (PM_{10})	87	87	4.64E-03	5.59E-04	4.64E-03	5.59E-04
Nickel (PM_{10})	81	87	1.54E-03	2.83E-04	1.45E-03	2.73E-04
Nickel ($PM_{2.5}$)	79	91	3.45E-03	4.12E-03	3.02E-03	3.58E-03
p-Dichlorobenzene	45	66	0.13	0.03	0.14	0.02
Tetrachloroethylene	53	66	0.17	0.04	0.15	0.03

Table 12-10. Non-Chronic Risk Summary at the Post-Katrina Mississippi Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Intermediate Average (µg/m^3)
GPMS	TO-15	Acrolein	1.55 ± 0.22	0.11	51	0.19	51	0.09	1.04 ± 0.21
PGMS	TO-15	Acrolein	1.42 ± 0.21	0.11	49	0.19	49	0.09	1.06 ± 0.21
PGMS	TO-15	Formaldehyde	27.15 ± 13.99	49	6	94	6	40	26.80 ± 13.82

13.0 Site in Missouri

This section presents meteorological, concentration, and spatial trends for the UATMP site in Missouri (S4MO). This site is located in the St. Louis metropolitan statistical area (MSA). Figure 13-1 is a topographical map showing the monitoring site in its urban location. Figure 13-2 identifies point source emission locations within 10 miles of the site that reported to the 2002 NEI for point sources. Numerous sources are located near the St. Louis site, most of which are involved in fuel combustion industries.

Hourly meteorological data at a weather station near this site were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the S4MO monitoring site is at St. Louis Downtown Airport (WBAN 03960).

St. Louis has a climate that is continental in nature, with cold, rather dry winters, warm, somewhat wetter summers, and significant seasonal variability. Wind speeds are generally light and wind flows from the southeast on average (Ruffner and Bair, 1987). Table 13-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 13-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

13.1 Pollutants of Interest at the Missouri Monitoring Site

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." A total of 81 HAPs are listed in the guidance document as having risk

screening values. Table 13-2 presents the eighteen pollutants that failed at least one screen at S4MO; a total of 479 measured concentrations failed screens. The pollutants of interest at S4MO were identified as the pollutants that contributed to the top 95% of the total failed screens, resulting in eleven pollutants: benzene (61 failed screens), acetaldehyde (60), arsenic (60), carbon tetrachloride (58), formaldehyde (51), manganese (50), 1,3-butadiene (39), cadmium (38), tetrachloroethylene (20), *p*-dichlorobenzene (17), and hexachloro-1,3-butadiene (9). It's important to note that the S4MO site sampled for carbonyls, VOC, and metals, and that this is reflected in the site's pollutants of interest.

Also listed in Table 13-2 are the total number of detects and the percent detects failing the screen. Of the eleven pollutants of interest, acetaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and hexachloro-1,3-butadiene had 100% of their detects fail the screening values.

13.2 Concentration Averages at the Missouri Monitoring Site

Three types of concentration averages were calculated for the eleven pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 13-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at S4MO, formaldehyde measured the highest concentration by mass (3.72 ± 0.63 μg/m^3), followed by acetaldehyde (2.70 ± 0.28 μg/m^3) and benzene (1.15 ± 0.10 μg/m^3). Formaldehyde and acetaldehyde concentrations were the highest in summer and

spring. Carbon tetrachloride concentrations tended to be higher in summer and autumn. The remaining concentrations did not vary much by season. Acetaldehyde, arsenic, benzene, cadmium, formaldehyde, and manganese were detected in every sample taken at S4MO, while *p*-dichlorobenzene and hexachloro-1,3-butadiene were detected in less than one-half of the samples taken.

13.3 Non-chronic Risk Evaluation at the Missouri Monitoring Site

Non-chronic risk for the concentration data at S4MO was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the eighteen pollutants with at least one failed screen, only acrolein exceeded the acute risk values, and its non-chronic risk is summarized in Table 13-4.

All five acrolein detects were greater than the ATSDR acute risk value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$. The average detected concentration was 1.00 ± 0.40 $\mu g/m^3$, which is more than five times the California REL value. As discussed in Sections 3.1.5, acrolein concentrations could only be measured beginning July 2005, and a valid seasonal average could potentially be calculated for autumn only. However, a valid seasonal average needs at least 7 detects, as stated in Section 13.2, and acrolein was detected only five times. Therefore, no seasonal averages could be calculated for acrolein, and intermediate risk could not be evaluated.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Figure 13-3 is a pollution rose for acrolein at S4MO. The pollution rose is a plot of daily concentration and daily average wind direction. As indicated in Figure 13-3, all acrolein concentrations exceeded the acute risk factors, indicated by a dashed (CalEPA REL) and solid line (ATSDR MRL). The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources. The highest concentration of acrolein occurred

on October 25, 2005 with a northwesterly wind. S4MO is located in downtown St. Louis and is wedged between I-70 and another major roadway.

13.4 Meteorological and Concentration Analysis at the Missouri Site

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

13.4.1 Pearson Correlation Analysis

Table 13-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the S4MO monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) Moderately strong to strong positive correlations were calculated for acetaldehyde, carbon tetrachloride, formaldehyde, and *p*-dichlorobenzene and maximum, average, dew point, and wet bulb temperatures. Aside from 1,3-butadiene and hexachloro-1,3-butadiene, the pollutants of interest exhibited negative correlations with the *u*-component of the wind, albeit weak. With the exception of hexachloro-1,3-butadiene, the pollutants of interest exhibited positive correlations with the *v*-component of the wind, and many of these were moderately strong. This indicates that concentrations of the pollutants of interest can be influenced by wind direction. The remaining correlations were generally weak.

13.4.2 Composite Back Trajectory Analysis

Figure 13-4 is a composite back trajectory map for the S4MO monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site in Figure 13-4 represents 100 miles.

As shown in Figure 13-4, the back trajectories originated from a variety of directions at S4MO, although there is an apparent lack of trajectories from the east. The 24-hour airshed

domain is very large at S4MO, with trajectories originating as far away as central Manitoba, Canada, or over 700 miles away. Nearly 57% of the trajectories originated within 300 miles of the site; and 83% within 400 miles from the S4MO monitoring site. The one trajectory originating from Manitoba occurred on a day when a strong frontal system moved across the central and eastern US on November 24, 2005. This wind pattern is also evident on several composite trajectory maps from other sites in the region including the DEMI, INDEM, NBIL and SPIL, DITN, MAWI, and MIMN monitoring sites.

13.4.3 Wind Rose Analysis

Hourly wind data from the St. Louis Downtown Airport near the S4MO monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 13-5 is the wind rose for the S4MO monitoring site on days sampling occurred. As indicated in Figure 13-5, hourly winds were predominantly out of the south-southeast (11% of observations), southeast (8%), north-northwest (8%), and north (7%) on sample days. Wind speeds tended to range from 7 to 11 knots on day samples were taken (33% of observations). Wind speeds greater than 22 knots were recorded most frequently with northwesterly winds. Calm winds (<2 knots) were observed for 22% of the measurements.

13.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

13.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in St. Louis City and St. Louis County, MO were obtained from the Missouri Department of Revenue and the U.S. Census Bureau, and are summarized in Table 13-6. Table 13-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile

population surrounding the monitor and the vehicle registration ratio. Finally, Table 13-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Compared to other UATMP sites, S4MO has the 7th highest population and the 3rd highest vehicle registration count. S4MO also has one of the highest estimated vehicle registration-to-population ratios. The average daily traffic count falls in the middle of the range compared to other UATMP sites. The S4MO monitoring site is in a residential area and is located in an urban-city center setting.

13.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. At S4MO the benzene-ethylbenzene and xylenes-ethylbenzene ratios (3.08 ± 0.24 and 3.08 ± 0.09, respectively) are identical, except for the confidence interval, as opposed to those of the roadside study (2.85 and 4.55, respectively). The toluene-ethylbenzene ratio (6.61 ± 1.10) is also somewhat higher than those of roadside study (5.85).

13.6 Site-Specific Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. S4MO has been a participant in the UATMP since 2002. Please refer to Figure 13-6. S4MO did not sample for VOC until 2003, therefore only formaldehyde concentrations were available in 2002.

- S4MO's benzene and 1,3-butadiene 2004 concentrations changed little from their 2003 concentrations, but both pollutants' concentrations decreased in 2005.

- When the confidence intervals, represented by the error bars, are taken into account, formaldehyde concentrations have changed little over the period.

13.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 13-7 presents the 1999 NATA results for the census tract where the Missouri monitoring site is located. Only pollutants that "failed" the screens are presented in Table 13-7. Pollutants of interest are bolded.

13.7.1 1999 NATA Summary

The S4MO monitoring site is located in census tract 29510109700. The population for the census tract where the S4MO monitoring site is located was 4,016, which represents about 0.3% of the county population in 2000. In terms of cancer risk, the Top 3 pollutants identified by NATA in the S4MO census tract are benzene (19.27 in-a-million risk), 1,3-butadiene (6.86), and acetaldehyde (5.18). These cancer risks are relatively low when compared to other urban areas, such as near the BAPR and MIMN monitoring sites (71.0 and 39.5 in-a-million, respectively). Acrolein was the only pollutant in the S4MO census tract to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.20, suggesting very little risk for noncancer health affects, with the exception of acrolein.

13.7.2 Annual Average Comparison

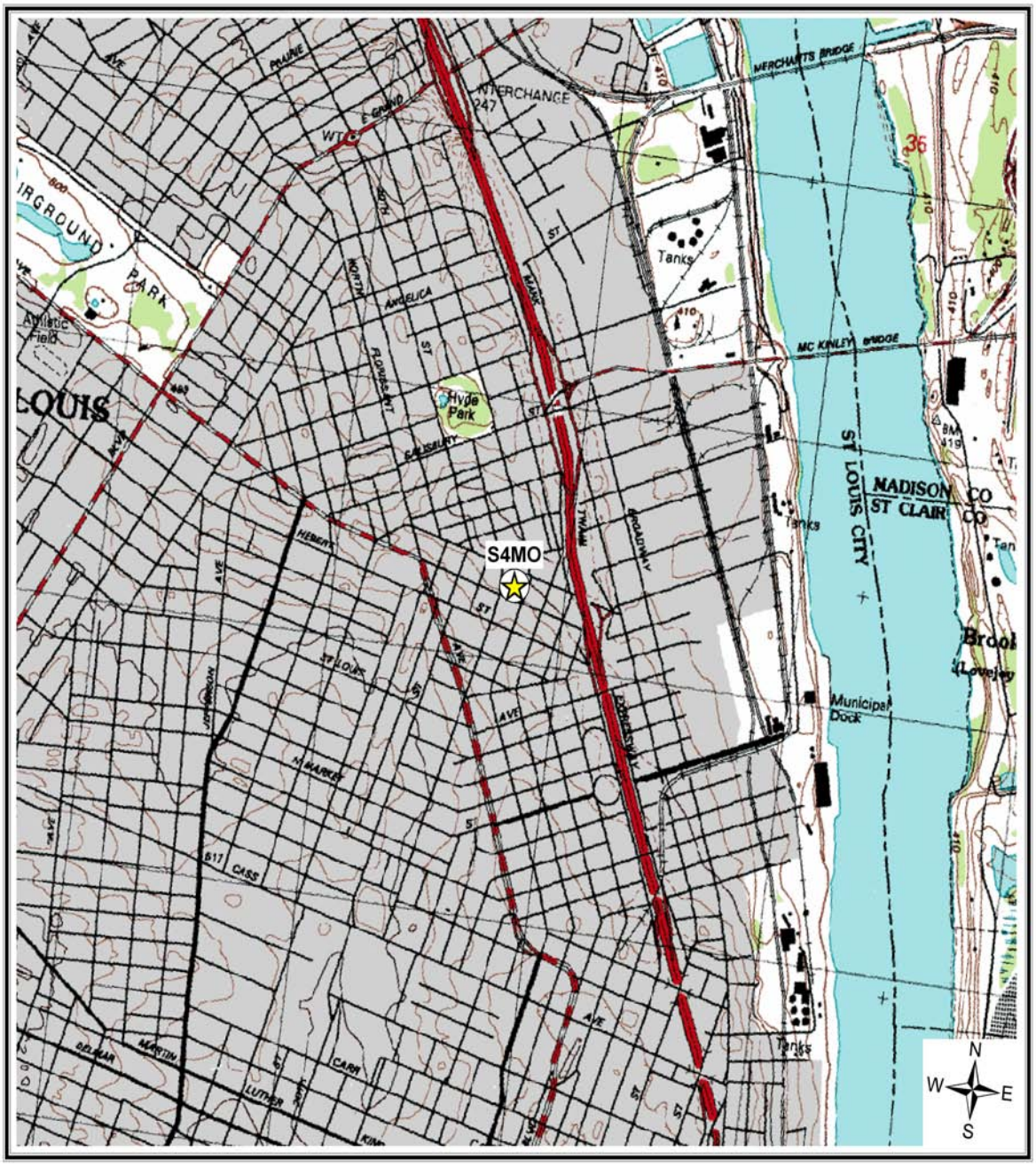
The Missouri monitoring site annual averages are also presented in Table 13-7 for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are

assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 13.2 on how a valid annual average is calculated). With the exception of the metals (cadmium, manganese, and nickel) and hexachloro-1,3-butadiene, all the pollutants were within one order of magnitude from each other. Formaldehyde, total xylenes, acetaldehyde, and benzene are identified as the Top 4 pollutants by mass concentration for the 2005 annual average concentrations, while manganese topped the list for the NATA-modeled concentrations, followed by total xylenes, benzene, and acetaldehyde.

Missouri Pollutant Summary

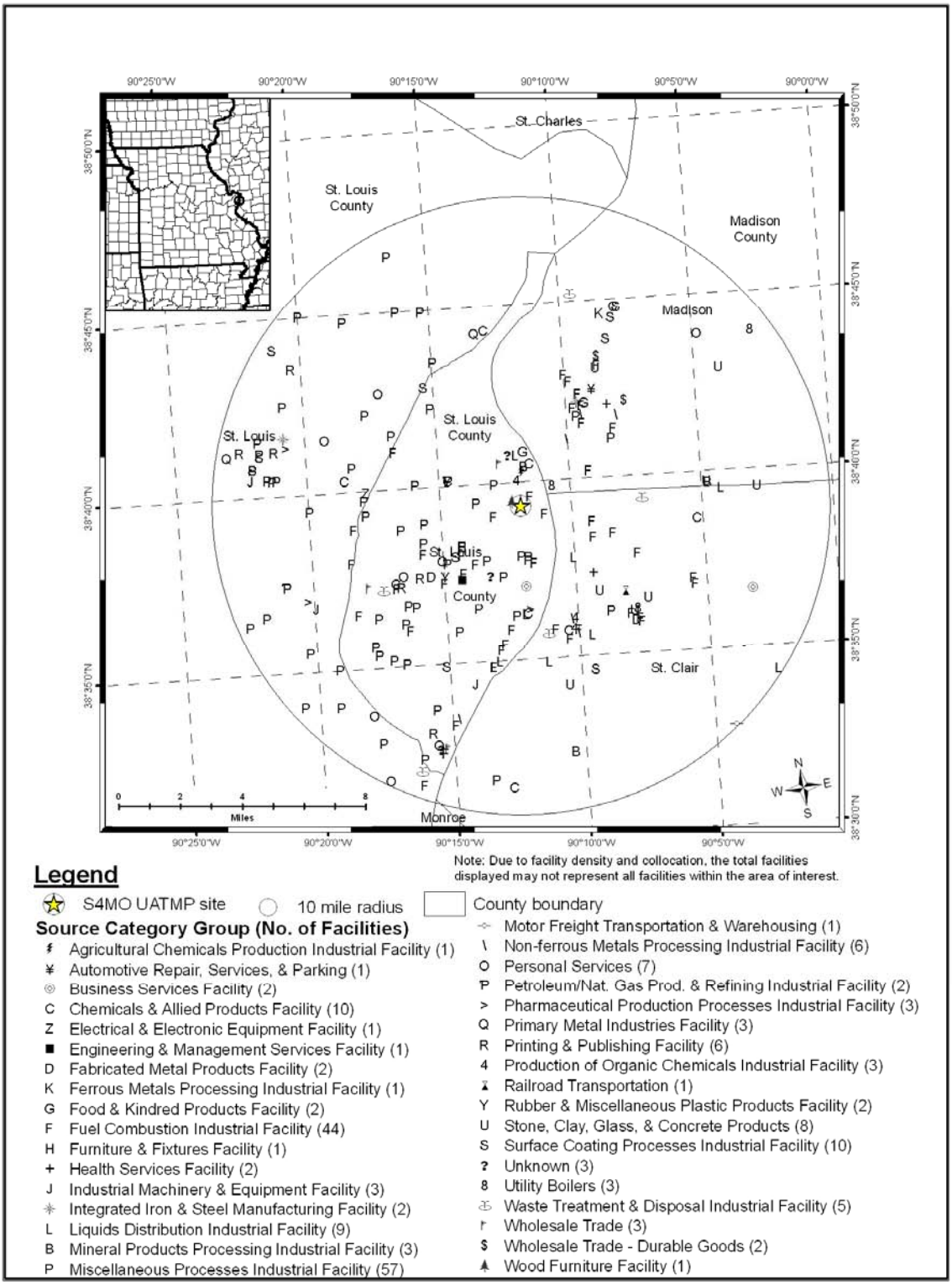
- *The pollutants of interest at the Missouri site are acetaldehyde, arsenic, benzene, 1,3-butadiene, cadmium, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, manganese, p-dichlorobenzene, and tetrachloroethylene.*
- *Formaldehyde measured the highest daily average at S4MO. Formaldehyde and acetaldehyde were highest in spring and summer, while carbon tetrachloride was highest in summer and autumn.*
- *Acrolein was the only pollutant to exceed either of the short-term risk factors.*
- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of all three pollutants appear to have decreased from 2004 to 2005. However, the formaldehyde confidence intervals indicate that this decrease in formaldehyde is not statistically significant.*

Figure 13-1. St. Louis, Missouri (S4MO) Monitoring Site



Source : USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 13-2. Facilities Located Within 10 Miles of S4MO



Legend

Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

S4MO UATMP site

10 mile radius

County boundary

Source Category Group (No. of Facilities)

- ⸗ Agricultural Chemicals Production Industrial Facility (1)
- ¥ Automotive Repair, Services, & Parking (1)
- ◎ Business Services Facility (2)
- C Chemicals & Allied Products Facility (10)
- Z Electrical & Electronic Equipment Facility (1)
- ■ Engineering & Management Services Facility (1)
- D Fabricated Metal Products Facility (2)
- K Ferrous Metals Processing Industrial Facility (1)
- G Food & Kindred Products Facility (2)
- F Fuel Combustion Industrial Facility (44)
- H Furniture & Fixtures Facility (1)
- \+ Health Services Facility (2)
- J Industrial Machinery & Equipment Facility (3)
- ✳ Integrated Iron & Steel Manufacturing Facility (2)
- L Liquids Distribution Industrial Facility (9)
- B Mineral Products Processing Industrial Facility (3)
- P Miscellaneous Processes Industrial Facility (57)
- ⸗ Motor Freight Transportation & Warehousing (1)
- \ Non-ferrous Metals Processing Industrial Facility (6)
- O Personal Services (7)
- Ꝑ Petroleum/Nat. Gas Prod. & Refining Industrial Facility (2)
- > Pharmaceutical Production Processes Industrial Facility (3)
- Q Primary Metal Industries Facility (3)
- R Printing & Publishing Facility (6)
- 4 Production of Organic Chemicals Industrial Facility (3)
- ⧗ Railroad Transportation (1)
- Y Rubber & Miscellaneous Plastic Products Facility (2)
- U Stone, Clay, Glass, & Concrete Products (8)
- S Surface Coating Processes Industrial Facility (10)
- ? Unknown (3)
- 8 Utility Boilers (3)
- ⛢ Waste Treatment & Disposal Industrial Facility (5)
- r Wholesale Trade (3)
- $ Wholesale Trade - Durable Goods (2)
- ▲ Wood Furniture Facility (1)

Figure 13-3. Acrolein Pollution Rose at S4MO

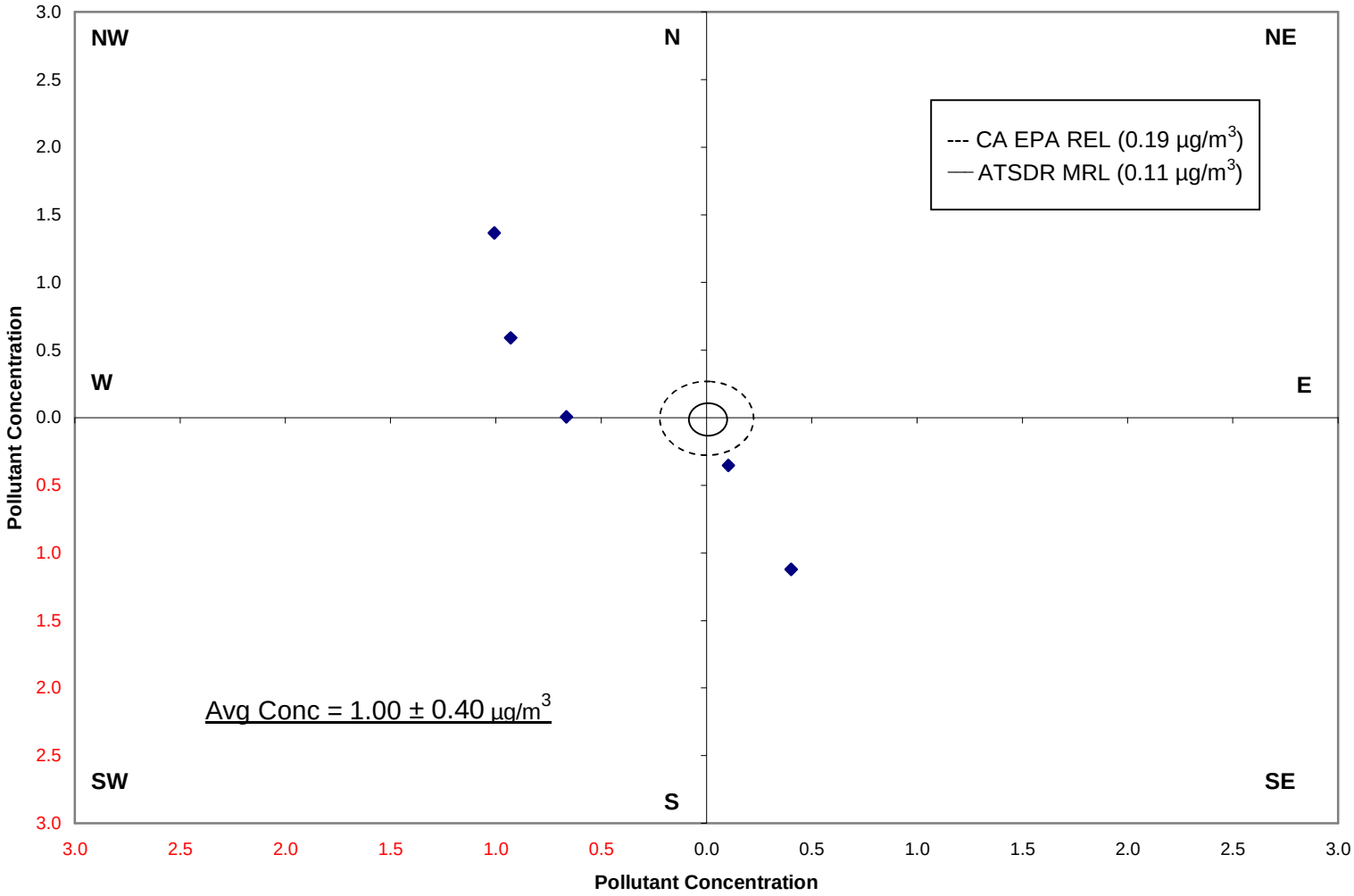


Figure 13-4. Composite Back Trajectory Map for S4MO

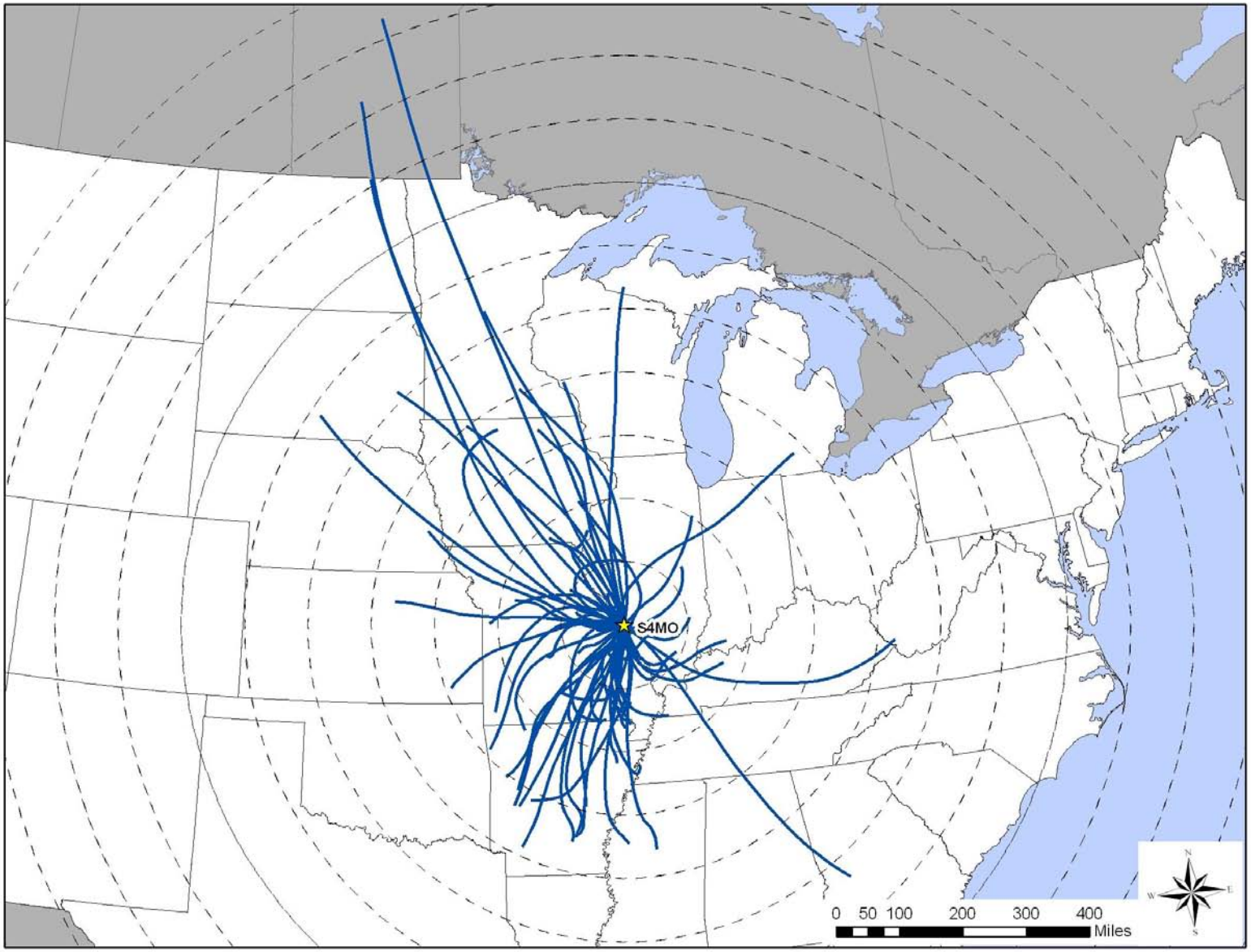


Figure 13-5. Wind Rose of Sample Days for the S4MO Monitoring Site

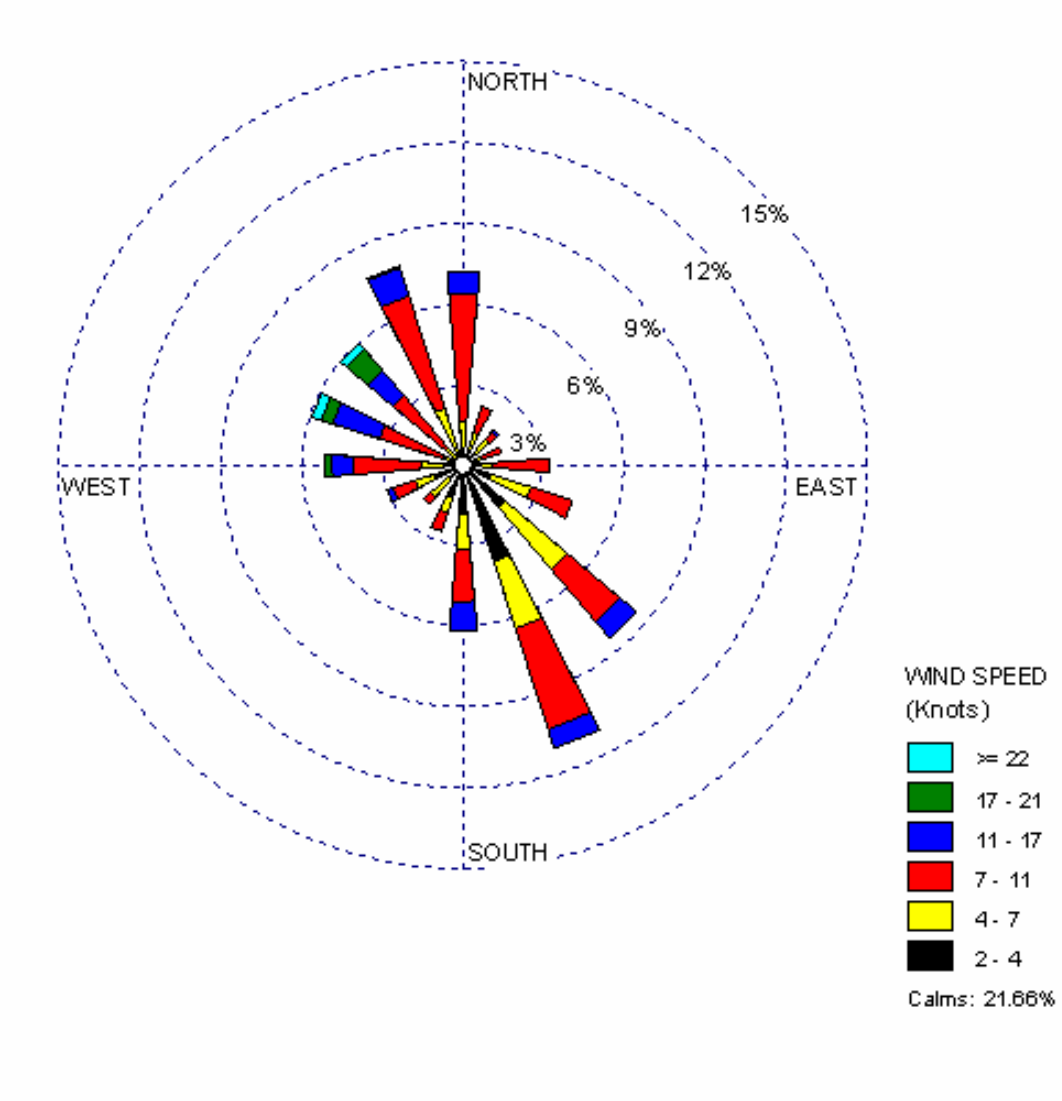


Figure 13-6. Comparison of Yearly Averages of the S4MO Monitoring Site

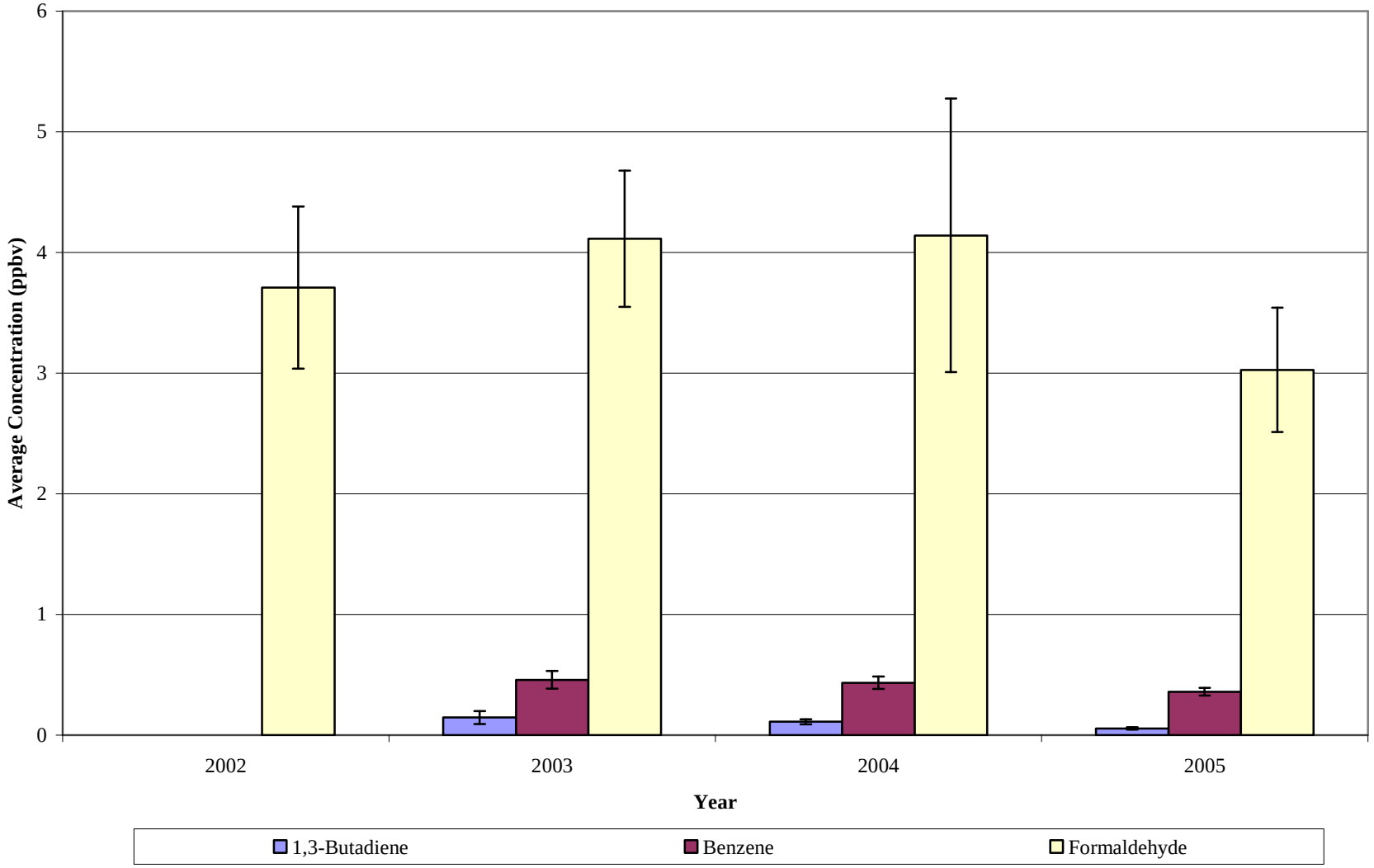


Table 13-1. Average Meteorological Parameters for Monitoring Site in Missouri

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
S4MO	03960	All 2005	67.33 ± 2.11	57.45 ± 1.92	46.85 ± 1.93	51.92 ± 1.77	71.01 ± 1.32	1017.3 ± 0.72	0.64 ± 0.42	-0.21 ± 0.43
		Sample Day	67.93 ± 5.30	58.31 ± 4.67	47.98 ± 4.60	52.79 ± 4.25	72.13 ± 3.25	1017.12 ± 1.74	0.79 ± 1.01	-0.22 ± 1.09

Table 13-2. Comparison of Measured Concentrations and EPA Screening Values at the Missouri Monitoring Site

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
St. Louis, Missouri - S4MO					
Benzene	61	61	100.0	12.7%	12.7%
Acetaldehyde	60	60	100.0	12.5%	25.3%
Arsenic (PM_{10})	60	61	98.4	12.5%	37.8%
Carbon Tetrachloride	58	58	100.0	12.1%	49.9%
Formaldehyde	51	60	85.0	10.6%	60.5%
Manganese (PM_{10})	50	61	82.0	10.4%	71.0%
1,3-Butadiene	39	39	100.0	8.1%	79.1%
Cadmium (PM_{10})	38	61	62.3	7.9%	87.1%
Tetrachloroethylene	20	32	62.5	4.2%	91.2%
p-Dichlorobenzene	17	23	73.9	3.5%	94.8%
Hexachloro-1,3-butadiene	9	9	100.0	1.9%	96.7%
Acrolein	5	5	100.0	1.0%	97.7%
Dichloromethane	3	50	6.0	0.6%	98.3%
Nickel (PM_{10})	3	61	4.9	0.6%	99.0%
1,2-Dichloroethane	2	2	100.0	0.4%	99.4%
Xylenes	1	61	1.6	0.2%	99.6%
Trichloroethylene	1	21	4.8	0.2%	99.8%
Bromomethane	1	30	3.3	0.2%	100.0%
Total	479	755	63.4		

Table 13-3. Daily and Seasonal Averages for Pollutants of Interest at the Missouri Monitoring Site

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
St. Louis, Missouri - S4MO												
1,3-Butadiene	39	61	0.12	0.02	NR	NR	NR	NR	0.09	0.02	0.12	0.03
Acetaldehyde	60	60	2.70	0.28	2.10	0.45	3.28	0.44	3.49	0.57	2.04	0.33
Arsenic (PM_{10})	61	61	0.0023	0.0011	0.0010	0.0003	0.0025	0.0015	0.0045	0.0038	0.0014	0.0004
Benzene	61	61	1.15	0.10	1.20	0.20	1.27	0.26	1.09	0.15	1.05	0.17
Cadmium (PM_{10})	61	61	0.0009	0.0002	0.0006	0.0001	0.0013	0.0006	0.0010	0.0003	0.0008	0.0004
Carbon Tetrachloride	58	61	0.62	0.04	0.49	0.08	0.51	0.06	0.67	0.06	0.72	0.08
Formaldehyde	60	60	3.72	0.63	1.42	0.46	4.77	0.77	6.29	1.10	2.57	0.90
Hexachloro-1,3-butadiene	9	61	0.21	0.07	NR	NR	NR	NR	NR	NR	NR	NR
Manganese (PM_{10})	61	61	0.0135	0.0032	0.0097	0.0046	0.0106	0.0049	0.0151	0.0081	0.0183	0.0061
p-Dichlorobenzene	23	61	0.32	0.13	NR	NR	NR	NR	0.37	0.18	0.21	0.08
Tetrachloroethylene	32	61	0.37	0.25	0.14	0.07	NR	NR	0.47	0.53	0.21	0.07

NR = Not reportable due to the low number of detects.

Table 13-4. Non-Chronic Risk Summary at the Missouri Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
S4MO	TO-15	Acrolein	1.00 ± 0.40	0.11	5	0.19	5	0.09	NR	NR	NR	NR

NR = Not reportable due to the low number of detects.

Table 13-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Missouri Monitoring Site

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
St. Louis, Missouri - S4MO									
1,3-Butadiene	39	-0.11	-0.13	-0.12	-0.14	-0.26	0.26	0.03	-0.33
Acetaldehyde	60	0.46	0.44	0.37	0.40	-0.15	-0.22	0.38	0.00
Arsenic (PM_{10})	61	0.22	0.20	0.22	0.22	0.05	-0.19	0.25	0.03
Benzene	61	-0.11	-0.11	-0.05	-0.09	0.06	-0.11	0.15	-0.14
Cadmium (PM_{10})	61	0.19	0.15	0.12	0.14	-0.02	-0.30	0.37	0.07
Carbon Tetrachloride	58	0.27	0.27	0.27	0.27	0.10	-0.18	0.07	0.11
Formaldehyde	60	0.68	0.66	0.59	0.62	-0.19	-0.21	0.41	-0.01
Hexachloro-1,3-butadiene	9	0.07	0.05	0.11	0.08	0.22	0.26	-0.40	-0.17
Manganese (PM_{10})	61	0.16	0.13	0.10	0.12	-0.03	-0.22	0.22	0.06
p-Dichlorobenzene	23	0.53	0.50	0.44	0.46	-0.21	-0.11	0.21	-0.01
Tetrachloroethylene	32	0.19	0.23	0.28	0.26	0.23	-0.05	-0.08	-0.05

Table 13-6. Motor Vehicle Information for the Missouri Monitoring Site

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
S4MO	1,349,028	1,474,341	1.09	822,941	899,385	22,840

Table 13-7. 1999 NATA Data Census Tract Summary for the Monitoring Site in Missouri

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
St. Louis, Missouri – S4MO, Census Tract 29510109700				
1,2-Dichloroethane	0.10 ± 0.01	0.03	0.91	<0.01
1,3-Butadiene	0.10 ± 0.02	0.23	6.86	0.11
Acetaldehyde	2.70 ± 0.28	2.36	5.18	0.26
Acrolein	NA	0.24	--	11.89
Arsenic (PM_{10})	<0.01	0.10	0.42	<0.01
Benzene	1.15 ± 0.10	2.47	19.27	0.08
Bromomethane	0.13 ± 0.11	0.17	--	0.03
Cadmium (PM_{10})	<0.01	1.54	2.77	0.08
Carbon Tetrachloride	0.60 ± 0.04	0.21	3.17	0.01
Dichloromethane	0.55 ± 0.15	1.10	0.52	<0.01
Formaldehyde	3.72 ± 0.63	2.18	0.01	0.22
Hexachloro-1,3-butadiene	1.03 ± 0.13	<0.01	0.03	<0.01
Manganese (PM_{10})	0.01 ± 0.003	12.02	--	0.24
Nickel (PM_{10})	<0.01	1.29	0.21	0.02
***p*-Dichlorobenzene**	0.23 ± 0.05	0.25	2.77	<0.01
Tetrachloroethylene	0.27 ± 0.14	0.23	1.37	<0.01
Trichloroethylene	0.16 ± 0.02	0.30	0.61	<0.01
Xylenes	2.98 ± 0.45	3.86	--	0.04

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

14.0 Sites in New Jersey

This section presents meteorological, concentration, and spatial trends for the four UATMP sites in New Jersey (CANJ, CHNJ, ELNJ, and NBNJ). The four sites are located in different cities (Camden, Chester, Elizabeth, and New Brunswick, respectively). Figures 14-1 through 14-4 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 14-5 through 14-7 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. CANJ is located on the southwest side of the state, near the PA/NJ border and east of Philadelphia. A number of sources are located mainly to its north and west, most of which are involved in fuel combustion industries. CHNJ is located in the north-central part of New Jersey and has only eight industrial sites nearby, most of which lie just within the ten mile radius from the site. ELNJ and NBNJ are somewhat close to each other, with the outer portions of their ten mile radii intersecting. These two sites are near the New Jersey/New York border, just west of Staten Island, and have a number of sources in the vicinity, most of which are liquid distribution facilities.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to CANJ is Philadelphia International (WBAN 13739); the closest station to CHNJ and NBNJ is Somerville-Somerset Airport (WBAN 54785); and Newark International Airport (WBAN 14734) is the closest weather station to ELNJ.

New Jersey is located in a region that most storm systems track across, allowing its weather to be somewhat variable. However, its proximity to the Atlantic Ocean has a moderating effect on temperature. Hence, summers along the coast tend to be cooler than areas farther inland, while winters tend to be warmer. New Jersey's location also tends to allow for ample annual precipitation and often high humidity. A southwesterly wind is most common in the summer and a northwesterly wind is typical in the winter (Ruffner and Bair, 1987). Table 14-1 presents average meteorological conditions of temperature (average maximum and average),

moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*-components of the wind) for the entire year and on days samples were taken. As shown in Table 14-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

14.1 Pollutants of Interest at the New Jersey Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 14-2 presents the pollutants that failed at least one screen at the New Jersey monitoring sites. The number of pollutants failing the screen varies by site, as indicated in Table 14-2. Sixteen pollutants with a total of 360 measured concentrations failed the screen at CANJ; eleven pollutants with a total of 235 measured concentrations failed the screen at CHNJ; sixteen pollutants with a total of 382 measured concentrations failed the screen at ELNJ; and thirteen pollutants with a total of 320 measured concentrations failed the screen at NBNJ. The pollutants of interest also varied by site, yet the following six pollutants contributed to the top 95% of the total failed screens at each New Jersey monitoring site: acetaldehyde, benzene, 1,3-butadiene, formaldehyde, carbon tetrachloride, and tetrachloroethylene. It's important to note that the New Jersey sites sampled for carbonyl compounds and VOC only, and that this is reflected in each site's pollutants of interest. Also listed in Table 14-2 are the total number of detects and the percent detects failing the screen. One hundred percent of benzene's detects failed the screen at each New Jersey site.

14.2 Concentration Averages at the New Jersey Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average

concentration of all detects. If there are at least seven detects within each season, then a *seasonal* average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the *annual* average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 14-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at CANJ, formaldehyde measured the highest concentration by mass (4.24 ± 1.03 $\mu g/m^3$), followed by acetaldehyde (2.94 ± 0.52 $\mu g/m^3$) and methyl tert-butyl ether (2.42 ± 0.60 $\mu g/m^3$). The seasonal averages of the pollutants of interest at CANJ did not vary much statistically from season to season. The summer formaldehyde average (6.73 ± 3.35 $\mu g/m^3$) appears much higher than the other seasonal averages, but the rather high confidence interval indicates that this average might be driven by a few outliers.

The pollutants with the highest daily averages at CHNJ were acrolein (2.39 ± 0.96 $\mu g/m^3$), formaldehyde (2.39 ± 0.49 $\mu g/m^3$), and acetaldehyde (1.48 ± 0.20 $\mu g/m^3$). Some of the CHNJ pollutants of interest do not have seasonal averages listed in Table 14-3 because there were so few detects. For the pollutants with valid seasonal averages, most of them did not vary much among the seasons. Formaldehyde is the one exception. The summer formaldehyde average (4.55 ± 1.03 $\mu g/m^3$) was higher than the winter, spring, and fall averages (1.47 ± 0.38 $\mu g/m^3$, 1.16 ± 0.19 $\mu g/m^3$, 2.26 ± 0.71 $\mu g/m^3$ respectively).

The pollutants with the highest daily averages at ELNJ were acetaldehyde (5.07 ± 0.65 $\mu g/m^3$), formaldehyde (4.74 ± 0.51 $\mu g/m^3$), and methyl tert-butyl ether (3.75 ± 1.24 $\mu g/m^3$). With the exception of benzene, the pollutants of interest tended to measure their highest concentrations in the summer or fall. However, the seasonal averages at ELNJ did not vary much statistically.

The pollutants with the highest daily averages at NBNJ were acetaldehyde (6.24 ± 0.90 $\mu g/m^3$), formaldehyde (5.39 ± 0.85 $\mu g/m^3$), and acrolein (2.15 ± 0.87 $\mu g/m^3$). The summer acetaldehyde average concentration (10.37 ± 1.70 $\mu g/m^3$) was significantly higher than its other seasonal averages. Formaldehyde appears to follow this trend too, but factoring in the confidence interval shows the difference is not statistically significant.

14.3 Non-chronic Risk Evaluation at the New Jersey Monitoring Sites

Non-chronic risk for the concentration data at New Jersey monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 14-4.

All acrolein detects at the New Jersey sites were greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and all but one of the acrolein detects exceeded the California REL value of 0.19 $\mu g/m^3$. The average detected concentration ranged from 0.87 ± 0.27 $\mu g/m^3$ (at CANJ) to 2.39 ± 0.96 $\mu g/m^3$ (at CHNJ), which are all significantly higher than either acute risk factor. Seasonal averages for acrolein could only be calculated for autumn, and only at CHNJ and NBNJ. Both autumn acrolein averages exceed the ATSDR intermediate risk value.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. For all four New Jersey monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 14-8 through 14-11 are pollution roses for acrolein at the New Jersey sites. A pollution rose is a plot of concentration and wind direction. As shown in Figures 14-8 through 14-11, and discussed above, all but one acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

Figure 14-8 is the acrolein pollution rose for the CANJ monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a pattern consistent with mobile sources, although they most frequently occur with westerly winds. The highest concentration of acrolein occurred on December 24, 2005 with a southwesterly wind. CANJ is wedged between several major thoroughfares, including I-676. Although located in a predominantly residential area, many industrial facilities are located fairly close to the monitoring site.

Figure 14-9 is the acrolein pollution rose for the CHNJ monitoring site. Similar to CANJ, the pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, a pattern consistent with mobile sources. The highest concentration of acrolein occurred on October 7, 2005 with a south-southeasterly wind. Although located in a rural area, the CHNJ monitoring site is located near a main road through town.

Figure 14-10 is the acrolein pollution rose for the ELNJ monitoring site. The pollution rose shows that only one concentration was less than both acute risk factors. Similar to CANJ and CHNJ, acrolein concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions. The highest concentration of acrolein occurred on December 24, 2005 with a south-southwesterly wind. Interestingly, the highest acrolein concentration at CANJ also occurred on this date. ELNJ is located near exit 13 of I-95, which is also where I-278 to Staten Island intersects I-95. The area is also very industrial with a major refinery located just south of the site.

Figure 14-11 is the acrolein pollution rose for the NBNJ monitoring site. Similar to the other New Jersey sites, the pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions. The highest concentration of acrolein occurred on July 27, 2005 with a west-southeasterly wind. Although the NBNJ monitoring site is located in a rural area, it is also wedged between several major roadways. The site is positioned just off a US-1 exit and is just west of the New Jersey Turnpike (I-95).

14.4 Meteorological and Concentration Averages at the New Jersey Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

14.4.1 Pearson Correlation Analysis

Table 14-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the New Jersey monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) At CANJ, the strongest correlations were calculated for hexachloro-1,3-butadiene. However, this pollutant was detected only nine times, and this low number of detects can skew the correlations. Carbon tetrachloride, formaldehyde, methyl *tert*-butyl ether, *p*-dichlorobenzene, and trichloroethylene exhibited moderately strong positive correlations with the maximum, average, dew point, and wet bulb temperatures, while 1,3-butadiene and bromomethane exhibited moderately strong negative correlations with these same parameters. Acrolein, 1,3-butadiene, and benzene exhibited moderately strong correlations with sea level pressure. Most of the correlations with the wind parameters were weak. Aside from hexachloro-1,3-butadiene, the strongest correlation with the *u*-component of the wind was calculated for acrolein (-0.42), and the strongest correlation with the *v*-component of the wind was calculated for trichloroethylene (0.44).

At CHNJ, acrolein and formaldehyde exhibited moderately strong to strong positive correlations with maximum, average, dew point, and wet bulb temperatures, while benzene exhibited moderately strong negative correlations with these same parameters. Moderately strong negative correlations were calculated between 1,3-butadiene and relative humidity, while moderately strong positive correlations were calculated between acrolein, carbon tetrachloride, and hexachloro-1,3-butadiene and relative humidity. Several pollutants exhibited moderately strong correlations with the wind components, indicating that winds influence concentrations of several of the pollutants of interest. Pearson correlations could not be calculated for 1,1,2,2-tetrachloroethane due to the low number of detects (less than 4 detects).

With the exception of 1,3-butadiene and hexachloro-1,3-butadiene, correlations calculated between the pollutants of interest at ELNJ and maximum, average, dew point, and wet bulb temperatures were all positive and tended to be at least moderately strong. Hexachloro-1,3-butadiene's correlations with these same parameters were strong and negative while 1,3-butadiene's were weak. All but one of the pollutants exhibited moderately strong to strong positive correlations with the *v*-component of the wind.

Very strong positive correlations were calculated between acetaldehyde and formaldehyde and the maximum, average, dew point, and wet bulb temperatures at NBNJ. Acrolein and *p*-dichlorobenzene had positive correlations with these parameters as well, but were weaker. Acetaldehyde and formaldehyde also exhibited the strongest correlations with a wind component, the *v*-component (0.44 and 0.42, respectively). Most of the remaining correlations at NBNJ were weak.

14.4.2 Composite Back Trajectory Analysis

Figures 14-12 thru 14-15 are composite back trajectory maps for the New Jersey monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site in Figure 14-12 through Figure 14-15 represents 100 miles.

As shown in Figure 14-12, the back trajectories originated from a variety of directions at CANJ. The 24-hour airshed domain is large, with trajectories originating as far away as southern Wisconsin, or over 700 miles away. Nearly 58% of the trajectories originated within 300 miles of the site; and 82% within 500 miles from the CANJ monitoring site.

As shown in Figure 14-13, the back trajectories originated from a variety of directions at CHNJ. The 24-hour airshed domain is large, with trajectories originating as far away as west-central Wisconsin, or over 800 miles away. Roughly 54% of the trajectories originated within 300 miles of the site; and 80% within 500 miles from the CHNJ monitoring site.

As shown in Figure 14-14, the back trajectories originated from a variety of directions at ELNJ. The 24-hour airshed domain is large, with trajectories originating as far away as central Wisconsin, or over 800 miles away. Nearly 57% of the trajectories originated within 300 miles of the site; and 84% within 500 miles from the ELNJ monitoring site.

As shown in Figure 14-15, the back trajectories originated from a variety of directions at NBNJ. The 24-hour airshed domain is large, with trajectories originating as far away as central Wisconsin, or nearly 800 miles away. Nearly 58% of the trajectories originated within 300 miles of the site; and 84% within 500 miles from the NBNJ monitoring site.

14.4.3 Wind Rose Analysis

Hourly wind data from the weather stations closest to the sites were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 14-16 through 14-19 are the wind roses for the New Jersey monitoring sites on days sampling occurred.

As indicated in Figure 14-16, hourly winds originated from a variety of directions on days samples were taken near CANJ. However, an apparent lack of winds originating from the east and southeast is evident in Figure 14-16. Wind observations were recorded most frequently from the south (9% of observations). In regards to wind speed, 40% of observations ranged from 7 to 11 knots. Calm winds (<2 knots) were recorded for 9% of the hourly measurements.

As indicated in Figure 14-17, hourly winds originated primarily from the north (10% of observations) on days samples were taken near CHNJ. However, a large percentage (49%) of wind observations were calm (<2 knots) at CHNJ, for which direction is negligible. For wind speeds greater than 2 knots, 23% of observations ranged from 7 to 11 kts.

As indicated in Figure 14-18, hourly winds originated primarily from the west (11% of observations, south (10%), and north-northeast (9%) at ELNJ. Similar to CANJ, an apparent

lack of winds originating from the east and southeast is evident in Figure 14-18. In regards to wind speed, 44% of observations ranged from 7 to 11 knots. Calm winds (<2 knots) were recorded for 5% of the hourly measurements.

Similar to CHNJ, hourly winds near NBNJ originated primarily from the north (10% of observations) on days samples were taken, as indicated in Figure 14-19. A large percentage (49%) of wind observations were also calm (<2 knots) at NBNJ, for which direction is negligible. This is reasonable as the weather stations for the CHNJ and NBNJ are both from Somerville-Somerset Airport. For wind speeds greater than 2 knots, 22% of observations ranged from 7 to 11 knots.

14.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

14.5.1 Pearson Correlation Analysis

County level vehicle registration information was not available for Camden, Middlesex, Morris, and Union Counties. Thus, state-level vehicle registration, from the Energy Information Administration (EIA), was allocated to the county level using the county-level population proportion. County-level population information in these counties was obtained from the U.S. Census Bureau, and is summarized in Table 14-6. Table 14-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 14-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

County population and vehicle registration is highest in Middlesex County, where NBNJ is located. Interestingly, the vehicles per person ratios are all very similar. Not surprisingly, the

10-mile population is lowest near CHNJ, the most rural site, and highest near ELNJ, the site closest to Newark and New York City. Ten mile population and estimated vehicle registration is second highest near CANJ, which is located near Philadelphia. The CHNJ and ELNJ sites also have the least and most daily traffic volume passing the sites, respectively. In relation to the other UATMP sites, the county-level populations are mid-range, yet ELNJ and CANJ have the highest and third highest 10-mile radius populations, and highest two estimated vehicle registrations. The ELNJ site's daily traffic count is second only to one of the Chicago sites (SPIL).

14.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. Of the four New Jersey sites, the ELNJ monitoring site ratios most resemble those of the roadside study, although the benzene-ethylbenzene and xylenes-ethylbenzene ratios are closer together at this site than they are for the roadside study (3.37 ± 0.24 and 3.68 ± 0.10 for ELNJ, and 2.85 and 4.55 for the roadside study). This suggests that mobile source emissions are major influences at this site. At CANJ, these two ratios are also very similar (3.84 ± 0.28 and 3.72 ± 0.12, respectively), and the toluene-ethylbenzene ratio is somewhat higher than that of the roadside study (7.92 ± 1.40 vs. 5.85). The benzene-ethylbenzene and xylenes-ethylbenzene ratios are even more similar at NBNJ (2.69 ± 0.33 and 2.70 ± 0.18, respectively). At CHNJ, the benzene-ethylbenzene is higher than the xylenes-ethylbenzene ratio (4.37 ± 0.56 and 3.07 ± 0.13), which is the reverse of the roadside study. Its toluene-ethylbenzene ratio is somewhat lower than that of the roadside study (5.39 ± 0.36 vs. 5.85).

14.6 Trends Analysis

For sites that participated in the UATMP prior to 2004 and are still participating in the 2005 program year (i.e., minimum 3 consecutive years); a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. CANJ has participated in the UATMP since 1994; ELNJ since 1999; and CHNJ and NBNJ since 2001.

- Figure 14-20 is a comparison of concentrations of 1,3-butadiene, benzene, and formaldehyde at CANJ and shows that there has been a lot of variation of the last ten years. The addition of confidence intervals shows that while the average concentrations have changed over the years, the difference has generally not be statistically significant. High formaldehyde concentrations in 2004, 1997, and 1996 may have been driven by outliers, as indicated by the large confidence interval.

- Figure 14-21 shows that formaldehyde concentrations at CHNJ have been decreasing since 2001. The slight increase in 2004 may have been driven by outliers, as indicated by the large confidence interval. Concentrations of benzene and 1,3-butadiene have not changed much since 2001.

- As indicated in Figure 14-22, after two years of decreasing, formaldehyde concentrations began to increase somewhat in 2003 at the ELNJ monitoring site. Benzene and 1,3-butadiene concentrations have not changed significantly since 2000.

- As indicated in Figure 4-23, formaldehyde levels at NBNJ decreased after 2001, but increased in later years. The 2004 increase may have been driven by outliers, as indicated by the large confidence interval. Benzene and 1,3-butadiene concentrations have not changed significantly since 2001.

14.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 14-7 presents the 1999

NATA results for the census tracts where the New Jersey monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 14-7. Pollutants of interest are bolded.

The CANJ monitoring site is located in census tract 34007601500 with a population of 6,424, which represents 1.3% of the Camdem County population in 2000. The CHNJ monitoring site is located in census tract 34027045901, with a population of 1,635, which represents 0.3% of Morris County's 2000 population. ELNJ is located in census tract 34039030100. The population in that census tract in 2000 was 334, or less than 0.1% of Union County's population. Finally, NBNJ is located in census tract 34023006206. In 2000, the population in this census tract was 1,794 or 0.2 % of the Middlesex County population.

14.7.1 1999 NATA Summary

In terms of cancer risk, the top pollutant identified by NATA in each New Jersey census tract is benzene, ranging from 8.08 in-a-million at CHNJ to 26.33 in a million at ELNJ. This benzene cancer risk for ELNJ was the fourth highest cancer risk calculated for a pollutant of interest at any UATMP site. Benzene, acetaldehyde, and 1,3-butadiene (not necessarily in that order) had the highest cancer risks at CANJ, ELNJ, and NBNJ. At CHNJ, the pollutants with the highest cancer risk were benzene, followed by 1,3-butadiene, and carbon tetrachloride. Acrolein was the only pollutant in the New Jersey census tracts to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects), ranging from 3.34 at CHNJ to 35.46 at ELNJ. Most noncancer hazard quotients were less than 0.20, suggesting very little risk for noncancer health affects, with the exception of acrolein.

14.7.2 Annual Average Comparison

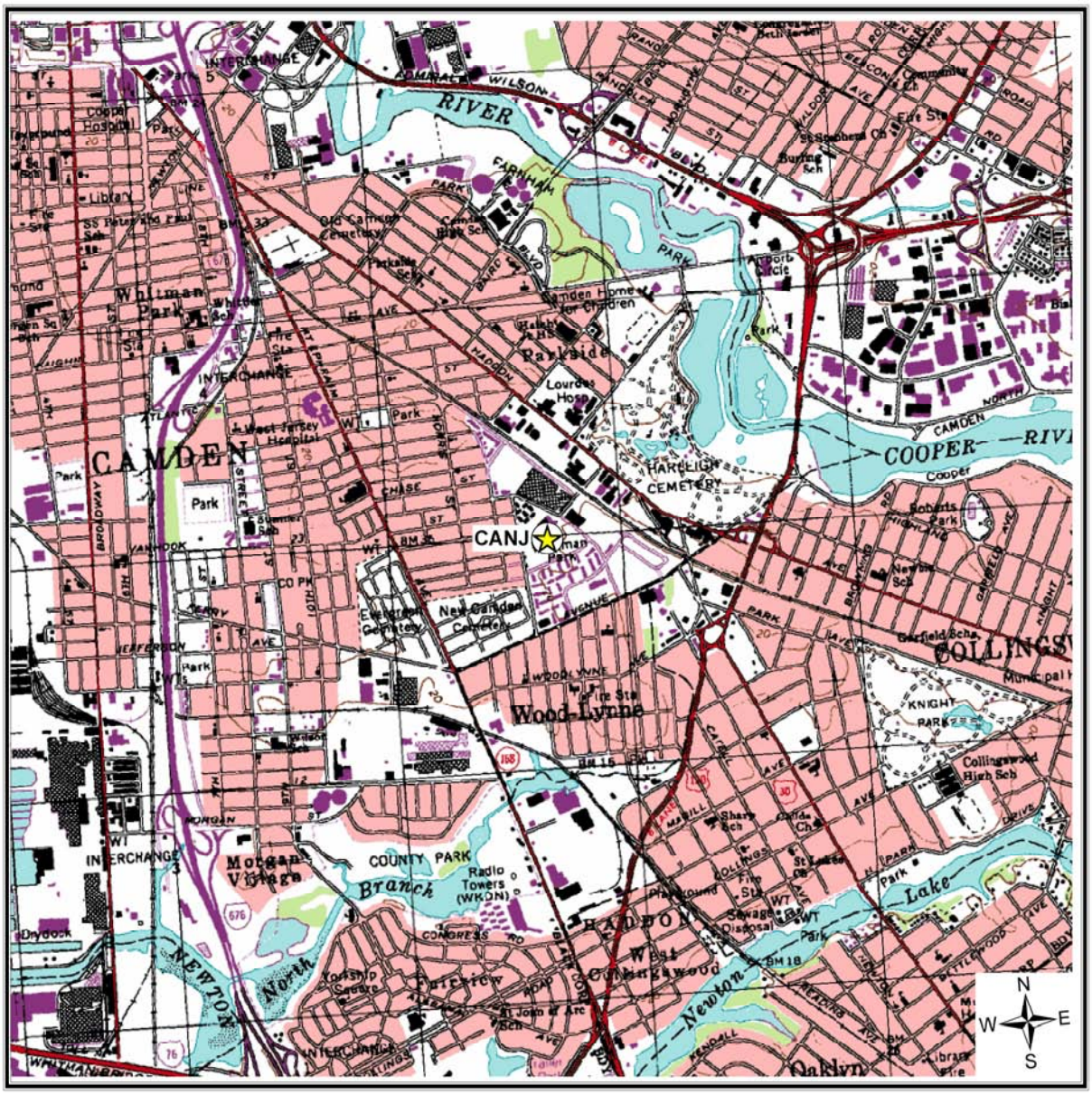
The New Jersey monitoring site annual averages are also presented in Table 14-7 for comparison to the 1999 NATA-modeled concentrations. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 14.2 on how a valid annual average is calculated). With the exception of hexachloro-1,3-butadiene, all the concentrations were within one order of

magnitude from each other. Many of the measured and NATA-modeled concentrations are very similar. At CANJ and ELNJ, the top 4 NATA-modeled concentrations were xylenes, acetaldehyde, formaldehyde, and methyl tert-butyl ether, not necessarily in that order. At CHNJ and NBNJ the top 4 NATA-modeled concentrations were formaldehyde, acetaldehyde, benzene, and dichloromethane, (not necessarily in that order). The pollutants with the highest measured concentrations were formaldehyde and acetaldehyde at CHNJ, ELNJ, and NBNJ. Formaldehyde and total xylenes were highest at CANJ, with acetaldehyde rounding out the top three.

New Jersey Pollutant Summary

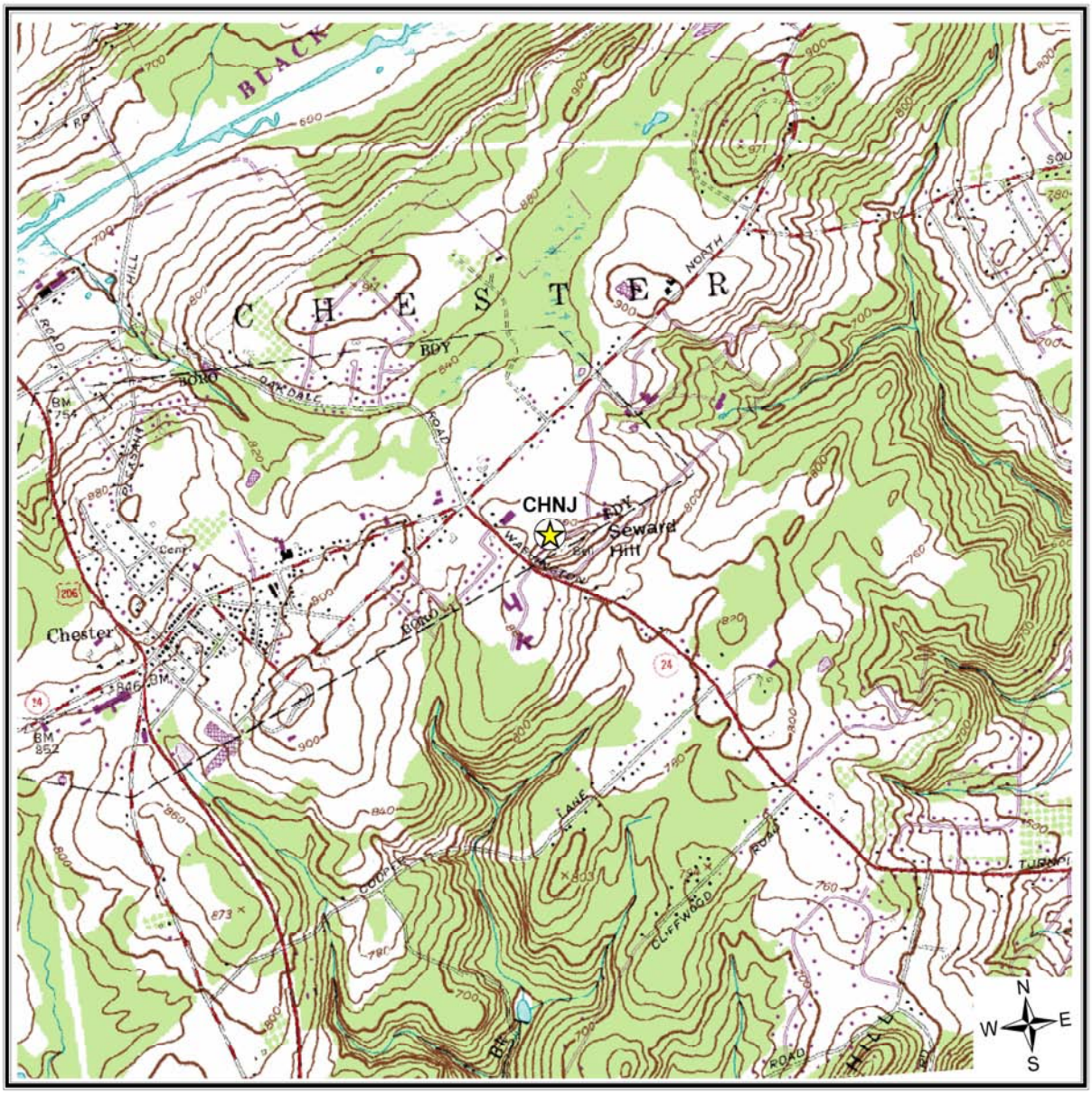
- *The pollutants of interest common to each of the New Jersey sites are acetaldehyde, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.*
- *Formaldehyde and acetaldehyde measured the highest daily averages at CANJ, ELNJ, and NBNJ, while formaldehyde and acrolein measured highest at CHNJ. Formaldehyde was highest in summer at CHNJ, while acetaldehyde was highest in summer at NBNJ.*
- *Acrolein exceeded the short-term risk factors at all four New Jersey sites.*
- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of benzene and 1,3-butadiene have changed little at these sites. Formaldehyde concentrations have been decreasing at CHNJ, increasing at ELNJ and NBNJ, and fluctuating at CANJ.*

Figure 14-1. Camden, New Jersey (CANJ) Monitoring Site



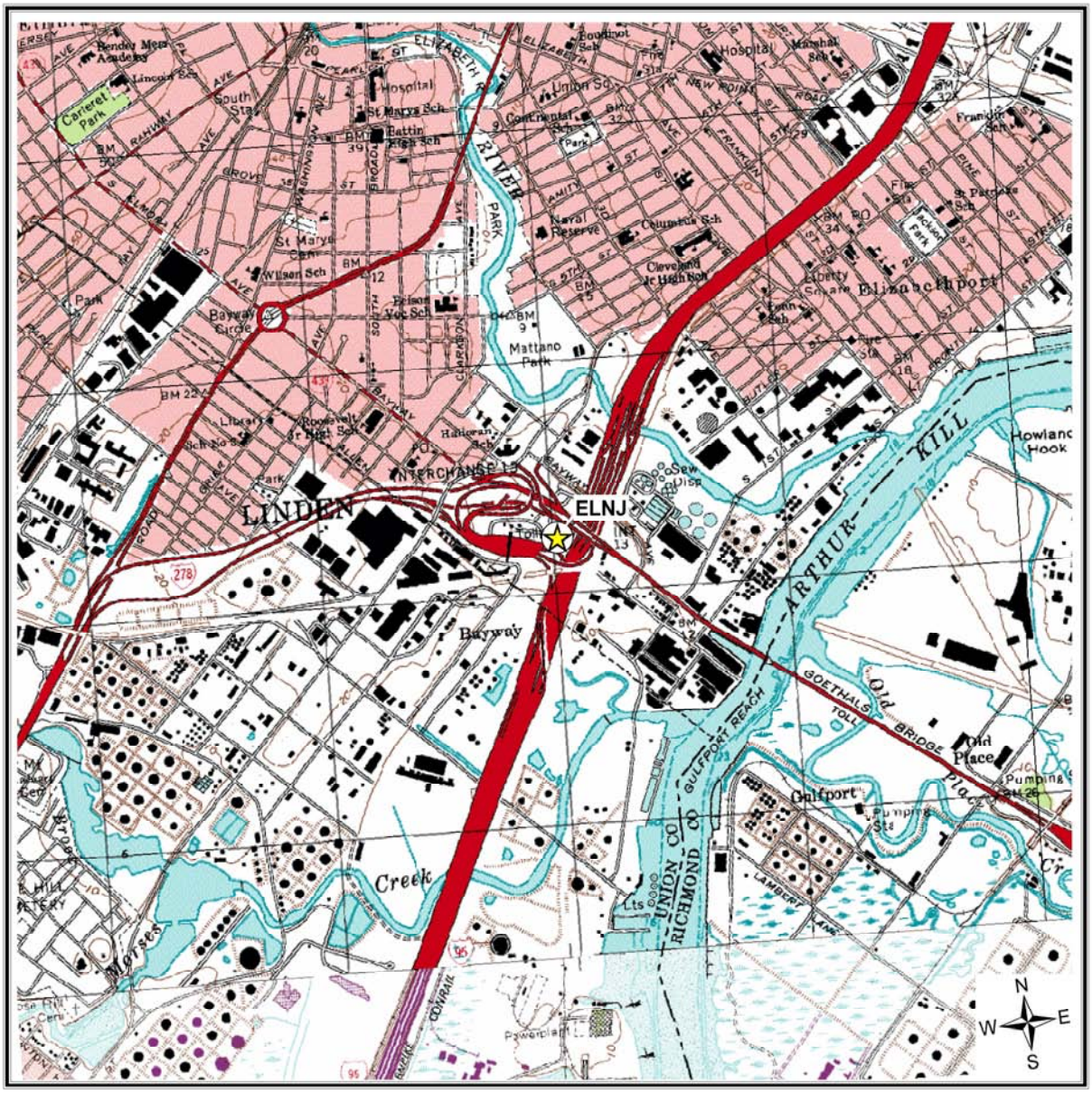
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 14-2. Chester, New Jersey (CHNJ) Monitoring Site



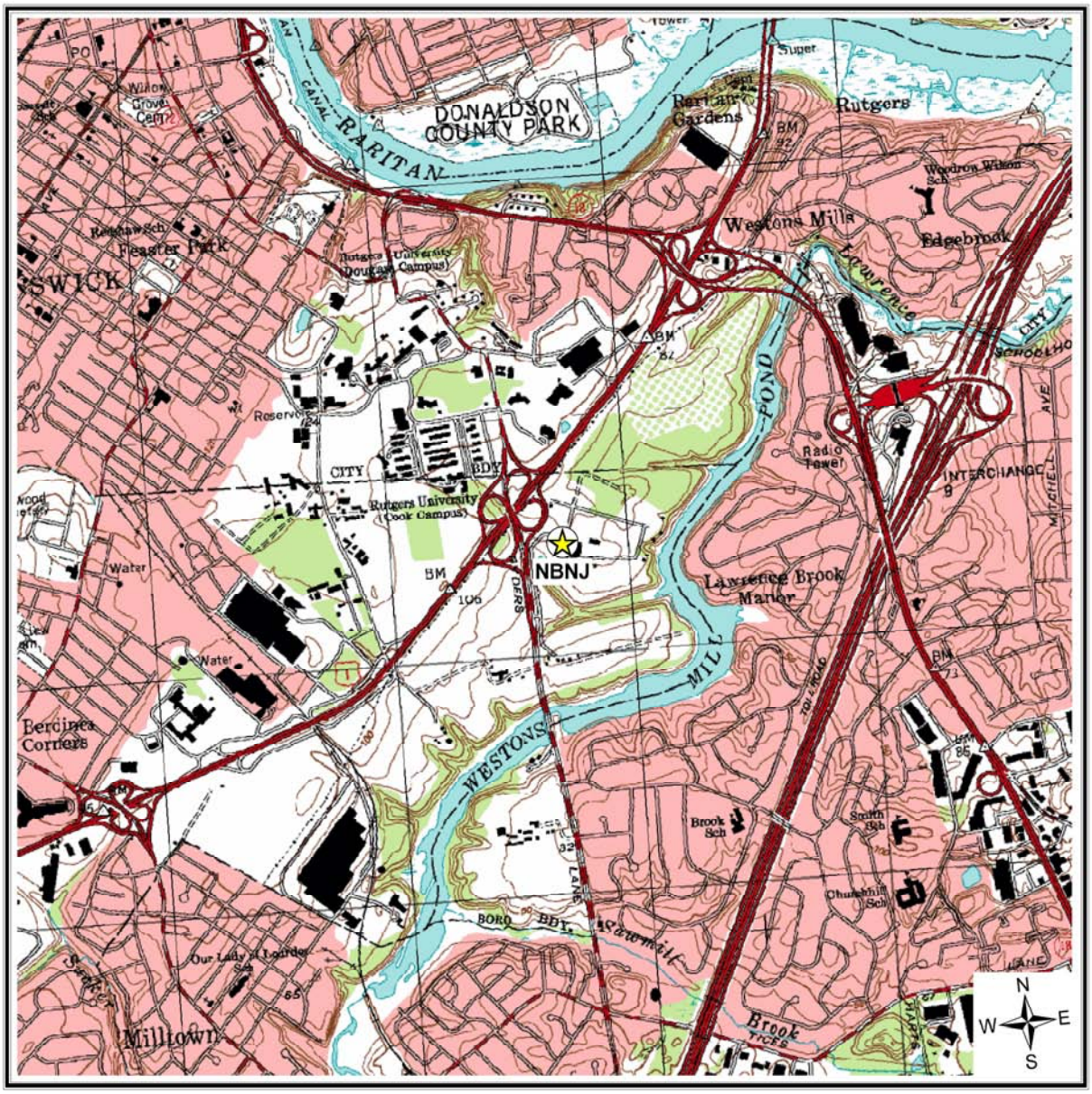
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 14-3. Elizabeth, New Jersey (ELNJ) Monitoring Site



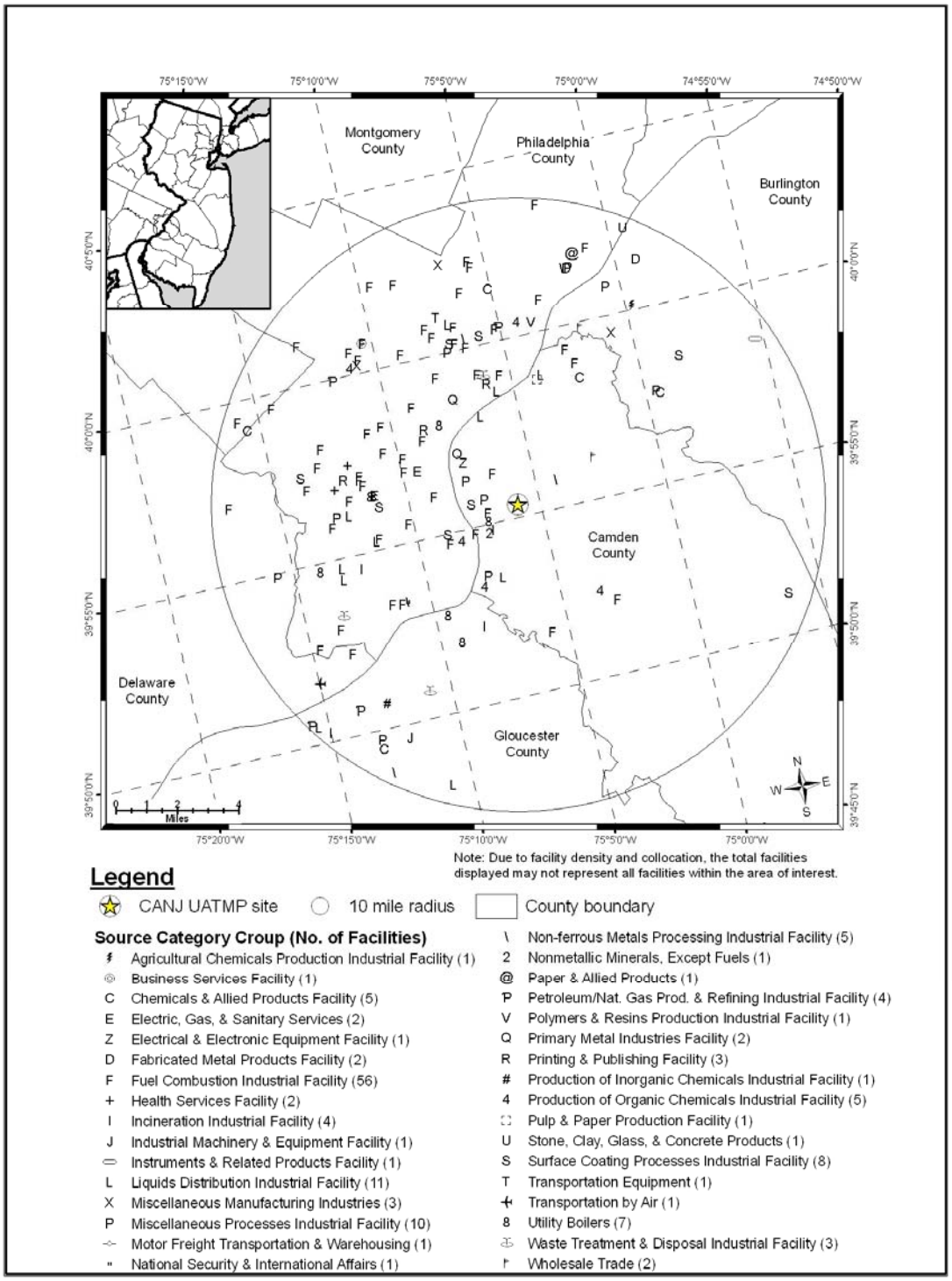
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 14-4. New Brunswick, New Jersey (NBNJ) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 14-5. Facilities Located Within 10 Miles of CANJ



Note: Due to facility density and collocation, the total facilities displayed may not represent all facilities within the area of interest.

Legend

CANJ UATMP site | 10 mile radius | County boundary

Source Category Croup (No. of Facilities)

- Agricultural Chemicals Production Industrial Facility (1)
- Business Services Facility (1)
- C Chemicals & Allied Products Facility (5)
- E Electric, Gas, & Sanitary Services (2)
- Z Electrical & Electronic Equipment Facility (1)
- D Fabricated Metal Products Facility (2)
- F Fuel Combustion Industrial Facility (56)
- \+ Health Services Facility (2)
- I Incineration Industrial Facility (4)
- J Industrial Machinery & Equipment Facility (1)
- Instruments & Related Products Facility (1)
- L Liquids Distribution Industrial Facility (11)
- X Miscellaneous Manufacturing Industries (3)
- P Miscellaneous Processes Industrial Facility (10)
- Motor Freight Transportation & Warehousing (1)
- " National Security & International Affairs (1)
- \ Non-ferrous Metals Processing Industrial Facility (5)
- 2 Nonmetallic Minerals, Except Fuels (1)
- @ Paper & Allied Products (1)
- Petroleum/Nat. Gas Prod. & Refining Industrial Facility (4)
- V Polymers & Resins Production Industrial Facility (1)
- Q Primary Metal Industries Facility (2)
- R Printing & Publishing Facility (3)
- # Production of Inorganic Chemicals Industrial Facility (1)
- 4 Production of Organic Chemicals Industrial Facility (5)
- Pulp & Paper Production Facility (1)
- U Stone, Clay, Glass, & Concrete Products (1)
- S Surface Coating Processes Industrial Facility (8)
- T Transportation Equipment (1)
- Transportation by Air (1)
- 8 Utility Boilers (7)
- Waste Treatment & Disposal Industrial Facility (3)
- Wholesale Trade (2)

Figure 14-6. Facilities Located Within 10 Miles of CHNJ

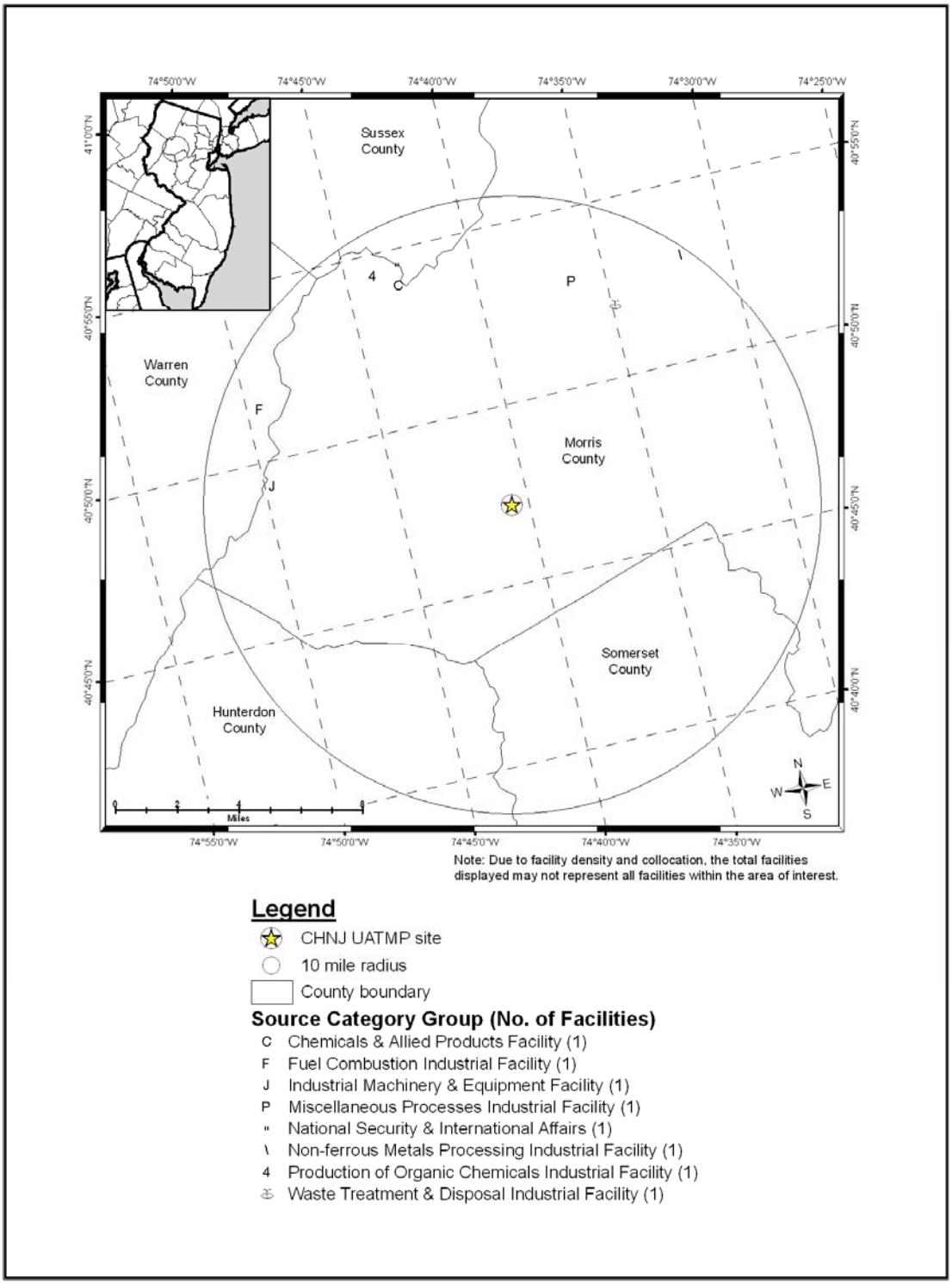


Figure 14-7. Facilities Located Within 10 Miles of ELNJ and NBNJ

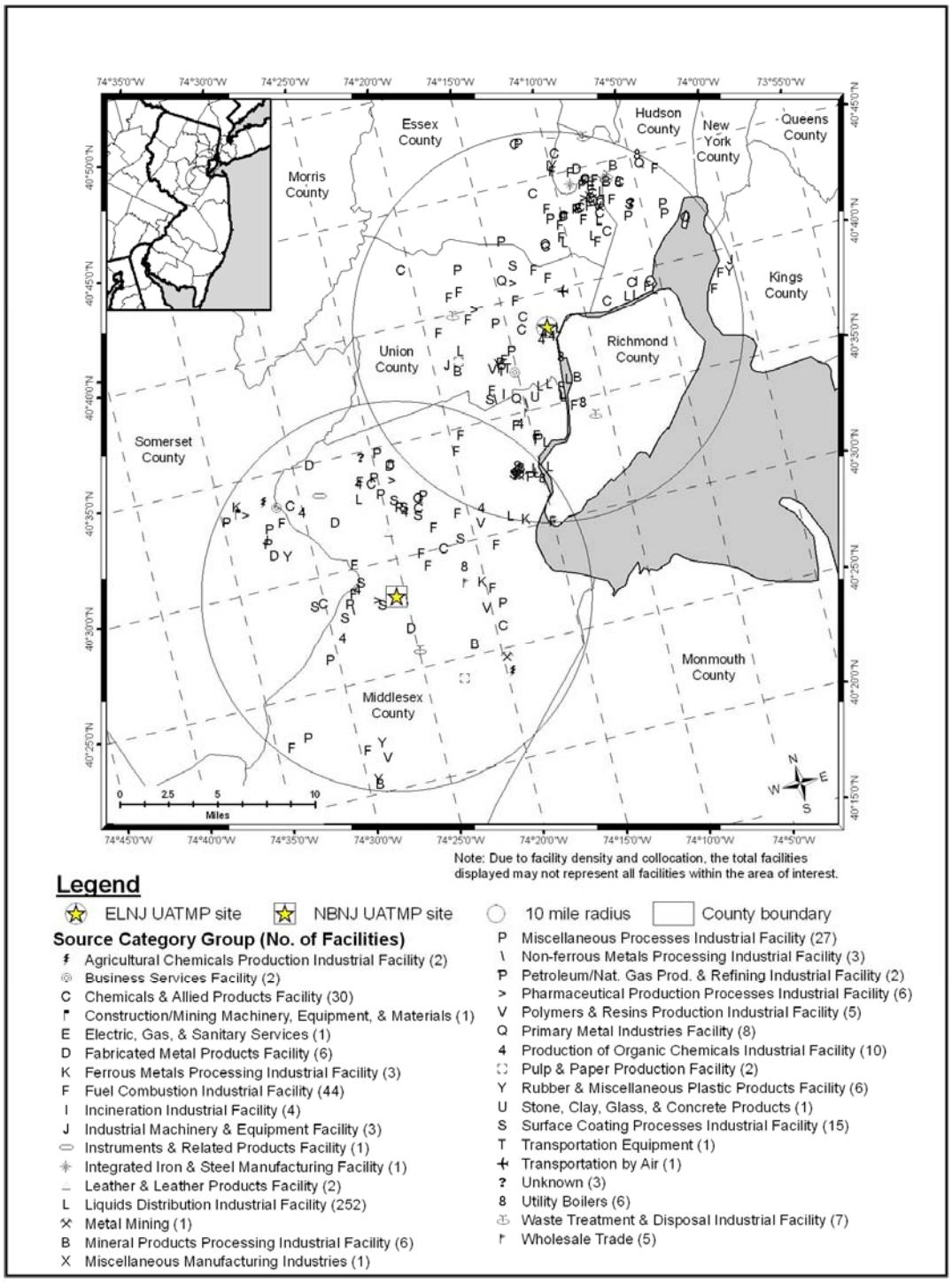


Figure 14-8. Acrolein Pollution Rose at CANJ

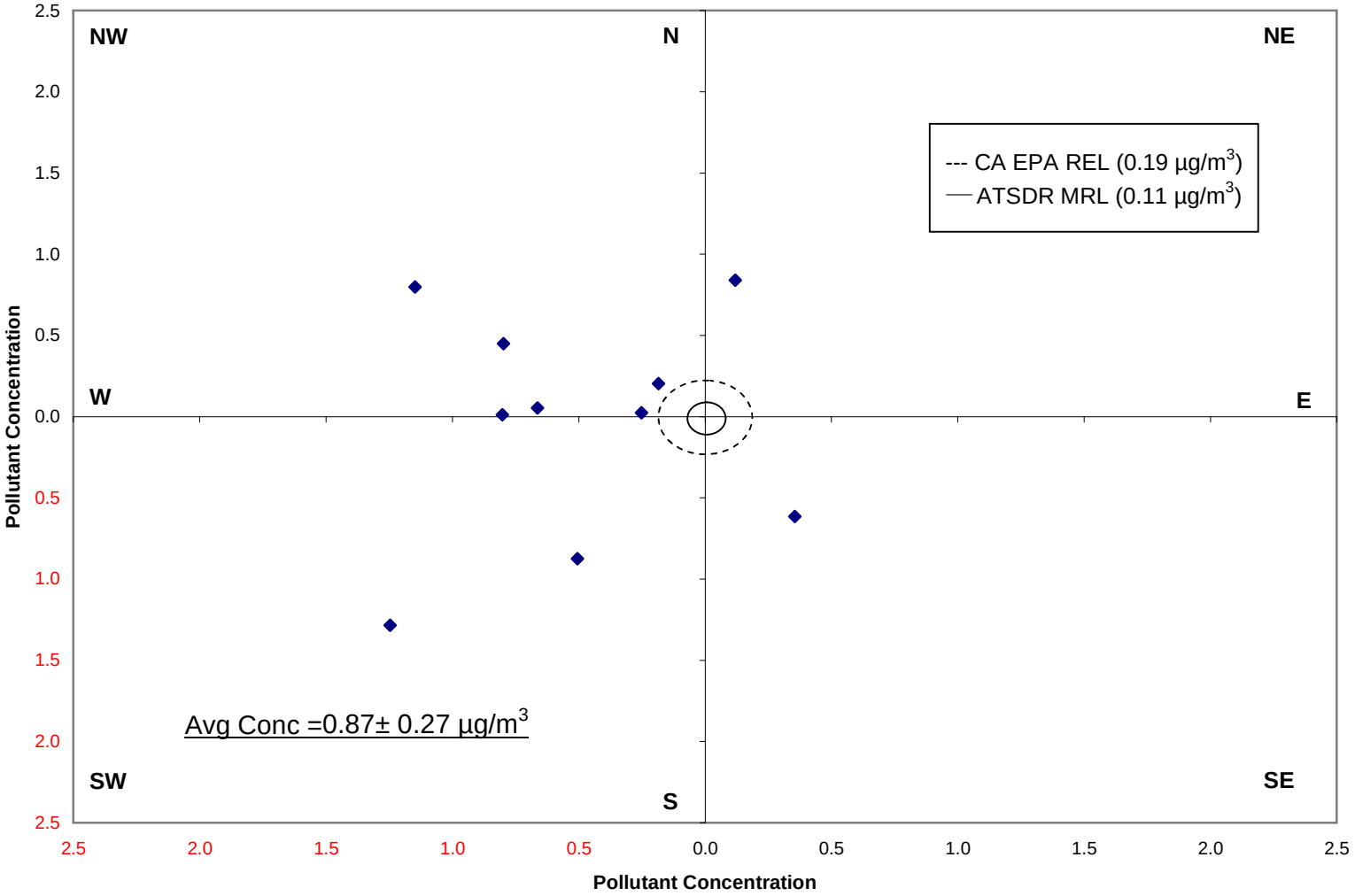


Figure 14-9. Acrolein Pollution Rose at CHNJ

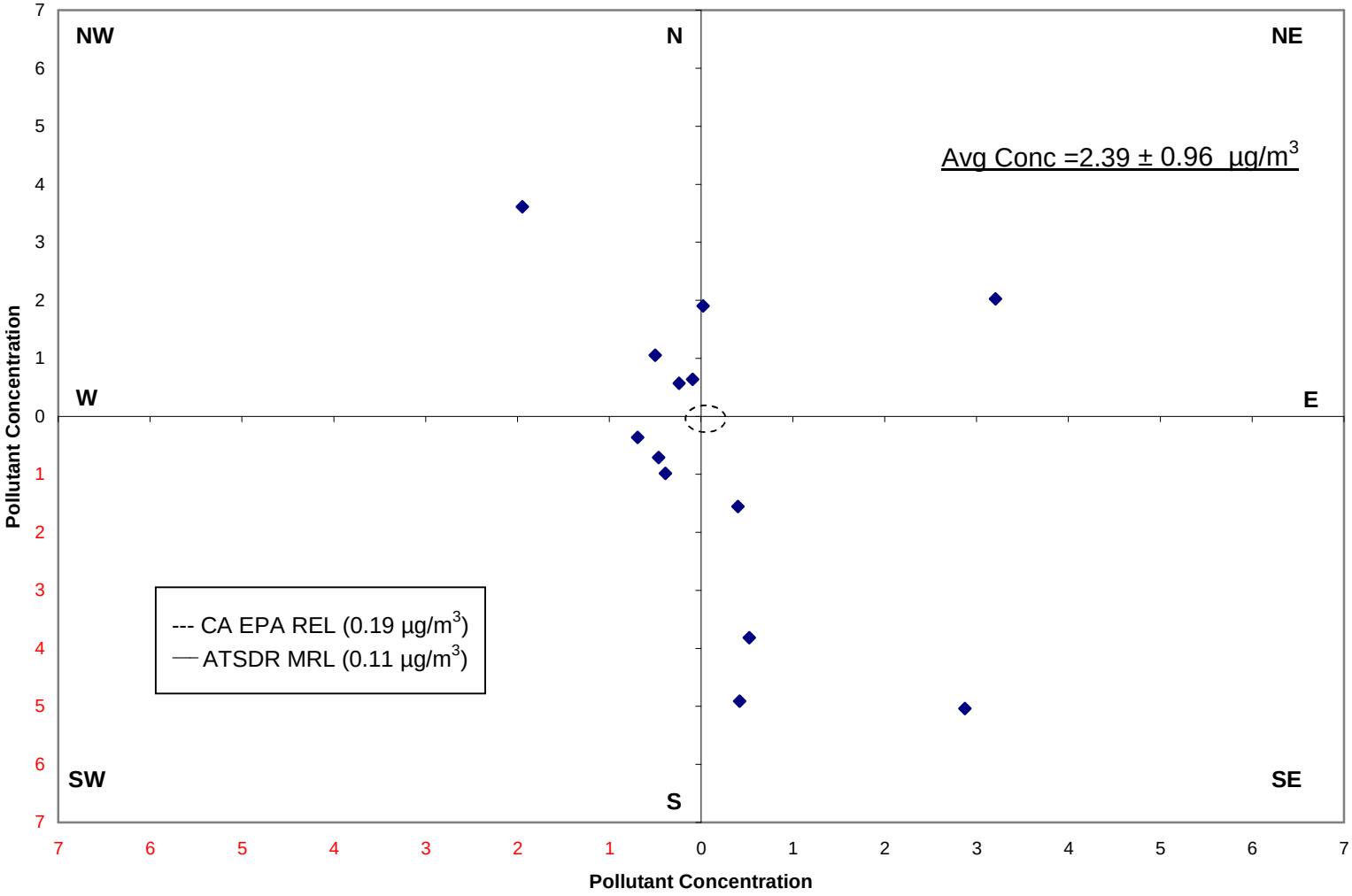


Figure 14-10. Acrolein Pollution Rose at ELNJ

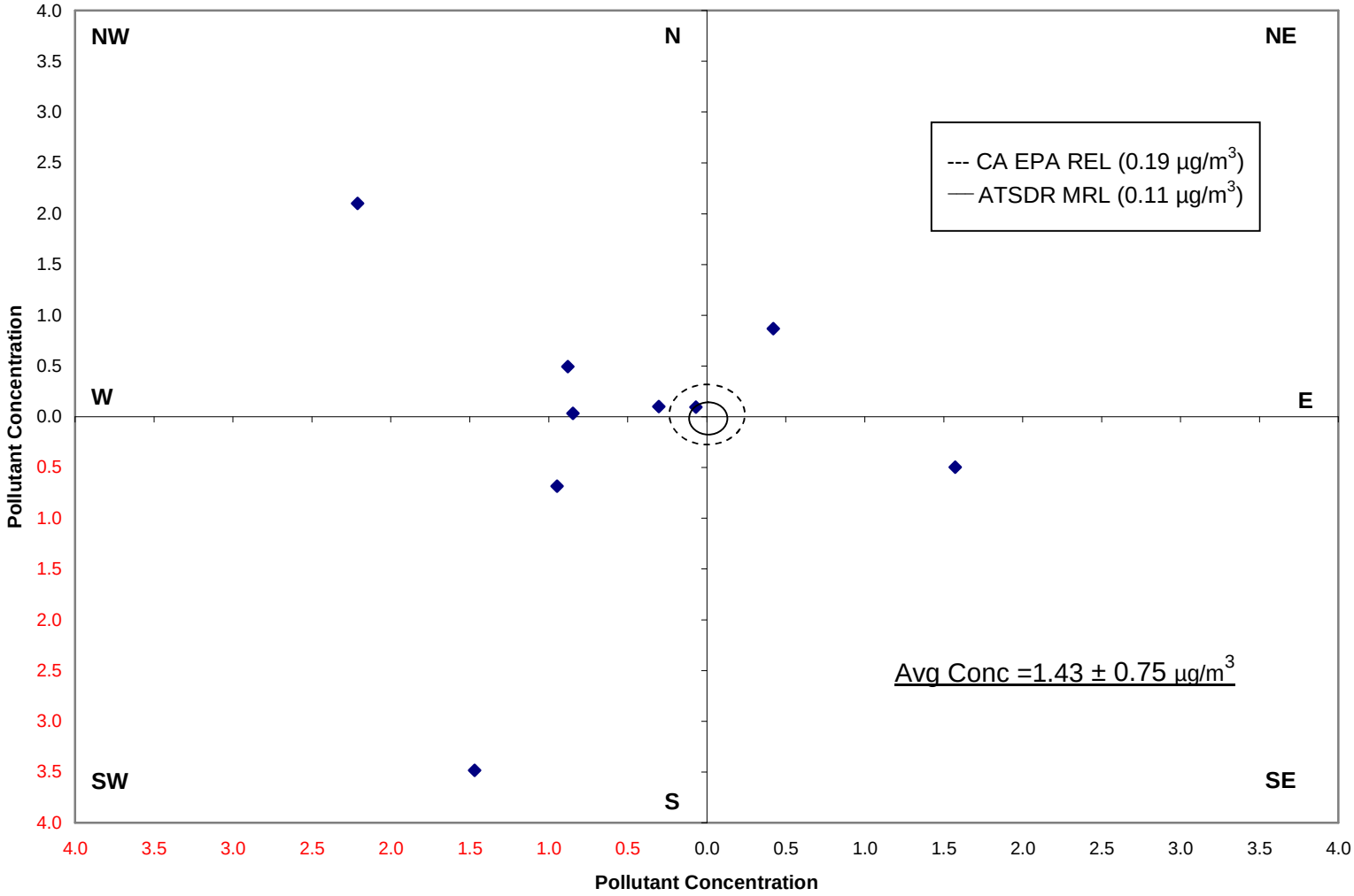


Figure 14-11. Acrolein Pollution Rose at NBNJ

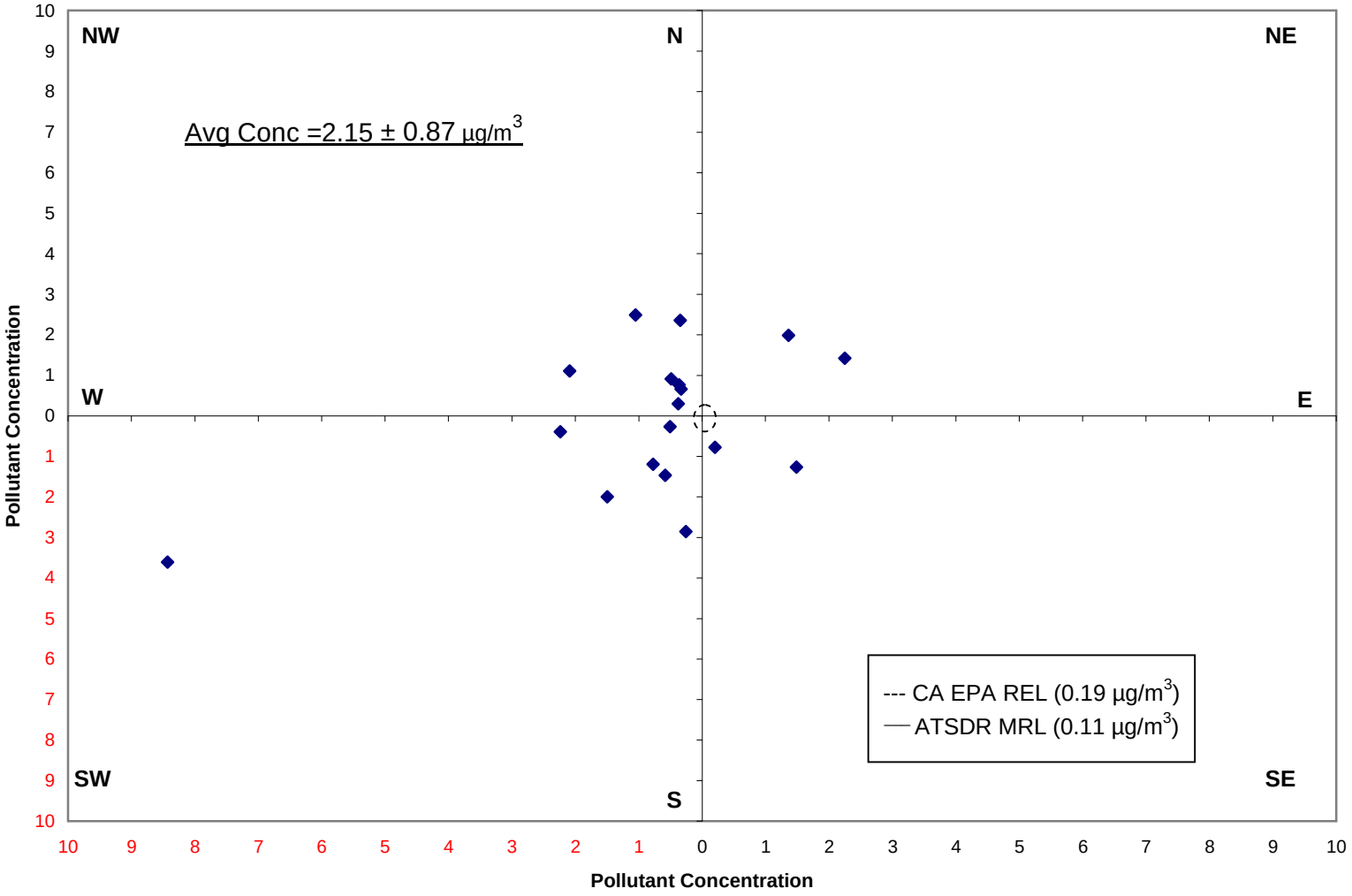


Figure 14-12. Composite Back Trajectory Map for CANJ

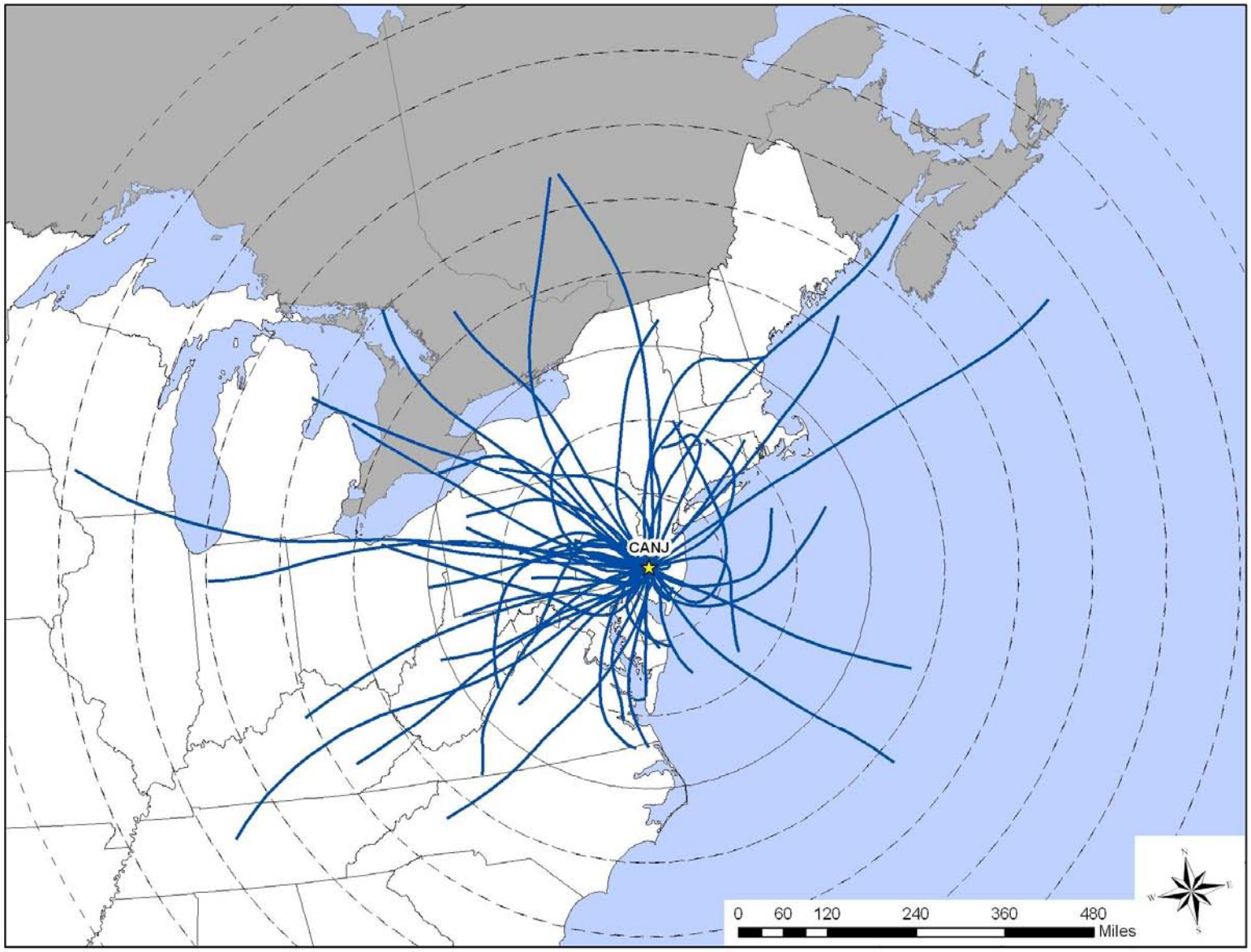


Figure 14-13. Composite Back Trajectory Map for CHNJ

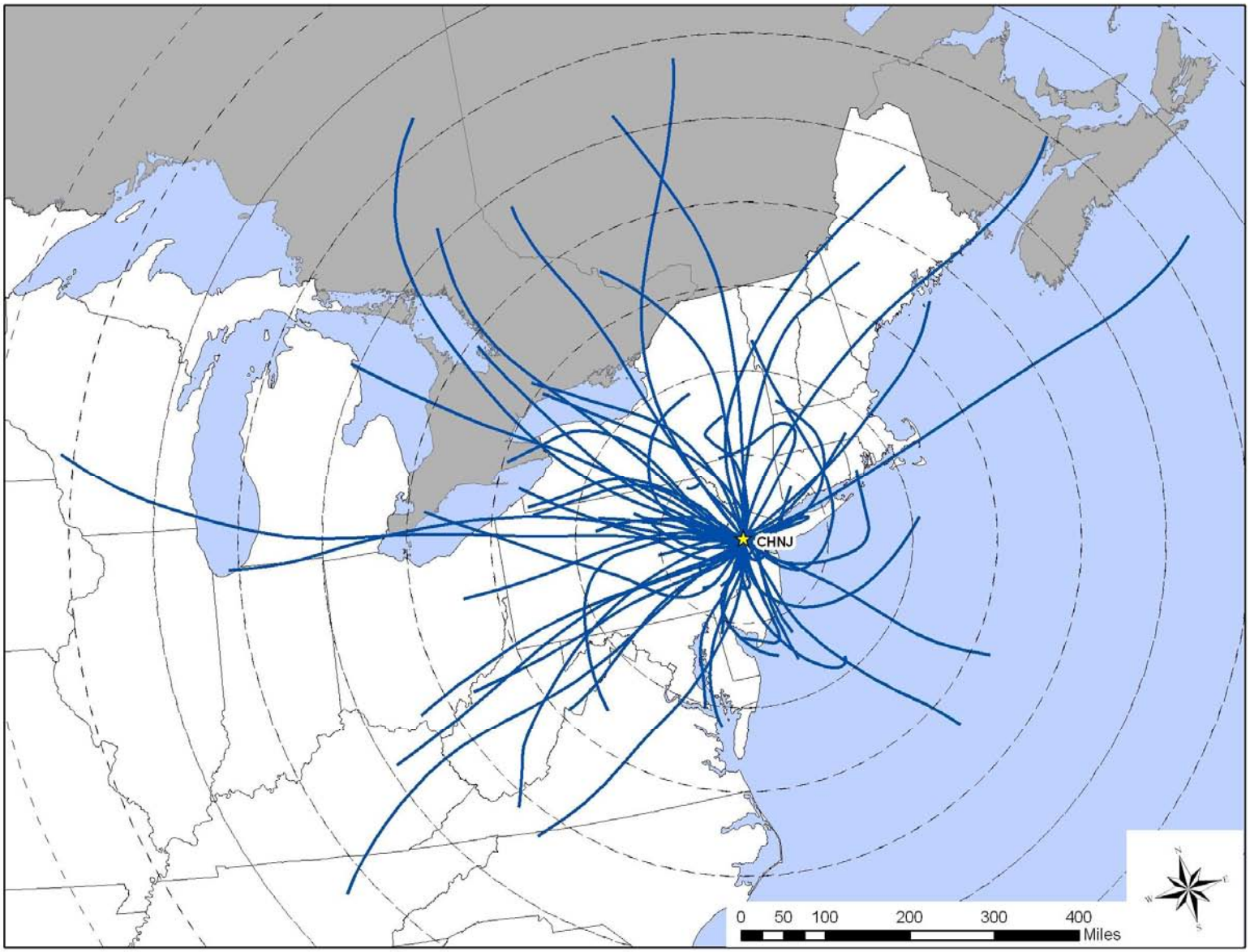


Figure 14-14. Composite Back Trajectory Map for ELNJ

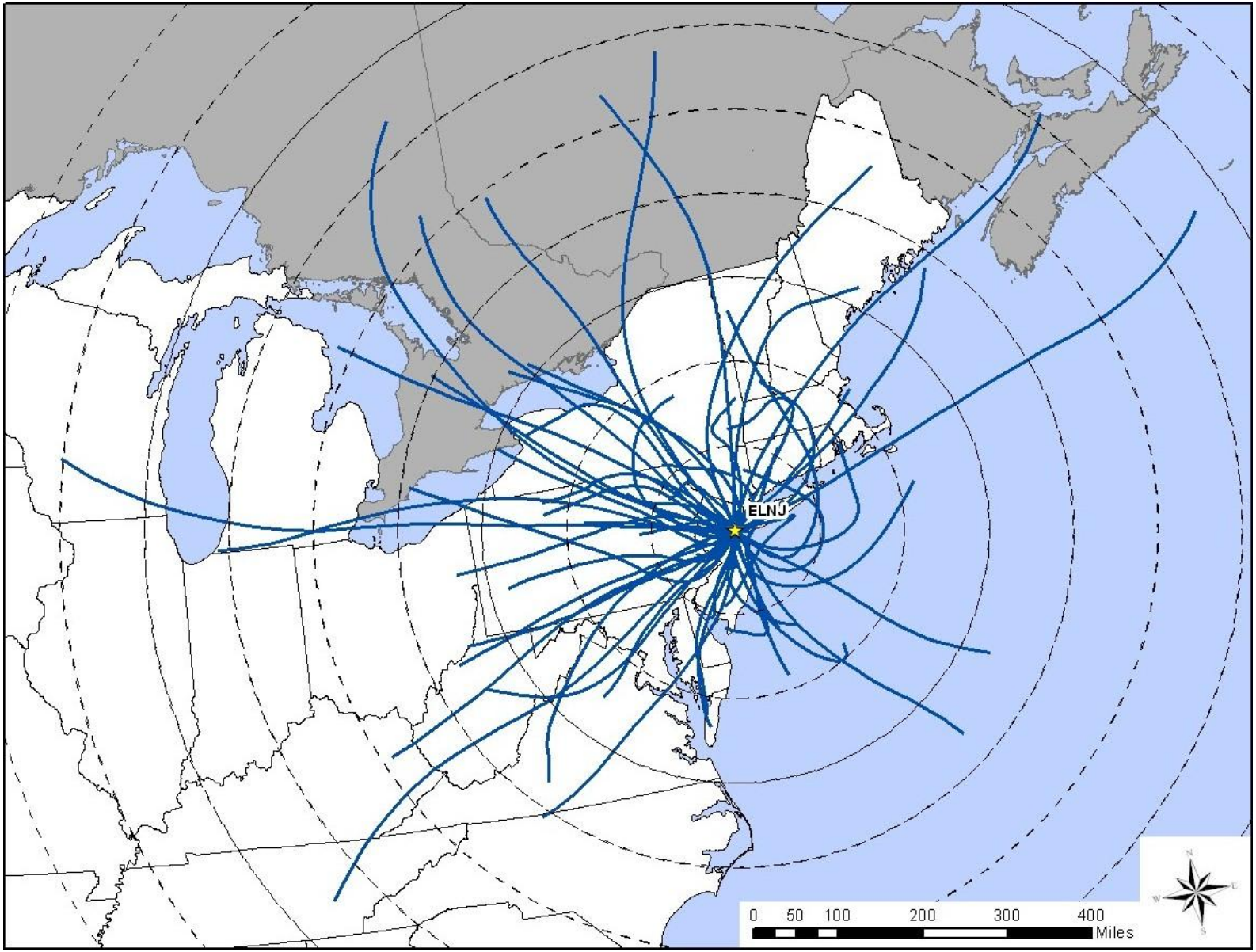


Figure 14-15. Composite Back Trajectory Map for NBNJ

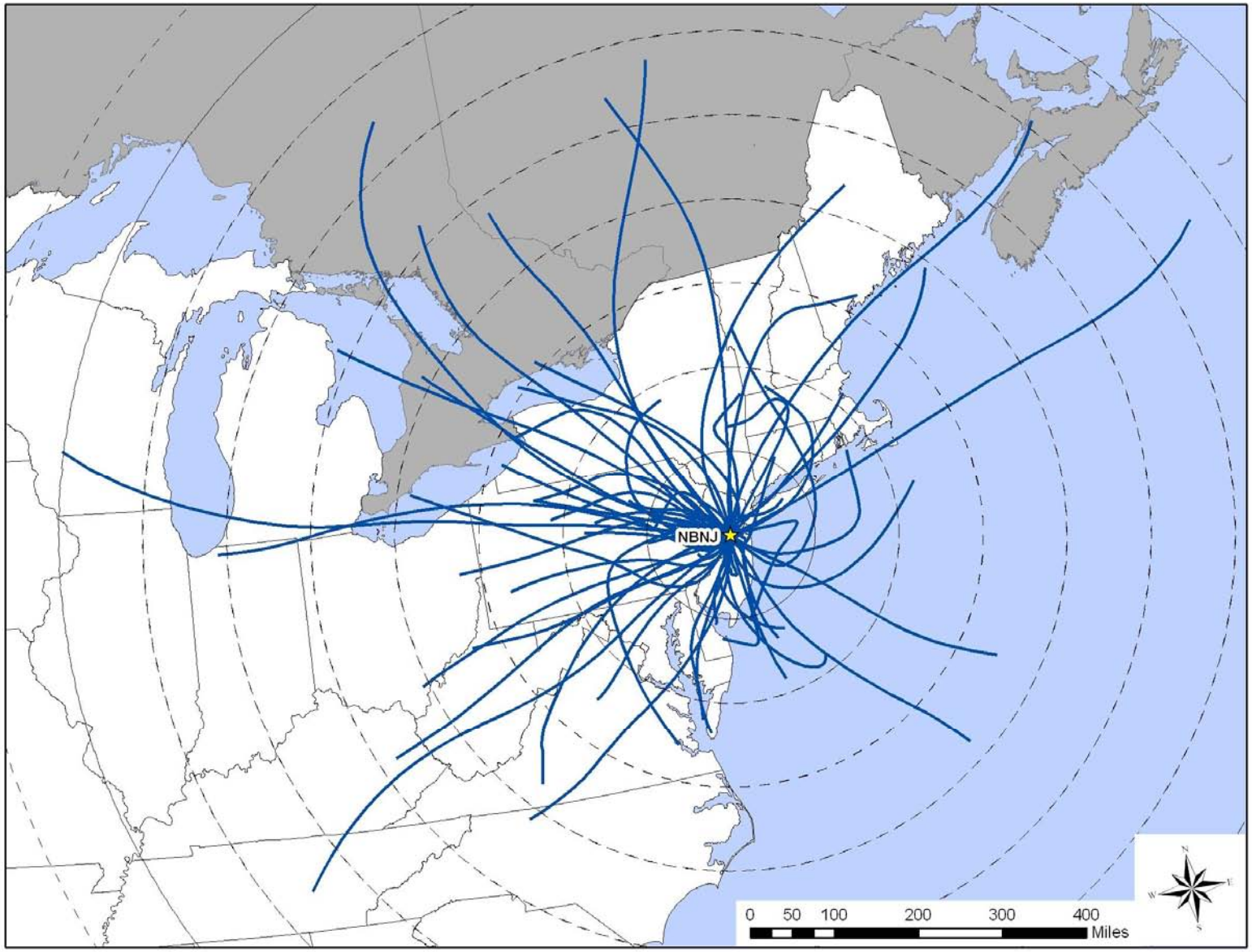


Figure 14-16. Wind Rose of Sample Days for the CANJ Monitoring Site

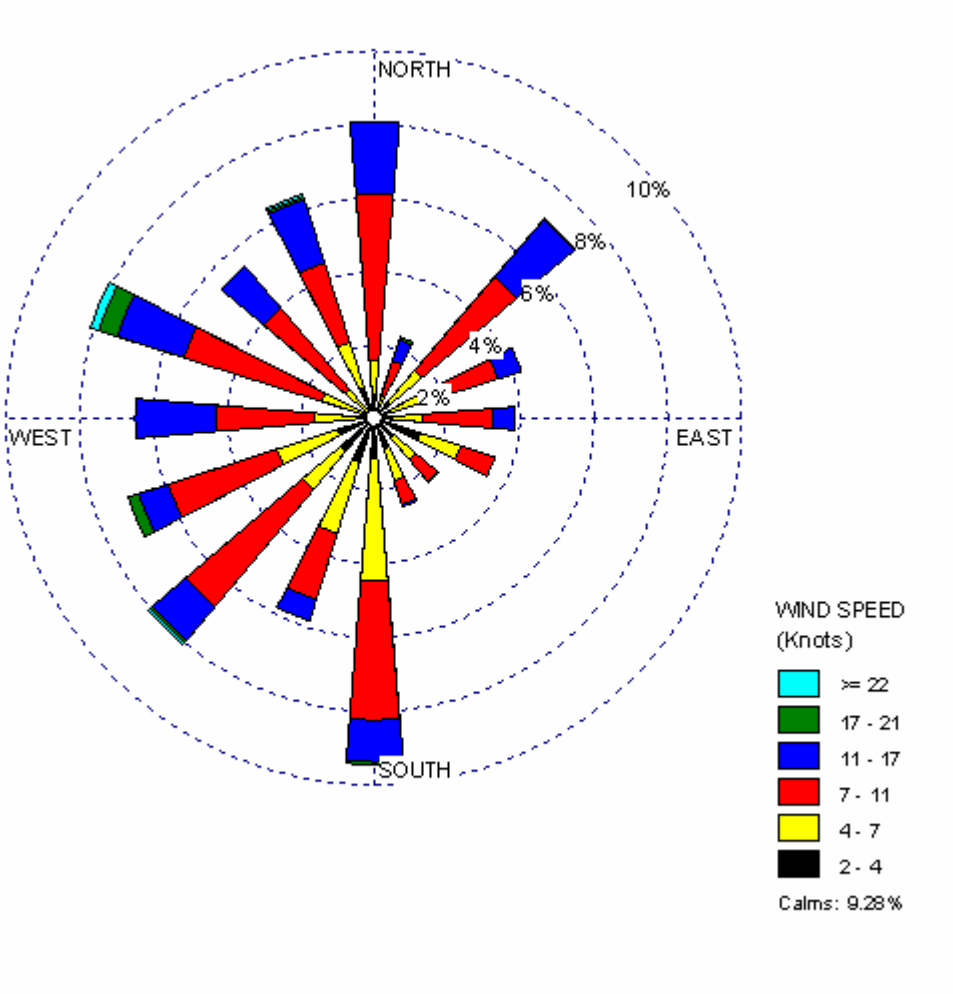


Figure 14-17. Wind Rose of Sample Days for the CHNJ Monitoring Site

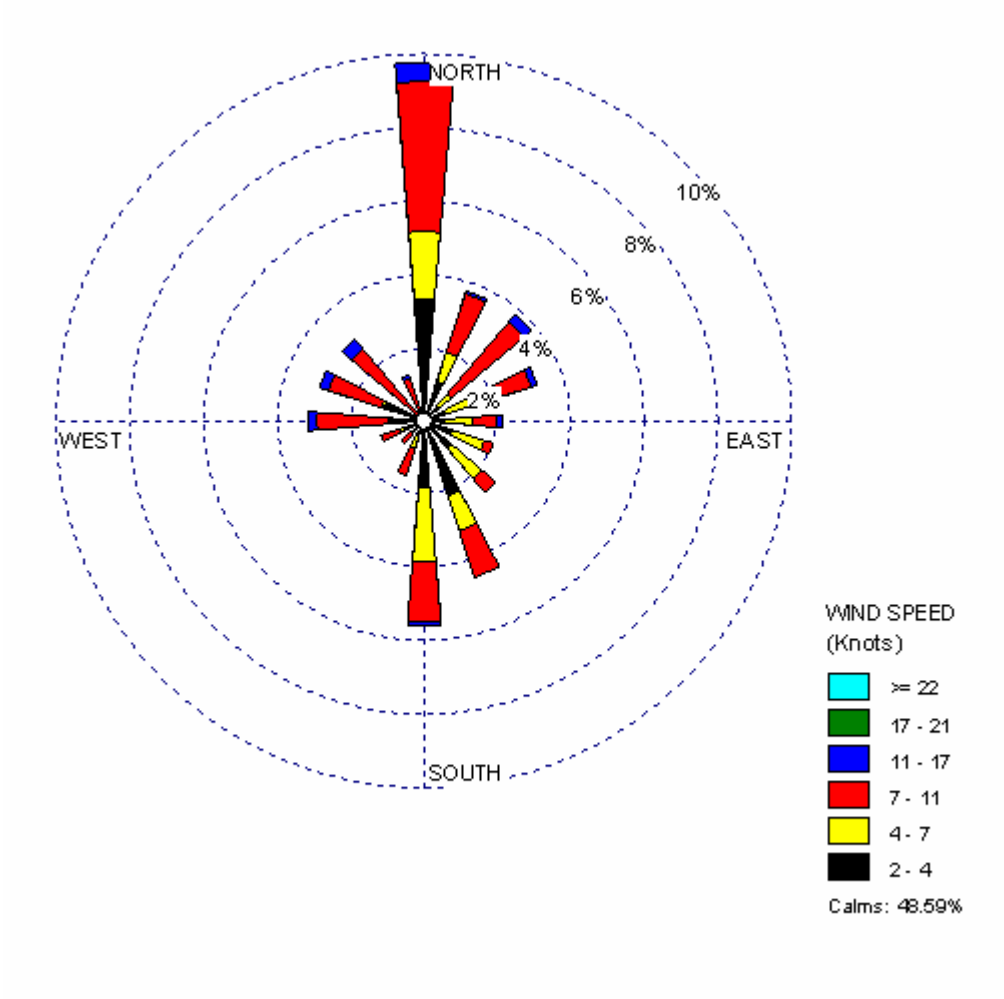


Figure 14-18. Wind Rose of Sample Days for the ELNJ Monitoring Site

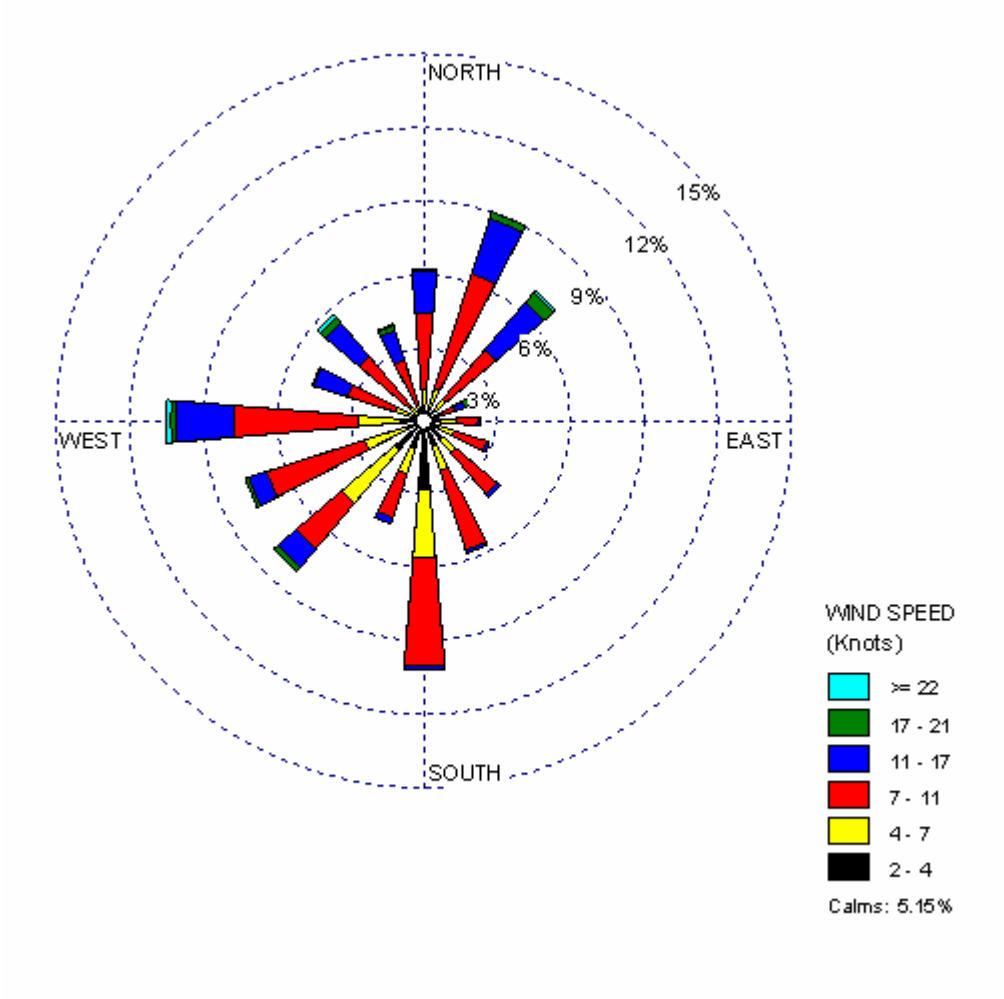


Figure 14-19. Wind Rose of Sample Days for the NBNJ Monitoring Site

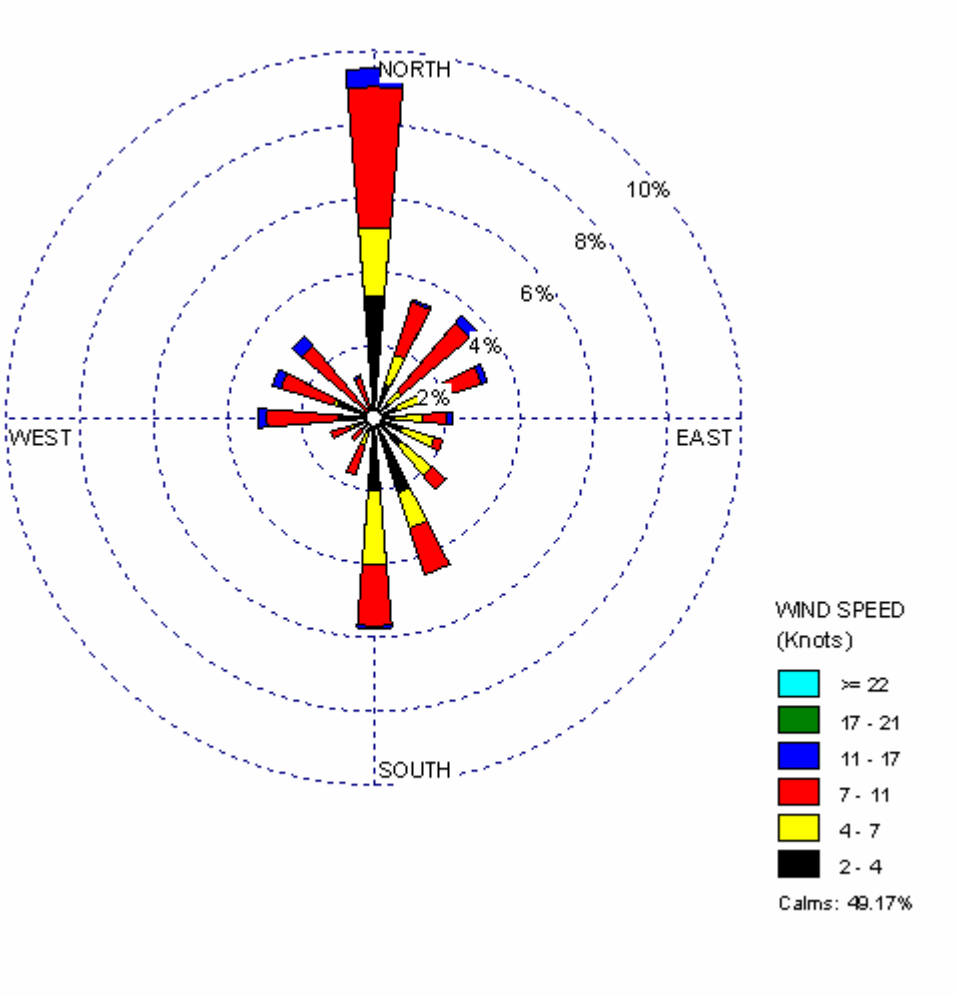


Figure 14-20. Comparison of Yearly Averages of the CANJ Monitoring Site

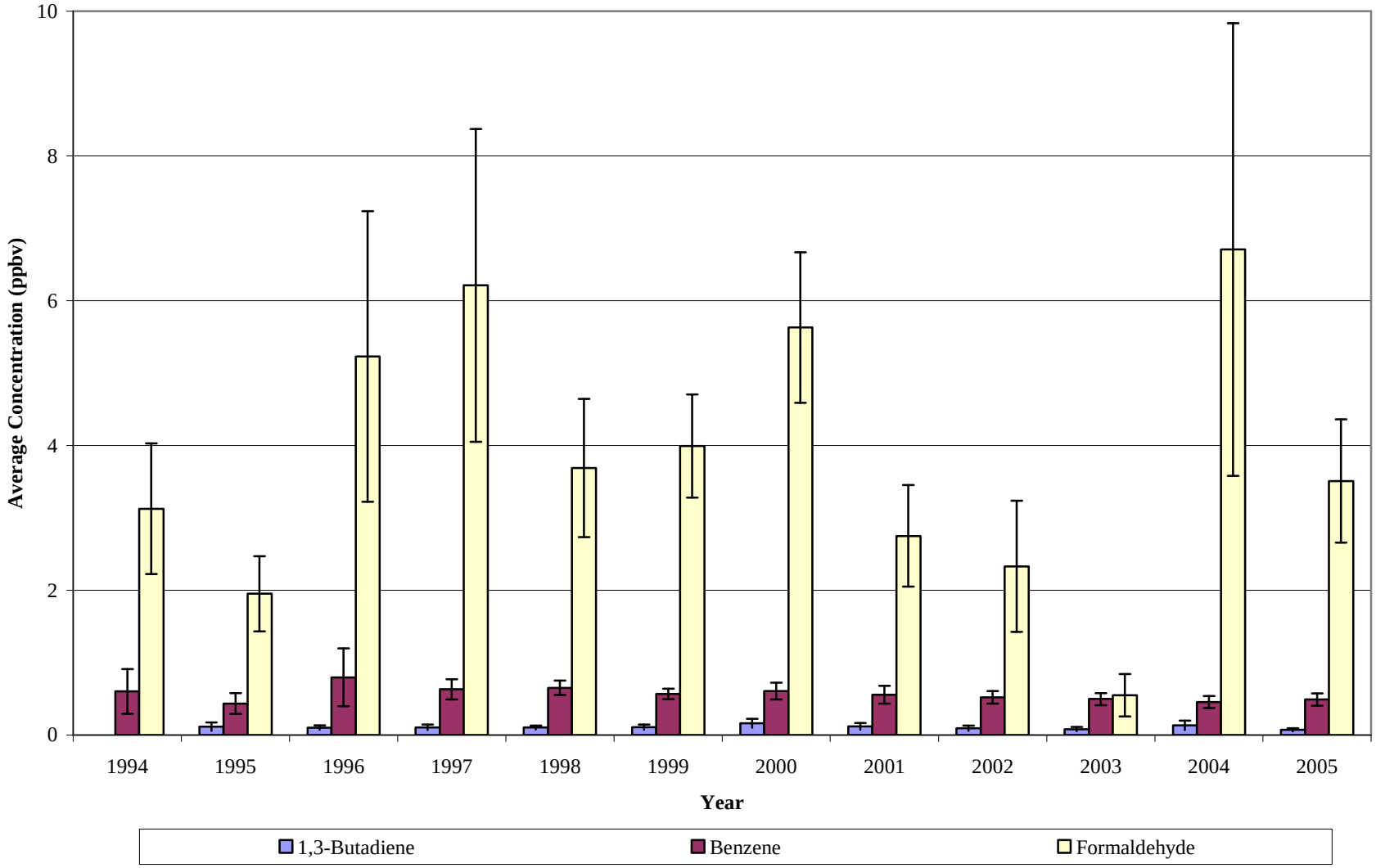


Figure 14-21. Comparison of Yearly Averages of the CHNJ Monitoring Site

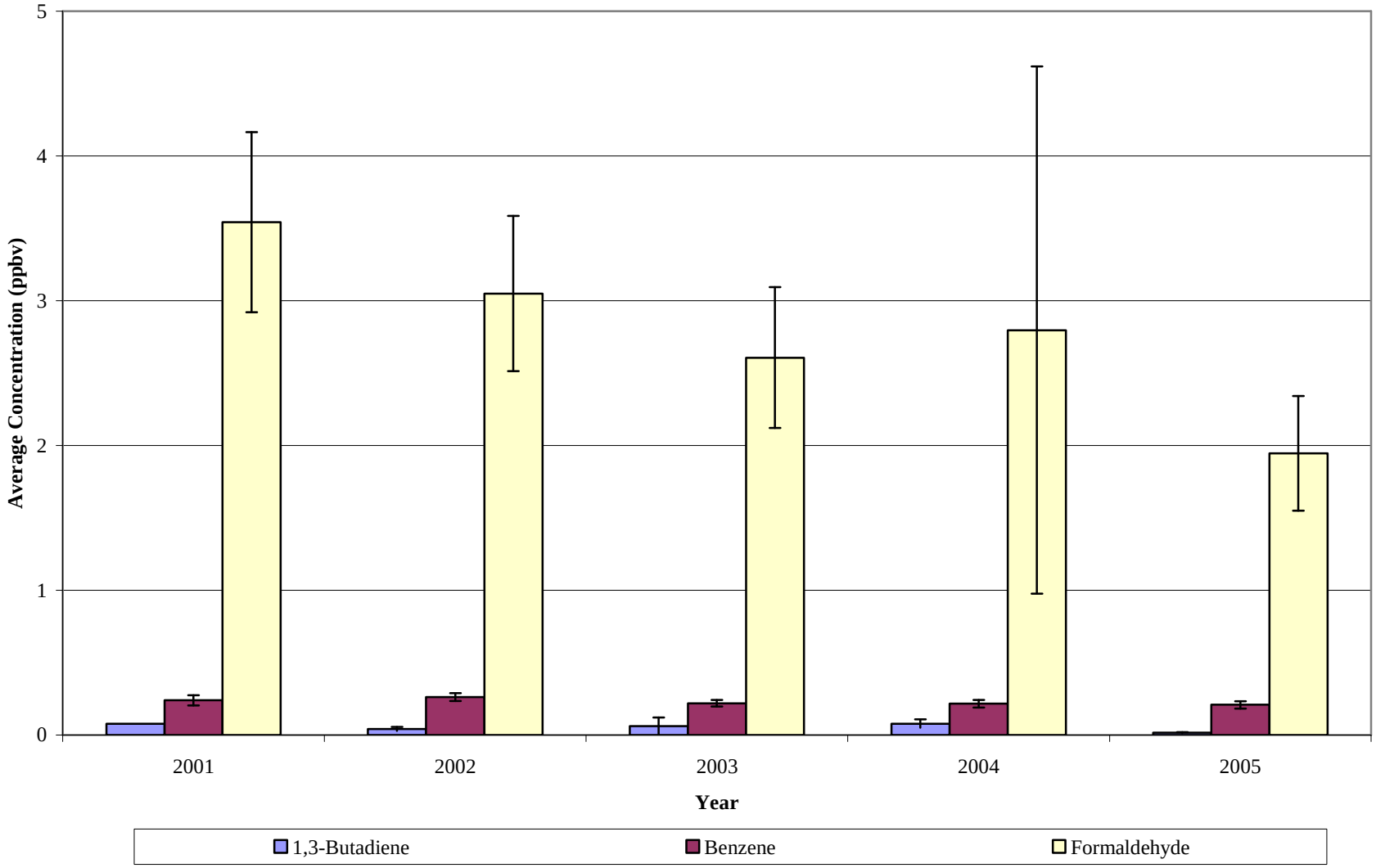


Figure 14-22. Comparison of Yearly Averages of the ELNJ Monitoring Site

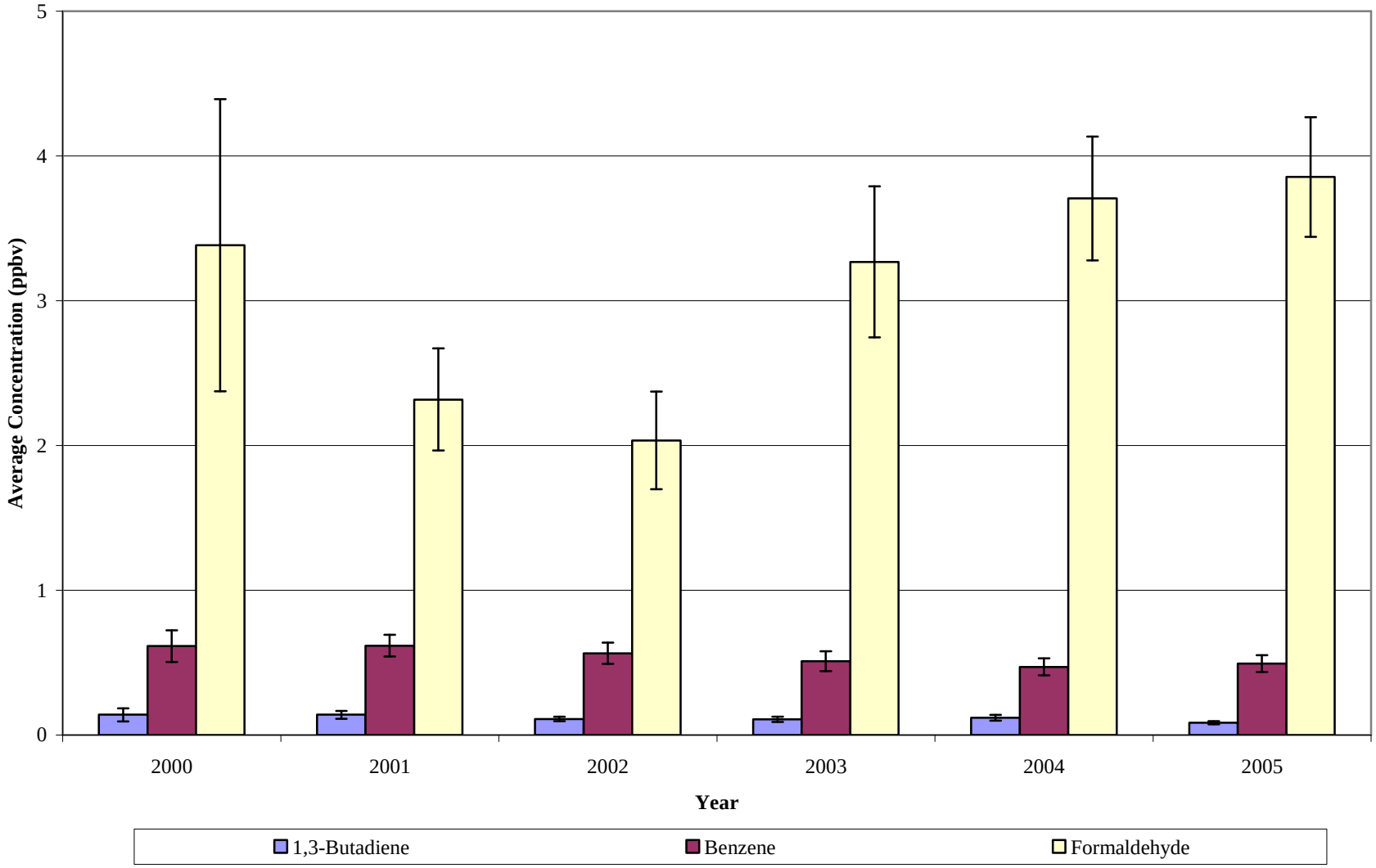


Figure 14-23. Comparison of Yearly Averages of the NBNJ Monitoring Site

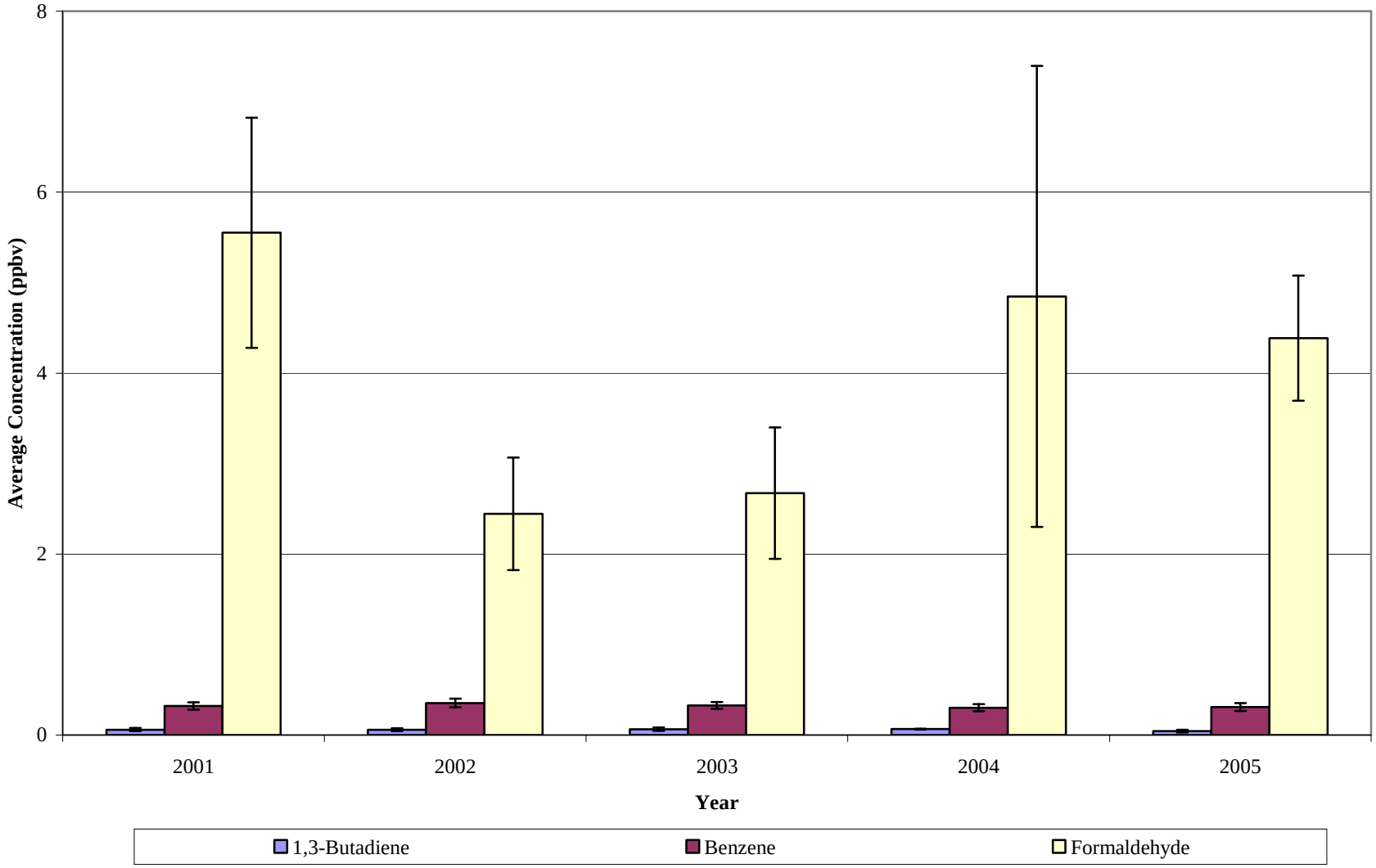


Table 14-1. Average Meteorological Parameters for Monitoring Sites in New Jersey

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
CANJ	13739	All 2005	64.07 ± 2.01	55.94 ± 1.89	42.02 ± 1.99	49.27 ± 1.73	62.74 ± 1.43	1016.77 ± 0.81	1.86 ± 0.54	-0.63 ± 0.48
		Sample Day	63.68 ± 5.22	55.29 ± 4.87	41.66 ± 5.04	48.75 ± 4.41	63.42 ± 3.63	1016.56 ± 2.19	1.66 ± 1.27	-0.65 ± 1.22
CHNJ	54785	All 2005	63.10 ± 2.09	52.30 ± 1.93	40.95 ± 2.02	47.09 ± 1.79	68.40 ± 1.27	1016.05 ± 0.83	0.00 ± 0.22	-0.99 ± 0.31
		Sample Day	63.79 ± 4.93	52.61 ± 4.66	41.58 ± 4.85	47.32 ± 4.35	70.10 ± 2.87	1016.37 ± 2.09	-0.15 ± 0.56	-0.71 ± 0.61
ELNJ	14734	All 2005	62.95 ± 2.07	55.28 ± 1.94	40.94 ± 1.98	48.41 ± 1.74	61.71 ± 1.48	1016.29 ± 0.83	1.92 ± 0.53	-1.37 ± 0.53
		Sample Day	63.48 ± 4.87	55.40 ± 4.61	41.58 ± 4.68	48.72 ± 4.13	62.85 ± 3.51	1016.65 ± 2.11	1.30 ± 1.26	-0.76 ± 1.23
NBNJ	54785	All 2005	63.10 ± 2.09	52.30 ± 1.93	40.95 ± 2.02	47.09 ± 1.79	68.40 ± 1.27	1016.05 ± 0.83	0.00 ± 0.22	-0.99 ± 0.31
		Sample Day	63.69 ± 4.90	52.48 ± 4.64	41.53 ± 4.84	47.25 ± 4.33	70.27 ± 2.87	1016.18 ± 2.09	-0.13 ± 0.56	-0.64 ± 0.6

Table 14-2. Comparison of Measured Concentrations and EPA Screening Values at the New Jersey Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Camden, New Jersey – CANJ					
Acetaldehyde	55	55	100.0	15.3%	15.3%
Benzene	54	54	100.0	15.0%	30.3%
Formaldehyde	52	55	94.5	14.4%	44.7%
Carbon Tetrachloride	45	46	97.8	12.5%	57.2%
Tetrachloroethylene	40	43	93.0	11.1%	68.3%
1,3-Butadiene	32	33	97.0	8.9%	77.2%
p-Dichlorobenzene	28	32	87.5	7.8%	85.0%
Bromomethane	11	40	27.5	3.1%	88.1%
Acrolein	10	10	100.0	2.8%	90.8%
Hexachloro-1,3-butadiene	9	9	100.0	2.5%	93.3%
Methyl tert-Butyl Ether	9	34	26.5	2.5%	95.8%
Trichloroethylene	9	28	32.1	2.5%	98.3%
Dichloromethane	2	51	3.9	0.6%	98.9%
Vinyl chloride	2	12	16.7	0.6%	99.4%
Xylenes	1	54	1.9	0.3%	99.7%
1,2-Dichloroethane	1	1	100.0	0.3%	100.0%
Total	360	557	64.6		
Chester, New Jersey – CHNJ					
Acetaldehyde	52	54	96.30	22.1%	22.1%
Benzene	49	49	100.0	20.9%	43.0%
Formaldehyde	44	54	81.48	18.7%	61.7%
Carbon Tetrachloride	39	39	100.0	16.6%	78.3%
Tetrachloroethylene	13	30	43.33	5.5%	83.8%
Acrolein	13	13	100.0	5.5%	89.4%
1,3-Butadiene	10	17	58.82	4.3%	93.6%
Hexachloro-1,3-butadiene	8	8	100.0	3.4%	97.0%
Dichloromethane	3	38	7.89	1.3%	98.3%
1,2-Dichloroethane	2	2	100.0	0.9%	99.1%
1,1,2,2-Tetrachloroethane	2	2	100.0	0.9%	100.0%
Total	235	306			
Elizabeth, New Jersey – ELNJ					
Benzene	60	60	100.0	15.7%	15.7%
Acetaldehyde	60	60	100.0	15.7%	31.4%
Formaldehyde	60	60	100.0	15.7%	47.1%
Carbon Tetrachloride	52	52	100.0	13.6%	60.7%
1,3-Butadiene	43	43	100.0	11.3%	72.0%
Tetrachloroethylene	39	42	92.9	10.2%	82.2%
p-Dichlorobenzene	22	30	73.3	5.8%	88.0%
Methyl tert-Butyl Ether	14	43	32.6	3.7%	91.6%
Hexachloro-1,3-butadiene	13	13	100.0	3.4%	95.03%
Acrolein	9	9	100.0	2.4%	97.4%

Table 14-2. Comparison of Measured Concentrations and EPA Screening Values at the New Jersey Monitoring Sites (Continued)

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Xylenes	3	60	5.0	0.8%	98.2%
Dichloromethane	2	55	3.6	0.5%	98.7%
1,2-Dichloroethane	2	2	100.0	0.5%	99.2%
Acrylonitrile	1	1	100.0	0.3%	99.5%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.3%	99.7%
Trichloroethylene	1	23	4.3	0.3%	100.0%
Total	382	554	69.0		
New Brunswick, New Jersey - NBNJ					
Acetaldehyde	58	58	100.0	18.1%	18.1%
Benzene	57	57	100.0	17.8%	35.9%
Formaldehyde	55	58	94.8	17.2%	53.1%
Carbon Tetrachloride	51	51	100.0	15.9%	69.1%
Tetrachloroethylene	28	36	77.8	8.8%	77.8%
1,3-Butadiene	27	30	90.0	8.4%	86.3%
Acrolein	18	18	100.0	5.6%	91.9%
p-Dichlorobenzene	11	18	61.1	3.4%	95.3%
Hexachloro-1,3-butadiene	9	9	100.0	2.8%	98.1%
1,2-Dichloroethane	2	2	100.0	0.6%	98.8%
Dichloromethane	2	47	4.3	0.6%	99.4%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.3%	99.7%
Vinyl chloride	1	6	16.7	0.3%	100.0%
Total	320	391	81.8		

Table 14-3. Daily and Seasonal Averages for Pollutants of Interest at the New Jersey Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Camden, New Jersey – CANJ												
1,3-Butadiene	33	54	0.16	0.05	NR	NR	NR	NR	0.07	0.02	0.19	0.07
Acetaldehyde	55	55	2.94	0.52	3.56	1.15	3.74	1.10	2.51	0.99	2.12	0.58
Acrolein	10	30	0.87	0.27	NA	NA	NA	NA	NR	NR	NR	NR
Benzene	54	54	1.57	0.27	1.99	0.52	1.31	0.30	1.14	0.21	1.73	0.70
Bromomethane	40	54	0.96	0.62	1.54	1.41	NR	NR	0.24	0.19	0.19	0.11
Carbon Tetrachloride	46	54	0.62	0.05	0.41	0.10	NR	NR	0.65	0.04	0.72	0.10
Formaldehyde	55	55	4.24	1.03	3.14	0.95	2.36	0.73	6.73	3.35	4.40	0.99
Hexachloro-1,3-butadiene	9	54	0.17	0.03	NR	NR	NR	NR	NR	NR	NR	NR
Methyl tert-Butyl Ether	34	54	2.42	0.60	1.43	0.94	1.69	1.12	1.94	0.78	1.26	0.99
p-Dichlorobenzene	32	54	0.27	0.06	NR	NR	NR	NR	0.25	0.09	0.31	0.10
Tetrachloroethylene	43	54	0.76	0.55	1.16	1.45	NR	NR	0.65	0.57	0.38	0.11
Trichloroethylene	28	54	0.74	0.34	0.37	0.24	NR	NR	0.61	0.49	0.55	0.47
Chester, New Jersey – CHNJ												
1,3-Butadiene	17	50	0.04	0.01	NR	NR	NR	NR	NR	NR	0.05	0.01
Acetaldehyde	54	54	1.48	0.20	1.52	0.32	1.30	0.23	1.93	0.55	1.25	0.32
Acrolein	13	26	2.39	0.96	NA	NA	NA	NA	NR	NR	1.67	1.05
Benzene	49	50	0.67	0.08	0.94	0.13	0.68	0.21	0.57	0.09	0.51	0.10
Carbon Tetrachloride	39	50	0.59	0.04	NR	NR	NR	NR	0.65	0.05	0.57	0.05
Formaldehyde	54	54	2.39	0.49	1.47	0.38	1.16	0.19	4.55	1.03	2.26	0.71
Hexachloro-1,3-butadiene	8	50	0.17	0.05	NR	NR	NR	NR	NR	NR	1.02	0.40
Tetrachloroethylene	30	50	0.18	0.03	NR	NR	NR	NR	0.18	0.03	0.12	0.03

Table 14-3. Daily and Seasonal Averages for Pollutants of Interest at the New Jersey Monitoring Sites (Continued)

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Elizabeth, New Jersey – ELNJ												
1,3-Butadiene	43	60	0.19	0.02	0.12	0.04	NR	NR	0.17	0.02	0.22	0.05
Acetaldehyde	60	60	5.07	0.65	4.34	0.82	3.91	0.73	5.75	0.94	6.14	1.82
Benzene	60	60	1.58	0.18	1.74	0.41	1.27	0.20	1.67	0.32	1.64	0.42
Carbon Tetrachloride	52	60	0.63	0.05	0.48	0.10	0.43	0.09	0.72	0.09	0.67	0.10
Formaldehyde	60	60	4.74	0.51	4.40	0.84	4.35	0.68	6.05	0.93	4.16	1.18
Hexachloro-1,3-butadiene	13	60	0.14	0.03	NA	NA	NA	NA	NR	NR	NR	NR
Methyl tert-Butyl Ether	43	60	3.75	1.24	1.55	0.84	1.71	0.81	4.72	3.28	3.01	1.66
p-Dichlorobenzene	30	60	0.19	0.05	NR	NR	NR	NR	0.19	0.04	0.21	0.09
Tetrachloroethylene	42	60	0.44	0.07	0.38	0.15	NR	NR	0.44	0.07	0.40	0.13
New Brunswick, New Jersey – NBNJ												
1,3-Butadiene	30	57	0.10	0.03	NR	NR	NR	NR	0.10	0.06	0.07	0.02
Acetaldehyde	58	58	6.24	0.90	4.24	0.98	4.34	0.72	10.37	1.70	6.29	1.58
Acrolein	18	27	2.15	0.87	NA	NA	NA	NA	NR	NR	1.25	0.57
Benzene	57	57	1.00	0.14	1.38	0.39	0.94	0.22	0.82	0.15	0.82	0.17
Carbon Tetrachloride	51	57	0.57	0.04	0.48	0.08	0.40	0.08	0.59	0.07	0.67	0.05
Formaldehyde	58	58	5.39	0.85	3.05	0.75	4.92	0.79	8.53	1.78	5.25	1.86
p-Dichlorobenzene	18	57	1.32	2.30	NR	NR	NR	NR	1.72	2.93	0.13	0.03
Tetrachloroethylene	36	57	0.41	0.19	0.33	0.14	NR	NR	0.48	0.47	0.28	0.07

NA = Not available due to short sampling duration.
NR = Not responsible due to low number of detects.

Table 14-4. Non-Chronic Risk Summary at the New Jersey Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
CANJ	TO-15	Acrolein	0.87 ± 0.27	0.11	10	0.19	10	0.09	NA	NA	NR	NR
CHNJ	TO-15	Acrolein	2.39 ± 0.96	0.11	13	0.19	13	0.09	NA	NA	NR	1.67 ± 1.05
ELNJ	TO-15	Acrolein	1.43 ± 1.15	0.11	9	0.19	8	0.09	NA	NA	NR	NR
NBNJ	TO-15	Acrolein	2.15 ± 0.87	0.11	18	0.19	18	0.09	NA	NA	NR	1.25 ± 0.57

NA = Not available due to short sampling duration.
NR = No reportable due to the low number of detects.

Table 14-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the New Jersey Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Camden, New Jersey – CANJ									
1,3-Butadiene	33	-0.23	-0.36	-0.37	-0.38	-0.18	-0.03	0.15	0.35
Acetaldehyde	55	-0.12	-0.18	-0.25	-0.22	-0.27	0.03	0.03	0.14
Acrolein	10	-0.12	-0.21	-0.23	-0.22	-0.11	-0.42	0.19	0.25
Benzene	54	-0.12	-0.20	-0.22	-0.22	-0.13	-0.01	0.14	0.31
Bromomethane	40	-0.27	-0.27	-0.24	-0.26	0.00	-0.04	-0.06	-0.02
Carbon Tetrachloride	46	0.23	0.26	0.27	0.28	0.07	-0.11	0.13	0.04
Formaldehyde	55	0.45	0.42	0.35	0.38	-0.12	0.23	0.29	0.02
Hexachloro-1,3-butadiene	9	-0.59	-0.70	-0.78	-0.74	-0.62	0.65	-0.06	0.25
Methyl tert-Butyl Ether	34	0.30	0.24	0.21	0.22	-0.03	0.11	0.39	0.04
p-Dichlorobenzene	32	0.41	0.32	0.18	0.23	-0.29	0.18	0.20	0.09
Tetrachloroethylene	43	-0.02	-0.07	-0.10	-0.09	-0.11	-0.02	0.03	-0.02
Trichloroethylene	28	0.35	0.30	0.27	0.29	-0.08	0.01	0.44	-0.04
Chester, New Jersey – CHNJ									
1,3-Butadiene	17	0.06	-0.04	-0.12	-0.09	-0.31	0.31	-0.07	-0.36
Acetaldehyde	54	0.22	0.12	0.10	0.10	-0.04	0.01	0.37	0.11
Acrolein	13	0.60	0.69	0.72	0.71	0.39	-0.47	0.40	-0.22
Benzene	49	-0.47	-0.49	-0.43	-0.47	0.04	-0.22	-0.09	0.14
Carbon Tetrachloride	39	0.30	0.33	0.37	0.35	0.27	-0.21	0.18	0.01
Formaldehyde	54	0.72	0.67	0.62	0.64	0.04	0.09	0.45	-0.01
Hexachloro-1,3-butadiene	8	-0.45	-0.14	0.04	-0.03	0.48	-0.31	-0.26	-0.94
Tetrachloroethylene	30	-0.06	-0.06	0.00	-0.04	0.22	-0.33	0.32	0.05

Table 14-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the New Jersey Monitoring Sites (Continued)

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Elizabeth, New Jersey – ELNJ									
1,3-Butadiene	43	0.05	-0.01	-0.05	-0.03	-0.09	-0.19	0.33	0.33
Acetaldehyde	60	0.51	0.46	0.34	0.39	-0.26	0.04	0.42	0.15
Benzene	60	0.18	0.15	0.11	0.12	-0.08	0.00	0.33	0.21
Carbon Tetrachloride	52	0.27	0.33	0.39	0.36	0.19	0.00	0.06	-0.04
Formaldehyde	60	0.48	0.44	0.33	0.38	-0.22	0.08	0.40	0.07
Hexachloro-1,3-butadiene	13	-0.68	-0.66	-0.62	-0.66	-0.05	0.06	-0.10	-0.03
Methyl tert-Butyl Ether	43	0.38	0.39	0.38	0.39	0.03	0.10	0.52	0.12
p-Dichlorobenzene	30	0.42	0.40	0.36	0.39	-0.06	-0.20	0.20	0.20
Tetrachloroethylene	42	0.15	0.12	0.14	0.12	0.08	-0.24	0.08	0.22
New Brunswick, New Jersey – NBNJ									
1,3-Butadiene	30	-0.09	-0.10	-0.04	-0.07	0.29	-0.27	0.15	0.26
Acetaldehyde	58	0.77	0.74	0.71	0.73	0.12	0.03	0.44	-0.01
Acrolein	18	0.42	0.43	0.41	0.42	-0.06	-0.04	0.05	-0.32
Benzene	57	-0.25	-0.29	-0.25	-0.28	0.07	-0.22	0.04	0.16
Carbon Tetrachloride	51	0.05	0.09	0.13	0.11	0.08	0.11	-0.06	-0.04
Formaldehyde	58	0.77	0.75	0.70	0.73	0.06	0.01	0.42	-0.06
p-Dichlorobenzene	18	0.32	0.29	0.28	0.28	-0.02	0.05	0.13	-0.32
Tetrachloroethylene	36	0.21	0.18	0.18	0.18	0.02	-0.05	0.10	-0.07

Table 14-6. Motor Vehicle Information for the New Jersey Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
CANJ	518,249	369,412	0.71	2,030,976	1,447,696	62,000
CHNJ	490,593	349,299	0.71	234,148	166,712	12,623
ELNJ	531,457	380,628	0.72	2,179,781	1,561,153	170,000
NBNJ	789,516	561,754	0.71	787,380	560,234	63,000

Table 14-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in New Jersey

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Camden, New Jersey - CANJ, Census Tract 34007601500				
1,2-Dichloroethane	0.09 ± 0.01	0.04	1.05	<0.01
1,3-Butadiene	0.13 ± 0.03	0.18	5.37	0.09
Acetaldehyde	2.94 ± 0.52	2.50	5.50	0.28
Acrolein	NA	0.19	--	9.63
Benzene	1.57 ± 0.27	1.91	14.87	0.06
Bromomethane	0.73 ± 0.47	0.29	--	0.06
Carbon Tetrachloride	0.56 ± 0.06	0.22	3.30	0.01
Dichloromethane	0.58 ± 0.14	0.79	0.37	<0.01
Formaldehyde	4.24 ± 1.03	2.45	0.01	0.25
Hexachloro-1,3-butadiene	0.99 ± 0.15	<0.01	0.03	<0.01
Methyl tert-Butyl Ether	1.56 ± 0.48	2.30	--	<0.01
***p*-Dichlorobenzene**	0.23 ± 0.04	0.09	1.00	<0.01
Tetrachloroethylene	0.64 ± 0.44	0.23	1.38	<0.01
Trichloroethylene	0.45 ± 0.20	0.15	0.31	<0.01
Vinyl chloride	0.05 ± 0.01	0.06	0.52	<0.01
Xylenes	3.64 ± 0.61	3.03	--	0.03
Chester, New Jersey - CHNJ, Census Tract 34027045901				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	0.05	2.63	--
1,2-Dichloroethane	0.10 ± 0.01	0.03	0.77	<0.01
1,3-Butadiene	0.05 ± 0.04	0.11	3.43	0.06
Acetaldehyde	1.48 ± 0.20	1.10	2.43	0.12
Acrolein	NA	0.07	--	3.34
Benzene	0.66 ± 0.08	1.04	8.08	0.03
Carbon Tetrachloride	0.50 ± 0.05	0.21	3.12	0.01
Dichloromethane	0.66 ± 0.42	0.39	0.18	<0.01
Formaldehyde	2.39 ± 0.49	1.29	0.01	0.13
Hexachloro-1,3-butadiene	1.02 ± 0.15	<0.01	0.03	<0.01
Tetrachloroethylene	0.17 ± 0.02	0.12	0.72	<0.01
Elizabeth, New Jersey - ELNJ, Census Tract 34039030100				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	0.06	3.26	--
1,2-Dichloroethane	0.10 ± 0.01	0.04	0.92	<0.01
1,3-Butadiene	0.16 ± 0.02	0.54	16.09	0.27
Acetaldehyde	5.07 ± 0.65	4.36	9.59	0.48
Acrolein	NA	0.71	--	35.46
Acrylonitrile	0.09 ± 0.04	0.00	0.07	<0.01
Benzene	1.58 ± 0.18	3.38	26.33	0.11
Carbon Tetrachloride	0.58 ± 0.06	0.21	3.17	0.01
Dichloromethane	0.85 ± 0.22	0.71	0.33	<0.01
Formaldehyde	4.74 ± 0.51	5.60	0.03	0.57

Table 14-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in New Jersey (Continued)

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Hexachloro-1,3-butadiene	0.90 ± 0.13	<0.01	0.04	<0.01
Methyl tert-Butyl Ether	2.72 ± 0.98	3.45	--	<0.01
***p*-Dichlorobenzene**	0.18 ± 0.03	0.07	0.73	<0.01
Tetrachloroethylene	0.36 ± 0.06	0.31	1.82	<0.01
Trichloroethylene	0.17 ± 0.03	0.12	0.24	<0.01
Xylenes	4.31 ± 0.65	6.20	--	0.06
New Brunswick, New Jersey - NBNJ, Census Tract 34023006206				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	0.06	3.20	--
1,2-Dichloroethane	0.10 ± 0.01	0.04	0.93	<0.01
1,3-Butadiene	0.08 ± 0.02	0.28	8.33	0.14
Acetaldehyde	6.24 ± 0.90	1.98	4.36	0.22
Acrolein	NA	0.15	--	7.61
Benzene	1.00 ± 0.14	2.26	17.62	0.08
Carbon Tetrachloride	0.53 ± 0.05	0.21	3.17	0.01
Dichloromethane	0.58 ± 0.16	0.50	0.24	<0.01
Formaldehyde	5.39 ± 0.85	2.29	0.01	0.23
Hexachloro-1,3-butadiene	0.97 ± 0.13	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.54 ± 0.74	0.04	0.44	<0.01
Tetrachloroethylene	0.32 ± 0.13	0.20	1.21	<0.01
Vinyl chloride	0.05 ± 0.04	0.06	0.50	<0.01

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

15.0 Sites in North Carolina

This section presents meteorological, concentration, and spatial trends for the UATMP sites in North Carolina (CANC and RTPNC). CANC is a rural site located in Candor near the Uwharrie National Forest. RTPNC is an urban site located in the Research Triangle Park area near Durham, North Carolina. Figures 15-1 and 15-2 are topographical maps showing the monitoring sites in their rural and urban locations. Figures 15-3 and 15-4 identify point source emission locations within 10 miles of these sites as reported to the 2002 NEI for point sources. The CANC site has few sources nearby, mostly located to the north or west of the site, and the majority are involved in lumber and wood products. The RTPNC site has a few more nearby sources, mostly to the north and east, and the majority are involved in fuel combustion and industrial machinery and equipment industries.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the CANC and RTPNC monitoring sites are the Moore County Airport and Raleigh-Durham International Airport (WBAN 3720 and 13722, respectively).

Candor is located in south-central North Carolina, about halfway between Charlotte and Fayetteville, near the Uwharrie National Forest. This area is considered the Sandhills region, where the sandy soil allows for rapid drainage, as well as rapid warming during the day and cooling during the night. As a result, daytime temperatures rise quickly, while nighttime temperatures cool quickly (http://www.pinehurstproperty.com/climate.html). Research Triangle Park is located between Raleigh and Durham in central North Carolina. Its Southeastern location allows for warm, usually muggy summers, and generally mild winters The Mid-Atlantic location of these sites allows for fairly ample rainfall. Afternoon thunderstorms are typical during the summer, although rainfall is distributed rather equally throughout the year (Ruffner and Bair, 1987). Table 15-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 15-1, average

meteorological conditions on sample days are fairly representative of average weather conditions throughout the year. The weather station at Moore County Airport did not record sea level pressure, therefore it is not presented in Table 15-1.

15.1 Pollutants of Interest at the North Carolina Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 15-2 presents the pollutants that failed at least one screen at the North Carolina monitoring sites. It's important to note that the North Carolina sites sampled for carbonyl compounds only, and that this is reflected in Table 15-2. Acetaldehyde and formaldehyde failed screens at the CANC and RTPNC monitoring sites. These two pollutants failed a total of 34 screens at CANC and 41 screens at RTPNC. Both pollutants contributed to 95% of the total failed screens at each North Carolina monitoring site, although acetaldehyde contributed to more than half of the failed screens at both sites. Also listed in Table 15-2 are the total number of detects and the percent detects failing the screen. Acetaldehyde concentrations failed more than 85% of screens at each site. Formaldehyde concentrations failed nearly twice as many screens at RTPNC than at CANC.

15.2 Concentration Averages at the North Carolina Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages

will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 15-3. Annual averages will be presented and discussed in further detail in later sections.

Acetaldehyde and formaldehyde were detected in every sampled taken at the North Carolina monitoring sites. The daily average of formaldehyde was higher than acetaldehyde at both sites, but if the confidence interval is considered, the concentrations are not significantly different. The seasonal averages of these two pollutants of interest did not vary much statistically at either site.

15.3 Non-chronic Risk Evaluation at the North Carolina Monitoring Sites

Non-chronic risk is evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the two pollutants with at least one failed screen, neither exceeded either the acute and intermediate risk values.

15.4 Meteorological and Concentration Analysis at the North Carolina Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

15.4.1 Pearson Correlation Analysis

Table 15-4 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the North Carolina monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) The correlations with acetaldehyde and the temperature and moisture parameters were all negative, although stronger at RTPNC than at CANC, indicating that concentrations tend to increase as temperature and humidity decrease. The correlations with formaldehyde and the temperature and moisture parameters were all moderately strong to strong and positive, and again stronger at RTPNC than at CANC, indicating

that concentrations tend to increase as temperature and moisture content increase. Acetaldehyde exhibited the strongest correlation with a wind parameter at both sites (0.29 at CANC and 0.34 at RTPNC with the *u*-component of the wind).

15.4.2 Composite Back Trajectory Analysis

Figures 15-5 and 15-6 are composite back trajectory maps for the North Carolina monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site represents 100 miles.

As shown in Figure 15-5, the back trajectories originated from a variety of directions at CANC, although there is an absence of trajectories from the north and south. The 24-hour airshed domain is somewhat large, with trajectories originating as far away as New York and Missouri, or greater than 600 miles away. Nearly 36% of the trajectories originated within 200 miles of the site; and 82% within 400 miles from the CANC monitoring site.

As shown in Figure 15-6, the back trajectories originated from a variety of directions at RTPNC, although there is an absence of trajectories from the north and south, and fewer trajectories from the northwest. The 24-hour airshed domain is somewhat large, with trajectories originating as far away as New York and Missouri, or greater than 600 miles away. Nearly 36% of the trajectories originated within 200 miles of the site; and 89% within 500 miles from the RTPNC monitoring site.

15.4.3 Wind Rose Analysis

Hourly wind data from the Moore County Airport and Raleigh-Durham International Airport weather stations were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 15-7 and 15-8 are the wind roses for the North Carolina monitoring sites on days sampling occurred.

As indicated in Figure 15-7, hourly winds were predominantly out of the southwest (10% of observations), west-southwest (10%), and northeast (9%) on days samples were taken near CANC. Calm winds (<2 knots) were recorded for 15% of the hourly measurements. For wind speeds greater than 2 knots, 30% of observations ranged from 7 to 11 knots, 28% ranged from 2 to 4 knots, and 21% ranged from 4 to 7 knots.

As indicated in Figure 15-8, hourly winds were predominantly out of southwest (16%) and northeast (10%) on days samples were taken near RTPNC. Calm winds (<2 knots) were recorded for 20% of the hourly measurements. For wind speeds greater than 2 knots, 35% of observations ranged from 7 to 11 knots.

15.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

15.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Montgomery County and Durham County, North Carolina were obtained from the North Carolina Department of Transportation and the U.S. Census Bureau, and are summarized in Table 15-5. Table 15-5 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 15-5 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

According to Table 15-5, the CANC monitoring site has a significantly lower population and vehicle ownership than RTPNC. Interestingly, the CANC vehicles per person ratio is higher than the RTPNC ratio, and is almost 1.0. CANC also has a significantly lower daily traffic volume than RTPNC. This is expected as the CANC site is located within the boundaries of a National Forest while RTPNC is located in a business park near a major interstate, as shown in Figures 15-1 and 15-2. Compared to other UATMP locations, CANC has one of the lowest daily traffic volumes,

second only to BAPR, while RTPNC's daily traffic volume falls mid-range. The pattern is consistent for county population and vehicle ownership as well as 10-mile population and vehicle ownership.

15.5.2 BTEX Analysis

A BTEX analysis could not be performed as the sites sampled for carbonyl compounds only.

15.6 Site-Specific Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The CANC monitoring site has participated in the UATMP since 2003. As previously mentioned, this site only sampled for carbonyl compounds, and this is reflected in Figure 15-9. Formaldehyde concentrations seem to have decreased somewhat since 2003. However, the confidence intervals, represented by the error bars, indicate that this decrease is not statistically significant.

15.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 15-6 presents the 1999 NATA results for the census tracts where the North Carolina monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 15-6. Pollutants of interest are bolded.

15.7.1 1999 NATA Summary

The CANC monitoring site is located in census tract 37123960500. This tract has a population of 5,228, which represents 19.5% of the Montgomery County population in 2000. The RTPNC monitoring site is located in census tract 37063002014, which has a population of 5,034.

This represents 2.3% of Durham County's 2000 population. In terms of cancer risk, the acetaldehyde cancer risk in the RTPNC census tract was more than twice that of the CANC census tract (2.65 in a million vs. 1.25, respectively). Cancer risk due to formaldehyde was very low at both sites. The noncancer hazard quotients were less than 0.15, suggesting very little risk for noncancer health affects (an HQ greater than 1.0 may lead to adverse health effects).

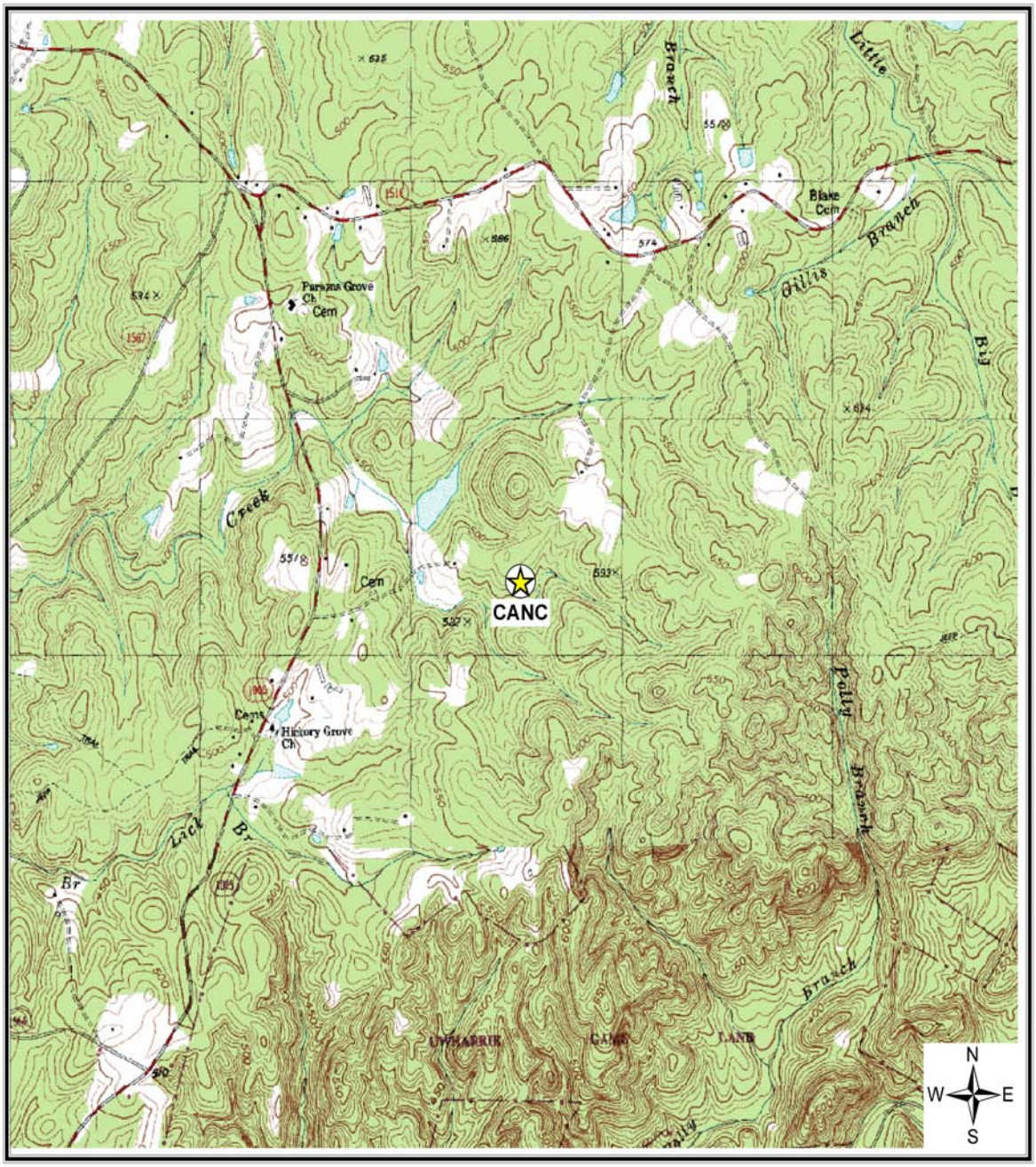
15.7.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 15.2 on how a valid annual average is calculated). For CANC, the UATMP annual averages were slightly higher than the NATA-modeled concentrations for acetaldehyde and formaldehyde. The NATA-modeled and UATMP annual average concentration differences for formaldehyde and acetaldehyde were not statistically significant at the RTPNC monitoring site.

North Carolina Pollutant Summary

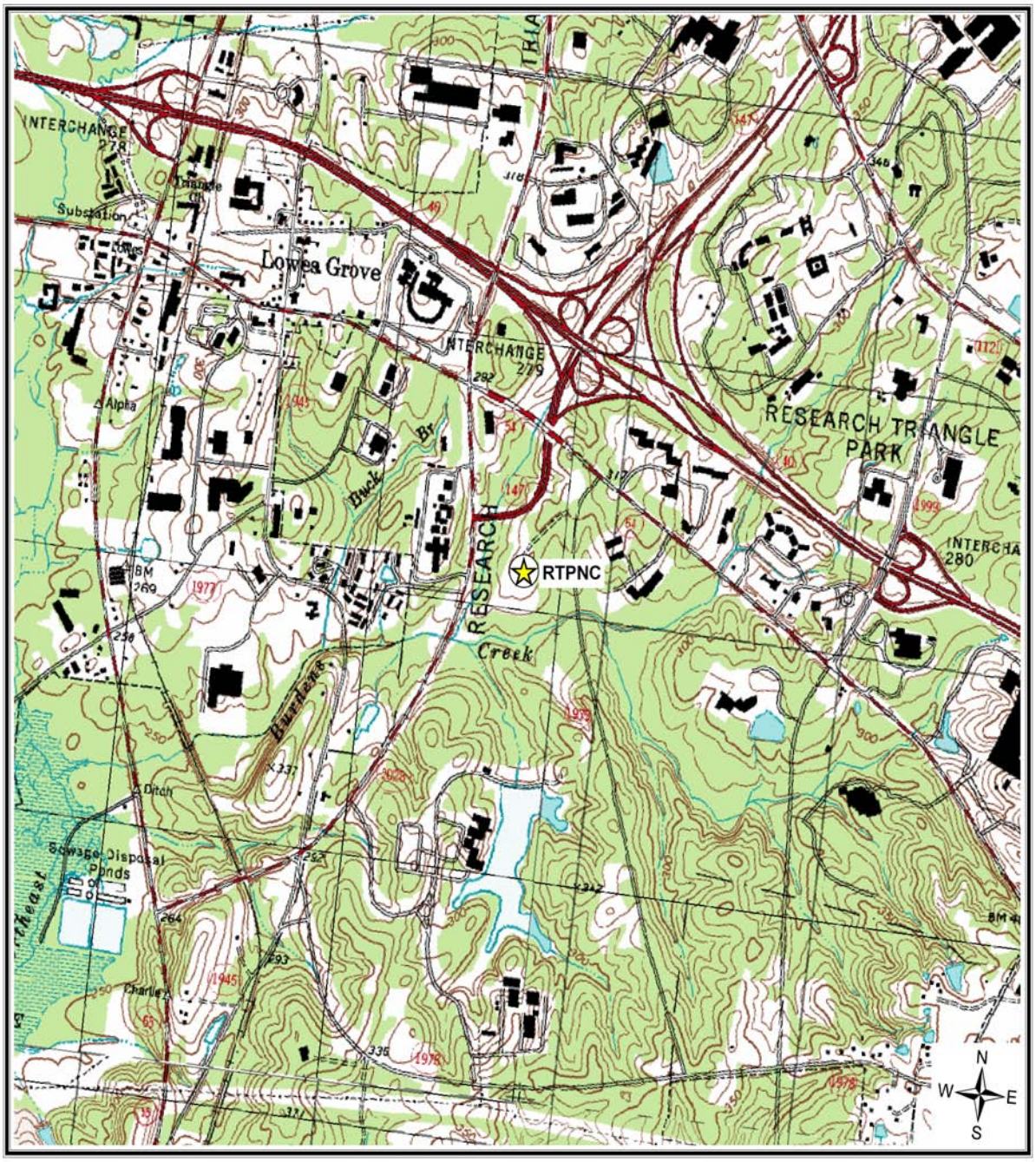
- *The pollutants of interest common to both North Carolina sites are acetaldehyde and formaldehyde.*
- *Formaldehyde measured the highest daily average at both sites.*
- *A comparison of formaldehyde concentrations for all years of UATMP participation shows that formaldehyde concentrations at CANC appear to have decreased from 2004 to 2005, although the confidence interval indicates that this decrease is not statistically significant.*

Figure 15-1. Candor, North Carolina (CANC) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 15-2. Research Triangle Park, North Carolina (RTPNC) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24, 000.

Figure 15-3. Facilities Located Within 10 Miles of CANC

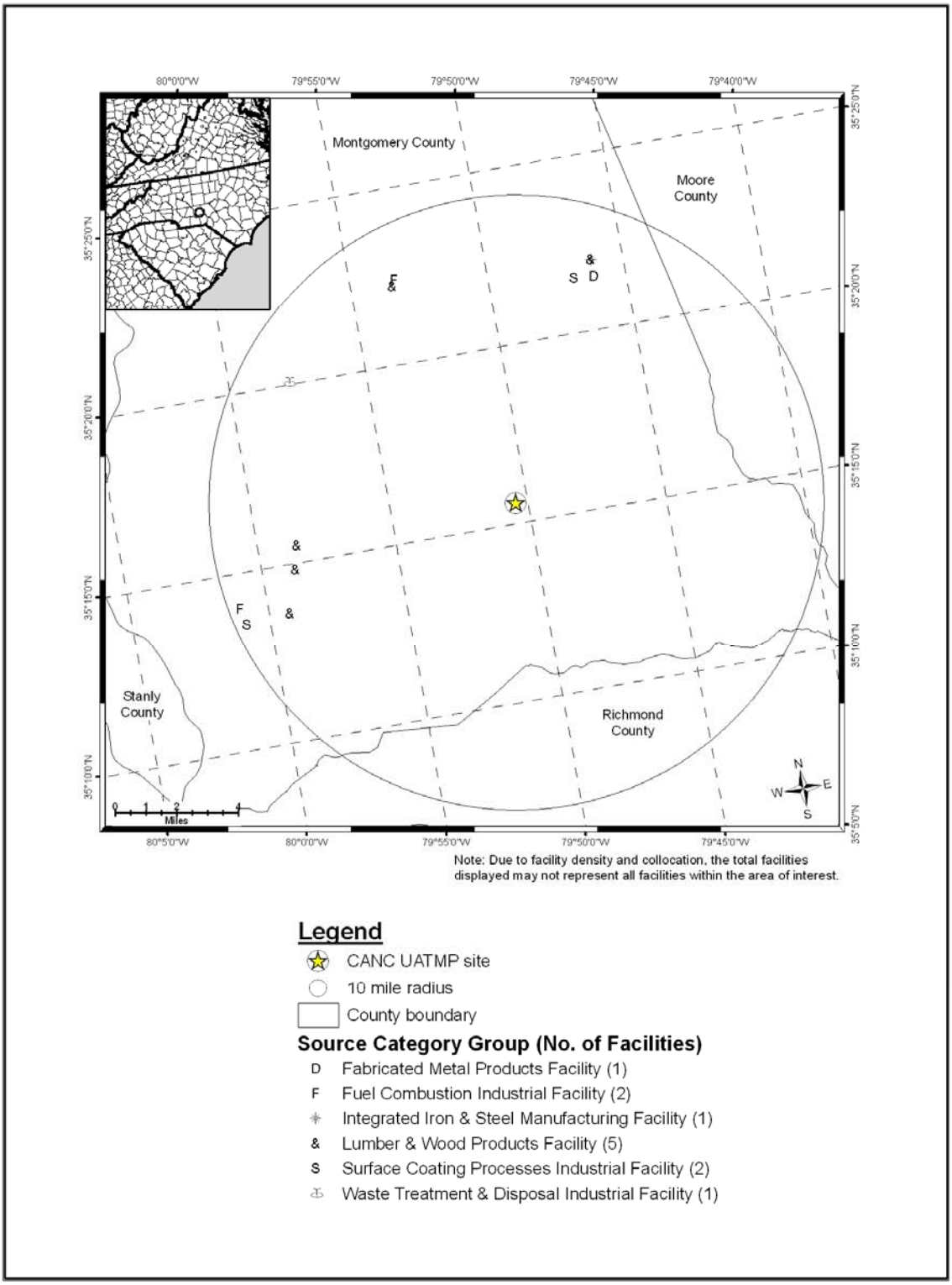
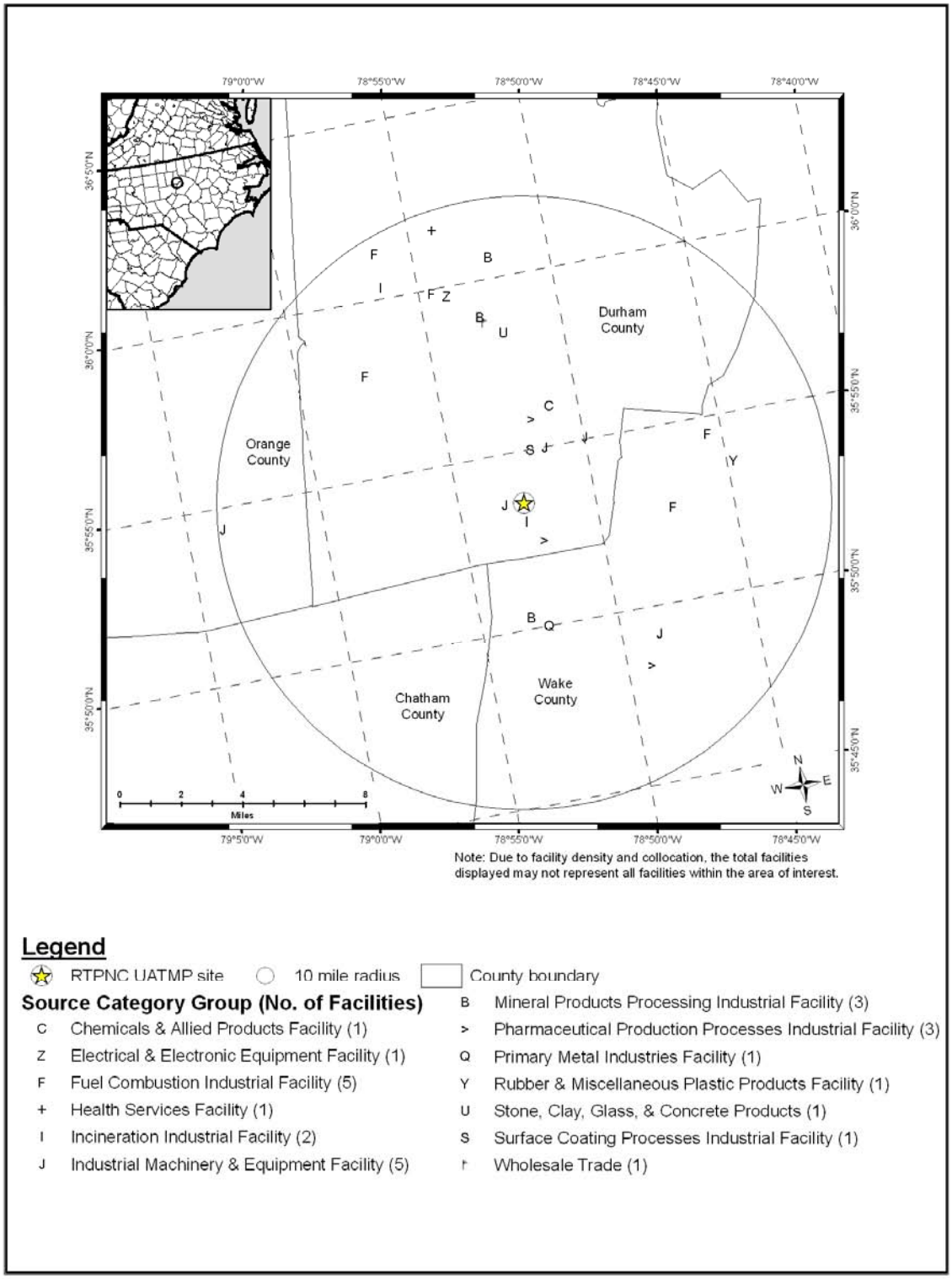


Figure 15-4. Facilities Located Within 10 Miles of RTPNC



Legend

RTPNC UATMP site | 10 mile radius | County boundary

Source Category Group (No. of Facilities)

- C Chemicals & Allied Products Facility (1)
- Z Electrical & Electronic Equipment Facility (1)
- F Fuel Combustion Industrial Facility (5)
- \+ Health Services Facility (1)
- I Incineration Industrial Facility (2)
- J Industrial Machinery & Equipment Facility (5)
- B Mineral Products Processing Industrial Facility (3)
- > Pharmaceutical Production Processes Industrial Facility (3)
- Q Primary Metal Industries Facility (1)
- Y Rubber & Miscellaneous Plastic Products Facility (1)
- U Stone, Clay, Glass, & Concrete Products (1)
- S Surface Coating Processes Industrial Facility (1)
- † Wholesale Trade (1)

Figure 15-5. Composite Back Trajectory Map for CANC

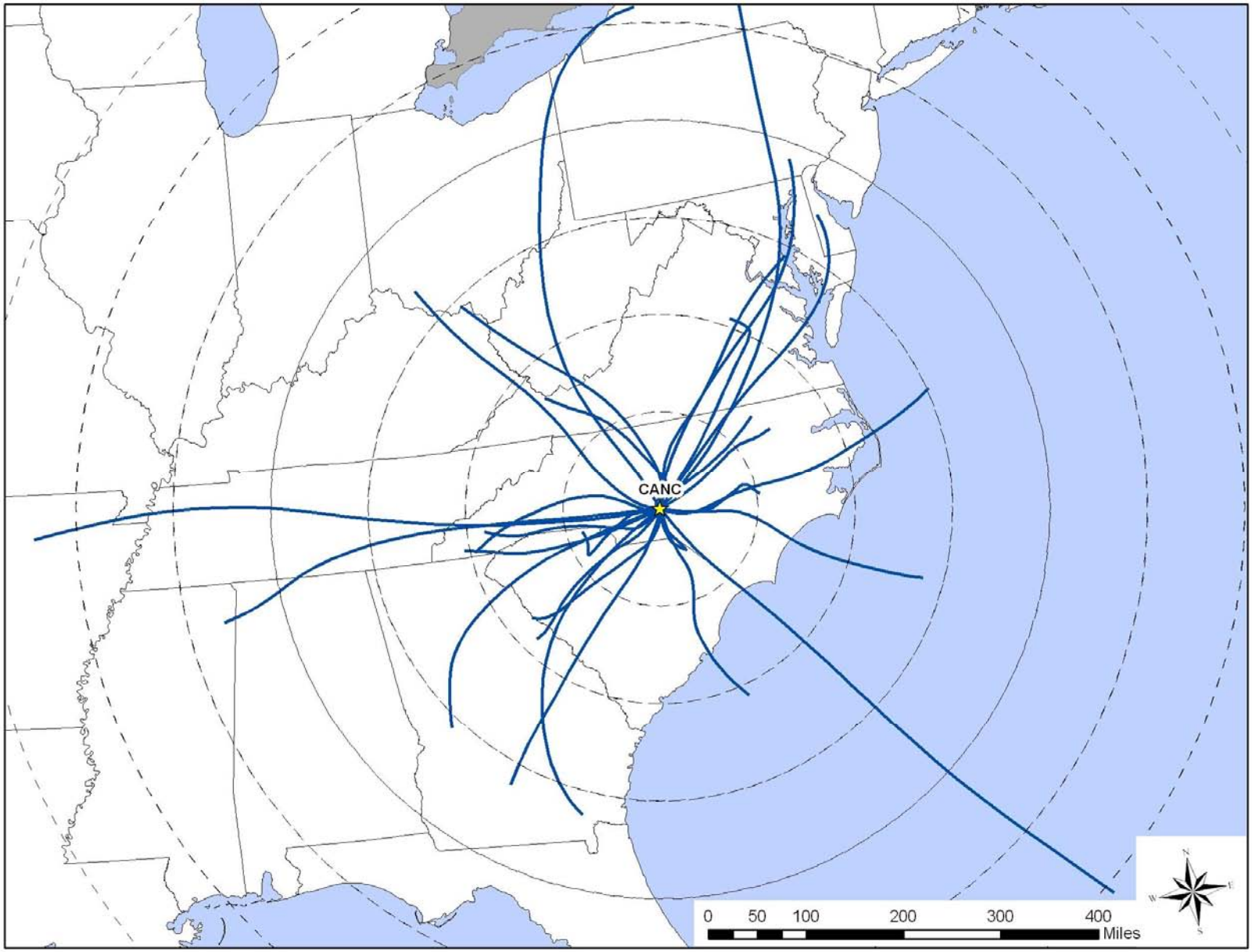


Figure 15-6. Composite Back Trajectory Map for RTPNC

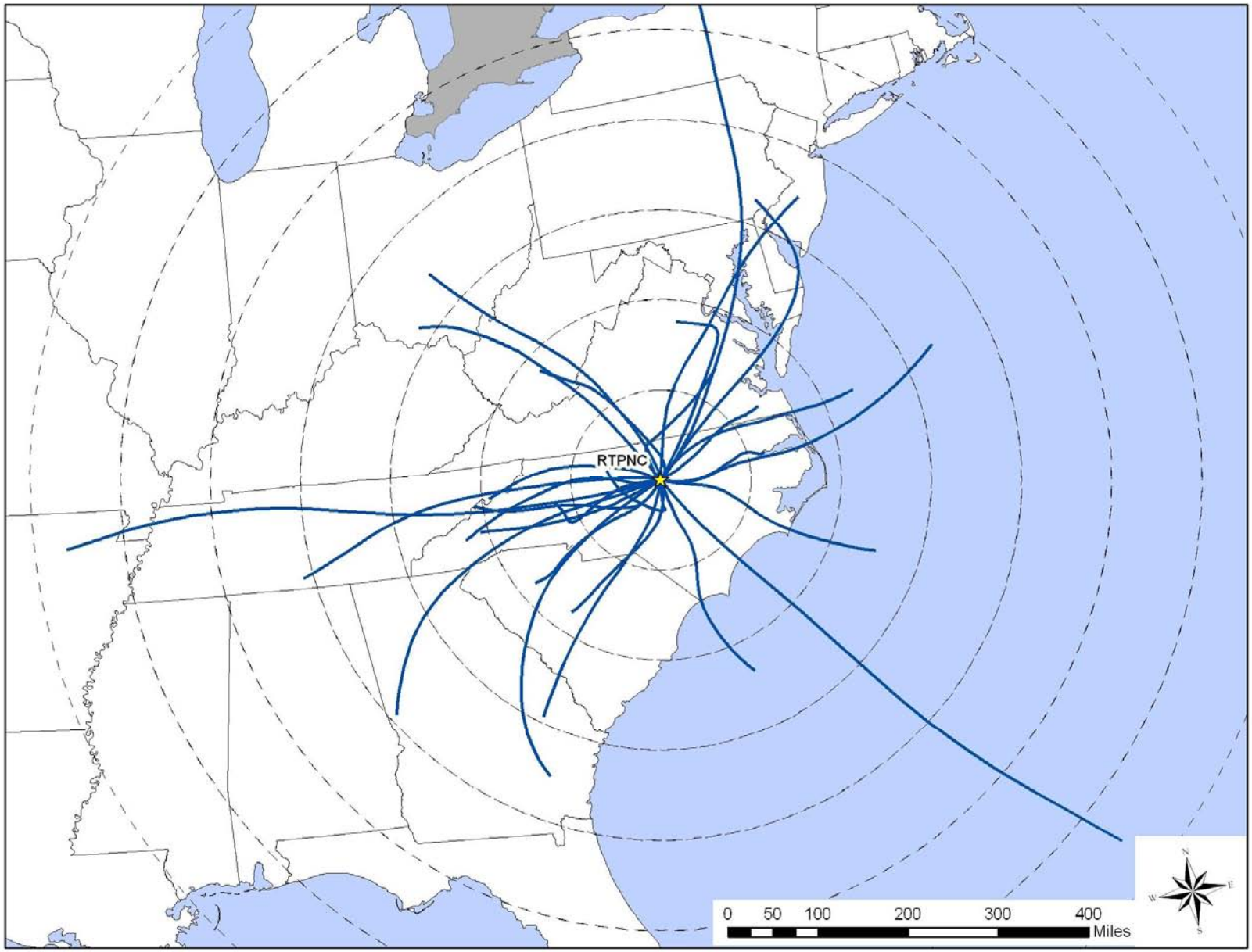


Figure 15-7. Wind Rose of Sample Days for the CANC Monitoring Site

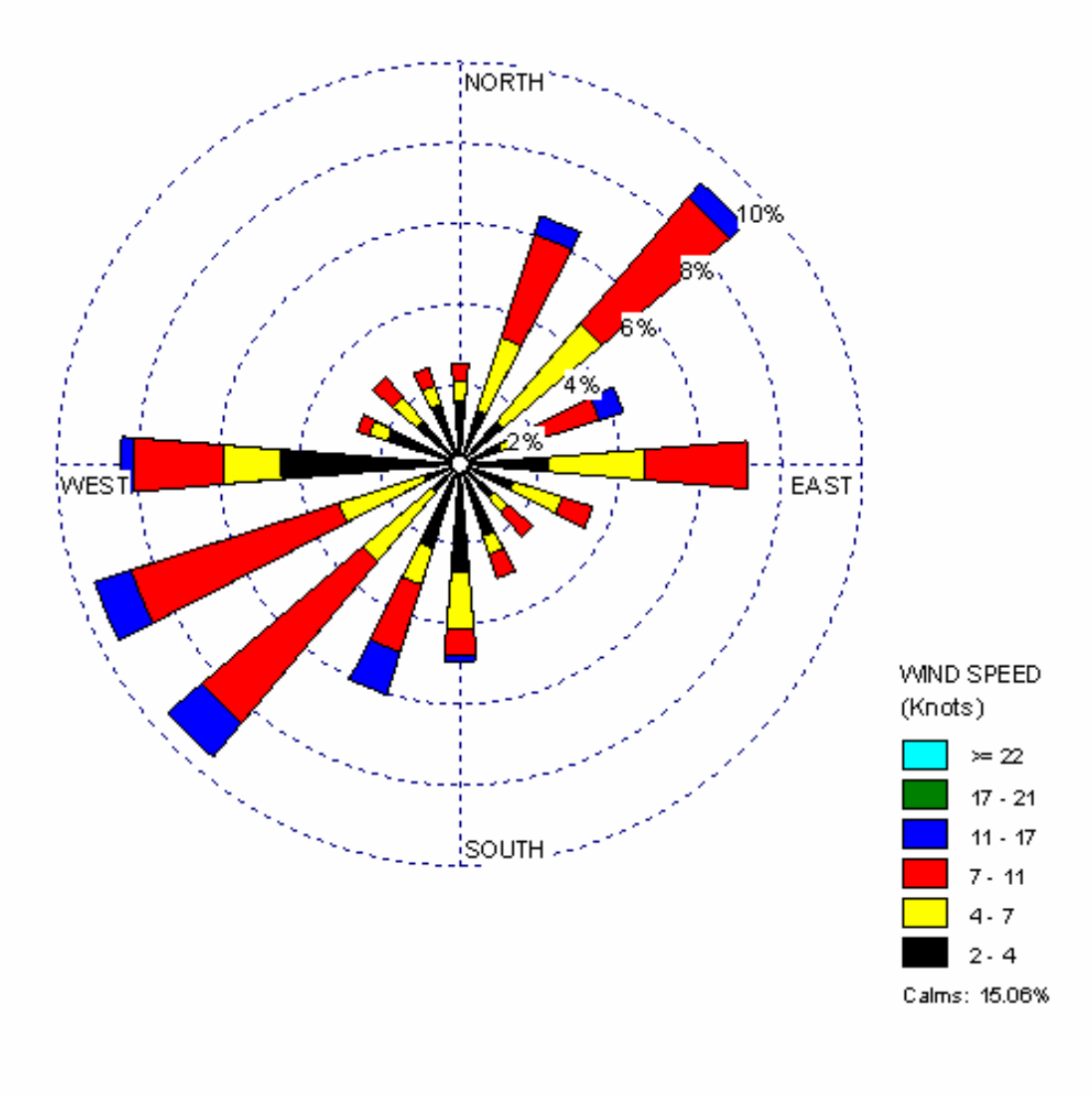


Figure 15-8. Wind Rose of Sample Days for the RTPNC Monitoring Site

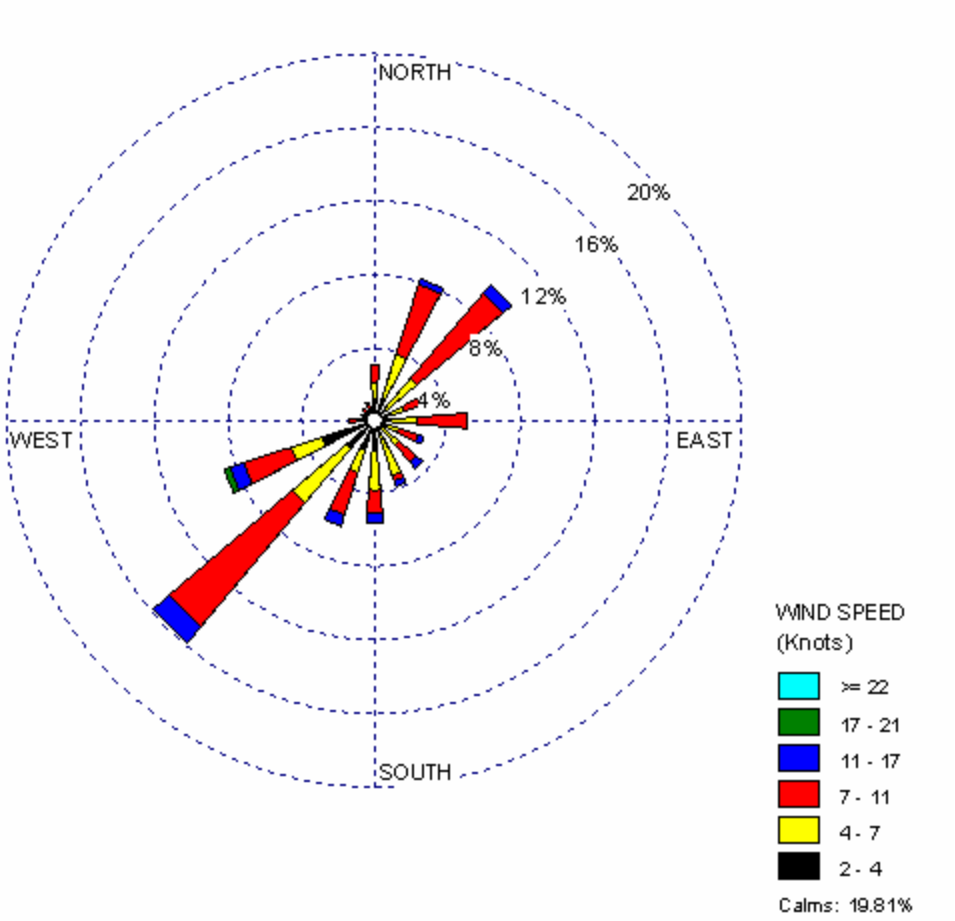


Figure 15-9. Comparison of Yearly Averages of the CANC Monitoring Site

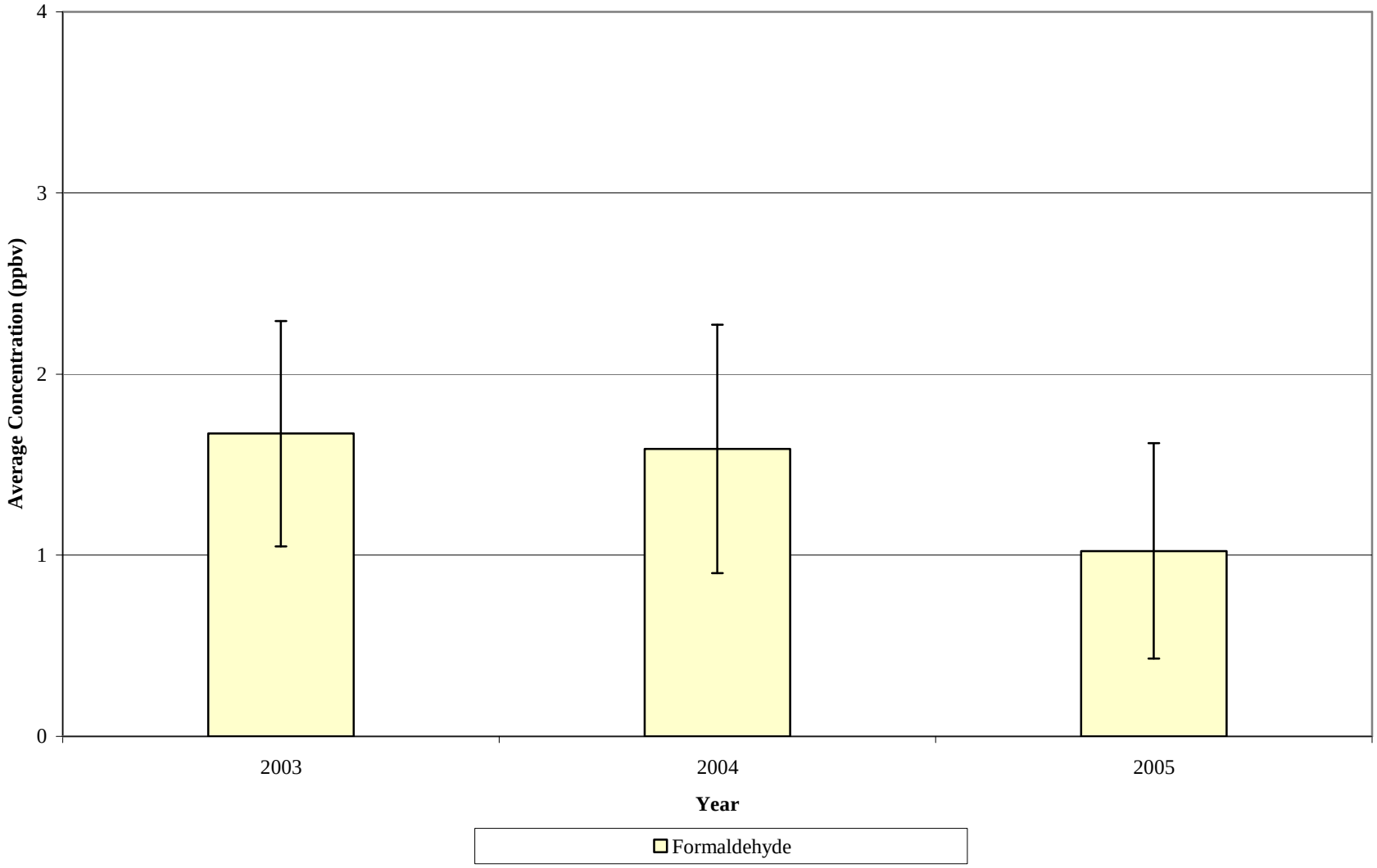


Table 15-1. Average Meteorological Parameters for Monitoring Sites in North Carolina

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
CANC	3720	All 2005	71.3 ± 1.68	60.51 ± 1.65	48.54 ± 1.94	56.09 ± 1.77	69.10 ± 1.67	NA[1]	0.34 ± 0.37	-0.01 ± 0.33
		Sample Day	71.46 ± 6.70	60.14 ± 6.18	48.23 ± 7.12	55.17 ± 6.95	68.18 ± 6.24	NA[1]	0.38 ± 1.47	0.35 ± 1.19
RTPNC	13722	All 2005	71.28 ± 1.74	60.53 ± 1.65	48.36 ± 1.86	54.25 ± 1.58	67.89 ± 1.34	1017.24 ± 0.69	0.32 ± 0.38	0.09 ± 0.37
		Sample Day	72.89 ± 6.54	62.57 ± 6.03	51.47 ± 6.56	56.55 ± 5.69	70.56 ± 4.92	1017.72 ± 2.75	-0.05 ± 1.41	0.84 ± 1.32

NA[1] = Sea level pressure was not recorded at this station.

Table 15-2. Comparison of Measured Concentrations and EPA Screening Values at the North Carolina Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Candor, North Carolina - CANC					
Acetaldehyde	24	27	88.9	70.6%	70.6%
Formaldehyde	10	27	37.0	29.4%	100.0%
Total	34	54	63.0		
Durham, North Carolina - RTPNC					
Acetaldehyde	23	27	85.2	56.1%	56.1%
Formaldehyde	18	27	66.7	43.9%	100.0%
Total	41	54	75.9		

Table 15-3. Daily and Seasonal Averages for Pollutants of Interest at the North Carolina Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Candor, North Carolina – CANC												
Acetaldehyde	27	27	0.82	0.14	0.85	0.17	0.77	0.20	NR	NR	0.87	0.33
Formaldehyde	27	27	1.26	0.73	0.69	0.16	0.54	0.12	NR	NR	1.16	0.40
Durham, North Carolina – RTPNC												
Acetaldehyde	27	27	1.23	0.28	NR	NR	NR	NR	0.59	0.38	1.19	0.45
Formaldehyde	27	27	1.57	0.56	NR	NR	NR	NR	2.91	1.65	1.48	0.46

NR = Not reportable due to the low number of detects.

Table 15-4. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the North Carolina Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Candor, North Carolina - CANC									
Acetaldehyde	26	-0.04	-0.03	-0.05	-0.09	-0.20	0.29	0.10	NA
Formaldehyde	26	0.33	0.36	0.30	0.32	0.02	0.04	0.01	NA
Durham, North Carolina - RTPNC									
Acetaldehyde	27	-0.21	-0.30	-0.37	-0.35	-0.34	0.34	0.16	-0.05
Formaldehyde	27	0.61	0.61	0.49	0.54	-0.12	0.13	0.10	-0.27

NA = This station did not record sea level pressure.

Table 15-5. Motor Vehicle Information for the North Carolina Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
CANC	27,322	26,843	0.98	11,014	10,821	100
RTPNC	242,582	175,758	0.72	380,541	275,713	12,000

Table 15-6. 1999 NATA Data Census Tract Summary for the Monitoring Sites in North Carolina

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Candor, North Carolina - CANC, Census Tract 37123960500				
Acetaldehyde	0.82 ± 0.14	0.57	1.25	0.06
Formaldehyde	1.26 ± 0.73	0.39	<0.01	0.04
Durham, North Carolina - RTPNC, Census Tract 37063002014				
Acetaldehyde	1.23 ± 0.28	1.21	2.65	0.13
Formaldehyde	1.57 ± 0.56	1.24	0.01	0.13

BOLD = pollutant of interest.

16.0 Sites in Oklahoma

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Oklahoma (PCOK and POOK). These sites are both located in Ponca City in north-central Oklahoma. Figures 16-1 and 16-2 are topographical maps showing the monitoring sites in their urban locations. Only a few city blocks separate the two sites. Figure 16-3 identifies point source emission locations within 10 miles of these sites as reported to the 2002 NEI for point sources. Only a handful of sources are located within a ten mile radius of these sites, although one chemical and allied products facility is located just south of PCOK.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the monitoring sites is the Ponca City Regional Airport (WBAN 13969).

Ponca City is located in north-central Oklahoma, just west of the Osage Indian Reservation and Kaw Lake. The area is characterized by a continental climate, with warm and often humid summers and cool winters. The region experiences ample rainfall, with spring as its wettest season. A southerly wind prevails, bringing warm, moist air northward from the Gulf of Mexico (Ruffner and Bair, 1987). Oklahoma is also in the heart of Tornado Alley, where severe thunderstorms capable of producing strong winds, hail, and tornadoes are not uncommon. Table16-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average u- and v- components of the wind) for the entire year and on days samples were taken. Table 16-1 shows a large difference between annual weather conditions and those observed on sample days. The Ponca City sites sampled only from May through July, which can explain the wide disparity between the two sets of averages.

16.1 Pollutants of Interest at the Oklahoma Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 16-2 presents the pollutants that failed at least one screen at the Oklahoma monitoring sites. The number of pollutants failing the screen varies by site, as indicated in Table 16-2. Ten pollutants with a total of 72 measured concentrations failed screens at PCOK, while six pollutants with a total of 57 measured concentrations failed screens at POOK. The pollutants of interest also varied by site, yet the following five pollutants contributed to the top 95% of the total failed screens at each Oklahoma monitoring site: acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene. An interesting observation between the two sites is that xylenes, toluene, acrylonitrile, and 1,1,2,2-tetrachloroethane were not detected at POOK, yet were detected just a few blocks away at PCOK.

It's important to note that the Oklahoma sites sampled for VOC and SNMOC only, and that this is reflected in Table 16-2. Also listed in Table 16-2 are the total number of detects and the percent detects failing the screen. Benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, and acrolein had 100% of their detects fail the screening values at both sites.

16.2 Concentration Averages at the Oklahoma Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently

higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 16-3. Annual averages will be presented and discussed in further detail in later sections.

The daily averages of 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene did not differ much between the two sites. The benzene concentration at PCOK (3.49 ± 1.87 μg/m^3) was three times that of POOK (1.16 ± 0.14 μg/m^3), while the acrolein concentration at POOK (7.36 ± 7.94 μg/m^3) was more than twice that of PCOK (3.00 ± 2.07 μg/m^3). However, the highest daily averages at the PCOK site were calculated for total xylenes (17.56 ± 11.48 μg/m^3) and toluene (15.57 ± 7.53 μg/m^3). The relatively large confidence interval indicates that these averages might be driven by a couple of outliers. As previously mentioned, the Oklahoma sites sampled during the summer only, so seasonal variability could not be evaluated.

16.3 Non-chronic Risk Evaluation at the Oklahoma Monitoring Sites

Non-chronic risk is evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 16-4.

All acrolein detects at the Oklahoma sites were greater than the ATSDR acute value of 0.11 μg/m^3 and the California REL value of 0.19 μg/m^3. The average detected concentration of acrolein was 3.00 ± 2.07 μg/m^3 at PCOK and 7.36 ± 7.94 μg/m^3 at POOK, which are an order of magnitude higher than either acute risk factor. The POOK daily acrolein average is one of the highest calculated for all VOC – sampling UATMP sites, second only to RRTX. No seasonal averages for acrolein could be calculated, therefore intermediate risk could not be evaluated.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Only acrolein concentrations exceeded the acute risk factors. Figures 16-4 and 16-5 are pollution roses for acrolein at the Ponca City sites. A pollution rose is a plot of concentration and wind direction. As shown in Figures 16-4 and 16-5, all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

There are not enough detects of acrolein at the Oklahoma sites to determine if a pattern exists between concentration and wind direction. However, it is interesting to note that the two detects at each site were detected on the same dates, July 6 and July 18, and that the July 18, 2005 concentrations were significantly higher than the July 6, 2005 concentrations at both sites. Also, these acrolein detects occurred with east and southeasterly winds. These sites are located in the heart of Ponca City, near a railroad that is oriented north-south through the middle of town.

16.4 Meteorological and Concentration Analysis at the Oklahoma Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

16.4.1 Pearson Correlation Analysis

Table 16-4 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Oklahoma monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) At PCOK, benzene, *p*-dichlorobenzene, and total xylenes exhibited moderately strong to very strong negative correlations with maximum and average temperature, while carbon tetrachloride exhibited moderately strong positive correlations with these parameters. With the exception of carbon tetrachloride, the correlations with dew point and wet bulb temperatures were negative, although carbon tetrachloride's correlations with these parameters were fairly strong (0.48 and 0.49, respectively). The strongest correlation with relative humidity was calculated for

p-dichlorobenzene (0.68). Several of the pollutants of interest at PCOK exhibited strong negative correlations with the *u*-component of the wind and very strong negative correlations with sea level pressure.

At POOK, all of the correlations between the pollutants of interest and maximum and average temperature were negative. *p*-Dichlorobenzene had the strongest of these correlations (with maximum temperature -0.62). *p*-Dichlorobenzene also had moderately strong to strong negative correlations with dew point and wet bulb temperatures (-0.27 and -0.38, respectively), the *u*-component of the wind (-0.45), and sea level pressure (-0.73). Moderately strong positive correlations were also calculated between relative humidity and 1,3-butadiene (0.44) and carbon tetrachloride (0.32) as well as between the *v*-component of the wind and benzene (0.33) and *p*-dichlorobenzene (0.37).

16.4.2 Composite Back Trajectory Analysis

Figures 16-6 and 16-7 are composite back trajectory maps for the Oklahoma monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site represents 100 miles.

As shown in Figure 16-6, the summer back trajectories originated predominantly from the south and southeast at PCOK. The 24-hour airshed domain is smaller than most UATMP sites, with trajectories originating as far away as the Texas Coast, or over 500 miles away. Over 50% of the trajectories originated within 300 miles of the site and 82% within 400 miles from the PCOK monitoring site. The composite back trajectory map might look different if a full year of sampling was included.

As shown in Figure 16-7, the summer back trajectories originated predominantly from the south and southeast at POOK. The 24-hour airshed domain is smaller than most UATMP sites, with trajectories originating as far away as the Texas Coast, or over 500 miles away. Nearly 36% of the trajectories originated within 200 miles of the site; and 82% within 400 miles

from the POOK monitoring site. The composite back trajectory map might look different if a full year of sampling was included.

16.4.3 Wind Rose Analysis

Hourly wind data from the Ponca City Regional Airport weather station were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 16-8 and 16-9 are the wind roses for the Oklahoma monitoring sites on days sampling occurred.

As indicated in Figure 16-8, hourly winds near PCOK were predominantly out of the southeast (21% of observations). Over 72% of wind direction observations originated from an easterly, southeasterly, or southerly direction. Calm winds (<2 knots) were recorded for nearly 13% of the hourly measurements. For wind speeds greater than 2 knots, 49% of observations ranged from 7 to 11 knots. The POOK percentages are very similar to PCOK's, as shown in Figure 16-9. Twenty percent of the wind observations at POOK originated from the southeast, and over 70% of wind direction observations originated from an easterly, southeasterly, or southerly direction. Nearly 49% of observations ranged from 7 to 11 knots while calm winds were recorded for nearly 13% of the hourly measurements.

16.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and ethylene-acetylene ratio analysis.

16.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Kay County were obtained from the Oklahoma Tax Commission and the U.S. Census Bureau, and are summarized in Table 16-6. Table 16-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the

vehicle registration ratio. Finally, Table 16-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis. With the two Oklahoma monitoring sites located so close to each other, the population and vehicle registration data is the same. However, the PCOK site experiences over twice the daily traffic volume than the POOK site. In comparison with other UATMP sites, PCOK and POOK's population and vehicle ownership is on the low side. But PCOK's daily traffic count falls in the middle of the range of UATMP sites.

16.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. Both Oklahoma sites' ratios somewhat resemble those of the roadside study. At PCOK, all three ratios are slightly lower than those of the roadside study (1.38 ± 0.21 vs. 2.85 for benzene-ethylbenzene; 4.87 ± 0.87 vs 5.85 for toluene-ethylbenzene; and 2.23 ± 0.47 vs 4.55 for xylenes-ethylbenzene). At POOK, the benzene-ethylbenzene and xylenes-ethylbenzene ratios are slightly lower than those of the roadside study (2.01 ± 0.22 vs. 2.85 for benzene-ethylbenzene and 2.95 ± 0.19 vs 4.55 for xylenes-ethylbenzene), while the toluene-ethylbenzene ratio is slightly higher (6.11 ± 0.57 vs. 5.85).

16.5.3 Mobile Tracer Analysis

As previously stated, PCOK and POOK sampled for SNMOCs in addition to VOCs. Acetylene is a pollutant that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile sources have found that concentrations of ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3.) Listed in Table 3-10 is the ethylene to acetylene ratio for the Oklahoma monitoring sites.

As shown, PCOK and POOK's ethylene-acetylene ratios, 1.53 ± 0.21 and 1.25 ± 0.23, respectively, are somewhat lower than the 1.7 ratio. These ratios suggest that while mobile sources may be influencing the air quality at the Oklahoma monitoring sites, there may also be atmospheric chemical processes affecting the quantities of ethylene in this area. Known sinks of ethylene include reactions with ozone, as well as soil (National Library of Medicine).

16.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 16-7 presents the 1999 NATA results for the census tracts where the Oklahoma monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 16-7. Pollutants of interest are bolded.

16.6.1 1999 NATA Summary

The PCOK monitoring site is located in census tract 40071000500 with a population of 4,232, which represents 8.8% of the Kay County population in 2000. The POOK monitoring site is located in census tract 40071000400, with a population of 2,608, which represents 5.4% of Kay County's 2000 population. The pollutants of interest at both sites with the highest cancer risk are benzene and carbon tetrachloride. While the POOK cancer risk for benzene was higher than at PCOK (9.38 in a million vs 5.69 in a million), the carbon tetrachloride risk was nearly the same at both sites (3.13 and 3.18). Acrolein was the only pollutant in the POOK census tract to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). However, the acrolein noncancer risk at PCOK was just less than 1.0 (0.90). The noncancer hazard quotients were less than 0.05, suggesting very little risk for noncancer health affects.

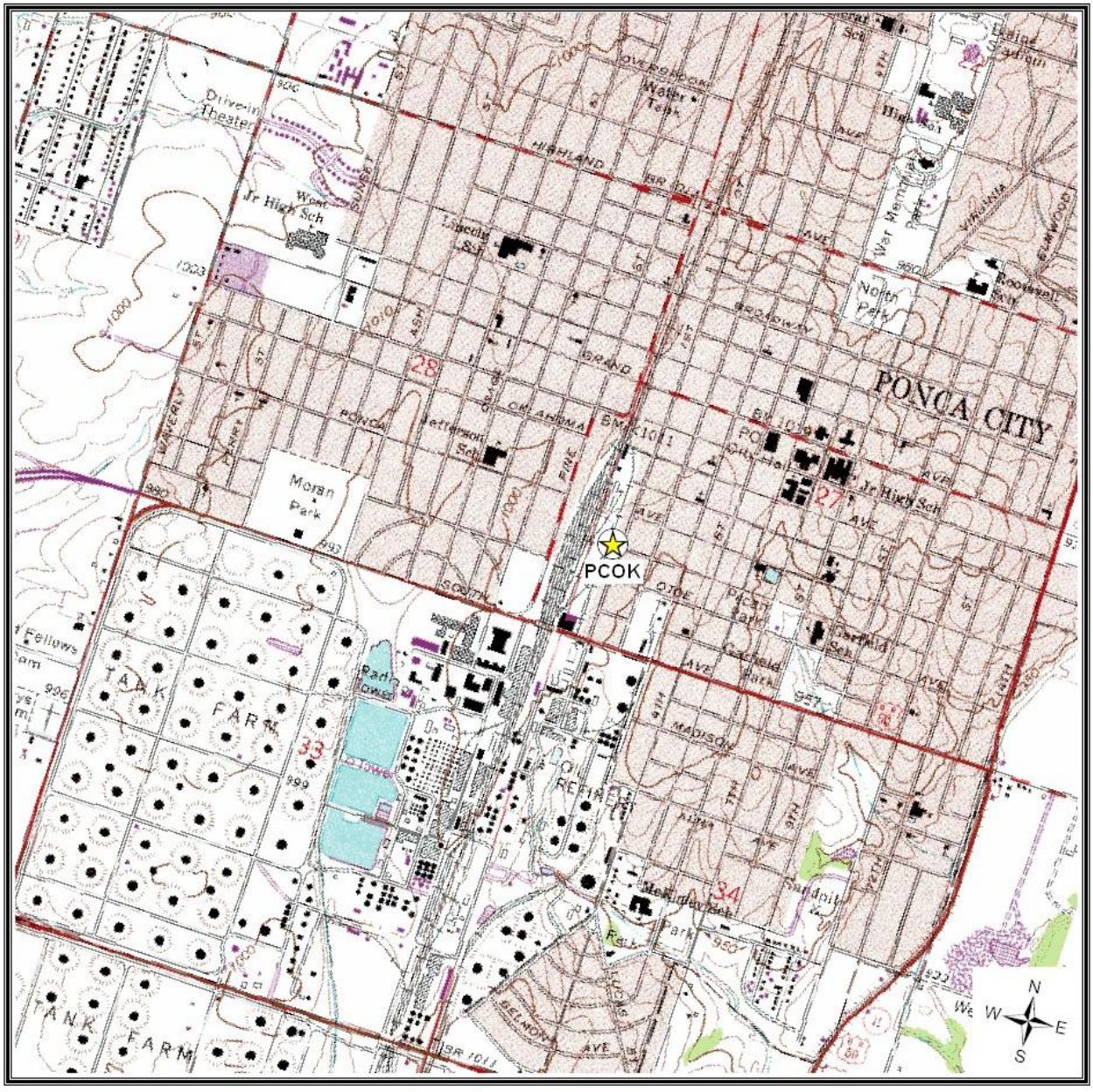
16.6.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 16.2 on how a valid annual average is calculated). Unfortunately, the Oklahoma sites did not begin sampling until May 2005 and ended in July 2005, therefore, valid annual averages could not be calculated.

Oklahoma Pollutant Summary

- *The pollutants of interest common to both Ponca City sites are acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and p-dichlorobenzene.*
- *Total xylenes measured the highest daily average at PCOK, while acrolein measured highest at POOK.*
- *Acrolein exceeded the short-term risk factors at both sites.*

Figure 16-1. Ponca City, Oklahoma (PCOK) Monitoring Site



Sources: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 16-2. Ponca City, Oklahoma (POOK) Monitoring Site

Sources: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 16-3. Facilities Located Within 10 Miles of PCOK and POOK

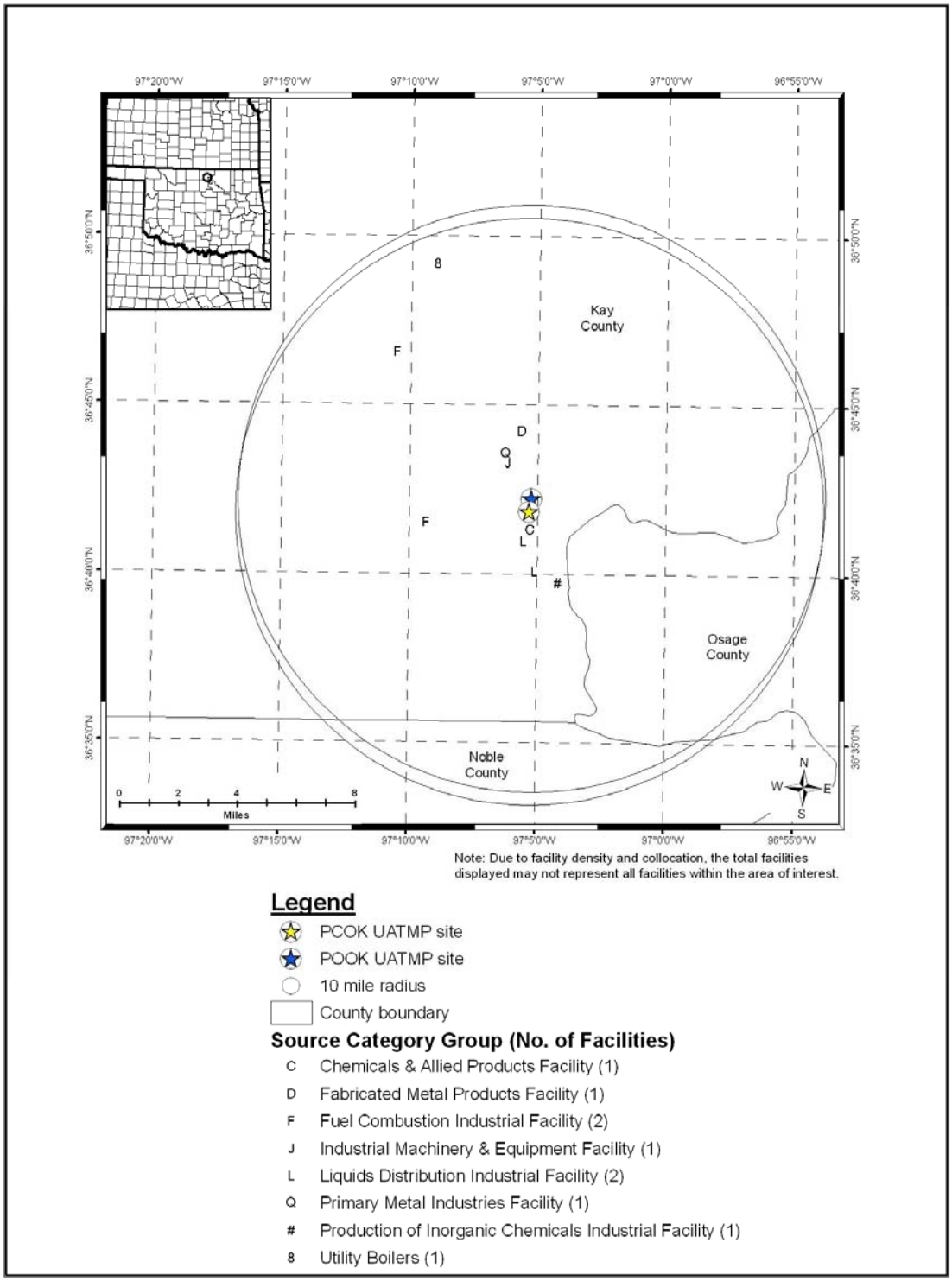


Figure 16-4. Acrolein Pollution Rose at PCOK

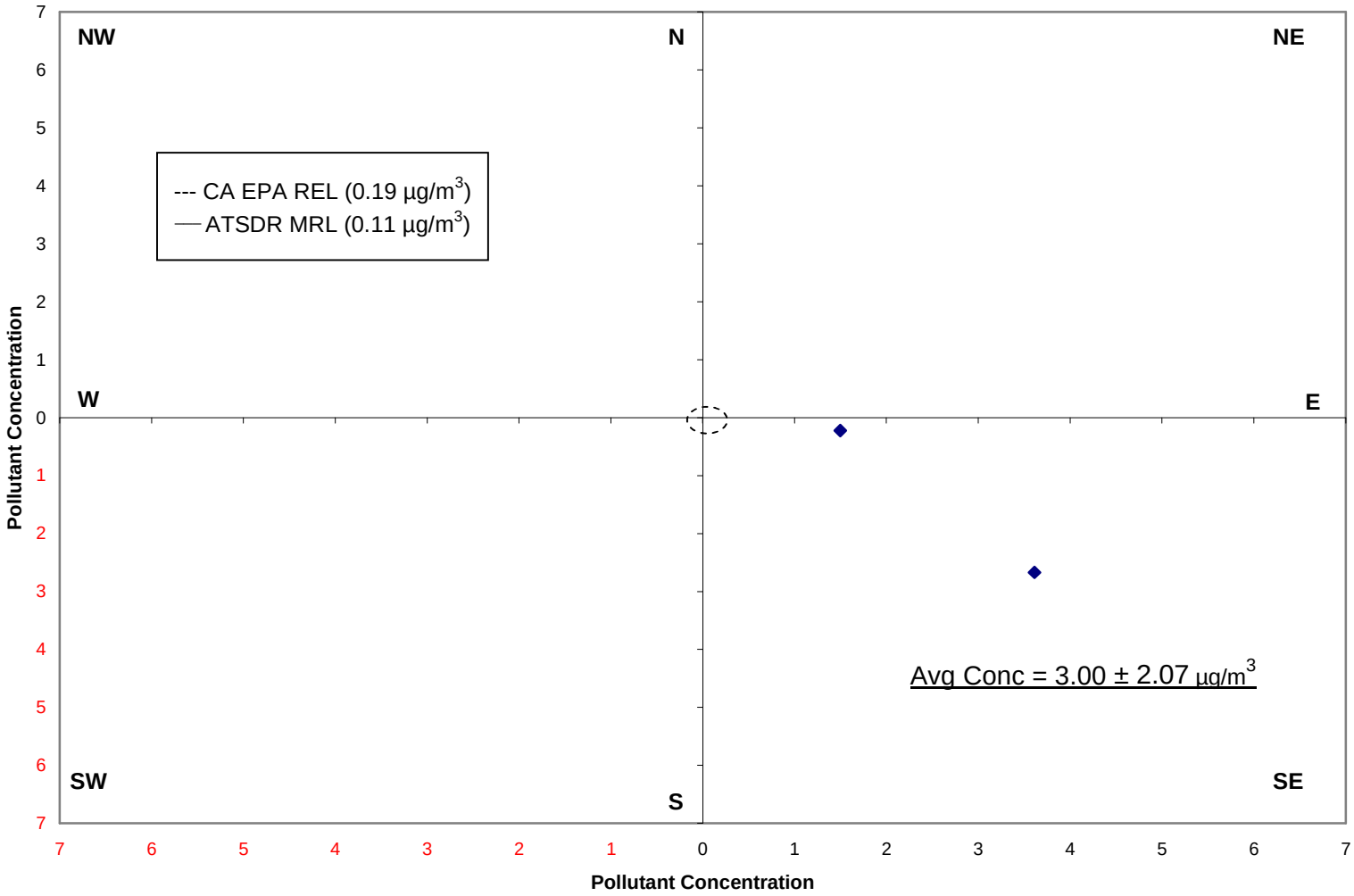


Figure 16-5. Acrolein Pollution Rose at POOK

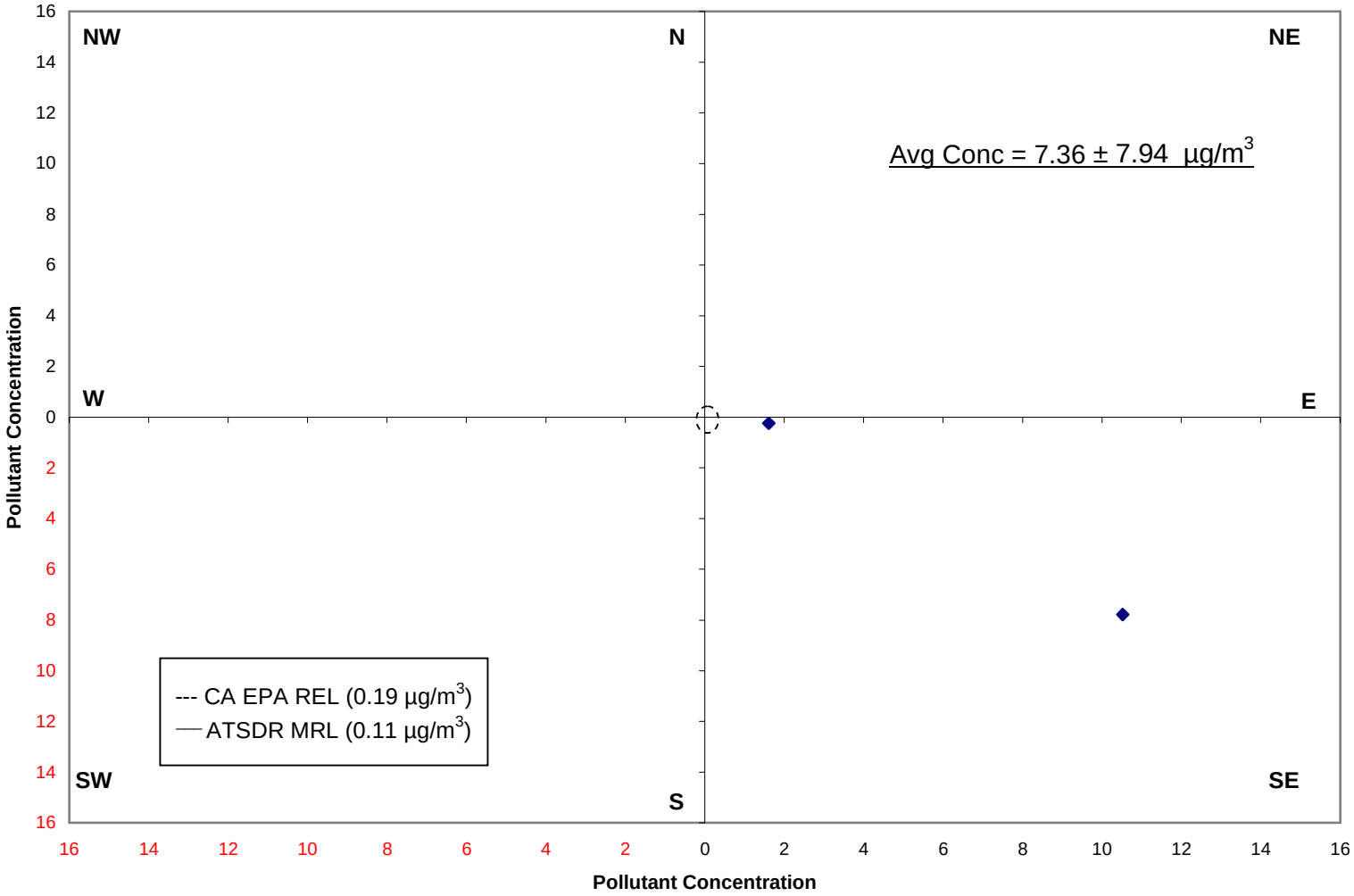


Figure 16-6. Composite Back Trajectory Map for PCOK

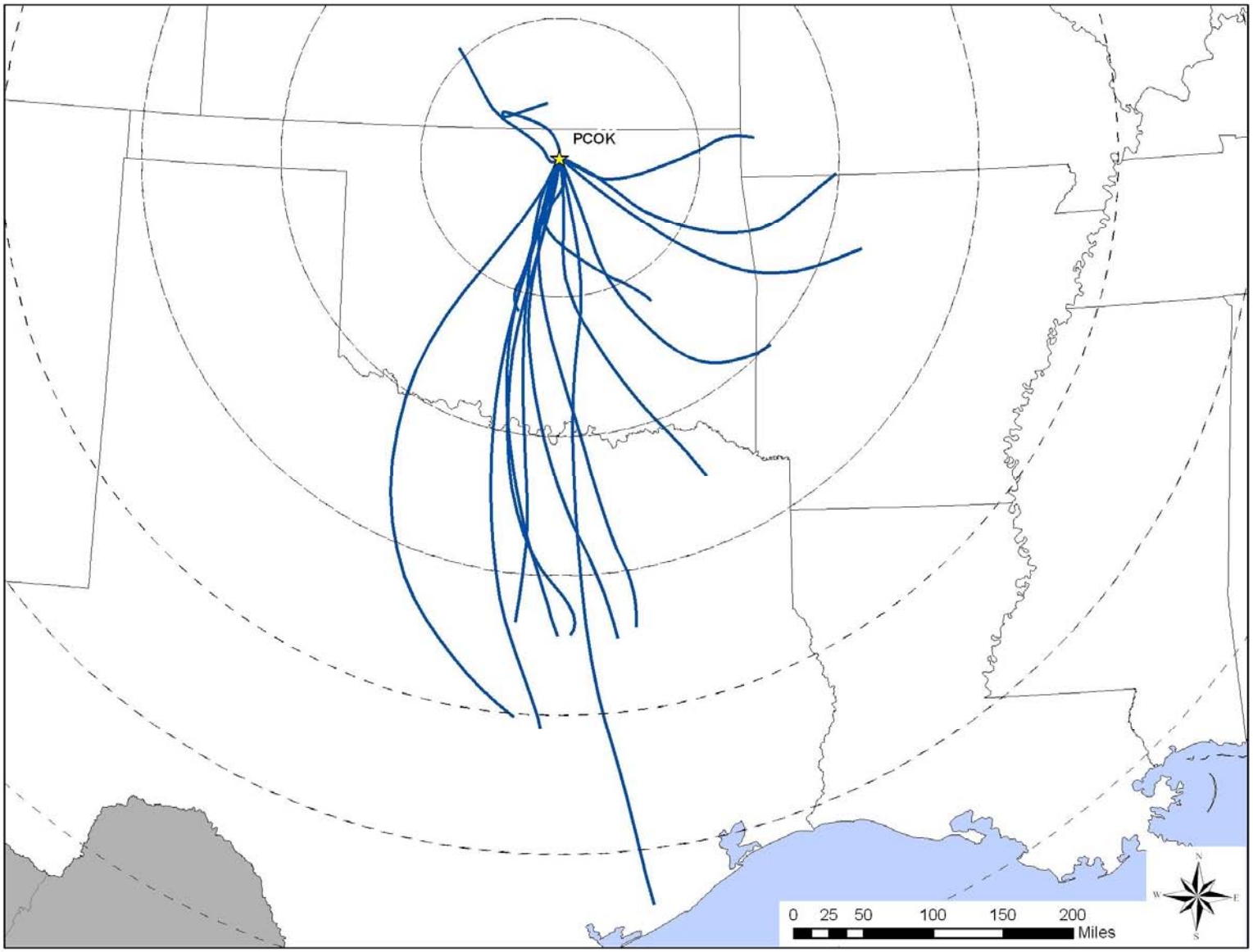


Figure 16-7. Composite Back Trajectory Map for POOK

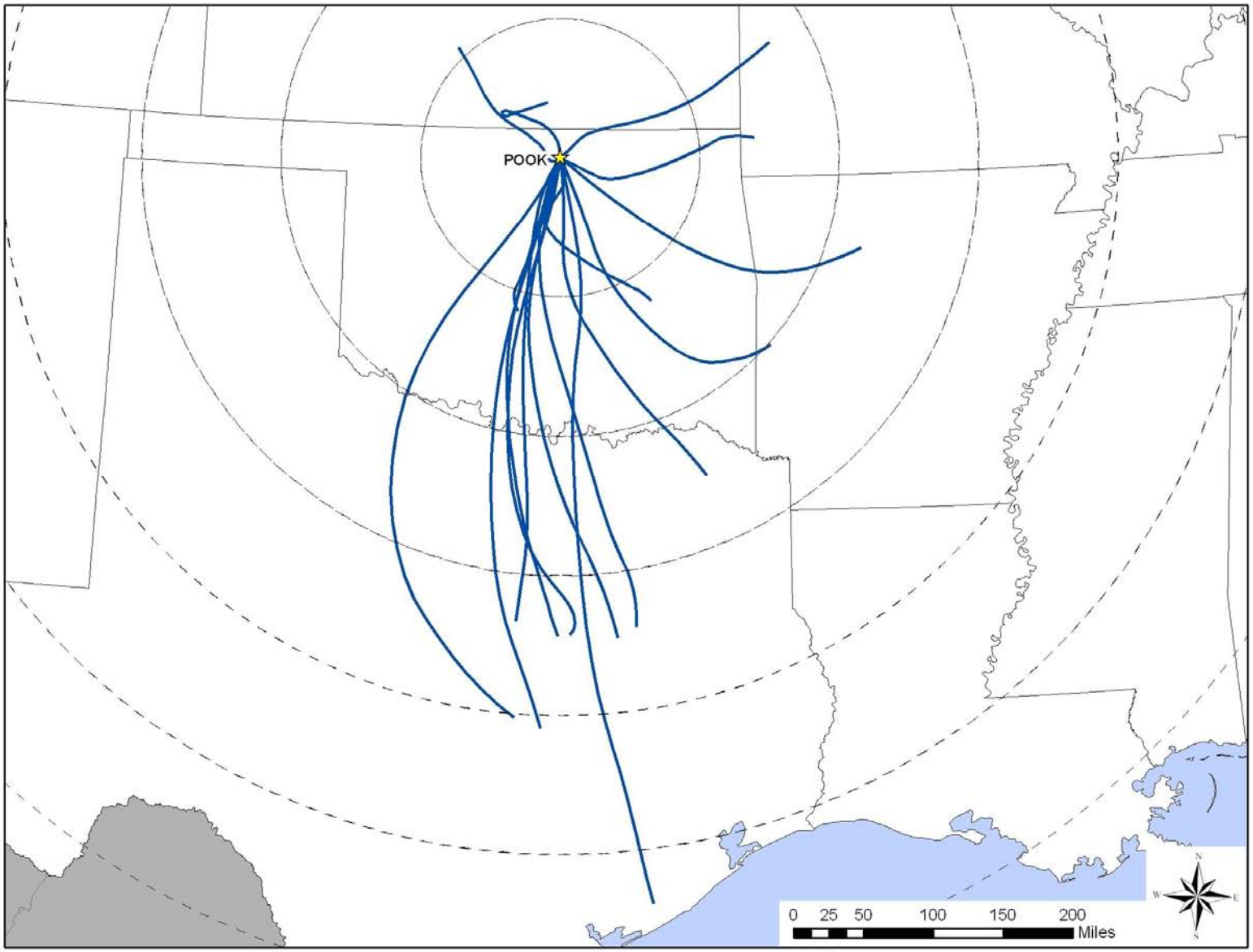


Figure 16-8. Wind Rose of Sample Days for the PCOK Monitoring Site

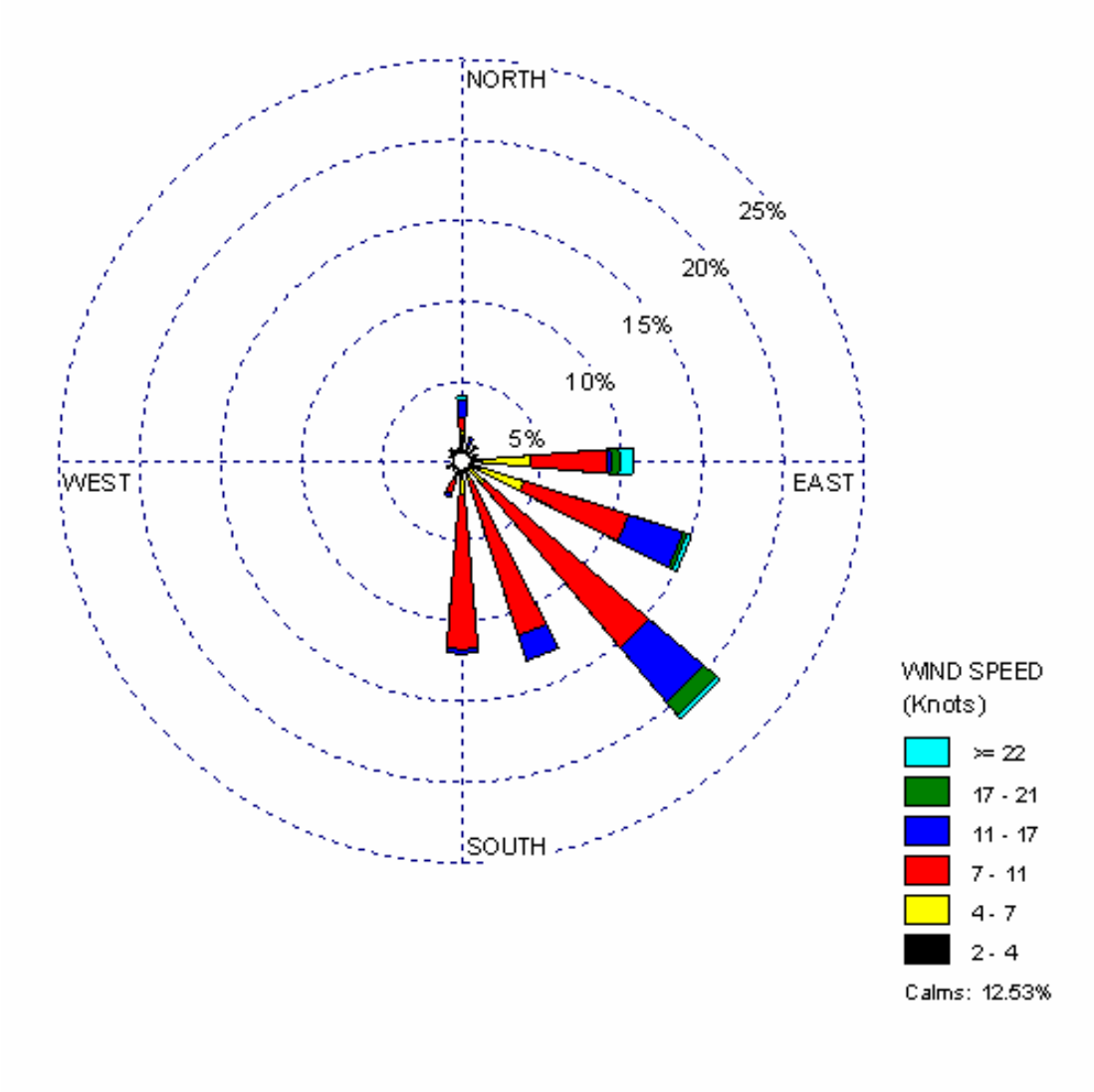


Figure 16-9. Wind Rose of Sample Days for the POOK Monitoring Site

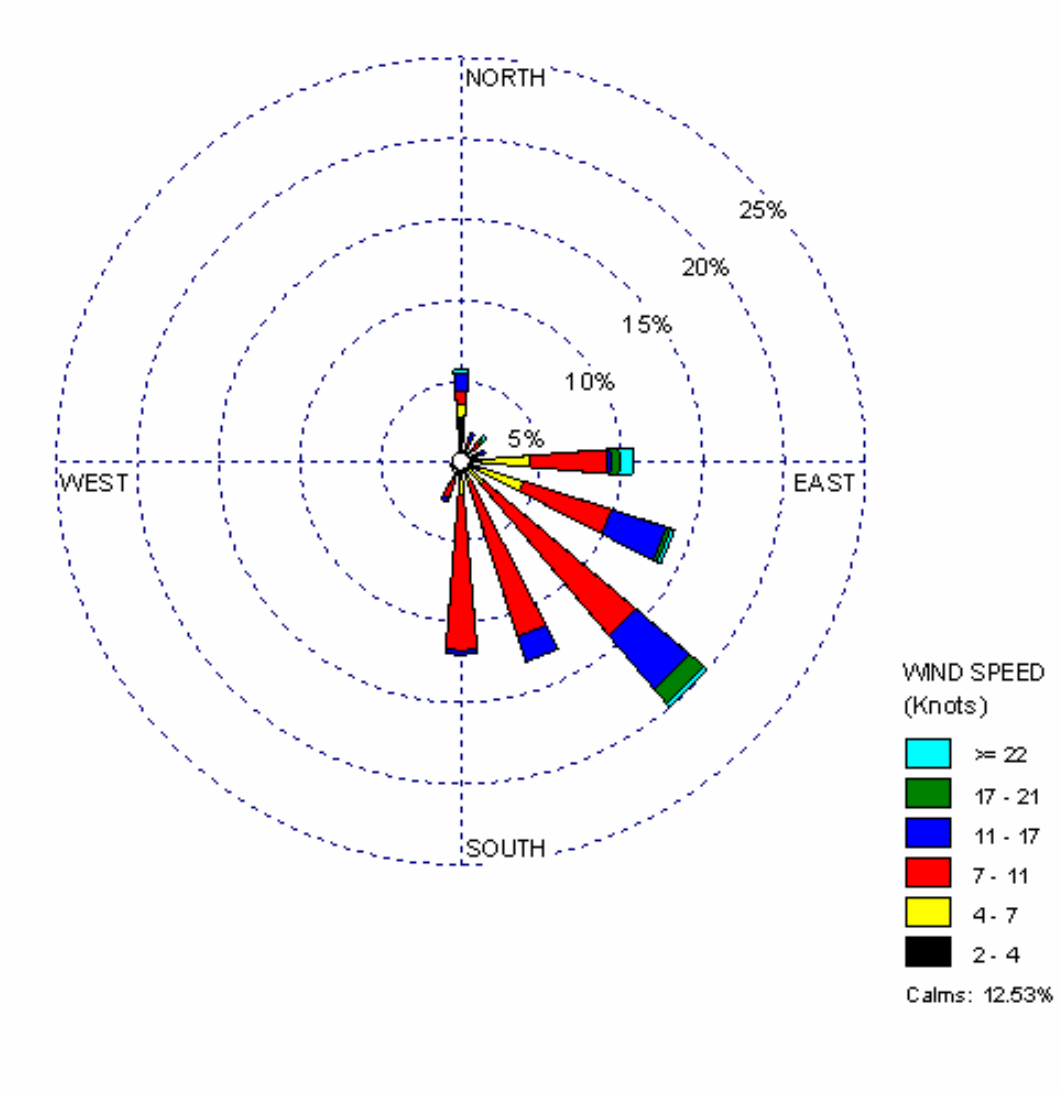


Table 16-1. Average Meteorological Parameters for Monitoring Sites in Oklahoma

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
PCOK	13969	All 2005	70.78 ± 1.91	59.97 ± 1.88	47.16 ± 1.8	53.03 ± 1.67	66.26 ± 1.25	1015.83 ± 0.73	-1.73 ± 0.40	1.17 ± 0.58
		Sample Day	88.29 ± 2.34	77.92 ± 2.63	65.55 ± 1.82	69.71 ± 1.73	68.36 ± 4.50	1012.60 ± 1.80	-4.08 ± 1.37	3.76 ± 1.60
POOK	13969	All 2005	70.78 ± 1.91	59.97 ± 1.88	47.16 ± 1.8	53.03 ± 1.67	66.26 ± 1.25	1015.83 ± 0.73	-1.73 ± 0.40	1.17 ± 0.58
		Sample Day	88.94 ± 2.14	78.69 ± 2.38	66.07 ± 1.87	70.28 ± 1.67	67.84 ± 4.23	1012.71 ± 1.79	-4.11 ± 1.37	3.56 ± 1.75

Table 16-2. Comparison of Measured Concentrations and EPA Screening Values at the Oklahoma Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Ponca City, OK – Site 1 - PCOK					
Benzene	17	17	100.00	23.6%	23.6%
Carbon Tetrachloride	17	17	100.00	23.6%	47.2%
1,3-Butadiene	15	15	100.00	20.8%	68.1%
p-Dichlorobenzene	10	10	100.00	13.9%	81.9%
Xylenes	5	17	29.41	6.9%	88.9%
Tetrachloroethylene	3	7	42.86	4.2%	93.1%
Acrolein	2	2	100.00	2.8%	95.8%
1,1,2,2-Tetrachloroethane	1	1	100.00	1.4%	97.2%
Toluene	1	17	5.88	1.4%	98.6%
Acrylonitrile	1	1	100.00	1.4%	100.0%
Total	72	104			
Ponca City, OK – Site 2 - POOK					
Carbon Tetrachloride	15	15	100.00	26.3%	26.3%
Benzene	15	15	100.00	26.3%	52.6%
p-Dichlorobenzene	12	12	100.00	21.1%	73.7%
1,3-Butadiene	12	12	100.00	21.1%	94.7%
Acrolein	2	2	100.00	3.5%	98.2%
Tetrachloroethylene	1	3	33.33	1.8%	100.0%
Total	57	59			

Table 16-3. Daily and Seasonal Averages for Pollutants of Interest at the Oklahoma Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Site #1 in Ponca City, OK – PCOK												
Acrolein	2	6	3.00	2.07	NA	NA	NA	NA	NR	NR	NA	NA
1,3-Butadiene	15	17	0.08	0.02	NA	NA	NA	NA	0.08	0.01	NA	NA
Benzene	17	17	3.49	1.87	NA	NA	NA	NA	3.57	2.10	NA	NA
Carbon Tetrachloride	17	17	0.67	0.05	NA	NA	NA	NA	0.70	0.05	NA	NA
p-Dichlorobenzene	10	17	0.24	0.05	NA	NA	NA	NA	0.22	0.04	NA	NA
Tetrachloroethylene	7	17	0.18	0.07	NA	NA	NA	NA	0.18	0.03	NA	NA
Xylenes	17	17	17.56	11.48	NA	NA	NA	NA	17.88	12.94	NA	NA
Site #2 in Ponca City, OK – POOK												
Acrolein	2	7	7.36	7.94	NA	NA	NA	NA	NR	NR	NA	NA
1,3-Butadiene	12	15	0.08	0.01	NA	NA	NA	NA	0.08	0.01	NA	NA
Benzene	15	15	1.16	0.14	NA	NA	NA	NA	1.17	0.15	NA	NA
Carbon Tetrachloride	15	15	0.66	0.04	NA	NA	NA	NA	0.67	0.04	NA	NA
p-Dichlorobenzene	12	15	0.27	0.05	NA	NA	NA	NA	0.26	0.05	NA	NA

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 16-4. Non-Chronic Risk Summary at the Oklahoma Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
PCOK	TO-15	Acrolein	3.00 ± 2.07	0.11	2	0.19	2	0.09	NA	NA	NR	NA
POOK	TO-15	Acrolein	7.36 ± 7.94	0.11	2	0.19	2	0.09	NA	NA	NR	NA

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 16-5. Pollutants of Interest Concentration Correlation with Selected Meteorological Parameters at the Oklahoma Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Ponca City, OK – Site 1 - PCOK									
1,3-Butadiene	15	0.01	0.01	-0.22	-0.13	-0.21	0.31	-0.05	0.41
Acrolein	2	NA							
Benzene	17	-0.40	-0.33	-0.04	-0.18	0.35	-0.68	0.01	-0.78
Carbon Tetrachloride	17	0.35	0.40	0.48	0.49	-0.10	-0.09	0.26	-0.24
p-Dichlorobenzene	10	-0.84	-0.82	-0.48	-0.73	0.68	-0.66	-0.22	-0.80
Tetrachloroethylene	7	0.16	-0.07	-0.47	-0.37	-0.21	0.22	-0.21	0.02
Xylenes	17	-0.41	-0.35	-0.04	-0.19	0.36	-0.70	-0.01	-0.78
Ponca City, OK – Site 2 - POOK									
1,3-Butadiene	12	-0.27	-0.49	-0.12	-0.36	0.44	0.16	-0.24	-0.05
Acrolein	2	NA							
Benzene	15	-0.10	-0.09	0.05	0.01	0.14	0.01	0.33	-0.23
Carbon Tetrachloride	15	-0.18	-0.19	0.11	-0.01	0.32	-0.11	-0.18	-0.17
p-Dichlorobenzene	12	-0.62	-0.39	-0.27	-0.38	0.20	-0.45	0.37	-0.73

Table 16-6. Motor Vehicle Information for the Oklahoma Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
PCOK	46,480	37,218	0.80	33,081	26,489	8,100
POOK	46,480	37,218	0.80	33,081	26,489	3,800

Table 16-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Oklahoma

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Site #1 in Ponca City, OK - PCOK, Census Tract 40071000500				
1,1,2,2-Tetrachloroethane	NA	0.02	1.41	--
1,3-Butadiene	NA	0.04	1.08	0.02
Acrolein	NA	0.02	--	0.90
Acrylonitrile	NA	<0.01	<0.01	<0.01
Benzene	NA	0.73	5.69	0.02
Carbon Tetrachloride	NA	0.21	3.15	0.01
***p*-Dichlorobenzene**	NA	0.01	0.15	<0.01
Tetrachloroethylene	NA	0.06	0.32	<0.01
Toluene	NA	1.30	--	<0.01
Xylenes	NA	1.11	--	0.01
Site #2 in Ponca City, OK - POOK, Census Tract 40071000400				
1,3-Butadiene	NA	0.08	2.29	0.04
Acrolein	NA	0.03	--	1.27
Benzene	NA	1.20	9.38	0.04
Carbon Tetrachloride	NA	0.21	3.18	0.01
***p*-Dichlorobenzene**	NA	0.01	0.15	<0.01
Tetrachloroethylene	NA	0.06	0.35	<0.01

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

17.0 Sites in Puerto Rico

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Puerto Rico (BAPR and SJPR). SJPR is located in San Juan, and BAPR is located further west in Barceloneta. Both sites lie on the northern coast of Puerto Rico. Figures 17-1 and 17-2 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 17-3 and 17-4 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 17-3 shows, many of the emission sources near BAPR are located just east of the monitoring site and are involved in pharmaceutical production. Many of the emission sources near SJPR are also located just east of the monitoring site and are involved in chemical and allied product and fabricated metal product industries.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the Puerto Rico monitoring sites is Luis Munoz Marin International Airport (WBAN 11641).

The island of Puerto Rico is located in the northern Caribbean and experiences a tropical climate, where the air is warm and humid year-round and rainfall is abundant. Breezy winds flow from the northeast to east on average with the aid of the sub-tropical high pressure that resides over the tropical Atlantic Ocean. However, the sea-breeze is a daily occurrence (Ruffner and Bair, 1987). Table 17-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 17-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

17.1 Pollutants of Interest at the Puerto Rico Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured

pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 17-2 presents the pollutants that failed at least one screen at the Puerto Rico monitoring sites. Fourteen pollutants with a total of 284 measured concentrations failed the screen at BAPR and 14 pollutants with a total of 272 measured concentrations failed the screen at SJPR. Interestingly, the pollutants with at least one failed screen are the same at both sites. However, the pollutants of interest varied by site; the following six pollutants contributed to the top 95% of the total failed screens at each Puerto Rico monitoring site: benzene, acetaldehyde, carbon tetrachloride, 1,3-butadiene, *p*-dichlorobenzene, and acrolein. It's important to note that the Puerto Rico sites sampled for carbonyl compounds and VOC only, and that this is reflected in each site's pollutants of interest.

Also listed in Table 17-2 are the total number of detects and the percent detects failing the screen. Of the six pollutants that were the same for both sites, five pollutants of interest, benzene, carbon tetrachloride, 1,3-butadiene, *p*-dichlorobenzene, and acrolein had 100% of their detects fail the screening values. Formaldehyde, a pollutant of interest at SJPR, failed 36 of 40 screens at SJPR, but failed only 5 of 49 screens at BAPR. Dichloromethane, a pollutant of interest at BAPR, failed 37 of 48 screens at BAPR, but failed only 3 of 34 screens at SJPR.

17.2 Concentration Averages at the Puerto Rico Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no

later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 17-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at BAPR, dichloromethane measured the highest concentration by mass (6.63 ± 2.03 μg/m^3), followed by acrolein (1.98 ± 1.00 μg/m^3) and acetaldehyde (1.44 ± 0.23 μg/m^3). As the Puerto Rico sites did not begin monitoring until late February, no seasonal average is available for winter. The seasonal averages of the pollutants of interest at BAPR did not vary much, although the spring acetaldehyde average is slightly higher than the other computable seasonal acetaldehyde averages. Acetaldehyde, benzene, carbon tetrachloride, and dichloromethane were detected in every sample taken at BAPR.

Among the daily averages at SJPR, total xylenes measured the highest concentration by mass (10.47 ± 1.31 μg/m^3), followed by acetaldehyde (6.21 ± 2.22 μg/m^3) and formaldehyde (2.24 ± 0.24 μg/m^3). Similar to BAPR, the seasonal averages of the pollutants of interest at SJPR did not vary much, although the spring acetaldehyde average is slightly higher than the other computable seasonal acetaldehyde averages. No seasonal average is available for winter. Acetaldehyde, benzene, carbon tetrachloride, formaldehyde, and total xylenes were detected in every sample taken at SJPR.

17.3 Non-chronic Risk Evaluation at the Puerto Rico Monitoring Sites

Non-chronic risk for the concentration data at Puerto Rico monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 17-4.

All acrolein detects at the Puerto Rico monitoring sites were greater than the ATSDR acute value of 0.11 $\mu g/m^3$, and all but one exceeded the California REL value of 0.19 $\mu g/m^3$. The average detected concentration was 1.98 ± 1.00 $\mu g/m^3$ at BAPR and 1.59 ± 0.54 $\mu g/m^3$ at SJPR, which are an order of magnitude higher than either acute risk factor. No seasonal averages for acrolein could be calculated, therefore intermediate risk could not be evaluated.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. For both Puerto Rico monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 17-5 through 17-6 are pollution roses for acrolein at the Puerto Rico sites. The pollution rose is a plot of concentration and wind direction. As shown in Figures 17-5 through 17-6, and discussed above, nearly all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

Figure 17-5 is the acrolein pollution rose for the BAPR monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds generally originating from the east-northeast or east. The highest concentration of acrolein occurred on December 30, 2005 with an east-northeasterly wind. However, it's important to note that winds originated out of the east at BAPR on a majority of the sample days. BAPR is located just north of a major road through Barceloneta, a town that lies to the west of San Juan. The immediate vicinity is classified as residential and rural. Several pharmaceutical industries are located east of the monitoring site.

Figure 17-6 is the acrolein pollution rose for the SJPR monitoring site. The pollution rose shows that most of the concentrations exceeding the acute risk factors occurred with winds originating from the east-northeast. The highest concentration of acrolein occurred on July 3, 2005 with an east-northeasterly wind. However, it's important to note that winds originated out of the east at SJPR on a majority of the sample days. SJPR is wedged between several major roadways, including Highway 22, 5, and 167, just west of Fort Buchanan and Luchetti Industrial Park.

17.4 Meteorological and Concentration Analysis at the Puerto Rico Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

17.4.1 Pearson Correlation Analysis

Table 17-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Puerto Rico monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) Acetaldehyde, acrolein, and hexachloro-1,3-butadiene exhibited moderately strong to very strong negative correlations with maximum, average, dew point, and wet bulb temperatures at BAPR. Very strong negative correlations were calculated for hexachloro-1,3-butadiene and the wind parameters, and a strong positive correlation was computed for this pollutant and sea level pressure. However, the low number of hexachloro-1,3-butadiene detects should be considered when reviewing these correlations. Most of the remaining correlations at BAPR were weak.

Moderately strong to strong negative correlations at SJPR were calculated for acetaldehyde, *p*-dichlorobenzene, tetrachloroethylene, and total xylenes and maximum, average, dew point, and wet bulb temperatures, while moderately strong positive correlations were computed for acrolein and formaldehyde. Several of the pollutants of interest at SJPR exhibited moderately strong correlations with relative humidity. While the correlations with the *v*-component of the wind were very weak, 1,3-butadiene, acrolein, and tetrachloroethylene exhibited moderately strong to strong correlations with the *u*-component of the wind. Acrolein, 1,3-butadiene, formaldehyde, and *p*-dichlorobenzene each had moderately strong to strong correlations with sea level pressure.

17.4.2 Composite Back Trajectory Analysis

Figures 17-7 thru 17-8 are composite back trajectory maps for the Puerto Rico monitoring sites for the days on which sampling occurred. Each line represents the 24-hour

trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site represents 100 miles.

As shown in Figure 17-7, the back trajectories originated predominantly from the east at BAPR. The 24-hour airshed domain is somewhat smaller at BAPR than other UATMP sites, with few back trajectories originating over 500 miles away. Thirty-seven percent of the trajectories originated within 300 miles of the site; and 82% originated within 400 miles from the BAPR monitoring site.

As shown in Figure 17-8, the back trajectories originated predominantly from the east at SJPR. The 24-hour airshed domain is similar to BAPR. Some back trajectories originated over 500 miles away. Forty percent of the trajectories originated within 300 miles of the site; and 83% originated within 400 miles from the SJPR monitoring site.

17.4.3 Wind Rose Analysis

Hourly wind data from the Luis Munoz Marin International Airport were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 17-9 through 17-10 are the wind roses for the Puerto Rico monitoring sites on days sampling occurred.

As indicated in Figure 17-9, hourly winds were predominantly out of the east (22% of observations) and east-northeast (18%) on days samples were taken near BAPR. Calm winds were observed for 36% of the observations. Wind speeds of 7 to 11 knots were recorded for 24% of the wind measurements, while the 2 to 4, 4 to 7, and 11 to 17 knot ranges were observed for 13% of observations each. Winds tended to be somewhat stronger out of the east-northeast.

As indicated in Figure 17-10, the wind rose for SJPR resembles the wind rose from BAPR. Hourly winds were predominantly out of east (22% of observations) and east-northeast (17%) on days samples were taken near SJPR. Calm winds were observed for 36% of the observations. Wind speeds of 7 to 11 knots were recorded for 23% of the wind measurements,

while the 2 to 4, 4 to 7, and 11-17 knot ranges were observed for 13% of observations each. Winds tended to be somewhat stronger out of the east-northeast.

The meteorological data show a predominant east wind flowing across the island due to the Trade Winds. On a typical day, air generally passes over the SJPR monitoring site first, and then towards the BAPR monitoring site 34 miles away. The location and distances of these monitors are optimal for a downwind analysis.

At BAPR, dichloromethane has the highest daily concentration (6.63 ± 2.03 $\mu g/m^3$), often exceeding its screening value (37 failures in 48 detects). In contrast, the dichloromethane daily average concentration at SJPR is 0.90 ± 0.30 $\mu g/m^3$ and rarely exceeded its screening value (3 failures in 34 detects). This significant difference in concentration is likely attributed to three pharmaceutical plants located between the two monitoring sites: Abbott Health Products, Inc.; Bristol-Myers Squibb Manufacturing; and Pfizer Pharmaceuticals. According to the NEI (US EPA, 2006a), these three facilities are the only dichloromethane emission sources in this region, and emitted nearly 345 tons of this pollutant in 2002.

17.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

17.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Bayamon and Barceloneta Municipo were obtained from the Air Monitoring Division of Puerto Rico's Air Quality Program and the U.S. Census Bureau, and are summarized in Table 17-6. Table 17-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 17-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Table 17-6 shows that the BAPR monitoring site has a significantly lower county and 10-mile population than the SJPR site, as well as a significantly lower county and estimated 10-mile vehicle ownership. Compared to other UATMP sites, Barceloneta County has one of the lowest county populations and vehicle registrations. However, both sites have comparatively low registration-populations ratios. Interestingly, SJPR has the fifth-highest 10-mile population of all the UATMP sites. While the daily traffic flow near BAPR is significantly lower than at SJPR, these two sites experience two of the lowest traffic volumes compared to other UATMP locations.

17.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4.). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. The ratios for BAPR and SJPR resemble those of the roadside study. Of all the UATMP sites, BAPR most resembles the roadside study. This indicates that mobile sources may contribute appreciably to concentrations at the Puerto Rico sites.

17.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 17-7 presents the 1999 NATA results for the census tracts where the Puerto Rico monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 17-7. Pollutants of interest are bolded.

17.6.1 1999 NATA Summary

The BAPR monitoring site is located in census tract 72017590300 with a population of 6,625, which represents 29.7% of the Barceloneta County population in 2000. The SJPR monitoring site is located in census tract 72021030103, with a population of 4,814, which represents 2.1% of Bayamon County's 2000 population. In terms of cancer risk, the BAPR site is located in a census tract with the highest calculated cancer risk of all the 2005 UATMP monitoring sites. The top 3 pollutants identified by NATA in the BAPR census tract are dichloromethane (71.00 in-a-million risk), followed by benzene (16.41), and carbon tetrachloride (10.35). The next highest modeled cancer risk at any UATMP site is 39.5 in a million for benzene at MIMN. Most cancer risks are less than 20 in a million. The top 3 pollutants identified by NATA in the SJPR census tract are tetrachloroethylene (18.04 in-a-million risk), followed by benzene (17.06), and carbon tetrachloride (10.48). As with most UATMP sites, acrolein was the only pollutant in the Puerto Rico census tracts to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

17.6.2 Annual Average Comparison

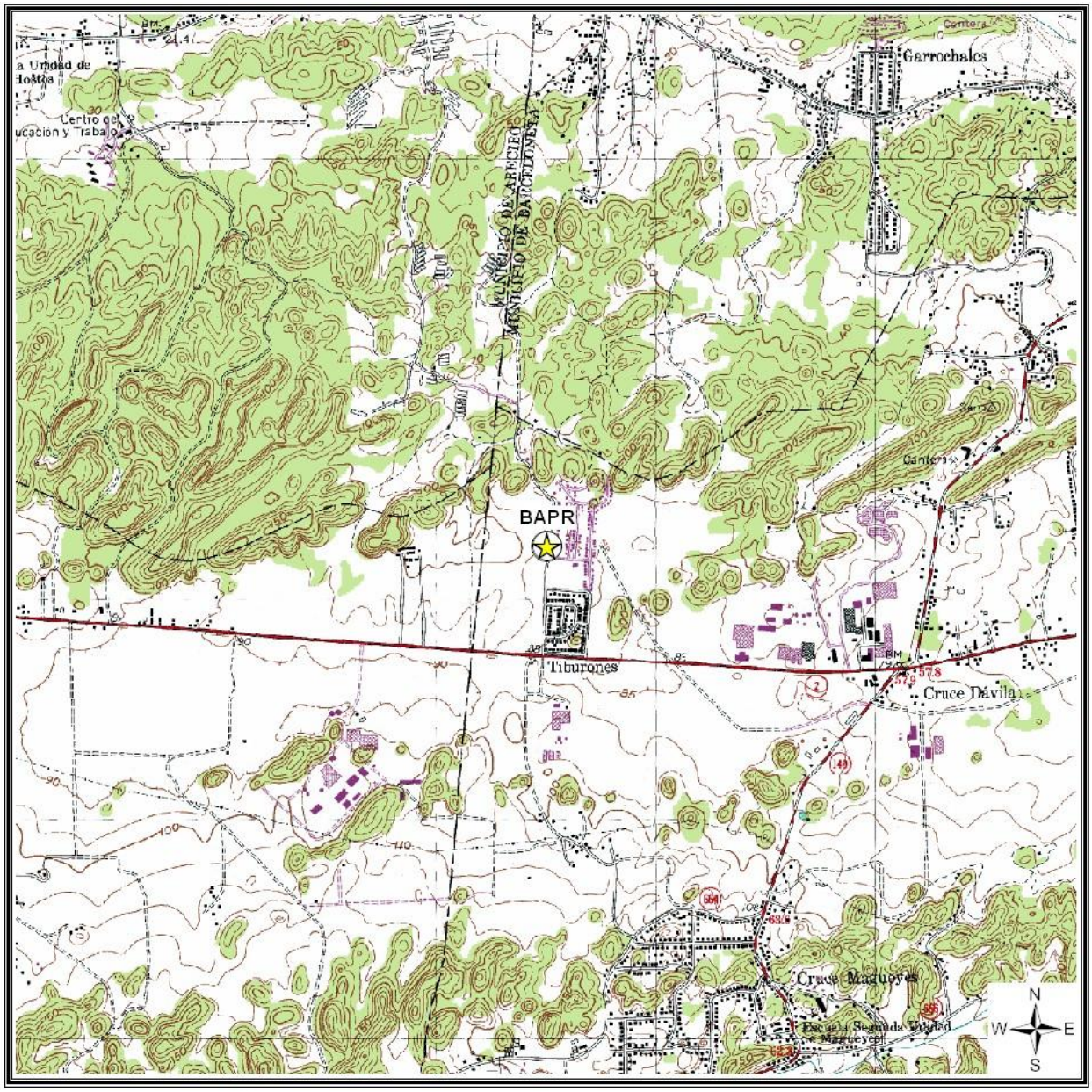
NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 17.2 on how a valid annual average is calculated). With few exceptions, the annual averages of the pollutants of interest at BAPR were within one order of magnitude of the NATA-modeled concentrations. The modeled concentration of dichloromethane (151.06 $\mu g/m^3$) is significantly higher than the annual average (6.63 ± 2.03 $\mu g/m^3$). However, the annual average of this pollutant is the highest of the BAPR pollutants of interest. The annual averages of several of the BAPR pollutants, such as 1,3-butadiene and carbon tetrachloride, are very similar to the NATA-modeled concentrations. Most of the annual averages of the pollutants of interest at SJPR were also within one order of magnitude of the NATA-modeled concentrations Total xylenes had the highest annual average of the SJPR pollutants of interest, as well as the highest NATA-modeled concentration. The

annual averages of several of the pollutants, such as benzene and carbon tetrachloride, are very similar to the NATA-modeled concentrations.

Puerto Rico Pollutant Summary

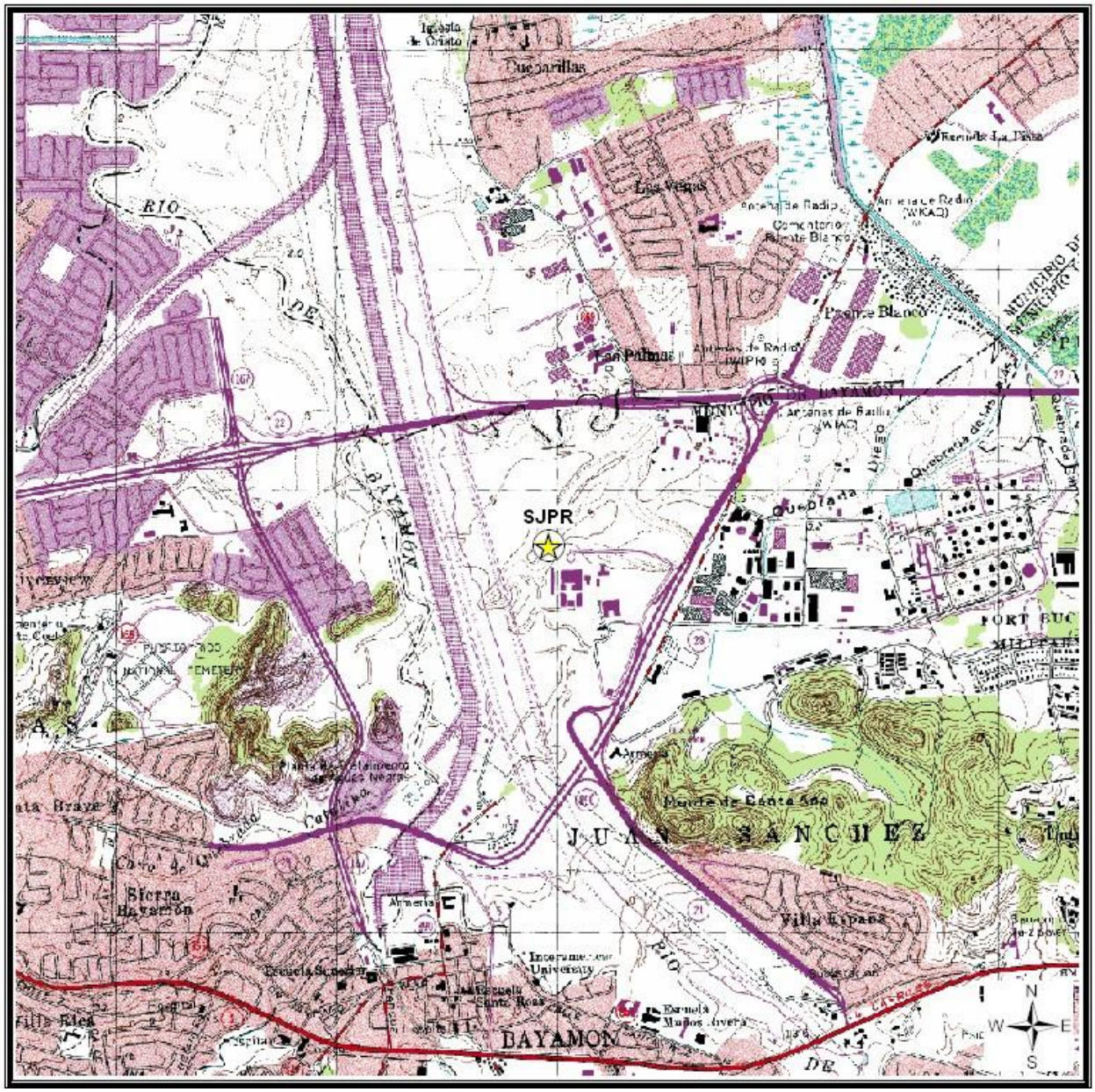
- *The pollutants of interest common to each Puerto Rico site are acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and p-dichlorobenzene.*
- *Dichloromethane measured the highest daily average at BAPR, while total xylenes measured highest at SJPR.*
- *Acrolein exceeded the short-term risk factors at both Puerto Rico sites.*

Figure 17-1. Barceloneta, Puerto Rico (BAPR) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 17-2. San Juan, Puerto Rico (SJPR) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 17-3. Facilities Located Within 10 Miles of BAPR

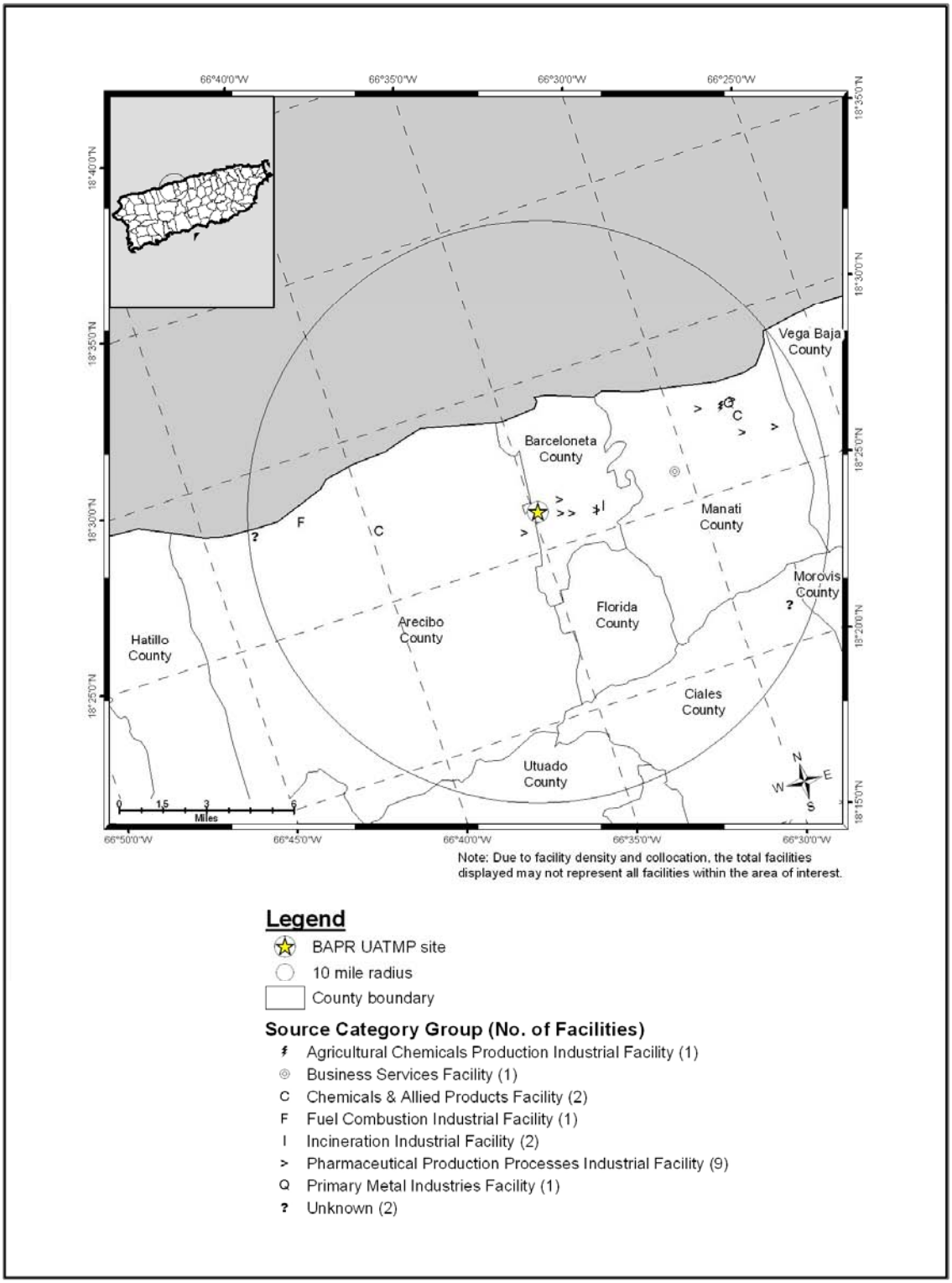


Figure 17-4. Facilities Located Within 10 Miles of SJPR

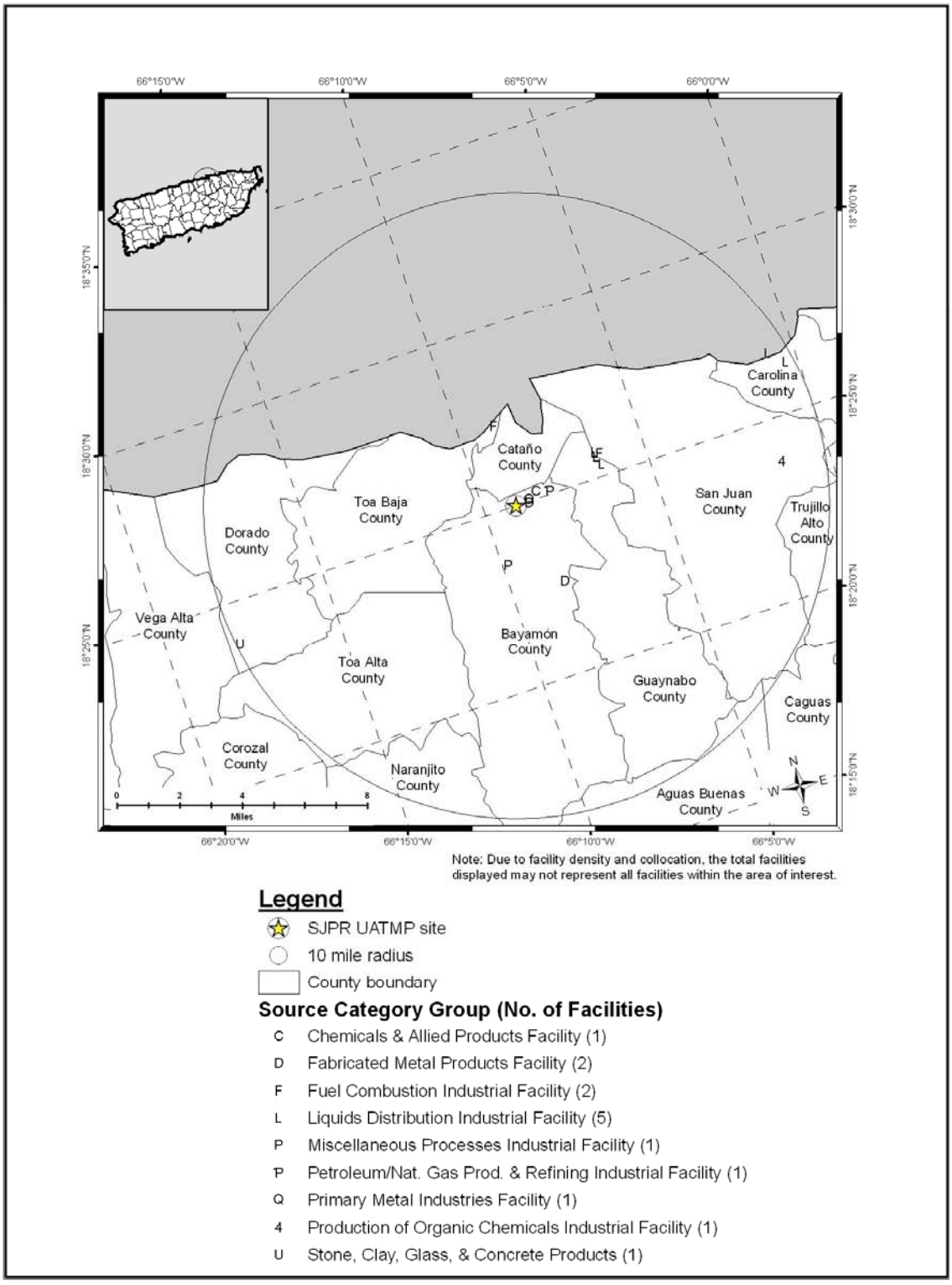


Figure 17-5. Acrolein Pollution Rose at BAPR

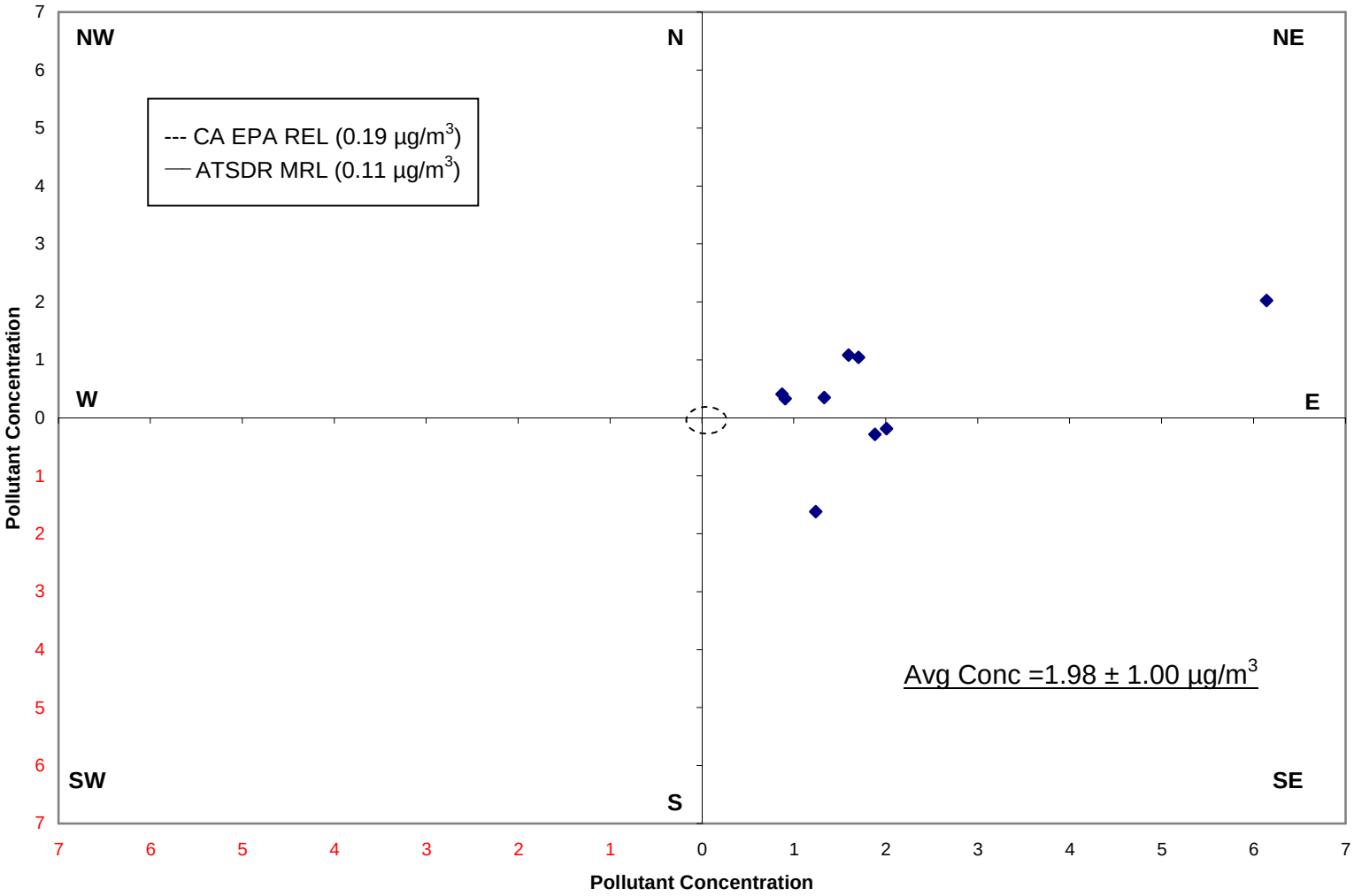


Figure 17-6. Acrolein Pollution Rose at SJPR

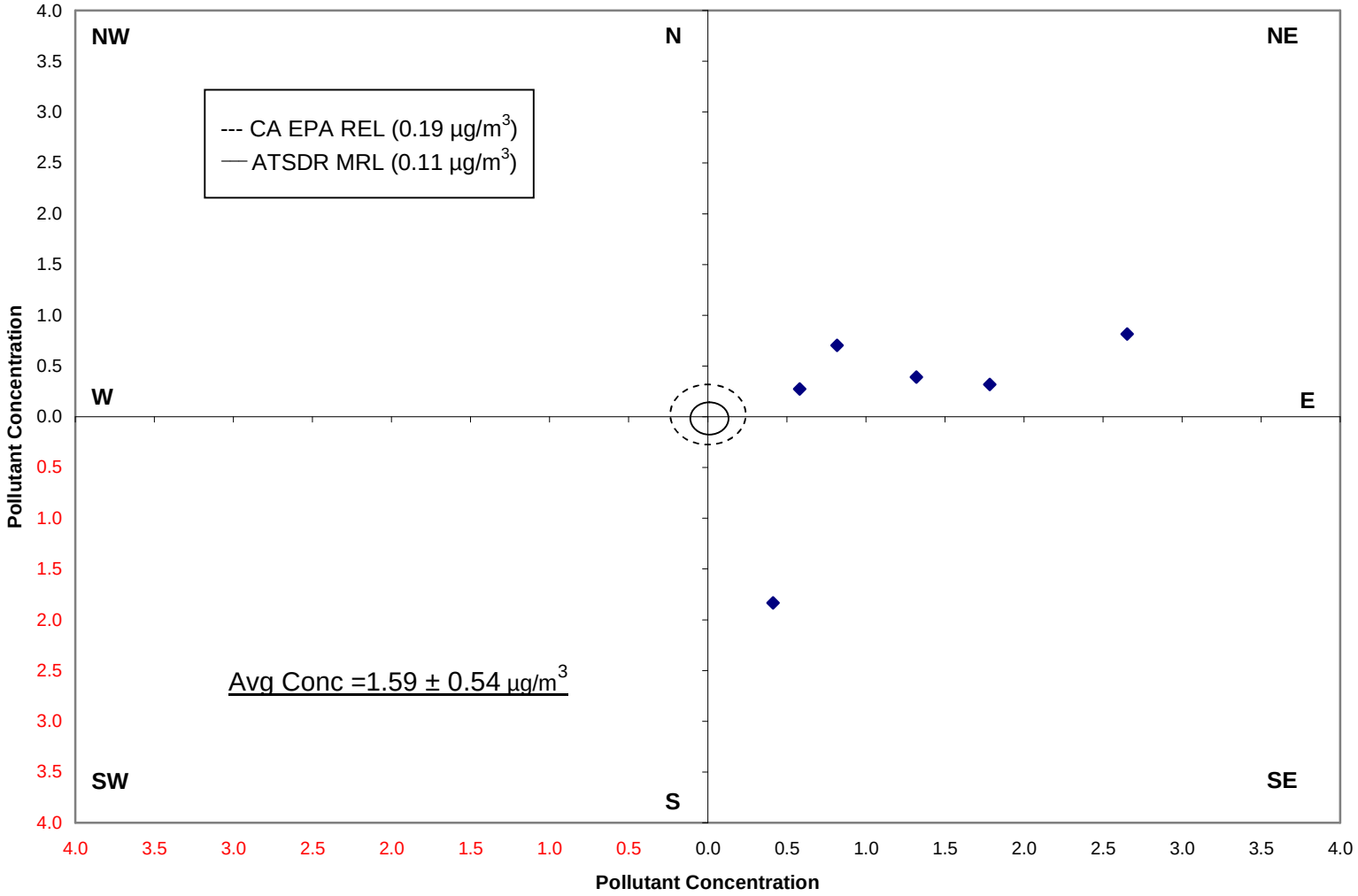


Figure 17-7. Composite Back Trajectory Map for Barceloneta, Puerto Rico (BAPR)

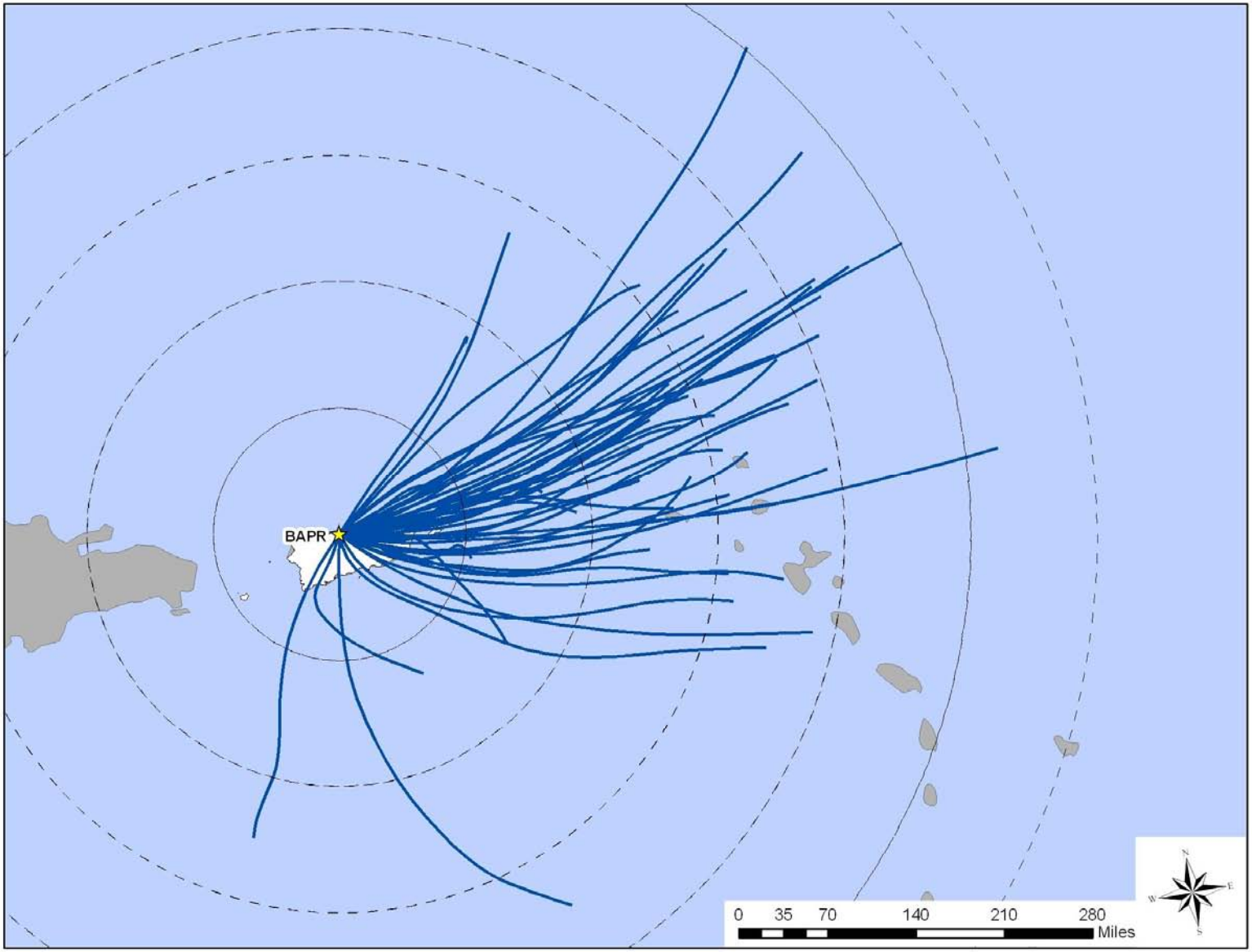


Figure 17-8. Composite Back Trajectory Map for San Juan, Puerto Rico (SJPR)

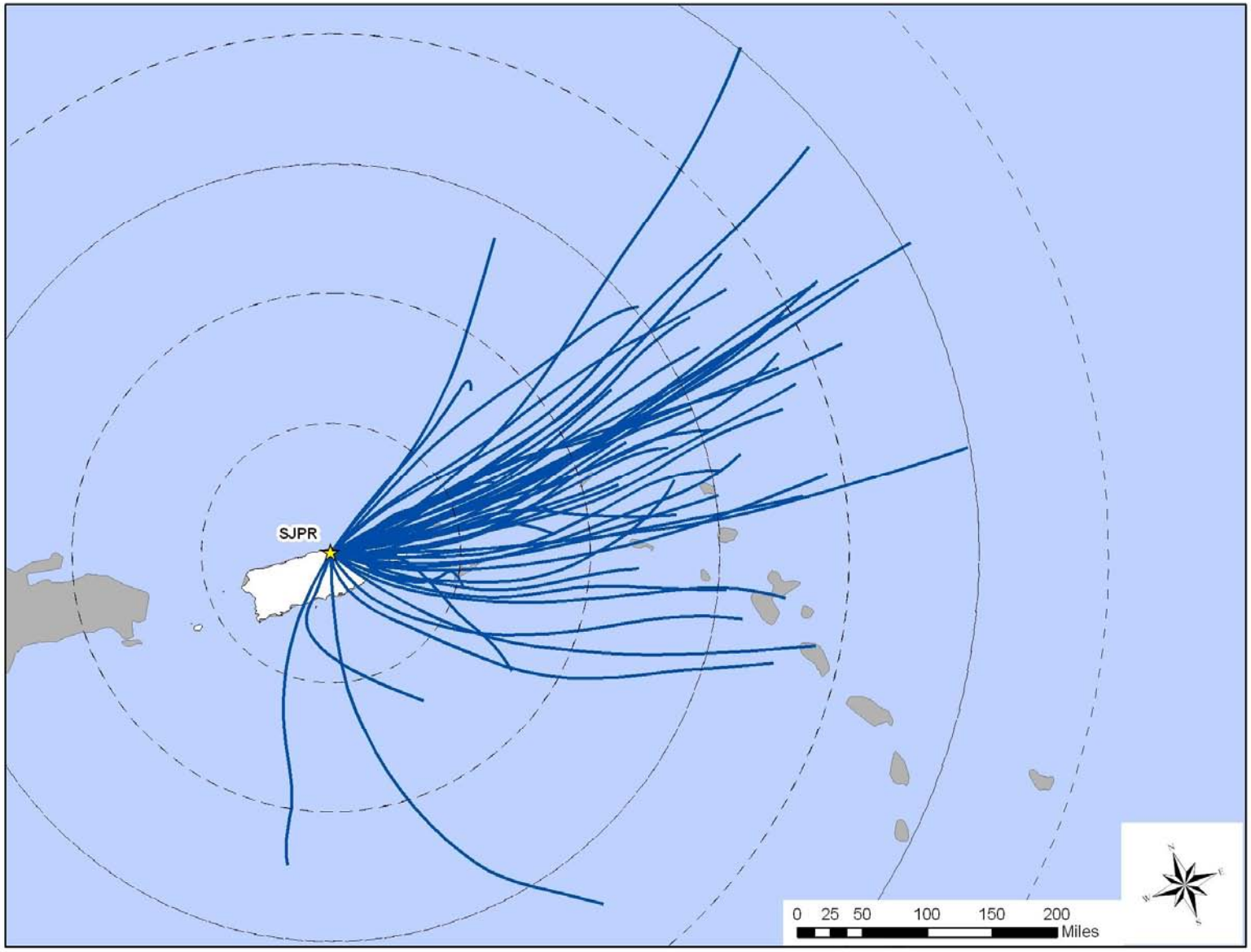


Figure 17-9. Wind Rose of Sample Days for the BAPR Monitoring Site

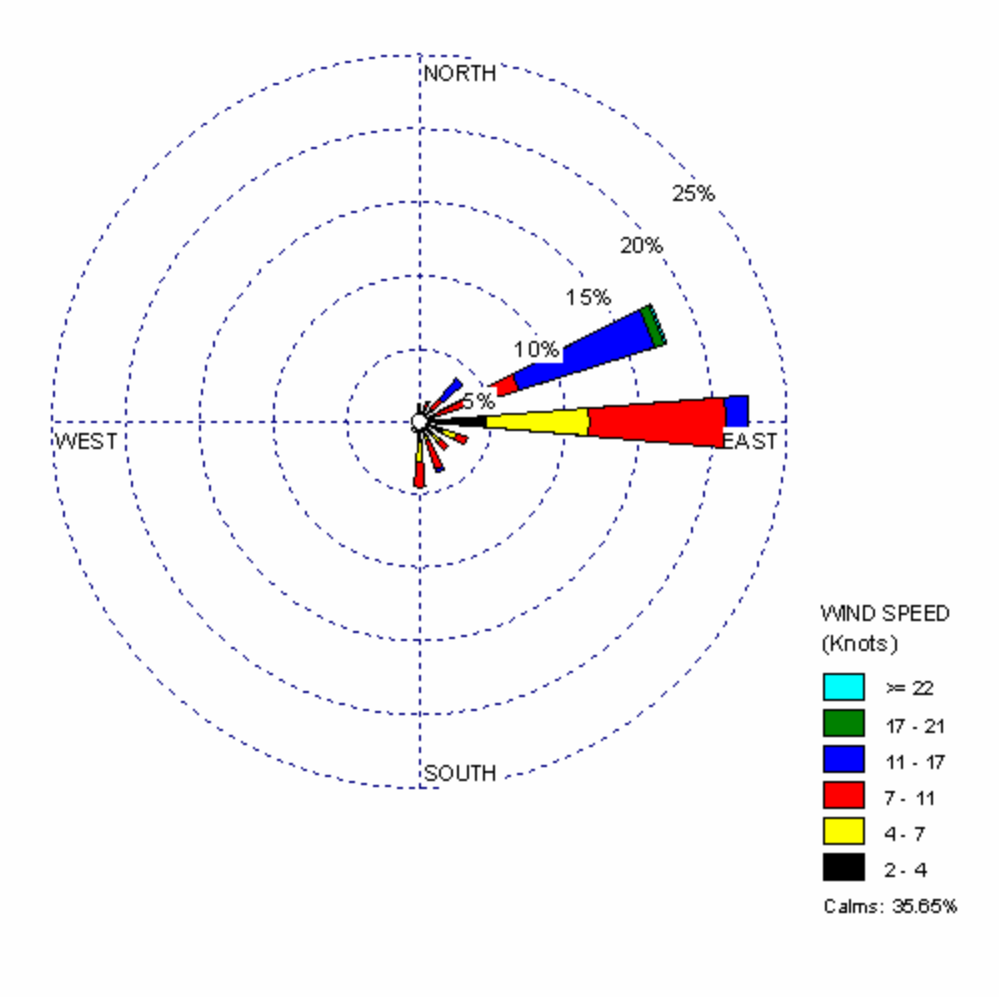


Figure 17-10. Wind Rose of Sample Days for the SJPR Monitoring Site

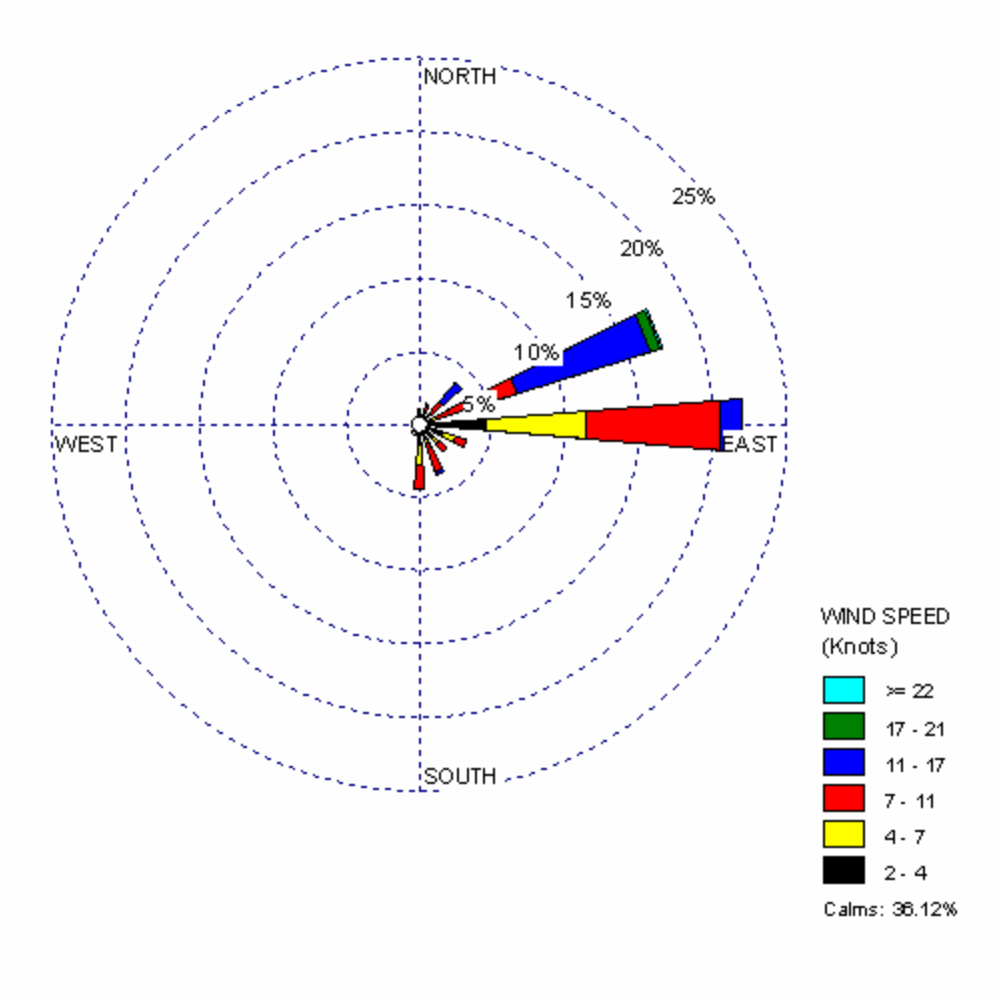


Table 17-1. Average Meteorological Parameters for Monitoring Sites in Puerto Rico

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
BAPR	11641	All 2005	85.87 ± 0.41	80.02 ± 0.33	72.06 ± 0.38	74.57 ± 0.32	77.50 ± 0.59	1014.49 ± 0.21	-3.86 ± 0.34	-1.49 ± 0.25
		Sample Day	87.49 ± 0.80	81.13 ± 0.73	73.15 ± 0.74	75.59 ± 0.64	77.55 ± 1.28	1014.40 ± 0.53	-3.99 ± 0.70	-0.68 ± 0.52
SJPR	11641	All 2005	85.87 ± 0.41	80.02 ± 0.33	72.06 ± 0.38	74.57 ± 0.32	77.50 ± 0.59	1014.49 ± 0.21	-3.86 ± 0.34	-1.49 ± 0.25
		Sample Day	87.33 ± 0.85	80.98 ± 0.77	73.09 ± 0.73	75.51 ± 0.65	77.78 ± 1.33	1014.45 ± 0.52	-3.89 ± 0.72	-0.68 ± 0.51

Table 17-2. Comparison of Measured Concentrations and EPA Screening Values at the Puerto Rico Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Barceloneta, Puerto Rico - BAPR					
Benzene	48	48	100.0	16.9%	16.9%
Acetaldehyde	48	49	98.0	16.9%	33.8%
Carbon Tetrachloride	48	48	100.0	16.9%	50.7%
Dichloromethane	37	48	77.1	13.0%	63.7%
1,3-Butadiene	37	37	100.0	13.0%	76.8%
p-Dichlorobenzene	35	35	100.0	12.3%	89.1%
Acrolein	10	10	100.0	3.5%	92.6%
Hexachloro-1,3-butadiene	7	7	100.0	2.5%	95.1%
Formaldehyde	5	49	10.2	1.8%	96.8%
Xylenes	3	48	6.3	1.1%	97.9%
Tetrachloroethylene	3	8	37.5	1.1%	98.9%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.4%	99.3%
Trichloroethylene	1	14	7.1	0.4%	99.6%
1,2-Dichloroethane	1	1	100.0	0.4%	100.0%
Total	284	403	70.5		
San Juan, Puerto Rico - SJPR					
Acetaldehyde	40	40	100.0	14.7%	14.7%
Benzene	40	40	100.0	14.7%	29.4%
Carbon Tetrachloride	40	40	100.0	14.7%	44.1%
Formaldehyde	36	40	90.0	13.2%	57.4%
1,3-Butadiene	30	30	100.0	11.0%	68.4%
p-Dichlorobenzene	27	27	100.0	9.9%	78.3%
Tetrachloroethylene	23	26	88.5	8.5%	86.8%
Xylenes	19	40	47.5	7.0%	93.8%
Acrolein	6	6	100.0	2.2%	96.0%
Hexachloro-1,3-butadiene	5	5	100.0	1.8%	97.8%
Dichloromethane	3	34	8.8	1.1%	98.9%
1,2-Dichloroethane	1	1	100.0	0.4%	99.3%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.4%	99.6%
Trichloroethylene	1	7	14.3	0.4%	100.0%
Total	272	337	80.7		

Table 17-3. Daily and Seasonal Averages for Pollutants of Interest at the Puerto Rico Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Barceloneta, PR – BAPR												
1,3-Butadiene	37	48	0.18	0.03	NA	NA	NR	NR	0.19	0.06	0.16	0.02
Acetaldehyde	49	49	1.44	0.23	NA	NA	1.61	0.31	1.11	0.15	1.04	0.22
Acrolein	10	28	1.98	1.00	NA	NA	NA	NA	NR	NR	NR	NR
Benzene	48	48	1.20	0.14	NA	NA	1.24	0.17	1.35	0.34	1.09	0.18
Carbon Tetrachloride	48	48	0.66	0.04	NA	NA	0.57	0.05	0.67	0.03	0.75	0.08
Dichloromethane	48	48	6.63	2.03	NA	NA	6.86	4.65	8.71	3.41	4.75	2.13
Hexachloro-1,3-butadiene	7	48	0.15	0.04	NA	NA	NR	NR	NR	NR	NR	NR
p-Dichlorobenzene	35	48	0.63	0.11	NA	NA	NR	NR	0.55	0.18	0.64	0.17
San Juan, PR – SJPR												
1,3-Butadiene	30	40	0.28	0.05	NA	NA	NR	NR	0.26	0.09	0.33	0.09
Acetaldehyde	40	40	6.21	2.22	NA	NA	9.32	4.36	3.88	1.03	3.01	0.75
Acrolein	6	20	1.59	0.54	NA	NA	NA	NA	NR	NR	NR	NR
Benzene	40	40	2.14	0.25	NA	NA	2.07	0.27	2.17	0.60	2.29	0.45
Carbon Tetrachloride	40	40	0.63	0.05	NA	NA	0.54	0.06	0.60	0.08	0.76	0.07
Formaldehyde	40	40	2.24	0.24	NA	NA	2.30	0.57	2.14	0.33	2.40	0.24
p-Dichlorobenzene	27	40	1.11	0.29	NA	NA	NR	NR	0.65	0.29	1.08	0.40
Tetrachloroethylene	26	40	0.33	0.05	NA	NA	NR	NR	0.26	0.07	0.31	0.05
Xylenes	40	40	10.47	1.31	NA	NA	11.69	1.71	9.85	2.55	9.59	2.59

NA = Not available due to short sampling duration.
NR = No reportable due to the low number of detects.

Table 17-4. Non-Chronic Risk Summary at the Puerto Rico Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
BAPR	TO-15	Acrolein	1.98 ± 1.00	0.11	10	0.19	9	0.09	NA	NA	NR	NR
SJPR	TO-15	Acrolein	1.59 ± 0.54	0.11	6	0.19	6	0.09	NA	NA	NR	NR

NA = Not available due to short sampling duration.
NR = No reportable due to the low number of detects.

Table 17-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Puerto Rico Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Barceloneta, Puerto Rico - BAPR									
1,3-Butadiene	37	0.05	0.08	0.13	0.12	0.06	-0.12	-0.09	0.24
Acetaldehyde	49	-0.51	-0.64	-0.59	-0.65	0.03	-0.04	0.01	0.23
Acrolein	10	-0.12	-0.27	-0.28	-0.29	0.12	0.12	0.06	-0.18
Benzene	48	0.12	0.10	0.21	0.18	0.16	0.28	0.10	-0.01
Carbon Tetrachloride	48	-0.10	-0.10	0.07	0.02	0.20	0.01	-0.04	-0.12
Dichloromethane	48	-0.04	-0.06	0.12	0.07	0.25	-0.24	-0.01	-0.03
Hexachloro-1,3-butadiene	7	-0.72	-0.48	-0.32	-0.37	0.30	-0.79	-0.83	0.54
p-Dichlorobenzene	35	0.19	0.24	0.11	0.16	-0.21	-0.20	-0.20	0.04
San Juan, Puerto Rico - SJPR									
1,3-Butadiene	30	-0.04	-0.06	0.18	0.12	0.35	0.31	0.05	-0.25
Acetaldehyde	40	-0.18	-0.43	-0.64	-0.62	-0.33	0.17	0.15	0.24
Acrolein	6	0.33	0.39	0.34	0.37	-0.35	-0.56	0.03	0.33
Benzene	40	-0.12	-0.20	0.02	-0.04	0.27	0.20	-0.04	-0.09
Carbon Tetrachloride	40	0.00	0.03	0.09	0.08	0.07	-0.02	-0.03	-0.24
Formaldehyde	40	0.26	0.25	0.31	0.32	0.12	0.11	0.10	-0.52
p-Dichlorobenzene	27	-0.22	-0.17	-0.29	-0.26	-0.23	-0.09	-0.06	0.29
Tetrachloroethylene	26	-0.62	-0.68	-0.62	-0.67	0.22	0.40	-0.04	0.02
Xylenes	40	-0.23	-0.33	-0.30	-0.33	-0.01	0.11	-0.10	0.17

Table 17-6. Motor Vehicle Information for the Puerto Rico Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
BAPR	22,829	13,912	0.61	235,376	143,438	10
SJPR	222,195	145,642	0.66	1,447,174	948,578	250

Table 17-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Puerto Rico

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Barceloneta, Puerto Rico - BAPR, Census Tract 72017590300				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	<0.01	<0.01	--
1,2-Dichloroethane	0.09 ± 0.01	0.05	1.24	<0.01
1,3-Butadiene	0.16 ± 0.03	0.13	3.79	0.06
Acetaldehyde	1.44 ± 0.23	0.27	0.59	0.03
Acrolein	NA	0.13	--	6.42
Benzene	1.20 ± 0.14	2.10	16.41	0.07
Carbon Tetrachloride	0.66 ± 0.04	0.69	10.35	0.02
Dichloromethane	6.63 ± 2.03	151.06	71.00	0.15
Formaldehyde	0.66 ± 0.09	1.01	0.01	0.10
Hexachloro-1,3-butadiene	1.05 ± 0.16	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.51 ± 0.10	0.06	0.62	<0.01
Tetrachloroethylene	0.21 ± 0.11	0.25	1.45	<0.01
Trichloroethylene	0.15 ± 0.04	0.12	0.23	<0.01
Xylenes	5.31 ± 0.70	3.91	--	0.04
San Juan, Puerto Rico - SJPR, Census Tract 72021030103				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	<0.01	<0.01	--
1,2-Dichloroethane	0.10 ± 0.01	0.05	1.25	<0.01
1,3-Butadiene	0.23 ± 0.05	0.08	2.44	0.04
Acetaldehyde	6.21 ± 2.22	0.22	0.49	0.02
Acrolein	NA	0.14	--	7.15
Benzene	2.14 ± 0.25	2.19	17.06	0.07
Carbon Tetrachloride	0.63 ± 0.05	0.70	10.48	0.02
Dichloromethane	0.78 ± 0.27	1.48	0.69	<0.01
Formaldehyde	2.24 ± 0.24	0.83	<0.01	0.08
Hexachloro-1,3-butadiene	1.01 ± 0.27	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.80 ± 0.24	0.18	1.98	<0.01
Tetrachloroethylene	0.27 ± 0.04	3.06	18.04	0.01
Trichloroethylene	0.20 ± 0.15	0.59	1.19	<0.01
Xylenes	10.47 ± 1.31	4.20	--	0.04

NA = Not available due to the short sampling duration.
BOLD = pollutant of interest.

18.0 Sites in South Dakota

This section presents meteorological, concentration, and spatial trends for the UATMP sites in South Dakota (CUSD and SFSD). One site is located in Sioux Falls, in southeastern South Dakota, and the other is in Custer, in western South Dakota, south of Rapid City. Figures 18-1 and 18-2 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 18-3 and 18-4 identify point source emission locations within 10 miles of the sites that reported to the 2002 NEI for point sources. The CUSD map shows no point source emission locations within 10 miles of the monitoring site. The SFSD map shows that there are very few industrial facilities near the monitoring site; most of these facilities are to the northwest of the site.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the CUSD monitoring site is Custer County Airport (WBAN 94032); the closest weather station to SFSD is Sioux Falls Joe Foss Field Airport (WBAN 14944).

The Sioux Falls area has a continental climate, with cold winters, warm summers, and often drastic day to day variations. Precipitation varies throughout the year, but is typically sufficient for the springtime growing season. On average, a south wind blows in the summer and a northwesterly wind blows in the winter. The weather in Custer is considered semi-arid continental; annual precipitation is light. Warm summers and relatively mild winters are characteristic of this area, thanks to the Black Hills to the west, allowing winters to be milder in comparison to the rest of the state (Ruffner and Bair, 1987). Table 18-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 18-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

18.1 Pollutants of Interest at the South Dakota Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 18-2 presents the pollutants that failed at least one screen at the South Dakota monitoring sites. Ten pollutants with a total of 294 measured concentrations failed the screen at CUSD and 15 pollutants with a total of 289 measured concentrations failed the screen at SFSD. The pollutants of interest varied by site, yet the following six pollutants contributed to the top 95% of the total failed screens at each South Dakota monitoring site: benzene, acetaldehyde, carbon tetrachloride, formaldehyde, 1,3-butadiene, and acrolein. It's important to note that the South Dakota sites sampled for carbonyl pollutants, SNMOC, and VOC, and that this is reflected in each site's pollutants of interest. Also listed in Table 18-2 are the total number of detects and the percent detects failing the screen. Of the six pollutants that were the same among both sites, three pollutants of interest, benzene, carbon tetrachloride, and acrolein had 100% of their detects fail screens.

18.2 Concentration Averages at the South Dakota Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are

presented in Table 18-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at CUSD, acrolein measured the highest concentration by mass (2.25 ± 0.61 μg/m^3), followed by formaldehyde (1.73 ± 0.20 μg/m^3) and acetaldehyde (1.30 ± 0.14 μg/m^3). Seasonal averages for some of the pollutants of interest are not available due to the low number of detects. The seasonal averages of some of the pollutants of interest at CUSD did not vary much, although the autumn seasonal average of 1,3-butadiene is slightly higher than the summer average. Acetaldehyde, benzene, and formaldehyde were detected in every sample taken at CUSD.

Among the daily averages at SFSD, formaldehyde measured the highest concentration by mass (4.11 ± 0.71 μg/m^3), followed by acetaldehyde (3.22 ± 0.49 μg/m^3), and acrolein (1.61 ± 0.78 μg/m^3). Similar to CUSD, seasonal averages for some of the pollutants of interest are not available due to the low number of detects. The seasonal averages of many of the pollutants of interest at SFSD did not vary much, although the summer seasonal average of formaldehyde is higher than the other seasonal averages. Acetaldehyde, benzene, and formaldehyde were detected in every sample taken at SFSD.

18.3 Non-chronic Risk Evaluation at the South Dakota Monitoring Sites

Non-chronic risk for the concentration data at the South Dakota monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute and intermediate risk values, and each site's non-chronic risk is summarized in Table 18-4.

All acrolein detects at the South Dakota monitoring sites were greater than the ATSDR acute value of 0.11 μg/m^3 and the California REL value of 0.19 μg/m^3. The average detected

concentration was 1.61 ± 0.78 μg/m^3 at SFSD and 2.25 ± 0.61 μg/m^3 at CUSD, which are an order of magnitude higher than either acute risk factor. With the exception of autumn at CUSD, no seasonal averages for acrolein could be calculated. At CUSD, the autumn acrolein average was 1.64 ± 0.81 μg/m^3. This value is significantly higher than the ATSDR intermediate risk value.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. For both South Dakota monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 18-5 through 18-6 are pollution roses for acrolein at the South Dakota sites. A pollution rose is a plot of concentration and wind direction. As shown in Figures 18-5 through 18-6, and discussed above, all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

Figure 18-5 is the acrolein pollution rose for the CUSD monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with a variety of wind directions, although most frequently with winds from the west or northwest. The highest concentration of acrolein occurred on September 19, 2005 with a westerly wind. Given that no point sources are located within ten miles of the CUSD site, acrolein concentrations may be attributable to mobile sources. The monitoring site is located near the intersection of two major roadways in the area.

Figure 18-6 is the acrolein pollution rose for the SFSD monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with a variety of wind directions, which is consistent with mobile source emissions, although the pollution rose shows no concentrations of acrolein occurring with easterly winds. The highest concentration of acrolein occurred on December 24, 2005 with a northwesterly wind. Most point sources within 10 miles of the SFSD site were located towards the northwest. As Figure 18-2 shows, the SFSD site is located near major roadways, such as I-229 and Highway 42.

18.4 Meteorological and Concentration Analysis at the South Dakota Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

18.4.1 Pearson Correlation Analysis

Table 18-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the South Dakota monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) Moderately strong to strong negative correlations were calculated for 1,3-butadiene and benzene and maximum, average, dew point, and wet bulb temperatures at CUSD, while very strong positive correlations were calculated for 1,1,2,2-tetrachloroethane and these same parameters. It's important to note that 1,1,2,2-tetrachloroethane was detected relatively few times at CUSD, which can skew the correlations. Carbon tetrachloride also exhibited moderately strong positive correlations with the moisture parameters, and formaldehyde exhibited moderately strong positive correlations with maximum and average temperatures. Most of the remaining correlations were weak at CUSD.

With the exception of acetaldehyde, nearly all the correlations with maximum, average, dew point, and wet bulb temperatures were moderately strong to strong, indicating that temperature and moisture influence the concentrations of the pollutants of interest at SFSD. Acrolein, benzene, carbon tetrachloride, and hexachloro-1,3-butadiene exhibited moderately strong positive correlations with relative humidity. The strongest correlations with the wind components were computed for 1,3-butadiene (0.33 with the *u*-component and -0.38 with the *v*-component). Benzene, 1,3-butadiene, and formaldehyde exhibited moderately strong correlations with sea level pressure.

18.4.2 Composite Back Trajectory Analysis

Figures 18-7 thru 18-8 are composite back trajectory maps for the South Dakota monitoring sites for the days on which sampling occurred. Each line represents the 24-hour

trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site represents 100 miles.

As shown in Figure 18-7, the back trajectories originated predominantly from the southwest, west, and northwest at CUSD. The 24-hour airshed domain is somewhat large at CUSD, with trajectories originating as far away as Alberta, Canada, over 600 miles away. Nearly 66% of the trajectories originated within 300 miles of the site; and 82% within 400 miles from the CUSD monitoring site.

As shown in Figure 18-8, the back trajectories originated predominantly from the south, northwest, and north at SFSD. The 24-hour airshed domain is larger at SFSD, with trajectories originating as far away as Alberta, Canada, over 800 miles away. Nearly 44% of the trajectories originated within 300 miles of the site; and 78% within 500 miles from the SFSD monitoring site.

18.4.3 Wind Rose Analysis

Hourly wind data from the Custer County and Foss Field Airports were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 18-9 through 18-10 are the wind roses for the South Dakota monitoring sites on days sampling occurred.

As indicated in Figure 18-9, hourly winds were predominantly out of the west (16% of observations), west-southwest (11%), and west-northwest (9%) on days samples were taken near CUSD. Calm winds (< 2 knots) were observed for 16% of the observations. Wind speeds of 7 to 11 knots were recorded for 34% of the wind measurements.

As indicated in Figure 18-10, hourly winds were predominantly out of south (12% of observations), west (10%), and northwest (9%) on days samples were taken near SFSD. Calm winds were observed for 12% of the observations. Wind speeds of 7 to 11 knots were recorded

for 39% of the wind measurements. Wind speeds greater than 22 knots were measured most frequently with a west or northwesterly direction.

18.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and ethylene to acetylene ratio analysis.

18.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Custer and Minnehaha Counties were obtained from the South Dakota Department of Revenue and Regulation and the U.S. Census Bureau, and are summarized in Table 18-6. Table 18-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 18-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

It's evident from Table 18-6 that the CUSD monitoring site has a significantly lower county and 10-mile population than the SFSD site, as well as a significantly lower county and estimated 10-mile vehicle ownership. CUSD has the lowest county and 10-mile population and county and 10-mile vehicle registration of all participating UATMP sites. However, the CUSD site has the highest registration-population ratio. While the daily traffic flow near CUSD is significantly lower than at SFSD, these two sites' daily traffic counts are both on the low end compared to other UATMP sites.

18.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compared

them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. At both South Dakota sites, the benzene-ethylbenzene ratio is higher than the xylenes-ethylbenzene ratio, which is the opposite of the roadside study. At CUSD, the benzene-ethylbenzene ratio and toluene-ethylbenzene ratios (4.77 ± 0.59 and 5.25 ± 0.47, respectively) are much closer together than they are for the roadside study (2.85 and 4.55, respectively).

18.5.3 Mobile Tracer Analysis

As previously stated, CUSD and SFSD sampled for SNMOC in addition to VOC. Acetylene is a pollutant that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile sources have found that concentrations of ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3.) Listed in Table 3-10 is the ethylene to acetylene ratio for the South Dakota monitoring sites.

As shown, SFSD's ethylene-acetylene ratio, 1.38 ± 0.21, is somewhat lower than the 1.7 ratio. CUSD's ethylene-acetylene ratio, 1.58 ± 0.35 is closer to the 1.7 ratio, although still lower. These ratios suggest that while mobile sources may be influencing the air quality at the South Dakota monitoring sites, there may also be atmospheric chemical processes affecting the quantities of ethylene in these areas. Known sinks of ethylene include reactions with ozone, as well as soil (National Library of Medicine).

18.6 Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The CUSD monitoring site has participated in the UATMP since 2002, as shown in Figure 18-11. The following observations can be made:

- Formaldehyde concentrations seem to have decreased somewhat since 2002. However, the large confidence interval, represented by the error bars, in 2004

indicates that the formaldehyde concentration in 2004 may have been driven upward by a few outliers.

- Similarly, 1,3-butadiene concentrations appear to decrease over the four year period, but the large confidence interval in 2002 indicates that the decrease is not statistically significant.

- Benzene concentrations have not changed significantly since 2002 at CUSD.

The SFSD has been a UATMP site since 2000. The following observations can be made:

- Carbonyl compounds were not sampled for at SFSD until 2002, as indicated in Figure 18-12. The large confidence interval, represented by the error bars in 2002, indicates that the formaldehyde concentration may have been driven upward by a few outliers, which makes it difficult to determine if formaldehyde concentrations actually decreased from 2002 to 2003. Formaldehyde concentrations have remained roughly the same since 2003.

- The 1,3-butadiene concentration was highest in 2002, similar to formaldehyde, but again, the high confidence interval indicates that the formaldehyde concentration may have been driven upward by a few outliers. In 2004, 1,3-butadiene was detected only once at SFSD, as the absence of a confidence interval indicates. If 2003 and 2004 are omitted, 1,3-butadiene concentrations seem to be decreasing slightly.

- Benzene concentrations have not changed significantly since 2000.

18.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 18-7 presents the 1999 NATA results for the census tracts where the South Dakota monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 18-7. Pollutants of interest are bolded.

18.7.1 1999 NATA Summary

The CUSD monitoring site is located in census tract 46033995200 with a population of 2,758, which represents 37.9% of the Custer County population in 2000. The SFSD monitoring site is located in census tract 46099001802, with a population of 7,498, which represents 5.1% of Minnehaha County's 2000 population. In terms of cancer risk, the top 3 pollutants identified by NATA in the CUSD census tract are carbon tetrachloride (3.11 in-a-million risk), followed by benzene (2.07), and acetaldehyde (0.95). The top 3 pollutants identified by NATA in the SFSD census tract are benzene (5.41 in-a-million risk), followed by carbon tetrachloride (3.12), and 1,3-butadiene (1.82). As with most UATMP sites, acrolein was the only pollutant in the South Dakota census tracts to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

18.7.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detect, needs to be calculated (refer to Section 18.2 on how a valid annual average is calculated). The annual averages of the South Dakota sites were generally within one order of magnitude of the NATA-modeled concentrations. Many of the annual averages were very similar to the modeled averages at the SFSD monitoring site. For example, the annual average concentration of benzene is 0.70 ± 0.10 $\mu g/m^3$ while the NATA-modeled concentration is 0.69 $\mu g/m^3$. The concentrations were less similar at CUSD. For the pollutants whose concentrations differ by more than one order of magnitude, the NATA-modeled concentration was often <0.01 $\mu g/m^3$.

South Dakota Pollutant Summary

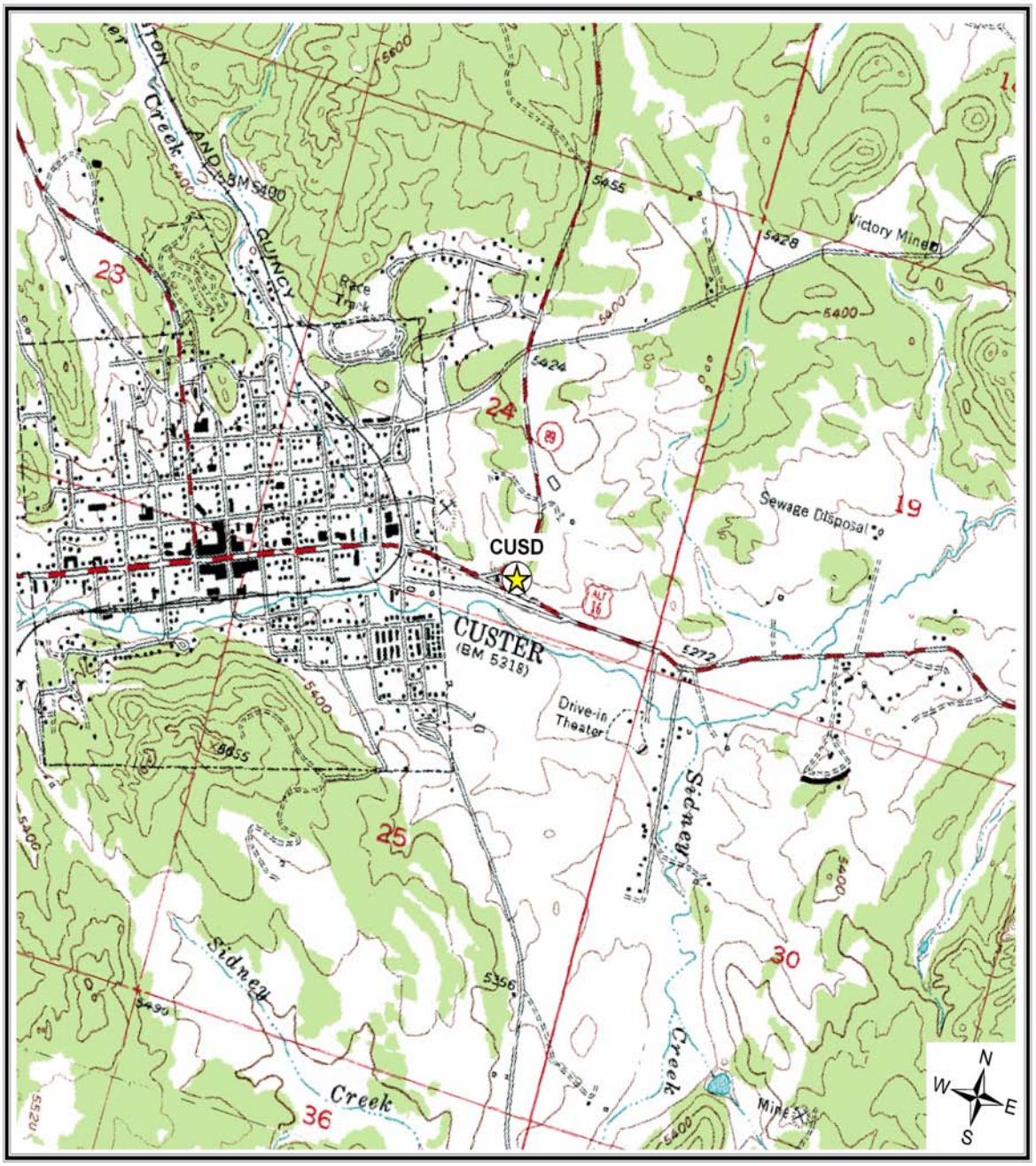
- *The pollutants of interest common to each of the South Dakota sites are acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and formaldehyde.*

- *Formaldehyde measured the highest daily average at SFSD, while acrolein measured highest at CUSD. Formaldehyde was highest in summer at SFSD, while 1,3-butadiene was highest in autumn at CUSD.*

- *Acrolein exceeded the short-term risk factors at both South Dakota sites.*

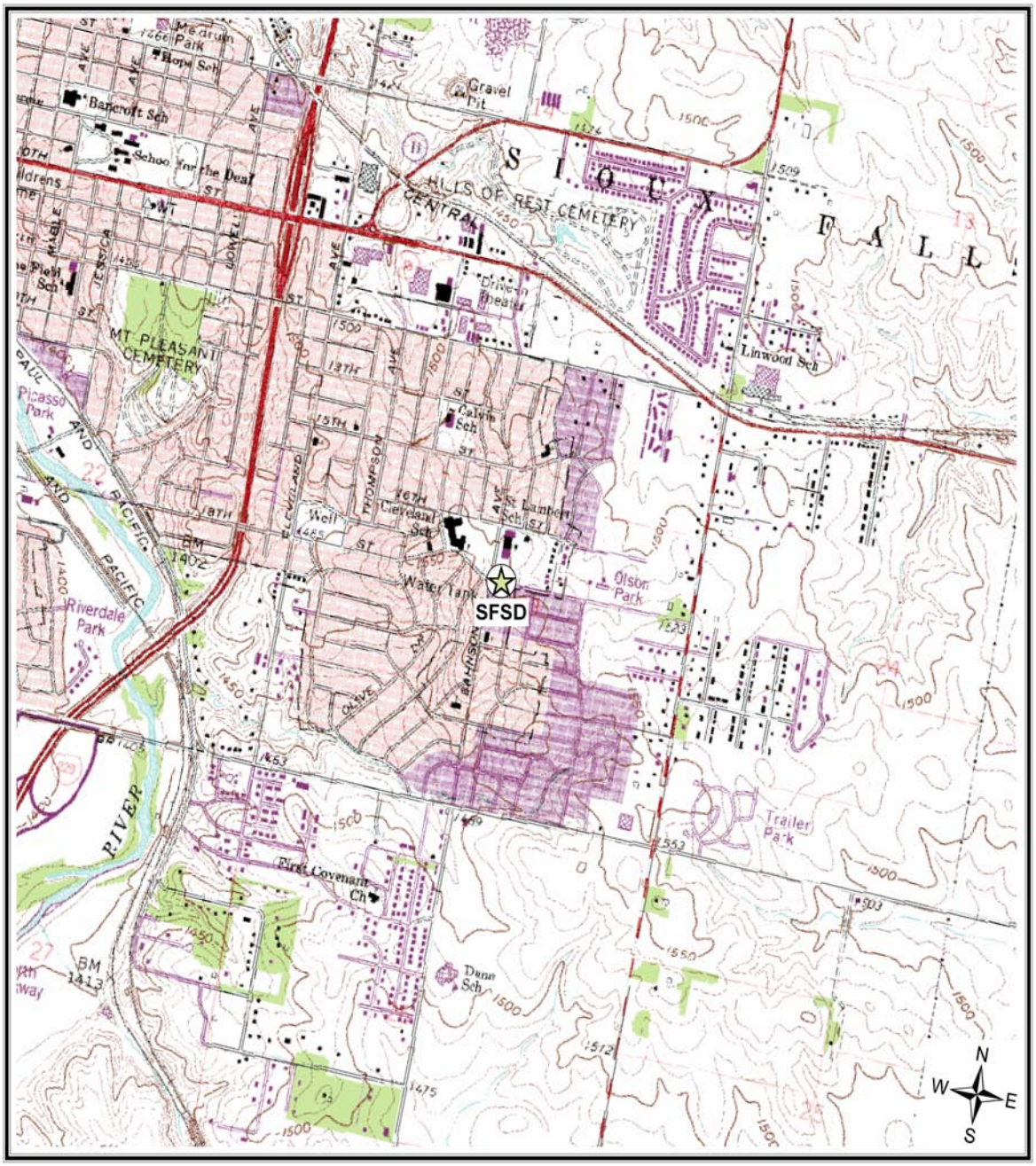
- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of formaldehyde have been decreasing at CUSD since 2002.*

Figure 18-1. Custer, South Dakota (CUSD) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 18-2. Sioux Falls, South Dakota (SFSD) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 18-3. Facilities Located Within 10 Miles of CUSD

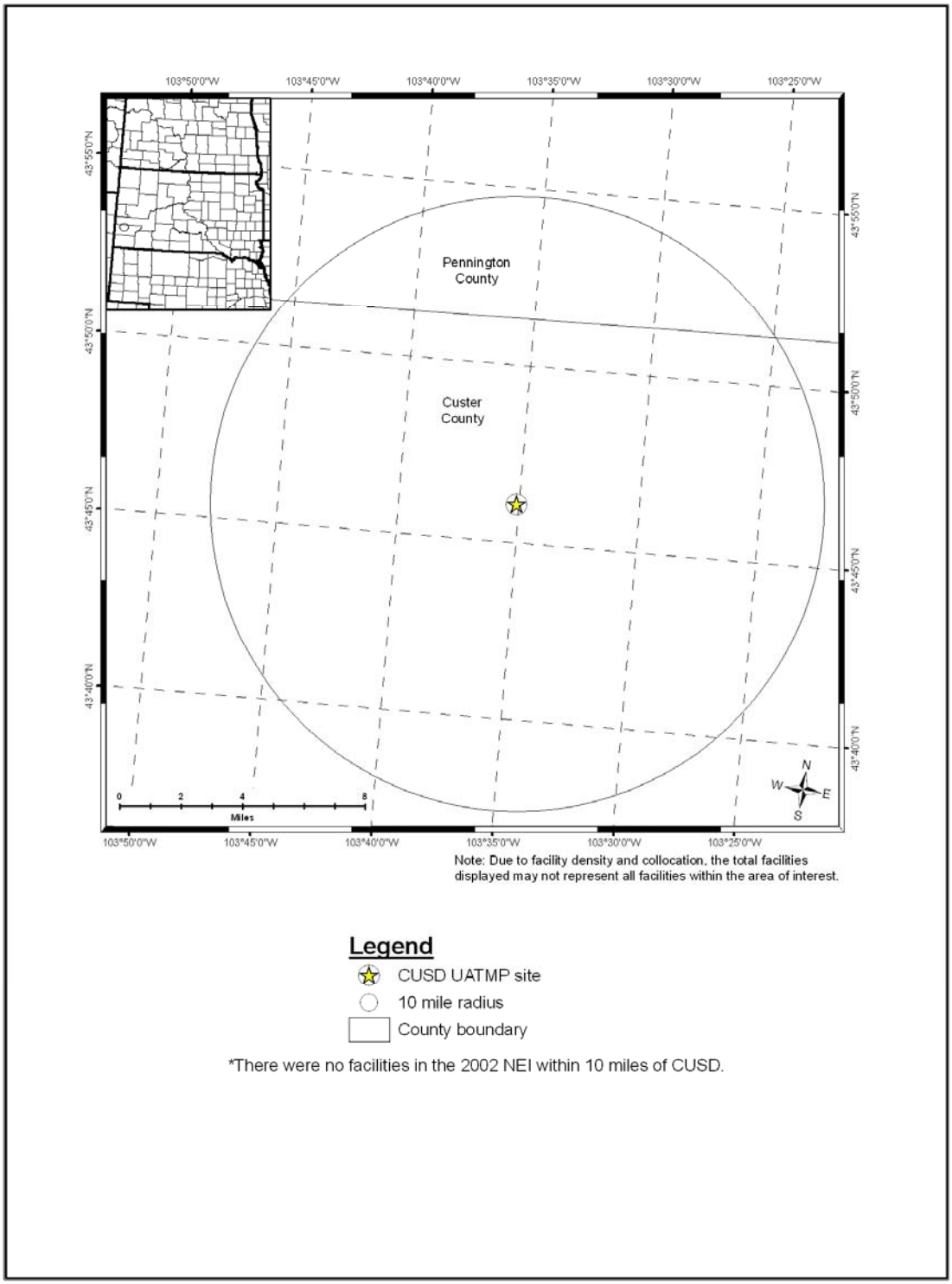


Figure 18-4. Facilities Located Within 10 Miles of SFSD

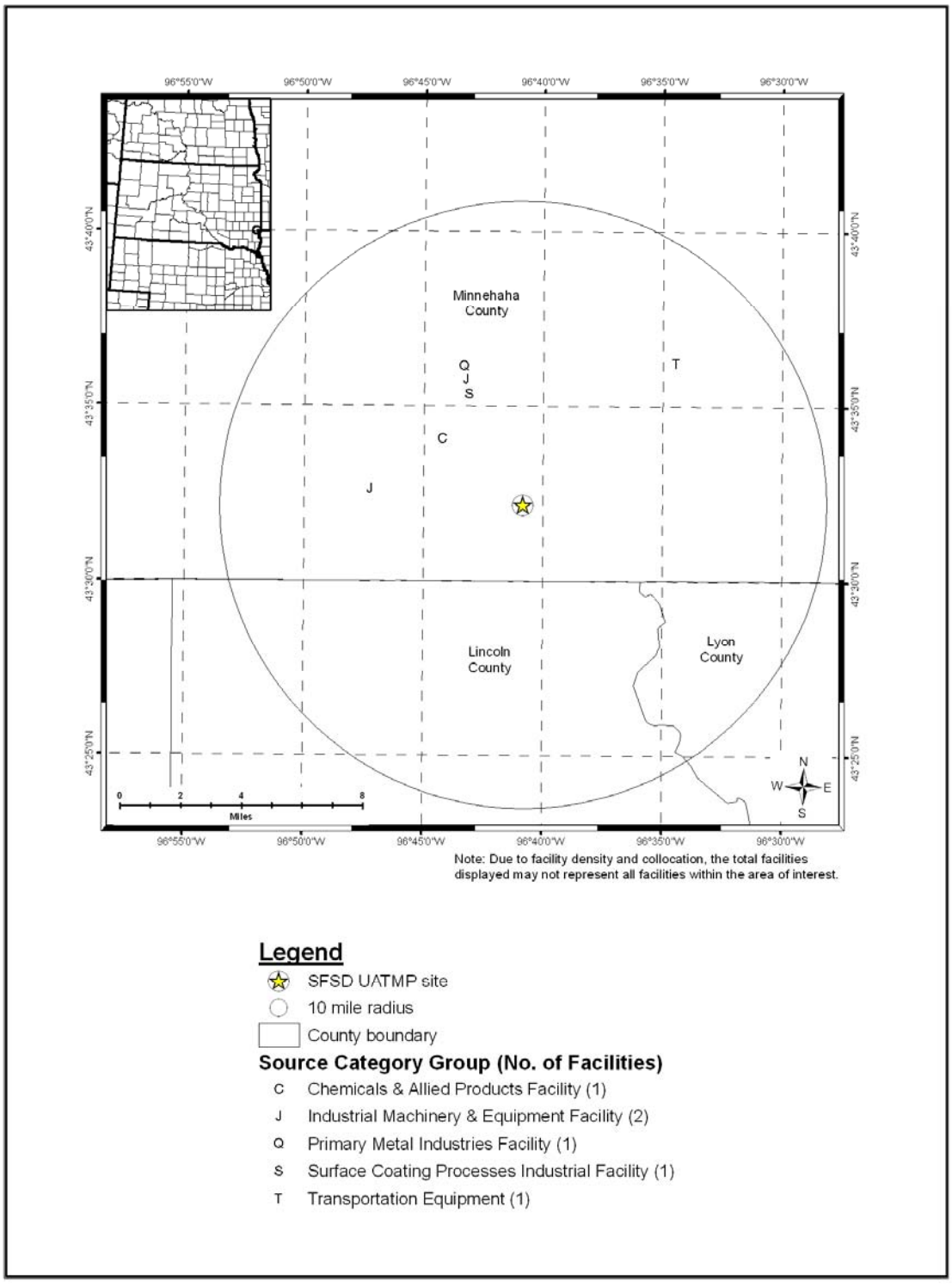


Figure 18-5. Acrolein Pollution Rose at CUSD

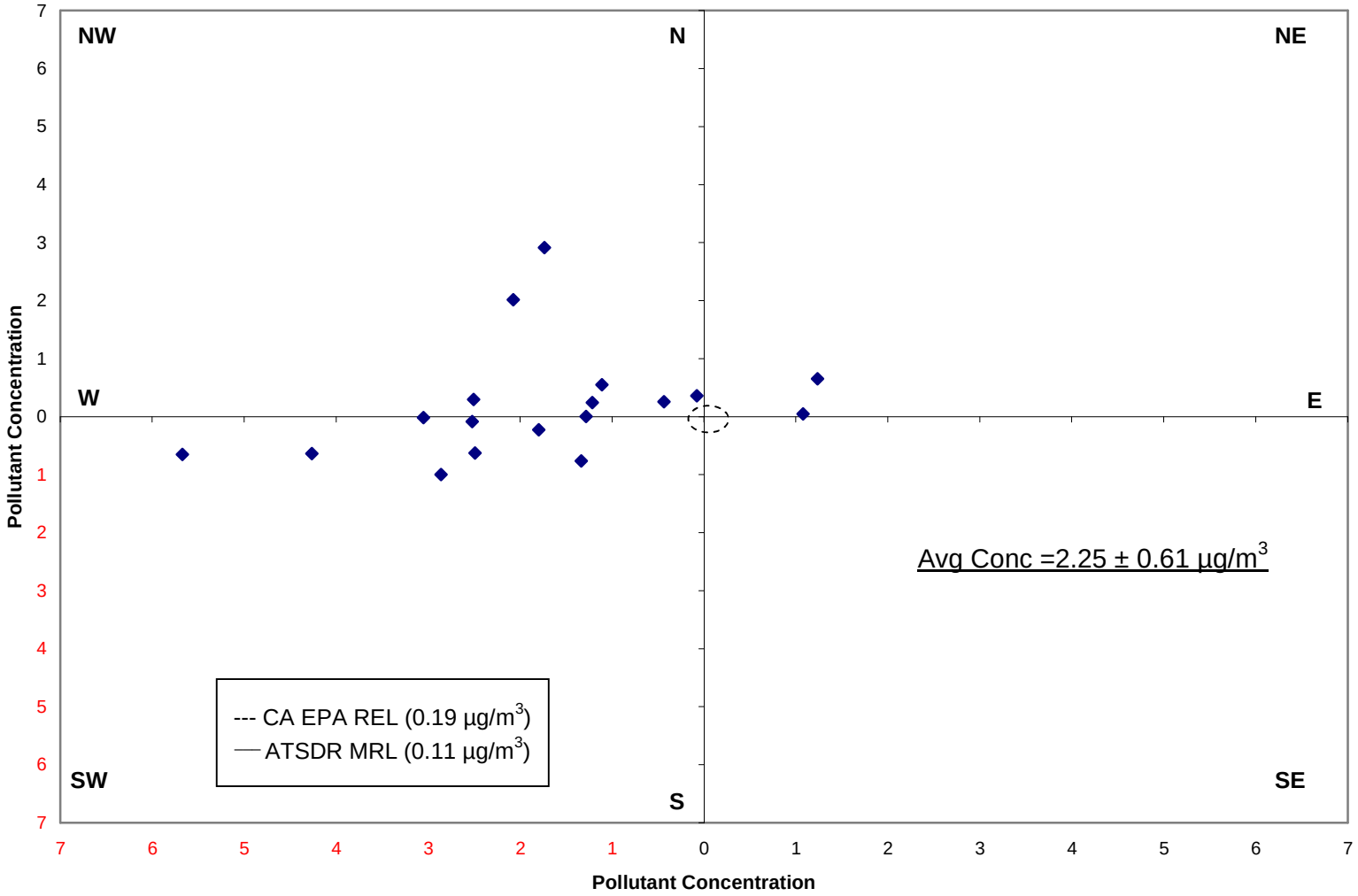


Figure 18-6. Acrolein Pollution Rose at SFSD

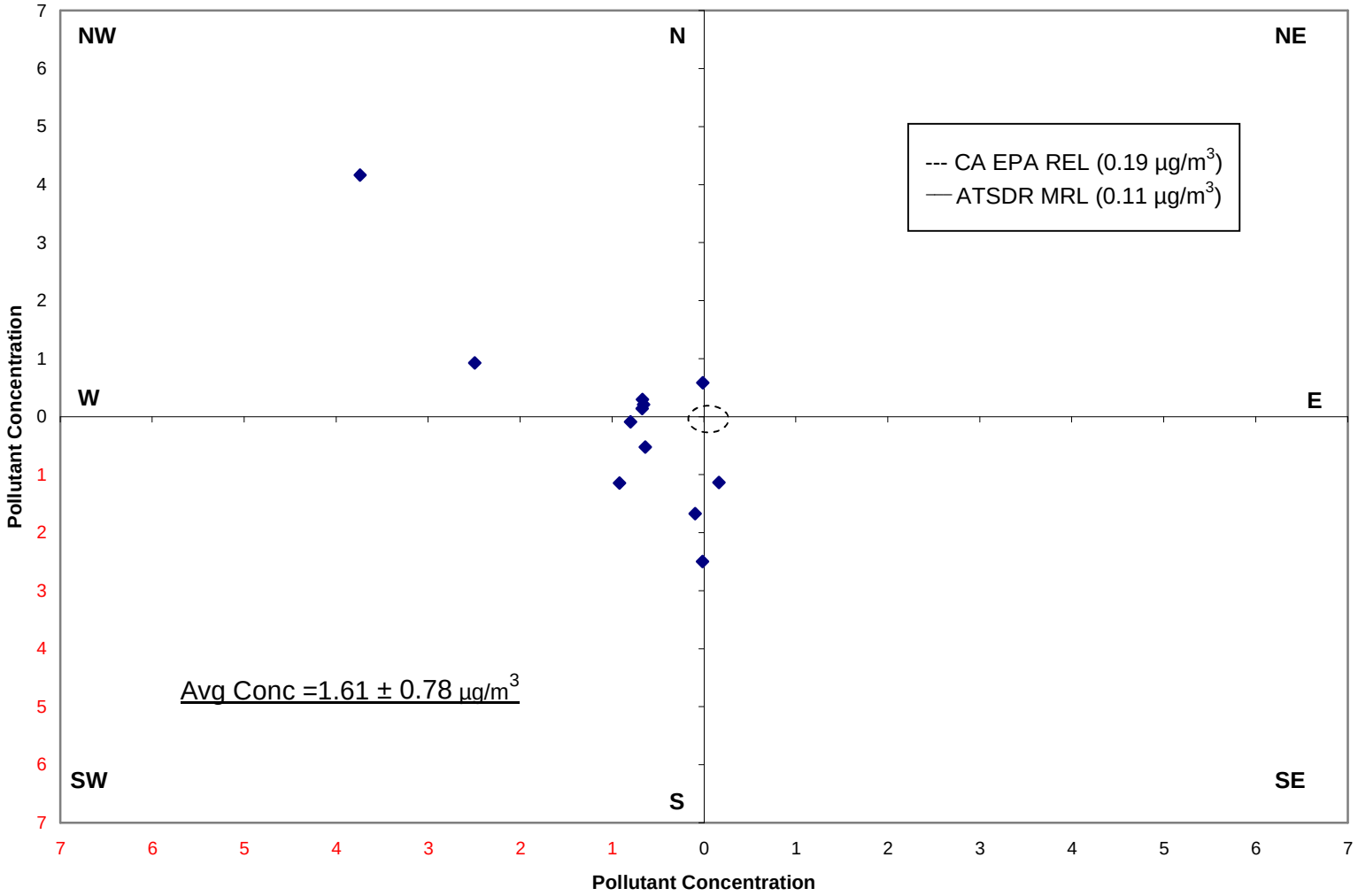


Figure 18-7. Composite Back Trajectory Map for CUSD

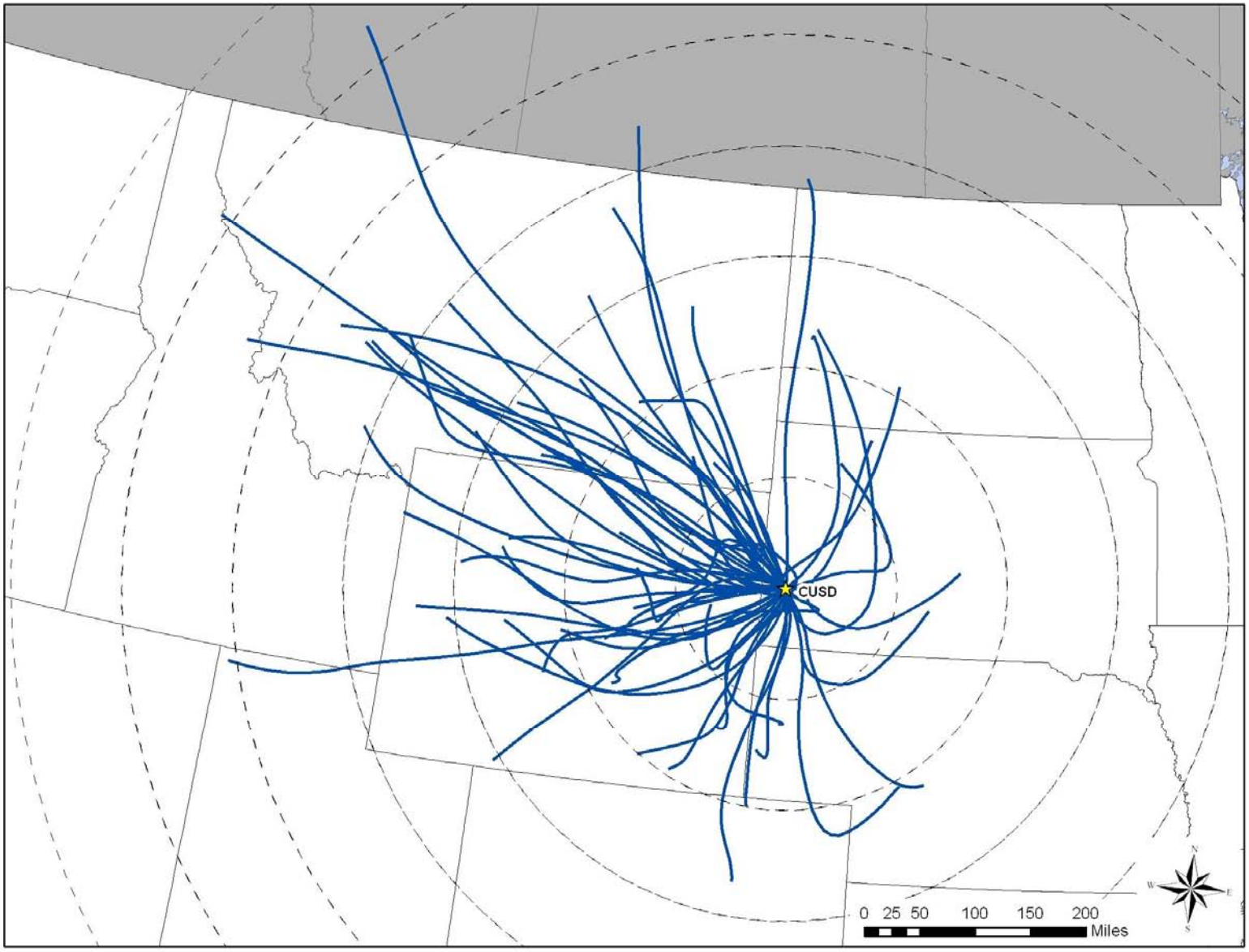


Figure 18-8. Composite Back Trajectory Map for SFSD

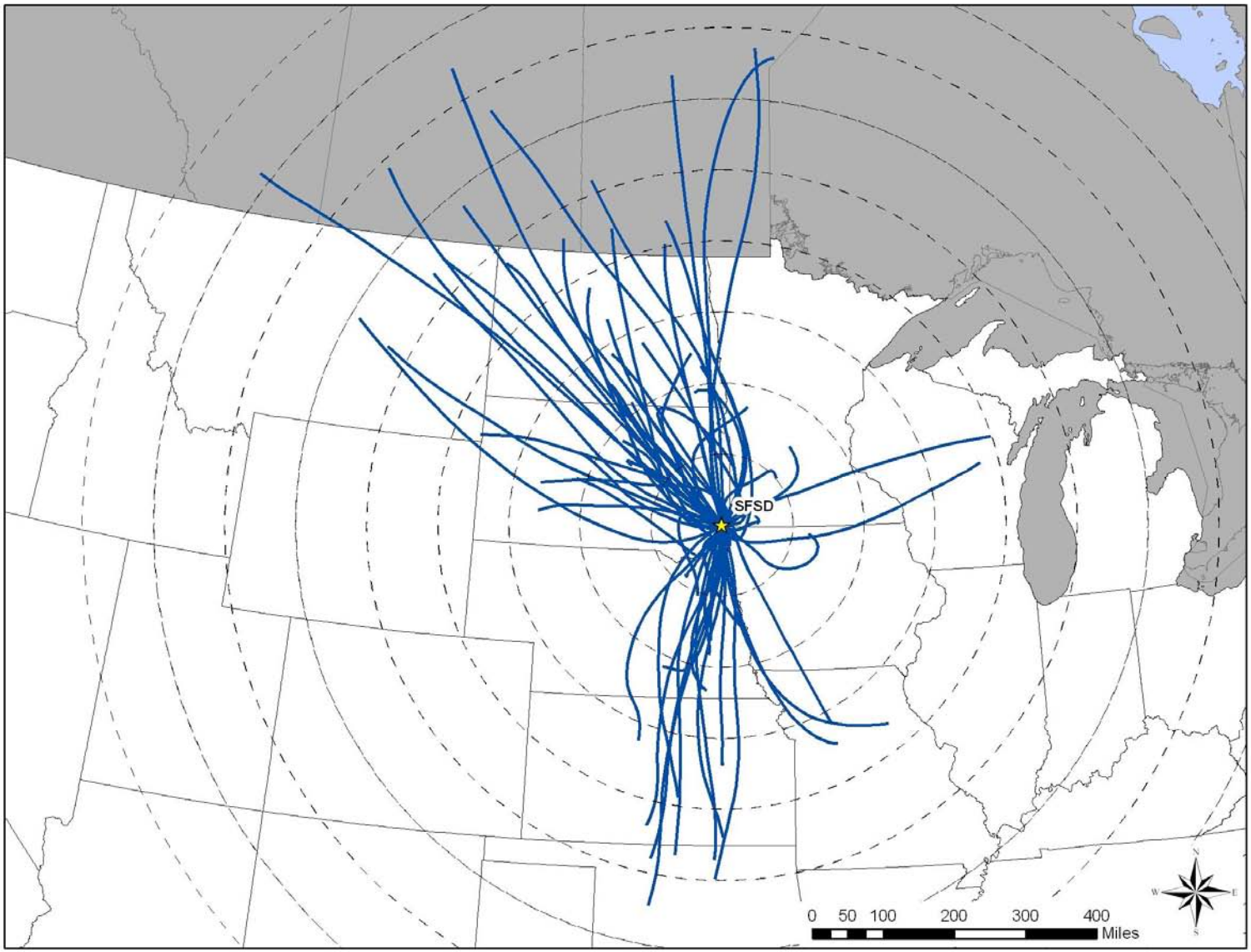


Figure 18-9. Wind Rose of Sample Days for the CUSD Monitoring Site

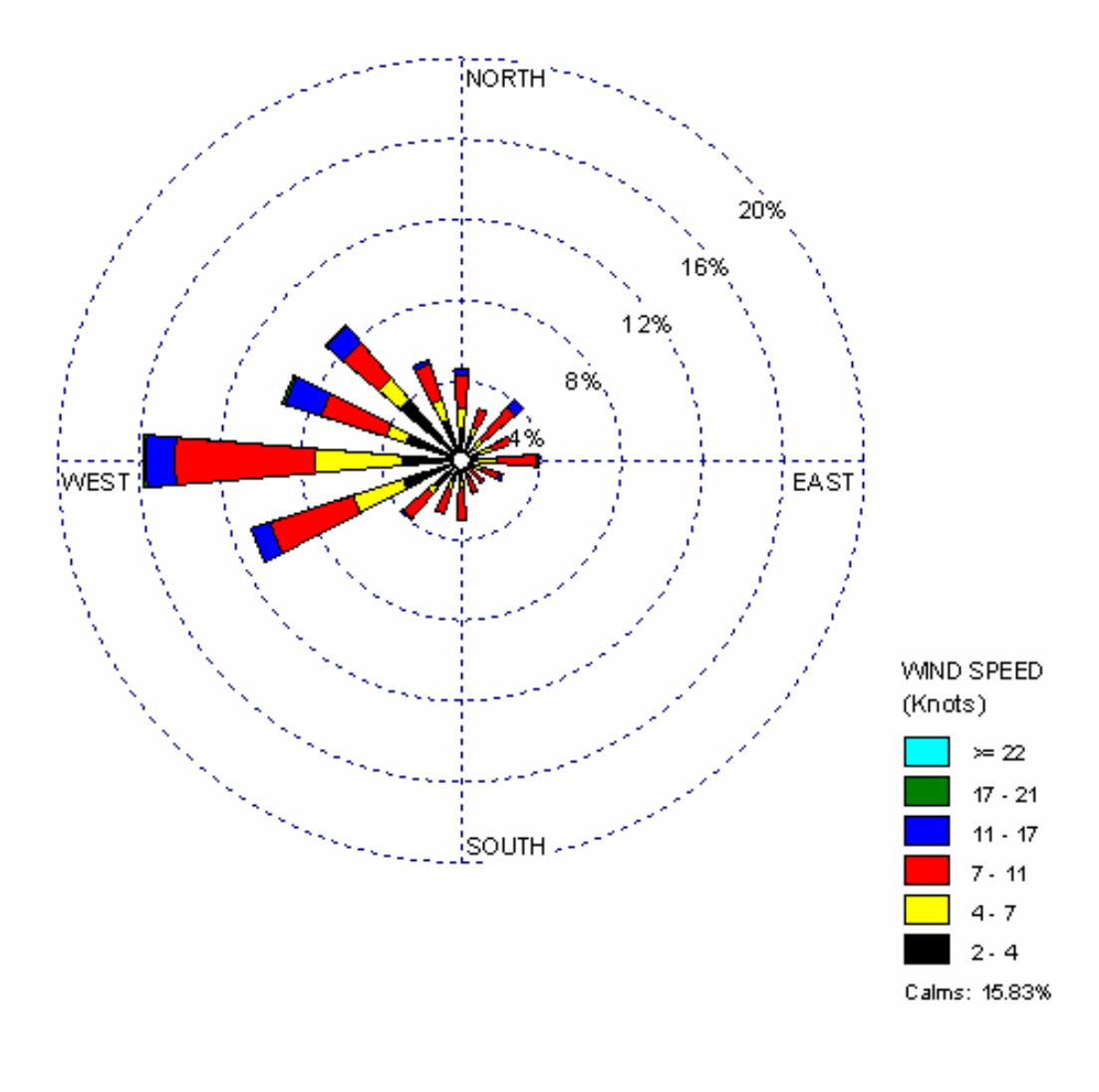


Figure 18-10. Wind Rose of Sample Days for the SFSD Monitoring Site

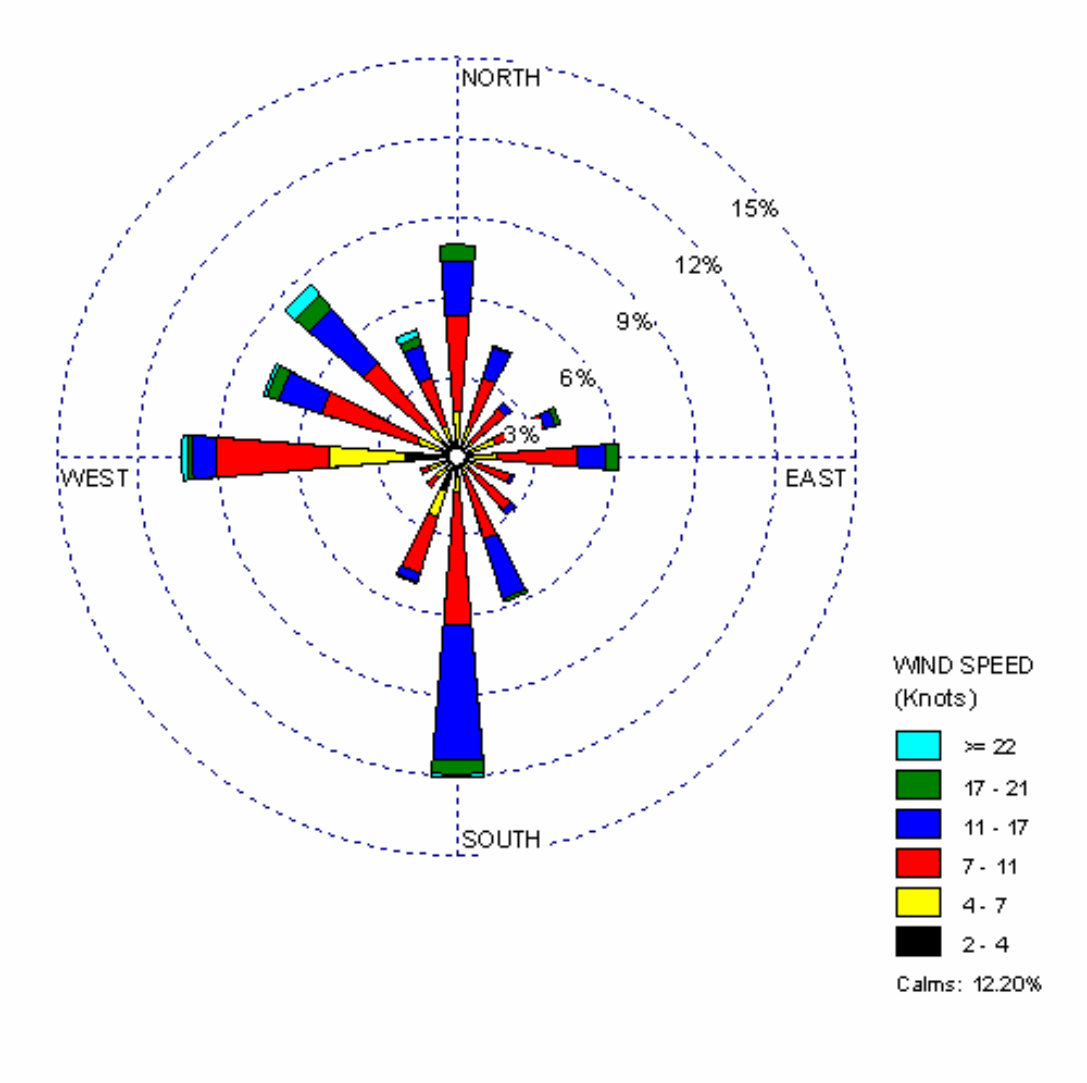


Figure 18-11. Comparison of Yearly Averages of the CUSD Monitoring Site

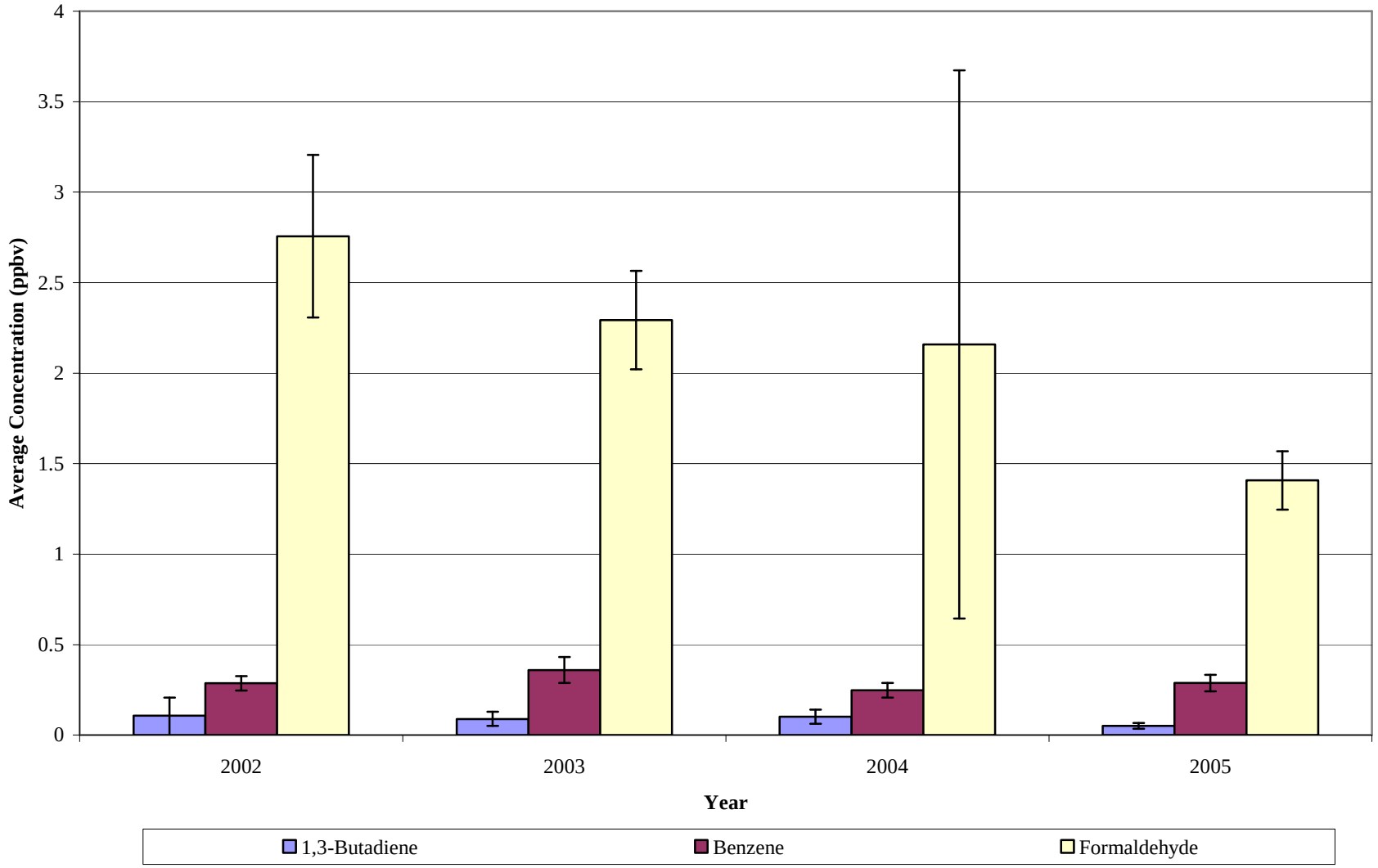


Figure 18-12. Comparison of Yearly Averages of the SFSD Monitoring Site

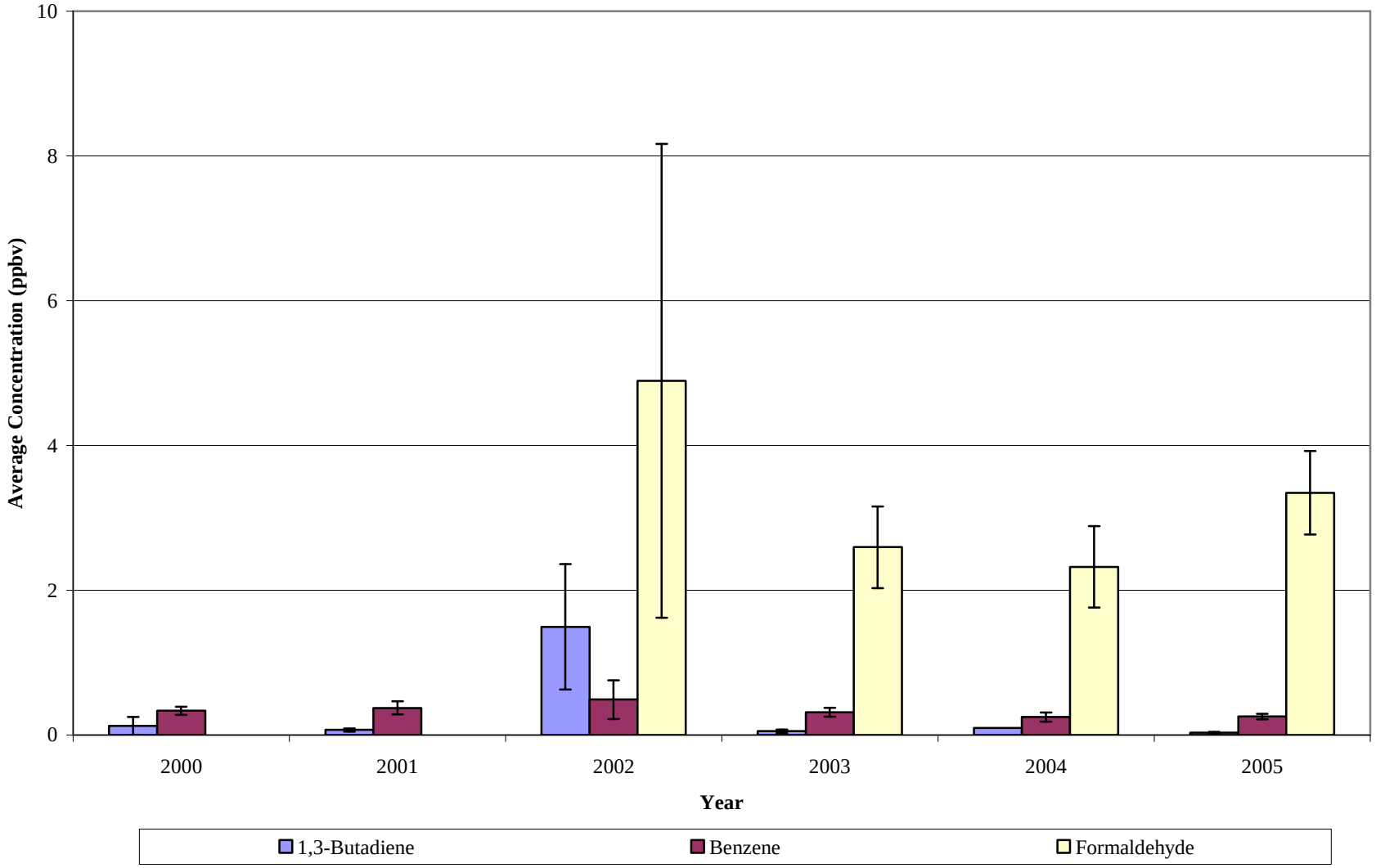


Table 18-1. Average Meteorological Parameters for Monitoring Sites in South Dakota

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
CUSD	94032	All 2005	55.73 ± 1.94	44.86 ± 1.78	27.33 ± 1.55	36.97 ± 1.45	55.72 ± 1.64	1014.00 ± 0.71	2.47 ± 0.39	-0.84 ± 0.30
		Sample Day	55.59 ± 4.72	44.01 ± 4.42	26.72 ± 3.94	36.29 ± 3.70	55.98 ± 3.52	1014.94 ± 1.94	2.17 ± 0.90	-0.64 ± 0.62
SFSD	14944	All 2005	58.05 ± 2.40	48.26 ± 2.27	38.71 ± 2.14	43.54 ± 2.07	72.48 ± 1.18	1015.31 ± 0.80	0.08 ± 0.54	0.54 ± 0.67
		Sample Day	57.05 ± 6.03	47.47 ± 5.70	38.12 ± 5.35	42.85 ± 5.21	72.92 ± 2.76	1016.1 ± 2.19	0.87 ± 1.19	-0.45 ± 1.49

Table 18-2. Comparison of Measured Concentration and EPA Screening Values at the South Dakota Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Custer, South Dakota - CUSD					
Benzene	60	60	100.00	20.4%	20.4%
Acetaldehyde	59	60	98.33	20.1%	40.5%
Formaldehyde	51	60	85.00	17.3%	57.8%
Carbon Tetrachloride	51	51	100.00	17.3%	75.2%
1,3-Butadiene	33	35	94.29	11.2%	86.4%
Acrolein	18	18	100.00	6.1%	92.5%
1,1,2,2-Tetrachloroethane	10	10	100.00	3.4%	95.9%
Hexachloro-1,3-butadiene	5	5	100.00	1.7%	97.6%
Tetrachloroethylene	5	16	31.25	1.7%	99.3%
1,2-Dichloroethane	2	2	100.00	0.7%	100.0%
Total	294	317			
Sioux Falls, South Dakota - SFSD					
Acetaldehyde	59	59	100.00	20.4%	20.4%
Benzene	59	59	100.00	20.4%	40.8%
Formaldehyde	56	59	94.92	19.4%	60.2%
Carbon Tetrachloride	53	53	100.00	18.3%	78.5%
1,3-Butadiene	21	27	77.78	7.3%	85.8%
Hexachloro-1,3-butadiene	12	12	100.00	4.2%	90.0%
Acrolein	12	12	100.00	4.2%	94.1%
Tetrachloroethylene	4	14	28.57	1.4%	95.5%
p-Dichlorobenzene	3	12	25.00	1.0%	96.5%
1,2-Dichloroethane	3	3	100.00	1.0%	97.6%
Xylenes	2	59	3.39	0.7%	98.3%
Acrylonitrile	2	2	100.00	0.7%	99.0%
Chloromethylbenzene	1	1	100.00	0.3%	99.3%
Dichloromethane	1	36	2.78	0.3%	99.7%
Trichloroethylene	1	5	20.00	0.3%	100.0%
Total	289	413			

Table 18-3. Daily and Seasonal Averages for Pollutants of Interest at the South Dakota Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Custer, South Dakota – CUSD												
1,1,2,2-Tetrachloroethane	10	60	0.15	0.03	NR	NR	NR	NR	NR	NR	NR	NR
1,3-Butadiene	35	60	0.10	0.03	NR	NR	NR	NR	0.07	0.01	0.13	0.03
Acetaldehyde	60	60	1.30	0.14	1.47	0.33	1.03	0.24	1.36	0.25	1.30	0.21
Acrolein	18	31	2.25	0.61	NA	NA	NA	NA	NR	NR	1.64	0.81
Benzene	60	60	0.78	0.13	1.26	0.23	0.40	0.12	0.55	0.07	0.87	0.29
Carbon Tetrachloride	51	60	0.55	0.04	0.42	0.08	0.35	0.08	0.63	0.06	0.56	0.07
Formaldehyde	60	60	1.73	0.20	2.04	0.49	1.16	0.26	2.08	0.33	1.61	0.26
Sioux Falls, South Dakota – SFSD												
1,3-Butadiene	27	59	0.07	0.02	NR	NR	NR	NR	0.08	0.01	0.11	0.02
Acetaldehyde	59	59	3.22	0.49	3.24	1.31	2.71	0.88	3.68	1.00	3.21	0.64
Acrolein	12	30	1.61	0.78	NA	NA	NA	NA	NR	NR	NR	NR
Benzene	59	59	0.70	0.09	0.90	0.19	0.58	0.17	0.62	0.12	0.69	0.22
Carbon Tetrachloride	53	59	0.59	0.04	0.47	0.09	0.42	0.08	0.69	0.05	0.62	0.11
Formaldehyde	59	59	4.11	0.71	2.37	0.95	3.13	0.71	7.16	1.56	3.64	0.80
Hexachloro-1,3-butadiene	12	59	0.16	0.03	NR	NR	NR	NR	NR	NR	0.89	0.41
Tetrachloroethylene	14	59	0.51	0.69	NR	NR	NR	NR	NR	NR	0.11	0.03

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 18-4. Non-Chronic Risk Summary at the South Dakota Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
CUSD	TO-15	Acrolein	2.25 ± 0.61	0.11	18	0.19	18	0.09	NA	NA	NR	1.64 ± 0.81
SFSD	TO-15	Acrolein	1.61 ± 0.78	0.11	12	0.19	12	0.09	NA	NA	NR	NR

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 18-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the South Dakota Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Custer, South Dakota – CUSD									
1,1,2,2-Tetrachloroethane	10	0.68	0.72	0.85	0.81	-0.02	-0.10	0.01	0.09
1,3-Butadiene	35	-0.47	-0.52	-0.59	-0.55	-0.26	0.27	-0.01	0.31
Acetaldehyde	60	0.15	0.07	-0.01	0.03	-0.18	-0.19	0.30	0.20
Acrolein	18	0.09	0.02	-0.06	0.00	-0.23	0.23	0.21	-0.03
Benzene	60	-0.36	-0.41	-0.44	-0.43	-0.09	0.23	0.06	0.26
Carbon Tetrachloride	51	0.21	0.24	0.34	0.30	0.27	-0.19	0.14	-0.10
Formaldehyde	60	0.30	0.25	0.16	0.21	-0.23	-0.14	0.22	0.22
Sioux Falls, South Dakota – SFSD									
1,3-Butadiene	27	-0.47	-0.48	-0.45	-0.47	0.18	0.33	-0.38	0.35
Acetaldehyde	59	0.06	0.03	0.03	0.03	-0.01	-0.04	0.25	-0.02
Acrolein	12	0.20	0.25	0.30	0.27	0.27	0.12	-0.10	-0.09
Benzene	59	-0.37	-0.36	-0.32	-0.35	0.25	0.14	-0.25	0.29
Carbon Tetrachloride	53	0.20	0.24	0.31	0.27	0.26	-0.27	0.19	-0.12
Formaldehyde	59	0.55	0.58	0.58	0.59	-0.09	-0.20	0.28	-0.33
Hexachloro-1,3-butadiene	12	-0.67	-0.62	-0.54	-0.60	0.25	0.30	0.10	0.07
Tetrachloroethylene	14	0.45	0.48	0.45	0.48	0.06	-0.23	-0.17	-0.05

Table 18-6. Motor Vehicle Information for the South Dakota Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
CUSD	7,904	9,403	1.19	4,449	5,293	1,940
SFSD	160,087	155,857	0.97	154,472	150,390	4,320

Table 18-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in South Dakota

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Custer, South Dakota - CUSD, Census Tract 46033995200				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	<0.01	<0.01	--
1,2-Dichloroethane	0.10 ± 0.01	<0.01	<0.01	<0.01
1,3-Butadiene	0.11 ± 0.01	0.01	0.39	0.01
Acetaldehyde	1.30 ± 0.14	0.43	0.95	0.05
Acrolein	NA	0.03	--	1.52
Benzene	0.78 ± 0.13	0.26	2.07	0.01
Carbon Tetrachloride	0.50 ± 0.05	0.21	3.11	0.01
Formaldehyde	1.73 ± 0.20	0.31	<0.01	0.03
Hexachloro-1,3-butadiene	1.11 ± 0.13	<0.01	0.03	<0.01
Tetrachloroethylene	0.16 ± 0.03	<0.01	0.01	<0.01
Sioux Falls, South Dakota - SFSD, Census Tract 46099001802				
1,2-Dichloroethane	0.16 ± 0.01	0.03	0.67	<0.01
1,3-Butadiene	0.10 ± 0.01	0.06	1.82	0.03
Acetaldehyde	3.22 ± 0.49	0.68	1.50	0.08
Acrolein	NA	0.02	--	1.21
Acrylonitrile	0.09 ± 0.04	<0.01	0.02	<0.01
Benzene	0.70 ± 0.10	0.69	5.41	0.02
Carbon Tetrachloride	0.55 ± 0.05	0.21	3.12	0.01
Chloromethylbenzene	0.11 ± 0.01	<0.01	<0.01	--
Dichloromethane	0.22 ± 0.07	0.24	0.11	<0.01
Formaldehyde	4.11 ± 0.71	0.80	<0.01	0.08
Hexachloro-1,3-butadiene	0.91 ± 0.13	<0.01	0.03	<0.01
p-Dichlorobenzene	0.19 ± 0.05	0.02	0.17	<0.01
Tetrachloroethylene	0.23 ± 0.17	0.09	0.51	<0.01
Trichloroethylene	0.18 ± 0.10	0.06	0.12	<0.01
Xylenes	1.73 ± 0.65	0.91	--	0.01

NA = No available due to short sampling duration.

BOLD = pollutant of interest.

19.0 Sites in Tennessee

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Tennessee (DITN and LDTN). One site is located west of Nashville in Dickson (DITN), and one is located southwest of Knoxville (LDTN). Figures 19-1 and 19-2 are topographical maps showing the monitoring sites in their urban locations. Figures 19-3 and 19-4 identify point source emission locations within 10 miles of these sites as reported to the 2002 NEI for point sources. The DITN site is surrounded by relatively few industrial sources, although most are located just to the south of the site. The facilities closest to the site are involved in organic chemical production, fabricated metal products, and polymer and resin production. The LDTN site has a few more sources nearby than DITN, and several of these are involved in waste treatment and disposal, polymer and resin production, or fuel combustion industries.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the DITN monitoring site is the Clarksville Outlaw Airport and weather station closest to the LDTN monitoring site is the Knoxville McGhee-Tyson Airport (WBAN 13891 and 03894, respectively).

Nashville=s climate is rather moderate in nature, lacking extreme fluctuations in temperature. The city has a long growing season and boasts four distinct seasons. The Dickson area has a climate similar to Nashville, although diurnal temperature fluctuations are probably greater due to the loss of the urban heat island. Loudon is located to the southwest of Knoxville. The Tennessee River and Watts Bar Lake run through town, influencing the area=s weather by moderating temperatures and affecting wind patterns. The Appalachian Mountains lie to the east. The area has ample rainfall year-round and, like Nashville, experiences all four seasons (Ruffner and Bair, 1987 and http://www.blueshoenashville.com/weather.html). Table 19-1 presents the average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity),

pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 19-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

19.1 Pollutants of Interest at the Tennessee Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 19-2 presents the pollutants that failed at least one screen at the Tennessee monitoring sites. Thirteen pollutants failed at least one screen at the DITN; a total of 144 measured concentrations failed screens. At LDTN, 15 pollutants failed at least one screen and a total of 152 measured concentrations failed screens. The same nine pollutants contributed to 95% of the total failed screens at both Tennessee monitoring sites: acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, *p*-dichlorobenzene, and tetrachloroethylene. It's important to note that the Tennessee sites sampled for carbonyls compounds and VOC only, and that this is reflected in Table 19-2.

Also listed in Table 19-2 are the total number of detects and the percent detects failing the screen. Acrolein, benzene, carbon tetrachloride, and hexachloro-1,3-butadiene concentrations failed 100% of screens at each site. Acetaldehyde, benzene, and carbon tetrachloride accounted for over 50% of the failed screens at both sites.

19.2 Concentration Averages at the Tennessee Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The *daily* average of a particular pollutant is simply the average

concentration of all detects. If there are at least seven detects within each season, then a *seasonal* average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the *annual* average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 19-3. Annual averages will be presented and discussed in further detail in later sections.

Acetaldehyde, benzene, and formaldehyde were detected in every sampled taken at the Tennessee monitoring sites. Among the daily averages at DITN, formaldehyde measured the highest concentration by mass (2.60 ± 0.62 $\mu g/m^3$), followed by acrolein (2.30 ± 0.69 $\mu g/m^3$). Most of the pollutants of interest were not detected enough for many seasonal averages to be calculated. For the ones that were, the seasonal averages did not vary much, with the exception of formaldehyde. Formaldehyde was significantly higher in the summer (4.59 ± 0.96 $\mu g/m^3$) than in winter or spring (1.45 ± 0.53 $\mu g/m^3$ and 2.16 ± 0.79 $\mu g/m^3$, respectively). No autumn average is available.

Similar to DITN, formaldehyde measured the highest concentration by mass (2.39 ± 0.52 $\mu g/m^3$) at LDTN, followed by acetaldehyde (2.02 ± 0.34 $\mu g/m^3$). Most of the pollutants of interest were not detected enough for many seasonal averages to be calculated. For the ones that were, the seasonal averages did not vary much, again with the exception of formaldehyde. Formaldehyde was significantly higher in the summer (4.10 ± 0.56 $\mu g/m^3$) than in autumn or spring (2.00 ± 0.87 $\mu g/m^3$ and 1.95 ± 0.72 $\mu g/m^3$, respectively). No winter average is available.

19.3 Non-chronic Risk Evaluation at the Tennessee Monitoring Sites

Non-chronic risk is evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined

as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen at either site, only acrolein exceeded the acute risk values, and its non-chronic risk is summarized in Table 19-4.

All detects of acrolein at the Tennessee monitoring sites exceeded the ATSDR acute value of 0.11 $\mu g/m^3$and the California REL value of 0.19 $\mu g/m^3$. The average acrolein concentration at DITN was higher than at LDTN (2.30 ± 0.69 $\mu g/m^3$ vs. 1.65 ± 0.63 $\mu g/m^3$, respectively). Seasonal acrolein averages could not be calculated, therefore intermediate risk could not be evaluated.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Figures 19-5 and 19-6 are pollution roses for acrolein at the Tennessee monitoring sites. The pollution rose is a plot of daily concentration and daily average wind direction. As indicated in Figure 19-5, all acrolein concentrations exceeded the acute risk factors at DITN, indicated by a dashed (CalEPA REL) and solid line (ATSDR MRL). The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources. The highest concentration of acrolein occurred on November 18, 2005 with a south-southwesterly wind. DITN is located just south of a major roadway through town, and is located in proximity to a local industrial park (Figure 19-1).

As indicated in Figure 19-6, all four acrolein concentrations exceeded the acute risk factors at LDTN, indicated by a dashed (CalEPA REL) and solid line (ATSDR MRL). The concentrations on the pollution rose occurred primarily with a west-southwesterly or westerly wind, although the highest concentration of acrolein occurred on October 13, 2005 with a northerly wind. However, the relatively low number of acrolein detects makes it difficult to detect a concentration-wind direction pattern on the pollution rose. LDTN is located on a mile-wide strip of land bounded on either side by the Tennessee River. A major roadway through town runs just to the northwest of the monitoring site (Figure 19-2).

19.4 Meteorological and Concentration Analysis at the Tennessee Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

19.4.1 Pearson Correlation Analysis

Table 19-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Tennessee monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) At DITN, moderately strong positive correlations were calculated between acetaldehyde and maximum, average, dew point, and wet bulb temperatures (0.43, 0.36, 0.25, and 0.31, respectively) and very strong positive correlations were calculated between formaldehyde and these same four parameters (0.84, 0.86, 0.81, and 0.84, respectively). This supports the high summer formaldehyde average discussed in Section 19.2. Moderately strong to very strong negative correlations were computed between 1,3-butadiene, acrolein, benzene, carbon tetrachloride, and hexchloro-1,3-butadiene and the aforementioned temperature parameters. It is important to consider that acrolein and hexachloro-1,3-butadiene, the pollutants with the strongest of these negative correlations, were detected infrequently. This low detection rate can skew the correlations. All of the correlations with relative humidity at DITN were moderately strong and negative, with the exception of carbon tetrachloride and formaldehyde, indicating that as relative humidity increases, concentrations of the pollutants of interest at DITN decrease. With the exception of carbon tetrachloride, the correlations with the *u*-component of the wind were moderately strong to strong, while this is true of relatively few pollutants and the *v*-component of the wind. This indicates that westerly and easterly winds have a higher impact on concentrations than northerly or southerly winds. Acetaldehyde, acrolein, benzene, 1,3-butadiene, and hexachloro-1,3-butadiene exhibited moderately strong correlations with sea level pressure.

The strongest correlations computed at LDTN were between acrolein and each of the meteorological parameters. However, this pollutant was detected only four times, and this low

detection rate may cause the correlations appear stronger than they would otherwise. However, the very strong positive correlations calculated for formaldehyde and the maximum, average, dew point, and wet bulb temperatures (0.88, 0.86, 0.77, and 0.82, respectively) are based on nearly 30 detects. Similar to DITN, these formaldehyde correlations support the higher summer formaldehyde averages discussed in Section 19.2. Acetaldehyde, *p*-dichlorobenzene, and tetrachloroethylene exhibit this trend as well, but the correlations are not nearly as strong. Moderately strong correlations were calculated between hexchloro-1,3-butadiene and the wind components and sea level pressure. However, this pollutant was also detected very few times at LDTN.

19.4.2 Composite Back Trajectory Analysis

Figures 19-7 and 19-8 are composite back trajectory maps for the Tennessee monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site represents 100 miles.

As shown in Figure 19-7, the back trajectories originated from a variety of directions at DITN. The 24-hour airshed domain is rather large at DITN, with trajectories originating as far away as South Dakota or greater than 800 miles away. However, nearly 52% of the trajectories originated within 200 miles of the site; and 86% within 400 miles from the DITN monitoring site. The one trajectory originating from South Dakota occurred on a day when a strong frontal system moved across the central and eastern US on November 24, 2005. This wind pattern is also evident on several composite trajectory maps from other sites in the region including the DEMI, INDEM, NBIL and SPIL, and MIMN monitoring sites.

As shown in Figure 19-8, the back trajectories originated from a variety of directions at LDTN. The 24-hour airshed domain is somewhat smaller at LDTN than DITN, with trajectories originating as far away as western Missouri, or nearly 500 miles away. Nearly 68% of the trajectories originated within 300 miles of the site; and 90% within 400 miles from the LDTN monitoring site.

19.4.3 Wind Rose Analysis

Hourly wind data from the Clarksville Outlaw Airport and Knoxville McGhee-Tyson Airport weather stations were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figures 19-9 and 19-10 are the wind roses for the Tennessee monitoring sites on days sampling occurred.

As indicated in Figure 19-9, hourly winds were predominantly out of the west (11% of observations), south (7%), and southwest (7%) on days samples were taken near DITN. Calm winds (<2 knots) were recorded for 25% of the hourly measurements. For wind speeds greater than 2 knots, 25% of observations ranged from 2 to 4 knots, 24% ranged from 7 to 11 knots, and 19% ranged from 4 to 7 knots. For wind speeds greater than 22 knots, the wind direction was most frequently from the west and northwest.

Similar to DITN, as indicated in Figure 19-10, hourly winds were predominantly out of west (10%), southwest (9%), and west-southwest (8%) on days samples were taken near LDTN. Calm winds (<2 knots) were recorded for 26% of the hourly measurements. For wind speeds greater than 2 knots, 27% of observations ranged from 2 to 4 knots, 20% ranged from 7 to 11 knots, and 19% ranged from 4 to 7 knots.

19.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

19.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Dickson County and Loudon County were obtained from the Tennessee Department of Safety and the U.S. Census Bureau, and are summarized in Table 19-6. Table 19-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented.

An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 19-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

The county populations and vehicle registration in DITN and LDTN's respective counties are fairly similar. However, LDTN has a higher vehicle-to-population ratio than DITN, even though both ratios are on the high end compared to other UATMP sites. DITN has about two-thirds the 10-mile population of LDTN, and roughly half the estimated 10-mile vehicle ownership. The population and vehicle registration statistics for the Tennessee monitoring sites are both on the low-end compared to other UATMP sites. The LDTN daily traffic count is three times that of DITN. But both traffic counts are in the low to mid range compared to other UATMP sites.

19.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-2 depicted the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the Tennessee monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. Of the two sites, the LDTN monitoring site's ratios most resemble those of the roadside study. The LDTN xylenes-ethylbenzene ratio (3.46 ± 0.17) is somewhat less than the roadside study's (4.55), and the toluene-ethylbenzene ratio (7.89 ± 0.69) at LDTN higher than that of the roadside study (5.85). At DITN the toluene-ethylbenzene ratio (22.06 ± 5.61) is significantly higher than that of the roadside study (5.85), as well as higher than any other UATMP site.

19.6 Site-Specific Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was

conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The Tennessee monitoring sites have participated in the UATMP since 2003.

- DITN began sampling in December 2003, so very few samples make up the 2003 averages. 1,3-Butadiene was not detected during the 2003 and 2004 programs years at DITN, as indicated in Figure 19-11. Benzene and formaldehyde concentrations increased from 2003 to 2004. Although benzene and formaldehyde concentrations appear to increase again in 2005, the 2004 and 2005 concentrations are not statistically different for DITN when confidence intervals are considered.

- Concentrations of formaldehyde appear to have decreased significantly since 2003 at the LDTN monitoring site. 1,3-Butadiene was not detected during the 2003 program year. Although difficult to discern in Figure 19-12, 2005 1,3-butadiene concentrations decreased slightly from 2004. Concentrations of benzene have been fairly steady at LDTN.

19.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 19-7 presents the 1999 NATA results for the census tracts where the Tennessee monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 19-7. Pollutants of interest are bolded.

19.7.1 1999 NATA Summary

The DITN monitoring site is located in census tract 47043060600 with a population of 8,647, which represents 20.0% of the Dickson County population in 2000. In terms of cancer risk, the Top 3 pollutants identified by NATA in the DITN census tract are benzene (3.99 in-a-million risk), carbon tetrachloride (3.17), and acetaldehyde (1.34). These cancer risks are low when compared to other areas with UATMP monitoring sites. Acrolein was the only pollutant in the DITN census tract to have a noncancer hazard quotient greater than 1.0 (an HQ greater than

1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

The LDTN monitoring site is located in census tract 47105060200, which had a population in 2000 of 9,529, representing 24.4% of Loudon County's population. In terms of cancer risk, the Top 3 pollutants identified by NATA in the LDTN census tract are benzene (6.95 in-a-million risk), carbon tetrachloride (3.19), and acetaldehyde (2.69). These cancer risks are also low when compared to other areas with UATMP monitoring sites. Acrolein was the only pollutant in the LDTN census tract to have a noncancer hazard quotient greater than 1.0. Acrolein noncancer risk at LDTN was three times that of the DITN census tract. Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

19.7.2 Annual Average Comparison

The Tennessee monitoring sites annual averages are also presented in Table 19-7 for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 19.2 on how a valid annual average is calculated). With the exception of hexacloro-1,3-butadiene at DITN, all the pollutants were within one order of magnitude from each other. Acetaldehyde, benzene, formaldehyde, and total xylenes are identified as the Top 4 pollutants by mass concentration from both the 1999 NATA-modeled and 2005 annual average concentrations at DITN (but not necessarily in that order). While toluene, acetaldehyde, total xylenes, and benzene were identified as the top 4 pollutants in the LDTN census tract by NATA, toluene, total xylenes, formaldehyde, and acetaldehyde were the top 4 pollutants by measured mass concentration in 2005.

Tennessee Pollutant Summary

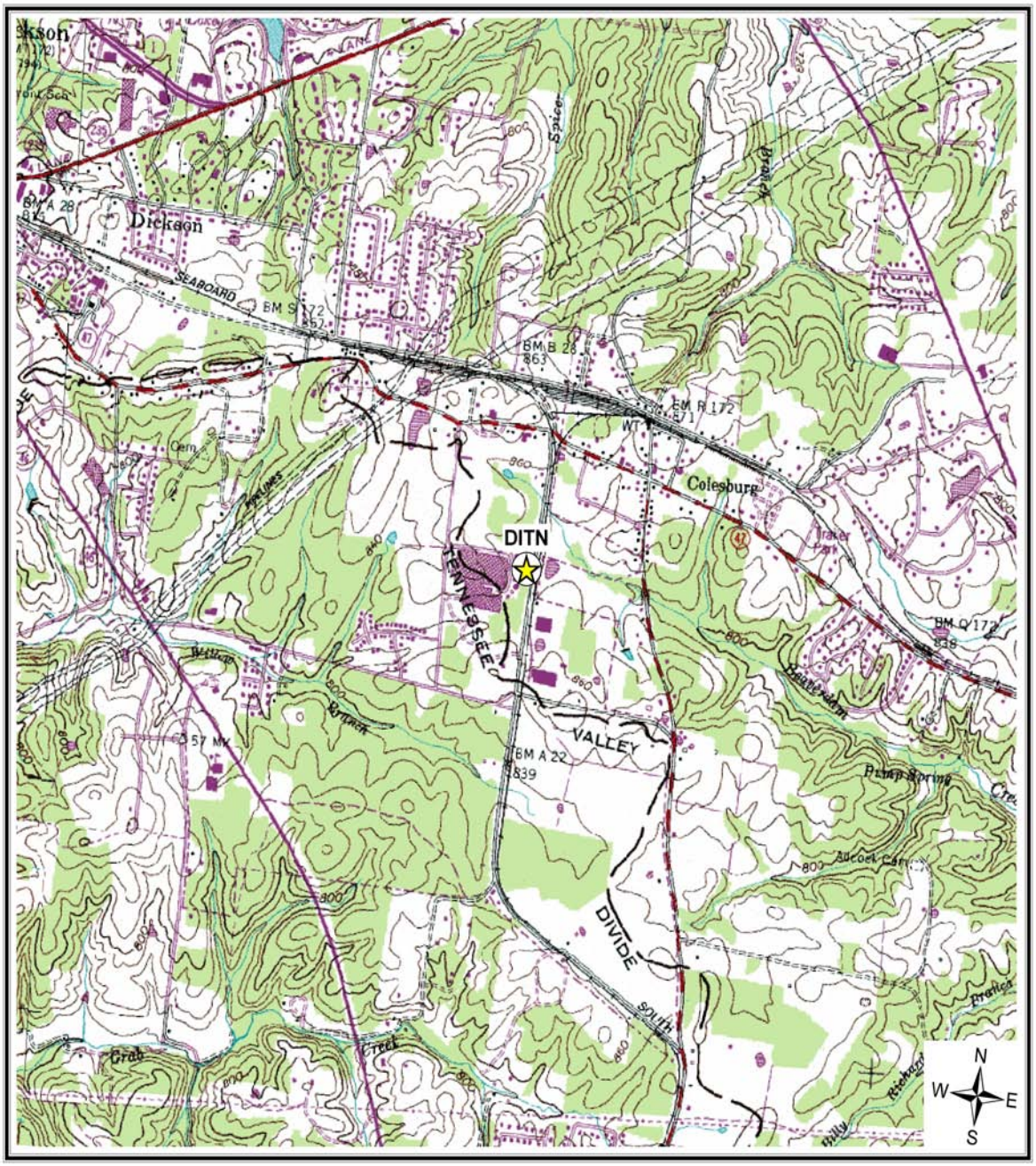
- *The pollutants of interest common to each of the Tennessee sites are acetaldehyde, acrolein, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, p-dichlorobenzene, and tetrachloroethylene..*

- *Formaldehyde measured the highest daily average at both DITN and LDTN. Formaldehyde was also highest during summer at both sites.*

- *Acrolein exceeded the short-term risk factors at both Tennessee sites.*

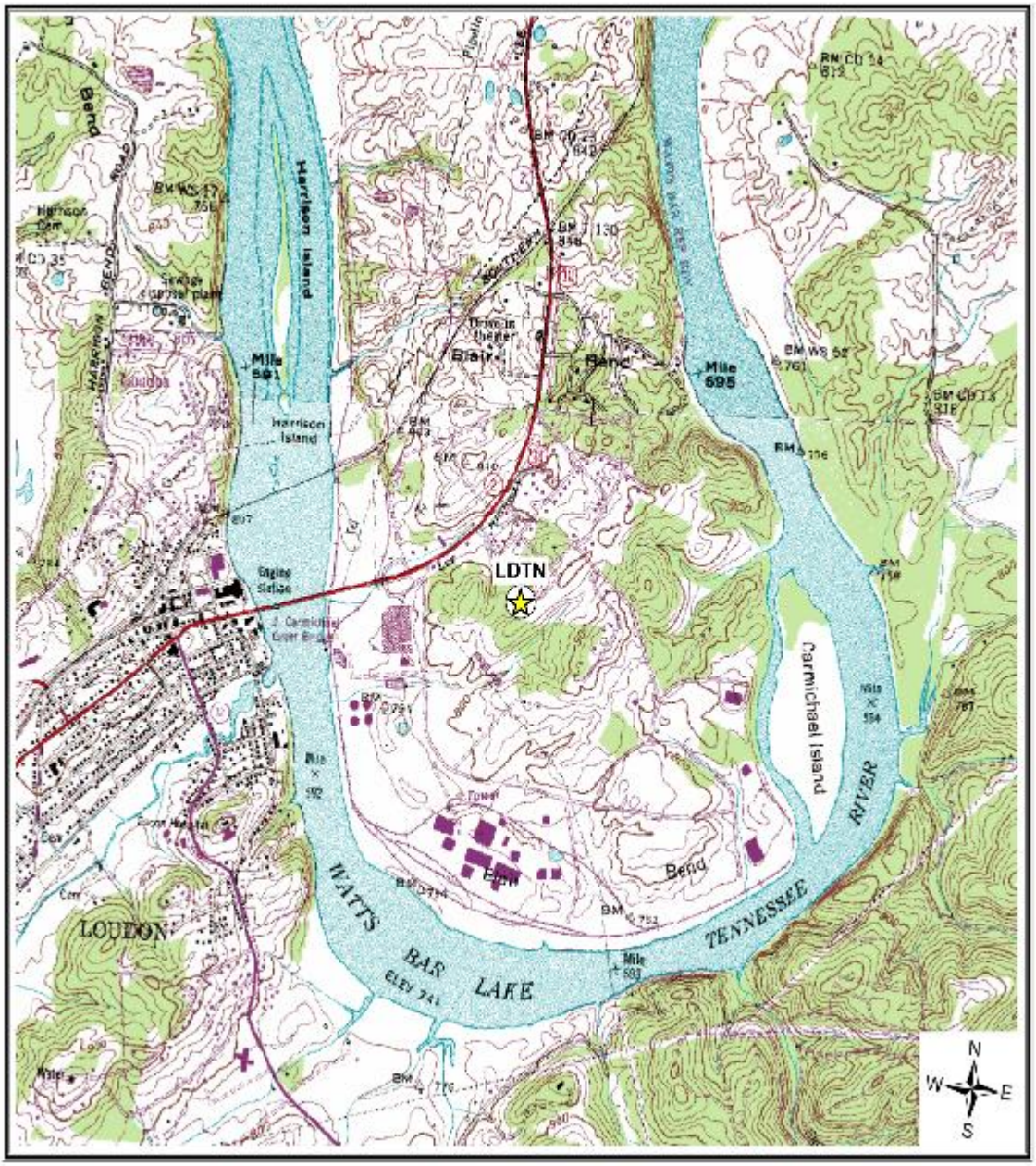
- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of benzene and formaldehyde have been increasing at DITN, while concentrations of formaldehyde have been decreasing at LDTN since the onset of sampling in 2003.*

Figure 19-1. Dickson, Tennessee (DITN) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:25,000.

Figure 19-2. Loudon, Tennessee (LDTN) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:25,000.

Figure 19-3. Facilities Located Within 10 Miles of DITN

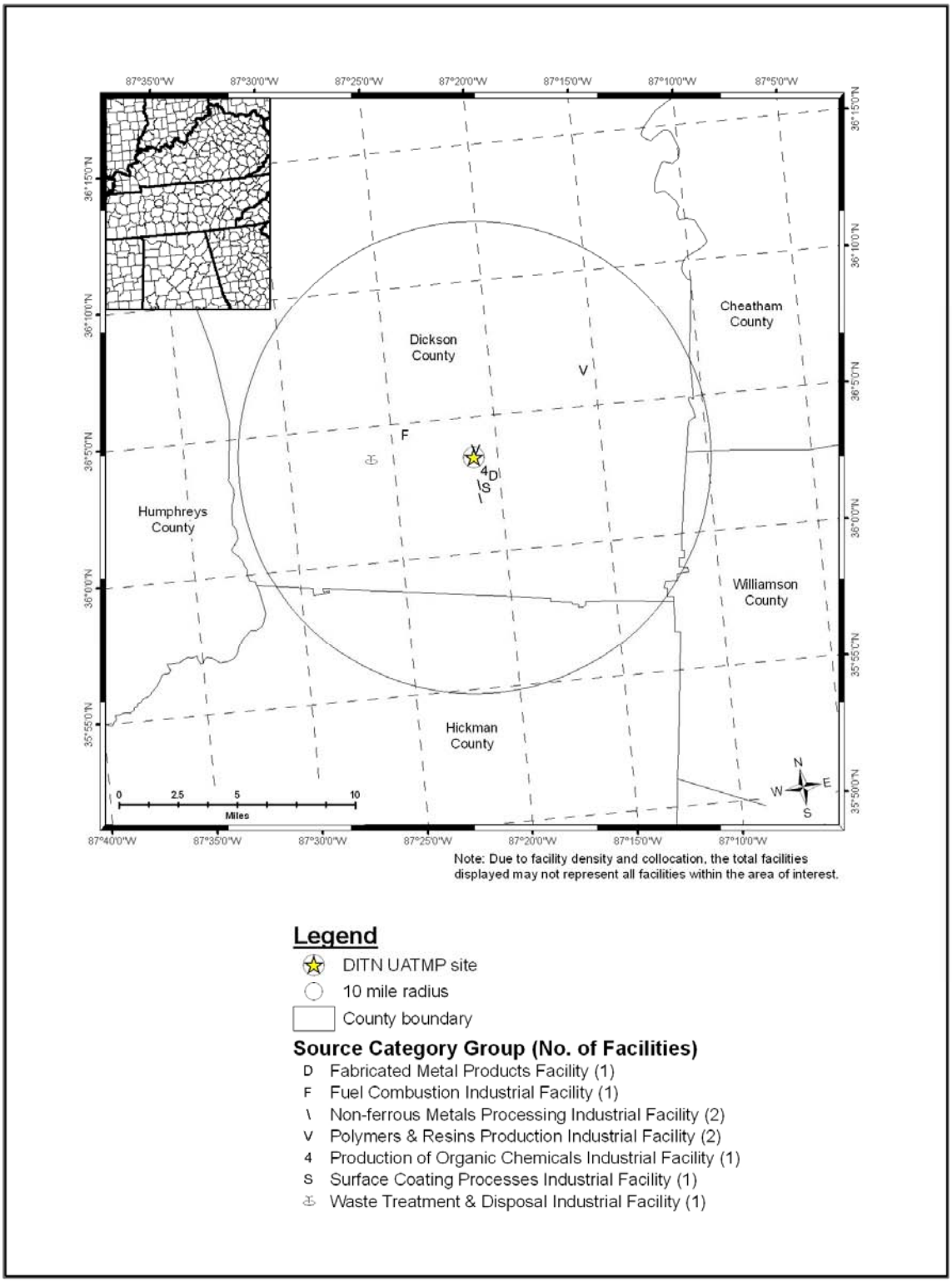


Figure 19-4. Facilities Located Within 10 Miles of LDTN

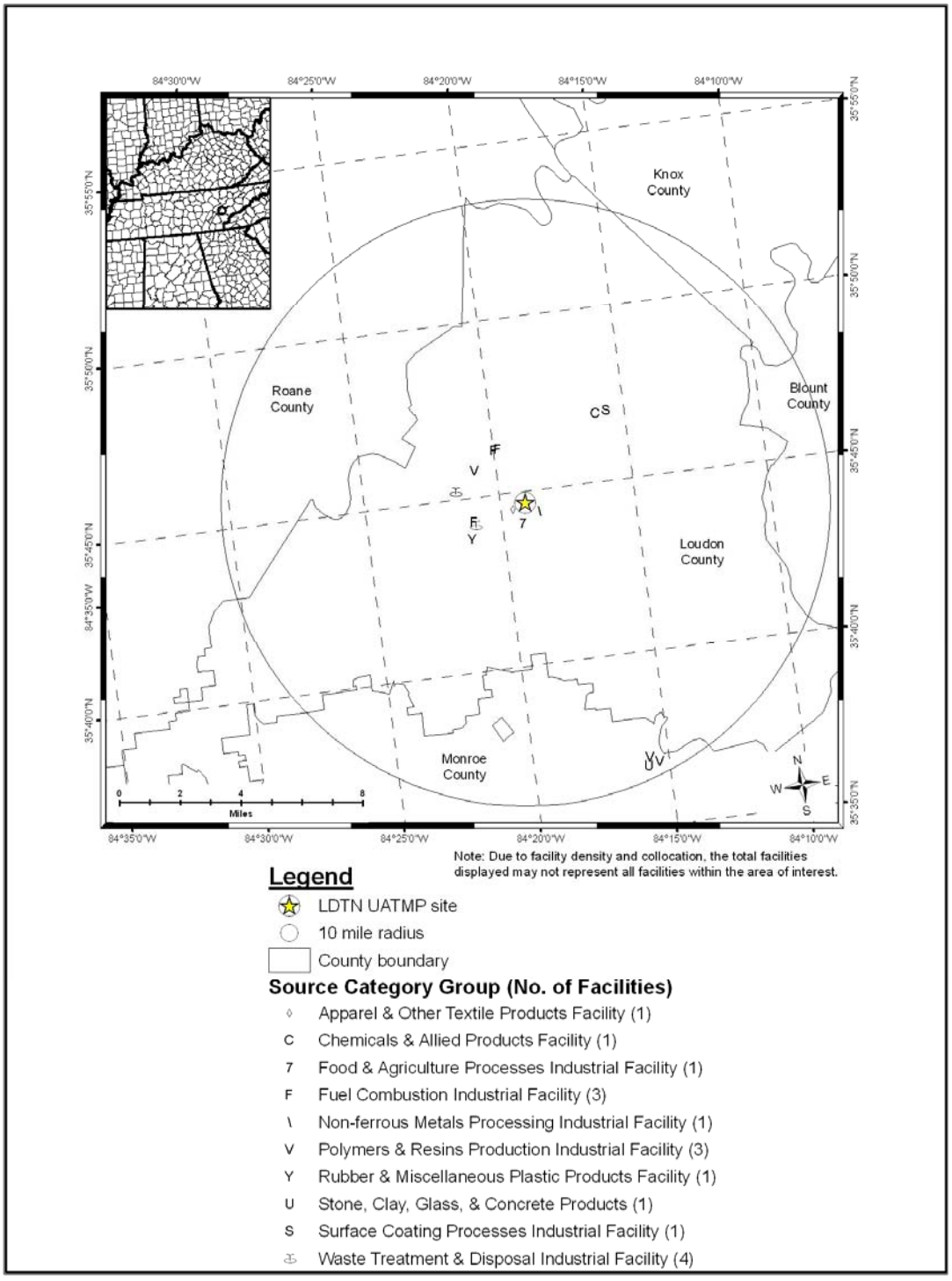


Figure 19-5. Acrolein Pollution Rose at DITN

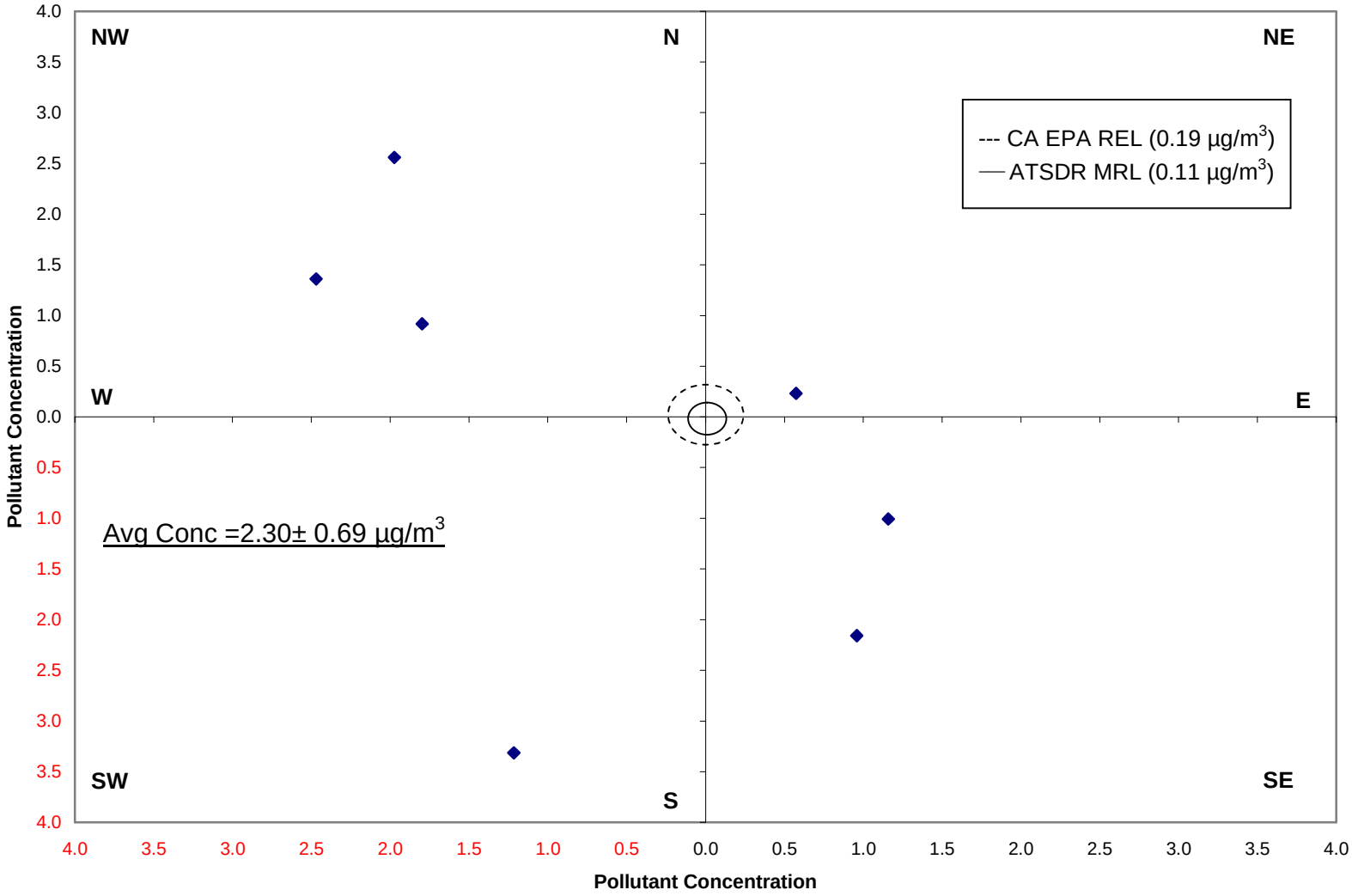


Figure 19-6. Acrolein Pollution Rose at LDTN

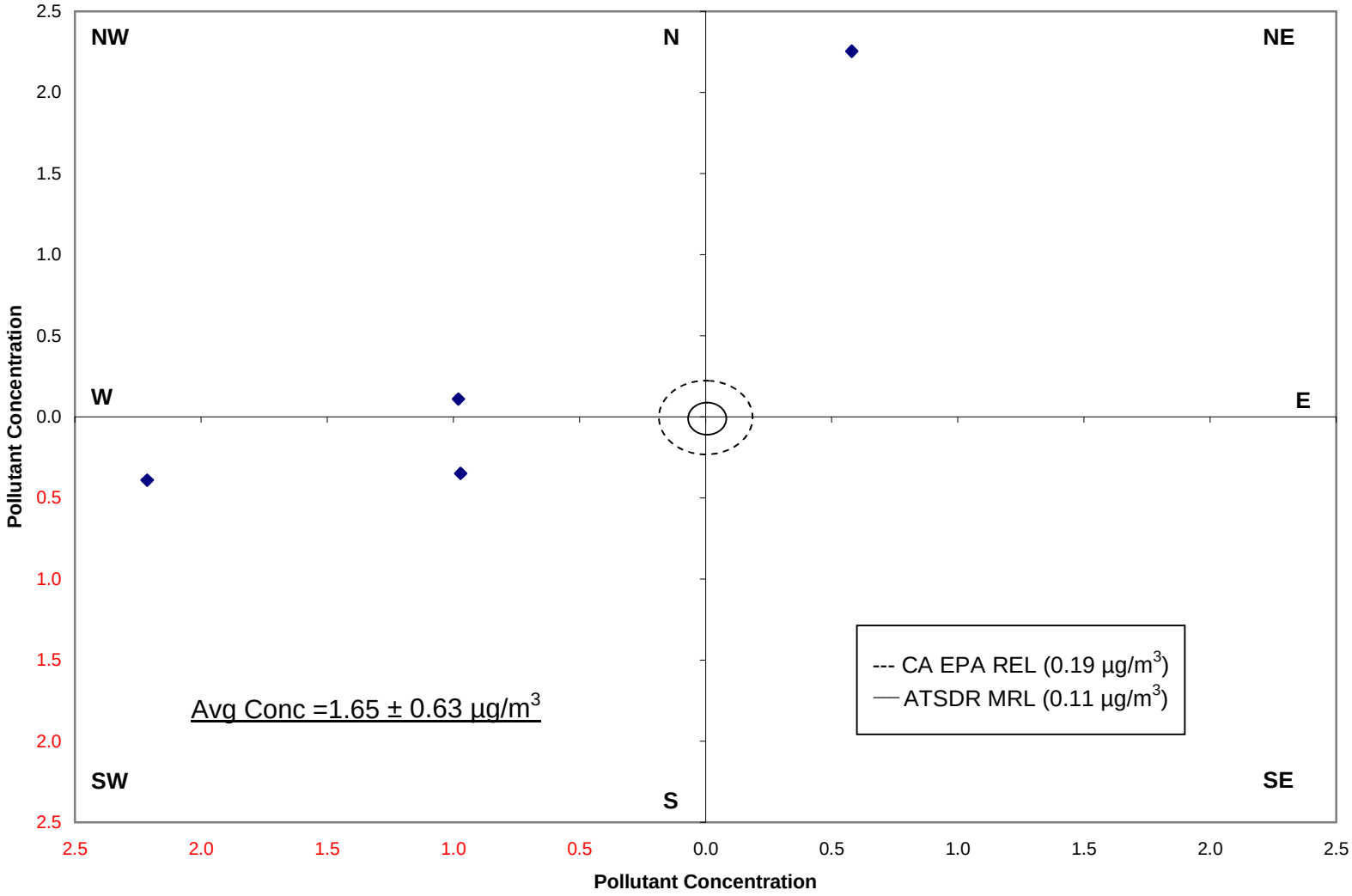


Figure 19-7. Composite Back Trajectory Map for DITN

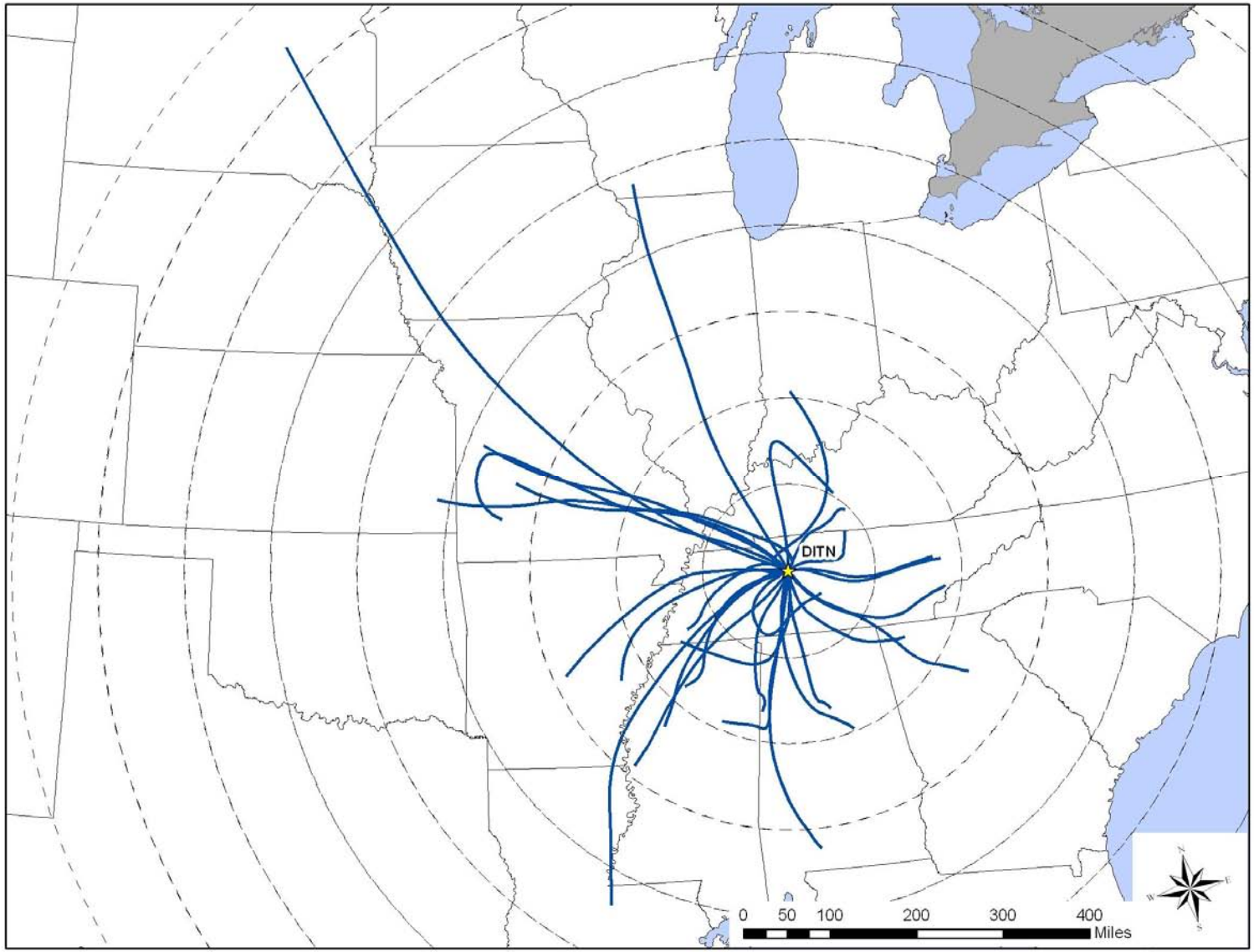


Figure 19-8. Composite Back Trajectory Map for LDTN

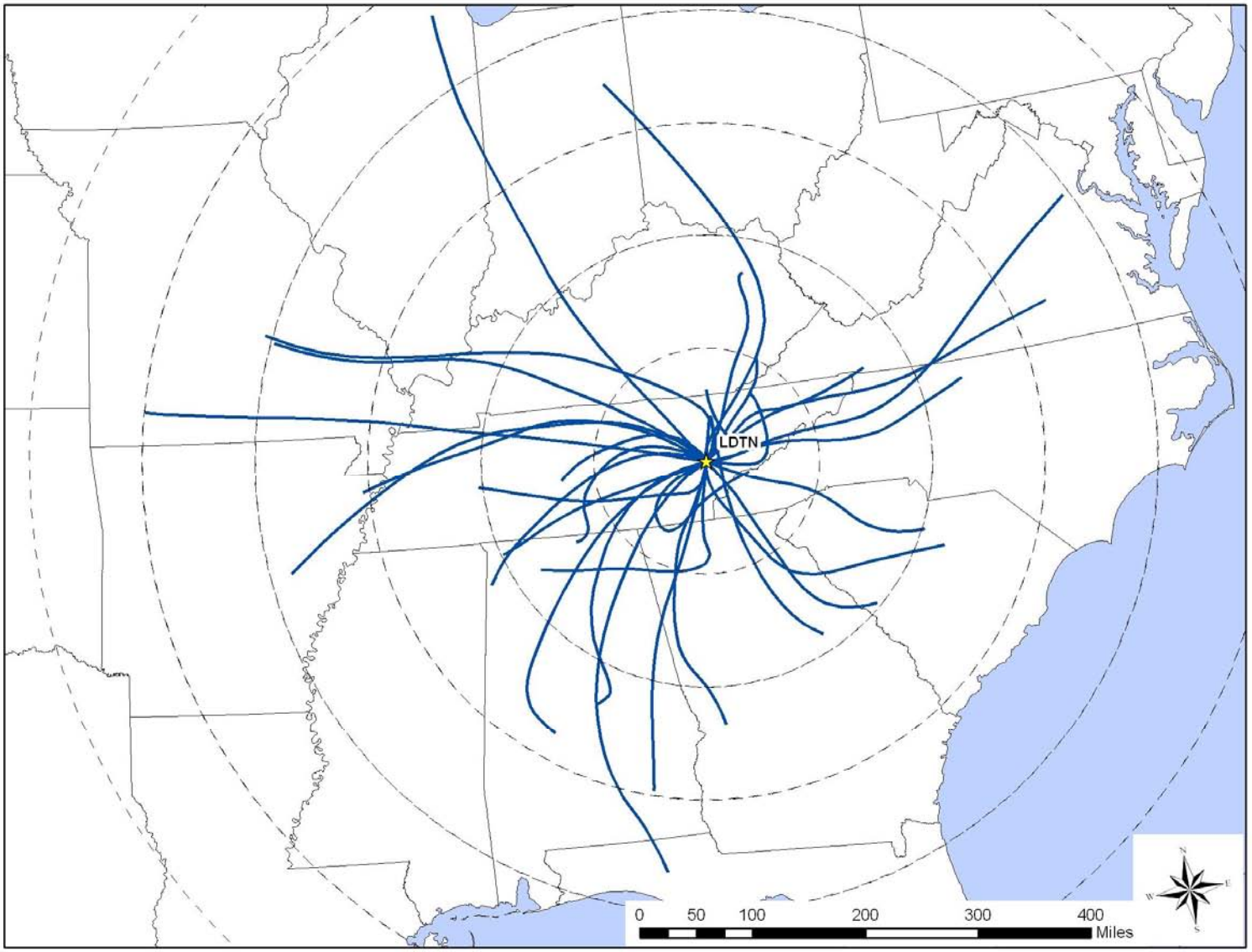


Figure 19-9. Wind Rose of Sample Days for the DITN Monitoring Site

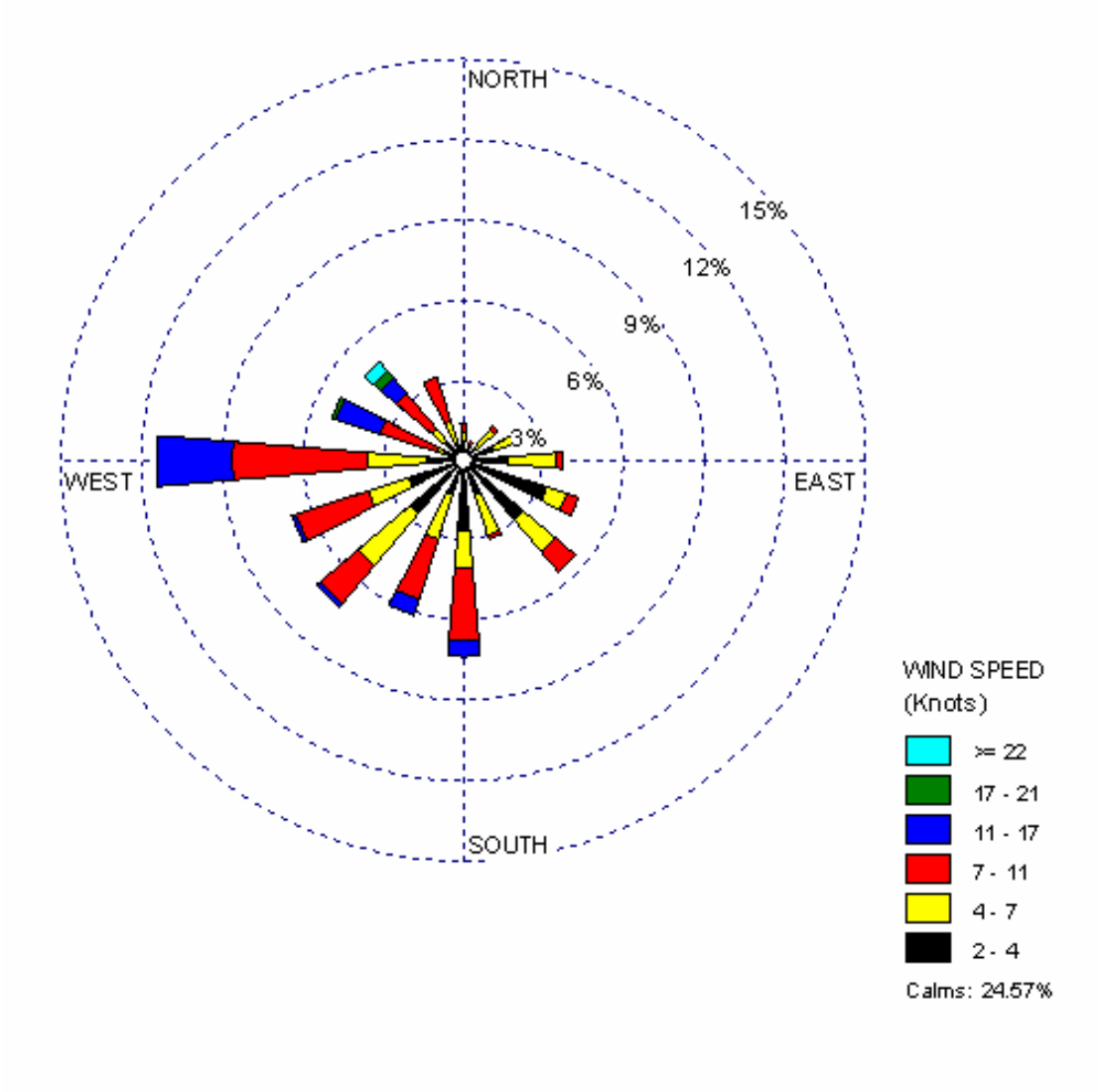


Figure 19-10. Wind Rose of Sample Days for the LDTN Monitoring Site

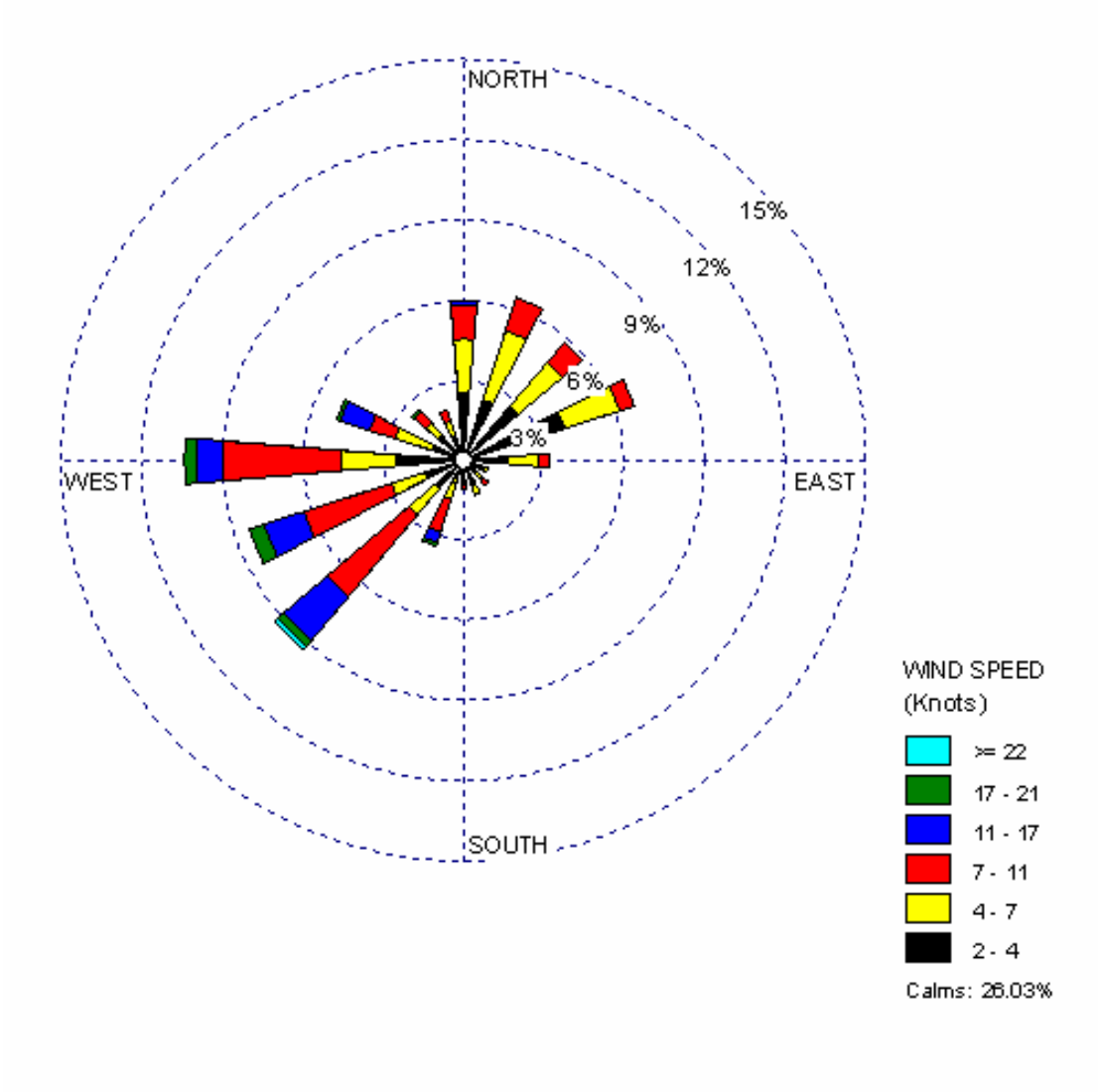


Figure 19-11. Comparison of Yearly Averages of the DITN Monitoring Site

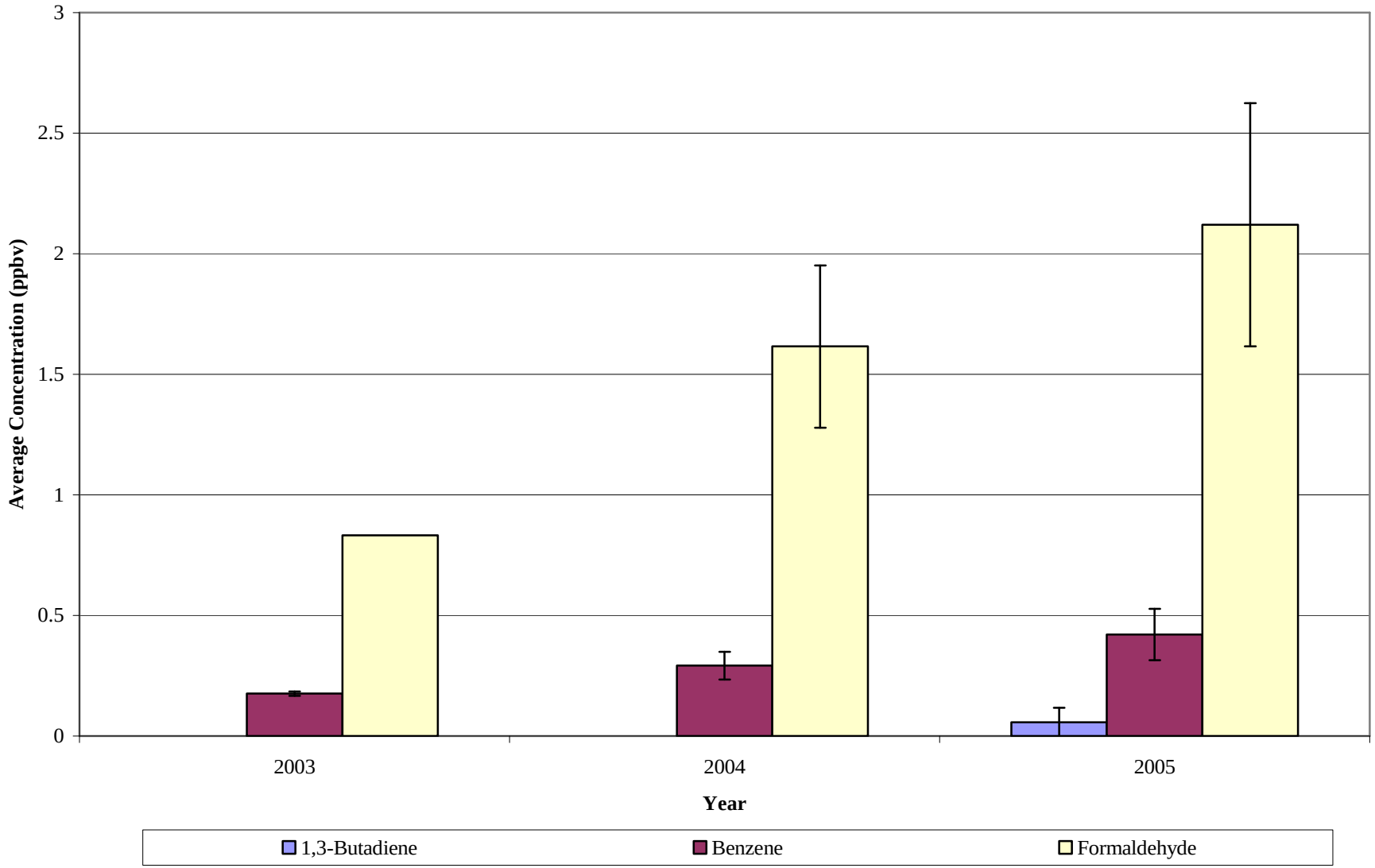


Figure 19-12. Comparison of Yearly Averages of the LDTN Monitoring Site

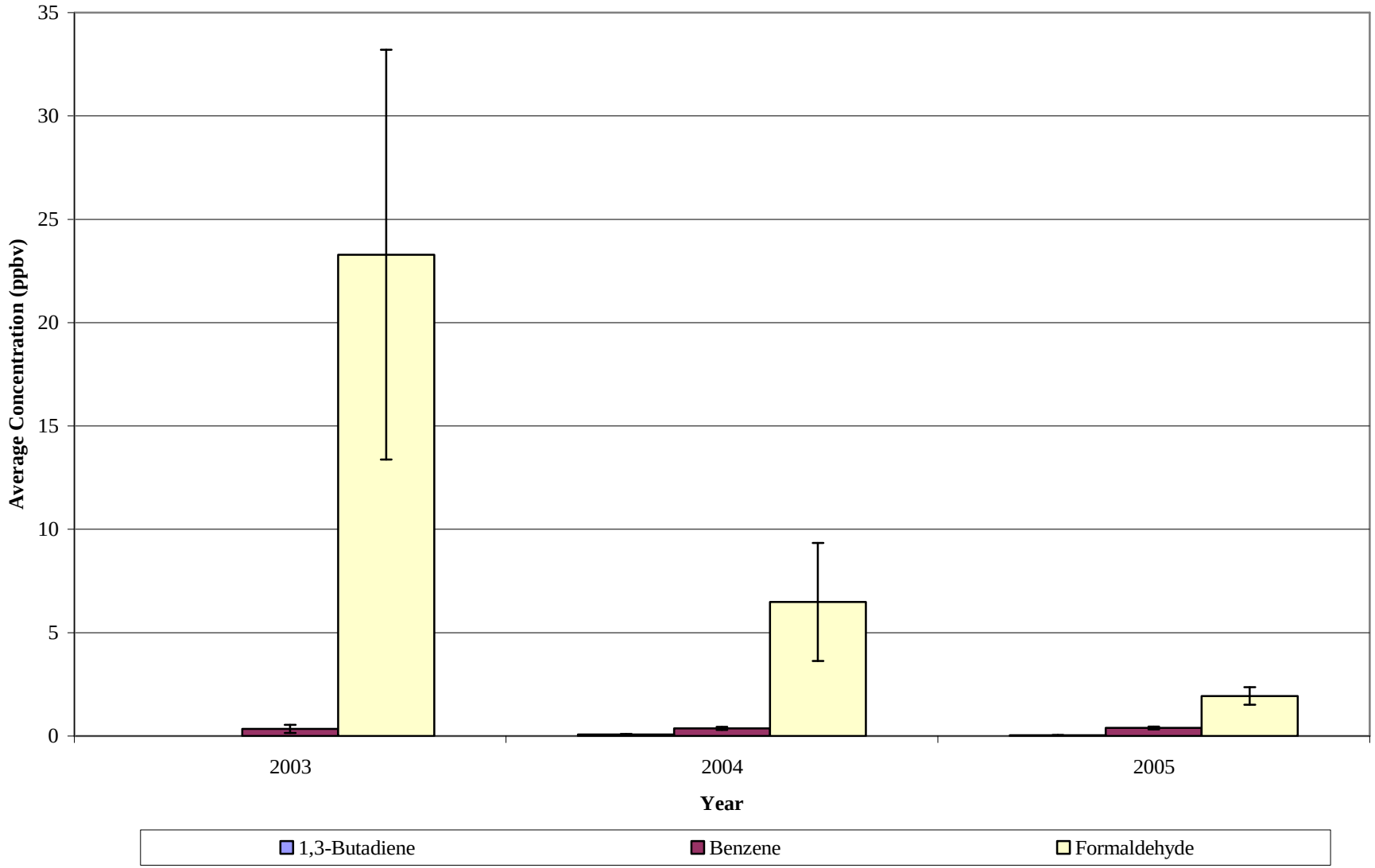


Table 19-1. Average Meteorological Parameters for Monitoring Sites in Tennessee

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
DITN	3894	All 2005	68.97 ± 1.84	58.68 ± 1.71	47.40 ± 1.77	52.76 ± 1.59	69.34 ± 1.15	1017.05 ± 0.65	0.99 ± 0.33	0.03 ± 0.41
		Sample Day	69.62 ± 6.42	59.12 ± 5.76	48.43 ± 5.88	53.42 ± 5.32	70.85 ± 4.22	1016.57 ± 1.94	1.90 ± 1.28	0.70 ± 0.97
LDTN	13891	All 2005	69.36 ± 1.68	59.41 ± 1.62	48.91 ± 1.76	53.88 ± 1.54	71.35 ± 1.23	1017.01 ± 0.62	1.35 ± 0.36	-0.20 ± 0.32
		Sample Day	69.39 ± 5.69	59.83 ± 5.37	49.65 ± 5.49	54.30 ± 4.97	72.26 ± 3.95	1017.02 ± 1.83	1.73 ± 1.23	-0.04 ± 0.86

Table 19-2. Comparison of Measured Concentrations and EPA Screening Values at the Tennessee Monitoring Sites

Pollutant	# of Failures	# of Detects	% Failing	% of total failures	% contribution
Dickson, Tennessee - DITN					
Benzene	28	28	100.0	19.4%	19.4%
Carbon Tetrachloride	27	27	100.0	18.8%	38.2%
Acetaldehyde	27	28	96.4	18.8%	56.9%
Formaldehyde	21	28	75.0	14.6%	71.5%
1,3-Butadiene	13	14	92.9	9.0%	80.6%
Acrolein	7	7	100.0	4.9%	85.4%
Tetrachloroethylene	7	10	70.0	4.9%	90.3%
p-Dichlorobenzene	5	14	35.7	3.5%	93.8%
Hexachloro-1,3-butadiene	5	5	100.0	3.5%	97.2%
Acrylonitrile	1	1	100.0	0.7%	97.9%
1,2-Dichloroethane	1	1	100.0	0.7%	98.6%
Trichloroethylene	1	10	10.0	0.7%	99.3%
Xylenes	1	28	3.6	0.7%	100.0%
Total	144	201	71.6		
Loudon, Tennessee - LDTN					
Acetaldehyde	27	27	100.0	17.8%	17.8%
Benzene	27	27	100.0	17.8%	35.5%
Carbon Tetrachloride	25	25	100.0	16.4%	52.0%
Formaldehyde	22	27	81.5	14.5%	66.4%
1,3-Butadiene	16	16	100.0	10.5%	77.0%
p-Dichlorobenzene	15	16	93.8	9.9%	86.8%
Hexachloro-1,3-butadiene	6	6	100.0	3.9%	90.8%
Acrolein	4	4	100.0	2.6%	93.4%
Tetrachloroethylene	4	9	44.4	2.6%	96.1%
Trichloroethylene	1	10	10.0	0.7%	96.7%
Xylenes	1	27	3.7	0.7%	97.4%
Toluene	1	27	3.7	0.7%	98.0%
Dichloromethane	1	22	4.5	0.7%	98.7%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.7%	99.3%
1,2-Dichloroethane	1	1	100.0	0.7%	100.0%
Total	152	245	62.0		

Table 19-3. Daily and Seasonal Averages for Pollutants of Interest at the Tennessee Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Dickson, Tennessee – DITN												
1,3-Butadiene	14	28	0.13	0.13	NR	NR	NR	NR	NR	NR	NR	NR
Acetaldehyde	28	28	1.35	0.23	1.20	0.60	1.34	0.39	1.43	0.35	NR	NR
Acrolein	7	13	2.30	0.69	NA	NA	NA	NA	NR	NR	NR	NR
Benzene	28	28	1.35	0.34	1.19	0.18	1.68	1.11	0.93	0.17	NR	NR
Carbon Tetrachloride	27	28	0.61	0.05	NR	NR	0.57	0.14	0.61	0.04	NR	NR
Formaldehyde	28	28	2.60	0.62	1.45	0.53	2.16	0.79	4.59	0.96	NR	NR
Hexachloro-1,3-butadiene	5	28	0.19	0.04	NR	NR	NR	NR	NR	NR	NR	NR
p-Dichlorobenzene	14	28	0.09	0.03	NR	NR	NR	NR	NR	NR	NR	NR
Tetrachloroethylene	10	28	0.49	0.42	NR	NR	NR	NR	NR	NR	NR	NR
Loudon, Tennessee – LDTN												
1,3-Butadiene	16	27	0.11	0.04	NR	NR	NR	NR	NR	NR	0.08	0.02
Acetaldehyde	27	27	2.02	0.34	NR	NR	2.31	0.84	2.31	0.33	1.80	0.64
Acrolein	4	13	1.65	0.63	NA	NA	NA	NA	NR	NR	NR	NR
Benzene	27	27	1.26	0.21	1.54	0.49	1.21	0.16	NR	NR	0.98	0.26
Carbon Tetrachloride	25	27	0.64	0.04	0.63	0.07	NR	NR	NR	NR	0.66	0.07
Formaldehyde	27	27	2.39	0.52	NR	NR	1.95	0.72	4.10	0.56	2.00	0.87
Hexachloro-1,3-butadiene	6	27	0.21	0.07	NR	NR	NR	NR	NR	NR	NR	NR
p-Dichlorobenzene	16	27	0.37	0.25	NR	NR	NR	NR	NR	NR	0.18	0.04
Tetrachloroethylene	9	27	0.58	0.81	NR	NR	NR	NR	NR	NR	NR	NR

NA = Not available due to short sampling duration.
NR = Not reportable due to the low number of detects.

Table 19-4. Non-Chronic Risk Summary at the Tennessee Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
DITN	TO-15	Acrolein	2.30 ± 0.69	0.11	7	0.19	7	0.09	NR	NR	NR	NR
LDTN	TO-15	Acrolein	1.65 ± 0.63	0.11	4	0.19	4	0.09	NR	NR	NR	NR

NR = Not reportable due to the low number of detects.

Table 19-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Tennessee Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Dickson, Tennessee – DITN									
1,3-Butadiene	14	-0.30	-0.24	-0.33	-0.28	-0.46	0.62	-0.13	-0.46
Acetaldehyde	28	0.43	0.36	0.25	0.31	-0.25	-0.50	0.07	0.33
Acrolein	7	-0.65	-0.78	-0.77	-0.77	-0.18	0.34	0.31	0.46
Benzene	28	-0.28	-0.23	-0.30	-0.26	-0.28	0.41	0.07	-0.26
Carbon Tetrachloride	27	-0.36	-0.29	-0.17	-0.23	0.28	0.02	-0.03	-0.21
Formaldehyde	28	0.84	0.86	0.81	0.84	0.03	-0.39	0.18	-0.05
Hexachloro-1,3-butadiene	5	-0.73	-0.64	-0.76	-0.70	-0.37	0.46	-0.05	-0.41
p-Dichlorobenzene	14	0.23	0.25	0.15	0.20	-0.27	0.39	0.45	-0.12
Tetrachloroethylene	10	0.10	0.13	-0.09	0.02	-0.62	0.50	0.34	-0.10
Loudon, Tennessee – LDTN									
1,3-Butadiene	16	0.18	0.13	0.16	0.15	0.19	-0.07	-0.20	-0.01
Acetaldehyde	27	0.46	0.38	0.20	0.30	-0.49	-0.26	0.20	0.23
Acrolein	4	0.95	0.92	0.93	0.93	0.74	-0.87	-0.52	0.98
Benzene	27	0.07	0.06	0.10	0.08	0.14	-0.23	-0.20	0.14
Carbon Tetrachloride	25	0.19	0.11	0.00	0.06	-0.37	-0.20	-0.24	-0.07
Formaldehyde	27	0.88	0.86	0.77	0.82	-0.08	-0.31	-0.01	0.06
Hexachloro-1,3-butadiene	6	0.15	0.26	0.28	0.24	0.22	0.46	0.47	-0.41
p-Dichlorobenzene	16	0.38	0.41	0.44	0.44	0.29	0.06	0.04	-0.01
Tetrachloroethylene	9	0.44	0.50	0.52	0.52	0.17	0.35	0.35	0.04

Table 19-6. Motor Vehicle Information for the Tennessee Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
DITN	45,894	43,784	0.95	29,214	27,871	4,420
LDTN	43,387	46,656	1.08	46,750	50,272	13,360

Table 19-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Tennessee

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Dickson, Tennessee – DITN, Census Tract 47043060600				
1,2-Dichloroethane	0.10 ± 0.01	0.01	0.20	<0.01
1,3-Butadiene	0.10 ± 0.07	0.02	0.65	0.01
Acetaldehyde	1.35 ± 0.23	0.61	1.34	0.07
Acrolein	NA	0.02	--	1.01
Acrylonitrile	0.09 ± 0.04	<0.01	0.03	<0.01
Benzene	1.35 ± 0.34	0.51	3.99	0.02
Carbon Tetrachloride	0.60 ± 0.06	0.21	3.17	0.01
Formaldehyde	2.60 ± 0.62	0.47	<0.01	0.05
Hexachloro-1,3-butadiene	0.93 ± 0.18	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.14 ± 0.02	0.01	0.08	<0.01
Tetrachloroethylene	0.27 ± 0.16	0.01	0.06	<0.01
Trichloroethylene	0.16 ± 0.08	0.04	0.09	<0.01
Xylenes	3.10 ± 1.46	0.67	--	0.01
Loudon, Tennessee – LDTN, Census Tract 47105060200				
1,1,2,2-Tetrachloroethane	0.15 ± 0.01	0.01	0.72	--
1,2-Dichloroethane	0.09 ± 0.01	0.01	0.27	<0.01
1,3-Butadiene	0.09 ± 0.02	0.03	0.77	0.01
Acetaldehyde	2.02 ± 0.34	1.22	2.69	0.14
Acrolein	NA	0.06	--	2.99
Benzene	1.26 ± 0.21	0.89	6.95	0.03
Carbon Tetrachloride	0.61 ± 0.06	0.21	3.19	0.01
Dichloromethane	0.46 ± 0.27	0.14	0.07	<0.01
Formaldehyde	2.39 ± 0.52	0.78	<0.01	0.08
Hexachloro-1,3-butadiene	0.88 ± 0.19	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	0.30 ± 0.15	0.02	0.17	<0.01
Tetrachloroethylene	0.29 ± 0.28	0.02	0.15	<0.01
Toluene	6.17 ± 5.95	1.67	--	<0.01
Trichloroethylene	0.16 ± 0.08	0.43	0.86	<0.01
Xylenes	4.24 ± 3.04	1.15	--	0.01

NA= Not available due to short sampling duration.
BOLD = pollutant of interest.

20.0 Sites in Texas

This section presents meteorological, concentration, and spatial trends for the UATMP sites in Texas (MUTX, PITX, RRTX, TRTX, WETX, and YDSP). Five sites are located in or near the Austin area. One site, YDSP, is located in El Paso. Figures 20-1 thru 20-6 are topographical maps showing the monitoring sites in their urban and rural locations. Figures 20-7 through 20-8 identify point source emission locations within 10 miles of each site as reported in the 2002 NEI for point sources. As Figure 20-7 shows, four monitoring sites are located within Travis County and the city of Austin (MUTX, PITX, TRTX, and WETX), while one is located further north in the neighboring town of Round Rock in Williamson County (RRTX). The monitoring sites are oriented in a line running roughly north-south, with RRTX the furthest north and TRTX the furthest south. Most of the industrial sites within ten miles of the sites are located fairly close to the sites. There are a variety of industries in the Austin area including, but not limited to, rubber and miscellaneous plastic products, utility boilers, mineral product processing, and chemical and allied products. YDSP is located within a mile of the US-Mexico border, as shown in Figure 20-8. Most of the nearby industries are located to the north and northwest of the monitoring site, and are primarily involved in fuel combustion industries, liquids distribution, and petroleum and natural gas production and refining. It is important to note that across the border in Mexico is Ciudad Juarez, a large industrial city.

Hourly meteorological data at weather stations near these sites were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the MUTX and PITX monitoring sites is Camp Mabry Army National Guard (WBAN 13958); the weather station closest to the TRTX and WETX monitoring sites is Austin-Bergstrom International Airport (WBAN 13904); the closest weather station to RRTX is Georgetown Municipal Airport (WBAN 53942); and El Paso International Airport (WBAN 23044) is closest to YDSP.

The city of Austin experiences a modified subtropical climate, that is, mild winters with only a handful of below freezing temperatures each year, and hot muggy summers, due in part to

the flow from the Gulf of Mexico. Northerly winds are prevalent in the winter and southeasterly winds are predominant in the summer. Precipitation is fairly evenly distributed throughout the year, through most frequently in the form of thunderstorms in the spring and summer. In contrast to Austin, El Paso's climate is more characteristic of the desert southwest. Winters are very mild, summers are hot, often with large diurnal temperature fluctuations, and precipitation is infrequent. Summertime thunderstorms tend to produce the heaviest rainfalls. Dust and sandstorms occur occasionally (Ruffner and Bair, 1987). Table 20-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 20-1, average meteorological conditions on sample days are slightly different than average weather conditions throughout the year. The sample days' maximum, average, dew point, and wet bulb temperatures are slightly higher, and relative humidities are slightly lower than the year-round averages. This can potentially be attributed to the start dates of each monitoring site. YDSP began sampling in March; MUTX, PITX, RRTX, and WETX in June; and TRTX in July. Please note that RRTX has no sea level pressure averages in Table 20-1. The Georgetown Municipal Airport weather station did not record sea level pressure.

20.1 Pollutants of Interest at the Texas Monitoring Sites

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." Pollutants of interest are those in which the individual pollutant's total failed screens contribute to the top 95% of the site's total screens. A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 20-2 presents the pollutants that failed at least one screen at the Texas monitoring sites. The number of pollutants failing the screen varies by site, as indicated in Table 20-2.

- Eleven pollutants with a total of 131 measured concentrations failed screens at MUTX;
- 13 pollutants with a total of 121 measured concentrations failed screens at PITX;
- 13 pollutants with a total of 141 measured concentrations failed screens at RRTX;
- 19 pollutants with a total of 142 measured concentrations failed screens at TRTX;
- 13 pollutants with a total of 128 measured concentrations failed screens at WETX; and
- 9 pollutants with a total of 179 measured concentrations failed screens at YDSP.

The pollutants of interest also varied by site, yet the following five pollutants contributed to the top 95% of the total failed screens at each Texas monitoring site: acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene. If YDSP is not included, the list of pollutants of interest is even more similar, and includes arsenic, acetaldehyde, formaldehyde, and manganese. It's important to note that the Austin sites sampled for carbonyls, VOC, and metals, while the El Paso site sampled for VOC only. This is reflected in each site's pollutants of interest. The Austin sites also sampled for total NMOC, but is not considered in the determination of the pollutants of interest. Also listed in Table 20-2 are the total number of detects and the percent detects failing the screen. Of the five pollutants that were the same among all six sites, four pollutants of interest, acrolein, benzene, 1,3-butadiene, and carbon tetrachloride, had 100% of their detects fail the screening values.

20.2 Concentration Averages at the Texas Monitoring Sites

Three types of concentration averages were calculated for the pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no

later than February and ended no earlier than November. The daily and seasonal averages are presented in Table 20-3. Annual averages will be presented and discussed in further detail in later sections.

Among the daily averages at the Austin sites, acrolein measured the highest concentration by mass, ranging from 5.50 ± 2.93 μg/m^3 at PITX to 9.08 ± 3.70 μg/m^3 at RRTX. Formaldehyde measured the second highest daily average at each Austin site, ranging from 3.28 ± 0.77 μg/m^3 at MUTX to 3.72 ± 0.52 μg/m^3 at RRTX. With the exception of WETX, acetaldehyde measured the third highest daily average at each Austin site. As the Austin sites did not begin monitoring until mid-June, late-June, or early July, no seasonal averages are available for winter, spring, and summer (except for metals). With the exception of MUTX, acrolein autumn averages are not available. The autumn seasonal averages that are available did not differ significantly from the daily averages at the Austin monitoring sites.

The pollutants with the highest daily averages at YDSP were total xylenes (7.37 ± 1.37 μg/m^3), acrolein (4.48 ± 4.09 μg/m^3), and benzene (2.33 ± 0.34 μg/m^3). The YDSP site began sampling in March, and therefore has more computable seasonal averages than the Austin sites. Although many of the pollutants of interest measured higher concentrations in autumn than spring or summer, most of these differences were not statistically significant. The one exception is the autumn benzene concentration. Acrolein has no seasonal averages.

20.3 Non-chronic Risk Evaluation at the Texas Monitoring Sites

Non-chronic risk for the concentration data at Texas monitoring sites was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the pollutants with at least one failed screen, only acrolein exceeded either the acute or the intermediate risk values, and each site's non-chronic risk is summarized in Table 20-4.

All acrolein detects at the Texas sites were greater than the ATSDR acute value of 0.11 $\mu g/m^3$ and the California REL value of 0.19 $\mu g/m^3$. The average detected concentration ranged from 4.48 ± 4.09 $\mu g/m^3$ (at YDSP) to 9.08 ± 3.70 $\mu g/m^3$ (at RRTX), which are an order of magnitude higher than either acute risk factor. An autumn seasonal average for acrolein could only be calculated for MUTX. The autumn acrolein average at MUTX is 4.89 ± 2.63 $\mu g/m^3$, which is significantly higher than the ATSDR intermediate value of 0.09 $\mu g/m^3$.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. For all six Texas monitoring sites, only acrolein concentrations exceeded the acute risk factors. Figures 20-9 through 20-14 are pollution roses for acrolein at the Texas sites. The pollution rose is a plot of concentration and wind direction. As shown in Figures 20-9 through 20-14, and discussed above, all acrolein concentrations exceeded the acute risk factors, which are indicated by a dashed line (CalEPA REL) and solid line (ATSDR MRL).

Figure 20-9 is the acrolein pollution rose for the MUTX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources. The highest concentration of acrolein occurred on August 26, 2005 with a southeasterly wind. The MUTX monitoring site is located in a primarily residential area at Murchison Middle School. The eastern edge of the school grounds is bordered by a major thoroughfare, the Mo-Pac expressway, which is paralleled by a railway.

Figure 20-10 is the acrolein pollution rose for the PITX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources. Interestingly, the highest concentration of acrolein also occurred on August 26, 2005 with a southeasterly wind. The PITX monitoring site is located at the University of Texas Pickle Research Center. The Pickle Research Center is located near the intersection of two major roadways, the Mo-Pac Expressway and Highway 183.

Figure 20-11 is the acrolein pollution rose for the RRTX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources, although primarily from the east and south. The highest concentration of acrolein occurred on August 2, 2005 with an east-southeasterly wind. The RRTX monitoring site is located on the northern edge of a residential area. Just to the west of the monitoring site, running north-south is I-35. The Georgetown railroad parallels I-35 on the west side.

Figure 20-12 is the acrolein pollution rose for the TRTX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources. The highest concentration of acrolein occurred on August 14, 2005 with a south-southeasterly wind. The TRTX monitoring site is located at Travis High School, which is just off I-35 on Oltorf Street, in a highly residential area of Austin.

Figure 20-13 is the acrolein pollution rose for the WETX monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources, although primarily from the southeast and south. The highest concentration of acrolein occurred on August 2, 2005 with a south-southeasterly wind. This is the same date as the RRTX monitoring site. The WETX monitoring site is located in a residential area off East 7th Street, which intersects I-35 about a mile and half west of the site. The Northwestern Railroad loops around the area where WETX is located. Zaragosa Park and Recreation Center is very close to the monitoring site.

Figure 20-14 is the acrolein pollution rose for the YDSP monitoring site. The pollution rose shows that concentrations exceeding the acute risk factors occurred with winds originating from a variety of directions, which is a characteristic of mobile sources. The highest concentration of acrolein occurred on July 5, 2005 with an east-southeasterly wind. The YDSP monitoring site is located in a residential area on the southeast side of El Paso, TX. The 375 Loop, Americas Avenue, runs less than a mile to the south of the site. The Loop intersects I-10 a couple miles east of YDSP. The US-Mexican border is less than a mile and a half from the site.

20.4 Meteorological and Concentration Analysis at the Texas Monitoring Sites

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

20.4.1 Pearson Correlation Analysis

Table 20-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the Texas monitoring sites. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) It is interesting to note that at each of the Austin sites, positive correlations were calculated between acrolein and formaldehyde and maximum, average, dew point, and wet bulb temperatures, and negative correlations were calculated between 1,3-butadiene and manganese and these four parameters. Its also important to note that the relatively low number of detects at the Austin sites, due to a June or July start date as well as a 1 in 12 sample schedule, may cause the correlations appear stronger than they would be with a larger number of detects.

At MUTX, 1,3-butadiene, manganese, and tetrachloroethylene exhibited moderately strong to strong negative correlations with the temperature and moisture parameters, while acrolein, benzene, formaldehyde, and *p*-dichlorobenzene exhibited moderately strong to strong positive correlations with these same parameters. Several pollutants also exhibited moderately strong to strong correlations with the wind components and/or sea level pressure. This may indicate that meteorological influences effect concentrations of the pollutants of interest at MUTX.

At PITX, 1,3-butadiene, acetaldehyde, and manganese exhibited moderately strong negative correlations with the temperature and moisture parameters, while acrolein, benzene, formaldehyde, and *p*-dichlorobenzene exhibited moderately strong to very strong positive correlations with these same parameters. Several pollutants also exhibited moderately strong to strong correlations with the wind components and/or sea level pressure. Interestingly, all of the correlations with the *v*-component of the wind were negative, with the exception of

p-dichlorobenzene. Similar to MUTX, this may indicate that meteorological influences effect concentrations of the pollutants of interest at PITX.

At RRTX, 1,3-butadiene, acetaldehyde, and manganese exhibited moderately strong to strong negative correlations with the temperature and moisture parameters, while acrolein, formaldehyde, and *p*-dichlorobenzene exhibited moderately strong to strong positive correlations with these same parameters. Moderately strong correlations were also calculated between carbon tetrachloride and wet bulb temperature and relative humidity (0.41 and 0.49, respectively). Interestingly, nearly all of the correlations with the *u*-component of the wind were negative and most of the correlations with the *v*-component were positive. Similar to MUTX and PITX, this may indicate that meteorological influences effect concentrations of the pollutants of interest at RRTX.

At TRTX, hexachloro-1,3-butadiene, manganese, and tetrachloroethylene exhibited moderately strong to strong negative correlations with the temperature and moisture parameters, while acrolein, arsenic, benzene, cadmium, formaldehyde, and *p*-dichlorobenzene exhibited moderately strong to very strong positive correlations with these same parameters. Several pollutants also exhibited moderately strong to strong correlations with the wind components and/or sea level pressure. Interestingly, most of the correlations with the *u*-component of the wind were negative. Similar to the other Austin sites, this may indicate that meteorological influences effect concentrations of the pollutants of interest at TRTX. Correlations were not computed for 1,2-dichloroethane because it was detected fewer than 4 times.

At WETX, 1,3-butadiene, acetaldehyde, arsenic, and manganese exhibited moderately strong to strong negative correlations with the temperature and moisture parameters, while acrolein, carbon tetrachloride, and hexachloro-1,3-butadiene exhibited moderately strong to very strong positive correlations with these same parameters. Moderately strong negative correlations were also calculated between benzene and *p*-dichlorobenzene and average and wet bulb temperatures. Several pollutants also exhibited moderately strong to very strong correlations with the wind components and/or sea level pressure. Similar to the other four Austin sites, this

may indicate that meteorological influences effect concentrations of the pollutants of interest at WETX.

At YDSP, with few exceptions, all of the correlations between the pollutants of interest and the temperature and moisture parameters were negative, which indicates that as temperature and moisture content decrease, concentrations of the pollutants of interest tend to increase. Correlations with the wind were fairly weak, although acrolein exhibited a moderately strong negative correlations with the *u*-component of the wind (-0.40). Acrolein and hexachloro-1,3-butadiene each exhibited a strong correlation with sea level pressure (-0.57 and 0.58, respectively). However, these two pollutants were detected only nine times each, and this low detection rate could skew the correlations.

20.4.2 Composite Back Trajectory Analysis

Figures 20-15 thru 20-20 are composite back trajectory maps for the Texas monitoring sites for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. Each circle around the site represents 100 miles.

As shown in Figure 20-15, the back trajectories predominantly originated from the southeast at MUTX. The 24-hour airshed domain is rather large at MUTX, with trajectories originating as far away as northern Colorado, or over 700 miles away. However, 69% of the trajectories originated within 300 miles of the site; and 84% within 400 miles from the MUTX monitoring site.

As shown in Figure 20-16, the back trajectories predominantly originated from the southeast at PITX. The 24-hour airshed domain is rather large at PITX, with trajectories originating as far away as northern Colorado, or over 700 miles away. However, 65% of the trajectories originated within 300 miles of the site; and 82% within 400 miles from the PITX monitoring site.

As shown in Figure 20-17, the back trajectories predominantly originated from the southeast at RRTX. The 24-hour airshed domain is rather large at RRTX, with trajectories originating as far away as northern Colorado, or over 700 miles away. However, 72% of the trajectories originated within 300 miles of the site; and 89% within 400 miles from the RRTX monitoring site.

As shown in Figure 20-18, the back trajectories predominantly originated from the southeast at TRTX. The 24-hour airshed domain is rather large at TRTX, with trajectories originating as far away as central Colorado, or over 700 miles away. However, 67% of the trajectories originated within 300 miles of the site; and 87% within 400 miles from the TRTX monitoring site.

As shown in Figure 20-19, the back trajectories predominantly originated from the southeast at WETX. The 24-hour airshed domain is rather large at WETX, with trajectories originating as far away as central Colorado, or over 700 miles away. However, 72% of the trajectories originated within 300 miles of the site; and 89% within 400 miles from the WETX monitoring site.

As shown in Figure 20-20, the back trajectories predominantly originated from the southeast, southwest, and west at YDSP. The 24-hour airshed domain is somewhat smaller at YDSP, with trajectories originating as far away as near Baja California, or over 400 miles away. However, 76% of the trajectories originated within 300 miles of the site; and 93% within 400 miles from the YDSP monitoring site. The majority of the 24-hour back trajectories originated from Mexico.

20.4.3 Wind Rose Analysis

As mentioned in Section 20.0, weather data from the four closest weather stations to monitoring sites were obtained to correlate concentrations and meteorological conditions. Hourly wind data from these stations were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different

shading to represent wind speeds. Figures 20-21 through 20-26 are the wind roses for the Texas monitoring sites on days sampling occurred.

As indicated in Figure 20-21, hourly winds were predominantly out of the south (8% of observations), southeast (8%), and south-southeast (6%) on days samples were taken near MUTX. However, calm winds (<2 knots) were recorded for 45% of the hourly measurements. For wind speeds greater than 2 knots, 27% of observations ranged from 7 to 11 knots. Figure 20-21 shows that wind speeds greater than 11 knots tended to occur most frequently with northwesterly and northerly winds.

As indicated in Figure 20-22, the wind rose for PITX looks similar to the one for MUTX. Hourly winds were predominantly out of the south (9% of observations), southeast (8%), and east-southeast (6%) on days samples were taken near PITX. However, calm winds (<2 knots) were recorded for 44% of the hourly measurements. For wind speeds greater than 2 knots, 30% of observations ranged from 7 to 11 knots. Figure 20-22 also shows that wind speeds greater than 11 knots tended to occur most frequently with northwesterly and northerly winds.

As indicated in Figure 20-23, hourly winds were predominantly out of the south (16% of observations) on days samples were taken near RRTX. Calm winds (<2 knots) were recorded for 27% of the hourly measurements. For wind speeds greater than 2 knots, wind observations were more evenly distributed up to 11 knots: 26% of observations ranged from 2 to 4 knots, 18% of observations ranged from 4 to 7 knots, 24% of observations ranged from 7 to 11 knots. The frequency decreases significantly after 11 knots.

As indicated in Figure 20-24, the wind rose for TRTX looks similar to the one for RRTX. Hourly winds were predominantly out of the south (17% of observations) on days samples were taken near TRTX. However, calm winds (<2 knots) were recorded for 35% of the hourly measurements. For wind speeds greater than 2 knots, 23% of observations ranged from 7 to 11 knots.

As indicated in Figure 20-25, the wind rose for WETX looks similar to the one for RRTX and TRTX. Hourly winds were predominantly out of the south (16% of observations) on days samples were taken near WETX. Calm winds (<2 knots) were recorded for 34% of the hourly measurements. For wind speeds greater than 2 knots, 23% of observations ranged from 7 to 11 knots.

As expected, the wind rose for YDSP is much different than the wind roses for the Austin sites. Figure 20-26 shows that hourly winds were predominantly out of the east (13% of observations), north (9%), and west (9%) on days samples were taken near YDSP. Calm winds (<2 knots) were recorded for less than 12% of the hourly measurements. For wind speeds greater than 2 knots, 30% of observations ranged from 7 to 11 knots. Figure 20-26 shows that wind speeds greater than 22 knots tended to occur most frequently with southwesterly and westerly winds.

20.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following meteorological analyses: population, vehicle ownership, and traffic volume comparison; and BTEX analysis.

20.5.1 Population, Vehicle Ownership, and Traffic Volume Comparison

County-level vehicle registration and population in Travis, Williamson, and El Paso Counties were obtained from the Texas Department of Transportation and the U.S. Census Bureau, and are summarized in Table 20-6. Table 20-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 20-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

It's evident from Table 20-6 that the RRTX monitoring site has a significantly lower county and 10-mile population than the other Austin sites, as well as a significantly lower county

and 10-mile estimated vehicle ownership. Interestingly, the vehicle-population ratios are very similar for Travis and Williamson Counties. The YDSP site has a higher population and vehicle ownership than RRTX, yet lower than the remaining Austin sites. Due to its low vehicle per person ratio, although the YDSP's 10-mile population is higher than RRTX, the 10 mile vehicle ownership near YDSP is just slightly higher than at RRTX. Of the five Austin sites, PITX experiences the most daily traffic, while MUTX experiences the least. Compared to other UATMP sites, the four Austin-proper sites are on the lower end of the more populous locations. The vehicle per person ratios for MUTX, PITX, RRTX, TRTX, and WETX are in the middle of the range of UATMP sites, while the YDSP ratio is on the low-side.

20.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impacts of on-road, or motor vehicle, emissions. Of the six Texas sites, the YDSP monitoring site's ratios most resemble those of the roadside study, suggesting that mobile source emissions are a major influence at this site, although its benzene-ethylbenzene and xylenes-ethylbenzene ratios are closer together than the roadside study's (2.83 ± 0.18 and 3.54 ± 0.10 for YDSP vs. 2.85 and 4.55 for the roadside study). Interestingly, the ratios for MUTX, PITX, TRTX, and WETX look very similar to each other. The ratios are all lower than those of the roadside study and the benzene-ethylbenzene and xylenes-ethylbenzene ratios are closer together than the roadside study's. The RRTX ratios resemble the other Austin sites except that its toluene-ethylbenzene ratio is significantly higher than those of the other sites as well as the roadside study's (8.28 ± 1.73 for RRTX and 5.85 for the roadside study).

20.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient

monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 20-7 presents the 1999 NATA results for the census tracts where the Texas monitoring sites are located. Only pollutants that "failed" the screens are presented in Table 20-7. Pollutants of interest are bolded.

The MUTX monitoring site is located in census tract 48453001718 with a population of 5,550, which represents 0.7% of the 2000 county population. The PITX monitoring site is located in census tract 48453001849, with a population in 2000 of 4,499, which represents 0.6% of Travis County's population. RRTX is located in census tract 48491021502. The population in 2000 in that census tract was 4,464, or just less than 1.8% of the Williamson County population. The TRTX monitoring site is located in census tract 48453002308 with a population in 2000 of 5,165, which represents 0.6% of the county population. The WETX monitoring site is located in census tract 48453000802 with a population in 2000 of 3,356, which represents 0.4% of the county population. Finally, YDSP is located in census tract 48141003902. In 2000, the population in this census tract was 2,400 or 0.4 % of the El Paso County population.

20.6.1 1999 NATA Summary

In terms of cancer risk, the Top 3 pollutants identified by NATA in the MUTX, PITX and WETX census tracts are benzene (13.63, 13.24, and 11.92 in-a-million risk, respectively), 1,3-butadiene (4.94, 4.70, and 4.73 in-a-million risk, respectively), and acetaldehyde (3.45, 3.67, and 3.46 in-a-million risk, respectively). The Top 3 pollutants identified by NATA in the RRTX census tract are benzene (10.61 in-a-million risk), 1,3-butadiene (3.34 in-a-million risk), and carbon tetrachloride (3.21in-a-million risk). Benzene (13.15 in-a-million risk), 1,2-dibromoethane (5.15 in-a-million risk), and 1,3-butadiene (5.11 in-a-million risk) are the Top 3 pollutants identified by NATA in the TRTX census tract. Finally, benzene (6.79 in-a-million risk), carbon tetrachloride (3.17 in-a-million risk), and 1,3-butadiene (2.63 in-a-million risk) are the Top 3 pollutants identified by NATA in the YDSP census tract. Benzene risk was highest at all six Texas sites, ranging from 6.79 in a million at YDSP to 13.63 in a million at MUTX.

Acrolein was the only pollutant in the Texas census tracts to have a noncancer hazard quotient greater than 1.0, ranging from 1.78 at YDSP to 6.64 at WETX. Hazard quotients greater than 1.0 may lead to adverse health effects. Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects near the Texas monitoring sites, with the exception of acrolein.

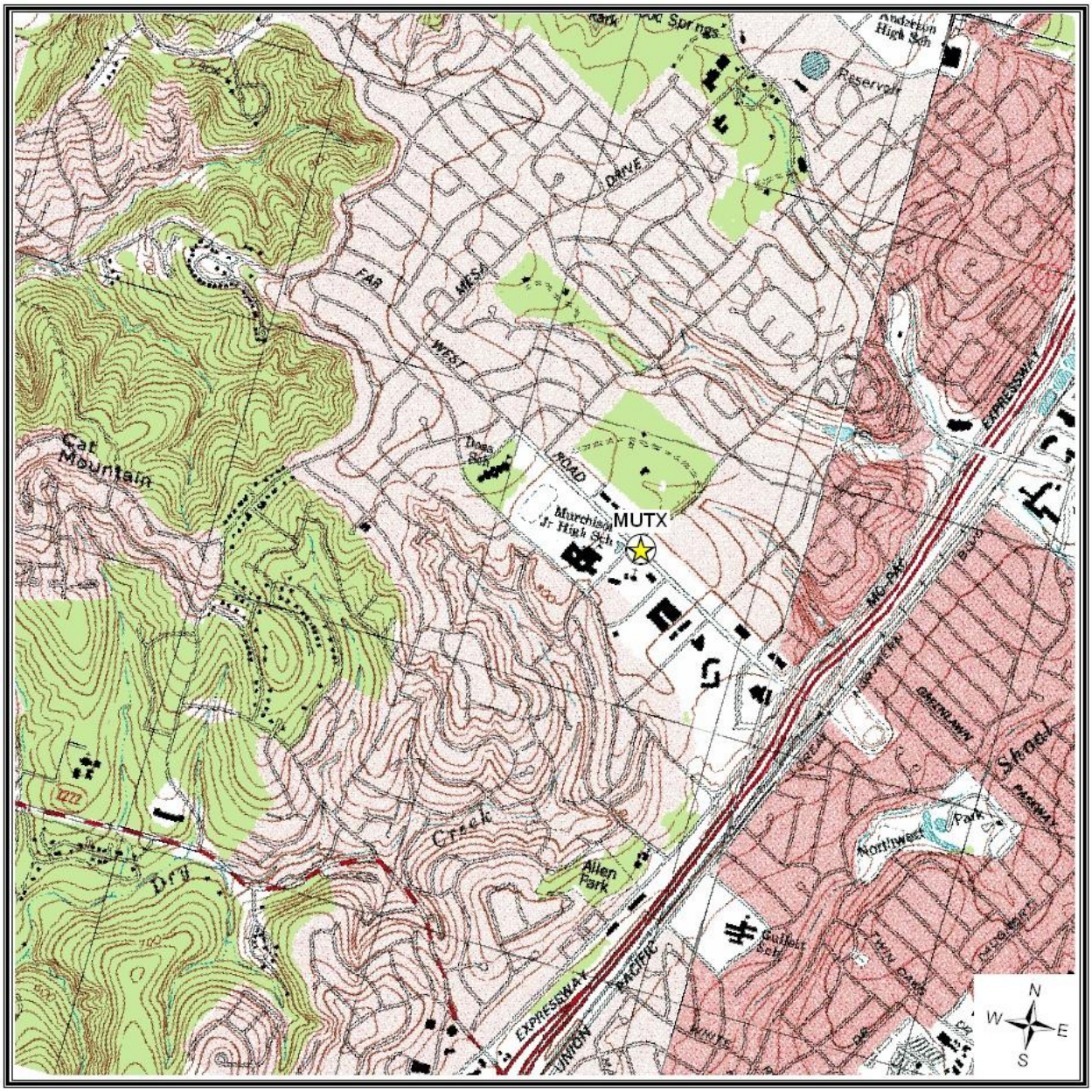
20.6.2 Annual Average Comparison

NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 20.2 on how a valid annual average is calculated). Unfortunately, the Texas sites did not begin sampling until after February 2005, therefore, valid annual averages could not be calculated.

Texas Pollutant Summary

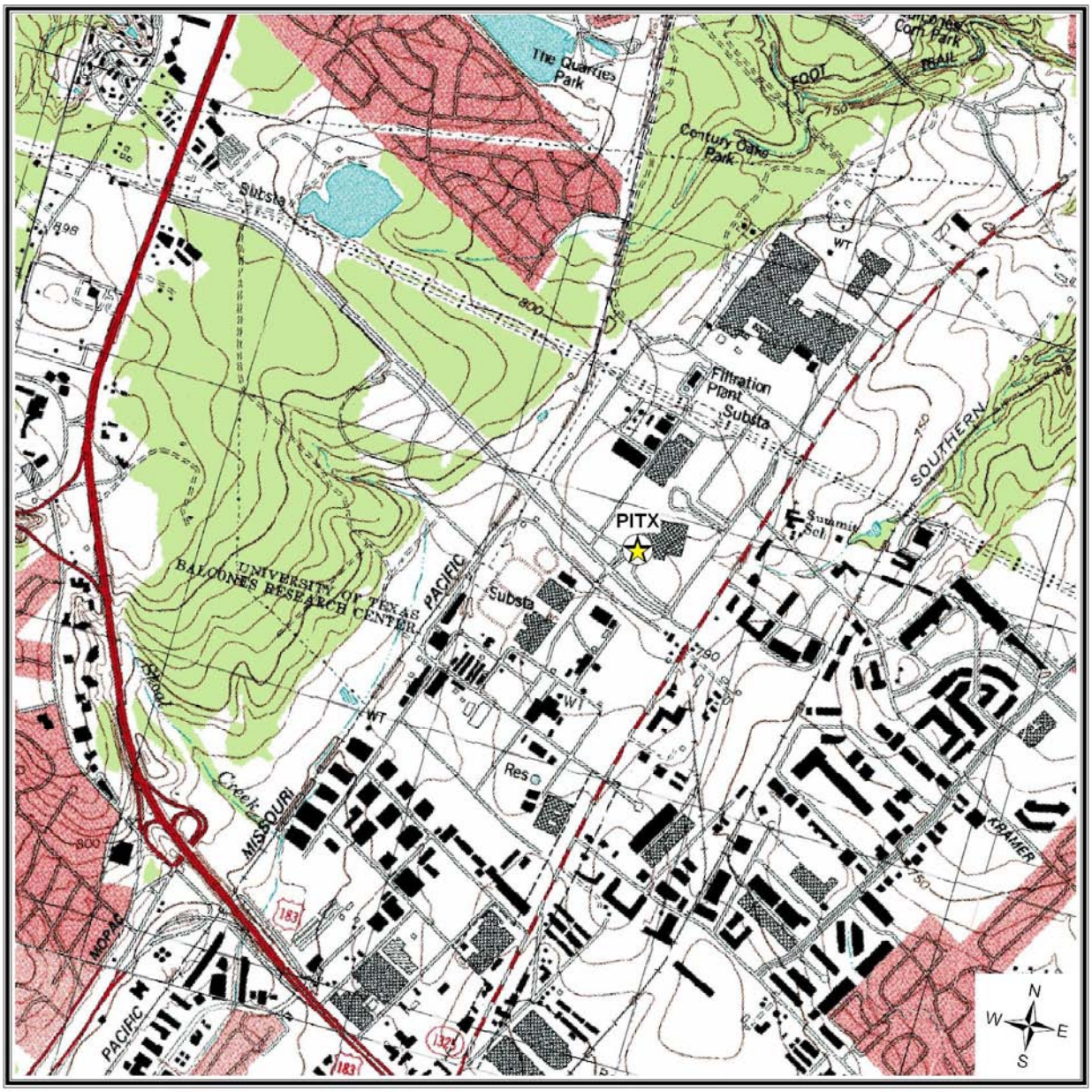
- *The pollutants of interest common to each of the Texas sites are acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and p-dichlorobenzene.*
- *Acrolein measured the highest daily average at all five Austin sites, while total xylenes measured highest at the El Paso site.*
- *Acrolein exceeded the short-term risk factors at all six Texas sites.*

Figure 20-1. Austin, Texas (MUTX) Monitoring Site



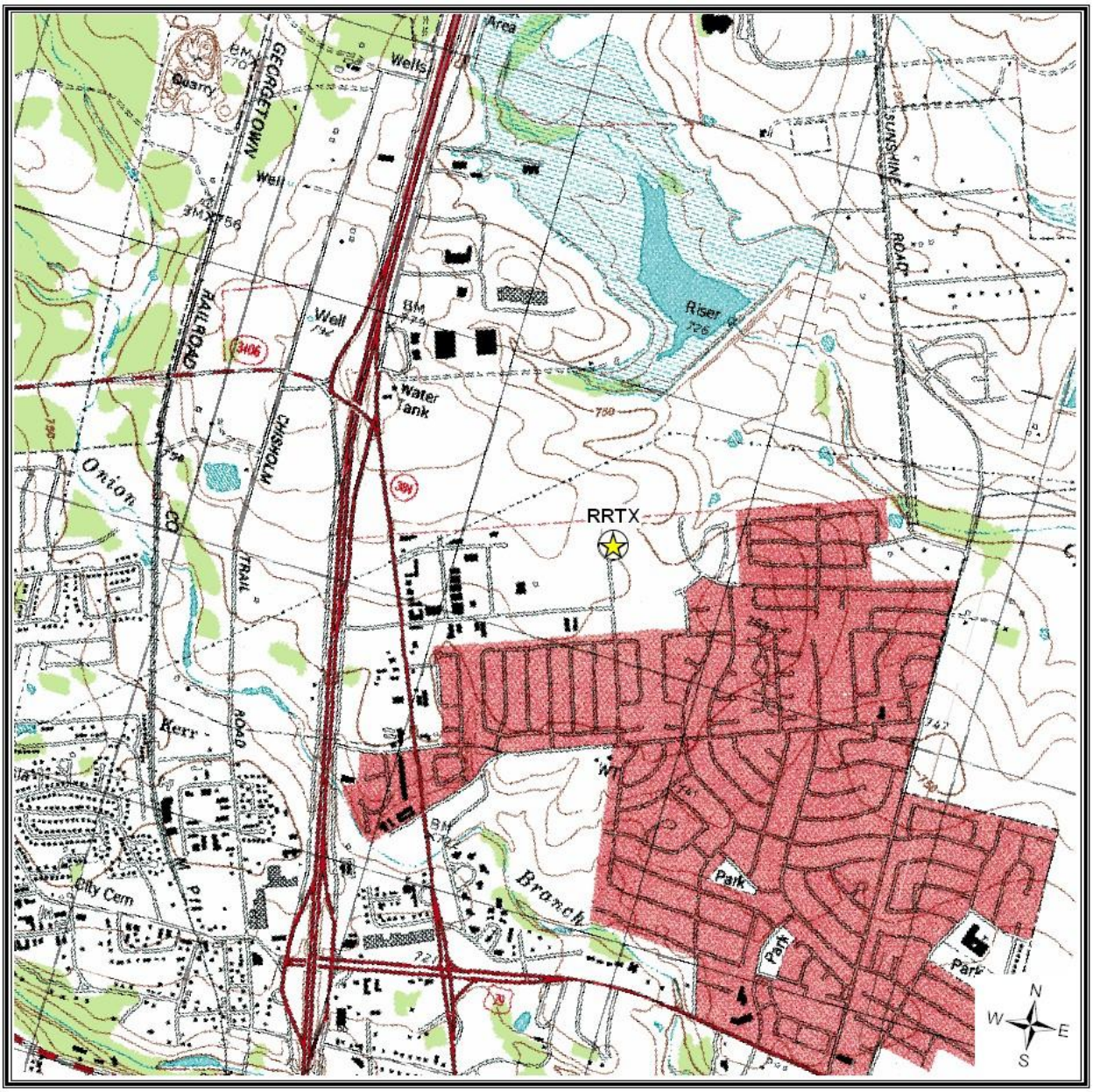
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 20-2. Austin, Texas (PITX) Monitoring Site



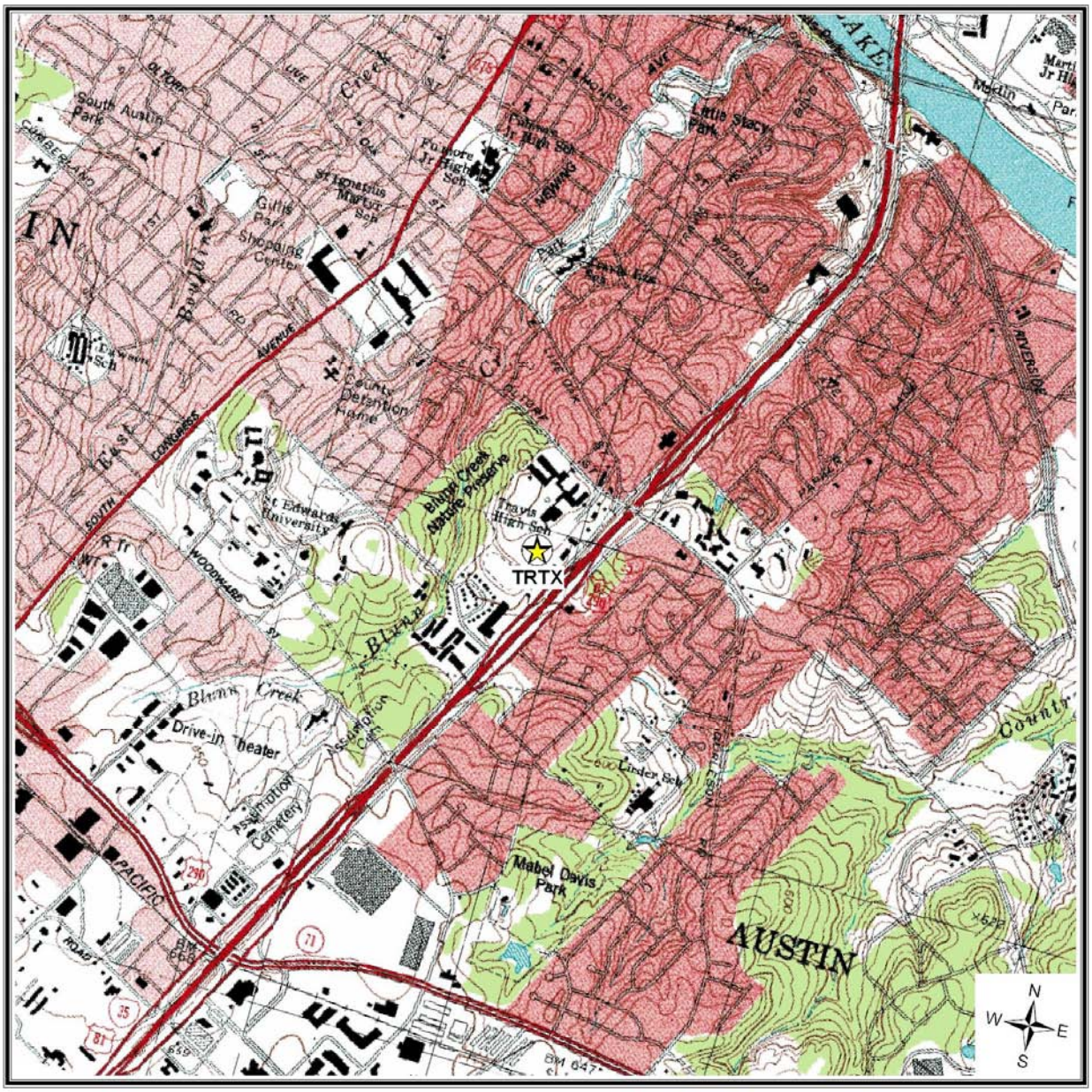
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 20-3. Austin, Texas (RRTX) Monitoring Site



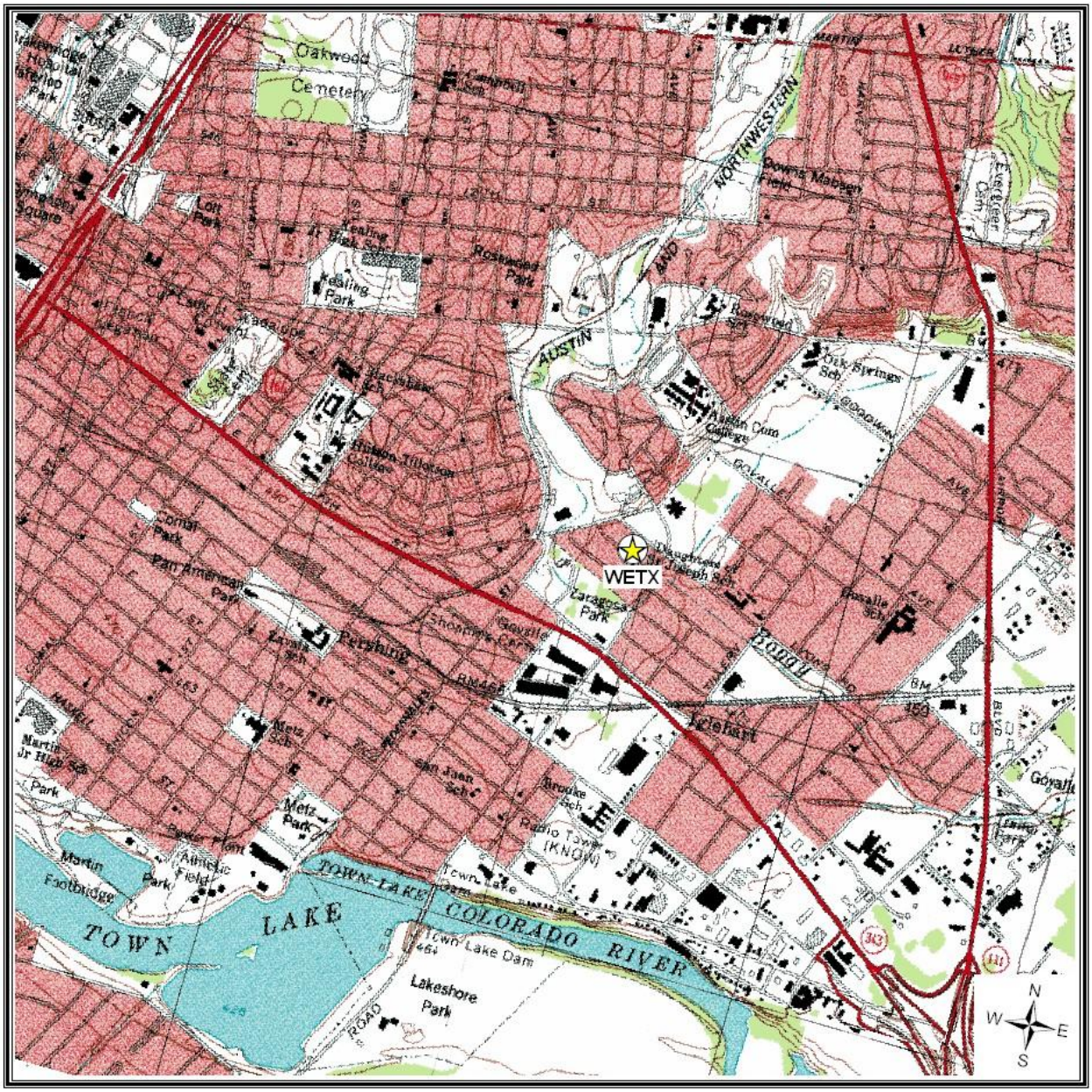
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 20-4. Austin, Texas (TRTX) Monitoring Site



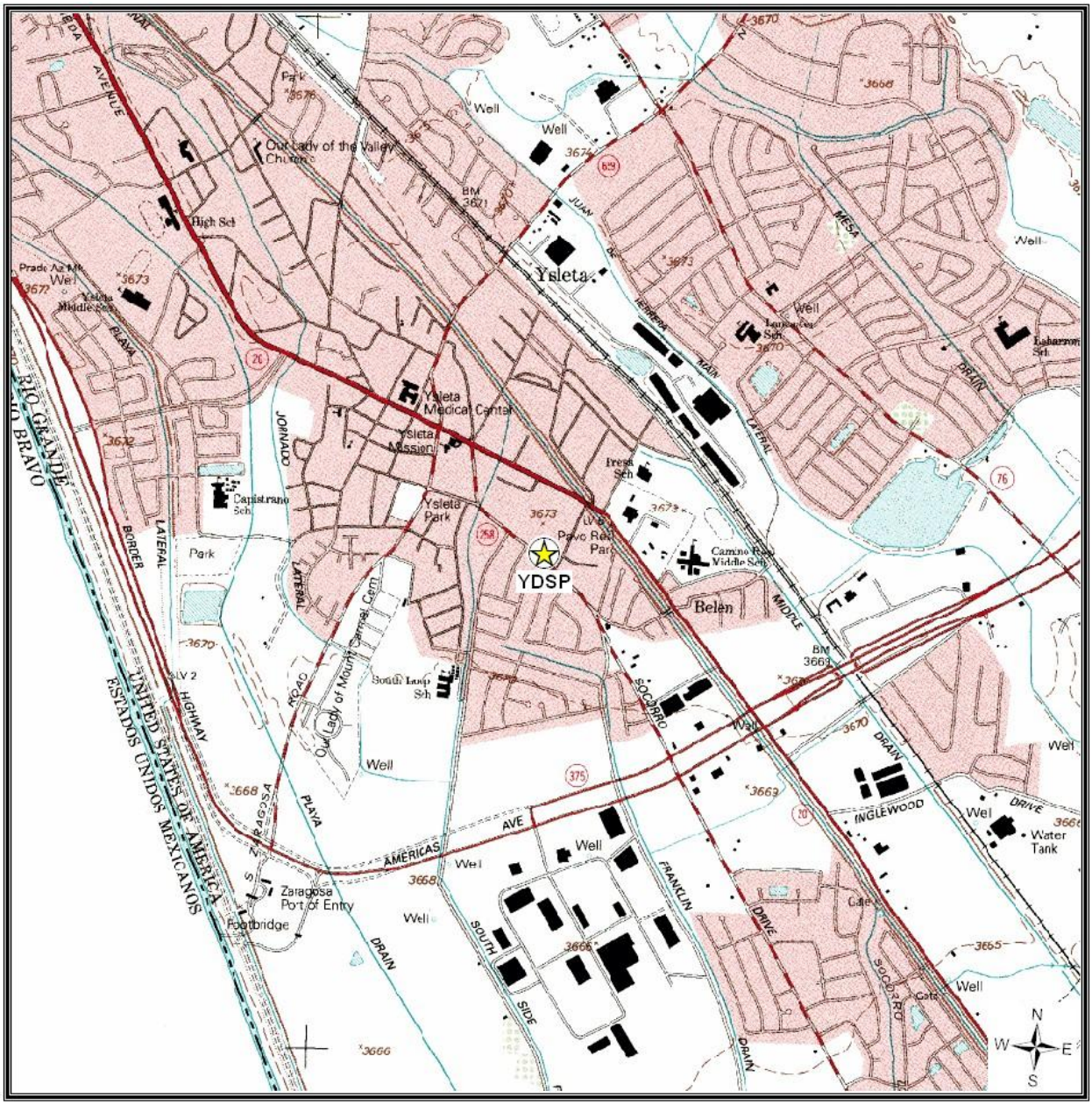
Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 20-5. Austin, Texas (WETX) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 20-6. El Paso, Texas (YDSP) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000

Figure 20-7. Facilities Located Within 10 Miles of the Austin, Texas Monitoring Sites (MUTX, PITX, RRTX, TRTX, and WETX)

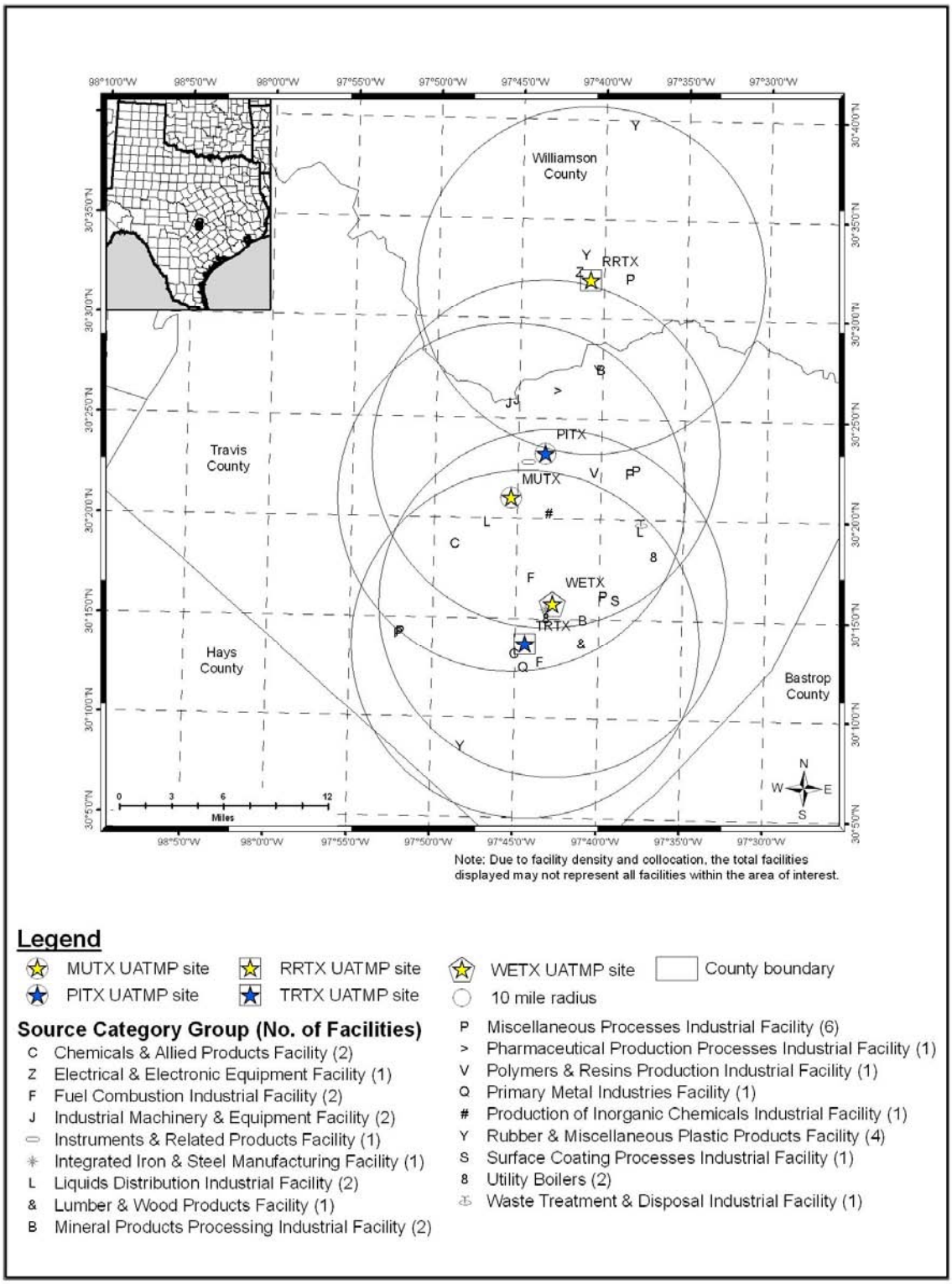


Figure 20-8. Facilities Located Within 10 Miles of YDSP

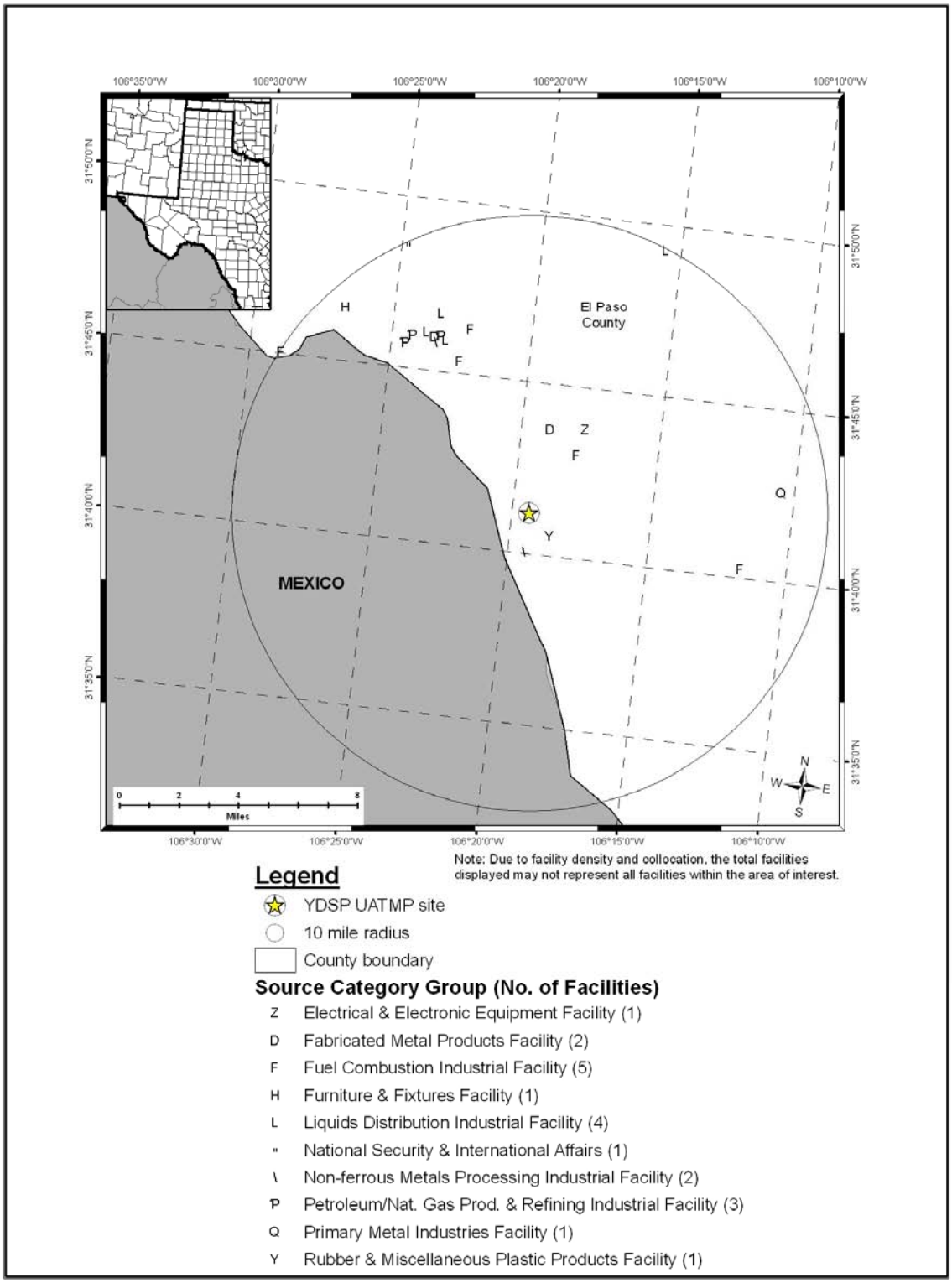


Figure 20-9. Acrolein Pollution Rose at MUTX

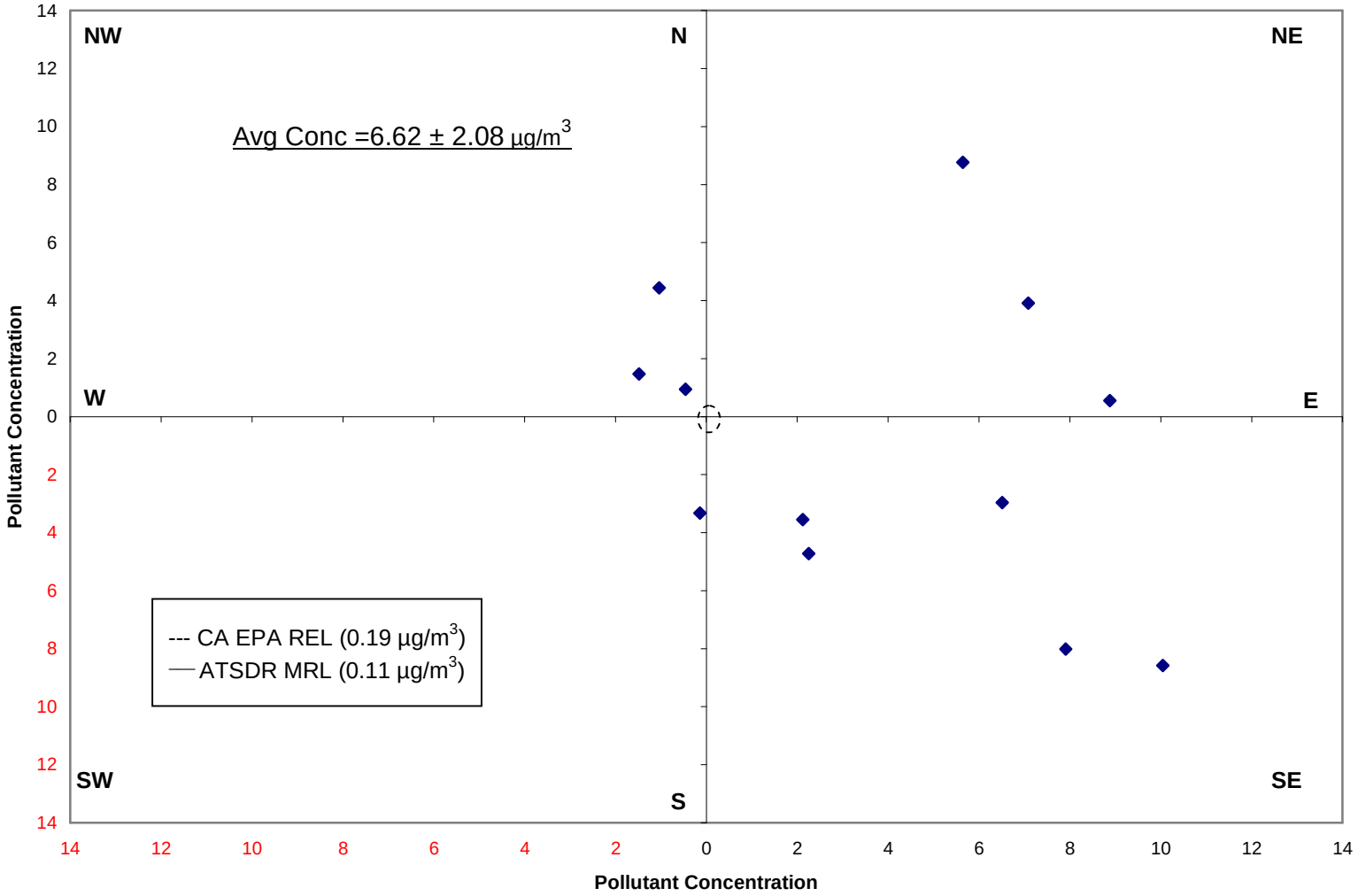


Figure 20-10. Acrolein Pollution Rose at PITX

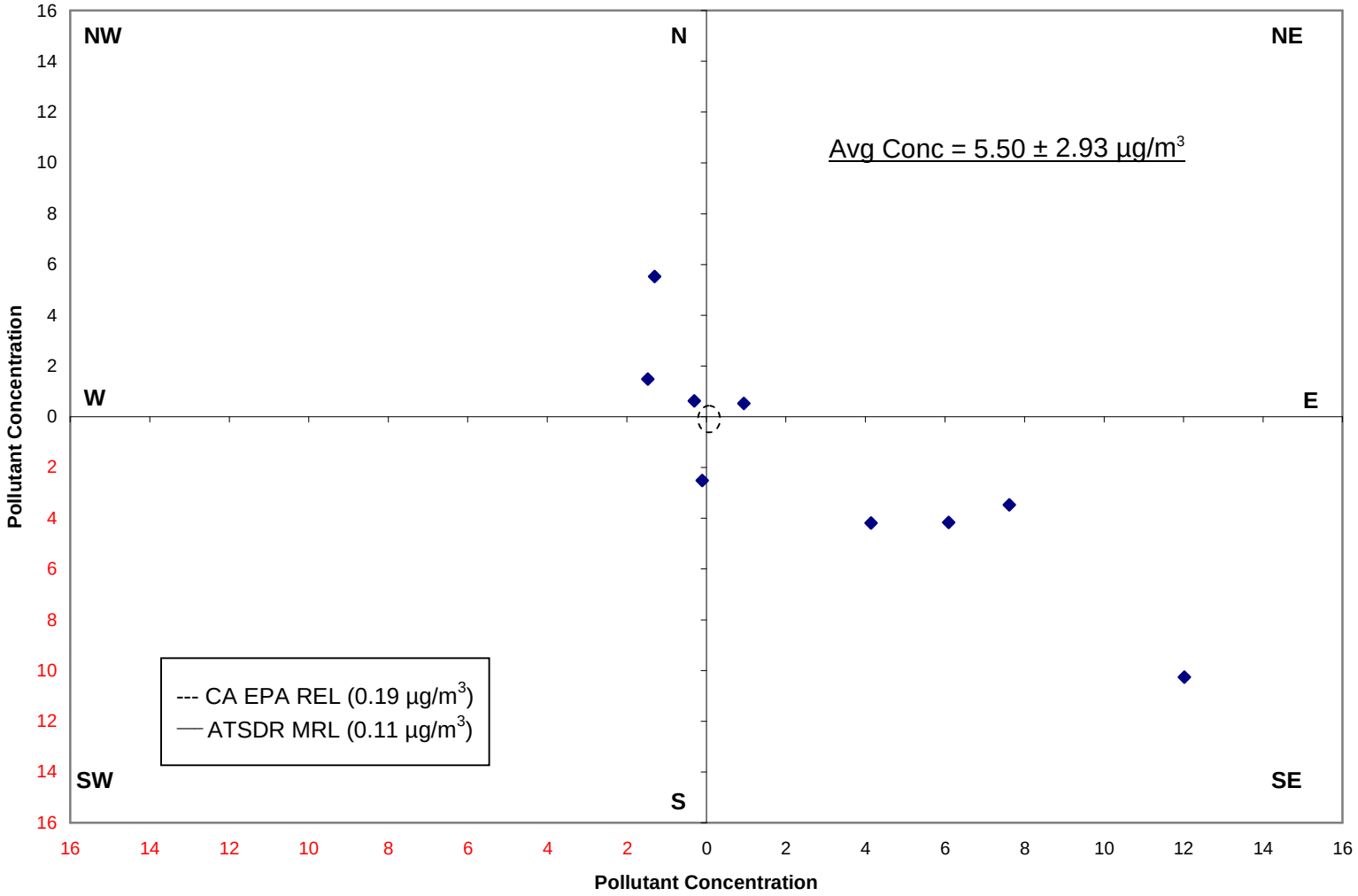


Figure 20-11. Acrolein Pollution Rose at RRTX

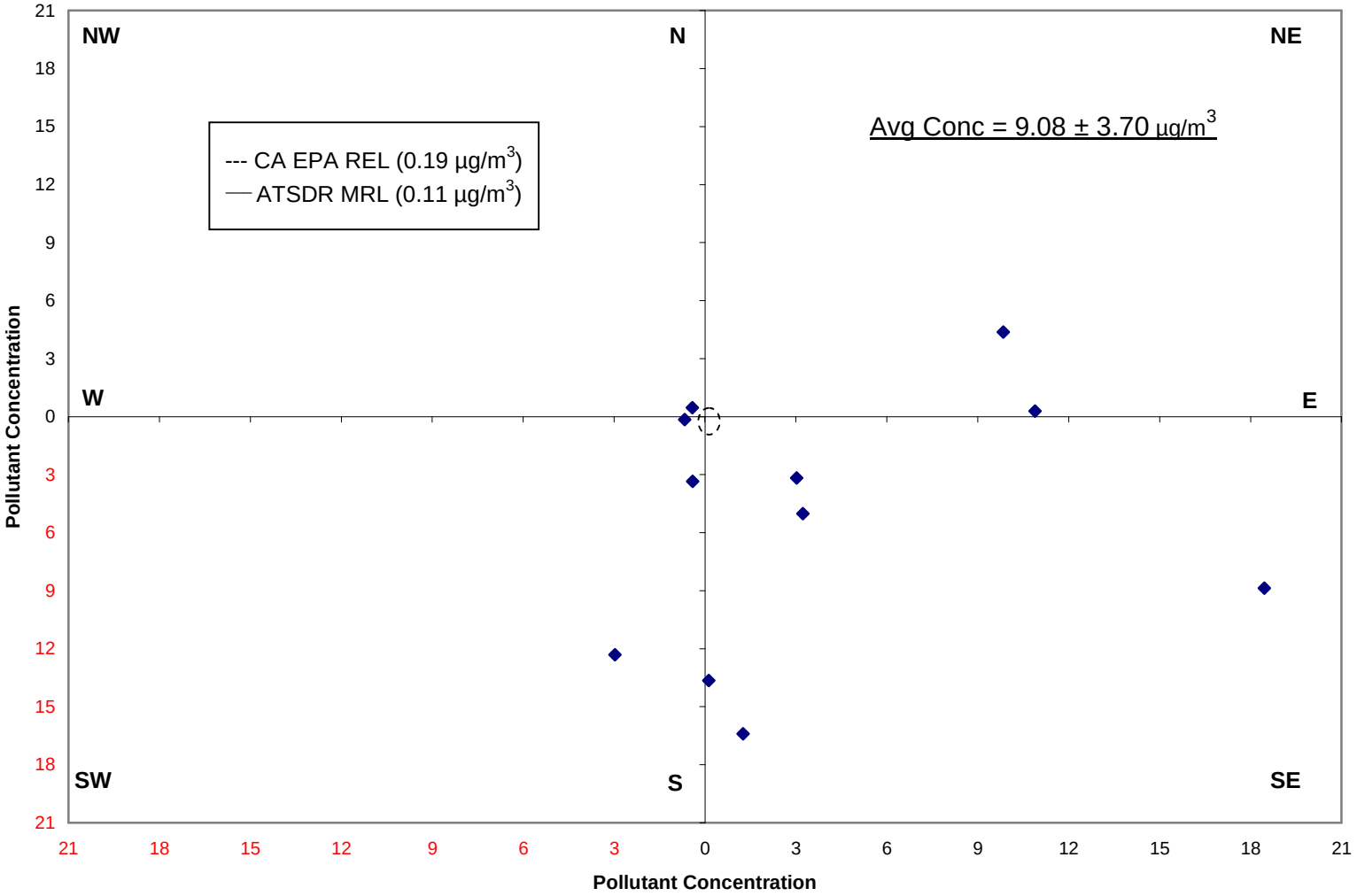


Figure 20-12. Acrolein Pollution Rose at TRTX

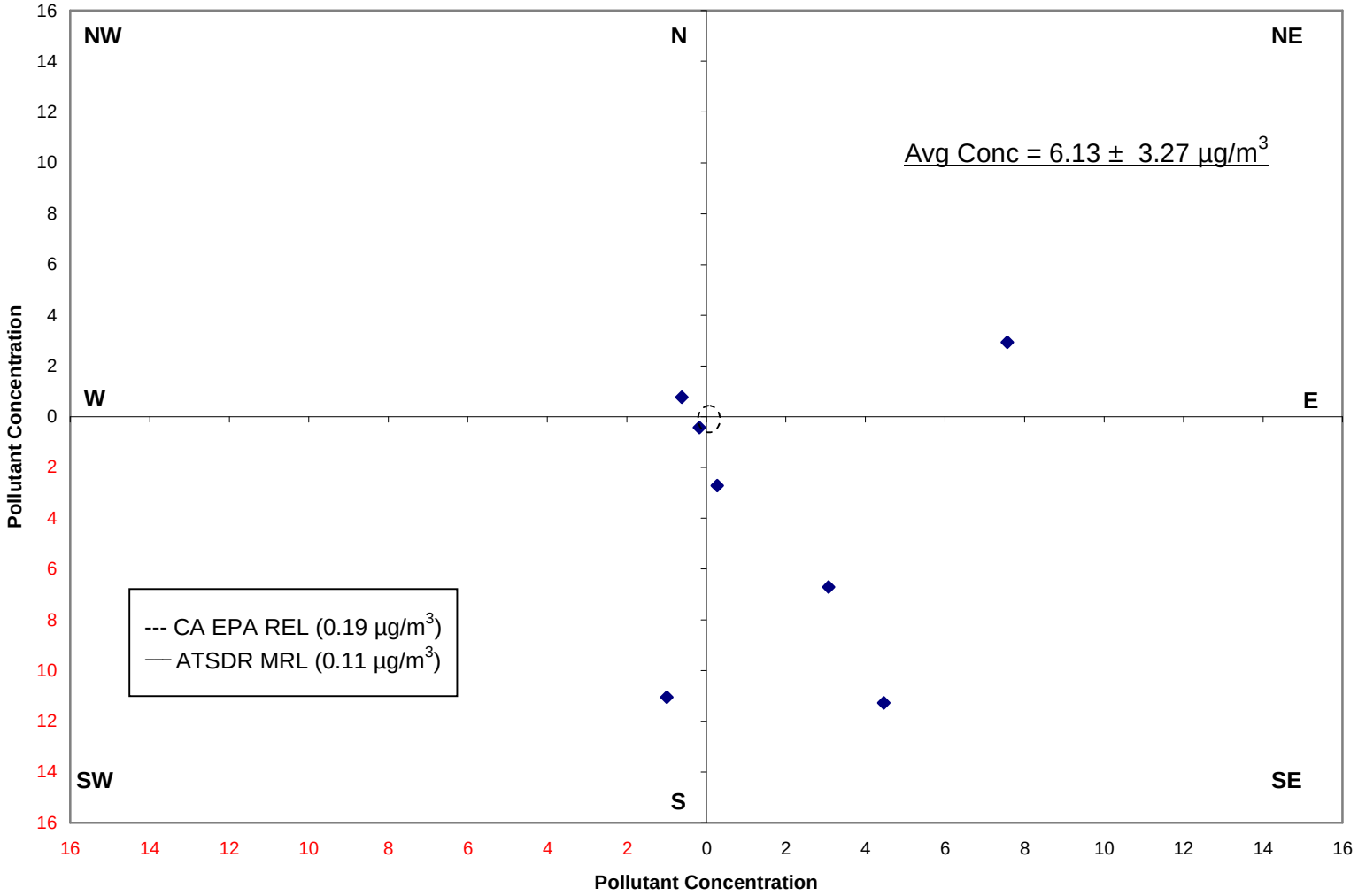


Figure 20-13. Acrolein Pollution Rose at WETX

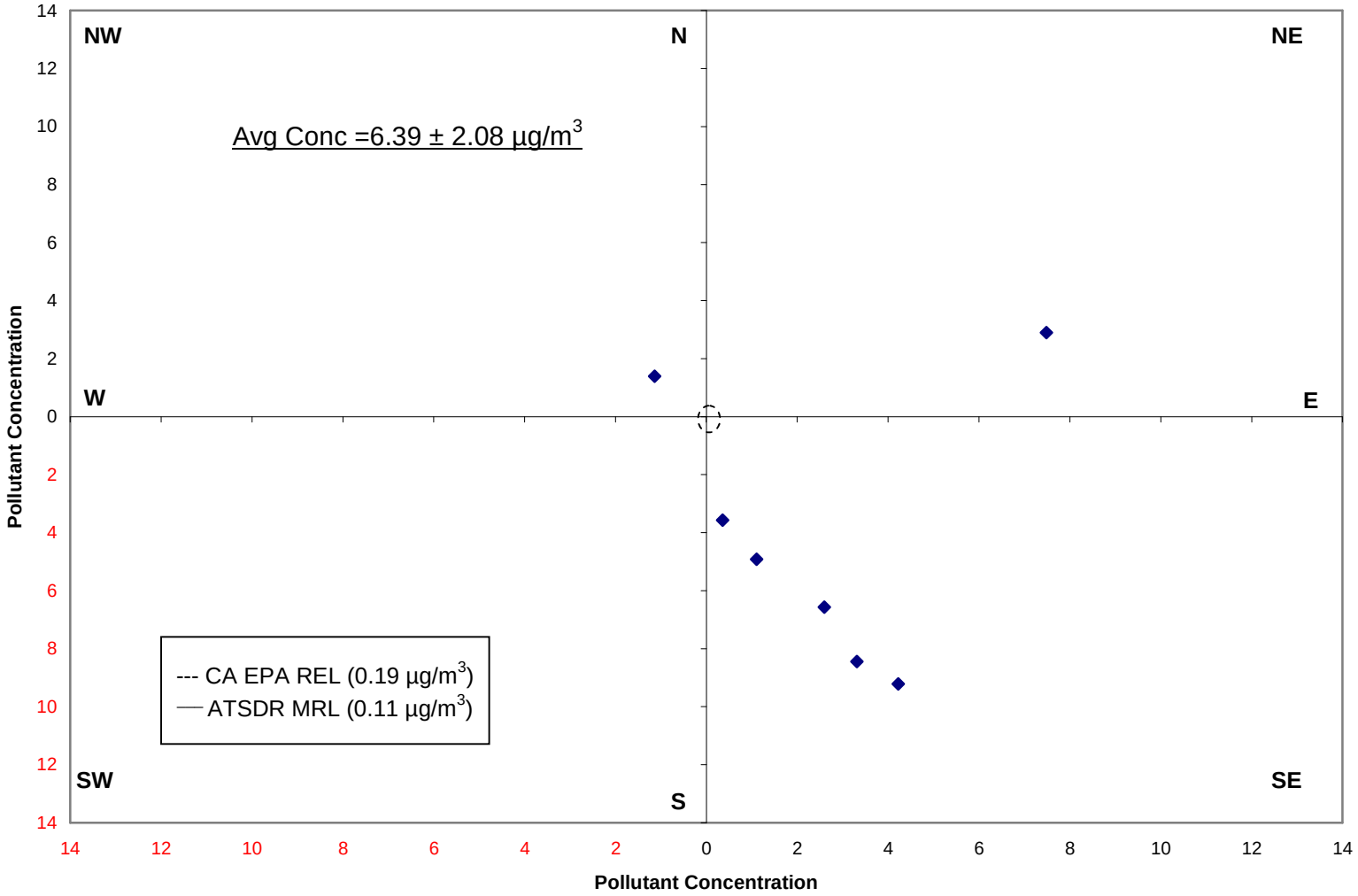


Figure 20-14. Acrolein Pollution Rose at YDSP

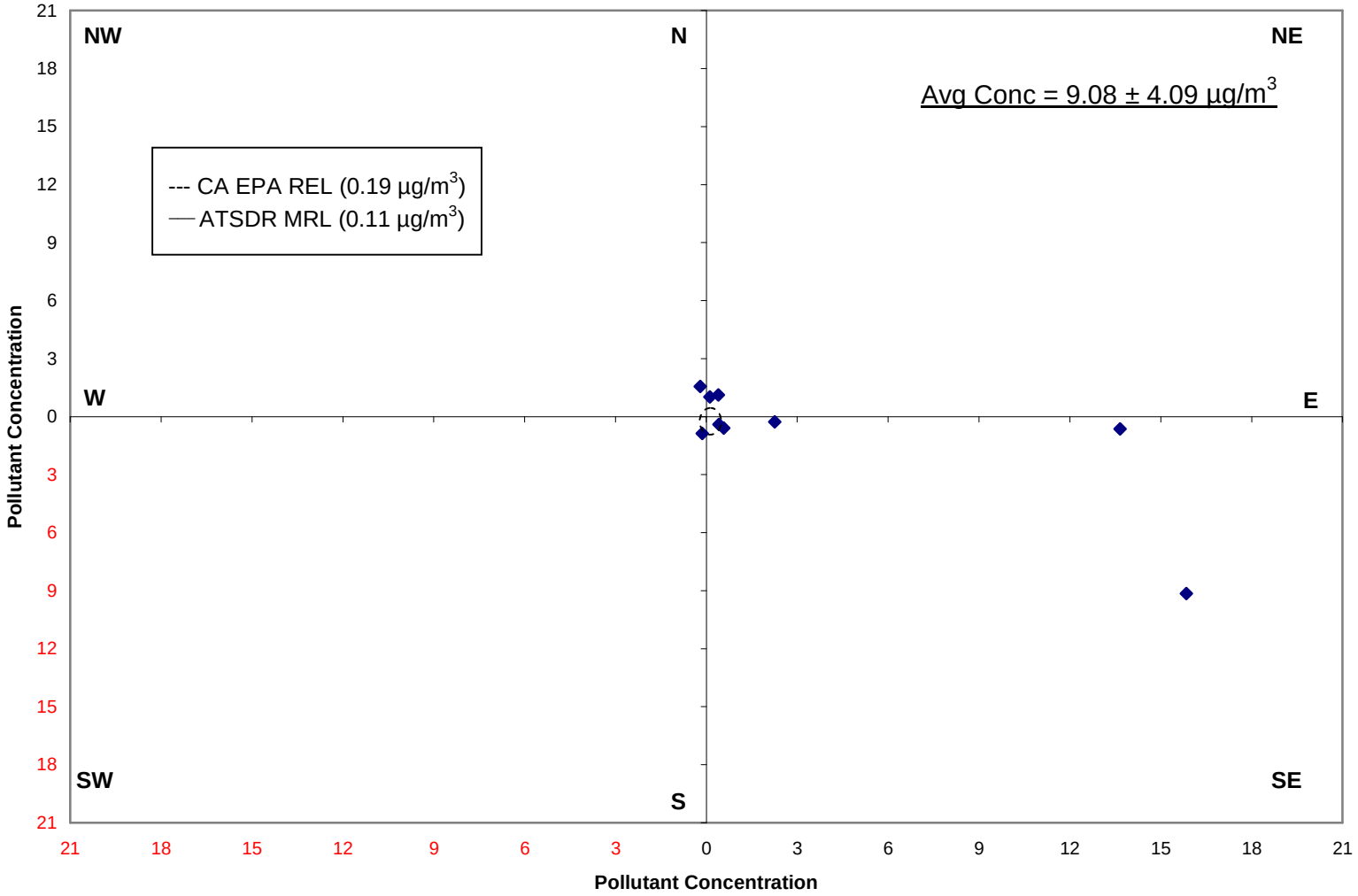


Figure 20-15. Composite Back Trajectory Map for MUTX

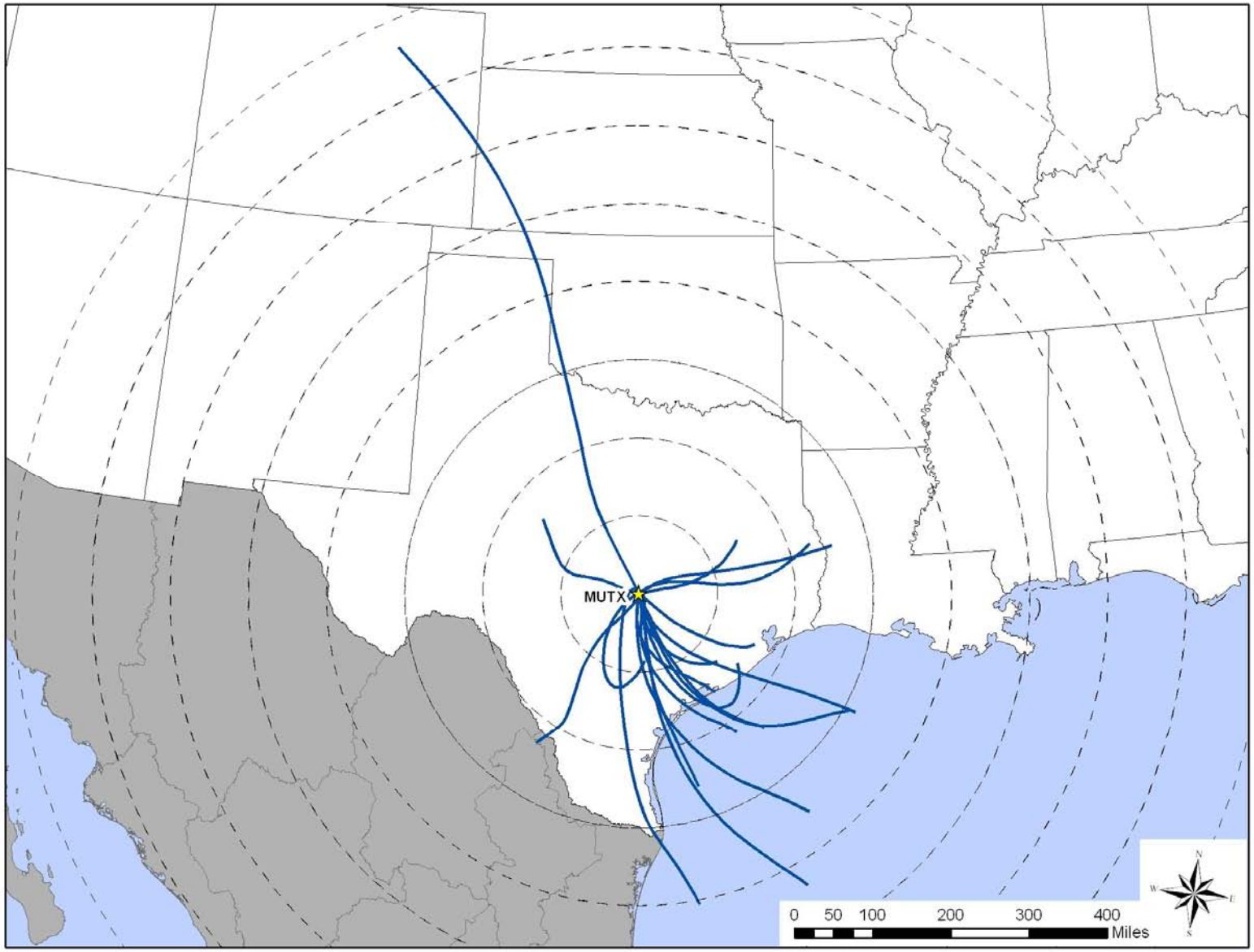


Figure 20-16. Composite Back Trajectory Map for PITX

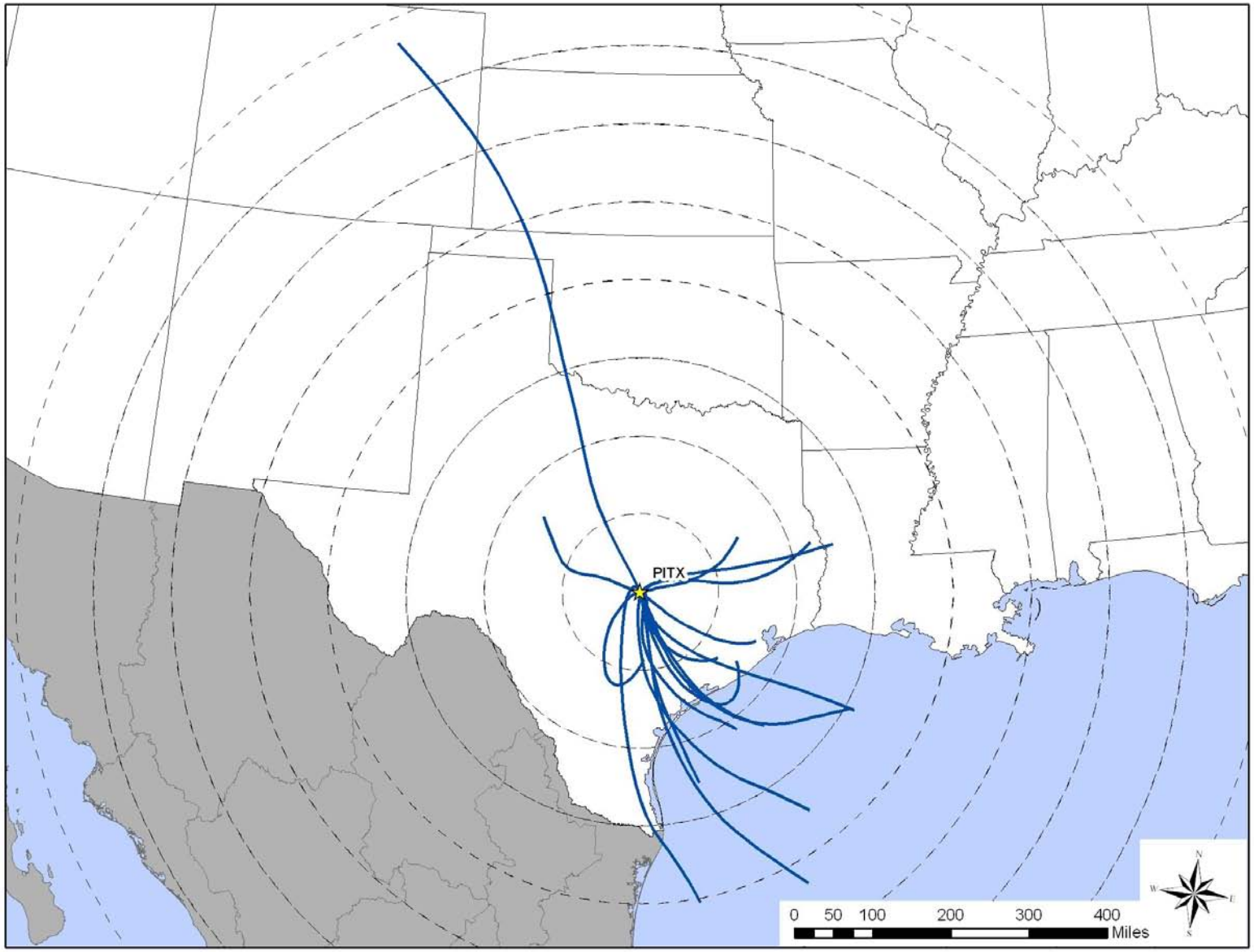


Figure 20-17. Composite Back Trajectory Map for RRTX

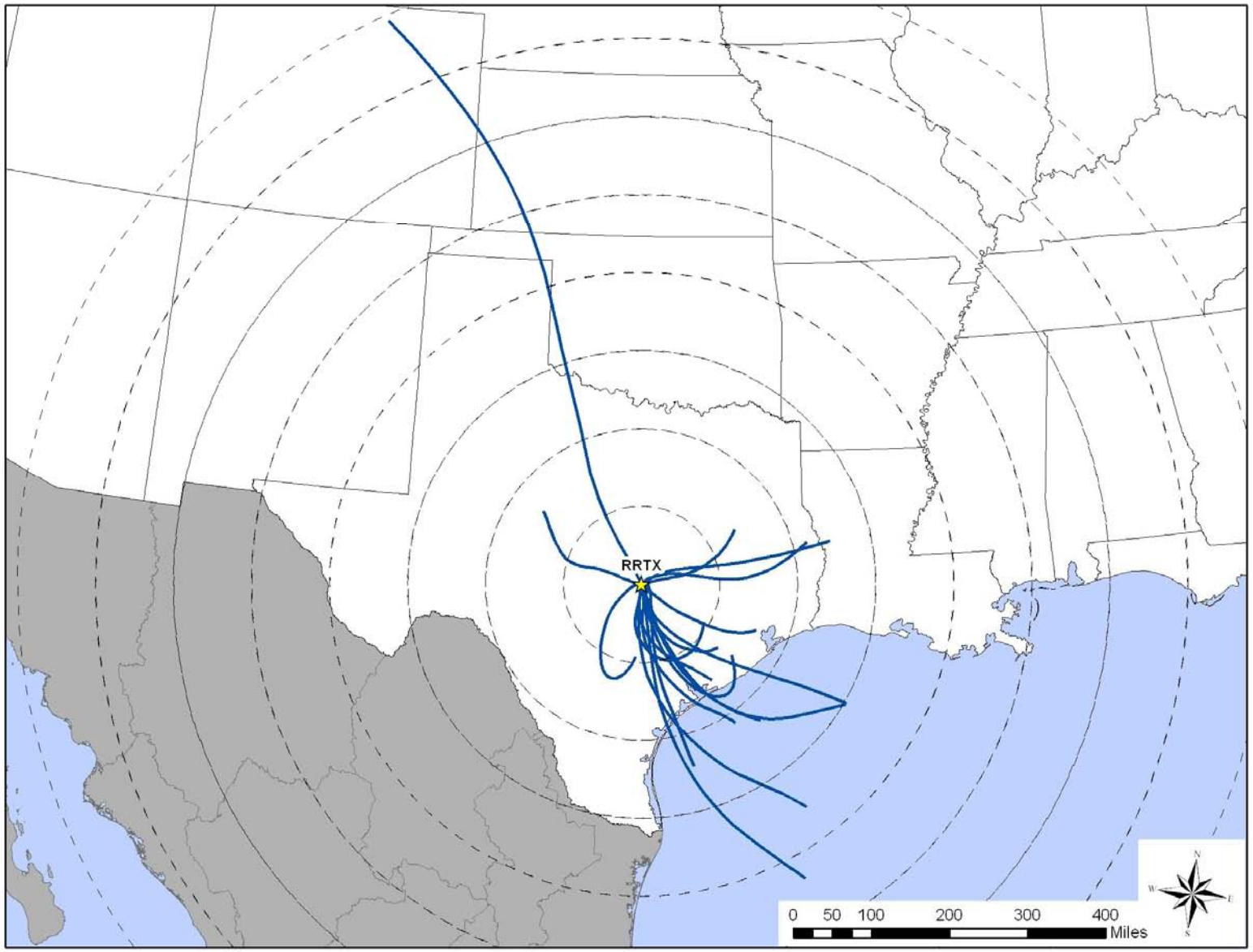


Figure 20-18. Composite Back Trajectory Map for TRTX

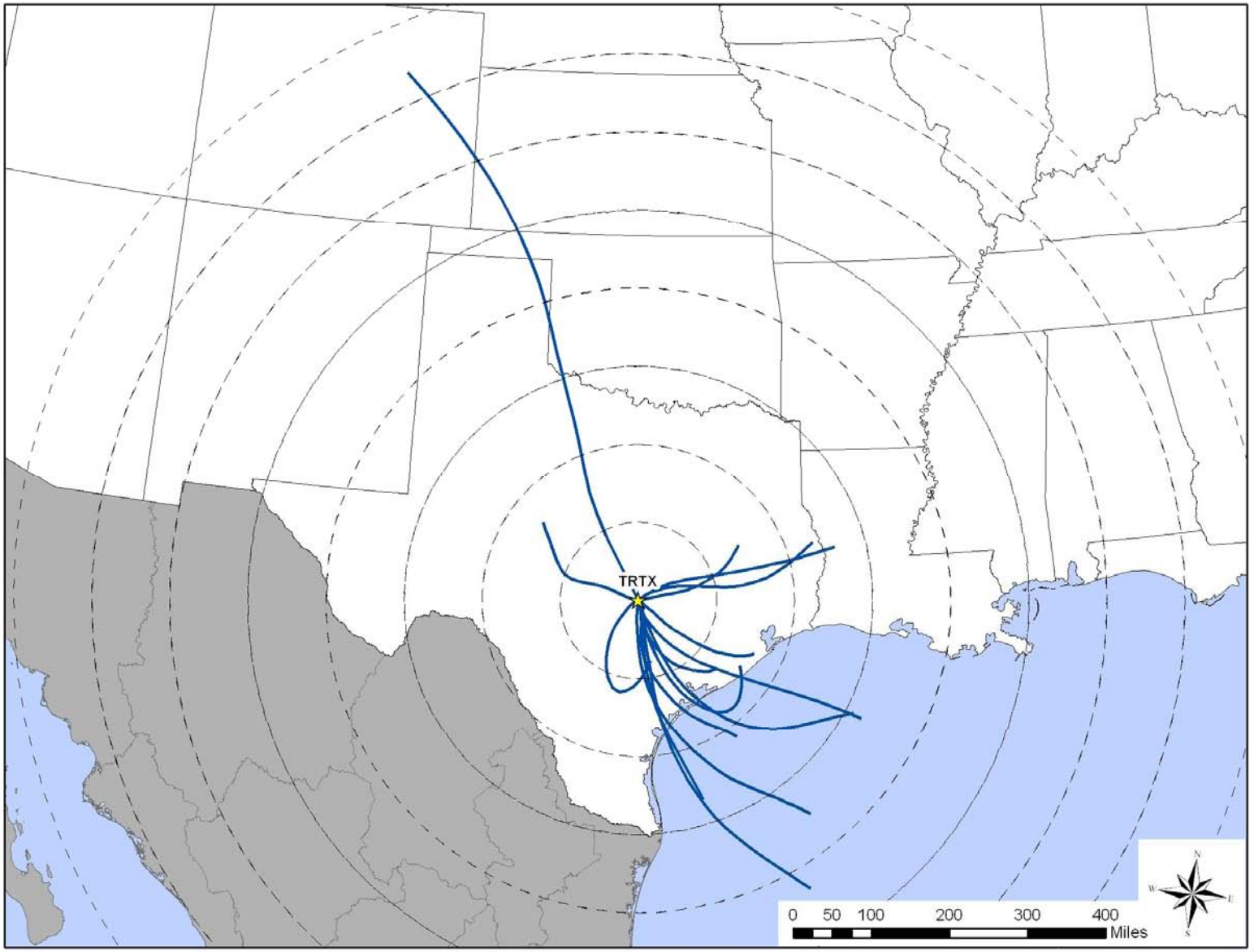


Figure 20-19. Composite Back Trajectory Map for WETX

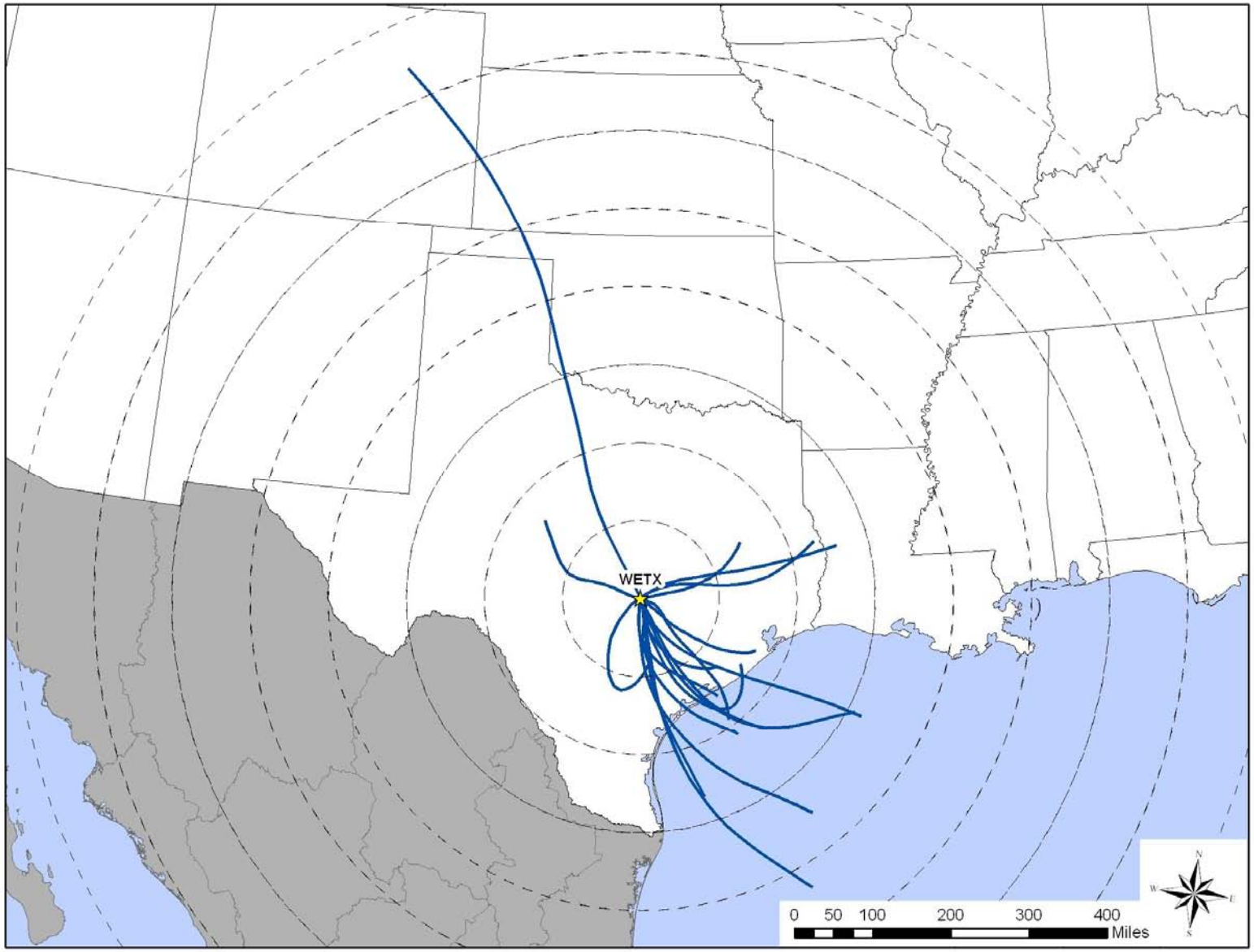


Figure 20-20. Composite Back Trajectory Map for YDSP

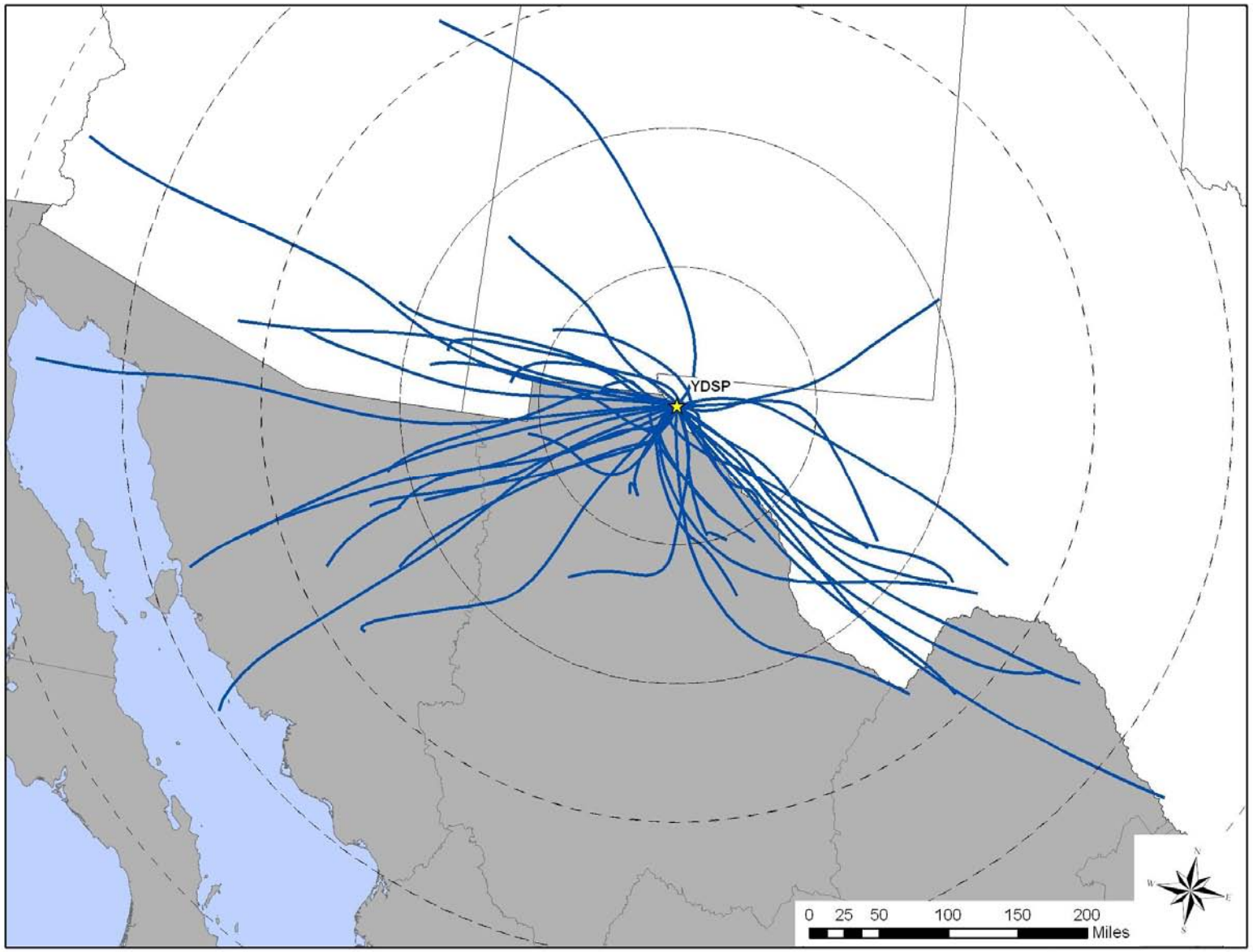


Figure 20-21. Wind Rose of Sample Days for the MUTX Monitoring Site

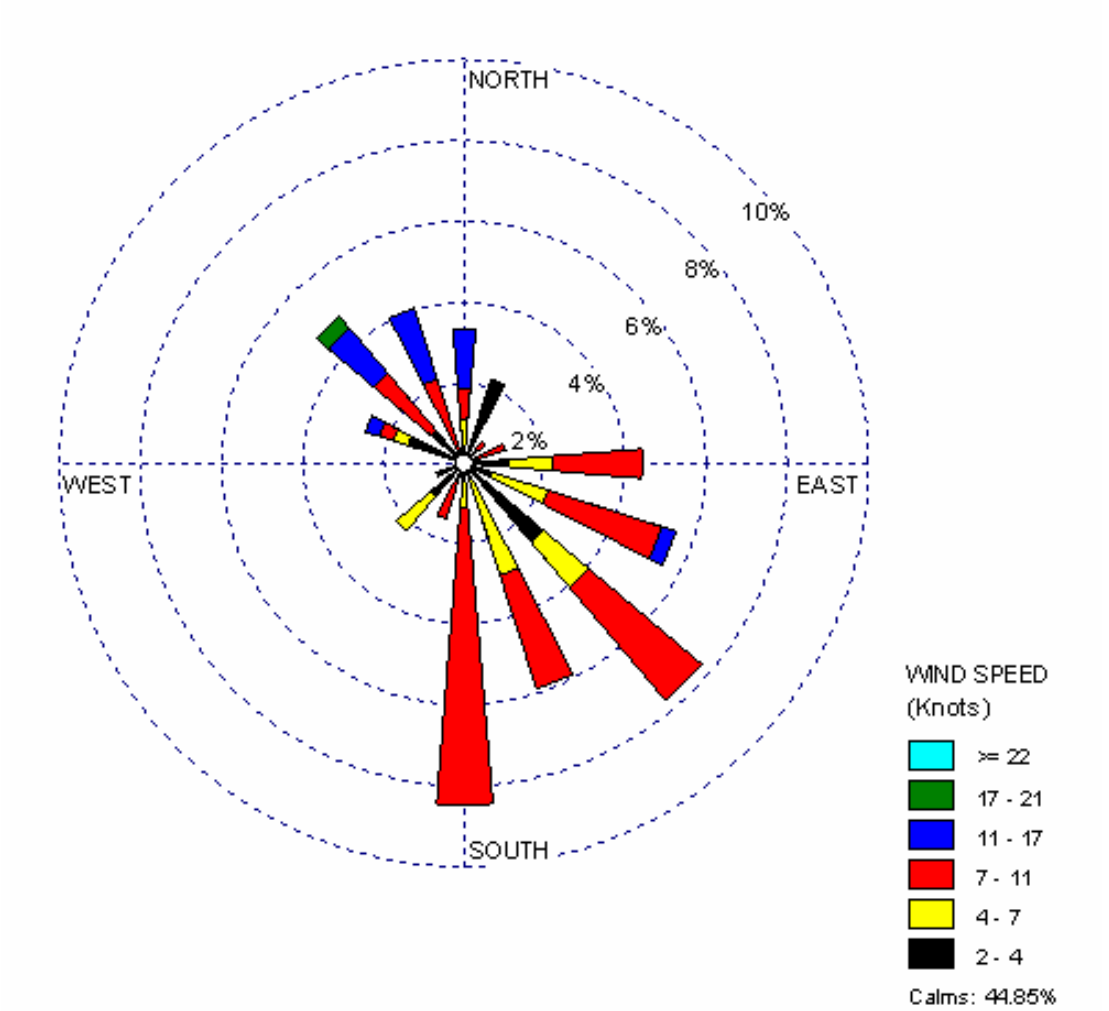


Figure 20-22. Wind Rose of Sample Days for the PITX Monitoring Site

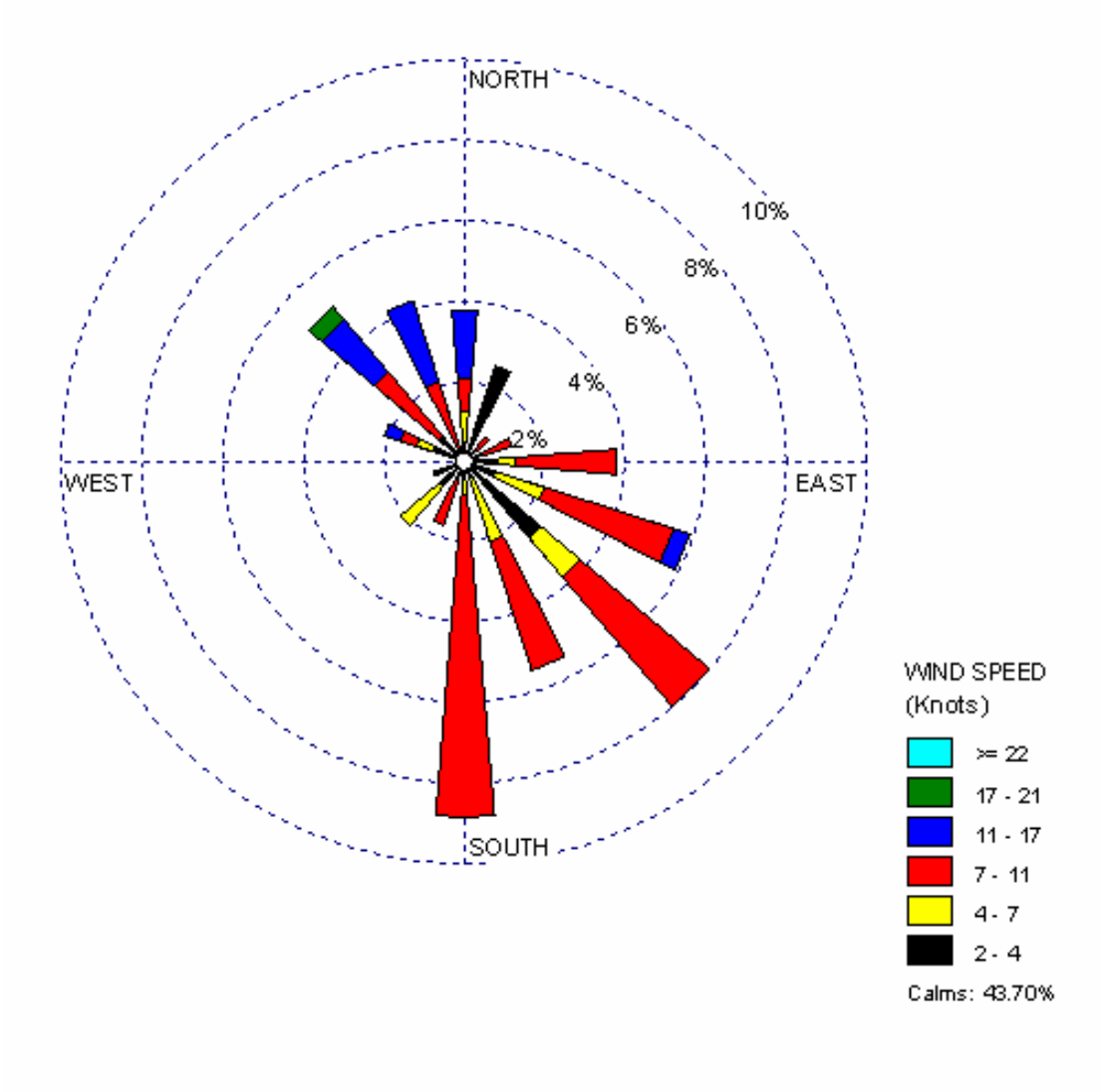


Figure 20-23. Wind Rose of Sample Days for the RRTX Monitoring Site

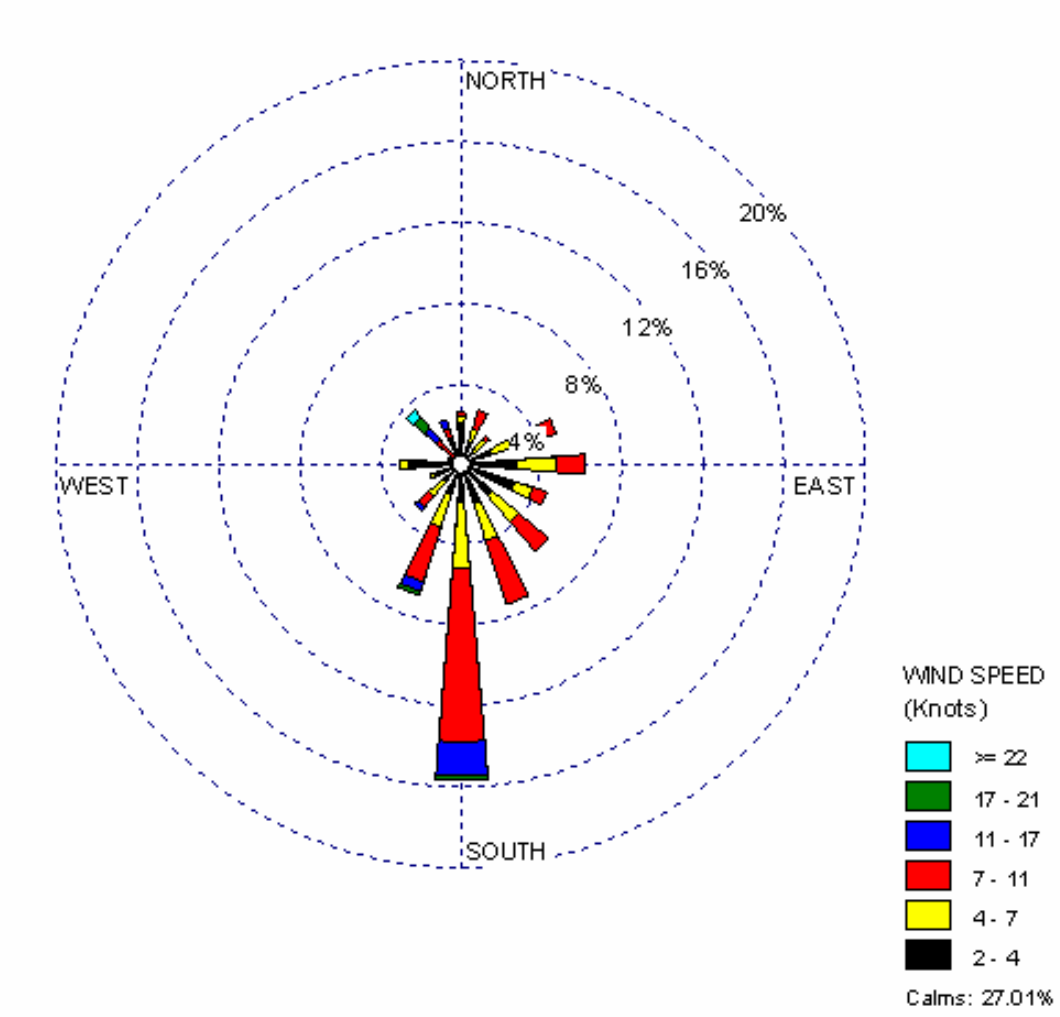


Figure 20-24. Wind Rose of Sample Days for the TRTX Monitoring Site

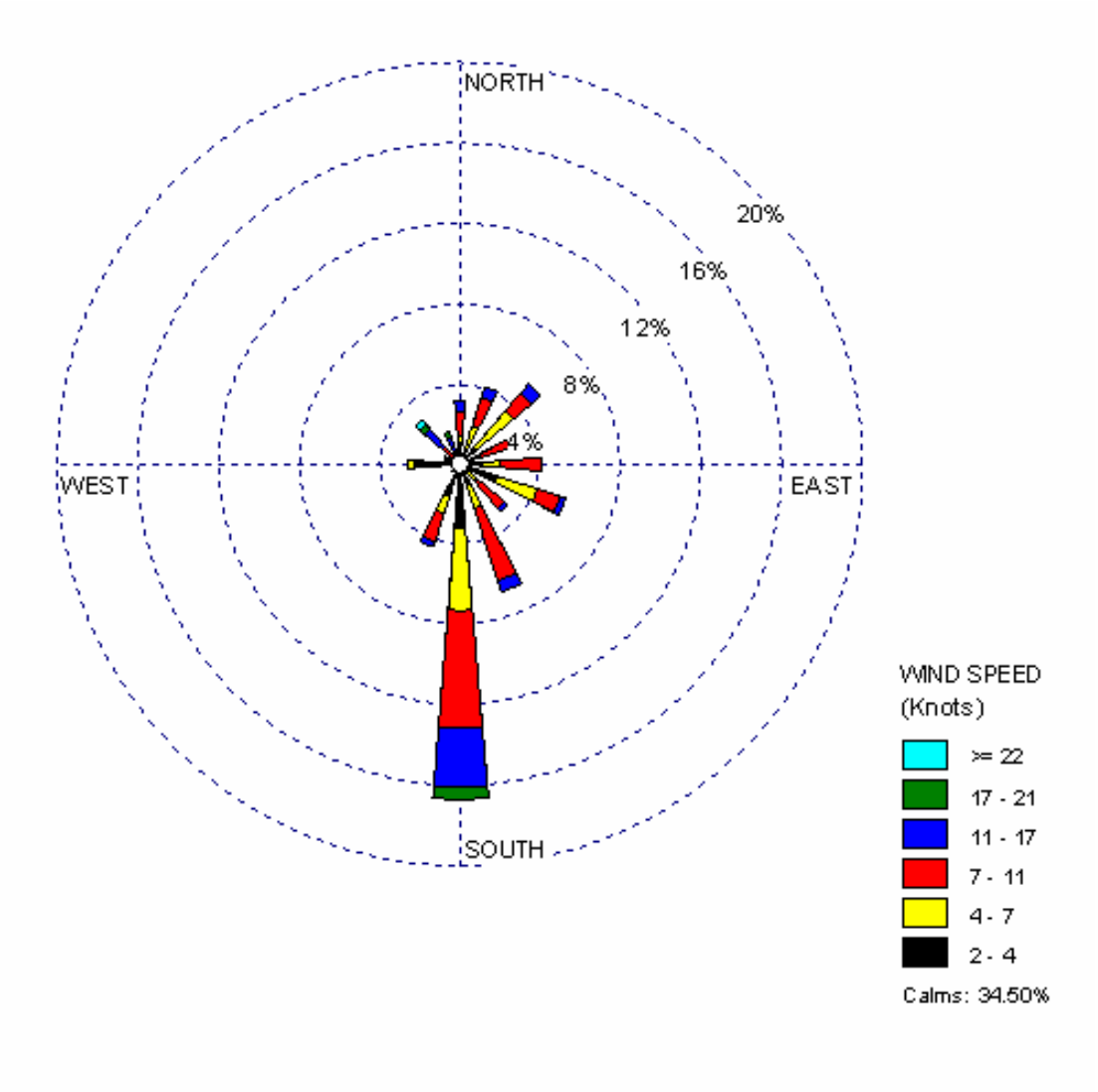


Figure 20-25. Wind Rose of Sample Days for the WETX Monitoring Site

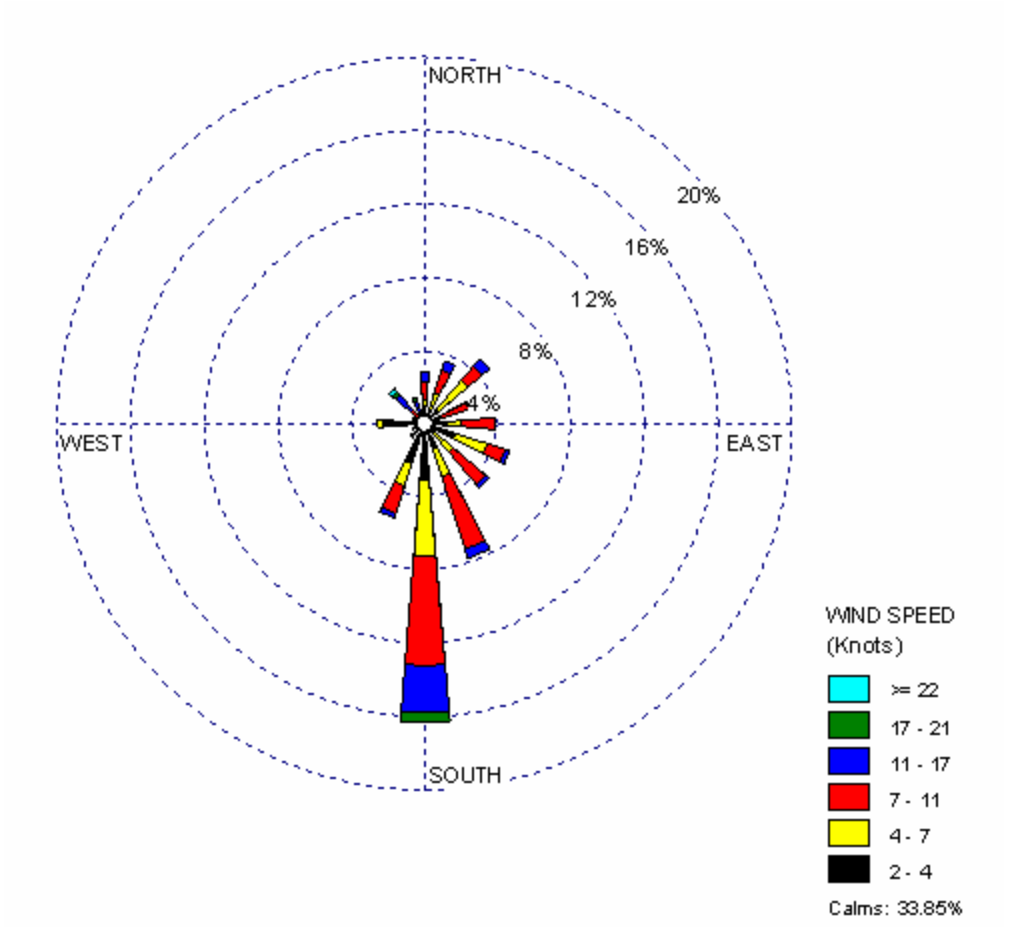


Figure 20-26. Wind Rose of Sample Days for the YDSP Monitoring Site

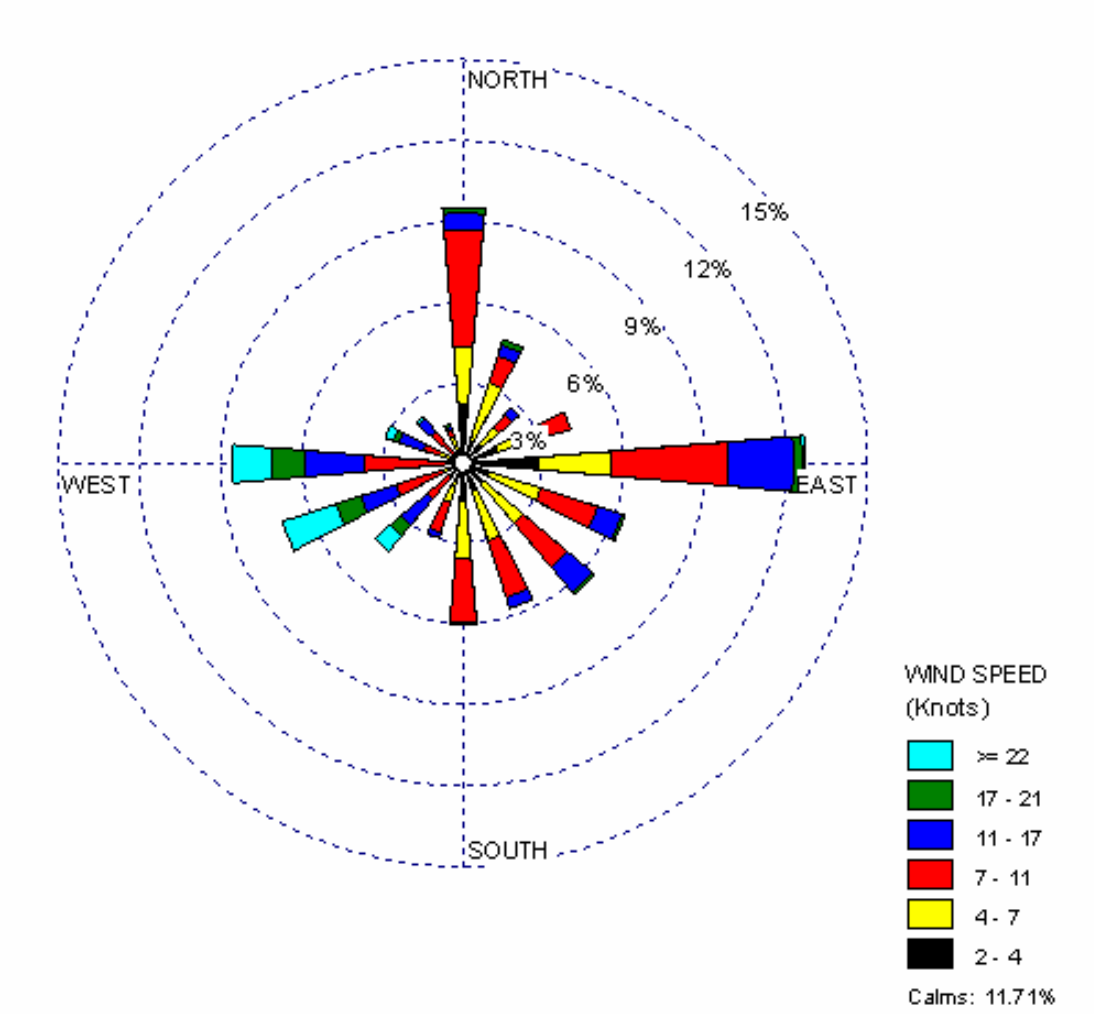


Table 20-1. Average Meteorological Parameters for Monitoring Sites in Texas

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
MUTX	13958	All 2005	79.97 ± 1.51	69.21 ± 1.40	54.25 ± 1.52	60.65 ± 1.26	62.97 ± 1.41	1016.00 ± 0.62	-0.77 ± 0.22	0.68 ± 0.41
		Sample Day	85.68 ± 5.16	73.88 ± 5.54	55.04 ± 7.27	63.13 ± 5.57	55.68 ± 4.70	1016.28 ± 1.84	-0.75 ± 0.93	0.55 ± 1.38
PITX	13958	All 2005	79.97 ± 1.51	69.21 ± 1.4	54.25 ± 1.52	60.65 ± 1.26	62.97 ± 1.41	1016.00 ± 0.62	-0.77 ± 0.22	0.68 ± 0.41
		Sample Day	85.35 ± 5.62	73.76 ± 5.97	55.24 ± 7.70	63.18 ± 5.94	56.28 ± 4.87	1016.76 ± 1.93	-0.77 ± 1.03	0.52 ± 1.54
RRTX	53942	All 2005	78.75 ± 1.53	67.49 ± 1.46	50.95 ± 1.49	59.46 ± 1.34	59.59 ± 1.25	NA[1]	0.00 ± 0.23	1.35 ± 0.54
		Sample Day	86.11 ± 5.63	73.35 ± 6.39	53.71 ± 7.52	64.20 ± 5.96	54.52 ± 3.36	NA[1]	-0.29 ± 1.04	1.62 ± 1.83
TRTX	13904	All 2005	81.08 ± 1.51	68.96 ± 1.42	56.58 ± 1.53	61.69 ± 1.32	69.02 ± 1.25	1015.75 ± 0.61	-0.84 ± 0.22	0.89 ± 0.57
		Sample Day	86.27 ± 6.19	72.59 ± 7.01	56.97 ± 8.82	63.56 ± 7.09	63.08 ± 5.51	1016.74 ± 2.21	-1.01 ± 1.10	0.94 ± 2.10
WETX	13904	All 2005	81.08 ± 1.51	68.96 ± 1.42	56.58 ± 1.53	61.69 ± 1.32	69.02 ± 1.25	1015.75 ± 0.61	-0.84 ± 0.22	0.89 ± 0.57
		Sample Day	87.41 ± 5.67	73.90 ± 6.41	58.61 ± 8.07	64.88 ± 6.49	63.72 ± 4.97	1016.41 ± 2.00	-0.94 ± 1.00	1.20 ± 1.89
YDSP	23044	All 2005	77.58 ± 1.56	66.21 ± 1.53	37.40 ± 1.54	51.36 ± 1.14	40.37 ± 1.86	1012.39 ± 0.57	0.77 ± 0.55	0.38 ± 0.33
		Sample Day	80.90 ± 4.02	69.12 ± 3.94	38.14 ± 4.96	53.11 ± 3.28	37.21 ± 5.32	1011.61 ± 1.52	0.61 ± 2.00	0.79 ± 1.03

[1]This station did not record seal level pressure.

Table 20-2. Comparison of Measured Concentrations and EPA Screening Values at the Texas Monitoring Sites

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Murchison Middle School in Austin, TX - MUTX					
Benzene	16	16	100.0	12.2%	12.2%
Carbon Tetrachloride	16	16	100.0	12.2%	24.4%
1,3-Butadiene	14	14	100.0	10.7%	35.1%
Arsenic (PM_{10})	13	17	76.5	9.9%	45.0%
Acetaldehyde	13	13	100.0	9.9%	55.0%
Formaldehyde	13	13	100.0	9.9%	64.9%
p-Dichlorobenzene	12	14	85.7	9.2%	74.0%
Acrolein	12	12	100.0	9.2%	83.2%
Tetrachloroethylene	11	13	84.6	8.4%	91.6%
Manganese (PM_{10})	6	17	35.3	4.6%	96.2%
Hexachloro-1,3-butadiene	5	5	100.0	3.8%	100.0%
Total	131	150	87.3		
Pickle Research Center in Austin, TX - PITX					
Formaldehyde	15	15	100.0	12.4%	12.4%
Carbon Tetrachloride	15	15	100.0	12.4%	24.8%
Benzene	15	15	100.0	12.4%	37.2%
Acetaldehyde	15	15	100.0	12.4%	49.6%
1,3-Butadiene	14	14	100.0	11.6%	61.2%
Arsenic (PM_{10})	12	15	80.0	9.9%	71.1%
p-Dichlorobenzene	12	14	85.7	9.9%	81.0%
Acrolein	9	9	100.0	7.4%	88.4%
Mnganese (PM_{10})	8	15	53.3	6.6%	95.04%
Hexachloro-1,3-butadiene	2	2	100.0	1.7%	96.7%
Tetrachloroethylene	2	10	20.0	1.7%	98.3%
Trichloroethylene	1	4	25.0	0.8%	99.2%
Nickel (PM_{10})	1	15	6.7	0.8%	100.0%
Total	121	158	76.6		
Round Rock, TX - RRTX					
Formaldehyde	16	16	100.0	11.3%	11.3%
Acetaldehyde	16	16	100.0	11.3%	22.7%
Carbon Tetrachloride	15	15	100.0	10.6%	33.3%
Benzene	15	15	100.0	10.6%	44.0%
1,3-Butadiene	14	14	100.0	9.9%	53.9%
Arsenic (PM_{10})	14	18	77.8	9.9%	63.8%
p-Dichlorobenzene	13	14	92.9	9.2%	73.0%
Acrolein	11	11	100.0	7.8%	80.9%
Tetrachloroethylene	11	15	73.3	7.8%	88.7%
Manganese (PM_{10})	10	18	55.6	7.1%	95.7%
Hexachloro-1,3-butadiene	4	4	100.0	2.8%	98.6%
Acrylonitrile	1	1	100.0	0.7%	99.3%
Chloromethylbenzene	1	1	100.0	0.7%	100.0%
Total	141	158	89.2		

Table 20-2. Comparison of Measured Concentrations and EPA Screening Values at the Texas Monitoring Sites (Continued)

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Travis High School in Austin, TX – TRTX					
Benzene	15	15	100.0	10.6%	10.6%
1,3-Butadiene	15	15	100.0	10.6%	21.1%
Carbon Tetrachloride	15	15	100.0	10.6%	31.7%
Formaldehyde	14	14	100.0	9.9%	41.5%
Arsenic (PM_{10})	14	15	93.3	9.9%	51.4%
p-Dichlorobenzene	14	14	100.0	9.9%	61.3%
Acetaldehyde	14	14	100.0	9.9%	71.1%
Manganese (PM_{10})	9	15	60.0	6.3%	77.5%
Tetrachloroethylene	7	11	63.6	4.9%	82.4%
Acrolein	7	7	100.0	4.9%	87.3%
Hexachloro-1,3-butadiene	6	6	100.0	4.2%	91.5%
Cadmium (PM_{10})	4	15	26.7	2.8%	94.4%
1,2-Dichloroethane	2	2	100.0	1.4%	95.8%
1,1,2,2-Tetrachloroethane	1	1	100.0	0.7%	96.5%
Nickel (PM_{10})	1	15	6.7	0.7%	97.2%
1,1,2-Trichloroethane	1	1	100.0	0.7%	97.9%
1,2-Dibromoethane	1	1	100.0	0.7%	98.6%
Vinyl chloride	1	7	14.3	0.7%	99.3%
Chloromethylbenzene	1	1	100.0	0.7%	100.0%
Total	142	184	77.2		
Webberville Road in Austin, TX – WETX					
Formaldehyde	15	15	100.0	11.7%	11.7%
Acetaldehyde	15	15	100.0	11.7%	23.4%
Arsenic (PM_{10})	14	17	82.4	10.9%	34.4%
Carbon Tetrachloride	13	13	100.0	10.2%	44.5%
Benzene	13	13	100.0	10.2%	54.7%
1,3-Butadiene	13	13	100.0	10.2%	64.8%
p-Dichlorobenzene	12	12	100.0	9.4%	74.2%
Manganese (PM_{10})	11	17	64.7	8.6%	82.8%
Acrolein	7	7	100.0	5.5%	88.3%
Tetrachloroethylene	6	11	54.5	4.7%	93.0%
Hexachloro-1,3-butadiene	5	5	100.0	3.9%	96.9%
Xylenes	3	13	23.1	2.3%	99.2%
1,2-Dichloroethane	1	1	100.0	0.8%	100.0%
Total	128	152	84.2		

Table 20-2. Comparison of Measured Concentrations and EPA Screening Values at the Texas Monitoring Sites (Continued)

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
El Paso, TX – YDSP					
Benzene	40	40	100.0	22.3%	22.3%
Carbon Tetrachloride	40	40	100.0	22.3%	44.7%
1,3-Butadiene	34	34	100.0	19.0%	63.7%
p-Dichlorobenzene	28	29	96.6	15.6%	79.3%
Hexachloro-1,3-butadiene	9	9	100.0	5.0%	84.4%
Xylenes	9	40	22.5	5.0%	89.4%
Acrolein	9	9	100.0	5.0%	94.4%
Tetrachloroethylene	8	17	47.1	4.5%	98.9%
Trichloroethylene	2	19	10.5	1.1%	100.0%
Total	179	237	75.5		

Table 20-3. Daily and Seasonal Averages for Pollutants of Interest at the Texas Monitoring Sites

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Murchison Middle School in Austin, TX - MUTX												
1,3-Butadiene	14	16	0.10	0.02	NA	NA	NA	NA	NR	NR	0.11	0.02
Acetaldehyde	13	13	1.64	0.27	NA	NA	NA	NA	NR	NR	1.83	0.32
Acrolein	12	15	6.62	2.08	NA	NA	NA	NA	NR	NR	4.89	2.63
Arsenic (PM_{10})	17	17	0.0005	0.0002	NA	NA	NA	NA	0.0004	0.0003	0.0005	0.0002
Benzene	16	16	1.10	0.14	NA	NA	NA	NA	NR	NR	1.07	0.13
Carbon Tetrachloride	16	16	0.68	0.07	NA	NA	NA	NA	NR	NR	0.74	0.07
Formaldehyde	13	13	3.28	0.77	NA	NA	NA	NA	NR	NR	2.82	0.74
Manganese (PM_{10})	17	17	0.0047	0.0021	NA	NA	NA	NA	0.0021	0.0009	0.0071	0.0037
p-Dichlorobenzene	14	16	0.37	0.16	NA	NA	NA	NA	NR	NR	0.21	0.07
Tetrachloroethylene	13	16	0.37	0.16	NA	NA	NA	NA	NR	NR	0.42	0.22
Pickle Research Center in Austin, TX – PITX												
1,3-Butadiene	14	15	0.11	0.02	NA	NA	NA	NA	NR	NR	0.13	0.03
Acetaldehyde	15	15	1.63	0.29	NA	NA	NA	NA	NR	NR	1.83	0.36
Acrolein	9	14	5.50	2.93	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (PM_{10})	15	15	0.0004	0.0001	NA	NA	NA	NA	NR	NR	0.0005	0.0001
Benzene	15	15	1.02	0.14	NA	NA	NA	NA	NR	NR	1.04	0.23
Carbon Tetrachloride	15	15	0.68	0.05	NA	NA	NA	NA	NR	NR	0.73	0.08
Formaldehyde	15	15	3.35	0.66	NA	NA	NA	NA	NR	NR	3.12	0.62
Manganese (PM_{10})	15	15	0.0066	0.0030	NA	NA	NA	NA	NR	NR	0.0095	0.0046
p-Dichlorobenzene	14	15	0.41	0.15	NA	NA	NA	NA	NR	NR	0.20	0.09
Round Rock, TX – RRTX												
1,3-Butadiene	14	15	0.12	0.05	NA	NA	NA	NA	NR	NR	0.11	0.04
Acetaldehyde	16	16	1.69	0.23	NA	NA	NA	NA	NR	NR	1.77	0.19
Acrolein	11	14	9.08	3.70	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (PM_{10})	18	18	0.0004	0.0001	NA	NA	NA	NA	0.0004	0.0002	0.0005	0.0002
Benzene	15	15	1.18	0.14	NA	NA	NA	NA	NR	NR	1.10	0.16
Carbon Tetrachloride	15	15	0.68	0.08	NA	NA	NA	NA	NR	NR	0.73	0.11
Formaldehyde	16	16	3.72	0.52	NA	NA	NA	NA	NR	NR	3.41	0.44
Manganese (PM_{10})	18	18	0.0059	0.0021	NA	NA	NA	NA	0.0029	0.0013	0.0081	0.0034

Table 20-3. Daily and Seasonal Averages for Pollutants of Interest at the Texas Monitoring Sites (Continued)

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
p-Dichlorobenzene	14	15	0.42	0.17	NA	NA	NA	NA	NR	NR	0.24	0.08
Tetrachloroethylene	15	15	0.30	0.10	NA	NA	NA	NA	NR	NR	0.30	0.12
Travis High School in Austin, TX – TRTX												
1,2-Dichloroethane	2	15	0.26	0.08	NA	NA	NA	NA	NR	NR	NR	NR
1,3-Butadiene	15	15	0.20	0.04	NA	NA	NA	NA	NR	NR	0.21	0.06
Acetaldehyde	14	14	1.63	0.29	NA	NA	NA	NA	NR	NR	1.81	0.35
Acrolein	7	15	6.13	3.27	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (PM_{10})	15	15	0.0010	0.0007	NA	NA	NA	NA	NR	NR	0.0012	0.0012
Benzene	15	15	1.36	0.22	NA	NA	NA	NA	NR	NR	1.31	0.27
Cadmium (PM_{10})	15	15	0.0004	0.0002	NA	NA	NA	NA	NR	NR	0.0006	0.0003
Carbon Tetrachloride	15	15	0.70	0.07	NA	NA	NA	NA	NR	NR	0.69	0.12
Formaldehyde	14	14	3.35	0.70	NA	NA	NA	NA	NR	NR	3.35	0.59
Hexachloro-1,3-butadiene	6	15	0.20	0.12	NA	NA	NA	NA	NR	NR	NR	NR
Manganese (PM_{10})	15	15	0.0061	0.0019	NA	NA	NA	NA	NR	NR	0.0073	0.0033
p-Dichlorobenzene	14	15	0.39	0.14	NA	NA	NA	NA	NR	NR	0.30	0.10
Tetrachloroethylene	11	15	0.35	0.17	NA	NA	NA	NA	NR	NR	NR	NR
Webberville Road in Austin, TX – WETX												
1,3-Butadiene	13	13	0.40	0.16	NA	NA	NA	NA	NR	NR	0.39	0.15
Acetaldehyde	15	15	2.19	0.42	NA	NA	NA	NA	NR	NR	2.30	0.43
Acrolein	7	12	6.39	2.08	NA	NA	NA	NA	NR	NR	NR	NR
Arsenic (PM_{10})	17	17	0.0014	0.0017	NA	NA	NA	NA	0.0004	0.0002	0.0025	0.0035
Benzene	13	13	2.20	0.55	NA	NA	NA	NA	NR	NR	2.04	0.58
Carbon Tetrachloride	13	13	0.67	0.06	NA	NA	NA	NA	NR	NR	0.70	0.08
Formaldehyde	15	15	3.57	0.54	NA	NA	NA	NA	NR	NR	3.50	0.39
Hexachloro-1,3-butadiene	5	13	0.18	0.05	NA	NA	NA	NA	NR	NR	NR	NR
Manganese (PM_{10})	17	17	0.0067	0.0021	NA	NA	NA	NA	0.0038	0.0018	0.0091	0.0033
p-Dichlorobenzene	12	13	0.42	0.10	NA	NA	NA	NA	NR	NR	0.39	0.14
Tetrachloroethylene	11	13	0.22	0.08	NA	NA	NA	NA	NR	NR	0.21	0.09

Table 20-3. Daily and Seasonal Averages for Pollutants of Interest at the Texas Monitoring Sites (Continued)

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
El Paso, TX – YDSP												
1,3-Butadiene	34	40	0.35	0.08	NA	NA	NR	NR	0.20	0.08	0.32	0.08
Acrolein	9	26	4.48	4.09	NA	NA	NR	NR	NR	NR	NR	NR
Benzene	40	40	2.33	0.34	NA	NA	1.79	0.33	1.65	0.50	2.68	0.44
Carbon Tetrachloride	40	40	0.62	0.04	NA	NA	0.53	0.06	0.59	0.06	0.72	0.08
Hexachloro-1,3-butadiene	9	40	0.19	0.04	NA	NA	NA	NR	NR	NR	1.02	0.40
p-Dichlorobenzene	29	40	0.60	0.22	NA	NA	NA	NR	0.29	0.13	0.72	0.37
Tetrachloroethylene	17	40	0.20	0.06	NA	NA	NA	NR	NR	NR	0.13	0.04
Xylenes	40	40	7.37	1.37	NA	NA	5.24	1.33	5.85	2.60	7.81	1.59

NA = Not available due to short sampling duration.
NR = Not responsible due to low number of detects.

Table 20-4. Non-Chronic Risk Summary at the Texas Monitoring Sites

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
MUTX	TO-15	Acrolein	6.62 ± 2.08	0.11	12	0.19	12	0.09	NA	NA	NR	4.89 ± 2.63
PITX	TO-15	Acrolein	5.50 ± 2.93	0.11	9	0.19	9	0.09	NA	NA	NR	NR
RRTX	TO-15	Acrolein	9.08 ± 3.70	0.11	11	0.19	11	0.09	NA	NA	NR	NR
TRTX	TO-15	Acrolein	6.13 ± 3.27	0.11	7	0.19	7	0.09	NA	NA	NR	NR
WETX	TO-15	Acrolein	6.39 ± 2.08	0.11	7	0.19	7	0.09	NA	NA	NR	NR
YDSP	TO-15	Acrolein	4.48 ± 4.09	0.11	9	0.19	9	0.09	NA	NA	Nr	NR

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 20-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Texas Monitoring Sites

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperataure	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Murchison Middle School in Austin, TX - MUTX									
1,3-Butadiene	14	-0.35	-0.47	-0.39	-0.45	-0.19	-0.14	0.22	0.55
Acetaldehyde	13	0.13	0.12	0.08	0.07	-0.03	-0.22	-0.05	0.23
Acrolein	12	0.54	0.59	0.47	0.52	0.04	-0.58	0.28	0.00
Arsenic (PM_{10})	17	0.04	0.07	0.05	0.05	-0.02	-0.14	-0.36	0.07
Benzene	16	0.48	0.46	0.49	0.47	0.39	-0.37	0.30	-0.07
Carbon Tetrachloride	16	-0.18	-0.17	-0.14	-0.16	-0.07	0.04	0.14	0.20
Formaldehyde	13	0.67	0.69	0.60	0.62	0.31	-0.48	0.29	-0.15
Manganese (PM_{10})	17	-0.42	-0.50	-0.40	-0.46	-0.11	0.25	-0.06	0.27
p-Dichlorobenzene	14	0.69	0.66	0.64	0.65	0.36	-0.38	0.29	-0.41
Tetrachloroethylene	13	-0.33	-0.26	-0.29	-0.28	-0.30	0.02	-0.45	0.46
Pickle Research Center in Austin, TX - PITX									
1,3-Butadiene	14	-0.21	-0.27	-0.26	-0.28	-0.22	-0.19	-0.04	0.58
Acetaldehyde	15	-0.26	-0.24	-0.28	-0.27	-0.32	0.29	-0.59	0.26
Acrolein	9	0.79	0.75	0.69	0.71	0.41	-0.42	0.45	-0.49
Arsenic (PM_{10})	15	-0.07	-0.01	0.00	-0.01	0.00	0.02	-0.40	0.22
Benzene	15	0.39	0.35	0.38	0.35	0.32	-0.19	-0.06	-0.10
Carbon Tetrachloride	15	-0.13	-0.05	-0.02	-0.02	0.09	0.23	-0.31	-0.06
Formaldehyde	15	0.61	0.63	0.56	0.59	0.26	-0.24	-0.08	-0.34
Manganese (PM_{10})	15	-0.36	-0.43	-0.27	-0.35	0.11	0.30	-0.11	0.12
p-Dichlorobenzene	14	0.76	0.77	0.73	0.74	0.43	-0.39	0.27	-0.60
Round Rock, TX - RRTX									
1,3-Butadiene	14	-0.33	-0.48	-0.44	-0.51	-0.44	0.10	0.24	NA
Acetaldehyde	16	-0.25	-0.33	-0.37	-0.23	-0.25	-0.33	-0.23	NA
Acrolein	11	0.45	0.54	0.59	0.69	0.66	-0.55	0.43	NA
Arsenic (PM_{10})	18	-0.05	-0.04	0.01	0.05	0.11	-0.41	-0.24	NA
Benzene	15	0.15	0.01	0.03	-0.01	-0.03	-0.29	0.06	NA
Carbon Tetrachloride	15	0.06	0.05	0.13	0.41	0.49	-0.61	0.66	NA

Table 20-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Texas Monitoring Sites (Continued)

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperataure	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Formaldehyde	16	0.61	0.52	0.48	0.47	0.32	-0.56	0.05	NA
Manganese (PM_{10})	18	-0.49	-0.66	-0.61	-0.50	-0.30	0.17	0.07	NA
p-Dichlorobenzene	14	0.69	0.64	0.63	0.54	0.42	-0.28	0.24	NA
Tetrachloroethylene	15	0.08	-0.10	-0.06	0.03	0.12	0.03	0.26	NA
Travis High School in Austin, TX – TRTX									
1,2-Dichloroethane	2	NA							
1,3-Butadiene	15	-0.11	-0.27	-0.20	-0.26	0.01	-0.18	0.24	0.18
Acetaldehyde	14	-0.12	-0.12	-0.15	-0.15	-0.15	-0.29	-0.48	0.31
Acrolein	7	0.88	0.85	0.92	0.90	0.80	-0.68	0.47	-0.55
Arsenic (PM_{10})	15	0.27	0.28	0.26	0.27	0.14	-0.16	0.29	-0.30
Benzene	15	0.29	0.21	0.29	0.25	0.43	-0.36	-0.16	-0.05
Cadmium (PM_{10})	15	0.30	0.30	0.34	0.32	0.29	-0.19	0.36	-0.27
Carbon Tetrachloride	15	-0.01	-0.09	0.02	-0.04	0.23	-0.09	0.58	-0.24
Formaldehyde	14	0.50	0.51	0.48	0.49	0.31	-0.51	-0.26	-0.17
Hexachloro-1,3-butadiene	6	-0.52	-0.56	-0.45	-0.51	0.17	0.42	0.65	0.03
Manganese (PM_{10})	15	-0.46	-0.57	-0.48	-0.54	-0.15	0.11	0.11	0.27
p-Dichlorobenzene	14	0.60	0.53	0.58	0.56	0.54	-0.46	0.14	-0.49
Tetrachloroethylene	11	-0.23	-0.36	-0.28	-0.33	-0.01	0.02	0.49	0.13
Webberville Road in Austin, TX – WETX									
1,3-Butadiene	13	-0.41	-0.55	-0.48	-0.53	-0.19	0.16	0.27	0.27
Acetaldehyde	15	-0.40	-0.45	-0.45	-0.47	-0.33	0.06	-0.23	0.42
Acrolein	7	0.81	0.78	0.83	0.81	0.65	-0.64	0.25	0.12
Arsenic (PM_{10})	17	-0.35	-0.46	-0.43	-0.45	-0.17	0.03	-0.09	0.40
Benzene	13	-0.17	-0.31	-0.23	-0.29	0.00	0.12	0.17	0.10
Carbon Tetrachloride	13	0.43	0.40	0.45	0.42	0.41	-0.39	0.36	-0.40
Formaldehyde	15	0.13	0.10	0.09	0.08	0.03	-0.21	-0.12	0.10
Hexachloro-1,3-butadiene	5	0.36	0.36	0.33	0.35	0.15	0.49	0.82	-0.47
Manganese (PM_{10})	17	-0.56	-0.69	-0.61	-0.67	-0.27	0.07	0.04	0.43

Table 20-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Texas Monitoring Sites (Continued)

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperataure	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
p-Dichlorobenzene	12	-0.15	-0.33	-0.23	-0.30	0.08	0.05	0.12	0.10
Tetrachloroethylene	11	0.00	-0.20	-0.16	-0.21	-0.04	-0.08	0.49	-0.05
El Paso, TX – YDSP									
1,3-Butadiene	34	-0.53	-0.61	-0.74	-0.73	-0.46	0.14	-0.03	0.35
Acrolein	9	0.58	0.51	0.16	0.28	-0.29	-0.40	0.10	-0.57
Benzene	40	-0.33	-0.43	-0.55	-0.54	-0.37	0.08	-0.08	0.24
Carbon Tetrachloride	40	-0.19	-0.18	0.09	-0.03	0.33	-0.05	-0.21	0.29
Hexachloro-1,3-butadiene	9	-0.45	-0.55	-0.48	-0.56	-0.27	-0.20	-0.07	0.58
p-Dichlorobenzene	29	-0.04	-0.12	-0.25	-0.22	-0.29	0.08	0.11	-0.04
Tetrachloroethylene	17	0.10	0.09	-0.12	-0.03	-0.34	-0.16	0.18	-0.02
Xylenes	40	-0.28	-0.37	-0.55	-0.51	-0.41	0.05	-0.07	0.23

NA = Not available due to short sampling duration.

Table 20-6. Motor Vehicle Information for the Texas Monitoring Sites

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 Mile Vehicle Ownership	Traffic Data (Daily Average)
MUTX	888,185	707,976	0.80	679,750	541,832	4,374
PITX	888,185	707,976	0.80	649,314	517,571	33,936
RRTX	333,457	269,253	0.81	365,870	295,425	20,900
TRTX	888,185	707,976	0.80	553,117	440,892	27,114
WETX	888,185	707,976	0.80	666,062	530,921	5,733
YDSP	721,598	505,459	0.70	430,692	301,688	12,400

Table 20-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Texas

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Murchison Middle School in Austin, Texas - MUTX, Census Tract 48453001718				
1,3-Butadiene	NA	0.16	4.94	0.08
Acetaldehyde	NA	1.57	3.45	0.17
Acrolein	NA	0.11	--	5.35
Arsenic (PM_{10})	NA	0.01	0.04	<0.01
Benzene	NA	1.75	13.63	0.06
Carbon Tetrachloride	NA	0.22	3.24	0.01
Formaldehyde	NA	1.57	0.01	0.16
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (PM_{10})	NA	0.35	--	0.01
***p*-Dichlorobenzene**	NA	0.03	0.38	<0.01
Tetrachloroethylene	NA	0.24	1.42	<0.01
Pickle Research Center in Austin, Texas - PITX, Census Tract 48453001849				
1,3-Butadiene	NA	0.16	4.70	0.08
Acetaldehyde	NA	1.67	3.67	0.19
Acrolein	NA	0.12	--	6.22
Arsenic (PM_{10})	NA	0.01	0.06	<0.01
Benzene	NA	1.70	13.24	0.06
Carbon Tetrachloride	NA	0.21	3.17	0.01
Formaldehyde	NA	1.75	0.01	0.18
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (PM_{10})	NA	1.89	--	0.04
Nickel (PM_{10})	NA	0.49	0.08	0.01
***p*-Dichlorobenzene**	NA	0.03	0.35	<0.01
Tetrachloroethylene	NA	0.24	1.40	<0.01
Trichloroethylene	NA	0.09	0.18	<0.01
Round Rock, Texas - RRTX, Census Tract 48491021502				
1,3-Butadiene	NA	0.11	3.34	0.06
Acetaldehyde	NA	1.31	2.89	0.15
Acrolein	NA	0.08	--	4.18
Acrylonitrile	NA	<0.01	0.01	<0.01
Arsenic (PM_{10})	NA	0.01	0.03	<0.01
Benzene	NA	1.36	10.61	0.05
Carbon Tetrachloride	NA	0.21	3.21	0.01
hloromethylbenzene	NA	<0.01	<0.01	--
Formaldehyde	NA	1.32	0.01	0.13
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (PM_{10})	NA	0.14	--	<0.01
***p*-Dichlorobenzene**	NA	0.04	0.46	<0.01
Tetrachloroethylene	NA	0.15	0.90	<0.01

Table 20-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Texas (Continued)

Pollutant	2005 UATMP Annual Average ($\mu g/m^3$)	1999 NATA Modeled Concentration ($\mu g/m^3$)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Travis High School in Austin, Texas - TRTX, Census Tract 48453002308				
1,1,2,2-Tetrachloroethane	NA	0.05	3.12	--
1,1,2-Trichloroethane	NA	<0.01	<0.01	<0.01
1,2-Dibromoethane	NA	0.02	5.15	0.03
1,2-Dichloroethane	NA	0.04	0.93	<0.01
1,3-Butadiene	NA	0.17	5.11	0.09
Acetaldehyde	NA	1.42	3.12	0.16
Acrolein	NA	0.10	--	4.85
Arsenic (PM_{10})	NA	0.01	0.03	<0.01
Benzene	NA	1.69	13.15	0.06
Cadmium (PM_{10})	NA	<0.01	0.01	<0.01
Carbon Tetrachloride	NA	0.21	3.18	0.01
Chloromethylbenzene	NA	<0.01	<0.01	--
Formaldehyde	NA	1.52	0.01	0.15
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (PM_{10})	NA	0.18	--	<0.01
Nickel (PM_{10})	NA	0.19	0.03	<0.01
***p*-Dichlorobenzene**	NA	0.03	0.36	<0.01
Tetrachloroethylene	NA	0.23	1.36	<0.01
Vinyl chloride	NA	0.05	0.46	<0.01
Webberville Road in Austin, Texas - WETX, Census Tract 48453000802				
1,2-Dichloroethane	NA	0.04	0.94	<0.01
1,3-Butadiene	NA	0.16	4.73	0.08
Acetaldehyde	NA	1.57	3.46	0.17
Acrolein	NA	0.13	--	6.64
Arsenic (PM_{10})	NA	0.01	0.02	<0.01
Benzene	NA	1.53	11.92	0.05
Carbon Tetrachloride	NA	0.22	3.24	0.01
Formaldehyde	NA	1.65	0.01	0.17
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
Manganese (PM_{10})	NA	0.19	--	<0.01
***p*-Dichlorobenzene**	NA	0.04	0.39	<0.01
Tetrachloroethylene	NA	0.21	1.25	<0.01
Xylenes	NA	2.10	--	0.02
El Paso, Texas - YDSP, Census Tract 48141003902				
1,3-Butadiene	NA	0.09	2.63	0.04
Acrolein	NA	0.04	--	1.78
Benzene	NA	0.87	6.79	0.03
Carbon Tetrachloride	NA	0.21	3.17	0.01
Hexachloro-1,3-butadiene	NA	<0.01	0.03	<0.01
***p*-Dichlorobenzene**	NA	0.03	0.34	<0.01

Table 20-7. 1999 NATA Data Census Tract Summary for the Monitoring Sites in Texas (Continued)

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Tetrachloroethylene	NA	0.14	0.81	<0.01
Trichloroethylene	NA	0.07	0.13	<0.01
Xylenes	NA	0.91	--	0.01

BOLD = pollutant of interest.

21.0 Site in Utah

This section presents meteorological, concentration, and spatial trends for the UATMP site in Utah (BTUT), located in Bountiful, just north of Salt Lake City. Figure 21-1 is a topographical map showing the monitoring site in its urban location. Figure 21-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. Most of the industrial facilities near the Bountiful site are located south of the site. A number of these sources are involved in fuel combustion industries, petroleum and natural gas production and refining, and fabricated metal production.

Hourly meteorological data at a weather station near this site were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the BTUT monitoring site is Salt Lake City International Airport (WBAN 24127).

The Salt Lake City area has a semi-arid continental climate, with large seasonal variations. The area is dry, located on the west side of the Wasatch Mountains, and the Great Salt Lake tends to have a moderating influence on the city's temperature. Moderate winds flow out of the southeast on average (Ruffner and Bair, 1987). Table 21-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average *u*- and *v*- components of the wind) for the entire year and on days samples were taken. As shown in Table 21-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

21.1 Pollutants of Interest at the Utah Monitoring Site

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration

"failed the screen." A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 21-2 presents the fifteen pollutants that failed at least one screen at BTUT; a total of 458 measured concentrations failed screens. The pollutants of interest at BTUT were identified as the pollutants that contributed to the top 95% of the total failed screens, resulting in eleven pollutants: arsenic (60 failed screens), acetaldehyde (56), benzene (56), formaldehyde (56), carbon tetrachloride (51), nickel (45), 1,3-butadiene (41), manganese (40), tetrachloroethylene (21), hexachloro-1,3-butadiene (12), and acrolein (12). This site has the largest number of failed screens of any UATMP site. It's important to note that the BTUT site sampled for carbonyls, SNMOC, VOC, and metals, and that this is reflected in the site's pollutants of interest. Also listed in Table 21-2 are the total number of detects and the percent detects failing the screen. Of the eleven pollutants of interest, acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and hexachloro-1,3-butadiene had 100% of their detects fail the screening values.

21.2 Concentration Averages at the Utah Monitoring Site

Three types of concentration averages were calculated for the eleven pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 21-3. Annual averages will be presented and discussed in further detail in later sections.

Acetaldehyde, arsenic, benzene, formaldehyde, manganese, and nickel were detected in every sample taken at BTUT, while acrolein was detected in less than one-half of the samples taken. Among the daily averages at BTUT, formaldehyde measured the highest concentration by

mass (6.20 ± 1.00 μg/m^3), followed by acetaldehyde (4.06 ± 0.51 μg/m^3) and acrolein (1.78 ± 0.97 μg/m^3). Seasonal averages did not vary much for each pollutant of interest at BTUT, with the exception of benzene and formaldehyde. Benzene was highest in the winter, while formaldehyde was highest in the summer and fall.

21.3 Non-chronic Risk Evaluation at the Utah Monitoring Site

Non-chronic risk for the concentration data at BTUT was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the sixteen pollutants with at least one failed screen, only acrolein exceeded both the acute and intermediate risk values, and its non-chronic risk is summarized in Table 21-4.

All twelve acrolein detects were greater than the ATSDR acute value of 0.11 μg/m^3 and the California REL value of 0.19 μg/m^3. The average detected concentration was 1.78 ± 0.97 μg/m^3, which is more than eight times the California REL value. For the intermediate acrolein risk, seasonal averages were compared to the ATSDR intermediate value of 0.09 μg/m^3. As discussed in Sections 3.1.5, acrolein concentrations could only be evaluated beginning July 2005, and a valid seasonal average (1.12 ± 0.95 μg/m^3) could only be calculated for autumn. The autumn seasonal average was significantly greater than the ATSDR intermediate risk level.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Figure 21-3 is a pollution rose for acrolein at BTUT. The pollution rose is a plot of daily concentration and daily average wind direction. As indicated in Figure 21-3, all acrolein concentrations exceeded the acute risk factors, indicated by a dashed (CalEPA REL) and solid line (ATSDR MRL). The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources. The highest concentration of acrolein occurred on September 13, 2005 with a north-northwesterly wind. BTUT is located on the grounds of a high school, which is just east of I-15 (Figure 21-1).

21.4 Meteorological and Concentration Analysis at the Utah Monitoring Site

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

21.4.1 Pearson Correlation Analysis

Table 21-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the BTUT monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) Many of the pollutants of interest had moderately strong to very strong correlations with the temperature and moisture variables, indicating that meteorology plays an important part in air quality near BTUT. The strongest correlations with temperature occurred with formaldehyde (0.71 with maximum temperature and 0.69 with average temperature), indicating that formaldehyde concentrations increase as temperatures increase. It is interesting to note that higher seasonal averages were calculated for formaldehyde in the summer, when its warmest. Strong positive correlations with temperature also occurred with acetaldehyde and manganese, while strong negative correlations were calculated for 1,3-butadiene. Strong positive and negative correlations were also calculated between the pollutants of interest and moisture variables. Formaldehyde exhibited the strongest correlation with wet bulb temperature (0.61); 1,3-butadiene exhibited the strongest correlation with dew point temperature (-0.46); and formaldehyde exhibited the strongest correlation with relative humidity (-0.70). Acetaldehyde, formaldehyde, and manganese exhibited moderately strong negative correlations with the *u*-component of the wind. Correlations with the *v*-component of the wind were weak. Moderately strong to strong positive correlations were calculated between 1,3-butadiene, arsenic, and benzene and sea level pressure.

21.4.2 Composite Back Trajectory Analysis

Figure 21-4 is a composite back trajectory map for the BTUT monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. As shown in Figure 21-4, the back trajectories predominantly originated from the south and northwest at BTUT. Each circle around

the site in Figure 21-4 represents 100 miles. The 24-hour airshed domain is somewhat smaller at BTUT than other UATMP sites, with trajectories originating as far away as northern California, or over 400 miles away. However, 70% of the trajectories originated within 200 miles of the site; and 82% within 300 miles from the BTUT monitoring site.

21.4.3 Wind Rose Analysis

Hourly wind data from the Salt Lake City International Airport near the BTUT monitoring site were uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 21-5 is the wind rose for the BTUT monitoring site on days sampling occurred. As indicated in Figure 21-5, hourly winds were predominantly out of the south-southeast (18% of observations), southeast (15%), and south (11%) on sample days. Wind speeds tended to range from 7 to 11 knots on day samples were taken (39% of observations). Calm winds (<2 knots) were observed for 10% of the measurements. Wind speeds greater than 22 knots were most frequently observed with south-southeasterly winds.

21.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; BTEX analysis; and ethylene-acetylene ratio analysis.

21.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Davis County, UT were obtained from the Utah State Tax Commission and the U.S. Census Bureau, and are summarized in Table 21-6. Table 21-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 21-6 contains the average daily traffic information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Compared to other UATMP sites, BTUT's county and 10-mile population count is in the low to mid range as is its county-level and 10-mile vehicle registration. The average daily traffic count falls in the middle of the range compared to other UATMP sites. The BTUT monitoring site is considered a commercial area and is located in an urban-city center setting.

21.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compared them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. At the BTUT site, the benzene-ethylbenzene ratio (4.28 ± 0.30) is very similar to the xylenes-ethylbenzene ratio (4.25 ± 0.18), unlike that of the roadside study. Similar to the roadside study, the BTUT toluene-ethylbenzene ratio (8.17 ± 0.64) is the highest concentration ratio.

21.5.3 Mobile Tracer Analysis

As previously stated, BTUT sampled for SNMOCs in addition to VOCs. Acetylene is a pollutant that is primarily emitted from mobile sources, while ethylene is emitted from mobile sources, petroleum refining facilities, and natural gas distribution facilities. Tunnel studies conducted on mobile sources have found that concentrations of ethylene and acetylene are typically present in a 1.7 to 1 ratio. (For more information, please refer to Section 3.2.1.3.) Listed in Table 3-10 is the ethylene to acetylene ratio for BTUT; as shown, BTUT's ethylene-acetylene ratio, 1.33 ± 0.22, is somewhat lower than the 1.7 ratio. This ratio suggests that while mobile sources may be influencing the air quality at the Utah monitoring site, there may also be atmospheric chemical processes affecting the quantities of ethylene in this area. Known sinks of ethylene include reactions with ozone, as well as soil (National Library of Medicine).

21.6 Trends Analysis

For sites that participated in the UATMP prior to 2004, and are still participating in the 2005 program year (i.e., minimum 3 consecutive years), a site-specific trends analysis was conducted. Details on how this analysis was conducted can be found in Section 3.3.4. The following observations were made:

- Concentrations of formaldehyde appear to have increased significantly over the three year period, according to Figure 21-6.
- Concentrations of 1,3-butadiene and benzene have changed little since 2003, as shown in Figure 21-6.

21.7 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 21-7 presents the 1999 NATA results for the census tract where the Utah monitoring site is located. Only pollutants that "failed" the screens are presented in Table 21-7. Pollutants of interest are bolded.

21.7.1 1999 NATA Summary

The BTUT monitoring site is located in census tract 49011126600. The population for the census tract where the BTUT monitoring site is located was 5,116, which represents about 2.1% of the county population in 2000. In terms of cancer risk, the Top 3 pollutants identified by NATA in the BTUT census tract are benzene (11.88 in-a-million risk), 1,3-butadiene (3.38), and carbon tetrachloride (3.16). These cancer risks are low when compared to other urban areas, such as near the BAPR and MIMN monitoring sites (71.0 and 39.5 in-a-million, respectively). Acrolein was the only pollutant in the BTUT census tract to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer

hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

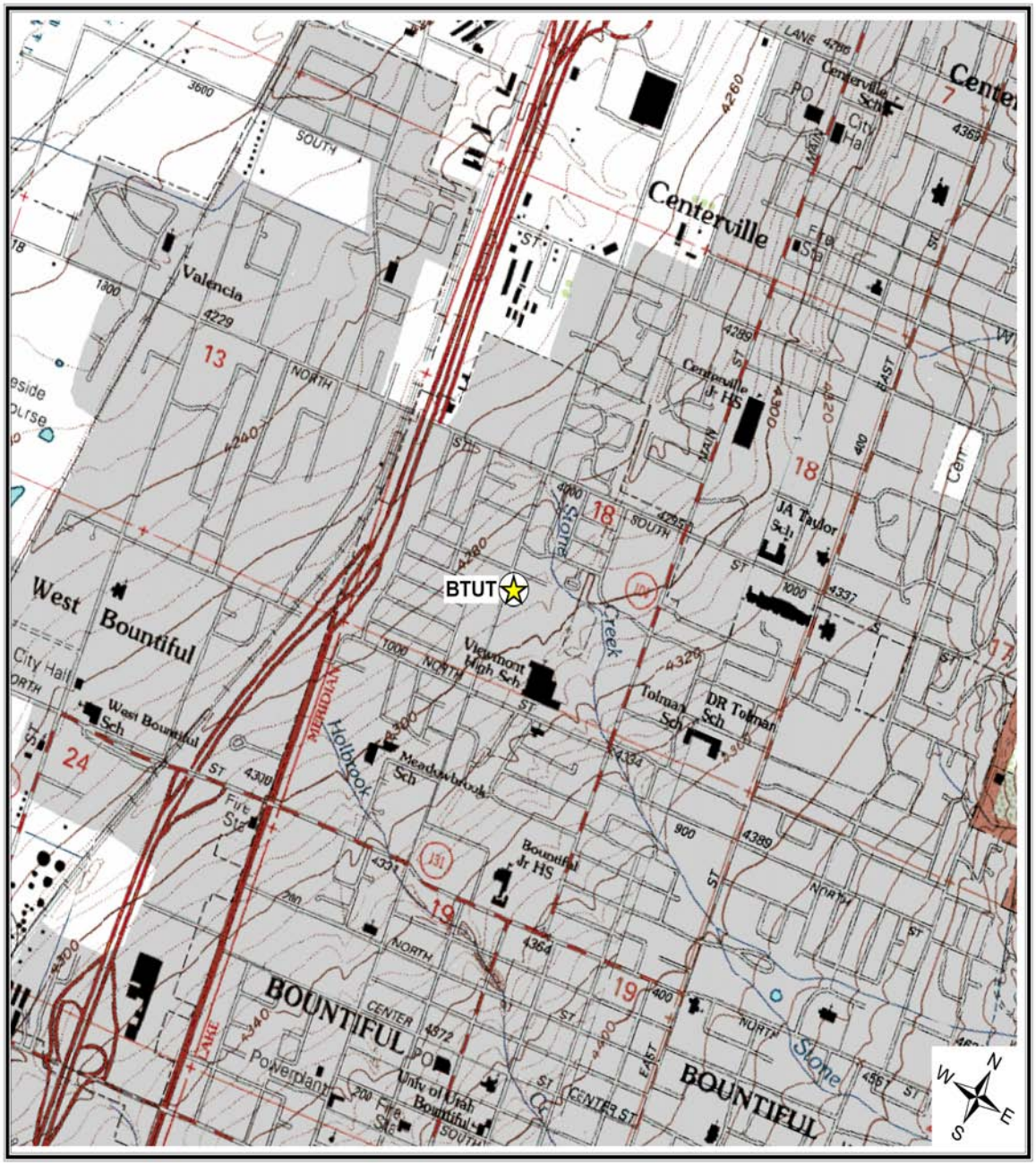
21.7.2 Average Annual Comparison

The Utah monitoring site annual averages are also presented in Table 21-7 for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 21.2 on how a valid annual average is calculated). With a few exceptions, the pollutants were within one order of magnitude from each other. In fact, the modeled and measured concentrations of benzene and 1,3-butadiene are very similar. Acetaldehyde, benzene, formaldehyde, and total xylenes are identified as the Top 4 pollutants by mass concentration for both the 1999 NATA-modeled and 2005 annual average concentrations, although not necessarily in that order.

Utah Pollutant Summary

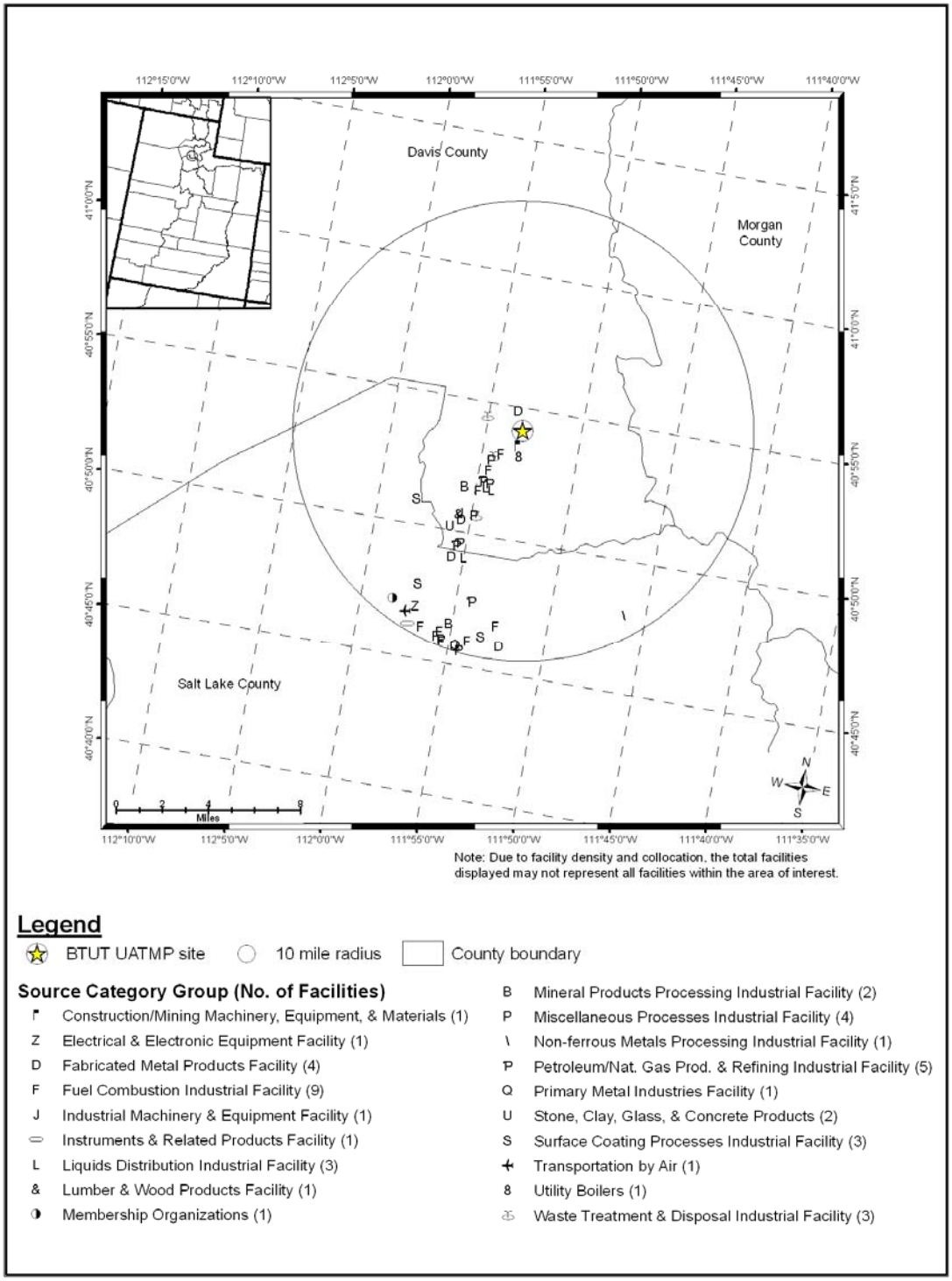
- *The pollutants of interest at the Utah site are acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, manganese, nickel, and tetrachloroethylene..*
- *Formaldeyde measured the highest daily average at BTUT. Formaldehyde was highest during the summer and autumn, and benzene was highest during the winter.*
- *Acrolein exceeded the short-term risk factors at BTUT.*
- *A comparison of formaldehyde, benzene and 1,3-butadiene concentrations for all years of UATMP participation shows that concentrations of formaldehyde have been increasing at BTUT since 2003, while concentrations of benzene and 1,3-butadiene have changed little.*

Figure 21-1. Bountiful, UT (BTUT) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 21-2. Facilities Located Within 10 Miles of BTUT



Legend

BTUT UATMP site | 10 mile radius | County boundary

Source Category Group (No. of Facilities)

- Construction/Mining Machinery, Equipment, & Materials (1)
- Z Electrical & Electronic Equipment Facility (1)
- D Fabricated Metal Products Facility (4)
- F Fuel Combustion Industrial Facility (9)
- J Industrial Machinery & Equipment Facility (1)
- Instruments & Related Products Facility (1)
- L Liquids Distribution Industrial Facility (3)
- & Lumber & Wood Products Facility (1)
- Membership Organizations (1)
- B Mineral Products Processing Industrial Facility (2)
- P Miscellaneous Processes Industrial Facility (4)
- \ Non-ferrous Metals Processing Industrial Facility (1)
- Petroleum/Nat. Gas Prod. & Refining Industrial Facility (5)
- Q Primary Metal Industries Facility (1)
- U Stone, Clay, Glass, & Concrete Products (2)
- S Surface Coating Processes Industrial Facility (3)
- Transportation by Air (1)
- 8 Utility Boilers (1)
- Waste Treatment & Disposal Industrial Facility (3)

Figure 21-3. Acrolein Pollution Rose at BTUT

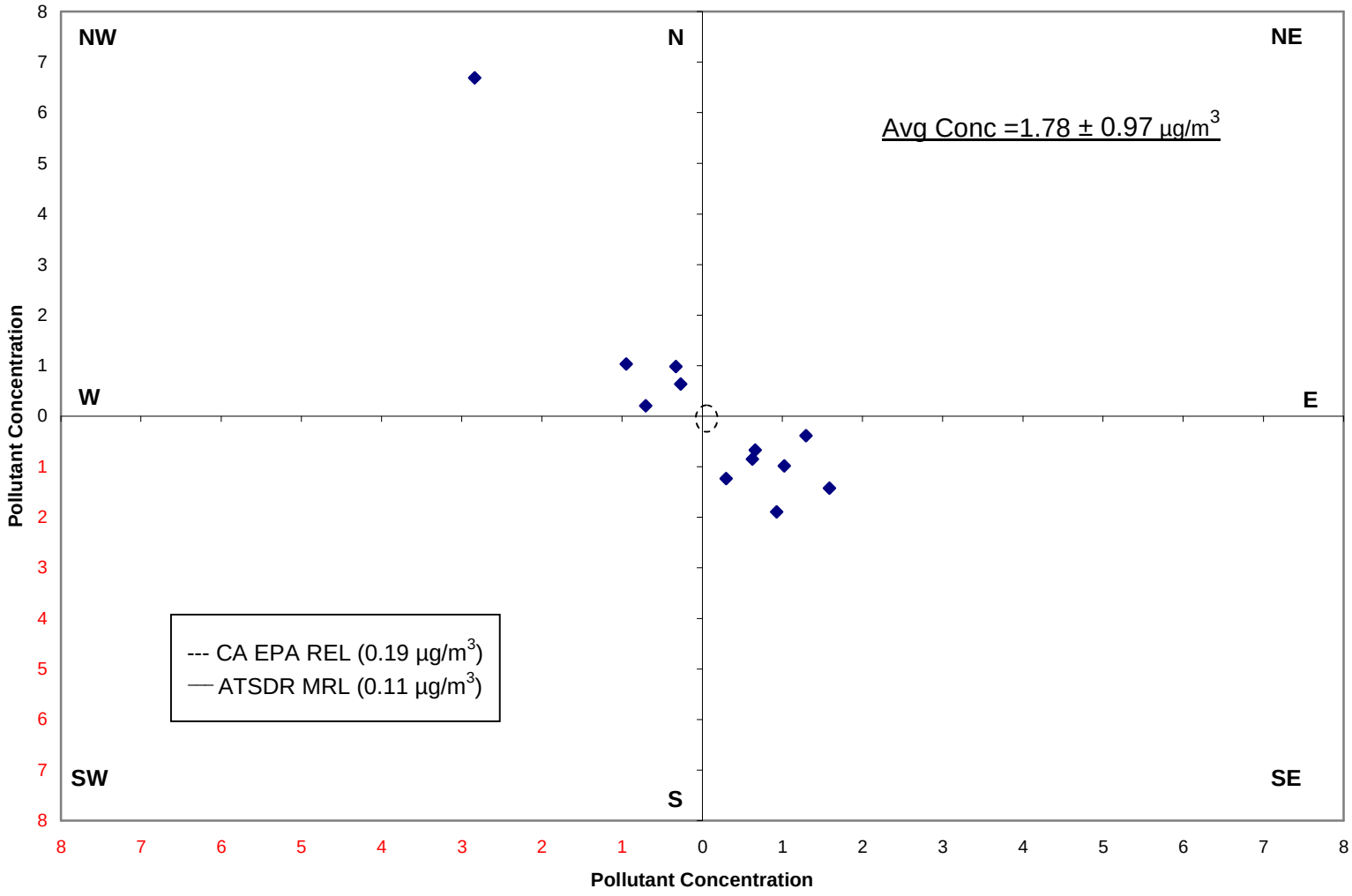


Figure 21-4. Composite Back Trajectory Map for BTUT

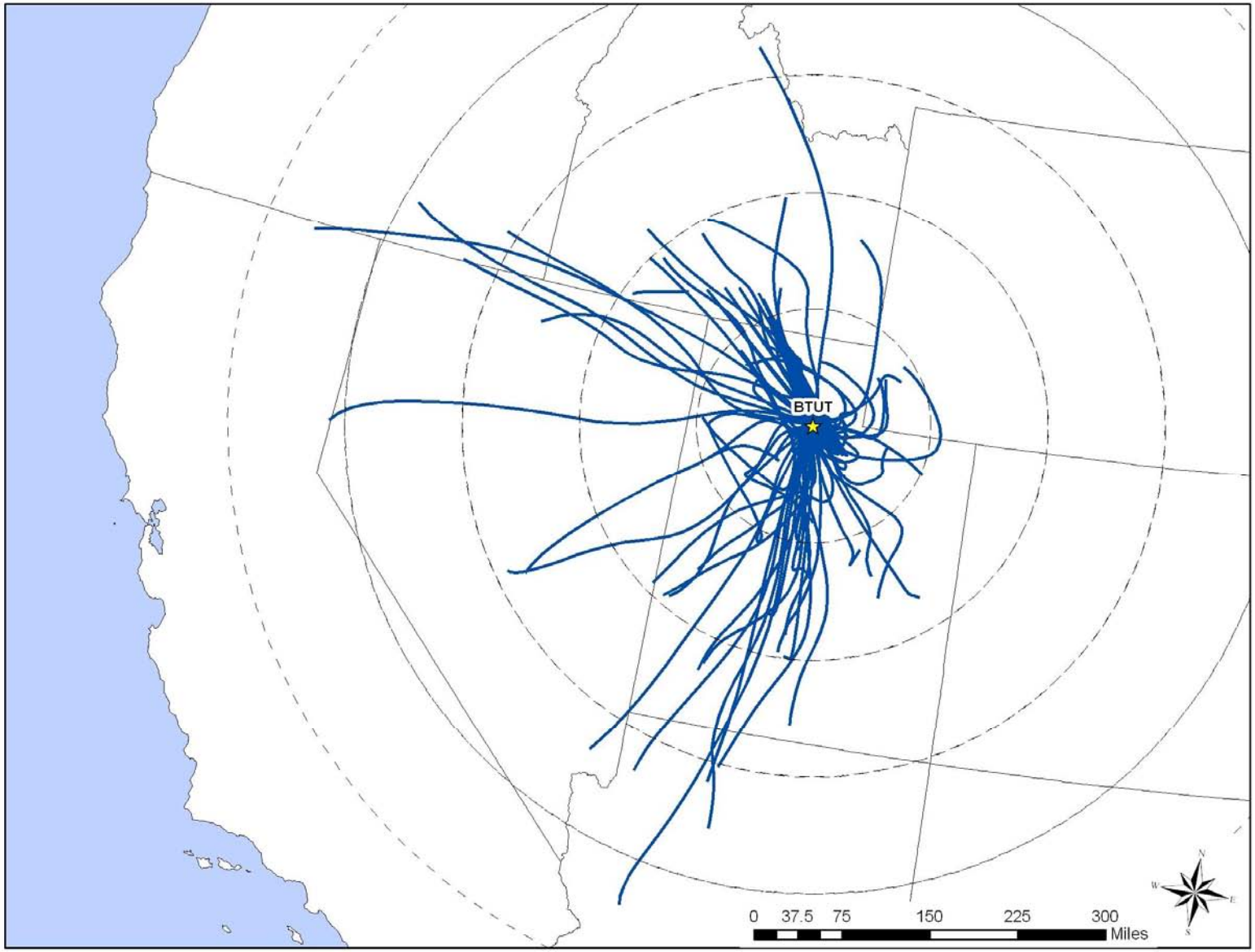


Figure 21-5. Wind Rose of Sample Days for the BTUT Monitoring Site

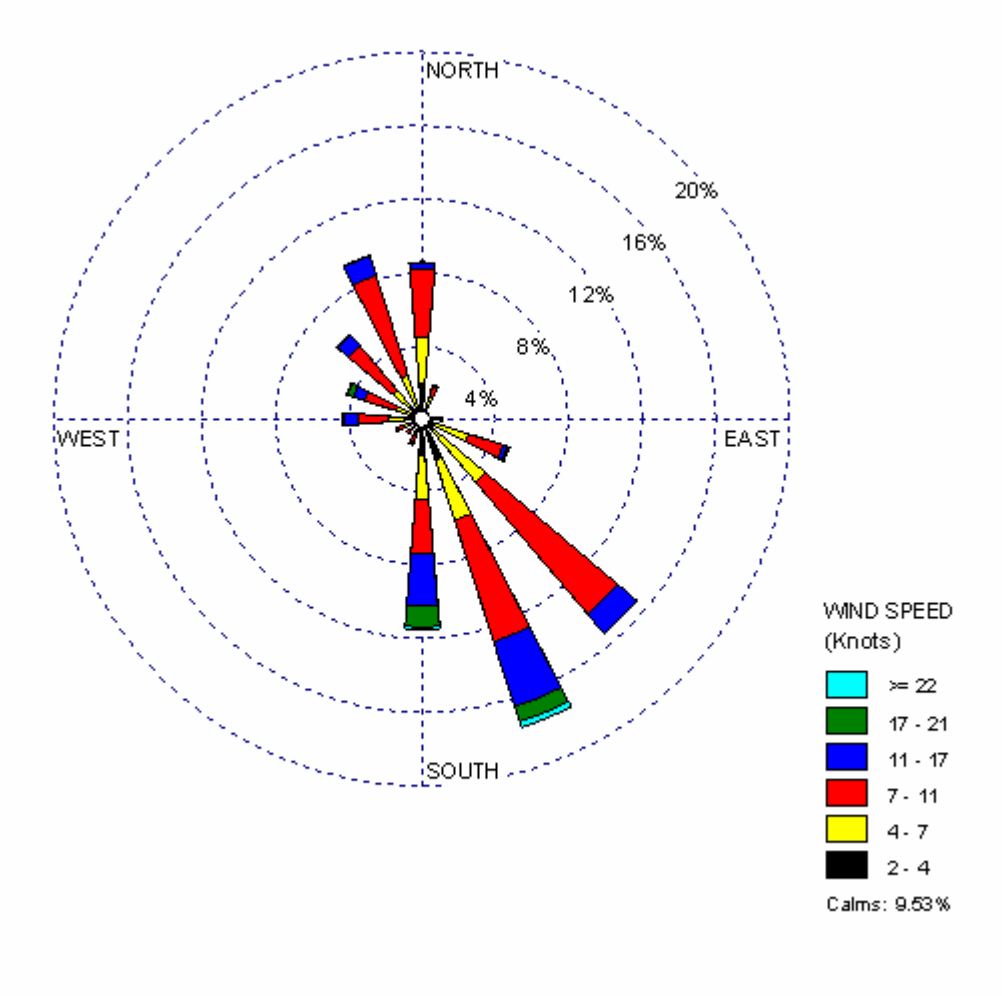


Figure 21-6. Comparison of Yearly Averages of the BTUT Monitoring Site

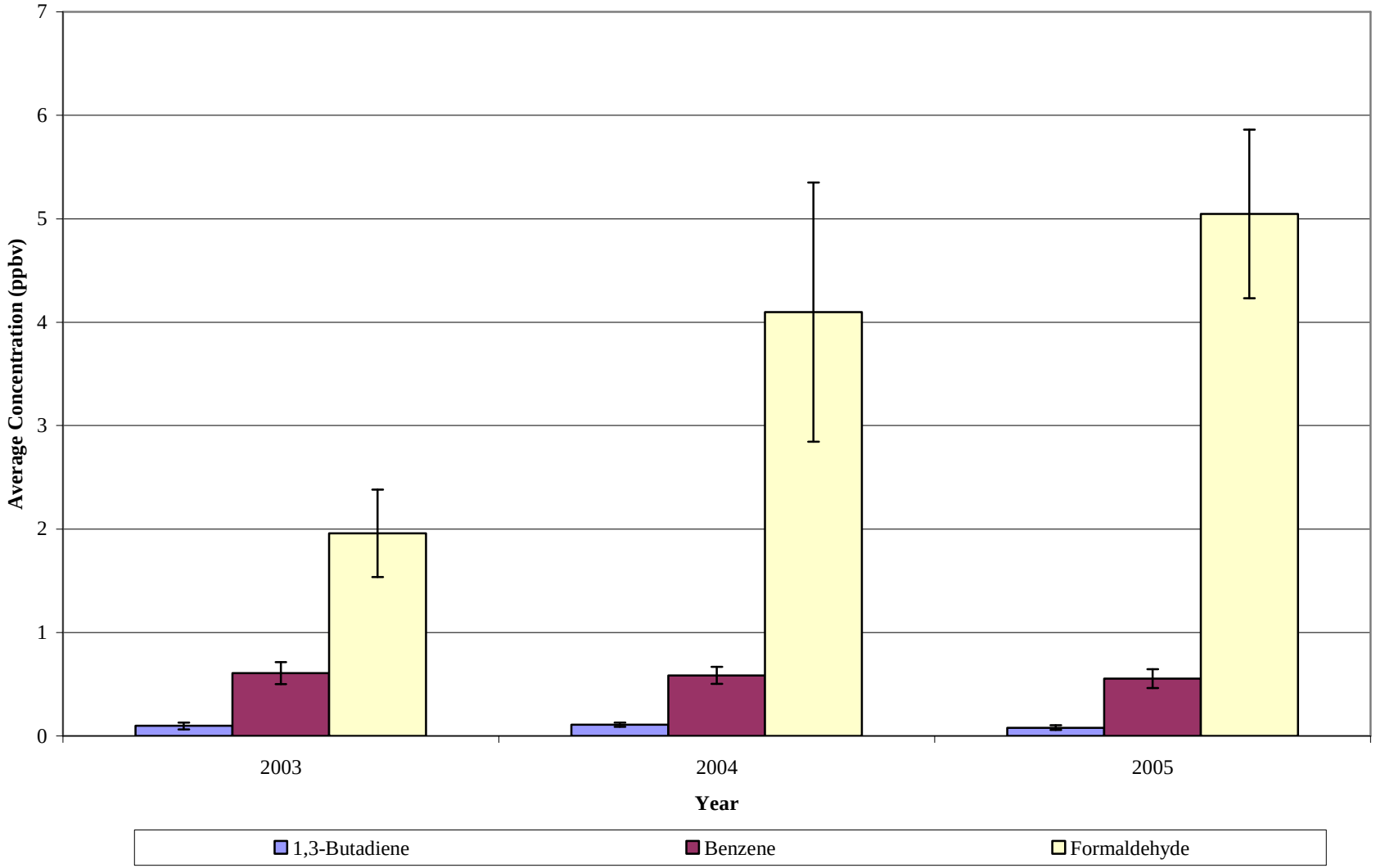


Table 21-1. Average Meteorological Parameters for Monitoring Site in Utah

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
BTUT	24127	All 2005	63.50 ± 2.05	53.41 ± 1.82	34.01 ± 0.92	43.52 ± 1.17	55.08 ± 2.03	1015.23 ± 0.79	-0.37 ± 0.29	2.02 ± 0.50
		Sample Day	64.78 ± 4.69	54.25 ± 4.14	34.24 ± 1.91	44.03 ± 2.56	54.48 ± 4.80	1014.75 ± 1.91	-0.46 ± 0.64	1.78 ± 1.12

Table 21-2. Comparison of Measured Concentrations and EPA Screening Values at the Utah Monitoring Site

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Bountiful, UT - BTUT					
Arsenic (TSP)	60	60	100.00	13.1%	13.1%
Acetaldehyde	56	56	100.00	12.2%	25.3%
Benzene	56	56	100.00	12.2%	37.6%
Formaldehyde	56	56	100.00	12.2%	49.8%
Carbon Tetrachloride	51	51	100.00	11.1%	60.9%
Nickel (TSP)	45	60	75.00	9.8%	70.7%
1,3-Butadiene	41	41	100.00	9.0%	79.7%
Manganese (TSP)	40	60	66.67	8.7%	88.4%
Tetrachloroethylene	21	31	67.74	4.6%	93.0%
Acrolein	12	12	100.00	2.6%	95.6%
Hexachloro-1,3-butadiene	12	12	100.00	2.6%	98.3%
Cadmium (TSP)	3	60	5.00	0.7%	98.9%
p-Dichlorobenzene	2	16	12.50	0.4%	99.3%
Acrylonitrile	2	2	100.00	0.4%	99.8%
Ethyl Acrylate	1	1	100.00	0.2%	100.0%
Total	458	574			

Table 21-3. Daily and Seasonal Averages for Pollutants of Interest at the Utah Monitoring Site

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Bountiful, UT - BTUT												
1,3-Butadiene	41	56	0.15	0.04	0.21	0.09	0.09	0.01	0.09	0.01	0.15	0.03
Acetaldehyde	56	56	4.06	0.51	3.05	0.83	2.71	0.67	5.83	0.94	4.43	0.68
Acrolein	12	28	1.78	0.97	NA	NA	NA	NA	NR	NR	1.12	0.95
Arsenic (TSP)	60	60	0.001	0.0002	0.0013	0.0005	0.0008	0.0002	0.0007	0.0002	0.0010	0.0004
Benzene	56	56	1.53	0.26	2.69	0.68	0.97	0.10	1.30	0.21	1.25	0.34
Carbon Tetrachloride	51	55	0.56	0.04	0.52	0.08	0.41	0.07	0.59	0.05	0.60	0.10
Formaldehyde	56	56	6.20	1.00	3.69	0.93	3.73	0.99	9.75	2.09	7.13	1.57
Hexachloro-1,3-butadiene	12	55	0.20	0.02	NR	NR	NR	NR	NR	NR	0.86	0.41
Manganese (TSP)	60	60	0.007	0.001	0.0057	0.0014	0.0066	0.0015	0.0091	0.0017	0.0081	0.0018
Nickel (TSP)	60	60	0.004	0.001	0.0036	0.0014	0.0055	0.0033	0.0034	0.0008	0.0035	0.0010
Tetrachloroethylene	31	55	0.29	0.08	0.34	0.15	NR	NR	0.21	0.07	0.23	0.07

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 21-4. Non-Chronic Risk Summary at the Utah Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
BTUT	TO-15	Acrolein	1.78 ± 0.97	0.11	12	0.19	12	0.09	NA	NA	NR	1.12 ± 0.95

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 21-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Utah Monitoring Site

Pollutant	# detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Bountiful, UT - BTUT									
1,3-Butadiene	41	-0.53	-0.56	-0.46	-0.58	0.51	0.04	-0.13	0.59
Acetaldehyde	56	0.64	0.60	0.26	0.52	-0.63	-0.32	0.16	0.04
Acrolein	12	0.36	0.35	0.16	0.32	-0.40	0.04	-0.15	-0.30
Arsenic (TSP)	60	-0.27	-0.30	-0.25	-0.32	0.27	0.04	-0.09	0.45
Benzene	56	-0.29	-0.33	-0.24	-0.35	0.34	-0.03	-0.03	0.45
Carbon Tetrachloride	51	0.07	0.03	-0.18	-0.05	-0.13	-0.15	0.06	0.23
Formaldehyde	56	0.71	0.69	0.34	0.61	-0.70	-0.31	0.21	-0.15
Hexachloro-1,3-butadiene	12	-0.34	-0.25	-0.11	-0.23	0.27	0.01	0.18	-0.08
Manganese (TSP)	60	0.53	0.48	0.29	0.44	-0.49	-0.26	0.14	0.05
Nickel (TSP)	60	0.02	-0.01	-0.05	-0.01	-0.02	-0.01	0.00	0.05
Tetrachloroethylene	31	-0.04	-0.07	0.22	0.00	0.30	0.07	-0.04	-0.22

Table 21-6. Motor Vehicle Information for the Utah Monitoring Site

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
BTUT	268,187	271,537	0.81	243,462	197,481	33,310

Table 21-7. 1999 NATA Data Census Tract Summary for the Monitoring Site in Utah

PM Type	Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Bountiful, Utah - BTUT, Census Tract 49011126600					
NA	**1,3-Butadiene**	0.13 ± 0.03	0.11	3.38	0.06
NA	**Acetaldehyde**	4.06 ± 0.51	1.15	2.53	0.13
NA	**Acrolein**	NA	0.08	--	4.05
NA	Acrylonitrile	0.08 ± 0.02	<0.01	0.05	<0.01
TSP	**Arsenic (TSP)**	<0.01	0.28	1.22	0.01
NA	**Benzene**	1.53 ± 0.26	1.52	11.88	0.05
TSP	Cadmium (TSP)	<0.01	0.07	0.12	<0.01
NA	**Carbon Tetrachloride**	0.53 ± 0.04	0.21	3.16	0.01
NA	Ethyl Acrylate	0.12 ± 0.002	<0.01	<0.01	--
NA	**Formaldehyde**	6.20 ± 1.00	1.23	0.01	0.13
NA	**Hexachloro-1,3-butadiene**	0.89 ± 0.13	<0.01	0.03	<0.01
TSP	**Manganese (TSP)**	0.01 ± 0.001	0.29	--	0.01
TSP	**Nickel (TSP)**	<0.01	0.32	0.05	<0.01
NA	*p*-Dichlorobenzene	0.06 ± 0.01	0.03	0.37	<0.01
NA	**Tetrachloroethylene**	0.23 ± 0.05	0.12	0.68	<0.01
NA	Xylenes	3.68 ± 0.58	2.25	--	0.02

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

22.0 Site in Wisconsin

This section presents meteorological, concentration, and spatial trends for the UATMP site in Wisconsin (MAWI), located in Madison. Figure 22-1 is a topographical map showing the monitoring site in its urban location. Figure 22-2 identifies point source emission locations within 10 miles of this site as reported in the 2002 NEI for point sources. The map shows that MAWI is surrounded by a number of industrial facilities, of which a majority are involved in fuel combustion industries.

Hourly meteorological data at a weather station near this site were retrieved for all of 2005. These data are used to determine how meteorological conditions on sample days vary from normal conditions throughout the year. They are also used to calculate correlations of meteorological data with ambient air concentration measurements. The weather station closest to the MAWI monitoring site is Dane County Regional - Traux Field Airport (WBAN 14837).

Madison is wedged between Lake Mendota and Lake Monona, in south-central Wisconsin. Its Great Lakes location ensures that the area experiences frequent weather systems, fairly typical of a continental climate. Temperatures can fluctuate drastically with potent weather systems, and the frozen lakes offer little moderating effects in the winter. Spring and summer tend to bring the most precipitation, but Madison receives its fair share of snow. Average wind direction depends on season. Summer and fall tend to bring southerly winds, while northwesterly winds are most common in the winter and spring (Ruffner and Bair, 1987). Table 22-1 presents average meteorological conditions of temperature (average maximum and average), moisture (average dew point temperature, average wet-bulb temperature, and average relative humidity), pressure (average sea level pressure), and wind information (average u- and v- components of the wind) for the entire year and on days samples were taken. As shown in Table 22-1, average meteorological conditions on sample days are fairly representative of average weather conditions throughout the year.

22.1 Pollutants of Interest at the Wisconsin Monitoring Site

As described in Section 3.1.4, the new methodology for evaluating pollutants of interest is a modification of guidance developed by EPA Region 4 (EPA, 2006b). Each measured pollutant concentration was compared against a list of risk screening values. If the daily concentration value was greater than the risk screening value, then the measured concentration "failed the screen." A total of 81 HAPs are listed in the guidance document as having risk screening values. Table 22-2 presents the sixteen pollutants that failed at least one screen at MAWI; a total of 335 measured concentrations failed screens. The pollutants of interest at MAWI were identified as the pollutants that contributed to the top 95% of the total failed screens, resulting in nine pollutants: benzene (60 failed screens), acetaldehyde (59), carbon tetrachloride (58), formaldehyde (56), arsenic (30), 1,3-butadiene (18), manganese (17), tetrachloroethylene (13), and hexachloro-1,3-butadiene (9). It's important to note that the MAWI site sampled for carbonyls, VOC, and metals, and that this is reflected in the site's pollutants of interest. Also listed in Table 22-2 are the total number of detects and the percent detects failing the screen. Of the nine pollutants of interest, acetaldehyde, benzene, carbon tetrachloride, arsenic, and hexachloro-1,3-butadiene had 100% of their detects fail the screening values.

22.2 Concentration Averages at the Wisconsin Monitoring Site

Three types of concentration averages were calculated for the nine pollutants of interest: daily, seasonal, and annual. The ***daily*** average of a particular pollutant is simply the average concentration of all detects. If there are at least seven detects within each season, then a ***seasonal*** average can be calculated. The seasonal average includes 1/2 MDLs substituted for all non-detects. A seasonal average will not be calculated for pollutants with less than seven detects in a respective season. Finally, the ***annual*** average is the average concentration of all detects and 1/2 MDLs substituted for non-detects. The resulting daily averages may therefore be inherently higher than the annual averages where 1/2 MDLs replacing non-detects are incorporated into the average. Annual averages will only be calculated for monitoring sites where sampling began no later than February and ended no earlier than November. Daily and seasonal averages are presented in Table 22-3. Annual averages will be presented and discussed in further detail in later sections.

Acetaldehyde, arsenic, benzene, formaldehyde, and manganese were detected in every sample taken at MAWI, while hexachloro-1,3-butadiene was detected in less than one-quarter of the samples taken. Among the daily averages at MAWI, formaldehyde measured the highest concentration by mass (2.49 ± 0.38 μg/m^3), followed by acetaldehyde (1.64 ± 0.17 μg/m^3) and benzene (0.89 ± 0.13 μg/m^3). Seasonal averages of the pollutants of interest did not vary much from season to season, with the exception of formaldehyde. Formaldehyde concentrations tended to be higher in the summer (4.15 ± 0.62 μg/m^3) compared to other seasons (1.45 ± 0.22 μg/m^3, 1.99 ± 0.31 μg/m^3, and 2.27 ± 0.76 μg/m^3 for winter, spring, and fall, respectively).

22.3 Non-chronic Risk Evaluation at the Wisconsin Monitoring Site

Non-chronic risk for the concentration data at MAWI was evaluated using ATSDR acute and intermediate minimal risk level (MRL) and California EPA acute reference exposure limit (REL) factors. Acute risk is defined as exposures from 1 to 14 days while intermediate risk is defined as exposures from 15 to 364 days. It is useful to compare daily measurements to the short-term MRL and REL factors, as well as compare seasonal averages to the intermediate MRL. Of the sixteen pollutants with at least one failed screen, only acrolein exceeded the acute risk values, and its non-chronic risk is summarized in Table 22-4.

All seven acrolein detects were greater than the ATSDR acute value of 0.11 μg/m^3 and the California REL value of 0.19 μg/m^3. The average detected concentration was 1.71 ± 1.48 μg/m^3, which is nearly ten times the California REL value. For the intermediate acrolein risk, seasonal averages were compared to the ATSDR intermediate value of 0.09 μg/m^3. As discussed in Sections 3.1.5, acrolein concentrations could only be evaluated beginning July 2005, and a valid seasonal average could only be calculated for autumn. However, intermediate risk could not be evaluated because acrolein was not detected frequently enough to calculate an autumn average for MAWI.

For the pollutants that exceeded the short-term (acute) risk factors, the concentrations were further examined. Figure 22-3 is a pollution rose for acrolein at MAWI. The pollution rose is a plot of daily concentration and daily average wind direction. As indicated in Figure 22-3, all acrolein concentrations exceeded the acute risk factors, indicated by a dashed (CalEPA REL) and

solid line (ATSDR MRL). The concentrations on the pollution rose are scattered around the center, a pattern characteristic of mobile sources. The highest concentration of acrolein occurred on September 22, 2005 with a northerly wind. MAWI is located on the athletic fields of a high school wedged between several major roadways just south of Traux Field Airport (Figure 22-1). A handful of industrial facilities are located within a half-mile of the MAWI monitoring site.

22.4 Meteorological and Concentration Analysis at the Wisconsin Monitoring Site

The following sub-sections describe and discuss the results of the following meteorological analyses: Pearson Correlation Coefficients between meteorological parameters (such as temperature) and concentrations of the pollutants of interest; sample-year composite back trajectories; and sample-year wind roses.

22.4.1 Pearson Correlation Analysis

Table 22-5 presents the summary of Pearson Correlation coefficients for each of the pollutants of interest and select meteorological parameters at the MAWI monitoring site. (Please refer to Section 3.1.6 for more information on Pearson Correlations.) The strongest correlations at MAWI were calculated for formaldehyde with maximum, average, dew point, and wet bulb temperatures, and ranged from 0.73 (dew point) to 0.79 (maximum). This indicates that as temperature and moisture increase, formaldehyde concentrations increase as well, and this correlates well with the high formaldehyde summer average discussed in Section 22.2. Manganese and hexachloro-1,3-butadiene each exhibited strong correlations with relative humidity (-0.64 and 0.73, respectively). With one exception, all of the correlations with the *u*-component of the wind were negative and all of the correlations with the *v*-component of the wind were positive, indicating that wind speed and direction influence concentrations of the pollutants of interest at MAWI. Pearson correlations with the sea level pressure were weak.

22.4.2 Composite Back Trajectory Analysis

Figure 22-4 is a composite back trajectory map for the MAWI monitoring site for the days on which sampling occurred. Each line represents the 24-hour trajectory along which a parcel of air traveled toward the monitoring site on a sampling day. As shown in Figure 22-4, the back trajectories originated from a variety of directions at MAWI. However, there seems to

be an absence of trajectories originating from the east of the site. Each circle around the site in Figure 22-4 represents 100 miles. The 24-hour airshed domain is very large at MAWI, with trajectories originating as far away as northern Manitoba, Canada, or over 1,000 miles away. However, 51% of the trajectories originated within 300 miles of the site; and 89% within 500 miles from the MAWI monitoring site. The one trajectory originating from Manitoba occurred on a day when a strong frontal system moved across the central and eastern US on November 24, 2005. This wind pattern is also evident on several composite trajectory maps from other sites in the region including the DEMI, INDEM, NBIL and SPIL, DITN, and MIMN monitoring sites.

22.4.3 Wind Rose Analysis

Hourly wind data from the Traux Field Airport near the MAWI monitoring site was uploaded into a wind rose software program, WRPLOT (Lakes, 2006). WRPLOT produces a graphical wind rose from the wind data. A wind rose shows the frequency of wind directions about a 16-point compass, and uses different shading to represent wind speeds. Figure 22-5 is the wind rose for the MAWI monitoring site on days sampling occurred. As indicated in Figure 22-5, hourly winds were predominantly out of the south (14% of observations) and north (10%) on sample days. Calm winds (<2 knots) were observed for 17% of the measurements. Wind speeds tended to range from 7 to 11 knots on day samples were taken (35% of observations).

22.5 Spatial Characteristics Analysis

The following sub-sections describe and discuss the results of the following spatial analyses: population, vehicle ownership, and traffic data comparisons; and BTEX analysis.

22.5.1 Population, Vehicle Ownership, and Traffic Data Comparison

County-level vehicle registration and population in Dane County, WI were obtained from the Wisconsin Department of Transportation and the U.S. Census Bureau, and are summarized in Table 22-6. Table 22-6 also includes a vehicle registration to county population ratio (vehicles per person). In addition, the population within 10 miles of each site is presented. An estimation of 10-mile vehicle registration was computed using the 10-mile population surrounding the monitor and the vehicle registration ratio. Finally, Table 22-6 contains the average daily traffic

information, which represents the average number of vehicles passing the monitoring sites on the nearest roadway to each site on a daily basis.

Compared to other UATMP sites, the MAWI site's county and 10-mile population and vehicle registration count falls in the middle of the range. However, MAWI has one of the higher estimated vehicle registration-to-population ratios. The average daily traffic count also falls in the middle of the range compared to other UATMP sites. The MAWI monitoring site is considered a residential but urban-city center area.

22.5.2 BTEX Analysis

A roadside study conducted to measure emissions from motor vehicles determined that the concentration ratios of the BTEX compounds were relatively consistent from urban area to urban area (for more information on this study, refer to Section 3.2.1.4). Table 3-11 presented and Figure 3-4 depicted the average concentration ratios of the roadside study and compares them to the concentration ratios at each of the monitoring sites in an effort to characterize the impact of on-road, or motor vehicle, emissions. At the MAWI site, the xylenes-ethylbenzene ratio (3.31 ± 0.18) is lower than the benzene-ethylbenzene ratio (4.71 ± 0.40), which is the reverse of the roadside study (4.55 and 2.85, respectively). The toluene-ethylbenzene ratio (6.34 ± 0.36) at MAWI is slightly higher than the roadside study (5.85).

22.6 1999 NATA Data Risk Assessment

Data from EPA's 1999 NATA were retrieved and are presented in this section. One purpose of NATA is to help state and local agencies evaluate and identify potential areas of air quality concern. NATA uses the NEI for HAPs as its starting point, along with ambient monitoring data, geographic information, and chemical/physical transformation information to model ambient concentrations at the census tract level. These census tract concentrations are then applied to cancer unit risk estimate (URE) and noncancer reference concentration (RfC) factors to yield census tract-level cancer and noncancer risk. Table 22-7 presents the 1999 NATA results for the census tract where the Wisconsin monitoring site is located. Only pollutants that "failed" the screens are presented in Table 22-7. Pollutants of interest are bolded.

22.6.1 1999 NATA Summary

The MAWI monitoring site is located in census tract 55025002100. The population for the census tract where the MAWI monitoring site is located was 5,093, which represents about 1.2% of the county population in 2000. In terms of cancer risk, the Top 3 pollutants identified by NATA in the MAWI census tract are benzene (13.30 in-a-million risk), 1,3-butadiene (4.98), and carbon tetrachloride (3.17). These cancer risks are relatively low when compared to other urban areas, such as near the BAPR and MIMN monitoring sites (71.0 and 39.5 in-a-million, respectively). Acrolein was the only pollutant in the MAWI census tract to have a noncancer hazard quotient greater than 1.0 (an HQ greater than 1.0 may lead to adverse health effects). Most noncancer hazard quotients were less than 0.10, suggesting very little risk for noncancer health affects, with the exception of acrolein.

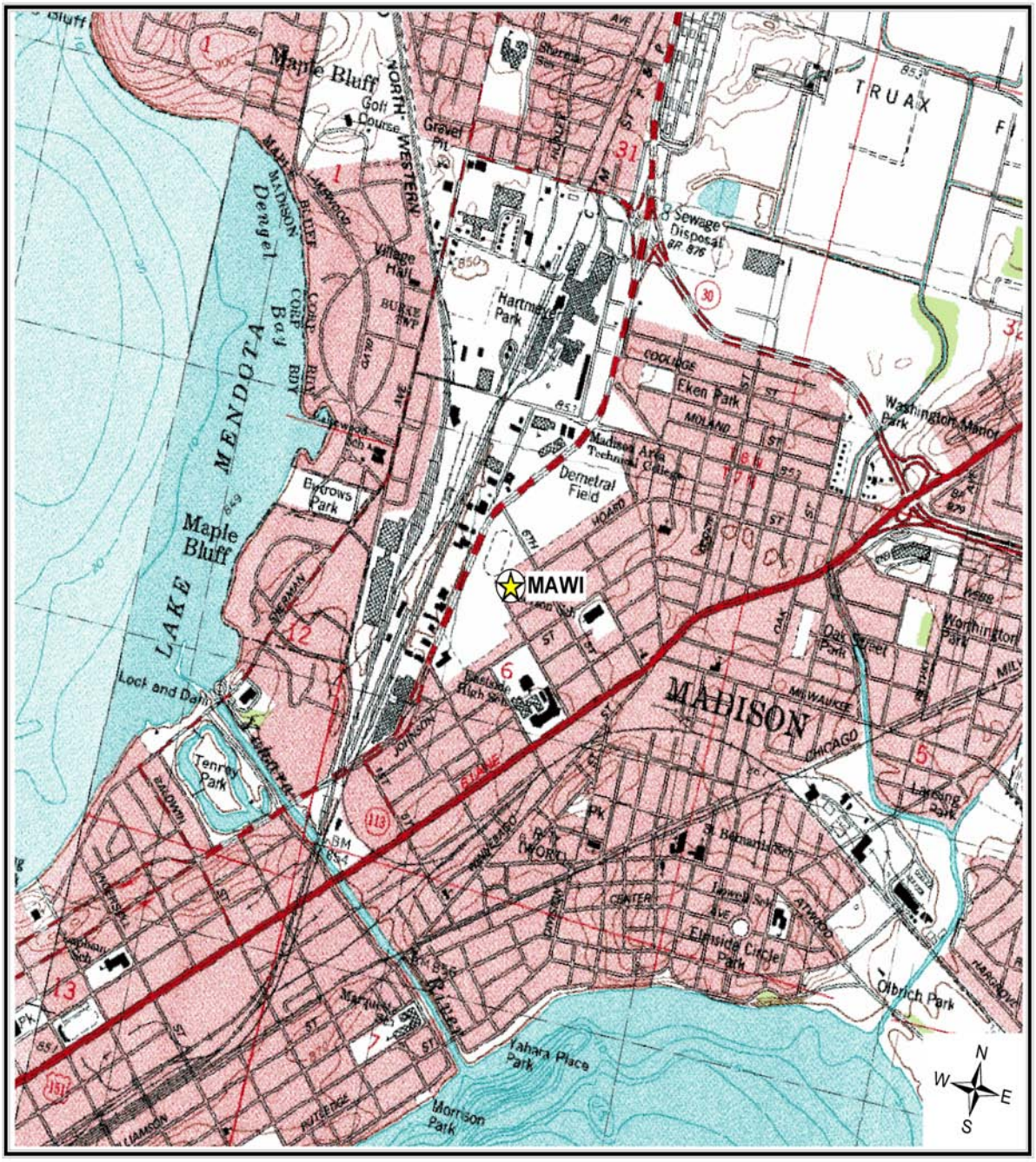
22.6.2 Annual Average Comparison

The Wisconsin monitoring site annual averages are also presented in Table 22-7 for comparison to the 1999 NATA modeled concentrations. NATA-modeled concentrations are assumed to be the average concentration that a person breathed for an entire year. Thus, a valid annual average representing an entire year, including detects and non-detects, needs to be calculated (refer to Section 22.2 on how a valid annual average is calculated). With the exceptions of nickel and hexachloro-1,3-butadiene, all the pollutants were within one order of magnitude from each other. Formaldehyde, acetaldehyde, hexachloro-1,3-butadiene, and benzene are identified as the Top 4 pollutants by mass concentration for the measured concentrations, while benzene, nickel, formaldehyde, and acetaldehyde were the highest 1999 NATA-modeled concentrations by mass.

Wisconsin Pollutant Summary

- *The pollutants of interest at MAWI are acetaldehyde, arsenic, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, hexachloro-1,3-butadiene, manganese, and tetrachloroethylene.*
- *Formaldehyde measured the highest daily average at MAWI, and was highest during the summer.*
- *Acrolein exceeded the short-term risk factors at this site.*

Figure 22-1. Madison, Wisconsin (MAWI) Monitoring Site



Source: USGS 7.5 Minute Series. Map Scale: 1:24,000.

Figure 22-2. Facilities Located Within 10 Miles of MAWI

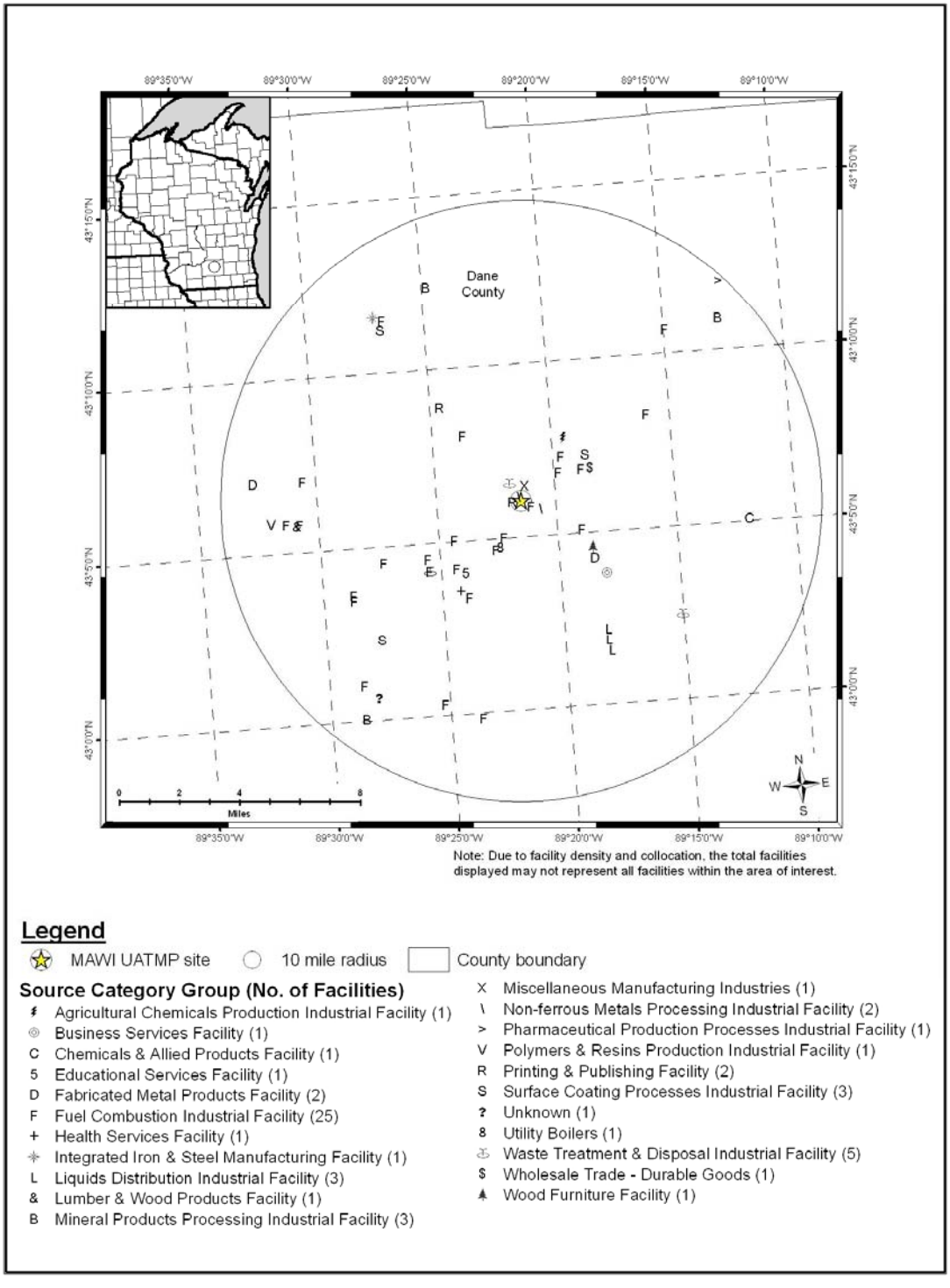


Figure 22-3. Acrolein Pollution Rose at MAWI

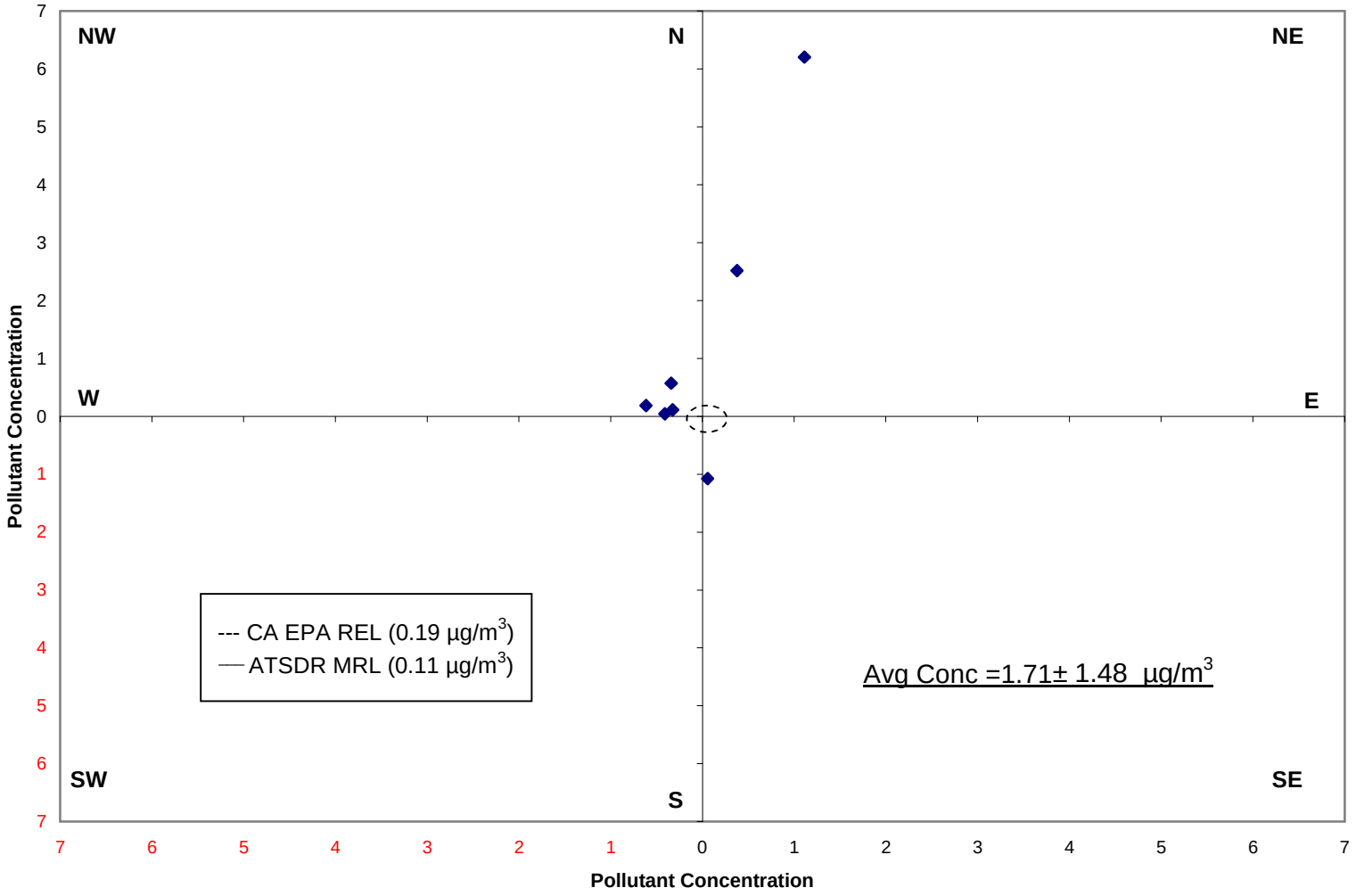


Figure 22-4. Composite Back Trajectory Map for MAWI

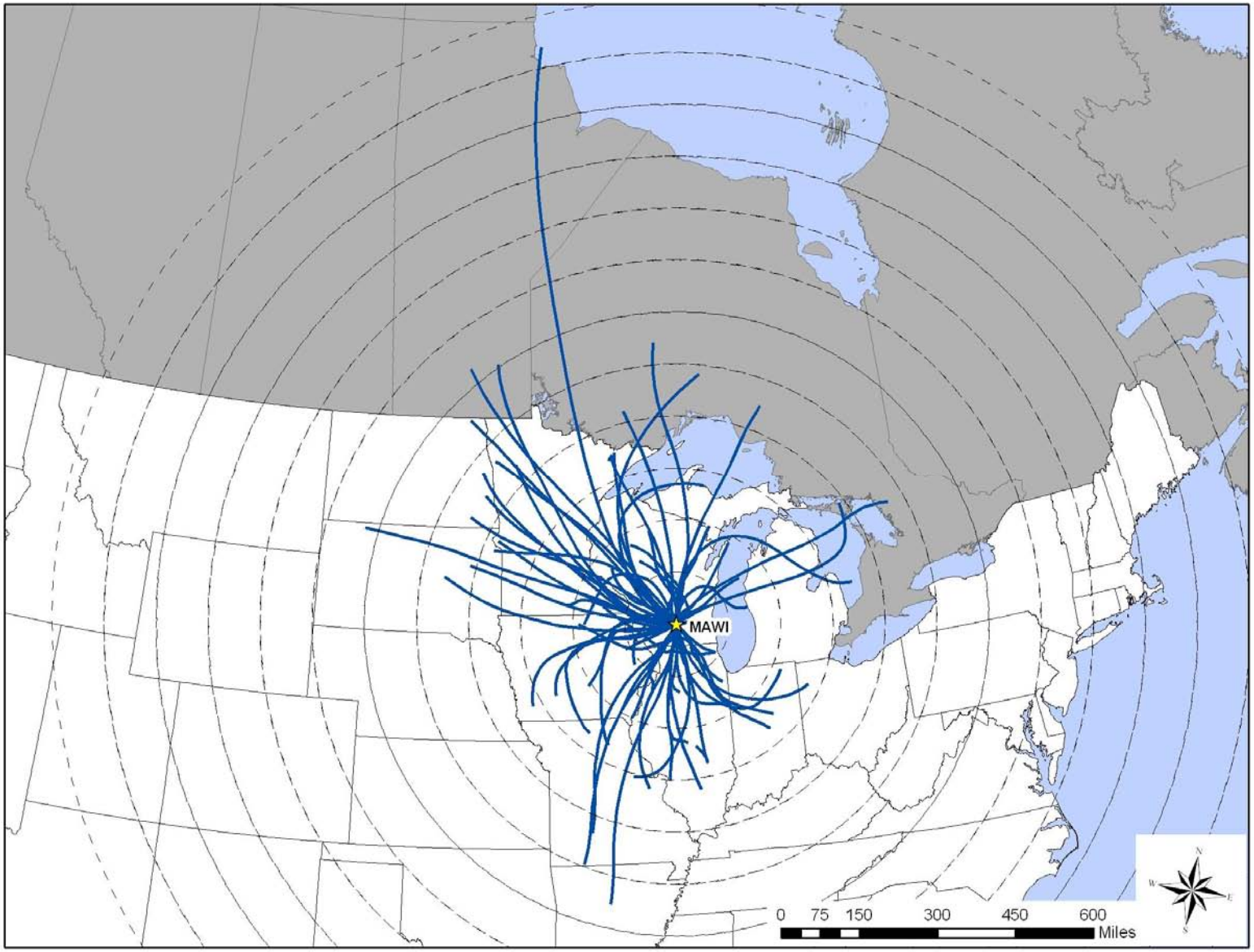


Figure 22-5. Wind Rose of Sample Days for the MAWI Monitoring Site

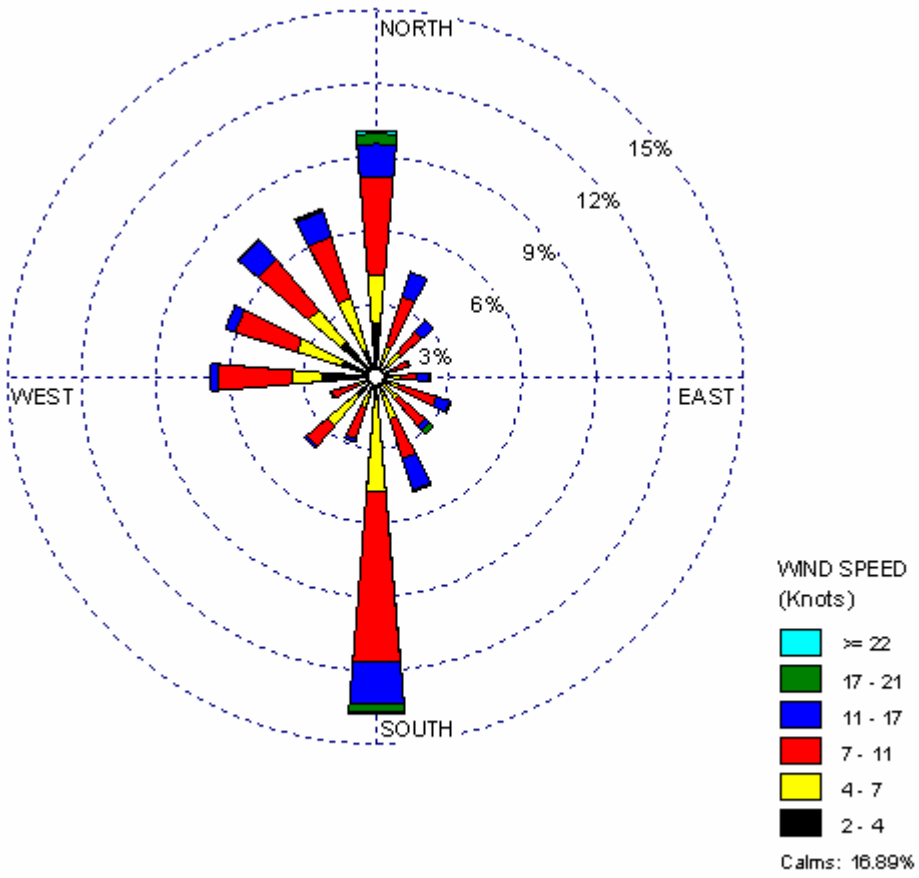


Table 22-1. Average Meteorological Parameters for Monitoring Site in Wisconsin

Site	WBAN	Type	Average Maximum Temperature (°F)	Average Temperature (°F)	Average Dew Point Temperature (°F)	Average Wet Bulb Temperature (°F)	Average Relative Humidity (%)	Average Sea Level Pressure (mb)	Average *u*-component of the wind	Average *v*-component of the wind
MAWI	14837	All 2005	57.64 ± 2.35	48.81 ± 2.17	38.07 ± 2.03	43.61 ± 1.94	69.37 ± 1.16	1016.38 ± 0.75	0.51 ± 0.39	0.31 ± 0.46
		Sample Day	57.19 ± 5.75	48.55 ± 5.31	37.46 ± 5.07	43.27 ± 4.79	68.44 ± 3.01	1016.43 ± 1.80	0.64 ± 0.83	-0.28 ± 1.24

Table 22-2. Comparison of Measured Concentrations and EPA Screening Values at the Wisconsin Monitoring Site

Pollutant	# of Failures	# of Detects	% of Detects Failing	% of Total Failures	% Contribution
Madison, WI - MAWI					
Benzene	60	60	100.0	17.9%	17.9%
Acetaldehyde	59	59	100.0	17.6%	35.5%
Carbon Tetrachloride	58	58	100.0	17.3%	52.8%
Formaldehyde	56	59	94.9	16.7%	69.6%
Arsenic (TSP)	30	30	100.0	9.0%	78.5%
1,3-Butadiene	18	26	69.2	5.4%	83.9%
Manganese (TSP)	17	30	56.7	5.1%	89.0%
Tetrachloroethylene	13	26	50.0	3.9%	92.8%
Hexachloro-1,3-butadiene	9	9	100.0	2.7%	95.5%
Acrolein	7	7	100.0	2.1%	97.6%
p-Dichlorobenzene	3	17	17.6	0.9%	98.5%
Cadmium (TSP)	1	30	3.3	0.3%	98.8%
Chloromethylbenzene	1	1	100.0	0.3%	99.1%
Acrylonitrile	1	1	100.0	0.3%	99.4%
Nickel (TSP)	1	30	3.3	0.3%	99.7%
Trichloroethylene	1	7	14.3	0.3%	100.0%
Total	335	450	74.4		

Table 22-3. Daily and Seasonal Averages for Pollutants of Interest at the Wisconsin Monitoring Site

Pollutant	# Detects	# Samples	Daily		Winter		Spring		Summer		Autumn	
			Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.	Avg ($\mu g/m^3$)	Conf. Int.
Madison, Wisconsin – MAWI												
1,3-Butadiene	26	60	0.06	0.02	NR	NR	NR	NR	0.06	0.01	0.06	0.02
Acetaldehyde	59	59	1.64	0.17	1.46	0.39	1.38	0.29	1.94	0.24	1.75	0.37
Arsenic (TSP)	30	30	0.0008	0.0002	0.0005	0.0001	0.0011	0.0008	0.0008	0.0003	0.0006	0.0002
Benzene	60	60	0.89	0.13	1.10	0.28	0.94	0.30	0.79	0.19	0.74	0.18
Carbon Tetrachloride	58	60	0.71	0.05	0.63	0.06	0.67	0.17	0.73	0.05	0.75	0.08
Formaldehyde	59	59	2.49	0.38	1.45	0.22	1.99	0.31	4.15	0.62	2.27	0.76
Hexachloro-1,3-butadiene	9	60	0.21	0.05	NR	NR	NR	NR	NR	NR	1.08	0.38
Manganese (TSP)	30	30	0.0126	0.0040	0.052	0.0043	0.0174	0.0094	0.0119	0.0059	0.0163	0.0081
Tetrachloroethylene	26	60	0.21	0.05	NR	NR	NR	NR	0.17	0.04	0.15	0.06

NR = Not reportable due to low number of detects.

Table 22-4. Non-Chronic Risk Summary at the Wisconsin Monitoring Site

Site	Method	Pollutant	Daily Average (µg/m^3)	ATSDR Short-term MRL (µg/m^3)	# of ATSDR MRL Exceedances	CAL EPA REL Acute (µg/m^3)	# of CAL EPA REL Exceedances	ATSDR Intermediate-term MRL (µg/m^3)	Winter Average (µg/m^3)	Spring Average (µg/m^3)	Summer Average (µg/m^3)	Autumn Average (µg/m^3)
MAWI	TO-15	Acrolein	1.71 ± 1.48	0.11	7	0.19	7	0.09	NA	NA	NR	NR

NA = Not available due to short sampling duration.
NR = Not reportable due to low number of detects.

Table 22-5. Pollutants of Interest Concentration Correlations with Selected Meteorological Parameters at the Wisconsin Monitoring Site

Pollutant	# Detects	Maximum Temperature	Average Temperature	Dew Point Temperature	Wet Bulb Temperature	Relative Humidity	*u*-Component of the Wind	*v*-Component of the Wind	Sea Level Pressure
Madison, WI – MAWI									
1,3-Butadiene	26	-0.23	-0.30	-0.29	-0.29	0.12	-0.19	-0.21	0.09
Acetaldehyde	59	0.40	0.36	0.36	0.36	0.04	-0.34	0.40	-0.04
Arsenic (TSP)	30	0.30	0.24	0.19	0.22	-0.21	-0.44	0.26	-0.13
Benzene	60	-0.04	-0.08	-0.07	-0.07	0.10	-0.47	0.15	0.17
Carbon Tetrachloride	58	0.18	0.20	0.23	0.21	0.13	-0.01	0.03	-0.24
Formaldehyde	59	0.79	0.77	0.73	0.75	-0.17	-0.21	0.38	-0.15
Hexachloro-1,3-butadiene	9	0.08	0.12	0.21	0.16	0.73	0.08	0.12	-0.17
Manganese (TSP)	30	0.44	0.36	0.19	0.29	-0.64	-0.11	0.30	-0.16
Tetrachloroethylene	26	0.11	0.07	0.05	0.07	-0.02	-0.23	0.03	0.23

Table 22-6. Motor Vehicle Information for the Wisconsin Monitoring Site

Site	2005 Estimated County Population	Number of Vehicles Registered	Vehicles per Person (Registration:Population)	Population Within 10 Miles	Estimated 10 mile Vehicle Ownership	Traffic Data (Daily Average)
MAWI	458,106	420,070	0.92	356,676	327,062	23,750

Table 22-7. 1999 NATA Data Census Tract Summary for the Monitoring Site in Wisconsin

Pollutant	2005 UATMP Annual Average (µg/m^3)	1999 NATA Modeled Concentration (µg/m^3)	1999 NATA Cancer Risk (in-a-million)	1999 NATA Noncancer Risk (hazard quotient)
Madison, Wisconsin - MAWI, Census Tract 55025002100				
1,3-Butadiene	0.06 ± 0.01	0.17	4.98	0.08
Acetaldehyde	1.64 ± 0.17	1.16	2.55	0.13
Acrolein	NA	0.08	--	3.77
Acrylonitrile	0.07 ± 0.01	0.00	0.03	<0.01
Arsenic (TSP)	<0.01	0.09	0.37	<0.01
Benzene	0.89 ± 0.13	1.71	13.30	0.06
Cadmium (TSP)	<0.01	0.02	0.04	<0.01
Carbon Tetrachloride	0.69 ± 0.05	0.21	3.17	0.01
Chloromethylbenzene	0.11 ± 0.01	0.00	<0.01	--
Formaldehyde	2.49 ± 0.38	1.34	0.01	0.14
Hexachloro-1,3-butadiene	1.01 ± 0.13	<0.01	0.03	<0.01
Manganese (TSP)	0.01 ± 0.004	0.93	--	0.02
Nickel (TSP)	<0.01	1.46	0.23	0.02
p-Dichlorobenzene	0.17 ± 0.03	0.03	0.38	<0.01
Tetrachloroethylene	0.17 ± 0.02	0.18	1.07	<0.01
Trichloroethylene	0.13 ± 0.02	0.10	0.19	<0.01

NA = Not available due to short sampling duration.
BOLD = pollutant of interest.

23.0 Data Quality

This section discusses the data quality for the ambient air concentrations. In accordance with the Quality Assurance Project Plan (QAPP), the following data calculations were performed: completeness, precision, and accuracy (also called bias). Completeness statistics were presented in Section 3 of this report. The QAPP goal of 85% completeness was met by most sites. As indicators of the reliability and representativeness of experimental measurements, both precision and bias are considered when interpreting ambient air monitoring data. The quality assessment presented in this section show that the UATMP monitoring data are of a known and high quality. All calculations are based on sample concentrations detected above the method detection limits (MDLs) for each pollutant. The overall precision level (the average for all sites) meets UATMP data quality objectives and adheres to the guidelines in the Compendium Methods (US EPA, 1999a; US EPA, 1999b, US EPA 1999c), which are 15 percent coefficient of variation.

Method precision for the UATMP is determined by repeated analyses of duplicate samples or collocated samples. A *duplicate* sample is a sample collected simultaneously with a primary sample using the same sampling system (i.e., two separate samples through the same sampling system at the same time). This simultaneous collection is typically achieved by teeing the line from the sampler to each of the two canisters and doubling the flow rate applied to achieve integration over the 24-hour collection period. As outlined in the QAPP, ten percent of all sample collections were duplicate samples. Collocated samples are samples collected simultaneously using two independent collection systems at the same location.

Both approaches provide valuable, but different, assessments of method precision:

- Replicate analysis of duplicate samples provides information on the potential for variability (or precision) expected from a single collection system, but does not provide information on the variability expected between different collection systems (inter-system assessment).

- Replicate analysis of collocated samples provide information on the potential for variability (or precision) expected between different collection systems, but does not provide information on the variability expected from single collection systems (intra-system assessment).

23.1 Precision

Precision refers to the agreement between independent measurements performed according to identical protocols and procedures. Two types of precision will be discussed: Analytical Precision and Analytical and Sampling Precision. To quantify "analytical precision" (i.e., how precisely the analytical methods measure ambient air concentrations), concentrations measured during analysis of duplicate samples are replicated. To quantify "sampling and analytical precision" (i.e., how precisely the sampling and analytical methods measure ambient air concentrations), concentrations measured during replicate analyses of duplicate samples are compared.

Applied to ambient air monitoring data, precision is a measurement of random errors inherent to the process of sampling and analyzing ambient air.

23.1.1 Analytical Precision

Analytical precision is a measurement of random errors associated with the process of analyzing environmental samples. These errors may result from various factors, but typically originate from random "noise" inherent to analytical instruments. Laboratories can easily evaluate analytical precision by comparing concentrations measured during replicate analysis of the same ambient air samples. This report uses three parameters to quantify random errors indicated by replicate analyses of UATMP samples:

- ***Average concentration difference*** simply quantifies how duplicate or replicate analytical results differ, on average, for each pollutant and each sample. When interpreting central tendency estimates for specific pollutants sampled during the UATMP, participating agencies are encouraged to compare central tendencies to the average concentration differences. If a pollutant's average concentration difference exceeds or nearly equals its central tendency, the analytical method may not be capable of precisely characterizing annual concentrations. Therefore, data interpretation for these pollutants should be made with caution. Average concentration differences are calculated by subtracting the first analytical result from the second analytical result and averaging the difference for each pollutant.

- ***Relative percent difference (RPD)*** expresses average concentration differences relative to the average concentrations detected during replicate analyses. The RPD is calculated as follows:

$$\frac{X_1 - X_2}{\overline{X}} \times 100 = RPD$$

Where:

X_1 is the ambient air concentration of a given pollutant measured in one sample;
X_2 is the concentration of the same pollutant measured during replicate analysis; and
X is the arithmetic mean of X_1 and X_2.

As this equation shows, replicate analyses with low variability have lower RPDs (and better precision), and replicate analyses with high variability have higher RPDs (and poorer precision).

- ***Coefficient of Variation (CV)*** provides a relative measure of data dispersion compared to the mean.

$$CV = \frac{s}{\overline{X}} \times 100$$

Where:

F is the standard deviation of the sets of duplicate or replicate results;
$\overline{X}$ is the arithmetic mean of the sets of duplicate or replicate results;

The CV is used to measure the imprecision in survey estimates introduced from analysis. A coefficient of 1 percent would indicate that the analytical results could vary slightly due to sampling error, while a variation of 50 percent means that the results are more imprecise.

The following approach was employed to estimate how precisely the central laboratory analyzed UATMP samples:

- CVs, RPDs and concentration differences were calculated for every replicate analyses performed during the program. In cases where pollutants were not detected during replicate analyses, these parameters were not calculated.

- To make an overall estimate of method precision, program-average CVs, RPDs, and absolute concentration differences were calculated for each pollutant by averaging the values from the individual replicate analyses.

It is important to note that EPA has recently revised the methodology for assessing analytical precision in "Revisions to Ambient Air Monitoring Regulations; Final Rule," finalized October 17, 2006 (US EPA, 2006d). The new methodology will be applied to the 2006 UATMP report.

The tables in this section use absolute average concentration differences, RPDs, and CVs to characterize the analytical precision for all sites sampling for VOC, CARB, and SNMOC representing all replicate analyses of duplicate and collocated samples, of collocated samples, and of duplicate samples, respectively. Acrolein was added to the VOC list in July 2005, therefore this pollutant analysis is based on 6 months of data.

Collocated samples were collected for metals, which provide sampling precision. However, replicate analyses were not performed for metals; therefore, metals will not be discussed in the analytical precision section. Duplicate/collocated and replicate samples were not collected for semi-volatile organic compounds (SVOC) because there were no collocate samplers and the samplers used were not equipped to collect duplicate samples. Therefore, precision for SVOC is not discussed in this section.

The GRMS site had one set of duplicate samples, yet there were no analytical replicates for those duplicates. The duplicates will be included in the sampling and analytical precision section, but not in the analytical precision section. MIMN also had one set of duplicate samples, yet one of the duplicates was invalidated, and could not be included in this section. The APMI, ITCMI, PITX, RRTX, MUTX, SPIL, TRTX, and YFMI sites did not collect duplicate samples, and were not included in this section. PCOK and POOK collected samples for only three months and were not included in this section.

23.1.2 VOC Analytical Precision

In Table 23-1, the replicate analyses of duplicate and collocated samples show that for most of the pollutants, the VOC analysis precision was within the control limits of 15 percent for CV. Pollutants exceeding the 15 percent control limit are bolded. The method is most precise when measuring air concentrations for the pollutants consistently found at levels exceeding their detection limits. In terms of average concentration difference, the precision of the VOC analytical method ranges from 0.004 ppbv for dichlorotetrafluoroethane to 2.80 ppbv for acetonitrile.

Table 23-2 shows the results from replicate analyses of collocated VOC samples taken at NBIL, DEMI, MAWI, NBAL, ETAL, PVAL, SIAL, LDTN, DITN and WETX. The replicate results from collocated samples shows variation for the pollutants ranging from 0.01 (several pollutants) to 2.04 percent (acetonitrile), as indicated by average concentration differences. The overall estimate of method precision, using program-average CVs, RPDs, and absolute concentration differences, is within the program's objectives. The overall average variability is 12.60 percent.

Table 23-3 shows the results from replicate analyses of duplicate VOC samples, including all post-Katrina data. The replicate results from duplicate samples variation ranges from 0.42 (1,2-dichloroethane) to 27.78 percent (1,2-dibromoethane), as represented by the coefficient of variation. The overall average variability is 8.23 percent. The average CV is within the control limits of 15 percent.

Tables 23-4 through 23-8 present results from VOC replicate analyses for all of the duplicate and collocated samples at the NATTS sites (BTUT, DEMI, GPCO, NBIL, and S4MO, respectively). The replicate results from duplicate samples show low to mid-level variability among the sites, as represented by CV, ranging from 1.06 to 47.14 percent (both at DEMI), with an average of 9.35 percent. This is within the NATTS requested 15 percent overall CV per site.

Table 23-9 shows the VOC results for the replicates for duplicate samples only, excluding all post-Katrina data. It should be noted that the averages presented in Tables 23-3 and 23-10 for GPMS, PGMS, and TUMS include post-Katrina data. As a result, the averages in these tables may differ from those presented in Table 23-9. Table 23-10 shows the average CV per pollutant and per site. The average CVs of all the sites ranged from 4.80 at YDSP to 14.22 at LDTN. The VOC analytical precision, in terms of overall average CV, is 8.46 percent.

23.1.3 SNMOC Analytical Precision

Table 23-11 presents replicate analytical data for all duplicate SNMOC samples, including all post-Katrina data. Nearly all of the CVs are within the control limits of 15 percent. The average concentration differences observed for replicate analyses of SNMOC ranges from

0.004 (n-tridecane) to 14.04 ppbC (2-methyl-1-pentene). The total speciated and total hydrocarbons (speciated and unspeciated) show greater average concentration differences, 10.50 and 13.94 ppbC, respectively, but low-to mid-range variability at 3.21 and 7.16 percent.

Tables 23-12 through 23-13 present results from SNMOC replicate analyses for all of the collocated and duplicate samples at the NATTS sites (BTUT and NBIL). Many of the pollutants sampled at NBIL exhibited an average variability greater than 15 percent. Fewer pollutants exceeded this control limit at BTUT.

Table 23-14 shows the SNMOC results for the replicates of duplicate samples only, excluding all post-Katrina data. It should be noted that the averages presented in Tables 23-11 and 23-15 for GPMS include post-Katrina data. As a result, the averages in these tables may differ from those presented in Table 23-14. The PGMS site did not collect any post-Katrina SNMOC duplicate/replicate samples. Table 23-15 presents the average CV per pollutant for each site that sampled SNMOC. The replicate results from collocated and duplicate samples show low to mid level variability among the pollutants, ranging from 0.19 (propane at PGMS) to 60.69 (1-undecene at CUSD) percent. The average variability at sites sampling for SNMOC ranged from 7.17 at BTUT to 15.46 at NBIL. The SNMOC analytical precision, in terms of overall average CV, is 9.06 percent.

23.1.4 Carbonyl Compound Analytical Precision

In Table 23-16 the replicate analyses for duplicate and collocated samples show that laboratory carbonyl compound analysis precision is within the control limits of 15 percent CV. In terms of average concentration difference, the precision of the carbonyl analytical method ranges from 0.001 ppbv for benzaldehyde, valeraldehyde, and hexaldehyde to 0.01 ppbv for formaldehyde, acetaldehyde, and 2,5-dimethylbenzaldehyde.

Table 23-17 shows the results from replicate analyses of collocated carbonyl samples taken at DEMI, CANC, RTPNC, MAWI, NBIL, ETAL, NBAL, PVAL, SIAL, LDTN, DITN and WETX. The replicate results from collocated samples show variation for the pollutants

ranging from 0.39 (acetone) to 4.44 (tolualdehydes) percent. The overall average variability is 2.18 percent.

Table 23-18 shows the results from replicate analyses of duplicate carbonyl samples, including all post-Katrina data. The replicate results from duplicate samples vary little for the majority of the pollutants, ranging from 0.46 (acetaldehyde) to 3.69 percent (tolualdehydes). The overall average variability was 2.15 percent.

Tables 23-19 through 23-25 present results from carbonyl replicate analyses for all of the duplicate and collocated samples at the NATTS sites (BTUT, DEMI, GPCO, NBIL, S4MO, SKFL, and SYFL, respectively). The average CV is within the NATTS requested 15 percent overall CV per site.

Table 23-26 shows the carbonyl results for the duplicate samples only excluding all post-Katrina data. It should be noted that the averages presented in Tables 23-18 and 23-27 for GPMS, PGMS, and TUMS include post-Katrina data. As a result, the averages in these tables may differ from those presented in Table 23-26. Table 23-27 presents the average CV per pollutant and per site. The replicate results from duplicate samples show low-level variability among the sites, ranging from 0.04 (acetone at NBAL) to 15.57 percent (tolualdehydes at BAPR), and an average variability ranging from 1.35 at NBNJ to 3.76 at NBIL. The analytical precision for carbonyl compounds, in terms of overall average CV, is 2.19 percent.

Overall, replicate analyses, both duplicate and collocated, of VOC, SNMOC, and carbonyl compounds suggest the analytical precision level is within the UATMP data quality objectives and guidelines in the Compendium Methods.

23.2 Sampling and Analytical Precision

Sampling and analytical precision quantifies random errors associated not only with analyzing ambient air samples in the laboratory but also with collecting the samples. This type of precision is most easily evaluated by comparing concentrations measured in duplicate samples collected from the same air parcel. During the UATMP, duplicate and collocated samples were

collected at least 10 percent of the scheduled sampling days. Most of these samples were analyzed in replicate.

To calculate sampling and analytical precision, data analysts compared the concentrations between the two replicates with each respective duplicate or collocated sample. Also, the CV for two duplicate samples was calculated for each pollutant and each site with the target recovery being 15 percent, similar to the replicate analyses. Tables 23-28 through 23-36, 23-38 through 23-41, 23-43 through 23-53, 23-55 through 23-57 present average concentration differences, RPDs, and CVs as estimates of duplicate and collocated sampling and analytical variability for VOC, SNMOC, carbonyls, and metals, respectively. Tables 23-37, 23-42, 23-54, and 23-58 present the average CVs per pollutant and per site. The number of observations from Tables 23-1 through 23-27, in comparison to the respective tables listed for duplicate analyses in Tables 23-28 through 23-49, is approximately twice as high.

Duplicate/collocated and replicate samples were not collected for SVOC due to sampling occurring at only three sites. Therefore, precision for SVOC is not discussed in this section.

23.2.1 VOC Sampling and Analytical Precision

Table 23-28 presents the sampling and analytical data precision for duplicate and collocated VOC samples. Twenty-four out of 59 VOC show greater variation than the target 15 percent. Due to the variation, duplicate sample data is being closely scrutinized in 2006 and those with large variations will be resampled. The average concentration differences observed for duplicate and collocated analyses of VOC range from 0.01 (several pollutants) to 7.96 ppbv (acetonitrile).

The collocated VOC sampling and analytical data are presented in Table 23-29, and the duplicate samples are shown in Table 23-30, including all post-Katrina data. Again, average CVs greater than 15 percent are present for each collection type (duplicate and collocated). This shows that the CVs in Table 23-28 were affected by both sampling techniques. However, more pollutants in the collocated comparisons had CVs greater than 15 percent than those presented in the duplicate comparisons. The range of variability was 6.87 (dichlorodifluoromethane) to 56.01

percent (acrolein) for the collocated samples, and 4.00 (dichlorodifluoromethane) to 37.59 percent (methyl ethyl ketone) for duplicate samples.

Tables 23-31 through 23-35 present the results from VOC duplicate analysis for all of the NATTS sites (BTUT, DEMI, GPCO, NBIL, and S4MO, respectively). The CV at the NATTS sites ranged from 0.69 (acetonitrile at BTUT) to 88.39 percent (chloroform at DEMI). Table 23-36 shows the VOC results for the duplicate samples only, excluding all post-Katrina data. It should be noted that the averages presented in Tables 23-30 and 23-37 for GPMS, PGMS, and TUMS include post-Katrina data. As a result, the averages in these tables may differ from those presented in Table 23-36. Table 23-37 presents the average CV per pollutant and per site. The results from duplicate samples show low- to high- level variability among sites, ranging from 8.87 at GRMS to 38.10 at DITN. The VOC sampling and analytical precision, in terms of overall average CV, is 16.35 percent. This is slightly higher than the NATTS requested 15 percent overall CV per site.

23.2.2 SNMOC Sampling and Analytical Precision

The SNMOC precision for duplicate samples is presented in Table 23-38, including all post-Katrina data. Coefficient of variation for duplicate samples ranged from 2.91 percent for n-butane to 56.01 percent for 1-dodecane. The pollutants with the highest variation are ones with a non-target peak eluting very close to the elution time of the target peak, which can interfere with the correct concentration determination for that analyte. For example, a target analyte, 2-methyl-2-butene, has methylene chloride, a non-target analyte, eluting in close proximity which can interfere with the integration of the analyte peak. The VOC and SNMOC sampling and analytical precision data differs from the analytical precision data as presented in tables above. This difference suggests that limitations associated with laboratory analysis of the VOC and SNMOC samples during the UATMP did not affect random errors associated with sampling procedures.

Tables 23-39 and 23-40 present the results from SNMOC duplicate analysis for the NATTS sites (BTUT and NBIL). As seen for the replicate analyses, many of the pollutants sampled at NBIL exhibited an average variability greater than 15 percent. Fewer pollutants

exceeded this control limit at BTUT. The overall average variability at BTUT is 11.39 percent, while the overall average variability at NBIL is 9.83. Table 23-41 shows the SNMOC results for the duplicate samples only, excluding all post-Katrina data. It should be noted that the averages presented in Tables 23-38 and 23-42 for GPMS include post-Katrina data. As a result, the averages in these tables may differ from those presented in Table 23-41. The PGMS site did not collect any post-Katrina SNMOC duplicate samples. Table 23-42 presents the average CV per pollutant and per site, NATTS sites included. The results from duplicate samples show low to high-level variability among sites, ranging from 0.26 (isobutane at PGMS) to 107.92 percent (2,3,4-trimethylpentane at PGMS). The average CV for sites sampling SNMOC ranged from 9.83 at NBIL to 19.80 percent at S4MO. The SNMOC sampling and analytical precision, in terms of overall average CV, is 15.08 percent.

23.2.3 Carbonyl Compounds Sampling and Analytical Precision

Table 23-43, presenting the sampling and analytical data for carbonyl compounds, shows that the total duplicate and collocated samples precision was within the control limits of 15 percent CV. The average concentration difference ranged from 0.005 ppbv for benzaldehyde to 0.33 ppbv for formaldehyde.

The collocated carbonyl sampling and analytical data are presented in Table 23-44 and the duplicate samples results are shown in Table 23-45. Formaldehyde, hexaldehyde, valeraldehyde, and tolualdehydes exceeded the 15 percent criterion for the collocated samples and isovaleraldehyde, valeraldehyde, and tolualdehydes exceeded the 15 percent criterion for the duplicate samples.

Tables 23-46 through 23-52 present results from carbonyl duplicate sample analyses for the NATTS sites (BTUT, DEMI, GPCO, NBIL, S4MO, SKFL, and SYFL, respectively). Table 23-53 shows the carbonyl results for the duplicate samples only, excluding all post-Katrina data. It should be noted that the averages presented in Tables 23-45 and 23-54 for GPMS, PGMS, and TUMS include post-Katrina data. As a result, the averages in these tables may differ from those presented in Table 23-53. Table 23-54 presents the average CV per pollutant and per site. The duplicate sample results show low to high level variability among the sites, ranging from 0.22

(acetaldehyde at ETAL) to 101.65 percent (hexaldehyde at RTPNC). The average CV at the sites sampling carbonyls ranged from 4.67 at ETAL to 46.03 percent at CANC. The sampling and analytical precision for carbonyl compounds, in terms of overall average CV, is 13.43 percent. The carbonyl sampling and analytical precision data differs from the analytical replicate precision data as presented in tables above. This difference suggests that limitations associated with laboratory analysis of the carbonyl samples during the UATMP did not affect random errors associated with sampling procedures.

23.2.4 Metals Sampling and Analytical Precision

The sampling and analytical variation for collocated metals samples are presented in Tables 23-55, including all post-Katrina data. The average CV values, as well as the average RPD values, show low to high-level variability among the sites, with average CVs ranging from 4.10 for arsenic to 40.49 percent for mercury.

Table 23-56 presents the results from collocated metals sample analyses for the NATTS site (BOMA). The average concentration difference ranges from 0.001 (beryllium) to 0.51 (lead). The overall average CV at BOMA is 13.35 percent. This is within the NATTS requested 15 percent overall CV per site. No replicate analytical data were available for the collocated metals samples.

Table 23-57 shows the metals results for the collocated samples only, excluding all post-Katrina data. It should be noted that the averages presented in Tables 23-55 and 23-58 for GPMS include post-Katrina data. As a result, the averages in these tables may differ from those presented in Table 23-57. Table 23-58 presents the average CV per metals and per site (BOMA, BTUT, GPMS, MAWI, S4MO). The results from collocated samples show low to high level variability among sites, ranging from 0.68 (lead at MAWI) to 120.53 (manganese at GPMS) percent. The average CV at each site that sampled metals ranged from 2.29 at MAWI to 40.97 at GPMS. The metals sampling and analytical precision, in terms of overall average CV, is 17.13 percent.

23.3 Bias

Laboratories typically evaluate their accuracy by analyzing external audit samples and comparing the measured concentrations obtained to the known concentrations of the audit samples.

Accuracy indicates the extent to which experimental measurements represent their corresponding "true" or "actual" values.

The accuracy of the UATMP monitoring data can also be assessed qualitatively by reviewing the accuracy of the monitoring methods and how they were implemented:

- The sampling and analytical methods used in the UATMP (i.e., Compendium Methods TO-11A and TO-15) have been approved by EPA for accurately measuring ambient levels of VOC and carbonyl compounds, respectively—an approval that is based on many years of research into the development of ambient air monitoring methodologies.

- When collecting and analyzing ambient air samples, all field sampling staff and laboratory analysts strictly followed quality control and quality assurance guidelines detailed in the respective monitoring methods. This strict adherence to the well-documented sampling and analytical methods suggests, though certainly does not prove, that the UATMP monitoring data accurately represent ambient air quality.

23.3.1 Proficiency Test (PT) Studies

Laboratories participating in NATTS are provided with PT audit samples on a quarterly basis for VOC, carbonyls, and metals. These PT samples can be used as a measure of analytical accuracy.

Tables 23-59 through 23-61 present results from the 2005 NATTS PT audit samples for VOC, carbonyls, and metals, respectively. The acceptable percent difference from the true values is ± 25%, and the values exceeding this criteria are bolded in the tables. While there are a few values outside the limits, there are no compounds that are consistently out over for multiple audits.

Table 23-1. VOC Analytical Precision:
540 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	540	9.72	0.18	7.12
Propylene	538	7.63	0.09	5.56
Dichlorodifluoromethane	539	4.49	0.05	3.20
Chloromethane	540	5.85	0.07	4.20
Dichlorotetrafluoroethane	340	12.72	0.004	7.76
Vinyl Chloride	52	**34.52**	0.01	**17.62**
1,3-Butadiene	326	9.22	0.01	6.45
Bromomethane	310	18.40	0.01	13.21
Chloroethane	273	17.62	0.01	11.27
Acetonitrile	195	10.78	2.80	6.82
Acrolein	134	9.99	0.12	6.82
Trichlorofluoromethane	537	5.23	0.03	3.73
Acrylonitrile	3	9.30	0.07	6.29
1,1-Dichloroethene	10	13.67	0.04	10.31
Methylene Chloride	471	14.38	0.04	9.88
Trichlorotrifluoroethane	540	8.11	0.02	5.79
trans-1,2-Dichloroethylene	6	10.28	0.03	7.69
1,1-Dichloroethane	4	1.49	0.01	1.07
Methyl *tert*-Butyl Ether	76	9.70	0.05	6.99
Methyl Ethyl Ketone	120	14.83	0.29	10.40
Chloroprene	5	10.40	0.06	7.82
cis-1,2-Dichloroethylene	4	1.90	0.43	1.36
Bromochloromethane	4	7.36	0.02	5.51
Chloroform	239	22.45	0.02	**15.21**
Ethyl *tert*-Butyl Ether	5	19.37	0.02	12.07
1,2-Dichloroethane	13	0.58	0.02	0.42
1,1,1-Trichloroethane	374	12.86	0.01	9.00
Benzene	540	7.67	0.05	5.38
Carbon Tetrachloride	505	7.48	0.01	5.38
tert-Amyl Methyl Ether	7	NA	0.06	NA
1,2-Dichloropropane	2	2.67	0.02	1.91
Ethyl Acrylate	2	23.26	0.10	**18.61**
Bromodichloromethane	9	8.25	0.02	5.60
Trichloroethylene	141	23.93	0.01	**17.12**
Methyl Methacrylate	17	9.50	0.03	7.14
cis-1,3-Dichloropropene	4	NA	NA	NA

Table 23-1. VOC Analytical Precision:
540 Replicate Analyses for all Duplicate and Collocated Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	78	12.75	0.04	9.40
trans-1,3-Dichloropropene	4	2.17	0.04	1.55
1,1,2-Trichloroethane	4	8.59	0.02	5.75
Toluene	540	8.15	0.10	5.75
Dibromochloromethane	11	**50.35**	0.01	**23.82**
1,2-Dibromoethane	8	**36.67**	0.02	**27.78**
n-Octane	332	13.78	0.03	9.40
Tetrachloroethylene	327	18.87	0.01	13.98
Chlorobenzene	22	8.33	0.01	5.33
Ethylbenzene	527	9.98	0.02	6.82
m,p-Xylene	538	9.16	0.04	6.24
Bromoform	4	6.25	0.01	4.16
Styrene	411	16.69	0.02	9.58
1,1,2,2-Tetrachloroethane	13	**50.00**	0.01	**23.57**
o-Xylene	527	9.76	0.02	6.79
1,3,5-Trimethylbenzene	411	15.09	0.01	10.17
1,2,4-Trimethylbenzene	440	13.54	0.02	8.96
m-Dichlorobenzene	19	**29.94**	0.02	**16.15**
Chloromethylbenzene	10	16.20	0.01	12.13
p-Dichlorobenzene	258	13.77	0.01	9.33
o-Dichlorobenzene	23	**36.07**	0.02	**19.33**
1,2,4-Trichlorobenzene	72	**28.47**	0.02	**23.35**
Hexachloro-1,3-Butadiene	116	**27.57**	0.01	**18.51**

Table 23-2. VOC Analytical Precision:
122 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	122	10.11	0.18	7.35
Propylene	120	7.93	0.06	5.73
Dichlorodifluoromethane	121	3.67	0.06	2.64
Chloromethane	122	5.12	0.07	3.68
Dichlorotetrafluoroethane	94	23.07	0.01	12.11
Vinyl Chloride	13	**41.67**	0.01	**21.89**
1,3-Butadiene	77	9.05	0.02	7.05
Bromomethane	78	21.69	0.02	**18.85**
Chloroethane	66	29.54	0.01	**18.51**
Acetonitrile	34	6.76	2.04	4.59
Acrolein	28	11.67	0.18	8.00
Trichlorofluoromethane	119	4.32	0.04	3.07
Acrylonitrile	1	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	104	16.67	0.03	11.02
Trichlorotrifluoroethane	122	6.99	0.02	4.99
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	4	12.50	0.01	7.86
Methyl Ethyl Ketone	36	14.25	0.31	10.01
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	70	**31.48**	0.02	**21.06**
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	2	NA	0.03	NA
1,1,1-Trichloroethane	100	16.72	0.01	12.76
Benzene	122	6.76	0.05	4.86
Carbon Tetrachloride	122	6.18	0.01	4.38
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	4	NA	0.04	NA
Trichloroethylene	47	19.72	0.01	**16.47**
Methyl Methacrylate	2	NA	0.01	NA
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-2. VOC Analytical Precision:
122 Replicate Analyses for all Collocated Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	34	11.26	0.04	7.84
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	122	8.07	0.07	5.77
Dibromochloromethane	6	**100.00**	0.01	**47.14**
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	62	14.06	0.02	9.75
Tetrachloroethylene	77	**27.08**	0.01	**20.20**
Chlorobenzene	15	9.38	0.01	5.89
Ethylbenzene	118	10.22	0.01	6.77
m,p-Xylene	122	8.94	0.03	6.08
Bromoform	0	NA	NA	NA
Styrene	93	**25.85**	0.01	12.39
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	118	10.27	0.01	7.26
1,3,5-Trimethylbenzene	102	20.99	0.01	13.53
1,2,4-Trimethylbenzene	105	13.18	0.02	8.98
m-Dichlorobenzene	6	**57.14**	0.01	**28.28**
Chloromethylbenzene	2	25.00	0.02	**20.20**
p-Dichlorobenzene	71	12.75	0.01	8.59
o-Dichlorobenzene	6	**57.14**	0.02	**29.01**
1,2,4-Trichlorobenzene	22	**32.64**	0.02	**27.79**
Hexachloro-1,3-Butadiene	21	**30.36**	0.01	**18.86**

Table 23-3. VOC Analytical Precision:
418 Replicate Analyses for all Duplicate Samples, Including all Post-Katrina Data

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	418	9.46	0.18	6.97
Propylene	418	7.43	0.10	5.44
Dichlorodifluoromethane	418	5.03	0.05	3.58
Chloromethane	418	6.34	0.06	4.54
Dichlorotetrafluoroethane	246	5.83	0.004	4.86
Vinyl Chloride	39	**27.38**	0.01	13.36
1,3-Butadiene	249	9.27	0.01	6.28
Bromomethane	232	16.75	0.01	10.39
Chloroethane	207	8.69	0.005	5.84
Acetonitrile	161	12.22	3.06	7.62
Acrolein	106	9.38	0.10	6.39
Trichlorofluoromethane	418	5.83	0.03	4.17
Acrylonitrile	2	9.30	0.04	6.29
1,1-Dichloroethene	10	13.67	0.04	10.31
Methylene Chloride	367	13.15	0.04	9.28
Trichlorotrifluoroethane	418	8.86	0.01	6.33
trans-1,2-Dichloroethylene	6	10.28	0.03	7.69
1,1-Dichloroethane	4	1.49	0.01	1.07
Methyl *tert*-Butyl Ether	72	9.24	0.06	6.84
Methyl Ethyl Ketone	84	15.08	0.28	10.58
Chloroprene	5	10.40	0.06	7.82
cis-1,2-Dichloroethylene	4	1.90	0.43	1.36
Bromochloromethane	4	7.36	0.02	5.51
Chloroform	169	17.19	0.01	11.80
Ethyl *tert*-Butyl Ether	5	19.37	0.02	12.07
1,2-Dichloroethane	11	0.58	0.02	0.42
1,1,1-Trichloroethane	274	10.76	0.01	6.95
Benzene	418	8.27	0.05	5.73
Carbon Tetrachloride	383	8.35	0.01	6.05
tert-Amyl Methyl Ether	7	NA	0.06	NA
1,2-Dichloropropane	2	2.67	0.02	1.91
Ethyl Acrylate	2	23.26	0.10	**18.61**
Bromodichloromethane	5	8.25	0.02	5.60
Trichloroethylene	94	**28.13**	0.01	**17.78**
Methyl Methacrylate	15	9.50	0.04	7.14
cis-1,3-Dichloropropene	4	NA	NA	NA

Table 23-3. VOC Analytical Precision:
418 Replicate Analyses for all Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	44	13.64	0.04	10.34
trans-1,3-Dichloropropene	4	2.17	0.04	1.55
1,1,2-Trichloroethane	4	8.59	0.02	5.75
Toluene	418	8.20	0.12	5.74
Dibromochloromethane	5	0.70	0.01	0.50
1,2-Dibromoethane	8	**36.67**	0.02	**27.78**
n-Octane	270	13.64	0.03	9.23
Tetrachloroethylene	250	13.40	0.01	9.83
Chlorobenzene	7	6.25	0.02	4.22
Ethylbenzene	409	9.83	0.02	6.85
m,p-Xylene	416	9.29	0.05	6.33
Bromoform	4	6.25	0.01	4.16
Styrene	318	11.81	0.02	8.08
1,1,2,2-Tetrachloroethane	13	**50.00**	0.01	**23.57**
o-Xylene	409	9.49	0.02	6.54
1,3,5-Trimethylbenzene	309	11.65	0.01	8.21
1,2,4-Trimethylbenzene	335	13.75	0.02	8.94
m-Dichlorobenzene	13	11.80	0.02	8.06
Chloromethylbenzene	8	11.81	0.01	8.09
p-Dichlorobenzene	187	14.28	0.02	9.70
o-Dichlorobenzene	17	15.00	0.02	9.64
1,2,4-Trichlorobenzene	50	**26.08**	0.03	**20.82**
Hexachloro-1,3-Butadiene	95	**26.17**	0.01	**18.34**

Table 23-4. VOC Analytical Precision:
32 Replicate Analyses for all Duplicate Samples in Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	32	9.21	0.11	6.98
Propylene	32	4.36	0.04	3.25
Dichlorodifluoromethane	32	4.83	0.03	3.60
Chloromethane	32	8.71	0.05	6.59
Dichlorotetrafluoroethane	19	11.11	0.004	8.38
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	17	19.20	0.01	11.36
Bromomethane	12	NA	NA	NA
Chloroethane	12	4.17	0.002	3.37
Acetonitrile	6	3.75	0.22	2.68
Acrolein	6	16.91	0.08	10.49
Trichlorofluoromethane	32	5.97	0.02	4.34
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	27	14.03	0.02	9.78
Trichlorotrifluoroethane	32	11.80	0.01	8.57
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	6	2.13	0.24	1.52
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	8	NA	NA	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	20	2.50	0.001	1.57
Benzene	32	7.25	0.04	5.07
Carbon Tetrachloride	29	13.69	0.02	11.05
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	8	NA	NA	NA
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-4. VOC Analytical Precision:
32 Replicate Analyses for all Duplicate Samples in Bountiful, UT (BTUT) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	0	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	32	8.12	0.08	5.70
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	24	15.92	0.02	11.22
Tetrachloroethylene	20	10.00	0.01	7.43
Chlorobenzene	1	NA	0.02	NA
Ethylbenzene	32	12.09	0.01	8.24
m,p-Xylene	32	8.61	0.04	6.12
Bromoform	0	NA	NA	NA
Styrene	20	7.08	0.02	5.18
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	32	9.95	0.02	7.06
1,3,5-Trimethylbenzene	21	17.96	0.01	11.06
1,2,4-Trimethylbenzene	24	14.00	0.03	10.79
m-Dichlorobenzene	0	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	8	NA	NA	NA
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	0	NA	NA	NA
Hexachloro-1,3-Butadiene	4	NA	NA	NA

Table 23-5. VOC Analytical Precision:
18 Replicate Analyses for Collocated Samples in Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	18	4.65	0.04	3.33
Propylene	18	5.91	0.04	3.97
Dichlorodifluoromethane	18	3.91	0.03	2.81
Chloromethane	18	5.58	0.04	3.87
Dichlorotetrafluoroethane	15	4.76	0.004	2.89
Vinyl Chloride	4	**50.00**	0.01	**23.57**
1,3-Butadiene	15	2.38	0.01	1.55
Bromomethane	14	14.29	0.001	6.73
Chloroethane	14	2.86	0.001	1.84
Acetonitrile	14	11.27	2.25	7.52
Acrolein	8	5.02	0.04	3.66
Trichlorofluoromethane	17	3.17	0.06	2.25
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	18	2.58	0.004	1.95
Trichlorotrifluoroethane	18	6.29	0.01	4.61
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	7	8.85	0.48	6.59
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	16	3.90	0.04	2.42
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	1	NA	NA	NA
1,1,1-Trichloroethane	17	12.29	0.01	8.91
Benzene	18	6.27	0.02	4.33
Carbon Tetrachloride	18	9.12	0.01	6.57
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	10	NA	NA	NA
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-5. VOC Analytical Precision:
18 Replicate Analyses for Collocated Samples in Detroit, MI (DEMI) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	9	9.19	0.03	6.18
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	18	4.44	0.05	3.17
Dibromochloromethane	2	**100.00**	0.01	**47.14**
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	12	11.67	0.06	8.08
Tetrachloroethylene	18	4.03	0.02	2.85
Chlorobenzene	9	6.25	0.01	3.93
Ethylbenzene	18	6.04	0.01	4.20
m,p-Xylene	18	5.61	0.02	4.04
Bromoform	0	NA	NA	NA
Styrene	15	1.43	0.01	1.06
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	17	4.56	0.01	3.36
1,3,5-Trimethylbenzene	18	10.71	0.004	9.27
1,2,4-Trimethylbenzene	18	4.11	0.01	2.83
m-Dichlorobenzene	2	**100.00**	0.01	**47.14**
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	11	NA	0.01	NA
o-Dichlorobenzene	3	**100.00**	0.04	**47.14**
1,2,4-Trichlorobenzene	2	**50.00**	0.01	**47.14**
Hexachloro-1,3-Butadiene	4	25.00	0.01	**23.57**

Table 23-6. VOC Analytical Precision:
30 Replicate Analyses for all Duplicate Samples in Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	30	6.16	0.44	4.55
Propylene	30	5.85	0.19	4.35
Dichlorodifluoromethane	30	4.76	0.10	3.47
Chloromethane	30	6.28	0.10	4.48
Dichlorotetrafluoroethane	18	NA	0.01	NA
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	19	9.87	0.05	6.90
Bromomethane	16	6.25	0.001	5.89
Chloroethane	15	NA	0.001	NA
Acetonitrile	16	6.43	3.48	4.91
Acrolein	6	14.19	0.10	9.55
Trichlorofluoromethane	30	4.53	0.05	3.30
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	26	11.57	0.03	6.36
Trichlorotrifluoroethane	30	9.22	0.02	6.33
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	9	10.08	0.51	6.86
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	10	19.17	0.01	12.98
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	17	3.13	0.01	2.53
Benzene	30	4.53	0.09	3.31
Carbon Tetrachloride	29	6.76	0.02	4.66
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	6	NA	NA	NA
Methyl Methacrylate	10	4.59	0.10	3.11
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-6. VOC Analytical Precision:
30 Replicate Analyses for all Duplicate Samples in Grand Junction, CO (GPCO) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	6	14.29	0.05	11.79
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	30	5.75	0.20	4.06
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	25	7.32	0.02	5.68
Tetrachloroethylene	18	1.79	0.01	1.36
Chlorobenzene	0	NA	NA	NA
Ethylbenzene	30	4.97	0.04	3.43
m,p-Xylene	30	6.30	0.13	4.42
Bromoform	0	NA	NA	NA
Styrene	29	9.24	0.06	6.43
1,1,2,2-Tetrachloroethane	4	NA	NA	NA
o-Xylene	30	4.34	0.05	3.09
1,3,5-Trimethylbenzene	26	8.75	0.02	6.19
1,2,4-Trimethylbenzene	26	7.61	0.05	5.79
m-Dichlorobenzene	0	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	10	25.00	0.01	11.79
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	4	16.67	0.01	14.14
Hexachloro-1,3-Butadiene	8	NA	NA	NA

Table 23-7. VOC Analytical Precision:
16 Replicate Analyses for Collocated Samples in North Brook, IL (NBIL)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	16	3.33	0.44	2.38
Propylene	14	17.58	0.23	12.84
Dichlorodifluoromethane	15	2.85	0.22	1.99
Chloromethane	16	5.94	0.28	4.30
Dichlorotetrafluoroethane	12	20.83	0.01	14.14
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	4	NA	0.03	NA
Bromomethane	4	NA	0.07	NA
Chloroethane	2	NA	0.02	NA
Acetonitrile	0	NA	NA	NA
Acrolein	0	NA	NA	NA
Trichlorofluoromethane	16	2.96	0.13	2.09
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	16	23.44	0.07	14.36
Trichlorotrifluoroethane	16	3.90	0.04	2.94
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	2	NA	0.34	NA
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	15	11.26	0.07	8.03
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	8	**29.17**	0.02	**24.24**
Benzene	16	3.53	0.11	2.51
Carbon Tetrachloride	16	3.77	0.05	2.76
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	4	NA	0.04	NA
Trichloroethylene	14	17.50	0.02	12.91
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-7. VOC Analytical Precision:
16 Replicate Analyses for Collocated Samples in North Brook, IL (NBIL) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	2	NA	0.04	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	16	13.19	0.18	8.07
Dibromochloromethane	4	NA	0.02	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	3	NA	0.05	NA
Tetrachloroethylene	16	20.83	0.02	13.47
Chlorobenzene	0	NA	NA	NA
Ethylbenzene	16	21.67	0.03	11.72
m,p-Xylene	16	20.73	0.09	11.95
Bromoform	0	NA	NA	NA
Styrene	11	**95.83**	0.02	**43.60**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	16	18.80	0.03	12.64
1,3,5-Trimethylbenzene	14	**65.63**	0.02	**32.72**
1,2,4-Trimethylbenzene	15	**36.78**	0.04	**21.46**
m-Dichlorobenzene	1	NA	0.01	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	3	NA	0.03	NA
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	1	NA	0.04	NA
Hexachloro-1,3-Butadiene	1	NA	0.01	NA

Table 23-8. VOC Analytical Precision:
26 Replicate Analyses for Duplicate Samples in St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	26	9.68	0.30	7.72
Propylene	26	10.90	0.15	8.67
Dichlorodifluoromethane	26	6.57	0.13	4.61
Chloromethane	26	8.43	0.14	5.90
Dichlorotetrafluoroethane	13	NA	0.004	NA
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	13	4.76	0.02	3.93
Bromomethane	12	**53.11**	0.04	**33.65**
Chloroethane	12	9.38	0.003	8.62
Acetonitrile	5	10.67	0.26	7.45
Acrolein	0	NA	NA	NA
Trichlorofluoromethane	26	10.61	0.08	7.89
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	1	NA	NA	NA
Methylene Chloride	20	16.73	0.07	13.62
Trichlorotrifluoroethane	26	11.88	0.02	8.22
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	8	**33.76**	0.50	**22.73**
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	8	16.67	0.02	9.43
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	1	NA	NA	NA
1,1,1-Trichloroethane	13	8.33	0.004	4.71
Benzene	26	16.33	0.11	10.98
Carbon Tetrachloride	22	6.49	0.04	4.42
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	0	NA	NA	NA
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-8. VOC Analytical Precision:
26 Replicate Analyses for Duplicate Samples in St. Louis, MO (S4MO) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	1	NA	NA	NA
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	26	17.79	0.52	12.58
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	10	**33.33**	0.08	**15.71**
Tetrachloroethylene	11	15.28	0.03	13.86
Chlorobenzene	0	NA	NA	NA
Ethylbenzene	26	14.79	0.04	10.32
m,p-Xylene	26	13.28	0.09	9.35
Bromoform	0	NA	NA	NA
Styrene	15	20.83	0.03	10.48
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	26	18.95	0.04	13.25
1,3,5-Trimethylbenzene	18	10.21	0.02	7.99
1,2,4-Trimethylbenzene	18	13.56	0.04	11.08
m-Dichlorobenzene	0	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	10	23.75	0.08	**25.14**
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	0	NA	NA	NA
Hexachloro-1,3-Butadiene	0	NA	NA	NA

Table 23-9. VOC Analytical Precision:
342 Replicate Analyses for all Duplicate Samples

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	342	9.41	0.18	7.08
Propylene	342	7.76	0.11	5.74
Dichlorodifluoromethane	342	5.00	0.05	3.54
Chloromethane	342	6.32	0.06	4.52
Dichlorotetrafluoroethane	170	6.37	0.00	5.25
Vinyl Chloride	29	4.76	0.01	3.14
1,3-Butadiene	177	9.09	0.02	6.16
Bromomethane	156	20.16	0.01	12.26
Chloroethane	143	9.19	0.01	6.04
Acetonitrile	100	11.72	1.71	7.80
Acrolein	61	NA	NA	NA
Trichlorofluoromethane	342	6.24	0.03	4.42
Acrylonitrile	2	9.30	0.04	6.29
1,1-Dichloroethene	8	16.94	0.04	12.84
Methylene Chloride	292	14.33	0.04	9.82
Trichlorotrifluoroethane	342	9.24	0.01	6.63
trans-1,2-Dichloroethylene	6	10.28	0.03	7.69
1,1-Dichloroethane	4	1.49	0.01	1.07
Methyl *tert*-Butyl Ether	72	9.24	0.06	6.84
Methyl Ethyl Ketone	84	15.08	0.28	10.58
Chloroprene	5	10.40	0.06	7.82
cis-1,2-Dichloroethylene	4	1.90	0.43	1.36
Bromochloromethane	4	7.36	0.02	5.51
Chloroform	102	20.70	0.02	13.82
Ethyl *tert*-Butyl Ether	5	19.37	0.02	12.07
1,2-Dichloroethane	8	0.58	0.03	0.42
1,1,1-Trichloroethane	203	12.35	0.01	8.57
Benzene	342	8.42	0.05	5.94
Carbon Tetrachloride	307	9.57	0.01	6.75
tert-Amyl Methyl Ether	7	NA	0.06	NA
1,2-Dichloropropane	2	2.67	0.02	1.91
Ethyl Acrylate	2	23.26	0.10	**18.61**
Bromodichloromethane	4	8.25	0.02	5.60
Trichloroethylene	63	**28.13**	0.02	**17.78**
Methyl Methacrylate	14	9.50	0.05	7.14
cis-1,3-Dichloropropene	4	NA	NA	NA
Methyl Isobutyl Ketone	44	13.64	0.04	10.34

Table 23-9. VOC Analytical Precision:
342 Replicate Analyses for all Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
trans-1,3-Dichloropropene	4	2.17	0.04	1.55
1,1,2-Trichloroethane	4	8.59	0.02	5.75
Toluene	342	8.54	0.13	6.20
Dibromochloromethane	5	0.70	0.01	0.50
1,2-Dibromoethane	8	**36.67**	0.02	**27.78**
n-Octane	194	13.77	0.03	9.47
Tetrachloroethylene	186	13.89	0.01	10.09
Chlorobenzene	7	6.25	0.02	4.22
Ethylbenzene	333	10.57	0.02	7.55
m,p-Xylene	340	10.02	0.05	7.21
Bromoform	4	6.25	0.01	4.16
Styrene	242	13.46	0.02	9.65
1,1,2,2-Tetrachloroethane	12	**50.00**	0.01	**23.57**
o-Xylene	333	9.85	0.02	7.12
1,3,5-Trimethylbenzene	233	12.53	0.01	8.96
1,2,4-Trimethylbenzene	261	12.71	0.02	8.59
m-Dichlorobenzene	11	11.80	0.02	8.06
Chloromethylbenzene	8	11.81	0.01	8.09
p-Dichlorobenzene	131	16.23	0.02	10.86
o-Dichlorobenzene	14	15.00	0.02	9.64
1,2,4-Trichlorobenzene	26	**26.72**	0.03	**21.27**
Hexachloro-1,3-Butadiene	39	**36.63**	0.03	**21.51**

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)	East Thomas,, AL (ETAL)	Grand Junction, CO (GPCO)
Acetylene	*7.12*	5.87	6.98	6.62	4.61	5.47	3.33	10.09	6.44	8.82	4.55
Propylene	*5.56*	5.93	3.25	5.75	5.73	7.05	3.97	9.61	4.09	5.09	4.35
Dichlorodifluoromethane	*3.20*	4.66	3.60	2.02	2.83	2.80	2.81	3.02	4.67	1.67	3.47
Chloromethane	*4.20*	6.16	6.59	4.22	3.64	3.14	3.87	3.03	6.26	3.17	4.48
Dichlorotetrafluoroethane	*7.76*	3.93	8.38	NA	1.35	NA	2.89	NA	9.43	NA	NA
Vinyl Chloride	**17.62**	NA	NA	NA	3.14	NA	**23.57**	**20.20**	NA	NA	NA
1,3-Butadiene	*6.45*	5.05	11.36	7.91	1.62	8.29	1.55	NA	7.73	NA	6.90
Bromomethane	*13.21*	**15.71**	NA	**15.71**	0.78	NA	6.73	NA	8.23	NA	5.89
Chloroethane	*11.27*	NA	3.37	**15.71**	0.16	1.49	1.84	NA	9.86	**23.57**	NA
Acetonitrile	*6.82*	6.59	2.68	3.80	7.24	7.62	7.52	3.28	11.86	NA	4.91
Acrolein	*6.82*	NA	10.49	NA	3.25	0.63	3.66	8.05	NA	NA	9.55
Trichlorofluoromethane	*3.73*	5.13	4.34	3.91	2.25	3.10	2.25	6.27	5.19	2.21	3.30
Acrylonitrile	*6.29*	NA	NA	NA	6.29	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	*10.31*	NA	NA	NA	8.44	17.25	NA	NA	NA	NA	NA
Methylene Chloride	*9.88*	9.56	9.78	14.55	6.99	7.52	1.95	**18.96**	8.73	9.43	6.36
Trichlorotrifluoroethane	*5.79*	10.65	8.57	3.50	4.30	6.12	4.61	3.54	9.43	4.04	6.33
trans - 1,2 - Dichloroethylene	*7.69*	NA	NA	NA	7.69	NA	NA	NA	NA	NA	NA
1,1 - Dichloroethane	*1.07*	NA	NA	NA	1.07	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	*6.99*	NA	NA	6.09	8.61	NA	NA	NA	8.80	NA	NA
Methyl Ethyl Ketone	*10.40*	**19.80**	1.52	NA	13.74	NA	6.59	NA	NA	NA	6.86
Chloroprene	*7.82*	NA	NA	NA	7.82	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	*1.36*	NA	NA	NA	1.36	NA	NA	NA	NA	NA	NA
Bromochloromethane	*5.51*	NA	NA	NA	5.51	NA	NA	NA	NA	NA	NA

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)	East Thomas,, AL (ETAL)	Grand Junction, CO (GPCO)
Chloroform	**15.21**	14.14	NA	**20.20**	0.76	**47.14**	2.42	14.14	7.54	**47.14**	12.98
Ethyl *tert*-Butyl Ether	*12.07*	NA	NA	NA	3.93	NA	NA	NA	NA	NA	NA
1,2 - Dichloroethane	*0.42*	NA	NA	NA	0.42	NA	NA	NA	NA	NA	NA
1,1,1 - Trichloroethane	*9.00*	NA	1.57	NA	10.24	5.66	8.91	NA	10.37	14.14	2.53
Benzene	*5.38*	6.27	5.07	4.10	5.39	4.41	4.33	5.10	6.91	3.28	3.31
Carbon Tetrachloride	*5.38*	5.41	11.05	4.53	2.67	6.15	6.57	2.08	11.48	2.62	4.66
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2 - Dichloropropane	*1.91*	NA	NA	NA	1.91	NA	NA	NA	NA	NA	NA
Ethyl Acrylate	**18.61**	NA	NA	NA	**18.61**	NA	NA	NA	NA	NA	NA
Bromodichloromethane	*5.60*	NA	NA	NA	5.60	NA	NA	NA	NA	NA	NA
Trichloroethylene	**17.12**	NA	NA	NA	3.52	NA	NA	NA	NA	NA	NA
Methyl Methacrylate	*7.14*	NA	NA	NA	4.16	NA	NA	NA	14.14	NA	3.11
cis -1,3 - Dichloropropene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone	*9.40*	NA	NA	NA	12.16	NA	6.18	9.09	NA	NA	11.79
trans - 1,3 - Dichloropropene	*1.55*	NA	NA	NA	1.55	NA	NA	NA	NA	NA	NA
1,1,2 - Trichloroethane	*5.75*	NA	NA	NA	5.75	NA	NA	NA	NA	NA	NA
Toluene	*5.75*	5.92	5.70	2.81	3.30	6.82	3.17	6.15	5.48	3.95	4.06
Dibromochloromethane	**23.82**	NA	NA	NA	0.50	NA	**47.14**	NA	NA	NA	NA
1,2-Dibromoethane	**27.78**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Octane	*9.40*	**15.71**	11.22	1.89	**29.94**	NA	8.08	14.14	5.10	NA	5.68
Tetrachloroethylene	*13.98*	NA	7.43	10.07	**20.35**	NA	2.85	**47.14**	10.67	**47.14**	1.36
Chlorobenzene	*5.33*	NA	NA	NA	4.22	NA	3.93	NA	NA	NA	NA

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)	East Thomas,, AL (ETAL)	Grand Junction, CO (GPCO)
Ethylbenzene	*6.82*	9.16	8.24	4.23	7.71	6.39	4.20	NA	7.59	2.44	3.43
m,p - Xylene	*6.24*	5.80	6.12	4.51	4.05	4.53	4.04	10.73	6.33	3.26	4.42
Bromoform	*4.16*	NA	NA	NA	4.16	NA	NA	NA	NA	NA	NA
Styrene	*9.58*	12.04	5.18	9.29	9.88	6.99	1.06	3.63	5.19	NA	6.43
1,1,2,2 - Tetrachloroethane	**23.57**	NA	NA	NA	NA	**23.57**	NA	NA	NA	NA	NA
o - Xylene	*6.79*	4.90	7.06	5.95	5.90	4.58	3.36	12.70	7.81	2.14	3.09
1,3,5-Trimethylbenzene	*10.17*	**18.38**	11.06	11.00	0.37	NA	9.27	**20.95**	10.11	10.10	6.19
1,2,4-Trimethylbenzene	*8.96*	10.51	10.79	9.56	13.47	7.25	2.83	5.24	11.22	2.83	5.79
m - Dichlorobenzene	**16.15**	NA	NA	NA	6.43	NA	**47.14**	NA	NA	NA	NA
Chloromethylbenzene	*12.13*	NA	NA	NA	7.86	NA	NA	NA	NA	NA	NA
p - Dichlorobenzene	*9.33*	**16.63**	NA	3.21	7.19	NA	NA	NA	11.61	7.86	11.79
o - Dichlorobenzene	**19.33**	NA	NA	NA	6.43	NA	**47.14**	NA	NA	NA	NA
1,2,4-Trichlorobenzene	**23.35**	NA	NA	NA	**17.25**	NA	**47.14**	NA	**47.14**	NA	14.14
Hexachloro-1,3-Butadiene	**18.51**	NA	NA	NA	**21.51**	NA	**23.57**	NA	NA	NA	NA
Average	*8.46*	*9.33*	*6.86*	*7.25*	*6.47*	*8.43*	*10.30*	*10.78*	*9.64*	*10.24*	*5.92*

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Gulfport, MS (GPMS)	Nashville, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	North Brook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)
Acetylene	*7.12*	6.03	5.45	5.23	12.74	2.38	5.47	9.60	5.41	7.72	4.52
Propylene	*5.56*	3.66	6.45	8.71	3.07	12.84	4.20	5.18	2.62	8.67	5.68
Dichlorodifluoromethane	*3.20*	2.93	4.67	2.72	4.00	1.99	3.03	3.78	1.88	4.61	3.17
Chloromethane	*4.20*	3.06	5.80	4.13	5.29	4.30	5.45	5.19	1.15	5.90	3.12
Dichlorotetrafluoroethane	*7.76*	NA	NA	7.86	NA	14.14	NA	2.95	**23.57**	NA	NA
Vinyl Chloride	**17.62**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Butadiene	*6.45*	11.50	14.28	9.43	NA	NA	4.71	3.67	NA	3.93	NA
Bromomethane	*13.21*	2.95	**47.14**	11.79	**23.57**	NA	NA	2.95	NA	**33.65**	NA
Chloroethane	*11.27*	NA	**47.14**	**23.57**	NA	NA	NA	4.46	2.83	8.62	NA
Acetonitrile	*6.82*	4.64	NA	NA	6.06	NA	10.27	11.35	1.61	7.45	5.86
Acrolein	*6.82*	4.64	11.84	NA	NA	NA	5.67	6.57	NA	NA	4.93
Trichlorofluoromethane	*3.73*	2.54	4.58	3.88	2.53	2.09	3.88	4.11	2.44	7.89	3.06
Acrylonitrile	*6.29*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	*10.31*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	*9.88*	7.64	13.90	13.86	NA	14.36	8.76	8.63	11.14	13.62	9.13
Trichlorotrifluoroethane	*5.79*	3.54	5.22	6.99	7.57	2.94	5.07	5.31	4.76	8.22	5.66
trans - 1,2 – Dichloroethylene	*7.69*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1 - Dichloroethane	*1.07*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	*6.99*	NA	NA	NA	NA	NA	9.87	NA	NA	NA	NA
Methyl Ethyl Ketone	*10.40*	NA	**16.09**	6.15	NA	NA	NA	2.77	NA	**22.73**	10.71
Chloroprene	*7.82*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	*1.36*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromochloromethane	*5.51*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Gulfport, MS (GPMS)	Nashville, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	North Brook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)
Chloroform	**15.21**	5.80	6.58	NA	NA	8.03	9.43	2.02	NA	9.43	NA
Ethyl *tert*-Butyl Ether	*12.07*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2 - Dichloroethane	*0.42*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1 - Trichloroethane	*9.00*	10.39	14.14	13.23	NA	**24.24**	10.13	10.02	NA	4.71	NA
Benzene	*5.38*	5.99	5.07	8.92	5.45	2.51	4.41	6.23	3.53	10.98	6.07
Carbon Tetrachloride	*5.38*	6.03	5.23	6.01	6.73	2.76	6.05	5.62	2.62	4.42	6.39
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2 - Dichloropropane	*1.91*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Acrylate	**18.61**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	*5.60*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	**17.12**	NA	**33.67**	NA	2.83	12.91	**47.14**	NA	NA	NA	NA
Methyl Methacrylate	*7.14*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis -1,3 - Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone	*9.40*	NA	NA	NA	NA	NA	NA	NA	NA	NA	**17.68**
trans - 1,3 - Dichloropropene	*1.55*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2 - Trichloroethane	*5.75*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	*5.75*	7.02	11.59	10.27	2.32	8.07	3.56	7.88	3.14	12.58	4.31
Dibromochloromethane	**23.82**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	**27.78**	NA	NA	NA	NA	NA	NA	**35.36**	NA	NA	NA
n-Octane	*9.40*	8.12	**15.71**	NA	7.86	NA	8.26	8.66	10.10	**15.71**	3.14
Tetrachloroethylene	*13.98*	7.78	NA	9.43	NA	13.47	5.66	NA	NA	13.86	NA
Chlorobenzene	*5.33*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	*6.82*	5.36	10.07	10.19	6.43	11.72	5.59	8.06	4.71	10.32	10.74

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Gulfport, MS (GPMS)	Nashville, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	North Brook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	St. Louis, MO (S4MO)	Sioux Falls, SD (SFSD)
m,p - Xylene	*6.24*	7.65	4.51	4.19	NA	11.95	7.34	8.83	NA	9.35	9.17
Bromoform	*4.16*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	*9.58*	8.01	14.94	**23.57**	NA	**43.60**	14.53	10.48	5.44	10.48	5.66
1,1,2,2 - Tetrachloroethane	**23.57**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o - Xylene	*6.79*	6.34	10.30	7.58	NA	12.64	7.07	10.59	NA	13.25	4.75
1,3,5-Trimethylbenzene	*10.17*	4.20	5.24	11.22	NA	**32.72**	6.34	12.98	NA	7.99	NA
1,2,4-Trimethylbenzene	*8.96*	11.16	9.43	**17.41**	NA	**21.46**	6.38	10.68	3.72	11.08	8.16
m - Dichlorobenzene	**16.15**	NA	NA	9.43	NA	NA	NA	8.32	NA	NA	NA
Chloromethylbenzene	*12.13*	NA	NA	**20.20**	NA	NA	NA	8.32	NA	NA	NA
p - Dichlorobenzene	*9.33*	6.93	7.86	14.63	NA	NA	7.07	12.18	6.43	**25.14**	NA
o - Dichlorobenzene	**19.33**	NA	NA	10.88	NA	NA	NA		NA	NA	NA
1,2,4-Trichlorobenzene	**23.35**	12.80	**47.14**	5.66	NA	NA	NA	9.15	NA	NA	NA
Hexachloro-1,3-Butadiene	**18.51**	11.79	NA	NA	NA	NA	NA	**16.50**	NA	NA	NA
Average	*8.46*	*6.61*	*14.22*	*10.25*	*6.89*	*12.43*	*8.28*	*8.39*	*5.39*	*11.24*	*6.59*

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)	Ysleta del Sur Pueblo ,TX (YDSP)
Acetylene	*7.12*	11.96	10.58	4.76	8.05	**15.36**
Propylene	*5.56*	0.77	5.56	5.20	4.16	7.36
Dichlorodifluoromethane	*3.20*	0.57	5.41	4.11	3.12	2.54
Chloromethane	*4.20*	1.59	3.86	3.67	4.46	3.34
Dichlorotetrafluoroethane	*7.76*	NA	NA	NA	NA	3.14
Vinyl Chloride	**17.62**	NA	NA	**23.57**	NA	NA
1,3-Butadiene	*6.45*	NA	4.58	5.05	2.94	5.68
Bromomethane	*13.21*	NA	11.79	NA	5.03	6.29
Chloroethane	*11.27*	NA	NA	NA	12.12	3.09
Acetonitrile	*6.82*	4.48	**17.33**	5.12	NA	NA
Acrolein	*6.82*	NA	9.18	9.72	8.46	5.67
Trichlorofluoromethane	*3.73*	1.16	7.23	3.74	3.32	2.85
Acrylonitrile	*6.29*	NA	NA	NA	NA	NA
1,1-Dichloroethene	*10.31*	NA	NA	5.24	NA	NA
Methylene Chloride	*9.88*	NA	12.74	7.47	4.55	7.65
Trichlorotrifluoroethane	*5.79*	4.24	9.20	3.70	5.97	5.30
trans - 1,2 - Dichloroethylene	*7.69*	NA	NA	NA	NA	NA
1,1 - Dichloroethane	*1.07*	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	*6.99*	NA	5.49	NA	7.86	2.20
Methyl Ethyl Ketone	*10.40*	NA	12.56	NA	11.20	4.51
Chloroprene	*7.82*	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	*1.36*	NA	NA	NA	NA	NA
Bromochloromethane	*5.51*	NA	NA	NA	NA	NA

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)	Ysleta del Sur Pueblo ,TX (YDSP)
Chloroform	**15.21**	**47.14**	2.72	9.43	**22.00**	NA
Ethyl *tert*-Butyl Ether	*12.07*	NA	NA	NA	NA	**20.20**
1,2 - Dichloroethane	*0.42*	NA	NA	NA	NA	NA
1,1,1 - Trichloroethane	*9.00*	NA	NA	2.53	1.89	8.32
Benzene	*5.38*	6.68	7.71	5.06	3.69	4.07
Carbon Tetrachloride	*5.38*	5.66	6.29	6.60	3.53	3.42
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA
1,2 - Dichloropropane	*1.91*	NA	NA	NA	NA	NA
Ethyl Acrylate	**18.61**	NA	NA	NA	NA	NA
Bromodichloromethane	*5.60*	NA	NA	NA	NA	NA
Trichloroethylene	**17.12**	NA	NA	NA	NA	2.67
Methyl Methacrylate	*7.14*	NA	NA	NA	NA	NA
cis -1,3 - Dichloropropene	*NA*	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone	*9.40*	NA	9.81	NA	8.23	0.27
trans - 1,3 - Dichloropropene	*1.55*	NA	NA	NA	NA	NA
1,1,2 - Trichloroethane	*5.75*	NA	NA	NA	NA	NA
Toluene	*5.75*	5.89	7.09	6.45	3.14	3.11
Dibromochloromethane	**23.82**	NA	NA	NA	NA	NA
1,2-Dibromoethane	**27.78**	NA	NA	**20.20**	NA	NA
n-Octane	*9.40*	7.07	7.74	5.17	5.30	2.86
Tetrachloroethylene	*13.98*	NA	11.31	NA	1.17	NA
Chlorobenzene	*5.33*	7.86	NA	NA	NA	NA
Ethylbenzene	*6.82*	7.88	9.44	3.47	3.33	3.07
m,p - Xylene	*6.24*	6.43	7.30	6.86	3.50	2.75

Table 23-10. VOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)	Ysleta del Sur Pueblo ,TX (YDSP)
Bromoform	*4.16*	NA	NA	NA	NA	NA
Styrene	*9.58*	4.16	8.57	5.29	2.72	3.25
1,1,2,2 - Tetrachloroethane	**23.57**	NA	NA	NA	NA	NA
o - Xylene	*6.79*	5.89	6.73	6.52	3.46	3.66
1,3,5-Trimethylbenzene	*10.17*	NA	7.97	NA	5.19	1.91
1,2,4-Trimethylbenzene	*8.96*	12.56	7.65	7.80	5.36	2.63
m - Dichlorobenzene	**16.15**	NA	NA	9.43	NA	NA
Chloromethylbenzene	*12.13*	NA	NA	NA	NA	NA
p - Dichlorobenzene	*9.33*	7.86	10.47	2.02	6.91	2.11
o - Dichlorobenzene	**19.33**	NA	NA	12.86	NA	NA
1,2,4-Trichlorobenzene	**23.35**	NA	**28.28**	**16.97**	11.22	NA
Hexachloro-1,3-Butadiene	**18.51**	NA	NA	**23.57**	14.14	NA
Average	*8.46*	*7.89*	*9.09*	*7.98*	*6.20*	*4.80*

Table 23-11. SNMOC Analytical Precision:
136 Replicate Analyses for all Duplicate Samples, Including all Post-Katrina Data

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	128	11.87	0.61	7.48
Acetylene	135	10.67	0.34	6.49
Ethane	135	14.42	1.24	4.63
Propylene	136	8.12	0.16	4.82
Propane	136	2.53	0.64	1.81
Propyne	0	NA	NA	NA
Isobutane	136	3.49	0.28	2.37
Isobutene/1-Butene	136	7.87	0.10	5.08
1,3-Butadiene	71	**26.96**	0.06	**17.40**
n-Butane	136	2.49	0.64	1.68
trans-2-Butene	100	13.71	0.06	10.06
cis-2-Butene	100	10.46	0.06	7.88
3-Methyl-1-butene	19	9.97	0.03	7.35
Isopentane	135	5.85	0.95	3.40
1-Pentene	100	**41.59**	0.34	18.15
2-Methyl-1-butene	91	11.43	0.08	7.26
n-Pentane	136	6.49	0.39	3.48
Isoprene	118	10.26	0.20	7.01
trans-2-Pentene	108	11.70	0.07	8.27
cis-2-Pentene	101	12.35	0.05	8.19
2-Methyl-2-butene	96	8.62	0.08	6.11
2,2-Dimethylbutane	121	12.26	0.07	8.18
Cyclopentene	21	**33.61**	0.13	**21.79**
4-Methyl-1-pentene	3	NA	0.14	NA
Cyclopentane	127	19.71	0.07	11.50
2,3-Dimethylbutane	127	11.24	0.12	7.07
2-Methylpentane	136	5.69	0.31	3.89
3-Methylpentane	135	18.53	0.23	10.75
2-Methyl-1-pentene	25	13.54	14.04	9.26
1-Hexene	99	21.65	0.09	13.62
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	136	10.08	0.18	6.45
trans-2-Hexene	15	21.67	0.07	13.02
cis-2-Hexene	1	NA	NA	NA
Methylcyclopentane	136	7.64	0.10	4.84
2,4-Dimethylpentane	111	12.89	0.11	8.01
Benzene	136	6.15	0.16	4.11

Table 23-11. SNMOC Analytical Precision:
136 Replicate Analyses for all Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Cyclohexane	122	19.33	0.10	12.15
2-Methylhexane	118	**34.17**	0.24	**23.88**
2,3-Dimethylpentane	126	22.26	0.26	14.68
3-Methylhexane	135	12.64	0.16	7.89
1-Heptene	58	9.14	0.03	6.76
2,2,4-Trimethylpentane	130	10.19	0.23	6.15
n-Heptane	135	**56.62**	0.12	9.00
Methylcyclohexane	126	14.86	0.08	7.45
2,2,3-Trimethylpentane	53	10.62	0.10	7.12
2,3,4-Trimethylpentane	108	22.16	0.11	8.70
Toluene	136	6.79	0.33	4.31
2-Methylheptane	97	14.42	0.05	8.89
3-Methylheptane	101	21.84	0.07	13.27
1-Octene	51	11.71	0.04	7.74
n-Octane	126	13.24	0.05	7.03
Ethylbenzene	136	8.94	0.11	6.21
m,p-Xylene	136	9.89	0.19	6.21
Styrene	102	15.01	0.11	10.59
o-Xylene	136	9.66	0.09	6.71
1-Nonene	67	22.08	0.08	13.87
n-Nonane	115	11.33	0.07	8.76
Isopropylbenzene	65	12.47	0.03	8.26
a-Pinene	88	8.28	0.22	6.09
n-Propylbenzene	101	14.68	0.07	11.49
m-Ethyltoluene	111	22.62	0.11	12.33
p-Ethyltoluene	110	13.97	0.09	10.76
1,3,5-Trimethylbenzene	106	9.35	0.06	6.87
o-Ethyltoluene	100	17.43	0.06	14.48
b-Pinene	9	8.60	0.34	5.59
1,2,4-Trimethylbenzene	113	9.05	0.12	7.35
1-Decene	0	NA	NA	NA
n-Decane	104	14.44	0.13	11.47
1,2,3-Trimethylbenzene	82	18.36	0.09	12.26
m-Diethylbenzene	59	23.38	0.10	**15.09**
p-Diethylbenzene	72	21.50	0.10	14.20
1-Undecene	11	24.77	0.07	**22.54**
n-Undecane	85	16.99	0.19	10.64

Table 23-11. SNMOC Analytical Precision:
136 Replicate Analyses for all Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
1-Dodecene	9	17.84	0.47	14.91
n-Dodecane	54	18.56	0.27	14.93
1-Tridecene	0	NA	NA	NA
n-Tridecane	2	2.48	0.004	1.74
TNMOC (speciated)	136	7.86	10.50	7.16
TNMOC (w/ unknowns)	136	4.78	13.94	3.21

Table 23-12. SNMOC Analytical Precision:
32 Replicate Analyses for Duplicate Samples in Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	32	11.75	0.27	10.23
Acetylene	32	7.63	0.27	5.54
Ethane	32	3.70	0.34	2.69
Propylene	32	2.60	0.07	1.87
Propane	32	2.34	0.29	1.70
Propyne	0	NA	NA	NA
Isobutane	32	2.00	0.29	1.46
Isobutene/1-Butene	32	5.58	0.07	3.72
1,3-Butadiene	20	16.52	0.03	11.27
n-Butane	32	2.04	0.23	1.48
trans-2-Butene	32	12.55	0.06	8.53
cis-2-Butene	30	7.53	0.03	5.25
3-Methyl-1-butene	8	7.87	0.02	5.38
Isopentane	31	1.88	0.67	1.36
1-Pentene	24	**49.65**	0.17	**16.35**
2-Methyl-1-butene	28	6.56	0.04	4.79
n-Pentane	32	2.46	0.15	1.74
Isoprene	28	13.15	0.07	8.98
trans-2-Pentene	28	8.20	0.04	5.83
cis-2-Pentene	28	6.58	0.02	4.59
2-Methyl-2-butene	28	4.83	0.02	3.46
2,2-Dimethylbutane	28	6.30	0.04	4.54
Cyclopentene	5	21.43	0.13	**19.28**
4-Methyl-1-pentene	0	NA	NA	NA
Cyclopentane	31	18.89	0.05	7.56
2,3-Dimethylbutane	31	4.62	0.06	3.31
2-Methylpentane	32	4.37	0.09	2.97
3-Methylpentane	32	7.69	0.16	5.45
2-Methyl-1-pentene	7	10.70	0.05	8.14
1-Hexene	24	15.33	0.07	10.61
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	32	6.63	0.16	4.45
trans-2-Hexene	5	**34.40**	0.08	**19.28**
cis-2-Hexene	1	NA	NA	NA
Methylcyclopentane	32	3.12	0.04	2.28
2,4-Dimethylpentane	28	3.17	0.03	2.17
Benzene	32	8.40	0.18	5.54

Table 23-12. SNMOC Analytical Precision:
32 Replicate Analyses for Duplicate Samples in Bountiful, UT (BTUT) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Cyclohexane	29	5.90	0.10	4.15
2-Methylhexane	32	14.97	0.10	8.68
2,3-Dimethylpentane	31	7.78	0.14	5.31
3-Methylhexane	32	9.67	0.12	5.94
1-Heptene	14	10.81	0.06	7.87
2,2,4-Trimethylpentane	30	4.13	0.15	2.77
n-Heptane	32	**272.83**	0.24	12.55
Methylcyclohexane	32	4.59	0.06	3.21
2,2,3-Trimethylpentane	16	7.71	0.04	5.33
2,3,4-Trimethylpentane	28	**66.26**	0.09	11.57
Toluene	32	5.98	0.28	4.12
2-Methylheptane	28	8.34	0.04	5.29
3-Methylheptane	28	18.61	0.07	11.40
1-Octene	18	16.48	0.06	10.64
n-Octane	28	3.21	0.04	2.24
Ethylbenzene	32	4.72	0.04	3.26
m,p-Xylene	32	4.17	0.09	2.86
Styrene	22	15.99	0.24	**16.09**
o-Xylene	32	5.99	0.06	4.08
1-Nonene	19	**51.96**	0.17	**21.18**
n-Nonane	27	5.81	0.05	3.92
Isopropylbenzene	13	13.08	0.03	8.46
a-Pinene	13	11.68	0.06	9.48
n-Propylbenzene	23	9.21	0.04	6.32
m-Ethyltoluene	27	6.95	0.05	4.98
p-Ethyltoluene	27	6.34	0.05	4.23
1,3,5-Trimethylbenzene	26	8.76	0.04	6.44
o-Ethyltoluene	26	9.29	0.04	6.68
b-Pinene	0	NA	NA	NA
1,2,4-Trimethylbenzene	27	6.77	0.10	4.95
1-Decene	0	NA	NA	NA
n-Decane	24	9.43	0.06	7.10
1,2,3-Trimethylbenzene	22	15.25	0.06	10.03
m-Diethylbenzene	11	**32.12**	0.09	**21.36**
p-Diethylbenzene	8	**28.81**	0.12	**25.01**
1-Undecene	0	NA	NA	NA
n-Undecane	18	7.21	0.12	5.47

Table 23-12. SNMOC Analytical Precision:
32 Replicate Analyses for Duplicate Samples in Bountiful, UT (BTUT) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
1-Dodecene	1	NA	NA	NA
n-Dodecane	12	**28.39**	0.34	**21.63**
1-Tridecene	0	NA	NA	NA
n-Tridecane	0	NA	NA	NA
TNMOC (speciated)	32	2.07	2.66	1.49
TNMOC (w/ unknowns)	32	5.96	9.12	3.90

Table 23-13. SNMOC Analytical Precision:
16 Replicate Analyses for Collocated Samples in North Brook, IL (NBIL)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	16	**38.40**	1.66	**22.23**
Acetylene	16	4.83	0.86	3.28
Ethane	16	3.72	4.60	2.84
Propylene	16	23.05	0.61	11.49
Propane	16	5.33	2.94	4.27
Propyne	0	NA	NA	NA
Isobutane	16	7.91	1.06	5.29
Isobutene/1-Butene	16	21.12	0.37	12.52
1,3-Butadiene	8	**56.67**	0.12	**31.22**
n-Butane	16	4.54	3.01	3.04
trans-2-Butene	11	**33.02**	0.11	**26.68**
cis-2-Butene	11	22.08	0.12	**18.92**
3-Methyl-1-butene	0	NA	NA	NA
Isopentane	16	21.37	4.39	10.94
1-Pentene	14	**34.78**	0.21	**36.20**
2-Methyl-1-butene	10	15.64	0.20	11.96
n-Pentane	16	**25.23**	1.83	11.39
Isoprene	16	9.91	0.84	7.76
trans-2-Pentene	15	23.58	0.21	**16.56**
cis-2-Pentene	15	**33.20**	0.13	**21.15**
2-Methyl-2-butene	11	8.57	0.21	6.15
2,2-Dimethylbutane	16	**25.48**	0.20	**17.28**
Cyclopentene	1	NA	NA	NA
4-Methyl-1-pentene	0	NA	NA	NA
Cyclopentane	16	**43.35**	0.19	**24.80**
2,3-Dimethylbutane	16	**27.12**	0.50	**15.27**
2-Methylpentane	16	9.44	1.46	6.25
3-Methylpentane	16	**39.97**	0.65	**20.35**
2-Methyl-1-pentene	0	NA	NA	NA
1-Hexene	13	**22.47**	0.12	14.70
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	16	21.31	0.61	12.85
trans-2-Hexene	0	NA	NA	NA
cis-2-Hexene	0	NA	NA	NA
Methylcyclopentane	16	20.11	0.41	11.17
2,4-Dimethylpentane	16	**30.38**	0.41	15.00
Benzene	16	8.49	0.47	5.57

Table 23-13. SNMOC Analytical Precision:
16 Replicate Analyses for Collocated Samples in North Brook, IL (NBIL) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Cyclohexane	16	**29.46**	0.18	**17.58**
2-Methylhexane	15	**66.88**	0.33	**33.98**
2,3-Dimethylpentane	16	**46.86**	0.65	**24.18**
3-Methylhexane	16	19.58	0.41	11.23
1-Heptene	0	NA	NA	NA
2,2,4-Trimethylpentane	16	**25.41**	0.99	12.40
n-Heptane	16	15.22	0.23	8.81
Methylcyclohexane	16	**50.96**	0.27	**17.89**
2,2,3-Trimethylpentane	12	23.80	0.18	14.49
2,3,4-Trimethylpentane	16	**32.53**	0.33	**16.59**
Toluene	16	16.40	1.08	9.01
2-Methylheptane	16	**46.91**	0.12	**26.47**
3-Methylheptane	16	**48.54**	0.11	**25.47**
1-Octene	0	NA	NA	NA
n-Octane	16	19.79	0.15	10.74
Ethylbenzene	16	16.08	0.23	9.64
m,p-Xylene	16	23.78	0.61	12.51
Styrene	16	13.73	0.13	9.13
o-Xylene	16	11.96	0.26	8.50
1-Nonene	9	**34.58**	0.11	**29.17**
n-Nonane	16	21.68	0.23	**21.12**
Isopropylbenzene	6	3.70	0.05	2.68
a-Pinene	15	8.08	0.62	5.93
n-Propylbenzene	16	14.38	0.09	11.09
m-Ethyltoluene	16	**27.11**	0.22	**20.21**
p-Ethyltoluene	16	19.89	0.16	**18.34**
1,3,5-Trimethylbenzene	15	11.40	0.16	10.21
o-Ethyltoluene	16	**47.11**	0.21	**47.74**
b-Pinene	1	NA	NA	NA
1,2,4-Trimethylbenzene	16	13.58	0.31	11.71
1-Decene	0	NA	NA	NA
n-Decane	15	23.61	0.44	**23.80**
1,2,3-Trimethylbenzene	13	20.78	0.15	**15.28**
m-Diethylbenzene	4	NA	0.23	NA
p-Diethylbenzene	5	**58.19**	0.13	**31.87**
1-Undecene	1	NA	NA	NA
n-Undecane	13	12.79	0.17	9.25

Table 23-13. SNMOC Analytical Precision:
16 Replicate Analyses for Collocated Samples in North Brook, IL (NBIL) (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
1-Dodecene	1	NA	NA	NA
n-Dodecane	8	10.85	0.13	8.11
1-Tridecene	0	NA	NA	NA
n-Tridecane	0	NA	NA	NA
TNMOC (speciated)	16	**29.29**	45.18	**29.62**
TNMOC (w/ unknowns)	12	4.54	7.00	3.20

Table 23-14. SNMOC Analytical Precision:
88 Replicate Analyses for Duplicate Samples Only

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	88	5.26	0.11	4.19
Acetylene	88	10.47	0.15	6.62
Ethane	88	1.89	0.14	1.36
Propylene	88	4.92	0.06	3.40
Propane	88	1.43	0.14	1.02
Propyne	0	NA	NA	NA
Isobutane	88	2.09	0.10	1.48
Isobutene/1-Butene	88	5.10	0.04	3.57
1,3-Butadiene	38	23.08	0.05	**16.08**
n-Butane	88	1.71	0.10	1.21
trans-2-Butene	65	9.51	0.05	6.47
cis-2-Butene	61	7.98	0.05	5.61
3-Methyl-1-butene	12	5.37	0.02	3.69
Isopentane	87	2.51	0.24	1.80
1-Pentene	58	**49.07**	0.44	**15.38**
2-Methyl-1-butene	53	6.49	0.05	4.75
n-Pentane	88	2.25	0.07	1.63
Isoprene	73	11.04	0.07	7.18
trans-2-Pentene	66	10.06	0.05	7.16
cis-2-Pentene	61	7.89	0.03	5.39
2-Methyl-2-butene	56	7.25	0.04	5.26
2,2-Dimethylbutane	75	8.96	0.03	5.80
Cyclopentene	16	**33.21**	0.13	**22.92**
4-Methyl-1-pentene	3	NA	0.14	NA
Cyclopentane	83	15.57	0.05	8.89
2,3-Dimethylbutane	79	7.84	0.04	5.39
2-Methylpentane	88	4.40	0.06	3.11
3-Methylpentane	87	15.35	0.15	9.20
2-Methyl-1-pentene	12	16.02	21.03	10.73
1-Hexene	63	20.59	0.09	13.14
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	88	8.15	0.10	5.33
trans-2-Hexene	11	22.95	0.09	13.36
cis-2-Hexene	1	NA	NA	NA
Methylcyclopentane	88	4.81	0.03	3.40
2,4-Dimethylpentane	67	8.64	0.05	6.05
Benzene	88	5.57	0.08	3.73

Table 23-14. SNMOC Analytical Precision:
88 Replicate Analyses for Duplicate Samples Only (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
Cyclohexane	74	17.79	0.09	11.43
2-Methylhexane	75	**32.70**	0.27	**26.04**
2,3-Dimethylpentane	82	19.31	0.21	14.32
3-Methylhexane	87	12.04	0.13	7.62
1-Heptene	36	6.87	0.03	5.05
2,2,4-Trimethylpentane	82	6.61	0.07	4.56
n-Heptane	87	**78.94**	0.11	9.79
Methylcyclohexane	78	7.87	0.05	5.50
2,2,3-Trimethylpentane	22	6.48	0.09	4.62
2,3,4-Trimethylpentane	64	22.84	0.07	7.23
Toluene	88	4.56	0.13	3.19
2-Methylheptane	53	7.94	0.03	5.38
3-Methylheptane	57	18.09	0.07	11.61
1-Octene	39	12.76	0.05	8.29
n-Octane	78	12.61	0.03	6.23
Ethylbenzene	88	7.22	0.08	5.44
m,p-Xylene	88	7.03	0.10	4.97
Styrene	54	16.41	0.12	11.96
o-Xylene	88	8.43	0.05	5.83
1-Nonene	33	19.77	0.08	10.09
n-Nonane	68	10.24	0.04	6.92
Isopropylbenzene	37	13.10	0.02	8.82
a-Pinene	41	8.83	0.14	6.53
n-Propylbenzene	57	15.67	0.07	12.43
m-Ethyltoluene	63	**25.78**	0.09	12.46
p-Ethyltoluene	63	13.98	0.08	10.13
1,3,5-Trimethylbenzene	61	9.37	0.03	6.45
o-Ethyltoluene	56	11.95	0.03	8.17
b-Pinene	8	8.60	0.35	5.59
1,2,4-Trimethylbenzene	65	7.77	0.07	6.09
1-Decene	0	NA	NA	NA
n-Decane	61	11.42	0.06	8.42
1,2,3-Trimethylbenzene	45	18.96	0.06	12.01
m-Diethylbenzene	32	20.31	0.07	13.91
p-Diethylbenzene	35	13.62	0.10	10.51
1-Undecene	6	**27.98**	0.09	**26.36**
n-Undecane	54	18.17	0.21	10.82

Table 23-14. SNMOC Analytical Precision:
88 Replicate Analyses for Duplicate Samples Only (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbC)	Coefficient of Variation (%)
1-Dodecene	7	17.84	0.63	14.91
n-Dodecane	35	21.39	0.34	**17.76**
1-Tridecene	0	NA	NA	NA
n-Tridecane	2	2.48	0.004	1.74
TNMOC (speciated)	88	2.36	1.90	1.67
TNMOC (w/ unknowns)	88	4.39	6.11	2.97

Table 23-15. SNMOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulf Port, MS (GPMS)	North Brook, IL (NBIL)	Pascagoula, MS (PGMS)	Sioux Falls, SD (SFSD)
Ethylene	*7.48*	10.23	2.15	5.90	22.23	2.38	1.98
Acetylene	*6.49*	5.54	9.09	9.17	3.28	3.68	8.15
Ethane	*4.63*	2.69	0.91	19.53	2.84	0.46	1.38
Propylene	*4.82*	1.87	4.30	3.82	11.49	3.42	3.99
Propane	*1.81*	1.70	1.10	2.48	4.27	0.19	1.11
Propyne	*NA*	NA	NA	NA	NA	NA	NA
Isobutane	*2.37*	1.46	1.44	2.98	5.29	1.44	1.60
Isobutene/1-Butene	*5.08*	3.72	3.27	3.64	12.52	2.89	4.42
1,3-Butadiene	**17.40**	11.27	**15.94**	8.86	**31.22**	**28.41**	8.70
n-Butane	*1.68*	1.48	1.11	2.22	3.04	0.52	1.74
trans-2-Butene	*10.06*	8.53	6.88	7.84	**26.68**	6.16	4.30
cis-2-Butene	*7.88*	5.25	9.04	5.95	**18.92**	3.33	4.82
3-Methyl-1-butene	*7.35*	5.38	2.01	14.66	NA	NA	NA
Isopentane	*3.40*	1.36	2.37	2.26	10.94	1.93	1.55
1-Pentene	**18.15**	**16.35**	**27.44**	11.16	**36.20**	13.67	4.08
2-Methyl-1-butene	*7.26*	4.79	8.11	12.61	11.96	2.94	3.16
n-Pentane	*3.48*	1.74	1.79	2.96	11.39	0.39	2.60
Isoprene	*7.01*	8.98	13.74	5.57	7.76	2.61	3.40
trans-2-Pentene	*8.27*	5.83	11.08	4.40	**16.56**	4.64	7.08
cis-2-Pentene	*8.19*	4.59	5.54	6.43	**21.15**	4.42	7.01
2-Methyl-2-butene	*6.11*	3.46	7.57	8.61	6.15	NA	4.75
2,2-Dimethylbutane	*8.18*	4.54	6.59	8.59	17.28	2.16	9.91
Cyclopentene	**21.79**	**19.28**	**20.23**	**18.40**	NA	NA	**29.25**
4-Methyl-1-pentene	*NA*	NA	NA	NA	NA	NA	NA
Cyclopentane	*11.50*	7.56	9.43	8.66	**24.80**	5.96	12.61
2,3-Dimethylbutane	*7.07*	3.31	7.16	5.60	**15.27**	2.57	8.49
2-Methylpentane	*3.89*	2.97	2.99	4.66	6.25	0.97	5.53
3-Methylpentane	*10.75*	5.45	10.24	7.35	**20.35**	5.30	**15.80**
2-Methyl-1-pentene	*9.26*	8.14	13.33	6.32	NA	NA	NA
1-Hexene	*13.62*	10.61	10.03	14.48	14.70	**17.18**	14.76
2-Ethyl-1-butene	*NA*	NA	NA	NA	NA	NA	NA
n-Hexane	*6.45*	4.45	6.57	4.55	12.85	2.59	7.70
trans-2-Hexene	*13.02*	19.28	7.43	12.34	NA	NA	NA
cis-2-Hexene	*NA*	NA	NA	NA	NA	NA	NA
Methylcyclopentane	*4.84*	2.28	4.07	4.28	11.17	2.97	4.29
2,4-Dimethylpentane	*8.01*	2.17	7.88	8.85	15.00	10.19	3.98
Benzene	*4.11*	5.54	5.47	4.15	5.57	0.64	3.27

Table 23-15. SNMOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulf Port, MS (GPMS)	North Brook, IL (NBIL)	Pascagoula, MS (PGMS)	Sioux Falls, SD (SFSD)
Cyclohexane	*12.15*	4.15	14.17	9.60	**17.58**	**15.23**	12.16
2-Methylhexane	**23.88**	8.68	**21.28**	5.14	**33.98**	**55.41**	**18.80**
2,3-Dimethylpentane	*14.68*	5.31	12.49	6.61	24.18	21.76	17.75
3-Methylhexane	*7.89*	5.94	6.94	5.63	11.23	6.91	10.71
1-Heptene	*6.76*	7.87	3.69	13.61	NA	5.27	3.37
2,2,4-Trimethylpentane	*6.15*	2.77	7.18	6.26	12.40	2.85	5.44
n-Heptane	*9.00*	12.55	9.26	6.06	8.81	4.05	13.30
Methylcyclohexane	*7.45*	3.21	8.09	4.81	**17.89**	3.59	7.10
2,2,3-Trimethylpentane	*7.12*	5.33	NA	7.26	14.49	6.10	2.41
2,3,4-Trimethylpentane	*8.70*	11.57	7.08	6.67	**16.59**	7.09	3.21
Toluene	*4.31*	4.12	5.24	4.09	9.01	0.67	2.73
2-Methylheptane	*8.89*	5.29	7.20	5.37	**26.47**	2.50	6.52
3-Methylheptane	*13.27*	11.40	**15.67**	7.69	**25.47**	4.88	14.49
1-Octene	*7.74*	10.64	7.97	5.52	NA	5.12	9.42
n-Octane	*7.03*	2.24	6.01	6.57	10.74	2.72	13.93
Ethylbenzene	*6.21*	3.26	12.64	5.85	9.64	1.95	3.92
m,p – Xylene	*6.21*	2.86	8.50	4.88	12.51	3.98	4.55
Styrene	*10.59*	**16.09**	10.60	7.95	9.13	NA	9.19
o-Xylene	*6.71*	4.08	7.60	8.46	8.50	4.69	6.94
1-Nonene	*13.87*	**21.18**	9.12	13.67	**29.17**	0.88	9.19
n-Nonane	*8.76*	3.92	7.83	3.77	**21.12**	6.95	8.99
Isopropylbenzene	*8.26*	8.46	7.54	11.59	2.68	4.64	14.62
a-Pinene	*6.09*	9.48	7.00	4.52	5.93	1.35	8.28
n-Propylbenzene	*11.49*	6.32	7.71	8.17	11.09	**27.33**	8.35
m-Ethyltoluene	*12.33*	4.98	5.95	3.91	**20.21**	**34.57**	4.34
p-Ethyltoluene	*10.76*	4.23	9.99	5.68	**18.34**	**17.70**	8.60
1,3,5-Trimethylbenzene	*6.87*	6.44	10.17	5.18	10.21	2.50	6.69
o-Ethyltoluene	*14.48*	6.68	14.88	6.45	**47.74**	5.87	5.24
b-Pinene	*5.59*	NA	1.77	NA	NA	13.62	1.37
1,2,4-Trimethylbenzene	*7.35*	4.95	12.38	8.01	11.71	2.61	4.43
1-Decene	*NA*	NA	NA	NA	NA	NA	NA
n-Decane	*11.47*	7.10	9.03	11.34	**23.80**	7.32	10.22
1,2,3-Trimethylbenzene	*12.26*	10.03	**30.62**	10.24	**15.28**	0.76	6.62
m-Diethylbenzene	**15.09**	**21.36**	10.51	19.81	NA	12.58	11.19
p-Diethylbenzene	*14.20*	**25.01**	9.44	11.30	**31.87**	3.88	3.69
1-Undecene	**22.54**	NA	**60.69**	11.09	NA	14.89	3.51
n-Undecane	*10.64*	5.47	**19.09**	11.32	9.25	2.73	**15.97**

Table 23-15. SNMOC Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulf Port, MS (GPMS)	North Brook, IL (NBIL)	Pascagoula, MS (PGMS)	Sioux Falls, SD (SFSD)
1-Dodecene	*14.91*	NA	2.14	NA	NA	**27.68**	NA
n-Dodecane	*14.93*	**21.63**	**18.15**	10.42	8.11	13.47	**17.80**
1-Tridecene	*NA*	NA	NA	NA	NA	NA	NA
n-Tridecane	*1.74*	NA	1.74	NA	NA	NA	NA
TNMOC (speciated)	*7.16*	1.49	1.80	6.67	**29.62**	1.63	1.78
TNMOC (w/ unknowns)	*3.21*	3.90	4.72	5.36	2.03	0.84	2.41
Average	*9.06*	*7.17*	*9.32*	*7.69*	**15.46**	*7.35*	*7.40*

Table 23-16. Carbonyl Analytical Precision:
708 Replicate Analyses for all Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	708	0.79	0.01	0.55
Acetaldehyde	708	0.81	0.01	0.57
Acetone	708	0.68	0.004	0.48
Propionaldehyde	702	2.52	0.002	1.79
Crotonaldehyde	694	3.11	0.002	2.19
Butyr/Isobutyraldehyde	704	2.67	0.002	1.89
Benzaldehyde	700	3.79	0.001	2.68
Isovaleraldehyde	249	4.68	0.002	3.40
Valeraldehyde	682	3.87	0.001	2.75
Tolualdehydes	642	5.06	0.002	3.35
Hexaldehyde	693	4.33	0.001	2.92
2,5-Dimethylbenzaldehyde	12	NA	0.01	NA

Table 23-17. Carbonyl Analytical Precision:
224 Replicate Analyses for all Collocated Samples

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	224	0.61	0.01	0.43
Acetaldehyde	224	0.57	0.005	0.40
Acetone	224	0.56	0.004	0.39
Propionaldehyde	222	1.97	0.002	1.37
Crotonaldehyde	215	3.75	0.002	2.63
Butyr/Isobutyraldehyde	220	1.97	0.002	1.39
Benzaldehyde	216	4.88	0.001	3.41
Isovaleraldehyde	88	5.63	0.002	3.98
Valeraldehyde	214	4.24	0.001	3.03
Tolualdehydes	211	6.17	0.002	4.44
Hexaldehyde	214	3.59	0.001	2.51
2,5-Dimethylbenzaldehyde	1	NA	NA	NA

Table 23-18. Carbonyl Analytical Precision:
484 Replicate Analyses for all Duplicate Samples, Including all Post-Katrina Data

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	484	0.74	0.01	0.52
Acetaldehyde	484	0.66	0.01	0.46
Acetone	484	0.68	0.005	0.48
Propionaldehyde	480	2.66	0.002	1.90
Crotonaldehyde	479	3.05	0.002	2.15
Butyr/Isobutyraldehyde	484	2.84	0.002	2.02
Benzaldehyde	484	3.52	0.001	2.49
Isovaleraldehyde	161	4.84	0.002	3.46
Valeraldehyde	468	3.83	0.001	2.72
Tolualdehydes	431	6.10	0.002	3.69
Hexaldehyde	479	3.83	0.001	2.66
2,5-Dimethylbenzaldehyde	11	4.50	0.01	3.22

Table 23-19. Carbonyl Analytical Precision:
26 Replicate Analyses for all Duplicate Samples in Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	26	0.46	0.02	0.32
Acetaldehyde	26	0.36	0.01	0.26
Acetone	26	0.34	0.01	0.24
Propionaldehyde	26	1.70	0.004	1.21
Crotonaldehyde	26	4.09	0.002	2.98
Butyr/Isobutyraldehyde	26	2.94	0.01	2.06
Benzaldehyde	26	2.57	0.001	1.82
Isovaleraldehyde	14	4.06	0.01	2.91
Valeraldehyde	26	2.89	0.005	2.07
Tolualdehydes	25	2.00	0.003	1.38
Hexaldehyde	26	2.69	0.002	1.85
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-20. Carbonyl Analytical Precision:
80 Replicate Analyses for Collocated Samples in Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	80	0.59	0.02	0.42
Acetaldehyde	80	0.90	0.01	0.64
Acetone	80	1.06	0.01	0.76
Propionaldehyde	80	1.88	0.002	1.32
Crotonaldehyde	80	3.02	0.002	2.09
Butyr/Isobutyraldehyde	80	3.09	0.004	2.16
Benzaldehyde	80	4.70	0.001	3.30
Isovaleraldehyde	22	2.74	0.01	1.97
Valeraldehyde	80	3.72	0.001	2.59
Tolualdehydes	78	3.53	0.001	2.53
Hexaldehyde	80	3.50	0.001	2.47
2,5-Dimethylbenzaldehyde	1	NA	NA	NA

Table 23-21. Carbonyl Analytical Precision:
30 Replicate Analyses for Duplicate Samples in Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	30	0.73	0.01	0.52
Acetaldehyde	30	0.87	0.01	0.60
Acetone	30	0.46	0.01	0.33
Propionaldehyde	30	2.37	0.002	1.65
Crotonaldehyde	30	3.81	0.002	2.65
Butyr/Isobutyraldehyde	30	2.43	0.003	1.74
Benzaldehyde	30	3.93	0.002	2.83
Isovaleraldehyde	10	8.00	0.001	5.86
Valeraldehyde	30	4.63	0.001	3.22
Tolualdehydes	28	5.09	0.002	3.92
Hexaldehyde	30	4.53	0.001	3.25
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-22. Carbonyl Analytical Precision:
8 Replicate Analyses for Duplicate Samples in Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	8	0.15	0.001	0.10
Acetaldehyde	8	0.28	0.002	0.20
Acetone	8	0.71	0.001	0.51
Propionaldehyde	8	0.87	0.0005	0.62
Crotonaldehyde	6	4.31	0.001	2.95
Butyr/Isobutyraldehyde	6	1.27	0.001	0.89
Benzaldehyde	6	6.71	0.002	4.97
Isovaleraldehyde	6	12.22	0.001	8.57
Valeraldehyde	6	7.97	0.001	6.08
Tolualdehydes	6	12.29	0.002	9.28
Hexaldehyde	6	10.59	0.002	7.23
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-23. Carbonyl Analytical Precision:
30 Replicate Analyses for Duplicate Samples in St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	30	0.75	0.01	0.53
Acetaldehyde	30	0.52	0.005	0.36
Acetone	30	0.84	0.01	0.59
Propionaldehyde	30	2.81	0.003	1.96
Crotonaldehyde	28	2.49	0.002	1.72
Butyr/Isobutyraldehyde	30	2.42	0.002	1.73
Benzaldehyde	30	3.44	0.001	2.44
Isovaleraldehyde	12	0.98	0.0002	0.71
Valeraldehyde	30	4.61	0.001	3.23
Tolualdehydes	30	**44.85**	0.003	12.49
Hexaldehyde	30	4.68	0.001	3.22
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-24. Carbonyl Analytical Precision:
16 Replicate Analyses for Duplicate Samples in Tampa, FL (SKFL)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	16	1.05	0.02	0.73
Acetaldehyde	16	0.84	0.01	0.59
Acetone	16	0.45	0.002	0.32
Propionaldehyde	16	1.85	0.002	1.30
Crotonaldehyde	16	5.01	0.004	3.41
Butyr/Isobutyraldehyde	16	3.37	0.002	2.39
Benzaldehyde	16	4.50	0.002	3.14
Isovaleraldehyde	5	NA	0.001	NA
Valeraldehyde	16	3.48	0.001	2.40
Tolualdehydes	13	4.18	0.003	3.05
Hexaldehyde	16	5.32	0.002	3.83
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-25. Carbonyl Analytical Precision:
20 Replicate Analyses for Duplicate Samples in Tampa, FL (SYFL)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	20	1.38	0.01	0.97
Acetaldehyde	20	2.61	0.01	1.84
Acetone	20	1.46	0.004	1.03
Propionaldehyde	20	4.41	0.004	3.21
Crotonaldehyde	20	4.21	0.003	2.98
Butyr/Isobutyraldehyde	20	3.14	0.002	2.20
Benzaldehyde	20	4.16	0.001	2.95
Isovaleraldehyde	0	NA	NA	NA
Valeraldehyde	20	2.68	0.001	1.87
Tolualdehydes	15	4.39	0.003	3.12
Hexaldehyde	20	4.30	0.001	3.12
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-26. Carbonyl Analytical Precision:
408 Replicate Analyses for all Duplicate Samples Only

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	408	0.78	0.01	0.55
Acetaldehyde	408	0.66	0.01	0.46
Acetone	408	0.73	0.004	0.52
Propionaldehyde	404	2.89	0.002	2.07
Crotonaldehyde	403	3.14	0.002	2.22
Butyr/Isobutyraldehyde	408	2.84	0.002	2.02
Benzaldehyde	408	3.59	0.001	2.54
Isovaleraldehyde	133	4.97	0.002	3.55
Valeraldehyde	392	4.06	0.001	2.89
Tolualdehydes	359	6.69	0.002	4.04
Hexaldehyde	403	4.11	0.001	2.84
2,5-Dimethylbenzaldehyde	11	4.50	0.01	3.22

Table 23-27. Carbonyl Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites

Pollutant	Average	St. Petersburg, FL (AZFL)	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Candor, NC (CANC)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)
Formaldehyde	*0.49*	1.36	0.46	0.32	0.66	0.59	0.44	0.53	0.42	0.45	0.25
Acetaldehyde	*0.44*	0.28	0.40	0.26	0.74	0.49	0.31	0.60	0.64	0.52	0.22
Acetone	*0.45*	0.78	0.39	0.24	0.33	0.29	0.35	0.43	0.76	0.35	0.33
Propionaldehyde	*1.71*	4.02	2.27	1.21	0.20	6.30	2.09	2.31	1.32	2.30	1.62
Crotonaldehyde	*2.33*	1.74	2.31	2.98	3.42	NA	1.20	2.65	2.09	1.76	1.02
Butyr/Isobutyraldehyde	*1.80*	3.69	2.56	2.06	1.00	0.22	1.70	2.66	2.16	1.92	2.01
Benzaldehyde	*2.81*	3.11	2.54	1.82	2.69	1.57	2.58	3.72	3.30	3.49	1.63
Isovaleraldehyde	*3.65*	NA	5.66	2.91	5.24	NA	3.34	3.50	1.97	NA	3.93
Valeraldehyde	*2.83*	1.48	6.77	2.07	2.61	2.21	2.94	2.31	2.59	2.00	1.85
Tolualdehydes	*3.95*	4.37	**15.57**	1.38	4.52	3.67	3.49	2.25	2.53	5.59	1.63
Hexaldehyde	*2.61*	1.11	0.94	1.85	1.53	2.85	2.56	3.44	2.47	1.97	2.59
2,5-Dimethylbenzaldehyde	*3.22*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average	*2.19*	*2.19*	*3.62*	*1.55*	*2.09*	*2.02*	*1.91*	*2.22*	*1.84*	*2.03*	*1.55*

Table 23-27. Carbonyl Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Birmingham, AL (ETAL)	Boward Co., FL (FLFL)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Grenada, MS (GRMS)	Loudon, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	Northbrook, IL (NBIL)
Formaldehyde	*0.49*	0.46	0.36	0.60	0.52	0.52	0.33	0.52	0.47	0.32	0.10
Acetaldehyde	*0.44*	0.37	NA	0.78	0.60	0.63	0.17	0.16	0.50	0.13	0.20
Acetone	*0.45*	NA	0.81	1.37	0.33	0.52	0.09	0.27	0.43	0.04	0.51
Propionaldehyde	*1.71*	1.58	0.84	1.28	1.65	1.07	0.85	1.36	0.70	1.81	0.62
Crotonaldehyde	*2.33*	4.10	2.04	2.36	2.65	1.89	NA	1.72	1.88	3.72	2.95
Butyr/Isobutyraldehyde	*1.80*	1.12	1.21	1.51	1.74	1.19	5.16	1.23	2.13	0.48	0.89
Benzaldehyde	*2.81*	3.02	2.99	2.44	2.83	1.67	3.07	2.74	1.85	3.86	4.97
Isovaleraldehyde	*3.65*	NA	NA	NA	5.86	3.81	NA	3.68	1.29	4.16	8.57
Valeraldehyde	*2.83*	1.00	2.68	3.42	3.22	2.14	4.16	5.27	3.98	3.54	6.08
Tolualdehydes	*3.95*	4.09	2.69	2.30	3.92	1.15	NA	5.92	1.81	4.56	9.28
Hexaldehyde	*2.61*	2.53	1.81	2.29	3.25	1.91	4.29	2.47	2.62	1.72	7.23
2,5-Dimethylbenzaldehyde	*3.22*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average	*2.19*	*2.03*	*1.72*	*1.84*	*2.42*	*1.50*	*2.27*	*2.31*	*1.61*	*2.21*	*3.76*

Table 23-27. Carbonyl Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	New Brunswick, NJ (NBNJ)	Orlando, FL (ORFL)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	Research Triangle Park, NC (RTPNC)	St. Louis, MO (Site 4 - S4MO)	Tampa, FL (SKFL)	Tampa, FL (SMFL)	Tampa, FL (SYFL)	Sioux Falls, SD (SFSD)
Formaldehyde	*0.49*	0.42	0.54	0.40	0.16	0.73	0.53	0.73	0.28	0.97	0.33
Acetaldehyde	*0.44*	0.27	0.25	0.35	0.09	0.39	0.36	0.59	0.32	1.84	0.12
Acetone	*0.45*	0.33	0.46	0.59	0.33	0.52	0.59	0.32	0.27	1.03	0.40
Propionaldehyde	*1.71*	1.39	1.18	1.45	0.34	4.56	1.96	1.30	0.80	3.21	1.99
Crotonaldehyde	*2.33*	2.17	0.93	2.97	2.14	3.23	1.72	3.41	1.87	2.98	2.91
Butyr/Isobutyraldehyde	*1.80*	1.79	1.39	2.46	0.96	1.94	1.73	2.39	0.81	2.20	1.78
Benzaldehyde	*2.81*	2.19	1.80	2.96	3.82	5.45	2.44	3.14	1.93	2.95	2.44
Isovaleraldehyde	*3.65*	1.31	4.44	2.00	2.28	NA	0.71	NA	1.54	NA	7.44
Valeraldehyde	*2.83*	1.88	2.78	2.66	1.57	1.31	3.23	2.40	2.91	1.87	1.81
Tolualdehydes	*3.95*	0.76	3.10	1.51	2.53	NA	12.49	3.05	2.86	3.12	3.17
Hexaldehyde	*2.61*	2.40	2.58	1.69	1.57	0.43	3.22	3.83	4.53	3.12	2.19
2,5-Dimethylbenzaldehyde	*3.22*	NA	NA	NA	NA	NA	NA	NA	3.22	NA	NA
Average	*2.19*	*1.35*	*1.77*	*1.73*	*1.43*	*2.06*	*2.64*	*2.11*	*1.78*	*2.33*	*2.23*

Table 23-27. Carbonyl Analytical Precision:
Coefficient of Variation for all Replicate Analyses, All Sites (Cont.)

Pollutant	Average	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Formaldehyde	*0.49*	0.35	0.26	0.78	0.51
Acetaldehyde	*0.44*	0.52	0.66	0.26	0.57
Acetone	*0.45*	0.22	0.56	0.15	0.61
Propionaldehyde	*1.71*	0.56	0.54	2.48	1.10
Crotonaldehyde	*2.33*	2.47	1.97	1.19	2.03
Butyr/Isobutyraldehyde	*1.80*	0.34	1.64	2.56	2.50
Benzaldehyde	*2.81*	3.52	1.96	2.95	2.23
Isovaleraldehyde	*3.65*	NA	1.95	NA	4.67
Valeraldehyde	*2.83*	3.05	2.46	2.52	3.31
Tolualdehydes	*3.95*	5.22	3.61	1.44	2.82
Hexaldehyde	*2.61*	3.48	2.43	3.56	2.12
2,5-Dimethylbenzaldehyde	*3.22*	NA	NA	NA	NA
Average	*2.19*	*1.97*	*1.64*	*1.79*	*2.04*

Table 23-28. VOC Sampling and Analytical Precision:
272 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	272	20.05	0.21	12.90
Propylene	271	17.44	0.11	12.71
Dichlorodifluoromethane	271	8.04	0.05	5.11
Chloromethane	272	10.04	0.06	6.56
Dichlorotetrafluoroethane	169	**34.52**	0.01	**21.78**
Vinyl Chloride	22	25.00	0.01	**23.57**
1,3-Butadiene	163	**25.64**	0.02	**18.33**
Bromomethane	149	**28.91**	0.01	**22.67**
Chloroethane	127	**71.82**	0.02	**34.47**
Acetonitrile	95	**36.24**	7.96	**24.38**
Acrolein	61	**53.13**	0.53	**24.98**
Trichlorofluoromethane	270	8.62	0.03	5.56
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	3	NA	0.13	NA
Methylene Chloride	233	**36.64**	0.09	**19.95**
Trichlorotrifluoroethane	272	17.24	0.04	12.59
trans-1,2-Dichloroethylene	2	NA	0.03	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl tert-Butyl Ether	37	14.37	0.08	9.85
Methyl Ethyl Ketone	63	**62.89**	0.39	**36.69**
Chloroprene	1	NA	NA	NA
cis-1,2-Dichloroethylene	1	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	116	**52.12**	0.02	**26.11**
Ethyl *tert*-Butyl Ether	1	NA	NA	NA
1,2-Dichloromethane	4	NA	0.03	NA
1,1,1-Trichloroethane	187	**26.84**	0.01	14.12
Benzene	272	15.34	0.05	10.75
Carbon Tetrachloride	254	15.12	0.02	9.87
tert-Amyl Methyl Ether	1	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	5	NA	0.01	NA
Trichloroethylene	74	**33.93**	0.01	**20.79**
Methyl Methacrylate	7	**28.85**	0.09	**18.93**
cis-1,3-Dichloropropene	0	NA	NA	NA
Methyl Isobutyl Ketone	39	**44.40**	0.07	**25.56**

Table 23-28. VOC Sampling and Analytical Precision:
272 Duplicate and Collocated Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2 -Trichloroethane	0	NA	NA	NA
Toluene	272	18.93	0.15	12.98
Dibromochloromethane	6	NA	0.02	NA
1,2-Dibromoethane	2	NA	0.04	NA
n-Octane	165	**120.25**	0.04	**24.64**
Tetrachloroethylene	158	24.16	0.03	15.07
Chlorobenzene	9	20.00	0.02	**17.68**
Ethylbenzene	266	19.91	0.03	**15.40**
m,p-Xylene	271	19.50	0.06	14.53
Bromoform	0	NA	NA	NA
Styrene	205	**25.19**	0.06	**19.74**
1,1,2,2-Tetrachloroethane	5	**100.00**	0.01	**47.14**
o-Xylene	267	20.02	0.03	14.96
1,3,5-Trimethylbenzene	207	21.72	0.01	**15.34**
1,2,4-Trimethylbenzene	222	22.79	0.03	**16.76**
m-Dichlorobenzene	9	NA	0.04	NA
Chloromethylbenzene	3	NA	0.08	NA
p-Dichlorobenzene	128	**31.85**	0.02	**20.89**
o-Dichlorobenzene	8	NA	0.03	NA
1,2,4-Trichlorobenzene	37	**54.17**	0.04	**24.92**
Hexachloro-1,3-Butadiene	55	**58.33**	0.01	**28.60**

Table 23-29. VOC Sampling and Analytical Precision: 58 Collocated Samples

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	58	**29.87**	0.30	**18.81**
Propylene	57	**25.46**	0.13	**18.20**
Dichlorodifluoromethane	57	12.06	0.07	6.87
Chloromethane	58	14.05	0.07	8.30
Dichlorotetrafluoroethane	45	**47.22**	0.01	**25.30**
Vinyl Chloride	5	NA	0.02	NA
1,3-Butadiene	35	**38.70**	0.02	**29.06**
Bromomethane	35	**35.65**	0.02	**26.33**
Chloroethane	28	**73.89**	0.02	**33.08**
Acetonitrile	15	**59.81**	7.74	**31.81**
Acrolein	11	**194.89**	1.18	**56.01**
Trichlorofluoromethane	56	12.86	0.04	7.60
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	47	**65.70**	0.06	**27.84**
Trichlorotrifluoroethane	58	**28.14**	0.07	**20.55**
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	2	25.00	0.01	**15.71**
Methyl Ethyl Ketone	19	**53.85**	0.43	**35.12**
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	34	**101.01**	0.04	**39.21**
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloromethane	0	NA	NA	NA
1,1,1-Trichloroethane	48	**53.50**	0.01	**23.92**
Benzene	58	21.60	0.07	14.36
Carbon Tetrachloride	58	18.21	0.01	9.52
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	4	NA	NA	NA
Trichloroethylene	27	**43.15**	0.01	**22.36**
Methyl Methacrylate	1	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
Methyl Isobutyl Ketone	16	**46.17**	0.06	**23.14**
trans-1,3-Dichloropropene	0	NA	NA	NA

Table 23-29. VOC Sampling and Analytical Precision: 58 Collocated Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
1,1,2 -Trichloroethane	0	NA	NA	NA
Toluene	58	**26.71**	0.23	**18.39**
Dibromochloromethane	5	NA	0.01	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	27	**37.87**	0.03	**33.19**
Tetrachloroethylene	35	**51.52**	0.06	**24.85**
Chlorobenzene	7	20.00	0.02	**17.68**
Ethylbenzene	56	**27.69**	0.03	**21.63**
m,p-Xylene	58	**28.56**	0.10	**21.74**
Bromoform	0	NA	NA	NA
Styrene	43	**34.79**	0.03	**25.13**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	56	**29.33**	0.04	**22.36**
1,3,5-Trimethylbenzene	47	**31.81**	0.02	**20.61**
1,2,4-Trimethylbenzene	49	**32.44**	0.03	**23.88**
m-Dichlorobenzene	3	NA	0.03	NA
Chloromethylbenzene	1	NA	NA	NA
p-Dichlorobenzene	35	**44.66**	0.02	**30.37**
o-Dichlorobenzene	3	NA	0.03	NA
1,2,4-Trichlorobenzene	12	25.00	0.05	14.82
Hexachloro-1,3-Butadiene	9	**33.33**	0.01	**15.71**

Table 23-30. VOC Sampling and Analytical Precision: 214 Duplicate Samples, Including all Post-Katrina Data

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	214	13.90	0.16	9.21
Propylene	214	12.43	0.10	9.28
Dichlorodifluoromethane	214	5.54	0.04	4.00
Chloromethane	214	7.54	0.06	5.47
Dichlorotetrafluoroethane	124	18.65	0.01	**17.38**
Vinyl Chloride	17	25.00	0.01	**23.57**
1,3-Butadiene	128	16.14	0.02	10.53
Bromomethane	114	**26.89**	0.01	**21.57**
Chloroethane	99	**71.20**	0.02	**34.88**
Acetonitrile	80	**27.82**	8.03	**21.73**
Acrolein	50	**27.36**	0.37	**19.34**
Trichlorofluoromethane	214	5.96	0.02	4.29
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	3	NA	0.13	NA
Methylene Chloride	186	21.14	0.12	**15.74**
Trichlorotrifluoroethane	214	10.44	0.01	7.62
trans-1,2-Dichloroethylene	2	NA	0.03	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	35	11.71	0.10	8.39
Methyl Ethyl Ketone	44	**68.06**	0.37	**37.59**
Chloroprene	1	NA	NA	NA
cis-1,2-Dichloroethylene	1	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	82	**27.67**	0.01	**19.55**
Ethyl *tert*-Butyl Ether	1	NA	NA	NA
1,2-Dichloroethane	4	NA	0.03	NA
1,1,1-Trichloroethane	139	12.30	0.01	8.77
Benzene	214	11.43	0.04	8.49
Carbon Tetrachloride	196	13.58	0.02	10.04
tert-Amyl Methyl Ether	1	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	1	NA	NA	NA
Trichloroethylene	47	**27.02**	0.01	**19.61**
Methyl Methacrylate	6	**28.85**	0.12	**18.93**
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-30. VOC Sampling and Analytical Precision: 214 Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	23	**42.02**	0.08	**28.78**
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	214	14.07	0.10	9.59
Dibromochloromethane	1	NA	NA	NA
1,2-Dibromoethane	2	NA	0.04	NA
n-Octane	138	**158.27**	0.05	**20.69**
Tetrachloroethylene	123	14.21	0.01	11.52
Chlorobenzene	2	NA	0.02	NA
Ethylbenzene	210	14.72	0.02	11.24
m,p-Xylene	213	14.40	0.04	10.47
Bromoform	0	NA	NA	NA
Styrene	162	20.07	0.08	**16.87**
1,1,2,2-Tetrachloroethane	5	**100.00**	0.01	**47.14**
o-Xylene	211	14.78	0.02	10.80
1,3,5-Trimethylbenzene	160	15.84	0.01	12.27
1,2,4-Trimethylbenzene	173	17.01	0.03	12.49
m-Dichlorobenzene	6	NA	0.05	NA
Chloromethylbenzene	2	NA	0.09	NA
p-Dichlorobenzene	93	21.89	0.02	13.52
o-Dichlorobenzene	5	NA	0.04	NA
1,2,4-Trichlorobenzene	25	**83.33**	0.03	**35.02**
Hexachloro-1,3-Butadiene	46	**64.58**	0.01	**31.82**

Table 23-31. VOC Sampling and Analytical Precision:
16 Duplicate Samples in Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	16	7.99	0.10	5.99
Propylene	16	6.11	0.05	4.52
Dichlorodifluoromethane	16	6.64	0.04	5.22
Chloromethane	16	7.70	0.05	6.11
Dichlorotetrafluoroethane	10	10.00	0.004	9.43
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	9	1.92	0.02	1.41
Bromomethane	6	16.67	0.002	**15.71**
Chloroethane	6	**50.00**	0.01	**31.43**
Acetonitrile	3	0.97	1.30	0.69
Acrolein	3	19.30	0.25	**15.10**
Trichlorofluoromethane	16	5.46	0.02	4.26
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	14	14.17	0.01	11.00
Trichlorotrifluoroethane	16	8.53	0.01	6.52
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	2	NA	0.36	NA
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	4	25.00	0.01	14.14
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	10	13.33	0.001	14.14
Benzene	16	6.12	0.03	4.50
Carbon Tetrachloride	15	**26.79**	0.03	**18.71**
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	4	16.67	0.01	10.10
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
Methyl Isobutyl Ketone	0	NA	NA	NA

Table 23-31. VOC Sampling and Analytical Precision:
16 Duplicate Samples in Bountiful, UT (BTUT) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	16	6.49	0.08	4.65
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	12	14.08	0.03	11.66
Tetrachloroethylene	11	NA	0.003	NA
Chlorobenzene	1	NA	NA	NA
Ethylbenzene	16	6.57	0.01	4.63
m,p-Xylene	16	7.19	0.04	5.16
Bromoform	0	NA	NA	NA
Styrene	11	3.33	0.01	2.57
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	16	10.11	0.02	7.52
1,3,5-Trimethylbenzene	11	5.00	0.01	4.04
1,2,4-Trimethylbenzene	12	14.71	0.05	9.23
m-Dichlorobenzene	0	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	4	**50.00**	0.01	**23.57**
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	0	NA	NA	NA
Hexachloro-1,3-Butadiene	2	NA	NA	NA

Table 23-32. VOC Sampling and Analytical Precision: 6 Collocated Samples in Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	6	**57.72**	0.42	**25.22**
Propylene	6	**50.28**	0.18	**22.18**
Dichlorodifluoromethane	6	3.61	0.02	2.53
Chloromethane	6	10.93	0.07	7.15
Dichlorotetrafluoroethane	6	11.11	0.00	9.43
Vinyl Chloride	2	NA	0.02	NA
1,3-Butadiene	6	**37.04**	0.01	**18.19**
Bromomethane	5	12.50	0.01	10.10
Chloroethane	5	**120.00**	0.03	**53.03**
Acetonitrile	5	**193.98**	23.17	**67.00**
Acrolein	3	**237.93**	0.56	**76.84**
Trichlorofluoromethane	5	14.44	0.14	9.41
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	6	23.31	0.03	14.03
Trichlorotrifluoroethane	6	8.86	0.01	6.16
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	2	**65.12**	0.56	**34.74**
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	5	**333.33**	0.14	**88.39**
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	6	25.00	0.01	**16.16**
Benzene	6	**45.95**	0.13	**20.46**
Carbon Tetrachloride	6	8.83	0.01	6.70
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	6	**77.78**	0.01	**33.00**
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
Methyl Isobutyl Ketone	4	**114.58**	0.10	**46.41**

Table 23-32. VOC Sampling and Analytical Precision:
6 Collocated Samples in Detroit, MI (DEMI) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	6	**77.06**	1.23	**33.51**
Dibromochloromethane	1	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	4	**55.00**	0.03	**27.29**
Tetrachloroethylene	6	**72.73**	0.31	**26.54**
Chlorobenzene	4	20.00	0.01	**17.68**
Ethylbenzene	6	**50.82**	0.09	**24.07**
m,p-Xylene	6	**62.24**	0.36	**28.61**
Bromoform	0	NA	NA	NA
Styrene	6	**56.11**	0.06	**22.84**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	6	**61.11**	0.10	**28.96**
1,3,5-Trimethylbenzene	6	**41.45**	0.02	**21.09**
1,2,4-Trimethylbenzene	6	**55.09**	0.06	**23.66**
m-Dichlorobenzene	1	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	5	**112.50**	0.04	**45.46**
o-Dichlorobenzene	1	NA	NA	NA
1,2,4-Trichlorobenzene	1	NA	NA	NA
Hexachloro-1,3-Butadiene	2	NA	0.02	NA

Table 23-33. VOC Sampling and Analytical Precision:
16 Duplicate Samples in Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	16	3.36	0.06	2.22
Propylene	16	20.28	0.14	14.50
Dichlorodifluoromethane	16	5.24	0.03	3.61
Chloromethane	16	4.43	0.03	3.15
Dichlorotetrafluoroethane	10	NA	NA	NA
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	11	5.93	0.04	3.91
Bromomethane	8	**28.57**	0.01	14.50
Chloroethane	7	16.67	0.01	**15.71**
Acetonitrile	8	20.69	15.85	12.98
Acrolein	3	3.77	0.58	2.72
Trichlorofluoromethane	16	6.04	0.02	4.30
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	14	19.99	0.02	11.86
Trichlorotrifluoroethane	16	8.01	0.01	5.11
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	6	**46.88**	0.39	**43.29**
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	5	**30.56**	0.01	**18.30**
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	9	5.00	0.01	3.93
Benzene	16	10.54	0.06	7.76
Carbon Tetrachloride	16	23.73	0.02	14.56
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	3	NA	0.01	NA
Methyl Methacrylate	4	**28.85**	0.13	**18.93**
cis-1,3-Dichloropropene	0	NA	NA	NA
Methyl Isobutyl Ketone	3	**64.71**	0.07	**34.57**

Table 23-33. VOC Sampling and Analytical Precision:
16 Duplicate Samples in Grand Junction, CO (GPCO) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	16	5.61	0.07	3.91
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	13	12.57	0.04	8.87
Tetrachloroethylene	9	6.25	0.01	4.26
Chlorobenzene	0	NA	NA	NA
Ethylbenzene	16	8.22	0.03	5.79
m,p-Xylene	16	6.22	0.06	4.29
Bromoform	0	NA	NA	NA
Styrene	16	23.49	0.09	21.63
1,1,2,2-Tetrachloroethane	2	NA	NA	NA
o-Xylene	16	7.61	0.03	5.34
1,3,5-Trimethylbenzene	14	16.75	0.02	12.38
1,2,4-Trimethylbenzene	14	20.18	0.04	12.67
m-Dichlorobenzene	0	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	5	NA	0.004	NA
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	2	NA	NA	NA
Hexachloro-1,3-Butadiene	4	NA	NA	NA

Table 23-34. VOC Sampling and Analytical Precision:
10 Collocated Samples in North Brook, IL (NBIL)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	10	9.80	0.11	7.78
Propylene	9	19.06	0.18	**15.61**
Dichlorodifluoromethane	9	6.94	0.16	5.21
Chloromethane	10	7.82	0.05	5.86
Dichlorotetrafluoroethane	8	8.33	0.002	7.07
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	4	**37.50**	0.02	**33.67**
Bromomethane	4	**44.44**	0.04	**21.76**
Chloroethane	2	NA	0.02	NA
Acetonitrile	0	NA	NA	NA
Acrolein	0	NA	NA	NA
Trichlorofluoromethane	10	5.62	0.02	4.24
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	10	11.86	0.02	9.85
Trichlorotrifluoroethane	10	6.97	0.01	5.27
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	2	**48.89**	0.22	**45.75**
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	9	21.70	0.04	**17.24**
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	6	**27.78**	0.01	**16.16**
Benzene	10	13.52	0.04	8.16
Carbon Tetrachloride	10	12.19	0.01	8.23
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	4	NA	NA	NA
Trichloroethylene	9	18.33	0.01	13.89
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
Methyl Isobutyl Ketone	2	25.00	0.01	**20.20**

Table 23-34. VOC Sampling and Analytical Precision:
10 Collocated Samples in North Brook, IL (NBIL) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	10	14.82	0.06	11.52
Dibromochloromethane	4	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	2	NA	0.04	NA
Tetrachloroethylene	10	16.67	0.01	12.84
Chlorobenzene	0	NA	NA	NA
Ethylbenzene	10	**27.33**	0.02	**22.74**
m,p-Xylene	10	21.84	0.05	**19.82**
Bromoform	0	NA	NA	NA
Styrene	7	25.00	0.01	**16.16**
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	10	17.14	0.02	14.71
1,3,5-Trimethylbenzene	9	21.88	0.01	**15.23**
1,2,4-Trimethylbenzene	10	11.30	0.01	8.56
m-Dichlorobenzene	1	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	3	25.00	0.01	**20.20**
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	1	NA	NA	NA
Hexachloro-1,3-Butadiene	1	NA	NA	NA

Table 23-35. VOC Sampling and Analytical Precision: Two Duplicate Samples in St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	14	7.21	0.11	4.75
Propylene	14	17.96	0.08	12.46
Dichlorodifluoromethane	14	9.92	0.06	6.63
Chloromethane	14	12.85	0.08	8.72
Dichlorotetrafluoroethane	7	NA	0.01	NA
Vinyl Chloride	0	NA	NA	NA
1,3-Butadiene	7	**26.19**	0.03	**16.20**
Bromomethane	6	**54.31**	0.04	**34.29**
Chloroethane	6	**250.00**	0.05	**52.38**
Acetonitrile	2	**33.22**	0.98	**28.17**
Acrolein	0	NA	NA	NA
Trichlorofluoromethane	14	12.00	0.04	7.88
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	0	NA	NA	NA
Methylene Chloride	12	15.74	0.02	9.47
Trichlorotrifluoroethane	14	10.67	0.01	6.80
trans-1,2-Dichloroethylene	0	NA	NA	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	0	NA	NA	NA
Methyl Ethyl Ketone	5	**38.27**	0.80	**33.47**
Chloroprene	0	NA	NA	NA
cis-1,2-Dichloroethylene	0	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	4	NA	0.01	NA
Ethyl *tert*-Butyl Ether	0	NA	NA	NA
1,2-Dichloroethane	0	NA	NA	NA
1,1,1-Trichloroethane	7	16.67	0.01	9.43
Benzene	14	9.98	0.03	6.76
Carbon Tetrachloride	11	7.50	0.02	5.03
tert-Amyl Methyl Ether	0	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	0	NA	NA	NA
Methyl Methacrylate	0	NA	NA	NA
cis-1,3-Dichloropropene	0	NA	NA	NA
Methyl Isobutyl Ketone	1	NA	NA	NA

Table 23-35. VOC Sampling and Analytical Precision: Two Duplicate Samples in St. Louis, MO (S4MO) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	14	**42.22**	0.27	**16.20**
Dibromochloromethane	0	NA	NA	NA
1,2-Dibromoethane	0	NA	NA	NA
n-Octane	6	**41.59**	0.01	**22.10**
Tetrachloroethylene	6	9.72	0.01	7.06
Chlorobenzene	0	NA	NA	NA
Ethylbenzene	14	7.30	0.01	5.44
m,p-Xylene	14	8.99	0.02	6.29
Bromoform	0	NA	NA	NA
Styrene	8	3.13	0.002	2.08
1,1,2,2-Tetrachloroethane	0	NA	NA	NA
o-Xylene	14	18.04	0.01	12.04
1,3,5-Trimethylbenzene	10	16.00	0.01	10.43
1,2,4-Trimethylbenzene	10	8.04	0.01	5.75
m-Dichlorobenzene	0	NA	NA	NA
Chloromethylbenzene	0	NA	NA	NA
p-Dichlorobenzene	6	13.60	0.01	8.69
o-Dichlorobenzene	0	NA	NA	NA
1,2,4-Trichlorobenzene	0	NA	NA	NA
Hexachloro-1,3-Butadiene	0	NA	NA	NA

Table 23-36. VOC Sampling and Analytical Precision:
176 Duplicate Samples

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Acetylene	176	12.61	0.15	8.88
Propylene	176	13.04	0.11	9.85
Dichlorodifluoromethane	176	5.85	0.04	4.24
Chloromethane	176	7.50	0.06	5.45
Dichlorotetrafluoroethane	86	22.78	0.01	**21.21**
Vinyl Chloride	12	25.00	0.01	**23.57**
1,3-Butadiene	92	17.82	0.03	11.58
Bromomethane	76	**29.19**	0.01	**23.32**
Chloroethane	69	**67.38**	0.02	**35.49**
Acetonitrile	50	**27.94**	5.21	**21.79**
Acrolein	29	NA	NA	NA
Trichlorofluoromethane	176	6.16	0.02	4.44
Acrylonitrile	0	NA	NA	NA
1,1-Dichloroethene	2	NA	0.13	NA
Methylene Chloride	149	19.49	0.12	**15.25**
Trichlorotrifluoroethane	176	10.98	0.01	8.03
trans-1,2-Dichloroethylene	2	NA	0.03	NA
1,1-Dichloroethane	0	NA	NA	NA
Methyl *tert*-Butyl Ether	35	11.71	0.10	8.39
Methyl Ethyl Ketone	44	**68.06**	0.37	**37.59**
Chloroprene	1	NA	NA	NA
cis-1,2-Dichloroethylene	1	NA	NA	NA
Bromochloromethane	0	NA	NA	NA
Chloroform	50	**30.61**	0.02	**21.52**
Ethyl *tert*-Butyl Ether	1	NA	NA	NA
1,2-Dichloroethane	2	NA	0.04	NA
1,1,1-Trichloroethane	103	16.79	0.01	11.49
Benzene	176	10.99	0.04	8.12
Carbon Tetrachloride	158	13.73	0.02	10.20
tert-Amyl Methyl Ether	1	NA	NA	NA
1,2-Dichloropropane	0	NA	NA	NA
Ethyl Acrylate	0	NA	NA	NA
Bromodichloromethane	0	NA	NA	NA
Trichloroethylene	31	24.91	0.02	**20.91**
Methyl Methacrylate	5	**28.85**	0.17	**18.93**
cis-1,3-Dichloropropene	0	NA	NA	NA

Table 23-36. VOC Analytical Precision:
176 Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Replicate Analyses (%)	Average Concentration Difference for Replicate Analyses (ppbv)	Coefficient of Variation (%)
Methyl Isobutyl Ketone	23	**42.02**	0.08	**28.78**
trans-1,3-Dichloropropene	0	NA	NA	NA
1,1,2-Trichloroethane	0	NA	NA	NA
Toluene	176	13.84	0.10	9.32
Dibromochloromethane	1	NA	NA	NA
1,2-Dibromoethane	2	NA	0.04	NA
n-Octane	100	**200.73**	0.06	**23.07**
Tetrachloroethylene	92	14.69	0.01	11.70
Chlorobenzene	2	NA	0.02	NA
Ethylbenzene	172	14.21	0.02	10.70
m,p-Xylene	175	13.85	0.04	9.93
Bromoform	0	NA	NA	NA
Styrene	124	22.33	0.07	**16.56**
1,1,2,2-Tetrachloroethane	4	**100.00**	0.01	**47.14**
o-Xylene	173	15.63	0.02	11.46
1,3,5-Trimethylbenzene	122	17.48	0.01	13.02
1,2,4-Trimethylbenzene	136	16.78	0.03	12.16
m-Dichlorobenzene	4	NA	0.07	NA
Chloromethylbenzene	2	NA	0.09	NA
p-Dichlorobenzene	66	**25.05**	0.04	**15.52**
o-Dichlorobenzene	3	NA	0.05	NA
1,2,4-Trichlorobenzene	12	NA	0.07	NA
Hexachloro-1,3-Butadiene	18	**100.00**	0.01	**47.14**

Table 23-37. VOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Samples, All Sites

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)	East Thomas,, AL (ETAL)	Grand Junction, CO (GPCO)
Acetylene	*12.90*	**17.64**	5.99	14.00	8.82	5.47	**25.22**	**37.03**	9.54	**35.08**	2.22
Propylene	*12.71*	8.42	4.52	2.83	10.43	12.73	**22.18**	**56.69**	5.65	**16.27**	14.50
Dichlorodifluoromethane	*5.11*	4.43	5.22	1.47	2.88	5.17	2.53	3.33	5.95	6.84	3.61
Chloromethane	*6.56*	9.21	6.11	6.40	5.50	7.78	7.15	8.01	8.71	5.24	3.15
Dichlorotetrafluoroethane	**21.78**	NA	9.43	NA	NA	NA	9.43	NA	**30.64**	NA	NA
Vinyl Chloride	**23.57**	NA	NA	NA	NA	NA	NA	NA	**23.57**	NA	NA
1,3-Butadiene	**18.33**	6.43	1.41	NA	**23.57**	**28.28**	**18.19**	**94.28**	9.69	10.88	3.91
Bromomethane	**22.67**	**23.57**	**15.71**	NA	**23.57**	NA	10.10	NA	**20.74**	NA	14.50
Chloroethane	**34.47**	NA	**31.43**	NA	**47.14**	NA	**53.03**	NA	**24.58**	NA	**15.71**
Acetonitrile	**24.38**	**47.34**	0.69	**29.87**	7.65	4.74	**67.00**	4.25	**30.52**	NA	12.98
Acrolein	**24.98**	NA	**15.10**	NA	**36.57**	8.84	**76.84**	NA	NA	NA	2.72
Trichlorofluoromethane	*5.56*	7.80	4.26	3.79	2.10	3.76	9.41	2.89	5.48	4.42	4.30
Acrylonitrile	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	**19.95**	**39.17**	11.00	11.00	**19.49**	10.43	14.03	**69.43**	13.75	NA	11.86
Trichlorotrifluoroethane	*12.59*	10.84	6.52	6.01	7.16	8.92	6.16	3.72	**20.22**	**22.93**	5.11
trans-1,2-Dichloroethylene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	*9.85*	NA	NA	6.37	NA	NA	NA	NA	10.53	NA	NA
Methyl Ethyl Ketone	**36.69**	NA	NA	NA	**74.87**	NA	**34.74**	NA	**17.68**	NA	**43.29**
Chloroprene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 23-37. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)	East Thomas,, AL (ETAL)	Grand Junction, CO (GPCO)
Chloroform	**26.11**	**28.28**	14.14	NA	**28.28**	**47.14**	**88.39**	**28.28**	10.10	NA	**18.30**
Ethyl *tert*-Butyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	*14.12*	NA	14.14	10.10	9.43	NA	**16.16**	NA	NA	**28.28**	3.93
Benzene	*10.75*	**17.55**	4.50	4.01	12.88	6.94	**20.46**	**34.96**	5.75	5.11	7.76
Carbon Tetrachloride	*9.87*	11.07	**18.71**	5.51	13.26	10.50	6.70	3.72	10.40	5.24	14.56
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Acrylate	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	**20.79**	NA	10.10	NA	NA	NA	**33.00**	NA	NA	NA	NA
Methyl Methacrylate	**18.93**	NA	NA	NA	NA	NA	NA	NA	NA	NA	**18.93**
cis-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone	**25.56**	NA	NA	NA	NA	NA	**46.41**	8.78	NA	NA	**34.57**
trans-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	*12.98*	**26.74**	4.65	6.66	10.74	7.89	**33.51**	**31.84**	6.76	**17.14**	3.91
Dibromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Octane	**24.64**	**47.14**	11.66	NA	**81.10**	NA	**27.29**	**103.71**	10.07	NA	8.87
Tetrachloroethylene	**15.07**	NA	NA	13.71	**15.71**	NA	**26.54**	NA	10.92	**47.14**	4.26
Chlorobenzene	**17.68**	NA	NA	NA	NA	NA	**17.68**	NA	NA	NA	NA
Ethylbenzene	**15.40**	**24.09**	4.63	4.61	**18.45**	NA	**24.07**	**53.97**	7.88	10.88	5.79

Table 23-37. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)	East Thomas,, AL (ETAL)	Grand Junction, CO (GPCO)
m,p-Xylene	*14.53*	**29.11**	5.16	5.98	12.33	12.41	**28.61**	**46.12**	7.75	13.69	4.29
Bromoform	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	**19.74**	14.14	2.57	13.80	**23.57**	**43.79**	**22.84**	**70.71**	9.87	**15.71**	**21.63**
1,1,2,2-Tetrachloroethane	**47.14**	NA	NA	NA	NA	**47.14**	NA	NA	NA	NA	NA
o-Xylene	*14.96*	**29.55**	7.52	7.47	**15.25**	**16.68**	**28.96**	**39.28**	8.07	9.43	5.34
1,3,5-Trimethylbenzene	**15.34**	11.79	4.04	NA	NA	**23.57**	**21.09**	**28.28**	**15.64**	NA	12.38
1,2,4-Trimethylbenzene	**16.76**	**23.93**	9.23	7.49	8.98	**33.88**	**23.66**	**70.71**	**17.02**	6.15	12.67
m-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethylbenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	**20.89**	10.10	**23.57**	**28.28**	NA	NA	**45.46**	NA	**24.43**	**47.14**	NA
o-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	**24.92**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloro-1,3-Butadiene	**28.60**	NA	NA	NA	NA	NA	NA	NA	**47.14**	NA	NAN
Average	**16.35**	**20.38**	*9.33*	*9.47*	**20.79**	**17.30**	**27.96**	**38.10**	*14.79*	**17.09**	*11.25*

Table 23-37. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Gulfport, MS (GPMS)	Grenada, MS (GRMS)	Nashville, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	North Brook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	St. Louis, MO (S4MO)
Acetylene	*12.90*	4.78	6.53	**23.92**	9.64	12.55	7.78	6.02	6.93	6.53	4.75
Propylene	*12.71*	4.78	4.04	**22.28**	9.84	3.01	**15.61**	7.17	7.63	**18.86**	12.46
Dichlorodifluoromethane	*5.11*	2.95	5.05	**28.00**	4.14	1.30	5.21	3.60	3.41	7.44	6.63
Chloromethane	*6.56*	3.05	1.17	**29.14**	8.31	5.14	5.86	4.02	7.71	3.45	8.72
Dichlorotetrafluoroethane	**21.78**	NA	NA	**47.14**	**15.71**	NA	7.07	NA	5.89	**47.14**	NA
Vinyl Chloride	**23.57**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Butadiene	**18.33**	7.03	NA	NA	12.86	**47.14**	**33.67**	NA	4.58	NA	**16.20**
Bromomethane	**22.67**	NA	NA	NA	NA	**47.14**	**21.76**	**28.28**	5.89	NA	**34.29**
Chloroethane	**34.47**	NA	NA	NA	NA	NA	NA	**16.16**	**29.41**	6.15	**52.38**
Acetonitrile	**24.38**	**28.54**	NA	NA	NA	**56.99**	NA	**28.53**	10.55	**19.96**	**28.17**
Acrolein	**24.98**	13.28	NA	NA	NA	NA	NA	7.20	8.18	NA	NA
Trichlorofluoromethane	*5.56*	2.95	2.67	**28.92**	3.74	2.48	4.24	3.74	4.15	9.75	7.88
Acrylonitrile	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene Chloride	**19.95**	**22.57**	NA	**70.71**	5.07	12.86	9.85	**15.05**	4.74	**32.64**	9.47
Trichlorotrifluoroethane	*12.59*	4.13	7.44	**34.03**	7.80	**22.10**	5.27	6.29	6.25	**29.60**	6.80
trans-1,2-Dichloroethylene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	*9.85*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Ethyl Ketone	**36.69**	NA	NA	**23.53**	NA	NA	**45.75**	NA	NA	NA	**33.47**
Chloroprene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 23-37. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Gulfport, MS (GPMS)	Grenada, MS (GRMS)	Nashville, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	North Brook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	St. Louis, MO (S4MO)
Chloroform	**26.11**	12.57	NA	**38.57**	NA	NA	**17.24**	NA	10.77	NA	NA
Ethyl *tert*-Butyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	*14.12*	5.77	NA	**70.71**	7.47	NA	**16.16**	11.79	2.53	NA	9.43
Benzene	*10.75*	6.16	10.88	**25.21**	8.20	7.07	8.16	9.37	6.92	**26.94**	6.76
Carbon Tetrachloride	*9.87*	8.98	8.32	**30.30**	13.59	NA	8.23	6.20	8.38	5.66	5.03
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl Acrylate	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	**20.79**	NA	NA	**20.20**	NA	NA	13.89	**47.14**	**15.71**	NA	NA
Methyl Methacrylate	**18.93**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone	**25.56**	NA	NA	NA	NA	NA	**20.20**	NA	NA	NA	NA
trans-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toluene	*12.98*	4.64	9.43	**23.88**	6.45	7.77	11.52	6.35	6.47	**39.60**	**16.20**
Dibromochloromethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Octane	**24.64**	12.22	NA	NA	NA	**15.71**	NA	12.89	12.15	**28.28**	**22.10**
Tetrachloroethylene	**15.07**	4.04	NA	NA	12.86	NA	12.84	9.70	3.93	NA	7.06
Chlorobenzene	**17.68**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	**15.40**	9.28	**28.28**	**17.92**	10.89	12.86	**22.74**	9.96	7.11	**47.14**	5.44

Table 23-37. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Gulfport, MS (GPMS)	Grenada, MS (GRMS)	Nashville, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	North Brook, IL (NBIL)	New Brunswick, NJ (NBNJ)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	St. Louis, MO (S4MO)
m,p-Xylene	*14.53*	7.58	11.79	**19.82**	7.42	NA	**19.82**	7.77	6.08	**43.51**	6.29
Bromoform	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	**19.74**	8.72	NA	**30.46**	NA	NA	**16.16**	11.00	6.77	**31.43**	2.08
1,1,2,2-Tetrachloroethane	**47.14**	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	*14.96*	6.99	10.88	**26.74**	7.10	NA	14.71	5.47	7.50	**58.23**	12.04
1,3,5-Trimethylbenzene	**15.34**	9.66	NA	**38.57**	6.73	NA	**15.23**	7.95	14.00	**28.28**	10.43
1,2,4-Trimethylbenzene	**16.76**	12.85	NA	**32.20**	10.68	NA	8.56	5.59	10.56	**40.41**	5.75
m-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloromethylbenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	**20.89**	7.33	NA	**22.33**	NA	NA	**20.20**	NA	5.66	**47.14**	8.69
o-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	**24.92**	9.43	NA	NA	**20.20**	NA	NA	NA	**60.61**	NA	NA
Hexachloro-1,3-Butadiene	**28.60**	**15.71**	NA	NA	NA	NA	NA	NA	**17.28**	NA	NA
Average	**16.35**	*9.08*	*8.87*	**32.03**	*9.44*	**18.15**	*14.91*	*11.55*	*10.26*	**27.53**	*13.54*

Table 23-37. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Sioux Falls, SD (SFSD)	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)	Ysleta del Sur Pueblo ,TX (YDSP)
Acetylene	*12.90*	6.95	**20.09**	11.49	**17.90**	10.27	**18.37**
Propylene	*12.71*	14.06	4.61	7.56	12.18	12.69	**19.47**
Dichlorodifluoromethane	*5.11*	3.44	4.64	2.68	3.63	5.31	3.92
Chloromethane	*6.56*	4.30	5.40	3.49	2.65	5.34	5.55
Dichlorotetrafluoroethane	**21.78**	NA	NA	**23.57**	NA	NA	NA
Vinyl Chloride	**23.57**	NA	NA	NA	NA	NA	NA
1,3-Butadiene	**18.33**	NA	9.43	1.39	NA	6.05	13.38
Bromomethane	**22.67**	NA	NA	14.14	NA	NA	**35.02**
Chloroethane	**34.47**	**23.57**	NA	**84.85**	NA	**40.07**	**23.58**
Acetonitrile	**24.38**	14.29	10.85	NA	**38.79**	NA	**21.57**
Acrolein	**24.98**	**36.65**	NA	9.64	**39.28**	**35.19**	**35.31**
Trichlorofluoromethane	*5.56*	2.95	4.56	5.47	3.64	5.60	3.72
Acrylonitrile	*NA*	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	*NA*	NA	NA	NA	NA	NA	NA
Methylene Chloride	**19.95**	**32.36**	NA	**15.74**	7.03	8.12	12.44
Trichlorotrifluoroethane	*12.59*	5.23	**50.91**	12.16	2.35	**23.00**	6.50
trans-1,2-Dichloroethylene	*NA*	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA
Methyl *tert*-Butyl Ether	*9.85*	NA	NA	10.35	NA	**15.71**	6.30
Methyl Ethyl Ketone	**36.69**	**24.96**	NA	**42.53**	NA	**36.45**	**26.37**
Chloroprene	*NA*	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethylene	*NA*	NA	NA	NA	NA	NA	NA

Table 23-37. VOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Sioux Falls, SD (SFSD)	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)	Ysleta del Sur Pueblo ,TX (YDSP)
Bromochloromethane	*NA*	NA	NA	NA	NA	NA	NA
Chloroform	**26.11**	14.14	NA	11.79	NA	**23.57**	NA
Ethyl *tert*-Butyl Ether	*NA*	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	*NA*	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	*14.12*	NA	NA	11.79	5.05	4.71	12.57
Benzene	*10.75*	6.20	1.30	7.49	9.79	6.15	12.86
Carbon Tetrachloride	*9.87*	14.29	NA	8.38	4.28	2.71	12.74
tert-Amyl Methyl Ether	*NA*	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	*NA*	NA	NA	NA	NA	NA	NA
Ethyl Acrylate	*NA*	NA	NA	NA	NA	NA	NA
Bromodichloromethane	*NA*	NA	NA	NA	NA	NA	NA
Trichloroethylene	**20.79**	NA	NA	NA	NA	NA	5.50
Methyl Methacrylate	**18.93**	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA
Methyl Isobutyl Ketone	**25.56**	NA	NA	13.92	NA	**17.19**	**37.87**
trans-1,3-Dichloropropene	*NA*	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	*NA*	NA	NA	NA	NA	NA	NA
Toluene	*12.98*	8.88	8.08	5.41	14.00	4.10	14.77
Dibromochloromethane	*NA*	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	*NA*	NA	NA	NA	NA	NA	NA
n-Octane	**24.64**	5.44	14.14	13.27	13.86	10.01	**18.18**
Tetrachloroethylene	**15.07**	NA	NA	**30.46**	**25.14**	NA	1.81

Table 23-37. VOC Sampling and Analytical Precision:
Coefficient of Variation for all Duplicate Samples, All Sites (Cont.)

Pollutant	Average	Sioux Falls, SD (SFSD)	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)	Ysleta del Sur Pueblo ,TX (YDSP)
Chlorobenzene	**17.68**	NA	NA	NA	NA	NA	NA
Ethylbenzene	**15.40**	9.17	8.32	4.97	12.78	7.57	**16.10**
m,p-Xylene	*14.53*	**17.91**	10.48	3.34	14.46	6.23	**15.27**
Bromoform	*NA*	NA	NA	NA	NA	NA	NA
Styrene	**19.74**	**17.86**	8.32	10.36	**49.53**	5.39	**17.34**
1,1,2,2-Tetrachloroethane	**47.14**	NA	NA	NA	NA	NA	NA
o-Xylene	*14.96*	9.93	11.79	5.33	8.86	5.02	**15.93**
1,3,5-Trimethylbenzene	**15.34**	NA	NA	7.48	12.12	6.07	**18.17**
1,2,4-Trimethylbenzene	**16.76**	11.79	**17.68**	3.18	6.40	4.89	**18.08**
m-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA
Chloromethylbenzene	*NA*	NA	NA	NA	NA	NA	NA
p-Dichlorobenzene	**20.89**	NA	**20.20**	9.16	NA	10.12	4.44
o-Dichlorobenzene	*NA*	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	**24.92**	NA	NA	NA	NA	9.43	NA
Hexachloro-1,3-Butadiene	**28.60**	**47.14**	NA	NA	NA	**15.71**	NA
Average	**16.35**	**15.07**	*12.40*	*13.50*	*14.46*	*12.24*	**15.62**

Table 23-38. SNMOC Sampling and Analytical Precision:
70 Duplicate Samples, Including all Post-Katrina Data

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	66	14.61	0.36	9.30
Acetylene	70	5.51	0.10	3.95
Ethane	70	20.85	0.43	6.10
Propylene	70	12.79	0.16	9.79
Propane	70	4.70	0.38	3.27
Propyne	0	NA	NA	NA
Isobutane	70	4.96	0.16	3.68
Isobutene/1-Butene	70	15.68	0.19	12.14
1,3-Butadiene	37	**37.97**	0.08	**25.54**
n-Butane	70	3.90	0.26	2.91
trans-2-Butene	51	15.38	0.08	10.48
cis-2-Butene	51	10.02	0.05	6.81
3-Methyl-1-butene	10	12.15	0.03	9.24
Isopentane	70	8.19	0.51	6.34
1-Pentene	50	**62.40**	0.38	**34.38**
2-Methyl-1-butene	46	13.65	0.06	9.17
n-Pentane	70	14.58	0.31	8.81
Isoprene	62	13.15	0.12	9.54
trans-2-Pentene	54	11.58	0.06	8.04
cis-2-Pentene	51	12.00	0.04	8.78
2-Methyl-2-butene	50	11.92	0.05	9.31
2,2-Dimethylbutane	62	18.59	0.09	14.04
Cyclopentene	11	**59.81**	0.21	**28.62**
4-Methyl-1-pentene	1	NA	NA	NA
Cyclopentane	66	12.47	0.05	8.80
2,3-Dimethylbutane	65	8.29	0.06	6.37
2-Methylpentane	70	17.58	0.42	12.16
3-Methylpentane	69	16.64	0.26	13.51
2-Methyl-1-pentene	13	14.90	0.03	9.63
1-Hexene	49	19.39	0.13	**15.40**
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	70	19.86	0.19	12.14
trans-2-Hexene	7	17.98	0.04	**15.05**
cis-2-Hexene	0	NA	NA	NA
Methylcyclopentane	70	7.93	0.05	5.96
2,4-Dimethylpentane	57	18.16	0.10	**15.36**
Benzene	70	8.92	0.13	6.63

Table 23-38. SNMOC Sampling and Analytical Precision: 70 Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Cyclohexane	64	20.03	0.09	12.11
2-Methylhexane	59	**27.67**	0.13	**15.01**
2,3-Dimethylpentane	64	24.66	0.35	**24.16**
3-Methylhexane	69	24.90	0.58	**20.45**
1-Heptene	28	22.06	0.14	**18.99**
2,2,4-Trimethylpentane	67	14.84	0.17	11.95
n-Heptane	70	13.35	0.14	10.90
Methylcyclohexane	66	23.20	0.15	19.51
2,2,3-Trimethylpentane	27	16.79	0.08	13.31
2,3,4-Trimethylpentane	56	**25.10**	0.29	**27.48**
Toluene	70	8.12	0.24	5.80
2-Methylheptane	51	20.07	0.07	**15.72**
3-Methylheptane	53	14.93	0.06	10.55
1-Octene	24	21.03	0.13	**17.21**
n-Octane	65	13.51	0.06	9.97
Ethylbenzene	70	20.11	0.17	**15.10**
m,p-Xylene	70	17.54	0.25	12.10
Styrene	53	**28.75**	0.27	**22.11**
o-Xylene	70	18.54	0.09	11.61
1-Nonene	34	**28.19**	0.12	**19.08**
n-Nonane	59	**28.12**	0.09	**16.19**
Isopropylbenzene	33	15.45	0.06	11.69
a-Pinene	46	**58.21**	1.39	**31.31**
n-Propylbenzene	54	22.97	0.08	**17.82**
m-Ethyltoluene	58	**45.10**	0.17	**21.65**
p-Ethyltoluene	58	**29.10**	0.19	**23.68**
1,3,5-Trimethylbenzene	55	20.62	0.07	14.09
o-Ethyltoluene	52	22.45	0.09	**15.51**
b-Pinene	5	NA	2.11	NA
1,2,4-Trimethylbenzene	59	17.97	0.14	11.81
1-Decene	0	NA	NA	NA
n-Decane	56	**39.90**	0.24	**19.02**
1,2,3-Trimethylbenzene	44	**53.60**	0.18	**25.94**
m-Diethylbenzene	32	**38.18**	0.27	**39.54**
p-Diethylbenzene	35	20.27	0.18	**17.81**
1-Undecene	6	12.33	0.19	9.29
n-Undecane	46	21.82	0.43	**15.07**

Table 23-38. SNMOC Sampling and Analytical Precision: 70 Duplicate Samples (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
1-Dodecene	4	**56.74**	0.48	**56.01**
n-Dodecane	30	**53.07**	0.50	**49.40**
1-Tridecene	0	NA	NA	NA
n-Tridecane	1	NA	NA	NA
TNMOC (speciated)	70	8.53	6.96	6.08
TNMOC (w/unknowns)	70	12.95	21.44	9.07

Table 23-39. SNMOC Sampling and Analytical Precision: 16 Duplicate Samples in Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	16	9.14	0.30	6.69
Acetylene	16	6.15	0.19	4.71
Ethane	16	6.16	0.48	4.95
Propylene	16	7.02	0.17	5.24
Propane	16	4.88	0.39	3.96
Propyne	0	NA	NA	NA
Isobutane	16	4.05	0.33	3.26
Isobutene/1-Butene	16	17.68	0.45	**16.48**
1,3-Butadiene	10	21.73	0.05	**17.62**
n-Butane	16	4.75	0.41	3.81
trans-2-Butene	16	9.53	0.04	6.70
cis-2-Butene	15	10.66	0.06	8.49
3-Methyl-1-butene	4	12.04	0.02	8.77
Isopentane	16	10.54	1.32	8.94
1-Pentene	12	11.65	0.06	10.14
2-Methyl-1-butene	14	16.59	0.07	12.02
n-Pentane	16	5.11	0.23	4.05
Isoprene	14	17.84	0.15	**15.20**
trans-2-Pentene	14	11.54	0.05	8.02
cis-2-Pentene	14	9.97	0.03	7.25
2-Methyl-2-butene	14	7.91	0.03	6.07
2,2-Dimethylbutane	14	7.09	0.05	5.28
Cyclopentene	2	NA	0.28	NA
4-Methyl-1-pentene	0	NA	NA	NA
Cyclopentane	15	9.27	0.05	6.91
2,3-Dimethylbutane	15	7.08	0.10	5.23
2-Methylpentane	16	5.84	0.15	4.55
3-Methylpentane	16	10.18	0.23	7.29
2-Methyl-1-pentene	4	**34.64**	0.04	**22.17**
1-Hexene	12	**29.01**	0.15	**22.67**
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	16	7.52	0.19	5.62
trans-2-Hexene	2	**38.78**	0.08	**34.01**
cis-2-Hexene	0	NA	NA	NA
Methylcyclopentane	16	5.29	0.06	4.25
2,4-Dimethylpentane	14	5.57	0.04	4.17

Table 23-39. SNMOC Sampling and Analytical Precision: 16 Duplicate Samples in Bountiful, UT (BTUT) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Benzene	16	6.11	0.15	4.49
Cyclohexane	15	9.04	0.16	7.06
2-Methylhexane	16	7.78	0.07	6.19
2,3-Dimethylpentane	16	6.23	0.08	4.75
3-Methylhexane	16	18.28	0.53	**16.60**
1-Heptene	7	19.10	0.13	12.46
2,2,4-Trimethylpentane	15	11.01	0.24	7.81
n-Heptane	16	19.50	0.45	**22.29**
Methylcyclohexane	16	6.03	0.08	4.55
2,2,3-Trimethylpentane	8	8.08	0.03	5.64
2,3,4-Trimethylpentane	14	21.18	0.18	**22.70**
Toluene	16	3.85	0.28	2.69
2-Methylheptane	14	13.70	0.08	10.73
3-Methylheptane	14	15.01	0.08	11.44
1-Octene	9	**26.11**	0.16	**22.88**
n-Octane	14	7.45	0.07	5.61
Ethylbenzene	16	6.88	0.07	5.00
m,*p*-Xylene	16	4.57	0.15	3.24
Styrene	11	**28.86**	0.59	**30.93**
o-Xylene	16	6.15	0.07	4.32
1-Nonene	9	16.49	0.12	11.10
n-Nonane	13	10.20	0.10	7.69
Isopropylbenzene	7	20.02	0.05	13.08
a-Pinene	7	**30.51**	0.13	**17.80**
n-Propylbenzene	12	19.22	0.07	14.29
m-Ethyltoluene	14	14.49	0.07	12.20
p-Ethyltoluene	14	14.20	0.12	12.20
1,3,5-Trimethylbenzene	13	9.87	0.06	7.37
o-Ethyltoluene	13	20.16	0.11	**15.34**
b-Pinene	0	NA	NA	NA
1,2,4-Trimethylbenzene	14	12.85	0.13	9.72
1-Decene	0	NA	NA	NA
n-Decane	12	13.56	0.07	11.34
1,2,3-Trimethylbenzene	11	6.79	0.04	5.01
m-Diethylbenzene	6	**33.11**	0.16	**28.07**
p-Diethylbenzene	4	NA	0.25	NA

Table 23-39. SNMOC Sampling and Analytical Precision: 16 Duplicate Samples in Bountiful, UT (BTUT) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
1-Undecene	0	NA	NA	NA
n-Undecane	9	**31.09**	0.41	**26.59**
1-Dodecene	0	NA	NA	NA
n-Dodecane	7	**93.19**	1.05	**74.16**
1-Tridecene	0	NA	NA	NA
n-Tridecane	0	NA	NA	NA
TNMOC (speciated)	16	5.95	8.44	4.52
TNMOC (w/unknowns)	16	10.76	21.36	8.29

Table 23-40. SNMOC Sampling and Analytical Precision: 10 Duplicate Samples in North Brook, IL (NBIL)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	10	**42.40**	0.56	**22.22**
Acetylene	10	7.97	0.15	5.93
Ethane	10	6.16	0.50	4.07
Propylene	10	14.30	0.15	13.04
Propane	10	9.13	0.38	5.71
Propyne	0	NA	NA	NA
Isobutane	10	6.43	0.09	4.79
Isobutene/1-Butene	10	15.02	0.11	12.89
1,3-Butadiene	5	23.86	0.04	14.19
n-Butane	10	5.91	0.21	4.55
trans-2-Butene	7	**33.68**	0.07	**22.65**
cis-2-Butene	7	19.21	0.06	10.62
3-Methyl-1-butene	0	NA	NA	NA
Isopentane	10	12.68	0.53	11.33
1-Pentene	8	**44.80**	0.21	**46.08**
2-Methyl-1-butene	6	4.81	0.08	3.34
n-Pentane	10	21.39	0.47	**17.39**
Isoprene	10	11.91	0.14	7.49
trans-2-Pentene	9	14.73	0.06	9.67
cis-2-Pentene	9	**30.83**	0.08	**25.07**
2-Methyl-2-butene	7	11.02	0.09	7.85
2,2-Dimethylbutane	10	14.90	0.05	11.81
Cyclopentene	1	NA	NA	NA
4-Methyl-1-pentene	0	NA	NA	NA
Cyclopentane	10	**31.55**	0.08	**20.99**
2,3-Dimethylbutane	10	16.28	0.12	14.21
2-Methylpentane	10	**43.36**	1.09	**23.46**
3-Methylpentane	10	22.52	0.28	**19.52**
2-Methyl-1-pentene	0	NA	NA	NA
1-Hexene	7	7.14	0.12	5.44
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	10	18.66	0.13	13.40
trans-2-Hexene	0	NA	NA	NA
cis-2-Hexene	0	NA	NA	NA
Methylcyclopentane	10	16.06	0.10	13.49
2,4-Dimethylpentane	10	22.25	0.10	**19.01**

Table 23-40. SNMOC Sampling and Analytical Precision: 10 Duplicate Samples in North Brook, IL (NBIL) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Benzene	10	10.63	0.10	8.09
Cyclohexane	10	23.14	0.07	**17.28**
2-Methylhexane	9	**53.86**	0.18	**24.68**
2,3-Dimethylpentane	10	22.73	0.26	**19.93**
3-Methylhexane	10	20.53	0.22	**19.01**
1-Heptene	0	NA	NA	NA
2,2,4-Trimethylpentane	10	20.38	0.26	**17.10**
n-Heptane	10	16.06	0.07	12.34
Methylcyclohexane	10	21.76	0.11	**21.13**
2,2,3-Trimethylpentane	6	12.55	0.03	10.44
2,3,4-Trimethylpentane	10	13.74	0.06	11.96
Toluene	10	16.91	0.31	13.19
2-Methylheptane	10	**32.00**	0.05	**23.15**
3-Methylheptane	10	**29.19**	0.05	**20.07**
1-Octene	0	NA	NA	NA
n-Octane	10	18.88	0.06	**15.07**
Ethylbenzene	10	16.86	0.08	14.29
m,p-Xylene	10	24.45	0.28	**21.44**
Styrene	10	**38.69**	0.15	**33.73**
o-Xylene	10	15.16	0.10	11.88
1-Nonene	5	**33.20**	0.09	**20.10**
n-Nonane	10	**59.11**	0.17	**20.75**
Isopropylbenzene	3	21.11	0.07	13.50
a-Pinene	9	23.33	0.45	**21.07**
n-Propylbenzene	10	**37.99**	0.07	**26.95**
m-Ethyltoluene	10	13.71	0.06	10.29
p-Ethyltoluene	10	**40.96**	0.10	**22.02**
1,3,5-Trimethylbenzene	10	**54.31**	0.14	**31.71**
o-Ethyltoluene	10	**36.78**	0.10	**19.34**
b-Pinene	1	NA	NA	NA
1,2,4-Trimethylbenzene	10	**33.29**	0.15	**17.32**
1-Decene	0	NA	NA	NA
n-Decane	10	**149.58**	0.53	**39.94**
1,2,3-Trimethylbenzene	8	**72.76**	0.14	**32.43**
m-Diethylbenzene	3	**74.33**	0.26	**83.65**
p-Diethylbenzene	2	NA	0.16	NA

Table 23-40. SNMOC Sampling and Analytical Precision: 10 Duplicate Samples in North Brook, IL (NBIL) (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
1-Undecene	1	NA	NA	NA
n-Undecane	8	7.97	0.22	5.33
1-Dodecene	1	NA	NA	NA
n-Dodecane	4	**34.29**	0.19	**29.26**
1-Tridecene	0	NA	NA	NA
n-Tridecane	0	NA	NA	NA
TNMOC (speciated)	10	5.99	3.82	4.44
TNMOC (w/unknowns)	10	5.35	5.58	3.98

Table 23-41. SNMOC Sampling and Analytical Precision: 44 Duplicate Samples Only

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Ethylene	44	10.75	0.25	7.99
Acetylene	44	5.35	0.08	3.76
Ethane	44	3.91	0.26	2.88
Propylene	44	14.54	0.19	10.64
Propane	44	4.26	0.41	3.11
Propyne	0	NA	NA	NA
Isobutane	44	5.55	0.20	4.13
Isobutene/1-Butene	44	17.66	0.23	13.36
1,3-Butadiene	19	**46.58**	0.10	**31.52**
n-Butane	44	3.95	0.29	2.92
trans-2-Butene	32	11.47	0.08	7.55
cis-2-Butene	30	7.23	0.05	5.26
3-Methyl-1-butene	6	9.50	0.03	6.76
Isopentane	44	8.53	0.58	6.29
1-Pentene	28	**62.49**	0.47	**30.57**
2-Methyl-1-butene	26	13.66	0.04	9.31
n-Pentane	44	15.16	0.27	7.89
Isoprene	37	14.79	0.13	11.00
trans-2-Pentene	32	11.82	0.06	8.31
cis-2-Pentene	30	9.07	0.02	6.06
2-Methyl-2-butene	28	13.91	0.04	11.24
2,2-Dimethylbutane	37	22.54	0.11	**16.89**
Cyclopentene	8	**79.58**	0.28	**34.95**
4-Methyl-1-pentene	1	NA	NA	NA
Cyclopentane	42	7.32	0.03	5.32
2,3-Dimethylbutane	39	7.08	0.05	5.12
2-Methylpentane	44	14.34	0.33	11.51
3-Methylpentane	43	17.23	0.30	13.71
2-Methyl-1-pentene	6	17.69	0.02	11.35
1-Hexene	30	24.96	0.16	**20.13**
2-Ethyl-1-butene	0	NA	NA	NA
n-Hexane	44	21.43	0.20	11.55
trans-2-Hexene	5	**25.02**	0.06	**21.23**
cis-2-Hexene	0	NA	NA	NA
Methylcyclopentane	44	6.51	0.04	4.53
2,4-Dimethylpentane	33	19.17	0.11	**16.34**

Table 23-41. SNMOC Sampling and Analytical Precision: 44 Duplicate Samples Only (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
Benzene	44	9.78	0.14	7.24
Cyclohexane	38	21.07	0.10	11.53
2-Methylhexane	36	**26.44**	0.13	**15.19**
2,3-Dimethylpentane	40	**30.16**	0.45	**30.45**
3-Methylhexane	43	**29.85**	0.79	**24.26**
1-Heptene	18	24.07	0.15	**21.48**
2,2,4-Trimethylpentane	41	15.45	0.17	12.37
n-Heptane	44	14.07	0.18	11.91
Methylcyclohexane	40	**28.03**	0.19	**23.02**
2,2,3-Trimethylpentane	11	17.50	0.09	13.82
2,3,4-Trimethylpentane	32	**32.23**	0.41	**36.84**
Toluene	44	6.78	0.18	4.55
2-Methylheptane	27	18.94	0.09	**15.41**
3-Methylheptane	29	11.22	0.06	8.19
1-Octene	18	23.16	0.16	**19.15**
n-Octane	39	13.32	0.06	9.55
Ethylbenzene	44	23.18	0.22	**16.83**
m,p-Xylene	44	18.29	0.24	11.37
Styrene	27	**31.90**	0.38	**22.96**
o-Xylene	44	21.49	0.09	12.57
1-Nonene	17	**27.19**	0.13	**18.61**
n-Nonane	34	24.59	0.09	**16.70**
Isopropylbenzene	19	16.14	0.04	12.93
a-Pinene	21	**77.58**	1.90	**38.40**
n-Propylbenzene	30	20.43	0.07	**15.18**
m-Ethyltoluene	32	**61.67**	0.21	**27.94**
p-Ethyltoluene	32	**29.01**	0.23	**25.94**
1,3,5-Trimethylbenzene	31	14.38	0.05	10.78
o-Ethyltoluene	28	18.13	0.08	12.91
b-Pinene	4	NA	2.70	NA
1,2,4-Trimethylbenzene	33	15.00	0.13	10.67
1-Decene	0	NA	NA	NA
n-Decane	31	17.38	0.19	14.30
1,2,3-Trimethylbenzene	23	57.68	0.13	**27.69**
m-Diethylbenzene	17	30.80	0.29	**30.72**
p-Diethylbenzene	17	23.03	0.20	**20.89**

Table 23-41. SNMOC Sampling and Analytical Precision: 44 Duplicate Samples Only (Cont.)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbC)	Coefficient of Variation (%)
1-Undecene	3	NA	0.28	NA
n-Undecane	28	**27.77**	0.55	**18.97**
1-Dodecene	3	**56.74**	0.64	**56.01**
n-Dodecane	19	**53.55**	0.64	**47.74**
1-Tridecene	0	NA	NA	NA
n-Tridecane	1	NA	NA	NA
TNMOC (speciated)	44	10.28	8.72	7.29
TNMOC (w/unknowns)	44	15.49	27.47	10.93

Table 23-42. SNMOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Analyses, All Sites

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	Gulf Port, MS (GPMS)	North Brook, IL (NBIL)	Pascagoula, MS (PGMS)	Sioux Falls, SD (SFSD)
Ethylene	*9.30*	6.69	4.64	1.59	**22.22**	13.21	7.44
Acetylene	*3.95*	4.71	2.93	2.75	5.93	1.91	5.48
Ethane	*6.10*	4.95	1.44	**21.04**	4.07	2.08	3.04
Propylene	*9.79*	5.24	7.89	3.14	13.04	14.01	**15.40**
Propane	*3.27*	3.96	1.85	1.46	5.71	4.12	2.53
Propyne	*NA*	NA	NA	NA	NA	NA	NA
Isobutane	*3.68*	3.26	4.73	0.80	4.79	0.26	8.25
Isobutene/1-Butene	*12.14*	**16.48**	**18.40**	6.48	12.89	2.07	**16.51**
1,3-Butadiene	**25.54**	**17.62**	**44.17**	12.98	14.19	**48.74**	**15.57**
n-Butane	*2.91*	3.81	4.35	1.22	4.55	2.07	1.44
trans-2-Butene	*10.48*	6.70	9.71	10.01	**22.65**	5.95	7.86
cis-2-Butene	*6.81*	8.49	1.71	9.22	10.62	3.78	7.05
3-Methyl-1-butene	*9.24*	8.77	4.75	14.21	NA	NA	NA
Isopentane	*6.34*	8.94	4.11	1.59	11.33	3.41	8.67
1-Pentene	**34.38**	10.14	**49.22**	**37.92**	**46.08**	**48.50**	14.44
2-Methyl-1-butene	*9.17*	12.02	12.58	14.45	3.34	2.49	10.15
n-Pentane	*8.81*	4.05	7.75	3.90	**17.39**	1.55	**18.19**
Isoprene	*9.54*	**15.20**	13.54	5.79	7.49	4.30	10.95
trans-2-Pentene	*8.04*	8.02	11.12	5.32	9.67	1.65	12.46
cis-2-Pentene	*8.78*	7.25	3.48	3.37	**25.07**	0.65	12.87
2-Methyl-2-butene	*9.31*	6.07	**19.12**	4.97	7.85	NA	8.53
2,2-Dimethylbutane	*14.04*	5.28	**22.16**	4.88	11.81	**24.27**	**15.84**
Cyclopentene	**28.62**	NA	10.35	**15.96**	NA	NA	**59.56**
4-Methyl-1-pentene	*NA*	NA	NA	NA	NA	NA	NA
Cyclopentane	*8.80*	6.91	8.36	10.52	**20.99**	0.35	5.68
2,3-Dimethylbutane	*6.37*	5.23	4.70	3.52	14.21	2.97	7.60
2-Methylpentane	*12.16*	4.55	**21.48**	3.46	**23.46**	12.18	7.83
3-Methylpentane	*13.51*	7.29	**18.79**	6.73	**19.52**	**20.80**	7.96
2-Methyl-1-pentene	*9.63*	**22.17**	0.52	6.20	NA	NA	NA
1-Hexene	**15.40**	**22.67**	13.77	6.44	5.44	**43.07**	1.00
2-Ethyl-1-butene	*NA*	NA	NA	NA	NA	NA	NA
n-Hexane	*12.14*	5.62	8.39	13.29	13.40	9.90	**22.28**
trans-2-Hexene	**15.05**	**34.01**	8.44	2.70	NA	NA	NA
cis-2-Hexene	*NA*	NA	NA	NA	NA	NA	NA
Methylcyclopentane	*5.96*	4.25	4.86	4.11	13.49	0.86	8.17
2,4-Dimethylpentane	**15.36**	4.17	12.90	7.81	**19.01**	**38.55**	9.74

Table 23-42. SNMOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Analyses, All Sites (Cont.)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	North Brook, IL (NBIL)	Pascagoula, MS (PGMS)	St. Louis, MO (Site 4 - S4MO)	Sioux Falls, SD (SFSD)
Benzene	*6.63*	4.49	12.49	2.76	8.09	7.81	4.17
Cyclohexane	*12.11*	7.06	14.03	9.27	**17.28**	6.12	**18.93**
2-Methylhexane	**15.01**	6.19	**19.39**	4.64	**24.68**	9.50	**25.69**
2,3-Dimethylpentane	**24.16**	4.75	2.86	3.23	**19.93**	**86.89**	**27.30**
3-Methylhexane	**20.45**	**16.60**	12.52	6.64	**19.01**	**50.30**	**17.64**
1-Heptene	**18.99**	12.46	2.75	9.03	NA	**62.99**	7.74
2,2,4-Trimethylpentane	*11.95*	7.81	5.94	5.16	17.10	**31.82**	3.91
n-Heptane	*10.90*	22.29	7.18	5.43	12.34	6.00	12.16
Methylcyclohexane	**19.51**	4.55	14.76	3.83	**21.13**	**45.64**	**27.15**
2,2,3-Trimethylpentane	*13.31*	5.64	NA	15.17	10.44	**22.00**	NA
2,3,4-Trimethylpentane	**27.48**	**22.70**	10.31	5.59	11.96	**107.92**	6.43
Toluene	*5.80*	2.69	5.20	3.42	13.19	2.34	7.96
2-Methylheptane	**15.72**	10.73	**32.36**	9.54	**23.15**	8.22	10.33
3-Methylheptane	*10.55*	11.44	12.63	10.50	**20.07**	2.02	6.66
1-Octene	**17.21**	**22.88**	9.16	9.44	NA	**37.62**	6.93
n-Octane	*9.97*	5.61	8.79	6.56	**15.07**	14.25	9.53
Ethylbenzene	**15.10**	5.00	9.20	9.01	14.29	**34.00**	**19.11**
m,p-Xylene	*12.10*	3.24	12.35	5.70	**21.44**	9.37	**20.51**
Styrene	**22.11**	**30.93**	14.83	7.95	**33.73**	NA	**23.12**
o-Xylene	*11.61*	4.32	13.68	7.49	11.88	9.46	**22.84**
1-Nonene	**19.08**	11.10	NA	**19.47**	**20.10**	**22.13**	**22.58**
n-Nonane	**16.19**	7.69	**26.88**	9.63	**20.75**	11.90	**20.31**
Isopropylbenzene	*11.69*	13.08	**24.44**	4.94	13.50	8.58	5.60
a-Pinene	**31.31**	**17.80**	**46.00**	13.23	**21.07**	**21.26**	**68.52**
n-Propylbenzene	**17.82**	14.29	**20.85**	**19.28**	**26.95**	13.08	12.49
m-Ethyltoluene	**21.65**	12.20	**18.71**	7.86	10.29	**69.96**	10.91
p-Ethyltoluene	**23.68**	12.20	**25.03**	**16.30**	**22.02**	**52.02**	14.49
1,3,5-Trimethylbenzene	*14.09*	7.37	**19.49**	9.71	**31.71**	7.98	8.26
o-Ethyltoluene	**15.51**	**15.34**	**20.59**	**22.05**	**19.34**	8.47	7.25
b-Pinene	*NA*	NA	NA	NA	NA	NA	NA
1,2,4-Trimethylbenzene	*11.81*	9.72	14.97	9.73	**17.32**	NA	7.32
1-Decene	*NA*	NA	NA	NA	NA	NA	NA
n-Decane	**19.02**	11.34	**29.69**	**16.97**	**39.94**	6.53	9.64
1,2,3-Trimethylbenzene	**25.94**	5.01	**38.21**	14.20	**32.43**	NA	**39.85**
m-Diethylbenzene	**39.54**	**28.07**	8.10	**30.71**	**83.65**	**84.96**	1.73
p-Diethylbenzene	**17.81**	**NA**	**36.62**	11.64	NA	5.17	NA

Table 23-42. SNMOC Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Analyses, All Sites (Cont.)

Pollutant	Average	Bountiful, UT (BTUT)	Custer, SD (CUSD)	North Brook, IL (NBIL)	Pascagoula, MS (PGMS)	St. Louis, MO (Site 4 - S4MO)	Sioux Falls, SD (SFSD)
1-Undecene	*9.29*	NA	NA	9.29	NA	NA	NA
n-Undecane	**15.07**	**26.59**	**20.29**	9.24	5.33	7.62	**21.37**
1-Dodecene	**56.01**	NA	**56.01**	NA	NA	NA	NA
n-Dodecane	**49.40**	**74.16**	**71.97**	**76.16**	**29.26**	**18.79**	**26.04**
1-Tridecene	*NA*	NA	NA	NA	NA	NA	NA
n-Tridecane	*NA*	NA	NA	NA	NA	NA	NA
TNMOC (speciated)	*6.08*	4.52	6.65	2.87	4.44	9.34	8.67
TNMOC (w/ unknowns)	*9.07*	8.29	11.84	6.70	3.98	11.67	11.91
Average	**15.08**	*11.39*	**15.64**	*9.83*	**17.57**	**19.80**	*13.96*

Table 23-43. Carbonyl Sampling and Analytical Precision: 320 Duplicate and Collocated Samples

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	320	**82.51**	0.33	9.64
Acetaldehyde	320	18.42	0.10	8.29
Acetone	320	**25.57**	0.11	12.92
Propionaldehyde	317	21.79	0.01	8.92
Crotonaldehyde	313	11.71	0.02	8.77
Butyr/Isobutyraldehyde	318	**36.01**	0.02	13.55
Benzaldehyde	316	14.48	0.005	10.60
Isovaleraldehyde	116	**46.17**	0.01	**24.65**
Valeraldehyde	306	21.57	0.01	**15.23**
Tolualdehydes	288	**31.38**	0.01	**19.44**
Hexaldehyde	313	16.45	0.01	12.75
2,5-Dimethylbenzaldehyde	6	NA	0.01	NA

Table 23-44. Carbonyl Sampling and Analytical Precision: 74 Collocated Samples

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	74	**173.74**	0.31	**19.16**
Acetaldehyde	74	**38.01**	0.11	14.51
Acetone	74	**59.51**	0.10	13.65
Propionaldehyde	73	**58.34**	0.01	13.44
Crotonaldehyde	70	12.06	0.02	11.35
Butyr/Isobutyraldehyde	72	10.92	0.01	9.24
Benzaldehyde	70	15.80	0.005	12.94
Isovaleraldehyde	33	14.74	0.002	10.86
Valeraldehyde	69	23.60	0.01	**16.53**
Tolualdehydes	68	22.81	0.01	**16.03**
Hexaldehyde	69	23.67	0.01	**21.56**
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-45. Carbonyl Sampling and Analytical Precision: 246 Duplicate Samples, Including all Post-Katrina Data

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	246	9.17	0.34	7.05
Acetaldehyde	246	12.90	0.17	8.52
Acetone	246	17.52	0.13	13.19
Propionaldehyde	244	16.92	0.01	9.96
Crotonaldehyde	243	15.33	0.01	10.65
Butyr/Isobutyraldehyde	246	**25.21**	0.02	12.89
Benzaldehyde	246	14.75	0.005	10.52
Isovaleraldehyde	83	**29.92**	0.01	**19.92**
Valeraldehyde	237	22.69	0.01	**15.66**
Tolualdehydes	220	**42.69**	0.01	**23.48**
Hexaldehyde	244	17.15	0.01	13.08
2,5-Dimethylbenzaldehyde	6	9.01	0.01	6.07

Table 23-46. Carbonyl Sampling and Analytical Precision: 14 Duplicate Samples in Bountiful, UT (BTUT)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	14	3.06	0.08	2.26
Acetaldehyde	14	3.09	0.04	2.24
Acetone	14	12.08	0.23	9.47
Propionaldehyde	14	2.22	0.003	1.61
Crotonaldehyde	13	21.69	0.01	**20.99**
Butyr/Isobutyraldehyde	14	7.37	0.01	5.60
Benzaldehyde	14	15.09	0.005	12.73
Isovaleraldehyde	7	22.27	0.01	14.31
Valeraldehyde	14	13.88	0.01	11.64
Tolualdehydes	14	19.01	0.01	14.08
Hexaldehyde	14	**25.91**	0.02	**21.62**
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-47. Carbonyl Sampling and Analytical Precision: 2 Collocated Samples in Detroit, MI (DEMI)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	2	6.54	0.20	4.48
Acetaldehyde	2	4.27	0.03	2.96
Acetone	2	2.86	0.03	1.99
Propionaldehyde	2	4.23	0.003	3.05
Crotonaldehyde	2	9.09	0.002	6.15
Butyr/Isobutyraldehyde	2	3.26	0.003	2.27
Benzaldehyde	2	11.76	0.002	7.86
Isovaleraldehyde	0	NA	NA	NA
Valeraldehyde	2	7.14	0.001	5.24
Tolualdehydes	2	**30.77**	0.004	**18.86**
Hexaldehyde	2	**30.00**	0.003	**18.45**
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-48. Carbonyl Sampling and Analytical Precision: 16 Duplicate Samples in Grand Junction, CO (GPCO)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	16	14.97	0.59	**17.19**
Acetaldehyde	16	13.43	0.23	**15.39**
Acetone	16	15.11	0.36	**17.49**
Propionaldehyde	16	15.45	0.02	**16.37**
Crotonaldehyde	16	14.17	0.01	13.96
Butyr/Isobutyraldehyde	16	19.66	0.02	**18.01**
Benzaldehyde	16	17.52	0.01	**16.84**
Isovaleraldehyde	5	**50.99**	0.01	**36.38**
Valeraldehyde	16	**29.84**	0.01	**20.94**
Tolualdehydes	15	**27.98**	0.01	**22.60**
Hexaldehyde	16	24.42	0.01	**17.71**
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-49. Carbonyl Sampling and Analytical Precision: 4 Duplicate Samples in Northbrook, IL (NBIL)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	4	**1562.92**	0.48	**67.35**
Acetaldehyde	4	**273.01**	0.29	**57.67**
Acetone	4	**582.05**	0.23	**60.67**
Propionaldehyde	4	**582.54**	0.03	**62.16**
Crotonaldehyde	3	6.25	0.01	4.56
Butyr/Isobutyraldehyde	3	1.89	0.02	1.35
Benzaldehyde	3	**26.32**	0.02	**16.44**
Isovaleraldehyde	3	16.67	0.01	12.86
Valeraldehyde	3	11.76	0.01	8.84
Tolualdehydes	3	13.33	0.01	8.84
Hexaldehyde	3	11.76	0.01	8.84
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-50. Carbonyl Sampling and Analytical Precision: 16 Duplicate Samples in St. Louis, MO (S4MO)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	16	13.63	0.74	12.72
Acetaldehyde	16	15.76	0.38	**15.64**
Acetone	16	14.38	0.10	8.85
Propionaldehyde	16	16.47	0.03	14.35
Crotonaldehyde	15	20.21	0.02	10.53
Butyr/Isobutyraldehyde	16	16.67	0.02	13.60
Benzaldehyde	16	**25.92**	0.01	**19.77**
Isovaleraldehyde	7	23.74	0.01	**19.87**
Valeraldehyde	16	**26.09**	0.01	**20.94**
Tolualdehydes	16	**33.95**	0.01	**29.81**
Hexaldehyde	16	13.35	0.01	11.06
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-51. Carbonyl Sampling and Analytical Precision: 8 Duplicate Samples in Tampa, FL (SKFL)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	8	4.76	0.09	3.20
Acetaldehyde	8	1.63	0.01	1.15
Acetone	8	4.84	0.02	3.52
Propionaldehyde	8	2.19	0.002	1.59
Crotonaldehyde	8	2.35	0.002	1.63
Butyr/Isobutyraldehyde	8	10.17	0.01	6.76
Benzaldehyde	8	8.67	0.003	6.69
Isovaleraldehyde	2	20.00	0.002	**15.71**
Valeraldehyde	8	5.49	0.001	3.61
Tolualdehydes	7	24.75	0.01	**20.03**
Hexaldehyde	8	15.48	0.01	12.90
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-52. Carbonyl Sampling and Analytical Precision: 10 Duplicate Samples in Tampa, FL (SYFL)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	10	13.62	0.10	8.90
Acetaldehyde	10	10.60	0.04	6.81
Acetone	10	16.49	0.05	14.92
Propionaldehyde	10	17.76	0.01	11.51
Crotonaldehyde	10	11.74	0.02	7.68
Butyr/Isobutyraldehyde	10	**201.31**	0.09	**46.47**
Benzaldehyde	10	10.19	0.001	7.09
Isovaleraldehyde	0	NA	NA	NA
Valeraldehyde	10	**45.69**	0.01	**32.42**
Tolualdehydes	8	**40.92**	0.01	**22.61**
Hexaldehyde	10	20.77	0.01	12.94
2,5-Dimethylbenzaldehyde	0	NA	NA	NA

Table 23-53. Carbonyl Sampling and Analytical Precision: 210 Duplicate Samples Only

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ppbv)	Coefficient of Variation (%)
Formaldehyde	210	9.18	0.32	7.03
Acetaldehyde	210	13.43	0.17	8.86
Acetone	210	17.06	0.13	13.01
Propionaldehyde	208	17.91	0.01	10.53
Crotonaldehyde	207	14.52	0.01	10.07
Butyr/Isobutyraldehyde	210	**25.90**	0.02	13.12
Benzaldehyde	210	16.73	0.005	12.02
Isovaleraldehyde	69	**32.93**	0.01	**21.89**
Valeraldehyde	201	24.17	0.01	**16.46**
Tolualdehydes	186	**42.57**	0.01	**22.59**
Hexaldehyde	208	17.30	0.01	13.02
2,5-Dimethylbenzaldehyde	6	9.01	0.01	6.07

Table 23-54. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Analyses, All Sites

Pollutant	Average	St. Petersburg, FL (AZFL)	Barceloneta, PR (BAPR)	Bountiful, UT (BTUT)	Candor, NC (CANC)	Camden, NJ (CANJ)	Chester, NJ (CHNJ)	Custer, SD (CUSD)	Detroit, MI (DEMI)	Dickson, TN (DITN)	Elizabeth, NJ (ELNJ)
Formaldehyde	*11.11*	11.37	3.74	2.26	**65.16**	8.69	12.75	7.58	4.48	0.44	12.11
Acetaldehyde	*10.63*	13.02	4.96	2.24	**54.97**	**22.87**	**18.99**	9.56	2.96	1.02	11.97
Acetone	*13.35*	**29.08**	7.97	9.47	**53.17**	**18.19**	11.41	5.88	1.99	0.50	13.72
Propionaldehyde	*11.19*	**25.38**	7.87	1.61	**49.08**	**51.55**	14.15	7.36	3.05	1.99	12.14
Crotonaldehyde	*10.58*	**22.72**	**19.17**	**20.99**	**70.62**	6.99	11.25	5.24	6.15	2.48	15.13
Butyr/Isobutyraldehyde	*11.67*	**29.56**	**16.09**	5.60	**49.67**	**24.04**	11.70	4.91	2.27	3.68	11.78
Benzaldehyde	*11.37*	13.21	**15.31**	12.73	**46.38**	6.27	13.44	13.43	7.86	4.85	6.72
Isovaleraldehyde	**17.04**	NA	NA	14.31	12.86	NA	**40.41**	**21.03**	NA	NA	21.21
Valeraldehyde	**15.93**	**42.70**	**43.51**	11.64	**26.60**	**19.61**	**16.80**	11.09	5.24	6.95	11.17
Tolualdehydes	**20.77**	**50.03**	**59.77**	14.08	12.57	**34.02**	14.02	**23.36**	**18.86**	**23.38**	**23.50**
Hexaldehyde	**16.07**	**40.50**	5.51	**21.62**	**65.25**	13.26	9.47	11.01	**18.45**	5.14	10.21
2,5-Dimethylbenzaldehyde	*6.07*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average	*13.43*	**27.76**	**18.39**	*10.60*	**46.03**	**20.55**	**15.85**	*10.95*	*7.13*	*5.04*	*13.61*

Table 23-54. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Analyses, All Sites (Cont.)

Pollutant	Average	Birmingham, AL (ETAL)	Boward Co., FL (FLFL)	Tampa, FL (GAFL)	Grand Junction, CO (GPCO)	Gulfport, MS (GPMS)	Grenada, MS (GRMS)	Loudon, TN (LDTN)	Madison, WI (MAWI)	North Birmingham, AL (NBAL)	Northbrook, IL (NBIL)
Formaldehyde	*11.11*	0.69	1.41	3.97	**17.19**	2.04	NA	1.14	0.59	2.29	**67.35**
Acetaldehyde	*10.63*	0.22	2.66	3.99	**15.39**	2.60	0.79	0.99	2.22	1.11	**57.67**
Acetone	*13.35*	0.64	8.41	**18.98**	**17.49**	7.89	11.28	3.29	0.69	13.60	**60.67**
Propionaldehyde	*11.19*	2.11	0.92	4.41	**16.37**	3.19	3.45	3.44	2.58	0.75	**62.16**
Crotonaldehyde	*10.58*	6.58	1.87	8.22	13.96	6.46	NA	2.69	5.16	2.40	4.56
Butyr/Isobutyraldehyde	*11.67*	NA	3.11	7.03	**18.01**	5.24	**19.51**	3.60	2.76	0.95	1.35
Benzaldehyde	*11.37*	5.98	6.23	6.65	**16.84**	3.32	**20.20**	4.75	3.05	2.67	**16.44**
Isovaleraldehyde	**17.04**	NA	7.07	6.73	**36.38**	5.59	NA	1.13	12.58	8.32	12.86
Valeraldehyde	**15.93**	NA	10.53	8.40	**20.94**	4.22	8.32	10.68	11.69	NA	8.84
Tolualdehydes	**20.77**	11.38	**15.68**	**26.11**	**22.60**	**16.66**	NA	**24.48**	**24.71**	12.48	8.84
Hexaldehyde	**16.07**	9.75	2.47	**15.40**	**17.71**	7.60	14.43	1.93	5.54	3.45	8.84
2,5-Dimethylbenzaldehyde	*6.07*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average	*13.43*	*4.67*	*5.49*	*9.99*	**19.35**	*5.89*	*8.66*	*5.28*	*6.51*	*4.80*	**28.14**

Table 23-54. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Analyses, All Sites (Cont.)

Pollutant	Average	New Brunswick, NJ (NBNJ)	Orlando, FL (ORFL)	Pascagoula, MS (PGMS)	Providence, AL (PVAL)	Research Triangle Park, NC (RTPNC)	St. Louis, MO (Site 4 - S4MO)	Tampa, FL (SKFL)	Tampa, FL (SMFL)	Tampa, FL (SYFL)	Sioux Falls, SD (SFSD)
Formaldehyde	*11.11*	11.21	3.92	6.17	4.38	**53.44**	12.72	7.89	**17.94**	2.83	3.20
Acetaldehyde	*10.63*	12.96	10.75	3.85	4.34	**23.43**	**15.64**	**16.64**	**15.68**	6.08	1.15
Acetone	*13.35*	11.17	**28.95**	12.23	13.51	5.97	8.85	**16.22**	2.71	7.07	3.52
Propionaldehyde	*11.19*	13.81	2.48	5.73	4.65	13.49	14.35	9.09	**15.47**	2.29	1.59
Crotonaldehyde	*10.58*	13.05	16.85	6.34	4.56	11.83	10.53	**16.62**	**16.78**	5.24	1.63
Butyr/Isobutyraldehyde	*11.67*	12.46	9.75	6.73	4.81	12.26	13.60	14.77	**16.55**	2.56	6.76
Benzaldehyde	*11.37*	9.71	4.72	8.74	3.82	**30.53**	**19.77**	9.09	**21.21**	7.71	6.69
Isovaleraldehyde	**17.04**	**19.63**	**18.30**	8.64	**15.71**	NA	**19.87**	NA	**NA**	8.52	15.71
Valeraldehyde	**15.93**	**18.42**	4.27	9.29	6.15	**58.14**	**20.94**	**16.37**	**25.71**	10.73	3.61
Tolualdehydes	**20.77**	**23.34**	**23.83**	9.90	10.48	9.43	**29.81**	**16.90**	**26.19**	8.26	**20.03**
Hexaldehyde	**16.07**	**17.76**	4.98	14.37	**25.38**	**101.65**	11.06	14.86	10.35	11.99	12.90
2,5-Dimethylbenzaldehyde	*6.07*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Average	*13.43*	*14.86*	*11.71*	*8.36*	*8.89*	**32.02**	**16.10**	*13.85*	**16.86**	*6.66*	*6.98*

Table 23-54. Carbonyl Sampling and Analytical Precision: Coefficient of Variation for all Duplicate Analyses, All Sites (Cont.)

Pollutant	Average	Birmingham, AL (SIAL)	San Juan, PR (SJPR)	Tupelo, MS (TUMS)	Austin, TX (WETX)
Formaldehyde	*11.11*	3.69	8.90	4.35	12.03
Acetaldehyde	*10.63*	3.75	6.81	0.79	9.52
Acetone	*13.35*	5.46	14.92	**21.98**	7.04
Propionaldehyde	*11.19*	4.79	11.51	5.05	2.46
Crotonaldehyde	*10.58*	5.75	7.68	7.90	2.45
Butyr/Isobutyraldehyde	*11.67*	8.08	**46.47**	5.80	3.75
Benzaldehyde	*11.37*	8.72	7.09	14.80	7.72
Isovaleraldehyde	**17.04**	**55.34**	NA	NA	12.57
Valeraldehyde	**15.93**	8.78	**32.42**	10.67	5.30
Tolualdehydes	**20.77**	13.77	**22.61**	**24.79**	9.60
Hexaldehyde	**16.07**	5.96	12.94	11.73	2.98
2,5-Dimethylbenzaldehyde	*6.07*	6.07	NA	NA	NA
Average	*13.43*	*10.85*	**17.14**	*10.79*	*6.86*

Table 23-55. Metals Sampling and Analytical Precision: 98 Collocated Samples, Including all Post-Katrina Data

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ng/m^3)	Coefficient of Variation (%)
Antimony	98	**60.33**	0.08	**23.36**
Arsenic	98	5.79	0.06	4.10
Beryllium	98	**30.30**	0.00	**21.55**
Cadmium	98	23.63	0.10	**16.19**
Chromium	98	7.30	0.15	5.15
Cobalt	98	13.97	0.02	10.78
Lead	98	17.56	0.51	10.78
Manganese	98	**235.51**	0.44	**27.49**
Mercury	59	**138.26**	0.04	**40.49**
Nickel	98	**32.36**	0.70	**18.09**
Selenium	95	10.08	0.04	6.50

Table 23-56. Metal Sampling and Analytical Precision: 60 Collocated Samples in Boston, MA (BOMA)

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ng/m^3)	Coefficient of Variation (%)
Antimony	60	11.28	0.12	7.87
Arsenic	60	6.74	0.03	4.81
Beryllium	60	34.04	0.001	**21.25**
Cadmium	60	58.47	0.25	**38.16**
Chromium	60	10.78	0.22	7.28
Cobalt	60	7.78	0.01	5.38
Lead	60	9.97	0.51	6.97
Manganese	60	7.63	0.35	5.36
Mercury	36	58.27	0.04	**36.92**
Nickel	60	9.48	0.25	6.48
Selenium	60	9.14	0.04	6.34

Table 23-57. Metals Sampling and Analytical Precision: 96 Collocated Samples Only

Pollutant	Number of Observations	Average RPD for Duplicate Analyses (%)	Average Concentration Difference for Duplicate Analyses (ng/m^3)	Coefficient of Variation (%)
Antimony	96	9.43	0.10	6.83
Arsenic	96	5.79	0.06	4.10
Beryllium	96	**30.30**	0.002	**21.55**
Cadmium	96	**28.85**	0.13	**19.77**
Chromium	96	6.74	0.19	4.67
Cobalt	96	13.97	0.02	10.78
Lead	96	8.57	0.64	6.00
Manganese	96	5.94	0.55	4.23
Mercury	57	**170.82**	0.05	**46.03**
Nickel	96	**28.62**	0.87	**15.84**
Selenium	95	10.08	0.04	6.50

Table 23-58. Metals Sampling and Analytical Precision: Coefficient of Variation for all Collocated Samples, All Sites

Pollutant	Average	Boston, MA (BOMA)	Bountiful, UT (BTUT)	Gulf Port, MS (GPMS)	Madison, WI (MAWI)	St. Louis, MO(S4MO)
Antimony	**23.36**	7.87	7.69	**72.94**	NA	4.93
Arsenic	*4.10*	4.81	3.12	NA	2.51	5.94
Beryllium	**21.55**	**21.25**	**26.54**	NA	NA	**16.86**
Cadmium	**16.19**	**38.16**	9.98	5.42	NA	11.18
Chromium	*5.15*	7.28	3.84	7.08	2.55	5.02
Cobalt	*10.78*	5.38	**16.09**	NA	NA	10.89
Lead	*10.78*	6.97	8.45	**29.87**	0.68	7.91
Manganese	**27.49**	5.36	5.59	**120.53**	1.98	3.99
Mercury	**40.49**	**36.92**	**57.24**	**23.85**	NA	**43.93**
Nickel	**18.09**	6.48	**41.90**	**27.07**	4.29	10.72
Selenium	*6.50*	6.34	13.27	NA	1.75	4.63
Average	**17.13**	*13.35*	**17.61**	**40.97**	*2.29*	*11.45*

Table 23-59. Accuracy VOC NATTS Audit Samples – Percent Difference from True (Acceptable Difference is 25%)

Pollutant	March, 2005	June, 2005	Nov., 2005 (1)	Nov., 2005 (2)
Vinyl Chloride	-10.0	4.1	12.0	Not included
1,3-Butadiene	-6.9	15.8	Not included	**27.8**
Acrolein	Not included	Not included	Not included	22.3
Methylene Chloride	5.5	10.9	Not included	Not included
Chloroform	7.5	15.2	23.7	Not included
1,2-Dichloroethane	3.5	13.2	**25.6**	Not included
Benzene	17.2	**30.0**	Not included	Not included
Carbon Tetrachloride	23.3	18.4	**37.7**	Not included
1,2-Dichloropropane	10.1	**26.5**	Not included	Not included
Trichloroethylene	16.4	10.2	14.0	Not included
cis-1,3-Dichloropropene	14.4	17.5	9.1	Not included
trans-1,3-Dichloropropene	23.2	18.5	16.4	Not included
1,2-Dibromoethane	13.6	24.7	Not included	Not included
Tetrachloroethylene	3.9	20.3	10.4	Not included
1,1,2,2-Tetrachloroethane	3.1	11.4	Not included	Not included

Table 23-60. Carbonyl NATTS Audit Samples – Percent Difference from True (Acceptable Difference is 25%)

Pollutant	Jan., 2005	July, 2005	Oct., 2005	Nov., 2005
Formaldehyde	-9.6	5.2	-5.3	2.5
Acetaldehyde	-10.5	13.9	3.7	9.2
Acetone	Not included	12.0	2.6	3.7

Table 23-61. Metals NATTS Audit Samples – Percent Difference from True (Acceptable Difference is 25%)

Pollutant	Jan., 2005	May, 2005	Sept., 2005	Nov., 2005
Arsenic	-16.7	13.1	9.5	15.5
Beryllium	**-25.9**	**25.4**	22.8	13.6
Cadmium	**-30.0**	-1.9	12.2	5.1
Chromium	12.5	-0.4	4.4	10.2
Lead	**-36.6**	1.2	13.0	5.1
Manganese	-19.4	-0.1	0.6	2.3
Nickel	**-77.8**	-1.1	2.0	21.8

24.0 Conclusions and Recommendations

As indicated throughout this report, UATMP monitoring data offer a wealth of information for evaluating trends, patterns, and the potential for health risk in air quality and should ultimately help a wide range of audiences understand the complex nature of urban and rural air pollution. The following discussion summarizes the main conclusions of this report and presents recommendations for ongoing urban air monitoring efforts.

24.1 Conclusions

Analyses of the 2005 UATMP monitoring data identified the following notable trends and patterns in national-level and state-level urban air pollution:

24.1.1 National-level Conclusions

$ *Ambient air concentration data sets generally met data quality objectives for completeness.* Completeness, or the number of valid samples collected compared to the number expected from a 6 or 12 day sampling schedule, measures the reliability of the sampling and analytical equipment as well as the efficiency of the program. Typically, a completeness of 85-100% is desired for a complete data set. Eleven of 110 data sets failed to comply with the data quality objective of 85% completeness. Twenty-three data sets achieved 100% completeness.

$ *Several UATMP sites are also NATTS sites.* Eight of the forty-seven sites are EPA-designated NATTS sites (NBIL, BOMA, DEMI, GPCO, S4MO, SKFL, SYFL, and BTUT).

$ *Total number of samples for UATMP pollutants.* Nearly 169,487 measurements of urban air toxics were made. Samples from the sites commissioned to the Hurricane Katrina monitoring effort account for an additional 33,932 measurements.

$ *Ambient air concentrations of urban air toxics.* Approximately 72% of the measured concentrations were less than 1 $\mu g/m^3$. Less than 4% of the concentrations were greater than 5 $\mu g/m^3$.

$ *Detects.* Detection of a UATMP pollutant is subject to the analytical methods used and the limitations of the instruments. Method detection limits are the lowest concentration an instrument can reliably quantify with a certain level of confidence. For 2005, five pollutants (1,2-dichloropropane, bromoform, 1-decene, 1-tridecene, and propyne) were not detected at any of the participating sites.

$ *Nationwide Pollutants of Interest.* The pollutants of interest at the national level, based on the number of exceedances, or “failures”, of the preliminary screening values, included: acetaldehyde, acrolein, arsenic, benzene, 1,3-butadiene, carbon tetrachloride,

p-dichlorobenzene, formaldehyde, hexachloro-1,3-butadiene, manganese, nickel, tetrachloroethylene, and total xylenes. At each site, the pollutants of interest varied.

- *Risk*. Three pollutants of interest (acrolein, benzene, and formaldehyde) had daily measurements that exceeded one or both of the short-term risk factors. Acrolein exceeded the ATSDR short-term MRL on 283 occasions and the CAL EPA REL on 279 occasions; benzene exceeded the ATSDR short-term MRL twice; and formaldehyde exceeded the ATSDR short-term MRL on 30 occasions and the CAL EPA REL on 22 occasions. Formaldehyde exceeded the ATSDR intermediate MRL twice, both during the summer season. Acrolein exceeded the ATSDR intermediate MRL on nine occasions.

$ *Pearson Correlations.* Pearson Correlations were computed at each site between each pollutant and various meteorological parameters. Generally, the meteorological parameters had poor correlations with the nationwide pollutants of interest across all the sites. The Pearson Correlations were much stronger at the individual sites.

$ *Automobile Impacts.* Cook County, IL had the highest vehicle registration, while Jefferson County, AL had the highest hydrocarbon average concentration of all the UATMP counties. The Schiller Park site (SPIL) near Chicago had the highest daily traffic passing by the monitor (214,900), and Cook County, IL also had the highest nonroad emissions of all the participating sites, while Wayne County, MI had the highest on-road emissions of all the sites. The Barceloneta site (BAPR) in Puerto Rico had the lowest daily traffic volume (100).

24.1.2 State-level Conclusions

$ *Alabama*.

< The Alabama sites began sampling in mid-July for VOC, carbonyl compounds, SVOC, and metals.

< The pollutants of interest common to each Alabama site are: acrolein, arsenic, formaldehyde, carbon tetrachloride, manganese, acetaldehyde, benzene, naphthalene, and *p*-dichlorobenzene.

< Total xylenes measured the highest daily average at each of the three Birmingham sites, while the pollutants of interest with the highest daily average at PVAL was formaldehyde. Seasonal averages were only available for summer and autumn, and no annual averages could be calculated.

< Acrolein was the only pollutant to exceed either of the short-term risk factors at any of the Alabama sites. Because seasonal averages for acrolein were not able to be calculated, an intermediate risk-assessment could not be performed.

< The strongest Pearson Correlations computed are listed as follows:

- ETAL: -0.95 between hexachloro-1,3-butadiene and dew point temperature.

- NBAL: -0.89 between hexachloro-1,3-butadiene and the *u*-component of the wind.

- PVAL: 0.78 between formaldehyde and maximum temperature.

- SIAL: 0.81 between dibenz (a,h) anthracene and average temperature.

< As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated from a variety of directions at the Alabama sites. The airshed domain is smaller than most sites, as the farthest away a back trajectory originated is nearly 500 miles. However, these sites sampled for only the second half of the year, and this is reflected in the trajectory maps.

< The wind roses for the Alabama sites show that northerly and south-southeasterly to southerly winds are predominant near the sites. However, these sites sampled for only the second half of the year, and this is reflected in the wind roses.

< Benzene, 1,3-butadiene, and acetaldehyde had the highest NATA-modeled cancer risk for the three Birmingham census tracts, while benzene, carbon tetrachloride, and acetaldehyde had the highest NATA-modeled cancer risk for the PVAL census tract.

$ *Colorado.*

< GPCO sampled year-round for VOC and carbonyl compounds.

< The pollutants of interest at GPCO are: acetaldehyde, formaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, tetrachloroethylene, xylenes, acrolein, and hexachloro-1,3-butadiene.

< Total xylenes measured the highest daily average at GPCO.

< Acrolein was the only pollutant to exceed either of the short-term risk factors at GPCO. Seasonal averages for acrolein were only calculated for autumn. The autumn acrolein average was nine times the intermediate risk factor.

< The strongest Pearson Correlation computed at GPCO was between hexachloro-1,3-butadiene and average temperature (-0.81).

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at GPCO. The airshed domain for GPCO is somewhat smaller than most sites, as the farthest away a back trajectory originated is nearly 500 miles.

< The wind rose for GPCO shows that easterly and southeasterly winds are predominant near the site.

< Benzene, carbon tetrachloride, and 1,1,2,2-tetrachloroethane had the highest NATA-modeled cancer risk for the GPCO census tract. With the exception of total xylenes and hexachloro-1,3-butadiene, the NATA-modeled and annual average concentrations of the pollutants that failed at least one screen were within one order of magnitude from each other. Formaldehyde had the highest NATA-modeled concentration while total xylenes had the highest annual average concentration.

$ *Florida*.

< With the exception of FLFL, which began sampling in October, the Florida sites sampled year-round. These sites sampled for carbonyl compounds only.

< The pollutants of interest at each Florida site are acetaldehyde and formaldehyde. These are the only two carbonyl compounds with risk screening values.

< Formaldehyde measured the highest daily average at GAFL, ORFL, SKFL, SMFL, and SYFL, while acetaldehyde measured the highest daily average at AZFL and FLFL. Seasonal trends show that acetaldehyde and formaldehyde did not differ significantly from season to season in most cases. This is not unexpected as the Florida sites experience less seasonal fluctuations than sites in most other locations.

< Formaldehyde exceeded one or both of the short-term risk factors at GAFL, SKFL, and SMFL. Seasonal averages of formaldehyde at these sites did not exceed the intermediate risk factor.

< The strongest Pearson Correlations computed are listed as follows:

- AZFL: 0.25 between acetaldehyde and sea level pressure.

- FLFL: -0.80 between acetaldehyde and average temperature.

- GAFL: 0.26 between acetaldehyde and both wind components.

- ORFL: -0.40 between acetaldehyde and both dew point and wet bulb temperature.

- SKFL: 0.41 between acetaldehyde and sea level pressure.

- SMFL: 0.25 between formaldehyde and the *u*-component of the wind.

- SYFL: -0.38 between acetaldehyde and relative humidity.

- < As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at the Florida sites. The airshed domain for these sites is rather large, as the farthest away a back trajectory originated is over 700 miles. The airshed domain of FLFL appears smaller than at other sites, but represents the three months of sampling.

- < The wind roses for the sites in the Tampa/St. Petersburg area show that generally north, northeasterly and easterly winds are predominant, although the two sites on the east side of Tampa Bay experience westerly winds as well. The Orlando and Ft. Lauderdale sites tend to more commonly experience winds from a variety of directions.

- < A comparison of formaldehyde concentrations for all years of UATMP participation show that:

    - at AZFL, formaldehyde concentrations have decreased since 2001, but have been fairly consistent since 2003.

    - at GAFL, formaldehyde concentrations decreased from 2002 to 2003, but increased from 2004 to 2005. However, the large confidence interval in 2005 shows that this increase may have been driven by a few outliers.

    - at ORFL, formaldehyde concentrations have held fairly steady since 2003.

- < Acetaldehyde had the highest NATA-modeled cancer risk for the each of the Florida monitoring site census tracts, although each was less than 5 in a million. With a few exceptions, the NATA-modeled and annual average concentrations of the pollutants of interest were within one or two microns of each other.

$ *Illinois.*

- < The Chicago sites sample year-round for VOC and began sampling carbonyl compounds in the spring. In addition, NBIL also sampled SNMOC and metals.

- < The pollutants of interest common to both Chicago sites are: benzene, formaldehyde, carbon tetrachloride, 1,3-butadiene, acetaldehyde, tetrachloroethylene, hexachloro-1,3-butadiene, *p*-dichlorobenzene, and trichloroethylene.

- < Formaldehyde measured the highest daily average at both NBIL and SPIL. Seasonal trends show that most of the seasonal averages for the pollutants of interest did not differ significantly from season to season. A full year of carbonyl sampling at these sites will allow a better evaluation of seasonal carbonyl trends in the future.

- < Acrolein exceeded the short-term risk factors at both Chicago sites, while formaldehyde exceeded the short-term risk factors at SPIL. Because seasonal

averages for acrolein could only be calculated for autumn at SPIL, a more complete intermediate risk-assessment may be performed in the future. However, the one seasonal average is more than seven times the intermediate risk factor. The summer formaldehyde average at SPIL exceeded the intermediate risk factor.

< The strongest Pearson Correlations computed are listed as follows:

- NBIL: -0.88 between hexachloro-1,3-butadiene and dew point and wet bulb temperature.

- SPIL: 0.65 between formaldehyde and average temperature. This correlates well with the seasonal formaldehyde averages.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at the Chicago sites, although less frequently from the east. The airshed domain for these sites is rather large, as the farthest away a back trajectory originated is over 1000 miles. However, most trajectories originated within 600 miles of the sites.

< The wind roses for the sites in the Chicago area show that westerly and southerly winds are most predominant, and least common from the east and southeast.

< A comparison of 1,3-butadiene and benzene concentrations for all years of UATMP participation shows that these pollutants have been holding steady since 2003. The seemingly high concentration at NBIL in 2004 seems to have been driven by a few outliers based on the confidence interval.

< Benzene had the highest NATA-modeled cancer risk for both Chicago site census tracts, over 20 in a million. Total xylenes had the highest NATA-modeled concentration at both sites' census tracts, and the highest annual average at NBIL. However, formaldehyde exhibited the highest annual average at SPIL. Unfortunately, an annual formaldehyde average could not be calculated at NBIL.

$ *Indiana*.

< INDEM sampled year-round for carbonyl compounds only.

< The pollutants of interest at INDEM are acetaldehyde and formaldehyde. These are the only two carbonyl compounds with risk screening values.

< Formaldehyde measured the highest daily average at INDEM and its summer average was ten times higher than the winter and spring averages. Acetaldehyde tended to be higher in winter and spring. Unfortunately, autumn average could not be calculated due to sampling equipment problems at the site.

- Formaldehyde exceeded both of the short-term risk factors thirteen times at INDEM. The summer formaldehyde average was nearly five times the intermediate risk factor.

- The strongest Pearson Correlation computed at INDEM was between formaldehyde and dew point temperature (0.73).

- As illustrated by the composite 24-hour back trajectory map, back trajectories originated from a variety of directions at INDEM, although less frequently from the east. The airshed domain for this site is rather large, as the farthest away a back trajectory originated is over 1000 miles. However, most trajectories originated within 600 miles of the site.

- The wind rose for INDEM shows that westerly and southerly winds are most predominant, and least common from the east.

- Acetaldehyde had the highest NATA-modeled cancer risk for the INDEM census tract. The acetaldehyde NATA-modeled concentration and annual average are very similar, while the formaldehyde annual average is significantly higher than the NATA-modeled concentration.

$ *Massachusetts*.

- BOMA sampled year-round for metals only.

- The pollutants of interest at BOMA are arsenic, nickel, manganese, and cadmium.

- Manganese measured the highest daily average at BOMA. Seasonal averages of nickel varied the most, with winter having the highest nickel average.

- The strongest Pearson Correlation computed at BOMA was between nickel and average temperature (-0.47). This correlates well with the seasonal average calculations.

- As illustrated by the composite 24-hour back trajectory map, back trajectories originated from a variety of directions at BOMA. The airshed domain for this site is somewhat large, as the farthest away a back trajectory originated is over 600 miles.

- The wind rose for BOMA shows that winds with an westerly component are mostly common.

- The NATA-modeled cancer risk for the pollutants of interest in the BOMA census tract are all less than 1 in a million. The NATA-modeled concentrations for the pollutants of interest are all higher than their respective annual averages.

$ *Michigan.*

< DEMI and APMI sampled for VOC and carbonyls, while ITCMI and YFMI sampled for VOC and SVOC. ITCMI sampled through September, YFMI sampled through October, and APMI sampled through November.

< The pollutants of interest common at each Michigan site are: benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, and tetrachloroethylene.

< Tetrachloroethylene measured the highest daily average at APMI; formaldehyde measured the highest daily average at DEMI; benzene measured the highest daily average at YFMI and ITCMI. Seasonally, the averages of the pollutants of interest did not vary much.

< Acrolein exceeded the short-term risk factors at each Michigan site, while benzene exceeded the short-term risk factor at YFMI. Because seasonal averages for acrolein could not be calculated, a more complete intermediate risk-assessment may be performed in the future. Benzene averages could be calculated for all seasons, but autumn. Unfortunately, the highest benzene concentrations measured occurred in autumn.

< The strongest Pearson Correlations computed are listed as follows:

- APMI: 0.60 between formaldehyde and maximum temperature.

- DEMI: 0.56 between hexachloro-1,3-butadiene and relative humidity.

- ITCMI: -0.98 between tetrachloroethylene and wet bulb temperature.

- YFMI: 0.63 between benzene and the *v*-component of the wind.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at the Detroit sites. The airshed domains for these sites are rather large, as the farthest away a back trajectory originated is over 1000 miles. However, most trajectories originated within 600 miles of the sites. The airshed domain for ITCMI is slightly smaller, with all trajectories originating within 600 miles of the site.

< The wind roses for the sites in the Detroit area show that winds come from a variety of directions, although north, south, and west are most common. Easterly and west-northwesterly winds are predominant in the Sault Ste. Marie area.

< Formaldehyde concentrations increased at APMI in 2005, while 1,3-butadiene and benzene changed little. A few outliers are likely responsible for the high formaldehyde concentration at DEMI in 2004. Little has change is noted at ITCMI.

- Benzene had the highest NATA-modeled cancer risk at APMI, DEMI, and ITCMI. No risk was calculated for the YFMI census tract due to a population of zero. Annual averages could not be calculated for ITCMI and YFMI. Xylenes had the highest NATA-modeled concentrations at APMI and DEMI, while tetrachloroethylene and formaldehyde had the highest annual averages at these two sites, respectively.

$ *Minnesota*.

- MIMN began sampling in March for VOC, carbonyl compounds, and metals.

- There were twelve pollutants of interest at MIMN, including three metals, two carbonyl compounds, and seven VOC.

- Formaldehyde measured the highest daily average at MIMN. No winter averages could be calculated for MIMN. Formaldehyde was highest in the summer, and nickel and manganese were highest in the summer and autumn.

- Acrolein exceeded both of the short-term risk factors at MIMN. The autumn acrolein average was nine times the intermediate risk factor.

- The strongest Pearson Correlation computed at MIMN was between formaldehyde and maximum temperature (0.65). This correlates well with the seasonal average calculations.

- As illustrated by the composite 24-hour back trajectory map, back trajectories originated from a variety of directions at MIMN, although hardly at all from the west and east. The airshed domain for this site is rather large, as the farthest away a back trajectory originated is over 900 miles. However, most trajectories originated within 600 miles of the site.

- The wind rose for MIMN shows that westerly and southeasterly winds are most predominant, and least common from the northeast.

- Benzene had the highest NATA-modeled cancer risk for the MIMN census tract. This is the second highest calculated cancer risk for any of the UATMP site census tracts.

C *Mississippi*.

- The Mississippi sites sampled for VOC and carbonyl compounds. In addition, PGMS also sampled for SNMOC.

- The pollutants of interest common at each Mississippi site are: acetaldehyde, benzene, carbon tetrachloride, and formaldehyde.

< Acetaldehyde measured the highest daily average at GRMS and TUMS, while benzene had the highest daily average at PGMS. Seasonal averages are not available for GRMS or PGMS. Seasonal averages of the pollutants of interest at TUMS show little seasonal variability.

< Acrolein exceeded the short-term risk factors at PGMS and TUMS. Because seasonal averages for acrolein could not be calculated except at TUMS in autumn, a more complete intermediate risk-assessment may be performed in the future.

< The strongest Pearson Correlations computed are listed as follows:

- GRMS: 0.77 between formaldehyde and average temperature.

- PGMS: 0.54 between formaldehyde and average temperature.

- TUMS: 0.48 between tetrachloroethylene and maximum temperature.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at the Mississippi sites. The airshed domains for GRMS and PGMS appear smaller than for TUMS. However, its important to note that these two sites' maps do not encompass a full year of sampling like the TUMS map does.

< The wind roses for GRMS and TUMS, the two northern Mississippi sites, show that winds are predominantly out of the north or south. At PGMS, northwesterly to northerly winds are prevalent. It is important to remember that the wind roses for GRMS and PGMS do not encompass and entire year's worth of sampling.

< Formaldehyde concentrations at the Mississippi sites have been steadily decreasing since the onset of UATMP participation. Benzene concentrations have decreased slightly at TUMS since sampling began in 2002, and have been relatively consistent at the other two sites. 1,3-Butadiene concentrations have changed little at PGMS and TUMS. This compound has never been detected at GRMS.

< Benzene had the highest NATA-modeled cancer risk at all three Mississippi sites. Acetaldehyde had the highest annual average at TUMS, while dichloromethane had the highest NATA-modeled concentration. Annual averages were not available for GRMS and PGMS.

< PGMS and GPMS (a previous UATMP site) began sampling daily in October to measure the air quality impacts in response to Hurricane Katrina in the Gulf Coast region. VOC, carbonyls, and metals were sampled for at PGMS and GPMS. In addition, GPMS also sampled for SNMOC and SVOC.

- Fifteen pollutants of interest were common to both sites: 1,2-dichloroethane, acetaldehyde, formaldehyde, benzene, beryllium (PM_{10}

and $PM_{2.5}$) 1,3-butadiene, carbon tetrachloride, arsenic (PM_{10} and $PM_{2.5}$), hexachloro-1,3-butadiene, acrolein, *p*-dichlorobenzene, manganese (PM_{10}), and tetrachloroethylene.

- Formaldehyde measured the highest daily average at both sites during the 90 day sampling period, although the daily average was nine times higher at PGMS than at GPMS.

- Acrolein exceeded the short-term risk factors at both PGMS and GPMS, as well as the intermediate risk factor at both sites. Formaldehyde exceeded the short-term risk factors six times at PGMS, although the intermediate average did not exceed the intermediate risk factor.

$ *Missouri.*

< S4MO sampled year-round for VOC, carbonyl compounds, and metals.

< The pollutants of interest at S4MO are: benzene, acetaldehyde, arsenic, carbon tetrachloride, formaldehyde, manganese, 1,3-butadiene, cadmium, tetrachloroethylene, *p*-dichlorobenzene, and hexachloro-1,3-butadiene.

< Formaldehyde measured the highest daily average at S4MO. Seasonal trends show that formaldehyde and acetaldehyde tend to be highest in spring and summer, while carbon tetrachloride is highest in the summer and autumn.

< Acrolein was the only pollutant to exceed either of the short-term risk factors at S4MO. Seasonal averages for acrolein could not be calculated. A more complete intermediate risk-assessment may be performed in the future.

< The strongest Pearson Correlation computed at S4MO was between formaldehyde and maximum temperature (0.68). This correlates well with the seasonal average calculations.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at S4MO, although less frequently from the east. The airshed domain for S4MO is rather large, as the farthest away a back trajectory originated is over 700 miles.

< The wind rose for S4MO shows that generally southeasterly and northwesterly winds are predominant near the site.

< Formaldehyde concentrations appear to have decreased from 2004 to 2005, although the confidence interval shows that this decrease is not statistically significant. Additionally, benzene and 1,3-butadiene did decrease slightly from 2004 to 2005.

< Benzene had the highest NATA-modeled cancer risk for the S4MO census tract, although manganese had the highest NATA-modeled concentration. In 2005, formaldehyde had the highest annual average.

$ *New Jersey.*

< The New Jersey sites sampled year-round for VOC and carbonyl compounds.

< The pollutants of interest common at each New Jersey site are: acetaldehyde, benzene, 1,3-butadiene, carbon tetrachloride, formaldehyde, and tetrachloroethylene.

< Formaldehyde and acetaldehyde measured the highest daily averages at the New Jersey sites, although acrolein was also the highest with formaldehyde at CHNJ. Generally, seasonal concentrations of the pollutants of interest did not vary much statistically at the New Jersey sites, although there are a few exceptions. Formaldehyde was highest during the summer at CHNJ and acetaldehyde was highest in the summer at NBNJ.

< Acrolein exceeded the short-term risk factors at all four New Jersey sites. Seasonal averages for acrolein could not be calculated except for autumn at CHNJ and NBNJ. But both of these autumn averages exceeded the intermediate risk factors. A more complete intermediate risk-assessment may be performed in the future.

< The strongest Pearson Correlations computed are listed as follows:

- CANJ: -0.78 between hexachloro-1,3-butadiene and dew point temperature.

- CHNJ: 0.72 between formaldehyde and maximum temperature, as well as acrolein and dew point temperature.

- ELNJ: -0.68 between hexachloro-1,3-butadiene and maximum temperature.

- NBNJ: 0.77 between formaldehyde and acetaldehyde and maximum temperature.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at the New Jersey sites. The airshed domains are rather large, with trajectories originating over 700 miles away at each site.

< The wind roses for the New Jersey sites show that the wind regimes are different at each site. Winds from every direction except from the southeast are common at CANJ; northerly winds are prevalent at CHNJ and NBNJ although calm winds

were observed almost half of the time; and northeasterly, southerly, and westerly winds are most common at NBNJ.

< Concentrations of formaldehyde appear to fluctuate from year to year at CANJ; have been decreasing at CHNJ; and have been increasing at ELNJ and NBNJ. Benzene and 1,3-butadiene have changed little over the various years of sampling at the New Jersey sites.

< Benzene had the highest NATA-modeled cancer risk at all four New Jersey sites. Total xylenes had the highest NATA-modeled concentration at CANJ and ELNJ, while formaldehyde the highest NATA-modeled concentration at CHNJ and NBNJ. Formaldehyde had the highest annual average concentration at CANJ and CHNJ, while acetaldehyde had the highest annual average concentration at ELNJ and NBNJ.

< The acrolein noncancer hazard quotient in the ELNJ census tract was the highest noncancer hazard quotient at any UATMP site.

C *North Carolina.*

< The North Carolina sites sample year-round for carbonyl compounds.

< The pollutants of interest at the North Carolina sites are acetaldehyde and formaldehyde. These are the only two carbonyl compounds with risk screening values.

< Formaldehyde measured the highest daily average at both CANC and RTPNC, although they didn't vary much statistically from the acetaldehyde concentrations. Seasonal concentrations were not available for every season at the North Carolina sites, making seasonal trends difficult to gage.

< The strongest Pearson Correlations computed are listed as follows:

- CANC: 0.36 between formaldehyde and average temperature.

- RTPNC: 0.61 between formaldehyde and maximum and average temperature.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at the North Carolina sites. The airshed domain for these sites is rather large, as the farthest away a back trajectory originated is over 600 miles.

< The wind rose for the CANC site shows that southwesterly, westerly and northeasterly winds are most predominant, and least common from the southeast and northwest. The wind rose for RTPNC is fairly similar.

< Formaldehyde concentrations at CANC appear to have decreased from 2004 to 2005, although the confidence interval shows that this decrease is not statistically significant.

< The RTPNC census tract has twice the acetaldehyde cancer risk of the CANC census tract, although both are fairly low. The NATA-modeled concentrations for the RTPNC census tract are similar to the 2005 annual averages.

$ *Oklahoma.*

< The Oklahoma sites sampled during the summer months only for VOC and SNMOC.

< The pollutants of interest common to both Ponca City sites are: acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene.

< Total xylenes measured the highest daily average at PCOK, significantly higher than any other pollutant. Interestingly, POOK, only a few blocks away, had a daily average that was about a quarter of the total xylenes daily average at PCOK.

< Acrolein was the only pollutant to exceed either of the short-term risk factors at the Ponca City sites. Seasonal averages for acrolein could not be calculated. A more complete intermediate risk-assessment may be performed in the future.

< The strongest Pearson Correlations computed are listed as follows:

- PCOK: -0.84 between *p*-dichlorobenzene and maximum temperature.

- POOK: -0.62 between *p*-dichlorobenzene and maximum temperature.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated predominantly from the southeast and south at the Oklahoma sites. The airshed domain for these sites is slightly smaller than other UATMP sites, as the farthest away a back trajectory originated is over 500 miles. The map, however, only presents the summer trajectories and may look differently if based on an entire year of sampling.

< The wind roses for the Oklahoma sites show that southeasterly winds are most predominant during the summer season.

< Benzene had the highest NATA-modeled cancer risk in both Oklahoma sites' census tracts.

$ *Puerto Rico.*

< The Puerto Rico sites began sampling in February for VOC and carbonyl compounds.

< The pollutants of interest common to both Puerto Rico sites are: acrolein, benzene, acetaldehyde, 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene.

< Dichloromethane measured the highest daily average at the BAPR site, while this was not even a compound of interest at the SJPR site. Total xylenes had the highest daily average at the SJPR site, while this was not even a pollutant of interest at the BAPR site. The seasonal acetaldehyde concentrations were higher in the spring than in other seasons, while the other pollutants of interest did not vary much statistically from season to season.

< Acrolein was the only pollutant to exceed either of the short-term risk factors at the Puerto Rico sites. Seasonal averages for acrolein could not be calculated. A more complete intermediate risk-assessment may be performed in the future.

< The strongest Pearson Correlations computed are listed as follows:

- BAPR: -0.83 between hexachloro-1,3-butadiene and the *v*-component of the wind.

- SJPR: -0.68 between tetrachloroethylene and average temperature.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated predominantly from the east at the Puerto Rico sites. The airshed domain for these sites is slightly smaller than other UATMP sites, as the farthest away a back trajectory originated is just over 500 miles.

< The wind roses for the Puerto Rico sites show that winds from the northeast and east are predominant near the sites.

< Dichloromethane had the highest NATA-modeled cancer risk in the BAPR site's census tract. This cancer risk (71.0 in a million) is the highest of any pollutant that failed at least one screen at a UATMP site. This pollutant also had both the highest NATA-modeled and annual average at this site. Tetrachloroethylene and benzene had the highest NATA-modeled cancer risk in the SJPR census tract. Total xylenes had both the highest NATA-modeled and annual average at SJPR.

< Tranport of dichloromethane emissions from three nearby pharmaceutical companies are likely being captured at the BAPR site.

$ *South Dakota.*

< The South Dakota sites sample year-round for VOC, SNMOC, and carbonyl compounds.

< The pollutants of interest common to both South Dakota sites are: benzene, formaldehyde, carbon tetrachloride, 1,3-butadiene, acetaldehyde, and acrolein.

- Formaldehyde measured the highest daily average at SFSD, while acrolein measured the highest daily average at CUSD. Seasonal trends show that the formaldehyde summer average was higher than the other seasons at SFSD. At CUSD, 1,3-butadiene was highest in autumn.

- Acrolein exceeded the short-term risk factors at both South Dakota sites. Because seasonal averages for acrolein could only be calculated for autumn at CUSD, a more complete intermediate risk-assessment may be performed in the future. However, the one seasonal average is significantly higher than the intermediate risk factor.

- The strongest Pearson Correlations computed are listed as follows:

  - CUSD: 0.85 between 1,1,2,2-tetrachloroethylene and dew point temperature.

  - SFSD: -0.67 between hexachloro-1,3-butadiene and maximum temperature.

- The back trajectories at the South Dakota sites illustrate how different wind regimes can be on opposite sides of a state. Back trajectories originated primarily from a west and northwest direction at CUSD, and primarily from a south, northwest and northerly direction at SFSD. The airshed domain for CUSD is a somewhat smaller than at SFSD.

- The wind roses for the sites in South Dakota correlate well with the back trajectory maps. West winds are predominant near CUSD, while south and west winds are most predominant near SFSD.

- Formaldehyde concentrations have been decreasing at CUSD since 2002. Concentrations of 1,3-butadiene and formaldehyde in 2002 at SFSD may have been driven by a few outliers, which makes it difficult to identify a trend.

- Benzene and carbon tetrachloride had the highest NATA-modeled cancer risks for the CUSD and SFSD census tracts. The NATA-modeled concentrations in both census tracts were all less than 1 $\mu g/m^3$. Only two pollutants at CUSD and three pollutants at SFSD had annual averages greater than 1 $\mu g/m^3$.

$ *Tennessee.*

- The Tennessee sites sample year-round for VOC and carbonyl compounds.

- The pollutants of interest common to both Tennessee sites are: acetaldehyde, acrolein, benzene, formaldehyde, carbon tetrachloride, 1,3-butadiene, hexachloro-1,3-butadiene, *p*-dichlorobenzene, and tetrachloroethylene.

< Formaldehyde measured the highest daily average at both DITN and LDTN. Formaldehyde was highest in summer compared to other seasons at both sites.

< Acrolein exceeded the short-term risk factors at both Tennessee sites. Seasonal averages for acrolein could not be calculated. A more complete intermediate risk-assessment may be performed in the future.

< The strongest Pearson Correlations computed are listed as follows:

- DITN: 0.86 between formaldehyde and average temperature. This correlates well with the seasonal formaldehyde averages.

- LDTN: 0.88 between formaldehyde and maximum temperature. This correlates well with the seasonal formaldehyde averages.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at the Tennessee sites. The airshed domain for DITN appears larger than for LDTN. This is mostly due to the presence of one trajectory. Most trajectories originated within 500 miles of the sites.

< The wind roses for the sites in Tennessee show that the back trajectories originate primarily from the southwest and west. Interestingly, northeasterly winds were uncommon at DITN but common at LDTN, and southeasterly winds were uncommon at LDTN, but common at DITN.

< Formaldehyde and benzene concentrations have been increasing since DITN began sampling as part of the UATMP in 2003. In 2005, 1,3-butadiene was detected at DITN for the first time. Formaldehyde concentrations have been decreasing steadily since LDTN began sampling as part of the UATMP in 2003.

< Benzene had the highest NATA-modeled cancer risk for both Tennessee sites' census tracts. All NATA-modeled concentrations for the DITN census tract were all less than 1 $\mu g/m^3$, and all NATA-modeled concentrations for the LDTN census tract were all less than 2 $\mu g/m^3$. Xylenes had the highest annual average at DITN, while toluene had the highest annual average at LDTN.

$ *Texas*

< The Austin, TX sites began sampling between mid-June and early July for VOC, carbonyls, TNMOC, and metals. The El Paso site began sampling in late March for VOC.

< The pollutants of interest common to each Texas site are: acrolein, benzene, 1,3-butadiene, carbon tetrachloride, and *p*-dichlorobenzene.

< Acrolein measured the highest daily average at each of the five Austin sites, while the pollutant of interest with the highest daily average at YDSP was total xylenes.

With the exception of metals, no seasonal averages are available at the Austin sites until autumn. Seasonal averages are available for a few pollutants at YDSP beginning in the spring, but do not vary much statistically.

< Acrolein exceeded both of the short-term risk factors at all of six Texas sites. Seasonal averages for acrolein could only be calculated at MUTX in autumn. The MUTX autumn acrolein average was significantly higher than the intermediate risk factor, and was the highest seasonal average of acrolein calculated at any UATMP site.

< The strongest Pearson Correlations computed are listed as follows:

- MUTX: 0.69 between formaldehyde and average temperature, and *p*-dichlorobenzene and maximum temperature.

- PITX: 0.79 between acrolein and maximum temperature.

- RRTX: 0.69 between acrolein and wet bulb temperature, and *p*-dichlorobenzene and maximum temperature.

- TRTX: 0.92 between acrolein and dew point temperature.

- WETX: 0.83 between acrolein and dew point temperature.

- YDSP: -0.74 between 1,3-butadiene and dew point temperature.

< As illustrated by the composite 24-hour back trajectory maps, the back trajectories originated primarily from the southeast and south at the Austin sites. The airshed domain is large at these sites, as the farthest away a back trajectory originated is over 700 miles. However, most trajectories originated within 400 miles. It is important to note that these sites sampled for only the second half of the year, and this is reflected in the trajectory maps. At YDSP, trajectories tended to originate from the southeast or southwest, and mostly across the border in Mexico.

< The wind roses for the Austin sites show that southeasterly to southerly winds are predominant near the sites. However, these sites sampled for only the second half of the year, and this may be reflected in the wind roses. At YDSP, easterly winds are most common.

< Benzene had the highest NATA-modeled cancer risk for the six Texas census tracts, although the cancer risk at YDSP was roughly half of the risk at each of the Austin sites.

$ *Utah.*

< BTUT sampled year-round for VOC, SNMOC, metals, and carbonyl compounds.

- The pollutants of interest at BTUT are: acetaldehyde, formaldehyde, benzene, hexachloro-1,3-butadiene, carbon tetrachloride, 1,3-butadiene, tetrachloroethylene, acrolein, arsenic, nickel, and manganese.

- Formaldehyde measured the highest daily average at BTUT. Seasonal trends show that benzene tends to be highest in winter, and formaldehyde is highest in the summer and autumn.

- Acrolein was the only pollutant to exceed either of the short-term risk factors at BTUT. Seasonal averages for acrolein were only calculated for autumn. The autumn acrolein average significantly higher than the intermediate risk factor.

- The strongest Pearson Correlation computed at BTUT was between formaldehyde and maximum temperature (0.71). This correlates well with the formaldehyde seasonal average tendency.

- As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at BTUT, although less frequently from the northeast or east. The airshed domain for BTUT is somewhat smaller than most sites, as the farthest away a back trajectory originated is less than 500 miles.

- The wind rose for BTUT shows that southeasterly and southerly winds are predominant near the site.

- A comparison of formaldehyde, benzene, and 1,3-butadiene concentrations for all years of UATMP participation shows that formaldehyde has increased since 2003 while benzene and 1,3-butadiene have changed little.

- Benzene had the highest NATA-modeled cancer risk for the BTUT census tract. Total xylenes had the highest NATA-modeled concentration of the pollutants that failed at least one screen, yet formaldehyde had the highest annual average at BTUT.

$ *Wisconsin.*

- MAWI sampled year-round for VOC, metal, and carbonyl compounds.

- The pollutants of interest at MAWI are: acetaldehyde, formaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, tetrachloroethylene, arsenic, hexachloro-1,3-butadiene, and manganese.

- Formaldehyde measured the highest daily average at MAWI. Seasonal trends show that formaldehyde is highest in the summer.

- Acrolein was the only pollutant to exceed either of the short-term risk factors at MAWI. Seasonal averages for acrolein could not be calculated.

< The strongest Pearson Correlation computed at MAWI was between formaldehyde and maximum temperature (0.79). This correlates well with the formaldehyde seasonal average tendency.

< As illustrated by the composite 24-hour back trajectory maps, back trajectories originated from a variety of directions at MAWI, although less frequently from the east. The airshed domain for MAWI is the largest of all UATMP sites, with one back trajectory originating over 1100 miles away. However, most trajectories originated within 600 miles of the site.

< The wind rose for MAWI shows that southerly winds are prevalent near the site.

< Benzene had the highest NATA-modeled cancer risk and NATA-modeled concentration for the MAWI census tract. Yet, formaldehyde had the highest annual average of the pollutants that failed at least one screen at MAWI.

24.1.3 Additional National-Level Observations

$ Acetaldehyde and formaldehyde were the two most common pollutants of interest at the UATMP sites. Only one site that sampled carbonyls did not have acetaldehyde as a pollutant of interest; only two sites that sampled carbonyls did not have formaldehyde as a pollutant of interest. Benzene and carbon tetrachloride were the two most common VOC pollutants of interest. Every site that sampled VOC had these two pollutants as pollutants of interest.

$ Formaldehyde frequently had the highest daily average at the UATMP sites; this pollutant had the highest daily average at nineteen sites. Xylenes followed with nine sites.

$ Pearson Correlations calculated between formaldehyde and the temperature parameters (maximum and average temperature) at many UATMP sites were at least moderately strong and positive. This indicates that as temperatures increase, concentrations of formaldehyde also increase. At some of these same sites, the summer formaldehyde average tended to be higher than other seasons, supporting this observation. This trend may become more apparent when more sites have valid seasonal averages for all four seasons.

$ Pearson Correlations calculated between benzene and the temperature parameters (maximum and average temperature) at many UATMP sites were at least moderately strong and negative. This indicates that as temperatures decrease, concentrations of benzene increase. At a few of these sites, the winter benzene average tended to be higher than other seasons, supporting this observation. This trend may become more apparent when more sites have valid seasonal averages for all four seasons.

$ Pearson Correlations calculated between hexachloro-1,3-butadiene and the meteorological parameters at many UATMP appear to be strong. It must be noted that this compound was detected fairly infrequently at most sites, and that this low number of

samples may skew the correlations into appearing stronger than they might be with a large sample population.

$ Acrolein was the only site-specific pollutant of interest that had a NATA noncancer hazard quotient greater than one at any UATMP site.

$ Benzene tended to have highest NATA cancer risk at many of the sites, although the highest cancer risk calculated for any of the sites was dichloromethane.

24.1.4 Data Quality

The precision of the sampling methods and concentration measurements was analyzed for the 2005 UATMP using relative percent difference (RPD), coefficient of variation (CV), and average concentration difference calculations based on duplicate and collocated samples. The overall precision was well within UATMP data quality objectives and Monitoring Method guidelines. Sampling and analytical method accuracy is assured by using proven methods and following strict quality control and quality assurance guidelines.

24.2 Recommendations

In light of the lessons learned from the 2005 UATMP, a number of recommendations for future ambient air monitoring are supported:

$ *Incorporate/Update Risk in State Implementation Plans (SIPs).* Use risk calculations to design State Implementation Plans (SIPs) to implement policies that will reduce the potential for human health risk.

$ *Encourage state/local/tribal agencies to develop and/or verify HAP and VOC emission inventories.* State/local/tribal agencies should use the data collected from the UATMP to develop and validate an emissions inventory, or at the very least, identify and/or verify emission sources of concern. Ideally, state/local/tribal agencies would compare the ambient monitoring results with an emission inventory for source category completeness. The emissions inventory would then be used to develop modeled concentrations useful to compare against ambient monitoring data.

- *Continue to identify and implement improvements to the sampling and analytical methods.* The improvements made to the analytical methods prior to the 1999-2000 UATMP allowed for measurement of ambient air concentrations of 11 pollutants that were not measured during previous programs. This improvement provides sponsoring agencies and a variety of interested parties with important information about air quality within their urban areas. Further research is encouraged to identify other method improvements that would allow the UATMP to characterize an even wider range of components in urban air pollution.

- *Continue to strive to develop standard conventions for interpreting air monitoring data.* The lack of consistent approaches to present and summarize ambient air monitoring data complicates or invalidates comparisons between different studies. Additional research should be conducted on the feasibility of establishing standard approaches for analyzing and reporting air monitoring data. The new approach in determining "pollutants of interest" and the presentation of daily, seasonal, and annual averages are attempts at this standardization.

- *Prepare a report* characterizing all years of the UATMP and then update it yearly to better assess trends and better understand the nature of U.S. urban air pollution.

- *Consider more rigorous study of the impact of automobile emissions on ambient air quality using the complete UATMP data set.* Because the UATMP has monitoring sites where years of continuous data are collected, a real opportunity exists to evaluate the importance and impact of automobile emissions on ambient air quality. Suggested areas of study include:

    1. *Signature Compound Assessment.* Sample data from each site should be evaluated to look for signature pollutants from mobile sources—that is, species typically associated with only diesel and/or gasoline combustion. If the appropriate pollutants are included in the UATMP speciation, sites lacking these pollutants can be excluded from subsequent analyses.

    2. *Parking Lot Characterizations*. Several monitoring locations are situated in or near parking lots. Evaporative emissions from parked gasoline vehicles could have a very significant impact on the monitors for these sites (depending upon the species of concern). Therefore we recommend determining the size of the lots in question in terms of number of spaces, as well as an average occupancy rate with total vehicles per day (to determine the number of start episodes). The occupancy rate should be a 24 hour annual average, and can be established either through observation or local "experts" (e.g., the lot operator). Also, it should be determined if the parking is covered or open—covered lots can significantly decrease crankcase temperatures and therefore lower evaporative emissions rates.

- *Encourage continued participation in the UATMP*. Ongoing ambient air monitoring at fixed locations can provide insight into long-term trends in urban air quality and the potential for urban air pollution to cause adverse health effects among the general population. Therefore, state and local agencies should be strongly encouraged either to develop and implement their own ambient air monitoring programs or to participate in future UATMP monitoring efforts.

- *Encourage year-round participation in the UATMP*. Many of the analyses presented in the 2005 UATMP require a full year of data to be most useful and representative of conditions experienced at each specified location. Therefore, state and local agencies should be strongly encouraged to implement year-long ambient air monitoring programs in addition to participating in future UATMP monitoring efforts.

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TECHNICAL REPORT DATA

(Please read Instructions on reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-454/R-07-001		

4. TITLE AND SUBTITLE	5. REPORT DATE
2005 Urban Air Toxics Monitoring Program (UATMP) Final Report	December 2006
	6. PERFORMING ORGANIZATION CODE OAQPS-EMAD

7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Eastern Research Group, Inc. 1600 Perimeter Park Morrisville, NC 27560-8421	

9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Office of Air Quality Planning and Standards Emissions, Monitoring and Analysis Division U.S. Environmental Protection Agency Research Triangle Park, NC 27711	11. CONTRACT/GRANT NO. 68-D-03-049

12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Director Office of Air Quality Planning and Standards Office of Air and Radiation U.S. Environmental Protection Agency Research Triangle Park, NC 27711	Annual 2005
	14. SPONSORING AGENCY CODE EPA/200/04

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Reporting and data characterization results for the Urban Air Toxics Monitoring Program (UATMP) for 2005.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Carbonyls, SNMOC, VOC, Semivolatiles, Dioxins, Metals, Hexavalent chromium, Analysis and Monitoring, Risk, Trends	Air Pollution control	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(Report)*	21. NO. OF PAGES
Release Unlimited	Unclassified	**901 + 2090**
	20. SECURITY CLASS *(Page)*	22. PRICE
	Unclassified	

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

United States
Environmental Protection
Agency

Office of Air Quality Planning and Standards
Emissions, Monitoring and Analysis Division
Research Triangle Park, NC 27711

Publication No. EPA-454/R-07-001
December 2006

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Publication No. EPA-454/R-07-001
December 2006