Wisconsin Department of Natural Resources

Wisconsin Air Quality Trends

April 2014

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Acronyms and Abbreviations

AQI: Air Quality Index

BAM/AM: Bureau of Air Management

CAA: Clean Air Act

CASAC: Clean Air Scientific Advisory Committee

CBSA: County Based Statistical Area

EOM: Enhanced Ozone Monitoring

FEM: Federal Alternate Method

FRM: Federal Reference Method

NAAQS: National Ambient Air Quality Standards

O_3: Ozone

NOx: Oxides of nitrogen

PAMS: Photochemical Assessment Monitoring Site

$PM_{2.5}$: Particulate Matter 2.5 micron or smaller in size

PPB: Parts Per Billion

SLAMS: State and Local Air Monitoring Sites

SO_2: Sulfur dioxide

US EPA: United States Environmental Protection Agency

VOC: Volatile Organic Compound

WDNR: Wisconsin Department of Natural Resources

Introduction and Background

Federal Regulatory History

The Clean Air Act requires US EPA to set NAAQS for pollutants considered harmful to public health and the environment. The technical basis for the NAAQS is provided through the independent advice of the CASAC. The current standards for fine particulate ($PM_{2.5}$) and Ozone are:

$PM_{2.5}$ (Annual) 15 micrograms per cubic meter ($\mu g/m^3$)*
$PM_{2.5}$ (24 hour) 35 micrograms per cubic meter ($\mu g/m^3$)
O_3 (8 hour) 75 parts per billion (ppb)**
SO2 (24 hour) 140 parts per million (ppm)
SO2 (1 hour) 75 parts per million (ppm)

*Note: The annual standard for $PM_{2.5}$ is currently 12 micrograms per cubic meter (effective January 2014), but all information identified here should be compared to 15 micrograms per cubic meter

**Note: A lower ozone standard is expected to be proposed by US EPA in late 2014

Fine Particulate ($PM_{2.5}$)

Particle pollution is made up of a number of components, including acids, organic chemicals, metals, soil or dust, and allergens. Fine particle pollution can be emitted directly or formed secondarily in the atmosphere.

Health studies have shown that there is an association between exposure to fine particles and premature death from heart or lung disease. Individuals that may be most sensitive to fine particle exposure include people with heart or lung disease, older adults, and children.

The 1997 $PM_{2.5}$ 24-hour standard was established at 65 micrograms per cubic meter, determined by the 3-year average of the annual 98th percentile concentrations. The 1997 annual standard was established at 15 micrograms per cubic meter, based on the 3-year average of the annual mean $PM_{2.5}$ concentrations. In 2006, the 24-hour standard was lowered to 35 micrograms per cubic meter. In 2012, the annual standard was lowered to 12 micrograms per cubic meter, effective January 2014, but this report focuses on data through 2012.

In 2009, Milwaukee, Racine, and Waukesha counties were designated nonattainment by US EPA, based on monitoring data from 2006 – 2008 that showed those areas were not meeting the fine particulate standard set by US EPA. In June 2012, the DNR submitted a request to US EPA to redesignate these counties from nonattainment to attainment based on monitoring data collected between 2008 – 2011. All $PM_{2.5}$ monitors in the state have measured attainment levels since that time. US EPA proposed redesignation of the three county area to attainment. That proposal was finalized and published in the federal register on April 22, 2014.

Ozone

Ozone is a gas composed of three atoms of oxygen. Ozone can be found in the Earth's upper atmosphere and at ground level. Monitored values of ozone found in this report represent ground level ozone, which is not directly emitted into the air. Ozone found at higher levels in the atmosphere (stratospheric ozone) filters out harmful UV rays, while ground level (tropospheric) ozone is created by photochemical reactions between NO_x and VOC and can have an adverse impact on health. Ozone concentrations typically reach higher levels on hot sunny days in urban environments and can be transported long distances by wind.

Breathing ozone has been shown to be harmful to health and can cause problems like chest pain, coughing, throat irritation, and congestion. Children are at the greatest risk from exposure to ozone because their lungs are still developing.

Ozone has also been shown to affect vegetation and ecosystems.

In July 1997, US EPA announced an 8-hour ozone standard of 84 ppb, replacing the 1-hour standard to protect the public against longer term exposure. In March 2008, the 8 – hour standard was lowered to 75 ppb. The 8-hour standard is met when the three year average of the annual fourth highest daily maximum 8 – hour O3 concentration measured at a monitoring site is equal to or less than 75 ppb. US EPA is currently reviewing the ozone standard and is expected to propose a new standard in 2014.

Sulfur Dioxide (SO_2)

Sulfur dioxide (SO2) is a chemical compound that is one of a group of highly reactive gases known as 'oxides of sulfur'. It is a product of combustion, so the largest emission sources of SO2 are solid fossil fuel combustion from power plants and other industrial facilities.

Exposure to SO2 has been shown to cause a range of adverse respiratory effects, including bronchoconstriction and increased asthma symptoms. Additionally, emission sources that lead to high concentrations of SO2 also lead to the formation of other oxides of sulfur. Some of these other oxides can react with other compounds in the atmosphere to form fine particles, which can penetrate deep into the lungs.

US EPA first set standards for SO2 in 1971. A 24-hour primary standard was set at 140 ppb and an annual average standard at 30 ppb. A 3-hour secondary standard was also set to protect public welfare. In 1996, the standards were reviewed and US EPA decided not to revise them.

In 2010, USEPA revised the primary SO2 standard by establishing a new 1-hour standard at 75 ppb. US EPA revoked the two existing primary standards (24-hour and annual) because the 1-hour standard is more protective of public health.

Report Summary

WDNR monitors for many compounds including coarse particulate matter, nitrogen oxides, sulfur dioxide, carbon monoxide, lead, and toxics. The focus for the previous version of this report was fine particulate ($PM_{2.5}$) and ozone (O_3) because they are important health concerns, for which WDNR issues advisories. The addition of sulfur dioxide (SO_2) was made this year. Fine particles and ozone are regional pollutants, while sulfur dioxide is directly emitted from sources. There is a long history of SO2 monitoring in Wisconsin, but locations have varied over the years because SO2 is such a site-specific pollutant. The data shown in the report is for current monitoring sites that have a history of data long enough to create a 3-year design value. Note that the form of the standard prior to 2010 was 24-hours, but a 1-hour standard was added in 2010 and the 24-hour standard was revoked. To provide a clearer picture, 1-hour values were calculated for data prior to 2010 and 24-hour values were calculated for periods after 2010.

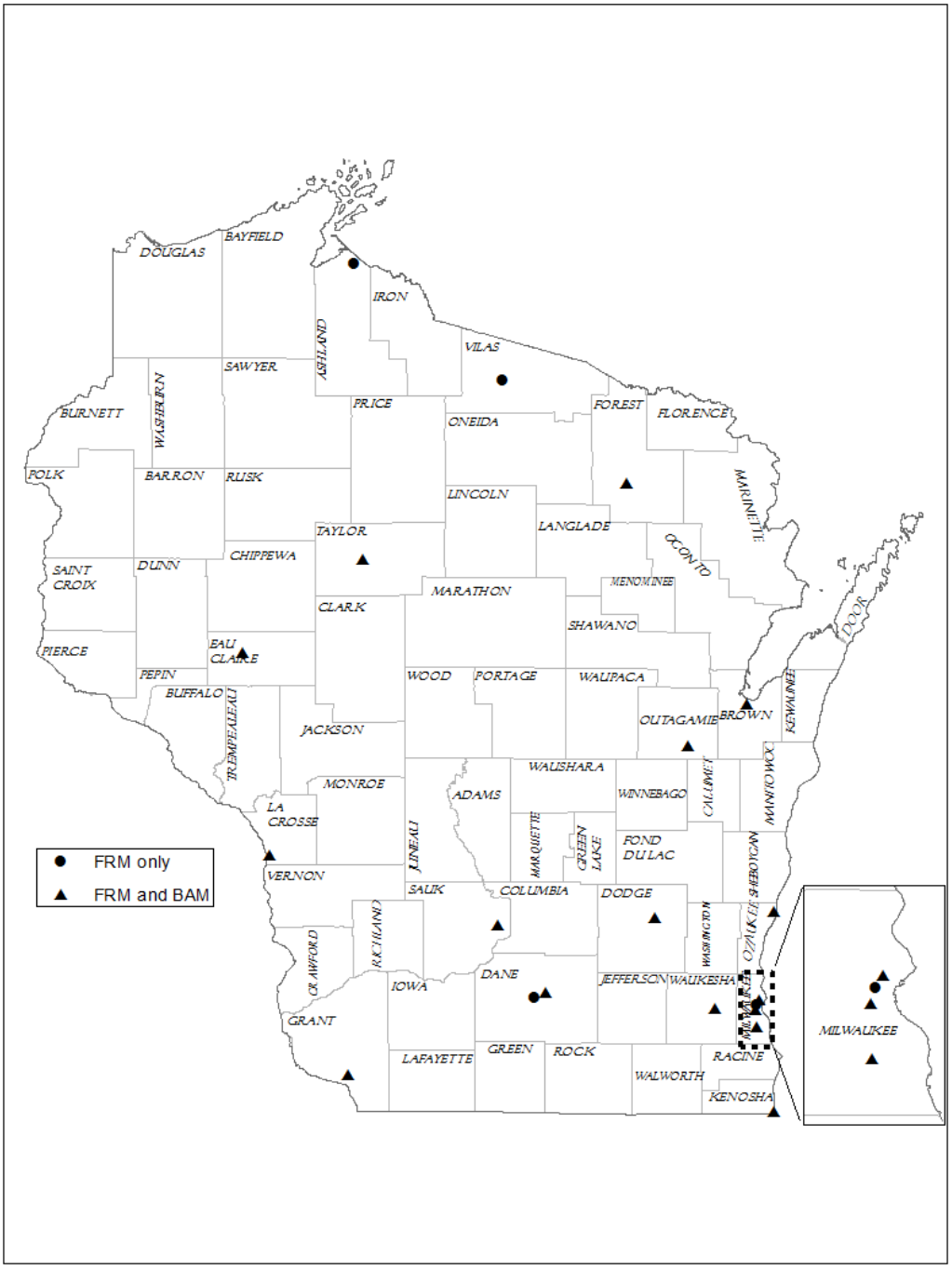
The trends in this report plotted along with the appropriate National Ambient Air Quality Standard (NAAQS) generally show that air quality has generally improved over the time period. There are counties that show trends of concern, and the WDNR is committed to working with partners in Wisconsin and other states in the region to improve air quality in those areas.

Annual differences in meteorological conditions can lead to variability in measured concentrations. The summer of 2012 was very hot with weather conditions that were conducive to the formation of ozone around Wisconsin. Milwaukee experienced a maximum temperature of 90 degrees or greater 20 times, which contributed to the lakeshore region's hottest summer on record. The ozone plots show slightly higher concentrations of ozone for many counties because of the meteorological conditions experienced in the summer of 2012. In contrast, the summer of 2013 was relatively cool and conditions were not conducive to ozone formation. Ozone data including 2013 will show a decrease in concentration, as compared to 2012. The WDNR will update trend charts within this report as data for 2013 reaches certification completion (after May 1 this year). While annual data is important to consider, long term trends in air quality guide decisions about management of air quality issues at the federal and state levels.

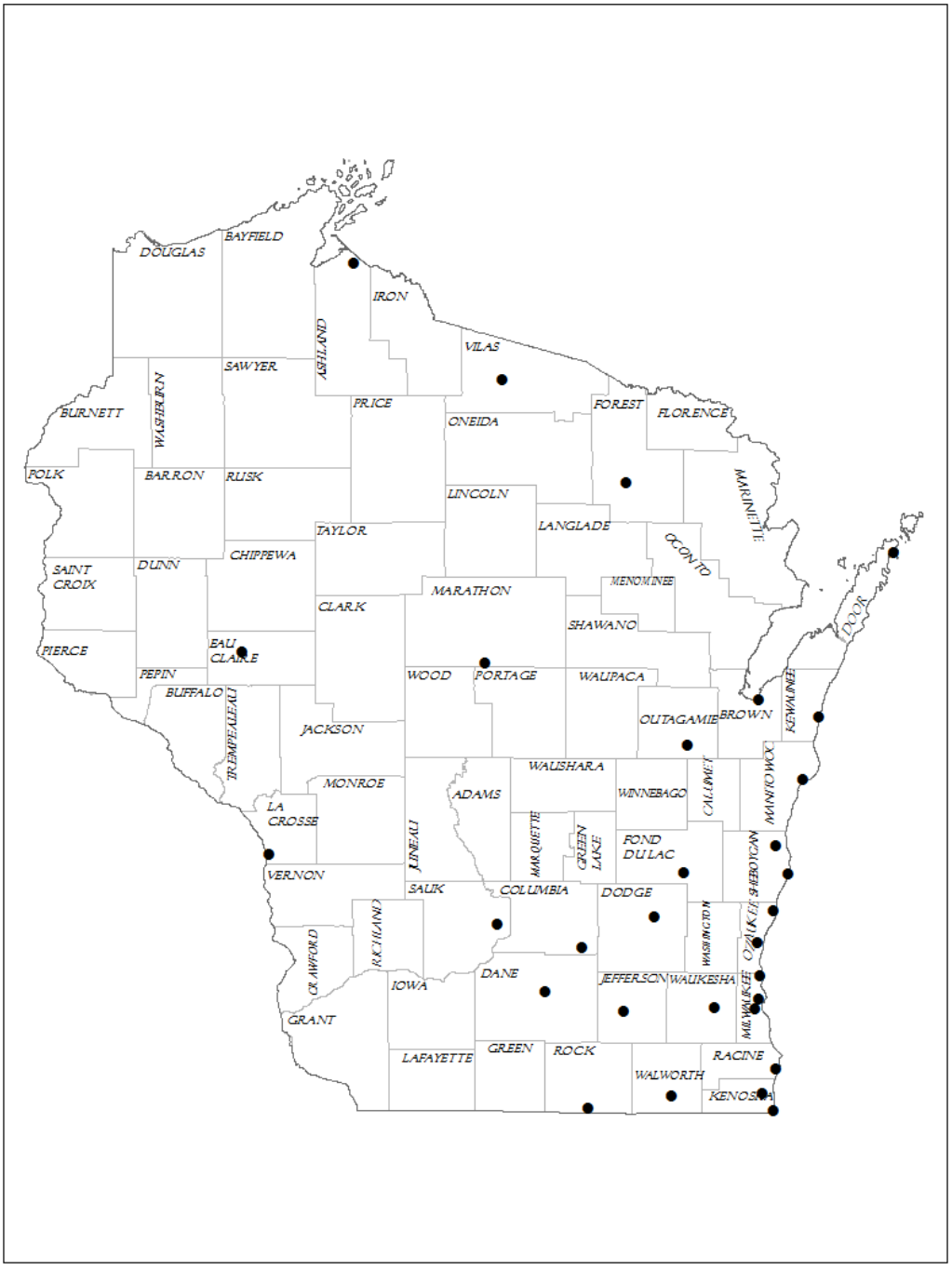
For the 2008 8-hour ozone standard, only Sheboygan County and a portion of Kenosha County (mainly east of I-94) are considered nonattainment.

The fine particulate information presented in this report is measured at WDNR sites containing Federal Reference Method monitors, which operate on a daily, every third day, or every sixth day basis. WDNR also operates a network of continuously operating monitors, which are the basis for real-time health advisories.

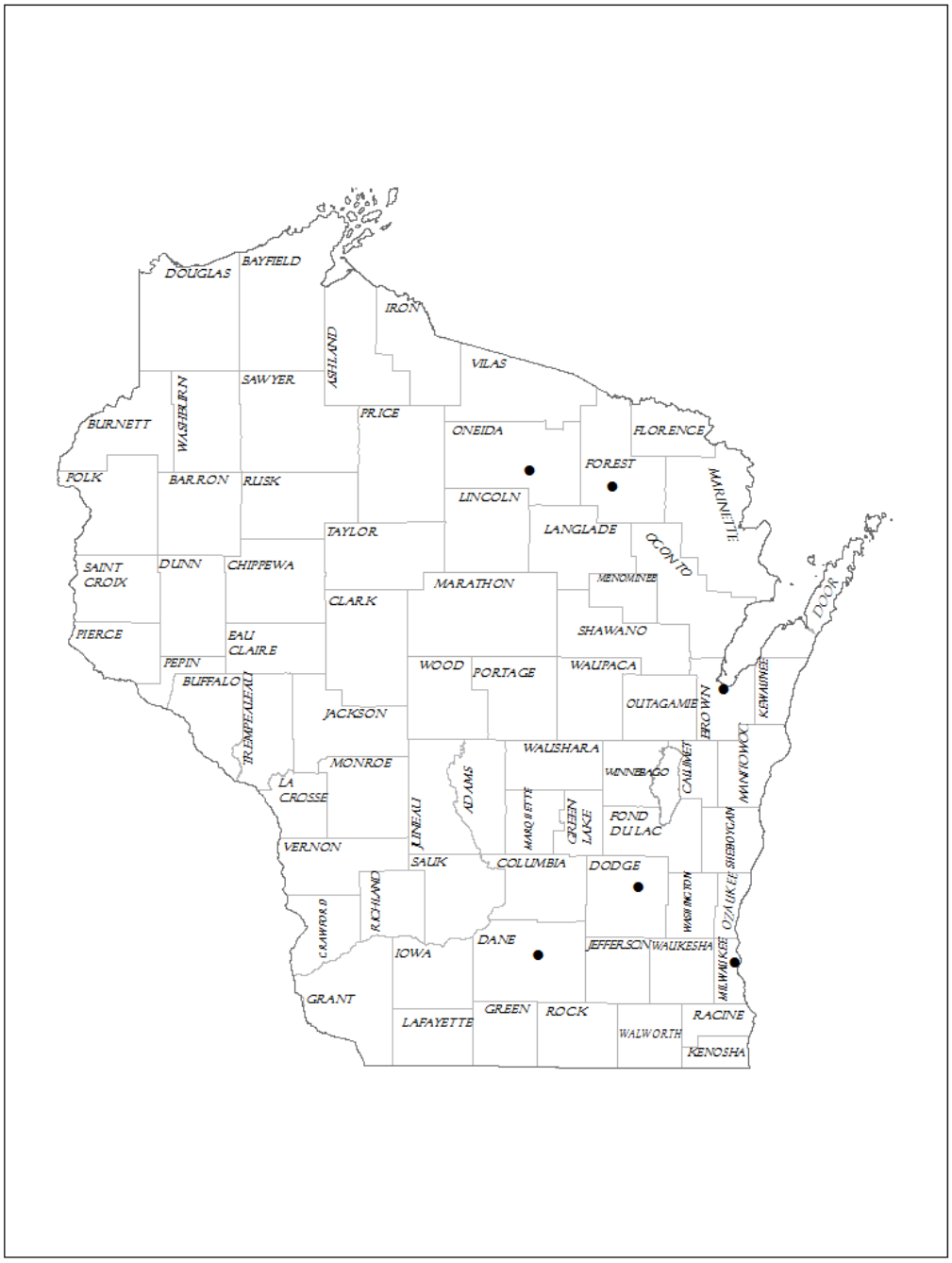
Fine Particle (PM2.5) Continuous (BAM) and Filter Based (FRM) Network Map



Ozone Network Map



Sulfur Dioxide Network Map

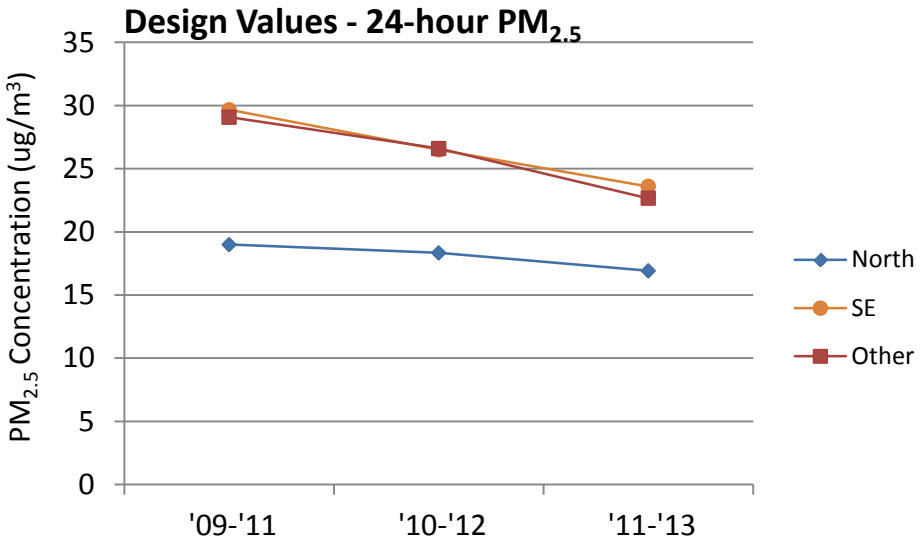


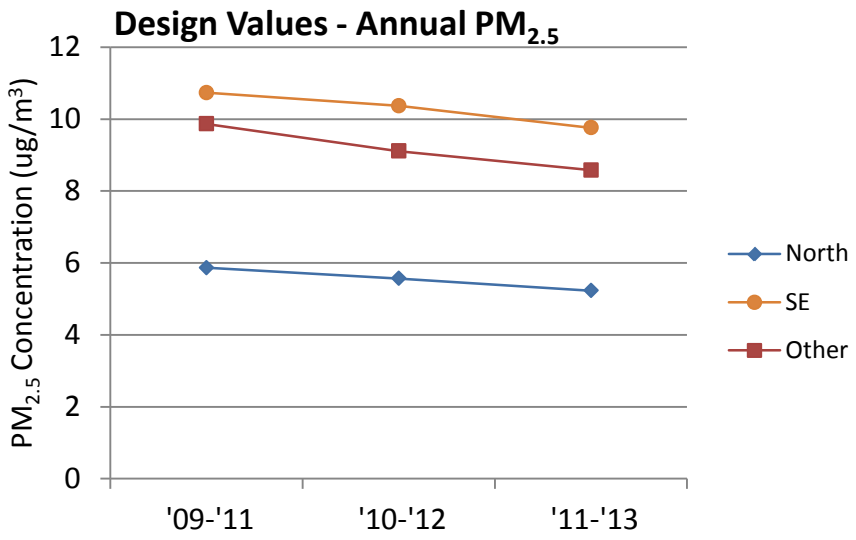
Air Quality by Region/Area

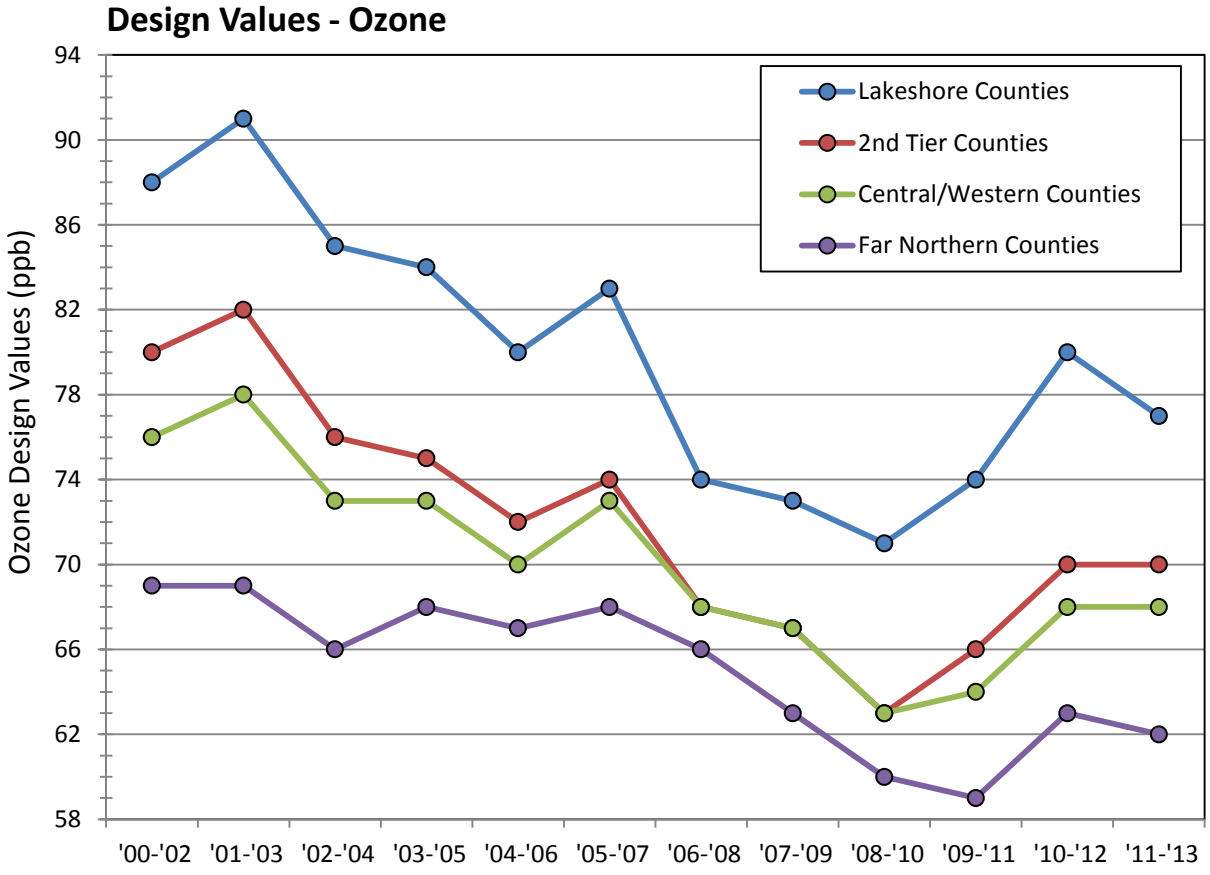
In order to understand air pollution in Wisconsin, it can be helpful to look at data by region. This kind of information can help guide efforts to reduce pollution because a focus can be placed on areas that experience the highest concentrations. The plots here also include draft monitored values for 2013 for each region. The monitored data for 2013 is in the process of being submitted for certification to US EPA.

The plots below show that both fine particles and ozone have generally decreased in concentration in all regions of the state. The fine particle plots examine the northern (rural) counties, southeast (urban) counties, and other (including central and western counties). The decrease in concentrations is very positive and is the result of cooperative regulatory control programs reducing emissions from vehicles and stationary sources in Wisconsin and the surrounding states.

The ozone plot presented here examines counties with respect to the Lake Michigan shoreline because it is widely known that concentrations along the lakeshore will generally be higher when compared to counties inland. Daytime heating, especially during the hot summer months leads to enhanced formation of ozone over the lake. Because of the relative properties of land and water, the land will heat up greater than water on a warm summer day. The temperature difference leads to pressure differences, which cause an on-shore or lake breeze. This lake breeze pushes ozone on shore, causing greater concentrations of ozone in the lakeshore counties.



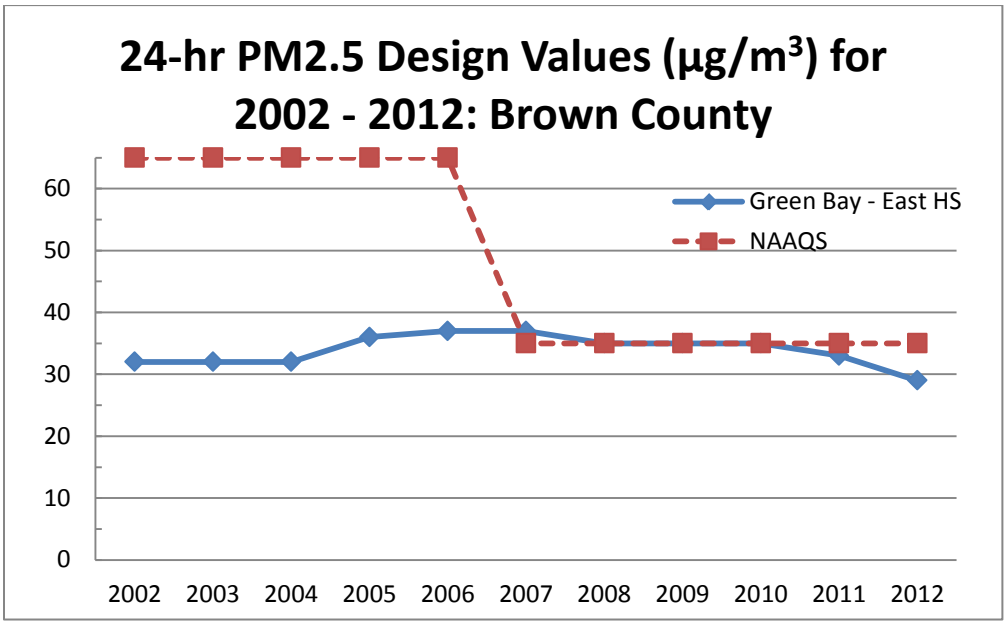

Design Values - Annual PM2.5
PM2.5 Concentration (ug/m3)
12
10
8
6
4
2
0
'09-'11
'10-'12
'11-'13
North
SE
Other

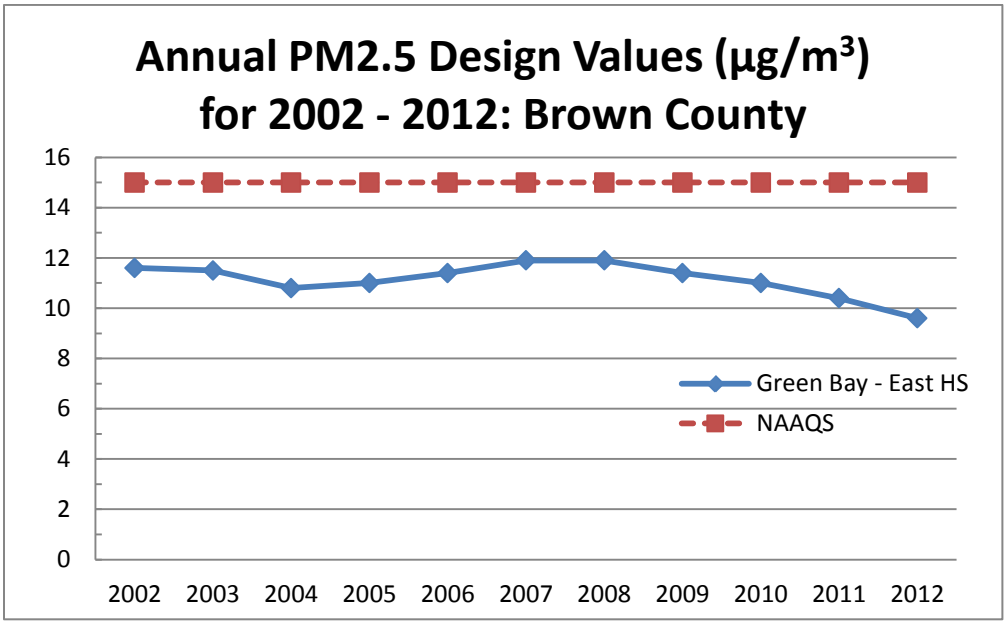

Design Values - Ozone
Ozone Design Values (ppb)
94
90
86
82
78
74
70
66
62
58
'00-'02
'01-'03
'02-'04
'03-'05
'04-'06
'05-'07
'06-'08
'07-'09
'08-'10
'09-'11
'10-'12
'11-'13
Lakeshore Counties
2nd Tier Counties
Central/Western Counties
Far Northern Counties

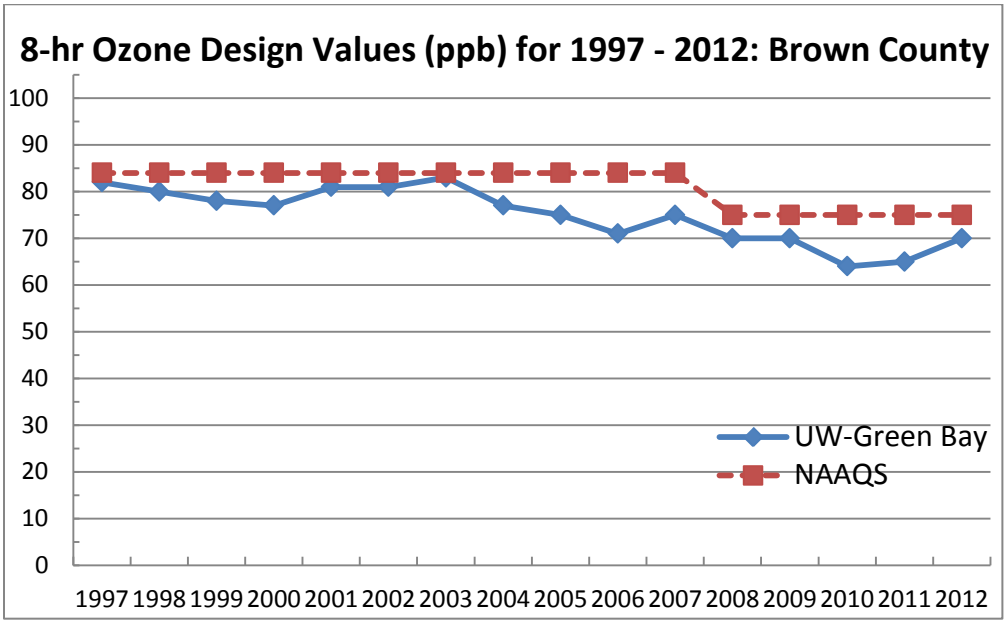
Air Quality by County

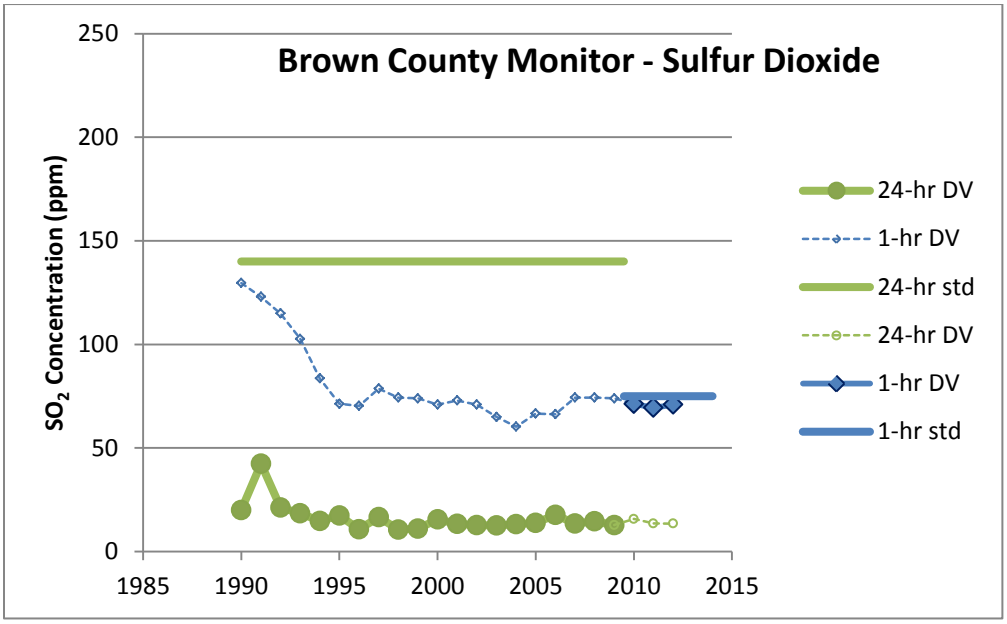
Brown County

$PM_{2.5}$ and SO_2 monitoring in Brown County is done at Green Bay East High School, located at 1415 East Walnut Street. Ozone monitoring in Brown County takes place at the University of Wisconsin – Green Bay.





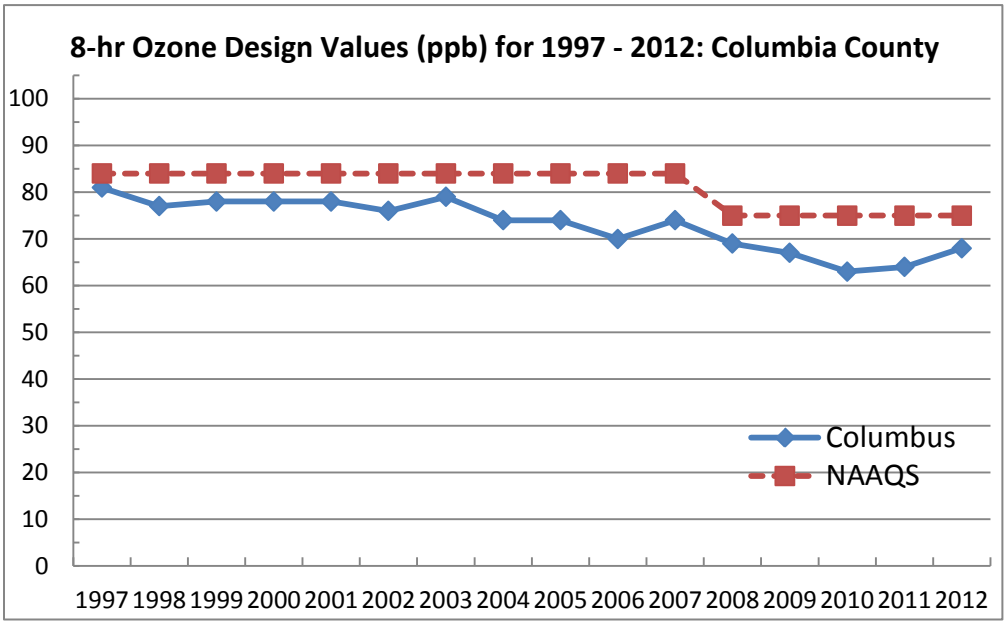




SO2 plot: Note that the form of the standard prior to 2010 was 24-hours, but a 1-hour standard was added in 2010 and the 24-hour standard was revoked. To provide a clearer picture, 1-hour values were calculated for data prior to 2010 and 24-hour values were calculated for periods after 2010.

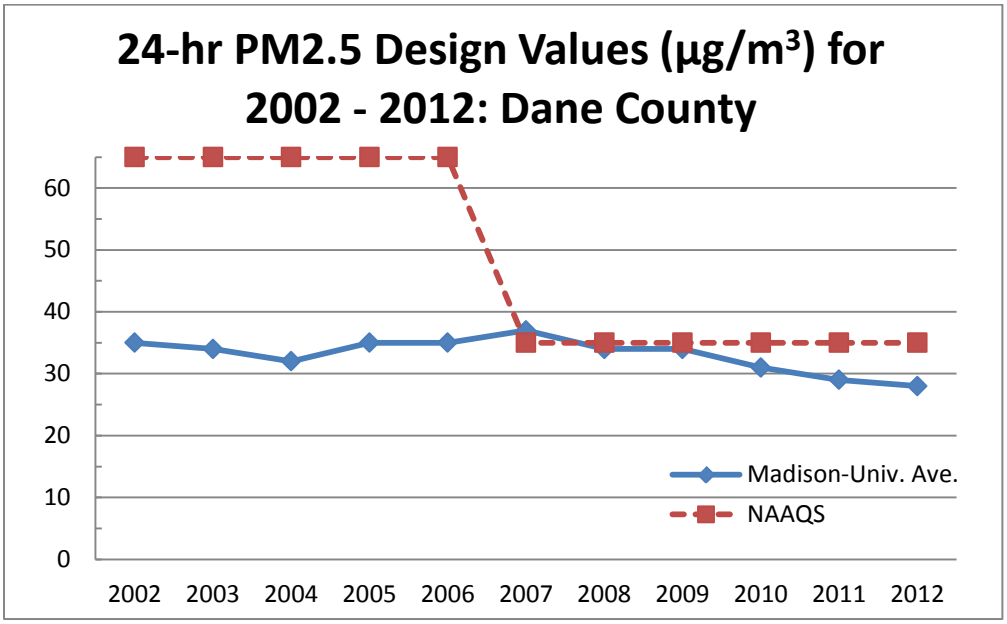
Columbia County

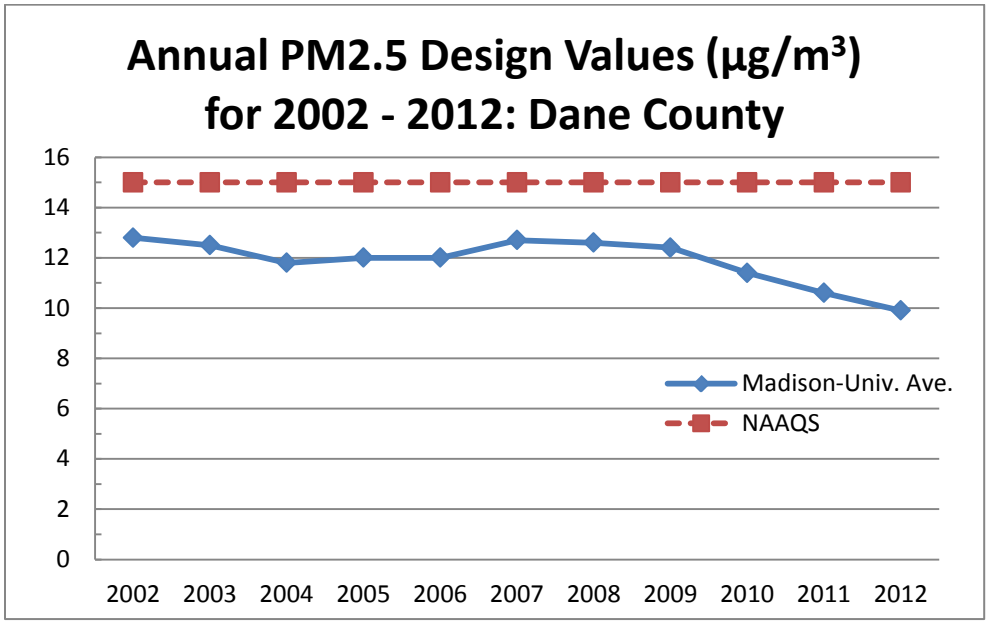
Ozone monitoring in Columbia County is done at a rural location on Wendt Road in Columbus Township. The ozone monitor serves as the downwind ozone instrument in the Madison CBSA.

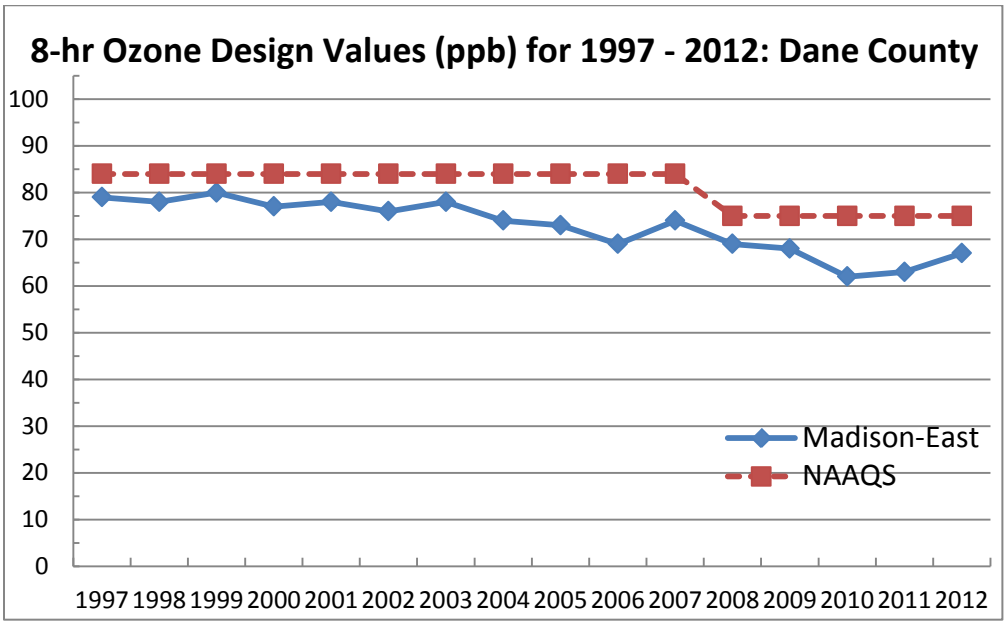


Dane County

$PM_{2.5}$ monitoring in Dane County is currently done at Madison East High School and Madison – University Avenue, but East High School $PM_{2.5}$ monitoring did not begin until 2010 and therefore is not shown in this report. The Madison East site is located at 2302 North Hoard Street, next to the Madison East High School Sports Field. The University Avenue site is at 2757 University Avenue. Ozone monitoring is done at Madison East High School.

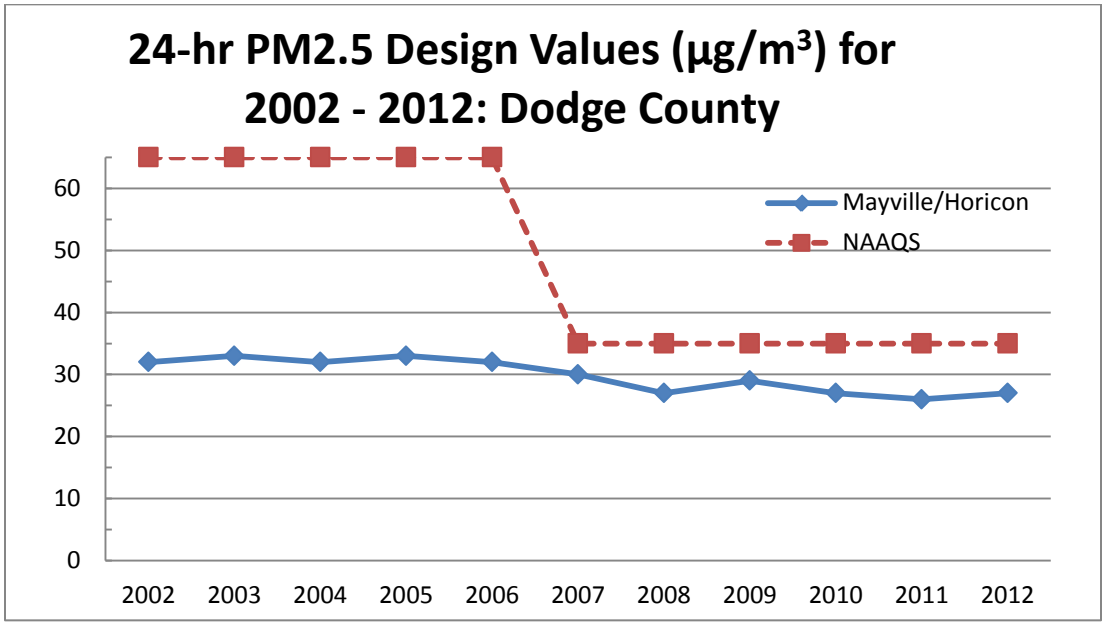


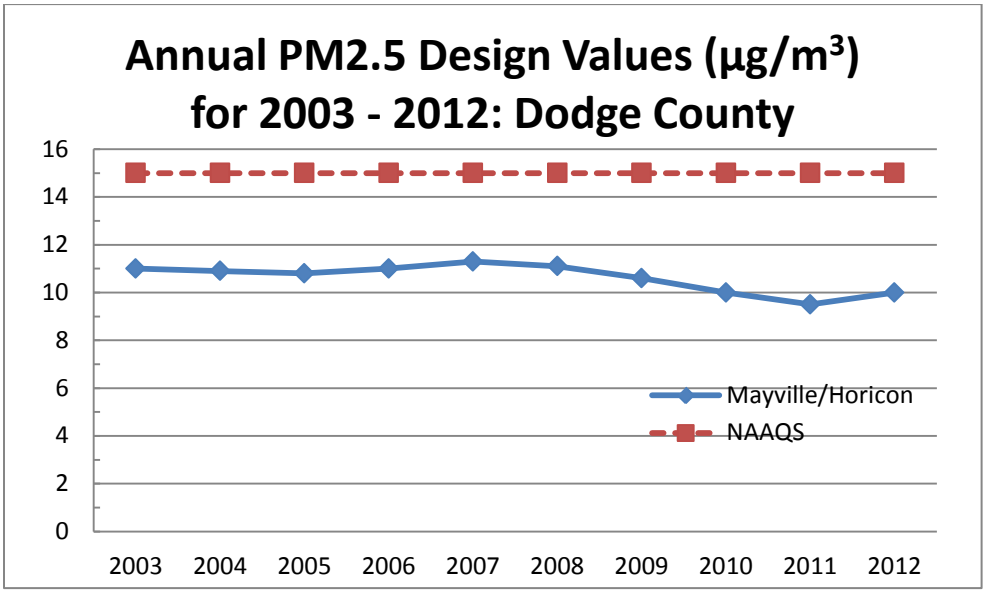


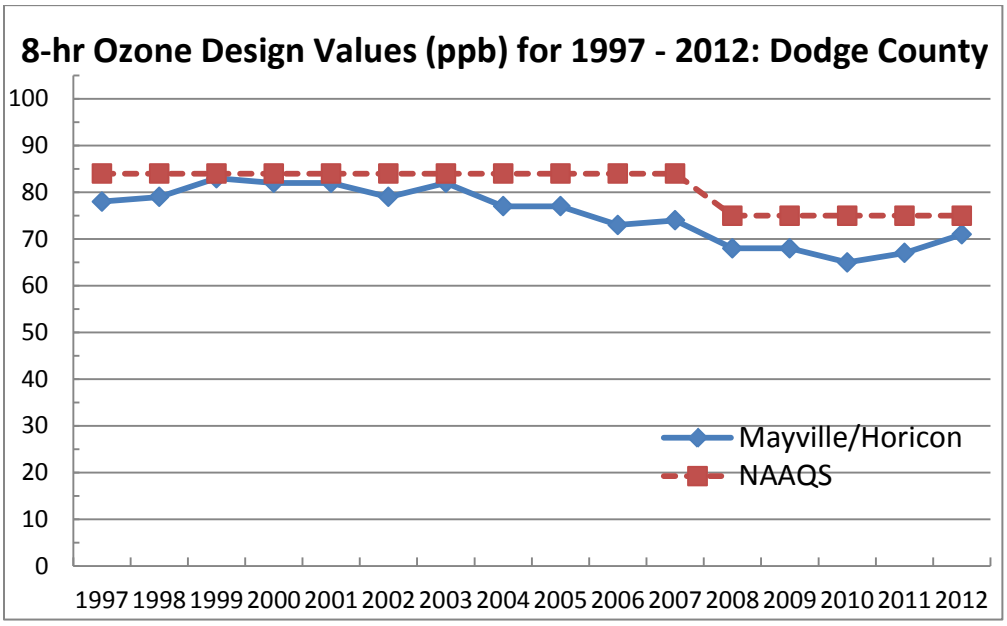


Dodge County

$PM_{2.5}$ monitoring in Dodge County is done at the Horicon Wildlife Area monitoring station located at 1210 North Palmatory Street. The Horicon site began sampling for daily $PM_{2.5}$ on December 18, 2009 and for ozone on January 22, 2010. Prior to these dates, sampling in Dodge County was performed at a site near Iron Ridge. Consequently, data from both sites is used to calculate design values for 2010, 2011, and 2012.

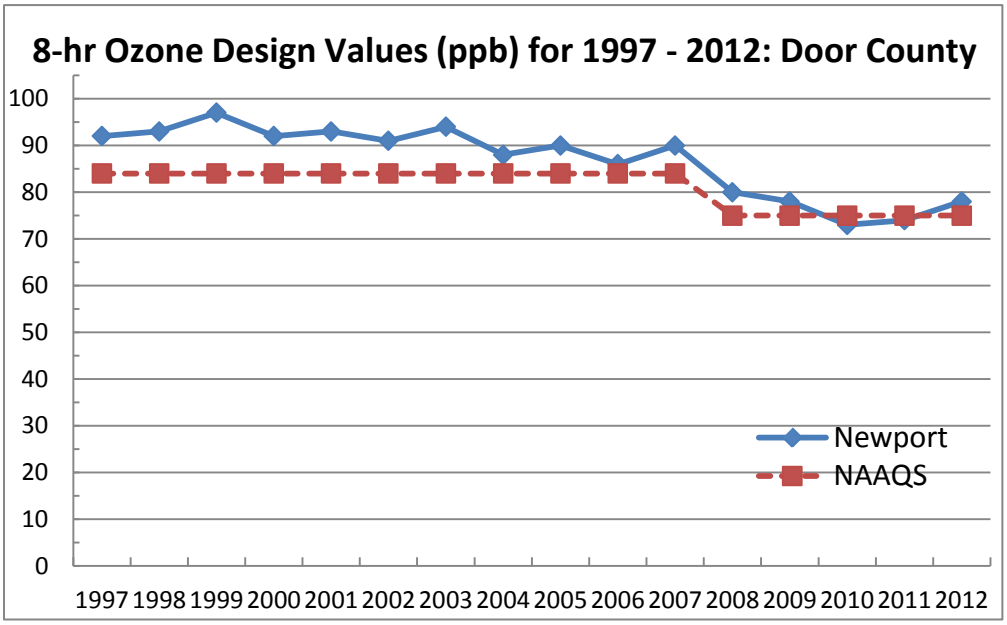



Annual PM2.5 Design Values (µg/m³) for 2003 - 2012: Dodge County
16
14
12
10
8
6
4
2
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Mayville/Horicon
NAAQS


8-hr Ozone Design Values (ppb) for 1997 - 2012: Dodge County
100
90
80
70
60
50
40
30
20
10
0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Mayville/Horicon
NAAQS

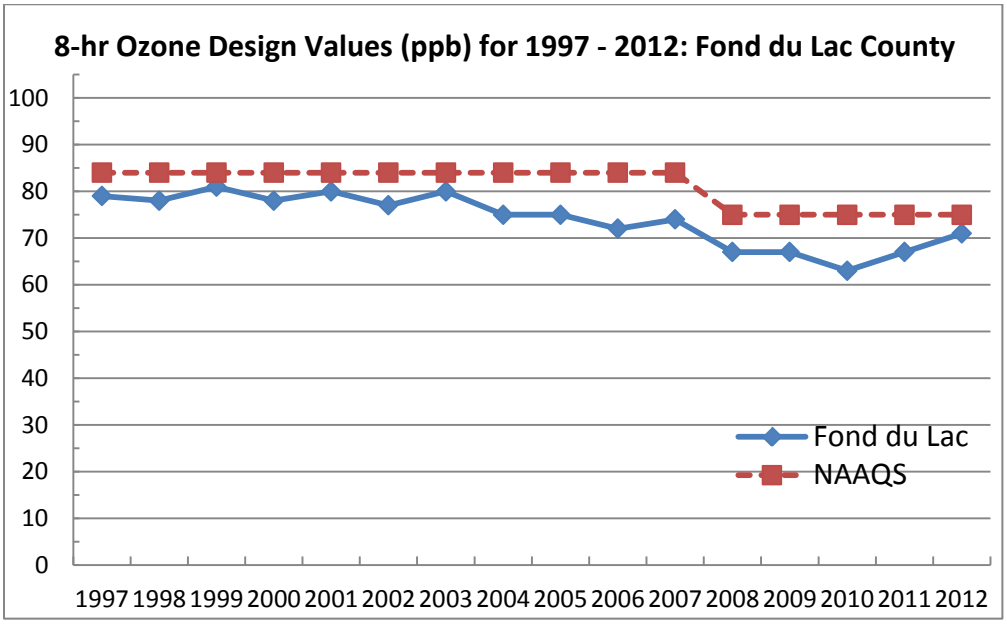
Door County

Ozone monitoring in Door County is done at Newport State Park at 475 County Trunk Highway NP in Ellison Bay. The monitor site is inside the state park.



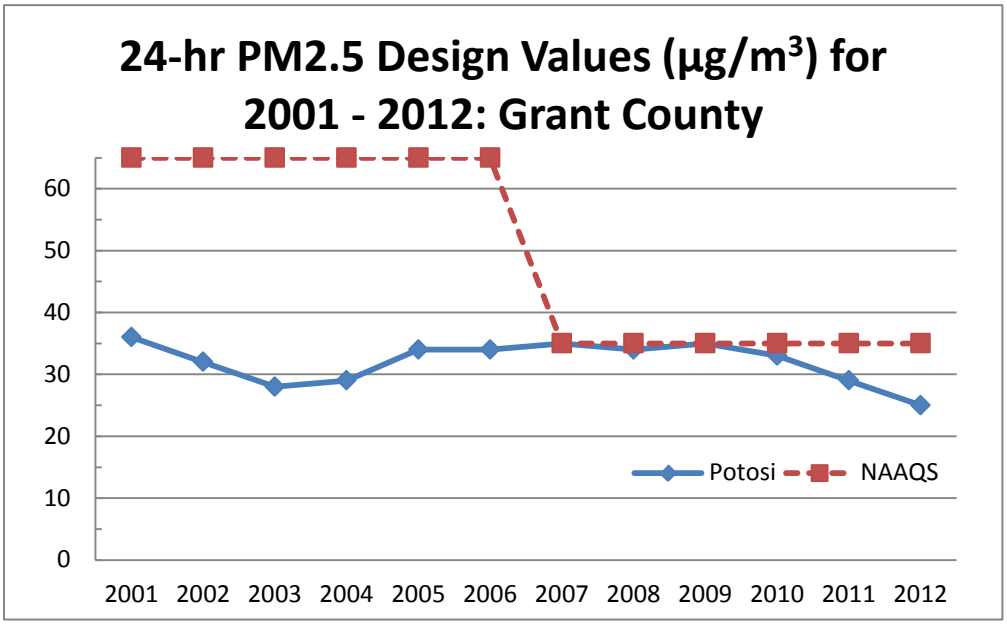
Fond du Lac County

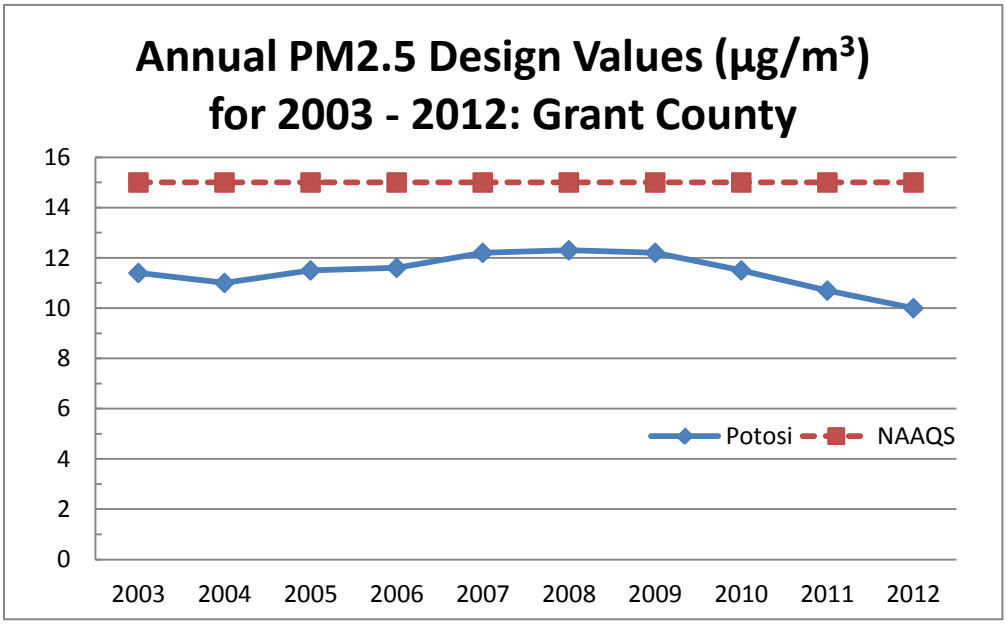
Ozone monitoring in Fond du Lac County is done at N3996 Kelly Road in the Town of Byron. The site is located at the edge of a farm field.



Grant County

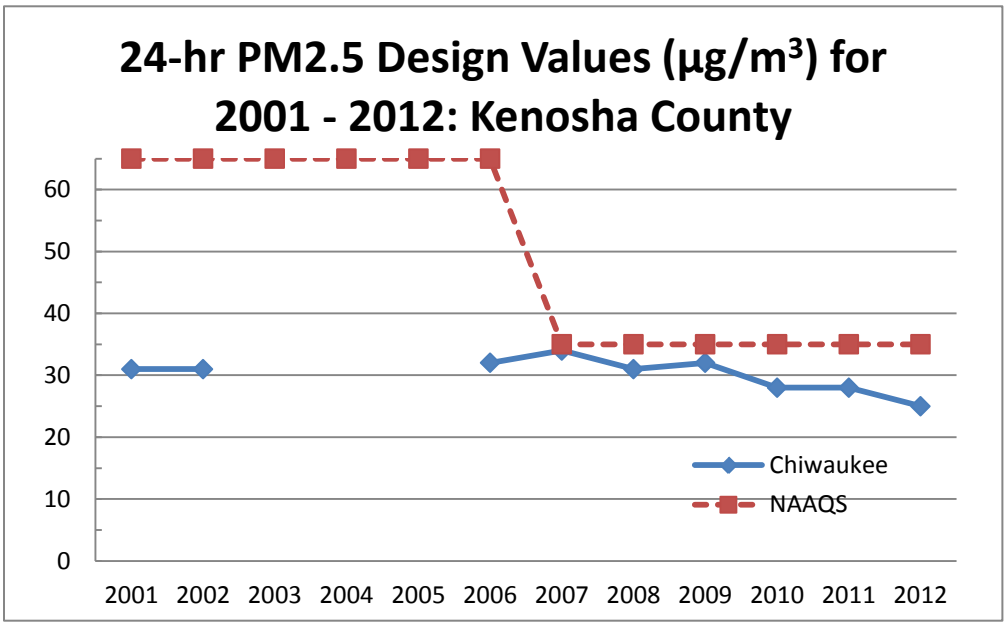
$PM_{2.5}$ monitoring in Grant County is done at 128 Highway 61 on Potosi High School property.

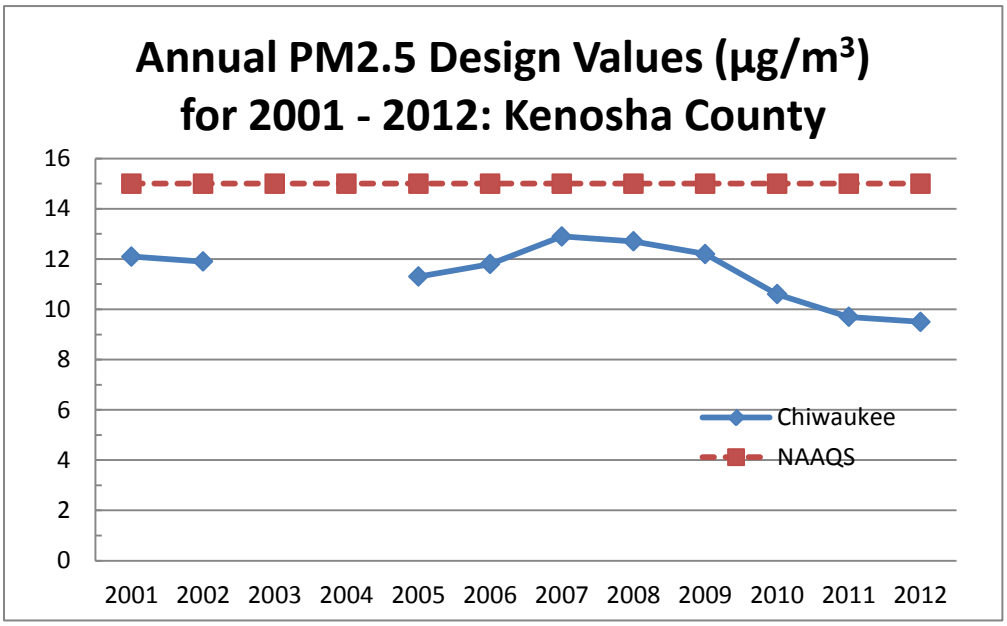


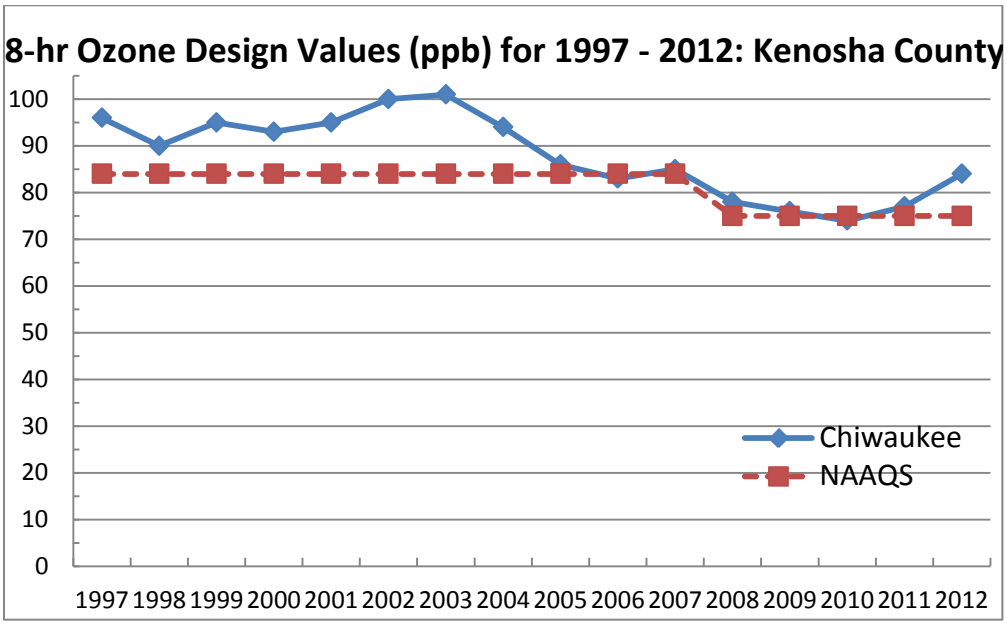


Kenosha County

$PM_{2.5}$ and ozone monitoring for Kenosha County is done at 11838 First Court in the Chiwaukee Prairie, which is a rural area near the Wisconsin – Illinois border. A second ozone monitoring site for Kenosha County was added in 2013 at 4504 64th Street. The water tower site is designated as a special purpose monitor. The comparisons for the two sites will be addressed in a separate document and will not be shown in the trends report.

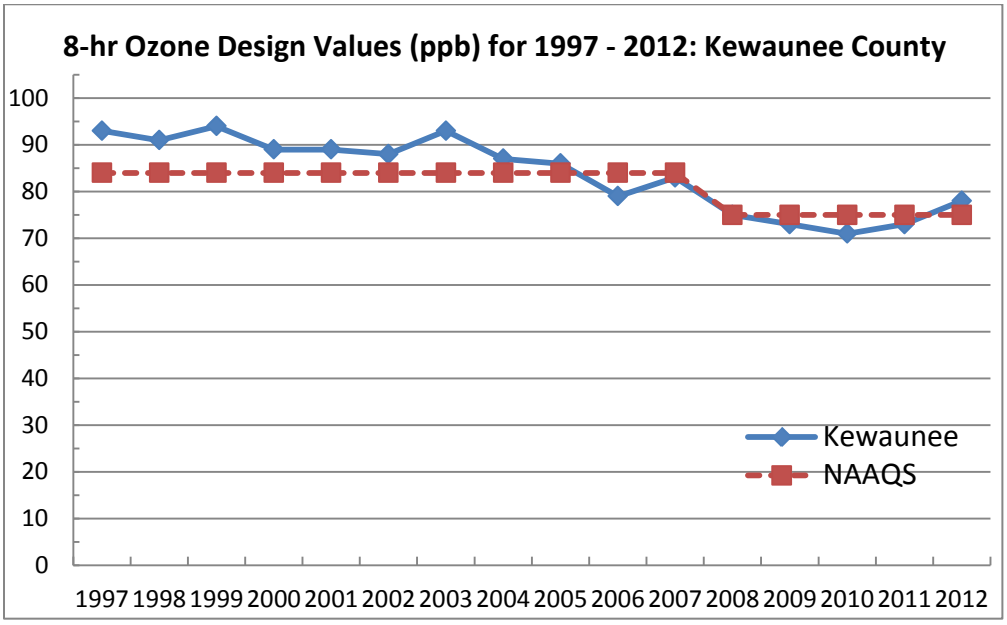






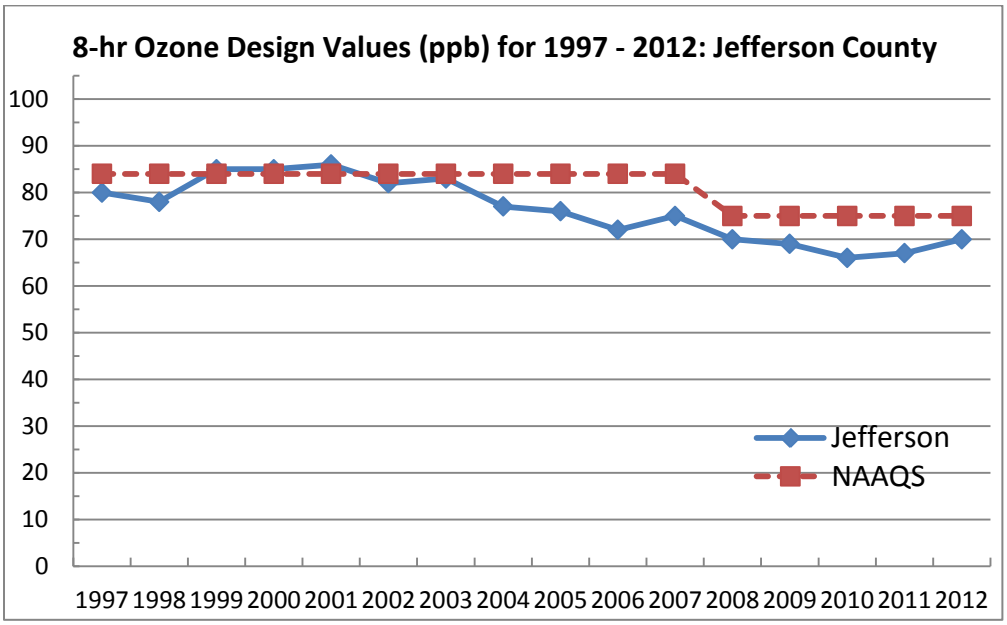
Kewaunee County

Ozone monitoring in Kewaunee County is done at Rural Route #1, Highway 42 on a bluff over Lake Michigan.



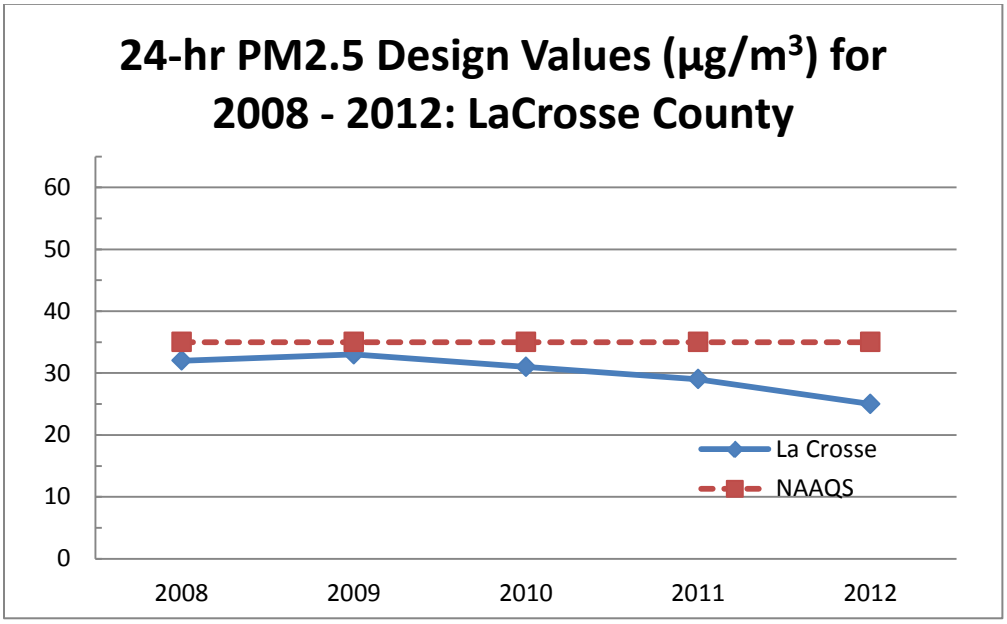
Jefferson County

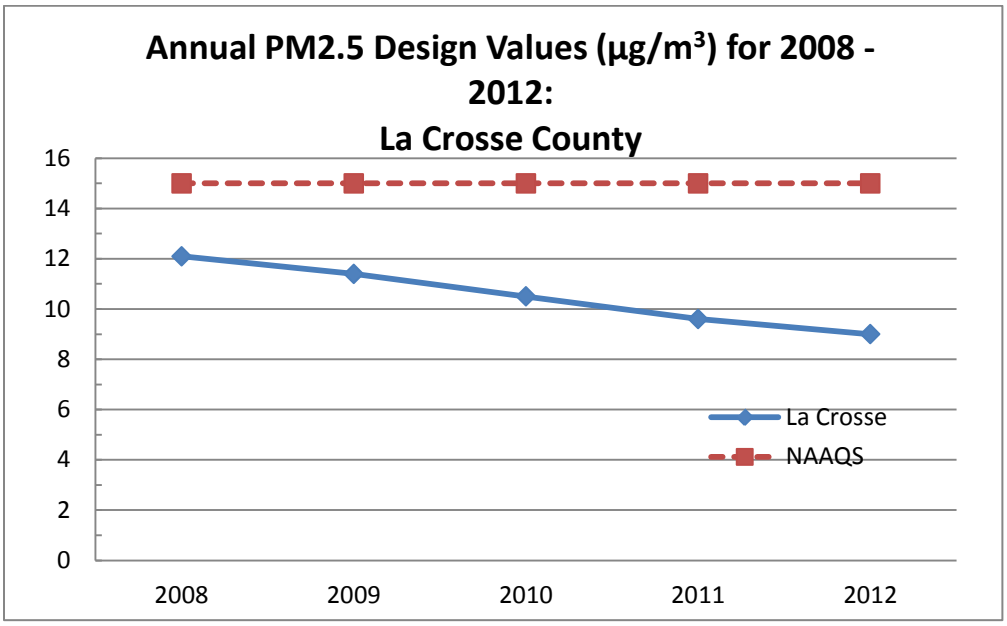
Ozone monitoring in Jefferson County has previously been done on the Jefferson High School next to the sports field grounds at 634 West Linden Drive. For the 2013 ozone season, the monitoring location was moved near the elementary school grounds, at Laatsch Lane in the City of Jefferson. This is approximately ¾ mile from the previous site (associated with the data shown here).



La Crosse County

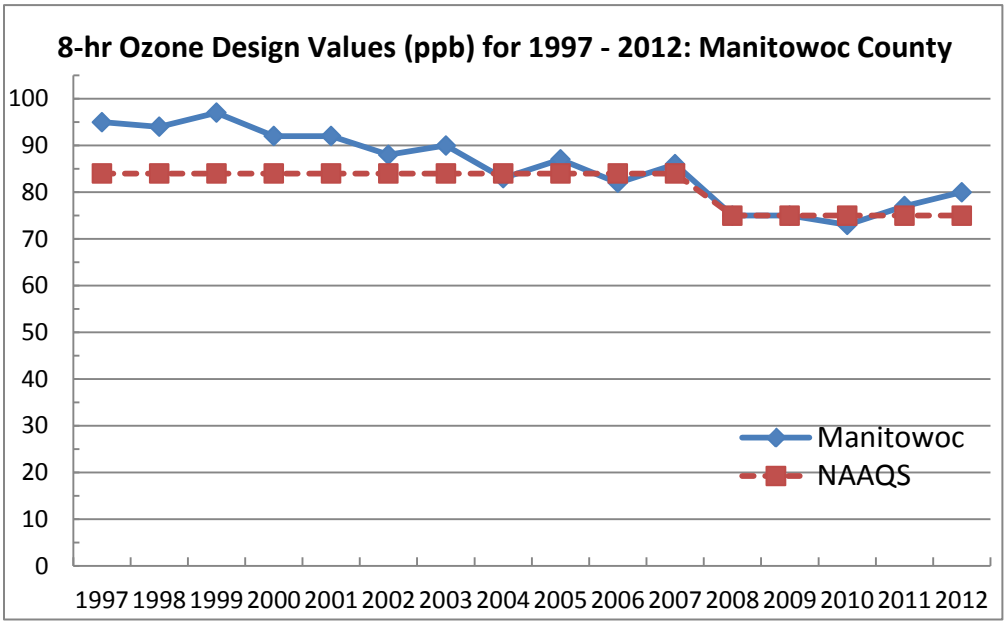
$PM_{2.5}$ monitoring for La Crosse County are done at the Department of Transportation office located at 3350 Mormon Coulee Road in La Crosse. Ozone monitoring is done as well, but there were not enough data points (years of data) to construct a plot.





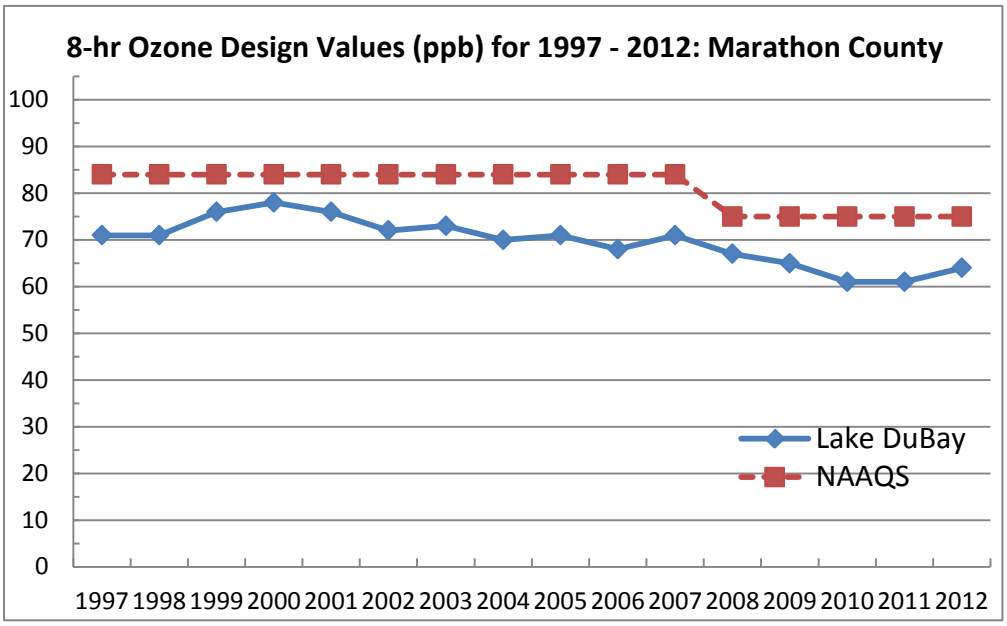
Manitowoc County

Ozone monitoring for Manitowoc County is done at 2315 Goodwin Road in Two Rivers at the Woodland Dunes Nature Center and Preserve.



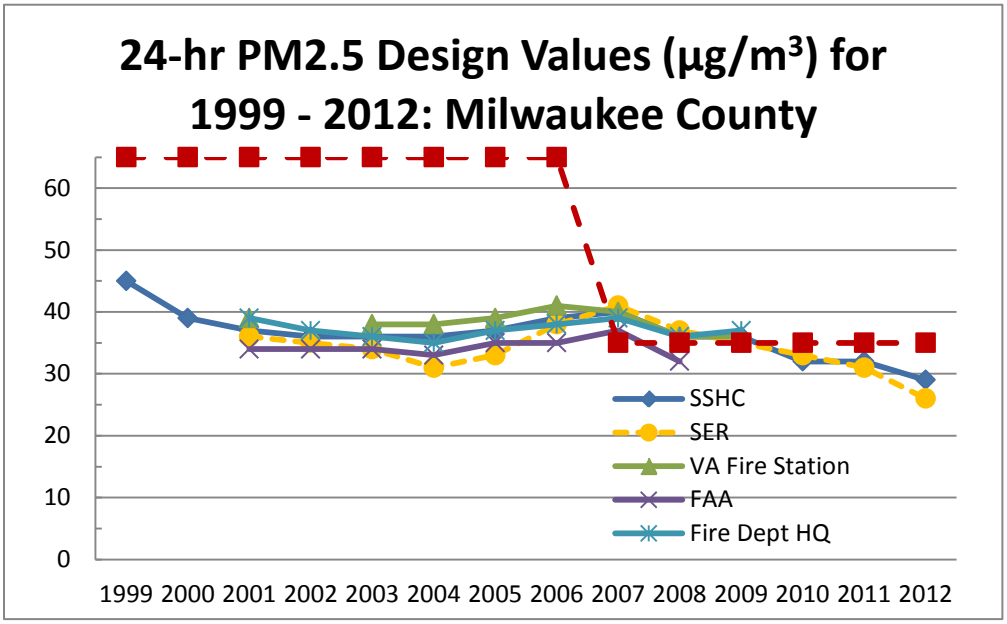
Marathon County

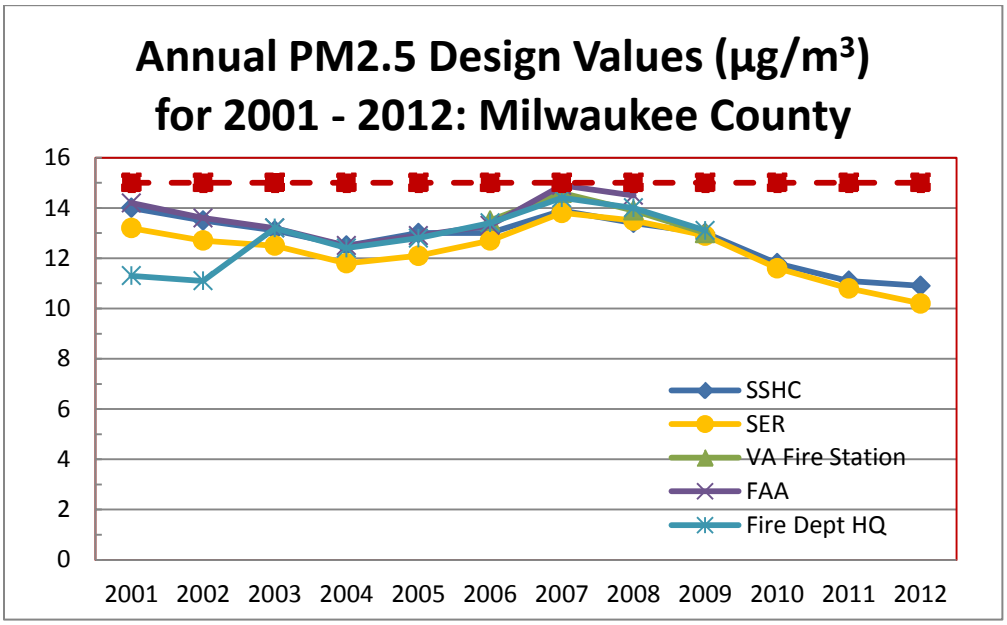
Ozone monitoring in Marathon County is done at a rural location on 1780 Bergen Road near Lake Dubay, in Bergen Township.

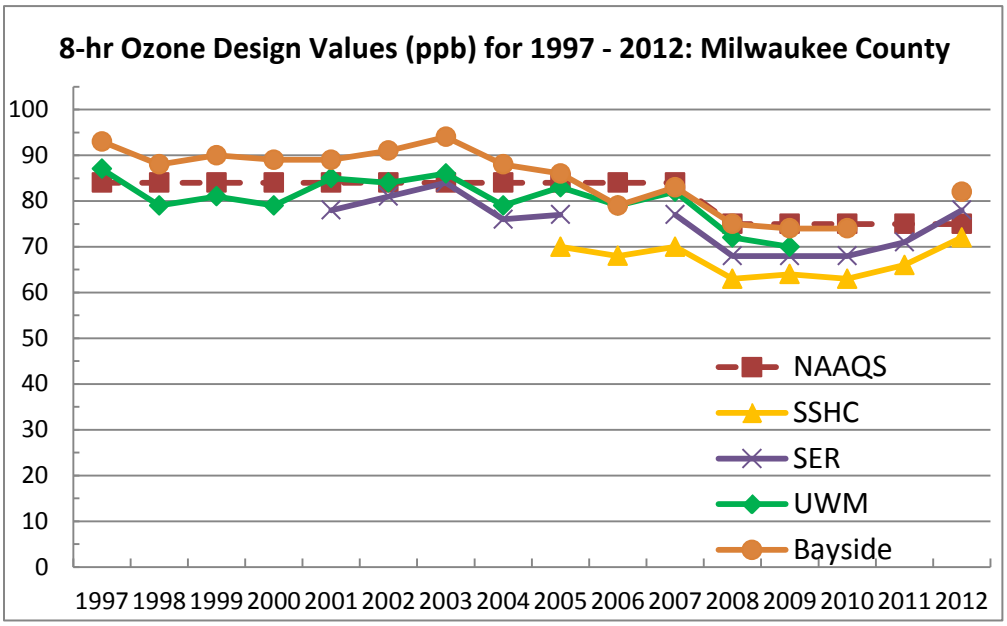


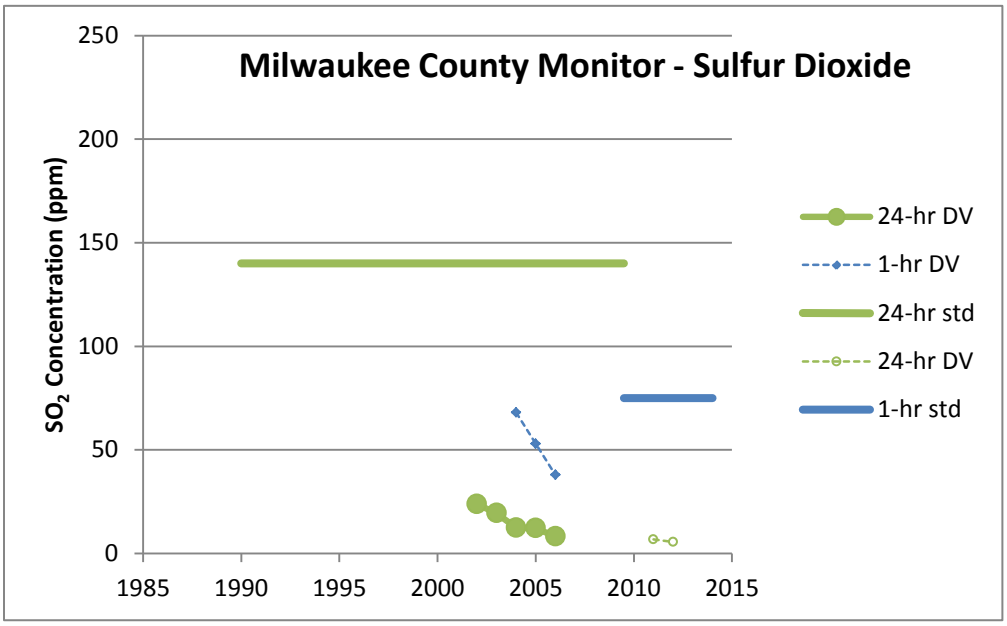
Milwaukee County

PM2.5 and ozone monitoring for Milwaukee County is done at many locations. They are all shown together in the following plots, for comparison. SO2 monitoring in Milwaukee County is done at the DNR Headquarters office at 2300 N. Dr. Martin Luther King Jr. Drive.





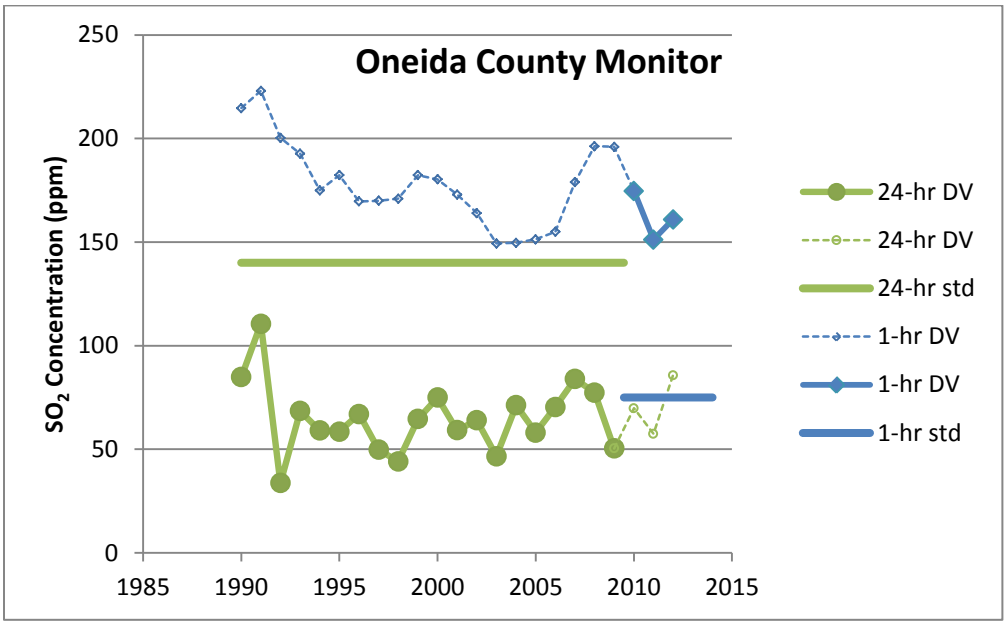




SO2 plot: Note that the form of the standard prior to 2010 was 24-hours, but a 1-hour standard was added in 2010 and the 24-hour standard was revoked. To provide a clearer picture, 1-hour values were calculated for data prior to 2010 and 24-hour values were calculated for periods after 2010.

Oneida County

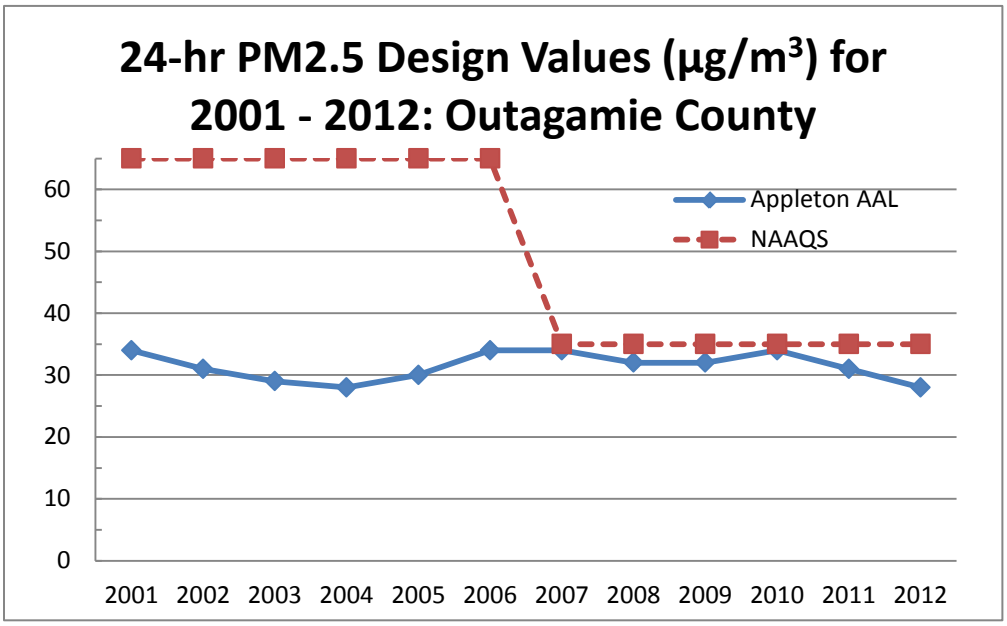
SO2 monitoring in Oneida County is done at 434 High Street, next to the Rhinelander Water Tower. This monitor is source-oriented and is sited to determine compliance with the SO NAAQS. Note that the monitor showed compliance with the 24-hour standard, but is out of compliance with the 1-hour standard. The facility primarily responsible for the monitored values is working with WDNR permit staff to resolve this issue through a permit action in compliance with required federal timeframes.

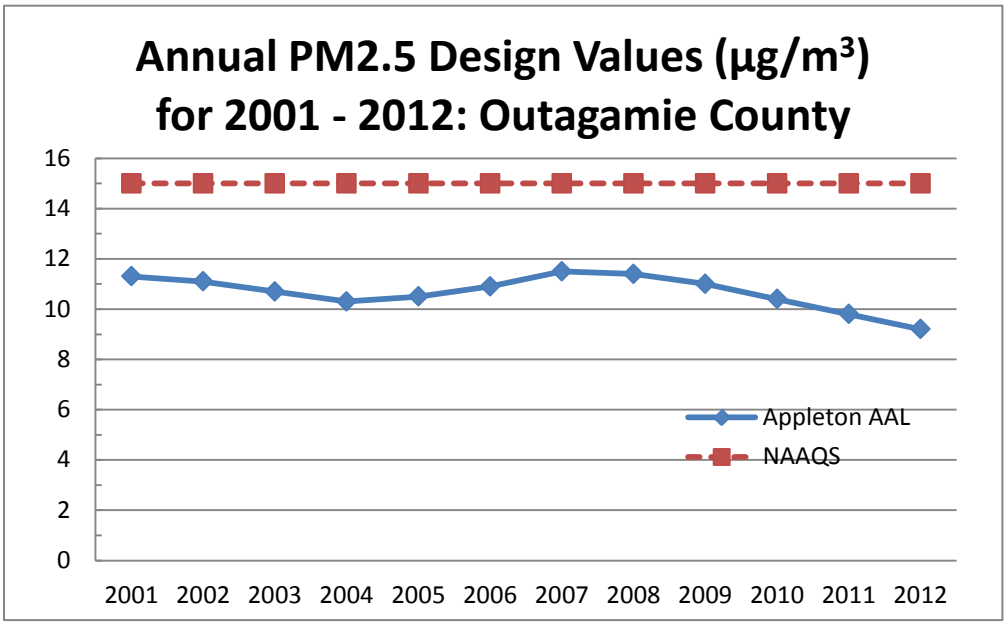


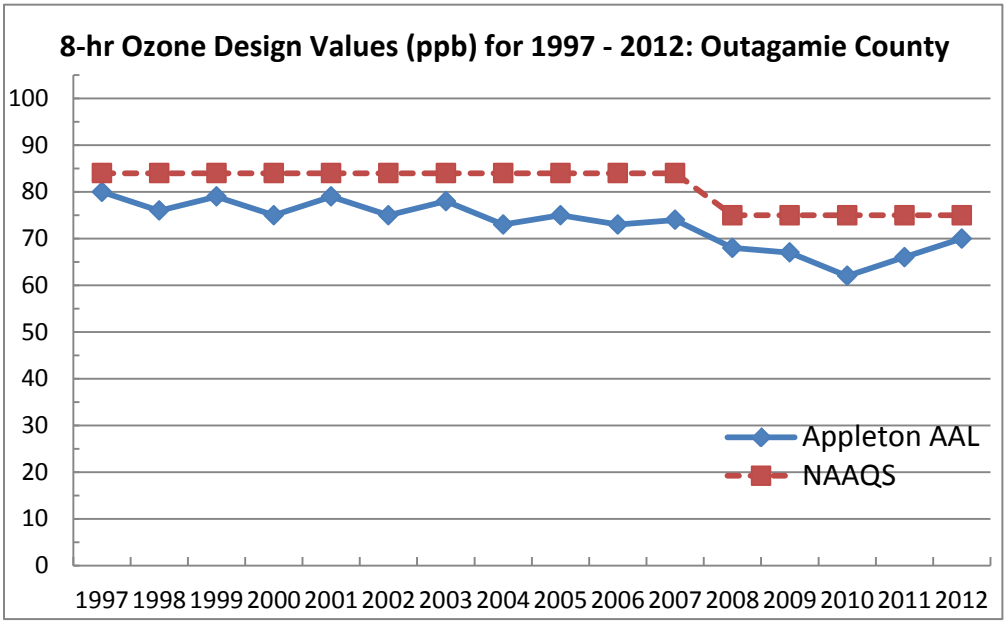
SO2 plot: Note that the form of the standard prior to 2010 was 24-hours, but a 1-hour standard was added in 2010 and the 24-hour standard was revoked. To provide a clearer picture, 1-hour values were calculated for data prior to 2010 and 24-hour values were calculated for periods after 2010.

Outagamie County

$PM_{2.5}$ and ozone monitoring in Outagamie County is done at 4432 North Meade Street in Appleton near a neighborhood.

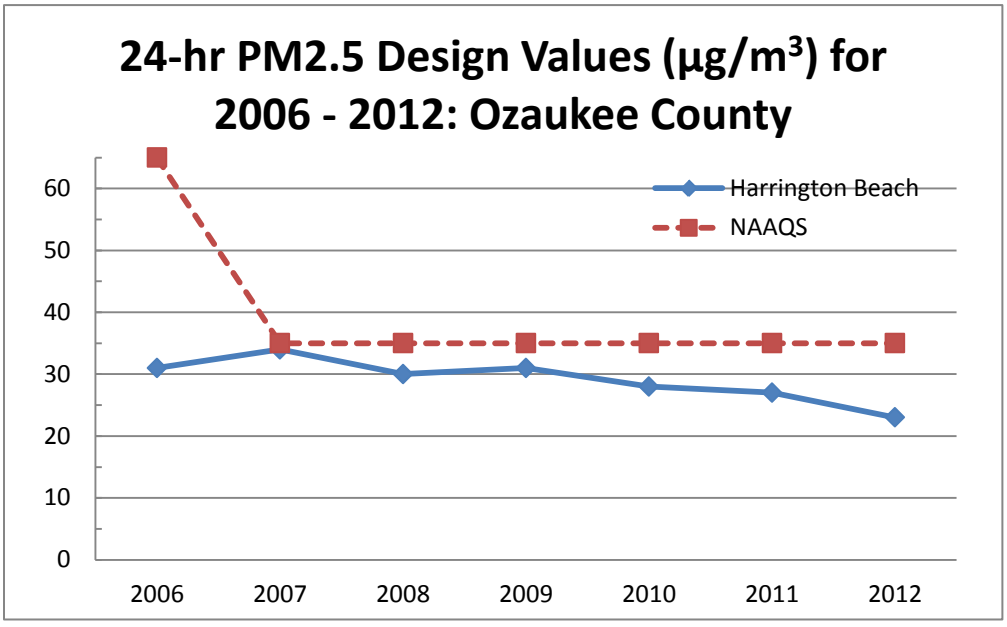


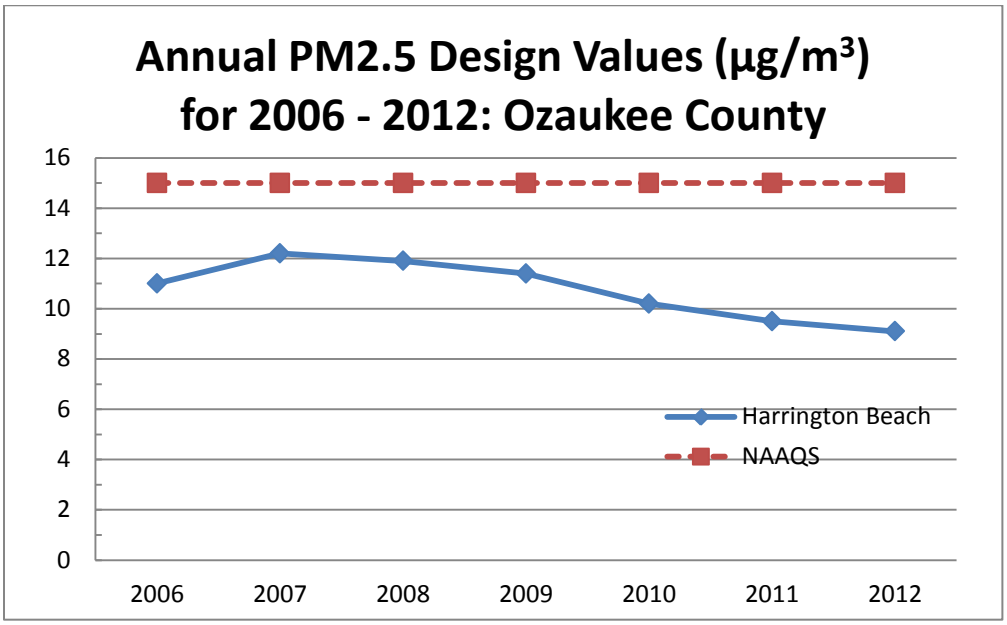


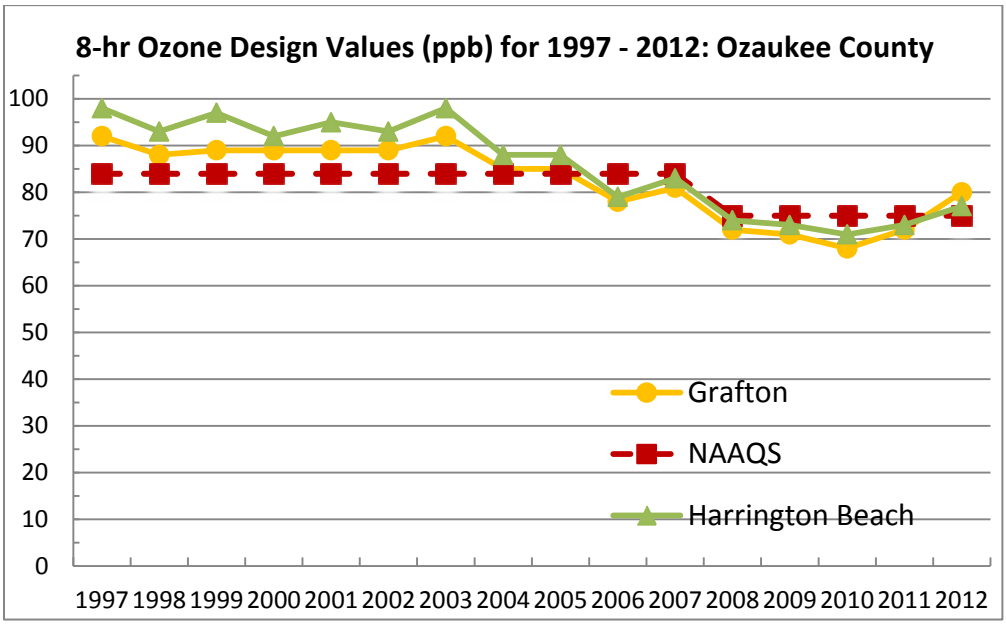


Ozaukee County

$PM_{2.5}$ monitoring in Ozaukee County is done at 531 Highway D in Harrington Beach State Park, while ozone monitoring is done both at Harrington Beach and at Highway 57 and I43 in Grafton.

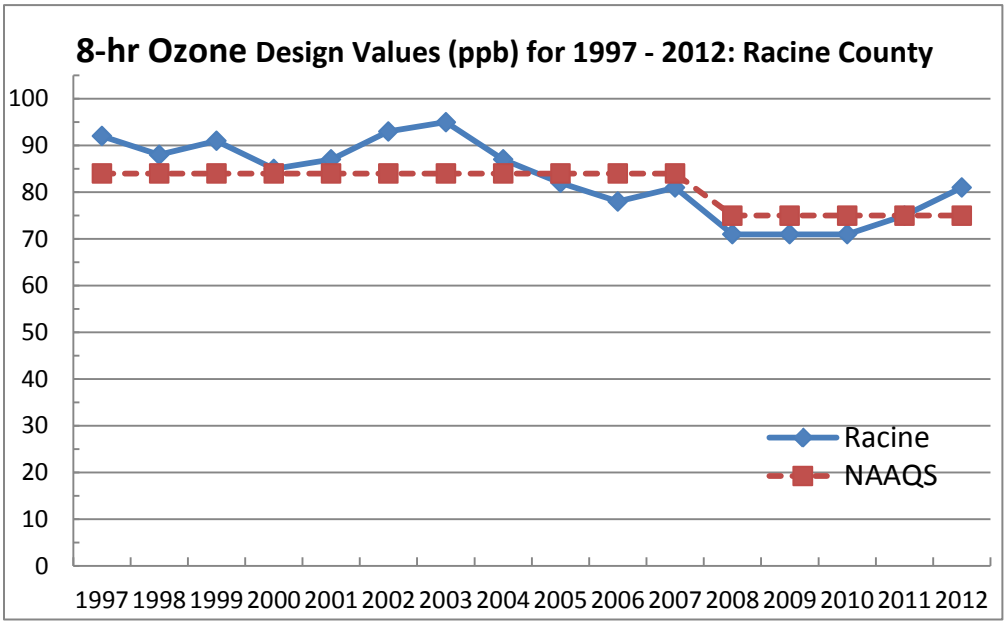



Annual PM2.5 Design Values (µg/m³) for 2006 - 2012: Ozaukee County
16
14
12
10
8
6
4
2
0
2006
2007
2008
2009
2010
2011
2012
Harrington Beach
NAAQS


8-hr Ozone Design Values (ppb) for 1997 - 2012: Ozaukee County
100
90
80
70
60
50
40
30
20
10
0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
Grafton
NAAQS
Harrington Beach

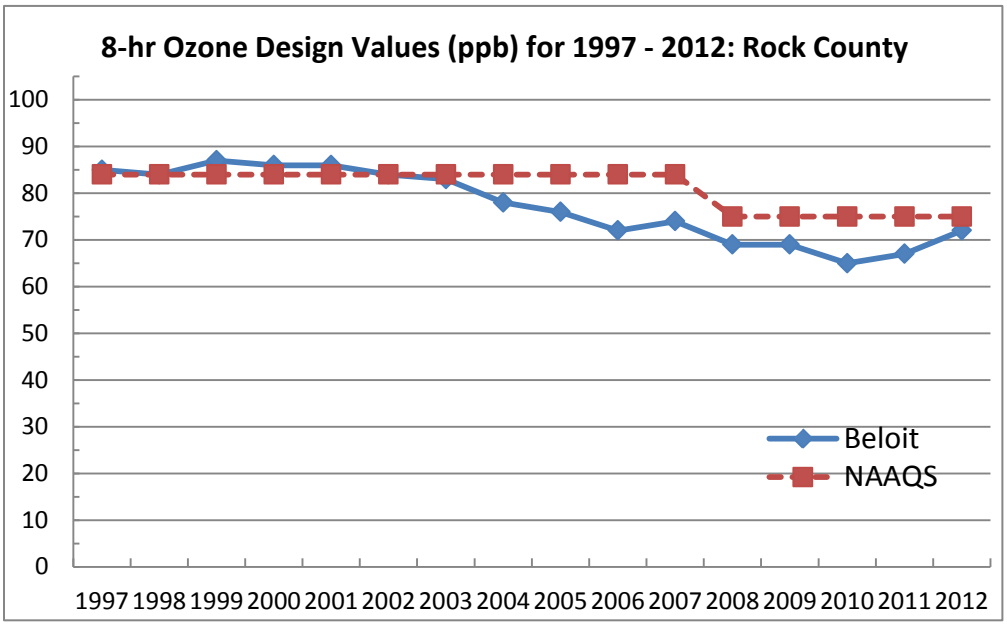
Racine County

Ozone monitoring in Racine County was done at 1519 Washington Avenue inside a local business in the downtown area of the City of Racine.



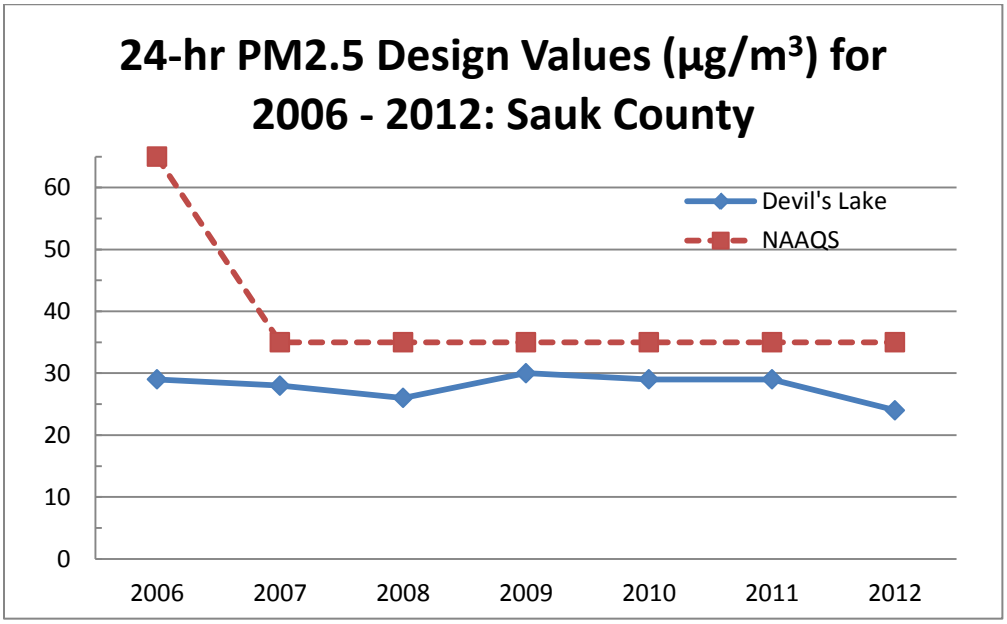
Rock County

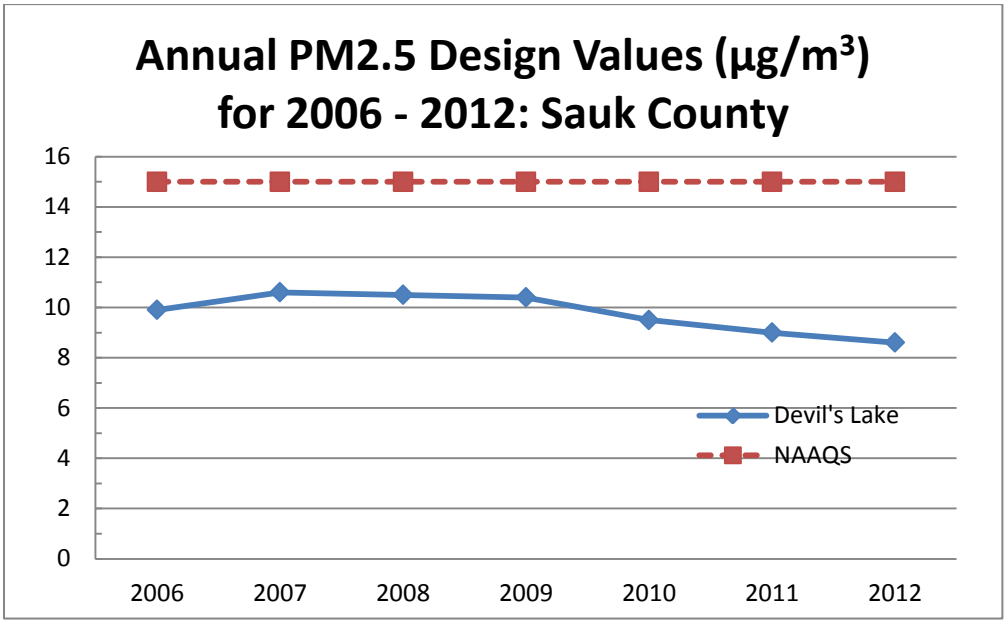
Ozone monitoring in Rock County is done at 1948 Merrill Street in Beloit. The site is located in a fenced area at the Cunningham School.

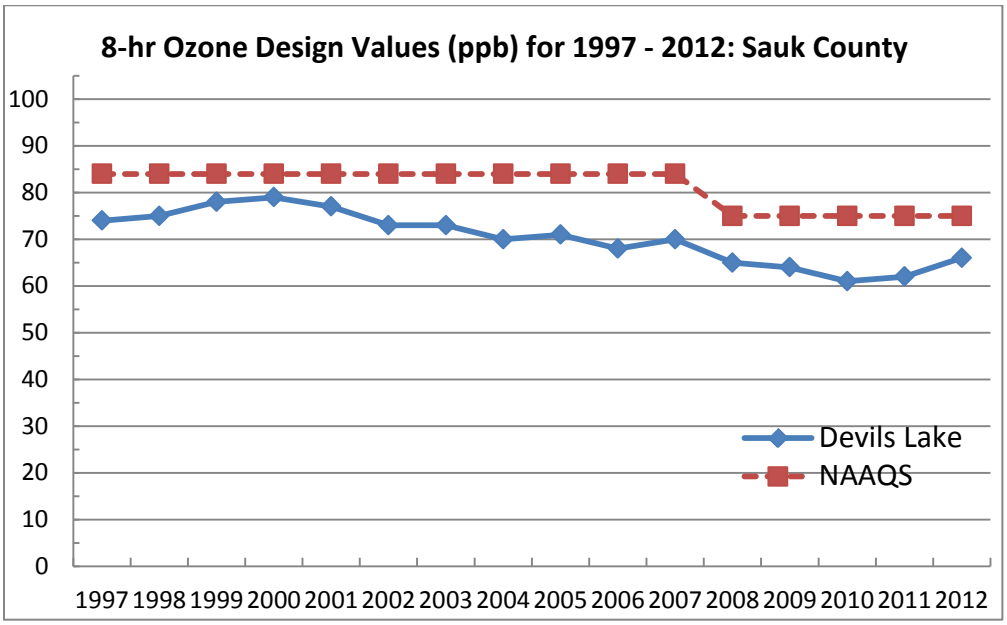


Sauk County

$PM_{2.5}$ and ozone monitoring in Sauk County are done at Devil's Lake State Park at E12886 Tower Road in Baraboo.

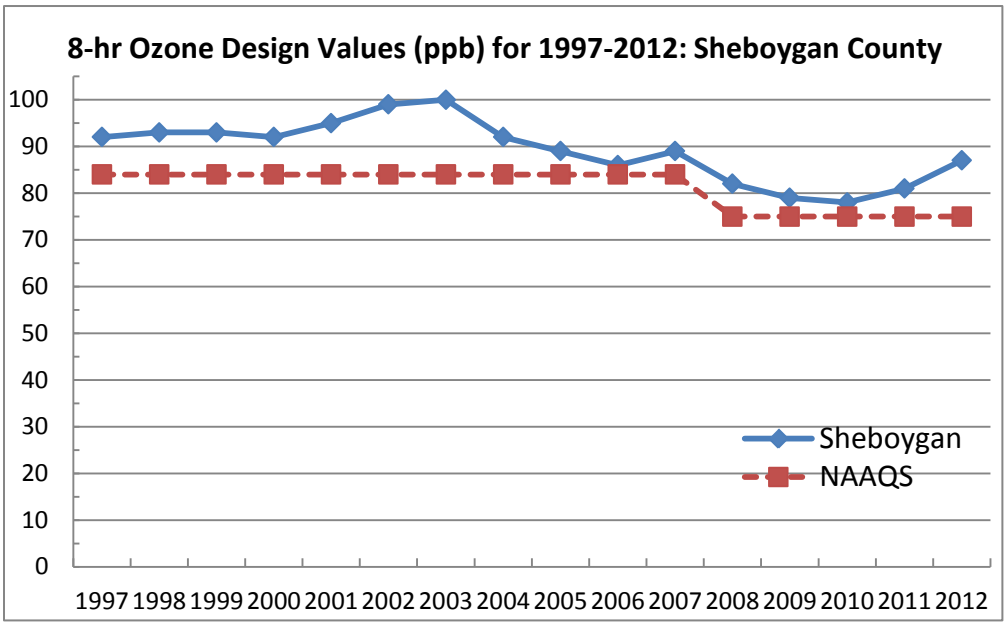






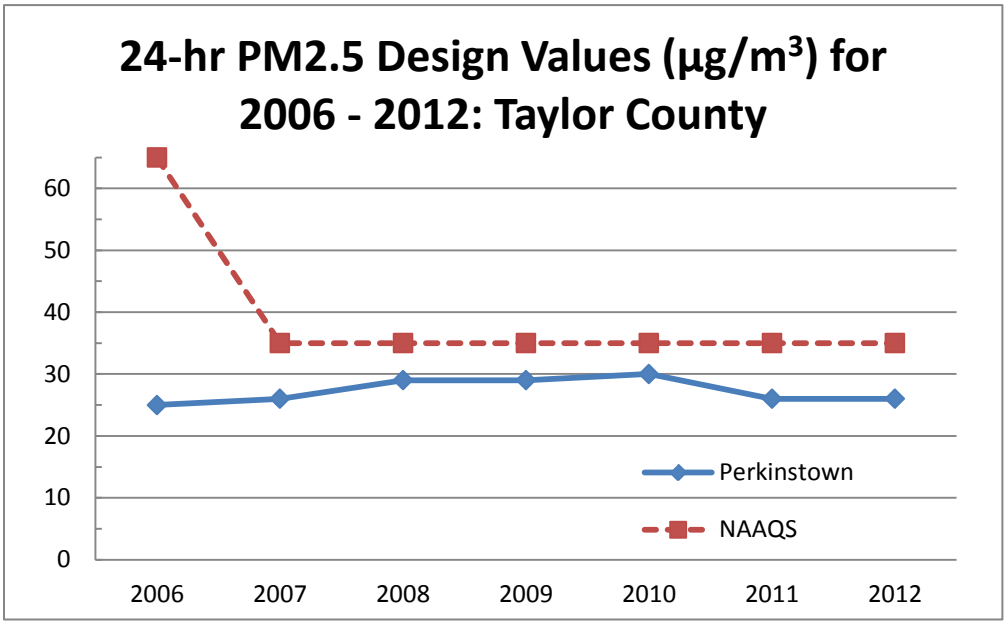
Sheboygan County

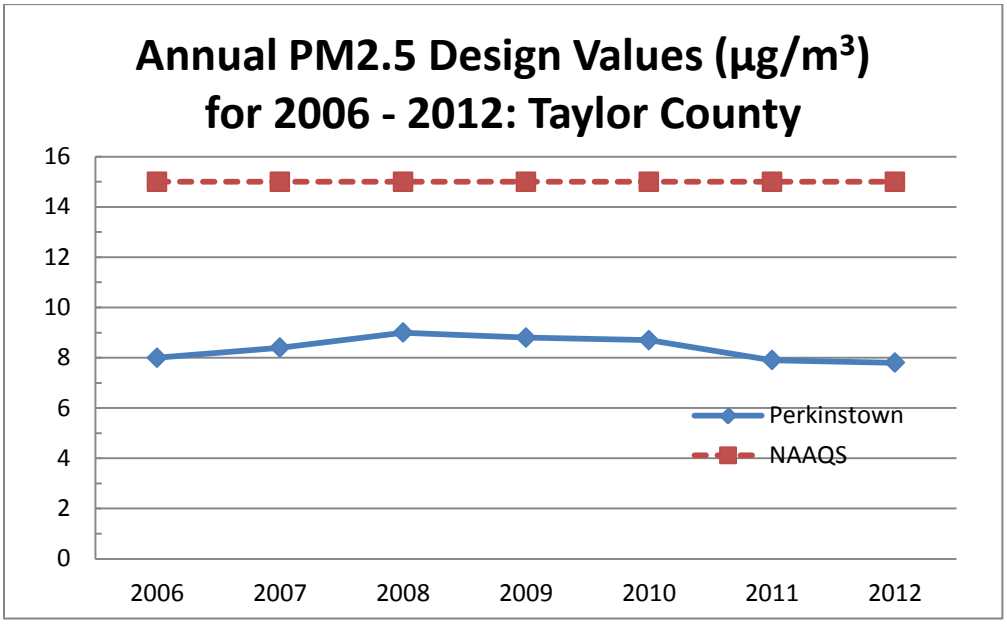
Ozone monitoring in Sheboygan County is done at a site located inside the nature center at Kohler-Andre State Park. This Lake Michigan shoreline site is located at 1520 Beach Park Road. A second special purpose ozone monitoring site has been added for the 2014 ozone season at approximately Highway 42 and County Road JJ. The comparison between the two ozone sites will be handled in a separate document and will not be addressed in the trends report.



Taylor County

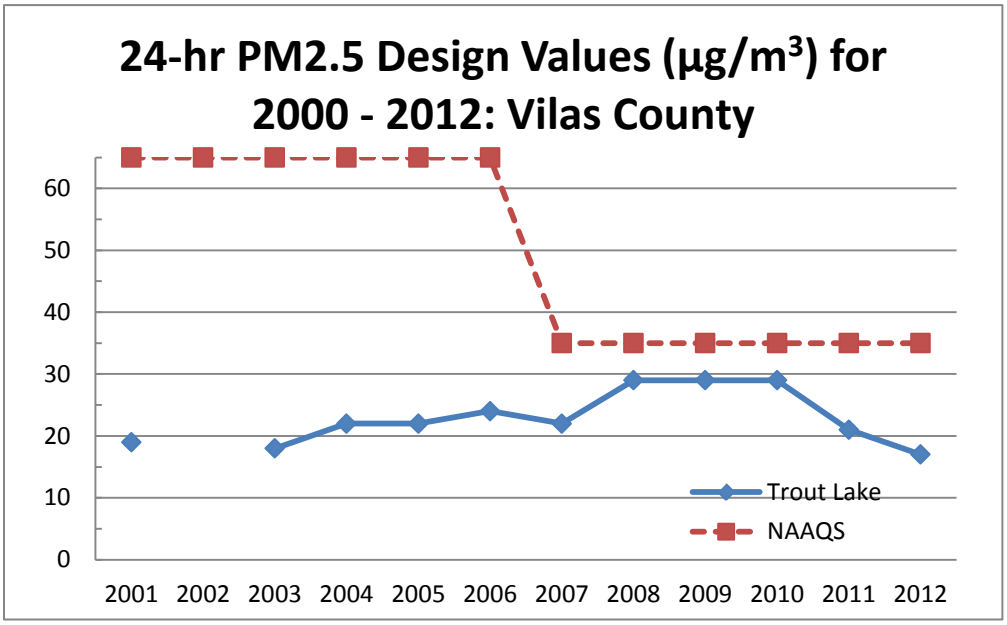
$PM_{2.5}$ monitoring in Taylor County is done at a rural site one mile east of Perkinstown on State Highway M.

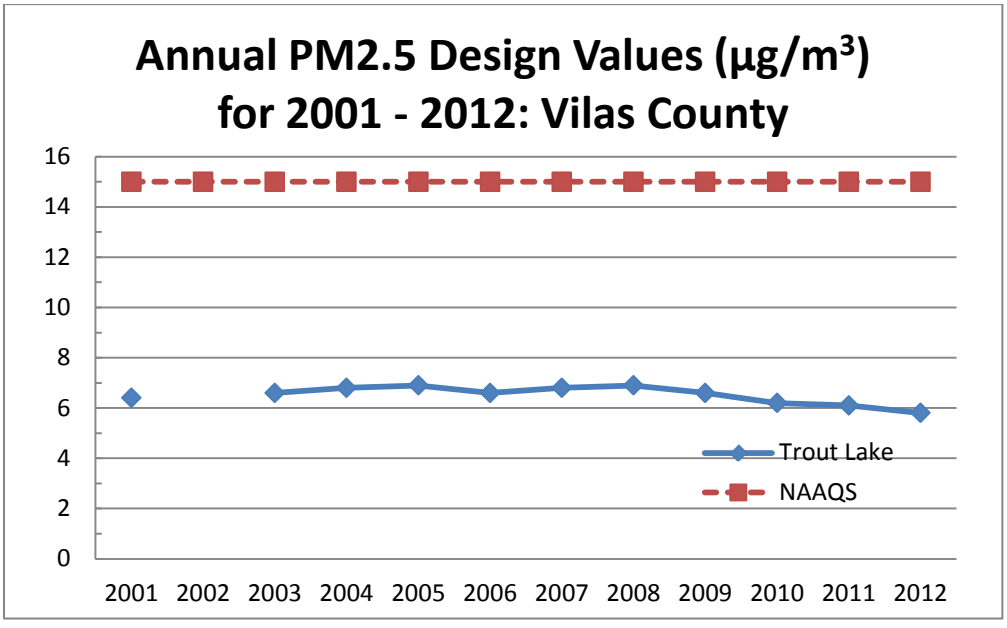


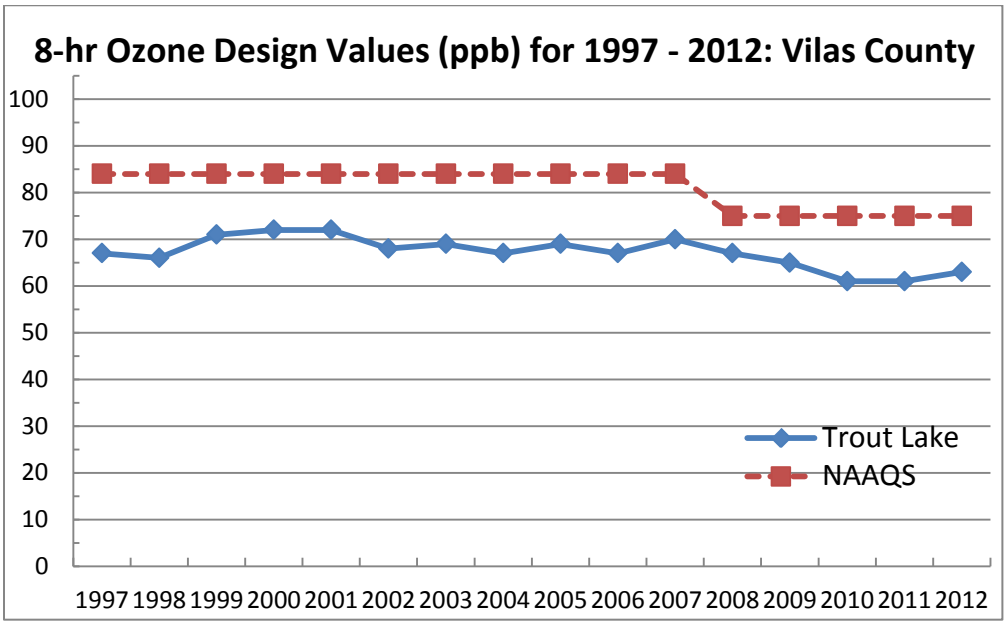


Vilas County

$PM_{2.5}$ and ozone monitoring in Vilas County is done in a field at the DNR Forestry Site at 10810 County Highway M in Boulder Junction.

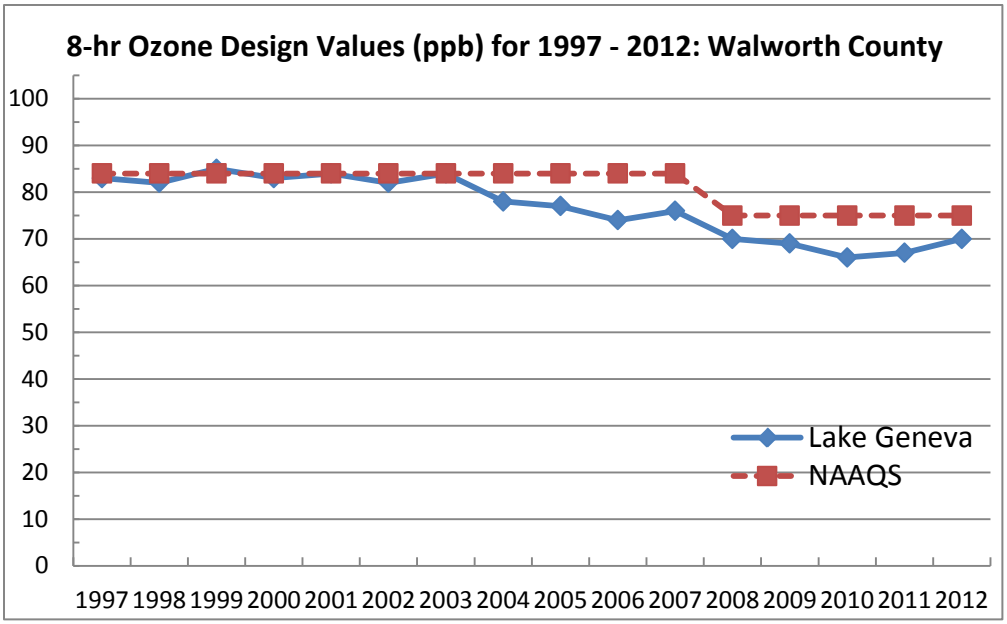






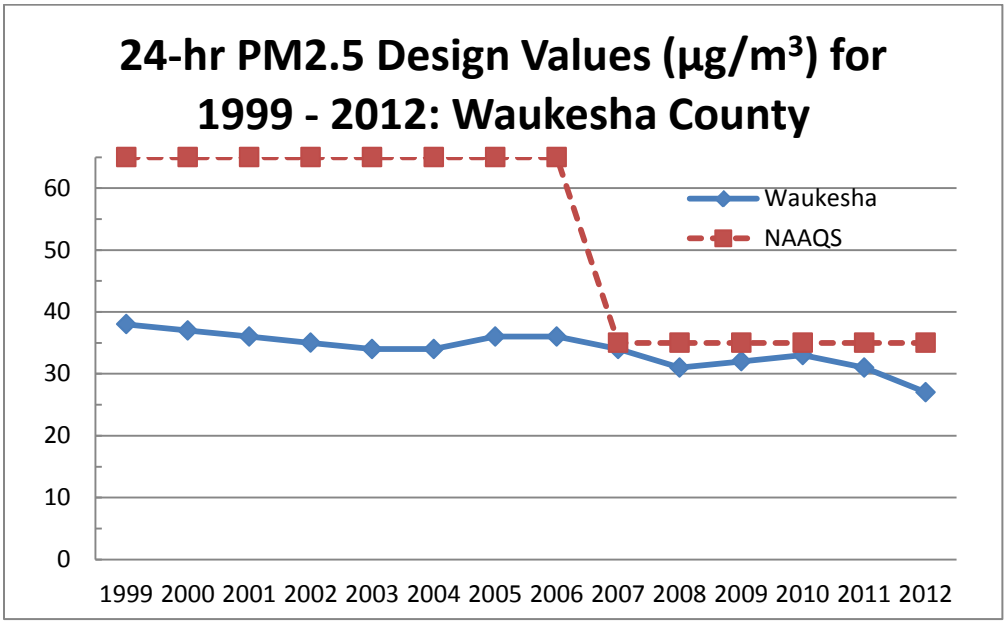
Walworth County

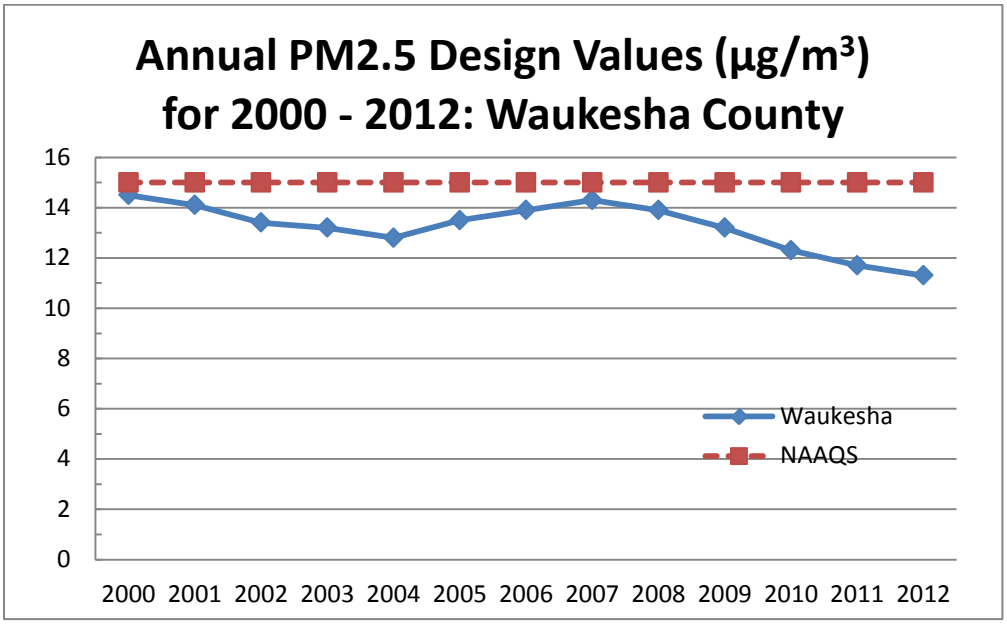
Ozone monitoring in Walworth County is done at a rural site on the outskirts of the City of Lake Geneva. The address for the site is Rural Route 4 Elgin Club Road.

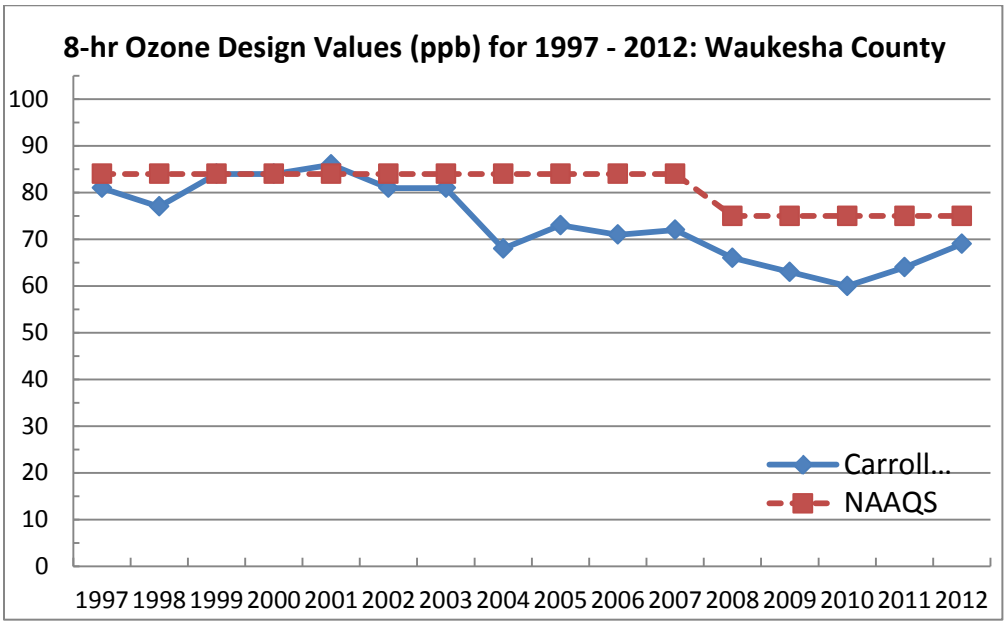


Waukesha County

$PM_{2.5}$ and ozone monitoring in Waukesha County is done at 1310 Cleveland Avenue in the City of Waukesha in a fenced-in area on a city lot. The Cleveland Ave. site began sampling for daily $PM_{2.5}$ on January 22, 2004 and for ozone on April 29, 2004. Prior to these dates, sampling for ozone in Waukesha County was performed at a Carroll College site.






8-hr Ozone Design Values (ppb) for 1997 - 2012: Waukesha County
100
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Carroll...
NAAQS