# Wisconsin:

## Northern Milwaukee/Ozaukee Shoreline Area, Sheboygan County Area, Manitowoc County Area, Door County Area

## Intended Final Area Designations for the 2015 Ozone National Ambient Air Quality Standards Technical Support Document (TSD)

### 1.0 Summary

This technical support document (TSD) describes the EPA's intent to designatefinal designation for the Northern Milwaukee/Ozaukee Shoreline Area, the Sheboygan (partial) County Area, the Manitowoc (partial) County Area, and the Door (partial) County Area in Wisconsin as nonattainment for the 2015 ozone National Ambient Air Quality Standards (NAAQS).

On October 1, 2015, the EPA promulgated revised primary and secondary ozone NAAQS (80 FR 65292; October 26, 2015). The EPA strengthened both standards to a level of 0.070 parts per million (ppm). In accordance with section 107(d) of the Clean Air Act (CAA), whenever the EPA establishes a new or revised NAAQS, the EPA must promulgate designations for all areas of the country for that NAAQS. The EPA must complete this process within 2 years of promulgating the NAAQS, unless the Administrator has insufficient information to make the initial designations decisions in that timeframe. In such circumstances, the EPA may take up to 1 additional year to complete the designations.

Under section 107(d), states were required to submit area designation recommendations to the EPA for the 2015 ozone NAAQS no later than 1 year following promulgation of the standards, i.e., by October 1, 2016. Tribes were also invited to submit area designation recommendations. On September 30, 2016, the Forest County Potawatomi Community (FCPC) Indian tribe recommended that the FCPC trust lands located within Forest County, Wisconsin be designated separately from adjacent lands as attainment for the 2015 ozone NAAQS based on air quality data from 2013-2015. In a September 21, 2016, letter from its governor, Wisconsin recommended that the entire state be designated as attainment for the 2015 ozone NAAQS, despite having violating monitors, since, in Wisconsin's opinion, elevated ozone levels in Wisconsin are primarily due to emissions originating from other states, recent ozone levels in Wisconsin have greatly improved, and Wisconsin has already significantly reduced ozone-causing emissions. Later in an April 20, 2017, supplemental submittal, Wisconsin submitted additional technical information to support the governor's recommendation and estimates of the geographic extent of the areas in Wisconsin with design values above 0.070 ppm. Wisconsin requested that if EPA designates nonattainment areas in Wisconsin, the EPA should ensure that the geographic scope of these areas is minimized. Wisconsin estimated the geographic extent of the design values above 0.070 ppm in Milwaukee County to be 2.9 miles from the lakeshore in the northeastern portion of the county and 2.8 miles south of the Bayside monitor before cutting due east to the coastlineshoreline. Wisconsin estimated the geographic extent of the design values above 0.070 ppm in Ozaukee County, Sheboygan County, and Manitowoc County to be

2.9 miles from the lakeshore. Wisconsin estimated that the geographic extent of the design values above 0.070 ppm in Door County does not extend beyond the Newport State Park boundary. Wisconsin emphasized in its April 20, 2017, submittal that these descriptions should not be construed as a recommendation for a potential nonattainment area designation for the 2015 ozone NAAQS. Subsequent to EPA's technical analyses and announcement of proposed nonattainment areas released on December 22, 2017, Wisconsin submitted a February 2018 comment letter and TSD (included in the docket for this action) revising its April 2017 geographic estimate of where air is above 0.070 ppm to 4.2 miles inland in Racine County and shrinking it from 2.9 to 2.3 miles inland in Sheboygan County.

After considering these recommendations and based on the EPA's technical analysis of the available data as described in this TSDthe state's recommendations, the EPA intends tois designatinge the areas listed in column 3 of Table 1 as nonattainment for the 2015 ozone NAAQS. The EPA must designate an area nonattainment if it has an air quality monitor that is violating the standard or if it has sources of emissions that are contributing to a violation of the NAAQS in a nearby area. Detailed descriptions of the intendedproposed nonattainment boundaries for these areas are found in the supporting technical analysisbelow for each area in Section 3, except for the Chicago-Naperville, IL-IN-WI area which is addressed in a separate TSD.

**Table 1. Wisconsin's Recommended Nonattainment Areas and the EPA's ~~Intended~~ Final Designated Nonattainment Areas for the 2015 Ozone NAAQS**

| Area | Wisconsin's Recommended Nonattainment Counties | EPA's ~~Intended~~ Final Nonattainment Counties |
|---|---|---|
| Chicago, IL-IN-WI* | Wisconsin recommended attainment. | **Wisconsin**<br>Kenosha (partial)<br><br>**Illinois**<br>Cook<br>DuPage<br>Grundy (partial)<br>Kane<br>Kendall (partial)<br>Lake<br>McHenry<br>Will<br><br>**Indiana**<br>Lake (partial)<br>~~Porter~~ |
| Door County, WI | Wisconsin recommended attainment. | Door County (partial) |
| Manitowoc County, WI | Wisconsin recommended attainment. | Manitowoc County (partial) |
| Sheboygan County, WI | Wisconsin recommended attainment. | Sheboygan County (partial) |
| Northern Milwaukee/Ozaukee Shoreline, WI | Wisconsin recommended attainment. | Milwaukee (partial)<br>Ozaukee (partial)<br>~~Racine~~<br>~~Washington~~<br>~~Waukesha~~ |

*Chicago, IL-IN-WI is a multi-state area composed of counties and/or partial counties in Illinois, Indiana, and Wisconsin. The technical analysis for this multi-state area is discussed in a separate TSD for the ~~intended~~ Chicago, IL-IN-WI nonattainment area.

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e.g. dropping Porter in Indiana and shrinking Lake to a partial county

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On November 6, 2017 (82 FR 54232; November 16, 2017), the EPA signed a final rule designating most of the areas in the state as attainment/unclassifiable.[1] As part of that rulemaking, EPA designated the FCPC trust lands located within Forest County separately from adjacent lands as attainment/unclassifiable. EPA explains in section 2.0 the approach it is now taking to designate the remaining areas in the state.

## 2.0 Nonattainment Area Analyses and ~~Intended~~ Boundary Determination

~~The EPA evaluated and determined the intended boundaries for each nonattainment area on a case-by-case basis, considering the specific facts and circumstances of the area.~~ In accordance with CAA section 107(d), the EPA ~~intends to~~ is designating~~s~~ as nonattainment all areas with monitor[s] that is [are] violating the 2015 ozone NAAQS and nearby areas with emissions sources (i.e., stationary, mobile, and/or area sources) that contribute to the violation[s]. As described in the EPA's designations guidance for the 2015 NAAQS (hereafter referred to as the "ozone designations guidance"[2] after identifying each monitor indicating a violation of the ozone NAAQS in an area, the EPA analyzed those nearby areas with emissions potentially contributing to the violating area. In guidance issued in February 2016, the EPA provided that using the Core Based Statistical Area (CBSA) or Combined Statistical Area (CSA)[3] as a starting point for the contribution analysis is a reasonable approach to ensure that the nearby areas most likely to contribute to a violating area are evaluated. The area-specific analyses may support nonattainment boundaries that are smaller or larger than the CBSA or CSA.

**Commented [LJ2]:** Attention reviewers: This sentence from the template language is not true for the final version of the Milwaukee area

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On November 6, 2017, the EPA issued attainment/unclassifiable designations for approximately 85% of the United States and one unclassifiable area designation.[4] At that time, consistent with statements in the designations guidance regarding the scope of the area the EPA would analyze in determining nonattainment boundaries, EPA deferred designation for any counties in the larger of a CSA or CBSA where one or more counties in the CSA or CBSA was violating the standard and any counties with a

[1] In previous ozone designations and in the designation guidance for the 2015 ozone NAAQS, the EPA used the designation category label Unclassifiable/Attainment to identify both areas that were monitoring attainment and areas that did not have monitors but for which the EPA had reason to believe were likely attainment and were not contributing to a violation in a nearby area. The EPA is now reversing the order of the label to be Attainment/Unclassifiable so that the category is more clearly distinguished from the separate Unclassifiable category.

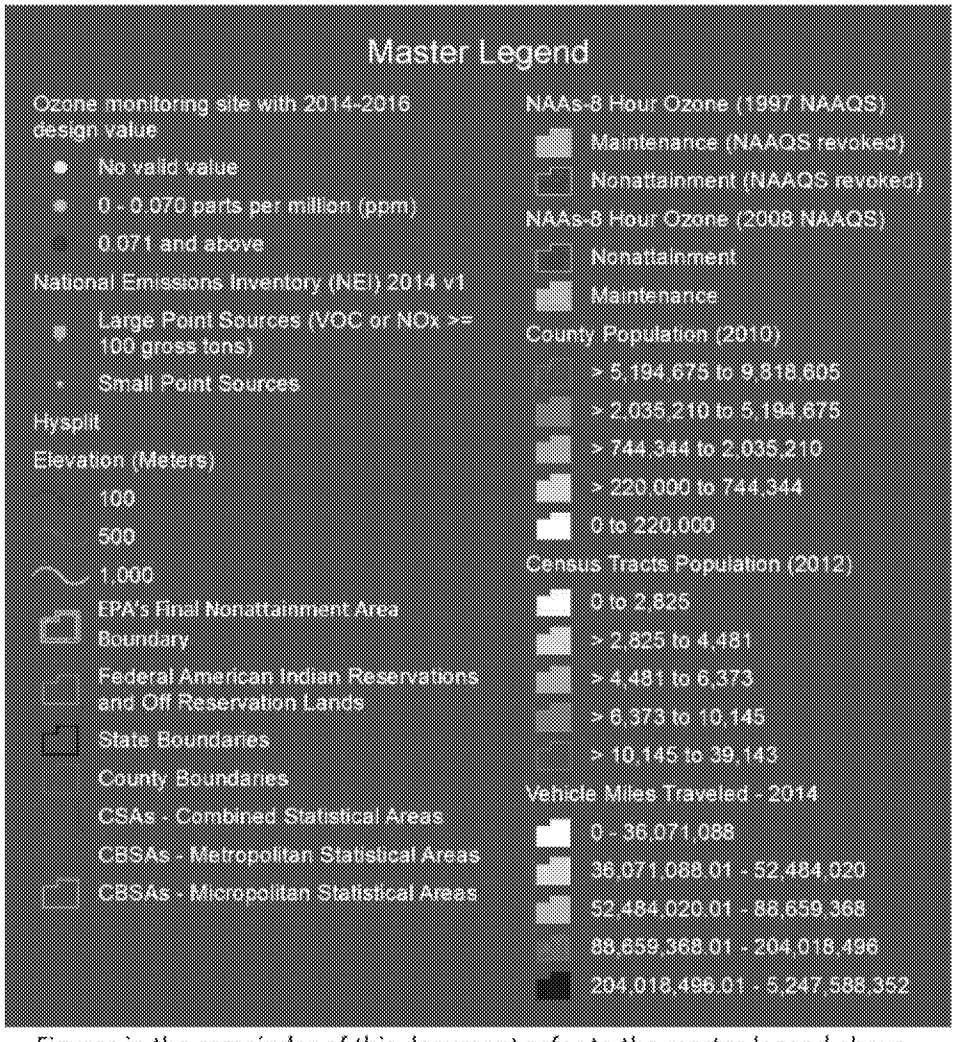
[2] The EPA issued guidance on February 25, 2016 that identified important factors that the EPA intends to evaluate in determining appropriate area designations and nonattainment boundaries for the 2015 ozone NAAQS. Available at *https://www.epa.gov/ozone-designations/epa-guidance-area-designations-2015-ozone-naaqs*

[3] Lists of CBSAs and CSAs and their geographic components are provided at www.census.gov/population/www/metroareas/metrodef.html. The Office of Management and Budget (OMB) adopts standards for defining statistical areas. The statistical areas are delineated based on U.S. Census Bureau data. The lists are periodically updated by the OMB. The EPA used the most recent July 2015 update (OMB Bulletin No. 15-01), which is based on application of the 2010 OMB standards to the 2010 Census, 2006-2010 American Community Survey, as well as 2013 Population Estimates Program data.

[4] Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards published on November 16, 2017(82 FR 54232).

violating monitor not located in a CSA or CBSA. In addition, the EPA deferred designation for any other counties adjacent to a county with a violating monitor. The EPA also deferred designation for any county that had incomplete monitoring data, any county in the larger of the CSA or CBSA where such a county was located, and any county located adjacent to a county with incomplete monitoring data.

The EPA is proceeding to complete the remaining designations ~~consistent with the designations guidance (and EPA's past practice) regarding the scope of the area EPA would analyze in determining nonattainment boundaries for the ozone NAAQS as outlined above~~. For those deferred areas where one or more counties violating the ozone NAAQS or with incomplete data are located in a CSA or CBSA, in most cases the technical analysis for the nonattainment area includes any counties in the larger of the relevant CSA or CBSA. For counties with a violating monitor not located in a CSA or CBSA, EPA explains in the 3.0 Technical Analysis section, its decision whether to consider in the five-factor analysis for each area any other adjacent counties for which EPA previously deferred action. We ~~intend to~~ are designating all counties not included in five-factor analyses for a specific nonattainment or unclassifiable area analyses, as attainment/unclassifiable. These deferred areas are identified in a separate document entitled "~~Intended~~ Designations for Deferred Counties and ~~Partial Counties~~ County Equivalents Not Addressed in the Technical Analyses." which is available in the docket.




Figures in the remainder of this document refer to the master legend above.

## 3.0 Technical Analyses ~~for Intended Nonattainment Areas~~

### 3.1 Technical Analysis for the Milwaukee Area

This technical analysis identifies the area with monitors that violate the 2015 ozone NAAQS. It also provides EPA's evaluation of this area and any nearby areas to determine whether those nearby areas have emissions sources that potentially contribute to ambient ozone concentrations at the violating monitors in the area, based on the weight-of-evidence of the five factors recommended in the EPA's ozone designations guidance and any other relevant information. In developing this technical analysis, the EPA used the latest certified data and information available to the EPA (and to the states and tribes through the Ozone Designations Mapping Tool and the EPA Ozone Designations Guidance and Data web page).[5] In addition, the EPA considered any additional data or information provided to the EPA by states or tribes.

The area of analysis was~~is~~ the Milwaukee-Racine-Waukesha CSA, which includes Dodge, Washington, Ozaukee, Jefferson, Waukesha, Milwaukee, Walworth, and Racine counties in Wisconsin. This area of analysis contains violating monitors. The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area.

The five factors recommended in the EPA's guidance are:

1. Air Quality Data (including the design value calculated for each Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitor;
2. Emissions and Emissions-Related Data (including locations of sources, population, amount of emissions, and urban growth patterns);
3. Meteorology (weather/transport patterns);
4. Geography/Topography (including mountain ranges or other physical features that may influence the fate and transport of emissions and ozone concentrations); and
5. Jurisdictional Boundaries (e.g., counties, air districts, existing nonattainment areas, areas of Indian country, Metropolitan Planning Organizations (MPOs)).

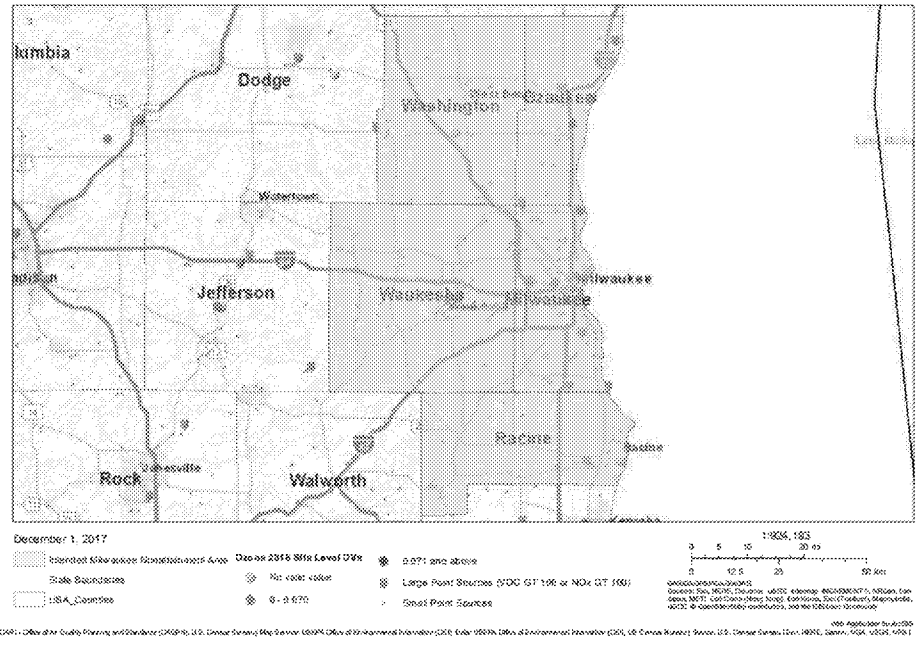
Figure 1 is a map of the EPA's ~~intended~~proposed nonattainment boundary for the Milwaukee area which was announced on December 22, 2017. The map shows the location of the ambient air quality monitors, county boundaries, and other jurisdictional boundaries.

For purposes of the 1997 ozone NAAQS, portions of this area were designated nonattainment. The boundary for the nonattainment area for the 1997 ozone NAAQS included the entire counties of Milwaukee, Ozaukee, Racine, Washington, Waukesha, and Kenosha County. For the purposes of the 2008 ozone NAAQS, the entire counties of Milwaukee, Ozaukee, Racine, Washington, and Waukesha ~~and a portion of Kenosha County~~ were designated as unclassifiable/attainment due to a lack of violating monitors at the time of designation. ~~The other~~A portion of Kenosha County was designated with the Chicago area as nonattainment for the 2008 ozone NAAQS, as explained ~~below~~in the Chicago TSD, since Kenosha County is part of the Chicago CSA.

[5] The EPA's Ozone Designations Guidance and Data web page can be found at *https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data.*

The EPA's ~~intended~~ announced on December 22, 2017, as a result of the 5-factor analysis below, ~~boundary for the 2015 ozone NAAQS for the Milwaukee area is the same as the boundary for the 1997 ozone NAAQS with the exception of Kenosha County. Kenosha County will be evaluated as part of the Chicago nonattainment area of analysis for the 2015 ozone NAAQS, since Kenosha County is part of the Chicago CSA not part of the Milwaukee-Racine-Waukesha CSA.~~ he EPA's proposed nonattainment boundary for the 2015 ozone NAAQS for the Milwaukee area as the entirety of the following 5 counties: Ozaukee (violating and contributing), Washington (contributing), Milwaukee (violating and contributing), Waukesha (contributing), and Racine (contributing). In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area described in the conclusion to this section (skip to page 22), which is a parcel of land around the violating monitors in Ozaukee and Milwaukee counties. Wisconsin believes that air above 0.070 ppm in these counties is confined to 2.9 miles inland from the shoreline in Ozaukee and Milwaukee counties (and 2.8 miles south of the violating monitor in Milwaukee County).

**Figure 1. EPA's ~~Intended~~ Proposed Nonattainment Boundary for the Milwaukee Area**




The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. Ozaukee and Milwaukee counties have monitors in violation of the 2015 ozone NAAQS, therefore these counties ~~were~~are included in the ~~intended~~proposed nonattainment area. In our December 22, 2017, TSD, the~~The~~ EPA determined that Washington, Waukesha, and Racine counties contribute to the violating area. The following sections describe the five-

factor analysis. While the factors are presented individually, they are not independent. The five-factor analysis process carefully considers the interconnections among the different factors and the dependence of each factor on one or more of the others, such as the interaction between emissions and meteorology for the area being evaluated.

**Factor Assessment**

**Factor 1: Air Quality Data**

The EPA considered 8-hour ozone design values in ppm for air quality monitors in the Milwaukee area of analysis based on data for the 2014-2016 period (i.e., the 2016 design value, or DV). This is the most recent three-year period with fully-certified air quality data. The design value is the 3-year average of the annual 4th highest daily maximum 8-hour average ozone concentration.[6] The 2015 NAAQS are met when the design value is 0.070 ppm or less. Only ozone measurement data collected in accordance with the quality assurance (QA) requirements using approved (FRM/FEM) monitors are used for NAAQS compliance determinations.[7] The EPA uses FRM/FEM measurement data residing in the EPA's Air Quality System (AQS) database to calculate the ozone design values. Individual violations of the 2015 ozone NAAQS that the EPA determines have been caused by an exceptional event that meets the administrative and technical criteria in the Exceptional Events Rule[8] are not included in these calculations. Whenever several monitors are located in a county (or designated nonattainment area), the design value for the county or area is determined by the monitor with the highest valid design value. The presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA identified monitors where the most recent certified design values violate the NAAQS, and examined historical ozone air quality measurement data (including previous design values) to understand the nature of the ozone ambient air quality problem in the area. Eligible monitors for providing design value data generally include State and Local Air Monitoring Stations (SLAMS) that are operated in accordance with 40 CFR part 58, appendices A, C, D and E and operating with an FRM or FEM monitor. These requirements must be met in order to be acceptable for comparison to the 2015 ozone NAAQS for designation purposes. All data from Special Purpose Monitors (SPMs) using an FRM or FEM are eligible for comparison to the NAAQS, subject to the requirements given in the March 28, 2016 Revision to Ambient Monitoring Quality Assurance and Other Requirements Rule (81 FR 17248).

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[6] The specific methodology for calculating the ozone design values, including computational formulas and data completeness requirements, is described in 40 CFR part 50, appendix U.

[7] The QA requirements for ozone monitoring data are specified in 40 CFR part 58, appendix A. The performance test requirements for candidate FEMs are provided in 40 CFR part 53, subpart B.

[8] The EPA finalized the rule on the Treatment of Data Influenced by Exceptional Events (81 FR 68513) and the guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events in September of 2016. For more information, see *https://www.epa.gov/air-quality-analysis/exceptional-events-rule-and-guidance.*

The 2016 design values for counties in the Milwaukee-Racine-Waukesha CSA are shown in Table 2.

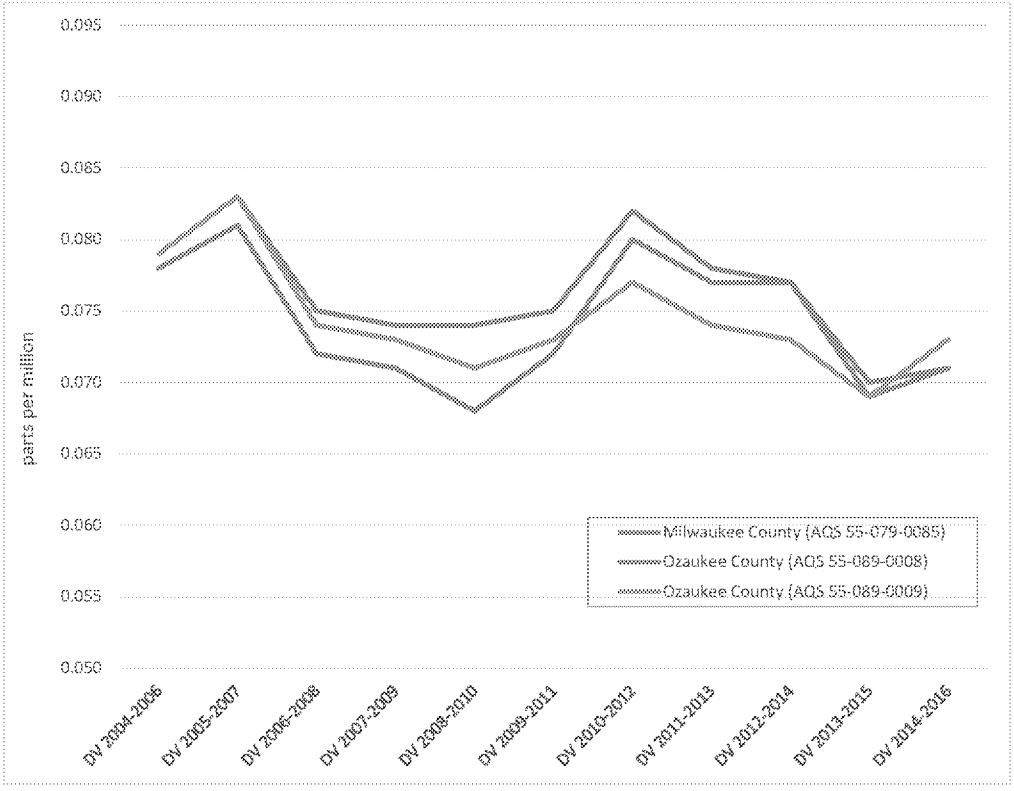
**Table 2. Air Quality Data (all values in ppm).**

| County, State | State Recommended Nonattainment? | AQS Site ID | 2014 -2016 DV | 2014 4th highest daily max value | 2015 4th highest daily max value | 2016 4th highest daily max value |
|---|---|---|---|---|---|---|
| Dodge, WI | No | 55-027-0001 | 0.068 | 0.071 | 0.066 | 0.068 |
| Jefferson, WI | No | 55-055-0009 | 0.069 | 0.071 | 0.065 | 0.071 |
| Milwaukee, WI | No | 55-079-0026 | 0.068 | 0.068 | 0.066 | 0.070 |
| | | 55-079-0085 | **0.071*** | 0.069 | 0.068 | 0.077 |
| | | 55-079-0010 | 0.064 | 0.062 | 0.063 | 0.068 |
| Ozaukee, WI | No | 55-089-0008 | **0.071*** | 0.074 | 0.070 | 0.071 |
| | | 55-089-0009 | **0.073*** | 0.070 | 0.071 | 0.079 |
| Racine, WI | No | 55-101-0020 | N/A | N/A | 0.068 | 0.076 |
| Walworth, WI | No | 55-127-0005 | 0.070 | 0.073 | 0.067 | 0.072 |
| Washington, WI | No | no monitor | | | | |
| Waukesha, WI | No | 55-133-0027 | 0.066 | 0.067 | 0.066 | 0.067 |

*Despite violating monitors, in a September 21, 2016 letter from its governor, Wisconsin recommended attainment for the entire state. Later in an April 20, 2017 supplemental submittal, which Wisconsin explains contains technical information to support the governor's recommendation and which contains Wisconsin's estimates of the geographic extent of the areas in Wisconsin with design values above 0.070 ppm, Wisconsin requested that if EPA designates nonattainment areas in Wisconsin, that the EPA should ensure that the geographic scope of these areas is minimized. Wisconsin estimated the geographic extent of the design values above 0.070 ppm in Milwaukee County to be 2.9 miles from the lakeshore in the northeastern portion of the county and 2.8 miles south of the Bayside monitor before cutting due east to the coastline. Wisconsin estimated the geographic extent of the design values above 0.070 ppm in Ozaukee County to be 2.9 miles from the lakeshore. Wisconsin emphasized in its April 20, 2017 submittal that these descriptions should not be construed as a recommendation for a potential nonattainment area designation for the 2015 ozone NAAQS.

Figure 1, shown previously, identifies the Milwaukee ~~intended~~proposed nonattainment area and the violating monitors. Table 2 identifies the 2016 design value for all monitors in the area of analysis and Figure 2 shows the historical trend of design values for the violating monitors. As indicated on the map, there are three violating monitors that are located in the Milwaukee-Racine-Waukesha CSA. Two of the violating monitors are located in Ozaukee County, including one in the northeast portion of the county approximately 0.9 miles from the shoreline of Lake Michigan and one in the east-central portion of the county approximately 2.0 miles from the shoreline of Lake Michigan. The third violating monitor is located in the northeastern portion of Milwaukee County approximately 0.8 miles from the shoreline of Lake Michigan. As shown in Figure 2, the violating monitors have historically high ozone design values, which have been generally decreasing over time; however, there was a small increase in 2016 design values.

**Figure 2. Three-Year Design Values for Violating Monitors.**




The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. Ozaukee County has two monitors and Milwaukee County has one monitor in violation of the 2015 ozone NAAQS, therefore these counties ~~are~~ were included in the ~~intended~~proposed nonattainment area based on the air quality data factor.

**Factor 2: Emissions and Emissions-Related Data**

As mentioned previously, the presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA evaluated emissions of ozone precursors, which include nitrogen oxides ($NO_x$) and volatile organic compounds (VOC), and other emissions-related data that provide information on areas contributing to violating monitors.

**Emissions Data**

The EPA reviewed data from the 2014 National Emissions Inventory (NEI). For each county in the area of analysis, the EPA examined the magnitude of large sources ($NO_x$ or VOC emissions greater than 100 tons per year) and small point sources and the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, non-road mobile, on-road mobile, and fires. Emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

Table 3 provides a county-level emissions summary of $NO_x$ and VOC (given in tons per year (tpy)) emissions for the area of analysis considered for inclusion in the ~~intended~~proposed Milwaukee nonattainment area.

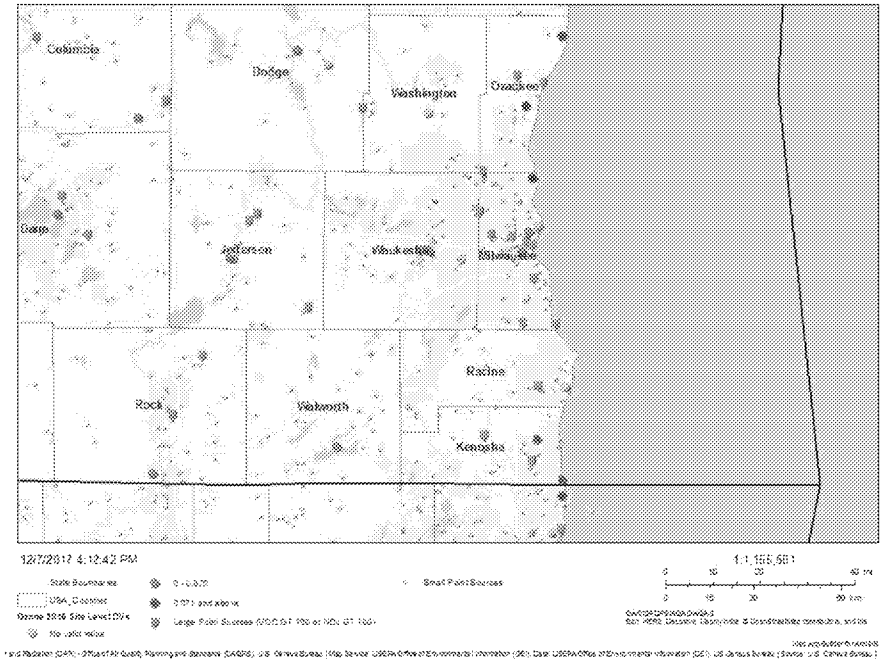
**Table 3. Total County-Level $NO_x$ and VOC Emissions.**

| County, State | State Recommended Nonattainment? | Total $NO_x$ (tpy) | Total VOC (tpy) |
|---|---|---|---|
| Dodge, WI | No | 3,087 | 4,450 |
| Jefferson, WI | No | 3,306 | 3,651 |
| Milwaukee, WI | No* | 22,012 | 17,016 |
| Ozaukee, WI | No* | 3,107 | 2,003 |
| Racine, WI | No | 4,153 | 4,296 |
| Walworth, WI | No | 2,929 | 3,563 |
| Washington, WI | No | 3,543 | 3,625 |
| Waukesha, WI | No | 9,685 | 10,526 |
| | Total: | 51,822 | 49,129 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

In addition to reviewing county-wide emissions of $NO_x$ and VOC in the area of analysis, the EPA also reviewed emissions from point sources. The location of these sources, together with the other factors, can help inform nonattainment boundaries. The locations of the point sources are shown in Figure 3 below.

**Figure 3. Point Sources in the Area of Analysis.**




The EPA's analysis of county-level emissions and the geographic locations of the emissions showed the following. In terms of $NO_X$ emissions from the counties without violating monitors in the Milwaukee-Racine-Waukesha CSA, Waukesha County has the greatest $NO_X$ emissions, on the order of 9,000 tpy, followed by Racine County, on the order of 4,000 tpy, followed by Washington, Jefferson, Dodge, and Walworth counties, each on the order of 3,000 tpy. In terms of VOC emissions from the counties without violating monitors in the Milwaukee-Racine-Waukesha CSA, Waukesha County has the greatest VOC emissions, on the order of 10,000 tpy, followed by Dodge and Racine counties, each on the order of 4,000 tpy, followed by Jefferson, Washington, and Walworth counties, each on the order of 3,000 tpy.

Of the counties without violating monitors, Waukesha County accounts for about 19% of the total CSA $NO_X$ emissions followed by Racine, Washington, Jefferson, Dodge, and Walworth, each accounting for about 6-8% of the CSA $NO_X$ emissions. Of the counties without violating monitors, Waukesha County accounts for about 21% of the total CSA VOC emissions followed by Dodge and Racine counties each accounting for about 9%, followed by Jefferson, Walworth, and Washington counties each accounting for about 7% of the total CSA VOC emissions.

**Population density and degree of urbanization**

In this part of the factor analysis, the EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. These include emissions of $NO_x$ and VOC from on-road and non-road vehicles and engines, consumer products, residential fuel combustion, and consumer services. Areas of dense population or commercial development are an indicator of area source and mobile source $NO_x$ and VOC emissions that may contribute to violations of the NAAQS. Table 4 shows the population, population density, and population growth information for each county in the area of analysis. Figure 4 shows the county-level population density map of the area of analysis.

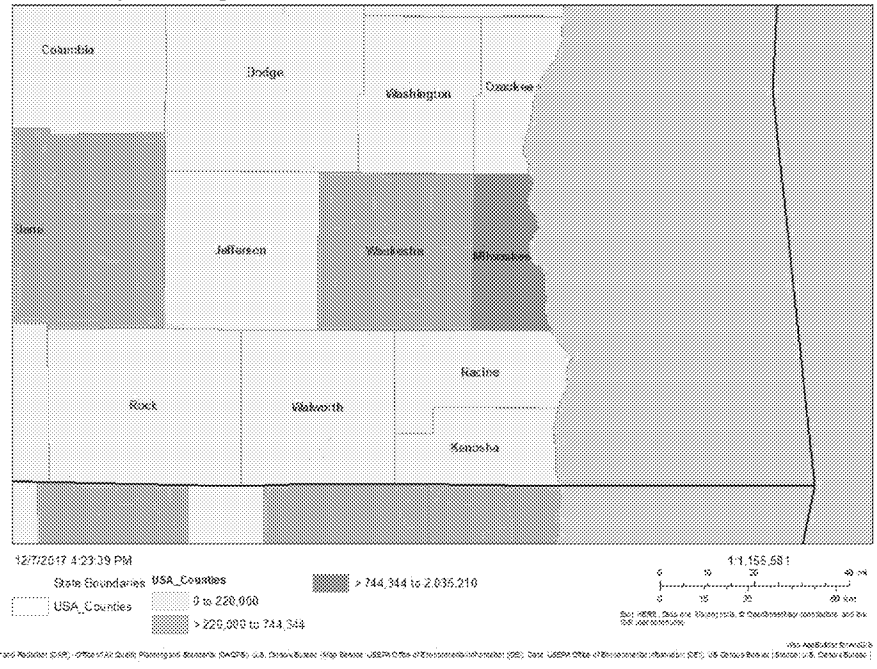
**Table 4. Population and Growth.**
Source: U.S. Census Bureau population estimates for 2010 and 2015. www.census.gov/data.htm.

| County, State | State Recommended Nonattainment? | 2010 Population | 2015 Population | 2015 Population Density (per sq. mi.) | Absolute change in population (2010-2015) | Population % change (2010-2015) |
|---|---|---|---|---|---|---|
| Dodge, WI | No | 88,759 | 88,502 | 101 | 257 | -0.3 |
| Jefferson, WI | No | 83,686 | 84,559 | 152 | 873 | 1.0 |
| Milwaukee, WI | No* | 947,735 | 957,735 | 3967 | 10,000 | 1.1 |
| Ozaukee, WI | No* | 86,395 | 87,850 | 377 | 1,455 | 1.7 |
| Racine, WI | No | 195,408 | 195,080 | 587 | 328 | -0.2 |
| Walworth, WI | No | 102,228 | 102,804 | 185 | 576 | 0.6 |
| Washington, WI | No | 131,887 | 133,674 | 310 | 1,787 | 1.4 |
| Waukesha, WI | No | 389,891 | 396,488 | 721 | 6,597 | 1.7 |
| | Total: | 2,222,938 | 2,242,067 | 460 | 19,129 | 0.9 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

The population did not change more than 2% from 2010 to 2015 in any county in the CSA. Of all the counties in the CSA, the population density is greatest in Milwaukee County (on the order of 4,000 per sq. mi.), which has a violating monitor for the 2014-2016 time period, followed by Waukesha and Racine counties (on the order of 700 and 600, respectively), which do not have violating monitors for the 2014-2016 time period. The remaining counties in the CSA have population densities less than 400 per sq. mi, including Ozaukee County, which is the only other county in the CSA, other than Milwaukee County, with a violating monitor(s).

**Figure 4. County-Level Population.**




## Traffic and Vehicle Miles Travelled (VMT)

The EPA evaluated the commuting patterns of residents, as well as the total vehicle miles traveled (VMT) for each county in the area of analysis. In combination with the population/population density data and the location of main transportation arteries, this information helps identify the probable location of non-point source emissions. A county with high VMT and/or a high number of commuters is generally an integral part of an urban area and high VMT and/or high number of commuters indicates the presence of motor vehicle emissions that may contribute to violations of the NAAQS. Rapid population or VMT growth in a county on the urban perimeter may signify increasing integration with the core urban area, and thus could indicate that the associated area source and mobile source emissions may be appropriate to include in the nonattainment area. In addition to VMT, the EPA evaluated worker data collected by the U.S. Census Bureau[9] for the area of analysis. Table 5 shows the traffic and commuting pattern data, including total VMT for each county, number of residents who work in each county, number of residents that work in counties with violating monitor(s), and the percent of residents working in counties with violating monitor(s). The data in Table 5 are 2014 data.

[9] The worker data can be accessed at: http://onthemap.ces.census.gov/.

**Table 5. Traffic and Commuting Patterns.**

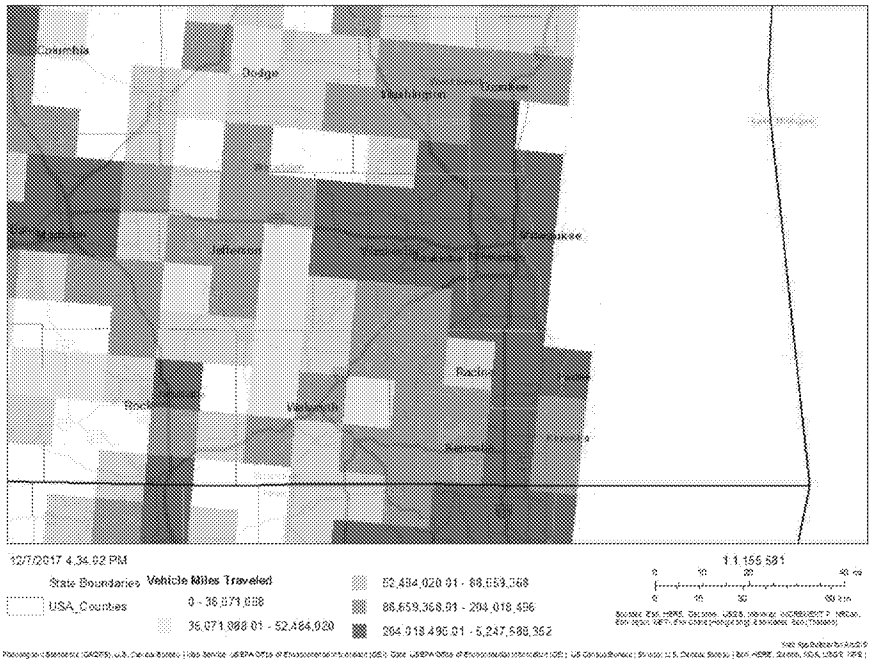
| County | State Recommended Nonattainment? | 2014 Total VMT (Million Miles) | Number of County Residents Who Work | Number Commuting to or Within Counties with Violating Monitor(s) | Percentage Commuting to or Within Counties with Violating Monitor(s) |
|---|---|---|---|---|---|
| Dodge, WI | No | 942 | 43,001 | 1,769 | 4% |
| Jefferson, WI | No | 989 | 42,341 | 3,405 | 8% |
| **Milwaukee, WI** | **No*** | **6,102** | **433,062** | **313,985** | **73%** |
| **Ozaukee, WI** | **No*** | **903** | **45,289** | **31,852** | **70%** |
| Racine, WI | No | 1,357 | 97,523 | 23,445 | 24% |
| Walworth, WI | No | 979 | 47,254 | 4,212 | 9% |
| Washington, WI | No | 1,330 | 72,126 | 22,484 | 31% |
| Waukesha, WI | No | 3,613 | 206,449 | 73,735 | 36% |
| | Total: | 16,215 | 987,045 | 474,887 | 48% |

Counties with a monitor(s) violating the NAAQS are indicated in bold.

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

To show traffic and commuting patterns, Figure 5 overlays twelve-kilometer gridded VMT from the 2014 NEI with a map of the transportation arteries.

**Figure 5. Twelve Kilometer Gridded VMT (Miles) Overlaid with Transportation Arteries.**



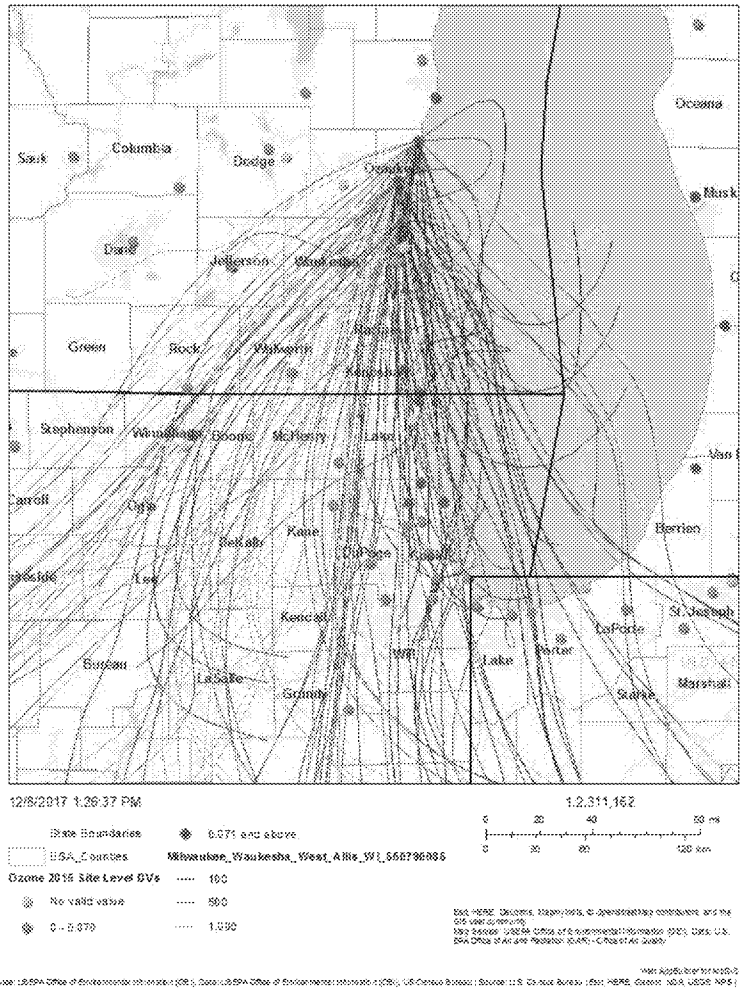

Approximately half of the residents in the CSA commute to or within the counties with violating monitors. Of the counties without violating monitors, Waukesha has the largest number of residents (approximately 74,000) commuting to counties with violating monitors, which is 36% of the Waukesha County residents who work. This is followed by Racine and Washington counties (with approximately 23,000 and 22,000, respectively), which is 24% and 31%, respectively, of the Racine County and Washington County residents who work. The remaining counties each have less than 5,000 residents who commute to counties with violating monitors, which, for each of the remaining counties, represents less than 10% of the county residents who work.

**Factor 3: Meteorology**

Evaluation of meteorological data helps to assess the fate and transport of emissions contributing to ozone concentrations and to identify areas potentially contributing to the monitored violations. Results of meteorological data analysis may inform the determination of nonattainment area boundaries. In order to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of ozone and precursor emissions from sources in the area, the EPA evaluated 2014-2016 HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) trajectories at 100, 500, and 1000 meters above ground level (AGL) that illustrate the three-

dimensional paths traveled by air parcels to a violating monitor. Figure 6a-d shows the 24-hour HYSPLIT back trajectories for each exceedance day (i.e., daily maximum 8 hour values that exceed the 2015 ozone NAAQS) for the violating monitors.

**Figure 6. HYSPLIT Back Trajectories for Violating Monitors.**




The HYSPLIT back trajectories show that, on exceedance days, air parcels traveled to the violating monitors from the south, west-southwest, southwest, and southeast. To the southeast of the violating monitors, is Lake Michigan. Directly south of the counties with the violating monitors, is Racine County

and Kenosha County. Racine County is part of the Milwaukee-Racine-Waukesha CSA. Kenosha County is in a separate CSA and is therefore being evaluated separately as part of the Chicago area. To the west-southwest of the counties with the violating monitors are Washington County, Waukesha County, Jefferson County, and Walworth County, which are all part of the Milwaukee-Racine-Waukesha CSA. Dodge County, while in the Milwaukee-Racine-Waukesha CSA, is due west of Ozaukee County with Washington County in between. Dodge County contains very few HYSPLIT back trajectories relative to the other counties in the CSA without violating monitors and these HYSPLIT back trajectories only cover the southeastern-most corner of Dodge County.

**Factor 4: Geography/topography**

Consideration of geography or topography can provide additional information relevant to defining nonattainment area boundaries. Analyses should examine the physical features of the land that might define the airshed. Mountains or other physical features may influence the fate and transport of emissions as well as the formation and distribution of ozone concentrations. The absence of any such geographic or topographic features may also be a relevant consideration in selecting boundaries for a given area.

The EPA uses geography/topography analysis to evaluate the physical features of the land that might affect the airshed and, therefore, the distribution of ozone over the area.

The Milwaukee area does not have any geographical or topographical features significantly limiting air pollution transport within its airshed. The eastern boundaries of Ozaukee, Milwaukee, and Racine counties follow the shoreline of Lake Michigan. As described under Factor 3: Meteorology, for the Sheboygan County, Manitowoc County, and Door County areas (Sections 3.2, 3.3, and 3.4 respectively), areas geographically located along the shoreline of Lake Michigan can be impacted by lake breeze meteorology, which has the potential to transport photochemically aged air masses containing ozone-rich air originating from nearby and upwind precursor plumes to nearby and downwind coastal areas along Lake Michigan. The emissions and emissions-related data from the counties in the Milwaukee area described above are a dominating factor influencing ozone formation in the Milwaukee area. The precursor emissions from the Milwaukee area (with or without the added influence of lake breeze meteorology to exacerbate ozone formation) are sufficiently high emissions for forming ozone in the Milwaukee area.

**Factor 5: Jurisdictional boundaries**

Once the geographic extent of the violating area and the nearby areas contributing to violations is determined, the EPA considered existing jurisdictional boundaries for the purposes of providing a clearly defined legal boundary to carry out the air quality planning and enforcement functions for nonattainment areas. In defining the boundaries of the ~~intended~~proposed Milwaukee nonattainment area, the EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Examples of jurisdictional boundaries include, but are not limited to: counties, air districts, areas of Indian country, metropolitan planning organizations, and existing nonattainment areas. If an existing jurisdictional boundary is used to help define the nonattainment area, it must encompass all of the area that has been identified as meeting the

nonattainment definition. Where existing jurisdictional boundaries are not adequate or appropriate to describe the nonattainment area, the EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the ~~intended~~proposed -designated areas.

The area of analysis was the Milwaukee-Racine-Waukesha CSA, which includes Dodge, Washington, Ozaukee, Jefferson, Waukesha, Milwaukee, Walworth, and Racine counties in Wisconsin. The Milwaukee area has a previously established nonattainment boundary associated with the 1997 ozone NAAQS consisting of Washington, Ozaukee, Waukesha, Milwaukee, Racine, and Kenosha counties in Wisconsin. For the purposes of the 2008 ozone NAAQS, the entire counties of Milwaukee, Ozaukee, Racine, Washington, Waukesha, and a portion of Kenosha County were designated as unclassifiable/attainment (the other portion of Kenosha County was designated with the Chicago area as nonattainment for the 2008 ozone NAAQS).

Based on the five-factor analysis, EPA's ~~intended~~proposed -boundary for the Milwaukee nonattainment area for the 2015 ozone NAAQS (announced on December 22, 2017) consisted~~s~~ of Washington, Ozaukee, Waukesha, Milwaukee, and Racine counties in Wisconsin. This differs from the 1997 ozone NAAQS Milwaukee nonattainment area in that Kenosha is not included in the Milwaukee area, since, as explained previously, Kenosha is part of the Chicago CSA and therefore included in the area of analysis for the Chicago nonattainment area. This December 22, 2017, ~~intended~~proposed -boundary is very similar to the previous (historical) boundary from the 1997 ozone NAAQS; this boundary is also a jurisdictional boundary in the sense that it is an air quality planning area used by the local Metropolitan Planning Organization (MPO) for transportation conformity purposes.

**Conclusion for Milwaukee Area**

Based on the assessment of factors described above, the EPA ~~has~~ on December 22, 2017, announced our conclu~~sion~~~~ded~~ that the following counties meet the CAA criteria for inclusion in the ~~intended~~proposed Milwaukee nonattainment area: Ozaukee County (violating and contributing), Milwaukee County (violating and contributing), Washington County (contributing), Waukesha County (contributing), and Racine County (contributing). These are the same counties that are included in the Milwaukee nonattainment area for the 1997 ozone NAAQS (with the exception of Kenosha County, which, ~~as explained previously, is~~ ~~being evaluated as~~now part of the Chicago CSA~~area~~). The air quality monitors in Ozaukee County and Milwaukee County indicate violations of the 2015 ozone NAAQS based on the 2016 design values, therefore these counties were~~are~~ included in the ~~intended~~proposed -nonattainment area.

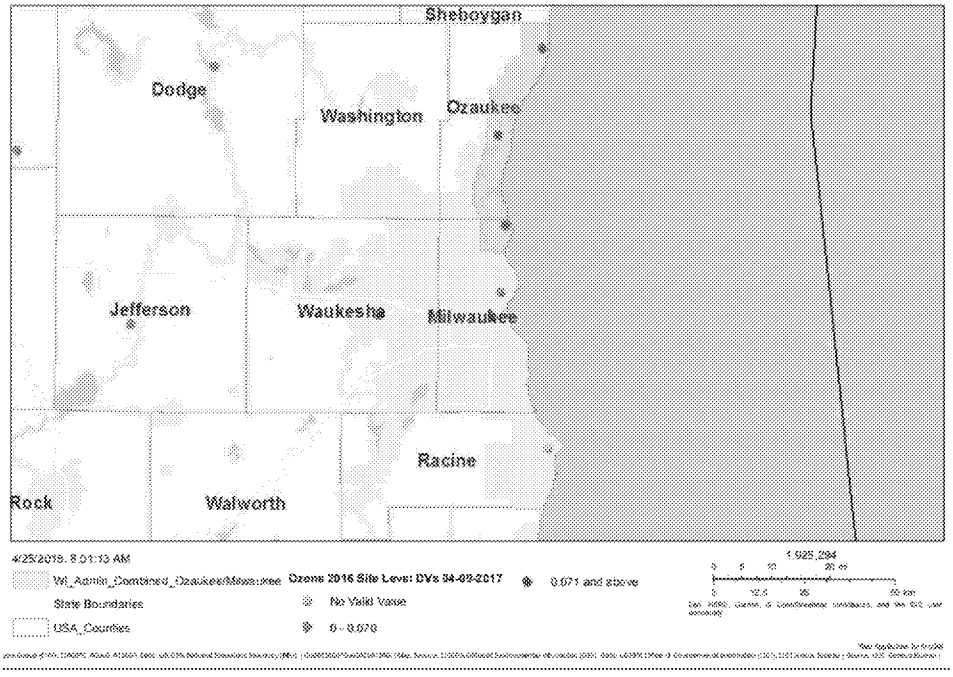
Washington County, Waukesha County, and Racine County are nearby counties that either do not have monitors (Washington County), or, in the case of Waukesha County, does not have a violating monitor. Racine County has a monitor that does not have a valid design value for 2016; however, the 4th high maximum daily 8-hour average ozone concentration in 2016 for the Racine County monitor was 0.076 ppm. The EPA ~~has~~ concluded that these nearby areas contribute to the ozone concentrations in violation of the 2015 ozone NAAQS through emissions from point and non-point sources into the counties with violating monitors. Waukesha County has, by far, the highest $NO_x$ and VOC emissions in the CSA of the

counties without violating monitors, followed by Racine and Washington counties, which have the next greatest $NO_x$ emissions. Waukesha and Racine counties have the greatest population densities of counties in the CSA without violating monitors. Waukesha (36%), Washington (31%), and Racine (24%) counties have the greatest percentage of county workers commuting to counties with violating monitors, whereas the remaining three counties in the CSA without violating monitors (Dodge, Jefferson, and Walworth counties) each have fewer than 10% of workers commuting to the counties with the violating monitors (Ozaukee and Milwaukee counties).

The HYSPLIT back trajectories from the northern violating monitor in Ozaukee County (AQS 55-089-0009) show the paths traveled by air parcels to this violating monitor on exceedance days at this violating monitor. These trajectories show air parcels traveling over, among other counties, Washington, Waukesha, Milwaukee, and Racine counties. The HYSPLIT back trajectories from the southern violating monitor in Ozaukee County (AQS 55-089-0008) show the paths traveled by air parcels to this violating monitor on exceedance days at this violating monitor. These trajectories show air parcels traveling over, among other counties, Waukesha, Milwaukee, and Racine counties. The HYSPLIT back trajectories from the violating monitor in Milwaukee County (AQS 55-079-0085) show the paths traveled by air parcels to this violating monitor on exceedance days at this violating monitor. These trajectories show air parcels traveling over, among other counties, Waukesha and Racine counties.

These factors, when considered together provide the key evidence for the EPA's December 22, 2017, determination of the 2015 ozone NAAQS ~~intended~~proposed ~~-~~nonattainment area boundary for the Milwaukee area, which is the same as the Milwaukee nonattainment area for the 1997 ozone NAAQS (with the exception of Kenosha County, which, as explained previously, is ~~being evaluated as~~ part of the Chicago ~~area~~CSA).

The above analysis was originally announced in EPA's December 22, 2017, TSD. In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area described below. To be clear, as per Wisconsin's February 2018 submittal included in the docket, the state requested a distance inland from the ordinary high water mark (OHWM). EPA prefers clearly identifiable roadways rather than the OHWM (see responses to comments (RTC) accompanying this final action). Therefore, EPA selected roadways that were roughly the distance inland from the shoreline requested by the state, which was 2.9 miles inland from the shoreline in Ozaukee and Milwaukee counties and 2.8 miles south of the violating monitor in Milwaukee County. Wisconsin believes that air above 0.070 ppm in these counties is confined to a distance of 2.9 miles inland from the shoreline in Ozaukee and Milwaukee counties and 2.8 miles south of the violating monitor in Milwaukee County. This final Milwaukee nonattainment area includes all of the violating monitors in the CSA and approximately 2% of the CSA NOx emissions, 2% of the CSA VOC emissions, and 4% of the CSA VMT.




The roadways for the Ozaukee County boundary are inclusive and east of County Road KW, Cedar Beach Road, 6 Mile Road, County Road A, Lovers Land Road, Woodland Road, County Road KK, Willow Road, Highway 57, County Road W, N. Riverside Drive, E. Green Bay Avenue, S. Main Street, N. Green Bay Road, 12th Avenue, Wisconsin Avenue, Green Bay Road, S. Main Street, N. Cedarburg Road/Highway 57.

The roadways for the Milwaukee County boundary are the northeastern corner of Milwaukee County bounded by and inclusive of the following roadways going from the northern county border to Lake Michigan: Highway 57/N. Sherman Blvd/N. 43rd Street to W. Mill Road to Highway 57/N. Green Bay Ave to W. Bender Road/Devon Street to N. Santa Monica Blvd to E. Belle Ave to the southern boundary of Klode Park.

### 3.2 Technical Analysis for the Sheboygan County Area

This technical analysis identifies the area with a monitor that violates the 2015 ozone NAAQS. It also provides EPA's evaluation of this area and any nearby areas to determine whether those nearby areas have emissions sources that potentially contribute to ambient ozone concentrations at the violating monitor in the area, based on the weight-of-evidence of the five factors recommended in the EPA's ozone designations guidance and any other relevant information. In developing this technical analysis, the EPA used the latest certified data and information available to the EPA (and to the states and tribes through the Ozone Designations Mapping Tool and the EPA Ozone Designations Guidance and Data web page).[10] In addition, the EPA considered any additional data or information provided to the EPA by states or tribes.

The initial area of analysis was Sheboygan County, which is not part of a CSA and which is its own CBSA.

The five factors recommended in the EPA's guidance are:

1. Air Quality Data (including the design value calculated for each Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitor;
2. Emissions and Emissions-Related Data (including locations of sources, population, amount of emissions, and urban growth patterns);
3. Meteorology (weather/transport patterns);
4. Geography/Topography (including mountain ranges or other physical features that may influence the fate and transport of emissions and ozone concentrations); and
5. Jurisdictional Boundaries (e.g., counties, air districts, existing nonattainment areas, areas of Indian country, Metropolitan Planning Organizations (MPOs)).

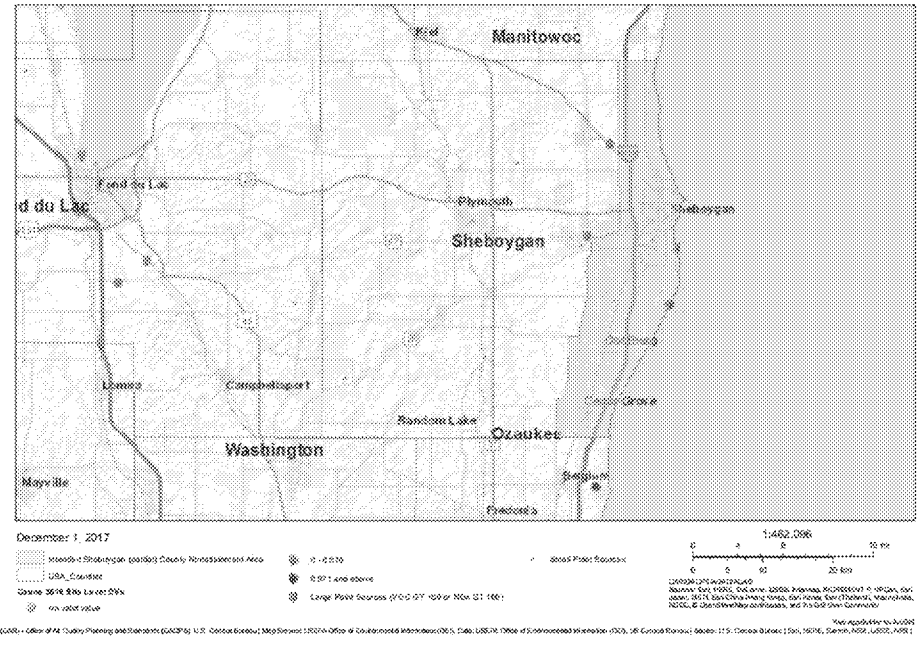
Figure 1 is a map of the EPA's ~~intended~~proposed nonattainment boundary for the Sheboygan County area, which was announced on December 22, 2017. The map shows the location of the ambient air quality monitors, county, and other jurisdictional boundaries.

For purposes of both the 1997 ozone NAAQS and the 2008 ozone NAAQS, the entirety of Sheboygan County was designated nonattainment. The EPA announced on December 22, 2017, that as a result of the 5-factor anlaysis below, and d~~D~~ue to new information from a second ozone monitor in Sheboygan County accompanied by an analysis submitted by Wisconsin, both of which are discussed in more detail below in the context of the five-factor weight-of-evidence analysis, the EPA's ~~intended~~proposed nonattainment boundary for the Sheboygan County area for the 2015 ozone NAAQS ~~was~~is a portion of Sheboygan County ~~inclusive and east of the following roadways with the boundary starting from north to south: Union Road which turns into County Road Y which turns into Highland Drive, to Lower Road which turns into Monroe Street, to Broadway/Main Street to Highway 32 which turns into Giddings Avenue to County Road W to County Road KW. This boundary is different from the boundary for the both the 1997 ozone NAAQS and the 2008 ozone NAAQS, which consisted of the entirety of Sheboygan County~~roughly 3.2 miles inland from the shoreline, which is the inland distance of the attaining monitor, which has a 2016 design value of 0.069 ppm and a 2017 preliminary design value of 0.070 ppm. In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area

[10] The EPA's Ozone Designations Guidance and Data web page can be found at *https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data.*

described in the conclusion to this section (skip to page X), which is roughly 2.3 miles inland from the shoreline.

**Figure 1. EPA's ~~Intended~~Proposed Nonattainment Boundary for the Sheboygan County Area**




The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. Sheboygan County has a monitor in violation of the 2015 ozone NAAQS, therefore a portion of this county containing the violating monitor is included in the ~~intended~~proposed nonattainment area. The following sections describe the five-factor analysis. While the factors are presented individually, they are not independent. The five-factor analysis process carefully considers the interconnections among the different factors and the dependence of each factor on one or more of the others, such as the interaction between emissions and meteorology for the area being evaluated.

**Factor Assessment**

**Factor 1: Air Quality Data**

The EPA considered the 8-hour ozone design value in ppm for the air quality monitors in Sheboygan County based on data for the 2014-2016 period (i.e., the 2016 design value, or DV). This is the most recent three-year period with fully-certified air quality data. The design value is the 3-year average of the

annual 4th highest daily maximum 8-hour average ozone concentration.[11] The 2015 NAAQS are met when the design value is 0.070 ppm or less. Only ozone measurement data collected in accordance with the quality assurance (QA) requirements using approved (FRM/FEM) monitors are used for NAAQS compliance determinations.[12] The EPA uses FRM/FEM measurement data residing in the EPA's Air Quality System (AQS) database to calculate the ozone design values. Individual violations of the 2015 ozone NAAQS that the EPA determines have been caused by an exceptional event that meets the administrative and technical criteria in the Exceptional Events Rule[13] are not included in these calculations. Whenever several monitors are located in a county (or designated nonattainment area), the design value for the county or area is determined by the monitor with the highest valid design value. The presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA identified monitors where the most recent design values violate the NAAQS, and examined historical ozone air quality measurement data (including previous design values) to understand the nature of the ozone ambient air quality problem in the area. Eligible monitors for providing design value data generally include State and Local Air Monitoring Stations (SLAMS) that are operated in accordance with 40 CFR part 58, appendices A, C, D and E and operating with an FRM or FEM monitor. These requirements must be met in order to be acceptable for comparison to the 2015 ozone NAAQS for designation purposes. All data from Special Purpose Monitors (SPMs) using an FRM or FEM are eligible for comparison to the NAAQS, subject to the requirements given in the March 28, 2016 Revision to Ambient Monitoring Quality Assurance and Other Requirements Rule (81 FR 17248).

There are two monitors located in Sheboygan County. The Sheboygan Kohler Andrae monitor (AQS Site ID 55-117-0006) is located within several hundred feet of the Lake Michigan shoreline, and the Sheboygan Haven monitor (AQS Site ID 55-117-0009) is located approximately 3.2 miles from the Lake Michigan shoreline and approximately 10.9 miles north northwest of the Kohler Andrae monitor. The 2016 design value for each of these monitors is shown in Table 2.

[11] The specific methodology for calculating the ozone design values, including computational formulas and data completeness requirements, is described in 40 CFR part 50, appendix U.

[12] The QA requirements for ozone monitoring data are specified in 40 CFR part 58, appendix A. The performance test requirements for candidate FEMs are provided in 40 CFR part 53, subpart B.

[13] The EPA finalized the rule on the Treatment of Data Influenced by Exceptional Events (81 FR 68513) and the guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events in September of 2016. For more information, see *https://www.epa.gov/air-quality-analysis/exceptional-events-rule-and-guidance.*

**Table 2. Air Quality Data (all values in ppm).**

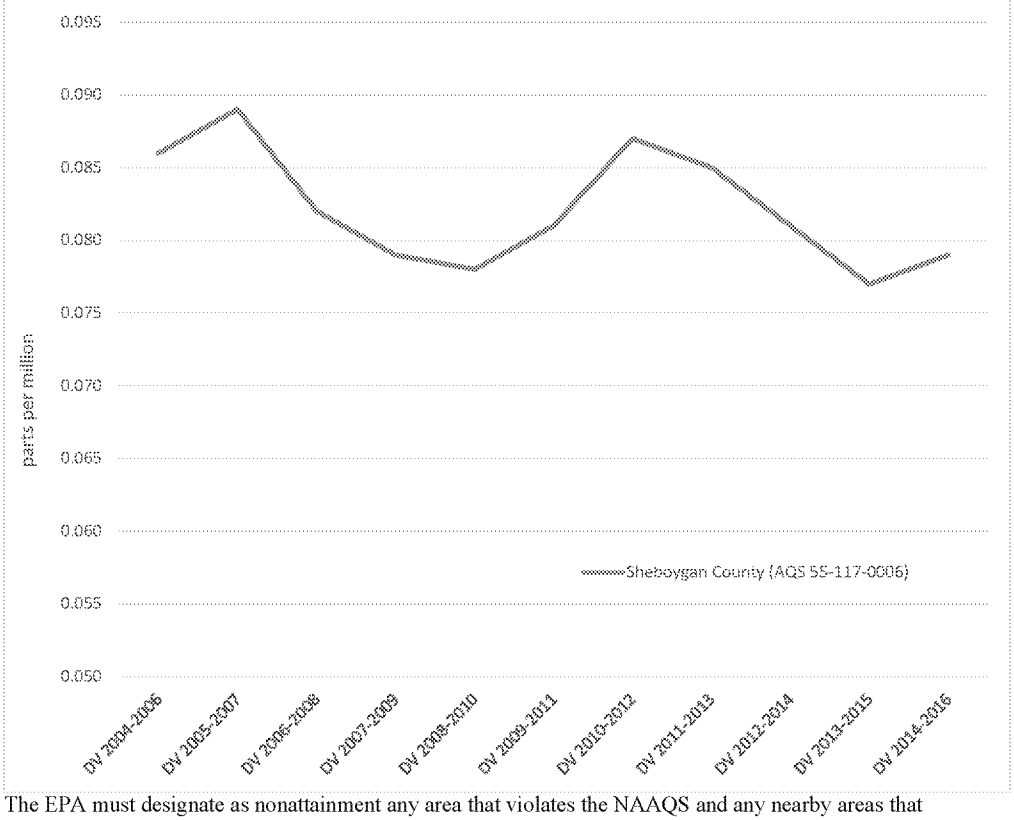
| County, State | State Recommended Nonattainment? | AQS Site ID | 2014-2016 DV | 2014 4th highest daily max value | 2015 4th highest daily max value | 2016 4th highest daily max value |
|---|---|---|---|---|---|---|
| Sheboygan, WI | No | 55-117-0006 | **0.079*** | 0.072 | 0.081 | 0.085 |
| | | 55-117-0009 | 0.069 | 0.068 | 0.067 | 0.074 |

*Despite violating monitors, in a September 21, 2016, letter from its governor, Wisconsin recommended attainment for the entire state. Later in an April 20, 2017, supplemental submittal, which Wisconsin explains contains technical information to support the governor's recommendation and which contains Wisconsin's estimates of the geographic extent of the areas in Wisconsin with design values above 0.070 ppm, Wisconsin requested that if EPA designates nonattainment areas in Wisconsin, that the EPA should ensure that the geographic scope of these areas is minimized. Wisconsin estimated the geographic extent of the design values above 0.070 ppm in Sheboygan County to be 2.9 miles from the lakeshore. Wisconsin emphasized in its April 20, 2017, submittal that these descriptions should not be construed as a recommendation for a potential nonattainment area designation for the 2015 ozone NAAQS.

The easternmost monitor in Sheboygan County shows a violation of the 2015 ozone NAAQS, therefore a portion of the county containing the easternmost monitor is included in the ~~intended~~proposed nonattainment area.

Figure 1, shown previously, identifies the Sheboygan County ~~intended~~proposed nonattainment area and the violating monitor. Table 2 identifies the 2016 design values for the monitors in Sheboygan County and Figure 2 shows the historical trend of design values for the violating monitor. As indicated on the map, there is one violating monitor that is located in Sheboygan County, the Sheboygan Kohler Andrae monitor (AQS Site ID 55-117-0006), which is located within several hundred feet of the Lake Michigan shoreline. In 2014, Wisconsin installed a second monitor in Sheboygan County, the Sheboygan Haven monitor (AQS Site ID 55-117-0009), which is located approximately 3.2 miles inland from the shoreline of Lake Michigan and approximately 10.9 miles north northwest of the Kohler Andrae monitor. The Sheboygan Haven monitor has a valid 2016 design value of 0.069 ppm which indicates that this monitor is not violating the 2015 ozone NAAQS of 0.070 ppm. There are several monitors to the west and southwest of the Sheboygan County CBSA, including one in Fond du Lac County and one in Dodge County that are not violating for the 2014-2016 time period. There are three monitors to the south of the Sheboygan County CBSA, including two in Ozaukee County, and one in Milwaukee County that are violating for the 2014-2016 time period, but this area will be addressed separately, since it is part of a separate CSA. As shown in Figure 2, the Sheboygan County violating monitor has historically high ozone design values, which have been generally decreasing over time; however, there was a small increase in the 2016 design value.

**Figure 2. Three-Year Design Values for Violating Monitors (2007-2016).**




The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. Sheboygan County has a monitor in violation of the 2015 ozone NAAQS, therefore a portion of Sheboygan County that contains the violating monitor is included in the ~~intended~~proposed nonattainment area based on the air quality data factor.

**Factor 2: Emissions and Emissions-Related Data**

As mentioned previously, the presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA evaluated emissions of ozone precursors, which include nitrogen oxides ($NO_x$) and volatile organic compounds (VOC), and other emissions-related data that provide information on areas contributing to violating monitors.

**Emissions Data**

The EPA reviewed data from the 2014 National Emissions Inventory (NEI). For each county in the area of analysis, the EPA examined the magnitude of large sources ($NO_x$ or VOC emissions greater than 100 tons per year) and small point sources and the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, non-road mobile, on-road mobile, and fires. Emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

Table 3 provides a county-level emissions summary of $NO_x$ and VOC (given in tons per year (tpy)) emissions for the area of analysis considered for Sheboygan County.

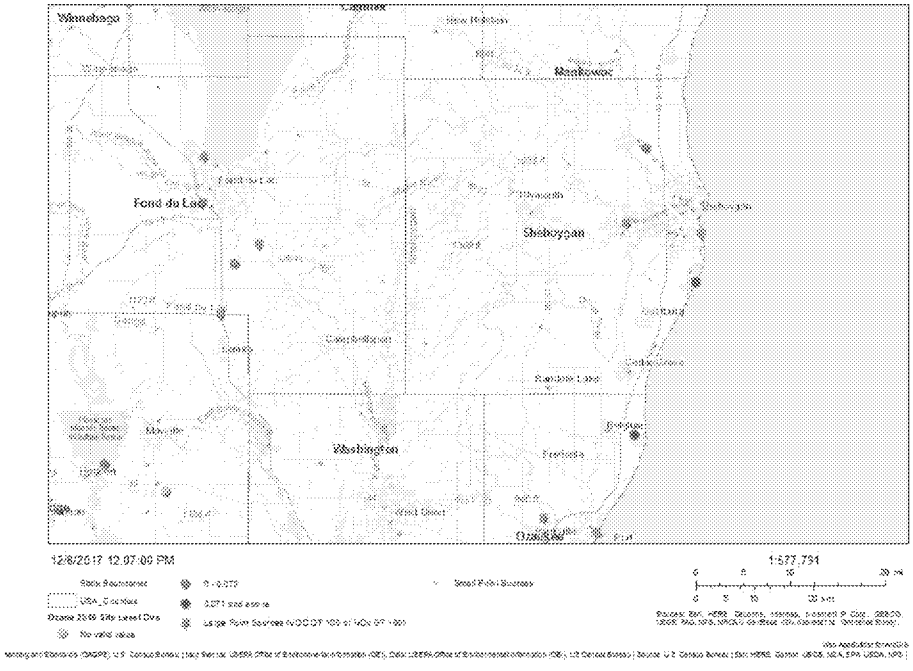
**Table 3. Total County-Level $NO_x$ and VOC Emissions.**

| County, State | State Recommended Nonattainment? | Total $NO_x$ (tpy) | Total VOC (tpy) |
|---|---|---|---|
| Sheboygan, WI | No* | 4,585 | 3,421 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

In addition to reviewing county-wide emissions of $NO_x$ and VOC in the area of analysis, the EPA also reviewed emissions from point sources. The location of these sources, together with the other factors, can help inform nonattainment boundaries. The locations of the point sources are shown in Figure 3 below.

**Figure 3. Point Sources in the Area of Analysis.**




The EPA's analysis of county-level emissions shows two large point sources in Sheboygan County, which are the Wisconsin Power and Light (WPL)-Edgewater Generating Station and the Bemis Manufacturing Company-Plant B. WPL-Edgewater reported 1,639.74 tons of $NO_X$ and 37.47 tons of VOC emitted in 2014. Bemis-Plant B reported 5.04 tons of $NO_X$ and 183.89 tons of VOC emitted in 2014. The EPA's analysis shows approximately 23 small point sources in Sheboygan County, 18 of which reported $NO_X$ emissions, and all of which reported VOC emissions to the 2014 NEI. These 23 small point sources collectively emitted a reported 166.72 tons of $NO_X$ and 329.64 tons of VOC in 2014. The largest $NO_X$ emitter of these sources, Nemak Gateway Plant, emitted a reported 45.39 tons of $NO_X$ and the largest VOC emitter of these sources, Plymouth Foam Inc., emitted a reported 56.67 tons of VOC in 2014. While the point source precursor emissions in Sheboygan County are not trivial, the $NO_X$ and VOC emissions from the point sources in Sheboygan County, with the exception of WPL-Edgewater, are relatively low, and are concentrated in the central and eastern portion of the county east of I-43 and mostly in the city of Sheboygan.

**Population density and degree of urbanization**

In this part of the factor analysis, the EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. These include emissions of $NO_X$ and VOC from on-road and non-road vehicles and engines, consumer

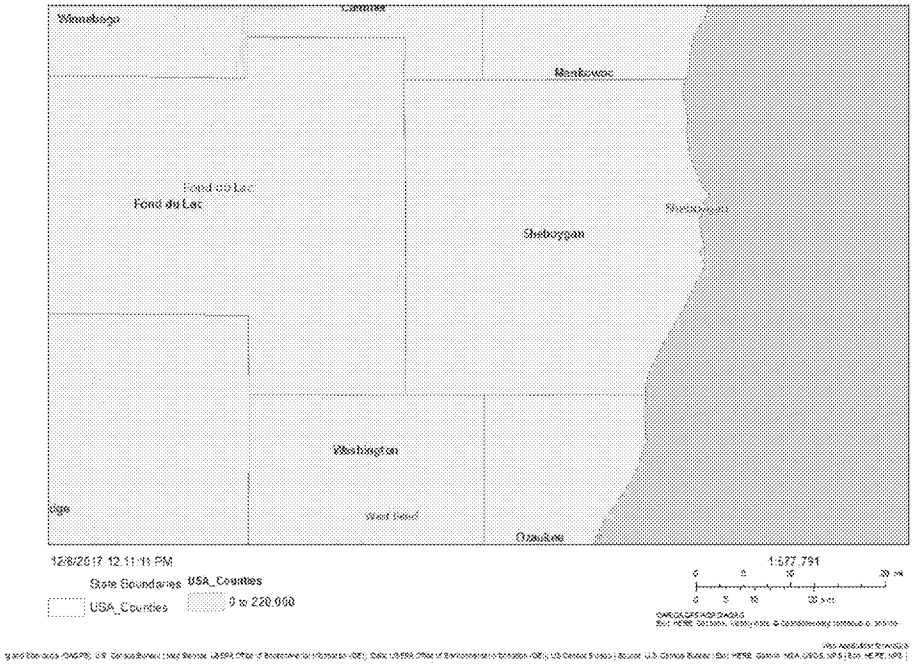
products, residential fuel combustion, and consumer services. Areas of dense population or commercial development are an indicator of area source and mobile source $NO_x$ and VOC emissions that may contribute to violations of the NAAQS. Table 4 shows the population, population density, and population growth information for the county in the area of analysis. Figure 4 shows the county-level population density map of the area of analysis.

**Table 4. Population and Growth.**
Source: U.S. Census Bureau population estimates for 2010 and 2015. www.census.gov/data.html.

| County, State | State Recommended Nonattainment? | 2010 Population | 2015 Population | 2015 Population Density (per sq. mi.) | Absolute change in population (2010-2015) | Population % change (2010-2015) |
|---|---|---|---|---|---|---|
| Sheboygan, WI | No* | 115,507 | 115,569 | 226 | 62 | 0.1 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

**Figure 4. County-Level Population.**




The population and population density in Sheboygan County are both relatively low. The non-point (area) source emissions reported to the 2014 NEI were 681 tons of $NO_X$ and 1,405 tons of VOC. The on-road emissions reported to the 2014 NEI were 1,384 tons of $NO_X$ and 676 tons of VOC. The non-road emissions reported to the 2014 NEI were 708 tons of $NO_X$ and 775 tons of VOC. These quantities of precursor emissions are not trivial; however, the reported $NO_X$ and VOC emissions from the non-point (area), on-road, and non-road source sectors, which are the source sectors that are often correlated with population and population density, are relatively low in Sheboygan County.

**Traffic and Vehicle Miles Travelled (VMT)**

The EPA evaluated the commuting patterns of residents, as well as the total vehicle miles traveled (VMT) for the county in the area of analysis. In combination with the population/population density data and the location of main transportation arteries, this information helps identify the probable location of non-point source emissions. A county with high VMT and/or a high number of commuters is generally an integral part of an urban area and high VMT and/or high number of commuters indicates the presence of motor vehicle emissions that may contribute to violations of the NAAQS. Rapid population or VMT growth in a county on the urban perimeter may signify increasing integration with the core urban area, and thus could indicate that the associated area source and mobile source emissions may be appropriate to include in the

nonattainment area. In addition to VMT, the EPA evaluated worker data collected by the U.S. Census Bureau[14] for the area of analysis. Table 5 shows the traffic and commuting pattern data, including total VMT for the county, number of county residents who work, number of county residents commuting within the county, and the percentage of county residents commuting within the county. The data in Table 5 are 2014 data.

**Table 5. Traffic and Commuting Patterns.**

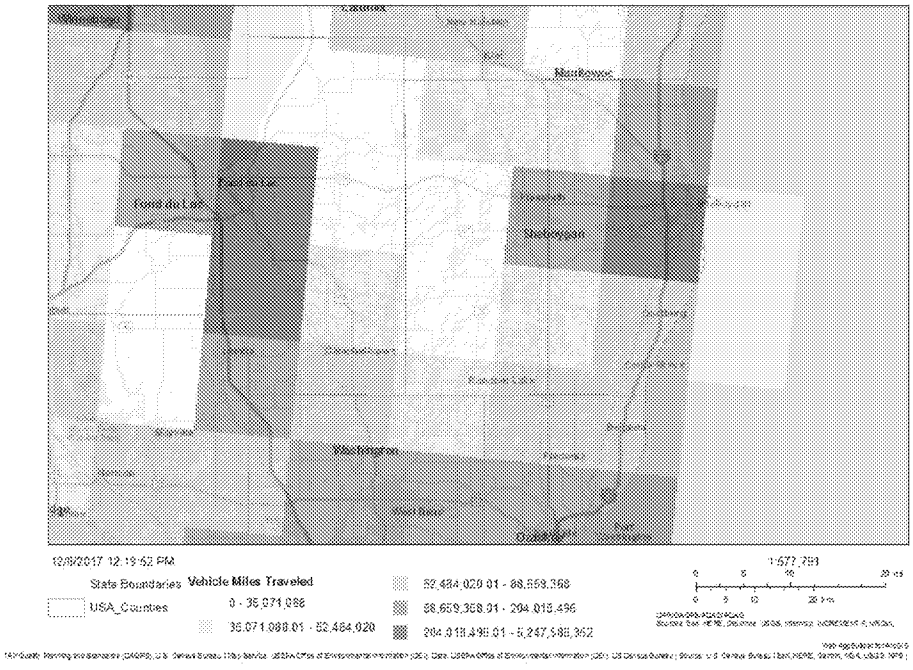
| County | State Recommended Nonattainment? | 2014 Total VMT (Million Miles) | Number of County Residents Who Work | Number of County Residents Commuting Within the County | Percentage of County Residents Commuting Within the County |
|---|---|---|---|---|---|
| Sheboygan, WI | No* | 928 | 58,178 | 39,848 | 68% |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

To show traffic and commuting patterns, Figure 5 overlays twelve-kilometer gridded VMT from the 2014 NEI with a map of the transportation arteries.

[14] The worker data can be accessed at: http://onthemap.ces.census.gov/.

**Figure 5. Twelve Kilometer Gridded VMT (Miles) Overlaid with Transportation Arteries.**




Sheboygan County has a relatively low population density and degree of urbanization. The reported vehicle miles traveled (VMT) for 2014 were 928 million miles, and the on-road emissions reported to the 2014 NEI were 1,384 tons of $NO_X$ and 676 tons of VOC. The majority of the VMT are concentrated along the I-43 corridor and in the area around the cities of Sheboygan, Sheboygan Falls, and the village of Kohler, as seen in Figure 5.

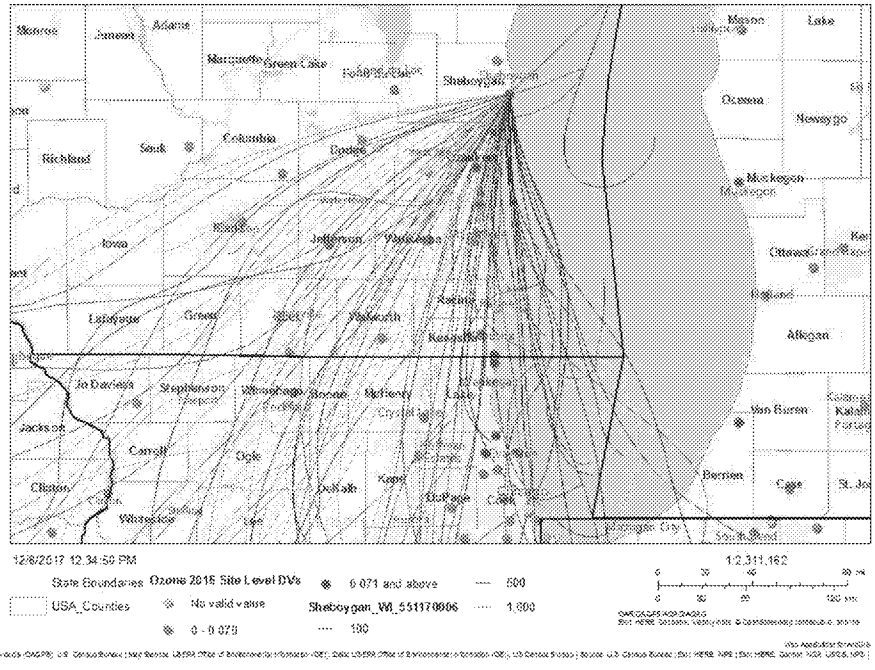
The Sheboygan County emissions and emissions-related data are not trivial. The $NO_X$ and VOC emissions from the various source sectors, including point (with the exception of WPL-Edgewater), non-point (area), on-road mobile, and off-road mobile, in Sheboygan County are relatively low, such that the emissions and emissions-related data factor of the analysis can be ranked relatively low (with the exception of WPL-Edgewater) in terms of potential contribution to ozone formation. Emission sources, emissions, and population are concentrated near the I-43 corridor and the cities of Sheboygan, Sheboygan Falls, and the village of Kohler.

**Factor 3: Meteorology**

Evaluation of meteorological data helps to assess the fate and transport of emissions contributing to ozone concentrations and to identify areas potentially contributing to the monitored violations. Results of

meteorological data analysis may inform the determination of nonattainment area boundaries. In order to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of ozone and precursor emissions from sources in the area, the EPA evaluated 2014-2016 HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) trajectories at 100, 500, and 1000 meters above ground level (AGL) that illustrate the three-dimensional paths traveled by air parcels to a violating monitor. Figure 6 shows the 24-hour HYSPLIT back trajectories for each exceedance day (i.e., daily maximum 8 hour values that exceed the 2015 ozone NAAQS) for the violating monitor.

**Figure 6. HYSPLIT Back Trajectories for Violating Monitor.**




The eastern boundary of Sheboygan County follows the shoreline of Lake Michigan. Due to its proximity to the lake, Sheboygan County has the potential to be impacted by lake breeze meteorology. The land breeze and lake breeze occur when wind blows from the land and lake, respectively, due to air pressure differences caused by the different heating capacities of the land and the water. Land absorbs and loses solar radiation much faster than water. The land breeze typically occurs in the early morning after air above the relatively warm nighttime water of Lake Michigan heats and rises, setting up an area of low pressure which is filled by the cooler air from the land. The lake breeze typically occurs in the afternoon when the area of low pressure is created by rising air over the heated land, creating winds off the cooler lake. The land/lake breeze is typically more localized than the prevailing (synoptic) winds. Studies indicate the land/lake breeze can trap, stratify, and recirculate offshore air, sometimes in a helical pattern.

Daytime inversions over the lake can create shallow, stable layers of precursor plumes, which, on warm sunny days, are conducive to ozone formation. The afternoon lake breeze can carry photochemically aged, ozone-rich air toward the land from nearby and upwind plumes, to nearby and downwind areas like Sheboygan County where violations of the ozone standard can be measured at locations along the shoreline. Additionally, large scale, summertime, stagnant high pressure systems centered to the south and southeast of Lake Michigan have been implicated in high ozone episodes for areas near the shoreline of Lake Michigan, because they can produce southerly and southeasterly flows over Lake Michigan, which can enhance the flow of photochemically aged air. The relative role of each (the land/lake breeze and synoptic flow) is episode-specific and not fully understood.[15, 16, 17, 18, 19]

The HYSPLIT trajectories (Figure 6) indicate that exceedance day air masses generally traveled from the south and southwest prior to being detected at the violating monitor. Many of the lower level trajectories represented by the red lines at 100 meters AGL and the blue lines at 500 m AGL traveled from over Lake Michigan while the higher level trajectories represented by the green lines at 1,000 m AGL traveled over land. Scientific studies indicate ozone can be preferentially transported over the Great Lakes relative to the land surface.[20, 21, 22, 23, 24, 25] Sheboygan County is downwind of two large CSAs including the Milwaukee-Racine-Waukesha CSA (total 2014 reported CSA $NO_X$ = 51,822 tons, VOC= 49,129 tons) and the Chicago CSA (total 2014 reported CSA $NO_X$ = 274,440 tons, VOC= 206,171 tons) which includes

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[15] Cleary, P. A., Fuhrman, N., Schulz, L., Schafer, J., Fillingham, J., Bootsma, H., McQueen, J., Tang, Y., Langel, T., McKeen, S., Williams, E. J., and Brown, S. S.: Ozone distributions over southern Lake Michigan: comparisons between ferry-based observations, shoreline-based DOAS observations and model forecasts, Atmos. Chem. Phys., 15, 5109–5122, 2015.

[16] Dye, T. S., Roberts, P. T., and Korc, M. E.: Observations of transport processes for ozone and ozone precursors during the 1991 Lake Michigan Ozone Study, J. Appl. Meteorol., 34, 1877–1889, 1995.

[17] Foley, T., Betterton, E. A., Jacko, P. E. R., and Hillery, J.: Lake Michigan air quality: The 1994–2003 LADCO Aircraft Project (LAP), Atmos. Environ., 45, 3192–3202, 2011.

[18] Hanna, S. R. and Chang, J. C.: Relations between meteorology and ozone in the Lake Michigan region, J. Appl. Meteorol., 34, 670–678, 1995.

[19] Lennartson, G. J., and Schwartz, M. D.: A synoptic climatology of surface-level ozone in Eastern Wisconsin, USA, Climate Research, 13, 207-220, 1999.

[20] Brook, J. R., Makar, P.A., Sills D. M. L., Hayden, K. L. and McLaren, R. Exploring the nature of air quality over southwestern Ontario: main findings from the Border Air Quality and Meteorology Study, Atmos. Chem. Phys., 13, 10461–10482, 2013.

[21] Lyons, W. A. and Cole, H. S., Fumigation and plume trapping on the shores of Lake Michigan during stable onshore flow, J. Appl. Meteor., 12, 494–510, 1973.

[22] Lyons, W. A. and Cole, H. S.: Photochemical oxidant transport–mesoscale lake breeze and synoptic-scale aspects, J. Appl. Meteor., 15, 733–743, 1976.

[23] Sillman, S., Samson, P. J., and Masters, J. M.: Ozone formation in urban plumes transported over water: photochemical model and case studies in the northeastern and midwestern U.S., J. Geophys. Res., 98, 12687–12699, 1993.

[24] Lyons, W. A., Pielke, R. A., Tremback, C. J., Walko, R. L., Moon, D. A., and Keen, C. S.: Modeling impacts of mesoscale vertical motions upon coastal zone air pollution dispersion, Atmos. Environ., 29, 283–301, 1995a.

[25] Lyons, W. A., Tremback, C. J., and Pielke, R. A.: Applications of the Regional Atmospheric Modeling System (RAMS) to provide input to photochemical grid models for the Lake Michigan Ozone Study (LMOS), J. Appl. Meteor., 34, 1762–1786, 1995b.

counties in northeast Illinois and northwest Indiana. The HYSPLIT trajectories indicate the exceedance day air masses traveled over these areas and Lake Michigan to reach the violating monitor in Sheboygan County. Any precursor emissions that flow out from these areas over the lake with the morning land breeze have the potential to photochemically react to form ozone, which has the potential to be transported by the afternoon lake breeze to the violating monitor in Sheboygan County as corroborated by the studies cited above and by the HYSPLIT trajectories shown in Figure 6. The Milwaukee area and the Chicago area are evaluated as separate nonattainment areas since they are part of their own CSAs whereas Sheboygan is not part of a CSA but is its own CBSA.

The HYSPLIT trajectories are just one piece of evidence corroborating the body of scientific literature on the potential for lake breeze meteorology, and lake breeze meteorology combined with synoptic meteorology, to transport photochemically aged, ozone-rich air masses from nearby and upwind areas to nearby and downwind areas near the shoreline of Lake Michigan, such as Sheboygan County, Wisconsin. Evidence of the potential for land/lake breeze and synoptic meteorology to transport ozone to areas along the shoreline of Lake Michigan is documented in the peer-reviewed scientific literature from study data specific to Lake Michigan collected mostly in the early 1990's.[18, 19, 20, 21, 22] It is important to reiterate that the relative role of the land/lake breeze and synoptic flow on ozone transport in the Lake Michigan area is episode-specific and not fully understood. Specific details on the factors and mechanisms by which a large body of water like Lake Michigan can impact photochemical ozone production are not well-known (e.g. changes in precursor mixes, changes in radical concentrations, relative importance of multi-day ozone formation versus same day formation, lake breeze inland penetration distances, the extent to which shallow inversions above the cool lake water prevent vertical mixing, etc.).[26]

While there are many gaps in the peer-reviewed scientific literature regarding lake breeze impacts on ozone production and transport in the Lake Michigan area, Wisconsin has recently been able to conduct an analysis of lake breeze ozone inland penetration distances specific to Sheboygan County. Wisconsin used wind direction data, satellite data, and the ozone data from the two monitors in Sheboygan County to investigate and analyze the local lake breeze ozone inland penetration distances for Sheboygan County. The Sheboygan Kohler Andrae monitor (AQS Site ID 55-117-0006) is located within several hundred feet of the Lake Michigan shoreline, whereas the Sheboygan Haven monitor (AQS Site ID 55-117-0009) is located approximately 3.2 miles from the Lake Michigan shoreline and approximately 10.9 miles north northwest of the Kohler Andrae monitor. Given the relative proximity from the lakeshore, we will sometimes refer to the Sheboygan Kohler Andrae monitor as the "lakeshore monitor" and the Sheboygan Haven monitor as the "inland monitor." The inland monitor began operating in 2014. Therefore, the 2014-2016 design value is the first design value for this monitor, making the data from this monitor a new component of the ozone analysis for Sheboygan County under the 2015 ozone NAAQS relative to previous designations under the previous ozone standards such as the 1997 ozone NAAQS and the 2008 ozone NAAQS.

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[26] Pierce, B., Kaleel, R., Dickens, A., Bertram T., and Stanier, C., Kenski D.: White Paper: Lake Michigan Ozone Study 2017 (LMOS 2017), http://www.ladco.org/, 2016.

Wisconsin used these new data to classify days with peak 1-hour ozone concentrations above the 2015 ozone NAAQS of 0.070 ppm (70 ppb) into one of three event types: 1) "Deep" lake breeze, meaning a day on which the lake breeze affected both the lakeshore and inland monitors; 2) "Shallow" lake breeze, meaning a day on which the lake breeze affected the lakeshore but not the inland monitor; and 3) No lake breeze, meaning a day with no apparent lake breeze. Wisconsin was not able to classify some days according to the event types above because of complex patterns. Wisconsin's classification of high-ozone days into these categories yielded the distribution of event types shown in Table 6 below.

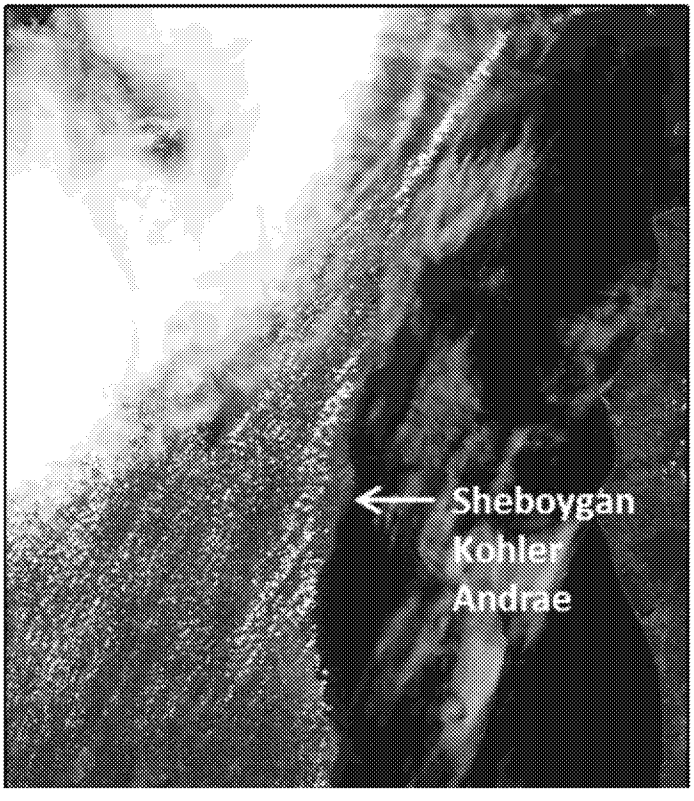
**Table 6. Distribution of the occurrence of different types of lake breeze events at the Sheboygan County monitors***

| | Deep lake breeze | Shallow lake breeze | No lake breeze | Unclear | Total days |
|---|---|---|---|---|---|
| Sheboygan | 33 (67%) | 5 (10%) | 11 (22%) | 8 | 57 (2014-16) |

*The percentage of the classifiable events (which excludes "unclear" events) in each category is shown in parentheses.

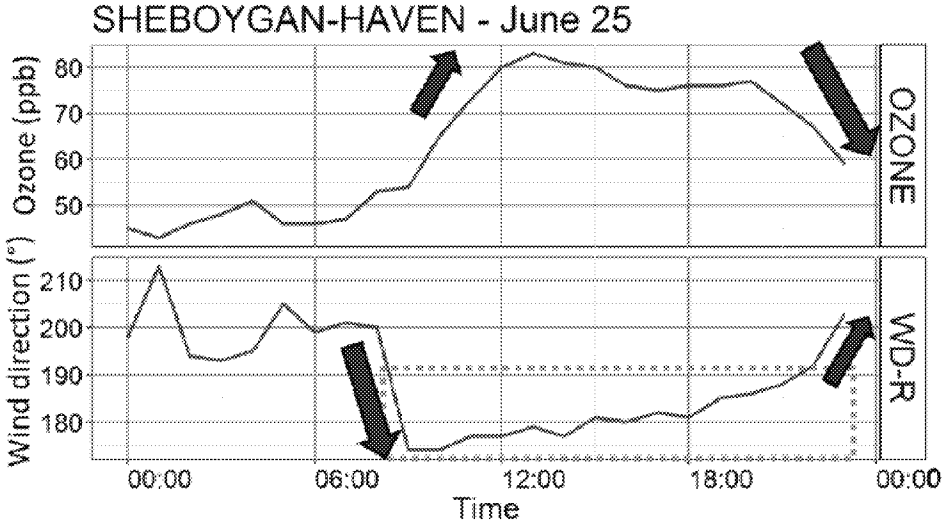
Wisconsin used Moderate Resolution Imaging Spectroradiometer (MODIS) satellite images to confirm lake breeze event types derived from the wind direction data. The MODIS satellite passes over the Lake Michigan region around 2:30 pm daily and collects visual images of the landscape. On days with a lake breeze and light cloud cover, lake breeze "fronts" can be seen as the interface between areas of clear skies towards the lake and light cloud cover to the west. The clear area is the area experiencing a lake breeze. On days with heavy cloud cover or no cloud cover, MODIS images cannot identify the presence or absence of a lake breeze front. The MODIS image in Figure 7 provided by Wisconsin shows a lake breeze impacting Sheboygan County. Wisconsin found that days with a shallow lake breeze did not show any obvious lake breeze in the MODIS images. If the lake breeze classification was not conclusive from the wind and MODIS data or if wind data was missing, Wisconsin looked for additional confirmation by examining the synoptic meteorology of that day or wind patterns at nearby airports or air quality monitors.

**Figure 7. MODIS satellite image for the afternoon of August 4, 2016, showing a lake breeze at Sheboygan.**




Wisconsin found that days with a lake breeze typically begin with winds from the southwest during the early morning hours. Wisconsin observed that these wind directions typically shift abruptly to come from a more southerly or southeasterly direction with this shift typically occurring in the morning at the lakeshore monitor and later in the day at the inland monitor. Wisconsin observed that the lake breeze may occur for anywhere from a few minutes to 15 or more hours. For its classification scheme, Wisconsin only counted as "lake breeze" a wind pattern that held for at least 2-3 hours. Wisconsin observed that at the conclusion of a lake breeze event, winds usually revert to their original southwesterly direction unless the lake breeze event is ended by a synoptic wind shift such as a frontal passage. Figure 8, provided by Wisconsin, shows an example of a lake breeze wind pattern with co-located ozone data from the Sheboygan Haven inland monitor.

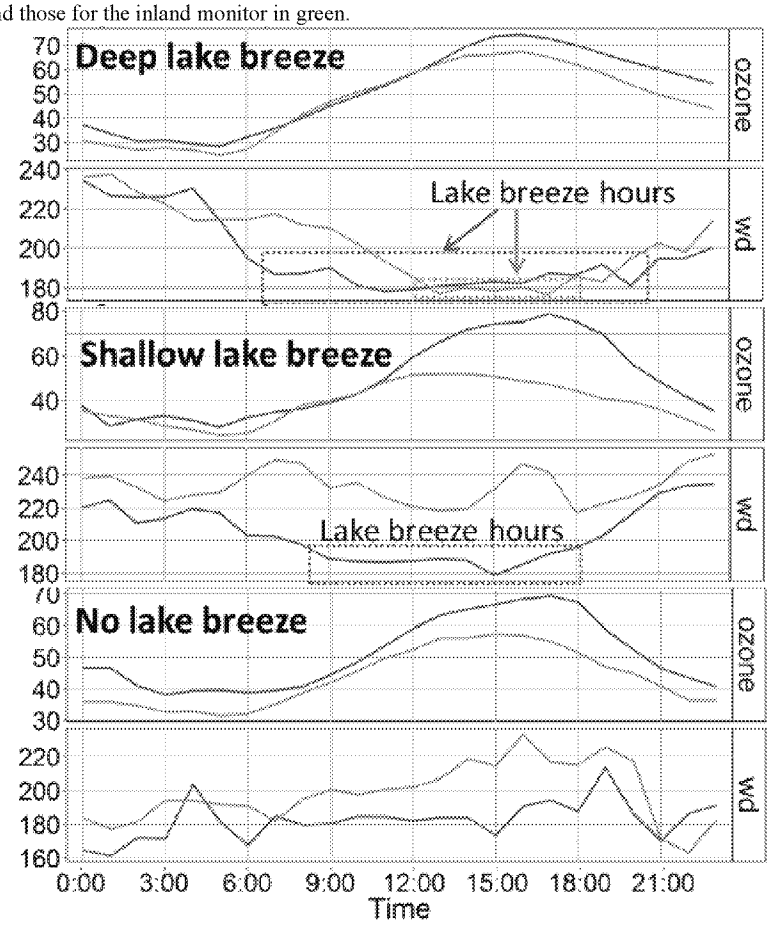
**Figure 8. Hourly ozone concentrations (top) and wind directions (bottom) for an example day (June 25, 2016) at the Sheboygan Haven monitor.** The red arrows show the onset and cessation of the lake breeze and when ozone concentrations rose and declined. The blue box encloses the hours with a lake breeze.




Wisconsin found that during "deep" lake breeze events, wind shifts occurred at both the inland and lakeshore monitor, whereas on "shallow" lake breeze days, they only occurred at the lakeshore monitor. Such shifts were absent on days without a lake breeze. Figure 9 shows the average (mean) ozone concentration and wind direction profile for each event type. The average ozone concentration profiles were similar for all three classes of events at the lakeshore monitor and inland monitor and follow the typical diurnal pattern associated with ozone formation. The highest mean peak lakeshore ozone concentrations were observed during lake breeze events and the lowest during events without a lake breeze. The greatest ozone concentrations at the inland monitor were observed during the deep lake breeze events. Shallow lake breeze events resulted in relatively low average peak mean inland ozone concentrations when the peak lakeshore concentrations were relatively high. Wisconsin reasoned that during deep lake breeze events, the lower ozone concentrations at the inland monitor likely resulted from dilution of ozone-rich air via mixing with less ozone-rich overlying air as the air moved inland from the lakeshore. This reasoning is consistent with the conceptual model of Lake Michigan ozone formation and transport developed by Dye et al. as a result of the aircraft and ground-based monitoring data collected during several high ozone episodes which occurred over the course of the Lake Michigan ozone study during the summer of 1991. Dye et al. indicate that when ozone-rich air from over the lake flowed downwind to onshore locations, air with the highest ozone concentrations mixed down to the surface first, causing the highest ozone observations along the shoreline. Eventually air from higher altitudes mixed

down to the surface farther inland, ~~but diluting the overall~~ ozone mixing ratios ~~in these air masses had lower concentrations~~.[27]

**Figure 9. Plots of mean hourly ozone concentrations (in ppb) and wind direction ("wd", in degrees) for Sheboygan County monitors for high ozone episodes with a deep lake breeze (top), a shallow lake breeze (middle), and no lake breeze (bottom).** Values for the lakeshore monitor are shown in blue and those for the inland monitor in green.




To summarize, many details of the various factors regarding how the local lake breeze (alone or combined with synoptic-scale meteorology) influences ozone production and transport around Lake Michigan are episode-specific and not well-understood. There are gaps in the peer-reviewed scientific

[27] Dye, T. S., Roberts, P. T., and Korc, M. E.: Observations of transport processes for ozone and ozone precursors during the 1991 Lake Michigan Ozone Study, J. Appl. Meteorol., 34, 1877–1889, 1995.

literature on this topic. However, the basic concepts of lake breeze meteorology and its potential to influence ozone production and transport are understood well enough to weight the meteorology factor relatively high given the above analysis. The peer-reviewed results from the Lake Michigan-specific ozone studies, the HYSPLIT trajectories presented here, and Wisconsin's lake breeze ozone inland penetration distance analysis, which relies on the ozone data from the new inland monitor, without which this analysis would not have been possible, provide evidence that meteorology plays a role in ozone production and transport to this area. Therefore, this factor can be weighted relatively high in terms of potential contribution to ozone formation with respect to this area.

**Factor 4: Geography/topography**

Consideration of geography or topography can provide additional information relevant to defining nonattainment area boundaries. Analyses should examine the physical features of the land that might define the airshed. Mountains or other physical features may influence the fate and transport of emissions as well as the formation and distribution of ozone concentrations. The absence of any such geographic or topographic features may also be a relevant consideration in selecting boundaries for a given area.

The EPA uses geography/topography analysis to evaluate the physical features of the land that might affect the airshed and, therefore, the distribution of ozone over the area.

Sheboygan County does not have any geographical or topographical features significantly limiting air pollution transport within its airshed. The eastern boundary of Sheboygan County follows the shoreline of Lake Michigan. As described under Factor 3: Meteorology, areas geographically located along the shoreline of Lake Michigan, including Sheboygan County, can be impacted by lake breeze meteorology which has the potential to transport photochemically aged air masses containing ozone-rich air originating from nearby and upwind precursor plumes to nearby and downwind coastal areas along Lake Michigan.

**Factor 5: Jurisdictional boundaries**

Once the geographic extent of the violating area and the nearby area contributing to violations is determined, the EPA considered existing jurisdictional boundaries for the purposes of providing a clearly defined legal boundary to carry out the air quality planning and enforcement functions for nonattainment areas. In defining the boundaries of the ~~intended~~proposed Sheboygan County nonattainment area, the EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Examples of jurisdictional boundaries include, but are not limited to: counties, air districts, areas of Indian country, metropolitan planning organizations, and existing nonattainment areas. If an existing jurisdictional boundary is used to help define the nonattainment area, it must encompass all of the area that has been identified as meeting the nonattainment definition. Where existing jurisdictional boundaries are not adequate or appropriate to describe the nonattainment area, the EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the ~~intended~~proposed designated areas.

The respective locations of the violating lakeshore monitor and the attaining inland monitor in Sheboygan County and Wisconsin's lake breeze ozone inland penetration distance analysis, which relies on the ozone data from the new inland monitor, are described in the factor analysis above and provide information suggesting that the spatial extent of the violating area is east of the attaining monitor in Sheboygan County. While more monitors would be needed to verify if this is true for the entire north-to-south length of Sheboygan County, the EPA has determined that the above analysis is sufficient for estimating the nonattainment boundary described as follows. The EPA delineated the ~~intended~~proposed nonattainment area boundary using roadways and excluded the attaining monitor (which is approximately 3.2 miles inland from the lakeshore) but included the land area at least as far inland as 3.2 miles from the shoreline (in some cases more than 3.2 miles inland given the location of existing roadways) over the length of the county in an effort to conservatively encompass the geographic extent of the nonattainment area. The EPA's ~~intended~~proposed nonattainment boundary for the Sheboygan County area for the 2015 ozone NAAQS ~~is~~ was a portion of Sheboygan County roughly 3.2 miles inland from the shoreline, which is the inland distance of the attaining monitor, which has a 2016 design value of 0.069 ppm and a 2017 preliminary design value of 0.070 ppm~~inclusive and east of the following roadways with the boundary starting from north to south: Union Road which turns into County Road Y which turns into Highland Drive, to Lower Road which turns into Monroe Street, to Broadway/Main Street to Highway 32 which turns into Giddings Avenue to County Road W to County Road KW~~.

**Conclusion for Sheboygan County Area**

The EPA must designate as nonattainment any area that violates the NAAQS. Since Sheboygan County has a monitor in violation of the 2015 ozone NAAQS, a portion of this county was~~is~~ included in the ~~intended~~proposed nonattainment area based on the air quality data factor. The remaining factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor. The emissions data and emissions-related data factor analysis including information about population density, degree of urbanization, traffic, and vehicle miles traveled for Sheboygan County indicates that overall ozone precursor emissions from sources in Sheboygan County (total 2014 reported $NO_x$ = 4,585 tons, VOC= 3,421 tons) are relatively low albeit non-trivial and are mainly concentrated in a portion of the county east of I-43 including the cities of Sheboygan, Sheboygan Falls, and the village of Kohler. This portion of the county is also the portion of the county in which the violating monitor is located. This portion of the county is also the portion of the county in which the largest $NO_x$ emitting point source, WPL-Edgewater, is located.

The EPA must designate as nonattainment any nearby areas that contribute to the violation in the violating area. Sheboygan County is immediately downwind of the Milwaukee-Racine-Waukesha CSA (total 2014 reported CSA $NO_x$ = 51,822 tons, VOC= 49,129 tons) and is also downwind of the Chicago CSA (total 2014 reported CSA $NO_x$ = 274,440 tons, VOC= 206,171 tons) which includes counties in northeast Illinois and northwest Indiana. The peer-reviewed scientific literature, the HYSPLIT trajectories, and Wisconsin's lake breeze ozone inland penetration distance analysis indicate that lake breeze meteorology can influence ozone transport to Sheboygan County. The HYSPLIT trajectories indicate that the exceedance day air masses traveled over the Milwaukee and Chicago areas and Lake Michigan to reach the violating monitor in Sheboygan County. The peer-reviewed scientific literature indicates that precursor emissions have the potential to flow out over the lake with the morning land

breeze, photochemically react to form high concentrations of ozone in a shallow, stable, inversion layer over the lake, and be transported back toward land by the afternoon lake breeze toward nearby and downwind areas such as the location of the violating monitor in Sheboygan County. As stated above, the EPA must designate as nonattainment any nearby areas that contribute to the violation in the violating area. While the Milwaukee area is immediately upwind and adjacent to Sheboygan County, it is being evaluated as a separate nonattainment area since, like Chicago, it is part of a separate CSA, whereas Sheboygan County is not part of a CSA but is its own CBSA.

Historically, the EPA has designated the entirety of Sheboygan County as nonattainment under previous ozone standards including the 1997 ozone NAAQS and the 2008 ozone NAAQS due to the violating lakeshore monitor. However, in 2014 Wisconsin began operating the Sheboygan Haven (3.2 miles inland) monitor, which is currently showing attainment. The 2014-2016 design value is the first design value for this monitor, making the data from this monitor a new component of the ozone analysis for Sheboygan County with respect to the 2015 ozone NAAQS designations as opposed to designations under the previous ozone standards for which ozone data from this new inland monitor was not available. The EPA does not consider eliminating geographic areas with attaining monitors from CSA's or CBSA's with violating monitors for nonattainment designations purposes on the basis of the monitoring data alone. The EPA must consider the monitoring data in conjunction with other relevant factors, including the emissions and meteorological data as a basis for excluding a portion of a CSA or CBSA, or, in this case, a portion of the county from an ~~intended~~proposed -nonattainment area. The HYSPLIT trajectories indicate that exceedance day air masses traveled over the Milwaukee and Chicago areas and Lake Michigan. The peer-reviewed scientific literature indicates that areas along the shoreline of Lake Michigan, such as Sheboygan County, can be impacted by land/lake breeze-related ozone production and transport. Wisconsin's lake breeze ozone inland penetration distance analysis, which would not have been possible without the new inland monitor, indicates that ozone measurements in Sheboygan County have a relationship with the lake breeze observations in Sheboygan County. These factors taken altogether enable the EPA to propose a smaller geographic extent for this nonattainment area rather than reiterate the historical nonattainment area boundary which included the entirety of Sheboygan county.

The factor analysis above suggests that Sheboygan County is impacted by ozone transport from nearby areas, like the Milwaukee area, which is immediately upwind and adjacent to Sheboygan County, and from areas farther upwind like the Chicago area, and that ozone production from precursor pollutants from these areas and subsequent downwind transport can be exacerbated by the lake breeze meteorology. The meteorology factor in conjunction with the information from the inland monitor, which is attaining the 2015 ozone NAAQS, indicate that the spatial extent of the violating area is not likely to extend beyond the location of the attaining monitor which is 3.2 miles inland from the lakeshore. Therefore, the EPA has delineated a proposed boundary using jurisdictional roadways which is approximately 3.2 miles inland from the lakeshore. The EPA delineated the ~~intended~~proposed -nonattainment area boundary using roadways and excluded the attaining monitor (which is approximately 3.2 miles inland from the lakeshore) but included the land area at least as far inland as 3.2 miles from the shoreline (in some cases slightly more than 3.2 miles inland given the location of existing roadways) over the length of the county. The EPA's ~~intended~~proposed -nonattainment boundary for the Sheboygan County area for the 2015 ozone NAAQS was a portion of Sheboygan County roughly 3.2 miles inland from the shoreline, which is the

inland distance of the attaining monitor, which has a 2016 design value of 0.069 ppm and a 2017 preliminary design value of 0.070 ppminclusive and east of the following roadways with the boundary starting from north to south. Union Road which turns into County Road Y which turns into Highland Drive, to Lower Road which turns into Monroe Street, to Broadway/Main Street to Highway 32 which turns into Giddings Avenue to County Road W to County Road KW.

After delineating this proposed boundary to somewhat conservatively capture the likely spatial extent of the violating area given the location of the attaining monitor, the EPA looked at the Sheboygan County precursor emissions on either side of the intendedproposed boundary. The precursor emissions in Sheboygan County are relatively low and the analysis above shows that the dominating factor contributing to ozone formation in Sheboygan County is upwind impacts from high precursor emitting urban areas like Milwaukee and Chicago. However, the Sheboygan County precursor emissions themselves, while relatively low, are not trivial. Table 7 below shows that in delineating the spatial extent of the violating area, EPA has also captured many of the Sheboygan County precursor emissions. Table 7 indicates that 95% of the 2014 reported Sheboygan County point source $NO_x$ emissions are captured within the intendedproposed nonattainment area boundary. These point source $NO_x$ emissions (which do not include area, on-road, and off-road mobile sources of emissions) are 38% of the total county $NO_x$ emissions. This analysis shows that only 41% of the 2014 reported Sheboygan County point source VOC emissions are captured within the nonattainment area boundary. These point source VOC emissions (which do not include area, on-road, and off-road mobile sources of emissions) are only 7% of the total county VOC emissions. EPA study results suggest that $NO_x$ is the more important ozone precursor relative to VOC in this region of the United States.[28] Therefore, the EPA has determined that it is not unreasonable to exclude the portion of the county west of the intendedproposed nonattainment area since this portion of the county has very little point sources of $NO_x$ emissions and the emissions related-data analysis suggests that the non-point (area), on-road, and off-road mobile) emissions (for both $NO_x$ and VOC) are mainly concentrated in a portion of the county east of I-43 including the cities of Sheboygan, Sheboygan Falls, and the village of Kohler. This portion of the county is also the portion of the county in which the violating monitor is located.

[28] Supplemental Information for Ozone Advance Areas Based On Pre-Existing National Modeling Analyses EPA Office of Air Quality Planning and Standards, Air Quality Modeling Group May 2017. https://www.epa.gov/sites/production/files/2017-05/documents/national_modeling.advance.may_2017.pdf Figures 1 and 3 in this document show maps of July 2011 modeled monthly maximum daily 8-hour ozone average (MDA8) changes with 50% VOC and 50% NOx across-the-board cuts, nationally. These results show that VOC reductions have some impact on ozone levels for the portion of the country in which Sheboygan County, Wisconsin, is located but that NOx reductions are expected to have larger impacts. This modeling is limited in that it only looks at one month and is thus not directly comparable to the design value calculated over 3 years. However, it is indicative that NOx reductions are likely to be more effective than VOC reductions for the portion of the country in which Sheboygan County, Wisconsin, is located but that VOC reductions may still have some impact.

**Table 7. Sheboygan County percent precursor emissions east and west of the ~~intended~~proposed nonattainment area boundary.**

| Precursor / Geographic Area | % of county point source emissions | % of total county emissions |
|---|---|---|
| $NO_x$ emissions east of ~~intended~~proposed boundary* | 95 | 38 |
| VOC emissions east of ~~intended~~proposed boundary* | 41 | 7 |
| $NO_x$ emissions west of ~~intended~~proposed boundary* | 5 | 2 |
| VOC emissions west of ~~intended~~proposed boundary* | 59 | 10 |

* The ~~intended~~proposed nonattainment area was~~is~~ a portion of Sheboygan County roughly 3.2 miles inland from the shoreline, which is the inland distance of the attaining monitor, which has a 2016 design value of 0.069 ppm and a 2017 preliminary design value of 0.070 ppm~~inclusive and east of the following roadways with the boundary starting from north to south: Union Road which turns into County Road Y which turns into Highland Drive, to Lower Road which turns into Monroe Street, to Broadway/Main Street to Highway 32 which turns into Giddings Avenue to County Road W to County Road KW~~.

Based on the assessment of factors described above, the EPA ~~has~~ concluded that this portion of Sheboygan County meets the CAA criteria for inclusion in the ~~intended~~proposed Sheboygan County nonattainment area. This boundary is different from the boundary for both the 1997 ozone NAAQS and the 2008 ozone NAAQS. For purposes of both the 1997 ozone NAAQS and the 2008 ozone NAAQS, the entirety of Sheboygan County was designated nonattainment. However, due to new information from a second ozone monitor in Sheboygan County coupled with a review of existing information on lake breeze meteorology including a recent ozone inland penetration distance analysis submitted by Wisconsin (all of which are discussed in detail above) and taken together in the context of the other factors in the five-factor weight-of-evidence analysis, the EPA's ~~intended~~proposed nonattainment boundary for the Sheboygan County area for the 2015 ozone NAAQS is a portion of Sheboygan County roughly 3.2 miles inland from the shoreline, which is the inland distance of the attaining monitor, which has a 2016 design value of 0.069 ppm and a 2017 preliminary design value of 0.070 ppm~~inclusive and east of the following roadways with the boundary starting from north to south: Union Road which turns into County Road Y which turns into Highland Drive, to Lower Road which turns into Monroe Street, to Broadway/Main Street to Highway 32 which turns into Giddings Avenue to County Road W to County Road KW~~.

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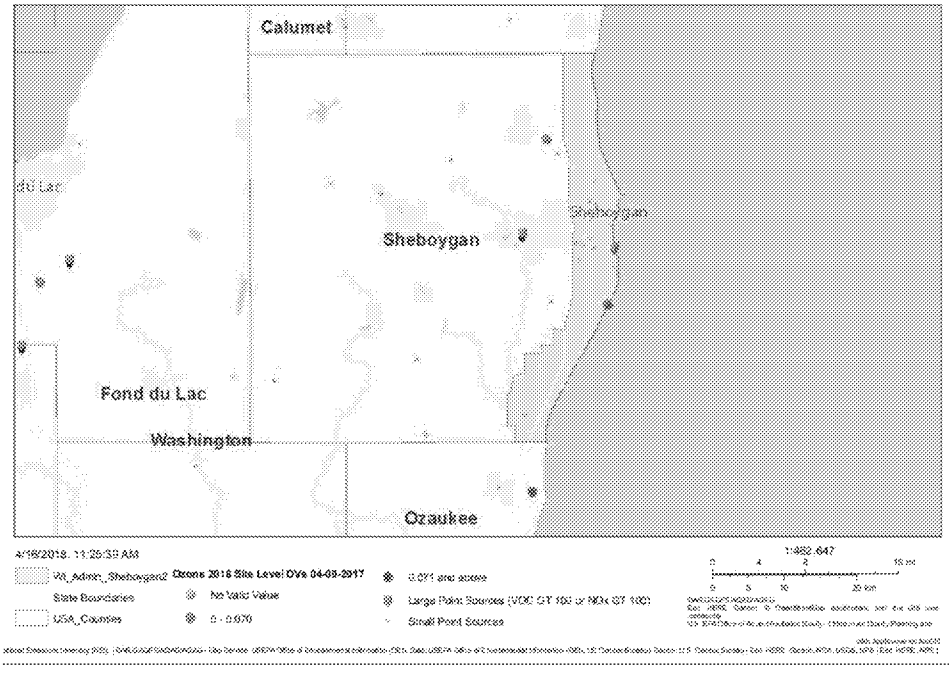
The above analysis was originally announced in EPA's December 22, 2017, TSD. In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area described below.

To be clear, the state requested a distance inland from the ordinary high water mark (OHWM). EPA prefers clearly identifiable roadways rather than the OHWM (see RTC). Therefore, EPA selected roadways that were roughly the distance inland (2.3 miles) from the shoreline most recently requested by the state, which in April 2017 was a distance of 2.9 miles and which, most recently, in February 2018 was a distance of 2.3 miles inland. The final nonattainment boundary is inclusive and east of the following roadways going from the northern county boundary to the southern county boundary: Highway 43, Wilson Lima Road, Minderhaud Road, County Road KK/Town Line Road, N 10th Street, County Road A S/Center Avenue, Gibbons Road, Hoftiezer Road, Highway 32, Palmer Road/Smies Road/Palmer Road, Amsterdam Road/County Road RR, Termaat Road.



### 3.3 Technical Analysis for the Manitowoc County Area

This technical analysis identifies the area with a monitor that violates the 2015 ozone NAAQS. It also provides EPA's evaluation of this area and any nearby areas to determine whether those nearby areas have emissions sources that potentially contribute to ambient ozone concentrations at the violating monitor in the area, based on the weight-of-evidence of the five factors recommended in the EPA's ozone designations guidance and any other relevant information. In developing this technical analysis, the EPA used the latest certified data and information available to the EPA (and to the states and tribes through the Ozone Designations Mapping Tool and the EPA Ozone Designations Guidance and Data web page).[29] In addition, the EPA considered any additional data or information provided to the EPA by states or tribes.

The area of analysis was Manitowoc County, which is not part of a CSA and which is its own CBSA.

The five factors recommended in the EPA's guidance are:

1. Air Quality Data (including the design value calculated for each Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitor;
2. Emissions and Emissions-Related Data (including locations of sources, population, amount of emissions, and urban growth patterns);
3. Meteorology (weather/transport patterns);
4. Geography/Topography (including mountain ranges or other physical features that may influence the fate and transport of emissions and ozone concentrations); and
5. Jurisdictional Boundaries (e.g., counties, air districts, existing nonattainment areas, areas of Indian country, Metropolitan Planning Organizations (MPOs)).

Figure 1 is a map of the EPA's ~~intended~~proposed nonattainment boundary for the Manitowoc County area, which was announced on December 22, 2017. The map shows the location of the ambient air quality monitors, county, and other jurisdictional boundaries.

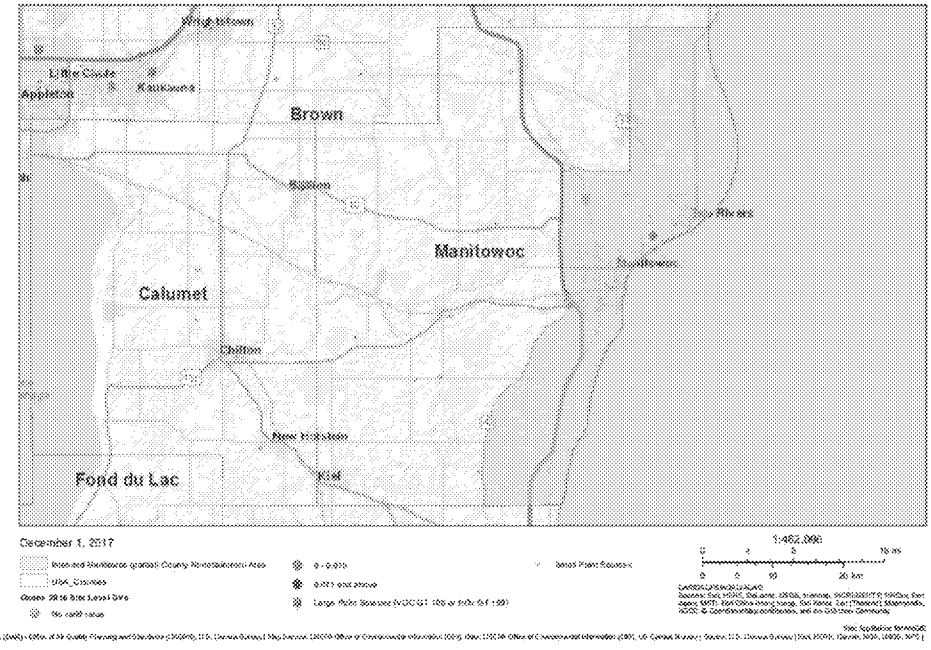
For purposes of the 1997 ozone NAAQS, the entirety of Manitowoc County was designated nonattainment, since the Manitowoc County monitor was violating the 1997 standard at the time of designation. For the purposes of the 2008 ozone NAAQS, Manitowoc County was designated as unclassifiable/attainment, since the Manitowoc County monitor was attaining the 2008 standard at the time of designation. The EPA announced on December 22, 2017, that as a result of the 5-factor analysis below, the EPA's ~~intended~~proposed nonattainment boundary for the Manitowoc County area for the 2015 ozone NAAQS was~~:~~ the portion of the county ~~inclusive and east of the following roadways with the boundary starting from north to south: County Road B which turns into South State Street to County Road V which turns into Forest Home Drive to South Packer Drive to West Hillcrest Road to Highway 43 to West Custer Street to Dufek Drive which turns into Highway 42~~roughly 3.2 miles inland from the shoreline.[30] This boundary is different from the boundary for the 1997 ozone NAAQS, which consisted of

[29] The EPA's Ozone Designations Guidance and Data web page can be found at *https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data.*

[30] 3.2 miles is the inland distance of the attaining monitor in Sheboygan County, which is just south of Manitowoc County. Manitowoc County only has one monitor, and it is violating. In other words, Manitowoc County does not

the entirety of Manitowoc County. This is primarily due to new information from a second ozone monitor, which is attaining the standard, located 3.2 miles~~farther~~ inland in an adjacent ~~neighboring~~ county (Sheboygan County, which is just south of Manitowoc County) and an accompanying lake breeze ozone inland penetration distance analysis submitted by Wisconsin, both of which are discussed in more detail below in the context of the five-factor weight-of-evidence analysis originally announced on December 22, 2017, and presented again below. In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area described in the conclusion to this section (skip to page X), which is roughly 2.9 miles inland from the shoreline.

**Figure 1. EPA's ~~Intended~~Proposed Nonattainment Boundary for the Manitowoc County Area**




The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. Manitowoc County has a monitor in violation of the 2015 ozone NAAQS, therefore a portion of this county containing the violating monitor was~~is~~ included in the ~~intended~~proposed nonattainment area. The following sections describe the five-factor analysis. While the factors are presented individually, they are not independent. The five-factor analysis process carefully considers the interconnections among the different factors and the dependence of each factor on one or more of the others, such as the interaction between emissions and meteorology for the area being evaluated.

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have a second inland attaining monitor on which to conduct a lake breeze inland penetration distance analysis, like the one conducted for Sheboygan County.

**Factor Assessment**

**Factor 1: Air Quality Data**

The EPA considered 8-hour ozone design values in ppm for the air quality monitor in the Manitowoc County area based on data for the 2014-2016 period (i.e., the 2016 design value, or DV). This is the most recent three-year period with fully-certified air quality data. The design value is the 3-year average of the annual 4th highest daily maximum 8-hour average ozone concentration.[31] The 2015 NAAQS are met when the design value is 0.070 ppm or less. Only ozone measurement data collected in accordance with the quality assurance (QA) requirements using approved (FRM/FEM) monitors are used for NAAQS compliance determinations.[32] The EPA uses FRM/FEM measurement data residing in the EPA's Air Quality System (AQS) database to calculate the ozone design values. Individual violations of the 2015 ozone NAAQS that the EPA determines have been caused by an exceptional event that meets the administrative and technical criteria in the Exceptional Events Rule[33] are not included in these calculations. Whenever several monitors are located in a county (or designated nonattainment area), the design value for the county or area is determined by the monitor with the highest valid design value. The presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA identified monitors where the most recent design values violate the NAAQS, and examined historical ozone air quality measurement data (including previous design values) to understand the nature of the ozone ambient air quality problem in the area. Eligible monitors for providing design value data generally include State and Local Air Monitoring Stations (SLAMS) that are operated in accordance with 40 CFR part 58, appendices A, C, D and E and operating with an FRM or FEM monitor. These requirements must be met in order to be acceptable for comparison to the 2015 ozone NAAQS for designation purposes. All data from Special Purpose Monitors (SPMs) using an FRM or FEM are eligible for comparison to the NAAQS, subject to the requirements given in the March 28, 2016 Revision to Ambient Monitoring Quality Assurance and Other Requirements Rule (81 FR 17248).

There is one monitor located in Manitowoc County. The 2016 design value for the monitor is shown in Table 2.

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[31] The specific methodology for calculating the ozone design values, including computational formulas and data completeness requirements, is described in 40 CFR part 50, appendix U.

[32] The QA requirements for ozone monitoring data are specified in 40 CFR part 58, appendix A. The performance test requirements for candidate FEMs are provided in 40 CFR part 53, subpart B.

[33] The EPA finalized the rule on the Treatment of Data Influenced by Exceptional Events (81 FR 68513) and the guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events in September of 2016. For more information, see *https://www.epa.gov/air-quality-analysis/exceptional-events-rule-and-guidance.*

**Table 2. Air Quality Data (all values in ppm).**

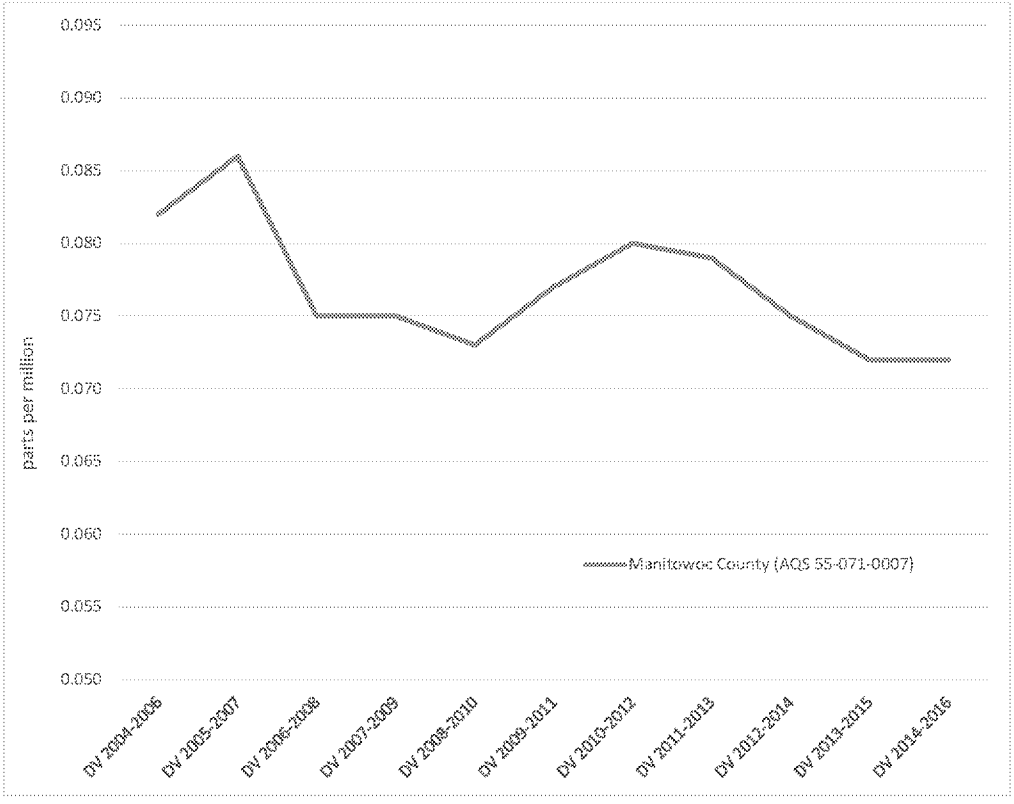
| County, State | State Recommended Nonattainment? | AQS Site ID | 2014-2016 DV | 2014 4th highest daily max value | 2015 4th highest daily max value | 2016 4th highest daily max value |
|---|---|---|---|---|---|---|
| Manitowoc, WI | No | 55-071-0007 | **0.072*** | 0.066 | 0.077 | 0.074 |

*Despite violating monitors, in a September 21, 2016, letter from its governor, Wisconsin recommended attainment for the entire state. Later in an April 20, 2017, supplemental submittal, which Wisconsin explains contains technical information to support the governor's recommendation and which contains Wisconsin's estimates of the geographic extent of the areas in Wisconsin with design values above 0.070 ppm, Wisconsin requested that if EPA designates nonattainment areas in Wisconsin, that the EPA should ensure that the geographic scope of these areas is minimized. Wisconsin estimated the geographic extent of the design values above 0.070 ppm in Manitowoc County to be 2.9 miles from the lakeshore. Wisconsin emphasized in its April 20, 2017, submittal that these descriptions should not be construed as a recommendation for a potential nonattainment area designation for the 2015 ozone NAAQS.

Manitowoc County shows a violation of the 2015 ozone NAAQS, therefore a portion of this county containing the violating monitor is included in EPA's ~~intended~~proposed nonattainment area.

Figure 1, shown previously, identifies the Manitowoc County ~~intended~~proposed nonattainment area and the violating monitor. Table 2 identifies the 2016 design value for the monitor in the area of analysis and Figure 2 shows the historical trend of design values for the violating monitor. As indicated on the map, there is one violating monitor that is located in the northeastern portion of Manitowoc County approximately 0.8 miles from the shoreline of Lake Michigan. There are three monitors to the north and northwest of the Manitowoc County CBSA, including one in Kewaunee County near the shoreline of Lake Michigan, one in Brown County, Wisconsin, and one in Outagamie County, Wisconsin, that are not violating for the 2014-2016 time period. There are two monitors to the southwest of the Manitowoc County CBSA, including one in Fond du Lac County and one in Dodge County, Wisconsin, that are not violating for the 2014-2016 time period. There are two monitors to the south of the Manitowoc County CBSA in Sheboygan County, one that is not violating for the 2014-2016 time period and one that is violating for the 2014-2016 time period, but this area will be addressed separately, since Sheboygan County is its own CBSA-Metropolitan Statistical Area. As shown in Figure 2, the Manitowoc County monitor has historically high ozone design values, which have been generally decreasing over time.

**Figure 2. Three-Year Design Values for Violating Monitor (2007-2016).**




The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. Manitowoc County has a monitor in violation of the 2015 ozone NAAQS, therefore a portion of this county containing the violating monitor is included in EPA's ~~intended~~proposed nonattainment area based on the air quality data factor.

**Factor 2: Emissions and Emissions-Related Data**

As mentioned previously, the presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA evaluated ozone precursor emissions of nitrogen oxides ($NO_x$) and volatile organic compounds (VOC) and other emissions-related data that provide information on areas contributing to violating monitors.

**Emissions Data**

The EPA reviewed data from the 2014 National Emissions Inventory (NEI). For each county in the area of analysis, the EPA examined the magnitude of large sources ($NO_x$ or VOC emissions greater than 100 tons per year) and small point sources and the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, non-road mobile, on-road mobile, and fires. Emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

Table 3 provides a county-level emissions summary of $NO_x$ and VOC (given in tons per year (tpy)) for Manitowoc County.

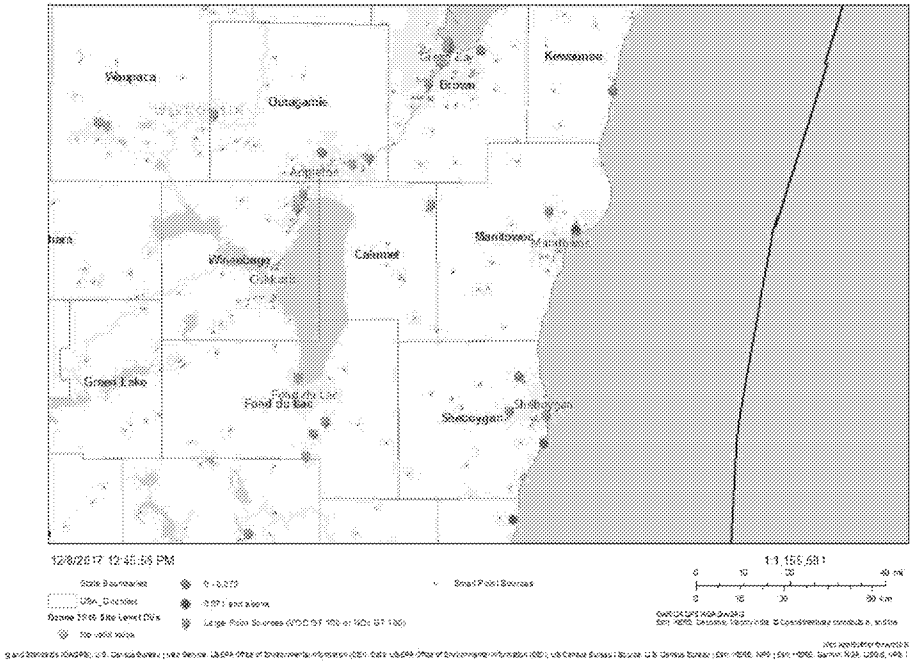
**Table 3. Total County-Level $NO_x$ and VOC Emissions.**

| County, State | State Recommended Nonattainment? | Total $NO_x$ (tpy) | Total VOC (tpy) |
|---|---|---|---|
| Manitowoc, WI | No* | 3,253 | 2,812 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

In addition to reviewing county-wide emissions of $NO_x$ and VOC, the EPA also reviewed emissions from point sources. The location of these sources, together with the other factors, can help inform nonattainment boundaries. The locations of the point sources are shown in Figure 3 below.

**Figure 3. Point Sources in the Area of Analysis.**




The EPA's analysis of county-level emissions shows one large point source in Manitowoc County, which is the Carmeuse Lime and Stone-Rockwell Operation. This facility reported 423.42 tons of $NO_X$ and 0.10 tons of VOC in 2014. The EPA's analysis showed approximately 27 small point sources in Manitowoc County, 23 of which reported $NO_X$ emissions and all of which reported VOC emissions to the 2014 NEI. These 27 small point sources collectively emitted a reported 409.49 tons of $NO_X$ and 467.17 tons of VOC in 2014. The largest $NO_X$ emitter of these sources, Manitowoc Public Utilities, emitted a reported 74.71 tons of $NO_X$ and the largest VOC emitter of these sources, Broadwind Towers, emitted a reported 76.57 tons of VOC in 2014. While the point source precursor emissions in Manitowoc County are not trivial, the $NO_X$ and VOC emissions from the point sources in Manitowoc County, with the exception of the Carmeuse Lime and Stone-Rockwell Operation, are relatively low, and are concentrated in the east central portion of the county in and around the city of Manitowoc.

**Population density and degree of urbanization**

In this part of the factor analysis, the EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. These include emissions of $NO_X$ and VOC from on-road and non-road vehicles and engines, consumer products, residential fuel combustion, and consumer services. Areas of dense population or commercial development are an indicator of area source and mobile source $NO_X$ and VOC emissions that may

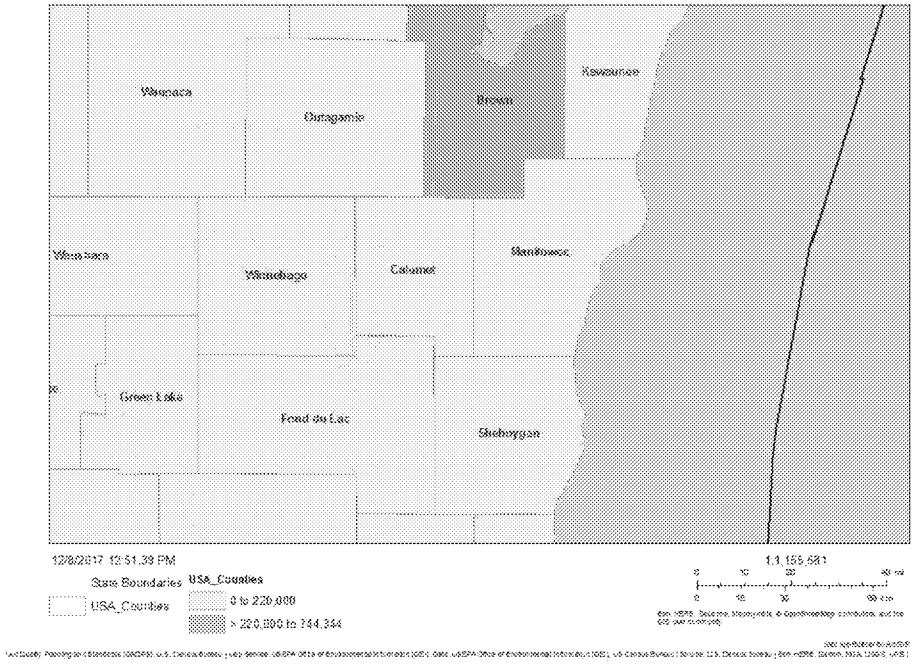
contribute to violations of the NAAQS. Table 4 shows the population, population density, and population growth information for Manitowoc County. Figure 4 shows the county-level population density map of the area of analysis.

**Table 4. Population and Growth.**
Source: U.S. Census Bureau population estimates for 2010 and 2015. www.census.gov/data.html.

| County, State | State Recommended Nonattainment? | 2010 Population | 2015 Population | 2015 Population Density (per sq. mi.) | Absolute change in population (2010-2015) | Population % change (2010-2015) |
|---|---|---|---|---|---|---|
| Manitowoc, WI | No* | 81,442 | 79,806 | 135 | 1,636 | -2.0 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

**Figure 4. County-Level Population.**




The population and population density in Manitowoc County are both relatively low. The non-point (area) source emissions reported to the 2014 NEI were 508 tons of $NO_x$ and 1,091 tons of VOC. The on-road emissions reported to the 2014 NEI were 1,372 tons of $NO_x$ and 699 tons of VOC. The non-road

emissions reported to the 2014 NEI were 539 tons of $NO_x$ and 554 tons of VOC. These quantities of precursor emissions are not trivial; however, the reported $NO_x$ and VOC emissions from the non-point (area), on-road, and non-road source sectors, which are the source sectors that are often correlated with population and population density, are relatively low in Manitowoc County.

**Traffic and Vehicle Miles Travelled (VMT)**

The EPA evaluated the commuting patterns of residents, as well as the total vehicle miles traveled (VMT) for the area of analysis. In combination with the population/population density data and the location of main transportation arteries, this information helps identify the probable location of non-point source emissions. A county with high VMT and/or a high number of commuters is generally an integral part of an urban area and high VMT and/or high number of commuters indicates the presence of motor vehicle emissions that may contribute to violations of the NAAQS. Rapid population or VMT growth in a county on the urban perimeter may signify increasing integration with the core urban area, and thus could indicate that the associated area source and mobile source emissions may be appropriate to include in the nonattainment area. In addition to VMT, the EPA evaluated worker data collected by the U.S. Census Bureau[34] for the area of analysis. Table 5 shows the traffic and commuting pattern data, including total VMT for the county, number of county residents who work, number of county residents commuting within the county, and the percentage of county residents commuting within the county. The data in Table 5 are 2014 data.

**Table 5. Traffic and Commuting Patterns.**

| County | State Recommended Nonattainment? | 2014 Total VMT (Million Miles) | Number of County Residents Who Work | Number of County Residents Commuting Within the County | Percentage of County Residents Commuting Within the County |
|---|---|---|---|---|---|
| Manitowoc, WI | No* | 762 | 41,356 | 23,181 | 56% |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

To show traffic and commuting patterns, Figure 5 overlays twelve-kilometer gridded VMT from the 2014 NEI with a map of the transportation arteries.

[34] The worker data can be accessed at: http://onthemap.ces.census.gov/.

**Figure 5. Twelve Kilometer Gridded VMT (Miles) Overlaid with Transportation Arteries.**

Manitowoc County has a relatively low population density and degree of urbanization. The reported vehicle miles traveled (VMT) for 2014 were 762 million miles, and the on-road emissions reported to the 2014 NEI were 1,372 tons of $NO_X$ and 699 tons of VOC. The majority of the VMT are concentrated in the central and eastern portions of the county, particularly around the I-43 corridor and the city of Manitowoc as seen in Figure 5.

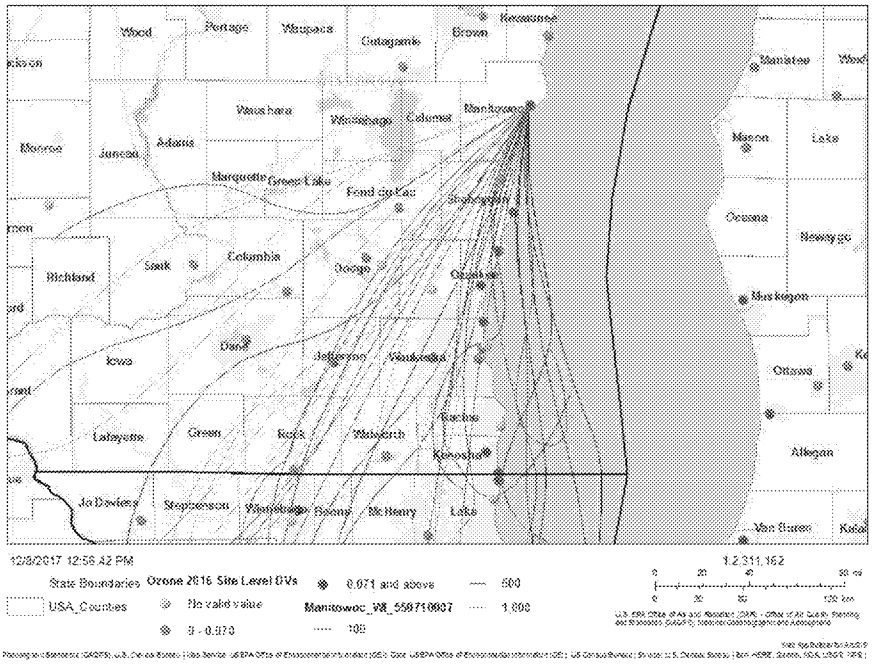
The Manitowoc County emissions and emissions-related data are not trivial. The $NO_X$ and VOC emissions from the various source sectors, including point (with the exception of the Carmeuse Lime and Stone-Rockwell Operation), non-point (area), on-road, and off-road, in Manitowoc County are relatively low, such that the emissions and emissions-related data factor of the analysis can be ranked relatively low in terms of contribution to ozone formation. Emissions sources, emissions, and population are largely concentrated in the eastern portion of the county near the I-43 corridor and the city of Manitowoc.

**Factor 3: Meteorology**

Evaluation of meteorological data helps to assess the fate and transport of emissions contributing to ozone concentrations and to identify areas potentially contributing to the monitored violations. Results of meteorological data analysis may inform the determination of nonattainment area boundaries. In order to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and stagnation conditions, could affect the fate and transport of ozone and precursor emissions from sources

in the area, the EPA evaluated 2014-2016 HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) trajectories at 100, 500, and 1000 meters above ground level (AGL) that illustrate the three-dimensional paths traveled by air parcels to a violating monitor. Figure 6 shows the 24-hour HYSPLIT back trajectories for each exceedance day (i.e., daily maximum 8 hour values that exceed the 2015 ozone NAAQS) for the violating monitor.

**Figure 6. HYSPLIT Back Trajectories for Violating Monitor.**




The eastern boundary of Manitowoc County follows the shoreline of Lake Michigan. Due to its proximity to the lake, Manitowoc County has the potential to be impacted by lake breeze meteorology. The land breeze and lake breeze occur when wind blows from the land and lake, respectively, due to air pressure differences caused by the different heating capacities of the land and the water. Land absorbs and loses solar radiation much faster than water. The land breeze typically occurs in the early morning after air above the relatively warm nighttime water of Lake Michigan heats and rises, setting up an area of low pressure which is filled by the cooler air from the land. The lake breeze typically occurs in the afternoon when the area of low pressure is created by rising air over the heated land, creating winds off the cooler lake. The land/lake breeze is typically more localized than the prevailing (synoptic) winds. Studies indicate the land/lake breeze can trap, stratify, and recirculate offshore air, sometimes in a helical pattern. Daytime inversions over the lake can create shallow, stable layers of precursor plumes, which, on warm sunny days, are conducive to ozone formation. The afternoon lake breeze can carry photochemically

aged, ozone-rich air toward the land from nearby and upwind plumes, to nearby and downwind areas like Manitowoc County where violations of the ozone standard can be measured at locations along the shoreline. Additionally, large scale, summertime, stagnant high pressure systems centered to the south and southeast of Lake Michigan have been implicated in high ozone episodes for areas near the shoreline of Lake Michigan, because they can produce southerly and southeasterly flows over Lake Michigan, which can enhance the flow of photochemically aged air. The relative role of each (the land/lake breeze and synoptic flow) is episode-specific and not fully understood.[35, 36, 37, 38, 39]

The HYSPLIT trajectories (Figure 6) indicate that exceedance day air masses generally traveled from the south and southwest prior to being detected at the violating monitor. Many of the lower level trajectories represented by the red lines at 100 meters AGL and the blue lines at 500 m AGL traveled from over Lake Michigan while the higher level trajectories represented by the green lines at 1,000 m AGL traveled over land. Scientific studies indicate ozone can be preferentially transported over the Great Lakes relative to the land surface.[40, 41, 42, 43, 44, 45] Manitowoc County is downwind of Sheboygan County (2014 reported $NO_X$ = 4,585 tons, VOC= 3,421 tons) and two large CSAs including the Milwaukee-Racine-Waukesha CSA (total 2014 reported CSA $NO_X$ = 51,822 tons, VOC= 49,129 tons) and the Chicago CSA (total 2014 reported CSA $NO_X$ = 274,440 tons, VOC= 206,171 tons) which includes counties in northeast Illinois and northwest Indiana. The HYSPLIT trajectories indicate the exceedance day air masses traveled over these

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[35] Cleary, P. A., Fuhrman, N., Schulz, L., Schafer, J., Fillingham, J., Bootsma, H., McQueen, J., Tang, Y., Langel, T., McKeen, S., Williams, E. J., and Brown, S. S.: Ozone distributions over southern Lake Michigan: comparisons between ferry-based observations, shoreline-based DOAS observations and model forecasts, Atmos. Chem. Phys., 15, 5109–5122, 2015.

[36] Dye, T. S., Roberts, P. T., and Korc, M. E.: Observations of transport processes for ozone and ozone precursors during the 1991 Lake Michigan Ozone Study, J. Appl. Meteorol., 34, 1877–1889, 1995.

[37] Foley, T., Betterton, E. A., Jacko, P. E. R., and Hillery, J.: Lake Michigan air quality: The 1994–2003 LADCO Aircraft Project (LAP), Atmos. Environ., 45, 3192–3202, 2011.

[38] Hanna, S. R. and Chang, J. C.: Relations between meteorology and ozone in the Lake Michigan region, J. Appl. Meteorol., 34, 670–678, 1995.

[39] Lennartson, G. J., and Schwartz, M. D.: A synoptic climatology of surface-level ozone in Eastern Wisconsin, USA, Climate Research, 13, 207-220, 1999.

[40] Brook, J. R., Makar, P.A., Sills D. M. L., Hayden, K. L. and McLaren, R. Exploring the nature of air quality over southwestern Ontario: main findings from the Border Air Quality and Meteorology Study, Atmos. Chem. Phys., 13, 10461–10482, 2013.

[41] Lyons, W. A. and Cole, H. S., Fumigation and plume trapping on the shores of Lake Michigan during stable onshore flow, J. Appl. Meteor., 12, 494–510, 1973.

[42] Lyons, W. A. and Cole, H. S.: Photochemical oxidant transport–mesoscale lake breeze and synoptic-scale aspects, J. Appl. Meteor., 15, 733–743, 1976.

[43] Sillman, S., Samson, P. J., and Masters, J. M.: Ozone formation in urban plumes transported over water: photochemical model and case studies in the northeastern and midwestern U.S., J. Geophys. Res., 98, 12687–12699, 1993.

[44] Lyons, W. A., Pielke, R. A., Tremback, C. J., Walko, R. L., Moon, D. A., and Keen, C. S.: Modeling impacts of mesoscale vertical motions upon coastal zone air pollution dispersion, Atmos. Environ., 29, 283–301, 1995a.

[45] Lyons, W. A., Tremback, C. J., and Pielke, R. A.: Applications of the Regional Atmospheric Modeling System (RAMS) to provide input to photochemical grid models for the Lake Michigan Ozone Study (LMOS), J. Appl. Meteor., 34, 1762–1786, 1995b.

areas and Lake Michigan to reach the violating monitor in Manitowoc County. Any precursor emissions that flow out from these areas over the lake with the morning land breeze have the potential to photochemically react to form ozone, which has the potential to be transported by the afternoon lake breeze to the violating monitor in Manitowoc County as corroborated by the studies cited above and by the HYSPLIT trajectories shown in Figure 6. Sheboygan County, the Milwaukee area, and the Chicago area are each evaluated as separate nonattainment areas since Sheboygan County is not part of a CSA and is its own CBSA and Milwaukee and Chicago are each part of separate CSAs, whereas Manitowoc County is not part of a CSA and is its own CBSA.

The HYSPLIT trajectories are just one piece of evidence corroborating the body of scientific literature on the potential for lake breeze meteorology, and lake breeze meteorology combined with synoptic meteorology, to transport photochemically aged, ozone-rich air masses from nearby and upwind areas to nearby and downwind areas near the shoreline of Lake Michigan, such as Manitowoc County, Wisconsin. Evidence of the potential for land/lake breeze and synoptic meteorology to transport ozone to areas along the shoreline of Lake Michigan is documented in the peer-reviewed scientific literature from study data specific to Lake Michigan collected mostly in the early 1990's.[37, 38, 39, 40, 41] It is important to reiterate that the relative role of the land/lake breeze and synoptic flow on ozone transport in the Lake Michigan area is episode-specific and not fully understood. Specific details on the factors and mechanisms by which a large body of water like Lake Michigan can impact photochemical ozone production are not well-known (e.g. changes in precursor mixes, changes in radical concentrations, relative importance of multi-day ozone formation versus same day formation, lake breeze inland penetration distances, the extent to which shallow inversions above the cool lake water prevent vertical mixing, etc.).[46]

While there are many gaps in the peer-reviewed scientific literature regarding lake breeze impacts on ozone production and transport in the Lake Michigan area, Wisconsin has recently been able to conduct an analysis of lake breeze ozone inland penetration distances specific to Sheboygan County, which is just south of Manitowoc County. Wisconsin's analysis is explained in detail in Section 3.2 Technical Analysis for the Sheboygan County Area and summarized here. Wisconsin's analysis showed information about the ozone observations at the monitors in Sheboygan County on days with peak 1-hour ozone concentrations above the 2015 ozone NAAQS of 0.070 ppm during three types of events including deep lake breeze, shallow lake breeze, and days with no apparent lake breeze. The average ozone profiles at the Sheboygan County "lakeshore" monitor, which is located within several hundred feet of the Lake Michigan shoreline, and the Sheboygan County "inland" monitor, which is located approximately 3.2 miles from the Lake Michigan shoreline, were similar for each event type and follow the typical diurnal pattern associated with ozone formation. The average ozone profiles were consistently lower for the inland monitor than the lakeshore monitor for all event types for the time of day during which ozone peaked. The average ozone profiles for both monitors were slightly higher for the deep and shallow lake breeze events relative to the days with no apparent lake breeze. The average ozone profiles for both monitors were slightly higher for the days with shallow lake breeze events than the days with deep lake breeze events (Figure 9 in Section 3.2 Technical Analysis for the Sheboygan County Area). Overall, this

[46] Pierce, B., Kaleel, R., Dickens, A., Bertram T., and Stanier, C., Kenski D.: White Paper: Lake Michigan Ozone Study 2017 (LMOS 2017), http://www.ladco.org/, 2016.

analysis showed that ozone measurements in Sheboygan County have a relationship with the lake breeze observations in Sheboygan County. Wisconsin reasoned that during deep lake breeze events, the lower ozone concentrations at the inland monitor in Sheboygan County likely resulted from dilution of ozone-rich air via mixing with less ozone-rich overlying air as the air moved inland from the lakeshore. This reasoning is consistent with the conceptual model of Lake Michigan ozone formation and transport developed by Dye et al. as a result of the aircraft and ground-based monitoring data collected during several high ozone episodes which occurred over the course of the Lake Michigan ozone study during the summer of 1991. Dye et al. indicate that when ozone-rich air from over the lake flowed downwind to onshore locations, air with the highest ozone concentrations mixed down to the surface first, causing the highest ozone observations along the shoreline. Eventually air from higher altitudes mixed down to the surface farther inland, ~~but ozone in these air masses had lower concentrations~~ diluting the overall ozone mixing ratios.[47]

The Sheboygan County inland monitor began operating in 2014. Therefore, the 2014-2016 design value is the first design value for this monitor, making the data from this monitor a new component of the ozone analysis for Sheboygan County under the 2015 ozone NAAQS relative to previous designations under the 1997 ozone NAAQS and the 2008 ozone NAAQS. Wisconsin's analysis provides recent, county-specific evidence that lake breeze meteorology plays a role in ozone production and transport to the Sheboygan County area. Wisconsin's analysis would not have been possible without the new inland ozone monitor in Sheboygan County. Manitowoc County does not have an "inland" ozone monitor. Manitowoc County only has one ozone monitor, which is located approximately 0.9 miles from the Lake Michigan shoreline, and which is approximately 24 miles northeast of the Sheboygan County inland monitor and approximately 33 miles north northeast of the Sheboygan County lakeshore monitor.

Since the Sheboygan County inland monitor has a fully-certified 2016 design value that is attaining the 2015 ozone NAAQS, the EPA used the information from the five-factor analysis to delineate a nonattainment area boundary for Sheboygan County which excludes the attaining inland monitor but includes the violating lakeshore monitor. Although Manitowoc County does not have an "inland" ozone monitor like Sheboygan County, since Manitowoc County is relatively close to Sheboygan County, the analysis of the lake breeze ozone inland penetration distance to the Sheboygan County monitors may be somewhat relevant to Manitowoc County. However, it is important to emphasize that lake breeze ozone events are episode and location-specific. For instance, during an air quality study over southwestern Ontario, Canada, Brook et al. observed lake breeze ozone events associated with Lake Erie, Lake Huron, and Lake St. Clair. Median lake breeze inland penetration distances ranged from 45-75 km (approximately 28-47 miles) with a maximum observed distance of 215 km (approximately 134 miles) inland from the Lake Huron shoreline. The Sheboygan County inland monitor located 3.2 miles from the Lake Michigan shoreline has a 2014-2016 design value of 0.069 ppm (just below the 2015 ozone NAAQS of 0.070 ppm) and a preliminary 2017 design value of 0.070 ppm (right at the standard, but not violating). This does not necessarily indicate that a hypothetical inland monitor placed 3.2 miles from the Lake Michigan shoreline in Manitowoc County would also have a 2016 design value below the 2015 ozone NAAQS. As mentioned previously, Manitowoc County only has one ozone monitor, which is located

[47] Dye, T. S., Roberts, P. T., and Korc, M. E.: Observations of transport processes for ozone and ozone precursors during the 1991 Lake Michigan Ozone Study, J. Appl. Meteorol., 34, 1877–1889, 1995.

approximately 0.9 miles from the Lake Michigan shoreline, and which is approximately 24 miles northeast of the Sheboygan County inland monitor and approximately 33 miles north northeast of the Sheboygan County lakeshore monitor.

To summarize, many details of the various factors regarding how the local lake breeze (alone or combined with synoptic-scale meteorology) influences ozone production and transport around Lake Michigan are episode-specific and not well-understood. There are gaps in the peer-reviewed scientific literature on this topic. However, the basic concepts of lake breeze meteorology and its potential to influence ozone production and transport are understood well enough to weight the meteorology factor relatively high. The peer-reviewed results from the Lake Michigan-specific ozone studies, the HYSPLIT trajectories presented here, and Wisconsin's Sheboygan County lake breeze ozone inland penetration distance analysis provide evidence that meteorology plays a role in ozone production and transport to the Manitowoc County area and nearby areas such as the Sheboygan County area. Therefore, this factor can be weighted relatively high.

**Factor 4: Geography/topography**

Consideration of geography or topography can provide additional information relevant to defining nonattainment area boundaries. Analyses should examine the physical features of the land that might define the airshed. Mountains or other physical features may influence the fate and transport of emissions as well as the formation and distribution of ozone concentrations. The absence of any such geographic or topographic features may also be a relevant consideration in selecting boundaries for a given area.

The EPA uses geography/topography analysis to evaluate the physical features of the land that might affect the airshed and, therefore, the distribution of ozone over the area.

The Manitowoc County area does not have any geographical or topographical features significantly limiting air pollution transport within its airshed. The eastern boundary of Manitowoc County follows the shoreline of Lake Michigan. As described under Factor 3: Meteorology, areas geographically located along the shoreline of Lake Michigan, including Manitowoc County, can be impacted by lake breeze meteorology which has the potential to transport photochemically aged air masses containing ozone-rich air originating from nearby and upwind precursor plumes to nearby and downwind coastal areas along Lake Michigan.

**Factor 5: Jurisdictional boundaries**

Once the geographic extent of the violating area and the nearby area contributing to violations is determined, the EPA considered existing jurisdictional boundaries for the purposes of providing a clearly defined legal boundary to carry out the air quality planning and enforcement functions for nonattainment areas. In defining the boundaries of the ~~intended~~proposed Manitowoc County nonattainment area, the EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Examples of jurisdictional boundaries include, but are not limited to: counties, air districts, areas of Indian country, metropolitan planning organizations, and existing nonattainment areas. If an existing jurisdictional boundary is used to help define the nonattainment area, it must encompass all of the area that has been identified as meeting the

nonattainment definition. Where existing jurisdictional boundaries are not adequate or appropriate to describe the nonattainment area, the EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the ~~intended~~proposed designated areas.

Wisconsin's Sheboygan County lake breeze inland penetration distance analysis described briefly above and in more detail in Section 3.2 Technical Analysis for Sheboygan County suggests that the spatial extent of the violating area for Sheboygan is east of the inland monitor in Sheboygan County, which is located 3.2 miles inland from the lakeshore and which is attaining the 2015 ozone NAAQS. While more monitors would be needed to verify if this is true for the entire north-to-south length of Sheboygan County, the EPA ~~has~~ determined that the available information and data analysis is sufficient for estimating the nonattainment boundary for Sheboygan County. Since Manitowoc County is just north of Sheboygan County, the EPA ~~has~~ determined that the above analysis is also informative for estimating the nonattainment boundary for Manitowoc County. Given the results of the Sheboygan County analysis, it is unlikely that the spatial extent of the violating area in Manitowoc County extends all the way to the western boundary of the county which is approximately 18 miles at its narrowest from the shoreline of Lake Michigan. There is no "inland" monitor in Manitowoc County; thus, there is no information from a second ozone monitor in Manitowoc County to indicate the exact spatial extent of the violating area. However, given the information from the nearby Sheboygan County inland monitor, the EPA delineated the Manitowoc County ~~intended~~proposed nonattainment area boundary using roadways but included the land area at least as far inland as 3.2 miles from the shoreline, which is the inland distance at which the attaining monitor in nearby Sheboygan County is located. The EPA delineated the ~~intended~~proposed nonattainment area boundary using roadways but included the land area at least as far inland as 3.2 miles from the shoreline (and in most cases more than 3.2 miles inland) over the length of the county in an effort to encompass the geographic extent of the nonattainment area. The EPA's ~~intended~~proposed nonattainment boundary for the Manitowoc County area for the 2015 ozone NAAQS was~~is~~ a portion of Manitowoc County ~~roughly 3.2 miles from the shoreline (and in most cases more than 3.2 miles inland)inclusive and east of the following roadways with the boundary starting from north to south: County Road B which turns into South State Street to County Road V which turns into Forest Home Drive to South Parker Drive to West Hillcrest Road to Highway 43 to West Center Street to Dufek Drive which turns into Highway 42~~.

**Conclusion for Manitowoc County Area**

The EPA must designate as nonattainment any area that violates the NAAQS. Since Manitowoc County has a monitor in violation of the 2015 ozone NAAQS, a portion of this county is included in the ~~intended~~proposed nonattainment area based on the air quality data factor. The remaining factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor. The emissions data and emissions-related data factor analysis including information about population density, degree of urbanization, traffic, and vehicle miles traveled for Manitowoc County indicates that overall ozone precursor emissions ($NO_x$ and VOC) from sources in Manitowoc County (total 2014 reported CSA $NO_x$ = 3,253 tons, VOC= 2,812 tons) are relatively low albeit non-trivial and are mainly concentrated in the east central portion of the county particularly around

the I-43 corridor and in and around the city of Manitowoc. This portion of the county is also the portion of the county in which the violating monitor is located. This is also the portion of the county in which the largest point source, the Carmeuse Lime and Stone-Rockwell Operation (2014 reported $NO_x$ = 423 tons VOC = 0.1 tons), is located.

The EPA must designate as nonattainment any nearby areas that contribute to the violation in the violating area. Manitowoc County (total 2014 reported CSA $NO_x$ = 3,253 tons, VOC= 2,812 tons) is immediately downwind of Sheboygan County (total 2014 reported CSA $NO_x$ = 4,585 tons, VOC= 3,421 tons) which is immediately downwind of the Milwaukee-Racine-Waukesha CSA (total 2014 reported CSA $NO_x$ = 51,822 tons, VOC= 49,129 tons) which is immediately downwind of the Chicago CSA (total 2014 reported CSA $NO_x$ = 274,440 tons, VOC= 206,171 tons) which includes counties in northeast Illinois and northwest Indiana. The peer-reviewed scientific literature, the HYSPLIT trajectories, and Wisconsin's Sheboygan County lake breeze ozone inland penetration distance analysis indicate that lake breeze meteorology can influence ozone transport to Manitowoc County and nearby areas such as the Sheboygan County area. The HYSPLIT trajectories indicate that the exceedance day air masses traveled over Sheboygan County, the Milwaukee and Chicago areas, and Lake Michigan to reach the violating monitor in Manitowoc County. The peer-reviewed scientific literature indicates that precursor emissions have the potential to flow out over the lake with the morning land breeze, photochemically react to form high concentrations of ozone in a shallow, stable, inversion layer over the lake, and be transported back toward land by the afternoon lake breeze toward nearby and downwind areas like the location of the violating monitor in Manitowoc County. As stated above, the EPA must designate as nonattainment any nearby areas that contribute to the violation in the violating area. While Sheboygan County and the Milwaukee area are immediately upwind of Manitowoc County, they are each being evaluated as separate nonattainment areas, since Sheboygan County is its own CBSA and the Milwaukee area, like the Chicago area, is part of a separate CSA, whereas Manitowoc County is not part of a CSA but is its own CBSA.

Historically, the EPA has designated the entirety of Manitowoc County as nonattainment under previous ozone standards such as the 1997 ozone NAAQS ~~due to the violating monitor near the lakeshore~~. Wisconsin's Sheboygan County lake breeze inland penetration distance analysis described briefly above and in more detail in Section 3.2 Technical Analysis for Sheboygan County suggests that the spatial extent of the violating area for Sheboygan is east of the inland monitor in Sheboygan County, which is located 3.2 miles inland from the lakeshore and which is attaining the 2015 ozone NAAQS. While more monitors would be needed to verify if this is true for the entire north-to-south length of Sheboygan County, the EPA ~~has~~ determined that the available information and data analysis is sufficient for estimating the nonattainment boundary for Sheboygan County. Since Manitowoc County is just north of Sheboygan County, the EPA ~~has~~ determined that the above analysis is also informative for estimating the nonattainment boundary for Manitowoc County. Given the results of the Sheboygan County analysis, it is unlikely that the spatial extent of the violating area in Manitowoc County extends all the way to the western boundary of the county which is approximately 18 miles at its narrowest from the shoreline of Lake Michigan. The EPA delineated the Manitowoc County ~~intended~~proposed nonattainment area boundary using roadways but included the land area at least as far inland as 3.2 miles from the shoreline, which is the inland distance at which the attaining monitor in nearby Sheboygan County is located. However, since there is no "inland" monitor in Manitowoc County, and thus, there is no information from a second ozone monitor in Manitowoc County to indicate the exact spatial extent of the violating area, in

an effort to be conservative, the EPA ~~has~~ attempted to capture the majority of the precursor emissions in the ~~intended~~proposed ~~-~~nonattainment portion of Manitowoc County (details provided below and in Table 6).

The EPA ~~has~~ captured the majority of the county precursor emissions in the ~~intended~~proposed nonattainment portion of Manitowoc County (details provided below and in Table 6). In reducing the spatial extent of the Manitowoc County ~~intended~~proposed ~~-~~nonattainment area relative to the historical entire county boundary, the EPA analyzed the point sources of emissions in Manitowoc County inside and outside of the ~~intended~~proposed ~~-~~nonattainment boundary described above to ensure that no potentially influential local Manitowoc County sources were omitted from the ~~intended~~proposed nonattainment area. The results of this point source analysis are presented in Table 6 below and indicate that 86% of the 2014 reported Manitowoc County point source $NO_x$ emissions are captured within the ~~intended~~proposed ~~-~~nonattainment area boundary. These point source $NO_x$ emissions (which do not include area, on-road, and off-road mobile sources of emissions) are 22% of the total county $NO_x$ emissions. This analysis shows that 83% of the 2014 reported Manitowoc County point source VOC emissions are captured within the nonattainment area boundary. These point source VOC emissions (which do not include area, on-road, and off-road mobile sources of emissions) are 14% of the total county VOC emissions. Therefore, the EPA ~~has~~ determined that it is not unreasonable to exclude the portion of the county west of the ~~intended~~proposed ~~-~~nonattainment area since this portion of the county has very few point sources of precursor emissions and the emissions related-data analysis suggests that the non-point (area), on-road, and off-road mobile) emissions (for both $NO_x$ and VOC) are mainly concentrated in the east central portion of the county. This portion of the county is also the portion of the county in which the violating monitor is located and the portion of the county included in the ~~intended~~proposed nonattainment area.

**Table 6. Manitowoc County percent precursor emissions east and west of the ~~intended~~proposed nonattainment area boundary.**

| Precursor / Geographic Area | % of county point source emissions | % of total county emissions |
|---|---|---|
| $NO_x$ emissions east of ~~intended~~proposed boundary* | 86 | 22 |
| VOC emissions east of ~~intended~~proposed boundary* | 83 | 14 |
| $NO_x$ emissions west of ~~intended~~proposed boundary* | 14 | 4 |
| VOC emissions west of ~~intended~~proposed boundary* | 17 | 3 |

*The ~~intended~~proposed nonattainment area is a portion of Manitowoc County roughly 3.2 miles inland from the shoreline.[48] ~~inclusive and east of the following roadways with the boundary starting from north to south: County Road B which turns into South State Street to County Road V which turns into Forest Home Drive to South Packer Drive to West Hillcrest Road to Highway 42 to West Custer Street to Dufek Drive which turns into Highway 42.~~

The factor analysis above suggests that Manitowoc County is impacted by ozone transport from nearby areas, like the Milwaukee area, which is upwind and adjacent to Sheboygan County, and from areas farther upwind like the Chicago area, and that ozone production from precursor pollutants from these areas and subsequent downwind transport can be exacerbated by the lake breeze meteorology. The meteorology factor in conjunction with the information associated with the nearby Sheboygan County inland monitor, which is attaining the 2015 ozone NAAQS, indicate that the spatial extent of the violating area is not likely to extend all the way to the western boundary of Manitowoc County which is approximately 18 miles at its narrowest from the shoreline of Lake Michigan. The EPA delineated the ~~intended~~proposed nonattainment area boundary using roadways but included the land area at least as far inland as 3.2 miles from the shoreline, which is the inland distance at which the attaining monitor in nearby Sheboygan County is located, (and in most cases more than 3.2 miles inland) over the length of Manitowoc County. The precursor emissions in Manitowoc County are relatively low and the analysis above shows that the dominating factor contributing to ozone formation in Manitowoc County is upwind impacts from high precursor emitting urban areas like Milwaukee and Chicago. However, the Manitowoc County precursor emissions themselves, while relatively low, are not trivial. Table 6 and the overall five-

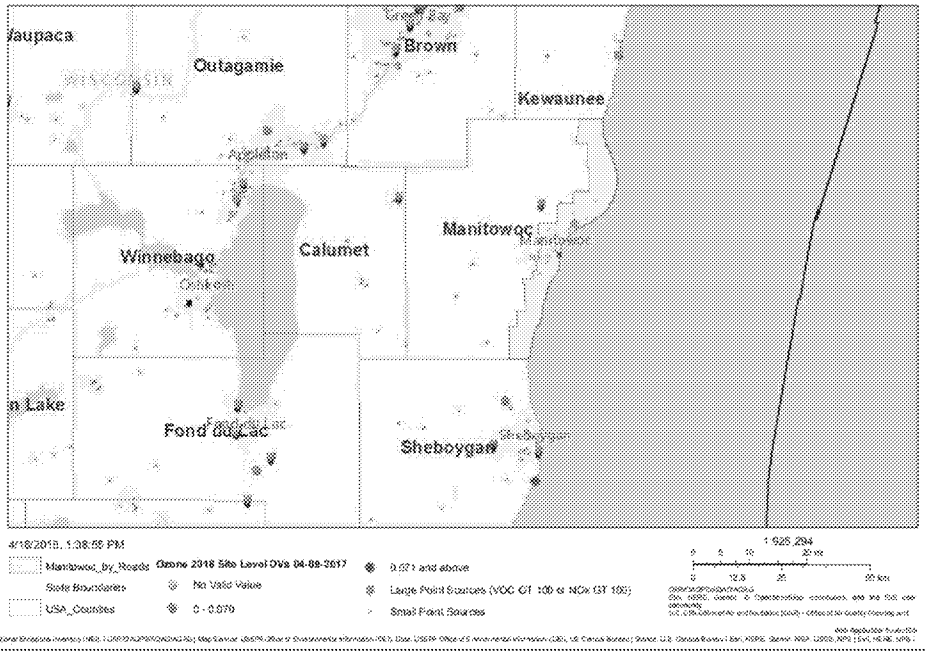
[48] 3.2 miles is the inland distance of the attaining monitor in Sheboygan County, which is just south of Manitowoc County. Manitowoc County only has one monitor, and it is violating. In other words, Manitowoc County does not have a second inland attaining monitor on which to conduct a lake breeze inland penetration distance analysis, like the one conducted for Sheboygan County.

factor analysis above show that in delineating the spatial extent of the violating area, EPA ~~has~~ also captured the majority of the Manitowoc County precursor emissions.

Based on the assessment of factors described above, the EPA ~~has~~ concluded that the portion of Manitowoc County described above meets the CAA criteria for inclusion in the ~~intended~~proposed Manitowoc County nonattainment area. This boundary is different from the nonattainment boundary for the 1997 ozone NAAQS, which was the entire county. However, due to new information from a second ozone monitor in neighboring Sheboygan County and an accompanying lake breeze ozone inland penetration distance analysis submitted by Wisconsin, both of which are discussed in detail above in the context of the five-factor weight-of-evidence analysis, the EPA's ~~intended~~proposed nonattainment boundary for the Manitowoc County area for the 2015 ozone NAAQS is roughly 3.2 miles inland from the shoreline.[49] ~~a portion of Manitowoc County inclusive and east of the following roadways with the boundary starting from north to south: County Road B which turns into South State Street to County Road V which turns into Forest Home Drive to South Packer Drive to West Hillcrest Road to Highway 43 to West Custer Street to Dufek Drive which turns into Highway 42.~~

The above analysis was originally announced in EPA's December 22, 2017, TSD. In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area shown on the map and described below. To be clear, the state requested a distance inland from the OHWM. EPA prefers clearly identifiable roadways rather than the OHWM (see RTC). Therefore, EPA selected roadways that were roughly the distance inland (2.9 miles) from the shoreline requested by the state. The final nonattainment boundary is inclusive and east of the following roadways going from the northern county boundary to the southern county boundary: Saxonburg Road, Zander Road, Saxonburg Road, Tapawingo Road, Tannery Road, E County Road V, Tannery Road, E Hillcrest Road, Sunset Drive, County Road VV, Manitou Drive, County Road B, Goodwin Road, N Rapids Raod, S Rapids Road, Calumet Avenue, Hecker Road, Silver Creek Road, Gass Lake Road, Clover Road, Center Road, County Road F, Westview Road, County Road X, S Union Road.

[49] 3.2 miles is the inland distance of the attaining monitor in Sheboygan County, which is just south of Manitowoc County. Manitowoc County only has one monitor, and it is violating. In other words, Manitowoc County does not have a second inland attaining monitor on which to conduct a lake breeze inland penetration distance analysis, like the one conducted for Sheboygan County.


Waupaca
Outagamie
Brown
Kewaunee
Appleton
Manitowoc
Winnebago
Calumet
Oshkosh
n Lake
Fond du Lac
Sheboygan
4/18/2018, 1:38:59 PM
Manitowoc_by_Roads
State Boundaries
USA_Counties
Ozone 2018 Site Level OVs 04-09-2017
No Valid Value
0 - 0.070
0.071 and above
Large Point Sources (VOC GT 100 or NOx GT 100)
Small Point Sources
1:925,294
0 12.5 25 50 km

### 3.4 Technical Analysis for Door County

This technical analysis identifies the area with a monitor that violates the 2015 ozone NAAQS. It also provides EPA's evaluation of this area and any nearby areas to determine whether those nearby areas have emissions sources that potentially contribute to ambient ozone concentrations at the violating monitor in the area, based on the weight-of-evidence of the five factors recommended in the EPA's ozone designations guidance and any other relevant information. In developing this technical analysis, the EPA used the latest certified data and information available to the EPA (and to the states and tribes through the Ozone Designations Mapping Tool and the EPA Ozone Designations Guidance and Data web page).[50] In addition, the EPA considered any additional data or information provided to the EPA by states or tribes.

The area of analysis was~~is~~ Door County, which is not part of a CSA or a CBSA. As per EPA's designations guidance to start with the CSA or CBSA, since Door County is not part of a CSA or CBSA, Door County was analyzed (as per past EPA practice) as a single county area. Door County is unique in the combination of its susceptibility to be impacted by lake breeze meteorology, its precursor emissions are relatively low, and it is located downwind of several large urban areas, making it a recipient of ozone transport from upwind urban areas with high precursor emissions.

The five factors recommended in the EPA's guidance are:

1. Air Quality Data (including the design value calculated for each Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitor;
2. Emissions and Emissions-Related Data (including locations of sources, population, amount of emissions, and urban growth patterns);
3. Meteorology (weather/transport patterns);
4. Geography/Topography (including mountain ranges or other physical features that may influence the fate and transport of emissions and ozone concentrations); and
5. Jurisdictional Boundaries (e.g., counties, air districts, existing nonattainment areas, areas of Indian country, Metropolitan Planning Organizations (MPOs)).

Figure 1 is a map of the EPA's ~~intended~~proposed nonattainment boundary for the Door County area, which was announced on December 22, 2017. The map shows the location of the ambient air quality monitor, county, and other jurisdictional boundaries.

For purposes of the 1997 ozone NAAQS, the entirety of Door County was designated nonattainment, since the Door County monitor was violating the 1997 standard at the time of designation. For purposes of the 2008 ozone NAAQS, the entirety of Door County was designated unclassifiable/attainment, since the Door County monitor was attaining the 2008 standard at the time of designation.

The EPA announced on December 22, 2017, that as a result of the 5-factor anlaysis below, the EPA's ~~The EPA's intended~~ proposed nonattainment boundary for the Door County area for the 2015 ozone NAAQS was~~is~~ the northern portion of the county cut off by the Sturgeon Bay canal. This boundary is different from the boundary for the 1997 ozone NAAQS, which consisted of the entirety of Door County. In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area

[50] The EPA's Ozone Designations Guidance and Data web page can be found at *https://www.epa.gov/ozone-designations/ozone-designations-guidance-and-data.*

described in the conclusion to this section (skip to page X), which is the Newport State Park boundary. Wisconsin believes that air above 0.070 ppm in Door County is confined to the boundaries of the 3.7 square mile Newport State Park.

**Figure 1. EPA's ~~Intended~~Proposed Nonattainment Boundary for the Door County Area**

The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. The northern portion of Door County has a monitor in violation of the 2015 ozone NAAQS, therefore this portion of the county is included in the ~~intended~~proposed nonattainment area. The following sections describe the five-factor analysis. While the factors are presented individually, they are not independent. The five-factor analysis process carefully considers the interconnections among the different factors and the dependence of each factor on one or more of the others, such as the interaction between emissions and meteorology for the area being evaluated.

**Factor Assessment**

**Factor 1: Air Quality Data**

The EPA considered the 8-hour ozone design value in ppm for the air quality monitor in Door County based on data for the 2014-2016 period (i.e., the 2016 design value, or DV). This is the most recent three-year period with fully-certified air quality data. The design value is the 3-year average of the annual 4th

highest daily maximum 8-hour average ozone concentration.[51] The 2015 NAAQS are met when the design value is 0.070 ppm or less. Only ozone measurement data collected in accordance with the quality assurance (QA) requirements using approved (FRM/FEM) monitors are used for NAAQS compliance determinations.[52] The EPA uses FRM/FEM measurement data residing in the EPA's Air Quality System (AQS) database to calculate the ozone design values. Individual violations of the 2015 ozone NAAQS that the EPA determines have been caused by an exceptional event that meets the administrative and technical criteria in the Exceptional Events Rule[53] are not included in these calculations. Whenever several monitors are located in a county (or designated nonattainment area), the design value for the county or area is determined by the monitor with the highest valid design value. The presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA identified monitors where the most recent design values violate the NAAQS, and examined historical ozone air quality measurement data (including previous design values) to understand the nature of the ozone ambient air quality problem in the area. Eligible monitors for providing design value data generally include State and Local Air Monitoring Stations (SLAMS) that are operated in accordance with 40 CFR part 58, appendices A, C, D and E and operating with an FRM or FEM monitor. These requirements must be met in order to be acceptable for comparison to the 2015 ozone NAAQS for designation purposes. All data from Special Purpose Monitors (SPMs) using an FRM or FEM are eligible for comparison to the NAAQS, subject to the requirements given in the March 28, 2016 Revision to Ambient Monitoring Quality Assurance and Other Requirements Rule (81 FR 17248).

There is one monitor located in Door County. The 2016 design value for the monitor is shown in Table 2.

[51] The specific methodology for calculating the ozone design values, including computational formulas and data completeness requirements, is described in 40 CFR part 50, appendix U.

[52] The QA requirements for ozone monitoring data are specified in 40 CFR part 58, appendix A. The performance test requirements for candidate FEMs are provided in 40 CFR part 53, subpart B.

[53] The EPA finalized the rule on the Treatment of Data Influenced by Exceptional Events (81 FR 68513) and the guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events in September of 2016. For more information, see *https://www.epa.gov/air-quality-analysis/exceptional-events-rule-and-guidance.*

**Table 2. Air Quality Data (all values in ppm).**

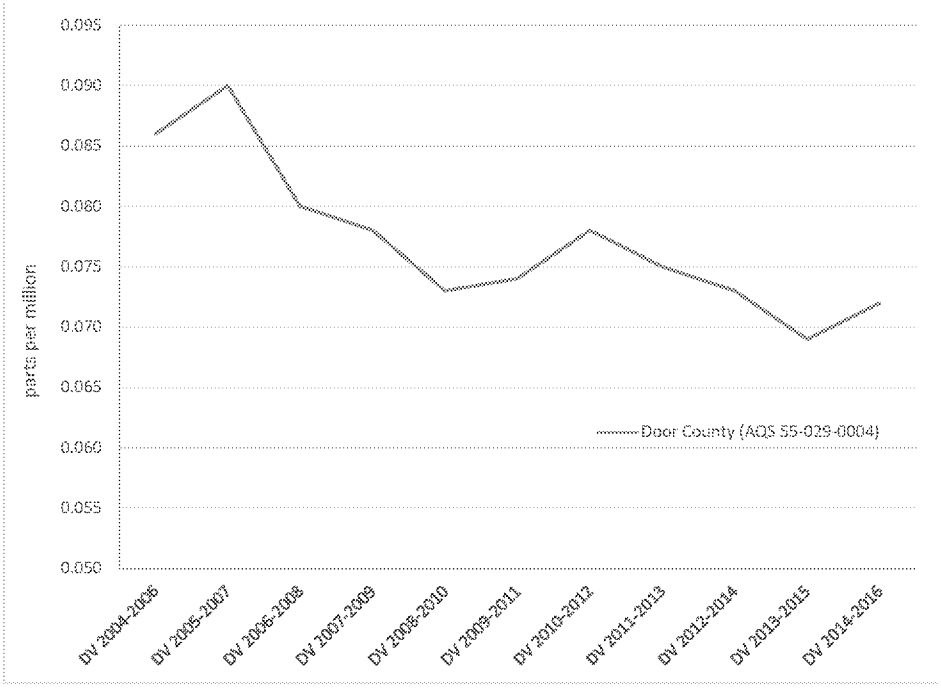
| County, State | State Recommended Nonattainment? | AQS Site ID | 2014-2016 DV | 2014 4th highest daily max value | 2015 4th highest daily max value | 2016 4th highest daily max value |
|---|---|---|---|---|---|---|
| Door County, WI | No | 55-029-0004 | **0.072*** | 0.065 | 0.074 | 0.077 |

*Despite violating monitors, in a September 21, 2016, letter from its governor, Wisconsin recommended attainment for the entire state. Later in an April 20, 2017, supplemental submittal, which Wisconsin explains contains technical information to support the governor's recommendation and which contains Wisconsin's estimates of the geographic extent of the areas in Wisconsin with design values above 0.070 ppm, Wisconsin requested that if EPA designates nonattainment areas in Wisconsin, that the EPA should ensure that the geographic scope of these areas is minimized. Wisconsin estimated the geographic extent of the design values above 0.070 ppm in Door County does not extend beyond the Newport State Park boundary. Wisconsin emphasized in its April 20, 2017, submittal that these descriptions should not be construed as a recommendation for a potential nonattainment area designation for the 2015 ozone NAAQS.

The monitor, which is in the northern portion of Door County, shows a violation of the 2015 ozone NAAQS, therefore this portion of the county is included in EPA's ~~intended~~proposed -nonattainment area.

Figure 1, shown previously, identifies the portion of Door County in the ~~intended~~proposed -nonattainment area and the violating monitor. Table 2 identifies the 2016 design value for the monitor in the area of analysis and Figure 2 shows the historical trend of design values for the violating monitor. As indicated on the map, there is one violating monitor that is located on the northeast portion of the Door County peninsula near the shoreline of Lake Michigan. There are three monitors to the south and southwest of Door County, including one in Kewaunee County, which is immediately south of Door County near the shoreline of Lake Michigan, one in Brown County, and one in Outagamie County, that are not violating for the 2014-2016 time-period. There is one monitor to the south of both Door and Kewaunee counties in Manitowoc County, which is near the shoreline of Lake Michigan, that is violating for the 2014-2016 time-period, but this area will be addressed separately, since Manitowoc County is its own CBSA-Micropolitan Statistical Area. As shown in Figure 2, the Door County monitor has historically high ozone design values, which have been generally decreasing over time; however, there was a small increase in the 2016 design value.

**Figure 2. Three-Year Design Values for Violating Monitor (2007-2016).**




The EPA must designate as nonattainment any area that violates the NAAQS and any nearby areas that contribute to the violation in the violating area. The northern portion of Door County has a monitor in violation of the 2015 ozone NAAQS, therefore this portion of the county is included in the ~~intended~~proposed nonattainment area based on the air quality data factor.

**Factor 2: Emissions and Emissions-Related Data**

As mentioned previously, the presence of one or more violating monitors (i.e. monitors with design values greater than 0.070 ppm) in a county or other geographic area forms the basis for designating that county or area as nonattainment. The remaining four factors are then used as the technical basis for determining the spatial extent of the designated nonattainment area surrounding the violating monitor(s) based on a consideration of what nearby areas are contributing to a violation of the NAAQS.

The EPA evaluated emissions of ozone precursors, which include nitrogen oxides ($NO_x$) and volatile organic compounds (VOC), and other emissions-related data that provide information on areas contributing to violating monitors.

**Emissions Data**

The EPA reviewed data from the 2014 National Emissions Inventory (NEI). For the Door County area of analysis, the EPA examined the magnitude of large sources ($NO_x$ or VOC emissions greater than 100 tons per year) and small point sources and the magnitude of county-level emissions reported in the NEI. These county-level emissions represent the sum of emissions from the following general source categories: point sources, non-point (i.e., area) sources, non-road mobile, on-road mobile, and fires. Emissions levels from sources in a nearby area indicate the potential for the area to contribute to monitored violations.

Table 3 provides a county-level emissions summary of $NO_x$ and VOC (given in tons per year (tpy)) emissions for the area of analysis considered for inclusion in the ~~intended~~proposed Door County nonattainment area.

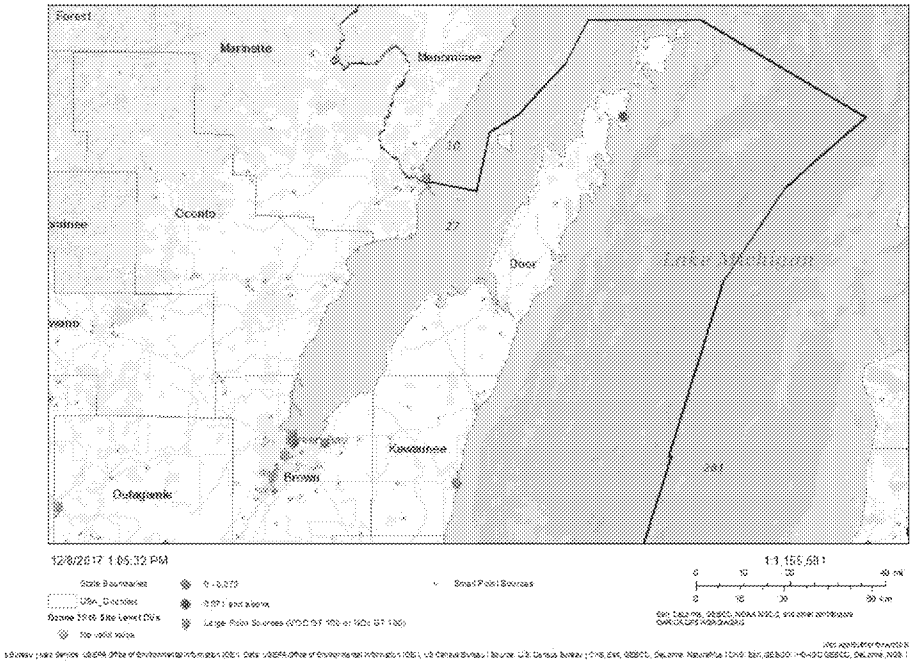
**Table 3. Total County-Level $NO_x$ and VOC Emissions.**

| County, State | State Recommended Nonattainment? | Total $NO_x$ (tpy) | Total VOC (tpy) |
|---|---|---|---|
| Door County, WI | No* | 3,066 | 2,439 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

In addition to reviewing county-wide emissions of $NO_x$ and VOC in the area of analysis, the EPA also reviewed emissions from point sources. The location of these sources, together with the other factors, can help inform nonattainment boundaries. The locations of the point sources are shown in Figure 3 below.

**Figure 3. Point Sources in the Area of Analysis.**




The EPA's analysis of county-level emissions showed no large point sources in Door County and four out of approximately ten small point sources that reported $NO_X$ and/or VOC emissions of greater than 1 ton to the 2014 NEI. These four sources, including Bay Shipbuilding Co., Marine Travel Lift, Door County Cherryland Airport, and Palmer Johnson Yachts, LLC, combined, emitted a reported 9 tons of $NO_X$ and 80 tons of VOC in 2014. The largest of these sources, Bay Shipbuilding Co., emitted a reported 51.26 tons of VOC and 2.58 tons of $NO_X$ in 2014. The $NO_X$ and VOC emissions from the point sources in Door County are relatively low.

**Population density and degree of urbanization**

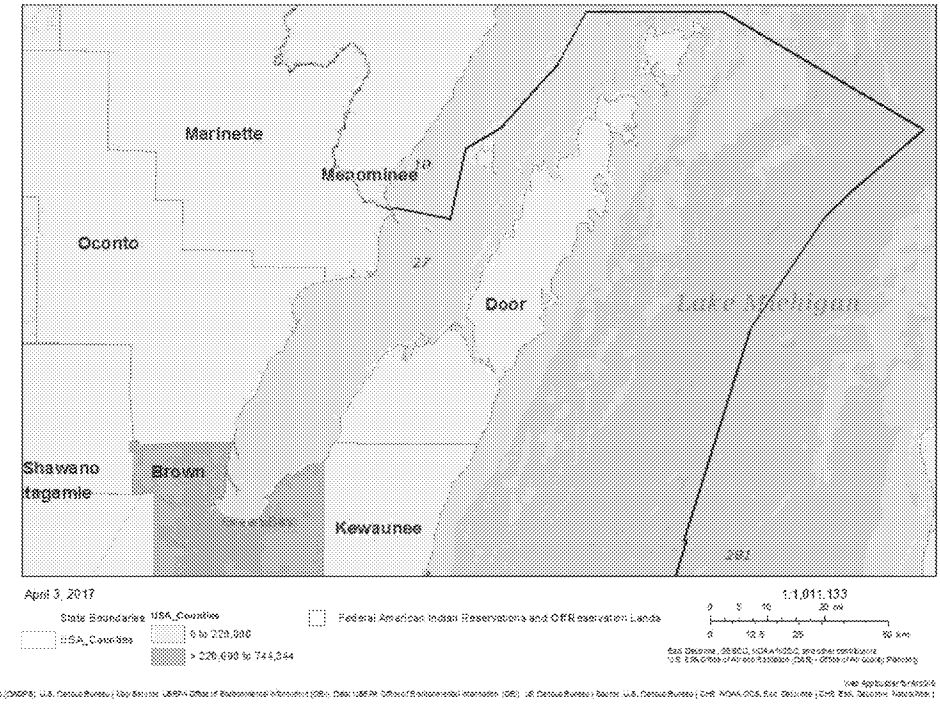
In this part of the factor analysis, the EPA evaluated the population and vehicle use characteristics and trends of the area as indicators of the probable location and magnitude of non-point source emissions. These include emissions of $NO_X$ and VOC from on-road and non-road vehicles and engines, consumer products, residential fuel combustion, and consumer services. Areas of dense population or commercial development are an indicator of area source and mobile source $NO_X$ and VOC emissions that may contribute to violations of the NAAQS. Table 4 shows the population, population density, and population growth information for Door County. Figure 4 shows the county-level population density map of the area of analysis.

**Table 4. Population and Growth.**
Source: U.S. Census Bureau population estimates for 2010 and 2015. www.census.gov/data.html.

| County, State | State Recommended Nonattainment? | 2010 Population | 2015 Population | 2015 Population Density (per sq. mi.) | Absolute change in population (2010-2015) | Population % change (2010-2015) |
|---|---|---|---|---|---|---|
| Door County, WI | No* | 27,785 | 27,554 | 57 | 231 | -0.8 |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

**Figure 4. County-Level Population.**




The population and population density in Door County are both relatively low. The non-point (area) source emissions reported to the 2014 NEI were 1,752 tons of $NO_x$ and 491 tons of VOC. The on-road emissions reported to the 2014 NEI were 600 tons of $NO_x$ and 356 tons of VOC. The non-road emissions reported to the 2014 NEI were 706 tons of $NO_x$ and 1,512 tons of VOC. These quantities of precursor emissions are not trivial; however, the reported $NO_x$ and VOC emissions from the non-point (area), on-

road, and non-road source sectors, which are the source sectors that are often correlated with population and population density, are relatively low in Door County.

**Traffic and Vehicle Miles Travelled (VMT)**

The EPA evaluated the commuting patterns of residents, as well as the total vehicle miles traveled (VMT) for the area of analysis. In combination with the population/population density data and the location of main transportation arteries, this information helps identify the probable location of non-point source emissions. A county with high VMT and/or a high number of commuters is generally an integral part of an urban area and high VMT and/or high number of commuters indicates the presence of motor vehicle emissions that may contribute to violations of the NAAQS. Rapid population or VMT growth in a county on the urban perimeter may signify increasing integration with the core urban area, and thus could indicate that the associated area source and mobile source emissions may be appropriate to include in the nonattainment area. In addition to VMT, the EPA evaluated worker data collected by the U.S. Census Bureau[54] for Door County. Table 5 shows the traffic and commuting pattern data, including total VMT for the county, number of county residents who work, number of county residents commuting within the county, and the percentage of county residents commuting within the county. The data in Table 5 are 2014 data.

**Table 5. Traffic and Commuting Patterns.**

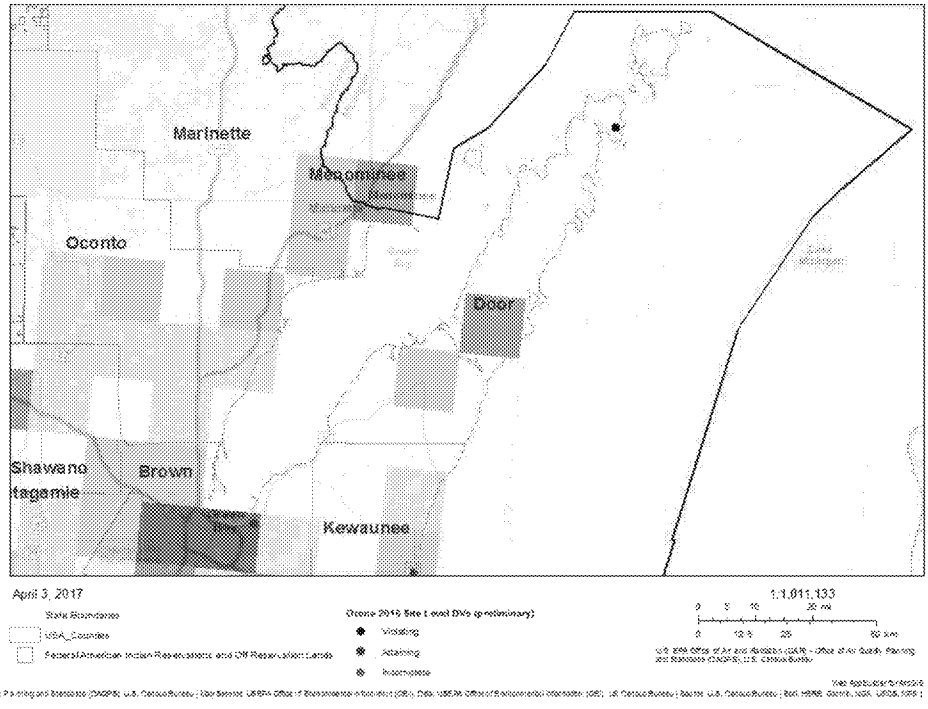
| County, State | State Recommended Nonattainment? | 2014 Total VMT (Million Miles) | Number of County Residents Who Work | Number of County Residents Commuting Within the County | Percentage of County Residents Commuting Within the County |
|---|---|---|---|---|---|
| Door County, WI | No* | 399 | 13,612 | 8,697 | 64% |

*Wisconsin submitted a request that any nonattainment areas be limited in size but did not make formal recommendations of nonattainment.

To show traffic and commuting patterns, Figure 5 overlays twelve-kilometer gridded VMT from the 2014 NEI with a map of the transportation arteries.

[54] The worker data can be accessed at: http://onthemap.ces.census.gov/.

**Figure 5. Twelve Kilometer Gridded VMT (Miles) Overlaid with Transportation Arteries.**




Door County has a relatively low population density and degree of urbanization. The reported vehicle miles traveled (VMT) for 2014 were 399 million miles, and the on-road emissions reported to the 2014 NEI were 600 tons of $NO_X$ and 356 tons of VOC. The majority of the VMT are concentrated in the central portion of the county just north of the Sturgeon Bay canal as seen in Figure 5.

The Door County emissions and emissions-related data are not trivial. However, the $NO_X$ and VOC emissions from the various source sectors, including point, non-point (area), on-road, and off-road, in Door County are relatively low, such that the county emissions and emissions-related data factor of the analysis can be ranked relatively low in terms of contribution to ozone formation in the county. The majority of the county point source emissions and the majority of the county VMT are concentrated north of the Sturgeon Bay canal.

**Factor 3: Meteorology**

Evaluation of meteorological data helps to assess the fate and transport of emissions contributing to ozone concentrations and to identify areas potentially contributing to the monitored violations. Results of meteorological data analysis may inform the determination of nonattainment area boundaries. In order to determine how meteorological conditions, including, but not limited to, weather, transport patterns, and

stagnation conditions, could affect the fate and transport of ozone and precursor emissions from sources in the area, the EPA evaluated 2014-2016 HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) trajectories at 100, 500, and 1,000 meters above ground level (AGL) that illustrate the three-dimensional paths traveled by air parcels to a violating monitor. Figure 6 shows the 24-hour HYSPLIT back trajectories for each exceedance day (i.e., daily maximum 8 hour values that exceed the 2015 ozone NAAQS) for the violating monitor. Figure 7 shows the same trajectories as Figure 6 with a zoomed-out perspective.

**Figure 6. HYSPLIT Back Trajectories for Violating Monitor.**

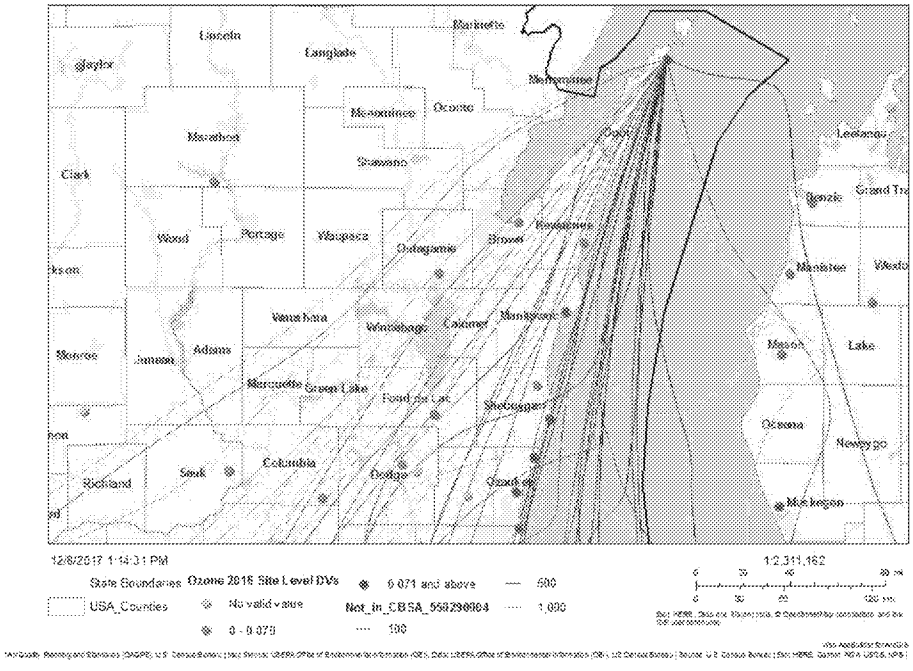
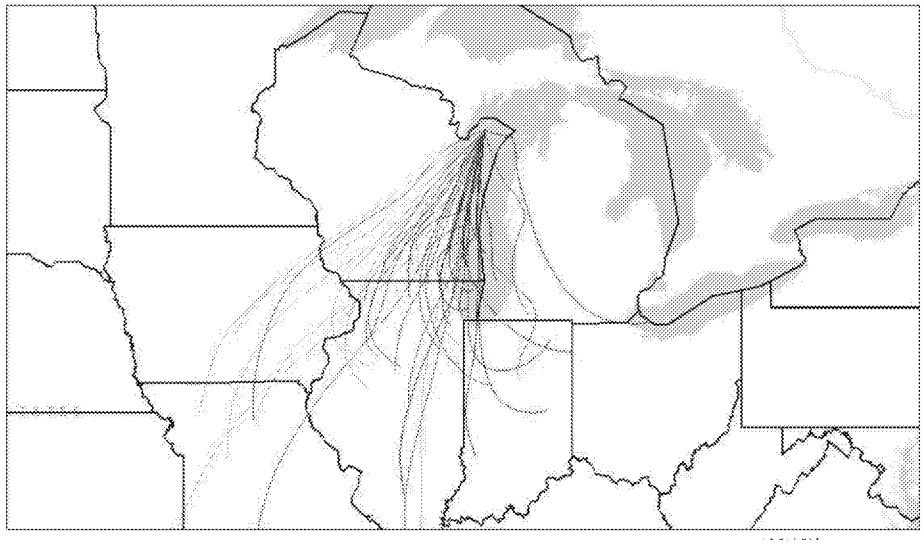


**Figure 7. HYSPLIT Back Trajectories for Violating Monitor. Red lines depict trajectories ending 100 m above the monitor, blue lines depict trajectories ending 500 m above the monitor and green lines depict trajectories ending 1,000 m above the monitor.**



Door County is a peninsula that juts out into Lake Michigan. Due to its proximity to the lake, Door County has the potential to be impacted by lake breeze meteorology. The land breeze and lake breeze occur when wind blows from the land and lake, respectively, due to air pressure differences caused by the different heating capacities of the land and the water. Land absorbs and loses solar radiation much faster than water. The land breeze typically occurs at night and into the morning when air above the relatively warm nighttime water of Lake Michigan heats and rises, setting up an area of low pressure which is filled by the cooler air from the land. The lake breeze typically occurs in the afternoon when the area of low pressure is created by rising air over the heated land, creating winds off the cooler lake. The land/lake breeze is typically more localized than the prevailing (synoptic) winds. Studies indicate the land/lake breeze can trap, stratify, and recirculate offshore air, sometimes in a helical pattern. Daytime inversions over the lake can create shallow, stable layers of precursor plumes, which, on warm sunny days, are conducive to ozone formation. The afternoon lake breeze can carry photochemically aged, ozone-rich air toward the land originating from nearby and upwind precursor plumes, to nearby and downwind areas like Door County where violations of the ozone standard can be measured at locations along the shoreline. Additionally, large scale, summertime, stagnant high pressure systems centered to the south and southeast of Lake Michigan have been implicated in high ozone episodes for coastal areas along Lake Michigan, because they can produce southerly and southeasterly flows over Lake Michigan, which can

enhance the flow of photochemically aged air. The relative role of each (the land/lake breeze and synoptic flow) is episode-specific and not fully understood.[55, 56, 57, 58, 59]

The HYSPLIT trajectories indicate that exceedance day air masses generally traveled from the south and southwest prior to being detected at the violating monitor. Many of the lower level trajectories represented by the red lines at 100 meters AGL and the blue lines at 500 m AGL traveled from over Lake Michigan while the higher level trajectories represented by the green lines at 1,000 m AGL traveled over land. Scientific studies indicate ozone can be preferentially transported over the Great Lakes relative to the land surface.[60, 61, 62, 63, 64, 65] Door County is downwind of the Green Bay-Shawano CSA, which includes Kewaunee, Brown, Oconto, Menominee, and Shawano counties. Of these counties, the majority of the HYSPLIT trajectories travel over Brown County and Kewaunee County on the path to the violating monitor in Door County. Kewaunee County emissions are relatively low, but Brown County emissions are among the highest in the state. The HYSPLIT trajectories also indicate that exceedance day air masses also traveled as far as the Milwaukee and Chicago CSAs to the violating monitor in Door County. The Milwaukee and Chicago CSAs are on the order of 100-200 miles away from the violating monitor in Door County, whereas Brown County is approximately 65 miles away from the Door County violating monitor. While Brown County is upwind of Door County (see HYSPLIT trajectories in Figure 6) and accounts for some of the highest precursor emissions in the state, Brown County (along with Kewaunee County which is immediately south of and adjacent to Door County) is part of a separate CSA (Brown

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[55] Cleary, P. A., Fuhrman, N., Schulz, L., Schafer, J., Fillingham, J., Bootsma, H., McQueen, J., Tang, Y., Langel, T., McKeen, S., Williams, E. J., and Brown, S. S., Ozone distributions over southern Lake Michigan: comparisons between ferry-based observations, shoreline-based DOAS observations and model forecasts, Atmos. Chem. Phys., 15, 5109–5122, 2015.

[56] Dye, T. S., Roberts, P. T., and Korc, M. E.: Observations of transport processes for ozone and ozone precursors during the 1991 Lake Michigan Ozone Study, J. Appl. Meteorol., 34, 1877–1889, 1995.

[57] Foley, T., Betterton, E. A., Jacko, P. E. R., and Hillery, J.: Lake Michigan air quality: The 1994–2003 LADCO Aircraft Project (LAP), Atmos. Environ., 45, 3192–3202, 2011.

[58] Hanna, S. R. and Chang, J. C.: Relations between meteorology and ozone in the Lake Michigan region, J. Appl. Meteorol., 34, 670–678, 1995.

[59] Lennartson, G. J., and Schwartz, M. D.: A synoptic climatology of surface-level ozone in Eastern Wisconsin, USA, Climate Research, 13, 207-220, 1999.

[60] Brook, J. R., Makar, P.A., Sills D. M. L., Hayden, K. L. and McLaren, R. Exploring the nature of air quality over southwestern Ontario: main findings from the Border Air Quality and Meteorology Study, Atmos. Chem. Phys., 13, 10461–10482, 2013.

[61] Lyons, W. A. and Cole, H. S., Fumigation and plume trapping on the shores of Lake Michigan during stable onshore flow, J. Appl. Meteor., 12, 494–510, 1973.

[62] Lyons, W. A. and Cole, H. S.: Photochemical oxidant transport–mesoscale lake breeze and synoptic-scale aspects, J. Appl. Meteor., 15, 733–743, 1976.

[63] Sillman, S., Samson, P. J., and Masters, J. M.: Ozone formation in urban plumes transported over water: photochemical model and case studies in the northeastern and midwestern U.S., J. Geophys. Res., 98, 12687–12699, 1993.

[64] Lyons, W. A., Pielke, R. A., Tremback, C. J., Walko, R. L., Moon, D. A., and Keen, C. S.: Modeling impacts of mesoscale vertical motions upon coastal zone air pollution dispersion, Atmos. Environ., 29, 283–301, 1995a.

[65] Lyons, W. A., Tremback, C. J., and Pielke, R. A.: Applications of the Regional Atmospheric Modeling System (RAMS) to provide input to photochemical grid models for the Lake Michigan Ozone Study (LMOS), J. Appl. Meteor., 34, 1762–1786, 1995b.

County and Kewaunee County are both part of the Green Bay-Shawano CSA) and is therefore not included in the area of analysis for the Door County nonattainment area.

The HYSPLIT trajectories are just one piece of evidence corroborating the body of scientific literature on the potential for lake breeze meteorology, and lake breeze meteorology combined with synoptic meteorology, to transport photochemically aged, ozone-rich air masses from nearby and upwind areas to nearby and downwind areas near the shoreline of Lake Michigan, such as Door County, Wisconsin. Other evidence of the potential for land/lake breeze and synoptic meteorology to transport ozone to areas along the shoreline of Lake Michigan are documented in the scientific literature from study data collected mostly in the early 1990's.[57, 58, 59, 60, 61] It is important to reiterate that the relative role of the land/lake breeze and synoptic flow on ozone transport in the Lake Michigan area is episode-specific and not fully understood. Specific details on the factors and mechanisms by which a large body of water like Lake Michigan can impact photochemical ozone production are not well-known (e.g. changes in precursor mixes, changes in radical concentrations, relative importance of multi-day ozone formation versus same day formation, lake breeze inland penetration distances, the extent to which shallow inversions above the cool lake water prevent vertical mixing, etc.).[66]

To summarize, many details of the various factors regarding how the local lake breeze (alone or combined with synoptic-scale meteorology) influences ozone production and transport around Lake Michigan are episode-specific and not well-understood. There are gaps in the peer-reviewed scientific literature on this topic. However, the basic concepts of lake breeze meteorology and its potential to influence ozone production and transport are understood well enough to weight the meteorology factor relatively high given the above analysis. The peer-reviewed results from the Lake Michigan-specific ozone studies and the HYSPLIT trajectories presented here provide evidence that meteorology plays a role in ozone production and transport to this area. Therefore, this factor can be weighted relatively high.

**Factor 4: Geography/topography**

Consideration of geography or topography can provide additional information relevant to defining nonattainment area boundaries. Analyses should examine the physical features of the land that might define the airshed. Mountains or other physical features may influence the fate and transport of emissions as well as the formation and distribution of ozone concentrations. The absence of any such geographic or topographic features may also be a relevant consideration in selecting boundaries for a given area.

The EPA uses geography/topography analysis to evaluate the physical features of the land that might affect the airshed and, therefore, the distribution of ozone over the area.

Door County does not have any geographical or topographical features significantly limiting air pollution transport within its airshed. Door County is a peninsula in the northeast portion of Wisconsin that juts out into Lake Michigan. As described under Factor 3: Meteorology, areas geographically located along the shoreline of Lake Michigan, including Door County, can be impacted by lake breeze meteorology which

[66] Pierce, B., Kaleel, R., Dickens, A., Bertram T., and Stanier, C., Kenski D.: White Paper: Lake Michigan Ozone Study 2017 (LMOS 2017), http://www.ladco.org/, 2016.

has the potential to transport photochemically aged air masses containing ozone-rich air originating from nearby and upwind precursor plumes to nearby and downwind coastal areas along Lake Michigan.

**Factor 5: Jurisdictional boundaries**

Once the geographic extent of the violating area and the nearby area contributing to violations is determined, the EPA considered existing jurisdictional boundaries for the purposes of providing a clearly defined legal boundary to carry out the air quality planning and enforcement functions for nonattainment areas. In defining the boundaries of the ~~intended~~proposed Door County nonattainment area, the EPA considered existing jurisdictional boundaries, which can provide easily identifiable and recognized boundaries for purposes of implementing the NAAQS. Examples of jurisdictional boundaries include, but are not limited to: counties, air districts, areas of Indian country, metropolitan planning organizations, and existing nonattainment areas. If an existing jurisdictional boundary is used to help define the nonattainment area, it must encompass all of the area that has been identified as meeting the nonattainment definition. Where existing jurisdictional boundaries are not adequate or appropriate to describe the nonattainment area, the EPA considered other clearly defined and permanent landmarks or geographic coordinates for purposes of identifying the boundaries of the ~~intended~~proposed designated areas.

Since Door County is not part of a CSA or CBSA, for this area, EPA looked at the county boundary as the initial area of analysis. The Door County area has a previously established nonattainment boundary associated with the 1997 ozone NAAQS. For the 1997 ozone NAAQS the entirety of Door County was designated as nonattainment, and the county immediately to the south of Door County, Kewaunee County, which also had a violating monitor at the time of the 1997 ozone NAAQS designations, was designated as a separate nonattainment area. Neither Door County nor Kewaunee County were violating the 2008 ozone NAAQS at the time of the 2008 ozone NAAQS designations. Kewaunee County does not contain a violating monitor for the 2015 ozone NAAQS. Given the lake breeze inland penetration distance analysis described in the Sheboygan County section (Section 3.2) and given that the Kewaunee County monitor, which is located near the Lake Michigan shoreline, is not violating the 2015 ozone NAAQS, it is unlikely that the spatial extent of the violating area in Door County extends to the southern portion of Door County (south of the Sturgeon Bay canal). As discussed in the factor analysis above, Door County emission and emissions-related data are relatively low. There are no large point sources in Door County and four out of approximately ten small point sources that reported $NO_x$ and/or VOC emissions of greater than 1 ton to the 2014 NEI. These four sources, including Bay Shipbuilding Co., Marine Travel Lift, Door County Cherryland Airport, and Palmer Johnson Yachts, LLC, combined, emitted a reported 9 tons of $NO_x$ and 80 tons of VOC in 2014. The largest of these sources, Bay Shipbuilding Co., emitted a reported 51.26 tons of VOC and 2.58 tons of $NO_x$ in 2014. Bay Shipbuilding Co. and Palmer Johnson Yachts, LLC are located north of the Sturgeon Bay canal, whereas Marine Travel Lift and Door County Cherryland Airport are located just south of the Sturgeon Bay canal. The majority of the VMT activity is concentrated just north of the canal (Figure 5). Further, Door County is a peninsula that juts out into Lake Michigan and is susceptible to ozone transport from upwind, high precursor emitting urban areas (Factor 4: Meteorology, Figure 6, Figure 7). Therefore, in light of Wisconsin's April 2017 recommendation that if EPA designates the area as nonattainment due to the violating monitor that EPA minimize the extent of the area included in the nonattainment area boundary, and in light of the above analysis, the EPA ~~intends~~

proposed to designate the northern portion of Door County (north of the Sturgeon Bay canal) as nonattainment for the 2015 ozone NAAQS. The canal is an easily identifiable clearly defined geographical boundary.

**Conclusion for Door County Area**

Based on the assessment above, the EPA is to designating the northern portion of Door County (north of the Sturgeon Bay canal) as nonattainment for the 2015 ozone NAAQS. The Door County air quality monitor, which is located in the northern portion of the county indicates a violation of the 2015 ozone NAAQS based on the 2016 design value; therefore, this portion of the county is included in the ~~intended~~proposed nonattainment area. Door County emissions are relatively low and the county also has a relatively small population and low population density. HYSPLIT trajectories suggest that emissions from upwind areas with significantly higher emissions (approximately 4 times higher from Brown County and 14 times higher from the Milwaukee nonattainment area) are a significant contributor to air quality at the violating monitor.

**Rural Transport Area (RTA) Analysis**

Section 182(h) of the Clean Air Act identifies a category of ozone nonattainment areas referred to as rural transport areas (RTAs). An RTA is treated as a Marginal area for purposes of ozone-related planning and control requirements, regardless of the area's classification. In order for an area to qualify as an RTA, the nonattainment area must meet two criteria. First, the nonattainment area cannot be adjacent to or include any part of a metropolitan statistical area, as defined by the U.S. Office of Management and Budget (OMB). Second, the $NO_X$ and VOC emissions from sources within the area cannot make a significant contribution to ozone concentrations in the area itself, or in other areas.

For the first criterion, while Door County is adjacent to Kewaunee County which is part of the Green Bay-Shawano, Wisconsin CSA, the portion of Door County that EPA ~~intends~~ proposed to designate as nonattainment (the portion of Door County which is north of the Sturgeon Bay canal) is not adjacent to or part of a metropolitan statistical area, as defined by the OMB. Thus, the ~~intended~~proposed nonattainment area meets the first criterion.

Regarding the second criterion, the EPA has provided in the designations guidance that a multi-factor, weight-of-evidence approach should be used to demonstrate that emissions within a potential RTA do not contribute significantly to the local ozone nonattainment or to ozone nonattainment downwind. While there is limited monitoring data north and east of Door County (the direction in which wind typically flows in this area of the country), there is one ozone monitor approximately 87 miles downwind (northeast) of the violating monitor in Door County, Wisconsin. This monitor is located on the upper peninsula of the state of Michigan in Schoolcraft County, Michigan. This monitor is not violating the 2015 ozone NAAQS based on fully-certified 2014-2016 data. Since Door County precursor emissions are relatively low, and since the monitor in Schoolcraft County, Michigan is not violating the 2015 ozone standard, there is little evidence to indicate that Door County precursor emissions are significantly contributing to ozone nonattainment downwind.

EPA's 2015 designations guidance indicates that the first step in demonstrating that the $NO_x$ and VOC emissions in a potential RTA do not significantly contribute to ozone in the area itself is the development of a conceptual description of the nature of ozone exceedances in the area. The section above entitled Factor 3: Meteorology, includes a conceptual description of lake breeze meteorology and its potential to influence ozone production and transport to areas along the shoreline of Lake Michigan, like Door County. EPA's 2015 designations guidance states that if the $NO_x$ and VOC inventories for a particular area are appreciably less than those for other areas for which there is evidence demonstrating contribution to ozone nonattainment (i.e. from the ambient and meteorological analyses), this provides support for concluding that the transport component is overwhelming any local ozone production. A simple approach to assessing the potential importance of local emissions is to compile county-level emission inventory estimates for each county potentially along the trajectories that are expected to contribute to ozone in the potential RTA. If the emissions from upwind contributing counties are substantially larger than what is being emitted locally, then this suggests that the impact of the local emissions may not be significant. The EPA analyzed the highest emitting areas that are upwind of Door County as evidenced by the HYSPLIT trajectories presented in Figures 6 and 7. Results of this analysis are presented in Table 6, which shows the precursor emissions from some of the highest emitting counties in Wisconsin that are upwind of Door County and over which the HYSPLIT trajectories to the Door County monitor travel.

**Table 6. Precursor emissions from some of the highest emitting upwind areas relative to Door County, Wisconsin, precursor emissions as reported for 2014.**

| Geographic Area | $NO_x$ (tpy) | VOC (tpy) |
|---|---|---|
| Door County, Wisconsin | 3,066 | 2,439 |
| Brown County, Wisconsin | 12,078 | 7,813 |
| Milwaukee Nonattainment Area (Ozaukee, Washington, Waukesha, Milwaukee, and Racine Counties, WI) | 42,499 | 37,467 |
| Chicago Nonattainment Area Cook, DuPage, Grundy (partial), Kane, Kendall (partial), Lake, McHenry, and Will Counties, IL Lake and Porter Counties, IN Kenosha County, WI (partial) | 274,440 | 206,171 |

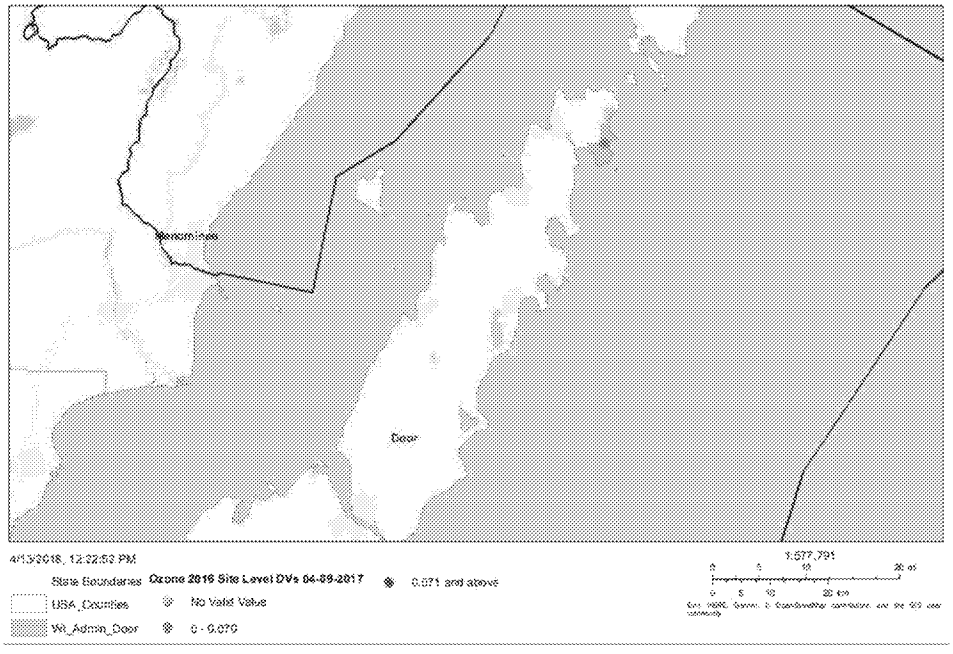
Brown County, which is immediately southwest of Door County, and over which many HYSPLIT trajectories travel prior to reaching the Door County monitor (Figure 6), has relatively high $NO_x$ and VOC emissions (2014 reported $NO_x$ = 12,078 tons, VOC = 7,813 tons). Brown County emissions are four times greater than Door County $NO_x$ emissions and three times greater than Door County VOC emissions. For reference Wisconsin statewide emissions were 228,843 tons of $NO_x$ and 235,708 tons of VOC reported for 2014.

Figure 7 indicates that the HYSPLIT back trajectories to the violating monitor in Door County also travel from as far south as the Milwaukee area and the Chicago area. The five counties that make up the

historical Milwaukee nonattainment area under the 1997 ozone NAAQS that are also included in the ~~intended~~proposed Milwaukee nonattainment area explained earlier in this TSD for the 2015 ozone NAAQS, which include Ozaukee, Washington, Waukesha, Milwaukee, and Racine counties collectively have emissions are 14 times greater than the Door County $NO_x$ emissions and 15 times greater than the Door County VOC emissions. The counties that make up the ~~intended~~proposed Chicago nonattainment area (which is a multi-state nonattainment area covered in a separate TSD) collectively have emissions are approximately 89 times greater than the Door County $NO_x$ emissions and approximately 84 times greater than the Door County VOC emissions. For the reasons discussed above, EPA ~~has~~ determined that the emissions in Door County do not significantly contribute to ozone concentrations in the area itself or to other areas.

Therefore, in light of Wisconsin's April 2017 recommendation for an RTA category for Door and ~~also in light of Wisconsin's April 2017 recommendation that if EPA designates the area as nonattainment due to the violating monitor that EPA minimize the extent of the area included in the nonattainment area boundary, and in light of~~ the above analysis, the EPA ~~intends~~ proposed to designate the northern portion of Door County (north of the Sturgeon Bay canal) as a nonattainment RTA for the 2015 ozone NAAQS.

The above analysis was originally announced in EPA's December 22, 2017, TSD. In this final action, however, EPA is deferring to the state's request and finalizing the nonattainment area shown on the map below, which is an approximately 3.7 square mile area confined within the boundaries of Wisconsin's Newport State Park.


Kewaunee
Door
4/13/2018, 12:22:53 PM
1:577,791
State Boundaries
Ozone 2016 Site Level DVs 04-09-2017
0.071 and above
USA_Counties
No Valid Value
WI_Admin_Door
0 - 0.070