2011 Annual Air Quality Report

Michigan Department of Environmental Quality

THE DEPARTMENT OF ENVIRONMENTAL QUALITY PROVIDES EQUAL OPPORTUNITIES FOR EMPLOYMENT AND FOR ACCESS TO MICHIGAN'S NATURAL RESOURCES. STATE AND FEDERAL LAWS PROHIBIT DISCRIMINATION ON THE BASIS OF RACE, COLOR, NATIONAL ORIGIN, RELIGION, DISABILITY, AGE, MARITAL STATUS, OR SEX UNDER THE CIVIL RIGHTS ACT OF 1964 AS AMENDED, MICHIGAN (MI) PA 453 AND MI PA 220, TITLE V OF THE REHABILITATION ACT OF 1973 AS AMENDED, AND THE AMERICANS WITH DISABILITIES ACT. FOR INFORMATION OR ASSISTANCE REGARDING THIS PUBLICATION, CONTACT THE DEPARTMENT OF ENVIRONMENTAL QUALITY, AIR QUALITY DIVISION, P.O. BOX 30260, LANSING, MI 48909-7760.

Printed by authority of the Department of Environmental Quality.
Total number of copies printed: 100 Total Cost: $ 811.61 Cost Per Copy: $8.11

Department of Environmental Quality

Dedication

Dr. Mary Ann Heindorf
July 7, 1959 – October 3, 2011

This Air Quality Report is dedicated to the memory of Dr. Mary Ann Heindorf, who dedicated her career to the air monitoring program and the greater good of the Citizens of the State of Michigan. She not only designed and implemented the air monitoring network in Michigan, she also helped to structure the air monitoring network across the country by being a member of the USEPA National Air Toxics Monitoring Steering Committee. She will be greatly missed.

ACKNOWLEDGMENTS

This publication was prepared utilizing information provided by the Air Quality Evaluation Section (AQES) and other staff of the Michigan Department of Environmental Quality (MDEQ), Air Quality Division (AQD). Copies can be obtained on-line at: http://www.michigan.gov/deqair, under "Spotlight," "Air Publications," "Reports," then "Annual Air Quality Reports," or call 517-373-7023 to request a hard copy.

AQES, Air Monitoring Unit Staff:

Peter Dehart
Jason Duncan
Craig Fitzner
Marc Foreman
Eric Gafner
Tom Gauthier
Navnit Ghuman, co-editor
Eric Hansen
Mary Ann Heindorf
Cynthia Hodges, co-editor
Steve Irrer
Susan Kilmer
Dan Ling
Bryan Lomerson
Mark Lotoszinski
Matthew Nowak
Matt Riselay
Amy Robinson, co-editor
Debbie Sherrod

AQES, Strategy Development Unit Staff: Jim Haywood, Mary Maupin, Teresa Cooper

AQES, Toxics Unit Staff: Mike Depa, Doreen Lehner, Bob Sills

AQES, Section Secretary: Lorraine Hickman

AQD Public Outreach Coordinator: Laura DeGuire

The AQD also wishes to acknowledge the significant contributions that were provided by Mark Bird and William Endres of the **City of Grand Rapids, Air Pollution Control Division**, which operates and maintains air monitoring equipment in West Michigan.

Cover Photos: Courtesy of Cindy Hodges, Upper Left – Iron County, Upper Right – Marquette Light House, Bottom Left – Picture Rock, Bottom Right – Historic Water Tower Manistique

TABLE OF CONTENTS

Page No.

Introduction 1
Chapter 1: Background Information 2
Chapter 2: Carbon Monoxide (CO) 9
Chapter 3: Lead (Pb) 11
Chapter 4: Sulfur Dioxide (SO_2) 13
Chapter 5: Nitrogen Dioxide (NO_2) 15
Chapter 6: Ozone (O_3) 17
Chapter 7: Particulate Matter (PM_{10}, $PM_{2.5}$) 24
Chapter 8: Toxic Air Pollutants 33
Chapter 9: MIair – Air Quality Information in Real-Time 36
Chapter 10: Meteorological Information 38

TABLES

1.1 NAAQS in Effect during 2011 for Criteria Pollutants 2
1.2 Criteria for the Determination of Compliance with the NAAQS 3
1.3 Types of Monitoring Conducted in 2011 and MASN Location 5
6.1 Three-Year Average of the 4th Highest 8-hour Ozone Values From 2007-2009, 2008-2010, and 2009-2011 19
6.2 2011 West Michigan Ozone Season 20
6.3 2011 Southeast Michigan Ozone Season 20
6.4 Eight-Hour Exceedance Days (>75 ppb) and Locations 21
7.1 Three-Year Average of the Annual Mean $PM_{2.5}$ Concentrations 29
7.2 98th Percentile of $PM_{2.5}$ Values Averaged Over 3 Years 30
8.1 2011 Toxics Sampling Sites 34
9.1 AQI Colors and Health Statements 37
10.1 *Action!* Days Declared During 2011 39

TABLE OF CONTENTS
Continued

Page No.

FIGURES

1.1 2011 MASN Monitoring Sites 4
1.2 Allen Park Monitoring Site 4
1.3 Manistee Monitoring Site 4
1.4 Historical Ozone at Detroit East 7 Mile Site 7
1.5 Historical SO_2 at Detroit – W. Fort Street (SWHS) 7
1.6 Historical CO at Allen Park 8
1.7 Historical Lead at Dearborn 8
2.1 Trace CO Monitors in 2011 9
2.2 CO Emissions by Source Sector 10
2.3 CO Emissions in 2008 10
2.4 CO Levels in Michigan from 2006-2011 10
3.1 Lead Monitors in 2011 11
3.2 Lead Emissions by Source Sector 12
3.3 Lead Emissions in 2008 12
3.4 Lead Levels in Michigan from 2006-2011 12
4.1 SO_2 Monitors in 2011 13
4.2 SO_2 Emissions by Source Sector 14
4.3 SO_2 Emissions in 2008 14
4.4 SO_2 Levels in Michigan from 2006-2011 14
5.1 NO_2/Trace NO_y Monitors in 2011 15
5.2 NO_2 Emissions by Source Sector 16
5.3 NO_2 Emissions in 2008 16
5.4 NO_2 Levels in Michigan from 2006-2011 16
6.1 Ozone Monitors in 2011 18
6.2 Volatile Organic Compounds (VOC) Emissions by Source Sector 18
6.3 VOC Emissions in 2008 18
6.4 Ozone Levels in the Detroit-Warren-Flint CSA from 2006-2011 22
6.5 Ozone Levels in the Grand Rapids-Muskegon-Holland CSA from 2006-2011 22
6.6 Ozone Levels in the Kalamazoo-Portage-MSA, Lansing-East Lansing-Owosso CSA, Niles-Benton Harbor MSA, and South Bend-Mishawaka MSAs from 2006-2011 22
6.7 Ozone Levels in Michigan's Northern Lower and Upper Peninsula Areas From 2006-2011 22
6.8 8-Hour Ozone Level Events Exceeding the 0.075 ppm NAAQS From 1992-2011 23
7.1 PM_{10} Monitors in 2011 25
7.2 PM_{10} Emissions by Source Sector 25
7.3 PM_{10} Emissions in 2006 25
7.4 PM_{10} Design Value, 2008-2010 and 2009-2011 26
7.5 $PM_{2.5}$ (Fine Particle) Monitors in 2011 27
7.6 $PM_{2.5}$ Emissions by Source Sector 28
7.7 $PM_{2.5}$ Emissions in 2008 28
7.8 Detroit-Warren-Flint CSA (Wayne County Only) Annual Arithmetic Means for $PM_{2.5}$ from 2009-2011 31
7.9 Detroit-Warren-Flint CSA (without Wayne County) Annual Arithmetic Means for $PM_{2.5}$ from 2006-2011 31

TABLE OF CONTENTS
Continued

Page No.

FIGURES, Continued

7.10 West Michigan Annual Arithmetic Means for $PM_{2.5}$ from 2005-2010 32
7.11 Lansing-East Lansing CSA, Saginaw-Bay City CSA, Traverse City MiSA, and Cadillac MiSA Annual Arithmetic Means for $PM_{2.5}$ from 2006-2011 32
8.1 National Air Toxics Trends Sites 35
10.1 Southern Lower Peninsula Observed Average Daily Temperatures vs Normal Average Daily Temperature 38
10.2 Northern Lower Peninsula Observed Average Daily Temperatures vs Normal Average Daily Temperature 38
10.3 Upper Peninsula Observed Average Daily Temperatures vs Normal Average Daily Temperature 38
10.4 Southern Lower Peninsula Observed Monthly Precipitation vs Normal Monthly Precipitation 38
10.5 Northern Lower Peninsula Observed Monthly Precipitation vs Normal Monthly Precipitation 38
10.6 Upper Peninsula Observed Monthly Precipitation vs Normal Monthly Precipitation 38
10.7 Surface Map of Weather Conditions on July 20, 2011 39

APPENDICES

Appendix A Criteria Pollutant Summary for 2011

Appendix B 2011 Air Toxics Monitoring Summary for Metals, VOCs, Carbonyl Compounds, and Speciated $PM_{2.5}$

Appendix C 2011 AQI Pie Charts

2011 Air Quality Report

Introduction

The federal Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for six criteria pollutants considered harmful to the public and the environment. These standards define the maximum permissible concentration of criteria pollutants in the air (see **Table 1.1**).

The six criteria pollutants are monitored by the Department of Environmental Quality (DEQ), Air Quality Division (AQD). These criteria pollutants are:

- Carbon monoxide (CO),
- Lead (Pb),
- Nitrogen dioxide (NO_2),
- Ozone (O_3),
- Particulate matter smaller than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$, respectively), and
- Sulfur dioxide (SO_2).

Chapters 2 through **7** provide information on each of the six criteria pollutants and include:

- Michigan's monitoring requirements for 2011,
- Attainment/nonattainment status,
- Monitoring site locations (tables show all the monitors active in 2011), and
- Air quality trends from 2006-2011 broken down by location.[1]

The actual 2011 data for each criteria pollutant is available in **Appendix A.**

The AQD also monitors air toxics. Air toxics are other hazardous air pollutants that can affect human health and the environment.[2] This data can be found in **Appendix B.**

The purpose of this report is to provide a snapshot of Michigan's 2011 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2012 Network Review)[3], air toxics monitoring program, and other AQD programs, such as MIAir and Emissions Inventory[4].

[1] The air quality trends are based on actual statewide monitored readings, which are also listed in the EPA's Air Quality Subsystem Quick Look Report Data.
[2] A fact sheet entitled What is an Air Contaminant/Pollutant? is available on the DEQ's website at http://www.deq.state.mi.us/documents/deq-ead-caap-airconfs.pdf.
[3] Available on online at http://www.michigan.gov/deq/0,1607,7-135-3310_4195-230649--,00.html
[4] Online information about criteria pollutants and air toxics, along with this and previous annual air quality reports, are available via the AQD's website at http://www.michigan.gov/deqair under "Air Monitoring" and then "Publications".

Chapter 1: Background Information

This chapter provides a summary of the development of the NAAQS and how compliance with these standards is determined. Also included is an overview of Michigan's air sampling network, a description of the metropolitan statistical areas (MSAs) and their uses, and the variety of monitoring techniques and requirements used to ensure quality data is obtained.

NAAQS

Under Section 109 of the CAA, the EPA establishes a primary and secondary NAAQS for each pollutant for which air quality criteria have been issued. The primary standard is designed to protect the public health with an adequate margin of safety, including the health of the most susceptible individuals in a population, such as children, the elderly, and those with chronic respiratory ailments. Factors in selecting the margin of safety for the primary standard include the nature and severity of the health effects involved and the size of the sensitive population at risk. Secondary standards are chosen to protect public welfare (personal comfort and well-being) and the environment by limiting economic damage, visibility and climatic factors, as well as the harmful effects on soil, water, crops, vegetation, wildlife, and buildings.

In addition, the NAAQS have various averaging times to address health impacts. Short averaging times reflect the potential for acute (immediate) effects, whereas long-term averaging times are designed to protect against chronic effects.

NAAQS have been established for CO, Pb, SO_2, NO_2, O_3, and PM. **Table 1.1** lists the primary and secondary NAAQS, averaging time, and concentration level for each criteria pollutant in effect in 2011. The concentrations are listed as parts per million (ppm), micrograms per cubic meter (µg/m^3), and/or milligrams per cubic meter (mg/m^3).

Table 1.1: NAAQS in Effect during 2011 for Criteria Pollutants

Pollutant	Primary (health-related)		Secondary (welfare-related)	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	2nd highest 8-hour	None	
	35 ppm (40 mg/m^3)	2nd highest 1-hour		
Lead (Pb)	0.15 µg/m^3	Maximum rolling 3-month average	Same as Primary	
Nitrogen Dioxide (NO_2)	0.053 ppm (100 µg/m^3)	Annual arithmetic mean	Same as Primary	
	0.100 ppm	98th percentile 1-hr averaged over 3-years		
Particulate Matter (PM_{10})	150 µg/m^3	24-hour	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual arithmetic mean	Same as Primary	
	35 µg/m^3	98th percentile 24-hour averaged over 3 years	Same as Primary	
Ozone (O_3)	0.075 ppm	4th highest 8-hour daily max. averaged over 3 years	Same as Primary	
Sulfur Dioxide (SO_2)	0.075 ppm	99th percentile of 1-hour averaged over 3 years	0.5 ppm	3 hours

To demonstrate compliance with the NAAQS, the EPA has defined specific criteria for each pollutant, which are summarized in **Table 1.2.**

Table 1.2: Criteria for the Determination of Compliance with the NAAQS

POLLUTANT	CRITERIA FOR COMPLIANCE
CO	Compliance with the CO standard is met when the 35 ppm 1-hour average standard and/or the 9 ppm 8-hour average standard is not exceeded more than once per year.
Pb	Compliance with the Pb standard is met when daily values collected for 3 consecutive months are averaged and do not exceed the 0.15 µg/m^3 standard.
NO_2	Compliance is met when the annual arithmetic mean concentration does not exceed the 0.053 ppm standard and the 98th percentile averaged over 3-years of the 1 hour concentration does not exceed 100 ppb.
O_3	The 8-hour O_3 primary and secondary standards are met when the 3-year average of the 4th highest daily maximum 8-hr average concentration is less than or equal to 0.075 ppm.
PM	**PM_{10}:** The 24-hour PM_{10} primary and secondary standards are met when the expected number of days per calendar year above 150 µg/m^3 is equal or less than one.
	$PM_{2.5}$: The $PM_{2.5}$ annual and secondary standards are met when the annual arithmetic mean concentration is less than or equal to 15 µg/m^3. The 24-hour $PM_{2.5}$ primary and secondary standards are met when the 3-year average of the 98$_{th}$ percentile 24-hour concentration is less than or equal to 35 µg/m^3.
SO_2	To determine compliance, the 1-hour concentration averaged over a three year period does not exceed 0.075 ppm, and the 3-hour average concentration shall not exceed 0.5 ppm more than once per calendar year.

As part of the EPA's grant to the DEQ, the AQD provides an annual review of monitoring data collected from the previous year and recommends any network changes. These recommendations are based on each monitor's exceedance history, changes in population distribution, and modifications to federal monitoring under the CAA. Under the amended air monitoring regulations that began in 2007, states are required to solicit public comment on their future air monitoring network design prior to submitting the annual review to the EPA.

Michigan Air Sampling Network

The Michigan Air Sampling Network (MASN) is operated by the DEQ's AQD, along with other governmental agencies. For instance, the O_3 and $PM_{2.5}$ monitors in Manistee County and Chippewa County are handled by the Little River Band of Ottawa Indians and the Inter-tribal Council of Michigan, respectively. **Figure 1.1** shows the 2011 MASN monitoring sites. **Figures 1.2** and **1.3** are pictures of two monitoring stations in Allen Park and Manistee, respectively.

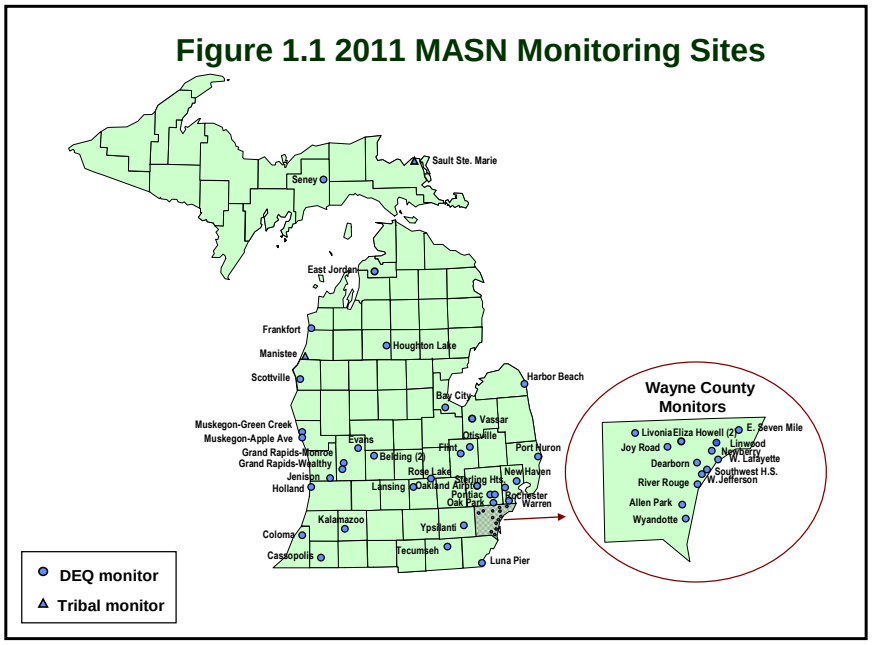


Figure 1.2: Allen Park

Figure 1.3: Manistee

The MASN consists of federal reference method (FRM) monitors that enable continuous monitoring for the gaseous pollutants (O_3, CO, NO_2, and SO_2), PM monitors that measure particulate concentrations over a 24-hour period, and high volume samplers for Pb. In addition, continuous $PM_{2.5}$ and PM_{10} monitors are used to provide real-time hourly data, and $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$ and help characterize background levels. The MASN data is also used to provide timely reporting to the DEQ's air quality reporting web page (discussed in **Chapter 9**). The types of monitoring conducted in 2011 and the MASN locations are shown in **Table 1.3.**

Table 1.3 Types of Monitoring Conducted in 2011 and MASN Location

Area	AIRS ID	Site Name	Trace CO	NO_2	Trace NO_y	O_3	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ TEOM	$PM_{2.5}$ Speciation	SO_2	Trace SO_2	VOC	Carbonyls	Trace Metals	Wind Speed & Direction, Temp.	Relative Humidity	Solar Radiation	Barometric Pressure
Detroit-Ann Arbor	260910007	Tecumseh				√		√	√	√						√			√
	260990009	New Haven				√		√								√	√	√	
	260991003	Warren				√													
	261250001	Oak Park				√		√								√			
	261250012	Oakland Co Int'l Airport													Pb				
	261470005	Port Huron				√		√	√	√						√			
	261610008	Ypsilanti				√		√	√							√			√
	261630001	Allen Park	√		√	√	√	√	√	√		√			√@	√	√		√
	261630005	River Rouge					√							√	√@	√			
	261630015	Detroit- W Fort S					√	√		√	√		√	√	√@	√	√		√
	261630016	Detroit- Linwood						√											
	261630019	Detroit- E Seven Mile		√		√		√								√	√		√
	261630025	Livonia						√								√	√		√
	261630027	Detroit-W Jefferson													√@				
	261630033	Dearborn					√	√	√	√			√	√	√ + Pb	√	√		√
	261630036	Wyandotte						√											
	261630038	Detroit- Newberry						√	√							√			
	261630039	Detroit W. Lafayette						√	√							√			
	261630093	Eliza Howell #1	√	√															
	261630094	Eliza Howell #2	√	√															
Flint	260490021	Flint				√		√	√						√#	√			√
	260492001	Otisville				√										√			
Grand Rapids	261390005	Jenison				√		√								√			
	260810007	Grand Rapids - Wealthy					√	√											
	260810020	Grand Rapids - Monroe	√		√	√	√	√	√	√		√			√@+Pb	√			√
	260810022	Evans				√										√			
Lansing/East Lansing	260650012	Lansing		√		√		√	√							√			√
	260370001	Rose Lake				√													
Monroe Co	261150005	Luna Pier						√		√									
Huron Co	260630007	Harbor Beach				√										√			
Bay Co	260170014	Bay City						√	√							√			
MissaukeeCo	261130001	Houghton Lake		√		√		√	√	√						√			√
Allegan Co	260050003	Holland				√		√								√	√	√	√
Benzie Co	260190003	Frankfort				√													
Berrien Co	260210014	Coloma				√		√								√			
Cass Co	260270003	Cassopolis				√										√			
Kalamazoo Co	260770008	Kalamazoo				√		√	√							√			
Manistee Co	261010922	Manistee $				√		√								√		√	√
Mason Co	261050007	Scottville				√										√			
Muskegon Co	261210038	Muskegon - Green				√										√			
	261210040	Muskegon - Apple Ave						√											
Schoolcraft Co	261530001	Seney Nat'l Wildlife				√			√							√	√	√	√
Chippewa Co	260330901	Sault Ste. Marie $				√		√	√							√			
Ionia Co	260670002	Belding - Reed St.													√@+Pb	√			
	260670003	Belding - Merrick St.													√@+Pb				
Charlevoix Co	260290011	East Jordan													√@+Pb				
Tuscola Co	261570001	Vassar													√@+Pb				

√ = Data Collected
= Mn only
@ = Mn, As, Cd, Ni
$= Tribal monitor

In 2006, the EPA amended its air monitoring requirements to include more co-located monitors. The amended air monitoring requirements also added National Core (NCore) sites that are multi-pollutant in nature, and are enhancing the understanding of how the various forms of air pollution are related and how it is transported. Michigan has two NCore sites, Allen Park and Grand Rapids – Monroe Street. Information on the effects of the 2006 amended monitoring requirements is discussed by criteria pollutant in **Chapters 2** through **7**.

Quality Assurance

The AQD's Air Monitoring Unit (AMU) ensures that all data collected and reported is of high quality and meets federal requirements. The AMU has a quality system in place that includes a Quality Assurance Project Plan (QAPP), standard operating procedures, standardized forms and documentation policies, and a robust audit and assessment program.

The monitoring network adheres to the requirements in Title 40 of the Code of Federal Regulations, Parts 50, 53, and 58. This ensures that the monitors are correctly sited, operated in accordance to the federal reference methods, and adhere to the quality assurance requirements.

Quality assurance checks are conducted by site operators at the frequencies required in the regulations and unit procedures. Independent audits are conducted by the AMU's Quality Assurance (QA) Team, which has a separate reporting line of supervision. The quality assurance checks and audits are reported to the EPA each quarter.

External audits are conducted annually by the EPA. The EPA conducts Performance Evaluation Program (PEP) audits for $PM_{2.5}$ samplers and the National Performance Audit Program (NPAP) checks for the gaseous monitors. The EPA also conducts program-wide Technical Systems Audits every three to five years to evaluate overall program operations, and assess adequacy of documentation and records retention. External audits are also conducted on the laboratory operations for certain analytical techniques using performance evaluation samples.

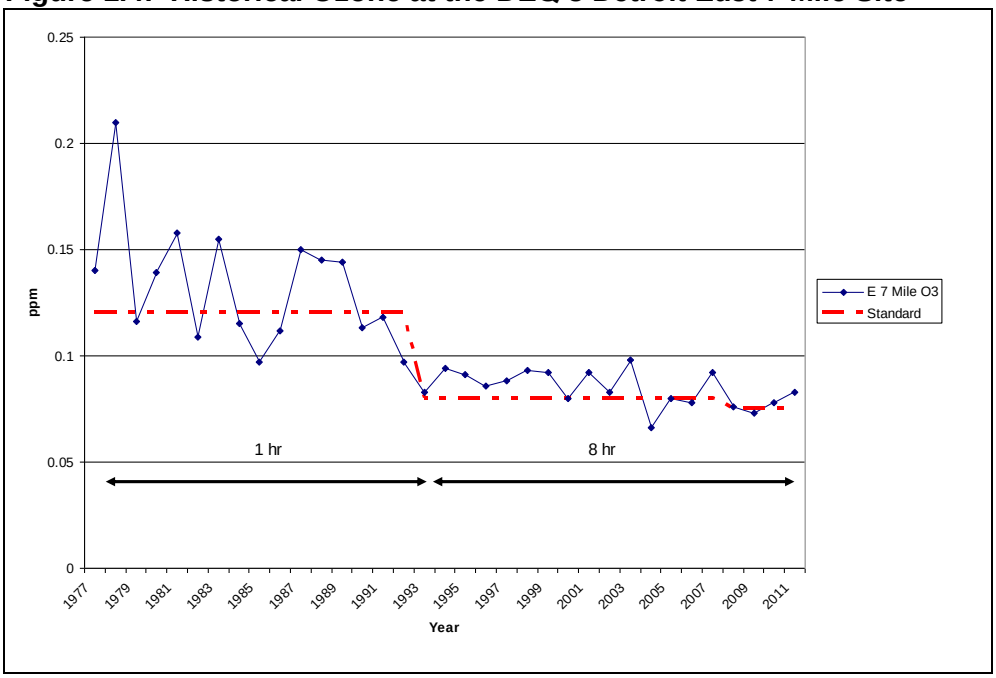
Trends

Congress passed the Clean Air Act in 1970; however, Michigan had a long history of environmental awareness before the Act was established. In 1887, Detroit adopted its first air quality ordinance. It declared that the dense smoke from coal burning was a public nuisance.

The EPA is required to review the criteria pollutant standards every five years. As a result, the standards may be lowered based on toxicological data. That is why the state can switch from attainment status to nonattainment status while the overall air quality continues to improve.

The following figures show how the levels of certain pollutants have changed over time and how the standards for those pollutants have changed. **Figure 1.4** shows the ozone levels at the Detroit East 7 Mile Road site. This graph shows how the standard was changed from a 1-hour average of .120 ppm to an 8-hour average of .08 ppm in 1997. The standard was again lowered to 0.075 ppm in 2008.

Figure 1.4: Historical Ozone at the DEQ's Detroit East 7 Mile Site



The SO_2 and CO trends are shown in **Figures 1.5** and **1.6**, respectively. In 2010, the EPA lowered the SO_2 standard and a portion of Wayne County is currently in nonattainment. You can read more about this in Chapter 4. Even though the area is now nonattainment for SO_2, the levels of SO_2 and CO have significantly decreased over the years.

Figure 1.5: Historical Annual SO_2 Averages at Detroit – W. Fort Street (SWHS)

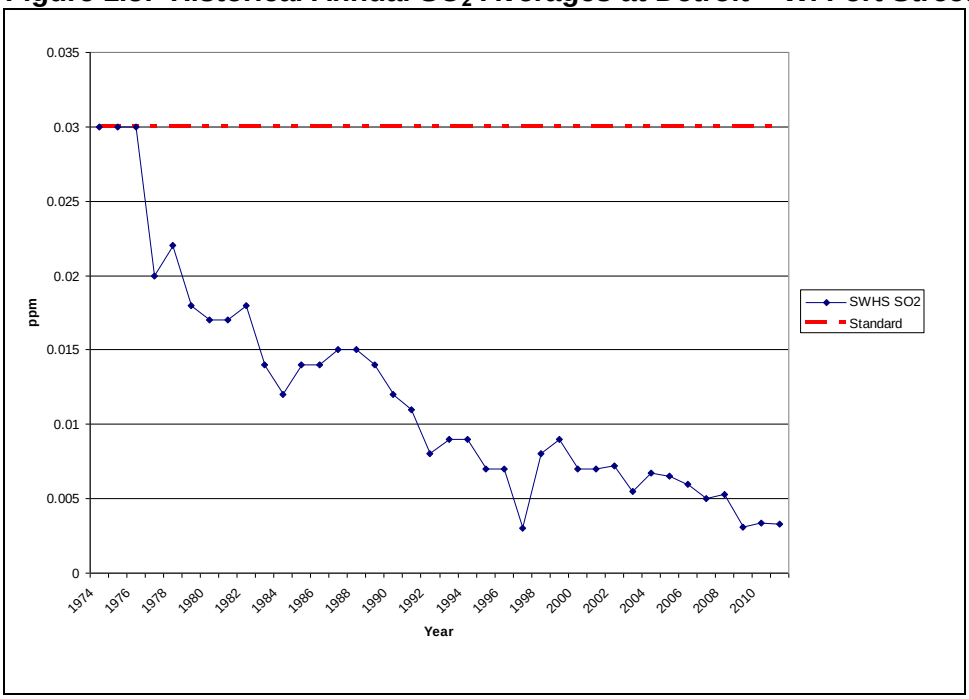
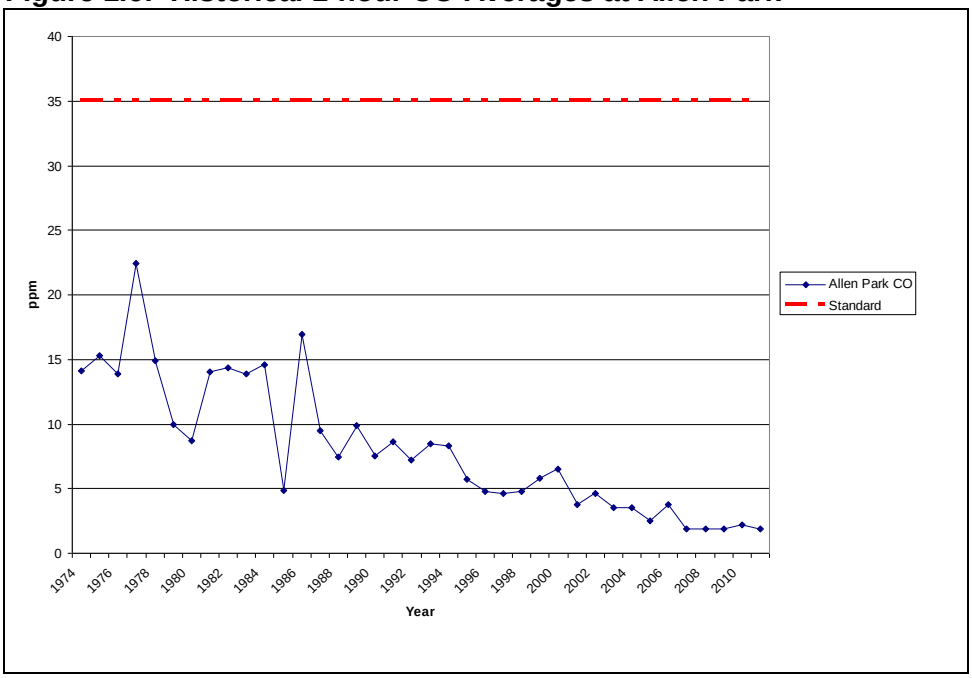
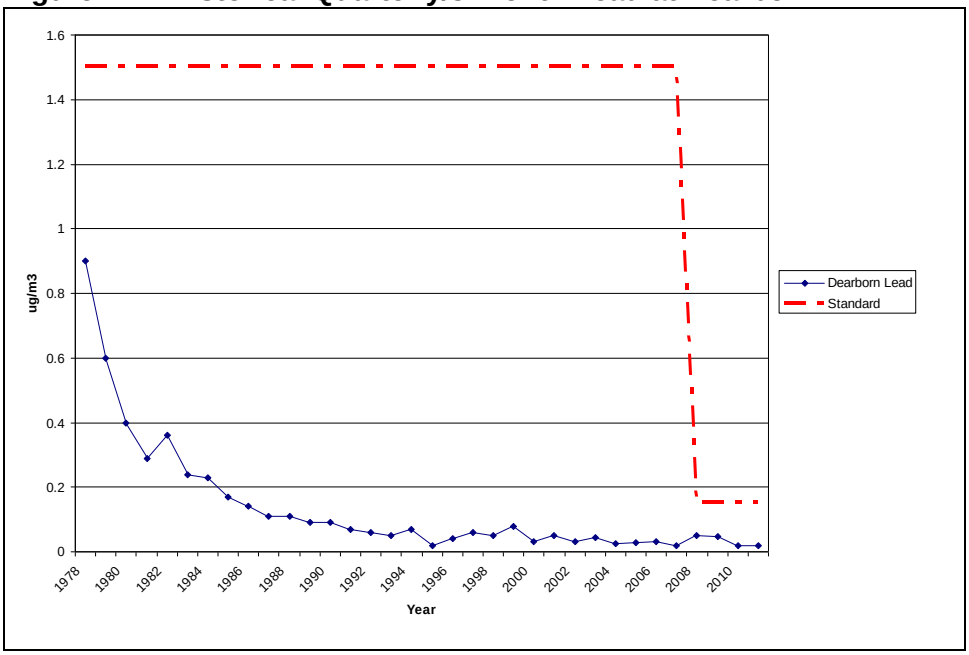


Figure 1.6: Historical 1-hour CO Averages at Allen Park



The historical lead trend is shown in Figure 1.7. Lead is of interest because it is harmful to the neurological development of children. This largest decrease in lead in the air is due to the removal of lead in gasoline. In 1975, most newly manufactured vehicles no longer required leaded gasoline and in 1996, the EPA banned the sale of leaded fuel for use in onroad vehicles. As a result, there was a dramatic decrease in ambient lead levels. The graph also shows the decrease in the lead standard that occurred in 2008.

Figure 1.7: Historical Quarterly/3-month Lead at Dearborn



Chapter 2: Carbon Monoxide (CO)

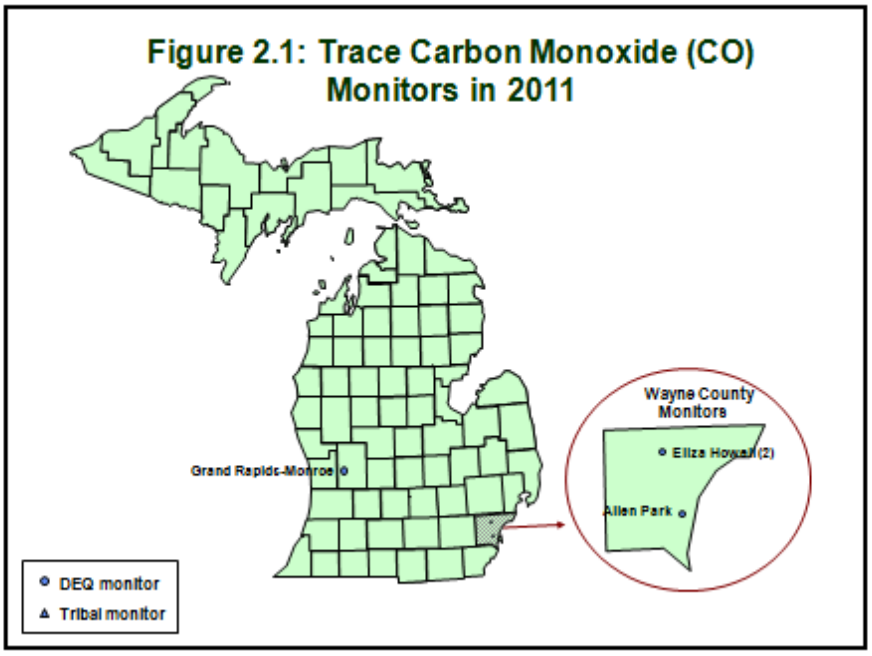
Carbon monoxide is a colorless, odorless and poisonous gas formed during incomplete burning of fuel. Levels peak during colder months primarily due to cold temperatures that affect combustion efficiency of engines. It has a standard of 9 ppm for the second highest 8-hour average and 35 ppm for the second highest 1-hour average. Its sources and effects are as follows:

Sources: Outdoor exposure sources are automobile exhaust, industrial processes (metal processing and chemical production), non-vehicle fuel combustion, and natural sources, such as forest fires. Indoor exposure sources are wood stoves, gas ranges with continuous pilot flame ignition, unvented gas or kerosene heaters, and cigarette smoke.

Effects: CO enters the bloodstream through the lungs, where it displaces oxygen delivered to the organs and tissues. Elevated levels can cause visual impairment, interfere with mental acuity by reducing learning ability and manual dexterity, and can decrease work performance in the completion of complex tasks. CO also alters atmospheric photochemistry that contributes to the formation of ground-level O_3, which can trigger serious respiratory problems.

Population most at risk: Those who suffer from cardiovascular (heart and respiratory) disease are most at risk for exposure to elevated levels of CO. People with angina and peripheral vascular disease are especially at risk, as their circulatory systems are already compromised and less efficient at carrying oxygen. However, elevated CO levels can also affect healthy people.

Figure 2.1 shows the two locations in Grand Rapids and Allen Park where trace CO is being monitored as part of the NCore Network and in Detroit at Eliza Howell Park, which is the near-roadway site operated by DEQ.



Figures 2.2 and **2.3** show CO emission sources and CO emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 2.2

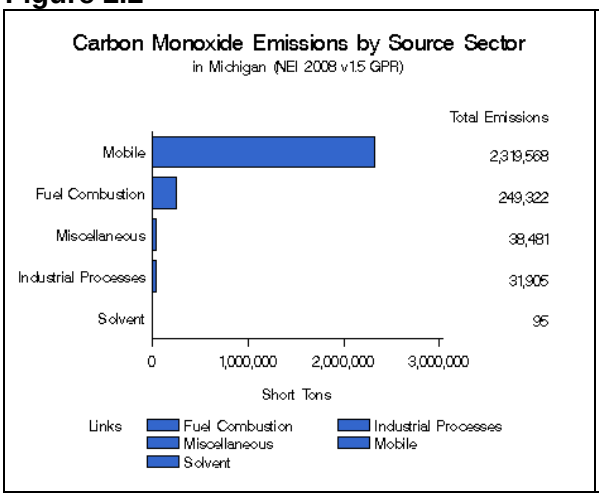
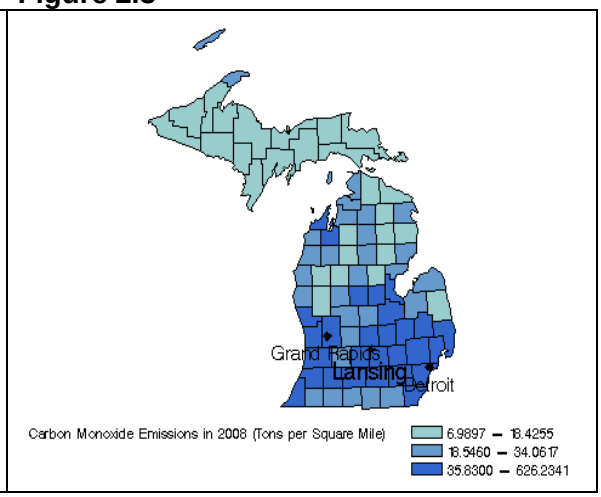
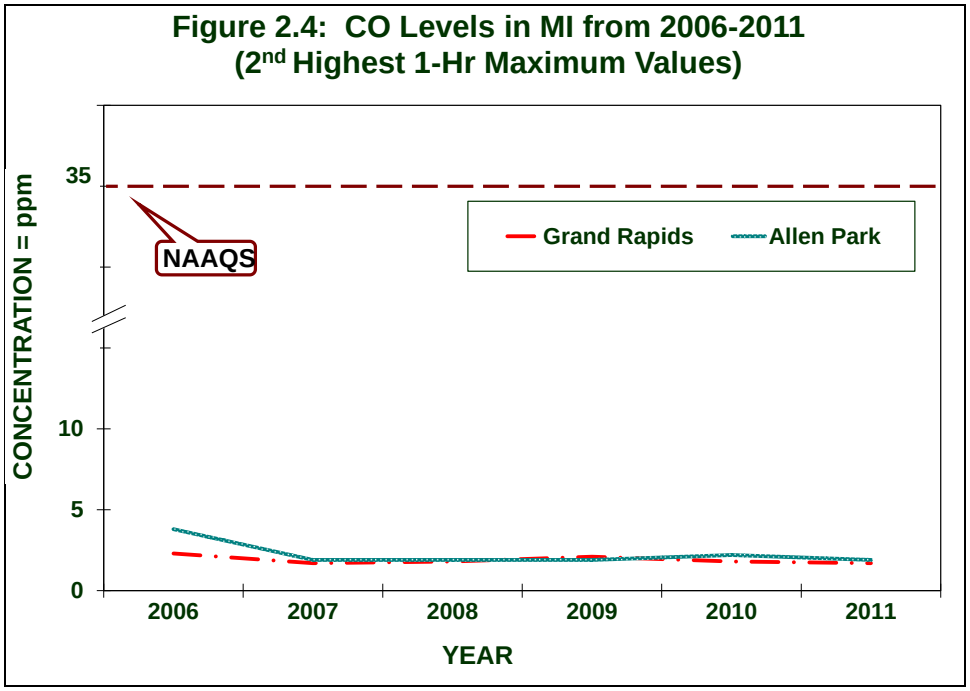


Figure 2.3



Near-roadway Monitoring: On August 31, 2011, the EPA approved design changes to the CO ambient monitoring network. It is referred to as near-roadway monitoring and is focused on highly trafficked urban roads in CBSAs with more than one million people. Final implementation is expected by January 2014; however, the DEQ took over two of the EPA's pre-existing, near-roadway sites in Detroit at Eliza Howell Park in June 2011.

Figure 2.4 provides the maximum second highest 1-hour CO level trends for Michigan from 2006-2011, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.



Chapter 3: Lead (Pb)

Lead is a highly toxic metal found in coal, oil, and other fuels. It is also found in older paints, municipal solid waste and sewage sludge and may be released to the atmosphere during their combustion. On November 12, 2008, the EPA modified the Pb NAAQS to a 3-month rolling average of 0.15 $\mu g/m^3$. Its sources and effects are as follows:

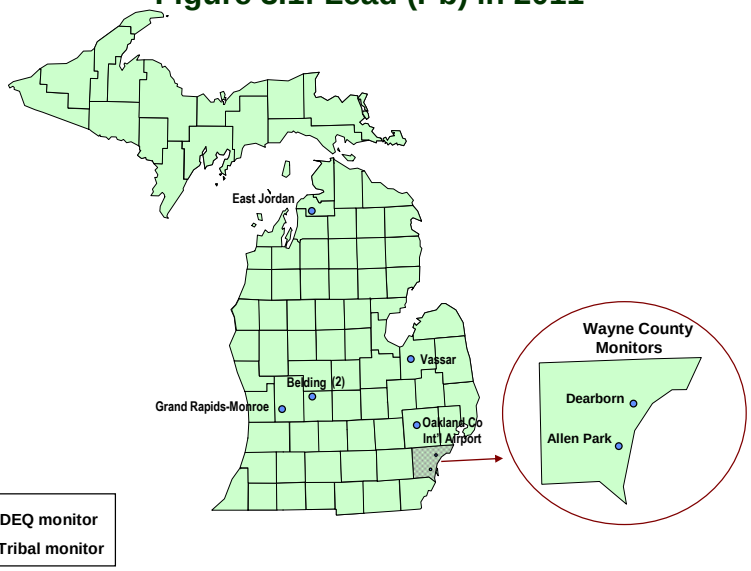
Sources: With the phase-out of leaded gas in the 1970s, the major sources of Pb emissions are industrial and combustion sources. The highest air concentrations of Pb are found near smelters and battery manufacturers (Pb acid batteries, Pb oxide/pigments). Other industrial sources include Pb glass, Portland cement, and solder production.

Effects: Exposure occurs through the inhalation or ingestion of Pb in food, water, soil, or dust particles. Pb primarily accumulates in the body's blood, bones, and soft tissues, and adversely affects the kidneys, liver, nervous system, and other organs.

Population most at risk: Fetuses and children are most at risk as low levels of Pb may cause central nervous system damage. Excessive Pb exposure during the early years of life is associated with lower IQ scores and neurological impairment (seizures, mental retardation, and behavioral disorders). Even at low doses, Pb exposure is associated with changes in fundamental enzymatic, metabolic, and homeostatic mechanisms in the body, and Pb may be a factor in high blood pressure and subsequent heart disease.

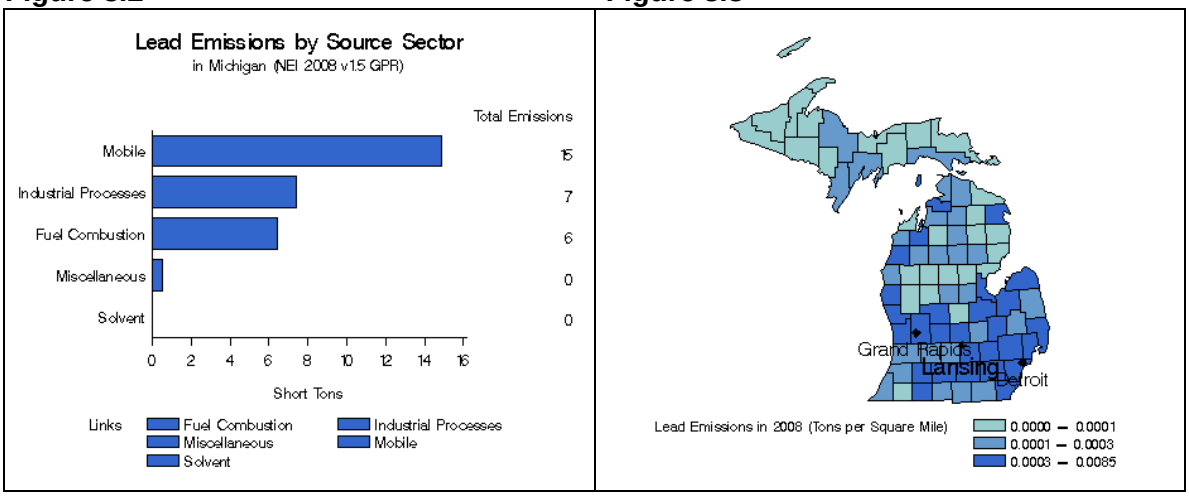
Figure 3.1 shows the location of the Pb monitors in the MASN.

Figure 3.1: Lead (Pb) in 2011



Figures 3.2 and **3.3** show Pb emission sources and Pb emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 3.2 **Figure 3.3**



On November 12, 2008, the EPA modified the Pb NAAQS by reducing the level of the standard from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. The monitoring network design was modified to consist of source-oriented monitors and population-oriented monitors. For details of the new Pb network that is in progress since 2010, see Michigan's 2011 Annual Ambient Air Monitoring Network Review.

As part of the new standard, the DEQ was required to monitor near stationary lead sources emitting more than 1 ton per year. One of these sources is located in Belding. Monitoring in Belding began in January 2010. As a result of this effort, the DEQ recorded a violation of the new health standard in 2010 and 2011, as shown in **Figure 3.4a.** Three other point-source lead monitoring sites were added in East Jordan (November 2011), Vassar (September 2011), and at the Oakland International Airport (July 2011). Values for these last three sites have been well below the NAAQS.

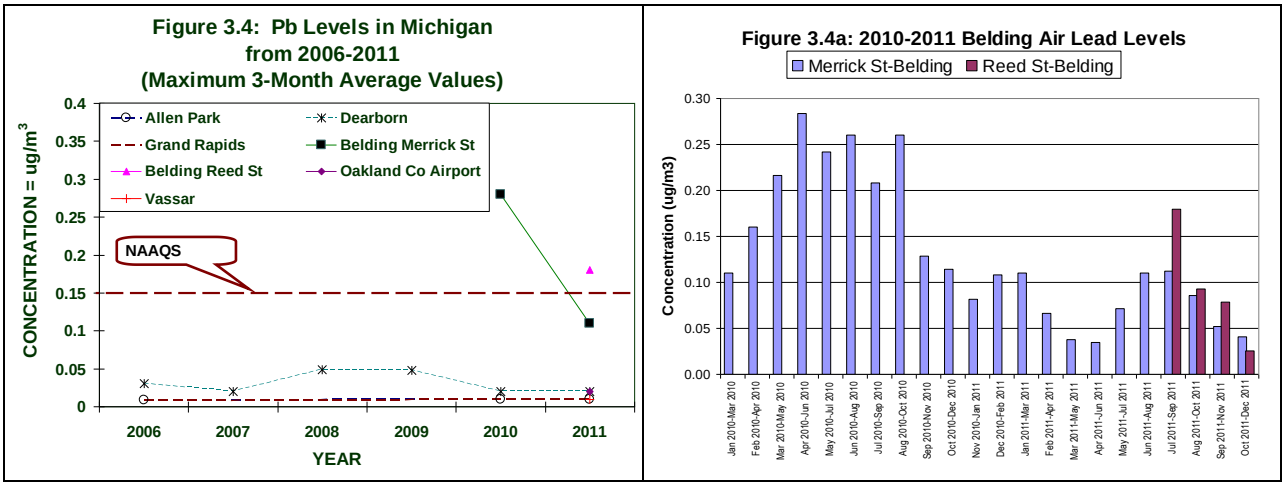


Figure 3.4 provides the maximum quarterly Pb level values for the years 2005 to 2009. Then starting in 2010, it is the maximum 3-month rolling average.

All other Pb sites in Michigan are well below the standard. The Dearborn site is part of the National Air Toxics Trend Sites (NATTS) program and monitors Pb and other trace metals, both as total suspended particulate (TSP) and PM_{10}. Pb measurements as $PM_{2.5}$ are made throughout the $PM_{2.5}$ speciation network.

Chapter 4: Sulfur Dioxide (SO_2)

Sulfur dioxide is a gas formed by the burning of sulfur-containing material. Odorless at typical ambient concentrations, SO_2 can react with other atmospheric chemicals to form sulfuric acid. When sulfur-bearing fuel is burned, the sulfur is oxidized to form SO_2, which then reacts with other pollutants to form aerosols. In liquid form, it is found in clouds, fog, rain, aerosol particles, and in surface films on these particles. It is a major precursor to $PM_{2.5}$. In June 2010, the EPA changed the primary SO_2 standard to a 99th percentile of 1-hour concentrations not to exceed 0.075 ppm, averaged over a 3-year period. The secondary standard has not changed and is a 3-hour average of 0.5 ppm. Its sources and effects are as follows:

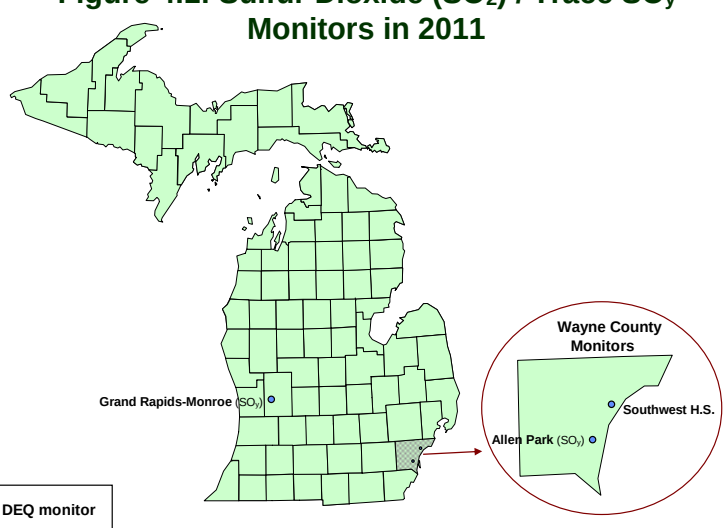
Sources: Coal-burning power plants are the largest source of SO_2 emissions. It is also emitted from smelters, petroleum refineries, pulp and paper mills, transportation sources, and steel mills. Other sources include residential, commercial and industrial space heating. SO_2 and PM are often emitted together.

Effects: Exposure to elevated levels aggravates existing cardiovascular and pulmonary disease. SO_2 and PM together may cause respiratory illness, alteration of the body's defense and clearance mechanisms, and aggravation of existing cardiovascular disease. SO_2 and NO_X together are the major precursors to acid rain, associated with the acidification of soils, lakes, and streams and accelerated corrosion of buildings and monuments.

Population most at risk: Asthmatics, children, and the elderly are especially sensitive to SO_2 exposure. Asthmatics receiving short-term exposures during moderate exertion may experience reduced lung function and symptoms, such as wheezing, chest tightness, or shortness of breath. Depending upon the concentration, SO_2 may also cause symptoms in people who do not have asthma.

Figure 4.1 shows the location of each SO_2 monitor.

Figure 4.1: Sulfur Dioxide (SO_2) / Trace SO_y Monitors in 2011



Figures 4.2 and **4.3** show SO_2 emission sources and SO_2 emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 4.2

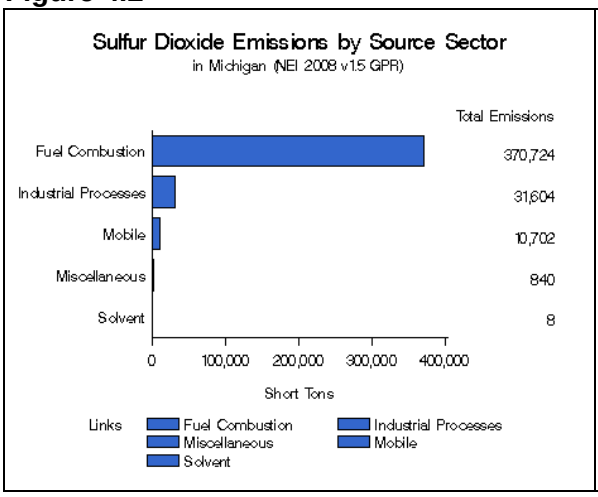
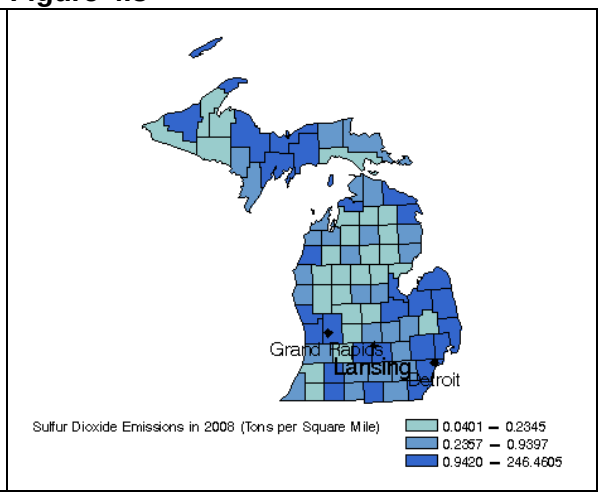
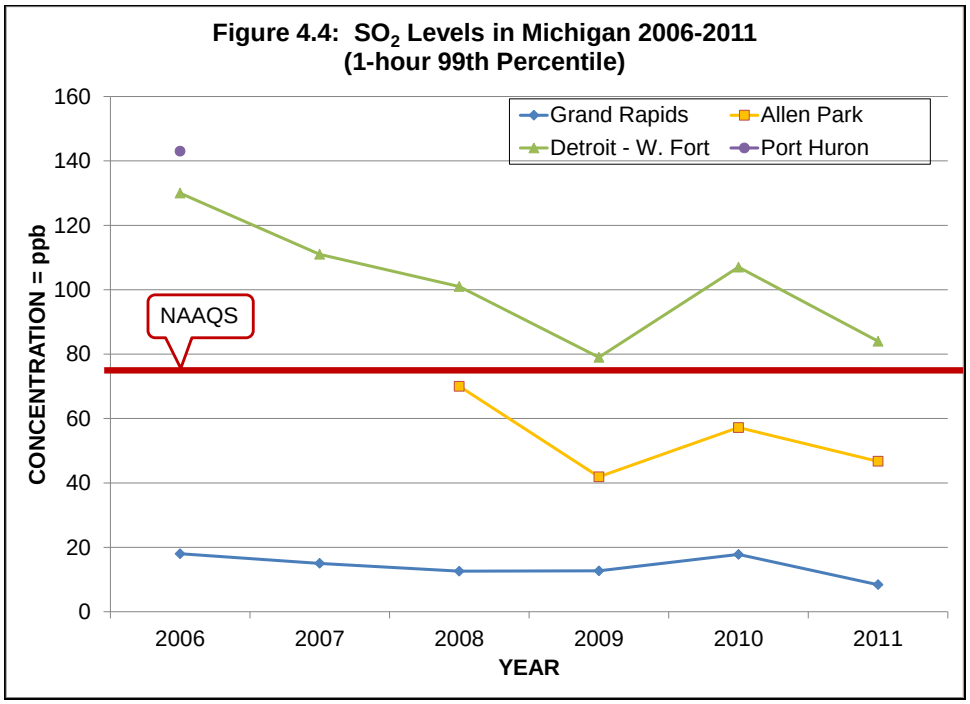


Figure 4.3



Michigan had been in attainment for SO_2 since 1982 with levels consistently well below the annual SO_2 NAAQS. However, the SO_2 monitor at W. Fort Street (Southwestern High School [SWHS]) in Detroit now does not meet the new 1-hour NAAQS (see appendix A). For the NCore network, trace SO_2 is monitored at the Grand Rapids and Allen Park NCore sites. For trend purposes, W. Fort Street is also added with Allen Park and Grand Rapids SO_2 monitors shown in **Figure 4.4.**



Chapter 5: Nitrogen Dioxide (NO_2)

Nitrogen Dioxide is a reddish-brown, highly reactive gas formed through oxidation of nitric oxide (NO). Upon dilution, it becomes yellow or invisible. High concentrations produce a pungent odor and lower levels have an odor similar to bleach. NO_X is the term used to describe the sum of NO, NO_2, and other nitrogen oxides. NO_X can lead to the formation of O_3 and NO_2, and can react with other substances in the atmosphere to form acidic products that are deposited in rain (acid rain), fog, snow, or as PM. Since 1971, the primary and secondary standard for NO_2 was an annual mean of 0.053 ppm. On January 22, 2010, the EPA added a 1-hour NO_2 standard of 100 ppb, taking the form of the 98th percentile averaged over three years. The sources and effects of NO_2 are as follows:

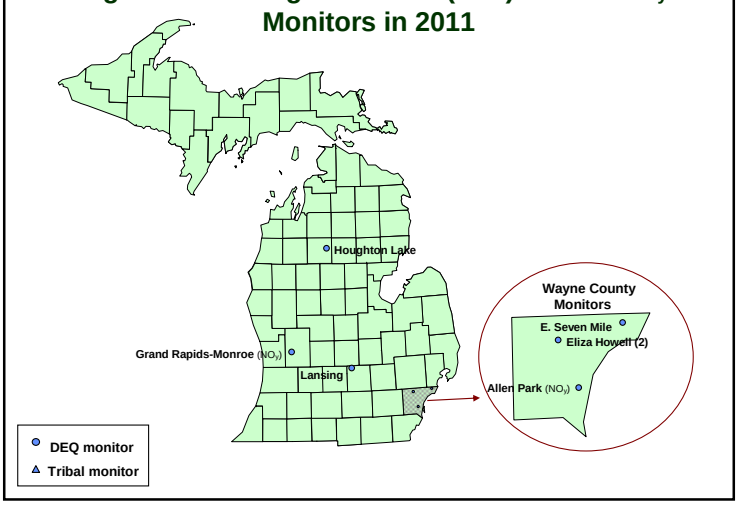
Sources: NO_X compounds and their transformation products occur both naturally and as a result of human activities. Natural sources of NO_X are lightning, biological and abiological processes in soil, and stratospheric intrusion. Ammonia and other nitrogen compounds produced naturally are important in the cycling of nitrogen through the ecosystem. The major sources of man-made (anthropogenic) NO_X emissions come from high-temperature combustion processes (such as those occurring in automobiles and power plants). Home heaters and gas stoves produce substantial amounts of NO_2 in indoor settings.

Effects: Exposure to NO_2 occurs through the respiratory system, irritating the lungs. Short-term NO_2 exposures (i.e., less than three hours) can produce coughing and changes in airway responsiveness and pulmonary function. Evidence suggests that long-term exposures to NO_2 may lead to increased susceptibility to respiratory infection and may cause structural alterations in the lungs. Exercise increases the ventilation rate and hence exposure to NO_2. Nitrate particles and NO_2 can block the transmission of light, thus causing visibility impairment. Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland, and aquatic systems.

Population most at risk: Individuals with pre-existing respiratory illnesses and asthmatics are more sensitive to the effects of NO_2 than the general population. Short-term NO_2 exposure can increase respiratory illnesses in children.

Figure 5.1 shows the location of each NO_2 monitor.

Figure 5.1: Nitrogen Dioxide (NO_2) / Trace NO_y Monitors in 2011



The East 7 Mile monitor in Detroit is a downwind urban scale site that measures NO_2. The Grand Rapids and Allen Park sites monitor trace NO_Y, which began in early January 2008 as part of the NCore program (however, only NO_2 monitors can be used for attainment/nonattainment purposes). In addition, in 2010, the AQD added NO_2 monitors at Lansing and Houghton Lake to provide background information for modeling applications.

Due to the January 22, 2010 near-roadway monitoring regulations, the EPA deployed two NO_2 sites at Eliza Howell in September 2010 .The monitoring of these two sites was taken over by the DEQ in October 2011. Please see the 2012 Annual Network Review document for more details.

Figures 5.2 and **5.3** show NO_2 emission sources and NO_2 emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 5.2

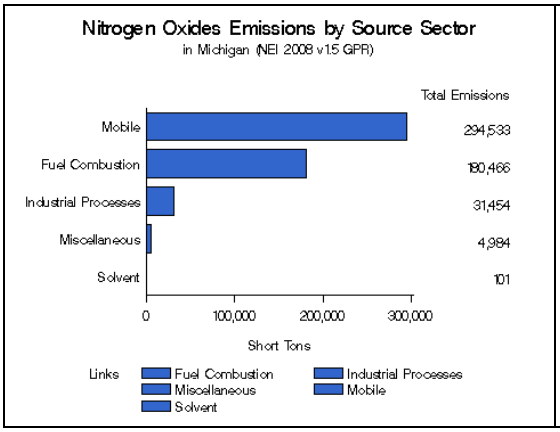
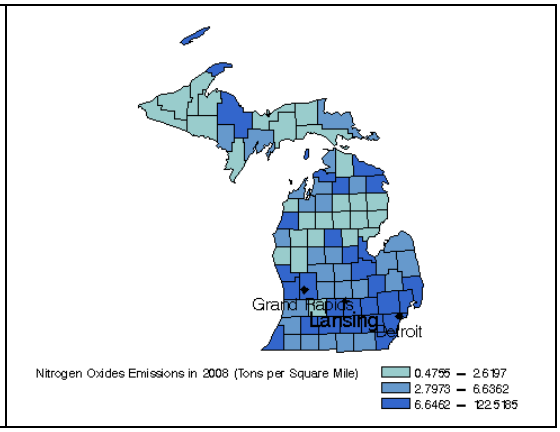
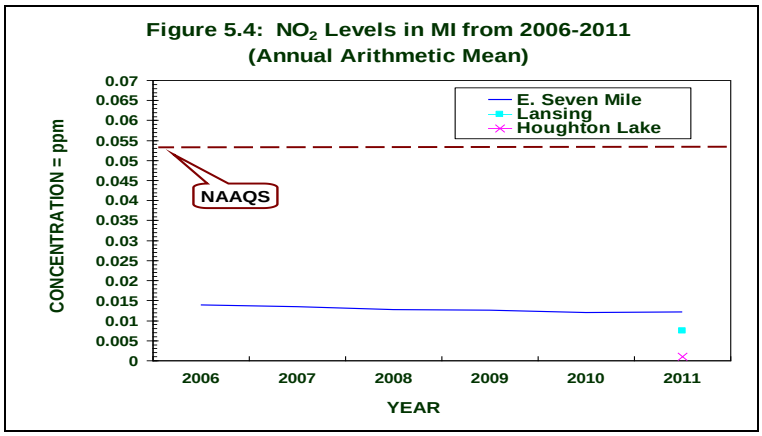


Figure 5.3



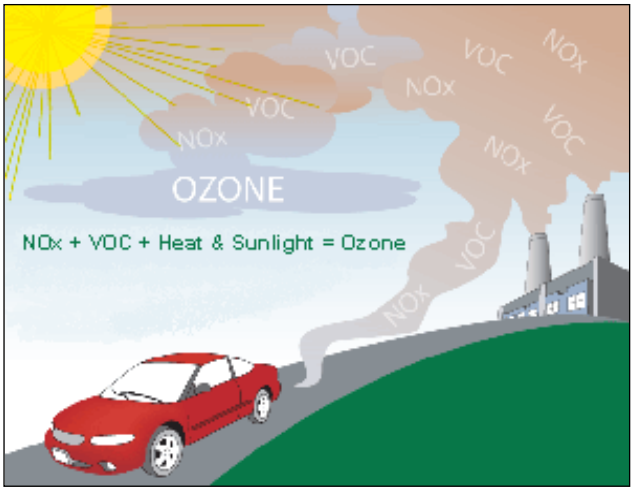
Michigan ambient NO_2 levels have always been well below the NAAQS. Since March 3, 1978, all areas in Michigan have been in attainment for the annual NO_2 NAAQS. As shown in **Figure 5.4**, all monitoring sites have had an annual NO_2 concentration at less than half of the 0.053 ppm NAAQS. As such, the DEQ requested a designation of nonclassifiable/attainment for the entire state.



Even though there are no nonattainment areas for NO_2 in Michigan and monitoring for attainment purposes is not required, monitors continue to operate to support photochemical model validation work.

Chapter 6: Ozone (O_3)

Ground-level O_3 is created by reactions involving nitrogen oxides (NO_X) and volatile organic compounds (VOCs), or hydrocarbons, in the presence of sunlight as the illustration to the right depicts (image courtesy of the EPA). These reactions usually occur during the hot summer months as ultraviolet radiation from the sun initiates a sequence of photo-chemical reactions. O_3 is also a key ingredient of urban smog. In Earth's lower atmosphere (also known as the troposphere), ozone is an air pollutant. Ground level ozone can also be transported hundreds of miles under certain meteorological conditions. Ozone levels are often higher in rural areas than in cities due to transport to regions downwind from the actual emissions of NO_X and VOCs. Shoreline monitors along Lake Michigan often measure high ozone concentrations due to transport from upwind states. The ozone NAAQS was revised by the EPA and became effective on May 27, 2008. The new standard is a 3-year average of the 4th highest daily maximum 8-hour average concentration within an area that must not exceed 0.075 ppm. The sources and effects of ozone follow:

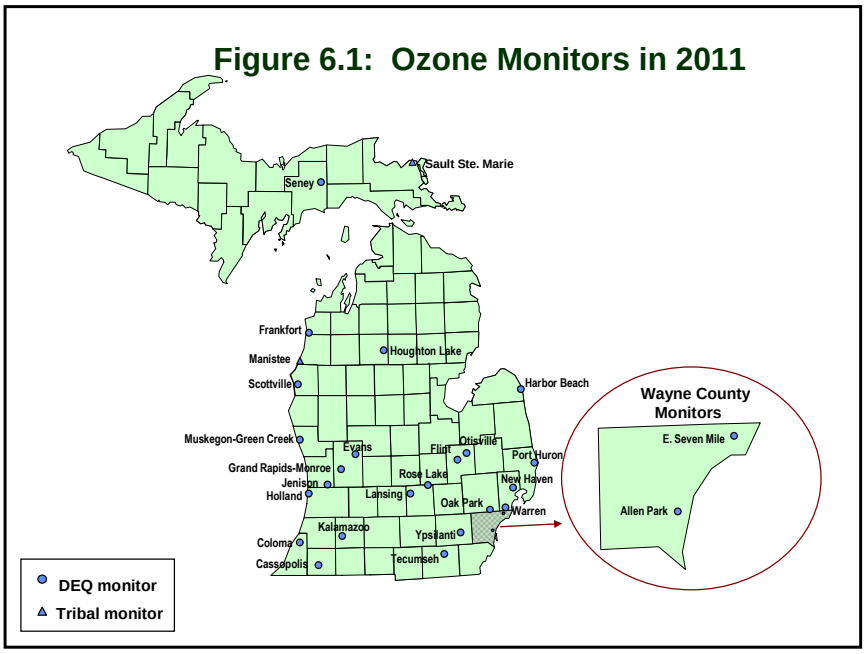


Sources: Major sources of NO_X and VOCs are engine exhaust, emissions from industrial facilities, combustion from power plants, gasoline vapors, chemical solvents, and biogenic emissions from natural sources. Ground-level O_3 can also be transported hundreds of miles under certain wind regimes. As a result, the long-range transport of air pollutants impacts the air quality of regions downwind from the actual area of formation.

Effects: Elevated O_3 exposure can irritate a person's airways, reduce lung function, aggravate asthma and chronic lung diseases like emphysema and bronchitis, and inflame and damage the cells lining the lungs. Other effects include increased respiratory related hospital admissions with symptoms such as chest pain, shortness of breath, throat irritation, and cough. O_3 may also reduce the immune system's ability to fight off bacterial infections in the respiratory system, and long-term, repeated exposure may cause permanent lung damage. O_3 also impacts vegetation and the forest ecosystem, including agricultural crop and forest yield reductions, diminished resistance to pest and pathogens, and reduced survivability of tree seedlings.

Population most at risk: Individuals most susceptible to the effects of O_3 exposure include those with a pre-existing or chronic respiratory disease, children who are active outdoors, and adults who actively exercise or work outdoors.

Figure 6.1 shows the location of the DEQ's O_3 monitors in Michigan.



Figures 6.2 and **6.3** show VOC emission sources and VOC emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 6.2

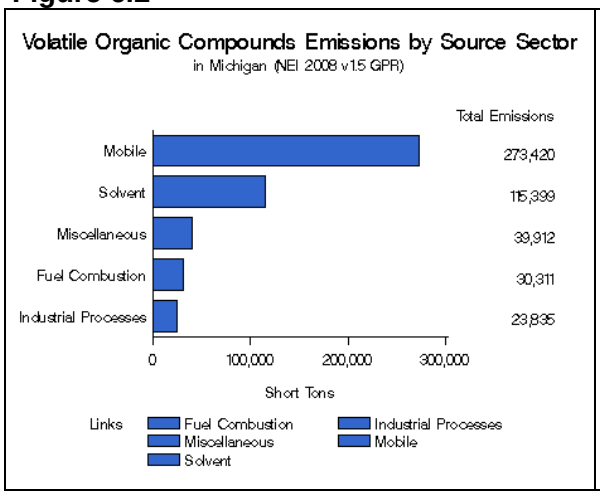
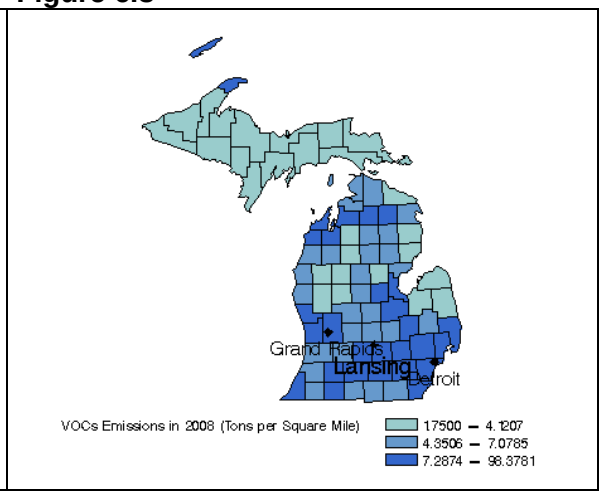


Figure 6.3



The ozone NAAQS was revised by the EPA on March 12, 2008 to 0.075 ppm and became effective on May 27, 2008. To attain the 2008 standard, the 3-year average of the 4th highest daily maximum 8-hour average concentration within an area must not exceed 0.075 ppm.

Nonattainment designations are assigned to areas that exceed the NAAQS or contribute to exceedances in a nearby area. The EPA planned to make attainment and nonattainment designations for this standard no later than March 12, 2010; however, the EPA decided to re-evaluate the standard instead. Attainment and nonattainment designations for the 0.08 ppm standard were made in 2004. Twenty-five counties in Michigan were originally designated as nonattainment. However, the ozone level has since dropped significantly, and the entire state was approved for attainment in a letter from the EPA on December 9, 2011.

The O_3 monitoring season in Michigan is from April 1 through September 30, during which time O_3 monitoring data is available for the public via the AQD's web site (discussed in **Chapter 9**). This data helps in attainment designation applications, to assess urban air quality, and population exposure.

Table 1.3 from **Chapter 1** shows all 27 O_3 air quality monitors active in Michigan at the beginning of 2011. It is important to note that under the 2006 amended air monitoring regulations, MSA boundaries have been modified and population totals tied to measurements of ambient air quality have increased. Basically, the amended regulations state that any monitors with a design value, using the most recent three years of data greater than or equal to 85% of the O_3 NAAQS, have a higher probability of violating the standard. Therefore, more monitors could be required in these MSAs.[5]

Table 6.1 Three-year Average of the 4th Highest 8-hour Ozone Values from 2007-2009, 2008-2010, and 2009-2011.

Areas	County	Monitor Sites	2007-2009	2008-2010	2009-2011
Detroit-Ann Arbor MI	Lenawee	Tecumseh	0.073	0.068	0.069
	Macomb	New Haven	0.079	0.074	0.075
		Warren	0.078	0.073	0.076
	Oakland	Oak Park	0.077	0.073	0.075
	St. Clair	Port Huron	0.075	0.071	0.074
	Washtenaw	Ypsilanti	0.070	0.066	0.069
	Wayne	Allen Park	0.069	0.066	0.069
		E 7 Mile	0.080	0.075	0.078
Flint MI	Genesee	Flint	0.072	0.068	0.069
		Otisville	0.074	0.068	0.069
Grand Rapids, MI	Ottawa	Jenison	0.075	0.069	0.073
	Kent	Grand Rapids	0.072	0.067	0.071
		Evans	0.075	0.069	0.071
Muskegon Co MI	Muskegon	Muskegon	0.077	0.074	0.076
Allegan Co MI	Allegan	Holland	0.081	0.074	0.078
Huron Co MI	Huron	Harbor Beach	0.072	0.067	0.068
Kalamazoo- Battle Creek MI	Kalamazoo	Kalamazoo	0.074	0.069	0.071
Lansing East Lansing MI	Ingham	Lansing	0.073	0.068	0.068
	Clinton	Rose Lake	0.071	0.065	0.066
Benton Harbor MI	Berrien	Coloma	0.076	0.071	0.075
Benzie Co MI	Benzie	Frankfort	0.072	0.069	0.070
Cass Co MI	Cass	Cassopolis	0.075	0.070	0.074
Chippewa Co MI	Chippewa	Sault Ste. Marie	3 years of data not available		
Mason Co MI	Mason	Scottville	0.073	0.068	0.070
Missaukee Co MI	Missaukee	Houghton Lake	0.069	0.065	0.065
Manistee Co MI	Manistee	Manistee	0.072	0.067	0.069
Schoolcraft Co MI	Schoolcraft	Seney	0.070	0.067	0.068

Tables 6.2 and **6.3** highlight the number of days when two or more monitors exceeded 0.075 ppm. They also specify in which month they occurred and the temperature range.

[5] Additional information is available in Michigan's 2010 Ambient Air Monitoring Network Review Final Report at http://www.michigan.gov/documents/deq/deq-aqd-air-aqe-2010-Monitoring-Network-Review-final-6-09_284564_7.pdf

Table 6.2

Daily High Temperature Range	2011 WEST MICHIGAN OZONE SEASON											
	April		May		June		July		August		September	
	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
>= 95	0	0	0	0	0	0	3	2	0	0	0	0
90 <= 94	0	0	0	0	4	2	4	1	1	0	2	2
85 <= 89	1	0	5	0	3	1	18	1	5	0	2	0
80 <= 84	0	0	1	0	9	0	4	0	15	0	2	0
75 <= 79	1	0	2	0	5	0	1	0	10	0	2	0
70 <= 74	0	0	8	0	5	0	1	0	0	0	6	0
65 <= 69	2	0	4	0	3	0	0	0	0	0	12	0
60 <= 64	7	0	7	0	1	0	0	0	0	0	3	0
55 <= 59	4	0	0	0	0	0	0	0	0	0	1	0
50 <= 54	5	0	4	0	0	0	0	0	0	0	0	0
49 <=	10	0	0	0	0	0	0	0	0	0	0	0
Totals	**30**	**0**	**31**	**0**	**30**	**3**	**31**	**4**	**31**	**0**	**30**	**2**

Days: Number of days during month when the daily high temperature falls within the specified temperature range.
O_3 Days: Number of days, during specified temperature range, when two or more area monitors exceeded 75 ppb.

Table 6.3

Daily High Temperature Range	2011 SOUTHEAST MICHIGAN OZONE SEASON											
	April		May		June		July		August		September	
	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
>= 95	0	0	0	0	2	2	5	0	0	0	2	1
90 <= 94	0	0	1	0	1	0	9	3	2	0	1	1
85 <= 89	0	0	1	0	4	0	13	2	9	0	0	0
80 <= 84	1	0	5	0	11	1	4	0	13	0	2	0
75 <= 79	0	0	3	0	6	0	0	0	6	0	6	0
70 <= 74	4	0	6	0	4	0	0	0	1	0	6	0
65 <= 69	1	0	6	0	1	0	0	0	0	0	7	0
60 <= 64	6	0	4	0	1	0	0	0	0	0	5	0
55 <= 59	2	0	1	0	0	0	0	0	0	0	1	0
50 <= 54	7	0	4	0	0	0	0	0	0	0	0	0
49 <=	9	0	0	0	0	0	0	0	0	0	0	0
Totals	**30**	**0**	**31**	**0**	**30**	**3**	**31**	**5**	**31**	**0**	**30**	**2**

Days: Number of days during month when the daily high temperature falls within the specified temperature range.
O_3 Days: Number of days, during specified temperature range, when two or more area monitors exceeded 75 ppb.

There were three days in June, four days in July and two days in September when ozone exceeded 0.075 ppm at two or more monitors in west Michigan. The respective temperatures for those days were between 85^{0}F to ≥ 94^{0}F. There were three days in June, five days in July, and two days in September when ozone exceeded 0.075 ppm at two or more monitors in southeast Michigan. The respective temperatures for those days were between 80^{0}F to ≥ 94^{0}F. **Table 6.4** gives a breakdown of those days and the specific monitors that went over the standard in the western, central/upper, and eastern portions of the state.

Table 6.4: Eight-hour Exceedance Days (>75 ppb) and Locations

Date	Monitors			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
05/12/2011		Otisville		1
06/04/2011			Port Huron	1
06/05/2011			Oak Park	1
06/06/2011	Scottville	Flint, Manistee, Otisville, Seney	Tecumseh, Ypsilanti	7
06/07/2011	Coloma, Evans, Grand Rapids, Holland, Jenison, Muskegon, Scottville	Frankfort, Harbor Beach, Houghton Lake, Manistee, Rose Lake	Allen Park, East 7 Mile, New Haven ,Oak Park, Port Huron, Tecumseh, Warren	19
06/08/2011	Coloma, Evans, Grand Rapids, Holland, Jenison, Muskegon		Ypsilanti	7
07/01/2011		Flint, Otisville	Allen Park, East 7 Mile, New Haven, Oak Park, Port Huron, Tecumseh, Warren, Ypsilanti	10
07/10/2011	Holland		East 7 Mile, Warren	3
07/16/2011	Cassopolis, Coloma, Evans, Grand Rapids, Holland	Lansing, Rose Lake		7
07/17/2011	Cassopolis, Coloma. Holland, Jenison, Kalamazoo		East 7 Mile, Oak Park, Warren	8
07/18/2011	Cassopolis			1
07/19/2011			Allen Park, East 7 Mile	2
07/20/2011	Coloma, Evans, Grand Rapids, Holland, Jenison, Muskegon, Scottville		Port Huron	8
07/21/2011	Cassopolis, Coloma			2
09/01/2011	Cassopolis, Coloma, Holland, Muskegon		East 7 Mile, New Haven, Warren	7
09/02/2011	Cassopolis, Holland, Kalamazoo		East 7 Mile	4
			TOTAL	**88**

June 7, 2011 had the most number of monitor readings exceeding the level of the standard, with 19. The East 7 Mile monitor exceeded the level of the standard most often on nine occasions. Sites with the most exceedances in the western region of Michigan were Coloma and Holland, each with eight. The central/upper Michigan sites with the most exceedances were Manistee and Otisville, with each having three.

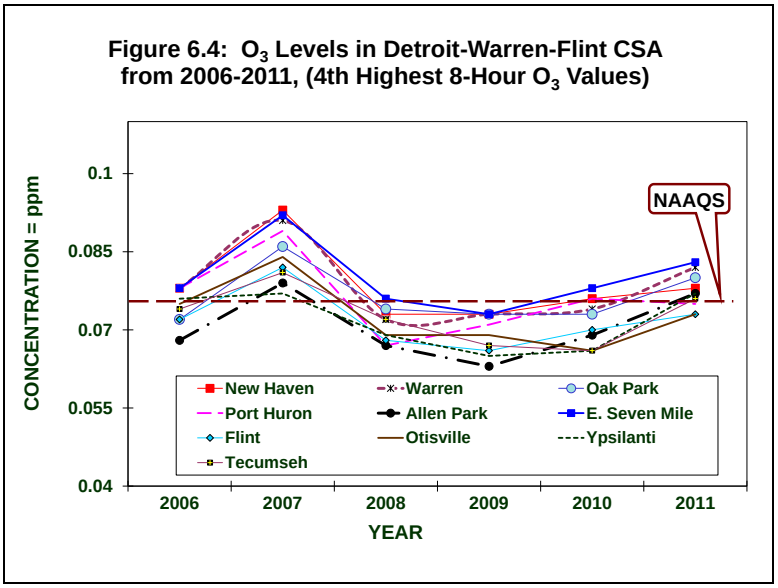
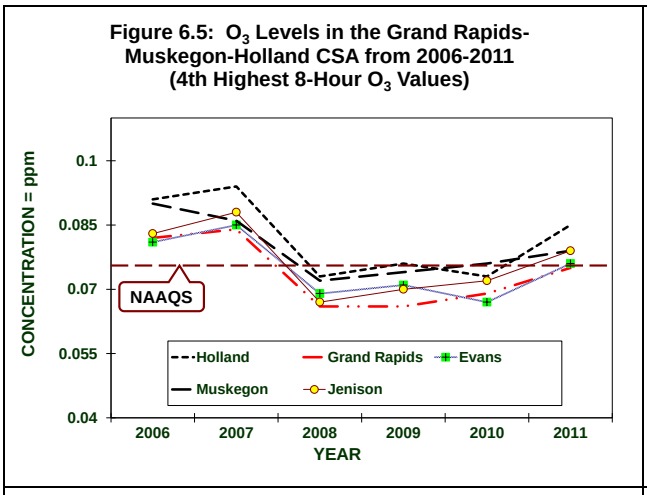
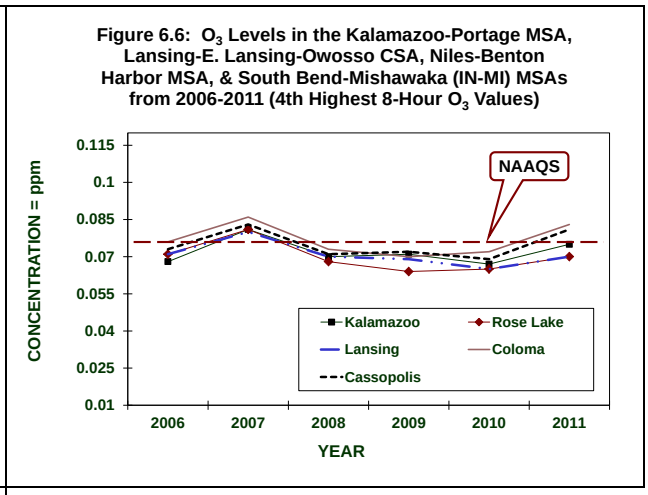
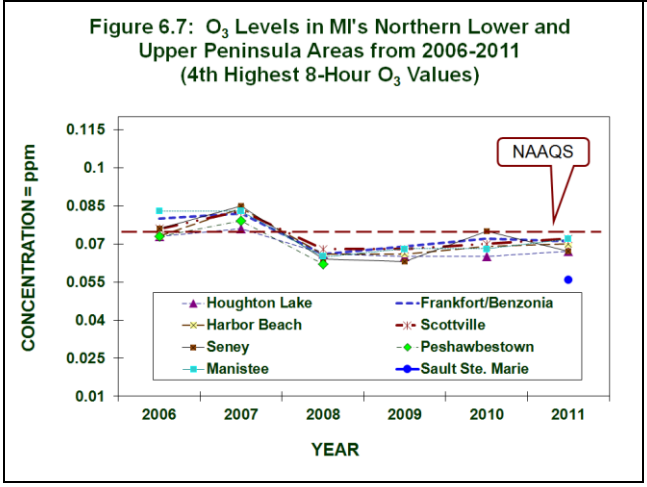


Figure 6.4 shows the 4th highest 8-hour O_3 values for all of Michigan's monitoring sites in southeast Michigan from 2006-2011. While eight sites during the 2011 monitoring season reached 0.075 ppm, only East 7 Mile and Warren violated the three year standard.

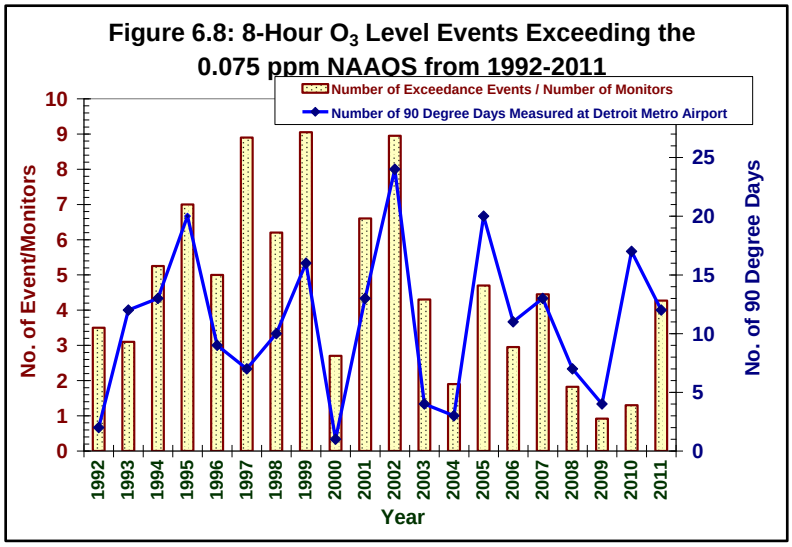






Figures 6.5, 6.6 and **6.7** show the 4th highest 8-hour O_3value trends for the other monitoring sites in Michigan over the last five years (see **Table 6.1** for reference). While eight sites during the 2011 monitoring season reached 0.075 ppm, only Holland and Muskegon violated the three year standard.

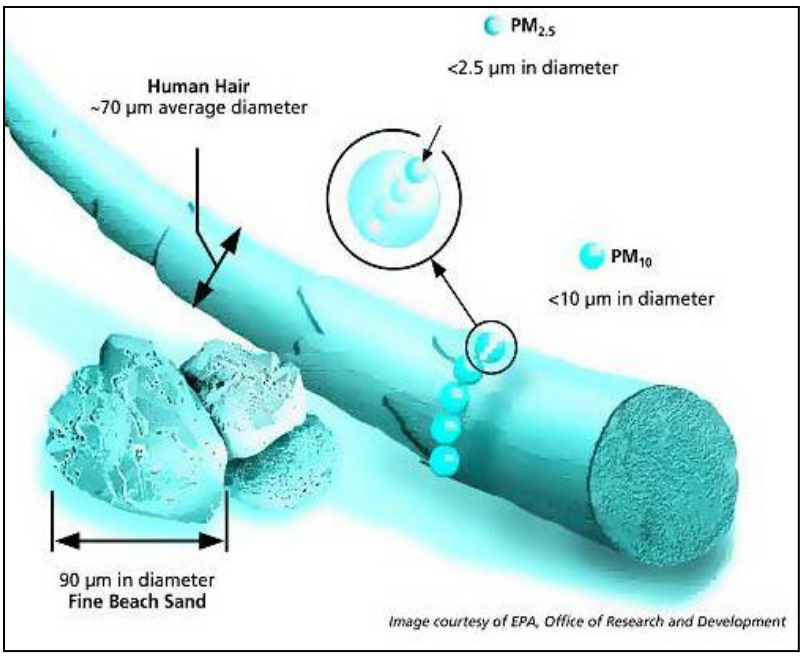
Figure 6.8 shows 8-hour O_3 readings ≥ 0.075 ppm with the number of 90°F days (≥ 90°F) measured at the Detroit Metropolitan Airport. The total number of southeastern Michigan-area 8-hour readings above 0.075 ppm were divided by the number of monitors that were in operation each year to provide a relative indication of the frequency of elevated 8-hour O_3 values.



This comparison shows the influence of temperature with respect to elevated O_3 levels. Over the past 19 years, a typical summer would have an average of 11 days with the maximum daily temperature exceeding 90°F. Over the time period from 1992 through 2011, the highest number of 90°F days occurred in 2002 (24 days), while the lowest number occurred in 2000 (one day). For 2011, there were 12 days greater than 90°F.

Chapter 7: Particulate Matter (PM_{10}, $PM_{2.5}$, $PM_{2.5}$ Chemical Speciation and TSP)

Particulate matter is a general term used for a mixture of solid particles and liquid droplets found in the air, which is further categorized according to size. Large particles with diameters of less than 50 micrometers (µm) are classified as total suspended particulates (TSP). PM_{10} consists of "coarse particles" less than 10 µm in diameter (about one-seventh the diameter of a human hair) and $PM_{2.5}$ are much smaller "fine particles" equal to or less than 2.5 µm in diameter. PM_{10} has a 24-hour average standard of 150 µg/m^3. $PM_{2.5}$ has an annual average standard of 15 µg/m^3, and a 98th percentile 24-hour average of 35 µg/m^3 over three years. Its sources and effects are as follows:



Sources: PM can be emitted directly (primary) or may form in the atmosphere (secondary). Most man-made particulate emissions are classified as TSP. PM_{10} consists of primary particles that can originate from power plants, various manufacturing processes, wood stoves and fireplaces, agriculture and forestry practices, fugitive dust sources (road dust and windblown soil), and forest fires. $PM_{2.5}$ can come directly from primary particle emissions or through secondary reactions that include VOCs, SO_2, and NO_X emissions originating from power plants, motor vehicles (especially diesel trucks and buses), industrial facilities, and other types of combustion sources.

Effects: Exposure to PM affects breathing and the cellular defenses of the lungs, aggravates existing respiratory and cardiovascular ailments, and has been linked with heart and lung disease. Particle size is the major factor that determines which particles will enter the lungs and how deeply the particles will penetrate. PM is the major cause of reduced visibility in many parts of the U.S. $PM_{2.5}$ is considered a primary visibility-reducing component of urban and regional haze. Airborne particles impact vegetation ecosystems and damage paints, building materials and surfaces. Deposition of acid aerosols and salts increases corrosion of metals and impacts plant tissue.

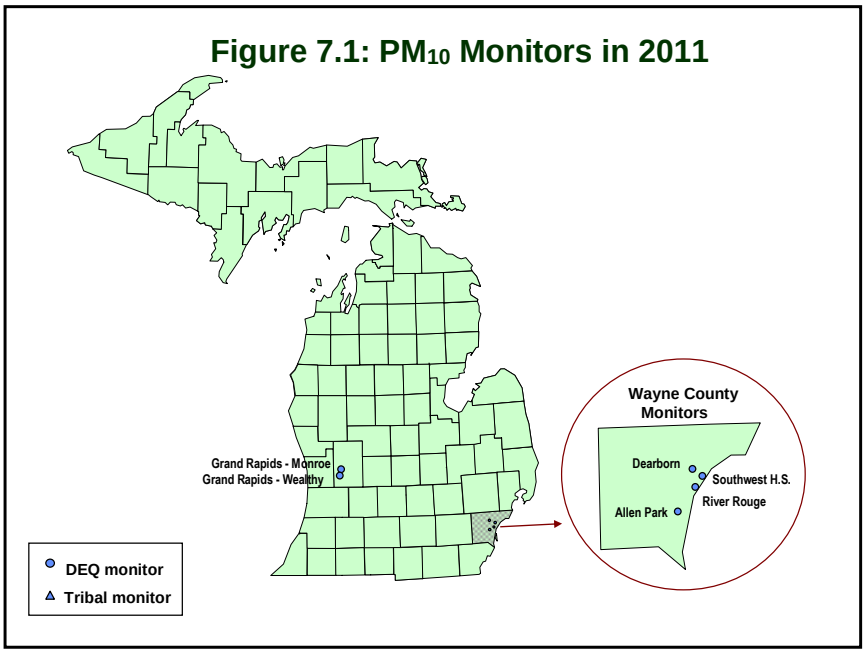
Population most at risk: $PM_{2.5}$ has been linked to the most serious health effects. People with heart or lung disease, the elderly, and children are at highest risk from exposure to PM.

PM_{10}

Since October 4, 1996, all areas in Michigan have been in attainment with the PM_{10} NAAQS. Due to the recent focus upon $PM_{2.5}$ and because of the relatively low concentrations of PM_{10} measured in recent years, Michigan's PM_{10} network has been reduced to a minimum level. **Table 1-3** identifies the locations of PM_{10} monitoring stations that were operating in Michigan

during 2011. These monitors are located in the state's largest populated urban areas - three in the Detroit area and two in Grand Rapids. To better characterize the nature of PM in Michigan, many of the existing PM_{10} monitors are co-located with $PM_{2.5}$ monitors in population-oriented areas.

Figure 7.1 shows the location of each PM_{10} monitor.



Figures 7.2 and **7.3** show PM_{10} emission sources and PM_{10} emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 7.2

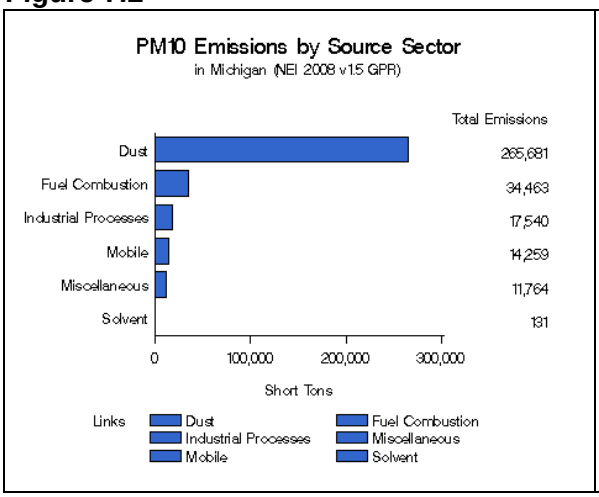


Figure 7.3

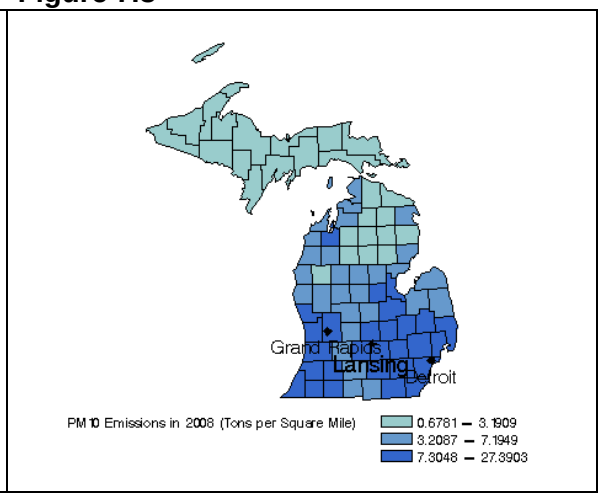
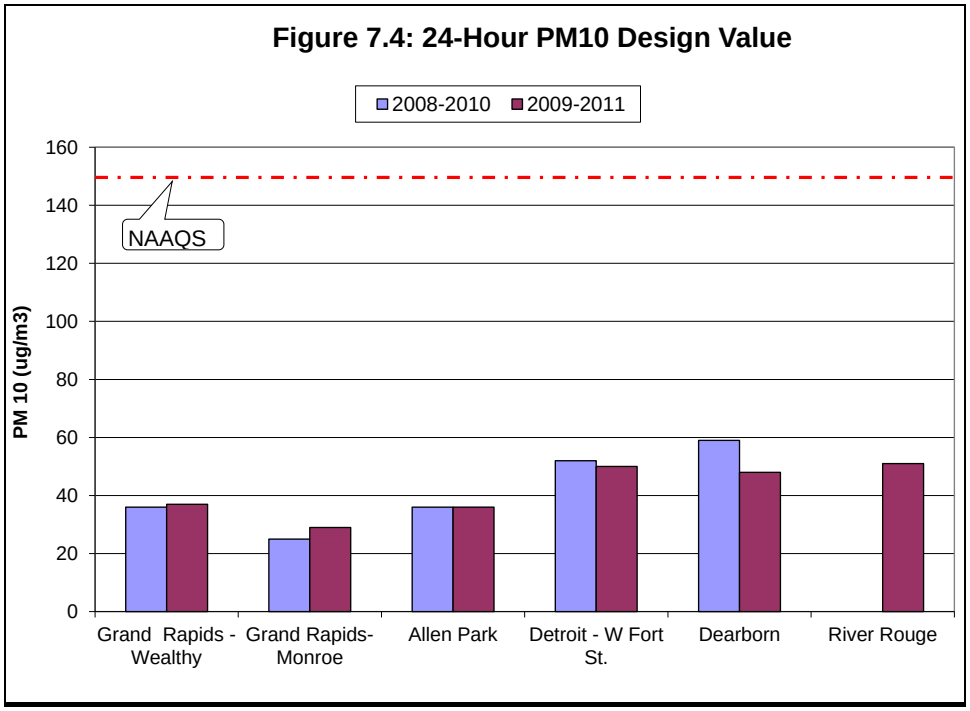


Figure 7.4 shows the PM_{10} levels in Michigan compared to the 24-hour average of 150 µg/m^3. This standard must not be exceeded on average more than once per year over a 3-year period. The design value is the 4th highest value over a 3-year period. The PM_{10} levels at all sites in Michigan are well below the national standard.



$PM_{2.5}$

On August 18, 2008, the EPA proposed the 7-county southeast Michigan area as nonattainment based on 2005-2007 data. The 2007-2011 data shows that the 7-county southeast Michigan area to be in attainment for $PM_{2.5}$. The AQD is currently working with the EPA to get the area redesignated to attainment.

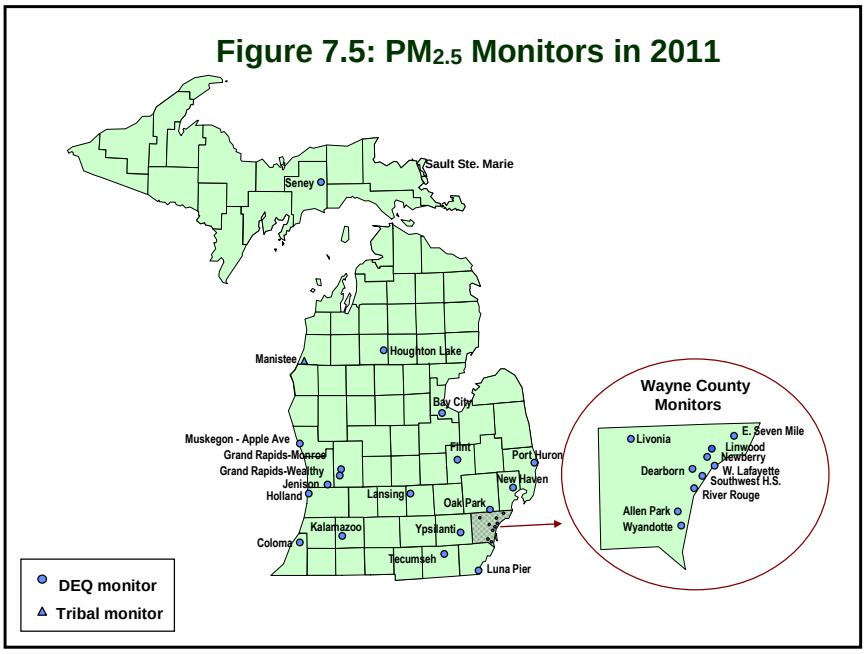
The $PM_{2.5}$ particulate network consists of the following components, which together provide a picture of the nature of PM within the state.

$PM_{2.5}$ FRM monitoring. The concentrations of $PM_{2.5}$ measured over a 24-hour time period are determined using the gravimetric FRM. Only data generated by the FRM monitors are used for comparisons to the NAAQS in Michigan. The sites are located in urban, commercial, and residential areas where people are exposed to $PM_{2.5}$.

Continuous $PM_{2.5}$ monitoring (*Tapered Element Oscillating Microbalance [TEOM]*). Continuous monitoring is beneficial as it provides real-time hourly data that supplements the $PM_{2.5}$ data collected by FRM monitors. This data forms the basis of the information reported on AirNow and MIair.

Chemical Speciation monitoring. Speciated monitoring provides a better under-standing of the chemical composition of $PM_{2.5}$ material and better characterizes background levels.

Figure 7.5 shows the location of each $PM_{2.5}$ monitor.



$PM_{2.5}$ FRM Monitoring Network: $PM_{2.5}$ FRM monitors are deployed to characterize background or regional $PM_{2.5}$ transport collectively from upwind sources. Two of the monitoring sites in Detroit, W. Lafayette and Newberry, measure PM levels in an area that is heavily impacted by mobile source emissions. In addition, five $PM_{2.5}$ FRM monitoring sites are co-located with PM_{10} monitors to allow for $PM_{2.5}$ and PM_{10} comparisons[6]. Co-located PM_{10} and $PM_{2.5}$ sites include Grand Rapids (Monroe and Wealthy), Dearborn, Allen Park, and Detroit's W. Fort Street (SWHS) station.

Continuous $PM_{2.5}$ Network: Short-term measurements of $PM_{2.5}$ or PM_{10} are updated on an hourly basis using TEOM instruments. At least one continuous TEOM is required at a core monitoring $PM_{2.5}$ site in a metropolitan area with a population greater than one million. Both Detroit (Allen Park) and Grand Rapids (Monroe) meet this requirement[7]. Under the revised 2006 air monitoring regulations, 50% of the FRM monitoring sites are now required to have a continuous $PM_{2.5}$ monitor. For Michigan, there are 26 FRM monitoring sites, 13 of which also have TEOMS. The DEQ initially operated all TEOM units with an inlet temperature of 50ºC, but this high inlet temperature was volatilizing nitrate levels during the winter months. Therefore, the DEQ began operating TEOMs with a 30°C inlet temperature October through March and a 50°C inlet temperature between April and September.

$PM_{2.5}$ Chemical Speciation Monitoring Network: Single event Met-One speciation air sampling system (SASS) monitors are used throughout Michigan's speciation network and are placed in population-oriented stations in both urban and rural locations. $PM_{2.5}$ chemical speciation samples are collected on two types of filters – Teflon and nylon – over a 24-hour period. Each filter is analyzed by a different method to determine various components of $PM_{2.5}$. In 2008, the EPA changed the protocol for the SASS monitors by removing the quartz carbon

[6] Requirements for $PM_{2.5}$ FRM sites are obtained from the Revised Requirements for Designation of Reference and Equivalent Methods for $PM_{2.5}$ and Ambient Air Quality Surveillance for PM [62 FR 38763]; Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks [EPA-454/R-98-012, May 1998]; and Appendix N to Part 50 - Interpretation of the National Ambient Air Quality Standards for PM [40 CFR Part 50, July 1, 1998].

[7] Under the Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks [EPA-454/R-98-012, May 1998].

channel and replacing it with an URG 3000 N sampler. The Dearborn and the Ypsilanti sites were changed over in 2008. The remaining sites were changed over in 2009. There are eight SASS monitors operating in Michigan; see **Table 1.3.**

The primary objectives of the chemical speciation monitoring sites are to provide data that will be used to determine the sources of poor air quality and to support the development of attainment strategies. Historical speciation data for Michigan indicates that $PM_{2.5}$ is made up of 30% nitrate compounds, 30% sulfate compounds, 30% organic carbon[8], and 10% unidentified or trace elements.

Continuous $PM_{2.5}$ Speciation Monitoring (EC/OC and Aethalometer) Network: To determine diurnal changes in $PM_{2.5}$ composition, the DEQ operated two aethalometers and three elemental carbon/organic carbon (EC/OC) monitors in 2011.

- Aethalometers measure carbon black, a combustion by-product typical of transportation sources, by concentrating particulate on a filter tape and measuring changes in optical transmissivity and absorption. In 2011, the DEQ's aethalometers were located at Allen Park and Dearborn.
- The EC/OC instruments measure elemental carbon, using pyroloysis coupled with a nondispersive infrared detector to separate the elemental and organic carbon fractions. These instruments are located at Dearborn, Detroit-Newberry, and Tecumseh.

$PM_{10-2.5}$

The 2006 amended air monitoring regulations specified that measurements of PM_{10}-$PM_{2.5}$ need to be added to the NCore sites[9]. The DEQ began PM_{10}-$PM_{2.5}$ monitoring in 2010 at Allen Park and Grand Rapids – Monroe Street.

Table 1.3 in chapter 1 shows all of Michigan's 26 $PM_{2.5}$ FRM monitoring stations operating in 2011 and denotes which sites also have TEOM and/or SASS monitors in operation.

Figures 7.6 and **7.7** show $PM_{2.5}$ emission sources and $PM_{2.5}$ emissions by county (from the EPA's State and County Emission Summaries).

Figure 7.6

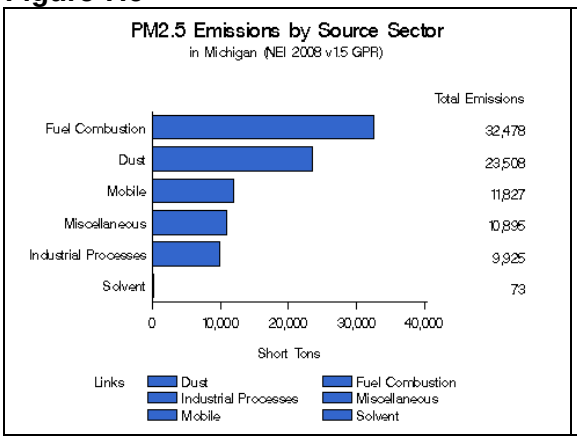
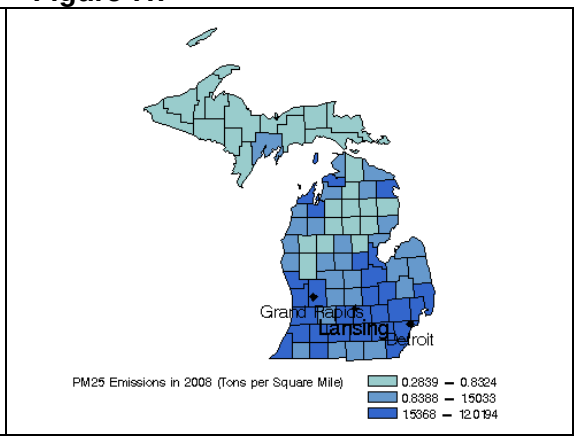


Figure 7.7



[8] To better understand the chemical composition of the organic carbon fraction, a number of studies have been conducted in southeast Michigan to further investigate organic carbon. Information can be found in the Michigan 2006 Ambient Air Monitoring Network Review, available at http://www.michigan.gov/deqair.
[9] Current information on both proposals can be found at http://www.epa.gov/air/particles/actions.html.

Table 7.1 provides the 2009-2011 annual mean $PM_{2.5}$ concentrations by individual monitoring stations[10]. Stations labeled #2 provide a precision estimate of the overall measurement and operate on a one in six sampling schedule. All other monitors sampled on a one in three day schedule except for Allen Park #1, which samples daily. The Allen Park #2 was moved to Dearborn #2 in January 2010.

Table 7.1: Three-Year Average of the Annual Mean PM2.5 Concentrations

Areas	County	Monitoring Sites	2009	2010	2011	2009-2011 Mean
Detroit-Ann Arbor MI	Lenawee	Tecumseh	9.74	8.91	9.57	9.4
	Livingston					
	Macomb	New Haven	9.49	8.92	8.61	9.0
	Oakland	Oak Park	10.03	9.12	9.14	9.4
	St. Clair	Port Huron	9.74	8.94	9.14	9.3
	Washtenaw	Ypsilanti #1	9.94	10.91	9.74	10.2
		Ypsilanti #2	9.80	9.40	8.54	9.2
	Wayne	Allen Park #1	11.06	10.23	10.47	10.6
		Allen Park #2	11.32	*		
		Detroit- Linwood	10.36	9.85	10.08	10.1
		Detroit - E 7 Mile	10.54	9.89	9.43	10.0
		Detroit - W Fort	11.12	10.67	10.90	10.9
		Detroit - Newberry	10.17	10.04	10.59	10.3
		Detroit - W. Lafayette	10.70	10.05	10.49	10.4
		Wyandotte	10.36	9.36	8.93	9.5
		Dearborn #1	12.07	11.33	11.21	11.5
		Dearborn #2			11.23	
		Livonia	9.88	9.16	9.47	9.5
Flint MI	Genesee	Flint	8.73	8.88	8.45	8.7
	Lapeer					
Grand Rapids, MI	Ottawa	Jenison	9.19	9.15	9.13	9.2
	Kent	Grand Rapids-Wealthy	9.88	9.63	9.46	9.7
		Grand Rapids #1	9.42	9.62	9.47	9.5
		Grand Rapids #2	9.67	10.04	9.25	9.7
Muskegon Co MI	Muskegon	Muskegon	8.75	8.26	8.40	8.5
Allegan Co MI	Allegan	Holland	8.57	8.50	8.44	8.5
Monroe Co MI	Monroe	Luna Pier	10.33	9.36	9.98	9.9
Kalamazoo- Battle Creek MI	Calhoun					
	Kalamazoo	Kalamazoo #1	10.02	9.31	9.01	9.4
		Kalamazoo #2	9.92	9.19	8.85	9.3
	Van Buren					
Lansing East Lansing MI	Ingham	Lansing	9.06	8.98	8.65	8.9
	Clinton					
	Eaton					
Benton Harbor MI	Berrien	Coloma	9.04	8.74	8.71	8.8
Bay Co MI	Bay	Bay City	8.19	8.16	7.67	8.0
Missaukee Co MI	Missaukee	Houghton Lake	5.91	5.94	6.16	6.0
Manistee Co MI	Manistee	Manistee	6.14	6.61	6.39	6.4
Chippewa Co MI	Chippewa	Sault Ste. Marie #1			6.37	
Chippewa Co MI	Chippewa	Sault Ste. Marie #2			6.53	

* moved to Dearborn

[10] For comparison to the standard, the average annual means is rounded to the nearest 0.1 $\mu g/m^3$.

Table 7.2 is a detailed assessment of the 24-hour 98th percentile $PM_{2.5}$ concentrations for 2009-2011 showing Michigan's levels are below the 35 µg/m^3 standard (3-year average)[11].

Table 7.2: 98th Percentile PM2.5 Values Averaged over 3 Years						
Areas	County	Monitoring Sites	2009	2010	2011	2009-2011 Mean
Detroit-Ann Arbor MI	Lenawee	Tecumseh	29.9	22.3	23.9	25.4
	Livingston					
	Macomb	New Haven	26.2	25.5	24.1	25.3
	Oakland	Oak Park	30.1	27.1	23.4	26.9
	St. Clair	Port Huron	29.9	25.8	23.7	26.5
	Washtenaw	Ypsilanti #1	28.2	23.3	23.9	25.1
		Ypsilanti #2	29.4	22.4	18.8	23.5
	Wayne	Allen Park #1	29.2	27.8	25.3	27.4
		Allen Park #2	32.4	*		
		Detroit- Linwood	31.0	27.9	24.8	27.9
		Detroit - E 7 Mile	29.2	28.6	24.0	27.3
		Detroit - W Fort	30.9	26.6	25.1	27.5
		Detroit - Newberry	25.9	30.4	24.9	27.1
		Detroit - W. Lafayette	31.7	27.7	25.3	28.2
		Wyandotte	26.9	24.4	21.4	24.2
		Dearborn #1	35.7	28.6	29.9	31.4
		Dearborn #2		31.5	26.1	
		Livonia	29.3	25.3	22.8	25.8
Flint MI	Genesee	Flint	26.2	24.7	20.7	23.9
	Lapeer					
Grand Rapids, MI	Ottawa	Jenison	26.5	22.7	23.5	24.2
	Kent	Grand Rapids-Wealthy	28.8	22.4	22.6	24.6
		Grand Rapids #1	30.0	24.3	22.8	25.7
		Grand Rapids #2	31.4	24.3	21.8	25.8
Muskegon Co MI	Muskegon	Muskegon	27.3	23.4	22.2	24.3
Allegan Co MI	Allegan	Holland	25.4	24.6	25.6	25.2
Monroe Co MI	Monroe	Luna Pier	23.6	26.3	23.5	24.5
Kalamazoo- Battle Creek MI	Calhoun					
	Kalamazoo	Kalamazoo #1	29.0	21.5	20.3	23.6
		Kalamazoo #2	36.4	20.8	17.4	24.9
	Van Buren					
Lansing East Lansing MI	Ingham	Lansing	27.1	23.7	20.6	23.8
	Clinton					
	Eaton					
Benton Harbor MI	Berrien	Coloma	22.2	23.3	20.5	22.0
Bay Co MI	Bay	Bay City	23.3	31.1	20.9	25.1
Missaukee Co MI	Missaukee	Houghton Lake	17.5	17.6	17.8	17.6
Manistee Co MI	Manistee	Manistee	19.8	21.9	17.5	19.7
Chippewa Co MI	Chippewa	Sault Ste. Marie #1			18.3	
Chippewa Co MI	Chippewa	Sault Ste. Marie #2			17.0	

*moved to Dearborn

[11] The 98th percentile value was obtained from the EPA AQS. For the purpose of comparing calculated values, the 3-year 24-hour average is rounded to the nearest 1 µg/m^3.

Figures 7.8 through **7.11** show the current annual mean $PM_{2.5}$ trend for each monitoring site in Michigan for the years monitoring was conducted. For clarity, the monitoring sites within the Detroit-Warren-Flint CSA, which are currently designated as nonattainment for the $PM_{2.5}$ NAAQS, have been broken down into two graphs. **Figure 7.8** shows those sites in Wayne County and **Figure 7.9** shows the remaining counties within the CSA.

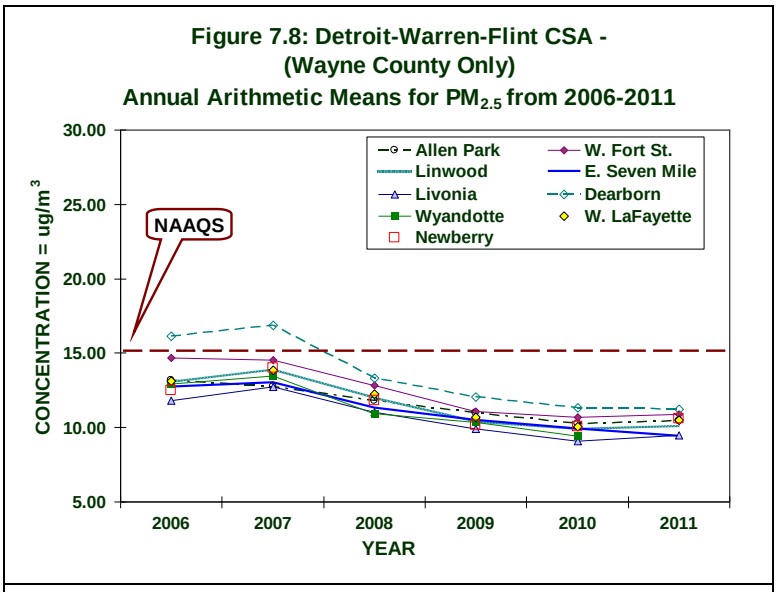


Figure 7.8 shows that 2011 levels in Wayne County have remained below the standard. Historically, Dearborn has had the highest readings in the state.

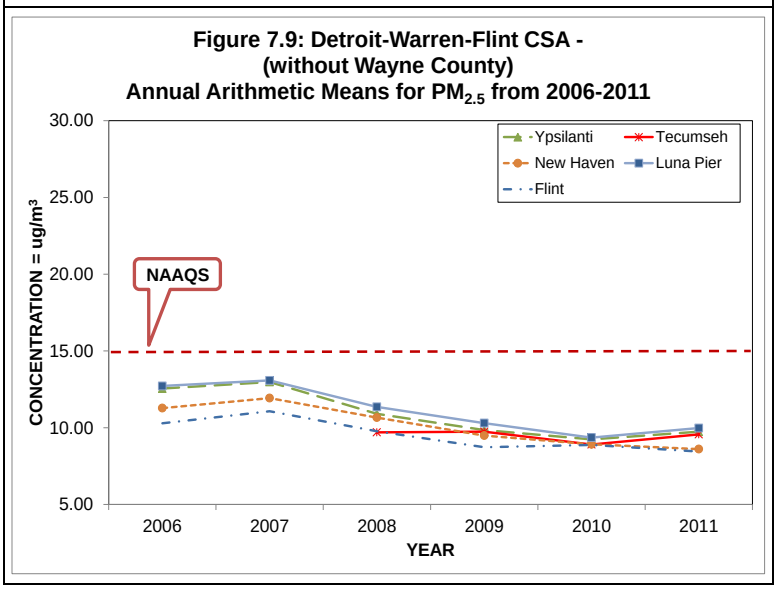


Figure 7.9 contains the remainder of those sites in the Detroit-Warren-Flint CSA that are outside of Wayne County. These sites show readings in 2011 below the $PM_{2.5}$ NAAQS.

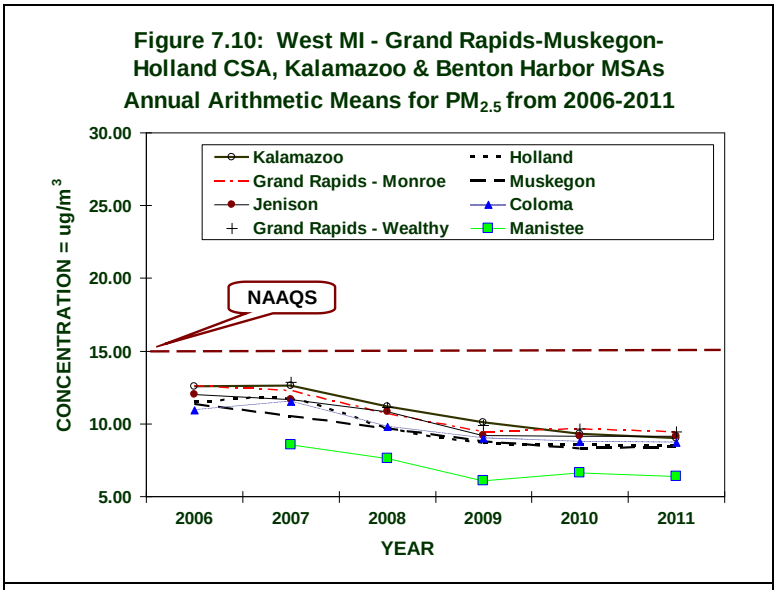


Figure 7.10 combines the $PM_{2.5}$ monitoring sites located in west Michigan. All sites in west Michigan have been below the annual $PM_{2.5}$ NAAQS since 2004.

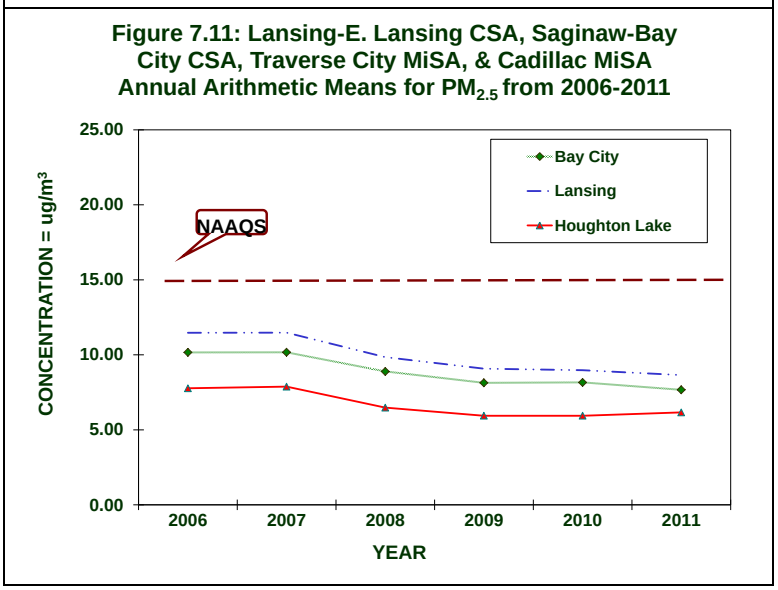


Figure 7.11 displays the remaining monitoring sites in Michigan's Lower Peninsula. All these sites have 2011 levels below the standard

Chapter 8: Toxic Air Pollutants

In addition to the six criteria pollutants discussed in the previous chapters, the AQD monitors for a wide variety of substances classified as toxic air pollutants, and/or Hazardous Air Pollutants (HAPs). Under the Clean Air Act (CAA), the EPA specifically addresses a group of 188 HAPs. Under Michigan's air regulations, Toxic Air Contaminants (TACs) are defined as all non-criteria pollutants that may be *"…harmful to public health or the environment when present in the outdoor atmosphere in sufficient quantities and duration."* The definition of TACs lists 41 substances that are not TACs, indicating that all others are TACs.

Sources: Air toxics come from a variety of mobile, stationary, indoor, and outdoor natural sources. Mobile sources include motor vehicles, stationary sources include industrial factories and power plants, indoor sources include household cleaners, and natural sources include forest fires and eruptions from volcanoes.

Effects: Once air toxics enter the body, there is a wide range of potential health effects. They include the aggravation of asthma; irritation to the eyes, nose, and throat; carcinogenicity; developmental toxicity (birth defects); nervous system effects and various other effects on internal organs. Some effects appear after a shorter period of exposure, while others may appear after long-term exposure or after a long period of time has passed since the exposure ended. Most toxic effects are not unique to one substance, and some effects may be of concern only after the substance has deposited to the ground or to a water body (e.g., mercury, dioxin), followed by exposure through an oral pathway such as the eating of fish or produce. This further complicates the assessment of air toxics concerns due to the broad range of susceptibility that various people may have.

Population most at risk: People with asthma, children, and the elderly**.**

Air Toxics can be categorized as:

- *Metals:* Examples include aluminum, arsenic, beryllium, barium, cadmium, chromium, cobalt, copper, iron, mercury, manganese, molybdenum, nickel, lead, vanadium, and zinc.
- *Organic Substances*: Further divided into sub-categories that include -
    - VOCs, include benzene (found in gasoline), perchlorethylene (emitted from some dry cleaning facilities), and methylene chloride (a solvent and paint stripper used by industry);
    - carbonyl compounds (aldehydes and ketones);
    - semi-volatile compounds (SVOCs);
    - polycyclic aromatic hydrocarbons (PAHs)/polynuclear aromatic hydrocarbons (PNAs);
    - pesticides and;
    - polychlorinated biphenyls (PCBs).
- *Other substances*: Asbestos, dioxin, and radionuclides such as radon.

Because air toxics are such a large and diverse group of substances, regulatory agencies sometimes further refine these classifications to address specific concerns.

For example:

- Some initiatives have targeted those substances that are *persistent, bioaccumulative* and *toxic* (PBT), such as mercury, which accumulates in body tissues.
- The EPA has developed an Integrated *Urban Air Toxics Strategy* with a focus on 33 substances (the Urban HAPs List).[12]

The evaluation of air toxics levels is difficult due to several factors.

- There are no health-protective NAAQS. Instead, air quality assessments utilize various short- and long-term screening levels and health benchmark levels estimated to be safe considering the critical effects of concern for specific substances.
- There is incomplete toxicity information for many substances. For some air toxics, the analytical detection limits are too high to consistently measure the amount present, and in some cases, the risk assessment-based "safe" levels are below the detection limits.
- Data gaps are present regarding the potential for interactive toxic effects for co-exposure to multiple substances present in emissions and in ambient air. Air toxics also pose a challenge due to monitoring and analytical methods that are either unavailable for some compounds or cost-prohibitive for others (e.g., dioxins).

These factors make it difficult to accurately assess the potential health concerns of all air toxics. Nevertheless, it is feasible and important to characterize the potential health hazards and risks associated with many air toxics.

Table 8.1 shows the monitoring stations and what air toxic was monitored at each station in 2011. This table can also be found in **Appendix B** with the Air Toxics Monitoring Summary.

Table 8.1

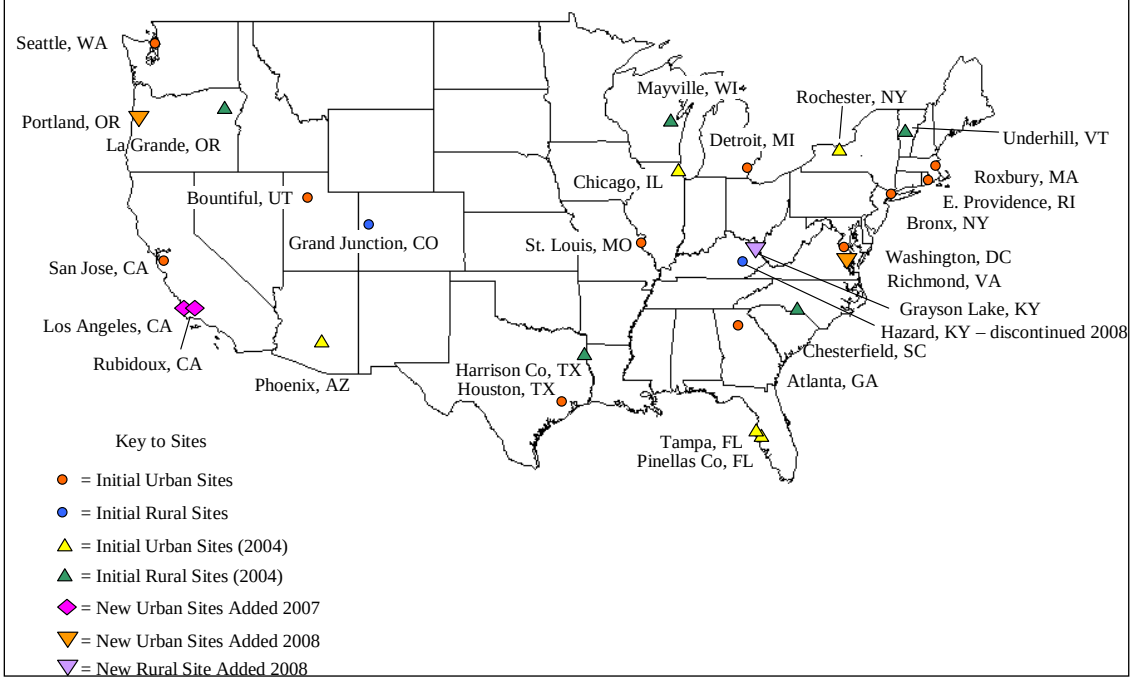
SITE NAME	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Hex Chrome	Speciated $PM_{2.5}$
Allen Park				x	x		x
Dearborn	x	x	x	x	x	x	x
Detroit W. Fort St	x	x		x	Mn		x
Detroit W. Jefferson				x			
Flint				Mn			
Grand Rapids				x			x
Belding- Merrick St.				x			
Belding- Reed St.				x			
Vassar				x			
East Jordan				x			
Houghton Lake							x
Luna Pier							x
Port Huron, Nat'l Guard Arm.							x
River Rouge		x		x	Mn		
Tecumseh							x

[12] EPA's Air Toxics Website – Urban Strategy is located at http://www.epa.gov/ttn/atw/urban/urbanpg.html.

National Monitoring Efforts and Data Analysis

The EPA administers national programs that identify air toxics levels, detect trends, and prioritize air toxics research. The DEQ participates in these programs. In addition, the AQD operates a site in Dearborn that is part of EPA's National Air Toxics Trend Stations (NATTS). The purpose of the NATTS network is to detect trends in high-risk air toxics such as benzene, formaldehyde, chromium, and 1,3-butadiene and to measure the progress of air toxics regulatory programs at the national level. Currently, the NATTS network contains 27 stations, 20 urban and 7 rural (see **Figure 8.1**). The EPA requires that the NATTS sites measure VOCs, carbonyls, PAHs, hexavalent chromium, and trace metals on a once every six day sampling schedule. The Dearborn measures trace metals as TSP, $PM_{10,}$ and $PM_{2.5}$.

Figure 8.1: National Air Toxics Trends Sites



Chapter 9: MIair – Air Quality Information in Real-Time

MIair is the internet tool that provides real-time air quality information via DEQ's webpage. The www.deqmiair.org hotlink opens to the current Air Quality Index (AQI) map and displays air quality forecasts for "today" and "tomorrow." **MIair** also hosts Enviroflash, the automated air quality notification system.

Air Quality Index

The Air Quality Index (AQI) is a simple tool developed to communicate current air quality information to the public. The current day's color-coded AQI values, ranging from Good to Hazardous, are displayed in a forecast table and as dots on a Michigan map.

As can be seen from the annual summaries in **Appendix C**, air quality in Michigan generally falls in the Good or Moderate range. An area will occasionally fall into the Unhealthy for Sensitive Groups range, but rarely reaches Unhealthy levels.

Air Quality Forecasts

Air Quality Division meteorologists provide air pollution forecasts to alert the public when air pollution levels may become elevated. *Action!* Days are declared when levels are expected to reach or exceed the Unhealthy for Sensitive Groups AQI health indicator. On *Action!* Days, businesses, industry, government and the public are encouraged to reduce air pollution levels by limiting vehicle use, refueling only after 6 PM, carpooling, walking, biking or taking public transit, deferring the use of gasoline-powered lawn and recreation equipment, limiting the use of volatile chemicals and curtailing all burning. More information on voluntary air pollution control measures can be found under the *Action!* Day tab on **MIair**.

Air Quality Notification

EnviroFlash is a free service that sends automated air quality and UV (ultraviolet) forecasts to subscribers. Those enrolled receive computer e-mails or text messages to their mobile phones. The iPhone or Android application provides real-time air quality information that individuals with mobile phones can use to protect their health when planning their daily activities. To receive notices and learn more about this program, select the 'Air Quality Notification' tab in **MIair** when logged onto www.michigan.gov/air. Michigan's EnviroFlash network has the potential to reach up to 98% of the state's population.

AIRNow

The DEQ supplies Michigan air monitoring data to AIRNow, the EPA's nation-wide air quality mapping system. Information about AIRNow is available at www.epa.gov/airnow or you can select the AIRNow hot link at the bottom of each **MIair** webpage.

Table 9.1: AQI Colors and Health Statements

AQI COLOR, CATEGORY & VALUE	PARTICULATE MATTER ($\mu g/m^3$) 24-Hour	OZONE (ppm) 8-Hour / 1-Hour	CARBON MONOXIDE (ppm) 8-hour	SULFUR DIOXIDE (ppm) 24-hour	NITROGEN DIOXIDE (ppm) 1-hour
GREEN: Good 1-50	None	None	None	None	None
YELLOW: Moderate 51-100	Unusually sensitive people should consider reducing prolonged or heavy exertion.	Unusually sensitive people should consider reducing prolonged or heavy exertion.	*None*	None	None
ORANGE: Unhealthy for Sensitive Groups 101-150	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.	Active children and adults, and people with lung disease such as asthma, should reduce prolonged or heavy outdoor exertion.	People with cardiovascular disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.	People with asthma should consider limiting outdoor exertion.	None
RED: Unhealthy 151-200	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should limit prolonged exertion.	Active children and adults, and people with lung disease such as asthma, should avoid pro-longed or heavy exertion. Everyone else, especially children, should reduce prolonged outdoor exertion.	People with cardiovascular disease, such as angina, should limit moderate exertion and avoid sources of CO, such as heavy traffic.	Children, asthmatics, and people with heart or lung disease should limit outdoor exertion.	None
PURPLE: Very Unhealthy 201-300	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.	Active children and adults, and people with respiratory disease such as asthma, should avoid all outdoor exertion. Everyone else, especially children should limit outdoor exertion.	People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.	Children, asthmatics, and people with heart or lung disease should avoid outdoor exertion. Everyone else should limit outdoor exertion.	Children and people with respiratory disease, such as asthma, should limit heavy outdoor exertion.
MAROON: Hazardous 301-500	Everyone should avoid any outdoor exertion; people with heart or lung disease, older adults, and children should remain indoors.	Everyone should avoid all outdoor exertion.	People with cardiovascular disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic. Everyone else should limit heavy exertion.	Children, asthmatics, and people with heart or lung disease should remain indoors. Every-one else should avoid outdoor exertion.	Children and people with respiratory disease, such as asthma, should limit moderate or heavy outdoor exertion.

Chapter 10: Meteorological Information

The following **Figures 10.1** through **10.3** (average daily temperatures) and **Figures 10.4** through **10.6** (total monthly precipitation amounts) show total amounts as compared to their climatic norms for sites in the Upper Peninsula, and the northern and southern Lower Peninsula. These figures were constructed by averaging data from several National Weather Service stations and therefore are not meant to be representative of any one single location in Michigan. Instead, they are intended to depict the regional trends that occurred during the year 2011.

Figure 10.1: Southern Lower Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

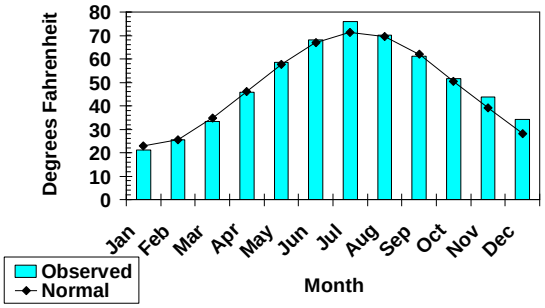


Figure 10.2: Northern Lower Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

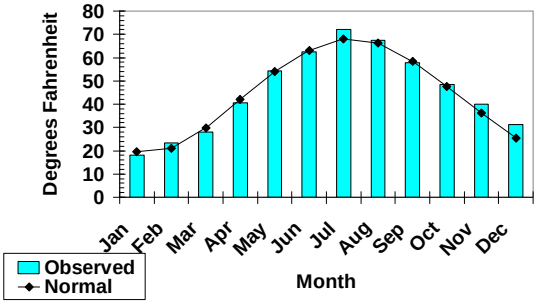


Figure 10.3: Upper Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

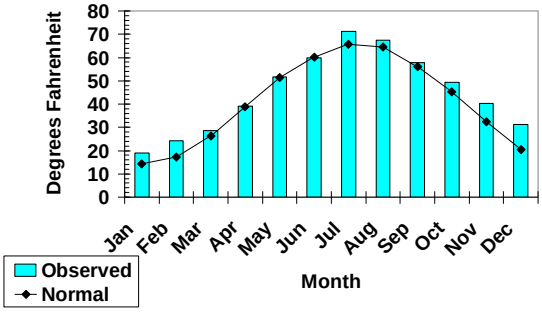


Figure 10.4: Southern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

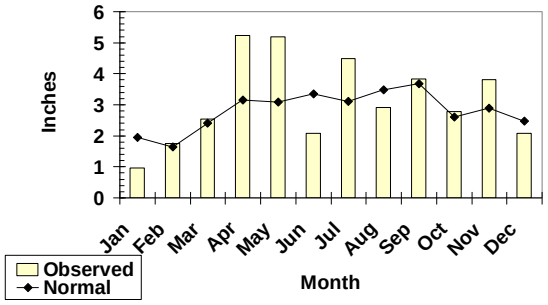


Figure 10.5: Northern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

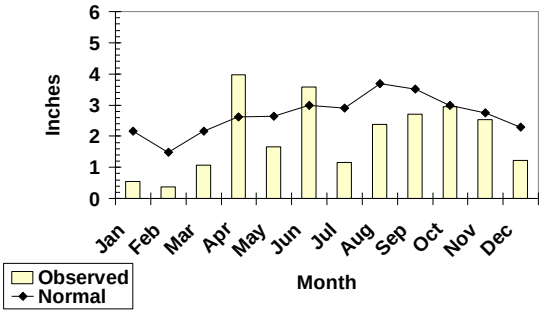
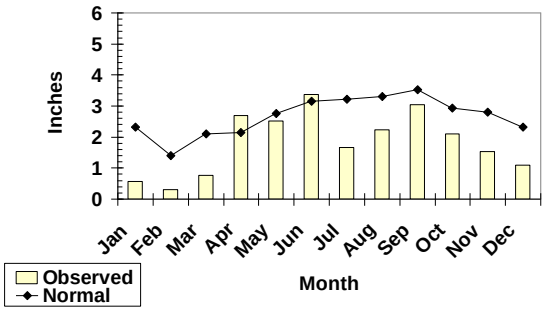


Figure 10.6: Upper Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation



The weather plays a significant role in air quality, and can either help increase or decrease the amount of pollution in the air. *Action!* Days are declared when levels are expected to reach or exceed the Unhealthy for Sensitive Groups AQI health indicator – specifically, when meteorological conditions are conducive for the formation of elevated ground-level O_3 or $PM_{2.5}$ concentrations.

Table 10.1 Shows that there were ten *Action!* Days declared during the summer of 2011.

Table 10.1

Location	Year	Number	Dates
Ann Arbor	2011	8	6/8,7/1,7/2,7/17,7/19,7/20,7/21,9/2
Benton Harbor	2011	8	6/7,6/8,7/2,7/17,7/20,7/21,9/1,9/2
Detroit	2011	8	6/8,7/1,7/2,7/17,7/19,7/20,7/21,9/2
Grand Rapids	2011	8	6/7,6/8,7/2,7/17,7/20,7/21,9/1,9/2
Kalamazoo	2011	5	6/7,6/8,7/20,7/21,9/2
Lansing	2011	1	7/21
Ludington	2011	5	6/7,6/8,7/17,7/20,9/1
Traverse City	2011	1	7/20

Figure 10.7: Surface Map of Weather Conditions on July 20, 2011

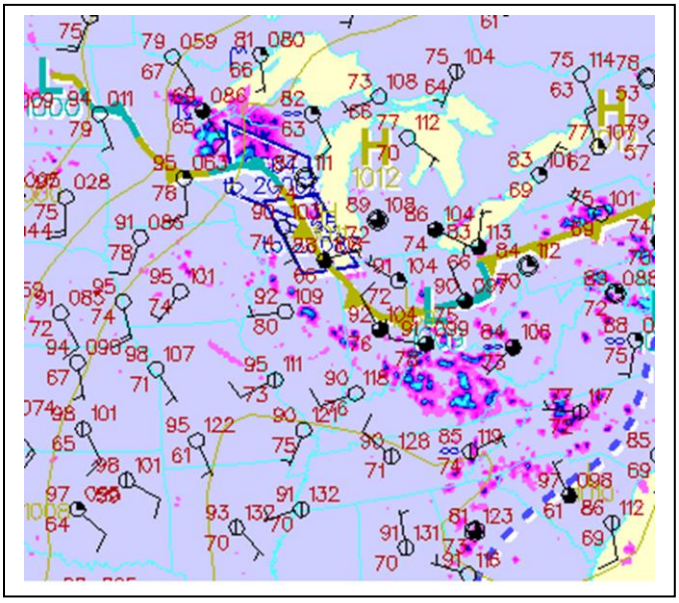


Figure 10.7 shows a surface map (courtesy of Unisys Weather: http://weather.unisys.com/) of the weather conditions on the morning of July 20, 2011.

From **Figure 10.7**, one can see that Michigan was in the center of a high pressure system located over the Great Lakes and just north of a front stretching from Manitoba down through Minnesota, Illinois, Indiana, Ohio, and across Pennsylvania. The weather conditions in the morning in southeast Michigan were hot and humid, with temperatures in the upper 80s, with broken cloud coverage and calm winds.

APPENDIX A: CRITERIA POLLUTANT SUMMARY FOR 2011

Appendix A utilizes EPA's 2011 AQS Quick Look Report Data to present a summary of ambient air quality data collected for the criteria pollutants at monitoring locations throughout Michigan. Concentrations of non-gaseous pollutants are generally given in $\mu g/m^3$ and in ppm for gaseous pollutants. The following define some of the terms listed in the **Appendix A** reports.

Site I.D.: The AQS site ID is the EPA's code number for these sites and has replaced the MASN number.

POC: The Parameter Occurrence Code or POC is used to assist in distinguishing different uses of monitors, i.e. under Pb, NO_2, and SO_2, POC #1-5 are used to help differentiate between individual monitors. For PM, the POC numbers are used more for the type of monitoring, such as:

- 1 - federal reference method (FRM);
- 2 - co-located FRM;
- 3 - TEOM hourly PM_{10} and $PM_{2.5}$ measurements; and
- 5 - $PM_{2.5}$ speciation monitors (shown at right is a Met One SASS - spiral aerosol speciation sampler).

 # OBS: For Pb, TSP, $PM_{2.5}$, and PM_{10}, the # OBS (number of observations) refers to the number of valid 24-hour values gathered.

For continuous monitors (CO, NO_2, O_3, $PM_{2.5}$ TEOM, and SO_2,), # OBS refers to the total valid hourly averages obtained from the analyzer.

Values: The value is listed for each criteria pollutant per its NAAQS (primary and secondary). The number of excursions per site for the primary and secondary standards utilize running averages for continuous monitors, except for O_3, and does not include averages considered invalid due to limited sampling times. For example, a particulate-mean based only on six months could not be considered as violating the annual standard. As noted, each site is allowed one short-term standard excursion before a violation is determined.

>: The "greater than" symbol (>) heads the column reporting values or observations above the corresponding primary or secondary standards.

CRITERIA POLLUTANT SUMMARY FOR 2011

Trace CO Measured in ppm

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	# > 35	8-hr Highest Value	8-hr 2nd Highest Value	# > 9
260810020	1	Grand Rapids	Kent	2011	8312	6.3	1.7	0	1.4	1.4	0
261630001	1	Allen Park	Wayne	2011	8218	2.0	1.9	0	1.6	1.2	0

Pb (24-Hour) Measured in $\mu g/m^3$

Site ID	POC	City	County	Year	# OBS	Highest rolling 3-month Arith Mean	2nd Highest rolling 3-month Arith Mean	3rd Highest rolling 3-month Arith Mean	4th Highest rolling 3-month Arith Mean	# 3-month Means > .15	Highest Value (24 hr)	2nd Highest Value (24hr)
260290011	1	East Jordan	Charlevoix	2011	10	Insufficient data to calculate 3-month mean.					0.01	0.007
260670002	1	Belding- Reed St.	Ionia	2011	31	0.18	0.09	0.08	0.02	1	0.868	0.811
260670003	1	Belding- Merrick St.	Ionia	2011	60	0.11	0.11	0.11	0.11	0	0.593	0.493
260810020	1	Grand Rapids	Kent	2011	60	0.01	0.01	0.00	0.00	0	0.029	0.019
261250013	1	Oakland Co. Int'l Airport	Oakland	2011	29	0.02	0.02	0.02	0.02	0	0.052	0.051
261570001	1	Vassar	Tuscola	2011	16	0.01	0.01	Insufficient data		0	0.032	0.032
261630001	1	Allen Park	Wayne	2011	61	0.01	0.01	0.01	0.01	0	0.015	0.013
261630033	1	Dearborn	Wayne	2011	60	0.02	0.02	0.02	0.01	0	0.111	0.052

NO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	Annual Arith Mean
260650012	1	Lansing	Ingham	2011	8212	46.0	43.9	7.45
261130001	1	Houghton Lake	Missaukee	2011	8248	13.0	10.0	1.01
261630019	2	Detroit - E. Seven Mile	Wayne	2011	8634	67.0	55.0	12.07
261630093	1	Eliza Howell #1	Wayne	2011	2065	67.0	59.0	20.99*
261630094	1	Eliza Howell #2	Wayne	2011	2157	54.0	45.0	14.56*

*Indicates the mean does not satisfy summary criteria

NO_Y Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	Annual Arith Mean
260810020	1	Grand Rapids	Kent	2011	7318	338.0	309.9	17.44
261630001	1	Allen Park	Wayne	2011	6618	392.3	350.7	20.46

O_3 (1-Hour) Measured in ppm

Site ID	POC	City	County	Year	Num Meas	Num Req	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max >/= 0.125 Measured	Values >/= 0.125 Estimated	Missed Days < 0.125 Standard
260050003	1	Holland	Allegan	2011	183	183	.123	.116	.108	.106	0	0.0	0
260190003	1	Benzonia	Benzie	2011	179	183	.095	.088	.084	.083	0	0.0	0

O_3 (1-Hour) Measured in ppm (continued)

Site ID	POC	City	County	Year	Num Meas	Num Req	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max >/= 0.125 Measured	Values >/= 0.125 Estimated	Missed Days < 0.125 Standard
260210014	1	Coloma	Berrien	2011	183	183	.112	.107	.099	.097	0	0.0	0
260270003	2	Cassopolis	Cass	2011	178	183	.100	.098	.098	.091	0	0.0	1
260330901	1	Sault Ste. Marie	Chippewa	2011	183	183	.082	.065	.064	.062	0	0.0	0
260370001	2	Rose Lake	Clinton	2011	183	183	.093	.087	.079	.078	0	0.0	0
260490021	1	Flint	Genesee	2011	182	183	.093	.083	.082	.080	0	0.0	1
260492001	1	Otisville	Genesee	2011	183	183	.093	.090	.084	.078	0	0.0	0
260630007	1	Harbor Beach	Huron	2011	183	183	.091	.084	.080	.077	0	0.0	0
260650012	2	Lansing	Ingham	2011	182	183	.079	.079	.079	.078	0	0.0	1
260770008	1	Kalamazoo	Kalamazoo	2011	170	183	.091	.083	.083	.082	0	0.0	3
260810020	1	Grand Rapids	Kent	2011	181	183	.095	.090	.082	.081	0	0.0	0
260810022	1	Evans	Kent	2011	181	183	.092	.090	.090	.082	0	0.0	0
260910007	1	Tecumseh	Lenawee	2011	180	183	.096	.083	.082	.080	0	0.0	3
260990009	1	New Haven	Macomb	2011	182	183	.104	.100	.095	.090	0	0.0	1
260991003	1	Warren	Macomb	2011	183	183	.104	.092	.091	.089	0	0.0	0
261010933	1	Manistee	Manistee	2011	177	183	.101	.095	.086	.081	0	0.0	4
261050007	1	Scottville	Mason	2011	183	183	.107	.099	.087	.080	0	0.0	0
261130001	1	Houghton Lake	Missaukee	2011	179	183	.087	.081	.077	.076	0	0.0	0
261210039	1	Muskegon	Muskegon	2011	182	183	.128	.117	.103	.093	1	1.0	1
261250001	2	Oak Park	Oakland	2011	179	183	.095	.090	.089	.086	0	0.0	0
261390005	1	Jenison	Ottawa	2011	183	183	.109	.108	.099	.086	0	0.0	0
261470005	1	Port Huron	St .Clair	2011	183	183	.104	.104	.091	.089	0	0.0	0
261530001	1	Seney	Schoolcraft	2011	182	183	.92	.084	.078	.078	0	0.0	1
261610008	1	Ypsilanti	Washtenaw	2011	181	183	.095	.087	.086	.085	0	0.0	0
261630001	2	Allen Park	Wayne	2011	173	183	.104	.100	.084	.082	0	0.0	1
261630019	2	Detroit - E. Seven Mile	Wayne	2011	181	183	.104	.100	.095	.089	0	0.0	0

O_3 (8-Hour) Measured in ppm

Site ID	POC	City	County	Year	% OBS	Valid Days Measured	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max > 0.075
260050003	1	Holland	Allegan	2011	100	183	.097	.095	.094	.085	7
260190003	1	Benzonia	Benzie	2011	98	179	.084	.080	.073	.071	2
260210014	1	Coloma	Berrien	2011	99	182	.096	.093	.087	.083	10
260270003	2	Cassopolis	Cass	2011	97	177	.087	.085	.085	.081	7
260330901	1	Sault Ste. Marie	Chippewa	2011	99	182	.069	.058	.056	.056	0
260370001	2	Rose Lake	Clinton	2011	100	183	.077	.077	.073	.070	2
260490021	1	Flint	Genesee	2011	99	182	.083	.077	.074	.073	2
260492001	1	Otisville	Genesee	2011	100	183	.085	.079	.078	.073	3
260630007	1	Harbor Beach	Huron	2011	100	183	.078	.072	.071	.070	1
260650012	2	Lansing	Ingham	2011	99	182	.076	.071	.071	.070	1
260770008	1	Kalamazoo	Kalamazoo	2011	92	169	.080	.077	.075	.075	2

O_3 (8-Hour) Measured in ppm (continued)

Site ID	POC	City	County	Year	% OBS	Valid Days Measured	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max > 0.075
260810020	1	Grand Rapids	Kent	2011	99	181	.082	.079	.079	.075	3
260810022	1	Evans	Kent	2011	99	181	.081	.080	.079	.076	4
260910007	1	Tecumseh	Lenawee	2011	98	179	.087	.080	.077	.076	5
260990009	1	New Haven	Macomb	2011	99	181	.089	.085	.082	.078	5
260991003	1	Warren	Macomb	2011	99	182	.088	.083	.082	.082	7
261010922	1	Manistee	Manistee	2011	96	175	.091	.084	.080	.072	3
261050007	1	Scottville	Mason	2011	100	183	.094	.085	.079	.072	3
261130001	1	Houghton Lake	Missaukee	2011	97	178	.077	.074	.067	.067	1
261210039	1	Muskegon	Muskegon	2011	99	182	.104	.093	.090	.079	5
261250001	2	Oak Park	Oakland	2011	97	178	.087	.081	.080	.080	6
261390005	1	Jenison	Ottawa	2011	100	183	.088	.088	.086	.079	6
261470005	1	Port Huron	St .Clair	2011	99	181	.089	.082	.078	.075	3
261530001	1	Seney	Schoolcraft	2011	98	179	.078	.074	.068	.065	1
261610008	1	Ypsilanti	Washtenaw	2011	998	180	.087	.079	.078	.077	4
261630001	2	Allen Park	Wayne	2011	94	172	.084	.080	.080	.077	4
261630019	2	Detroit - E. Seven Mile	Wayne	2011	98	179	.087	.087	.085	.083	10

$PM_{2.5}$ (24-Hour) Measured in $\mu g/m^3$ at Local Conditions

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	98%	Wtd. Arith. Mean
260050003	1	FRM	Holland	Allegan	2011	114	27.2	26.8	25.6	21.5	25.6	8.44
260170014	1	FRM	Bay City	Bay	2011	118	24.2	20.9	20.9	20.0	20.9	7.67
260210014	1	FRM	Coloma	Berrien	2011	119	23.9	22.4	20.5	20.3	20.5	8.71
260330901	1	FRM	Sault Ste. Marie	Chippewa	2011	99	19.3	18.3	16.5	16.3	18.3	6.37*
260330901	2	FRM	Sault Ste. Marie	Chippewa	2011	41	17.0	14.8	12.1	11.7	17.0	6.37*
260490021	1	FRM	Flint	Genesee	2011	119	22.5	21.0	20.7	20.6	20.7	8.45
260650012	1	FRM	Lansing	Ingham	2011	116	21.9	21.3	20.6	20.3	20.6	8.65
260770008	1	FRM	Kalamazoo	Kalamazoo	2011	118	21.5	20.7	20.3	19.6	20.3	9.01
260770008	2	FRM	Kalamazoo	Kalamazoo	2011	59	19.8	17.4	16.8	16.3	17.4	8.85
260810007	1	FRM	Grand Rapids - Wealthy	Kent	2011	120	25.5	23.2	22.6	22.5	22.6	9.46
260810020	1	FRM	Grand Rapids - Monroe	Kent	2011	121	25.4	23.3	22.8	22.6	22.8	9.47
260810020	2	FRM	Grand Rapids - Monroe	Kent	2011	58	22.8	21.8	19.6	16.7	21.8	9.25
260910007	1	FRM	Tecumseh	Lenawee	2011	115	24.1	23.9	23.9	21.8	23.9	9.57
260990009	1	FRM	New Haven	Macomb	2011	119	27.1	24.1	24.1	23.2	24.1	8.61

*Indicates the mean does not satisfy summary criteria

$PM_{2.5}$ (24-Hour) Measured in $\mu g/m^3$ at Local Conditions (continued)

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	98%	Wtd. Arith. Mean
261010922	1	FRM	Manistee	Manistee	2011	114	23.0	20.0	17.5	16.6	17.5	6.39
261130001	1	FRM	Houghton Lake	Missaukee	2011	113	21.0	19.3	17.8	15.4	17.8	6.16
261150005	1	FRM	Luna Pier	Monroe	2011	111	25.3	25.2	23.5	22.8	23.5	9.98
261210040	1	FRM	Muskegon	Muskegon	2011	119	25.2	24.8	22.2	21.3	22.2	8.40
261250001	1	FRM	Oak Park	Oakland	2011	118	24.4	23.7	23.4	23.1	23.4	9.14
261390005	1	FRM	Jenison	Ottawa	2011	120	27.5	25.9	23.5	23.0	23.5	9.13
261470005	1	FRM	Port Huron	St. Clair	2011	121	27.5	27.0	23.7	23.4	23.7	9.14
261610008	1	FRM	Ypsilanti	Washtenaw	2011	116	24.5	24.1	23.9	22.9	23.9	9.74
261610008	2	FRM	Ypsilanti	Washtenaw	2011	59	23.3	18.8	18.2	16.6	18.8	8.54
261630001	1	FRM	Allen Park	Wayne	2011	352	31.2	29.0	27.8	27.0	25.3	10.47
261630015	1	FRM	Detroit - W. Fort	Wayne	2011	118	36.7	26.5	25.1	24.6	25.1	10.90
261630016	1	FRM	Detroit - Linwood	Wayne	2011	120	32.1	25.0	24.8	24.6	24.8	10.08
261630019	1	FRM	Detroit - E. Seven Mile	Wayne	2011	115	25.7	24.1	24.0	23.5	24.0	9.43
261630025	1	FRM	Livonia	Wayne	2011	119	25.1	24.2	22.8	22.8	22.8	9.47
261630033	1	FRM	Dearborn	Wayne	2011	146	32.0	30.6	29.9	28.4	29.9	11.21
261630033	2	FRM	Dearborn	Wayne	2011	60	28.7	26.1	26.0	22.1	26.1	11.23
261630036	1	FRM	Wyandotte	Wayne	2011	110	24.2	24.2	21.4	21.4	21.4	8.93*
261630038	1	FRM	Detroit - Newberry.	Wayne	2011	119	31.1	25.6	24.9	24.7	24.9	10.59
261630039	1	FRM	Detroit – W. Lafayette	Wayne	2011	345	30.7	30.6	30.6	27.8	25.3	10.49

*Indicates the mean does not satisfy summary criteria

$PM_{2.5}$ TEOM (1-Hour) Measured in $\mu g/m^3$

Site ID	POC	Monitor (with FDMS)	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
260170014	3	TEOM	Bay City	Bay	2011	8053	58.0	50.0	50.0	47.0	8.74
260330901	3	BAM	Sault Ste. Marie	Chippewa	2011	5861	22.2	20.6	18.5	16.8	4.47*
260490021	3	TEOM	Flint	Genesee	2011	8478	91.0	87.0	79.0	79.0	9.30
260650012	5	TEOM	Lansing	Ingham	2011	8601	544.0	379.0	146.0	117.0	8.87
260770008	3	TEOM	Kalamazoo	Kalamazoo	2011	8396	82.0	81.0	68.0	63.0	9.57
260810020	3	TEOM	Grand Rapids	Kent	2011	8407	44.0	43.4	42.0	41.0	9.34
260910007	3	TEOM	Tecumseh	Lenawee	2011	8363	157.0	59.0	37.0	37.0	9.30
261130001	3	TEOM	Houghton Lake	Missaukee	2011	6776	36.0	36.0	34.0	34.0	7.24
261470005	3	TEOM	Port Huron	St. Clair	2011	8653	72.0	69.0	61.0	55.0	9.52
261530001	3	TEOM	Seney	Schoolcraft	2011	8175	63.0	59.0	58.0	57.0	6.03
261610008	3	TEOM	Ypsilanti	Washtenaw	2011	8339	102.0	92.0	89.0	76.0	10.47
261630001	3	TEOM	Allen Park	Wayne	2011	8561	264.0	94.0	92.0	87.0	10.92
261630033	3	TEOM	Dearborn	Wayne	2011	8317	206.0	110.0	96.0	91.0	12.22
261630038	3	TEOM	Detroit – 29th Street	Wayne	2011	8219	174.0	169.0	151.0	149.0	11.09
261630039	3	TEOM	Detroit – W. Lafayette	Wayne	2010	7884	76.0	73.0	72.0	57.0	11.04

*Indicates the mean does not satisfy summary criteria

PM_{10} (24-Hour) Measured in $\mu g/m^3$

Site ID	POC	Monitor	City	County	Year	# OBS	# Req.	Valid Days	% OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd Arith Mean
260810007	1	GRAV	Grand Rapids - Wealthy	Kent	2011	59	61	59	97	44	38	35	30	14.4
260810020	1	GRAV	Grand Rapids - Monroe	Kent	2011	61	61	61	100	41	35	30	28	13.5
261630001	1	GRAV	Allen Park	Wayne	2011	59	61	59	97	53	38	36	34	16.4
261630005	1	GRAV	River Rouge	Wayne	2011	57	61	57	93	62	51	38	32	18.7
261630015	1	GRAV	Detroit - W. Fort	Wayne	2011	60	61	60	98	77	42	38	33	17.0
261630033	1	GRAV	Dearborn	Wayne	2011	61	61	61	100	96	45	44	43	20.2

*Indicates the mean does not satisfy summary criteria

PM_{10} TEOM (1-Hour) Measured in $\mu g/m^3$

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
261630033	3	TEOM	Dearborn	Wayne	2011	7408	200	196	195	161	21.5

SO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	99th %ile 1-hr	24-hr Highest Value	24-hr 2nd Highest Value	OBS >0.5	Arith Mean
261630015	1	Detroit - W. Fort	Wayne	2011	8300	111.6	94.0	84	38.4	30.9	0	3.28
260810020	2	Grand Rapids	Kent	2011	8152	16.7	12.5	8.4	4.5	4.1	0	.73
261630001	1	Allen Park	Wayne	2011	8261	58.1	52.5	46.7	10.5	10.1	0	1.61

APPENDIX B: 2011 AIR TOXICS MONITORING SUMMARY FOR METALS, VOCS, CARBONYL COMPOUNDS, PAHS, HEXAVALENT CHROMIUM & SPECIATED $PM_{2.5}$

Appendix B provides summary statistics of ambient air concentrations of various substances monitored in Michigan during 2011. At each monitoring site, air samples were taken over a 24-hour period (midnight to midnight). These air samples represent the average air concentration during that 24-hour period. The frequency of air samples collected is typically done once every 6 or 12 days. Sometimes the sampled air concentration is lower than the laboratory's analytical method detection level (MDL). When the concentration is lower than the MDL, two options are used to estimate the air concentration. The calculation of the minimum average ("Average (ND=0)") uses 0.0 $\mu g/m^3$ for a value less than the MDL. In the calculation of the maximum average ("Average (ND=MDL/2)") the MDL divided by 2 (i.e., ½ the MDL) is substituted for air concentrations less than the MDL.

Table B shows the monitoring stations and what types of air toxics were monitored at each station in 2011. The following terms and acronyms are used in **Appendix B-1** and **B-2** data tables:

- Num Obs: Number of Observations (number of daily air samples taken during the year)
- Obs>MDL: Number of daily samples above the MDL
- Average (ND=0): average air concentration in 2011, assuming daily samples below MDL were equal to 0.0 $\mu g/m^3$.
- Average (ND=MDL/2): average air concentration in 2011, assuming daily samples below MDL were equal to one half MDL.
- MDL: Analytical MDL in units of $\mu g/m^3$
- Max1: Highest daily air concentration during 2011
- Max2: Second highest daily air concentration during 2011
- Max3: Third highest daily air concentration during 2011
- $\mu g/m^3$: Micrograms per cubic meter (1,000,000 µg = 1 g)

Table B: Monitoring Stations and Types of Air Samples Collected

	Appendix B-1						Appendix B-2
Site Name	**VOC**	**Carbonyl**	**PAHs**	**Metals TSP**	**Metals PM_{10}**	**Hex Chrome**	**Speciated PM2.5**
Allen Park				x	x		x
Dearborn	x	x	x	x	x	x	x
Detroit, W. Fort	x	x		x	Mn		x
Detroit, W. Jefferson				x			
Flint				Mn			
Grand Rapids				x			x
Belding-Merrick St.				x			
Belding-Reed St.				x			
Vassar				x			
East Jordan				x			
Houghton Lake							x
Luna Pier							x
Port Huron, Nat'l Guard Arm.							x
River Rouge		x		x	Mn		
Tecumseh							x

VOC = volatile organic compound; SVOC = semi-volatile organic compound; TSP = total suspended particulate; PM_{10} = particulate matter with aerodynamic diameter less than 10 µm; Hex Chrome = hexavalent chromium (Cr+6)

APPENDIX B-1

Allen Park (261630001) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (PM-10)	59	59	0.00106	0.00106	0.0000393	0.00336	0.00298	0.0029
Arsenic (TSP)	61	61	0.0012	0.0012	0.0000315	0.00356	0.00294	0.00293
Cadmium (PM-10)	59	59	0.000195	0.000195	0.0000286	0.000573	0.000474	0.000394
Cadmium (TSP)	61	61	0.000172	0.000172	0.0000229	0.00059	0.000318	0.000309
Chromium (PM-10)	59	59	0.00237	0.00237	0.000272	0.00354	0.00342	0.00325
Lead (TSP)	61	61	0.00516	0.00516	0.00003	0.0151	0.0131	0.0114
Lead (PM-10)	59	59	0.00437	0.00437	0.00003	0.0156	0.014	0.0108
Manganese (PM-10)	59	59	0.0102	0.0102	0.0003	0.0403	0.0259	0.0243
Manganese (TSP)	61	61	0.0235	0.0235	0.00024	0.0774	0.0729	0.058
Nickel (PM-10)	59	59	0.000881	0.000881	0.000161	0.00205	0.00193	0.0018
Nickel (TSP)	61	61	0.00129	0.00129	0.000129	0.00298	0.00289	0.00281

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,1-Trichloroethane	69	52	0.00000626	0.0166	0.124	0.0000135	0.0000117	0.0000108
1,2,4-Trichlorobenzene	69	1	0.000000426	0.155	0.313	0.0000294	0	0
1,2,4-Trimethylbenzene	69	68	0.0131	0.0196	0.156	0.89	0.000826	0.000755
1,2-Dichloroethane	69	12	0.0000013	0.0187	0.0438	0.0000129	0.0000092	0.00000736
1,3,5-Trimethylbenzene	69	67	0.0000696	0.00891	0.142	0.000283	0.000254	0.000219
1,3-Butadiene	69	64	0.00508	0.00698	0.02	0.35	0.0000292	0.0000289
1,4-Dichlorobenzene	69	17	0.00000402	0.0881	0.228	0.0000329	0.0000272	0.0000229
2,2,4-Trimethylpentane	2	2	0.595	0.595	0.155	0.61	0.58	
2-Chloro-1,3-Butadiene	69	1	0.0000000759	0.0157	0.0318	0.00000524	0	0
Acenaphthene	66	66	0.0132	0.0132	0.0000434	0.111	0.0842	0.0575
Acenaphthylene	66	48	0.000642	0.000648	0.0000383	0.00282	0.00268	0.00259
Acetaldehyde	67	67	0.000197	0.000197	0.00901	0.000372	0.000337	0.000329
Acetone	67	67	0.000202	0.000202	0.0124	0.000497	0.000425	0.000382
Acetonitrile	69	68	0.348	0.35	0.0506	24	0.00054	0.000536
Acetylene	67	67	0.000638	0.000638	0.017	0.00171	0.0013	0.00119
Acrylonitrile	69	1	0.000000193	0.0205	0.0413	0.0000133	0	0
Anthracene	66	63	0.00091	0.000912	0.0000494	0.00907	0.00704	0.00413
Arsenic (PM-10)	120	120	0.00127	0.00127	0.000039	0.00405	0.00379	0.00339
Arsenic (TSP)	116	116	0.00164	0.00164	0.0000312	0.0154	0.00641	0.00389
Barium (PM-10)	120	120	0.014	0.014	0.0016	0.0342	0.027	0.0268
Barium (TSP)	116	116	0.0484	0.0484	0.00128	0.164	0.143	0.141
Benzaldehyde	67	67	0.000002	0.000002	0.00868	0.00000425	0.00000425	0.00000384
Benzene	69	69	0.0394	0.0394	0.104	1.5	1.2	0.00076
Benzo(a)anthracene	66	66	0.000212	0.000212	0.0000713	0.0024	0.00128	0.000767

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Benzo(a)pyrene	66	64	0.000178	0.000179	0.0000699	0.00199	0.00111	0.000569
Benzo(b)fluoranthene	66	66	0.000452	0.000452	0.000037	0.0028	0.00224	0.00139
Benzo(ghi)perylene	66	66	0.00021	0.00021	0.0000613	0.00155	0.000815	0.000582
Benzo(k)fluoranthene	66	63	0.000126	0.000127	0.0000506	0.000861	0.000721	0.000366
Beryllium (PM-10)	120	114	0.0000219	0.000022	0.0000142	0.000129	0.000116	0.0000914
Beryllium (TSP)	116	115	0.0000694	0.0000694	0.0000113	0.000325	0.000309	0.000255
Bromomethane (Methyl Bromide)	69	28	0.00000167	0.015	0.0443	0.00000773	0.00000552	0.00000515
Cadmium (PM-10)	120	119	0.000381	0.000381	0.0000284	0.007	0.0013	0.00126
Cadmium (TSP)	116	116	0.000389	0.000389	0.0000227	0.00149	0.00142	0.00124
Carbon Disulfide	67	66	0.0000648	0.000832	0.103	0.000173	0.000169	0.000169
Carbon Tetrachloride	69	68	0.00966	0.0117	0.154	0.66	0.000144	0.000135
Chlorobenzene	69	1	0.000000299	0.0532	0.108	0.0000206	0	0
Chloroethane	69	11	0.00000118	0.0128	0.0292	0.0000125	0.000011	0.000011
Chloroform	69	69	0.0209	0.0209	0.0505	0.73	0.71	0.000169
Chloromethane	69	69	0.0612	0.0612	0.0296	2.3	1.9	0.000452
Chromium (PM-10)	120	120	0.0028	0.0028	0.00027	0.00834	0.008	0.00559
Chromium (TSP)	116	116	0.00499	0.00499	0.000215	0.0161	0.0143	0.0136
Chromium VI (TSP)	67	66	0.0000458	0.0000459	0.00000428	0.0002	0.000167	0.000126
Chrysene	66	66	0.000471	0.000471	0.0000331	0.00304	0.00196	0.00163
Cobalt (PM-10)	120	120	0.000216	0.000216	0.0000142	0.000695	0.000595	0.000542
Cobalt (TSP)	116	116	0.000216	0.000216	0.0000113	0.000764	0.000751	0.000508
Copper (PM-10)	120	120	0.0406	0.0406	0.000841	0.101	0.101	0.0999
Copper (TSP)	116	116	0.14	0.14	0.000672	0.479	0.404	0.372
Dibenzo(ah)anthracene	66	41	0.0000296	0.0000418	0.0000629	0.000276	0.00023	0.000128
Dibromochloromethane	69	1	0.0000000746	0.0973	0.197	0.00000515	0	0
Dichlorodiflouromethane	69	69	0.0872	0.0872	0.0612	3.1	2.9	0.000327
Ethylbenzene	69	68	0.00691	0.0113	0.0846	0.47	0.000534	0.000306
Fluoranthene	66	66	0.00534	0.00534	0.0000323	0.0395	0.0293	0.0216
Fluorene	66	66	0.0111	0.0111	0.0000446	0.0705	0.0692	0.0556
Formaldehyde	67	67	0.000709	0.000709	0.00976	0.00186	0.0018	0.00171
Halocarbon 113	2	1	0.325	0.625	0.775	0.65	0	
Halocarbon 114	69	66	0.0000061	0.00785	0.0759	0.0000081	0.0000081	0.00000773
Hexachloro-1,3-Butadiene	69	1	0.00000057	0.223	0.453	0.0000393	0	0
Hexanaldehyde	65	64	0.00000213	0.0000652	0.00819	0.00000499	0.00000458	0.0000045
Indeno(123-cd)pyrene	66	65	0.000201	0.000202	0.0000594	0.00127	0.000831	0.000569
Iron (PM-10)	120	120	0.529	0.529		2.21	2.07	1.85
Iron (TSP)	116	116	1.1	1.1	0.0000119	4.84	4.59	3.78
Lead (TSP)	116	116	0.0126	0.0126	0.00003	0.12	0.111	0.0566
Lead (PM-10)	119	119	0.0112	0.0112	0.00003	0.137	0.129	0.0569
m/p -Xylene	69	69	0.0426	0.0426	0.167	1.6	1.3	0.00353
Manganese (PM-10)	120	120	0.0403	0.0403	0.000298	0.746	0.357	0.179
Manganese (TSP)	116	116	0.0916	0.0916	0.000238	0.694	0.52	0.349
Methyl Ethyl Ketone	69	67	0.00197	0.0114	0.468	0.00522	0.00515	0.00498
Methyl Isobutyl Ketone	69	67	0.0000667	0.0106	0.109	0.000186	0.000158	0.000155
Methyl Methacrylate	67	2	0.000000242	0.0437	0.0901	0.0000099	0.0000063	0

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Methylene Chloride	69	67	0.000237	0.0297	0.0925	0.00198	0.00142	0.000937
Molybdenum (PM-10)	120	120	0.000662	0.000662	0.0000497	0.00224	0.00219	0.00202
Molybdenum (TSP)	116	116	0.00087	0.00087	0.0000397	0.00256	0.00249	0.00247
Naphthalene	66	66	0.143	0.143	0.000124	0.473	0.408	0.357
n-Hexane	2	2	1.35	1.35	0.225	1.6	1.1	
Nickel (PM-10)	120	120	0.00138	0.00138	0.00016	0.00961	0.00468	0.00403
Nickel (TSP)	116	116	0.00211	0.00211	0.000128	0.00722	0.00587	0.00496
n-Octane	67	66	0.0000224	0.000545	0.0701	0.0000613	0.0000546	0.0000466
o-xylene	69	68	0.00777	0.0123	0.0891	0.53	0.000421	0.000225
Phenanthrene	66	66	0.0213	0.0213	0.0000326	0.169	0.139	0.0942
Propionaldehyde	67	67	0.0000107	0.0000107	0.00475	0.0000211	0.00002	0.0000197
Propylene	67	67	0.000715	0.000715	0.0671	0.00143	0.00128	0.00119
Pyrene	66	66	0.00288	0.00288	0.0000278	0.019	0.0131	0.0102
Styrene	69	65	0.0000269	0.00885	0.106	0.0000981	0.0000648	0.0000639
Tetrachloroethene	69	64	0.0739	0.0784	0.134	3.6	1.5	0.0000545
Tolualdehydes	60	60	0.00000292	0.00000292	0.0144	0.00000859	0.00000748	0.00000589
Toluene	69	69	0.102	0.102	0.0674	3.8	3.2	0.00488
Trichloroethene	69	6	0.0000012	0.0652	0.142	0.0000225	0.0000174	0.0000112
Trichloroflouromethane	69	69	0.0682	0.0682	0.063	2.5	2.2	0.000216
Valeraldehyde	67	67	0.000002	0.000002	0.00705	0.00000466	0.00000425	0.00000417
Vanadium (PM-10)	120	120	0.0015	0.0015	0.0000497	0.00906	0.00865	0.00459
Vanadium (TSP)	116	116	0.00312	0.00312	0.0000397	0.0145	0.0136	0.0101
Vinyl Chloride	69	7	0.00000027	0.0121	0.0262	0.00000524	0.0000036	0.00000262
Zinc (PM-10)	120	120	0.0751	0.0751	0.001	0.585	0.582	0.324
Zinc (TSP)	116	116	0.122	0.122	0.000799	0.664	0.623	0.49

Detroit, Fort Street (N. Delray-SWHS) (261630015) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,2,4-Trimethylbenzene	27	10	0.514	0.721	0.654	3.1	2.2	1.9
1,3,5-Trimethylbenzene	27	3	0.0967	0.378	0.634	1	0.86	0.75
1,4-Dichlorobenzene	27	1	0.0256	0.351	0.676	0.69	0	0
2,2,4-Trimethylpentane	27	7	0.161	0.311	0.404	1.2	0.76	0.6
Acetaldehyde	30	30	0.000212	0.000212	0.0101	0.000759	0.000477	0.000323
Acetone	30	30	0.000337	0.000337	0.017	0.00181	0.00143	0.000847
Arsenic (TSP)	60	60	0.00141	0.00141	0.0000311	0.00396	0.0033	0.00298
Benzaldehyde	30	28	0.00000229	0.000749	0.00959	0.00000965	0.00000532	0.00000434
Benzene	27	27	0.881	0.881	0.216	1.7	1.2	1.2
Cadmium (TSP)	60	60	0.000317	0.000317	0.0000226	0.0013	0.00102	0.000936
Carbon Tetrachloride	27	2	0.0496	0.35	0.648	0.68	0.66	0
Chloroform	27	21	0.631	0.689	0.512	1.6	1.5	1.2
Chloromethane	27	27	1.22	1.22	0.597	2	2	1.9
Dichlorodiflouromethane	27	27	2.64	2.64	0.634	3.3	3.2	3.2
Ethylbenzene	27	4	0.156	0.459	0.712	1.4	1.1	0.92
Formaldehyde	30	30	0.000791	0.000791	0.0108	0.00222	0.00164	0.00137
Halocarbon 113	27	14	0.367	0.518	0.626	0.8	0.75	0.74
Hexanaldehyde	30	28	0.00000348	0.00142	0.0103	0.0000306	0.0000101	0.00000564
m/p -Xylene	27	19	1.26	1.37	0.735	4.1	3.9	2.9

Detroit, Fort Street (N. Delray-SWHS) (261630015) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	(ND=0)	(ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Manganese (PM-10)	60	60	0.0294	0.0294	0.0003	0.341	0.279	0.097
Manganese (TSP)	60	60	0.0563	0.0563	0.000237	0.302	0.173	0.171
Methyl Ethyl Ketone	27	27	1.43	1.43	0.12	2.6	2.4	2
Methyl Isobutyl Ketone	27	14	0.602	0.724	0.507	2.7	2.5	1.6
Methylene Chloride	27	26	0.474	0.479	0.243	1	0.8	0.79
n-Hexane	27	25	0.977	0.986	0.227	3	2.8	2.6
Nickel (TSP)	60	60	0.00305	0.00305	0.000127	0.0112	0.00981	0.00836
o-xylene	27	9	0.351	0.575	0.675	1.9	1.5	0.99
Propionaldehyde	30	28	0.00000946	0.00134	0.00709	0.0000344	0.000019	0.000018
Styrene	27	2	0.0604	0.293	0.503	0.87	0.76	0
Tetrachloroethene	27	1	0.0407	0.552	1.06	1.1	0	0
Tolualdehydes	26	26	0.00000361	0.00000361	0.0141	0.0000121	0.00000859	0.00000577
Toluene	27	27	2.12	2.12	0.461	8.1	4.1	3.4
Trichloroflouromethane	27	27	1.35	1.35	0.505	2	1.7	1.6
Valeraldehyde	30	28	0.00000254	0.00136	0.00929	0.0000197	0.00000712	0.00000425

Detroit, W. Jefferson, South Delray (261630027) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (TSP)	58	58	0.00159	0.00159	0.000032	0.00393	0.00371	0.00369
Cadmium (TSP)	58	58	0.000405	0.000405	0.0000233	0.00191	0.00167	0.00122
Manganese (TSP)	58	58	0.0886	0.0886	0.000245	0.27	0.208	0.205
Nickel (TSP)	58	58	0.00273	0.00273	0.000131	0.00933	0.00682	0.00506

River Rouge (261630005) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Acetaldehyde	57	57	0.00019	0.00019	0.00898	0.000342	0.000337	0.000331
Acetone	57	57	0.000182	0.000182	0.0121	0.000323	0.000299	0.000292
Arsenic (TSP)	60	60	0.0014	0.0014	0.000031	0.00383	0.00373	0.00344
Benzaldehyde	57	55	0.00000235	0.000155	0.0086	0.00000589	0.00000466	0.00000442
Cadmium (TSP)	60	60	0.000466	0.000466	0.0000225	0.00197	0.00161	0.00148
Formaldehyde	57	57	0.000831	0.000831	0.00931	0.00219	0.00217	0.0019
Hexanaldehyde	57	53	0.00000141	0.000217	0.00697	0.00000507	0.00000491	0.00000466
Manganese (PM-10)	57	57	0.0171	0.0171	0.000296	0.0709	0.0492	0.0461
Manganese (TSP)	60	60	0.0537	0.0537	0.000237	0.156	0.153	0.15
Nickel (TSP)	60	60	0.00131	0.00131	0.000127	0.00357	0.00332	0.00294
Propionaldehyde	57	55	0.00000902	0.0000925	0.00475	0.0000214	0.0000173	0.0000173
Tolualdehydes	47	45	0.00000231	0.000211	0.0131	0.00000798	0.00000601	0.00000577
Valeraldehyde	57	55	0.00000184	0.000125	0.00705	0.00000532	0.00000458	0.0000045

Flint (260490021) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Manganese (TSP)	60	60	0.00939	0.00939	0.000241	0.0338	0.0318	0.0273

Vassar (261570001) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (TSP)	16	16	0.000721	0.000721	0.000031	0.00151	0.00121	0.00109
Cadmium (TSP)	16	16	0.000687	0.000687	0.0000225	0.00311	0.00213	0.00166
Lead (TSP)	16	16	0.0104	0.0104	0.00003	0.0328	0.0324	0.0259
Manganese (TSP)	16	16	0.041	0.041	0.000237	0.165	0.111	0.105
Nickel (TSP)	16	16	0.00171	0.00171	0.000127	0.00301	0.0025	0.00221

Grand Rapids - Monroe St. (260810020) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (TSP)	60	60	0.00122	0.00122	0.0000317	0.00565	0.00481	0.00373
Cadmium (TSP)	60	60	0.000144	0.000144	0.0000231	0.000328	0.000303	0.000302
Chromium (TSP)	60	60	0.0035	0.0035	0.000219	0.0782	0.00408	0.00406
Lead (TSP)	60	60	0.00552	0.00552	0.00003	0.029	0.0195	0.0134
Manganese (TSP)	60	60	0.0148	0.0148	0.000242	0.0807	0.0622	0.0519
Nickel (TSP)	60	60	0.00155	0.00155	0.00013	0.0318	0.00291	0.00277

Belding - Merrick St. (260670003) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (TSP)	60	60	0.000905	0.000905	0.0000311	0.00483	0.00319	0.00219
Cadmium (TSP)	60	60	0.000607	0.000607	0.0000226	0.00505	0.00456	0.00211
Chromium (TSP)	60	60	0.00161	0.00161	0.000215	0.00263	0.00251	0.00226
Lead (TSP)	60	60	0.0768	0.0768	0.00003	0.593	0.493	0.43
Manganese (TSP)	60	60	0.0109	0.0109	0.000237	0.037	0.0304	0.0291
Nickel (TSP)	60	60	0.00106	0.00106	0.000127	0.00621	0.00389	0.00192

Belding - Reed St. (260670002) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (TSP)	31	31	0.000912	0.000912	0.0000317	0.00291	0.00232	0.00167
Cadmium (TSP)	31	31	0.00028	0.00028	0.000023	0.00159	0.00108	0.000774
Lead (TSP)	31	31	0.101	0.101	0.00003	0.869	0.811	0.645
Manganese (TSP)	31	31	0.00754	0.00754	0.000242	0.0219	0.0166	0.0128
Nickel (TSP)	31	31	0.000993	0.000993	0.00013	0.00244	0.00226	0.00189

East Jordan (260290011) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (TSP)	10	10	0.000356	0.000356	0.0000304	0.00109	0.000486	0.000457
Cadmium (TSP)	10	10	0.0001	0.0001	0.0000221	0.000265	0.000166	0.000126
Lead (TSP)	10	10	0.00392	0.00392	0.00003	0.0102	0.00744	0.00721
Manganese (TSP)	10	10	0.026	0.026	0.000232	0.126	0.0538	0.0348
Nickel (TSP)	10	10	0.00135	0.00135	0.000124	0.0017	0.00158	0.00157

APPENDIX B-2

Dearborn (261630033), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	53	0.0313	0.0324	0.02	0.217	0.0992	0.0895
Ammonium Ion Pm2.5 Lc	60	58	1.13	1.13	0.0142	4.94	4.14	3.95
Antimony Pm2.5 Lc	60	22	0.0108	0.0222	0.0353	0.0687	0.0619	0.0572
Arsenic Pm2.5 Lc	60	32	0.00097	0.00141	0.0018	0.00501	0.00467	0.00393
Barium Pm2.5 Lc	60	14	0.000905	0.00507	0.0145	0.0137	0.00898	0.00735
Bromine Pm2.5 Lc	60	60	0.00489	0.00489	0.00158	0.0258	0.0136	0.0132
Cadmium Pm2.5 Lc	60	23	0.00367	0.00845	0.0147	0.0221	0.021	0.021
Calcium Pm2.5 Lc	60	60	0.081	0.081	0.0062	0.737	0.199	0.162
Cerium Pm2.5 Lc	60	9	0.000159	0.00475	0.0156	0.00233	0.00152	0.00152
Cesium Pm2.5 Lc	60	17	0.00119	0.00548	0.0149	0.00898	0.00828	0.00748
Chlorine Pm2.5 Lc	60	57	0.0671	0.0673	0.00735	0.764	0.457	0.425
Chromium Pm2.5 Lc	60	50	0.0012	0.00139	0.00217	0.00438	0.00385	0.00381
Cobalt Pm2.5 Lc	60	50	0.00112	0.00124	0.00142	0.00722	0.0049	0.00484
Copper Pm2.5 Lc	60	60	0.0146	0.0146	0.00209	0.0632	0.0426	0.0424
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	0.48	0.48		1.09	0.92	0.911
Indium Pm2.5 Lc	60	15	0.00295	0.0106	0.0193	0.0187	0.0186	0.0175
Iron Pm2.5 Lc	60	60	0.266	0.266	0.00204	1.39	1.23	0.805
Lead Pm2.5 Lc	60	50	0.00714	0.00743	0.00365	0.113	0.04	0.0291
Magnesium Pm2.5 Lc	60	28	0.017	0.0209	0.0146	0.209	0.205	0.124
Manganese Pm2.5 Lc	60	57	0.00767	0.00772	0.00186	0.0512	0.0484	0.0318
Nickel Pm2.5 Lc	60	41	0.000735	0.000977	0.00149	0.00396	0.00294	0.00282
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	2.46	2.46		5.54	4.77	4.13
Phosphorus Pm2.5 Lc	60	3	0.0000367	0.00513	0.0105	0.00116	0.00093	0.00011
Potassium Ion Pm2.5 Lc	60	49	0.0551	0.0566	0.0139	0.184	0.181	0.152
Potassium Pm2.5 Lc	60	60	0.0639	0.0639	0.00761	0.271	0.226	0.154
Rubidium Pm2.5 Lc	60	20	0.000239	0.000869	0.00192	0.00193	0.00163	0.00135
Selenium Pm2.5 Lc	60	43	0.0012	0.00152	0.00233	0.00641	0.00563	0.00408
Silicon Pm2.5 Lc	60	58	0.064	0.0643	0.0139	0.608	0.148	0.146
Silver Pm2.5 Lc	60	12	0.00155	0.00879	0.0168	0.017	0.0135	0.0121
Sodium Ion Pm2.5 Lc	60	60	0.0667	0.0667	0.0177	0.206	0.186	0.181
Sodium Pm2.5 Lc	60	46	0.0618	0.0669	0.0416	0.454	0.3	0.191
Strontium Pm2.5 Lc	60	36	0.000947	0.00145	0.00239	0.00711	0.00583	0.00443
Sulfate Pm2.5 Lc	60	59	2.27	2.27	0.0138	6.85	6.78	6.75
Sulfur Pm2.5 Lc	60	60	0.823	0.823	0.00775	2.93	2.52	2.4
Tin Pm2.5 Lc	60	16	0.00395	0.0132	0.0242	0.0314	0.0303	0.0268
Titanium Pm2.5 Lc	60	38	0.00161	0.00249	0.00469	0.00689	0.00655	0.0049
Total Nitrate Pm2.5 Lc	60	60	1.75	1.75	0.0115	8.01	7.66	7.57
Vanadium Pm2.5 Lc	60	29	0.000753	0.00156	0.0031	0.00666	0.00408	0.0035
Zinc Pm2.5 Lc	60	59	0.0529	0.0529	0.00236	0.542	0.204	0.158
Zirconium Pm2.5 Lc	60	11	0.000622	0.00359	0.00788	0.00932	0.00888	0.00593

Detroit, Fort Street (N. Delray-SWHS) (261630015), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	57	49	0.0285	0.0298	0.0196	0.174	0.0848	0.0753
Ammonium Ion Pm2.5 Lc	57	57	1.11	1.11	0.0127	3.87	3.36	3.19
Antimony Pm2.5 Lc	57	23	0.00714	0.0185	0.0368	0.0549	0.0396	0.0374
Arsenic Pm2.5 Lc	57	29	0.000722	0.00114	0.0018	0.0049	0.00362	0.00326
Barium Pm2.5 Lc	57	10	0.00103	0.00683	0.0139	0.0141	0.0121	0.00826
Bromine Pm2.5 Lc	57	56	0.00395	0.00396	0.00162	0.0221	0.00852	0.0085
Cadmium Pm2.5 Lc	57	19	0.00329	0.00884	0.0156	0.021	0.0198	0.0163
Calcium Pm2.5 Lc	57	57	0.0655	0.0655	0.00609	0.618	0.187	0.144
Cerium Pm2.5 Lc	57	8	0.000191	0.0035	0.0145	0.00339	0.00222	0.00128
Cesium Pm2.5 Lc	57	20	0.00147	0.00549	0.015	0.0133	0.0112	0.00852
Chlorine Pm2.5 Lc	57	50	0.0408	0.0413	0.00714	0.433	0.291	0.228
Chromium Pm2.5 Lc	57	46	0.00157	0.00178	0.00221	0.00738	0.00652	0.00615
Cobalt Pm2.5 Lc	57	47	0.00093	0.00105	0.00141	0.00379	0.00315	0.00233
Copper Pm2.5 Lc	57	52	0.0092	0.00929	0.00202	0.0768	0.0278	0.0224
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	0.431	0.431		1.2	0.916	0.894
Indium Pm2.5 Lc	57	12	0.00194	0.00984	0.0201	0.028	0.0152	0.0106
Iron Pm2.5 Lc	57	57	0.219	0.219	0.00198	0.692	0.642	0.58
Lead Pm2.5 Lc	57	48	0.00672	0.007	0.0037	0.0977	0.0231	0.019
Magnesium Pm2.5 Lc	57	28	0.0108	0.0142	0.014	0.222	0.0631	0.053
Manganese Pm2.5 Lc	57	53	0.0044	0.00447	0.00186	0.0123	0.0119	0.0119
Nickel Pm2.5 Lc	57	38	0.000707	0.000961	0.00144	0.00311	0.00278	0.00273
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	2.25	2.25		5.86	5.17	5.17
Phosphorus Pm2.5 Lc	57	3	0.0000981	0.00532	0.0107	0.00232	0.00187	0.0014
Potassium Ion Pm2.5 Lc	57	50	0.056	0.0568	0.0128	0.189	0.179	0.16
Potassium Pm2.5 Lc	57	57	0.0589	0.0589	0.00717	0.224	0.215	0.204
Rubidium Pm2.5 Lc	57	16	0.000209	0.000949	0.00197	0.00183	0.00136	0.00114
Selenium Pm2.5 Lc	57	34	0.000986	0.0014	0.00226	0.00721	0.00582	0.00489
Silicon Pm2.5 Lc	57	56	0.0624	0.0625	0.0133	0.493	0.196	0.154
Silver Pm2.5 Lc	57	10	0.000795	0.00875	0.0179	0.0106	0.0092	0.00872
Sodium Ion Pm2.5 Lc	57	56	0.0592	0.0593	0.0172	0.206	0.176	0.143
Sodium Pm2.5 Lc	57	51	0.0471	0.0494	0.0397	0.204	0.177	0.115
Strontium Pm2.5 Lc	57	20	0.000547	0.00135	0.00247	0.0117	0.00488	0.00221
Sulfate Pm2.5 Lc	57	57	2.25	2.25	0.0119	6.94	6.9	6.34
Sulfur Pm2.5 Lc	57	57	0.78	0.78	0.00775	2.45	2.43	2.38
Tin Pm2.5 Lc	57	17	0.00459	0.0136	0.025	0.048	0.0328	0.0211
Titanium Pm2.5 Lc	57	34	0.00176	0.00272	0.00468	0.0126	0.0122	0.0101
Total Nitrate Pm2.5 Lc	57	57	1.81	1.81	0.0113	7.39	7.38	7.21
Vanadium Pm2.5 Lc	57	32	0.000826	0.00155	0.00313	0.00547	0.00489	0.00374
Zinc Pm2.5 Lc	57	57	0.0296	0.0296	0.00234	0.126	0.103	0.0723
Zirconium Pm2.5 Lc	57	15	0.00111	0.00386	0.00852	0.0142	0.0104	0.00819

Allen Park (261630001), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	119	102	0.0318	0.033	0.0192	0.425	0.207	0.101
Ammonium Ion Pm2.5 Lc	119	119	1.18	1.18	0.0139	4.25	3.87	3.8
Antimony Pm2.5 Lc	119	38	0.00705	0.0203	0.0378	0.0956	0.0571	0.0514
Arsenic Pm2.5 Lc	119	63	0.00074	0.00119	0.00178	0.00501	0.0042	0.00397
Barium Pm2.5 Lc	119	32	0.00169	0.00551	0.0133	0.0607	0.0173	0.0105
Bromine Pm2.5 Lc	119	117	0.00354	0.00356	0.00164	0.015	0.00921	0.00886
Cadmium Pm2.5 Lc	119	28	0.00166	0.00804	0.016	0.0158	0.0152	0.0148
Calcium Pm2.5 Lc	119	119	0.048	0.048	0.00603	0.197	0.13	0.115
Cerium Pm2.5 Lc	119	17	0.000143	0.00376	0.0136	0.00339	0.00257	0.00152
Cesium Pm2.5 Lc	119	32	0.000811	0.00573	0.0153	0.0103	0.00724	0.00701
Chlorine Pm2.5 Lc	119	108	0.0184	0.0188	0.00699	0.205	0.176	0.165
Chromium Pm2.5 Lc	119	108	0.00239	0.00249	0.00224	0.0124	0.0103	0.01
Cobalt Pm2.5 Lc	119	84	0.000595	0.000807	0.00139	0.00279	0.00198	0.00187
Copper Pm2.5 Lc	119	113	0.00885	0.0089	0.00196	0.0479	0.045	0.0357
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	117	117	0.452	0.452		2.2	0.942	0.912
Indium Pm2.5 Lc	119	37	0.00306	0.0102	0.0205	0.0327	0.028	0.0268
Iron Pm2.5 Lc	119	119	0.0987	0.0987	0.00194	0.288	0.276	0.247
Lead Pm2.5 Lc	119	86	0.00232	0.00285	0.00373	0.0138	0.0124	0.0122
Magnesium Pm2.5 Lc	119	34	0.0037	0.00842	0.0136	0.134	0.046	0.0225
Manganese Pm2.5 Lc	119	111	0.00242	0.00249	0.00187	0.0122	0.00974	0.00845
Nickel Pm2.5 Lc	119	87	0.000744	0.000941	0.0014	0.00451	0.00386	0.00348
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	117	117	2.28	2.28		6.21	5.64	5.07
Phosphorus Pm2.5 Lc	119	1	0.0000304	0.00551	0.011	0.00362	0	0
Potassium Ion Pm2.5 Lc	119	107	0.0702	0.0708	0.0138	1.7	0.239	0.229
Potassium Pm2.5 Lc	119	119	0.0725	0.0725	0.0069	1.81	0.26	0.239
Rubidium Pm2.5 Lc	119	35	0.000229	0.000947	0.00199	0.0028	0.00187	0.00175
Selenium Pm2.5 Lc	119	72	0.00103	0.00144	0.00221	0.0091	0.00572	0.00537
Silicon Pm2.5 Lc	119	118	0.0553	0.0553	0.013	0.327	0.205	0.198
Silver Pm2.5 Lc	119	21	0.00121	0.00924	0.0184	0.0191	0.0153	0.0147
Sodium Ion Pm2.5 Lc	119	117	0.0636	0.0639	0.0172	0.338	0.282	0.186
Sodium Pm2.5 Lc	119	96	0.0344	0.0385	0.0387	0.35	0.132	0.128
Strontium Pm2.5 Lc	119	63	0.00129	0.00189	0.0025	0.0683	0.00665	0.00502
Sulfate Pm2.5 Lc	119	119	2.32	2.32	0.0134	8.91	7.8	7.06
Sulfur Pm2.5 Lc	119	119	0.818	0.818	0.00777	3.81	2.44	2.38
Tin Pm2.5 Lc	119	25	0.00246	0.0128	0.0254	0.0502	0.0338	0.0303
Titanium Pm2.5 Lc	119	71	0.00156	0.00251	0.00468	0.009	0.00829	0.00806
Total Nitrate Pm2.5 Lc	119	119	1.98	1.98	0.011	9.69	8.06	7.68
Vanadium Pm2.5 Lc	119	58	0.000557	0.00138	0.00316	0.00421	0.00385	0.00327
Zinc Pm2.5 Lc	119	116	0.0158	0.0158	0.00235	0.0618	0.0432	0.0426
Zirconium Pm2.5 Lc	119	31	0.0011	0.00406	0.00868	0.0123	0.0113	0.00957

Port Huron, Nat'l Guard Arm. (261470005), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	50	0.0215	0.0231	0.0186	0.0719	0.0717	0.066
Ammonium Ion Pm2.5 Lc	60	59	0.805	0.805	0.0129	3.45	3.04	2.13
Antimony Pm2.5 Lc	60	18	0.00605	0.0193	0.0374	0.0629	0.0501	0.0326
Arsenic Pm2.5 Lc	60	33	0.000806	0.00121	0.00166	0.00408	0.00396	0.00361
Barium Pm2.5 Lc	60	4	0.000272	0.00569	0.0122	0.00767	0.00548	0.0028
Bromine Pm2.5 Lc	60	59	0.00387	0.00389	0.00157	0.0285	0.0222	0.0104
Cadmium Pm2.5 Lc	60	14	0.00266	0.00899	0.0158	0.0196	0.0186	0.0186
Calcium Pm2.5 Lc	60	60	0.0347	0.0347	0.00619	0.131	0.121	0.1
Cerium Pm2.5 Lc	60	5	0.0000913	0.00368	0.0117	0.00163	0.00152	0.00117
Cesium Pm2.5 Lc	60	12	0.000652	0.00621	0.0157	0.00746	0.00605	0.00524
Chlorine Pm2.5 Lc	60	50	0.01	0.0107	0.00696	0.0833	0.0425	0.0409
Chromium Pm2.5 Lc	60	36	0.000602	0.00104	0.00224	0.00422	0.00347	0.00245
Cobalt Pm2.5 Lc	60	35	0.000331	0.000614	0.00135	0.00157	0.00153	0.00121
Copper Pm2.5 Lc	60	42	0.00154	0.00182	0.00193	0.00949	0.00865	0.0059
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	60	59	0.194	0.197		0.562	0.474	0.462
Indium Pm2.5 Lc	60	18	0.00273	0.00972	0.0196	0.0248	0.0233	0.0175
Iron Pm2.5 Lc	60	60	0.0372	0.0372	0.00188	0.0948	0.0856	0.0736
Lead Pm2.5 Lc	60	34	0.00515	0.00592	0.0036	0.0675	0.0602	0.043
Magnesium Pm2.5 Lc	60	9	0.000882	0.00675	0.0136	0.0155	0.0102	0.0102
Manganese Pm2.5 Lc	60	40	0.000901	0.0012	0.00183	0.00377	0.00307	0.00296
Nickel Pm2.5 Lc	60	44	0.00077	0.000962	0.00139	0.00377	0.00253	0.00249
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	60	60	1.97	1.97		5.02	3.94	3.88
Phosphorus Pm2.5 Lc	60	3	0.00167	0.00691	0.0112	0.0459	0.0422	0.012
Potassium Ion Pm2.5 Lc	60	46	0.0386	0.0401	0.0131	0.171	0.126	0.0916
Potassium Pm2.5 Lc	60	59	0.0427	0.0427	0.0071	0.187	0.182	0.102
Rubidium Pm2.5 Lc	60	16	0.000114	0.000807	0.00192	0.00113	0.00082	0.00081
Selenium Pm2.5 Lc	60	31	0.000549	0.00107	0.00215	0.00431	0.00311	0.00228
Silicon Pm2.5 Lc	60	58	0.0383	0.0385	0.013	0.24	0.132	0.119
Silver Pm2.5 Lc	60	15	0.00172	0.00833	0.0166	0.0128	0.0128	0.0124
Sodium Ion Pm2.5 Lc	60	59	0.0407	0.0407	0.0168	0.133	0.132	0.0815
Sodium Pm2.5 Lc	60	38	0.021	0.0291	0.0396	0.0947	0.0825	0.0796
Strontium Pm2.5 Lc	60	19	0.000559	0.00135	0.00238	0.0093	0.00349	0.00245
Sulfate Pm2.5 Lc	60	59	1.89	1.89	0.0127	6.84	5.82	5.2
Sulfur Pm2.5 Lc	60	60	0.678	0.678	0.00804	2.25	2.16	2.04
Tin Pm2.5 Lc	60	19	0.00395	0.013	0.025	0.0279	0.0233	0.0175
Titanium Pm2.5 Lc	60	27	0.00109	0.0024	0.00474	0.0116	0.00936	0.00408
Total Nitrate Pm2.5 Lc	60	59	1.28	1.28	0.0115	6.65	5.99	4.88
Vanadium Pm2.5 Lc	60	32	0.00114	0.00189	0.00321	0.00908	0.00536	0.00525
Zinc Pm2.5 Lc	60	56	0.021	0.0211	0.00242	0.184	0.159	0.0939
Zirconium Pm2.5 Lc	60	7	0.000301	0.00359	0.00734	0.00466	0.00466	0.00234

Luna Pier (261150005), Speciated $PM_{2.5}$ (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	61	51	0.0207	0.0222	0.0182	0.0945	0.0855	0.0804
Ammonium Ion Pm2.5 Lc	61	61	1.07	1.07	0.0138	3.81	3.58	3.31
Antimony Pm2.5 Lc	61	16	0.00505	0.0198	0.0384	0.0478	0.0338	0.0337
Arsenic Pm2.5 Lc	61	24	0.000493	0.00104	0.00178	0.0054	0.00443	0.0021
Barium Pm2.5 Lc	61	8	0.000468	0.00511	0.0137	0.00977	0.0063	0.00372
Bromine Pm2.5 Lc	61	60	0.00302	0.00304	0.00168	0.00723	0.00674	0.00629
Cadmium Pm2.5 Lc	61	13	0.00187	0.0088	0.0166	0.0186	0.0166	0.0124
Calcium Pm2.5 Lc	61	61	0.037	0.037	0.00583	0.173	0.163	0.103
Cerium Pm2.5 Lc	61	5	0.000059	0.00417	0.014	0.00151	0.00105	0.0007
Cesium Pm2.5 Lc	61	11	0.00059	0.00695	0.0178	0.0114	0.00595	0.00467
Chlorine Pm2.5 Lc	61	51	0.00791	0.00851	0.00676	0.0751	0.0338	0.0243
Chromium Pm2.5 Lc	61	46	0.0019	0.00218	0.00224	0.0185	0.0174	0.00756
Cobalt Pm2.5 Lc	61	38	0.000494	0.000753	0.00136	0.00241	0.00207	0.00176
Copper Pm2.5 Lc	61	39	0.00129	0.0016	0.00186	0.00678	0.00671	0.00573
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	0.272	0.272		0.719	0.688	0.667
Indium Pm2.5 Lc	61	17	0.00314	0.0114	0.0208	0.0223	0.0221	0.0215
Iron Pm2.5 Lc	61	61	0.0622	0.0622	0.00189	0.374	0.184	0.179
Lead Pm2.5 Lc	61	49	0.00291	0.00333	0.0039	0.0303	0.00942	0.00794
Magnesium Pm2.5 Lc	61	13	0.00194	0.00729	0.0131	0.0228	0.0226	0.0179
Manganese Pm2.5 Lc	61	51	0.00166	0.00183	0.00189	0.0166	0.00592	0.00436
Nickel Pm2.5 Lc	61	44	0.000714	0.000901	0.00136	0.00383	0.00352	0.00349
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	1.94	1.94		5.95	4.24	4.18
Phosphorus Pm2.5 Lc	61	2	0.000115	0.00541	0.0108	0.0036	0.00339	0
Potassium Ion Pm2.5 Lc	61	52	0.044	0.0452	0.0137	0.175	0.104	0.102
Potassium Pm2.5 Lc	61	61	0.0499	0.0499	0.00637	0.227	0.155	0.0984
Rubidium Pm2.5 Lc	61	22	0.000219	0.000884	0.002	0.00141	0.0014	0.00138
Selenium Pm2.5 Lc	61	48	0.00185	0.00207	0.00216	0.0183	0.00887	0.00885
Silicon Pm2.5 Lc	61	58	0.0472	0.0475	0.0124	0.254	0.208	0.202
Silver Pm2.5 Lc	61	14	0.00164	0.00852	0.0182	0.0221	0.0174	0.0163
Sodium Ion Pm2.5 Lc	61	60	0.0506	0.0508	0.0172	0.181	0.133	0.113
Sodium Pm2.5 Lc	61	47	0.0298	0.0344	0.038	0.159	0.143	0.128
Strontium Pm2.5 Lc	61	24	0.000665	0.00143	0.00252	0.00477	0.00465	0.00384
Sulfate Pm2.5 Lc	61	61	2.35	2.35	0.0128	7.9	6.44	6.25
Sulfur Pm2.5 Lc	61	61	0.842	0.842	0.00765	2.71	2.64	2.21
Tin Pm2.5 Lc	61	15	0.00305	0.0134	0.0262	0.035	0.0209	0.0201
Titanium Pm2.5 Lc	61	32	0.00933	0.0104	0.00462	0.364	0.102	0.0408
Total Nitrate Pm2.5 Lc	61	61	1.7	1.7	0.0118	8.64	7.37	5.89
Vanadium Pm2.5 Lc	61	29	0.00065	0.00149	0.00313	0.00687	0.00257	0.00256
Zinc Pm2.5 Lc	61	58	0.00963	0.00972	0.00245	0.0308	0.0282	0.0281
Zirconium Pm2.5 Lc	61	15	0.000736	0.0038	0.00838	0.0116	0.00886	0.00314

Houghton Lake (261130001), Speciated $PM_{2.5}$ ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	58	41	0.0143	0.0171	0.0191	0.0848	0.0535	0.0523
Ammonium Ion Pm2.5 Lc	58	55	0.51	0.511	0.0124	2.1	2.04	1.92
Antimony Pm2.5 Lc	58	20	0.00721	0.0207	0.0386	0.0608	0.0443	0.0373
Arsenic Pm2.5 Lc	58	19	0.000367	0.000989	0.0018	0.00297	0.00275	0.0021
Barium Pm2.5 Lc	58	3	0.000117	0.0055	0.0121	0.0042	0.00198	0.00058
Bromine Pm2.5 Lc	58	55	0.00241	0.00245	0.00166	0.007	0.00544	0.00531
Cadmium Pm2.5 Lc	58	11	0.00123	0.00829	0.0164	0.0173	0.0117	0.0105
Calcium Pm2.5 Lc	58	56	0.0154	0.0156	0.00583	0.075	0.0535	0.0528
Cerium Pm2.5 Lc	58	6	0.000137	0.00348	0.0115	0.00222	0.00198	0.0014
Cesium Pm2.5 Lc	58	11	0.000555	0.00699	0.0169	0.00747	0.00536	0.00466
Chlorine Pm2.5 Lc	58	41	0.00452	0.00554	0.00663	0.0492	0.0224	0.0157
Chromium Pm2.5 Lc	58	35	0.00103	0.00147	0.00222	0.0263	0.00218	0.00211
Cobalt Pm2.5 Lc	58	35	0.000327	0.000593	0.00135	0.00165	0.00117	0.00111
Copper Pm2.5 Lc	58	31	0.000702	0.00113	0.00191	0.0117	0.00422	0.00309
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	59	59	0.0767	0.0767		0.27	0.214	0.21
Indium Pm2.5 Lc	58	13	0.00224	0.0108	0.021	0.0315	0.0163	0.014
Iron Pm2.5 Lc	58	58	0.0201	0.0201	0.00186	0.161	0.0703	0.0645
Lead Pm2.5 Lc	58	24	0.000834	0.00195	0.00385	0.0133	0.00525	0.00431
Magnesium Pm2.5 Lc	58	9	0.00184	0.00731	0.0133	0.0479	0.0365	0.00896
Manganese Pm2.5 Lc	58	31	0.000665	0.00107	0.00184	0.00313	0.00266	0.00254
Nickel Pm2.5 Lc	58	31	0.000493	0.000821	0.00137	0.0072	0.00502	0.00171
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	59	59	1.36	1.36		5.21	3.97	3.71
Phosphorus Pm2.5 Lc	58	2	0.0000443	0.00528	0.0107	0.00175	0.00082	0
Potassium Ion Pm2.5 Lc	58	33	0.0284	0.031	0.0126	0.151	0.143	0.0838
Potassium Pm2.5 Lc	58	58	0.0324	0.0324	0.00663	0.207	0.118	0.0692
Rubidium Pm2.5 Lc	58	12	0.000151	0.000933	0.00196	0.00201	0.0014	0.00114
Selenium Pm2.5 Lc	58	21	0.000358	0.00108	0.00223	0.00289	0.00166	0.00163
Silicon Pm2.5 Lc	58	52	0.0249	0.0257	0.0131	0.202	0.118	0.101
Silver Pm2.5 Lc	58	8	0.000857	0.00908	0.0182	0.0129	0.0128	0.00735
Sodium Ion Pm2.5 Lc	58	56	0.0316	0.0319	0.0173	0.0864	0.0744	0.0669
Sodium Pm2.5 Lc	58	36	0.0162	0.0246	0.0393	0.136	0.0882	0.0537
Strontium Pm2.5 Lc	58	19	0.000211	0.00103	0.00247	0.00163	0.00151	0.00128
Sulfate Pm2.5 Lc	58	58	1.45	1.45	0.0145	4.22	4.1	3.79
Sulfur Pm2.5 Lc	58	58	0.507	0.507	0.00769	1.65	1.53	1.47
Tin Pm2.5 Lc	58	15	0.00289	0.0131	0.0266	0.0281	0.0198	0.0187
Titanium Pm2.5 Lc	58	20	0.000523	0.00203	0.00462	0.0042	0.00315	0.00315
Total Nitrate Pm2.5 Lc	58	58	0.783	0.783	0.01	5.29	5.25	3.99
Vanadium Pm2.5 Lc	58	18	0.000324	0.00142	0.00313	0.00268	0.00257	0.00257
Zinc Pm2.5 Lc	58	43	0.00325	0.00364	0.00252	0.0133	0.0107	0.00981
Zirconium Pm2.5 Lc	58	13	0.001	0.00384	0.00858	0.0175	0.00883	0.00595

Tecumseh (260910007), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	48	0.0187	0.0203	0.0193	0.0872	0.067	0.0549
Ammonium Ion Pm2.5 Lc	60	58	0.986	0.986	0.0129	3.83	3.06	2.97
Antimony Pm2.5 Lc	60	25	0.0098	0.0204	0.0365	0.0794	0.0589	0.0432
Arsenic Pm2.5 Lc	60	30	0.000735	0.00119	0.00183	0.00376	0.00327	0.00291
Barium Pm2.5 Lc	60	5	0.000451	0.00566	0.0145	0.0118	0.00862	0.00349
Bromine Pm2.5 Lc	60	54	0.00296	0.00303	0.00164	0.00665	0.00664	0.00661
Cadmium Pm2.5 Lc	60	18	0.0021	0.0078	0.0155	0.0187	0.0152	0.014
Calcium Pm2.5 Lc	60	59	0.0229	0.0229	0.00596	0.101	0.0726	0.0644
Cerium Pm2.5 Lc	60	5	0.0000483	0.00545	0.0154	0.00081	0.00081	0.0007
Cesium Pm2.5 Lc	60	12	0.000568	0.00602	0.0165	0.00641	0.00519	0.00454
Chlorine Pm2.5 Lc	60	46	0.00588	0.00691	0.00708	0.032	0.0234	0.0228
Chromium Pm2.5 Lc	60	40	0.00117	0.00155	0.00219	0.00846	0.00729	0.00654
Cobalt Pm2.5 Lc	60	33	0.00034	0.000654	0.0014	0.00233	0.0015	0.00143
Copper Pm2.5 Lc	60	39	0.00122	0.00155	0.002	0.00874	0.00569	0.0038
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	56	56	0.166	0.166		0.354	0.349	0.341
Indium Pm2.5 Lc	60	17	0.00336	0.0108	0.0201	0.0222	0.018	0.0177
Iron Pm2.5 Lc	60	60	0.039	0.039	0.00199	0.138	0.107	0.101
Lead Pm2.5 Lc	60	36	0.00184	0.00258	0.00381	0.00652	0.0063	0.00571
Magnesium Pm2.5 Lc	60	17	0.00179	0.00673	0.014	0.0302	0.0114	0.00932
Manganese Pm2.5 Lc	60	48	0.00283	0.00302	0.00187	0.0382	0.0209	0.0124
Nickel Pm2.5 Lc	60	41	0.000428	0.000664	0.00144	0.00222	0.00188	0.00175
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	56	56	1.87	1.87		4.95	3.84	3.47
Phosphorus Pm2.5 Lc	60	1	7.67E-06	0.00516	0.0104	0.00046	0	0
Potassium Ion Pm2.5 Lc	60	52	0.0466	0.0474	0.0135	0.206	0.154	0.128
Potassium Pm2.5 Lc	60	60	0.0487	0.0487	0.00702	0.222	0.182	0.119
Rubidium Pm2.5 Lc	60	15	0.000169	0.000918	0.00196	0.00163	0.00128	0.0012
Selenium Pm2.5 Lc	60	30	0.000656	0.0012	0.00229	0.00431	0.00385	0.00348
Silicon Pm2.5 Lc	60	56	0.0349	0.0352	0.0133	0.207	0.189	0.0917
Silver Pm2.5 Lc	60	9	0.00148	0.00944	0.0176	0.0181	0.0158	0.0113
Sodium Ion Pm2.5 Lc	60	58	0.038	0.0383	0.014	0.233	0.0811	0.0766
Sodium Pm2.5 Lc	60	42	0.0166	0.0235	0.0402	0.06	0.055	0.0522
Strontium Pm2.5 Lc	60	19	0.000316	0.00116	0.00247	0.00431	0.00221	0.00175
Sulfate Pm2.5 Lc	60	60	2.12	2.12	0.0138	7.53	7.36	6.1
Sulfur Pm2.5 Lc	60	60	0.777	0.777	0.00761	2.76	2.61	2.41
Tin Pm2.5 Lc	60	17	0.00166	0.0113	0.0252	0.0199	0.0163	0.0152
Titanium Pm2.5 Lc	60	29	0.00103	0.00225	0.00463	0.00525	0.00502	0.00455
Total Nitrate Pm2.5 Lc	60	60	1.66	1.66	0.0124	7.48	6.91	6.67
Vanadium Pm2.5 Lc	60	22	0.000441	0.00141	0.00308	0.00351	0.0035	0.00303
Zinc Pm2.5 Lc	60	55	0.00944	0.00957	0.00241	0.0302	0.0297	0.025
Zirconium Pm2.5 Lc	60	14	0.000483	0.00371	0.00833	0.0064	0.00536	0.00246

Grand Rapids - Monroe St. (260810020), Speciated PM2.5 (µg/m3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	94	69	0.0228	0.0249	0.0182	0.134	0.11	0.109
Ammonium Ion Pm2.5 Lc	95	95	1.08	1.08	0.0137	4.49	4.47	4.04
Arsenic Pm2.5 Lc	94	51	0.000788	0.00121	0.00167	0.00489	0.00454	0.00408
Barium Pm2.5 Lc	94	17	0.000899	0.00522	0.0135	0.0166	0.0118	0.00898
Bromine Pm2.5 Lc	94	92	0.0034	0.00342	0.00156	0.0125	0.00911	0.00841
Cadmium Pm2.5 Lc	94	22	0.00223	0.00833	0.0154	0.0234	0.0175	0.0156
Calcium Pm2.5 Lc	94	94	0.0396	0.0396	0.00619	0.446	0.214	0.131
Cerium Pm2.5 Lc	94	10	0.000139	0.00365	0.0137	0.00339	0.00233	0.00187
Cesium Pm2.5 Lc	94	16	0.000595	0.00678	0.0172	0.00806	0.00736	0.00584
Chlorine Pm2.5 Lc	94	82	0.0279	0.0284	0.00712	1.02	0.254	0.134
Chromium Pm2.5 Lc	94	68	0.00119	0.0015	0.00222	0.00894	0.00606	0.0044
Cobalt Pm2.5 Lc	94	62	0.000457	0.000699	0.00136	0.00218	0.00165	0.00154
Copper Pm2.5 Lc	94	81	0.0035	0.00364	0.00194	0.0131	0.0128	0.0123
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	97	97	0.315	0.315		0.891	0.766	0.639
Indium Pm2.5 Lc	94	27	0.00307	0.0101	0.019	0.0233	0.021	0.0187
Iron Pm2.5 Lc	94	94	0.0737	0.0737	0.00192	0.267	0.235	0.219
Lead Pm2.5 Lc	94	66	0.00228	0.00283	0.00369	0.0135	0.0101	0.00887
Magnesium Pm2.5 Lc	94	28	0.00353	0.00841	0.014	0.0552	0.048	0.0417
Manganese Pm2.5 Lc	94	72	0.004	0.00424	0.00185	0.0393	0.0312	0.03
Nickel Pm2.5 Lc	94	62	0.000394	0.000637	0.00141	0.00412	0.00182	0.00154
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	97	97	2.37	2.37		7.25	5.68	5.44
Phosphorus Pm2.5 Lc	94	1	2.55E-06	0.00551	0.0111	0.00024	0	0
Potassium Ion Pm2.5 Lc	95	72	0.0482	0.0498	0.0135	0.346	0.158	0.153
Potassium Pm2.5 Lc	94	94	0.0539	0.0539	0.00714	0.408	0.194	0.167
Rubidium Pm2.5 Lc	94	29	0.000149	0.000822	0.00189	0.00211	0.00123	0.00105
Selenium Pm2.5 Lc	94	53	0.000599	0.00107	0.00217	0.00398	0.00325	0.00265
Silicon Pm2.5 Lc	94	93	0.0478	0.0479	0.0131	0.403	0.265	0.261
Silver Pm2.5 Lc	94	18	0.0014	0.0078	0.0156	0.016	0.0156	0.0132
Sodium Ion Pm2.5 Lc	95	88	0.0413	0.0421	0.0183	0.138	0.121	0.121
Sodium Pm2.5 Lc	94	73	0.0248	0.0296	0.0406	0.179	0.088	0.076
Strontium Pm2.5 Lc	94	40	0.000556	0.00125	0.00235	0.00679	0.00666	0.00327
Sulfate Pm2.5 Lc	95	95	1.83	1.83	0.0129	9.21	5.86	4.94
Sulfur Pm2.5 Lc	94	94	0.654	0.654	0.00796	3.35	2.05	2.01
Tin Pm2.5 Lc	94	19	0.00132	0.0115	0.0246	0.021	0.0141	0.0134
Titanium Pm2.5 Lc	94	50	0.00155	0.00265	0.00472	0.0141	0.0131	0.00854
Total Nitrate Pm2.5 Lc	95	95	1.94	1.94	0.0108	10.9	8.32	7.75
Vanadium Pm2.5 Lc	94	35	0.000427	0.00145	0.00317	0.00397	0.00339	0.00338
Zinc Pm2.5 Lc	94	90	0.0108	0.0109	0.00247	0.0433	0.0329	0.0321
Zirconium Pm2.5 Lc	94	20	0.000914	0.00339	0.0066	0.0152	0.00736	0.00641

Appendix C: 2011 AQI Pie Charts

Appendix C contains pie charts that were created to show the AQI values for each of Michigan's 2011 monitoring sites and includes the total number of days measurements were taken, along with the pollutant distribution of the AQI values for those measurements. It is important to note that not all pollutants are measured at each site. In fact, some sites only obtain AQI measurements for that portion of the year corresponding to the O3 season; therefore, the number of days for each site may not be equivalent to 365. **Figures C.1** through **C.4** are grouped by CSA. **Figures C.5** and **C.6** show the remaining sites (not part of a CSA) located in Michigan's Upper and Lower Peninsulas.

Figure C.1: AQI Summaries for Detroit-Warren-Flint CSA

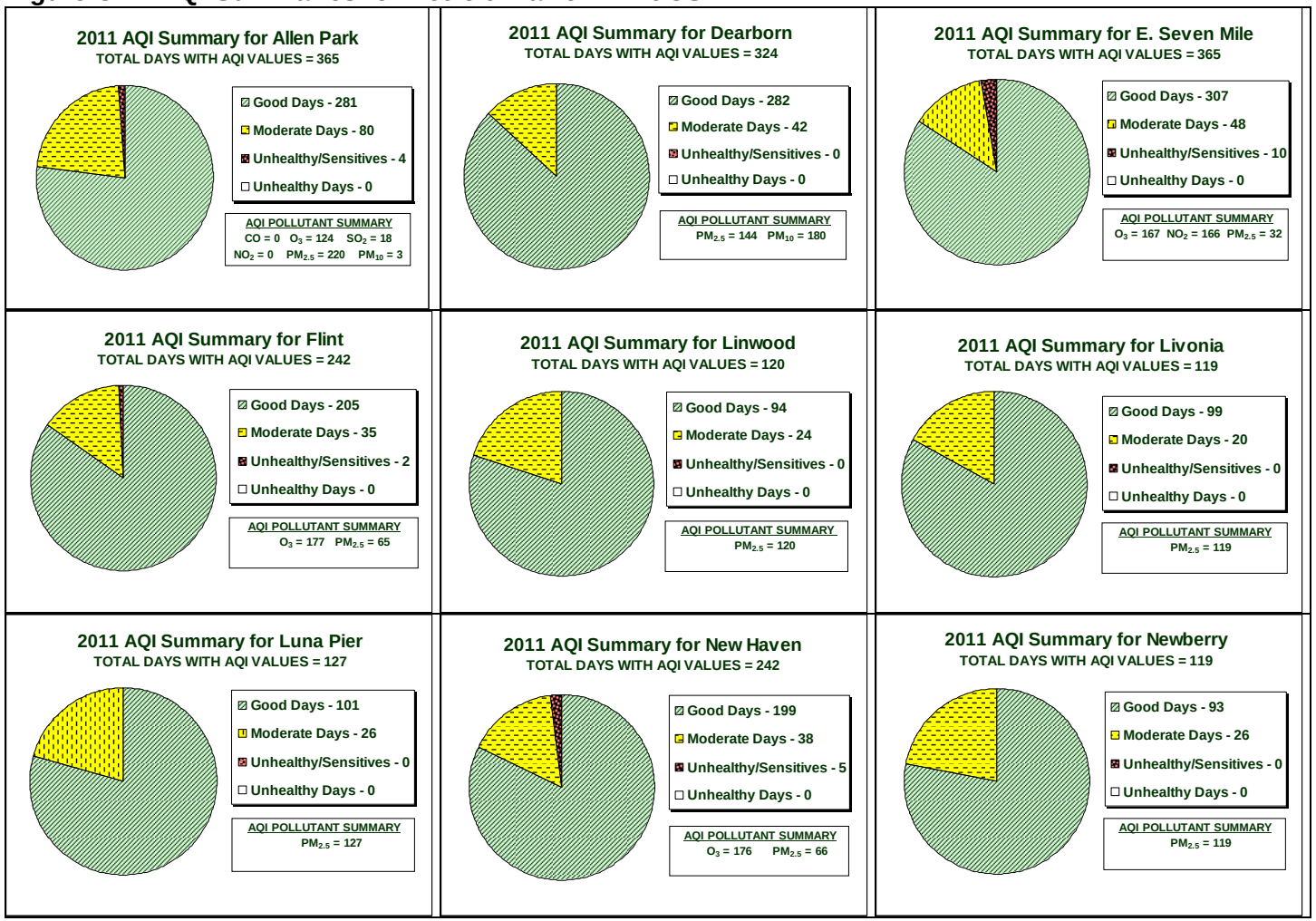
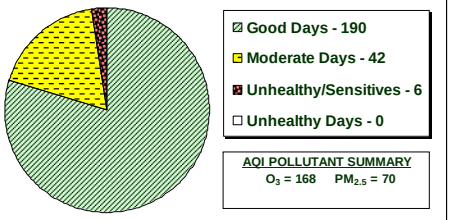
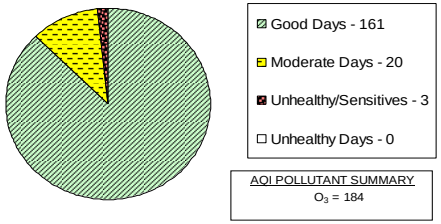
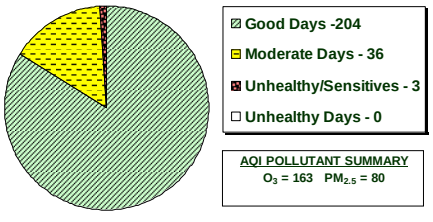
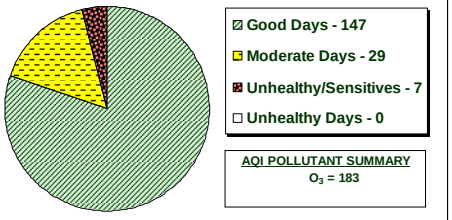


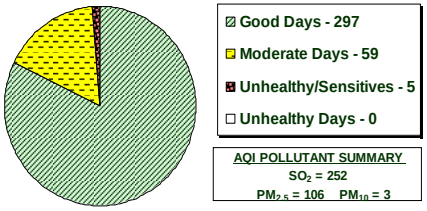
Figure C1, continued: AQI Summaries for Detroit-Warren-Flint-CSA

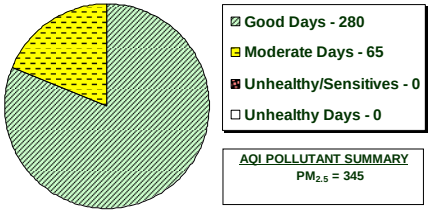


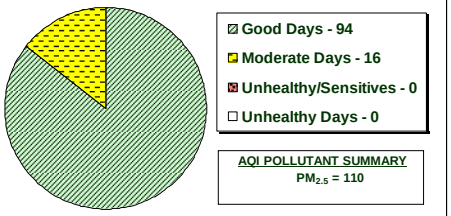












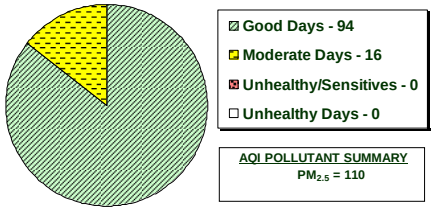


Figure C2: AQI Summaries for Lansing-East Lansing-Owosso CSA

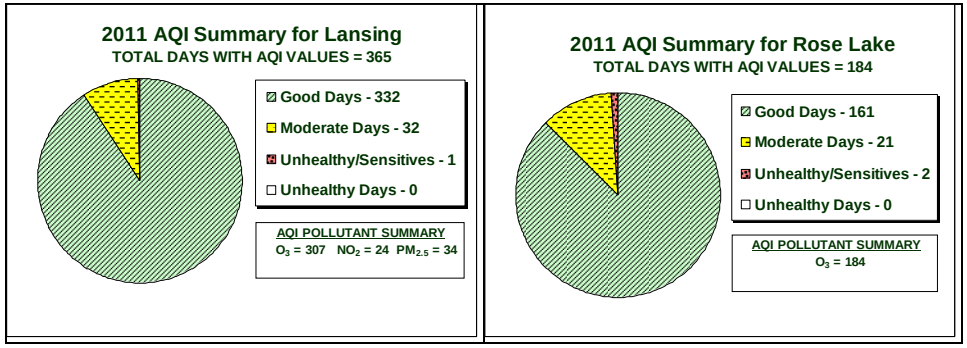


Figure C3: AQI Summary for Saginaw-Bay City-Saginaw Twp North CSA

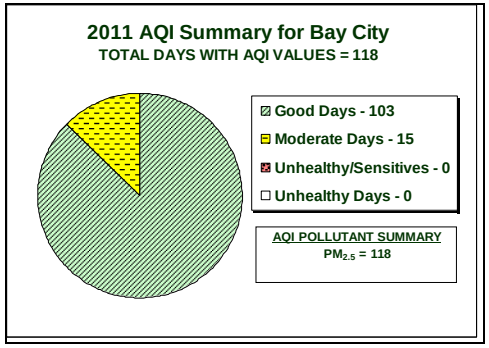


Figure C4: AQI Summaries for Grand Rapids-Muskegon-Holland CSA

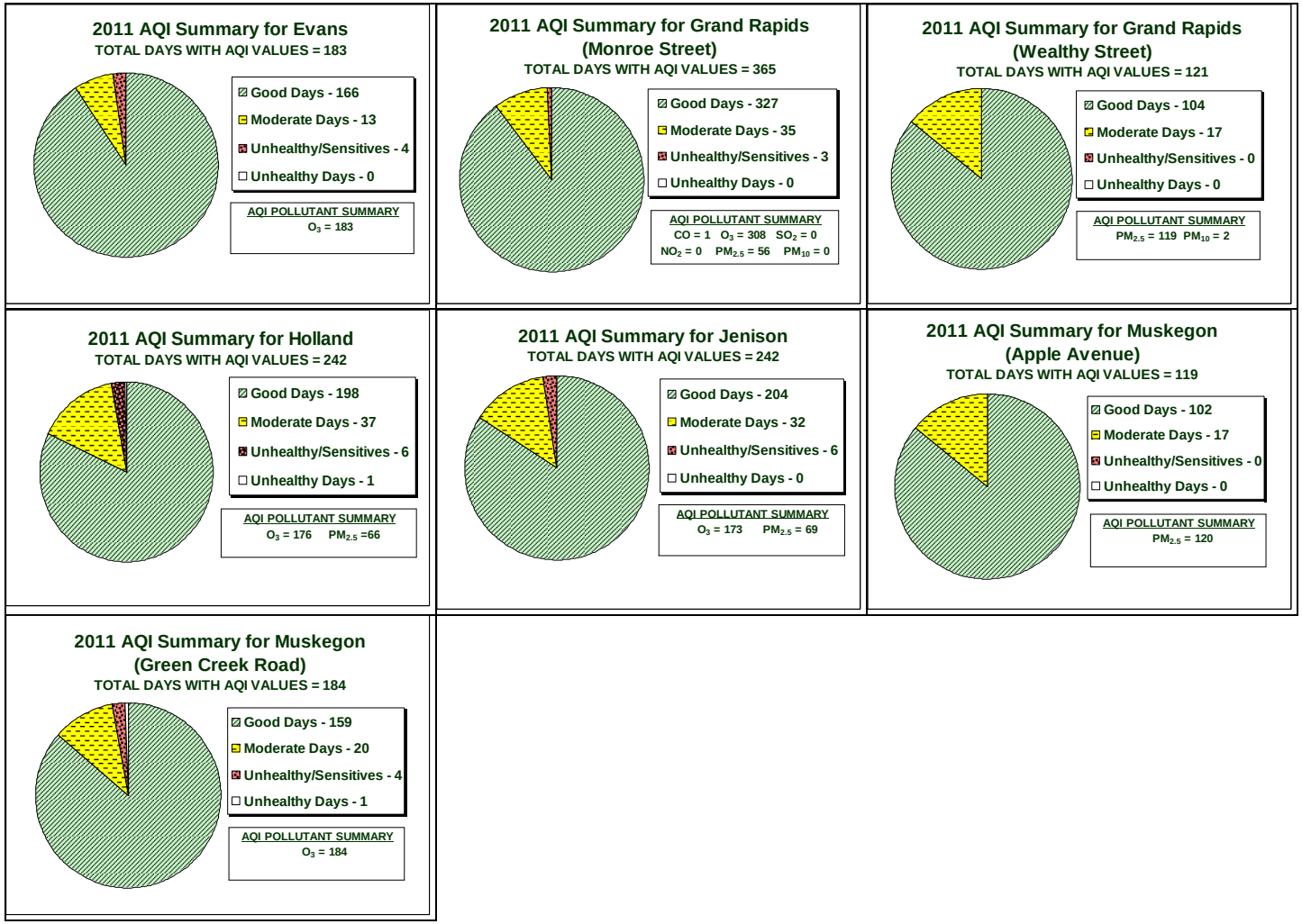


Figure C5: AQI Summary for Upper Peninsula

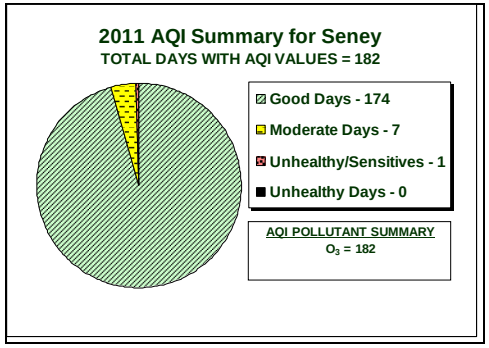
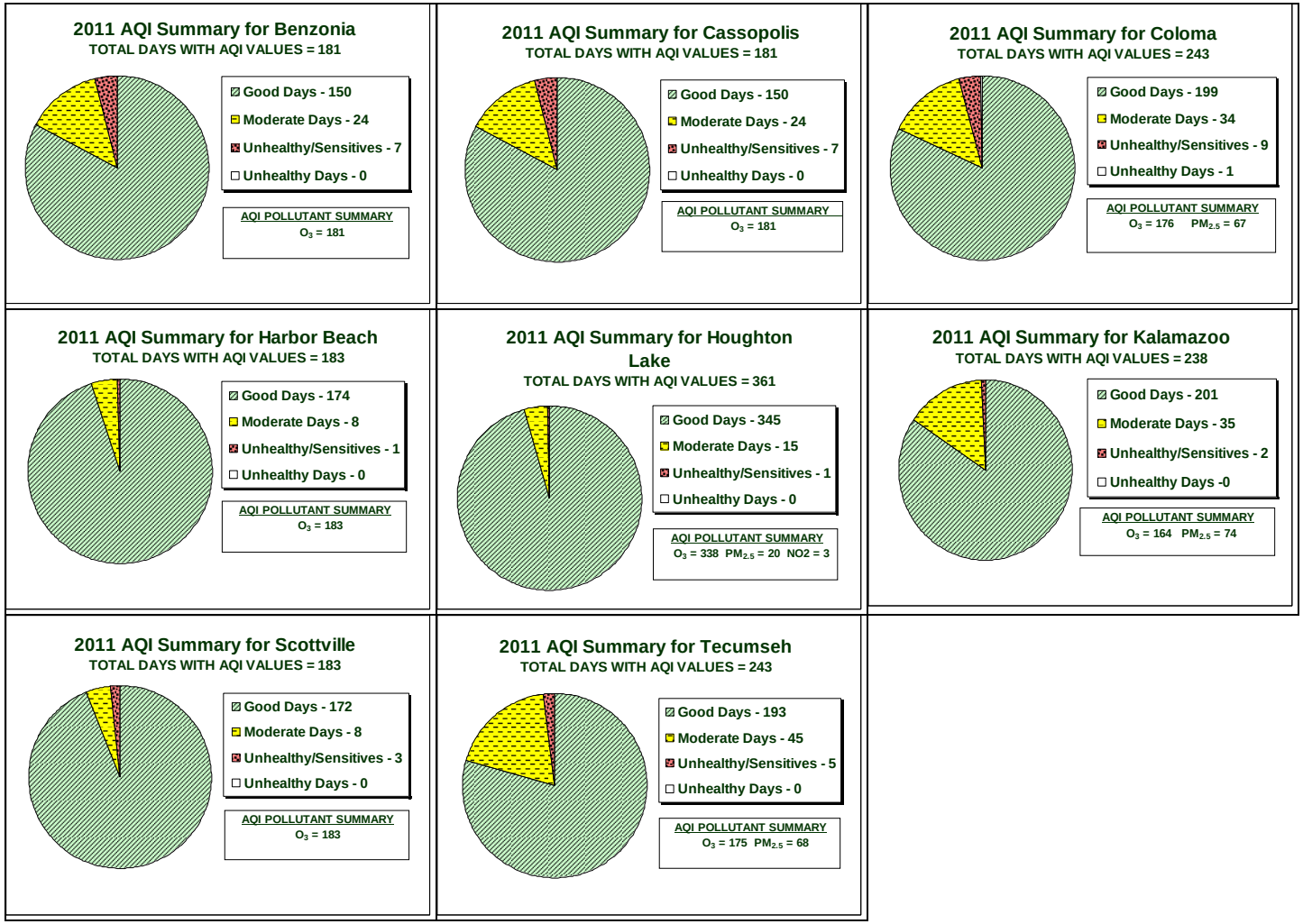
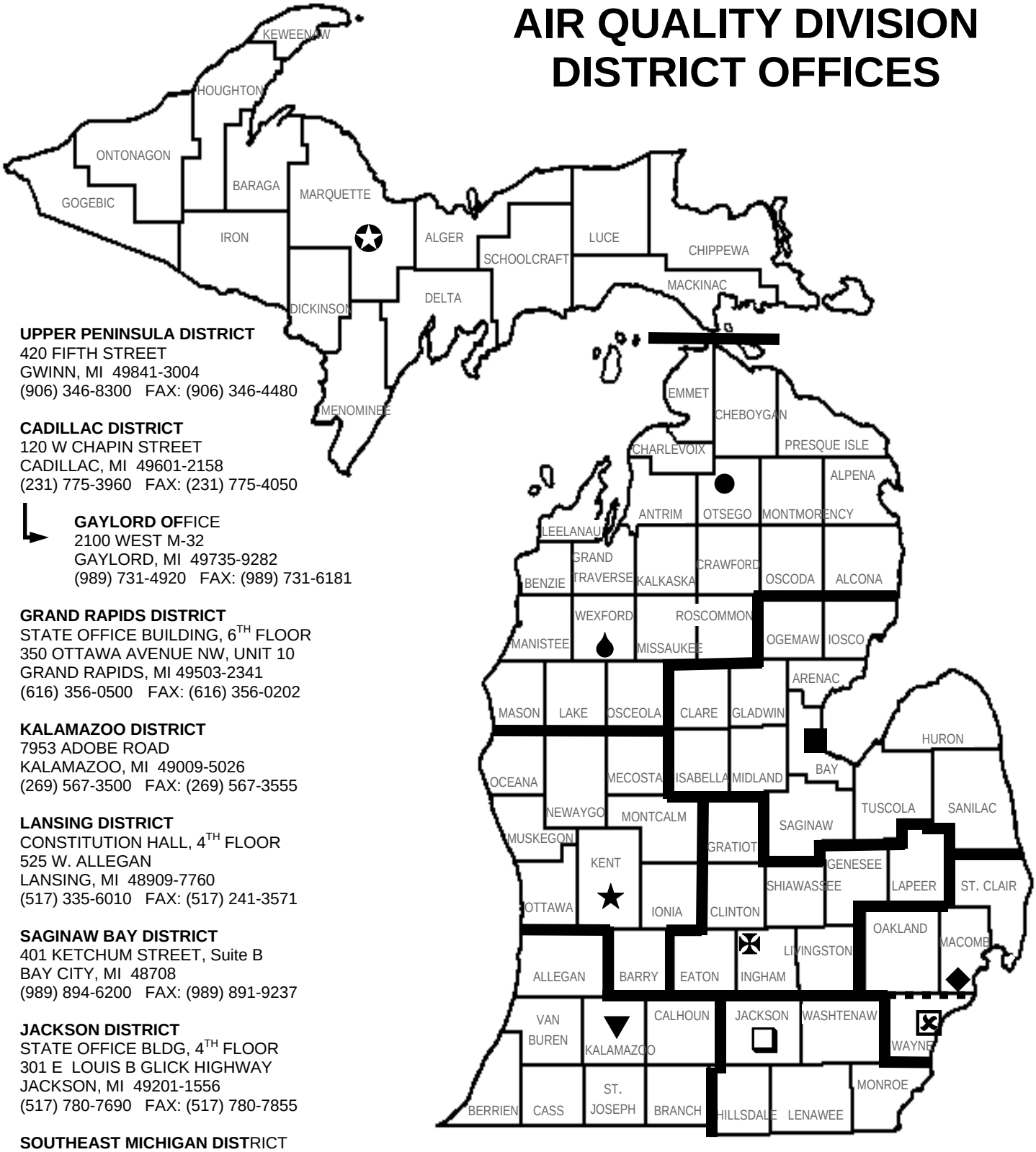


Figure C6: AQI Summaries for Michigan's Other Lower Peninsula Areas



MICHIGAN DEPARTMENT ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

AIR QUALITY DIVISION DISTRICT OFFICES



UPPER PENINSULA DISTRICT
420 FIFTH STREET
GWINN, MI 49841-3004
(906) 346-8300 FAX: (906) 346-4480

CADILLAC DISTRICT
120 W CHAPIN STREET
CADILLAC, MI 49601-2158
(231) 775-3960 FAX: (231) 775-4050

GAYLORD OFFICE
2100 WEST M-32
GAYLORD, MI 49735-9282
(989) 731-4920 FAX: (989) 731-6181

GRAND RAPIDS DISTRICT
STATE OFFICE BUILDING, 6TH FLOOR
350 OTTAWA AVENUE NW, UNIT 10
GRAND RAPIDS, MI 49503-2341
(616) 356-0500 FAX: (616) 356-0202

KALAMAZOO DISTRICT
7953 ADOBE ROAD
KALAMAZOO, MI 49009-5026
(269) 567-3500 FAX: (269) 567-3555

LANSING DISTRICT
CONSTITUTION HALL, 4TH FLOOR
525 W. ALLEGAN
LANSING, MI 48909-7760
(517) 335-6010 FAX: (517) 241-3571

SAGINAW BAY DISTRICT
401 KETCHUM STREET, Suite B
BAY CITY, MI 48708
(989) 894-6200 FAX: (989) 891-9237

JACKSON DISTRICT
STATE OFFICE BLDG, 4TH FLOOR
301 E LOUIS B GLICK HIGHWAY
JACKSON, MI 49201-1556
(517) 780-7690 FAX: (517) 780-7855

SOUTHEAST MICHIGAN DISTRICT
27700 DONALD COURT
WARREN, MI 48092-2793
(586) 753-3700 FAX: (586) 753-3731

DETROIT DISTRICT OFFICE
CADILLAC PLACE, SUITE 2-300
3058 WEST GRAND BLVD
DETROIT, MI 48202-6058
(313) 456-4700 FAX: (313) 456-4692
[Wayne County sources]

AIR QUALITY INTERNET ADDRESS:

www.michigan.gov/air

4/2012