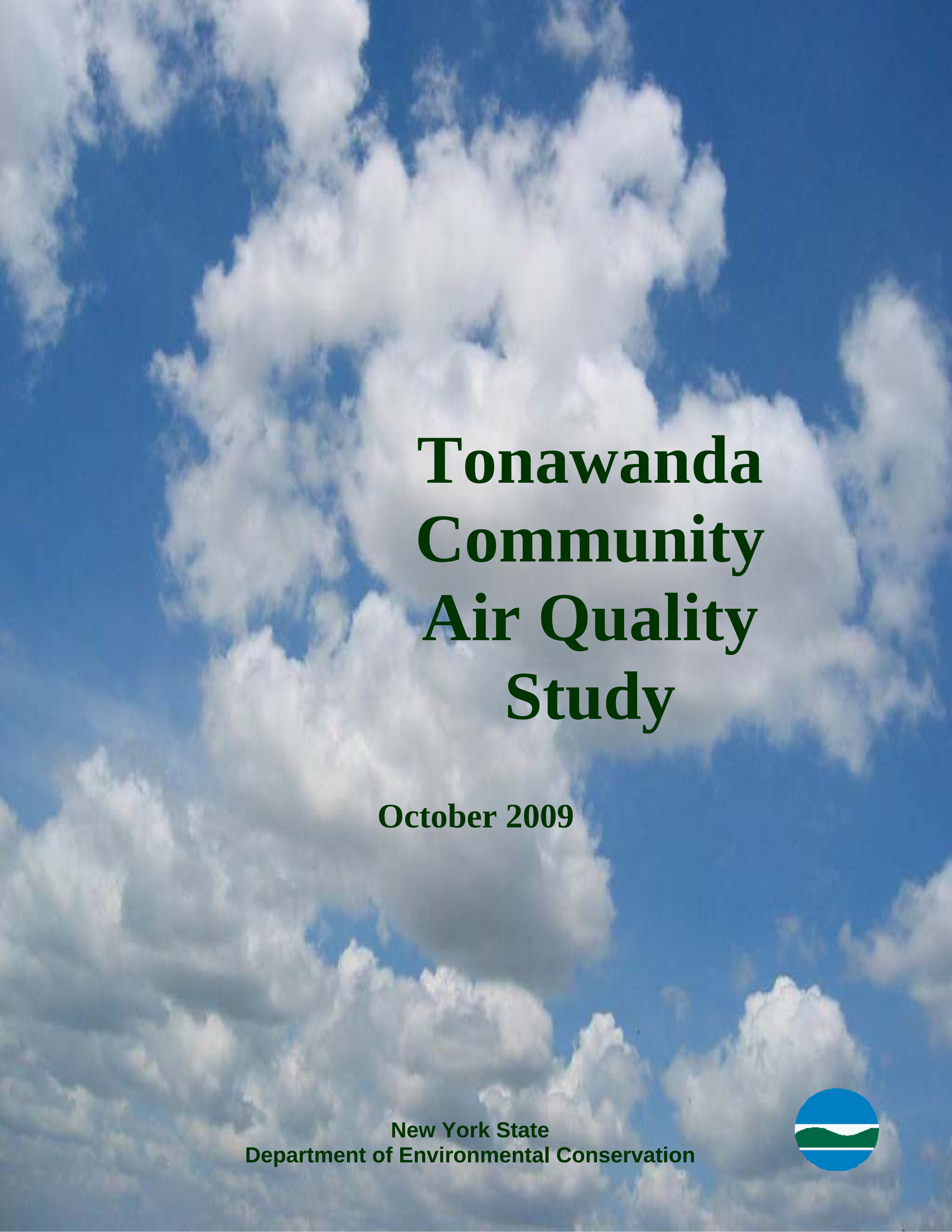

Tonawanda Community Air Quality Study

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New York State
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Preface

The Tonawanda Community Air Quality Study was conducted to determine the ambient concentrations for selected air toxics and criteria pollutants at four locations in Tonawanda, New York. Tonawanda is an industrialized, urban community located in the western part of New York State in Erie County, just north of the city of Buffalo. The air quality monitoring study was designed to identify inhalation exposure risks to the community, identify risk reduction efforts in the community and to generate data that can be used to evaluate air quality models and other risk assessment tools.

Disclaimer

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List of Acronyms and Abbreviations

AerMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
AFS	Air Facility System
AGC	Annual Guideline Concentration
AIRS	Aerometric Information Retrieval System
ANSI	American National Standard Institute
AQS	Air Quality System
ASTM	American Society for Testing and Materials
BAQAR	Bureau of Air Quality Analysis & Research
BAQS	Bureau of Air Quality Surveillance
BISP	Beaver Island State Park
BLP	Buoyant Line Plume
BSO	Benzene Soluble Organics
BTEX	Benzene, toluene, ethylbenzene and xylene
BTRS	Brookside Terrace Residential Site
BQA	Bureau of Quality Assurance
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAC	Clean Air Act Advisory Committee
CACWNY	Clean Air Coalition Western New York
CAS	Chemical Abstracts Service
CL	Confidence Limit
CO	Carbon monoxide
CPS	Citizen Participation Specialist
CRM	Certified Reference Material
CSATAM	Community-Scale Air Toxics Ambient Monitoring
DAR	Division of Air Resources
DBMS	Database Management System
DNPH	2,2-Dinitro-phenyl hydrazine
DQA	Data Quality Assessment
DQI	Data Quality Indicators
DQO	Data Quality Objectives
EJ	Environmental Justice
ELAP	Environmental Laboratory Approval Program
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FIPS	Federal Information Processing Standards
FOSTTA	Forum on State and Tribal Toxics Actions
FRM	Federal Reference Method

GC/MS	Gas Chromatography/Mass Spectrometry
GIBI	Grand Island Boulevard Industrial
GIS	Geographic Information System
HAP	Hazardous Air Pollutant
HEM	Human Exposure Modeling
HI	Hazard Index
HPLC	High Performance Liquid Chromatography
HQ	Hazard Quotient
HVAC	Heating, Ventilation, Air Conditioning system
IRIS	Integrated Risk Information System
ISCST3	Industrial Source Complex Short-Term 3
ISO	International Organization for Standardization
IUPAC	International Union for Pure and Applied Chemistry
IUR	Inhalation unit risk
LC	Liquid Chromatograph
LCD	Liquid Crystal Display
MACT	Maximum Achievable Control Technology
MDL	Method Detection Limit
MQO	Measurement Quality Objectives
MSR	Management System Review
NAAQS	National Ambient Air Quality Standards
NATA	National-scale Air Toxics Assessment
NATTS	National Air Toxics Trends Stations
NEI	National Emissions Inventory
NESHAP	National Emission Standards for Hazardous Air Pollutant
NIST	National Institute of Standards and Technology
NSPS	New Source Performance Standards
NYC	New York City
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OAQPS	Office of Air Quality Planning and Standards
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbons
PAMS	Photochemical Assessment Monitoring Stations
PBS	Petroleum Bulk Storage
PC	Personal Computer
PE	Performance Evaluation
$PM_{2.5}$	Particulate matter aerodynamic diameter of 2.5 microns or less
POM	Polycyclic Organic Matter
POTW	Publicly Owned Treatment Works

ppb	Part Per Billion
ppbv	Part Per Billion by Volume
QA	Quality Assurance
QA/QC	Quality Assurance / Quality Control
QAD	Quality Assurance Division
QAPP	Quality Assurance Project Plan
QASA	Quality Assurance System Audit
QC	Quality Control
RAIMI	Regional Air Impact Modeling Initiative
RAPCE	Regional Air Pollution Control Engineer
SGC	Short-term Guideline Concentration
SO_2	Sulfur dioxide
SOP	Standard Operating Procedure
SPWT	Sheridan Park Water Tower
SUNY	State University of New York
TEOM	Tapered Element Oscillating Microbalance
TPY	Tons per year
TRI	Toxics Release Inventory
TWA	Time-Weighted Average
UATMP	Urban Air Toxics Monitoring Program
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound

1. Executive Summary

In July 2007, the New York State Department of Environmental Conservation (NYSDEC) initiated a year-long community air quality monitoring study in the town of Tonawanda (Erie County) to measure the concentration of air contaminants within the community and to evaluate the potential risk to public health. The Tonawanda Community Air Quality Study (hereinafter referred to as Study) was motivated by a number of critical factors: first and foremost, complaints received by NYSDEC from the community regarding odors and an overall compromised quality of life; second, the elevated ambient benzene concentrations sampled by a local community group and the NYSDEC; and third, the Tonawanda industrial area represents an excellent opportunity to assess the effectiveness of the current federal and state hazardous air pollution reduction strategies.

To address these issues, NYSDEC conducted monitoring, modeling and an inhalation risk assessment to estimate the risk posed by ambient concentrations of hazardous air pollutants (HAPs). The Study design allowed for the identification of results which could be used for risk management decisions and selection of options to reduce exposure to HAPs in the Tonawanda community. The Study design and findings were presented through a series of public meetings within the community to seek input, hear concerns and answer questions from the public and all interested parties in attendance. The findings from the Study have already resulted in a number of actions by NYSDEC and USEPA to evaluate and address potential sources of benzene emissions in the Study area.

Four air quality monitors were installed in and around the community in reference to the prevailing wind direction from the southwest. One monitor at Beaver Island State Park (BISP) was sited to establish background measurements of air toxics upwind of the industrial sources. Three monitors were placed downwind of the industrial sources in the Study area: Grand Island Boulevard Industrial (GIBI), Brookside Terrace Residential Site (BTRS) and Sheridan Park Water Tower (SPWT). The monitors collected 24-hour average ambient air concentrations of 56 air toxic pollutants on a one-in-six day schedule. All four monitors collected hourly average concentrations of fine particulate matter ($PM_{2.5}$). Monitors placed at the BTRS site collected hourly average concentrations of sulfur dioxide (SO_2) and carbon monoxide (CO). A meteorological station was placed at the BISP site to assess the local meteorology for the Study area and for use in assessing the sources influencing the air monitoring concentrations.

The GIBI monitoring site found significantly elevated concentrations of benzene and formaldehyde when compared to other areas of New York. The evaluation for benzene indicated higher daily concentrations of benzene when the wind originated from the direction of the largest known point source, Tonawanda Coke Corporation. The BTRS monitor, downwind from the industrial sources, also indicated more of an influence from the industrial sources than contributions from mobile sources in the area. The results for benzene at the other two ambient air quality monitors were similar to ambient air levels found in large urban areas such as New York City. The formaldehyde evaluation indicated that the measured concentrations were influenced by local area sources and mobile sources. The GIBI monitor reported the highest concentrations, much higher than the other study monitors and other monitors in the statewide network. The formaldehyde concentrations also appear to be influenced both by temperature and wind speed fluctuations with direct temperature correlations and an inverse wind speeds correlation.

A public health evaluation was conducted using NYSDEC derived health-based guideline concentrations and the results from the ambient air quality monitoring. The annual average concentration for five air toxics (1,3-butadiene, acetaldehyde, benzene, carbon tetrachloride, formaldehyde) exceeded the cancer risk screening level of one-in-one-million and one air toxic (acrolein) exceeded the non-cancer health-based comparison value.

A comprehensive inventory of sources for the Study area was prepared for use with two air dispersion models (Regional Air Impact Modeling Initiative (RAIMI) and AerMod) that are used by NYSDEC to evaluate the inhalation risk of exposure to HAPs from stationary and mobile sources. The predicted concentrations of the HAPs were modeled for the entire Study area and the results were compared to the monitored data and predictions from the 2002 National-scale Air Toxics Assessment (NATA).

The average ratios for ten air pollutants selected for the comparison of the RAIMI modeled predictions to the monitored concentrations were in close agreement (ranged from 0.58 to 1.25) across all four monitoring sites. However, an analysis of the site by site comparisons for benzene and formaldehyde revealed very poor agreement between the modeled and measured concentrations at the GIBI site.

The comparisons of the monitoring data to the 2002 NATA predictions indicated that the 2002 National Emission Inventory (NEI) used in the NATA model was fairly accurate for a number of HAPs. However, the NEI emissions inventory under reported acrolein emissions for the entire Tonawanda area and under reported 1,3-butadiene, benzene, ethylbenzene, formaldehyde, and propionaldehyde emissions for sources near the GIBI monitor. As a risk assessment screening tool designed to identify areas for further air pollution investigations, it would be preferable for the NATA modeled ambient concentrations to be similar to measured ambient concentrations for those air toxics that are identified as risk drivers.

The Study measured air quality in close proximity to the Tonawanda Coke Corporation in order to fill a data gap identified in the USEPA's Residual Risk Assessment for Coke Ovens which identified the lack of ambient monitoring information. Some HAPs known to be released from the facility were measured and an elevated concentration of benzene was observed at the Study area monitors. When compared to the USEPA's residual risk assessment, NYSDEC's modeling assessment, using a revised facility emissions inventory, resulted in larger predicted impacts within the community. Based on the assessment of the monitored and modeled data, the maximum individual cancer risk and population cancer risk associated with facility-wide emissions from the Tonawanda Coke Corporation exceeds an excess lifetime cancer risk of 10 in-one-million for the nine census tract Study area. Specific neighborhoods exceed a 100 in-one-million cancer risk level. Further work will be conducted on this issue by NYSDEC prior to USEPA's 2011 scheduled completion of a final residual risk assessment for the Coke Oven source category.

The Study design had several noteworthy strengths. The source attribution conclusions were derived from a weight-of-evidence approach rather than relying on a single result to achieve a conclusion. The source attribution assessment included evaluating meteorological information, emission releases through dispersion modeling and an in depth evaluation of the USEPA's residual risk assessment that included a site specific risk assessment for the Tonawanda Coke Corporation. A comprehensive emissions inventory was developed to further elucidate source contributions and emission reduction strategies for sources identified as contributing to elevated risk levels in the community. This information, coupled with the results between the upwind and downwind inhalation cancer risk values, provides a strong basis for further compliance monitoring and regulatory actions to reduce the inhalation cancer risk in the Tonawanda community.

In conclusion, the results of the Tonawanda Community Air Quality Study indicate that further work can be done to improve air quality in the community. Follow-up activities (e.g. increased compliance inspections and community observations) already have been implemented by the NYSDEC and the USEPA in an effort to improve air quality in the community. NYSDEC is continuing to monitor hourly benzene concentrations at the GIBI site to further evaluate the high levels of benzene measured at this monitoring site with a higher degree of temporal resolution.

2. Background

2.1 Why Tonawanda, New York was Selected for a Community Air Monitoring Study

Tonawanda, NY was selected based on a number of critical factors: first, complaints by the community regarding odors and an overall compromised quality of life; second, the elevated ambient benzene results sampled by a local community group and the New York State Department of Conservation (NYSDEC); and third, the Tonawanda industrial area represents an excellent area to assess the effectiveness of the current federal and state hazardous air pollution reduction strategies. In addition, elevated inhalation cancer risk estimates from the 1999 National-Scale Air Toxics Assessment (NATA) and the federal residual risk assessment conducted for coke ovens under §112(f) of the Clean Air Act Amendments indicated the potential for an additional inhalation cancer risk associated with emissions from the Tonawanda Coke Corporation. All these factors provided a strong impetus for an in-depth community air quality study.

2.2 Community Concerns

The residents of the Town of Tonawanda have been concerned about air quality issues for many years. The Tonawanda community has a large active industrial base that is surrounded by residential neighborhoods. The citizen complaints in the neighborhoods that are in or surround the area zoned as a general industrial district have primarily involved odors, particulate deposition and events associated with eye and upper respiratory tract irritation. Additionally, citizens expressed concerns about other possible long-term health effects associated with exposure to the industrial emissions. A group of concerned citizens organized to form the Clean Air Coalition of Western New York (CACWNY) in an effort to identify, monitor and reduce emissions in the Town of Tonawanda. Their concerns were summarized succinctly in a recent community newsletter, “These emissions impact our quality of life on a daily basis and make us worry for the health of our loved ones.”

The CACWNY has been constructively working with the NYSDEC and their federal, state and local government officials to address and find solutions to the quality of life issues in their community. The Tonawanda Community Air Quality Study was developed to define the air quality within the community over a period of one year to assist the Department in the development a focused air quality management strategy.

2.3 Results from Short-term Air Monitoring

In February 2005, the CACWNY presented results of their short-term ambient air monitoring study to NYSDEC Region 9 staff. CACWNY used a “Bucket” air collection method which is advertised as an easy to use and inexpensive method and consists of a sampling device housed inside a five gallon plastic bucket. The Bucket was developed 1995 by an environmental engineering firm Northern California. Sampling is conducted over a short time frame, generally 5-15 minutes. After collection, the sample is sent to an USEPA certified laboratory for analysis.

Bucket sampling can provide useful information but the results must be interpreted carefully. For example, certain chemicals are associated with the Bucket sampling media (Tedlar™) and this makes interpretation of those chemicals very difficult. Additionally, for sources with intermittent releases, it may be very difficult to associate a short-term collected sample with releases from a particular source. Finally, in the absence of relevant meteorological data (e.g., wind direction data) and "upwind" air measurements, information may not be sufficient to relate the measurements to a particular source of air contaminants.

CACWNY collected fifteen minute air samples from two locations in the town of Tonawanda. On July 20, 2004, at 11:00 pm CACWNY collected a sample across from the 3M facility at 340 Sawyer Avenue. The sample was analyzed and carbon disulfide was found at a concentration of 100 ppbv (320 $\mu g/m^3$). CACWNY compared their short-term monitoring results with NYSDEC's Annual Guideline Concentrations (AGC)[1]. Comparison of short-term monitoring results with long-term health-based comparison values is generally, not considered an acceptable approach. This value was below NYSDEC's Short-term Guideline Concentration (SGC) of 6200 $\mu g/m^3$ and AGC of 700 $\mu g/m^3$ for carbon disulfide.

On August 16, 2004, at 10:55 pm, CACWNY collected a second fifteen minute bucket sample across from the NOCO Energy Facility at 700 Grand Island Boulevard. The sample was analyzed and a concentration of 50 $\mu g/m^3$ was found for benzene. This value was approximately ten times higher than other statewide data reported by NYSDEC for the years of 1990 through 2000. NYSDEC's SGC for benzene is 1300 $\mu g/m^3$ and the AGC is 0.13 $\mu g/m^3$. This area of Tonawanda has three significant point sources of benzene, a coke plant and two gasoline distribution terminals (NOCO Energy and Sunoco Transfer Station). This prompted NYSDEC to investigate a long-term monitoring approach which would allow for comparisons to NYSDEC's AGC.

NYSDEC investigated the results obtained by CACWNY with consideration for the limitations of this type of sampling media. NYSDEC conducted a modeling evaluation to identify locations of maximum impact to assist staff in selecting the best locations for short-term ambient air monitoring. Benzene emissions from three facilities were modeled: Tonawanda Coke, NOCO Energy, and Sunoco Transfer Station. Next, NYSDEC Region 9 staff collected four one-hour ambient air samples using a Summa Canister. In the final phase, a monitor-to-model comparison was performed to confirm the selection of the sampling location.

The results of the limited ambient air collection on June 21, and June 23, 2005 at four locations indicated no acute health exposure concerns for benzene in the area but

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[1] AGC's are discussed in Section 7 – Public health interpretation of measured air concentrations.

suggested the need to assess chronic exposure through a long-term sampling and analysis effort. The results can be found in Table 2.1**.**

Staff in the NYSDEC Region 9 office have been working with the CACWNY and the Town of Tonawanda Commission for Conservation and Environment (Commission), since the initial bucket results were presented to the Department. These two groups have expressed their concerns about odors in the area and the potential health effects associated with air toxics emissions from facilities in the area. The Department concluded that a long-term monitoring study would help to assess potential health risks to people living in the Tonawanda area. The results of this effort could identify a need to further reduce facility emissions.

2.4 Results of USEPA's Residual Risk Assessment for Coke Ovens

In 2005, the USEPA released the Coke Oven Residual Risk Assessment (USEPA, 2005a). The Tonawanda Coke Corporation was one of four coke oven facilities included in this assessment which concluded that "The results of the more refined level of analysis of this assessment showed that the emissions from these four facilities are not considered to cause a potential concern for adverse noncancer health impacts but do pose potential cancer risks to the individual most exposed living within 50 km of these facilities." Cancer risk isopleths around Tonawanda Coke showed a greater than one-in-one-million potential cancer risk for individuals living within 5 km from the facility. However, the risk assessment documentation stated "For this risk analysis, no monitoring data exist. Therefore, it was not possible to evaluate the ambient concentrations estimated by the modeling using monitoring data."

The Department concluded that information from a community-based monitoring study in the vicinity of the coke oven may help verify the conclusions of the residual risk assessment.

2.5 Results of the USEPA's 1999 National-Scale Air Toxics Assessment

The results of the 1999 NATA indicated that Erie County, in comparison to other counties in New York State, had a higher cancer and respiratory non-cancer risk associated with inhalation exposure to hazardous air pollutants. One of the primary objectives of NATA is to help state and local air pollution agencies identify areas for further data gathering (e.g. monitoring), investigate the underlying data (e.g. accuracy of emissions inventory) and facilitate further assessment (e.g. where to focus local-scale assessments). A more refined analysis of local-scale ambient air quality and spatial variability of air toxic contaminants through the establishment of an ambient air monitoring study may verify the applicability of such modeled ambient concentration data and risk characterization.

3. Introduction

3.1 New York State and Federal Air Pollution Control Programs

In the early 1960's, The New York State Legislature passed the Air Pollution Control Act, Article 12-A of the Public Health Law in recognition of the need to safeguard the air resources of the State from pollution by controlling or abating air pollutant releases from existing sources and preventing new source releases for the public good. The State's policy was then and remains:

> "It is declared to be the public policy of the state of New York to maintain a reasonable degree of purity of the air resources of the state, which shall be consistent with public health and welfare and the public enjoyment thereof, the industrial development of the state, the propagation and protection of flora and fauna, and the protection of physical property and resources, and to that end to require the use of all practical and reasonable methods to prevent and control air pollution in the State of New York….This can be done most effectively by focusing on goals to be achieved by a maximum of cooperation of all parties and that codes, rules and regulations established under the provisions of this article should clearly be premised upon scientific knowledge of causes as well as effects." (Environmental Conservation Law Section 19-0103).

This policy statement was used to develop a state air pollution control program in 1962 to control emissions from industrial processes and the combustion of fuels. The state program was designed to protect the public from adverse effects of air contamination and to further protect and conserve the natural resources and environment. The goal of the program was to promote maximum comfort and enjoyment and use of property consistent with the economic and social well-being of the community. The state program continued to evolve over the decades as our knowledge about the adverse public health and environmental impacts of air pollution grew, coupled with advances in our ability to assess the impacts of air pollution and technological advances in air pollution control. This allowed New York to implement numerous air pollution abatement strategies over the years to improve air quality and better ensure the protection of public health and the environment. One of these strategies was the development of a state program to control emissions of toxic ambient air contaminants (air toxics) from stationary sources (Cashman 1982, NYSDEC, 1991). The state program covered numerous sources of air toxics and required control of an emission source based on its impacts on public health and the environment.

In 1990, extensive revisions of the federal Clean Air Act (CAA) resulted in the development of a national program to control hazardous air pollutant (HAP) emissions from industrial and mobile sources. The 1990 amendments required the federal government to develop National Emission Standards for Hazardous Air Pollutants (NESHAPs) for 187 listed pollutants referred to as HAPs. Prior to the 1990 CAA, only eight substances were identified and listed as HAPs (asbestos, beryllium, mercury, vinyl chloride, radionuclides, inorganic arsenic, benzene and coke oven emissions). NESHAPs only were promulgated for sources of seven of these eight HAPs. One of the main goals of the 1990 CAA was to ensure that the requirements to reduce HAPs were national, with no facility being allowed a competitive edge by having to meet less stringent control requirements.

The 1990 CAA established a number of milestones or regulatory deadlines to improve air quality. The goal of the NESHAP program was to reduce air toxics emissions by over 75% from industrial source categories within 10 years. This goal was to be accomplished by enacting a two stage regulatory process. First, the development and implementation of technology based standards (NESHAPS) for 174 categories of industrial sources, followed by an assessment of the risk to public health and the environment after the source is in compliance with the NESHAP. Other goals established by the USEPA to measure progress in the reduction of air pollution under the CAA are briefly discussed below. In summary, the goals of the federal and state air pollution control programs are consistent and promote the economic and social well-being of the community.

3.2 USEPA’s Urban Air Toxics Monitoring Program

The Clean Air Act Amendments (CAAA) of 1990 requires USEPA to regulate source categories to substantially reduce the public health risk due to exposure to HAPs. Recognizing that HAPs pose unique threats in urban areas and that industrial and mobile sources contribute to the public health risk, USEPA supplemented their existing air toxics regulatory program with an Integrated Urban Air Toxics Strategy. In the Strategy, USEPA presents a framework for addressing air toxics in urban areas, looking collectively at large and small industrial and commercial sources. Goals for the Strategy reflect both statutory requirements stated in section 112(k) and the goals of the overall air toxics program. The overall goal is to attain a 75% reduction in incidence of cancer attributable to exposure to HAPs emitted by air pollution sources. To achieve this goal, the Integrated Urban Air Toxics Strategy selected a primary focus of reducing 33 priority HAPs in urban areas from both the stationary and mobile source sectors, rather than the full suite of 187 HAPs.

USEPA developed as a component of the Integrated Urban Air Toxics Strategy, the Urban Air Toxics Monitoring Program (UATMP). The goals of this Program are to measure the effectiveness of the national mitigation efforts and establish long-term trends in ambient air toxic levels. Since the inception of UATMP in 1987, many environmental and health agencies have participated in the UATMP to assess the causes and effects of air pollution within their jurisdictions (USEPA 2004a). The program has four key air toxics monitoring objectives. The first is to develop trends in air toxic concentrations to assess the effectiveness of HAP reduction strategies. The second component establishes ambient air monitors in locations of elevated air toxics concentrations (“hot spots”), whereby concentration gradients within communities can be identified through a network of monitors. These types of projects also provide data for the potential identification of personal exposure and health effects associated with air toxics. A third component provides data to support and evaluate dispersion and deposition models used for air quality planning and risk assessment evaluations. Finally, the fourth component provides data to the scientific community to support studies to reduce uncertainty about the relationships between levels of ambient air toxics, actual human exposure to air toxics, and health effects from such exposures.

In 2004, USEPA began awarding grants to State and local agencies to conduct short-term, local-scale air monitoring projects through the Community-Scale Air Toxics Ambient Monitoring (CSATAM) program. In the first year of funding, USEPA selected 16 local-scale projects and awarded $6.2 million in funding (USEPA, 2005b). NYSDEC applied for CSATAM program funding in the 2005/2006 grant cycle. The Department was awarded approximately $300,000 and matched this with additional in-kind support to conduct a community-based monitoring study in the town of Tonawanda.

3.3 Study Community

The Study community is an industrialized, urban area in the western part of New York State in Erie County, north of the city of Buffalo. Access to waterways and proximity to an international border and the development of railroad lines (Buffalo and Niagara Falls Railroad in 1836 (BHW 2006)) fostered the development of industry over the years.

The Study community includes the western portions of the Town of Tonawanda, the City of Tonawanda, and the Village of Kenmore (collectively called “Tonawanda”). The Study community includes nine census tracts[2] and is framed by the Niagara River to the west and the Erie Canal waterway at the northern edge as shown in Figure 3.1. The general area can be characterized as flat terrain with industry located in the western region and residences and commerce in the north, east and south regions. The Study community area is approximately 9,000 acres and the 2000 census reports a total population size of 38,875. The 2002 Economic Census compiled by the US Census Bureau reports the manufacturing industry as the largest employment sector for the Town of Tonawanda based on the North American Industry Classification System (NAICS) scheme (USCB 2002).

Two major interstate highways bisect the community, I-190[3] and I-290 (Youngmann Memorial Highway). A toll booth is located on I-190 prior to crossing the Grand Island Bridge in the northern direction and traffic congestion is common at this location. Grand Island Boulevard is a major street adjacent to the I-190 between the Grand Island Bridge and Sheridan Drive.

The area is also home to some of New York’s largest industrial facilities, located in the western portion, including: a coke production facility, two petroleum distribution terminals, chemical bulk storage terminals, combined-cycle combustion turbine (gas-fired) electric generation facility, a coal-burning electric generation facility, a tire manufacturing plant, chemical manufacturing facilities, a cellulose sponge manufacturing

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[2] Federal Information Processing Standards (FIPS) codes for the tracts included in the study community: 36029008202, 36029008700, 36029008800, 36029007700, 36029007800, 36029008300, 36029008201, 36029008400, 36029005800.

[3] I-190 through Tonawanda is called the NYS Thruway – Niagara section.

facility, and DuPont Corian® (solid surfaces) and Tedlar® (polyvinyl fluoride) manufacturers. Section 6 (Emission Inventory) and Appendix F (Emission Inventory Development) provide a more comprehensive list of facilities and emissions inventory for the area.

3.4 Air Pollutants of Interest in the Study

The air toxics of interest are the 15 priority urban HAPs identified in section 112(k) of the CAAA of 1990. In addition to monitoring for these 15 priority HAPs, the Study also evaluated air concentrations of 41 additional HAPs. Table 3.1 lists the air toxics selected for the study and identifies the 15 priority HAPs and those HAPs reported in the USEPA NATA for 1996 and 1999.

Additionally, fine particulate matter ($PM_{2.5}$ - aerodynamic diameter of 2.5 microns or less), sulfur dioxide (SO_2) and carbon monoxide (CO) were monitored on a continuous basis to identify potential health risks and long-range transport versus local contribution to air quality. Meteorological parameters of wind speed and direction, horizontal wind deviation (sigma theta), temperature and relative humidity also were measured on a continuous basis to assist in the evaluation of source contribution to air quality.

3.5 Potential Environmental Justice Area

Following NYSDEC's Commissioner Policy 29, Environmental Justice and Permitting (Policy), an area is considered to be a potential environmental justice (EJ) area if minority or low-income communities are present. NYSDEC's Policy defines minority communities when a census block group, or continuous area with multiple census block groups, has a minority population (Hispanics, African-Americans or Black persons, Asian Americans and Pacific Islanders, American Indians, Alaskan Natives, and other race or multi-race) equal to or greater than 51.1 percent of the total population. NYSDEC's Policy defines a low-income community to be any census block group, or continuous area with multiple census block groups, having a low income population (i.e., percent living below the poverty threshold) equal to or greater than 23.59 percent of the total population (NYSDEC 2003).

Two potential environmental justice areas have been identified within this community as shown in Figure 3.2. These areas, comprised of four census blocks[4], contain a total population of 3,855. Eighty-seven percent of the total population is white, six percent is Black or African-American, one percent is American Indian, three percent is multi-race and two percent is other race not specified. This area can be described as residential, surrounded by commercial and industrial business and some community services. The percent below the poverty threshold for the four census blocks is 39%, 41%, 43%, and 28%.

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[4] Census block FIPS codes: 360290083001, 360290083003, 360290083005 and 360290058008.

NYSDEC awarded two EJ Community Grants to the CACWNY a community group in the Study area. Details of these two grants are discussed in Section 4 (Community Component).

3.6 Study Objectives

The Study objectives are summarized below:

1. Conduct ambient air monitoring of selected HAPs and criteria pollutants for one year to determine the overall air quality in the Tonawanda area;
2. Use available emissions inventory databases from NYSDEC and USEPA to generate a point, area and mobile source emission estimates for monitored HAPs in the Tonawanda area;
3. Predict ambient air concentrations using the Regional Air Impact Modeling Initiative (RAIMI) software model;
4. Compare the ambient air monitoring results of the selected HAPs to modeled predictions (residual risk assessment for coke ovens, 2002 National-scale Air Toxics Assessment (NATA) and RAIMI) using various statistical analyses;
5. Assess the relative contributions of various air pollution sources in the Tonawanda area using time-weighted pollutant concentration roses and pie charts generated from the emissions inventory data analysis;
6. Hold public meetings to present the ongoing and final results of the Study; and
7. Prepare a final report to summarize the data and explain the results of the various data analyses that were conducted.

4. Community Component

NYSDEC's Office of Environmental Justice awarded two Environmental Justice Grants to a community group in the Tonawanda area. The grant goals and assistance provided by the Department are discussed in this section. One of the project tasks, listed in the Quality Assurance Program Plan (QAPP) (NYSDEC 2007a) was a series of public meetings in the Tonawanda community, presenting ongoing and final results of the study. Those meetings also are discussed in this section. Finally, other outreach efforts initiated by the Department will be detailed.

4.1 Environmental Justice Grant

NYSDEC's Environmental Justice (EJ) program awards grants to community groups for projects that address exposure of communities to multiple environmental harms and risks. NYSDEC began funding projects in 2006, with awards ranging from $2,500 to $50,000. Two awards were given to the Clean Air Coalition of Western New York (CACWNY), a community-based organization that formed to reduce pollution in Tonawanda. Their primary focus has been the reduction of benzene from the Tonawanda Coke Corporation.[5]

4.1.1 2007 Award

During the 2007 funding cycle, the Department awarded an EJ community grant in the amount of $24,000 to the CACWNY to research the potential link between negative health outcomes and air pollution from sources in the Tonawanda area. The CACWNY study placed emphasis on community exposure and health outcomes. The study proposed the use of personal air monitoring badges that would be worn by resident volunteers. Additionally, the study proposed the collection and analysis of bucket samples, and the use of a network of volunteers to track odors and acute health effects of residents. The project was intended to complement the NYSDEC's community air toxics study.

Staff in NYSDEC's Bureau of Air Quality Analysis and Research assisted the CACWNY by providing information to enhance the personal air monitoring portion of their study. Staff researched and summarized best practices used by other researchers and offered recommendations on the following topics: placement of the badges, optimization of the detection limit, assessment of indoor sources, and the assessment of personal activities. Appendix A details the recommendations prepared by staff for CACWNY.

Upon completion of sampling, staff provided meteorological information to CACWNY to aid in their evaluation of potential sources for the concentrations recorded by the sampling badges.

During the course of their EJ project, CACWNY requested an evaluation of the benzene risk using the first six months Study monitoring results collected by the Department.

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[5] To learn more about CACWNY visit their web site at: http://www.cacwny.org/.

Staff conducted this analysis and presented the information shown in Appendix B, which included a description of confidence in the derivation of the unit risk estimate[6]. For comparison purposes, the cancer risk estimate based on the benzene concentration from the 2007 State average (an average of all the monitors recording ambient air benzene concentrations in 2007) and the background monitor in the State for 2006 were included.

CACWNY shared the results of their personal air monitoring with NYSDEC. Detectable levels of the three air toxics evaluated (benzene, naphthalene, and toluene) were not found in any of the personal air monitoring badges evaluated. The detection limit for the personal air monitoring badges was relatively high compared to the ambient concentrations commonly found in the urban environment.

4.1.2 2008 Award

During the 2008 funding cycle, the NYSDEC awarded an EJ community grant of $40,000 to CACWNY. The focus of this grant was to implement benzene reduction strategies, which included working with a facility in the area to reduce benzene emissions (Tonawanda Coke) and educating the community about ways they could reduce personal exposure to benzene. The outline listed below summarizes the project components:

1. Continue air testing for benzene in the affected communities;
2. Create a Good Neighbor Program to encourage local businesses to reduce their benzene emissions;
3. Host various educational events for the affected community. The educational component of the Project will consist of a series of seminars, development and dissemination of educational materials through meetings and canvassing, development of a website, and use of news media;
4. Research the potential for benzene emissions policies and/or guidelines; and
5. Investigate potential tollbooth removal within the research area.

4.2 Community Outreach and Presentations

For each of the community presentations, local media outlets received a press release to inform the community and encourage participation. Additionally, a fact sheet with a study area map was presented at each of the meetings. On the date of the public presentations, key staff met with reporters from local newspaper and television stations to discuss details of the study. In June 2009, a web site was created to provide a platform for presenting information to the community including the posting of community presentations and maps of the study area.

At the release of this report, four presentations have been given to the Tonawanda community, detailing various aspects of the study. The meeting dates were; September 2006, March 2008, November 2008 and June 2009.

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[6] Unit risk estimated is discussed in more detail in Section 7.2 – Public health interpretation of measured air concentrations

4.2.1 September 2006

For this first meeting, NYSDEC representatives met with the CACWNY and introduced the air quality monitoring study design. The location of the monitoring sites and the importance of prevailing wind direction on monitoring concentrations were presented. Additionally, a description of the monitoring methods and equipment was provided. Involving the community prior to implementation of the monitoring network fostered a collaborative and collegial relationship that was apparent in subsequent public meetings. Approximately 25 people attended.

4.2.2 April 2007

The NYSDEC issued a press release which formally announced that funding had been obtained from the State and USEPA to conduct air monitoring of hazardous air pollutants in the Town of Tonawanda for a period of one year (Appendix C).

4.2.3 August 2007

A press conference was held at the Grand Island Boulevard monitoring site to announce the beginning of actual air quality sampling in the community. Individuals from NYSDEC, CACWNY, University of Buffalo and local and state elected officials attended the media event. News stories about the event were carried by local newspapers, television and radio stations (Appendix C). Community residents and staff from the NYSDEC and were interviewed by the press.

4.2.4 March 2008

For the second community meeting, the Department presented the results of the first six months of air monitoring data. The six-month average concentrations for four air toxics were provided and compared to the State average for 2007, if available. Additionally, this meeting was used by the CACWNY to recruit volunteers for their community study funded by a NYSDEC EJ grant.

The presentation generated interest in ambient air benzene concentrations and its sources. Approximately 80 people attended. Provided in Appendix C are news articles written as a result of the March public meeting.

4.2.5 November 2008

At the third community meeting, staff presented 12-month average concentrations and characterized risk for five air toxics with results above the NYSDEC's Annual Guideline Concentrations (AGC)[7]. Study results were compared to the State average for 2007 for each air toxic. Staff used a risk communication tool called a "tox tree" to communicate the fairly conservative margin of safety used when uncertainty factors are applied to derive non-cancer guidance values and the one-in-a-million risk level is selected for cancer guidance values. Two example diagrams (non-cancer and cancer endpoints) are presented in Appendix D. The diagrams presented are not intended to represent a specific pollutant.

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[7] AGCs are discussed in Section 7.2 - Public health interpretation of measured air concentrations.

Because the content of this presentation was technical, staff prepared a number of posters that were displayed in the meeting room. This format allowed individuals to ask specific questions about technical components in the presentation in a more personal and private venue.

Approximately 100 people attended the meeting. The public feedback from this meeting indicated some confusion in understanding the presentation. Appendix C provides ongoing news articles about NYSDEC's study and a factsheet and press releases for the November 2008 meeting.

4.2.6 June 2009

The purpose of the meeting was to discuss analysis of the air monitoring results, recent inspection activities at facilities in the area, and on-going air quality monitoring conducted by NYSDEC, and to address questions from the public. The presentation was structured to provide the conclusions in the beginning followed by technical details related to recent analysis.

Approximately 100 people attended the meeting including many local elected officials. The meeting was well received and staff received two rounds of applause and praise for the presentation's clarity and informational content provided. An hour of questions and answers followed the presentation. Most questions focused on the recent compliance inspections conducted by NYSDEC and other concerns related to Tonawanda Coke.

In June 2009, a web site[8] providing details of the study was created. The web site includes a map of the location and lists facilities in the area and also includes contact information for questions about the project. The November 2008 and June 2009 community presentations have been posted to this site and a link to the CACWNY web site is included.

Appendix C provides ongoing news articles about NYSDEC's study as well as a factsheet, flyer and press releases for the June 2009 meeting.

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[8] Link for the Tonawanda Community Air Quality Study web site available at: http://www.dec.ny.gov/chemical/55471.html

5. Monitoring Network

5.1 Site Selection and Equipment Installation

The Study's Quality Assurance Project Plan (QAPP) (NYSDEC 2007a) details the measuring of ambient air quality at four monitoring sites. Included in the QAPP, is the site selection process which began with an examination of thirty years of local meteorological data (1973 – 2003), showing the predominant wind direction from southwest to northeast. This information was used to select four small areas of interest for the placement of the air quality monitors with reference to the industrial sources in Tonawanda. By probing local maps and touring the Study area, potential sites with full access for one year and meeting USEPA's siting criteria (USEPA, 2009c), were selected from the areas of interest. The siting criteria are listed below.

1) Access to reliable power and phone service;
2) 24-hour access for monitor operators and low likelihood of vandalism;
3) Allow for the siting of monitors at required height;
4) Absence of trees or other wind obstacles;
5) For criteria pollutant monitor, site must meet specific minimum distance to roadway.

Two types of sites – upwind and perimeter - were implemented for the Study. The upwind site southwest of the industrial sources captured background measurements of air toxics. Three perimeter sites in locations east and northeast of the Study area provided measurements downwind of the industrial sources. The site selection process involved many months of investigation and discussions with property owners. The sites selected for the Study are described below.

1. Upwind Site – The area southwest of the Tonawanda Industrial zone at Beaver Island State Park (BISP) on the southern tip of Grand Island was selected for the upwind site. The monitor, shown in Figure 5.1, was placed near the golf course, south of the park maintenance garage approximately 200 feet west of the Niagara River.
2. Perimeter Industrial Site – A large open field under the high power transmission lines on Grand Island Blvd in the industrial zone was selected. National Grid granted permission to site a temporary monitor, provided specific safety regulations were followed. This site called the Grand Island Boulevard Industrial (GIBI) and shown in Figure 5.2 is located directly northeast of most of the industrial facilities.
3. Perimeter Northern Industrial – National Grid granted permission to site a monitor on their property next to the transmission power lines at the western end of the residential neighborhood of Brookside Terrace West (Brookside Terrace Residential Site (BTRS)), close to the northern portion of the Tonawanda industrial zone. This monitor is shown in Figure 5.3.

4. Perimeter Southern Industrial – A monitor was placed at the Sheridan Park Water Tower (SPWT), by permission of the Town of Tonawanda Water Department. This monitor is shown in Figure 5.4.

Figure 5.5 is a map of all monitor locations, and large industrial facilities.

5.2 Monitoring

All monitoring stations were installed and the instruments were calibrated during the spring of 2007. The continuous monitoring instruments (collecting fine particulate matter, sulfur dioxide, carbon dioxide and meteorological data) were collecting and storing valid data on July 1, 2007. The first volatile organic and carbonyl compound samples were collected on July 5, following USEPA's one-in-six day manual monitoring schedule and samples were collected until June 29, 2008. The laboratory analyses quality assurance can be found in Appendix E.

A summary of the parameters and sampling information is presented in Table 5.1.

5.2.1 Hazardous Air Pollutants - Sampling and Analysis Method

The sampled hazardous air pollutants (HAPs) are divided into two categories, volatile organic compounds (VOCs) and carbonyl compounds (hereinafter referred to as carbonyls) based on molecular structure, with distinct sampling and laboratory analysis methods. VOCs are defined as organic compounds having a vapor pressure greater than 10^{-1} Torr[9] (USEPA 2007a). Carbonyls are a type of VOC with a characteristic molecular arrangement of a carbon atom double bonded to an oxygen atom (aldehydes and ketones). All HAP air monitoring samples were collected over a 24-hour period, on a one-in-six day schedule.

Volatile organic compounds

VOCs were collected by using a RMESI (Xon Tech) 910PC 24-hour sampler to fill an evacuated pre-cleaned 6-liter stainless steel canister (Figure 5.6) at a constant flow rate.

The canisters were sent to NYSDEC's Bureau of Air Quality Surveillance (BAQS) laboratory in Albany, New York for analysis of 42 target compounds consistent with NYS Toxics Air Monitoring Network. Two additional compounds (acrolein and carbon disulfide), not included in the QAPP, were added for a total of 44 compounds. Table 5.2 lists all VOCs with associated method detection limit (MDL), NYSDEC's Annual Guideline Concentration (AGC)[10] (NYSDEC 2007b), chemical abstract service (CAS#) and USEPA's urban HAP designation.

The target maximum holding time from sampling to analysis of 30 days was met for all samples obtained. The canister samples were analyzed using a modified version of USEPA's method TO-15 (NYSDEC 2007a). The analytical process is described as

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[9] At temperature of 25°C and pressure of 760 millimeters of mercury

[10] AGC's are discussed in detail in Section 6 - Public health interpretation of measured air concentrations.

follows: Air samples are taken from the canister at a controlled flow and temperature by an Entech Model 7100A preconcentrator. The sample was injected into a Varian Saturn gas chromatograph/mass spectrometer (GC/MS).

Carbonyl compounds

USEPA Method TO-11a (USEPA 1999) sampling and analytical procedures were followed. The method traps carbonyls by reaction with 2,2-dinitro-phenyl hydrazine (DNPH) coated silica gel contained within a commercially available sampling cartridge (Supelco LpDNPH S10). Figure 5.7 shows a photograph of a carbonyl cartridge. Approximately 1440 liters of ambient air were drawn first through an ozone denuder to remove interfering ozone and then through an assembled DNPH cartridge over a 24-hour period by an ATEC 8000 sampler. When the carbonyls contact the DNPH, they react and are retained within the cartridge as carbonyl-DNPH derivatives. Following sampling, the cartridges were sent to the BAQS laboratory for analysis. During storage and transport, all cartridges were kept cold as required. Table 5.3 lists the carbonyls with associated MDL, AGC, CAS# and USEPA's urban HAP designation.

A Gilson ASPEC XL automated sample processor was used to extract the DNPH derivatives, mix the extract and transfer a portion of the extract into auto-sampler vials for analysis using high performance liquid chromatography (HPLC).

5.2.2 Criteria Pollutants and Instrumentation

Particulate matter ($PM_{2.5}$)

Particulate matter, in the size range of 2.5 microns ($PM_{2.5}$) and below, was monitored with a Thermo Environment Inc. Model 1400ab Tapered Element Oscillating Microbalance (TEOM) with a sharp cut cyclone inlet. While this method for monitoring of $PM_{2.5}$ is not considered a federal reference method (FRM), it is used by federal and state agencies to evaluate $PM_{2.5}$ ambient concentrations in real-time for the purpose of reporting the Air Quality Index[11]. Hourly average measurements of $PM_{2.5}$ were recorded at all four Study monitoring sites. The TEOMs were connected to Environmental Systems Corporation (ESC) data loggers which transmitted the data to the NYSDEC central office in Albany every hour. TEOM instruments use a gravimetric method to measure particulate matter concentration. The instrument is heated to 50°C to remove water vapor collected. An adjustment was made to the TEOM results to account for the loss of volatile organic compounds due to the heating of the sample and this adjustment provides results similar to values obtained using the filter-based FRM for monitoring of particulate matter (Felton, 2005).

Sulfur dioxide (SO_2)

A Thermo Electron Model 43C Sulfur Dioxide (SO_2) analyzer which uses a federally approved method for monitoring of SO_2 was installed at the BTRS site. This instrument is capable of detecting SO_2 at concentrations as low as 0.1 ppb. This instrument continuously recorded SO_2 concentrations and transmitted hourly average values to the NYSDEC central office in Albany.

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[11] For more information about the Air Quality Index see http://www.dec.ny.gov/chemical/34985.html

Carbon monoxide (CO)
A Thermo Electron Model 48C Carbon Monoxide (CO) analyzer which uses a federally approved method for monitoring of CO was installed at the BTRS site. This instrument is capable of detecting CO at concentrations as low as 0.02 ppm. This instrument continuously recorded CO concentrations and transmitted hourly average values to the NYSDEC central office in Albany.

5.2.3 Meteorological Parameters and Instrumentation

The BISP site was selected for a meteorological station since this location had the fewest wind obstructions (few surrounding buildings and trees) and a surrounding, expansive flat terrain. A Met One Wind Sensor was installed on a 10-meter high meteorological tower which records wind speed and direction. Barometric pressure, relative humidity, and temperature probes were installed on the tower at ground-level. The data were stored in an ESC data logger and transmitted hourly to NYSDEC central office in Albany.

5.3 Limitations

The air toxics monitored in this study were selected based on those listed in analysis methods TO-11a and TO-15. These two methods include some irritants released by facilities in the Study area, such as acrolein and acetaldehyde, but does not include others released by facilities such as hydrogen fluoride, hydrogen chloride, ammonia, and sulfuric acid. The modeling portion of the Study (Subsection 7.3.2.2) evaluated potential ambient air concentrations of irritants not monitored in the study

Additionally, the Study did not monitor benzene soluble organics (BSO) which is used to characterize coke oven emissions. Coke Oven Emissions are considered a hazardous air pollutant, identified in the 1990 Clean Air Act Amendments and have been classified by the USEPA as a known human carcinogen.

Finally, the results for acrolein should be interpreted with caution. Obtaining accurate measurements of this air toxic is difficult and the laboratory found many validation comparisons exceeding the acceptance limit.

6. Emission Inventory

An emission inventory was compiled for the facilities occupying the nine census tracts encompassing the Study area and was developed to serve several purposes. First and foremost was to gather data on the combined quantity of air toxic emissions impacting the Study area. Air toxic emissions can come from large and small industrial facilities, fugitive emissions from landfills, construction activity, and automobile, truck, and railroad vehicle emissions. Air toxic emissions are also released by residential activities such as lawn mowing, pesticide use, and home repair activities. The mass emissions, in conjunction with the toxicological characteristics making up these emissions, need to be quantified and compared to accepted health based standards or recognized guidance limits. Second, the mass emission data gathered for the Study area were used as input data entered into an air dispersion model. Air dispersion models are used to predict ambient concentrations from the source categories noted above. Air dispersion models are needed to predict ambient concentrations of air toxic emissions which were not or are unable to be monitored. As part of the Study design, the predicted concentrations of air toxics which were modeled were compared to monitored concentrations to quantitatively determine how well the air dispersion model was performing.

The emission inventory for the non-residential sector is comprised of three source categories; major, area and mobile. The distinction between major and area sources is based upon regulatory emission cutoffs defined by the USEPA for a single pollutant or class of pollutants. Major sources describe the facilities with the most significant amount of mass emissions. Area sources describe facilities which are either small stand-alone facilities (i.e. gas stations) or locations with fugitive emission releases, such as landfills or sewage treatment plants. Major and area size facilities with individual emission points are also referred to as point sources or stationary sources. Mobile sources represent passenger car traffic and off-road vehicle traffic. Off-road vehicles generally are described as construction equipment. The emissions of off-road vehicles were not included in this section due to the absence of specific emissions information for the Study area. When a model to monitor comparison was performed, non-road emission estimates were obtained from the National Air Toxic Assessment (NATA2002) data. Other source categories such as railroad yard emissions (thought to be contributors to $PM_{2.5}$) also lacked the emissions information necessary to make a quantitative evaluation.

A list of emission quantities for all HAPs and non-HAPs emitted from major and area point sources can be found in Figures F1 and F2 of Appendix F. Pie charts for the air emissions with the greatest mass can also be found in Figures F1 and F2, as well as those emissions from Mobile sources (Figure F3) of Appendix F.

6.1 Major Sources

A facility emitting criteria pollutants and/or hazardous air pollutants greater than a federally defined mass emission rate is classified as a major source. Depending on the geographical location within New York State, all criteria pollutants have defined mass emission cutoff amounts signifying the major source level. For example, the Niagara

Frontier area, consisting of Niagara and Erie Counties, has a major source cutoff level set at 50 tons per year or greater for any single facility's emissions of volatile organic compounds. The federally defined mass emission rate for HAPs is the same state-wide and is set at 10 tons per year for individual HAPs and 25 tons per year for a combination of HAPs. For the Study location, the classification of major was used as a starting point to identify facilities of concern and was not limited to only HAPs when identifying toxic air contaminants. Facilities whose emissions are greater than the federally defined mass emission rate for major facilities are required to obtain a Title V permit.

Title V sources are the most rigorously regulated sources in the NYSDEC's air permitting system and are required to submit yearly emission statements of actual emissions to the Department. For the purpose of this study, the combined emission statements of 2002, 2005 and 2006 were chosen and the highest reported emission of an individual air contaminant was selected. These years were selected because 2002 and 2005 are classified as periodic inventory years. Periodic inventory years are when a more robust collection of data is required from the regulated facilities. The additional year of 2006 was added as a check and was the latest complete inventory year at the time the data gathering effort began. All of the Title V facilities are also required to submit Toxic Release Inventory[12] (TRI) data to the USEPA under the under Emergency Planning and Community Right-to-Know Act (EPCRA). Emission statement data was compared and verified with all Toxic Release Inventory data. The USEPA releases the National Emission Inventory (NEI) each year after it is complied. The emissions statements filed with NYSDEC are verified and used to populate the NEI.

To remain below major source classification, source owners can obtain a State Facility permit limiting the emissions from the facility to below major size status. Of the State Facility Permit holders, FMC Corporation has a cap of 98 tons per year of sulfur dioxide and Gibraltar Steel Corporation limits its potential emissions below all major source emission levels.

Sources included in the major source category account for the greatest amount of point source emissions. Within the inventory development process, the emission estimates for the major source categories would be qualitatively determined to be of high quality. Source types within the major source category generally have the most robust data for emission factor estimation and are more likely to have been stack tested to verify emissions and compliance with emission limits.

Facilities with Title V and State Facility permits limiting emissions can be found in Table F1 of Appendix F

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[12] To learn more about the Toxic Release Inventory visit: http://www.epa.gov/tri/triprogram/whatis.htm

6.2 Area Sources

Traditionally, area sources have been described as emission sources that are numerous, relatively small stand-alone facilities or locations with fugitive emission releases. For the purpose of this study, the definition of area sources will include NYSDEC regulated Registration sources, petroleum bulk storage facilities, trucking depots, sewage treatment plants, and landfills.

6.2.1 Registration Facilities

There are 22 facilities in the Study area eligible for a Registration certificate. A Registration certificate is issued to sources limiting their actual facility wide emissions below 50 percent of the major source limits. An additional Registration Certificate is held by the Tonawanda sewage treatment plant and its emissions will be addressed separately due to its unique source characteristics. There are an additional three facility owners, who retained permits from our previous permitting system, and are not required to update the permits at this time. The emissions from these facilities are considered negligible and not a significant impact to the Tonawanda area. The Niagara Landfill holds a Registration Certificate but will also be addressed in its own subsection.

A listing of Regulated Air Pollutants for Registration facilities can be found in Table F2 of Appendix F.

6.2.2 Petroleum Bulk Storage

Petroleum Bulk Storage (PBS) facilities include the large petroleum storage facilities, such as NOCO Energy and Tonawanda Sunoco, identified under the Major sources category list. The major facilities are in the business of unloading petroleum products to tanker trucks for further distribution. PBS facilities can also be smaller storage facilities designed to load fleet vehicles and finally PBS facilities can be gasoline retail stations. Petroleum products such as gasoline are a mixture of various hydrocarbons (e.g. toluene, xylene, cyclohexane, ethylbenzene, n-hexane, naphthalene, 1,2,4- trimethylbenzene, benzene and cumene). Five of these chemicals were sampled by the monitoring network. They are considered to be representative of emissions from PBS facilities.

Staff from the Division of Environmental Remediation maintains NYSDEC's Petroleum Bulk Storage database. This database lists all active and inactive PBS sites, including last inspections, liquid stored, tank size, number of tanks and age. This database was used to locate the gasoline fleet and retail sites in the study area. Sixteen retail gasoline stations were located in the nine census block study area.

A listing of Regulated Air Pollutants for Petroleum Bulk Storage facilities can be found in Table 2.0 of Appendix F.

6.2.3 Trucking Depots

The mobile emission sector within the nine census tract Study area is extensive. Although, the emissions of air toxics from mobile sources will be addressed under section 6.3 of this report, another potential contribution of air toxic emissions in the Study area is from the daily operation of trucking depots. The potential for air toxic emissions is from truck idling and traffic including shuttle trucks used to move trailers, and, to a lesser degree, diesel storage.

The air toxics of concern from trucking depots are fine particulate, ultra-fine particulate and black carbon, a surrogate for diesel particulate. The current Study monitored for $PM_{2.5}$ and did not specifically target black carbon. The TEOM monitors measured all particulate matter less than 2.5 microns.

The Study area has thirty-three active trucking depots and one bus terminal recorded in the Petroleum Bulk Storage database. The estimation of VOC and diesel PM emissions from the trucking depot source category is unknown. Low confidence is assigned to this emission estimates for this source category until better verification of truck activity can be established.

A listing of Regulated Air Pollutants for Trucking Depots facilities can be found in Table F2 of Appendix F.

6.2.4 Sewage Treatment Plant

Industrial and residential waste water sent to publicly owned treatment works (POTW) may be treated or untreated prior to release from industrial facilities. POTWs may treat waste water from residential, institutional, and commercial facilities and/or storm water runoff. A POTW will consist of a primary settling tank or tanks, biotreatment, secondary settling, and disinfection.

One sewage treatment plant is located within the nine census block Study area, the Tonawanda SD #2 facility. This facility holds a Registration Certificate from NYSDEC indicating that the potential of volatile organic compound and nitrogen dioxides emissions from this facility are below 50 and 100 tons per year, respectively and actual emissions are below 25 and 50 tons per year respectively. Tonawanda SD #2 has a three stage aqueous packed tower odor scrubbing system. Foul air from a thermal conditioning sludge treatment process, containing low molecular weight volatile compounds, passes first through a water scrubber, second through an oxidative scrubber, and third through an alkaline scrubber. It is then discharged to the atmosphere through a roof exhaust stack.

Listed in Table F3 of Appendix F are the total VOCs estimated for this source category and the five Category C contaminants determined to be above the Annual Guideline Concentration.

6.2.5 Landfills

The Study area encompasses three landfills in close proximity to two of NYSDEC's air monitoring stations. One landfill, Huntley flyash landfill, located between Grand Island Blvd and the Tonawanda Coke Corporation is an actively used landfill; the other two landfills are municipal solid waste landfills no longer in operation. The Niagara Landfill located north of the Highway 290, adjacent to the toll booths and River Road has been closed since the middle 1990's. The Niagara landfill size is below the thresholds for the New Source Performance Standards, Subpart Cc, requiring a flare or 98% control on captured gas emissions. Even though the landfill was below the NSPS threshold, this site was equipped with a flare at the time of final capping. The flare is no longer in use due to issues with gas production and ceased operation. The other municipal landfill adjacent to Highway 290, between two mile creek and the Conrail railroad tracks is the Town of Tonawanda's landfill. This landfill was the site of a municipal waste incinerator and the bottom ash was disposed on-site. Also, some solid waste was disposed on-site and radioactive waste from the Manhattan project is located at this site. The incinerator and landfill shut down in the early 1980's but the site was recently reopened for waste relocation work. Most of the current activity is along Hackett Road. As of this report, a final cover is not on the site.

Listed in Table F3 of Appendix F are the total VOCs estimated for this source category and the five Category C contaminants determined to be above the AGC.

6.3 Mobile Sources

For this study, the mobile source inventory was restricted to on-road diesel and gasoline engines of all size weight classes.

To generate emission factors for various types of light-duty and heavy-duty vehicles, the Division of Air Resources used MOBILE6[13]. MOBILE6 is a computer-based model used to analyze air pollutant impacts from gasoline-fueled and diesel on-road mobile sources. The software program is capable of generating mobile emission profiles for various road types. The software program also provides the user with a flexible analytical tool that can be applied in a wide variety of air quality planning functions. Among the many conditions that can be altered are roadway type, ambient temperature, weekday/weekend, and gasoline formulation.

Using emission factors and the daily vehicle miles traveled for the Study area, the emissions were calculated for the mobile source contribution in the Study area in tons per year and listed in Figure F3 of Appendix F.

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[13] Mobile6 software and documentation are available at http://www.epa.gov/otaq/mobile

6.4 Limitations

The use of modeling to predict ambient air concentrations has inherent uncertainty and limitations. Limitations with models will be discussed in Section 7. Modeling begins with the development of an accurate emission inventory. Although this Study used a number of data sources (NYSDEC facility permits and national derived emissions from TRI and NEI) to develop an emissions profile for each facility in the Study area, there are inherent limitations with these data sources. In most cases, emissions estimates are both variable and uncertain[14]. When measured values are available, they are based on a single day sampling which does not reflect operational variability. Uncertainty for each source category will be further discussed below.

Major facilities: The emission derived for the larger facilities in the Study area have the highest degree of confidence in the estimation since emissions information for these facilities can be verified by multiple data sources. Within this source category the confidence in specific emission profiles varies by source type. For example, emissions from electrical generating facilities are better characterized than emissions from unique source categories such as a coke production facility.

Minor facilities: This source category includes smaller stationary sources such as truck depots, gas stations, sewage treatment plants, and landfills. While many of these facilities hold some type of permit or registration with NYSDEC, less information is included in these applications compared to the major facilities. Additionally, for small sources not required to obtain permits or Registrations, an inventory was developed by using a commercial database compiled from public records (e.g., U.S. Census, yellow page listings, etc.). The reliability of this data source is dependent on the frequency of updates and an accurate listing of facilities. This data were used to determine if a source or group of sources was not previously identified.

Mobile sources: NYSDEC staff model on-road emissions from mobile sources on a routine basis as part of development of the State Implementation Plan to assess criteria pollutant reduction strategies. Therefore, NYSDEC staff has a higher level of confidence in the emission estimates for this category although day-to-day variability may be difficult to characterize accurately. Non-road sources were not modeled due to the lack of a sufficient local inventory.

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[14] Variability refers to differences over time and/or location, whereas uncertainty arises because of lack of perfect knowledge regarding the true value of a quantity (e.g., emission rate) at a given place or time.

7. Air Monitoring Analysis

7.1 Air Monitoring Concentrations in Perspective

Many of the air toxics monitored were at concentrations below the level of detection. Criteria were developed to assess the adequacy of deriving annual average concentrations from these data. For those air toxics that met the criteria, summary statistics were developed and the results were compared among all four monitoring sites and also with the ambient air concentrations obtained at other monitoring sites in the State and in the U.S. Additionally, the annual average concentrations were compared to health-based comparison values in Subsection 7.2.2.

The criteria pollutants were detected frequently and the results were compared to the National Ambient Air Quality Standards (NAAQS) in Subsection 7.2.2.

It was found that the measured pollutant concentrations were not normally distributed, and therefore appropriate approaches (parametric and non-parametric) were used for all statistical comparisons conducted in this Section. Additionally, appropriate statistical tests indicated negligible autocorrelation for the air toxics monitoring data.

7.1.1 Suitability of the Measured Air Concentrations for Data Analysis and Health Risk Evaluation[15]

Air Toxics

Monitored air concentrations must be present at levels that can be measured accurately and detected with sufficient frequency to characterize an annual average concentration. Accurately detecting ambient levels of air toxics is dependent on the lowest reliable monitored level (i.e., MDL[16]) which varies by pollutant and by monitoring method. The MDL and NYSDEC's Annual Guideline Concentrations (AGC) (NYSDEC 2007b) were used to develop a decision matrix for evaluating the level of confidence in deriving annual average concentrations primarily to assess potential adverse health risk. The outcome from the application of the decision matrix categorized air toxics for use in other data analysis components of this Study.

There is low confidence in the ability to derive an annual average concentration if the air toxic was detected in less than 50% of the monitored samples and those air toxics are listed in Categories A1 and A2 of Table 7.1. Air toxics have been placed in one of these two categories based on whether the health-based comparison value (AGC) is above or

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[15] Sonoma Technology's approach presented at the Toxics Data Analysis Workshop, Rosemont, IL on October 4, 2007 was adopted (available online at: http://www.epa.gov/ttn/amtic/files/ambient/airtox/2007-workshop/03_100407_hafner_mccarthy.pdf). The threshold for inclusion in the risk characterization analysis is 50% rather than the 15% threshold presented by Sonoma Technology.

[16] MDL = method detection limit. It is defined in the *Code of Federal Regulations* (Title 40, Part 136, Appendix B, Revision 1.11) as the lowest value at which it can be 99% confident that the true concentration is nonzero.

below the MDL, because a determination about risk can only be made if the MDL is below the AGC. For category A1, NYSDEC's AGC is below the MDL. A risk evaluation for these air toxics will not be conducted because there is low confidence in the ambient air concentrations measured and it cannot be determined whether the air concentrations are above or below the health-based comparison values. For category A2, the AGC is above the MDL therefore, the risk will be qualitatively discussed.

Category B represents the air toxics that were detected above the MDL 50% to less than 75% of the monitoring period. A daily average for those days when the air concentration was less than the MDL was estimated by using the measurement reported by the laboratory. Although there is less reliability in those measurements reported below the MDL, USEPA's Science Advisory Board (USEPA 2001) has stated that these values may be recognized as measurable results. There is less confidence in the annual average for the air toxics in this category because the use of values below the MDL introduces uncertainty in the estimates. A risk evaluation will be estimated, but the results should be interpreted with caution.

There is high confidence in the annual average concentration for those air toxics that were detected above the MDL with a frequency of 75% or greater. For this category, the values below the MDL as reported by the laboratory were used for less than 25% of the days. A risk evaluation will be conducted for all air toxics in this category, labeled as C.

A decision matrix, as shown in Figure 7.1, was developed to summarize the approach for evaluating the suitability of the data for health risk evaluations. Additional analyses presented in this section will be conducted on the air toxics in categories B and C.

Criteria Pollutants

Continuous monitoring was used for the criteria pollutants and MDL is not as much of an issue with these pollutants as compared to the air toxic pollutants. Additionally, the health-based standards used to compare ambient air concentrations for criteria pollutants are much higher than the MDLs. Therefore, the suitability of using the criteria pollutant data was evaluated based on data capture percentages. All four monitor locations report a high data capture (93% or greater) for the $PM_{2.5}$. Carbon monoxide (CO) and sulfur dioxide (SO_2) were monitored at only one site, the BTRS monitor. The data capture for CO was 98% and for SO_2 it was 97%. CO and SO_2 monitoring data will be compared to the appropriate NAAQS with high degree of confidence in this comparison. $PM_{2.5}$ data will be compared to nearby $PM_{2.5}$ monitoring sites.

7.1.2 Summary Statistics of the Measured Air Toxics and Criteria Pollutants

Air Toxics

Tables 7.2 (Category B) and 7.3 (Category C) provide the mean, median, 25th and 75th percentile concentrations and coefficient of variation for the Study area monitoring sites.

For Category B, six air toxics are reported at more than one site and most are very similar in concentration across the monitoring sites. Only one air toxic is reported across all sites for Category B, 2-butanone, also known as methyl ethyl ketone. The GIBI site concentrations are higher for 1,3-butadiene and hexanal as compared to the concentrations at the other sites. The GIBI site reports the most number of air toxics, generally carbonyls, in this category.

All sites in Category C reported the following air toxics: acetaldehyde, acrolein, benzene, carbon disulfide, carbon tetrachloride, chloromethane, dichlorodifluoromethane, dichloromethane, formaldehyde, toluene, trichlorofluoromethane, and trichlorotrifluoroethane. The following air toxics were reported at both the GIBI and SPWT sites: m,p-xylene and o-xylene. Propionaldehyde was reported for only one site, SPWT. The following air toxics were reported for the GIBI and no other sites: benzaldehyde, ethylbenzene, and valeraldehyde.

For Category C, the variability is much greater for those air toxics (benzene, carbon disulfide, formaldehyde) with known point source releases in the area.

More comparisons will be presented in Subsection 7.4.

Criteria Pollutants

Summary information for the criteria pollutants will be presented in Subsection 7.4.7 and Appendix R.

7.1.3 Air Toxics Concentrations in Perspective

In this Subsection an attempt is made to provide a better perspective on the measured air toxics through a series of questions and answers.

How Does the Upwind (Background) Site Compare to the Perimeter Sites in the Study?

Two types of monitor locations – upwind and perimeter - were implemented for the Study. The upwind monitor (BISP) was sited to capture background measurements of air toxics upwind from the industrial sources in the Study area since the predominant wind direction is from the southwest. Three perimeter sites were sited in locations east and northeast of the Study area to provide air quality measurements downwind of the industrial sources. A comparison was made between the air toxic concentrations obtained at the BISP monitor and the perimeter sites. Fewer air toxics were detected at the BISP monitor. Of the 24 air toxics reported in categories B and C, only 16 were detected at the BISP monitor.

The variability in concentrations found in the industrial area was compared by ratio of the annual averages at each perimeter site to the background site. The ratios are shown in Figure 7.2 for each of the 16 air toxics detected at BISP. Ratios equivalent to one indicate similar concentrations for the perimeter monitors as compared to the background monitor. The ratios for benzene, formaldehyde, hexanal and toluene at the GIBI are much higher than the other perimeter sites, indicating a source influence for these air toxics on the GIBI monitor concentrations. All three ratios for chloromethane and trichlorotrifluoroethane and two sites for dichloromethane are less than one, indicating a source influence for these air toxics on the BISP monitor concentrations. The ratio for carbon disulfide at SPWT indicates a source influence on the monitor concentrations.

An Analysis of Variance (Tukey test on log transformed data) was conducted between BISP and the perimeter monitors' air toxics concentrations. Nine air toxics were found to be statistically different at the BISP monitor. Table 7.4 summarizes the results of this comparison. Three halogenated organic compounds (chloromethane, dichloromethane, and trichlorotrifluoroethane) were found to be statistically higher at the BISP monitor; indicating this monitor is affected by a source (or sources) for these air toxics. An evaluation of the wind direction and concentration for these three air toxics indicates a source (or sources) in the south, southwest direction (See Appendix M).

For six air toxics (acetaldehyde, acrolein, benzene, carbon disulfide, formaldehyde and toluene), the BISP monitor reports significantly lower air concentrations compared to the perimeter monitors. Four of these six air toxics also were found to significantly contribute to health risk concerns for the area as discussed in Subsection 7.2.2. For six air toxics (2-butanone, carbon tetrachloride, dichlorodifluoromethane, hexanal, proprionaldehyde, and trichlorotrifluoromethane) the monitor concentrations at BISP were not statistically different than the concentrations obtained at the perimeter sites.

What Are the Local Concentrations of Air Toxics?

The New York State ambient air toxics monitoring program was first established in 1985 with a focused network as part of the Staten Island/New Jersey Urban Air Toxics Assessment Project. The network expanded in 1990 to a statewide network. The goal of this monitoring network is to characterize air quality related to toxics in the State.

The results from the statewide monitoring network were compared to the Tonawanda results for the same time period as this Study. The statewide monitoring network consisted of 12 monitors, characterized as the following types: 7 urban, 2 industrial, 1 rural and 2 source sited. The rural monitor was removed for this comparison and will be discussed later in this Subsection. The results for categories B and C were combined. Only16 air toxics consistently (>50% above detection limit) report measurable air concentrations for both the statewide and Study monitors. The comparison of the annual average concentrations for the Tonawanda monitors with the results from the statewide network is shown in Figure 7.3 with concentrations displayed on the log-scale**.** Although this comparison with the state monitors includes some sites impacted by specific sources (e.g., near roadway, landfill, specific industry), this comparison was found to be meaningful when conducted across the full spectrum of different monitoring sites.

The annual average measured concentration at the GIBI site for two air toxics (benzene, formaldehyde) were much greater, as compared to the statewide network average during the same monitoring period. Additionally, the benzene average concentration was higher at the BTRS monitor as compared to the results from the statewide network. For all other pollutants, the Tonawanda results were similar to the average concentrations reported by the statewide network.

How Do Air Toxics Concentrations Compare with Typical National Levels?

Annual average concentrations from the U.S. air toxics network has been prepared by Sonoma Technology and reported on USEPA's web site (USEPA 2009a). The year 2005 was selected for this comparison since it represented the most recent year with complete reporting for many monitoring sites.

Monitors reporting greater than 50% detection were selected for the comparison[17] (categories B and C). Only 12 air toxics consistently (>50% above detection limit) report measurable air concentrations for both the U.S. and Study monitors. Figure 7.4 shows the comparison of the Tonawanda (combining all monitor results) and U.S. annual average concentrations displayed on a log-scale**.** An Analysis of Variance was conducted and, for those comparisons statistically significant ($p < 0.05$), the Wilcoxon two-sided test was performed. Benzene was the only air toxic, statistically significantly higher at the Study monitors as compared to the U.S. monitors. The benzene annual average concentration at the GIBI monitor was higher than the 95th percentile value for the U.S. network and all other Study sites were greater than the median U.S. concentration. Carbon tetrachloride was not statistically significantly higher, although the Study concentrations appear to be higher than most of the U.S. monitor concentrations. For all other air toxics, the Study results were within the 5th and 95th percentile range reported by the U.S. network. For the following air toxics (acetaldehyde, acrolein, chloromethane, dichloromethane, propionaldehyde) all Study site average concentrations were below the U.S. median concentration.

This comparison provided useful information, although it is recognized that the U.S. data are compiled across different sampling and analysis methods. Additionally, comparisons have been made between different monitoring time periods and some monitors in the U.S. network may have been sited to capture source emission releases. Finally, some of the monitors in the U.S. network may be located near specific sources (e.g., near roadway, landfill, or specific industry).

How Do the Benzene Concentrations Compare with National Levels Near Benzene Emitting Facilities?

The monitoring data (year 2005) used in the previous section were used for this comparison. National Emissions Inventory (NEI) data for large stationary sources for the year 2005 were obtained from USEPA Technology Transfer Network[18]. This inventory is compiled by USEPA every three years and provides information on chemical releases from outdoor stationary and mobile sources. All facilities reporting benzene emissions in the U.S. were selected and the individual emission units were combined to provide a total benzene annual emission release for the facility. In the Study area, the facility reporting the largest release of benzene was the Tonawanda Coke Corporation. The reported

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[17] Selected 50% to be consistent with the reporting of Category B (U.S. 2005 network, 2449 monitors report greater than 50% detection (47% of all sites reporting)) and Category C (U.S. 2005 network, 2910 monitors report greater than 75% detection (56% of all sites reporting)).

[18] Data available online at: http://www.epa.gov/ttn/chief/net/2005inventory.html#inventorydata [accessed 8/17/09]

releases from this facility were above the 95th distribution among all facilities releasing benzene in the 2005 NEI. Therefore, to create an equivalent comparison between the Study results and the air monitoring concentrations from the U.S. network, only facilities reporting annual releases greater than the 95th percentile were selected. Monitors reporting benzene concentrations above the MDL greater than 50% of the time and within 1.0 mile of these facilities were selected. The benzene concentrations for the U.S. monitors are summarized in Figure 7.5 and the annual averages from the four Study site monitors have been included for comparison.

Benzene concentrations monitored at the GIBI monitor were higher than the highest monitored concentration near a source with facility releases greater than the 95th percentile. The highest monitor concentration based on the selection criteria listed previously is 8.2 $\mu g/m^3$. This monitor (located in River Rouge, Michigan) is approximately 0.2 miles from EES Coke Battery LLC, a facility which reported total benzene releases in 2005 of 15.7 tons per year (TPY). In comparison, the Tonawanda Coke Corporation reported 4.5 TPY benzene emissions in 2005 and the GIBI monitor is 0.5 miles. More recently, the facility reported benzene emissions of 4.9 TPY in 2007 and 5.2 TPY in 2008.

An important limitation of this evaluation is that there is no knowledge of whether the monitors in the U.S. network are sited downwind of the nearby facilities. The influence of wind direction on monitor concentration is demonstrated in Figure 7.5 by comparison of the GIBI and SPWT monitor concentrations. Both the GIBI and SPWT monitors are within 1.0 mile of the Tonawanda Coke. The SWPT monitor is not in the predominant downwind direction from the facility and the resulting annual average concentration at this monitor is fairly low (below the 25th percentile concentration across US monitors located near sources). Whereas the annual average concentration at GIBI monitor, which is downwind from Tonawanda Coke, is higher than the maximum concentration among all the monitors selected.

This evaluation also excludes monitors located near a large congregation of small release sources, which could result in high benzene monitor concentrations. Additionally, this approach assumes the benzene monitor concentrations are primarily from local point sources. Benzene emissions from mobile and area sources also contribute to monitored concentration.

What Are Rural Concentrations of Air Toxics?

The average concentration for the rural monitor at Whiteface Mountain (Essex County) for the same time period as the Study was compared with the Study results. NYSDEC has been operating an ambient air monitor at Whiteface since 1989. The monitor is located in an undeveloped area in the Adirondack Park and is sited at an elevation of 2050 ft. As shown in Figure 7.6, the concentration of the air toxics generally associated with mobile source releases (such as benzene and toluene) are an order of magnitude higher in the Study area as compared to Whiteface. An Analysis of Variance (Tukey test on log transformed data) was conducted and the mean concentrations of following air toxics were statistically significantly higher in the Study area as compared to Whiteface

Mountain; acetaldehyde, benzene, carbon tetrachloride, dichloromethane, formaldehyde, toluene, and trichlorotrifluoroethane.

How Do Ambient Concentrations Compare with National-Scale Air Toxics Assessment Results?[19]

The National-Scale Air Toxics Assessment (NATA) is USEPA's ongoing comprehensive evaluation of air toxics in the U.S. (USEPA 2009b). USEPA conducts NATA to provide a screening tool to identify and prioritize air toxics, emissions source types, and locations that are of greatest potential concern in terms of contributing to population risk. The NATA models emission information from the NEI, an emission inventory of outdoor stationary and mobile sources which is compiled every three years, to derive annual average ambient concentrations. Estimated population exposures are then modeled from the concentration information. Finally, the potential cancer and noncancer public health risks due to inhalation of air toxics are characterized.

The most recent assessment available, which modeled the 2002 emission inventory, was used. The NATA annual average air concentration estimates are modeled to a population-weighted census-tract point (centroid). Therefore, the centroid closest to the Study monitor was selected for comparison for all sites except BISP. The closest census-tract centroid to the BISP monitor is located east in the industrial census tract (029008400) along Kenmore Avenue. The BISP monitor is surrounded by residential development and the modeled concentrations in the tract containing this monitor is a better representation. Only the air toxics that met the suitability criteria (categories B and C) were used in this evaluation. NATA models all xylenes as mixed isomers therefore, all isomers were combined for this comparison.

The Figure 7.7 displays, on a log-scale, the annual average concentrations for the four NATA result census tracts and the Study area monitor concentrations. For acrolein, the monitoring results were consistently higher than the modeled results. The GIBI monitor results were higher, in some cases by an order of magnitude, as compared to the NATA results for the following air toxics: 1,3-butadiene, acrolein, benzene, ethylbenzene, formaldehyde, and total mixed xylenes.

Table 7.5 shows the predicted-to-observed ratios for the NATA modeled concentrations versus the Study area monitored concentrations. For the following air toxics, the NATA modeled results were within a factor of two of the monitoring results for all sites: acetaldehyde, carbon tetrachloride, chloromethane, ethylbenzene, propionaldehyde, and total mixed xylenes. In general, it can be concluded that the 2002 NEI used in the NATA model was fairly accurate in the reporting of emissions for a number of air toxics. The inventory clearly has under reported acrolein emissions for the entire Tonawanda area

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[19] The summary statistics and graphical comparisons as listed in the QAPP were not conducted since all predicted-to-observed ratios could be presented in one table. Additionally, it was determined that no further knowledge would be gained by doing similar comparisons for the 1996 NATA and 1999 NATA because of the age of the emission inventories and the NATA modeling procedures and tools have become more refined leading to a better estimation of ambient concentrations in the 2002 NATA version.

and under reported 1,3-butadiene, benzene, ethylbenzene, formaldehyde, and propionaldehyde emissions for sources near the GIBI monitor.

As a risk assessment screening tool, it is preferable that NATA modeled concentrations are similar to measured ambient concentrations for those air toxics where the ambient measured concentrations are higher than the AGC. For acrolein, the NATA modeled concentration estimates are approximately an order of magnitude lower than the ambient monitor concentrations in this Study. Therefore, the risks predicted by NATA would be an order of magnitude lower than the actual risk. At the GIBI monitor, the NATA model concentration estimates for benzene are nearly an order of magnitude lower than the ambient monitor concentrations. The risk predicted by NATA at this location also would be almost an order of magnitude lower than the actual risk. In general, NATA emission inventory, and therefore model results, appear to be under predicting concentrations and risks for those air toxics dominated by point source contributions (such as benzene, formaldehyde) in the Study area.

How Do the Pollutants Compare with Each Other?

Comparisons between pollutants at the different monitoring sites were conducted graphically and statistically. Box plots for each of the air toxics in categories B and C were produced and are shown in Appendix G. The data were found to be log-normally distributed, and therefore, a Tukey test for multiple comparisons was performed on log-transformed data and the means (geometric means) were compared. Table 7.6 summarizes the statistical comparison across all sites.

Box plots for the following air toxics show little variability across the sites and this is confirmed statistically: 2-butanone, carbon tetrachloride, dichlorodifluoromethane, propionaldehyde and trichlorofluoromethane.

Greater variability is seen in the following air toxics and many of the mean comparisons were statistically different: acrolein, benzene, dichloromethane, formaldehyde, toluene, and trichlorotrifluoroethane.

The GIBI site reports much greater variability (shown graphically in Appendix G) and the greatest difference in mean concentration compared to the other sites was found for the following air toxics: 1,3-butadiene, acetaldehyde, acrolein, benzene, formaldehyde, m,p-xylene, o-xylene, and toluene. The following air toxics met the suitability criteria (Categories B and C) for only the GIBI monitor; benzaldehyde, ethylbenzene, and valeraldehyde.

The box plot and statistical comparison indicates there is a source for trichlorotrifluoroethane near the BISP monitor, which has little impact on the other three monitoring locations.

Does Tonawanda have a Unique Set of Compounds?

In the Study area, the concentrations of benzene and formaldehyde were much higher, as compared to, other industrial and urban monitors in the State.

7.2 Public health interpretation of measured air concentrations

7.1.1 Approach for Evaluating Risk

Air Toxics

To evaluate potential non-cancer health risks, the monitored concentrations in the Study were compared with NYSDEC's AGC. Interim AGCs were derived for three aldehydes; benzaldehyde, butyraldehyde and hexaldehyde and details of the approach used to develop the interim AGCs can be found in Appendix H. To evaluate potential excess inhalation cancer risks, the monitored concentrations in the Study were compared to the AGCs derived from inhalation unit risk (IUR[20]) values. For those air toxics that were not or could not be monitored, an air dispersion modeling analysis was conducted and the predicted concentrations were compared to AGCs as presented in Subsection 7.3.

Many organizations and agencies derive annual exposure limits to protect workers or the general public from adverse exposures to toxic air contaminants. Each one of these exposure limits requires extensive research and development time. As such, NYSDEC often uses the health-based guidance concentrations published by other agencies or organizations to derive health-based guideline concentrations.

AGCs are ambient annual based guideline concentrations that were developed to protect the public's health from effects which may be associated with long-term (e.g., lifetime) exposure to an air pollutant. AGCs are based on the most conservative cancer or non-cancer annual exposure limits. For the evaluation of risk in this Study, only inhalation exposure to HAPs was investigated.

AGCs based on reference concentrations assess the risk for non-cancer effects. USEPA has defined a reference concentration as an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups such as children) that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure (USEPA, 2002a). AGCs derived from cancer studies are defined as a chemical concentration in air that is associated with an estimated excess lifetime human cancer risk of one per one-million people (1×10^{-6}).

An evaluation of potential health risks for the non-cancer compounds was conducted by comparing the 12-month average concentration (considered an annual concentration) obtained in the Study to the AGC for each chemical. To evaluate potential non-cancer effects, a "hazard quotient" was calculated by dividing the annual measured concentration by the reference concentration. A hazard quotient that is equal to or less than one is generally not considered to be a significant public health concern. If the

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[20] The IUR is an upper-bound estimate of the excess cancer risk resulting from a lifetime (assumed 70 years) of continuous exposure to the air pollutant at a concentration of $1 \mu g/m^3$ in air.

annual concentration of an air toxic exceeds the reference concentration, there may be concern for potential non-cancer health effects. However, for most chemicals, the reference concentration (defined above) is set at an exposure level that is lower (often by as much as 100- or 1000-times) than exposure levels that cause health effects. Exceedance of a reference concentration usually triggers a case-by-case evaluation of whether actions to reduce exposures should be taken. Generally, the greater the hazard quotient, the greater the level of concern.

To calculate the excess lifetime inhalation cancer risk, the annual measured concentration was multiplied by the chemical specific inhalation unit risk (IUR) estimate as shown in the following equation:

Cancer risk = annual measured air concentration ($\mu g/m^3$) x IUR $(\mu g/m^3)^{-1}$

($\mu g/m^3$ = micrograms of air toxic per cubic meter of air)

The AGCs are based on a one-in-one-million excess cancer risk. This annual concentration is derived by using the following formula:

$$\frac{\text{One-in-one-million risk } (1\text{x}10^{-6})}{\text{IUR}} = \text{AGC}$$

There is general consensus in the scientific and regulatory communities that an increased lifetime cancer risk of one per one-million (10^{-6}) or less is not a significant public health concern and that an increased cancer risk level of greater than 100 per one-million (10^{-4}) may warrant measures to reduce the risk (e.g., exposure reduction measures). Risk levels that fall between 10^{-4} and 10^{-6} usually warrant further evaluation (e.g., the actual vs. potential exposure, “background” exposure, and the strength of the toxicological data), with the need for risk reduction measures depending on where in that range the risk estimate falls[21].

The risk estimates presented in this Study assume that the exposure to the air pollutant is at the level of the mean concentration measured or predicted at the specific monitoring location for 24 hours per day and 7 days per week, over 70 years. No adjustments are made to account for an individual’s time and activity patterns (e.g. time spent at work or school). Risks for cancer are generally expressed as individual risk (i.e. the risk borne by

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[21] In 1980, the Supreme Court struck down the Occupational Safety and Health Administration (OSHA) policy of reducing benzene concentrations to the lowest technologically feasible level. The Judges concluded that OSHA could regulate benzene emissions only if it found that benzene posed a significant risk of harm. This ruling is known as the “Benzene decision”. As part of the policy decision making process for section 112 of the Clean Air Act, the Benzene decision and subsequently future District of Columbia Circuit Court rulings required USEPA to make a determination of “safe” exposure level (i.e., representing an acceptable degree of risk and to establish an “acceptable cancer risk range”). USEPA adopted a policy that a lifetime excess cancer risk of approximately 100 in-one- million for the most exposed person would constitute acceptable risk and that the margin of safety should reduce the risk for the greatest possible number of persons to an individual lifetime cancer risk no higher than one in one million (Benzene Decision, 1980**)**.

an individual in a larger population). As presented above, the estimates of cancer risk are usually expressed as statistical probabilities (e.g. the additional risk of developing cancer is one-in-one-million).

There is inherent uncertainty in the use of health-based comparison values (NYSDEC's AGCs) which are generally derived from animal or human data on a chemical. Scientists account for this uncertainty when extrapolating data from animal or human studies to non-cancer or cancer endpoints. For non-cancer endpoints, scientists use uncertainty factors to develop a reference concentration. The reference concentration represents an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups such as children) that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure. Animal or human studies with cancer endpoints lead to the development of an inhalation unit risk estimate which represents an upper-bound estimate of the excess cancer risk resulting from a lifetime (assumed 70 years) of continuous exposure to the air pollutant at a concentration of $1 \mu g/m^3$ in air.

Criteria Pollutants

The results of the monitoring for CO, and SO_2 were compared to the current NAAQS. $PM_{2.5}$ monitoring results were compared to nearby monitors.

7.2.2 Results from Risk Evaluation

Air Toxics

Category A1

The air toxics in this category were detected less than the MDL concentration 50% of the time and the AGCs are below the MDL. A risk evaluation was not conducted because it could not be determined whether the annual average was above or below the AGC.

Category A2

The air toxics in this category were detected less than the MDL concentration 50% of the time. The risk estimate for these air toxics are qualitatively discussed because the AGC is above the MDL, even though there is low confidence deriving an annual average concentration for this category.

A check on the potential annual average concentration was conducted to verify the risk statements. The MDL concentration was conservatively assumed for all those compounds detected below the MDL and the sample concentrations that were detected were retained. An estimated annual average concentration was calculated which is considered to be conservative (an overestimate) because for those samples not detected, the actual concentration would be below the MDL.

For each air toxic, the estimated annual average concentrations were compared to the AGC and it was found that, for all air toxics in this category, the estimated annual average was lower than the AGC value. Therefore, the air toxics in this category are not expected to be a public health concern.

Category B

Table 7.7 shows the results for the risk evaluation for the air toxics in Category B. The air toxics in this category were detected in at least 50% to less than 75% of the monitored air samples and therefore there is less confidence with this data when making definitive risk statements.

For the non-cancer evaluation, all hazard quotients were well below a value of one and range from 7.4×10^{-5} to 8.7×10^{-3}. These results indicate that individual air toxics in this category are not expected to be a public health concern for non-cancer effects.

As shown in Table 7.7, 1,3-butadiene was the only air toxic in this category with an AGC based on a cancer endpoint. The cancer risk estimates are 2.7 and 7.3 in-one-million (2.7×10^{-6} and 7.3×10^{-6}) for the BTRS and GIBI sites, respectively. State-wide data (for the same time period as this Study) for 1,3-butadiene show an average cancer risk estimate of 3.6 in-one-million (range 1.8×10^{-6} to 5.3×10^{-6}) for urban and industrial locations. The cancer risk estimate at the BTRS monitor is therefore lower than the average State-wide risk for this air toxic. The cancer risk at the GIBI monitor is approximately 36% higher than the highest 1,3-butadiene concentration found at a monitor in New York City. Compared to data across the country (year 2005), the cancer risk attributable to 1,3-butadiene at the BTRS and GIBI monitors is below the U.S. monitoring average value of 12 in-one-million (12×10^{-6}).

Category C

Table 7.8 shows the results for the risk evaluation for the air toxics in Category C. The air toxics in this category were detected in greater than 75% of the air samples and therefore there is high confidence with this data when making definitive risk statements.

For the non-cancer evaluation, the hazard quotients range from 3.5×10^{-6} to 22. Acrolein is the only air toxic with a hazard quotient above one. Acrolein is a difficult air toxic to monitor accurately[22] and is currently only monitored at two sites in the State in addition to the Study sites. The acrolein results have been reported, although some laboratory quality assurance thresholds[23] were exceeded. The hazard quotient for acrolein at the two monitoring locations in the State network was 18 and 23. The hazard quotient for acrolein at the Study site monitors was similar to the values reported by the other two monitors in the State. Acrolein also is monitored to a limited degree by other states. The acrolein hazard quotients at the monitors in the Study are below the U.S. monitoring (year 2005) average hazard quotient of 39 (range 2.2 to 120)[24] .

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[22] Acrolein is a difficult air toxic to monitor accurately because the concentrations are affected by humidity and the chemical reacts with the liner of the sampling device (a summa canister). See Section 5 for additional information.

[23] See Appendix E Quality Assurance for VOCs and Carbonyls

[24] The hazard quotient evaluation for acrolein is based on a limited number of monitors in the U.S. network which report greater than 50% detects (43 monitors) for the 2005 results.

At all four Study monitoring sites, four air toxics (acetaldehyde, benzene, carbon tetrachloride and formaldehyde) were above a one per one-million cancer risk estimate. A risk comparison from State-wide urban and industrial monitors and for all monitors in the U.S. is shown in Figure 7.8.

For acetaldehyde, the cancer risk estimate at BISP and SPWT was below the state average, whereas the other sites were above the State average. In comparison, these four sites are below the U.S. average for acetaldehyde.

The benzene cancer risk estimate at all Study sites was close to or above a 10 in-one-million cancer risk with an estimated risk at the GIBI monitor of 75 in-one-million. The benzene cancer risk estimate at all four sites was above the State average and above the U.S. average at the BTRS and GIBI monitors. Figure 7.9 shows a comparison of the benzene risk estimate for the Study monitors and all the other State monitors. To minimize the scale, the benzene risk estimate at the GIBI monitor (75 in-one-million) was not included. The estimated benzene risk at the BISP and SPWT monitors is similar to the risk estimates found at the NYC monitors. The estimated benzene risk at the BTRS and the GIBI was much higher, indicating that these monitors were potentially affected by a benzene source in addition to the mobile source contributions commonly found at other urban areas and NYC. Additional analyses are presented in Subsection 7.4 which includes an evaluation of potential benzene point sources.

The cancer risk estimate at all the Study sites for carbon tetrachloride, a ubiquitous air toxic with a long half-life, was similar to the annual average concentrations found at other monitor locations in the State and U.S.

The formaldehyde cancer risk estimate for the Study sites was slightly higher than the State average at the BISP, BTRS and SPWT monitors, whereas the cancer risk estimate found at the GIBI monitor was higher than the maximum value found in the State network. In comparison, the cancer risk estimate for formaldehyde at the BISP, BTRS, and SPWT monitors was below the U.S. average and the cancer risk estimate at the GIBI monitor was above the U.S. average.

Criteria Pollutants

Carbon monoxide has an hourly standard of 35 ppm and an 8-hour standard of 9 ppm. There were no exceedances of these standards at the only monitor where it was measured (BTRS) during the Study period. The CO maximum hourly concentration and average annual concentration (of all the hourly concentrations in the Study period) were 1.4 ppm and 0.29 ppm, respectively.

Sulfur dioxide has three Federal standards: a 3-hour secondary standard[25] of 0.5 ppm, a 24-hour standard of 0.14 ppm, and an annual standard of 0.03 ppm. There were no

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[25] The secondary standards set limits to protect public welfare, including protection against decreased visibility, and damage to animals, crops, vegetation, and buildings. All other NAAQS values displayed in this report are primary standards which are limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly.

exceedances of these standards at the only monitor where it was measured (BTRS) during the Study period. The SO_2 maximum hourly concentration and average annual concentration (of all the hourly concentrations in the Study period) were 0.058 ppm and 0.0029 ppm, respectively.

$PM_{2.5}$ has a 24-hour NAAQS of 35 $\mu g/m^3$ and an annual NAAQS of 15 $\mu g/m^3$. A comparison with the NAAQS for PM2.5 was not conducted with the Study results because the monitoring method is not considered a federally approved method. A comparison with the monitoring results obtained at the Buffalo and Niagara Falls monitors was conducted since those monitors both use a federally approved method. This comparison is further supported by the fact that $PM_{2.5}$ monitoring concentrations are generally the result of regional transport from sources outside the monitoring area. Therefore, it can be expected that exceedances of the NAAQS at the Buffalo and Niagara Falls monitors also would likely occur at the Study site monitors if the primary influence in monitor concentrations was regional in nature. On five dates (8/3/07, 8/29/07 9/6/07, 4/18/08 and 4/19/08) during the Study period, the $PM_{2.5}$ monitoring results exceeded the NAAQS at either the Buffalo or Niagara monitors. On all five dates, the Study $PM_{2.5}$ concentrations were also above 35 $\mu g/m^3$ for at least one monitor in the Study area. Only one date (9/7/07) during the Study was the $PM_{2.5}$ above 35 $\mu g/m^3$ at one Study monitor, but not above this value for Buffalo or Niagara Falls monitors. The remaining Study site monitors on this date were within 15% to 27% of the Study monitor value. Additionally, a graph of the $PM_{2.5}$ daily concentrations was produced (not shown) across the Study period to provide a day-by-day comparison between the Buffalo and Niagara Falls monitors with the Study monitors. In general, it can be concluded that the Study site monitoring $PM_{2.5}$ concentrations were influenced by regional transport since the concentrations were very similar to the comparison monitoring concentrations at Buffalo and Niagara Falls.

The averages for the Study period at the Buffalo and Niagara Fall monitors were 12 $\mu g/m^3$ and 11 $\mu g/m^3$, respectively. These 12-month averages, although not calculated across a calendar year, do not exceed the NAAQS annual average. In comparison, the Study monitoring 12-month averages were very similar with values of 11, 13, 13 and 11 $\mu g/m^3$ for the BISP, BTRS, GIBI and SPWT monitors, respectively.

7.2.3 Limitations of the Risk Evaluation

The risk estimates do not account for other sources of exposure such as indoor or occupational. Additionally, the risk estimates assume that people reside at the monitor location and that these values are not attenuated by time spent at other locations (such as work, school, etc.). This study is not able to determine an individual's overall exposure. Other factors (such as smoking, hobbies and occupations using solvents) can lead to increases exposure to HAPs and contributes to the overall uncertainty in the estimates provided in this report.

Conservative cancer risk estimates have been provided in this Study for the air toxics, which assumes continuous exposure for 70 years (365 days per year, 24 hours per day) at the monitor locations and that the monitor concentrations remain constant for 70 years. In addition, all air toxics with a cancer risk associated with them are based upon the upper-bound excess lifetime cancer risk resulting from continuous exposure to an air contaminant. The USEPA defines the upper bound as “a plausible upper limit to the true value of a quantity. This is usually not a true statistical confidence limit.” The use of an “upper limit” means that the true risk of developing cancer from exposure is not likely to be higher and may be lower than the estimates provided in this Study.

7.3 Public Health Interpretation of Modeled Air Concentrations

Part of the Study grant was to utilize and comment on the USEPA's air dispersion modeling software called the Regional Air Impact Modeling Initiative (RAIMI). In addition to air dispersion modeling capabilities, RAIMI is a software program designed to review and modify data output. The RAIMI program allows the user to input multiple sources and emission scenarios in order to predict ambient air concentrations at various locations in the representative study area. The emission inventory complied in Appendix F provided invaluable data for running the RAIMI model. For a more detailed description of the RAIMI model, see Appendix I and for the evaluation of the RAIMI modeling tool, see Appendix J. To establish a degree of confidence with the modeled predictions, a model-to-monitor ratio comparison is conducted with those pollutants capable of being monitored. The model-to-monitor comparison can be found in Appendix L.

This Subsection will address the cancer risk drivers that were not capable of being monitored with methods applied during the Study period. With the exception of Benzene Soluble Organics (BSO) and naphthalene, all of the identified carcinogenic compounds were monitored and classified as either Category B or C compounds during the one year study period. It was necessary to model the BSO and naphthalene emissions to obtain a complete picture of the potential carcinogenic risk in the Study area. Naphthalene was not included as BSO because BSO compounds have greater than 16 carbons and naphthalene only has 10 carbons in its molecular structure. BSO and its constituents will be defined and discussed in later Subsections.

When conducting community studies, the use of air dispersion models to predict ambient concentrations of HAPs, in addition to, the actual monitoring of HAPs is essential and is recommended by the USEPA's, a Tier 2 analysis (USEPA, 2004b). Modeling offers the ability to estimate trace quantities and mixtures of HAP concentrations that cannot accurately be measured. Also, the modeling results can be substituted for a costly monitoring network in order to make regulatory decisions for specific sources of HAPs.

Subsections 7.3.1 and 7.3.2 present the potential health risks associated with simultaneous exposures to multiple HAPs. Section 7.3.1.1 discusses the characterization and evaluation of Coke Oven Emissions. The predicted ambient air concentration of Coke Oven Emissions will be referred to as benzene soluble organics (BSO) throughout this report. In section 7.3.1.2 the risks attributable to BSO, naphthalene and PAH will be evaluated to provide a total cancer risk for the Study area. Subsection 7.3.2 presents the Hazard Index for the monitored and/or modeled non-cancer compounds in four Study area neighborhoods chosen based upon locations where either citizen complaints have been documented, schools are located, and/or have been designated environmental justice areas.

7.3.1 Evaluation of Inhalation Cancer Risk

7.3.1.1 Benzene Soluble Organics (BSO), a Surrogate for Coke Oven Emissions

Many sources in the Study area, both stationary and mobile, emit polycyclic organic matter (POM). POM is identified in the Clean Air Act Amendments of 1990 as a HAP. POM is a broad class of compounds, which includes all organic compounds with more than one benzene ring and a boiling point greater than or equal to 212 ºF. The principal formation mechanism for POM occurs during the fuel combustion process for many source categories. Polycyclic aromatic hydrocarbons (PAHs) are a subset of POM and seven specific PAHs have been identified as probable human carcinogens. They are referred to as the 7-PAH group. The emissions of POM are a by-product from all combustion sources. The largest combustion source in the Study area is NRG's Huntley coal-fired power plant. NRG recently authorized the installation of a fabric filter to replace the older electrostatic precipitators in order to reduce emissions of particulate in general. This, in turn will also reduce emissions of POM. Another large source of POM and ultimately Benzene Soluble Organics (BSO) is the Tonawanda Coke Corporation.

Coke Oven Emissions are identified in the 1990 Clean Air Act Amendments as a HAP. Coke Oven emissions have also been classified by the USEPA as a known human carcinogen. The Tonawanda Coke Corporation is the sole source of Coke Oven Emissions in the Study area. Coke Oven Emissions are characterized as consisting of a mixture of organic chemicals, metals, and POM. The semi-volatile organic constituents of Coke Oven Emissions are termed BSO, which is considered an appropriate surrogate for quantifying the cancer risk associated with Coke Oven Emissions.

The term BSO is based on a test method used to quantify coke oven emissions directly from the coking operations. The POM is collected on a sampling filter that is dissolved in benzene, then the benzene is evaporated off and the organic matter that is left behind is classified as BSO (USEPA, 1998). The probable human carcinogenic compounds within BSO include the carcinogenic 7-PAH group, which can account for 3 to 10 percent of the BSO (USEPA, 1998). The BSO risk level incorporates the Inhalation Unit Risk Estimate (IUR) for Coke Oven Emissions to calculate the potential inhalation excess cancer risk associated with these emissions.

7.3.1.2 Inhalation Cancer Risk Analysis

The modeled and measured concentrations for the various carcinogenic contaminants will be added together for each monitoring location. The carcinogenic HAPs emitted from sources in the Study area are: acetaldehyde, benzene, BSO, 1, 3- butadiene, carbon tetrachloride, dichloromethane, formaldehyde, and naphthalene. Naphthalene has been identified as a carcinogen by California EPA (CALEPA, 2009)[26]. The USEPA's Center of Environmental Assessment investigated the potential carcinogenic potency of naphthalene and posted the following statement on the Integrated Risk Information System (IRIS): "An inhalation unit risk estimate for naphthalene was not derived because

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[26] NYSDEC has not identified naphthalene as a carcinogen.

of the weakness of the evidence (observations of predominant benign respiratory tumors in mice at high dose only) that naphthalene may be carcinogenic in humans." Naphthalene is not included as BSO because BSO compounds have greater than 16 carbons and naphthalene only has 10 carbons in its molecular structure.

The emissions of BSO and naphthalene were modeled with AerMod (USEPA, 2007b) and RAIMI to determine the potential concentrations occurring outside of the Tonawanda Coke facility property boundary. Tonawanda Coke Corporation has the largest reported amount of BSO and naphthalene emissions in the Study area (USEPA, 2002b). To assess the total individual inhalation cancer risk associated with exposure to multiple HAPs, the modeled and measured cancer risk estimates for the various HAPs will be added. Combining the inhalation cancer risk for each HAP is a conservative public health approach providing a total estimated individual inhalation cancer risk for the Study area.

Within the March 2005 Risk Assessment Document for the Coke Oven MACT Residual Risk, the USEPA presented the maximum individual risk and the population risk for carcinogens and non-carcinogens. This is discussed further in Appendix K.

In the public meetings held by NYSDEC, individual cancer risk was presented as a statistical probability (expressed as the number of individuals at risk per million people). These risks were derived at the particular monitor locations for each HAP; for example, the individual cancer risk for exposure to benzene was determined to be 15.4 in-a-million at the BTRS monitor. The modeling results of BSO and naphthalene also will be expressed as the number of excess estimated cancer cases per million individuals. Finally, the individual inhalation cancer risk will be presented based upon the monitored and predicted concentration at the four monitoring sites.

Benzene Soluble Organics

For the GIBI site, the modeled ambient air concentration of BSO emissions from Tonawanda Coke Corporation was predicted to be 0.875 $\mu g/m^3$. The concentration modeled at the GIBI site is based upon the Maximum Achievable Control Technology (MACT) emission limit for BSO from coke batteries. The cancer risk is calculated using the IUR for Coke Oven Emissions from the USEPA Integrated Risk Information System (IRIS). The ambient air concentration of coke oven emissions that corresponds to a one-in-a-million cancer risk is 0.0016 $\mu g/m^3$ (USEPA, 2009d).

Table 7.10 presents the HAP specific and total inhalation cancer risk for the measured and modeled HAPs. The inhalation cancer risk based upon modeled BSO emissions ranges from 26 in-one-million at the upwind BISP monitor to 547 in-one-million at the GIBI monitor.

PAH Monitored Data

After the implementation of the MACT requirements for coke oven batteries, the calculated cancer risk from BSO was found to be very high. BSO is used as a surrogate for coke oven emissions. In the final USEPA residual risk assessment for coke oven emissions, two HAPs (BSO and benzene) were responsible for the elevated cancer risk estimate for the Tonawanda Coke Corporation. However, even though there was a high estimated maximum individual cancer risk (100 per million) for HAP emissions from the Tonawanda Coke Corporation, the decision was made by the USEPA that the risk was acceptable due to concerns that adjustments for uncertainties had led to an overestimation of risk in the surrounding community (USEPA, 2004c).

To gain a greater understanding of the predicted BSO concentration, the NYSDEC installed a PAH monitor at the GIBI site after the one year monitoring study was completed in an effort to verify the modeling results for BSO and naphthalene. The annual concentration (11 months) for the total PAHs monitored was 0.122 µg/m^3, as compared to the predicted concentration for BSO of 0.875 µg/m^3. The PAH analysis method reports the results for 21 PAH compounds, plus naphthalene.

According to the USEPA Locating and Estimating Air Emissions from Sources of POM (USEPA, 1998), the PAH compounds monitored at the GIBI site accounted for approximately one-half of the total BSO emissions. The PAH annual averaged concentration measured for the 21 compounds was 0.122 µg/m^3. Using the one-half approximation, the total BSO could more or less be doubled and estimated to be 0.244 µg/m^3. This is a conservative assumption since there are other sources of PAHs in the Study area. Using these assumptions, the BSO cancer risk calculated from the monitored data was found to be substantially below the predicted 547 in-one-million cancer rate and closer to 150 in-one-million. The unadjusted modeled risks for the BTRS and SPWT monitoring sites were 98 and 65 in-one-million, respectively.

The cancer risk associated with the measured PAH concentrations at the GIBI site was only 1.9 in-one-million. This large range of cancer risk estimates between the modeled BSO and measured PAHs concentrations results in considerable uncertainty associated with the cancer risk estimates associated with the BSO model predictions.

Naphthalene

The predicted GIBI concentration for naphthalene based upon the modeling of actual emissions reported by Tonawanda Coke was 0.128 µg/m^3, while the PAH monitor captured higher than expected concentrations. The annual measured concentration (11 months) for naphthalene at the GIBI monitor was 0.679 µg/m^3. This value is five times greater than the modeled estimate and would indicate that either another large source of naphthalene was in the area or the reported emissions were underestimated.

7.3.1.3 Air Toxic Cancer Risks in Perspective

Table 7.9 provides the ambient air concentration results of the four monitoring sites and the projected inhalation cancer risk. The risks identified above are overly conservative because they add the inhalation cancer risk for all identified carcinogens even though these different contaminants may not have additive effects. This approach is used as a starting point to identify which air toxics need to be evaluated for further reductions. This approach assumes that an individual lives at the monitor location 24-hours per day, 7 days per week, for 70 years and does not alter their activities. It is very possible that someone would live in a particular location for their lifetime, but not likely that they would remain at that location 24-hours per day, 7 days per week. In the USEPA's NATA study, the USEPA applies another step or tier, called an exposure assessment, with the modeled concentrations. As stated on the NATA webpage:

> Estimating exposure is a key step in determining potential health risk. People move around from one location to another, e.g., outside to inside, commute to work, etc. Exposure isn't the same as concentration at a static site. People also breathe at different rates depending on their activity levels. For these reasons, the average concentration of a pollutant that people breathe, i.e., exposure concentration, may be significantly higher or lower than the concentration at a fixed location (USEPA, 2002c).

The USEPA uses census data, human activity pattern data, and indoor/outdoor concentration relationships to estimate a range of more realistic inhalation exposure concentrations for a particular location. These human activity patterns try to account for the many different activities a person undergoes within the day. Exposures can be altered for individuals exercising or engaged in heavy physical labor due to increased breathing rates. Spending a portion of the day in an office environment is different than time commuting or time spent indoor at home. All of these activities need to be considered in order to estimate an individual's overall exposure. This report did not evaluate these adjusted inhalation exposures because the purpose of the Study was to determine if further regulatory actions are needed to reduce the burden of ambient air pollution in the Tonawanda community. Table 7.9 shows the total inhalation cancer risk for each site. The monitored air toxics results reflect the actual emissions from sources in the Study area, while those predicted from modeling represent the allowable emission limits. The PAH monitoring results at the GIBI site provides a perspective between the measured concentrations from the actual emissions of BSO and the predicted concentrations from the allowable emission limits of BSO. Overall, the calculated difference between actual and modeled PAHs is approximately 25 percent. This ratio between the modeled and monitored results for BSO at the GIBI site could be applied to the other sites to determine an overall actual monitored inhalation cancer risk.

Table 7.9 shows that the total monitored inhalation cancer risk at the background site BISP was 90 in-one-million. This calculated risk is driven by the monitored concentration for formaldehyde of 42 in-one-million is consistent with the two residential sites. The downwind residential monitoring site, BTRS, has a total monitored inhalation cancer risk of 170 in-one-million. When using an adjusted modeled BSO concentration to account for actual emissions, the cancer risks are greater than 150 in-one-million for the BTRS. The difference between these upwind and downwind inhalation cancer risk values provide a strong basis for further compliance monitoring and regulatory actions to reduce the inhalation cancer risk in the Tonawanda community.

7.3.2 Hazard Index Analysis of Four Selected Neighborhoods in the Tonawanda/Kenmore Area

7.3.2.1 Chronic Non-Cancer Health Effects

Using the modeling results from the RAIMI software program, the hazard index was calculated for the non-cancer compounds known to be emitted from facilities in the Study area. For this analysis, four specific geographical areas were chosen based upon locations where either citizen complaints have been documented, schools are located, or which have been designated environmental justice areas. The four locations are:

1.) Kaufman Ave.
2.) Ken-Ton Occupational School and Neighborhood Location
3.) Tonawanda School District Location
4.) Esminger Playground Neighborhood

To establish the potential non-cancer health consequences from inhaling an air pollutant over a lifetime, the measured or predicted air concentration of a pollutant can be divided by its health-based benchmark concentration to produce a ratio of the two concentrations. The ratio of the measured or predicted concentration and the health-based concentration is called the hazard quotient (HQ) for non-carcinogens. The potential risk is elevated when the resultant ratio calculation is greater than 1.0. The hazard index is the sum of hazard quotients for all of the air contaminants evaluated. USEPA cautions the use of the Hazard Index (HI) approach as follows (USEPA2002b):

> The hazard index is the sum of hazard quotients for substances that affect the same target organ or organ system. Because different pollutants may cause similar adverse health effects, it is often appropriate to combine hazard quotients associated with different substances. EPA has drafted revisions to the national guidelines on mixtures that support combining the effects of different substances in specific and limited ways. Ideally, hazard quotients should be combined for pollutants that cause adverse effects by the same toxic mechanism. The HI for respiratory irritation is only an approximation of the aggregate effect on the respiratory system (i.e., lungs and air passages) because it is possible that some of the substances cause irritation by different (i.e., non-additive) mechanisms. As with the hazard quotient, aggregate exposures below a HI of 1.0 will likely not result in adverse noncancer health effects over a lifetime of exposure. However, an HI greater than 1.0 does not necessarily suggest a likelihood of adverse effects. Furthermore, the HI cannot be translated to a probability that adverse effects will occur, and is not likely to be proportional to risk. A respiratory HI greater than 1.0 can be best described as indicating that a potential may exist for adverse irritation to the respiratory system.

The HI results for the four areas identified above are listed in Table 7.10. The HI results represent the potential contribution from point and area sources, but not the mobile sector. The top five HQs are shown for each location.

Acrolein

In each neighborhood, acrolein was modeled and monitored as one of the compounds with the highest HQs, but the modeling results were underestimated as compared to the monitoring results. The average model-to-monitor ratio across all four monitoring sites was 0.09. The HI presented for the neighborhoods located near the monitors, the Tonawanda School District and the Ken-Ton Occupational School, are estimated low because the monitors indicate the actual measured concentration of acrolein is approximately ten times higher than the modeled concentration. The highest monitored acrolein concentration was recorded at the GIBI site.

Monitoring Site	Acrolein Concentration (μg/m^3)
Beaver Island Site	0.32
Brookside Terrace	0.33
Grand Island Blvd.	0.43
Sheridan Park Water Tower	0.34

Although the upwind and residential sites appear to be slightly different they are statistically similar in concentration. The three point sources of acrolein in the Tonawanda area inventory are 3M Tonawanda, Tonawanda Goodyear, and Tonawanda Coke with reported emissions of 31, 57, and 37 pounds per year, respectively. For the mobile source sector, the NATA 2002 estimated concentrations for acrolein are 3 to 4 times higher than the Study's calculation, but as shown in Table 7.5, NATA 2002 also under predicts the total acrolein concentration by a factor of 10. Combining the monitored data for acrolein with the other modeled compounds would result in a HI above one for all the Study sites.

Naphthalene

As discussed in the Inhalation Cancer Risk Analysis section, naphthalene was monitored at the GIBI after the Study period. A comparison of monitored concentration to the modeled value indicates an underestimate of the model by a factor of 5.3. The modeled naphthalene concentration in the four neighborhoods may be under estimated.

Chronic inhalation studies on animals determine that naphthalene aggravated cells in the olfactory and respiratory system. The IRIS database (USEPA, 2009d) established a reference dose concentration for naphthalene of 3.0 μg/m^3 in 1998, and this value has been adopted by the NYSDEC as the AGC. The annual concentration modeled at the Kaufman Ave. neighborhood was 0.131 μg/m^3 and resulted in a hazard quotient of 0.04. However, the potential underestimation of naphthalene, as determined from the GIBI monitor results, could change this concentration by a factor of five. The maximum 24-hour concentration measured at the GIBI site was 2.93 μg/m^3. Twenty-eight percent of the 24-hour naphthalene concentration measurements at the GIBI site were greater than 1.0 μg/m^3. In consideration of exposures to other air toxics, it is conceivable that the days with the higher naphthalene monitored concentrations could be playing a significant role in the complaints of eye and respiratory irritation in the Kaufman area neighborhood when combined with other known irritants in the area.

The USEPA's Residual Risk report did not document any non-cancer compounds exceeding a HQ of 1.0 for the Tonawanda Coke facility. The highest HQ recorded was for benzene at 0.2. The HQ cited for naphthalene was 0.004, whereas the GIBI monitor recorded a HQ of 0.23. The USEPA's approach was to examine each compound emitted from an emission source, (e.g. battery doors leaks) and establish a HQ. HQs were summed to establish an HI for an emission source. The combined HI for naphthalene was 0.262 for the Tonawanda Coke facility. The other point sources of naphthalene identified in the area are NOCO Energy, NRG Huntley Steam Station, and Tonawanda Goodyear, with emissions reported at 39, 20, and 90 pounds per year, respectively. Tonawanda Coke reported releases of 3,000 pounds a year of naphthalene.

7.3.2.2 Air Toxic Non-Cancer Risks in Perspective

Using the RAIMI software program, an HI of 1.03, was calculated for the Kaufman Ave. location with the top five contributing compounds being acrolein, sulfuric acid, hydrochloric acid, naphthalene, and ammonia. As explained above, the HQ represents a measured or modeled concentration divided by the health-benchmark concentration. The endpoints for the development of the health benchmarks for these specific compounds are based on irritation effects. Although a detailed exposure assessment analysis could be conducted to evaluate daily variability for an individual's exposure, the variability based on meteorological conditions is likely be much greater than the variability based on daily activity. Meteorological conditions that are conducive to increasing the concentrations of air toxics, including irritants, are stagnant warm air. Similar to alerts issued by the NYSDEC and the NYSDOH for high ozone and high particulate days, these events tend to occur on days with minimal wind movement. Work displayed in Section 7.4 of this report showed how daily concentrations of monitored air toxics increased on calm wind days. The NYSDEC Region 9 office has received many complaints from citizens living in the Kaufman Ave area of upper respiratory and eye irritation. These events would be considered an acute health episode and future air pollutant reduction strategies need to be implemented to reduce emissions from multiple sources which create high concentrations of air pollutants associated with acute irritation events.

The air monitoring strategy was not conducive for evaluating short-term exposures and acute health effects but rather was designed to investigate chronic health outcomes. Short-term exposures are better evaluated with sampling time frames on the order of one to a few hours. For the air toxics evaluated in this study, a daily average was collected, limiting the ability to evaluate acute health effects. The modeling analysis conducted above evaluated air contaminants for which this Study was not able to monitor through the methods selected (TO-11 and TO-15) such as sulfuric acid, hydrochloric acid, and ammonia. The chronic toxicity endpoint for these air contaminants is irritancy, an endpoint that is commonly associated with acute exposures.

7.3.3 Limitations

The use of modeling to predict ambient air concentrations has inherent uncertainty and limitations. The type of air dispersion model (RAIMI and AerMOD) used in this assessment is a Gaussian plume model. The Gaussian models assume an ideal steady-state of variable meteorological conditions over long distances, idealized plume geometry, complete conservation of mass, and exact Gaussian distribution. These ideal conditions rarely occur at one location. The modeling of these types of conditions leads to an overestimate of actual concentrations and is conducted to provide a conservative estimate, protective of public health.

Additionally, a number of assumptions are made during the development of the modeling inputs. For example, USEPA used the Buoyant Line Plume model and ISCST3 model to calculate ambient concentrations resulting from the dispersion of contaminants from the Tonawanda Coke facility for the Coke Oven Residual Risk Assessment. Unique to the coking process are the high temperatures attained in the coke oven battery. These high temperatures add to the dispersion of emissions from the coking process and subsequently the pushing process. Appendix E, of the Residual Risk Assessment, details the enhanced plume calculation completed by USEPA. USEPA included the following statement in their document “coke ovens facilities produce significant heat from large, parallel oven batteries, which behave as low-level buoyant line sources. Because of the parallel-line source configuration, plume rise is enhanced as ambient air is not fully entrained into the plume.” The buoyant line plume model (BLP), which was used in the Residual Risk Assessment, was specifically developed to stimulate the plume rise from multiple line sources subject to downwash. The models used by NYSDEC did not employ enhanced buoyancy calculations.

The modeled and measured inhalation cancer risk estimates were added to assess the total cancer risk associated with exposure to multiple HAPs. The addition of the inhalation cancer risk is a conservative public health approach and was conducted to provide a total estimated inhalation cancer risk for the Study area. An inherent assumption is made that exposure to multiple HAPs results in an additive effect on cancer outcomes and that each HAP has the same cancer endpoint. In addition, all air contaminants with a cancer risk associated with them are based upon the upper-bound excess lifetime cancer risk resulting from continuous exposure to an air contaminant. The USEPA defines the upper bound as “a plausible upper limit to the true value of a quantity. This is usually not a true statistical confidence limit.” The use of an “upper limit” means that the true risk of developing cancer from exposure is not likely to be higher and may be lower than the estimates provided in this study.

The hazard quotient was obtained by combing the hazard index for each of the HAPs. This calculation assumes that each HAP affects the same target organ or organ system. This approach was utilized in this Study to provide a screening-level conservative estimate based for non-cancer effects.

Finally, the model estimates do not account for other sources of exposure such as indoor or occupational and these estimates were not attenuated by time spent at other locations (such as work, school, etc.).

7.4 Assess the Relative Contributions of Various Air Pollution Sources and the Influences of Various Meteorological Parameters

The evaluations conducted in this Subsection were done primarily to support the risk assessment analyses and to identify potential sources, especially for those air contaminants with measured concentrations exceeding NYSDEC's AGCs. As stated previously, increased cancer risk levels greater than one-in-a-million (10^{-6}) or noncancer hazard quotients greater than one usually warrant further evaluation (e.g., the actual vs. potential exposure, "background" exposure contribution, and the strength of the toxicological data) including the need for risk reduction measures depending on where the risk estimate falls. This Subsection includes the full analyses for the following contaminants, which had measured concentrations above these levels during the Study period at one or more of the four air monitors in the Tonawanda area: 1,3-butadiene, acetaldehyde, acrolein, benzene, carbon tetrachloride and formaldehyde. Expanded analyses of additional contaminants that were evaluated for other purposes, such as, in support of discerning point versus mobile sources are provided in appendices. The expanded wind directionality analyses for these additional contaminants are provided in Appendix N.

7.4.1 Methods used to Evaluate the Influence of Wind Direction on the Measured Air Contaminant Concentrations

During the Study period, hourly meteorological measurements (wind speed, wind direction, ambient temperature, relative humidity and barometric pressure) were collected at the BISP site. Although many parameters were collected, wind direction data was initially used to evaluate the air toxic monitoring concentrations and three different approaches were used: polar plots, time-weight pollution concentration roses [Harrison and Williams 1982, Cosemans et. al., 2008], and comparisons of the wind roses for the concentrations equal to or greater than the 90th percentile and equal to or less than the 10th percentile.

For the first approach, polar plots were created by determining the most frequently occurring hourly wind direction for each monitoring day and assigning it to the 24-hr air toxic concentration for that day. Because the direction of wind is highly variable and wind coming from a range of directions may have similar influences on monitoring concentrations, the hourly wind data were assigned to one of sixteen, 22.5 degree arcs. With this approach, each daily air toxic concentration was matched with the most frequently observed wind direction. This information was then plotted for the entire Study period creating a polar plot diagram[27]. The results of this exercise are discussed in further detail in following Subsection.

The predominant wind direction across the 12-month Study period corresponds to the Study design hypothesis – winds are primarily from the southwest direction. Figure 7.10

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[27] Polar plots - the coordinate system for a polar plot is radius length (r) and theta (q). The distance from the origin of the graph is the concentration (r) and wind direction is the angle theta (q) between the positive horizontal axis. The concentration is plotted at the mid-point of each 22.5-degree arc.

shows the wind rose diagram for the BISP monitor over the time period of the Study. The most prevalent wind direction was from the 190 – 260 degree sector (south, south-west to west, south-west). Roughly 45% (about 637 hours out of 1416 total monitoring hours based on a 1-in-6 day schedule) of the time during the Study, the winds came from this direction, resulting in a higher number of data points in these southwest quadrant directions of the polar plots. However, it is not the overall number of data points in any given direction that indicates a local source(s), but rather, elevated measured concentrations that result when the wind is coming from a certain direction. For example, the carbon tetrachloride pollution roses have more data points in the southwest/south, southwest directions but the resulting concentrations when the wind is coming from these directions are very similar to those concentrations that resulted when the wind was blowing from the other directions (Appendix M). Additionally, an absence of data points for any direction simply indicates that this direction was never the most frequently observed wind direction for any of the sampling days over the yearlong Study. Therefore, no determinations about the presence or absence of a local source in that direction can be made. Directionality of the pollution roses resulting from generally higher monitored concentrations when the wind was blowing from a particular direction(s) indicates a local source(s) of this air contaminant influencing the concentrations at the monitor sites from that wind direction(s).

Polar plots were created for all the Category C and B air contaminants and are located in Appendix M. The summaries of the results for those air contaminants which had measured annual concentrations below DEC's health-based guideline concentrations are included in Appendix N. Two sets of diagrams were created for certain air contaminants because the differences between their concentrations at the various monitoring sites were so substantial. The first set uses the same standardized scale for all four monitor diagrams and the second set maximizes the scale of each monitor diagram to more clearly determine source influences.

For the second approach, time-weighted average (TWA) pollution concentration roses were developed by deriving an average concentration for each 22.5 degree wind direction sector[28]. The concentration average for each wind direction sector was derived by this equation:

$$TWMC_i^d = \frac{\sum c_i h_i^d}{\sum h_i^d}$$

Where $TWMC_i^d$ = time-weighted mean concentration during period i in sector d

c_i = 24-hr concentration during period

h_i^d = number of hours during period i that wind is in sector d

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[28] The QAPP states that fixed 30-degree arcs would be used in this analysis. Upon review of the data and graphical output, it was decided that a more refined approach using 22.5 degree arcs would be applied.

The TWA pollution concentration roses allocate the 24-hr monitored concentrations to the percent of time the wind was blowing from each direction during the day. For example, if a 24-hr air toxic concentration was 10 μg/m^3 and the wind was blowing from the southwest 50% of that day, then 5 μg/m^3 would be allocated to the southwest and the remaining 5 μg/m^3 would be apportioned to the remaining wind directions according to percent allocation.

By reviewing many years of historical meteorological data prior to siting the Study monitors, it was noted that the prevailing wind comes from the southwest. Therefore, the Study design involved the placement of one upwind site (BISP) and three downwind sites to evaluate the air mass moving over the industrial area of Tonawanda on the measured monitor concentrations. The GIBI monitor provided measurements of air toxic concentrations in close proximity to the industrial area. When the wind was blowing in the prevailing direction (from the southwest), the measured concentrations were primarily influenced by the industrial area, which would be upwind of the GIBI monitor in this wind scenario, but with little or no influences from the nearby highway(s), which would be downwind of the GIBI monitor. This can then be compared with the measured concentrations that resulted when the wind was coming from the opposite direction (northeast) without the influences from the industrial area but with the influences of the highway(s). Because the BTRS and GIBI monitors are lined up with respect to the industrial area and the prevailing wind direction, the BTRS monitor allowed for the evaluation of the dispersion of the air contaminants in cases where higher concentrations were observed at the GIBI monitor due to local source impacts from the industrial area. Finally, the SPWT site allowed for the evaluation of monitor results when the wind was blowing over the industrial area from the west as opposed to the prevailing wind direction (from the southwest).

The placement of these four monitors surrounding the Tonawanda industrial area only allowed for the evaluation of sources contributing to the measured air toxic concentrations which are located within that industrial area. The pollution roses depicting these TWA concentrations were superimposed over the four monitoring locations on a map of the Study area. The result is a diagram that shows peaks that point towards the direction of a local source(s) which impact the monitoring site. In those instances when the TWA pollution roses for all four monitors point towards the industrial area, vector lines were added that extend out from the monitor locations along the degree sector lines surrounding the portion of the TWA pollution rose that is pointing towards the industrial area. These vector lines backtrack from the monitor to the local source(s) that are influencing the elevated concentrations observed when the wind was blowing from that particular direction. A triangulation process then indicates the location of a primary local source for that particular contaminant by highlighting the area where the four sets of vector lines intersect. There are instances where the TWA pollution roses point in directions other than towards the industrial area but, while these cases will be highlighted, no local source can be indicated because no triangulation with the other monitoring site's results can be accomplished. The vector lines extending out from the different monitors were given more weight for higher monitor concentrations initially and then subsequently by distance if the concentrations at the different monitors were equal.

Only a subset of the air contaminants for which the polar plots were generated have been depicted in this TWA pollution rose fashion. Those air contaminants which had mean concentrations exceeding their representative health-based AGCs are presented in the body of this report. Several others that were of interest for tracing sources are presented in appendices (Appendix N).

The third approach compares wind roses created from the concentration days at and above the 90th percentile (highest 10%) to the wind roses created from the concentration days at and below the 10th percentile (lowest 10%) to observe the different wind directionality patterns (Appendix O). This method provides the truest representation of the wind direction out of the three tools for comparing measured concentrations and wind directionality because the hourly wind data was not manipulated to be compared with the 24-hour air toxic concentrations. A resultant wind direction vector[29] is shown in the wind rose diagrams.

Finally, benzene/toluene ratios were calculated to investigate the relative contributions from the mobile versus non-mobile sources (Bravo, 2002). In many other studies, often investigating urban areas with larger amounts of vehicular traffic relative to the point sources, the emissions from mobile sources tend to dominate the measured and modeled HAP concentrations. In these cases, the influences from the toluene emissions are much greater than those for benzene, and subsequently, the toluene concentrations dominate the ratio resulting in the use of the toluene/benzene ratio (instead of benzene/toluene) in order to present the ratios as whole numbers. The results in Tonawanda were different in that the benzene emissions, and subsequently, the benzene concentrations are very high and thus dominate the ratio. For this reason, the benzene/toluene ratio was used. The normal range for the toluene/benzene ratio is 3-5 (equivalent to benzene/toluene ratios of 0.2-0.33) in areas dominated by influences from mobile sources, such as urban areas, and 1-2 (equivalent to benzene/toluene ratios of 0.5-1) is considered low to very low.

7.4.2 Analyses of Wind Directionality Influences on Measured Concentrations for Air Contaminants Exceeding DEC's AGCs

1,3-Butadiene

1,3-butadiene was classified as either Category C or B at the GIBI and BTRS monitors so polar plots were generated for these sites only (Appendix M). The GIBI and BTRS 1,3-butadiene polar plots indicate directionality to the south-west with only isolated high concentrations in the other directions.

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[29] The definition of the resultant vector as provided by software program used to create the diagrams (Lakes Environmental) is as follows: "The resultant vector is the dominant direction or mean direction of the vectors. This is calculated by computing the vector resultant or vector sum of the unit vectors that represent the various directions in the data. The magnitude of the resultant vector represents the mean resultant vector length. The direction of the resultant vector is a common way to represent the mean wind direction. The magnitude of the resultant vector for the wind rose represents the frequency count for the mean direction."

The 1,3-butadiene TWA pollution roses have a similar profile to those of benzene where vector lines from all four monitoring sites extending through the industrial area intersect in the same vicinity indicating the same source as a major contributor to the airborne concentrations of this contaminant in the area (Figure 7.11). However, because only the GIBI and BTRS monitors were in category C or B, using the data from the BISP and SPWT monitors where it was based on less than 50% above the MDL has more uncertainty associated with it. The differences between the maximum concentrations at the different locations are not nearly as dramatic with 1,3-butadiene as it is with benzene.

The 1,3-butadiene wind roses at the GIBI, BTRS, and BISP monitor locations are similar to benzene in indicating the same predominant source (Appendix N). Both the GIBI and the BTRS sites indicate that the highest concentration days occurred when the winds came predominantly out of the southwest and that winds from this direction were absent on the lowest concentration days. The BISP site indicates that the highest concentrations include winds from the northeast, whereas the lowest concentrations do not include any winds from this direction. The SPWT site differs in that the winds from the direction of the above referenced source are not the dominant directions for the highest concentration days. The top 10% wind rose shows more of an influence from the east to southeast direction, indicating that perhaps the mobile sources from the adjacent road are acting as an influence at this location. There is a substantially higher percentage of calm winds for the highest concentration days as compared to the lowest concentration days (not only at SPWT but also at the other three sites as well) which also could be influencing this observed effect.

Acetaldehyde

The acetaldehyde polar plots only weakly indicate directionality (Appendix M). The GIBI and, to a lesser extent, the BTRS polar plots both indicated a directionality to the south, southwest/southwest (at 202.5-225°) and to the southeast (at 135°). The GIBI polar plot also indicates directionality to the northeast. The BTRS polar plot has one isolated higher concentration point to the west. The SPWT and BISP polar plots do not show any strong directionality but have isolated high points to the southeast and also have slightly elevated concentration points in the southwesterly direction.

Acetaldehyde is another general product of combustion and the TWA pollution roses for acetaldehyde show some similarities to those for formaldehyde (Figure 7.12). All four TWA pollution roses point in the direction of the city of Buffalo to the southeast. The GIBI TWA pollution rose for acetaldehyde points towards the industrial area and also towards the adjacent highways, although not as strongly with formaldehyde. The TWA pollution roses for the other three sites do not show any real directionality other than pointing to the southeast. Overall, the smaller differences between the maximum concentrations at the various monitoring locations indicate that this air contaminant has fewer major point sources and rather has a more widespread emissions profile.

The wind roses analyses for acetaldehyde are discussed with formaldehyde in a subsequent Subsection below because of the similarities between these contaminants (Figures presented in Appendix O).

Acrolein

The acrolein polar plots weakly indicate directionality (Appendix M). The GIBI and BTRS polar plot indicate directionality to the south, southwest/southwest (at 202.5-225°). The GIBI polar plot has one isolated high point to the southeast. The SPWT and BISP polar plots do not show any real directionality.

While acrolein is also another general product of combustion, it appears to be more generally distributed in nature (Figure 7.13). The GIBI TWA pollution rose points to the industrial area, in addition to, the direction of one of the large petroleum storage facilities in the area and the I-190 highway (northwest). There are only slight indications of potential mobile source influences at the three downwind locations. Similar to acetaldehyde, the relatively equal maximum concentrations indicates acrolein emissions from many smaller spread out sources rather than from isolated major point sources.

Again, because the wind roses analyses for acrolein are similar to formaldehyde, these acrolein results are discussed with those for formaldehyde in a subsequent Subsection below (Figures presented in Appendix O).

Benzene

Benzene is one of the contaminants with a wide range of different concentration levels between the various monitoring sites so the polar plots are provided both with a standardized scale across all four sites and with the scale maximized at each monitoring site Appendix M. The benzene polar plots showed strong directionality. The GIBI and BTRS polar plots clearly indicate directionality to the south, southwest/southwest (at 202.5-225°). The SPWT and BISP polar plots both have one isolated higher concentration point directly to the east. The SPWT polar plot shows directionality to the west, while the BISP polar plot shows directionality both to the northeast and to the southwest. Therefore, all four monitors indicated directionality towards the industrial area.

The TWA pollution roses for benzene at all four monitoring sites also primarily point in towards the industrial area (Figure 7.14). Additionally, the maximum benzene concentrations for the TWA pollution roses at all monitoring sites are very different; indicating that combination of the wind direction and vicinity to the source greatly influenced the concentrations measured. The lower benzene concentrations at BTRS are likely due to the contaminant’s dispersion over distance and the lower concentrations at SPWT are likely due to the fact that this is not in line with the prevailing wind direction as it blows over the industrial area. The vector lines extended out from the 22.5° arcs pointing towards the industrial area all intersect in the industrial area. More weight was given to those TWA pollution roses with higher concentrations and which were closer to the industrial area. The circled area in Figure 7.14 where the vector lines intersect indicates the vicinity of a local source(s) influencing the monitored concentrations and is the location of the largest known source of benzene in the area. The GIBI and SPWT, TWA pollution roses also point in other directions in addition to the industrial area. Each of the additional directions appears to follow an adjacent highway or road which indicates influences from mobile sources when the wind is blowing from those directions. One high concentration day when the wind was blowing directly from the east greatly influenced the directionality of the SPWT TWA pollution rose in that direction.

The wind roses for the highest 10% concentration days versus the lowest 10% for benzene clearly indicate that the highest concentrations resulted when the wind blew from the direction of the largest local benzene source to the monitor location and the lowest concentrations occurred when the winds from this direction were absent (Appendix O). The highest 10% concentration days at both the GIBI and BTRS monitors were when wind was primarily out of the southwest, whereas the lowest 10% concentration days at these same two monitors had no winds coming directly out of the southwest. The resultant wind vector for the highest and lowest 10% concentration days was included on the wind roses. The resultant wind vector indicates both the wind direction in degrees and a percentage indicating how representative this wind direction is for the overall wind patterns during that particular time period. The higher resultant wind direction percentages for GIBI and BTRS (54% and 47%, respectively) over the highest 10% concentration days indicate that the resultant wind direction (210° for GIBI and 215° for BTRS) better represents the combined winds for those days as compared to the lowest 10% concentration days. The resultant wind directions and percentages for the lowest 10% concentration days at GIBI and BTRS were 173° at 29% and 268° at 21%, respectively. The wind roses for the SPWT monitor indicate that the winds resulting in the highest 10% concentrations were out of the west, again from the direction where the largest local benzene source is located (resultant vector at 271° for 28%), whereas the winds resulting in the lowest 10% concentrations clearly indicate a lack of winds from the west (resultant vector at 177° for 22%). The wind roses for the BISP monitor indicated that the winds resulting in the highest 10% concentrations were out of the northeast in the direction of the largest local benzene source (the resultant wind vector was at 101° but only with 32%), whereas the winds resulting in the lowest 10% concentrations again clearly indicate a lack of winds from the northeast (resultant vector at 240° for 77%).

Carbon Tetrachloride

Carbon tetrachloride is a chemical that was phased out in January 1996 by the Montreal Protocol. According to the TRI, the last reported emissions in NYS were in 2001. However, it is a chemical that has been reported to have a half-life of 50 years or more, so it will remain a ubiquitously distributed airborne contaminant for many years to come.

The carbon tetrachloride polar plots did not show any evidence of directionality at any of the four air monitoring sites and a relatively narrow range of concentrations is seen in the diagrams (Appendix M). This indicates that there are no local sources of this air contaminant and the air contaminant concentration is at background level.

The TWA pollution roses for carbon tetrachloride at all four monitoring sites clearly indicate that there is no directionality to the influences resulting in the monitored concentrations (Figure 7.15). Further support of this arises from the equal maximum concentrations at all four locations.

The carbon tetrachloride wind roses do not show any indications of a local source or any influences from the industrial area (Appendix O). Additionally, both the top 10% and the bottom 10% wind roses look similar across all four monitoring sites, with the exception of the missing southwest degree sector in the highest 10% wind rose at the GIBI monitor. All the wind roses except the GIBI highest 10% indicate that wind patterns resulting in either the highest or lowest concentration days simply resemble the general prevailing wind patterns for this area.

Formaldehyde

Formaldehyde also had substantially different concentrations between monitoring locations, and therefore, the polar plots are provided with both standardized and maximized scales (Appendix M). The formaldehyde polar plots do indicate some directionality, but less strongly than with benzene. All four sites indicate directionality to the south, southwest/southwest (at 202.5-225°), but also from several other directions as well. Three of the four sites (GIBI, SPWT, and BISP) also indicate directionality to the northeast. The GIBI polar plot has one isolated high point to the west, northwest. The BTRS polar plot has one isolated higher concentration point directly to the west and also shows slight directionality to the southeast. The SPWT polar plot has isolated high points to the south and southeast. The BISP polar plot has one isolated higher concentration point directly to the south and also indicates directionality to the southeast.

The TWA pollution roses for formaldehyde, which is a general product of combustion, do not clearly indicate a prevailing source in the Tonawanda industrial area (Figure 7.16). However, the differences in the concentrations between the various monitoring sites indicate that local sources are influencing the GIBI monitor more than any of the other three locations. The closest monitoring site, GIBI, does point towards the industrial area, in addition to, pointing along the two major highways adjacent to it. This indicates that this product of combustion is coming both from point and mobile sources in the area. It appears that the formaldehyde concentrations at the other three monitors have greater influences from the direction of the city of Buffalo (from the southeast), and so, are influenced by the local source contribution to a lesser degree. The BISP TWA pollution rose also points in towards the industrial area and the SPWT and BTRS TWA pollution roses indicate some additional minor sources, in some cases also towards roads indicating mobile source influences.

The wind roses for formaldehyde and acetaldehyde are similar, and neither these nor those for acrolein provide strong indications of a large point source in the area as those for benzene did (Appendix O). There are many point sources, as well as, widespread mobile sources of combustion products like formaldehyde, acetaldehyde, and acrolein. The wind roses for formaldehyde, acetaldehyde, and acrolein were unlike those for benzene in that they did not consistently indicate that winds blowing from the industrial area to the monitor resulted in the highest 10% concentration days and an absence of those same direction winds resulted in the lowest 10% concentration days. Both the highest and lowest 10% concentration day wind roses for all three of these contaminants at all four monitoring locations indicate one or more of the three primary wind degree sectors from the southwest. The remaining wind directions observed do not consistently point toward the industrial area or to a common source. The GIBI highest concentration days do indicate more winds from the south, southwest and southwest (the direction of the industrial area) than the GIBI lowest concentration days for all three contaminants. Only the acrolein wind roses at the BTRS show this. In addition to the lack of an indication of a predominant source in the industrial area, formaldehyde and acetaldehyde at the BTRS also indicate wind patterns that are spread out over more wind directions. The wind roses for SPWT for all three contaminants indicate the reverse of what would be expected if the predominant source was within the industrial area because there are more winds from the westerly direction for the lowest 10% as compared to the highest 10% concentration days. The BISP wind roses also did not indicate any influences from within the industrial area. There are a substantially higher percentage of calm winds for the highest concentration days as compared to the lowest concentration days at all four sites for formaldehyde, acetaldehyde, and acrolein which also could be influencing the differences in concentrations observed.

7.4.3 Upwind versus Downwind Analyses of Measured Air Contaminant Concentrations

By study design, three monitors have been placed in line with the predominant southwest wind direction, which allowed for further evaluation of wind directionality influences. Previous analyses clearly indicated a wind directionality influence on the benzene concentration measured, with the highest concentrations resulting when the wind lined up the largest local benzene source with each of the monitors. The analyses presented in this Subsection further expand on that and evaluate the concentration differences with opposing wind directions which place these three in-line monitors in both upwind and downwind situations. Because there were also indications that this facility and/or a culmination of combustion sources (stationary and mobile) in the Tonawanda industrial area were influencing the concentrations of additional combustion air contaminants at the monitors, several other contaminants were included in the analyses. Due to the differences in average concentrations, three different scale graphs were generated so the trends could be more easily observed. The days were isolated when the most frequent wind direction was from directly out of the southwest (from 225°) lining up the traditionally upwind monitor (BISP) with the largest local benzene source and the industrial area, then the GIBI monitor, and finally the BTRS monitor. This analysis indicated that the average concentrations of all the air contaminants except carbon tetrachloride increased from BISP to GIBI and then decreased from GIBI to BTRS (Figure 7.17). The carbon tetrachloride average concentrations remained relatively constant from one monitoring location to the next. Benzene had by far the largest percent increase from the upwind site to both of these downwind sites with a greater than 2,000% increase at GIBI (compared to the next highest percent increase of just under a 450% increase for m,p-xylene) and an almost 450% increase at BTRS (compared to the next highest percent increase of almost a 250% increase for toluene). Benzene also had the largest percent decrease from the highest average concentrations seen at the GIBI monitor to the reduced average concentrations seen at the BTRS monitor. The average benzene concentration at BTRS was roughly 21% of the GIBI average concentration, compared to the next largest percent decrease (for formaldehyde) which had a BTRS average concentration that was roughly 37% of the GIBI average concentration.

A similar analysis was then conducted using those days when the wind direction was in the opposite direction, out of the northeast (from 45°), to validate the previous findings. This scenario places the BTRS monitor upwind, followed by the GIBI monitor (which would be after the I-190 interstate but just before the largest local benzene source and industrial area), and finally the BISP monitor would become the downwind site in reference to the industrial area (Figure 7.18). The findings were interesting because the benzene concentrations increased both from those measured at the BTRS monitor to those at the GIBI site and also from those at the GIBI site to those at the BISP site. The average concentrations for all of the other nine air contaminants analyzed, except for carbon tetrachloride, increased in the vicinity of the industrial area at the GIBI monitor but did not increase further after the winds passed over the industrial area and reached the BISP monitor, as those for benzene did. Additionally, the initial increase of benzene from the BTRS monitor to the GIBI monitor was among the smallest of all the contaminants (only carbon tetrachloride and two other contaminants, out of the nine investigated, had smaller percent increases) before the winds reached the industrial area. However, the overall increase in benzene concentrations from the BTRS monitor to the BISP monitor was the largest out of all the air contaminants analyzed (almost a 300% increase for benzene and a roughly 200% increase for the next largest percent increase which was with formaldehyde). Carbon tetrachloride showed very little difference in average concentrations measured across the three monitoring sites.

A line graph showing all the individual days when the winds were blowing over the Study area from the southwest (225°) shows that the concentrations are low at the upwind site (BISP), peak at the GIBI monitor (after the winds have traveled over the largest local benzene source and industrial area), and have decreased away from this source at the BTRS monitor likely due to dispersion (Figure 7.19). The average wind speed for each of the days is included alongside the date. The two days with the highest increased concentration at the GIBI monitor had the second and third highest wind speeds. However, the highest wind speed day (which was roughly 44% and 56% higher than the second and third highest, respectively) only resulted in an increased concentration at the GIBI monitor that was in the middle of the range, potentially indicating increased dispersion. The subsequent change in concentration from the GIBI monitor to the BTRS monitor indicated that the two highest wind speed days resulted in the largest two percentage decreases, again potentially indicating that the higher wind speeds result in greater dispersion.

Scatter plots were generated to compare the benzene, toluene, and 1,3-butadiene concentrations at the GIBI monitor when the winds were coming from the southwest (202.5°-247.5°) versus when they were coming from the northeast (22.5°-67.5°) (Figures 7.4.20-22). The scatter plot with benzene and toluene indicates that when the winds were coming out of the northeast the benzene concentrations were primarily very low but the toluene concentrations were across the full range of concentrations (with the slight majority near the high end of the concentration range). Whereas when the winds were out of the southwest, the highest benzene concentrations were observed but the toluene concentrations remained consistent to what was observed in the opposite wind direction (Figure 7.20). The scatter plot with 1,3-butadiene and toluene indicates that 1,3-butadiene acts similarly to benzene in that the lowest concentrations were measured when the winds were out of the northeast and the highest primarily were when the winds were out of the southwest (Figure 7.21). The scatter plot with benzene and 1,3-butadiene figure clearly shows the similar influence(s) for these two contaminant concentrations when the winds were out of the southwest versus the northeast (Figure 7.22). The wind rose for the one outlier is provided to show that, although the most frequently observed wind direction for that day was from the northeast, there were several wind directions coming from the southwest direction that combined would total a greater percentage than the one northeast degree sector. This illustrates the limitation of assigning one wind direction sector to represent the overall movement of air mass throughout the day (Figure 7.23).

7.4.4 Background versus Local Source Analyses of Air Contaminants

The following background analysis investigating the spatial variation from downwind to upwind used ratio cut points that were applied previously in a study of air toxics in Alleghany County, PA (Carnegie Mellon University, 2009). This investigative technique was used to determine whether contaminant concentrations can be attributed primarily to regional influences or to local source contributions. The following thresholds were developed in the Alleghany County Study based on changes in the downwind to upwind concentration:

1) ≤ 25% increase indicates regional background contaminant.
2) > 25% to < 200% increase indicates moderate effects of local sources.
3) >200% increase indicates strong effects of local sources.

Initially, the annual mean of the contaminants were used to derive the ratios. Then, a refined analysis of the estimated background concentration, without the predicted impacts from the industrial area influencing the upwind monitor, was performed for a subset of the air contaminants. The difference between the mean concentration for the three downwind sites (GIBI, BTRS, and SPWT) and the upwind site (BISP) (Figure 7.24) are:

CONTAMINANT	GIBI	BTRS	SPWT
1,3-BUTADIENE	+ 370%	+ 36%	+ 21%
ACROLEIN	+ 34%	+ 4%	+ 7%
ACETALDEHYDE	+ 44%	+ 22%	+ 11%
BENZENE	+ 790%	+ 61%	+ 8%
BENZENE/TOLUENE RATIO	+ 330%	+ 23%	- 14%
CARBON DISULFIDE	+ 44%	+ 24%	+ 250%
CARBON TETRACHLORIDE	- 2%	- 1%	- 1%
FORMALDEHYDE	+ 240%	- 7%	- 23%

When the annual mean BISP average was used as the background, the contaminants that are indicated to have experienced strong local source effects are: benzene, formaldehyde, 1,3-butadiene, as well as, the benzene/toluene ratio at the GIBI monitor and carbon disulfide at the SPWT monitor. Those that are indicated to have experienced moderate local source effects are acetaldehyde, acrolein, and carbon disulfide at the GIBI monitor and benzene and 1,3-butadiene at the BTRS monitor. Except for carbon disulfide, there were no contaminants at the SPWT monitor that are indicated to have experienced any local source effects when the annual mean for BISP was used as the background. Because the reported monitoring results for 1,3-butadiene were below the MDL more than 50% of the time at the BISP and SPWT monitors, the 1,3-butadiene downwind to upwind ratios have more uncertainty associated with them.

An additional background analysis was performed because the previous analyses have indicated that the BISP upwind site is influenced from the sources in the industrial area and therefore cannot be considered truly representative of regional background levels. The concentrations were organized in descending order to initially observe which ones appeared to be part of a continuous range, as opposed to, which ones appeared to be outliers. Then the background cut points chosen were placed on the temporal trend graph for the various contaminants to determine if these cut points were appropriate for separating the apparent background from the local source impacted concentration spikes. Finally, the estimated background from this trends analysis was compared to the mean concentrations for the contaminant during those days when the predominant wind was directly out of the southwest (from 225°) and a second downwind to upwind ratio was calculated. In all cases where the trends background analysis was done, this background was lower that the mean BISP concentration when the predominant wind was from 225°. These results indicate that there may still be some source(s) influencing the BISP monitor from the southwest direction as well. Or that the BISP monitor is close enough to the industrial area sources to be influenced on low average wind speed days/days with a high percentage of calm winds by the general spread of the contaminant over the area (even if the wind is from the predominant 225° direction). Additionally, as was seen previously, even if the predominant wind direction is from one degree sector, there can be a higher percentage of winds over a few adjacent wind degree sectors coming from a different general direction. For example, the percentage of winds from 225° might only be 28% but the winds from the north, northeast, the northeast, and the east, northeast might be 24% each, respectively, for a total of 72%. The concentration for this day would be placed into the 225° sector although the overall majority of the winds are generally coming from the opposite direction (northeast) with more variation across these wind sectors.

For the following analysis, it is important to note that the trends background concentration provided is the average for only the concentrations below the cut point indicated in the associated graphs.

For benzene, the trends analysis indicated a BISP background concentration of 0.64 $\mu g/m^3$ (Figure 7.25 and 7.26), as compared to the 225° BISP concentration of 1.0 $\mu g/m^3$, the BISP annual mean of 1.2 $\mu g/m^3$, and a NATA 2002 background of 0.703 $\mu g/m^3$.

Using the roughly 49% lower trends background approximately doubled the ratios to 1,540%, 310%, and 210% increases at the GIBI, BTRS, and SPWT monitors, respectively. Therefore, all three downwind monitors would be considered to have experienced strong local source effects for benzene when this trends analysis background level is used.

For formaldehyde, the trends analysis indicated a BISP background concentration of 1.4 $\mu g/m^3$ (Figure 7.27 and 7.28), as compared to the 225° BISP concentration of 2.3 $\mu g/m^3$, the BISP annual mean of 2.5 $\mu g/m^3$, and a NATA 2002 background of 1.25 $\mu g/m^3$. Using the roughly 44% lower trends background increased the ratios to 420%, 64%, and 37% increases at the GIBI, BTRS, and SPWT monitors, respectively. Therefore, the BTRS and SPWT monitors would be considered to have experienced moderate local source effects for formaldehyde when this trends analysis background level is used.

For acetaldehyde, the trends analysis indicated a BISP background concentration of 0.75 $\mu g/m^3$ (Figure 7.29 and 7.30), as compared to the 225° BISP concentration of 0.80 $\mu g/m^3$, the BISP annual mean of 0.90 $\mu g/m^3$, and a NATA 2002 background of 0.9 $\mu g/m^3$. Using the roughly 17% lower trends background increased the ratios to 80%, 42%, and 37% increases at the GIBI, BTRS, and SPWT monitors, respectively. Therefore, all three downwind monitors would be considered to have experienced moderate local source effects for acetaldehyde when this trends analysis background level is used.

For carbon disulfide, the trends analysis indicated a BISP background concentration of 0.14 $\mu g/m^3$ (Figure 7.31 and 7.32), as compared to the 225° BISP concentration of 0.21 $\mu g/m^3$, and the BISP annual mean of 0.77 $\mu g/m^3$ (there was no NATA 2002 background). Using the roughly 82% lower trends background increased the ratios to 820%, 700%, and 1,420% increases at the GIBI, BTRS, and SPWT monitors, respectively. Therefore, all three downwind monitors would be considered to have experienced strong local source effects for carbon disulfide when this trends analysis background level is used. Even when the 225° BISP concentration (which is roughly 73% lower than the full BISP annual mean) was used, the ratios increased to 530%, 450%, and 910% increases at the GIBI, BTRS, and SPWT monitors, respectively. As stated previously, this would result in all three downwind monitors being considered to have experienced strong local source effects for carbon disulfide.

The acrolein trends BISP background was 94% of the BISP annual mean so it did not change the ratios enough to change their categories for local source impacted. The carbon tetrachloride trends background showed even less change.

For the benzene/toluene ratio, no trends analysis was performed but the 225° BISP concentration was just low enough to change the ratio at the BTRS monitor to a 27% increase over the upwind BISP monitor resulting in it being classified as moderately impacted by local sources as opposed to regional background when the BISP annual means were used.

7.4.5 Analyses Summaries for Wind Speeds and Temperature/Seasonality Influences on Measured Air Contaminant Concentrations

Other meteorological parameter variables (e.g. wind speed, temperature) were investigated to evaluate influences on the monitored concentrations. Similar to wind directionality, the data for these other variables was dichotomized into the highest and lowest 10, 20, or 30% to compare the two extremes and observe the differences between each. Only summaries of these analyses are provided here but the full analyses are included in Appendix P.

The analyses of wind speeds indicated that the concentrations for the following contaminants showed the strongest overall correlations with average wind speed: 1,3-butadiene, acetaldehyde, acrolein, carbon disulfide, formaldehyde, and toluene. The measured concentrations for these contaminants increased with lower average wind speeds. Wind speed did not appear to influence the measured concentrations of benzene or carbon tetrachloride. Finally, the benzene/toluene ratio showed the reverse relationship indicating a direct correlation between the wind speeds and the measured concentrations because of the large differences in toluene but very little difference with benzene.

The temperature/seasonality analyses indicated that the concentrations for the following contaminants showed the strongest overall correlations with average temperature: 1,3-butadiene, carbon disulfide, and formaldehyde. These contaminants also had the largest concentration increases in the summer months as compared to the winter months. However, the monthly trends do not indicate that same correlation with temperature for either 1,3-butadiene or carbon disulfide. The monthly 1,3-butadiene concentrations appear to correlate with the benzene concentrations and similarly do not appear to have any meaningful monthly trends over the year. Indications are that benzene, and 1,3-butadiene to a lesser extent, are dominated more by influences from local point source(s) resulting from the wind directionality (carrying the wind mass from the point source(s) to the various monitors), as compared to, influences from the wind speeds or temperature fluctuations. The indications of a correlation between the 1,3-butadiene concentration and temperature fluctuations could be due to the lower overall emissions and subsequent concentration levels of 1,3-butadiene, as compared to benzene, which does not mask the effect of these underlying influences to the same extent. The same situation might exist with carbon disulfide because there is a predominant source in the industrial area but it is well controlled resulting in lower emissions and subsequent concentrations potentially allowing the underlying effects from temperature fluctuation influences to be observed. Acrolein, toluene, and acetaldehyde concentrations also appeared to be influenced by temperature fluctuations, as observed both through the direct temperature correlations and the summer to winter concentration differences, but to a lesser extent. The monthly trends provide indications of concentration correlations with temperature fluctuations most strongly for acrolein, followed by formaldehyde and then acetaldehyde with the two aldehydes following similar monthly trends. The monthly trends for toluene also provide indications of concentration correlations with temperature fluctuations with a few exceptions, but carbon tetrachloride shows very little monthly average concentration variability. The average monthly benzene/toluene ratio trend appears to be dominated by the benzene fluctuations resulting in a lack of a meaningful trend. Both benzene and carbon tetrachloride show very little difference between the summer and winter average concentrations and carbon tetrachloride also does not show any direct correlation with temperature. The benzene concentrations were elevated with the higher temperatures versus the lower temperatures, but the percent difference between the two extremes is the lowest out of all nine contaminants analyzed except carbon tetrachloride. Because of the relative differences for benzene and toluene described above, the benzene/toluene ratio showed an opposite relationship with temperature/seasonality as the majority of the other contaminants. The benzene/toluene ratios were increased with the higher temperatures/summer as compared to the lower temperatures/winter.

7.4.6 Analyses Summaries for Day of the Week/Weekday Versus Weekend Trends and Individual Measured Concentrations Trends including Correlating Contaminants

Only summaries of these analyses are provided here but the full analyses are included in Appendix Q. Additionally, these analyses for the benzene/toluene ratio and those measured air contaminants that were below the NYSDEC's AGCs are not summarized in this subsection and are only provided in Appendix Q.

Acrolein and toluene concentrations increase during the weekdays and have the lowest concentrations on Saturday and Sunday and therefore have among the highest percentage increases in weekday concentrations as compared to weekend concentrations. Acetaldehyde had the lowest average concentration on Saturday and the third lowest on Sunday (after Wednesday) so it too had among the highest percentage increases in weekday concentrations as compared to weekend concentrations. The day of the week trends for 1,3-butadiene, benzene, benzene/toluene ratio, carbon disulfide, and formaldehyde do not show any meaningful trends and can be explained by the wind directionality variations. Benzene apparently dominated the influences on the benzene/toluene ratio because it followed the benzene concentration day of the week trend. 1,3-Butadiene also had a trend that was very similar to benzene but did have lower average concentrations on Saturday and Sunday. This resulted in 1,3-butadiene having a lower average concentration for the weekend versus the weekdays, whereas the weekday and weekend concentrations of benzene showed very little difference to one another. Again, this appears to be due to the much higher benzene emissions (and therefore ambient air concentrations) potentially masking any underlying effects observed for the similarly fluctuating 1,3-butadiene, which appears to be generated primarily from the same dominating benzene source. The weekday and weekend concentrations for carbon disulfide and formaldehyde showed very little difference to one another. Because there was a substantially lower average toluene concentration on the weekends as compared to the weekdays with little difference in benzene concentrations, the benzene/toluene ratio was substantially increased on the weekends as compared to the weekdays. The carbon tetrachloride concentrations vary very little for the different days of the week and therefore also differ very little in weekday and weekend average concentrations.

Only the two monitors that were lined up with respect to the largest benzene source had benzene and 1,3-butadiene concentrations which tracked similarly to one another, indicating that the wind directionality and local source emissions are primarily driving the measured concentrations. However, there are indications that wind speed is an underlying influence, but its effects on the benzene concentrations are mostly masked by the wind directionality influences. 1,3-Butadiene shows stronger indications of wind speed influences affecting the measured concentrations. The benzene and 1,3-butadiene concentration trendlines also track very similarly to one another indicating a common source. The individual monitored concentration data points trendline for benzene and 1,3-butadiene did not indicate strong correlations with either average temperature or average wind speeds.

The acrolein concentration trendlines for the different monitors show more variability, potentially indicating that there are more numerous smaller and widespread sources in the area. This, along with the higher reactivity including secondary atmospheric formation and breakdown of acrolein, resulted in the observed variability. The analyses of the individual data point trendlines supports the previous analyses results indicating correlations of the acrolein concentrations with both wind speeds and temperature. Both wind speed and temperature, in conjunction with solar radiation (not measured in this Study) can play a role in these secondary atmospheric reactions.

The formaldehyde and acetaldehyde concentration trendlines track very similarly to one another indicating a common source, but the analyses indicated a lack of a strong influence from wind directionality suggesting direct effects from a local source. However, these carbonyls can form through secondary atmospheric formations so the indications of local source effects could be arising from the emissions of precursors that then lead to increases in ambient air concentrations. The analyses of the individual data point trendlines supports the previous analyses results indicating correlations of the formaldehyde and acetaldehyde concentrations with both wind speeds and temperature.

The carbon tetrachloride concentration trendlines at all four monitors track very closely to one another and the concentration range is tight both indicating that this air contaminant is a background issue being regionally transported into the Tonawanda area. The trendline for the individual monitored concentration data points of carbon tetrachloride did not indicate correlations with either average temperature or average wind speeds.

7.4.7 Analyses of Criteria Pollutants

As discussed previously, CO and SO2 Study monitoring concentrations were below comparable NAAQS, while the $PM_{2.5}$ Study monitoring concentrations were similar to concentrations obtained at nearby monitors. However, an evaluation of temporal and spatial trends, along with correlation with various meteorological parameters, was conducted.

The full analyses for $PM_{2.5}$ are provided in this subsection. The remaining analyses for CO and SO_2 are provided in Appendix R.

$PM_{2.5}$ was measured at all four monitoring sites, so this was the only criteria pollutant for which the concentration trendlines at all four monitors could be compared to investigate potential correlations. The trendlines of average daily concentrations at all four monitoring sites track together almost exactly, indicating that it is either a regionally transported background contaminant or that the concentrations measured are driven more by another meteorological variable such as wind speed rather than by wind directionality (Figures 7.33-34). An analysis was conducted with the full set of data and for illustration purposes a subset of the data (first two months) has been provided to better visualize potential weekly trends (Figure 7.34). The day of the week rather than the date is shown on the 2-month graph, so potential weekly/day of the week trends can also be observed. As illustrated, there is no strong overall weekly trend or day of the week effect although there are some indications that the $PM_{2.5}$ concentrations might be slightly lower over the weekends.

The Study monitoring 12-month $PM_{2.5}$ averages were 11, 13, 13 and 11 $\mu g/m^3$ for the BISP, BTRS, GIBI and SPWT monitors, respectively. It is interesting to note that the two monitors that were directly downwind of the industrial area and adjacent to (GIBI) or downwind of (BTRS) the highway (with winds from the prevailing southwest direction) had the highest annual average concentrations. Additionally, the third downwind monitor (but which was not sited along that same prevailing wind direction), SPWT, had the next highest annual average concentration, and the upwind monitor, BISP, had the lowest. This was also the most commonly observed ranking of the monitoring sites seen with the average daily concentrations (Figures 7.33-34), which indicate minor contributions to the measured concentrations of $PM_{2.5}$ from sources in the industrial area.

To further investigate the potential presence of any weekly/day of the week trends, all the concentrations for each of the individual days of the week were averaged together and these pooled averages are graphically presented. While all three criteria pollutants had higher concentration averages for the five weekdays combined as compared to the two weekend days combined (Figures 7.35-37), none were substantially different (SO_2 +21%, Combined $PM_{2.5}$ +13%, and CO +8%). The $PM_{2.5}$ concentrations at all four monitors increased slightly on Friday before decreasing over the weekend and increasing on Monday (Figure 7.35). Another point of interest is that the three downwind monitors again consistently measured higher $PM_{2.5}$ concentrations than the upwind monitor. Comparing the $PM_{2.5}$ concentration averages for the full year at the three downwind monitors versus the upwind monitor, indicated an 18% increase at the BTRS monitor, a 16% increase at the GIBI monitor, and a 4% increase at the SPWT monitor. This indicates that there are primary (release of $PM_{2.5}$ from nearby sources) or secondary (release of $PM_{2.5}$ precursors) influencing the downwind monitor concentrations. However, when these increases are compared to the increases for those of a point source driven contaminant like benzene (which had downwind concentration increases of 2,000% at the GIBI monitor and 450% at the BTRS monitor), the increases in $PM_{2.5}$ do not appear to be substantial. In fact, the percent difference between the BISP monitor (which was the upwind site for almost half of the time over the Study year) and the downwind monitors indicates that roughly 80% or more of the $PM_{2.5}$ concentration could be from regional background. This could mask most of the underlying influences. Given the correlation of individual trendlines at all four monitors but with consistently higher concentrations at the downwind monitors versus the upwind monitor, it appears as if these primary and/or secondary emissions from the industrial area along with the right meteorological conditions (such as low wind speed/high calms percentage days) could be influencing the measured concentrations. This meteorological situation would result in stagnant air leading to the temporal variations in $PM_{2.5}$ concentrations observed. No indications of a relationship between wind speeds and $PM_{2.5}$ concentrations were observed using either the daily or the hourly average wind speeds (data not shown). However, before determining that it appeared the similar trendlines between the four monitoring sites was almost entirely due to the regional drift of $PM_{2.5}$ into the area, a potential correlation between temperature and $PM_{2.5}$ concentrations was also investigated. It was surprising to find a strong positive correlation between the short-term changes in short-term (daily) average temperature over consecutive sampling events and the changes in daily $PM_{2.5}$ concentrations (Figures 7.38). However, the mechanism driving this relationship is not understood and a correlation between the long-term temperature trend and the measured $PM_{2.5}$ concentrations does not exist.

No meaningful trends were apparent for $PM_{2.5}$ measured concentration using either monthly and weekly time frames, so only the monthly averages are presented here (Figures 7.39).

Because the criteria pollutants are measured as 1-hour average concentrations, this allowed for an investigation of hourly trends. The individual daily $PM_{2.5}$ trends (2 weeks worth of which is shown in Figure 7.40) do not indicate any apparent meaningful trend(s). Figure 7.40 was generated from the GIBI monitoring concentrations data, but the same lack of any meaningful trends was observed with the concentration data from the other three monitors (data not shown). However, after the short-term influences from the hourly variations in meteorological conditions are diminished by pooling 6 months worth of data into combined concentrations, the underlying trends could be observed Only 6 months of data being pooled into each hour of the combined time of day averages was needed to bring out these hourly trends. The $PM_{2.5}$ trendline showed an increase in concentration starting midday and continuing into the evening before leveling off until the night time hours when the concentrations then began to steadily fall until they leveled off again in the morning hours (Figure 7.41). While all four monitors show this same general trend, the trendline for the monitor that is the farthest distance from the industrial area, BTRS, seems to have a lag time as compared to the trendlines of the other three monitors.

Several individual days with different wind directionality patterns across all four monitoring sites were subsequently investigated and it was observed that the concentration influences at the BTRS monitor had a lag time of one to two hours when compared to the other monitors (GIBI, SPWT, and BISP). This effect was found to be independent of wind direction (Figure 7.42-44). These results suggest that $PM_{2.5}$ sources in the area influence local monitor concentrations, albeit only incrementally, as illustrated in concentration fluctuations between the monitor that is located the farthest away from the industrial area (BTRS) and the other monitors. The lag time in the concentration fluctuations (apparently due to influences of sources in the industrial area) between the closer monitors and farthest monitor are understandable when the wind is blowing in the prevailing southwest direction (Figure 7.42), because the BTRS site would be the last to be affected by the windblown $PM_{2.5}$. Although, when the fluctuations at the upwind BISP monitor and at the GIBI and SPWT downwind monitors track together, the $PM_{2.5}$ dispersion appears to be traveling out in all directions, including opposite to the wind direction which appears to be counter intuitive. This lag time can also be explained when there is a high percentage of calm/low winds (Figure 7.43), because then the $PM_{2.5}$ would be expected to be able to spread out over the entire Study area influencing the closest monitors first and then the farthest monitor. What is not understood is how this same lag time is observed when the wind is blowing from the northeast (in the direction opposite to that which would transport $PM_{2.5}$ emissions from sources in the industrial area to the BTRS monitor) (Figure 7.44), again because the $PM_{2.5}$ dispersion appears to be traveling out in all directions including opposite to the wind direction.

7.4.8 Limitations

Three different methods were applied to evaluate the influence of meteorological information on the monitored concentrations, since a limitation of the study is the collection of air toxic concentrations over a 24-hour average and the collection of meteorological information (especially wind direction) on an hourly basis. The two methods, polar plots and time-weight average (TWA) pollutant roses, introduced some uncertainty in the analysis.

In the creation of the polar plots, each daily air toxic concentration was matched with the most frequently observed, hourly wind direction for the day. This exercise assumes that the assignment of one wind direction to the concentration is the best representation of the wind influence for the day. It has certain advantages over selecting the resultant wind direction which may, in some cases, indicate a direction the wind never came from for a particular day. When there are numerous data points in a wind direction, it can create a graphical illusion of an influence from a particular direction although the measured concentration may not be elevated.

The TWA pollutant roses allocate the 24-hr monitored concentrations to the percent of time the wind blows from each direction during the day. The TWA pollutant roses can be influenced by days with high concentrations and wind directions with limited number of hours. Our research did not adjust for these biases whereas others (Harrison and Williams 1982, Cosemans et. al., 2008) apply formulaic approaches to reduce the outlier and limited data influence.

For some of the air toxics, the comparison of these two constructs provides conflicting information. For example, the polar plot for formaldehyde at the GIBI monitor indicates sources in the southwest and northeast directions. Whereas, the TWA pollutant rose suggests greater influences from sources northwest (along the I-190 thruway) and northeast directions. In contrast, the results for benzene at the GIBI monitor indicate a source in the southwest direction for both the polar plot and TWA pollutant rose diagrams.

These two constructs in conjunction with other pieces of information, such as emissions from facilities, were used in this Study to indicate the location of potential sources.

An implicit assumption with pollution roses is that the wind measured is identical to the transport wind from the source to the monitor site. Pollutant releases from tall stacks leads to different trajectories than near ground sources. Additionally, trajectories can vary during unusual wind patterns (such as veering and backing wind) (Cosemans et. al., 2008).

Finally, the Study design only allows for the triangulation of sources within the perimeter of the four monitors

8. Source Identification

Within the Study area, there are a variety of sources releasing air toxics. This section will focus on the HAPs exceeding NYSDEC's annual guideline concentrations (AGCs). At all four monitoring sites, the ambient concentrations of acetaldehyde, acrolein, benzene, carbon tetrachloride, and formaldehyde were above their respective AGCs. At two monitoring sites (GIBI and BTRS), ambient concentrations of 1, 3-butadiene were detected above the AGC. For the HAPs monitored in this Study, there are direct emissions of these HAPs, as well as, the secondary atmospheric formation for a subset of these HAPs.

All the HAPs exceeding the AGC, with the exception of carbon tetrachloride, are fossil fuel combustion by-products. Emissions of 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde are all associated with the combustion of fuel by motor vehicles and the combustion of fuels for electricity, industrial processes, and residential space heating. In addition to combustion by-products, these HAPs are used as chemical intermediates in the production of plastics, organic chemicals, solvents, and other consumer products. Three of the HAPs (acetaldehyde, acrolein, and formaldehyde) also are formed during the breakdown of other organic chemicals within the atmosphere by a process known as photochemical oxidation (e.g. breakdown by sunlight and reactions with ozone, hydroxyl, and nitrate radicals). For example, the formation of acrolein and formaldehyde is associated with the photochemical oxidation of 1, 3-butadiene.

The multiple sources and secondary formation of these HAPs make source identification very difficult. However, by combining the following factors: 1) point and mobile source inventory; 2) the statistical analysis of the monitored data; and 3) the investigation of wind direction, wind speed and other potential influences; the NYSDEC attempted to establish a profile of contributing sources to a particular monitor or series of monitors.

1, 3-Butadiene

Emissions

1, 3-Butadiene (butadiene) is released from both stationary and mobile sources. Ambient concentrations of butadiene are primarily associated with mobile source emissions, unless there are large stationary sources using it to produce synthetic rubber or plastics. In the atmosphere, butadiene is expected to undergo rapid destruction via photochemical reactions, with a reported half-life of 1 to 9 hours. It has been shown to be short-lived in the presence of sunlight and free radicals (USEPA, 2002d).

The 2002 NATA emission inventory for Erie County shows that mobile source emissions account for 99.3% of the reported annual 85 tons per year. NATA reports 34 pounds per year from major point sources and 1000 pounds per year from area sources in Erie County. The Tonawanda Study's emissions inventory data documents 40 pounds per year from Tonawanda Coke Corporation and 52 pounds per year from Tonawanda Goodyear. The largest reported source in the inventory, at 140 pounds per year, is Valley Retread Corp. which is located on corner of Sawyer Ave and Kenmore Ave and currently holds a Registration Certificate. Mobile source emissions in the Study area were calculated to be approximately 1500 pounds per year. Based upon the Study's inventory data, NATA's major point source approximation is underestimated.

Source Identification

The measured concentrations of butadiene are categorized as Category C pollutants at only the GIBI and BTRS monitors. The concentration difference between the two sites is statistically significant using a Tukey test performed for log-transformed data and the geometric means. This indicates that the GIBI monitoring site is detecting a greater concentration for butadiene than the downwind BTRS site. The possible reason for this finding is that the emissions from mobile sources on Interstate 290 and the Tonawanda Coke Corporation will dissipate with distance as the air mass moves toward BTRS. Butadiene is a highly reactive HAP and will decay rapidly under certain conditions, so it is not transported very far from the emission source.

The two tools used for wind analysis in the Study report; polar plots and time-weighted average (TWA) pollution concentration roses (see section 7.4) were invaluable to assess the emission patterns of butadiene. The butadiene polar plots for the GIBI and BTRS monitoring sites indicate directionality to the south-west with only isolated high concentrations in the other directions (Appendix M). The butadiene TWA pollution roses have a similar profile to those of benzene where the vector lines from all four monitoring sites extend through the industrial area and intersect in the same vicinity similar to the airborne concentrations of benzene (Figure 7.14). Under several analyses performed in Section 7.4, benzene and butadiene track similarly to one another (similar timing of the concentration increases and decreases). These trend correlations indicate that the mobile source sector and/or point source sector emissions are coming from the same location. The results for butadiene were detected in less than 50% of the monitoring samples at the BISP and SPWT monitoring sites.

Using the background data analysis presented in Section 7.4.4, Background versus Local Source Analyses of Air Contaminants, the concentration increases of butadiene are calculated at 370% and 36% for the GIBI and BTRS monitoring sites, respectively. These two values are interpreted to indicate strong effects of local sources for the GIBI site and moderate effects of local sources for the BTRS site. A limitation of this conclusion is the utilization of the butadiene concentration at the BISP site to estimate local source contribution. The results for butadiene were detected in less than 50% of the monitoring samples.

The above factors indicate the measured butadiene concentrations at the GIBI and BTRS monitoring sites have point source contributions beyond the expected mobile source sector emissions. The largest reported local point source of direct butadiene emissions, Valley Retread Corp. is located south, southwest from the SPWT monitoring site. The emissions of Valley Retread Corp. are based upon voluntary data submitted by the company and the modeled air concentration of the emissions reported does not indicate an exceedance of the AGC.

Based upon the individual facts that butadiene is a known by-product of combustion processes, its strong signal identified in the TWA pollution roses and its tracking with benzene concentrations indicates that Tonawanda Coke Corp. is substantially contributing to the elevated concentrations measured, which are beyond the contributions expected from mobile sources alone.

Acetaldehyde

Emissions

Acetaldehyde is released from both stationary and mobile sources. It is predominantly a product of combustion and is also extensively used as a chemical intermediate in the production of plastics, resins, and the synthesis of organic chemicals. It also can be formed by the photochemical oxidation of larger hydrocarbons in the atmosphere. It has an atmospheric half-life that ranges from 12 to 24 hours (Verschueren, 1996). The 2002 NATA emission inventory for Erie County shows that mobile source emissions account for 96% of the reported annual 96 tons per year.

According to the Study's emission inventory, the point sources of acetaldehyde in order of the greatest mass emissions reported are: 3M Tonawanda, Tonawanda Goodyear, NRG Huntley power plant, Indeck Yerkes, and the Tonawanda sewage treatment plant. All of the point sources represent combustion or an oxidation manufacturing process generating acetaldehyde. In 2005, 3M Tonawanda reported its largest mass emission rate at 12 tons per year but has instituted technological changes to reduce its emissions. With the reduction of emissions from 3M Tonawanda, the reported emissions within the Study location is 760 pounds per year. 2002 NATA reported major point sources releasing 870 pounds per year of acetaldehyde for Erie County. Within the Study area, the mobile source sector emissions of acetaldehyde were calculated to be approximately 1700 pounds per year.

Source Identification

The average acetaldehyde concentration measured at the GIBI monitor had a significantly higher air concentration as compared to the BISP monitor. The concentrations at the GIBI monitoring site, where a significantly greater concentration of acetaldehyde was detected as compared to the upwind site, indicates there are sources within the Study area. The averaged acetaldehyde concentration at all sites in the Study area was determined to be below the U.S. median result (Figure 7.4).

The acetaldehyde polar plots only weakly indicate directionality from a stationary source (Appendix M). The GIBI and, to a lesser extent, the BTRS polar plots both indicated a directionality to the south, southwest/southwest (at 202.5-225°) and to the southeast (at 135°). The acetaldehyde TWA pollution roses do not indicate directionality for any particular point source, except the GIBI TWA pollution rose pointing towards the industrial area (Figure 7.12).

The hazard index (HI) analysis under Section 7.3, based upon air dispersion modeling, found two processes at 3M Tonawanda contributing to the elevated HI for the Kaufman area neighborhood. The HI was calculated to be greater than 1.0 for the Kaufman area location. Since 2005, the reported acetaldehyde emissions of 12 tons per year have been reduced by 95% due to technological changes and thermal oxidation. These processes will continue to be monitored as part of the 3M compliance Title V permit to ensure emissions in the Kaufman area location are minimized. The majority of monitored emissions appear to be mobile source driven and no point sources could be identified at this time.

Acrolein

Emissions

Acrolein is released from both stationary and mobile sources and is predominantly a product of combustion. Another source of acrolein is the photochemical oxidation of 1,3-butadiene. The inventory does not account for the secondary formation of acrolein from the breakdown of 1,3-butadiene. The 2002 NATA emission inventory for Erie County shows that mobile source emissions account for 83% of the reported annual 15.3 tons per year.

The Tonawanda Study's emission inventory indicates that the point sources of acrolein in the Study area account for approximately 900 pounds per year. Tonawanda 3M accounted for the majority of emissions at 775 pounds per year reported in the inventory year of 2005, but has instituted technological changes in recent years to reduce its emissions. Mobile source emissions in the Study area were calculated to be approximately 250 pounds per year.

Source Identification

Acrolein is the only air toxic with a hazard quotient (HQ) above one; for all other air toxics the HQ is less than one. Acrolein is a difficult air toxic to monitor accurately, as explained in section 5.0, and is currently only monitored at two sites in the State in addition to the Study sites. NYSDEC elected to report the acrolein results although some laboratory quality assurance thresholds[30] were exceeded. The HQs for acrolein at the two monitoring locations in the State-wide network are 18 and 23. The HQ for acrolein at the Study site monitors is similar to these values reported by the other two monitors in the State. Acrolein also is monitored to a limited degree by other states. The acrolein HQs at the Tonawanda monitors are below the US monitoring (based on 2005 data) average HQ of 39 (range 2.2 to 120)[31].

The average acrolein concentration measured at the GIBI monitor reported a statistically significant higher air concentration compared to the BISP monitor. The acrolein polar plots only weakly indicate directionality (Appendix M). Similar to acetaldehyde, the GIBI and BTRS polar plots indicate directionality to the south, southwest/southwest (at 202.5-225°). The GIBI polar plot has one isolated high point to the southeast. The SPWT and BISP polar plots do not show any distinct directionality and do not show any

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[30] See Appendix E Quality Assurance for VOCs and Carbonyls

[31] The HQ evaluation for acrolein is based on a limited number of monitors in the US network which report greater than 50% detects (43 monitors) for the 2005 results.

strong concentration gradients between the monitoring sites. The acrolein TWA pollution roses do not indicate directionality for any particular point source, except the GIBI TWA pollution rose pointing towards the industrial area (Figure 7.13).

Acrolein is a known by-product of combustion and the Tukey statistical analysis shows a contribution between the upwind and industrial monitoring sites. The similarity between the TWA pollution roses of acetaldehyde and acrolein indicate that the monitor concentrations could be dominated by mobile sources with some contribution coming from Tonawanda Coke's coking operation. Since 2005, the reported acrolein emissions of 770 pounds per year from 3M Tonawanda's two processes have undergone technological changes and thermal oxidation reducing the emissions by 95%. The majority of monitored emissions appear to be mobile source driven and no point sources could be identified at this time.

Benzene

Emissions

Benzene is released from both stationary and mobile sources and is predominantly a product of combustion. Emissions also can occur from the evaporation of oils, fuels, and solvents containing benzene and also can be liberated from the coal coking process. Benzene has an atmospheric half-life of approximately 5.7 days (Verschueren, 1996).

According to the Study's emission inventory, the point sources of benzene in order of the greatest mass emissions reported are: the Tonawanda Coke Corporation, NRG Huntley power plant, NOCO Energy, and Tonawanda Sunoco. The total point source emissions for the study are 26.5 tons per year. The 2002 NATA emission inventory for Erie County shows that mobile source emissions account for 77% of the reported annual 897 tons per year. Mobile source emissions in the Study area were calculated to be approximately 6.5 tons per year.

Toluene/Benzene Ratio

Considerable research has been dedicated to the study of ambient concentrations of air toxics in urban areas. Urban airshed research predominantly focuses on the mobile source sector's emissions of benzene, toluene, ethylbenzene, and xylene. One parameter studied is the ratio between the concentrations of toluene and benzene. The toluene/benzene ratio is used as an indicator to evaluate the mobile versus non-mobile source sector contributions within an urban air shed (Bravo, 2002). A review of urban air quality studies indicates the toluene/benzene ratio ranges from 2 to 10. Statewide data for the same time period during the study shows that monitored concentrations in the New York City area have an average toluene/benzene ratio of 2.7. Other urban areas in the state have an average toluene/benzene ratio of 2.5. The Whiteface background monitoring site has a toluene/benzene ratio of 1.0. As seen with other urban studies, the New York City area is not dominated by heavy industry and the toluene/benzene ratio is driven by mobile sources. The four monitoring sites have toluene/benzene ratios of 1.07, 1.02, 0.29, and 1.38 for BISP, BTRS, GIBI, and SPWT, respectively. These toluene/benzene ratios indicate that the monitors located in the Study area are less influence by mobile sources than other urban sites. Whereas the rural Whiteface site has a toluene/benzene ratio of 1.0, similar to the Study sites, the annual averaged benzene concentration at Whiteface is only 3% of the annual averaged benzene concentration at the GIBI site and 20% of the concentrations at the other Study area sites. The toluene/benzene ratio and the annual average benzene concentration for the GIBI site clearly demonstrate that the benzene monitoring results are dominated by stationary source emissions and not mobile source emissions. Also, for the BTRS site, the annual average benzene concentration is greater than all other urban monitored sites in the State, clearly demonstrating that the monitored results are dominated by emissions from local stationary sources and not mobile sources.

Source Identification

Comparing the benzene concentration at the GIBI monitor to all other U.S. monitors, the benzene concentration was found to be statistically significantly higher than most other data recorded. The annual average benzene concentration at the GIBI monitor was higher than the 95th percentile value for the U.S. network and average annual concentrations at all of the other Study area monitoring sites were greater than the median U.S. concentration. In section 7.1.3, an analysis of variance was conducted between BISP and the other three monitors to determine if the measured concentrations were significantly different than the upwind site. The GIBI and BTRS annual concentrations were both found to be statistically different than the BISP concentration.

The details in section 7.4.2 - Analyses of Wind Direction Influences on Measured Concentrations for Air Contaminants Exceeding DEC's AGCs showed strong directionality with measured benzene concentrations. The GIBI and BTRS polar plots clearly indicate directionality to the south, southwest/southwest (at 202.5-225°) (Appendix M).

The TWA pollution roses for benzene at all four monitoring sites primarily point in towards the industrial area (Figure 7.14). Also, the maximum benzene concentrations for the TWA pollution roses at the various monitoring sites are substantially different, indicating that the combination of the wind direction (with respect to the orientation of a particular monitor and the coke oven facility) and the vicinity to the source greatly influenced the concentrations measured.

The vector lines extended out from the 22.5° arcs pointing towards the industrial area all intersect in the industrial area right at the largest known source of benzene in the area, the Tonawanda Coke Corporation facility. The wind roses for the highest 10% concentration days versus the lowest 10% concentration days for benzene again clearly indicate that the highest concentrations resulted when the wind blew from the direction of the coke oven facility to the monitor location and the lowest concentrations occurred when the winds from this direction were absent. The highest 10% concentration days at both the GIBI and BTRS monitors were when wind was primarily out of the southwest, whereas the lowest 10% concentration days at these same two monitors had no winds coming directly out of the southwest.

The analysis performed in section 7.4.4 - Background versus Local Source Analyses investigated the spatial variation using downwind to upwind ratios. This investigative technique indicates whether a contaminant was predominantly a regional background pollutant or local source issue. The analysis showed that the measured benzene concentration was a product of local sources within the Study area and not a background pollutant.

Over the course of the Study year, inspections by Regional staff indicated that NOCO Energy and Tonawanda Sunoco were in compliance and their emission control equipment was operating appropriately. The NYSDEC is awaiting sampling results from a USEPA inspection conducted in April of 2009 of the Tonawanda Coke Corporation's waste-water and by-product plant emissions. Air Dispersion modeling of the Tonawanda Coke facility underestimated the monitored concentrations detected at the GIBI even when emissions were increased to the maximum potential (See Appendix L - Model to Monitor Comparison).

The analysis of multiple factors (e.g. wind data analysis, benzene/toluene ratios, and facility specific inspection information that has identified uncontrolled emission points), as described throughout the report, identify Tonawanda Coke Corporation as the single largest benzene source contributing to the high benzene emissions monitored at the GIBI and BTRS monitors.

Carbon Tetrachloride

Emissions

The manufacturing and usage of carbon tetrachloride has been phased out as part of the Montreal Protocol. The only reported emissions of carbon tetrachloride emissions in the Study area are residual emissions from the landfills calculated to be less than 1 pound per year.

Source identification

Section 7.1.3 identified six air toxics where the monitor concentrations at the BISP monitor were not statistically different than the concentrations obtained at the other three sites. Carbon tetrachloride was among this group. Carbon tetrachloride monitored data was similar for the entire State of New York and consistent with the median concentration nationwide.

According to the Toxic Release Inventory and the NYSDEC's Air Facility System, the last reported emissions of carbon tetrachloride in NYS were in 2001. The analyses conducted in section 7.4 did not show evidence of directionality based upon the polar plots or the TWA pollution roses at any of the four air monitoring sites.

Formaldehyde

Emissions

Formaldehyde is released from both stationary and mobile sources. It is predominantly a product of combustion and all sources of fossil fuel combustion for electrical generation, industrial processes, and residential heating will release formaldehyde. According to the Study's emission inventory, the point sources of formaldehyde in order of the greatest mass emission are: Indeck Yerkes, NRG Huntley power plant, and Unifrax Inc. The 2002 NATA emission inventory for Erie County shows that mobile source emissions account for 95% of the reported annual 270 tons per year. Mobile source emissions in the Study area were calculated to be approximately 2.0 tons per year. Currently, regulated sources of combustion are required to report to the NYSDEC only criteria pollutant contaminants and the reporting of formaldehyde for major sources is not mandatory.

Source Identification

In the Study area, the concentrations of benzene and formaldehyde at the GIBI site are much higher, as compared to other industrial and urban monitors in the State. The formaldehyde polar plots indicate some directionality, but less strongly than with benzene (Appendix M). All four sites indicate directionality to the south, southwest/southwest (at 202.5-225°), but also from several other directions as well.

The TWA pollution roses for formaldehyde do not clearly indicate a prevailing source in the Tonawanda industrial area (Figure 7.16). However, the differences in the concentrations between the various monitoring sites indicate that there are more local sources influencing the GIBI monitor than any of the other three locations. The closest monitoring site, GIBI does point towards the industrial area, in addition to, pointing along the two major highways adjacent to it. This indicates that this product of combustion is coming both from point and mobile sources in the area. The BISP TWA pollution rose also points in towards the industrial area and the SPWT and BTRS TWA pollution roses indicate some additional minor sources, in some cases also towards roads indicating mobile source influences.

The wind roses for formaldehyde and acetaldehyde are similar, and neither these nor those for acrolein provide strong indications of a large point source in the area as those for benzene. There are many point sources, as well as widespread mobile sources of combustion products like formaldehyde, acetaldehyde, and acrolein. The wind roses for formaldehyde, acetaldehyde, and acrolein were unlike those for benzene in that they did not consistently indicate that winds blowing from the industrial area to the monitor resulted in the highest 10% concentration days and an absence of those same direction winds resulted in the lowest 10% concentration days. Yearly trends showed increases in formaldehyde emissions in the summer months indicating enhanced secondary formation of formaldehyde during the warmer temperatures.

9. Follow-up Activities

The NYSDEC has identified several follow-up activities, as a result of the air quality Study, which are currently being undertaken or expected to be undertaken in the future. The NYSDEC will provide the monitoring and modeling information to the New York State Department of Health for the assessment of a possible community health study in the Tonawanda community. The NYSDEC will continue to work with the community and the CACWNY to investigate odor and irritation complaints associated with industrial emissions in the area. The NYSDEC will continue to work with local industry in the Study area to implement strategies to improve air quality.

9.1 Air Monitoring

The NYSDEC has continued VOC, carbonyl, and $PM_{2.5}$ monitoring at the GIBI and BTRS locations since the end of the formal USEPA grant program in July 2008. The network was continued to evaluate ambient concentrations of HAPs for an additional year at these sites in relation to the base 2007–2008 sampling period. In addition, these sites will allow the NYSDEC to examine the benefits of current HAP reduction activities and any future regulatory actions that may be undertaken by state or federal agencies to reduce mobile and point source emissions.

The NYSDEC has installed a continuous automated benzene, toluene, ethylbenzene, and xylene (BTEX) monitor at the GIBI site, which collects samples every 15 minutes, to further evaluate the high levels of benzene measured at this monitoring site with a higher degree of temporal resolution. The original study used stainless steel canisters, which collected a 24-hour composite sample. The BTEX monitor will allow the NYSDEC to evaluate time of day trends in BTEX concentrations on a daily basis.

The NYSDEC also has installed a high volume sampler for ambient PAHs measurements at the GIBI site that collects a 24-hour sample on a one-in-six day sampling schedule. This monitor was established to measure ambient PAHs in the study area and the samples gathered are analyzed for 21 specific PAHs, including naphthalene. The sampler was located to measure the PAH impacts from known sources of PAH emissions, such as, the Tonawanda Coke Corporation and Huntley Electric Generating station, as well as emissions associated with vehicle and diesel truck traffic and diesel locomotive engines.

9.2 Compliance Inspections

The NYSDEC has increased compliance inspections of all air pollution sources within the study area and has inspected additional sources outside the study area. Initially, these inspections focused on sources of known benzene emissions in the study area. Inspections of the Tonawanda Sunoco and NOCO Energy Petroleum Distribution facilities have been conducted to assess compliance with state and federal air pollution regulations

During and after the Study period, NYSDEC regional staff visited the Tonawanda Coke Corporation many times to observe facility operations to assess potential sources of HAP emissions and assess compliance with their Title V Air Facility Permit. This continuing effort has already resulted in emission reductions that are outlined in the following Subsection (9.3). In April 2009, the USEPA, with cooperation from the NYSDEC, conducted a comprehensive compliance inspection of the Tonawanda Coke Corporation. The results of this inspection will be available in the near future. The NYSDEC is also reviewing the state and federal conditions contained in the air permits of the facilities in the Study area to evaluate if these conditions could be rewritten to ensure better work practices and oversight of these practices.

As per the Consent Decree between NYSDEC and NRG, the NRG Huntley Electric Generating Station was required to reduce emissions of particulate, nitrogen oxides and sulfur dioxide. In addition, 6NYCRR Part 246 established a cap for mercury emissions starting in January of 2010 which reduces the emissions of mercury at a minimum of 50%. NRG Huntley replaced the electrostatic precipitators, (which only controlled particulates), with baghouses for particulate control, which also allowed for the injection of powder activated carbon for mercury control, trona injection for SO_2 control and urea injection for additional NO_x control. The baghouses operating since the beginning of 2009 have made a tremendous reduction in the number of opacity violations. The trona, urea, and activated carbon are undergoing performance testing and as of the date of this report are not yet in full operation.

9.3 Hazardous Air Pollutant Reduction Actions

In 2008, the Tonawanda Coke Corporation agreed to control emissions from the light oil storage and loading area of the facility. Current air regulations do not require emission controls on these specific units. Emissions from these operations were controlled by connecting the light oil emission points to the suction side of the coke oven gas collection system, thereby reintroducing the collected emissions into coke oven gas stream for further processing. This resulted in a benzene emission reduction from the facility of approximately 1,700 pounds per year.

In 2009, the Tonawanda Coke Corporation agreed to control emissions from their ammonia still beyond levels required by air pollution regulations. This emission unit includes the processes that steam strip ammonia from the ammonia liquor which is removed as a waste contaminant from the raw coke oven gas collected in the coke battery. The remaining clean water is discharged to the local municipal sewage treatment facility. This emissions point was identified by NYSDEC regional staff during their facility operational observation visits as a large source of uncontrolled ammonia, benzene, toluene, xylene, and naphthalene emissions. The control of the ammonia still will reduce ammonia emissions significantly from their current maximum emission rate of 800,000 pounds per year and will also result in smaller, but significant, reductions of benzene (approximately 3000 pounds per year), toluene, xylene, and naphthalene.

During the April 2009 inspection, a pressure regulator on the coke oven gas system was identified as being a possible source of gas oven emissions. Although the amount of gas released from this source is impossible to determine, Tonawanda Coke agreed to increase the pressure set point of the unit to prevent further releases. Since Tonawanda Coke is currently operating at only 50% capacity, a flare has been installed to combust emissions from the pressure regulator should the need arise when production increases.

As a result of the April 2009 inspection, the USEPA has required a number of emission tests and sampling of the various operations at the Tonawanda Coke facility during 2009 and 2010 to assess compliance with federal laws and regulations. The results of these tests may result in further HAP reductions, as required under the NESHAP program. In addition, the results of these tests could be used to make decisions about updating the current New York State regulation, 6NYCRR Part 214 By-Product Coke Oven Batteries.

10. Conclusions

The results of the Tonawanda Community Air Quality Study indicate there is a need for a focused effort to reduce the amount of some HAPs being released in the community. This goal, which is already underway, will be accomplished through continued compliance inspections of facilities in the area, assessments of technological advances in air pollution control that can be implemented through new regulations and/or voluntary reductions to reduce emissions at existing facilities, and continued efforts to reduce emissions from the mobile source sector (e.g. low emissions vehicle program, increased mileage standards for new vehicles, removal of older vehicles from the roadways, and vehicle inspection and maintenance program). These efforts will be monitored with the continuation of ambient air monitoring at the GIBI and BTRS sites (see Follow-up Activities Section 9 for more details).

The monitoring data indicated that there needs to be a concerted effort by the NYSDEC and the USEPA to evaluate all sources of benzene emissions in the community for reductions. This effort has already commenced with the comprehensive inspections of known stationary sources of benzene emissions in the Study area by the NYSDEC and the USEPA.

The investigation of the annual air concentration predictions from two air dispersion models (RAIMI and AerMod) in relation to our monitoring revealed some unexpected results. The predicted model concentration for benzene using the actual emissions inventory for the Tonawanda Coke Corporation was significantly less than the measurements made at the GIBI site. The scaling up of the benzene emissions to reflect the allowable amount under the NESHAP standards resulted in predicted benzene concentrations that remained well below the measured concentrations at the GIBI site. The reason for this discrepancy appears to be the under reporting of benzene emissions by the Tonawanda Coke Corporation. The additional coke oven facility benzene emissions could be the result of leaks and/or other releases of benzene that are not accounted for by the facility in their annual actual emission statements or they could be the results of inaccuracies in the USEPA approved emission factors used to determine facility emissions. This specific issue is being investigated further by the NYSDEC and the USEPA.

In contrast to our benzene findings, the measured concentrations of carbon disulfide were in close agreement with the model predictions. Carbon disulfide has one large point source of emissions and a small contribution of minor emissions from other sources, with no mobile source contributions. 3M Tonawanda is a major source of carbon disulfide releasing over 150 tons per year. The SPWT monitor is within 1,200 meters of 3M Tonawanda and in the prevailing wind direction. The model-to-monitor ratio at this site was close to one (0.99), indicating that the use of modeling with an accurate emissions inventory will provide an accurate prediction of the near site ambient air concentrations in the community.

The comparisons of our monitoring data to the 2002 NATA results indicate that the 2002 NEI used in the NATA model is fairly accurate for a number of air toxics. The NEI emissions inventory has under reported acrolein emissions for the entire Tonawanda area and under reported 1,3-butadiene, benzene, ethylbenzene, formaldehyde, and propionaldehyde emissions for sources near the GIBI monitor. As a risk assessment screening tool designed to identify areas for further air pollution investigations, it would be preferable for the NATA modeled ambient concentrations to be similar to the measured ambient concentrations for those air toxics that are identified as risk drivers. For acrolein, the NATA modeled concentration estimates are approximately an order of magnitude lower than the ambient monitor concentrations in this Study. Therefore, the risks predicted by NATA would be an order of magnitude lower than the actual risk. At the GIBI monitor, the NATA model concentration estimate for benzene is nearly an order of magnitude lower than the ambient monitor concentration. The risk predicted by NATA at this location also would be almost an order of magnitude lower than the actual risk. In general, NATA emission inventory estimates, and therefore model results, appear to be under predicting concentrations and risks for air toxics dominated by emissions from large point sources (benzene) and for air toxics that are also the products of secondary photochemical formation (acrolein and formaldehyde) within the Study area.

It was difficult to verify the benzene results in the Risk Assessment Document for the Coke Oven MACT Residual Risk (which included an evaluation of Tonawanda Coke) using the benzene monitoring data. The maximum individual cancer risk in the residual risk assessment for benzene emissions from the Tonawanda Coke Corporation was 50 in-one-million. However, isopleths illustrating the risk associated with benzene exposure from the facility were not presented in the residual risk document. The residual risk document presents the population cancer risk as the combined risk of arsenic, benzene, and BSO exposure. An assessment of the population cancer risk in the surrounding community, using cancer risk isopleths in the residual risk document, was limited since the isopleths were not provided on a map of the area. This made it extremely difficult to verify the conclusion of the residual risk assessment that facility wide emissions resulted in only three individuals in the surrounding community with a maximum individual cancer risks that were equal to 100 in-one-million. Based on our assessment of the monitored and modeled data, the maximum individual cancer risk and population cancer risk associated with facility-wide emissions from the Tonawanda Coke Corporation exceeds 10 in-one-million cancer risk for the nine census tract Study area and specific neighborhoods exceed the 100 in-one-million cancer risk level (Figure K-3 in Appendix K). Further work will be conducted on this issue by the NYSDEC and information will be provided to the USEPA. A final residual risk assessment for all individual processes within the Coke Oven source category will be prepared by the USEPA in 2011.

Communicating the science of risk assessments related to exposure to air toxics was an extremely important aspect of this study but the presentation of the Study results, including technical details, through a series of public meetings proved to be challenging. Important goals of our public presentations were transparency and the presentation of the study results in a format that would be understood by the general public. In general, the achievement of these goals varies by audience, but for the most part the NYSDEC was able to attain these goals. This success was due to our close relationship with the CACWNY. We worked together to develop an understanding of the air quality issues that needed to be addressed and worked together to inform the public and elected officials of our findings.

The management of air quality for hazardous air pollutants relies on the use of cancer and non-cancer risk estimates to determine if any further regulatory actions are needed to reduce air pollution. The results of the Tonawanda Community Air Quality Study clearly indicate that further actions are needed to reduce ambient concentrations of benzene and formaldehyde in the community and that further monitoring must be continued to measure any progress in current and future emission reduction strategies. In addition, a comprehensive evaluation of the allowable hazardous air pollutants emissions associated with the modeled cancer risk predictions from the entire Tonawanda Coke Corporation facility needs to be carefully undertaken.

The results of the Tonawanda Community Air Quality Study have provided a better understanding of the necessary future actions to improve air quality in the Tonawanda area. The Study also has demonstrated the need for carefully designed community-based air toxics monitoring studies to evaluate the effectiveness of State and Federal regulatory actions to reduce exposures to hazardous air pollutants. NYSDEC remains committed to continue the work initiated by this community Study.

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Table 2.1 Results of the Air Sampling Conducted by NYSDEC Region 9 Office in June 2005

Compound Name	Sample 1 on 6/21/05 (ppbv)	Sample 2 on 6/21/05 (ppbv)	Sample 1 on 6/23/05 (ppbv)	Sample 2 on 6/23/05 (ppbv)
Air Toxics List				
Propene	1.75	0.00	1.01	0.00
Dichlorodifluoromethane	0.45	0.55	0.47	0.41
Chloromethane	0.50	0.51	0.54	0.43
Dichlorotetrafluoroethane	0.00	0.00	0.02	0.01
Vinyl Chloride	0.00	0.00	0.00	0.00
1,3-Butadiene	0.09	0.00	0.11	0.00
Bromomethane	0.00	0.00	0.02	0.03
Chloroethane	0.00	0.00	0.00	0.00
Trichlorofluoromethane	0.20	0.23	0.22	0.22
Isopropyl alcohol[a]	0.00	0.00	0.00	0.00
1,1-Dichloroethylene	0.00	0.00	0.00	0.00
Dichloromethane	0.05	0.10	0.03	0.02
Carbon disulfide[a]	0.13	0.14	0.06	0.06
Trichlorotrifluoroethane	0.07	0.05	0.06	0.05
cis-1,2-Dichloroethylene	0.00	0.00	0.00	0.00
1,1-Dichloroethane	0.00	0.00	0.02	0.03
Methyl tert butyl ether	0.00	0.00	0.00	0.00
Vinyl acetate[a]	0.04	0.14	0.00	0.02
Methyl ethyl ketone[a]	0.27	0.55	0.00	0.00
trans-1,2-Dichloroethylene[a]	0.00	0.00	0.00	0.00
n-Hexane	0.06	0.09	0.52	0.06
Chloroform	0.02	0.03	0.00	0.03
Tetrahydrofuran[a]	0.00	0.05	0.00	0.00
1,2-Dichloroethane	0.00	0.00	0.03	0.03
1,1,1-Trichloroethane	0.02	0.03	0.04	0.04
Benzene	3.41	0.15	2.87	0.23
Carbon tetrachloride	0.09	0.10	0.10	0.10
Cyclohexane	0.00	0.04	0.07	0.03
1,2-Dichloropropane	0.00	0.00	0.00	0.00
Bromodichloromethane	0.01	0.00	0.00	0.03
Trichloroethylene	0.00	0.00	0.00	0.00
1,4-Dioxane[a]	0.00	0.00	0.00	0.00
n-Heptane	0.03	0.06	0.08	0.03
cis-1,3-Dichloropropylene	0.00	0.00	0.01	0.02
Methyl isobutyl ketone[a]	0.00	0.00	0.00	0.00

trans-1,3-Dichloropropylene	0.01	0.00	0.00	0.02
1,1,2-Trichloroethane	0.00	0.00	0.00	0.02
Toluene	0.46	0.22	0.89	0.11
Methyl n-butyl ketone[a]	0.00	0.00	0.00	0.00
Dibromochloromethane[a]	0.00	0.00	0.00	0.02
1,2-Dibromoethane	0.01	0.02	0.02	0.02
Tetrachloroethylene	0.02	0.03	0.02	0.03
Chlorobenzene	0.01	0.02	0.02	0.02
Ethylbenzene	0.04	0.05	0.07	0.03
m,p-Xylene	0.13	0.10	0.25	0.07
Tribromomethane[a]	0.00	0.00	0.00	0.00
Styrene	0.05	0.06	0.05	0.03
1,1,2,2-Tetrachloroethane	0.01	0.02	0.03	0.02
o-Xylene	0.07	0.07	0.11	0.04
p-Ethyl toluene[a]	0.02	0.04	0.04	0.03
1,3,5-Trimethylbenzene	0.02	0.03	0.04	0.02
1,2,4-Trimethylbenzene	0.05	0.06	0.10	0.04
aChlorotoluene	0.00	0.01	0.00	0.01
1,3-Dichlorobenzene	0.01	0.02	0.02	0.02
1,4-Dichlorobenzene	0.01	0.02	0.02	0.02
1,2-Dichlorobenzene	0.01	0.02	0.02	0.02
1,2,4-Trichlorobenzene	0.01	0.01	0.01	0.00
Hexachloro1,3-butadiene	0.01	0.02	0.01	0.03
Photochemical Target List				
Propene	1.65	0.00	1.33	0.00
Propane	1.18	0.00	0.95	0.34
Isobutane	0.15	0.15	3.56	0.14
1-Butene	0.06	0.23	1.03	0.00
n-Butane	0.34	0.40	8.30	0.21
t-2-Butene	0.02	0.00	0.93	0.00
c-2-Butene	0.02	0.02	0.70	0.01
isopentane	0.54	0.59	9.34	0.26
1-Pentene	0.03	0.04	0.43	0.01
Pentane	0.25	0.28	3.26	0.15
Isoprene	0.18	0.56	0.10	0.18
t-2-Pentene	0.02	0.02	0.90	0.01
c-2-Pentene	0.01	0.01	0.46	0.00
2,2-Dimethylbutane	0.02	0.03	0.30	0.00
Cyclopentane	0.02	0.01	0.23	0.00
2,3-Dimethylbutane	0.02	0.00	0.31	0.02

2-Methylpentane	0.07	0.08	1.13	0.04
3-Methylpentane	0.05	0.07	0.63	0.04
Hexene	0.01	0.02	0.06	0.00
n-Hexane	0.06	0.10	0.50	0.06
Methylcyclopentane	0.02	0.02	0.27	0.01
2,4-Dimethylpentane	0.01	0.02	0.06	0.01
Benzene	3.18	0.14	2.71	0.21
Cyclohexane	0.01	0.02	0.07	0.03
2-Methylhexane	0.01	0.00	0.12	0.00
2,3-Dimethylpentane	0.02	0.03	0.08	0.01
3-Methylhexane	0.02	0.03	0.12	0.01
2,2,4-Trimethylpentane	0.02	0.03	0.13	0.01
n-Heptane	0.03	0.05	0.08	0.03
Methylcyclohexane	0.02	0.02	0.05	0.01
2,3,4-Trimethylpentane	0.02	0.01	0.04	0.01
Toluene	0.44	0.20	0.86	0.10
2-Methylheptane	0.01	0.01	0.03	0.01
3-Methylheptane	0.00	0.02	0.02	0.01
Octane	0.01	0.01	0.02	0.01
Ethylbenzene	0.03	0.05	0.07	0.03
m,p-Xylene	0.15	0.12	0.27	0.07
Styrene	0.04	0.05	0.04	0.02
o-Xylene	0.06	0.06	0.10	0.04
Nonane	0.03	0.02	0.03	0.01
Isopropylbenzene	0.02	0.04	0.01	0.02
n-Propylbenzene	0.01	0.02	0.02	0.01
m-Ethyltoluene	0.01	0.02	0.04	0.01
p-Ethyltoluene	0.02	0.04	0.04	0.03
1,3,5-Trimethylbenzene	0.02	0.03	0.04	0.02
o-Ethyltoluene	0.01	0.02	0.03	0.01
1,2,4-Trimethylbenzene	0.04	0.06	0.09	0.04
Decane	0.02	0.02	0.04	0.01
1,2,3-Trimethylbenzene	0.01	0.02	0.02	0.01
1,3-Diethylbenzene	0.00	0.01	0.01	0.01
1,4-Diethylbenzene	0.01	0.01	0.01	0.00
undecane	0.01	0.00	0.03	0.00

[a] Indicates a compound this is not in current target list. Concentrations reported are estimated.

Table 3.1 Hazardous Air Pollutants Monitored in Tonawanda Study

CHEMICAL	112 k[a]	1996 NATA[b]	1999 NATA[b]	CAS #[c]
1,1,1 Trichloroethane			X	71-55-6
1,1,2 Trichloroethane			X	79-00-5
1,1,2,2 Tetrachloroethane	X	X	X	79-34-5
1,1-Dichloroethane				75-34-3
1,1-Dichloroethylene				75-35-4
1,2 Dichlorobenzene				95-50-1
1,2 Dichloroethane	X	X	X	107-06-2
1,2 Dichloropropane	X	X	X	78-87-5
1,2,4 Trichlorobenzene			X	120-82-1
1,2,4-Trimethylbenzene				95-63-6
1,2-Dibromoethane				106-93-4
1,3 Butadiene	X	X	X	106-99-0
1,3 Dichlorobenzene				541-73-1
1,3,5-Trimethylbenzene				108-67-8
1,4 Dichlorobenzene			X	106-46-7
2-Butanone			X	78-93-3
Acetaldehyde	X	X	X	75-07-0
Acetone				67-64-1
A-chlorotoluene (Benzylchloride)			X	100-44-7
Acrolein		X	X	107-02-8
Benzaldehyde				100-52-7
Benzene	X	X	X	71-43-2
Bromodichloromethane				75-27-4
Bromomethane				74-83-9
Carbon disulfide			X	75-15-0
Carbon tetrachloride	X	X	X	56-23-5
Chlorobenzene			X	108-90-7
Chloroethane				75-00-3
Chloroform	X	X	X	67-66-3
Chloromethane				74-87-3
cis 1,3-Dichloropropene	X	X	X	542-75-6
cis1,2-Dichloroethylene				156-59-2
Crotonaldehyde				4170-30-3
Dichlorodifluoromethane				75-71-8
Dichlorotetrafluoroethane				76-14-2
Ethylbenzene				100-41-4
Formaldehyde	X	X	X	50-00-0
Hexachloro-1,3-butadiene				87-68-3
Hexanal				66-25-1
m,p-Xylene			X	1330-20-7
Methacrolein				75-83-3
Methyl tert butyl ether			X	1634-04-4
Methylene chloride (Dichloromethane)	X	X	X	75-09-2
m-Tolualdehyde				620-23-5

n-Butyraldehyde				123-72-8
o-Xylene			X	95-47-6
Propionaldehyde				123-38-6
Styrene			X	100-42-5
Tetrachloroethylene	X	X	X	127-18-4
Toluene			X	108-88-3
trans 1,3-Dichloropropene	X	X	X	542-75-6
Trichloroethylene	X	X	X	79-01-6
Trichlorofluoromethane				75-69-4
Trichlorotrifluoroethane				76-13-1
Valeraldehyde				110-62-3
Vinyl Chloride	X	X	X	75-01-4

[a] X – indicates HAP is designated as priority urban HAP in Section 112(k) of the Clean Air Act

[b] X – indicates HAP was modeled in the designated USEPA National-scale Air Toxics Assessment

[c] CAS# - Chemical Abstract Number

Table 5.1 Sample Method, Analysis Method, Frequency of Sampling and Site Locations by Parameter

Parameter	Sample Method or Instrument	Analysis Method	Frequency of Sampling	Site Locations
Volatile organic compounds	Canister	TO-15	1 in 6 days	BISP, BTRS, GIBI, SPWT
Carbonyls	Cartridge	TO-11a	1 in 6 days	BISP, BTRS, GIBI, SPWT
Fine particulate matter ($PM_{2.5}$)	Tapered Element Oscillating Microbalance (TEOM)	*None* – direct read instrumentation	Real-time (hourly average reported)	BISP, BTRS, GIBI, SPWT
Sulfur dioxide (SO_2)	Thermo Electron Model 43C	*None* – direct read instrumentation	Real-time (hourly average reported)	BTRS
Carbon monoxide (CO)	Thermo Electron Model 48C	*None* – direct read instrumentation	Real-time (hourly average reported)	BTRS
Meteorological parameters	Met One Wind Sensor	*None* – direct read instrumentation	Real-time (hourly average reported)	BISP

Table 5.2 Study VOCs, MDL, AGC, CAS# and Priority Urban HAP Designation

Chemical	MDL[a] (ppbv)	AGC (ppbv)	CAS#	112(k)[b]
1,1,1-Trichloroethane	0.024	183	71-55-6	
1,1,2,2-Tetrachloroethane	0.03	2.0	79-34-5	X
1,1,2-Trichloroethane	0.03	0.26	79-00-5	
1,1-Dichloroethane	0.02	0.15	75-34-3	
1,1-Dichloroethylene	0.02	18	75-35-4	
1,2,4-Trichlorobenzene	0.034	NA	120-82-1	
1,2,4-Trimethylbenzene	0.05	59	95-63-6	
1,2-Dibromoethane	0.03	0.0007	106-93-4	
1,2-Dichlorobenzene	0.03	60	95-50-1	
1,2-Dichloroethane	0.03	0.01	107-06-2	X
1,2-Dichloropropane	0.03	0.87	78-87-5	X
1,3,5-Trimethylbenzene	0.05	59	108-67-8	
1,3-Butadiene	0.04	0.01	106-99-0	X
1,3-Dichlorobenzene	0.03	60	541-73-1	
1,4-Dichlorobenzene	0.04	0.015	106-46-7	
a-Chlorotoluene (Benzylchloride)	0.04	0.004	100-44-7	
Acrolein	0.03	0.008	107-02-8	X
Benzene	0.03	0.04	71-43-2	X
Bromodichloromethane	0.024	0.003	75-27-4	
Bromomethane	0.03	1.29	74-83-9	
Carbon disulfide	0.03	225	75-15-0	
Carbon tetrachloride	0.03	0.01	56-23-5	X
Chlorobenzene	0.03	24	108-90-7	
Chloroethane	0.06	3790	75-00-3	
Chloroform	0.024	0.009	67-66-3	X
Chloromethane	0.025	44	74-87-3	
cis 1,3-Dichloropropene	0.03	0.04	542-75-6	
cis1,2-Dichloroethylene	0.03	16	156-59-2	
Dichlorodifluoromethane	0.024	2427	75-71-8	
Dichlorotetrafluoroethane	0.04	2432	76-14-2	
Ethylbenzene	0.06	230	100-41-4	
Hexachloro-1,3-butadiene	0.024	0.005	87-68-3	
m,p-Xylene	0.06	23	1330-20-7	
Methyl tert butyl ether	0.03	834	1634-04-4	
Methylene chloride (dichloromethane)	0.02	0.61	75-09-2	X
o-Xylene	0.04	23	95-47-6	
Styrene	0.1	235	100-42-5	
Tetrachloroethylene	0.025	0.15	127-18-4	X
Toluene	0.035	1326	108-88-3	
trans 1,3-Dichloropropene	0.04	0.04	542-75-6	
Trichloroethylene	0.025	0.08	79-01-6	X
Trichlorofluoromethane	0.03	178	75-69-4	

Chemical	MDL[a] (ppbv)	AGC (ppbv)	CAS#	112(k)[b]
Trichlorotrifluoroethane	0.02	23488	76-13-1	
Vinyl chloride	0.05	0.04	75-01-4	X

[a] Compounds with AGC's below the MDL have received special attention to attempt to further reduce the MDL. However, the extremely small AGC values of these compounds are beyond the capabilities of the canister based GC/MS methodology.
[b] Compound is designated a priority urban HAP in Section 112(k) of the Clean Air Act.
ppbv = parts per billion volume
NA – An AGC has not been derived by NYSDEC at the time of this report.

Table 5.3 Study Carbonyls, MDL, AGC, CAS# and Priority Urban HAP Designation

Chemical	MDL (ppbv)	AGC (ppbv)	CAS#	112(k)[a]
2-Butanone (MEK)	0.009	1700	78-93-3	X
Acetaldehyde	0.004	0.25	75-07-0	X
Benzaldehyde [b]	0.004	2.1	100-52-7	
Crotonaldehyde	0.009	NA	4170-30-3	
Formaldehyde	0.007	0.05	50-00-0	X
Hexanal [b]	0.008	4.9	66-25-1	
Methacrolein	0.005	NA	75-85-3	
m-Tolualdehyde	0.003	NA	620-23-5	
n-Butyraldehyde [b]	0.007	5.1	123-72-8	
Propionaldehyde	0.004	46	123-38-6	
Valeraldehyde	0.011	120	110-62-3	

[a] Compound is designated as priority urban HAP in Section 112(k) of the Clean Air Act
[b] NYSDEC staff developed an interim AGC for this study
ppbv = parts per billion volume
NA – An AGC has not been derived by NYSDEC at the time of this report.

Table 7.1 Summary of the Suitability of the Air Toxics for Assessing Risks

	Category A Low Confidence		Category B Moderate Confidence	Category C High Confidence
	Category A1	Category A2		
BISP	1,2,4-trichlorobenzene	1,1,1-trichloroethane	2-Butanone	Acetaldehyde
	1,2-dibromoethane	1,1,2,2-tetrachloroethane	Hexanal	Acetone
	1,2-dichloroethane	1,1,2-trichloroethane	Propionaldehyde	acrolein
	1,3-butadiene	1,1-dichloroethane		Benzene
	1,4-dichlorobenzene	1,1-dichloroethylene		Carbon disulfide
	aChlorotoluene	1,2,4-trimethylbenzene		Carbon tetrachloride
	Benzaldehyde	1,2-dichlorobenzene		Chloromethane
	Bromodichloromethane	1,2-dichloroethylene		Dichlorodifluoromethane
	Chloroform	1,2-dichloropropane		Dichloromethane
	cis1,3-dichloropropylene	1,3,5-trimethylbenzene		Formaldehyde
	Crotonaldehyde	1,3-dichlorobenzene		Toluene
	Hexachloro1,3-butadiene	Bromomethane		Trichlorofluoromethane
	Methacrolein	Chlorobenzene		Trichlorotrifluoroethane
	Methyl tert butyl ether	Chloroethane		
	n-Butyraldehyde	Dichlorotetrafluoroethane		
	trans1,3-dichloropropylene	Ethylbenzene		
	Vinyl chloride	m,p-xylene		
		m-Tolualdehyde		
		o-xylene		
		Styrene		
		Tetrachloroethylene		
		Trichloroethylene		
		Valeraldehyde		
BTRS	1,2,4-trichlorobenzene	1,1,1-trichloroethane	1,3-butadiene	Acetaldehyde
	1,2-dibromoethane	1,1,2,2-tetrachloroethane	2-Butanone	Acetone
	1,2-dichloroethane	1,1,2-trichloroethane	Hexanal	acrolein
	1,4-dichlorobenzene	1,1-dichloroethane	m,p-xylene	Benzene

	Category A Low Confidence		Category B Moderate Confidence	Category C High Confidence
	Category A1	Category A2		
	aChlorotoluene	1,1-dichloroethylene	n-Butyraldehyde	Carbon disulfide
	Benzaldehyde	1,2,4-trimethylbenzene	o-xylene	Carbon tetrachloride
	Bromodichloromethane	1,2-dichlorobenzene	Propionaldehyde	Chloromethane
	Chloroform	1,2-dichloroethylene	1,3-butadiene	Dichlorodifluoromethane
	cis1,3-dichloropropylene	1,2-dichloropropane	2-Butanone	Dichloromethane
	Crotonaldehyde	1,3,5-trimethylbenzene	Hexanal	Formaldehyde
	Hexachloro1,3-butadiene	1,3-dichlorobenzene	m,p-xylene	Toluene
	Methacrolein	Bromomethane	n-Butyraldehyde	Trichlorofluoromethane
	Methyl tert butyl ether	Chlorobenzene	o-xylene	Trichlorotrifluoroethane
	trans1,3-dichloropropylene	Chloroethane	Propionaldehyde	
	Vinyl chloride	Dichlorotetrafluoroethane		
		Ethylbenzene		
		m-Tolualdehyde		
		Styrene		
		Tetrachloroethylene		
		Trichloroethylene		
GIBI	1,2,4-trichlorobenzene	1,1,1-trichloroethane	1,2,4-trimethylbenzene	Acetaldehyde
	1,2-dibromoethane	1,1,2,2-tetrachloroethane	1,3-butadiene	Acetone
	1,2-dichloroethane	1,1,2-trichloroethane	2-Butanone	acrolein
	1,4-dichlorobenzene	1,1-dichloroethane	Benzaldehyde	Benzene
	aChlorotoluene	1,1-dichloroethylene	Ethylbenzene	Carbon disulfide
	Bromodichloromethane	1,2-dichlorobenzene	Hexanal	Carbon tetrachloride
	Chloroform	1,2-dichloroethylene	n-Butyraldehyde	Chloromethane
	cis1,3-dichloropropylene	1,2-dichloropropane	Propionaldehyde	Dichlorodifluoromethane
	Crotonaldehyde	1,3,5-trimethylbenzene	Valeraldehyde	Dichloromethane
	Hexachloro1,3-butadiene	1,3-dichlorobenzene		Formaldehyde
	Methacrolein	Bromomethane		m,p-xylene
	Methyl tert butyl ether	Chlorobenzene		o-xylene

	Category A **Low Confidence**		**Category B** **Moderate** **Confidence**	**Category C** **High** **Confidence**
	Category A1	**Category A2**		
	trans1,3-dichloropropylene	Chloroethane		Toluene
	Vinyl chloride	Dichlorotetrafluoroethane		Trichlorofluoromethane
		m-Tolualdehyde		Trichlorotrifluoroethane
		Styrene		
		Tetrachloroethylene		
		Trichloroethylene		
SPWT	1,2,4-trichlorobenzene	1,1,1-trichloroethane	1,2,4-trimethylbenzene	Acetaldehyde
	1,2-dibromoethane	1,1,2,2-tetrachloroethane	2-Butanone	Acetone
	1,2-dichloroethane	1,1,2-trichloroethane	n-Butyraldehyde	acrolein
	1,3-butadiene	1,1-dichloroethane		Benzene
	1,4-dichlorobenzene	1,1-dichloroethylene		Carbon disulfide
	aChlorotoluene	1,2-dichlorobenzene		Carbon tetrachloride
	Benzaldehyde	1,2-dichloroethylene		Chloromethane
	Bromodichloromethane	1,2-dichloropropane		Dichlorodifluoromethane
	Chloroform	1,3,5-trimethylbenzene		Dichloromethane
	cis1,3-dichloropropylene	1,3-dichlorobenzene		Formaldehyde
	Crotonaldehyde	Bromomethane		m,p-xylene
	Hexachloro1,3-butadiene	Chlorobenzene		o-xylene
	Hexanal	Chloroethane		Propionaldehyde
	Methacrolein	Dichlorotetrafluoroethane		Toluene
	Methyl tert butyl ether	Ethylbenzene		Trichlorofluoromethane
	trans1,3-dichloropropylene	m-Tolualdehyde		Trichlorotrifluoroethane
	Vinyl chloride	Styrene		
		Tetrachloroethylene		
		Trichloroethylene		
		Valeraldehyde		

Table 7.2 Summary of Air Toxic Concentrations for Category B[a]

Category B					
Chemical	**Mean** ($\mu g/m^3$)	**25th Percentile** ($\mu g/m^3$)	**Median** ($\mu g/m^3$)	**75th Percentile** ($\mu g/m^3$)	**Coefficient of Variation**
BISP					
2-Butanone	0.39	0.19	0.34	0.55	0.73
Hexanal	0.16	0.045	0.14	0.24	0.87
Propionaldehyde	0.15	0.090	0.13	0.19	0.57
BTRS					
1,3-butadiene	0.088	0.049	0.066	0.10	0.76
2-Butanone	0.40	0.21	0.37	0.55	0.64
Hexanal	0.15	0	0.070	0.16	1.6
m,p-xylene	0.87	0.40	0.76	1.0	0.7
n-Butyraldehyde	0.081	0.032	0.056	0.10	1.0
o-xylene	0.34	0.15	0.30	0.37	0.6
Propionaldehyde	0.18	0.10	0.16	0.23	0.72
GIBI					
1,2,4-trimethylbenzene	0.33	0.17	0.29	0.43	0.62
1,3-butadiene	0.24	0.066	0.12	0.31	1.2
2-Butanone	0.37	0.24	0.33	0.46	0.63
Benzaldehyde	0.38	0.18	0.30	0.51	0.84
Ethylbenzene	0.50	0.17	0.33	0.54	1.0
Hexanal	0.35	0.033	0.12	0.57	1.3
n-Butyraldehyde	0.16	0.029	0.071	0.28	1.0
Propionaldehyde	0.21	0.093	0.18	0.29	0.78
Valeraldehyde	0.12	0.039	0.099	0.16	0.99
SPWT					
1,2,4-trimethylbenzene	0.31	0.19	0.28	0.34	0.63
2-Butanone	0.40	0.21	0.40	0.55	0.58
n-Butyraldehyde	0.063	0.032	0.053	0.094	0.74

[a] For this category of air toxics, the potential health risk will be estimated and reported in Subsection 7.2.2

Table 7.3 Summary of Air Toxic Concentrations for Category C

Category C					
Chemical	**Mean** (μg/m^3)	**25th Percentile** (μg/m^3)	**Median** (μg/m^3)	**75th Percentile** (μg/m^3)	**Coefficient of Variation**
BISP					
Acetaldehyde	0.90	0.67	0.78	1.0	0.42
Acrolein	0.32	0.24	0.30	0.40	0.35
Benzene	1.2	0.45	0.71	1.4	1.2
Carbon disulfide	0.77	0.090	0.14	0.54	3.0
Carbon tetrachloride	0.70	0.65	0.70	0.74	0.080
Chloromethane	1.1	0.99	1.1	1.1	0.26
Dichlorodifluoromethane	2.6	2.6	2.6	2.7	0.050
Dichloromethane	0.34	0.12	0.26	0.49	0.73
Formaldehyde	2.5	1.3	2.1	3.4	0.57
Toluene	1.3	0.60	0.92	1.6	0.77
Trichlorofluoromethane	1.0	0.72	0.79	1.4	0.35
Trichlorotrifluoroethane	0.74	0.61	0.66	0.95	0.24
BTRS					
Acetaldehyde	1.1	0.74	0.93	1.2	0.47
Acrolein	0.33	0.25	0.30	0.40	0.38
Benzene	2.0	0.91	1.2	2.0	0.98
Carbon disulfide	0.96	0.12	0.47	1.4	1.2
Carbon tetrachloride	0.69	0.65	0.67	0.74	0.077
Chloromethane	1.0	0.94	0.99	1.1	0.10
Dichlorodifluoromethane	2.6	2.5	2.6	2.7	0.053
Dichloromethane	0.36	0.11	0.22	0.45	1.1
Formaldehyde	2.3	1.2	1.7	2.3	0.97
Toluene	2.1	0.99	1.7	2.8	0.65
Trichlorofluoromethane	1.0	0.73	0.80	1.4	0.35
Trichlorotrifluoroethane	0.67	0.61	0.62	0.67	0.22
GIBI					
Acetaldehyde	1.3	0.80	1.2	1.8	0.53
Acrolein	0.43	0.29	0.39	0.56	0.45
Benzene	9.8	1.3	4.5	13	1.3
Carbon disulfide	1.1	0.18	0.32	1.2	1.5
Carbon tetrachloride	0.68	0.64	0.67	0.72	0.081
Chloromethane	1.0	0.94	1.0	1.1	0.083
Dichlorodifluoromethane	2.6	2.5	2.6	2.7	0.043
Dichloromethane	0.19	0.097	0.13	0.25	0.68
Formaldehyde	5.9	1.2	2.4	10	0.97
m,p-xylene	1.8	0.72	1.1	2.0	0.90
o-xylene	0.60	0.26	0.43	0.69	0.83

Category C

Chemical	Mean (μg/m^3)	25th Percentile (μg/m^3)	Median (μg/m^3)	75th Percentile (μg/m^3)	Coefficient of Variation
Toluene	3.1	1.7	2.7	3.8	0.66
Trichlorofluoromethane	1.0	0.74	0.80	1.4	0.35
Trichlorotrifluoroethane	0.64	0.61	0.63	0.67	0.13
SPWT					
Acetaldehyde	1.0	0.77	0.94	1.2	0.40
Acrolein	0.34	0.26	0.32	0.41	0.35
Benzene	1.3	0.78	1.0	1.4	1.2
Carbon disulfide	1.9	0.22	0.92	2.8	1.3
Carbon tetrachloride	0.69	0.65	0.68	0.74	0.083
Chloromethane	1.0	0.93	0.98	1.1	0.084
Dichlorodifluoromethane	2.6	2.5	2.6	2.7	0.052
Dichloromethane	0.23	0.11	0.16	0.27	1.4
Formaldehyde	1.9	1.2	1.8	2.4	0.44
m,p-xylene	0.88	0.56	0.72	0.99	0.63
o-xylene	0.34	0.21	0.29	0.40	0.61
Propionaldehyde	0.20	0.12	0.18	0.24	0.76
Toluene	1.9	1.1	1.5	2.1	0.58
Trichlorofluoromethane	1.0	0.74	0.82	1.4	0.33
Trichlorotrifluoroethane	0.63	0.61	0.62	0.67	0.079

Table 7.4 Statistical Comparisons between BISP (upwind site) and Perimeter Monitors

	Not detected at BISP monitor	BISP monitor statistical comparisons[a]		
		BTRS	GIBI	SPWT
2-Butanone				
1,2,4-Trimethylbenzene	X			
1,3-Butadiene	X			
Acetaldehyde			Lower	
Acrolein			Lower	
Benzaldehyde	X			
Benzene		Lower	Lower	
Carbon disulfide			Lower	Lower
Carbon tetrachloride				
Chloromethane		Higher		Higher
Dichlorodifluoromethane				
Dichloromethane		Higher		Higher
Ethylbenzene	X			
Formaldehyde			Lower	
Hexanal				
m,p-Xylene	X			
n-Butyraldehyde	X			
o-Xylene	X			
Propionaldehyde				
Toluene		Lower	Lower	Lower
Trichlorofluoromethane				
Trichlorotrifluoroethane		Higher	Higher	Higher
Valeraldehyde	X			

[a] Only statistically significant differences are displayed and direction of this significance stated. Higher indicates that the geometric mean for BISP is greater than the others sites indicated. Lower indicates that the geometric mean for BISP is lower and the other sites indicated.

Table 7.5 National-scale Air Toxics Assessment Annual Average Concentrations Compared to Tonawanda Study Monitor Concentrations (Predicted-to-Observed Ratios)

Site	BISP	BTRS	GIBI	SPWT	Mean
1,3-butadiene		0.91	0.35		
Acetaldehyde	1.4	1.4	1.1	1.5	1.4
Acrolein	0.10	0.14	0.10	0.16	0.12
Benzene	0.99	0.77	0.16	1.4	0.84
Carbon disulfide	0.48	0.49	2.7	0.72	1.1
Carbon tetrachloride	0.88	0.89	0.90	0.89	0.89
Chloromethane	1.1	1.2	1.2	1.2	1.2
Dichloromethane	0.48	0.66	1.2	1.1	0.85
Ethylbenzene			0.61		
Formaldehyde	0.60	0.70	0.27	0.90	0.62
Propionaldehyde	0.69	0.84	0.68	0.80	0.75
Toluene	1.7	1.5	1.1	2.2	1.6
Xylene(m,p,o)		1.2	0.66	1.7	1.2

Table 7.6 Statistical Comparisons between Sites for Category B and C Air Toxics

Air Toxic	BISP	BTRS	GIBI	SPWT
1,2,4-Trimethylbenzene	▨	▨		
1,3-Butadiene	▨	🟢	🟢	▨
2-Butanone				
Acetaldehyde	🟢		🟢	
Acrolein	🟢	🟣	🟢 🟣 🟠	🟠
Benzaldehyde	▨	▨		▨
Benzene	🟢 🔵	🟣 🔵	🟢 🟣 🟠	🟠
Carbon disulfide	🟢 🟣		🟢	🟣
Carbon tetrachloride				
Chloromethane	🟢 🟣		🟢	🟣
Dichlorodifluoromethane				
Dichloromethane	🟢 🟣	🟠	🟠 🟢	🟣
Ethylbenzene	▨	▨		▨
Formaldehyde	🟢	🟣	🟣 🟢 🟠	🟠
Hexanal				▨
m,p-Xylene	▨	🟢	🟢 🟣	🟣
n-Butyraldehyde	▨			
o-Xylene	▨	🟢		🟢
Propionaldehyde				
Toluene	🟠 🟢 🟣	🟢 🔵	🟣 🔵 🔴	🟠 🔴
Trichlorofluoromethane				
Trichlorotrifluoroethane	🟠 🟢 🟣	🟢	🟣	🟠
Valeraldehyde	▨	▨		▨

Table footnotes:

- Sites sharing similar symbols are significantly different at the 0.05 level.
- Cells with gray highlight indicate air toxic not detected greater than 50% above MDL.

Table 7.7 Summary of Risk Comparison for Category B[a]

Chemical	AGC (μg/m^3)	Inhalation Unit Risk[b] (μg/m^3)$^{-1}$	Toxicity Endpoint[c]	Tonawanda			New York State Risk	US Risk
				Mean (μg/m^3)	Non-cancer Risk (Hazard Quotient)	Cancer Risk	Mean (range)[d]	Mean (range)[d]
BISP								
2-Butanone	5000		Non-cancer	0.39	7.8 x 10^{-5}			
Hexanal	20^{e}		Non-cancer	0.16	0.0080			
Propionaldehyde	110		Non-cancer	0.15	0.0014			
BTRS								
1,3-butadiene	0.033	3 × 10^{-5}	Cancer	0.088		2.7 x 10^{-6}	3.6 x 10^{-6} (1.8 x 10^{-6} to 5.3 x 10^{-6})	12 x 10^{-6} (1.6 x 10^{-6} to 110 x 10^{-6})
2-Butanone	5000		Non-cancer	0.40	8.0 x 10^{-5}			
Hexanal	20^{e}		Non-cancer	0.15	0.0075			
m,p-xylene	100		Non-cancer	0.87	0.0087			
n-Butyraldehyde	15^{e}		Non-cancer	0.081	0.0054			
o-xylene	100		Non-cancer	0.34	0.0034			
Propionaldehyde	110		Non-cancer	0.18	0.0016			
GIBI								
1,2,4-trimethylbenzene	290		Non-cancer	0.33	0.0011			
1,3-butadiene	0.033	3 × 10^{-5}	Cancer	0.24		7.3 x 10^{-6}	3.6 x 10^{-6} (1.8 x 10^{-6} to 5.3 x 10^{-6})	12 x 10^{-6} (1.6 x 10^{-6} to 110 x 10^{-6})
2-Butanone	5000		Non-cancer	0.37	7.4 x 10^{-5}			
Benzaldehyde	9^{e}		Non-cancer	0.38	0.042			
Ethylbenzene	1000		Non-cancer	0.50	0.00050			
Hexanal	20^{e}		Non-cancer	0.35	0.018			
n-Butyraldehyde	15^{e}		Non-cancer	0.16	0.011			
Propionaldehyde	110		Non-cancer	0.21	0.0019			
Valeraldehyde	420		Non-cancer	0.12	0.00029			

Chemical	AGC (μg/m^3)	Inhalation Unit Risk[b] (μg/m^3)$^{-1}$	Toxicity Endpoint[c]	Tonawanda Mean (μg/m^3)	Tonawanda Non-cancer Risk (Hazard Quotient)	Tonawanda Cancer Risk	New York State Risk Mean (range)[d]	US Risk Mean (range)[d]
SPWT								
1,2,4-trimethylbenzene	290		Non-cancer	0.31	0.0011			
2-Butanone	5000		Non-cancer	0.40	8.0×10^{-5}			
n-Butyraldehyde	15[e]		Non-cancer	0.063	0.0042			

[a] For this category of air toxics, risk is estimated

[b] Inhalation Unit Risk (IUR) values were used in the cancer risk evaluation. AGCs are derived from IUR values as shown in the following formula, using acetaldehyde as the example:

$$AGC = \frac{1x10^{-6}}{IUR} \quad \text{Acetaldehyde: } 0.45\mu g/m^3 = \frac{1x10^{-6}}{2.2x10^{-6}(\mu g/m^3)^{-1}}$$

[c] Based on source of AGC assignment

[d] State and US results displayed when Tonawanda air toxic result is above hazard index of 1 or cancer risk greater than one in a million (1×10^{-6})

[e] Interim AGCs – see Appendix H for explanation of derivation

Table 7.8 Summary of Risk Comparison for Category C

Chemical	AGC ($\mu g/m^3$)	Inhalation Unit Risk[a] $(\mu g/m^3)^{-1}$	Toxicity Endpoint[b]	Tonawanda			New York State Risk Mean (range)[c]	US Risk Mean (range)[c]
				Mean ($\mu g/m^3$)	Non-cancer Risk (Hazard Quotient)	Cancer Risk		
BISP								
Acetaldehyde	0.45	2.2×10^{-6}	Cancer	0.90		2.0×10^{-6}	2.4×10^{-6} ($1.3 \times 10^{-6} – 2.9 \times 10^{-6}$)	4.4×10^{-6} ($0.77 \times 10^{-6} – 14 \times 10^{-6}$)
Acrolein	0.02		Non-cancer	0.32	16		(18, 23)[d]	39 (2.2 – 120)
Benzene	0.13	7.8×10^{-6}	Cancer	1.2		9.2×10^{-6}	7.5×10^{-6} ($5.3 \times 10^{-6} – 9.6 \times 10^{-6}$)	11×10^{-6} ($2.2 \times 10^{-6} – 220 \times 10^{-6}$)
Carbon disulfide	700		Non-cancer	0.77	0.0011			
Carbon tetrachloride	0.067	1.5×10^{-5}	Cancer	0.70		10×10^{-6}	9.7×10^{-6} ($9.2 \times 10^{-6} – 11 \times 10^{-6}$)	9.7×10^{-6} ($6.4 \times 10^{-6} – 83 \times 10^{-6}$)
Chloromethane	90		Non-cancer	1.1	0.012			
Dichlorodifluoromethane	12000		Non-cancer	2.6	0.00022			
Dichloromethane	2.1	4.7×10^{-7}	Cancer	0.34		0.16×10^{-6}		
Formaldehyde	0.06	1.7×10^{-5}	Cancer	2.5		42×10^{-6}	31×10^{-6} ($16 \times 10^{-6} – 43 \times 10^{-6}$)	55×10^{-6} ($8.3 \times 10^{-6} – 260 \times 10^{-6}$)
Toluene	5000		Non-cancer	1.3	0.00026			
Trichlorofluoromethane	1000		Non-cancer	1.0	0.0010			
Trichlorotrifluoroethane	180000		Non-cancer	0.74	4.1×10^{-6}			
BTRS								
Acetaldehyde	0.45	2.2×10^{-6}	Cancer	1.1		2.4×10^{-6}	2.4×10^{-6} ($1.3 \times 10^{-6} – 2.9 \times 10^{-6}$)	4.4×10^{-6} ($0.77 \times 10^{-6} – 14 \times 10^{-6}$)
Acrolein	0.020		Non-cancer	0.33	17		(18, 23)[d]	39 (2.2 – 120)
Benzene	0.13	7.8×10^{-6}	Cancer	1.9		15×10^{-6}	7.5×10^{-6} ($5.3 \times 10^{-6} – 9.6 \times 10^{-6}$)	11×10^{-6} ($2.2 \times 10^{-6} – 220 \times 10^{-6}$)
Carbon disulfide	700		Non-cancer	0.96	0.0014			
Carbon tetrachloride	0.067	1.5×10^{-5}	Cancer	0.69		10×10^{-6}	9.7×10^{-6} ($9.2 \times 10^{-6} – 11 \times 10^{-6}$)	9.7×10^{-6} ($6.4 \times 10^{-6} – 83 \times 10^{-6}$)

Chemical	AGC (µg/m^3)	Inhalation Unit Risk[a] (µg/m^3)$^{-1}$	Toxicity Endpoint[b]	Tonawanda			New York State Risk Mean (range)[c]	US Risk Mean (range)[c]
				Mean (µg/m^3)	Non-cancer Risk (Hazard Quotient)	Cancer Risk		
Chloromethane	90		Non-cancer	1.0	0.011			
Dichlorodifluoromethane	12000		Non-cancer	2.6	0.00022			
Dichloromethane	2.1	4.7 x 10^{-7}	Cancer	0.36		0.17 x 10^{-6}		
Formaldehyde	0.06	1.7 x 10^{-5}	Cancer	2.3		38 x 10^{-6}	31 x 10^{-6} (16 x 10^{-6} – 43 x 10^{-6})	55 x 10^{-6} (8.3 x 10^{-6} – 260 x 10^{-6})
Toluene	5000		Non-cancer	2.1	0.00042			
Trichlorofluoromethane	1000		Non-cancer	1.0	0.0010			
Trichlorotrifluoroethane	180000		Non-cancer	0.67	3.7 x 10^{-6}			
GIBI								
Acetaldehyde	0.45	2.2 x 10^{-6}	Cancer	1.3		2.89 x 10^{-6}	2.4 x 10^{-6} (1.3 x 10^{-6} – 2.9 x 10^{-6})	4.4 x 10^{-6} (0.77 x 10^{-6} – 14 x 10^{-6})
Acrolein	0.020		Non-cancer	0.43	22		(18, 23)[d]	39 (2.2 – 120)
Benzene	0.13	7.8 x 10^{-6}	Cancer	9.8		75 x 10^{-6}	7.5 x 10^{-6} (5.3 x 10^{-6} – 9.6 x 10^{-6})	11 x 10^{-6} (2.2 x 10^{-6} – 220 x 10^{-6})
Carbon disulfide	700		Non-cancer	1.1	0.0016			
Carbon tetrachloride	0.067	1.5 x 10^{-5}	Cancer	0.68		10 x 10^{-6}	9.7 x 10^{-6} (9.2 x 10^{-6} – 11 x 10^{-6})	9.7 x 10^{-6} (6.4 x 10^{-6} – 83 x 10^{-6})
Chloromethane	90		Non-cancer	1.0	0.011			
Dichlorodifluoromethane	12000		Non-cancer	2.6	0.00022			
Dichloromethane	2.1	4.7 x 10^{-7}	Cancer	0.19		0.091 x 10^{-6}		
Formaldehyde	0.06	1.7 x 10^{-5}	Cancer	5.9		98 x 10^{-6}	31 x 10^{-6} (16 x 10^{-6} – 43 x 10^{-6})	55 x 10^{-6} (8.3 x 10^{-6} – 260 x 10^{-6})
m,p-xylene	100		Non-cancer	1.8	0.018			
o-xylene	100		Non-cancer	0.60	0.0060			
Toluene	5000		Non-cancer	3.1	0.00062			
Trichlorofluoromethane	1000		Non-cancer	1.0	0.0010			
Trichlorotrifluoroethane	180000		Non-cancer	0.64	3.6 x 10^{-6}			

Chemical	AGC (μg/m^3)	Inhalation Unit Risk[a] (μg/m^3)$^{-1}$	Toxicity Endpoint[b]	Tonawanda			New York State Risk Mean (range)[c]	US Risk Mean (range)[c]
				Mean (μg/m^3)	Non-cancer Risk (Hazard Quotient)	Cancer Risk		
SPWT								
Acetaldehyde	0.45	2.2 x 10^{-6}	Cancer	1.0		2.20 x 10^{-6}	2.4 x 10^{-6} (1.3 x 10^{-6} – 2.9 x 10^{-6})	4.4 x 10^{-6} (0.77 x 10^{-6} – 14 x 10^{-6})
Acrolein	0.020		Non-cancer	0.34	17		(18, 23)[d]	39 (2.2 – 120)
Benzene	0.13	7.8 x 10^{-6}	Cancer	1.3		9.9 x 10^{-6}	7.5 x 10^{-6} (5.3 x 10^{-6} – 9.6 x 10^{-6})	11 x 10^{-6} (2.2 x 10^{-6} – 220 x 10^{-6})
Carbon disulfide	700		Non-cancer	1.9	0.0027			
Carbon tetrachloride	0.067	1.5 x 10^{-5}	Cancer	0.69		10 x 10^{-6}	9.7 x 10^{-6} (9.2 x 10^{-6} – 11 x 10^{-6})	9. 7 x 10^{-6} (6.4 x 10^{-6} – 83 x 10^{-6})
Chloromethane	90		Non-cancer	1.0	0.011			
Dichlorodifluoromethane	12000		Non-cancer	2.6	0.00022			
Dichloromethane	2.1	4.7 x 10^{-7}	Cancer	0.23		0.110 x 10^{-6}		
Formaldehyde	0.06	1.7 x 10^{-5}	Cancer	1.9		32 x 10^{-6}	31 x 10^{-6} (16 x 10^{-6} – 43 x 10^{-6})	55 x 10^{-6} (8.3 x 10^{-6} – 260 x 10^{-6})
m,p-xylene	100		Non-cancer	0.88	0.0088			
o-xylene	100		Non-cancer	0.34	0.0034			
Propionaldehyde	110		Non-cancer	0.20	0.0018			
Toluene	5000		Non-cancer	1.9	0.00038			
Trichlorofluoromethane	1000		Non-cancer	1.00	0.0010			
Trichlorotrifluoroethane	180000		Non-cancer	0.63	3.5 x 10^{-6}			

[a] Inhalation Unit Risk (IUR) values were used in the cancer risk evaluation. AGCs are derived from IUR values as shown in the following formula, using acetaldehyde as the example: $AGC = \frac{1x10^{-6}}{IUR}$ Acetaldehyde: $0.45\mu g/m^3 = \frac{1x10^{-6}}{2.2x10^{-6}(\mu g/m^3)^{-1}}$

[b] Based on source of AGC assignment

[c] State and US results displayed when Tonawanda air toxic result is above hazard index of 1 or cancer risk greater than one in a million (1 x 10^{-6})

[d] Acrolein is monitored at two sites in the State’s network of toxics monitors.

Table 7.9 Annual Inhalation Cancer Risk at the Study's Four Monitoring Sites

(Risk expressed as excess inhalation cancer cases per million individuals exposed in a lifetime)

Grand Island Blvd Monitoring Site

Compound	Concentration µg/m^3	Category	AGC µg/m^3	Risk 1x 10^6
Acetaldehyde	1.3	C	0.45	2.9
Benzene	9.8	C	0.13	75.4
BSO	0.875	Modeled	0.0016	547
1,3-Butadiene	0.24	B	0.033	7.4
Carbon tetrachloride	0.68	C	0.067	10.1
Dichloromethane	0.19	C	2.1	0.09
Formaldehyde	5.9	C	0.06	98.3
Naphthalene	0.128	Modeled	0.0294	4.4
Total				**745**

Compound	Concentration µg/m^3	Category	AGC µg/m^3	Risk 1x 10^6
Acetaldehyde	1.3	C	0.45	2.9
Benzene	9.8	C	0.13	75.4
BSO	0.244	Monitored[1]	0.0016	152.5
1,3-Butadiene	0.24	B	0.033	7.4
Carbon tetrachloride	0.68	C	0.067	10.1
Dichloromethane	0.19	C	2.1	0.09
Formaldehyde	5.9	C	0.06	98.3
Naphthalene	0.679	Monitored	0.0294	23
Total				**370**

Brookside Terrace Site

Compound	Concentration µg/m^3	Category	AGC ug/ µg/m^{3}m^3	Risk 1x 10^6
Acetaldehyde	1.1	C	0.45	2.4
Benzene	2.0	C	0.13	15.4
BSO	0.157	Modeled	0.0016	98.1
1,3-Butadiene	0.088	B	0.033	2.7
Carbon tetrachloride	0.69	C	0.067	10.3
Dichloromethane	0.36	C	2.1	0.17
Formaldehyde	2.3	C	0.06	38.3
Naphthalene	0.041	Modeled	0.0294	1.4
Total				**169**

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[1] Monitored data reflects the results and extrapolation from the PAH monitor in operation from July, 2008 to May 2009, see section 7.3 for details.

Sheridan Park Water Tower Site

Compound	Concentration µg/m^3	Category	AGC µg/m^3	Risk 1x 10^6
Acetaldehyde	1.0	C	0.45	2.2
Benzene	1.3	C	0.13	10.0
BSO	0.104	Modeled	0.0016	65.0
1,3-Butadiene		A		
Carbon tetrachloride	0.69	C	0.067	10.3
Dichloromethane	0.23	C	2.1	0.11
Formaldehyde	1.9	C	0.06	31.7
Naphthalene	0.063	Modeled	0.0294	2.1
Total				**121**

Beaver Island State Park Site

Compound	Concentration µg/m^3	Category	AGC µg/m^3	Risk
Acetaldehyde	0.9	C	0.45	2.0
Benzene	1.2	C	0.13	9.2
BSO	0.041	Modeled	0.0016	25.6
1,3-Butadiene		A		
Carbon tetrachloride	0.7	C	0.067	10.4
Dichloromethane	0.34	C	2.1	0.16
Formaldehyde	2.5	C	0.06	41.7
Naphthalene	0.012	Modeled	0.0294	0.82
Total				**90**

Note: 1.) The Category column represents the suitability of the air toxic for assessing risks based upon the decision tree described in subsection 7.1.1
2.) The “M” in the Category column represents modeled concentration data only.
3.) The AGC represents the air concentration that corresponds to a one-in-one-million inhalation excess cancer risk
4.) The Risk, expressed as the excess inhalation cancer cases per million individuals exposed is calculated by multiplying the chemical specific inhalation unit risk estimate.

Table 7.10 Hazard Index Analysis

Kaufman Avenue,

Top five Hazard Quotient (HQ) Compounds Attributing to the Hazard Index (HI) from Stationary Sources Only

	Acrolein	Sulfuric Acid	Hydrochloric Acid	Naphthalene	Ammonia	Total HI
HQ	0.48	0.42	0.05	0.04-0.23*	0.04	**1.03-1.22**
Facility	3M	FMC Corp.	FMC Corp.	Tonawanda Coke	Tonawanda Coke	

*see text section 7.4.2

Ken-Ton Occupational School and Neighborhood South

Top five Hazard Quotient (HQ) Compounds Attributing to the Hazard Index (HI) from Stationary Sources Only

	Acrolein	**Ammonia**	**Sulfuric acid**	**Acetaldehyde**	**Aniline**	**Total HI**
HQ	0.28	0.03	0.02	0.015	0.012	**0.48**
Facility	3M	Tonawanda Coke	3M	3M	Valley Retread	

Tonawanda School District

Top five Hazard Quotient (HQ) Compounds Attributing to the Hazard Index (HI) from Stationary Sources Only

	Acrolein	Chloroform	Ammonia	Hydrogen Sulfide	Toluene Diisocyanate	Total HI
HQ	0.12	0.08	0.03	0.03	0.02	**0.28**
Facility	Sewage Treatment Plant	Sewage Treatment Plant	Tonawanda Coke	Sewage Treatment Plant	Keller Technology	

Esminger Playfield Neighborhood

Top five Hazard Quotient (HQ) Compounds Attributing to the Hazard Index (HI) from Stationary Sources Only

	Acrolein	**Hydrochloric Acid**	**Ammonia**	**Toluene Diisocyanate**	**Chloroform**	**Total HI**
HQ	0.09	0.07	0.02	0.002	0.023	**0.21**
Facility	3M	ASPCA	Tonawanda Coke	Keller Technology	Niagara Landfill	

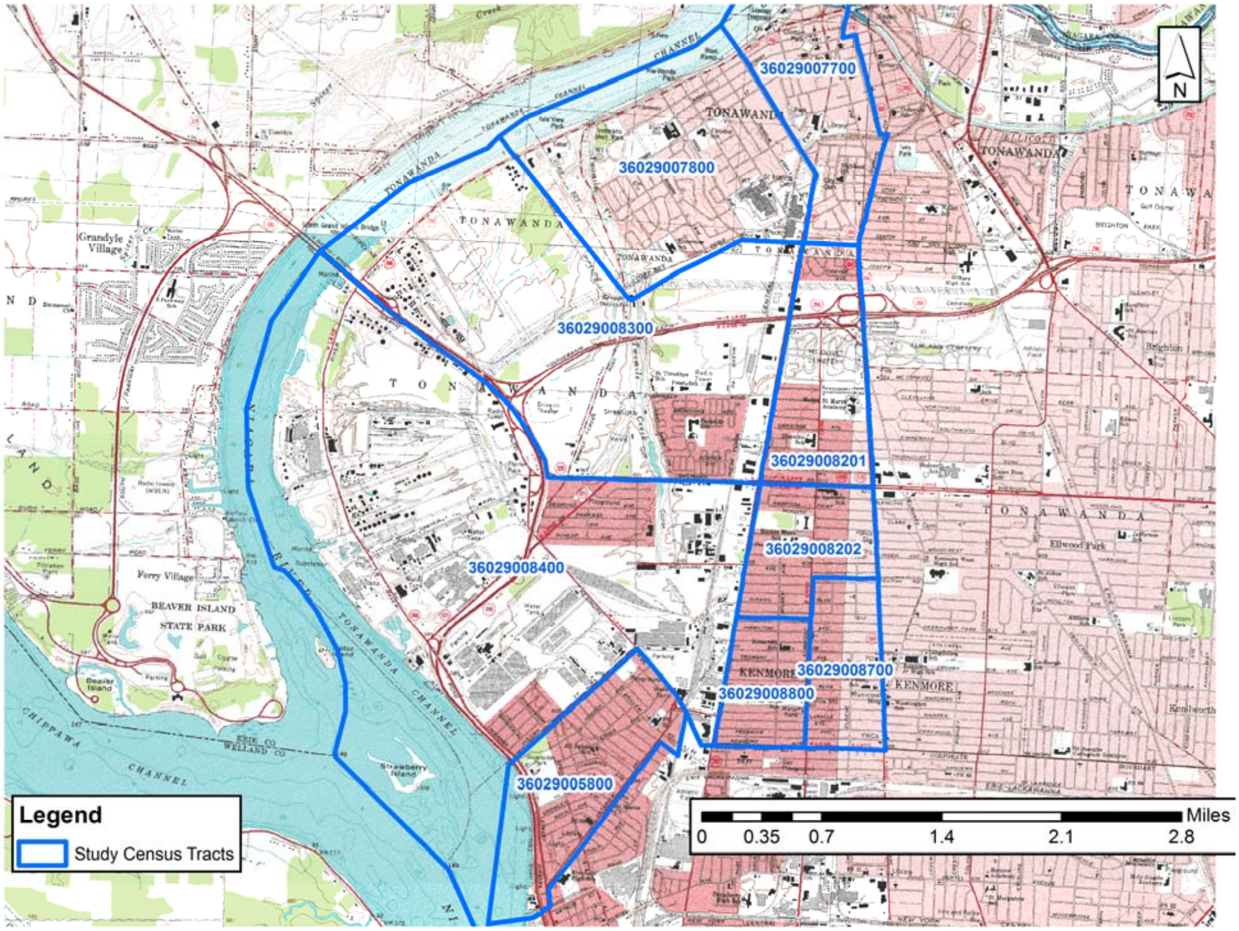


Figure 3.1 Tonawanda Study Area and Census Tract Codes

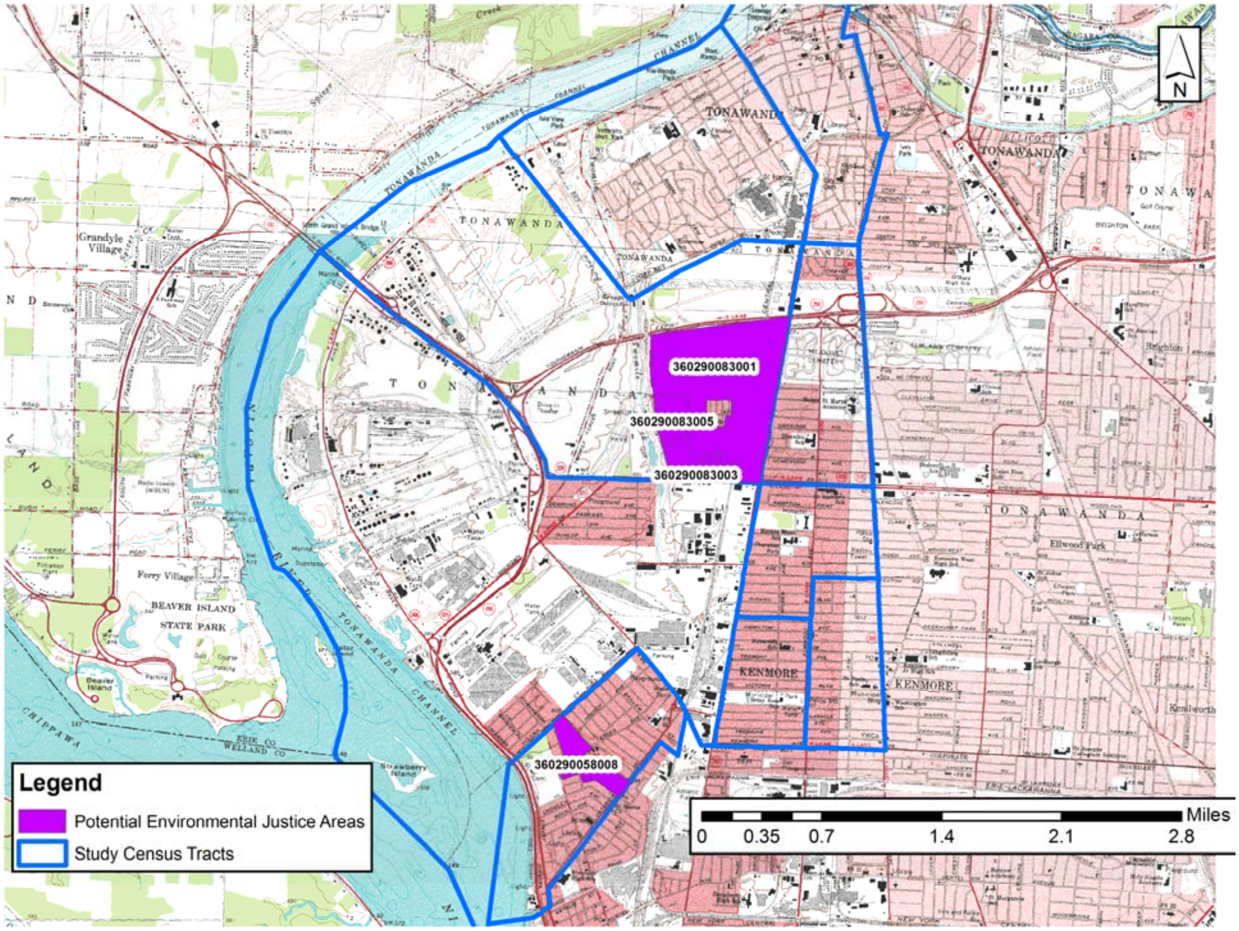


Figure 3.2 Tonawanda Study and Potential Environmental Justice Areas

Figure 5.1 BISP Monitor

Figure 5.2 GIBI Monitor

Figure 5.3 BTRS Monitor

Figure 5.4 SPWT Monitor

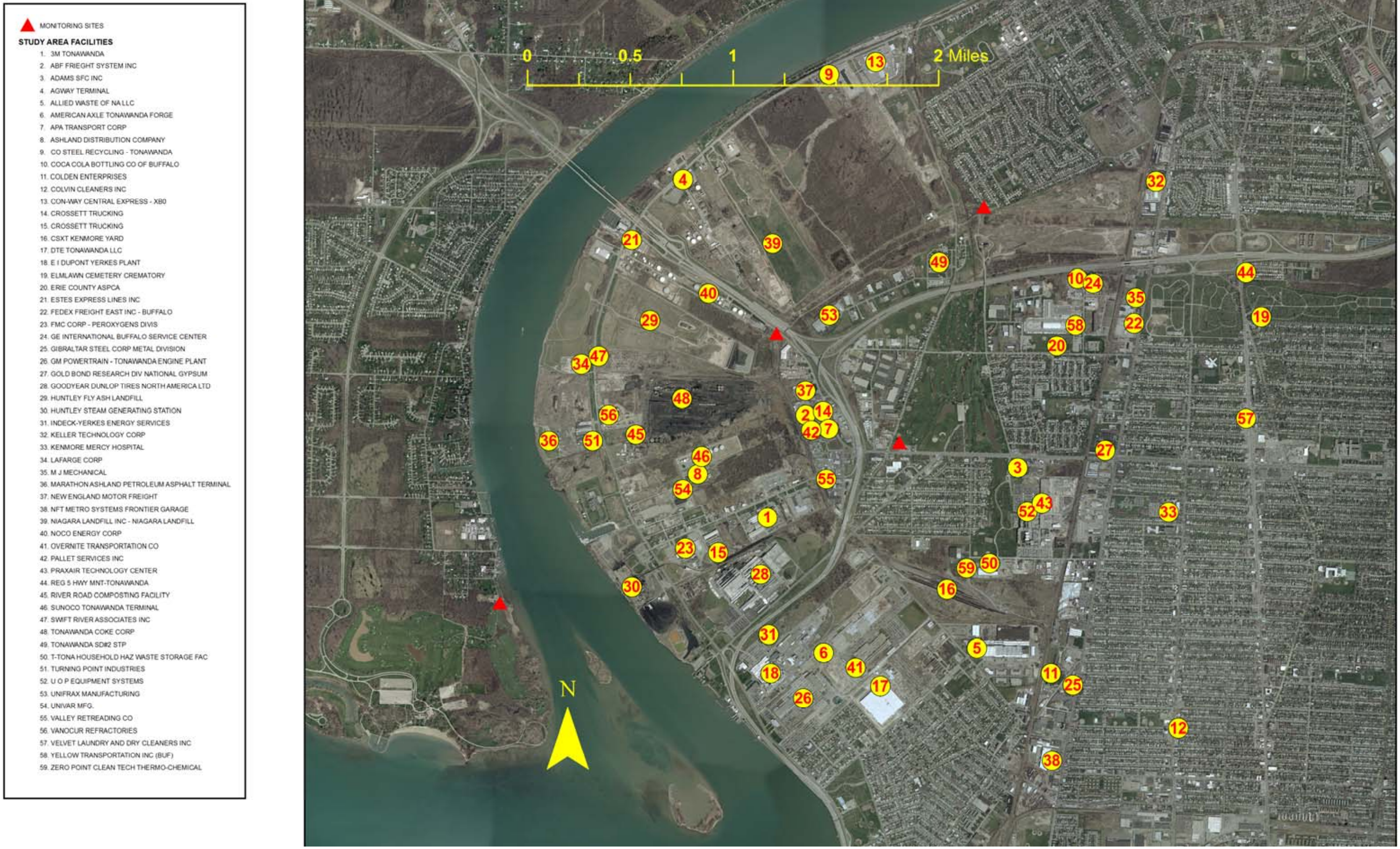
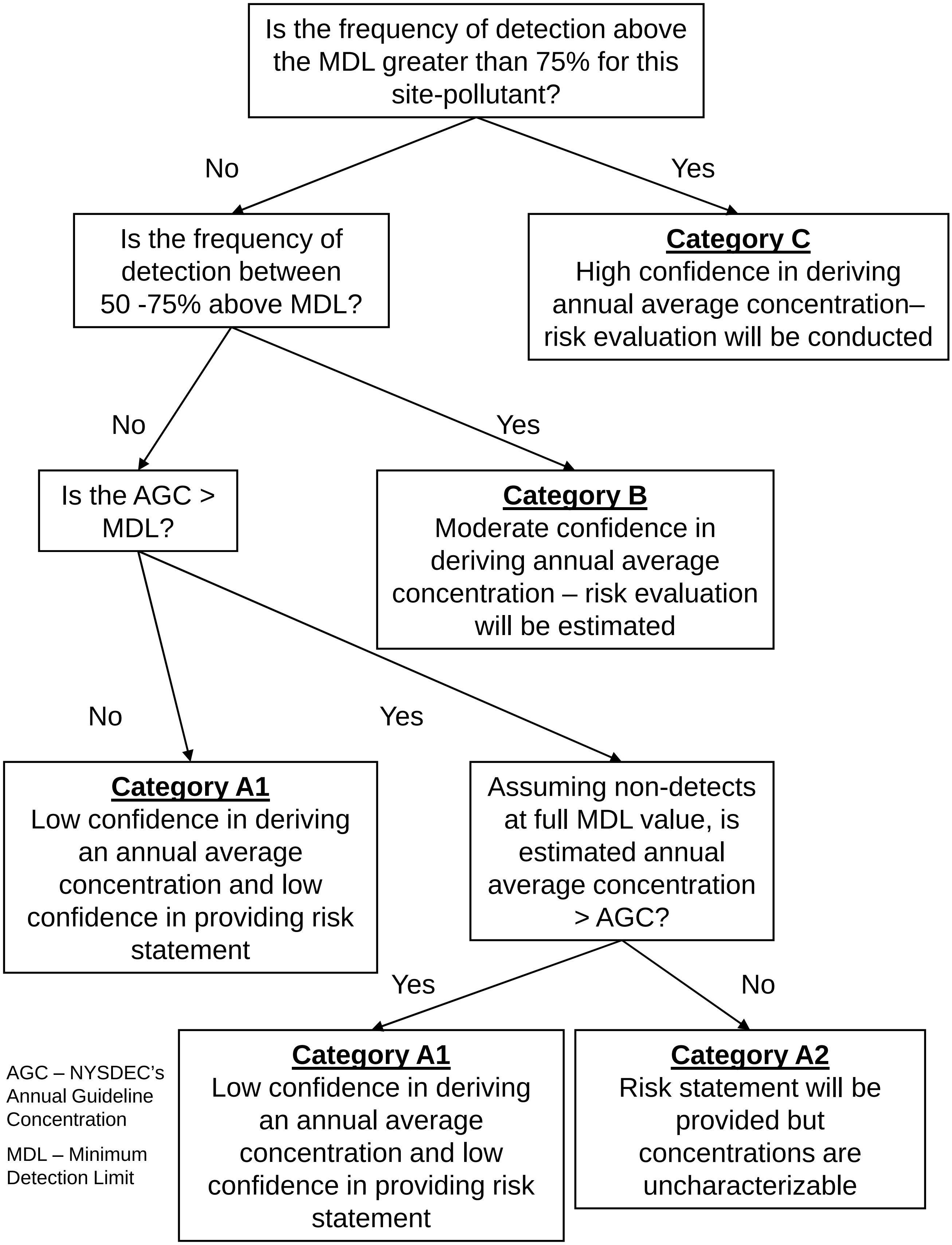


Figure 5.5 Map of Monitoring Locations and Facilities

Figure 5.6 Stainless Steel Canister

Figure 5.7 Carbonyl Cartridge



AGC – NYSDEC's Annual Guideline Concentration

MDL – Minimum Detection Limit

Figure 7.1 Decision Matrix to Assess the Suitability of Characterizing Annual Averages for Health Risk Evaluations

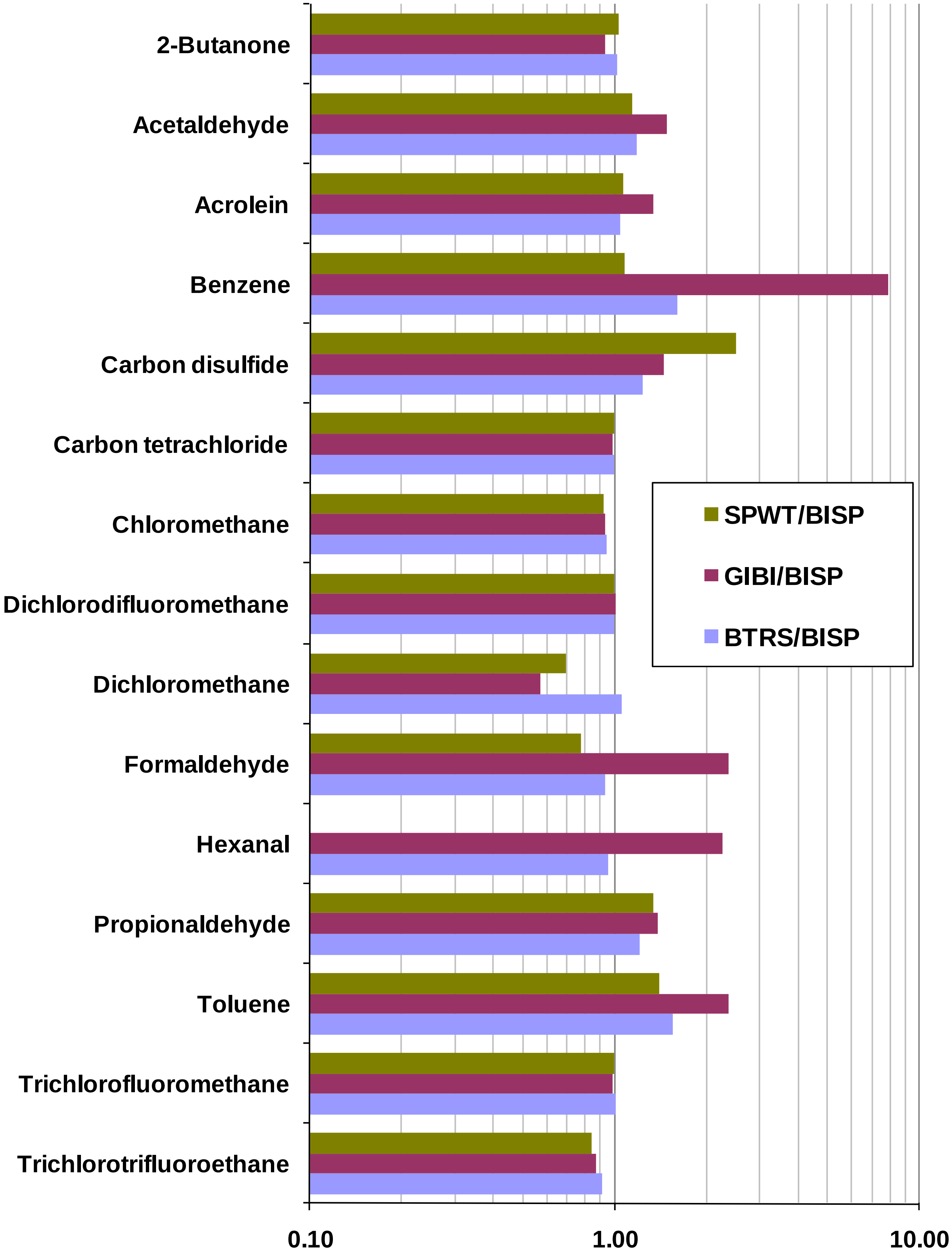


Figure 7.2 Comparison Annual Averages of Perimeter Sites to BISP (Background Site)

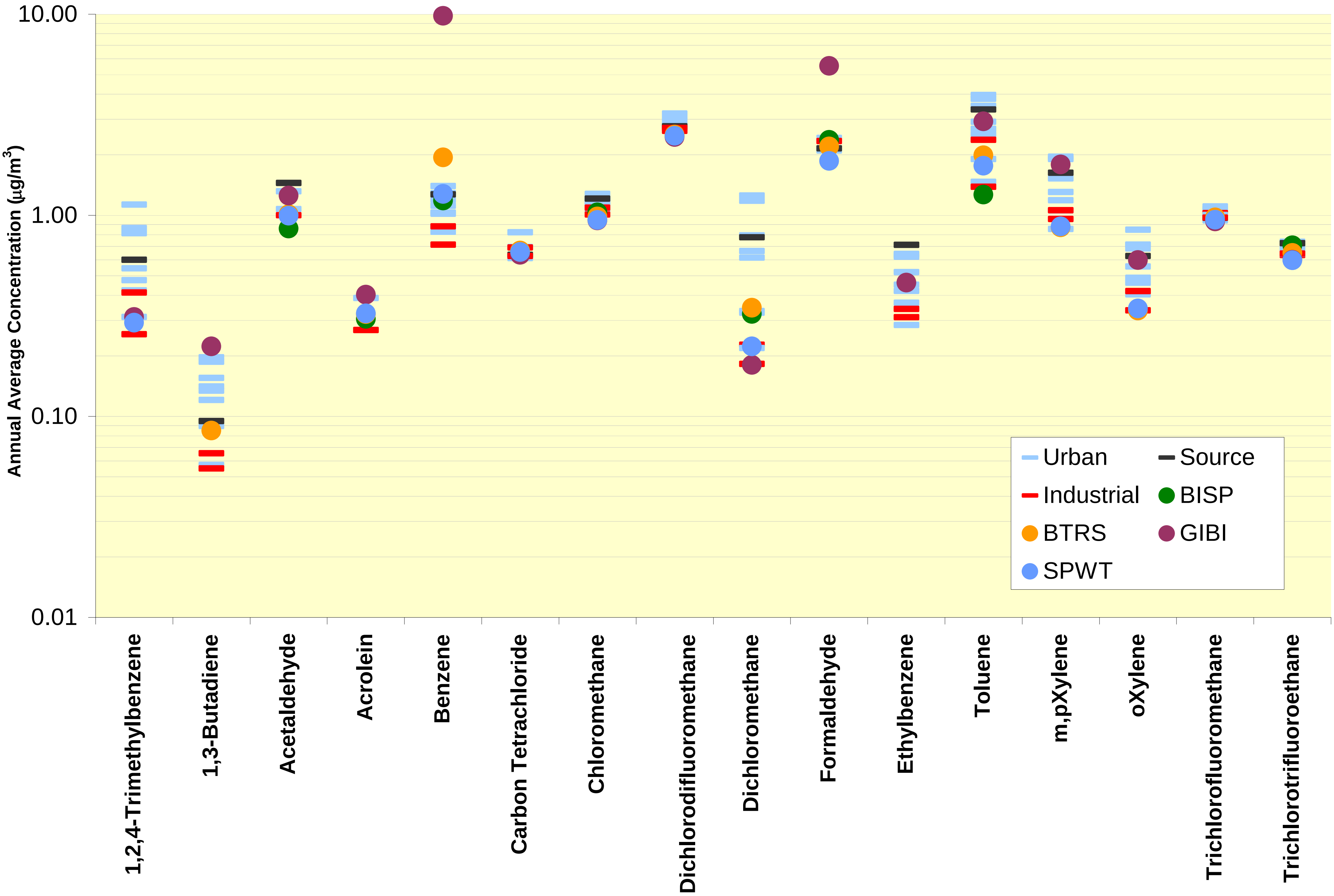


Figure 7.3 Comparison of NYS Air Monitoring Concentrations and Tonawanda Study Sites

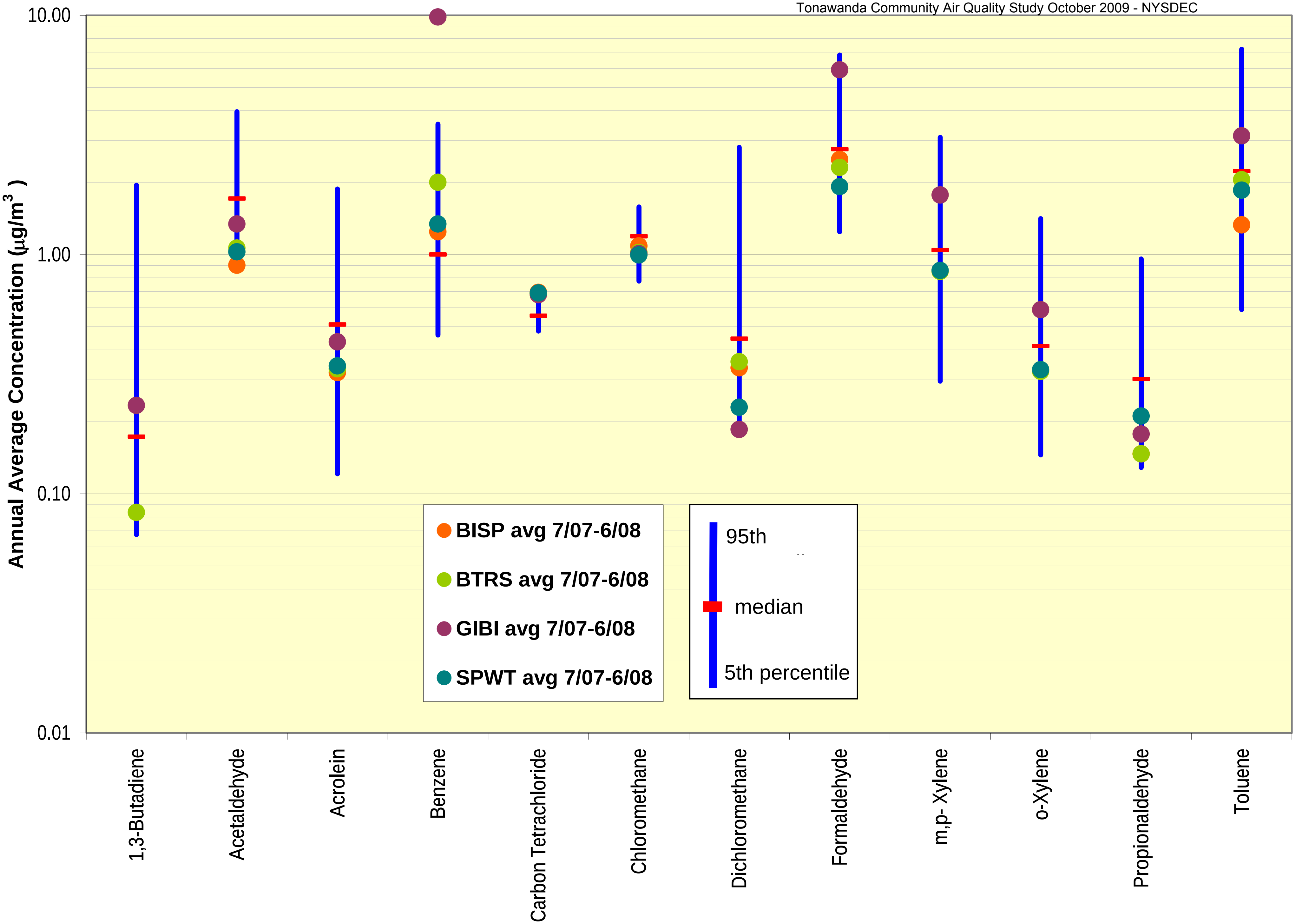


Figure 7.4 Comparison of US (2005) Air Monitoring Concentrations and Tonawanda Study Sites

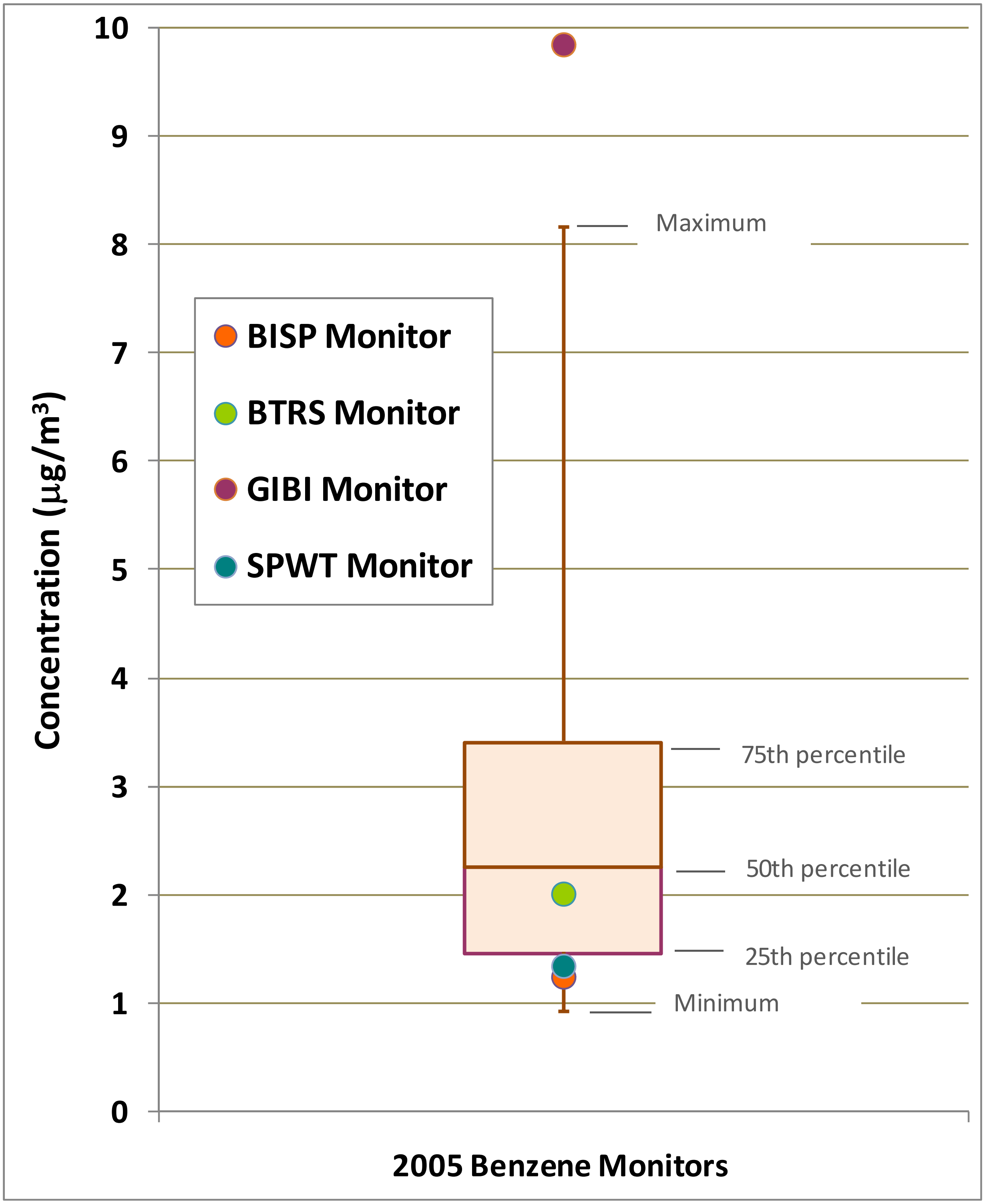


Figure 7.5 Comparison of 2005 Annual Average Benzene Concentrations from Monitors Near Facilities Releasing Benzene

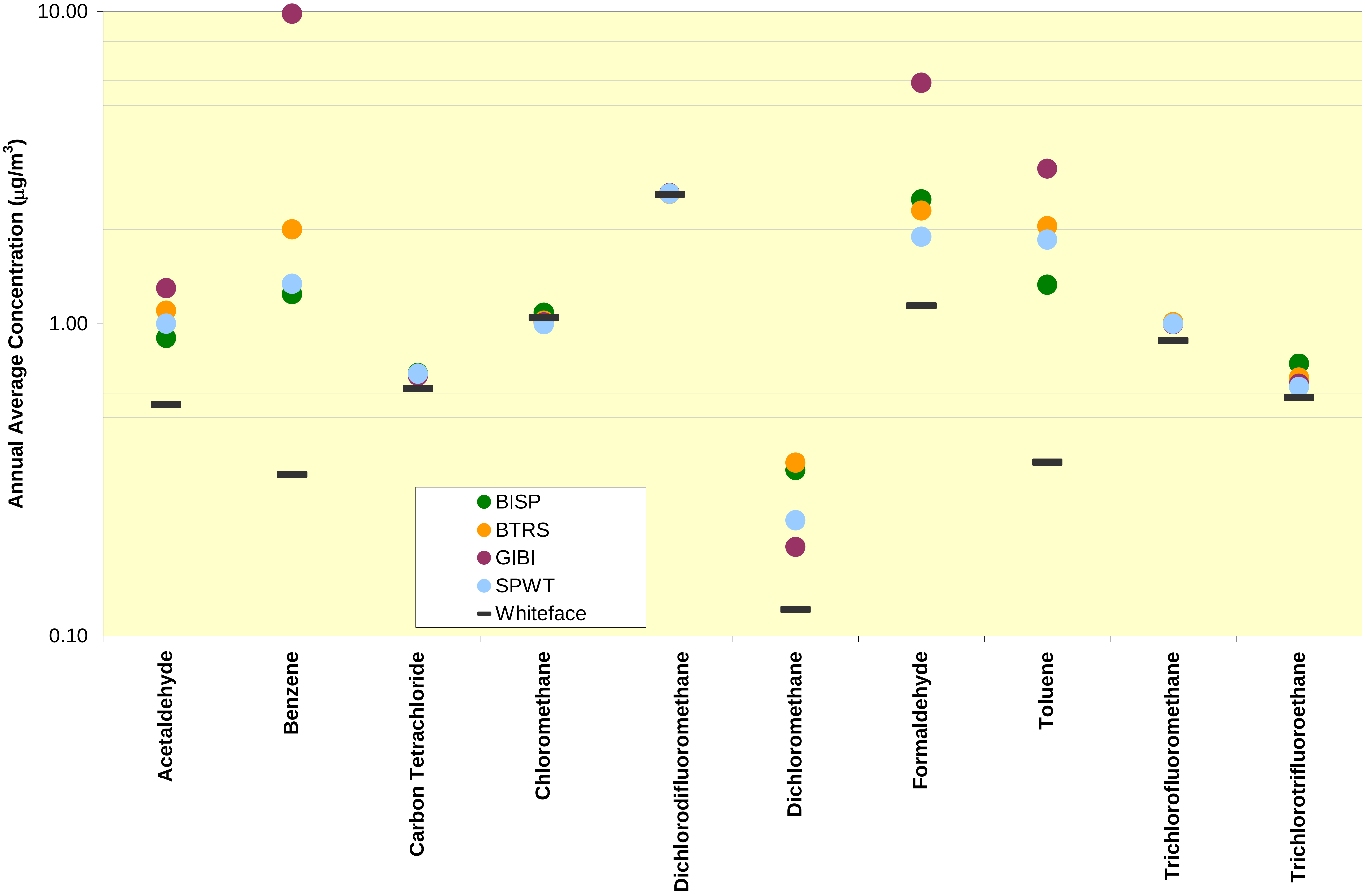


Figure 7.6 NYS Air Toxic Concentrations for Rural (Whiteface Mountain) Monitor and Tonawanda Study Sites

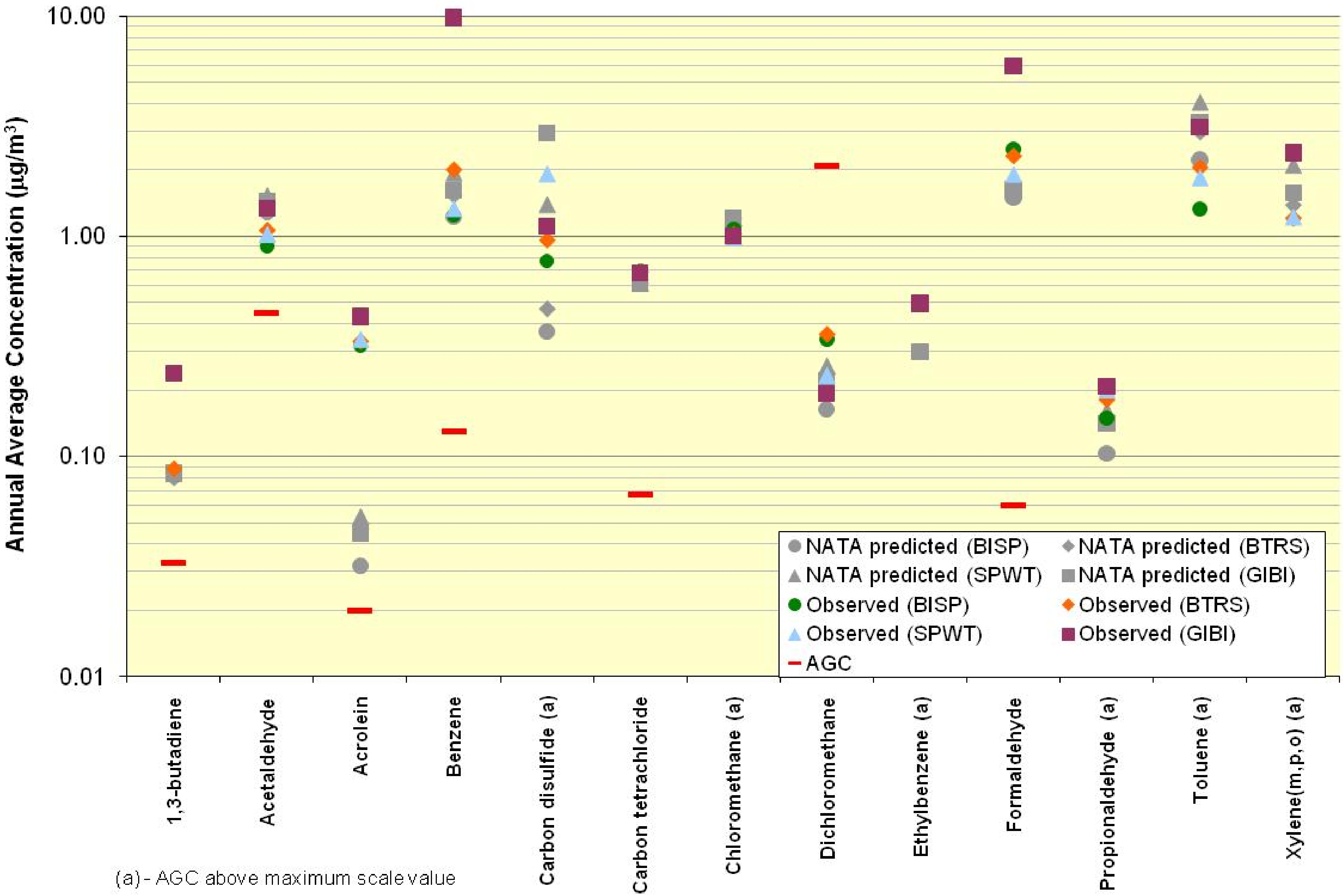


Figure 7.7 Comparison Study Monitors and USEPA's 2002 National-scale Air Toxics Assessment Annual Average Concentrations

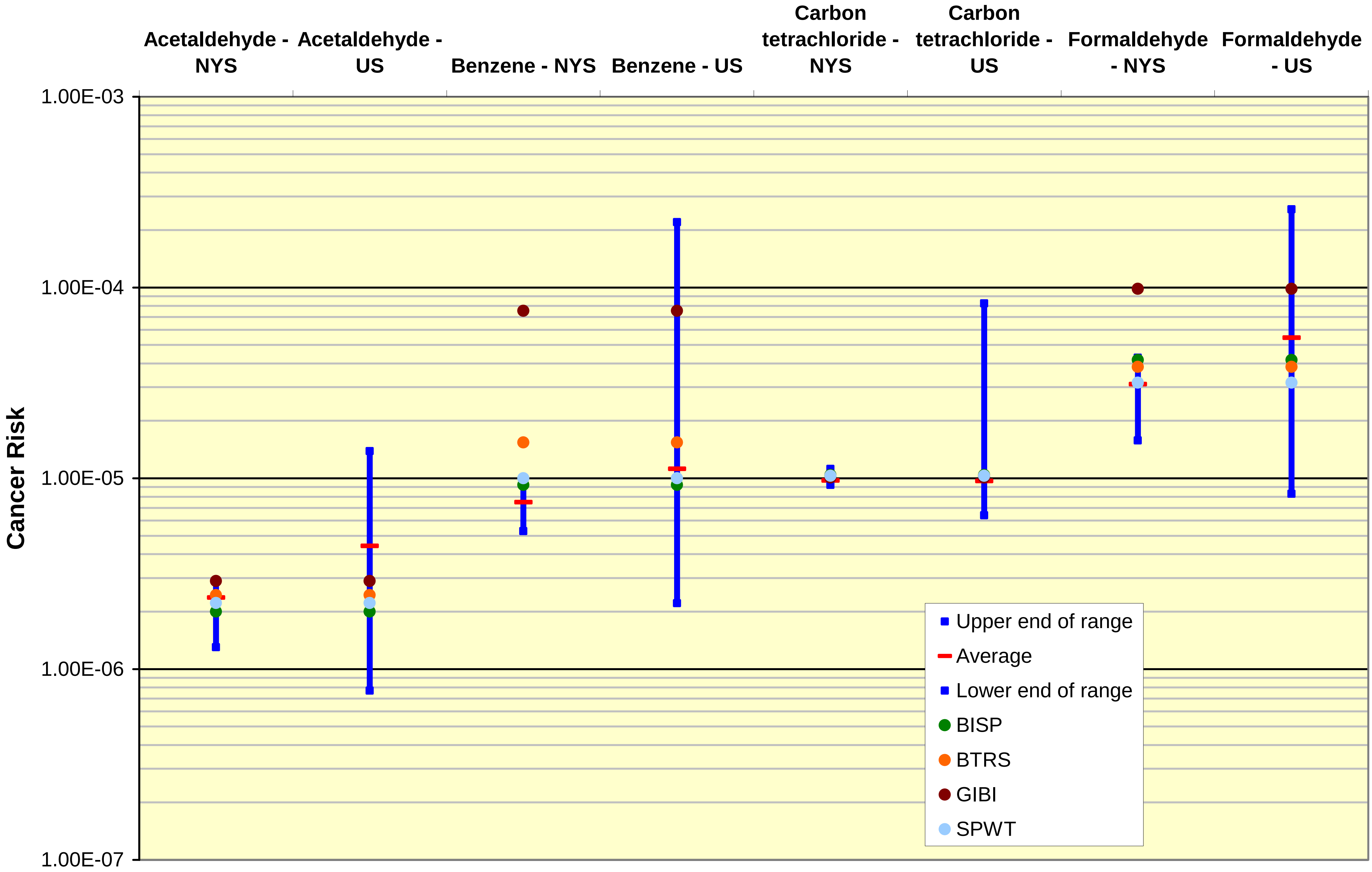


Figure 7.8 Comparison New York State, US and Tonawanda Study Site Cancer Risk Estimates for Acetaldehyde, Benzene, Carbon Tetrachloride and Formaldehyde

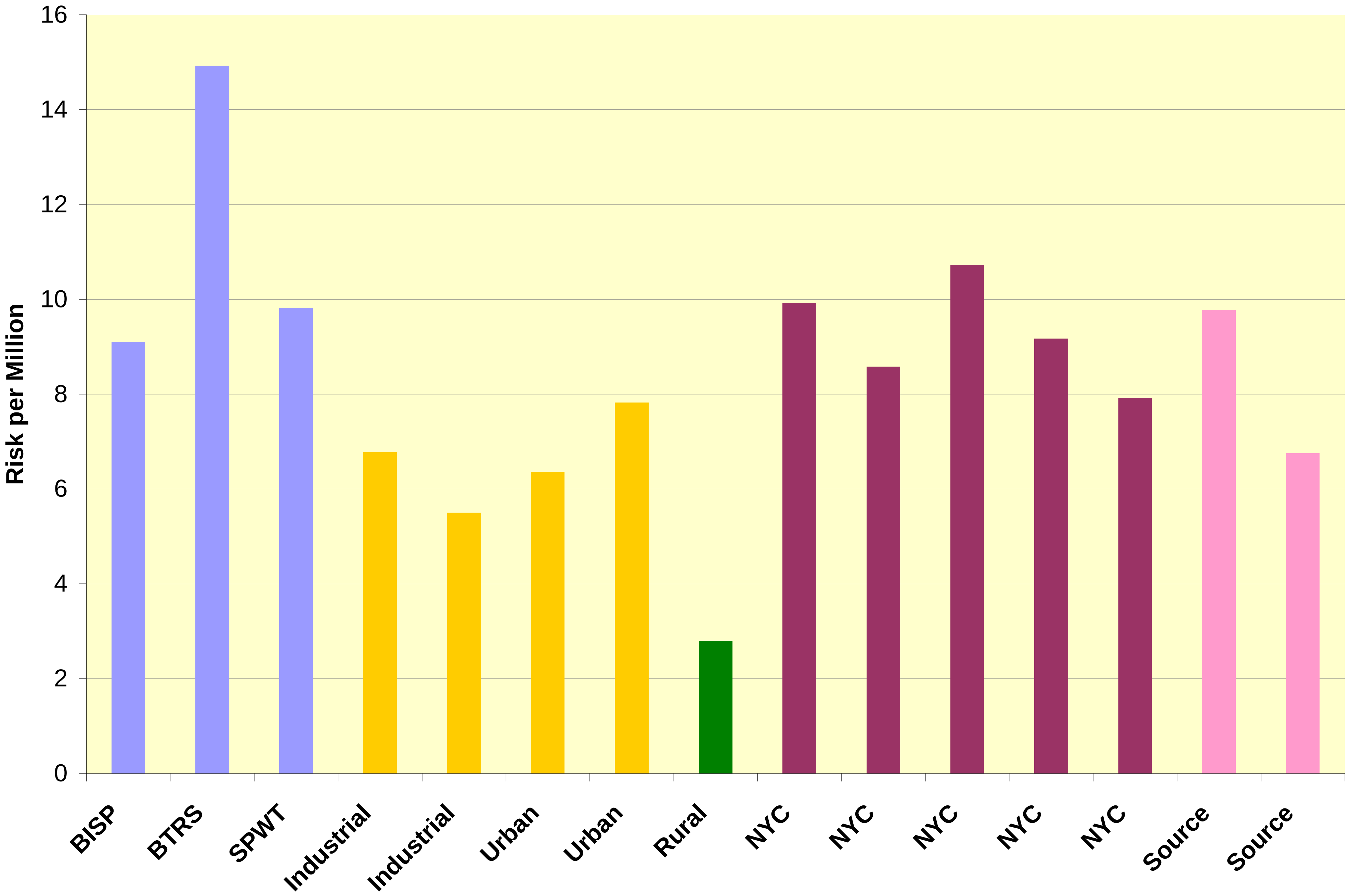


Figure 7.9 Comparison Benzene Risk Estimates for Study and State Sites (The risk estimate of 75 per million for the GIBI monitor is not included.)

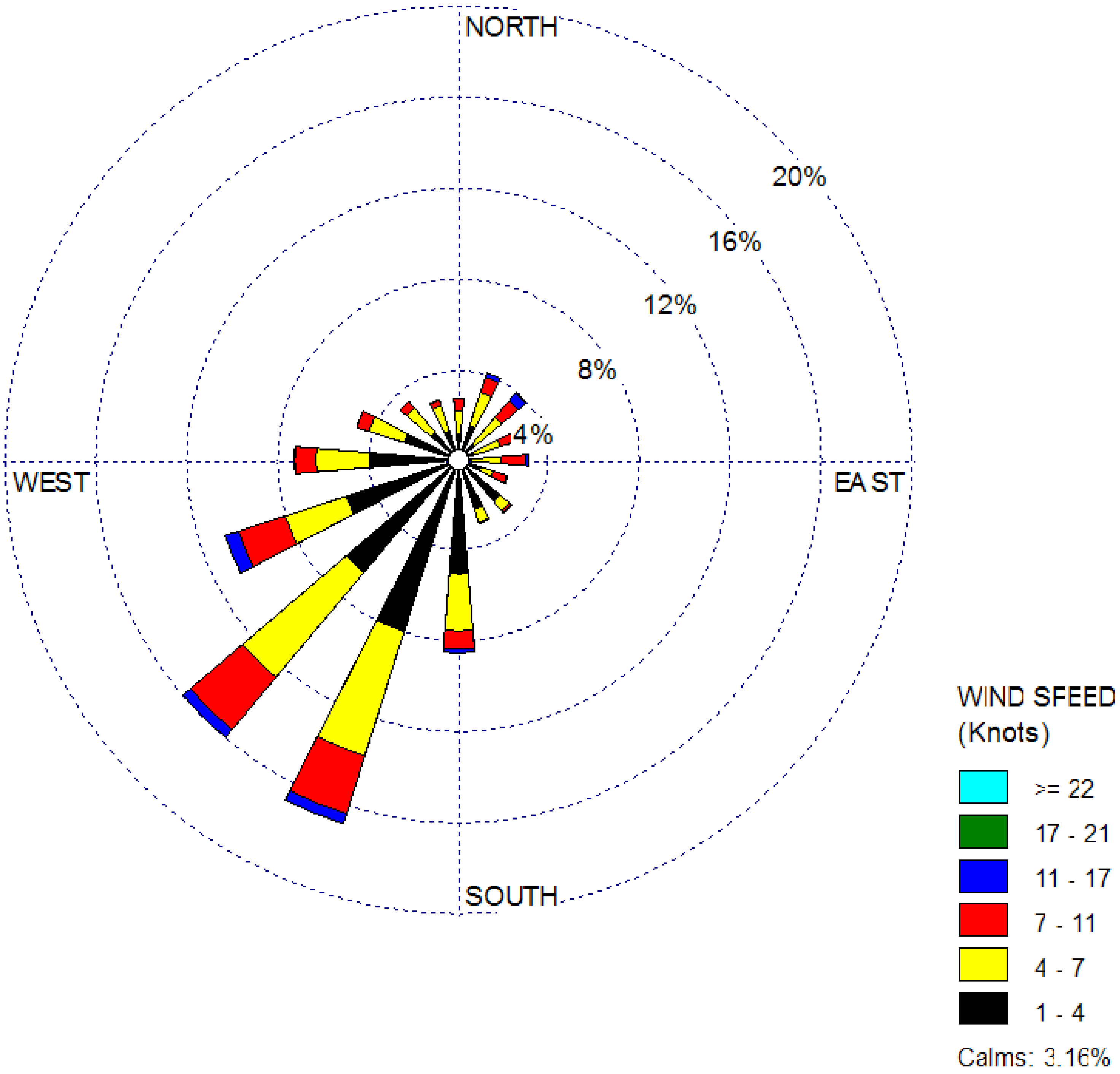


Figure 7.10. Beaver Island State Park Wind Direction and Wind Speed over the Study Period (12 Months).

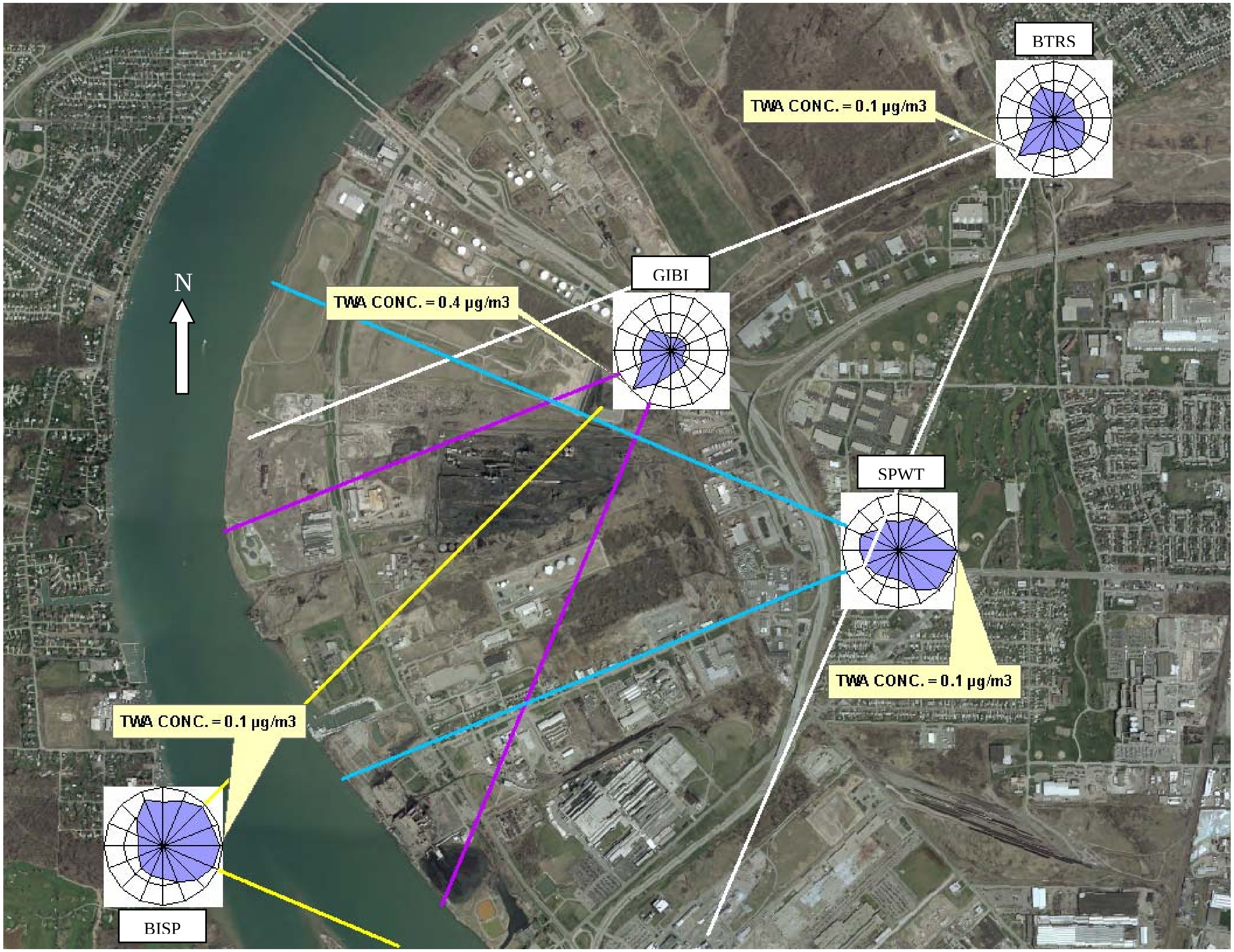


Figure 7.11. 1,3-Butadiene TW Pollution Roses

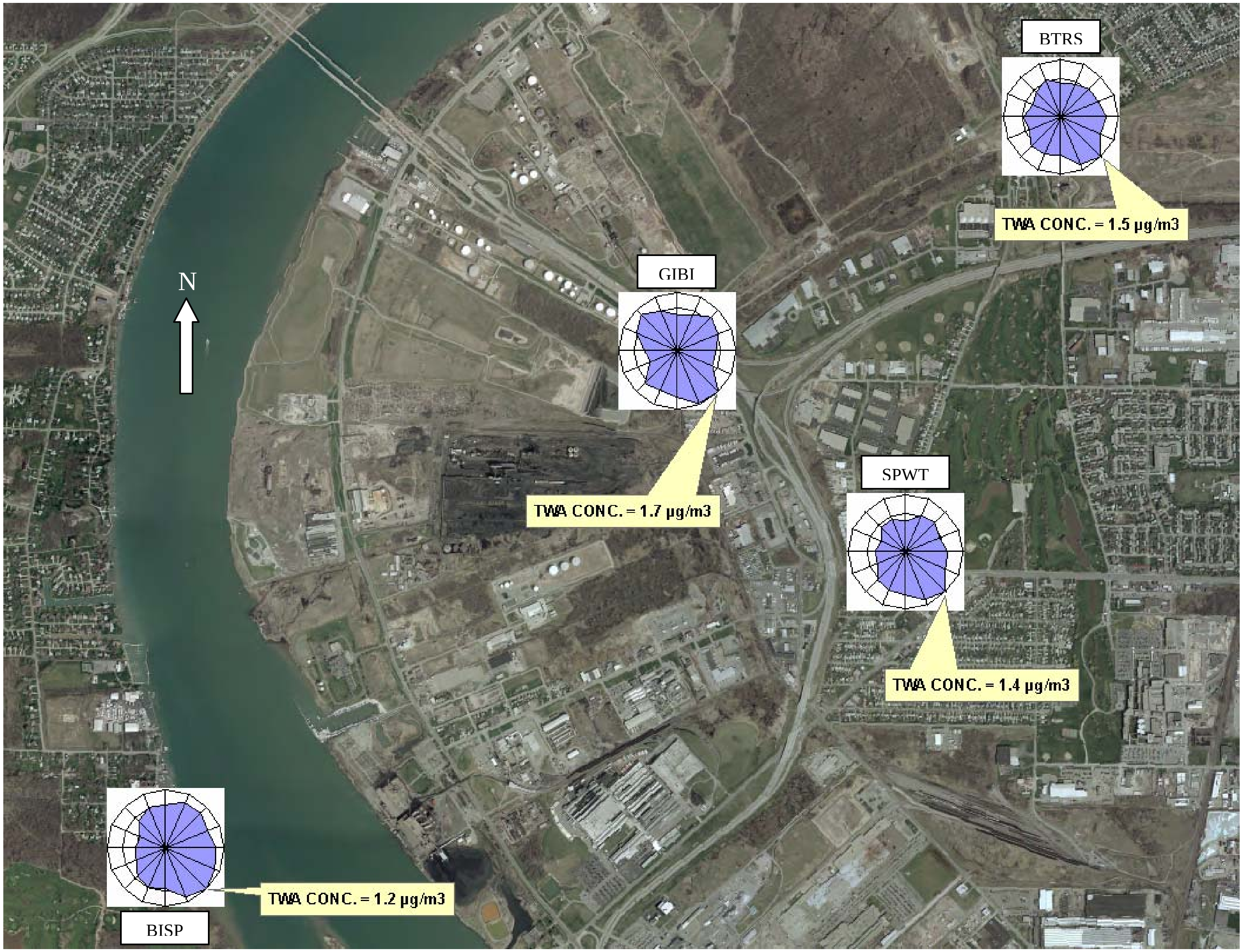


Figure 7.12. Acetaldehyde TW Pollution Roses

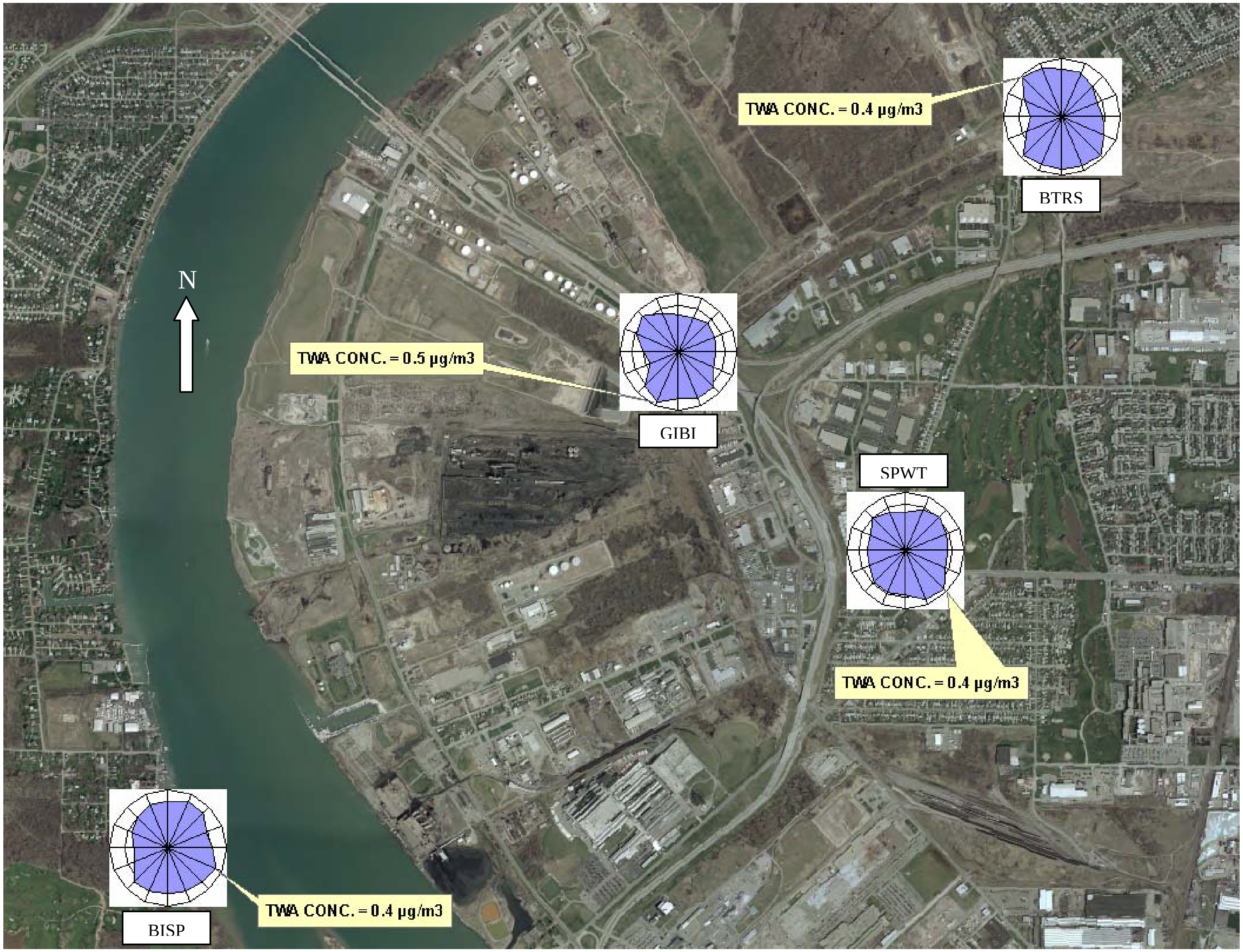


Figure 7.13. Acrolein TW Pollution Roses

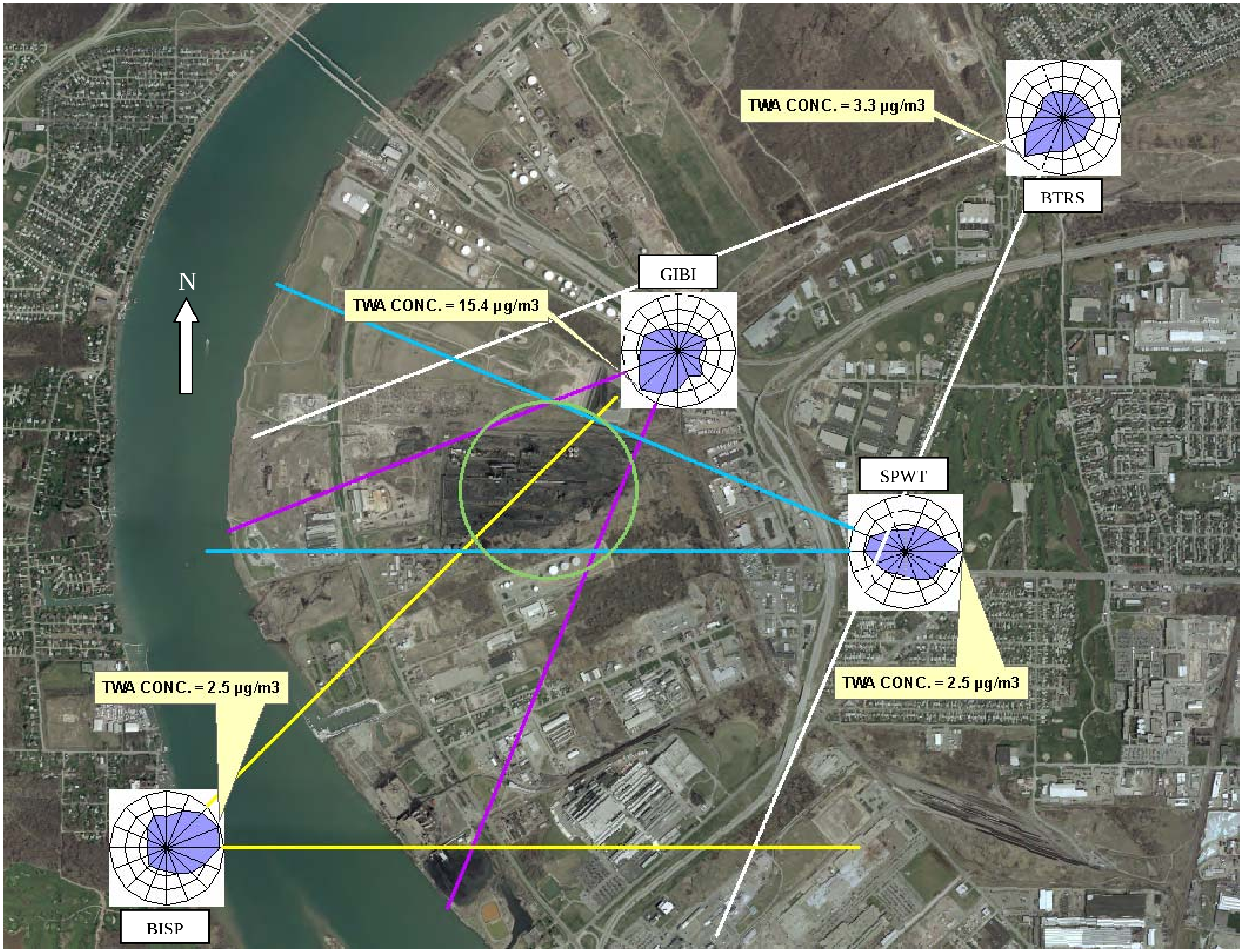


Figure 7.14. Benzene TW Pollution Roses

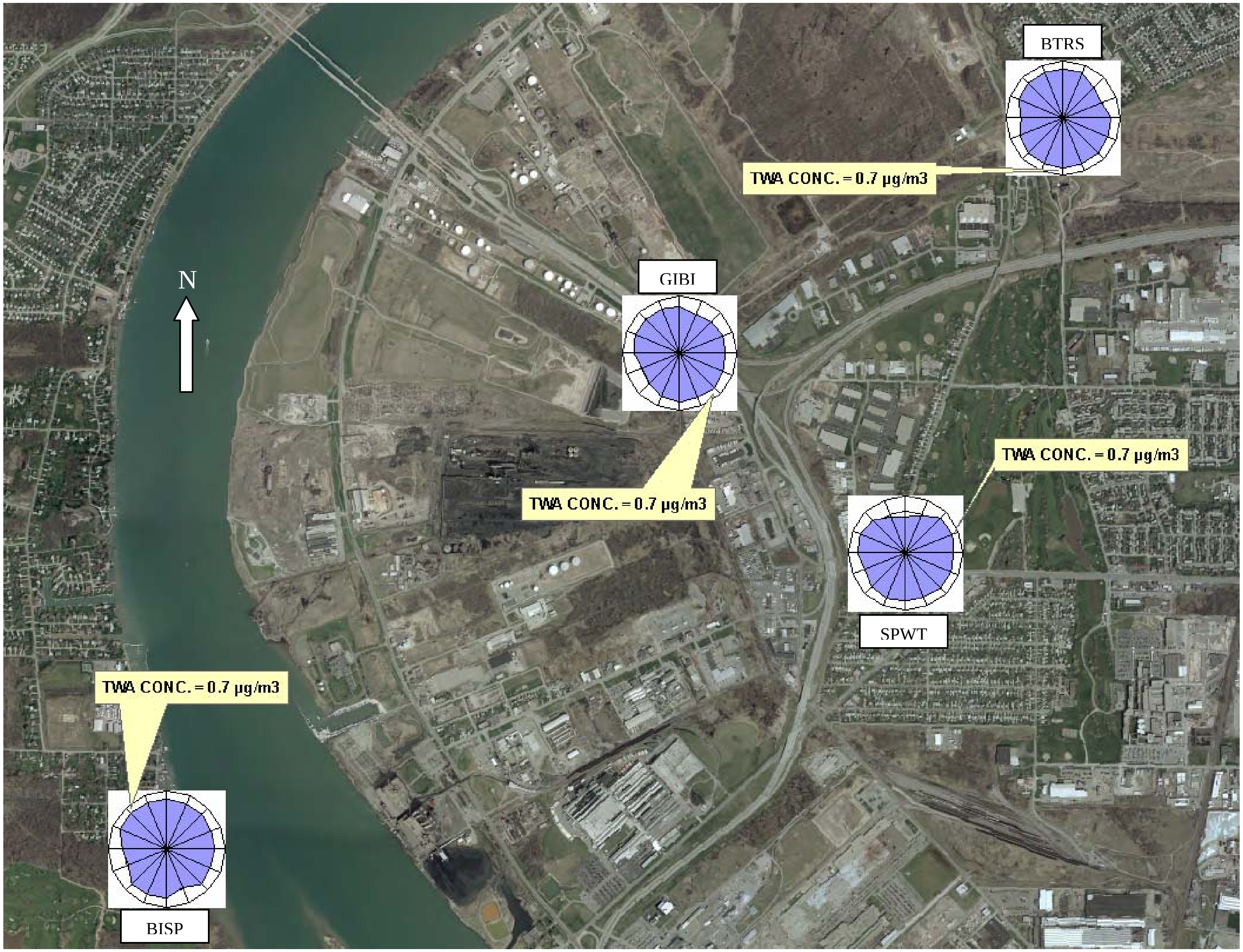


Figure 7.15. Carbon Tetrachloride TW Pollution Roses

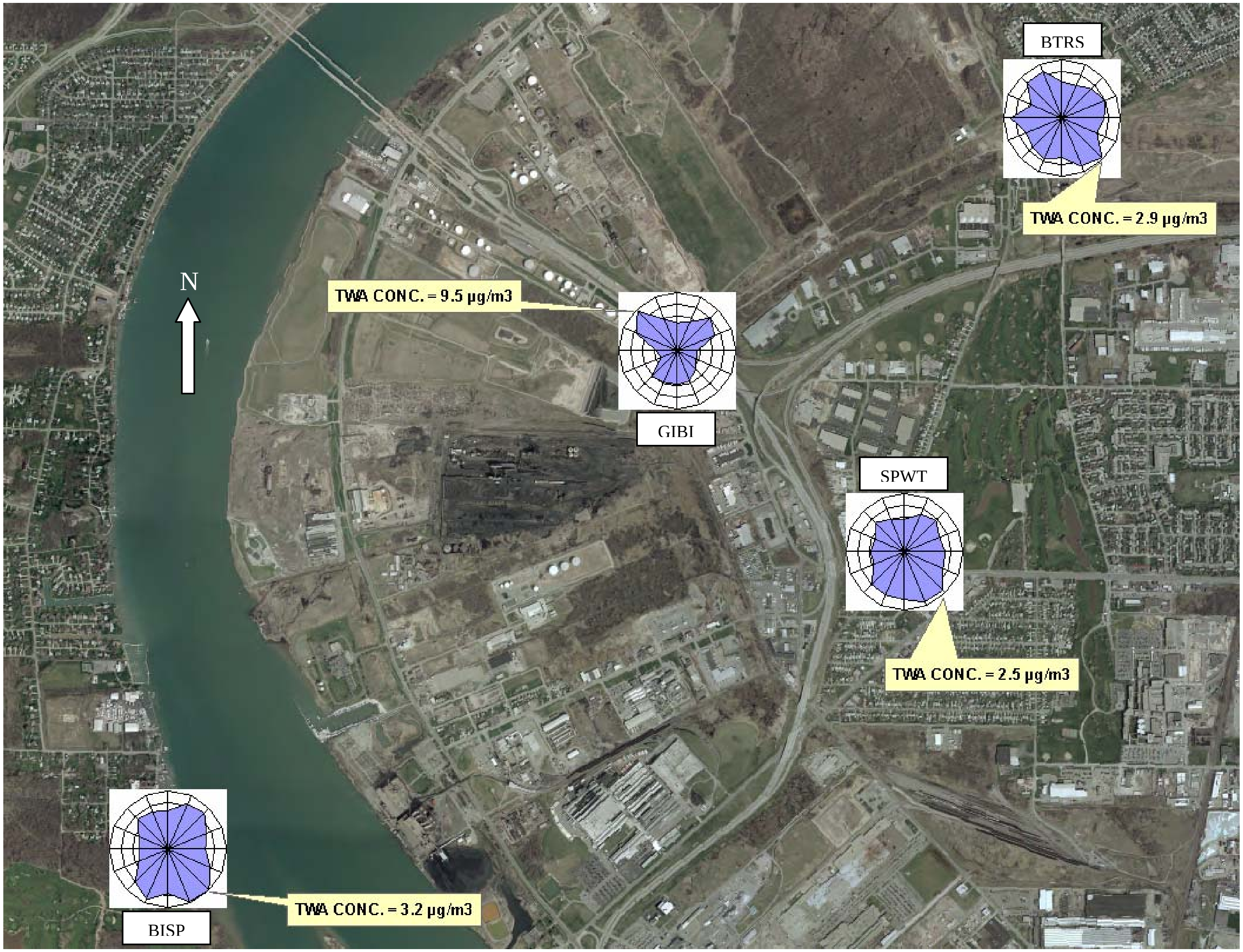


Figure 7.16. Formaldehyde TW Pollution Roses

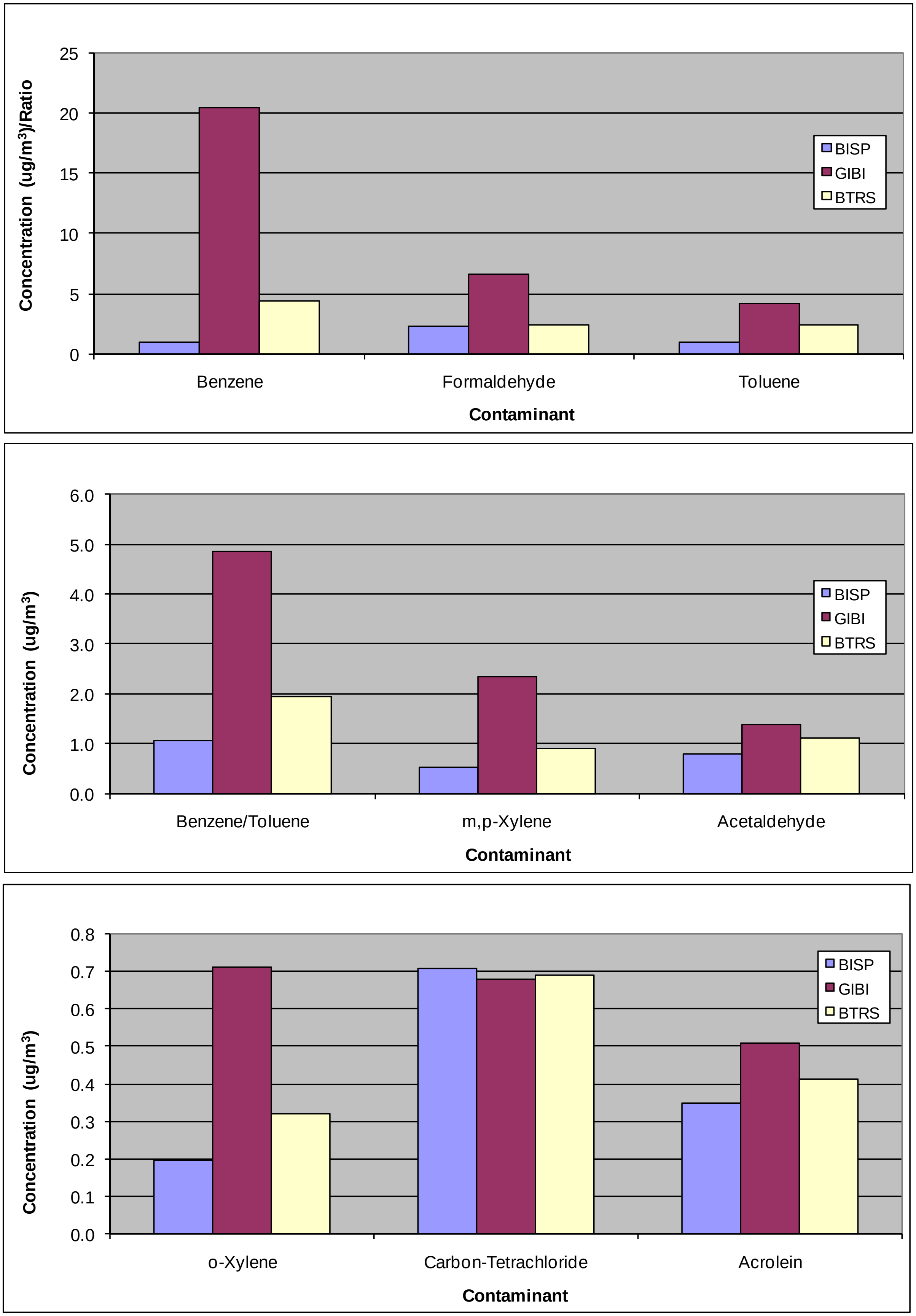


Figure 7.17. Concentrations Upwind versus Downwind of Tonawanda Coke Corporation with Winds from 225°. The BISP monitor is the upwind site and the GIBI and BTRS monitors are the downwind sites with this wind scenario.

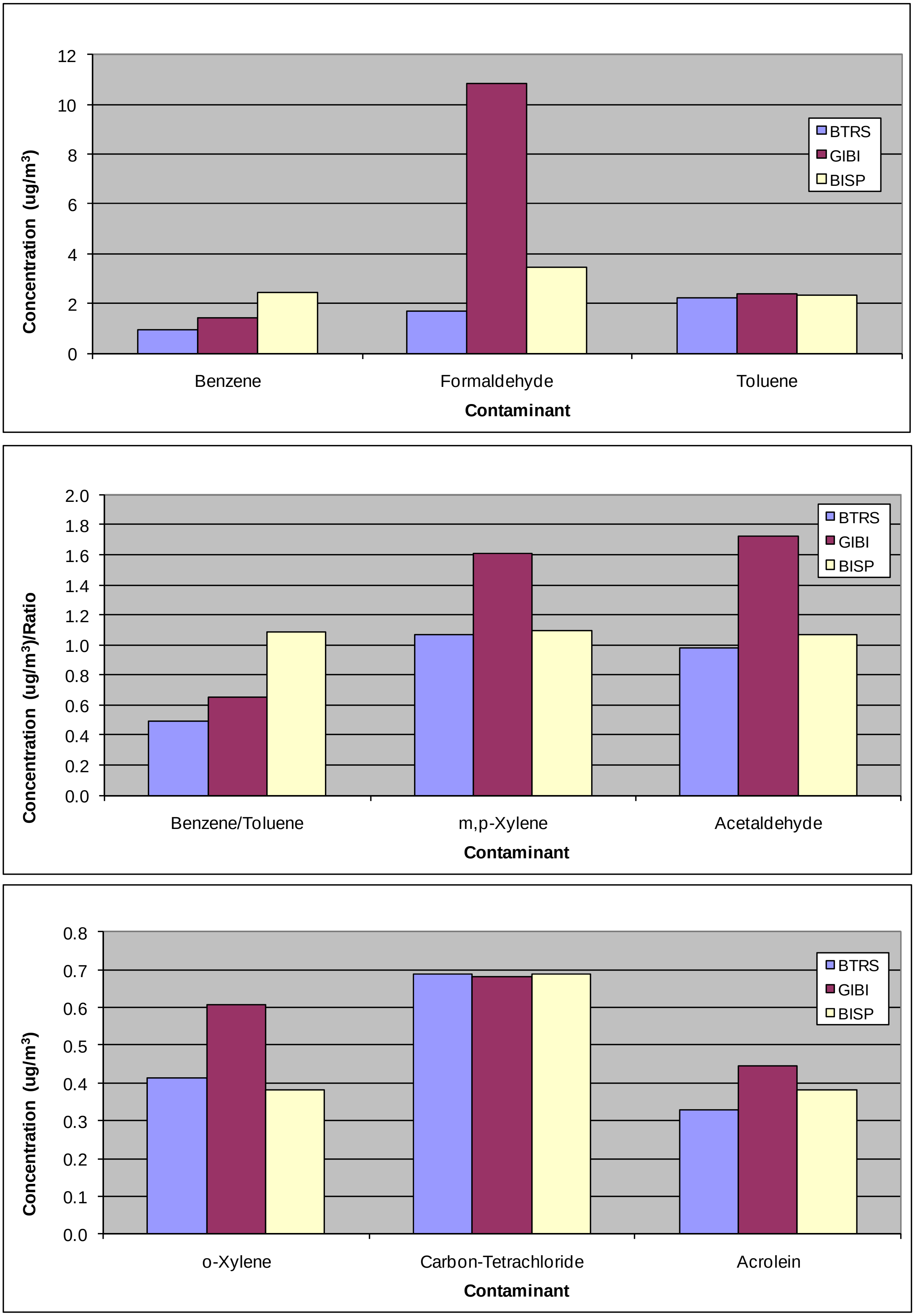


Figure 7.18. Concentrations Upwind versus Downwind of Tonawanda Coke Corporation with Winds from 45°. The GIBI and BTRS monitors are the upwind sites and the BISP monitor is the downwind site with this wind scenario.

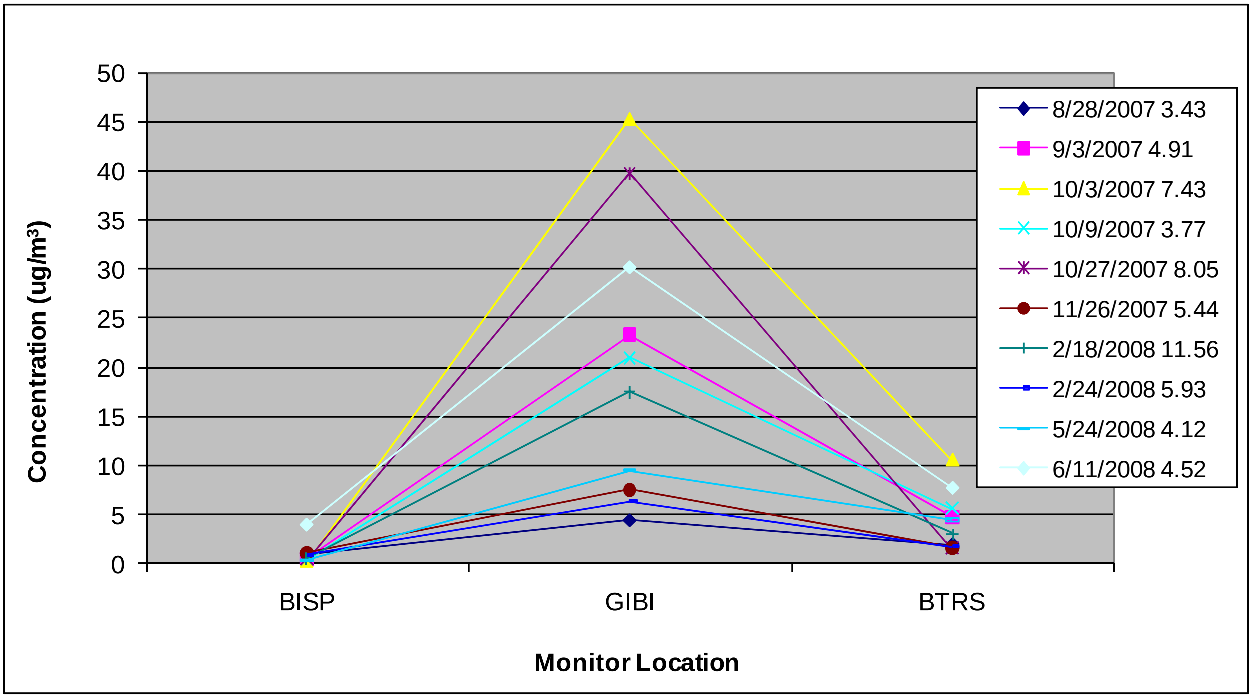


Figure 7.19. Benzene Concentrations Upwind versus Downwind of Tonawanda Coke Corporation with Winds from 225°. The BISP monitor is the upwind site and the GIBI and BTRS monitors are the downwind sites with this wind scenario. The average daily wind speeds in miles per hour (mph) are included adjacent to the date in the legend.

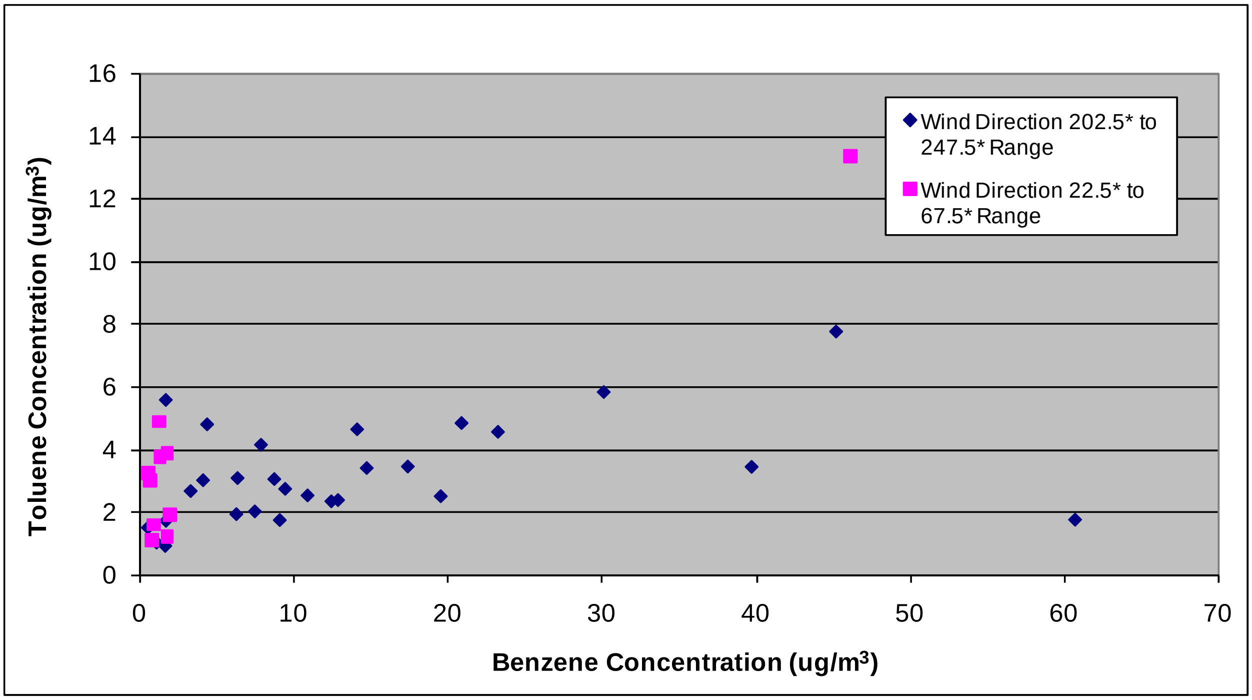


Figure 7.20. Benzene to Toluene Concentrations at the GIBI Monitor with Varying Wind Direction Ranges. The coke oven is upwind and the adjacent highway is downwind with the 202.5° to 247.5° wind direction range and the adjacent highway is upwind and the coke oven is downwind with the 22.5° to 67.5° wind direction range. The wind rose for the one outlying point for the 22.5° to 67.5° wind direction range is provided as Figure 7.3.14.

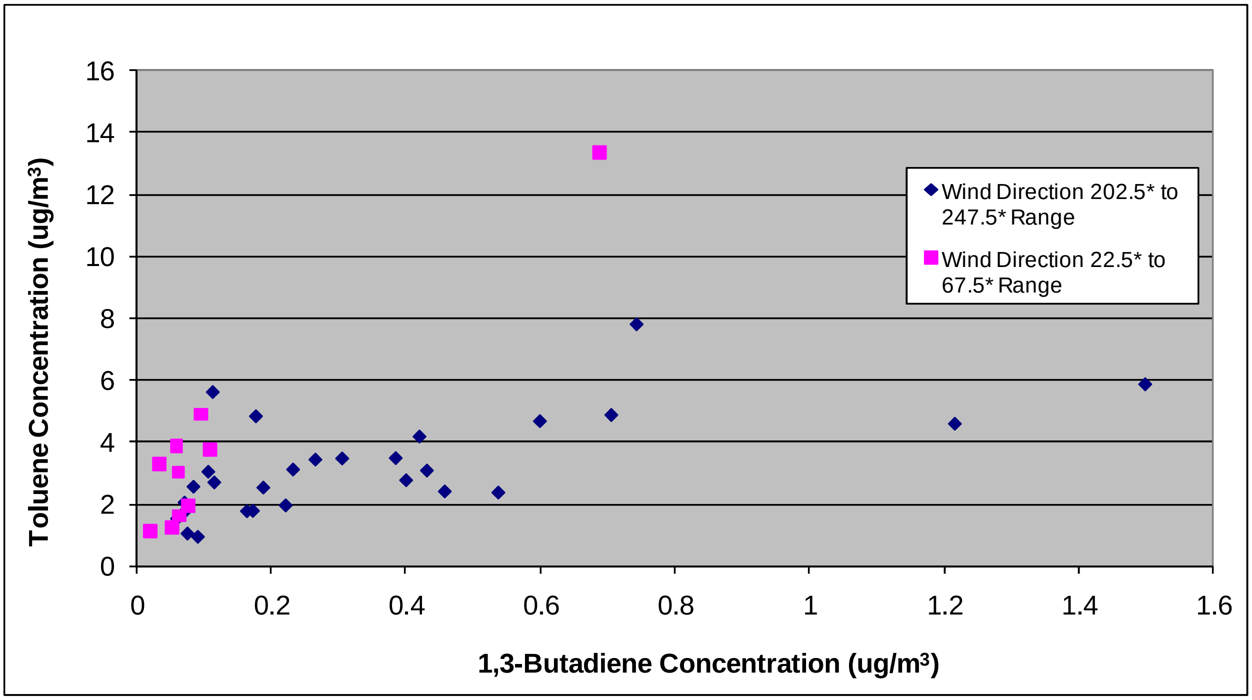


Figure 7.21. 1,3-Butadiene to Toluene Concentrations at the GIBI Monitor with Varying Wind Direction Ranges. The coke oven is upwind and the adjacent highway is downwind with the 202.5° to 247.5° wind direction range and the adjacent highway is upwind and the coke oven is downwind with the 22.5° to 67.5° wind direction range. The wind rose for the one outlying point for the 22.5° to 67.5° wind direction range is provided as Figure 7.3.14.

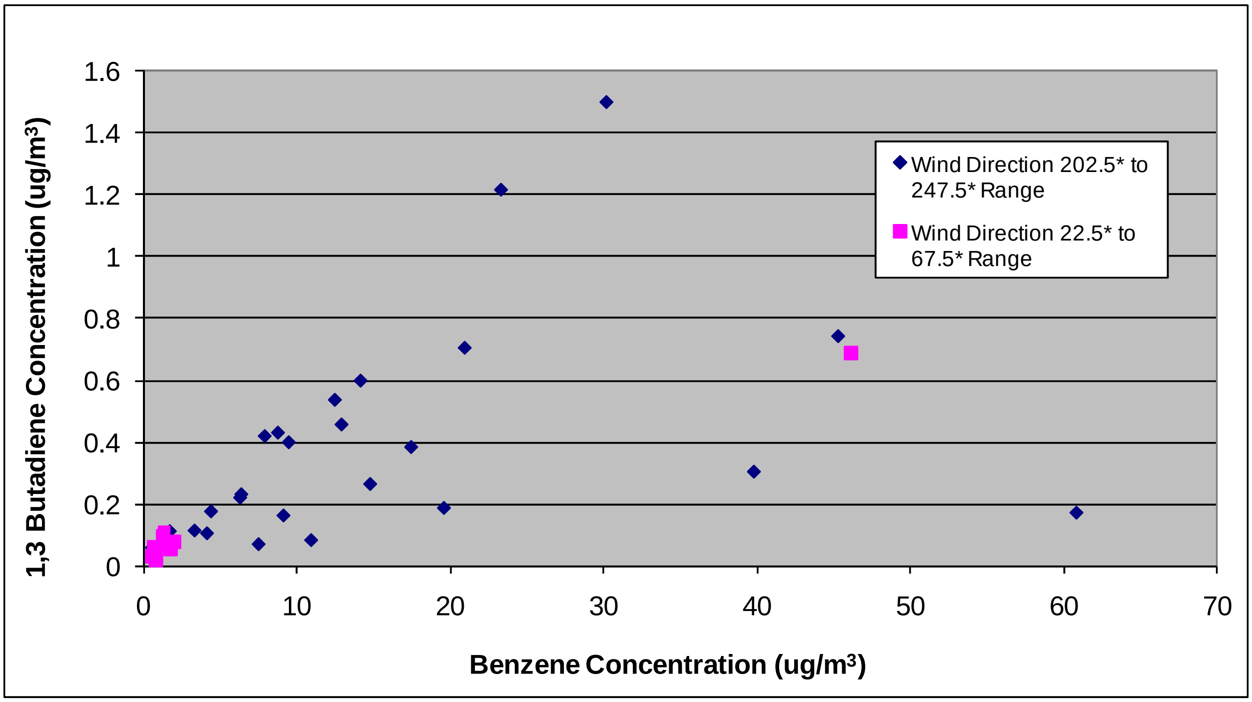


Figure 7.22. Benzene to 1,3-Butadiene Concentrations at the GIBI Monitor with Varying Wind Direction Ranges. The coke oven is upwind and the adjacent highway is downwind with the 202.5° to 247.5° wind direction range and the adjacent highway is upwind and the coke oven is downwind with the 22.5° to 67.5° wind direction range. The wind rose for the one outlying point for the 22.5° to 67.5° wind direction range is provided as Figure 7.3.14.

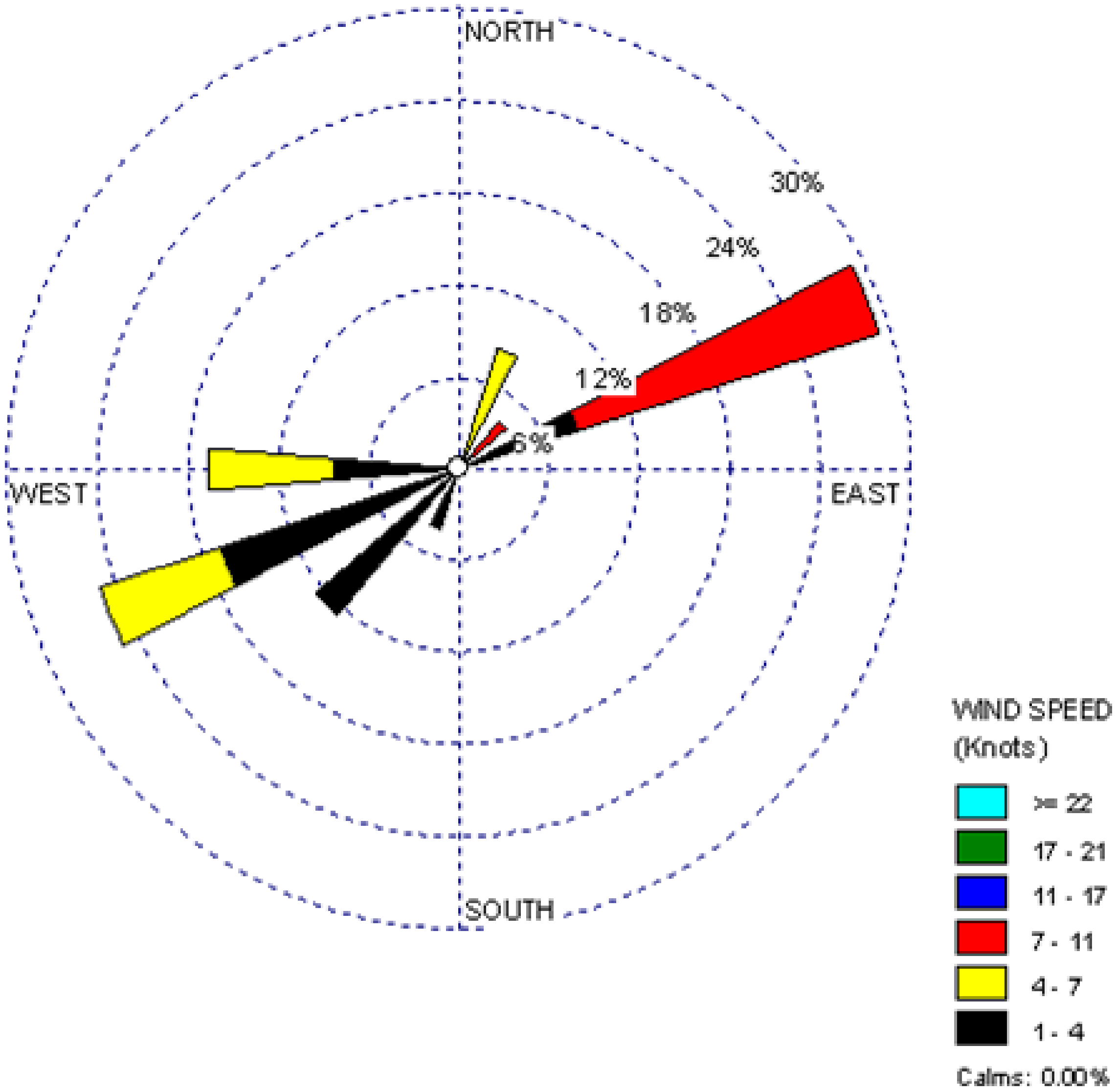


Figure 7.23. Wind Rose for the Outlying Point for the 22.5° to 67.5° Wind Direction Range in Figures 7.20-22.

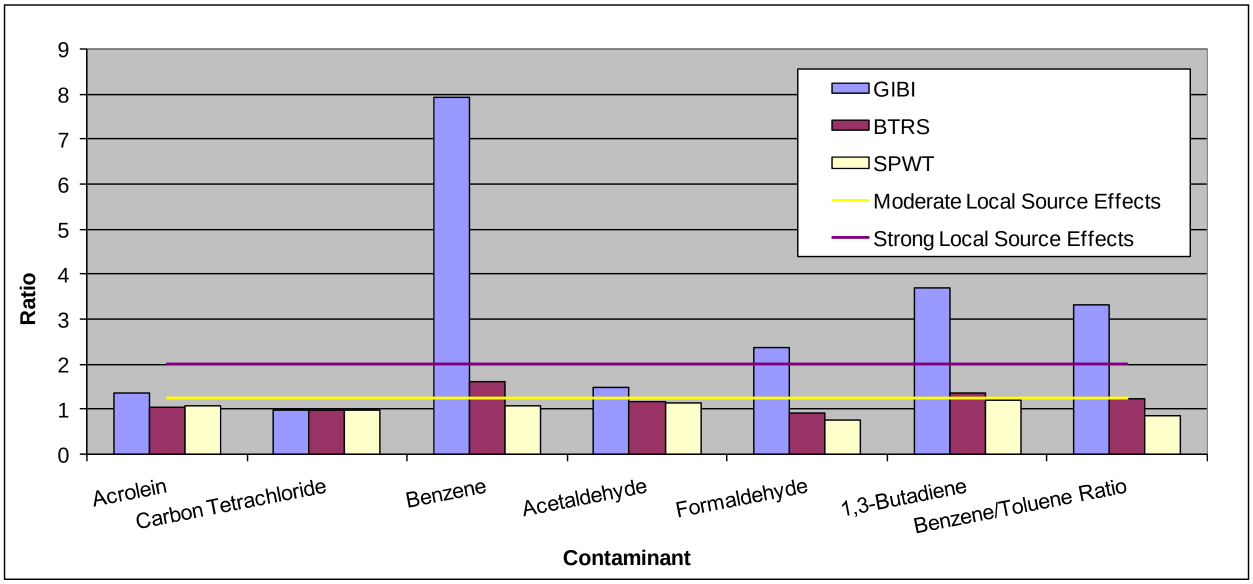


Figure 7.24. Downwind to Upwind Concentration Ratios. Each of the downwind monitor average concentrations (GIBI, BTRS, and SPWT) were divided by the upwind monitor average concentration (BISP) to determine if the influences resulting in the measured concentrations were potentially due primarily to regional background effects, local source effects, or some combination of these effects.

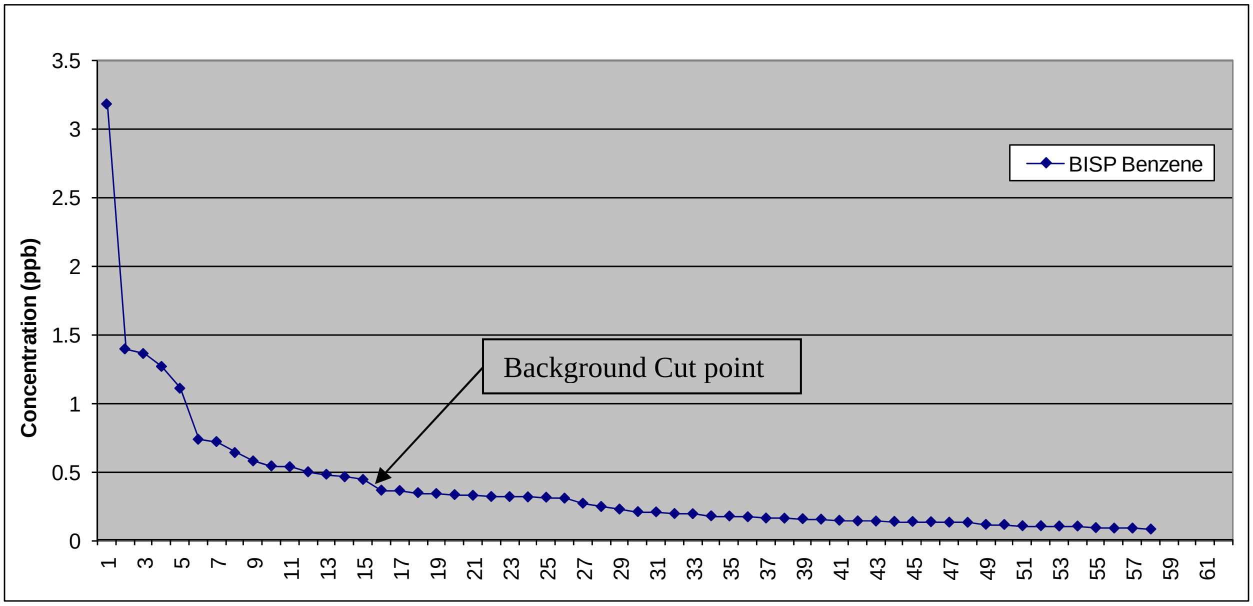


Figure 7.25. Benzene Concentrations presented in Descending Order. The background cut point for this trends analysis was chosen halfway between the data points where the slope transitions to only a very gradually decreasing line. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

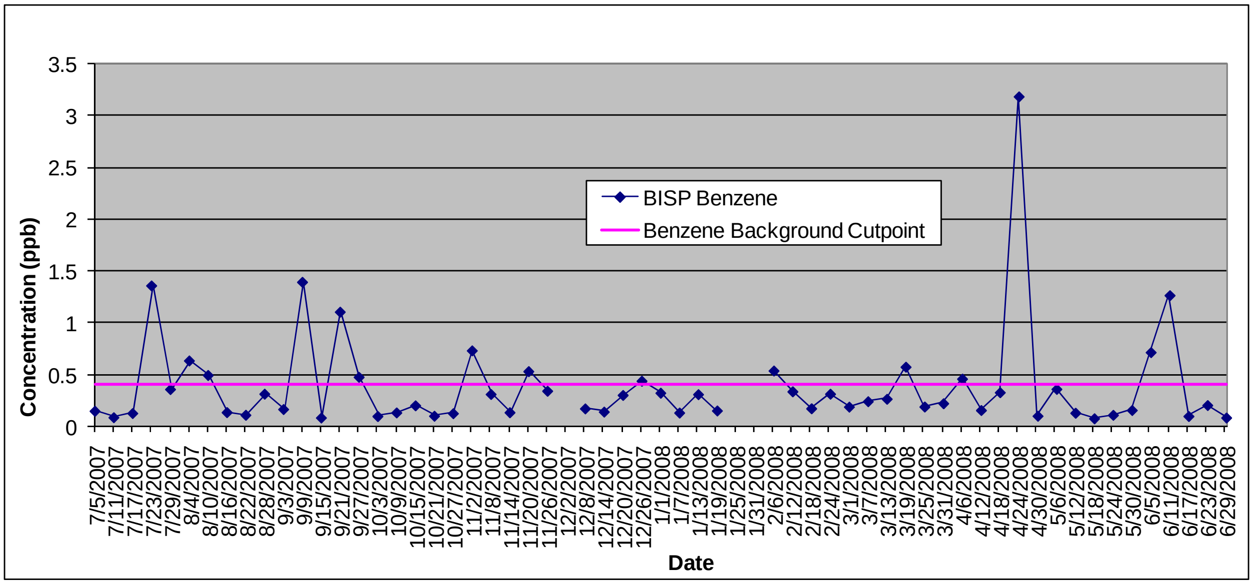


Figure 7.26. Benzene Concentrations over the Study Time Period including the Trends Analysis Cut point Concentration. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

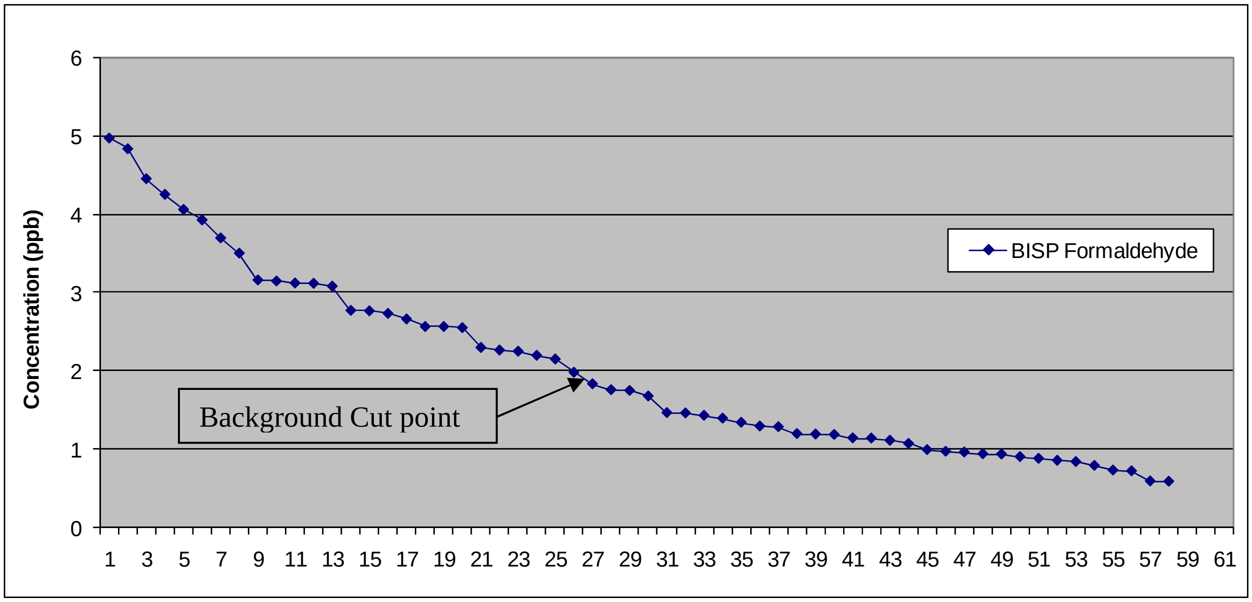


Figure 7.27. Formaldehyde Concentrations presented in Descending Order. The background cut point for this trends analysis was chosen halfway between the data points where the slope transitions to only a very gradually decreasing line. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

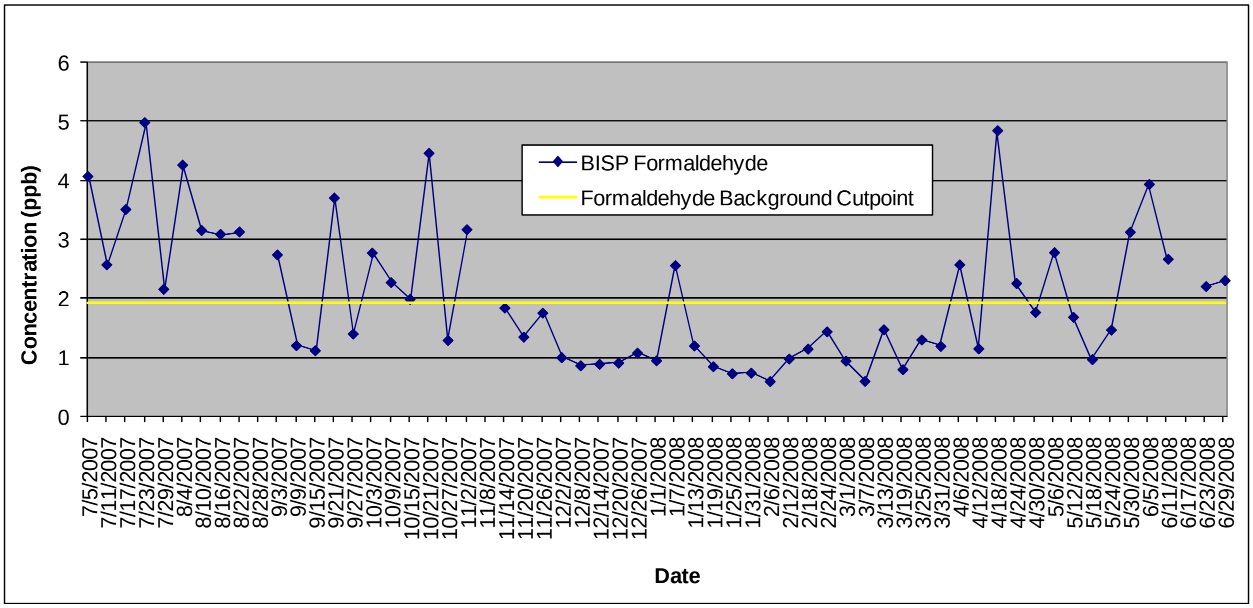


Figure 7.28. Formaldehyde Concentrations over the Study Time Period including the Trends Analysis Cut point Concentration. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

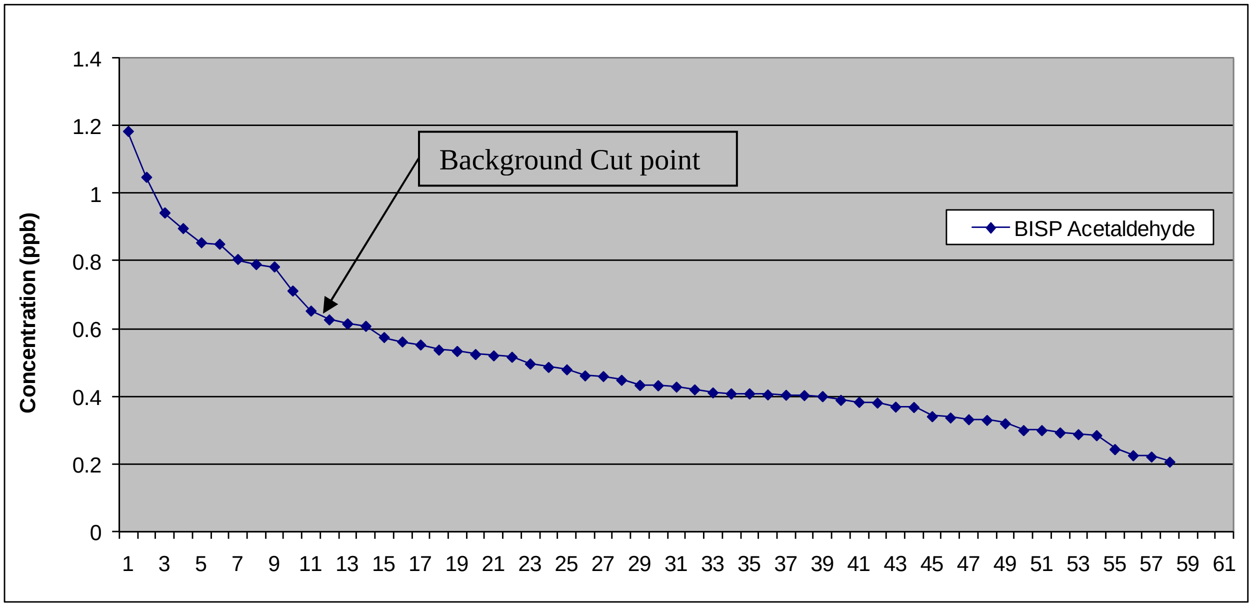


Figure 7.29. Acetaldehyde Concentrations presented in Descending Order. The background cut point for this trends analysis was chosen halfway between the data points where the slope transitions to only a very gradually decreasing line. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

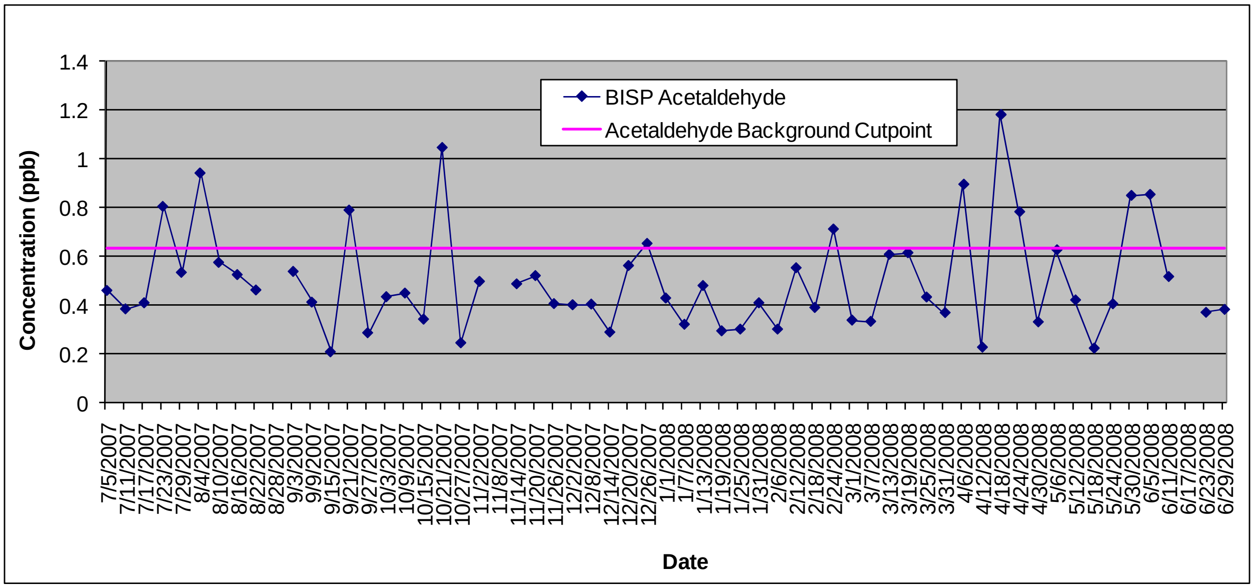


Figure 7.30. Acetaldehyde Concentrations over the Study Time Period including the Trends Analysis Cut point Concentration. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

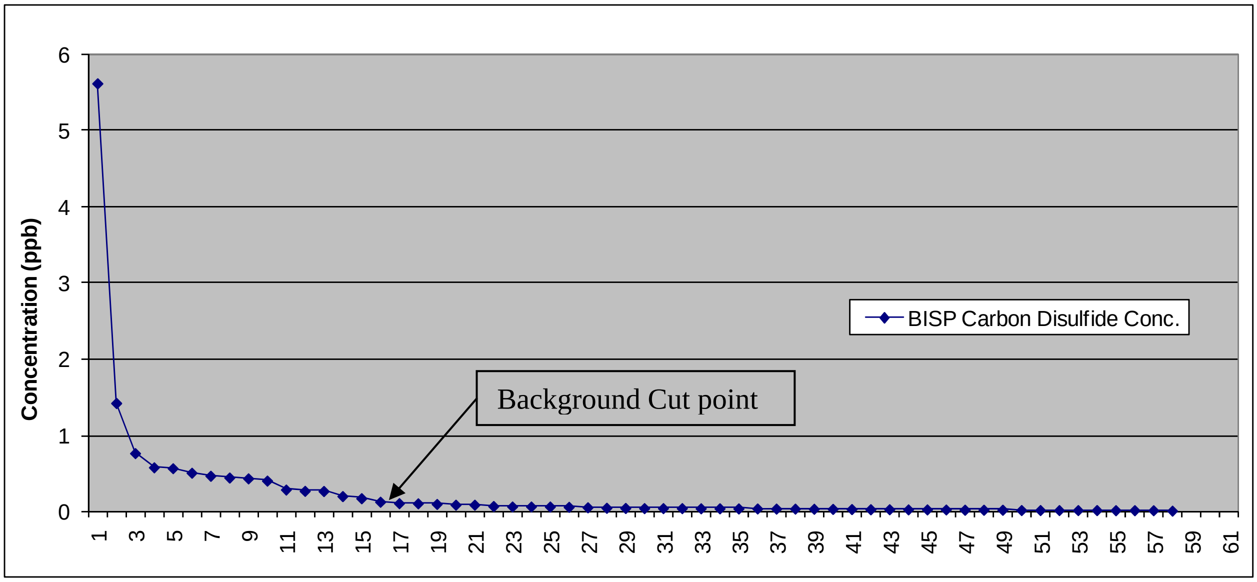


Figure 7.31. Carbon Disulfide Concentrations presented in Descending Order. The background cut point for this trends analysis was chosen halfway between the data points where the slope transitions to only a very gradually decreasing line. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

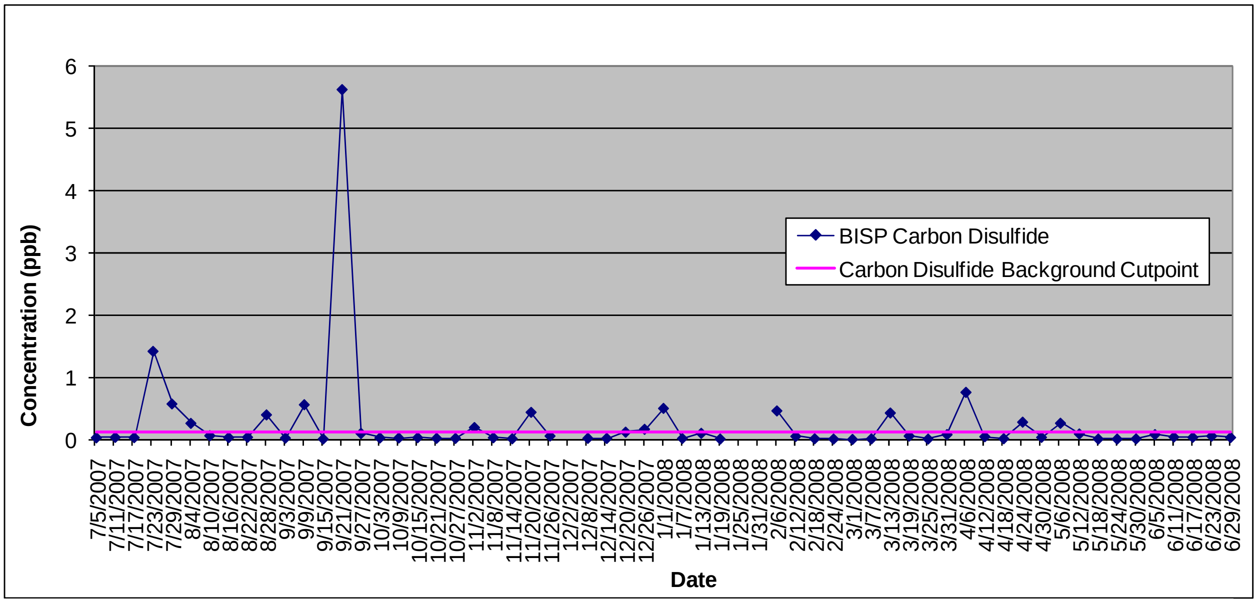


Figure 7.32. Carbon Disulfide Concentrations over the Study Time Period including the Trends Analysis Cut point Concentration. Please note that the trends background concentration provided in the text is the average of only the concentrations below the cut point indicated in this graph.

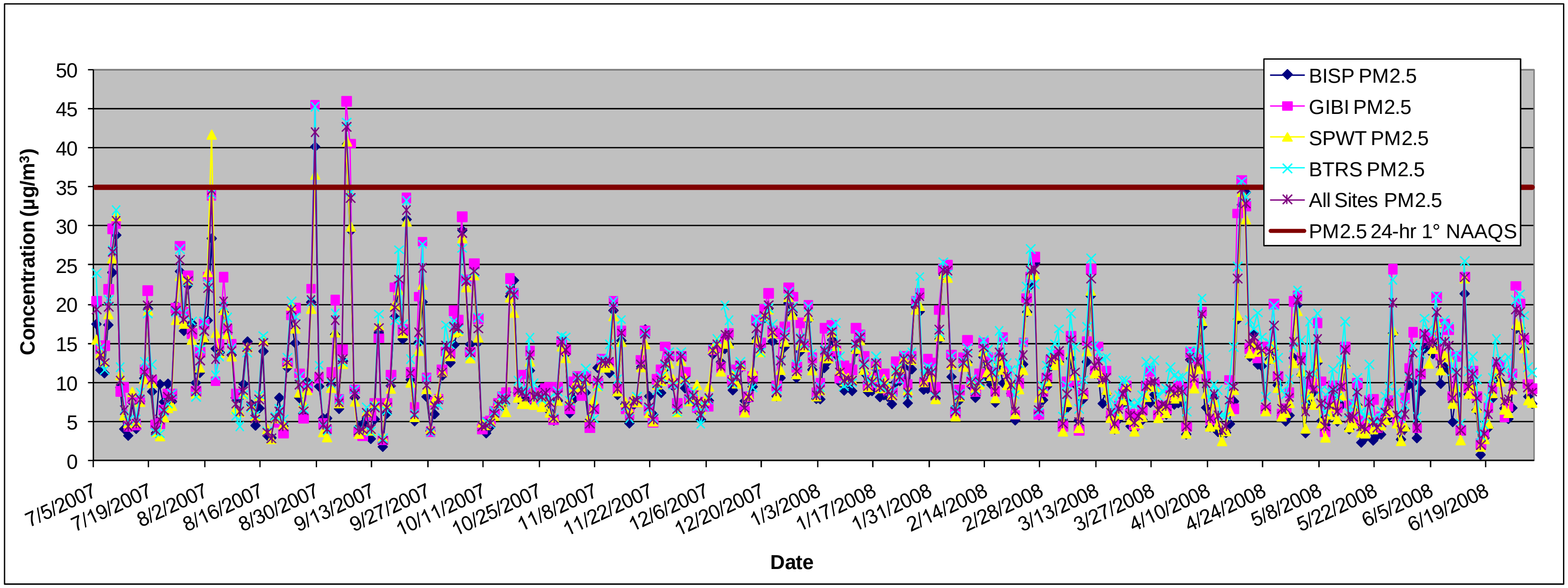


Figure 7.33. Weekly Trends of $PM_{2.5}$ Daily Average Concentrations.

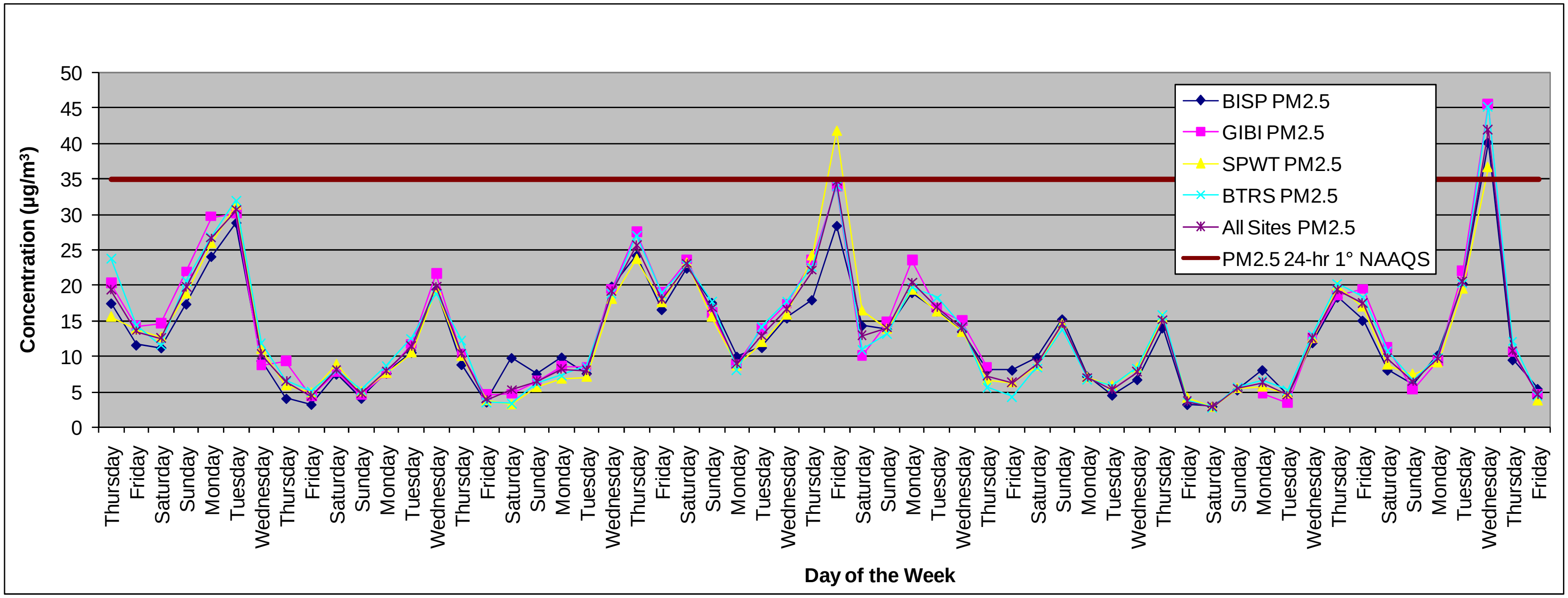


Figure 7.34. Two Months of Weekly Trends of $PM_{2.5}$ Daily Average Concentrations.

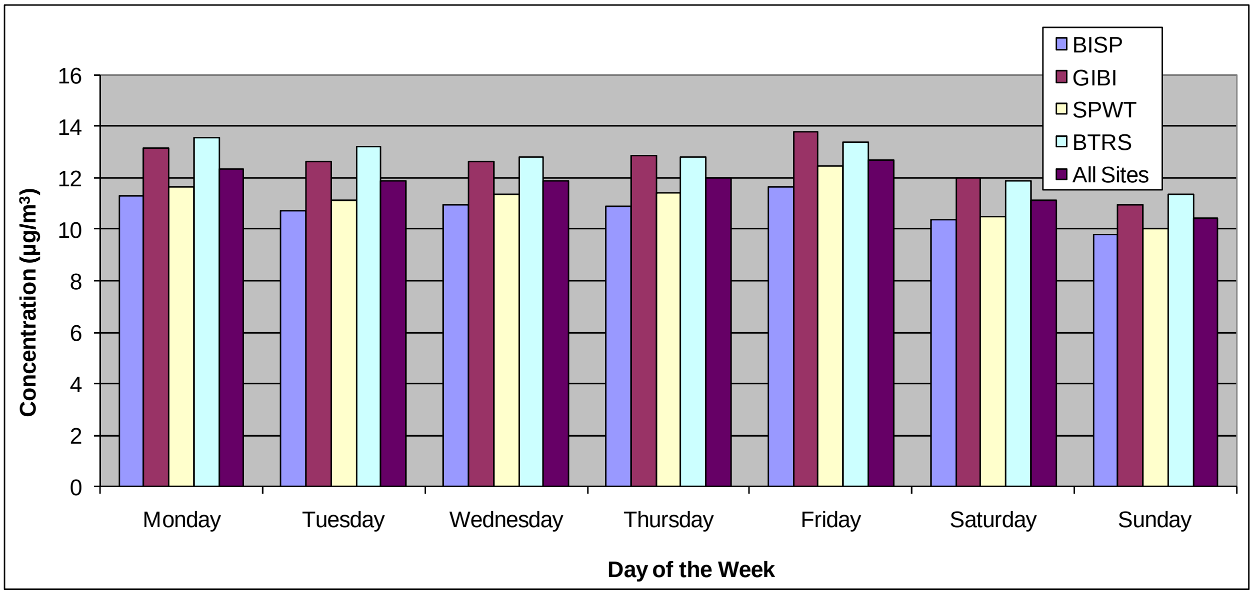


Figure 7.35. Weekly $PM_{2.5}$ Trends using Year Long Concentration Averages for each Day of the Week.

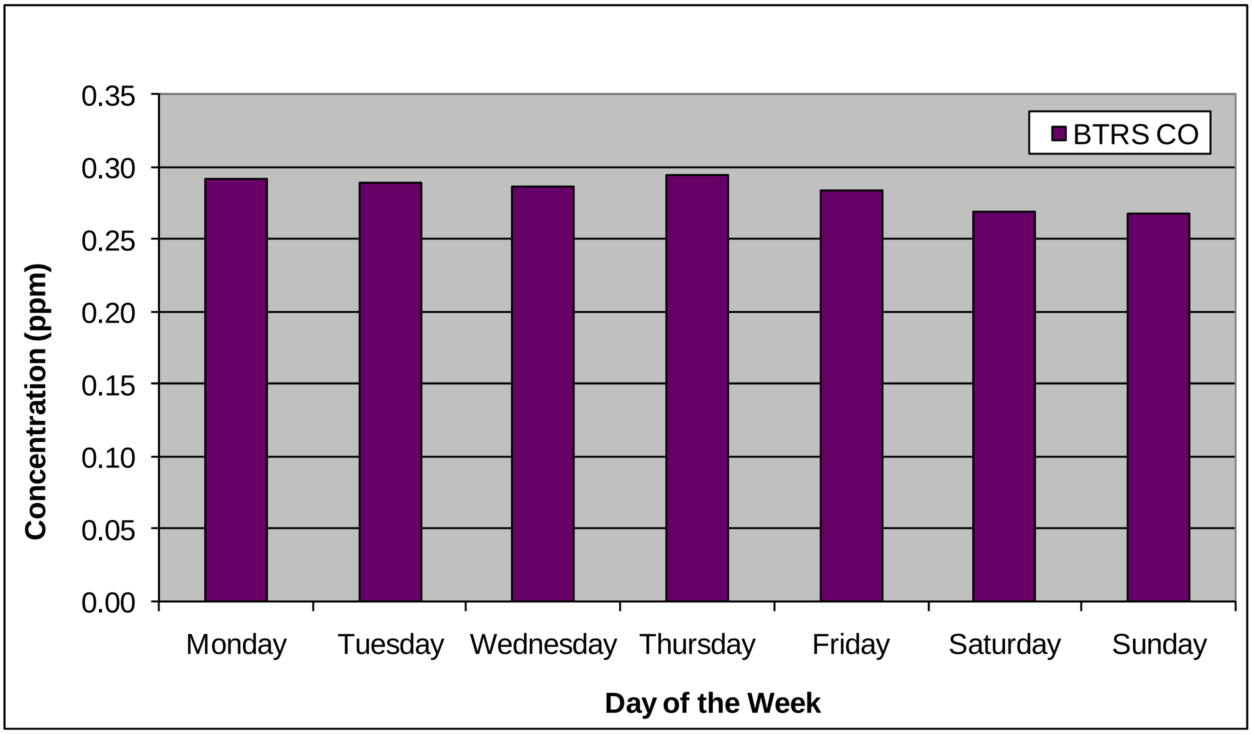


Figure 7.36. Weekly CO Trend using Year Long Concentration Averages for each Day of the Week.

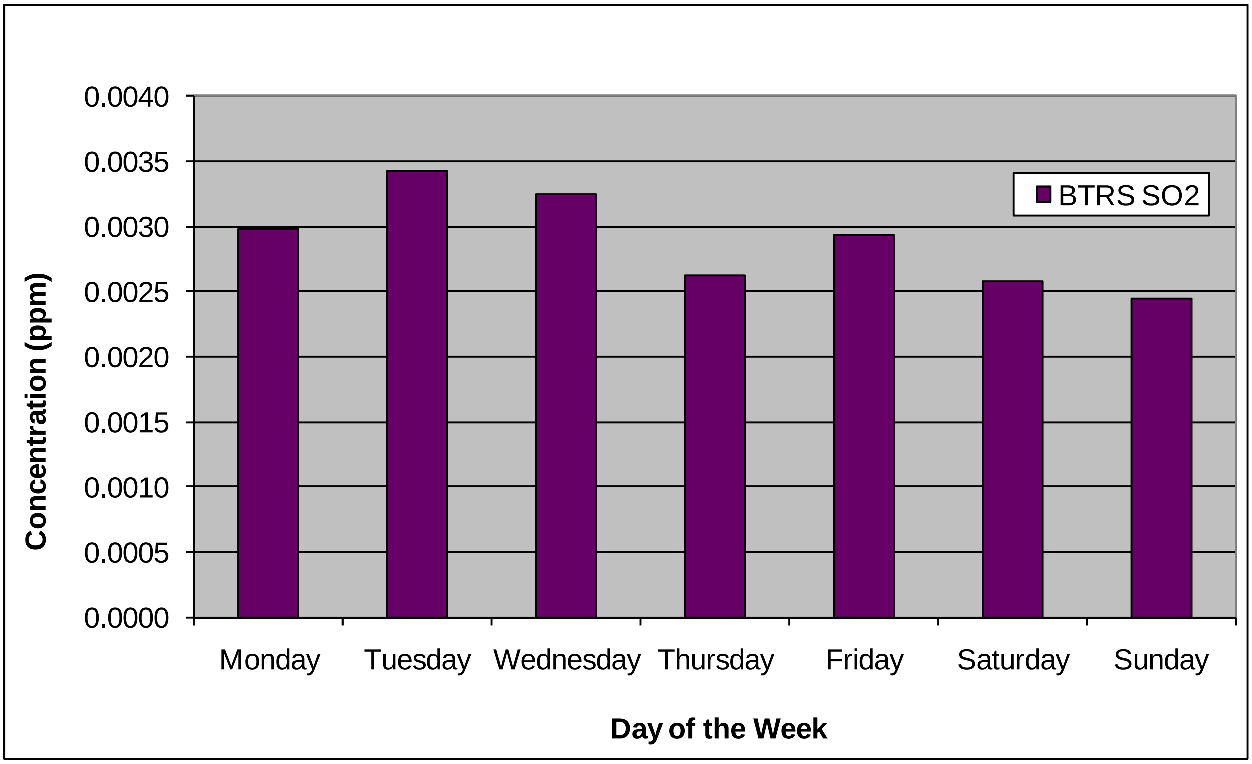


Figure 7.37. Weekly SO_2 Trend using Year Long Concentration Averages for each Day of the Week.

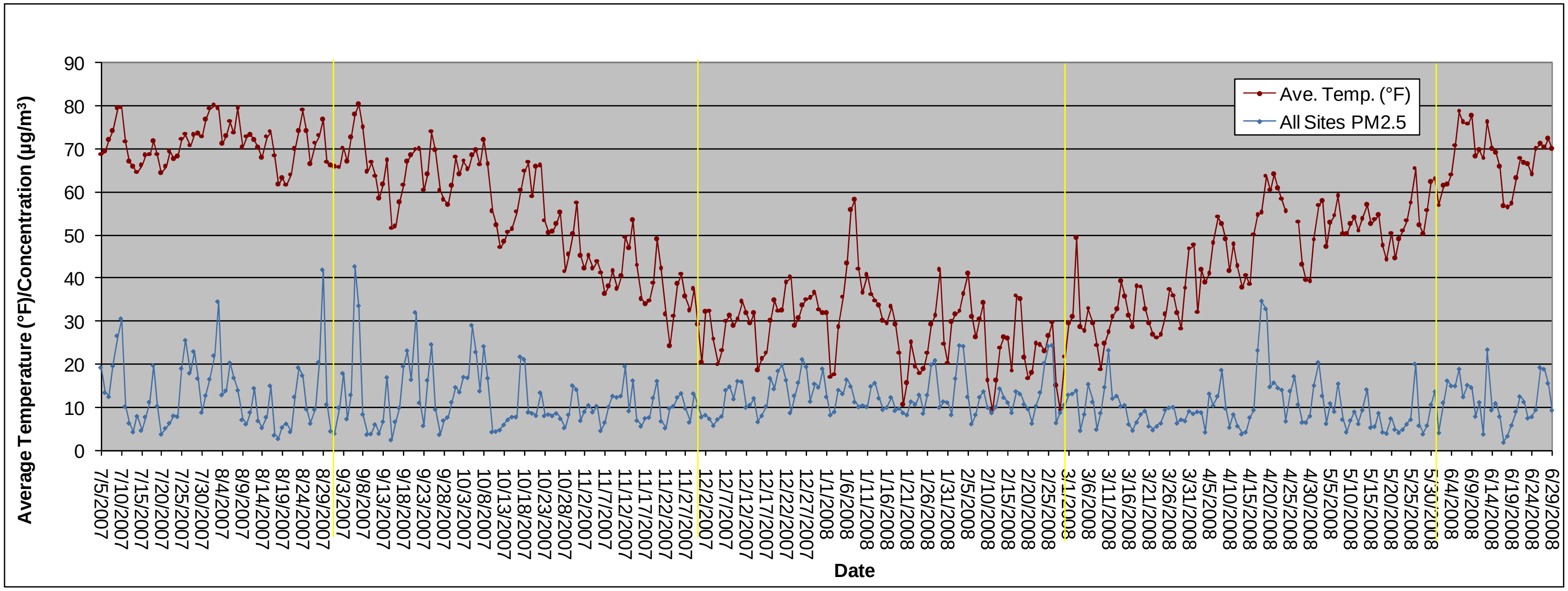


Figure 7.38. Comparisons between the $PM_{2.5}$ Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station Daily over the Study Period Year.

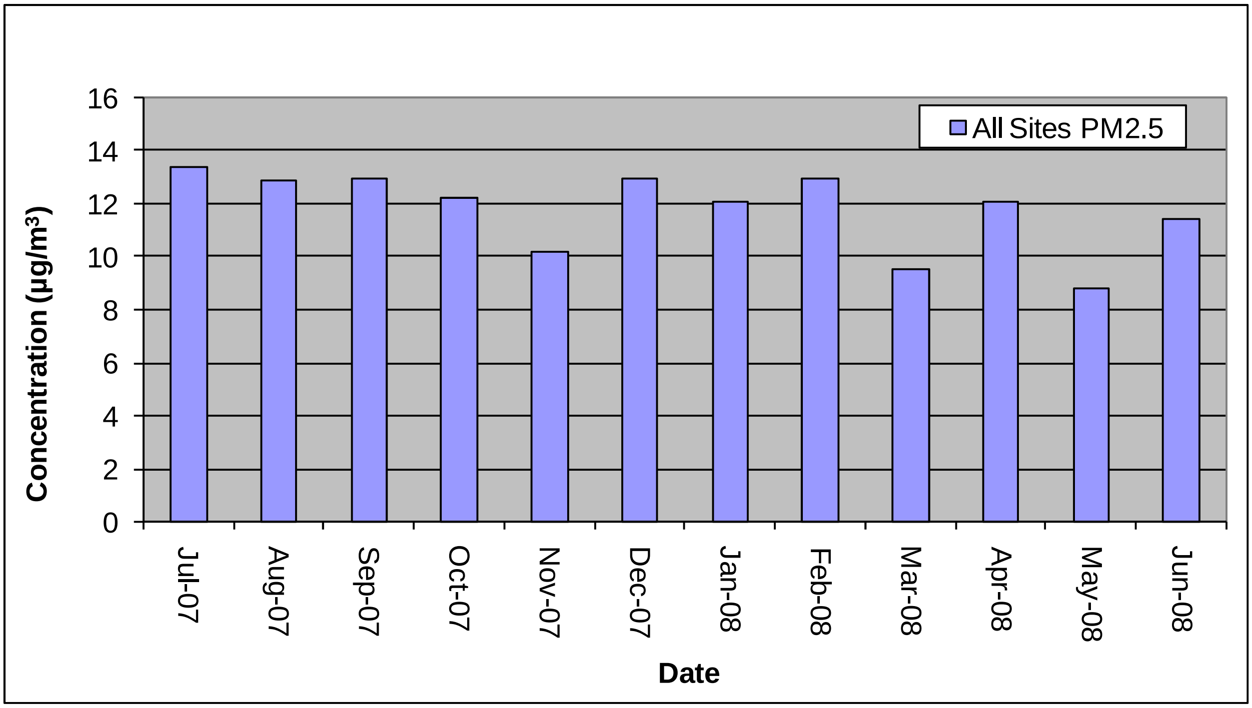


Figure 7.39. Combined Sites Average $PM_{2.5}$ Concentrations for the Different Months of the Year.

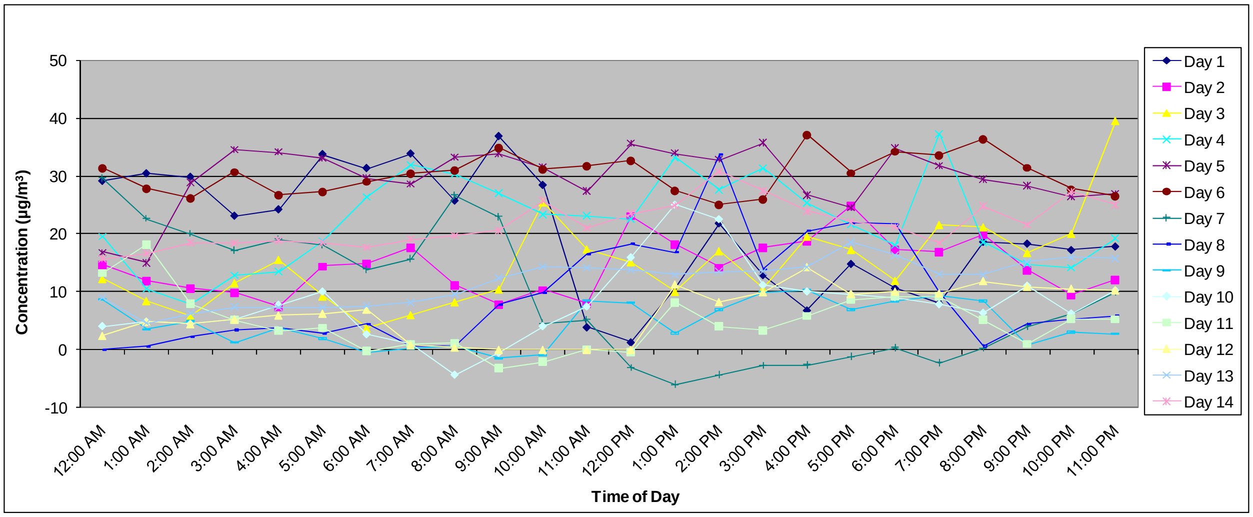


Figure 7.40. Individual Data Point Measurements of $PM_{2.5}$ Concentrations for each Hour of the Day at the GIBI Monitor for the First Two Weeks of the Study Year.

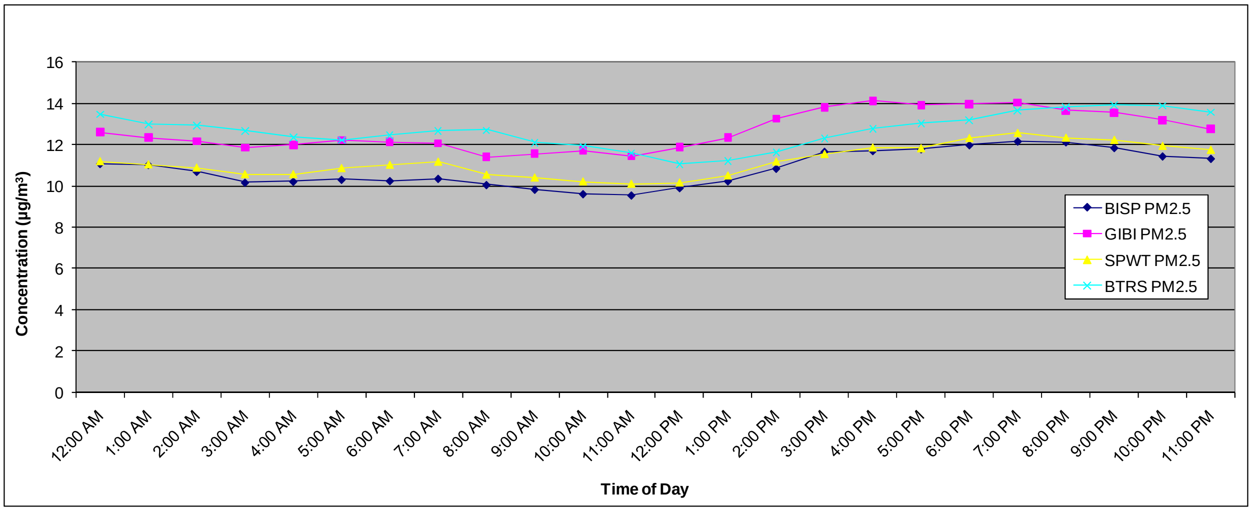
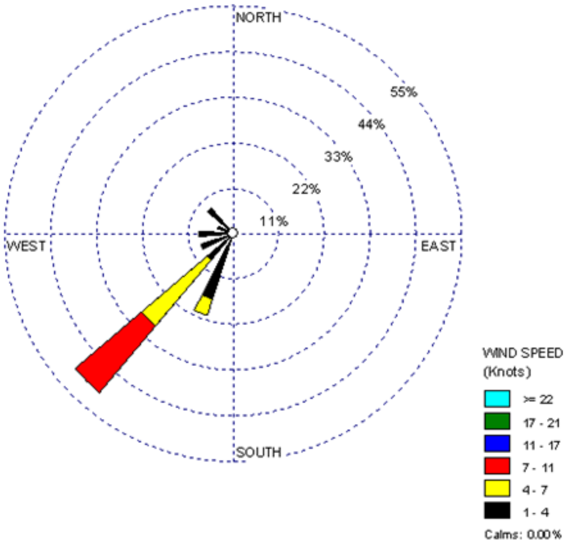


Figure 7.41. Daily $PM_{2.5}$ Concentration Trends generated by Pooling Six Months of Concentration Measurements Data into a Combined Average of Concentrations for each Hour of the Day.



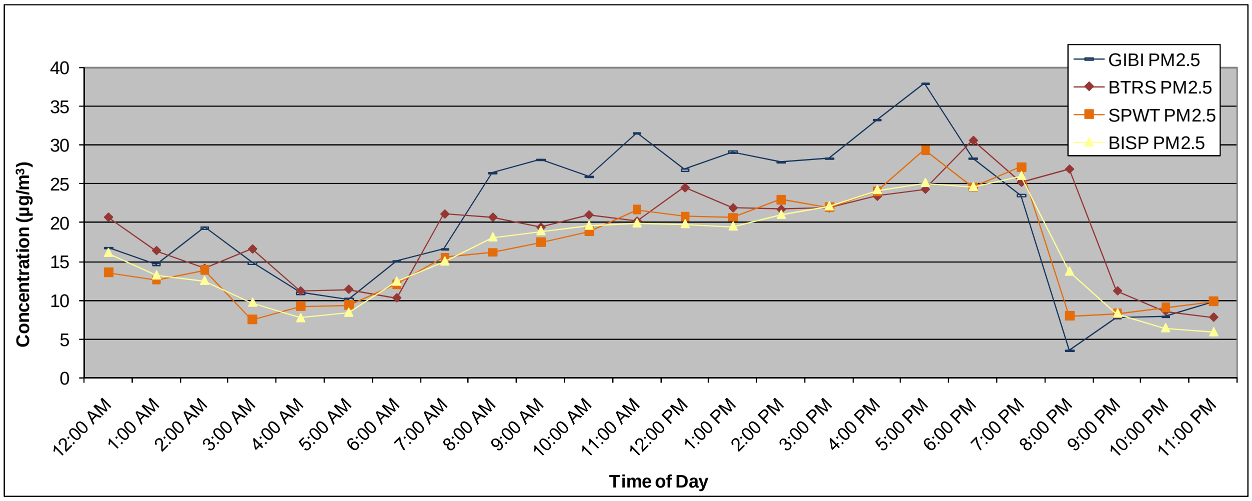


Figure 7.42. Wind Rose for 9/3/07 and Graph of the Individual Data Point Measurements of $PM_{2.5}$ Concentrations for each Hour of the Day on 9/3/07 at all Four Monitors.

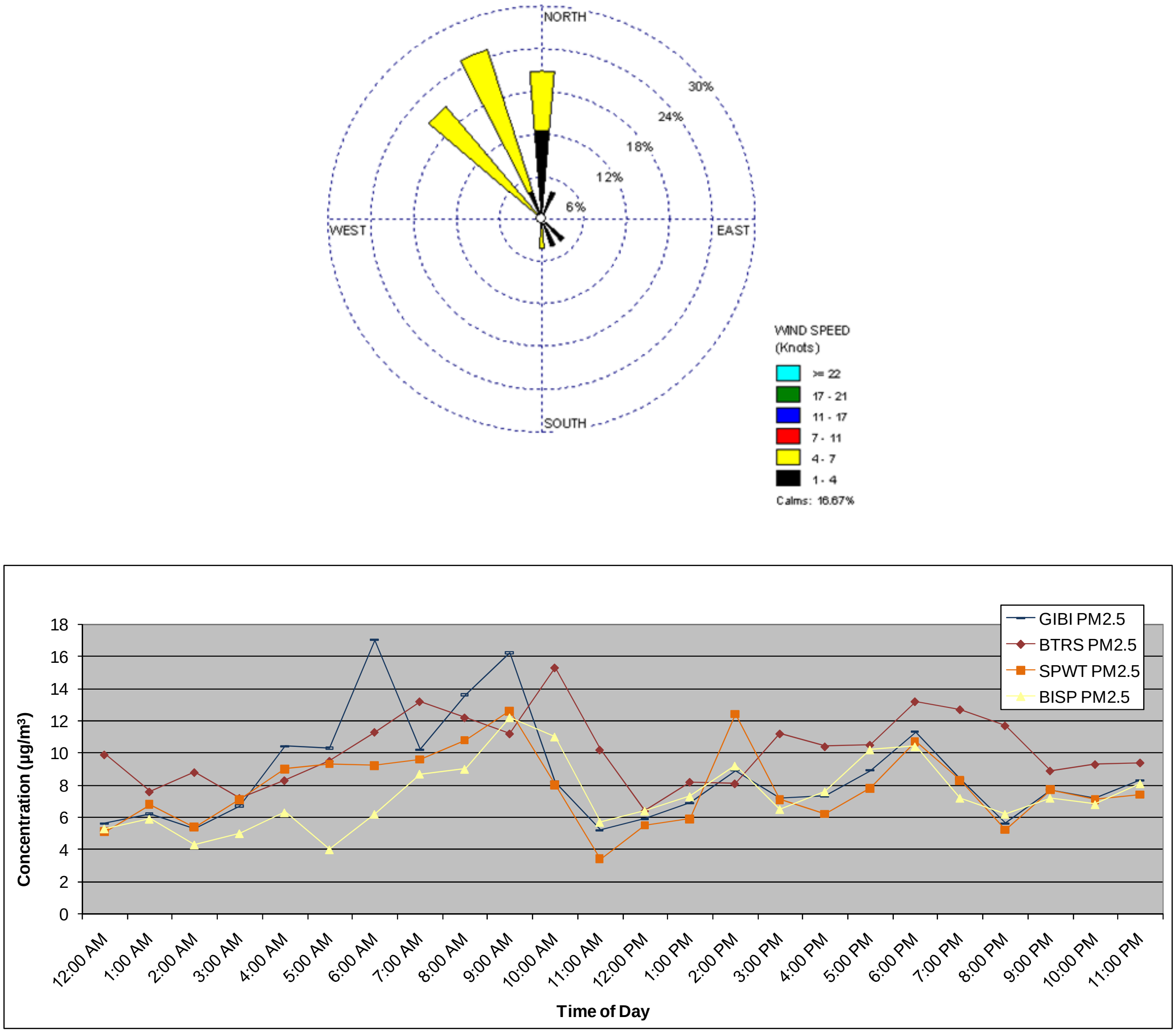
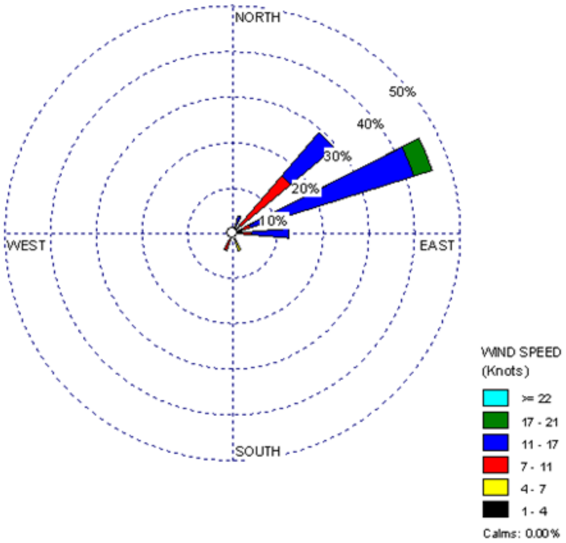


Figure 7.43. Wind Rose for 3/19/08 and Graph of the Individual Data Point Measurements of $PM_{2.5}$ Concentrations for each Hour of the Day on 3/19/08 at all Four Monitors.



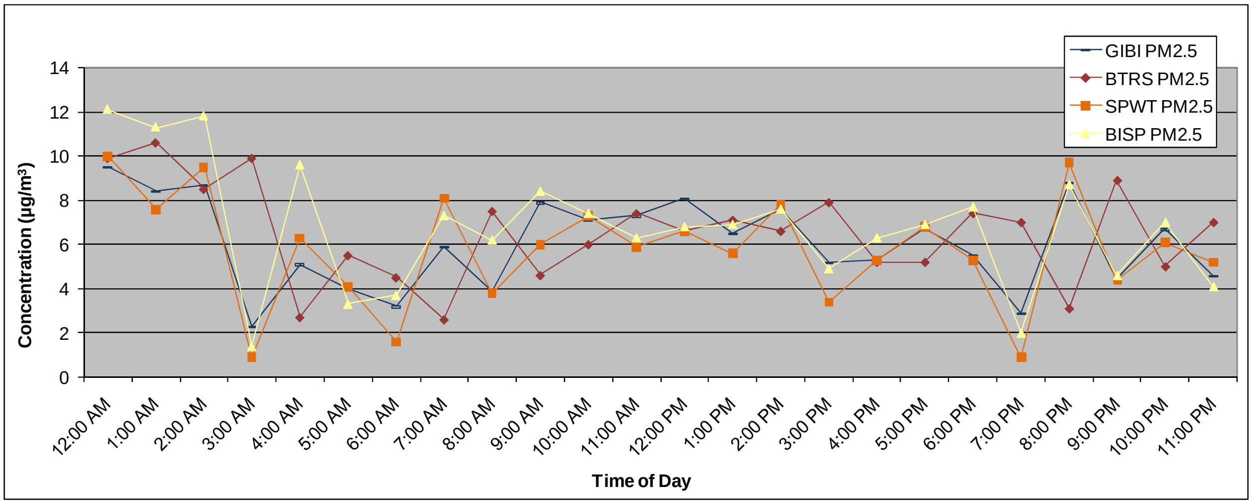


Figure 7.44. Wind Rose for 2/6/08 and Graph of the Individual Data Point Measurements of $PM_{2.5}$ Concentrations for each Hour of the Day on 2/6/08 at all Four Monitors.

Appendix A - Recommendations to the Clean Air Coalition Western New York for Optimizing the Personal Air Monitoring

Placement of personal air monitors

One way your study could complement our monitoring study would be to focus your personal air monitoring on outdoor sources. Personal air monitors generally focus on capturing an individual's exposure, which is complicated because it includes indoor and outdoor sources and sources remote from their home location area when that individual travels about their day. Since our study is focused on sources in the neighborhood of the fixed-site monitor locations, personal air monitoring focused on outdoor sources could potentially provide useful information about the spatial distribution of pollutant sources which may help us when we investigate which sources contribute to specific pollutant levels. Therefore, we thought if each volunteer were given two badges, one could be used to capture outdoor source exposures with the badges placed in the following arrangement:

- One badge would be worn by the individual and would reflect personal exposure as it would capture both indoor and outdoor sources.
- One badge would be placed outside the home, not near home-based sources (such as a car, garage, outdoor gas-powered equipment, dryer vent). This badge could be useful to compare to our fixed-site monitoring.

Optimizing the detection limit

A US EPA study conducted in the Houston-Galveston area of Texas[1], evaluated increasing the sampling time of personal air monitors (3M 3500 Organic Vapor Monitor) to improve the detection limit. Many of the air toxics in their study are also ones we are monitoring in our study. Their results show an optimal sampling duration of two and three days for some of the air toxics.

The ambient air concentrations for many of the toxics we measured in the first six months are on the order of parts-per-billion. These low level air concentrations may be hard to detect with short-term personal air monitoring devices. One way to resolve this is a longer sampling duration, which may pose an inconvenience for some volunteers who may not want the responsibility of wearing a monitor for two to three days. This could be resolved by the placement of a personal air monitor outside the home with the sampling time beginning one day before and ending one day after our fixed-site monitoring date.

Assessing indoor sources

We see from your volunteer sign-up form that you have given consideration of the confounding influence that smoking may provide. We suggest you consider other home-based sources that may significantly influence the results. Many studies which have

---

[1] AMBIENT AIR TOXICS IN THE HOUSTON-GALVESTON AREA WITH HIGH AND LOW TRI EMISSIONS- A PILOT STUDY OF TEMPORAL AND SPATIAL CONCENTRATIONS USING PASSIVE SAMPLING DEVICES (PSDs), October 2004
http://www.epa.gov/ttn/amtic/files/ambient/passive/PATM_Pilot_Houston_Final%20report_2004.pdf

conducted personal air monitoring (such as Relationships of Indoor, Outdoor, and Personal Air (RIOPA) and Toxic Exposure Assessment: A Columbia-Harvard (TEACH) Study) assess indoor sources through a questionnaire. Some examples of air toxics sources that may influence the indoor environment are fresh paint, fumes in gas fueling, or hobbies which involve the use of solvent based paints or glues. Other indoor sources to be aware of include attached garages, air fresheners, home renovations and indoor fuel oil tanks.

Assessing influence of personal activities

We also are providing links to studies that contain examples of time-location-activity diaries. You might find this information helpful when you develop a form for participants to complete.

VOC Exposure in an Industry-Impacted Community, 2005
http://www.sph.uth.tmc.edu/mleland/attachments/Buckley_Report4.pdf

Toxic Exposure Assessment: A Columbia-Harvard
(TEACH) Study (The New York City Report), 2005
http://www.sph.uth.tmc.edu/mleland/attachments/NY_TEACH%20Study3.pdf

Appendix B. Benzene Cancer Risk Estimates

The NYSDEC Annual Guideline Concentration (AGC) for benzene is based on a Unit Risk Estimate for cancer effects. The AGC value is 0.13 $\mu g/m^3$ (0.04 ppb) and it is used to protect the public from an additional "one-in-one-million" risk of contracting cancer over a lifetime of continuous exposure. The source for the value is USEPA's Integrated Risk Information System[1].

Unit Risk Estimate - discussion of confidence

The unit risks and/or risk-specific concentrations derived by authoritative bodies for benzene are largely based on the increased incidence of leukemia in human occupational exposure studies. All of these analyses apply some form of linear-low dose extrapolation model (a) to the epidemiological data, assuming a non-threshold mode of action for the cancers observed in the occupational study group. The non-threshold approach to carcinogenic risk assessment assumes that any exposure to a carcinogenic agent carries with it an increased risk for cancer, although the risk may not be quantifiable or lead to developing the disease. The use of a linear model is a default public health protective approach used by governmental agencies. The true risk could be either be higher or lower depending on the recognition of supralinear (b) and sublinear (c) relationships at low doses and non-threshold or threshold modes of action on exposure to benzene.

> (a) The risk is strictly linear (risk is directly proportional to dose). This is called the Linear No-Threshold (LNT) model.
>
> (b) supralinear extrapolation is where risks at lower doses are higher per unit dose than if one extrapolated linearly from, for example, the higher doses experienced by the A-bomb survivor data.
>
> (c) sublinear extrapolation is where risks at lower doses are lower per unit dose than if one extrapolated linearly.

Air monitoring data

Although we have prepared comparison estimates of the Unit Risk Estimate with the first six months of air monitoring data, we urge caution in interpreting these values. AGCs are intended to be protective of long-term exposure to a contaminant's air concentration. It is most appropriate to compare annual average results for an air contaminant with the AGC values. Additionally, studies have shown that benzene levels can vary by season. Therefore, it would not be unexpected, if the next six months of data January – June 2008, vary from our first six months, assuming no change from local source contribution.

---

[1] http://www.epa.gov/ncea/iris/subst/0276.htm#suminhal

Comparison to Unit Risk Estimate

We compared the six month average for all four Tonawanda study air monitors. We also are providing comparisons to the statewide average and a comparison to a monitor in a rural location as shown in Table 1. The cancer risk estimate is the number of cases predicted per one million exposed individuals over a lifetime exposure.

Table 1. Benzene Cancer Risk Comparison

Site	Description	Estimated Cancer Risk (on a per million basis)
Grand Island Blvd	Central site monitor located nearest industrial sources	88
Sheridan Park Water Tower	Northern edge of a residential community	8
Brookside Terrace	Located in a residential community Northeast of industrial sources	14
Beaver Island State Park	Background site, upwind of the Tonawanda industrial area	9
NYS annual average for 2007		7
Whiteface Mountain annual average 2006	Base of Whiteface Mountain, remote from industrial sources	3

Appendix C – Press Releases, News Articles, Fact Sheets

2007 - Press Releases, Newspaper Articles, Fact Sheets

NEWS
REGION 9, Abby Snyder, Regional Director
Niagara, Erie, Wyoming, Chautauqua,
Cattaraugus and Allegany counties
New York State Department of Environmental Conservation
Eliot Spitzer, Governor
www.dec.state.ny.us
270 Michigan Avenue
Buffalo, NY 14203-2999

For Release: IMMEDIATE
Tuesday, April 17, 2007

Contact: Meaghan Boice-Green
(716) 683-5959

DEC TO BEGIN TONAWANDA COMMUNITY AIR QUALITY STUDY
Community Groups Involved With Project

The New York State Department of Environmental Conservation (DEC) announced today that DEC has been awarded a grant from the US Environmental Protection Agency (EPA) to conduct air monitoring of hazardous air pollutants in the Town of Tonawanda, Erie County. EPA will provide $300,000 in grant funds, and DEC will spend an additional $300,000 to complete this study.

DEC Region 9 Director Abby M. Snyder said, “This project will provide a foundation for future air pollution studies across New York State. It also provides a model for community participation.”

Traditionally, air pollution studies have focused on a few sites over a wide area. DEC and EPA are trying a new approach by focusing more effort on evaluating air quality in a smaller, industrial community, as well as by involving the local community in the study.

DEC has been collaborating with the Clean Air Coalition of Western New York (WNY) and the Town of Tonawanda Commission for Conservation and Environment to address concerns about hazardous air pollutants and odors in the Tonawanda community. In 2004 and 2005, the Clean Air Coalition of WNY and DEC collected and tested air samples for benzene, a hazardous pollutant emitted from local industries, automobiles and trucks. The testing indicated a need to collect additional data over a longer period of time to better understand the ambient (outdoor) air quality in Tonawanda.

DEC will measure hazardous air pollutants and fine particulate matter (PM) at four sites in Tonawanda for one year. Fine particles, those less than 2.5 microns in diameter, present potential health problems because they can penetrate into the deepest parts of the lungs. DEC intends to characterize air quality for air toxics and fine PM in the Tonawanda community on a micro scale level and use that information in collaboration with the community to evaluate possible air pollution reduction strategies. A final report will summarize the overall local air monitoring results, analyze the contributions of various air pollution sources in the community and include possible recommendations for community risk reduction strategies.

(MORE)

Clean Air Coalition of WNY Executive Director Jackie James said, “There are 53 permitted air polluters within 2 square miles in our Tonawanda community. This is the highest concentration of industrial air polluters within our state. We are concerned about the combined effect of all the air pollutants on our health and believe the pollutants emitted by Tonawanda's industries may be the cause of higher than average illness in our community. We look forward to our continued research investigation with DEC and the University at Buffalo(UB)."

University at Buffalo Professor Joseph Gardella said, "This project is an exciting example of how DEC public participation can work best. The community sampling identified a potential long term problem, in an area with careful and fully documented oversight by DEC's Division of Air Resources. The cooperation with professional staff helped define needs for further data on emissions and exposure, and through the hard work of DEC staff, EPA funding was identified and granted, to support an exemplary study. UB resources will be developed to complement the air sampling with a special focus on air particulates. A great advantage is the well organized and active community leadership, such as the Clean Air Coalition, which has led efforts to gather and coordinate resources. I look for this effort to focus all community, university and government resources on the environment and health of Tonawanda community members."

DEC met with the local community groups in Fall 2006 to discuss the study design in detail. DEC will continue to engage the local community in discussions by providing a progress report and preliminary findings at a second meeting in fall 2007. A third public meeting will be held when a final study report is available.

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Rare Partnership Seeks Clean Air
Joyce Kryszak

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TONAWANDA, NY (2007-08-02) Environmental advocates and government agencies often clash over how to control pollution. Advocates seek clean air and water free from deadly toxins. Government agencies worry about how to do that without placing a huge burden on public resources and the economy. But a rare collaboration that overcame that divide is being announced Thursday in Tonawanda.

The state Department of Environmental Conservation, UB, and the Clean Air Coalition of Western New York will unveil four, high-tech air sampling units. They will be used for a year-long study of air pollutants from nearby industry.

WBFO's Joyce Kryszak takes us to one of the sites where she talked with the people who pulled the project together.

Click the "listen" icon above to hear Joyce Kryszak's story now or use your podcasting software to download it to your computer or iPod.

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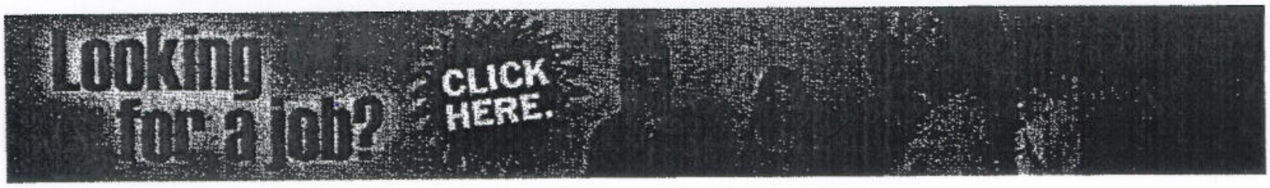


The Buffalo News : City & Region

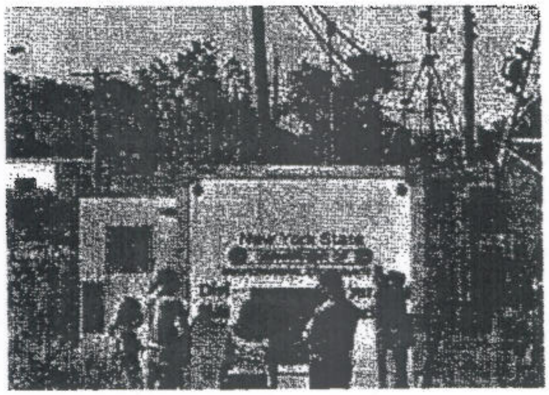
Friday, August 3, 2007

Home > City & Region > Northern Suburbs

TOWN OF TONAWANDA

Air quality testing is under way

By Janice L. Habuda NEWS STAFF REPORTER
Updated: 08/03/07 7:13 AM



Derek Gee/Buffalo News
This high-tech monitoring shed off Grand Island Boulevard, unveiled Thursday, will be used to monitor air quality in a highly industrialized area.

A&E: air quality

From the 5-gallon paint buckets used by a community group to the high-tech monitoring shed unveiled Thursday by the state Department of Environmental Conservation, air quality in the Town of Tonawanda is under the microscope.

A shed off Grand Island Boulevard is one of four installed by the DEC for a yearlong project to monitor hazardous air pollutants in the town. The first air samples were collected July 5.

Other sheds are located upwind at Beaver Island State Park — whose air quality will provide the background level against which readings are compared; near the Sheridan Park water tower; and off Brookside Terrace West, which borders a residential area in the City of Tonawanda.

Funded equally by the DEC and the U.S. Environmental Protection Agency, the $600,000 study continues air monitoring done in 2004 and 2005 to detect benzene, a hazardous pollutant emitted by local industries and motor vehicles.

"We anticipate this will be the highest-level site," Paul Sierzenga, an environmental engineer with the DEC, said of the Grand Island Boulevard shed. The Tonawanda Coke Plant is nearby, as well as the heavily traveled south Grand Island bridges.

Samples are collected every six days, when the air pumps shut off and samples are sealed within 6-liter canisters and small vials. DEC officials said they're awaiting results from the initial samples.

Members of the Clean Air Coalition of Western New York also were at the Grand Island Boulevard site Thursday. They brought along one of their $100 portable air monitors, a modified paint bucket that collects air samples for analysis by the EPA.

The group has been working with the DEC and the University at Buffalo's Chemistry Department to identify air pollution and improve air quality in the town and surrounding community.

"This is the most highly industrialized area in New York State," said Jackie James, the coalition's executive director. "The biggest issue here is it's in a community."

The coalition is investigating the link between the combined effect of all air pollutants and community health.

When they announced the air-monitoring project in the spring, DEC officials said they expected to meet with the community this fall to provide a progress report and preliminary findings.

"We have a plan and we are going to stick to that plan," said Thomas Gentile, chief of the department's air toxics section.

jhabuda@buffnews.com

TOWN OF TONAWANDA: DEC study will determine if there are risks from plant emissions

By Daniel Pye/pyed@gnnewspaper.com
The Tonawanda News

— TOWN OF TONAWANDA —There's something in the air in the Town of Tonawanda, and the Department of Environmental Conservation wants to know what it is.

Using a $300,000 grant from the Environmental Protection Agency, the DEC has started a year-long air quality study in the town. Since July 1, air samples have been collected from four sites around the town to be analyzed to determine whether the heavy concentration of industrial polluters poses any health risks, according to environmental engineer Paul Sierzenga.

The sites were chosen according to EPA standards with an eye toward monitoring plants that could pose health risks for residents.

The machine that tests for particulate matter 2.5 microns or smaller, which is small enough to enter the lungs and do damage, runs 24 hours a day and sends data to the DEC headquarters every hour. Once things are properly set up, the data will be available on the DEC Web site, Sierzenga said.

This is a welcome look at a problem that could affect many town residents, said Martha Meyers, a member of the Clean Air Coalition.

"It's nice to see them get the monitors in," Meyers said. "I have asthma, so I want to see if pollutants are causing problems in general for people with breathing problems."

Another pair of machines collect air samples in sealed canisters once every six days, which are then sent to the EPA for analysis, Sierzenga said.

"They pull air from outside into the canister for a 24-hour period," Sierzenga said. "Collecting every six days gets us every day of the week and what's in the canister represents what was in the air at each site for the 24-hour period."

The final set of machines pull outside air through filters, capturing alcohols like formaldehyde that would stick to the sides of the canisters and not show up in the other analysis, Sierzenga said.

Samples have been collected every six days since the start of July, but the analysis still needs to be verified and more data collected before any sophisticated modeling can be done, said Tom Gentile, chief of the DEC's air toxins section.

"When we have a full quarter of data we can take a hard look at what we're seeing," Gentile said. "At that time in the fall, we'll have a meeting with residents to discuss the findings."

The study will make sure local plants are meeting EPA standards and see if the pollutants in the area are contributing to health risks, said DEC environmental engineer Al Carlacci.

"One of the specific goals of the grant is trying to verify the results of a DEC risk assessment," Carlacci said. "The focus is this industrial pocket, which is one of the heaviest industrial areas in the state or even the country when you look at it."

That layering of several polluters in one area makes each individual factory's compliance to federal regulations mean less when the emissions are all covering the same area, said Jackie James, head of the Clean Air Coalition.

"If there are four factories emitting benzene, they can all be within federal regulations," James said. "But combined, that still might not be enough. We're looking at what the community can do to make everyone happy and healthy."

While the EPA regulations are a start, if the data reveals a problem it would likely be up to the state to work with companies to get the emissions down in the short term, Gentile said.

"Right now, all the facilities are in compliance with federal regulations," Gentile said. "Federal regulations are very rigid, whereas the state has the ability to tighten and adapt to changing things. I like to say all federal regulation has its genesis in good state programs."

The Clean Air Coalition is still looking for volunteers to collect data that will augment the DEC study. Anyone interested can contact Jackie James at asireps@roadrunner.com.

Contact reporter Daniel Pye at 693-1000, ext. 158.

Photos

James Neiss/staff photographer Town of Tonawanda, NY - Paul Sierzenga, with the NYS Department of Environmental Conservation, reads air sample data at a portable air monitoring station on Grand Island Boulevard, where they plan to monitor air quality in Tonawanda and the surrounding community for 1 year.

2008 - Press Releases, Newspaper Articles, Fact Sheets

TOWN OF TONAWANDA

Air quality sampling results to be reviewed

Updated: 02/29/08 6:47 AM

Analysis of air quality samples, collected in canisters and vials last year in the Town of Tonawanda, will be discussed at an informational meeting Saturday.

Sponsored by the state Department of Environmental Conservation's Division of Air Resources, the meeting is scheduled for 9:30 to 11 a.m. in Sheridan Parkside Community Center, 169 Sheridan Parkside Drive.

"The Tonawanda Community Air Quality Study will be a valuable tool in evaluating the impact of stationary and mobile source air emissions in the Tonawanda area," Abby Snyder, the DEC's regional director, said this week.

Last summer, the DEC installed four air quality monitoring stations around the Tonawanda area for what's to be a year-long study. The stations are on Grand Island Boulevard, near the NOCO terminal; Brookside Terrace Drive; Two Mile Creek Road, at the Sheridan Park water tower; and Beaver Island State Park golf course, which will provide background samples against which other readings will be compared.

Data on samples collected between July and December will be discussed Saturday.

The study continues air monitoring done in 2004 and 2005 to detect benzene downwind of the industrial area bordered by River Road, the Niagara Thruway and Youngmann Memorial Highway.

Information generated by the study will be shared with lawmakers, public health officials, and business and community groups toward local air pollution reduction strategies.

Also Saturday, the leader of a local environmental group will talk about a companion study to investigate the potential link between air pollutants and community health.

The Clean Air Coalition of Western New York received a grant from the DEC for that study, which will be carried out by volunteers wearing personal air monitoring badges, among other things.

citydesk@buffnews.com

TOWN OF TONAWANDA: What’s in the air?

Tonawanda has higher than recommended pollutant levels

By Caitlin Murray / murrayc@gnnewspaper.com
Greater Niagara Newspapers

Tonawanda News
http://tonawanda-news.com/

By Caitlin Murray - 3/2/08

murrayc@gnnewspaper.com

TOWN OF TONAWANDA — There’s something in the air in Tonawanda: Benzene and 1, 3-butadiene emissions.

But the state’s Department of Environmental Conservation is still figuring out exactly how much of the chemicals are in the air so officials will know how to reduce them.

A representative from the DEC shared with residents six-month results Saturday from its ongoing Tonawanda Community Air Quality Study.

The preliminary findings show higher than recommended levels of carcinogens benzene and 1,3-butadiene at all four data collection sites: Beaver Island State Park, Brookside Terrace Drive, the Sheridan Park Water Tower and Grand Island Boulevard.

While benzene levels are recommended at .13 micrograms per cubic meter, the Sheridan Park site had the lowest of the four at about 1.0. Grand Island Park Boulevard overwhelmingly had the highest at more than 11.0.

But the numbers for this area are not unique, said Garry Boynton, an environmental chemist for the DEC. Even at the top of White Face Mountain in Lake Placid, benzene levels are above guideline recommendations and Antarctica’s levels are rising, too.

“Benzene is everywhere,” Boynton said. “There’s no where you can get away from it.”

The chemical compound benzene is a carcinogen emitted from the production, burning and service stations of oil and gasoline. It also comes from tobacco smoke and some types of manufacturing plants.

The four sites were chosen, in part, to measure the wind patterns of the emissions at different points around the area.

The Tonawanda area was also found to have levels of 1,3-butadiene above recommended levels. All the sites, except for Grand Island Boulevard, were still under the statewide average, however.

There were some positive results, too. All four sites were well below the recommended levels for carbon disulfide.

The difference in the various chemical levels may be a direct result of the level of attention each emission has received from the DEC and government officials, said Thomas Gentile, chief of the air toxics section for the DEC.

“It seems like there’s a way to go still with benzene,” Gentile told the crowd of about 30 residents. “I showed you earlier the sort of success we’ve had reducing carbon disulfide and carbon monoxide. … That’s been a 30-year effort to get some of these values down. We’ve worked on this (benzene) effort earlier than some other states, but we still have a long way to go.”

Residents attending the presentation wanted answers.

“What is the end result of this study?” asked Tonawanda resident Ron Meegan, who lives near the Sheridan Park site. “When you say, ‘OK, the benzene level is (several) times higher than it should be,’ what does that mean to all of us living in this particular area?”

Gentile said residents should know that the DEC has heard their concerns and is examining the situation.

“What the study results do is give you information to work with us and work with the local government and local businesses to see what we can do to get reductions down to those guideline levels,” Gentile said.

Lifelong Tonawanda resident Thomas Rapp said he’s noticed chemical smells walking outside and came to the meeting to learn about what the odors mean for his family’s health.

“I didn’t take as much as I would’ve liked to from it,” he said of the presentation, “but it does reassure me that they’re doing something about this and at least there’s some effort going on here.”

Residents from Tonawanda were joined by Erie County Legislator Michele Iannello, D-Kenmore, and Jackie James, director of the Clean Air Coalition of Western New York to hear the study’s preliminary findings.

The DEC will offer another public presentation to discuss the findings of the one-year study once it’s completed, Gentile said.

Tom Gentile
Central office
3259

DEC Study shows levels of toxic matter in town air

by **JILL SCHMELZER**
Editor

Ken Ton Bee
3/5/08 pg A1

Six months after the Department of Environmental Conservation installed four air monitoring trailers around Tonawanda some tests show high levels of toxic matter. To be exact: benzene, 1,3-butadiene and acrolein.

Thomas Gentile, chief of the DEC Air Toxics Section Bureau Air Quality Analysis & Research Division of Air Resources, refused to comment on whether or not the air in Tonawanda is safe to breathe.

"I would rather not comment until the full year (of testing) is complete," Gentile said.

> **" The question is can we get to below one in a million? "**
>
> ***— Gary Boynton, DEC specialist***

The Tonawanda Community Air Quality Study measures daily toxics emitted from the industrial area bordered by River Road and Interstates 190 and 290.

Members of the DEC explained to the public Saturday what six months of air monitoring has revealed about the air toxics in Tonawanda.

(Please turn to back page)

DEC Study

(Continued from page one)

The monitors are placed upwind at Beaver Island State Park, and downwind at Two Mile Creek Road near the Sheridan Water Tower, the NOCO terminal on Grand Island Boulevard and at the end of Brookside Terrace Drive.

Engineers measure the toxics released into the atmosphere on a daily basis from gasoline distribution terminals, coke ovens, tire manufacturing, sponge manufacturing and a coal-fire power plant. It also measures the effects of traffic on the Grand Island bridges and the two interstate highways that run through and alongside the town.

Each day, scientists measure fine particulate matter, which can embed deeply in a person's lungs; sulfur dioxide, which causes concerns about more people suffering from asthma; and carbon monoxide, which places stress on the heart.

Since 1980, the levels of the above toxics have been on the decline across the nation because of new technology that works to lower the amount of carbon monoxide, sulfur dioxide and fine particulate matter that are being released into the atmosphere.

Hourly measurements are taken at the four monitoring sites, and thus far, the study reveals high levels of volatile organic compounds, including benzene, 1,3-butadiene and acrolein.

Benzene comes from tobacco smoke; motor vehicles and oil and natural gas production; petroleum refining and distribution; burning coal, oil and gas; gasoline service stations; coke ovens and coal chemical manufacturing; rubber tire manufacturing; and storage or transport of benzene. Natural sources include emissions from forest fires.

In Tonawanda, benzene levels at Beaver Island, Brookside Terrace and the water tower are about average with the statewide levels at approximately 1.3 micrograms per cubic meter.

The guideline for benzene, meaning there is a one in a million risk of developing cancer because of benzene, is at about .03 micrograms per cubic meter.

At Grand Island Boulevard, the level of benzene is measured at an average of 11 micrograms per cubic meter.

"It's not unexpected for an industrial site," Gentile said of the levels measured at the Grand Island site. "Benzene is everywhere."

The goal of the Clean Air Coalition is to lower the exposure of the chemicals to less than the guidelines.

The butadiene guideline is .03 micrograms per cubic meter. The statewide average is at .13. In Tonawanda, the levels are below the statewide average, except at Grand Island Boulevard, which is at .23 micrograms per cubic meter.

"This is not an easy target compound to find," said Gary Boynton of the DEC.

At .3 micrograms per cubic meter, there is a 10 in a million chance of getting cancer from butadiene, Boynton said.

Butadiene comes from tobacco smoke, oil refineries, chemical manufacturing, commercial plastic and rubber factories, gasoline service stations and motor vehicles. Natural sources include emissions from forest fires and biomass burning.

"The question is can we get to below one in a million," he asked.

Acrolein levels are uniform across all four sites at about .40 micrograms per cubic meter, Gentile said. The guideline is at .02 micrograms per cubic meter.

Acrolein comes from tobacco smoke, chemical manufacturing, combustion of petrochemical fuels and coal, mobile source exhaust — formed when cooking fats are overheated, breakdown by sunlight of various hydrocarbon pollutants and use as an herbicide and algaecide. Natural sources come from fermentation and ripening, as well as when organic matter such as trees and plants are burned.

"The study results give you an idea of how to work with us," Gentile said, noting that the public empowers the DEC to find ways of lowering the toxic levels.

For example, the downstate area uses reformulated gasoline, which lowers the vapor pressure released, thus lowering the amount of benzene in the air. However, Gentile said, reformulated gas isn't offered throughout the state.

The air monitoring study is funded through a $300,000 grant from the Environmental Protection Agency, with additional funding and staff support from the DEC. There are only about 12 of these studies being conducted nationwide, Gentile said.

For more information and for daily results, visit the Web site http://www.dec.ny.gov/airmon/regionMap.php?regionno=9.

Buffalo Evening News

TOWN OF TONAWANDA

Tests find elevated air pollution

By Janice L. Habuda NEWS STAFF REPORTER
Updated: 03/06/08 6:58 AM

Air quality test results in the Town of Tonawanda aren’t necessarily surprising, a state environmental expert and a local citizens group leader agreed.

When it comes to benzene, a carcinogen connected to industry, motor vehicle emissions and even tobacco smoke, they’re as bad as expected.

“What’s very concerning is that all of New York State is above that threshold limit,” said Jackie James, executive director of the Clean Air Coalition of Western New York. “Obviously, we are going to be concentrating our efforts on reducing benzene.

Testing by the state Department of Environmental Conservation continues through July at four sites in the town. It is part of a two-year effort to identify and address the risks posed by hazardous air pollutants.

Thomas Gentile, chief of the DEC’s Air Toxics Section, briefed residents last weekend on the first six months’ data. Informing the public is repeated in the two-year timeline, with another briefing expected after the year of sampling concludes.

“That’s the primary goal of a study like this,” Gentile said Tuesday. “You need to be informed, and you need to have good information to get people’s attention.”

Samples are being analyzed for 42 volatile organic compounds and 10 carbonyls. Fifteen of the chemicals are among 33 identified by the federal Environmental Protection Agency as urban air toxics that need to be reduced.

“The results that we are getting there are not unexpected,” Gentile said of benzene readings.

As expected, benzene concentrations at a Grand Island Boulevard site are several times the state average. By way of explanation, Gentile cites several nearby industries and motor vehicle traffic.

Another site, near Brookside Terrace West, recorded the second- highest concentrations — roughly double the statewide average. Gentile noted that site is directly downwind from Grand Island Boulevard.

Other pollutants of concern are 1,3-butadiene — another carcinogen linked to motor vehicle exhausts and industrial production; and acrolein, an upper respiratory tract irritant. Manmade sources of acrolein include tobacco smoke, and it is also formed when cooking fats are overheated.

Grand Island Boulevard also tops the six-month average for 1,3- butadiene concentration, at roughly double the statewide average. The three other sites fall below.

The Clean Air Coalition will study air quality at the personal level and is seeking volunteers to wear clip-on badges containing filters designed to absorb various chemicals.

The area of study includes the 14217 and 14150 ZIP codes. Volunteers cannot be cigarette smokers or professional cleaners and won't be allowed to pump gasoline while wearing a badge.

jhabuda@buffnews.com

Find this article at:
http://www.buffalonews.com/cityregion/northernsuburbs/story/292706.html

Funds sought to keep monitoring air

Published on July 16, 2008
Author: Janice L. Habuda - NEWS STAFF REPORTER

The U.S. Environmental Protection Agency is being asked to continue funding an air monitoring program in the Town of Tonawanda that is set to expire at the end of this month.

The EPA provided a $300,000 grant under which the state Department of Environmental Conservation installed four air quality monitoring stations in July 2007. "The monitoring program [is] set to end about now -- in another week or so," said Daniel David, a regional DEC engineer.

Tuesday, Sen. Charles E. **Schumer**, D-N.Y., announced that he wrote a letter to EPA Administrator Stephen L. Johnson, urging the immediate release of money to continue the monitoring and the search for the sources of contamination.

Preliminary monitoring results, released in March, showed levels of benzene -- a carcinogen connected to industry and motor vehicle emissions -- that exceeded state levels at a Grand Island Boulevard monitoring site. That area, near the south Grand Island bridge, is host to gasoline distribution terminals, coke ovens, tire and sponge manufacturing and a coal-fired power plant.

Measured in micrograms per cubic meters of air, the Grand Island Boulevard location had a six-month average of more than 11; the statewide average in 2007 was 0.9.

The implications of such readings on public health couldn't be learned Tuesday, but part of the overall air quality study is to look at the effects of long-term exposure.

From the DEC's perspective, benzene level guidelines are used in issuing permits to industry. "It's not a standard, per se, but it's what we would recommend," David said.

Regarding the readings released in March, David said: "It's a level that raises some concerns but is not a violation of anything at this point. It's not necessarily a health concern."

Mary Mears, a spokeswoman for Region 2, which includes New York, said: "We agree it's an important project and . . at this point, haven't made any decisions to absolutely end the project."

The results of the year's readings will be discussed at a public meeting that likely will be held in September, the DEC engineer said.

The DEC is spending $300,000 for the second part of the two-year study. A final report will summarize the monitoring results, analyze the air pollution sources and include recommendations for reducing risk.

e-mail: jhabuda@buffnews.com

TONAWANDA NEWS

TOWN OF TONAWANDA: Bucket activists work to collect air samples

By Daniel Pye
The Tonawanda News

October 15, 2008 12:40 am

— While the Clean Air Coalition of Western New York's bucket brigade isn't stacking sand to fight a flood, they would argue the air samples their buckets collect could save lives.

The CAC has spearheaded several air monitoring projects in Tonawanda, and now is setting its sights on helping DuPont and Kaufman aveneue residents find out what is going into their lungs and where it's coming from.

In late July, homeowners on those roads began inexplicably waking up sick, and they believe nearby industrial plants are the cause. New York State Department of Environmental Conservation and health department officials came to the houses to investigate complaints that foul odors and soot are the culprits, but have yet to make any concrete assertions. Work by the CAC using modified buckets to draw in air samples that could then be tested led the DEC to start taking a closer look last year, said CAC Director Jackie James.

"That data that we presented to the DEC got us our four air monitors," James said. "Because we stood up, said there's something wrong with our air and took samples."

The DEC installed monitoring in the town last July to examine the contents of the air at different times and on each day of the week. Early findings included a higher than normal level of the carcinogen benzene, and two of the four monitors were kept operational to collect more data. But those at the CAC meeting were worried the DEC posting its monitoring schedule on-line lets companies plan around the tests.

Mary Moore, one of the residents who complained in July, attended the CAC's Tuesday meeting and made several suggestions for documenting the negative effects of air pollutants, including having blood and urine tests done during or immediately after any illness.

"Our quality of life has been ruined by these plants," Moore said.

Moore and others said the worst of the odors occur at night and in the early morning. That's also when people are suddenly feeling nauseous and they worry that by the time the DEC is able to send someone to investigate, polluters have stopped releasing whatever made them sick. So the CAC assembled some concerned people to put monitoring tools into the hands of people who need them, said Co-director Adele Henderson.

"We're placing the three buckets strategically," Henderson said. "They'll be in the keeping of one person, but if there's an incident where you have to take a sample you have to call two other people in the group to do it together."

The process is strict, with participants expected to document the entire process with forms and photographs. At least two people have to be present for the event so there's a witness, and considering the usual hours the smells occur early morning wake-up calls are to be expected. With each sample analysis costing $500, things have to be handled carefully.

But taking air samples isn't the only way to get involved. The CAC handed out notebooks to the assembled group and asked them to document anything they think is out of the ordinary. Glen Ratajczak listed all of the things people should be recording for their letters to the DEC, including their location, air direction and speed, how long the incident occurs, any smells or tastes they encounter and what effects the incident has on their bodies.

"It's important to be very specific," Ratajczak said. "The biggest thing about documenting an episode is getting as much information as you can. Even things that you don't think are important might be."

Ratajczak's wife Jennifer echoed those sentiments, relating a recent trip to DEC headquarters where she found an empty folder for complaints relating to the area. To create a lasting record that gets the DEC's attention, she said it's important for residents to send letters documenting their personal experiences.

"I know some people are making calls and e-mailing, but that doesn't guarantee your complaint is recorded or kept," she said.

For more information or to participate in future CAC events, visit www.cacwny.org or e-mail jackie@cacwny.org.

Contact reporter Daniel Pye at 693-1000, ext. 158.

Photos

Aaron Ingrao/Contributor Kenmore, NY ?Jackie James, the Director of The Clean Air Coalition, demonstrates how the buckets, used to take air samples, work.

081014 Bucket Brigade ?Tonawanda News Aaron Ingrao/Contributor Kenmore, NY

FACT SHEET

Update on Tonawanda Community Air Quality Study

Division of Air Resources **November 2008**

INTRODUCTION

New York State Department of Environmental Conservation (DEC) would like to update you on the status of the Tonawanda Community Air Quality Study initiated in July 2007 to evaluate air pollutant concentrations in the industrial area of Tonawanda. Sampling at four air quality monitoring stations situated in this industrial area (see map on opposite page) concluded in July 2008. DEC will present the air monitoring results at a public meeting on **Tuesday November 18, 2008** at **7 PM** in the **Sheridan Parkside Community Center** (169 Sheridan Parkside Drive in the Town of Tonawanda) to discuss the findings and next steps, and to answer questions from the public. DEC is providing this fact sheet to update the community on the study's progress and to encourage public participation in developing strategies to reduce local sources of air pollution.

PROJECT BACKGROUND

The section of Tonawanda that borders the Niagara River is one of the most heavily industrialized regions of Western New York. A number of industrial sites in the vicinity, including a coke plant and gasoline terminals, produce emissions which at certain levels may be harmful to human health and/or the environment. In response to citizen concerns about possible hazards and in order to identify the scope of the problem, DEC decided to study ambient (outdoor) air quality in more depth.

DEC applied for air study funding from the United States Environmental Protection Agency (EPA) in August 2005 after sampling conducted by the Tonawanda Clean Air Coalition in 2004 and 2005, and later by DEC, showed elevated ambient air concentrations of certain pollutants. DEC won the grant in the amount of $300,000 and contributed its own money to fully fund the project.

In 2007, DEC installed four air monitoring stations placed strategically around the Tonawanda industrial zone. The sampling sites include a station at Grand Island Boulevard near the NOCO terminal, a station at the end of Brookside Terrace Drive, a station on Two Mile Creek Road at the Sheridan Park water tower, and an upwind station located at the Beaver Island State Park golf course. For a period of one year (July 2007 through July 2008) air samples were collected at these locations every 6 days for a 24 hour period.

NEXT STEPS

With the conclusion of the air monitoring in July 2008, DEC has completed 12 months of air monitoring, allowing us to calculate annual average ambient air concentrations and characterize the risk from specific air pollutants in the community. A public meeting will be held on Tuesday November 18, 2008 at 7PM in the Sheridan Parkside Community Center to discuss the air monitoring results. Members of the Clean Air Coalition will also be on hand to discuss their efforts to improve air quality and suggest ways for citizens to become involved.

WHO SHOULD I CONTACT IF I HAVE QUESTIONS ABOUT THE STUDY?

If you have any question about the project, please contact the following representatives:

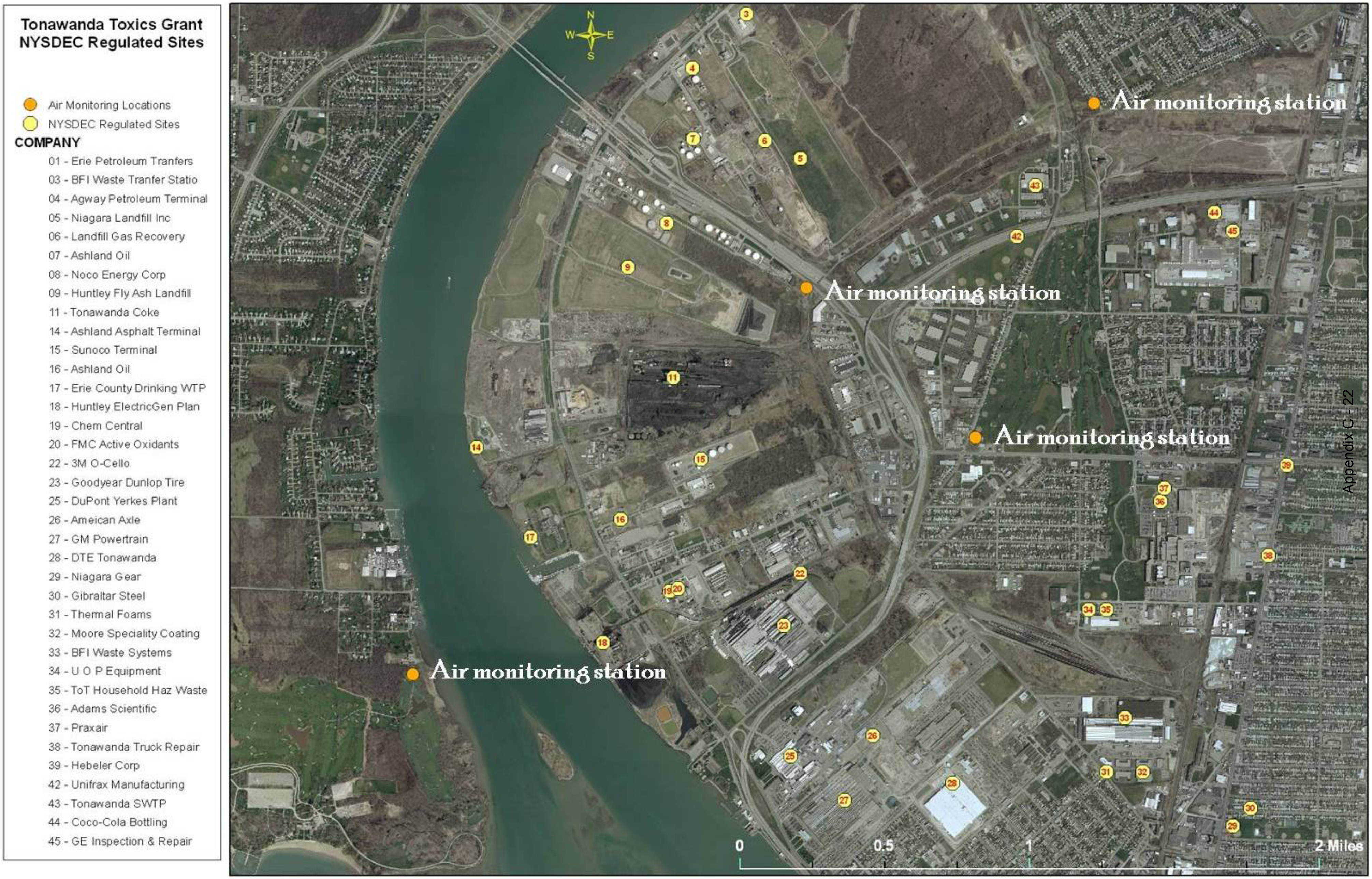
Questions About Emission Sources

Mr. Larry Sitzman
NYSDEC
270 Michigan Avenue
Buffalo, NY 14203
(716) 851-7130
lbsitzma@gw.dec.state.ny.us

Mr. Al Carlacci
NYSDEC
270 Michigan Avenue
Buffalo, NY 14203
(716) 851-7130
axcarlac@gw.dec.state.ny.us

Questions About Tonawanda Study

Mr. Tom Gentile
NYSDEC
625 Broadway
Albany, NY 12233
(518) 402-8402
tjgentil@gw.dec.state.ny.us


Tonawanda Toxics Grant
NYSDEC Regulated Sites
Air Monitoring Locations
NYSDEC Regulated Sites
COMPANY
01 - Erie Petroleum Tranfers
03 - BFI Waste Tranfer Statio
04 - Agway Petroleum Terminal
05 - Niagara Landfill Inc
06 - Landfill Gas Recovery
07 - Ashland Oil
08 - Noco Energy Corp
09 - Huntley Fly Ash Landfill
11 - Tonawanda Coke
14 - Ashland Asphalt Terminal
15 - Sunoco Terminal
16 - Ashland Oil
17 - Erie County Drinking WTP
18 - Huntley ElectricGen Plan
19 - Chem Central
20 - FMC Active Oxidants
22 - 3M O-Cello
23 - Goodyear Dunlop Tire
25 - DuPont Yerkes Plant
26 - Ameican Axle
27 - GM Powertrain
28 - DTE Tonawanda
29 - Niagara Gear
30 - Gibraltar Steel
31 - Thermal Foams
32 - Moore Speciality Coating
33 - BFI Waste Systems
34 - U O P Equipment
35 - ToT Household Haz Waste
36 - Adams Scientific
37 - Praxair
38 - Tonawanda Truck Repair
39 - Hebeler Corp
42 - Unifrax Manufacturing
43 - Tonawanda SWTP
44 - Coco-Cola Bottling
45 - GE Inspection & Repair
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NEWS
REGION 9, Abby Snyder, Regional Director
Niagara, Erie, Wyoming, Chautauqua,
Cattaraugus and Allegany counties

New York State Department of Environmental Conservation

David A.Paterson, Governor
Alexander B. Grannis, Commissioner
www.dec.ny.gov
270 Michigan Avenue
Buffalo, NY 14203-2915

For Release: Immediate
Friday, November 7, 2008

Contact: Mark Baetzhold
(716) 851-7220

DEC INVITES PUBLIC TO MEETING TO DISCUSS RESULTS OF THE TONAWANDA COMMUNITY AIR QUALITY STUDY

The New York State Department of Environmental Conservation (DEC) Division of Air Resources will hold an informational public meeting about the Tonawanda Community Air Quality Study on **Tuesday, Nov. 18, from 7 p.m. to approximately 9 p.m. at the Sheridan Parkside Community Center located at 169 Sheridan Parkside Drive in Tonawanda.** At the meeting, DEC will present the results of a year-long air monitoring study conducted from July 2007 to July 2008 in an industrialized area of Tonawanda. Anyone interested is welcome and encouraged to attend.

This meeting is the third informational public meeting to be held on the Tonawanda Community Air Quality Study by DEC. The purpose of the meeting is to discuss the air monitoring results and address questions from the public.

“The information gained from the Tonawanda Community Air Quality Study will allow the DEC and its community partners to develop strategies to decrease air pollution in the Tonawanda area,” said Larry Sitzman, Regional Air Pollution Control Engineer.

The Tonawanda Community Air Quality Study is funded through a $300,000 grant from the U.S. Environmental Protection Agency (EPA) with additional funding and staff support provided by DEC. DEC initiated the study in response to concerns about elevated air concentrations of benzene in the area downwind of the industrial area bordered by River Road, Interstate 90 and Interstate 290. Industrial facilities located in the study area include gasoline distribution terminals, coke ovens, tire manufacturers, sponge manufacturers, and a coal-fired power plant. The area contains significant truck and automobile traffic, which are also contributing factors that need to be evaluated when assessing air quality.

As part of the study, four air quality monitoring stations were installed around the Tonawanda area. Air sampling at the stations began in July 2007 and concluded in July 2008. The air sampling sites included a station on Grand Island Boulevard near the NOCO terminal, a

(MORE)

station at the end of Brookside Terrace Drive, a station on Two Mile Creek Road at the Sheridan Park Water Tower, and an upwind station located at the Beaver Island State Park golf course.

The data collected from the air quality monitoring study will be used for the following:

- Characterizing air quality in the community;
- Evaluating community exposures and characterizing risk;
- Assisting in developing a model ready inventory of emission sources;
- Evaluating air quality models and other risk assessment tools used by the DEC and EPA to predict community exposures to air pollutants;
- Evaluating EPA Coke Oven Residual Risk Assessment; and
- Evaluating our progress in reducing emissions of air toxics through numerous emission reduction efforts.

The information from this study will be shared with local government, state and local public health officials, community groups and business groups to continue discussions about the need for local air pollution reduction strategies for the community.

Members of the Clean Air Coalition of Western New York will also be on hand to discuss their efforts to improve air quality and to encourage continued public participation.

For more information on the upcoming meeting or the Tonawanda Community Air Quality Study, please contact DEC’s Region 9 Air Resources Division at (716) 851-7130 or region9@gw.dec.state.ny.us.

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http://www.buffalonews.com/cityregion/story/498375.html
11/19/08

High benzene levels found in Tonawanda

Work in town seeks to reduce emissions

By Janice L. Habuda
BUFFALO NEWS STAFF REPORTER

Concentrations of benzene, a known carcinogen, exceeded state guidelines at Town of Tonawanda sites monitored during a yearlong study of air quality, residents learned Tuesday. The state Department of Environmental Conservation says it has a good idea what industries are contributing to those levels and continues to work toward reducing emissions of benzene and other toxins.

"There's a lot more work to be done on the data we collected," said Thomas Gentile, head of the DEC's Air Toxics Section. He was among several DEC personnel at Tuesday's public meeting in the Sheridan Parkside Community Center.

The Tonawanda study is part of the federal Environmental Protection Agency's Ambient Air Toxics Monitoring Strategy. A final report will be presented to the EPA and local residents next spring, Gentile said.

From July 2007 to this July, air samples were collected at four monitoring sites. Sampling continues at two locations with the highest concentrations of toxins: Grand Island Boulevard and Brookside Terrace West.

The DEC bases regulatory decisions on annual guideline concentrations - a standard of .13 micrograms per cubic meter in the case of benzene. The year's readings at the Grand Island Boulevard monitoring station averaged around 9.

"The good news . . . is that nobody's living here," Gentile said.

That particular monitoring station lies in the heart of the town's industrial area, next to the heavily traveled Niagara Thruway and South Grand Island bridges. Motor vehicles also emit benzene.

In determining cancer risks - benzene has been linked to leukemia - most annual guideline concentrations are based on animal studies conducted during the two-year life span of laboratory animals.

For human exposure, such concentrations are considered unlikely to pose appreciable risk of harmful effects over a 70- year lifetime of constant exposure.

The cancer risk in the Town of Tonawanda is similar to that in Lackawanna and the New York City area.

Confused? So was Tuesday's audience.

"Looking at the study, I am confused whether or not there's a problem here," one man said during the question-and-answer period. "Should I be concerned? Should I not be concerned?"

Gentile replied: "The [annual guideline concentrations] are tools to help guide decisions. We err on the side of caution. That's why the [concentrations] are too low."

“We probably need to get a focused benzene reduction program,” Gentile continued.

Another resident commented on smelly emissions in in neighborhoods abutting industry in the middle of the night.

Larry Sitzman, the DEC’s regional pollution control engineer, said the still night air causes a local buildup of contaminants.

jhabuda@buffnews.com

TONAWANDA NEWS

TOWN OF TONAWANDA: DEC needs more time to study benzene data

http://www.tonawanda-news.com/archivesearch/local_story_324011942.html

By John J. Hopkins
The Tonawanda News

November 19, 2008 01:21 am

— High levels of the carcinogen benzene indeed do exist in the air in Town of Tonawanda neighborhoods to the immediate east of River Road.

However, residents will have to wait until at least April to learn what the next step is in the process toward clearing the air around their homes.

That’s what representatives from the state Department of Environmental Conservation’s Buffalo and Albany offices told a crowd of about 75 during an informational meeting Tuesday at the Sheridan Parkside Community Center.

Data collected from four DEC-installed air monitors surrounding the neighborhood from July 2007 through July 2008 is still being analyzed. An inventory of data from “major” sources, such as industry, is complete, but inventory of data from area sources such as gas stations and mobile sources remains under review.

“There’s a lot more work to be done on the data we’ve collected,” said Tom Gentile, who heads the air toxins section of the DEC’s Division of Air Resources in Albany. Gentile plans to provide another update to the public in April 2009. “If you don’t have good emissions inventory, you’re wasting time.”

Benzene was one of six compounds for which the DEC provided test results, but was the only one that state officials determined had levels that were “of concern to the community.”

Levels from monitoring stations at Beaver Island and the Sheridan Parkside water tower were just above the state’s acceptable limits. The level was higher at the Brookside Terrace station, but very high levels were found at the Grand Island Boulevard monitor.

Data collected from Brookside indicates that 16 people out of 1 million could be expected to develop cancer from benzene. The DEC threshold used to determine whether action is necessary is one in 1 million. The state is much more stringent than the federal standard, 10 cases in 1 million.

Information at the Grand Island Boulevard site, located just west of the 290-190 interchange, is still being collected because Gentile said the “information there has been interesting.”

DEC officials are reluctant to identify contributors to the high benzene levels.

Many in the audience were quick to point the finger at Tonawanda Coke, which they believe is also responsible for undesirable odors in the area. Tom Ryan said it was his understanding that Tonawanda Coke is part of a grandfather clause that exempts the company from tighter emissions standards. Gentile said that's not true, the company must still adhere to the federal Clean Air Act.

Larry Sitzman, a representative from the Buffalo office of the DEC, said he's visited Tonawanda Coke and is trying to determine the odor source within the plant. Overall, the company is in compliance with standards.

"They have self-regulators, but we still go out and inspect them," Sitzman said.

Answering another question, Gentile said odors are sometimes more intense at night because there is a "mixing zone" in the atmosphere that shuts down at night, allowing the odors to be more prominent.

Tonawanda Coke is just one of six area companies that generate benzene. The others are Indek Yerkes Energy Services, Goodyear-Dunlop, NOCO Energy Corp., NRG Huntley Electric Generators and Sunoco Tonawanda Terminal.

Add area gas stations, truck terminals and exhaust from vehicles to the list, and narrowing the culprit down to one contributor isn't easy.

"It's hard to say who's doing it," Gentile said. "You don't want to choose based on hearsay. You need a scientific basis to fortify your action."

When the DEC hosts its meeting next April, Gentile said he hopes to be able to offer residents possible solutions. However, the strategy involved is complex. Gentile said he hopes residents will have an answer between 18 months to two years.

"I can't promise overnight," Gentile said. "Everything takes time."

Tonawanda is not the only town in the United States where benzene is a problem. Gentile said there are 353 areas being monitored for benzene across the country, and not one is below the one in 1 million threshold.

Jackie James-Creedon, president of the Clean Air Coalition of Western New York, said the information doesn't appear encouraging in terms of enforcing tighter controls.

"Here we are in a community that's upset with the information and there's not a darn thing we can do about it," James-Creedon said.

Gentile said that benzene levels do exceed state guidelines, and therefore there is room for improvement.

James-Creedon said her group hopes to use its "power of community organization" to ask local companies that produce benzene as a byproduct to be "good neighbors" and initiate their own tighter controls.

The coalition recently received a $40,000 grant that will fortify its efforts. James-Creedon said the coalition will announce its plans for the funding at 11 a.m. Friday at the Kenmore-Tonawanda Chamber of Commerce.

Gentile, who has worked with James-Creedon, praised the coalition for its work.

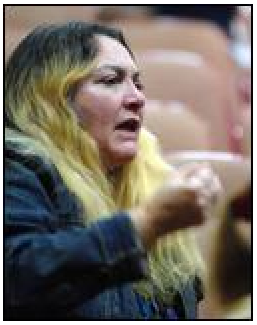
"Improvements happen when you get involved," Gentile said, adding that community inaction promotes maintaining the status quo. "You have to be an environmental steward."

Overall, DEC officials believe there is no reason for residents to believe that nearby industry is causing severe health problems. But they stressed the data still needs to be studied.

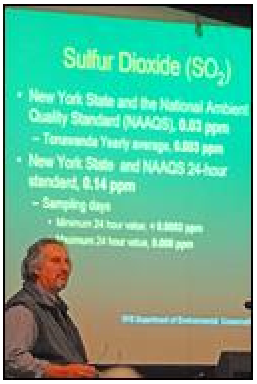
"I would say there's no imminent threat right now," Gentile said.

Photos

081118 AIR STUDY3 - TON/NOV DOUG BENZ/STAFF PHOTOGRAPHER
TONAWANDA, N.Y. - The DEC conducts a public air quality meeting at Sheridan Parkside Community Center, Tuesday, Nov. 18, 2008.



081118 AIR STUDY1 - TON/NOV DOUG BENZ/STAFF PHOTOGRAPHER
TONAWANDA, N.Y. - Nancy Brach speaks during a public air quality meeting conducted by the DEC at Sheridan Parkside Community Center, Tuesday, Nov. 18, 2008.



081118 AIR STUDY2 - TON/NOV DOUG BENZ/STAFF PHOTOGRAPHER
TONAWANDA, N.Y. - Tom Gentile of the DEC conducts a public air quality meeting at Sheridan Parkside Community Center, Tuesday, Nov. 18, 2008.

11/22/08 06:06 AM
Buffalo Evening News
http://www.buffalonews.com/cityregion/northernsuburbs/story/501575.html

Group seeks meeting on benzene

By Janice L. Habuda NEWS STAFF REPORTER

A citizens group seeking to reduce benzene exposure in the Town of Tonawanda plans to start its mission by going directly to the source.

At a news conference Friday, members of the Clean Air Coalition of Western New York announced they hope to meet with representatives of Tonawanda Coke Corp., whose River Road facility emits the most benzene of local industries.

“We want to sit down with them. We’re looking for them to be a good neighbor,” said Jackie James, the coalition’s executive director.

A representative of Tonawanda Coke could not be reached to comment Friday.

The coalition’s announcement came days after the state Department of Environmental Conservation met with residents to discuss results of a yearlong air quality study in the Town of Tonawanda. Several toxic substances were detected in varying concentrations, but it was the levels of benzene — a known carcinogen — that most alarmed residents.

Tonawanda Coke’s emission of 5 to 6 tons of benzene a year is equal to the emissions of motor vehicles traveling the busy corridor near the South Grand Island bridges, according to Al Carlacci, an environmental engineer with the DEC.

The air quality study determined that benzene readings at all four monitoring sites exceeded not only the state standard used for regulating industry but also the statewide average.

“What we are looking to do is reduce the overall threshold of air pollutants in the community,” James said. “The first thing we are going to target is benzene, because we have hard evidence of that.”

In addition, the coalition intends to use a $40,000 grant to educate the public about reducing their exposure.

“There’s actually a lot that people can do, too, to reduce benzene. If you’re reducing your carbon footprint, you’re also reducing your benzene footprint.”

Because of their exposure to the carcinogen, residents wonder whether multiple cases of cancer diagnosed in their families and neighbors are related.

“I am very concerned about the health of the residents in my district,” said Erie County Legislator Michele M. Iannello, D-Kenmore.

Iannello said she’s going to submit a resolution seeking the involvement of the Erie County Health Department.

jhabuda@buffnews.com

2009 - Press Releases, Newspaper Articles, Fact Sheets

Buffalo Evening News
3/5/09
Health study of Tonawanda residents sought
By Janice Habuda
News Staff Reporter

Erie County and state Health Department officials were on hand this morning to hear pleas for a health study of Tonawanda-area residents exposed daily to industrial air pollutants.

Neither made any promises; they're awaiting a final report from the state Department of Environmental Conservation, which concluded a year-long air quality study last fall.

Both appeared before a meeting of the county Legislature's Health and Human Services Committee, during which Legislators Michele M. Iannello, D-Kenmore, and Majority Leader Maria Whyte, D-Buffalo, asked for the health study for their constituents. A formal resolution is being composed for the Legislature's approval.

Air quality tests revealed excessive levels of benzene and formaldehyde - two known carcinogens ... in the neighborhoods near the Town of Tonawanda's industrial corridor.

"The final results should start to point closer to a source. There's a number of potential sources there," said Mark Kowalski, Erie County's assistant director of environmental health.

Ralph Van Houten, the state's environmental health director for the western region, similarly said: "Once we have that information, we will have a better understanding of what populations may be exposed to these chemicals."

That wasn't good enough for Iannello.

"The problem is that you're saying that we have to see the final results. I understand that ... I feel we need to take action now," she said.

"What I am asking for ... for you to work with the Clean Air Coalition of Western New York [CACWNY] because I've got sick residents. They've been sick for years," Iannello said.

It was the coalition, which began its own air testing several years ago to investigate residents' illnesses, that prompted the DEC's year-long study. "It's absolutely essential that the Department of Health gets involved," Jackie James, its executive director, said this morning.

Jean Thomson, a resident of the Sheridan-Parkside neighborhood, told the committee about undiagnosable illnesses she's suffered during the past 30 years.

"There's got to be something that's wrong with me that can actually be proven," Thomson said. "If it's environmental, then something should be done about it."

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Published: May 19, 2009 11:27 pm
http://www.tonawanda-news.com/local/local_story_139232822.html

TOWN OF TONAWANDA: CAC group organizing members, awaiting results

By Daniel Pye
E-mail Dan
The Tonawanda News

For a third time, members and supporters of the Clean Air Coalition of Western New York invited J.D. Crane, owner of the Town's Tonawanda Coke plant, to sit down and discuss his company's air emissions. For a third time, Crane refused.

So Tuesday evening, before an empty chair seated behind a name tag bearing Crane's name, members of the community told their stories to their neighbors and media cameras instead.

Those tales were varied, but all had an underlying theme of illness and despair over suspicions that those illnesses are related to living in a community the storytellers love. Life-long Ken-Ton resident Jackie James-Creedon, one of the group's executive directors, said her fibromyalgia diagnosis nine years ago left her asking questions about the cause. She quickly found plenty of people with similar serious issues, like Jeani Thompson, who also experienced fibromyalgia and five types of cancer to boot.

Others, like Jennifer Strickland, moved to the area more recently and are already feeling the results. After living in her Kaufman Avenue home for three years, Strickland said she, her children and her mother are all waking up with headaches and finding themselves prone to severe allergies.

"I try to spend most of my time away from my own home," Strickland said. "At this point, I wish I could move. I wish that was an option, but it's not."

Details of the New York State Department of Environmental Conservation's year-long air quality study have been trickling out since its completion in July 2008, with a final meeting scheduled for June 12 to present the complete picture. The data collected shows that benzene in certain areas — especially on Grand Island Boulevard in the town's industrial district — are up to 75 times higher than DEC recommended guidelines. That fact continued to baffle listeners Thursday, who were enraged that the guidelines for healthy air aren't laws which carry penalties.

In his lawyer's written responses to the CAC, Crane asserts his company is within the bounds set by law, and the company's self-reported numbers back up that claim. The fact that Tonawanda Coke's numbers for releasing benzene — a carcinogen — are kept by the company itself also raised the question of what prevents employees from lying at the meeting.

Dan David, regional environmental quality engineer for the DEC, said the agency tours the facility at least once a month, although since the number of complains began to spike last year the schedule has been more like once a week. DEC officials also accompanied federal Environmental Protection Agency inspectors on a recent tour of the plant, spending more than two days inspecting operations. And while David said coke production is a drawn-out process that's hard to alter or change on a moment's notice when the inspectors arrive at the door, he acknowledged that self-reporting can have its problems.

"There are some kinds of records, as with any type of business, that if someone wants to be dishonest they can get away with it for a period of time," David said. "But it would always catch up with them."

While the EPA report won't be out for more than a month, CAC members are hopeful that it will involve just that kind of catching up. Strickland said the smoke that settles in her yard from 5:30 a.m. until 9:30 a.m. and the soot it deposits on her home leaves little question in her mind that the emissions aren't safe, whether they're legal or not.

The City of Tonawanda, Town of Tonawanda and Erie County have all passed resolutions calling for the area's industrial polluters, and specifically Tonawanda Coke, to address their emissions. But local municipalities don't have the authority to impose restrictions, so CAC Community Organizer Colin O'Malley recommended other ways of getting results. Educating the people who buy Tonawanda Coke's products is one of those methods, appealing to the company's wallet instead of its conscience. Putting together other, more extreme actions like leading a protest at Crane's home or within his neighborhood were also discussed. While that kind of activity might seem impolite and make many uncomfortable, O'Malley said if the group isn't willing to make Crane and his company uncomfortable there won't be any incentive to change.

"We need to push. We need to agitate. We need to create some tension," O'Malley said.

Simultaneously, the group is still advocating for a legislative resolution. Erie County Legislator Michele Iannello said even though she can't make the law that tightens pollution restrictions, her office can help make the form letters and provide the addresses to citizens so they can bend the ears of state representatives. DEC complaint forms, which were handed out at the meeting, are another way people can make their voices heard.

Finally, the June 12 meeting will include representatives from both the DEC and the State Department of Health, who can take what they hear into the on-going discussions related to Tonawanda Coke's air permit, which is up for review and renewal this year. Charles Cobb, one of the CAC's core members, said getting the word out to the community is the only thing that can grow the group, fill its committees and get movement toward improvement.

“Talk to your neighbors, talk to your family members, talk at your churches,” Cobb said. “Talk, talk, talk.”

Contact reporter Daniel Pye at 693-1000, ext. 158.

NEWS
REGION 9, Abby Snyder, Regional Director
Niagara, Erie, Wyoming, Chautauqua,
Cattaraugus and Allegany counties

New York State Department of Environmental Conservation

David A.Paterson, Governor
Alexander B. Grannis, Commissioner
www.dec.ny.gov
270 Michigan Avenue
Buffalo, NY 14203-2915

For Release: IMMEDIATE
Friday, June 5, 2009

Contact: Mark Baetzhold
(716) 851-7220

DEC INVITES PUBLIC TO MEETING TO DISCUSS NEXT STEPS OF TONAWANDA COMMUNITY AIR QUALITY STUDY

The New York State Department of Environmental Conservation (DEC) will hold an informational public meeting about the Tonawanda Community Air Quality Study on **Friday, June 12, from 7 p.m. to approximately 9 p.m. at the Sheridan Parkside Community Center located at 169 Sheridan Parkside Drive in Tonawanda**. At the meeting, DEC will discuss plans to reduce the burdens of air toxics in the Tonawanda area. The public is encouraged to attend.

This meeting is the fourth informational public meeting held on the Tonawanda Community Air Quality Study by DEC. The purpose of the meeting is to discuss analysis of the air monitoring results, recent inspection activities of facilities in the area, and on-going air quality monitoring conducted by DEC and to address questions from the public.

The Tonawanda Community Air Quality Study is funded through a $300,000 grant from the U.S. Environmental Protection Agency (EPA) with additional funding and staff support provided by DEC. DEC initiated the study in response to concerns about elevated air concentrations of benzene in the area downwind of the industrial area bordered by River Road, Interstate 190 and Interstate 290. Industrial facilities located in the study area include gasoline distribution terminals, coke manufacturing, tire manufacturers, sponge manufacturers, and a coal-fired power plant. The area contains significant truck and automobile traffic, which are also contributing factors that need to be evaluated when assessing air quality.

As part of the study, four air quality monitoring stations were installed around the Tonawanda area. Air sampling at the stations began in July 2007 and concluded in July 2008. The air sampling sites included a station on Grand Island Boulevard near the NOCO terminal, a station at the end of Brookside Terrace Drive, a station on Two Mile Creek Road at the Sheridan Park Water Tower, and an upwind station located at the Beaver Island State Park golf course.

(MORE)

The data collected from the air quality monitoring study will be used for the following:

- Evaluating community exposures and characterizing risk
- Evaluating air quality models and other risk assessment tools used by the DEC and EPA to predict community exposures to air pollutants
- Evaluating the results of the EPA Coke Oven Residual Risk Assessment
- Evaluating our progress in reducing emissions of air toxics through numerous emission reduction efforts.

The information from this study will be shared with local government, state and local public health officials, community groups and business groups to continue discussions about the need for local air pollution reduction strategies for the community.

Members of the Clean Air Coalition of Western New York will also be on hand to discuss their efforts to improve air quality and to encourage continued public participation.

###

The New York State Department of
Environmental Conservation (DEC)
invites you to attend an informational

Public Meeting

for the

Tonawanda Air Quality Study

<u>Where</u>: **Sheridan Parkside Community Ctr.**
Auditorium
169 Sheridan Parkside Dr.
Tonawanda, NY 14150

<u>When</u>: **Friday, June 12, 2009**
7:00 PM to 9:00 PM

……

Join DEC officials for an update on the Community Air Quality Study in the Tonawanda area. Learn about DEC's plan to reduce the burdens of air toxics in the Tonawanda area.

Anyone interested is welcome to attend!

Update on Tonawanda Community Air Quality Study

Division of Air Resources **June 2009**

INTRODUCTION

The New York State Department of Environmental Conservation (DEC) would like to update you on the status of the Tonawanda Community Air Quality Study initiated in July 2007 to evaluate air pollutant concentrations in the industrial area of Tonawanda. Sampling at four air quality monitoring stations situated in this industrial area (see map on opposite page) concluded in July 2008. Over the past year, DEC has been studying this data as well as data on wind direction. DEC also has conducted a number of facility inspections in the area.

DEC is providing this fact sheet to update the community on the study's progress and to encourage public participation in developing strategies to reduce local sources of air pollution.

PROJECT BACKGROUND

The section of Tonawanda that borders the Niagara River is one of the most heavily industrialized regions of Western New York. A number of industrial sites in the vicinity, including a coke plant and gasoline terminals, produce emissions which at certain levels may be harmful to human health and/or the environment. In response to citizen concerns about possible hazards and in order to identify the scope of the problem, DEC decided to study ambient (outdoor) air quality in more depth.

DEC applied for air study funding from the United States Environmental Protection Agency (EPA) in August 2005 after sampling conducted by the Tonawanda Clean Air Coalition in 2004 and 2005, and later by DEC, showed elevated ambient air concentrations of certain pollutants. DEC won the grant in the amount of $294,000 and contributed its own money and staff time to fully fund and conduct the study.

In 2007, DEC installed four air monitoring stations placed strategically around the Tonawanda industrial zone. The sampling sites include a station at Grand Island Boulevard near the NOCO terminal, a station at the end of Brookside Terrace Drive, a station on Two Mile Creek Road at the Sheridan Park water tower, and an upwind station located at the Beaver Island State Park golf course. For a period of one year (July 2007 through July 2008) air samples were collected at these locations every 6 days for a 24 hour period.

The year-long air monitoring allowed DEC to calculate annual average ambient air concentrations, characterize the risk from specific air pollutants in the community, and evaluate the data with wind direction information.

NEXT STEPS

DEC will continue compliance inspections of the many air pollution sources in the area. The department is continuing to gather and investigate complaint information in the community. In addition, two air monitoring sites (Grand Island Blvd. and Brookside Terrace) are continuing to collect data.

The results of these inspections and the monitoring results will be used to make decisions about revising current NY State regulations that govern certain air pollution sources and requiring a greater degree of air pollution control at specific sources using current NY State regulations. DEC will continue to provide study information to the New York State Department of Health (NYSDOH), which will determine the feasibility of conducting a community health study. Finally, DEC will continue our dialogue with the community and industry representatives to evaluate the achievement of our goals to improve air quality for the community.

WHO SHOULD I CONTACT IF I HAVE QUESTIONS ABOUT THE AIR QUALITY STUDY?

If you have any question about the project, please contact the following representatives:

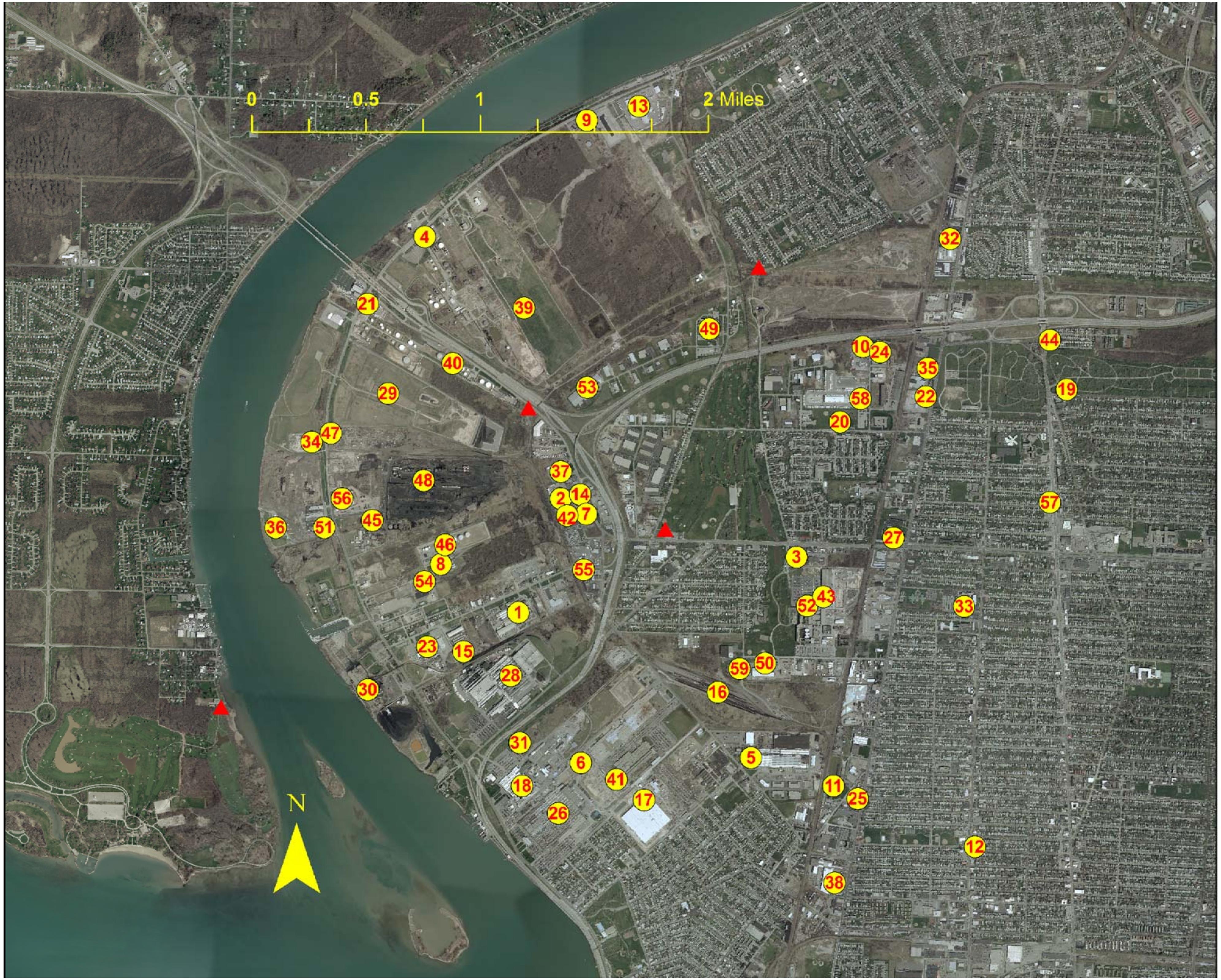
Questions About Emission Sources			Questions About Tonawanda Study
Mr. Larry Sitzman	OR	Mr. Al Carlacci	Mr. Tom Gentile
NYSDEC		NYSDEC	NYSDEC
270 Michigan Avenue		270 Michigan Avenue	625 Broadway
Buffalo, NY 14203		Buffalo, NY 14203	Albany, NY 12233
(716) 851-7130		(716) 851-7130	(518) 402-8402
lbsitzma@gw.dec.state.ny.us		axcarlac@gw.dec.state.ny.us	tjgentil@gw.dec.state.ny.us

Information will also be available soon on the DEC Region 9 website, http://www.dec.ny.gov/about/619.html. Look for the Tonawanda Air Study link at the bottom of the left column. Open the link for an electronic version of the fact sheet, along with the PDF version of the Power Point presentation.

▲ MONITORING SITES

STUDY AREA FACILITIES

1. 3M TONAWANDA
2. ABF FRIEGHT SYSTEM INC
3. ADAMS SFC INC
4. AGWAY TERMINAL
5. ALLIED WASTE OF NA LLC
6. AMERICAN AXLE TONAWANDA FORGE
7. APA TRANSPORT CORP
8. ASHLAND DISTRIBUTION COMPANY
9. CO STEEL RECYCLING - TONAWANDA
10. COCA COLA BOTTLING CO OF BUFFALO
11. COLDEN ENTERPRISES
12. COLVIN CLEANERS INC
13. CON-WAY CENTRAL EXPRESS - XB0
14. CROSSETT TRUCKING
15. CROSSETT TRUCKING
16. CSXT KENMORE YARD
17. DTE TONAWANDA LLC
18. E I DUPONT YERKES PLANT
19. ELMLAWN CEMETERY CREMATORY
20. ERIE COUNTY ASPCA
21. ESTES EXPRESS LINES INC
22. FEDEX FREIGHT EAST INC - BUFFALO
23. FMC CORP - PEROXYGENS DIVIS
24. GE INTERNATIONAL BUFFALO SERVICE CENTER
25. GIBRALTAR STEEL CORP METAL DIVISION
26. GM POWERTRAIN - TONAWANDA ENGINE PLANT
27. GOLD BOND RESEARCH DIV NATIONAL GYPSUM
28. GOODYEAR DUNLOP TIRES NORTH AMERICA LTD
29. HUNTLEY FLY ASH LANDFILL
30. HUNTLEY STEAM GENERATING STATION
31. INDECK-YERKES ENERGY SERVICES
32. KELLER TECHNOLOGY CORP
33. KENMORE MERCY HOSPITAL
34. LAFARGE CORP
35. M J MECHANICAL
36. MARATHON ASHLAND PETROLEUM ASPHALT TERMINAL
37. NEW ENGLAND MOTOR FREIGHT
38. NFT METRO SYSTEMS FRONTIER GARAGE
39. NIAGARA LANDFILL INC - NIAGARA LANDFILL
40. NOCO ENERGY CORP
41. OVERNITE TRANSPORTATION CO
42. PALLET SERVICES INC
43. PRAXAIR TECHNOLOGY CENTER
44. REG 5 HWY MNT-TONAWANDA
45. RIVER ROAD COMPOSTING FACILITY
46. SUNOCO TONAWANDA TERMINAL
47. SWIFT RIVER ASSOCIATES INC
48. TONAWANDA COKE CORP
49. TONAWANDA SD#2 STP
50. T-TONA HOUSEHOLD HAZ WASTE STORAGE FAC
51. TURNING POINT INDUSTRIES
52. U O P EQUIPMENT SYSTEMS
53. UNIFRAX MANUFACTURING
54. UNIVAR MFG.
55. VALLEY RETREADING CO
56. VANOCUR REFRACTORIES
57. VELVET LAUNDRY AND DRY CLEANERS INC
58. YELLOW TRANSPORTATION INC (BUF)
59. ZERO POINT CLEAN TECH THERMO-CHEMICAL



06/13/09 06:28 AM
Buffalo Evening News

Tonawanda Coke plant at fault for foul air, DEC study concludes

By Harold McNeil NEWS STAFF REPORTER

Kenmore-Town of Tonawanda residents have long suspected that cancer-causing benzene emitted from the Tonawanda Coke plant was behind the bad smells and illnesses they have been experiencing, and the conclusions of an air quality study would seem to support their contention.

The state Department of Environmental Conservation held an informational meeting Friday to share the analysis of the Tonawanda Community Air Quality Study with about 200 residents in the Sheridan Parkside Community Center auditorium.

Among the conclusions shared by Thomas Gentile, head of the DEC’s Air Toxics Section, was that the Tonawanda Coke plant on River Road has been the likely source of the irritations to the eyes, ears, noses and throats of nearby residents.

For Jackie James-Creedon, director of the Clean Air Coalition of Western New York, it was a long-awaited vindication.

“For a government agency to actually say the culprit is one specific company, that was like, finally, because we knew that,” said James-Creedon.

“We suspected that all along because of benzene emissions and just by our residents seeing all of the smoke and getting sick because of all of that smoke coming from Tonawanda Coke,” she added.

According to the Centers for Disease Control and Prevention, long-term exposure to benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells, leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

The study, funded through a $300,000 grant from the U. S. Environmental Protection Agency, involved the collection of wind and meteorological data, as well as the monitoring of pollution concentrations at four monitoring stations: Beaver Island State Park, the Brookside Terrace neighborhood in the town, Grand Island Boulevard off of the Niagara Thruway, and the Sheridan Drive Water Tower.

The monitoring took place between July 2007 and July 2008. Five hazardous chemical compounds were measured, with the most volatile being benzene, which the study found in concentrations that greatly exceed the state average, particularly at the Grand Island monitoring station.

“We knew that our air stunk. We know the people are getting sick. However, we have so many industries here. Let’s face it, it’s the combination of all of them, but we have to draw the line somewhere. And we had to draw the line at the worst culprit,” said James-Creedon.

Friday’s meeting was the third in a series of meetings that the DEC has held with residents. Representatives from the EPA also attended the meeting.

Larry Sitzman, the DEC’s regional pollution control engineer, said the goal, after all the data from the study is analyzed, is to reduce odor complaints and the emission of chemicals that are associated with the illnesses and irritations that residents in the Kenmore-Town of Tonawanda area have been complaining about.

“The job is a long way from being done,” said Sitzman.

He added that air sampling will continue at both the Grand Island Boulevard and Brookside Terrace sites, and he promised continuous inspections at the larger plants in the area, such as the Huntley Power Station and NOCO.

Meanwhile, James-Creedon and members of the Clean Air Coalition sought a commitment from the DEC that there will be more resident involvement in any remediation.

“We want to have a say in how our air pollution is reduced and by what limit it should be reduced to, by what concentration,” said James- Creedon.

The group also wants the DEC to enforce tighter controls on the permits of polluters.

hmcneil@buffnews.com

06/23/09 07:09 AM
http://www.buffalonews.com/cityregion/northernsuburbs/story/711911.html

Buffalo Evening News

ENVIRONMENT

Tonawanda Coke urged to cut benzene emissions

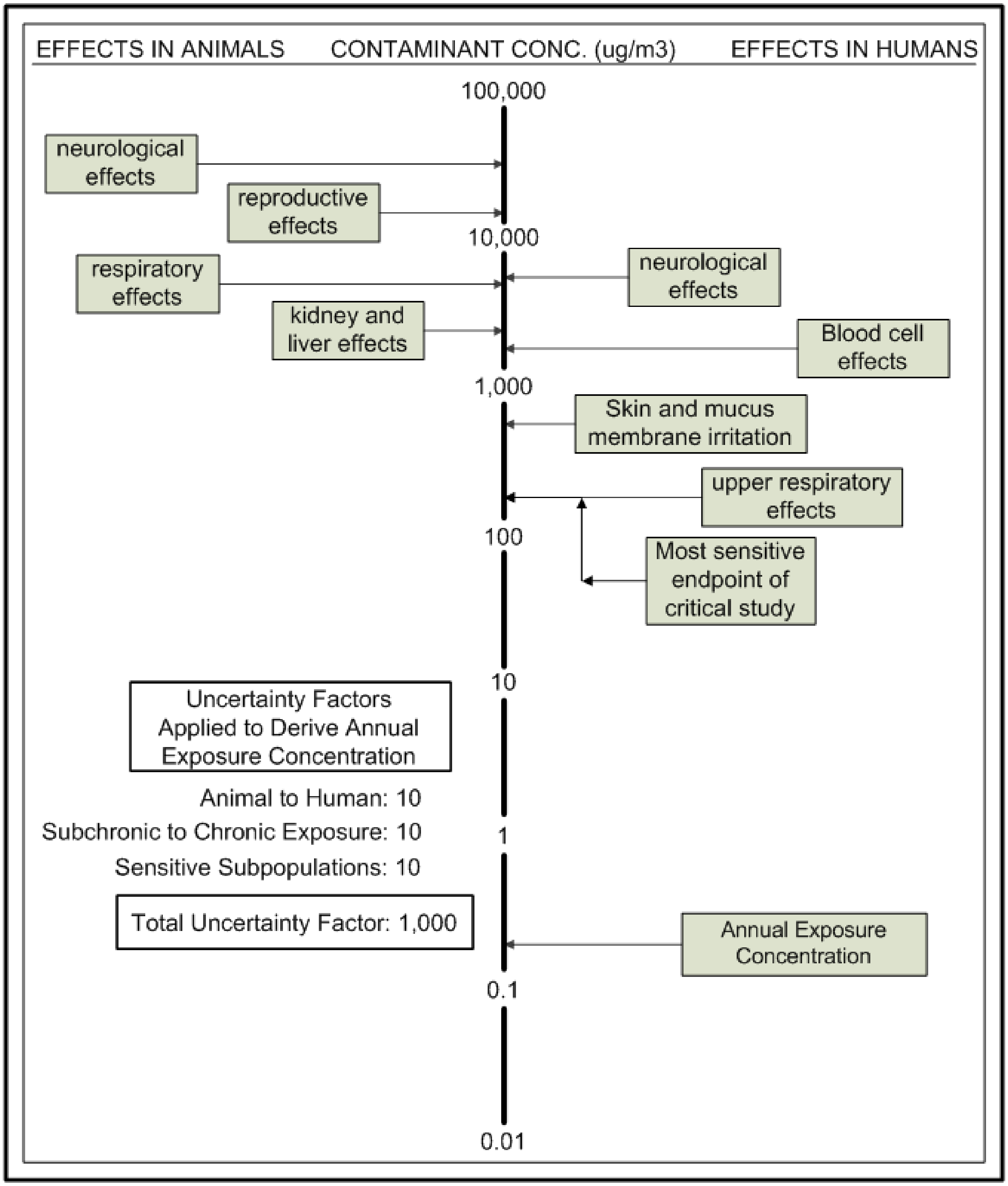
WASHINGTON—Sen. Charles E. Schumer is pressing the owner and CEO of the Tonawanda Coke Corp. to reduce the release of harmful benzene emissions from the Tonawanda plant.

Noting that government data confirms that Tonawanda Coke is responsible for releasing tons of toxic chemical compounds into the air, Schumer said the company needs to act to reduce benzene levels that are up to 75 times higher than the state Department of Environmental Conservation recommends.

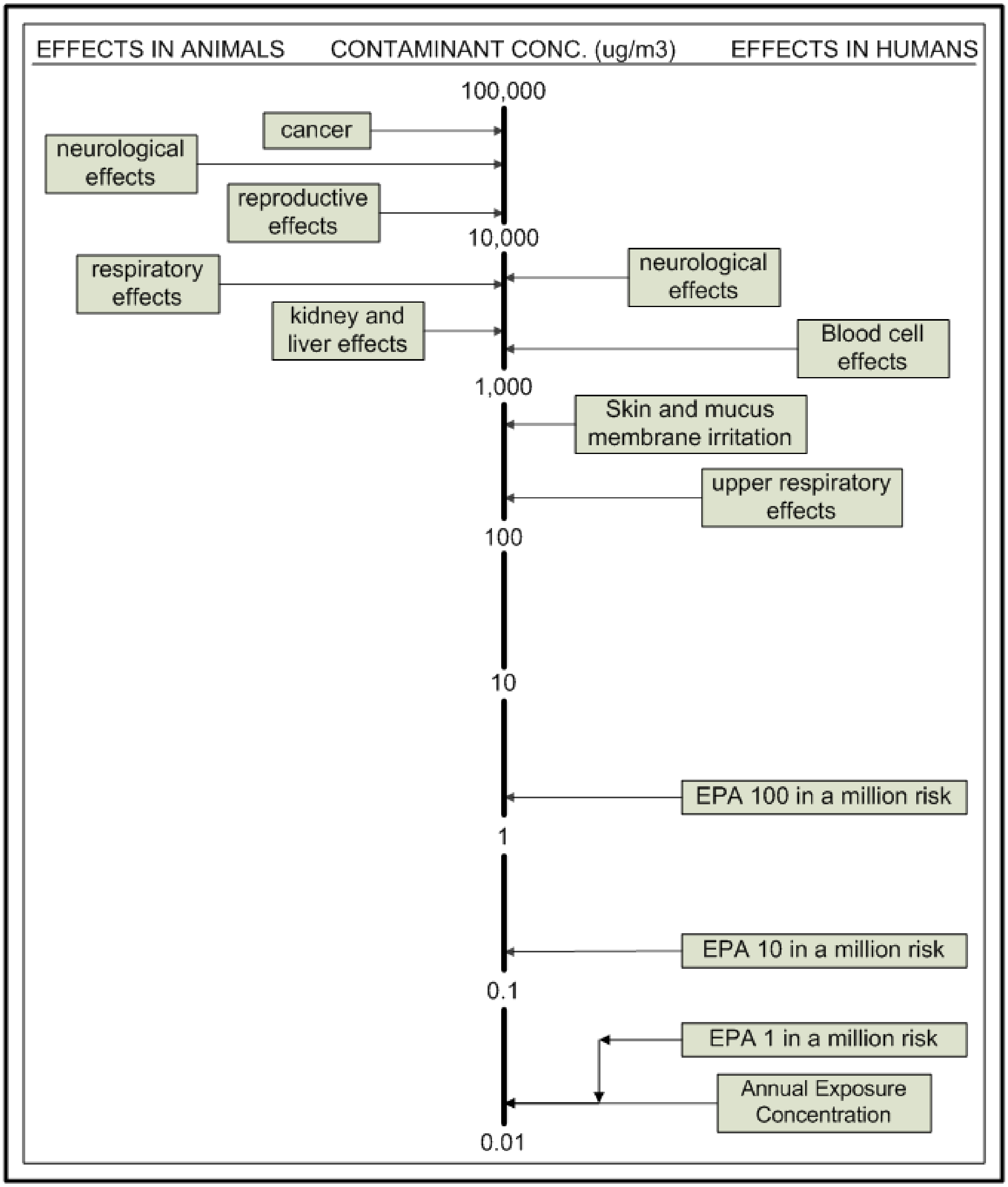
“I have long championed manufacturing in Western New York, and I value Tonawanda Coke’s importance as an employer in the region, but with the health and safety of Tonawanda residents at risk, now is the time to ramp up efforts to reduce these emissions,” Schumer wrote in a letter to J. D. Crane, the owner and CEO of the company.

Appendix D - Non-cancer and Cancer Risk “Tox Tree” Diagrams

Non-cancer diagram used to communicate the fairly conservative margin of safety applied to derive an annual exposure concentration with a non-cancer endpoint (the example presented is not intended to represent a specific pollutant).



Cancer Diagram used to communicate the conservative risk level selected for an annual exposure concentration with a cancer endpoint (the example presented is not intended to represent a specific pollutant).



Appendix E – Laboratory Analyses Quality Assurance

1.0 Quality Assurance Program Plan

The quality assurance methods (precision and accuracy evaluations) were conducted to ensure accurate results were obtained and the method applied varied by type of parameter evaluated. For the criteria pollutants ($PM_{2.5}$, SO_2, CO) quality assurance was primarily conducted in the field since measurements were made with continuous monitoring instruments. In-house quality assurance was performed by comparing the results for the criteria pollutants and meteorological parameters with data from other monitors in the state. For the VOCs and carbonyls the quality assurance requirements outlined in the QAPP were used and are discussed in further detail in (this Appendix) Section 3.0.

The BAQS participates in USEPA's National Air Toxics Trends System (NATTS) and follows the guidelines outlined the Technical Assistance Document (USEPA 2007) for quality assurance evaluations. Some discrepancies between the QAPP (Table A.7.1) and procedures outlined in the NATTS program were identified.   A revised table (**Table E1**) correcting the discrepancies and the changes are discussed below.

A precision and accuracy evaluation was conducted on all three criteria pollutants (the QAPP reported only evaluations for $PM_{2.5}$) and the acceptance threshold applied for both types of evaluations was +/- 10%.

For the VOCs and carbonyls, the accuracy thresholds set by the NATTS performance program (accuracy evaluation) were used and are shown in **Table E1**.

Table E1 Study Data Quality Indicators and Expected Metrics

Parameter	Availability	Precision	Accuracy	Sensitivity
Volatile organic compounds	>75%	+/- 25%	+/- 25%	100 pptv
Carbonyls	>75%	+/- 25%	+/- 25%	100 pptv
Fine particulate matter ($PM_{2.5}$)	>75%	+/- 10%	+/- 10%	100 ng/m^3
Sulfur dioxide (SO_2)	>75%	+/- 10%	+/- 10%	0.1 ppb
Carbon monoxide (CO)	>75%	+/- 10%	+/- 10%	0.02 ppm
Meteorological parameters	>75%			

Units: pptv = parts per trillion volume, ppbv = parts per billion volume, ppmv = parts per million volume, ng/m^3 = nanograms per cubic meter.

1.1 Data Availability

The overall data availability for the Study was high as shown in **Table B2**, exceeding the QAPP target of 75% and greater than the NATTS requirement of 85%.

Table E2 Percent Data Availability[1] by Sites

Parameter	BISP	BTRS	GIBI	SPWT
Canister Samples	95	97	93	95
Carbonyl Samples	92	93	92	95
TEOM (Continuous $PM_{2.5}$)	97	98	93	96
Carbon Monoxide (CO)		98		
Sulfur Dioxide (SO_2)		97		
Collocated Canister Samples			100	
Collocated Carbonyl Samples			92	
Meteorological Parameters	**BISP**			
Wind Speed	95			
Wind Direction	95			
Relative Humidity	99			
Barometric Pressure	95			
Temperature	99			

2.0 Quality Assurance – Criteria Pollutants and Meteorological Parameters

Criteria Pollutants

The criteria pollutants were monitored using continuous instruments. Therefore, precision and accuracy checks were conducted in the field. Results for these checks have been reported to USEPA's Air Quality System and only a summary is provided in this report.

$PM_{2.5}$

$PM_{2.5}$ results were graphed to verify that the data were within expected range of values as compared to results obtained from the Buffalo and Niagara Falls monitors.

Precision checks for the TEOM instruments were conducted monthly by the field operator and consist of an instrument flow rate and temperature check. The results of these two precision checks on all four instruments were within the 10% acceptance limit.

Accuracy checks are an independent audit conducted on a bi-annual basis. Staff from the Department's Bureau of Quality Assurance conducted these tests using a different device than the one used by the field operator. These checks verify instrument flow rate and temperature. The results of the accuracy checks on all four instruments were within the 10% acceptance limit.

Carbon monoxide

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[1] Data availability is calculated based on the number of valid samples collected during the Study period.

Carbon monoxide results were graphed to verify that the data were within expected range of values as compared to results obtained from the Buffalo and Niagara Falls monitors.

Precision checks on the CO instruments were conducted by the field operator and include a zero and span check every week. Every two weeks the field operator conducts an additional precision check by challenging the instrument with CO gas at concentrations near the National Ambient Air Quality Standard (NAAQS). Results of the precision checks were within 4%, well below the 10% acceptance limit.

The accuracy check is a multi-point audit performed quarterly by field operators using the same equipments as the precision checks. Twice a year, staff in the Department's Quality Assurance Bureau perform a multi-point audit using a different device than the one used by the field operator. All precision checks are included in the multi-point audit. Results of the precision checks were within 4%, well below the 10% acceptance limit.

Sulfur dioxide
Sulfur dioxide results were graphed to verify that the data were within expected range of values obtained from the Buffalo and Niagara Falls monitors.

Precision checks on the SO_2 instruments were conducted by the field operator and include a zero and span check every week. Every two weeks the field operator conducts an additional precision check by challenging the instrument with SO_2 gas at concentrations near the NAAQS. Results of the precision checks were within 4%, well below the 10% acceptance limit.

The accuracy check is a multi-point audit performed quarterly by field operators using the same equipment as the precision checks. Twice a year, staff in the Department's Bureau of Quality Assurance perform a multi-point audit using a different device than the one used by the field operator. All precision checks are included in the multi-point audit. Results of the precision checks were within 4%, well below the 10% acceptance limit.

Meteorological Parameters
Meteorological parameters were graphed to verify that the data are within expected values as compared with data obtained from Buffalo and Niagara Falls monitors.

3.0 Quality Assurance – VOCs and Carbonyls

Quality assurance evaluations for VOCs and carbonyls include precision and accuracy analysis, sensitivity testing and checks for interferences (blanks).

3.1 Precision – Replicate Analysis and Collocated Sampling Results

Precision refers to agreement between independent measurements performed according to identical protocols and procedures and applies to both sample collection and laboratory analysis. To evaluate laboratory precision, samples collected from the GIBI site were analyzed twice. The first analysis is labeled "primary" and the subsequent analysis of this sample is a "replicate". To evaluate overall sample precision, which includes collection and laboratory analysis, a second canister and cartridge sample were collected at the GIBI site. These second samples (called collocated) were handled by field and laboratory personnel using the same protocols as the primary samples. Both types of precision measurements are assessed by calculating a percent difference (PD) [2] for results obtained at concentrations greater than five times the method detection limit. Comparisons within +/- 25% PD are considered acceptable.

Results for VOCs Samples

Of the 53 samples[3] (22%) replicated, the acceptance threshold for precision was demonstrated across all analysis runs, although some individual analytes exceeded the threshold. Therefore, no corrective actions were implemented.

Of the 53 samples (22%) collocated, the acceptance threshold for precision was demonstrated across all analysis runs, although some individual analytes exceeded the threshold. Therefore, no corrective actions were implemented.

Table E3 summarizes the replicates and collocated results. Exceedance of the threshold was found for a number of acrolein[4] comparisons. These results are not surprising given that acrolein is a difficult air toxic to measure accurately. We have elected to report the results but the risk evaluation[5] with acrolein will be noted as an estimate.

Table E3 VOC Precision Exceedances

VOC	Replicates	Collocated
1,3-Butadiene		1
Acrolein	6	13
Benzene		1
Dichlorofluoromethane		1
m,p-Xylene		2

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[2] Percent difference is expressed as the difference between two measurements divided by the average, expressed as a percent. NATTS recommends a relative percent difference for precision calculations. We have opted to show the direction of error as opposed to taking an absolute value.

[3] We did not specify in the QAPP the number of replicate and collocated samples that would be obtained in this study. The NATTS requirement for VOC and carbonyl precision measurements is 10% of the samples obtained. We exceeded the NATTS requirement for all replicate and collocated sampling for both VOCs and carbonyls analysis.

[4] The determination of acrolein has inherent analytical and sampling issues cited by various state agencies during the implementation of acrolein by the NATTS program. The Varian Ion Trap has a very low response to acrolein as compared to most of the other analytes of interest. As an illustration, benzene has 15 times the response of acrolein at the same concentration. A subtle change in acrolein peak shape can result in a greater precision difference. Acrolein is a polar compound causing the analytical peak shape to broaden rather than being a tight Gaussian shaped peak. The polar nature of acrolein also causes reactivity in the presence of water associated with the humidity at the time of sampling. Samples are collected with a final pressure of 1 – 3 psi to reduce this affect. Canisters also have an affect on acrolein sampling. There may be a loss or gain of acrolein. Only glass lined canisters were used for sample collection to minimize this effect. The results from the collocated analysis show a possible canister effect.

[5] Section 7 - Public health interpretation of measured air concentrations

Results for Carbonyl Samples

Twenty-three percent (57 samples) of the Study samples were replicated. Across the analysis runs, replicate comparisons demonstrated high precision. For the two carbonyls of interest, acetaldehyde and formaldehyde, **Figure E1** shows the individual comparison results. We focus on these two carbonyls since these are more commonly found in the urban environment at levels close to health comparison values. Corrective action was taken for the two dates outside the acceptance threshold. **Table E4** summarizes the results of the replicated analysis.

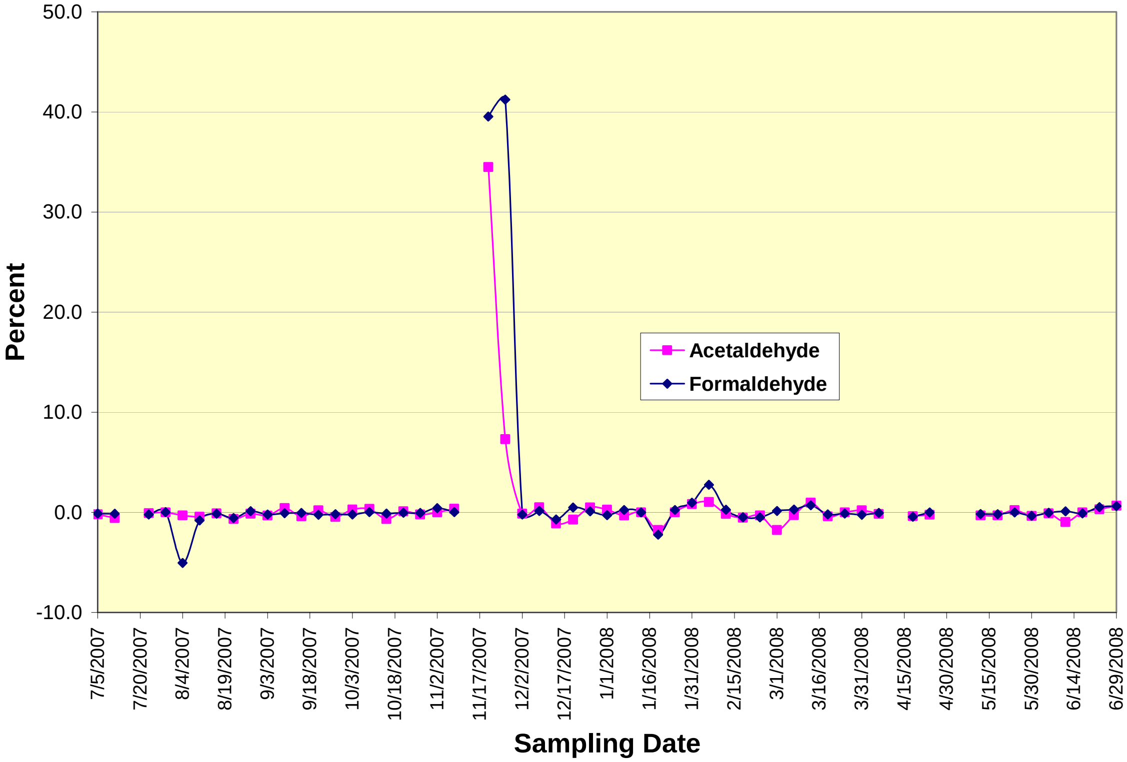

Figure E1 GIBI Replicate Analysis Percent Difference Results

Twenty-three percent (57 samples) of the Study samples were collocated. Across the analysis runs, the collocated comparisons demonstrate high precision. **Figure E2** shows the results for acetaldehyde and formaldehyde. The collocated samples collected on two exceedance dates, appeared to be handled consistent with the primary sample. Therefore, no further actions were taken. The graph demonstrates that these two aldehydes track one another and shows a consistent negative bias, most likely the result of minor flow rate differences between the two sampling systems. **Table E4** summarizes the results of the collocated analysis.

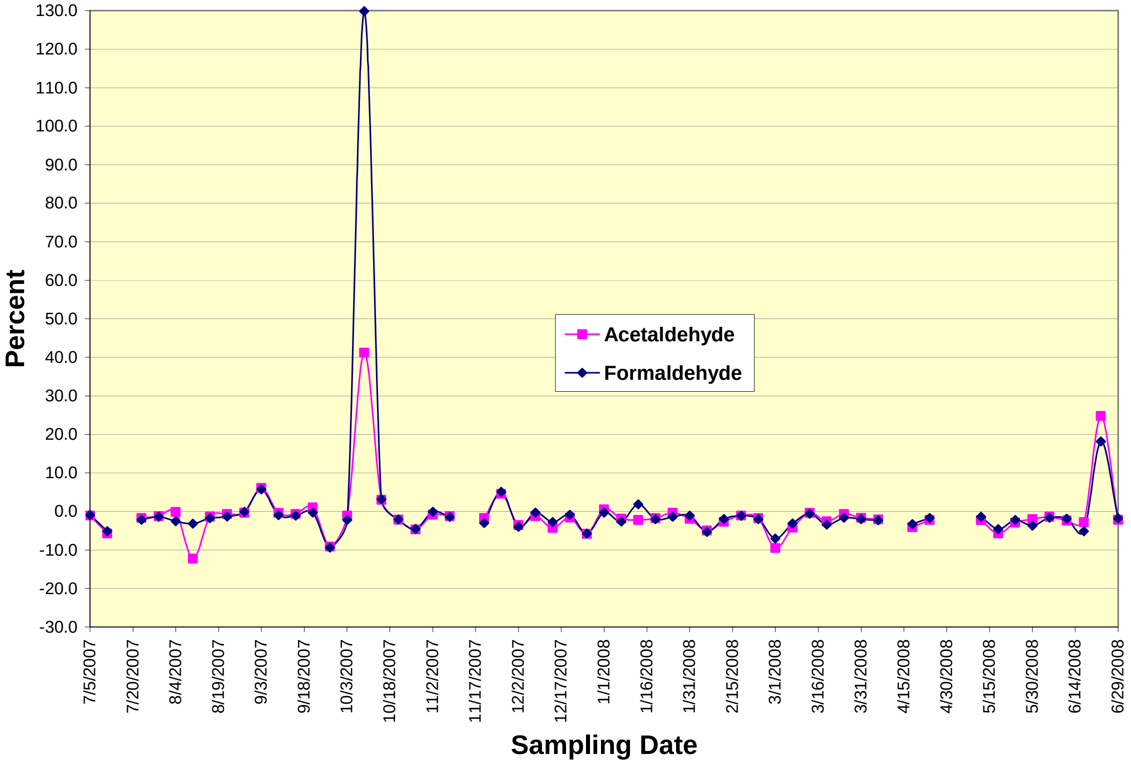

Figure E2 GIBI Collocated Analysis Percent Difference Results

Table E4 Summary Carbonyl Replicate and Collocated Results

Carbonyl	Replicates	Collocated
2-Butanone	2	1
Acetaldehyde	1	1
Benzaldehyde	3	3
Crotonaldehyde	1	1
Formaldehyde	2	1
Hexanal	0	0
Methacrolein	0	0
m-Tolualdehyde	1	0
n-Butyraldehyde	0	2
Propionaldehyde	2	1
Valeraldehyde	1	7

3.2 Accuracy – Proficiency Testing

Accuracy is defined as the degree of agreement between the laboratory analytical (observed) concentration and the actual (true) concentration. The BAQS laboratory participates in the NATTS program which includes a periodic evaluation of the laboratory’s accuracy through testing of VOC and carbonyl proficiency samples.

Accuracy is assessed by calculating a percent error from the true value[6] and comparisons within +/- 25% are considered acceptable.

Volatile Organic Compounds

The NATTS proficiency tests do not include all compounds which are included in the Study. The proficiency tests results before, during and after the Study are shown in **Table E5**. Ninety-one percent of the results are within acceptable limits and this illustrates the strength of BAQS' laboratory performance in the NATTS proficiency testing program.

Table E5 NATTS Proficiency Test Results for VOC Analysis (expressed as percent)

Chemical	January 2007	February 2007	March 2007	April 2007	January 2008	January 2009
1,1,2,2-Tetrachloroethane	-16.7	3.7	0	0	-4.3	-3.1
1,2-Dibromoethane	-4.2	2	-12	-6.6	-6.6	13.5
1,2-Dichloroethane	0	1.8	-8.5	-6.2	-11.6	13.7
1,2-Dichloropropane	9.2	7.1	2.5		-3	11.6
1,3-Butadiene	3.6	-16.6	-2.5	-3.9	29.3 (O)	24.8 (W)
Acrolein	25.5 (O)	-32.9 (O)	-11.9	8.4	-23.7 (W)	-4.9
Benzene	2.6	3.1	-7.5		-9.2	-4.3
Carbon tetrachloride	-10.6	0.9	-5.9	-31.6 (O)	-28.6 (O)	-7
Chloroform	0	2	-14.7		-2.9	12.8
cis-1,3-Dichloropropene	2.9	6.8	5.4		-1.6	18.5
Dichloromethane	10	-4.4	12	8	-16.2	6.9
Tetrachloroethylene (PERC)	7.9	3.1	-2.5		-3	8.9
trans-1,3-Dichloropropene	-9.2	1.2	-1.4		-8.3	20.6 (W)
Trichloroethylene	-4.1	-0.9	0.8	3.1	-10.5	12.5
Vinyl chloride	-4.3	-6.7	0		0	9.9

Codes: (W) Warning +/- 20%, (O) Outside Control Limits +/- 25%
Blank cells indicate VOC not included as analyte in proficiency testing.

Carbonyls

The USEPA NATTS proficiency testing program periodically provides the laboratory with an unknown quantity of acetaldehyde and formaldehyde to extract and analyze. **Table E6** includes results for proficiency tests before, during and after the Study period. The NATTS audits suggest the laboratory accuracy improved over this period to approximately 10% (+/-) of the true value.

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[6] Formula for percent error from true value = (true concentration - observed concentration) / (true concentration) × 100

Table E6 NATTS Proficiency Test Results for Carbonyl Analysis (expressed as percent)

Chemical	April 2007	November 2007	April 2008	January 2009
Acetaldehyde	-21.2 (W)	-14.0	7.4	-8.0
Formaldehyde	-27.5 (O)	-18.8	10.4	-10.3

Codes: (W) Warning +/- 20%, (O) Outside Control Limits +/- 25%

3.3 Sensitivity – Method Detection Limit Evaluation

The sensitivity analysis expresses, the confidence of detecting an analyte's signal above background noise and is quantified through calculation of a method detection limit (MDL). The MDL is defined as the lowest value at which we can be 99% confident that the true concentration is nonzero as outlined in the *Code of Federal Regulations* (Title 40, Part 136, Appendix B, Revision 1.11).

There is less accuracy and precision with results obtained close to the MDL and data users are cautioned not to place too much reliance on these values. Background noise is a greater percentage of the total instrument signal when the measured result is near the MDL. Results in this range place greater emphasis on the technician's ability to separate the baseline noise from the instrument's response to an analyte's signal.

Volatile Organic Compounds

To verify the sensitivity of the analytical system, seven replicates of the TO-15 standard were analyzed on 12/18/2007 and 7/8/2008 and MDLs were derived[7] from these results. System linearity[8] was reconfirmed concurrently with the MDL evaluation. The MDL results were used in the precision assessment (discussed in Section 5.5.1). **Table E7** shows the comparisons between the MDL reported in the QAPP and the values obtained in the laboratory at each six month interval in the Study. As shown, all MDL evaluations met or surpassed the QAPP requirement.

Table E7 MDL Evaluations for VOCs (ppbv)

Compound	QAPP MDL	12/18/2007 MDL	7/8/2008 MDL
1,1,1-Trichloroethane	0.04	0.01	0.01
1,1,2,2-Tetrachloroethane	0.04	0.01	0.01
1,1,2-Trichloroethane	0.05	0.01	0.02
1,1-Dichloroethane	0.04	0.01	0.01
1,1-Dichloroethylene	0.04	0.01	0.01
1,2,4-Trichlorobenzene	0.04	0.01	0.04
1,2,4-Trimethylbenzene	0.05	0.02	0.004
1,2-Dibromoethane	0.04	0.02	0.01

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[7] MDL formula: [(3 x the standard deviation of 7 replicate analyses) / (the average of the same replicates)] x (the concentration of the analytes)

[8] System linearity is consistent correspondence between sample concentration and instrument response.

Compound	QAPP MDL	12/18/2007 MDL	7/8/2008 MDL
1,2-Dichlorobenzene	0.05	0.01	0.01
1,2-Dichloroethane	0.03	0.01	0.01
1,2-Dichloroethylene	0.04	0.02	0.01
1,2-Dichloropropane	0.05	0.02	0.02
1,3,5-Trimethylbenzene	0.06	0.01	0.01
1,3-Butadiene	0.03	0.02	0.02
1,3-Dichlorobenzene	0.05	0.01	0.01
1,4-Dichlorobenzene	0.05	0.01	0.02
A-chlorotoluene (Benzylchloride)	0.06	0.01	0.02
Acrolein[a]	0.03	--	--
Benzene	0.05	0.02	0.01
Bromodichloromethane	0.05	0.01	0.01
Bromomethane	0.04	0.01	0.01
Carbon disulfide[a]	0.03	--	--
Carbon tetrachloride	0.05	0.01	0.01
Chlorobenzene	0.04	0.01	0.01
Chloroethane	0.05	0.03	0.02
Chloroform	0.04	0.01	0.01
Chloromethane	0.07	0.02	0.03
cis1,3-Dichloropropylene	0.05	0.01	0.01
Dichlorodifluoromethane	0.04	0.01	0.01
Dichloromethane	0.02	0.02	0.01
Dichlorotetrafluoroethane	0.03	0.01	0.004
Ethylbenzene	0.07	0.01	0.01
Hexachloro-1,3-butadiene	0.06	0.02	0.01
m,p-Xylene	0.12	0.02	0.01
Methyl tert butyl ether	0.05	0.01	0.01
o-Xylene	0.05	0.01	0.01
Styrene	0.1	0.01	0.01
Tetrachloroethylene	0.04	0.01	0.01
Toluene	0.05	0.01	0.01
trans1,3-Dichloropropylene	0.04	0.01	0.01
Trichloroethylene	0.05	0.01	0.01
Trichlorofluoromethane	0.04	0.01	0.01
Trichlorotrifluoroethane	0.05	0.01	0.01
Vinyl Chloride	0.07	0.01	0.01

[a] Acrolein and carbon disulfide are not among the 42 target compounds in the NYS Toxics Air Monitoring Network. MDL checks for these two compounds were not conducted at the two six-month intervals.

Carbonyls

For the carbonyls, sensitivity analysis considers all dilutions and concentrations resulting from the sample extraction (preparation) process and instrument analysis. The results are expressed in terms of ambient air concentration by assuming that a total volume of air of

1440 liters was collected for a twenty-four hour sample. Variable analytical inputs include final extract volume (5.0 mL) and injection volume (20 μL).

The MDL evaluations are shown in **Table E8** and most surpass the QAPP requirement. For the two carbonyls of primary interest, acetaldehyde and formaldehyde, the QAPP specifications were unmet for at least one of the sensitivity checks. However, since these two compounds were found in all samples collected at levels well above the MDL, no further actions were necessary.

Table E8 MDL Evaluations for Carbonyls (ppbv)

Compound	QAPP MDL	March 2008 MDL	November 2008 MDL
2-Butanone	0.009	0.006	0.008
Acetaldehyde	0.004	0.01	0.01
Benzaldehyde	0.004	0.004	0.001
Crotonaldehyde	0.009	0.006	0.006
Formaldehyde	0.007	0.015	0.006
Hexanal	0.008	0.004	0.002
Methacrolein	0.005	0.006	0.002
m-Tolualdehyde	0.003	0.003	0.001
n-Butyraldehyde	0.007	0.006	0.004
Propionaldehyde	0.004	0.006	0.002
Valeraldehyde	0.011	0.003	0.003

3.4 Interferences - Blank Evaluations

Control over sample contamination is essential when attempting to measure concentrations at the parts-per-billion or parts-per-trillion level. Contamination arises from principally four sources: the environment from which the sample was collected and/or analyzed, the reagents used in the analysis, the apparatus used, and introduction by staff performing the analysis. The potential for sample contamination interferences are possible at any stage of sampling and/or analysis and determining the source is achieved through evaluation of blank samples. The laboratory routinely incorporates a number of blank samples into its quality assurance program, including cleaning (VOCs only), field (carbonyls only), lot (carbonyls only) and lab blanks.

Volatile Organic Compounds

Cleaning Blank: One canister was selected from a cleaning batch of 10 for each quarter of the Study. **Table E9** shows the maximum result for each quarter. As demonstrated, the pre-deployment acceptance criterion of 0.2 ppbv for any target compound or three times the detection limit of the compound, whichever is higher[9] has been met in all cases.

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[9] Although both pre-deployment cleaning criteria were referenced in the QAPP, the integration of the two as specified in the NATTS Technical Document (USEPA 2007) was not stated.

Table E9 Summary Results Quarterly Cleaning Blanks

Compound Name	MDL (ppbv)	3rd Quarter 2007 Max (ppbv)	4th Quarter 2007 Max (ppbv)	1st Quarter 2008 Max (ppbv)	2nd Quarter 2008 Max (ppbv)
1,1,1-Trichloroethane	0.04	0.022	0.010	0.024	0.018
1,1,2,2-Tetrachloroethane	0.05	0.025	0.014	0.028	0.031
1,1,2-Trichloroethane	0.05	0.024	0.010	0.000	0.025
1,1-Dichloroethane	0.04	0.023	0.022	0.022	0.018
1,1-Dichloroethylene	0.04	0.024	0.009	0.023	0.017
1,2,4-Trichlorobenzene	0.06	0.039	0.050	0.033	0.070
1,2,4-Trimethylbenzene	0.06	0.028	0.010	0.027	0.126
1,2-Dibromoethane	0.04	0.028	0.010	0.021	0.020
1,2-Dichlorobenzene	0.04	0.022	0.014	0.026	0.037
1,2-Dichloroethane	0.03	0.020	0.009	0.022	0.015
1,2-Dichloroethylene	0.04	0.023	0.010	0.022	0.024
1,2-Dichloropropane	0.05	0.021	0.009	0.017	0.021
1,3,5-Trimethylbenzene	0.05	0.026	0.008	0.027	0.081
1,3-Butadiene	0.03	0.028	0.011	0.021	0.018
1,3-Dichlorobenzene	0.05	0.019	0.011	0.023	0.036
1,4-Dichlorobenzene	0.05	0.077	0.019	0.089	0.039
aChlorotoluene	0.05	0.016	0.009	0.023	0.061
Benzene	0.05	0.030	0.031	0.021	0.026
Bromodichloromethane	0.05	0.021	0.007	0.019	0.015
Bromomethane	0.04	0.021	0.009	0.020	0.022
Carbon tetrachloride	0.05	0.021	0.011	0.021	0.017
Chlorobenzene	0.04	0.024	0.011	0.021	0.020
Chloroethane	0.05	0.000	0.000	0.000	0.150
Chloroform	0.04	0.022	0.009	0.022	0.012
Chloromethane	0.07	0.022	0.029	0.000	0.042
cis1,3-Dichloropropylene	0.05	0.017	0.008	0.020	0.020
Dichlorodifluoromethane	0.04	0.023	0.010	0.020	0.022
Dichloromethane	0.02	0.067	0.143	0.000	0.011

Compound Name	MDL (ppbv)	3rd Quarter 2007 Max (ppbv)	4th Quarter 2007 Max (ppbv)	1st Quarter 2008 Max (ppbv)	2nd Quarter 2008 Max (ppbv)
Dichlorotetrafluoroethane	0.03	0.024	0.009	0.000	0.017
Ethylbenzene	0.07	0.025	0.009	0.023	0.024
Hexachloro1,3Butadiene	0.024	0.017	0.015	0.043	0.033
m,p-Xylene	0.12	0.046	0.016	0.051	0.056
Methyl tert butyl ether	0.05	0.016	0.005	0.019	0.010
o-Xylene	0.06	0.024	0.010	0.026	0.028
Styrene	0.04	0.023	0.007	0.019	0.033
Tetrachloroethylene	0.04	0.022	0.009	0.023	0.023
Toluene	0.05	0.028	0.016	0.023	0.023
trans1,3-Dichloropropylene	0.04	0.029	0.008	0.020	0.022
Tribromomethane	0.10	0.019	0.008	0.019	0.015
Trichloroethylene	0.05	0.021	0.009	0.022	0.023
Trichlorofluoromethane	0.04	0.012	0.005	0.012	0.018
Trichlorotrifluoroethane	0.05	0.016	0.019	0.022	0.014
Vinyl chloride	0.07	0.021	0.013	0.019	0.013

Footnote: The maximum quarterly result for each compound has been displayed to illustrate that each run meet pre-deployment acceptance criteria.

<u>Lab Blank</u>: Blanks were generated in the GC/MS system by sampling pure nitrogen through the cryogenic trap. These checks assure no carryover during the batch analysis process. No interferences were identified during these checks.

Carbonyls

<u>Lot blanks</u>: To assure carbonyl adsorbent tubes are suitable for use, tubes are tested and certified prior to use. Upon arrival of each shipment, three lot blanks were randomly selected from the shipment and were analyzed using normal procedures.
A cartridge certificate of analysis is received with each batch lot and this was verified against the method quality control criteria. All cartridges were found acceptable for use upon receipt and the background method blank results closely matched cartridge contamination levels stated by the manufacturer.

<u>Field blanks</u>: The two aldehydes of primary concern, acetaldehyde and formaldehyde, were found in blanks well below thresholds of concern. Acetaldehyde and formaldehyde sample concentrations were approximately 50 and 100 times, respectively, of blank concentrations as illustrated in **Table E10**. The lowest sample concentration was at an order of magnitude higher than the blanks, indicating that the blanks were not an analytical interference. No other target analytes were found in the blanks.

Table E10 Results of the Field Blank Evaluation for Acetaldehyde and Formaldehyde

Parameter	Acetaldehyde (ppbv)	Formaldehyde (ppbv)
Average blank	0.008	0.013
Maximum blank value	0.009	0.017
Standard deviation	0.000978	0.00373
3 Sigma blank QC limit	0.011	0.024
Lowest sample result	0.176	0.221

4.0 Data Review and Assessment

Volatile Organic Compounds

The results were reviewed by importing the data into USEPA's VOCdat software for analysis. This software allows a reviewer to assess the data for consistency by plotting a time based graph and facilitates sample to sample or analyte to analyte comparisons.

VOC results were reviewed quarterly by graphing each individual site and combining all four sites. VOCs with common sources such as automotive exhaust and those known to be ubiquitous[10] were compared. Additionally, the Study data were compared to historical and concurrent data from other industrial, urban and rural sites in the State's air toxics monitoring network. Summary statistics were prepared (e.g., range, mean, median and standard deviation) for each VOC. Anomalies were noted and the raw data reviewed for errors. In cases where errors were confirmed, the results were flagged.

An example of a comparison with ubiquitous VOCs at the State's background monitor (Whiteface Mountain) is shown in **Table E11**. The results for the Whiteface monitor are similar to the levels found at all Study site monitors. This comparison adds an extra level of validity to the data set.

Table E11 Annual Average Concentrations of Ubiquitous Compounds

Compound	Whiteface 2007 (ppbv)	Whiteface 2008 (ppbv)	BISP (ppbv)	BTRS (ppbv)	GIBI (ppbv)	SPWT (ppbv)
Carbon tetrachloride	0.098	0.093	0.11	0.11	0.11	0.11
Chloromethane	0.51	0.53	0.53	0.48	0.48	0.48
Dichlorodifluoromethane	0.53	0.54	0.53	0.53	0.53	0.53
Trichlorofluoromethane	0.16	0.23	0.18	0.18	0.18	0.18
Trichlorotrifluoroethane	0.076	0.081	0.10	0.09	0.08	0.08

Carbonyls

The results were reviewed by importing the data into USEPA's VOCdat software for analysis.

A 2008, laboratory audit revealed analytical problems which compromised sample validity for samples analyzed from, July 5, 2007 through September 21, 2007. A retention time shift in samples caused later eluting compounds[11] to be misidentified and resulted in unrecoverable data loss. Consequently, the laboratory discarded results of the later eluting compounds. Two early eluting compounds, acetaldehyde and formaldehyde were unaffected because the retention time shift had not moved their peaks outside the identification window and these results were determined to be valid. Samples collected September 27, 2007 and forward were unaffected.

In February 2008, a new HPLC replaced the older unit. For three consecutive sampling dates, samples were run on both instruments for comparison to verify the new instrument would provide comparable results.

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[10] Ubiquitous VOCs are those with little variability across the statewide network such as carbon tetrachloride, chloromethane, dichlorodifluoromethane, trichlorofluoromethane, and trichlorotrifluoroethane.

[11] Later eluting carbonyls are heavier in weight which is the following in our Study: 2-butanone, benzaldehyde, crotonaldehyde, hexanal, m-Tolualdehyde, methacrolein, n-Butyraldehyde, propionaldehyde, and valeraldehyde.

Appendix F –Development of Emission Inventory for Modeling

The non-residential emission inventory section is comprised of three source categories; major, area and mobile. The distinction between major and area sources is based upon regulatory emission cutoffs defined by the USEPA for a single pollutant or class of pollutants. Major sources describe the facilities with the most significant amount of mass emissions. Area sources describe facilities which are either small stand-alone facilities (i.e. gas stations) or locations with fugitive emission releases, such as landfills or sewage treatment plants. Major and area size facilities with individual emission points are also referred to as point sources or stationary sources. Mobile sources represent passenger car traffic and off-road vehicle traffic. Off-road vehicles generally are described as construction equipment. The emissions of off-road vehicles were not included in this appendix due to the absence of specific emissions information for the Study area.

The listing and emission quantity of all Hazardous Air Pollutants (HAPs) and non-HAPs emitted from major and area point sources can be found in Tables F1 and F2. Pie Charts for the air contaminants with the greatest mass by emissions can also be found in Figures F1 and F2, Emissions from Mobile sources, Figure F3.

1.0 Major Sources

The definition for major sources can be found within the New York State Department of Environmental Conservation's air pollution regulations, 6NYCRR Part 201-2.1(b)(21). The definition for regulated air contaminants, which includes criteria pollutants and hazardous air pollutants, can be found in 6NYCRR Part 200.1[1]

A facility emitting criteria pollutants and/or hazardous air pollutants greater than a federally defined mass emission rate is classified as a major source. Depending on the geographical location within New York State, all criteria pollutants have defined mass emission cutoff amounts signifying the major source level. For example, the Niagara Frontier area, consisting of Niagara and Erie Counties, has a major source cutoff level set at 50 tons per year (TPY) or greater for any single facility's emissions of volatile organic compounds. The federally defined mass emission rate for hazardous air pollutants (HAPs) is the same state-wide and is set at ten (10) tons per year and twenty five (25) tons per year for multiple HAPs emitted. For the Study location, the classification of major was used as a starting point to identify facilities of concern and was not limited to only HAPs when identifying toxic air contaminants. Facilities whose emissions are greater than the federally defined mass emission rate for major facilities are required to obtain a Title V permit.

Sources classified as major sources are required to obtain a Title V air permit (Title V) under federal and state regulations. Major sources are the most rigorously regulated sources in the NYSDEC's air permitting system and are required to submit yearly emission statements of actual emissions to the Department. The emission statements are generated by the facility and

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[1] http://www.dec.ny.gov/regs/13427.html

reviewed by staff in NYSDEC's Stationary Source Planning Section. For the purpose of this study, the combined emission statements of 2002, 2005 and 2006 were chosen and the highest reported emission of an individual air contaminant was selected. These years were selected because 2002 and 2005 are classified as periodic inventory years. Periodic inventory years are when a more robust collection of data is required from the regulated facilities. The additional year of 2006 was added as a check and was the latest complete inventory year at the time the data gathering effort began. All of the Title V facilities are also required to submit Toxic Release Inventory[2] data to the USEPA under the Emergency Planning and Community Right-to-Know Act (EPCRA). Emission statement data was compared and verified with all Toxic Release Inventory data. The USEPA releases the National Emission Inventory (NEI) each year after it is complied. The emissions statements filed with NYSDEC are verified and used to populate the NEI.

Table F1 includes the nine Title V sources located within the nine census block Study area. In addition to the nine Title V sources located within the nine census block study area, two facilities, FMC Corporation and Gibraltar Steel Corporation in Table F1 have legally enforceable permit conditions that restrict the facility's emissions below major size limits.

Title V facilities must report all Regulated Air Pollutants:

- Hazardous Air Pollutants;
- Contaminants with a National Ambient Air Quality Standard;
- Chlorofluorocarbons;
- The class of contaminants identified as volatile organic compounds (VOCs);
- Nitrogen oxides;
- Contaminants of the Clean Air Act Amendments section 112(r) accidental release program; and
- Contaminants with a federal emission limit under New Source Performance Standards.

VOCs as a class of compounds can contain numerous individual compounds. Each of these individual compounds within the class can have varying degrees of toxicity. All Title V facilities are required to report the individual HAPs within the VOC category and the remaining VOC compounds as Total VOC. The remaining Total VOC compounds needed to be speciated to understand the potential health hazard associated with the overall reported Total VOCs. The breakdown of Total VOC was obtained from facility records and/or old permit data. Hydrocarbon emissions from combustion sources and gasoline evaporative emissions were assigned to the general classification of aliphatic hydrocarbons and compared to the health-based guidance concentration value of hexane (a straight chain six carbon molecule).

Of the State Facility Permit holders remaining below major source classification, FMC Corp. has a cap of 98 tons per year of sulfur dioxide and Gibraltar Steel Corporation limits its potential emissions below all major source emission levels.

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[2] To learn more about the Toxic Release Inventory visit: http://www.epa.gov/tri/triprogram/whatis.htm

Sources included in the major source category account for the largest amount of point source emissions. Within the inventory development process, the emission estimates would be qualitatively determined to be of high quality. Sources within the major source category generally have the most robust data for emission factor estimation and more likely to have been stack tested to verify emissions.

Limitations

6NYCRR Part 202 requires yearly emission statements from major facilities with a larger periodic inventory every three years. The periodic inventory requires the facility owner to report emissions from exempt permitted sources. Emission reporting under Part 202 is based upon self reporting with NYSDEC oversight and the emissions are the actual emissions for the calendar year. Actual emissions are required because facility owners pay an annual fee based upon actual emissions rather than upon potential emissions. The potential for higher ambient impacts can occur if facility operations operated at facility maximum allowed by permit.

In the major source category, the sources range from well characterized emission estimates such as the Huntley electric utility steam generating power plant versus the Tonawanda Coke plant where the emissions have a lesser degree of certainty. The confidence in emission factors for the Coke industry in general are of low quality and the USEPA on July 6, 2009 sent an enforcement action to the owner of Tonawanda Coke to verify the assumptions used to generate facility-wide emissions and in some instances the July 6th action required stack testing.

2.0 Area Sources

Traditionally, area sources have been described as emission sources that are either numerous, relatively small, stand-alone facilities or locations with fugitive emission releases. In 1990, the USEPA revised this general definition for area sources and created a specific regulatory definition for area sources as part of the Clean Air Act amendments. Under the National Emission Standards for Hazardous Air Pollutant (NESHAP) program[3], processes at facilities whose emission potential of one HAP are less than ten tons per year or multiple HAPs are less than twenty-five tons per year can be classified as an area sources. Also, those facilities which have emission limitations restricting emissions of one or more HAPs below ten and twenty-five tons can be classified as an area sources. Facilities exceeding those size limitations are considered major under the NESHAP program.

For the purpose of this study, the definition of area sources will include petroleum bulk storage facilities, trucking depots, sewage treatment plants, landfills and NYSDEC regulated Registration sources.

2.1 Registration Facilities

Under the NYSDEC permitting program, area size sources can be regulated with a Registration Certificate. Registrations are issued to facility owners, whose potential process source emissions

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[3] USEPA, Office of Air and Radiation, http://www.epa.gov/ttn/atw/eparules.html

do not exceed the major size classification for HAPs or if possible take legally enforceable limits to keep their actual emissions below 50% of major size classification.

There are twenty-two facilities in the Study area eligible for a Registration certificate. An additional Registration Certificate is held by the Tonawanda sewage treatment plant and its emissions will be addressed separately due to its unique source characteristics. There are an additional three facility owners, who retained permits from our previous permitting system, and are not required to update the permits at this time. The emissions from these facilities are considered negligible and not a significant impact to the Tonawanda area. The Niagara Landfill is a Registered facility but will also be addressed in its own subsection.

Limitations

Facility owners of Registration Certificates are required to list the name of the hazardous air pollutant emitted at the facility but not the quantity. In cases where actual emissions could not be quantified for this report, emission estimates were based upon the maximum allowable under a Registration Certificate.

A listing of Regulated Air Pollutants for Registration facilities can be found in Table F2

2.2 Petroleum Bulk Storage Facilities

Petroleum Bulk Storage (PBS) facilities can include large storage facilities such as the ones identified under the Major sources category list. The major facilities are in the business of unloading petroleum products to tanker trucks for further distribution. PBS facilities can also be smaller storage facilities designed to load fleet vehicles and finally PBS facilities can be gasoline retail stations. Gasoline consists of many chemical compounds, of which benzene, toluene, ethylbenzene and xylene (BTEX) are the compounds monitored for the Study and are considered to be a good representative of gasoline emissions and potential toxic exposure. Other chemical compounds monitored representative of gasoline emissions are the dimethyl and trimethyl benzenes.

Staff from the Division of Environmental Remediation maintains NYSDEC's Petroleum Bulk Storage database. This database lists all active and inactive PBS sites, including last inspections, liquid stored, tank size, number of tanks and age. This database was used to locate the gasoline fleet and retail sites in the study area. Sixteen retail gasoline stations were located in the nine census block study area.

The PBS database was used to locate the number of petroleum storage tanks and their size (in gallons) for facilities located in the study area. Total VOC emissions were estimated according to the potential of yearly throughput of petroleum and emission factors obtained from the Factor Information Retrieval system (FIRE)[4]. Benzene was estimated at 1% of total VOC. Emissions of the storage, fueling and evaporative emissions can be found in Table F2

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[4] USEPA - FIRE ,Technology Transfer Network, Clearinghouse for Emissions and Inventories, http://www.epa.gov/ttn/chief/

2.3 Trucking Depots

The mobile emission sector within the nine census tract Study area is extensive. Although, the emissions of air toxics from mobile sources will be addressed under section 3.0 of this Appendix, another potential contribution of air toxic emissions in the study area is from the daily operation of trucking depots. The potential for air toxic emissions are from truck idling, shuttle trucks whose job is to move trailers and to a lesser degree diesel storage.

As identified in numerous studies and referenced below for a study in the Boston area, fine particulate, ultra-fine particulate and black carbon, a surrogate for diesel particulate, are the air contaminants of most concern when investigating potential health effects from diesel vehicles. (Levy, et.al) The air toxics of concern from trucking depots are fine particulate, ultra-fine particulate and black carbon, a surrogate for diesel particulate. The current Study monitored for $PM_{2.5}$ and did not specifically target black carbon. The TEOM monitors measured all particle material less than 2.5 microns.

The Study area has thirty-three active trucking depots and one bus terminal recorded in the Petroleum Bulk Storage database. When trying to evaluate the amount of trucking activity occurring at these emission sites, it was first thought that the quantity of diesel fuel stored on site could be a potential indicator of facility size and activity. The trucking depots in the Study area have a wide range of storage capacity; the largest trucking site has storage capacity of 120,000 gallons of petroleum diesel and the smallest at 10,000 gallons. Also, the number of loading bays a terminal operates could be another indicator of size and activity. During site-visits with trucking managers, it became clear that diesel storage was not a good measure of activity because storage was used more to buy and store diesel when fuel prices were low. Although, generalizing about the number of bays is a potential method to classify truck depots into large and small, the current economic climate has business down and many idled bays. During site-visits with trucking managers, it was determined that trailer drop-offs and hook-ups account for 15 minutes of time. According to a study conducted by Environ International (Lindhjem), the drop off and hook-up time was closer to 0.57 hours per day. Also, during the day, each facility operates a shuttle truck to move trailers from bay to storage waiting for pick-up.

The estimation of VOC and diesel PM emissions from the trucking depot source category is unknown. Studies have been undertaken to quantify nitrogen oxides, diesel PM and VOCs from idling heavy duty diesel engines as part of the rest-stop electrification programs conducted in New York, California and Oregon but not at on-going operations at a trucking depot. When undertaking a study to determine the localized ambient air impact from trucking depots, the data needed to properly derive an emission estimate are:

1.) The averaged daily number of trucks serviced at each trucking depot;
2.) The average idling time during loading and unloading;
3.) The average emission rate of VOC and diesel PM,

The emission evaluation study conducted by ENVIRON determined truck yard idling at 0.57 hours per day. Baseline estimates of VOCs and diesel PM for idling trucks were generated as an average from three data sources, USEPA (Mobile5 model), Colorado Institute for Fuels and

Environmental Research, and University of California Davis for a study conducted by The New York State Energy Research Development Authority (NYSERDA 2005).

Item#2 can be estimated from the Lindhjem study and Item #3 above can be derived from the NYSERDA study, leaving the estimate of the number of trucks serviced unknown. Also, for the purpose of this study, an estimate of trucking activity was based upon the site-visits where it was determined the number of trucks loading and unloading was in the range of 40 to 80 trucks a day.

The NYSERDA idling study data released emissions factors for VOC and diesel PM of 36.4 grams/hr and 2.19 grams/hr, respectively. Based upon the estimate of 0.57 hours per day of idling, the daily VOC and PM results in 20.7 grams/day and 0.1.2 grams/day, respectively. Using the estimation of each trucking depot servicing 60 trucks a day, the following estimates were derived. Low confidence is assigned to this emission estimate until better verification of truck activity can be established. The benzene is conservatively estimated at 1.0 % of the VOC. Using the emission ratio found in Mobile6, formaldehyde is 7.5 times the emission rate for benzene.

A listing of Regulated Air Pollutants for Registration facilities can be found in Table F2

2.4 Sewage Treatment Plant

Industrial and residential waste water sent to publicly owned treatment works (POTW) may be treated or untreated prior to release. POTWs may treat waste water from residential, institutional, and commercial facilities and/or storm water runoff. A POTW will consist of a primary settling tank or tanks, biotreatment, secondary settling, and disinfection.

As stated by the Great Lakes Commission, whose charge is to reduce air deposition and discharge to the Great Lakes, "specific industrial and commercial activities are the largest source of organic compounds entering the municipal collection systems. However, other residential sources of organic compounds such as home maintenance and cleaning products contribute to the total organic compounds that enter the POTWs. These organic compounds produce emissions through volatilization at the surface of the wastewater during treatment processes. Nationwide estimates indicate that POTWs are significant sources of volatile organic compounds (VOC) in the United States."[5]

One sewage treatment plant is located within the nine census block Study area. The Tonawanda SD #2 facility holds a Registration Certificate from NYSDEC indicating that the potential of volatile organic compound and nitrogen dioxides emissions from this facility are below fifty and 100 tons per year, respectively and actual emissions are below 25 and 50 tons per year respectively. Tonawanda SD #2 has a three stage aqueous packed tower odor scrubbing system. Foul air from a thermal conditioning sludge treatment process containing low molecular weight volatile compounds passes through first a water scrubber; second, an oxidative scrubber; third, an alkaline scrubber. It is then discharged to the atmosphere through a roof exhaust stack.

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[5] http://wiki.glin.net/dashboard.action

Emissions for this source category are derived based upon the National Emission Inventory methodology established in 1999. POTW emission factors are in units of pounds of HAP emitted per million gallons of wastewater (lb/10^6 gal) treated. The amount of waste water treated at the Tonawanda SD #2 was obtained from NYSDEC's Division of Water and the following estimates were calculated.

Listed in Table F3 are the total VOCs estimated for this source category and the five Category C contaminants determined to be above our Annual Guideline Concentration.

2.5 Landfills

The Study area encompasses three landfills in close proximity to two of NYSDEC's air monitoring stations. One landfill, Huntley flyash landfill, located between Grand Island Blvd and the Tonawanda Coke Corporation is an actively used landfill; the other two landfills are no longer used municipal solid waste landfills. The Niagara Landfill located north of the Highway 290, adjacent to the toll booths and River Road has been closed since the middle 1990's. The Niagara landfill size is below the thresholds for the New Source Performance Standards, Subpart Cc, requiring a flare or 98% control on captured gas emissions. Even though the landfill was below the New Source Performance Standards (NSPS) threshold, this site was equipped with a flare at the time of final capping. The flare is no longer in use due to issues with gas production and ceased operation. The other municipal landfill adjacent to Highway 290, between two mile creek and the Conrail railroad tracks was the town of Tonawanda's landfill. The site was recently reopened for waste relocation work. This landfill was the site of a municipal waste incinerator and the bottom ash was disposed of on-site. Also, some solid waste was disposed on-site and radioactive waste from the Manhattan project was located at this site. The incinerator and landfill shut down in the early 1980's. Most of the activity was along Hackett Road. A final cover is not on the site as of this report.

Emissions from the two municipal waste landfills are based upon the EPA software program LandGEM. LandGEM is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of land filled waste in MSW landfills. The software provides a simple approach to estimating landfill gas emissions. Model defaults are based on empirical data from U.S. landfills (USEPA, 2005c). The emissions were based upon the landfills being filled up to but not exceeding the NSPS limit of 2.5 million cubic meters of waste.[6]

Listed in Table F3 are the total VOC estimated for this source category and the five Category C contaminants that were above our AGCs.

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[6] USEPA New Source Performance Standard, Subpart WWW, §60.750, 61 FR 9919, March 12, 1996 and New Source Performance Standard, Subpart Cc, §60.30c, 61 FR 9919, March 12, 1996

3.0 Mobile Sources

For this study, the mobile source inventory was restricted to on-road diesel and gasoline engines of all size weight classes. The size weight classes included in the inventory are included in Table F4.

To determine the ambient air concentrations attributed to vehicle traffic, the generated emissions were modeled with the Human Exposure Model (HEM3)[7], derived by the USEPA. The list of size weight classes in Table F4 was restricted to seven major weight class categories for the purpose of modeling mobile sources. The seven weight class categories are a function of the SMOKE emission processor which prepares emissions for large scale modeling exercises. Sparse Matrix Operator Kernel Emissions (SMOKE) is an "emissions data modeling system that prepares emissions data for use in air quality models. It converts the resolution of pollution source inventories into the hourly, gridded, model-species resolution needed by air quality models."[8] Smoke was not used in the Study but its methodology was chosen to represent the seven large automotive classes which capture the majority of emissions from this source sector.

For the study area, a majority of the emissions, 90.5 percent, were attributed to SMOKE categories Light Duty Gas Vehicle (LDGV), Light Duty Gas Truck (LDGT1) and LDGT2. The remaining emissions were attributed to the Heavy Duty Gas and Diesel Vehicle classes.

To generate emission factors for various types of light-duty and a heavy-duty vehicle, the Division of Air Resources uses MOBILE6[9]. MOBILE6 is a computer-based model used to analyze air pollutant impacts from gasoline-fueled and diesel highway mobile sources. The software program provides the user with a flexible analytical tool that can be applied in a wide variety of air quality planning functions. Among the many conditions that can be altered are roadway type, ambient temperature, weekday/weekend and gasoline formulation.

The grams per mile emission factors generated by MOBILE6 for criteria pollutants and for a limited set of hazardous air pollutants, were integrated with daily vehicle miles traveled (DVMT) to construct an emission profile for a given roadway in the Tonawanda Study area. The Study area of Tonawanda was represented by the following roadway classifications: urban interstate, urban primary arterial, urban major collector and urban local. These four road classifications accounted for 814, 948 annual DVMT. The annual DVMT is calculated based upon the measured annual average daily traffic counts multiplied by the roadway length to determine DVMT.

Using emission factors and the DVMT for the study area, the emissions were calculated for the mobile source contribution in the Study area in tons per year and listed in Table F5 and Figure F3.

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[7] USEPA, Fate, Exposure and Risk Models, http://www.epa.gov/ttn/fera

[8] SMOKE v2.5 User Manual, The institute for the Environment - The University of North Carolina at Chapel Hill, 2008

[9] Mobile6 software and documentation are available at http://www.epa.gov/otaq/mobile

Table F1 Listing of Major Sources in Study Area

Facility	DEC ID	Address	Main Product
3M Tonawanda	9146400164	35 Sawyer Ave.	Production of cellulose sponges
E I Dupont Yerkes	9146400031	Sheridan Drive at River Road	Production of Corian® shape products and Tedlar® polymer
GM Powertrain	9146400048	2995 River Road	Primary processes involve the machining of engine components, as well as engine assembly and testing.
Goodyear Dunlop Tires	9146400030	3333 River Road	Production of truck, motorcycle, (ATV) and automobile tires.
Huntley Steam Station	9146400130	3500 River Road	Coal-fired steam generation power plant
Indeck-Yerkes Energy	9146400153	1 Sheridan Ave	Cogeneration of steam and electrical energy
NOCO Energy Corporation	9146400090	700 Grand Island Blvd.	Bulk marketing terminal for the distribution of gasoline, diesel products and asphalt
Sunoco Tonawanda Terminal	9146400132	3733 River Road	Bulk marketing terminal for the distribution of gasoline, diesel products and ethanol
Tonawanda Coke Corporation	9146400113	3750 River Road	Production of metallurgical foundry coke

State Facility Permit Holders:

Facility	DEC ID	Address	Main Product
FMC Corporation	9146400040	37 Sawyer Ave.	Production of persulfates and peracetic acid using batch and continuous process
Gibraltar Steel Corporation	9146400256	1050 Military Road	Engaged in the cold reducing tempering and, in certain cases, the annealing of cold-rolled steel coils to pre-specified dimensions

Table F2 Area Sources in Study Area

Registration Facilities

The tons per year of all regulated air pollutants with VOC and HAP broken out for Registration facilities located in the Tonawanda Community Air Monitoring Study area.

All Regulated Air Contaminants	VOC Total	HAP Total
310.6	106.6	94.8

Petroleum Bulk Storage

The tons per year of VOC and Benzene broken out for Petroleum Bulk Storage facilities located in the Tonawanda Community Air Monitoring Study area.

Petroleum Bulk Storage	VOC TPY	Benzene TPY
Gasoline Retail	122.2	1.22
Gasoline Fleet	13.5	0.14
Total	135.7	1.36

Trucking Depots

The estimated tons per year of VOCs and Diesel PM for Trucking Depots located in the Tonawanda Community Air Monitoring Study area.

VOC Total TPY	Formaldehyde TPY	Benzene Total TPY	Diesel PM Total TPY
8.8	0.66	0.09	0.51

Table F3 Emission Inventory for Air Toxics Exceeding NYSDEC's AGCs (units are tons per year)[a]

Facility Size	Total VOC	Benzene	Formaldehyde	Carbon Tetrachloride	Acetaldehyde	Acrolein
Major	365.9	23.8	0.49	0	11.96	0.42
Registration	106.6	1.1	6.9	0	0	0.007
Sewage Treatment Plants	32.7	0.31	<0.01	0.05	0.014	0.018
Landfills	51.13	0.17	< 0.001	< 0.001	< 0.001	< 0.001
Petroleum Bulk Storage	135.7	1.36	< 0.001	< 0.001	< 0.001	< 0.001

[a] Estimated emissions for HAPs identified exceeding NYSDEC's health-based Annual Guideline Concentrations (AGC)from the point sources are listed in this table

Table F4 Size Weight Classes Used in Automotive Inventory

MOBILE6 Vehicle Types	SMOKE Vehicle Type
LDGV: Light Duty Gasoline Vehicles (Passenger Cars)	LDGV
LDGT1: Light Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3,750 lbs)	LDGT1
LDGT2: Light Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3,751-5,750 lbs)	LDGT1
LDGT3: Light Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5,750 lbs.)	LDGT2
LDGT4: Light Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, >5,751 lbs)	LDGT2
HDGV2b: Class 2b Heavy Duty Gasoline Vehicles (8,501-10,000 lbs)	HDGV
HDGV3: Class 3 Heavy Duty Gasoline Vehicles (10,001-14,000 lbs)	HDGV
HDGV4: Class 4 Heavy Duty Gasoline Vehicles (14,001-16,000 lbs)	HDGV
HDGV5: Class 5 Heavy Duty Gasoline Vehicles (16,001-19,500 lbs)	HDGV
HDGV6: Class 6 Heavy Duty Gasoline Vehicles (19,501-26,000 lbs)	HDGV
HDGV7: Class 7 Heavy Duty Gasoline Vehicles (26,001-33,000 lbs)	HDGV
HDGV8a: Class 8a Heavy Duty Gasoline Vehicles (33,001-60,000 lbs)	HDGV
HDGV8b: Class 8b Heavy Duty Gasoline Vehicles (>60,000 lbs)	HDGV
HDGB: Gasoline Buses (School, Transit, and Urban)	HDGV
LDDV: Light Duty Diesel Vehicles (Passenger Cars)	LDDV
LDDT12: Light Duty Diesel Trucks 1 and 2 (0-6,000 lbs)	LDDT
LDDT34: Light Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs)	LDDT
HDDV2b: Class 2b Heavy Duty Diesel Vehicles (8,501-10,000 lbs)	HDDV
HDDV3: Class 3 Heavy Duty Diesel Vehicles (10,001-14,000 lbs)	HDDV
HDDV4: Class 4 Heavy Duty Diesel Vehicles (14,001-16,000 lbs)	HDDV
HDDV5: Class 5 Heavy Duty Diesel Vehicles (16,001-19,500 lbs)	HDDV
HDDV6: Class 6 Heavy Duty Diesel Vehicles (19,501-26,000 lbs)	HDDV
HDDV7: Class 7 Heavy Duty Diesel Vehicles (26,001-33,000 lbs)	HDDV
HDDV8a: Class 8a Heavy Duty Diesel Vehicles (33,001-60,000 lbs)	HDDV
HDDV8b: Class 8b Heavy Duty Diesel Vehicles (>60,000 lbs)	HDDV
HDDBT: Diesel Transit and Urban Buses	HDDV
HDDBS: Diesel School Buses	HDDV

Table F5 Mobile Source Emission (units are tons per year)

Naphthalene	Benzene	Formaldehyde	1, 3-Butadiene	Acetaldehyde	Acrolein
0.35	6.52	1.98	0.78	0.86	0.12

Figure F1 Modeled Point Source HAP Emissions - Tons per Year

CAS#	Chemical Name	Tons per year	CAS#	Chemical Name	Tons per year
50000	Formaldehyde	7.402	101144	Methyl chloroaniline	0.054
56235	Carbon tetrachloride	0.053	101688	Diphenylmethane diisocyanate	0.010
57125	Cyanide Compounds	1.046	106467	Dichlorobenzene,1,4-	0.040
59892	Nitrosomorpholine	0.009	106934	Ethylene Dibromide	0.005
62533	Aniline	0.561	106990	Butadiene	0.098
67561	Methanol	2.107	107028	Acrolein	0.445
67663	Chloroform	0.478	107062	Dichloroethane, 1,2	0.049
67721	Hexachloroethane (Perchloroethane)	0.085	107131	Acrylonitrile	0.313
68122	Dimethylformamide	1.500	107211	Ethylene glycol	1.031
71432	Benzene	25.291	108054	Vinyl acetate	6.003
71556	Trichloroethane, 1,1,1-	5.565	108101	Methyl isobutyl ketone	4.190
74839	Methyl bromide (Bromomethane)	0.002	108883	Toluene	12.563
74873	Methyl chloride (Chloromethane)	0.073	108907	Chlorobenzene	0.085
74908	Hydrogen cyanide	1.338	108952	Phenol	0.146
75003	Chloroethane	0.098	110805	2-Ethoxy ethanol	0.537
75014	Vinyl chloride	0.427	117817	Ethylhexyl phthalate, bis-2-	0.128
75058	Acetonitrile	1.525	118741	Hexachlorobenzene	0.005
75070	Acetaldehyde	11.975	121448	Triethylamine	0.131
75092	Methylene chloride	8.460	121697	Dimethylaniline, N,N-	0.015
75150	Carbon disulfide	203.642	123319	Hydroquinone	0.043
75218	Ethylene oxide	0.011	123911	Dioxane, 1,4-	0.002
75252	Bromoform (Tribromomethane)	0.054	127184	Tetrachloroethylene	1.064
75343	Dichloroethane 1,1-	0.216	131113	Dimethyl phthalate	0.008
75354	Dichloroethylene 1,1-	0.045	132649	Dibenzofuran	0.001
75569	Propylene oxide	0.103	140885	Ethylacrylate	0.004
78591	Isophorone	0.958	463581	Carbonyl sulfide	3.344
78875	Dichloropropane, 1,2-	0.019	584849	Toluene-2, 4-diisocyanate	0.130
78933	Methyl ethyl ketone (2-Butanone)	3.120	1330207	Xylene - Mixed isomers	16.794
	Chemical Name	**Tons per year**	**CAS#**	**Chemical Name**	**Tons per year**

CAS#					
79016	Trichloroethylene	1.950	1634044	Methyl tert butyl ether	0.030
79345	Tetrachloroethane, 1,1,2,2-	0.023	7439921	Lead compounds	0.065
80626	Methyl methacrylate	100.354	7439965	Manganese compounds	0.011
82688	Pentachloronitrobenzene	0.012	7439976	Mercury (elemental)	0.143
84742	Di-n-butyl phthalate	0.680	7440020	Nickel	0.062
87683	Hexachloro-1,3-butadiene	0.003	7440360	Antimony compounds	0.001
87865	Pentachlorophenol	0.559	7440382	Arsenic Compounds	0.035
91203	Naphthalene	1.867	7440417	Beryllium compounds	0.001
92524	Biphenyl	0.016	7440439	Cadmium compounds	0.091
92671	Aminobiphenyl	0.002	7440473	Chromium compounds	0.027
95487	Cresol, o-	0.060	7440484	Cobalt compounds	0.030
95534	Toluidine, o-	0.017	7647010	Hydrogen chloride	180.334
98828	Cumene (Isopropylbenzene)	1.471	7664393	Hydrogen fluoride	63.200
98862	Acetophenone	0.414	8007452	Coke oven emissions	4.900
98953	Nitrobenzene	0.014	130498292	PAH-TOTAL	1.556
100414	Ethylbenzene	7.198			
100425	Styrene	0.371		**Total**	688.901
100447	Benzyl chloride	0.001			

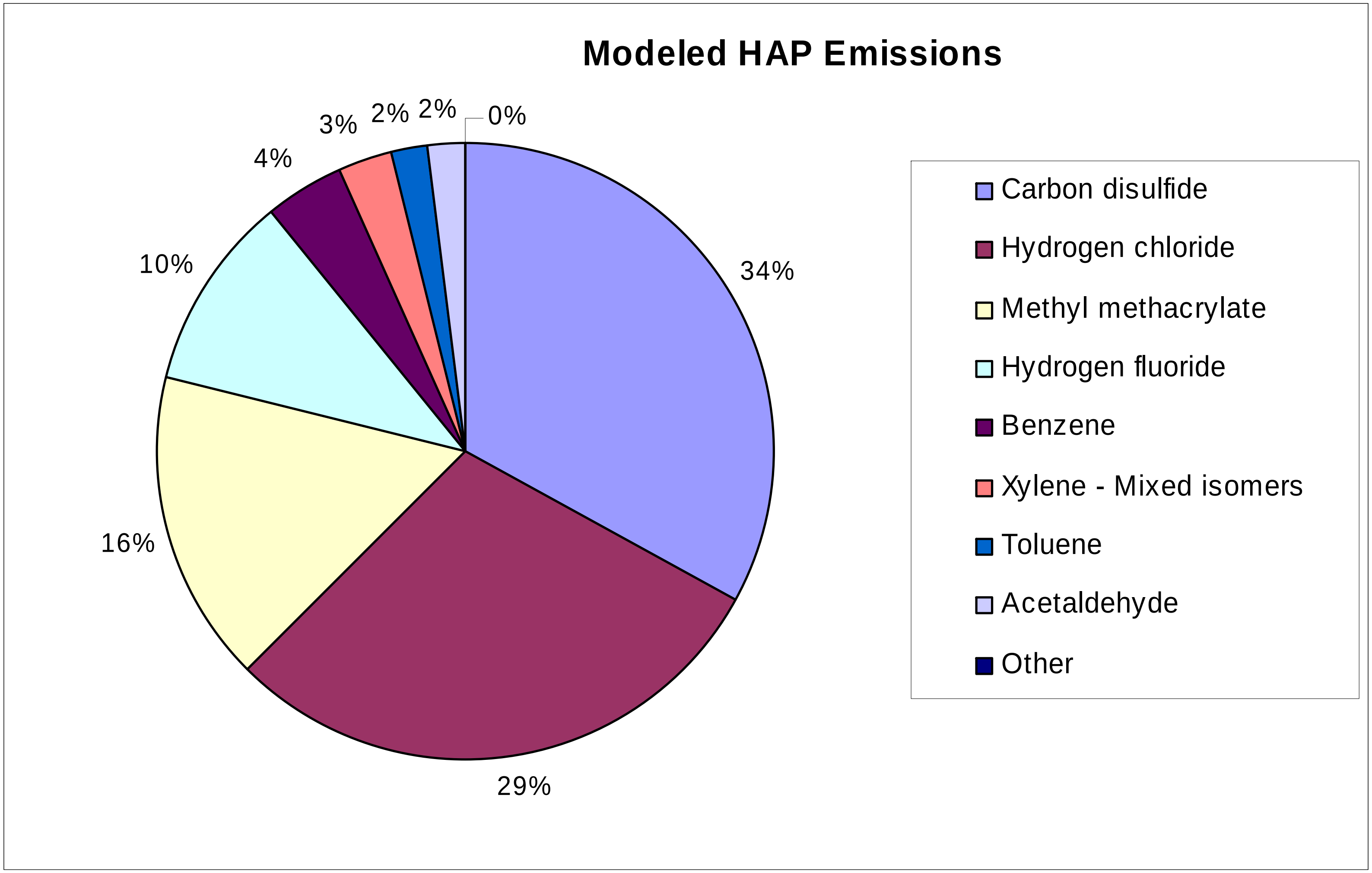

Modeled HAP Emissions
34%
29%
16%
10%
4%
3%
2%
2%
0%
Carbon disulfide
Hydrogen chloride
Methyl methacrylate
Hydrogen fluoride
Benzene
Xylene - Mixed isomers
Toluene
Acetaldehyde
Other

Figure F2 Modeled Point Source Non-HAP Emissions - Tons per Year

CAS#	Chemical Name	Tons per year	CAS#	Chemical Name	Tons per year
64175	Ethanol	23.122	111762	2-Butoxy ethanol	5.925
67630	Isopropanol	58.312	120821	Trichlorobenzene, 1,2,4-	1.825
67641	Acetone	0.337	126987	Methacrylonitrile	0.018
75025	Vinyl fluoride	38.841	127195	Dimethylacetamide	82.899
75183	Dimethyl sulfide	0.450	142825	Heptane	55.521
75274	Bromodichloromethane	0.475	540590	Acetylene dichloride	0.255
75434	Dichloromonofluoromethane	0.070	630206	Tetrachloroethane, 1,1,1,2-	0.173
75456	Chlorodifluoromethane	0.104	872504	Methyl pyyrolidone	7.742
75718	Dichlorodifluoromethane	1.759	7429905	Aluminum compounds	37.012
85687	Butylbenzylphthalate	0.031	7439987	Molybdenum	0.003
86306	Nitrosodiphenylamine, N-	0.054	7440393	Barium	0.264
95636	Trimethyl benzene 1,2,4-	0.961	7446119	Sulfur trioxide	0.110
96128	Dibromo-3-chloropropane, 1,2-	0.013	7664417	Ammonia	491.749
96333	Methylacrylate	0.015	7664939	Sulfuric acid	1.920
100027	Nitrophenol, 4-	0.006	7722841	Hydrogen peroxide	1.000
109660	Pentane	7.875	7783064	Hydrogen sulfide	1.165
110123	Methyl isoamyl ketone	0.625		**Total**	**820.6**

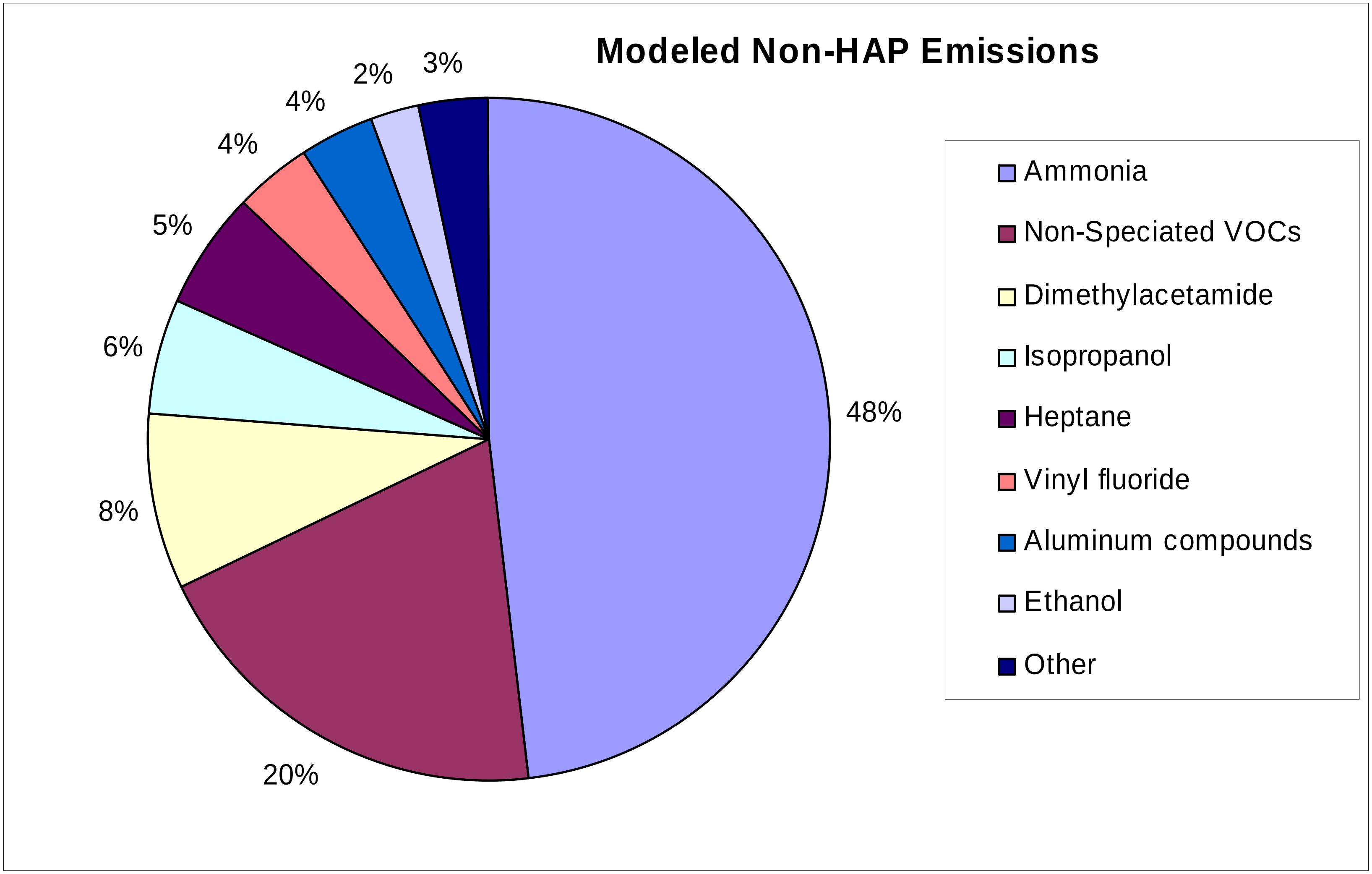
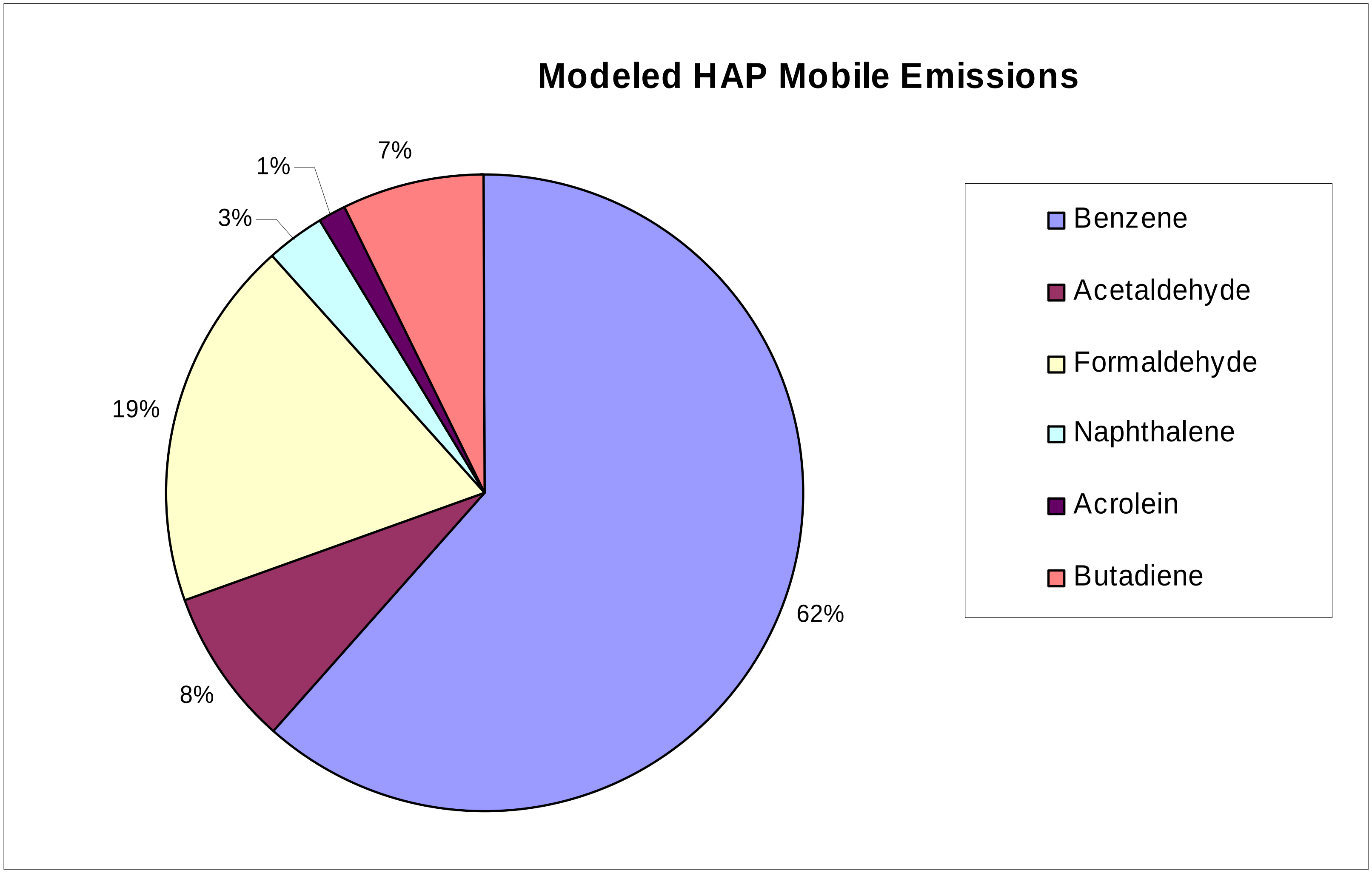
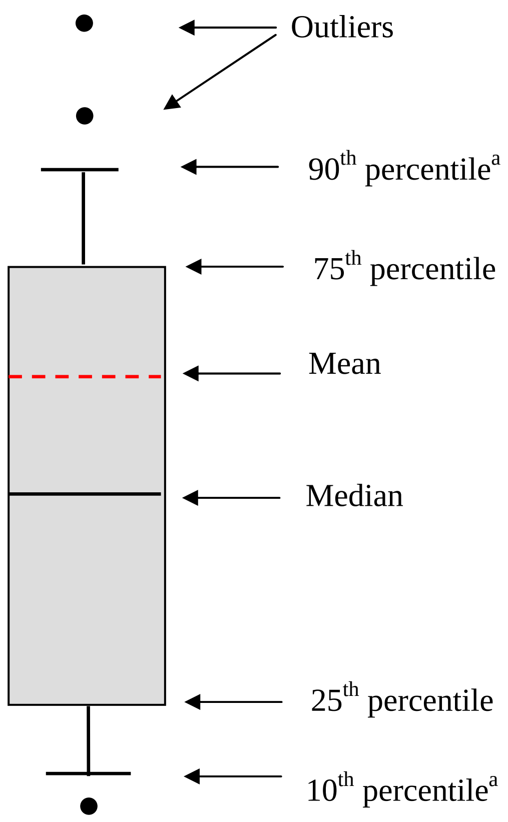

Modeled Non-HAP Emissions
48%
20%
8%
6%
5%
4%
4%
2%
3%
Ammonia
Non-Speciated VOCs
Dimethylacetamide
Isopropanol
Heptane
Vinyl fluoride
Aluminum compounds
Ethanol
Other

Figure F3 Modeled Mobile Source Emissions

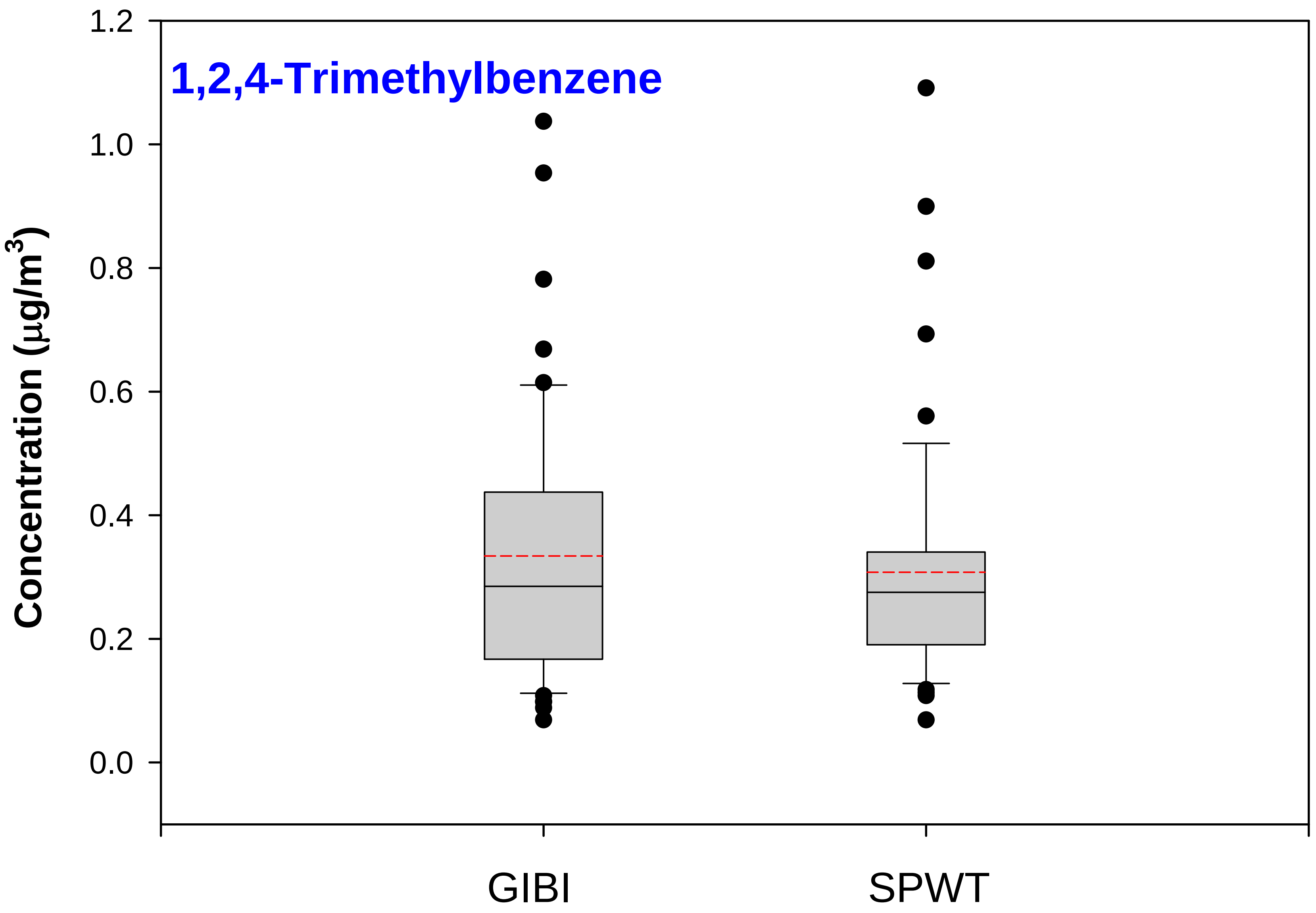


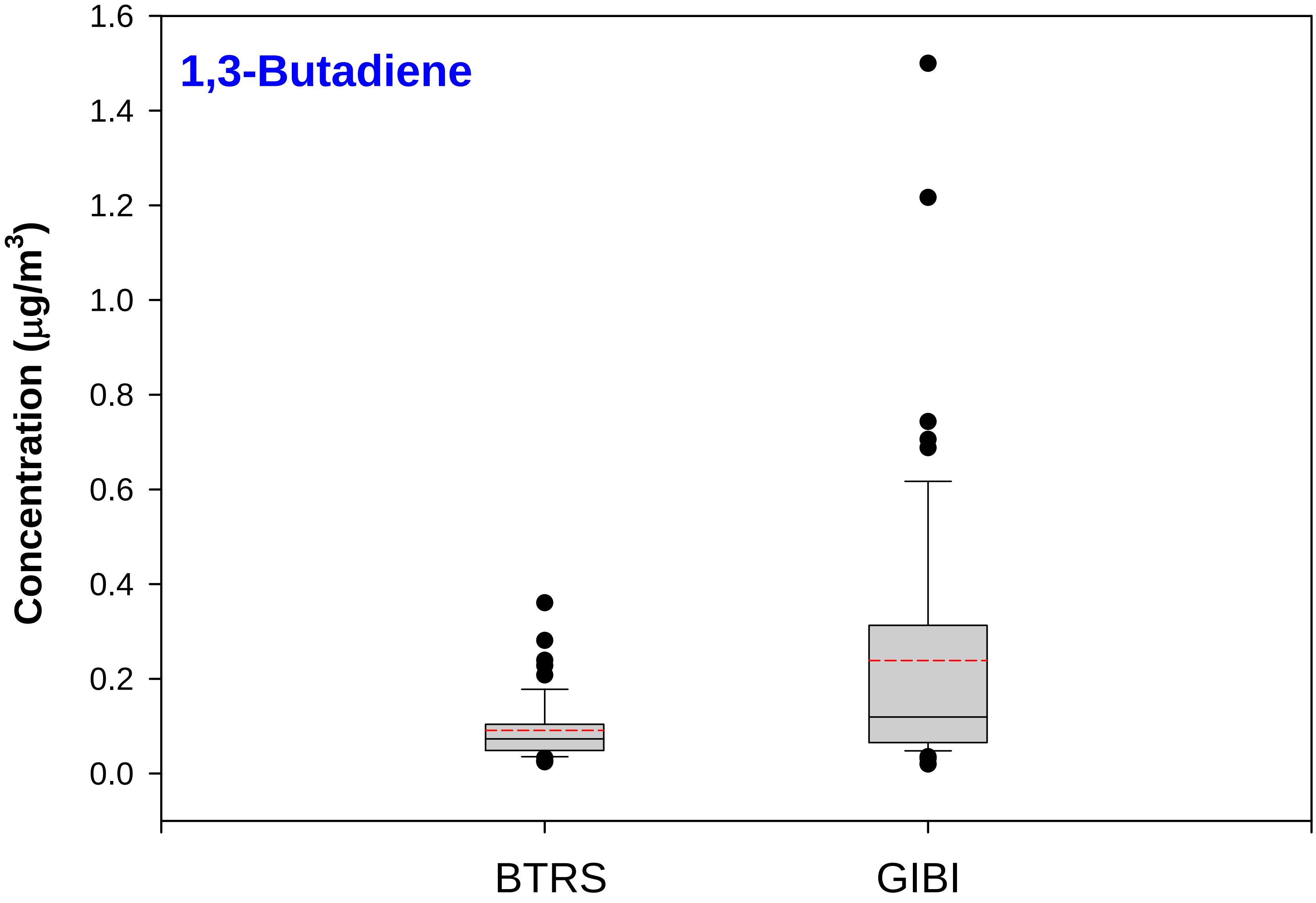
Appendix G Box Plots for Category B and C Air Toxics

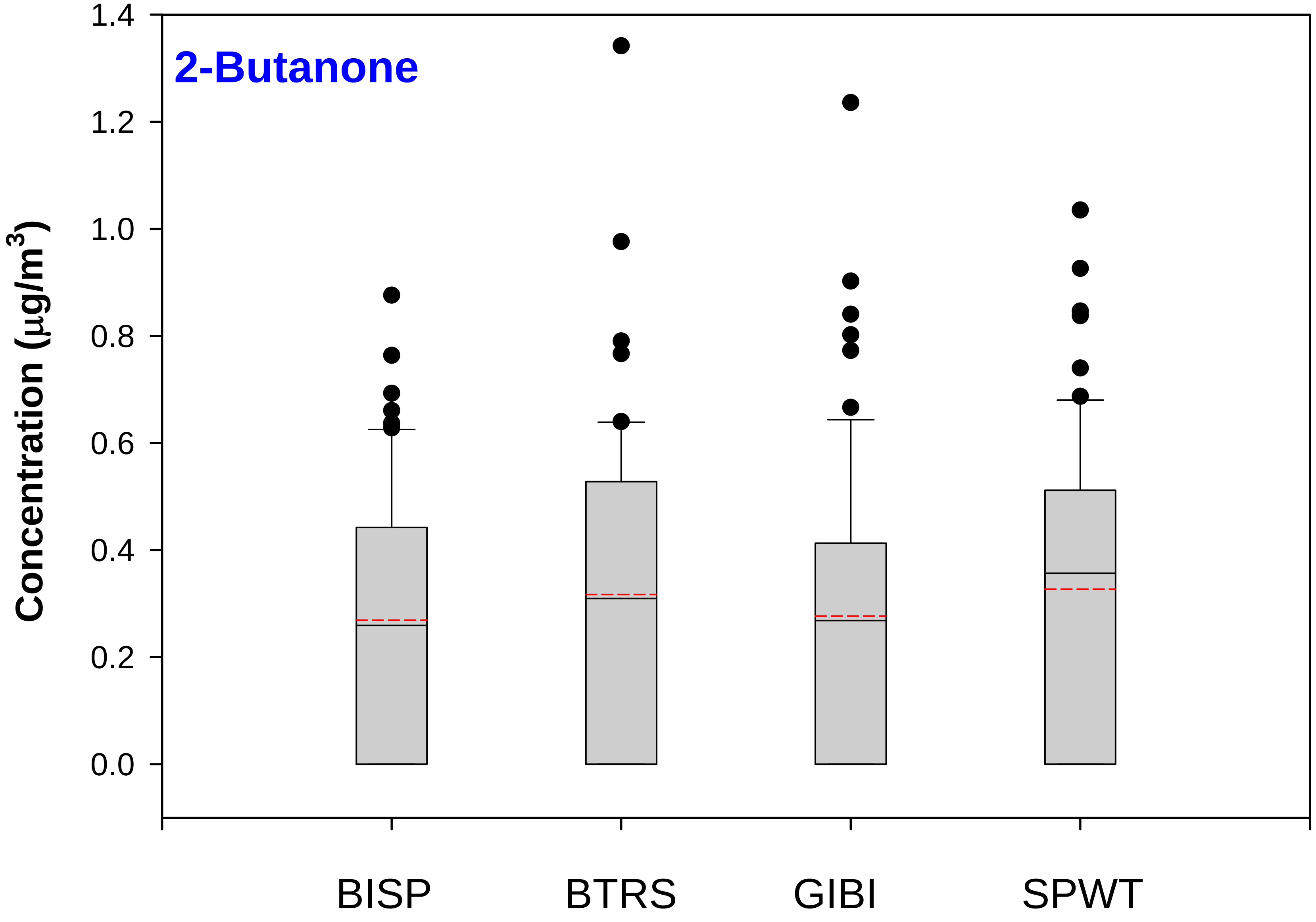
Schematic for Box Plot

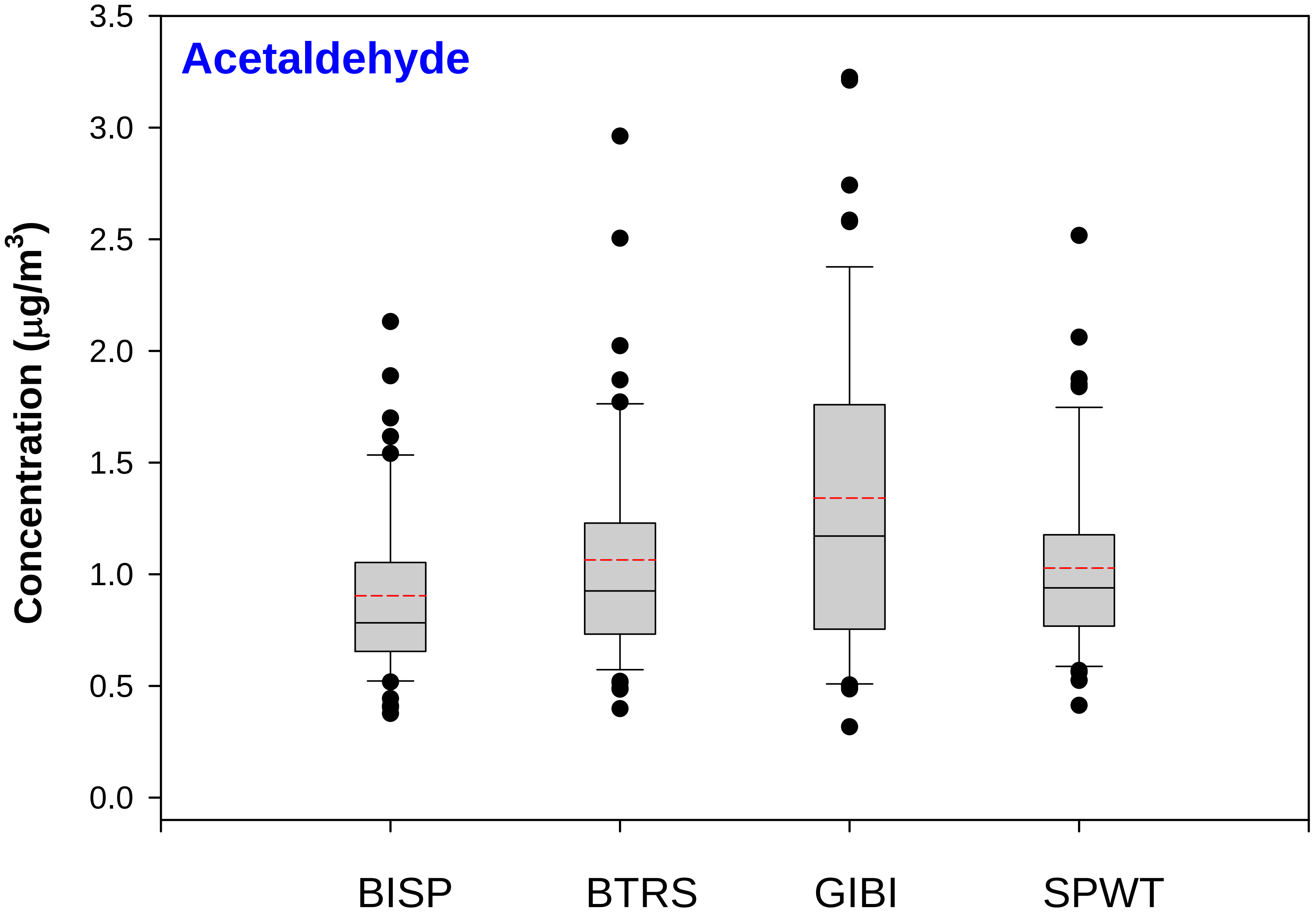


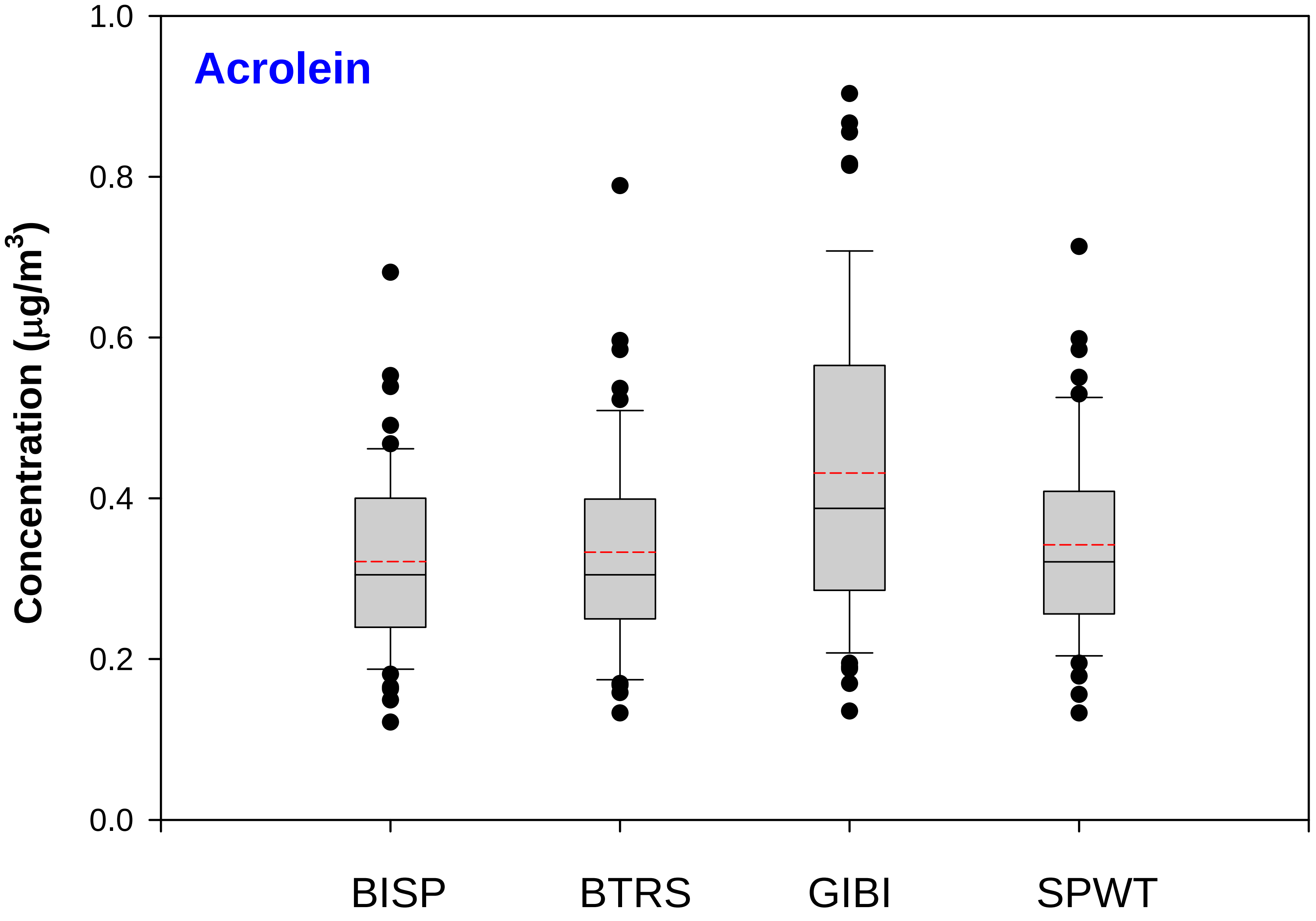
[a] SigmaPlot© 8.02 was used to produce the box plots. This program does not follow the true definition of a box plot where the whiskers represent 1.5 times the interquartile range.

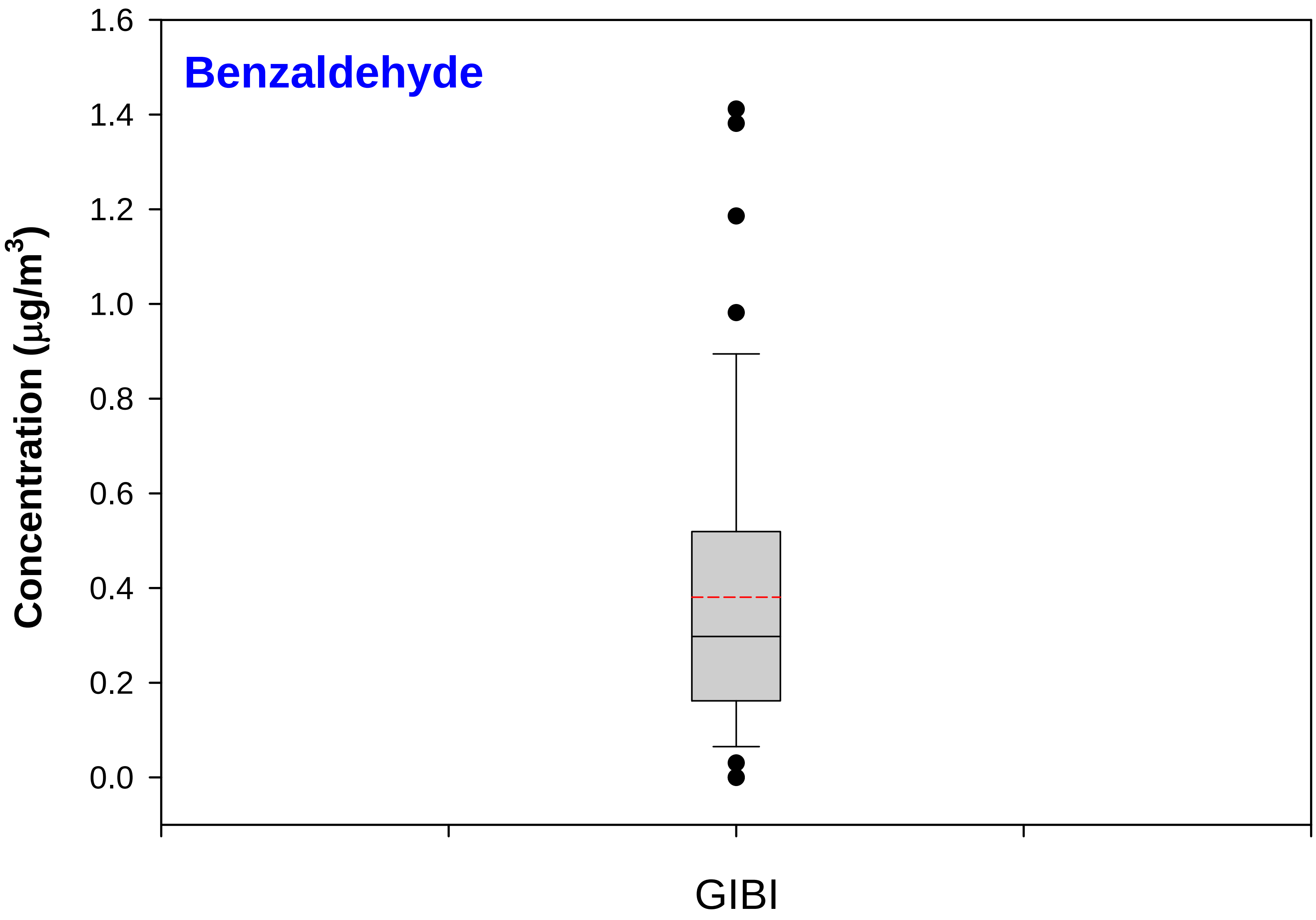

1,2,4-Trimethylbenzene
Concentration (µg/m³)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
GIBI
SPWT

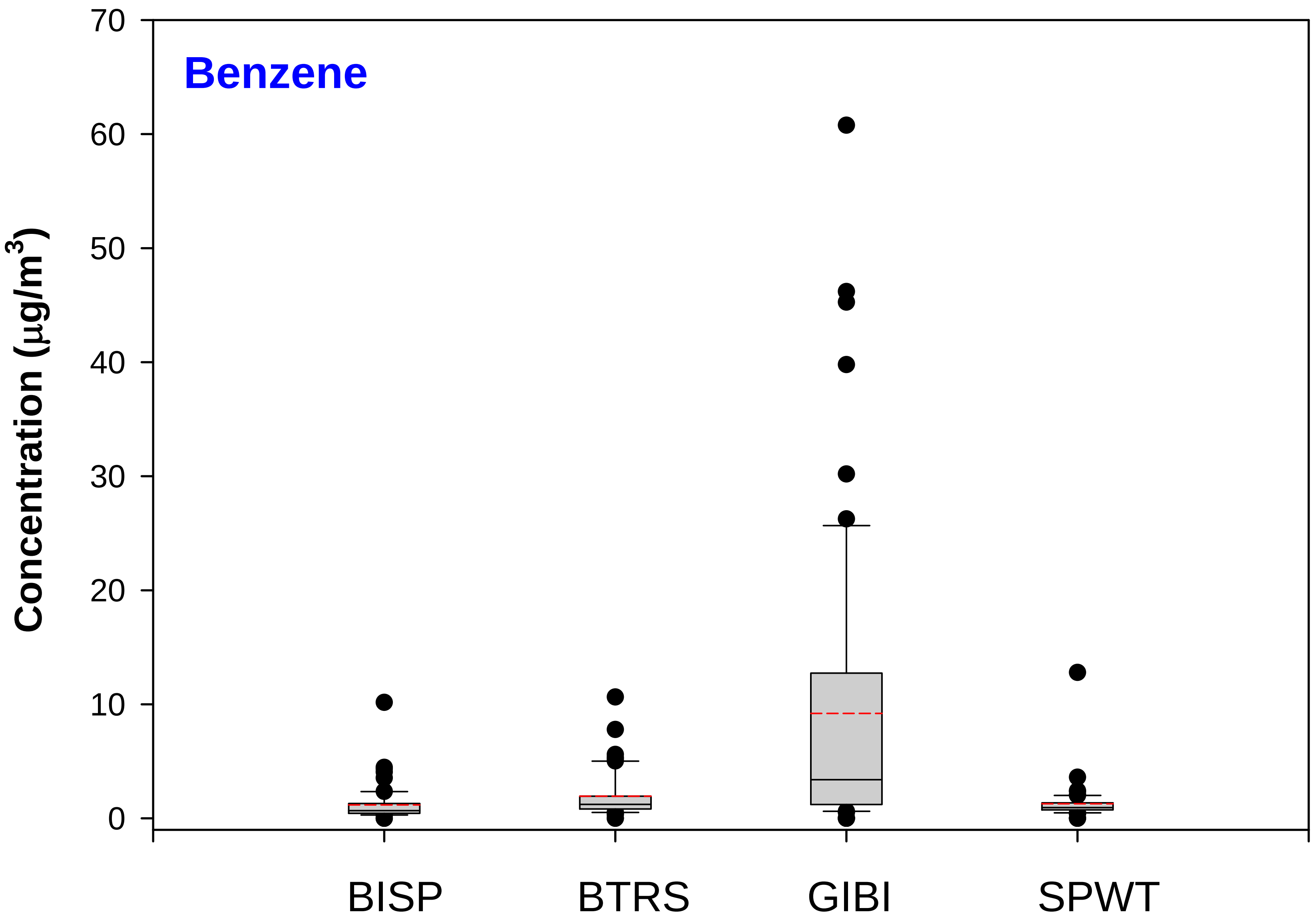

1,3-Butadiene
Concentration (µg/m3)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
BTRS
GIBI

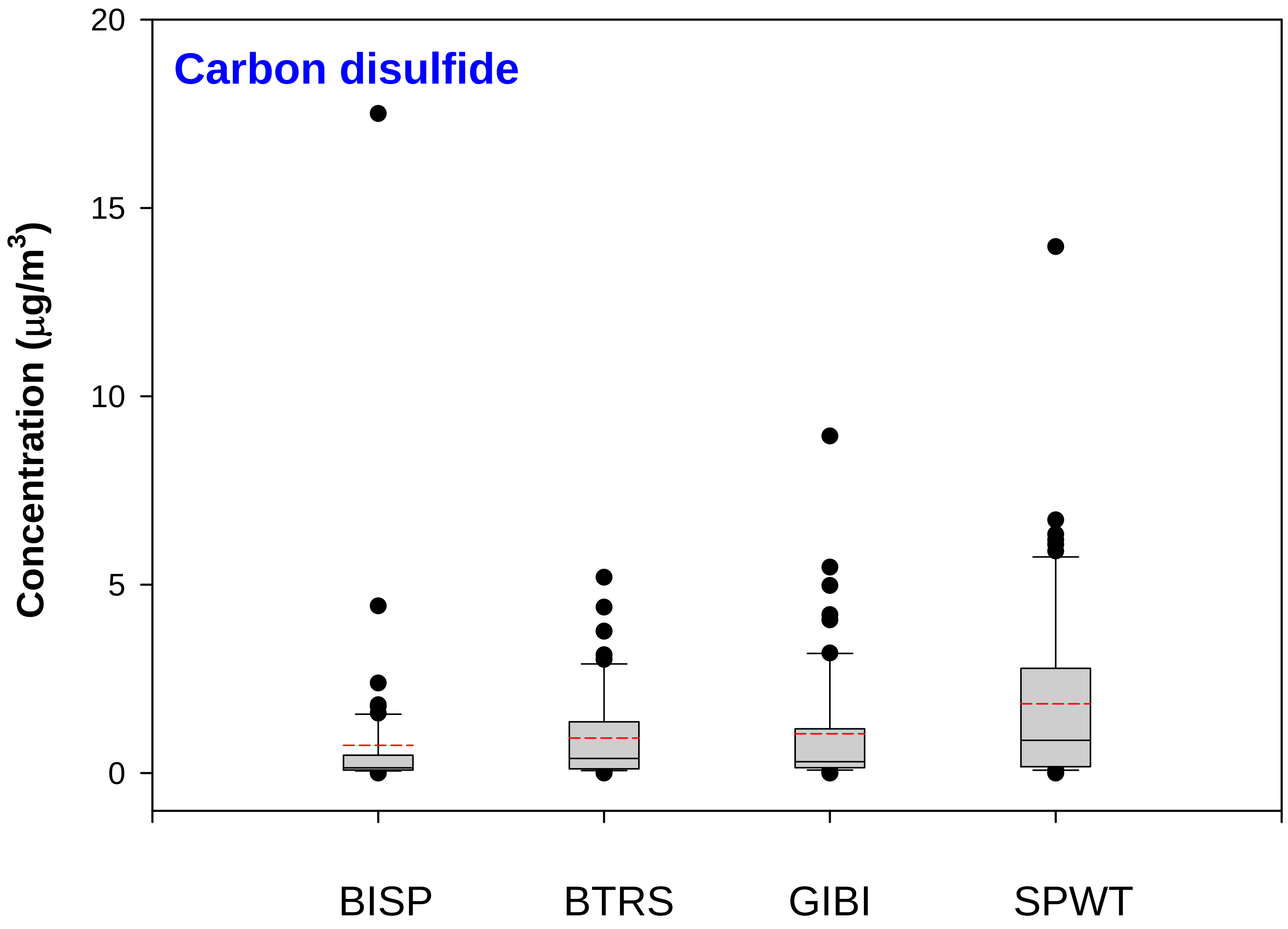

2-Butanone
Concentration (µg/m³)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
BISP
BTRS
GIBI
SPWT

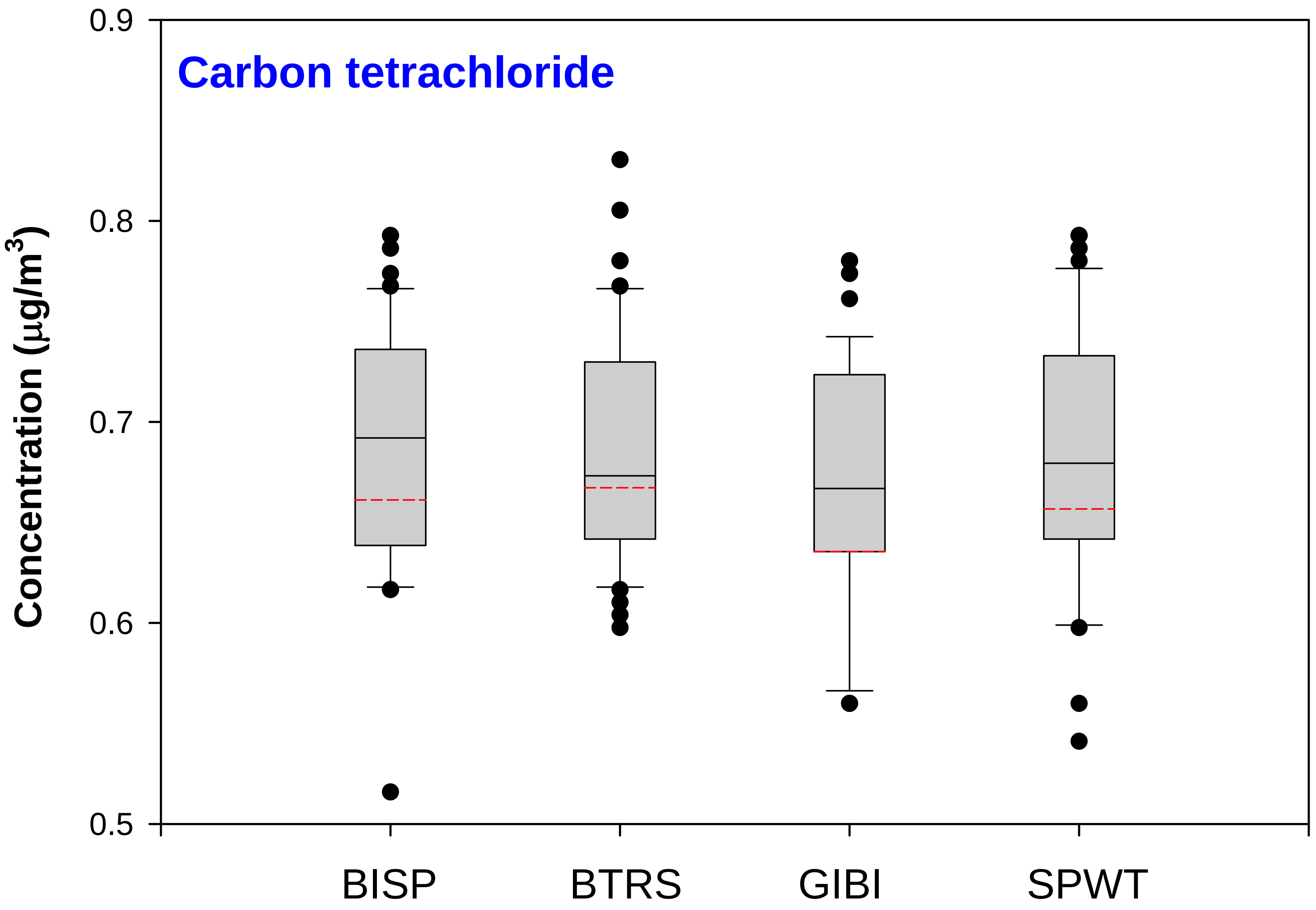

Acetaldehyde
Concentration (µg/m³)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
BISP
BTRS
GIBI
SPWT

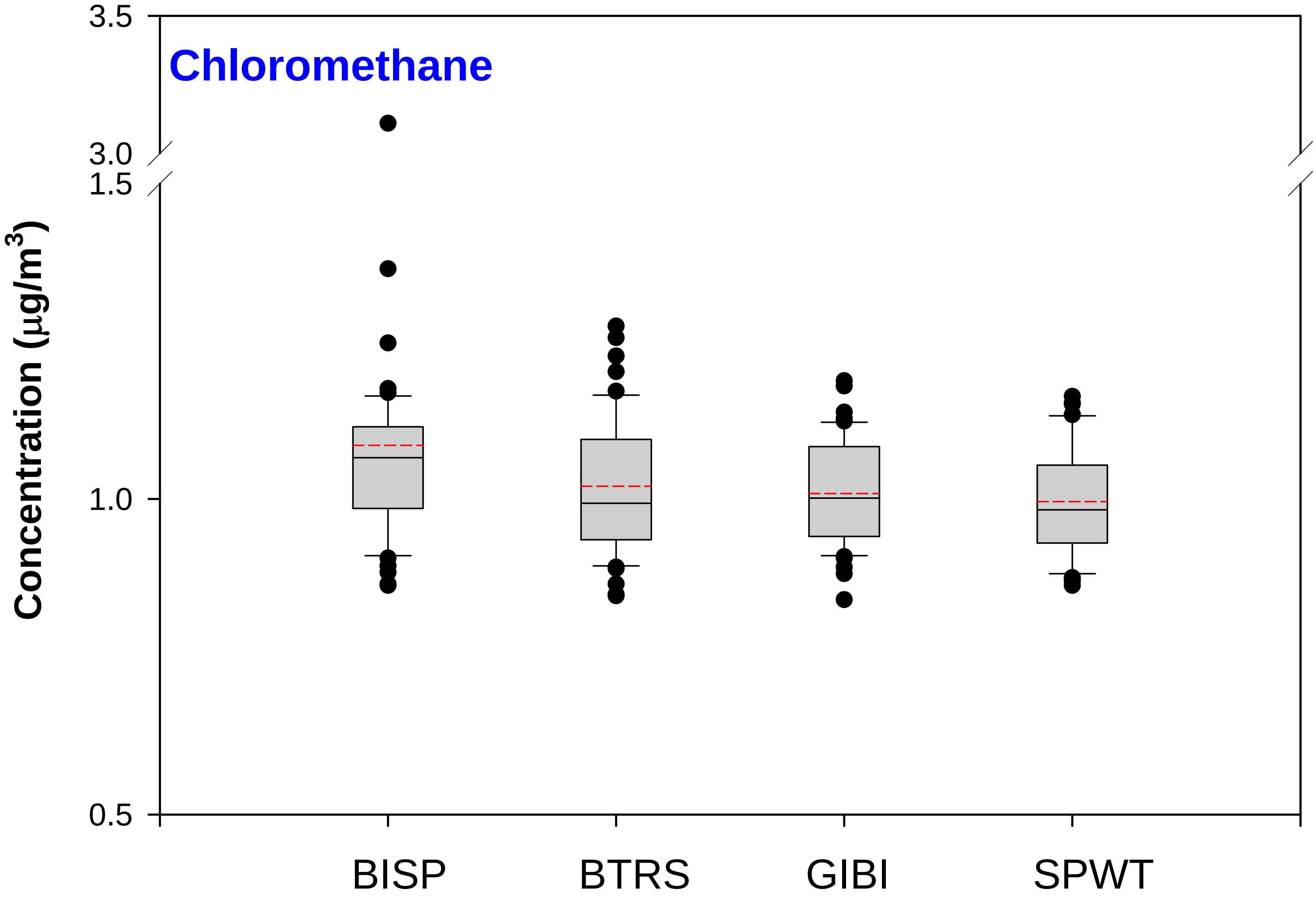

Acrolein
Concentration (μg/m^3)
1.0
0.8
0.6
0.4
0.2
0.0
BISP
BTRS
GIBI
SPWT

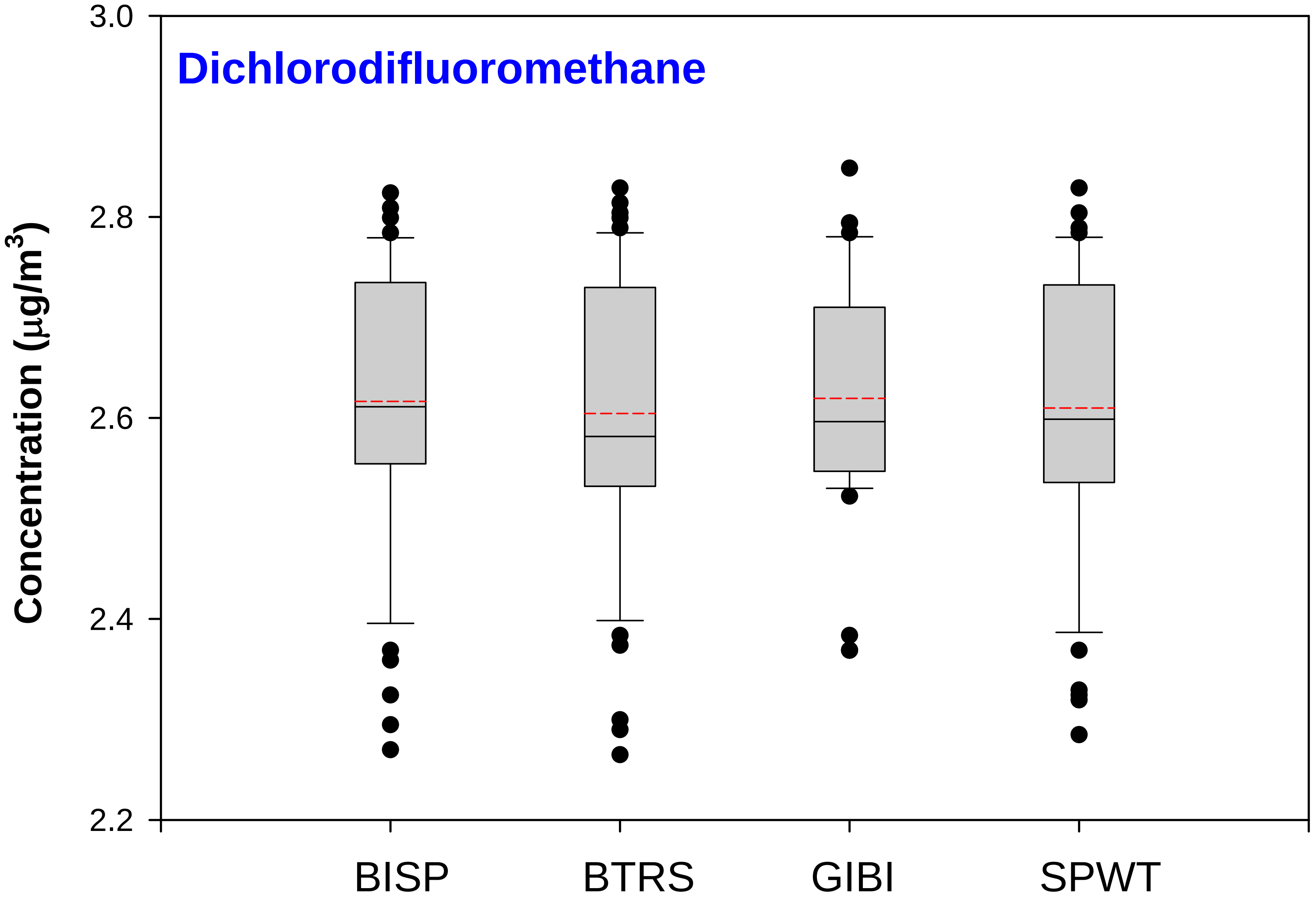

Benzaldehyde
Concentration (µg/m³)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
GIBI

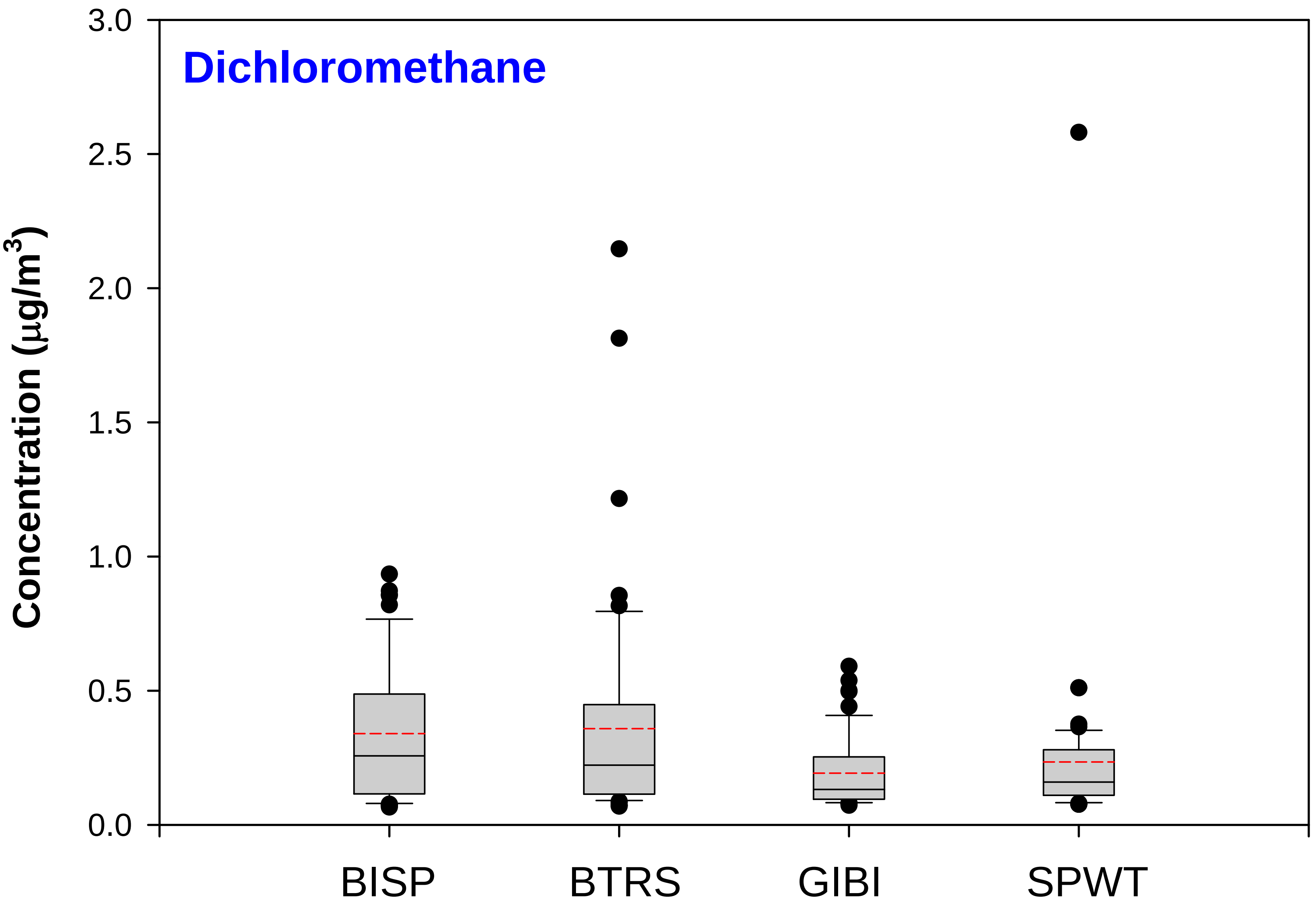

Benzene
Concentration (µg/m³)
70
60
50
40
30
20
10
0
BISP
BTRS
GIBI
SPWT

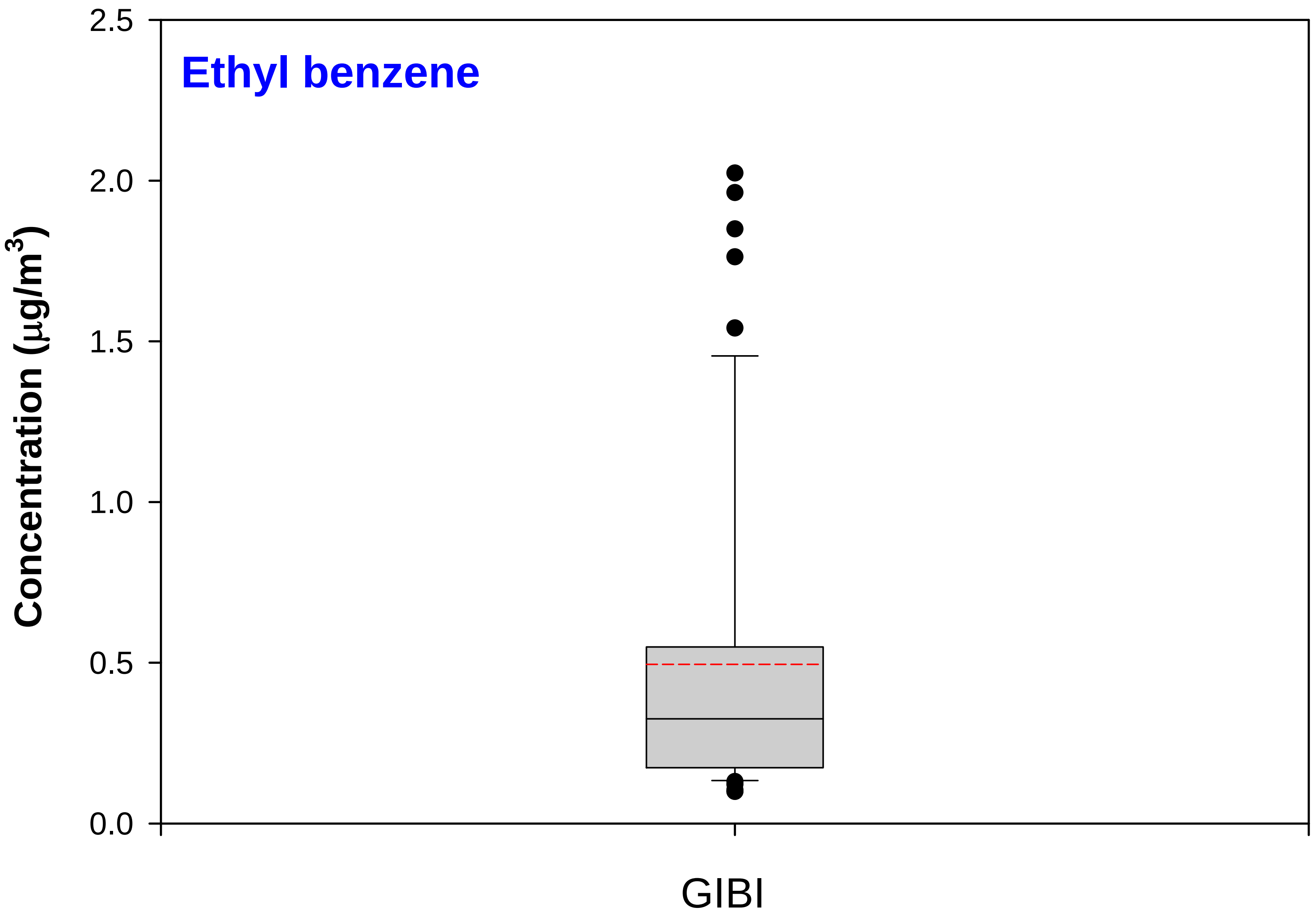

Carbon disulfide
Concentration (µg/m^3)
20
15
10
5
0
BISP
BTRS
GIBI
SPWT

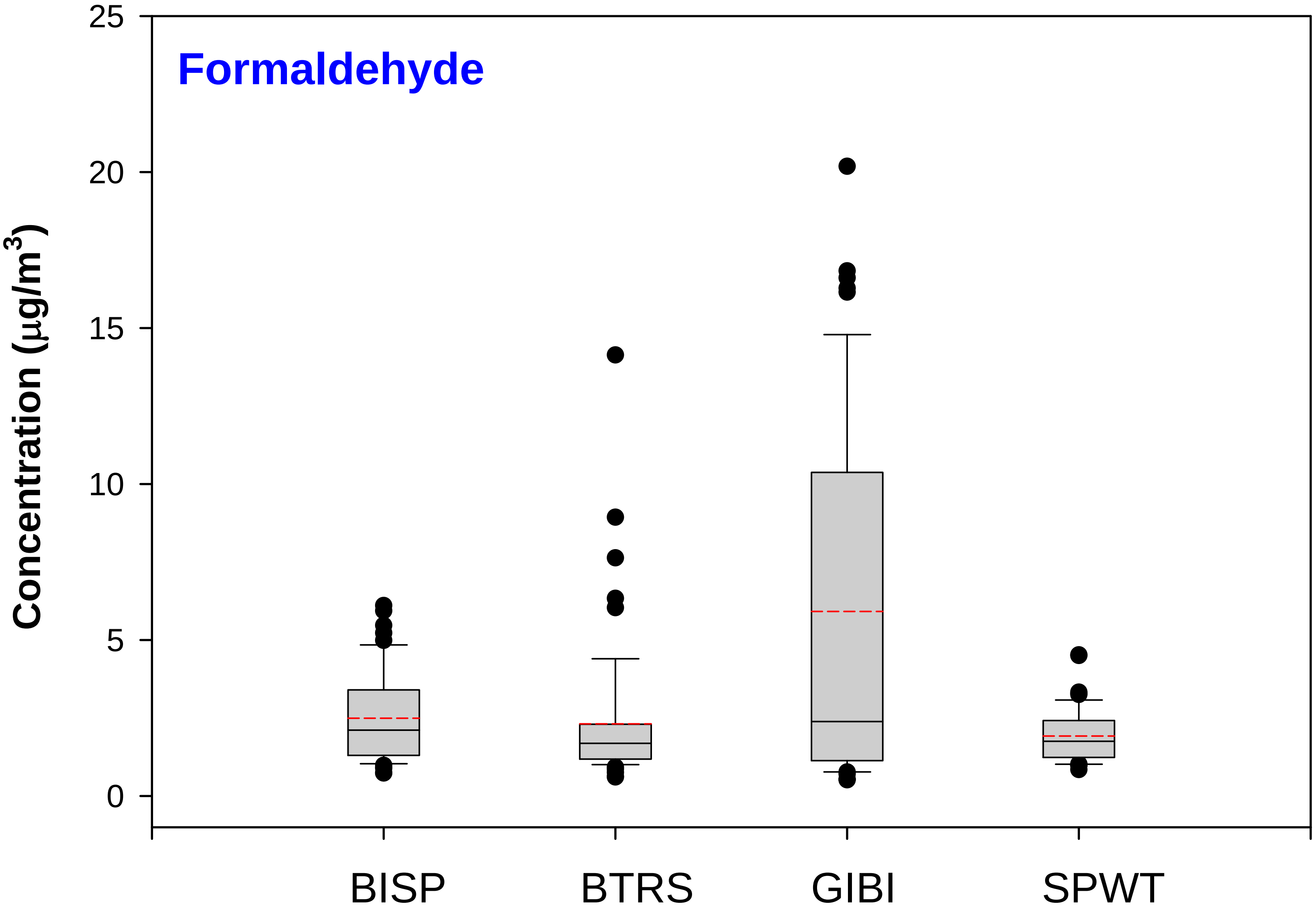

Carbon tetrachloride
Concentration (µg/m³)
0.9
0.8
0.7
0.6
0.5
BISP
BTRS
GIBI
SPWT

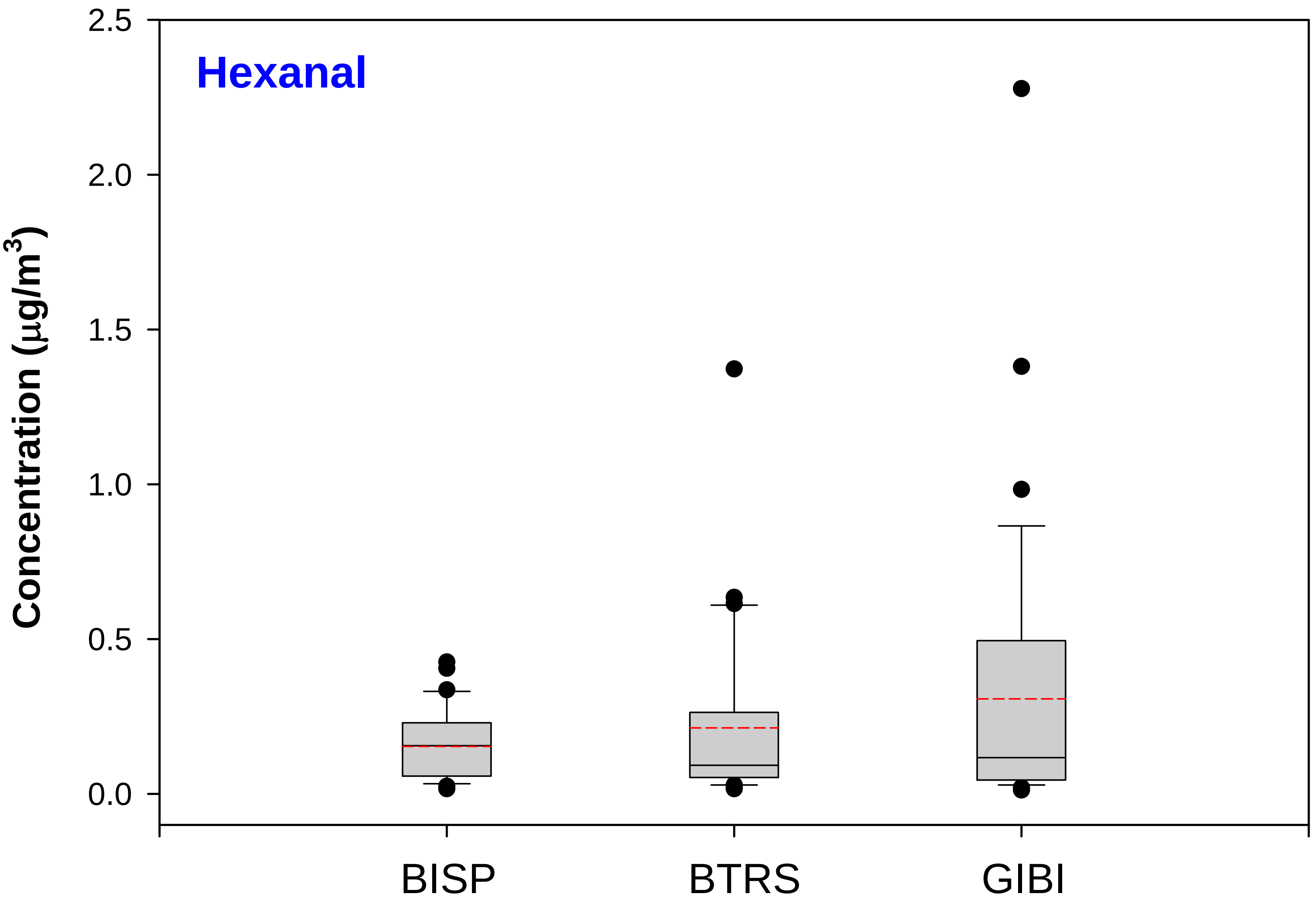

Chloromethane
Concentration (µg/m³)
3.5
3.0
1.5
1.0
0.5
BISP
BTRS
GIBI
SPWT

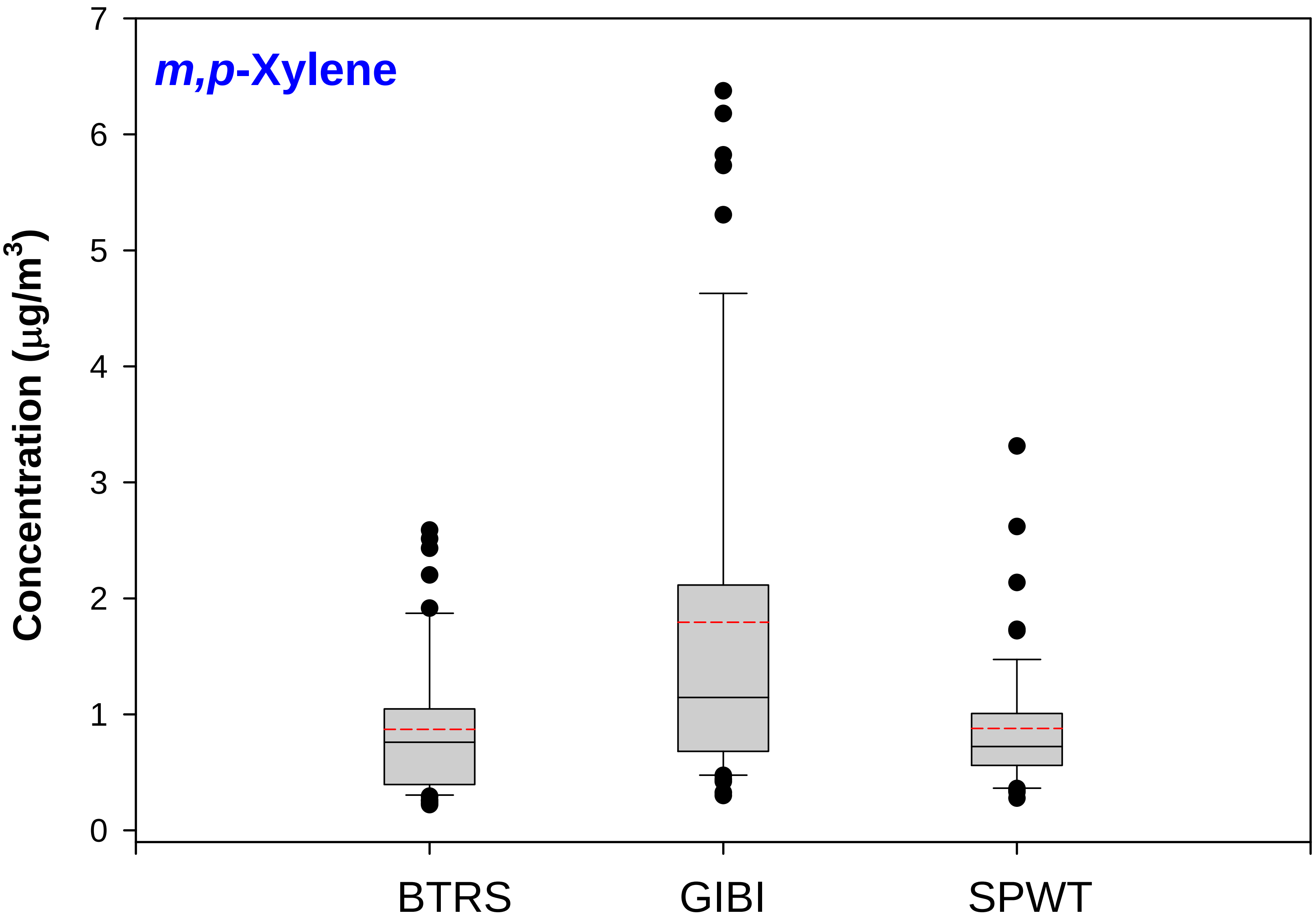

Dichlorodifluoromethane
Concentration (µg/m³)
3.0
2.8
2.6
2.4
2.2
BISP
BTRS
GIBI
SPWT

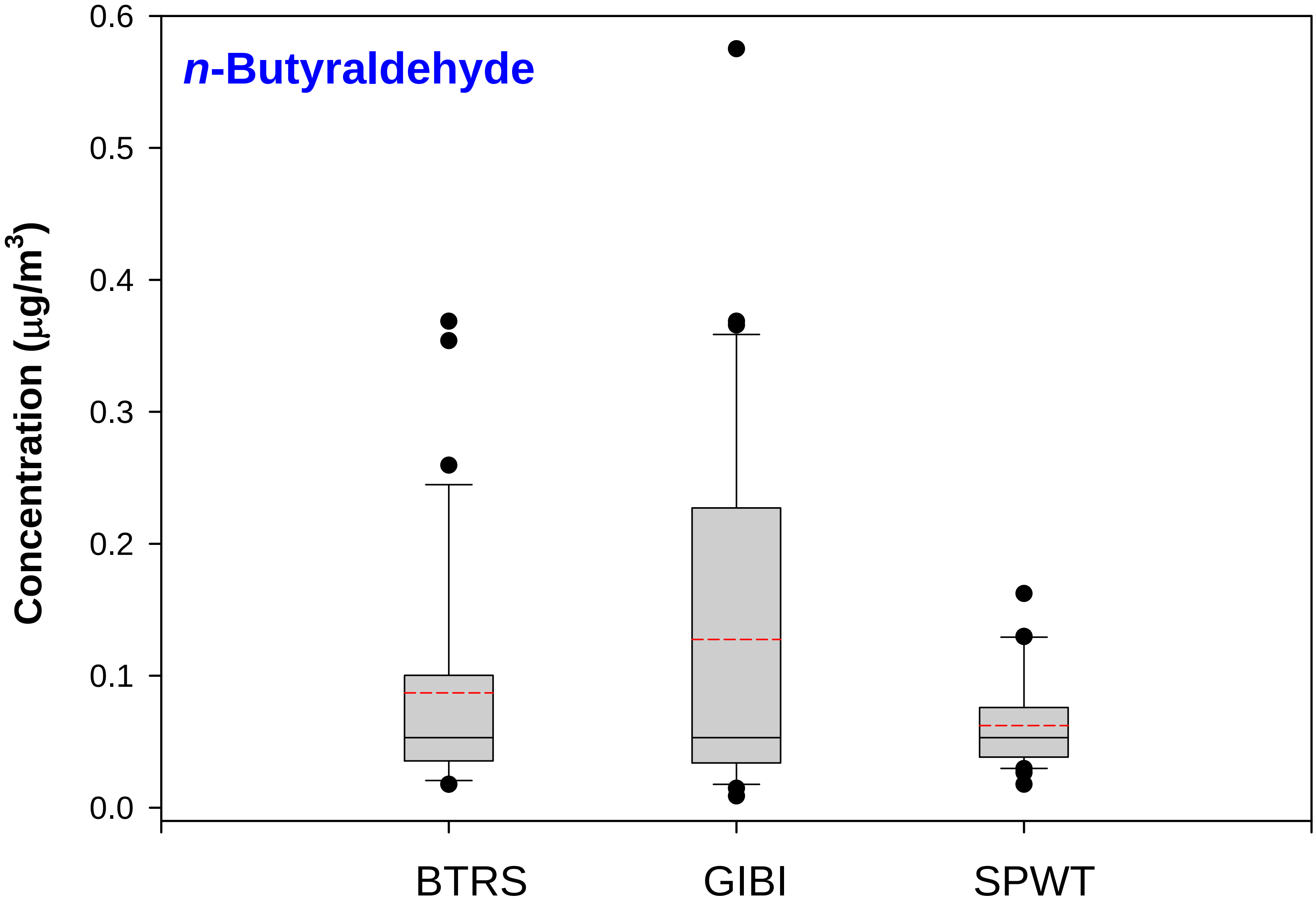

Dichloromethane
Concentration (µg/m³)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
BISP
BTRS
GIBI
SPWT


Ethyl benzene
Concentration (µg/m3)
2.5
2.0
1.5
1.0
0.5
0.0
GIBI

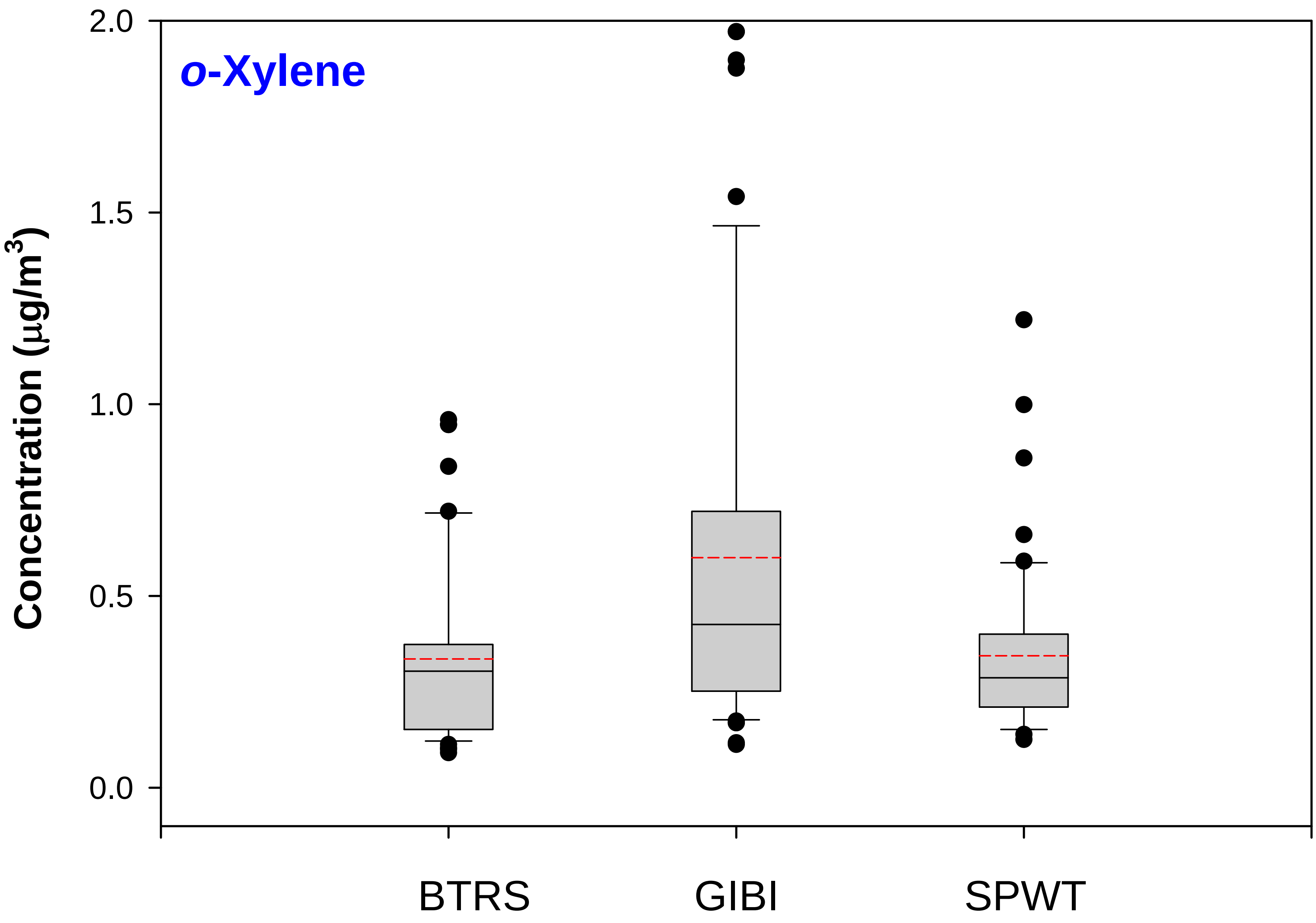

Formaldehyde
Concentration (µg/m³)
0
5
10
15
20
25
BISP
BTRS
GIBI
SPWT

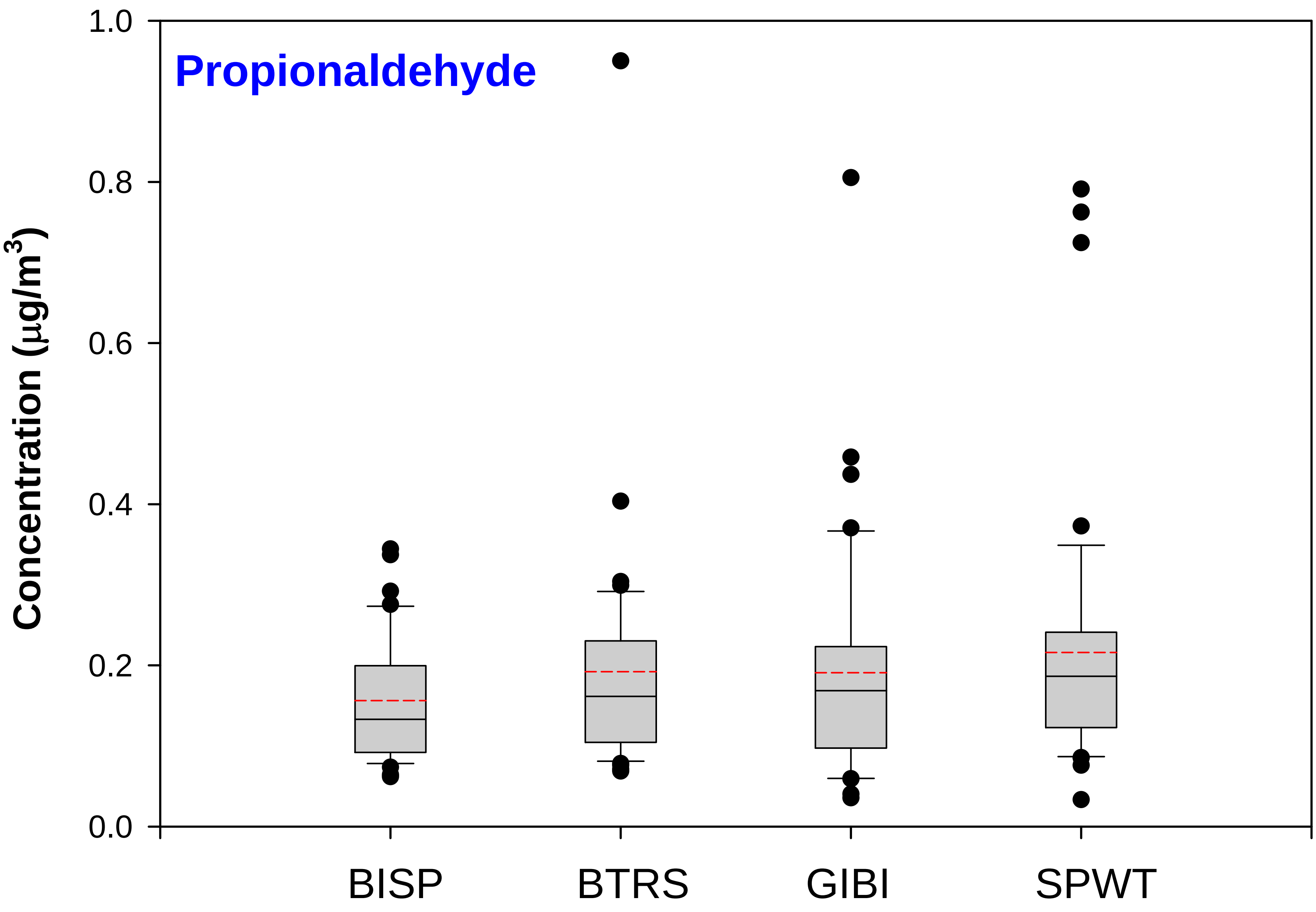

Hexanal
Concentration (µg/m³)
2.5
2.0
1.5
1.0
0.5
0.0
BISP
BTRS
GIBI

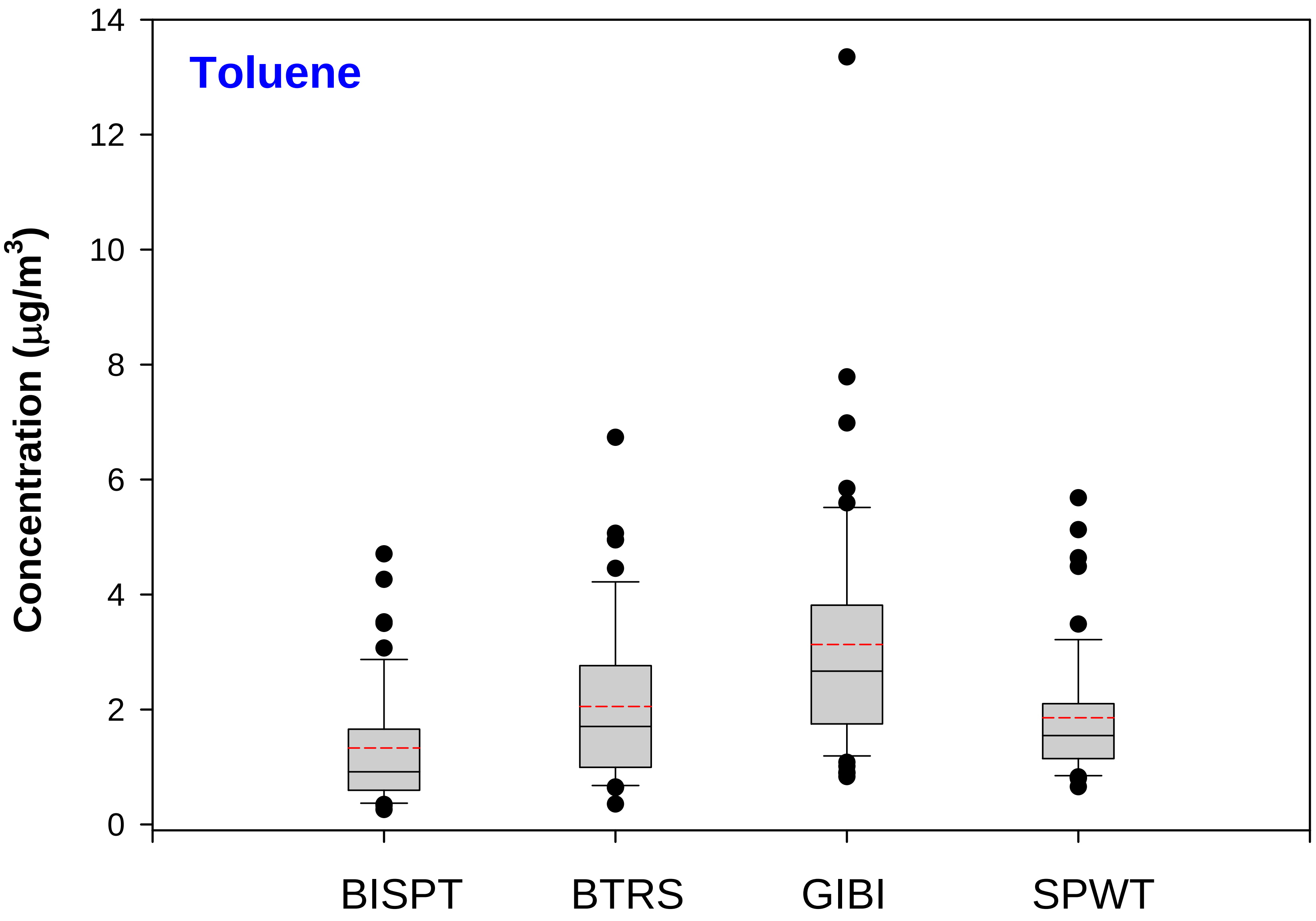

m,p-Xylene
Concentration (µg/m³)
0
1
2
3
4
5
6
7
BTRS
GIBI
SPWT

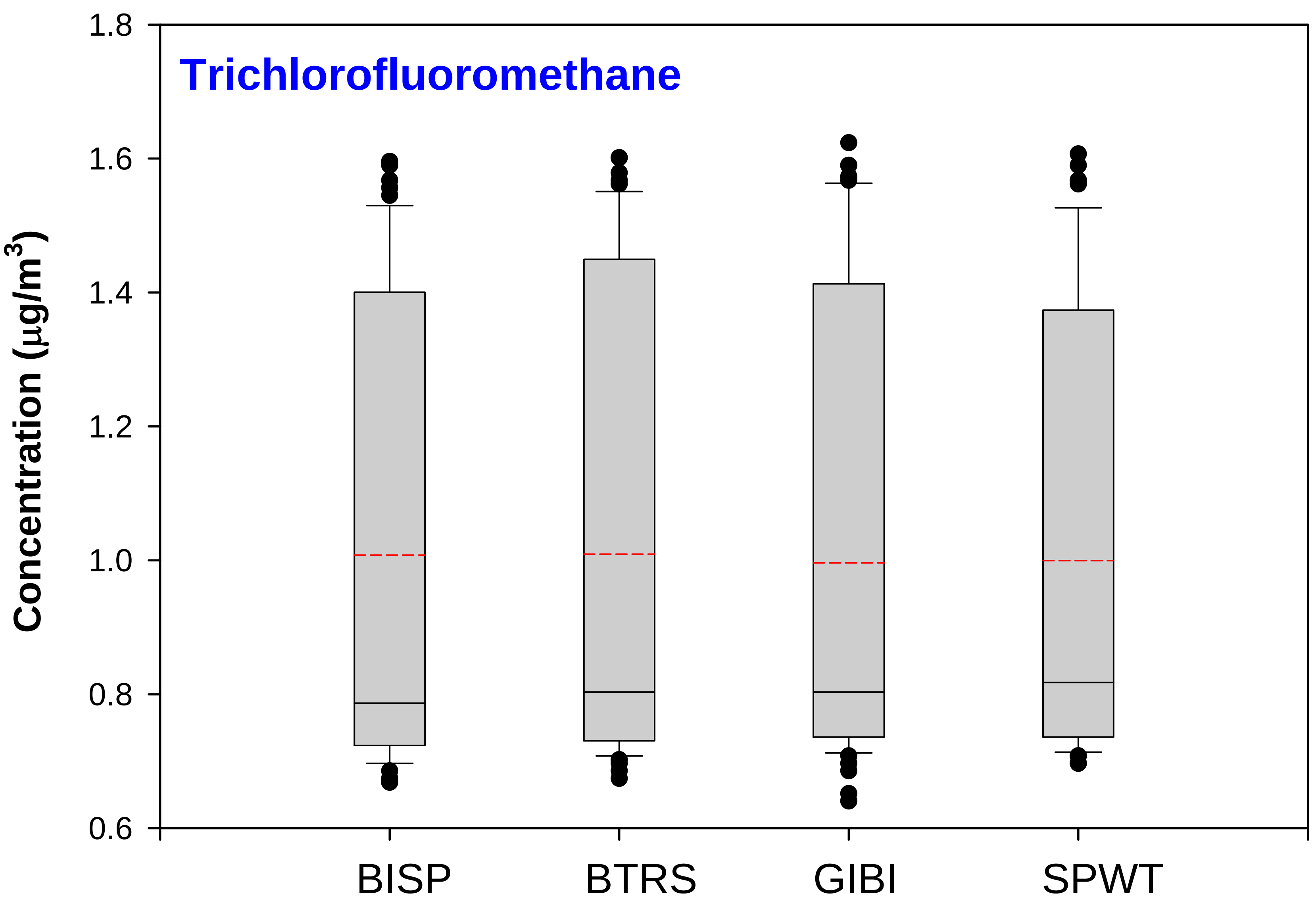


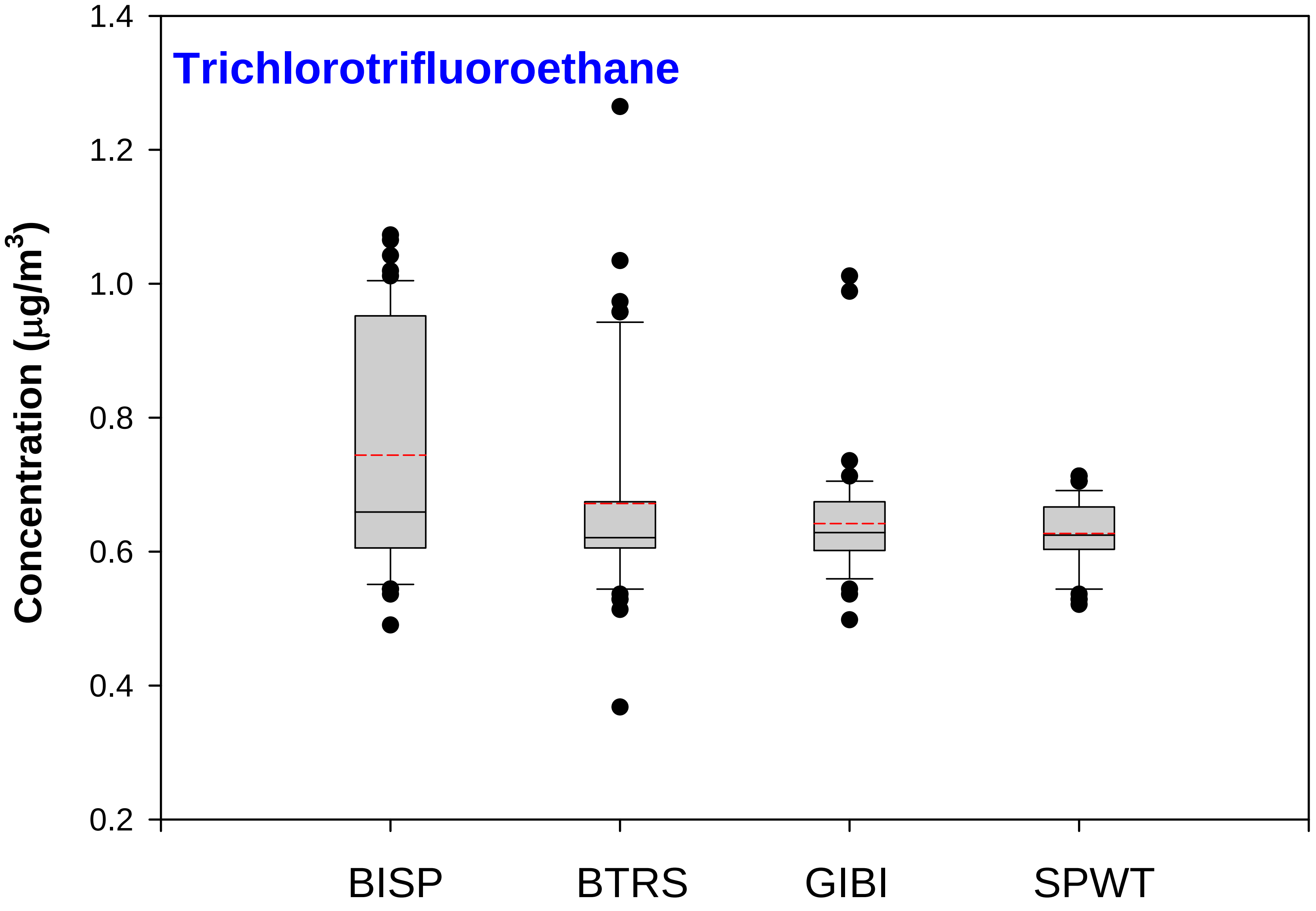
n-Butyraldehyde
Concentration (µg/m³)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
BTRS
GIBI
SPWT

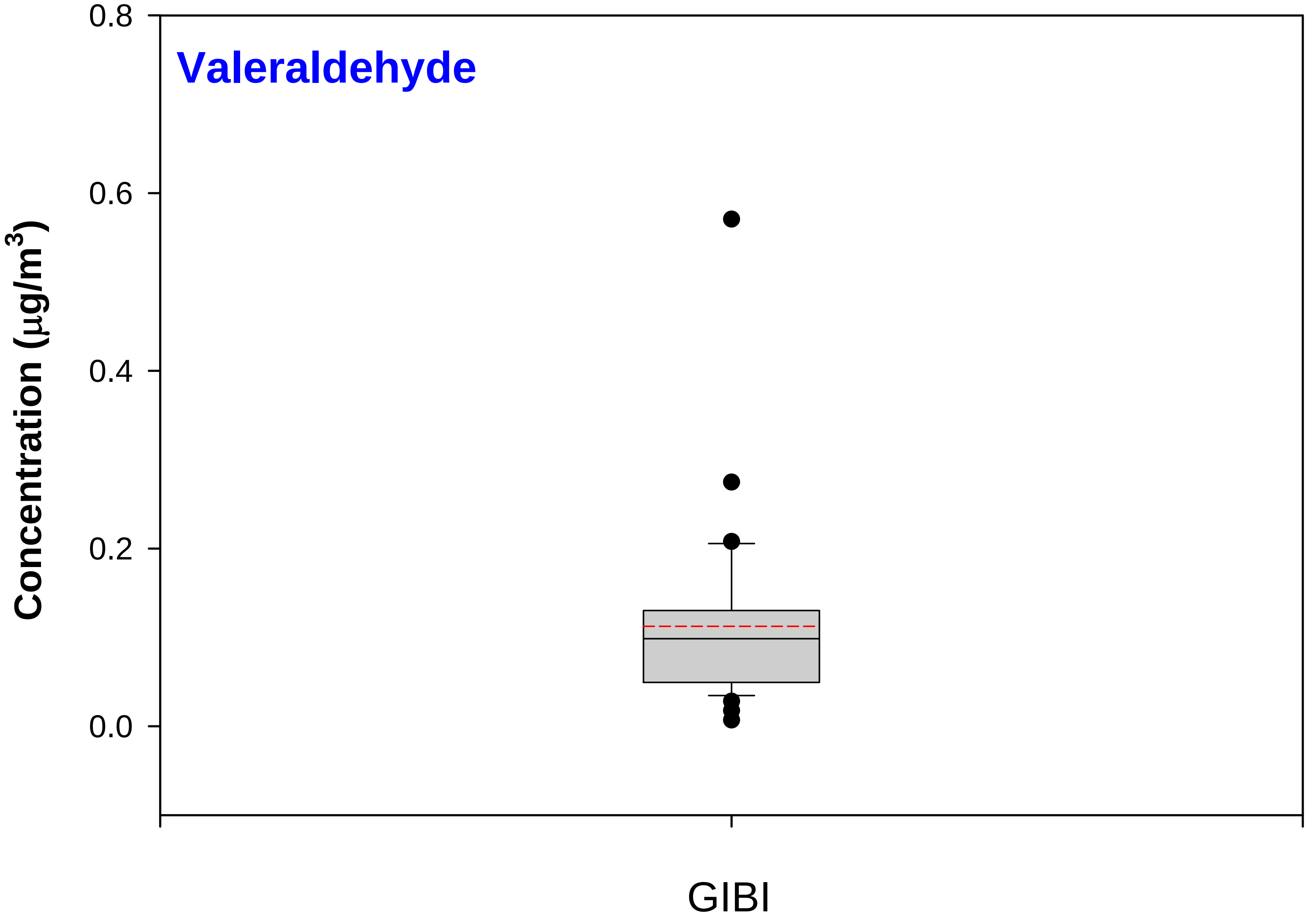

o-Xylene
Concentration (µg/m³)
2.0
1.5
1.0
0.5
0.0
BTRS
GIBI
SPWT


Propionaldehyde
Concentration (µg/m³)
1.0
0.8
0.6
0.4
0.2
0.0
BISP
BTRS
GIBI
SPWT


Toluene
Concentration (µg/m³)
0
2
4
6
8
10
12
14
BISPT
BTRS
GIBI
SPWT


Trichlorofluoromethane
Concentration (µg/m³)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
BISP
BTRS
GIBI
SPWT


Trichlorotrifluoroethane
Concentration (µg/m³)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
BISP
BTRS
GIBI
SPWT


Valeraldehyde
Concentration (μg/m^3)
0.0
0.2
0.4
0.6
0.8
GIBI

Appendix H - Derivation of AGCs for Aldehyde Compounds

New York State Department of Environmental Conservation
Division of Air Resources
Bureau of Air Quality Analysis and Research, 2nd Floor
625 Broadway, Albany, New York 12233-3259
Phone: (518) 402-8402 • **FAX:** (518) 402-9035
Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

M E M O R A N D U M

To: File

From: Steven De Santis, Research Scientist III

Subject: Aldehyde Compounds Without Health-based Concentration Values Detected During the Study Period of the Tonawanda Air Quality Community Monitoring Grant

Date: June 15, 2009

Aldehyde compounds were measured and detected at all four sites during the year long Tonawanda Air Quality Community Monitoring Study (Study). For all compounds measured during the Study, a risk classification scheme was derived based upon the percent of measured values above the method detection limit (MDL). Those compounds falling in Category A were detected less than fifty percent of the time and were classified as not being able to have their risk characterized. Compounds in Category B were detected above the MDL greater than fifty percent of the time and less than seventy-five percent of the time. The risk associated with compounds in Category B will be estimated and reported. Category C compounds were detected greater than the MDL more than seventy-five percent of the time and the risk will be quantified. For a complete description of this methodology, see the Section *"Suitability of the ambient data for data analysis and health risk evaluation"* found in Section 7.0 of the Final Report.

Several aldehyde compounds falling into Categories B and C did not have AGC (Annual Guideline Concentrations) concentration values adopted or derived by the Department. Table1 lists all the aldehyde compounds found in Category B and C with their AGCs. Currently, there are no AGCs for benzaldehyde, butyraldehyde and hexanal.

The AGC listed for formaldehyde in the 2007 AGC/SGC Tables is based upon a cancer endpoint and the Integrated Risk Information System (IRIS) does not support a non-cancer inhalation Reference Concentration (RfC) for formaldehyde. In December of 2008, California's Office of Environmental Health and Hazard Assessment published a Reference Exposure Level of 9.0 $\mu g/m^3$ published for formaldehyde. The Department recognizes this concentration value as the non-cancer health-based concentration.

Aldehydes can be described as unsaturated, saturated, linear and/or cyclic chemical compounds. The low molecular weight aldehydes, the halogenated aliphatic aldehydes, and the unsaturated aldehydes are the most irritating (1). Unsaturated aldehyde compounds possess a double bond along with the R-C-O-H aldehyde structure. The irritating inhalation health effects of the unsaturated compounds, acrolein and crotanaldehyde are well documented. Low molecular weight compounds such as formaldehyde and acetaldehyde are also well documented for their irritating inhalation health effects and their non-cancer health based concentration values are listed in Table 1.

Table 1 Category B & C Aldehydes Non-cancer RfC

CAS#	**Compound**	**Non-cancer RfC (µg/m3)**	**Reference Agency**
000050-00-0	Formaldehyde	9.8	ATSDR
000066-25-1	Hexanal	NA	
000075-07-0	Acetaldehyde	9	IRIS
000100-52-7	Benzaldehyde	NA	
000107-02-8	Acrolein	0.02	IRIS
000110-62-3	Valeraldehyde	420	OEHHA
000123-38-6	Propionaldehyde	8	IRIS
000123-42-8	Butyraldehyde	NA	

ATSDR – Agency for Toxic Substance Disease Registry
IRIS - Integrated Risk Information System
OEHHA - Office of Environmental Health Hazard Assessment - California

As an indication of the acute relative potency of compounds within a class, a review comparing of the lethal dose-50 (LD_{50}) or the lethal concentration-50 (LC_{50}) can be performed. Table 2 below lists the LD_{50} and LC_{50} for the compounds meeting the requirements of Category B and C of the Study.

Table 2 Category B & C Aldehydes LC50 and LD50 Values

CAS#	Compound	**Molecular Weight**	**Molecular Formula**	**LC50 (mg/m3)**	**LD50 (mg/kg)**	**Route**	**Species**
000050-00-0	Formaldehyde	30.03	CH2O		100	oral	Rat
				590		inhalation	Rat
000075-07-0	Acetaldehyde	44.06	C2H4O		661	oral	Rat
000123-38-6	Propionaldehyde	54.50	C3H2O		1410	oral	Rat
				21,800		inhalation	Mouse
000107-02-8	Acrolein*	56.06	C2H4O		46	oral	Rat
				300		inhalation	Rat
004170-30-3	Crotanaldehyde*	70.09	C4H6O		206	oral	Rat
000123-42-8	n-Butyraldehyde	72.12	C4H8O		2490	oral	Rat
				44,610		inhalation	Mouse
000110-62-3	Valeraldehyde	86.15	C5H10O		4581	oral	Rat
000066-25-1	Hexanal	100.18	C6H12O		4890	oral	Rat
000100-52-7	Benzaldehyde	106.13	C7H6O		1300	oral	Rat
				200		inhalation	Rat

* - unsaturated compounds

As shown in Table 2, the lower molecular weight and unsaturated compounds have the lowest lethal acute concentration values. As the compounds' molecular weight increases for aliphatic compounds, the acute toxicity of the compound decreases. Benzaldehyde, an aromatic aldehyde, did show a greater lethal acute concentration than the lower molecular weight compounds.

A paper submitted by Babiuk, et. al. to the Journal of Toxicology and Applied Pharmacology (2), attempted to determine if sensory irritation to laboratory rats could be decreased with a preliminary exposure to other irritating substances. The usefulness of this paper is that the researchers' control were laboratory animals with no previous exposures to respiratory irritants. The sensory irritation response in these animals was quantified by measuring respiratory rate depression in a head-only inhalation chamber. The researchers were trying to discern the concentration eliciting a 50% decrease in respiratory rate (RD_{50}). The results of their study showed that the aldehydes tested produced RD_{50} values which spanned 3 orders of magnitude. The unsaturated aliphatic aldehydes, acrolein and crotanaldehyde, produced an RD_{50} of a 6 and 23 ppm respectively. The cyclic aldehydes had a RD_{50} ranging from 600 to 1000 ppm while the least potent irritants were the saturated aliphatic aldehydes, acetaldehyde, propionaldehyde and butyraldehyde with RD_{50} values 3000 to 6800 ppm.

Benzaldedhyde was part of a 2-Year National Toxicology Program (NTP) cancer study where male mice were given 0, 200, or 400 mg/kg benzaldehyde in corn oil by gavage, 5 days per week for 103 weeks and female mice were administered 0, 300, or 600 mg/kg benzaldehyde for 103 weeks. No significant differences in survival or body weight loss was observed between any of the groups of mice. The only effects of benzaldehyde were those seen in the forestomach of mice. The incidences of uncommonly occurring cell papillomas of the forestomach in both exposure groups were significantly greater than those in the controls, (1/50; low dose, 2/50; high dose, 5/50; female: 0/50; 5/50; 6/50). Also increased incidences of papillomas were observed by dose related increases in the incidences in forestomach hyperplasia (male: 7/50; 8/50; 16/50; female 12/50; 23/50; 39/50). The two year study concluded there was some evidence of carcinogenic activity of benzaldehyde for male or female mice, as indicated by the increased incidences of cell papillomas and hyperplasia of the fore stomach (3).

Recommendation:

Several aldehyde compounds falling into Categories B and C did not have Annual Guideline Concentrations values adopted or derived by the Department. Currently, there are no AGCs for benzaldehyde, butyraldehyde and hexanal.

The first approach to assigning an interim AGC is to choose the lowest AGC concentration in the chemical class and assign this concentration value to the unknown compound. In the case of aldehydes, the lowest annual guideline concentration is for formaldehyde. The AGC value for formaldehyde is based upon an inhalation cancer unit risk value set at a one-in-one-million excess cancer rate. The AGC value for acetaldehyde was established with the same procedure. The three compounds being evaluated do not have clear evidence that their adverse health effects are cancer related. Benzaldehyde was evaluated for its ability to elicit cancer in the NTP study but this was an ingestion study and it was not clearly established that the inhalation of benzaldehyde would produce cancer in test animals and/or humans. Due to these concerns, the interim AGC assignments for the three compounds will be evaluated for non-cancer health effects.

Interim AGC Assignment:

Aldehydes can be described as unsaturated, saturated, linear and/or cyclic chemical compounds. Based upon the data in the literature cited, acute irritation health effects can be associated with the aldehyde chemical type.

For the three compounds currently without an AGC (benzaldehyde, butyraldehyde and hexanal) an interim AGC will be assigned as shown in Table 3. None of these compounds are unsaturated aldehydes so it is inappropriate for them to be compared to acrolein. The non-cancer reference concentration established by IRIS for acetaldehyde is the best fit compound for these unevaluated aldehydes. For the interim AGC concentration for butyraldehyde and hexanal, it is suggested the AGC established for acetaldehyde be used with a correction for molecular weight. This practice is currently employed in the AGC/SGC tables for other aliphatic compounds. The cyclic compound, benzaldehyde was found to elicit a greater RD_{50} response in the research by Babiuk, et. al. and the NTP study suggested a potential for carcinogenic activity for ingestion so it is recommended to compare this compound to acetaldehyde but not adjust the comparison by the molecular weight.

Table 3 Interim AGC Concentration Values

CAS#	Compound	Non-cancer RfC (µg/m3)	Reference Agency
000050-00-0	Formaldehyde	9.8	ATSDR
000066-25-1	Hexanal	20.0	Interim AGC
000075-07-0	Acetaldehyde	9	IRIS
000100-52-7	Benzaldehyde	9	Interim AGC
000107-02-8	Acrolein	0.02	IRIS
000110-62-3	Valeraldehyde	420	TLV/420
000123-38-6	Propionaldehyde	8	IRIS
000123-42-8	Butyraldehyde	15.0	Interim AGC
004170-30-3	Crotanaldehyde	NA	

TLV/420 - Threshold Limit Value divided by safety factor of 420.

References:

(1) Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982

(2) Babiuk, C; Steinhagen, W.H; and Barrow, C.S.; Sensory Irritation to Inhaled Aldehydes after Formaldehyde Pretreatment, Toxicology and Applied Pharmacology, Vol 79, 143-149 1985

(3) National Toxicology Program NTP; Toxicology and Carcinogenesis Studies of Benzaldehyde in F344/N Rats and B6C3F1 Mice (Gavage Studies) p.3 (1988) Technical Rpt Series No. 378 NIH Pub No. 88-2588

Appendix I - Regional Air Impact Modeling Initiative (RAIMI)

1.0 RAIMI Software Description

Part of the grant for the Tonawanda Community Study was to utilize the Regional Air Impact Modeling Initiative software program or RAIMI. When conducting community studies, the use of air dispersion models to predict ambient impacts is important because the costs involved of establishing monitors and analyzing data is limited to specific test methods and overall costs. RAIMI incorporates the Industrial Source Complex Short-Term model (ISCST3) air dispersion model but the RAIMI software program is not just an air dispersion model but a software interface to review and modify data output.

The RAIMI software program was designed by the Compliance Assurance and Enforcement Division of EPA Region 6. The objective of RAIMI software was to model multiple sources within the Houston ship channel area to determine the overall hazard index for various pollutants and/or predict an inhalation excess cancer risk for carcinogens.

The RAIMI software program operates within the framework of Geographical Interface Software (GIS) to produce a finished output which can show ambient concentrations on a map or satellite image. NYSDEC uses the ESRI GIS software ArcMap.[1] The RAIMI software program is designed to display the predicted ambient concentrations (output) to a gridded system overlaid on satellite imagery. By highlighting a specific area within the Study area, in our case a monitor or census tract centroid, the output can describe the maximum concentration predicted for the chosen point(s) for all pollutants modeled, including the hazard index and/or cancer risk. Specific feature of the RAIMI software program is to allow the user to determine each source's contribution to the point or points on the grid selected. Also, to understand the effect of process changes or control strategies on predicted ambient concentrations, the RAIMI software allows the user to make changes to emission input data without having to re-run the air dispersion model.

The RAIMI program utilizes the Industrial Source Complex Short-Term (ISCST3)[2] model for all its point source calculations. The model is incapable of running non-point source (area, volume, etc.) calculations at this time and this will be address in Appendix K as a limitation of the model. The RAIMI modeling performs as a screening tool for multiple air pollution sources.

2.0 Preparation Meteorological Input Data

Five years of meteorological data was required for input into the RAIMI program. In conjunction with the RAIMI program, a software program called AMP-GIS (Air

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[1] ESRI®ArcMap 9.3

[2] http://www.epa.gov/scram001/dispersionindex.htm

Modeling Pre-processor-geographic information system) was used to pre-process the data for the air dispersion model run.

As described in the users manual, the AMP-GIS performs three key functions for air modeling within the RAIMI environment: (1) Implements site parameter quantification (surface roughness, urban/rural land use) for each emission source in accordance with RAIMI methods; (2) Prepares source-specific meteorological files using U.S. EPA Meteorological Processor for Regulatory Models (MPRM); (3) Auto-generates air model input files for multiple sources for all four potential contaminant phases to include source-centered universal grid node array with extracted terrain elevations.

The AMP-GIS software incorporates the location of each source with surrounding terrain data from U.S. Geological Survey's digital elevation model (DEM) files to build a universal grid aligned with the longitude/latitude locations specific for DEM files. These files are needed to create the required Industrial Source Complex Short Term (ISCST3) air model input files for volatile and particle species in air modeling. The output grid forms the basis of the 3 km by 3 km grid used to predict ambient impacts at locations with the Study area. The five year meteorological data set used was the upper and lower air data obtained from the Buffalo airport for the years 1986 to 1990.

As part of the Tonawanda Community Air Quality Study, one new meteorological station was deployed and a second station was already in operation at the Tonawanda sewage treatment plant on Two Mile Creek Road. The stations collected one year worth of hourly wind speed data, wind direction data, temperature and dew point data to calculate relative humidity. Data collected by NYSDEC does not meet the quality control specifications established for airport meteorological data but is collected to aid in detecting localized (near source) ambient air pollution impacts. The two meteorological stations were established to determine directionality of monitored air toxic data and results will presented in latter sections. The data was also used to create one-year surface and plot files for use with the Human Exposure Model (HEM3)[3]. HEM3 is an air dispersion model incorporating dispersion modeling with census tract data allowing the user to quantify the number of individuals exposed to a predicted modeled air concentration. HEM3 was used as a second model to be a comparison to the predicted data generated from the RAIMI software program.

3.0 Preparation of Point and Area Input Data for Modeling

Each subsection explains the methods used to identify sources, assign stack parameters, other modeling considerations, and source specific emissions.

DAR staff obtained facility wide information from Title V air permits and Registration certificates for each facility identified in Tonawanda Community Air Quality Study. Title V permits are organized in the following top down order: Facility → Emission Unit → Emission Source → Process. For example, a coal fired power plant (facility) can be divided into multiple emission units, in this example, coal handling system (Emission

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[3] http://www.epa.gov/ttn/fera/.html

Unit) and the coal crusher (Emission Source) grinds coal (Process). Emission Points (stacks) are assigned at the emission unit level. In the example, the stack exiting the coal crusher would be the emission point. Stack identification and stack parameters were extracted from the New York State's Air Facility System (AFS) to obtain the necessary stack information such as stack height, exit velocity, temperature and building dimensions. When a facility had numerous emission points, the decision was made to identify one representative emission point to be used for all air contaminant emissions from an individual emission unit. If stack data was unavailable for any facilities, and for the facilities issued a Registration Certificate under 6 NYCRR Part 201, the stack parameters were based upon EPA default assumptions. The emissions used in the modeling were taken from DAR's mandated annual emission inventory statements for the years 2002, 2005 and 2006. The highest of either of three reporting periods was used in the RAIMI software air dispersion model.

To accurately predict ambient air concentrations using air dispersion models for an emission source, it is necessary to correctly locate the emission points at the facility. To facilitate this process, NYSDEC developed a GIS tool called FLIT (Facility Locational Improvement Tool) to expedited this task. With use of FLIT and through the use of orthoimagery and facility plot plans, all emission points (stacks) were properly located at the facilities to be used in the RAIMI software.

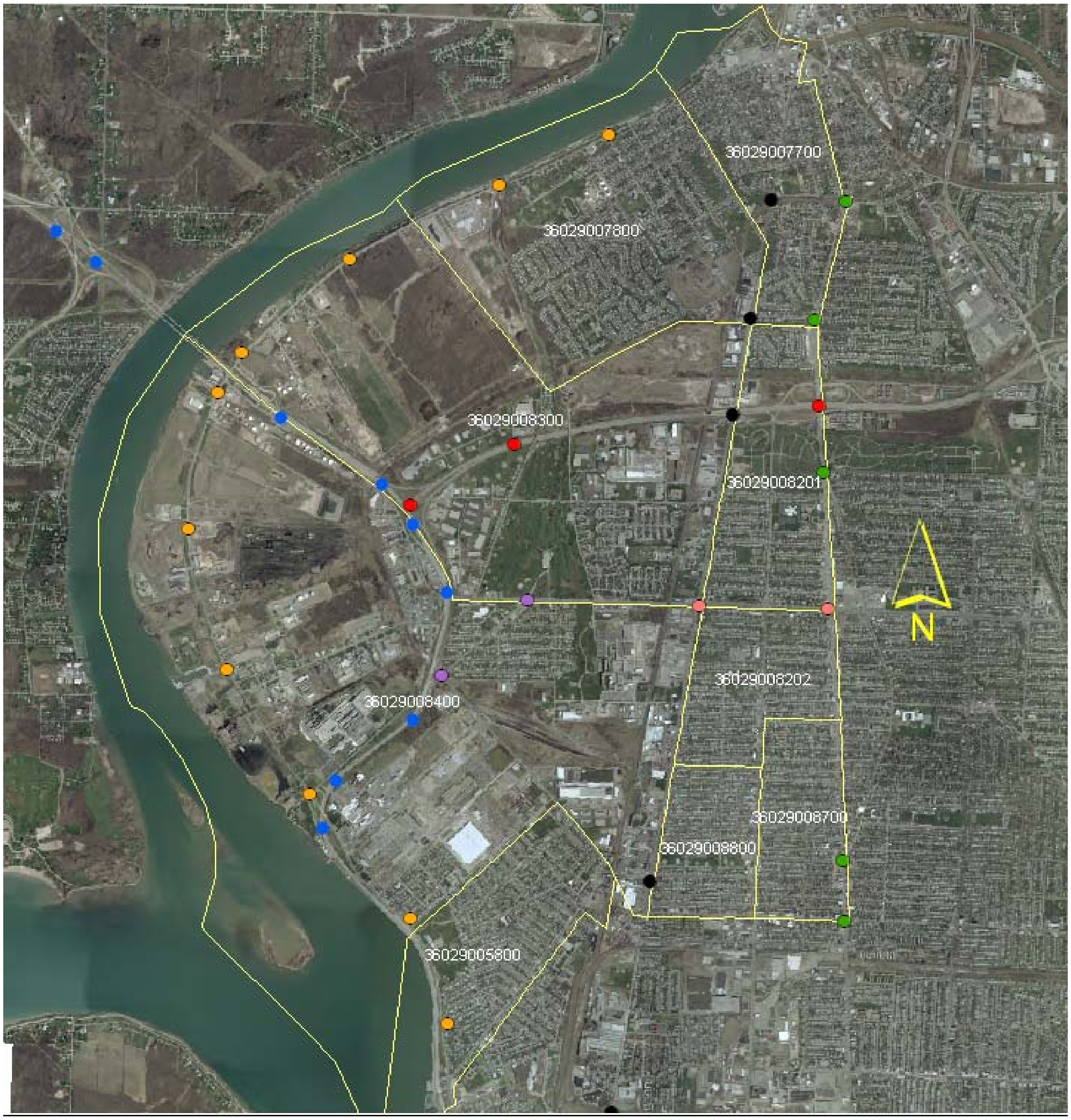
4.0 Preparation of Mobile Source Input Data for Modeling

The RAIMI model, as currently designed, is limited to predicting ambient air concentrations for point source data only. HEM3 was chosen to predict ambient air impacts from on-road sources. Non-road sources were not modeled due to the lack of a sufficient local inventory.

The emissions attributed to mobile sources were assigned to the four road classifications, as described in Appendix F, Section 3.0. The individual road classifications were further divided into segments along the road to accommodate for road angle and length. Each segment within a roadway classification was modeled as an area source. Each area source was depicted as a rectangle and based upon the road classification; roadway width was determined by the number of traffic lanes. For an illustration, see Figure I-1 below for the roadway segments.

Ambient concentrations were predicted for six hazardous air pollutants at the four monitoring stations as well as the census tract centroid for each of the nine census tracts in the study area.

Figure I-1 Individual segments within the four major roadway classifications used for modeling on-road mobile emissions with the Human Exposure Model (HEM3)



Appendix J - Evaluation of the Regional Air Impact Modeling Initiative (RAIMI) Modeling Tool

The RAIMI software program was found to be an effective tool to model multiple sources simultaneously. Acting as a screen model it allows the user the ability to input emissions data from multiple facilities with multiple emission points. Its software interface allows the user to review and modify the predicted ambient concentrations without having to re-run the mathematical air dispersion model. The RAIMI program utilizes existing USEPA approved air dispersion models and adds the capability to display the output on satellite imagery. This capability makes the RAIMI program an effective tool to generate output data for presentations allowing the user to effectively convey ideas.

1.0 Evaluate the effectiveness and usefulness of the RAIMI software

Within the Advanced Analyses section of the Air Toxics Data Analysis Workbook[1], USEPA describes approved methodology to evaluate modeled to monitored air toxics data. Even though, the Tonawanda Air Quality Study data was limited to four monitoring sites, all compounds meeting our Category C criteria were evaluated with the approved methodology to determine whether the modeled concentrations were within an acceptable range. The range established by USEPA was a model to monitor ratio that is within a factor of two. As suggested in the workbook, the median and average ratios for the ten compounds meeting our Category C requirements are described and presented in Appendix L.

The RAIMI software can be an effective tool for analyzing many sources with multiple contaminants. As with using any new software, a learning curve was encountered that delayed our initial use. Presently, the latest version of the RAIMI program is version 3.0 which required the later version of GIS software ArcMap, version 9.3. The software requires interaction between Microsoft Access and Excel and these subsequent files need to be accessed by the RAIMI software. All these steps require individuals with background in data management, air dispersion modeling and GIS training. The usefulness of the RAIMI software program for community groups and non-air pollution personnel is limited.

The limitations encountered and future improvements suggested by NYSDEC staff for running the RAIMI software were:

1.) It was difficult to add additional air contaminants and their associated health based guideline concentrations to the original set of air contaminants packaged in the RAIMI software and was not accomplished for this Study.

2.) When the RAIMI software was conceived, the air dispersion model of choice was the Industrial Source Complex (ISC) model, since then the USEPA requires

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[1] USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, June 2009

the use of AerMod to evaluate ambient air concentrations for regulatory use. The air dispersion model within the software should be updated.

3.) The RAIMI software in conjunction with its meteorological data processor (see Appendix I) requires a large amount of the data needed to run ISC such as land classifications, etc. but the current software does not utilize it. Also, the meteorological data processor associated with the RAIMI software requires that the meteorological data be processed with the EPA software, Meteorological Processor for Regulatory Models (MPRM)[2] originally written in 1986 requiring a binary formatting process. Air modeling staff within our Division have stated this process could be updated with newer meteorological processing techniques and/or that the RAIMI software accept preprocessed data.

4.) The RAIMI software is limited to point source air dispersion modeling only. Some traditional volume or area sources needed to be reconfigured to be accepted by the software's input files. A simpler process for inputting files should be investigated.

Overall, RAIMII software performed to our satisfaction but has difficulty with non-point sources such as landfills and mobile emissions. It is a strong tool when combined with GIS and we believe that EPA needs to enhance the model with more capabilities and upgrade the dispersion model to AerMod.

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[2] USEPA, TTN, Support Center for Regulatory Air Models
http://www.epa.gov/scram001/metobsdata_procaccprogs.htm

Appendix K - Residual Risk Assessment (§112(f)) performed for the Coke Oven National Emission Standards for Hazardous Air Pollutant (NESHAP)

Evaluation of the Residual Risk Assessment (§112(f)) performed for the National Emission Standards for Coke Oven Batteries (USEPA 2005b)

1.0 Introduction

The 1990 CAA requires the USEPA to conduct a residual risk review of every technology based NESHAP standard developed under section 112(d) of the Act. Section 112(f) Standard to Protect Public Health and the Environment, requires the USEPA to promulgate additional standards for a specific NESHAP if such standards are required in order to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect. This process is referred to as a residual risk assessment. The residual risk assessment is conducted to determine if the cancer and non-cancer risk to the neighboring communities are within "acceptable" limits after a NESHAP standard is implemented. The target non-cancer risk level is the determination of a Hazard Index less the 1.0. The target cancer risk level is to reduce the lifetime excess cancer risk, to the individual most exposed to emissions of pollutants classified as known, probable or possible carcinogens, to less than one-in-one-million. These desired risk levels have not been achieved in all post-NESHAP residual risk evaluations.

In April of 2005, the USEPA promulgated the National Emission Standards for Coke Oven Batteries final rule[1] and determined that the risks from the Tonawanda Coke Corporation coke oven batteries were acceptable when the additional lowest achievable emission rate (LAER) controls are implemented as required in the final rule. However, the determination did not include any monitoring data in the vicinity of Tonawanda Coke or the three other coke ovens included in the residual risk assessment.

As part of the Study grant, the results from the monitored data collected in the vicinity of Tonawanda Coke will be used to evaluate if the modeled results reported by the USEPA in their March 2005 Risk Assessment Document for Coke Oven MACT Residual Risk was reasonably correct. USEPA's 2005 Residual Risk Assessment determination is based on an evaluation of inhalation cancer risk posed by emissions from the Tonawanda coke oven battery operation. There was a determination that the risk from the coke oven batteries was acceptable. The hazard index was less than one and a maximum individual cancer risk of 50 in one million was determined using air dispersion modeling. However, the USEPA also conducted a facility wide risk assessment of emissions from all operations at the Tonawanda Coke facility and determined a maximum individual cancer risk of 100 in-one-million. The USEPA identified a limitation - the lack of monitoring data in the vicinity of the coke oven facilities - that could be used to evaluate the modeled ambient concentrations. The USEPA noted that monitoring data may be useful

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[1] USEPA, NESHAP for Coke Oven Batteries, FR Vol. 70, Number 72 page 1992

for evaluating the modeling approaches used in the residual risk assessment if the monitoring network had the following characteristics:

(1) the monitor was designed to measure at least one of the HAPs known to be emitted from the facility;
(2) the monitoring method should be sensitive enough to measure the anticipated ambient concentration of HAP from the facility;
(3) the monitoring area should be encompassed by the modeling study area (usually within 50 kilometers);
(4) the monitoring data should, ideally, be contemporaneous or as close as possible with the emission estimates which drive the modeling. For short-term emission events, site specific meteorological data are needed to interpret the monitoring results;
(5) The monitored data should be identified or linked to the facility modeled. This may be accomplished by knowing that the monitor was intentionally placed to capture specific facility emissions, or that the HAP being monitored is unique to the facility that was modeled. This determination should also consider the degree to which the other HAP sources in the vicinity might contribute to background levels of the HAP. Ideally, for the most utility in evaluating the modeling approach, the monitoring data should be dominated by contributions from the source or facility being assessed.

Characteristics of the Tonawanda Community Study ("Study") monitoring network in response to the items above:

(1) The monitoring network was capable of measuring HAPs known to be emitted from the Tonawanda Coke facility (1,3-butadiene, benzene, carbon disulfide, toluene, and all isomers of xylene);
(2) The monitoring methods were sensitive enough to measure ambient concentrations of these HAPs. All of the above compounds were either classified as Category B or Category C pollutants (see Section 7.0 of the Study report);
(3) All four monitors were located within the residual risk study area and capable of capturing the modeled receptors at the distance predicted for maximum impact from all coke oven processes
(4) The emissions data from the facility is contemporaneous with the network, but the emission rates from the facility were adjusted in some cases as described in this Appendix. A meteorological station was established in the study area to collect local meteorological data;
(5) The monitoring network was developed to measure the dispersion of HAPs from the Tonawanda Coke facility and other industrial sources, as well as, motor vehicle emissions within the study area. One monitor at the Grand Island Boulevard Industrial (GIBI) site was located in the predominant wind direction near the property line of Tonawanda Coke. The study also accounted for other sources of these HAPs within the study area.

The cancer risk calculation performed by NYSDEC used a greater emission rate for these two compounds than found in the Residual Risk document. The benzene emission rates modeled by NYSDEC which are different than those modeled for the Residual Risk assessment are due to the following changes. First, the battery emissions represent data submitted to the Department in July of 2003. Second, the increase in emissions from the by-products operation is based upon sampling conducted at the ammonia still in the Fall of 2008 and lastly, the equipment leaks represent the combined emissions of leaks, loading and wastewater reported in the Residual Risk assessment to consolidate the modeling runs.

USEPA and NYSDEC modeled benzene emissions from the Tonawanda Coke facility of 15.5 and 20.6 tons per year respectively and the reported emissions from Tonawanda Coke for the year of 2008 were 5.2 tons year as shown in Table K-1.

Table K-1. Emission Comparisons (emission in tons per year)

		Battery	Pushing	Quenching	Combustion	By-Products	Equipment Leaks	**Totals**
USEPA's Residual Risk	**Benzene**	0.88	0.00	0.00	9.05	2.30	3.25	**15.5**
	BSO	1.73	2.00	1.00	0.00	0.00	0.00	**4.7**
NYSDEC	**Benzene**	1.23	0.00	0.00	9.05	6.28	4.0	**20.6**
	BSO	1.73	2.00	1.23	0.00	0.00	0.00	**4.9**

2.0 Inhalation Cancer Risk Calculations - Facility Wide

USEPA's maximum annual cancer risk from the Tonawanda Coke facility is predicted to occur directly offsite from the facility, between 200 meters southwest and to 500 meters northeast from the plant in non-residential locations. These maximum impact areas are still frequented by individuals working at several near-by manufacturing facilities. The greatest annual cancer risk occurs on plant property but not always in the same location when using different models and different meteorological data sets.

The USEPA did not characterize facility-wide risk other than to indicate that the maximum risk occurs on plant property, so NYSDEC's monitor data will only be utilized to compare the maximum individual risk from the coke oven battery. NYSDEC evaluated two models in this Study, HEM3 and RAIMI (see Appendix I for more details). Using RAIMI, HEM3, an independent version of AerMod[2] and data from the USEPA modeling runs for the Coke Oven Residual Risk[3], the calculated cancer risk is presented for the facility-wide emissions of the Tonawanda Coke facility. The risk associated with the coke battery alone (MACT1) will be addressed in the next section.

In the coke manufacturing process, the cancer risk drivers are benzene and benzene soluble organics (BSO). Coke manufacturing has a unique emission profile as shown in the emissions table above. Where by the by-product processes and combustion processes

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[2] BEEST for Windows, Version 9.77a, Bee-line Software

[3] USEPA, output files for modeling run, communication with Ted Palma, OAQPS

emit the risk driver benzene, the coking process emits BSO and benzene. For a complete description of coke oven gas and its surrogate BSO, see section 7.3 of the Study report.

The first step is to determine if the modeling performed by the USEPA can be considered reasonably correct in comparison to the monitoring data. This will be accomplished by predicting ambient concentrations for benzene and BSO at the monitoring site. The USEPA does not state in the Residual Risk document the exact locations where the final population cancer risks were calculated. The cancer risks presented for the MACT1 portion of the analysis indicates an inhalation cancer risk of 44 in-one-million for emissions associated with LAER controls. To characterize a receptor location representing a population based receptor, the Brookside Terrace Residential Site (BTRS) monitor was chosen.

The BTRS represents a residential location downwind of the Tonawanda Coke Plant. Using the RAIMI model output, NYSDEC calculated a model-to-monitor ratio of 1.0 after accounting for all sources of benzene in the Study areas. Initially, the GIBI monitor, located approximately 800 meters north-northeast of the coke oven battery, was not selected for the residual risk evaluation because the HEM3 and RAIMI models calculated a model-to-monitor ratio for benzene of 0.3 and less. The annual benzene concentration measured at the GIBI site of 9.8 μg/m^{3}could not be replicated with either Tonawanda Coke's emission statements or the revised emission inventory as shown in the above table.

To calculate the cancer risk at the BTRS monitor, the predicted concentrations of benzene and BSO were multiplied by their respective cancer unit risk concentration. When the benzene and BSO risks are combined, the total risk is 32 in-one-million. The contribution from other suspected cancer compounds emitted from the facility such as total polycyclic organic compounds, and 1,3-butadiene were calculated to contribute an additional inhalation risk of 1.1 in-one-million excess cancer risk.

Predicted Facility-wide Risk at the BTRS Monitor Location

RAIMI - ISCST3	Break down of risk, BSO 3.1E-5 (concentration - 0.05 μg/m^3) Break down of risk, Benzene 7.6E-7 (concentration - 0.10 μg/m^3) **Total Risk** = 3.2E-5 or 32 in-one-million excess cancer risk
HEM3 - AerMod	Break down of risk, BSO 9.8E-5 (concentration - 0.157 μg/m^3) Break down of risk, Benzene 4.4E-6 (concentration - 0.57 μg/m^3) **Total Risk** = 1.02E-4 or 102 in-one-million excess cancer risk
BEEST - AerMod	Break down of risk, BSO 9.8E-5 (concentration - 0.157 μg/m^3) Break down of risk, Benzene 3.5E-6 (concentration - 0.45 μg/m^3) **Total Risk** = 1.01 E-4 or 101 in-one-million excess cancer risk

USEPA - ISC/BLP Break down of risk, BSO 1.7E-5 (concentration - 0.027 μg/m^3)
Break down of risk, Benzene 1.2E-6 (concentration - 0.15 μg/m^3)
Total Risk = 1.8 E-5 or 18 in-one-million excess cancer risk

As can be seen from the USEPA model, the combined risk of the two cancer risk drivers are below the 44 in-one-million for emissions associated with LAER controls for the battery alone. The USEPA must have identified a receptor location closer to the Coke Oven facility than the Brookside Terrace monitor. Nonetheless, USEPA's predicted concentration for benzene at this location is 0.15 μg/m^3. The AerMod runs predicted higher concentrations in the range of 0.45 to 0.57 μg/m^3.

The predicted concentration impact from the coke ovens is dependent on how the model input described the emission source, within the model. The RAIMI software could only accept the coke oven battery emission input as separate virtual stacks and the other two models were treated two ways, the coke oven as an area source and as virtual stacks. When treating the coke oven as virtual stacks, the outcome from the HEM3 model was to decrease the overall concentration predicted at the Brookside Terrace monitor. The difference in benzene was 0.52 μg/m^3 compared to the 0.57 μg/m^3 shown above. The difference in BSO was 0.085 μg/m^3 compared to the 0.157 μg/m^3 shown above. This difference accounted for a reduction of overall inhalation cancer risk of 57 in-one-million versus the 102 shown above. Treating the emissions from the coke oven as virtual stacks has the effect of lowering the overall concentration. Overall, the RAIMI software model when compared to the HEM3 model for the Tonawanda Coke facility, predicted ambient concentrations three times less for the main risk driver BSO. Some of this calculated difference in concentration is the two models use different meteorological data sets but in total the RAIMI software is less conservative. Also, USEPA also used virtual stacks with an enhanced buoyancy calculation which be discussed in a section below.

In the Table D-2 , Appendix D of USEPA's Residual Risk document, the location of the maximum concentration for the coke oven, by-product plant, combustion stack and quench tower were presented based upon a unitized gram per second concentration. Multiplying the gram per second emission rate by the unitized value calculates a concentration for any emission rate input. Using the formula in the Residual Risk document, the maximum benzene concentration for the coke oven battery is 0.043 μg/m^3 at 500 meters. The other models show maximum benzene concentration much higher at 100 to 500 meters from the plant, 1.5 and 2.5 μg/m^3, RAIMI and HEM3 respectively. This difference could potentially be explained by USEPA's use of the enhanced buoyancy calculation.

The unitized concentration listed in the Residual Risk document for the by-product plant states a maximum predicted benzene concentration of 6.3 μg/m^3 at 300 meters from the plant. The GIBI monitored data, representing all source sectors, shows an annual impact of 9.8 μg/m^3 for benzene at approximately 800 and 900 meters from the coke oven and by-product plant, respectively. It is possible that the high readings for benzene can be attributed to the by-product plant even though it would be expected that the maximum concentration calculated by USEPA of 6.3 µg/m^3 at 300 meters would be considerably lower at the GIBI monitor at 900 meters away.

3.0 Predicted MACT 1 Risk at Brookside Terrace Monitor Location

MACT 1 refers to the emissions from the coking process at the coke oven battery and not the emissions associated with the pushing or quenching process. The coking process emits benzene and BSO. The pushing and quenching process accounts for almost half of the BSO emissions assigned to the facility and no appreciable benzene emissions. The maximum risk reported in the Residual Risk document based upon actual emissions from the coke oven for populated receptors is 33 in-one-million excess inhalation cancer risk. The excess cancer risk increases to 50 in-one-million based upon MACT allowable emissions and 44 in-one-million for LAER allowable. The risk reported in the Residual Risk document does not state which populated receptor location or locations were chosen. Also, it is not stated if the populated receptor was chosen to be a census tract centroid similar to NATA, or if the populated receptor is a census block centroid. The nearest census block centroid is located directly across from the coke battery and is on top of the Huntley landfill. Obviously this is not an appropriate location to make population based risk decisions, so NYSDEC choose the BTRS monitor to make risk based comparisons betweens models and monitored data. If a census tract centroid was chosen, the census tract centroid with the greatest predicted concentration is 36029-007800 located 800 meters northeast from the BTRS monitor.

The emissions from the coke oven battery are benzene soluble organic (BSO) emissions and other volatile compounds which are predominantly benzene. The contribution from other suspected cancer compounds emitted from the facility such as total polycyclic organic compounds, and 1,3-butadiene were calculated to contribute an additional inhalation risk of 1.1 in-one-million excess cancer risk. The risk from the coke oven battery for the cancer risk drivers, benzene and BSO, are presented below:

RAIMI - ISCST3	Break down of risk, BSO 1.1E-5 (concentration - 0.018 µg/m^3) Break down of risk, Benzene 6.9E-8 (concentration - 0.009 µg/m^3) **Total Risk** = 1.1 E-5 or 11 in-one-million excess cancer risk
HEM3 - AerMod (As Area Source)	Break down of risk, BSO 9.8E-5 (concentration - 0.157 µg/m^3 Break down of risk, Benzene 0.8E-6 (concentration 0.11 µg/m^3) **Total Risk** = 9.9 E-5 or 99 in–one-million excess cancer risk
HEM3 - AerMod (As Point Source)	Break down of risk, for BSO is 7.3E-5 in a million (0.116 µg/m^3) Break down of risk, for Benzene 0.4E-6 in a million (0.058 µg/m^3) **Total Risk** = 7.3E-5 or 73 inone-million excess cancer risk

USEPA - ISC/BLP* Break down of risk, BSO 8.1E-6 (concentration - 0.013 μg/m^3)
Break down of risk, Benzene 5.3E-8 (concentration - 0.007 μg/m^3)
Total Risk = 8.1 E-6 or 8 in-one-million excess cancer risk

* Emissions modeled from the USEPA are lower than NYSDEC model, see table above.

Discussion of Modeling Parameters Assumptions

The USEPA used the Buoyant Line Plume model and ISCST3 model to calculate ambient concentrations resulting from the dispersion of contaminants from the Tonawanda Coke facility. Unique to the coking process is the high temperatures attained in the coke oven battery. These high temperatures add to the dispersion of emissions from the coking process and subsequently the pushing process. Appendix E of the Residual Risk document details the enhanced plume calculation completed by USEPA.

As stated in Appendix E of the Residual Risk document, "coke ovens facilities produce significant heat from large, parallel oven batteries, which behave as low-level buoyant line sources. Because of the parallel-line source configuration, plume rise is enhanced as ambient air is not fully entrained into the plume." The buoyant line plume model (BLP), which was used in the Residual Risk Assessment, was specifically developed to stimulate the plume rise from multiple line sources subject to downwash.

According to Appendix D of the Residual Risk document, the location of the maximum concentration predicted by the BLP model from the coke oven was 500 meters northeast from the facility. The HEM3 model and an independent AerMod model predicted the maximum impact for a vapor or particle to be 85 and 130 meters respectively. In either case, BLP or AerMod the maximum impact is occurring on plant property or within the Huntley Landfill boundary.

The models used by NYSDEC did not employ enhanced buoyancy calculations since this Study was not intended to make multiple model-to-model comparisons. One objective of the Tonawanda Community Air Quality Study grant was to compare the residual risk modeling results completed by the USEPA to monitored concentrations conducted by NYSDEC and to note the limitations of our approach.

4.0 MACT 1 Predicted Risk vs. the Monitored Data at Brookside Terrace Monitor

The predicted concentrations for benzene from the facility-wide emissions and the coke oven battery have been estimated using various models and modeling approaches as seen above. This is needed to give the reader an understanding of the various predictions that can be calculated using different modeling assumptions and meteorological data.

As stated in the initial objectives in Section 1.0, "the degree to which the other HAP sources in the vicinity might contribute to background levels of the HAP" need to be included when comparing model to monitor data so the other sources contributing to the total benzene concentration were identified. The use of ambient concentration predictions from NATA were used to assess the contributions from non-road and background sources. The on-road and area source data as described in the inventory chapter (section 6.0) of the Study document were modeled. Tonawanda Coke is the only source of BSO and the largest source of benzene in the area, as identified from the inventory. Combing the predicted benzene concentrations from the other source categories with the predicted benzene concentration contribution from the MACT 1 source will provide a complete model prediction at the location of the BTRS monitor for the MACT 1 contribution, see Table K-2. This same procedure is presented for the GIBI monitor as seen in Table K-3. even though the initial RAIMI model to monitor results showed significant underestimation at that monitoring location.

Table K-2 Model-to-Monitor Concentrations of Benzene in μg/m^3 at the BTRS Monitor

Model	**Location**	**Major**	**Area**	**On-road**	**Non-road**	**Background**	**Total**
RAIMI All sources	Monitor Location	0.17	0.27	0.508	0.083	0.703	1.73
RAIMI Tonawanda Coke	Monitor Location	0.10	0.27	0.508	0.083	0.703	1.66
RAIMI Coke oven battery	Monitor Location	**0.009**	0.27	0.508	0.083	0.703	1.57
HEM3 Coke oven battery	Monitor Location	**0.058**	0.27	0.508	0.083	0.703	1.62
USEPA Coke oven battery	Nearest Receptor to Monitor	**0.007**	0.27	0.508	0.083	0.703	1.57
Monitor	**Concentration**						1.95

As seen in Table K-2, the MACT 1 point source (coke oven battery) contributes a small amount to the overall predicted benzene concentration at the BTRS monitor.
The USEPA's predicted concentration at the BTRS monitor is 0.007 μg/m^3. This represents less than 0.5 % of the total concentration measured at the monitor. The HEM3 prediction is 3.5% of the total concentration measured at the monitor. The RAIMI software predicts the benzene concentration from the Tonawanda Coke facility to be 0.10 μg/m^3 or 6% of total.

With or without the point source contribution, the predicted modeled concentration would be within the target range of 0.5 to 2 model-to-monitor ratio. Because the emissions from other source categories dominant the monitor's measured results, it is not possible to definitively state that the risks projected in Table 3-15 of the Residual Risk assessment are in agreement with the monitored data found in the year long monitoring study.

4.1 MACT 1 and Facility-wide Predicted Risk vs. the Monitored Data at the GIBI Site

A second approach is to use the GIBI site to make a comparison between monitored emissions and predicted model emissions, see Table K-3. At this monitoring site, the contributing factors are less of an influence. It is important to note that the modeled emission input for benzene is four times higher than what is reported to NYSDEC's emission inventory and the USEPA's National Emissions Inventory and Toxics Release Inventory. In the USEPA's Residual Risk document, the USEPA used NESHAP allowable emissions to estimate Tonawanda Coke's benzene emissions impact. This emission rate is three times higher than the actual benzene emissions reported to NYSDEC's emission inventory.

Table K-3 Model to Monitor Concentrations of Benzene in μg/m^3 at GIBI Monitor.

Model	**Location**	**Major**	**Area**	**On-road**	**Non-road**	**Background**	**Total**
RAIMI	Monitor Location	1.35	0.089	0.716	0.131	0.703	2.99
HEM3	Monitor Location	3.75	0.089	0.716	0.131	0.703	5.39
HEM3 Coke oven facility	Monitor Location	3.42	0.089	0.716	0.131	0.703	5.06
HEM3 battery	Monitor Location	0.496	0.089	0.716	0.131	0.703	2.14
USEPA Coke oven facility	Monitor Location	1.18	0.089	0.716	0.131	0.703	2.82
USEPA battery	Monitor Location	0.02	0.089	0.716	0.131	0.703	1.66
USEPA Coke oven facility	Monitor Location Adjusted emissions*	3.21	0.089	0.716	0.131	0.703	4.83
USEPA Coke oven battery	Monitor Location Adjusted emissions*	0.028	0.089	0.716	0.131	0.703	1.67
USEPA Coke oven facility	Maximum Impact (300 meters)	**6.3**	0.089	0.716	0.131	0.703	7.93
Monitor	**Concentration**						9.8

- Adjusted emissions to replicate the emissions used by NYSDEC
- HEM3 represents all benzene major benzene sources in the inventory

A benzene concentration of 2.82 μg/m^3 is predicted for the GIBI monitoring site when the USEPA facility wide prediction of 1.18 μg/m^3 is combined with the benzene contributions from other source sectors. The model-to-monitor ratio is less 0.5 and not in the target range of 0.5 to 2.0. The predicted concentration is dominated by the emissions from the by-product plant and not the coke oven battery. If the emissions are increased to represent the adjusted NYSDEC emission inventory, the facility-wide concentration is 4.83 μg/m^3 which just meets the 0.5 of the target range of 0.5 to 2.0 for modeling to monitor. Adding the predicted concentrations of the other major sources in the area would increase the adjusted USEPA concentration to 5.16 μg/m^3, This calculation is not shown above but is based upon the difference between HEM3 and HEM3-coke oven facility.

Using the data presented in Table K-3, it is evident that the USEPA modeled concentrations for the Tonawanda Coke Corporation could not be replicated without adjusting the emissions upward an additional 25%. Even with this increase, the model was on the lower range of acceptability with the model to monitor ratio goal of 0.5 to 2.0. The benzene emissions and predicted ambient impacts appear to be dominated by emissions from the by-products plant and this source appears to be where benzene reduction efforts should be focused.

5.0 Residual Risk Assessment for Coke Ovens: Comparing the Residual Risk Report Cancer Risk isopleths with Benzene and Benzene Soluble Organic (BSO) Modeled Data.

The Residual Risk document contains isopleths maps of potential excess cancer risk around the Tonawanda Coke facility modeled out to a distance of fifty kilometers. The isopleth map shows that within ten kilometers of the facility, the risks range from 1 in-one-million excess cancer risk to greater than 100 in-one-million excess cancer risk near the Tonawanda Coke facility. The study area of nine census tracts encompasses a radius of three kilometers around Tonawanda Coke and Figure 3.3 indicates risks between 10 in-one-million and in excess of 100 in-one-million.

Air dispersion modeling completed using the RAIMI software shows excess cancer risk in the nine census tract area also ranging between 10 in-one-million and in excess of 100 in-one-million. The USEPA's isopleth map in the residual risk assessment is not an effective tool for the public or State air pollution personnel to interpret and it should have been presented with a maximum distance of ten kilometers with major roadways included.

Figure K-1 presents the potential inhalation cancer risk with the use of GIS for the modeled benzene emissions from the Tonawanda Coke facility. Figure K-2 shows the potential inhalation cancer risk using the emissions reported to NYSDEC from the Tonawanda Coke Corporation. The reported emissions data are considerably lower than the modeled benzene emission. Figure K-3 shows the potential inhalation cancer risk for all carcinogens monitored and estimated from the Tonawanda Coke Corporation. The cancer risk estimates are based upon the upper-bound excess lifetime cancer risk resulting from continuous exposure to an air contaminant. The USEPA defines the upper bound as "a plausible upper limit to the true value of a quantity. This is usually not a true statistical confidence limit." The use of an "upper limit" means that the true risk of developing cancer from exposure is not likely to be higher and may be lower than the estimates provided in this study. The risk drivers from the Tonawanda Coke Corporation were established to be benzene and benzene soluble organics. The benzene is a measured concentration while the benzene soluble organics represents a modeled estimate based upon specific modeling assumptions. As discussed above, the modeled cancer risk for these two HAPs range from 18 to 102 in-one-million excess cancer risk at BTRS.

6.0 Cancer Incidence

This discussion was included because the Residual Risk document presented population facility wide risk as a cancer incidence value. Residual risk assessments have presented increased cancer risk incidence values for the entire receptor population within the area of analysis or entire modeling domain. NYSDEC does not believe cancer incidence is a good metric to present cancer risk information to the public, elected officials or non-technical risk managers. Nonetheless, in order to analyze the results of the USEPA residual risk report, NYSDEC performed air dispersion modeling with the Human Exposure Model (HEM3) to calculate a cancer incidence for the surrounding nine census tracts in the Study area. The cancer risk drivers (benzene and BSO) for the Tonawanda Coke facility as identified in the residual risk assessment were modeled.

Using the HEM3 model, the facility wide cancer incidence, based upon the emissions modeled above, is 0.044 new cancer annual cases versus 0.023 found in the Residual Risk Report. Adjusting for the increased in emissions used in the HEM3 model would only account for an increase of 1.32 (20.6/15.5, using benzene as an example) and not the factor of 1.9 calculated by the HEM3 model. Also, the 0.044 calculated cancer incidence represents the nine census tract Study area, approximately a six kilometer radius. This radius is significantly smaller than the radius used by USEPA of 50 km. HEM3 would calculate a cancer incidence of 0.13 for this larger area because of the greater population exposed. A 6 km ring represents about 85,000 people and a 50 km ring represents over one million people. Using HEM3 to measure cancer incidence resulted in a more conservative outcome at the 50 km radius. This difference could not be explained by substituting a different meteorological dataset alone. The HEM3 air dispersion modeling was conducted with the 5 year meteorological dataset and the one year local meteorological dataset assembled by NYSDEC.

The USEPA reports the lifetime cancer cases associated with residents living in the exposure area for 70 years to be 1.6 cases (0.023 * 70). The HEM3 model for the nine census tract Study area resulted in 3 lifetime cancer cases associated with residents living in the exposure area for 70 years.

NYSDEC believes the use of 50 km to portray risk from a single facility emitting hazardous air pollutants is not appropriate and the use of cancer incidence values is not the best approach to portray risk to the general public because the risk calculation will change when describing a larger population size. The overall cancer incidence which is influenced by the population size and geographical locations affects the final calculation does not offer the transparency needed for effective risk communication. The 1990 CAA requires the presentation of maximum individual risk. The presentation of maximum individual risk provides the public and risk managers with an understandable and transparent metric to make risk management decisions.

7.0 Comparison of Benzene Ambient Air Measurements Near Coke Plants

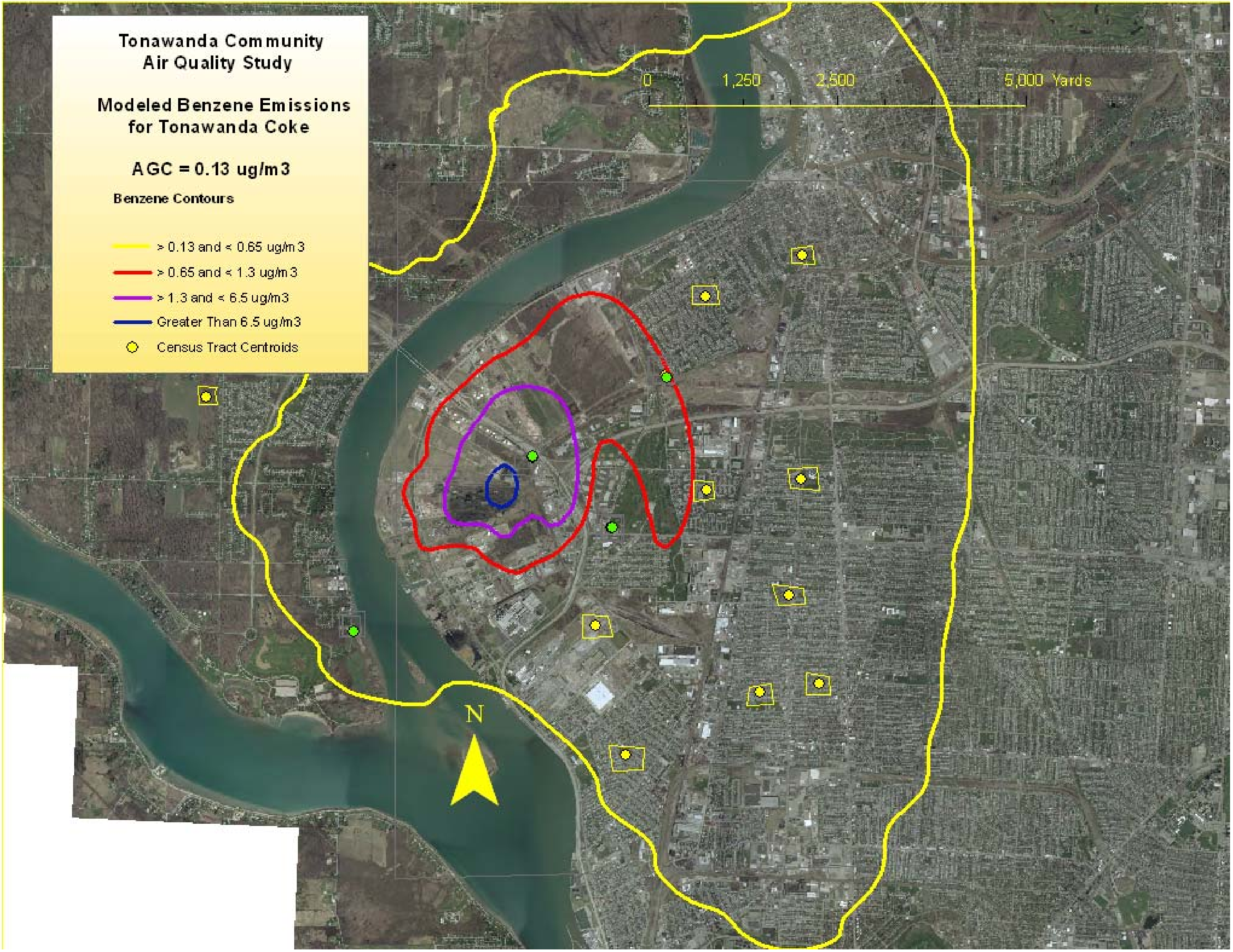
There are other studies that have measured ambient levels of benzene near Coke Plants. The Indiana Department of Environmental Management (IDEM) sited a monitoring station near the property line of the Citizens Gas and Coke Utility in Indianapolis. The monitor was located at Indianapolis Public School #21 (IPS21) and measured benzene and other air pollutants (IDEM, 2006). Four years of data was collected and the average benzene concentration over the four year period was 5.7$\mu g/m^3$. During the course of the study the average annual benzene concentrations at IPS21 decreased from 8.7 $\mu g/m^3$ to 2.3 $\mu g/m^3$. Much of this decline was attributed to emission reduction activities that occurred at the Citizens Gas and Coke Utility during this time period.

Similar to the NYSDEC study, the IDEM study conducted modeling to monitor analysis to evaluate how well the model predicted the measured concentrations of benzene at IPS21. When all sources of benzene in the study area including background concentrations were accounted for the modeling results accounted for 45.4% of the monitored value (2.54 versus 5.59 $\mu g/m^3$). IDEM noted many difficulties in modeling the benzene releases which may have lead to the discrepancy between the modeling and monitor comparison. Some of the reasons stated were selection of general modeling assumptions, receptor location variability in benzene modeled concentrations, uncertainty in the location of the leaking benzene sources, and default modeling assumptions used in place of actual emission point information.

The modeling to monitor analysis conducted in the Tonawanda Community Air Quality Study as described in Appendix K also accounted for all known sources and background concentrations of benzene. Our modeling results only accounted for 28% of the benzene monitored value at the GIBI site. A number of the same factors cited by the IDEM are possible reasons for the disagreement, but there also may be an issue with the emission factors currently used to estimate benzene emissions from coke operations. The modeling conducted by IDEM and NYSDEC used the NESHAP allowable emission rates that are dependent on benzene emissions factors developed for the various processes at a Coke facility (USEPA, 2008). The confidence ranking in these benzene emission factors ranges from A (high reliability in the estimate) to E (low reliability in the estimate) (USEPA, 1997).

A recent study conducted by Carnegie Mellon University in Allegheny County, Pennsylvania also measured elevated concentrations of benzene that were attributed to Coke plants (Carnegie Mellon University, 2009). The report concludes that new programs are needed to control the benzene emissions from the local major sources.

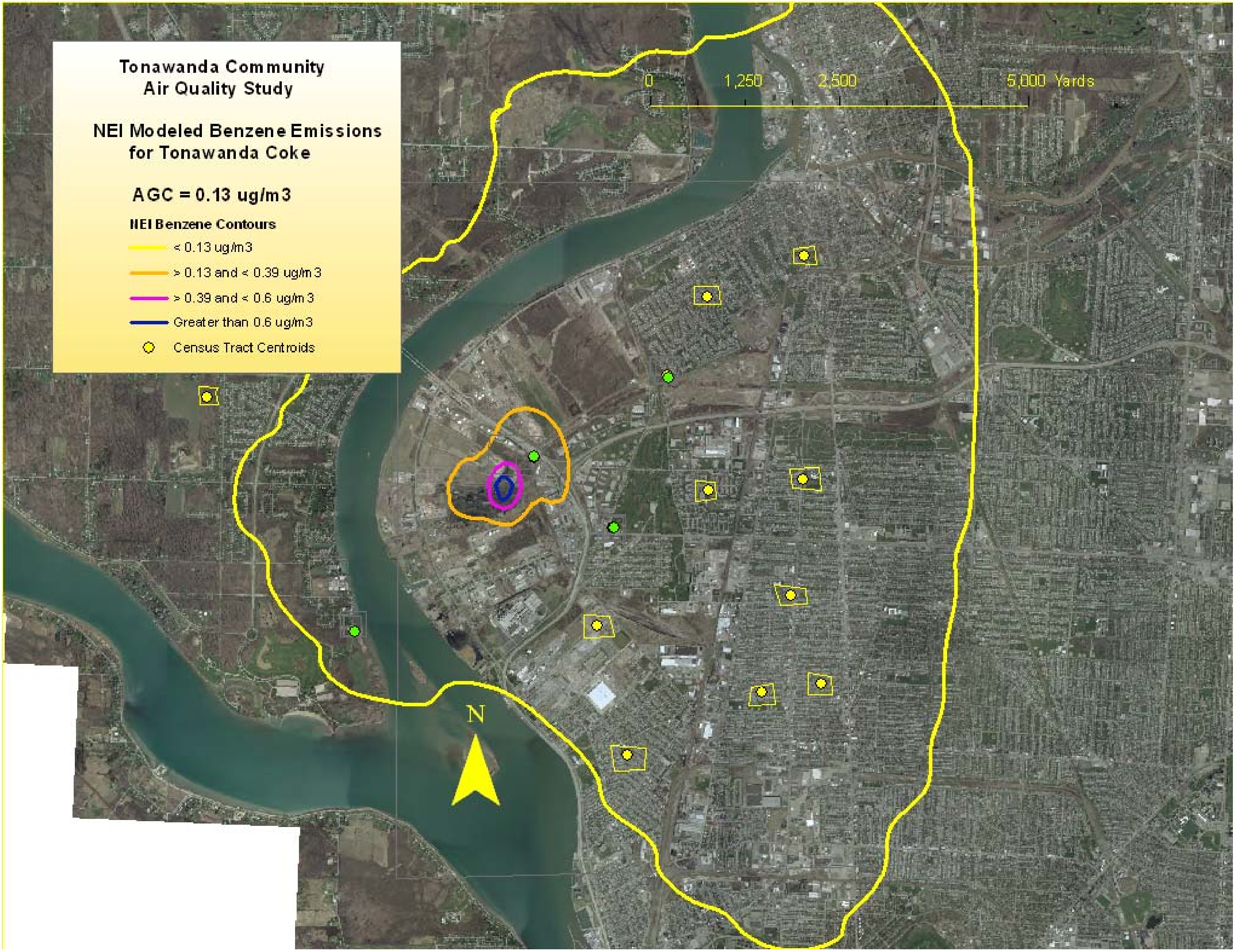
Figures K-1 through K-3 on Landscape pages

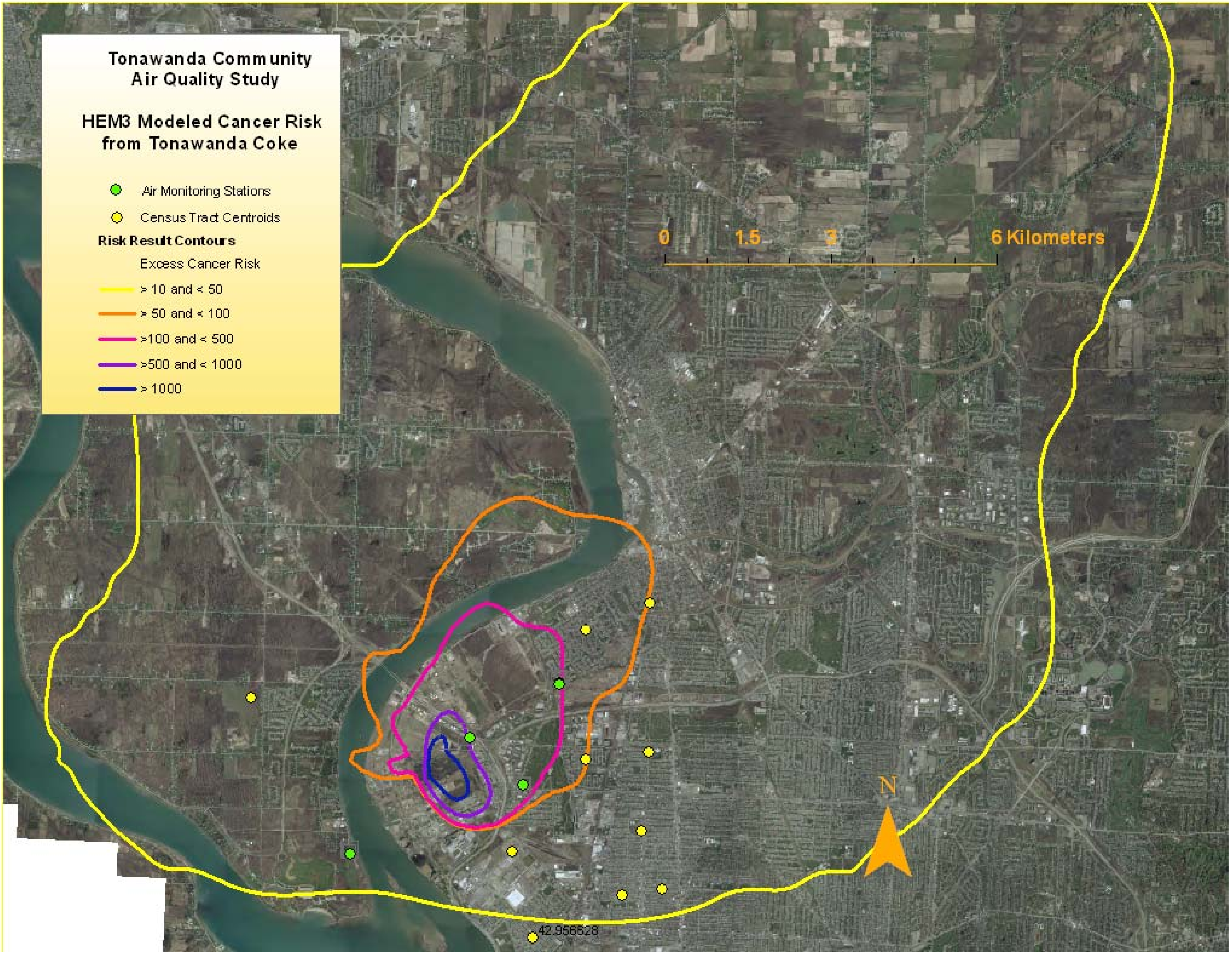


Tonawanda Community Air Quality Study

Modeled Benzene Emissions for Tonawanda Coke

AGC = 0.13 ug/m3


Tonawanda Community
Air Quality Study
NEI Modeled Benzene Emissions
for Tonawanda Coke
AGC = 0.13 ug/m3
NEI Benzene Contours
< 0.13 ug/m3
> 0.13 and < 0.39 ug/m3
> 0.39 and < 0.6 ug/m3
Greater than 0.6 ug/m3
Census Tract Centroids
0
1,250
2,500
5,000 Yards
N


Tonawanda Community
Air Quality Study
HEM3 Modeled Cancer Risk
from Tonawanda Coke
● Air Monitoring Stations
● Census Tract Centroids
Risk Result Contours
Excess Cancer Risk
> 10 and < 50
> 50 and < 100
>100 and < 500
>500 and < 1000
> 1000
0
1.5
3
6 Kilometers
N
42.956628

Appendix L – Model to Monitor Comparison

1.0 The Comparison of the Monitored Ambient Concentrations at the Four Study Sites to Modeled Predicted Concentrations.

Part of the grant for the Tonawanda Community Study was to utilize the Regional Air Impact Modeling Initiative software program or RAIMI. When conducting community studies, the use of air dispersion models to predict ambient impacts is important because the costs involved of establishing monitors and analyzing data is limited by analytical test methods and overall high costs. RAIMI is more than an air dispersion model but a software program designed to review and modify data output. The RAIMI program allows the user to input multiple sources and emission scenarios to predict ambient air concentrations at various locations in the Study area. The emission inventory complied in Appendix F was invaluable data for running the RAIMI model. For a more detailed description of the RAIMI model, see Appendix I.

In section 7.1.3, the measured ambient concentrations for the study area sites were compared and evaluated to the modeled 2002 National Air Toxics Assessment data (NATA). Monitored data for Category C compounds were compared to the modeled concentration of the census tract centroid representative of the air monitoring site. Section 7.1.3 describes the procedures that were used to make these comparisons. It was determined that no further knowledge could be gained by doing similar comparisons for the 1996 NATA and 1999 NATA because of one, the age of the emission inventories, and two, the NATA modeling procedures and tools have become more refined in later years yielding a better estimation of ambient concentrations in the 2002 NATA version.

When using the RAIMI software air dispersion model to compare the model to monitored concentration data, the monitored values classified in the Study's Category C were chosen for the comparison of predicted modeled concentrations to actual monitored concentrations. In addition, for the monitoring sites, Beaver Island State Park (BISP) and Brookside Terrace (BTRS), the Category B compound, mixed xylenes, was included in the model to monitor comparison. Mixed xylenes were chosen because it is a good indicator of gasoline emissions from mobile sources and PBS transfer and storage facilities. Also, for the monitoring sites Grand Island Blvd (GIBI) and BTRS, Category B compound, 1,3,- butadiene was included in the model to monitoring comparison because 1,3,- butadiene is a good indicator of combustion decay products from mobile and point sources. At the other two monitoring sites, 1,3,- butadiene was listed in Category A and there is less valid data for a model to monitoring comparison but the data is presented.

For the model to monitoring comparison analysis, two Category C compounds were excluded from the analysis. Carbon tetrachloride and chloromethane were not part of the model to monitored comparisons because these compounds are determined to be ubiquitous nationwide at the concentrations measured at the Study area's monitors. For these two compounds, the background concentrations are estimated to be either at or above the monitored concentration at the Study area's monitors and there are no reported localized emissions.

Also excluded from the model to monitoring analysis, were the compounds trichlorofluoromethane, trichlorotrifluoroethane and acetone. There is no data on ambient background concentrations of these compounds nor is there data of localized emissions. The emissions of acetone may be obscured because under the allowable reporting emissions procedures, acetone can be classified within the class of compounds known as total volatile organic compounds. A review of the VOC emissions from the major facilities did not uncover the use or release of acetone.

2.0 Predicted Modeled Concentrations using the RAIMI Software versus Modeled NATA 2002 Concentrations at Census Tract Centroid Level

The intention of comparing the predicted ambient concentrations from the RAIMI program with similar data from NATA 2002 is to evaluate how well the RAIMI program is performing with respect to a model that has under gone extensive peer review.

The predicted output concentrations of RAIMI at the census tract centroid were compared to the similar predictions from NATA. NATA, which uses the ASPEN model (Assessment System for Exposure Nationwide) incorporates breakdown and secondary formation of pollutants whereas the RAIMI model does not. Breakdown and secondary pollutant formation is important when modeling pollutants that are extremely reactive or modeling pollutants traveling over great distances. For our comparison between the predicted concentrations of NATA vs. RAIMI, five Category C compounds were chosen to make a model to model comparison. The goal of the model to monitor comparison is a 1:1 ratio between the two models. The compounds chosen, benzene, toluene, xylene, and acetaldehyde yielded ratios between 1:2 and 2:1. When conducting model to monitor comparisons, USEPA believes this as an acceptable outcome[1]. A scatter plot describing the relationship between the two models is presented in Table L-1.

When preparing a model to monitor or model to model comparison, the total predicted concentration can include up to five sectors, point, area, mobile including on-road and non-road and background. For the total predicted RAIMI calculated concentration, the background and non-road concentrations used in NATA were used.

For example, Table L-2 shows the predicted benzene concentrations of the two models at the nine census tract centroids. RAIMI under predicts on all occasions except for census tract 7800. This census tract centroid is located downwind of our study site; and RAIMI shows a greater point source influence.

For benzene in general, the RAIMI model under predicted for the area source sector. The contribution to the area source sector in our localized inventory did not have the number of area source categories that were modeled with NATA, source categories such as open burning, lawn mower emissions, natural emissions, etc. The complete breakdown of the

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[1] USEPA, Air Toxics Data Analysis Workbook, Section 7, Advanced Analyses, June 2009

point, area and mobile source's contribution to the total concentration at the census tract centroid can be found in Table L-3

The greatest discrepancy in the ratios is the first census tract 5800, south of the Study area nearest to the city of Buffalo, and it is believed that the influence of the Buffalo area impacts raises these concentrations for NATA. Plus, this census tract is downwind of the Tonawanda industrial area missing a significant of contribution of point source emissions.

Census tract 7302 is across the Niagara River located with our upwind monitor. This is a large census tract and largely wooded. This tract would have upwind influence not captured in our Study area.

For the remaining census tracts, the two models perform within 60 to 80 percent of each other. The RAIMI model ambient air quality predictions were similar to the NATA predictions.

3.0 Predicted Modeled Concentrations using the RAIMI software versus Monitored Concentrations

The predicted modeled concentrations were calculated using the RAIMI software air dispersion model. In total, ten compounds were chosen for a model to monitoring comparison. See Table L-4 for a complete listing of model to monitoring results.

Under the National Air Toxics Assessment (NATA), model to monitor comparisons were performed to assess the reliability of the ASPEN model. As stated above, the USEPA believes that a factor of two indicates good agreement between the predicted modeled concentration value and the actual monitored concentration. To account for a model to monitor concentration for air contaminants, especially those which have many sources of emissions, including mobile sources, it is important to have an inclusive emission inventory. In the Tonawanda Air Quality Community Study, one monitored pollutant, carbon disulfide, had one large point source of emissions and a small contribution of minor emissions from other sources, with no mobile source contribution. The model to monitor ratio for carbon disulfide was in good agreement as shown below at the nearest sites:

Monitoring Site	BISP	SPWT	GIBI	BTRS
Model to Monitor Ratio	0.47	0.99	0.82	0.39
Distance (m) of Monitor to 3M	2,200	1,200	1,400	3,000

3M Tonawanda is a major source of carbon disulfide emitting over 150 TPY. The Sheridan Park Water Tower (SPWT) monitor is within 1,200 meters of 3M Tonawanda and in the prevailing wind direction, winds from the southwest. The ratios for SPWT and GIBI are in agreement with the US EPA's target for a modeled to monitored concentration within a factor of two. The other two sites were under the one-half ratio indicating less agreement. This will be further addressed in the Bias Statistic section 4.0

When calculating the median value of the model to monitoring ratio for an air contaminant across all four monitoring sites, all sites span within a factor of two with the exception of acrolein and dichlorodifluoromethane. Acrolein, a product of combustion was most likely not properly accounted for from large combustion sources and automobiles. Dichlorodifluoromethane, with the exception of the landfills has no known reported emissions.

When comparing the range of model to monitor ratios for the individual air contaminants, the lower end of the range (under prediction) was dichlorodifluoromethane at all sites. The upper end of the range (over prediction) was mixed xylene compounds at Brookside Terrace and 1,3- butadiene at Sheridan Park Water Tower at 3.6 and 2.7, respectively.

The average ratio along with the minimum and maximum ratio is presented below for all air contaminants at each site to describe the consistency of the model at each location. The range is driven by the two compounds described below which were under predicted, acrolein and dichlorodifluoromethane.

Monitoring Site	**BISP**	**SPWT**	**GIBI**	**BTRS**
Model to Monitor Ratio Average	0.58	1.17	0.61	1.25
Minimum Ratio	0.005	0.02	0.02	0.11
Maximum Ratio	1.1	2.7	1.16	3.6

With exception of dichlorodifluoromethane and acrolein, the model to monitor ratios shows a fairly consistent trend that the model is reasonably accurate for the purposes of this study. The modeling results matched with the Beaver Island State Park monitor appears to under predict because of the lack emission source data coming from the south towards Buffalo and Lake Erie and the GIBI site appears to under predict because of the the low emissions inventory input for benzene, acrolein and formaldehyde. The Bias statistic section below allows for a mathematical approach to describe the model to monitor results.

4.0 Mean Bias Statistics and Mean Error for RAIMI Model Air Concentration Predictions and Monitored Concentrations

In air pollution science, the Mean Bias and Mean Fractional Bias calculations are used to evaluate the model to monitored paired values for criteria pollutants to determine if the model adequately reflects the observed data. Large scale regional models developed for State Implementation Planning contain hundreds of data points and similar paired results leading to a more robust mean bias and mean error type of mathematical analysis. In the Study area, only four points (monitors) are available for mean bias and mean error reporting. Nonetheless, the results depict another way to express the model to monitor comparisons besides using only the ratio approach as discussed in section 3.0

Mean Bias (MB) and Mean Error (ME) are useful metrics for comparing the differences between modeled concentrations and monitored data but for data skewed by a couple of paired results, the use of the Mean Fractional Bias (MFB) and Mean Fractional Error (MFE) helps to better characterize the data (Boylan, et.al 2006). It is suggested by Boylan to portray both types of bias, MB and MFB, to understand the difference when using normalized or fractional bias data and error. The performance metrics for MFB is -200% to 200%, similar to the one-half to a factor 2 suggested by USEPA for model to monitor performance. The performance metric of MB and ME is zero but without the bounded statistic found with the MFB.

The results of the MB and ME calculations can be found in Table L-5. Acrolein and formaldehyde were both greater than the performance metric, -200%, -493 and -228 percent respectively for MFB indicating a gross under prediction for these two compounds. 1,3-Butadiene was within 200% for MFB but the gross Error exceeded the two hundred percent indicating specific paired values were grossly over predicted but not all the values were unacceptable.

Table L-1 Scatter Plot of RAIMI versus NATA

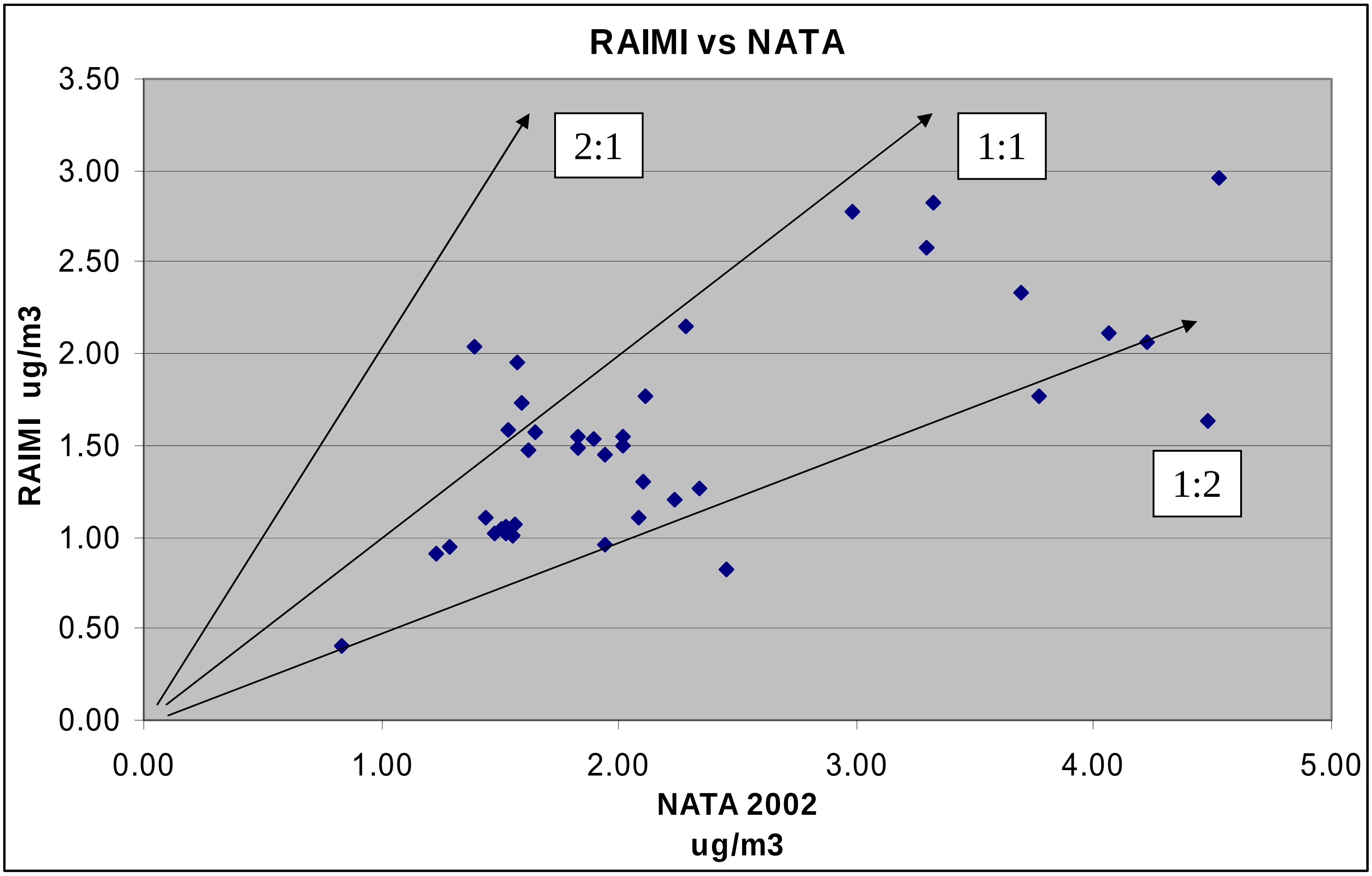


Table L-2 NATA 2002 vs RAIMI

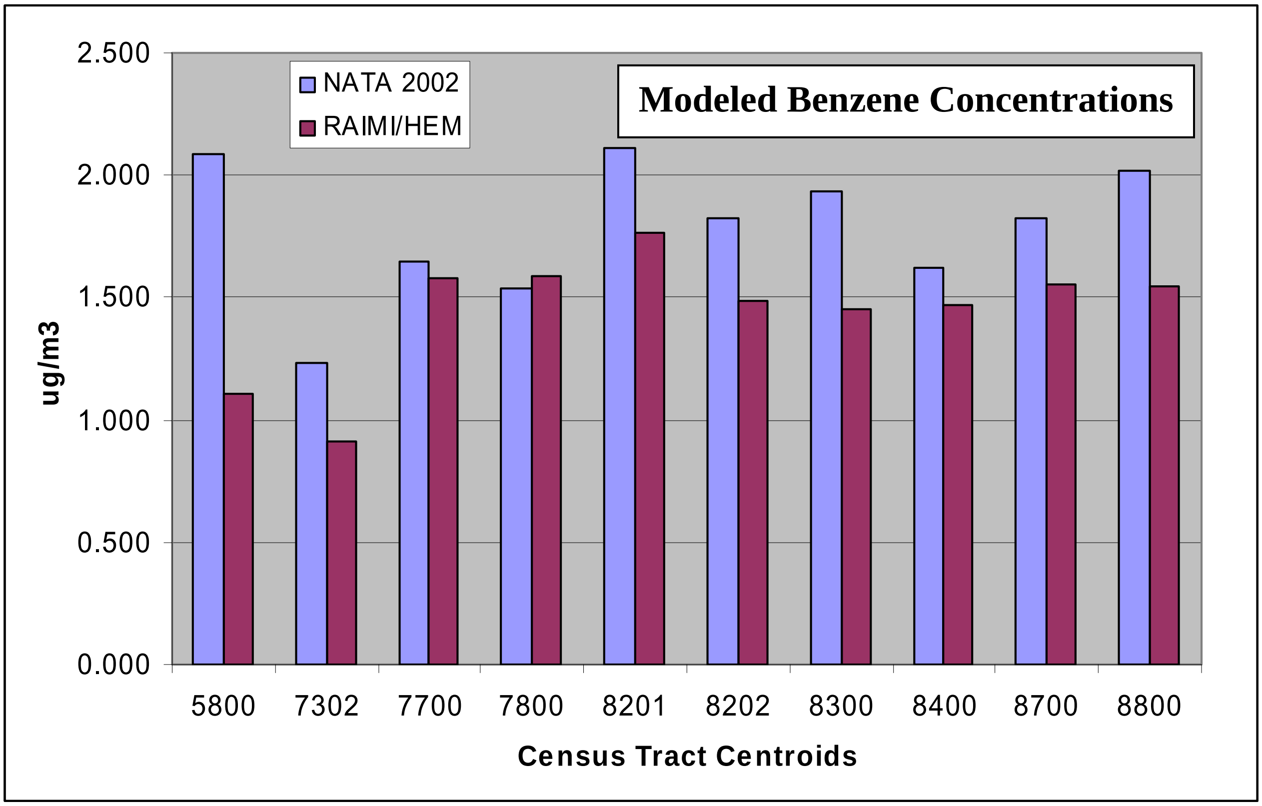
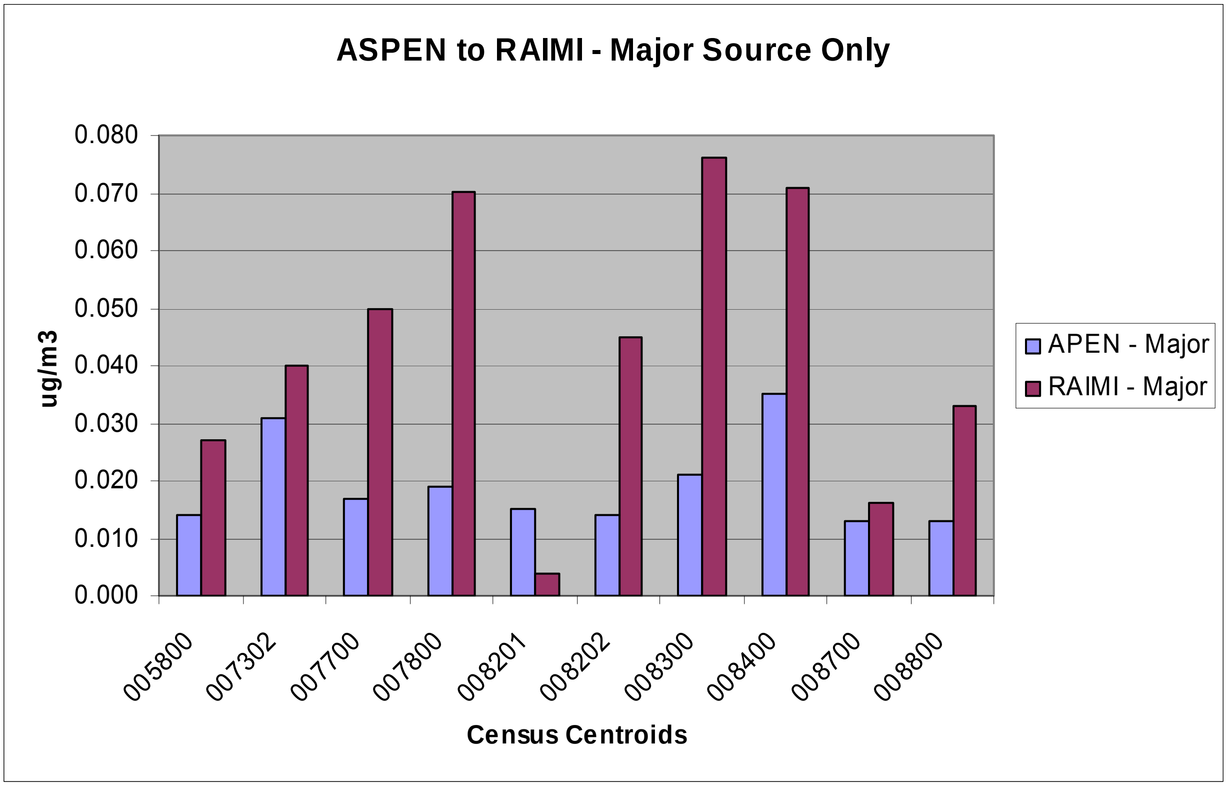
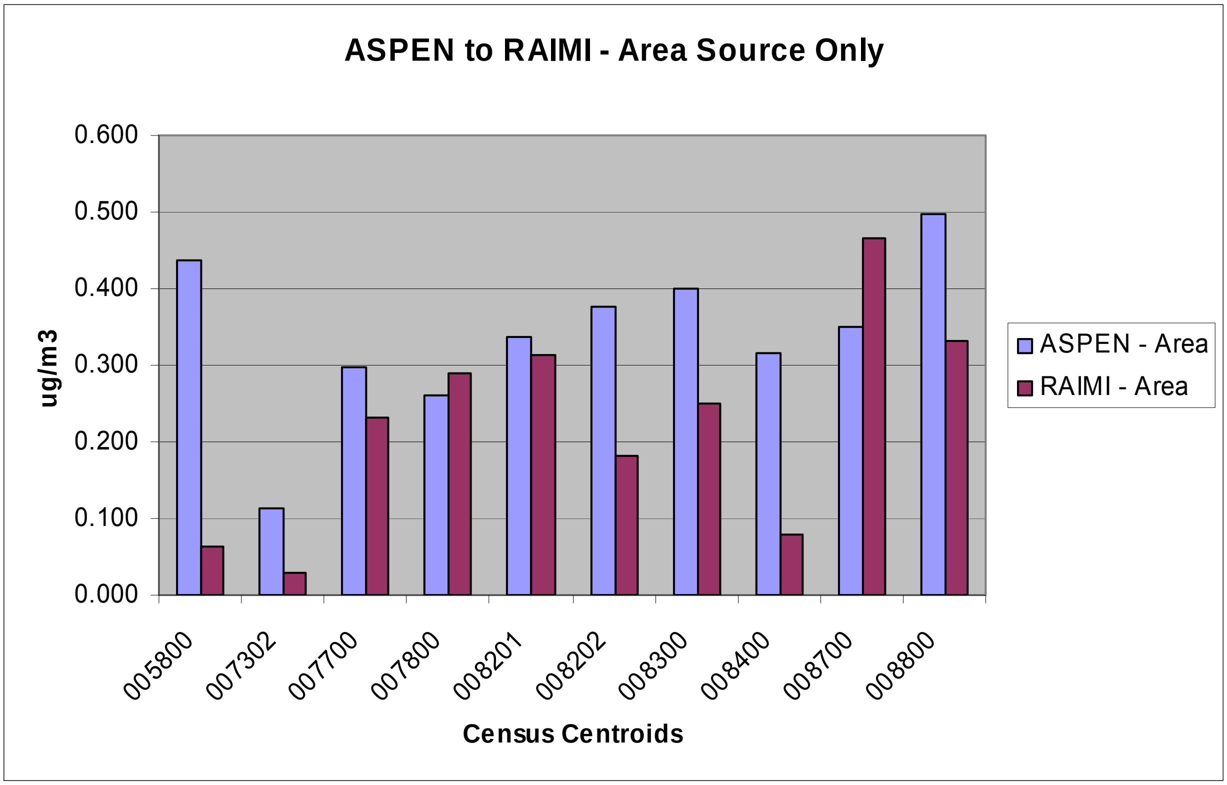


Table L-3 - Difference between Major, Area and Mobile Source Contribution on Total Concentration at Census Tract Centroid Locations - Benzene




ASPEN to RAIMI - Area Source Only
ug/m3
0.600
0.500
0.400
0.300
0.200
0.100
0.000
005800
007302
007700
007800
008201
008202
008300
008400
008700
008800
Census Centroids
ASPEN - Area
RAIMI - Area

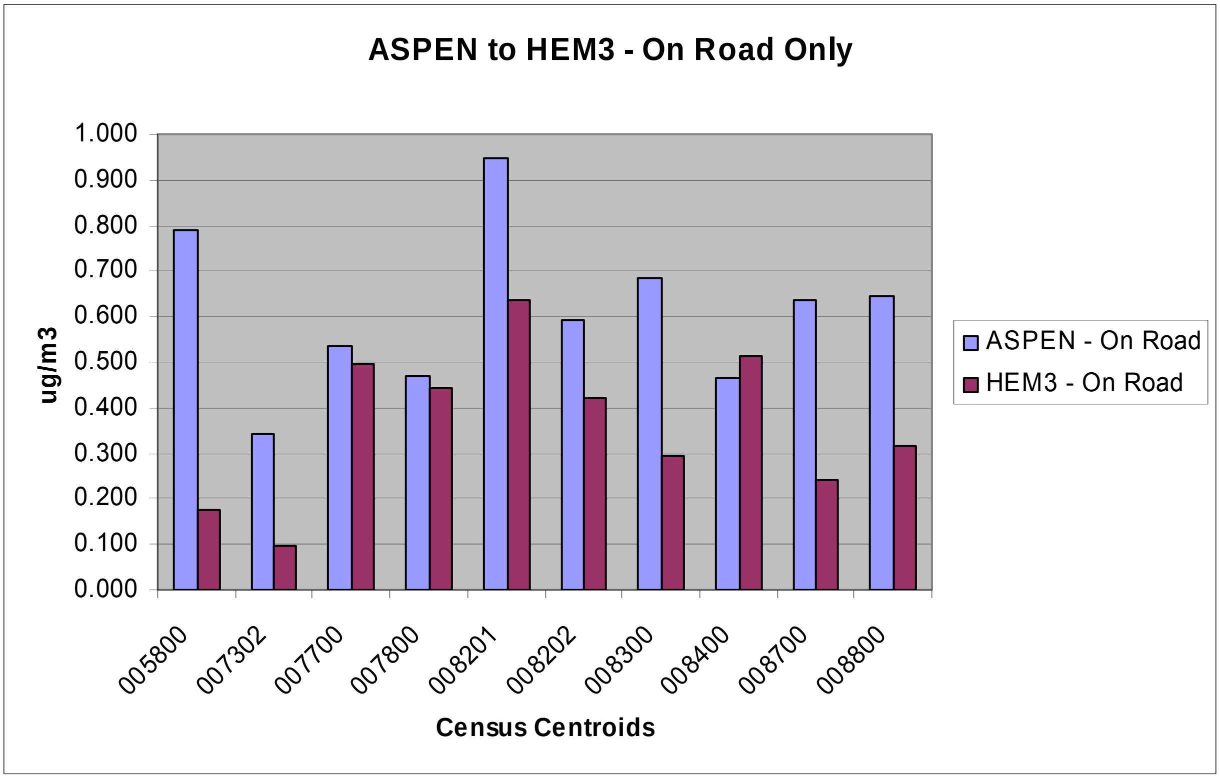

ASPEN to HEM3 - On Road Only
ug/m3
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
005800
007302
007700
007800
008201
008202
008300
008400
008700
008800
Census Centroids
ASPEN - On Road
HEM3 - On Road

Table L-4 - Ratio of Model to Monitoring for Selected Ten Compounds

Compounds	BISP	SPWT	GIBI	BTRS	Median	Average
Acetaldehyde	1.08	1.27	0.87	0.95	1.02	1.05
Acrolein	0.07	0.11	0.06	0.106	0.09	0.09
Benzene	0.82	1.78	0.30	1.1	0.95	0.99
1,3 Butadiene	0.99	2.68	0.61	1.79	1.39	1.51
Carbon disulfide	0.46	0.99	0.83	0.51	0.67	0.68
Dichlorodifluoromethane	0.005	0.018	0.018	0.12	0.02	0.04
Dichloromethane	0.39	1.00	1.16	1.69	1.08	1.06
Formaldehyde	0.53	0.94	0.29	0.74	0.64	0.63
Xylene - Mixed Isomers	0.52	0.77	0.98	3.58	0.87	1.45
Toluene	0.95	2.17	0.98	1.95	1.47	1.52
Average by Site	0.58	1.17	0.61	1.25		

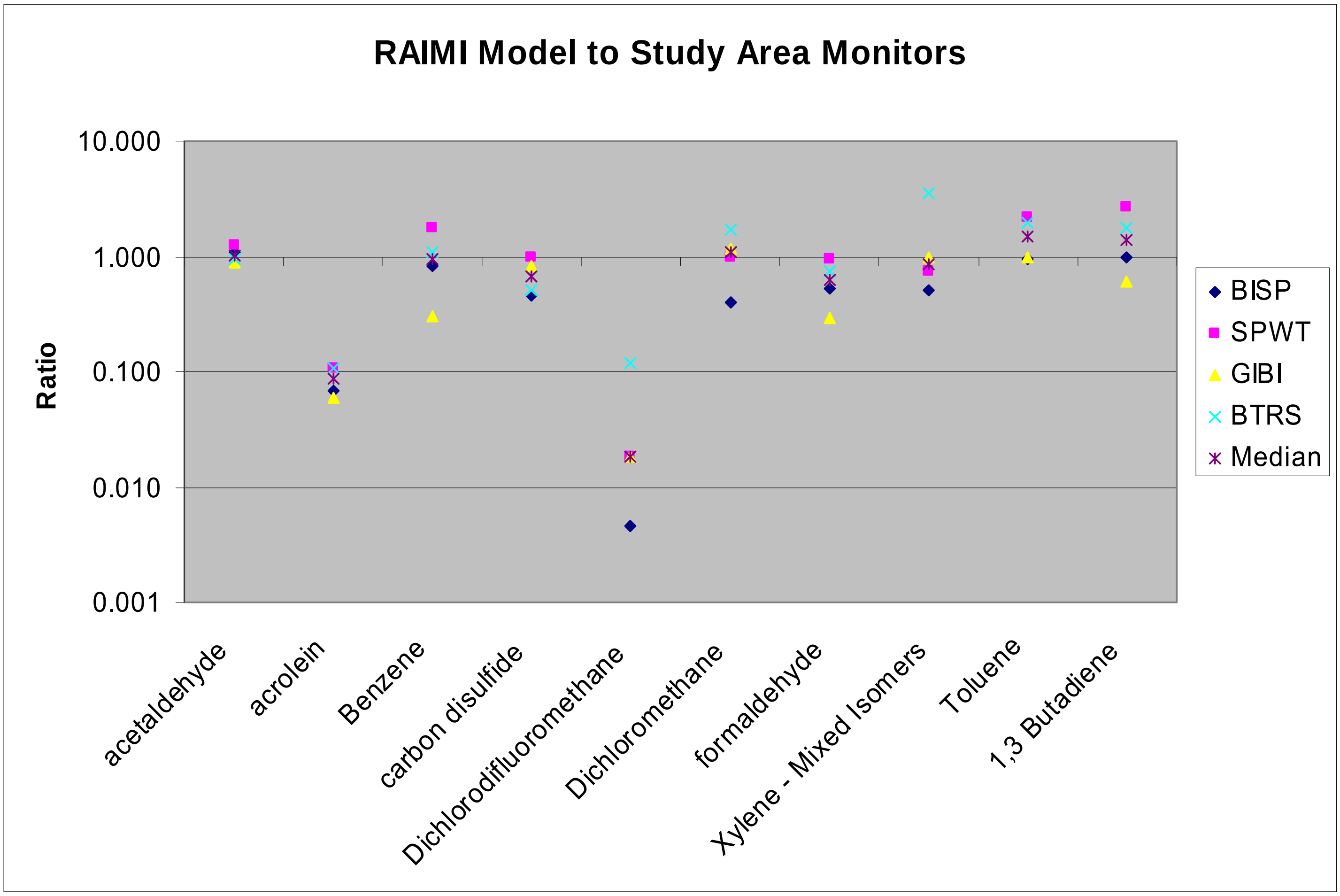


Table L-5 Mean Bias and Error Statistics

Compound	Mean BIAS	Mean ERROR	Mean Fractional BIAS	Mean Fractional ERROR
Acetaldehyde	0.03	0.14	7.4	44.4
Acrolein	-0.31	0.31	**-493.3**	**493.3**
Benzene	-1.71	1.95	-95.4	158.0
Carbon disulfide	-0.47	0.47	-155.0	155.0
Dichloromethane	0.21	0.31	169.5	213.0
Formaldehyde	-1.75	1.75	**-228.9**	**228.9**
Xylene - Mixed Isomers	0.38	0.77	49.7	142.3
Toluene	0.31	0.36	51.3	57.0
1,3 Butadiene	0.63	0.68	164.2	**263.4**

Mean Bias = 1/N ∑n (model -Obs)

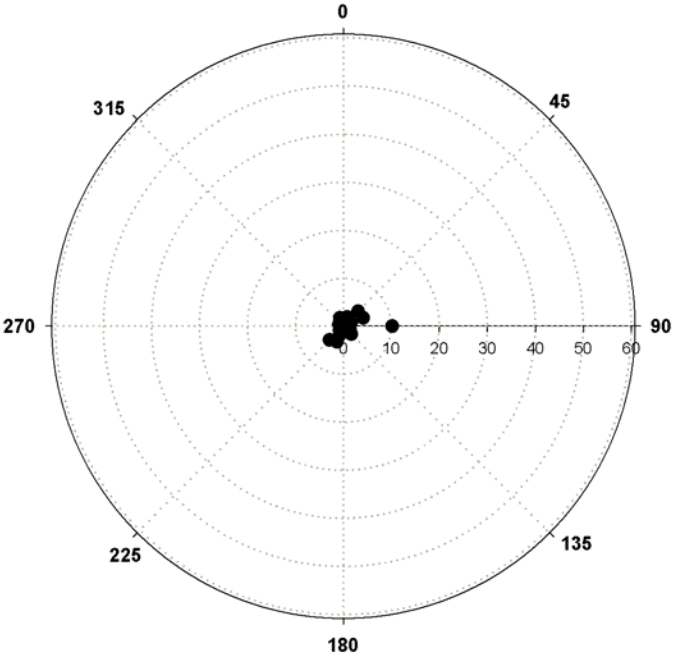
Mean Error = 1/N ∑n (ABS(model -Obs))

Mean Fractional Bias Statistic = 1/N ∑n ((model -Obs)/((Obs+model)/2) * 100

Mean Fractional Error Statistic = 1/N ∑n ((ABS(model -Obs))/((Obs+model)/2) * 100

Appendix M. Polar Plot Graphs for All Category B and C Air Contaminants in Units of µg/m^3

BISP Benzene



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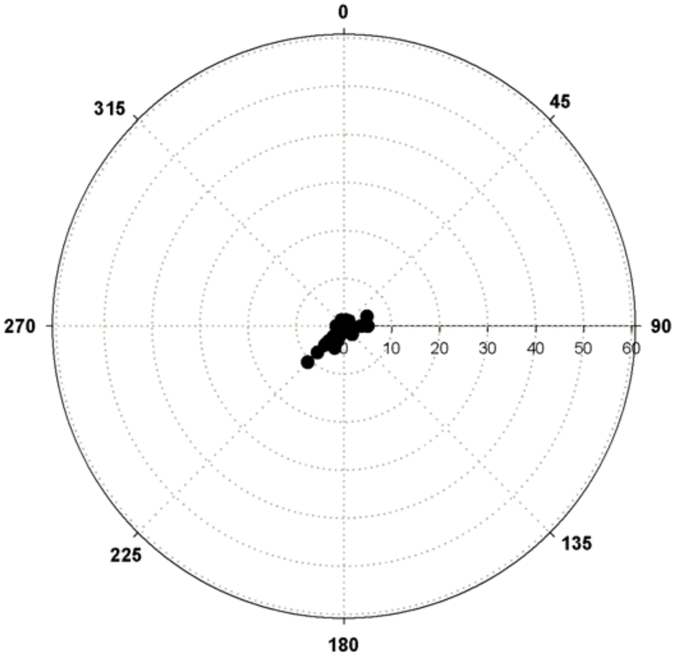
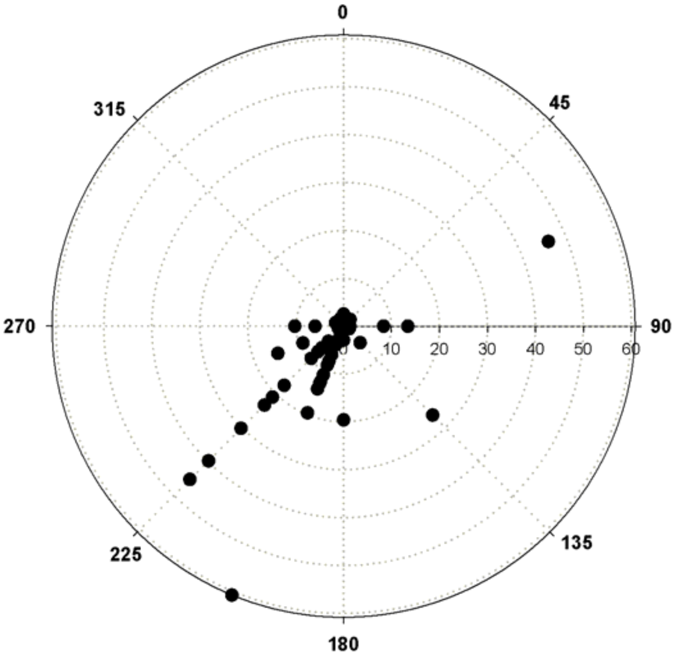


GIBI Benzene



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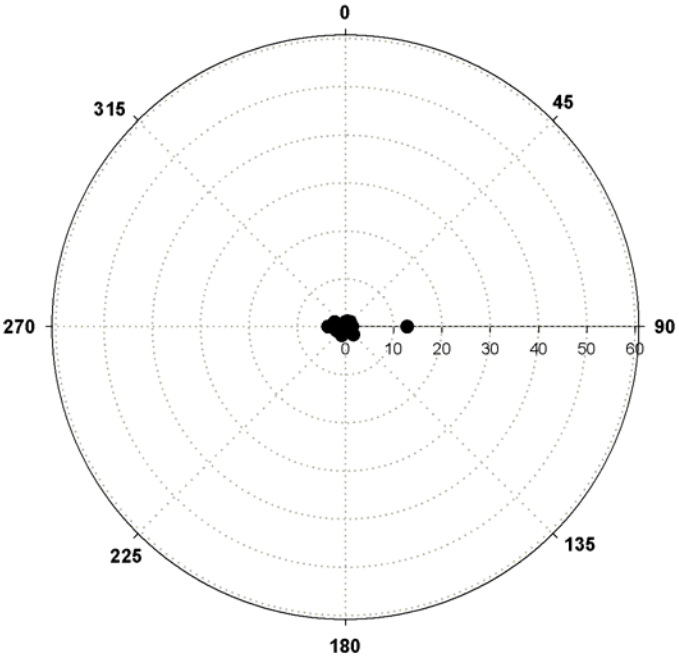

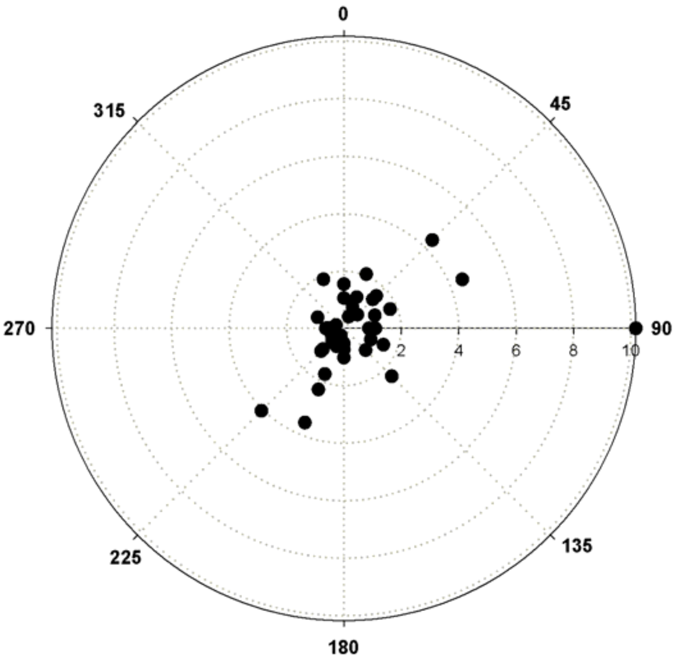
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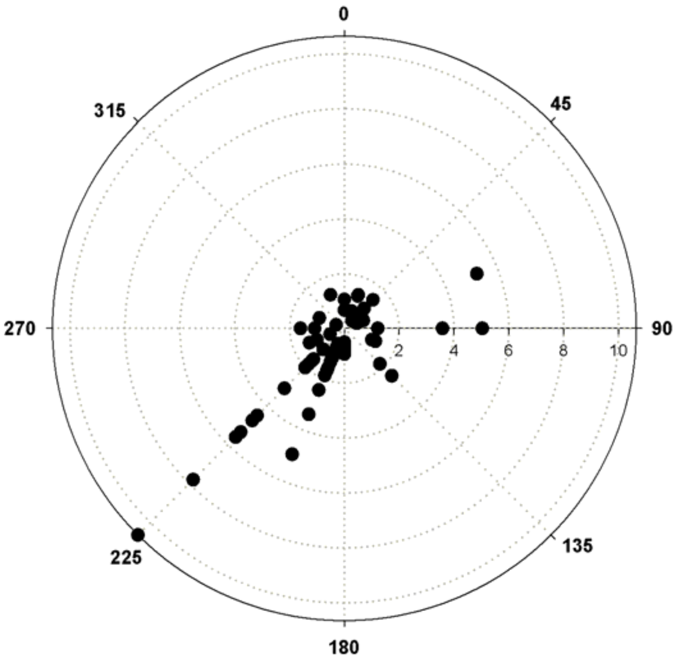
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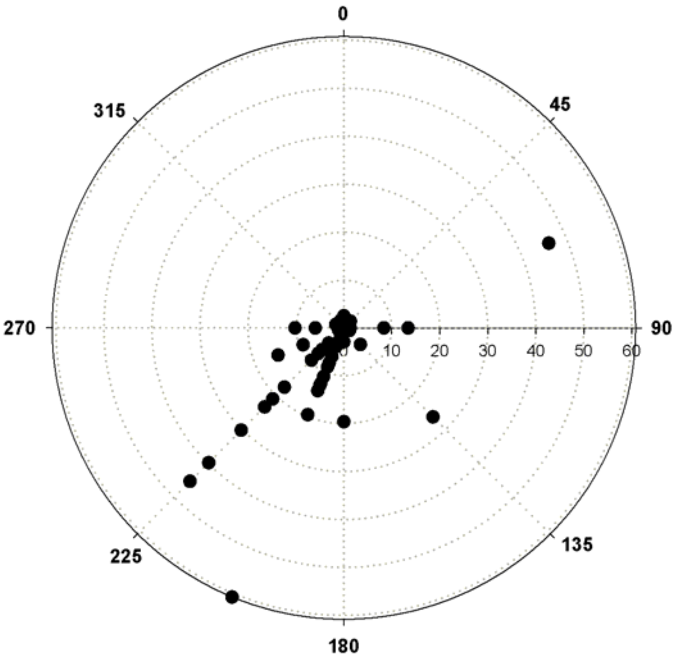
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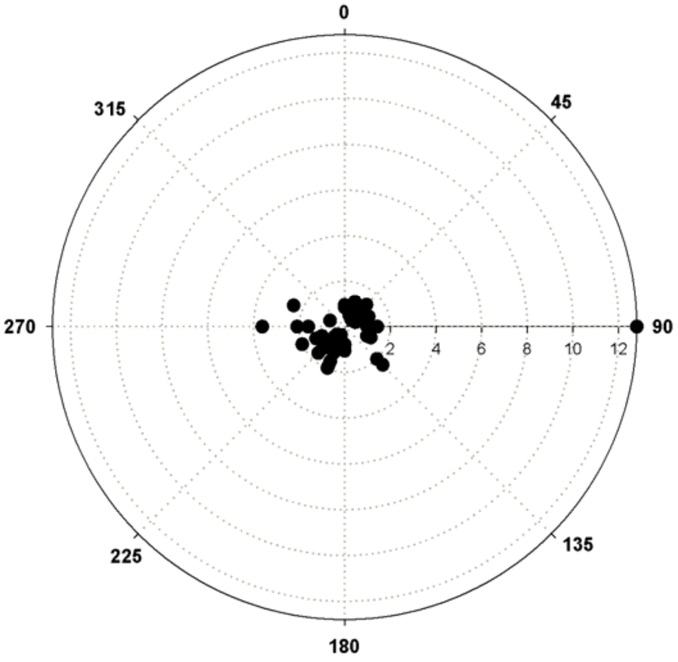
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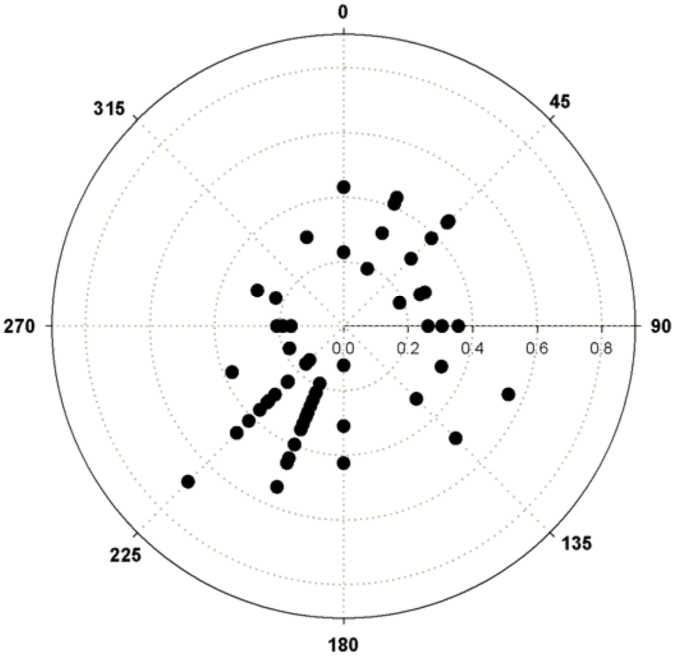
BISP Acrolein



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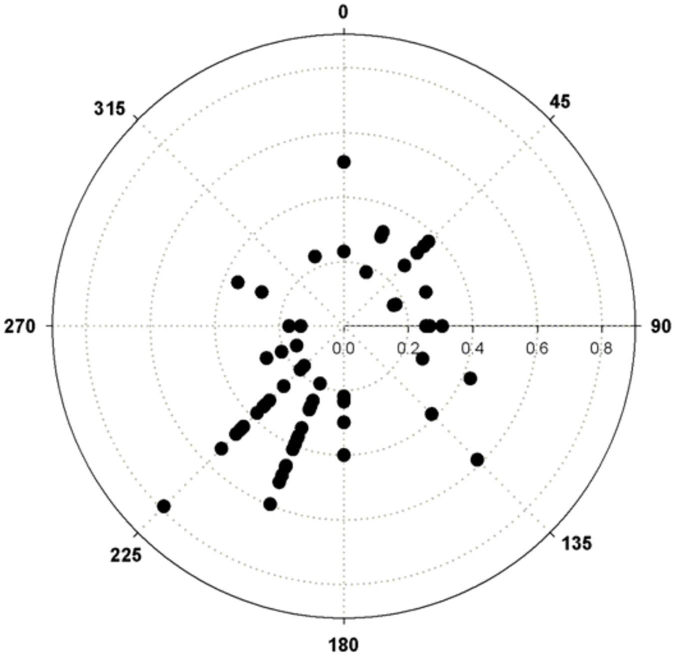

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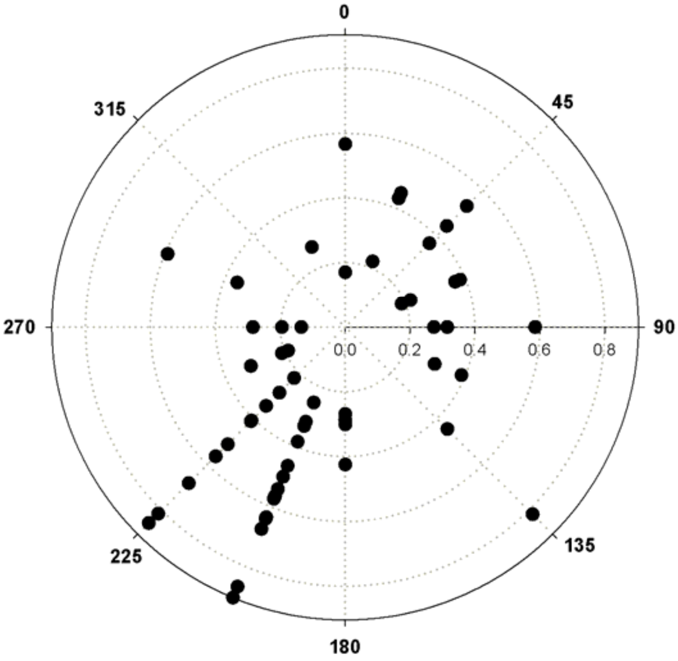

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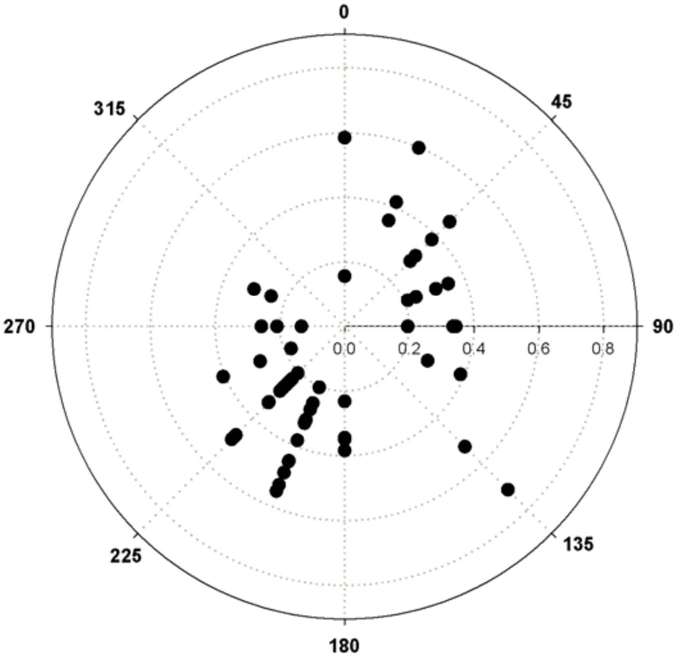

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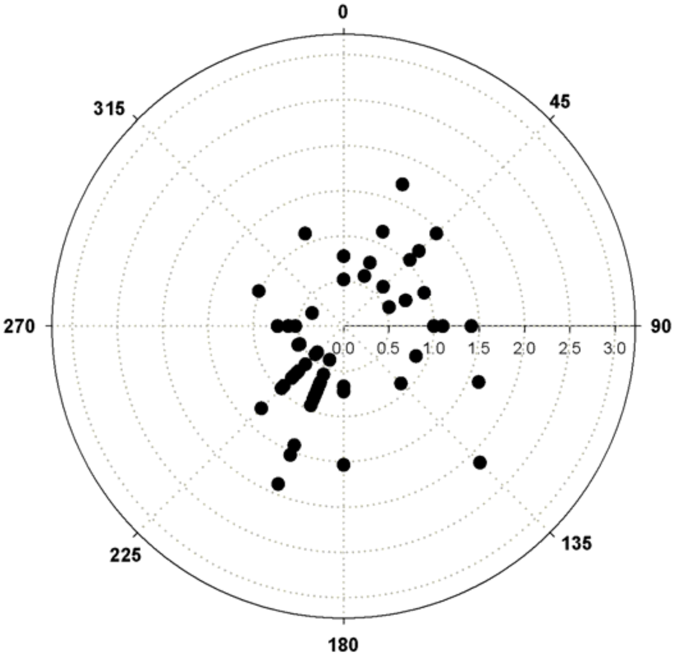

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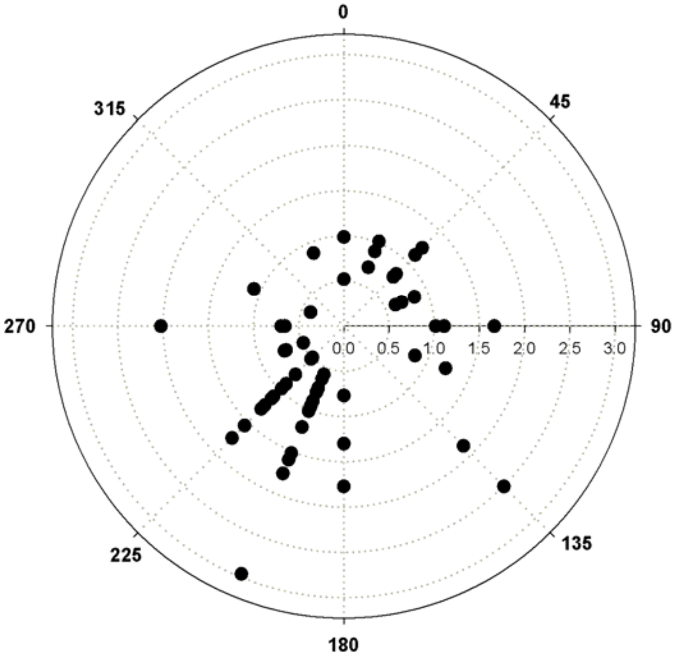

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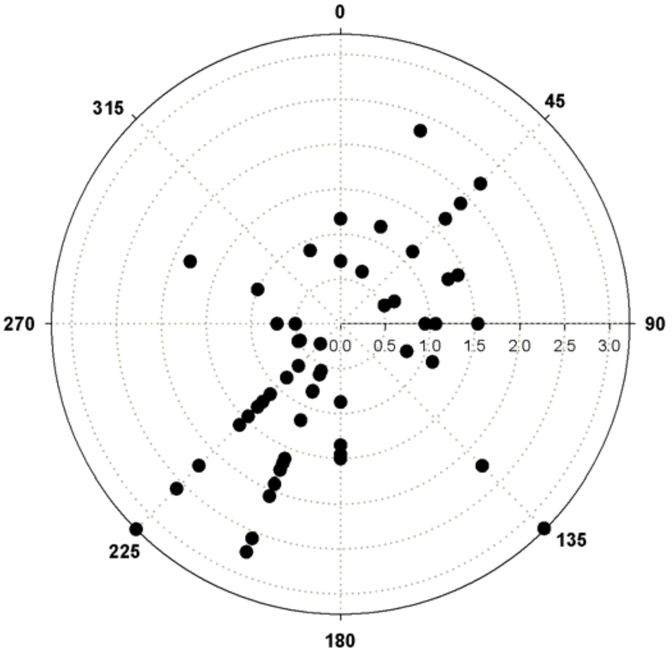

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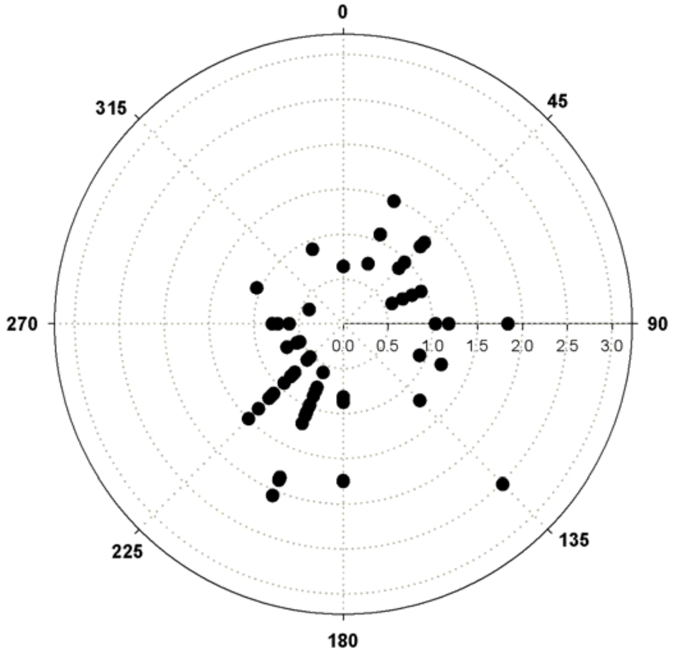

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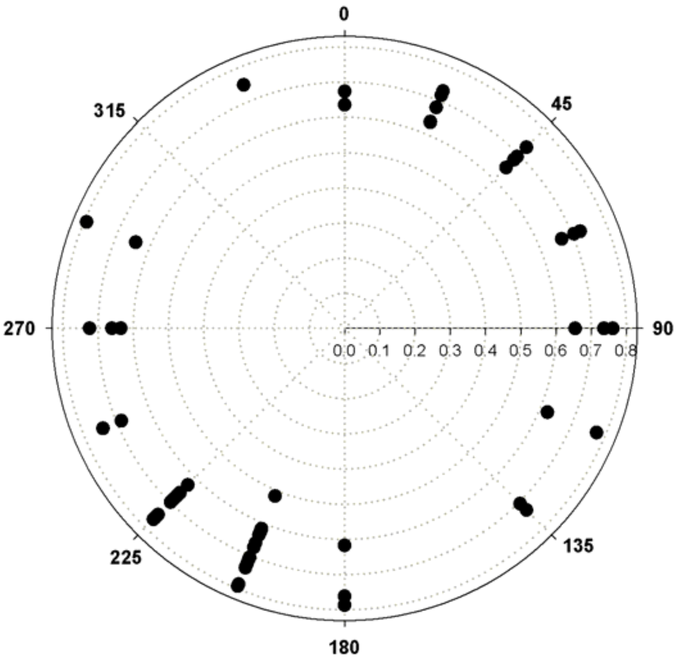

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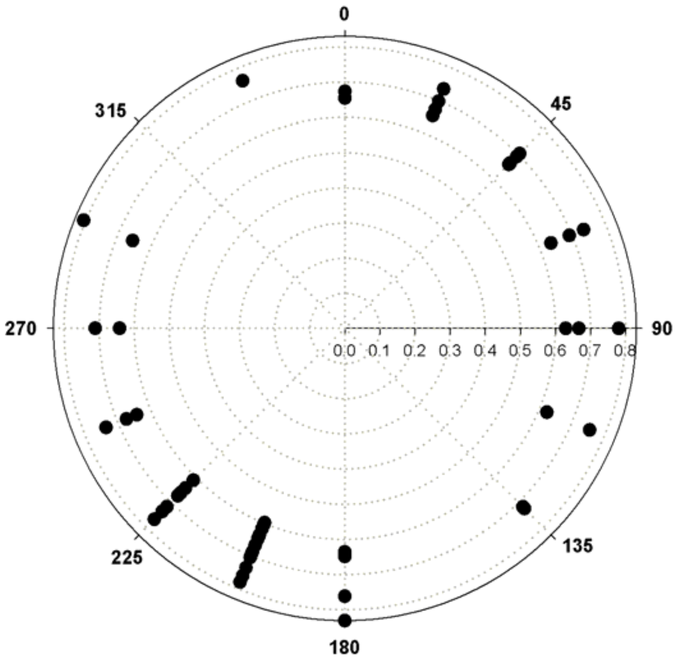

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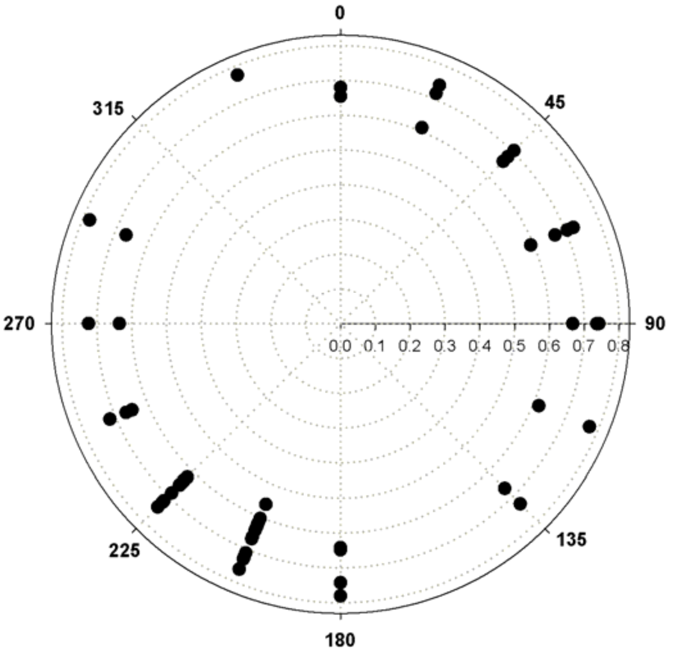

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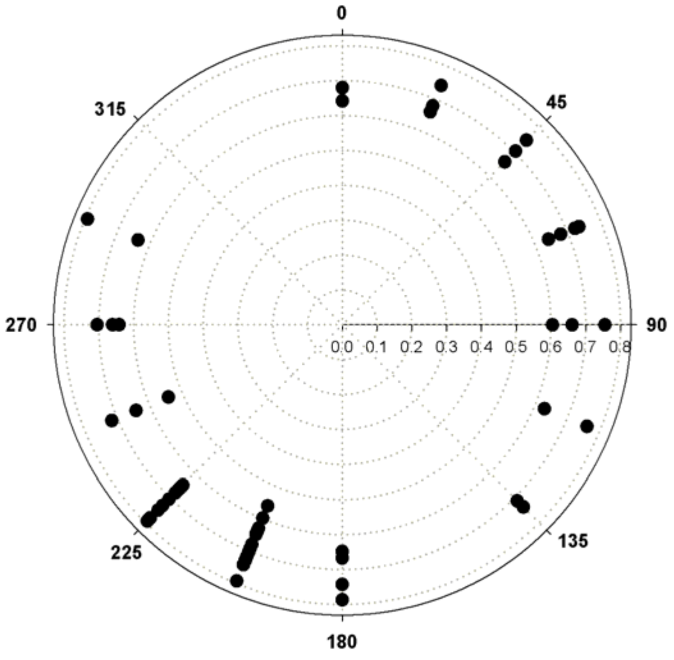

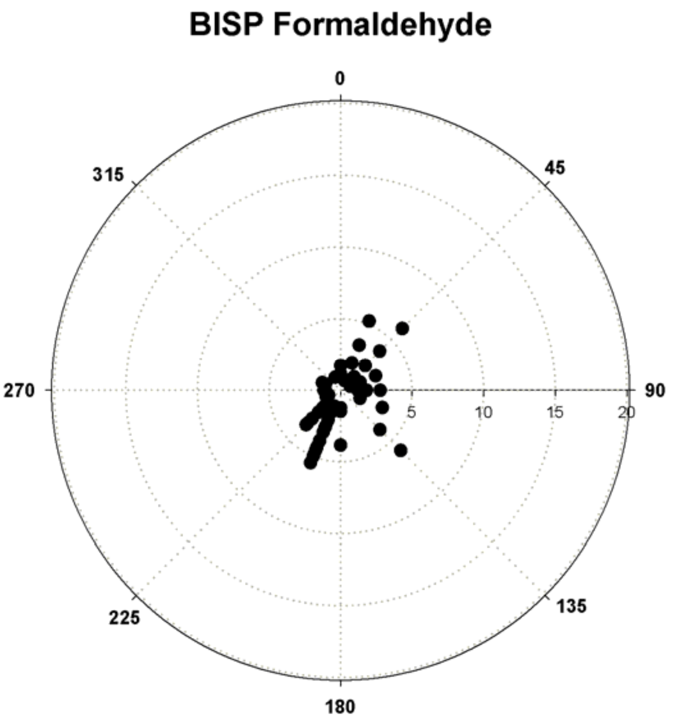
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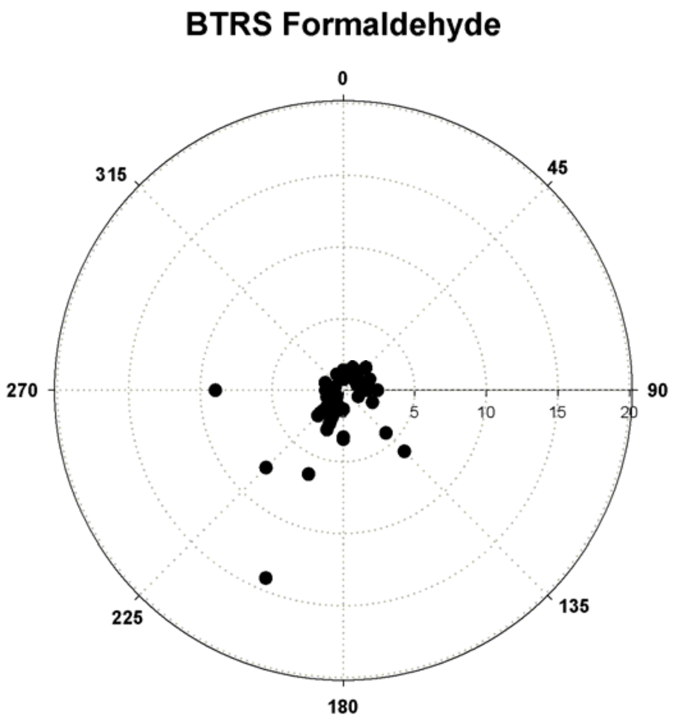
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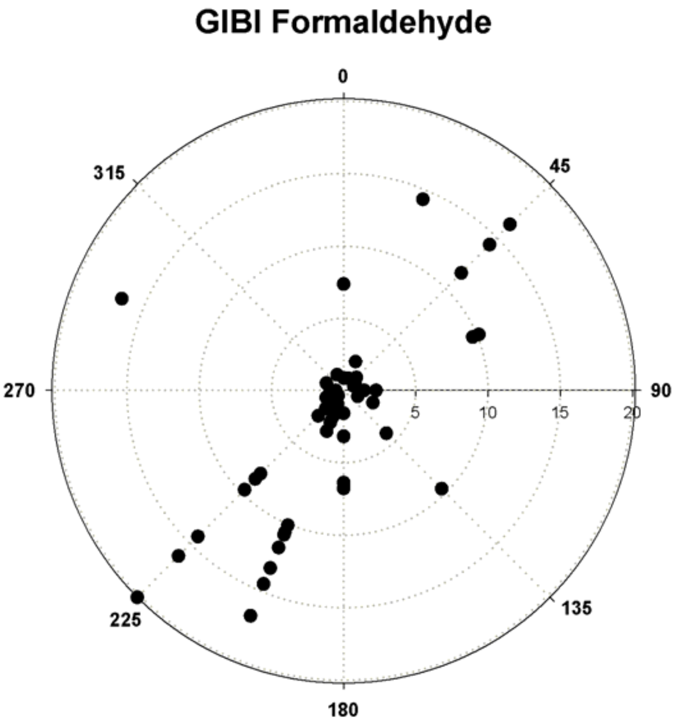
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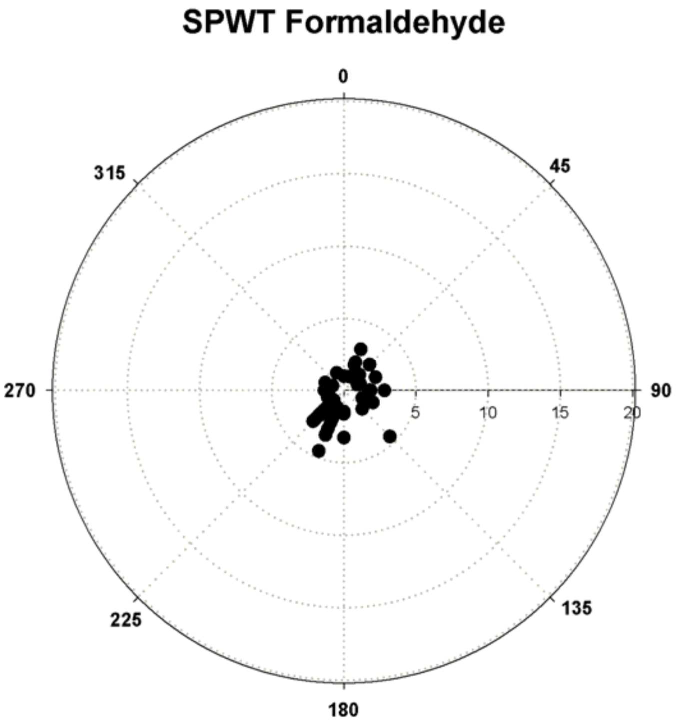
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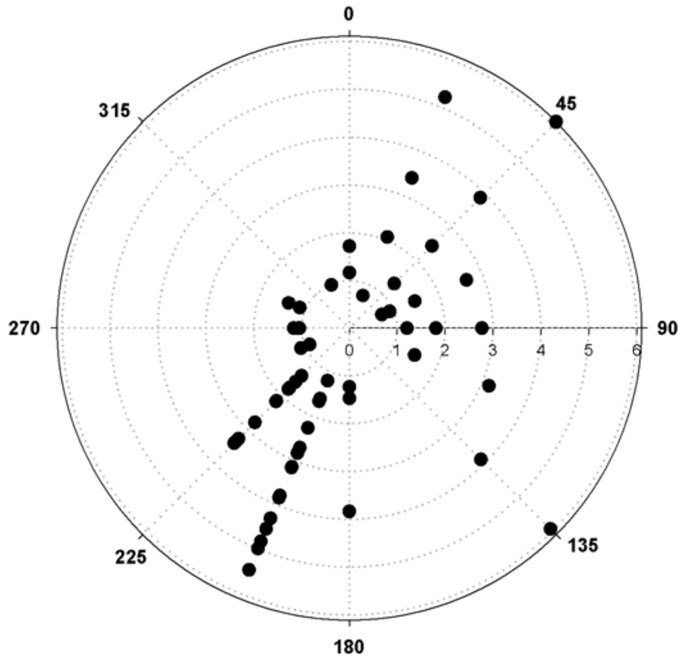

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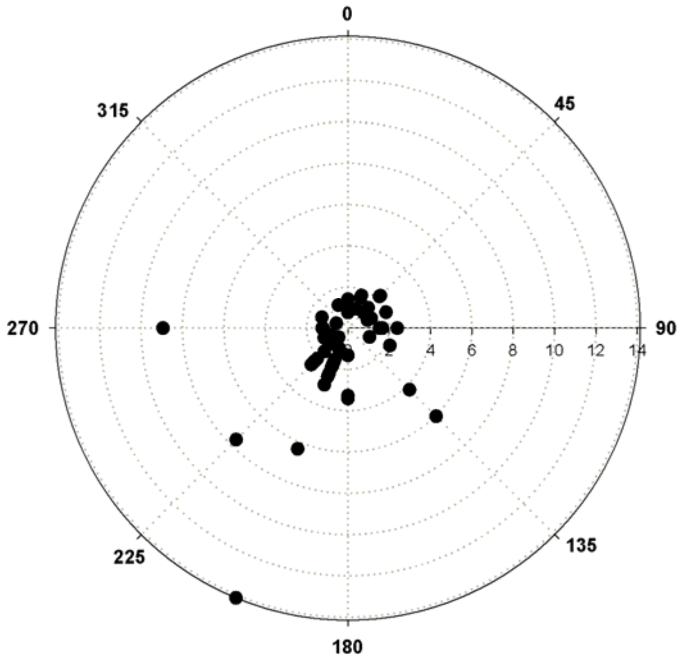

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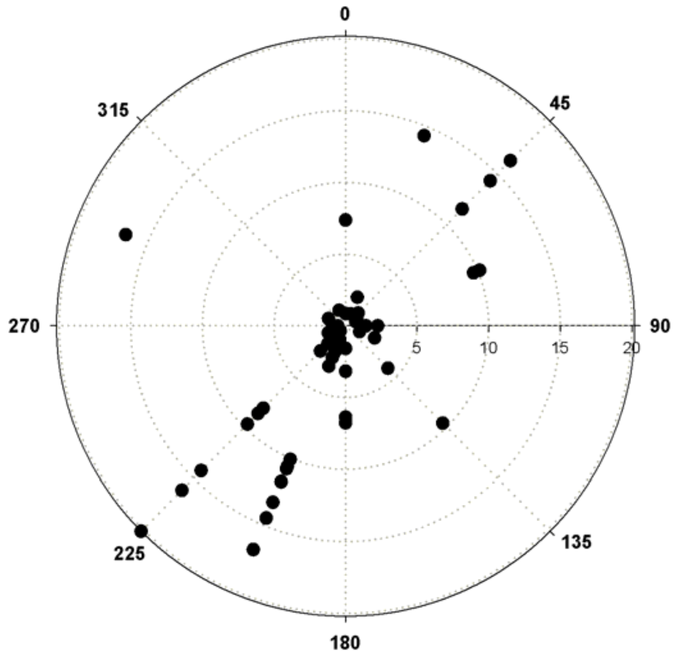

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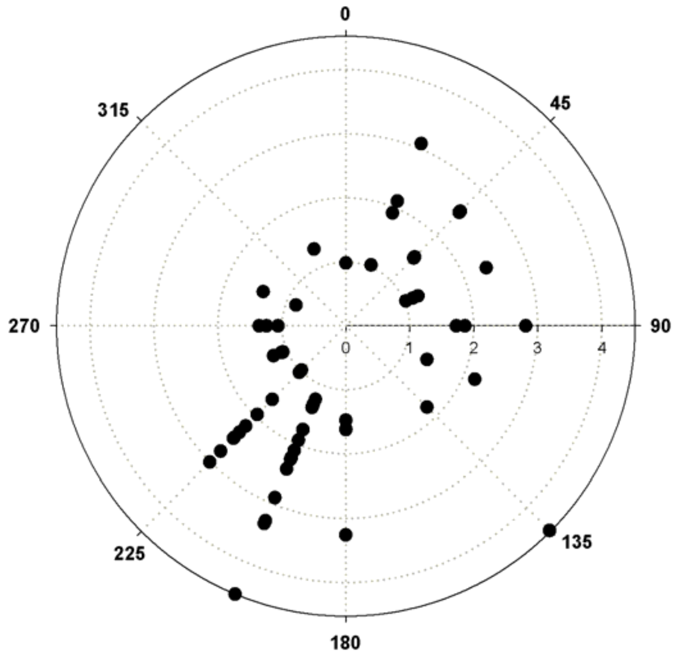

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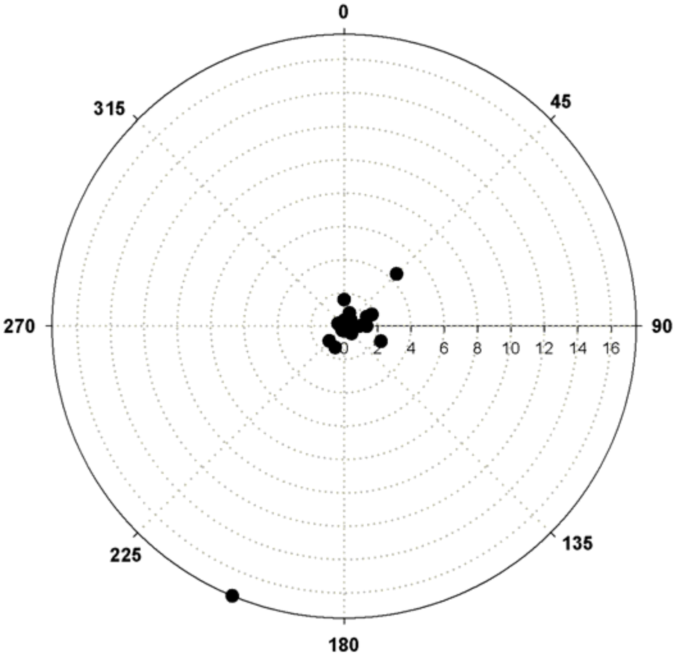

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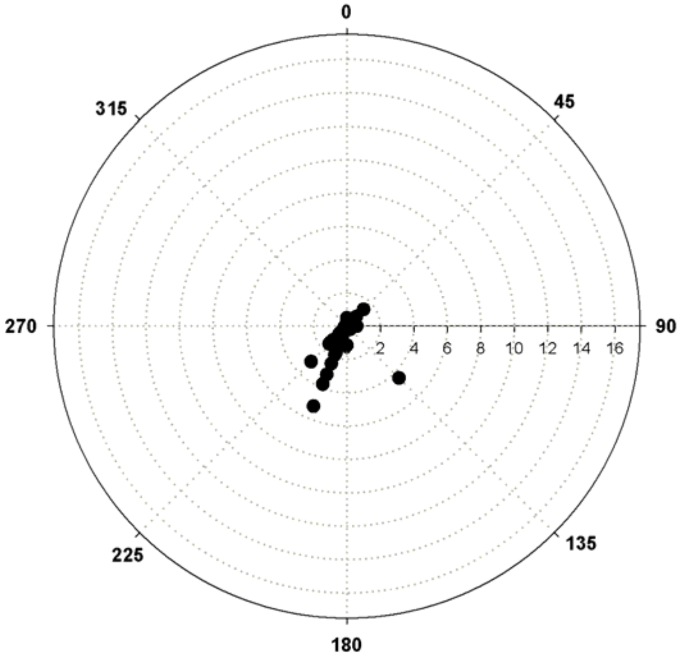

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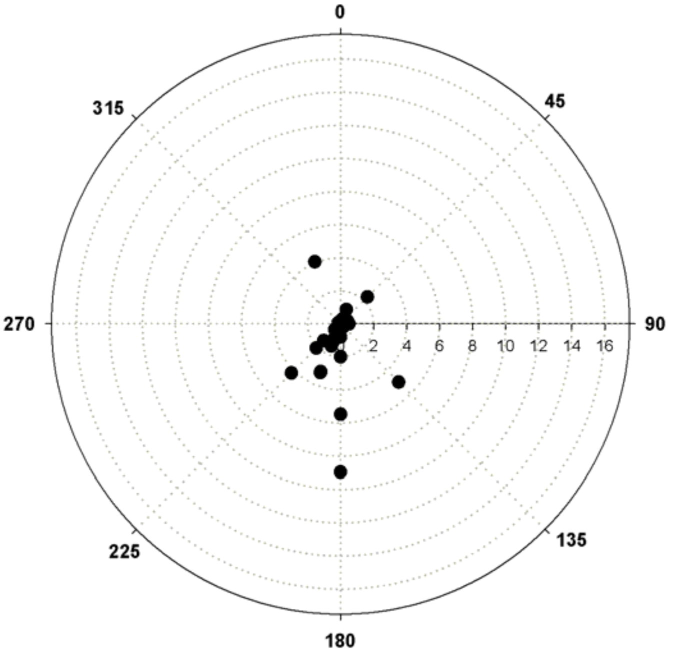

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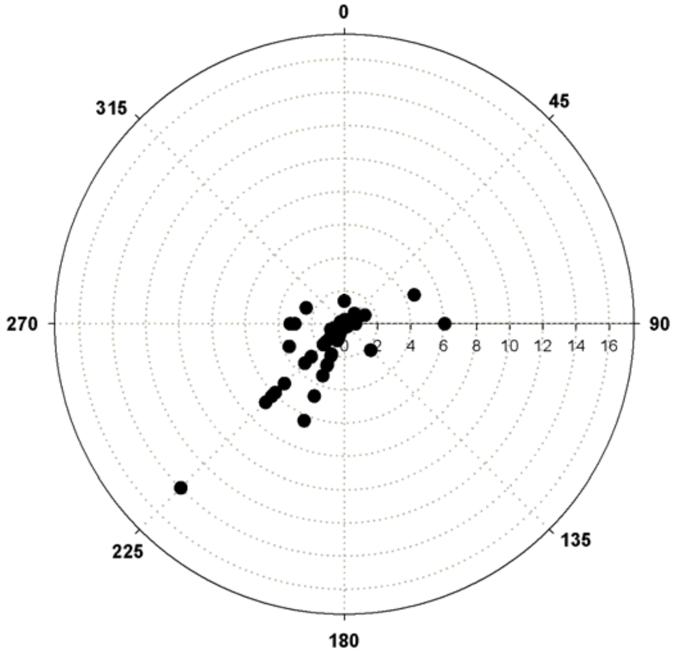

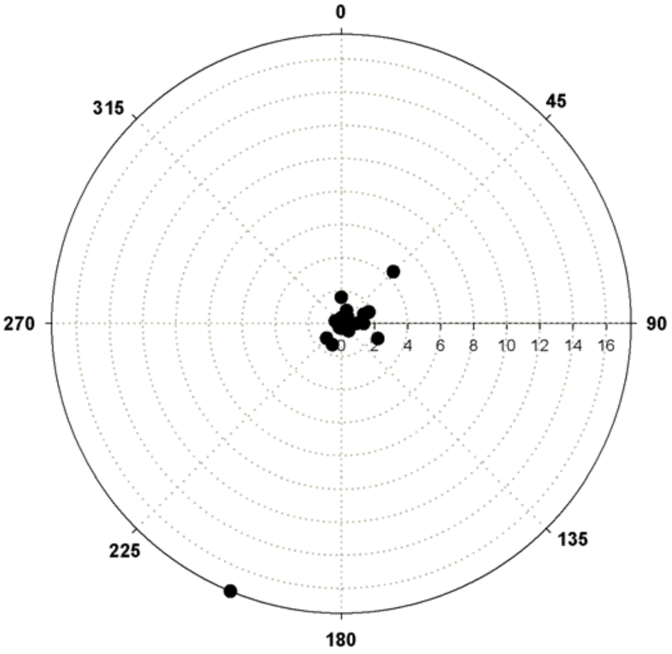

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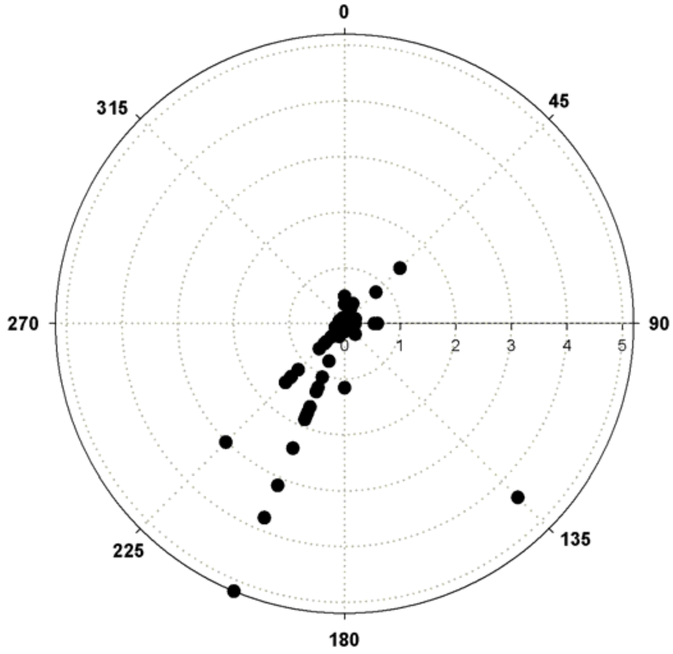

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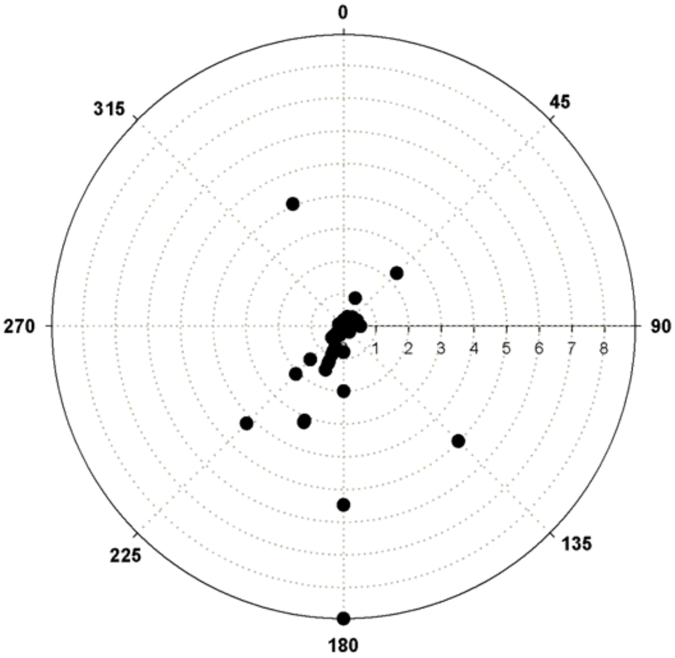

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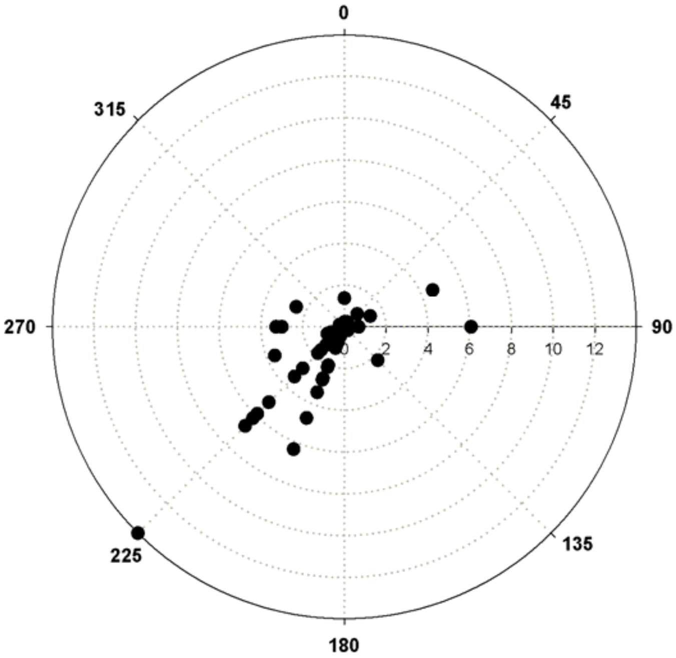

SPWT Carbon Disulfide

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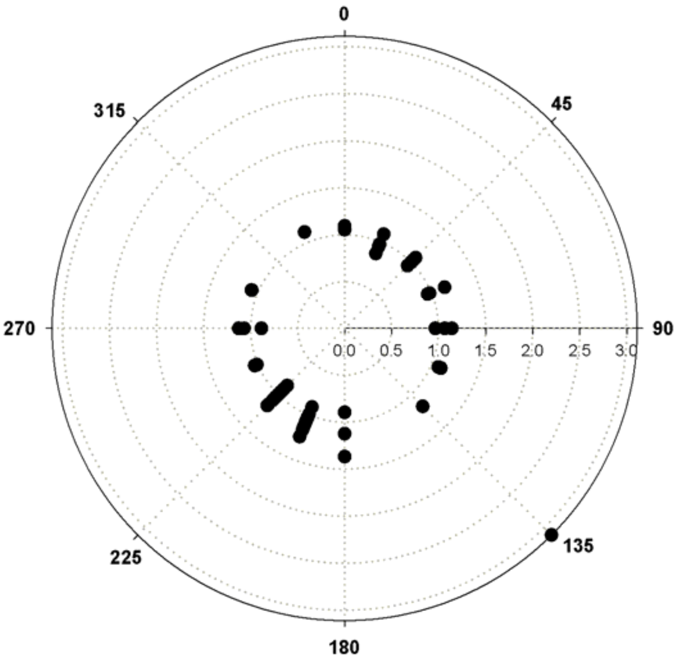

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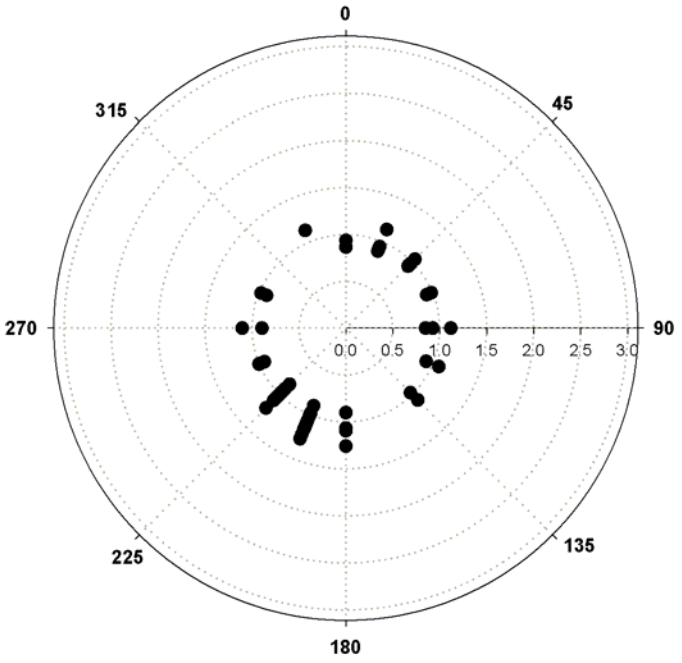

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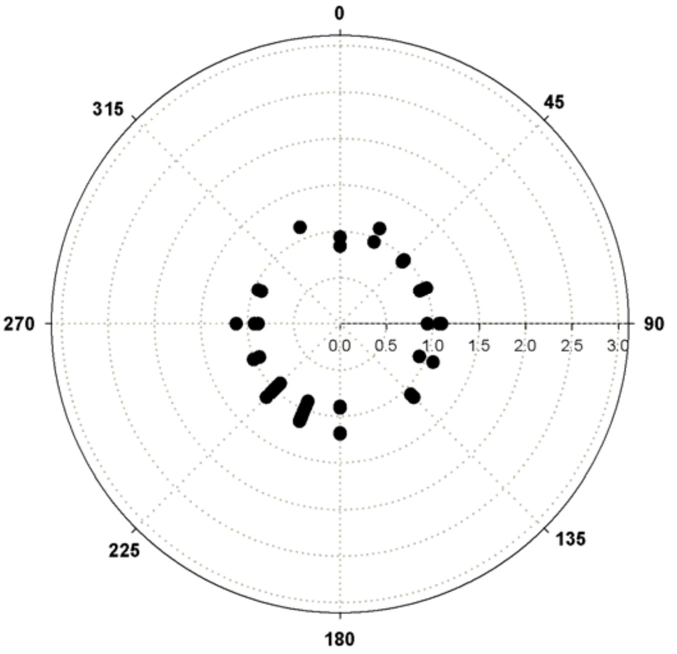

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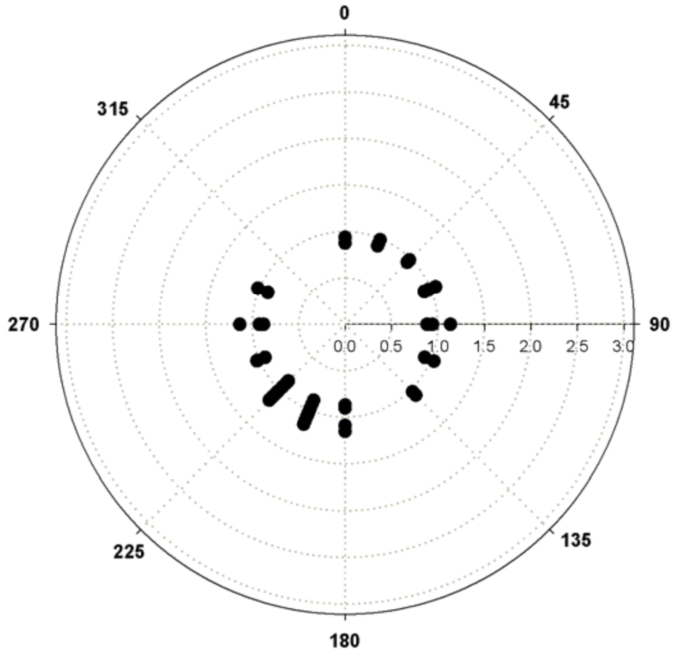

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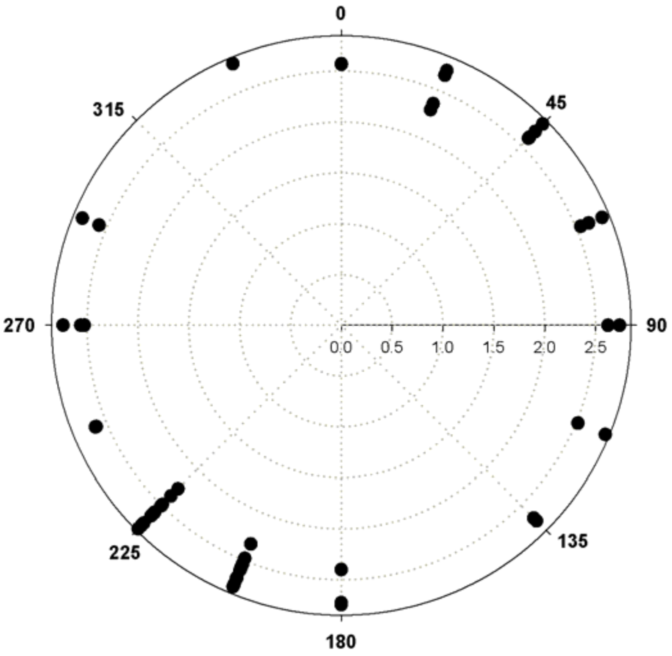

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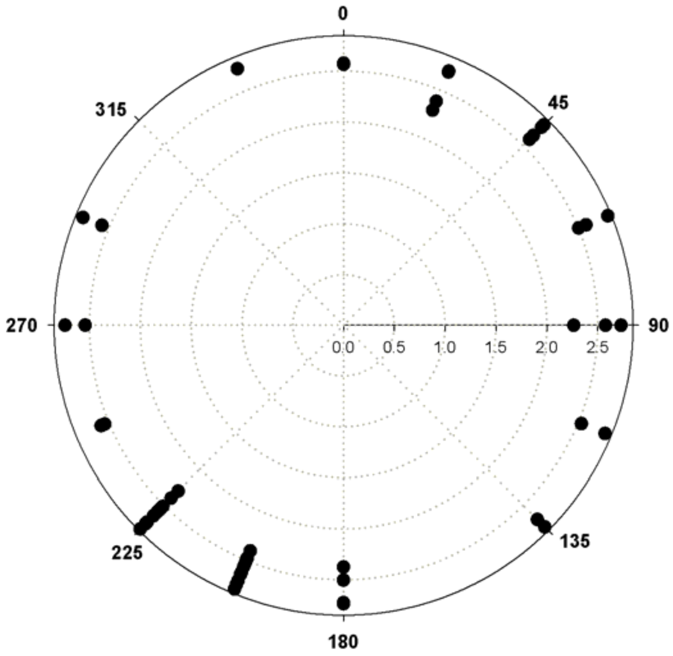

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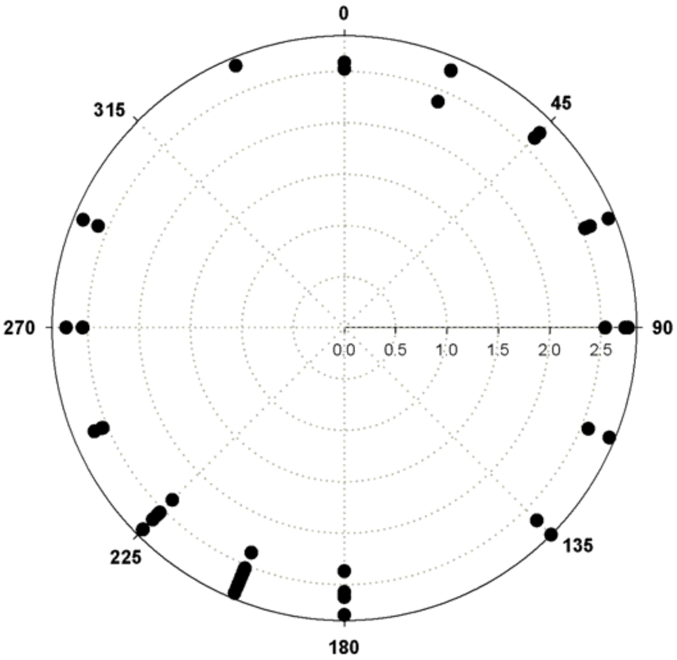

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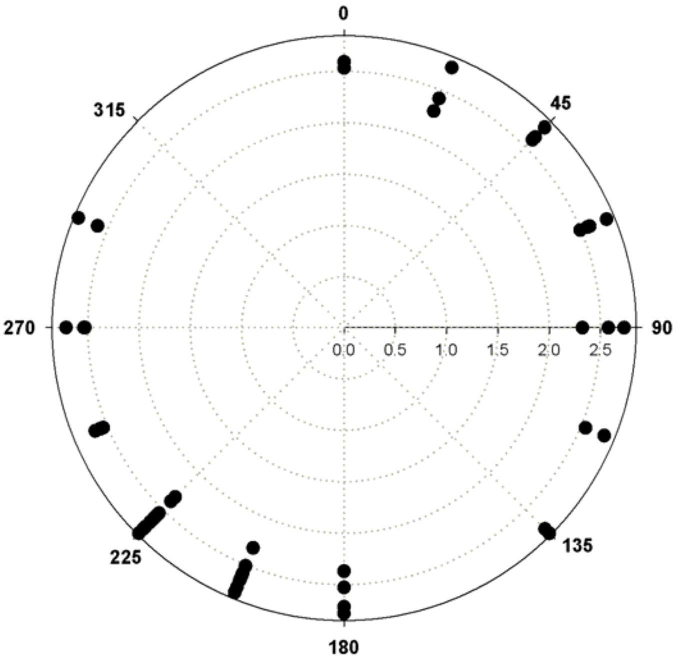

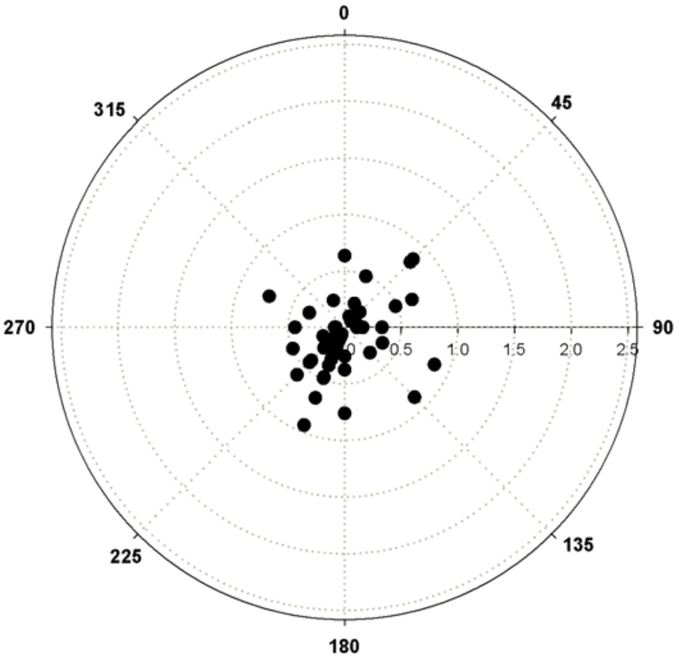

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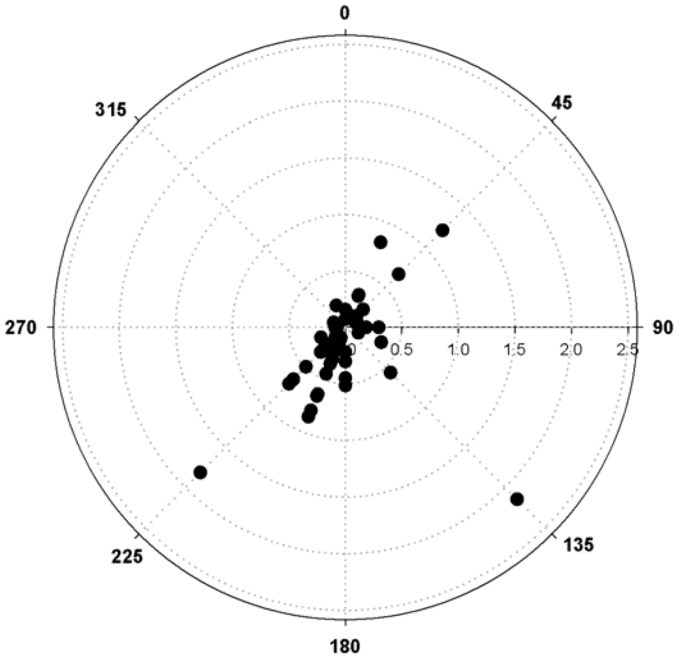

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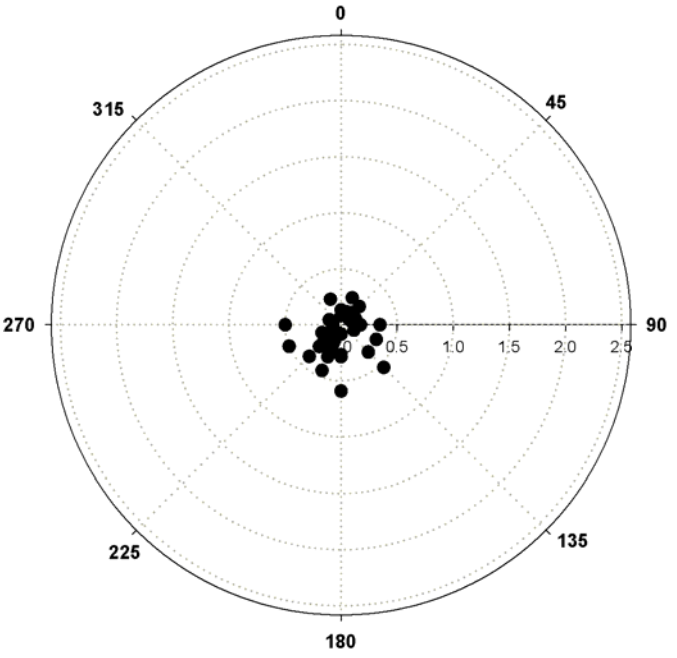

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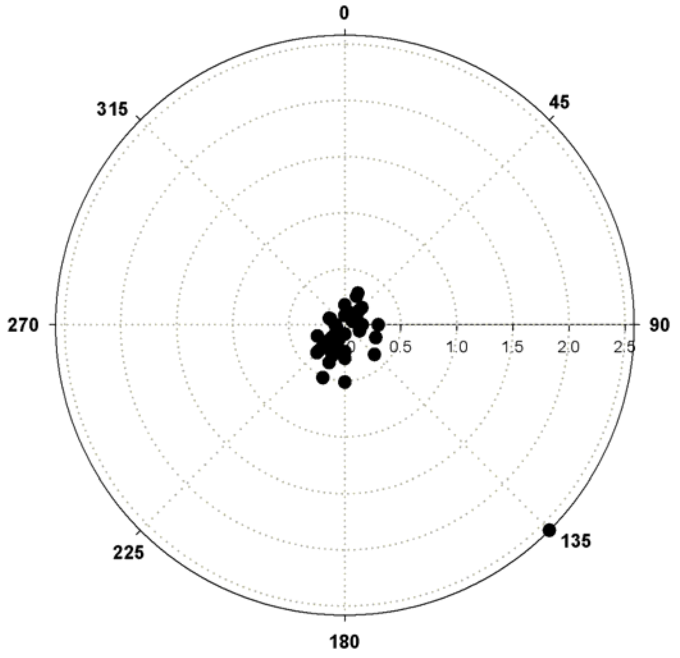

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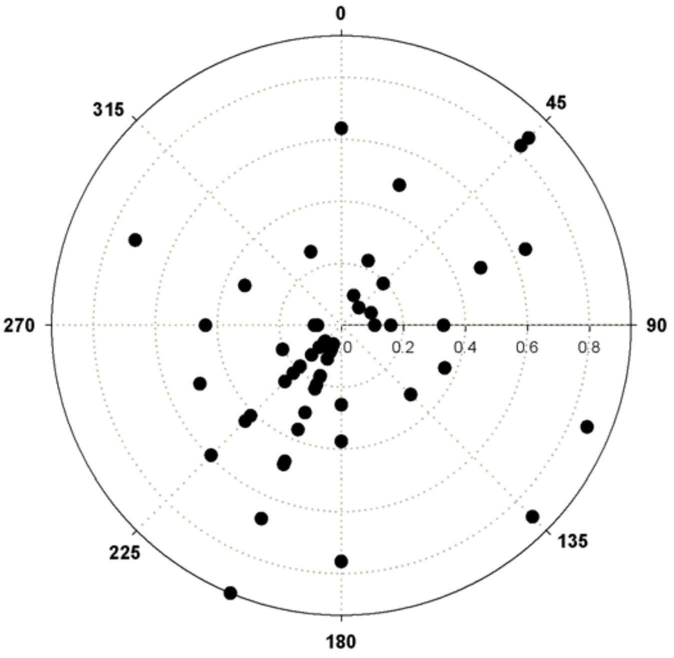

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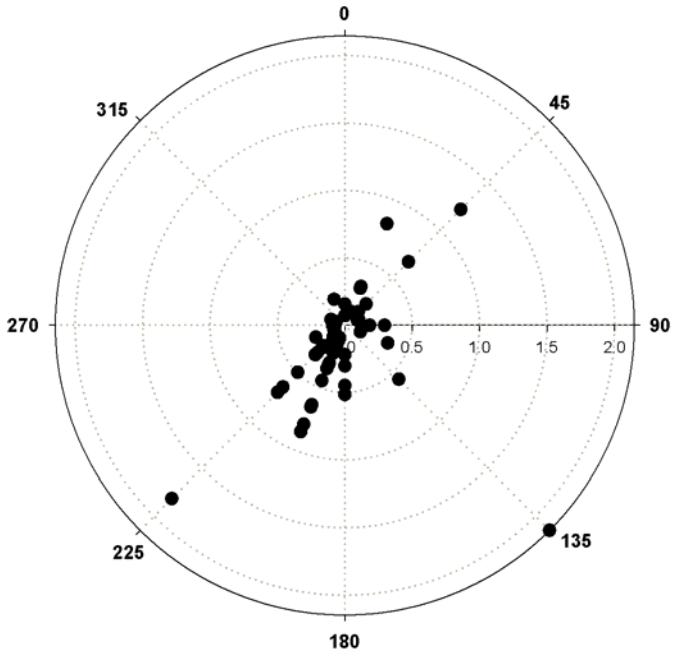

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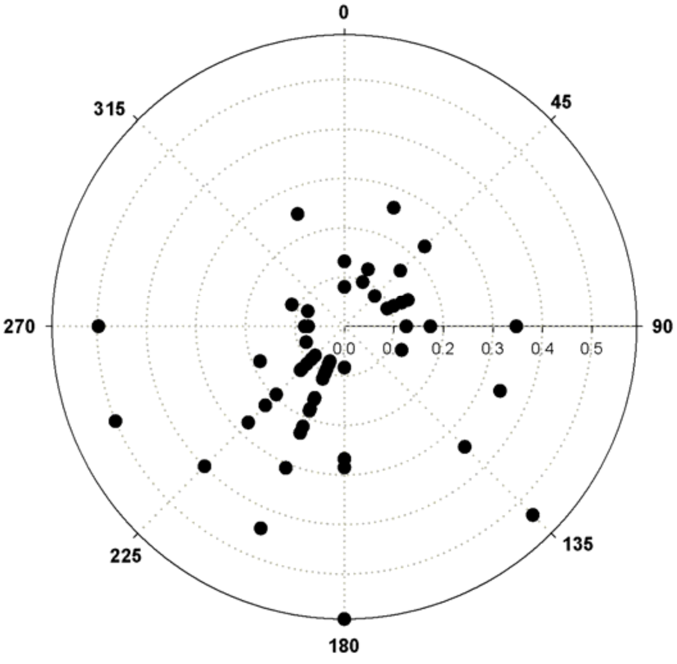

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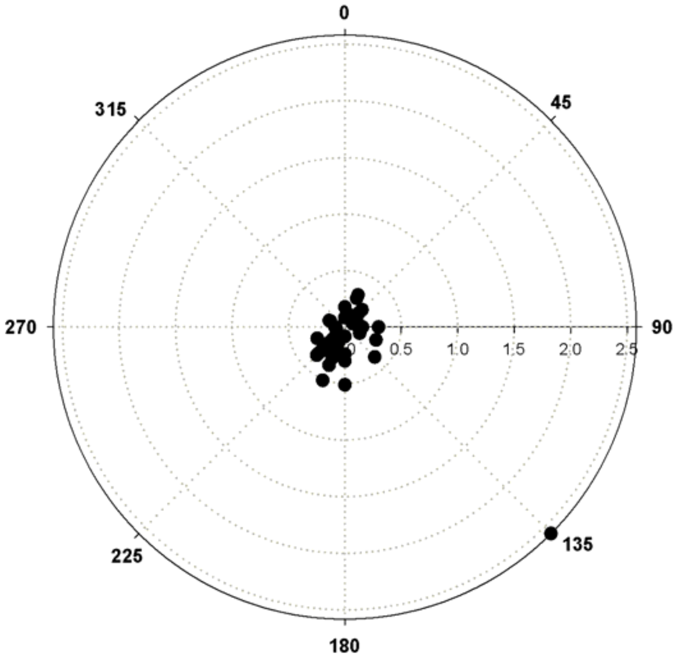

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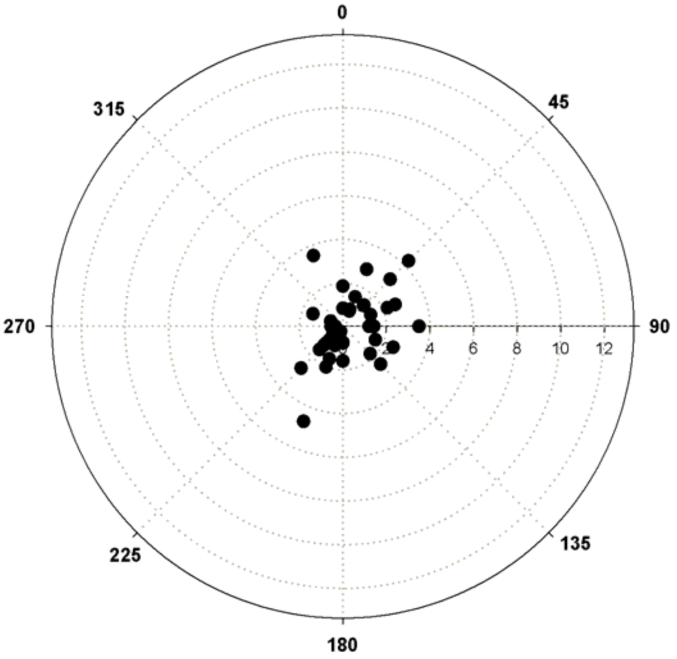

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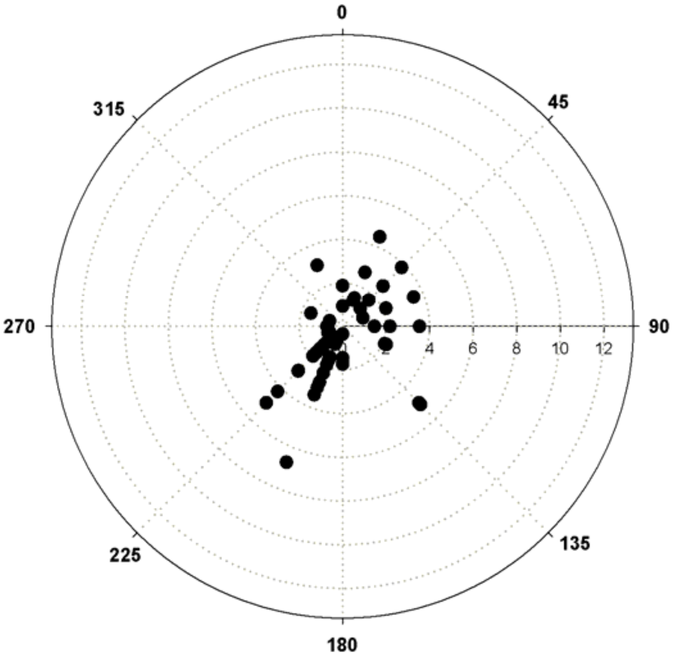

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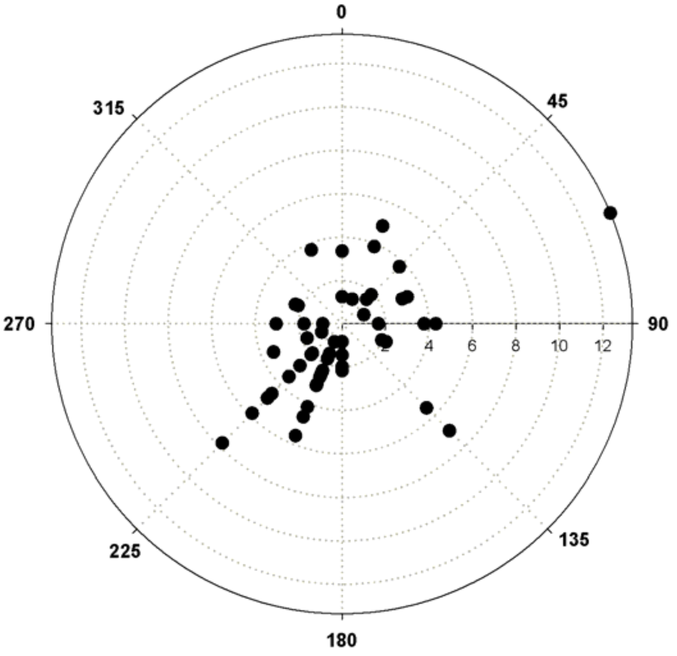

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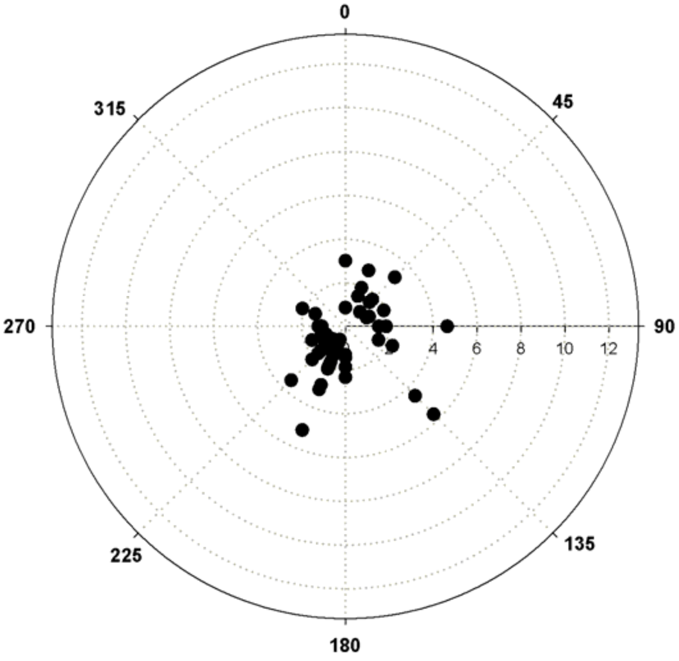

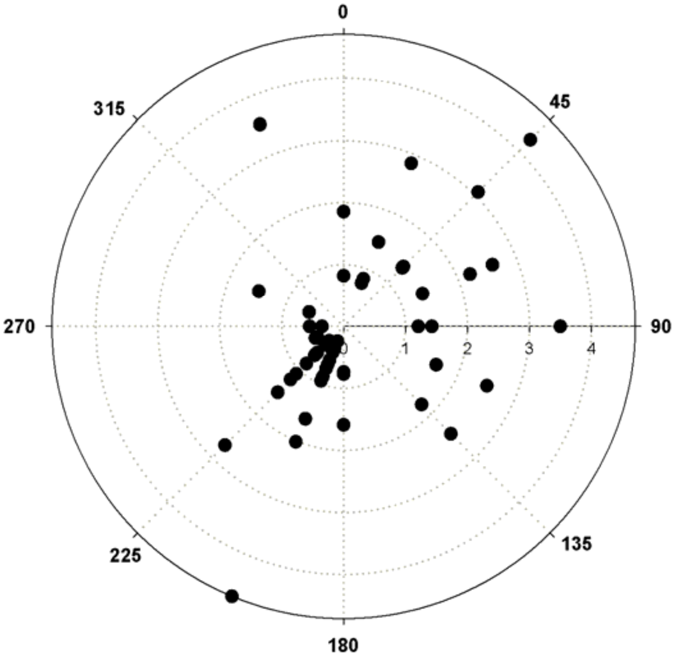

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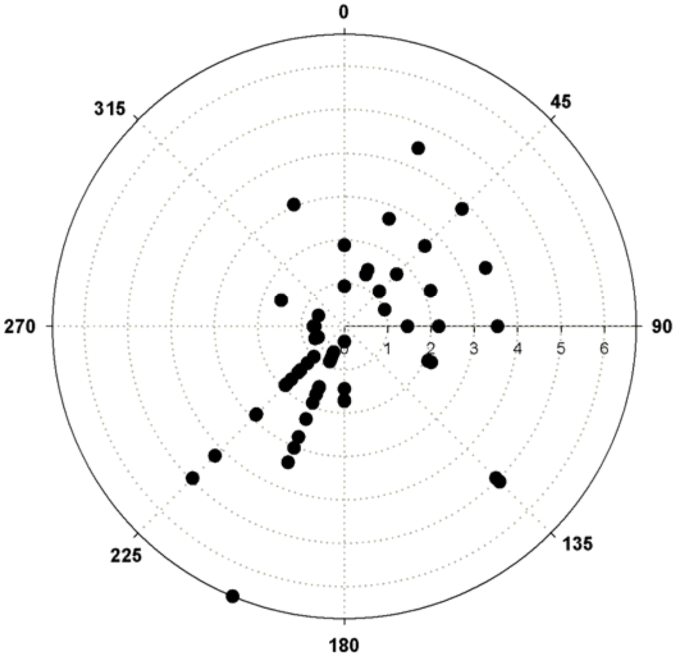

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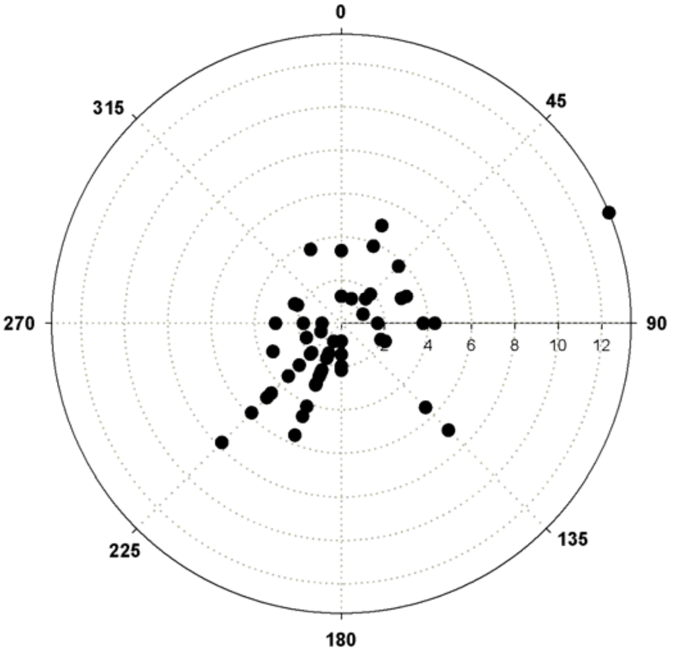

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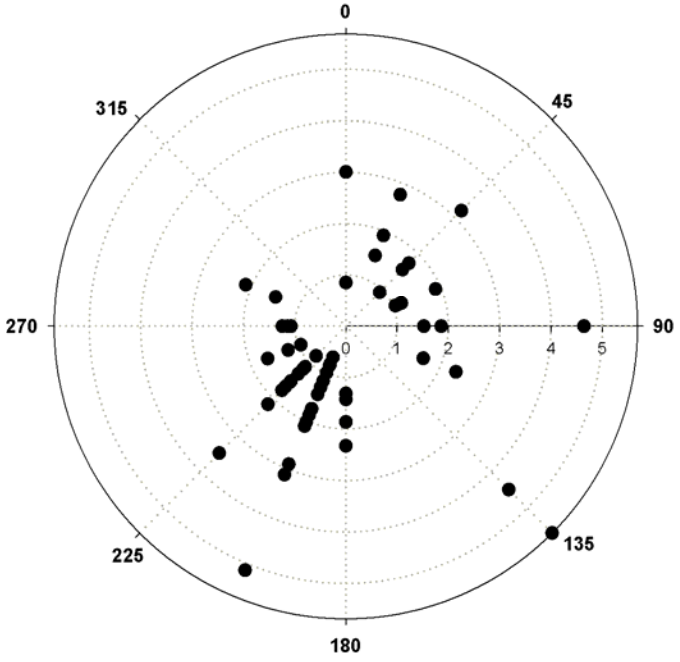

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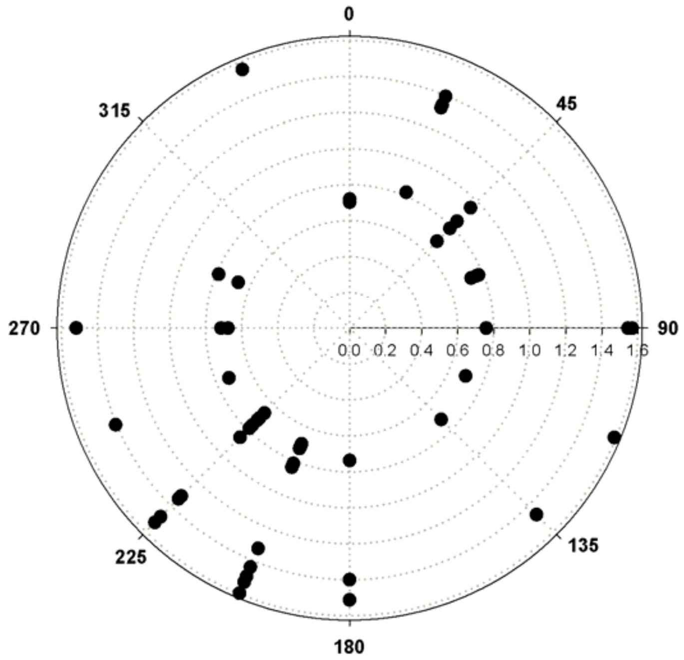
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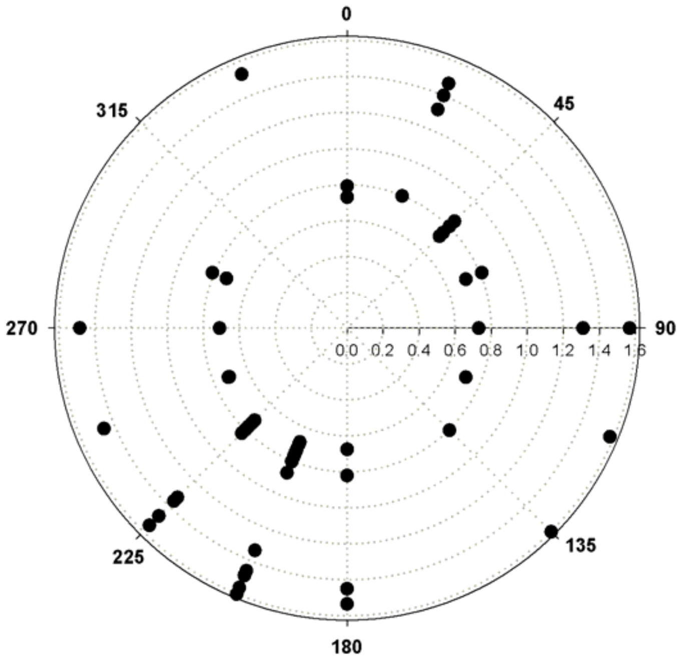
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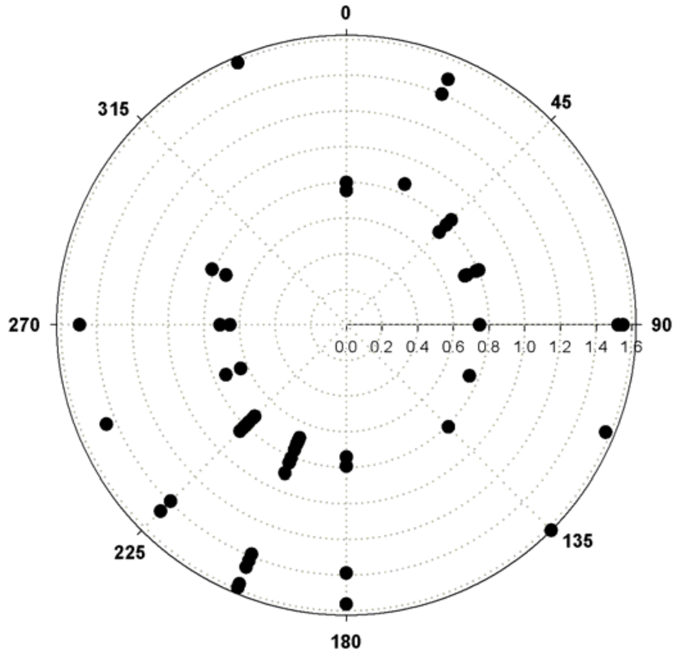
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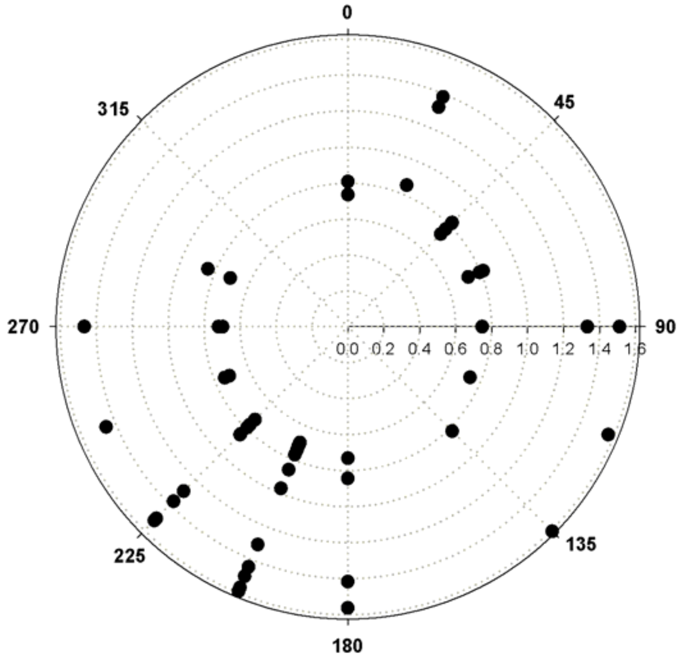
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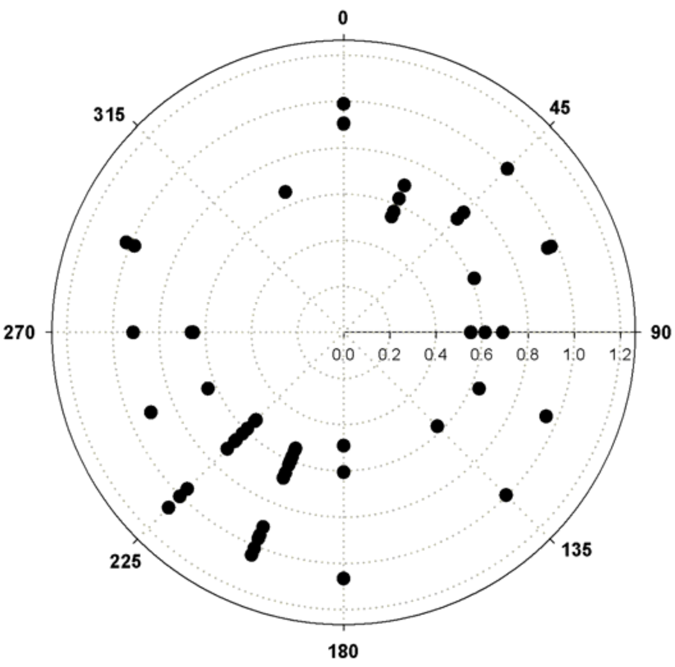

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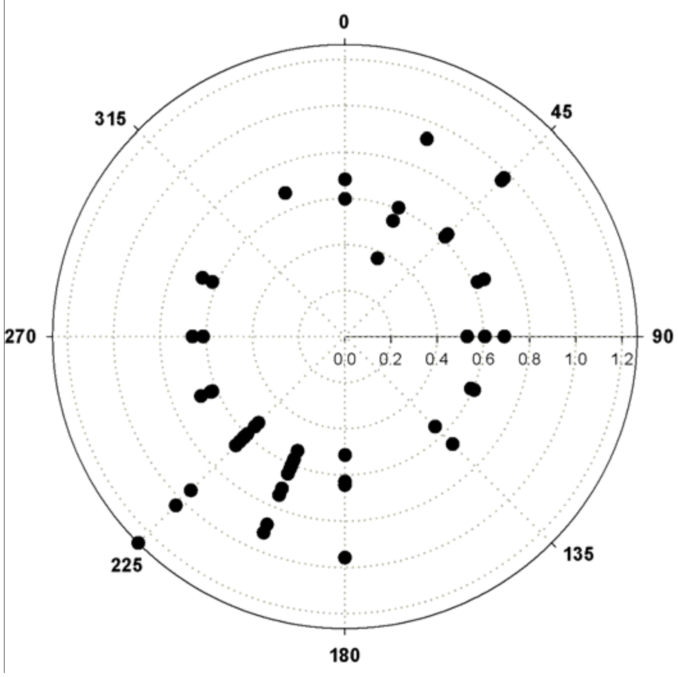

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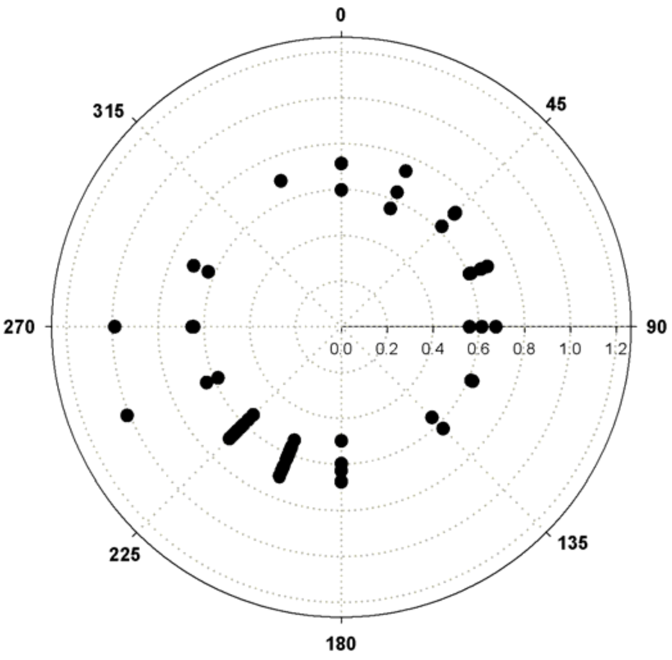

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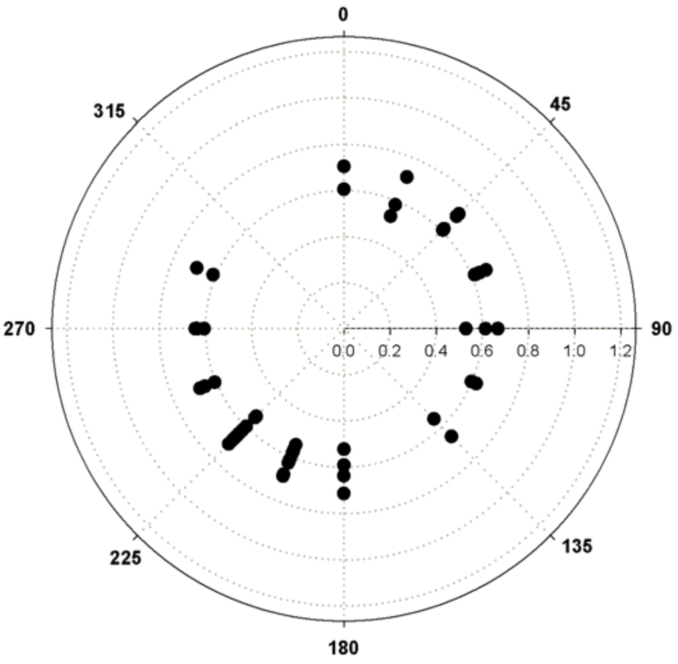

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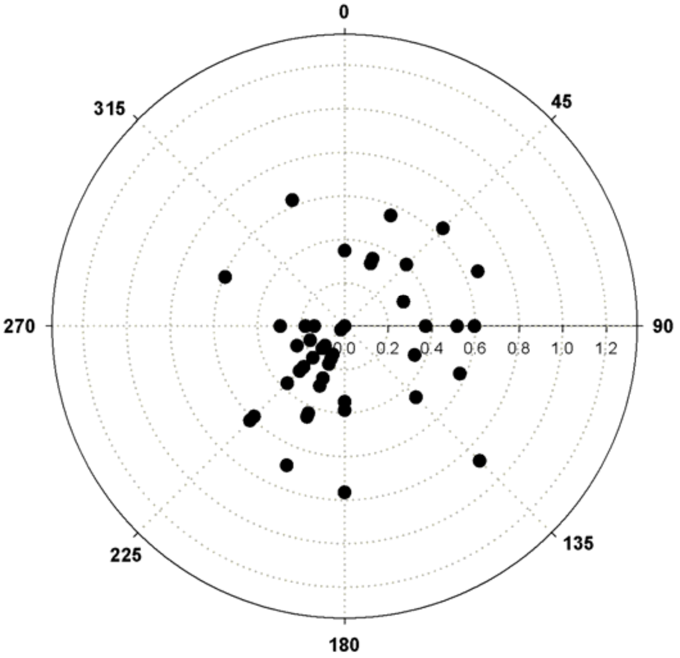

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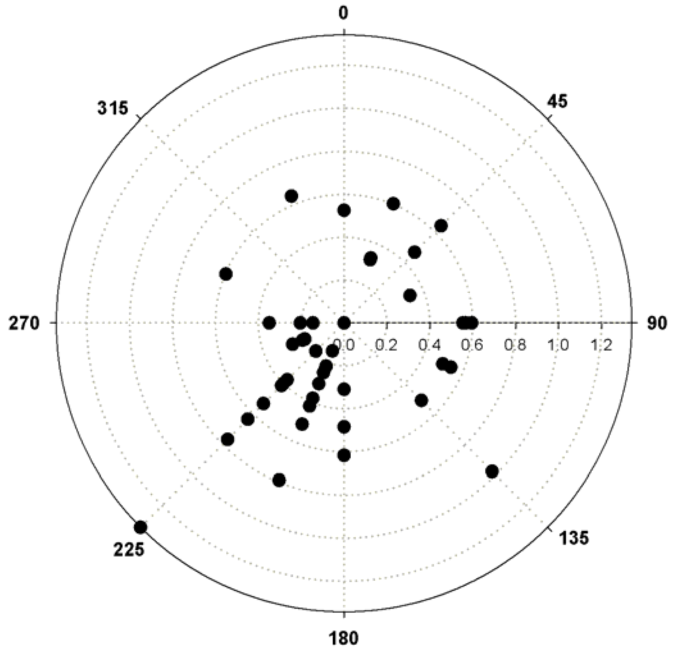

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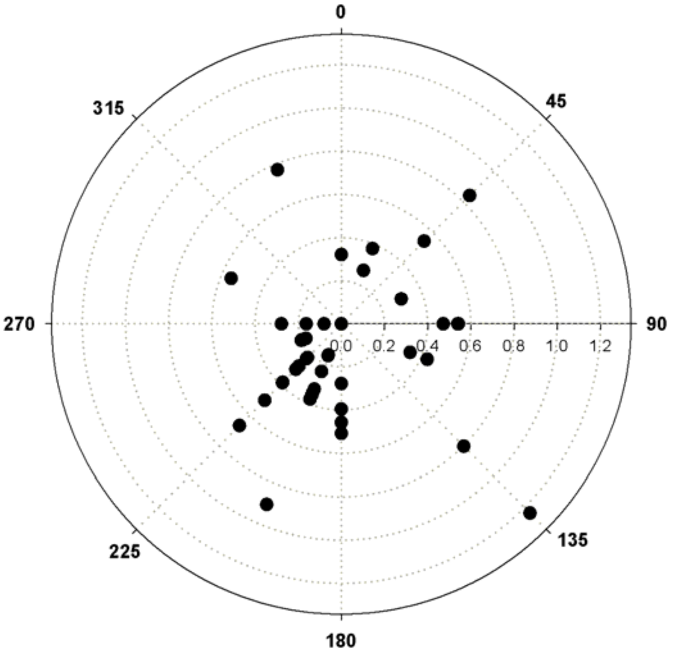
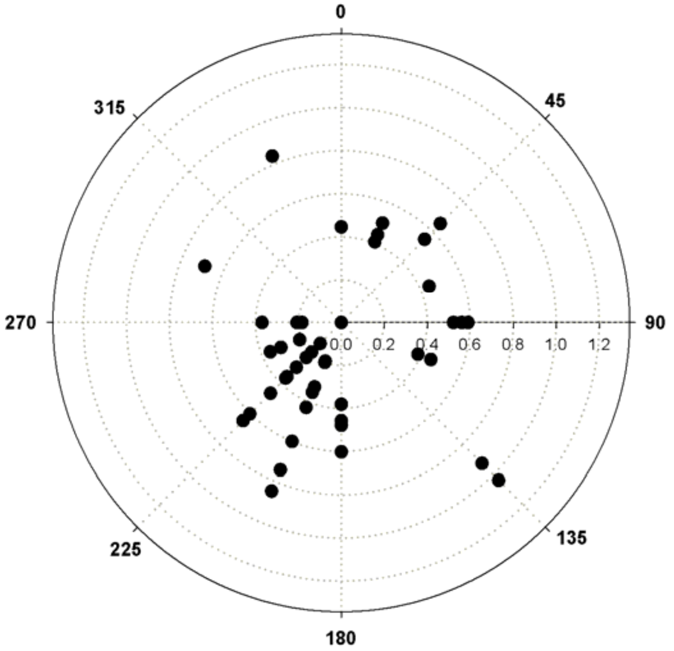


SPWT 2-Butanone



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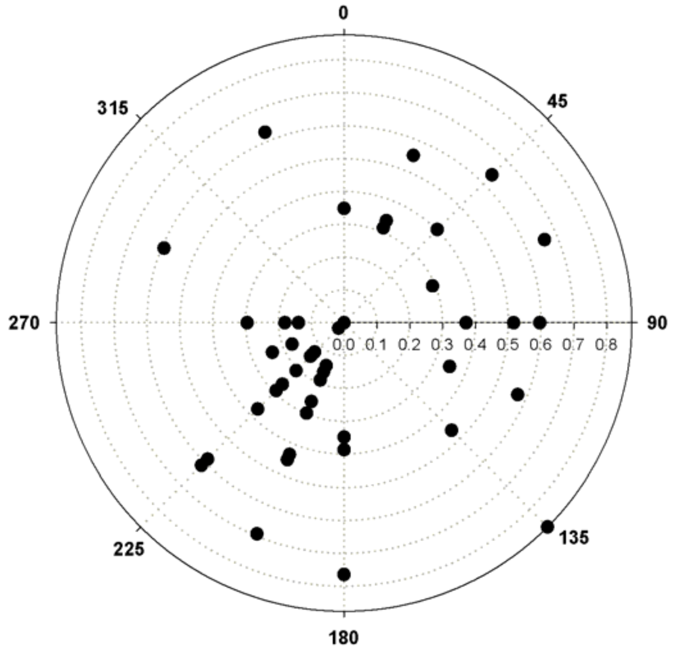

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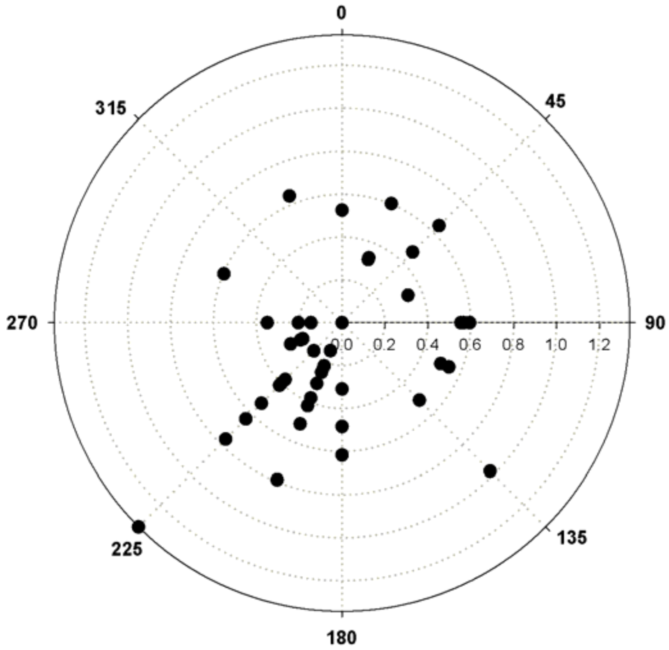

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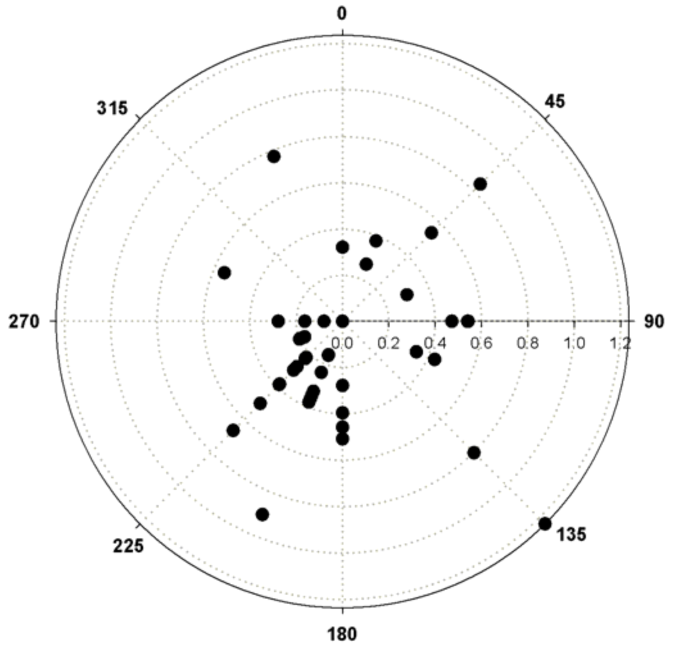
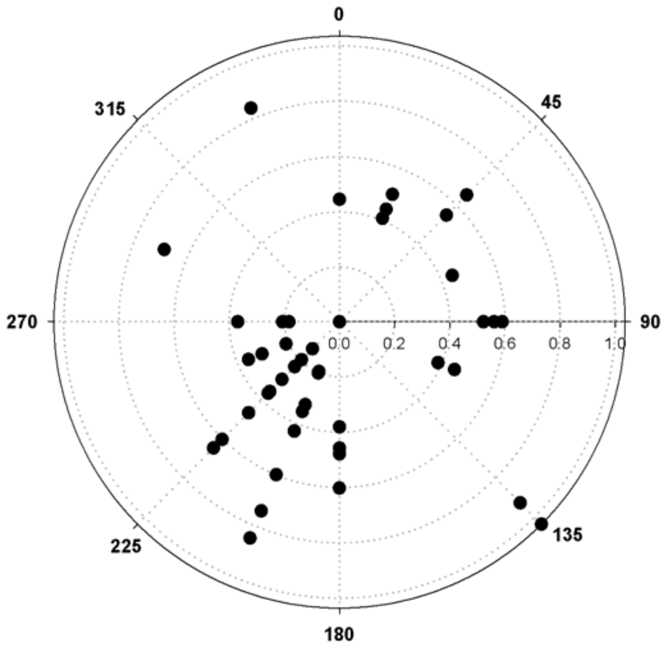
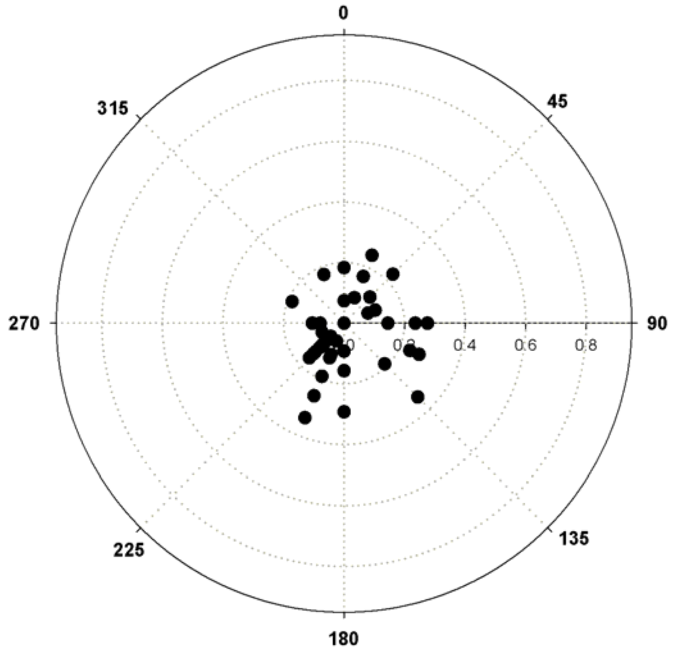
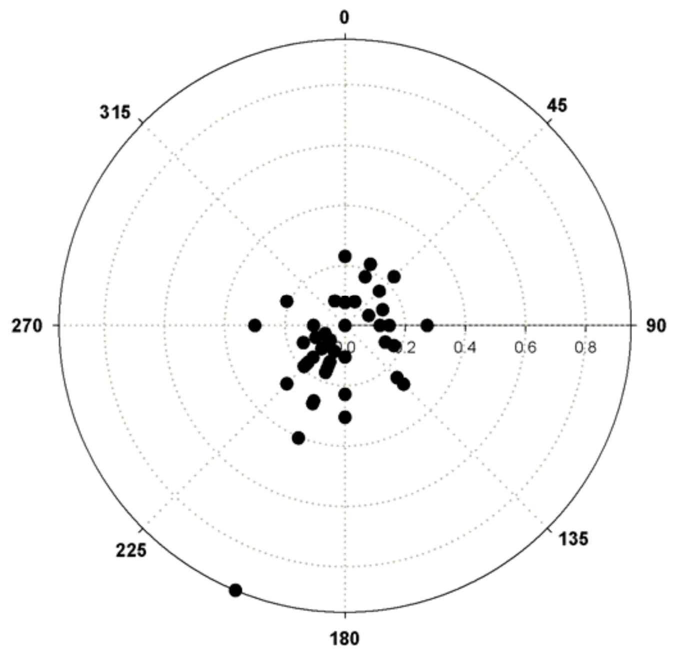


SPWT 2-Butanone





BISP Propionaldehyde



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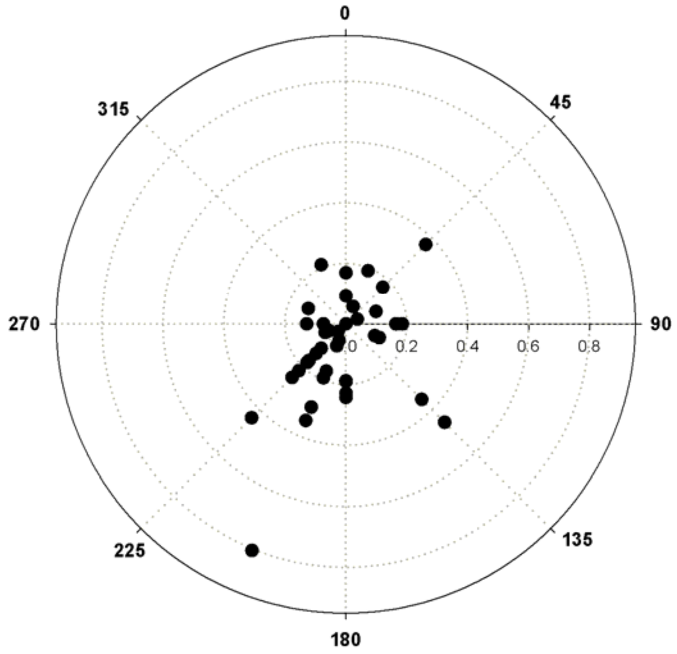

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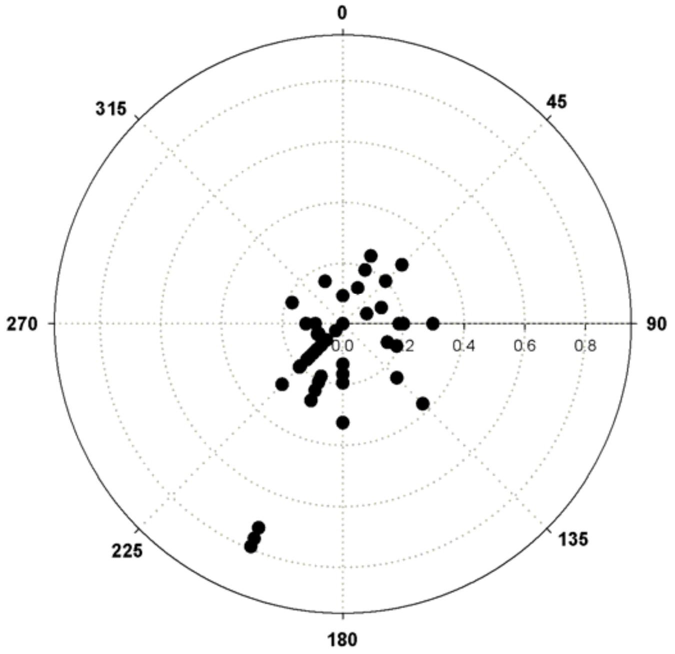
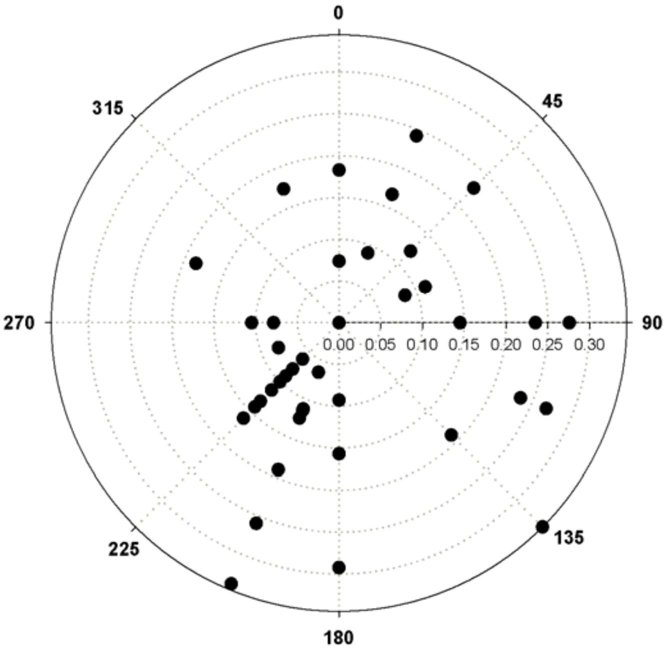


SPWT Propionaldehyde

BISP Propionaldehyde



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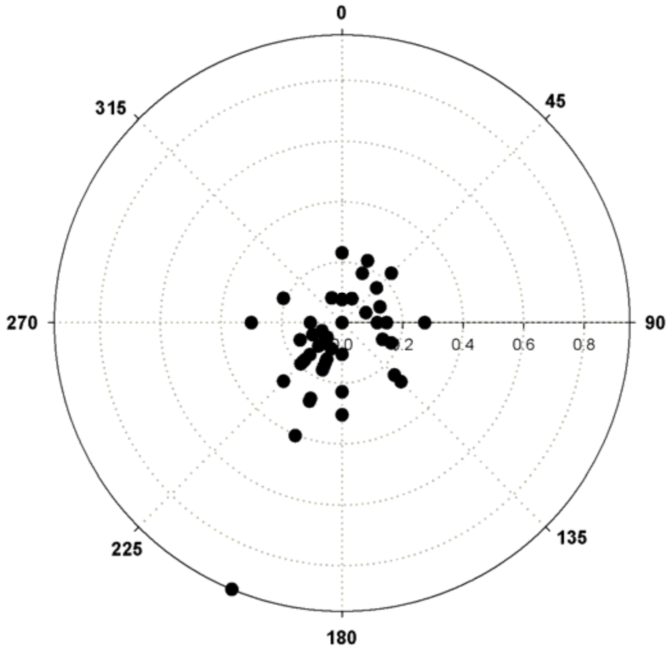

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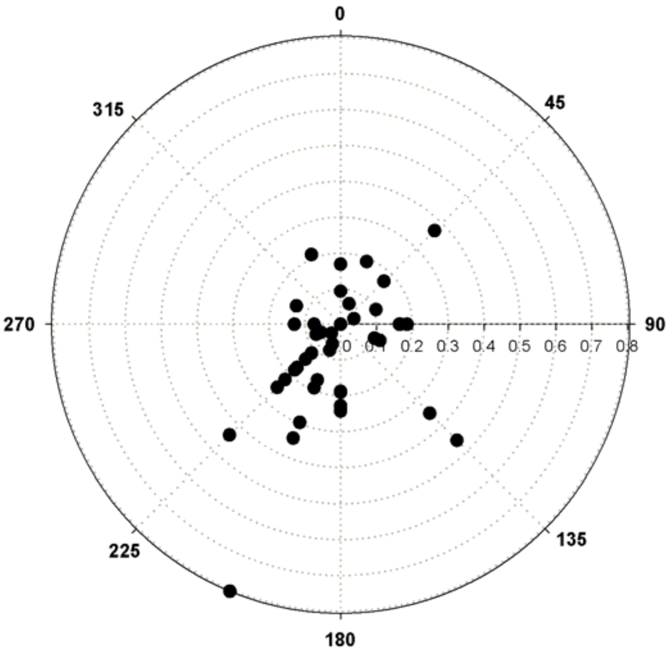
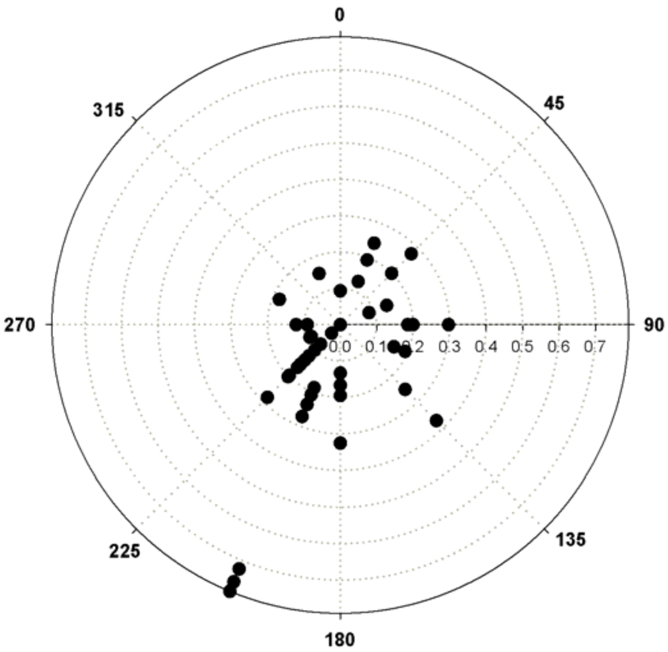
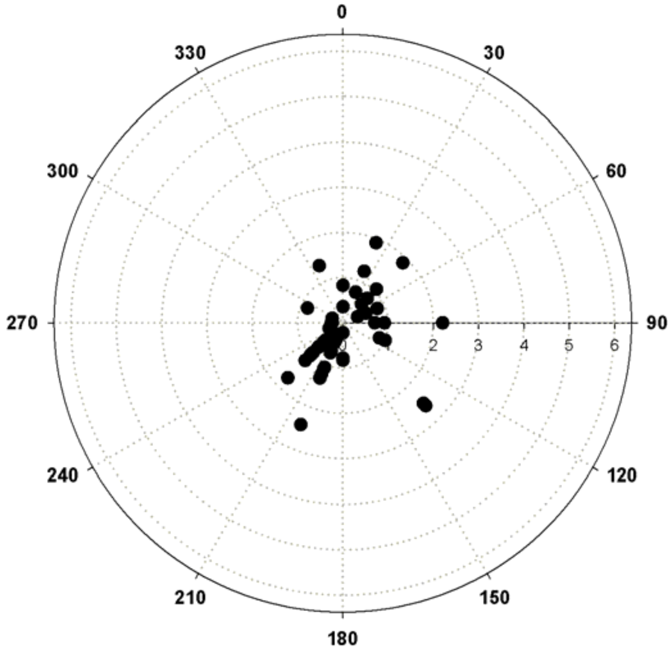
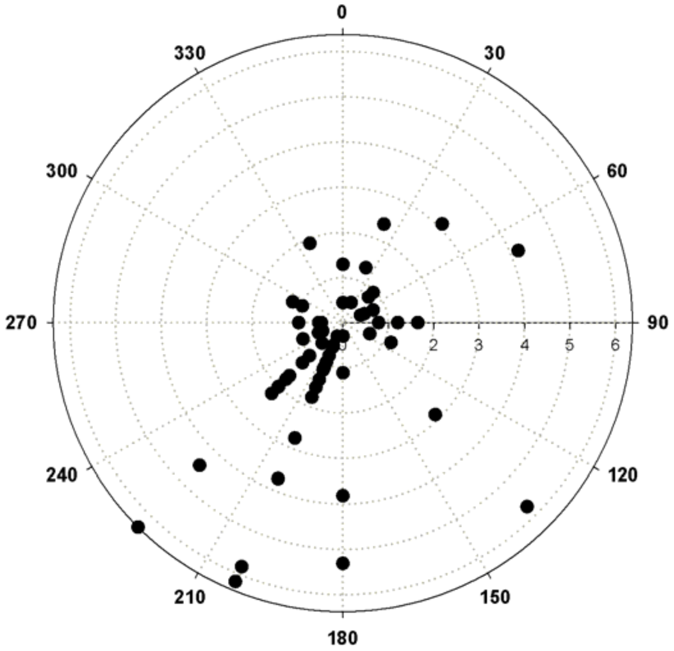


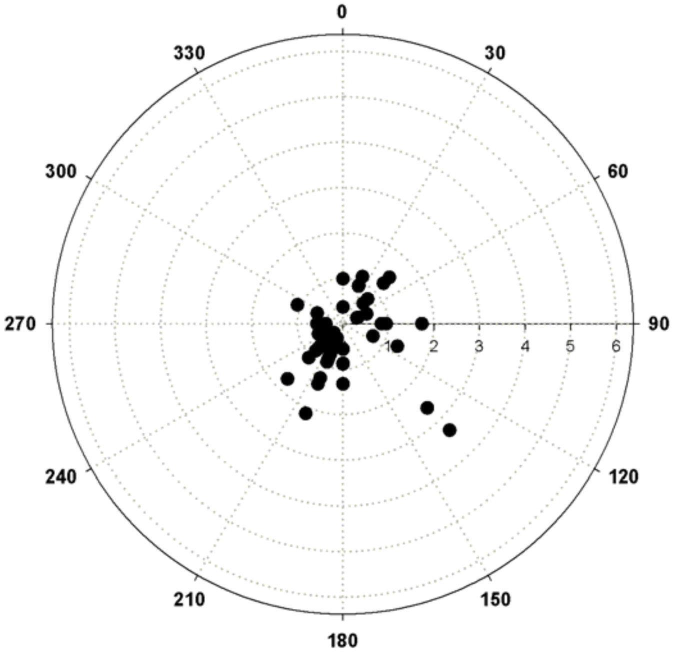
SPWT Propionaldehyde



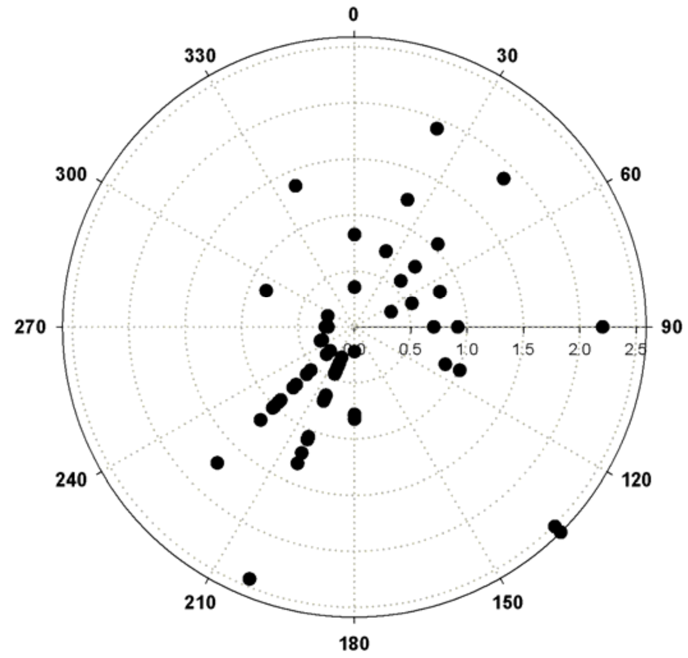

BTRS m,p-Xylene

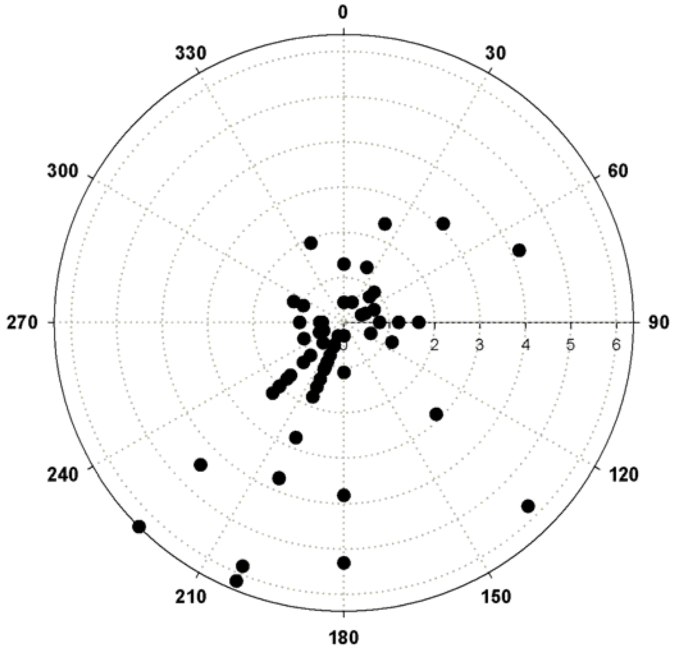
BISP is not in Category C or B


GIBI m,p-Xylene


SPWT m,p-Xylene

BISP is not in Category C or B


BTRS m,p-Xylene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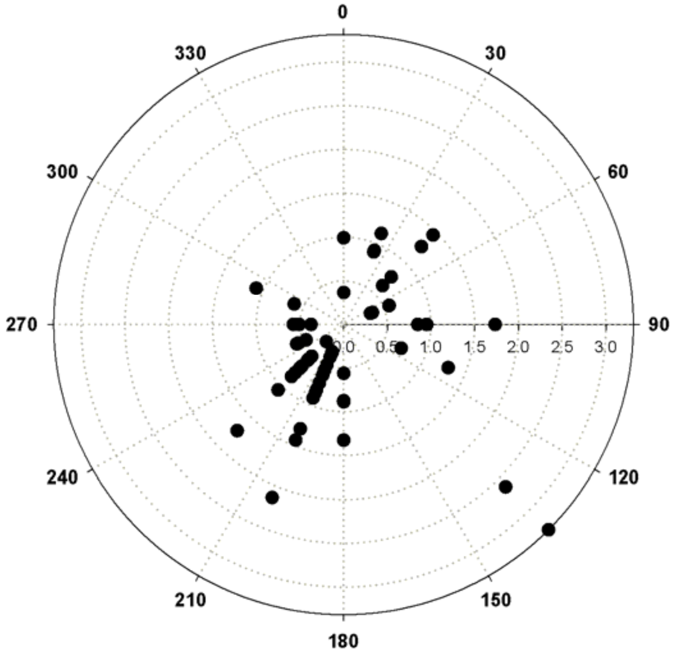
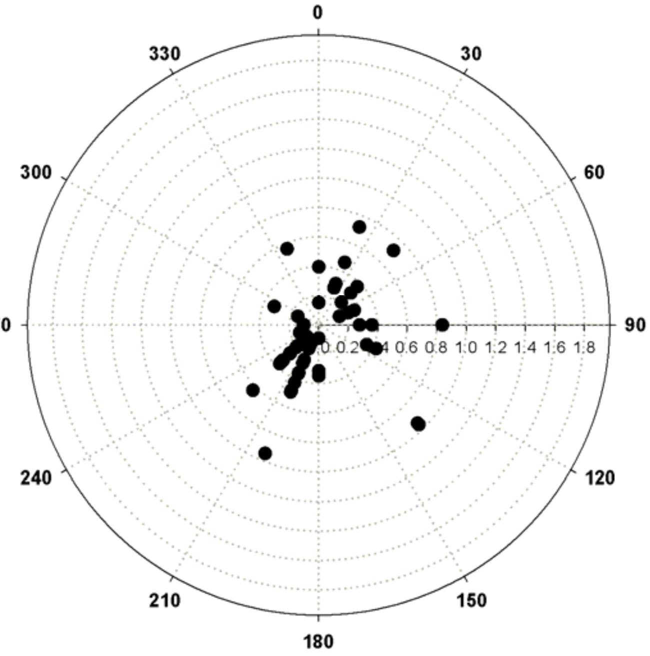
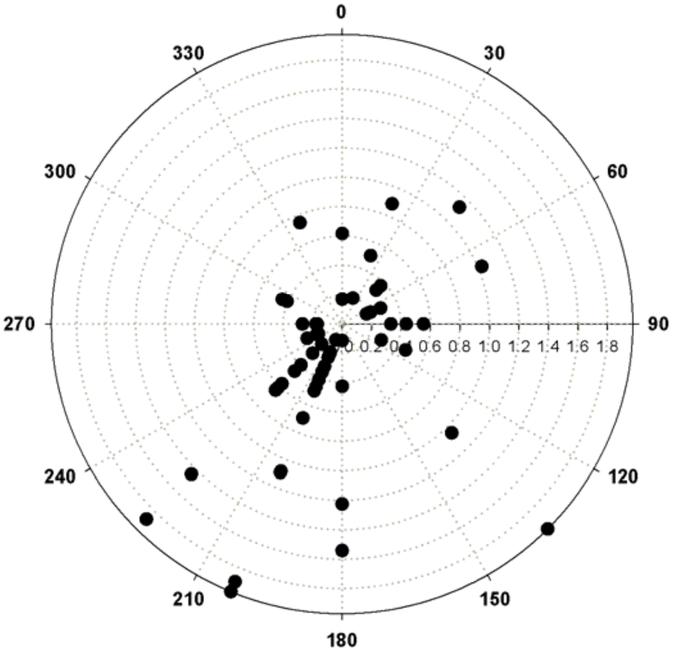

SPWT m,p-Xylene

BTRS o-Xylene



BISP is not in Category C or B

GIBI o-Xylene



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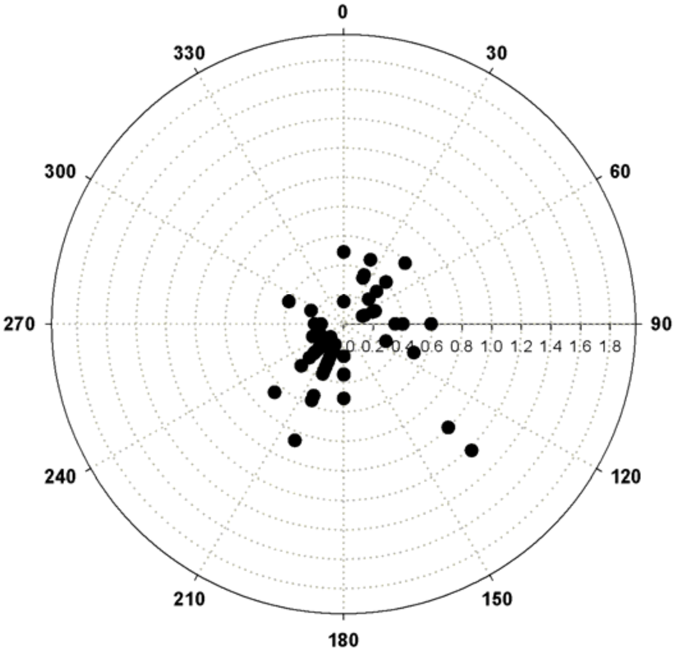
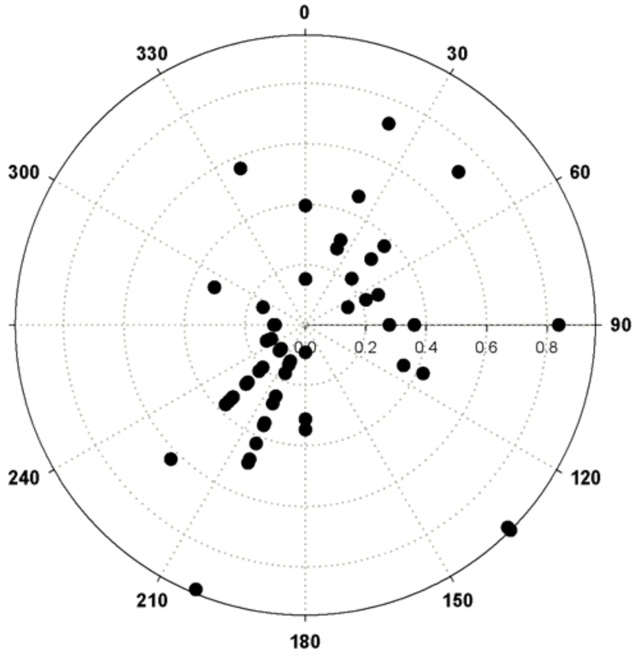
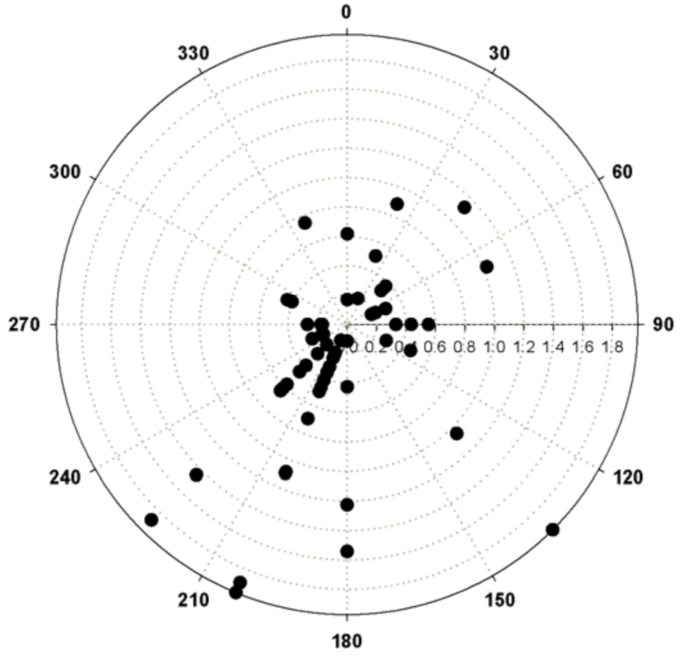


BTRS o-Xylene



BISP is not in Category C or B

GIBI o-Xylene



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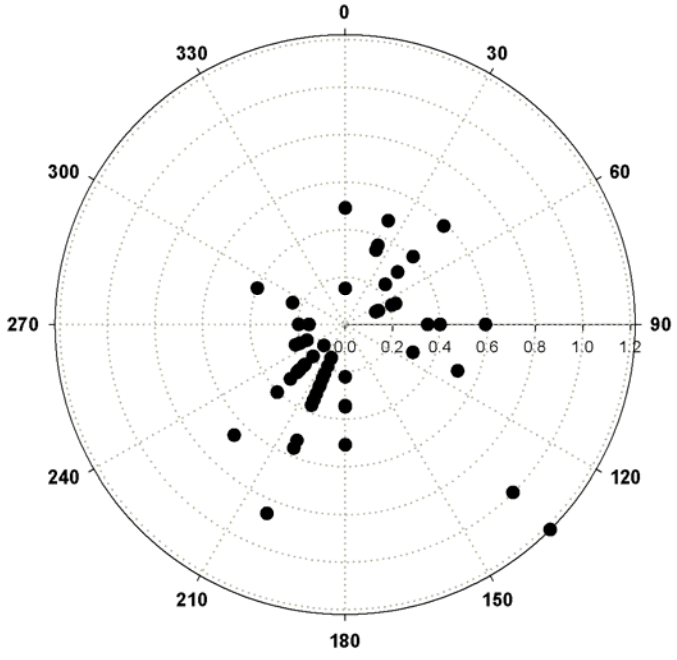
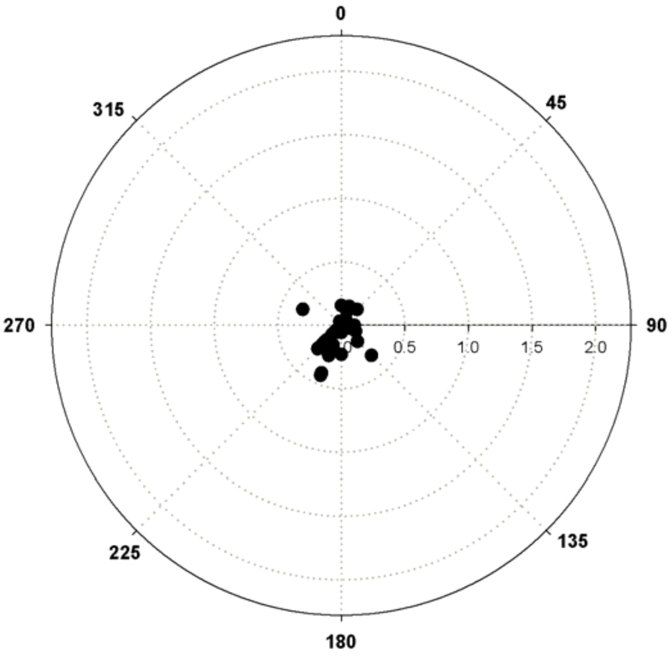
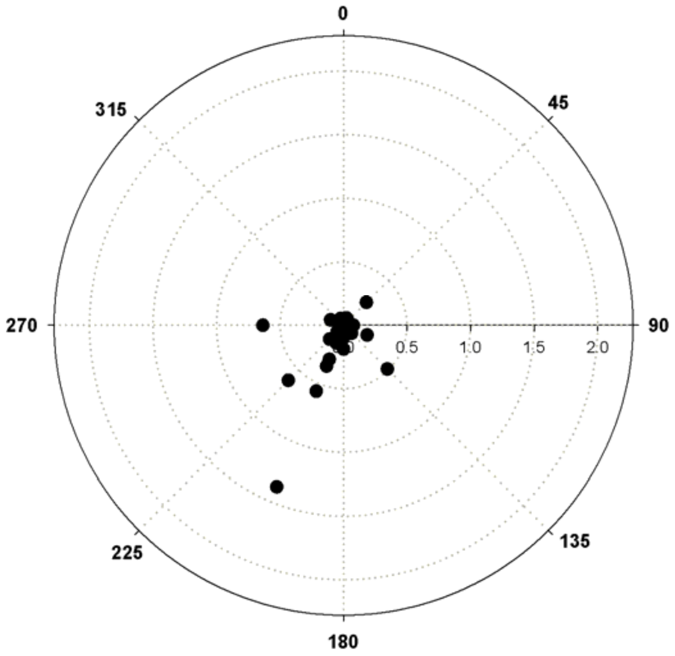


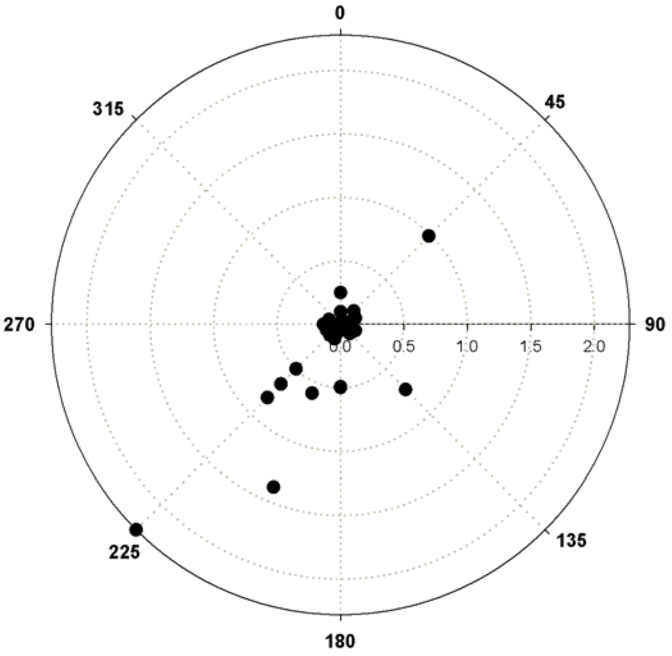
BISP Hexanal



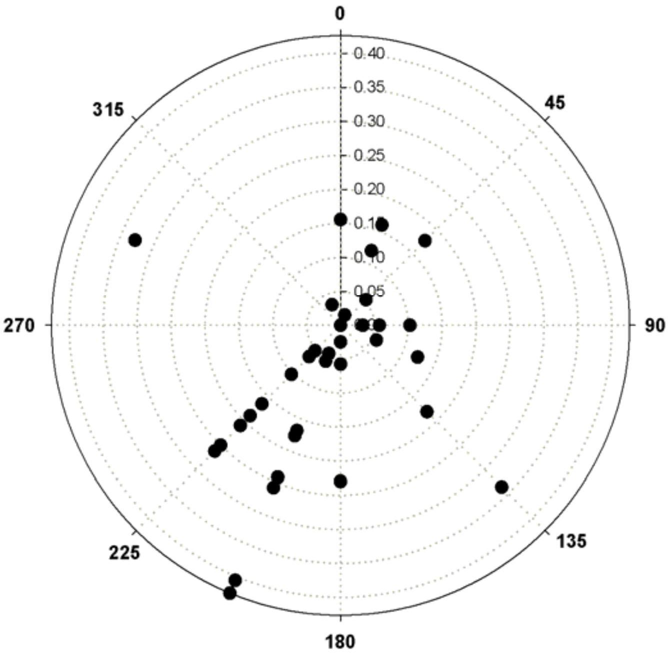
BTRS Hexanal



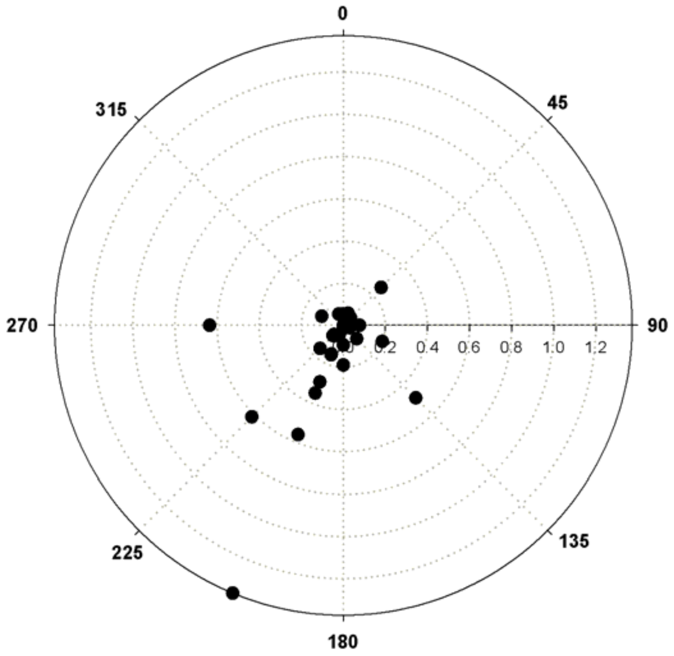
GIBI Hexanal



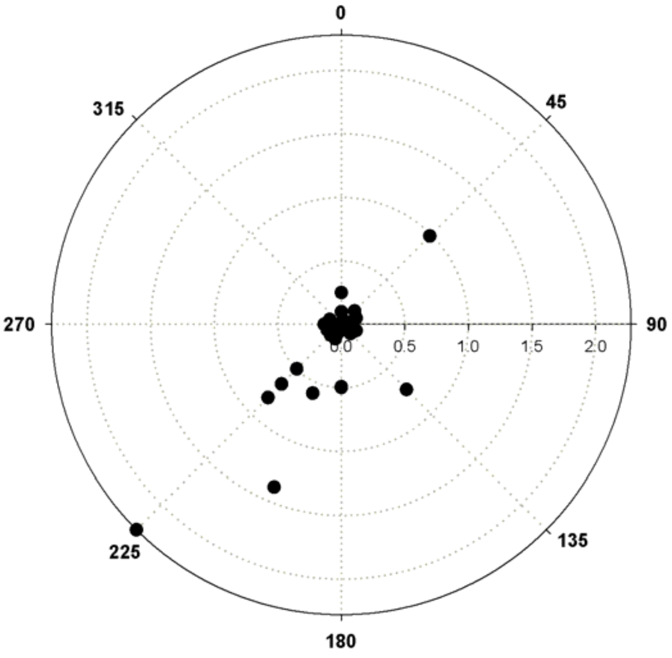
SPWT is not in Category C or B



BISP Hexanal

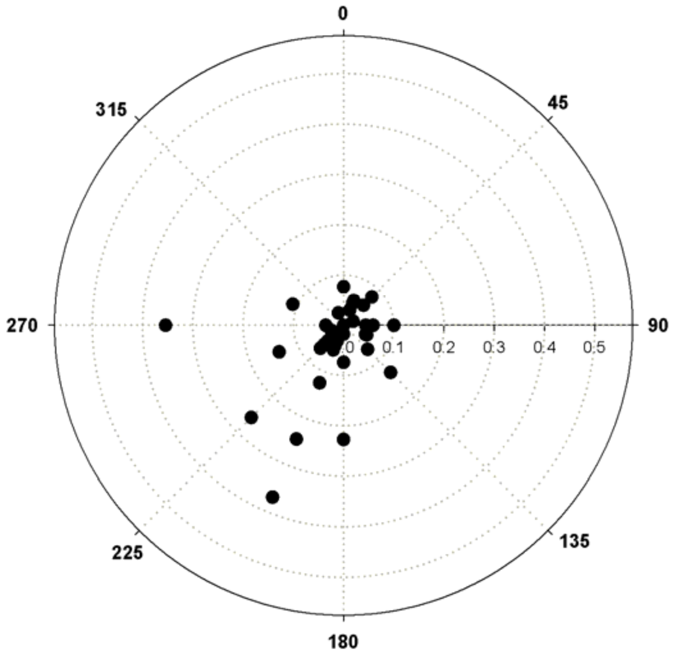


BTRS Hexanal



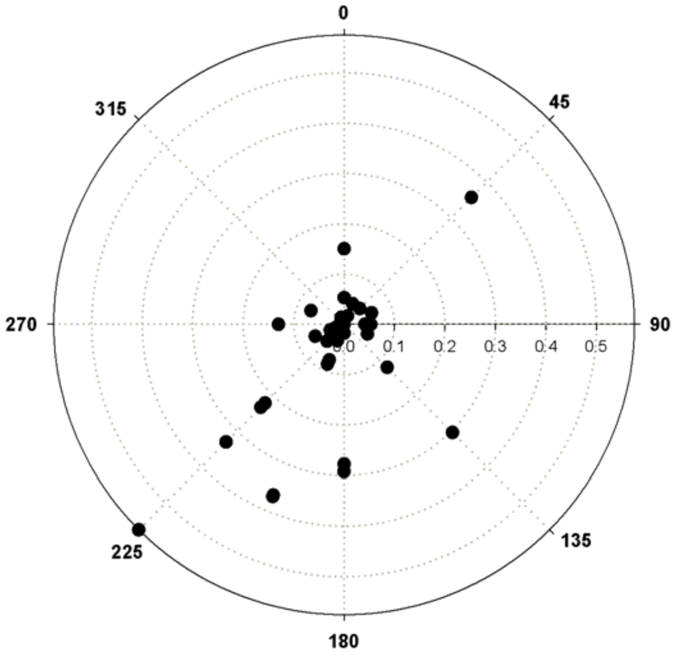
GIBI Hexanal

SPWT is not in Category C or B

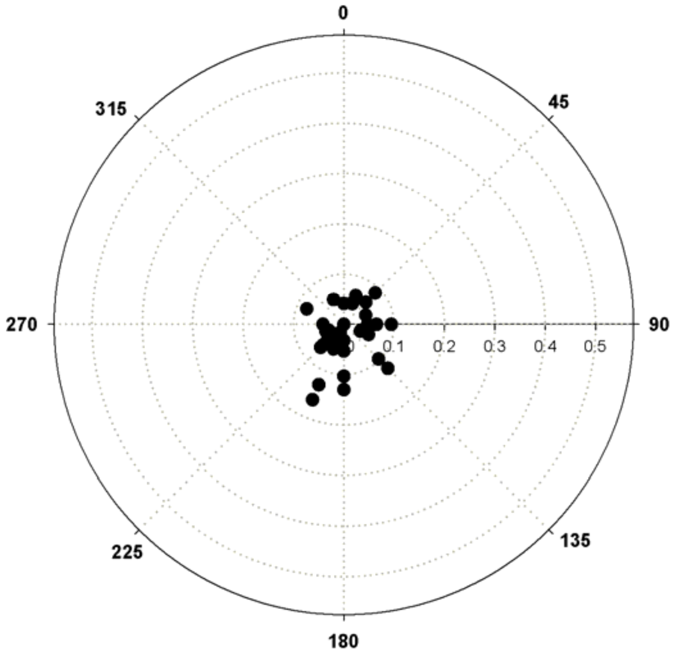


BTRS n-Butyraldehyde

BISP is not in Category C or B

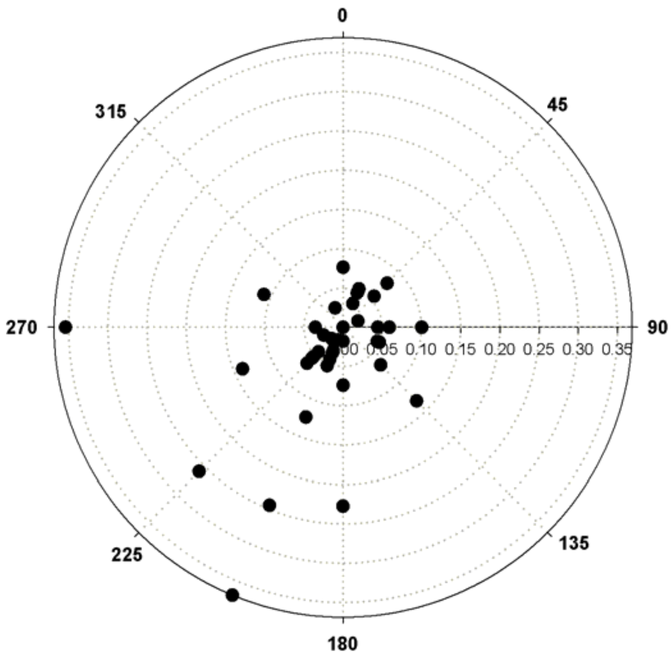


GIBI n-Butyraldehyde



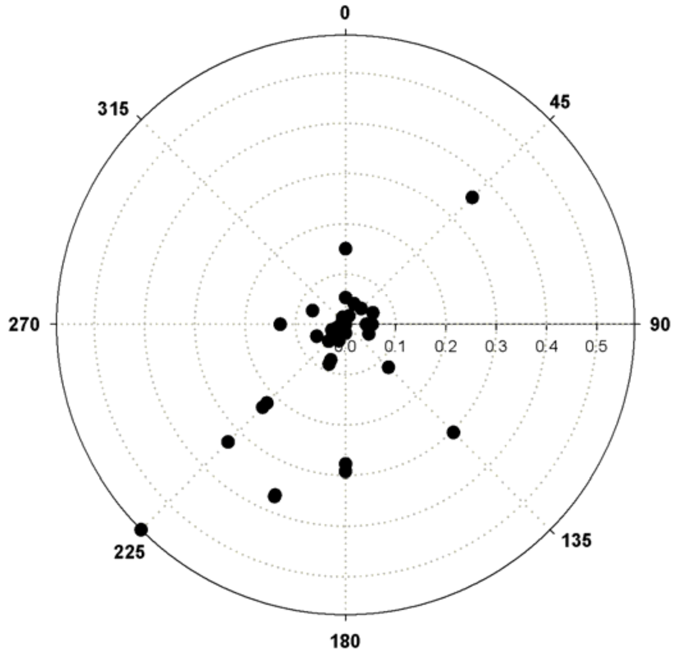
SPWT n-Butyraldehyde

BTRS n-Butyraldehyde



BISP is not in Category C or B

GIBI n-Butyraldehyde



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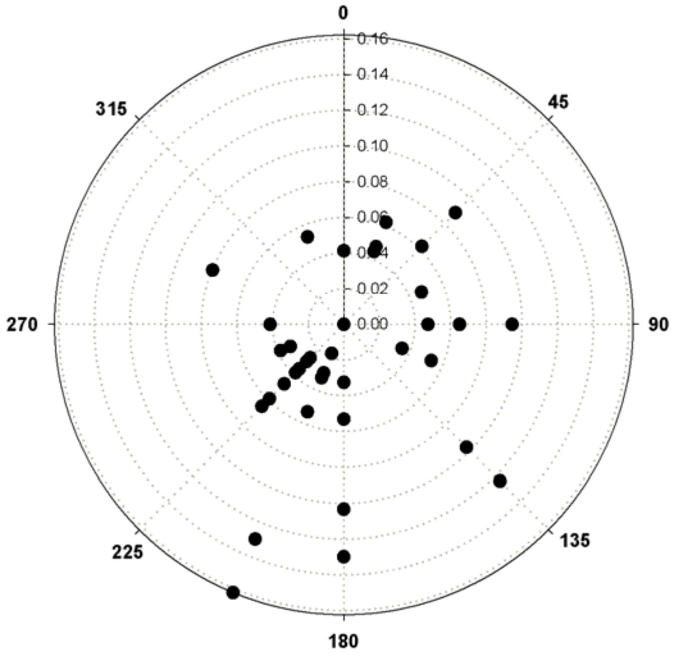
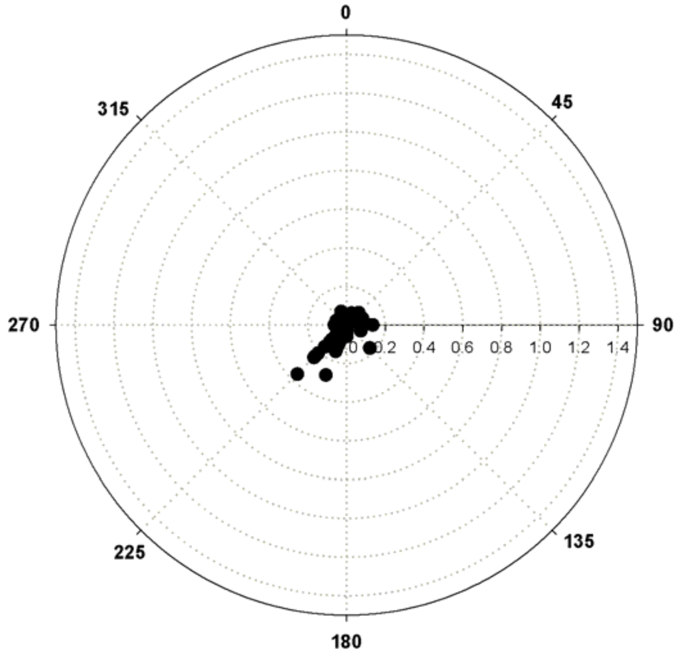
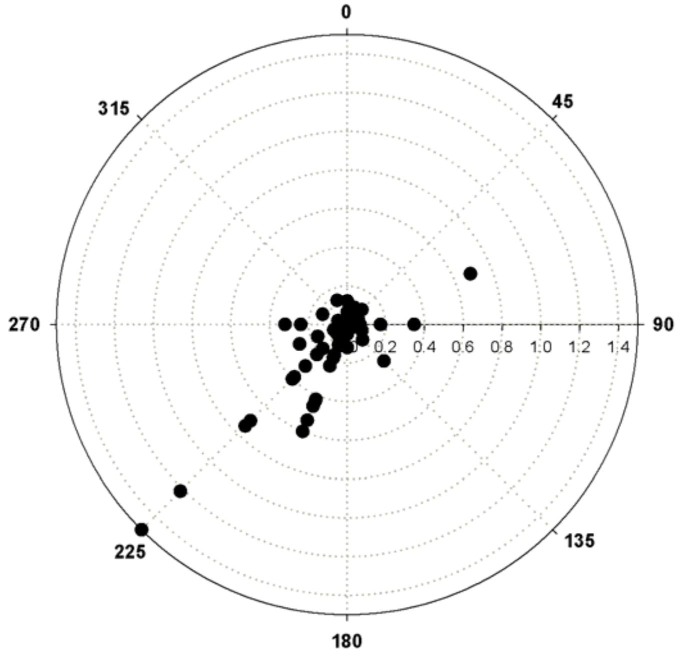


BISP is not in Category C or B

BTRS 1,3-Butadiene

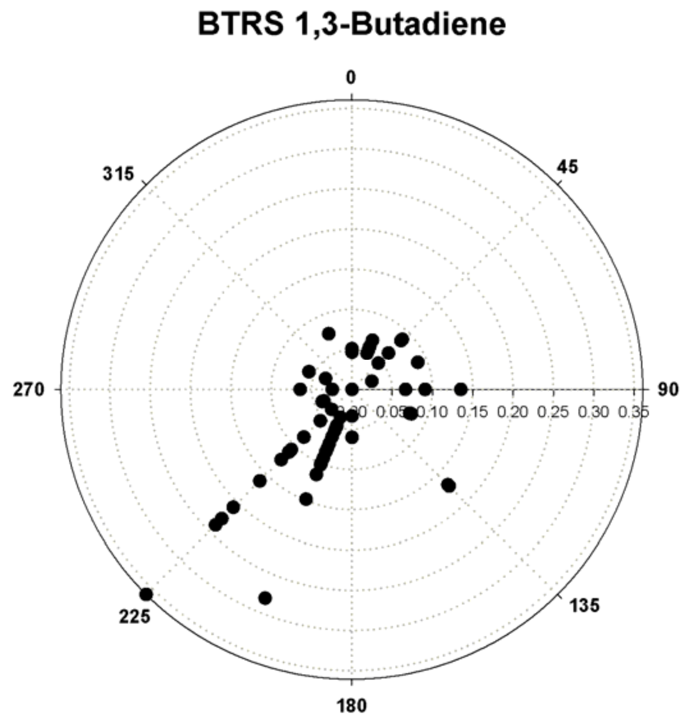


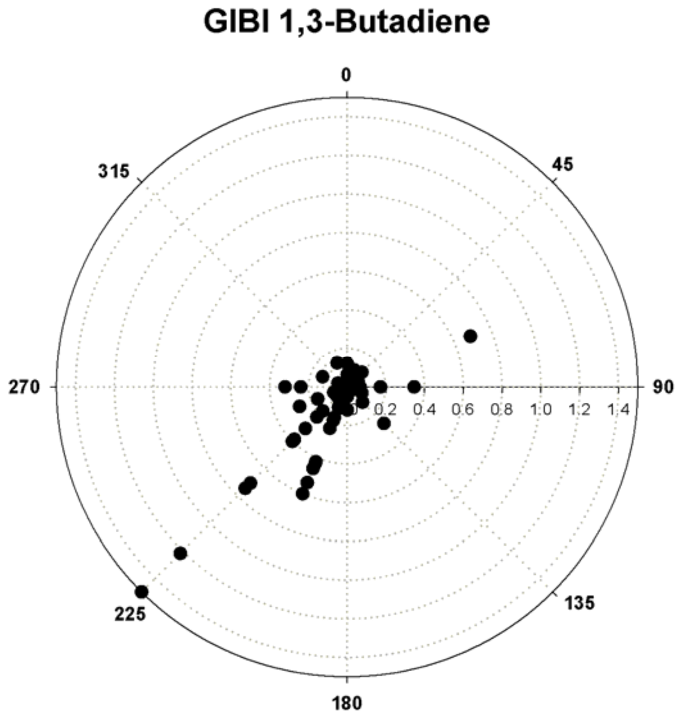
GIBI 1,3-Butadiene



SPWT is not in Category C or B

BISP is not in Category C or B

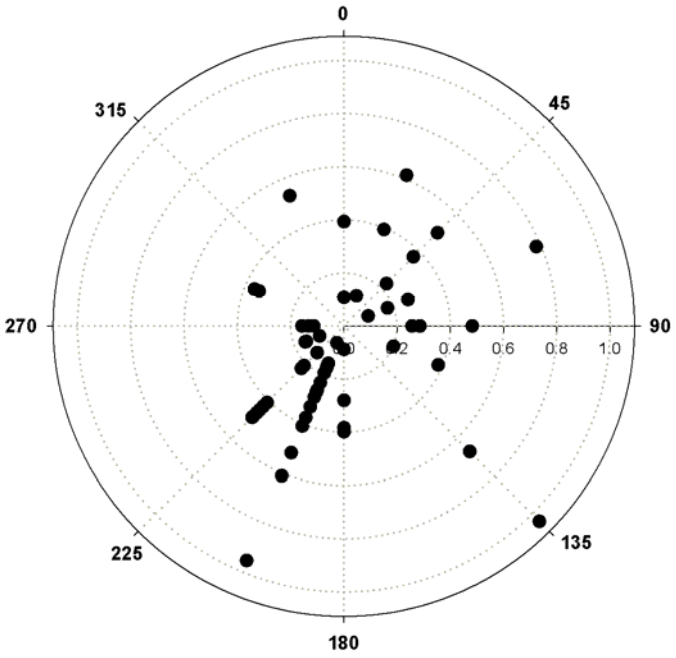




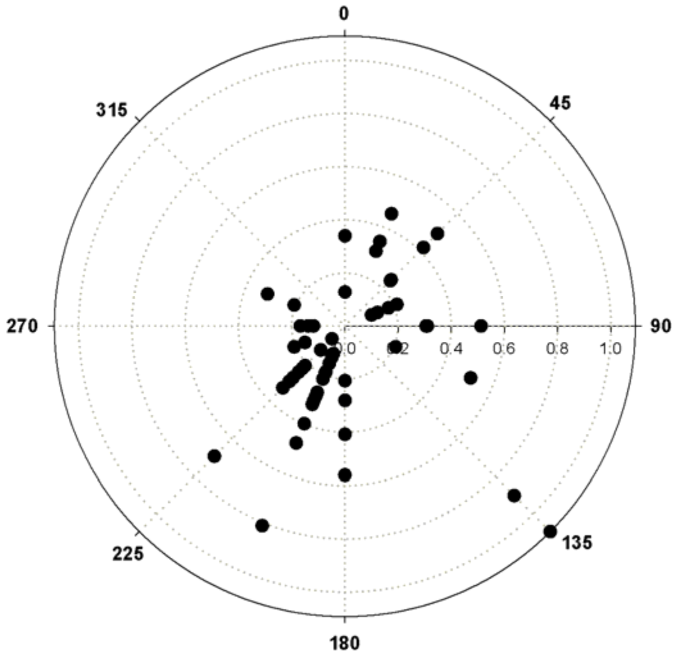
SPWT is not in Category C or B

BISP is not in Category C or B

BTRS is not in Category C or B

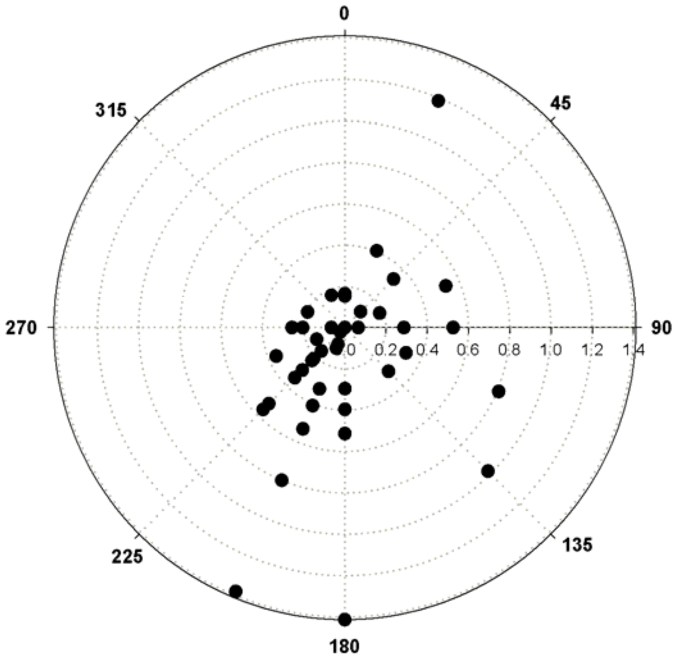


GIBI 1,2,4-Trimethylbenzene

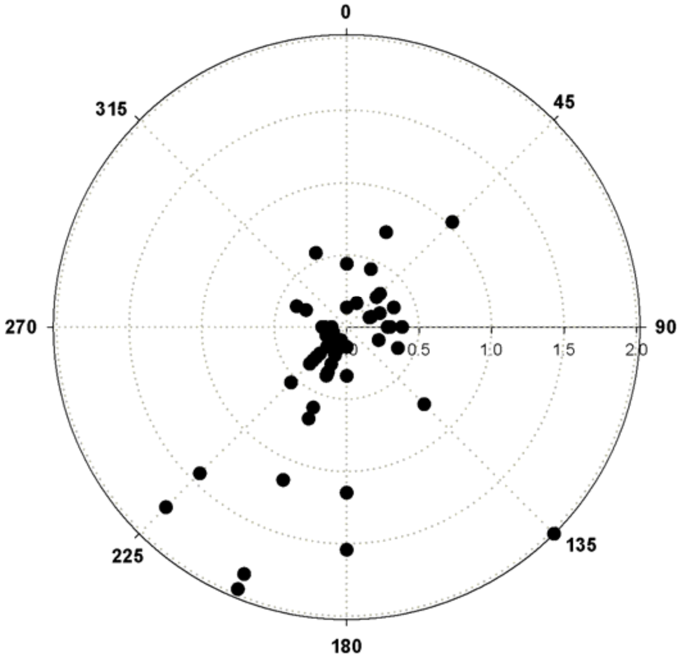


SPWT 1,2,4-Trimethylbenzene

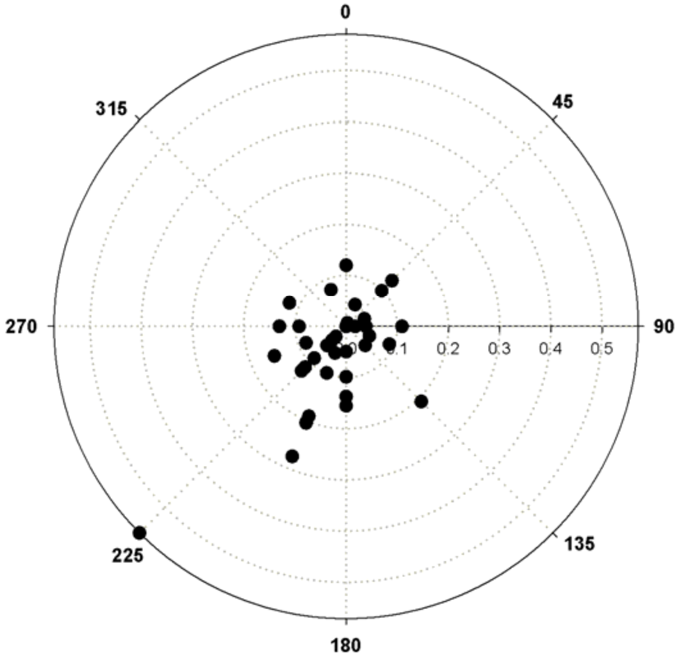
GIBI Benzaldehyde



GIBI Ethylbenzene



GIBI Valeraldehyde



These 3 contaminants are not in Category C or B at any other monitoring locations.

APPENDIX N - Expanded Wind Directionality Analyses for those Contaminants Below NYSDEC's AGCs

The analyses presented herein are for air contaminants which were below their respective NYSDEC health-based guidelines, so only a brief summary of each is provided.

Polar Plots

The carbon disulfide polar plots indicate directionality and are shown on both the standardized and maximized scales because of the differences in relative concentrations at the different monitoring locations (Appendix M). Directionality for carbon disulfide is indicated by the BTRS and the SPWT polar plots to the southwest/south, southwest (at 202.5-225°) and by the GIBI polar plot to the south (at 180°) but, while the BISP polar plot has one isolated high point to the south/southwest, overall it only slightly indicates directionality to the northeast. There were isolated high points in several directions in the GIBI carbon disulfide polar plot and in the southeast direction in the BTRS polar plot.

The hexanal polar plots indicate directionality and are shown on both the standardized and maximized scales because of the differences in relative concentrations at the different monitoring locations. Hexanal, m,p-xylene, o-xylene, n-butyraldehyde, 1,2,4-trimethylbenzene, benzaldehyde, ethylbenzene, and valeraldehyde had at least one monitoring location where it was not a Category C or B contaminant so the polar plots were not done for them at those particular sites (Appendix M). The remaining hexanal and ethylbenzene polar plot all indicate directionality to the south-west with only isolated high concentrations in the other directions. The n-butyraldehyde polar plots all indicate weaker directionality to the south/southwest and again only have isolated high concentrations in the other directions. The dichloromethane, toluene, 2-butanone, propionaldehyde, m,p-xylene, o-xylene, and benzaldehyde polar plots indicate very little or weaker directionality. Rather, the polar plots for these contaminants have elevated concentrations in several directions (many of which appear to be only isolated higher concentration points) with the exception of the GIBI polar plots for toluene, m,p-xylene, and o-xylene, which do show some directionality to the southwest. The chloromethane, dichlorodifluoromethane, trichlorofluoromethane, trichlorotrifluoroethane, 1,2,4-trimethylbenzene, and valeraldehyde polar plots do not show any real directionality at all and only have isolated high concentrations in various directions. The dichloromethane, toluene, 2-butanone, m,p-xylene, o-xylene, and 1,2,4-trimethylbenzene polar plots were interesting in that the only two days where the prevailing wind direction was from the southeast (at 135°) resulted in one or both of the measured concentrations to be elevated at all four monitoring locations.

TWA Pollution Roses

The carbon disulfide TWA pollution roses all point in towards the industrial area (Figure N.1). The vector lines intersect in the southern end of the industrial area and triangulate on the largest emitter of this air contaminant in the area. The carbon disulfide TWA pollution roses have maximum concentrations that differ from one monitoring site to the next indicating influences from local source effects. The m,p-xylene and o-xylene TWA pollution roses at three of the four sites very closely resemble one another (Figure N.2 and Figure N.3). The BISP TWA pollution rose for m,p-xylene and o-xylene are the only pair that differ somewhat. The pollution roses for both of the xylenes at GIBI indicate that both the industrial area and the adjacent roads influence the monitored concentrations, and at SPWT and BTRS they indicate a drift into the area from the direction of Buffalo. The BISP pollution roses for both xylenes indicate influences from the north/northwest and from the industrial area to the northeast, but only the BISP pollution rose for o-xylene indicates the drift into the area from the direction of Buffalo. The TWA pollution roses for the xylenes have some differences between the maximum concentrations from one monitoring site to the next indicating some influences from local source effects. The toluene TWA pollution roses show many similarities to those for the xylenes (as would be expected having similar sources) with the largest variation occurring at the GIBI monitor (Figure N.4). The GIBI toluene TWA pollution rose shows slight indications that the concentrations observed at this monitor are influenced by both the mobile sources on the adjacent roads and the industrial area. The SPWT and BTRS toluene TWA pollution roses indicate a drift into the area from the direction of Buffalo with BTRS also indicating additional sources to the north/northwest, the northeast, and the southwest (which potentially indicates an influence from the adjacent highway). The BISP toluene TWA pollution rose indicates an influence from the industrial area and to the north/northwest. The toluene TWA pollution roses also have some differences between the maximum concentrations from one monitoring site to the next indicating some influences from local source effects.

Wind Roses

The benzene/toluene ratio wind roses show some interesting similarities and differences as compared to those for benzene (Appendix O). The highest 10% benzene/toluene ratio days at the GIBI and BTRS monitors also have winds that are predominantly from the southwest as well as the south, southwest, but the lowest ratio days indicate a predominance of winds in the opposite direction (from the northeast), as opposed to, just an absence of winds from the southwest like with benzene. This indicates that the toluene from the mobile sources of the adjacent roads helps drive down the benzene/toluene ratio, along with the obvious reduction of benzene contributions from the industrial area and the largest local benzene source. The SPWT benzene/toluene ratio wind roses closely resemble those for benzene in that the highest ratios resulted when the winds were from a westerly direction and the lowest ratios were when this wind was absent. The BISP wind rose for the highest benzene/toluene ratio days differed from that of benzene in that it did not indicate predominant winds from the direction of the industrial area (from the northeast), but there were more winds from that direction than in the wind rose for the lowest ratio days.

Because a known large source of carbon disulfide was located in the southern portion of the industrial area, wind roses for the highest and lowest 10% carbon disulfide concentration days were also generated in order to observe if influences from this local source were apparent (Appendix O). The source is located to the southwest of the SPWT site and the wind roses indicate that this wind direction is predominant for the highest 10% carbon disulfide concentration days and absent in the lowest 10%. The source is south of the GIBI monitor and again the highest 10% carbon disulfide concentration days indicate winds from this direction whereas the lowest 10% do not. It is also clear by looking at the BISP wind roses that the source is to the northeast. The BTRS also shows local source effects with the source to the south, southwest/southwest of the monitor and this direction accounting for over 70% of the wind directionality for the highest carbon disulfide concentration days as opposed to only 12% for the lowest concentration days with much more wind in the opposite direction (from the northeast).

Because the xylenes appeared to track together, they were combined in order to investigate the wind patterns for the highest and lowest concentration days (Appendix H). The wind roses for the GIBI and BISP sites indicate influences from the industrial area. There were winds from the southwest at the GIBI site and from the northeast at the BISP site for the highest total xylenes concentration days but few and no winds from those same directions, respectively, for the lowest concentration days at these monitors. The BTRS and SPWT total xylenes wind roses do not show the same influences from the industrial area. In fact, the BTRS wind rose indicates that the highest total xylenes concentrations occur when the winds are predominantly out of the north, northeast to the east, northeast in addition to the southeast, and that the lowest concentrations occur when the winds are more out of the south, southwest to west direction. The primary differences between the highest and lowest total xylenes concentration days at the SPWT are fewer winds from the south, southwest direction and the additional winds from the south, the southeast, and the east, northeast directions for the highest 10% concentration days.

Upwind/Downwind Analysis

An upwind/downwind analysis for carbon disulfide was also performed because the local area emissions are well understood and limited primarily to one main source (Figure N.5). For this analysis, only two monitors were able to be used because of the position of this facility with respect to the monitor locations. The opposite wind directions were both used to compare the various situations with the two monitors acting as both upwind and downwind sites. As expected, the results indicated that when the winds were out of the west, southwest (from 247.5°), the average carbon disulfide concentrations were lower at the BISP monitor (upwind) and higher at the SPWT monitor (downwind), and when the winds were out of the east, northeast (from 67.5°), the average carbon disulfide concentrations were lower at the SPWT monitor (now upwind) and higher at the BISP monitor (now downwind). It was surprising that the average carbon disulfide concentration at the SPWT was so close to that at the BISP monitor when the winds were coming from the 67.5° degree sector, so the concentrations for the individual days were reviewed. It was found that one day with low wind speeds resulted in a high carbon disulfide concentration at the SPWT, even though the direction of the wind would mean that the monitor was upwind of the facility. It is believed that the low wind speeds for that day allowed the carbon disulfide to spread out over the area and result in the high concentration observed. When this day was removed, the average carbon disulfide concentration at the SPWT monitor plummeted from 1.60 $\mu g/m^3$ to 0.11 $\mu g/m^3$ while the average concentration at the BISP monitor only changed from 1.68 $\mu g/m^3$ to 1.64 $\mu g/m^3$, so the difference between the site upwind to that downwind became much greater.

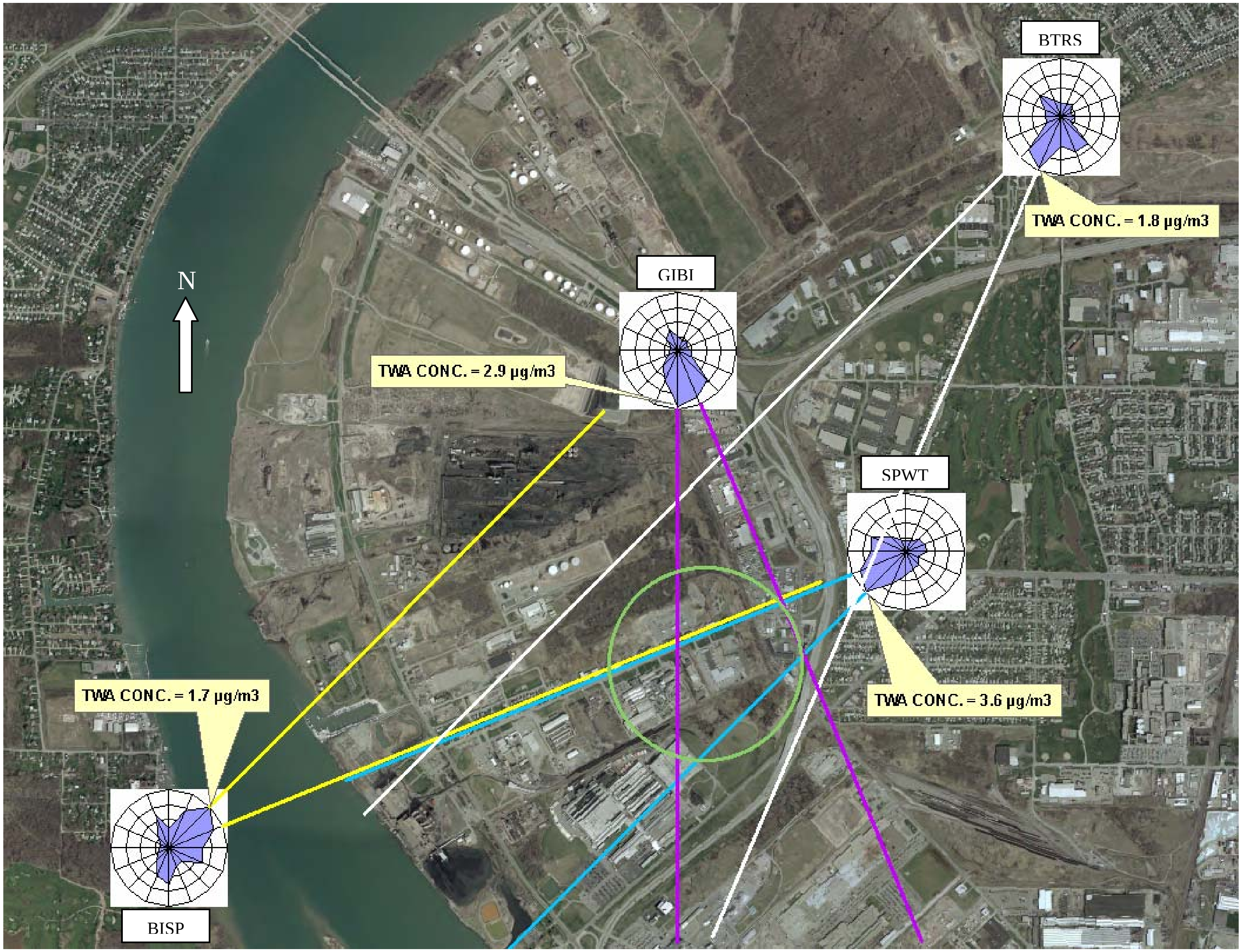


Figure N.1. Carbon Disulfide TW Pollution Roses

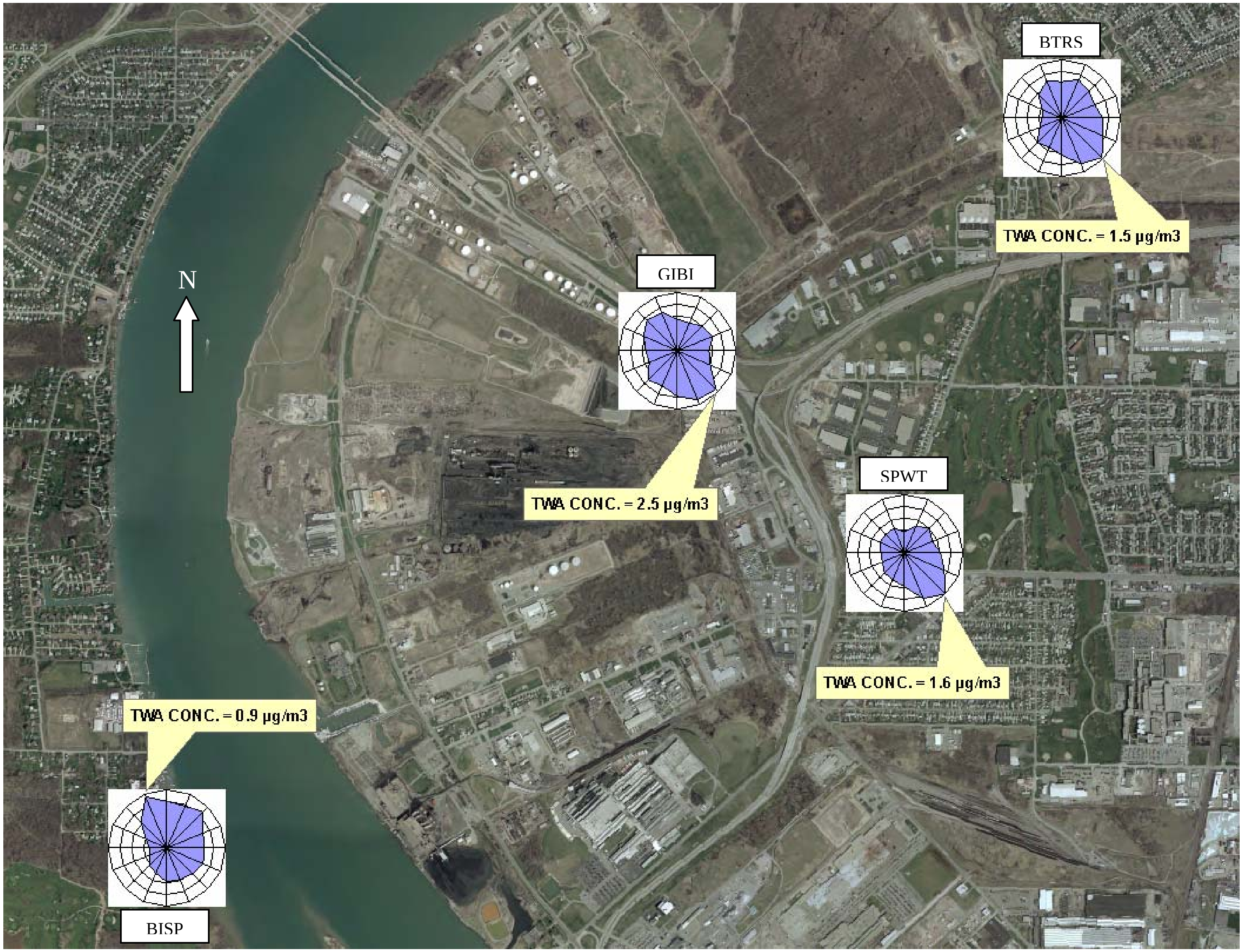


Figure N.2. m,p-Xylene TW Pollution Roses

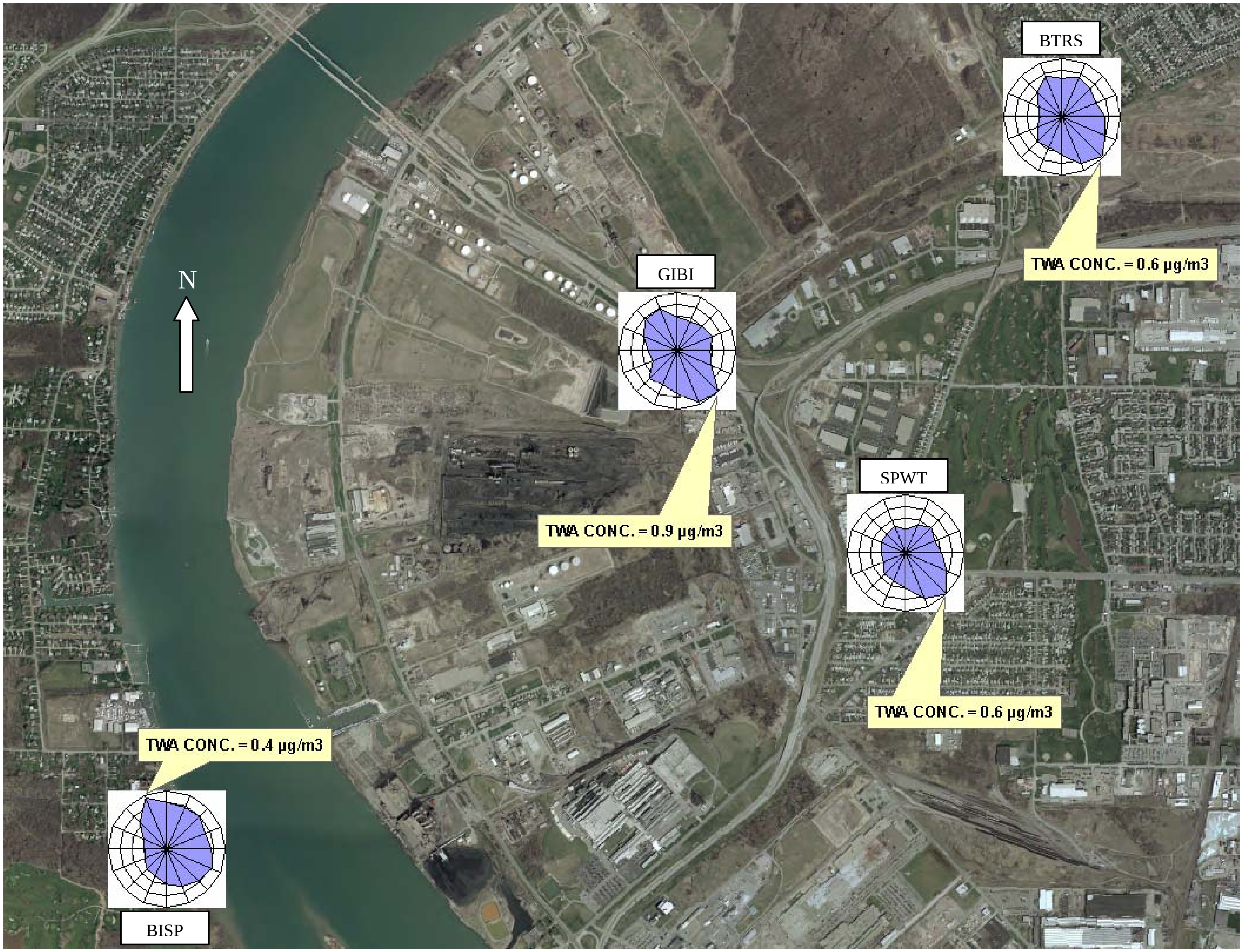


Figure N.3. o-Xylene TW Pollution Roses

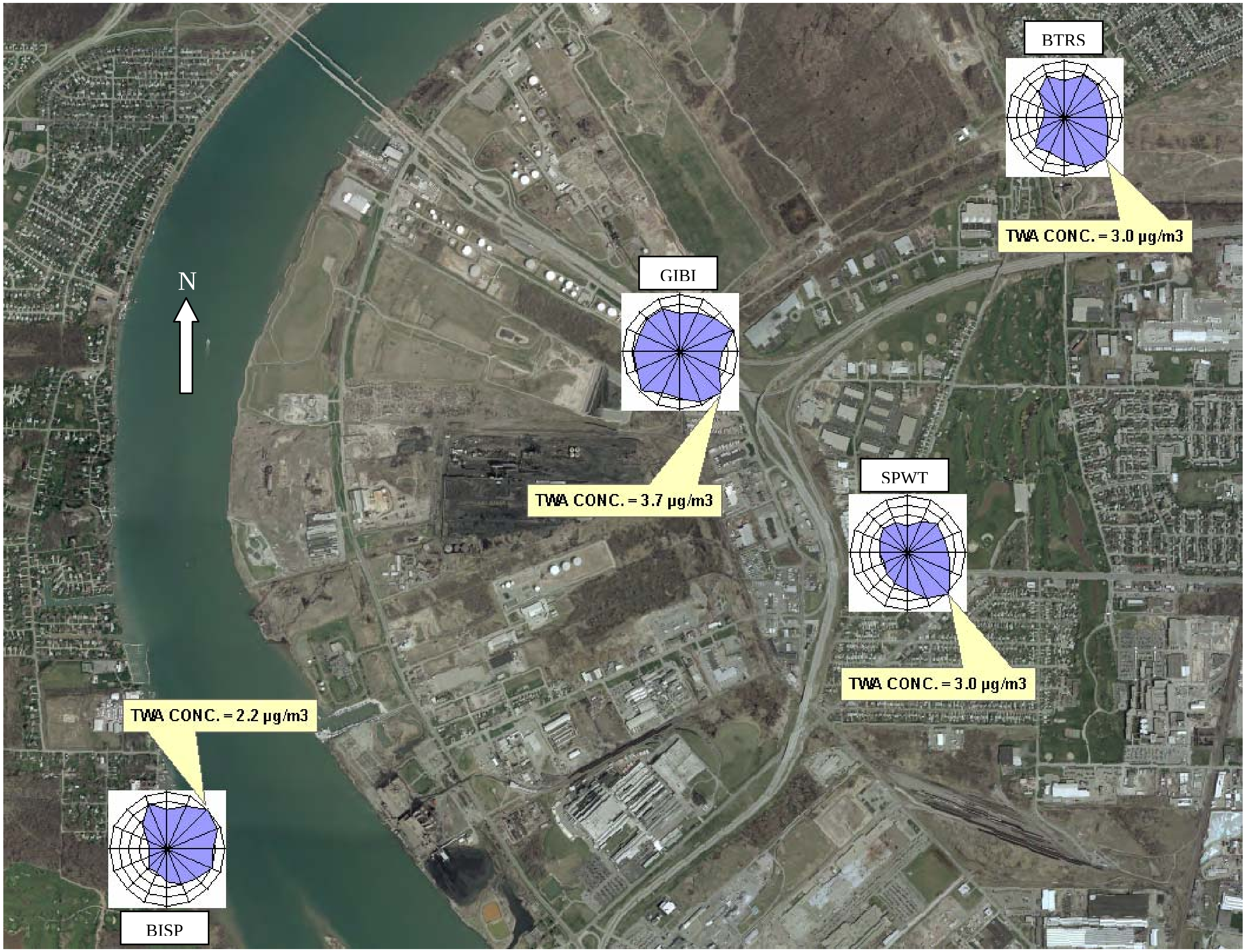


Figure N.4. Toluene TW Pollution Roses

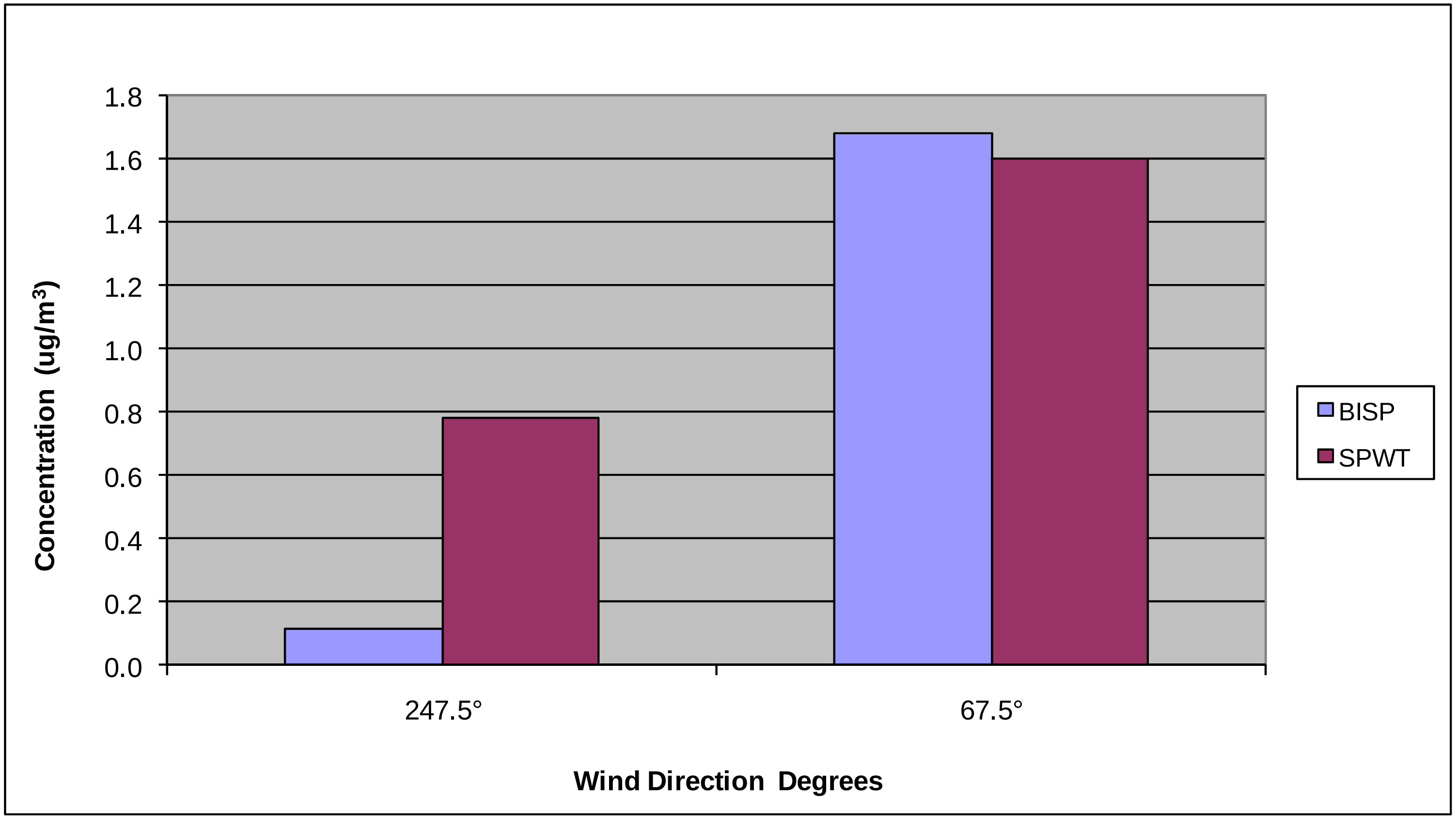
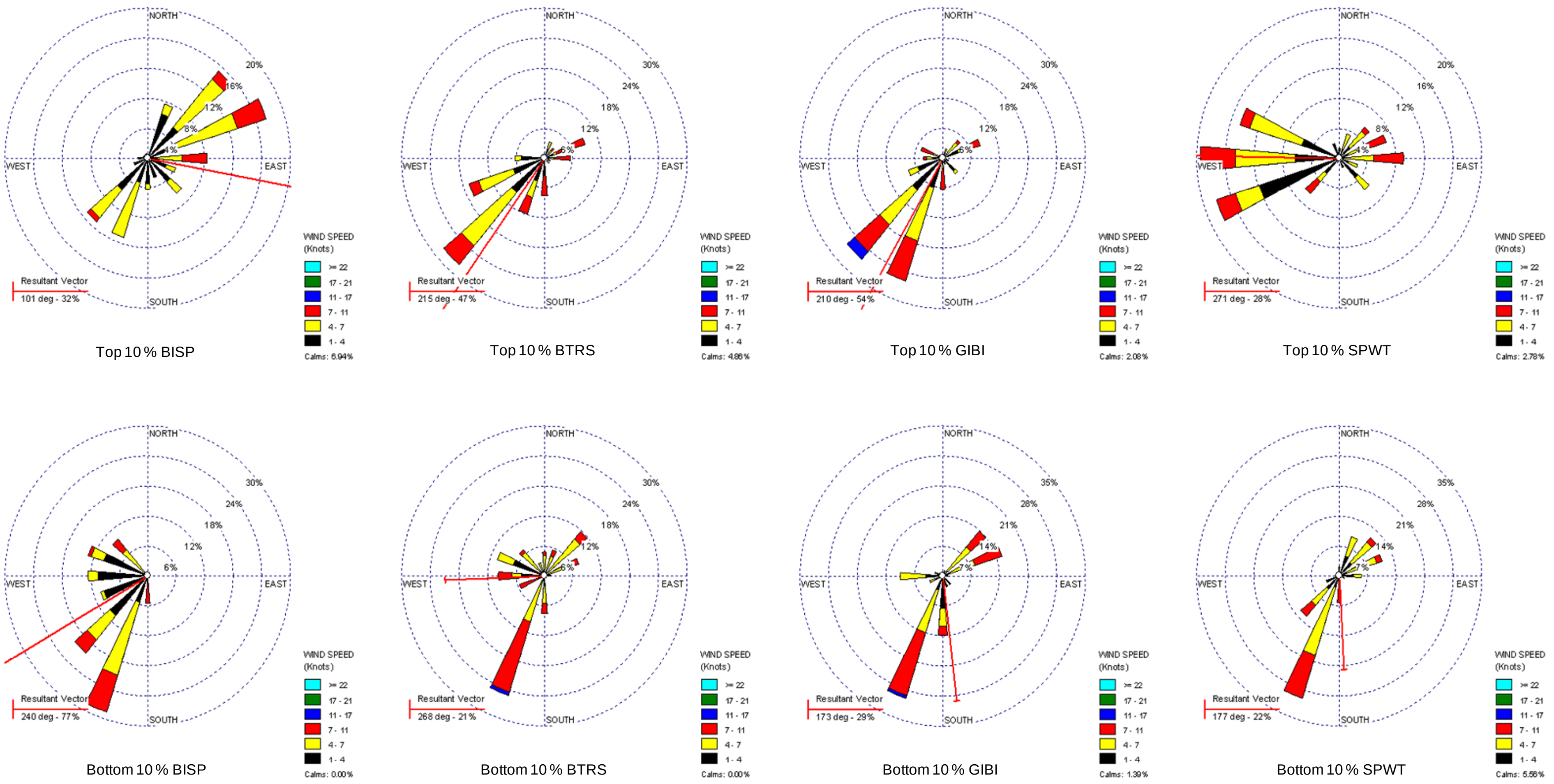


Figure N.5. Carbon Disulfide Concentrations Upwind versus Downwind of the Largest Local Area Source. The BISP monitor is the upwind site and the SPWT monitor is the downwind site with the 247.5° wind scenario and the SPWT monitor is the upwind site and the BISP monitor is the downwind site with the 67.5° wind scenario.

Appendix O. Wind Roses for the Highest and Lowest 10% Combined Concentration Days



Top 10% BISP

Top 10% BTRS

Top 10% GIBI

Top 10% SPWT

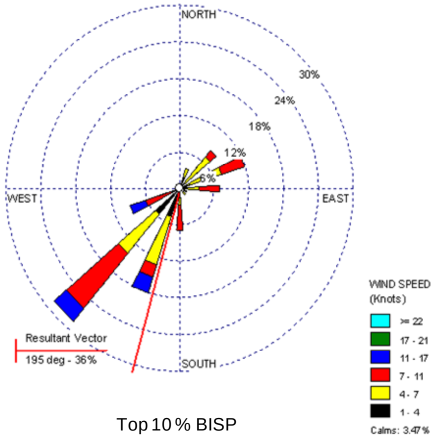
Bottom 10% BISP

Bottom 10% BTRS

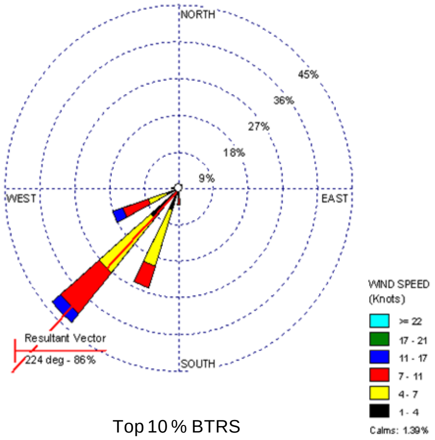
Bottom 10% GIBI

Bottom 10% SPWT

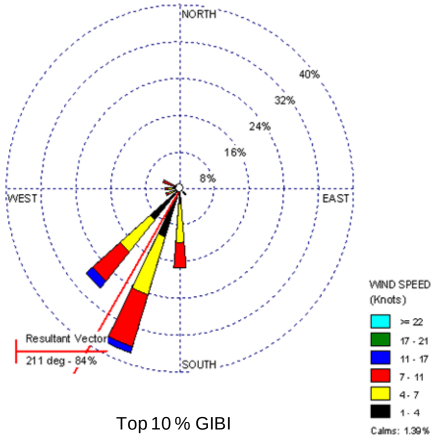
Wind Roses for the Highest 10% and Lowest 10% Benzene Concentration Days Combined at the Four Monitors.



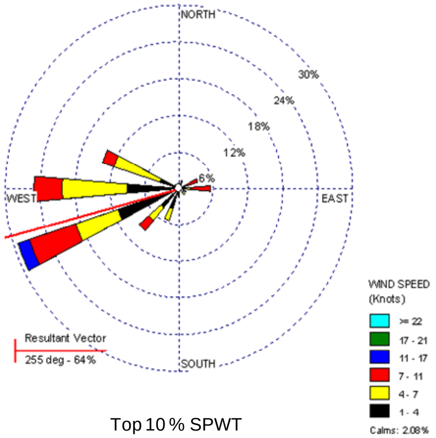
Top 10 % BISP



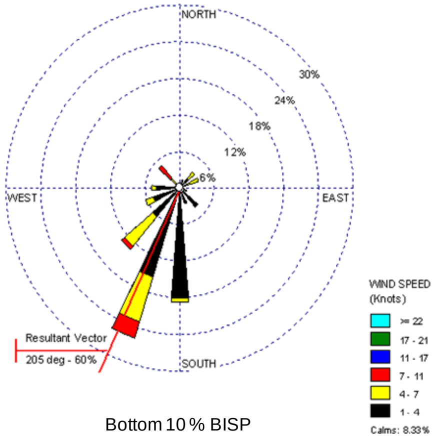
Top 10 % BTRS



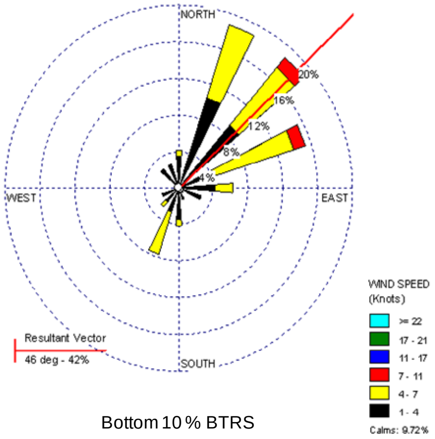
Top 10 % GIBI



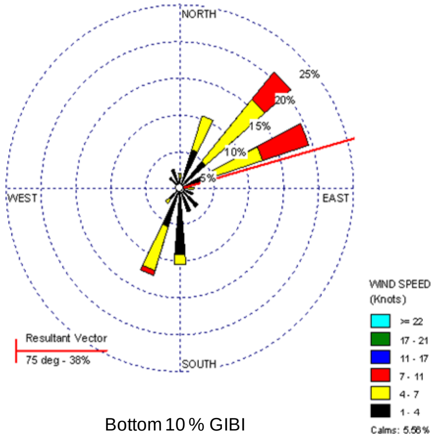
Top 10 % SPWT



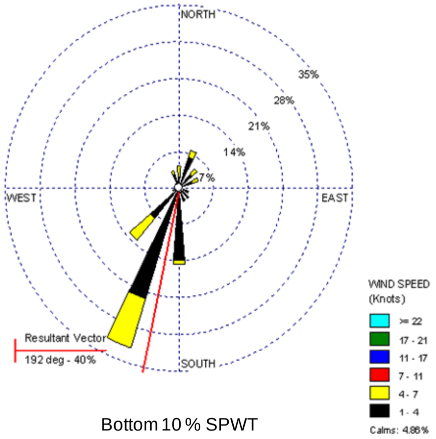
Bottom 10 % BISP



Bottom 10 % BTRS

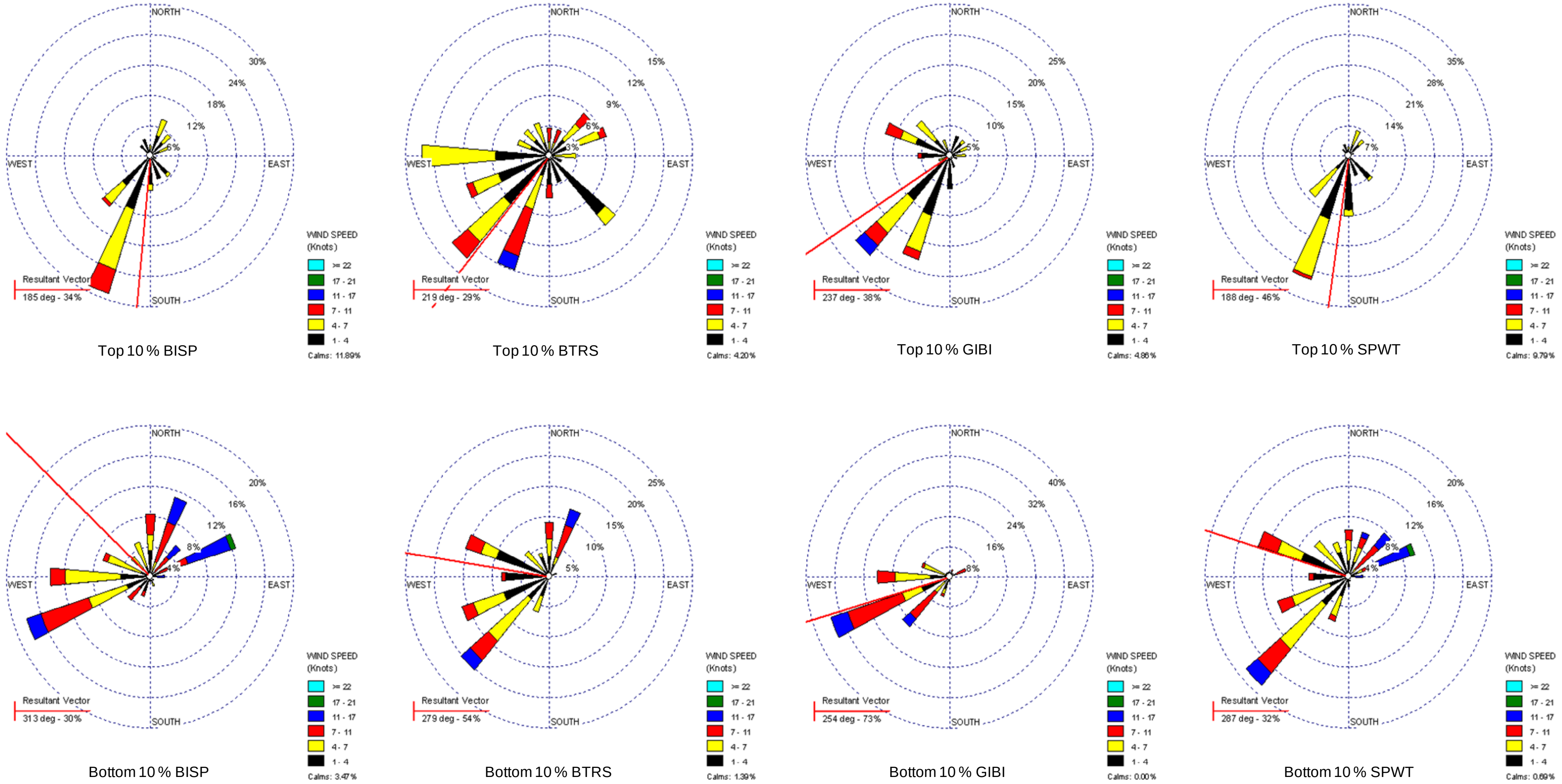


Bottom 10 % GIBI



Bottom 10 % SPWT

Wind Roses for the Highest 10% and Lowest 10% Benzene/Toluene Ratio Days Combined at the Four Monitors.



Top 10 % BISP

Top 10 % BTRS

Top 10 % GIBI

Top 10 % SPWT

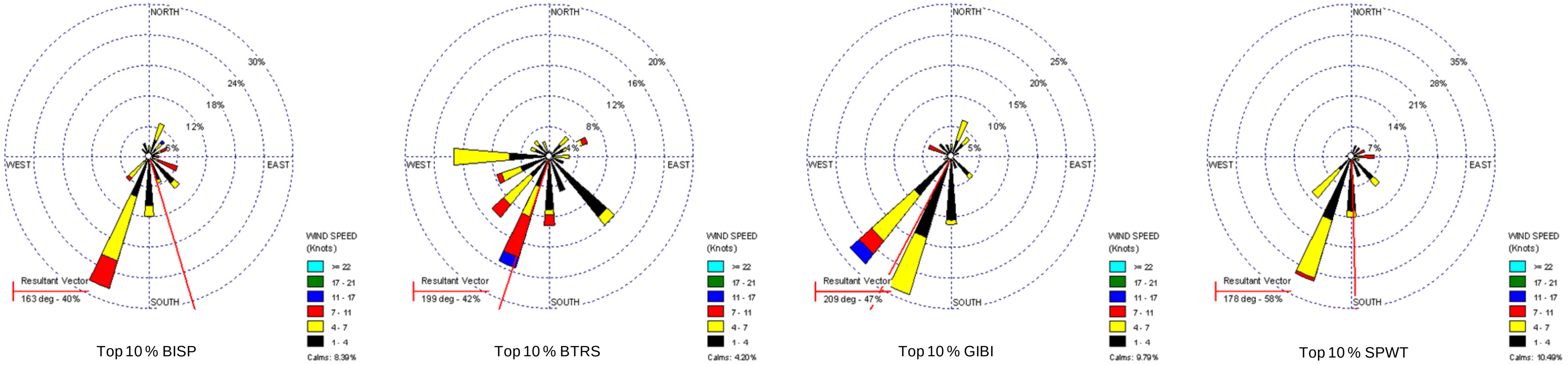
Bottom 10 % BISP

Bottom 10 % BTRS

Bottom 10 % GIBI

Bottom 10 % SPWT

Wind Roses for the Highest 10% and Lowest 10% Formaldehyde Concentration Days Combined at the Four Monitors.

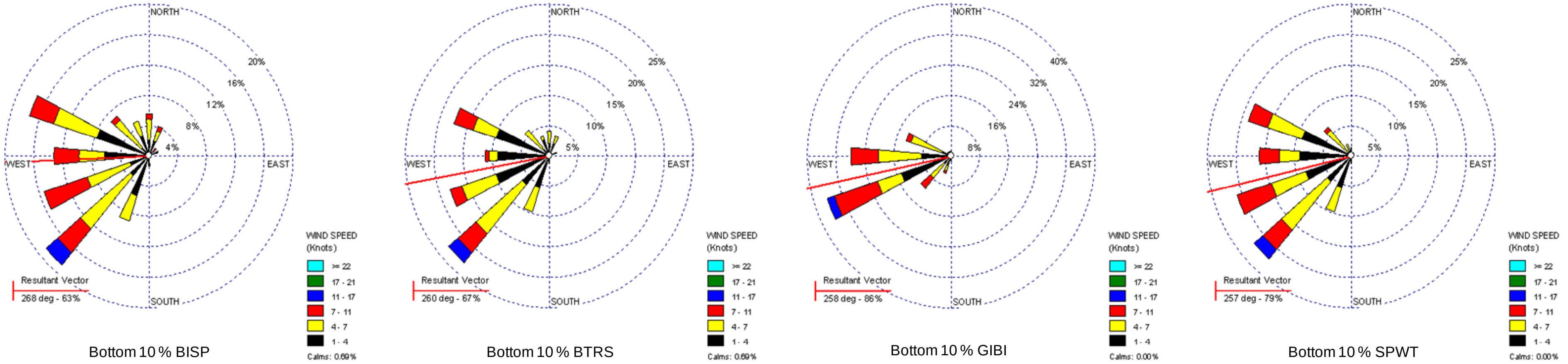


Top 10 % BISP

Top 10 % BTRS

Top 10 % GIBI

Top 10 % SPWT



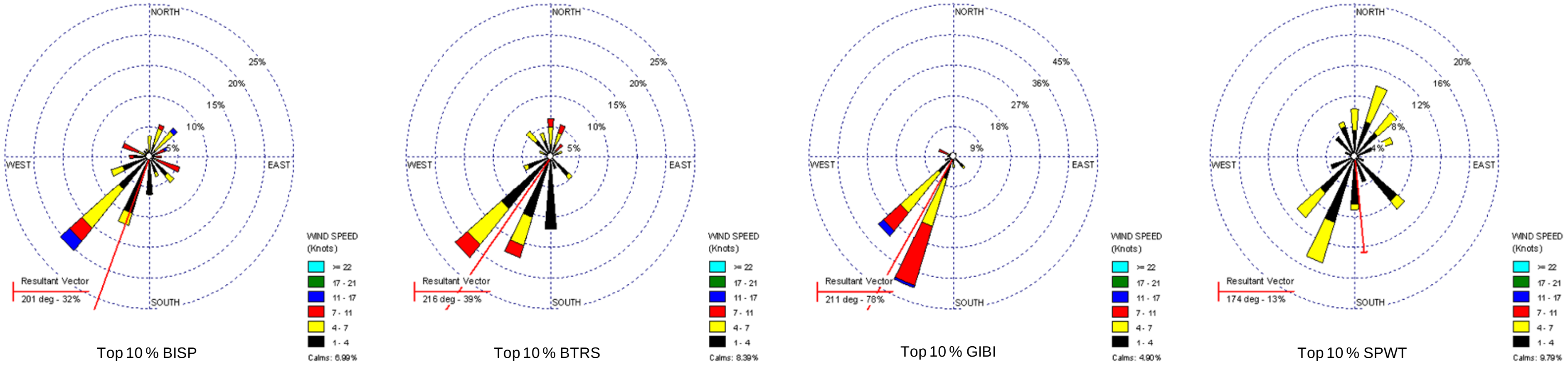
Bottom 10 % BISP

Bottom 10 % BTRS

Bottom 10 % GIBI

Bottom 10 % SPWT

Wind Roses for the Highest 10% and Lowest 10% Acetaldehyde Concentration Days Combined at the Four Monitors.

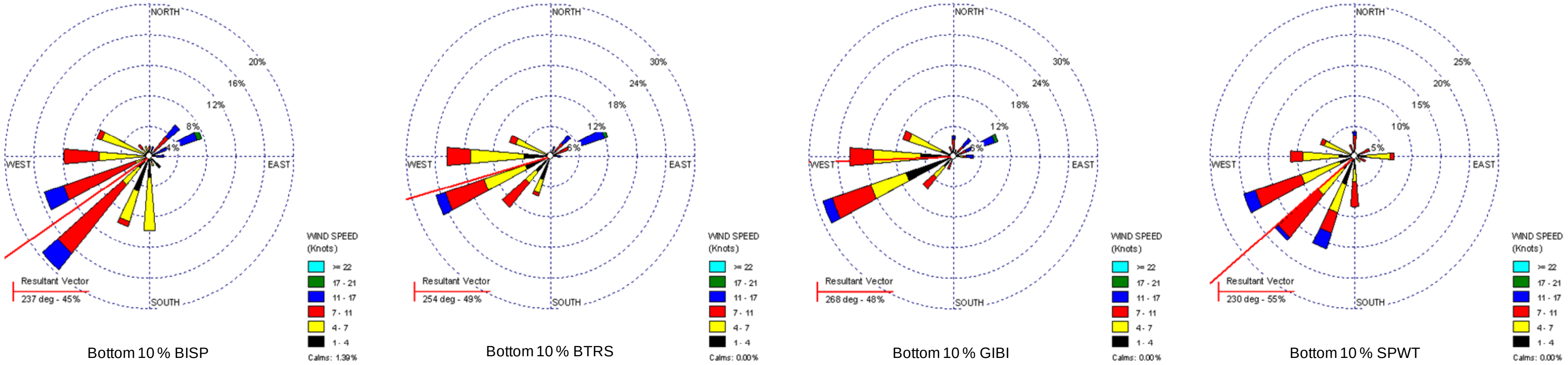


Top 10% BISP

Top 10% BTRS

Top 10% GIBI

Top 10% SPWT



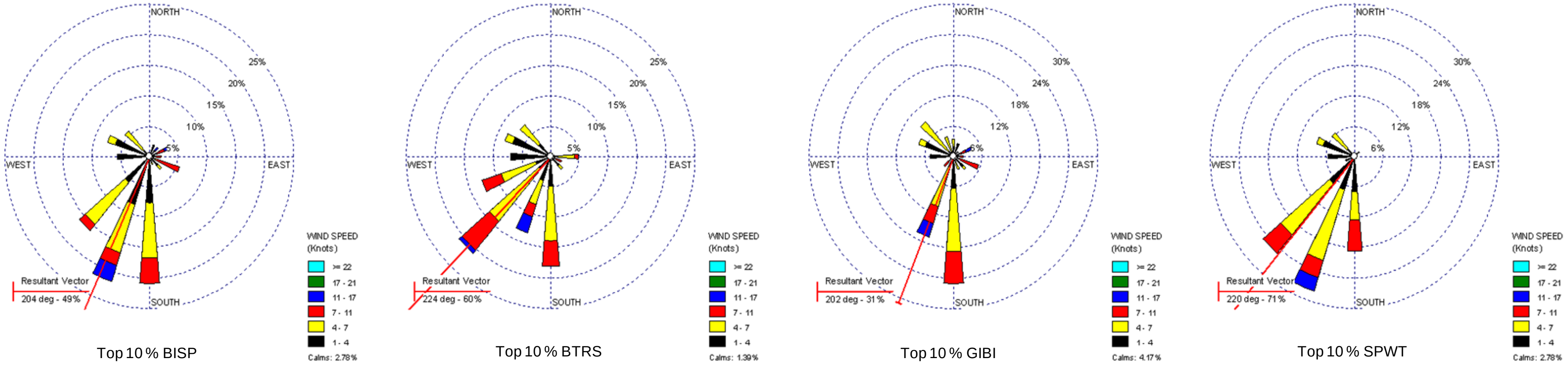
Bottom 10% BISP

Bottom 10% BTRS

Bottom 10% GIBI

Bottom 10% SPWT

Wind Roses for the Highest 10% and Lowest 10% Acrolein Concentration Days Combined at the Four Monitors.

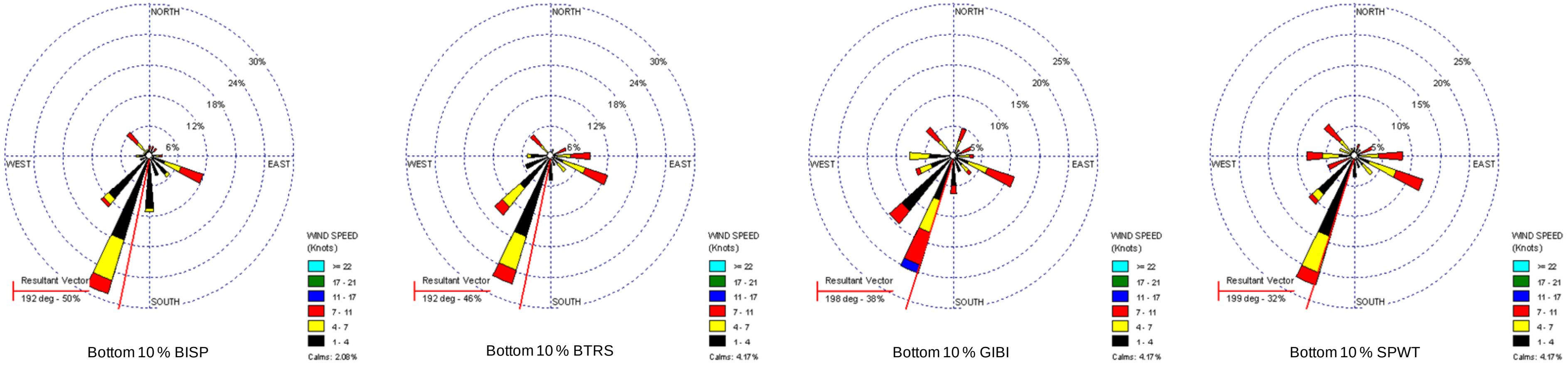


Top 10 % BISP

Top 10 % BTRS

Top 10 % GIBI

Top 10 % SPWT



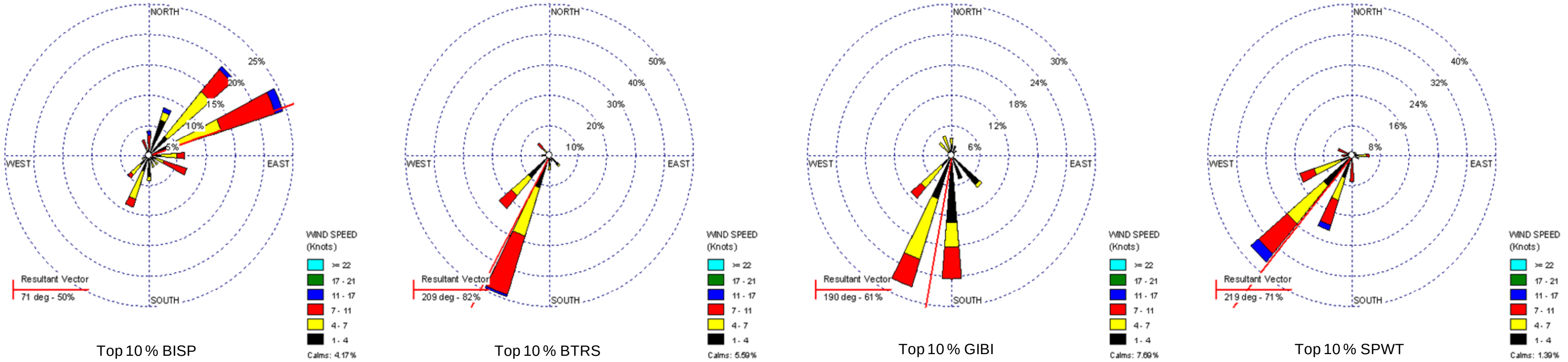
Bottom 10 % BISP

Bottom 10 % BTRS

Bottom 10 % GIBI

Bottom 10 % SPWT

Wind Roses for the Highest 10% and Lowest 10% Carbon Tetrachloride Concentration Days Combined at the Four Monitors.

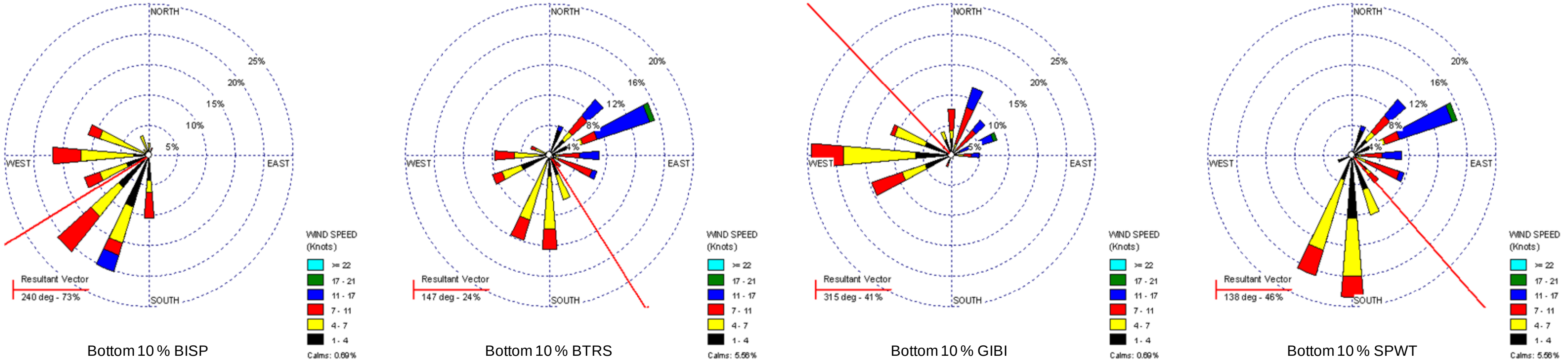


Top 10 % BISP

Top 10 % BTRS

Top 10 % GIBI

Top 10 % SPWT



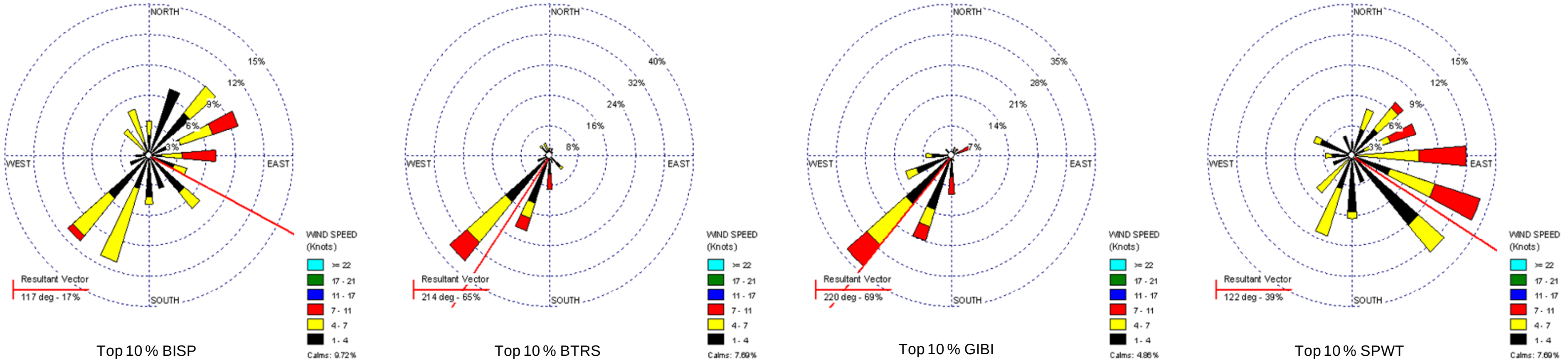
Bottom 10 % BISP

Bottom 10 % BTRS

Bottom 10 % GIBI

Bottom 10 % SPWT

Wind Roses for the Highest 10% and Lowest 10% Carbon Disulfide Concentration Days Combined at the Four Monitors.

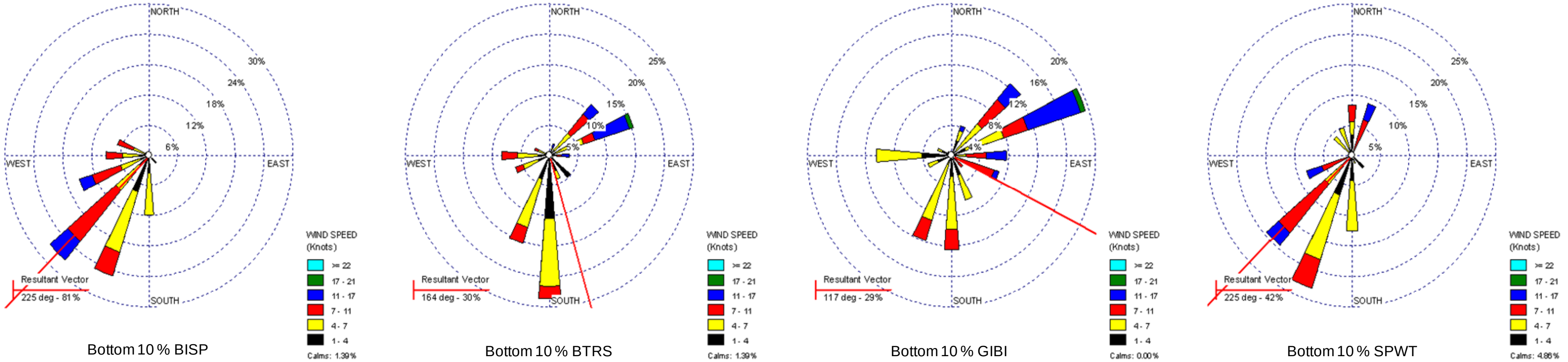


Top 10 % BISP

Top 10 % BTRS

Top 10 % GIBI

Top 10 % SPWT



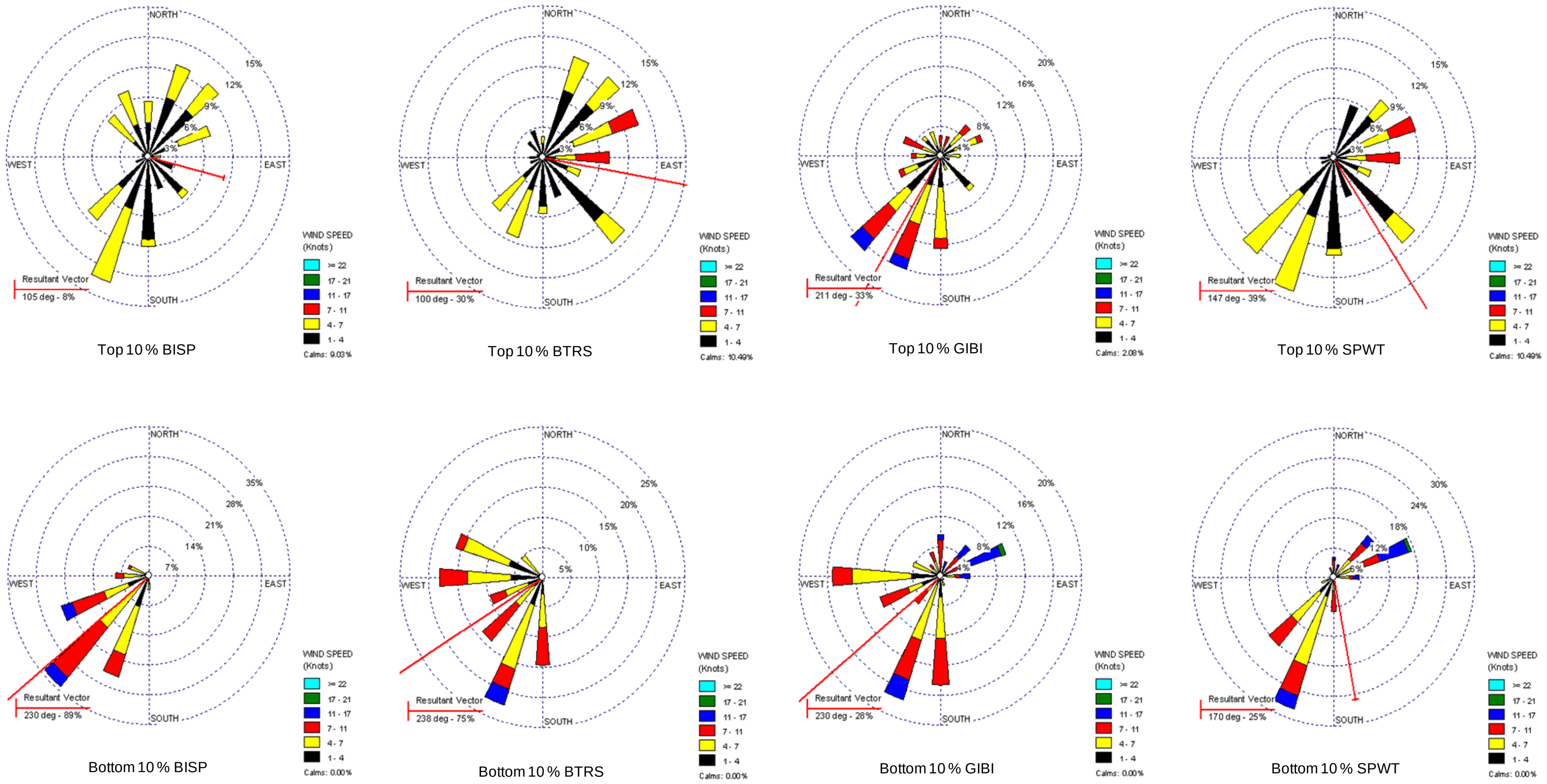
Bottom 10 % BISP

Bottom 10 % BTRS

Bottom 10 % GIBI

Bottom 10 % SPWT

Wind Roses for the Highest 10% and Lowest 10% 1,3-Butadiene Concentration Days Combined at the Four Monitors.



Wind Roses for the Highest 10% and Lowest 10% Total Xylenes Concentration Days Combined at the Four Monitors.

Appendix P. Expanded Analyses of Wind Speeds and Temperature/Seasonality Influences on Measured Air Contaminant Concentrations

Analyses of Average Wind Speed Influences on Measured Air Contaminant Concentrations

To investigate the relationship between average wind speed and concentration, the monitored concentration data was separated into the highest and lowest 20% average daily wind speed days. The top and bottom 20% were used instead of the top and bottom 10% to ensure that the daily variability in the meteorological conditions was smoothed out and so the wind direction patterns became closer to the overall prevailing wind patterns. This allows the wind directionality patterns for the highest and lowest average wind speed days to more closely resemble one another, thus removing the influences of wind direction to a greater extent. The wind roses for the highest and lowest 20% average wind speed days are included which indicate that both the overall wind direction percentages spread and the resultant vector are similar (Figure P.1). The differences in the resultant vector towards the 225° direction and the additional wind from the west, southwest observed with the highest 20% wind speed day's wind rose would be expected to result in an increase of the industrial area influences. However, it is the lowest average wind speed days that have the higher mean concentration, as compared to that of the highest average wind speed days, for the majority of the contaminants. With benzene, however, increased influences from the industrial area and the largest study area benzene source (due to these wind directionality differences) could be masking any effects due to variations in the average wind speeds because the increased wind from the direction of the industrial area during the highest average wind speed days would result in more influences on the measured concentrations at both the GIBI and BTRS monitors. For this analysis, the concentrations over all four monitoring locations were averaged together, allowing any differences in wind direction patterns to be smoothed out because the various monitors are orientated so that they capture winds moving over the industrial area in different directions. The percentage differences for the contaminants investigated from the highest 20% wind speed days (average = 9.18 mph) to the lowest 20% wind speed days (average = 3.15 mph) are as follows: Benzene -7%, Formaldehyde +240%, Acetaldehyde +76%, Acrolein +51%, Carbon Tetrachloride +3%, Toluene +260%, Benzene/Toluene Ratio -49%, 1,3-Butadiene and Carbon Disulfide +69% (Figure P.2).

Another method to analyze the relationship between wind speed and concentration was to organize the data by the concentration and then determine what the average wind speed was for the top 10 and 20% and the bottom 10 and 20% concentration days. The average wind speeds for the highest versus lowest concentration days was observed for each monitoring site individually and with all the monitoring sites combined for each contaminant investigated. Acrolein, toluene, and 1,3-butadiene all show substantially lower wind speeds for the highest 10 and 20% concentration days consistently at all four monitoring sites (Figures P.3-5). Formaldehyde and acetaldehyde show this same relationship but the differences observed for the top and bottom 10% at the BTRS site are not nearly as substantial as those seen with acrolein, toluene, and 1,3-butadiene (Figures P.6-7). Benzene also indicates this same relationship for both the top and bottom 10% and the top and bottom 20% at all four monitoring sites (with the one exception of the top and bottom 20% at BISP), although to a much smaller degree than was the case with acrolein, toluene, and 1,3-butadiene (Figure P.8). Because of the small differences with benzene and the large differences with toluene, the benzene/toluene ratio shows the opposite trend with substantially higher wind speeds for the highest 10 and 20% concentration days consistently at all four monitoring sites (Figure P.9). Carbon tetrachloride also shows only small differences in average wind speed with the highest and lowest concentration days and does not show any consistency between the monitoring sites and different percentages (Figure P.10). Finally, carbon disulfide shows the same overall trend as did most of the other contaminants with lower wind speeds for the highest 10 and 20% concentration days at all four monitoring sites, again with the one exception of the top and bottom 20% at BISP (Figure P.11). The most substantial differences were seen at the GIBI site, then at the BTRS site, but only small differences were seen at the BISP and SPWT sites.

Analyses of Seasonality and Average Temperature Influences on Measured Air Contaminant Concentrations.

The seasons were segmented by temperature rather than by calendar dates which was verified by looking at the temperature trends at the BISP monitoring site over the study period on the sampling days (Figure P.12). Therefore, summer included June, July, and August, autumn included September, October, and November, winter included December, January, and February, and spring included March, April, and May. The analysis of seasonality indicates that the majority of the contaminants analyzed had the lowest concentrations measured in the winter and the highest concentrations measured in the summer and autumn (Figure P.13). The average temperatures (on the sampling days only) calculated for the seasons were 70°F for summer, 57°F for autumn, 30°F for winter, and 45°F for spring so the autumn temperature was substantially that of the winter and almost as close to the summer average as it was to the spring average. The contaminants that followed the general trend described above and their percentage increase from the winter to the summer were: Formaldehyde (300%), Acrolein (58%), Acetaldehyde (39%), Toluene (50%), and 1,3-Butadiene (67%). Benzene had very similar concentrations in the summer, winter, and spring with a percentage increase of only 7% from winter to summer but the autumn average concentration was more than double than that of any of the other three seasons. Because the benzene concentrations changed very little while the toluene concentrations were substantially lower in the winter as compared to the summer, the benzene/toluene ratio was slightly lower in the summer than in the winter (12%). Carbon tetrachloride showed very little difference in concentration between any of the four seasons and the percentage increase from winter to summer was only 6%. Carbon disulfide concentrations had a percent increase of 88% from winter to summer, but the average concentrations were even higher in the autumn and spring as compared to the summer.

It is important again to look at the differences in the wind patterns for each season to investigate the potential contributions to the concentration differences noted (Figure P.14). While the wind roses and the resultant vectors shown are similar, there are certain differences that may have contributed to some of the concentration differences measured. The summer winds were out of the south, southwest almost 30% of the time and directly out of the southwest just over 18% of the time. The winter winds were out of the south, southwest just over 16% of the time and directly out of the southwest 10% of the time, but overall, the winds were more variable with additional winds from the west, southwest (15%) and the west (12%). The autumn winds were out of the south, southwest almost 20% of the time and directly out of the southwest almost 16%

of the time, but again, were more variable than in the summer with additional winds from the south (14%). The spring winds were the most variable with winds out of the south, southwest 13% of the time, the southwest 11% of the time, the south 12% of the time, and the west, southwest and north, northeast 9% of the time. What makes the wind variations somewhat less influential in this analysis is the fact that the concentrations of all four sites, which are in different directions with respects to the industrial area and the local sources, again have all been pooled together to look at the seasonal variability.

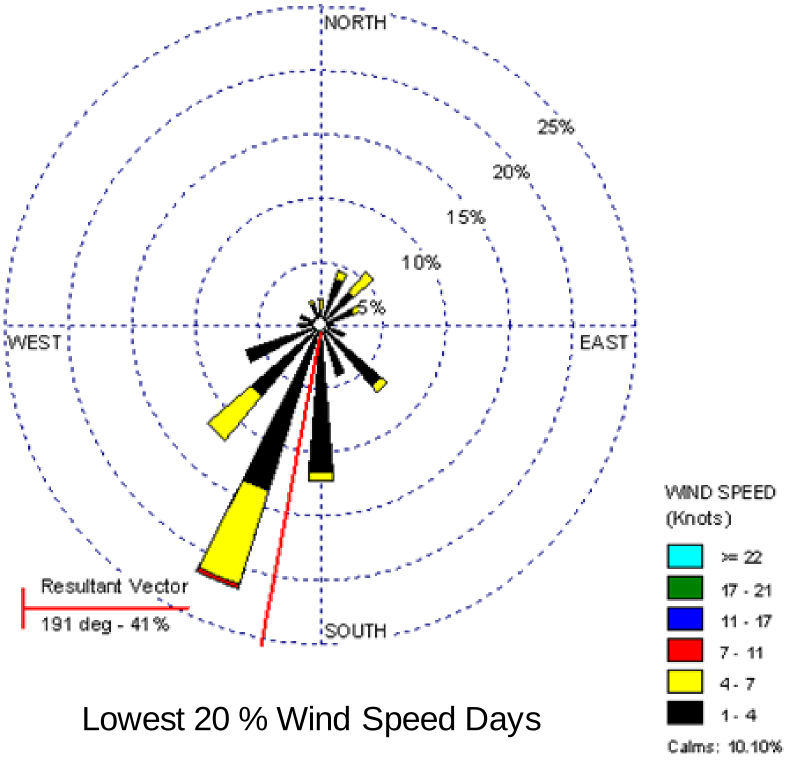
Whether or not any monthly trends were apparent was then investigated. The average monthly concentrations for only the monitoring days were: 70°F for July, 72°F for August, 63°F for September, 61°F for October, 57°F for November, 32°F for December, 31°F for January, 30°F for February, 35°F for March, 48°F for April, 45°F for May, and 70°F for June. The benzene concentration in October was substantially higher than for any other month, so the monthly trends graph for benzene is in log scale (Figure P.15). However, this causes the difference between the benzene concentration in October and the other months less strikingly visible. There were no meaningful monthly trends apparent over the year for the monitored benzene concentrations. Note that the concentrations at the GIBI and BTRS monitors followed the same monthly trends, indicating that their similar directionality with respect to the largest study area benzene source/industrial area resulted in the different wind patterns over the year leading to similar changes in relative benzene concentrations. Additionally, the monthly trends for 1,3-butadiene over the study year track closely with benzene and also do not appear to have meaningful annual temporal differences (Figure P.16). The monthly acrolein concentrations clearly indicate a consistent increase at all four monitors during the warmer months as opposed to the colder months (Figure P.17). With few exceptions, the monthly formaldehyde and, to a slightly lesser extent, acetaldehyde concentrations also indicate increased levels at all four monitors during the warmer months as opposed to the colder months (Figures P.18-19). This trend can be seen more clearly when the four monitoring sites are combined to lessen the overall influence of the wind directionality. The monthly trends over the year for formaldehyde and acetaldehyde are similar to one another but at different relative scales. The concentration scale for carbon tetrachloride exhibits very little variability and the monthly concentrations vary only slightly (Figure P.20). With several exceptions, the monthly toluene concentrations also indicate increased levels during the warmer months as opposed to the colder months (Figure P.21). The benzene/toluene ratio seems apparently to be dominated by the benzene concentrations, resulting again in both no meaningful monthly trends being observed over the study year and the large spike in October causing the need to use a log scale for the ratio levels in our graph (Figure P.22). Although the carbon disulfide concentrations for the coldest months are among the lowest when all four monitoring sites were combined, individually there do not appear to be any meaningful trends and there is little indication that the differences in carbon disulfide concentrations can be attributed to variations in temperature or sun intensity/insolation over the course of a year (Figure P.23).

Once again, combined monthly wind roses, for only the monitoring days of each month, were reviewed to determine if the differences in wind directionality could have contributed to the concentration differences observed (Figure P.24). The previously summarized analyses indicated that benzene, 1,3-butadiene, and carbon disulfide are the three contaminants which most clearly show indications that their measured concentrations were primarily driven by differences in wind direction and the relative orientation relationships between the locations of the large local point sources and the monitoring sites. Therefore, this review of the monthly patterns as compared to the wind directionality during that time period will be limited to those contaminants and, due to the monthly trend similarities between benzene and 1,3-butadiene, only benzene will be discussed to avoid redundancy.

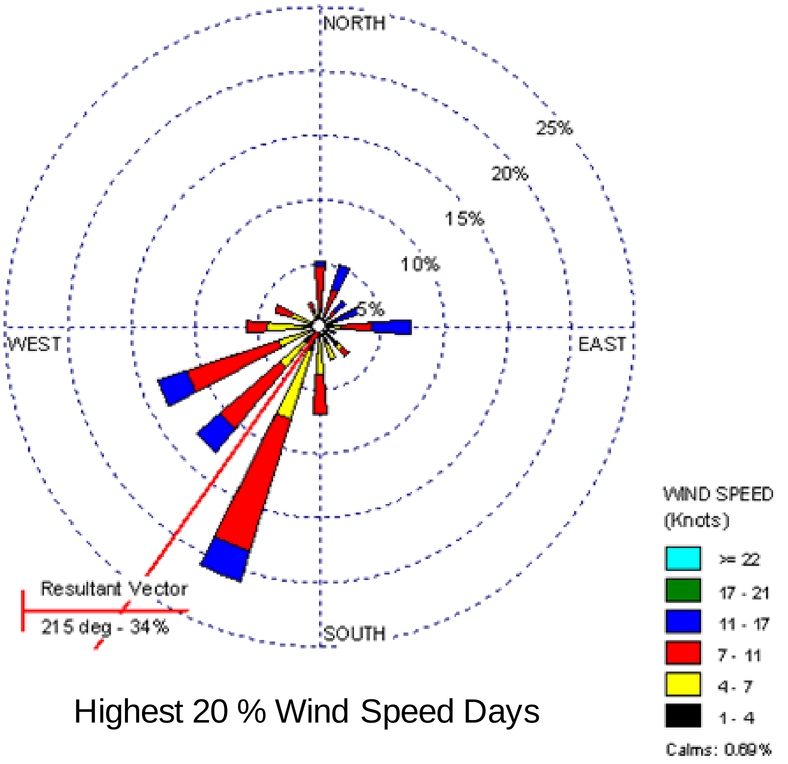
The highest monthly benzene concentration at both the GIBI and the BTRS monitor in October can be explained by wind directionality. The wind rose for October indicates that roughly 60% of the time the winds were either directly out of the southwest or from the south, southwest (the direction of the monitor with respect to the largest study area benzene source). The resultant vector for the October wind rose was at 217° with a percentage of 66% and this month had a relatively large amount of calms (8.33%) during that time period (Figure P.24). The combined percentage of winds from these two directions was greater than for all other months except for June which was also among the highest benzene concentration months at the GIBI and BTRS monitors. In contrast, the lowest percentage of winds from these two wind directions combined was during the month of December and the resulting concentration at the GIBI and BTRS monitors was also among the lowest. Even though the winds directly from the southwest were seldom during January, the two wind sectors adjacent to this wind direction on either side had the highest percentages of winds blowing from them and the monthly benzene concentration was among the highest at the GIBI and BTRS monitors. The one month at the GIBI and BTRS monitors that seems to be an anomaly of sorts is November where the benzene concentration is the second highest but the percentage of winds from the southwest and south, southwest combined is only in the middle of the range. The highest benzene concentration month at both the SPWT and BISP monitors (April) has a wind rose that indicates some wind from the east northeast (but not the highest amount) and no winds from the northwest quadrant. It appears that the elevated concentrations are the result of the amount of calm winds which was the second highest in April as compared to any other month (6.72%). The next two highest concentration months at SPWT (December and January) do have the second and third highest percentage of winds coming from the east, northeast, respectively (the direction of the monitor with respect to the largest study area benzene source). At the BISP monitor, the next highest benzene concentration month is September which has the highest overall percentage of winds from the three wind sectors in the northeast quadrant (the direction of the monitor with respect to the largest study area benzene source).

The monthly carbon disulfide concentrations at the SPWT monitor also indicate that both wind direction and wind speed are influencing factors (Figure P.24). While the second highest concentration month at the SPWT monitor, April, has the second highest percentage of wind from the west, southwest, the highest month at this site, October, is only in the middle of the range as far as the percentage of wind from that direction (the direction of the monitor with respect to the largest source). However, these two months have the highest percentage of calm winds out of all months (6.72% and 8.33%, respectively). In addition, the month with the highest percentage of winds from the west, southwest at the SPWT monitor, January, is only in the middle of the range in terms of carbon disulfide concentration, but this month is also the one with the lowest percentage of calm winds (0.00%). The lowest carbon disulfide concentration month at the SPWT monitor, December, is in the middle of the range for percentage of wind from the west, southwest but has the second lowest percentage of calm winds (0.83%). The second lowest concentration month at the SPWT monitor, August, does have one of the lowest percentages of wind from the west, southwest. The highest carbon disulfide concentration months at the GIBI monitor, March and May, have the highest percentages of wind directly from the south and the lowest two months, January and February, indicate no winds from this direction (the direction of the monitor with respect to the largest source). The highest three carbon disulfide concentration months at the BTRS monitor, July, June, and October, have the highest percentages of wind from the southwest/south, southwest and the lowest concentration month, December, has the lowest percentage of winds from this direction (the direction of the monitor with respect to the largest source). Finally, the highest two carbon disulfide concentration months at the BISP monitor, September and July, have the highest percentages of wind from the east, northeast and five out of the six months with the lowest percentages of winds from this direction (the direction of the monitor with respect to the largest source) are also the lowest 5 concentration months.

To attempt to reduce the wind directionality influence as much as possible, the data was then dichotomized into the highest and lowest 30% temperature days and then the four monitors were combined together to observe what the resulting mean concentrations for those days were (Figure P.25). As can be seen in the wind roses for the highest and lowest concentration days, the wind directionality patterns did differ from one another somewhat (Figure P.26). However, because the monitoring locations were combined together, the increased influence from the industrial area at the GIBI monitor and, to a lesser extent, the BTRS monitor during the highest 30% temperature days was concurrent with a decreased influence from the industrial area at the SPWT and BISP monitors. Then, the diminished influence from the industrial area at the GIBI monitor and also at the BTRS monitor (but less so than at GIBI) during the lowest 30% temperature days was concurrent with an increased influence from the industrial area at the SPWT and BISP monitors. Therefore, combining the monitoring locations together allows for less overall influence from the wind directionality and more influence from the temperature differences, but the full effect cannot be totally deciphered. Almost all the contaminants investigated had higher concentrations with the highest temperatures as compared to the lowest temperatures, with the highest percentage differences being the following: Formaldehyde at 325%, Carbon Disulfide at 220%, 1,3-Butadiene at 200%, Acrolein at 78%, and Toluene at 75% (Figure P.25). Acetaldehyde and benzene had lower percentage increased concentrations during the highest temperature versus lowest temperature days at 47% and 43%, respectively. Because the toluene concentration had a greater percentage increase than the benzene concentration with the highest temperature days as compared to the lowest, the benzene/toluene ratio was lower with the higher temperatures versus the lower temperatures. The carbon tetrachloride concentration showed almost no difference between the highest temperature days and the lowest temperature days.



Lowest 20 % Wind Speed Days



Highest 20 % Wind Speed Days

Figure P.1. Wind Roses for the Lowest 20% Wind Speed Days Combined and the Highest 20% Wind Speed Days Combined.

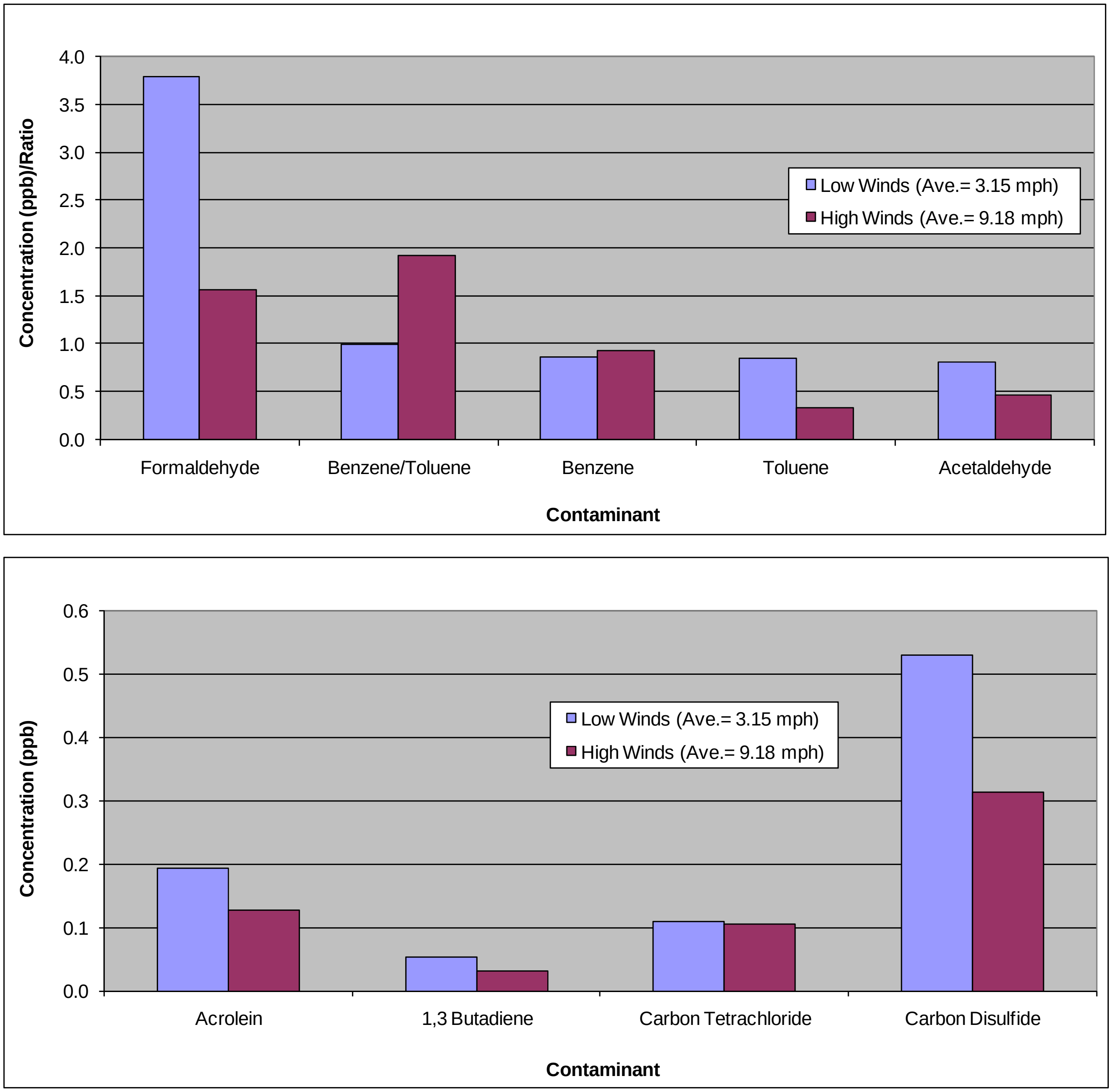


Figure P.2. Concentrations/Ratios during the Lowest 20% Average Wind Speed Days Combined compared to the Highest 20% Average Wind Speed Days Combined.

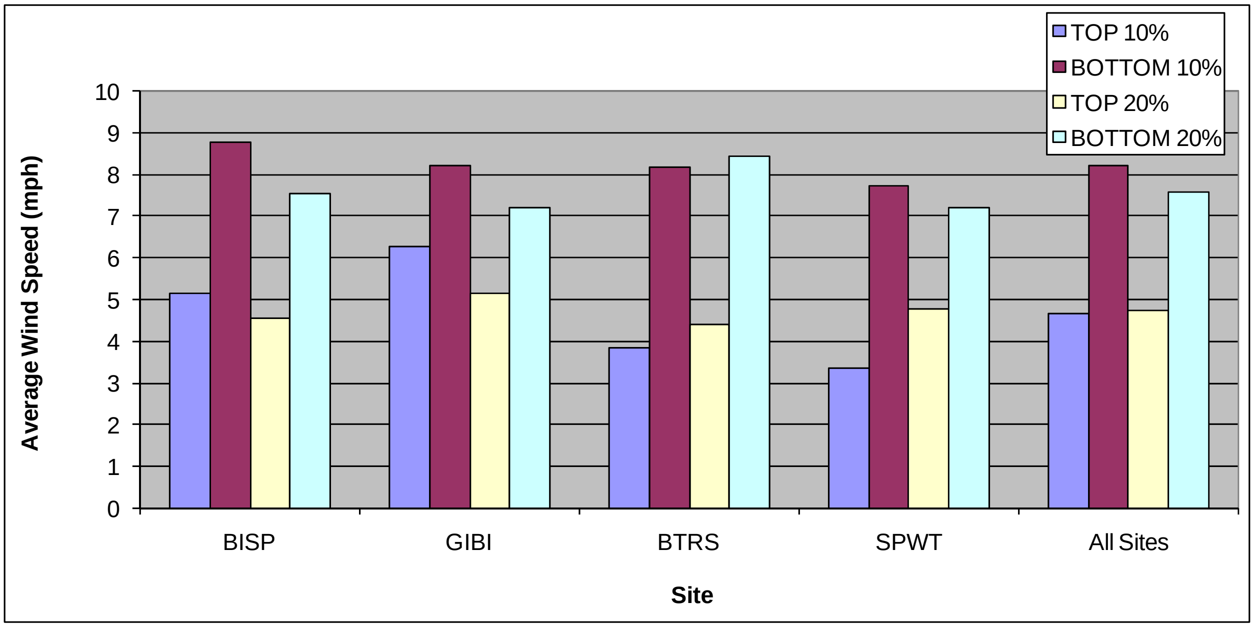


Figure P.3. Average Wind Speeds for Highest and Lowest 10% and 20% Acrolein Concentration Days Combined.

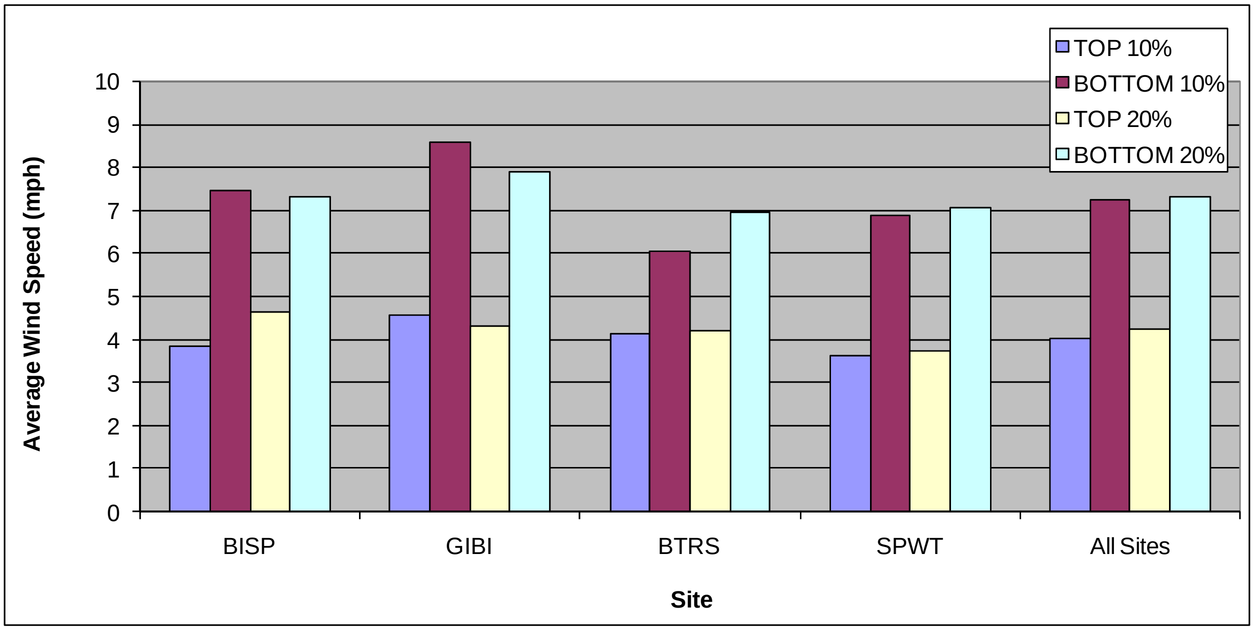


Figure P.4. Average Wind Speeds for Highest and Lowest 10% and 20% Toluene Concentration Days Combined.

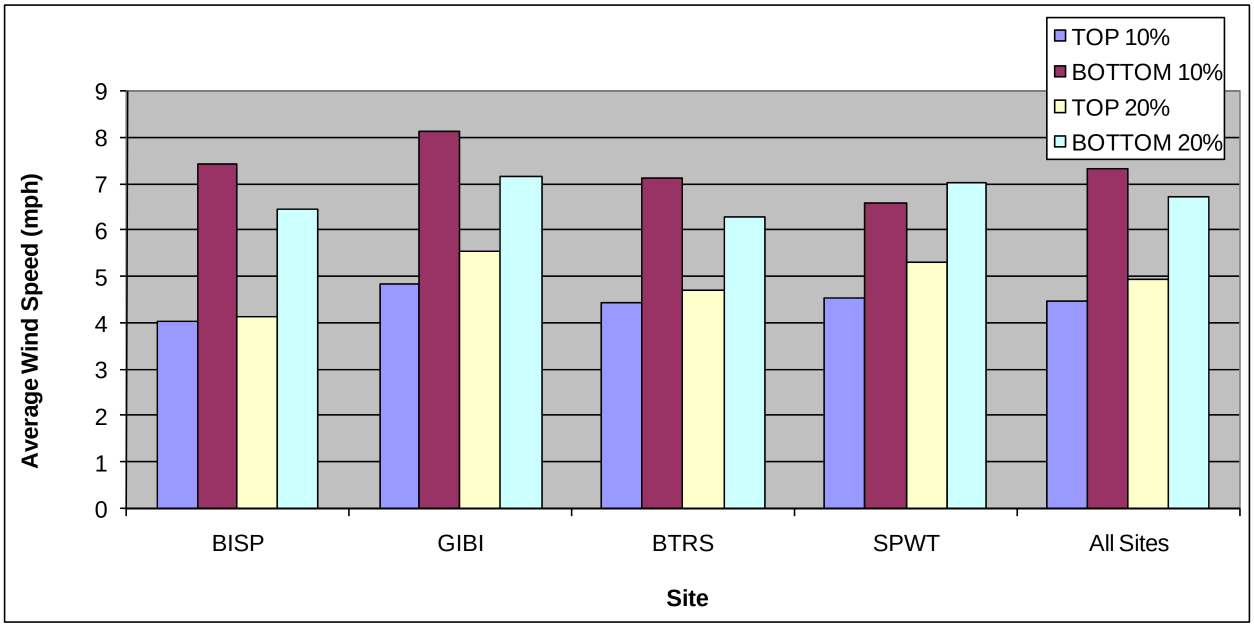


Figure P.5. Average Wind Speeds for Highest and Lowest 10% and 20% 1,3-Butadiene Concentration Days Combined.

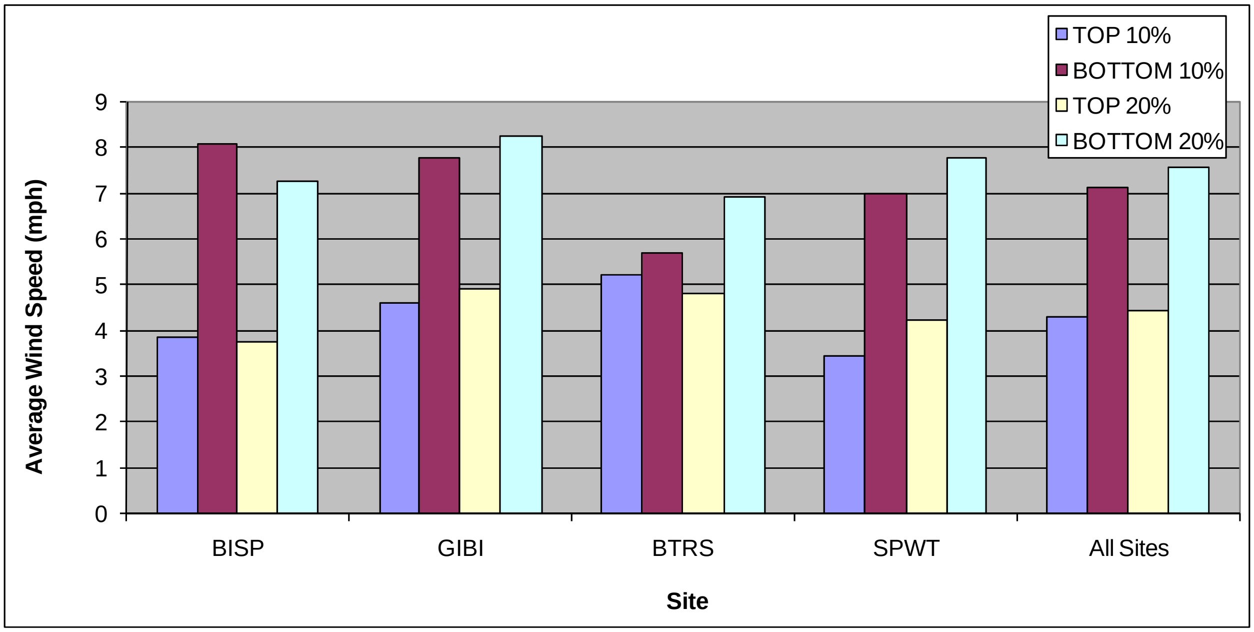


Figure P.6. Average Wind Speeds for Highest and Lowest 10% and 20% Formaldehyde Concentration Days Combined.

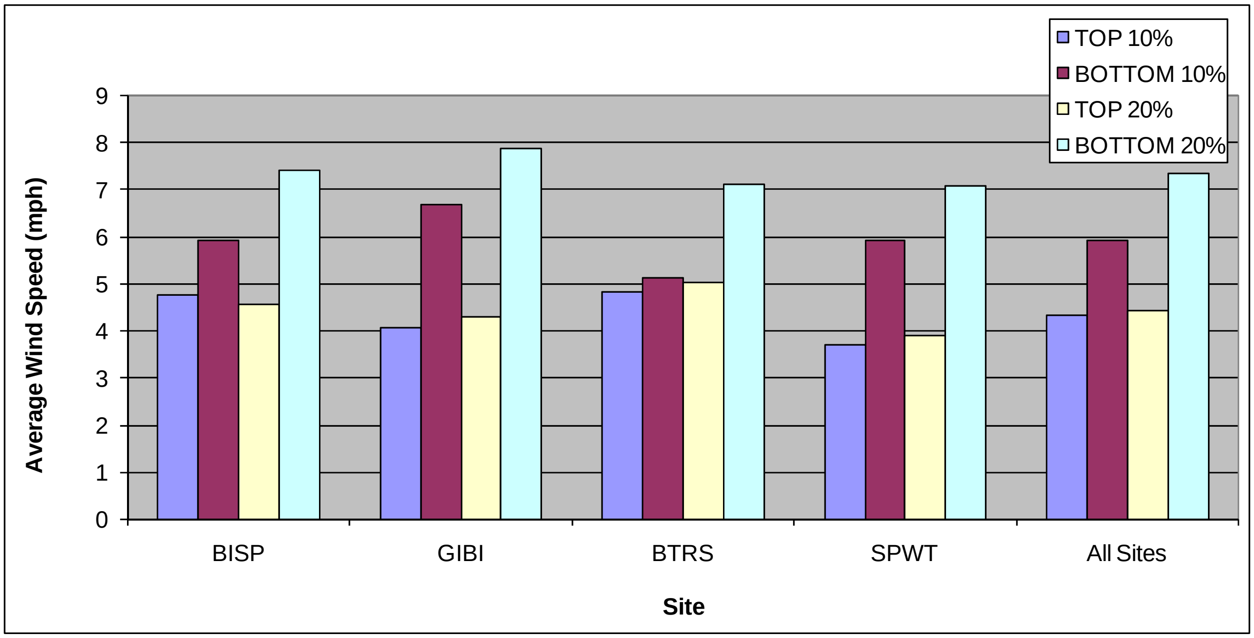


Figure P.7. Average Wind Speeds for Highest and Lowest 10% and 20% Acetaldehyde Concentration Days Combined.

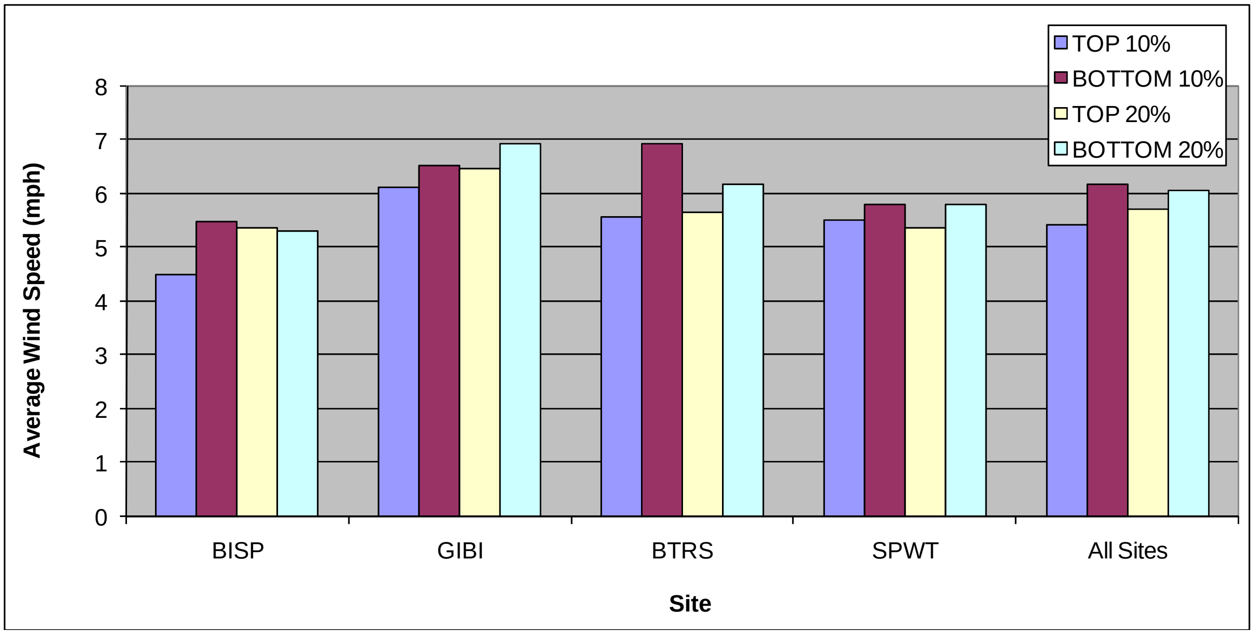


Figure P.8. Average Wind Speeds for Highest and Lowest 10% and 20% Benzene Concentration Days Combined.

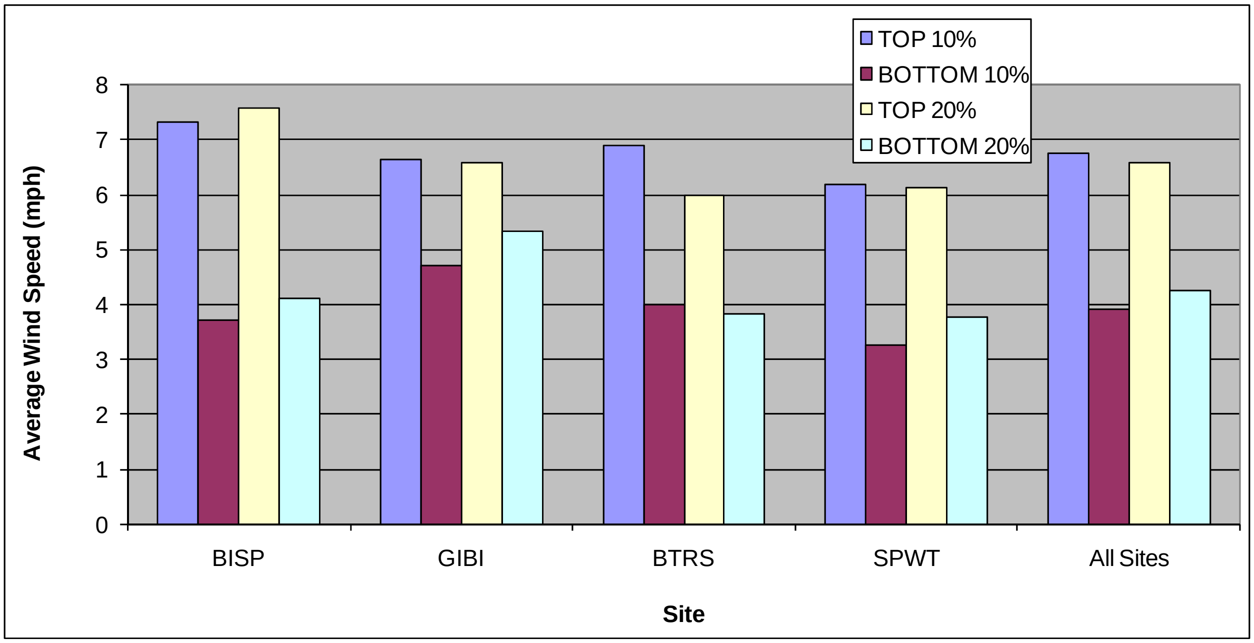


Figure P.9. Average Wind Speeds for Highest and Lowest 10% and 20% Benzene/Toluene Ratio Days Combined.

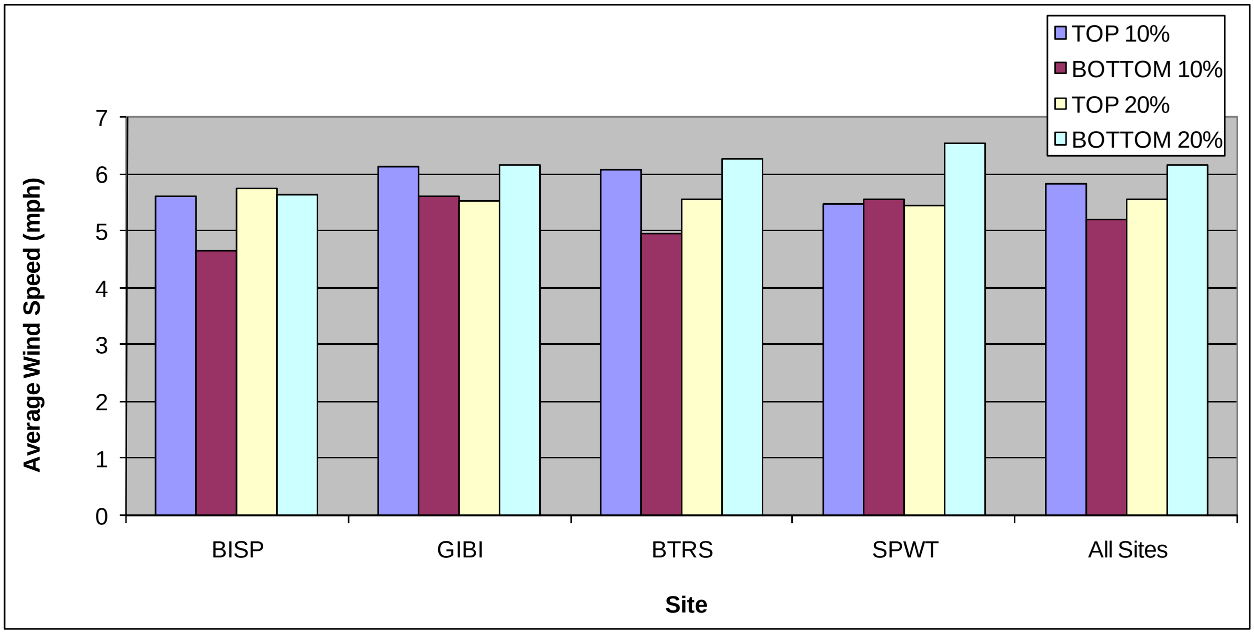


Figure P.10. Average Wind Speeds for Highest and Lowest 10% and 20% Carbon Tetrachloride Concentration Days Combined.

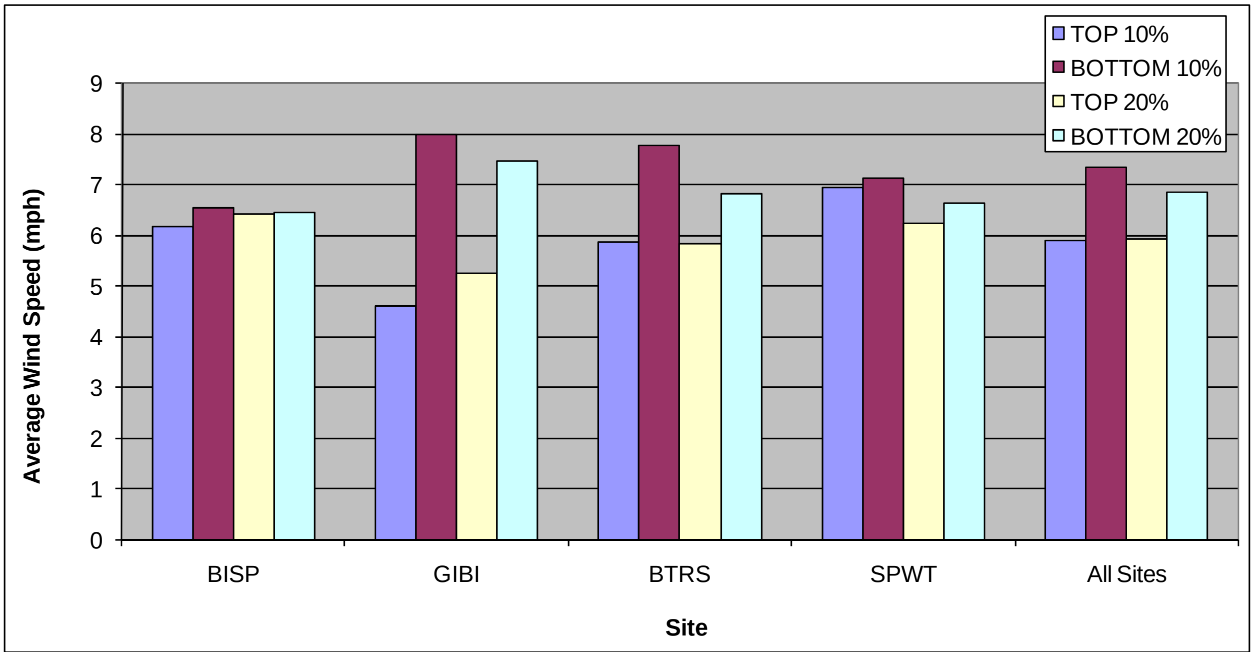


Figure P.11. Average Wind Speeds for Highest and Lowest 10% and 20% Carbon Disulfide Concentration Days Combined.

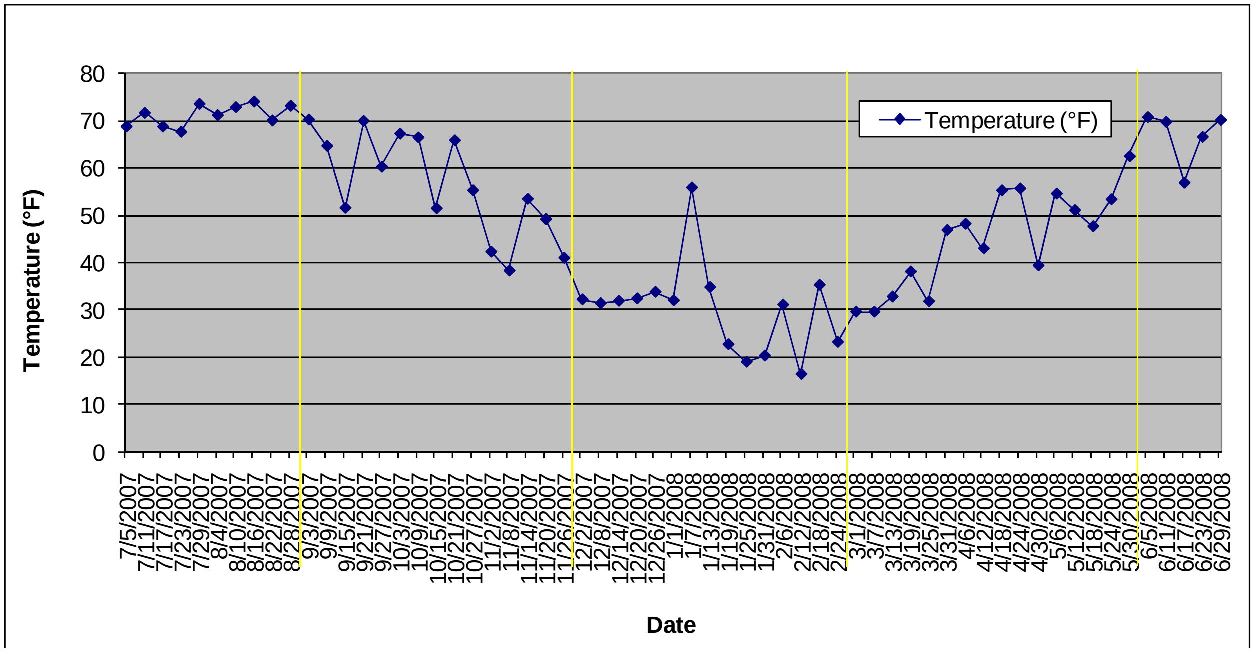


Figure P.12. BISP Monitor Meteorological Station Average Temperatures (°F) for the Study Dates.

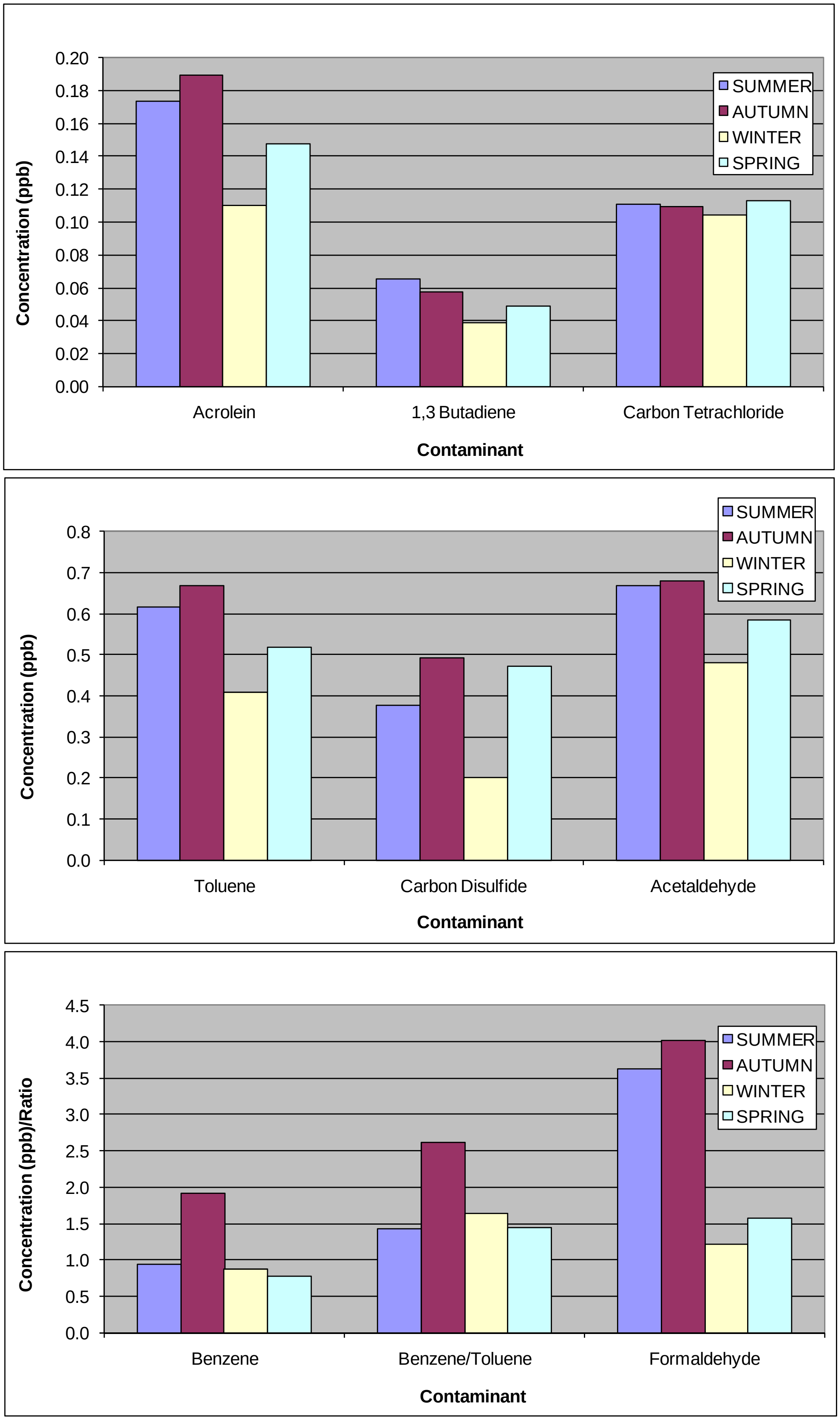
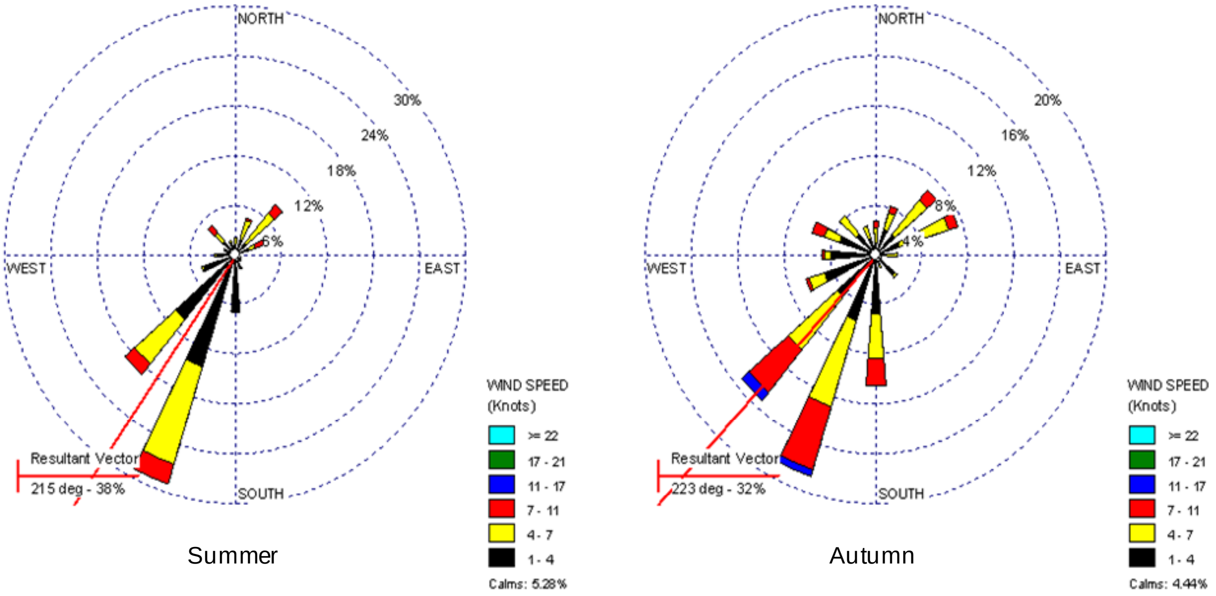
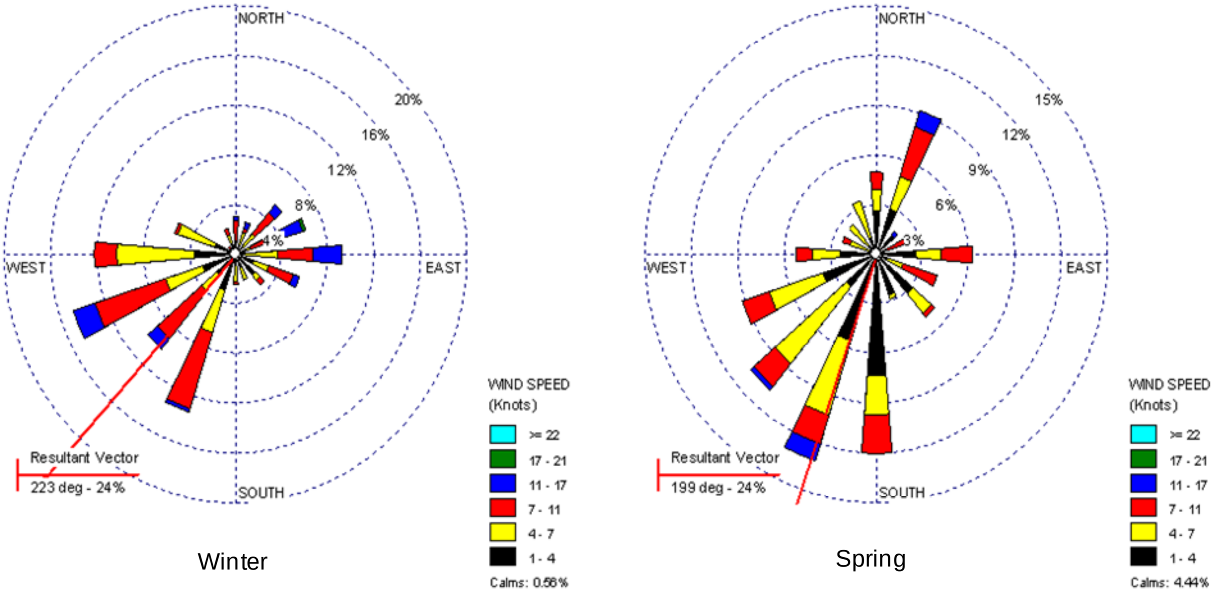


Figure P.13. Average Air Contaminant Concentrations during the Different Seasons.



Summer

Autumn



Winter

Spring

Figure P.14. Wind Roses for the Four Seasons of the Study Period.

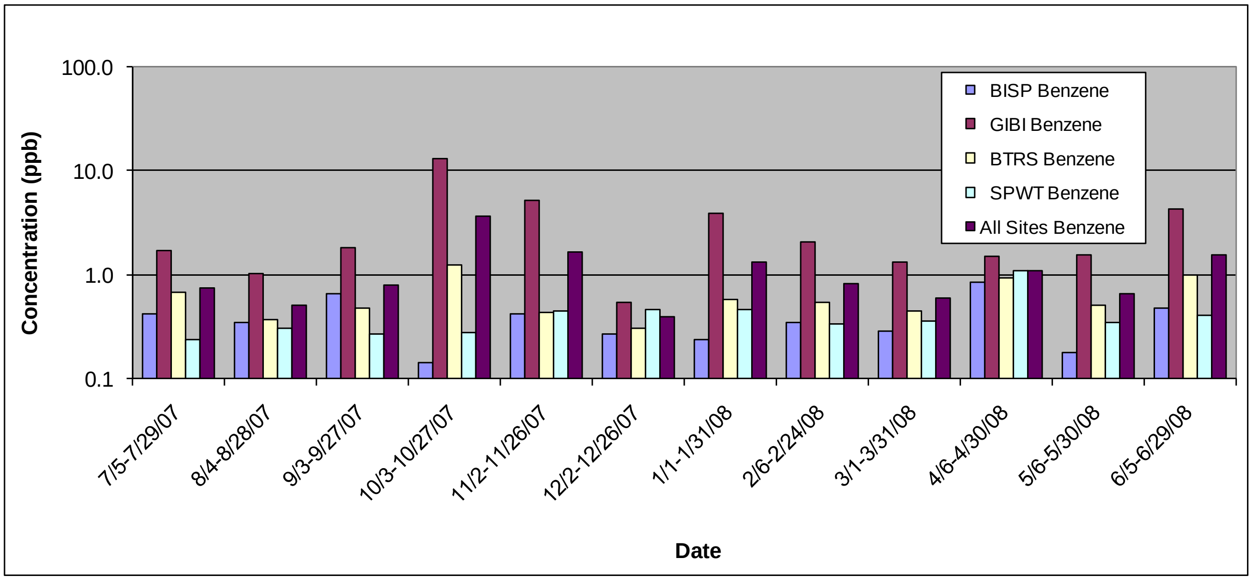


Figure P.15. Monthly Trends of Benzene Concentrations in Log Scale. The concentrations are presented using the logarithmic scale because the high GIBI monitor concentration in October resulted in very small bars for many of the other concentrations presented when the normal scale was used.

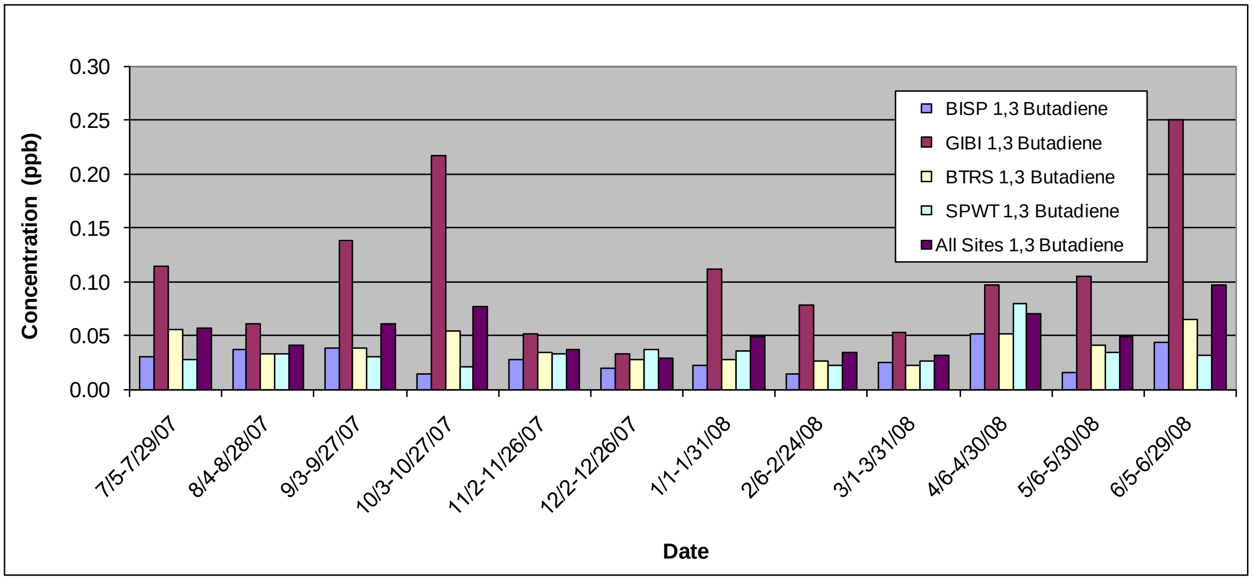


Figure P.16. Monthly Trends of 1,3-Butadiene Concentrations.

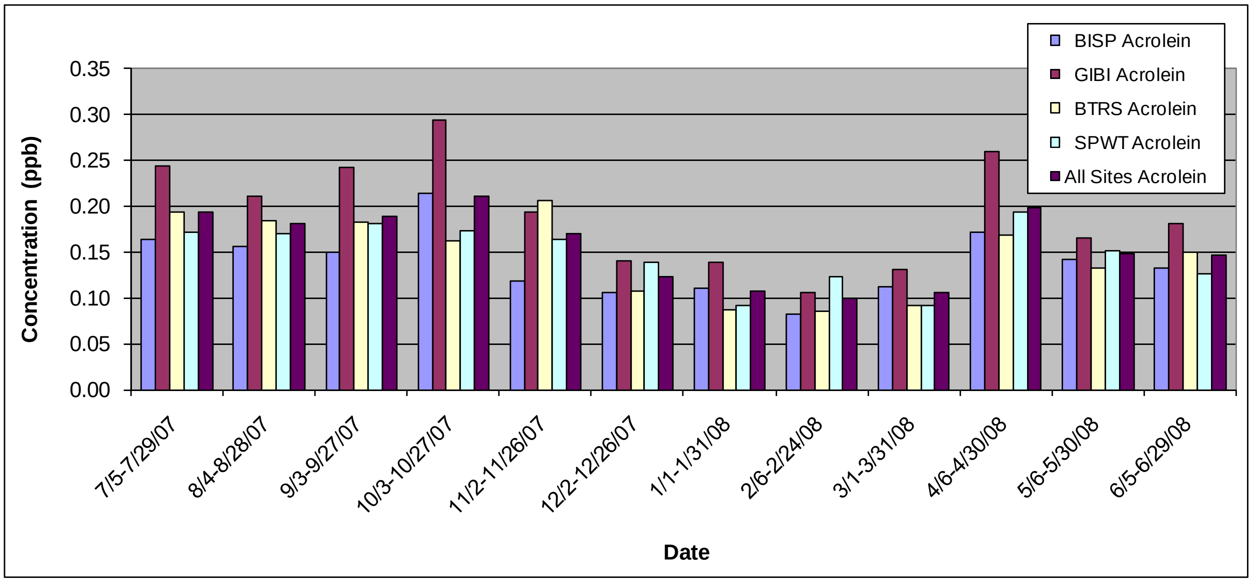


Figure P.17. Monthly Trends of Acrolein Concentrations.

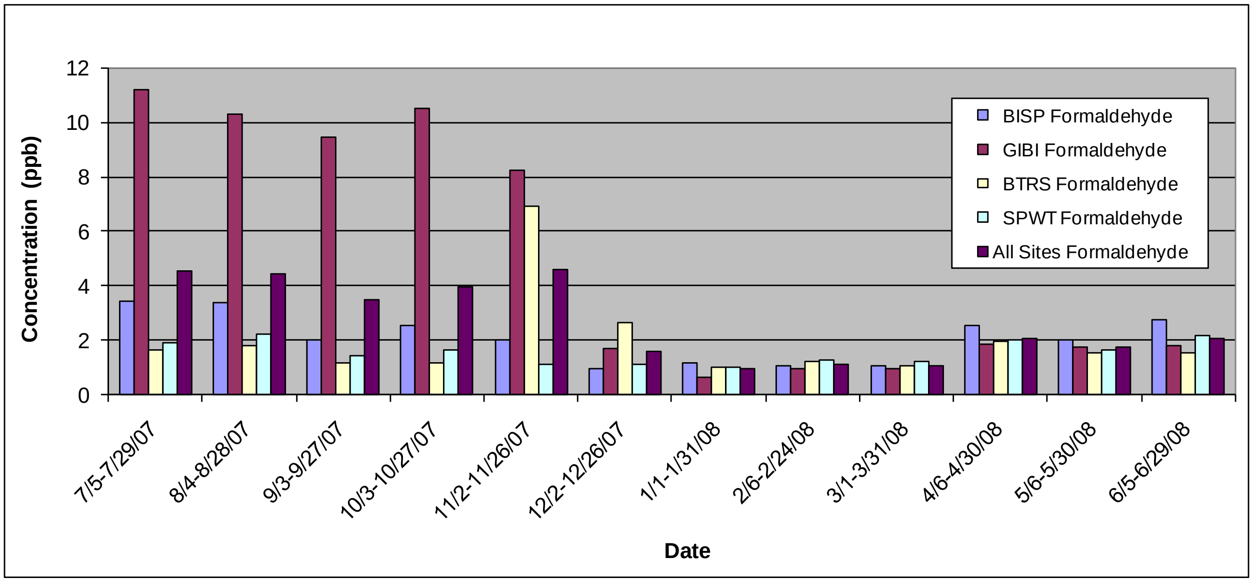


Figure P.18. Monthly Trends of Formaldehyde Concentrations.

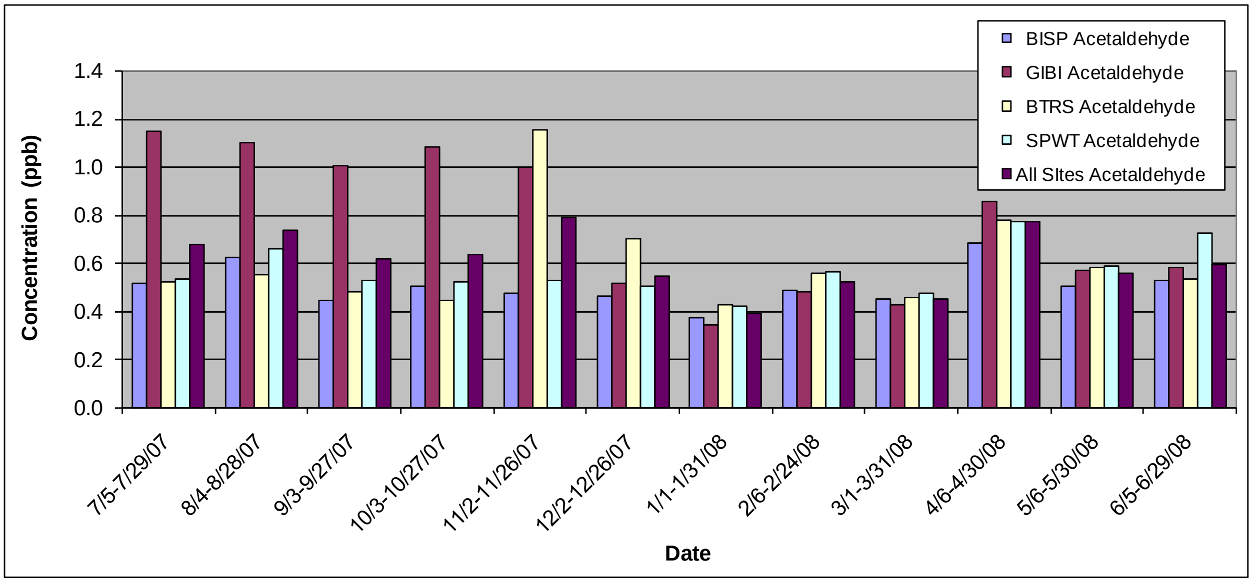


Figure P.19. Monthly Trends of Acetaldehyde Concentrations.

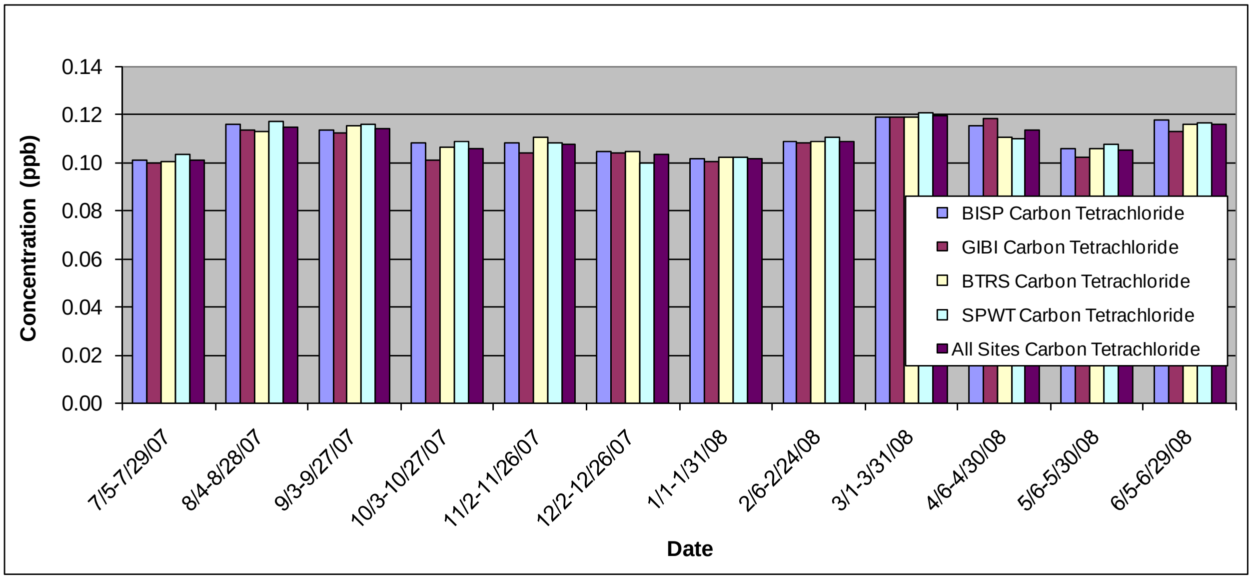


Figure P.20. Monthly Trends of Carbon Tetrachloride Concentrations.

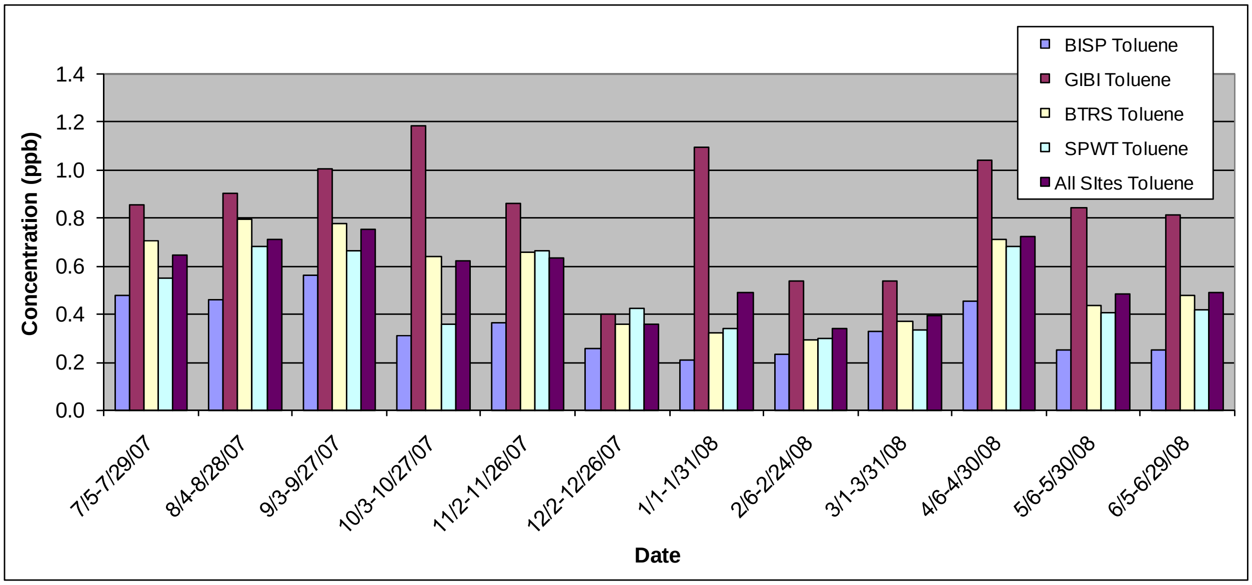


Figure P.21. Monthly Trends of Toluene Concentrations.

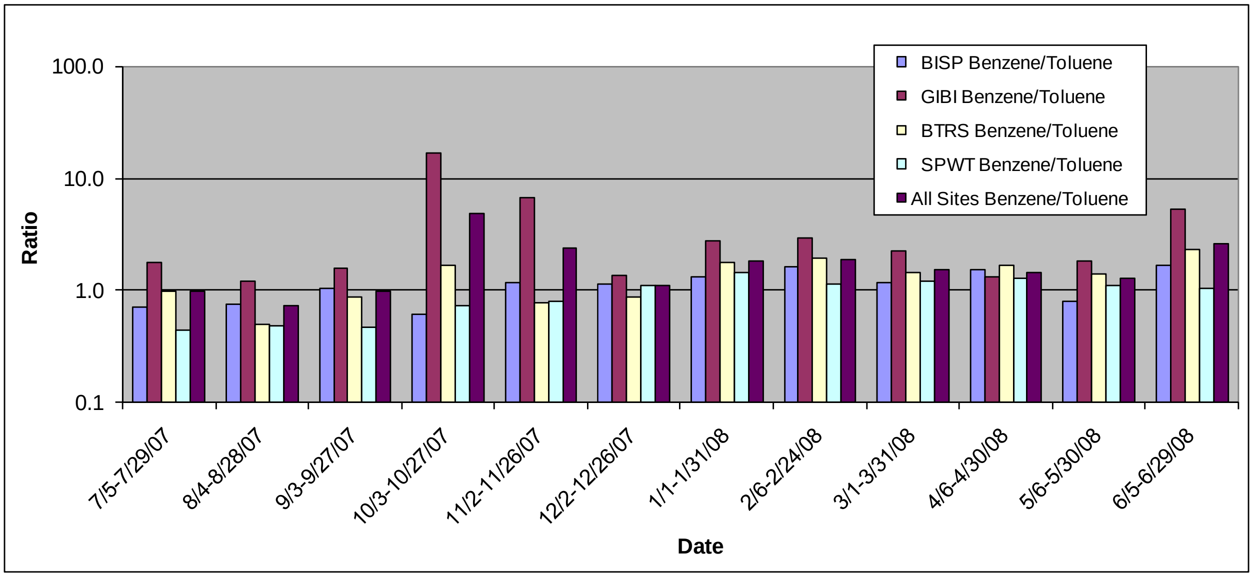


Figure P.22. Monthly Trends of Benzene/Toluene Ratios in Log Scale. The concentrations are presented using the logarithmic scale because the high GIBI monitor concentration in October resulted in very small bars for many of the other concentrations presented when the normal scale was used.

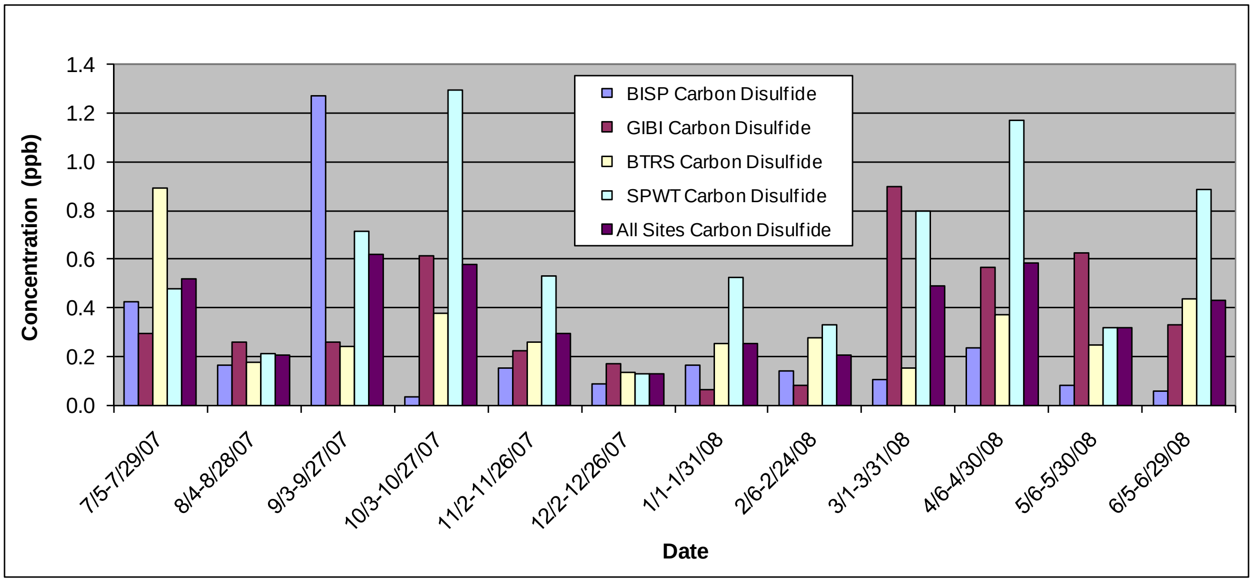
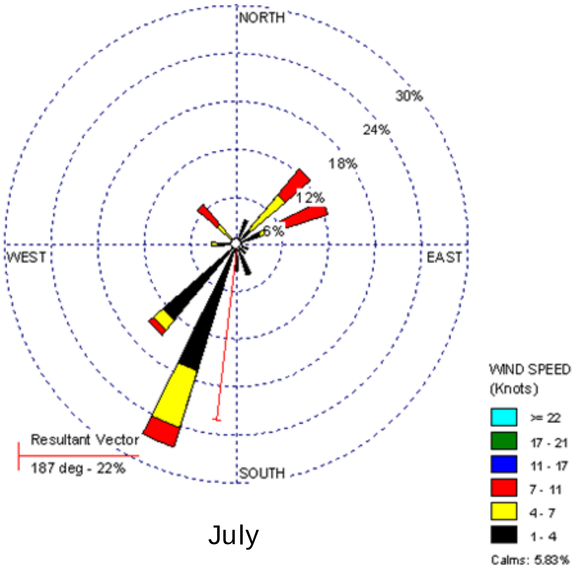
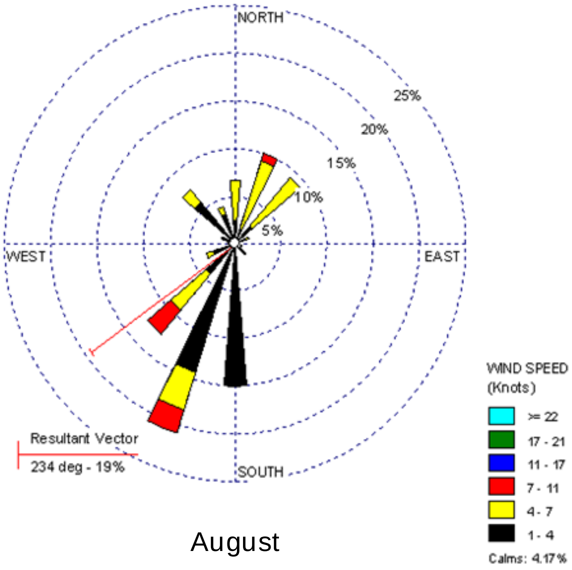


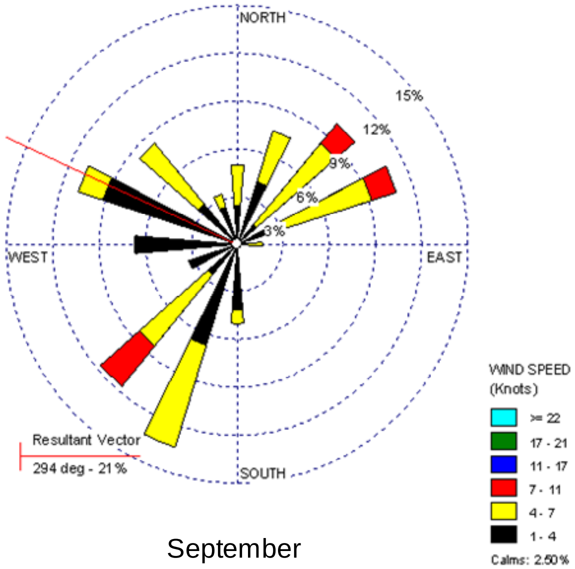
Figure P.23. Monthly Trends of Carbon Disulfide Concentrations.



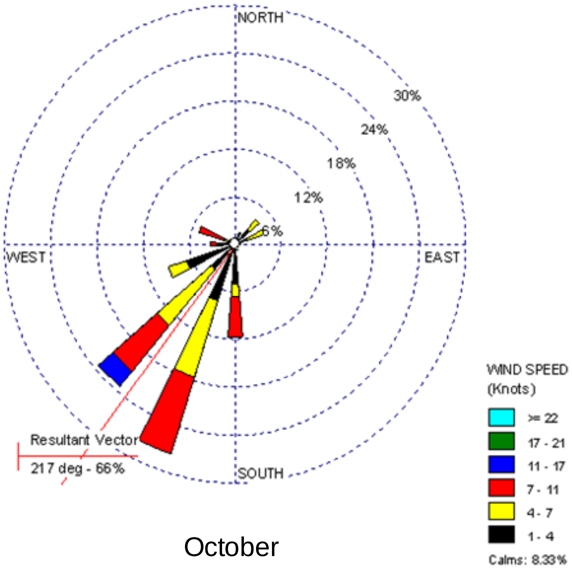
July



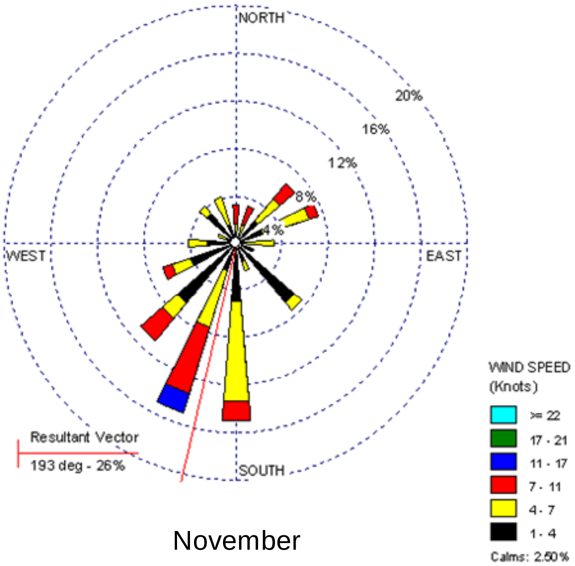
August



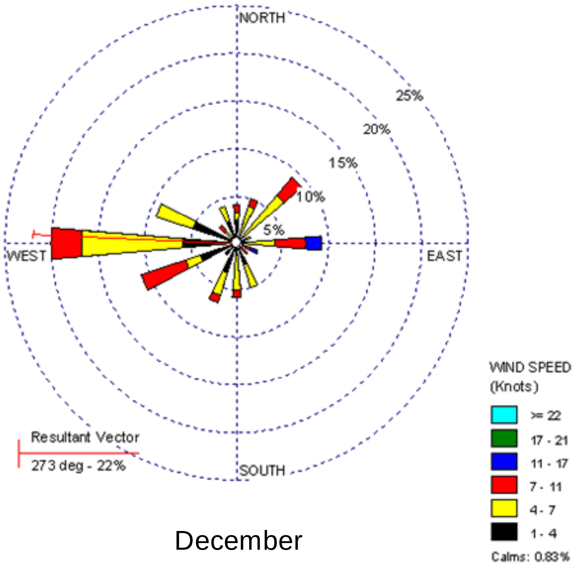
September



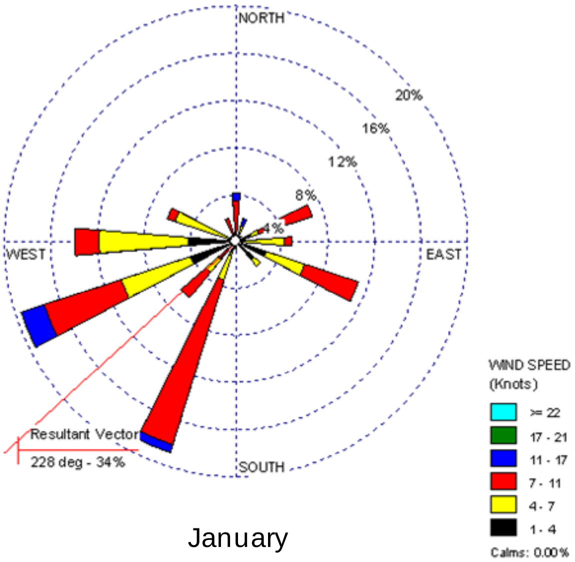
October



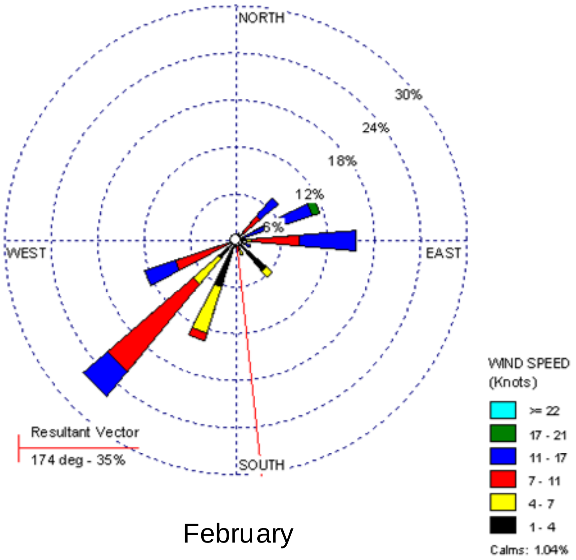
November



December



January



February

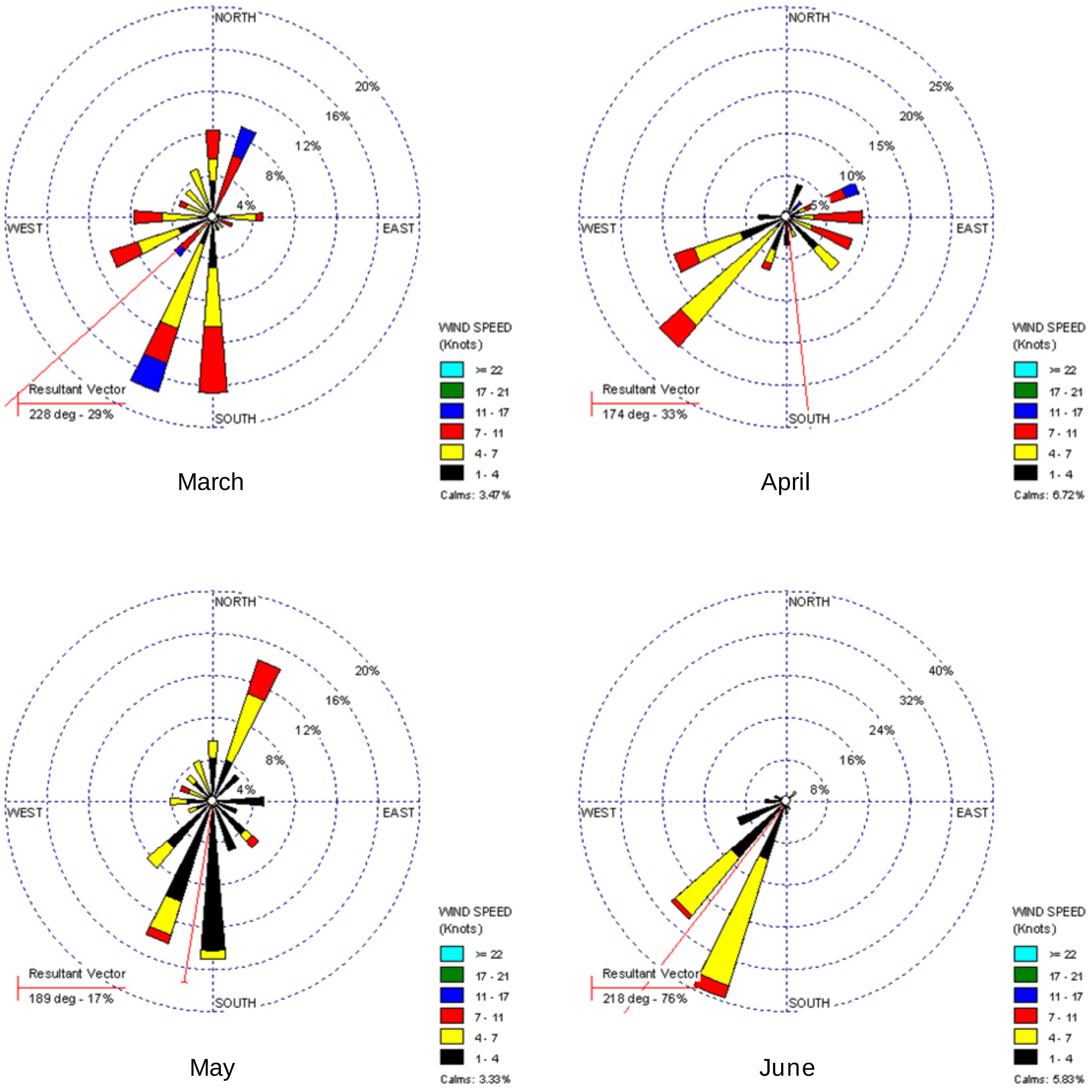


Figure P.24. Wind Roses for the Twelve Months of the Study Period.

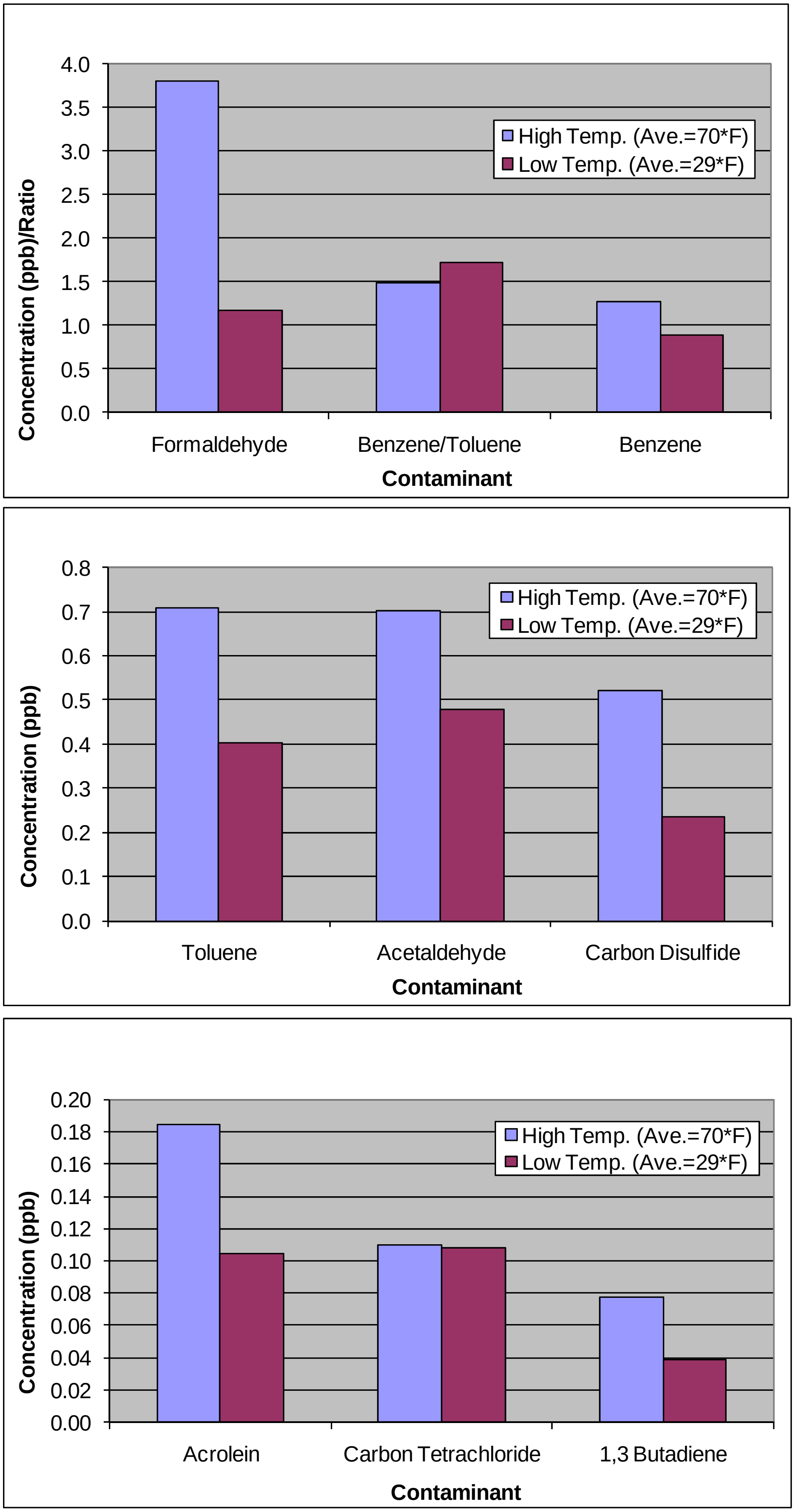
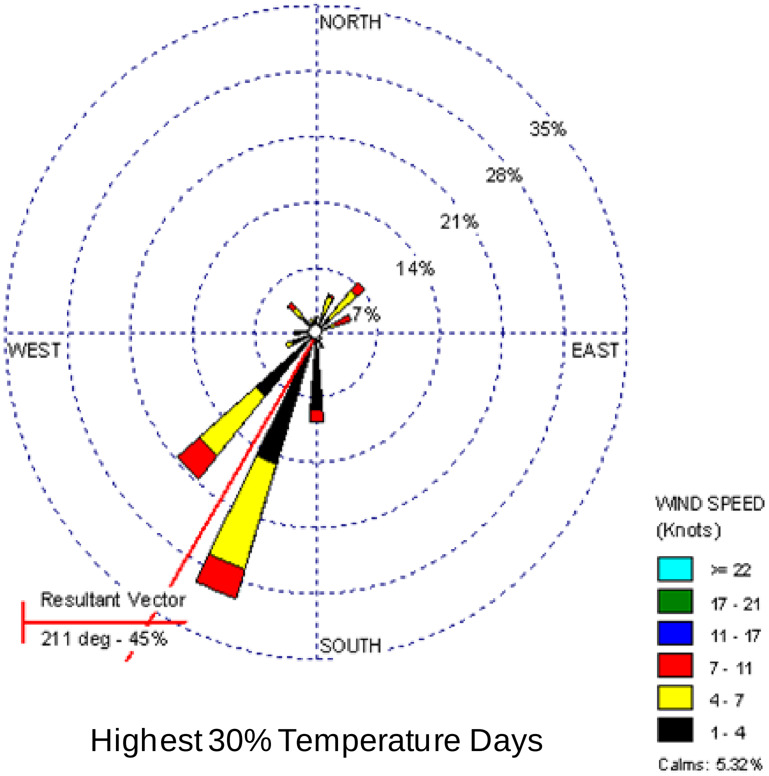
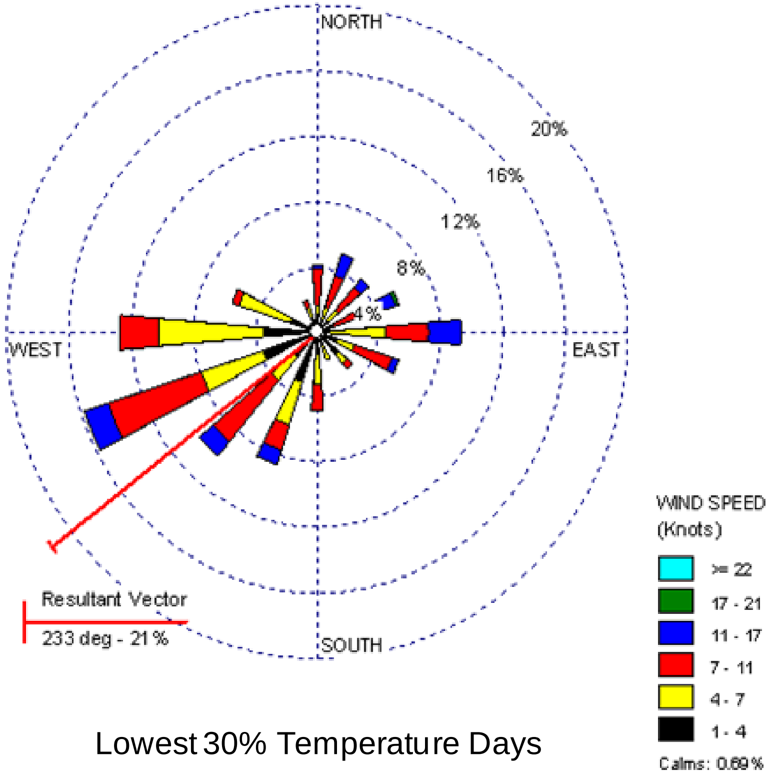


Figure P.25. Concentrations of Air Contaminants for the Highest 30% versus the Lowest 30% Temperature Days Combined.



Highest 30% Temperature Days



Lowest 30% Temperature Days

Figure P.26. Wind Roses for the Highest 30% versus the Lowest 30% Temperature Days Combined.

Appendix Q. Expanded Analyses of Day of the Week/Weekday Versus Weekend Trends for Measured Air Contaminant Concentrations and Individual Measured Concentration Trends including Correlating Contaminants

Analyses of Day of the Week and Weekday Versus Weekend Trends for Measured Air Contaminant Concentrations.

With only a maximum of 61 data points per monitor over the course of this one year study, this limits the number of data points for each day of the week at each monitor to nine or less. Therefore, the variability in the concentrations due to meteorological differences with a reduced number of data points could make trends harder to visualize. To both increase the number of data points for each day of the week and again to try and limit the influence of wind directionality as much as possible, the sites were combined together and the mean average concentration was calculated over all four sites for each day of the week (Figure Q.1). However, while the data is not presented, each monitoring location was also analyzed individually to ensure that no observations were overlooked by using only the pooled data.

As discussed previously, monitored benzene concentrations are apparently most influenced by the wind direction transporting the emissions from the largest local source of benzene to the monitors. Because the GIBI and BTRS sites have the two highest benzene concentrations and their concentrations also fluctuate in a similar fashion due to the orientation of both with respect to the largest local benzene source (thus doubling the influence on the combined sites concentration with the varied wind directionality), the weekly concentration variations are driven primarily by the similar trends seen at these two monitors (individual monitoring site day of the week trends data not shown). The benzene combined mean concentrations are the highest on Wednesdays and Thursdays (Figure Q.1), but the wind roses for those days indicate potential reasons that the concentrations are elevated these two days (Figure Q.2). The wind patterns for Wednesdays indicate that the percentage of winds from the southwest and south, southwest combined (the direction of the two monitors with the most influential concentrations, GIBI and BTRS, with respect to the largest local benzene source) is the second highest out of all the days of the week. The combined winds from these two degree sectors for Thursdays is only the middle of the range but there are additional winds in the direction of the other two monitors (SPWT and BISP) and their concentrations are also elevated substantially this day of the week. In addition, the percentage of calms is the highest out of all the days, again indicating the influence of wind speeds in dispersing the contaminants. The lower combined mean concentrations on Mondays seems to be an anomaly because this day of the week has the highest percentage of winds from the southwest and south, southwest combined (the direction of the GIBI and BTRS monitors with respect to the largest local benzene source) and the second highest percentage of calm winds. Although 1,3-butadiene appears to track similarly to benzene in response to the changes in wind direction with respect to the orientation of the largest local benzene source and the monitors, 1,3-butadiene does show an elevated combined mean concentration on Mondays, as well as, also having the highest combined mean concentrations on Wednesdays and Thursdays.

The combined mean acrolein concentration was lower on Saturday and Sunday and the combined mean toluene concentration showed an even more substantial decrease on Saturday and Sunday, after both showed a build-up of concentrations throughout the week (Figure Q.1). Both of these contaminants are emitted by mobile sources so this could be due to the higher amount of traffic on the area highways and roads Monday through Friday (with this being an area with a high concentration of industry and smaller businesses) which decreases over the weekend. The combined mean acetaldehyde concentrations for the days of the week indicate the potential for a similar trend, but to a lesser extent and with Wednesdays and Sundays being out of line with the other days of the week. However, reviewing the individual monitoring sites reveals that all four of them follow virtually the same patterns with only a few minor exceptions indicating that this trend is independent of the influences of wind directionality (data not shown). Acetaldehyde is also emitted by mobile sources so the reasoning for this trend provided above could be the case for this contaminant as well. A similar pattern was seen with the concentration of particulate matter less than 2.5 micrometers ($PM_{2.5}$) seen in various cities including New York City in response to the mobile source influence over the course of the week (DeGaetano and Doherty 2004, Lough et al. 2006). However, there may be sources of toluene or of acetaldehyde and acrolein, which are products of incomplete combustion, which are operating only during the weekdays but not on the weekend and could contribute to this observed trend. With the seven day a week operation of the largest local benzene source resulting in similar benzene concentrations on the weekend as compared to the weekdays and the decrease in toluene concentrations over the weekends, the benzene/toluene ratios for Saturdays and Sundays are elevated from that of the weekdays.

The combined mean carbon tetrachloride concentrations do not vary very much at all from one day to the next (Figure Q.1). The combined mean carbon disulfide concentrations do not show any indications of a meaningful trend over the days of the week but are elevated on Wednesdays and Fridays. Again, the combination of wind directionality and percentage of calm winds apparently influenced the elevated concentrations observed (Figure Q.2). At the SPWT monitor, which is closest to the largest carbon disulfide source in the area and has the highest concentration of all four monitors, the combined mean concentration for Wednesdays was elevated (data not shown) with the second highest percentage of winds from the southwest quadrant (the direction of the monitor with respect to the largest source). The next highest combined mean carbon disulfide concentration day at the individual monitoring sites was Friday at the BISP monitor which resulted from the second highest percentage of winds from the northeast quadrant (the direction of the monitor with respect to the largest source) and the third highest percentage of calm winds. Additionally, the combined mean carbon disulfide concentrations for Wednesdays and Fridays were in the top three at both the BTRS and GIBI monitors with the wind roses again indicating an influence from both directionality (combinations of winds and resultant vector from the south to southwest direction towards the largest source in the area) and percentage of calm winds (third highest on Fridays). The combined mean formaldehyde concentrations do not show any indications of a meaningful day of the week trend.

Following up on the day of the week analyses, the all sites combined mean concentration for all the weekdays together versus all the weekend days together were compared (Figure Q.3). By pooling all the weekdays and the two weekend days together, the combined wind patterns became more similar to each other, as compared to, those for the individual days of the week (Figure Q.4). The combined monitoring sites again allowed for the influences of the wind directionality to be reduced. There was a higher percentage of calm winds for the combined weekdays (4.64%) then there was for the combined weekend days (1.23%) which could have contributed to the observed increases in the contaminant combined mean concentrations. The results of this analysis indicated that the following contaminants had the largest increase in combined mean weekday concentration as compared to the combined mean weekend concentration: Toluene at 38%, 1,3-butadiene at 32%, Acrolein at 16%, and Acetaldehyde at 15%. The weekday and weekend concentrations for formaldehyde, benzene, carbon tetrachloride, and carbon disulfide showed very little difference to one another with the largest difference being only 6%. While it has been noted that there are indications of similarities between the concentration trends of benzene and 1,3-butadiene, here a difference is seen. It appears that the much higher concentrations of benzene, arising from the influences of the largest local benzene source, mask most of the influences from the mobile source or smaller local point source emissions. Whereas, the much lower emissions of 1,3-butadiene from the largest local benzene source allow for the influences of mobile source and/or other point sources operating only during the weekdays to be observed, similar to that discussed above for toluene, acrolein, and acetaldehyde. With very little weekday to weekend differences in average benzene concentration, along with the substantial decrease in average toluene concentration on the weekends as compared to the weekdays, the benzene/toluene ratio increases by 34% on the weekends versus the weekdays.

Analyses of the Individual Measured Concentration Trends and Similarly Correlating Air Contaminants.

To further indicate similarities or differences in the concentration trends between the different contaminants at the same monitoring site or between the different monitoring sites for the same contaminants, individual data points for all of the monitoring days were analyzed using line graphs. The benzene line graphs of the individual data points at all four monitors indicate that the two monitors that are in the same direction with respect to the largest local benzene source, GIBI and BTRS, track very similarly to one another (Figure Q.5). However, the overall trend lines for the GIBI and BTRS monitors differ, for the most part, from those for the SPWT and BISP monitors. This graph is presented using the log scale in order to observe the trends for all four monitors because of the large differences in the relative benzene concentrations measured at each site. These relationships provide additional indications that the benzene concentrations are driven more by the wind directionality with respect to local sources, as opposed to regional transport which would result in similar trends for all four monitors. There are situations where all four monitors do show similar trends for benzene on particular days during which another factor or factors appear to additionally be exerting an influence(s) on the resulting concentration. Reviewing the wind roses for these isolated days indicates that the wind speeds, in addition to the wind direction, appear to be playing a role in the measured concentrations (data not shown). For example, three days where the benzene concentrations were elevated at all four monitors, 4/24/08, 9/21/07, and 11/2/07, had calm winds percentages of 12.5%, 8.33%, and 4.17%, whereas, three days where the benzene concentrations were depressed at all four monitors, 1/7/08, 3/31/08, and 5/30/08, all have calm winds percentages of 0% in addition to having wind directionality that did not directly line the largest local benzene source up with any of the monitors. The calm winds percentage of 4.17% on 11/2/07 is somewhat lower than the other two days with high benzene concentrations at all four monitors, but reviewing the wind rose reveals that the winds are primarily in the lowest wind speed range with no wind speeds higher than the second lowest wind speeds range and the wind directionality indicates shifting winds throughout the day in most directions. As one could imagine, having shifting low speed winds from a wide variety of directions would result in a more stagnant mass of air that would not allow the contaminants, including benzene, to disperse into the upper atmosphere and/or out of the area.

The carbon tetrachloride line graphs of the individual data points at all four monitors indicate that they all track very similarly to one another (Figure Q.6). In addition, even with the substantially smaller range of the concentration scale, one can see how the carbon tetrachloride concentration had much less temporal variation than benzene did. Both of these suggest that this contaminant's concentrations are driven primarily by regional transport of the pollutant into the area. The acrolein line graphs of the individual data points at the monitors indicate that there are only isolated occasions where all four monitors have similar concentration trends and, while the GIBI and BTRS monitors track together at times, this is much less apparent then with benzene (Figure Q.7). This might arise from the presence of more numerous sources of acrolein in the industrial area and the lower overall difference between the amount of emissions coming from the largest industrial area sources and from the variety of other sources in the area. Therefore, the wind directionality variations result in a different mix of acrolein emissions, from the variety of sources, influencing each of the monitors from different degree sectors at varied percentages. However, there are some large sources of acrolein (which is a product of incomplete combustion) nearby in the industrial area, including the largest local benzene source. Therefore, there are situations where the meteorological conditions would be expected to result in similar trends being observed at the GIBI and the BTRS monitors, as they are lined up with respect to the industrial area and this source. Acrolein is very unstable with a half life in the range of 8 to 19 hours and quickly reacts with other products in the atmosphere. Concurrently, photochemical reactions occur in the atmosphere producing secondary acrolein from precursor chemicals (such as 1,3-butadiene). Further indicating that the largest local benzene source is only one of many acrolein sources in the area, or that the instability resulting in rapid destruction and/or secondary formation is occurring, is the lack of overall similarities of the trendlines for both benzene and acrolein at either the GIBI or the BTRS monitors (Figures Q.8-9). In contrast, the trendline for 1,3-butadiene compared to benzene at both the BTRS site, and especially, the GIBI site are very similar. These graphs are presented in log scale in order to observe the trends for all three contaminants because of the large differences in the relative concentrations for each contaminant. There are instances when all four monitors show similar acrolein concentration trends, indicating that another influencing factor(s) in addition to wind directionality is potentially exerting its effects (Figure Q.7), and the wind speed seems to provide an explanation (data not shown). On both 7/5/07 and 4/18/08, the acrolein concentrations were elevated at all four monitors and the percentage of calm winds were 12.5% and 20.83%, respectively. In contrast, the acrolein concentrations were reduced at all four monitors on both 1/1/08 and 1/19/08 and the percentage of calm winds were 0% on both of these days.

The 1,3-butadiene line graphs of the individual data points at the monitors indicate that the GIBI and BTRS monitors have similar trends and, while they do not track together as closely as benzene, they are more similar than the acrolein concentration trendlines for these two monitors

(Figure Q.10). This indicates that the lower overall emissions of 1,3-butadiene from the largest local benzene source, as compared to those of benzene, allow for the additional smaller sources of 1,3-butadiene to exert their influences on the measured concentrations or that the increased reactivity of 1,3-butadiene (half-life of roughly 1 to 9 hours) results in the differences in the trends observed between these two monitors. This graph is presented using the log scale, again in order to observe the trends for all four monitors because of the large differences in the relative concentrations measured at each site. To see how certain contaminants compare to one another at the same monitor location, the GIBI monitor was used because it is the closest to the industrial area and the largest local benzene source. As stated previously, the trendlines of the benzene and 1,3-butadiene concentrations are similar but, while the trendline for acrolein shows some similarities to these other two contaminants, overall it tracks much less closely with either benzene and 1,3-butadiene as these two contaminants track with respect to one another (Figure Q.9). Next, the individual trendlines of the benzene concentrations were compared to the concentrations of toluene, m,p-xylene, o-xylene, and the benzene/toluene ratio at the GIBI monitor (Figure Q.11). The two xylenes tracked almost identically with one another and toluene was very similar to the xylenes but with some subtle differences and a few isolated variations. As all these contaminants are emitted by the largest local benzene source, the benzene trendline does show many similarities to these other three contaminants. However, the lower emissions and, subsequently, overall concentration levels of toluene and the xylenes result in the influences from other emissions (such as mobile sources) being greater overall, thus leading to additional differences between these three contaminants and benzene. The substantially higher concentrations of benzene as compared to toluene cause the benzene/toluene ratio to primarily be influenced by, and therefore track closely with, the benzene concentrations. This graph is presented in log scale, again because of the large differences in the relative concentrations/ratio.

The formaldehyde and acetaldehyde line graphs of the individual data points at the monitors indicate that all four track very similarly to one another (Figures Q.12-13). This was not expected because with a half-life of only around one day or less, as opposed to over 50 years like that of carbon tetrachloride, it was unexpected that these two contaminants were acting like a regional background air pollutant drifting over the study area and causing similar trends to be observed at all four monitors simultaneously. However, because both of these contaminants (being the smallest two carbonyls) can be formed secondarily in the atmosphere by photochemical reactions breaking down larger hydrocarbon molecules, it was thought that potentially a higher percentage of calm winds would allow the time necessary for the precursor chemicals to remain in the area and undergo the chemical transformations to these smaller compounds. This is supported by the previous discussion of the different concentrations resulting from lower versus higher average wind speed days which showed that formaldehyde had the second largest percentage increase during the lowest average wind speed days as compared to the highest average wind speed days at 240% and acetaldehyde had the third largest percentage increase at 76%.

The GIBI monitor was again used to investigate if formaldehyde and acetaldehyde have similar trendlines, as they can both be formed through the secondary atmospheric chemical breakdown reactions. With only a few minor exceptions, formaldehyde and acetaldehyde do track together indicating that their measured concentrations are due to the same processes (Figure Q.14). The trendline for the carbonyls was then compared with those for the various other products of incomplete combustion and mobile source contaminants at the GIBI monitor in order to see how they matched up with one another (Figure Q.15). Only one of the xylenes (o-xylene) and one of the carbonyls (formaldehyde) was included due to the similarity with the other closely related contaminant (m,p-xylene and acetaldehyde, respectively), and 1,3-butadiene was also not included because of how closely it tracked with benzene. There appeared to be some agreement between formaldehyde and certain contaminants at certain times, but overall there was not a strong correlation between formaldehyde and these other incomplete combustion/mobile source contaminants.

Because of the similarities between formaldehyde and acetaldehyde with respect to one another and across all four monitoring sites, to investigate the theory of secondary formation of these two contaminants from atmospheric precursors, the concentrations of both formaldehyde and acetaldehyde over the four different sites were combined into one trendline. Then, whether or not any correlation existed between the measured concentrations and either the average wind speeds or an additional variable involved in the secondary formation of these compounds through atmospheric chemical reactions, insolation, was investigated. Insolation is the intensity of the sun’s rays penetrating through the atmosphere. The overall solar intensity is primarily driven by the angle of the sun’s rays with respect to the Earth’s atmosphere and depends both on the time of year and the latitude (however, other variables such as cloud cover also affect the amount of insolation on any given day). The insolation differences throughout the year due to the angle of the solar radiation is the major influence in the seasonal temperature trends (shorter term wind patterns and short-term insolation variations both cause fluctuations around the general seasonal temperature trend, however). The time of the year was the only gauge of insolation available and, as expected, it showed a close relationship with the general temperature trends. Therefore, because only the direct measurement of temperature was available, it was used to represent insolation. A relationship between these two carbonyls and temperature or season is supported by the previous discussion of the different concentrations resulting from lower versus higher average temperature days and the monthly trends/seasonality analyses. Recall that the formaldehyde showed the largest percentage increase during the highest average temperature days, as compared to, the lowest average temperature days at 325% and acetaldehyde showed an almost 50% increase. Additionally, the monthly trends for both of these carbonyls indicated a relationship of increasing concentrations with increasing temperatures, which was further supported by the percentage increases for the summer months versus the winter months, where formaldehyde had the largest increase at 300% and acetaldehyde was also among those with the highest percentage increases at 39%.

Reviewing the line graph of the individual monitoring days for the all sites formaldehyde and acetaldehyde combined concentration indicated that this trendline had correlations with both average temperature and average wind speeds. The long-term trend for the combined concentrations over the full year followed the annual temperature trendline (Figure Q.16). The highest concentrations were generally seen at the beginning of the study period when the temperatures were also the highest, followed by a marked decrease in concentrations in late November to early December when the temperatures also dropped and both stayed lower until March when the temperatures began to steadily rise again along with the combined concentrations. There was also some agreement between the short-term changes in average temperature and combined carbonyls concentration. However, the overall lack of similarities in the short-term combined concentration and temperature trendline fluctuations indicates that another factor, such as the wind speeds, was the primary influence driving the shorter term trends (e.g. daily), whereas, the temperature/insolation drives the general, longer term trends. The short term/daily trendline does indeed indicate a reverse correlation with average wind speeds (Figure Q.17). While there are instances where this inverse relationship breaks down indicating that there is another factor influencing the measured concentration to a greater degree at that time, very regularly when the average wind speeds are low or decrease, the combined concentration is high or increases and vice versa. Evidence of this inverse relationship between the two trendlines can even be observed during the winter months when the least amount of overall atmospheric secondary formation is occurring. There are cases when this relationship breaks down but most of these instances could be explained by influences of the short-term temperature fluctuations. For example, on 9/27/07, 10/3/07, 10/21/07, 11/8/07, 11/26/07, 12/8/07, 4/6/08, and 6/17/08 when the combined concentration and the average wind speed did not show the inverse trend, the temperature that day showed a direct relationship with the combined concentration potentially explaining the pattern for the resulting measured concentration.

After discovering this relationship with these two carbonyls, whether or not similar relationships could be observed for other contaminants was investigated. Acrolein was investigated first because of the previous indications that both temperature and wind speeds are influencing factors for the concentrations measured. The average acrolein concentration was 51% higher with the lowest average wind speed days as compared to the highest, and acrolein showed the strongest monthly trend of a direct correlation between average temperature and concentration. The percentage increase in acrolein concentration from the winter months to the summer months was the third highest at 58%, and percentage increase over the highest average temperature days as compared to the lowest average temperature days was among the highest at 78%. As described earlier, the individual acrolein trendlines for the four different monitors, while showing some similarities between the two monitors that are in the same general direction with respect to the industrial area (GIBI and BTRS), indicated not only much more variability between these two monitors, but also, fewer instances where all four monitors showed similar trends. Again, this increased variability in the line graph of the individual monitoring days potentially arises because of the numerous widespread sources of acrolein, along with, the lower relative emissions from the largest industrial area sources and the instability/reactivity of acrolein. Therefore, acrolein is being produced by both emissions from a wide variety of sources and by secondary formation through atmospheric photochemical reactions while, at the same time, acrolein is being reduced by reacting with other products in the air. This results in increased temporal and spatial variability in acrolein concentrations.

Once again, to investigate the general effects of average temperature and wind speed and to reduce the overall influences from wind direction, the acrolein concentrations from all four monitors were pooled together into one trendline. The comparison of this mean pooled acrolein trendline and the average temperature indicated that the concentration not only followed the general longer term temperature trend over the course of the year (similar to the carbonyls), but also that it was influenced by the shorter term variations in temperature as well (Figure Q.18). The comparison between the mean pooled acrolein concentration and average wind speed indicated, however, that the short-term inverse correlation between these two variables also apparently existed (Figure Q.19). The times when either one of these inter-relationships broke down, it appeared as though the other independent variable was exerting a greater influence on the acrolein concentration, causing it to break from agreement with the less influential variable on that particular day. For example, on, 8/4/07, 9/15/07, 11/26/07, and 2/12/08 the combined acrolein concentration went up even though the average temperature dropped, but the average wind speed dropped dramatically that day indicating that it was the more influential factor. The opposite also held true, in that, when the combined acrolein concentration decreased even though the average temperature increased, the average wind speed for that day was substantially increased (e.g. 7/11/07, 7/29/07, 10/3/07, and 2/18/08). A similar situation was observed when the inter-relationship with the other independent variable, average wind speed, was investigated. For example, on, 8/28/07, 10/21/07, 11/14/07, 1/7/08, and 6/23/08 the combined acrolein concentration went up even though the average wind speed also went up but looking at the average temperature shows that it increased dramatically that day. The opposite again also held true, in that, when the combined acrolein concentration decreased even though the average wind speed also decreased, the average temperature for that day was lower (e.g. 7/17/07, 8/22/07, 10/15/07, 11/2/07, 11/20/07, 1/13/07, 2/24/08, 3/31/08, 4/12/08, 4/30/08, and 6/17/08). The temperature fluctuations appear to exert a greater influence on the resulting acrolein concentrations measured (as compared to the wind speed variations) because, when these two variables were exerting opposing influences, the concentration trendline more often followed the temperature fluctuations. Only a few anomalies were found when either the combined acrolein concentration decreased even though both the average temperature increased and the average wind speed decreased (3/31/08), or the combined acrolein concentration increased even though both the average temperature decreased and the average wind speed increased (9/3/07, 3/25/08, and 6/11/08).

The combined sites concentration trendlines for carbon tetrachloride does not indicate a correlation with either average temperature (long or short-term) or average wind speed (Figures Q.20-21). The combined benzene concentration and the combined sites benzene/toluene ratio, which is driven primarily by the benzene concentrations, do not indicate strong correlations with either average temperature (long or short-term) or average wind speed (Figures Q.22-25). This is further support that wind direction appears to be the factor exerting the largest influence on the resulting benzene concentration measured. The combined sites concentration trendlines for 1,3-butadiene, tracking similarly to benzene, also does not indicate a strong correlation with either average temperature (long or short-term) or average wind speed (Figures Q.26-27). However, there are a few instances where the benzene and 1,3-butadiene concentrations differ and it appears that the 1,3-butadiene concentration is at least partially driven by the average wind speed (e.g. 10/21/07 and 10/27/07). Previous results indicated that the largest local benzene source was primarily contributing the airborne concentration of these contaminants, but that benzene emissions are substantially higher than those of 1,3-butadiene. The lower emissions of 1,3-butadiene is believed to allow the influences from other variables to be exerted to a greater extent, whereas, the higher emissions of benzene appear to mask most of these other influences. The combined sites concentration trendlines for toluene and total xylenes, being very similar, both potentially indicate only a weak correlation with average temperature (both long and short-term) and a moderate inverse correlation with average wind speed, although slightly less of a correlation for toluene (Figures Q.28-31). The similarities and differences between the combined total xylenes/combined toluene concentration and the combined benzene concentration potentially indicate that, similar to the relationship between benzene and 1,3-butadiene, the largest local benzene source is a predominant source but that there are additional sources in the area (e.g. mobile sources and additional stationary sources) and the measured concentrations are influenced by other factors in addition to wind directionality. However, the larger relative emissions of benzene from the largest local benzene source likely masks almost all of the other influences besides wind direction with respect to the orientation of the largest local benzene source and monitor(s). Whereas, the smaller relative emissions of 1,3-butadiene, xylenes, and toluene from the this same local point source allows for influences from the other variables (e.g. temperature and wind speed), as well as, from the other local sources (via different wind directionality impacts at the monitors) exerted on the measured concentrations to be observed.

The combined sites concentration trendline for carbon disulfide does not indicate a consistent strong correlation with either average temperature (long or short-term) or average wind speed (Figures Q.32-33).

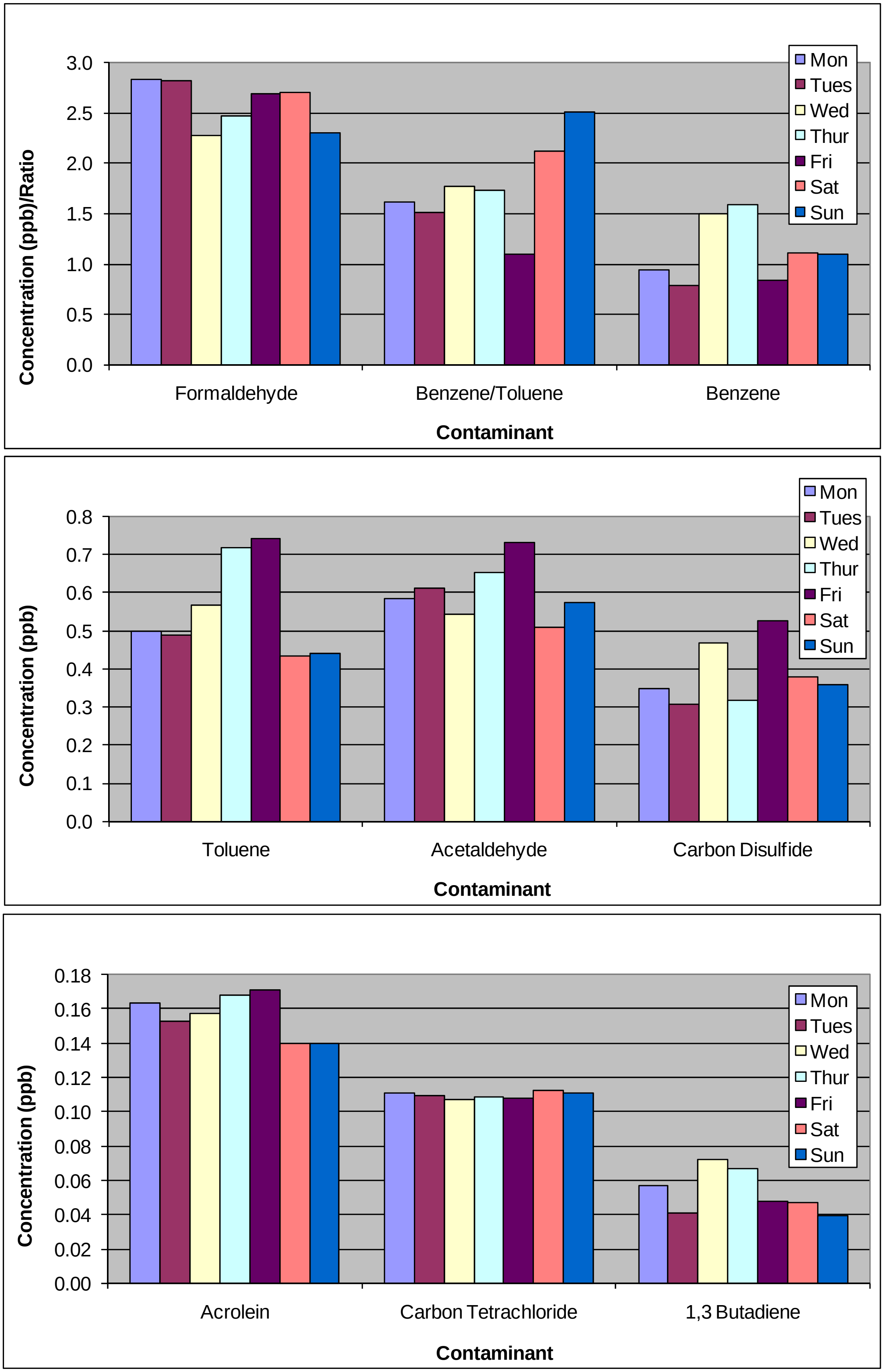
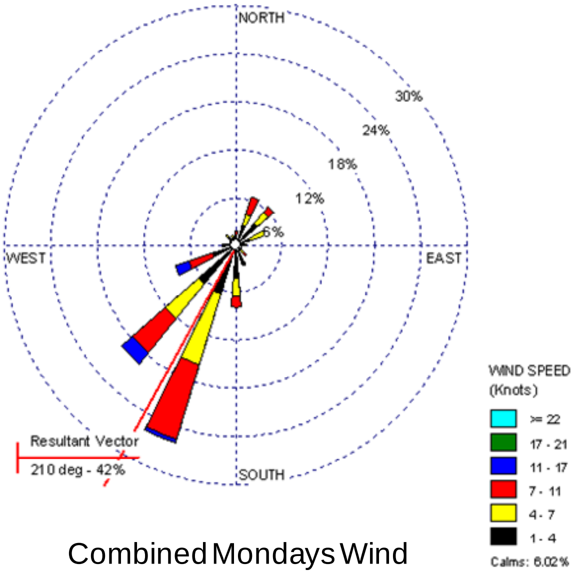
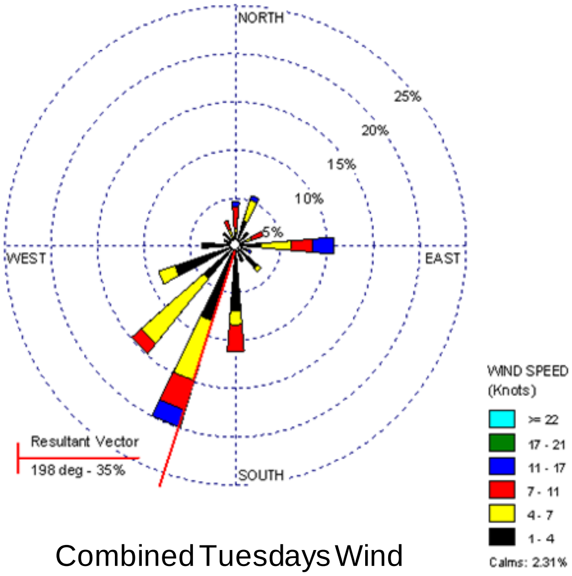


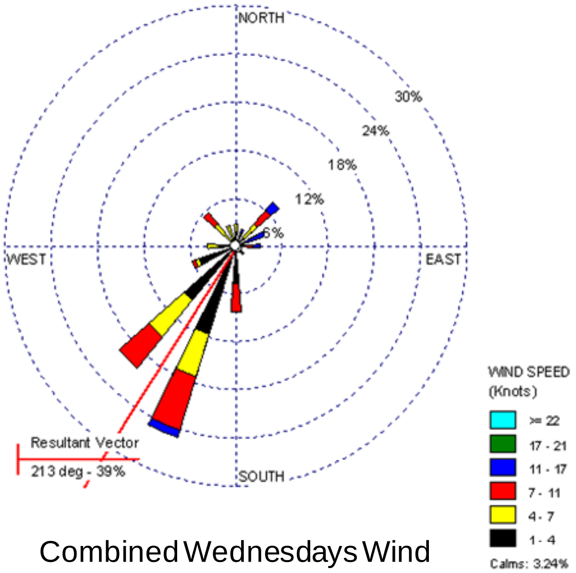
Figure Q.1. Combined Sites Concentrations of Air Contaminants for the Different Days of the Week.



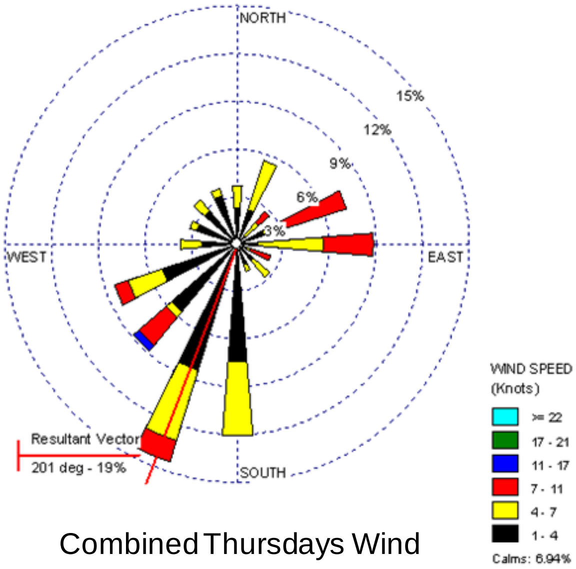
Combined Mondays Wind



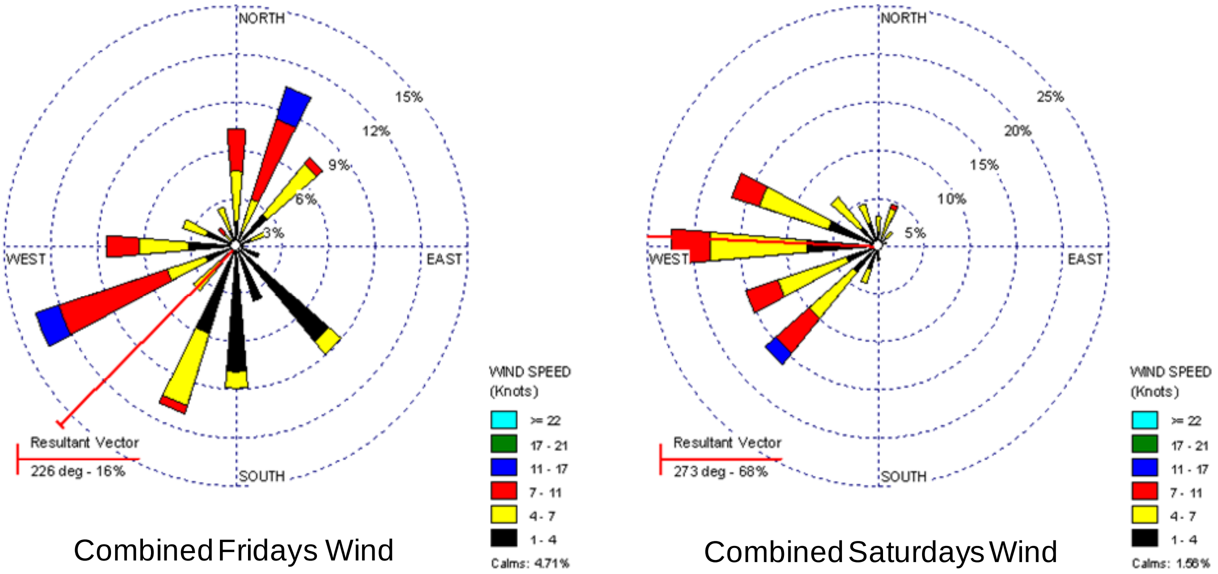
Combined Tuesdays Wind



Combined Wednesdays Wind

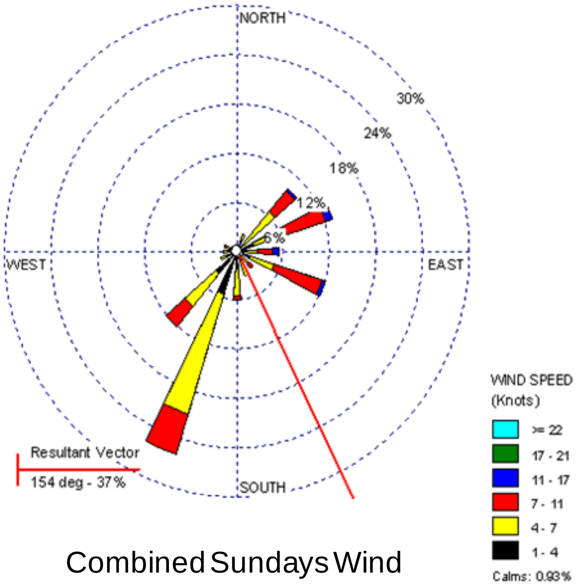


Combined Thursdays Wind



Combined Fridays Wind

Combined Saturdays Wind



Combined Sundays Wind

Figure Q.2. Wind Roses for the Different Days of the Week Combined.

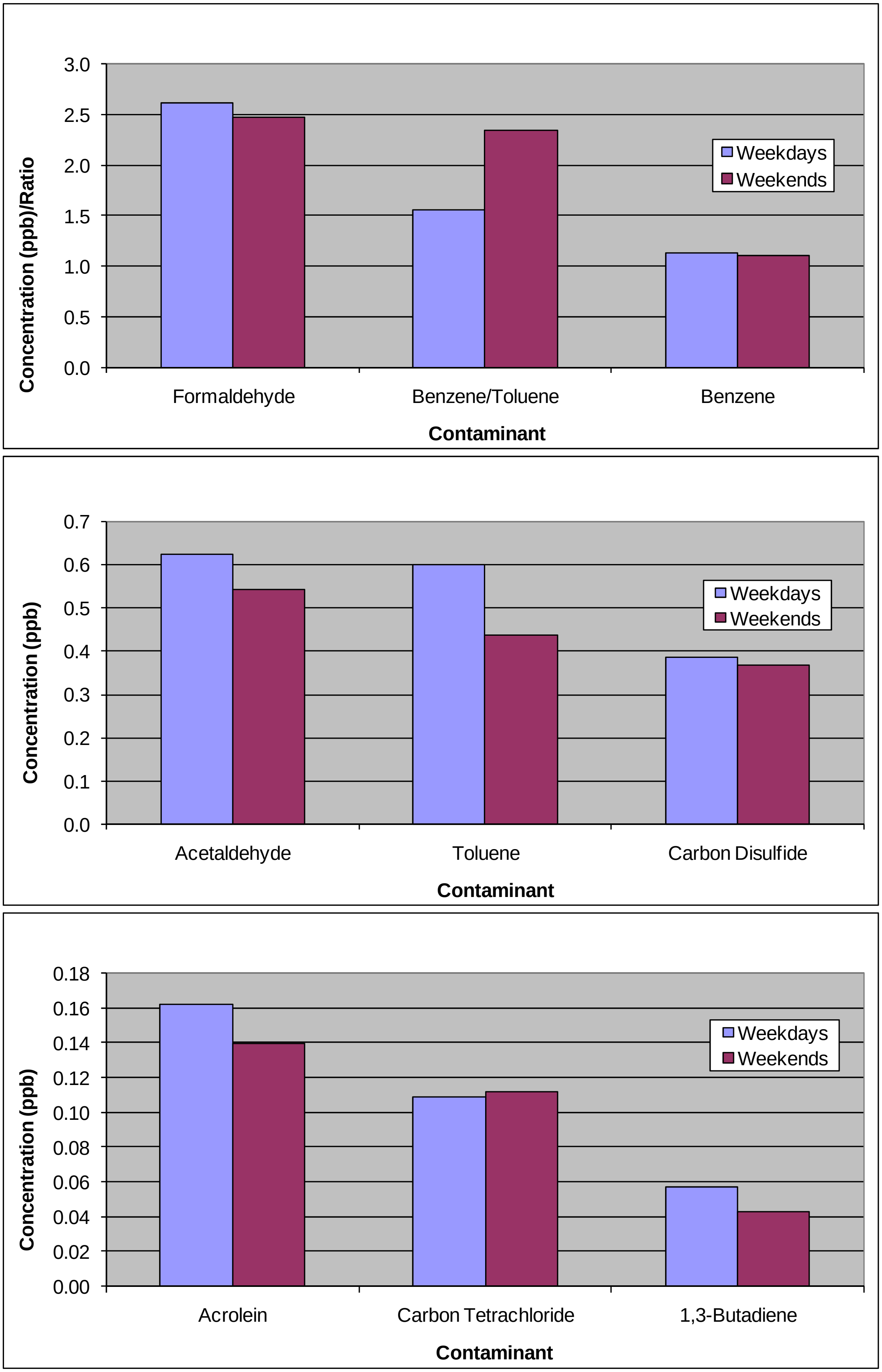
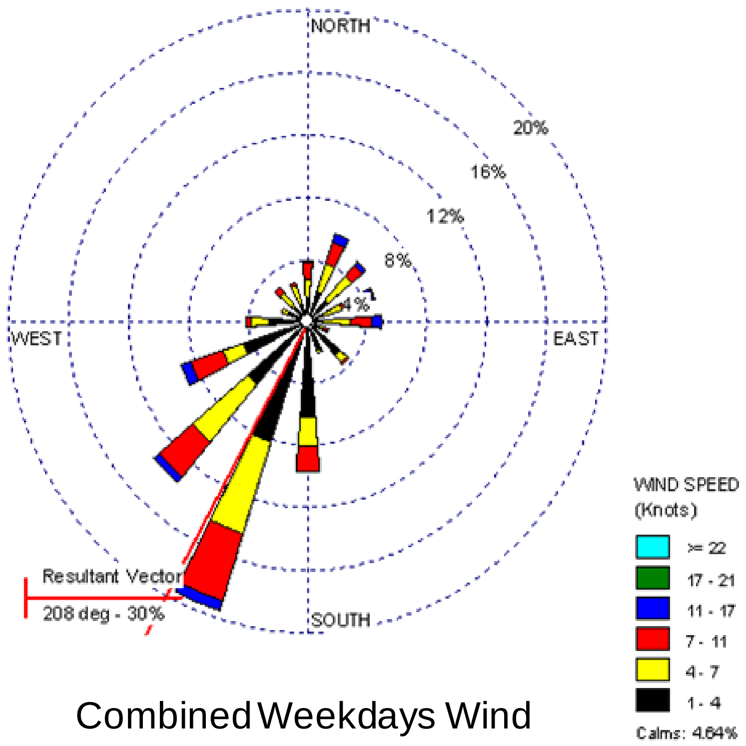
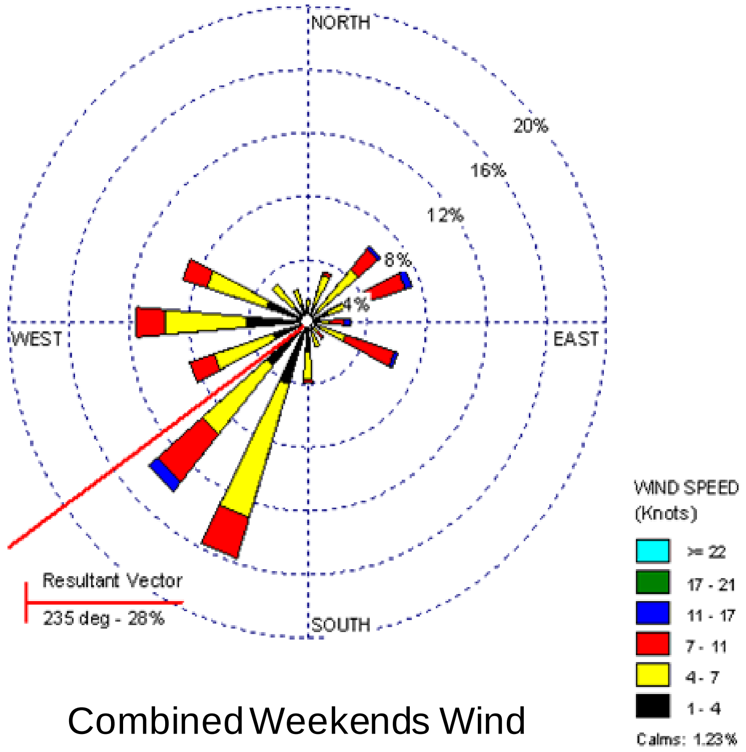


Figure Q.3. Average Air Contaminant Concentrations during the Weekdays versus the Weekends.



Combined Weekdays Wind



Combined Weekends Wind

Figure Q.4. Wind Roses for the Weekdays and Weekends Combined.

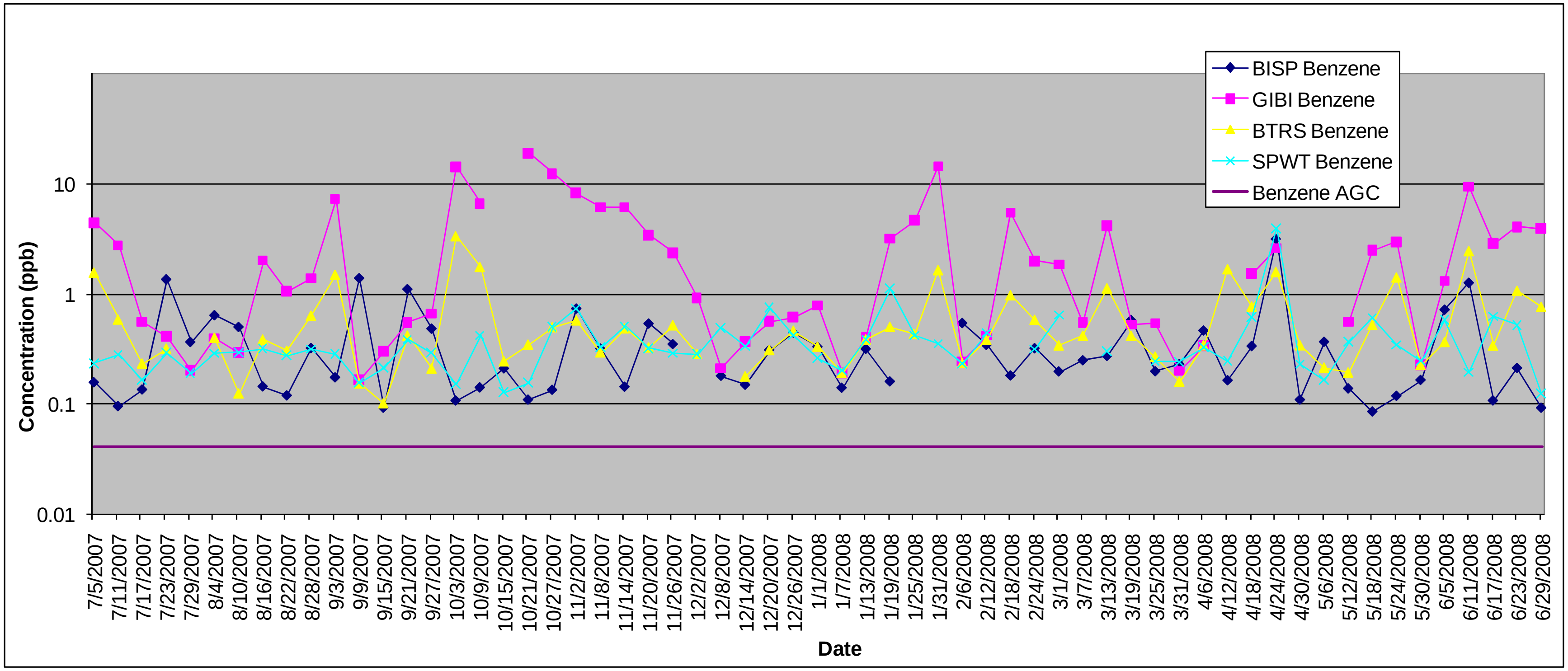


Figure Q.5. Individual Data Points of the Daily Benzene Concentrations for all Four Monitoring Sites in Log Scale. The concentrations are presented using the logarithmic scale because the GIBI monitor had several concentrations which were substantially higher than the others resulting in line graphs when the normal scale was used where observing how the trendlines tracked in relation to one another was not as easy to see.

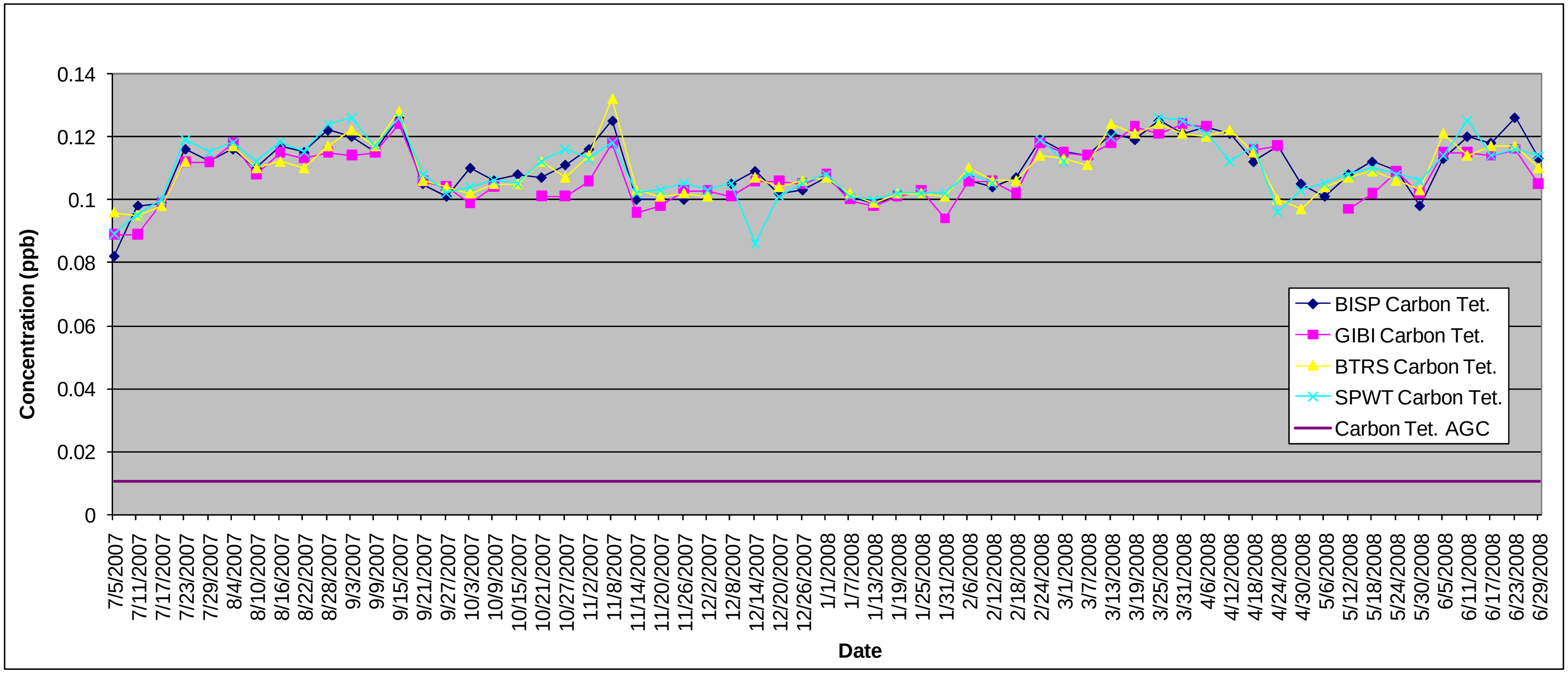


Figure Q.6. Individual Data Points of the Daily Carbon Tetrachloride Concentrations for all Four Monitoring Sites.

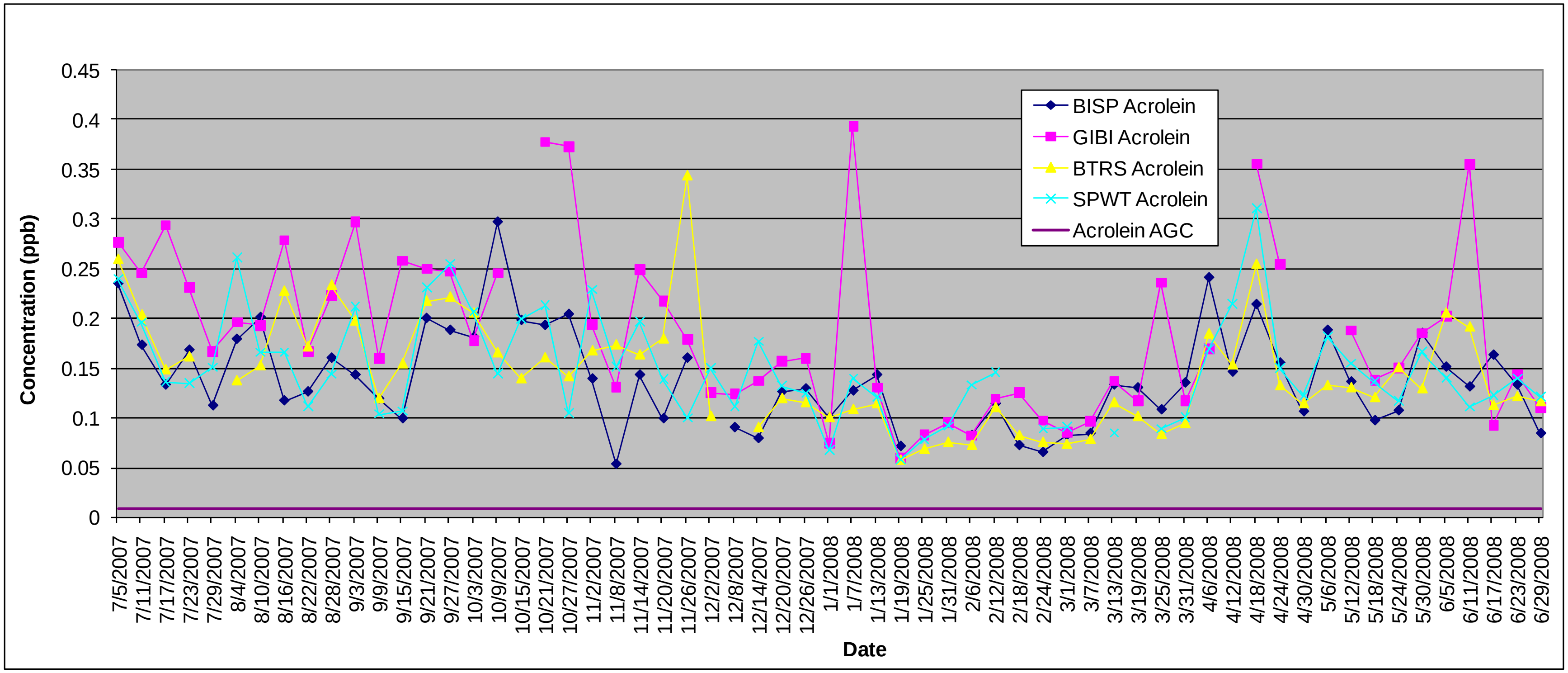


Figure Q.7. Individual Data Points of the Daily Acrolein Concentrations for all Four Monitoring Sites.

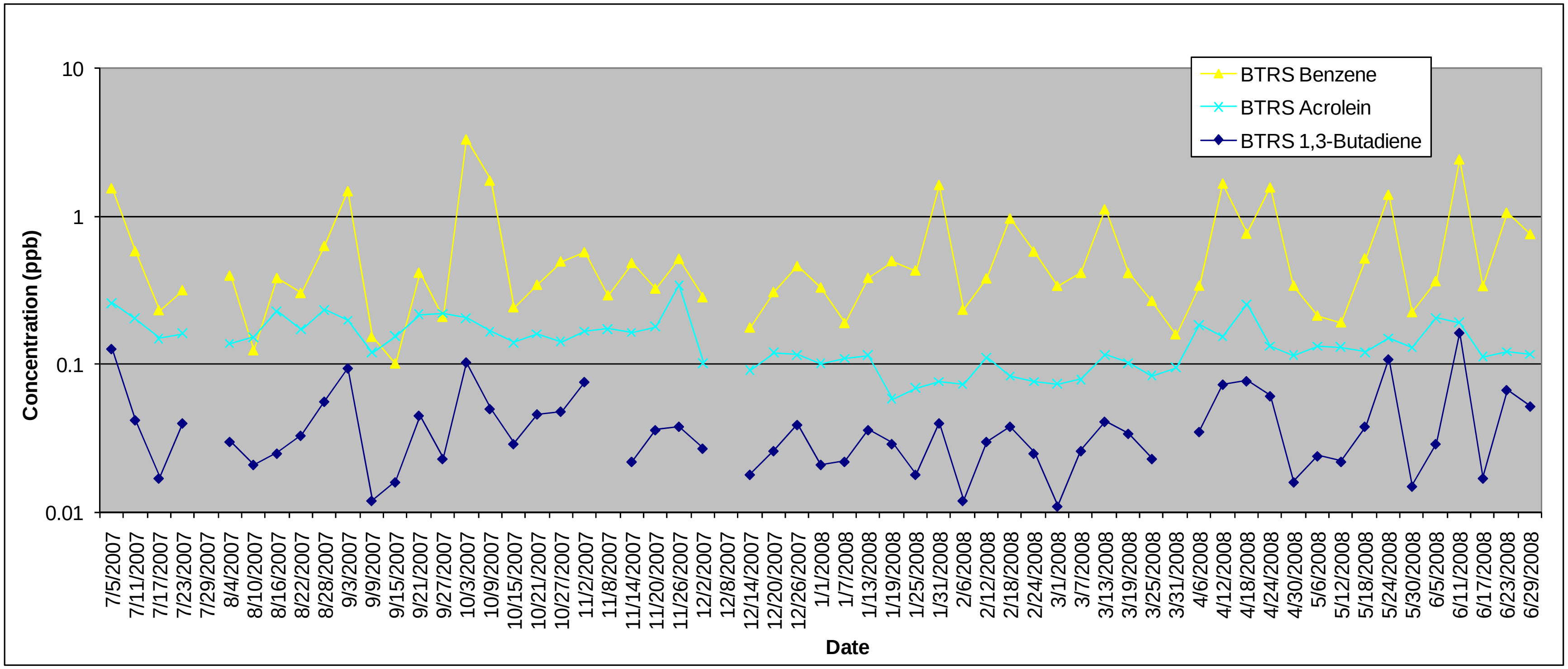


Figure Q.8. Comparisons between the Individual Data Point Trendlines of the Daily Concentrations for Acrolein, Benzene, and 1,3-Butadiene at the BTRS Monitor in Log Scale. The concentrations are presented using the logarithmic scale because of the substantial differences between the concentration range for benzene as compared to that of 1,3-butadiene resulting in line graphs when the normal scale was used where observing how the trendlines tracked in relation to one another was not as easy to see.

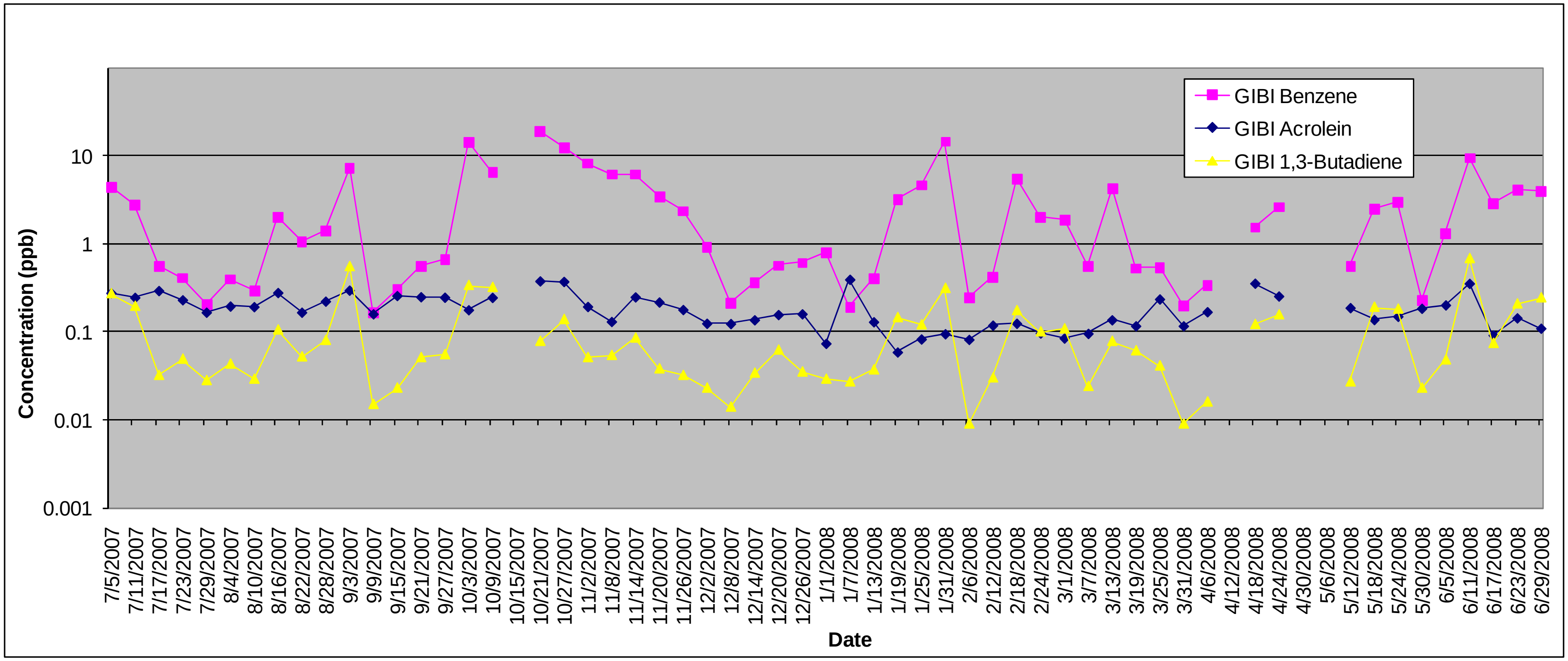


Figure Q.9. Comparisons between the Individual Data Point Trendlines of the Daily Concentrations for Acrolein, Benzene, and 1,3-Butadiene at the GIBI Monitor in Log Scale. The concentrations are presented using the logarithmic scale because of the substantial differences between the concentration range for benzene as compared to that of 1,3-butadiene resulting in line graphs when the normal scale was used where observing how the trendlines tracked in relation to one another was not as easy to see.

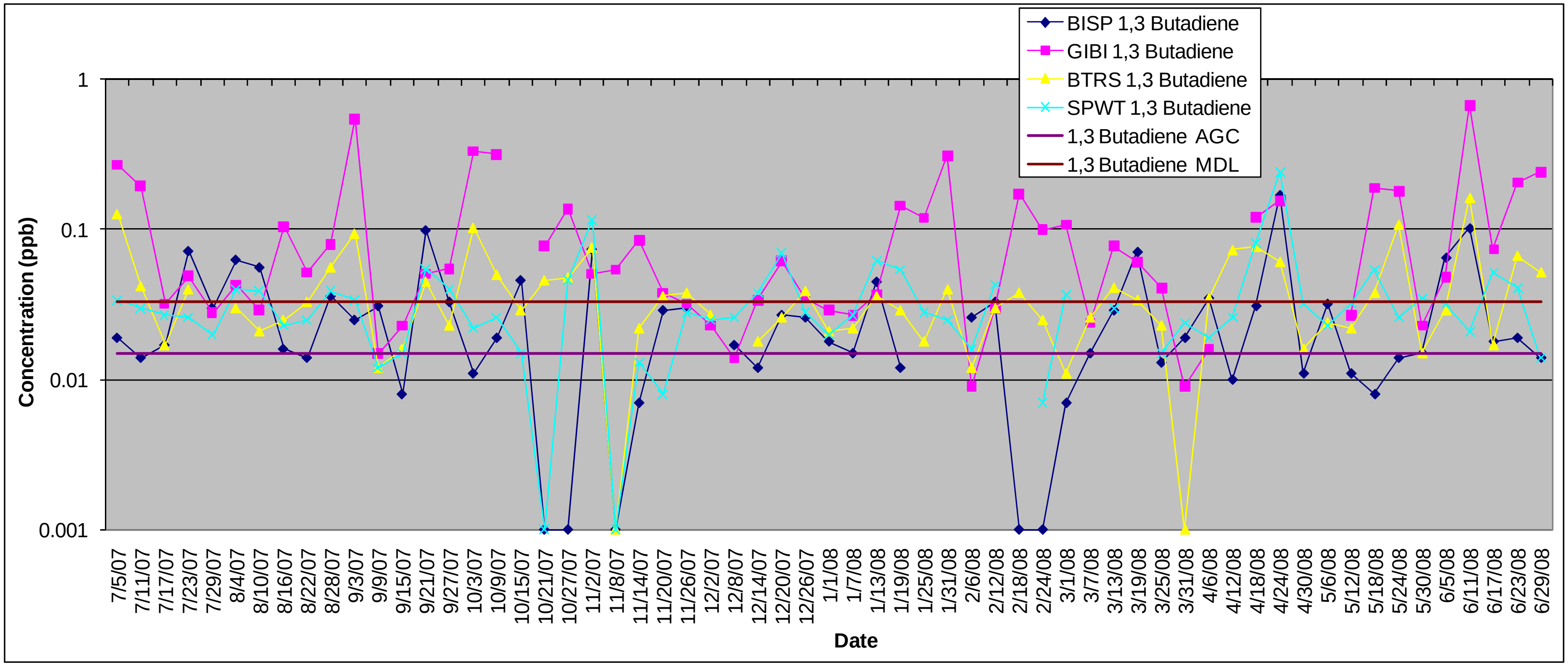


Figure Q.10. Individual Data Points of the Daily 1,3-Butadiene Concentrations for all Four Monitoring Sites in Log Scale. The concentrations are presented using the logarithmic scale because the GIBI monitor had several concentrations which were substantially higher than the others resulting in line graphs when the normal scale was used where observing how the trendlines tracked in relation to one another was not as easy to see.

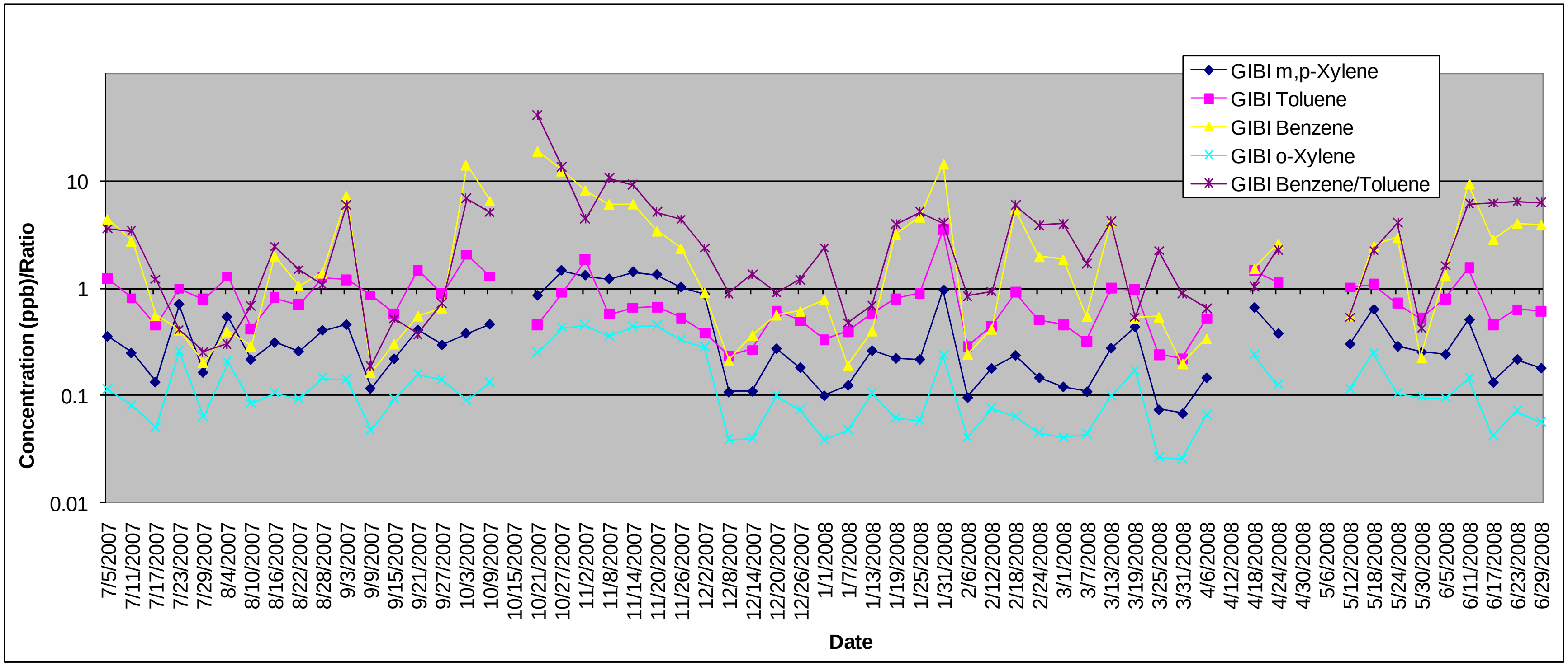


Figure Q.11. Comparisons between the Individual Data Point Trendlines of the Daily Concentrations for m,p-Xylene, Toluene, Benzene, and o-Xylene, along with the Daily Benzene/Toluene Ratios at the GIBI Monitor in Log Scale. The concentrations are presented using the logarithmic scale because of the substantial differences between the concentration range for benzene as compared to that of o-xylene resulting in line graphs when the normal scale was used where observing how the trendlines tracked in relation to one another was not as easy to see.

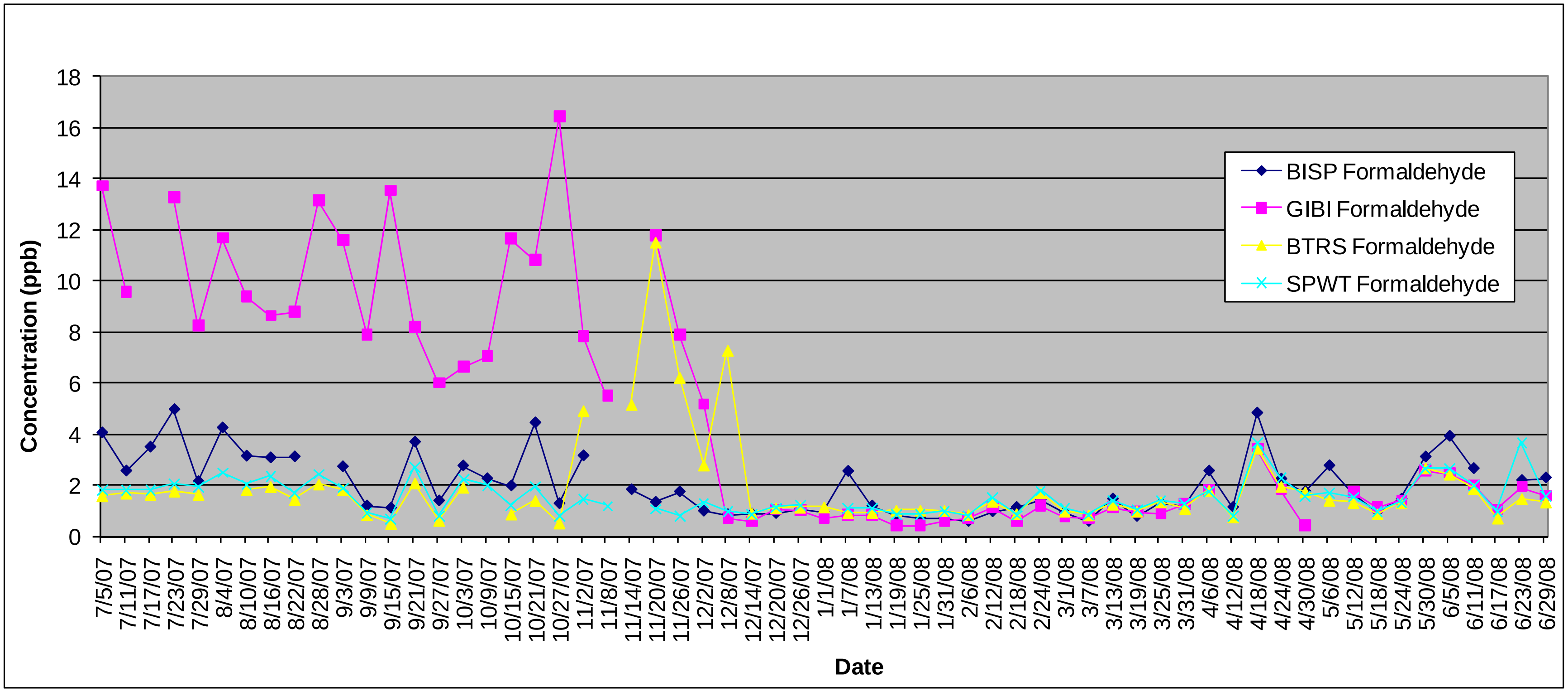


Figure Q.12. Individual Data Points of the Daily Formaldehyde Concentrations for all Four Monitoring Sites.

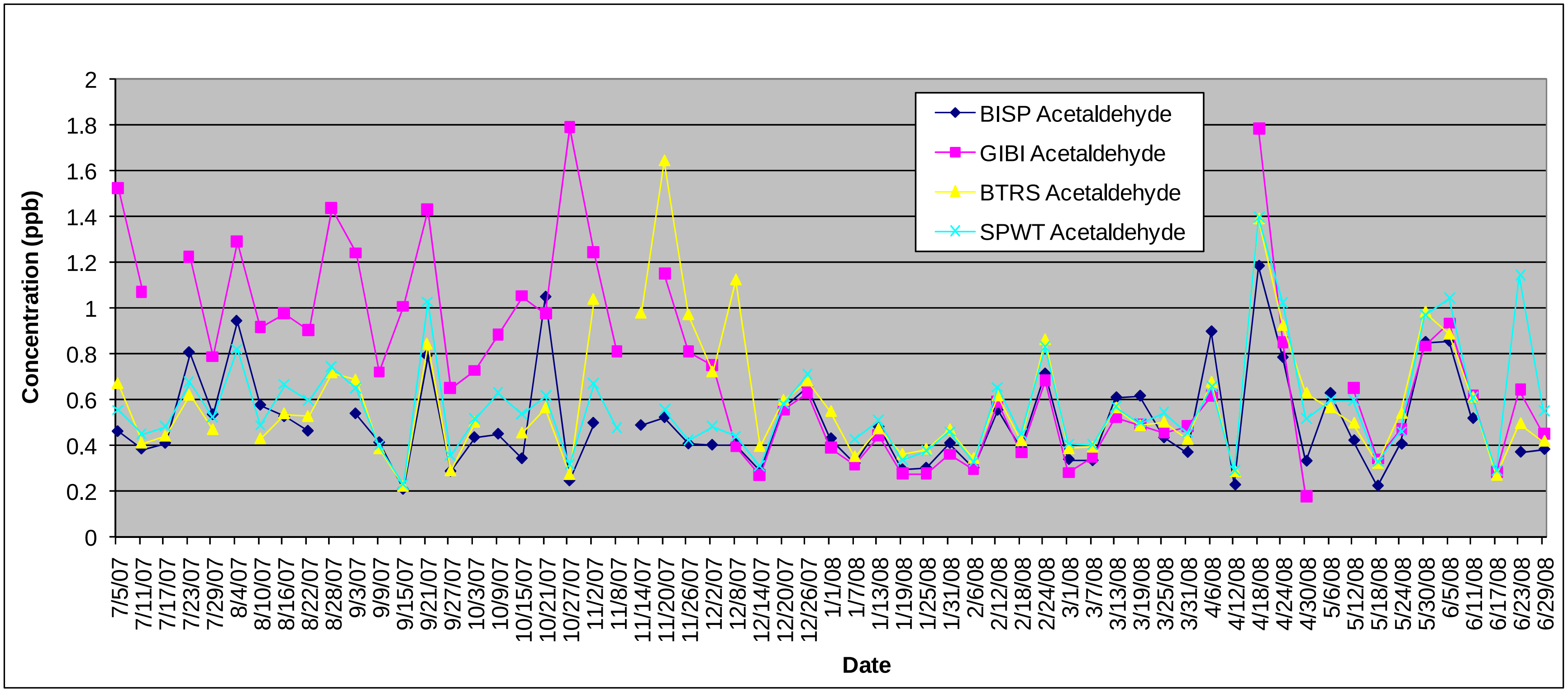


Figure Q.13. Individual Data Points of the Daily Acetaldehyde Concentrations for all Four Monitoring Sites.

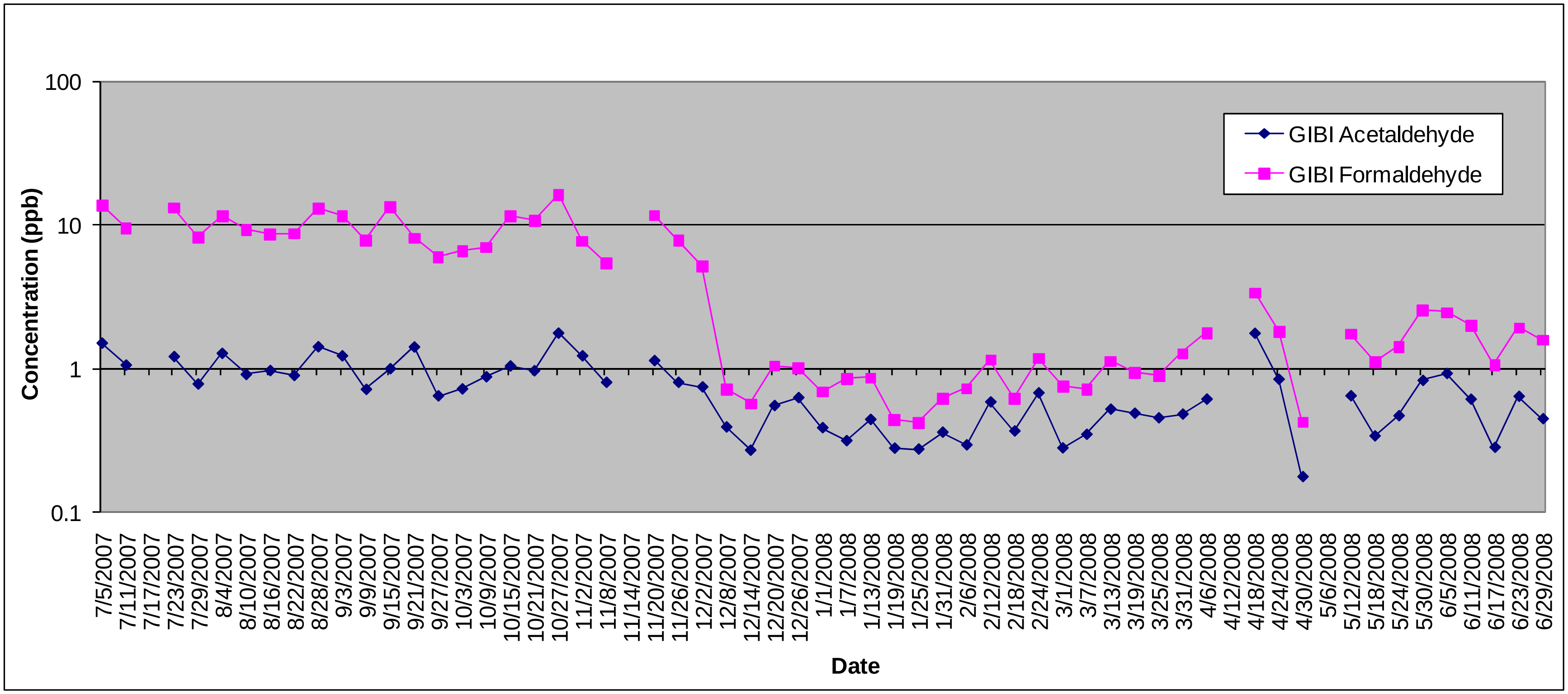


Figure Q.14. Comparisons between the Individual Data Point Trendlines of the Daily Concentrations for Acetaldehyde and Formaldehyde at the GIBI Monitor in Log Scale. The concentrations are presented using the logarithmic scale because of the substantial differences between the concentration range for formaldehyde as compared to that of acetaldehyde resulting in line graphs when the normal scale was used where observing how the trendlines tracked in relation to one another was not as easy to see.

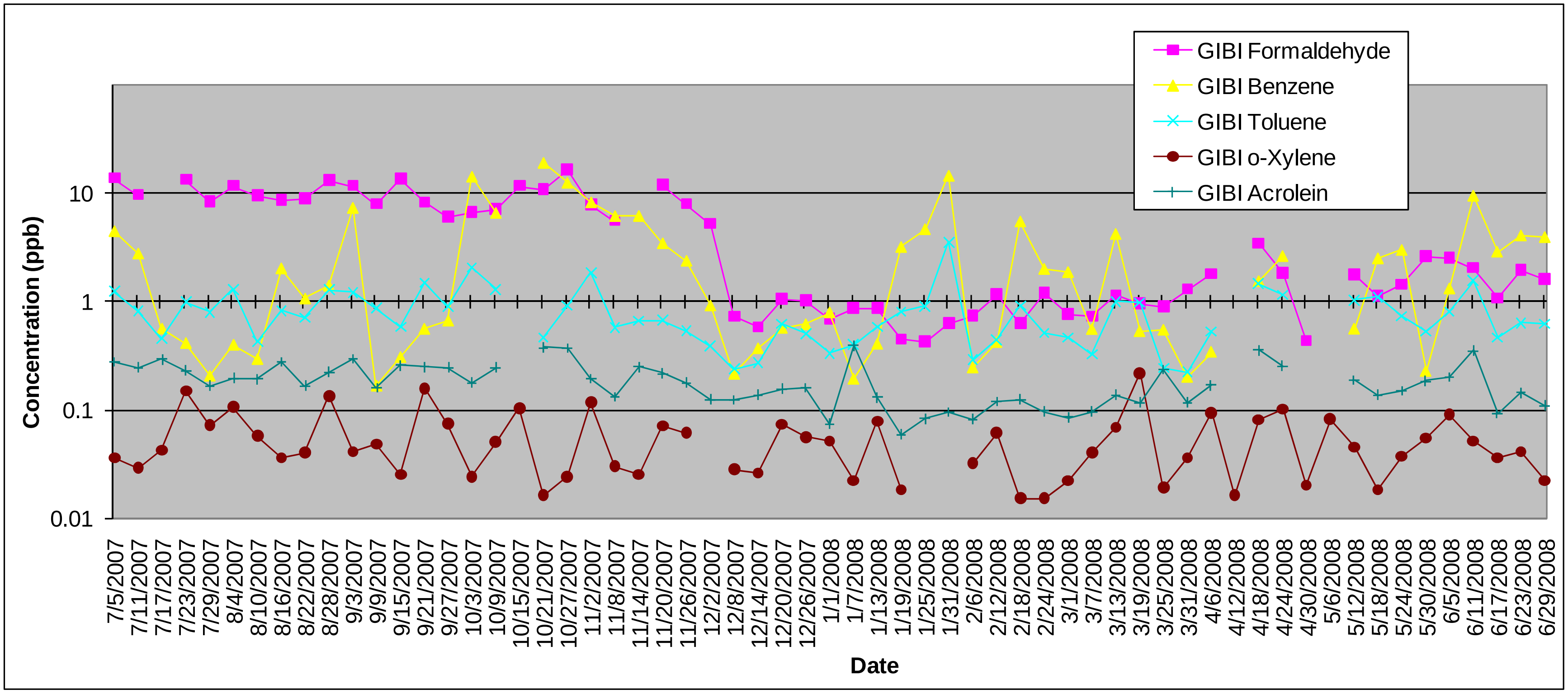


Figure Q.15. Comparisons between the Individual Data Point Trendlines of the Daily Concentrations for Formaldehyde, Benzene, Toluene, o-Xylene, and Acrolein at the GIBI Monitor in Log Scale. The concentrations are presented using the logarithmic scale because of the substantial differences between the concentration range for formaldehyde and benzene as compared to that of o-xylene resulting in line graphs when the normal scale was used where observing how the trendlines tracked in relation to one another was not as easy to see.

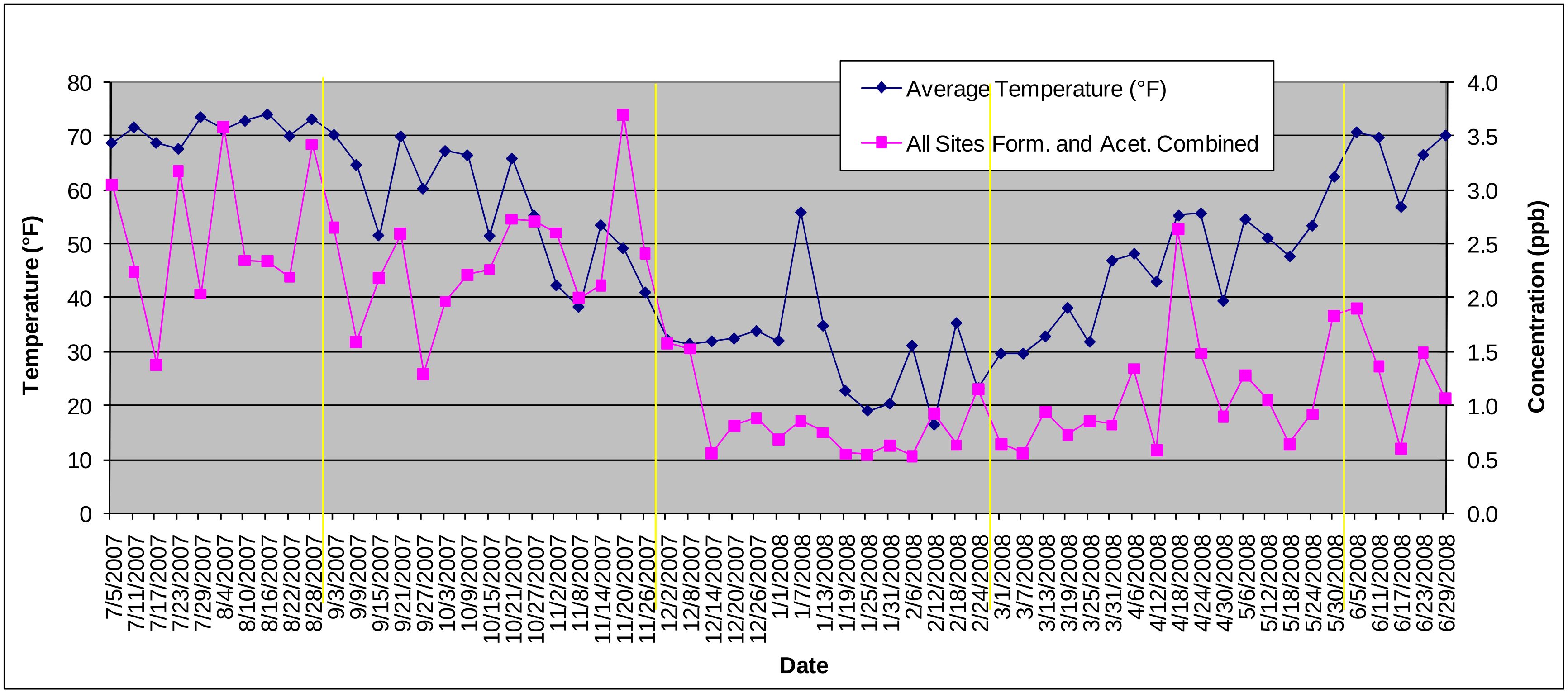


Figure Q.16. Comparisons between the Combined Formaldehyde and Acetaldehyde Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

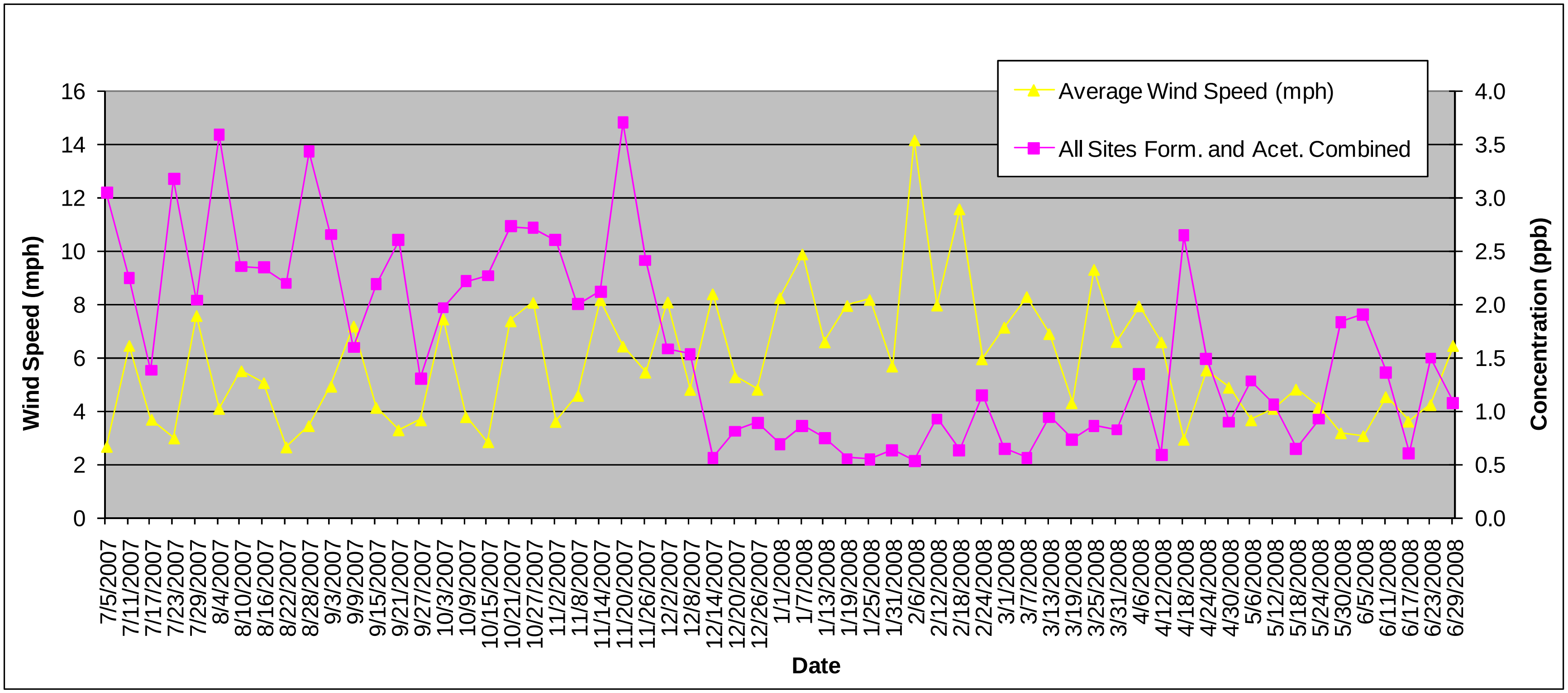


Figure Q.17. Comparisons between the Combined Formaldehyde and Acetaldehyde Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

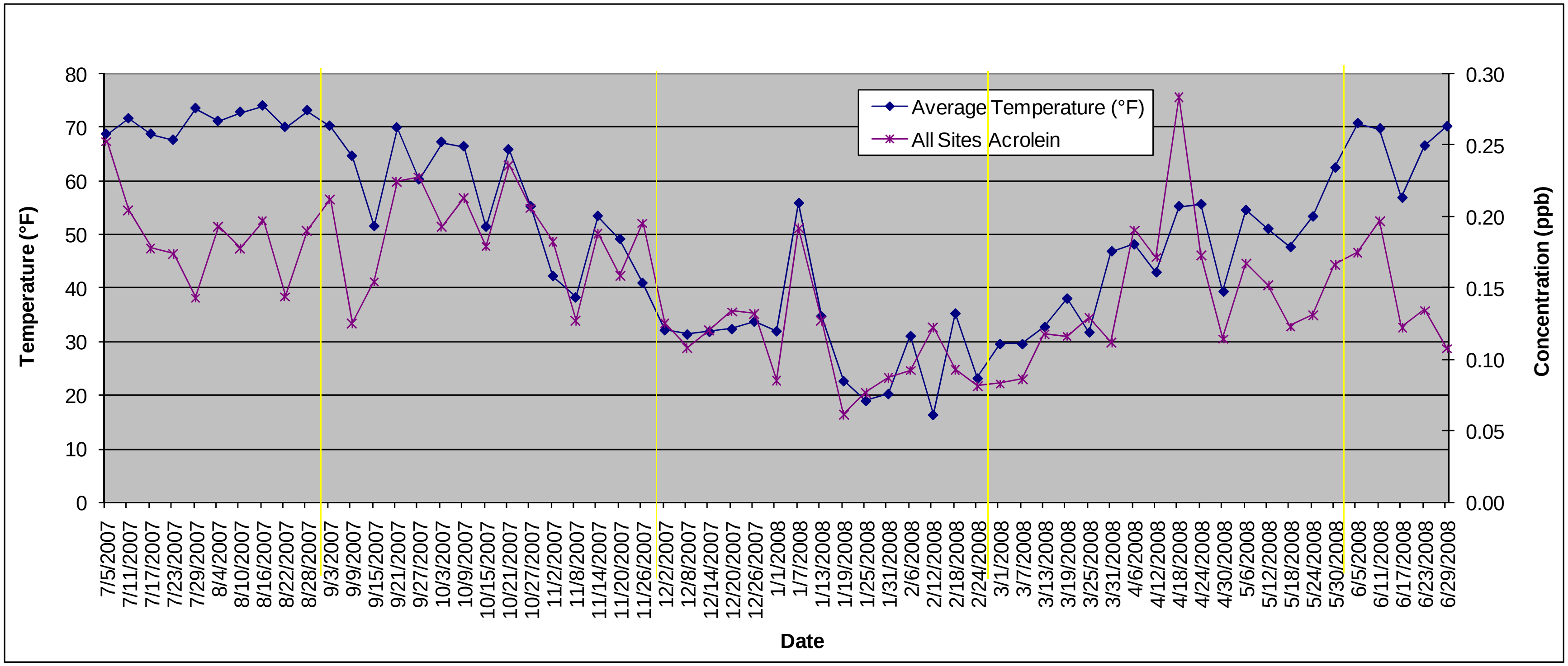


Figure Q.18. Comparisons between the Acrolein Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

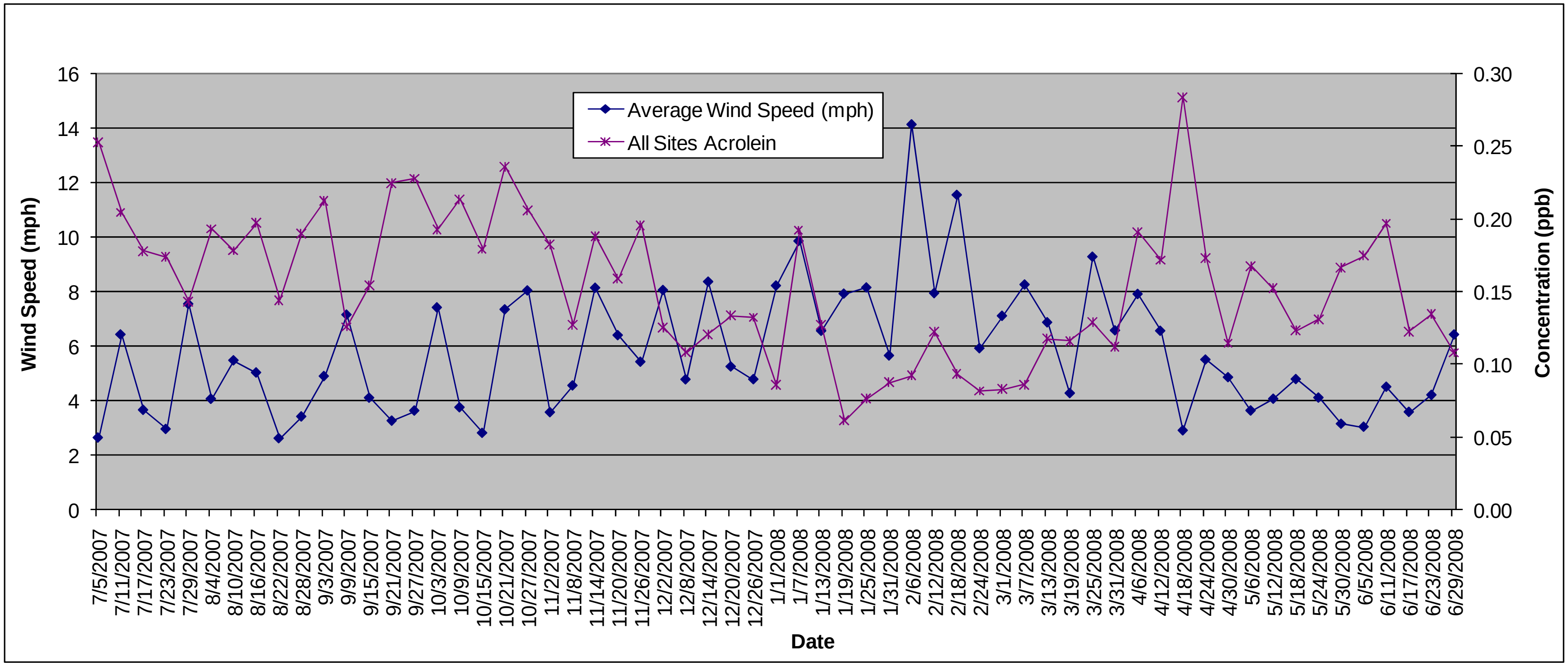


Figure Q.19. Comparisons between the Acrolein Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

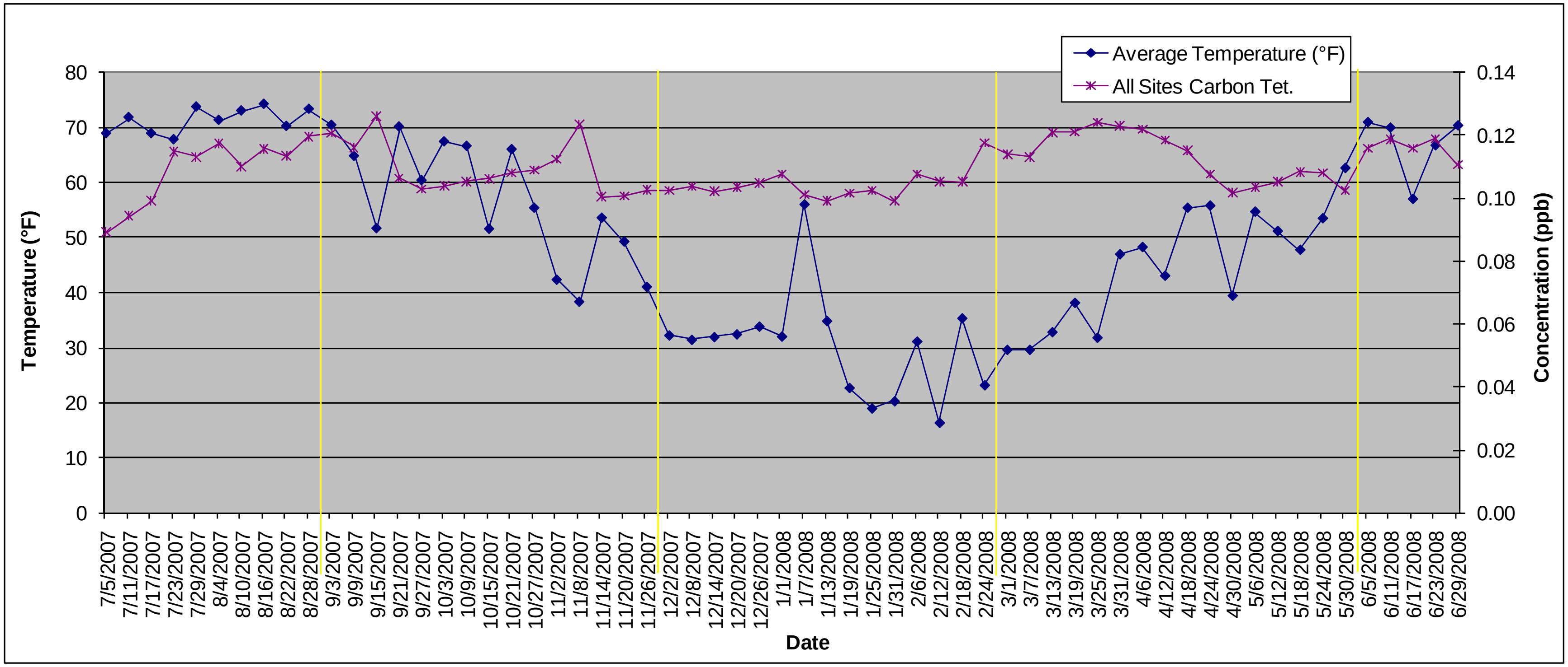


Figure Q.20. Comparisons between the Carbon Tetrachloride Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

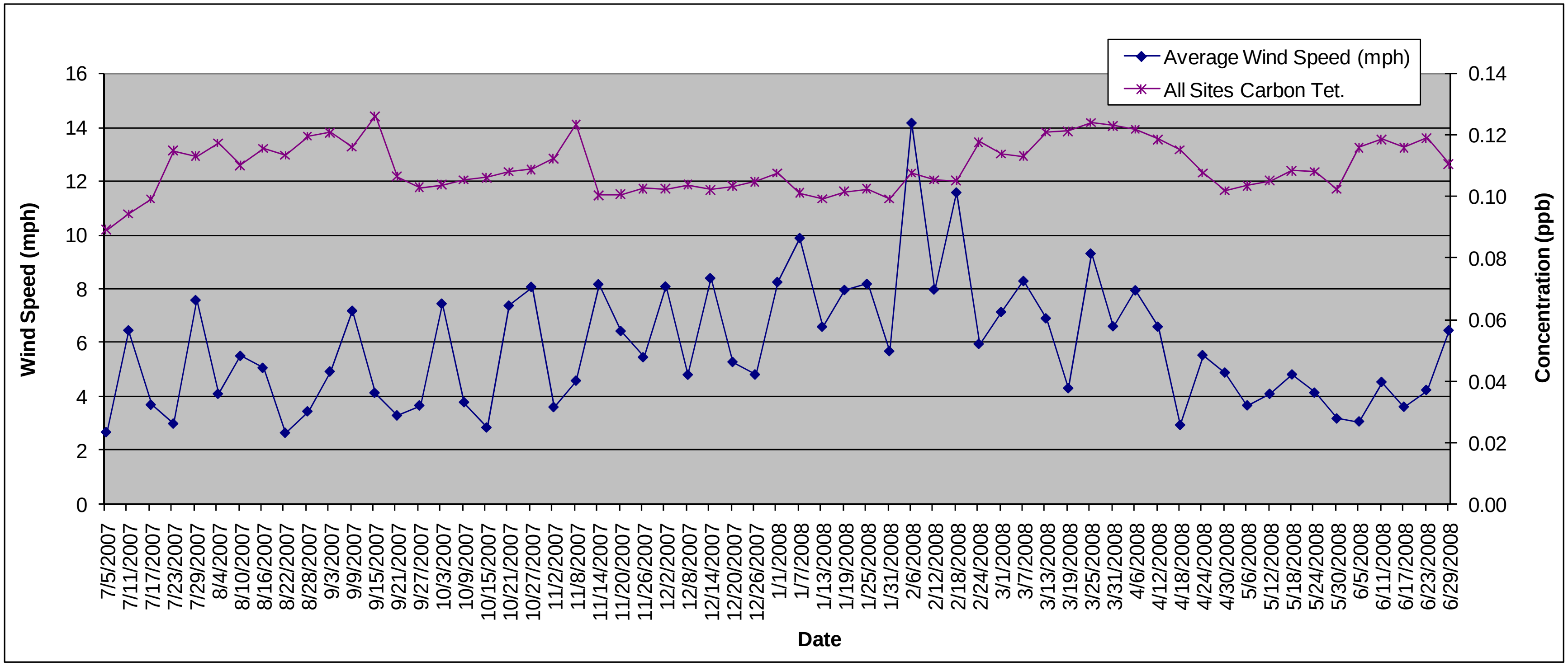


Figure Q.21. Comparisons between the Carbon Tetrachloride Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

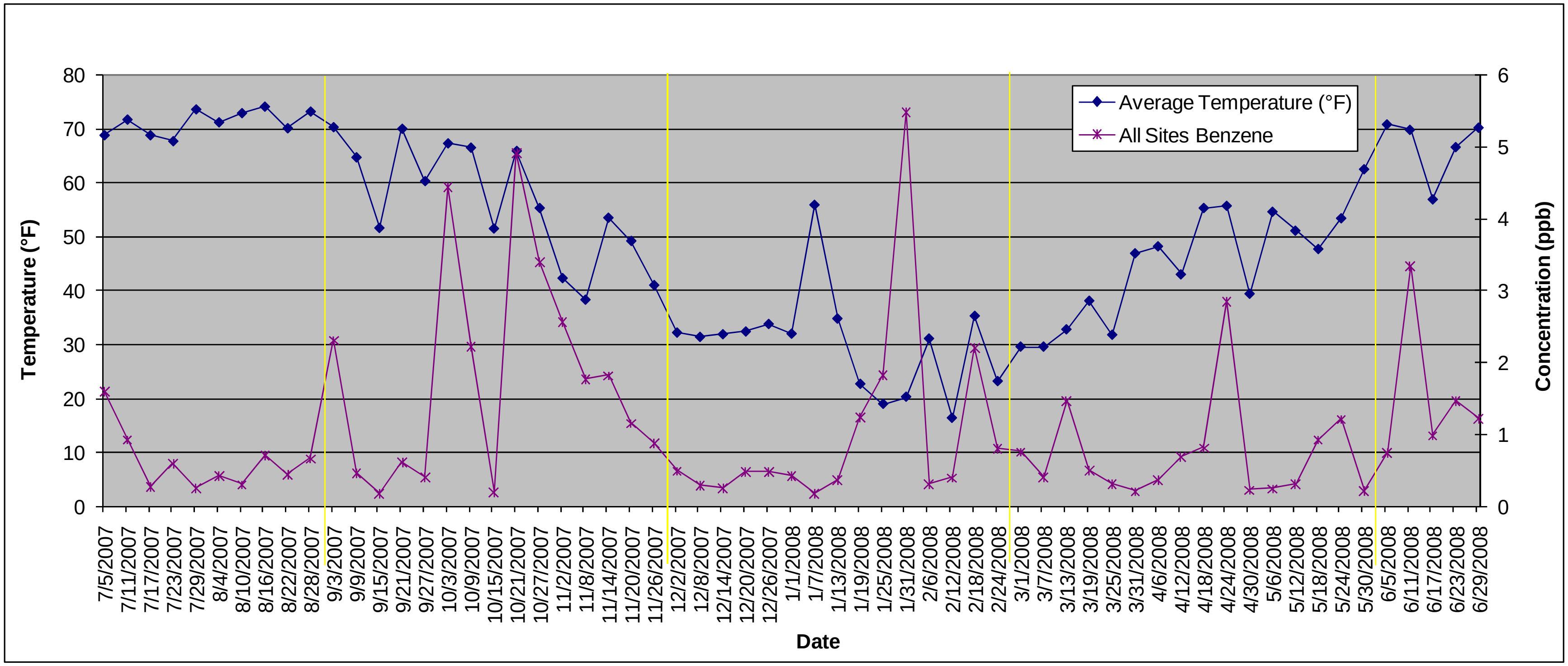


Figure Q.22. Comparisons between the Benzene Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

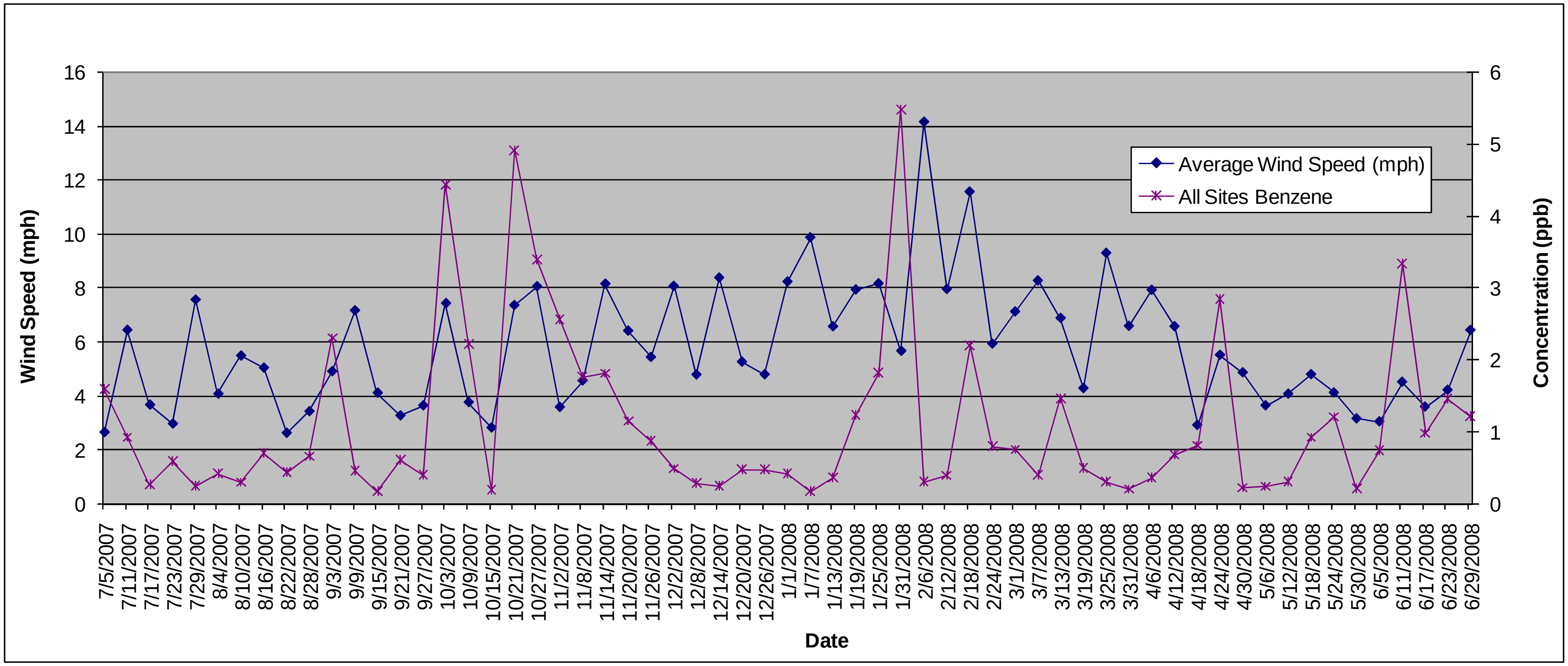


Figure Q.23. Comparisons between the Benzene Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

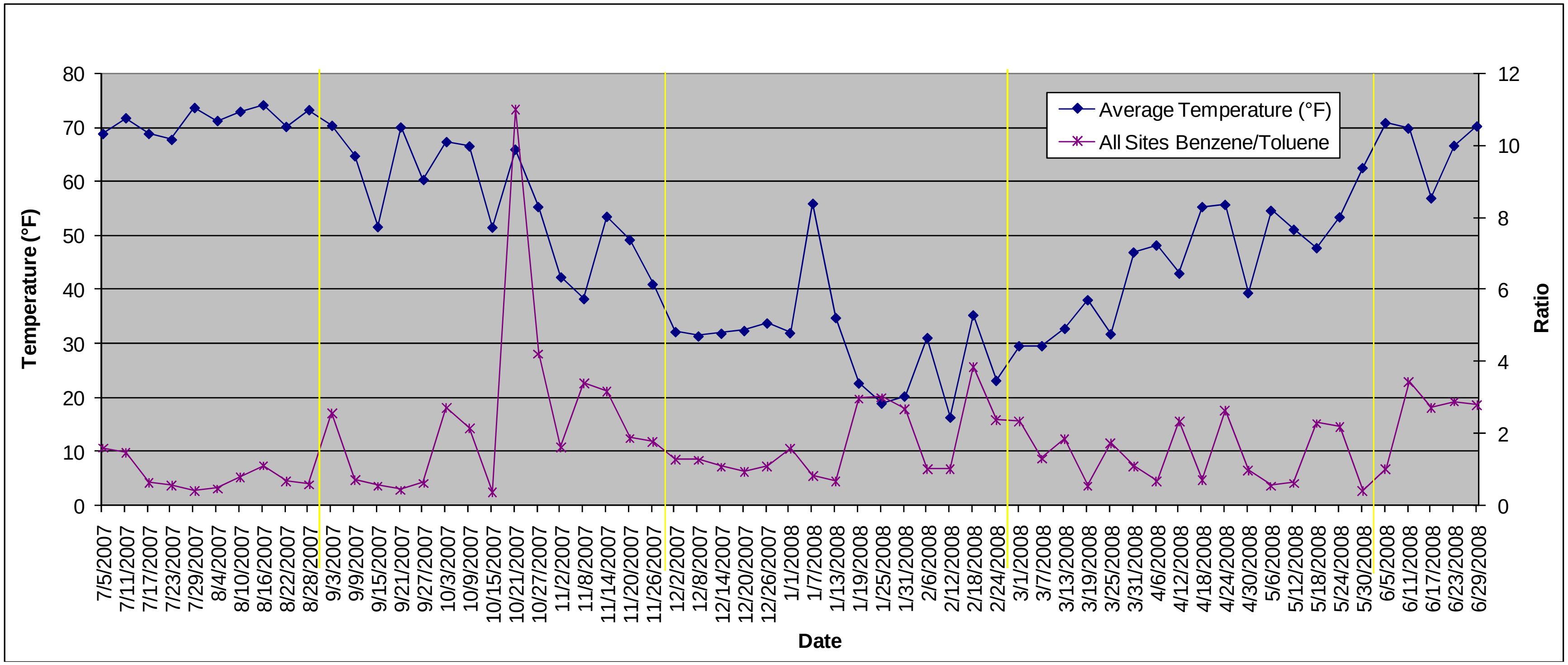


Figure Q.24. Comparisons between the Benzene/Toluene Combined Daily Average Ratios for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

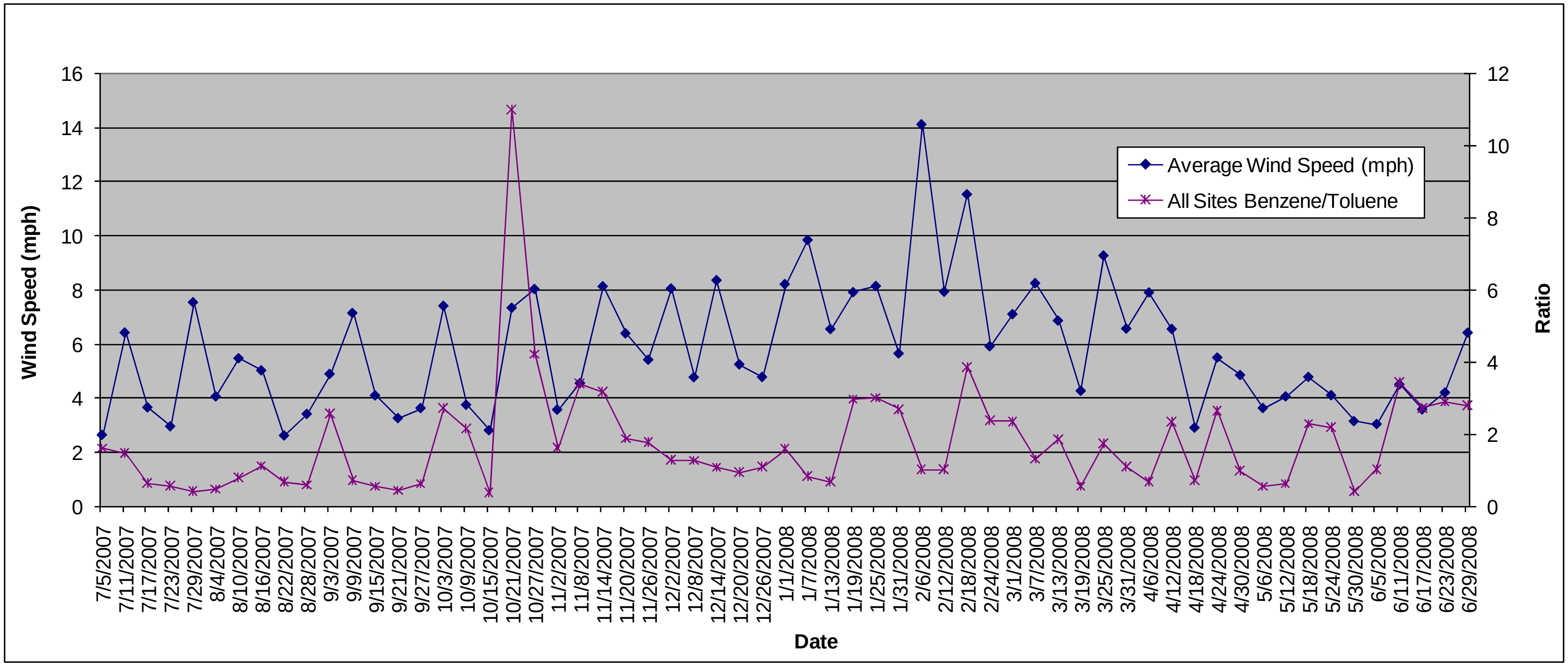


Figure Q.25. Comparisons between the Benzene/Toluene Combined Daily Average Ratios for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

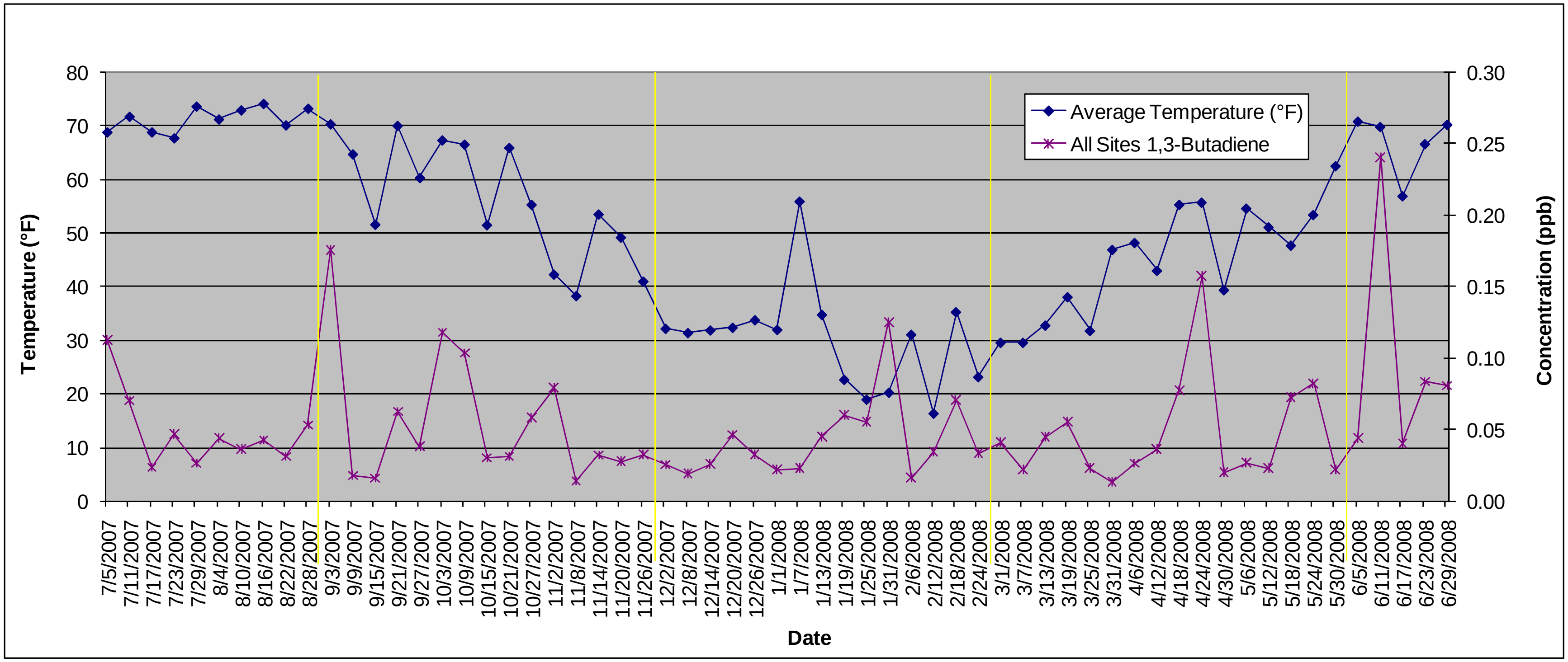


Figure Q.26. Comparisons between the 1,3-Butadiene Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

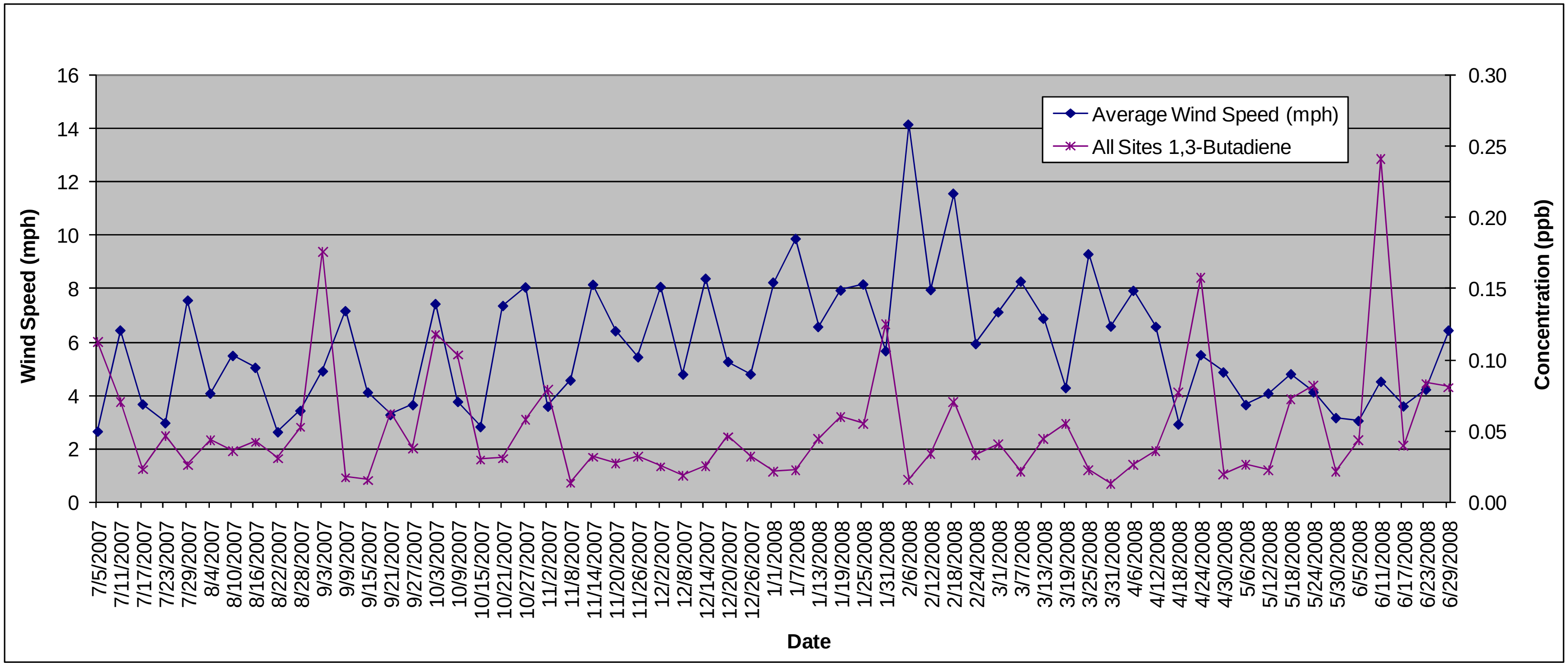


Figure Q.27. Comparisons between the 1,3-Butadiene Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

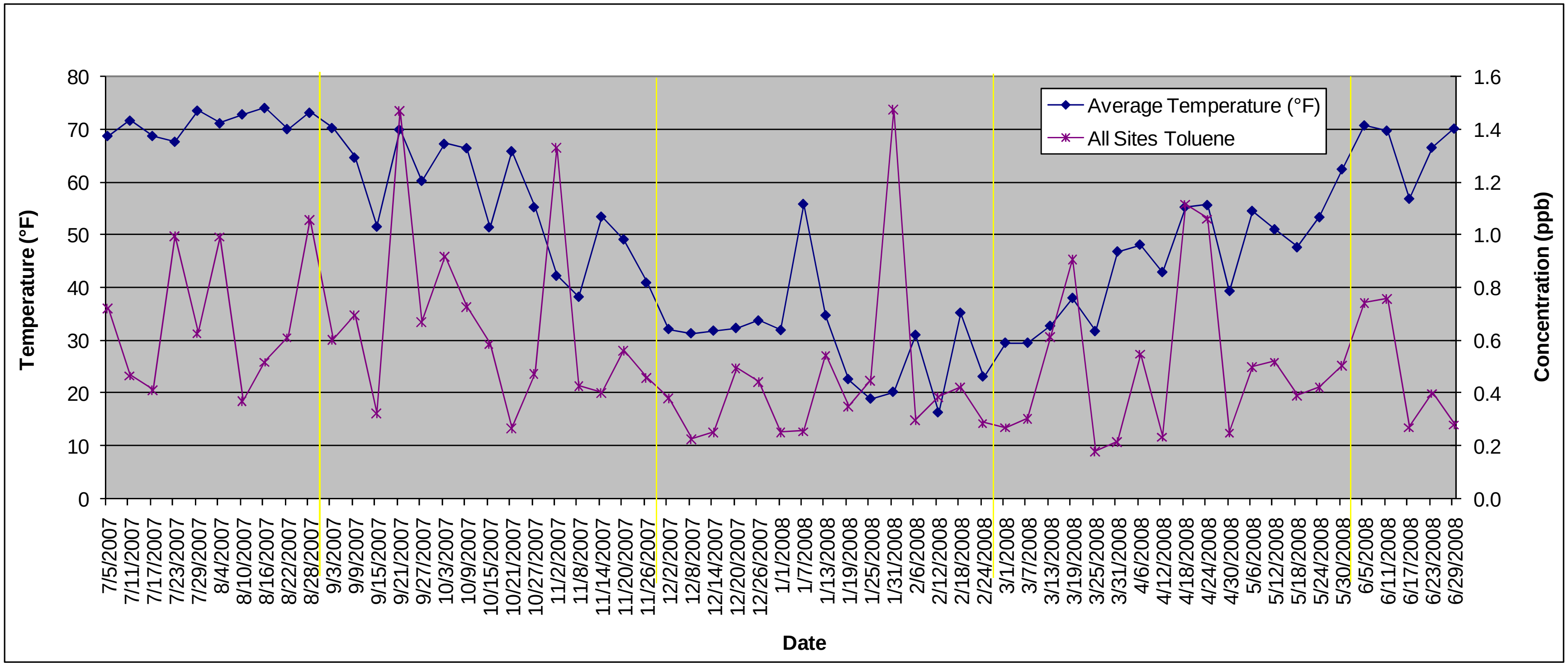


Figure Q.28. Comparisons between the Toluene Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

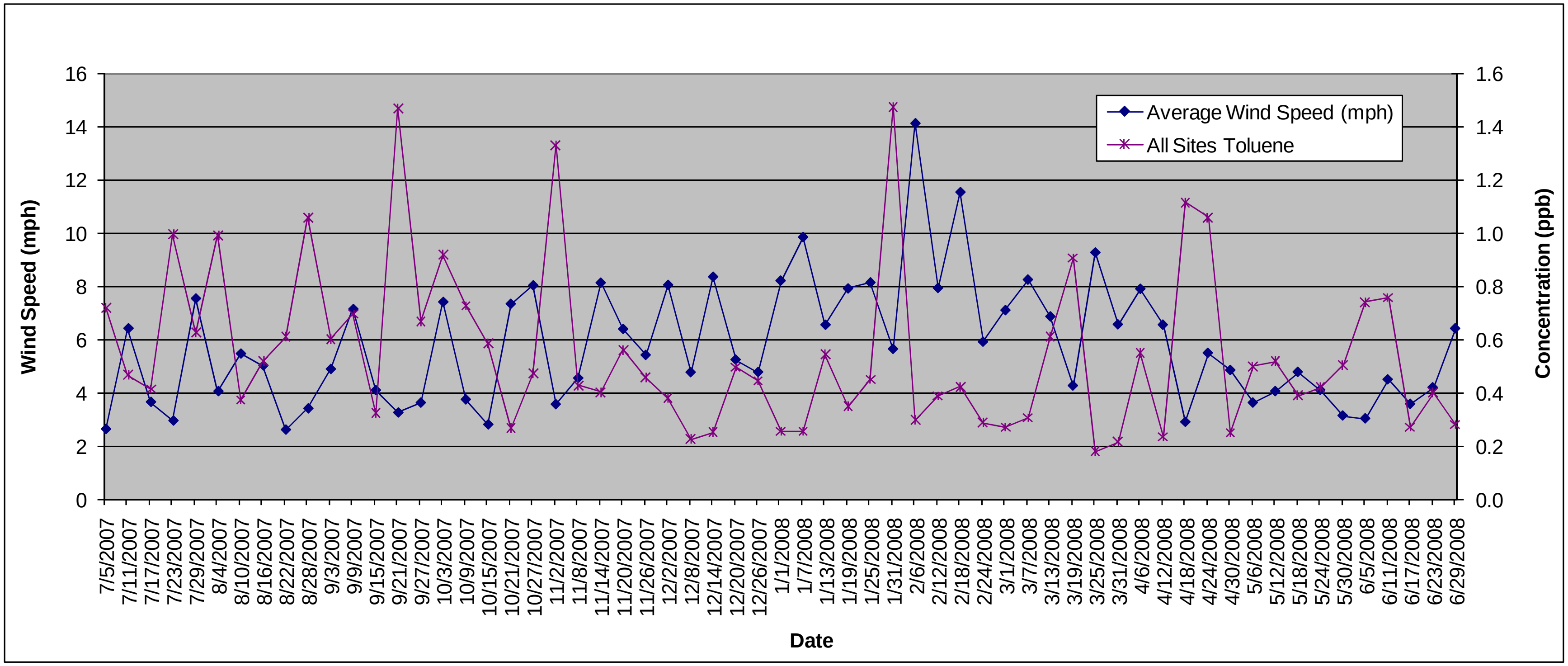


Figure Q.29. Comparisons between the Toluene Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

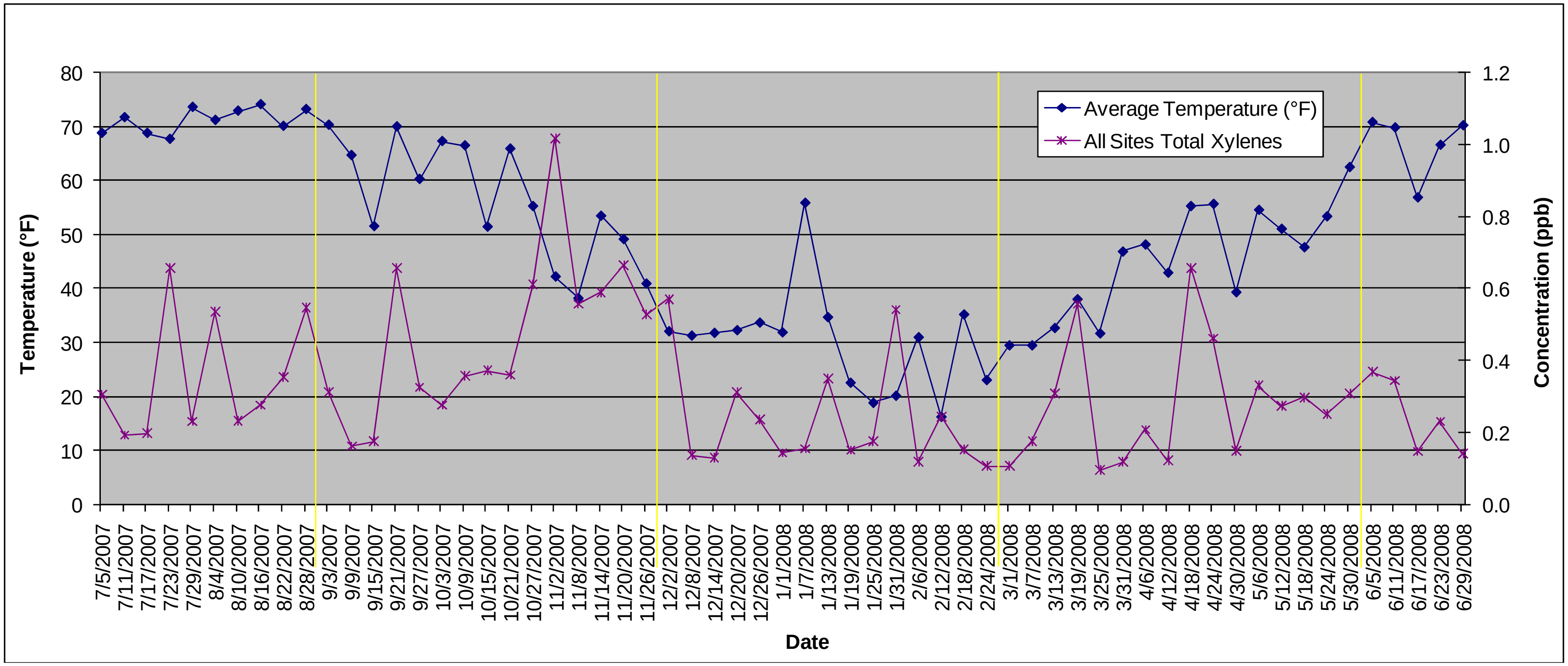


Figure Q.30. Comparisons between the Total Xylenes Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

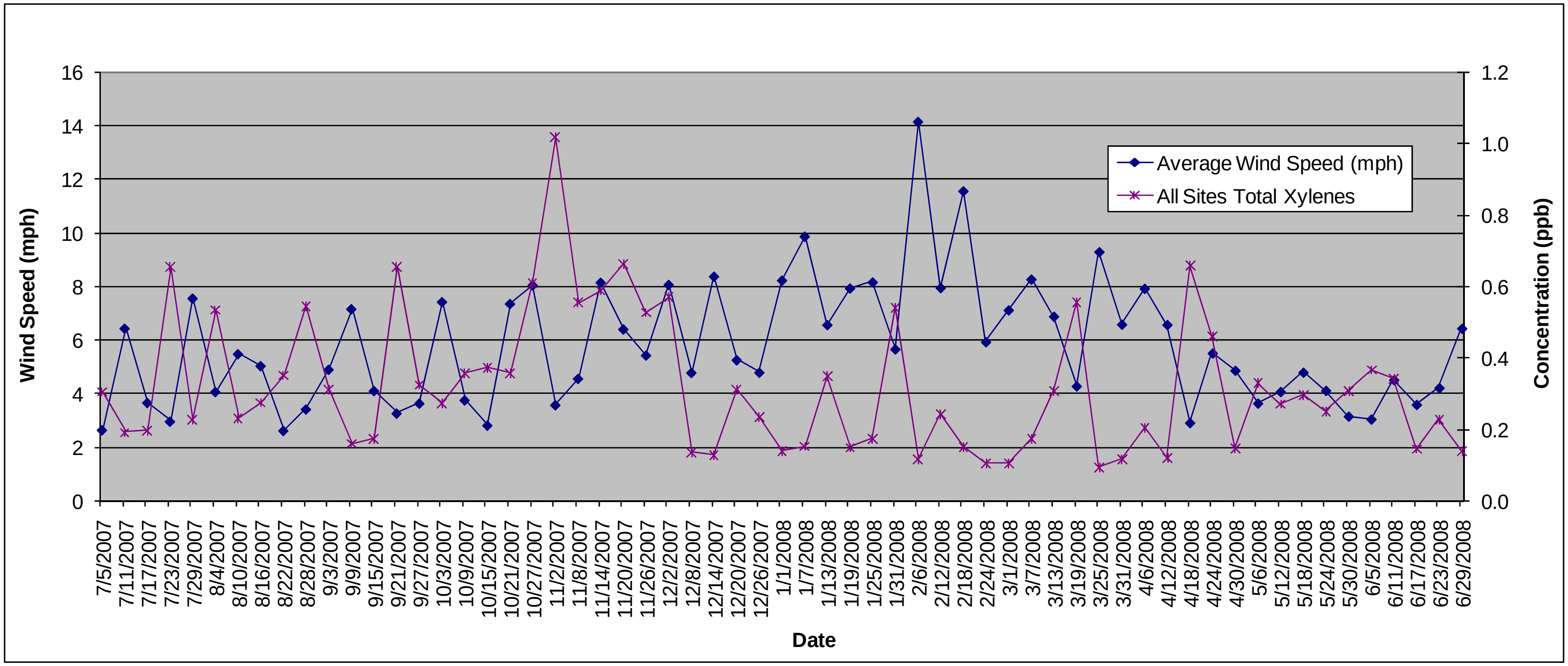


Figure Q.31. Comparisons between the Total Xylenes Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

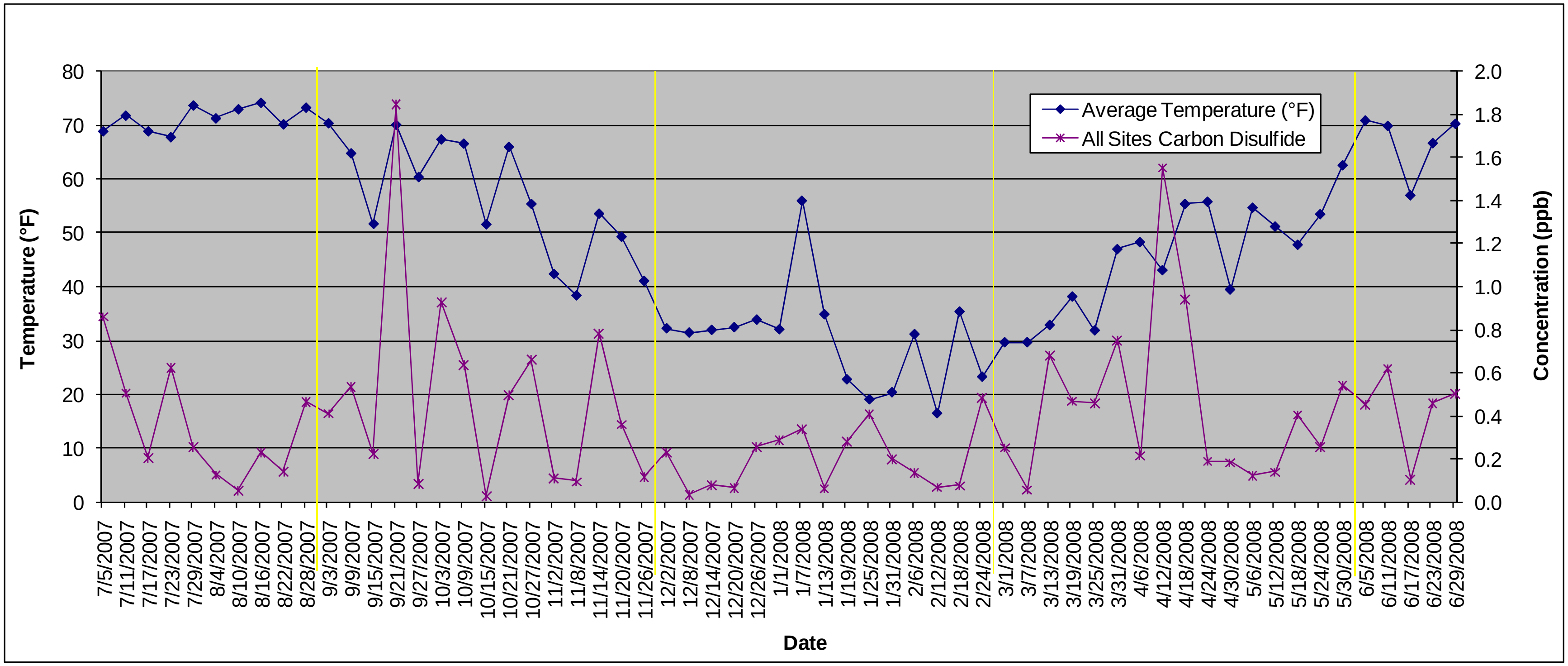


Figure Q.32. Comparisons between the Carbon Disulfide Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Short-Term and Long-Term Average Temperature Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both temperature (°F) and concentration (ppb).

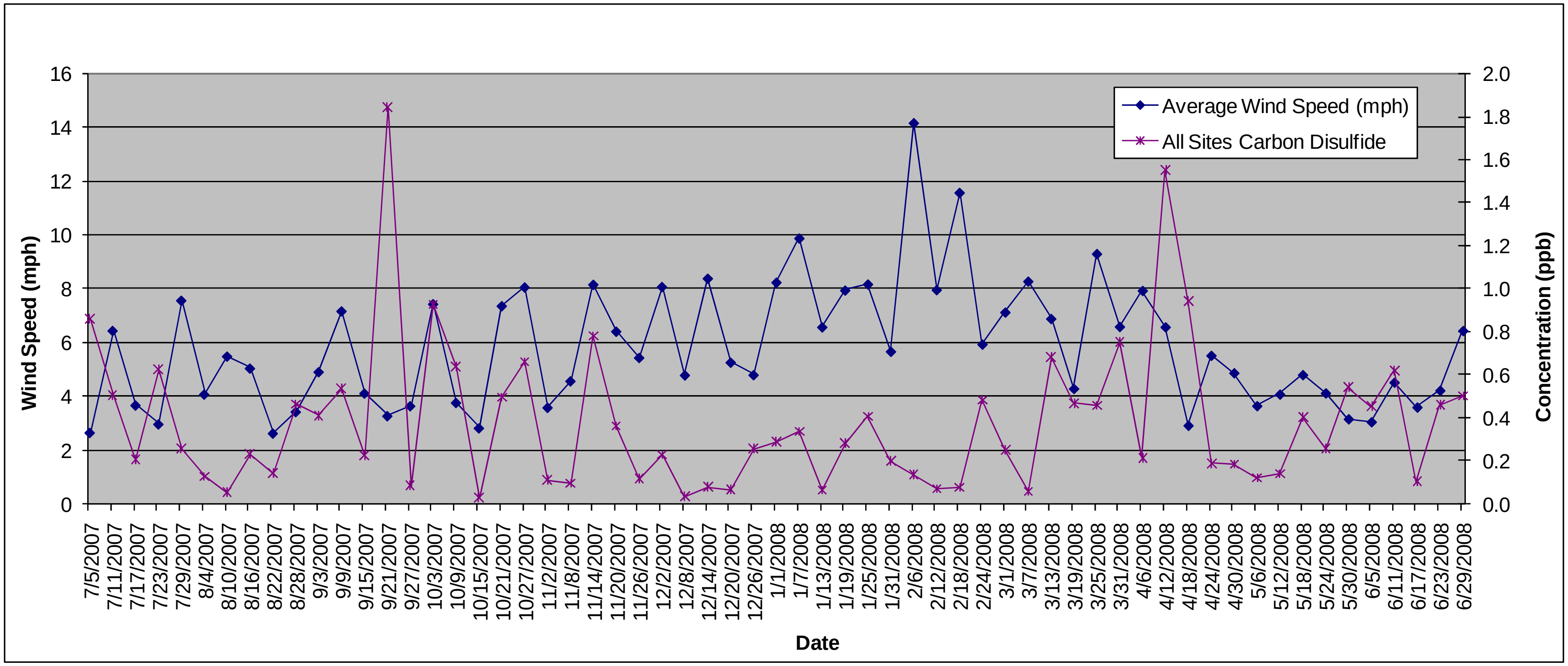


Figure Q.33. Comparisons between the Carbon Disulfide Combined Daily Average Concentrations for All Four Monitoring Sites Together and the Average Wind Speed Fluctuations measured at the BISP Meteorological Station on the Monitoring Days over the Study Period Year. Please note that there are two Y-axes allowing separate scales for both wind speed (mph) and concentration (ppb).

Appendix R. Expanded Analyses of SO_2 and CO Criteria Pollutants

As discussed previously, none of the criteria pollutants had exceedances of their respective NAAQS levels. However, for completeness, whether or not any temporal or spatial trends or any correlations with the various meteorological parameters appeared to exist was investigated.

The daily SO_2 concentration averages do not even approach the 24-hour NAAQS level with the highest concentration roughly a factor of 10 below that standard (Figure R.1). There is no 24-hour NAAQS for CO and the graph of individual data points did not indicate any meaningful trends so this data is not shown. Graphical illustrations of the criteria pollutant concentrations averaged over various time frames as compared to the most appropriate NAAQS are also included. The annual SO_2 concentration average, which was only measured at the BTRS monitor, is nowhere close to the annual primary NAAQS level (Figure R.2). The maximum 1-hour CO concentration, which again was only measured at the BTRS monitor, is much lower than the 1-hour primary NAAQS level and is even well below the 8-hour primary NAAQS level (Figure R.3).

The presence or absence of any apparent trends over the year of the study, broken up into monthly and weekly time frames, was investigated. No meaningful trends were apparent with SO_2 so only the monthly averages is presented here (Figures R.4). The monthly CO averages were highest in December, July, and August potentially indicating increased holiday travel traffic as CO is emitted by mobile sources, in addition to, other processes of combustion (Figure R.5). The graph of the weekly CO averages was included as well. It shows the CO concentrations increasing in July and remaining elevated until early September (around the time school starts up following the summer break) and then the CO concentration jumps up again around Thanksgiving time and remains elevated to Christmas time (Figure R.6). To determine if different weekday to weekend trends were present during these higher CO weeks, the weekday to weekend concentration averages for each of the high CO time periods was also investigated (data not shown). Interestingly, it was found that the increased CO weeks during the summer months were due to increases during the week, with the weekday concentration average roughly 20% higher than the weekend concentration average, but the increased CO weeks during the winter months were due to increases over the weekend, with the weekday concentration average roughly 9% lower than the weekend concentration average. This potentially indicates that the increased holiday travel during the summer is throughout the entire week while the increased holiday travel during the winter is primarily over the weekends.

Because the criteria pollutants are measured as 1-hour average concentrations, whether or not any potential temporal trends were apparent over the different hours of the day was also able to be investigated. The individual daily SO_2 trends (2 weeks worth of which is shown in Figure R.7) do not indicate any apparent meaningful trend(s) but the pooled SO_2 concentration trendline showed an increase in concentration starting in the early morning hours and peaking midday before steadily decreasing until the evening hours when the concentration trendline leveled off (Figure R.8). The individual daily CO trends (2 weeks worth of which is shown in Figure R.9) do indicate a general trend of increasing concentrations in the early morning hours which then decrease in the evening hours. However, when the 6 months of data are pooled together and the short-term influences from the hourly variations in meteorological conditions are diminished, a different underlying trend became apparent. The CO concentration trendline showed a fairly rapid increase in the early morning and a slightly less rapid decrease throughout the remaining morning hours before leveling off around midday. Then, a slower buildup of CO concentrations was observed starting during the time of the afternoon rush hour in the early evening hours (but peaking at a lower concentration level than that of the morning increase) before leveling off then slowly decreasing over the nighttime hours (Figure R.10). This trend in CO concentrations could be explained by the combination of mobile source emissions and atmospheric conditions. Atmospheric inversions develop over the nighttime hours but well after the afternoon rush hour traffic has dissipated, therefore, the increase in concentration during the evening hours is not as great as in the morning when the rush hour traffic at that time is combined with the lingering atmospheric inversion. Atmospheric inversions create a ceiling or cap above the lower air mass by preventing convection mixing of the lower and upper atmospheres. Normally, lower air mass gets warmed by the Earth, which has been heated by the solar radiation, then rises. As the morning proceeds, both the morning rush hour dissipates and the solar radiation heating the Earth's surface breaks up the inversion resulting in the decrease observed throughout the later morning hours into midday.

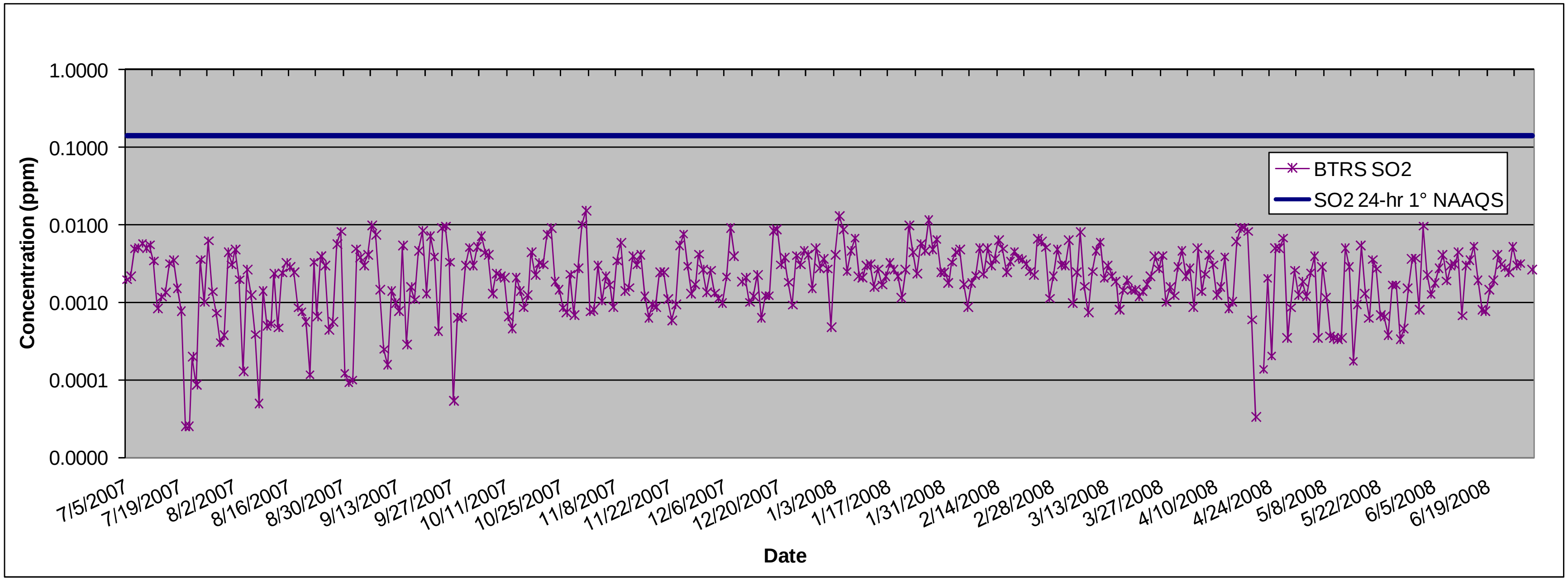


Figure R.1. Weekly Trends of SO_2 Daily Average Concentrations. The concentrations are presented using the logarithmic scale because of the substantial differences between the concentration of the SO_2 24-hour NAAQS concentration as compared to the concentration range for SO_2 resulting in a line graph when the normal scale was used where observing how the BTRS SO_2 concentration trendline tracked was not as easy to see.

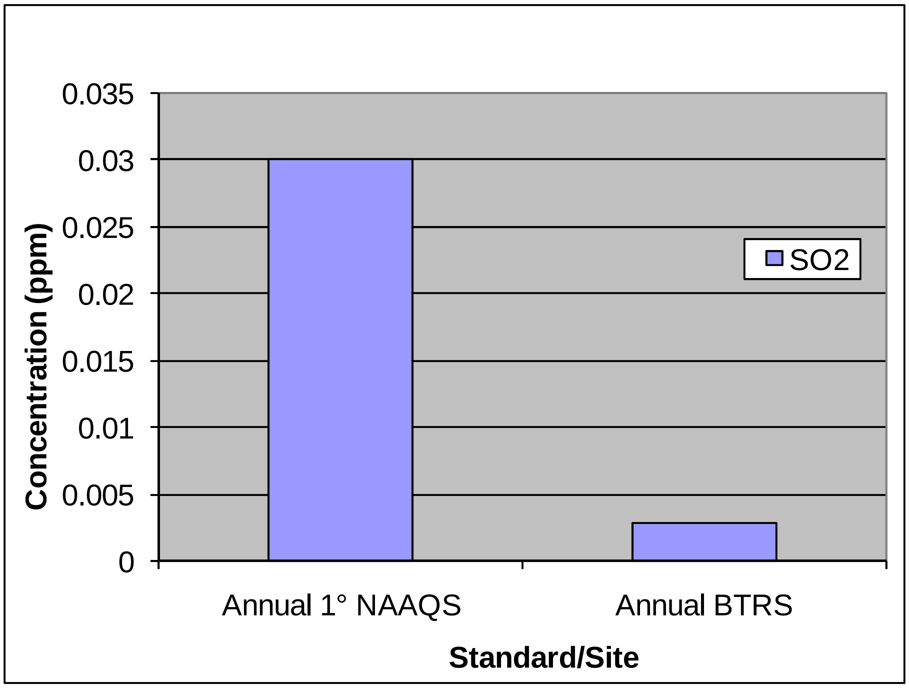


Figure R.2. BTRS Annual SO_2 Concentration Average Versus the SO_2 Annual Primary NAAQS Concentration.

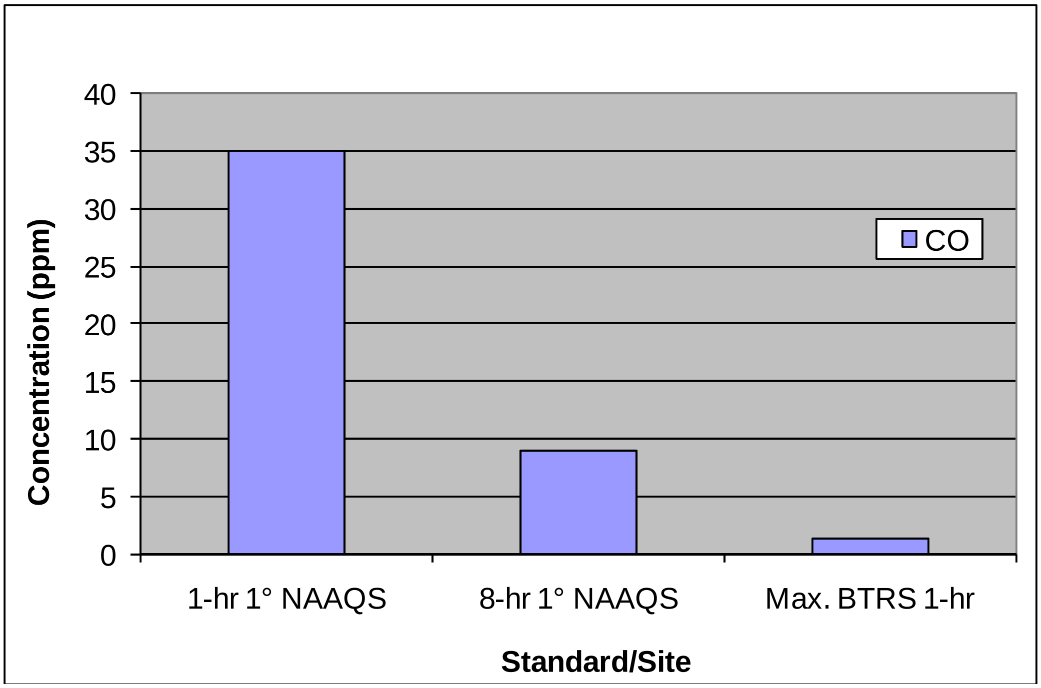


Figure R.3. BTRS Maximum 1-hour CO Concentration Average Versus the CO 1-hour and 8-hour Primary NAAQS Concentrations.

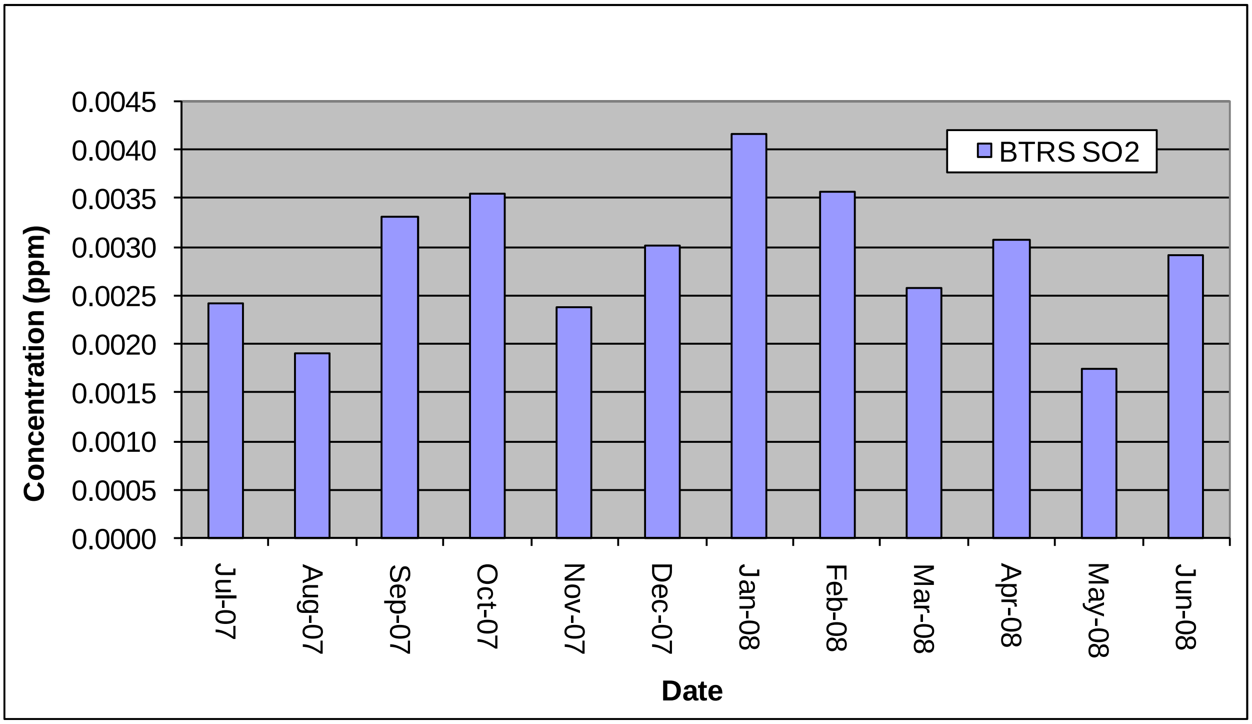


Figure R.4. Average SO_2 Concentrations at the BTRS Monitor for the Different Months of the Study Year.

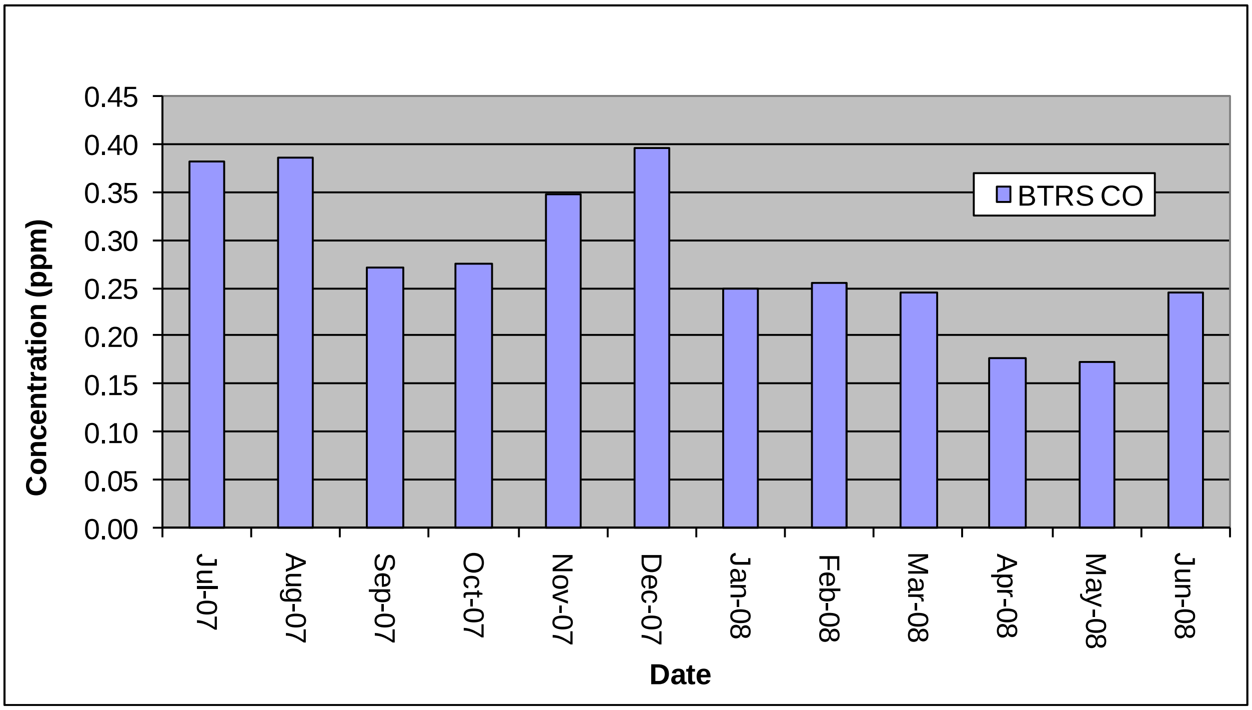


Figure R.5. Average CO Concentrations at the BTRS Monitor for the Different Months of the Study Year.

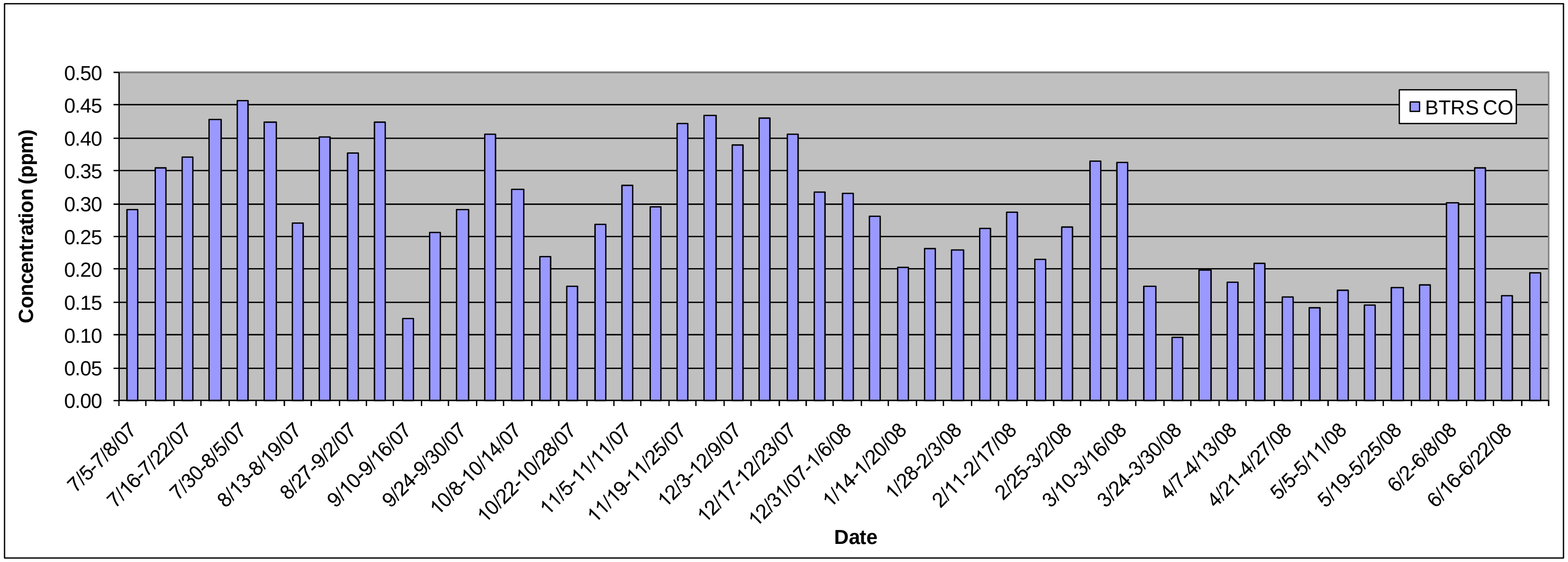


Figure R.6. Average CO Concentrations at the BTRS Monitor for the Different Weeks of the Study Year.

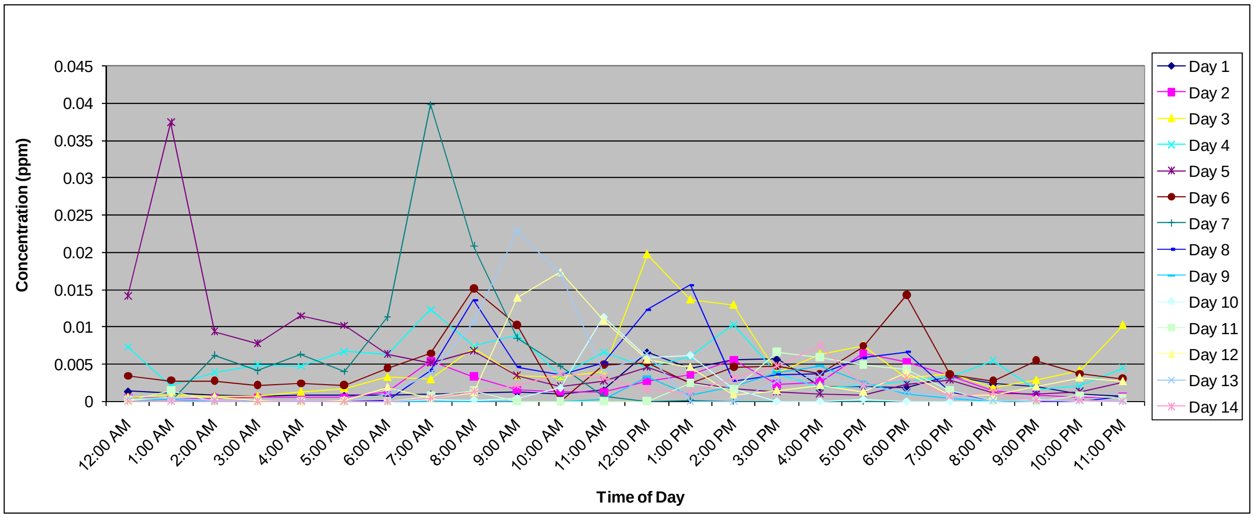


Figure R.7. Individual Data Point Measurements of SO_2 Concentrations for each Hour of the Day at the BTRS Monitor for the First Two Weeks of the Study Year.

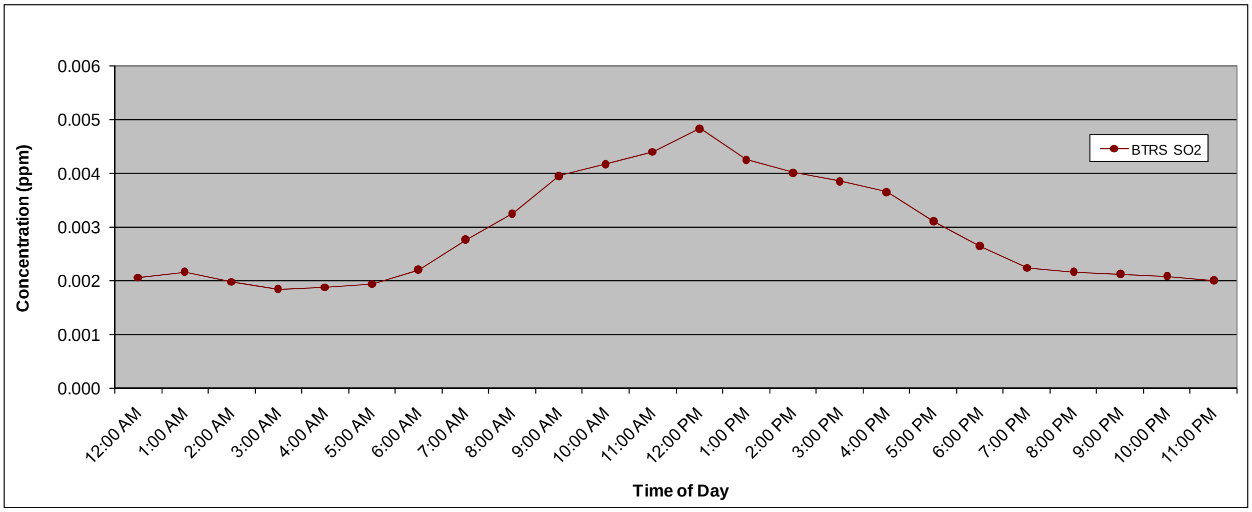


Figure R.8. Daily SO_2 Concentration Trends generated by Pooling Six Months of Concentration Measurements Data into a Combined Average of Concentrations for each Hour of the Day.

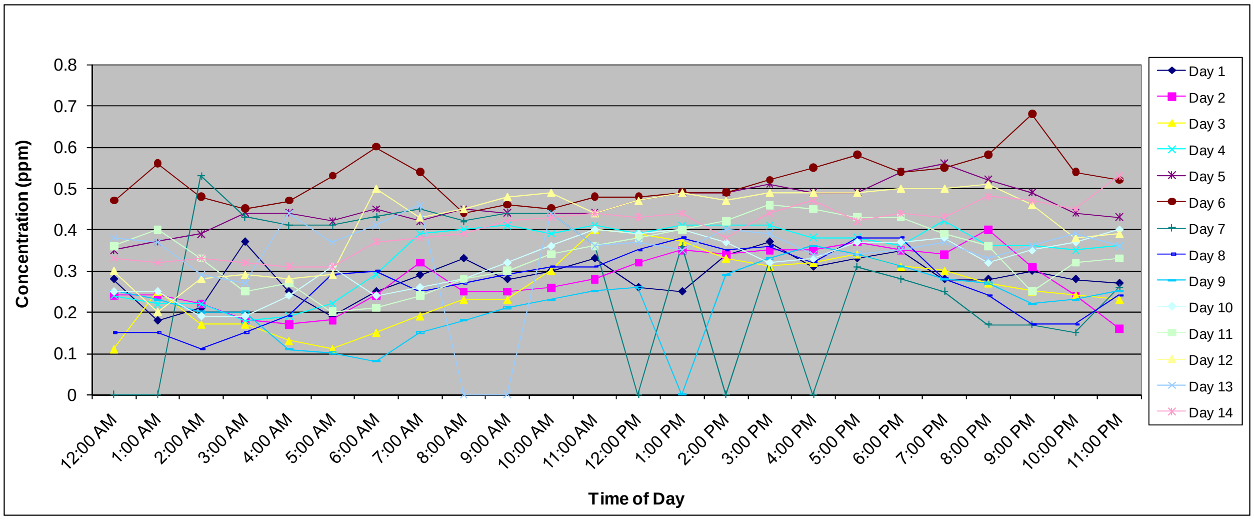


Figure R.9. Individual Data Point Measurements of CO Concentrations for each Hour of the Day at the BTRS Monitor for the First Two Weeks of the Study Year.

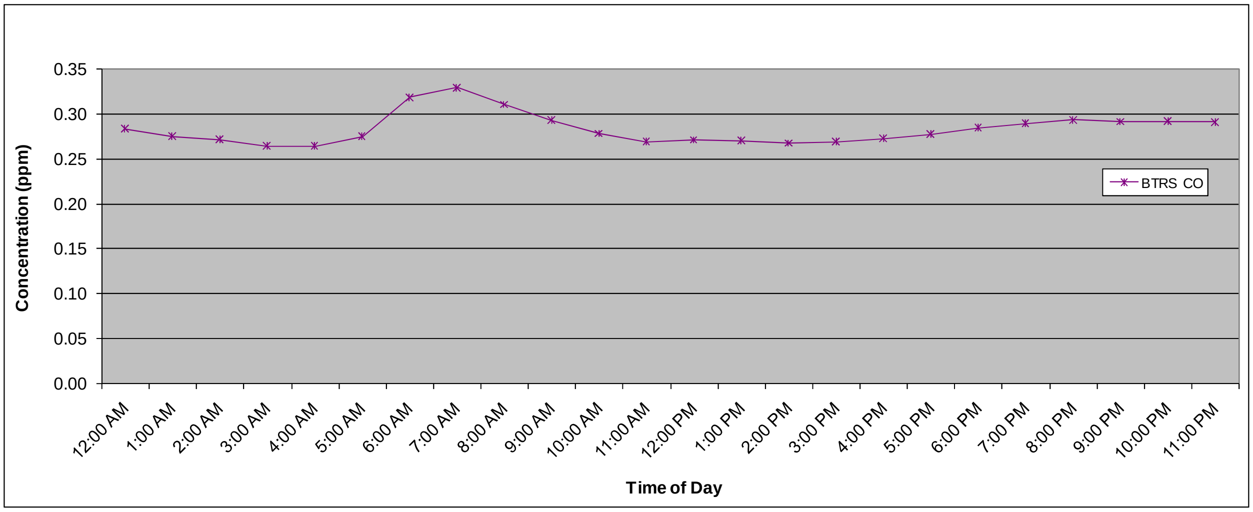


Figure R.10. Daily CO Concentration Trends generated by Pooling Six Months of Concentration Measurements Data into a Combined Average of Concentrations for each Hour of the Day.