2016 Annual Air Quality Report

Michigan

Department of Environmental Quality

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AQES, Air Monitoring Unit Staff:

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

AQES, Biowatch Unit Staff: David Gregory

AQES, SIP Unit Staff: Mary Maupin

AQES, Strategy Develop Unit Staff: Jim Haywood

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

AQES, Section Secretary: Lorraine Hickman

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Cover Photos: Top – Foliage near Kalkaska, Courtesy of Andrew Kent, Lower Right and Lower Left – Leaves, Courtesy of Peter DeHart

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2016 Air Quality Report

Introduction

The federal Clean Air Act (CAA) requires the United States Environmental Protection Agency (USEPA) to establish National Ambient Air Quality Standards (NAAQS) for six criteria pollutants considered harmful to public health and the environment. Criteria pollutants are the pollutants for which the USEPA must describe the characteristics and potential health and welfare effects.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 Michigan 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 2016,
- Attainment/nonattainment status,
- Monitoring site locations (tables show all the monitors active in 2016), and
- Air quality trends from 2011-2016 broken down by location.[1]

The 2016 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 2016 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2016 Network Review),[3] air toxics monitoring program, and other AQD programs, such as MIair and the Emissions Inventory.[4]

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[1] Air quality trends are based on actual statewide monitored readings, which are also listed in the USEPA's Air Quality Subsystem Quick Look Report Data at https://www3.epa.gov/airtrends/

[2] A fact sheet and a Citizen's guide to participation are available on the DEQ's website at http://www.michigan.gov/documents/deq/deq-ess-caap-citizensguidetomiairpollutioncontrol_195548_7.pdf and http://www.michigan.gov/documents/deq/deq-ead-guide-aqdguide_273529_7.pdf.

[3] Available online at http://www.michigan.gov/documents/deq/deq-aqd-toxics-2016_Air_Mon_Network_Review_489490_7.pdf

[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/deq/0,4561,7-135-3310_4195---,00.html

Chapter 1: Background Information

This chapter provides a summary of the development of the NAAQS (see Appendix D) and how compliance with these standards is determined. Also included is an overview of Michigan's air sampling network, long-term air quality trends, and the variety of monitoring techniques and requirements used to ensure quality data is obtained.

National Ambient Air Quality Standards (NAAQS)

Under Section 109 of the CAA, the USEPA established 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, impacts on visibility and climate, and 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 (long-term) effects.

NAAQS have been established for CO, Pb, NO_2, PM, O_3, and SO_2. **Table 1.1** lists the primary and secondary NAAQS, averaging time and concentration level for each criteria pollutant in effect in 2016. 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 2016 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)	8-hour average, not to be exceeded more than once per year *(1971)*	None*	
	35 ppm (40 mg/m^3)	1-hour average, not to be exceeded more than once per year *(1971)*		
Lead (Pb)	0.15 µg/m^3	Maximum rolling 3-month average *(2008)*	Same as Primary	
Nitrogen Dioxide (NO_2)	0.053 ppm (100 µg/m^3)	Annual mean *(1971)*	Same as Primary	
	0.100 ppm	98^{th} percentile of 1-hour average, averaged over 3 years *(2010)*	None	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour average, not to be exceeded more than once per year over 3 years *(1987)*	Same as Primary	
Particulate Matter ($PM_{2.5}$)	12.0 µg/m^3	Annual mean, averaged over 3 years *(2012)*	15.0 µg/m^3	Annual mean
	35 µg/m^3	98^{th} percentile of 24-hour concentration, averaged over 3 years *(2006)*	Same as Primary	
Ozone (O_3)	0.070 ppm	Annual 4^{th} highest 8-hour daily max averaged over 3 years *(2015)*	Same as Primary	
Sulfur Dioxide (SO_2)	0.075 ppm	99^{th} percentile of 1-hour daily max averaged over 3 years *(2010)*	0.5 ppm	3 hours

*In 1985, the USEPA revoked the secondary standard for CO (for public welfare) due to a lack of evidence of adverse effects on public welfare at or near ambient concentrations.

To demonstrate compliance with the NAAQS, the USEPA 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 second highest, non-overlapping, 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* of the daily maximum 1-hour concentration averaged over 3 years does not exceed 100 ppb.
PM	PM_{10}: The 24-hour PM_{10} primary and secondary standards are met when 150 µg/m^3 is not exceeded more than once per year on average over 3 years.
	$PM_{2.5}$: The annual $PM_{2.5}$ primary and secondary standards are met when the annual arithmetic mean concentration is less than or equal to 12 µg/m^3 and 15 µg/m^3, respectively. The 24-hour $PM_{2.5}$ primary and secondary standards are met when the 3-year average of the 98th percentile** 24-hour concentration is less than or equal to 35 µg/m^3.
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-hour average concentration is less than or equal to 0.070 ppm.
SO_2	To determine compliance, the 99th percentile*** 1-hour concentration averaged over a 3-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.

**98th percentile daily maximum 1-hour value* is the value below which nominally 98 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5.2 of appendix S of CFR Part 50.

** *98th percentile* is the daily value out of a year of $PM_{2.5}$ monitoring data below which 98 percent of all daily values fall using the ranking and selection method specified in section 4.5(a) of appendix N of CFR Part 50.

*** *99th percentile daily maximum 1-hour value* is the value below which nominally 99 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5 of appendix T of CFR Part 50.

As part of the USEPA's grant to the DEQ, the AQD provides an annual Network Review document[5] of all monitoring data collected from the previous year and recommendations on any network changes. These recommendations are based on each monitor's exceedance history, changes in population distribution, and modifications to federal monitoring requirements under the CAA. Under the amended air monitoring regulations that began in 2007, states are required to solicit public comment (in May of each year) on their future air monitoring network design prior to submitting the annual review to the USEPA in July.

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 tribal monitors handled by the Little River Band of Ottawa Indians and the Inter-tribal Council of Michigan, respectively. **Figure 1.1** shows the 2016 MASN monitoring sites. **Figures 1.2** and **1.3** are pictures of two monitoring stations; one at Coloma and the other at New Mount Herman 48217 (NMH 48217), respectively.

[5] Most recent Network Reviews are available online at: http://www.michigan.gov/documents/deq/deq-aqd-toxics-2016_Air_Mon_Network_Review_489490_7.pdf

The MASN consists of federal reference method (FRM) monitors that enable continuous monitoring for the gaseous pollutants CO, NO_2, O_3, 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 provide real-time hourly data. $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$. 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 2016 and the MASN locations are shown in **Table 1.3.**

The **NCore network** began January 1, 2011, as part of the USEPA's 2006 amended air monitoring requirements. NCore is a multi-pollutant network that integrates several advance measurement systems for particles, pollutant gases, and meteorology. This information will support scientific studies ranging across technological, health, and atmospheric process disciplines. Michigan has two NCore sites; Allen Park and Grand Rapids-Monroe Street. Further information on the effects of these criteria pollutants is provided in **Chapters 2** through **7**.

The **Near-Road Monitoring Network** focuses on vehicle emissions and how they disperse near roadways. In 2011 Michigan took over the USEPA's pre-existing near-roadway site at Eliza Howell Park in Detroit. A second near-road site was added in Livonia in January 2015. Data from these sites are presented in **Chapters 2** and **5.**

Figure 1.1: 2016 MASN Monitoring Sites

Figure 1.2: Coloma Monitoring Site

Figure 1.3: New Mount Hermon (NMH 48217) Monitoring Site

Table 1.3 Types of Monitoring Conducted in 2016 and MASN Location

Area	AIRS ID	Site Name	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				√		√	√	√+E						√			√
	260990009	New Haven				√		√								√	√	√	
	260991003	Warren				√													
	261250001	Oak Park				√		√								√			
	261470005	Port Huron				√		√	√		√					√			
	261470031	Port Huron-Rural St.													√@+Pb				
	261610008	Ypsilanti				√		√	√							√			√
	261630001	Allen Park	√*		√	√	√	√	√	√+A		√			√@+Pb	√	√		√
	261630005	River Rouge					√							√	√@	√			
	261630015	Detroit-W. Fort St.					√	√		√	√		√	√	√@	√	√		√
	261630016	Detroit-Linwood						√											
	261630019	Detroit-E. 7 Mile		√		√		√								√	√		√
	261630025	Livonia						√											
	261630027	Detroit-W. Jefferson													√@				
	261630033	Dearborn					√	√	√	√+EA			√	√	√ + Pb	√	√		√
	261630036	Wyandotte						√											
	261630039	Detroit-W. Lafayette						√	√							√			
	261630093	Eliza Howell-Roadway	√	√		√										√			
	261630094	Eliza Howell-Downwind	√	√		√										√	√		√
	261630095	Livonia-Roadway	√	√				√								√	√		√
	261630097	NMH 48217							√		√		√		√ + Pb				
Flint	260490021	Flint				√		√	√							√			√
	260492001	Otisville				√										√			
Grand Rapids	261390005	Jenison				√										√			
	261390011	West Olive									√					√			
	260810007	Grand Rapids-Wealthy						√											
	260810020	Grand Rapids-Monroe	√*		√	√	√	√	√	√		√			√@+Pb	√			√
	260810022	Evans				√										√			
Lansing/East Lansing	260650012	Lansing		√		√		√	√		√					√			√
	260370001	Rose Lake				√													
Monroe Co	261150006	Sterling State Park						√			√					√			
Huron Co	260630007	Harbor Beach				√										√			
Bay Co	260170014	Bay City						√	√							√			
Missaukee Co	261130001	Houghton Lake		√		√		√	√							√			√
Allegan Co	260050003	Holland				√		√								√	√	√	√
Benzie Co	260190003	Benzonia				√													
Berrien Co	260210014	Coloma				√		√								√			
Cass Co	260270003	Cassopolis				√										√			
Kalamazoo Co	260770008	Kalamazoo				√		√	√							√			
Manistee Co	261010922	Manistee $				√		√								√		√	√
Mason Co	261050007	Scottville				√										√			
Muskegon Co	261210039	Muskegon-Green				√										√			
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				

√ = Data Collected
= Mn only
@ = Mn, As, Cd, Ni
Pb = Lead
$ = Tribal monitor
* = Trace CO monitor
E = EC/OC monitor
A = Aethalometer monitor

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 (SOPs), 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 (CFR), 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 USEPA each quarter.

External audits are conducted annually by the USEPA. The USEPA conducts Performance Evaluation Program (PEP) audits for $PM_{2.5}$ samplers and the National Performance Audit Program (NPAP) checks for the gaseous monitors. The USEPA also conducts program-wide Technical Systems Audits (TSAs) every three 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.

Long-term Trends

Congress passed the CAA in 1970; however, Michigan has had a long-standing history of environmental awareness well before the Act was established. In 1887, Detroit was the first city in Michigan to adopt an air quality ordinance, which declared that the dense smoke from burning coal was a public nuisance.

The USEPA is required to review the criteria pollutant standards every five years. Over time, based upon toxicological data, the standards (NAAQS) have been tightened to better protect public health (see Appendix D). Areas that meet the NAAQS are considered to be in "attainment." Locations where air pollution levels persistently exceed the NAAQS may be designated as "nonattainment." The tightening standards are why some areas in the state may be designated to nonattainment from attainment even though monitoring shows that air quality continues to improve.

Due to the vast availability of historical data, criteria pollutant data from Southeast Michigan are shown in **Figures 1.4** through **1.9.** These figures show how the ambient levels and the standards for these pollutants have changed over the last 35-plus years. Since Southeast Michigan is highly industrialized, it is a good indicator of the air quality improvement for the rest of the state.

Figure 1.4 shows the ozone levels at the Detroit E. 7 Mile Road site. This graph shows how the standard changed from a 1-hour average of 0.120 ppm to an 8-hour average of 0.08 ppm in 1997. The standard was further lowered to 0.075 ppm in 2008 and to 0.070 ppm at the end of 2015.

Figure 1.4: Historical Ozone at DEQ's Detroit E. 7 Mile Site

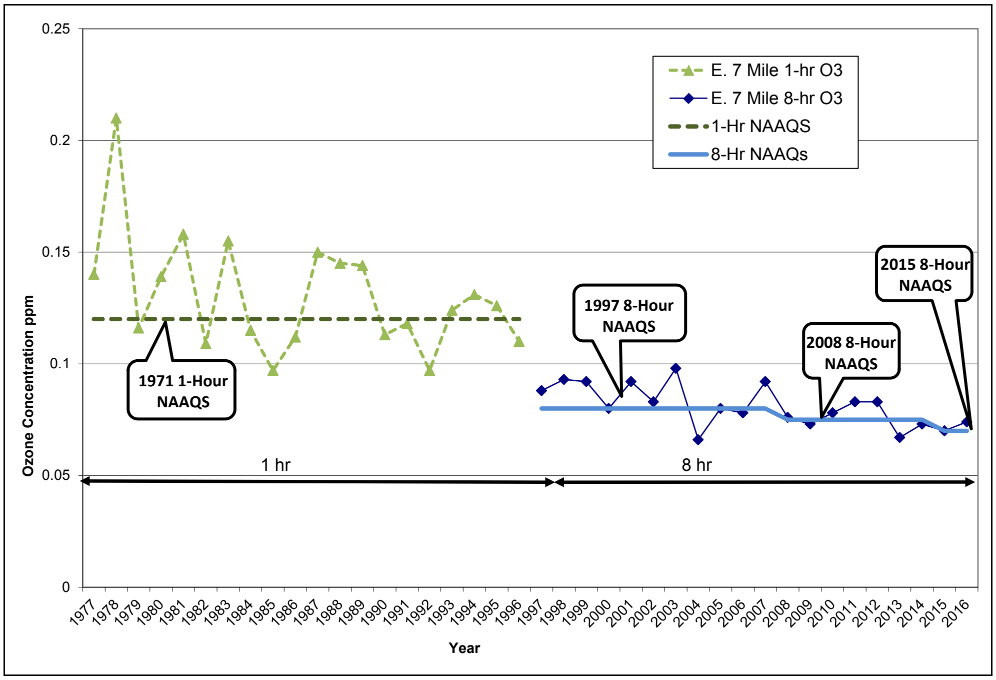


Figure 1.5 shows the SO_2 trend for the old annual standard and the new 1-hour standard for W. Fort Street (SWHS) in Detroit. In 2010, the USEPA changed the standard from an annual average to 99th percentile of a 1-hour standard in which the SO_2 concentration cannot exceed 0.075 ppm averaged over 3 years. This resulted in nonattainment status for a portion of Wayne County (see **Chapter 4** for additional details). Even though the area is in nonattainment for the 1-hour SO_2 standard, levels of SO_2 have decreased significantly over the years.

Figure 1.5: Historical Annual and 1-hour SO_2 Averages at Detroit–W. Fort Street (SWHS)

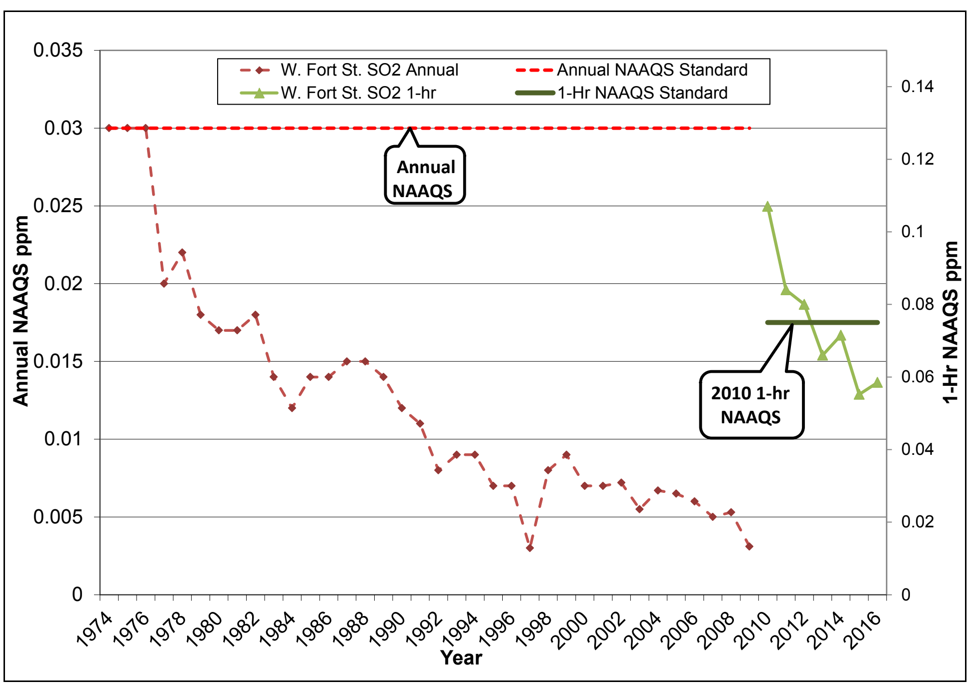


Figure 1.6 shows the CO trend at Allen Park to be well below the 1-hour standard of 35 ppm, which has not changed since 1971.

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

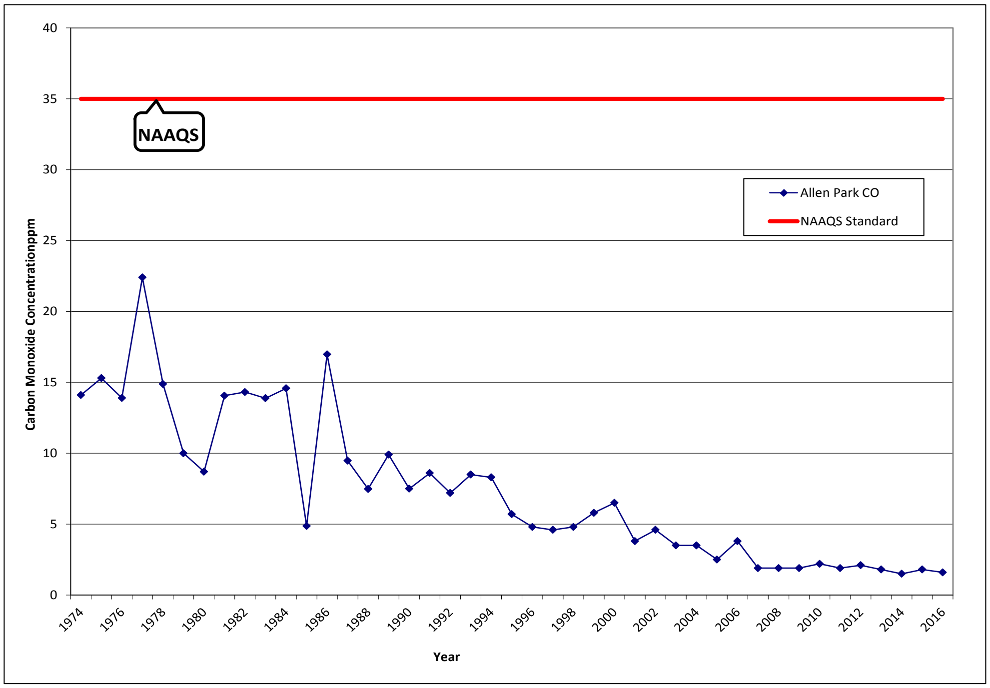


Figure 1.7 shows the trend for lead at Dearborn. Lead is of concern because it is harmful to the neurological development of children. The largest decrease in lead in the air is due to the removal of lead in gasoline. By 1975, most newly manufactured vehicles no longer required leaded gasoline, and as a result, there was a dramatic decrease in ambient lead levels. In 1996, the USEPA banned the sale of leaded fuel for use in on-road vehicles. The graph also shows the decrease in the lead standard that occurred in 2008.

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

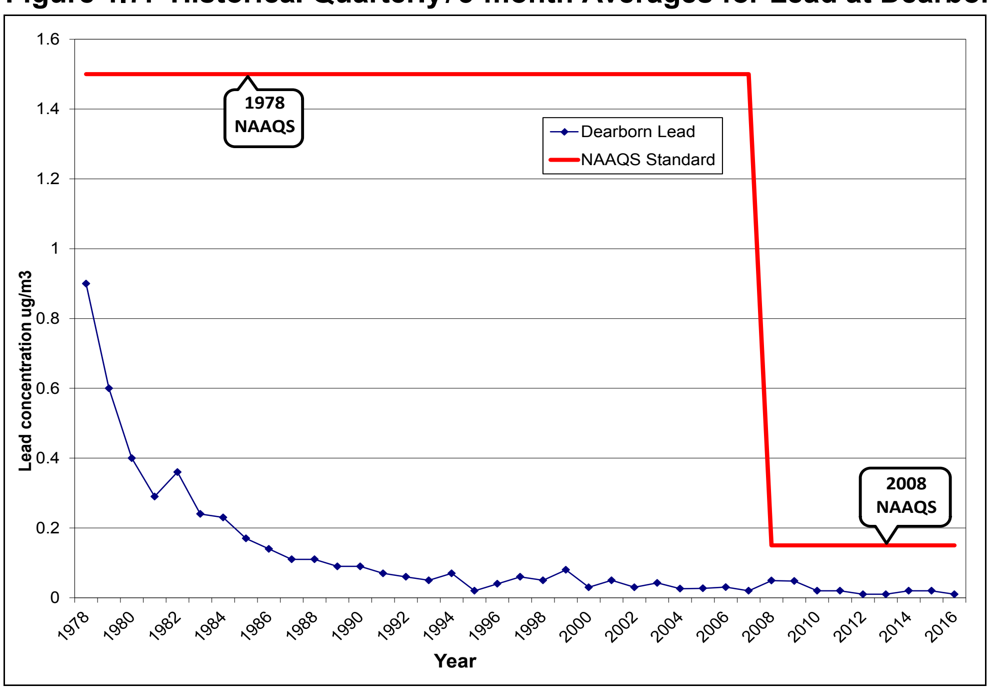


Figure 1.8 shows the trend for NO_2, which has been well below the annual standard of 53 ppb, and shows a downward trend. In 2010, the USEPA added a 1-hour standard of the 98th percentile not to exceed 100 ppb averaged over 3 years. One-hour NO_2 concentrations in Michigan have also remained well below the standard.

Figure 1.8: Historical Annual NO_2 at E. 7 Mile Road

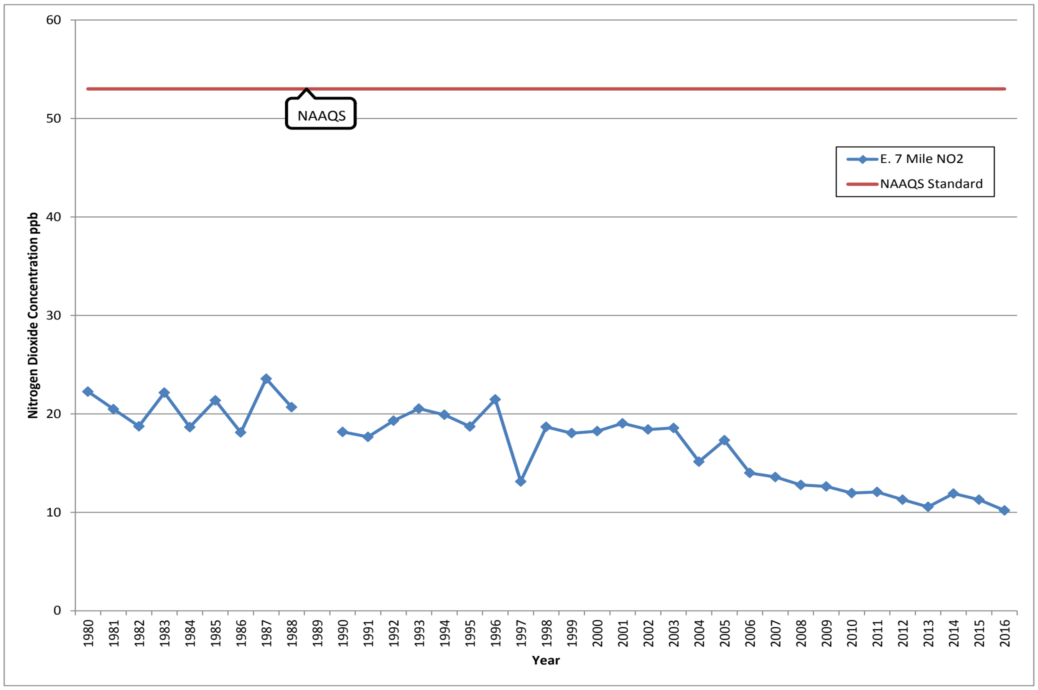
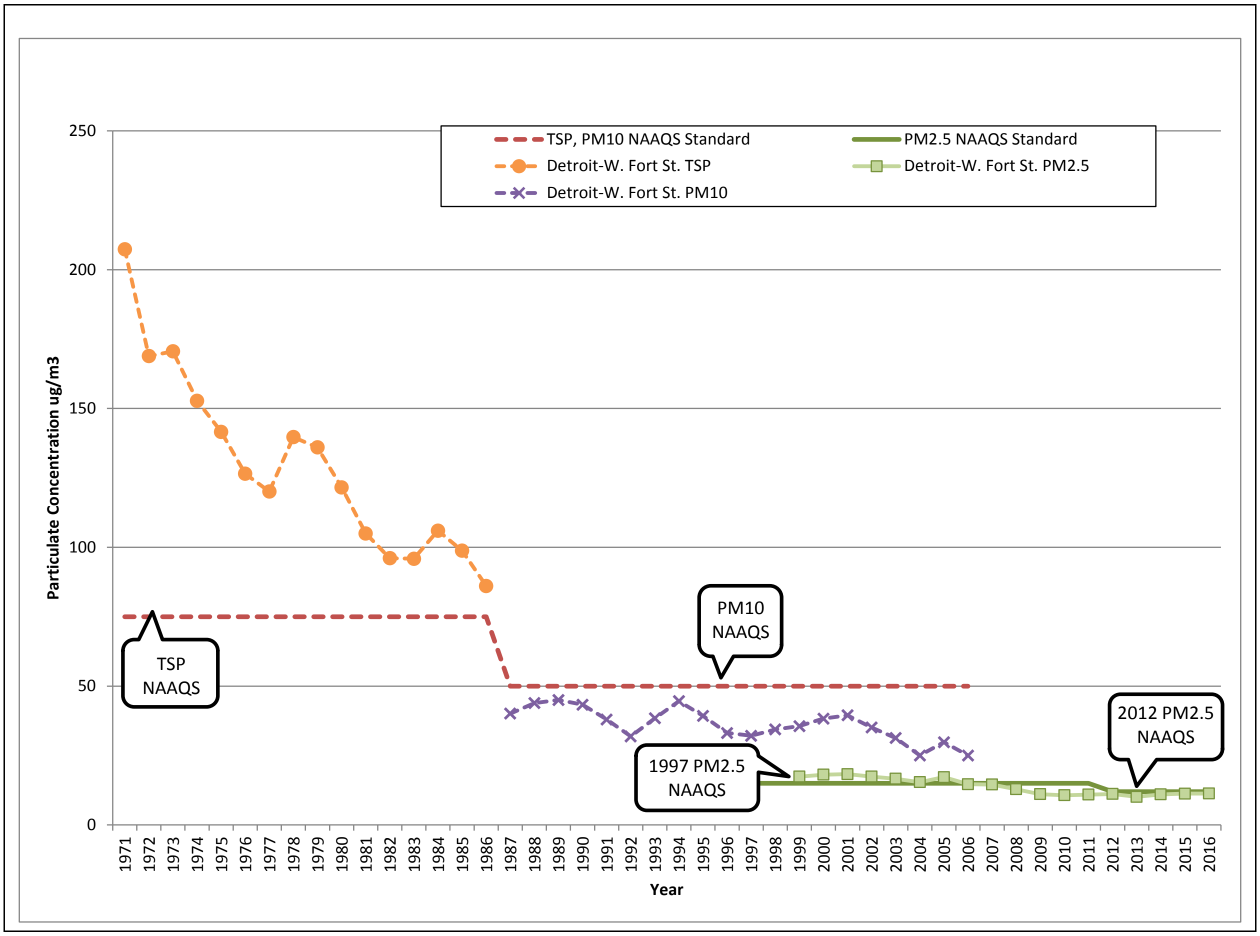


Figure 1.9 shows the trends for particulate matter. In 1971, the USEPA promulgated an annual and 24-hour particulate standard based on total suspended particulates (TSP). In 1987, the USEPA changed the standard to $PM_{10.}$ Health studies indicated that particles smaller than 10 microns affect respiration. In 1997, the USEPA added additional NAAQS for a smaller particle fraction size, $PM_{2.5}$, which can get deeper into the lungs and possibly into the blood stream. In 2006, the USEPA revoked the PM_{10} annual standard but kept the PM_{10} 24-hour standard. The $PM_{2.5}$ 24-hour standard was also reduced from 65 µg/m^3 to 35 µg/m^3. In 2012, the USEPA again reduced the annual standard from 15 µg/m^3 to 12 µg/m^3. Particulate trends show that particulate concentrations have decreased and the state is in compliance for all particulate NAAQS; however, Michigan has had past nonattainment issues in Southeast Michigan for TSP, PM_{10} and $PM_{2.5}$.

Figure 1.9: Historical Annual Particulate Matter at W. Fort St. (SWHS).



Chapter 2: Carbon Monoxide (CO)

Carbon monoxide is a gas formed during incomplete burning of fuel. CO is colorless, odorless, and tasteless, and is lethal at elevated concentrations. Levels peak during colder months primarily due to cold temperatures that affect combustion efficiency of engines. The CO NAAQS is 9 ppm for the second highest 8-hour average and 35 ppm for the second highest 1-hour average. Its sources and effects are provided below.

Sources: CO is given off whenever fuel or other carbon-based materials are burned. Outdoor exposure sources include automobile exhaust, industrial processes (metal processing and chemical production), and non-vehicle fuel combustion. Natural sources include volcanos, forest fires and photochemical reactions in the atmosphere. Indoor exposure sources include wood stoves and fireplaces, 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. In extreme cases, unconsciousness and death can occur. CO also alters atmospheric photochemistry contributing 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, fetuses, infants and the elderly 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 location of each CO monitor that operated in 2016. The Eliza Howell Park and Livonia sites are required under the Near-Roadway Network. A second downwind site at Eliza Howell Park provides a comparison to the near-roadway sites. The other two sites, Grand Rapids and Allen Park, are where trace CO (lower detection levels 1 ppm-50 ppm) is being monitored as part of the NCore Network.

Figure 2.1: Trace Carbon Monoxide (CO) Monitors in 2016

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

Figure 2.2: CO Emissions by Source Sector

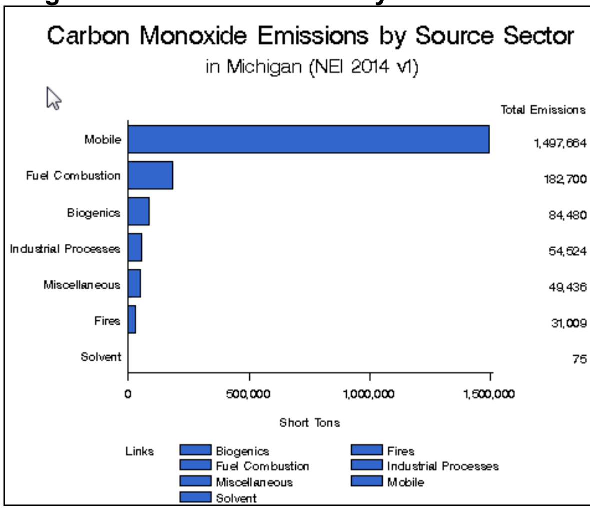
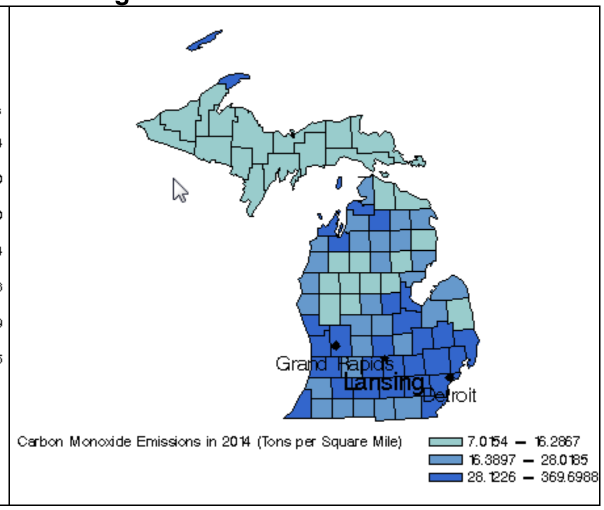


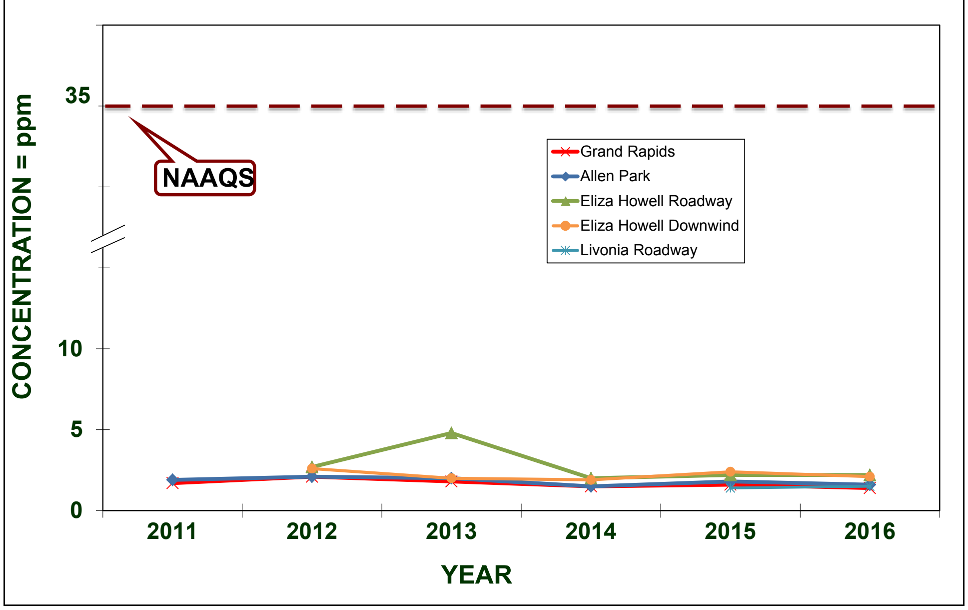
Figure 2.3: CO Emissions in 2014



Near-roadway Monitoring: On August 31, 2011, the USEPA approved design changes to part of the CO ambient monitoring network. This network, now referred to as the near-roadway network, is focused on high traffic urban roads in Core-Based Statistical Areas (CBSAs) with more than one million people. The DEQ took over two of the USEPA's pre-existing, near-roadway sites at Eliza Howell Park, Detroit in June 2011. In January 2015, the second required near-road site started sampling in Livonia.

Figure 2.4 shows the maximum second highest 1-hour CO level trends for Michigan from 2011-2016, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.

Figure 2.4: CO Levels in MI from 2011-2016 (2nd Highest 1-Hr Maximum Values)



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 combustion. On November 12, 2008, the USEPA lowered the Pb NAAQS from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. Its sources and effects are presented below.

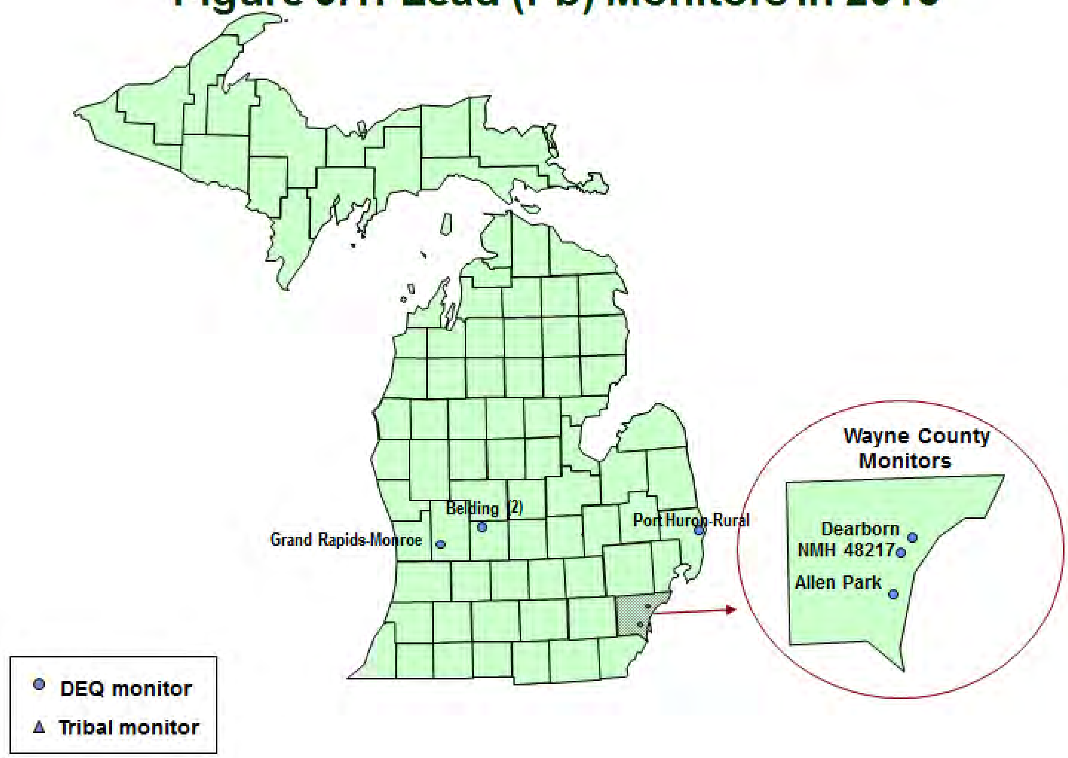
Sources: With the phase-out of leaded gas in the 1970s, the major sources of lead emissions have been due to ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other industrial sources include lead acid battery manufacturers, waste incinerators, and utilities. The highest air concentrations of lead are usually found near lead smelters.

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 since low levels of lead may cause central nervous system damage. Excessive lead exposure during the early years of life is associated with lower IQ scores and neurological impairment (seizures, mental development, and behavioral disorders). Even at low doses, lead 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 lead monitors in the MASN in 2016.

Figure 3.1: Lead (Pb) Monitors in 2016



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

Figure 3.2: Lead Emissions by Source Sector

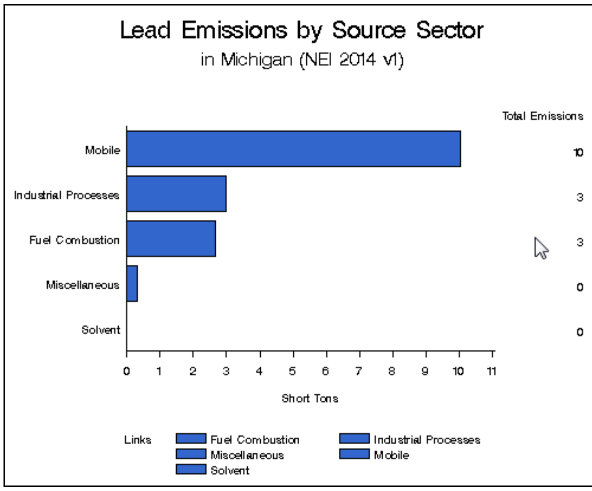
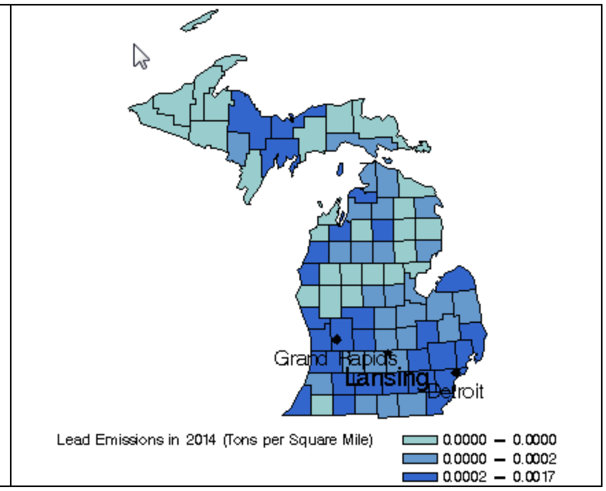
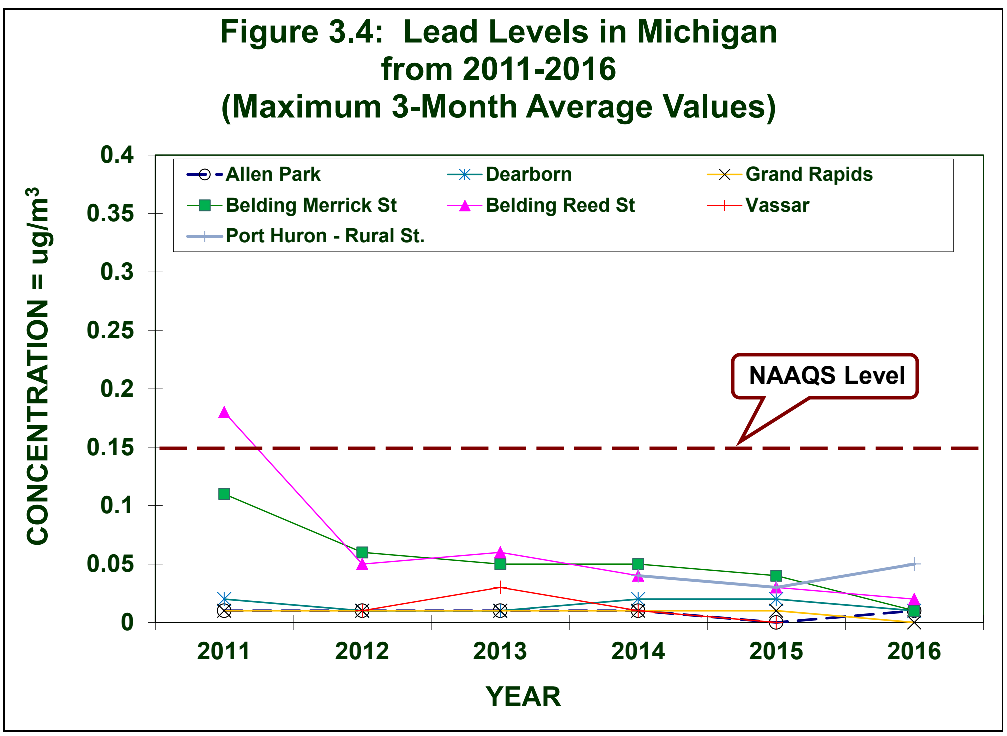


Figure 3.3: Lead Emissions in 2014

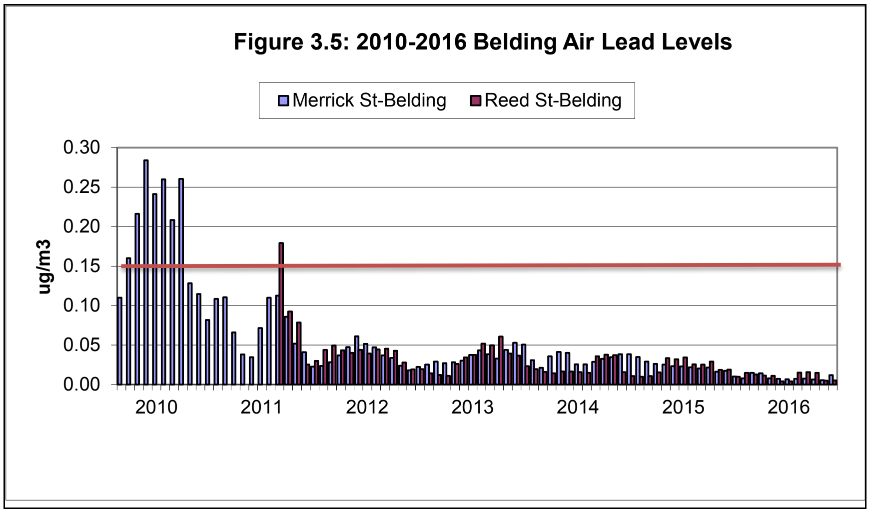


On November 12, 2008, the USEPA modified the Pb NAAQS by reducing the level of the standard from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. The monitoring network design was modified to consist of source-oriented monitors and population-oriented monitors.

Figure 3.4 shows the maximum 3-month rolling average values for lead from 2011 to 2016.



As part of the 2008 lead NAAQS, the DEQ is required to monitor near stationary lead sources emitting more than 1/2 ton per year. The DEQ currently has three point-source lead monitoring sites: Rural St. in Port Huron (started November 2012), Merrick St. in Belding (started January 2010), and Reed St. in Belding (started July 2011). The Merrick St. monitor located in Belding recorded a violation of the new health standard in 2010, as shown in **Figure 3.5.** Hence a second site, Reed St., was added in July 2011 at Belding, which also recorded a violation in 2011. Values for both the sites have been below the NAAQS for the past five years. The DEQ's redesignation request for Belding will be effective July 31, 2017, unless the USEPA receives adverse comments.



All other lead monitor sites in Michigan are well below the standard. The Dearborn site is part of the National Air Toxics Trend Sites (NATTS) and monitors lead and trace metals, both as total suspended particulate (TSP) and PM_{10}. Lead measurements as $PM_{2.5}$ are also 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. At higher concentrations it has a pungent, irritating odor similar to a struck match. When sulfur-bearing fuel is burned, the sulfur is oxidized to form SO_2, which then reacts with other pollutants to form aerosols. These aerosols can form particles in the air causing increases in $PM_{2.5}$ levels. In liquid form, it is found in clouds, fog, rain, aerosol particles, and in surface films on these particles. In June 2010, the USEPA changed the primary SO_2 standard to a 99^{th} 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 that cannot exceed 0.5 ppm once per year. Its sources and effects are presented below.

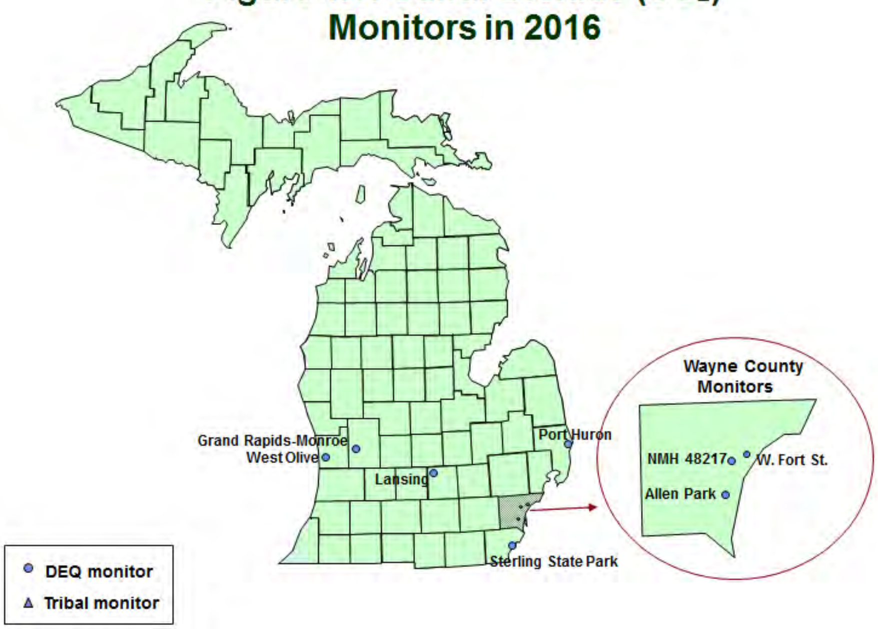
Sources: Coal-burning power plants are the largest source of SO_2 emissions. Other sources include petroleum refineries, ore smelters, pulp and paper mills, steel mills and non-road transportation sources. SO_2 and particulate matter are often emitted together.

Effects: Exposure to elevated levels can affect breathing, can cause respiratory illnesses, aggravate existing cardiovascular and pulmonary diseases, and alter the body's immune system. SO_2 and NOx together are the major precursors to acid rain and are associated with the acidification of soils, lakes, and streams, as well as 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 on 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 that operated in 2016. The two NCore Sites, Allen Park and Grand Rapids, have trace SO_2 monitors that have lower detection limits than traditional SO_2 monitors.

Figure 4.1: Sulfur Dioxide (SO_2) Monitors in 2016



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

Figure 4.2: SO_2 Emissions by Source Sector

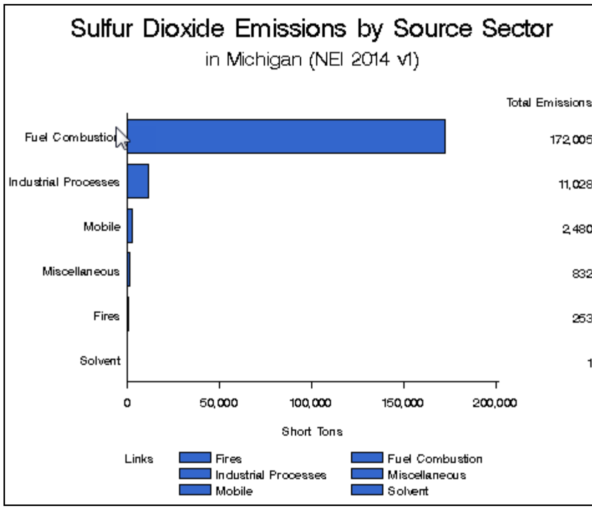
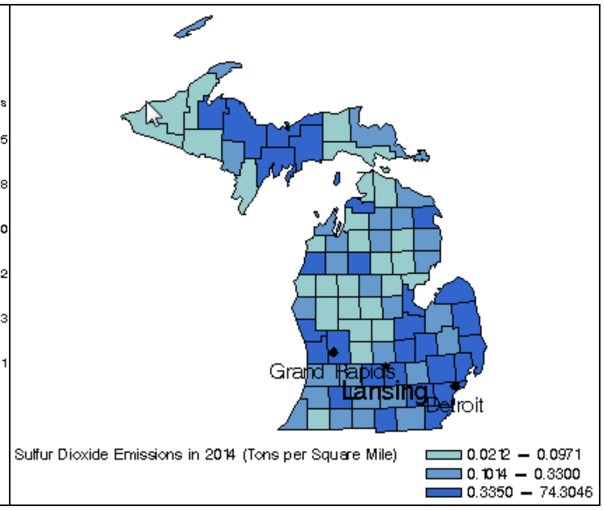


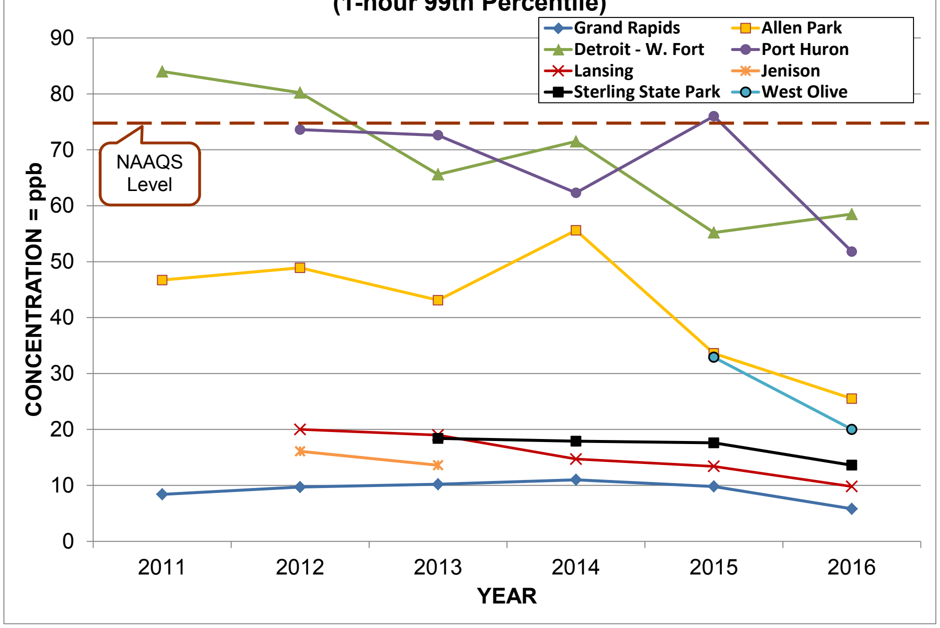
Figure 4.3: SO_2 Emissions in 2014



Historically, Michigan had been in attainment for SO_2 since 1982 with levels consistently well below the annual SO_2 NAAQS. However, in 2010, the USEPA changed the SO_2 NAAQS to a 1-hour standard, which showed that the SO_2 monitor at W. Fort Street (SWHS) in Detroit did not meet the new NAAQS. SO_2 concentrations have decrease at this site and are currently under the NAAQS, although modeling concentrations are not below the NAAQS. In September 2016, a portion of St. Clair County was also designated as nonattainment by the USEPA.

The NCore sites, Grand Rapids and Allen Park, monitor for trace SO_2. For trend purposes, all SO_2 data are graphed together in **Figure 4.4**. Jenison and Port Huron were added to the SO_2 network in December 2011, and Sterling State Park in Monroe County was added to the SO_2 network in December 2012. The Jenison monitor was shut down on January 1, 2014 and later moved to West Olive, which started sampling in January 2015.

Figure 4.4: SO_2 Levels in Michigan from 2011-2016 (1-hour 99th Percentile)



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 particulate matter or acidic products that are deposited in rain (acid rain), fog, or snow. Since 1971, the primary and secondary standard for NO_2 was an annual mean of 0.053 ppm. In January 2010, the USEPA added a 1-hour NO_2 standard of 100 ppb, taking the form of the 98^{th} percentile averaged over three years. The sources and effects of NO_2 are as follows:

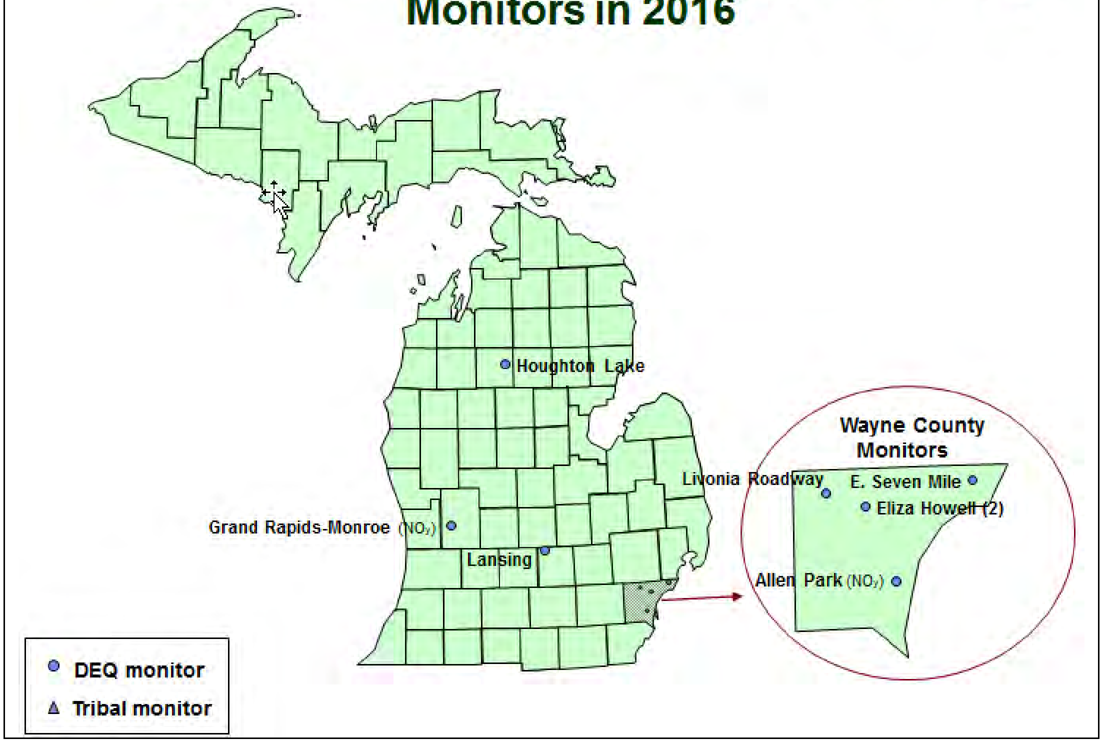
Sources: NO_X compounds and their transformed products occur both naturally and as a result of human activities. Natural sources of NO_X are lightning, forest fires, bacterial processes in soil, and stratospheric intrusion. Stratospheric intrusion is when the stratospheric air descends towards the surface of the earth and mixes with the air at breathing level. 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, resulting in visibility impairment (i.e., smog or haze). 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 all NO_2 monitors that operated in 2016. The E. 7 Mile monitor in Detroit is a downwind urban scale site that measures NO_2. The Detroit Eliza Howell (roadway and downwind sites) and Livonia sites measure NO_2 in a near-road environment. The NCore sites, Grand Rapids and Allen Park, monitor trace NO_Y, which includes NO_X, nitric acid and organic and inorganic nitrates (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.

Figure 5.1: Nitrogen Dioxide (NO_2) / Trace NO_y Monitors in 2016



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

Figure 5.2: NO_2 Emissions by Source Sector

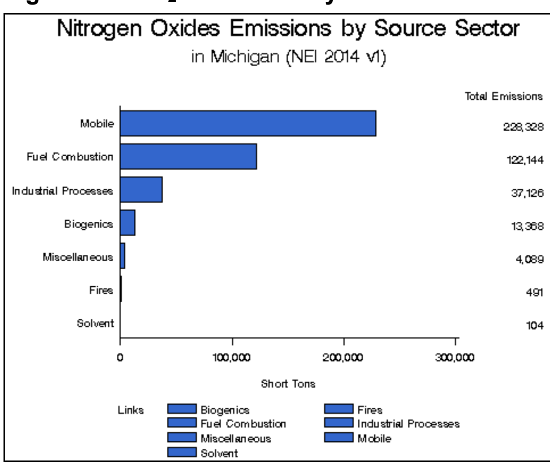
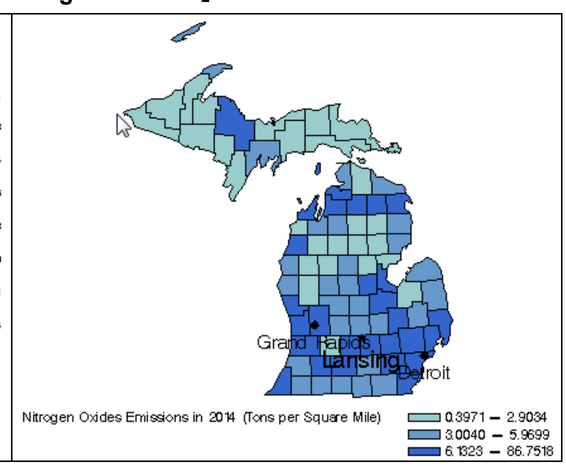
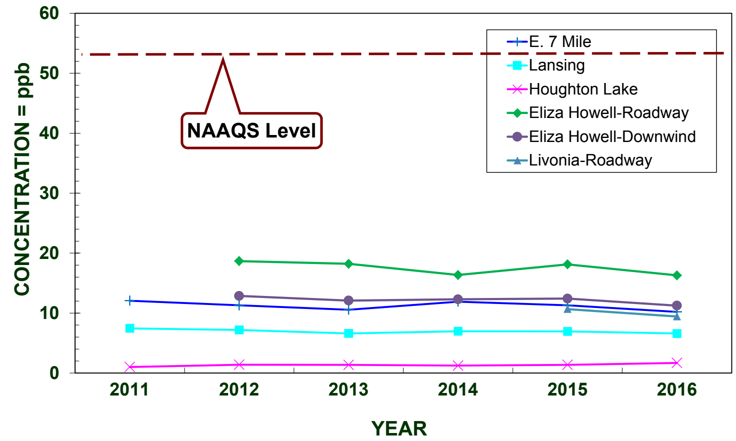


Figure 5.3: NO_2 Emissions in 2014



Michigan's 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, when the USEPA lowered the NO_2 NAAQS in 2010, they designated Michigan as unclassifiable/attainment, since the existing NO_2 network did not provide adequate evidence that the NAAQS was met in all areas; however, there were no violations of the NO_2 standard. Thus, unclassifiable/attainment better reflects the current air quality conditions.

Figure 5.4: NO_2 Levels in MI from 2011-2016 (Annual Arithmetic Mean)*

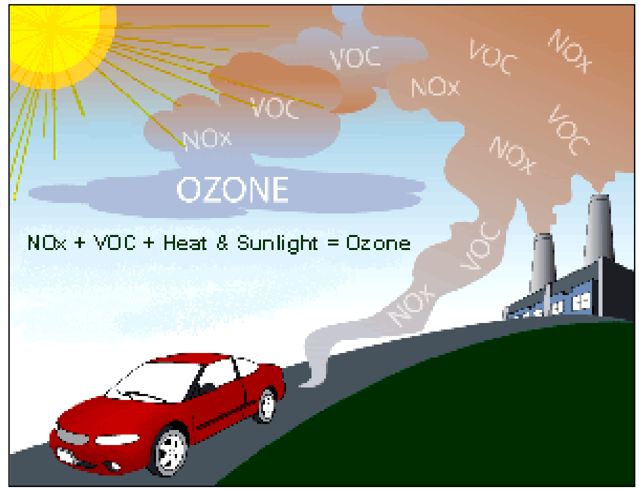


*Since Allen Park and Grand Rapids are monitoring NO_Y, those sites are not included in graph.

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 USEPA). These reactions usually occur during the hot summer months as ultraviolet radiation from the sun initiates a sequence of photochemical reactions. In Earth's upper atmosphere (the stratosphere), O_3 helps by absorbing much of the sun's ultraviolet radiation, but in the lower atmosphere (the troposphere), ozone is an air pollutant. O_3 is also a key ingredient of urban smog and can 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 USEPA and became effective in November 2015. It is a 3-year average of the 4th highest daily maximum 8-hour average concentration that must not exceed 0.070 ppm. The sources and effects of ozone follow.



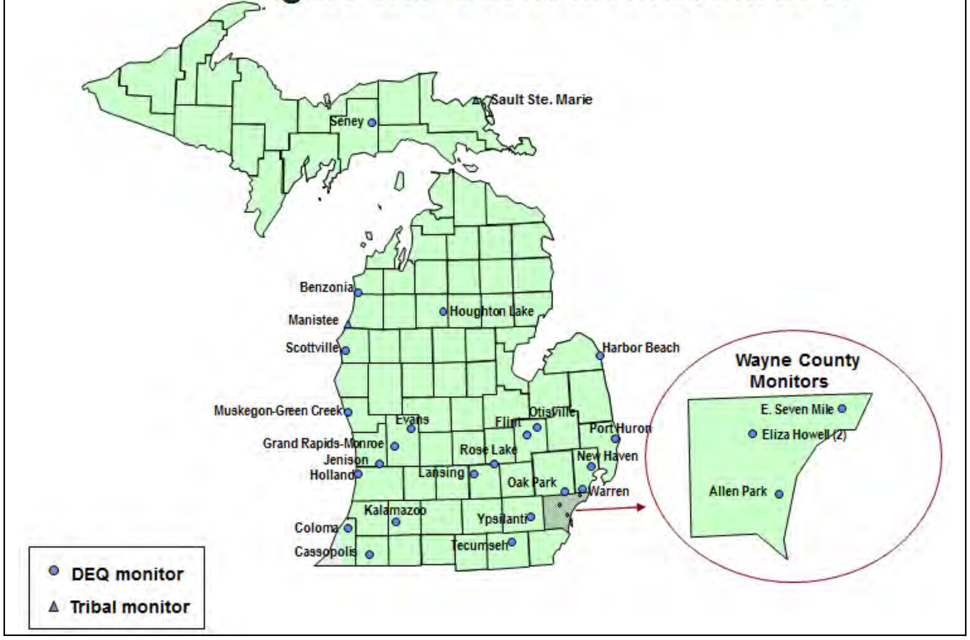
Sources: Major sources of NO_X and VOCs are engine exhaust, emissions from industrial facilities, combustion from power plants, gasoline vapors, chemical solvents, and biogenic emissions from natural sources. Ground-level O_3 can also be transported hundreds of miles under certain wind regimes. As a 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 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 forest ecosystems, including agricultural crop and forest yield reductions, diminished resistance to pests 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.

Figure 6.1: Ozone Monitors in 2016



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

Figure 6.2: VOC Emissions by Source Sector

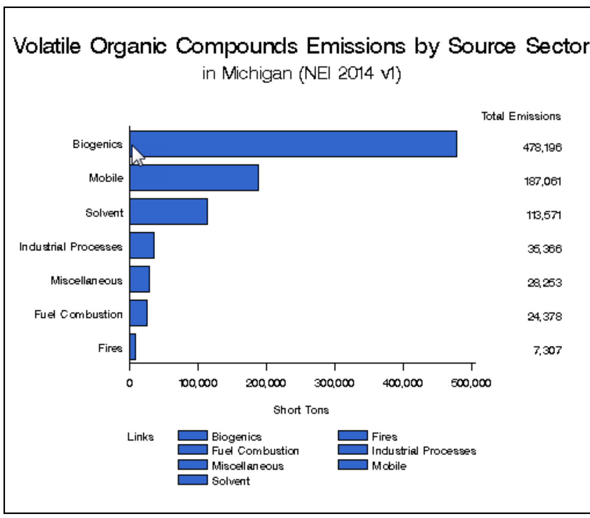
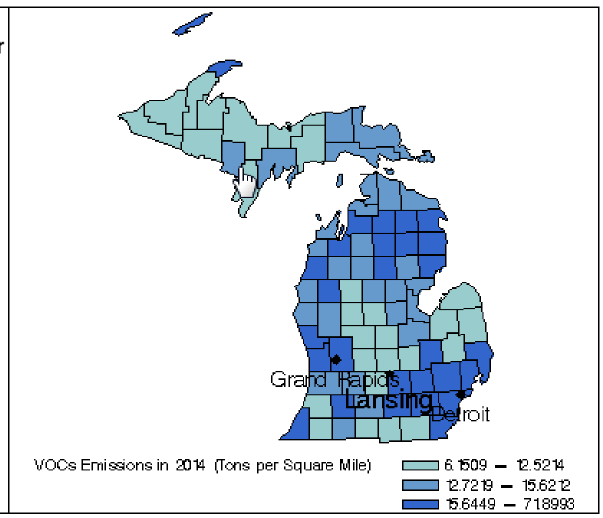


Figure 6.3: VOC Emissions in 2014



The USEPA revised the primary 8-hour ozone NAAQS to 0.070 ppm in November 2015, which became effective for the 2016 ozone season. To attain the 2015 standard, the 3-year average of the 4th highest daily maximum 8-hour average concentration within an area must not exceed 0.070 ppm. The secondary 8-hour ozone NAAQS was also revised, making it identical to the primary standard.

In 2016, several monitors violated the 2015 standard of 0.070 ppm. The AQD has recommended several counties be designated as nonattainment, but the USEPA has not made their final designations for the 2015 standard.

The O_3 monitoring season in Michigan is currently from April 1 through September 30, the hottest portion of the year. Starting in 2017, the ozone season will be extended to March 1 through October 31, based on the 2015 NAAQS. During this time O_3 monitoring data is available for the public via the AQD's web site (discussed in **Chapter 9**). However, year round O_3 monitoring is conducted at the following four sites: Allen Park, Grand Rapids, Houghton Lake and Lansing. This data helps in attainment designations, and urban air quality and population exposure assessments.

Figure 6.1 shows all O_3 air quality monitors active in Michigan at the beginning of the 2016 ozone season.

Table 6.1: 3-Year Average of the 4th Highest 8-hour Ozone Values from 2012-2014, 2013-2015, 2014-2016 (concentrations in ppm). Numbers in bold indicate 3-year averages over the 2015 ozone standard of 0.070 ppm for 2013-2016, for 2012-2014 and 2013-2015 bold numbers indicate values below 0.075 ppm.

Areas	County	Monitor Sites	2012-2014*	2013-2015*	2014-2016*
Detroit-Ann Arbor	Lenawee	Tecumseh	0.073	0.065	0.067
	Macomb	New Haven	0.074	0.071	**0.072**
		Warren	0.072	0.066	0.067
	Oakland	Oak Park	0.071	0.066	0.069
	St. Clair	Port Huron	0.074	0.072	**0.073**
	Washtenaw	Ypsilanti	0.073	0.066	0.067
	Wayne	Allen Park	0.068	0.064	0.065
		Detroit-E. 7 Mile	0.074	0.070	**0.072**
Flint	Genesee	Flint	0.072	0.066	0.068
		Otisville	0.072	0.067	0.069
Grand Rapids	Ottawa	Jenison	0.075	0.068	0.070
	Kent	Grand Rapids	0.071	0.067	0.069
		Evans	0.070	0.066	0.067
Muskegon Co	Muskegon	Muskegon	**0.079**	0.074	**0.075**
Allegan Co	Allegan	Holland	**0.083**	0.075	**0.075**
Huron	Huron	Harbor Beach	0.071	0.065	0.068
Kalamazoo-Battle Creek	Kalamazoo	Kalamazoo	0.073	0.067	0.069
Lansing-East Lansing	Ingham	Lansing	0.070	0.065	0.067
	Clinton	Rose Lake	0.069	0.064	0.067
Benton Harbor	Berrien	Coloma	**0.079**	0.073	**0.074**
Benzie Co	Benzie	Benzonia	0.073	0.068	0.069
Cass Co	Cass	Cassopolis	0.073	0.068	0.070
Chippewa Co	Chippewa	Sault Ste. Marie	0.065	0.059	0.059
Mason Co	Mason	Scottville	0.074	0.068	0.070
Missaukee Co	Missaukee	Houghton Lake	0.070	0.064	0.067
Manistee Co	Manistee	Manistee	0.072	0.067	0.068
Schoolcraft Co	Schoolcraft	Seney	0.073	0.068	0.070

* Only 2014-2016 data are subject to the 2015 NAAQS level of 0.070 ppm; the previous year's level was 0.075 ppm from the 2008 NAAQS standard.

Tables 6.2 and **6.3** highlight the number of days when two or more O_3 monitors exceeded 0.070 ppm. It also specifies in which month they occurred and the temperature range.

Table 6.2: 2016 West Michigan Ozone Season

Daily High Temperature Range			2016 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	0	0	0	0	0	0
90	<=	94	0	0	0	0	6	4	8	2	4	2	1	0
85	<=	89	0	0	6	2	6	1	12	0	6	0	2	0
80	<=	84	2	1	3	1	8	0	6	0	16	0	6	0
75	<=	79	2	2	3	0	6	0	3	0	5	0	10	0
70	<=	74	2	0	5	0	2	0	2	0	0	0	5	0
65	<=	69	2	0	7	0	1	0	0	0	0	0	3	0
60	<=	64	5	0	1	0	1	0	0	0	0	0	3	0
55	<=	59	1	0	2	0	0	0	0	0	0	0	0	0
50	<=	54	4	0	3	0	0	0	0	0	0	0	0	0
49	<=		12	0	1	0	0	0	0	0	0	0	0	0
Totals			**30**	**3**	**31**	**3**	**30**	**5**	**31**	**2**	**31**	**2**	**30**	**0**

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 70 ppb.

For West Michigan, there were three O_3 exceedance days in April, three days in May, five days in June, two days in July, two days in August and no days in September when ozone exceeded 0.070 ppm at two or more ozone monitors. The temperatures for those days ranged between 75°F and above 94°F.

Table 6.3: 2016 Southeast Michigan Ozone Season

Daily High Temperature Range			2016 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	0	0	2	0	3	1	0	0
90	<=	94	0	0	0	0	5	1	7	1	4	1	2	0
85	<=	89	0	0	6	2	6	0	14	0	12	0	1	0
80	<=	84	1	1	2	0	10	2	2	0	9	0	10	0
75	<=	79	1	1	3	0	5	0	6	0	3	0	7	0
70	<=	74	2	0	6	0	4	0	0	0	0	0	6	0
65	<=	69	3	0	6	0	0	0	0	0	0	0	1	0
60	<=	64	4	0	3	0	0	0	0	0	0	0	3	0
55	<=	59	6	0	2	0	0	0	0	0	0	0	0	0
50	<=	54	5	0	3	0	0	0	0	0	0	0	0	0
49	<=		8	0	0	0	0	0	0	0	0	0	0	0
Totals			**30**	**2**	**31**	**2**	**30**	**3**	**31**	**1**	**31**	**2**	**30**	**0**

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 70 ppb.

For Southeast Michigan, there were two O_3 exceedance days in April, two days in May, three days in June, one day in July, two days in August and no days in September when ozone exceeded 0.075 ppm at two or more ozone monitors. The temperature for those days ranged between 75°F and above 95°F.

Table 6.4 gives a breakdown of the O_3 days and the specific monitors that went over the standard in western, central/upper, and eastern Michigan.

Table 6.4: 8-Hour Exceedance Days (>0.070 ppm) and Locations

Date	Monitors with Exceedances of the Ozone Standard			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
04/16/2016	Holland, Benzonia,	Lansing, Rose Lake, Houghton Lake, Seney		6
04/17/2016	Holland, Coloma, Cassopolis, Kalamazoo, GR-Monroe, Scottville, Muskegon	Rose Lake, Houghton Lake, Seney	Flint, Oak Park, Ypsilanti	13
04/18/2016	Holland, Benzonia, Coloma, Cassopolis, Kalamazoo, GR-Monroe, Evans, Scottville, Muskegon, Jenison	Lansing, Rose Lake, Houghton Lake	Flint, Otisville, Harbor Beach, Tecumseh, Warren, Oak Park, Port Huron, Ypsilanti, E. 7 Mile, Eliza Howell-Downwind	23
05/23/2016	Coloma, Cassopolis	Seney	Otisville	4
05/24/2016	Benzonia, Coloma, Cassopolis, Kalamazoo, GR-Monroe, Evans, Manistee, Scottville, Muskegon, Jenison	Lansing, Rose Lake, Houghton Lake	Flint, Otisville, Harbor Beach, Tecumseh, New Haven, Warren, Oak Park, Port Huron, Allen Park, E. 7 Mile, Eliza Howell-Downwind	24
05/25/2016	Holland, Muskegon		Otisville, Harbor Beach, New Haven, Port Huron, E. 7 Mile	7
05/26/2016			Harbor Beach	1
06/04/2016			Flint	1
06/10/2016	Holland, Coloma, Cassopolis, Kalamazoo, GR-Monroe, Evans, Scottville, Muskegon, Jenison	Lansing, Rose Lake, Houghton Lake	Flint, Otisville, Oak Park, Allen Park, E. 7 Mile	17
06/11/2016	Holland, Coloma, Cassopolis, Jenison			4
06/15/2016	Coloma, Cassopolis			2
06/18/2016			Ypsilanti	1
06/19/2016	Holland, Benzonia, Coloma, Cassopolis, Kalamazoo, GR-Monroe, Evans, Scottville, Muskegon, Jenison	Lansing, Rose Lake, Houghton Lake, Seney	Flint, New Haven, Warren, Oak Park, Port Huron, E. 7 Mile	20
06/20/2016	Coloma			1
06/25/2016	Holland, Coloma, Cassopolis, Kalamazoo, GR-Monroe, Muskegon	Seney		7
06/30/2016	Coloma		New Haven, E. 7 Mile	3
07/06/2016	Holland, Jenison			2
07/12/2016			Harbor Beach	1
07/13/2016		Seney		1
07/20/2016	Kalamazoo, GR-Monroe, Evans, Jenison	Seney		5
07/27/2016			New Haven, E. 7 Mile	2
08/03/2016	Benzonia, GR-Monroe, Scottville			3
08/04/2016	Benzonia, Manistee	Seney	Flint, Otisville	5
08/10/2016	Kalamazoo	Lansing, Rose Lake	New Haven, Warren, Oak Park, Allen Park, E. 7 Mile, Eliza Howell-Downwind	9
			TOTAL	162

On May 24, 2016, there were 24 monitors and on April 18, 2016, there were 23 monitor readings that exceeded the level of the standard. The site with the most exceedances in the western region of Michigan was Coloma with 11. The central / upper Michigan site with the most exceedances was Seney with 8. The monitor at E. 7 Mile had 8 exceedances in eastern Michigan.

Figure 6.4: O_3 Levels in Detroit-Warren-Flint CSA from 2011-2016 (4th Highest 8-Hour O_3 Values)

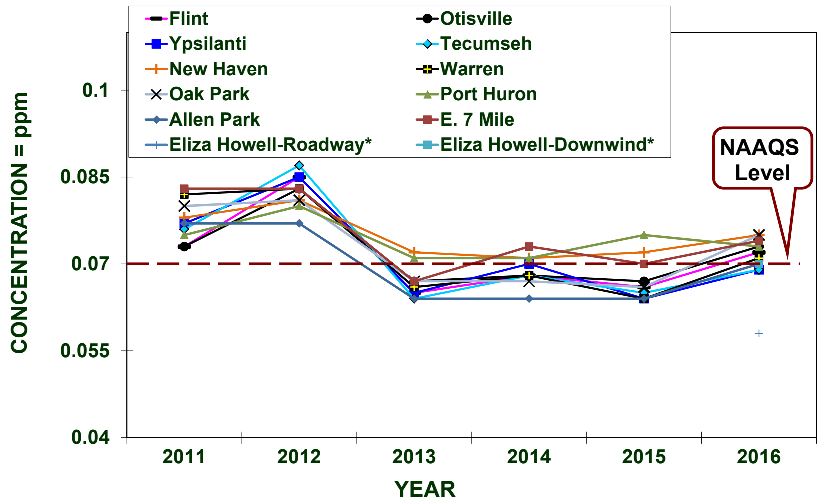


Figure 6.4 shows the 4th highest 8-hour O_3 values for Southeast Michigan monitoring sites from 2011-2016. New Haven, Port Huron and Detroit E. 7 Mile site violated the 3-year standard.

*Note: The two Eliza Howell sites are part of a two-year special study. Ozone monitoring will not continue after the 2-year study.

Figure 6.5: O_3 Levels in the Grand Rapids-Muskegon-Holland CSA from 2011-2016 (4th Highest 8-Hour O_3 Values)

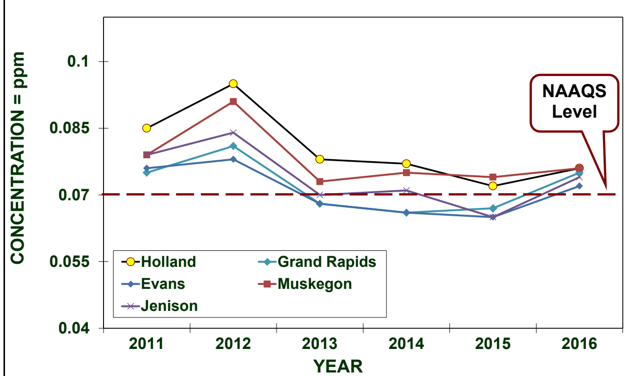


Figure 6.6: O_3 Levels in the Kalamazoo-Portage MSA, Lansing-E. Lansing-Owosso CSA, Niles-Benton Harbor MSA, & South Bend-Mishawaka (IN-MI) MSAs from 2011-2016 (4th Highest 8-Hour O_3 Values)

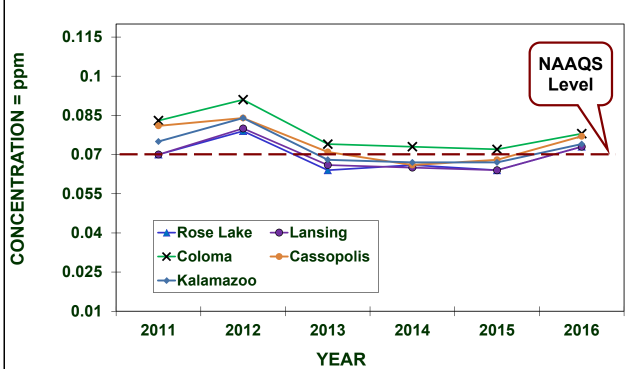


Figure 6.7: O_3 Levels in MI's Northern Lower and Upper Peninsula Areas from 2011-2016 (4th Highest 8-Hour O_3 Values)

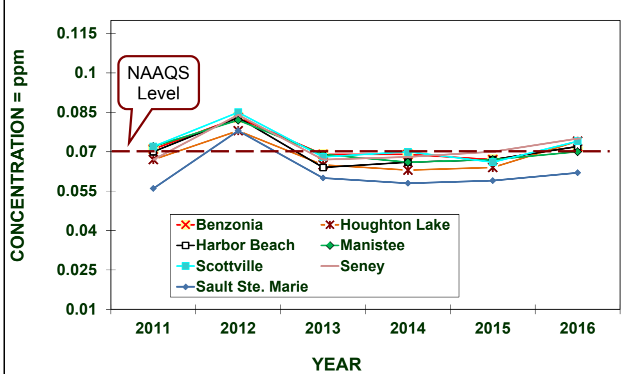


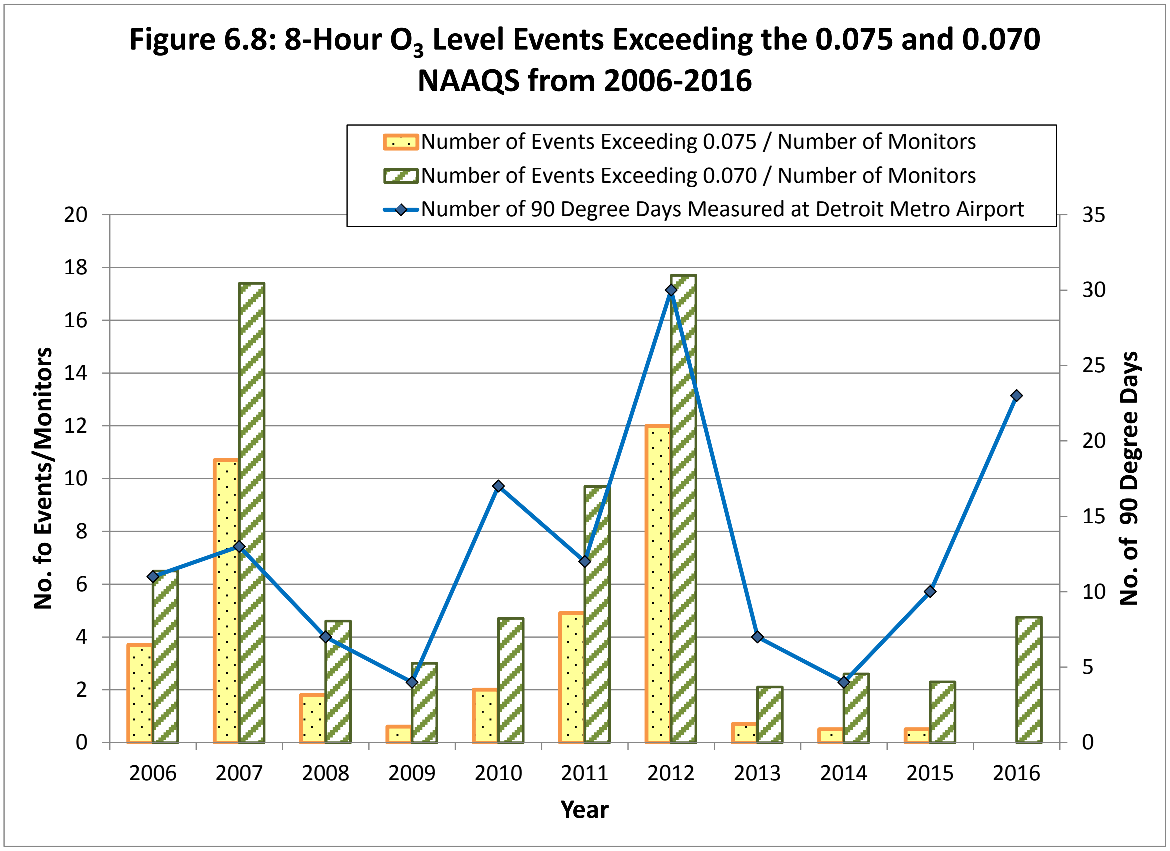
Figure 6.5 shows the 4th highest 8-hour O_3 values for Grand Rapids-Muskegon-Holland CSA. Muskegon and Holland violated the 3-year standard.

Figure 6.6 shows 4th highest 8-hour O_3 values for mid-Michigan. Coloma violated the 3-year standard.

Figure 6.7 shows 4th highest 8-hour O_3 values for Northern Lower and Upper Peninsula. No sites violated the 3-year standard.

Figure 6.8 shows 8-hour O_3 readings ≥ 0.070 ppm and ≥ 0.075 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 the standard (events) was 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.

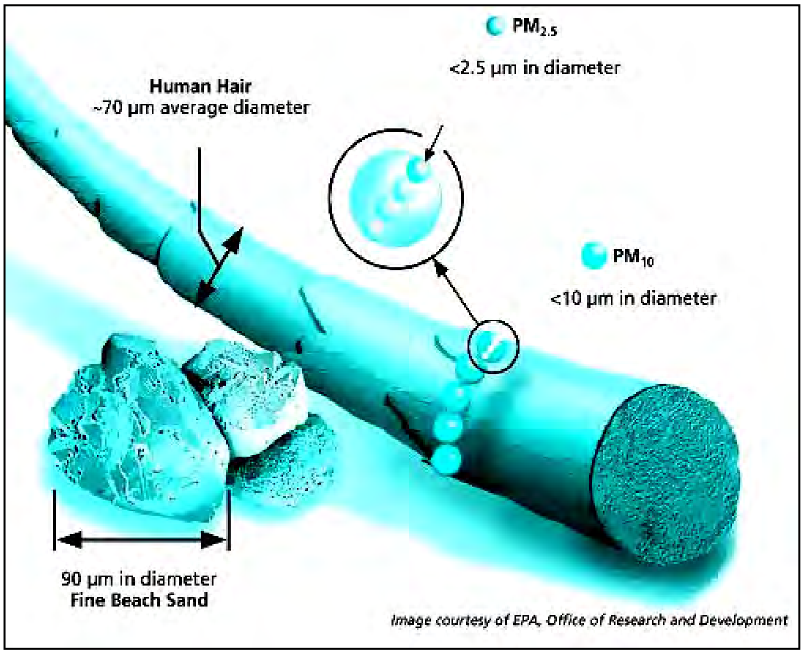
Since the ozone NAAQS level changed from 0.075 ppm to 0.070 ppm for the 2016 ozone season, Figure 6.8 shows the events/monitors at the 0.075 ppm level and the additional days that would be included at the 0.070 ppm level. Since 2016 is subject to the 0.070 NAAQS standard, it only shows the events exceeding the 0.070 ppm level.



This comparison shows the influence of temperature with respect to elevated O_3 levels. Over the past 10 years, a typical summer would have an average of 12.5 days with the maximum daily temperature exceeding 90°F. Over the time period from 2006 through 2016, the highest number of 90°F days occurred in 2012 (30 days), while the lowest number occurred in 2009 and 2014 (four days).

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

Particulate matter (PM) is a general term used for a mixture of solid particles and liquid droplets (aerosols) found in the air. These are further categorized according to size; larger 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 not to be exceeded more than once per year over 3 years. $PM_{2.5}$ has an annual average standard of 12 µg/m^3, and a 98th percentile 24-hour concentration of 35 µg/m^3 averaged over 3 years. The sources and effects of PM 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.

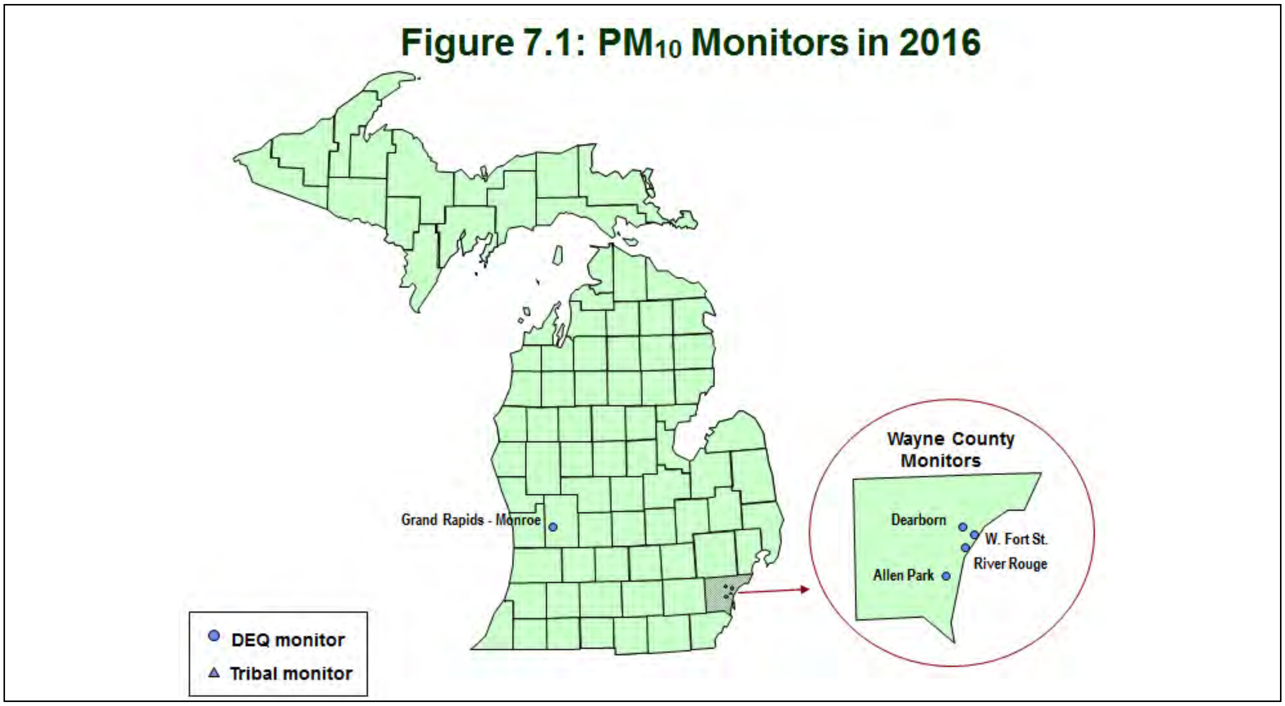
Effects: Exposure to PM affects breathing and the cellular defenses of the lungs, aggravates existing respiratory and cardiovascular ailments, and has been linked with heart and lung disease. Smaller particles (PM_{10} or smaller) pose the greatest problems, because they can penetrate deep in the lungs and possibly into the bloodstream. PM is the major cause of reduced visibility in many parts of the United States. $PM_{2.5}$ 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: People with heart or lung disease, the elderly, and children are at highest risk from exposure to PM.

PM$_{10}$

Since October 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 2016. These monitors are located mostly in the state's largest populated urban areas: four in the Detroit area and one in Grand Rapids. To better characterize the nature of particulate matter 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 USEPA's State and County Emission Summaries).

Figure 7.2: PM$_{10}$ Emissions by Source Sector

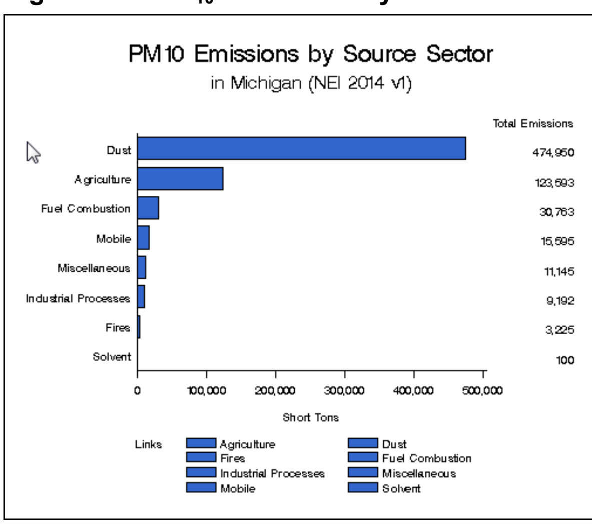


Figure 7.3: PM$_{10}$ Emissions in 2014

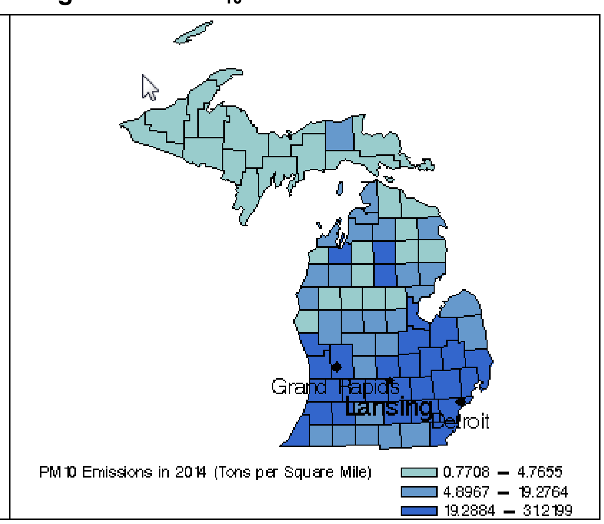
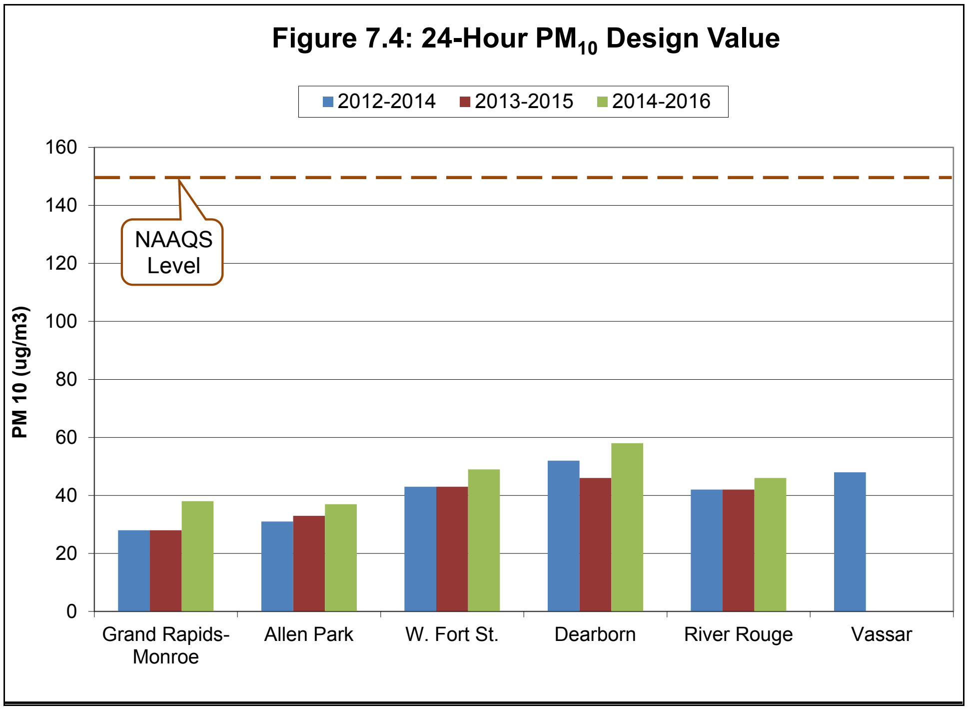


Figure 7.4 shows the PM_{10} levels in Michigan compared to the 24-hour average of 150 µg/m^3. This standard must not be exceeded on average more than once per year over a 3-year period. The design value is the 4th highest value over a 3-year period. The PM_{10} levels at all sites in Michigan are well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



$PM_{2.5}$

The USEPA designated Michigan in attainment of the 1997 annual $PM_{2.5}$ standard of 15 µg/m^3 and the 2006 24-hour $PM_{2.5}$ standard of 35 µg/m^3 in August 2013. In December 2012, the USEPA revised the annual primary standard to 12 µg/m^3 while the annual secondary standard remained at 15 µg/m^3. The primary and secondary 24-hour standard remained at 35 µg/m^3. In December 2014, the USEPA determined that no area in Michigan violated the 2012 standard and the state was classified as unclassifiable/attainment.

Fine particulate matter ($PM_{2.5}$) is measured using three techniques: Federal Reference Method (FRM), Continuous Methods, and Chemical Speciation Methods. These methods are described in more detail below.

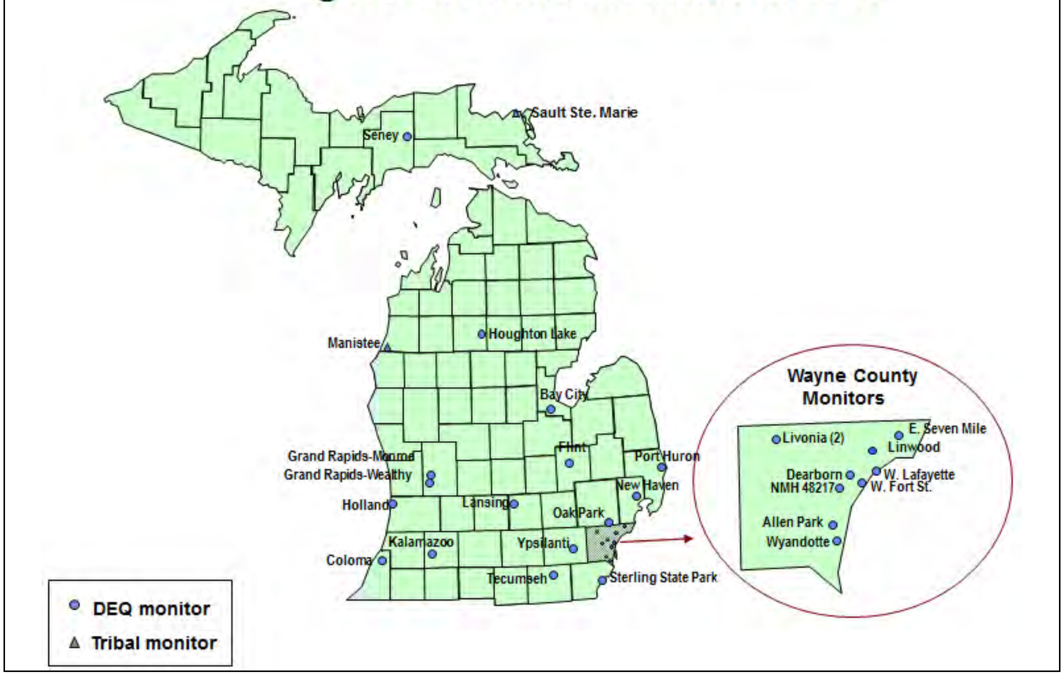
$PM_{2.5}$ FRM Monitoring: The concentrations of $PM_{2.5}$ measured over a 24-hour time period are determined using the filter-based gravimetric FRM. Only data generated by the FRM monitors are used for comparisons to the NAAQS in Michigan. The sites are located in urban, commercial, and residential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

Continuous $PM_{2.5}$ Monitoring: 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 understanding 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.

Figure 7.5: $PM_{2.5}$ Monitors in 2016



$PM_{2.5}$ FRM Monitoring Network: $PM_{2.5}$ FRM monitors are deployed to characterize background or regional $PM_{2.5}$ transport collectively from upwind sources. A $PM_{2.5}$ monitor was added to the new near-roadway site in Livonia that started in January 2015.

Four $PM_{2.5}$ 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, Dearborn, Allen Park, and Detroit's W. Fort Street (SWHS).

Continuous $PM_{2.5}$ Network: Short-term measurements of $PM_{2.5}$ or PM_{10} are updated on an hourly basis using Tapered Element Oscillating Microbalance (TEOM) instruments. At least one continuous TEOM is required at the NCore $PM_{2.5}$ monitoring 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 percent 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 over a 24-hour period and analyzed to determine various components of $PM_{2.5}$. There are five SASS monitors operating in Michigan**.** Houghton Lake, Port Huron and Sterling State Park monitors were shut down on January 24, 2015 due to lack of

[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].

funding. The primary objectives of the chemical speciation monitoring sites are to provide data that will be used to determine 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 percent nitrate compounds, 30 percent sulfate compounds, 30 percent organic carbon,[8] and 10 percent 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 operates two aethalometers and two elemental carbon/organic carbon (EC/OC) monitors.

- 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. The DEQ's aethalometers are located at Allen Park and Dearborn.
- The EC/OC instruments measure elemental carbon using pyrolysis coupled with a nondispersive infrared detector to separate the elemental and organic carbon fractions. EC/OC instruments are located at Dearborn and Tecumseh.

$PM_{10-2.5}$

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

Table 1.3 in chapter 1 shows all of Michigan's $PM_{2.5}$ FRM monitoring stations operating in 2016 and denotes which sites have TEOM, SASS, Aethalometer or EC/OC monitors in operation.

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

Figure 7.6: $PM_{2.5}$ Emissions by Source Sector

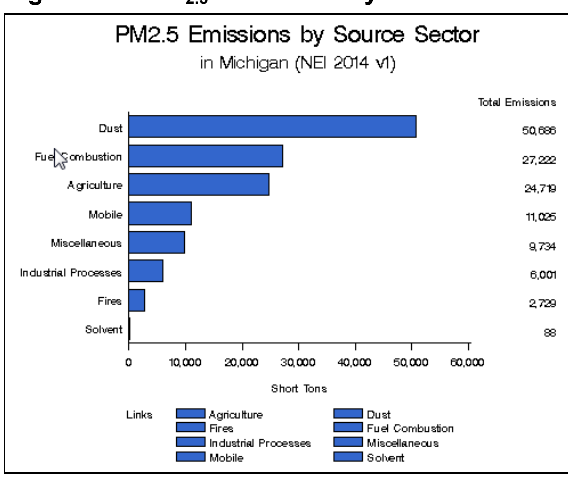
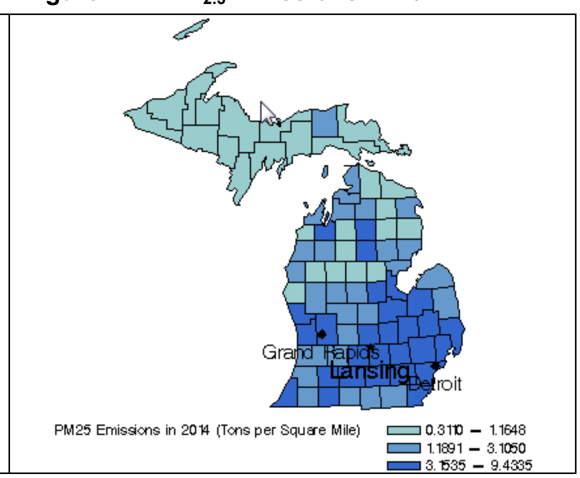


Figure 7.7: $PM_{2.5}$ Emissions in 2014



[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 2012 Ambient Air Monitoring Network Review, available at http://www.michigan.gov/documents/deq/deq-aqd-aqe-2012-Air-Mon-Network-Review_357137_7.pdf
[9] Current information can be found at https://www3.epa.gov/ttn/amtic/ncoreguidance.html.

Table 7.1 provides the 3-year average of the annual mean $PM_{2.5}$ concentrations for 2013-2015. Michigan's levels are below the 12 μg/m^3 primary standard.[10] Stations labeled #2 provide a precision estimate of the overall measurement and operate on a one-in-six sampling schedule. All other monitors are sampled on a one-in-three-day schedule, except for Allen Park #1 and Detroit–W. Lafayette, which sample daily.

Table 7.1: 3-Year Average of the Annual Mean $PM_{2.5}$ Concentrations

Areas	County	Monitoring Sites	2014	2015	2016	2014-2016 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	8.78	8.58	7.46	8.3
	Livingston					
	Macomb	New Haven	9.10	9.73	7.51	8.8
	Oakland	Oak Park	9.33	9.37	7.87	8.9
	St. Clair	Port Huron	9.40	9.51	7.77	8.9
	Washtenaw	Ypsilanti #1	9.79	9.56	7.84	9.1
		Ypsilanti #2	9.37	9.08	8.06	8.8
	Wayne	Allen Park	10.13	9.66	8.72	9.5
		Detroit-Linwood	9.74	10.18	8.94	9.6
		Detroit-E. 7 Mile	9.64	9.79	8.11	9.2
		Detroit-W. Fort St.	10.99	11.26	11.32	11.2
		Detroit-W. Lafayette	9.68	9.12	8.38	9.1
		Wyandotte	9.71	8.62	7.70	8.7
		Dearborn #1	11.77	11.50	10.67	11.3
		Dearborn #2	11.64	11.65	10.52	11.3
		Livonia	9.46	9.31	8.16	9.0
		Livonia-Roadway		9.53	8.53	9.0
Flint	Genesee	Flint	8.92	8.16	7.18	8.1
	Lapeer					
Grand Rapids	Ottawa	Jenison				
	Kent	Grand Rapids-Wealthy	9.91	9.37	8.79	9.4
		Grand Rapids #1	9.49	9.30	8.16	9.0
		Grand Rapids #2	9.30	10.37	8.48	9.4
Allegan Co	Allegan	Holland	8.68	7.88	6.99	7.9
Monroe Co	Monroe	Luna Pier				
		Sterling State Park	9.03*	9.26	7.75	8.5
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	9.64	8.90	8.09	8.9
		Kalamazoo #2	9.45	9.34	8.25	9.0
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	9.38	8.56	7.31	8.4
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	8.49	8.15	7.35	8.0
Bay Co	Bay	Bay City	8.17	7.74	6.84	7.6
Missaukee Co	Missaukee	Houghton Lake	5.62	5.59	4.87	5.4
Manistee Co	Manistee	Manistee	6.16	6.37	5.50	6.0
Chippewa Co	Chippewa	Sault Ste. Marie #1	6.23	5.79*	5.04*	5.7
		Sault Ste. Marie #2	5.67	6.18*	5.03*	5.6

*Indicates mean does not meet completeness criteria.

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

Table 7.2 provides the 24-hour 98th percentile $PM_{2.5}$ concentrations for 2013-2015 showing Michigan's levels are below the 35 μg/m³ standard (3-year average).[11]

Table 7.2: 24-Hour 98th Percentile $PM_{2.5}$ Values Averaged over 3 Years						
Areas	County	Monitoring Sites	2014	2015	2016	2014-2016 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	22.8	25.2	15.1	21
	Livingston					
	Macomb	New Haven	27.0	31.6	20.1	26
	Oakland	Oak Park	23.3	29.6	19.8	24
	St. Clair	Port Huron	25.2	28.7	19.1	24
	Washtenaw	Ypsilanti #1	24.5	25.9	17.6	23
		Ypsilanti #2	23.7	20.6	17.4	21
	Wayne	Allen Park	26.4	23.1	20.3	23
		Detroit-Linwood	23.6	27.1	22.5	24
		Detroit-E. 7 Mile	22.0	25.6	19.5	22
		Detroit-W. Fort St.	23.8	27.1	25.6	26
		Detroit-W. Lafayette	25.5	22.4	20.5	23
		Wyandotte	25.6	21.1	18.8	22
		Dearborn #1	26.5	28.1	25.8	27
		Dearborn #2	26.7	24.7	24.7	25
		Livonia	25.7	26.8	19.9	24
		Livonia-Roadway		25.2	21.4	23
Flint	Genesee	Flint	24.3	22.3	18.8	22
	Lapeer					
Grand Rapids	Ottawa	Jenison				
	Kent	Grand Rapids-Wealthy	24.3	25.5	22.7	24
		Grand Rapids #1	23.0	25.6	19.5	23
		Grand Rapids #2	26.9	24.3	19.5	24
Allegan Co	Allegan	Holland	23.4	21.2	17.2	21
Monroe Co	Monroe	Luna Pier				
		Sterling State Park	23.9*	25.7	18.3	23
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	23.9	22.3	20.1	22
		Kalamazoo #2	30.6	21.3	20.2	24
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	22.1	24.5	18.0	22
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	19.8	19.4	17.2	19
Bay Co	Bay	Bay City	21.1	23.3	19.6	21
Missaukee Co	Missaukee	Houghton Lake	16.3	17.9	12.4	16
Manistee Co	Manistee	Manistee	17.3	19.3	12.6	16
Chippewa Co	Chippewa	Sault Ste. Marie #1	15.3	15.8	11.3	14
		Sault Ste. Marie #2	12.7	16.4	10.8	13

*Indicates mean does not meet completeness criteria.

Figures 7.8 through **7.11** illustrate the current annual mean $PM_{2.5}$ trend for each monitoring site in Michigan. For clarity, the monitoring sites within the Detroit-Warren-Flint CSA have been

[11] The 98th percentile value was obtained from the USEPA AQS. For the purpose of comparing calculated values, the 3-year 24-hour average is rounded to the nearest 1 μg/m³.

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.

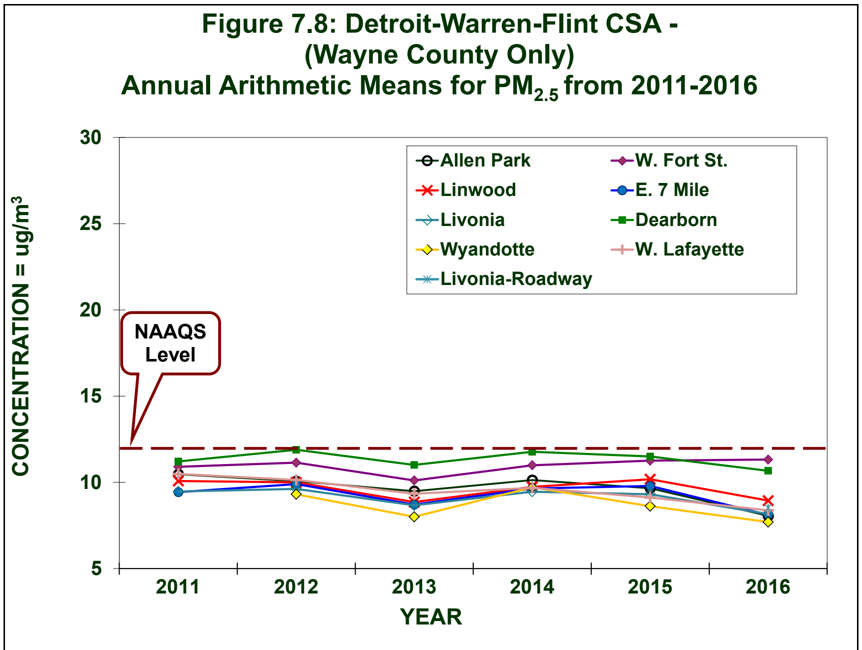


Figure 7.8 shows the 2016 levels in Wayne County remained below the $PM_{2.5}$ NAAQS standard. Historically, Dearborn has had the highest readings in the state, but W. Fort St. now has the highest readings.

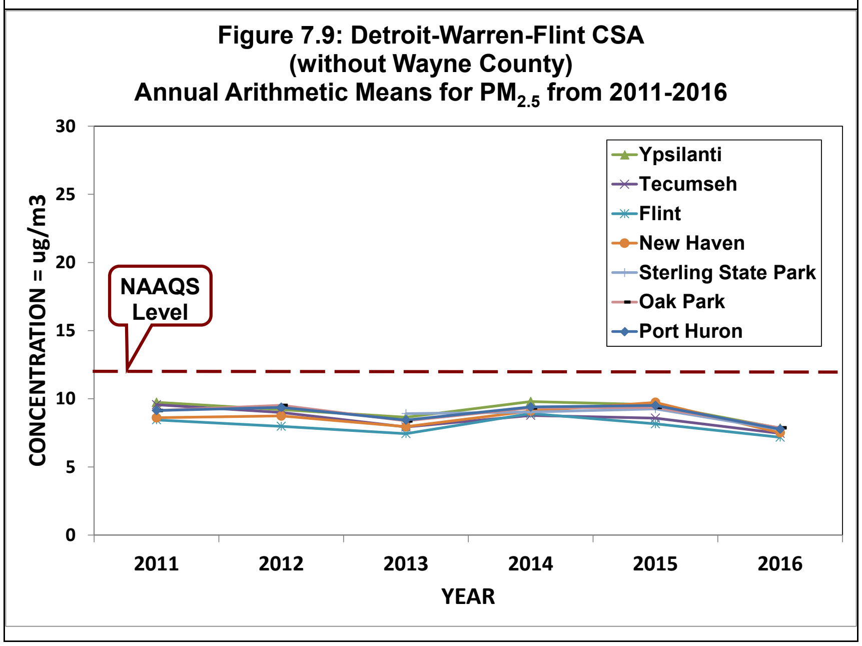


Figure 7.9 contains the remainder of those sites in the Detroit-Warren-Flint CSA that are outside of Wayne County. These sites also show readings in 2016 to be below the $PM_{2.5}$ NAAQS.

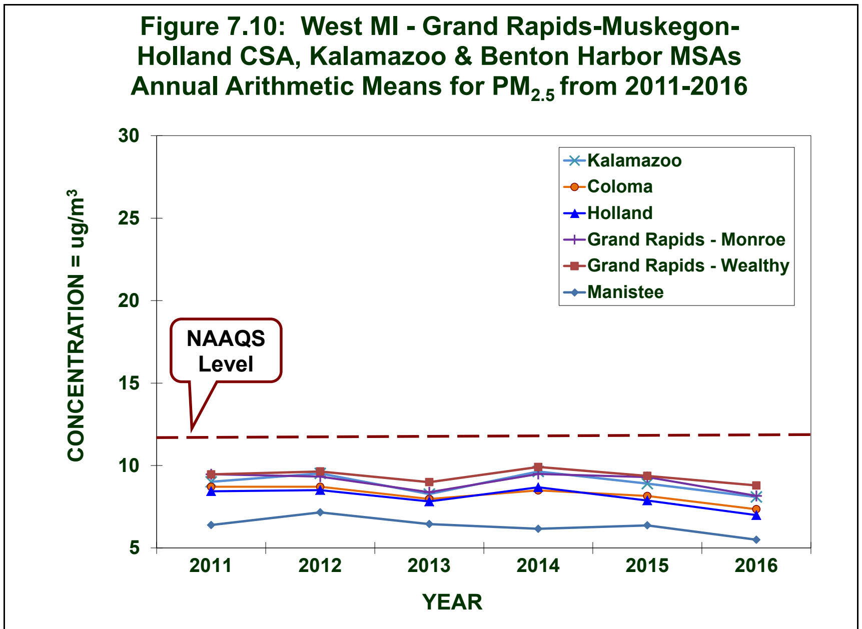


Figure 7.10 combines the $PM_{2.5}$ monitoring sites located in West Michigan-Grand Rapids-Muskegon-Holland CSA, Kalamazoo and Benton Harbor MSAs. All sites are below the annual $PM_{2.5}$ NAAQS.

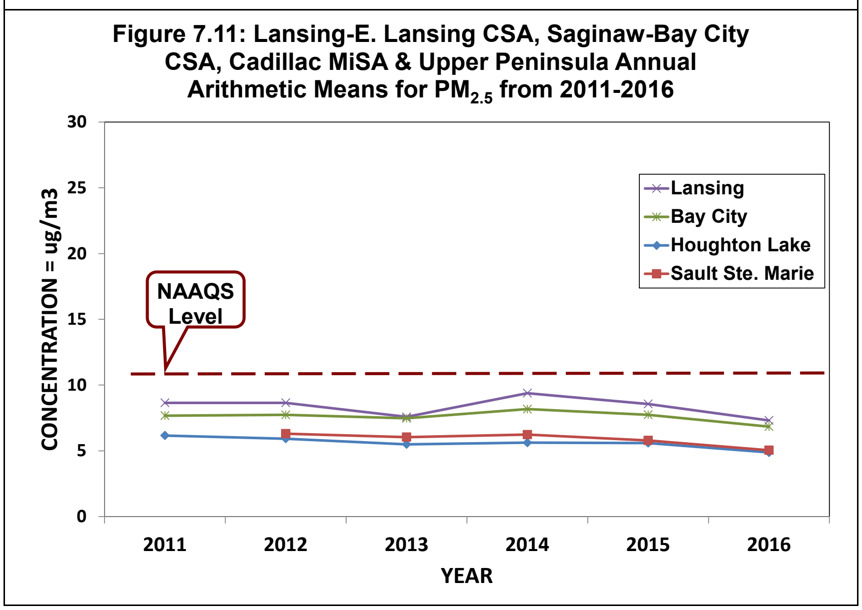


Figure 7.11 displays the remaining monitoring sites in the Northern Lower and Upper Peninsula. All of these sites are below the annual $PM_{2.5}$ NAAQS standard.

Chapter 8: Toxic Air Pollutants

In addition to the six criteria pollutants discussed in 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, the USEPA specifically addresses a group of 187 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. The sources and effects of toxics are as follows:

Sources: Air toxics come from a variety of mobile, stationary, and indoor man-made sources as well as 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 are at the highest risk from exposure to air toxics**.**

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 (formaldehyde, acetone, and acetaldehyde);
    - 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 USEPA has developed an Integrated *Urban Air Toxics Strategy* with a focus on 30 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 2016. This table can also be found in **Appendix B** with the Air Toxics Monitoring Summary.

The $PM_{2.5}$ speciation network was reduced due to USEPA funding cuts. In January 2015, the DEQ shut down three monitors at Houghton Lake in Missaukee County, Sterling State Park in Monroe County, and Port Huron in St. Clair County.

Table 8.1: 2016 Toxics Sampling Sites

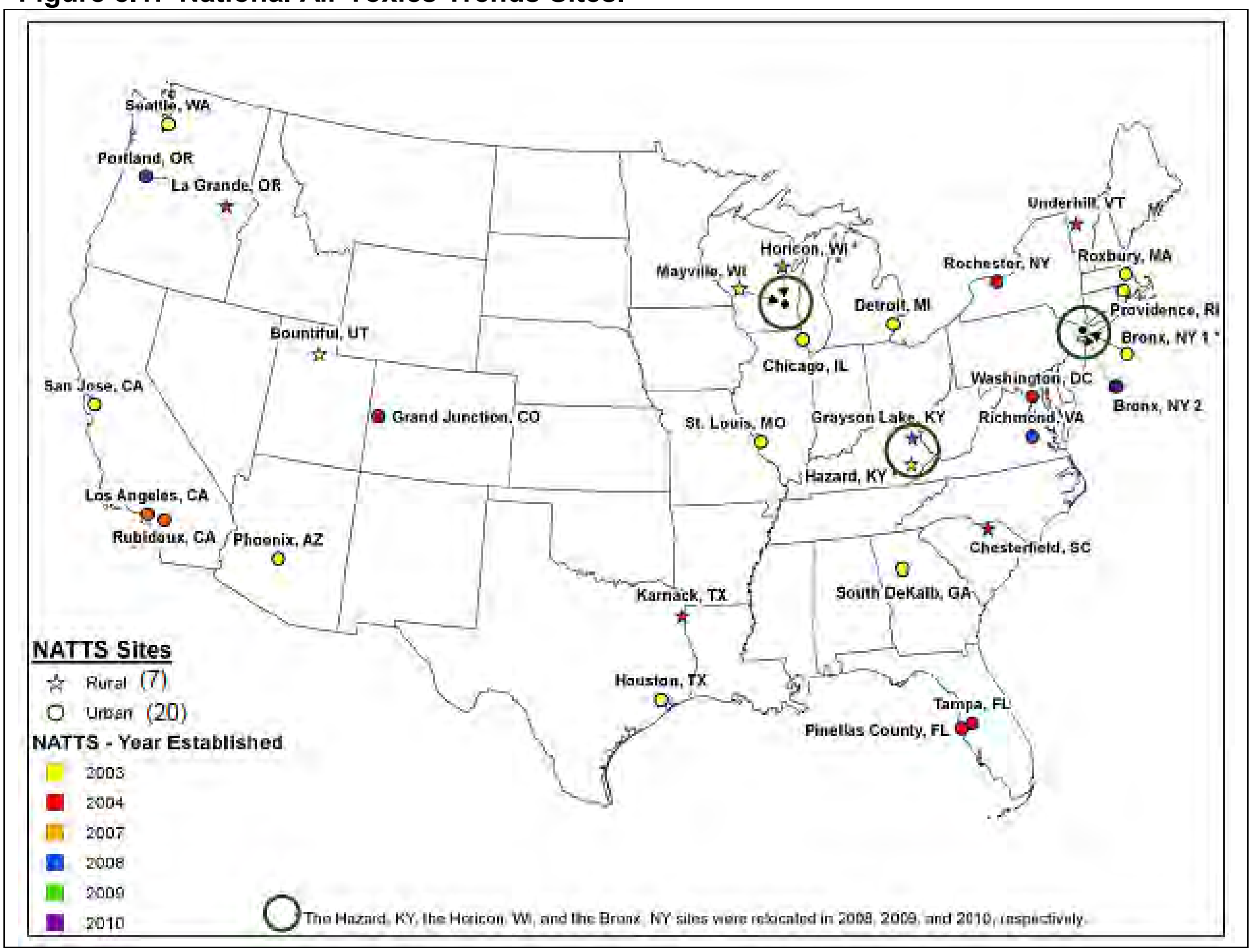
Site Name	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Speciated $PM_{2.5}$
Allen Park				x	x	x
Dearborn	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn	x
Detroit-W. Jefferson				x		
Grand Rapids-Monroe				x		x
Belding-Merrick St.				x		
Belding-Reed St.				x		
NMH 48217	x		x	x		
Port Huron-Rural St.				x		
River Rouge		x		x	Mn	
Tecumseh						x

[12] USEPA’s Air Toxics Website: Urban Strategy is located at https://www.epa.gov/urban-air-toxics/urban-air-toxic-pollutants.

National Monitoring Efforts and Data Analysis

The USEPA 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 the USEPA's 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 USEPA requires that the NATTS sites measure VOCs, carbonyls, PAHs and trace metals on a once-every-six-day sampling schedule. Hexavalent chromium is no longer required at NATTS sites and data collection was discontinued July 2013. The Dearborn NATTS site 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 the 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 (**Table 9.1**), 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 is generally in the Good or Moderate range. An area will occasionally fall into the Unhealthy for Sensitive Groups range, but rarely reaches Unhealthy levels.

MIair includes an "Actions to Protect Health" link: http://www.deqmiair.org/assets/AQIActionsToProtectHealth_2011.pdf which contains activity recommendations based on the AQI levels.

Air Quality Forecasts

AQD 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!* Days tab on **MIair**.

Air Quality Notification

EnviroFlash is a free service that provides automated air quality (AQI) and ultraviolet (UV) forecasts to subscribers. Those enrolled receive e-mail or mobile phone text messages when the health level they select is predicted to occur. AIRNow iPhone and Android applications deliver ozone and fine particle air quality forecasts plus detailed real-time information that can be used to better protect health when planning daily activities. To learn more about this program, select the **MIair** button from Michigan's Air Quality page www.michigan.gov/air. To receive notices chose the "Air Quality Notification" tab and click the "Enroll in AQI EnviroFlash" link. 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 USEPA'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, Children, and Older adults should reduce prolonged or heavy exertion.**	**People with heart or lung disease, Children & older adults, and People who are active outdoors should reduce prolonged or heavy exertion.**	**People with heart 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, Children, and Older adults should avoid prolonged or heavy exertion.** **Everyone should reduce prolonged or heavy exertion.**	**People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid prolonged or heavy exertion.** **Everyone should reduce prolonged or heavy exertion.**	**People with heart disease, such as angina, should reduce moderate exertion and avoid sources of CO, such as heavy traffic.**	**Children, Asthmatics, and People with heart or lung disease should reduce outdoor exertion.**	**None**
PURPLE: Very Unhealthy 201- 300	**People with heart or lung disease, Children, and Older adults should avoid all physical exertion outdoors.** **Everyone else should limit outdoor exertion.**	**People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid all physical exertion outdoors. Everyone else should limit outdoor exertion.**	**People with heart 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 should reduce outdoor exertion.**	**Children and People with respiratory disease, such as asthma, should reduce outdoor exertion.**
MAROON: Hazardous 301- 500	**People with heart or lung disease, Children, and Older adults should remain indoors.** **Everyone should avoid prolonged or heavy exertion.**	**People with heart or lung disease, Children, and Older adults should remain indoors.** **Everyone should avoid all outdoor exertion.**	**People with heart 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.** **Everyone should avoid outdoor exertion.**	**Children and People with respiratory disease, such as asthma, should avoid outdoor exertion.**

Chapter 10: Meteorological Information

Figures 10.1 through **10.3** shows average daily temperatures and **Figures 10.4** through **10.6** shows total monthly precipitation amounts compared to their climatic norms for sites in the Northern, Southern Lower and Upper 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 2016.

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

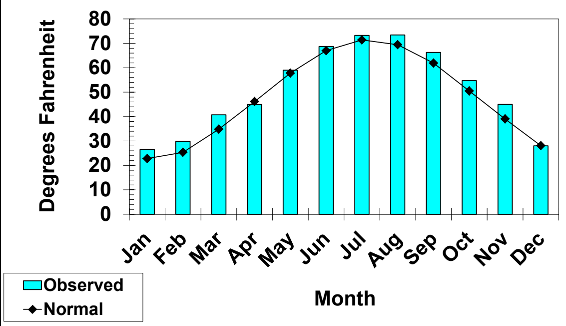


Figure 10.2: Northern Lower Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

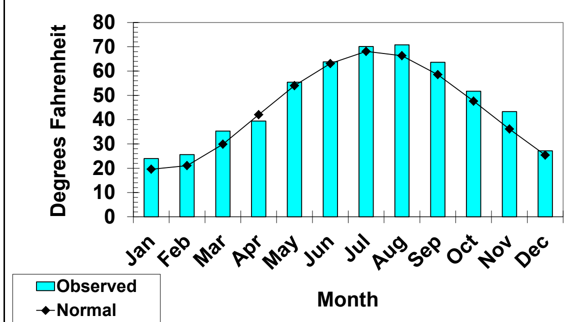


Figure 10.3: Upper Peninsula Observed Average Daily Temperatures vs. Normal Average Daily Temperatures

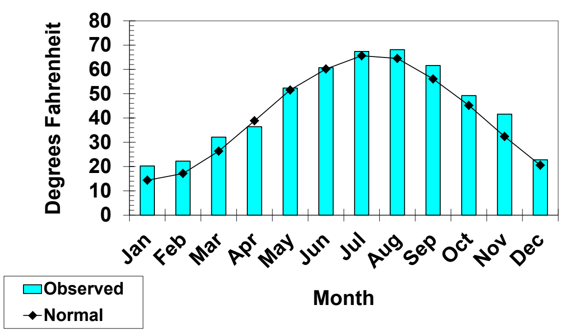


Figure 10.4: Southern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

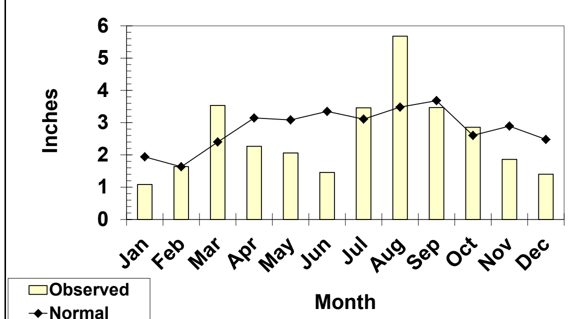


Figure 10.5: Northern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

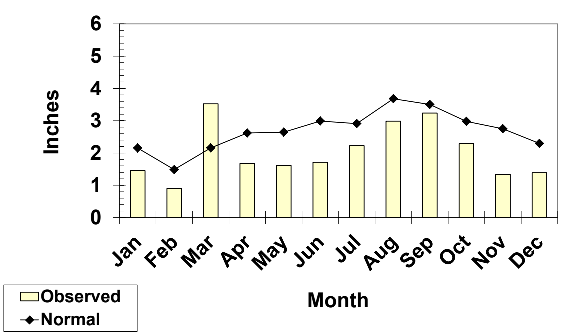
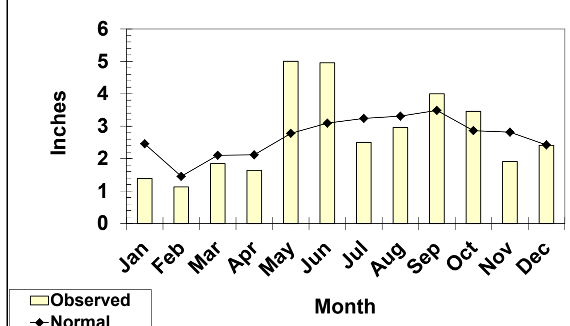


Figure 10.6: Upper Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation



The weather plays a significant role in air quality, and can either help increase or decrease the amount of pollution in the air. High temperatures, sun and longer days (i.e., more daylight hours) are conducive to ozone formation, whereas rain tends to wash pollutants out of 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 several *Action!* Days declared during the summer of 2016.

Table 10.1: *Action!* Days Declared During Summer 2016

Location	Year	Number	Dates
Ann Arbor	2016	8	6/18, 6/19, 6/25, 7/12, 7/23, 8/4, 8/10, 8/11
Benton Harbor	2016	7	5/23, 6/10, 6/11, 6/19, 7/23, 8/4, 8/10
Detroit	2016	9	6/11, 6/18, 6/19, 6/25, 7/12, 7/23, 8/4, 8/10, 8/11
Flint	2016	3	6/10, 6/25, 8/4
Grand Rapids	2016	9	5/23, 6/10, 6/11, 6/19, 6/25, 7/23, 8/4, 8/10, 8/11
Kalamazoo	2016	1	6/11
Ludington	2016	5	5/23, 6/19, 6/25, 7/23, 8/4
Saginaw	2016	1	8/4
Traverse City	2016	1	6/19

Chapter 11: Special Projects

Near-Road Air Toxics Grant: The DEQ is currently working on two special projects. The first project is a Community Scale Air Toxics Ambient Monitoring (CSATAM) grant. In 2015, the DEQ applied for a CSATAM grant to study near-roadway emissions at three sites in Detroit: Eliza Howell Near-Road, Eliza Howell Downwind, and Livonia Near-Road. The grant involves two years of monitoring at these sites, with an intensive 3-month sampling period when additional samples and increased sampling frequency will be employed. The additional measurements at these sites are listed in **Table 11.1**. The 3-month intensive sampling period will allow for the analysis of toxic compounds that are more labor intensive to collect. The schedule for the intensive period has been delayed due to road construction at the Livonia Near-Road site, but will run from May through July 2017.

Table 11.1. Types of Measurements, Duration and Purpose at Near-Road Sites

Measurement	Duration	Purpose
Hourly Black Carbon (BC[1])	2 years	Characterize diesel PM
Hourly BTEX	2 years	Characterize benzene and mobile source indicators
Hourly PM	2 years	Characterize hourly particulate matter
Hourly $NO/NO_2/NOx$	2 years	Mandated near-road measurement
Hourly CO	2 years	Mandated near-road measurement
Hourly Ozone	2 years	Help differentiate NOx and NO_2 concentrations
Hourly UFP[2]	6-12 months	Determine Ultra Fine Particulate Matter (UFP) levels, which have acute and likely chronic health affects
Hourly PM_{10} toxic metals	1 month	Use high–time-resolution measurements to apportion roadway influence, upwind versus downwind, and variations with traffic
Every other day 24-hour TSP toxic metals	3 months	Obtain full suite of toxics metals, for comparison among near-road and urban sites, apportion roadway influence
Every other day 24-hour carbonyls	3 months	Obtain toxics formaldehyde, acetaldehyde, acrolein to best determine risk from these air toxics
Meteorology	2 years	Provide capability to differentiate upwind from downwind
Traffic counts	2 years	Provide data on traffic patterns to link traffic mix and speed to air toxics concentrations

[1] BC is a marker for diesel particulate matter (DPM), which the USEPA has concluded ranks with the other substances that the national-scale assessment suggests pose the greatest relative risk; see https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=29060
[2] Mobile sources are a key source of exposure to ambient UFP emissions. Epidemiological studies have so far been inconclusive regarding UFP toxicity, but more data are needed, as discussed in detail in Health Effects Institute Perspectives.
[3] Understanding the Health Effects of Ambient Ultrafine Particles is available at: https://www.healtheffects.org/system/files/Perspectives3.pdf

Community Monitoring Project: The second special purpose monitoring project resulted from a request from community members in the Detroit 48217 ZIP code for an air monitoring station in their neighborhood. The 48217 community has many industrial sources located in and around it. The DEQ has agreed to place an air monitoring station in their community for a 1-year study. The monitor site, known as "NMH 48217," is located at New Mount Herman Church at 3225 South Deacon Street in Detroit. The site monitors for SO_2, $PM_{2.5}$, VOCs, PAHs, TSP metals, hydrochloric acid, sulfuric acid, and hydrogen cyanide. Sampling started in August 2016 for some instruments, with all instruments being online by the end of September 2016. The data will be analyzed at the end of the 1-year study, and a determination will be made whether to shut down all or some of the parameters that are being collected at this site. **Figure 11.1** shows the 1-hour maximum SO_2 per day and **Figure 11.2** shows the daily $PM_{2.5}$ concentrations. See Appendix B-1 for a summary of the other air pollutants sampled at this site.

Figure 11.1. 1-Hour Maximum SO_2 Concentrations per Day at NMH 48217

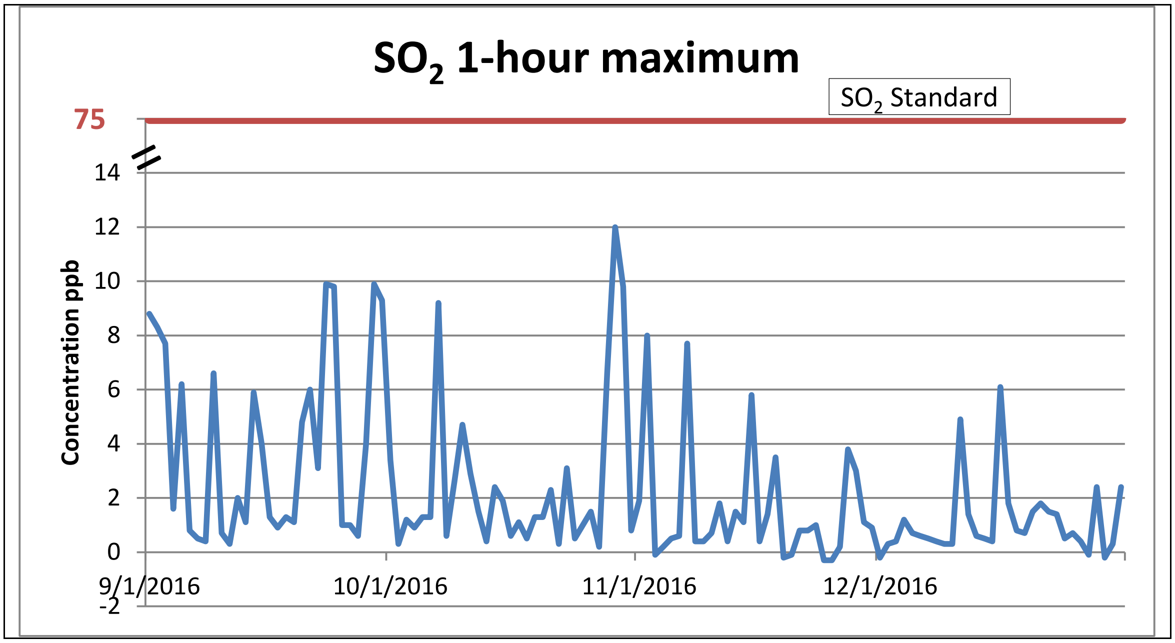
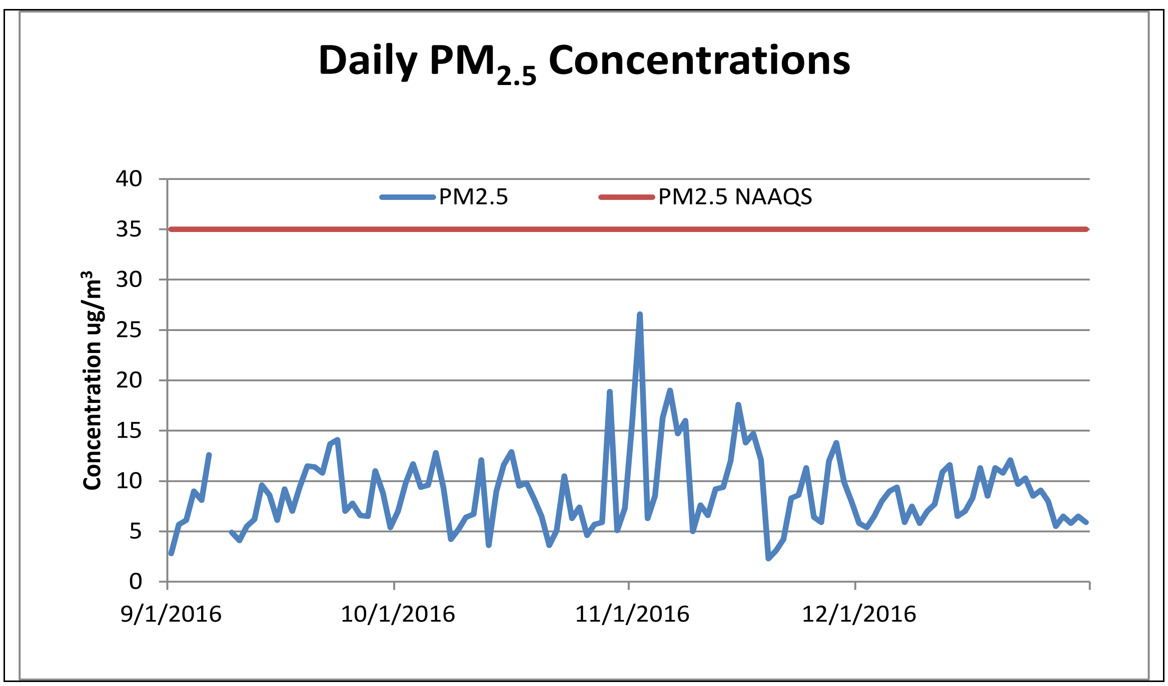


Figure 11.2. Daily $PM_{2.5}$ Concentrations at NMH 48217



Appendix A: Criteria Pollutant Summary for 2016

Appendix A utilizes the USEPA's 2016 Air Quality System (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 USEPA's code number for these sites.

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 - 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 – speciation air sampling system).

 # 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 exceedances 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 exceedance 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 2016

CO Measured in ppm

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	1-hr OBS > 35	8-hr Highest Value	8-hr 2nd Highest Value	8-hr OBS > 9
260810020	1	Grand Rapids-Monroe	Kent	2016	7625	1.5	1.4	0	0.9	0.9	0
261630001	1	Allen Park	Wayne	2016	8153	1.9	1.6	0	1.4	1.1	0
261630093	1	Eliza Howell-Roadway	Wayne	2016	8021	2.2	2.2	0	2.0	1.5	0
261630094	1	Eliza Howell-Downwind	Wayne	2016	8381	2.2	2.1	0	2.0	1.5	0
261630095	1	Livonia-Roadway	Wayne	2016	8380	1.7	1.5	0	1.3	1.3	0

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

Site ID	POC	City	County	Year	# OBS	Highest rolling 3-month Arith Mean	Highest Value (24-hr)	2nd Highest Value (24-hr)
260670002	1	Belding-Reed St.	Ionia	2016	61	0.02	0.167	0.117
260670003	1	Belding-Merrick St.	Ionia	2016	61	0.01	0.099	0.082
260810020	1	Grand Rapids-Monroe	Kent	2016	61	0.00	0.010	0.008
261470031	1	Port Huron-Rural St.	St. Clair	2016	60	0.07	0.237	0.129
261630001	1	Allen Park	Wayne	2016	57	0.01	0.018	0.009
261630033	1	Dearborn	Wayne	2016	58	0.01	0.034	0.031
261630097	1	NMH 48217*	Wayne	2016	20	0.01	0.008	0.007

*Indicates the site is part of a one-year special study

NO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	98th Percentile 1-hr	Annual Arith Mean
260650012	1	Lansing	Ingham	2016	6895	53.0	45.0	38.0	6.60
261130001	1	Houghton Lake	Missaukee	2016	8295	15.0	12.0	9.0	1.69
261630019	2	Detroit-E. 7 Mile	Wayne	2016	8368	55.2	54.0	42.3	10.20
261630093	1	Eliza Howell-Roadway	Wayne	2016	8179	47.0	47.0	44.0	16.29
261630094	1	Eliza Howell Downwind	Wayne	2016	8448	62.0	61.0	40.4	11.24
261630095	1	Livonia–Roadway	Wayne	2016	8095	51.0	49.0	41.0	9.43

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-Monroe	Kent	2016	7407	200.7	179.8	13.48
261630001	1	Allen Park	Wayne	2016	8215	204.7	203.1	17.20

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	2016	181	183	0.97	0.089	0.082	0.080	0	0	0
260190003	1	Benzonia	Benzie	2016	168	183	0.084	0.082	0.080	0.079	0	0	3
260210014	1	Coloma	Berrien	2016	182	183	0.093	0.090	0.086	0.084	0	0	1
260270003	2	Cassopolis	Cass	2016	183	183	0.087	0.082	0.082	0.081	0	0	0
260330901	1	Sault Ste. Marie	Chippewa	2016	170	183	0.079	0.076	0.073	0.068	0	0	0
260370001	2	Rose Lake	Clinton	2016	181	183	0.083	0.081	0.080	0.079	0	0	0
260490021	1	Flint	Genesee	2016	182	183	0.085	0.084	0.080	0.079	0	0	1
260492001	1	Otisville	Genesee	2016	183	183	0.093	0.083	0.082	0.080	0	0	0
260630007	1	Harbor Beach	Huron	2016	183	183	0.086	0.086	0.081	0.080	0	0	0
260650012	2	Lansing	Ingham	2016	171	183	0.083	0.081	0.079	0.077	0	0	2
260770008	1	Kalamazoo	Kalamazoo	2016	180	183	0.080	0.078	0.078	0.078	0	0	0
260810020	1	Grand Rapids-Monroe	Kent	2016	183	183	0.087	0.085	0.083	0.078	0	0	0
260810022	1	Evans	Kent	2016	181	183	0.084	0.080	0.080	0.078	0	0	0
260910007	1	Tecumseh	Lenawee	2016	183	183	0.078	0.078	0.077	0.076	0	0	0
260990009	1	New Haven	Macomb	2016	183	183	0.094	0.092	0.090	0.087	0	0	0
260991003	1	Warren	Macomb	2016	183	183	0.084	0.080	0.080	0.078	0	0	0
261010922	1	Manistee	Manistee	2016	183	183	0.092	0.079	0.076	0.075	0	0	0
261050007	1	Scottville	Mason	2016	181	183	0.095	0.094	0.084	0.081	0	0	0
261130001	1	Houghton Lake	Missaukee	2016	182	183	0.080	0.078	0.077	0.077	0	0	1
261210039	1	Muskegon	Muskegon	2016	178	183	0.108	0.099	0.089	0.081	0	0	3
261250001	2	Oak Park	Oakland	2016	183	183	0.087	0.083	0.082	0.081	0	0	0
261390005	1	Jenison	Ottawa	2016	168	183	0.087	0.086	0.083	0.079	0	0	0
261470005	1	Port Huron	St .Clair	2016	183	183	0.088	0.084	0.082	0.081	0	0	0
261530001	1	Seney	Schoolcraft	2016	183	183	0.090	0.086	0.080	0.080	0	0	0
261610008	1	Ypsilanti	Washtenaw	2016	181	183	0.081	0.079	0.077	0.077	0	0	2
261630001	2	Allen Park	Wayne	2016	183	183	0.086	0.082	0.080	0.078	0	0	0
261630019	2	Detroit-E. 7 Mile	Wayne	2016	176	183	0.084	0.083	0.083	0.082	0	0	2
261630093	1	Eliza Howell-Roadway*	Wayne	2016	180	183	0.072	0.072	0.068	0.068	0	0	0
261630094	1	Eliza Howell-Downwind*	Wayne	2016	182	182	0.079	0.078	0.078	0.078	0	0	1

* Indicates sampling is part of a two-year special study.

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 > 0.070
260050003	1	Holland	Allegan	2016	97	178	0.085	0.079	0.076	0.076	9
260190003	1	Benzonia	Benzie	2016	92	169	0.083	0.075	0.074	0.072	6
260210014	1	Coloma	Berrien	2016	98	179	0.082	0.079	0.079	0.078	11
260270003	2	Cassopolis	Cass	2016	99	182	0.079	0.078	0.078	0.077	9
260330901	1	Sault Ste. Marie	Chippewa	2016	92	168	0.071	0.065	0.064	0.062	1
260370001	2	Rose Lake	Clinton	2016	98	179	0.077	0.076	0.074	0.073	7
260490021	1	Flint	Genesee	2016	98	180	0.079	0.076	0.076	0.072	7
260492001	1	Otisville	Genesee	2016	99	182	0.079	0.077	0.075	0.073	6

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 > 0.070
260630007	1	Harbor Beach	Huron	2016	99	182	0.076	0.074	0.072	0.072	5
260650012	2	Lansing	Ingham	2016	93	171	0.078	0.078	0.075	0.073	6
260770008	1	Kalamazoo	Kalamazoo	2016	98	179	0.076	0.075	0.074	0.074	8
260810020	1	Grand Rapids	Kent	2016	100	183	0.079	0.076	0.075	0.075	8
260810022	1	Evans	Kent	2016	98	180	0.079	0.074	0.074	0.072	5
260910007	1	Tecumseh	Lenawee	2016	98	180	0.076	0.074	0.069	0.069	2
260990009	1	New Haven	Macomb	2016	99	182	0.084	0.078	0.076	0.075	6
260991003	1	Warren	Macomb	2016	99	182	0.079	0.076	0.072	0.071	4
261010922	1	Manistee	Manistee	2016	98	180	0.080	0.071	0.070	0.070	2
261050007	1	Scottville	Mason	2016	98	179	0.079	0.075	0.074	0.074	6
261130001	1	Houghton Lake	Missaukee	2016	99	182	0.075	0.075	0.075	0.074	6
261210039	1	Muskegon	Muskegon	2016	97	177	0.089	0.087	0.079	0.076	7
261250001	2	Oak Park	Oakland	2016	99	178	0.078	0.076	0.075	0.075	6
261390005	1	Jenison	Ottawa	2016	89	163	0.080	0.075	0.075	0.074	7
261470005	1	Port Huron	St .Clair	2016	99	181	0.082	0.077	0.077	0.073	4
261530001	1	Seney	Schoolcraft	2016	99	182	0.084	0.077	0.076	0.075	8
261610008	1	Ypsilanti	Washtenaw	2016	98	180	0.072	0.071	0.071	0.069	3
261630001	2	Allen Park	Wayne	2016	99	182	0.078	0.074	0.074	0.070	3
261630019	2	Detroit-E. 7 Mile	Wayne	2016	95	174	0.080	0.075	0.074	0.074	8
261630093	1	Eliza Howell-Roadway*	Wayne	2016	98	179	0.066	0.061	0.059	0.058	0
261630094	1	Eliza Howell-Downwind*	Wayne	2016	99	181	0.075	0.073	0.071	0.070	3

* Indicates sampling is part of a two-year special study.

$PM_{2.5}$ (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	2016	119	26.6	18.8	17.2	17.1	17.2	6.99
260170014	1	FRM	Bay City	Bay	2016	120	26.5	19.7	19.6	17.0	19.6	6.84
260210014	1	FRM	Coloma	Berrien	2016	121	29.1	18.8	17.2	16.7	17.2	7.35
260330901	1	FRM	Sault Ste. Marie	Chippewa	2016	72	12.7	11.3	11.2	10.0	11.3	5.04*
260330901	2	FRM	Sault Ste. Marie	Chippewa	2016	38	10.8	10.0	8.2	8.2	10.8	5.03*
260490021	1	FRM	Flint	Genesee	2016	119	24.3	21.8	18.8	17.9	18.8	7.18
260650012	1	FRM	Lansing	Ingham	2016	117	19.6	19.2	18.0	17.0	18.0	7.31
260770008	1	FRM	Kalamazoo	Kalamazoo	2016	116	20.4	20.3	20.1	20.0	20.1	8.09
260770008	2	FRM	Kalamazoo	Kalamazoo	2016	61	20.8	20.2	18.9	15.8	20.2	8.25
260810007	1	FRM	Grand Rapids-Wealthy	Kent	2016	121	25.6	23.1	22.7	22.6	22.7	8.79
260810020	1	FRM	Grand Rapids-Monroe	Kent	2016	118	26.9	22.3	19.5	18.6	19.5	8.16
260810020	2	FRM	Grand Rapids-Monroe	Kent	2016	61	21.3	19.5	18.4	17.4	19.5	8.48
260910007	1	FRM	Tecumseh	Lenawee	2016	112	21.6	19.1	15.1	15.1	15.1	7.46
260990009	1	FRM	New Haven	Macomb	2016	121	22.0	21.3	20.1	17.2	20.1	7.51

*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	2016	112	18.5	13.9	12.6	12.3	12.6	5.50
261130001	1	FRM	Houghton Lake	Missaukee	2016	118	16.1	15.5	12.4	12.3	12.4	4.87
261150006	1	FRM	Sterling State Park	Monroe	2016	120	20.4	20.2	18.3	17.4	18.3	7.75
261250001	1	FRM	Oak Park	Oakland	2016	119	24.2	20.6	19.8	19.6	19.8	7.87
261470005	1	FRM	Port Huron	St. Clair	2016	121	21.9	21.0	19.7	16.7	19.1	7.77
261610008	1	FRM	Ypsilanti	Washtenaw	2016	119	21.8	18.6	17.6	16.2	17.6	7.84
261610008	2	FRM	Ypsilanti	Washtenaw	2016	61	20.8	17.4	16.6	16.3	17.4	8.06
261630001	1	FRM	Allen Park	Wayne	2016	356	25.8	23.7	22.9	22.3	20.3	8.72
261630015	1	FRM	Detroit-W. Fort St.	Wayne	2016	121	26.3	26.2	25.6	24.1	25.6	11.32
261630016	1	FRM	Detroit-Linwood	Wayne	2016	120	24.8	23.3	22.5	19.5	22.5	8.94
261630019	1	FRM	Detroit-E. 7 Mile	Wayne	2016	118	22.0	20.9	19.5	19.0	19.5	8.11
261630025	1	FRM	Livonia	Wayne	2016	118	22.1	20.5	19.9	17.2	19.9	8.16
261630033	1	FRM	Dearborn	Wayne	2016	121	28.8	26.8	25.8	24.6	25.8	10.67
261630033	2	FRM	Dearborn	Wayne	2016	60	27.1	24.7	19.9	19.8	24.7	10.52
261630036	1	FRM	Wyandotte	Wayne	2016	116	19.8	19.3	18.8	18.3	18.8	7.70
261630039	1	FRM	Detroit-W. Lafayette	Wayne	2016	337	22.2	21.9	21.8	21.6	20.5	8.38
261630095	1	FRM	Livonia-Roadway	Wayne	2016	121	23.8	22.3	21.4	20.0	21.4	8.53

$PM_{2.5}$ 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
260170014	3	TEOM	Bay City	Bay	2016	8378	41.0	38.0	38.0	37.0	7.28
260330901	3	BAM	Sault Ste. Marie	Chippewa	2016	8975	81.8	57.3	39.4	39.3	7.09*
260490021	3	TEOM	Flint	Genesee	2016	8533	58.0	53.0	51.0	40.0	7.59
260650012	3	TEOM	Lansing	Ingham	2016	8138	78.0	65.0	65.0	60.0	8.26
260770008	3	TEOM	Kalamazoo	Kalamazoo	2016	8600	57.0	53.0	47.0	47.0	8.04
260810020	3	TEOM	Grand Rapids-Monroe	Kent	2016	8623	131.0	109.0	80.0	65.0	8.53
260910007	3	TEOM	Tecumseh	Lenawee	2016	8462	70.0	52.0	46.0	46.0	7.77
261130001	3	TEOM	Houghton Lake	Missaukee	2016	8629	75.0	40.0	28.0	28.0	6.06
261470005	3	TEOM	Port Huron	St. Clair	2016	8655	53.0	48.0	48.0	46.0	7.91
261530001	3	TEOM	Seney	Schoolcraft	2016	8201	29.0	27.0	26.0	23.0	5.25
261610008	3	TEOM	Ypsilanti	Washtenaw	2016	7827	96.0	79.0	55.0	51.0	8.03
261630001	3	TEOM	Allen Park	Wayne	2016	8218	115.0	104.0	100.0	91.0	9.38
261630033	3	TEOM	Dearborn	Wayne	2016	7073	80.0	77.0	64.0	63.0	10.07
261630039	3	TEOM	Detroit–W. Lafayette	Wayne	2016	7884	150.0	134.0	114.0	97.0	9.86
261630093	3	BAM	Eliza Howell-Roadway**	Wayne	2016	5009	97.3	94.1	72.1	67.2	12.22*
261630098	3	BAM	Eliza Howell–Downwind**	Wayne	2016	2502	127.1	61.5	43.7	42.8	7.84*
261630097	3	TEOM	NMH 48217***	Wayne	2016	2856	66.6	42.1	42.1	39.7	8.88*

*Indicates the mean does not satisfy summary criteria, less than one year of data
**Indicates sampling is part of a 2-year special study
***Indicates the site is part of a 1-year special study

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
260810020	1	GRAV	Grand Rapids-Monroe	Kent	2016	56	61	56	92	68	56	38	34	15.6
261630001	1	GRAV	Allen Park	Wayne	2016	59	61	58	95	61	48	37	33	19.0
261630005	1	GRAV	River Rouge	Wayne	2016	59	61	59	97	63	53	41	36	21.0
261630015	1	GRAV	Detroit-W. Fort St.	Wayne	2016	61	61	60	98	96	92	74	53	27.9
261630033	1	GRAV	Dearborn	Wayne	2016	61	61	60	98	81	58	58	56	27.5
261630033	9	GRAV	Dearborn	Wayne	2016	30	31	29	94	81	58	45	44	27.9

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	2016	8720	288	268	249	213	21.8

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
260650012	1	Lansing	Ingham	2016	8187	126.8	11.1	9.8	7.4	4.0	0	0.87
260810020	2	Grand Rapids-Monroe	Kent	2016	8137	6.8	6.4	5.8	1.8	1.8	0	0.45
261150006	1	Sterling State Park	Monroe	2016	8378	26.0	23.1	13.6	8.0	4.2	0	0.83
261390011	1	West Olive	Ottawa	2016	8352	40.8	26.1	20.0	7.7	5.6	0	0.41
261470005	1	Port Huron	St. Clair	2016	8260	67.7	60.0	51.8	15.5	12.7	0	1.21
261630001	1	Allen Park	Wayne	2016	8288	45.6	36.8	25.5	10.0	5.0	0	0.78
261630015	1	Detroit-W. Fort St.	Wayne	2016	8334	77.1	73.2	58.5	35.2	17.2	0	1.52
261630097	1	NMH 48217**	Wayne	2016	2788	23.1	17.9	17.9	5.7	3.8	0	0.64*

*Indicates the mean does not satisfy summary criteria, less than 1 year of data
**Indicates the site is part of a 1-year special study

Appendix B: 2016 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 2016. 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 µg/m³ 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 2016. 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 2016, assuming daily samples below MDL were equal to 0.0 µg/m³.
- Average (ND=MDL/2): average air concentration in 2016, assuming daily samples below MDL were equal to one half the MDL.
- MDL: Analytical MDL in units of µg/m³
- Max1: Highest daily air concentration during 2016
- Max2: Second highest daily air concentration during 2016
- Max3: Third highest daily air concentration during 2016
- µg/m³: Micrograms per cubic meter (1,000,000 µg = 1 g)

SITE NAME	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Speciated $PM_{2.5}$
Allen Park				x	x	x
Dearborn	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn	x
Detroit-W. Jefferson				x		
Grand Rapids-Monroe				x		x
Belding-Merrick St.				x		
Belding-Reed St.				x		
NMH 48217	x		x	x		
Port Huron-Rural St.				x		
River Rouge		x		x	Mn	
Tecumseh						x

VOC = volatile organic compound; PAHs = polycyclic aromatic hydrocarbon; TSP = total suspended particulate; PM_{10} = particulate matter with aerodynamic diameter less than 10 µm; Mn = manganese

APPENDIX B-1

Allen Park (261630001) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	57	57	0.00177	0.00177	8.65E-06	0.00791	0.00602	0.00587
Arsenic Pm10 Stp	60	59	0.0013	0.0013	1.00E-05	0.00565	0.00381	0.00327
Cadmium (Tsp) Stp	57	57	0.000229	0.000229	8.65E-06	0.002	0.00106	0.00037
Cadmium Pm10 Stp	60	60	0.00032	0.00032	1.00E-05	0.00233	0.0015	0.00123
Lead (Tsp) Lc Frm/Fem	57	57	0.00498	0.00498	0	0.0185	0.00936	0.00922
Lead Pm10 Lc	58	58	0.00316	0.00316	0	0.0168	0.00682	0.00676
Manganese (Tsp) Stp	57	57	0.0254	0.0254	5.84E-05	0.09	0.0625	0.0597
Manganese Pm10 Stp	60	60	0.00982	0.00982	7.13E-05	0.0406	0.0296	0.0241
Nickel (Tsp) Stp	57	57	0.00146	0.00146	5.58E-05	0.00406	0.00289	0.00266
Nickel Pm10 Stp	60	60	0.000891	0.000891	6.83E-05	0.00349	0.00264	0.00181

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	60	0	0	0.103	0.206	0	0	0
1,1,2-Trichloroethane	60	0	0	0.0546	0.109	0	0	0
1,1-Dichloroethane	60	0	0	0.0243	0.0486	0	0	0
1,1-Dichloroethylene	60	0	0	0.0456	0.0912	0	0	0
1,2,4-Trichlorobenzene	60	0	0	0.13	0.26	0	0	0
1,2,4-Trimethylbenzene	60	60	0.596	0.596	0.118	1.74	1.61	1.56
1,2-Dichlorobenzene	60	0	0	0.0812	0.162	0	0	0
1,2-Dichloropropane	60	0	0	0.0439	0.0878	0	0	0
1,3,5-Trimethylbenzene	60	60	0.186	0.186	0.118	0.541	0.526	0.511
1,3-Butadiene	60	59	0.0822	0.0827	0.0575	0.327	0.241	0.17
1,3-Dichlorobenzene	60	0	0	0.0721	0.144	0	0	0
1,4-Dichlorobenzene	60	9	0.0129	0.0717	0.138	0.253	0.126	0.0902
2,5-Dimethylbenzaldehyde	67	0	0	0.00822	0.0164	0	0	0
Acenaphthene (Tsp) Stp	67	67	0.0103	0.0103	0.0002	0.05	0.0413	0.039
Acenaphthylene (Tsp) Stp	67	60	0.000459	0.00046	1.50E-05	0.0023	0.00129	0.0012
Acetaldehyde	67	67	1.92	1.92	0.0106	4.78	3.28	3.1
Acetone	67	67	3.01	3.01	0.122	9.59	6.05	5.91
Acetonitrile	60	60	1.29	1.29	0.0856	4.13	3.04	2.28
Acetylene	60	60	1.02	1.02	0.0309	3.28	2.86	2.4
Acrylonitrile	60	0	0	0.0326	0.0651	0	0	0
Anthracene (Tsp) Stp	67	67	0.000579	0.000579	7.61E-05	0.00187	0.00184	0.00159
Arsenic (Tsp) Stp	85	85	0.00192	0.00192	8.67E-06	0.00596	0.00573	0.00505
Arsenic Pm10 Stp	91	91	0.00164	0.00164	9.93E-06	0.00604	0.00568	0.00472
Barium (Tsp) Stp	85	85	0.0497	0.0497	0.000344	0.124	0.119	0.119
Barium Pm10 Stp	91	91	0.0144	0.0144	0.000422	0.0925	0.0631	0.0479

Dearborn (261630033) Concentrations in micrograms per cubic meter ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Benzaldehyde	67	67	0.205	0.205	0.0173	0.43	0.421	0.421
Benzene	60	60	0.682	0.682	0.0671	1.84	1.55	1.38
Benzo[A]Anthracene (Tsp) Stp	67	67	0.000177	0.000177	6.01E-05	0.0012	0.000772	0.000566
Benzo[A]Pyrene (Tsp) Stp	67	67	0.000164	0.000164	6.31E-05	0.000836	0.000599	0.000482
Benzo[B]Fluoranthene (Tsp) Stp	67	67	0.000411	0.000411	7.41E-05	0.00199	0.00145	0.00119
Benzo[G,H,I]Perylene (Tsp) Stp	67	67	0.000214	0.000214	4.21E-05	0.000708	0.00069	0.000534
Benzo[K]Fluoranthene (Tsp) Stp	67	41	8.23E-05	9.38E-05	5.91E-05	0.000489	0.000406	0.000291
Beryllium (Tsp) Stp	85	85	9.22E-05	9.22E-05	5.78E-06	3.70E-04	3.70E-04	3.60E-04
Beryllium Pm10 Stp	91	65	2.05E-05	2.15E-05	6.97E-06	0.00014	0.00013	0.00009
Bromochloromethane	60	20	0.1	0.123	0.0688	0.466	0.445	0.434
Bromodichloromethane	60	1	0.000893	0.0635	0.127	0.0536	0	0
Bromoform	60	0	0	0.124	0.248	0	0	0
Bromomethane	60	60	0.0618	0.0618	9.71E-02	0.0893	0.0854	0.0816
Butyraldehyde	67	67	0.483	0.483	1.73E-02	1.94	1.32	1.26
Cadmium (Tsp) Stp	85	85	0.000413	0.000413	8.67E-06	0.00164	0.00136	0.0012
Cadmium Pm10 Stp	91	91	0.000329	0.000329	9.93E-06	0.00181	0.00125	0.00118
Carbon Disulfide	60	60	0.138	0.138	0.0623	0.595	0.514	0.433
Carbon Tetrachloride	60	60	0.659	0.659	0.101	0.856	0.805	0.786
Chlorobenzene	60	1	0.00046	0.0457	0.0921	0.0276	0	0
Chloroethane	60	50	0.0708	0.0771	0.0765	0.193	0.19	0.187
Chloroform	60	60	0.333	0.333	0.0586	0.596	0.522	0.522
Chloromethane	60	60	1.24	1.24	0.0702	1.65	1.54	1.48
Chloroprene	60	0	0	0.0181	3.62E-02	0	0	0
Chromium (Tsp) Stp	85	85	0.00713	0.00713	0.000138	0.022	0.0206	0.0204
Chromium Pm10 Stp	91	91	0.00975	0.00975	1.68E-04	0.0397	0.039	0.0386
Chrysene (Tsp) Stp	67	67	0.000459	0.000459	7.41E-05	0.00183	0.00145	0.00131
Cis-1,2-Dichloroethene	60	0	0	0.0278	0.0555	0	0	0
Cis-1,3-Dichloropropene	60	0	0	0.0454	0.0908	0	0	0
Cobalt (Tsp) Stp	85	85	2.89E-04	2.89E-04	2.02E-05	7.10E-04	6.80E-04	6.40E-04
Cobalt Pm10 Stp	91	91	0.000133	0.000133	2.99E-05	0.00048	0.00045	0.00036
Copper (Tsp) Stp	85	85	0.0241	0.0241	0.00023	0.0694	0.0656	0.06
Copper Pm10 Stp	91	91	0.0298	0.0298	0.000281	0.0886	0.0808	0.0808
Crotonaldehyde	67	0	0	0	0	0	0	0
Dibenzo[A,H]Anthracene (Tsp) Stp	67	66	3.76E-05	3.77E-05	0.000017	0.000157	0.000137	0.000129
Dibromochloromethane	60	2	0.00128	0.0877	0.179	0.0511	0.0256	0
Dichlorodifluoromethane	60	60	2.73	2.73	0.0989	3.3	3.13	3.13
Dichloromethane	60	60	2.34	2.34	0.0729	8.65	6.57	5.66
Ethyl Acrylate	60	0	0	0.0553	0.111	0	0	0
Ethylbenzene	60	60	0.355	0.355	0.0825	3.07	0.803	0.786
Ethylene Dibromide	60	0	0	0.0807	0.161	0	0	0
Ethylene Dichloride	60	54	0.0602	0.0628	0.0526	0.113	0.105	0.089

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Fluoranthene (Tsp) Stp	67	67	0.00474	0.00474	0.000285	0.0226	0.0204	0.0193
Fluorene (Tsp) Stp	67	59	0.00952	0.00952	0.00048	0.0438	0.0381	0.0367
Formaldehyde	67	67	3.53	3.53	0.0118	9.06	7.79	7.75
Freon 114	60	60	0.189	0.189	0.217	0.426	0.412	0.412
Hexachlorobutadiene	60	2	0.0016	0.218	0.448	0.064	0.032	0
Hexanaldehyde	67	67	0.105	0.105	0.0201	0.266	0.25	0.238
Indeno[1,2,3-Cd]Pyrene (Tsp) Stp	67	67	0.000203	0.000203	4.51E-05	0.00071	0.000702	0.000571
Iron (Tsp) Stp	85	85	1.72	1.72	3.15E-03	5.47	5.33	4.91
Iron Pm10 Stp	91	91	0.724	0.724	0.00386	2.75	2.61	2.56
Isovaleraldehyde	67	0	0	0.00529	0.0106	0	0	0
Lead (Tsp) Lc Frm/Fem	86	85	0.01	0.01	0	0.0368	0.0342	0.0318
Lead Pm10 Lc	91	91	0.0075	0.0075	1.07E-05	0.0283	0.0265	0.0211
M/P Xylene	60	60	1.03	1.03	1.74E-01	9.81	2.48	2.31
Manganese (Tsp) Stp	85	85	0.107	0.107	5.78E-05	0.382	0.353	0.333
Manganese Pm10 Stp	91	91	0.0346	0.0346	6.97E-05	0.142	0.137	0.108
Methyl Chloroform	60	24	0.0103	0.0348	8.18E-02	0.0436	0.0382	0.0327
Methyl Ethyl Ketone	67	67	0.527	0.527	0.0144	1.75	0.959	0.932
Methyl Isobutyl Ketone	60	60	0.304	0.304	0.0901	0.57	0.57	0.549
Methyl Methacrylate	60	1	0.000818	0.0552	0.111	0.0491	0	0
Methyl Tert-Butyl Ether	60	2	0.00072	0.0164	0.0325	0.0216	0.0216	0
Molybdenum (Tsp) Stp	85	85	0.00104	0.00104	0.00001	0.00804	0.00781	0.00246
Molybdenum Pm10 Stp	91	91	0.000758	0.000758	1.06E-05	0.00748	0.00228	0.00223
Naphthalene (Tsp) Stp	67	67	0.11	0.11	0.00154	0.311	0.297	0.296
Nickel (Tsp) Stp	85	85	0.00266	0.00266	5.48E-05	0.015	0.0137	0.00643
Nickel Pm10 Stp	91	91	0.00156	0.00156	6.64E-05	0.0173	0.00531	0.0052
N-Octane	60	60	0.277	0.277	0.0841	0.678	0.608	0.589
O-Xylene	60	60	0.402	0.402	0.0869	2.79	1.04	0.947
Phenanthrene (Tsp) Stp	67	67	0.0184	0.0184	0.000165	0.0749	0.0732	0.0718
Propionaldehyde	67	67	0.346	0.346	0.00946	0.905	0.653	0.651
Propylene	60	60	0.634	0.634	0.093	2.08	2.07	1.32
Pyrene (Tsp) Stp	67	67	0.00209	0.00209	1.07E-04	0.00908	0.00576	0.00576
Styrene	60	60	2.74	2.74	8.95E-02	15	13.1	11.2
Tert-Butyl Ethyl Ether	60	0	0	0.0251	0.0502	0	0	0
Tetrachloroethylene	60	55	0.208	0.213	0.109	0.583	0.576	0.482
Tolualdehydes	61	61	0.145	0.145	0.038	0.354	0.295	0.29
Toluene	60	60	1.27	1.27	0.0641	4.56	4.3	3.73
Trans-1,2-Dichloroethylene	60	1	0.000397	0.0238	0.0476	0.0238	0	0
Trans-1,3-Dichloropropene	60	0	0	0.0613	0.123	0	0	0
Trichloroethylene	60	10	0.0113	0.0471	0.086	0.102	0.0967	0.0806
Trichlorofluoromethane	60	60	1.69	1.69	0.112	3.61	2.98	2.79
Valeraldehyde	67	67	0.0999	0.0999	0.014	0.254	0.24	0.226
Vanadium (Tsp) Stp	85	85	0.00401	0.00401	0.00002	0.0151	0.0138	0.0108
Vanadium Pm10 Stp	91	87	0.00154	0.00154	0.0000243	0.00584	0.00576	0.00483
Vinyl Chloride	60	16	0.0112	0.0412	0.0818	0.0613	0.0588	0.0537
Zinc (Tsp) Stp	85	85	0.186	0.186	0.00114	0.72	0.671	0.553
Zinc Pm10 Stp	91	91	0.103	0.103	0.00139	0.607	0.472	0.399

Detroit-W. Fort St. (N. Delray-SWHS) (261630015) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	31	0	0	0.16	0.32	0	0	0
1,1,2-Trichloroethane	31	0	0	0.0486	0.0972	0	0	0
1,1-Dichloroethane	31	0	0	0.085	0.17	0	0	0
1,1-Dichloroethylene	31	0	0	0.0761	0.152	0	0	0
1,2,4-Trichlorobenzene	31	1	1.9	2.57	1.38	59	0	0
1,2,4-Trimethylbenzene	31	8	3.02	3.13	0.304	89	1	0.98
1,2-Dichlorobenzene	31	1	0.21	0.387	0.366	6.5	0	0
1,2-Dichloropropane	31	0	0	0.55	1.1	0	0	0
1,3,5-Trimethylbenzene	31	1	0.839	0.955	0.24	26	0	0
1,3-Butadiene	31	0	0	0.06	0.12	0	0	0
1,3-Dichlorobenzene	31	1	0.135	0.271	0.281	4.2	0	0
1,4-Dichlorobenzene	31	1	0.206	0.391	0.382	6.4	0	0
2,2,4-Trimethylpentane	31	6	0.119	0.177	0.145	0.98	0.73	0.56
Acetaldehyde	31	31	1.93	1.93	0	4.55	4.04	3.27
Acetone	31	31	4.06	4.06	0	18.3	9.08	7.4
Acetonitrile	31	14	0.541	0.678	0.499	5.7	1.7	1.4
Acrylonitrile	31	1	0.03	0.413	0.79	0.93	0	0
Arsenic (Tsp) Stp	61	61	0.00186	0.00186	8.49E-06	0.00655	0.00394	0.00379
Benzaldehyde	31	30	0.143	0.143	0	0.412	0.334	0.273
Benzene	31	30	0.778	0.78	0.0946	2.2	1.4	1.3
Bromodichloromethane	31	0	0	0.075	0.15	0	0	0
Bromoform	31	0	0	0.173	0.346	0	0	0
Bromomethane	31	0	0	0.11	0.22	0	0	0
Cadmium (Tsp) Stp	61	61	0.000256	0.000256	8.49E-06	0.00171	0.00076	0.00075
Carbon Tetrachloride	31	6	0.0971	0.189	0.228	0.62	0.58	0.51
Chlorobenzene	31	1	0.0274	0.127	0.205	0.85	0	0
Chloroethane	31	1	0.00774	0.0658	0.12	0.24	0	0
Chloroform	31	30	0.674	0.676	0.12	1.2	0.93	0.92
Chloromethane	31	31	1.27	1.27	0.159	2.2	1.8	1.7
Chloroprene	31	0	0	0.055	0.11	0	0	0
Cis-1,2-Dichloroethene	31	0	0	0.0611	0.122	0	0	0
Cis-1,3-Dichloropropene	31	0	0	0.065	0.13	0	0	0
Crotonaldehyde	31	4	0.0064	0.0064	0	0.0668	0.0512	0.0409
Dibromochloromethane	31	0	0	0.146	0.292	0	0	0
Dichlorodifluoromethane	31	31	2.33	2.33	0.25	3	2.7	2.7
Dichloromethane	31	30	0.631	0.637	0.37	0.93	0.92	0.81
Ethylbenzene	31	6	0.155	0.272	0.29	1.2	1	0.77
Ethylene Dibromide	31	0	0	0.148	0.296	0	0	0
Ethylene Dichloride	31	0	0	0.0955	0.191	0	0	0
Formaldehyde	31	31	3.06	3.06	0	7.76	7.43	6.84
Freon 113	31	2	0.0332	0.136	0.22	0.52	0.51	0
Freon 114	31	0	0	0.171	0.343	0	0	0
Hexachlorobutadiene	31	1	0.839	1.27	0.891	26	0	0
Hexanaldehyde	31	22	0.0874	0.0874	0	0.37	0.216	0.195

Detroit-W. Fort St. (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
M/P Xylene	31	15	0.83	1.02	0.731	3.8	3.6	2.5
Manganese (Tsp) Stp	61	61	0.0588	0.0588	5.67E-05	0.181	0.176	0.16
Manganese Pm10 Stp	59	59	0.0229	0.0229	7.08E-05	0.101	0.0865	0.0523
Methyl Chloroform	31	0	0	0.105	0.21	0	0	0
Methyl Ethyl Ketone	31	22	3.01	3.17	1.1	54	6.8	2.2
Methyl Isobutyl Ketone	31	8	11.1	11.4	0.858	330	4.2	3.4
Methyl Tert-Butyl Ether	31	0	0	0.095	0.19	0	0	0
N-Hexane	31	27	1.13	1.14	0.0861	6.7	4.2	3.6
Nickel (Tsp) Stp	61	61	0.00271	0.00271	5.38E-05	0.00673	0.00667	0.00556
O-Xylene	31	8	0.232	0.355	0.33	1.4	1.2	1.1
Propionaldehyde	31	31	0.358	0.358	0	0.868	0.726	0.643
Styrene	31	1	0.0645	0.434	0.764	2	0	0
Tetrachloroethylene	31	1	0.0271	0.139	0.23	0.84	0	0
Tolualdehydes	31	2	0.0032	0.0032	0	0.0565	0.0428	0
Toluene	31	30	1.54	1.55	0.44	4.8	4.4	3.5
Trans-1,2-Dichloroethylene	31	0	0	0.0748	0.15	0	0	0
Trans-1,3-Dichloropropene	31	0	0	0.0446	0.0893	0	0	0
Trichloroethylene	31	1	0.0194	0.0997	0.166	0.6	0	0
Trichlorofluoromethane	31	31	1.21	1.21	0.23	1.6	1.6	1.4
Valeraldehyde	31	31	0.217	0.217	0	0.715	0.509	0.439
Vinyl Chloride	31	0	0	0.065	0.13	0	0	0

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) Stp	59	59	0.00199	0.00199	8.68E-06	0.00655	0.00574	0.00363
Cadmium (Tsp) Stp	59	59	0.000336	0.000336	8.68E-06	0.00125	0.00092	0.00092
Manganese (Tsp) Stp	59	59	0.118	0.118	5.86E-05	0.889	0.626	0.331
Nickel (Tsp) Stp	59	59	0.00289	0.00289	5.58E-05	0.0129	0.00951	0.0069

Port Huron-Nat'l Guard Arm. (261470005), 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
Arsenic (Tsp) Stp	60	60	0.00134	0.00134	8.58E-06	0.00538	0.00486	0.00469
Cadmium (Tsp) Stp	60	60	0.000354	0.000354	8.58E-06	0.00205	0.00182	0.00165
Lead (Tsp) Lc Frm/Fem	60	60	0.0267	0.0267	0	0.237	0.13	0.121
Manganese (Tsp) Stp	60	60	0.0107	0.0107	5.73E-05	0.0275	0.0266	0.025
Nickel (Tsp) Stp	60	60	0.00139	0.00139	5.38E-05	0.00303	0.00261	0.0023

River Rouge (261630005) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Acetaldehyde	32	32	1.81	1.81	0	4.73	3.54	2.86
Acetone	32	32	2.94	2.94	0	7.91	6.07	4.95
Arsenic (Tsp) Stp	57	57	0.00169	0.00169	8.58E-06	0.00542	0.00408	0.00358
Benzaldehyde	32	32	0.166	0.166	0	0.313	0.301	0.289
Cadmium (Tsp) Stp	57	57	0.000415	0.000415	8.58E-06	0.00193	0.0014	0.00103
Crotonaldehyde	32	10	0.0201	0.0201	0	0.103	0.0959	0.0905
Formaldehyde	32	32	4.87	4.87	0	10.4	9.43	8.98
Hexanaldehyde	32	32	0.349	0.349	0.00E+00	0.816	0.764	0.699
Manganese (Tsp) Stp	57	57	0.0577	0.0577	5.74E-05	0.22	0.14	0.127
Manganese Pm10 Stp	58	58	0.0193	0.0193	7.19E-05	0.0928	0.0497	0.0457
Nickel (Tsp) Stp	57	57	0.00184	0.00184	5.44E-05	0.00455	0.00452	0.00387
Propionaldehyde	32	32	0.351	0.351	0	0.956	0.761	0.545
Tolualdehydes	32	2	0.00303	0.00303	0	0.0505	0.0463	0
Valeraldehyde	32	32	0.3	0.3	0	0.848	0.654	0.53

Grand Rapids-Monroe St. (260810020) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	61	61	0.00128	0.00128	8.54E-06	0.00311	0.00284	0.00252
Cadmium (Tsp) Stp	61	61	0.000107	0.000107	8.54E-06	0.00035	0.00028	0.00025
Lead (Tsp) Lc Frm/Fem	61	61	0.00379	0.00379	0	0.0103	0.00827	0.00703
Manganese (Tsp) Stp	61	61	0.0122	0.0122	5.74E-05	0.0499	0.0384	0.0347
Nickel (Tsp) Stp	61	61	0.00136	0.00136	5.30E-05	0.00403	0.00318	0.00305

Belding-Merrick St. (260670003) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	61	61	0.00136	0.00136	8.51E-06	0.0117	0.00371	0.00341
Cadmium (Tsp) Stp	61	61	0.000141	0.000141	8.51E-06	0.00082	0.00066	0.00034
Lead (Tsp) Lc Frm/Fem	61	61	0.01	0.01	0	0.0992	0.0822	0.0251
Manganese (Tsp) Stp	61	61	0.00755	0.00755	5.69E-05	0.0338	0.0267	0.0207
Nickel (Tsp) Stp	61	61	0.000818	0.000818	5.43E-05	0.00163	0.0016	0.00153

Belding-Reed St. (260670002) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	61	61	0.000966	0.000966	8.48E-06	0.00324	0.00254	0.00241
Cadmium (Tsp) Stp	61	61	0.000133	0.000133	8.48E-06	0.00051	0.00048	0.00047
Lead (Tsp) Lc Frm/Fem	61	61	0.00982	0.00982	0	0.168	0.118	0.0316
Manganese (Tsp) Stp	61	61	0.00678	0.00678	5.75E-05	0.0292	0.0279	0.0195
Nickel (Tsp) Stp	61	61	0.000825	0.000825	5.38E-05	0.00458	0.00195	0.00152

NMH 48217 (261630097) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	16	0	0	1.72	3.43	0	0	0
1,1,2-Trichloroethane	16	0	0	1.36	2.73	0	0	0
1,1-Dichloroethane	16	0	0	1.01	2.02	0	0	0
1,1-Dichloroethylene	16	0	0	0.991	1.98	0	0	0
1,2,4-Trichlorobenzene	16	0	0	1.86	3.71	0	0	0
1,2,4-Trimethylbenzene	16	0	0	1.23	2.46	0	0	0
1,2-Dichlorobenzene	16	0	0	1.5	3.01	0	0	0
1,2-Dichloropropane	16	0	0	1.16	2.31	0	0	0
1,3,5-Trimethylbenzene	16	0	0	1.23	2.46	0	0	0
1,3-Butadiene	16	0	0	0.553	1.11	0	0	0
1,3-Dichlorobenzene	16	0	0	1.5	3.01	0	0	0
1,4-Dichlorobenzene	16	0	0	1.5	3.01	0	0	0
2,2,4-Trimethylpentane	16	0	0	1.17	2.34	0	0	0
2-Methylnaphthalene (Tsp) Stp	7	7	0.0521	0.0521	0.01	0.069	0.063	0.06
Acetone	1	1	34.2	34.2	4.75	34.2		
Acetonitrile	16	0	0	0.788	1.58	0	0	0
Arsenic (Tsp) Stp	22	22	0.00133	0.00133	0.00000832	0.00283	0.00267	0.00264
Barium (Tsp) Stp	22	22	0.0174	0.0174	0.000337	0.0389	0.0372	0.0331
Benzene	16	1	0.134	0.883	1.6	2.14	0	0
Benzyl Chloride	16	0	0	1.29	2.59	0	0	0
Beryllium (Tsp) Stp	22	22	0.0000231	0.0000231	0.00000564	0.00007	0.00005	0.00005
Bromodichloromethane	16	0	0	1.68	3.35	0	0	0
Bromoform	16	0	0	2.58	5.17	0	0	0
Bromomethane	16	0	0	0.971	1.94	0	0	0
Cadmium (Tsp) Stp	22	22	0.000197	0.000197	0.00000832	0.00043	0.00035	0.00029
Carbon Disulfide	16	0	0	0.778	1.56	0	0	0
Carbon Tetrachloride	16	0	0	1.57	3.15	0	0	0
Chlorobenzene	16	0	0	1.15	2.3	0	0	0
Chloroethane	16	0	0	0.66	1.32	0	0	0
Chloroform	16	0	0	1.22	2.44	0	0	0
Chloromethane	16	11	0.768	0.929	1.03	1.2	1.18	1.18
Chromium (Tsp) Stp	22	22	0.00271	0.00271	0.000135	0.00533	0.00508	0.0039
Cis-1,2-Dichloroethene	16	0	0	0.991	1.98	0	0	0
Cis-1,3-Dichloropropene	16	0	0	1.13	2.27	0	0	0
Cobalt (Tsp) Stp	22	22	0.000144	0.000144	0.0000205	0.0003	0.00026	0.00021
Copper (Tsp) Stp	22	22	0.208	0.208	0.000225	0.402	0.322	0.29
Dibromochloromethane	16	0	0	2.13	4.26	0	0	0
Dichlorodifluoromethane	16	11	1.76	2.15	2.47	2.72	2.67	2.67
Dichloromethane	16	0	0	1.63	3.25	0	0	0
Diethyl Phthalate (Tsp) Stp	2	2	0.054	0.054	0.01	0.058	0.05	
Ethylbenzene	16	0	0	1.09	2.17	0	0	0
Ethylene Dibromide	16	0	0	1.92	3.84	0	0	0
Ethylene Dichloride	16	0	0	1.01	2.02	0	0	0
Hexachlorobutadiene	16	0	0	2.67	5.33	0	0	0
Iron (Tsp) Stp	22	22	0.476	0.476	0.00309	1.13	1.09	1.08
Lead (Tsp) Lc Frm/Fem	20	20	0.00417	0.00417	0	0.00835	0.00772	0.00744

NMH 48217 (261630097) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
M/P Xylene	16	0	0	2.17	4.34	0	0	0
Manganese (Tsp) Stp	22	22	0.0234	0.0234	0.0000564	0.0597	0.053	0.0489
Methanol	16	10	14.5	15.4	5.81	56.2	49.5	24.5
Methyl Chloroform	16	0	0	1.36	2.73	0	0	0
Methyl Ethyl Ketone	16	3	0.557	1.66	2.77	3.01	2.95	2.95
Methyl Isobutyl Ketone	16	0	0	1.02	2.05	0	0	0
Methyl Tert-Butyl Ether	16	0	0	0.902	1.8	0	0	0
Molybdenum (Tsp) Stp	22	22	0.000563	0.000563	0.00001	0.00143	0.00121	0.00091
Naphthalene (Tsp) Stp	14	14	0.0724	0.0724	0.01	0.146	0.113	0.113
N-Hexane	16	2	0.384	1.15	1.76	3.88	2.26	0
Nickel (Tsp) Stp	22	22	0.00256	0.00256	0.0000523	0.00767	0.00643	0.00376
O-Xylene	16	0	0	1.09	2.17	0	0	0
Propylene	16	0	0	0.807	1.61	0	0	0
Styrene	16	0	0	1.07	2.13	0	0	0
Tetrachloroethylene	16	0	0	1.7	3.39	0	0	0
Toluene	16	5	1.6	2.24	1.88	7.35	6.22	4.56
Trans-1,2-Dichloroethylene	16	0	0	0.991	1.98	0	0	0
Trans-1,3-Dichloropropene	16	0	0	1.13	2.27	0	0	0
Trichloroethylene	16	0	0	1.34	2.69	0	0	0
Trichlorofluoromethane	16	0	0	1.4	2.81	0	0	0
Vanadium (Tsp) Stp	22	22	0.00116	0.00116	0.00002	0.00278	0.00243	0.00203
Vinyl Chloride	16	0	0	0.639	1.28	0	0	0
Zinc (Tsp) Stp	22	22	0.0525	0.0525	0.00111	0.21	0.109	0.0947

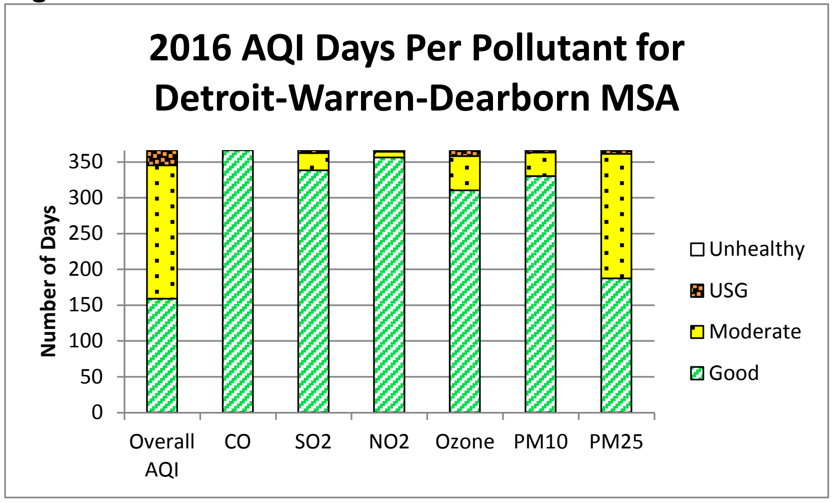
APPENDIX B-2

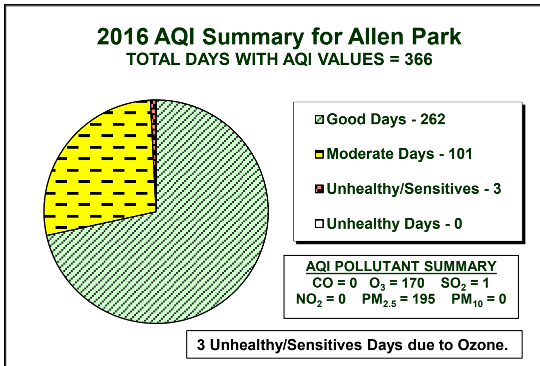
Appendix B-2 will be appended with $PM_{2.5}$ speciated data summaries when complete 2016 data are available from the lab.

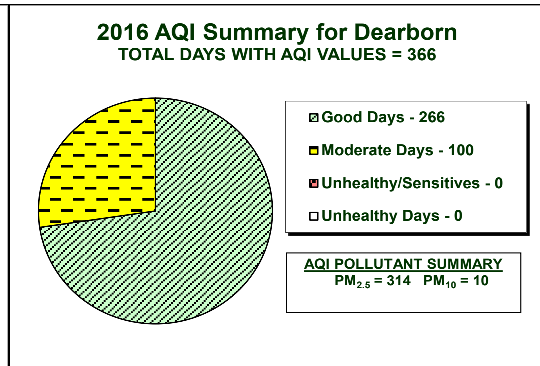
Appendix C: 2016 AQI Pie Charts

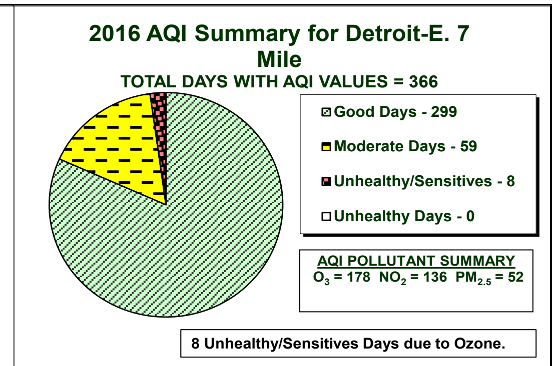
Appendix C contains pie charts that were created to show the AQI values for each of Michigan's 2016 monitoring sites and includes the total number of days measurements were taken, along with the pollutant distribution of the AQI values for those measurements. It is important to note that not all pollutants are measured at each site. In fact, some sites only obtain AQI measurements for that portion of the year corresponding to the ozone season; therefore, the number of days for each site may not be equivalent to 365. **Figures C.1** through **C.7** are grouped by Metropolitan Statistical Area (MSA). MSAs are geographic regions based on population and employment data that the US Census compiles. They are defined by the US Office of Management and Budget. More information on MSAs can be found on the US Census website: www.census.gov **Figures C.5** and **C.6** show the remaining sites (not part of a CSA) located in Michigan's Upper and Lower Peninsulas.

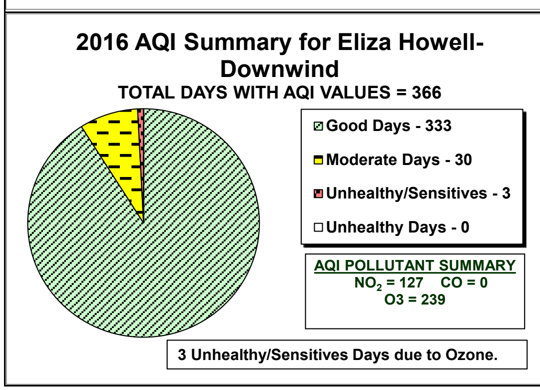
Figure C.1: AQI Summaries for Detroit-Warren-Dearborn MSA

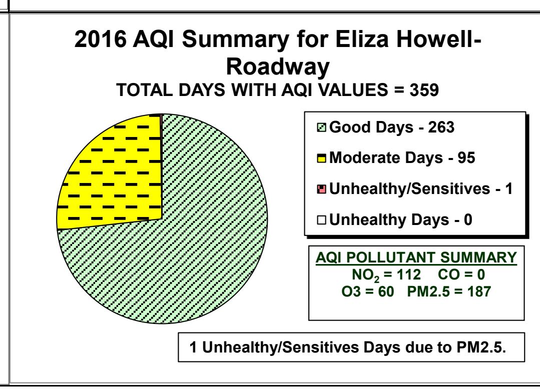












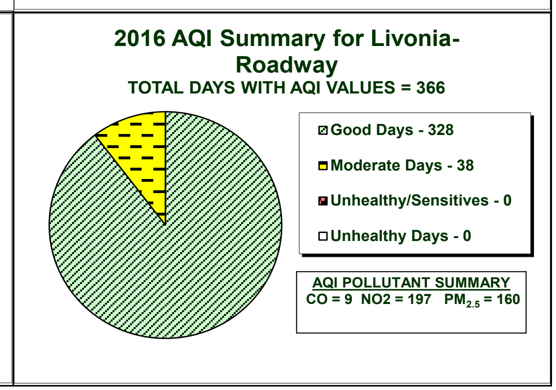


Figure C1, continued: AQI Summaries for Detroit-Warren-Dearborn-MSA

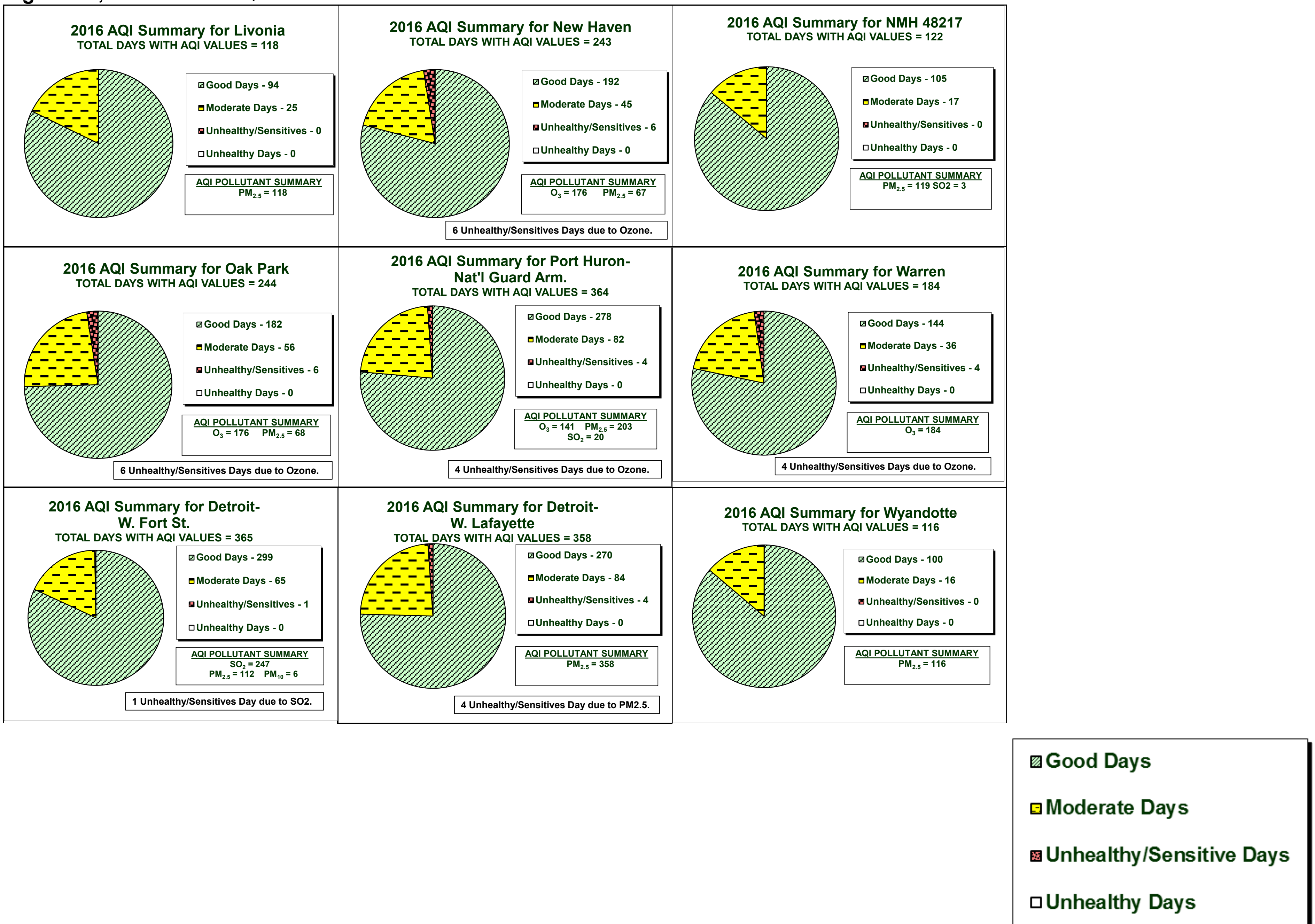


Figure C2: AQI Summaries for Flint MSA

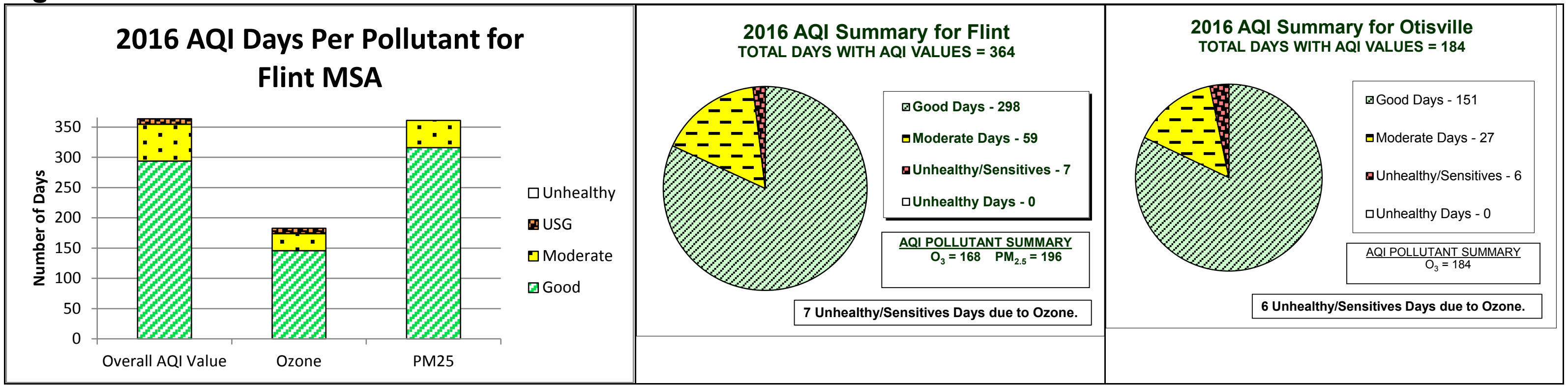


Figure C3: AQI Summaries for Lansing-East Lansing-MSA

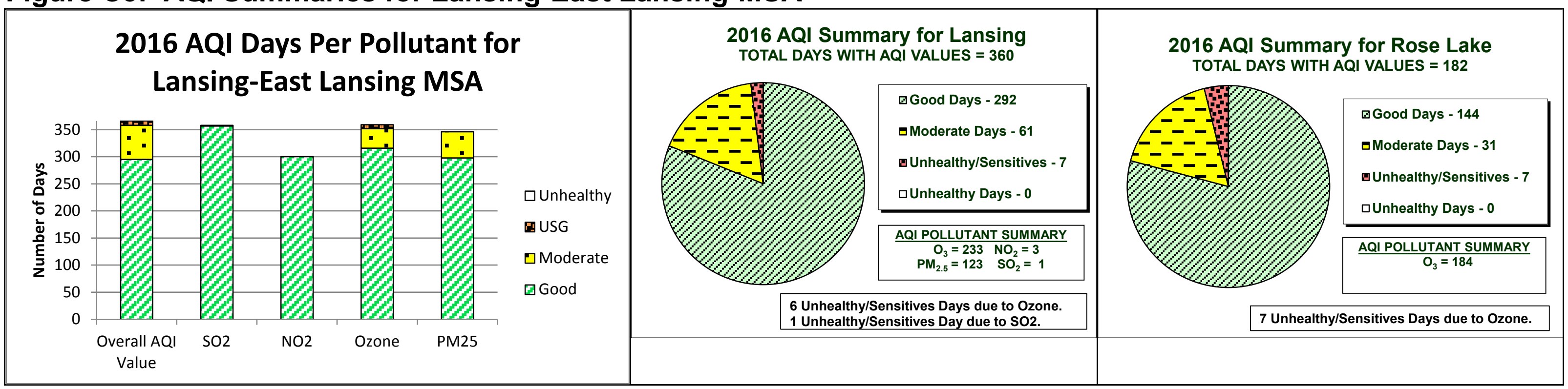
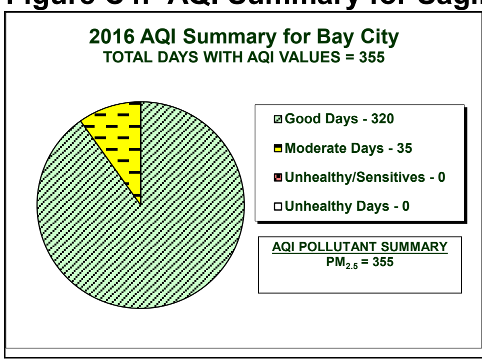


Figure C4: AQI Summary for Saginaw-Midland-Bay City-MSA



*Note: This site does not have AQI per pollutant graphs since only one pollutant is monitored in one location in these areas.

Figure C5: AQI Summaries for Grand Rapids-Wyoming MSA

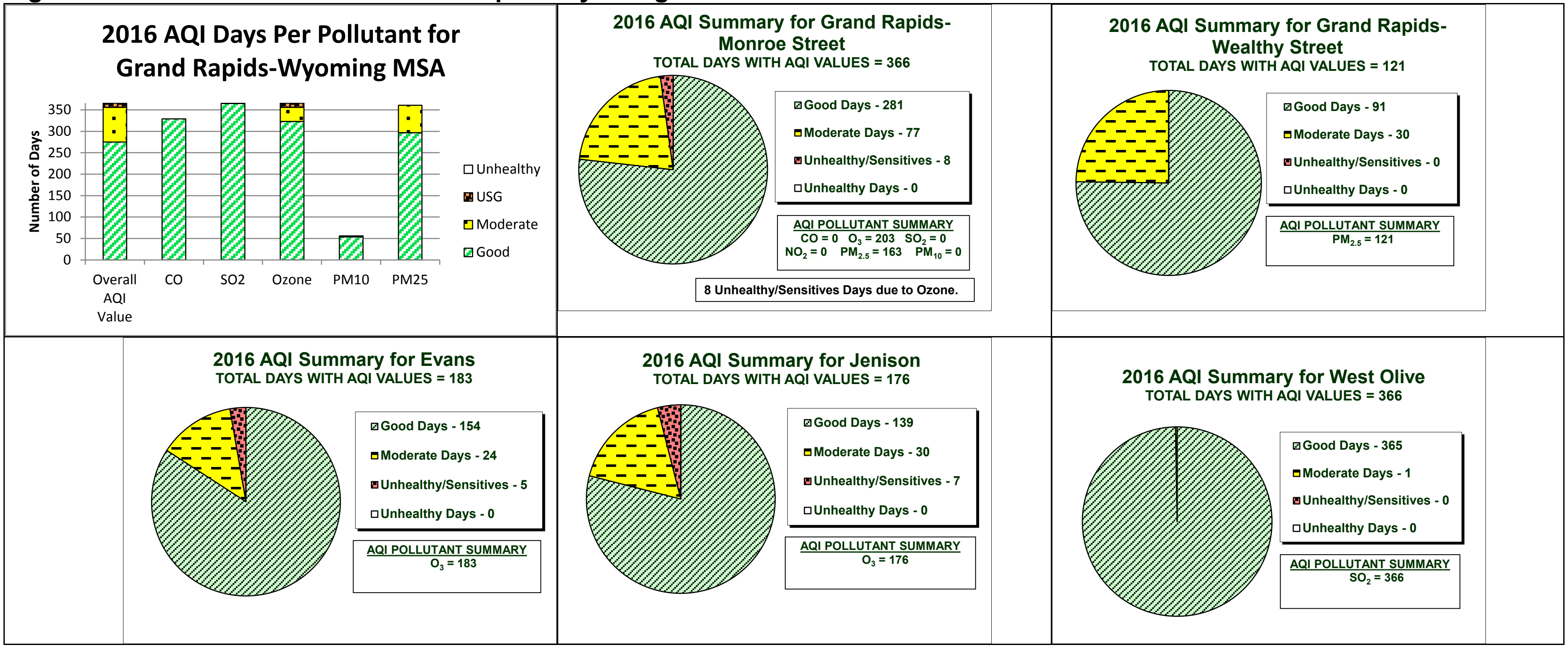
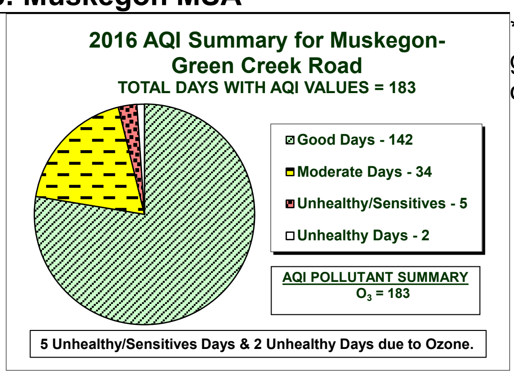
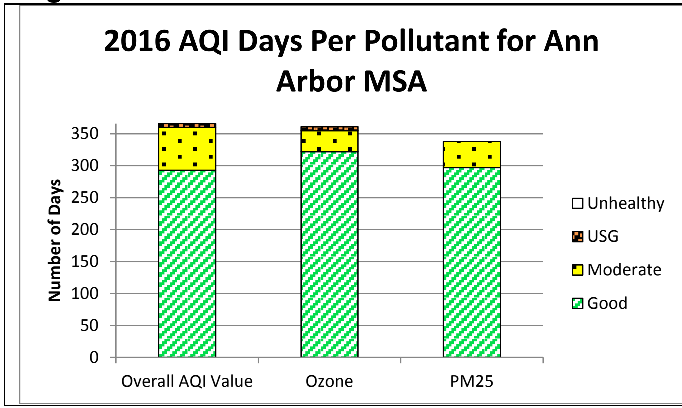


Figure C6: Muskegon MSA



*Note: This site does not have AQI per pollutant graphs since only one pollutant is monitored in one location in these areas.

Figure C7: Ann Arbor MSA



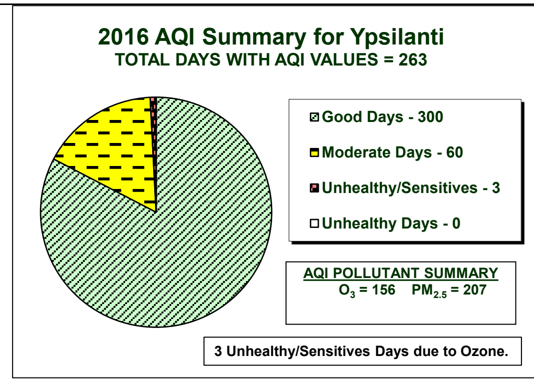
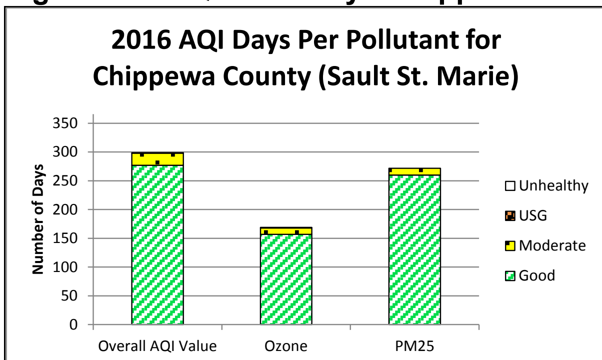
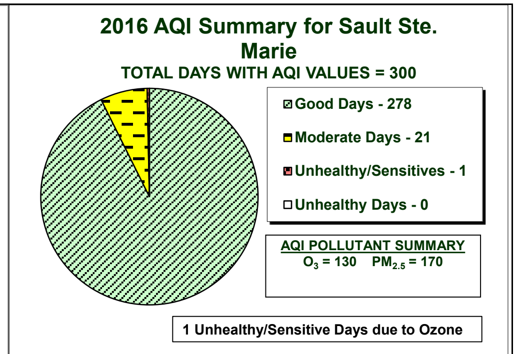
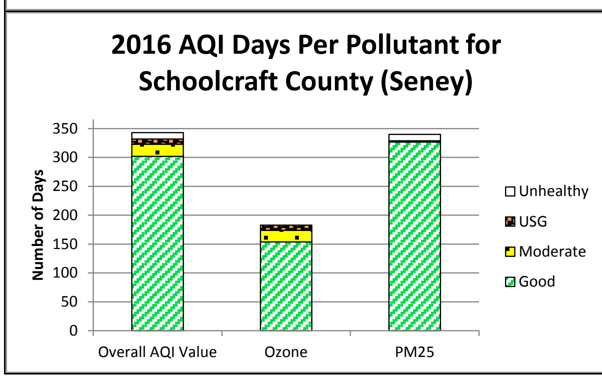


Figure C8: AQI Summary for Upper Peninsula







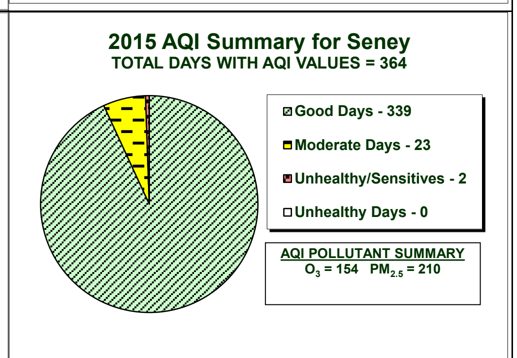
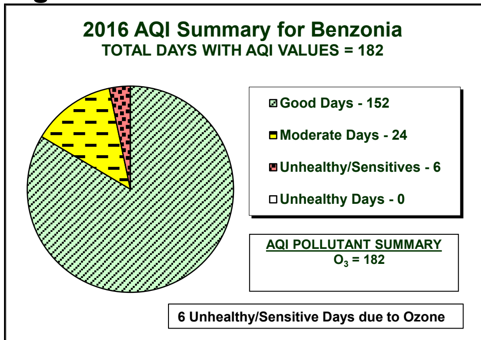
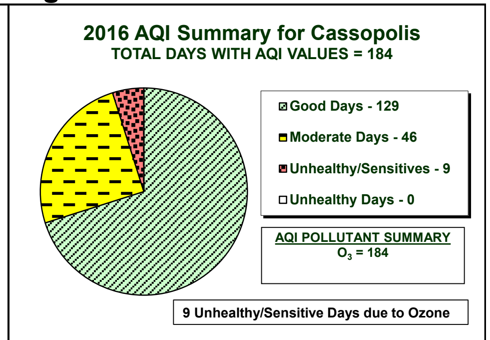
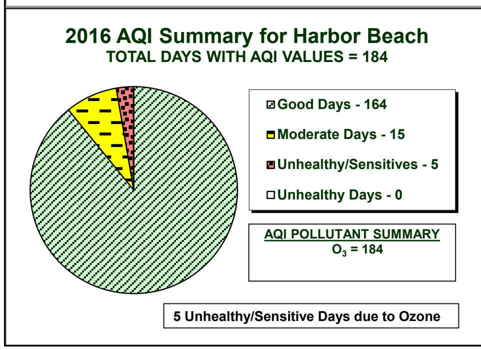
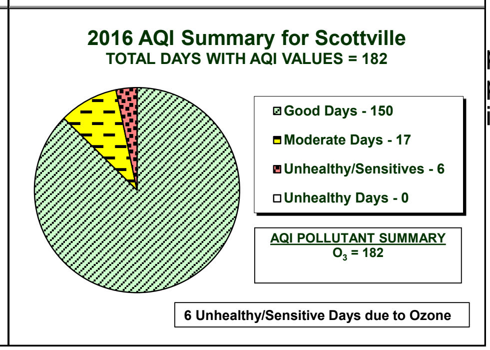


Figure C9: AQI Summaries for Michigan's Other Lower Peninsula Areas

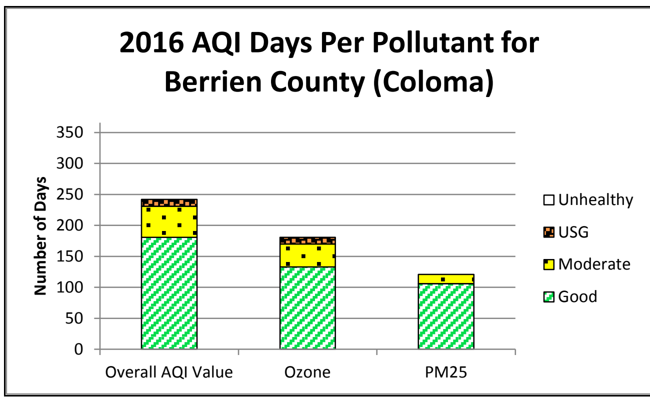








*Note: These sites do not have AQI per pollutant graphs since only one pollutant is monitored in one location in these areas.



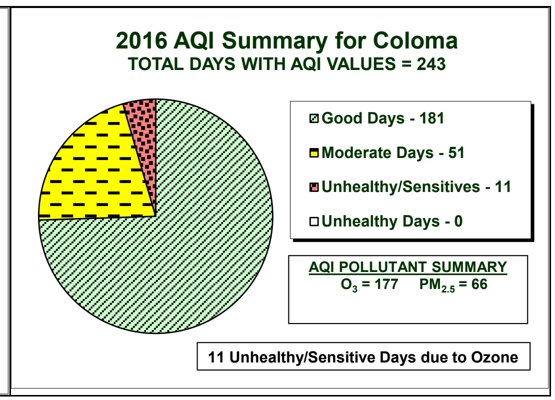
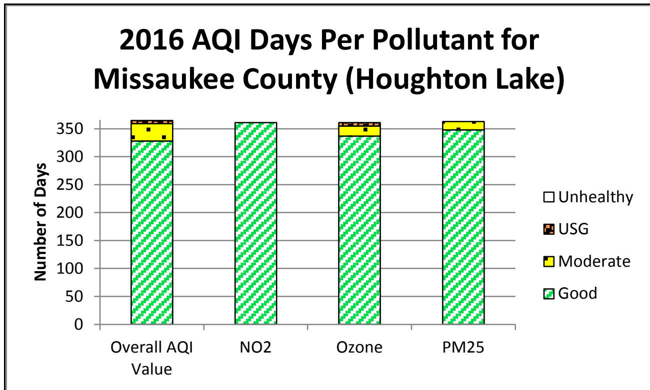
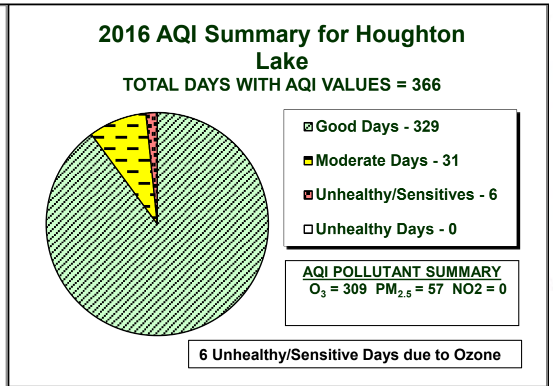
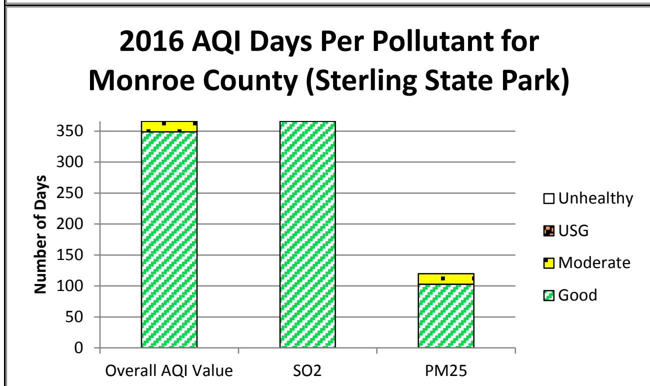
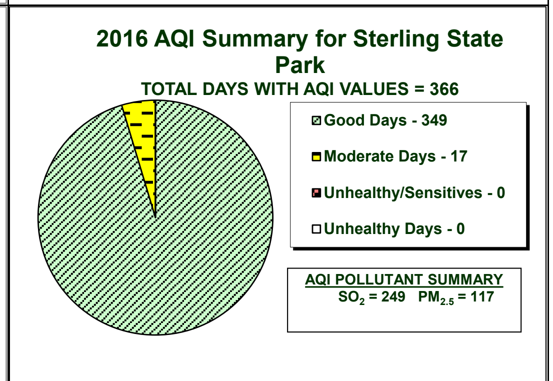


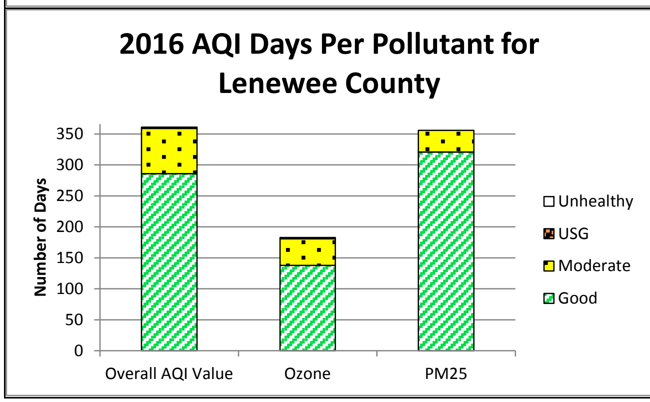
Figure C9, continued: AQI Summaries for Michigan's Other Lower Peninsula Areas











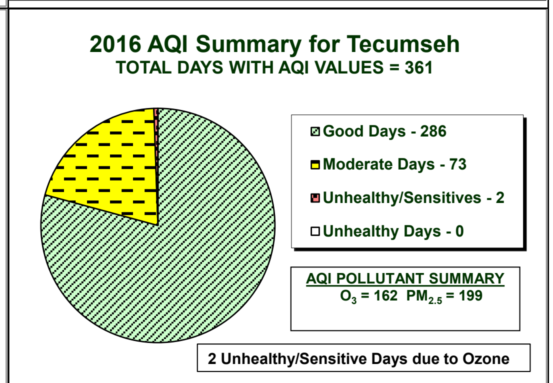
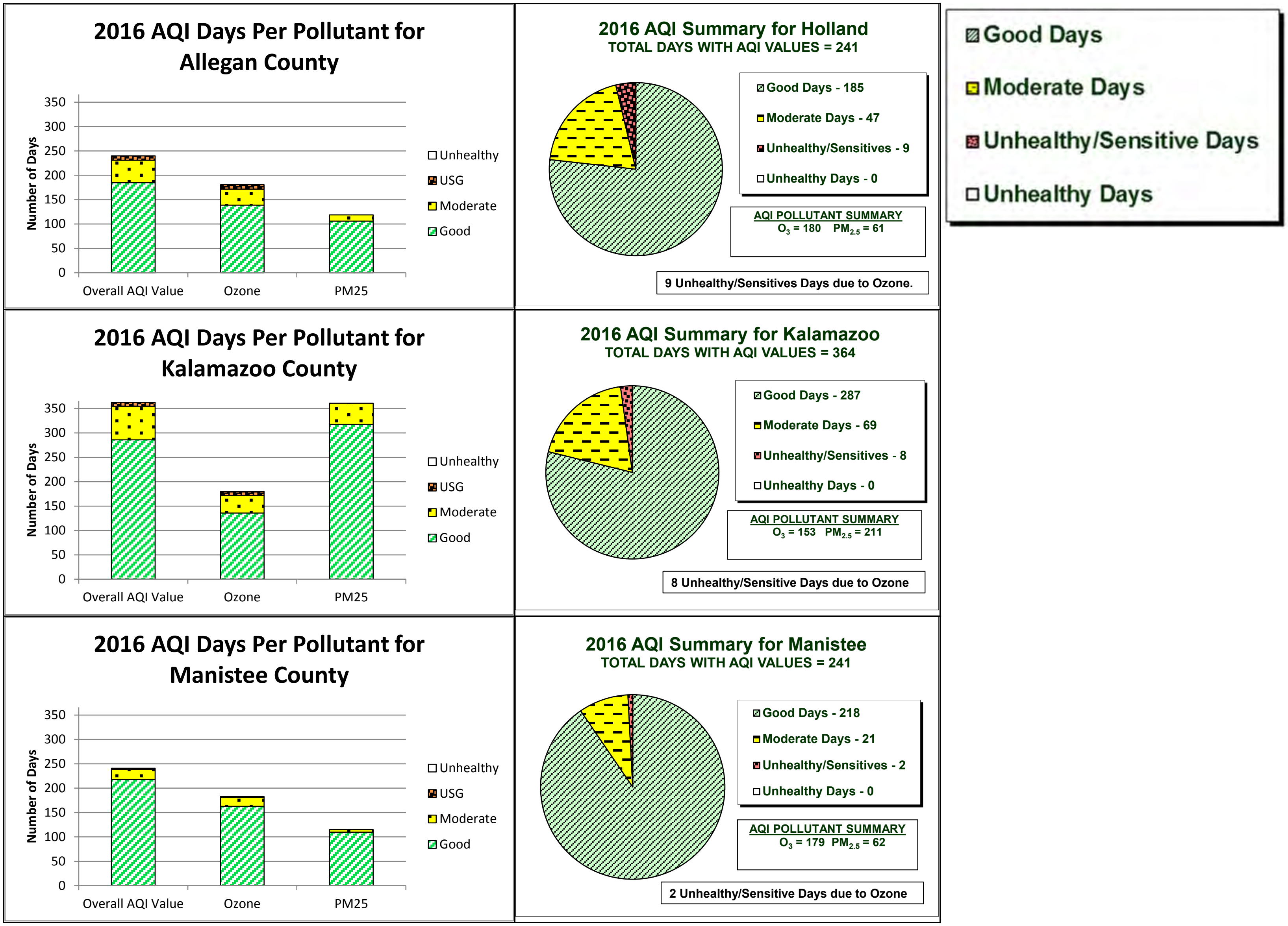


Figure C9, continued: AQI Summaries for Michigan's Other Lower Peninsula Areas



Appendix D: NAAQS Changes

	1971	1978	1979	1987	1997	2006	2008	2010	2012	2015
CO	1-hour maximum not to exceed 35 ppm more than once in a year. 8-hour maximum not to exceed 9 ppm more than once in a year.									
Lead		Calendar quarter average of 1.5 µg/m^3 not to be exceeded					3-month average of 0.15 µg/m^3 not to be exceeded			
NO_2	Annual average of 53 ppb or less.							98th percentile of the 1-hour concentration averaged over 3 yrs is 100 ppb or less		
SO_2	24-Hour concentration of 0.14 ppm not exceeded more than once per year. Annual average of 0.03 ppm or less.							1-hour average of 99th percentile is 75 ppb or less, averaged over 3 yrs. Previous revoked		
Ozone	Total photochemical oxidants: 1-hour max of 0.08 ppm not exceeded once per yr		1-hour maximum concentration is 0.12 ppm one or less hour per yr		4th highest daily maximum 8-hour concentration averaged over 3 yrs is 0.08 ppm or less		4th highest daily maximum 8-hour concentration averaged over 3 yrs is 0.075 ppm or less			4th highest daily maximum 8-hour concentration averaged over 3 yrs is 0.070 ppm or less
TSP & PM_{10}	TSP: 24-hour average not to exceed 260 µg/m^3 more than once per yr Annual geometric mean of 75 µg/m^3			PM_{10}: 24-hour average not to exceed 150 µg/m^3 more than once per yr on average over a 3-yr period Annual mean of 50 µg/m^3 or less average over 3 yrs		Annual average revoked 24-hour average retained				
$PM_{2.5}$					Annual mean of 15.0 µg/m^3 or less average over 3 yrs. 98th percentile of 24-hour average of 65 µg/m^3 or less averaged over 3 yrs	Annual mean retained. 98th percentile of 24-hour average of 35 µg/m^3 or less averaged over 3 yrs			Annual mean of 12.0 µg/m^3 or less average over 3 yrs. 98th percentile of 24-hour average retained	

Appendix E: Acronyms and Their Definitions

>	Greater than
<	Less than
≥	Greater than or equal to
≤	Less than or equal to
%	Percent
$\mu g/m^3$	Micrograms per cubic meter
µm	micrometer
AIRS ID	Aerometric Information Retrieval System Identification Number
AMU	Air Monitoring Unit
AQD	Air Quality Division
AQES	Air Quality Evaluation Section
AQI	Air Quality Index
AQS	Air Quality System (EPA air monitoring data archive)
As	Arsenic
BAM	Beta Attenuation Monitor (hourly $PM_{2.5}$ measurement monitor)
BC	Black Carbon
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CAA	Clean Air Act
CBSA	Core-Based Statistical Area
Cd	Cadmium
CFR	Code of Federal Regulations
CO	Carbon monoxide
CSA	Consolidated Statistical Area
DEQ	Michigan Department of Environmental Quality
EC/OC	Elemental carbon/Organic carbon
FDMS	Filter Dynamic Measurement System
FEM	Federal Equivalent Method
FIA	Family Independence Agency
FR	Federal Register
FRM	Federal Reference Method
HAP	Hazardous Air Pollutant
hr	Hour
Lc	Local Conditions
MASN	Michigan Air Sampling Network
MDL	Method Detection Limit
mg/m^3	Milligrams per meter cubed
MI	Michigan
MiSA	Micropolitan Statistical Area
Mn	Manganese
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standard
NAMS	National Air Monitoring Station
NATTS	National Air Toxics Trend Sites
NCore	National Core Monitoring Sites
ND	Non-detect
NEI	National Emission Inventory
Ni	Nickel

Appendix E: Acronyms and Their Definitions, Continued

NMH 48217	New Mount Hermon 48217
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of Nitrogen
NO_Y	Oxides of nitrogen + nitric acid + organic and inorganic nitrates
NPAP	National Performance Audit Program
O_3	Ozone
Obs or OBS	Observations
PAH	Polynuclear Aromatic Hydrocarbon
Pb	Lead
PBT	Persistent, Bioaccumulative and Toxic
PCB	Polychlorinated biphenyls
PEP	Performance Evaluation Program
PM	Particulate matter
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	Particulate matter with a diameter of 10 microns or less
$PM_{10\text{-}2.5}$	Coarse PM equal to the concentration difference between PM_{10} and $PM_{2.5}$
PNA	Polynuclear aromatic hydrocarbons
POC	Parameter Occurrence Code
ppb	parts per billion
ppm	parts per million = mg/kg, mg/L, µg/g (1 ppm = 1,000 ppb)
QA	Quality assurance
QAPP	Quality Assurance Project Plan
SASS	Speciation Air Sampling System ($PM_{2.5}$ Speciation Sampler)
SO_2	Sulfur dioxide
SOP	Standard Operating Procedures
STN	Speciation Trend Network ($PM_{2.5}$)
Stp	Standard Temperature and Pressure
SVOC	Semi-Volatile Compound
SWHS	Southwestern High School
TAC	Toxic Air Contaminant
TEOM	Tapered element oscillating microbalance (hourly $PM_{2.5}$ measurement monitor)
tpy	ton per year
TRI	Toxic Release Inventory
TSP	Technical Systems Audit
TSP	Total Suspended Particulate
US	United States
USEPA	United States Environmental Protection Agency
UV	Ultra-violet
VOC	Volatile organic compounds
Vs	Versus

Air Quality Division District Office Contact Information

Cadillac District – Cadillac Office (Northwest Lower Peninsula) 120 W Chapin Street Cadillac, MI 49601-2158 231-775-3960 Fax: 231-775-4050 *Counties: Benzie, Grand Traverse, Kalkaska, Lake, Leelanau, Manistee, Mason, Missaukee, Osceola, and Wexford*	**Cadillac District - Gaylord Office** (Northeast Lower Peninsula) 2100 West M-32 Gaylord, MI 49735-9282 989-731-4920 Fax: 989-731-6181 *Counties: Alcona, Alpena, Antrim, Charlevoix, Cheboygan, Crawford, Emmet, Montmorency, Oscoda, Otsego, Presque Isle, and Roscommon*
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Jackson District (South Central Michigan) State Office Building, 4th Floor 301 E Louis B Glick Highway Jackson, MI 49201-1556 517-780-7690 Fax: 517-780-7855 *Counties: Hillsdale, Jackson, Lenawee, Monroe, and Washtenaw*	**Kalamazoo District** (Southwest Michigan) 7953 Adobe Road Kalamazoo, MI 49009-5026 269-567-3500 Fax: 269-567-3555 *Counties: Allegan, Berrien, Branch, Calhoun, Cass, Kalamazoo, St. Joseph, and Van Buren*
Lansing District (Central Michigan) P.O. Box 30242 Constitution Hall, 525 W. Allegan St., 1 South Lansing, MI 48909-7760 517-284-6651 Fax:517-241-3571 *Counties: Clinton, Eaton, Genesee, Gratiot, Ingham, Lapeer, Livingston, and Shiawassee*	**Saginaw Bay District** (Central East Michigan) 401 Ketchum Street, Suite B Bay City, MI 48708 989-894-6200 Fax: 989-891-9237 *Counties: Arenac, Bay, Clare, Gladwin, Huron, Iosco, Isabella, Midland, Ogemaw, Saginaw, Sanilac, and Tuscola*
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