MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

AIR QUALITY ANNUAL REPORT

2018

Michigan Department of Environment, Great Lakes, and Energy
Michigan.gov/egle | 800-662-9278

Air Quality Annual Report

2018

EXECUTIVE SUMMARY

This report gives an overview of the air quality for 2018. Current data for Michigan can be found on MIAir (www.deqmiair.org) and Air Quality alerts can be delivered directly to email by signing up for the Michigan EnviroFlash program (http://miair.enviroflash.info/). In April 2019, by Governor's executive order, the Michigan Department of Environmental Quality (MDEQ) became the Michigan Department of Environment, Great Lakes, and Energy (EGLE). While the data in this report was collected in 2018 under the agency name of MDEQ, this report will use EGLE.

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.

The six pollutants monitored by EGLE, Air Quality Division (AQD) 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).

EGLE has established a network of over 40 monitoring sites throughout the state that monitor for one or more of the criteria pollutants (Figure 1.1 and Table 1.3).

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 reviews the criteria pollutant standards every five years. Over time, based upon health data, the standards have been tightened to better protect public health (see Appendix D). Areas that meet the NAAQS are considered 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.

Since EGLE began monitoring in the early 1970s, criteria pollutant levels have continually decreased (see Chap. 2-7). The air is much cleaner today than when the CAA began. The entire state of Michigan is in attainment for CO, Pb, NO_2, and particulate matter. Although portions of the state are in nonattainment for SO_2 and O_3, as illustrated in the figure below, levels of these pollutants are still decreasing. The NAAQS levels have also decreased recently, which prompted these nonattainment areas. EGLE is currently working on State Implementation Plans (SIPs) to reduce pollutants further and bring the entire state into attainment for SO_2 and ozone.

Attainment Status for the National Ambient Air Quality Standards

Several changes to the monitoring network occurred during 2018.

- Establishing three new monitoring sites and modifying an established site, Detroit-W. Fort St., near the Gordie Howe International Bridge construction area (Chap. 11)
- Shut down $PM_{2.5}$ at Coloma, and Sterling State Park to reduce workload and costs (Chap. 7).
- Shut down PM_{10} at River Rouge (Chap 7).
- Grand Rapids-Wealthy St., Lansing, and Detroit-W. Lafayette shut down due to site access issues (Chap. 7).
- $PM_{2.5}$ and PM_{10} monitors installed at Jenison site (Chap. 7).
- Established Lansing-Filley St. to replace Lansing site.
- Lead analysis added to all the metal sites to provide network consistency (Chap. 3).
- Secondary metals monitor added to Port Huron for USEPA compliance (Chap. 3).

Two special studies were completed in 2018. The Air Toxics Near-roadway study sampling was completed and the three near-roadway, Eliza Howell-Roadway, Eliza Howell-Downwind and Livonia-Roadway sites returned to their normal sampling protocol. NMH 48217 completed their one-year study, but EGLE will continue to monitor for five metals, SO_2 and $PM_{2.5}$ (see Chap. 11).

TABLE OF CONTENTS

INTRODUCTION........ 1
CHAPTER 1: BACKGROUND INFORMATION........ 2
National Ambient Air Quality Standards (NAAQS)........ 2
Michigan Air Sampling Network........ 3
Current Attainment Status........ 6
MIair – Air Quality Information in Real-Time........ 7
Air Quality Index........ 7
Air Quality Forecasts........ 7
Air Quality Notification........ 8
AIRNow........ 8
CHAPTER 2: CARBON MONOXIDE (CO)........ 10
CHAPTER 3: LEAD (PB)........ 13
CHAPTER 4: NITROGEN DIOXIDE (NO_2)........ 17
CHAPTER 5: SULFUR DIOXIDE (SO_2)........ 22
CHAPTER 6: OZONE (O_3)........ 27
CHAPTER 7: PARTICULATE MATTER (PM10, PM10-2.5, PM2.5, PM2.5 CHEMICAL SPECIATION AND TSP)........ 37
PM_{10}........ 39
$PM_{10-2.5}$........ 41
$PM_{2.5}$........ 41
CHAPTER 8: TOXIC AIR POLLUTANTS........ 50
National Monitoring Efforts and Data Analysis........ 52
CHAPTER 9: METEOROLOGICAL INFORMATION........ 53
CHAPTER 10: SPECIAL PROJECTS........ 54

APPENDIX A: CRITERIA POLLUTANT SUMMARY FOR 2018
APPENDIX B: 2018 AIR TOXICS MONITORING SUMMARY FOR METALS, VOCS, CARBONYL COMPOUNDS, PAHS, HEXAVALENT CHROMIUM & SPECIATED $PM_{2.5}$
APPENDIX C: 2018 AIR QUALITY INDEX (AQI) PIE CHARTS
APPENDIX D: NAAQS
APPENDIX E: ACRONYMS AND THEIR DEFINITIONS1
ACKNOWLEDGMENTS

INTRODUCTION

Air quality regulations in Michigan are based on National Ambient Air Quality Standards (NAAQS) established by United States Environmental Protection Agency (USEPA) based on the federal Clean Air Act (CAA). The NAAQS designates six criteria pollutants considered harmful to public health and the environment. The USEPA must describe the characteristics and potential health and welfare effects for these criteria pollutants. These standards define the maximum permissible concentration of criteria pollutants in the air (see **Table 1.1**).

The Michigan Department of Environment, Great Lakes, and Energy (EGLE), Air Quality Division (AQD) monitors the six criteria pollutants, which 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 2018;
- Attainment/nonattainment status;
- Monitoring site locations (tables and maps show all the monitors active in 2018); and
- Air quality trends from 2013-2018 broken down by location.[1]

The 2018 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 2018 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2018 Network Review),[3] air toxics monitoring program, and other AQD programs, such as MIair and the Emissions Inventory.[4]

[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 www3.epa.gov/airtrends/

[2] An Overview of Michigan Air Toxic Rules is available on the AQD website at www.michigan.gov/air (select "Permits," then "Toxics Laws and Rules.")

[3] Available online at www.michigan.gov/documents/deq/deq-aqd-amu-2018_air_monitoring_network_review__565062_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 www.michigan.gov/air (select "Monitoring).

CHAPTER 1: BACKGROUND INFORMATION

This section summarizes the development of the NAAQS (see **Appendix D** for further details) and how compliance with these standards is determined. Also included is an overview of Michigan's air sampling network, attainment status of the state, and information on MIAir and the Air Quality Index (AQI).

National Ambient Air Quality Standards (NAAQS)

Under the CAA, the USEPA established a primary and secondary NAAQS for each criteria pollutant. The primary standard is designed to protect 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. Secondary standards are chosen to protect public welfare (personal comfort and well-being) and the environment.

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 2018. 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 2018 for Criteria Pollutants

Pollutant	Primary (health) Level	Primary Averaging Time	Secondary (welfare) Level	Secondary Averaging Time
CO 8-hour average	9 ppm (10 mg/m^3)	8-hour average, not to be exceeded more than once per year *(1971)*	None*	None*
CO 1-hour average	35 ppm (40 mg/m^3)	1-hour average, not to be exceeded more than once per year *(1971)*	None*	None*
Lead	0.15 µg/m^3	Maximum rolling 3-month average *(2008)*	Same as Primary	Same as Primary
NO_2 Annual mean	0.053 ppm (100 µg/m^3)	Annual mean *(1971)*	Same as Primary	Same as Primary
NO_2 1-hour average	0.100 ppm	98th percentile of 1-hour average, averaged over 3 years *(2010)*	Same as Annual	Same as Annual
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	Same as Primary
$PM_{2.5}$ Annual average	12.0 µg/m^3	Annual mean averaged over 3 years *(2012)*	15.0 µg/m^3	Annual mean
$PM_{2.5}$ 24-hour average	35 µg/m^3	98th percentile of 24-hour concentration, averaged over 3 years *(2006)*	Same as Primary	Same as Primary
Ozone	0.070 ppm	Annual 4th highest 8-hour daily max averaged over 3 years *(2015)*	Same as Primary	Same as Primary
SO_2	0.075 ppm	99th 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.

Michigan Air Sampling Network

EGLE's AQD operates the Michigan Air Sampling Network (MASN), 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** is a picture our new Gordie Howe Bridge site at Trinity. **Figure 1.2** shows a map of the 2018 MASN monitoring sites.

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 providing real-time hourly data. PM and Pb monitors measure concentrations over a 24-hour period. In addition, continuous $PM_{2.5}$ and PM_{10} monitors provide real-time hourly data for PM. $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$. The MASN data is also used to provide timely reporting to EGLE's air quality reporting web page (MIAir, see **Chap. 9**). The types of monitoring conducted in 2018 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. Michigan has two NCore sites; Allen Park and Grand Rapids-Monroe Street. Further information on this network is provided in **Chapters 2** through **7**.

The **Near-road Monitoring Network** focuses on vehicle emissions and how they disperse near roadways. Data from these sites are presented in **Chapters 2, 5**, and **7.**

Figure 1.1: Trinity Monitoring Site

Figure 1.2: 2018 MASN Monitoring Sites

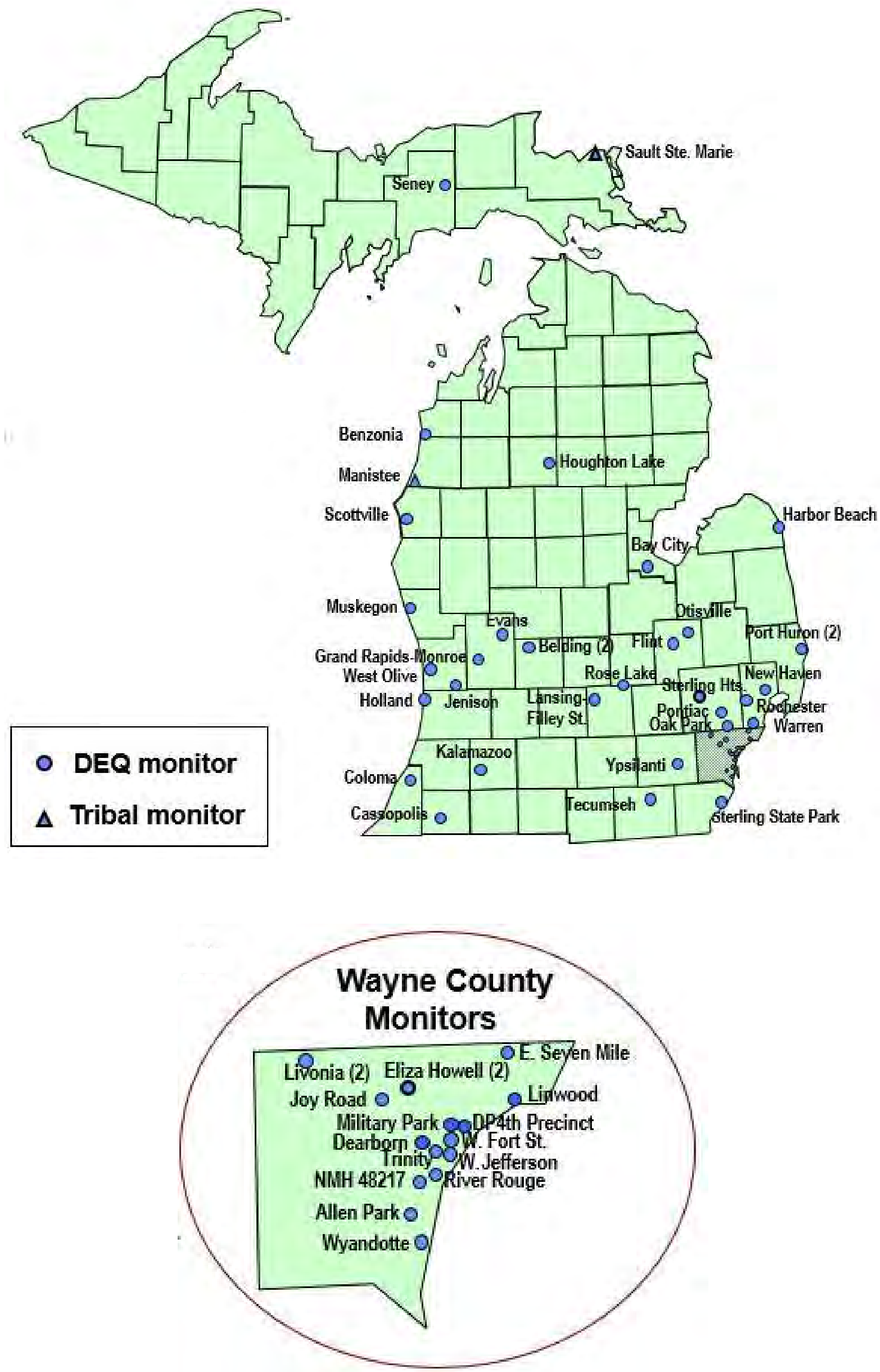


Table 1.2 Types of Monitoring Conducted in 2018 and MASN Location

Area	AIRS ID	Site Name	CO	NO_2	Trace NO_y	O_3	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Continuous	$PM_{2.5}$ Speciation	SO_2	VOC	Carbonyls	Trace Metals&	Wind Speed & Direction,	Relative Humidity	Solar Radiation	Barometric Pressure
Detroit-Ann Arbor	260910007	Tecumseh				√		√	√T	√+E					√			√
	260990009	New Haven				√		√							√	√	√	
	260991003	Warren				√												
	261250001	Oak Park				√		√							√			
	261470005	Port Huron				√		√	√T		√				√			
	261470031	Port Huron-Rural St.												√				
	261610008	Ypsilanti				√		√	√T						√			√
	261630001	Allen Park	√*		√	√	√	√	√T	√+A	√*			√	√	√		√
	261630005	River Rouge											√	√	√			
	261630015	Detroit-W. Fort St.		√			√	√	√B	√+A	√	√	√	√	√	√		√
	261630016	Detroit-Linwood						√										
	261630019	Detroit-E. 7 Mile		√		√		√							√	√		√
	261630025	Livonia						√										
	261630027	Detroit-W. Jefferson												√				
	261630033	Dearborn					√^	√	√T	√+A		√	√	√#	√	√		√
	261630036	Wyandotte						√										
	261630093	Eliza Howell-Roadway	√	√											√			
	261630094	Eliza Howell-Downwind	√	√											√	√		√
	261630095	Livonia-Roadway	√	√				√							√	√		√
	261630097	NMH 48217							√T		√			√				
	261360098	DP4th Precinct	√	√					√B	A	√			√				
	261360099	Trinity	√	√					√B	A	√			√	√			
	261360100	Military Park		√					√B	A	√			√				
Flint	260490021	Flint				√		√	√B						√			√
	260492001	Otisville				√									√			
Grand Rapids	261390005	Jenison				√	√	√							√			
	261390011	West Olive									√				√			
	260810020	Grand Rapids-Monroe	√*		√	√	√	√	√T	√	√*			√	√			√
	260810022	Evans				√									√			
Lansing/East Lansing	260650018	Lansing-Filley St.		√		√		√	√T		√				√			√
	260370002	Rose Lake				√												
Monroe Co	261150006	Sterling State Park									√				√			
Huron Co	260630007	Harbor Beach				√									√			
Bay Co	260170014	Bay City						√	√T						√			
Missaukee Co	261130001	Houghton Lake		√		√		√	√T						√			√
Allegan Co	260050003	Holland				√		√							√	√	√	√
Benzie Co	260190003	Benzonia				√												
Berrien Co	260210014	Coloma				√									√			
Cass Co	260270003	Cassopolis				√									√			
Kalamazoo Co	260770008	Kalamazoo				√		√	√T						√			
Manistee Co	261010922	Manistee $				√		√							√		√	√
Mason Co	261050007	Scottville				√									√			
Muskegon Co	261210039	Muskegon				√									√			
Schoolcraft Co	261530001	Seney Nat'l Wildlife				√			√T						√	√	√	√
Chippewa Co	260330901	Sault Ste. Marie $				√			√B						√			
Ionia Co	260670002	Belding-Reed St.												√	√			
	260670003	Belding-Merrick St.												√				

√ = Data Collected
& = 5 trace metals: As, Cd, Mn, Ni and Pb
# = 9 additional metals sampled: Ba, Be, Cr, Co, Cu, Fe, Mo, V, Zn
B = BAM continuous PM2.5 monitor
T = TEOM continuous PM2.5 monitor

$ = Tribal monitor
* = Trace monitor
^ = Continuous PM10 monitor
A = Aethalometer monitor
E = EC/OC monitor

Current Attainment Status

Areas of the state that are below the NAAQS concentration level are called attainment areas. The entire state of Michigan is in attainment for the following pollutants:

- CO
- Pb
- NO_2
- Particulate Matter

Nonattainment areas are those that have been classified by the USEPA as having concentrations over the NAAQS level. Portions of the state are in nonattainment for SO_2 and O_3 (see **Fig. 1.3**). The SO_2 nonattainment area includes a portion of Wayne County and a portion of St. Clair County. Ozone nonattainment areas include Allegan County, Berrien County, a portion of Muskegon County and the 7-county area of Southeast Michigan, which includes Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne Counties. Nonattainment status for O_3 was effective on August 3, 2018.

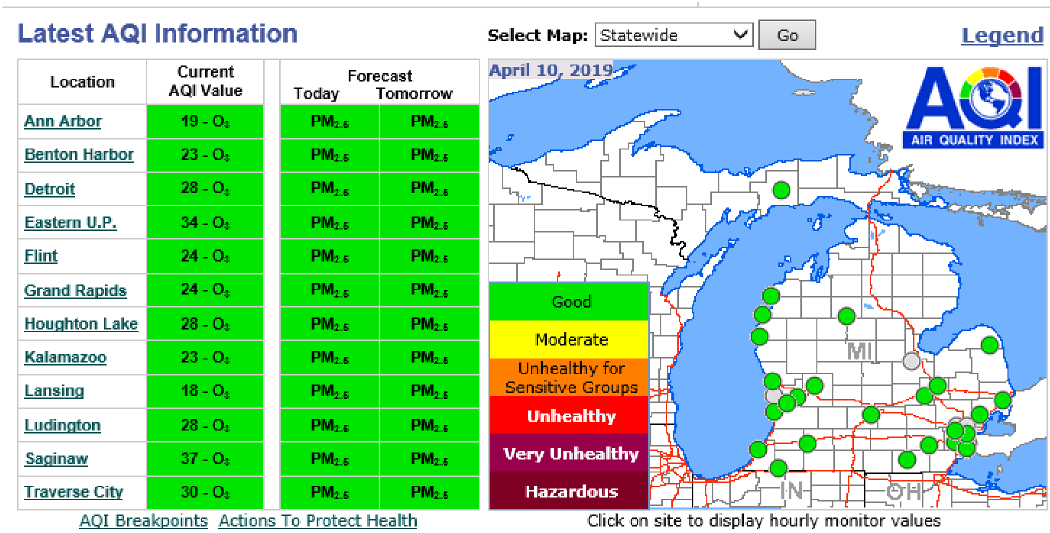
Figure 1.3: Attainment Status for the National Ambient Air Quality Standards

MIair – Air Quality Information in Real-Time

MIair is the internet tool that provides real-time air quality information via EGLE's web page. 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 (see **Table 1.4**), are displayed in a forecast table and as dots on a Michigan map (see example below).



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 "Air Quality Index Fact Sheet" link: www.michigan.gov/documents/deq/deq-aqd-aqifacts_273090_7.pdf which contains activity recommendations based on the AQI levels (also **Table 1.4**).

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**.

The weather plays a significant role in air quality (see Chap. 9 for an annual weather summary) 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 meteorological conditions are conducive for the formation of elevated ground-level O_3 or $PM_{2.5}$ concentrations.

Table 1.3 shows that there were some *Action!* Days declared during the summer of 2018.

Table 1.3: *Action!* Days Declared During Summer 2018

Location	Year	Number	Dates
Ann Arbor	2018	9	5/25, 5/28, 5/29, 6/17, 6/29, 6/30, 7/1, 8/4, 8/5
Benton Harbor	2018	10	5/25, 5/27, 5/28, 6/16, 6/17, 6/30, 7/9, 7/13, 8/4, 8/5
Detroit	2018	9	5/25, 5/28, 5/29, 6/17, 6/29, 6/30, 7/1, 8/4, 8/5
Grand Rapids	2018	11	5/25, 5/27, 5/28, 6/16, 6/17, 6/30, 7/1, 7/9, 7/13, 8/4, 8/5
Ludington	2018	9	5/27, 5/28, 6/16, 6/17, 6/29, 6/30, 7/1, 8/4, 8/5
Kalamazoo	2018	1	6/17
Traverse City	2018	2	6/29, 6/30

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, choose 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

EGLE 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** web page.

Table 1.4: AQI Colors and Health Statements

AQI Color, Category and Value	Particulate Matter (µg/m³) 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 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.

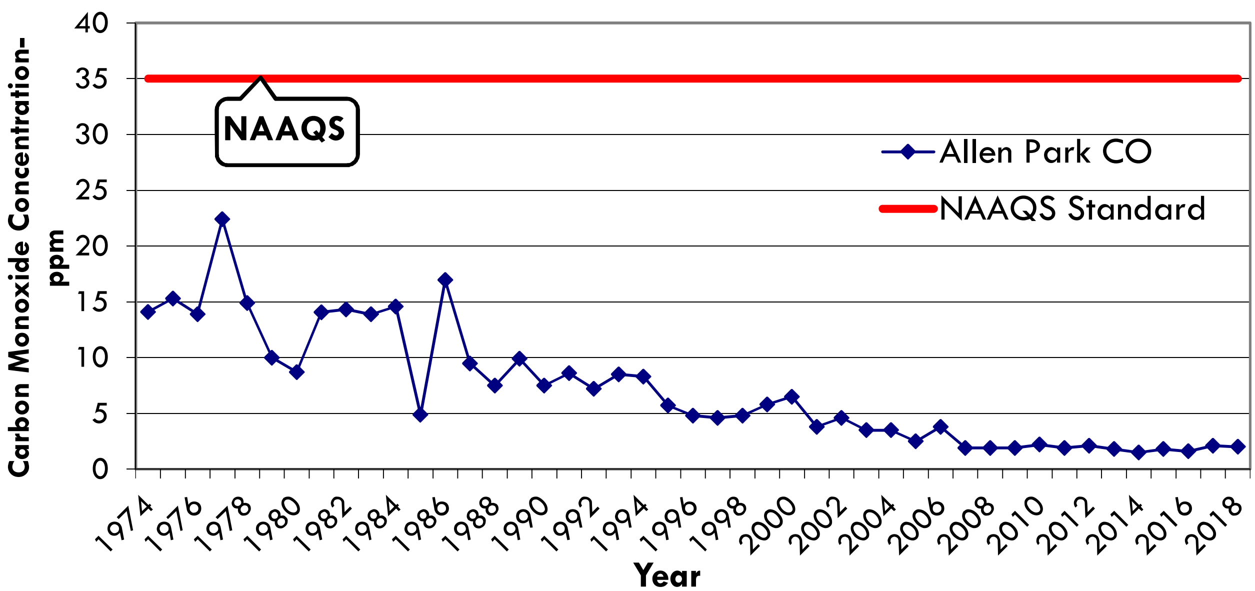
Sources: CO is given off whenever fuel or other carbon-based materials are burned. Outdoor exposure sources include automobile exhaust, industrial processes (metal processing and chemical production), and non-vehicle fuel combustion. Natural sources include volcanos, forest fires and photochemical reactions 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.

Historical Trends: Southeast Michigan has been monitoring for CO for 45 years. **Figure 2.1** shows the CO trend at Allen Park to be well below the 1-hour standard of 35 ppm. This standard has not changed since 1971.

Figure 2.1: Historical 1-hour CO Averages at Allen Park



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

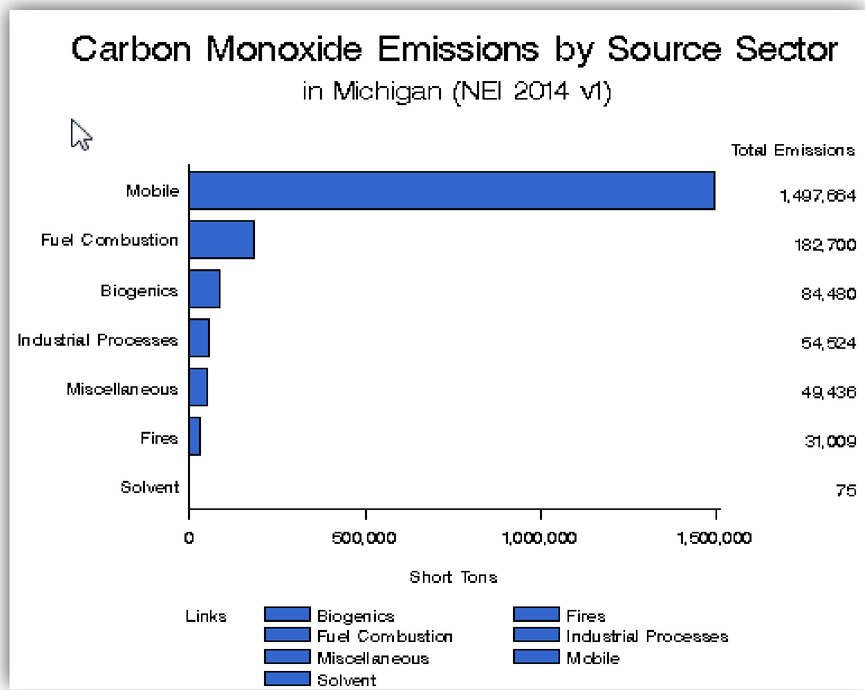


Figure 2.3: CO Emissions in 2014

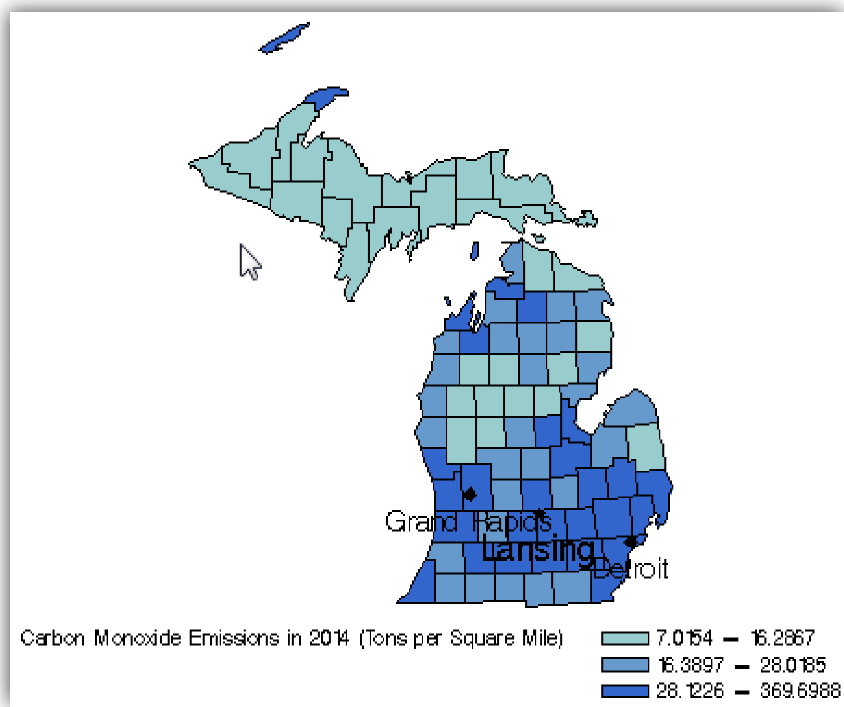


Figure 2.4 shows the location of each CO monitor that operated in 2018.

- Near-roadway network sites: two Eliza Howell Park and Livonia. A second downwind site at Eliza Howell Park provides a comparison to the near-roadway sites.
- NCore Network: Grand Rapids and Allen Park measure trace CO (lower detection levels 1 ppm-50 ppm).
- Gordie Howe Bridge project: Trinity St. Marks (Trinity) and Detroit Police 4th Precinct (DP4th Precinct), started 2018.

Figure 2.4: CO Monitors in 2018

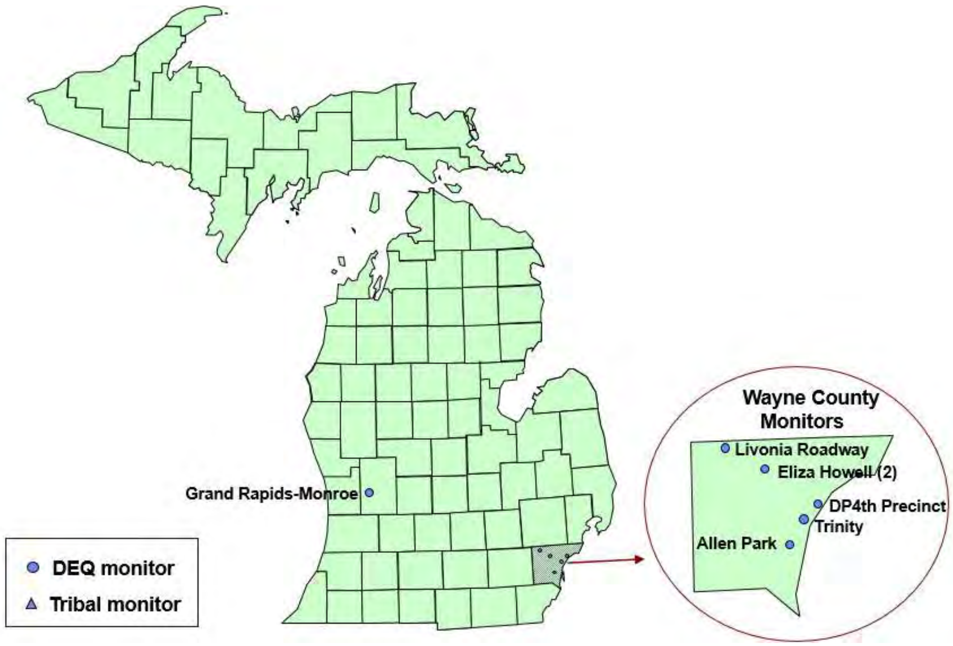
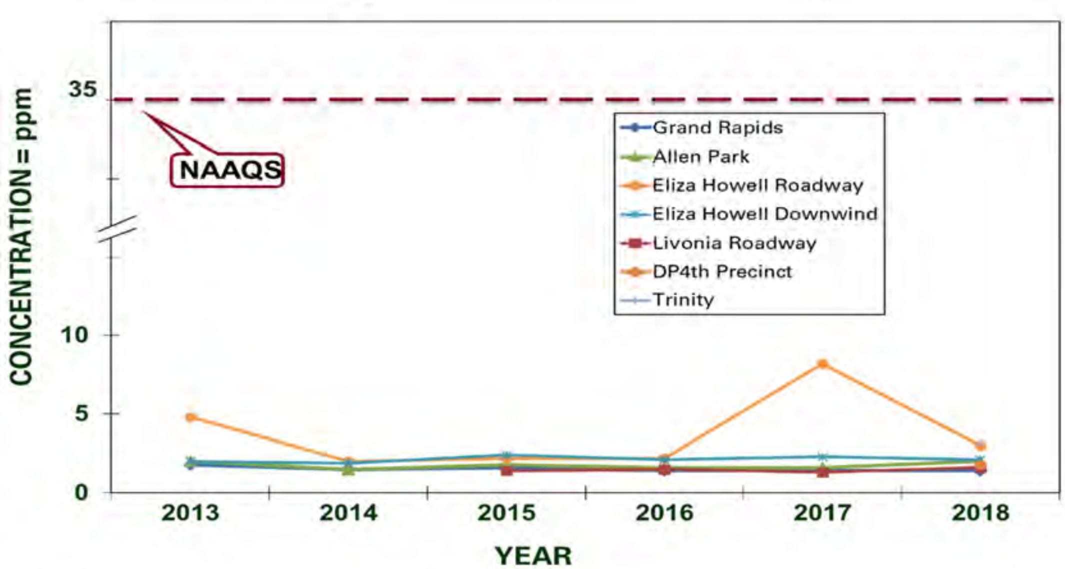


Figure 2.5 shows the second highest 1-hour CO concentrations for Michigan from 2013-2018, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.

Figure 2.5: CO Levels in Michigan from 2013-2018 (2nd Highest 1-Hour 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. In 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.

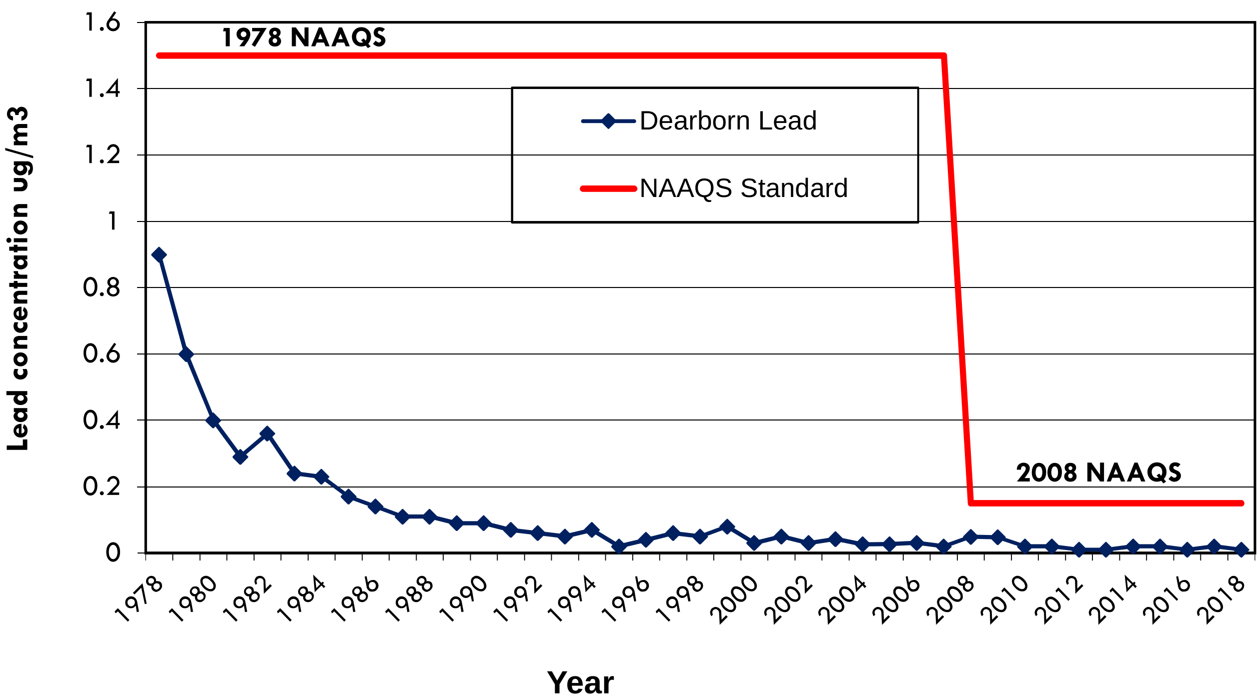
Sources: With the phase-out of leaded gas in the 1970s, the major sources of Pb emissions have been due to ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other industrial sources include Pb acid battery manufacturers, waste incinerators, and utilities. The highest air concentrations of Pb 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 nervous system as well as the cardiovascular system, reproductive system, blood, kidneys, and other organs.

Population most at risk: Fetuses and children are most at risk since low levels of Pb may cause central nervous system damage. Excessive Pb exposure during the early years of life is associated with lower IQ scores and neurological impairment (seizures, mental 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.

Historical Trends: Southeast Michigan has been monitoring for lead for 40 years. **Figure 3.1** shows the trend for lead at Dearborn. The largest decrease in Pb in the air is due to the removal of Pb in gasoline. By 1975, most newly manufactured vehicles no longer required leaded gasoline, and as a result, there was a dramatic decrease in ambient Pb 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 Pb standard that occurred in 2008.

Figure 3.1: Historical Quarterly/3-month Averages for Lead at Dearborn



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: Pb Emissions by Source Sector

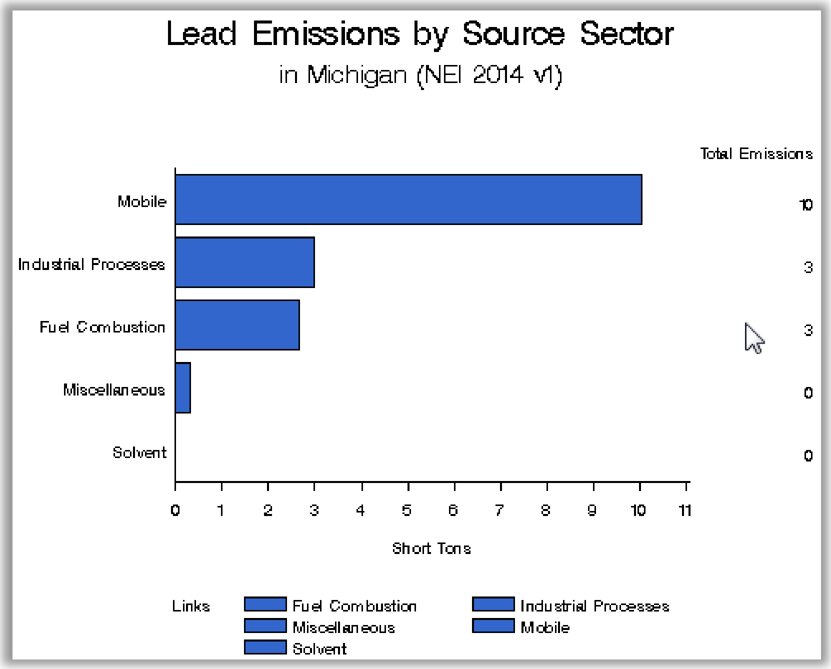


Figure 3.3: Pb Emissions in 2014

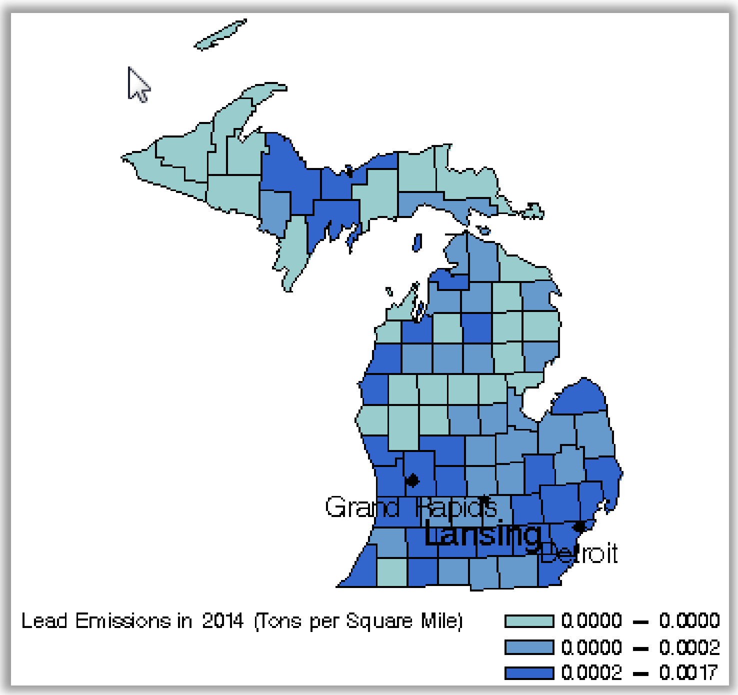


Figure 3.4 shows the location of the Pb monitors in the MASN in 2018. When the Pb NAAQS was lowered in 2008, the monitoring network was modified to consist of source-oriented monitors and population-oriented monitors. As part of the 2008 Pb NAAQS, EGLE must monitor near stationary sources emitting more than 1/2 ton of Pb per year.

Source-oriented sites: Port Huron-Rural St., Belding-Merrick St., and Belding-Reed St. The two sites in Belding previously were above the standard, but values for both the sites have been below the NAAQS for the past five years. Belding was designated to attainment on July 31, 2018.

- National Air Toxics Trend Sites (NATTS): Dearborn 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.
- Network consistency: River Rouge, Detroit-W. Jefferson, and Detroit-W. Fort St. On January 1, 2018, lead sampling was started at all the TSP metals sites to maintain consistency and to be more protective of public health. Many older homes, which often contain lead-based paint, are being demolished in the Detroit area near these monitors.
- Secondary monitor: Port Huron-Rural St. to comply with the USEPA's collocation regulations.
- Gordie Howe Bridge project: DP4th Precinct, Trinity, and Military Park.

Figure 3.4: Lead (Pb) Monitors in 2018

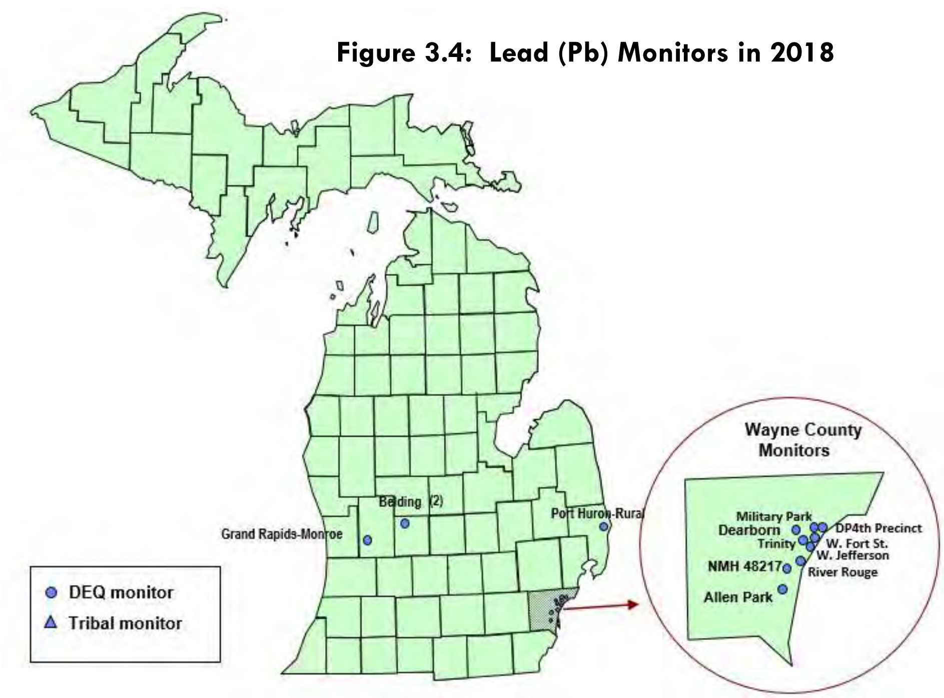
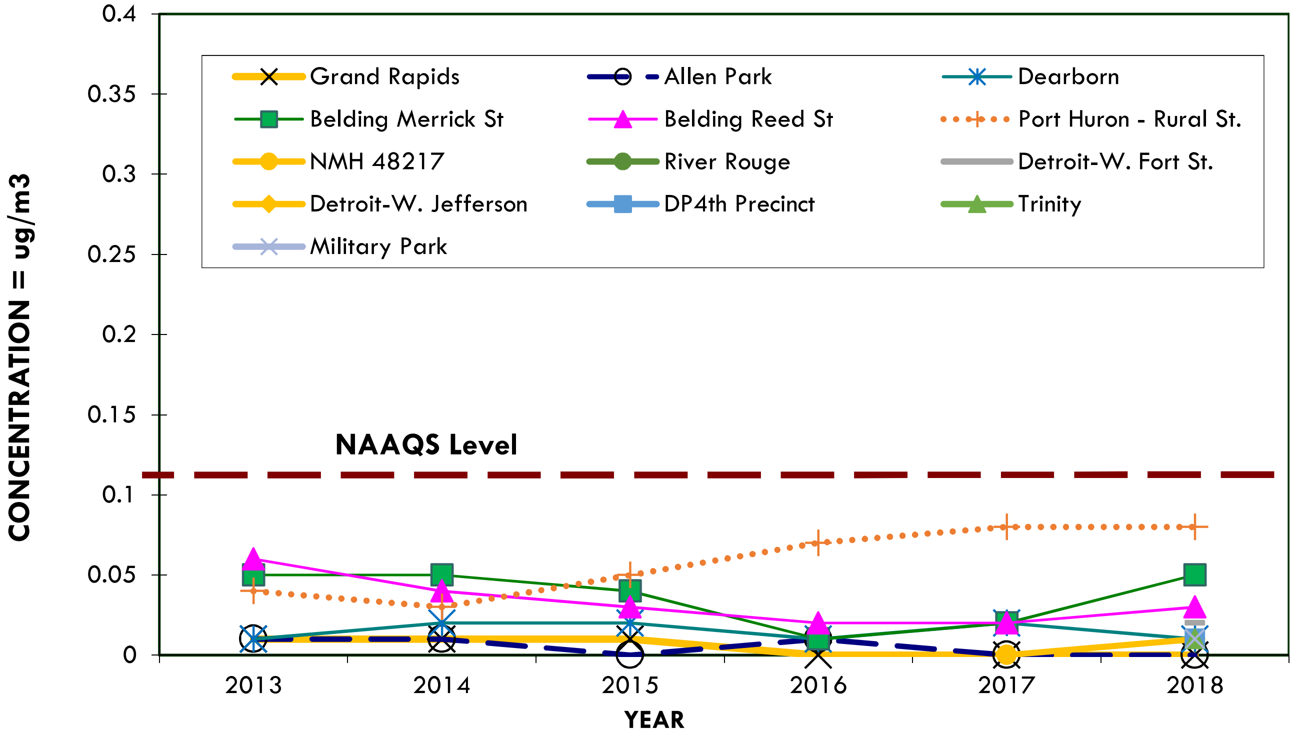


Figure 3.5 shows the maximum 3-month rolling average values for Pb from 2013 to 2018. All Pb monitor sites in Michigan are below the standard.

Figure 3.5: Lead Levels in Michigan from 2014-2018 (Maximum 3-Month Average Values)



CHAPTER 4: 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 98th percentile averaged over three years. The sources and effects of NO_2 are as follows:

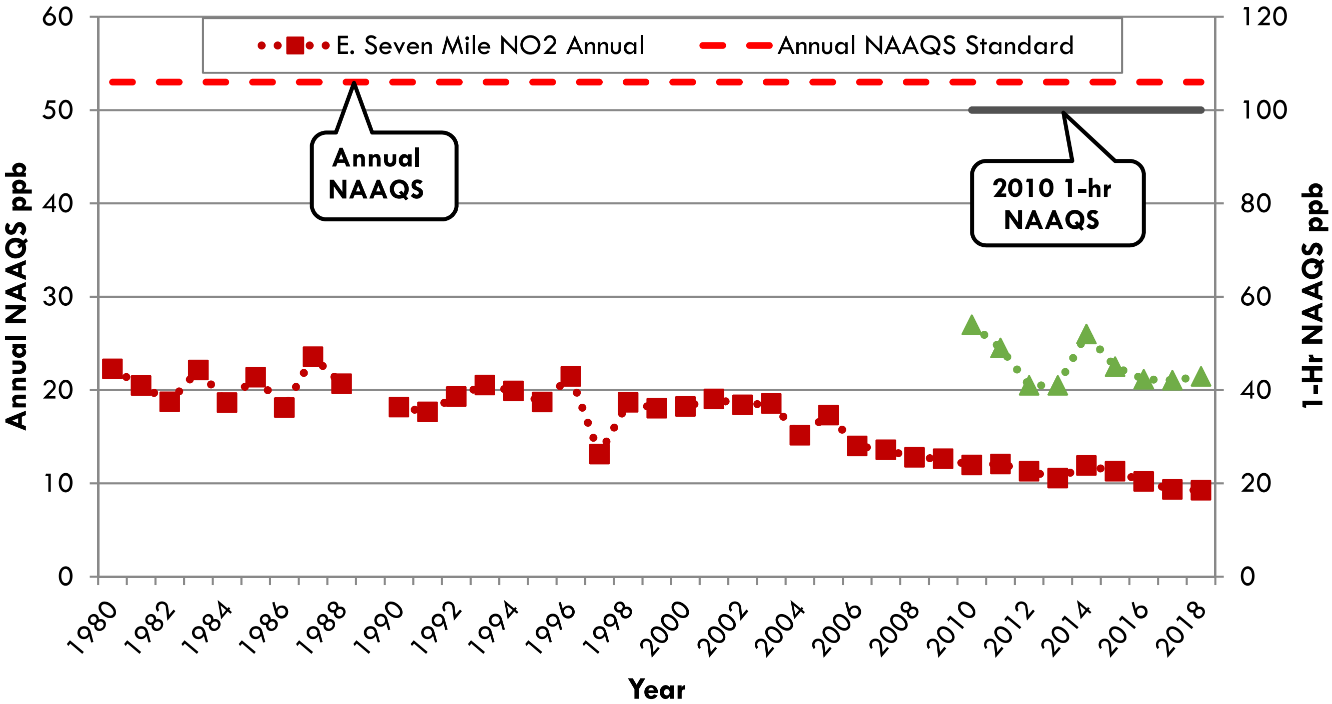
Sources: NO_X compounds and their transformed products occur both naturally and as a result of human activities. Natural sources of NO_X are lightning, forest fires, bacterial processes in soil, and stratospheric intrusion. Stratospheric intrusion is when the air upper atmosphere (stratosphere) descends 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 lung function. Evidence suggests that long-term exposures to NO_2 may lead to increased susceptibility to respiratory infection and may cause structural changes 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). Nitrogen deposition can lead to fertilization, excessive nutrient enrichment, or acidification of terrestrial, wetland, and aquatic systems that can upset the delicate balance in those ecosystems.

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.

Historical Trends: Southeast Michigan has been monitoring for NO_2 for almost 40 years. **Figure 4.1** shows the trend for NO_2 at E. 7 Mile Road, 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 for NO_2, which have also remained well below the standard in Michigan. Southeast Michigan is highly industrialized; therefore, it is a good indicator of the air quality improvement for the rest of the state.

Figure 4.1: Historical Annual and 1-hour NO_2 at E. 7 Mile Road



Figures 4.2 and **4.3** show NO_2 emission sources and NO_2 emissions by county (courtesy of the USEPA's State and County Emission Summaries).

Figure 4.2: NO_2 Emissions by Source Sector

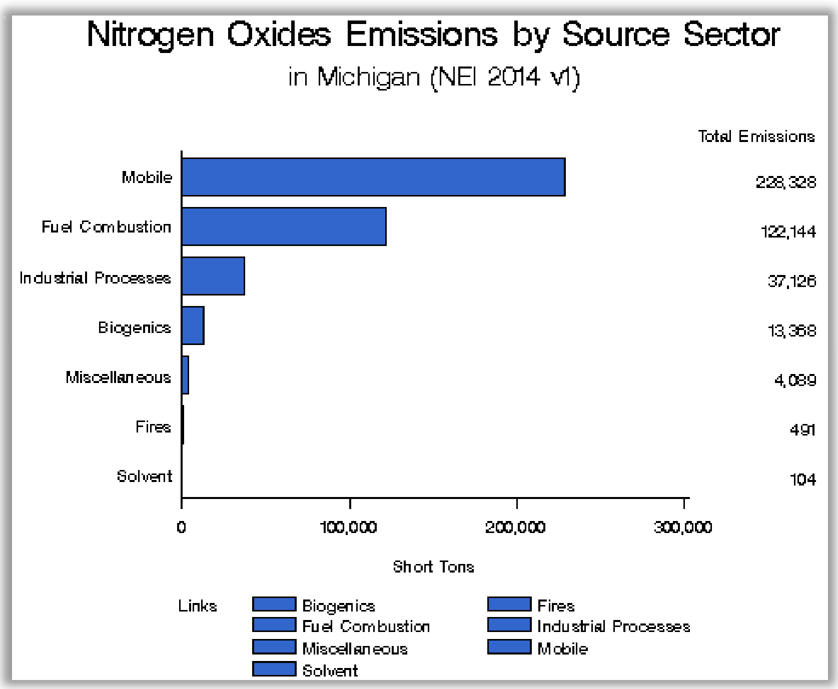


Figure 4.3: NO_2 Emissions in 2014

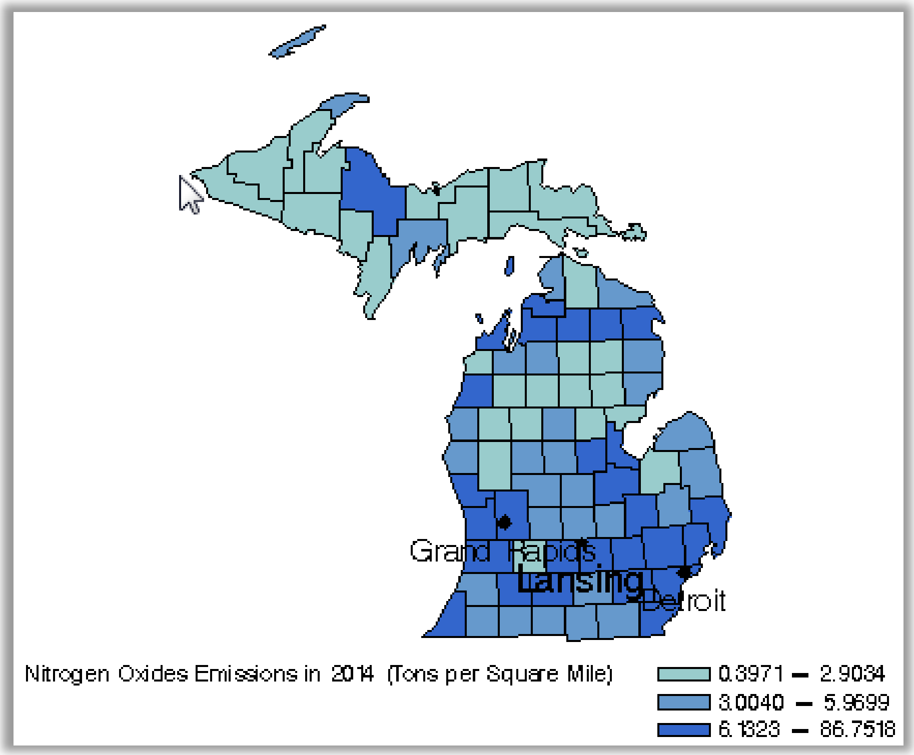
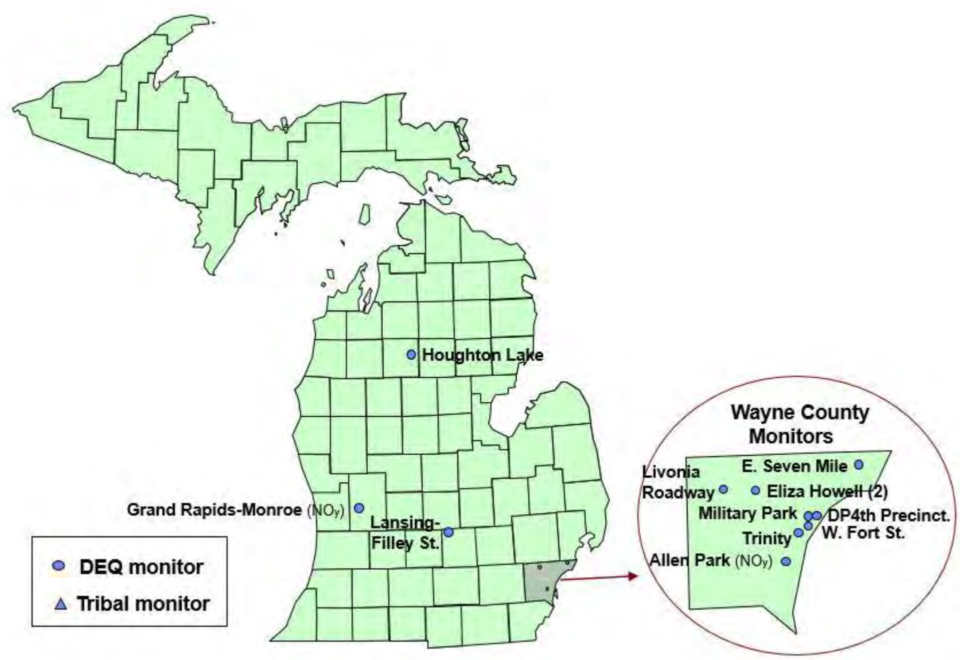


Figure 4.4 shows the location of all NO_2 monitors that operated in 2018.

- Downwind urban scale site: E. 7 Mile in Detroit
- Near-roadway Network sites: Two Detroit Eliza Howell (roadway and downwind sites) and Livonia.
- NCore sites: Grand Rapids and Allen Park, monitor NO_Y, which includes NO_X, nitric acid and organic and inorganic nitrates (not used for attainment/nonattainment purposes).
- Background monitors for modeling: Lansing and Houghton. The Lansing monitor was moved in April 2018 from Eastern High School to its current location on Filley Street in Lansing to due to construction.
- Gordie Howe Bridge project: W. Fort St., DP4th Precinct, Trinity, and Military Park

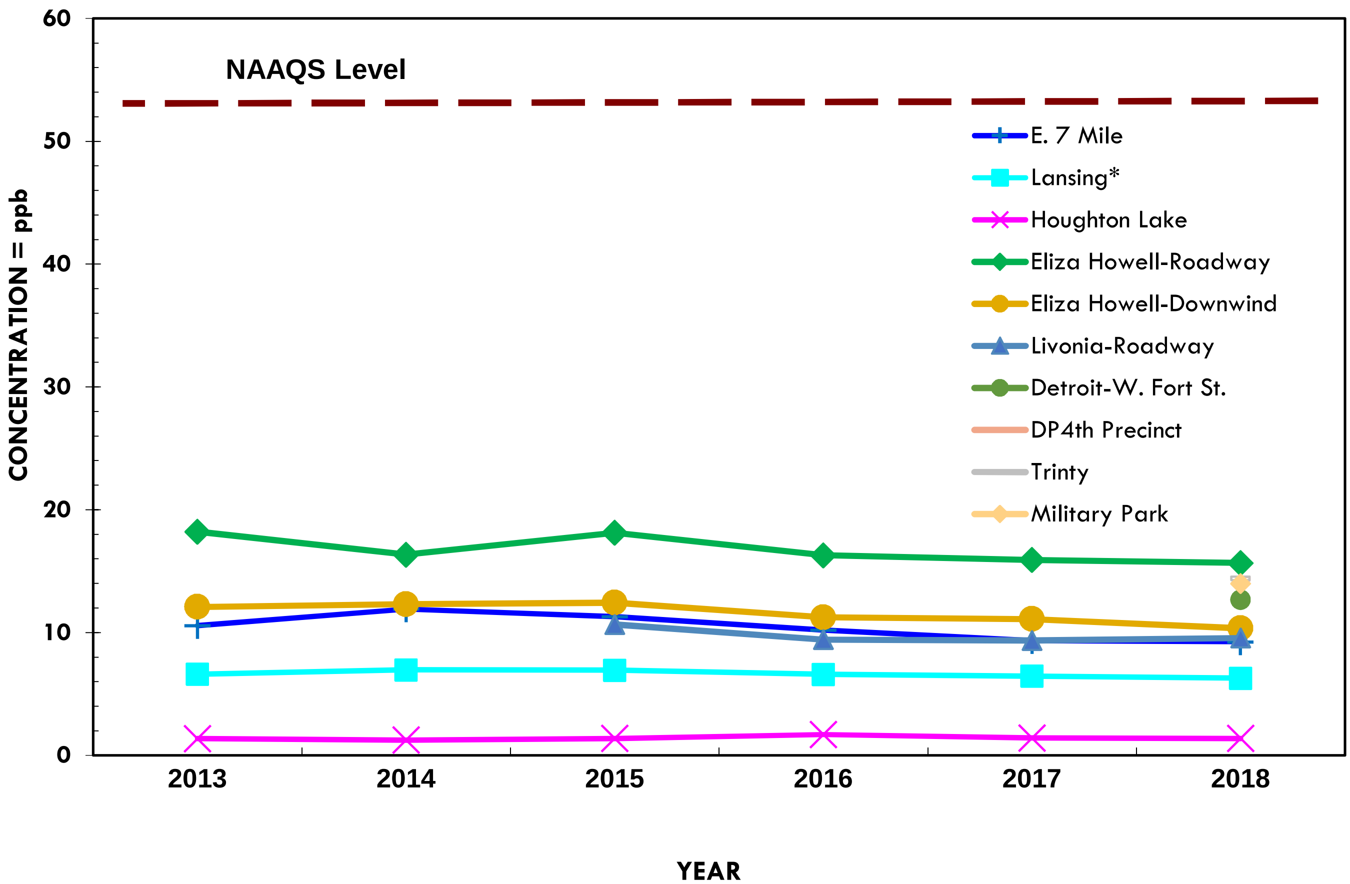
Figure 4.4: Nitrogen Dioxide (NO_2)/NO_y Monitors in 2018



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 4.5**, all monitoring sites have had an annual NO_2 concentration at less than half of the 0.053 ppm NAAQS.

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.

Figure 4.5: NO_2 Levels in MI from 2013-2018 (Annual Arithmetic Mean)**



*Indicates site was moved during the year and concentrations were averaged together for both locations.
**Since Allen Park and Grand Rapids are monitoring NO_Y, those sites are not included in graph.

CHAPTER 5: 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 99th percentile of 1-hour concentrations not to exceed 0.075 ppm, averaged over a 3-year period. The secondary standard has not changed and is a 3-hour average that cannot exceed 0.5 ppm once per year. Its sources and effects are presented below.

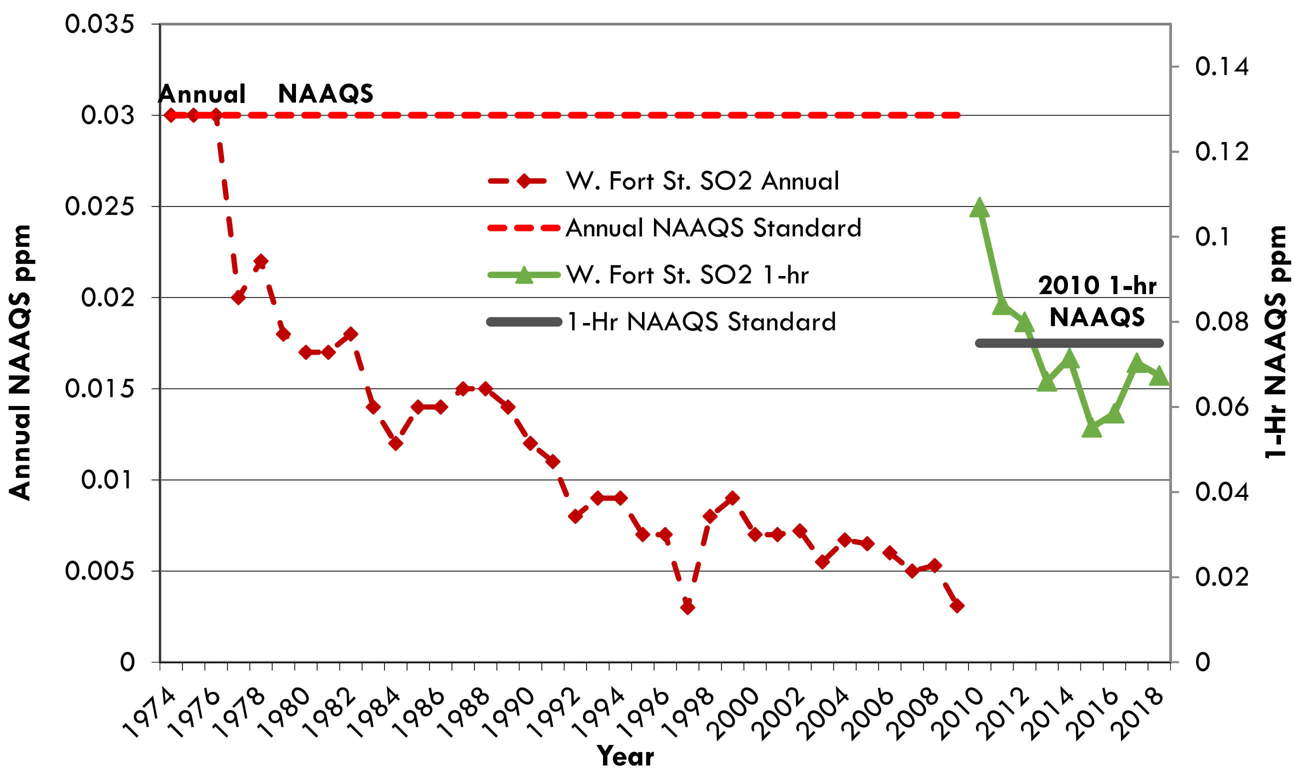
Sources: Coal-burning power plants are the largest source of SO_2 emissions. Other sources include industrial processes such as extracting metal from ore, and non-road transportation sources, and natural sources such as volcanoes. SO_2 and particulate matter are often emitted together.

Effects: Exposure to elevated levels can aggravate symptoms in asthmatics and cause respiratory problems in healthy groups as well. 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.

Historical Trends: Southeast Michigan has been monitoring for SO_2 for 45 years. **Figure 5.1** shows the SO_2 trend for the old annual standard and the new 1-hour standard for W. Fort Street in Detroit. Michigan had been in attainment for SO_2 since 1982 with levels consistently well below the annual SO_2 NAAQS. In 2010, when the USEPA changed the standard from an annual average to a 1-hour standard, a portion of Wayne County was designated nonattainment. In September 2016, a portion of St. Clair County was also designated as nonattainment by the USEPA based on emissions and modeling. Even though the areas are in nonattainment for the 1-hour SO_2 standard, SO_2 concentrations have decreased at these sites and are currently under the NAAQS, although modeling results are not below the NAAQS.

Figure 5.1: Historical Annual and 1-hour SO_2 Averages at W. Fort St.



Figures 5.2 and **5.3** show SO_2 emission sources and SO_2 emissions by county (courtesy of the USEPA's State and County Emission Summaries).

Figure 5.2: SO_2 Emissions by Source Sector

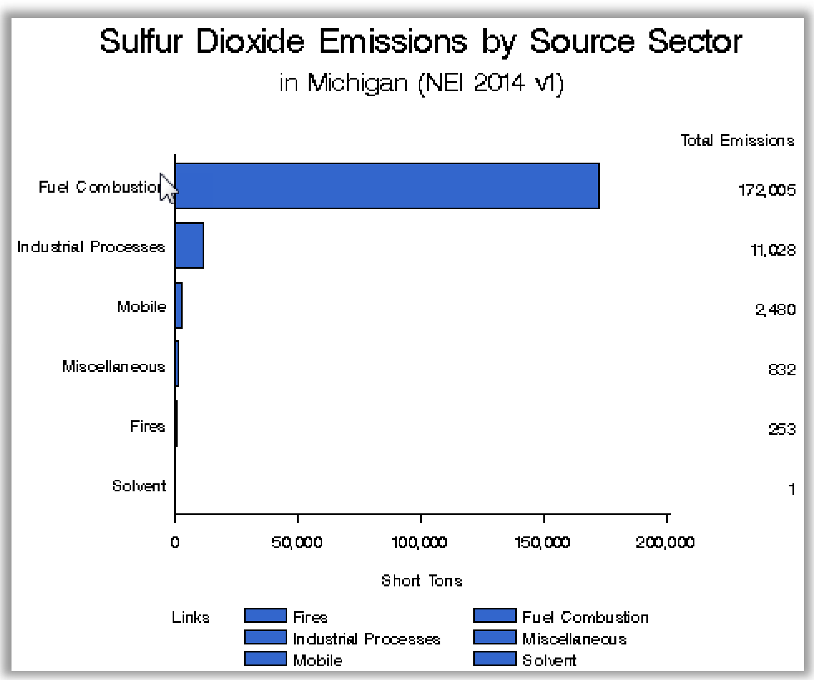


Figure 5.3: SO_2 Emissions in 2014

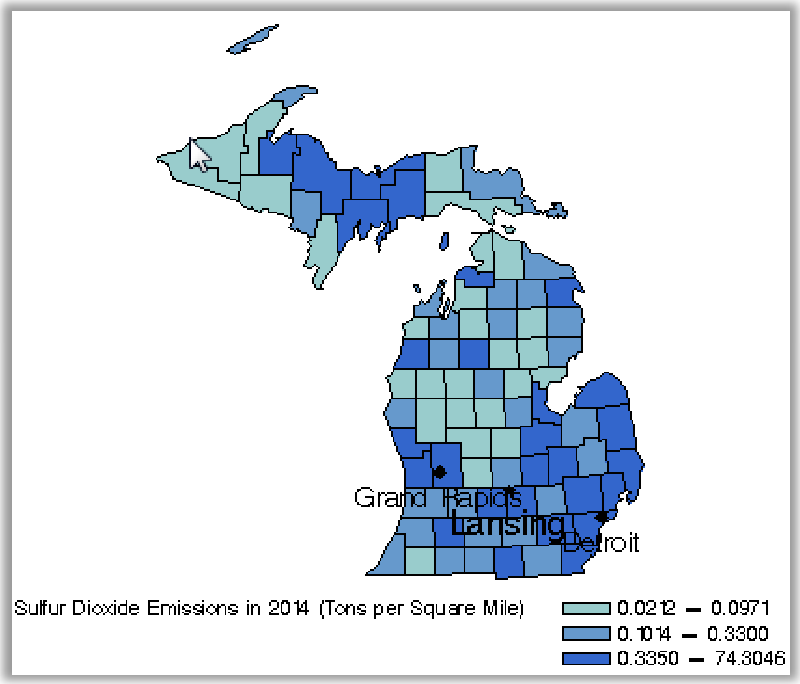


Figure 5.4 shows the location of each SO_2 monitor that operated in 2018.

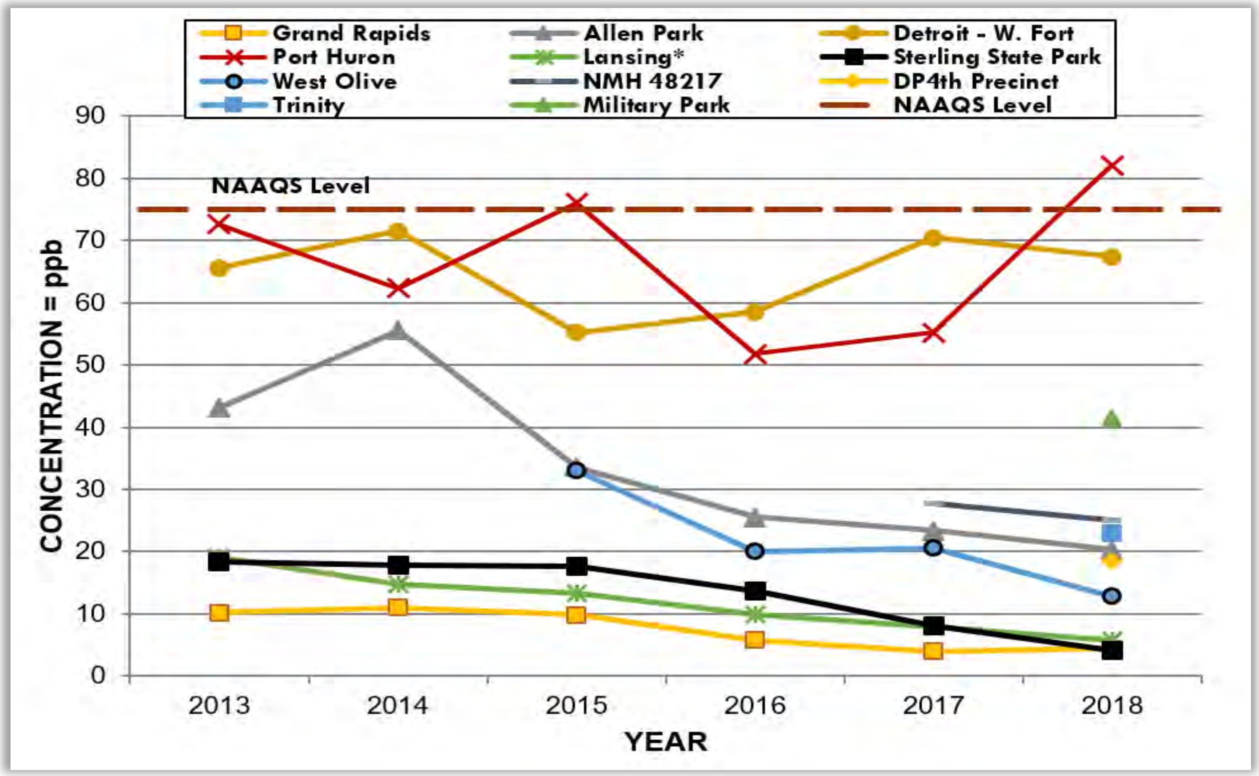
- NCore sites: Allen Park and Grand Rapids have trace SO_2 monitors that have lower detection limits than traditional SO_2 monitors.
- Source-oriented sites: Lansing, Port Huron, W. Fort St., Sterling State Park, West Olive
- Community monitoring project: NMH 48217
- Background monitor: the Lansing monitor was moved in April 2018 from Eastern High School to its current location on Filley Street in Lansing due to construction.
- Gordie Howe Bridge project: DP4th Precinct, Trinity, and Military Park.

Figure 5.4: Sulfur Dioxide (SO_2) Monitors in 2018

Figure 5.5 shows that all the SO_2 sites in Michigan are below the standard even though there is a nonattainment area for SO_2. The standard is a three-year average, therefore having one point above the NAAQS level line does not mean the monitor is over the standard. SO_2 pollution is extremely variable and would require a large monitoring network to designate areas as attainment. Therefore, SO_2 attainment depends on both emission modeling and monitoring data.

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 5.5**.

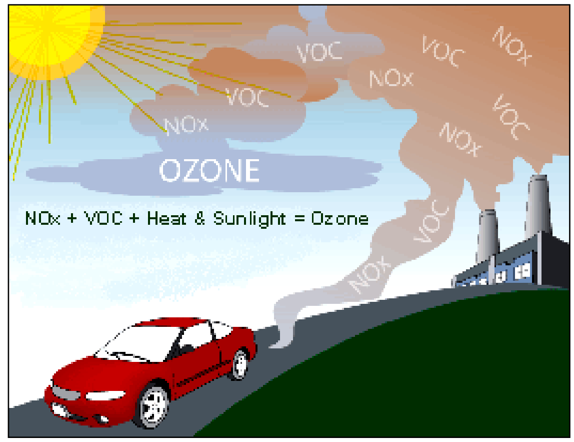
Figure 5.5: SO_2 Level in Michigan from 2013-2018 (1-Hour 99th Percentile)



*Indicates site was moved during the year and concentrations were averaged together for both locations.

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.



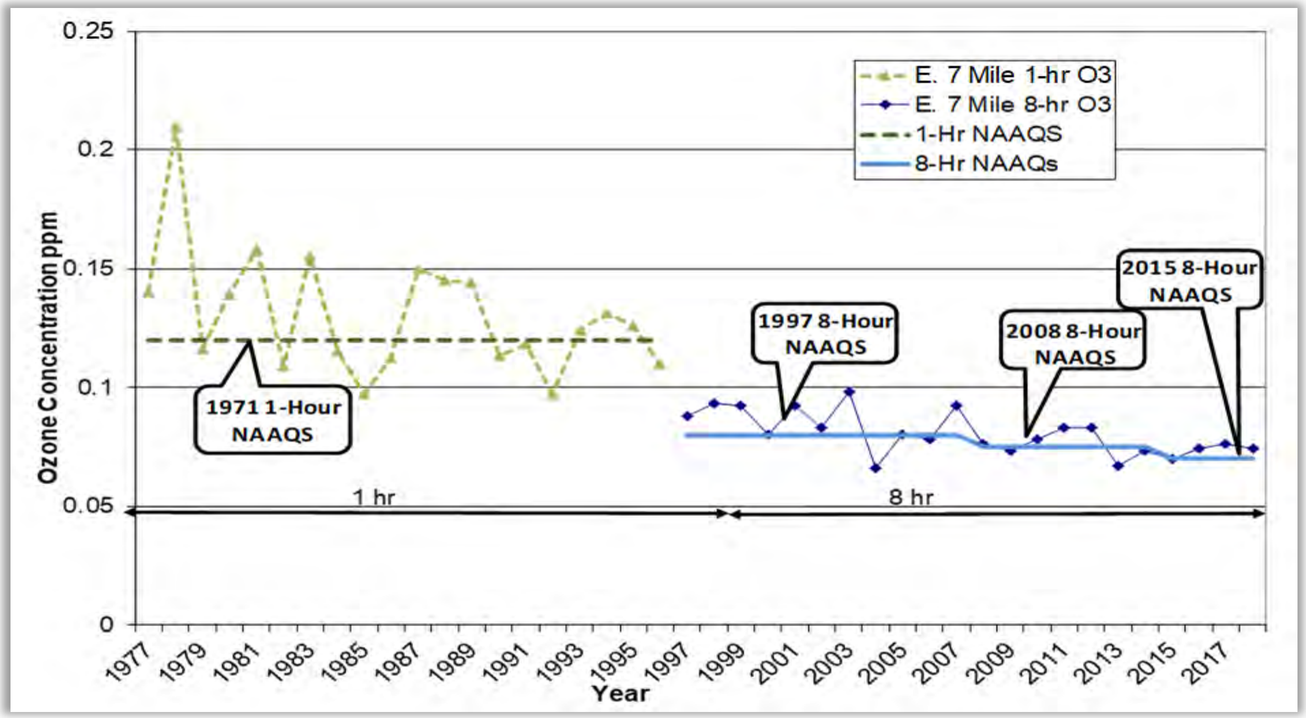
Sources: Major sources of NO_X and VOCs are engine exhaust, emissions from industrial facilities, combustion from power plants, gasoline vapors, chemical solvents, and biogenic emissions from natural sources. Ground-level O_3 can also be transported hundreds of miles under certain wind regimes. As a 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.

Historical Trends: Southeast Michigan has been monitoring for ozone for over 40 years. **Figure 6.1** 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. Ozone depends on weather conditions, so ozone concentrations are more variable than other pollutants. Ozone is also monitored primarily in warmer months. In the 2015 NAAQS, the ozone season was extended by two months to March 1 to October 31.

Figure 6.1: Historical 1-hour and 8-hour Ozone at E. 7 Mile



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

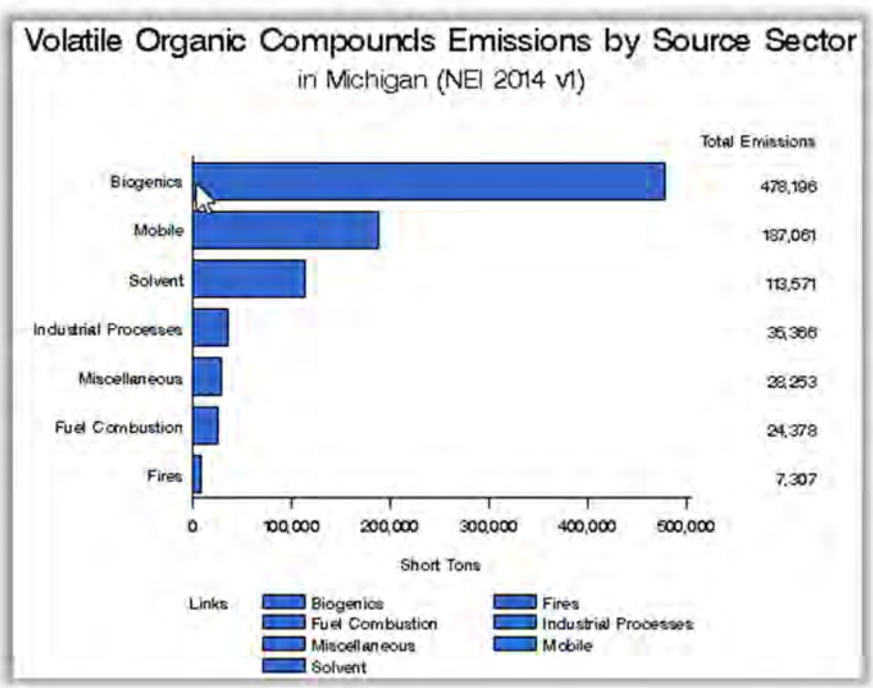


Figure 6.3: VOC Emissions in 2014

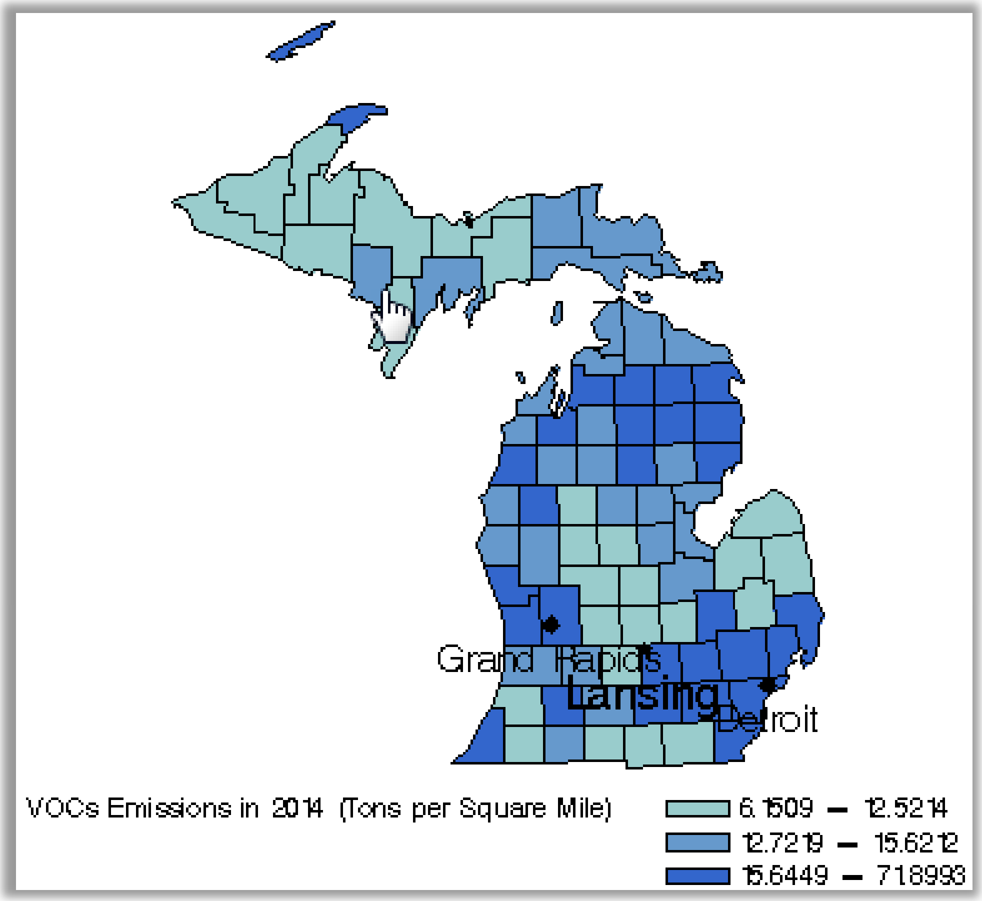


Figure 6.4 shows all O_3 air quality monitors active in Michigan at the beginning of the 2018 ozone season.

- Background site monitors: Houghton Lake, Scottville, Seney.
- Transport site monitors: Benzonia, Coloma, Harbor Beach, Holland, Muskegon, Tecumseh.
- Population-oriented monitors: all other sites. The Lansing monitor was moved in April 2018 from Eastern High School to its current location on Filley Street in Lansing to due to construction.

Figure 6.4: Ozone Monitors in 2018

Table 6.1 shows the three-year averages of ozone. The USEPA uses these values (called design values) to determine attainment / nonattainment areas. In 2016, several monitors violated the 2015 standard of 0.070 ppm. The AQD recommended several counties be designated as nonattainment. The USEPA made their final designations for the 2015 standard on April 30, 2018 (effective August 3, 2018) based on 2014-2016 data. Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw and Wayne Counties were designated nonattainment in Southeast Michigan, and all of Berrien County, and portions of Allegan and Muskegon Counties were designated nonattainment in Western Michigan.

The O_3 monitoring season in Michigan was from April 1 through September 30, the hottest portion of the year. In 2017, the ozone season was 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 website (discussed in **Chapter 1**). 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.

Table 6.1: 3-Year Average of the 4th Highest 8-hour Ozone Values from 2014-2016, 2015-2017, 2016-2018 (concentrations in ppm).

Areas	County	Monitor Sites	2014-	2015-	2016-2018
Detroit-Ann Arbor	Lenawee	Tecumseh	0.067	0.066	0.068
	Macomb	New Haven	**0.072**	**0.071**	**0.072**
		Warren	0.067	0.066	0.069
	Oakland	Oak Park	0.069	0.070	**0.073**
	St. Clair	Port Huron	**0.073**	**0.071**	**0.072**
	Washtenaw	Ypsilanti	0.067	0.067	0.069
	Wayne	Allen Park	0.065	0.066	0.068
		Detroit-E. 7 Mile	**0.072**	**0.073**	**0.074**
Flint	Genesee	Flint	0.068	0.067	0.068
		Otisville	0.069	0.067	0.068
Grand Rapids	Ottawa	Jenison	0.070	0.068	0.070
	Kent	Grand Rapids	0.069	0.068	0.070
		Evans	0.067	0.067	0.068
Muskegon Co	Muskegon	Muskegon	**0.075**	**0.074**	**0.076**
Allegan Co	Allegan	Holland	**0.075**	**0.073**	**0.073**
Huron	Huron	Harbor Beach	0.068	0.067	0.068
Kalamazoo-Battle Creek	Kalamazoo	Kalamazoo	0.069	0.069	**0.071**
Lansing-East Lansing	Ingham	Lansing	0.067	0.067	0.068*
	Clinton	Rose Lake	0.067	0.066*	0.069*
Benton Harbor	Berrien	Coloma	**0.074**	**0.073**	**0.073**
Benzie Co	Benzie	Benzonia	0.069	0.065	0.068
Cass Co	Cass	Cassopolis	0.070	**0.072**	**0.074**
Chippewa Co	Chippewa	Sault Ste. Marie	0.059	0.057	0.055
Mason Co	Mason	Scottville	0.070	0.068	0.068
Missaukee Co	Missaukee	Houghton Lake	0.067	0.066	0.067
Manistee Co	Manistee	Manistee	0.068	0.067	0.066
Schoolcraft Co	Schoolcraft	Seney	0.070	0.067	0.064

Numbers in bold indicate 3-year averages over the 2015 ozone standard of 0.070 ppm.

*The three-year average is using data averaged from sites that were moved.

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: 2018 West Michigan Ozone Season

Daily High Temperature Range			2018 WEST MICHIGAN OZONE SEASON															
			March		April		May		June		July		August		September		October	
					Days	O_3 Days	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	0	0	0	0
90	<=	94	0	0	0	0	3	3	4	1	8	1	3	0	1	0	0	0
85	<=	89	0	0	0	0	3	2	2	0	8	1	11	0	4	0	0	0
80	<=	84	0	0	0	0	6	0	8	1	9	0	9	0	8	0	4	0
75	<=	79	0	0	0	0	7	0	6	0	5	0	7	0	4	0	0	0
70	<=	74	0	0	2	0	2	0	8	0	1	0	1	0	4	0	2	0
65	<=	69	0	0	0	0	5	0	2	0	0	0	0	0	6	0	1	0
60	<=	64	0	0	8	0	2	0	0	0	0	0	0	0	2	0	2	0
55	<=	59	2	0	2	0	2	0	0	0	0	0	0	0	0	0	9	0
50	<=	54	4	0	2	0	1	0	0	0	0	0	0	0	1	0	8	0
49	<=		25	0	16	0	0	0	0	0	0	0	0	0	0	0	5	0
Totals			31	0	30	0	31	5	30	2	31	2	31	0	30	0	31	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 five O_3 exceedance days in May, two in June, and two in July when ozone exceeded 0.070 ppm at two or more ozone monitors. The temperatures for those days ranged between 80°F and 94°F.

Table 6.3: 2018 Southeast Michigan Ozone Season

Daily High Temperature Range			2018 SOUTHEAST MICHIGAN OZONE SEASON															
			March		April		May		June		July		August		September		October	
					Days	O_3 Days	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	1	1	0	0	0	0	0	0	0
90	<=	94	0	0	0	0	4	2	2	1	9	3	3	0	5	0	0	0
85	<=	89	0	0	0	0	4	1	4	0	6	0	16	1	6	0	1	0
80	<=	84	0	0	0	0	4	0	6	1	13	0	8	0	0	0	3	0
75	<=	79	0	0	1	0	9	0	8	0	0	0	4	0	7	0	2	0
70	<=	74	0	0	2	0	4	0	7	0	2	0	0	0	4	0	2	0
65	<=	69	0	0	1	0	3	0	0	0	0	0	0	0	4	0	0	0
60	<=	64	1	0	4	0	1	0	1	0	0	0	0	0	4	0	4	0
55	<=	59	1	0	6	0	0	0	0	0	0	0	0	0	0	0	9	0
50	<=	54	3	0	1	0	2	0	0	0	0	0	0	0	0	0	6	0
49	<=		26	0	15	0	0	0	0	0	0	0	0	0	0	0	4	0
Totals			31	0	30	0	31	3	30	3	31	3	31	1	30	0	31	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 three days in each of the months of May, June, and July, and one day in August when ozone exceeded 0.070 ppm at two or more ozone monitors. The temperature for those days were 80°F or higher.

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 in 2018.

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	
5/1/2018	Benzonia			1
5/24/2018		Seney	Port Huron	2
5/25/2018	Benzonia, Cassopolis, Coloma, Evans, Grand Rapids, Holland, Jenison, Kalamazoo, Manistee, Muskegon, Scottville	Lansing, Rose Lake	E. 7 Mile, Flint, Harbor Beach, New Haven, Oak Park, Otisville, Port Huron, Tecumseh, Warren	22
5/27/2018	Coloma, Holland, Kalamazoo, Muskegon	Rose Lake		5
5/28/2018	Cassopolis, Coloma, Kalamazoo	Rose Lake	Allen Park, E. 7 Mile, Flint, New Haven, Oak Park, Port Huron, Tecumseh, Ypsilanti	12
5/29/2018	Cassopolis, Coloma, Evans, Grand Rapids, Holland, Jenison, Muskegon	Lansing, Rose Lake	Flint, New Haven, Oak Park, Otisville, Tecumseh, Ypsilanti	15
5/31/2018	Cassopolis, Coloma, Grand Rapids, Holland, Jenison			5
6/7/2018			New Haven, Oak Park	2
6/8/2018			Oak Park	1
6/15/2018	Cassopolis, Coloma			2
6/17/2018	Holland, Muskegon		New Haven, Port Huron	4
6/29/2018			E. 7 Mile, Harbor Beach, New Haven, Oak Park, Port Huron, Warren	6
7/8/2018			Oak Park	1
7/9/2018	Cassopolis, Coloma, Holland, Muskegon, Scottville		E. 7 Mile, New Haven,	7
7/13/2018	Coloma, Grand Rapids, Holland, Jenison, Kalamazoo, Muskegon		E. 7 Mile, New Haven, Oak Park, Port Huron, Tecumseh, Warren, Ypsilanti	13
7/15/2018			E. 7 Mile, Harbor Beach, New Haven	3
8/2/2018	Holland			1
8/4/2018		Seney	Allen Park, E. 7 Mile, New Haven, Oak Park, Warren	6
			TOTAL	107

On May 25, 2018, there were 22 monitors and on May 29, 2018, there were 15 monitor readings that exceeded the level of the standard. The sites with the most exceedances in the western region of Michigan was Cassopolis and Holland with eight. The central/upper Michigan site with the most exceedances was Rose Lake with four. The monitor at New Haven had 10 exceedances in eastern Michigan

Figure 6.5 shows the 4th highest 8-hour O_3 values for Southeast Michigan monitoring sites from 2013-2018. Detroit-E. 7 Mile, New Haven, Oak Park, and Port Huron site violated the 3-year standard.

Figure 6.6 shows the 4th highest 8-hour O_3 values for Grand Rapids-Muskegon-Holland CSA. Muskegon and Holland violated the 3-year standard.

Figure 6.7 shows 4th highest 8-hour O_3 values for mid-Michigan. Cassopolis, Coloma, and Kalamazoo violated the 3-year standard.

Figure 6.8 shows 4th highest 8-hour O_3 values for Northern Lower and Upper Peninsula. No sites violated the 3-year standard.

Figure 6.5: O3 Levels in Detroit-Warren-Flint CSA from 2013-2018 (4th Highest 8-Hour O3 Values).

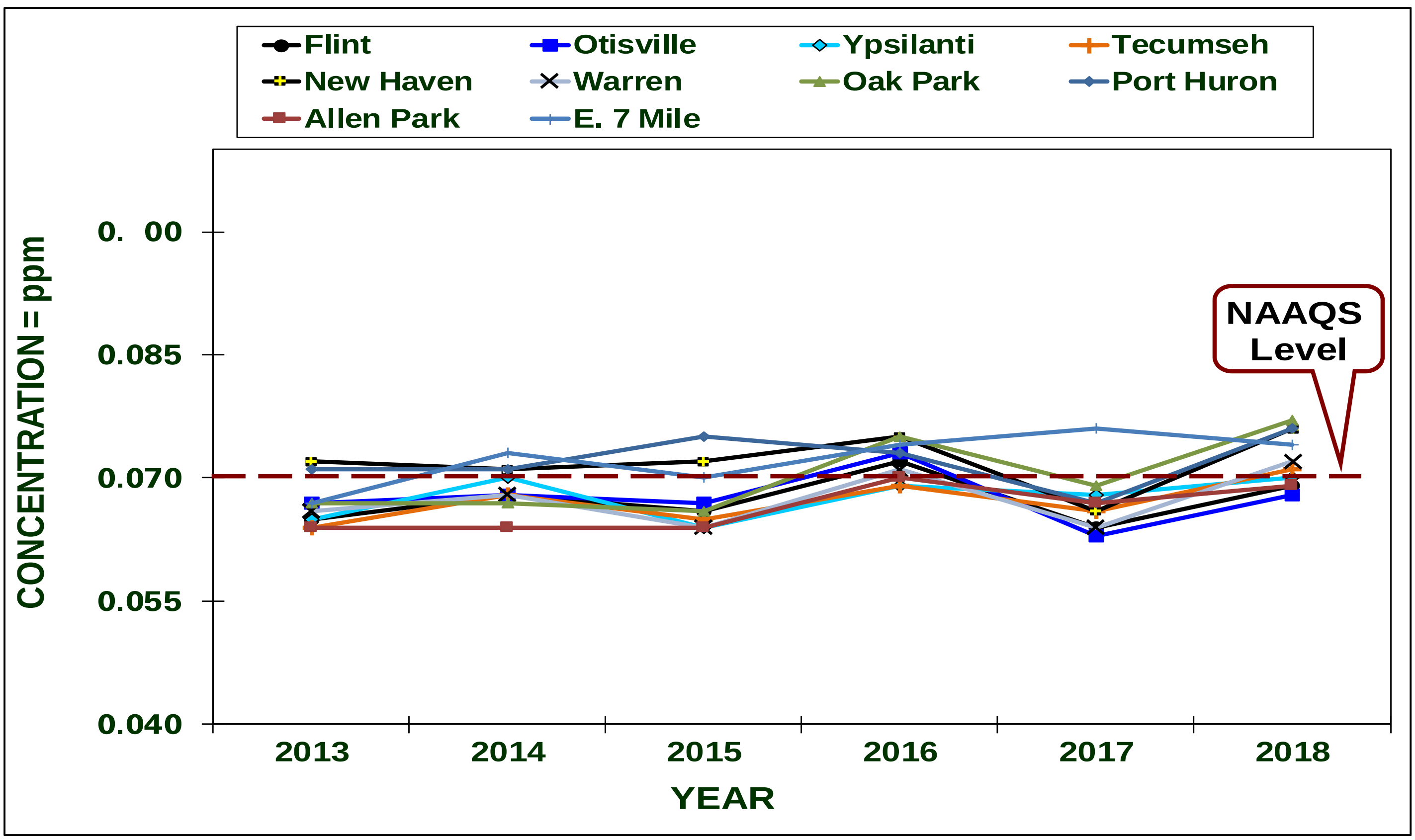


Figure 6.6: O3 Levels in the Grand Rapids-Muskegon-Holland CSA from 2014-2018 (4th Highest 8-Hour O3 Values)

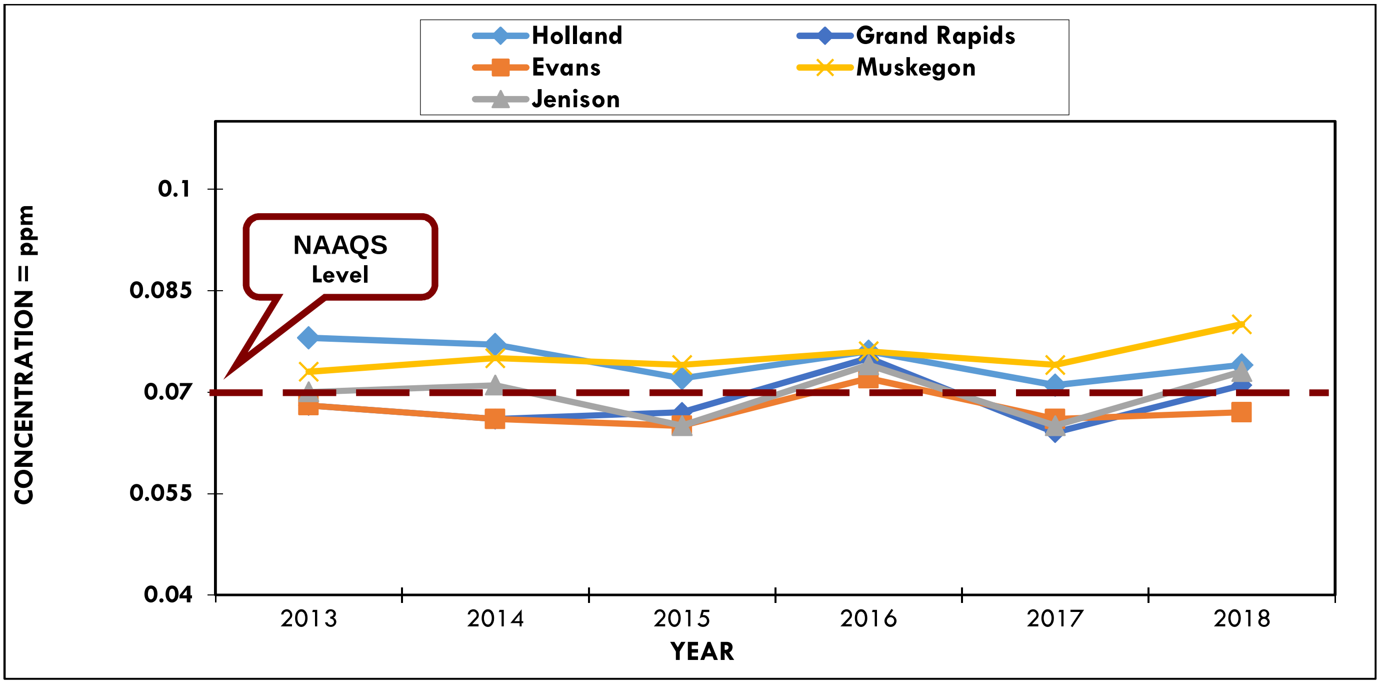
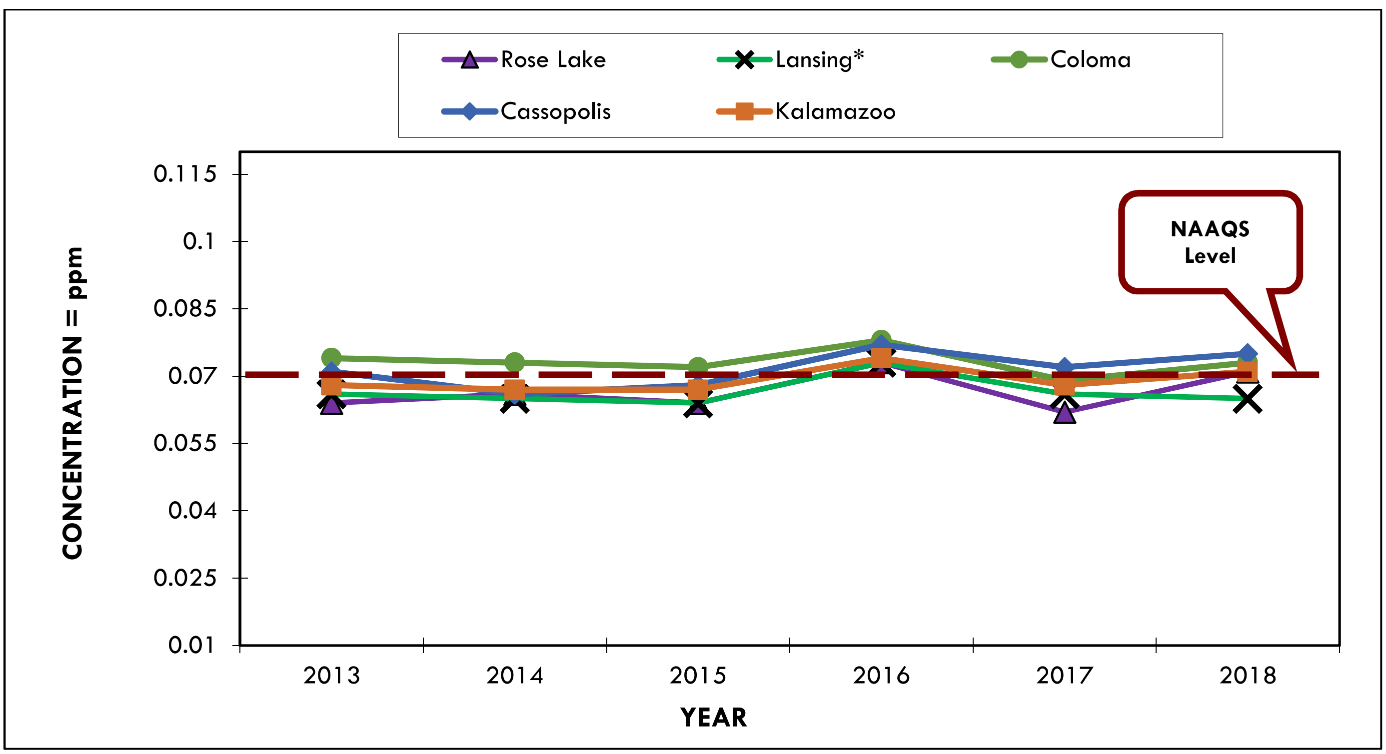
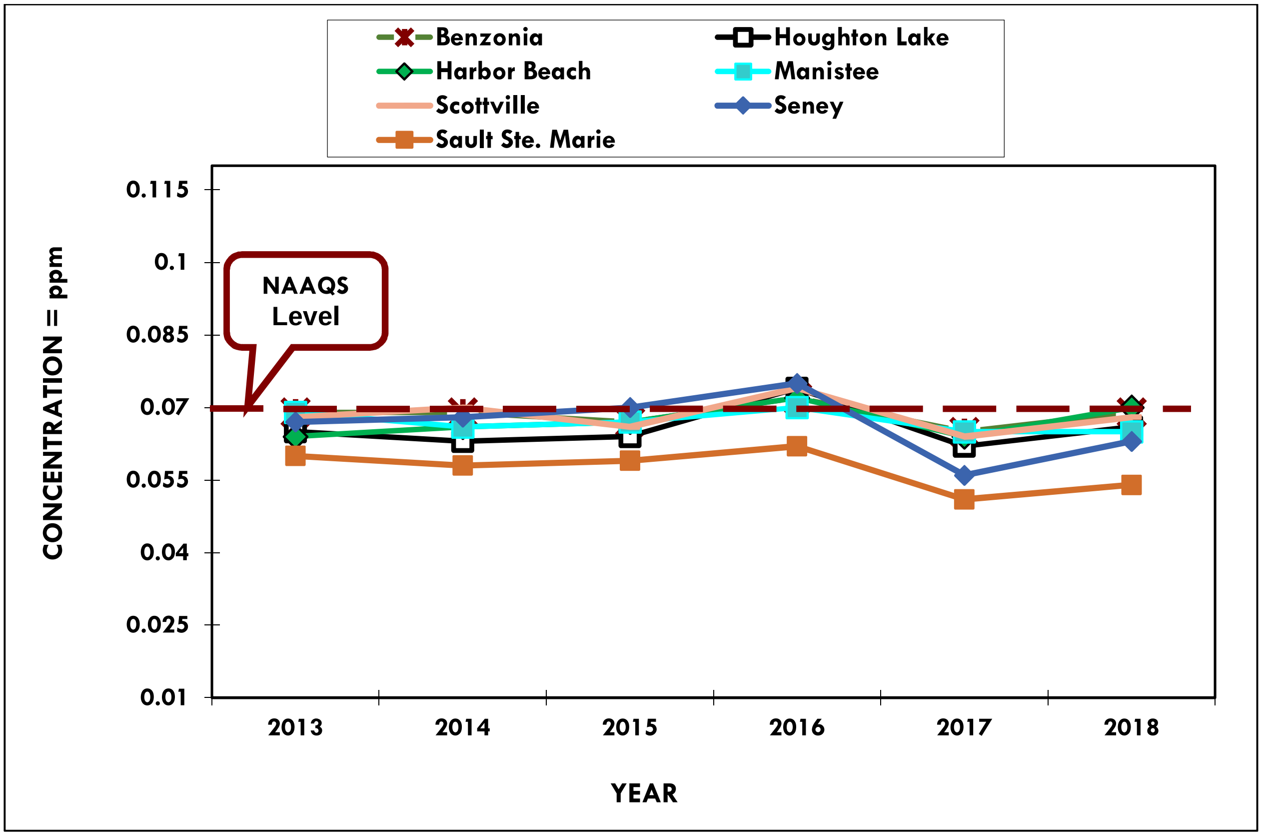


Figure 6.7: O_3 Levels in the Kalamazoo-Portage MSA, Lansing-E. Lansing-Owosso CSA, Niles-Benton Harbor MSA, & South Bend-Mishawaka (IN-MI) MSAs from 2013-2018 (4th Highest 8-Hour O_3 Values)



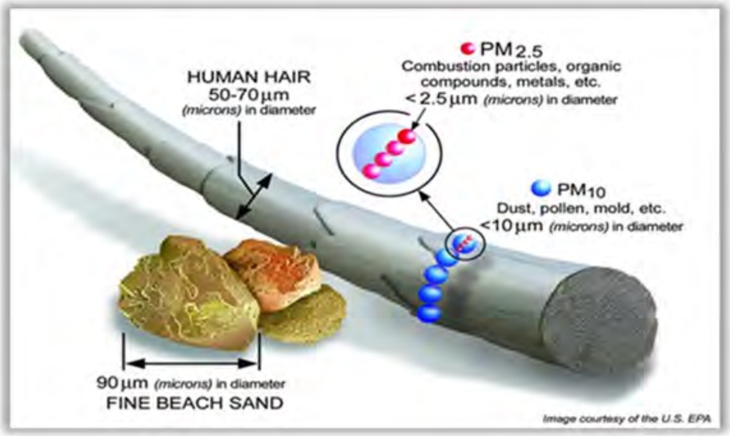
*Indicates site was moved during the year and concentrations were averaged together for both locations.

Figure 6.8: O_3 Levels in MI's Northern Lower and Upper Peninsula Areas from 2013-2018 (4th Highest 8-Hour O_3 Values)



CHAPTER 7: PARTICULATE MATTER (PM10, PM10-2.5, PM2.5, PM2.5 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.

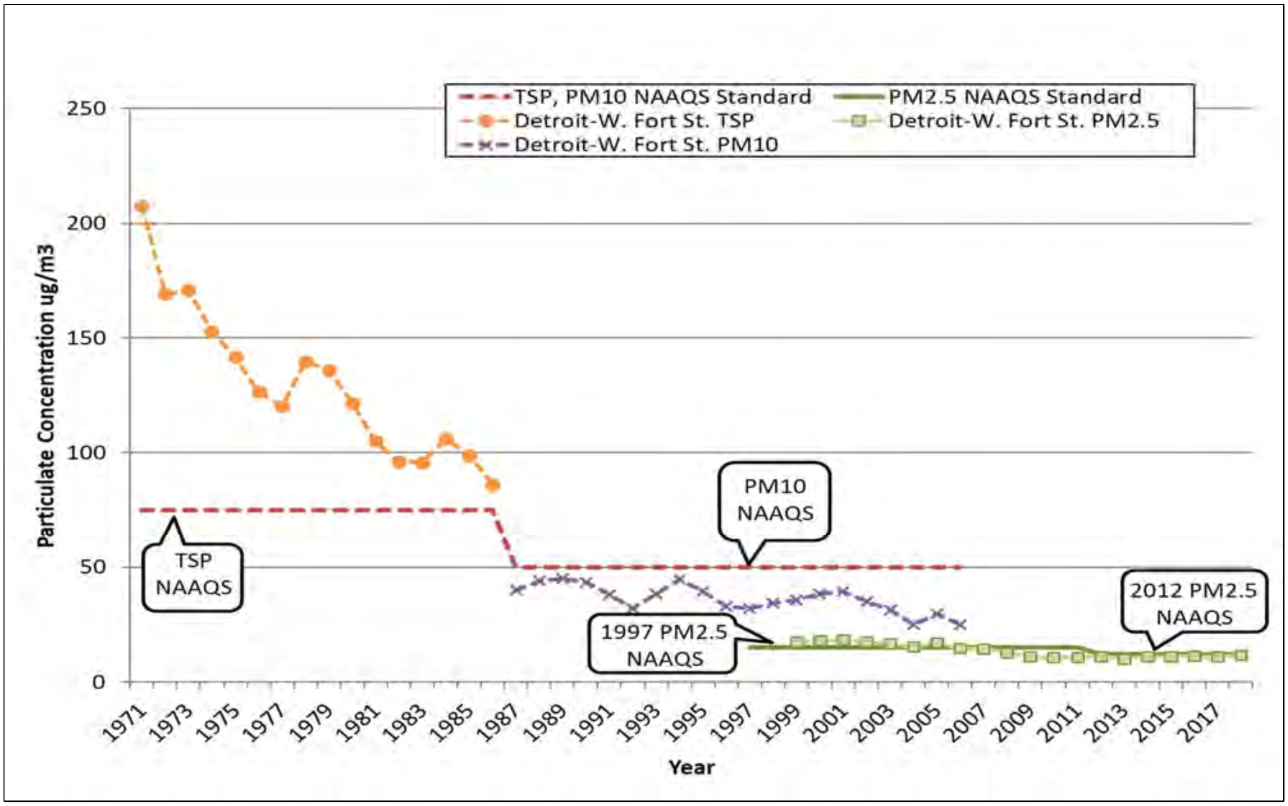
Effects: Exposure to PM can aggravate existing cardiovascular ailments and even cause death in susceptible populations. PM may affect breathing and the cellular defenses of the lungs and has been linked with heart and lung disease. Smaller particles (PM_{10} or smaller) pose the greatest problems, because 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.

Historical Trends: Southeast Michigan has been monitoring for particulate for over 40 years. **Figure 7.1** 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 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 7.1: Historical Annual Particulate Matter at W. Fort St. (SWHS)



PM_{10}

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

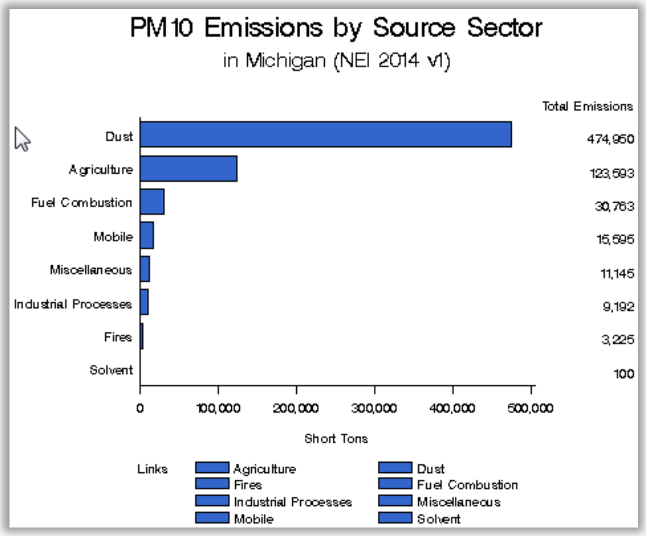
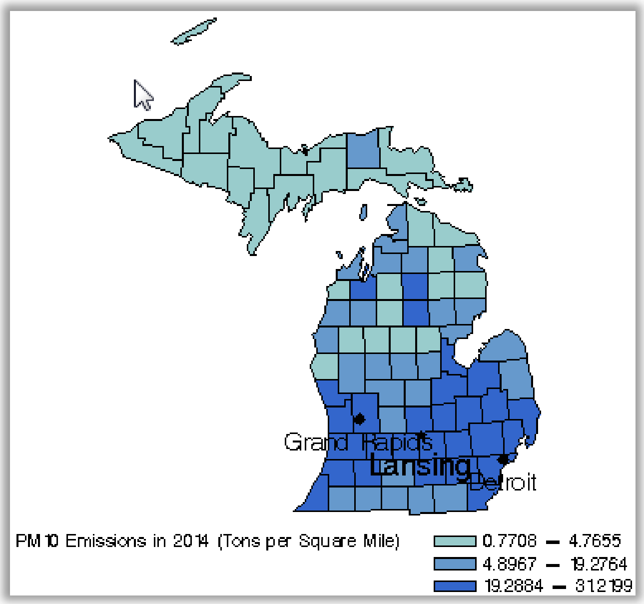


Figure 7.3: PM_{10} Emissions in 2014

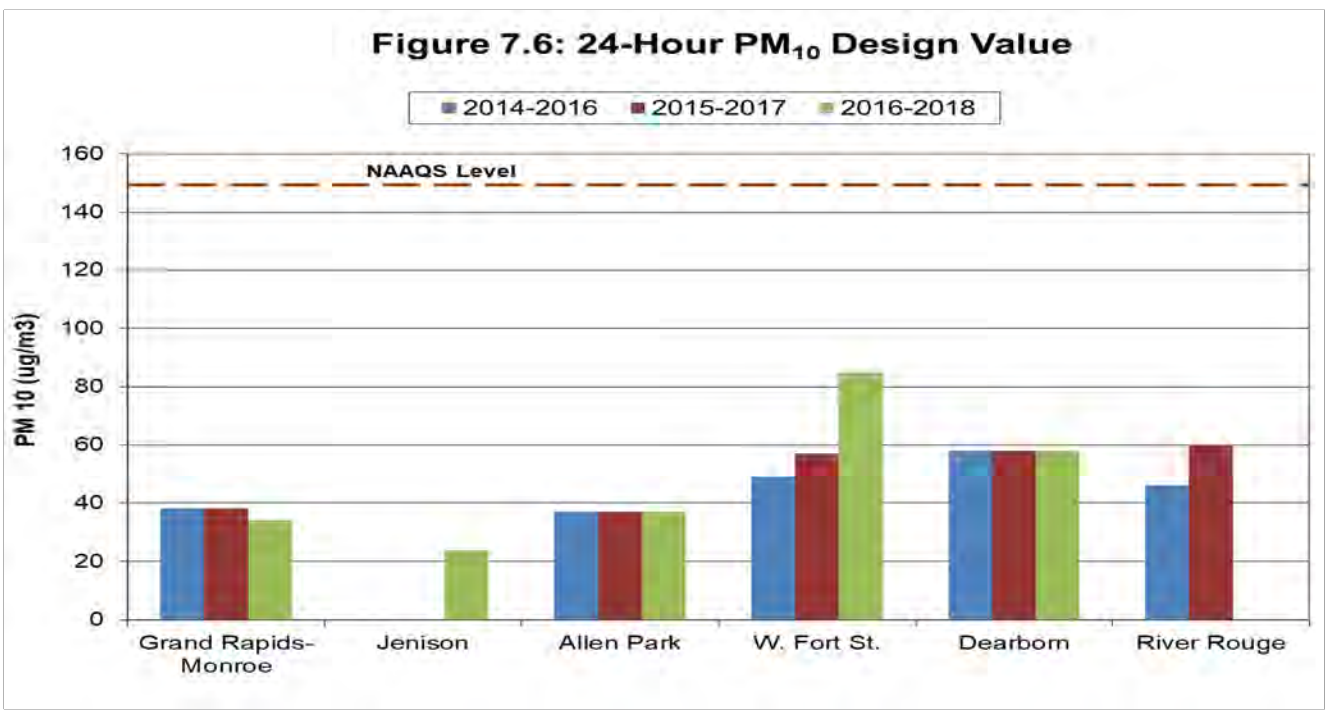


Since October 1996, all areas in Michigan have been in attainment with the PM_{10} NAAQS. Due to the recent focus upon $PM_{2.5}$ and because of the relatively low concentrations of PM_{10} measured in recent years, Michigan's PM_{10} network has been reduced to a minimum level. Table 1-3 identifies 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: three in the Detroit area and two 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 7.4 shows the location of each PM_{10} monitor. All PM_{10} monitors are population-oriented monitors. A second PM_{10} monitor was added to the Grand Rapids area in Jenison (**Figure 7.5**) based on the USEPA's population requirements. The River Rouge PM_{10} monitor was shut down in the Detroit area to reduce cost and work load and since it is not required by the USEPA.

Figure 7.4: PM_{10} Monitors in 2018

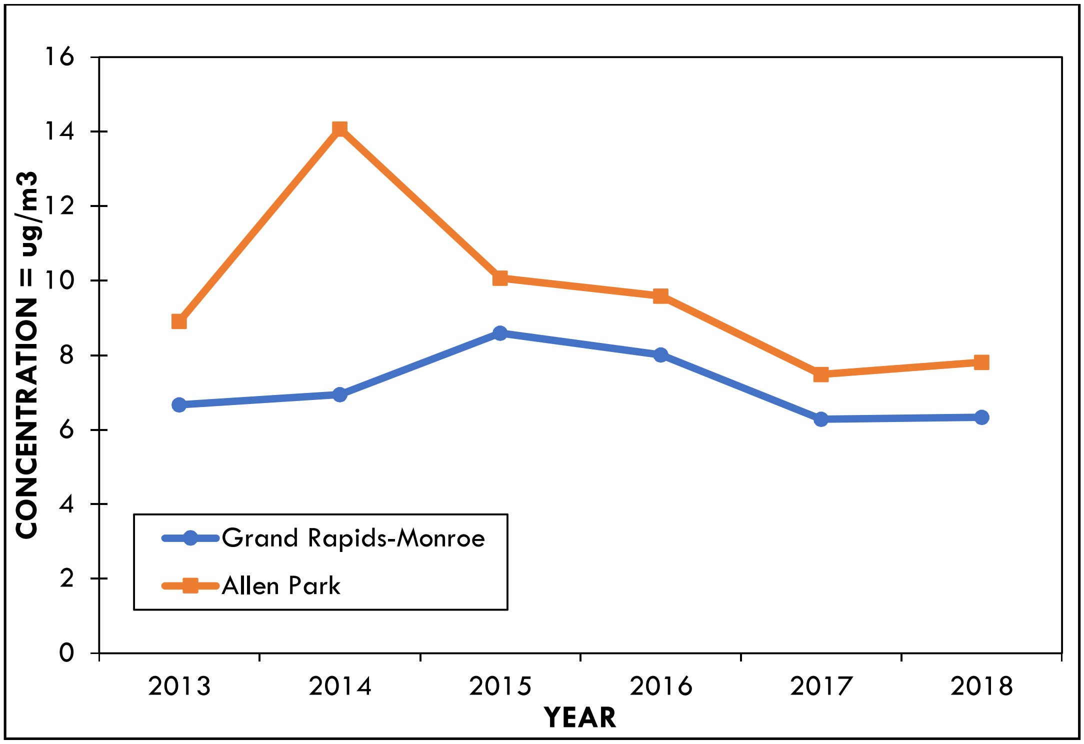
Figure 7.6 shows the PM_{10} levels in Michigan compared to the 24-hour average NAAQS of 150 µg/m³. This standard must not be exceeded on average more than once per year over a 3-year period. The design value is the 4th highest value over a 3-year period. The PM_{10} levels at all sites in Michigan are well below the national standard.



$PM_{10\text{-}2.5}$

The 2006 amended air monitoring regulations specified that measurements of PM course ($PM_{10\text{-}2.5}$) needed to be added to the NCore sites.[5] EGLE began PM course monitoring at Allen Park and Grand Rapids-Monroe Street in 2010. **Figure 7.7** shows the $PM_{10\text{-}2.5}$ levels in Michigan.

Figure 7.7: PM Coarse Levels in Michigan from 2013-2018 (Annual Arithmetic Mean)



$PM_{2.5}$

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.

[5] Current information can be found at https://www3.epa.gov/ttn/amtic/ncoreguidance.html.

Figures 7.8 and **7.9** show $PM_{2.5}$ emission sources and $PM_{2.5}$ emissions by county (from the USEPA's State and County Emission Summaries).

Figure 7.8: $PM_{2.5}$ Emissions by Source Sector

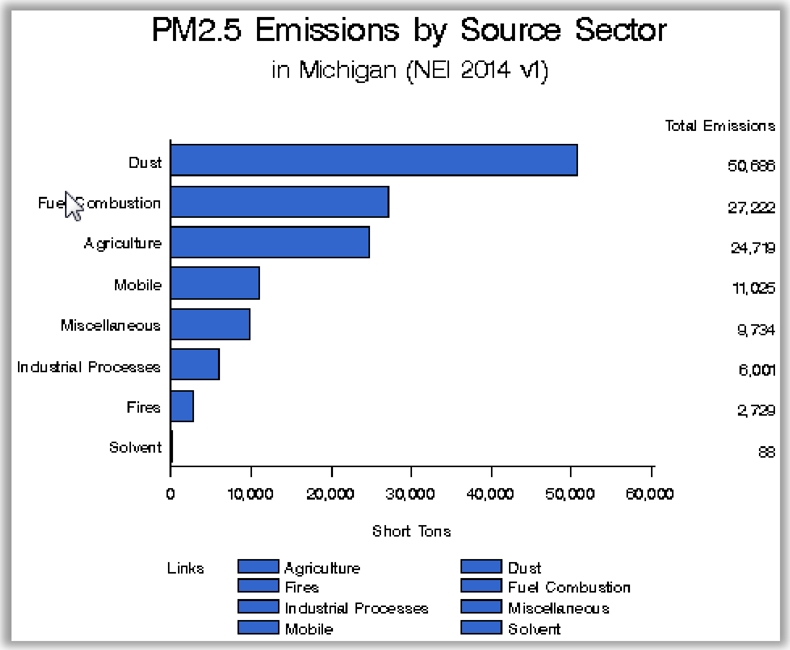
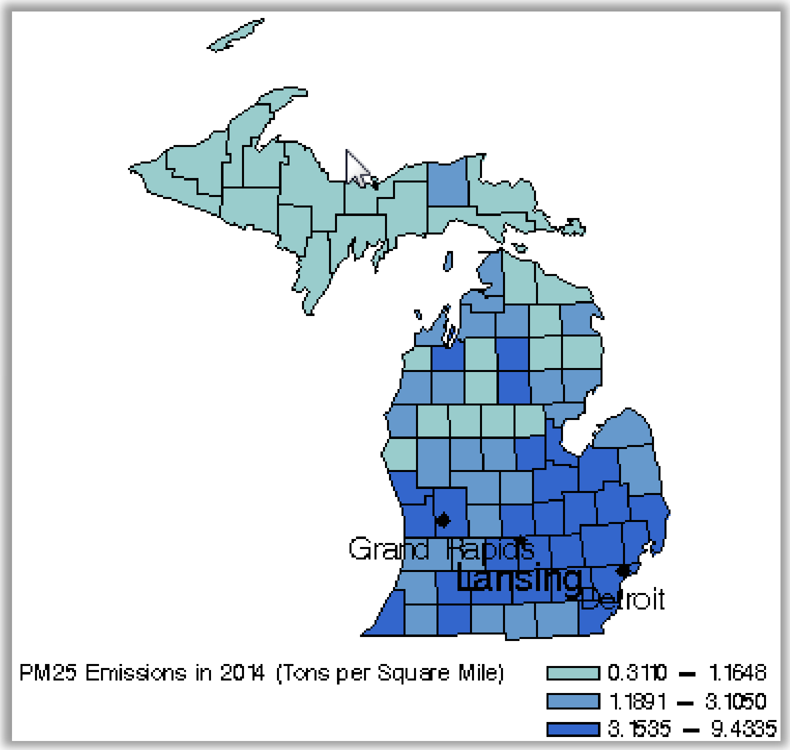


Figure 7.9: $PM_{2.5}$ Emissions in 2014



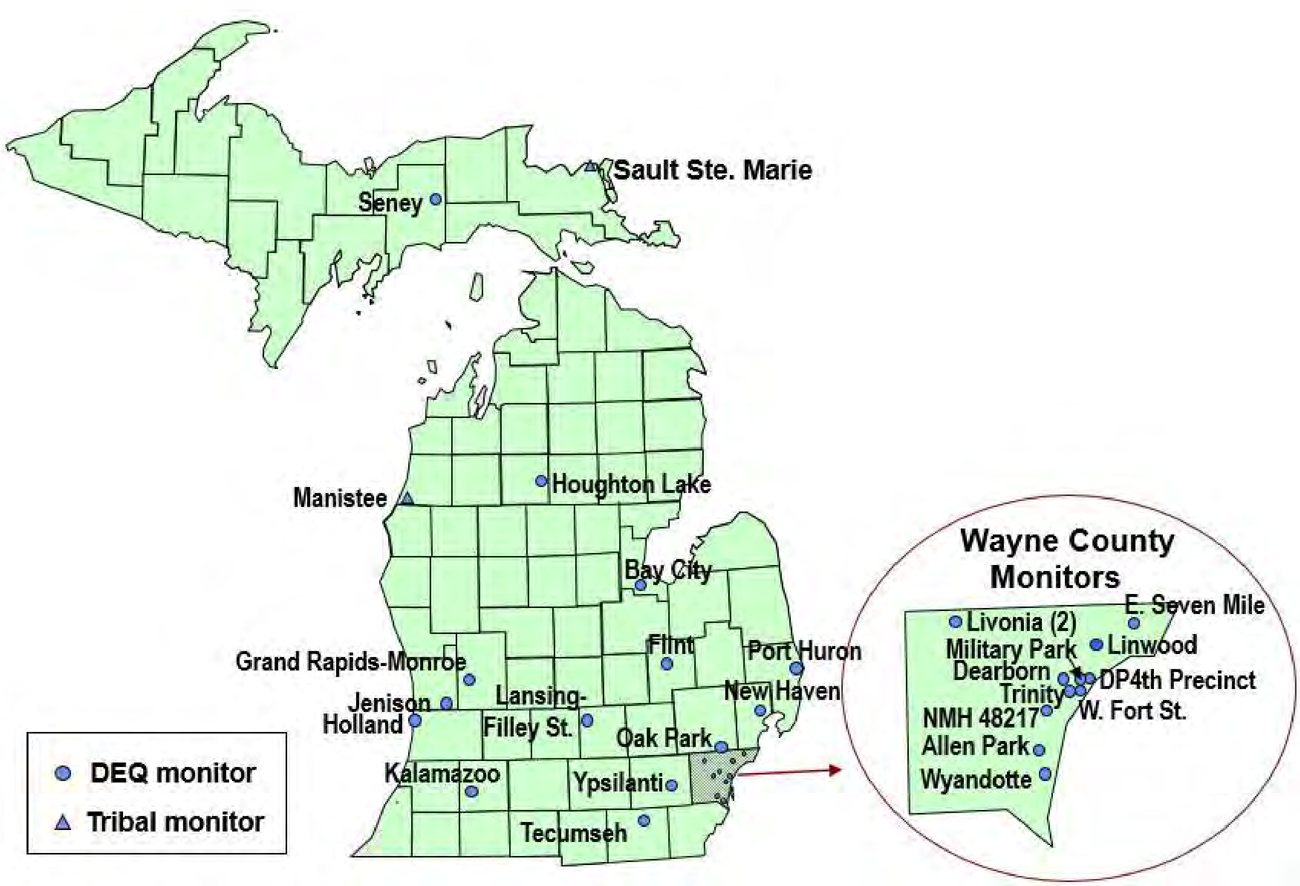
Fine particulate matter ($PM_{2.5}$) is measured using three techniques: a filter-based Federal Reference Method (FRM), Continuous Methods, and Chemical Speciation Methods. These methods are described in more detail in Appendix A.

Figure 7.10 shows the location of each $PM_{2.5}$ monitor.

$PM_{2.5}$ FRM Monitoring Network: $PM_{2.5}$ FRM filter-based monitors are deployed to characterize background or regional $PM_{2.5}$ transport collectively from upwind sources as well as population-oriented sites. Several changes occurred in the FRM network in 2018.

- Loss of site access shut down: Grand Rapids-Wealthy (moved to Jenison), Detroit-W. Lafayette on May 23, 2018 (property sold), Lansing in April 2018 (moved to Filley Street, due to construction).
- Low concentration monitors shut down: Coloma and Sterling State Park to reduce costs and workload.
- Collocations site added: Five $PM_{2.5}$ FRM monitoring sites are co-located with PM_{10} monitors to allow for $PM_{2.5}$ and PM_{10} comparisons.[6] Co-located PM_{10} and $PM_{2.5}$ sites include Grand Rapids-Monroe, Dearborn, Allen Park, Detroit's W. Fort Street (SWHS), and newly added site, Jenison.

Figure 7.10: $PM_{2.5}$ Monitors in 2018



[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].

Continuous $PM_{2.5}$ Network: Short-term measurements of $PM_{2.5}$ or PM_{10} are updated on an hourly basis using TEOM or BAM instruments. At least one continuous monitor 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 22 FRM monitoring sites, 12 of which also had TEOMs or BAMs.

- A continuous $PM_{2.5}$ monitor (BAM) operates at Sault Ste. Marie tribal monitor site for NAAQS comparison. Having a BAM as an FEM triggered a federal requirement to have an FEM and FRM co-located. EGLE replaced the TEOM with a BAM at the Flint site co-located with the FRM in October of 2018 to fulfill this requirement.
- BAMs replaced TEOMS: Detroit-W. Fort St.(co-located), Seney, Tecumseh, and Houghton Lake in fall 2018. Tecumseh and Houghton Lake stopped running the FRMs on January 1, 2019 and the BAMs will be used for NAAQS comparison. Seney was formerly running a TEOM and by changing it to a BAM, it will be used for NAAQS comparison in the Upper Peninsula of Michigan starting January 1, 2019.
- Gordie Howe Bridge project: DP4th Precinct, Trinity, and Military Park, also, the $PM_{2.5}$ BAM monitor was added to Detroit-W. Fort St. as a special project for the Gordie Howe Bridge construction.

Speciation Monitors: Speciation monitors consist of filter-based, 24-hour monitors and two types of continuous speciation monitors, aethalometers and EC/OC monitors. The continuous monitors are used determine diurnal changes in $PM_{2.5}$ composition

- 24-hour speciation monitors: Allen Park and Grand Rapids (NCore sites), Dearborn (NATTS site), Detroit-W. Fort St. and Tecumseh. These monitor 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 $PM_{2.5}$. 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.
- Aethalometers: Allen Park, Dearborn and Gordie Howe Bridge project (DP4th Precinct, Trinity, Military Park, and Detroit-W. Fort St. started in 2018). These continuous monitors measure carbon black, a combustion by-product typical of transportation sources.
- EC/OC instruments were located at Dearborn and Tecumseh. The EC/OC instrument began to malfunction at Dearborn in September 2017 and was later shut down. The EC/OC at Tecumseh was run until the end of 2018 then shut down as well. These antiquated instruments were too costly to fix and not required to for regulatory purposes.

Table 1.2 in Chapter 1 shows all of Michigan's $PM_{2.5}$ FRM monitoring stations operating in 2018 and denotes which sites have TEOM, BAM, Speciation, Aethalometer or EC/OC monitors in operation.

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

[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

Table 7.1 provides the design value, the 3-year average of the annual mean $PM_{2.5}$ concentrations for 2016-2018. Michigan's levels are below the 12 µg/m³ primary standard.[9] 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, which samples daily.

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

Areas	County	Monitoring Sites	2016	2017	2018	2016-2018 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	7.46	7.34	7.96	7.6
	Livingston					
	Macomb	New Haven	7.51	7.41	7.82	7.6
	Oakland	Oak Park	7.87	8.11	8.27	8.1
	St. Clair	Port Huron	7.77	8.01	8.09	8.0
	Washtenaw	Ypsilanti #1	7.84	7.93	8.35	8.0
		Ypsilanti #2	8.06	8.32	8.81	8.4
	Wayne	Allen Park	8.72	8.47	9.14	8.8
		Detroit-Linwood	8.94	8.99	8.86	8.9
		Detroit-E. 7 Mile	8.11	7.88	8.40	8.1
		Detroit-W. Fort St.	11.32	11.01	11.89	11.4
		Detroit-W. Lafayette	8.38	7.93*	8.87*	8.4
		Wyandotte	7.70	7.18	8.02	7.6
		Dearborn #1	10.67	10.57	10.80	10.7
		Dearborn #2	10.52	10.82	11.06	10.8
		Livonia	8.16	7.98	7.45*	7.9
		Livonia-Roadway	8.53	8.46	9.10	8.7
Flint	Genesee	Flint	7.18	7.10	7.33	7.2
	Lapeer					
Grand Rapids	Ottawa	Jenison			8.32*	8.3
	Kent	Grand Rapids-Wealthy	8.79	9.15		9.0
		Grand Rapids #1	8.16	8.12	8.45	8.2
		Grand Rapids #2	8.48	8.31	8.93	8.6
Allegan Co	Allegan	Holland	6.99	7.49	7.61	7.4
Monroe Co	Monroe	Luna Pier				
		Sterling State Park	7.75	7.71		7.7
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	8.09	8.03	8.47	8.2
		Kalamazoo #2	8.25	8.36	8.68	8.4
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	7.31	7.23	7.73**	7.4
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	7.35	7.99		7.7
Bay Co	Bay	Bay City	6.84	6.75	7.15	6.9
Missaukee Co	Missaukee	Houghton Lake	4.87	4.81	5.42	5.0
Manistee Co	Manistee	Manistee	5.50	5.84	6.13	5.8
Chippewa Co	Chippewa	Sault Ste. Marie #1	5.04*	6.10*		5.6
		Sault Ste. Marie #2	5.03*	5.88*		5.5

*Indicates site was moved during the year and concentrations were averaged together for both locations.
**Indicates the site does not have a compete year of data.

[9] For comparison to the standard, the average annual means is rounded to the nearest 0.1 µg/m³.

Table 7.2 provides the 24-hour 98th percentile $PM_{2.5}$ concentrations for 2016-2018 showing Michigan's levels are below the 35 µg/m³ standard (3-year average) .[10]

Table 7.2: 24-Hour 98th Percentile $PM_{2.5}$ Values Averaged over 3 Years						
Areas	County	Monitoring Sites	2016	2017	2018	2016-2018 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	15.1	17.5	23.4	19
	Livingston					
	Macomb	New Haven	20.1	17.0	18.9	19
	Oakland	Oak Park	19.8	20.1	20.1	20
	St. Clair	Port Huron	19.1	19.2	19.6	19
	Washtenaw	Ypsilanti #1	17.6	18.8	21.3	19
		Ypsilanti #2	17.4	19.0	19.1	19
	Wayne	Allen Park	20.3	21.8	22.8	22
		Detroit-Linwood	22.5	25.0	18.6	22
		Detroit-E. 7 Mile	19.5	16.6	21.5	19
		Detroit-W. Fort St.	25.6	30.0	28.1	28
		Detroit-W. Lafayette	20.5	19.5	26.9	22
		Wyandotte	18.8	19.3	20.4	20
		Dearborn #1	25.8	24.5	26.1	25
		Dearborn #2	24.7	23.5	26.6	25
		Livonia	19.9	19.1	18.1	19
		Livonia-Roadway	21.4	19.0	29.0	23
Flint	Genesee	Flint	18.8	16.8	16.9	18
	Lapeer					
Grand Rapids	Ottawa	Jenison			22.3	22
	Kent	Grand Rapids-Wealthy	22.7	26.2		24
		Grand Rapids #1	19.5	22.6	18.9	20
		Grand Rapids #2	19.5	22.8	26.5	23
Allegan Co	Allegan	Holland	17.2	24.6	21.2	21
Monroe Co	Monroe	Luna Pier				
		Sterling State Park	18.3	20.5		19
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	20.1	22.6	19.1	21
		Kalamazoo #2	20.2	22.5	19.1	21
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	18.0	17.1	19.5*	18
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	17.2	26.2		19
Bay Co	Bay	Bay City	19.6	22.4	17.8	21
Missaukee Co	Missaukee	Houghton Lake	12.4	14.9	16.2	15
Manistee Co	Manistee	Manistee	12.6	19.2	16.9	16
Chippewa Co	Chippewa	Sault Ste. Marie #1	11.3	25.3		18
		Sault Ste. Marie #2	10.8	16.4		13

*Indicates site was moved during the year and concentrations were averaged together for both location

[10] 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.

Figures 7.11 through **7.14** 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 broken down into two graphs.

Figure 7.11 shows the 2018 levels in Wayne County remained below the $PM_{2.5}$ NAAQS standard. Historically, Dearborn has had the highest concentrations in the state, but W. Fort St. now has the highest concentrations.

Figure 7.12 contains the remainder of those sites in the Detroit-Warren-Flint CSA that are outside of Wayne County. These sites also show readings in 2018 to be below the $PM_{2.5}$ NAAQS.

Figure 7.13 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 7.14 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.

Figure 7.11: Detroit-Warren-Flint CSA (Wayne County Only)
Annual Arithmetic Means for $PM_{2.5}$ from 2013-2018

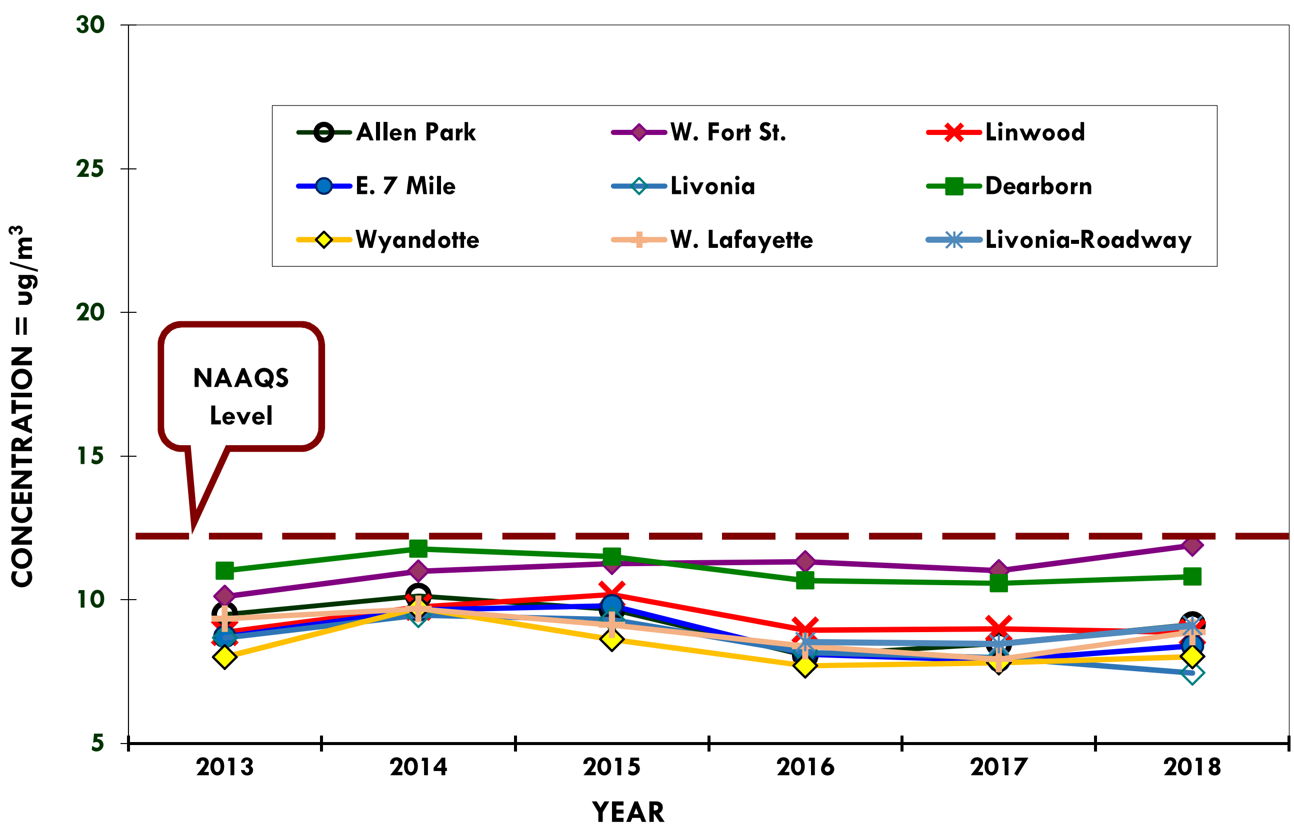


Figure 7.12: Detroit-Warren-Flint CSA (without Wayne County) Annual Arithmetic Means for $PM_{2.5}$ from 2013-2018

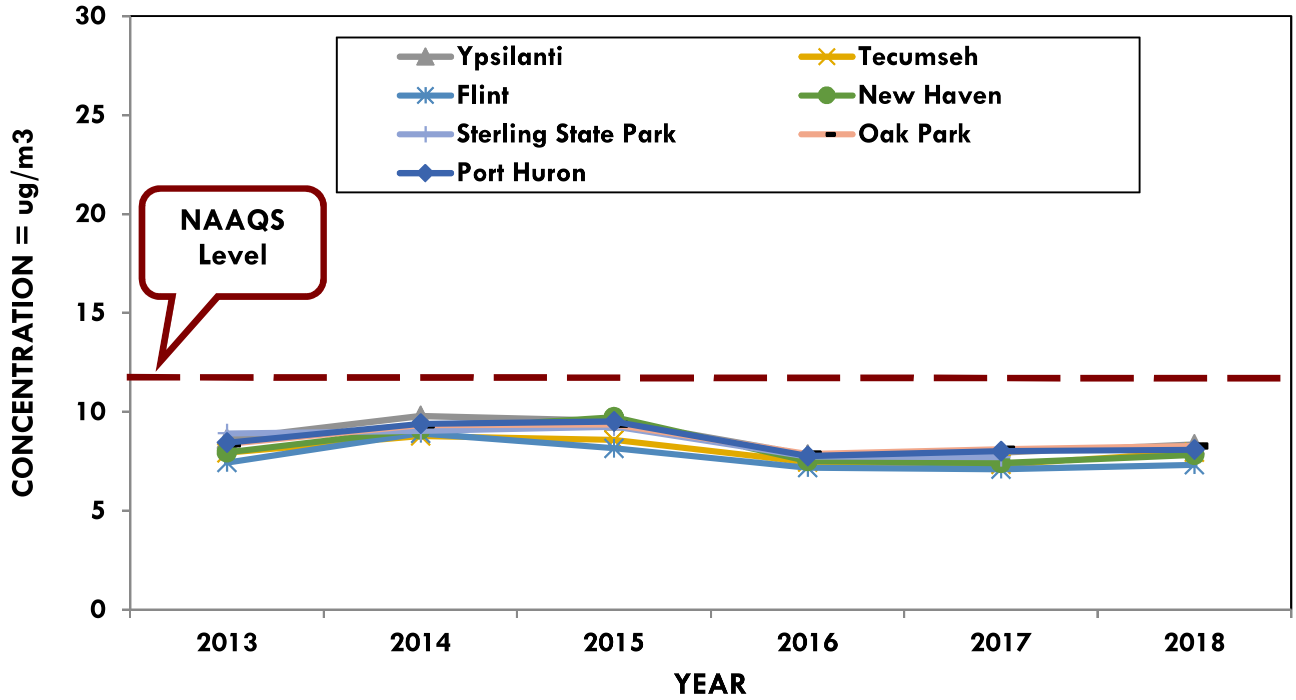


Figure 7.13: West MI - Grand Rapids-Muskegon-Holland CSA, Kalamazoo and Benton Harbor MSAs Annual Arithmetic Means for $PM_{2.5}$ from 2013-2018

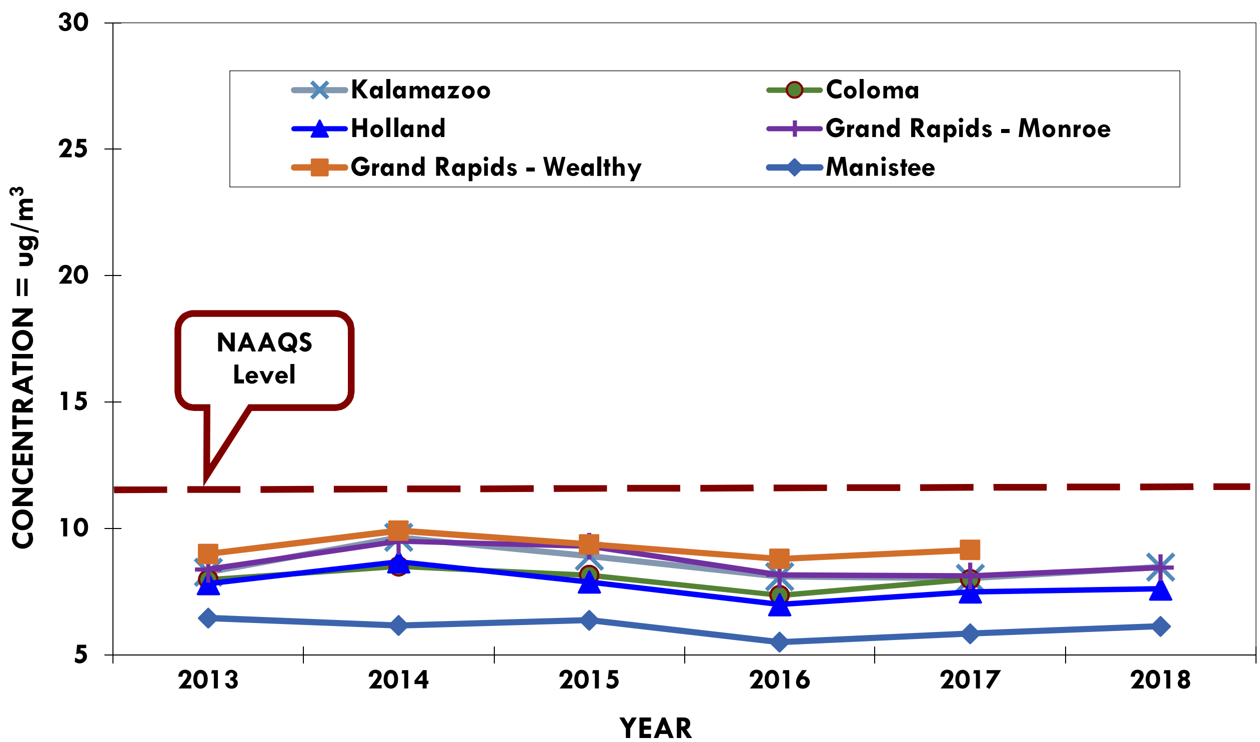
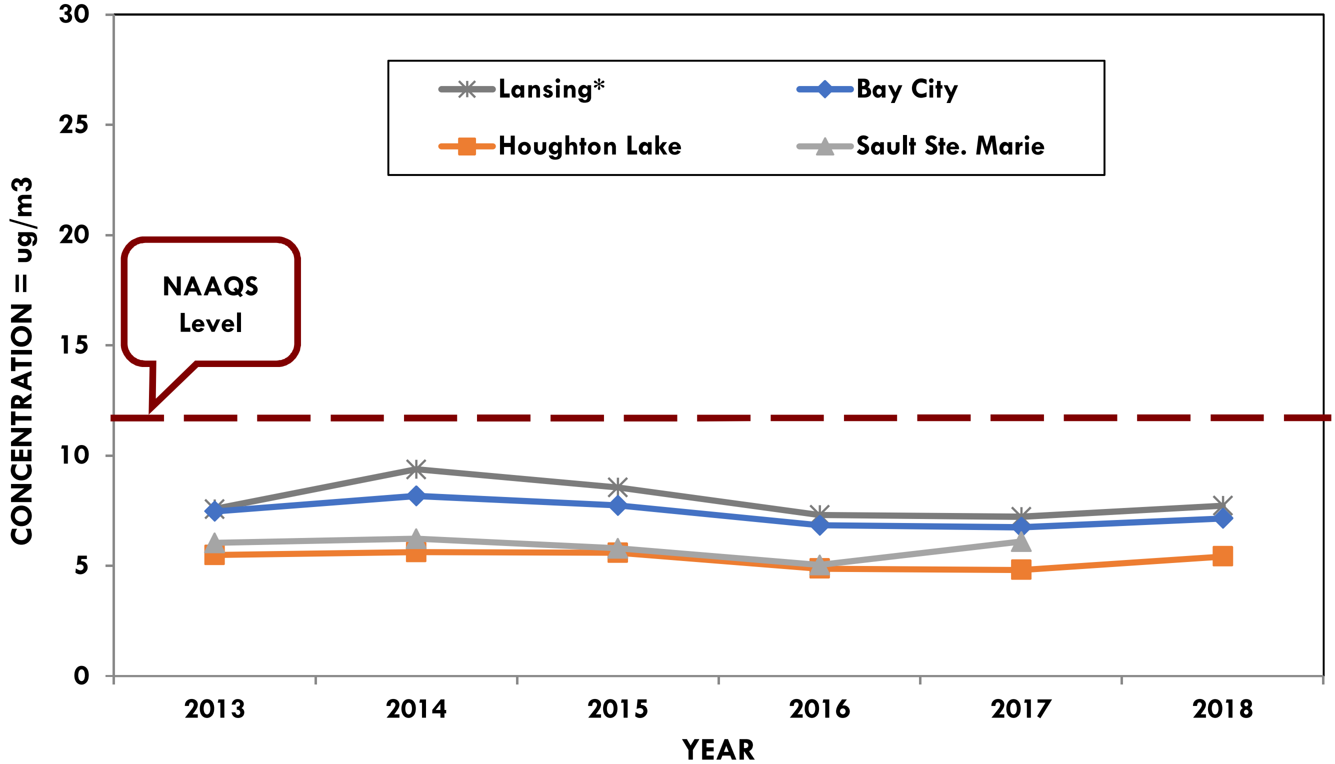


Figure 7.14: Lansing-E. Lansing CSA, Saginaw-Bay City CSA, Cadillac MiSA and Upper Peninsula Annual Arithmetic Means for $PM_{2.5}$ from 2013-2018



*Indicates site was moved during the year and concentrations were averaged together for both locations.

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 42 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 generally at the highest risk for health effects 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), perchloroethylene (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).[11]

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-based 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 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 2018. This table can also be found in **Appendix B** with the Air Toxics Monitoring Summary.

The NMH 48217 had VOCs and PAHs shut down after the one-year study was completed. More information can be found in Chapter 11. The PM_{10} metals sampling for Mn was also shut down at River Rouge to reduce cost and work load. TSP Metals were added to the three new Gordie Howe Bridge sites, DP4th Precinct, Military Park, and Trinity.

Table 8.1: 2018 Toxics Sampling Sites

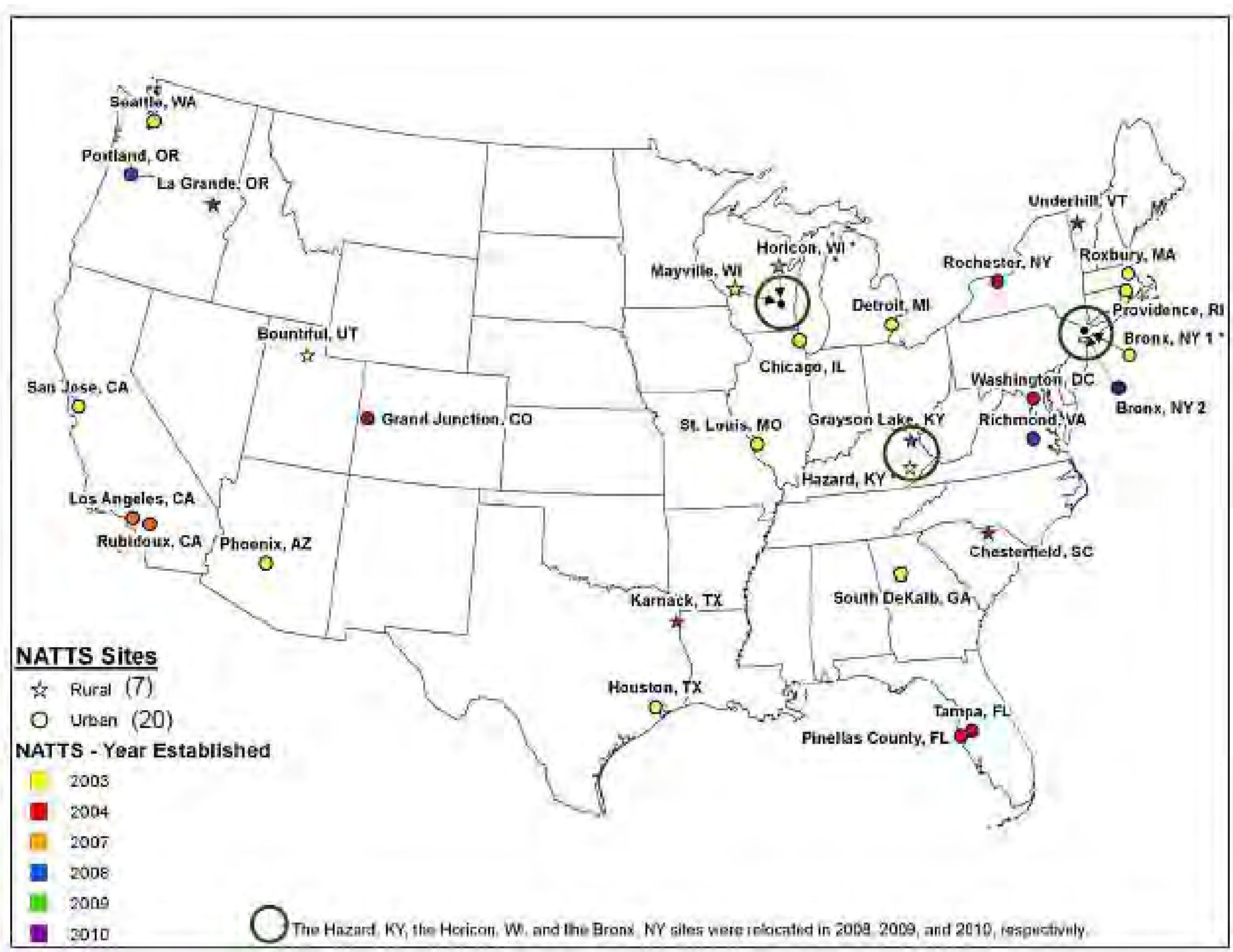
Site Name	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Speciated $PM_{2.5}$
Allen Park				x	x	x
Dearborn	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn	x
Detroit-W. Jefferson				x		
Grand Rapids-Monroe				x		x
Belding-Merrick St.				x		
Belding-Reed St.				x		
NMH 48217				x		
Port Huron-Rural St.				x		
River Rouge		x		x		
Tecumseh						x
DP 4th Precinct				x		
Military Park				x		
Trinity				x		

[11] USEPA's Air Toxics website: Urban Strategy is located at https://www.epa.gov/urban-air-toxics.

National Monitoring Efforts and Data Analysis

The USEPA administers national programs that identify air toxics levels, detect trends, and prioritize air toxics research. EGLE 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. 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: METEOROLOGICAL INFORMATION

Figures 9.1 through **9.3** show average daily temperatures, and **Figures 9.4** through **9.6** show 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 2018.

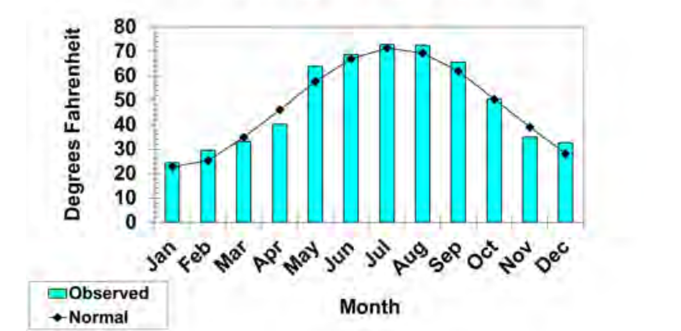


Figure 9.1: Southern Lower Peninsula Observed Average Monthly Temperatures vs. Normal Average Monthly Temperatures

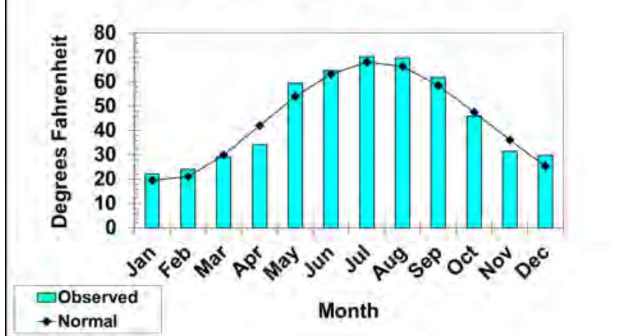


Figure 9.2: Northern Lower Peninsula Observed Average Monthly Temperatures vs. Normal Average Monthly Temperatures

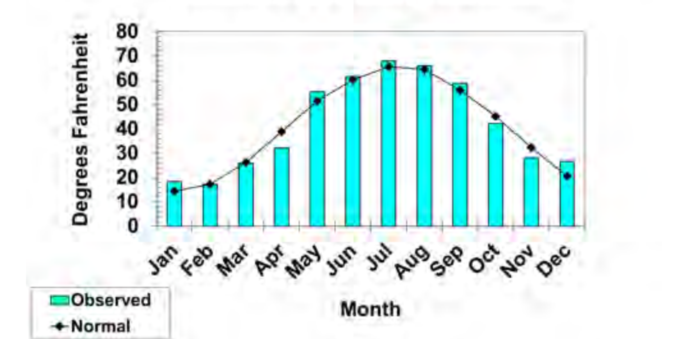


Figure 9.3: Upper Peninsula Observed Average Monthly Temperatures vs. Normal Average Monthly Temperatures

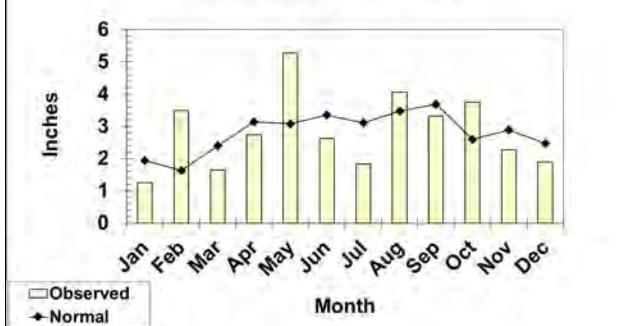


Figure 9.4: Southern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

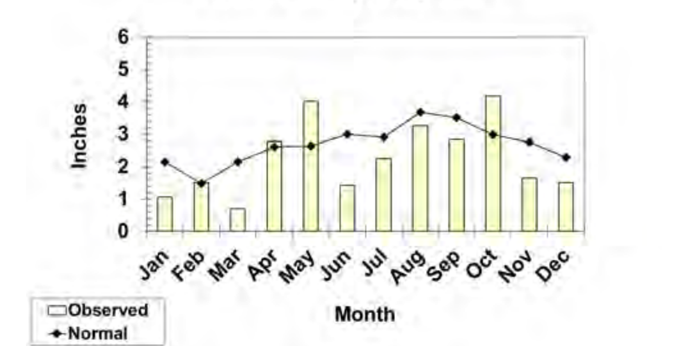


Figure 9.5: Northern Lower Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

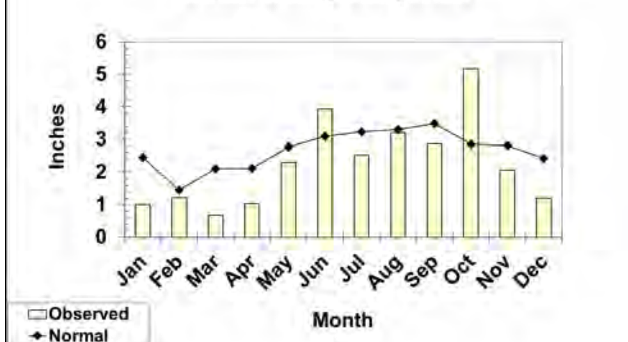


Figure 9.6: Upper Peninsula Observed Monthly Precipitation vs. Normal Monthly Precipitation

CHAPTER 10: SPECIAL PROJECTS

EGLE completed the sampling for two special projects and began a new project for the Gordie Howe Bridge. Each of these projects are discussed below.

Near-road Air Toxics Grant: The Community Scale Air Toxics Ambient Monitoring (CSATAM) grant completed data collection in 2018 and the final report is expected in the fall of 2019. This final report will be posted to EGLE's Web site when it is completed.

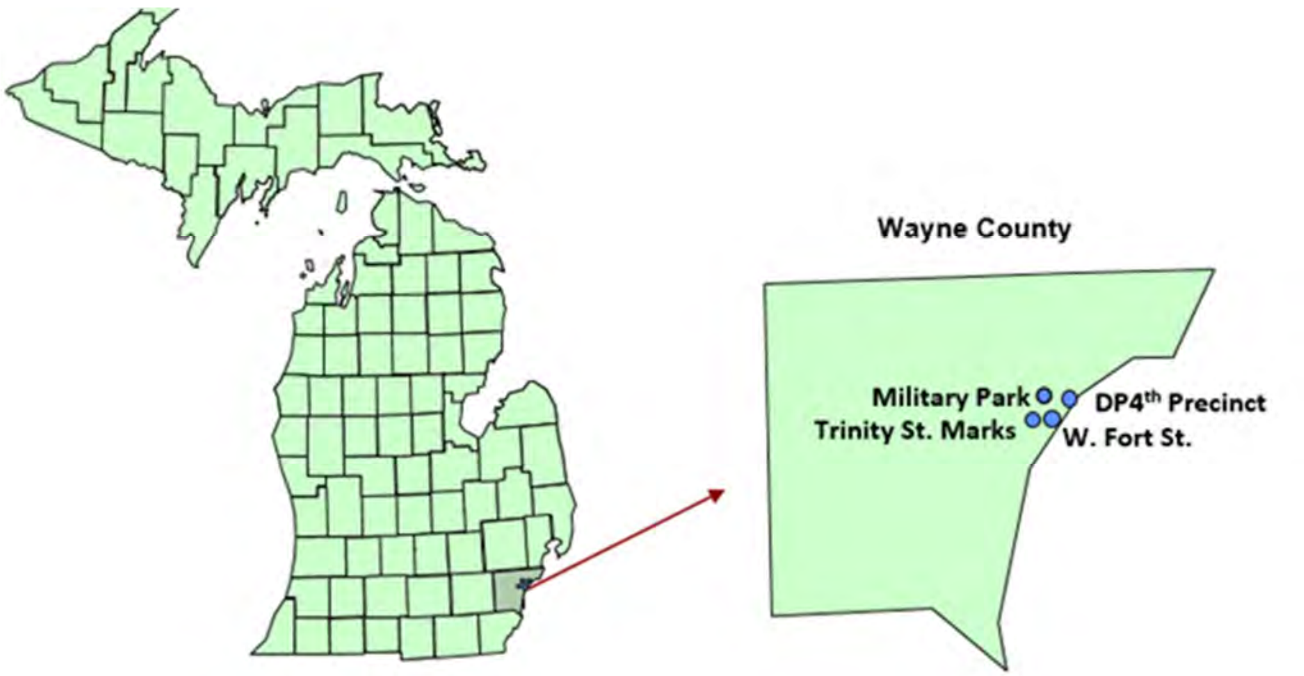
Community Monitoring Project: The second special purpose monitoring project resulted from a request from community members in the Detroit 48217 ZIP code for an air monitoring station in their neighborhood. The 48217 community has many industrial sources located in and around it. In a collaborative effort, EGLE was able to establish an air monitoring station in the community for a 1-year study. The monitor site, known as "NMH 48217," is located at New Mount Hermon Baptist Church at 3225 South Deacon Street in Detroit. The site monitored for SO_2, continuous $PM_{2.5}$, VOCs, PAHs, TSP metals, hydrochloric acid, sulfuric acid, and hydrogen cyanide. Sampling was conducted in September 2016 through September 2017. The data was analyzed at the end of the 1-year study and a final report was developed, which is available on www.michigan.gov/48217monitoring. The study found that all sampled compounds were below the levels of concern with the exception of arsenic and two samples of sulfuric acid. Arsenic levels are above the health benchmark at all sites statewide that measure metals. At the completion of the study, the following parameters were continued; $PM_{2.5}$, SO_2, and five metals (arsenic, cadmium, manganese, nickel, and lead).

Gordie Howe International Bridge Project: The third special purpose monitoring project is related to a joint Canadian-American venture. The Gordie Howe Bridge will be built linking Windsor, Ontario and Detroit, Michigan. Construction is slated to begin in 2019-2020.

EGLE is conducting ambient air quality monitoring in the Delray community to ascertain air pollution levels in the community. The three new sites, indicated below, will monitor air pollutants before, during, and after construction of the bridge. In addition, NOx, continuous $PM_{2.5}$, and black carbon was added to the Detroit-W. Fort St. (261630015) monitoring site for this project.

- **Trinity (261630098)**: meteorological parameters, NOx, SO_2, CO, continuous $PM_{2.5}$, black carbon, and five trace metals including lead.
- **DP4TH Precinct (261630099)**: NOx, SO_2, CO, continuous $PM_{2.5}$, black carbon, and five trace metals including lead.
- **Military Park (261630100)**: NOx, SO_2, continuous $PM_{2.5}$, black carbon, and five trace metals including lead.

Figure 10.1: Gordie Howe Bridge Sites



Parameters Monitored:

Detroit Police 4th Precinct:	CO, NO_x, SO_2, $PM_{2.5}$, Pb, Mn, As, Cd, Ni, Black Carbon
Military Park:	NO_x, SO_2, $PM_{2.5}$, Pb, Mn, As, Cd, Ni, Black Carbon
Trinity St. Marks:	CO, NO_x, SO_2, $PM_{2.5}$, Pb, Mn, As, Cd, Ni, Black Carbon, MET
W. Fort Street:	NO_x, SO_2, $PM_{2.5}$, $PM_{2.5}$ Speciated, PM_{10}, Pb, Mn, As, Cd, Ni, Black Carbon, MET, VOCs and Carbonyls

APPENDIX A: CRITERIA POLLUTANT SUMMARY FOR 2018

Appendix A utilizes the USEPA's 2018 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, BAM 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 O3) 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.

Criteria Pollutant Summary For 2018

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	2018	8287	1.4	1.4	0	0.9	0.9	0
261630001	1	Allen Park	Wayne	2018	8050	2.3	2.0	0	1.6	1.6	0
261630093	1	Eliza Howell-Roadway	Wayne	2018	8358	3.0	3.0	0	2.9	2.4	0
261630094	1	Eliza Howell-Downwind	Wayne	2018	7766	2.2	2.1	0	1.6	1.5	0
261630095	1	Livonia-Roadway	Wayne	2018	8223	1.6	1.6	0	1.3	1.1	0
261630098	1	DP4th Precinct*	Wayne	2018	3500	2.4	1.8	0	1.2	1.0	0
261630099	1	Trinity*	Wayne	2018	1545	3.7	3.1	0	1.8	1.7	0

*Indicates site does not have a complete year of data.

PB (24-HOUR) MEASURED IN µG/M³

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	2018	60	0.03	0.131	0.107
260670003	1	Belding-Merrick St.	Ionia	2018	59	0.05	0.213	0.171
260810020	1	Grand Rapids-Monroe	Kent	2018	61	0.00	0.008	0.006
261470031	1	Port Huron-Rural St.	St. Clair	2018	61	0.08	0.311	0.221
261630001	1	Allen Park	Wayne	2018	61	0.00	0.011	0.006
261630005	1	River Rouge	Wayne	2018	59	0.01	0.014	0.013
261630015	1	Detroit-W. Fort St.	Wayne	2018	61	0.02	0.107	0.060
261630027	1	Detroit-W. Jefferson	Wayne	2018	60	0.01	0.033	0.030
261630033	1	Dearborn	Wayne	2018	58	0.01	0.030	0.027
261630097	1	NMH 48217	Wayne	2018	61	0.01	0.026	0.017
261630098	1	DP4th Precinct*	Wayne	2018	25	0.01	0.017	0.013
261630099	1	Trinity*	Wayne	2018	12	0.01	0.024	0.016
261630100	1	Military Park*	Wayne	2018	10	0.01	0.069	0.023

*Indicates site does not have a complete year of data.

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	2018	927	44.3	37.3	44.3	5.23*
260650018	1	Lansing	Ingham	2018	5175	35.3	33.6	29.9	6.49*
261130001	1	Houghton Lake	Missaukee	2018	8328	9.9	9.3	7.7	1.37
261630015	1	Detroit-W. Fort St.	Wayne	2018	4596	43.9	40.1	38.5	12.67*
261630019	2	Detroit-E. 7 Mile	Wayne	2018	7895	62.3	62.3	42.9	9.25
261630093	1	Eliza Howell-Roadway	Wayne	2018	8279	51.1	46.1	43.0	15.67
261630094	1	Eliza Howell Downwind	Wayne	2018	7721	53.3	46.1	43.1	10.34
261630095	1	Livonia–Roadway	Wayne	2018	8303	51.2	47.5	38.0	9.56
261630098	1	DP4th Precinct	Wayne	2018	3448	46.0	44.6	42.5	14.38*
261630099	1	Trinity	Wayne	2018	1491	36.8	35.7	35.7	14.41*
161630100	1	Military Park	Wayne	2018	1199	36.6	35.2	35.2	13.98*

*Indicates site does not have a complete year of data.

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	2018	6881	216.7	170.1	11.72
261630001	1	Allen Park	Wayne	2018	7243	181.7	175.2	14.28

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	2018	245	245	0.101	0.089	0.087	0.084	0	0	0
260190003	1	Benzonia	Benzie	2018	213	245	0.098	0.082	0.079	0.076	0	0	0
260210014	1	Coloma	Berrien	2018	215	245	0.089	0.085	0.082	0.071	0	0	0
260270003	2	Cassopolis	Cass	2018	210	245	0.091	0.082	0.081	0.080	0	0	1
260330901	1	Sault Ste. Marie	Chippewa	2018	157	245	0.066	0.061	0.060	0.060	0	0	0
260370002	2	Rose Lake 2	Clinton	2018	215	245	0.100	0.077	0.077	0.077	0	0	0
260490021	1	Flint	Genesee	2018	215	245	0.080	0.079	0.079	0.078	0	0	0
260492001	1	Otisville	Genesee	2018	208	245	0.080	0.078	0.077	0.071	0	0	0
260630007	1	Harbor Beach	Huron	2018	241	245	0.088	0.086	0.084	0.082	0	0	1
260650012	2	Lansing*	Ingham	2018	41	245	0.054	0.053	0.052	0.052	0	0	0
260650018	1	Lansing-Filley St.*	Ingham	2018	137	245	0.098	0.076	0.075	0.075	0	0	0
260770008	1	Kalamazoo	Kalamazoo	2018	210	245	0.081	0.081	0.077	0.076	0	0	0
260810020	1	Grand Rapids-Monroe	Kent	2018	305	365	0.084	0.082	0.079	0.075	0	0	0
260810022	1	Evans	Kent	2018	194	245	0.082	0.078	0.072	0.072	0	0	1
260910007	1	Tecumseh	Lenawee	2018	214	245	0.082	0.078	0.075	0.074	0	0	0
260990009	1	New Haven	Macomb	2018	211	245	0.095	0.094	0.089	0.086	0	0	0
260991003	1	Warren	Macomb	2018	214	245	0.088	0.087	0.083	0.079	0	0	0
261010922	1	Manistee	Manistee	2018	181	245	0.082	0.080	0.079	0.073	0	0	1
261050007	1	Scottville	Mason	2018	215	245	0.084	0.081	0.076	0.074	0	0	0
261130001	1	Houghton Lake	Missaukee	2018	214	245	0.072	0.072	0.071	0.071	0	0	1
261210039	1	Muskegon	Muskegon	2018	213	245	0.113	0.095	0.093	0.088	0	0	1
261250001	2	Oak Park	Oakland	2018	206	245	0.093	0.091	0.090	0.087	0	0	0
261390005	1	Jenison	Ottawa	2018	213	245	0.090	0.086	0.079	0.079	0	0	1
261470005	1	Port Huron	St. Clair	2018	215	245	0.099	0.092	0.092	0.089	0	0	0
261530001	1	Seney	Schoolcraft	2018	206	245	0.091	0.073	0.071	0.070	0	0	0
261610008	1	Ypsilanti	Washtenaw	2018	215	245	0.081	0.079	0.079	0.078	0	0	0
261630001	2	Allen Park	Wayne	2018	268	365	0.088	0.078	0.075	0.075	0	0	0
261630019	2	Detroit-E. 7 Mile	Wayne	2018	213	245	0.089	0.088	0.085	0.080	0	0	2

* Indicates site was moved from Lansing to Lansing-Filley St.

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	2018	100	245	0.085	0.080	0.077	0.074	3
260190003	1	Benzonia	Benzie	2018	87	213	0.087	0.075	0.070	0.069	1
260210014	1	Coloma	Berrien	2018	88	215	0.078	0.077	0.076	0.073	3
260270003	2	Cassopolis	Cass	2018	85	209	0.078	0.076	0.076	0.075	3
260330901	1	Sault Ste. Marie	Chippewa	2018	63	154	0.058	0.057	0.056	0.054	0
260370002	1	Rose Lake 2	Clinton	2018	88	215	0.083	0.074	0.074	0.071	1
260490021	1	Flint	Genesee	2018	88	215	0.077	0.076	0.071	0.069	2
260492001	1	Otisville	Genesee	2018	94	207	0.077	0.075	0.070	0.068	1
260630007	1	Harbor Beach	Huron	2018	98	240	0.077	0.076	0.071	0.070	2
260650012	2	Lansing*	Ingham	2018	17	71	0.053	0.051	0.050	0.049	0
260650018	1	Lansing-Filley St.*	Ingham	2018	56	137	0.084	0.074	0.070	0.069	1
260770008	1	Kalamazoo	Kalamazoo	2018	85	208	0.075	0.073	0.072	0.071	0
260810020	1	Grand Rapids	Kent	2018	83	304	0.075	0.075	0.071	0.071	0
260810022	1	Evans	Kent	2018	78	192	0.075	0.074	0.068	0.067	0
260910007	1	Tecumseh	Lenawee	2018	77	214	0.075	0.072	0.072	0.071	0
260990009	1	New Haven	Macomb	2018	86	210	0.083	0.081	0.080	0.076	4
260991003	1	Warren	Macomb	2018	87	212	0.079	0.077	0.077	0.072	3
261010922	1	Manistee	Manistee	2018	74	181	0.074	0.067	0.066	0.065	0
261050007	1	Scottville	Mason	2018	88	215	0.080	0.070	0.069	0.068	1
261130001	1	Houghton Lake	Missaukee	2018	87	214	0.069	0.067	0.067	0.066	0
261210039	1	Muskegon	Muskegon	2018	85	208	0.095	0.088	0.086	0.080	6
261250001	2	Oak Park	Oakland	2018	84	206	0.086	0.082	0.078	0.077	5
261390005	1	Jenison	Ottawa	2018	87	212	0.075	0.075	0.074	0.073	0
261470005	1	Port Huron	St. Clair	2018	18	214	0.086	0.081	0.080	0.076	4
261530001	1	Seney	Schoolcraft	2018	84	206	0.072	0.071	0.067	0.063	0
261610008	1	Ypsilanti	Washtenaw	2018	88	215	0.076	0.072	0.072	0.070	1
261630001	2	Allen Park	Wayne	2018	72	261	0.079	0.071	0.070	0.069	1
261630019	2	Detroit-E. 7 Mile	Wayne	2018	86	210	0.080	0.080	0.075	0.074	2

* Indicates site was moved from Lansing to Lansing-Filley St.

$PM_{2.5}$ (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	0685	Holland	Allegan	2018	120	26.1	23.6	21.2	17.6	21.2	7.61
260170014	1	0685	Bay City	Bay	2018	118	27.4	21.5	17.8	17.6	17.8	7.15
260490021	1	FRM	Flint	Genesee	2018	121	23.4	19.3	16.9	16.7	16.9	7.33
260650012	1	FRM	Lansing	Ingham	2018	34	16.3	15.7	15.1	14.6	16.3	7.62*
260650018	1	0685	Lansing-Filley St.	Ingham	2018	44	29.0	23.7	19.5	18.0	29.0	7.82*
260770008	1	FRM	Kalamazoo	Kalamazoo	2018	108	23.6	20.3	19.1	18.4	19.1	8.47
260770008	2	FRM	Kalamazoo	Kalamazoo	2018	56	23.6	19.1	17.5	17.0	19.1	8.68
260810020	1	FRM	Grand Rapids-Monroe	Kent	2018	121	35.1	22.8	18.9	17.8	18.9	8.45
260810020	2	FRM	Grand Rapids-Monroe	Kent	2018	61	35.1	26.5	24.3	19.3	26.5	8.93
260910007	1	FRM	Tecumseh	Lenawee	2018	115	27.6	24.2	23.4	19.3	23.4	7.96
260990009	1	FRM	New Haven	Macomb	2018	120	23.6	20.0	18.9	18.0	18.9	7.82
261010922	1	FRM	Manistee	Manistee	2018	114	26.3	19.8	16.9	16.0	16.9	6.13
261130001	1	FRM	Houghton Lake	Missaukee	2018	121	26.2	16.5	16.2	14.7	16.2	5.42
261250001	1	FRM	Oak Park	Oakland	2018	115	34.3	25.5	20.1	18.3	20.1	8.27
261390005	1	FRM	Jenison	Ottawa	2018	100	27.1	22.3	21.2	18.9	22.3	8.32*
261470005	1	FRM	Port Huron	St. Clair	2018	118	26.5	21.5	19.6	18.4	19.6	8.09
261610008	1	FRM	Ypsilanti	Washtenaw	2018	111	24.3	23.8	21.3	19.6	21.3	8.35
261610008	2	FRM	Ypsilanti	Washtenaw	2018	54	24.6	19.1	19.1	18.8	19.1	8.81
261630001	1	FRM	Allen Park	Wayne	2018	351	29.9	27.4	25.6	25.4	22.8	9.14
261630015	1	FRM	Detroit-W. Fort St.	Wayne	2018	116	33.2	32.8	28.1	26.7	28.1	11.89
261630016	1	FRM	Detroit-Linwood	Wayne	2018	118	24.5	23.5	18.6	18.5	18.6	8.86
261630019	1	FRM	Detroit-E. 7 Mile	Wayne	2018	117	25.8	24.2	21.5	20.3	21.5	8.40
261630025	1	FRM	Livonia	Wayne	2018	105	25.5	18.5	18.1	17.8	18.1	7.45*
261630033	1	FRM	Dearborn	Wayne	2018	119	31.0	28.3	26.1	22.5	26.1	10.80
261630033	2	FRM	Dearborn	Wayne	2018	60	28.3	26.6	22.5	21.5	26.6	11.06
261630036	1	FRM	Wyandotte	Wayne	2018	111	23.1	20.6	20.4	20.0	20.4	8.02
261630039	1	FRM	Detroit-W. Lafayette	Wayne	2018	44	26.9	22.0	17.5	17.5	26.9	8.87*
261630095	1	FRM	Livonia-Roadway	Wayne	2018	117	29.0	29.0	29.0	26.0	29.0	9.10

*Indicates the site does not have a complete year of data.

$PM_{2.5}$ TEOM (1-HOUR) MEASURED IN µG/M³

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	2018	8444	95.0	87.0	58.0	58.0	7.24
260330901	3	BAM	Sault Ste. Marie	Chippewa	2018	4596	87.1	50.2	49.4	49.0	9.75*
260490021	3	BAM	Flint**	Genesee	2018	6698	57.1	51.0	41.5	38.8	7.56
260650012	3	TEOM	Lansing***	Ingham	2018	7849	341.1^	173.3^	104.3^	60.9	7.82
260770008	3	TEOM	Kalamazoo	Kalamazoo	2018	8077	70.0	70.0	51.0	38.0	8.12
260810020	3	TEOM	Grand Rapids-Monroe	Kent	2018	7912	76.0	64.0	57.0	57.0	7.87
260910007	3	TEOM	Tecumseh	Lenawee	2018	4329	38.0	27.0	27.0	27.0	7.41*
261130001	3	TEOM	Houghton Lake	Missaukee	2018	3608	29.0	25.0	24.0	23.0	5.75*
261470005	3	TEOM	Port Huron	St. Clair	2018	6781	55.0	34.0	34.0	32.0	7.85
261530001	3	TEOM	Seney**	Schoolcraft	2018	5578	158.0	115.0	104.0	64..0	5.44*
261610008	3	TEOM	Ypsilanti	Washtenaw	2018	8490	175.0	83.0	74.0	45.0	8.03
261630001	3	TEOM	Allen Park	Wayne	2018	8203	53.0	45.0	44.0	42.0	8.94
261630015	3	BAM	Detroit-W. Fort St.	Wayne	2018	2636	99.0	86.3	79.2	78.1	11.26*
261630033	3	TEOM	Dearborn	Wayne	2018	7242	103.0	60.0	59.0	56.0	10.05
261630039	3	TEOM	Detroit–W. Lafayette	Wayne	2018	2133	62.0	54.0	52.0	50.0	9.37*
261630097	3	TEOM	NMH 48217	Wayne	2018	6705	40.8	35.8	35.4	34.4	8.90
261630098	3	BAM	DP4th Precinct	Wayne	2018	3368	50.0	49.1	48.1	47.9	11.48*
261630099	3	BAM	Trinity	Wayne	2018	1735	163.1	102.4	84.3	80.4	11.92*
261630100	3	BAM	Military Park	Wayne	2018	1260	70.6	70.5	54.0	53.6	12.17*

* Indicates the site does not have a complete year of data.

**Indicates monitor changed from a TEOM to a BAM during the year, data from monitors are combined.

***Monitor location was moved during the year, data from sites are combined.

^High numbers recorded during July 4.

PM_{10} (24-HOUR) measured in µg /m3

Site ID	POC	Monitor	City	County	Year	# OBS	# Req.	ValidDays	% OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd Arith Mean
260810020	1	GRAV	Grand Rapids-Monroe	Kent	2018	60	61	60	98	31	30	28	23	13.8
261390005	1	GRAV	Jenison	Ottawa	2018	61	61	61	100	31	27	25	24	13.0
261630001	1	GRAV	Allen Park	Wayne	2018	60	61	60	98	34	34	32	30	16.3
261630015	1	GRAV	Detroit-W. Fort St.	Wayne	2018	60	61	60	98	88	85	64	50	29.2
261630033	1	GRAV	Dearborn	Wayne	2018	61	61	61	100	65	48	43	39	22.6
261630033	9	GRAV	Dearborn	Wayne	2018	31	31	30	97	66	50	49	45	24.5

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	2018	8720	81	77	69	50	19.0

$PM_{10-2.5}$ (24-HOUR) MEASURED IN $\mu G/M^3$

Site ID	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
260810020	GRAV	Grand Rapids-Monroe	Kent	2018	117	24.9	24.5	18.2	16.5	6.33
261630001	GRAV	Allen Park	Wayne	2018	114	44.9	22.6	19.4	18.4	7.81

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	2018	2288	6.0	5.7	6.0	2.6	2.5	0	0.73*
260650018	1	Lansing-Filley St.*	Ingham	2018	5243	7.9	7.0	5.6	1.7	1.6	0	0.68*
260810020	2	Grand Rapids-Monroe	Kent	2018	8344	6.1	4.6	4.4	1.1	1.1	0	0.12
261150006	1	Sterling State Park	Monroe	2018	8368	7.5	5.5	4.2	1.8	1.7	0	0.56
261390011	1	West Olive	Ottawa	2018	7888	17.8	15.1	12.8	5.8	2.9	0	0.56*
261470005	1	Port Huron	St. Clair	2018	8298	109.4	89.0	82.1	29.4	26.3	0	2.49
261630001	1	Allen Park	Wayne	2018	8059	28.2	26.6	20.3	7.7	5.8	0	0.68
261630015	1	Detroit-W. Fort St.	Wayne	2018	8148	81.0	74.9	67.4	20.5	18.8	0	2.40
261630097	1	NMH 48217	Wayne	2018	7846	33.6	33.0	25.1	10.4	8.9	0	1.09
261630098	1	DP4th Precinct*	Wayne	2018	3441	18.5	18.5	18.5	3.9	3.5	0	0.63*
261630099	3	Trinity*	Wayne	2018	1589	22.9	17.6	22.9	6.1	2.7	0	0.55*
261630100	1	Military Park*	Wayne	2018	1207	41.5	25.2	41.5	4.0	3.4	0	-0.15*

*Indicates the site does not have a complete year of data.

APPENDIX B: 2018 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 2018. At each monitoring site, air samples were taken over a 24-hour period (midnight to midnight). These air samples represent the average air concentration during that 24-hour period. The frequency of air samples collected is typically done once every 6 or 12 days. Sometimes the sampled air concentration is lower than the laboratory's analytical method detection level (MDL). When the concentration is lower than the MDL, two options are used to estimate the air concentration. The calculation of the minimum average ("Average (ND=0)") uses 0.0 $\mu g/m^3$ for a value less than the MDL. In the calculation of the maximum average ("Average (ND=MDL/2)") the MDL divided by 2 (i.e., ½ the MDL) is substituted for air concentrations less than the MDL.

Table B shows the monitoring stations and what types of air toxics were monitored at each station in 2018. 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 2018, assuming daily samples below MDL were equal to 0.0 $\mu g/m^3$.
- Average (ND=MDL/2): average air concentration in 2018, assuming daily samples below MDL were equal to one half the MDL.
- MDL: Analytical MDL in units of $\mu g/m^3$
- Max1: Highest daily air concentration during 2018
- Max2: Second highest daily air concentration during 2018
- Max3: Third highest daily air concentration during 2018
- $\mu g/m^3$: Micrograms per cubic meter (1,000,000 µg = 1 g)

Table B

SITE NAME	VOC	Carbonyl	PAHs	Metals TSP	Metals PM10	Speciated PM2.5
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		
Port Huron-Rural St.				x		
River Rouge		x		x		
Tecumseh						x
DP4th Precinct				x		
Military Park				x		
Trinity				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	61	61	0.0013	0.0013	8.46E-06	0.00527	0.004	0.00362
Arsenic Pm10 Stp	60	60	0.00105	0.00105	9.98E-06	0.00473	0.00337	0.00328
Cadmium (Tsp) Stp	61	61	0.000132	0.000132	8.46E-06	0.00048	0.0004	0.0003
Cadmium Pm10 Stp	60	60	0.000217	0.000217	9.98E-06	0.00081	0.0005	0.00048
Lead (Tsp) Lc Frm/Fem	61	61	0.00334	0.00334		0.0114	0.00697	0.00624
Lead Pm10 Lc	60	60	0.00257	0.00257		0.0109	0.00815	0.00565
Manganese (Tsp) Stp	61	61	0.0223	0.0223	5.70E-05	0.0835	0.0704	0.0458
Manganese Pm10 Stp	60	60	0.00844	0.00844	7.03E-05	0.0268	0.0185	0.0179
Nickel (Tsp) Stp	61	61	0.00116	0.00116	5.39E-05	0.00318	0.00257	0.00239
Nickel Pm10 Stp	60	60	0.000854	0.000854	6.75E-05	0.00189	0.00185	0.00169

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	56	0	0	0.0717	0.143	0	0	0
1,1,2-Trichloroethane	56	0	0	0.0518	0.104	0	0	0
1,1-Dichloroethane	56	0	0	0.0289	0.0579	0	0	0
1,1-Dichloroethylene	56	0	0	0.0236	0.0472	0	0	0
1,2,4-Trichlorobenzene	56	13	0.0235	0.733	1.85	0.142	0.119	0.115
1,2,4-Trimethylbenzene	56	56	1.09	1.09	0.132	3.62	3.46	3.34
1,2-Dichlorobenzene	56	0	0	0.0619	0.124	0	0	0
1,2-Dichloropropane	56	1	0.000602	0.0467	0.0938	0.0337	0	0
1,3,5-Trimethylbenzene	56	56	0.307	0.307	0.167	1.01	0.954	0.919
1,3-Butadiene	56	56	0.0803	0.0803	0.0427	0.343	0.167	0.129
1,3-Dichlorobenzene	56	0	0	0.0547	0.109	0	0	0
1,4-Dichlorobenzene	56	19	0.0217	0.0614	0.12	0.132	0.103	0.0902
2,5-Dimethylbenzaldehyde	66	0	0	0.00801	0.016	0	0	0
9-Fluorenone (Tsp) Stp	68	68	0.00219	0.00219	0.00008	0.00925	0.00808	0.00792
Acenaphthene (Tsp) Stp	68	68	0.00869	0.00869	0.000287	0.0798	0.0501	0.0361
Acenaphthylene (Tsp) Stp	68	66	0.000468	0.000468	0.0000188	0.0107	0.00202	0.00163
Acetaldehyde	66	66	2	2	0.0387	4.26	3.87	3.77
Acetone	66	66	3.45	3.45	0.366	10.8	8.38	7.07
Acetonitrile	56	56	1.49	1.49	0.0274	27.7	2.7	2.44
Acetylene	56	56	0.94	0.94	0.042	3.79	2.13	1.96
Acrylonitrile	55	0	0	0.0115	0.023	0	0	0
Anthracene (Tsp) Stp	68	61	0.000415	0.000415	0.0000214	0.00301	0.00227	0.00172
Arsenic (Tsp) Stp	90	90	0.00129	0.00129	0.00000842	0.00458	0.00422	0.0036
Arsenic Pm10 Stp	90	90	0.0012	0.0012	0.00001	0.00494	0.00461	0.00351
Barium (Tsp) Stp	90	90	0.0222	0.0222	0.000337	0.038	0.0375	0.0365
Barium Pm10 Stp	92	92	0.0128	0.0128	0.000424	0.0261	0.0234	0.0229

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	66	66	0.487	0.487	0.0101	4.1	2.63	2.42
Benzene	56	56	0.762	0.762	0.0463	2.24	1.47	1.46
Benzo[A]Anthracene (Tsp) Stp	68	68	0.000158	0.000158	0.0000121	0.000475	0.000408	0.000331
Benzo[A]Pyrene (Tsp) Stp	68	68	0.000164	0.000164	0.0000154	0.00078	0.000532	0.000385
Benzo[B]Fluoranthene (Tsp) Stp	68	68	0.000474	0.000474	0.0000245	0.00118	0.00117	0.00104
Benzo[E]Pyrene (Tsp) Stp	68	68	0.00025	0.00025	0.0000153	0.000807	0.000623	0.000548
Benzo[G,H,I]Perylene (Tsp) Stp	68	68	0.000261	0.000261	0.0000166	0.00248	0.000847	0.000704
Benzo[K]Fluoranthene (Tsp) Stp	68	68	0.00014	0.00014	0.0000182	0.000389	0.000325	0.000293
Beryllium (Tsp) Stp	90	90	0.0000793	0.0000793	0.00000568	0.0002	0.0002	0.0002
Beryllium Pm10 Stp	91	81	0.0000191	0.0000195	0.00000704	0.00009	0.00007	0.00007
Bromochloromethane	56	0	0	0.0352	0.0704	0	0	0
Bromodichloromethane	56	1	0.0047	0.059	0.111	0.263	0	0
Bromoform	56	0	0	0.0915	0.183	0	0	0
Bromomethane	56	50	0.0506	0.053	0.0447	0.447	0.273	0.168
Butyraldehyde	66	66	0.594	0.594	0.0391	2.47	2.31	2.1
Cadmium (Tsp) Stp	90	90	0.000231	0.000231	0.00000842	0.00087	0.00062	0.00059
Cadmium Pm10 Stp	92	92	0.000198	0.000198	0.00001	0.00068	0.00055	0.0005
Carbon Disulfide	56	55	0.154	0.156	0.239	0.495	0.445	0.399
Carbon Tetrachloride	56	56	0.607	0.607	0.0837	0.824	0.742	0.742
Chlorobenzene	56	3	0.00119	0.043	0.0884	0.0253	0.0221	0.0193
Chloroethane	56	43	0.068	0.0757	0.0657	0.348	0.33	0.303
Chloroform	56	56	0.458	0.458	0.063	1.61	1.31	1.27
Chloromethane	56	56	1.28	1.28	0.096	1.77	1.58	1.47
Chloroprene	56	0	0	0.0234	0.0467	0	0	0
Chromium (Tsp) Stp	90	90	0.00556	0.00556	0.000134	0.0158	0.0153	0.015
Chromium Pm10 Stp	92	92	0.00266	0.00266	0.00017	0.00671	0.00655	0.00505
Chrysene (Tsp) Stp	68	68	0.000393	0.000393	0.0000116	0.00077	0.000736	0.00073
Cis-1,2-Dichloroethene	56	0	0	0.0369	0.0737	0	0	0
Cis-1,3-Dichloropropene	56	0	0	0.0447	0.0894	0	0	0
Cobalt (Tsp) Stp	90	90	0.000246	0.000246	0.00002	0.00073	0.00066	0.00065
Cobalt Pm10 Stp	92	92	0.000108	0.000108	0.00003	0.00036	0.00034	0.00023
Copper (Tsp) Stp	90	90	0.0258	0.0258	0.000225	0.0547	0.0511	0.0501
Copper Pm10 Stp	92	92	0.0341	0.0341	0.000283	0.0991	0.0926	0.0873
Coronene (Tsp) Stp	68	68	0.000146	0.000146	0.00000508	0.00178	0.000613	0.00042
Crotonaldehyde	63	63	0.128	0.128	0.00817	0.602	0.533	0.479
Cyclopenta[Cd]Pyrene (Tsp) Stp	68	64	0.0000601	0.0000604	0.0000135	0.00194	0.000141	0.000132
Dibenzo[A,H]Anthracene (Tsp) Stp	68	67	0.000038	0.0000381	0.0000154	0.0000941	0.000079	0.0000715
Dibromochloromethane	56	1	0.000532	0.065	0.131	0.0298	0	0
Dichlorodifluoromethane	56	56	2.59	2.59	0.135	3.31	3.02	2.98
Dichloromethane	56	56	4.44	4.44	0.05	30.3	27	19.2
Ethyl Acrylate	56	0	0	0.0481	0.0962	0	0	0
Ethylbenzene	56	56	0.37	0.37	0.112	1.09	0.938	0.79

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
Ethylene Dibromide	56	0	0	0.0726	0.145	0	0	0
Ethylene Dichloride	56	56	0.0819	0.0819	0.0563	0.12	0.113	0.113
Fluoranthene (Tsp) Stp	68	68	0.00447	0.00447	0.0000587	0.022	0.022	0.0163
Fluorene (Tsp) Stp	68	68	0.00774	0.00774	0.000238	0.0517	0.0433	0.0281
Formaldehyde	66	66	2.98	2.98	0.067	6.78	6.51	6.33
Freon 114	56	56	0.125	0.125	0.0937	0.148	0.146	0.143
Hexachlorobutadiene	56	19	0.023	0.119	0.292	0.0906	0.0896	0.08
Hexanaldehyde	64	62	0.137	0.137	0.00774	0.37	0.369	0.361
Indeno[1,2,3-Cd]Pyrene (Tsp) Stp	68	68	0.000231	0.000231	0.0000175	0.000961	0.000621	0.000528
Iron (Tsp) Stp	90	90	1.31	1.31	0.00309	4.95	4.5	4.33
Iron Pm10 Stp	92	92	0.625	0.625	0.00389	2.69	2.59	1.97
Isovaleraldehyde	66	0	0	0.00501	0.01	0	0	0
Lead (Tsp) Lc Frm/Fem	90	90	0.00887	0.00887		0.031	0.0304	0.0271
Lead Pm10 Lc	91	91	0.00762	0.00762		0.0353	0.0345	0.0225
M/P Xylene	56	56	1.04	1.04	0.156	3.44	3.04	2.27
Manganese (Tsp) Stp	90	90	0.0868	0.0868	0.0000568	0.372	0.344	0.34
Manganese Pm10 Stp	92	92	0.0318	0.0318	0.0000704	0.172	0.15	0.0948
Methyl Chloroform	56	26	0.0101	0.0301	0.0747	0.0284	0.0251	0.0251
Methyl Ethyl Ketone	66	66	0.427	0.427	0.0859	1.07	1	0.994
Methyl Isobutyl Ketone	56	56	0.388	0.388	0.0971	1.89	1.13	0.983
Methyl Methacrylate	56	1	0.211	0.412	0.41	11.8	0	0
Methyl Tert-Butyl Ether	56	2	0.000568	0.0185	0.0371	0.0177	0.0141	0
Molybdenum (Tsp) Stp	90	90	0.0011	0.0011	0.00000999	0.0043	0.00263	0.00257
Molybdenum Pm10 Stp	92	92	0.000954	0.000954	0.0000109	0.00262	0.00239	0.0023
Naphthalene (Tsp) Stp	68	68	0.0817	0.0817	0.00337	0.213	0.196	0.18
Nickel (Tsp) Stp	90	90	0.00219	0.00219	0.0000537	0.0101	0.0057	0.00483
Nickel Pm10 Stp	92	92	0.00143	0.00143	0.0000671	0.00416	0.00358	0.00347
N-Octane	56	56	0.298	0.298	0.151	0.949	0.678	0.542
O-Xylene	56	56	0.439	0.439	0.116	1.5	1.08	0.942
Perylene (Tsp) Stp	68	68	0.0000309	0.0000309	0.0000103	0.000123	0.000106	0.0000659
Phenanthrene (Tsp) Stp	68	68	0.014	0.014	0.000194	0.0788	0.076	0.0509
Propionaldehyde	66	66	0.411	0.411	0.00798	0.945	0.895	0.883
Propylene	56	56	0.676	0.676	0.11	2.2	1.93	1.28
Pyrene (Tsp) Stp	68	68	0.0025	0.0025	0.000019	0.0112	0.00955	0.00946
Retene (Tsp) Stp	68	68	0.000334	0.000334	0.0000657	0.00149	0.00133	0.00121
Styrene	56	54	11.3	11.3	0.173	78.8	62.2	49.8
Tert-Butyl Ethyl Ether	56	0	0	0.0228	0.0456	0	0	0
Tetrachloroethylene	56	56	0.284	0.284	0.099	1.28	1.13	1.09
Tolualdehydes	18	16	0.167	0.17	0.067	0.32	0.259	0.246
Toluene	56	56	1.44	1.44	0.49	5.95	3.84	3.81
Trans-1,2-Dichloroethylene	56	1	0.000559	0.0267	0.0531	0.0313	0	0
Trans-1,3-Dichloropropene	56	0	0	0.0443	0.0885	0	0	0
Trichloroethylene	56	15	0.0125	0.042	0.0806	0.0978	0.0704	0.0543
Trichlorofluoromethane	56	56	1.35	1.35	0.0652	1.8	1.79	1.61
Valeraldehyde	65	64	0.0754	0.0755	0.01	0.225	0.211	0.195
Vanadium (Tsp) Stp	90	90	0.00293	0.00293	0.00002	0.00901	0.00842	0.00818
Vanadium Pm10 Stp	92	92	0.00146	0.00146	0.0000246	0.00569	0.00523	0.00423
Vinyl Chloride	56	0	0	0.0164	0.0327	0	0	0
Zinc (Tsp) Stp	90	90	0.15	0.15	0.00111	0.781	0.644	0.633
Zinc Pm10 Stp	92	92	0.109	0.109	0.0014	0.518	0.504	0.497

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	0.0753	0.151	0	0	0
1,2,4-Trichlorobenzene	31	3	0.152	0.779	1.39	1.6	1.6	1.5
1,2,4-Trimethylbenzene	30	4	0.104	0.236	0.304	1.3	0.98	0.47
1,2-Dichlorobenzene	31	0	0	0.184	0.367	0	0	0
1,2-Dichloropropane	31	0	0	0.55	1.1	0	0	0
1,3,5-Trimethylbenzene	31	1	0.0106	0.127	0.24	0.33	0	0
1,3-Butadiene	31	1	0.00806	0.0661	0.12	0.25	0	0
1,3-Dichlorobenzene	31	2	0.0335	0.165	0.28	0.72	0.32	0
1,4-Dichlorobenzene	31	3	0.0832	0.255	0.381	1.2	0.96	0.42
2,2,4-Trimethylpentane	31	10	0.142	0.191	0.145	0.78	0.6	0.59
Acetaldehyde	31	31	1.76	1.76		3.37	3.22	2.87
Acetone	31	31	2.35	2.35		4.89	4.48	3.8
Acetonitrile	31	20	0.76	0.848	0.498	3.9	2.5	2.1
Acrylonitrile	31	0	0	0.395	0.79	0	0	0
Arsenic (Tsp) Stp	61	61	0.00157	0.00157	8.49E-06	0.00521	0.00484	0.00374
Benzaldehyde	31	31	0.218	0.218		0.436	0.393	0.392
Benzene	31	30	0.991	0.993	0.0945	2.5	1.9	1.7
Bromodichloromethane	31	0	0	0.075	0.15	0	0	0
Bromoform	31	0	0	0.173	0.347	0	0	0
Bromomethane	31	0	0	0.11	0.22	0	0	0
Cadmium (Tsp) Stp	61	61	0.000239	0.000239	8.49E-06	0.00071	0.00059	0.00058
Carbon Tetrachloride	31	12	0.179	0.248	0.228	0.95	0.55	0.51
Chlorobenzene	31	0	0	0.102	0.205	0	0	0
Chloroethane	31	0	0	0.06	0.12	0	0	0
Chloroform	31	18	0.255	0.281	0.12	0.89	0.61	0.53
Chloromethane	31	30	1.21	1.22	0.16	1.9	1.7	1.7
Cis-1,2-Dichloroethene	31	0	0	0.0605	0.121	0	0	0
Cis-1,3-Dichloropropene	31	0	0	0.065	0.13	0	0	0
Crotonaldehyde	31	1	0.0032	0.0032		0.0992	0	0
Dibromochloromethane	31	0	0	0.145	0.291	0	0	0
Dichlorodifluoromethane	30	29	2.26	2.26	0.25	2.7	2.7	2.6
Dichloromethane	31	21	0.399	0.455	0.344	1.5	1.2	0.84
Ethylbenzene	31	6	0.116	0.233	0.29	1	0.76	0.71
Ethylene Dibromide	31	0	0	0.149	0.297	0	0	0
Ethylene Dichloride	31	0	0	0.0952	0.19	0	0	0
Formaldehyde	31	31	3.08	3.08		6.98	5.86	5.09
Hexanaldehyde	31	30	0.222	0.222		0.505	0.505	0.471
Lead (Tsp) Lc Frm/Fem	61	61	0.0135	0.0135		0.107	0.061	0.0424

Detetroit-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
M/P Xylene	31	16	0.733	0.91	0.73	3.4	2.5	2.3
Manganese (Tsp) Stp	61	61	0.0707	0.0707	5.74E-05	0.351	0.27	0.179
Manganese Pm10 Stp	59	59	0.0252	0.0252	7.02E-05	0.137	0.0709	0.0691
Methyl Chloroform	31	0	0	0.105	0.21	0	0	0
Methyl Ethyl Ketone	31	4	0.206	0.685	1.1	2.2	1.6	1.4
Methyl Isobutyl Ketone	31	2	0.194	0.595	0.858	3.7	2.3	0
Methyl Tert-Butyl Ether	31	0	0	0.095	0.19	0	0	0
N-Hexane	31	23	1	1.01	0.0861	4.2	3.3	2.8
Nickel (Tsp) Stp	61	61	0.00273	0.00273	5.39E-05	0.00801	0.00724	0.0067
O-Xylene	31	12	0.297	0.399	0.33	1.3	1.2	1.1
Propionaldehyde	31	31	0.293	0.293		0.736	0.554	0.46
Styrene	31	5	0.264	0.584	0.764	2.5	2	1.7
Tetrachloroethylene	31	11	4.52	4.59	0.23	55	22	20
Tolualdehydes	31	7	0.00887	0.00887		0.0437	0.0423	0.0412
Toluene	31	27	1.36	1.39	0.44	3.3	3.1	3
Trans-1,2-Dichloroethylene	31	0	0	0.075	0.15	0	0	0
Trans-1,3-Dichloropropene	31	0	0	0.0447	0.0894	0	0	0
Trichloroethylene	31	0	0	0.0834	0.167	0	0	0
Trichlorofluoromethane	31	30	1.43	1.44	0.23	3	2	1.9
Valeraldehyde	31	31	0.189	0.189		0.327	0.309	0.303
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/m³)								
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	0.00171	0.00171	0.0000087	0.00482	0.00409	0.00393
Cadmium (Tsp) Stp	60	60	0.000348	0.000348	0.0000087	0.00256	0.00122	0.00097
Lead (Tsp) Lc Frm/Fem	60	60	0.0106	0.0106		0.0336	0.0303	0.0251
Manganese (Tsp) Stp	60	60	0.134	0.134	0.000059	0.636	0.448	0.351
Nickel (Tsp) Stp	60	60	0.0026	0.0026	0.0000555	0.00715	0.00641	0.00627

Port Huron-Rural St. (261470031), Speciated $PM_{2.5}$ (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	0.00104	0.00104	8.49E-06	0.00906	0.00385	0.00345
Cadmium (Tsp) Stp	61	61	0.000426	0.000426	8.49E-06	0.00368	0.00237	0.00206
Lead (Tsp) Lc Frm/Fem	74	74	0.0368	0.0368		0.312	0.222	0.22
Manganese (Tsp) Stp	61	61	0.0118	0.0118	5.74E-05	0.0625	0.0504	0.0467
Nickel (Tsp) Stp	61	61	0.00104	0.00104	5.36E-05	0.00276	0.00232	0.00223

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	31	31	2.37	2.37		4.22	4.06	3.4
Acetone	31	31	2.4	2.4		6.37	4.34	4
Arsenic (Tsp) Stp	61	61	0.0013	0.0013	8.70E-06	0.00541	0.00426	0.00354
Benzaldehyde	31	31	0.185	0.185		0.579	0.384	0.376
Cadmium (Tsp) Stp	61	61	0.0004	0.0004	8.70E-06	0.00237	0.00126	0.00092
Crotonaldehyde	31	1	0.000227	0.00703		0.00703	0	0
Formaldehyde	31	31	3.83	3.83		8.16	7.66	7.4
Hexanaldehyde	31	30	0.19	0.196		0.597	0.501	0.409
Lead (Tsp) Lc Frm/Fem	59	59	0.00592	0.00592		0.0143	0.0134	0.0124
Manganese (Tsp) Stp	61	61	0.0554	0.0554	5.93E-05	0.19	0.158	0.158
Nickel (Tsp) Stp	61	61	0.00146	0.00146	5.61E-05	0.00346	0.00315	0.0028
Propionaldehyde	31	31	0.346	0.346		0.844	0.688	0.536
Tolualdehydes	31	6	0.00827	0.0427		0.0642	0.0453	0.0397
Valeraldehyde	31	31	0.17	0.17		0.437	0.432	0.274

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	0.000957	0.000957	8.62E-06	0.00414	0.00272	0.00231
Cadmium (Tsp) Stp	61	61	0.0000823	0.0000823	8.62E-06	0.0002	0.00019	0.00016
Lead (Tsp) Lc Frm/Fem	61	61	0.00323	0.00323		0.00816	0.00674	0.00661
Manganese (Tsp) Stp	61	61	0.0124	0.0124	5.90E-05	0.0391	0.036	0.0334
Nickel (Tsp) Stp	61	61	0.00103	0.00103	5.46E-05	0.00183	0.00181	0.00178

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	59	59	0.000886	0.000886	8.44E-06	0.00276	0.00192	0.00191
Cadmium (Tsp) Stp	59	59	0.000323	0.000323	8.44E-06	0.00455	0.00166	0.00124
Lead (Tsp) Lc Frm/Fem	59	59	0.0305	0.0305		0.213	0.172	0.128
Manganese (Tsp) Stp	59	59	0.00828	0.00828	5.64E-05	0.0277	0.0212	0.0178
Nickel (Tsp) Stp	59	59	0.000842	0.000842	5.36E-05	0.00588	0.00278	0.00177

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	60	60	0.000779	0.000779	8.45E-06	0.00648	0.00316	0.00263
Cadmium (Tsp) Stp	60	60	0.000158	0.000158	8.45E-06	0.00097	0.00072	0.00067
Lead (Tsp) Lc Frm/Fem	60	60	0.0156	0.0156		0.132	0.108	0.0842
Manganese (Tsp) Stp	60	60	0.00626	0.00626	5.70E-05	0.0288	0.0241	0.0129
Nickel (Tsp) Stp	60	60	0.000784	0.000784	5.37E-05	0.0036	0.00202	0.00187

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
Arsenic (Tsp) Stp	61	61	0.00118	0.00118	0.00000836	0.00582	0.00568	0.00289
Cadmium (Tsp) Stp	61	61	0.000134	0.000134	0.00000836	0.00063	0.00038	0.00032
Lead (Tsp) Lc Frm/Fem	61	61	0.00489	0.00489		0.0263	0.0172	0.0128
Manganese (Tsp) Stp	61	61	0.0271	0.0271	0.0000557	0.069	0.0672	0.0621
Nickel (Tsp) Stp	61	61	0.0016	0.0016	0.0000526	0.0131	0.00471	0.00319

DP 4th Precinct (261630098) 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	25	25	0.00153	0.00153	8.52E-06	0.00716	0.00328	0.00268
Cadmium (Tsp) Stp	25	25	0.000145	0.000145	8.52E-06	0.00032	0.00026	0.00023
Lead (Tsp) Lc Frm/Fem	25	25	0.00693	0.00693		0.0173	0.0137	0.0132
Manganese (Tsp) Stp	25	25	0.0467	0.0467	5.76E-05	0.125	0.0927	0.0854
Nickel (Tsp) Stp	25	25	0.00195	0.00195	5.28E-05	0.00432	0.00392	0.00345

Military Park (261630100) 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	10	10	0.0094	0.0094	0.000084	0.0257	0.0241	0.0147
Cadmium (Tsp) Stp	10	10	0.00238	0.00238	0.000084	0.00866	0.00504	0.00482
Lead (Tsp) Lc Frm/Fem	10	10	0.0142	0.0142		0.0693	0.0236	0.00894
Manganese (Tsp) Stp	10	10	0.378	0.378	0.000552	1.81	0.516	0.473
Nickel (Tsp) Stp	10	10	0.0118	0.0118	0.000527	0.0334	0.0299	0.0205

Military Park (261630100) 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	10	10	0.0094	0.0094	0.000084	0.0257	0.0241	0.0147
Cadmium (Tsp) Stp	10	10	0.00238	0.00238	0.000084	0.00866	0.00504	0.00482
Lead (Tsp) Lc Frm/Fem	10	10	0.0142	0.0142		0.0693	0.0236	0.00894
Manganese (Tsp) Stp	10	10	0.378	0.378	0.000552	1.81	0.516	0.473
Nickel (Tsp) Stp	10	10	0.0118	0.0118	0.000527	0.0334	0.0299	0.0205

APPENDIX B-2

Allen Park (261630001), Speciated $PM_{2.5}$ ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	116	80	0.0264	0.0264	0.0325	0.448	0.233	0.199
Ammonium Ion Pm2.5 Lc	112	112	0.565	0.565	0.00476	3.84	2.93	2.7
Antimony Pm2.5 Lc	116	59	0.00155	0.00155	0.0388	0.0409	0.0355	0.0354
Arsenic Pm2.5 Lc	116	36	0.000243	0.000393	0.00239	0.00483	0.0044	0.00413
Barium Pm2.5 Lc	116	67	0.00984	0.00984	0.08	0.112	0.0784	0.0698
Bromine Pm2.5 Lc	116	82	0.00186	0.00232	0.00454	0.00931	0.00851	0.00794
Cadmium Pm2.5 Lc	116	63	0.000178	0.000178	0.0159	0.0154	0.0141	0.0115
Calcium Pm2.5 Lc	116	114	0.0898	0.0898	0.0187	1.19	0.596	0.528
Cerium Pm2.5 Lc	116	57	0.00432	0.00432	0.0953	0.114	0.106	0.101
Cesium Pm2.5 Lc	116	58	0.00406	0.00406	0.0537	0.0875	0.0701	0.0623
Chlorine Pm2.5 Lc	116	80	0.00628	0.00628	0.00504	0.11	0.072	0.0509
Chromium Pm2.5 Lc	116	84	0.00321	0.00321	0.00292	0.0449	0.0196	0.0162
Cobalt Pm2.5 Lc	116	44	0	0	0.0033	0.00308	0.00221	0.00203
Copper Pm2.5 Lc	116	111	0.00829	0.00829	0.0113	0.079	0.033	0.0315
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	120	120	0.336	0.336	0.0158	0.794	0.761	0.644
Indium Pm2.5 Lc	116	56	0	0	0.0381	0.0328	0.0214	0.0195
Iron Pm2.5 Lc	116	114	0.0935	0.0935	0.0176	0.521	0.388	0.28
Lead Pm2.5 Lc	116	66	0.003	0.003	0.0122	0.0237	0.0224	0.0211
Magnesium Pm2.5 Lc	116	68	0.0146	0.0172	0.0426	0.209	0.15	0.0874
Manganese Pm2.5 Lc	116	88	0.00246	0.00246	0.00639	0.0179	0.011	0.011
Nickel Pm2.5 Lc	116	91	0.00114	0.00115	0.00186	0.0121	0.00621	0.00475
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	120	120	2.1	2.1	0.14	5.82	5.64	5.41
Phosphorus Pm2.5 Lc	116	92	0.000506	0.000576	0.00228	0.0152	0.0138	0.00493
Potassium Ion Pm2.5 Lc	112	110	0.0417	0.042	0.0605	1.39	0.384	0.242
Potassium Pm2.5 Lc	116	114	0.0744	0.0744	0.00497	2	0.458	0.219
Rubidium Pm2.5 Lc	116	52	0	0	0.00887	0.00562	0.00528	0.00462
Selenium Pm2.5 Lc	116	66	0.000739	0.000762	0.00526	0.00761	0.00761	0.00754
Silicon Pm2.5 Lc	116	111	0.0795	0.0795	0.0157	0.918	0.857	0.436
Silver Pm2.5 Lc	116	59	0.00115	0.00115	0.0164	0.0196	0.0186	0.0174
Sodium Ion Pm2.5 Lc	112	108	0.031	0.031	0.0273	0.651	0.18	0.151
Sodium Pm2.5 Lc	116	57	0.0218	0.0226	0.0885	0.137	0.121	0.115
Strontium Pm2.5 Lc	116	76	0.00178	0.00178	0.00722	0.0499	0.00925	0.00816
Sulfate Pm2.5 Lc	112	112	1.05	1.05	0.0254	4.65	3.11	2.51
Sulfur Pm2.5 Lc	116	114	0.401	0.401	0.00371	1.66	1.22	1.02
Tin Pm2.5 Lc	116	61	0.00292	0.00292	0.0488	0.0442	0.0391	0.0376
Titanium Pm2.5 Lc	116	99	0.00366	0.00366	0.00321	0.0289	0.027	0.0159
Total Nitrate Pm2.5 Lc	112	112	1.54	1.54	0.0349	10.9	8.7	7.68
Vanadium Pm2.5 Lc	116	59	0.000304	0.000396	0.00134	0.0017	0.00166	0.00163
Zinc Pm2.5 Lc	116	116	0.0162	0.0162	0.00309	0.0886	0.0571	0.0536
Zirconium Pm2.5 Lc	116	71	0.00361	0.00361	0.0359	0.0372	0.0329	0.0328

Dearborn (261630033), Speciated $PM_{2.5}$ (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	41	0.017	0.017	0.0324	0.122	0.0835	0.0751
Ammonium Ion Pm2.5 Lc	60	60	0.657	0.657	0.00457	2.57	1.96	1.91
Antimony Pm2.5 Lc	60	27	0.000885	0.000885	0.0388	0.0318	0.0272	0.0254
Arsenic Pm2.5 Lc	60	14	0.000208	0.000265	0.00244	0.00506	0.00495	0.00276
Barium Pm2.5 Lc	60	37	0.0104	0.0104	0.0801	0.118	0.107	0.0649
Bromine Pm2.5 Lc	60	47	0.00262	0.003	0.00454	0.0126	0.0112	0.00905
Cadmium Pm2.5 Lc	60	30	0.000972	0.000972	0.0159	0.0266	0.0196	0.017
Calcium Pm2.5 Lc	60	60	0.0916	0.0916	0.0183	0.372	0.286	0.23
Cerium Pm2.5 Lc	60	35	0.00783	0.00783	0.0954	0.114	0.108	0.0776
Cesium Pm2.5 Lc	60	30	0.00076	0.00076	0.0538	0.0886	0.0524	0.048
Chlorine Pm2.5 Lc	60	56	0.0355	0.0355	0.00499	0.42	0.401	0.17
Chromium Pm2.5 Lc	60	42	0.00168	0.00168	0.00292	0.0165	0.0154	0.00896
Cobalt Pm2.5 Lc	60	23	0	0	0.0033	0.00314	0.00221	0.00217
Copper Pm2.5 Lc	60	59	0.0227	0.0227	0.0114	0.0969	0.0585	0.0562
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	0.485	0.485	0.0158	1.31	1.17	0.958
Indium Pm2.5 Lc	60	39	0.00221	0.00221	0.0381	0.0312	0.0224	0.0149
Iron Pm2.5 Lc	60	60	0.29	0.29	0.0176	1.32	1.27	1.26
Lead Pm2.5 Lc	60	50	0.00649	0.00649	0.0122	0.0327	0.0232	0.0205
Magnesium Pm2.5 Lc	60	41	0.0229	0.0245	0.0426	0.174	0.167	0.0793
Manganese Pm2.5 Lc	60	58	0.00846	0.00846	0.0064	0.0405	0.0366	0.0319
Nickel Pm2.5 Lc	60	48	0.00123	0.00123	0.00186	0.0182	0.00427	0.00416
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	58	58	2.59	2.59	0.136	5.71	5.33	4.9
Phosphorus Pm2.5 Lc	60	46	0.000246	0.000326	0.00229	0.00289	0.00258	0.00206
Potassium Ion Pm2.5 Lc	60	60	0.0378	0.0378	0.0606	0.15	0.129	0.128
Potassium Pm2.5 Lc	60	60	0.0705	0.0705	0.00495	0.253	0.193	0.162
Rubidium Pm2.5 Lc	60	36	0.000822	0.000822	0.00888	0.00724	0.00626	0.00539
Selenium Pm2.5 Lc	60	39	0.00154	0.00159	0.00526	0.00778	0.00771	0.00627
Silicon Pm2.5 Lc	60	60	0.0628	0.0628	0.0157	0.306	0.164	0.145
Silver Pm2.5 Lc	60	38	0.00296	0.00296	0.0164	0.0194	0.0164	0.0155
Sodium Ion Pm2.5 Lc	60	58	0.0451	0.0451	0.0268	0.246	0.159	0.158
Sodium Pm2.5 Lc	60	39	0.0456	0.0456	0.0886	0.426	0.386	0.18
Strontium Pm2.5 Lc	60	41	0.00115	0.00115	0.00723	0.00718	0.00682	0.0068
Sulfate Pm2.5 Lc	60	60	1.28	1.28	0.0254	3.02	2.62	2.52
Sulfur Pm2.5 Lc	60	60	0.474	0.474	0.00372	1.02	0.98	0.967
Tin Pm2.5 Lc	60	37	0.00507	0.00507	0.0488	0.047	0.033	0.0323
Titanium Pm2.5 Lc	60	56	0.00309	0.00309	0.00321	0.00844	0.00719	0.00713
Total Nitrate Pm2.5 Lc	60	60	1.56	1.56	0.0355	6.38	6.17	5.72
Vanadium Pm2.5 Lc	60	34	0.000454	0.000588	0.00135	0.00355	0.00351	0.00199
Zinc Pm2.5 Lc	60	60	0.065	0.065	0.0031	0.353	0.32	0.304
Zirconium Pm2.5 Lc	60	31	0.00137	0.00137	0.0359	0.0388	0.0301	0.0238

Detroit, W Fort St. (N. Delray-SWHS) (261630015), Speciated $PM_{2.5}$ ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	46	0.145	0.145	0.0325	2.62	2.01	0.437
Ammonium Ion Pm2.5 Lc	60	60	0.671	0.671	0.00458	3.1	2.4	2.4
Antimony Pm2.5 Lc	60	32	0.00122	0.00122	0.0388	0.04	0.0391	0.0266
Arsenic Pm2.5 Lc	60	18	0.000192	0.000223	0.00246	0.005	0.00445	0.00423
Barium Pm2.5 Lc	60	30	0.00291	0.00291	0.0801	0.108	0.0752	0.0708
Bromine Pm2.5 Lc	60	45	0.00244	0.00289	0.00454	0.0118	0.00997	0.0079
Cadmium Pm2.5 Lc	60	26	0	0.0000798	0.0159	0.0196	0.0192	0.0165
Calcium Pm2.5 Lc	60	60	0.128	0.128	0.0181	0.63	0.613	0.544
Cerium Pm2.5 Lc	60	27	0.00296	0.00296	0.0953	0.106	0.0799	0.0639
Cesium Pm2.5 Lc	60	26	0	0	0.0538	0.0877	0.0419	0.0342
Chlorine Pm2.5 Lc	60	51	0.0433	0.0433	0.005	0.413	0.285	0.221
Chromium Pm2.5 Lc	60	39	0.00095	0.00095	0.00293	0.0155	0.00515	0.00467
Cobalt Pm2.5 Lc	60	30	0	0	0.0033	0.0029	0.00264	0.00217
Copper Pm2.5 Lc	60	59	0.00837	0.00837	0.0113	0.0237	0.0183	0.0161
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	61	61	0.733	0.733	0.0157	3.21	2.46	1.86
Indium Pm2.5 Lc	60	30	0.00111	0.00111	0.0381	0.0243	0.0235	0.0205
Iron Pm2.5 Lc	60	60	0.172	0.172	0.0176	0.804	0.669	0.624
Lead Pm2.5 Lc	60	48	0.00435	0.00435	0.0122	0.0183	0.0176	0.0154
Magnesium Pm2.5 Lc	60	45	0.0391	0.0408	0.0426	0.875	0.178	0.0927
Manganese Pm2.5 Lc	60	51	0.00532	0.00532	0.0064	0.0306	0.0257	0.0225
Nickel Pm2.5 Lc	60	43	0.000719	0.000719	0.00186	0.00424	0.00372	0.00336
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	61	61	2.81	2.81	0.137	6.72	5.68	5.4
Phosphorus Pm2.5 Lc	60	44	0.000121	0.000287	0.00229	0.00212	0.00135	0.0006
Potassium Ion Pm2.5 Lc	60	59	0.0881	0.0881	0.0606	0.674	0.488	0.425
Potassium Pm2.5 Lc	60	60	0.133	0.133	0.00499	0.936	0.541	0.525
Rubidium Pm2.5 Lc	60	36	0.000511	0.000511	0.00887	0.00463	0.00453	0.0044
Selenium Pm2.5 Lc	60	36	0.00108	0.00108	0.00526	0.0112	0.00985	0.005
Silicon Pm2.5 Lc	60	59	0.119	0.119	0.0157	0.693	0.589	0.517
Silver Pm2.5 Lc	60	27	0.000715	0.000715	0.0164	0.0234	0.02	0.0181
Sodium Ion Pm2.5 Lc	60	58	0.0361	0.0361	0.0267	0.11	0.0918	0.0918
Sodium Pm2.5 Lc	60	37	0.0339	0.0339	0.0885	0.155	0.111	0.104
Strontium Pm2.5 Lc	60	37	0.00136	0.00136	0.00722	0.0156	0.0134	0.00618
Sulfate Pm2.5 Lc	60	60	1.38	1.38	0.0252	3.76	3.21	3.16
Sulfur Pm2.5 Lc	60	60	0.49	0.49	0.00371	1.26	1.15	1.07
Tin Pm2.5 Lc	60	34	0.0038	0.0038	0.0488	0.0321	0.0318	0.0302
Titanium Pm2.5 Lc	60	58	0.0131	0.0131	0.00321	0.0682	0.0576	0.0456
Total Nitrate Pm2.5 Lc	60	60	1.69	1.69	0.0357	7.39	7.26	6.17
Vanadium Pm2.5 Lc	60	33	0.000793	0.000949	0.00135	0.00829	0.00361	0.00358
Zinc Pm2.5 Lc	60	60	0.0364	0.0364	0.0031	0.265	0.144	0.122
Zirconium Pm2.5 Lc	60	25	0	0	0.0359	0.0304	0.0288	0.0269

Tecumseh (260910007), Speciated $PM_{2.5}$ ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	31	0.00664	0.00664	0.0325	0.108	0.106	0.0874
Ammonium Ion Pm2.5 Lc	61	61	0.516	0.516	0.00453	2.69	2.01	1.74
Antimony Pm2.5 Lc	60	35	0.00348	0.00348	0.0388	0.0372	0.0359	0.0323
Arsenic Pm2.5 Lc	60	25	0.000116	0.00021	0.00246	0.00688	0.0009	0.00007
Barium Pm2.5 Lc	60	31	0.00016	0.00016	0.0801	0.0986	0.0403	0.0379
Bromine Pm2.5 Lc	60	38	0.00145	0.00198	0.00454	0.00639	0.00554	0.00537
Cadmium Pm2.5 Lc	60	35	0.00105	0.00105	0.0159	0.0171	0.0136	0.0135
Calcium Pm2.5 Lc	60	60	0.0455	0.0455	0.0183	0.171	0.115	0.101
Cerium Pm2.5 Lc	60	27	0	0	0.0953	0.0721	0.061	0.0569
Cesium Pm2.5 Lc	60	37	0.00446	0.00446	0.0538	0.0649	0.0511	0.0504
Chlorine Pm2.5 Lc	60	29	0.00193	0.00193	0.00499	0.0386	0.0243	0.0234
Chromium Pm2.5 Lc	60	38	0.000911	0.000911	0.00293	0.00902	0.00643	0.00446
Cobalt Pm2.5 Lc	60	32	0	0	0.0033	0.00303	0.00266	0.00209
Copper Pm2.5 Lc	60	50	0.00243	0.00252	0.0113	0.00834	0.00711	0.00657
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	61	60	0.173	0.173	0.0157	0.423	0.385	0.362
Indium Pm2.5 Lc	60	33	0.00147	0.00147	0.0381	0.0198	0.0188	0.0184
Iron Pm2.5 Lc	60	60	0.0429	0.0429	0.0176	0.114	0.105	0.0985
Lead Pm2.5 Lc	60	31	0.0015	0.0015	0.0122	0.0163	0.0162	0.0147
Magnesium Pm2.5 Lc	60	38	0.00924	0.0109	0.0424	0.0583	0.0542	0.0511
Manganese Pm2.5 Lc	60	39	0.00322	0.00322	0.0064	0.0327	0.0211	0.021
Nickel Pm2.5 Lc	60	33	0.000279	0.000294	0.00186	0.00463	0.00221	0.00192
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	61	61	1.72	1.72	0.137	4.6	4.34	4.05
Phosphorus Pm2.5 Lc	60	46	0.000192	0.000213	0.00228	0.00307	0.00223	0.00194
Potassium Ion Pm2.5 Lc	61	60	0.026	0.026	0.0605	0.107	0.092	0.0616
Potassium Pm2.5 Lc	60	60	0.0516	0.0516	0.00497	0.197	0.168	0.111
Rubidium Pm2.5 Lc	60	30	0.000424	0.000424	0.00887	0.0105	0.00735	0.00516
Selenium Pm2.5 Lc	60	31	0.000285	0.000285	0.00526	0.00611	0.00488	0.0032
Silicon Pm2.5 Lc	60	59	0.0528	0.0528	0.0156	0.224	0.197	0.147
Silver Pm2.5 Lc	60	35	0.00141	0.00141	0.0164	0.0249	0.0183	0.0147
Sodium Ion Pm2.5 Lc	61	59	0.0223	0.0223	0.0264	0.105	0.103	0.0799
Sodium Pm2.5 Lc	60	38	0.0303	0.0303	0.0885	0.167	0.146	0.121
Strontium Pm2.5 Lc	60	39	0.000868	0.000868	0.00722	0.00579	0.00575	0.00507
Sulfate Pm2.5 Lc	61	61	1.02	1.02	0.0252	2.45	2.13	1.84
Sulfur Pm2.5 Lc	60	60	0.372	0.372	0.00371	0.816	0.786	0.762
Tin Pm2.5 Lc	60	29	0.00277	0.00277	0.0488	0.0467	0.0395	0.0293
Titanium Pm2.5 Lc	60	52	0.00201	0.00201	0.00321	0.00766	0.00612	0.00611
Total Nitrate Pm2.5 Lc	61	61	1.45	1.45	0.0355	6.81	5.69	5.6
Vanadium Pm2.5 Lc	60	28	0.000246	0.00038	0.00135	0.00217	0.00126	0.00124
Zinc Pm2.5 Lc	60	60	0.0118	0.0118	0.0031	0.0431	0.0331	0.0289
Zirconium Pm2.5 Lc	60	26	0.000206	0.000206	0.0359	0.0275	0.0186	0.0167

Grand Rapids-Monroe St. (260810020), Speciated $PM_{2.5}$ ($\mu g/m^3$)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	120	75	0.0201	0.0201	0.0325	0.414	0.277	0.121
Ammonium Ion Pm2.5 Lc	120	120	0.548	0.548	0.00463	4.48	2.97	2.61
Antimony Pm2.5 Lc	120	62	0.00122	0.00122	0.0388	0.0402	0.0353	0.0299
Arsenic Pm2.5 Lc	120	41	0.000321	0.000416	0.00242	0.00756	0.00722	0.00594
Barium Pm2.5 Lc	120	70	0.00981	0.00981	0.0801	0.166	0.0879	0.0828
Bromine Pm2.5 Lc	120	78	0.00149	0.00197	0.00454	0.00677	0.00648	0.00623
Cadmium Pm2.5 Lc	120	52	0	0	0.0159	0.0197	0.0167	0.0159
Calcium Pm2.5 Lc	120	119	0.0345	0.0345	0.018	0.18	0.131	0.129
Cerium Pm2.5 Lc	120	64	0.00501	0.00501	0.0954	0.107	0.101	0.099
Cesium Pm2.5 Lc	120	58	0.00285	0.00285	0.0538	0.0877	0.0734	0.0598
Chlorine Pm2.5 Lc	120	71	0.00714	0.00714	0.00479	0.37	0.133	0.0443
Chromium Pm2.5 Lc	120	91	0.0027	0.00271	0.00292	0.0209	0.0174	0.0168
Cobalt Pm2.5 Lc	120	42	0	0	0.0033	0.00421	0.00307	0.00286
Copper Pm2.5 Lc	120	110	0.00585	0.00585	0.0114	0.081	0.0188	0.0172
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	120	120	0.3	0.3	0.0156	0.69	0.683	0.6
Indium Pm2.5 Lc	120	49	0	0	0.0381	0.0242	0.021	0.0205
Iron Pm2.5 Lc	120	120	0.0663	0.0663	0.0176	0.24	0.219	0.203
Lead Pm2.5 Lc	120	71	0.00247	0.00247	0.0122	0.0203	0.0193	0.0181
Magnesium Pm2.5 Lc	120	63	0.0121	0.014	0.0427	0.389	0.0813	0.0793
Manganese Pm2.5 Lc	120	87	0.00187	0.00187	0.0064	0.015	0.0116	0.00863
Nickel Pm2.5 Lc	120	87	0.000769	0.000769	0.00186	0.00494	0.0045	0.00418
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	120	120	2.14	2.14	0.138	6.05	5.84	5.6
Phosphorus Pm2.5 Lc	120	91	0.000367	0.000475	0.00229	0.00715	0.0049	0.00455
Potassium Ion Pm2.5 Lc	120	116	0.0482	0.0487	0.0606	2.5	0.326	0.302
Potassium Pm2.5 Lc	120	120	0.0722	0.0722	0.00494	2.53	0.442	0.174
Rubidium Pm2.5 Lc	120	52	0.0000345	0.0000345	0.00888	0.00949	0.00692	0.00683
Selenium Pm2.5 Lc	120	53	0	0	0.00527	0.0052	0.00422	0.00394
Silicon Pm2.5 Lc	120	116	0.0464	0.0464	0.0157	0.464	0.32	0.24
Silver Pm2.5 Lc	120	66	0.00149	0.00149	0.0164	0.0201	0.0194	0.0185
Sodium Ion Pm2.5 Lc	120	116	0.0256	0.0256	0.0268	0.527	0.107	0.106
Sodium Pm2.5 Lc	120	73	0.0343	0.0343	0.0886	0.178	0.147	0.145
Strontium Pm2.5 Lc	120	72	0.00165	0.00165	0.00723	0.069	0.00806	0.00763
Sulfate Pm2.5 Lc	120	120	0.936	0.936	0.0254	4.17	2.99	2.47
Sulfur Pm2.5 Lc	120	120	0.35	0.35	0.00372	1.41	1.17	0.898
Tin Pm2.5 Lc	120	63	0.000491	0.000491	0.0488	0.0395	0.0327	0.0304
Titanium Pm2.5 Lc	120	109	0.00337	0.00337	0.00321	0.0281	0.0269	0.0143
Total Nitrate Pm2.5 Lc	120	120	1.49	1.49	0.0349	12.3	7.81	6.91
Vanadium Pm2.5 Lc	120	50	0.000203	0.000337	0.00135	0.00141	0.0013	0.00129
Zinc Pm2.5 Lc	120	117	0.0129	0.0129	0.0031	0.0444	0.0391	0.0378
Zirconium Pm2.5 Lc	120	62	0	0	0.0359	0.0255	0.0251	0.0241

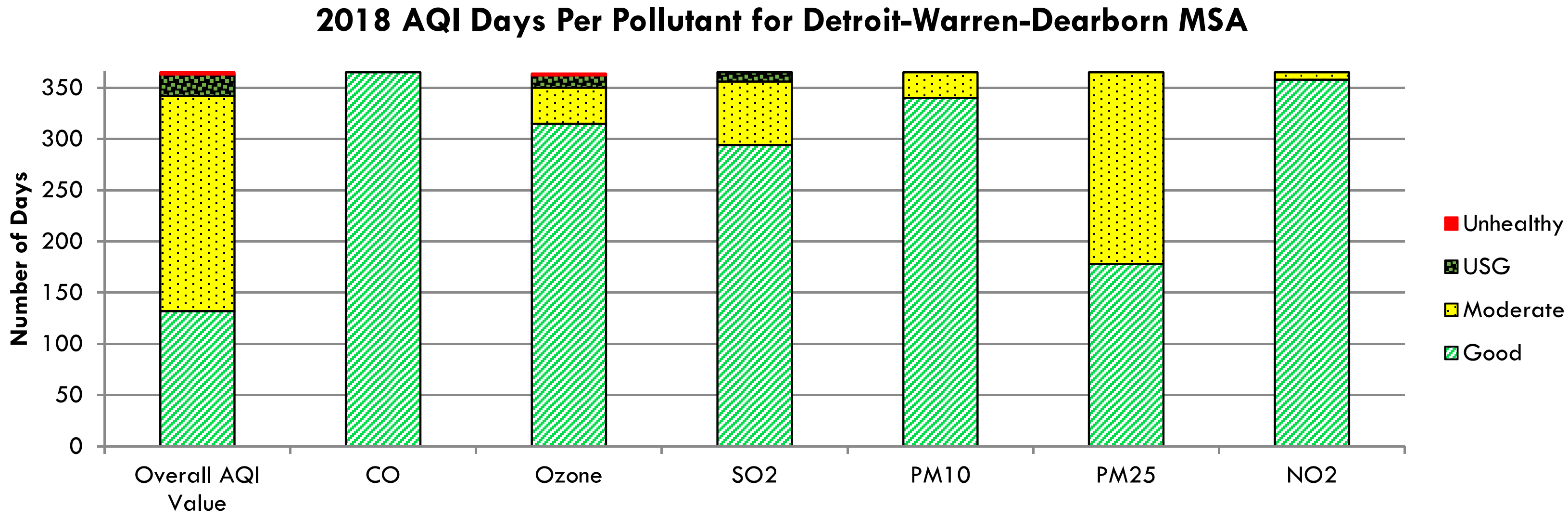
APPENDIX C: 2018 AIR QUALITY INDEX (AQI) PIE CHARTS

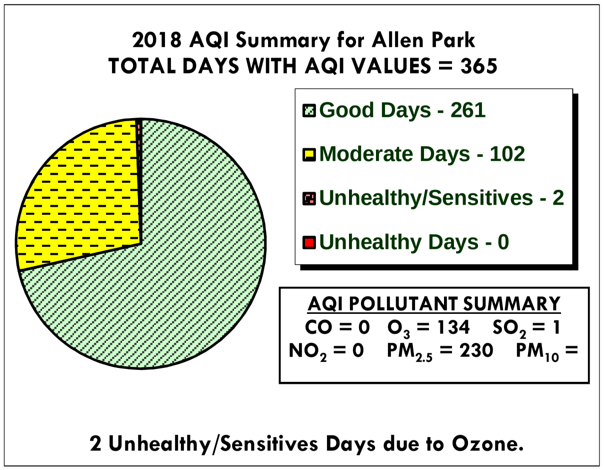
Appendix C contains pie charts that were created to show the AQI values for each of Michigan's 2018 monitoring sites and includes the total number of days measurements were taken, along with the pollutant distribution of the AQI values for those measurements. It is important to note that not all pollutants 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.

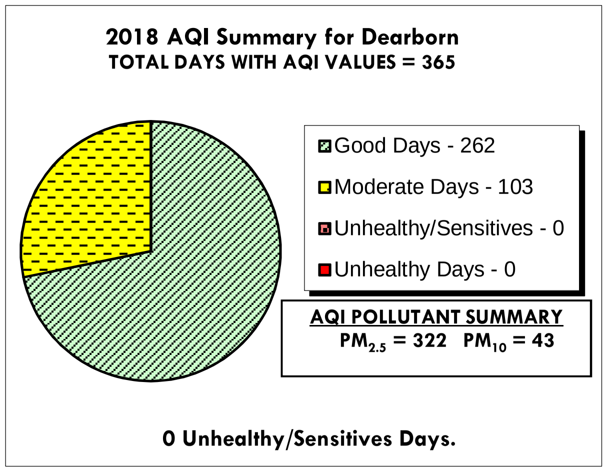
Figures C.1 through **C.7** are grouped by Metropolitan Statistical Area (MSA). MSAs are geographic regions based on population and employment data that the US Census compiles. They are defined by the US Office of Management and Budget. More information on MSAs can be found on the US Census website: www.census.gov.

Figures C.8 and **C.9** show the remaining sites (not part of a CSA) located in Michigan's Upper and Lower Peninsulas, respectively.

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







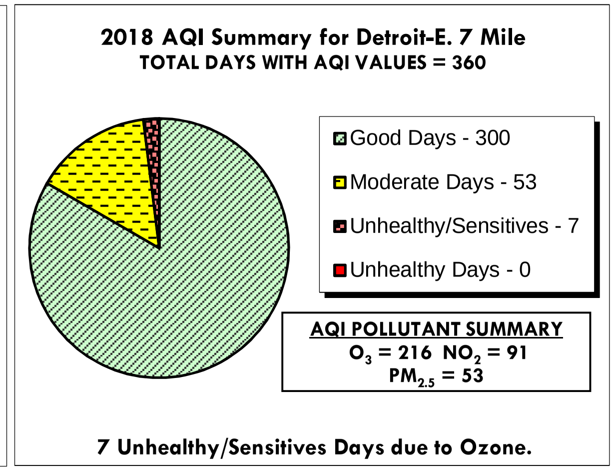
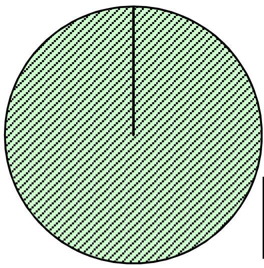


Figure C1, continued: AQI Summaries for Detroit-Warren-Dearborn-MSA

2018 AQI Summary for Eliza Howell-Downwind
TOTAL DAYS WITH AQI VALUES = 340

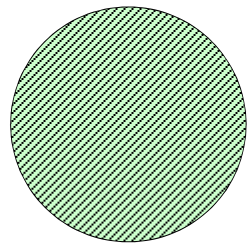


- Good Days - 328
- Moderate Days - 0
- Unhealthy/Sensitives - 0
- Unhealthy Days - 0

AQI POLLUTANT SUMMARY
NO_2 = 306 CO = 0
O3 = 27

0 Unhealthy/Sensitives Days.

2018 AQI Summary for Eliza Howell-Roadway
TOTAL DAYS WITH AQI VALUES = 365

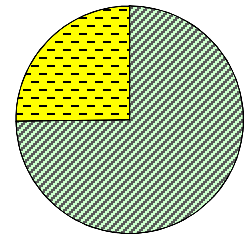


- Good Days - 365
- Moderate Days - 0
- Unhealthy/Sensitives - 0
- Unhealthy Days - 0

AQI POLLUTANT SUMMARY
NO_2 = 346 CO = 1
O3 = 18

0 Unhealthy/Sensitives Days.

2018 AQI Summary for Linwood
TOTAL DAYS WITH AQI VALUES = 119

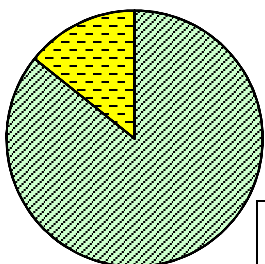


- Good Days - 89
- Moderate Days - 30
- Unhealthy/Sensitives - 0
- Unhealthy Days - 0

AQI POLLUTANT SUMMARY
$PM_{2.5}$ = 119

0 Unhealthy/Sensitive Days.

2018 AQI Summary for Livonia
TOTAL DAYS WITH AQI VALUES = 105

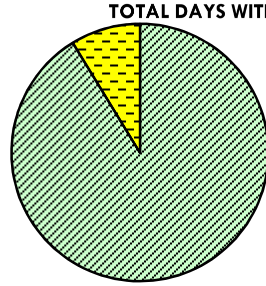


- Good Days - 90
- Moderate Days - 15
- Unhealthy/Sensitives - 0
- Unhealthy Days - 0

AQI POLLUTANT SUMMARY
$PM_{2.5}$ = 105

0 Unhealthy/Sensitive Days.

2018 AQI Summary for Livonia-Roadway
TOTAL DAYS WITH AQI VALUES = 365

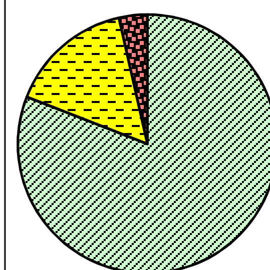


- Good Days - 333
- Moderate Days - 32
- Unhealthy/Sensitives - 0
- Unhealthy Days - 0

AQI POLLUTANT SUMMARY
CO = 2 NO2 = 245
$PM_{2.5}$ = 118

0 Unhealthy/Sensitive Days.

2018 AQI Summary for New Haven
TOTAL DAYS WITH AQI VALUES = 283

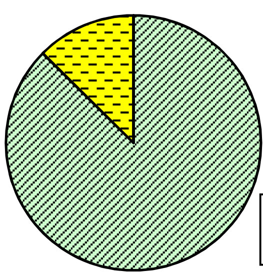


- Good Days - 228
- Moderate Days - 44
- Unhealthy/Sensitives - 10
- Unhealthy Days - 0

AQI POLLUTANT SUMMARY
O_3 = 227 $PM_{2.5}$ = 56

10 Unhealthy/Sensitives Days due to Ozone.

2018 AQI Summary for NMH 48217
TOTAL DAYS WITH AQI VALUES = 357

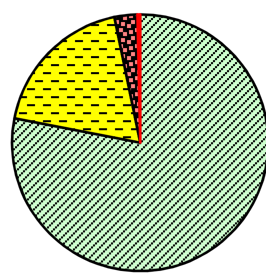


- Good Days - 312
- Moderate Days - 45
- Unhealthy/Sensitives - 0
- Unhealthy Days - 0

AQI POLLUTANT SUMMARY
$PM_{2.5}$ = 257 SO2 = 100

0 Unhealthy/Sensitive Days.

2018 AQI Summary for Oak Park
TOTAL DAYS WITH AQI VALUES = 278

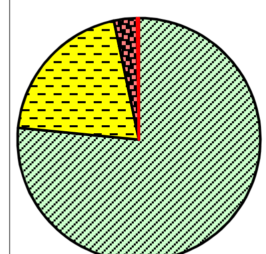


- Good Days - 217
- Moderate Days - 52
- Unhealthy/Sensitives - 8
- Unhealthy Days - 1

AQI POLLUTANT SUMMARY
O_3 = 220 $PM_{2.5}$ = 58

8 Unhealthy/Sensitives Days due to Ozone.
1 Unhealthy Day due to Ozone

2018 AQI Summary for Pt Huron-Nat'l Guard Arm.
TOTAL DAYS WITH AQI VALUES = 362

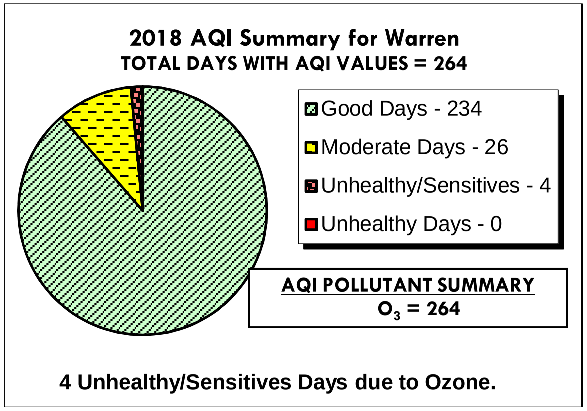


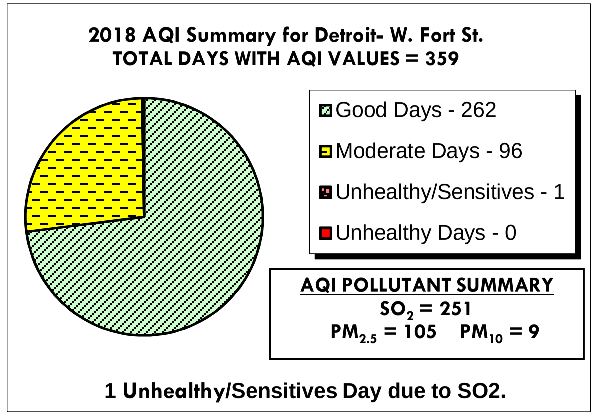
- Good Days - 277
- Moderate Days - 73
- Unhealthy/Sensitives -11
- Unhealthy Days - 1

AQI POLLUTANT SUMMARY
O_3 = 169 $PM_{2.5}$ = 111
SO_2 = 82

6 Unhealthy/Sensitives Days due to Ozone,
5 Unhealthy/Sensitivess Days due to SO2,
1 Unhealthy Day due to Ozone.

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





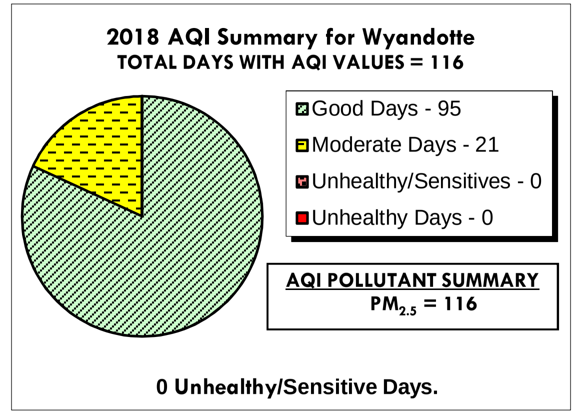
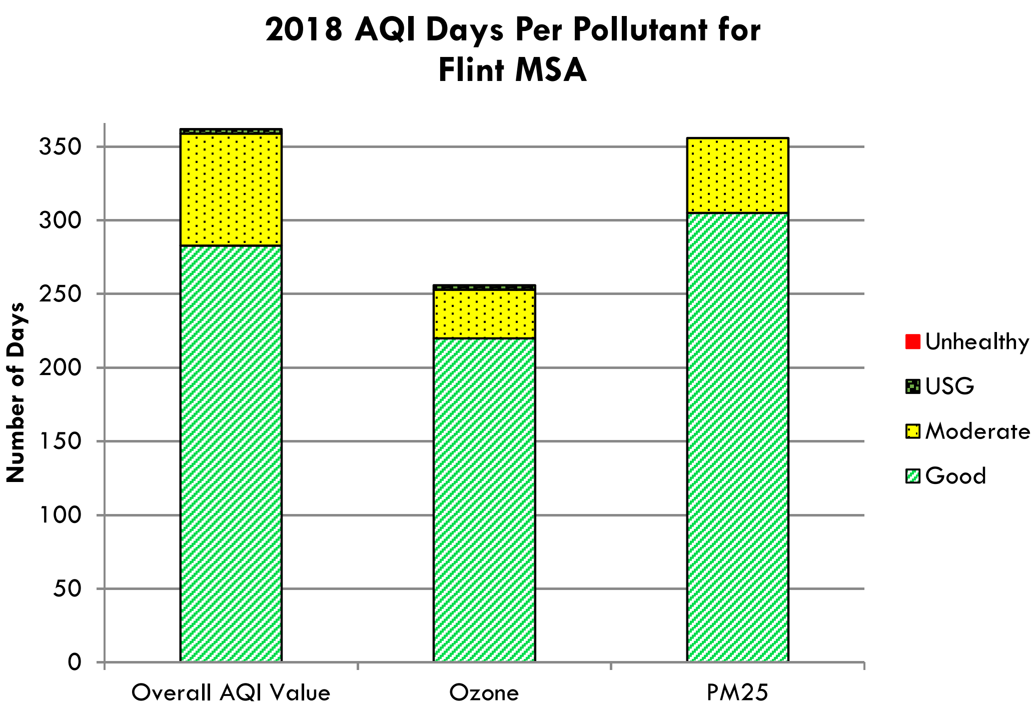
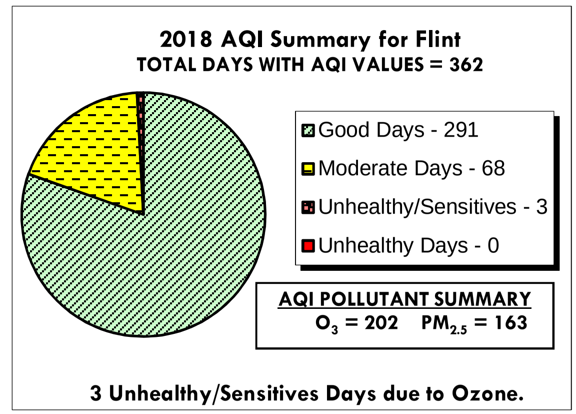


Figure C2: AQI Summaries for Flint MSA





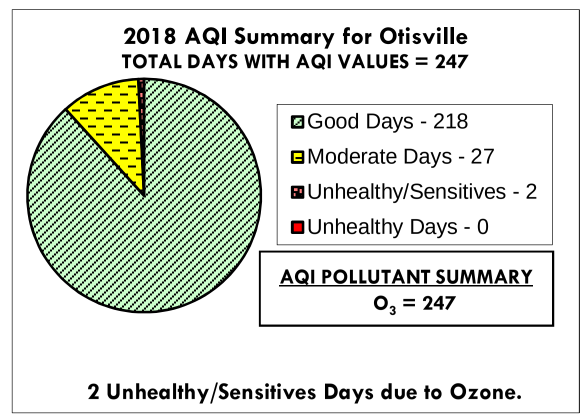
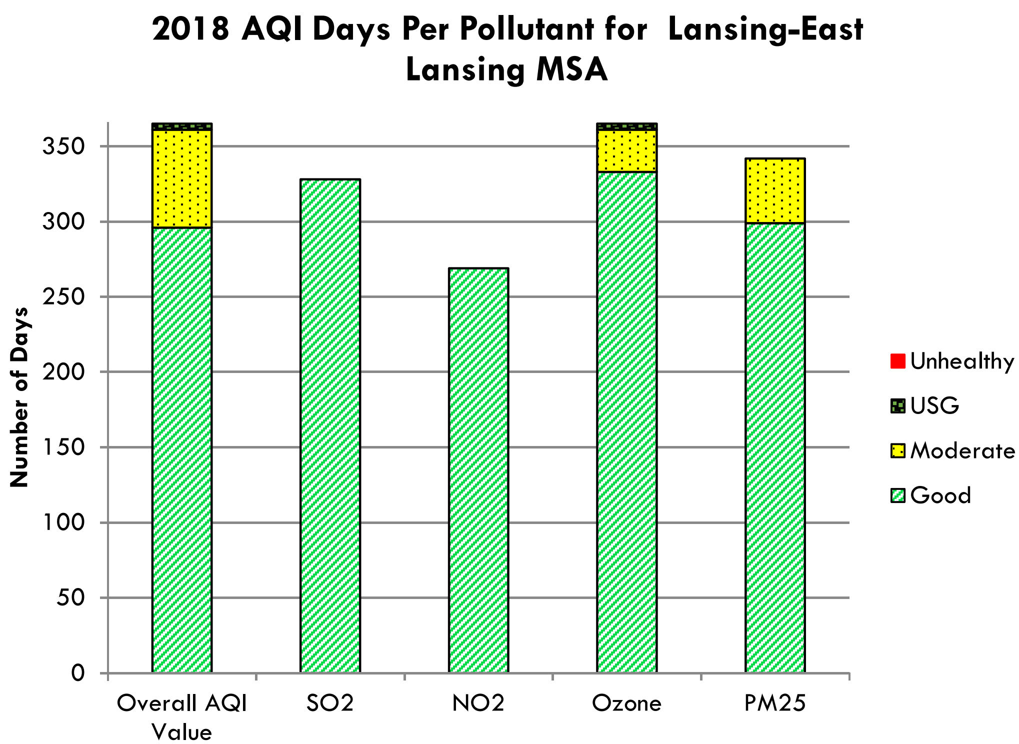
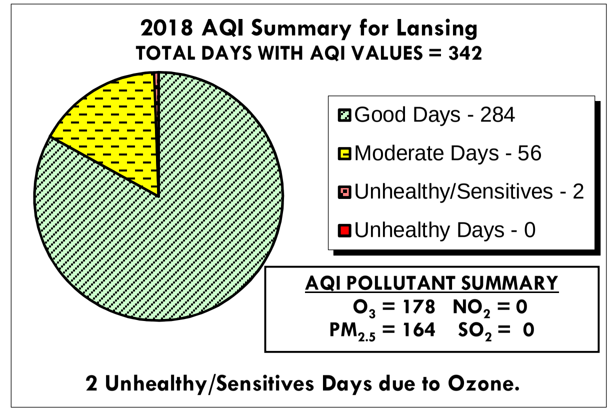


Figure C3: AQI Summaries for Lansing-East Lansing-MSA





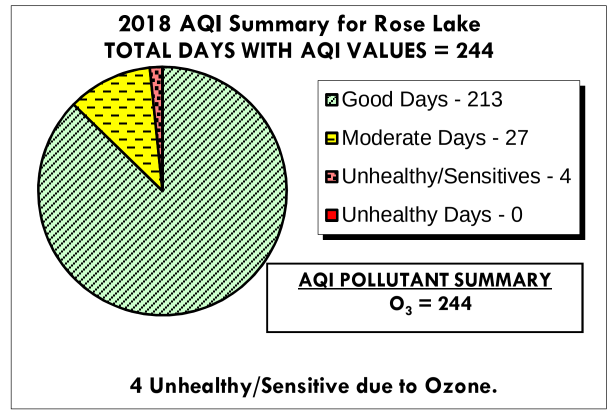
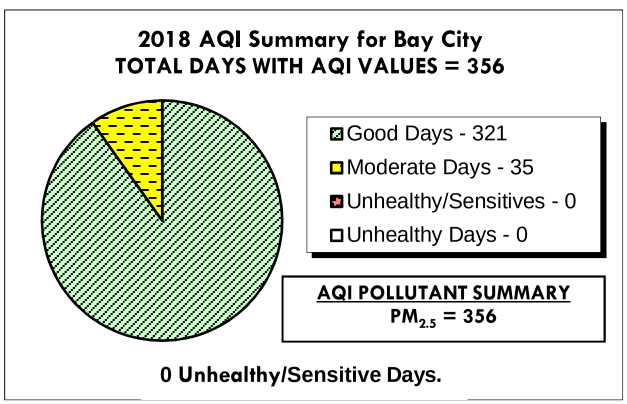
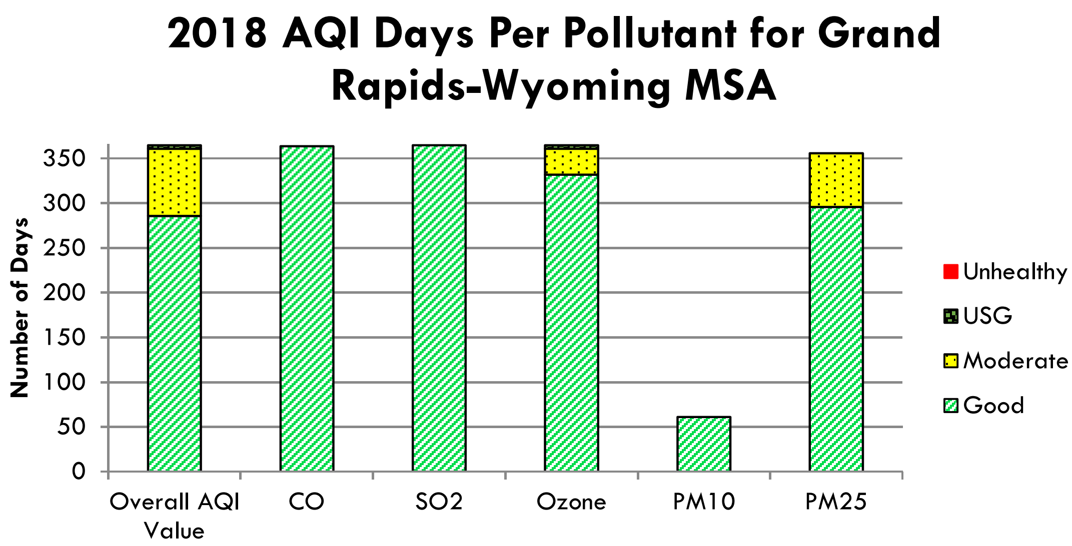


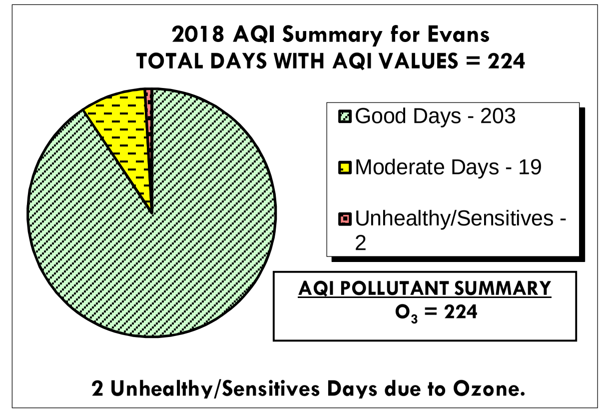
Figure C4: AQI Summary for Saginaw-Midland-Bay City-MSA

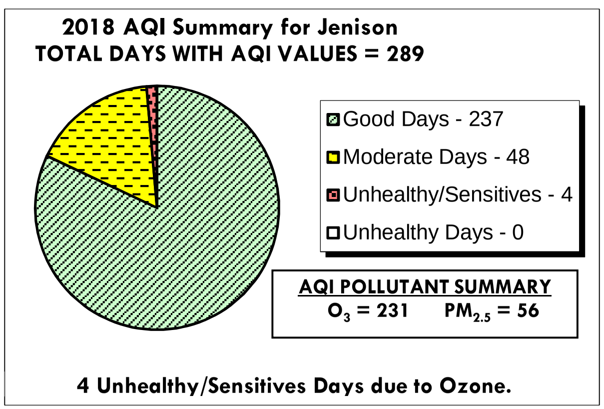


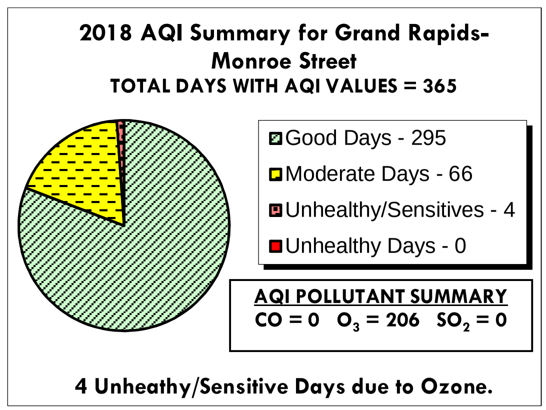
*Note: This site does not have AQI per pollutant graphs since only one pollutant is monitored in one location in these areas.

Figure C5: AQI Summaries for Grand Rapids-Wyoming MSA









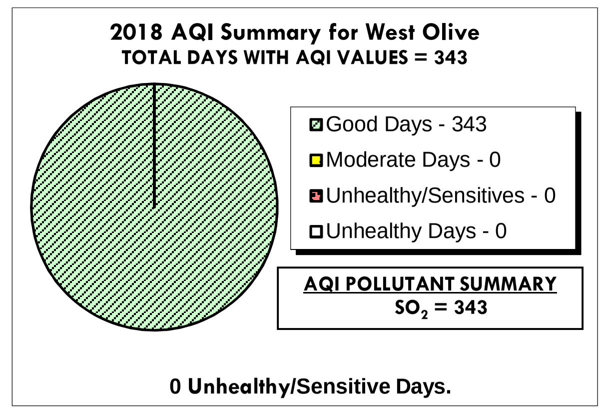
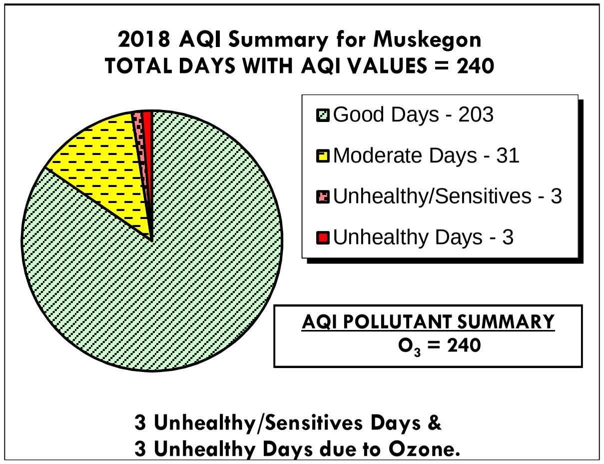
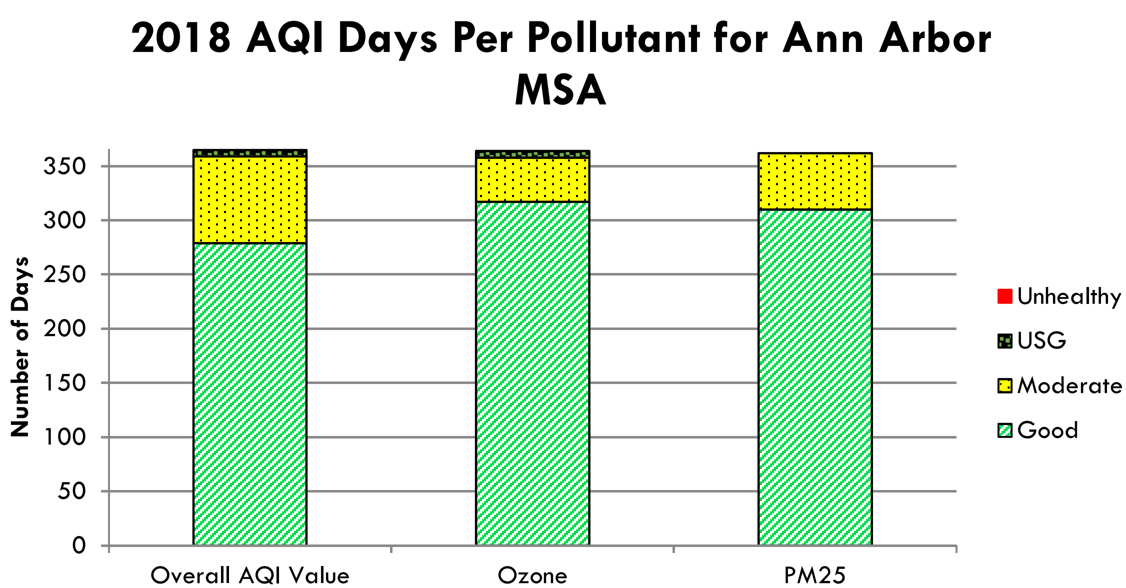


Figure C6: Muskegon MSA



*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



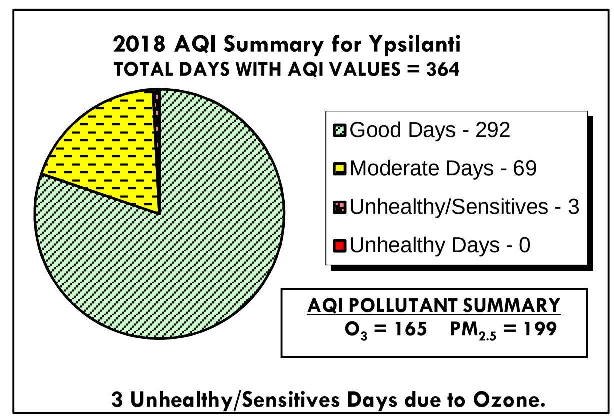
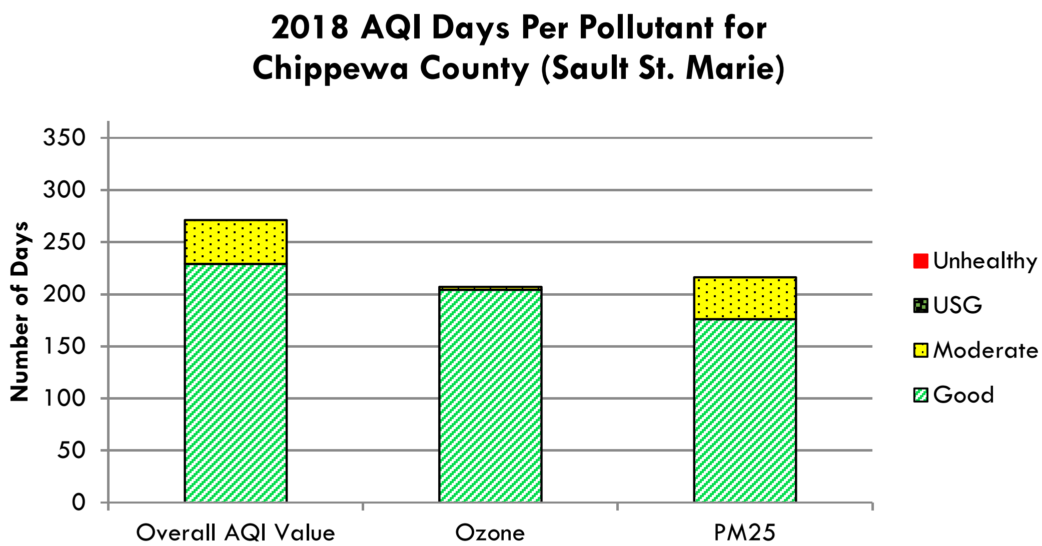
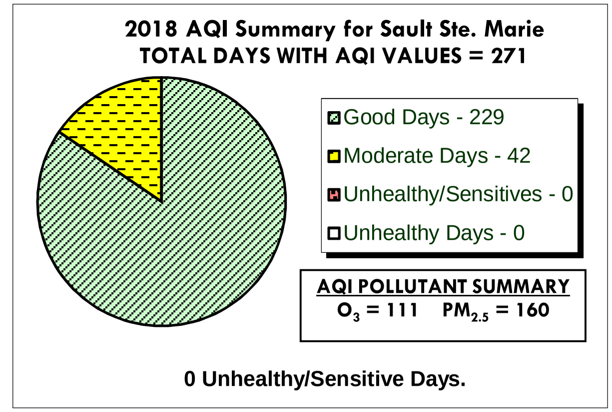
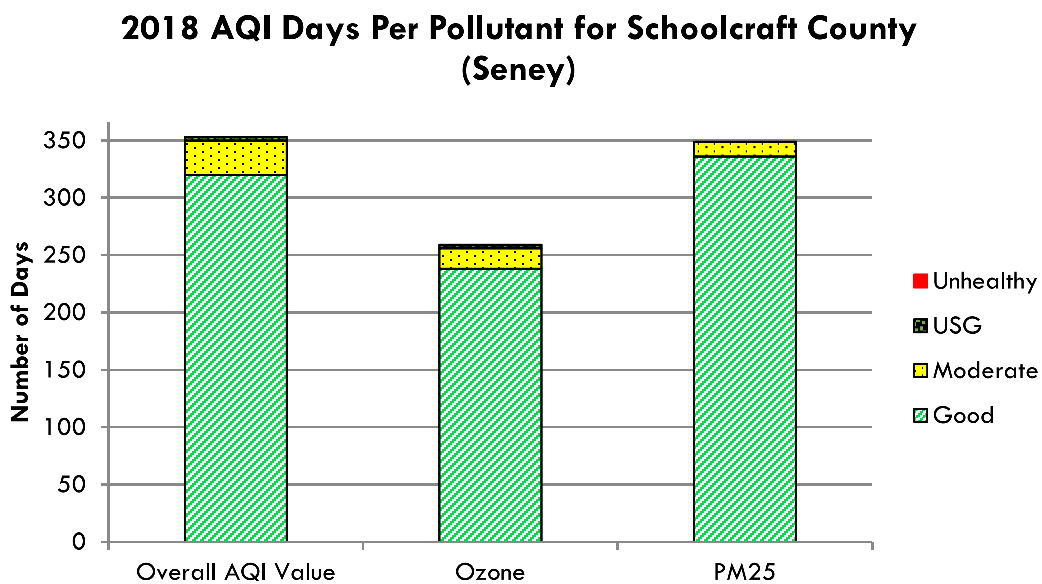


Figure C8: AQI Summary for Upper Peninsula







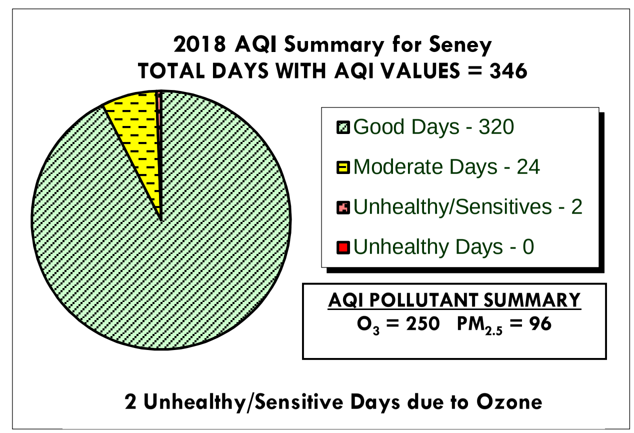
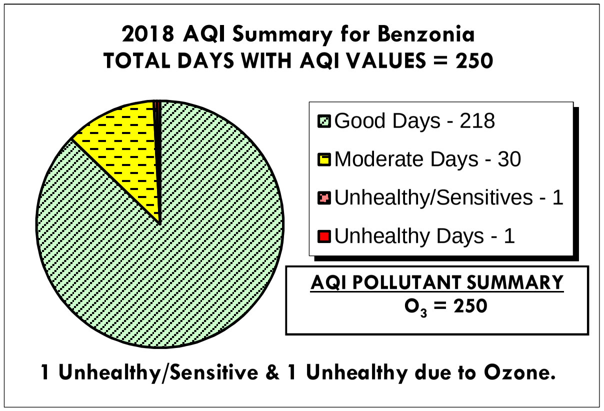
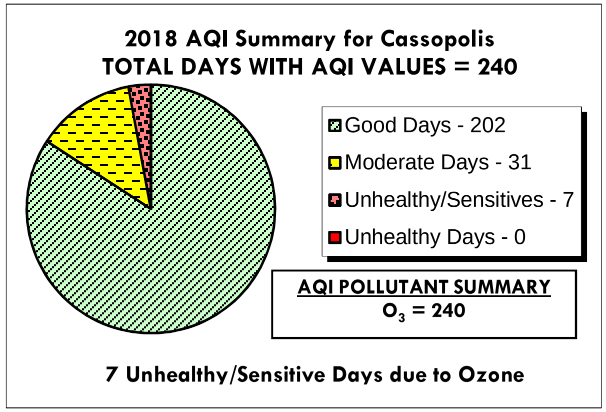
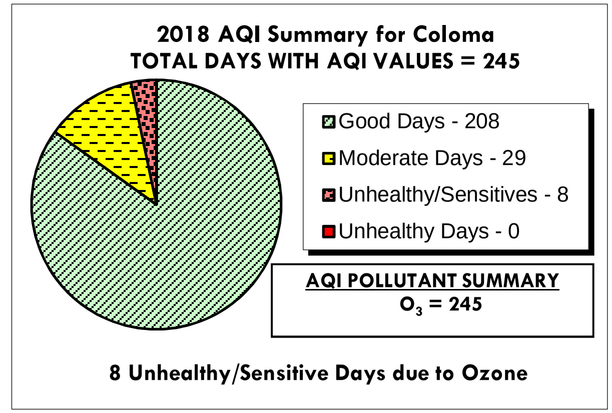
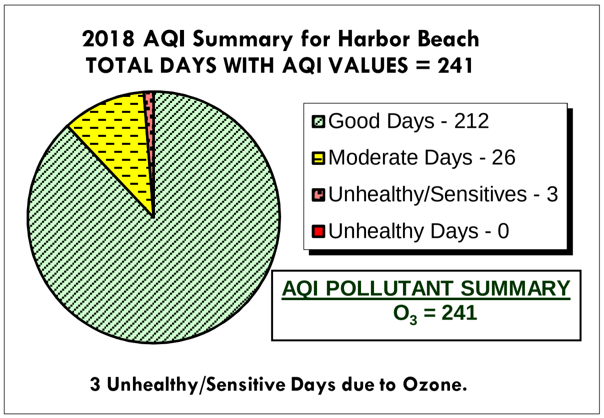


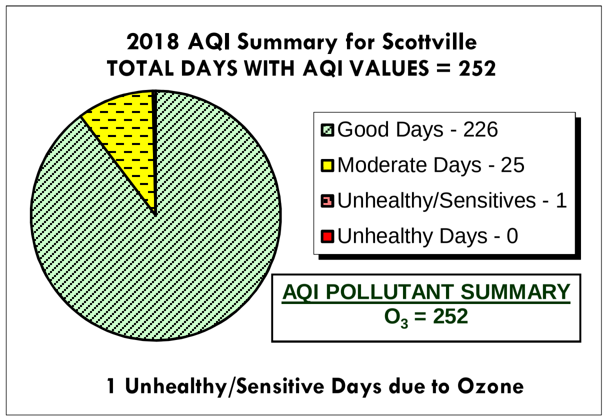
Figure C9: AQI Summaries for Michigan's Other Lower Peninsula Areas





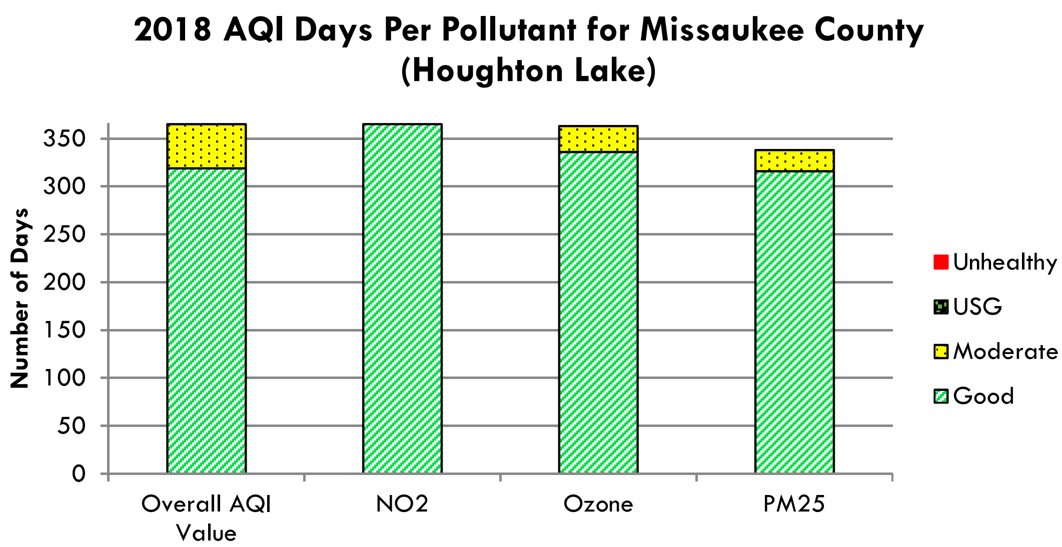


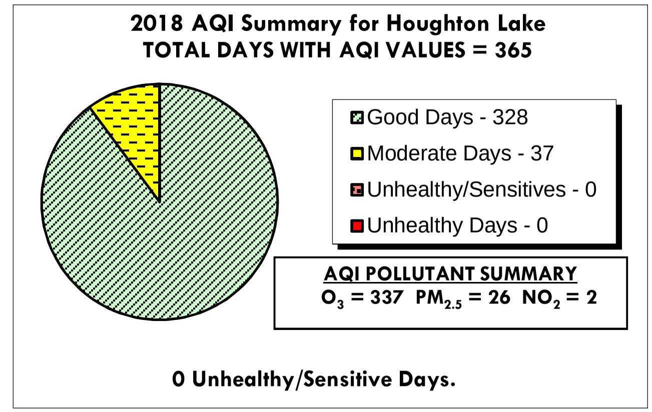


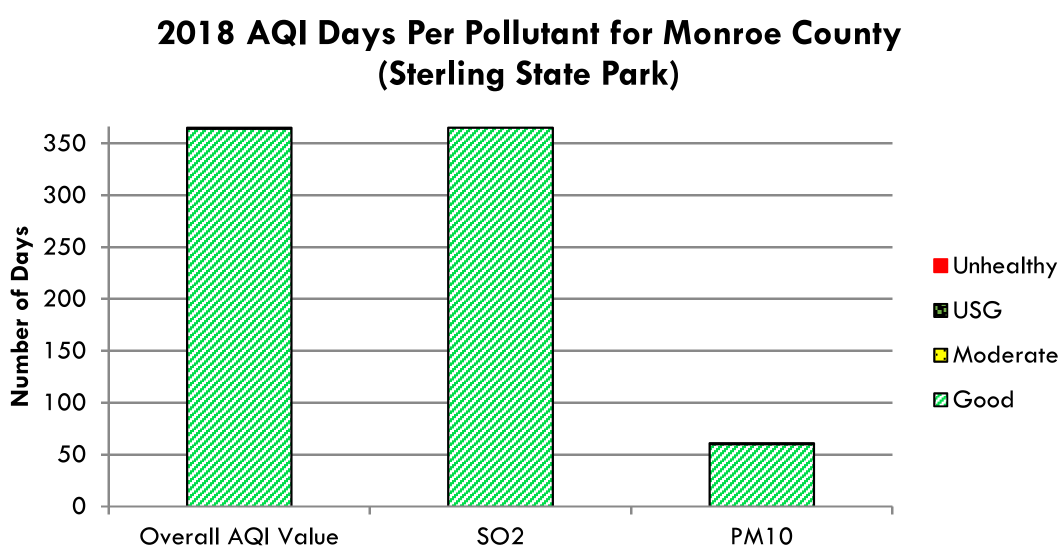


NOTE: These sites do not have AQI per pollutant graphs since only one pollutant is monitored in one location in these areas.

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







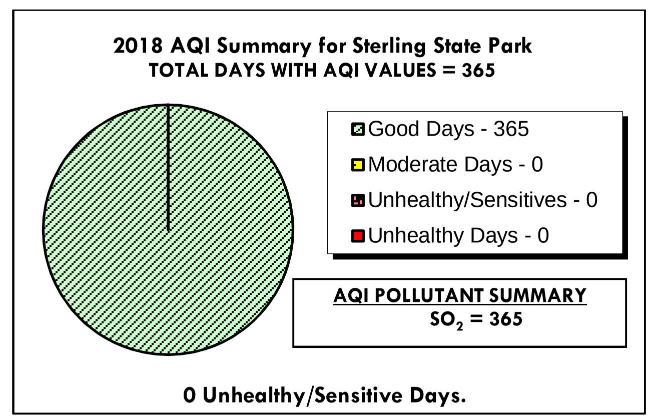
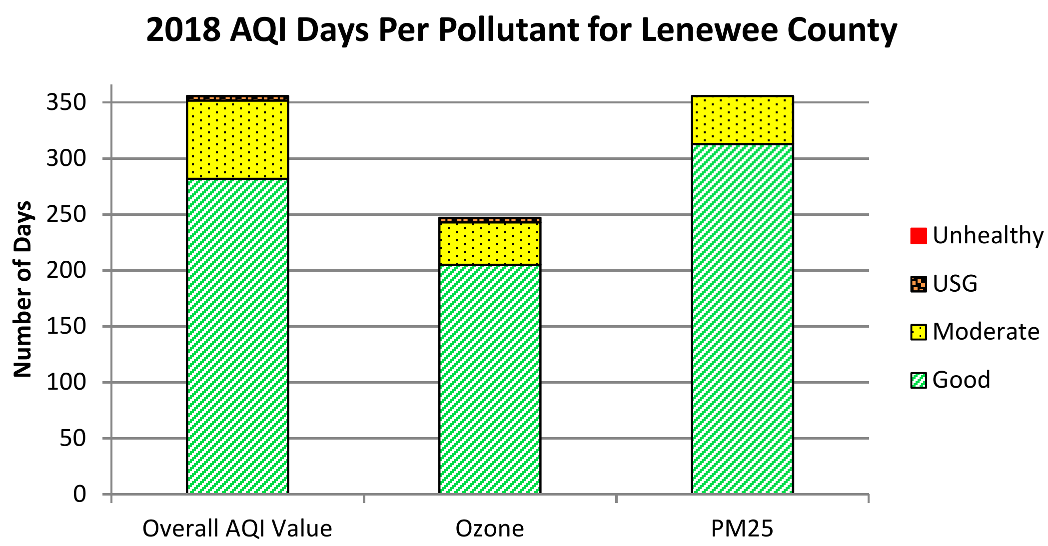
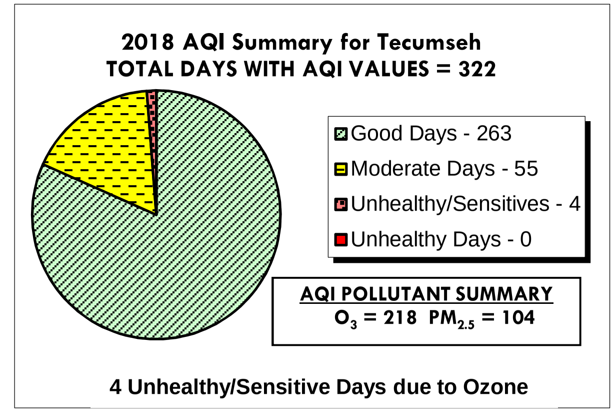
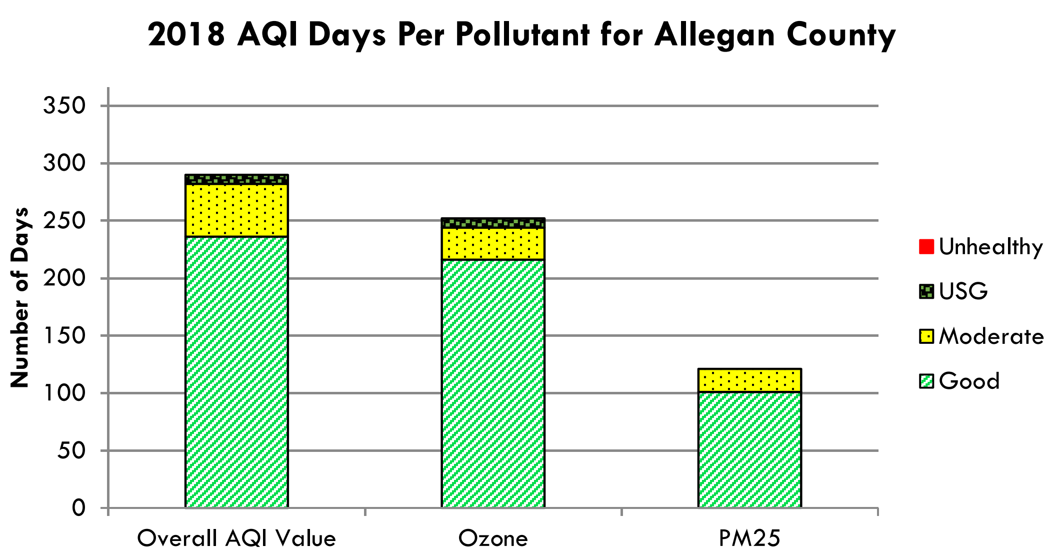


Figure C9, continued: AQI Summaries for Michigan's Other Lower Peninsula Areas







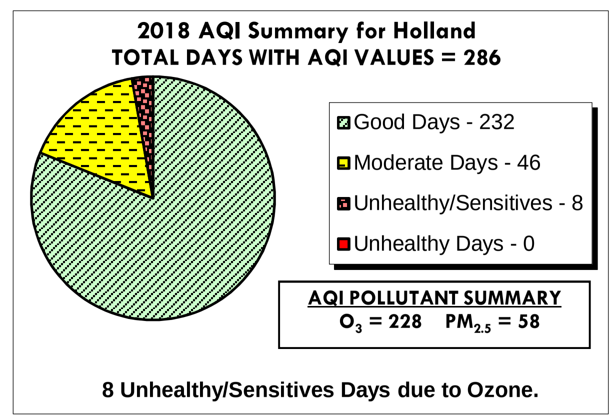
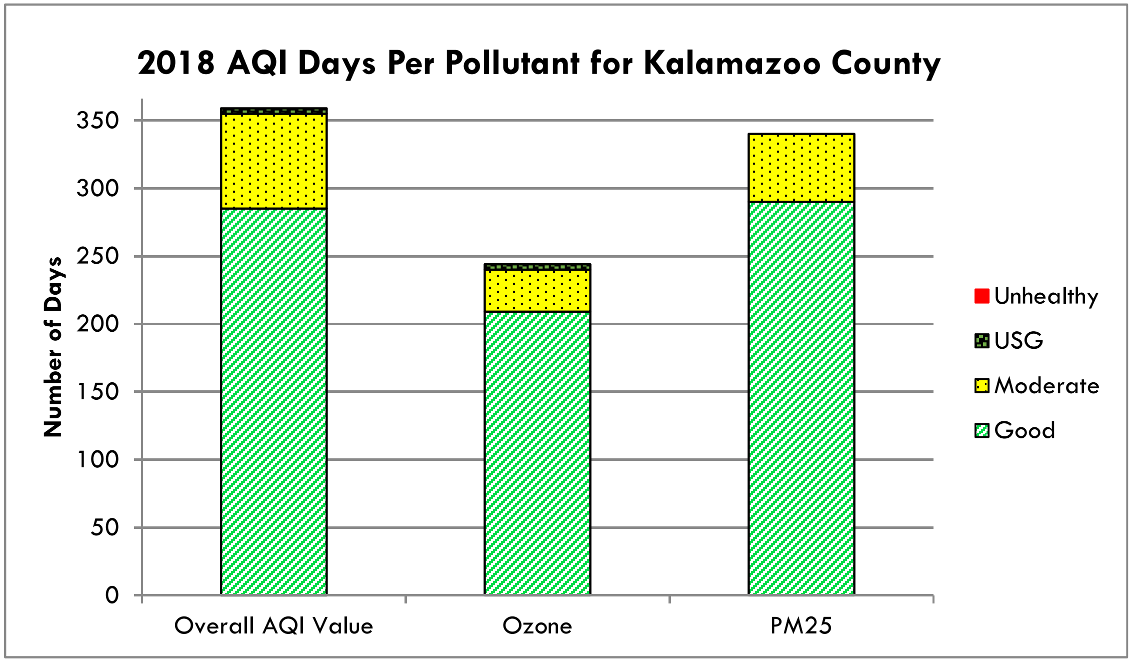
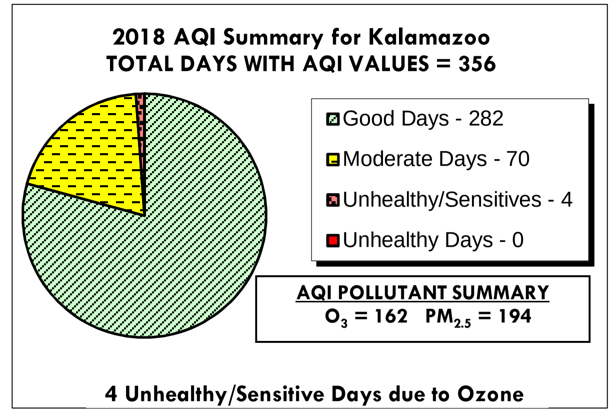


Figure C9, continued: AQI Summaries for Michigan's Other Lower Peninsula Areas





APPENDIX D

Appendix D summarizes the development of the NAAQS and how compliance with these standards is determined. Also included is the variety of monitoring techniques, requirements used to ensure quality data is obtained, and a history of NAAQS changes that have occurred since the inceptions of the CAA.

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 2018. The concentrations are listed as parts per million (ppm), micrograms per cubic meter ($\mu g/m^3$), and/or milligrams per cubic meter (mg/m^3).

Table 1.1: NAAQS in Effect during 2018 for Criteria Pollutants

Pollutant	Primary (health) Level	Primary Averaging Time	Secondary (welfare) Level	Secondary Averaging Time
Carbon Monoxide (CO) 8-hour average	9 ppm (10 mg/m^3)	8-hour average, not to be exceeded more than onceper year *(1971)*	None*	None*
Carbon Monoxide (CO) 1-hour average	35 ppm (40 mg/m^3)	1-hour average, not to be exceeded more than once per year *(1971)*	None*	None*
Lead (Pb)	0.15 $\mu g/m^3$	Maximum rolling 3-month average *(2008)*	Same as Primary	Same as Primary
Nitrogen Dioxide (NO_2) Annual mean	0.053 ppm (100 $\mu g/m^3$)	Annual mean *(1971)*	Same as Primary	Same as Primary
Nitrogen Dioxide (NO_2) 1-hour average	0.100 ppm	98^{th} percentile of 1-hour average, averaged over 3 years *(2010)*	Same as Annual	Same as Annual
Particulate Matter (PM_{10})	150 $\mu g/m^3$	24-hour average, not to be exceeded more than once per year over 3 years *(1987)*	Same as Primary	Same as Primary
Particulate Matter ($PM_{2.5}$) Annual average	12.0 $\mu g/m^3$	Annual mean averaged over 3 years *(2012)*	15.0 $\mu g/m^3$	Annual mean
Particulate Matter ($PM_{2.5}$) 24-hour average	35 $\mu g/m^3$	98^{th} percentile of 24-hour concentration, averaged over 3 years *(2006)*	Same as Primary	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	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 three 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_{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 EGLE, the AQD provides an annual Network Review document[12] 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.

Types of Monitors

Federal Reference Method (FRM): method of sampling and analyzing the ambient air for an air pollutant that USEPA uses as the "gold standard" for measuring that pollutant. FRM monitors are used to designate attainment/nonattainment areas. The gaseous pollutants CO, NO_2, O_3, and SO_2 are measured with continuous FRM monitors that provide real-time hourly data. The FRM for PM and Pb requires a filter that measure concentrations over a 24-hour period. These filters must be further analyzed in a laboratory; therefore, the samples results are delayed.

[12] Most recent Network Reviews are available online at: https://www.michigan.gov/deq/0,4561,7-135-3310_70316_4195---,00.html

Rural background monitors: measure background air quality in non-urban areas

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.

EC/OC instruments measure elemental carbon using pyrolysis coupled with a nondispersive infrared detector to separate the elemental and organic carbon fractions.

Federal Equivalent Method (FEM): method for measuring the concentration of an air pollutant in the ambient air that has been designated as equivalent to the FRM.

Continuous Monitors: measure data in real-time, meaning concentrations of the air pollutant are usually available within an hour on the MIair website.

TEOM: tapered element oscillating monitors (TEOMs) are continuous PM monitor that is used only for real-time data indications since they are not FEMs and cannot be used for attainment/nonattainment designations.

BAM: Beta attenuation monitors (BAMs) are real-time, continuous PM2.5 monitor that is FEM, thus can be used for attainment/nonattainment designation.

$PM_{2.5}$ FRM Monitoring: The concentrations of $PM_{2.5}$ measured over a 24-hour time period are determined using the filter-based gravimetric FRM. 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 $PM_{2.5}$.

Chemical Speciation Monitoring: Speciated monitoring provides a better understanding of the chemical composition of $PM_{2.5}$ material and better characterizes background levels. Single event Met-One Speciation Air Sampling System (SASS) monitors are used throughout Michigan's speciation network

National Air Toxics Trend Station (NATTS): Network developed to fulfill the need for long-term hazardous air pollutants (HAPs) monitoring data of consistent quality. Among the principle objectives are assessing trends and emission reduction program effectiveness, assessing and verifying air quality models.

NCore Network: began January 1, 2011, as part of the USEPA's 2006 amended air monitoring requirements. National Core (NCore) sites provide a full suite of measurements at one location. NCore stations collect the following measurements: ozone, SO_2 (trace), CO (trace), NO_Y (reactive oxides of nitrogen), $PM_{2.5}$ FRM, continuous $PM_{2.5}$, speciated $PM_{2.5}$, wind speed, wind direction, relative humidity, and ambient temperature. In addition, filter-based measurements are required for PM coarse ($PM_{10-2.5}$) on a once every three-day sampling frequency. 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.

Near-road Monitoring Network: focuses on vehicle emissions and how they disperse near roadways, was approved by USEPA in 2011. 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. 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.

Population-Oriented Monitors: monitors that are located in an area where many people live, also considered ambient air.

Transport monitors: measure air pollutants that that have travelled a distance from the emission sources and are formed in the atmosphere when certain pollutants are present, like ozone.

Source-Oriented/Point-Source Monitors: monitors that are located near a specific emissions source (e.g., factory) of a pollutant.

Primary Monitor: data from these monitors are used to compare to the NAAQS and must meet quality assurance criteria.

Secondary/Precision/Co-located Monitor: two or more air samplers, analyzers, or other instruments that are operated simultaneously while located side by side. These are used for quality assurance purposes.

Urban Scale Monitors: measures air pollution concentrations in more populated urban areas.

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.

Historical NAAQS Changes

<table>
<tr><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>2010</th><th>2012</th><th>2015</th></tr>
<tr><td></td><td colspan="10">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.</td></tr>
<tr><td></td><td></td><td colspan="5">Calendar quarter average of 1.5 µg/m³ not to be exceeded</td><td colspan="4">3-month average of 0.15 µg/m³ not to be exceeded</td></tr>
<tr><td>NO_2</td><td colspan="7">Annual average of 53 ppb or less.</td><td colspan="3">98th percentile of the 1-hour concentration averaged over 3 yrs is 100 ppb or less</td></tr>
<tr><td>SO_2</td><td colspan="7">24-Hour concentration of 0.14 ppm not exceeded more than once per year.
Annual average of 0.03 ppm or less.</td><td colspan="3">1-hour average of 99th percentile is 75 ppb or less, averaged over 3 yrs.
Previous revoked</td></tr>
<tr><td>Ozone</td><td colspan="2"><u>Total photochemical oxidants</u>:
1-hour max of 0.08 ppm not exceeded once per yr</td><td colspan="2">1-hour maximum concentration is 0.12 ppm one or less hour per yr</td><td colspan="2">4th highest daily maximum 8-hour concentration averaged over 3 yrs is 0.08 ppm or less</td><td colspan="3">4th highest daily maximum 8-hour concentration averaged over 3 yrs is 0.075 ppm or less</td><td>4th highest daily maximum 8-hour concentration averaged over 3 yrs is 0.070 ppm or less</td></tr>
<tr><td>TSP & PM_{10}</td><td colspan="3"><u>TSP</u>: 24-hour average not to exceed 260 µg/m³ more than once per yr
Annual geometric mean of 75 µg/m³</td><td colspan="2"><u>PM_{10}</u>: 24-hour average not to exceed 150 µg/m³ more than once per yr on average over a 3-yr period
Annual mean of 50 µg/m³ or less average over 3 yrs</td><td colspan="5">Annual average revoked
24-hour average retained</td></tr>
<tr><td>$PM_{2.5}$</td><td colspan="4"></td><td>Annual mean of 15.0 µg/m³ or less average over 3 yrs.
98th percentile of 24-hour average of 65 µg/m³ or less averaged over 3 yrs</td><td colspan="3">Annual mean retained.
98th percentile of 24-hour average of 35 µg/m³ or less averaged over 3 yrs</td><td colspan="2">Annual mean of 12.0 µg/m³ or less average over 3 yrs.
98th percentile of 24-hour average retained</td></tr>
</table>

APPENDIX E: ACRONYMS AND THEIR DEFINITIONS

> .... Greater than
< .... Less than
≥ .... Greater than or equal to
≤ .... Less than or equal to
%........................... Percent
µg/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
EC/OC .... Elemental carbon/Organic carbon
EGLE .... Michigan Department of Environment, Great Lakes and Energy
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
NMH 48217 .... New Mount Hermon 48217 ZIP code monitoring site
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
$PM_{10-2.5}$ .... 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

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