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April 2, 2025

Cheryl Newton
Acting Regional Administrator
U.S. Environmental Protection Agency - Region 5
77 West Jackson Blvd.
Chicago, IL 60604-3507

Subject: Attainment State Implementation Plans (SIPs) for Wisconsin's 2015 Ozone National Ambient Air Quality Standard (NAAQS) Moderate Nonattainment Areas

Dear Ms. Newton:

In accordance with Section 182(c) of the Clean Air Act (CAA), the Wisconsin Department of Natural Resources (WDNR) is submitting three attainment plans as revisions to the Wisconsin SIP (enclosed). These plans fulfill moderate ozone attainment planning requirements prescribed by Sections 172 and 182(b) of the CAA for the Milwaukee, Kenosha, and Sheboygan, Wisconsin, 2015 ozone NAAQS nonattainment areas.

These areas were initially designated by the EPA as nonattainment of the 2015 ozone NAAQS on June 4, 2018. The areas were revised and expanded by EPA on June 14, 2021. On October 7, 2022, the EPA reclassified these areas to moderate ozone nonattainment. Due to this reclassification, the state of Wisconsin is required to develop plans to attain the NAAQS and meet the moderate area attainment planning requirements specified by the CAA.

On December 17, 2024, the EPA further reclassified these areas to serious ozone nonattainment. This reclassification renders moot several "leftover" SIP requirements associated with the previous classification of moderate.[1] As such, the WDNR is requesting that EPA act on all elements of these submittals with the exception of:

- The modeled attainment demonstrations
- Reasonably Available Control Measures (RACM) analyses

In addition, the WDNR requests that the EPA approve the 2017 base year emissions inventories contained in these submittals, as these inventories cover the nonattainment areas as revised by the EPA in 2021.[2] Approval of these inventories will satisfy marginal classification requirements for these areas.

The WDNR has legal authority under ss. 285.11(6), Wis. Stats., to develop a SIP for the prevention, abatement, and control of air pollution. These SIP revisions meet the completeness requirements of 40 CFR § 51, Appendix V. Pursuant to the requirements of 40 CFR § 51.102, the WDNR provided public notice of these submittals and held a public hearing on January 16, 2025. The public comment period concluded on January 17, 2025. A summary of comments received, the WDNR's response to those comments, and documentation of the public notice and hearing process are included in the attached documents.

[1] See the EPA final rule "State Implementation Plan Submittal Deadlines and Implementation Requirements for Reclassified Nonattainment Areas Under the Ozone National Ambient Air Quality Standards" (90 FR 5651, Jan. 17, 2025).
[2] The WDNR submitted base year inventories on August 3, 2021 for these areas as they were initially designated. The inventories contained in the plans being submitted on this date supersede and replace those prior submittals.

These SIPs are being submitted electronically using the EPA's SPeCs system. If you have any questions regarding this submittal, please contact Emma Cleveland at emma.cleveland@wisconsin.gov.

Sincerely,

Signed by:
Gail E. Good
9AA91D46A40C4A3...

4/2/2025 | 8:43 AM CDT

Gail E. Good
Director, Air Management Program

Enclosures (3)

cc: Brianna Denk – AM/7
Emma Cleveland – AM/7
David Bizot – AM/7
Phil Bower – LS/8

# Attainment Plan
# for the
# Sheboygan County, Wisconsin
# 2015 Ozone National Ambient Air Quality Standard
# Moderate Nonattainment Area

## Sheboygan County (Partial)

**Developed By:**
**The Wisconsin Department of Natural Resources**

**April 2025**

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## List of Acronyms

| | |
|---|---|
| AEI | WDNR's air emissions inventory |
| CAA | Clean Air Act |
| CAIR | Clean Air Interstate Rule |
| CART | Classification and regression tree |
| CBL | Convective boundary layer |
| CSAPR | Cross-State Air Pollution Rule |
| CTG | Control techniques guideline |
| EGU | Electric generating unit |
| EPA | U.S. Environmental Protection Agency |
| FID | Facility identification number |
| I/M | Vehicle inspection and maintenance (emissions testing) |
| ICI | Industrial, commercial and institutional emissions sources |
| LADCO | Lake Michigan Air Directors Consortium |
| MOVES | EPA's Motor Vehicle Emission Simulator model |
| MPO | Metropolitan planning organization |
| MVEB | Motor vehicle emissions budget |
| NAAQS | National Ambient Air Quality Standard |
| NAICS | North American Industrial Classification System |
| NEI | National Emissions Inventory |
| NESHAP | National Emission Standards for Hazardous Air Pollutants |
| NOx | Nitrogen oxides (NO and $NO_2$) |
| NNSR | Nonattainment New Source Review (permitting program) |
| ppb | Parts per billion |
| ppm | Parts per million |
| RACM | Reasonably available control measures |
| RACT | Reasonably available control technology |
| RFP | Reasonable further progress |
| RTP | Regional transportation plan |
| SIP | State implementation plan |
| TIP | Transportation improvement program |
| tposd | Tons per ozone season day |
| tposwd | Tons per ozone season weekday |
| VMT | Vehicle miles traveled |
| VOC | Volatile organic compounds |
| WDNR | Wisconsin Department of Natural Resources |
| WDOT | Wisconsin Department of Transportation |

# 1. INTRODUCTION

The Wisconsin Department of Natural Resources (WDNR) has prepared this attainment plan to fulfill the Clean Air Act (CAA) state implementation plan (SIP) requirements for the Sheboygan County, Wisconsin moderate nonattainment area for the 2015 ozone National Ambient Air Quality Standard (NAAQS). This document was developed in accordance with the U.S. Environmental Protection Agency (EPA)'s implementation rule for the 2015 ozone NAAQS (83 FR 62998) and other applicable guidance and requirements. It covers all required moderate-area attainment plan elements for the 2015 ozone NAAQS as they apply to this nonattainment area.

## 1.1. Clean Air Act Requirements

The CAA requires an area not meeting a NAAQS for a specified criteria pollutant to develop or revise its SIP to expeditiously attain and maintain the NAAQS in that nonattainment area. For moderate nonattainment areas, these SIP requirements are:

1) An attainment plan (required under CAA section 182(b)).
2) Reasonably Available Control Technology (RACT) for volatile organic compounds (VOCs) and nitrogen oxides (NOx) (CAA section 182(b)(2)).
3) Reasonably Available Control Measures (RACM) (CAA section 172(c)(1)).
4) Reasonable Further Progress (RFP) reductions in VOC and/or NOx emissions in the area (CAA sections 172(c)(2) and 182(b)(1)).
5) Contingency measures to be implemented in the event of failure to attain the standard (CAA section 172(c)(9)).
6) A vehicle inspection and maintenance (I/M) program, as applicable (CAA section 181(b)(4)).
7) NOx and VOC emission offsets at a ratio of 1.15 to 1 for major source permits (CAA section 182(b)(5)).

This plan addresses the first six of these requirements for the Sheboygan County 2015 ozone NAAQS nonattainment area. Wisconsin has an approved Nonattainment New Source Review (NNSR) permitting program that fulfills the seventh requirement.[1] Where existing state rules implementing these requirements exist, by this submittal the WDNR certifies them as meeting the requirements for Moderate nonattainment areas for this NAAQS.

## 1.2. The Sheboygan County 2015 Ozone NAAQS Nonattainment Area

<u>Nonattainment History</u>

Historically, exceedances of the federal ozone standards have been recorded along the lakeshore of Lake Michigan, including in Sheboygan County. All or parts of Sheboygan County have been designated nonattainment for previous ozone NAAQS, but have subsequently been either redesignated to attainment of, or found to be attaining, each of these standards (Table 1.1).

[1] The EPA approved Wisconsin's NNSR SIP submittal for the 2015 ozone NAAQS on Jan. 19, 2022 (87 FR 2719).

**Table 1.1. Sheboygan County ozone NAAQS nonattainment history.**

| NAAQS | 1979 | 1997 | | 2008 | | 2015 |
|---|---|---|---|---|---|---|
| **Level** | 0.12 ppm | 0.08 ppm | | 0.075 ppm | | 0.070 ppm |
| **Averaging Period** | 1 hour | 8 hour | | 8 hour | | 8 hour |
| **Nonattainment Area** | Sheboygan County | Inland Sheboygan County[a] | Shoreline Sheboygan County[a] | Inland Sheboygan County[a] | Shoreline Sheboygan County[a] | Sheboygan County (partial)[c] |
| **Most Recent Classification** | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate |
| **Redesignated to Attainment** | 8/26/1996 (61 FR 43668) | NAAQS revoked[b] | NAAQS revoked[b] | 7/10/2020 (85 FR 41400) | 7/10/2020 (85 FR 41405) | TBD |

[a] The EPA originally designated all of Sheboygan County as nonattainment for both the 1997 and 2008 ozone NAAQS. The EPA split the county into two separate nonattainment areas on July 15, 2019 (84 FR 33699).
[b] EPA finalized a determination of attainment for the Sheboygan County 1997 ozone NAAQS nonattainment area on Mar. 1, 2011 (76 FR 11080). However, the area was not officially redesignated to attainment before the NAAQS was revoked in 2015.
[c] Area is geographically identical to the 1997 and 2008 ozone NAAQS Shoreline Sheboygan County areas.

## 2015 Ozone NAAQS

In October 2015, the EPA finalized a revision to the 8-hour ozone NAAQS (80 FR 65291). The 2015 ozone NAAQS (0.070 parts per million; ppm) is more stringent than the previous 2008 ozone NAAQS (0.075 ppm). On June 4, 2018, the EPA published a final rulemaking that designated part of Sheboygan County as marginal nonattainment for the 2015 ozone NAAQS (83 FR 25776).

On June 14, 2021, in response to a July 10, 2020, decision by the D.C. Circuit Court, the EPA published a final rule revising the 2015 ozone NAAQS designations for 13 counties, including Sheboygan County (86 FR 31438). As part of this action, the EPA revised and expanded the Sheboygan County nonattainment area.[2] This revised designation was effective July 14, 2021. This area retained the marginal classification and attainment date of August 3, 2021 of the original nonattainment area.

Since the Sheboygan County nonattainment area did not attain the 2015 ozone NAAQS by its marginal area deadline, on October 7, 2022 the EPA reclassified the area from marginal to moderate nonattainment and set a new attainment date of August 3, 2024 (87 FR 60897). The WDNR has developed this submittal to fulfill moderate attainment planning requirements for this area as required by Sections 172(c) and 182(c)(2) of the CAA.

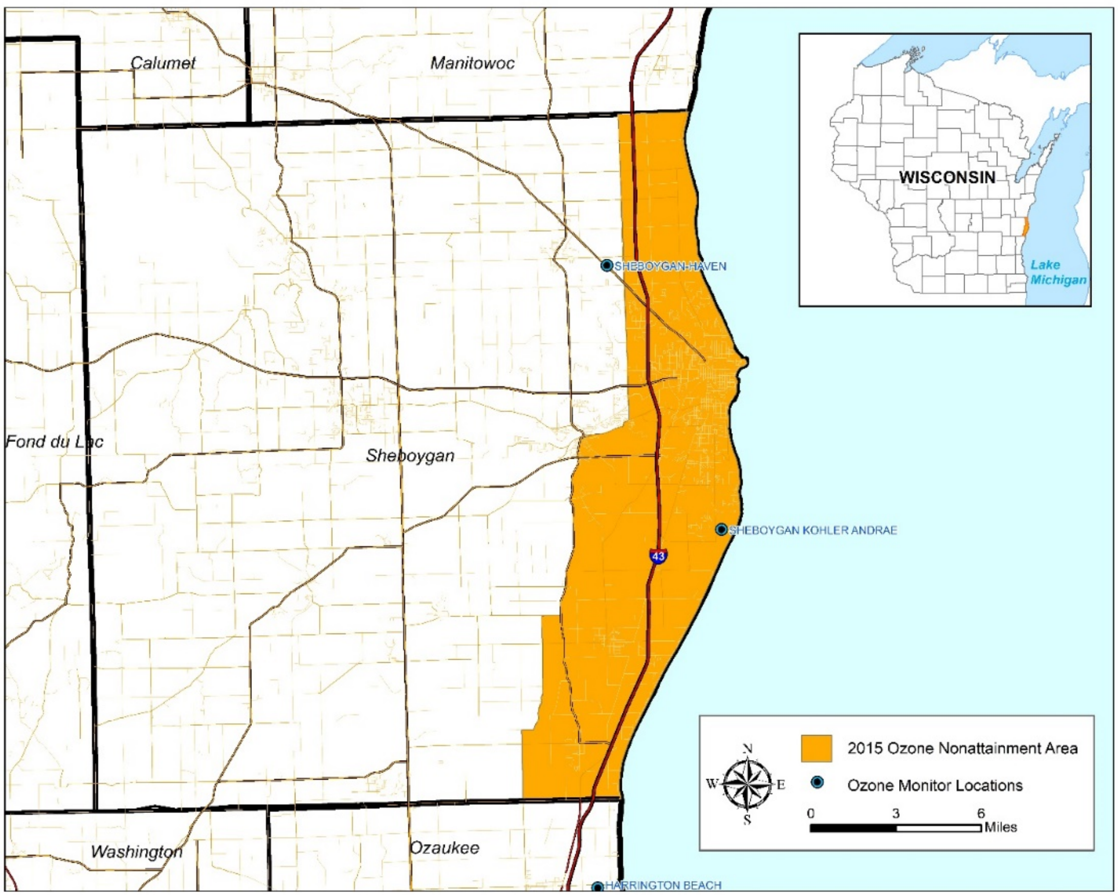
[2] The expanded area is geographically identical to the 1997 and 2008 ozone NAAQS Shoreline Sheboygan County areas. As such, it is occasionally referred to as the 2015 "Shoreline Sheboygan County" area, although that is not its official EPA designation.

## Description of the Nonattainment Area

The Sheboygan County 2015 ozone NAAQS nonattainment area consists of the portion of the county extending approximately two to three miles inland from the Lake Michigan shoreline. The nonattainment area includes the roadways that separate the nonattainment area from the rest of Sheboygan County (Figure 1.1).[3]

The Sheboygan County 2015 ozone NAAQS nonattainment area constitutes about 12 percent of the county's total land area. Sheboygan County's population was 118,034 in 2020 and was projected to decrease by 0.2 percent between 2020 and 2023.[4] Almost half of the residents live in the largest city, Sheboygan, which is located within the nonattainment area.

**Figure 1.1. Map of the Sheboygan County, Wisconsin, 2015 ozone NAAQS nonattainment area, with locations of ozone monitors shown.**




[3] The western boundary of the nonattainment area is formed by the following roadways (from north to south): 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.

[4] https://www.census.gov/quickfacts/fact/table/sheboygancountywisconsin,wi,US/PST120217.

### 1.3. Overview of this Attainment Plan

The remainder of this attainment plan SIP submittal is structured as follows:

Section 2 provides the conceptual model for ozone formation in the Lake Michigan region, including the nonattainment area. This section describes how synoptic-scale and mesoscale meteorology combine to create high ozone along the Wisconsin lakeshore under certain conditions, which complicates state efforts to address nonattainment.

Section 3 presents base and future year inventories for the nonattainment area and describes how these inventories show that the state has met its requirements for reasonable future progress. This section also describes how permanent and enforceable emissions reduction measures have reduced ozone precursor emissions.

Section 4 summarizes the attainment modeling that was completed in support of this plan, as required by the CAA.

Section 5 presents air quality information and weight of evidence support. This includes analysis of trends in ozone and ozone precursor emissions, as well as meteorologically adjusted trends in ozone concentrations. This section also demonstrates the important roles that transport, meteorology and chemistry play in determining ozone concentrations in the nonattainment area.

Section 6 describes how the state has addressed all other moderate nonattainment area SIP requirements. These requirements include transportation conformity, RACT programs for NOx and VOCs, RACM, a vehicle I/M program, and contingency measures.

Section 7 describes how the WDNR complied with the applicable public participation requirements.

Section 8 summarizes the conclusions of this submittal.

Collectively, this plan contains or otherwise addresses all moderate-area requirements required under the Clean Air Act for this nonattainment area.

# 2. OZONE DYNAMICS ALONG THE WISCONSIN LAKESHORE

## 2.1. Introduction

While ozone concentrations in the region have decreased dramatically due to implementation of an array of measures controlling emissions of ozone precursors, many states around Lake Michigan have areas that are in nonattainment of the 2015 ozone NAAQS. This discussion describes the complex dynamics that cause elevated ozone concentrations in the upper Midwest. These dynamics have been extensively studied for over three decades and are well documented.[5]

Wisconsin's lakeshore monitors most frequently measure ozone concentrations exceeding the ozone NAAQS from late May through early August. Ozone concentrations peak in the late spring and early summer because of the abundance of sunlight and heat, both of which drive ozone formation. In addition, strong land-lake temperature gradients in late spring and early summer drive lake breeze circulations, which contribute to high ozone concentrations, as discussed below.

The region's persistent ozone problems have been shown to be due to the unique meteorology of the Lake Michigan area. This meteorology causes transport of significant amounts of ozone and emissions of ozone precursors from upwind sources to lakeshore counties in Wisconsin and neighboring states. Two types of meteorological patterns have been shown to affect ozone concentrations in the region:

1) Synoptic scale meteorology[6] transports high concentrations of ozone and ozone precursors northward from source regions to the south and southeast.

2) Mesoscale meteorology[6] (via land-lake breeze circulation patterns) carries precursors over the lake, where they react to form ozone. Winds then shift to move the high ozone air onshore.

## 2.2. The Role of Synoptic-Scale Meteorology on High Ozone Days

Research has shown that high pressure systems can generate meteorological conditions favorable to elevated ozone as they move through the region from west to east during late May - early September. These systems are typified by hazy, sunny skies with generally weak, clockwise-rotating winds and relatively shallow mixing such that pollution concentrations are not diluted by mixing. These weather conditions contribute to the buildup of considerable amounts of ozone precursors and facilitate formation of ozone via photochemical reactions.

The location of surface high pressure systems is an important driver of ozone transport into the region. Research has shown that ozone episodes are generally associated with high pressure systems over the eastern U.S. that transport pollutants and precursors from the south and east

[5] This discussion uses some historical data to illustrate the science being described; however, the findings discussed in this section all still apply, as they have been extensively studied and documented over several decades.
[6] Synoptic-scale meteorology refers to weather features of 24-48 hours' duration, whereas mesoscale meteorology refers to weather patterns of shorter duration.

into the region.[7,8] One study estimated that 50% of Wisconsin's ozone exceedance days during 1980-1988 under the 1-hour ozone NAAQS occurred when the center of a high pressure system was situated southeast of the area (i.e., Ohio and east thereof).[9] Under these circumstances, high ozone concentrations in the Lake Michigan region may result when polluted air from high emissions regions such as the Ohio River Valley is transported northward along the western side of a high pressure system.[10] In addition, while emissions from the heavily industrialized Chicago and Milwaukee areas have decreased dramatically in recent decades, sources in these large metropolitan areas still generate significant ozone precursor emissions. Pollution from sources in these areas can add to the pool of pollution transported into the region.[7]

Figure 2.1 shows the synoptic scale weather pattern for one such episode, along with the resulting patterns in ozone concentrations. On this day, a high pressure system was located to the southeast, centered over Virginia. Southeasterly to southerly winds on the western side of this system carried pollutants from the Ohio River Valley to Lake Michigan. This episode shows a common pattern for ozone distributions on episode days: ozone concentrations were lowest in the regions with the highest emissions (in central Chicago and extending into northwestern Indiana) and the highest in rural coastal areas far downwind. During such classic transport episodes, peak ozone concentrations move northward over the course of the day. For example, on the day shown in Figure 2.2, ozone peaked at Wisconsin's southern Chiwaukee Prairie monitor between 11 a.m. and 1 p.m., at the Kohler Andrae monitor midway up the coast between 2 p.m. and 4 p.m., and at the northern Newport monitor between 4 p.m. and 6 p.m.

### 2.3. The Role of Mesoscale Meteorology on High Ozone Days

The synoptic meteorological conditions often work in combination with unique lake-induced mesoscale meteorological features to produce the highest ozone concentrations in this region. Wisconsin's ozone nonattainment areas are located along Lake Michigan. With a surface area of approximately 22,400 square miles, Lake Michigan acts as a huge heat sink during the warm months. Figure 2.2 highlights the considerable difference between the over-land air temperatures (measured at Racine, Wisconsin) and over-water air temperatures (measured at a buoy in southern Lake Michigan) during a 5-day ozone episode in June 2002. The strong daytime temperature contrast between the warm land and cold lake can lead to the formation of a thermally driven circulation cell called the lake breeze, which runs approximately perpendicular to the Lake Michigan shoreline (Figure 2.3). As this figure shows, the lake breeze is generally preceded by an early morning land breeze, driven by relatively warm temperatures over the lake. The land breeze can carry ozone precursors emitted from urban areas, primarily Chicago, out over the lake, where they can react to form ozone. The onshore flow of the lake breeze

[7] Dye, T.S., P.T. Roberts, and M.E. Korc, 1995: Observations of transport processes for ozone and ozone precursors during the 1991 Lake Michigan Ozone Study. J. App. Meteor, 34: 1877-1889.
[8] Hanna, S.R., and J.C. Chang, 1995: Relations between meteorology and ozone in the Lake Michigan region. J. Applied Meteorology, 34: 670-678.
[9] Haney, J.L., S.G. Douglas, L.R. Chinkin, D.R. Souten, C.S. Burton, and P.T. Roberts, 1989: Ozone Air Quality Scoping Study for the Lower Lake Michigan Air Quality Region, SAI report #SYSAPP-89/101, prepared for the EPA, August, 197 pp.
[10] For example, Ragland, K. and P. Samson, 1977: Ozone and visibility reduction in the Midwest: evidence for large-scale transport. J. Applied Meteorology, 16: 1101–1106.

circulation then transports elevated ozone from over the lake onshore into southeastern Wisconsin.

**Figure 2.1. Surface synoptic weather map for 6 a.m. CST (left) and MDA8 ozone concentrations (right) for the Lake Michigan region for June 19, 2016.**

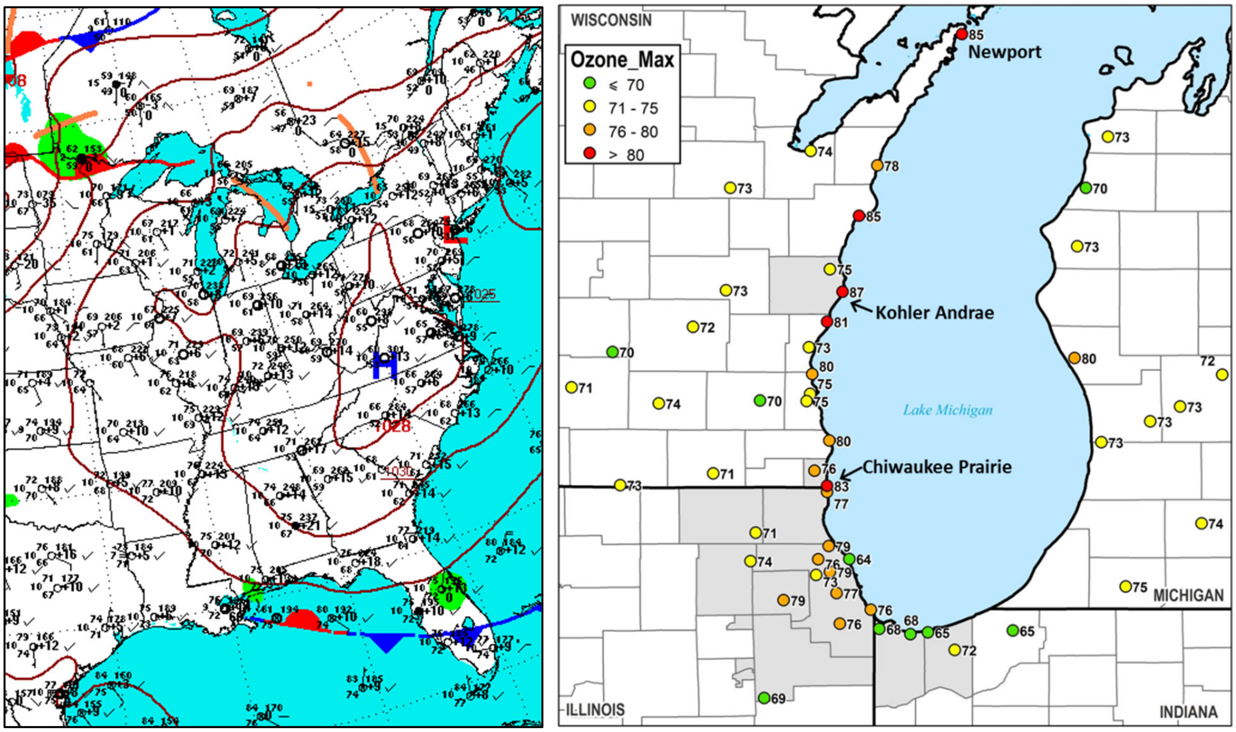



**Figure 2.2. Hourly surface air temperatures at Racine, WI and the South Lake Michigan Buoy during June 20-25, 2002.**

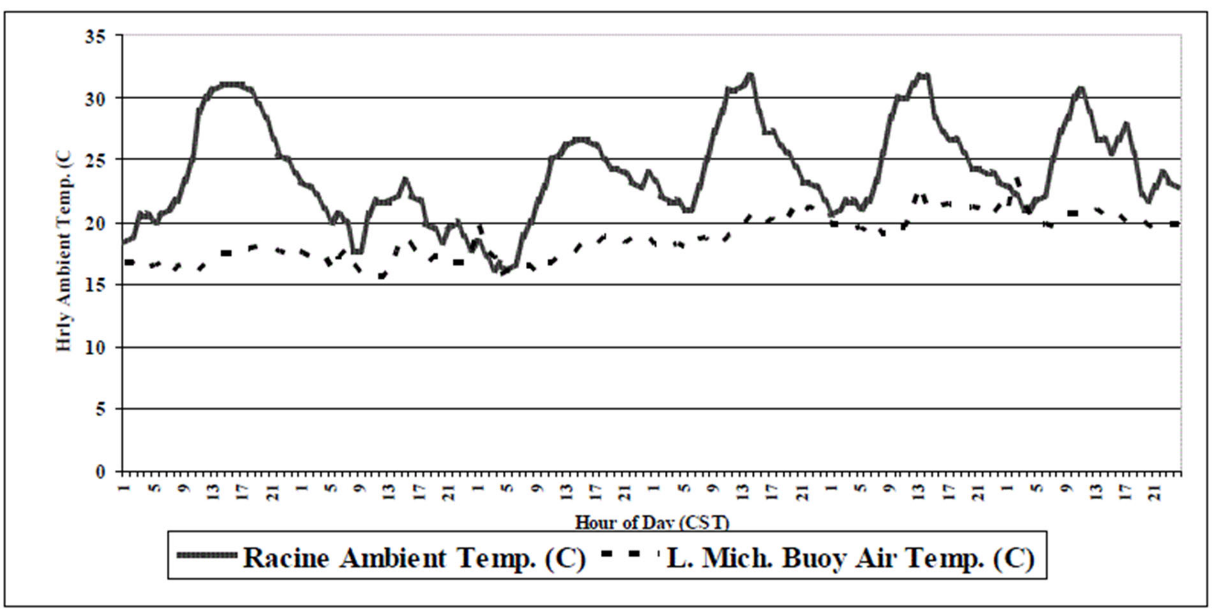
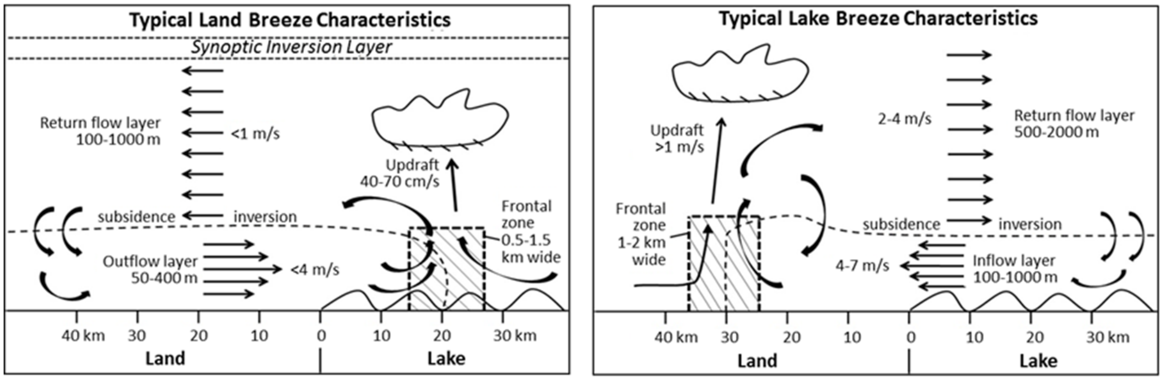


**Figure 2.3. Diagrams of the early morning land breeze (left) and late morning/afternoon lake breeze circulations (right) responsible for enhanced ozone production along the Lake Michigan shoreline.** Modified from Foley et al., 2011.[11]




## 2.4. Conceptual Model for Ozone Formation in the Lake Michigan Region

Synoptic and mesoscale meteorological patterns together drive ozone formation in the region, as described in a conceptual model in Dye et al. (1995).[7] Dye et al. (1995) described this model with the following series of inter-related steps. This discussion focuses on the conditions impacting Wisconsin's shoreline:

1) A shallow but stable conduction inversion exists just above the relatively cold lake surface. During the early morning hours the land breeze and general offshore flow (i.e., southerly to west-southwesterly winds) transport ozone and fresh precursor emissions into the stable air in the conduction layer over Lake Michigan. A primary source region is the Chicago area, located at the southern edge of the lake.

2) By midmorning a sharp horizontal temperature gradient forms along the shoreline between the cold lake air and the increasingly warmer air over the land. This gradient effectively "cuts off" air in the conduction layer from additional injections of shore-emitted precursors. Strong stability in the conduction layer limits dispersion, creating high concentrations of ozone precursors, which can react in this layer.

3) By midmorning, the developing convective boundary layer (CBL) grows and the resulting convection mixes ozone vertically, where it combines with ozone transported from sources outside the region. Ozone concentrations in this air are lower due to the dilutive effects of convective mixing. As this air is transported lakeward, it is forced to flow up and over the conduction layer.

4) The ozone-rich air in both layers is transported northward over Lake Michigan by the prevailing winds. When a lake breeze is present, it produces southerly to south-

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

southeasterly winds along the western shore of Lake Michigan. This wind pattern transports the ozone originating from sources in the south to downwind receptor regions in eastern Wisconsin. On occasion, areas north of Ozaukee County experience elevated ozone levels as a southerly wind intercepts the shoreline where it extends into Lake Michigan.

5) When the ozone-laden air flows onshore in the downwind receptor regions, air with the highest ozone concentrations, located in the lowest 300 m, mixes down to the surface first. This causes the highest ozone concentrations to be found along the shoreline. Eventually, air from higher altitudes mixes down to the surface further inland, but ozone concentrations in this air are lower. This air mass is the remnant of the ozone-diluted CBL air that flowed up and over the conduction layer during the mid-morning hours.

This complex meteorology leads to the high ozone concentrations and persistent nonattainment issues faced by the counties along the Lake Michigan shoreline. The impact of this meteorology on the transport of ozone, NOx, and VOCs to the Sheboygan County area is discussed in more detail in Section 5.

# 3. EMISSIONS INVENTORIES AND DEMONSTRATION OF REASONABLE FURTHER PROGRESS

## 3.1. Introduction

Sections 172(c)(2) and 182(b)(1) of the CAA require states with ozone nonattainment areas classified as moderate or higher to submit plans that show reasonable further progress (RFP) towards attaining the NAAQS. The EPA's SIP requirements rule for the 2015 ozone NAAQS defines RFP for moderate nonattainment areas as a demonstration that there has been at least a 15% emission reduction between the base year (2017) and the attainment year (2023).[12] Because the Sheboygan County nonattainment area has a previously approved 15% VOC rate of progress (ROP) plan (61 FR 11735), the 15% reduction requirement for the 2015 NAAQS can be satisfied with any combination of NOx and VOC reductions. These reductions may come from any SIP-approved or federally promulgated measures implemented after the base year.

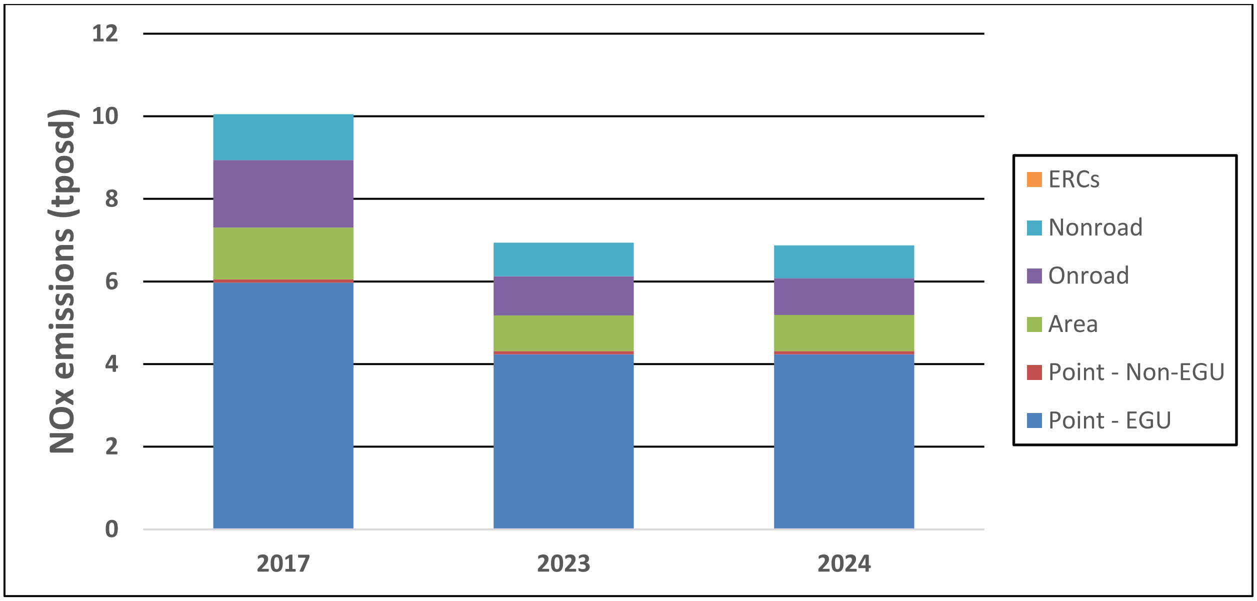
Table 3.1 and Figure 3.1 provide a summary of the emission inventories for NOx and VOCs for the Sheboygan County 2015 ozone NAAQS nonattainment area. Sections 3.2 and 3.3 present the emission inventories by emissions sector (i.e., point, area, onroad and nonroad) for this area for the base and projected years. These sections also include the supporting methodology used to develop the inventories. Sections 3.4 and 3.5 describe how the state has met its RFP and contingency emissions reduction requirements for the nonattainment area. Section 3.6 covers the enforceable control measures that led to the reductions in NOx and VOC emissions.

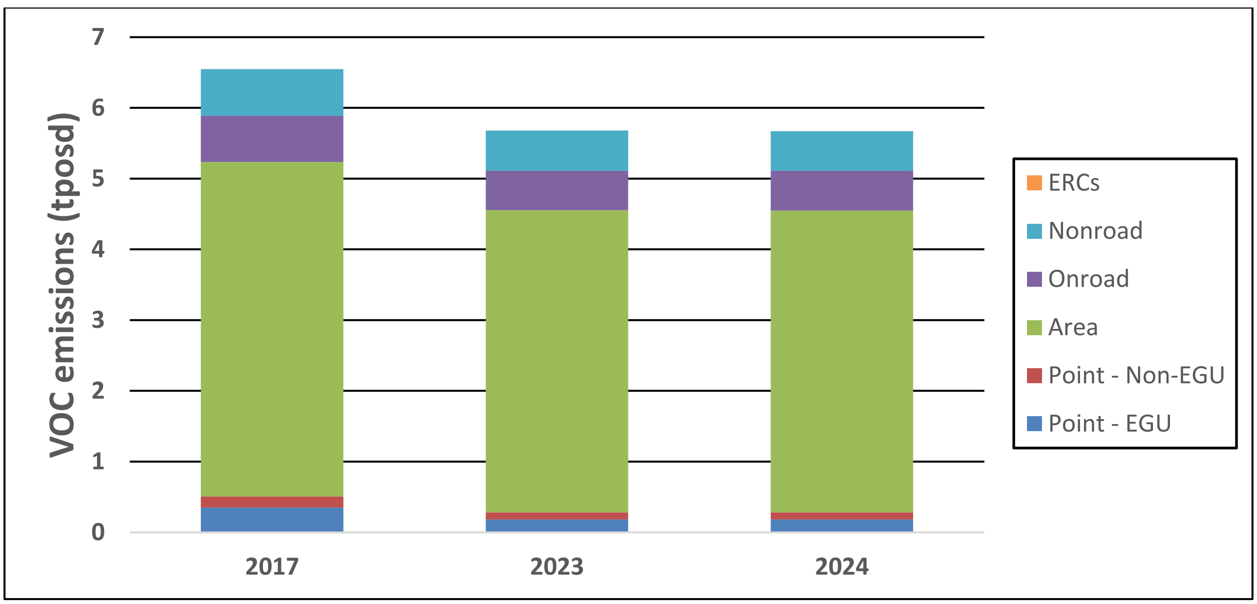
**Table 3.1. Summary of Sheboygan County nonattainment area NOx and VOC emissions, 2017-2024.** Figures in tons per ozone season day.

| Pollutant | 2017 | 2023 | 2024 |
|---|---|---|---|
| NOx | 10.05 | 6.94 | 6.87 |
| VOC | 6.55 | 5.68 | 5.67 |
| **Total** | **16.60** | **12.62** | **12.55** |

[12] EPA Final Rule: Implementation of the 2015 National Ambient Air Quality Standard for Ozone: Nonattainment Area State Implementation Plan Requirements (December 6, 2018; 83 FR 62998).

**Figure 3.1. Sheboygan County nonattainment area NOx and VOC emissions by source type.**



### 3.2. 2017 Base Year Inventory

The base year (2017) portion of the RFP requirement is a compilation of all anthropogenic sources of NOx and VOCs for an average ozone season day in 2017, incorporating all control programs in place at that time. The WDNR followed the EPA's requirements and guidance to prepare a comprehensive statewide emission inventory of NOx and VOC emissions for 2017. Appendix 1 includes a discussion of the methodology used to estimate sector-specific emissions for 2017 (shown in Table 3.2).

**Table 3.2. Sheboygan County nonattainment area NOx and VOC emissions for base year 2017.** Figures in tons per ozone season day.

| Pollutant | Point EGU | Point Non-EGU | Area | Onroad | Nonroad | ERCs | Total |
|---|---|---|---|---|---|---|---|
| **NOx** | 5.97 | 0.08 | 1.25 | 1.64 | 1.11 | - | **10.05** |
| **VOC** | 0.35 | 0.16 | 4.73 | 0.65 | 0.66 | - | **6.55** |

### 3.3. 2023 & 2024 Projected Inventories

The WDNR developed emissions information to satisfy requirements to submit an attainment year (2023) inventory for NOx and VOCs. Appendix 2 includes information on sector-specific emissions projection methodology. The same approaches were used to project emissions for 2024, which was used to assess attainment contingency requirements. Tables 3.3 and 3.4 show the projected NOx and VOC emissions (in tposd) in 2023 and 2024 by sector.

**Table 3.3. Sheboygan County nonattainment area NOx and VOC emissions for attainment year 2023.** Figures in tons per ozone season day.

| Pollutant | Point EGU | Point Non-EGU | Area | Onroad | Nonroad | ERCs | Total |
|---|---|---|---|---|---|---|---|
| **NOx** | 4.24 | 0.08 | 0.86 | 0.95 | 0.81 | - | **6.94** |
| **VOC** | 0.18 | 0.10 | 4.27 | 0.56 | 0.57 | - | **5.68** |

**Table 3.4. Sheboygan County nonattainment area NOx and VOC emissions for contingency year 2024.** Figures in tons per ozone season day.

| Pollutant | Point EGU | Point Non-EGU | Area | Onroad | Nonroad | ERCs | Total |
|---|---|---|---|---|---|---|---|
| **NOx** | 4.24 | 0.08 | 0.87 | 0.89 | 0.79 | - | **6.87** |
| **VOC** | 0.18 | 0.10 | 4.27 | 0.56 | 0.56 | - | **5.67** |

### 3.4. Demonstration of Reasonable Further Progress

Because Sheboygan County already met the 15% VOC rate of progress requirement when addressing a prior ozone NAAQS, the required 15% RFP reduction for this plan can come from any combination of NOx and VOC reductions occurring between 2017 and 2023.

Table 3.5 compares actual emissions from 2017 to emission estimates for the attainment year (2023) for the Sheboygan County 2015 ozone NAAQS nonattainment area. As shown in the table, NOx emissions are projected to decrease by 31% and VOC emissions are projected to decrease by 13%. The combined reductions exceed 15%, thereby satisfying RFP requirements for this area (line G).

**Table 3.5. Demonstration of 15% RFP requirement and contingency measure reductions.** Figures in tons per ozone season day.

| Step | Description | Formula | NOx | VOC |
|---|---|---|---|---|
| A | 2017 base year inventory | | 10.05 | 6.55 |
| B | RFP reductions totaling 15% | | 12% | 3% |
| C | Emissions reductions required between base and attainment year | A * B | 1.21 | 0.20 |
| D | RFP target level of 2023 | A - C | 8.84 | 6.35 |
| E | 2023 projected emissions | | 6.94 | 5.68 |
| F | Percentage reduction from 2017 | | 31% | 13% |
| G | Compare RFP target with projected 2023 emissions. Are RFP requirements met? | E < or = D? | Yes | Yes |
| H | Contingency percentage (3% of base year VOCs) | | | 3% |
| I | Contingency reduction amount | A * H | 0.20 | |
| J | 2024 projected emissions | | 6.87 | 5.67 |
| K | Emissions reductions between 2023 and 2024 | E - J | 0.07 | 0.01 |
| L | Combined NOx+VOC reductions between 2023 and 2024 | Total of K | 0.08 | |
| M | Compare contingency measures target with projected 2024 emissions. Is contingency measure target met? | L > or = I? | No | No |

### 3.5. Demonstration of Contingency Reduction

The state must also include contingency measures representing one year of emissions reduction progress, equivalent to 3% of base year VOC emissions. As with RFP, contingency measure reductions can come from any combination of NOx and VOC emissions. These measures must be implemented within one year of an area failing to attain the NAAQS by its attainment date (in this case, 2024). This requirement is discussed further in Section 6.7.

Tables 3.5 shows that, from 2023 to 2024, NOx emissions are projected to decrease an additional 1%, while VOC emissions decrease less than 1%. Overall, NOx and VOC emissions are expected to decrease by a less than 1% combined from 2023 to 2024. While this figure is less than the 3% recommended by the EPA, given the extraordinarily low amount of total emissions from all sources in this area (under 13 tons per day), this small additional reduction is reasonable and expected.

Further, these contingency emission reductions are due to permanent and enforceable control measures enacted within the nonattainment area on point, area, and mobile source NOx and VOC emissions described in detail in Section 3.6, below.

### 3.6. Control Strategies for Ozone Precursor Emissions

This section documents the permanent and enforceable control measures that reduced NOx and VOC emissions in the Sheboygan County 2015 ozone NAAQS nonattainment area. Many of the control measures have been implemented under programs that began before 2017.[13] These measures will continue to contribute to emissions reductions that will support attainment of the NAAQS in this area. However, this discussion highlights those control measures and emission reductions that have occurred since 2017. Other federal control programs reducing emissions in both the larger nonattainment area and transport regions are also discussed.

#### 3.6.1. Point Source Control Measures

<u>NOx Reasonably Available Control Measures (RACM) and Reasonably Available Control Technology (RACT)</u>

Wisconsin implemented RACM for NOx sources in the state's nonattainment areas for the 1997 ozone NAAQS. This area included the Sheboygan County 2015 ozone NAAQS nonattainment area. The NOx RACM requirements are codified under ss. NR 428.01 to 428.12, Wis. Adm. Code, and apply to new and existing NOx emissions units located in southeastern Wisconsin. Section NR 428.04, Wis. Adm. Code, lists NOx performance standards for the NOx emissions units that are constructed or modified after February 1, 2001, and have design capacities greater than the capacity thresholds listed in this provision. Section NR 428.05 includes NOx performance standards for NOx emissions units constructed on or before February 1, 2001, that exceed the provision's capacity threshold. All emissions units subject to this section are required

[13] Section 5.3 shows emission trends extending back to 2002, with reductions over that period due in part to these control measures.

to install continuous emissions monitoring equipment to demonstrate compliance with the NOx emissions limit specified in this rule.

Wisconsin has also implemented RACT for major NOx sources in nonattainment areas in southeastern Wisconsin to meet requirements for the 1997 ozone NAAQS. This area is inclusive of the Sheboygan County 2015 ozone NAAQS nonattainment area. Section 6.2 includes details about Wisconsin's NOx RACT program.

In 2023 there were 536 tons of NOx from EGUs, and 158 tons of NOx from other (non-EGU) emission units in the Sheboygan County 2015 ozone NAAQS nonattainment area (Table 3.7). Annual point source NOx emissions have decreased in the nonattainment area by 85% since 2008 and 60% since 2017. These reductions are the result of abovementioned NOx RACT and RACM programs, as well as federal emissions standards (e.g., new source performance standards), consent decrees, and NNSR permitting.

**Table 3.7. NOx emissions and requirements for point sources in the Sheboygan County nonattainment area, 2008-2023**

<table>
<tr><th>Facility</th><th>Emissions/ Number of Units</th><th>2008</th><th>2017</th><th>2023</th><th>Change 2017 – 2023</th><th>Permanent and Enforceable Control Measures</th></tr>
<tr><td>Alliant – Edgewater: Boilers B23, B24 and B25</td><td>Annual NOx Emissions (TPY)</td><td>4,503</td><td>1,571</td><td>536</td><td>-66%</td><td>Boiler B23: retired in 2015<br>Boiler B24: retired in 2018<br>Boiler B25: 0.07 lb/mmBTU (May 2013)</td></tr>
<tr><td rowspan="2">Other NOx Emissions Units</td><td>Annual NOx Emissions (TPY)</td><td>167</td><td>161</td><td>158</td><td>-2%</td><td rowspan="2">-NOx RACM<br>-Emissions units become subject to NOx RACT if facilities exceed major source threshold</td></tr>
<tr><td>Number of Units</td><td>93</td><td>90</td><td>80</td><td>-</td></tr>
<tr><td>Total NOx Emissions (TPY)</td><td></td><td>4,670</td><td>1,731</td><td>694</td><td>-60%</td><td></td></tr>
</table>

<u>Federal NOx Transport Rules</u>

EGUs in 23 states east of the Mississippi, including Wisconsin, have been subject to a series of federal ozone transport rules since 2009. These rules have included the Clean Air Interstate Rule, the Cross State Air Pollution Rule (CSAPR), the CSAPR Update Rule and the Revised CSAPR Update Rule. These rules have reduced NOx emissions in and around the Sheboygan County 2015 ozone NAAQS nonattainment area.

Beginning January 1, 2009, EGUs in 22 states (including Wisconsin) became subject to ozone season NOx emission budgets under CAIR. CAIR addressed CAA transport requirements for the 1997 ozone NAAQS. For the three states contributing most to the Sheboygan County 2015 ozone NAAQS nonattainment area ozone concentrations (Illinois, Indiana, and Wisconsin), CAIR resulted in a 35% reduction of total EGU NOx emissions across the three states during the ozone season over the 2009-2014 period (Table 3.8).

Starting with the 2015 ozone season, CSAPR replaced CAIR to reduce interstate NOx transport relative to the 1997 ozone NAAQS. CSAPR implemented NOx budgets for the impacted states in two phases. Phase I limited NOx emissions in 2015 and 2016.

The EPA published the CSAPR Update (81 FR 74504) in 2016 to address NOx transport affecting the attainment and maintenance of the 2008 ozone NAAQS (79 FR 16436). The CSAPR Update established Phase II NOx budgets starting with the 2017 ozone season. On April 30, 2021, the EPA promulgated the Revised CSAPR Update rule in order to fully address 21 states' outstanding interstate pollution transport obligations for the 2008 ozone NAAQS (86 FR23054). This rule further reduced EGU NOx emissions in 12 states starting in the 2021 ozone season. For the three-state area of Illinois, Indiana, and Wisconsin, these CSAPR rules (CSAPR, CSAPR Update and Revised CSAPR Update) resulted in a 39% reduction of total EGU NOx emissions across the three states during the ozone season over the 2014-2017 period, and a 54% reduction over the 2017-2023 period (Table 3.8).

On June 5, 2023, the EPA published the Good Neighbor Plan (GNP) to address 23 states' interstate pollution transport obligations for the 2015 ozone NAAQS (88 FR 36654). On February 16, 2024, the EPA proposed a supplemental rule to address transport requirements for an additional five states (89 FR 12703). These rules are intended to reduce EGU NOx emissions in starting in the 2023 ozone season and reduce non-EGU NOx emissions in many states starting in the 2026 ozone season. Implementation of the GNP is currently stayed and no emissions reductions from any EPA transport rule for the 2015 NAAQS are reflected in this attainment plan.

**Table 3.8. EGU NOx emissions under the CAIR and CSAPR programs in Illinois, Indiana, and Wisconsin.**

| State | Ozone Season NOx Emissions (Tons) | | | | Percent Reduction | | |
|---|---|---|---|---|---|---|---|
| | 2008 | 2014 | 2017 | 2023 | 2008-2014 | 2014-2017 | 2017-2023 |
| Illinois | 31,106 | 18,489 | 13,039 | 5,365 | 41% | 29% | 59% |
| Indiana | 53,016 | 40,247 | 20,396 | 8,694 | 24% | 49% | 57% |
| Wisconsin | 19,951 | 9,087 | 8,103 | 5,198 | 55% | 11% | 36% |
| **Total** | **104,073** | **67,823** | **41,538** | **19,257** | **35%** | **39%** | **54%** |

Source: EPA Clean Air Markets Program Data (CAMPD), database of reported emissions, for 2008-2023 ozone season emissions.

Point Source VOC Control Measures

In 2023, non-combustion processes accounted for the majority (79%) of total VOC emissions in the Sheboygan County 2015 ozone NAAQS nonattainment area (Table 3.9). Examples of non-combustion processes include printing, coating, painting, and storage tank emissions.

Combustion processes related to boilers, process heaters, and reciprocating engines, accounted for the remaining 21% of the area's VOC emissions in 2023.

Sources of VOC emissions in the Sheboygan County 2015 ozone NAAQS nonattainment area are subject to source-specific NESHAP requirements and/or VOC RACT rules, as applicable.[14]

**Table 3.9. Process-level VOC emissions from the Sheboygan County nonattainment area in 2023.**

| | Combustion Processes | Non-Combustion Processes | Total |
|---|---|---|---|
| Tons (2023) | 50 | 192 | 242 |
| Percent of total | 21% | 79% | - |

VOC RACT Rules

Non-combustion activities or processes in the Sheboygan County 2015 ozone NAAQS nonattainment area are subject to Wisconsin VOC RACT rules. Section 6.3 includes details about VOC RACT program implementation in this nonattainment area.

Federal NESHAP Rules

Several federal NESHAP rules have been implemented to control hazardous pollutants. These rules include requirements to control hazardous organic pollutants through ensuring complete combustion of fuels or implementing requirements for emissions of total hydrocarbons. Under either approach, the rules act to reduce total VOC emitted by the affected sources. These NESHAP rules apply to both major and area source facilities. Major sources are those facilities emitting more than 10 tons per year of a single hazardous air pollutant or more than 25 tons per year of all hazardous air pollutants in total. Area sources are those facilities that emit less than the major source thresholds for hazardous air pollutants.

NESHAP requirements apply to sources within the Sheboygan County 2015 ozone NAAQS nonattainment area but also apply nationally, thereby reducing the transport of VOC emissions into the nonattainment area. The NESHAP rules that may have contributed to reductions in point source VOC emissions include:

- *Major Source ICI Boiler and Process Heater NESHAP* – On March 21, 2011, the EPA promulgated the "National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters" under part 63 subpart DDDDD. This NESHAP requires all boilers and process heaters, including natural gas fired units, at major source facilities to perform an initial energy

[14] Non-combustion and combustion processes are subject to either major source or area source NESHAP emission requirements based on size thresholds. The applicability of requirements and exemptions for each process has not been determined for purposes of this assessment. Natural gas-fired boilers and processes at area sources are not subject to NESHAP requirements.

assessment and perform periodic tune-ups by January 31, 2016. This action is intended to ensure complete combustion.

- *Area Source (non-major point sources) ICI Boiler and Process Heater NESHAP* – On March 21, 2011, the EPA promulgated the "National Emission Standards for Hazardous Air Pollutants for Area Sources: Industrial, Commercial, and Institutional Boilers" under part 63 subpart JJJJJJ. This NESHAP requires solid fuel and oil fuel fired boilers operated by sources that are below the major source threshold to begin periodic combustion tuning by March 21, 2014.

- *Internal Combustion Engine Rules* – The EPA has promulgated three rules which limit the total amount of hydrocarbon emissions from internal combustion engines - the "National Emission Standards for Hazardous Pollutants for Reciprocating Internal Combustion Engines" (RICE MACT) was promulgated on June 15, 2004 under Part 63, subpart ZZZZ and revised in January 2008 and March 2010, with the two revisions impacting additional RICE units; the "Standards of Performance for Stationary Spark Ignition Internal Combustion Engines" promulgated on January 18, 2008 under Part 60, subpart JJJJ; and "Standards of Performance for Stationary Compression Ignition Internal Combustion Engines promulgated on July 11, 2006 under Part 60, subpart IIII. These rules implement hydrocarbon emission limitations prior to and after 2011 based on compliance dates. These rules also act to continuously reduce emissions as existing stationary engines are replaced by new, cleaner-burning engines.

### 3.6.2. Area Source Control Measures

As noted for point sources, Wisconsin has implemented VOC RACT rules under chs. NR 420 through 423, Wis. Adm. Code, that are aligned with the EPA's CTGs. Wisconsin has also adopted VOC limits for source categories not covered by CTGs throughout chs. NR 419 through 424, Wis. Adm. Code. In addition, VOC emissions standards for consumer and commercial products also limited VOC emissions from area sources, as did NESHAPs for gasoline distribution (Stage I vapor recovery requirements) and area source ICI boilers.

Wisconsin previously had a Stage 2 vehicle refueling vapor recovery program in place. However, this program was removed from Wisconsin's ozone SIP on November 4, 2013 (78 FR 65875) because the equipment was found to defeat onboard vapor recovery systems for some new vehicles.

There are also federal programs in place which reduce area source VOC emissions. VOC emission standards for consumer and commercial products were promulgated under 40 CFR Part 59. This program was implemented prior to 2017 and will continue to reduce VOCs emitted from this sector. Two other federal rules, the NESHAPs for gasoline distribution (Stage I vapor recovery requirements) and area source ICI boilers, also control area source VOC emissions associated with fuel storage and transfer activities.

### 3.6.3. Onroad Source Control Measures

Both NOx and VOC emissions from onroad mobile sources are substantially controlled through federal new vehicle emissions standards programs and fuel standards. Although initial compliance dates in many cases were prior to 2017, these regulations have continued to reduce area-wide emissions as fleets turn over to newer vehicles. These programs apply nationally and have reduced emissions both within the Sheboygan County 2015 ozone NAAQS nonattainment area and contributing ozone precursor transport areas. The federal programs contributing to attainment of the 2015 ozone NAAQS include those listed in Table 3.10.

The EPA has recently finalized a series of updated mobile source rules that will further reduce emissions from this sector. However, since those reductions will occur in the future and after the moderate attainment date for this NAAQS, no emissions reductions from those and other mobile source programs (e.g., from the Inflation Reduction Act) implemented after 2023 are reflected in this attainment plan.

**Table 3.10. Federal onroad mobile source regulations contributing to attainment.**

| Onroad Control Program | Pollutants | Model Year[1] | Regulation |
|---|---|---|---|
| Passenger vehicles, SUVs, and light duty trucks – emissions and fuel standards | VOC & NOx | 2004 – 2009+ (Tier 2) 2017+ (Tier 3) | 40 CFR Part 85 & 86 |
| Light-duty trucks and medium duty passenger vehicle – evaporative standards | VOC | 2004 – 2010 | 40 CFR Part 86 |
| Heavy-duty highway compression engines | VOC & NOx | 2007+ | 40 CFR Part 86 |
| Heavy-duty spark ignition engines | VOC & NOx | 2005 – 2008+ | 40 CFR Part 86 |
| Motorcycles | VOC & NOx | 2006 – 2010 (Tier 1 & 2) | 40 CFR Part 86 |
| Mobile Source Air Toxics – fuel formulation, passenger vehicle emissions, and portable container emissions | Organic Toxics & VOC | 2009 - 2015[2] | 40 CFR Part 59, 80, 85, & 86 |
| Light duty vehicle corporate average fuel economy (CAFE) standards | Fuel efficiency (VOC and NOx) | 2012-2016 & 2017-2025 | 40 CFR Part 600 |

[1] The range in model years affected can reflect phasing of requirements based on engine size or initial years for replacing earlier tier requirements.
[2] The range in model years reflects phased implementation of fuel, passenger vehicle, and portable container emissions requirements as well as the phasing by vehicle size and type.

Wisconsin's enhanced I/M program also limits on-road VOC and NOx emissions from onroad sources and is required within the Sheboygan County 2015 ozone NAAQS nonattainment area. Section 6.5 contains a complete description of the I/M program.

### 3.6.4. Nonroad Source Control Measures

VOC and NOx emitted by nonroad mobile sources are significantly controlled via federal standards for new engines. These programs therefore reduce ozone precursor emissions generated within the Sheboygan County 2015 ozone NAAQS nonattainment area and in the broader regional areas contributing to ozone transport. Table 3.11 lists the nonroad source categories and applicable federal regulations. The nonroad regulations continue to slowly lower average unit and total sector emissions as equipment fleets are replaced each year (approximately 20 years for complete fleet turnover) pulling the highest emitting equipment out of circulation or substantially reducing its use. The new engine tier requirements are implemented in conjunction with fuel programs regulating fuel sulfur content. The fuel programs enable achievement of various new engine tier VOC and NOx emission limits.

**Table 3.11. Federal nonroad mobile source regulations contributing to attainment.**

| Nonroad Control Program | Pollutants | Model Year[1] | Regulation |
|---|---|---|---|
| Aircraft | HC & NOx | 2000 – 2005+ | 40 CFR Part 87 |
| Compression Ignition[2] | NMHC & NOx | 2000 – 2015+ (Tier 4) | 40 CFR Part 89 & 1039 |
| Large Spark Ignition | HC & NOx | 2007+ | 40 CFR Part 1048 |
| Locomotive Engines | HC & NOx | 2012 – 2014 (Tier 3)<br>2015+ (Tier 4) | 40 CFR Part 1033 |
| Marine Compression Ignition | HC & NOx | 2012 – 2018 | 40 CFR Part 1042 |
| Marine Spark Ignition | HC & NOx | 2010+ | 40 CFR Part 1045 |
| Recreational Vehicle[3] | HC & NOx | 2006 – 2012 (Tier 1 – 3) (phasing dependent on vehicle type) | 40 CFR Part 1051 |
| Small Spark Ignition Engine[4] < 19d Kw – emission standards | HC & NOx | 2005 – 2012 (Tier 2 & 3) | |

HC – Hydrocarbon (VOCs)
NMHC – Non-Methane Hydrocarbon (VOCs)
[1] The range in model years affected can reflect phasing of requirements based on engine size or initial years for replacing earlier tier requirements.
[2] Compression ignition applies to diesel non-road compression engines including engines operated in construction, agricultural, and mining equipment.
[3] Recreational vehicles include snowmobiles, off-road motorcycles, and ATVs
[4] Small spark ignition engines include engines operated in lawn and hand-held equipment.

# 4. ATTAINMENT MODELING

Section 182(j) of the CAA requires that photochemical grid modeling be used to demonstrate attainment in multistate ozone nonattainment areas. In this plan, the WDNR is including modeling conducted by the Lake Michigan Air Directors Consortium (LADCO) to satisfy this requirement for the Sheboygan County 2015 ozone NAAQS moderate nonattainment area.

## 4.1. Overview

In 2022 LADCO completed air quality modeling to support the development of attainment demonstration SIPs for 2015 ozone NAAQS moderate nonattainment areas for its member states. The resulting technical support document (TSD) includes an ozone trends analysis, air quality modeling platform description, base and future year emissions summary, chemical transport modeling evaluation, attainment testing, and source apportionment analysis. The TSD is included as Appendix 9 to this document. This section summarizes the methods and results of that analysis.[15]

LADCO's modeling used the Comprehensive Air Quality Model with Extensions (CAMx) v7.10. Because the attainment deadline occurs during the 2024 ozone season, the effective year for attainment is the 2023 ozone season. Therefore, LADCO selected 2023 as the projection year for this modeling effort. LADCO used 2016 as the base modeling year from which it projected air quality for 2023.

The modeling's 2023 ozone air quality and attainment forecasts were based on meteorology modeling that was optimized for conditions in the Great Lakes Basin. LADCO used the EPA's 2016fh_16j emissions modeling platform data (2016v1), and other CAMx modeling platform inputs released by the EPA in September 2019 for this application. LADCO replaced the EGU emissions in the EPA 2016fh_16j platform with 2023 EGU forecasts estimated with the ERTAC EGU Tool version 16.2 beta. ERTAC EGU 16.2 beta integrated state-reported information on EGU operations and forecasts as of September 2021. Overall, both the NOx and VOC ozone season emissions are projected to decrease in 2023 relative to 2016 in all LADCO states, including Wisconsin.

LADCO's modeling differs from contemporaneous EPA ozone modeling[16] in that LADCO relies upon different emissions data and, especially, a photochemical modeling configuration optimized to best reflect ground-level ozone formation in the Great Lakes region. However, the LADCO and EPA modeling efforts are consistent in their core respects and give similar results. The LADCO TSD includes a full model performance evaluation and a discussion of the differences between the EPA and LADCO modeling.

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[15] All technical files associated with this modeling are publicly available on LADCO's website: https://www.ladco.org/technical/ladco-internal/ladco-projects/ladco-2015-o3-naaqs-moderate-area-sip-technical-support-document/.

[16] See, for example, modeling completed by the EPA for both the proposed and final Good Neighbor Plan rule for the 2015 ozone NAAQS (2016v2 and 2016v3 platform modeling), available at: https://www.epa.gov/Cross-State-Air-Pollution/good-neighbor-plan-2015-ozone-naaqs.

### 4.2. Modeling Results

An attainment demonstration based on air quality modeling is used to determine whether identified emission reduction measures are enough to reduce projected pollutant concentrations to a level that meets the NAAQS by the statutory deadline established by the EPA.

LADCO estimated 2023 design values using version 1.6 of the Software for Modeled Attainment Test Community Edition (SMAT-CE) using the EPA's recommended approach and guidance.[17] This software computes the fractional changes, or relative response factors, of ozone concentrations at each monitor location based on a comparison of the modeled air quality in the base and future years. Meteorological conditions are assumed to be unchanged for the base and projection years. Modeled relative reduction factors are then applied to a weighted baseline 2017 design value, which is determined by averaging three successive three-year design values centered on 2017 (i.e., 2015-2017, 2016-2018, 2017-2019). The resulting estimates of design values in 2023 can then be compared to the level of the NAAQS to assess attainment.

Table 4.1 gives the results of this modeling for the attainment year of 2023 for the Sheboygan Kohler-Andrae monitor, the only ozone monitor in the Sheboygan County 2015 ozone NAAQS nonattainment area.

**Table 4.1. Modeled 2023 ozone design values in the Sheboygan County 2015 ozone NAAQS nonattainment area.***

| Site # | Monitor name | County | Modeled 2023 design value (ppb) |
|---|---|---|---|
| 551170006 | Sheboygan - Kohler Andrae | Sheboygan | 75.1 |

* From LADCO's modeling TSD for the 2015 ozone standard, Table 6-1 ("2023 DVF Average" values), as well as LADCO's attainment test results, which can be found on LADCO's website (https://www.ladco.org/wp-content/uploads/Projects/Ozone/ModerateTSD/LADCO_2016bcc2_2023_O3_DVs_25May2022.xlsx). Design values are average 2023 values calculated from the LADCO 4-km CAMx modeling with water cells included in the 3x3 matrix surrounding each monitor. The TSD contains a complete explanation of results.

As will be discussed in Section 5, the area's actual design values in 2023 exceeded the NAAQS (Table 5.1). The WDNR has included additional information in Section 5 describing how ozone-causing emissions continue to decrease in Wisconsin but, due to emissions transported from out of state, the Sheboygan area has not yet attained the standard.

[17] See https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf. As discussed in Section 5, a design value is the three-year average of the annual fourth highest 8-hour averaged daily ozone value.

# 5. AIR QUALITY AND WEIGHT OF EVIDENCE ANALYSES

## 5.1. Introduction

The EPA recommends that states submit supplemental analyses in support of any attainment plan. These analyses are intended to provide additional support for the required modeled attainment assessment. Such supplemental analyses are part of a "weight of evidence" showing that an area will attain a standard. This section presents trends in ambient ozone and ozone precursor concentrations and forms the core of such a showing relative to the Sheboygan County 2015 ozone NAAQS nonattainment area.

Ozone concentrations in Sheboygan County are largely determined by a number of factors that are outside of the state's control. Crucially, nearly all the ozone at Sheboygan comes from transported ozone and ozone precursors originating in upwind states. Wisconsin sources that impact the area are already well-controlled and contribute very little to the elevated ozone concentrations. Modeling conducted by both LADCO and the EPA confirms that Wisconsin has limited ability to further reduce ozone concentrations in this area.

## 5.2. Air Quality Data and Trends

### 5.2.1. Trends in Monitored Ozone Concentrations

Section 110(a)(2)(B) of the CAA requires a monitoring strategy for measuring, characterizing, and reporting ozone concentrations in the ambient air. The WDNR maintains a comprehensive network of air quality monitors throughout the state with the primary objective of being able to determine compliance with NAAQS.[18] Wisconsin conducts seasonal monitoring of ambient ozone concentrations from April 1 through October 15.[19]

The current ozone monitoring network in Sheboygan County is depicted in Figure 1.1. There are two monitors measuring ozone concentrations in the county, with one monitor (Sheboygan Kohler-Andrae) located in the Sheboygan County 2015 ozone NAAQS nonattainment area.[20] The Kohler-Andrae monitor is used to determine compliance with the ozone NAAQS for this area.

An exceedance of an 8-hour ozone NAAQS occurs when a monitor measures ozone concentrations above the standard. A violation occurs when the three-year average of the annual fourth highest 8-hour averaged daily ozone level is greater than a standard. This three-year average is termed the "design value" for the monitor. The design value for a nonattainment area is derived from the monitor with the highest design value.

Table 5.1 shows ozone ambient air quality monitoring data for the Kohler Andrae monitor for the last six years, concluding with the most recent 2021-2023 design value period. This data shows

[18] The latest state air quality monitoring network plan can be found at: https://dnr.wisconsin.gov/topic/AirQuality/Monitor.html.
[19] Except for Kenosha County, which monitors ozone from March 1 through October 31 to align with monitoring requirements applicable to the tristate Chicago nonattainment area.
[20] The Sheboygan Haven monitor is located further west in the county and outside of the nonattainment area. Data from that monitor is not further discussed in this attainment plan.

that the area continues to experience nonattainment levels, even if design values have decreased about 5% since the 2016-2018 period.

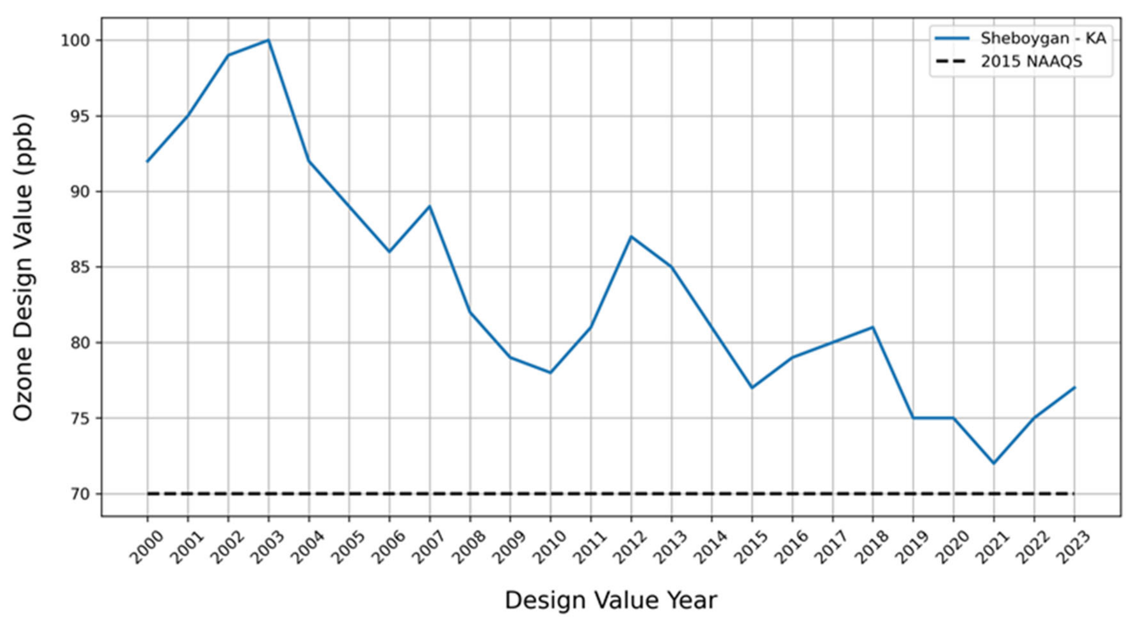
**Table 5.1. Monitored ozone design values in the Sheboygan County 2015 ozone NAAQS nonattainment area, 2016-2023.**

| Site # | Monitor name | Design value (ppb) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2016-18 | 2017-19 | 2018-20 | 2019-21 | 2020-22 | 2021-23 |
| 551170006 | Sheboygan Kohler-Andrae | 81 | 75 | 75 | 72 | 75 | 77 |

This decline in recent monitored ozone values is consistent with the long term trends at this location, which show a significant decrease since 2000 (Figure 5.1). Design values have decreased from well over 90 ppb before 2004 to as low as 72 ppb in 2021. The largest reductions occurred during the early years of this period, with the design value decreasing 22 ppb from 2003 to 2010. While ozone values continue to decline, smaller reductions have been observed in more recent years.

Meteorological variability significantly affects ozone concentrations and can obscure trends over shorter time periods. For example, 2012 had an extremely hot summer with a high frequency of elevated ozone concentrations, while 2008, 2009 and 2015 were relatively cool summers with a lower frequency of elevated ozone concentrations. The next two sections discuss the impact of meteorology on ozone concentrations and describe how ozone concentrations in this area have decreased even when adjusted for meteorology.

**Figure 5.1. Trends in ozone design values for the Sheboygan Kohler-Andrae monitor.**

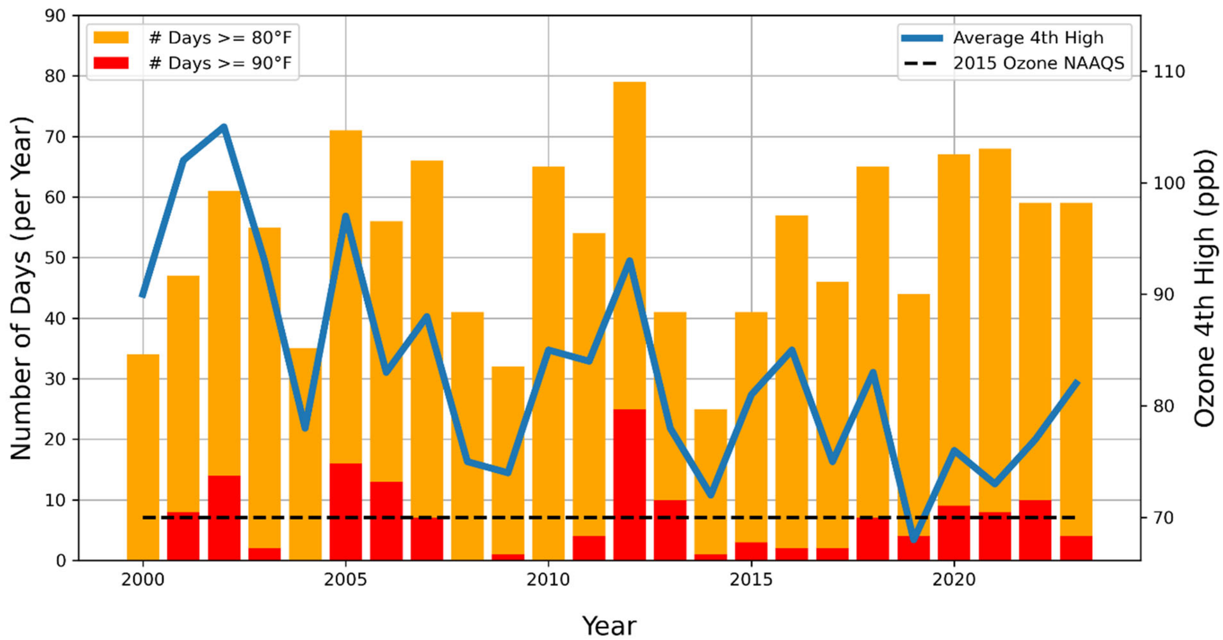


### 5.2.2. Influence of Temperature on Ozone Concentrations

Temperature is an important and well-known driver of ozone formation, with more ozone being produced at high temperatures than at low temperatures. Figure 5.2 compares annual fourth high MDA8 concentration averages across the Sheboygan County 2015 ozone NAAQS nonattainment area with temperature measurements at the Sheboygan County Memorial Airport. The count of days in which maximum temperatures reached 80–90+°F indicate how often extreme temperatures occurred each year.

The correlations between ozone concentrations and elevated temperature are shown in Figure 5.2. While the highest ozone concentrations occurred in years with the highest temperatures, the amount of ozone produced for a given temperature level has decreased over time. For example, comparison of the years 2002, 2012, and 2021 shows that the average fourth high MDA8 value steadily decreased across decades, even in these years with many hot days. These reductions are presumably due to reduced emissions of ozone precursors, analyzed further in the following section.

**Figure 5.2. Comparison of Sheboygan County ozone values to temperature (2000-2021).** Average annual fourth high maximum daily 8-hour average (MDA8) ozone concentrations plotted with the number of days with temperatures above 80 °F and 90 °F at Sheboygan County Memorial Airport.[21]




[21] Climatological data is from the Midwestern Regional Climate Center "cli-MATE" database (https://mrcc.purdue.edu/CLIMATE/).

### 5.2.3. Ozone Trends Adjusted for Meteorology

Because of the large effect of meteorology, particularly temperature, on ozone concentrations, meteorologically driven variability in ozone concentrations often obscures trends in ozone due to factors such as permanently reduced rates of precursor emissions. For this reason, it is important to adjust ozone concentrations for meteorology to examine trends in ozone concentrations due to precursor emission reductions and other factors. The following analysis shows that ozone concentrations in the Sheboygan County 2015 ozone NAAQS nonattainment area are continuing to decrease even after accounting for the impacts of meteorology.

<u>LADCO CART Analysis</u>

Classification and Regression Tree (CART) analysis allows ozone concentrations on days with similar meteorological conditions to be compared. This analysis partially controls for the influence of year-to-year meteorological variability on ozone concentrations. A CART analysis produces average ozone concentrations for several different classes of days (determined by meteorology) for each year being assessed. This analysis therefore allows examination of average ozone concentration trends over long periods resulting from non-meteorological factors, including permanent and enforceable reductions in emissions of ozone precursors impacting the area of interest.

In 2021, LADCO completed a CART analysis for regional nonattainment and maintenance areas to assess changes in ozone concentrations under different meteorological conditions from 2006-2020 (note that this timeframe incorporates a period predating the 2015 standard).[22]

<u>Results for Sheboygan County</u>

From the LADCO CART analysis, Figure 5.3 shows average ozone concentrations for the five sets of meteorological conditions (“nodes”) that resulted in the highest ozone concentrations at the Sheboygan Kohler-Andrae monitor.

The data shown for each node are the average ozone concentrations on all days sharing a particular set of meteorological conditions.[23] This analysis shows that high-ozone days at this monitor generally are associated with southerly winds and transport as well as hot temperatures. Southerly transport-related parameters are the most important variables, along with atmospheric pressure and precipitation. Mean ozone concentrations in all of the high-ozone nodes have decreased from 2005 to 2020.

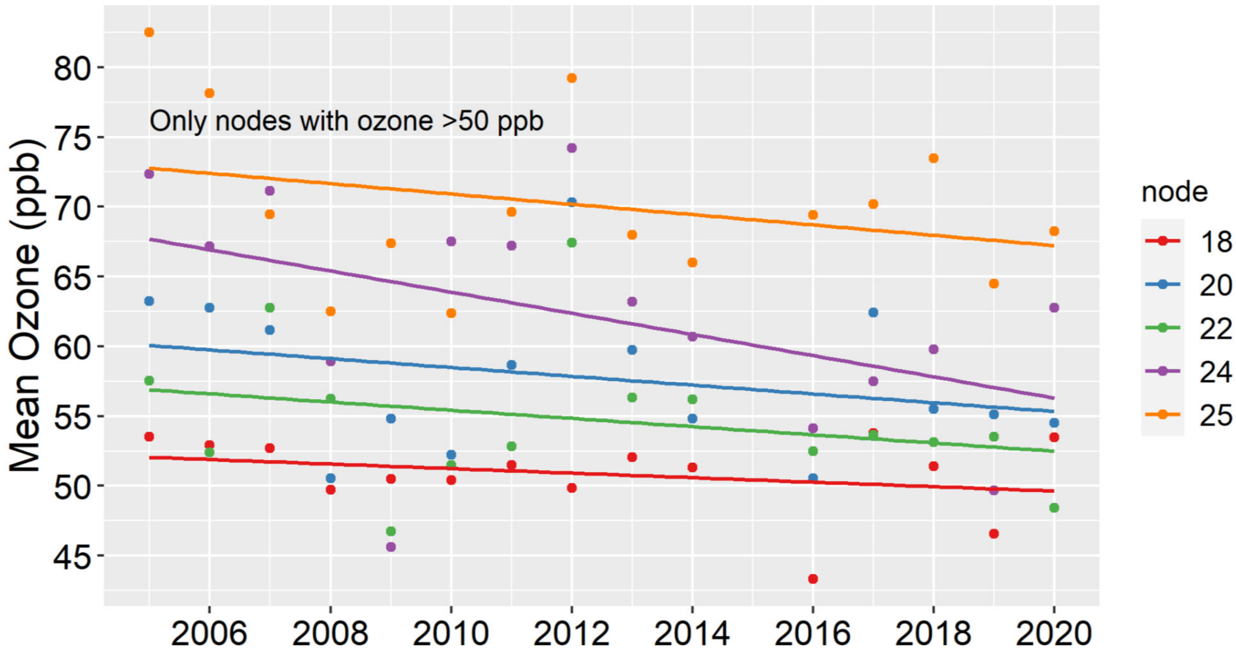
Critically, this analysis shows that average ozone concentrations decreased under all assessed meteorological conditions over this period. This suggests that the observed, long-term decreases

[22] LADCO. Classification and Regression Tree (CART) Analysis for LADCO Ozone Nonattainment Areas Memorandum (October 2021) available at: https://www.ladco.org/wp-content/uploads/Projects/Ozone/LADCO_O3_CART-Analysis_27Oct2021-FINAL-with-Appendices.pdf.

[23] For example, Node 25 in Figure 5.3 shows the average ozone concentrations for days characterized by southernly transport, maximum temperatures above 75 °F, average southerly winds greater than 3.2 m/s and average morning temperatures above 75 °F.

in average ozone concentrations on days when meteorology favors ozone production are due, at least in part, to permanent and enforceable reductions in ozone precursors.

**Figure 5.3. CART analysis results for the Sheboygan Kohler-Andrae monitor (2005-2020).** Data points show the average ozone concentration for days sharing certain meteorological conditions ("nodes"). Node criteria are described below the figure. Only meteorological nodes with an average ozone concentration above 50 ppb are shown.[24]




| Node 25 | Node 24 | Node 20 | Node 22 | Node 18 |
|---|---|---|---|---|
| 72 ppb $O_3$ | 64 ppb $O_3$ | 58 ppb $O_3$ | 55 ppb $O_3$ | 51 ppb $O_3$ |
| 24-hr southerly transport (>37 km) | 24-hr southerly transport (>37 km) | 24-hr southerly transport (>37 km) | 24-hr southerly transport (>37 km) | 24-hr southerly transport (>37 km) |
| Southerly winds >3.2 m/s | Southerly winds >3.2 m/s | Southerly winds <3.2 m/s | Southerly winds >3.2 m/s | Southerly winds <3.2 m/s |
| Maximum Temp >75 °F | Maximum Temp >75 °F | Maximum Temp >80 °F | Maximum Temp <75 °F | Maximum Temp <80 °F |
| AM Temp >75 °F | AM Temp <75 °F | | | Wind direction from <123° (easterly) |

### 5.3. Emissions Data and Trends

Ozone is formed from the reaction of NOx and VOCs in the presence of sunlight. Ozone formation involves a number of different reactions. Partly because of the interactions between these different reactions, rates of ozone formation often respond non-linearly to reductions in ozone precursor concentrations. For example, under some circumstances, ozone formation may be NOx-limited, such that reductions in NOx emission cause reductions in ozone concentrations.

[24] Taken from LADCO's 2021 CART analysis memorandum, Appendix 8.

Conversely, in some cases ozone formation may be VOC-limited, in which case additional VOC reductions will lower ozone.

Ozone formation in most of the Midwest is currently understood to be NOx-limited.[25] The primary exception to this is in large urban centers (such as Chicago and parts of Milwaukee), where the ozone chemistry is such that ozone formation is limited by the concentrations of VOCs. Because of this complex chemistry and its impacts on specific geographic areas, approaches to decreasing ozone concentrations in the region have historically relied on reductions in both NOx and VOC emissions.

NOx consists of nitric oxide (NO) and nitrogen dioxide ($NO_2$). Most NOx is emitted as NO, which reacts fairly rapidly in the atmosphere to form $NO_2$, which has a longer lifetime in the atmosphere and can be transported longer distances. VOCs are a complex mixture of hundreds of different types of organic compounds, including compounds that contain only carbon and hydrogen (“hydrocarbons”) and compounds that also include oxygen, nitrogen, sulfur and/or other elements. Some VOCs are emitted directly by anthropogenic sources, including benzene and toluene, whereas others are emitted directly by biogenic sources, such as isoprene. In addition to direct emissions, VOCs are formed in the atmosphere from reaction of other VOCs. These “secondary VOCs” include formaldehyde and acetaldehyde, which are important “carbonyl” compounds.[26]

Emissions of both NOx and VOCs from Wisconsin sources have decreased significantly in the last few decades (Figure 5.4). Total NOx emissions decreased 72% from 2002 through 2020, with the greatest reductions coming from highway vehicles and fuel combustion at electric utilities. VOC emissions decreased approximately 28% over this same period. Note that the apparent increase in VOC emissions in 2020 is due to significant changes in the EPA’s inventory methodology. Specifically, the EPA added agricultural silage emissions to the inventory for the first time, a source category that was unaccounted for in previous versions of the NEI. Had this category been included in the earlier inventories, the statewide decrease in VOCs since 2002 would be significantly greater.

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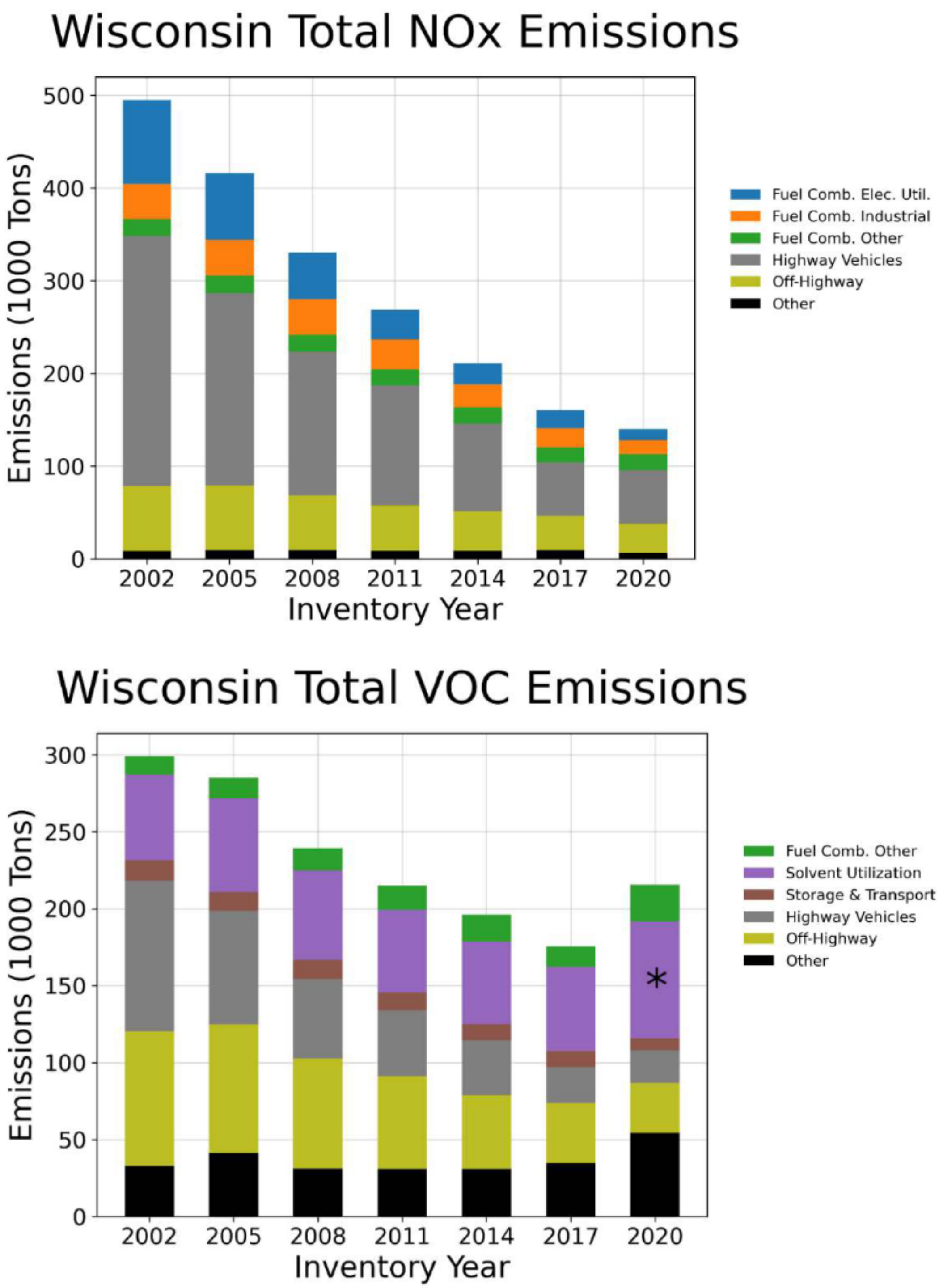
[25] For examples, see the LADCO NOx/VOC Ozone Sensitivity contract reports.
Task 1: https://widnr.widen.net/s/pprfxr5v5f/am_ladcotask1finalreport_20200930, Tasks 2 & 3: https://widnr.widen.net/s/xcfnfxmk8x/am_ladcotasks3and4finalreport_20201020

[26] Carbonyl compounds contain a carbon-oxygen double bond.

**Figure 5.4. Wisconsin statewide annual NOx (top) and VOC (bottom) emissions by sector (2002-2020).** Data from the EPA's National Emissions Inventory (NEI).[27]




* This apparent increase in emissions is due to a methodology change (see text).

[27] Data is from https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data.

### 5.4. Influence of Transport on Ozone Levels

The most important factor driving high ozone concentrations in Wisconsin's ozone nonattainment areas is the transport of ozone and ozone precursors from upwind areas. This section describes recent analyses of ozone transport and its impact on the Sheboygan County 2015 ozone NAAQS nonattainment area. The transport of ozone and ozone precursors from areas outside Wisconsin significantly limits the state's ability to reduce high ozone concentrations within this nonattainment area.

#### 5.4.1. LADCO modeling results

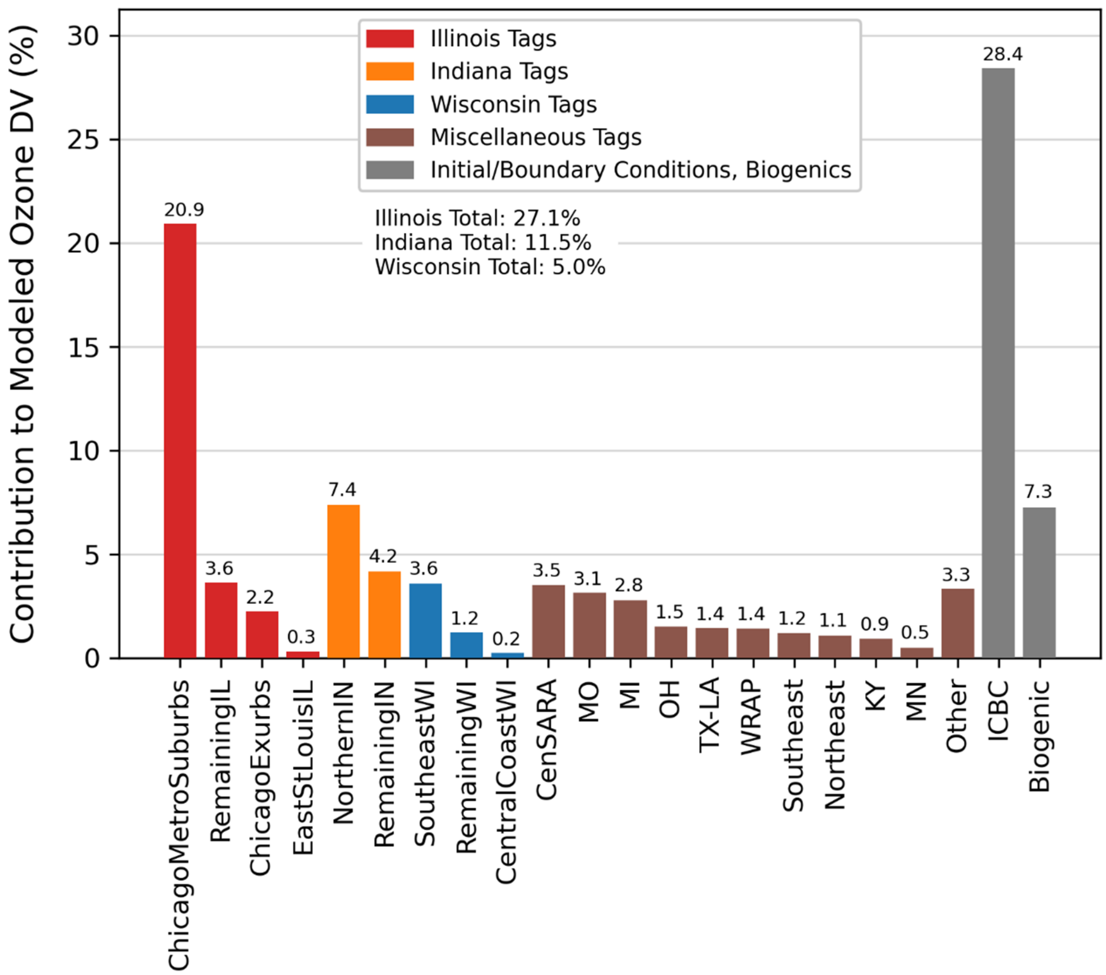
As described in Section 4, LADCO conducted photochemical modeling to support 2015 ozone NAAQS attainment planning for its member states. As part of this effort, LADCO used the CAMx Anthropogenic Precursor Culpability Assessment (APCA) tool to calculate emissions tracers for identifying upwind sources of ozone precursors at downwind monitoring sites. This allowed the model to quantify the impacts of inventory sectors and geographic source regions on ozone concentrations at specific monitor locations. These results are included in the files available on the LADCO 2015 ozone modeling website.[28]

These source apportionment results allow one to identify the origins the ozone measured in the Sheboygan County 2015 ozone NAAQS nonattainment area. As shown in Figure 5.5, Wisconsin sources contribute about 5% of the total ozone recorded at the Kohler-Andrae monitor, with "central coast Wisconsin," which includes Sheboygan County, only contributing 0.2%.

In contrast, other, upwind states together contributed nearly 60% of the ozone. Of these states, Illinois and Indiana were the largest state contributors, being responsible for 27% and 11% of Sheboygan's ozone, respectively. This result is consistent with results for other monitors along the Wisconsin lakeshore, all of which are dominated by transported emissions from outside Wisconsin, with Illinois and Indiana being the largest out-of-state contributors. These results are further confirmed the EPA photochemical modeling results, discussed next.

[28] https://www.ladco.org/technical/ladco-internal/ladco-projects/ladco-2015-o3-naaqs-moderate-area-sip-technical-support-document/. Data for individual receptors are available from this file: https://www.ladco.org/wp-content/uploads/Projects/Ozone/ModerateTSD/LADCO_2016_APCA_Tracers_27July2022.xlsx.

**Figure 5.5. LADCO source apportionment results for the Sheboygan Kohler-Andrae monitor.[29]**




[29] Total emissions from IL, IN and WI are obtained from summing the "sub-state" results in the figure. "SoutheastWI" is Kenosha, Racine, Milwaukee, Washington, Waukesha and Ozaukee counties. "CentralCoastWI" is Sheboygan, Manitowoc and Kewaunee counties. "RemainingWI" is the rest of WI. "CenSARA" is IA, KS, NE, OK, AR. "WRAP" is WA, OR, CA, NV, ID, MT, WY, UT, AZ, NM, CO, ND, SD. "Southeast" is FL, MS, AL, GA, SC, NC, TN, VA, WV. "Northeast" is CT, ME, MA, NH, NJ, NY, RI, VT, PA, MD, DE, DC. "ICBC" is initial/boundary conditions (including emissions from outside the U.S.). "Biogenic" is emissions from biogenic sources. Graphic by WDNR from LADCO modeling data.

### 5.4.2. EPA modeling results

For its 2015 ozone NAAQS transport rule (the Good Neighbor Plan), the EPA also conducted photochemical modeling, which included state source apportionment results.[30] This modeling was used by EPA to determine which upwind states are responsible for ozone measured in downwind state nonattainment and maintenance areas. Consistent with LADCO's modeling, the EPA found that the ozone along Wisconsin's lakeshore is significantly influenced by upwind state emissions.

Specific to the Sheboygan County 2015 ozone NAAQS nonattainment area, the EPA's modeling found that Wisconsin sources are responsible for about 10% of the ozone at the Kohler-Andrae monitor, with other states responsible for 48% (with Illinois responsible for 19% and Indiana 12%). The EPA also identified Ohio, Texas, Missouri, and Michigan as states contributing significantly to the Sheboygan County area. About 42% of ozone at the Kohler Andrae monitor was due to non-state emissions, such as international and biogenic sources.

The difference in results between the EPA and LADCO modeling are due to the use of different emissions platforms, model configurations, analysis years, and other factors; however, both efforts are consistent in that they conclude that Wisconsin emissions contribute very little to the ozone measured in the Sheboygan County 2015 ozone NAAQS nonattainment area, especially relative to other, upwind states. They both highlight that Wisconsin has little to no ability to reduce ozone values in this area further through unilateral action.

## 5.5. Conclusion

These analyses show that monitored ozone concentrations in the area have decreased since 2000. When adjusted to account for meteorological variability, ozone concentrations for equivalent meteorological conditions also show a decrease. Emissions of NOx and VOCs from Wisconsin have decreased from 2002 through 2020. A critical limitation to attainment planning is that the area remains highly impacted by transport of out-of-state ozone and ozone precursors; this limits the state's ability to independently drive ozone values lower and attain the NAAQS.

[30] The EPA's air quality modeling technical support document and data files are available at: https://www.epa.gov/csapr/good-neighbor-plan-2015-ozone-naaqs. Data cited in this discussion is for analysis year 2023 from the 2016v3 modeling conducted by the EPA for the final Good Neighbor Plan. The EPA's 2016v2 modeling, used to support the draft Good Neighbor Plan, produced similar results.

# 6. OTHER MODERATE AREA SIP REQUIREMENTS

## 6.1. Reasonably Available Control Technology (RACT) Program for NOx

Wisconsin's NOx RACT program was first adopted by the state in July 2007 as codified under subchapter IV of ch. NR 428 (s. NR 428.20 to 428.26), Wis. Adm. Code. The program was approved by the EPA into the SIP in October 2009 (75 FR 64155). This program was established to fulfill NOx RACT requirements for southeast Wisconsin counties (including Sheboygan County) designated moderate nonattainment for the 1997 ozone NAAQS.

The WDNR has determined that Wisconsin's current NOx RACT program fulfills RACT requirements under the 2015 ozone NAAQS. The basis for this determination is:

1) In moderate ozone nonattainment areas, Wisconsin's NOx RACT program applies to major sources with a potential-to-emit of 100 tons per year and thus meets the necessary applicability requirements.

2) A review of control technology indicates that a new assessment of control technology conducted for the 2015 ozone NAAQS would not change the determination of RACT under Wisconsin's existing program.

Details supporting this finding are described below.

### 6.1.1. Major Source Applicability

To ensure consistency with the CAA, ch. NR 428, Wis. Adm. Code, was revised in March 2022 so that the level of an area's ozone nonattainment classification determines the major source emission threshold in the area. The EPA set applicability of RACT for facilities in moderate ozone nonattainment areas at a NOx emissions threshold of 100 tons per year (TPY) or more based on a facility's PTE[31]. Under Wisconsin's revised NOx RACT rule, the applicability threshold for NOx emissions sources in the Sheboygan County 2015 ozone nonattainment area is 100 TPY (s. NR 428.20, Wis. Adm. Code).

### 6.1.2. Control Technology Assessment

The 2015 ozone implementation rule provides that states can show that existing NOx RACT programs fulfill requirements for the 2015 ozone NAAQS.[32] The EPA states this demonstration should be based on a review of RACT control technologies for conditions in 2015. If this review indicates there would be no incremental difference in control technologies between the existing program and the updated assessment, the existing program can be certified as meeting RACT under the 2015 ozone NAAQS. Even in the case that an updated RACT could result in additional emission reductions, the EPA indicates that such an action would likely not be cost-effective, stating:

[31] EPA, 1988, *Issues Relating to VOC Regulation Cutpoints, Deficiencies, and Deviations, Clarification to Appendix D of November 24, 1987 Federal Register,* May 25, 1988.
[32] EPA, 2015, *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: Requirements for State Implementation Plans*, 80 FR 12279, March 6, 2015.

> *"In cases where controls were applied due to the 1-hour or 1997 NAAQS ozone RACT requirement, we expect any incremental emissions reductions from the application of a second round of RACT controls may be small and, therefore, the cost for advancing that small additional increment of reduction may not be reasonable."*

The WDNR relied on this provision from the 2008 ozone NAAQS implementation rule to show that Wisconsin's existing NOx RACT programs also fulfill requirements for the 2015 NAAQS.[33] This demonstration should then be based on a review of RACT control technologies for conditions in 2015. Wisconsin's NOx RACT program was first implemented in 2007 based on an assessment of the control technologies and cost information available at that time. The WDNR expects little, if any, change in the assessment of RACT control technology between 2007 and 2015, since the RACT assessments would be based on essentially the same information.

To verify this conclusion, the WDNR reviewed the current Wisconsin RACT requirements that could apply for emission units operating in the Sheboygan County 2015 ozone NAAQS nonattainment area in 2015. The RACT source categories and applicable control technologies are presented in Table 6.1. The WDNR's review showed that two coal-fired boilers operating at the Edgewater power plant fall into the RACT source category of coal-fired boilers greater than 1,000 mmBtu/hr. These power plant boilers accounted for 90% of $NO_x$ emissions in the Sheboygan County nonattainment area in 2015.

After reviewing the identified source categories and applicable control technologies, the WDNR has concluded there would be no change in RACT if an updated assessment of control technology were performed based on 2015 information. Thus, based on equivalency in major source applicability and RACT control technology, the WDNR concludes that Wisconsin's current NOx RACT program under ss. NR 428.20 to 25 fulfills 2015 ozone NAAQS moderate-area RACT requirements.

**Table 6.1. Control technologies required under Wisconsin's NOx RACT program.**

| Source Category | RACT Control Technology |
|---|---|
| Coal-fired boilers > 1,000 mmBtu/hr | SCR |
| Rich Burn IC engines > 500 hp | NSCR 80 – 90% Control |
| Simple cycle combustion turbines | DLN |
| Asphalt plants > 65 mmBtu/hr | LNB |
| Natural gas-fired boiler > 100 mmBtu/hr | LNB/OFA/GR |
| Natural gas-fired process heaters > 100 mmBtu/hr | LNB |
| Natural gas-fired furnaces > 75 mmBtu/hr | LNB/OFA/GR |

SCR = Selective Catalytic Reduction, NSCR = nonselective catalytic reduction, DLNB, = Dry Low NOx Burner, LNB = Low NOx Burner, OFA = Overfire Air, GR = Gas Recirculation

[33] The 2015 ozone implementation rule references the 2008 ozone implementation rule for how air agencies can provide for RACT in their nonattainment SIPs (see 83 FR 63007).

### 6.2. Reasonably Available Control Technology (RACT) Program for VOCs

Section 182(b)(2) of the CAA requires states with moderate nonattainment areas to implement VOC RACT under section 172(c)(1). Wisconsin's VOC RACT requirements are codified under chapters NR 419 through 425, Wis. Adm. Code. A summary of Wisconsin's VOC rules is included in Appendix 8. No additional measures are reasonably available that will advance the attainment date.

The EPA periodically issues Control Techniques Guidelines (CTGs) to establish VOC RACT requirements for specific source categories, and WDNR has incorporated most of those CTGs into Wisconsin's VOC rules. Five CTGs have not been incorporated. Appendix 8 contains negative declarations for these five CTGs to certify that Wisconsin has determined that there are no identified sources in the Sheboygan County 2015 ozone NAAQS nonattainment area that meet the applicability criteria of these CTGs.

Given these negative declarations, Wisconsin's VOC RACT rules found in chapters NR 419 through 425, Wis. Adm. Code, satisfy Wisconsin's obligations under Section 182(b)(2) of the CAA for the Sheboygan County 2015 ozone NAAQS nonattainment area.

### 6.3. Evaluation of Reasonably Available Control Measures (RACM)

CAA Section 172(c)(1) requires that states implement any reasonably available control measures necessary for attainment of the NAAQS. As described in 40 CFR 51.1108(d), any control measures needed for attainment must be implemented by the beginning of the attainment year ozone season, which in this case is 2023 (to support the August 3, 2024, moderate attainment date). With this submittal, Wisconsin is demonstrating that attainment will be achieved by this date and therefore no additional control measures are required for attainment purposes.

However, additional control measures are required if it can advance the attainment date by a year or more. This means that any measures advancing the attainment date by a year would have needed to be in place for the 2022 ozone season (for Sheboygan County, that season is April 1 through October 15, 2022). Given the timing of this submittal, it is not possible to implement any new measures during that period that could advance attainment by one year. Accordingly, RACM requirements are satisfied for the Sheboygan County 2015 ozone NAAQS nonattainment area.

### 6.4. Transportation Conformity

Transportation conformity is required by section 176(c) of the CAA (42 U.S.C. 7506(c)). Conformity to a SIP means that transportation activities will not produce new air quality violations, worsen existing violations, or delay timely attainment of the NAAQS (CAA 176(c)(1)(B)).

The EPA's conformity rule in 40 CFR part 93 requires that transportation plans, programs and projects conform to SIPs and establish the criteria and procedures for determining whether they conform. The conformity rule generally requires a demonstration that emissions from the Regional Transportation Plan (RTP) and the Transportation Improvement Program (TIP) are consistent with the motor vehicle emissions budget (MVEB) contained in the control strategy

SIP revision or maintenance plan (40 CFR 93.101, 93.118. and 93.124). A MVEB is defined as "that portion of the total allowable emissions defined in the submitted or approved control strategy implementation plan revision or maintenance plan for a certain date for the purpose of meeting reasonable further progress milestones or demonstrating attainment or maintenance of the NAAQS, for any criteria pollutant or its precursors, allocated to highway and transit vehicle use and emissions" (40 CFR 93.101). The WDNR is submitting MVEBs for the Sheboygan County 2015 ozone NAAQS nonattainment area in this attainment plan.

#### 6.4.1. Motor Vehicle Emissions Modeling

The MVEBs were developed using the latest version of the EPA's MOtor Vehicle Emission Simulator (MOVES) model available at the time of drafting, MOVES4.0.1, and a travel demand model. The MOVES4.0.1 model derives estimates of hot summer day emissions for ozone precursors of NOx and VOCs. Numerous variables can affect these emissions, especially the size of the vehicle fleet (the number of vehicles on the road), the fleet's age, the distribution of vehicle types, and the vehicle miles of travel. The transportation information is derived from the travel demand model. Appendix 7 contains key data used to develop inputs to MOVES4.0.1.[34]

#### 6.4.2. Motor Vehicle Emissions Budgets

Table 6.2 shows the MVEBs developed by the WDNR for the Sheboygan County 2015 ozone NAAQS nonattainment area for 2023. These budgets are identical to the corresponding projected emissions inventories presented in section 3. They include a margin of safety to account for uncertainties in future mobile source emissions. 40 CFR 93.101 defines this safety margin as the amount by which the total projected emissions from all sources of a given pollutant are less than the total emissions that would satisfy the applicable requirement for RFP, attainment, or maintenance. To provide a safety margin, the WDNR increased the emissions calculated by MOVES4.0.1 by 15% for 2023 for the Sheboygan 2015 ozone NAAQS area.

**Table 6.2. Motor vehicle emissions budgets for the Sheboygan 2015 ozone NAAQS area for 2023.**

| Year | Emissions (tons per hot summer day) | |
|---|---|---|
| | VOC | $NO_x$ |
| 2023 | 0.56 | 0.95 |

### 6.5. Motor Vehicle Inspection and Maintenance (I/M) Program

The purpose of motor vehicle I/M programs is to reduce emissions from in-use motor vehicles in need of repairs and thereby contribute to state and local efforts to improve air quality and attain the NAAQS. Wisconsin's I/M program has been in operation since 1984. It was originally implemented in accordance with the 1977 CAA Amendments and operated in the six counties of Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha. Sheboygan County was added to the program in July 1993, resulting in a seven-county program area that has remained to

[34] The complete set of inputs to MOVES4.0.1 is too lengthy to include in this document. However, electronic copies of the inputs can be obtained from the WDNR upon request.

the present. Vehicles were originally tested by measuring tailpipe emissions using a steady-state idle test. Tampering inspections were added in 1989.

The 1990 CAA Amendments set additional requirements for I/M programs. For moderate areas, a "basic" program was required under section 182(b)(4). For serious or worse areas, an "enhanced" program was required under section 182(c)(3). The EPA's requirements for basic and enhanced I/M programs are found in 40 CFR part 51, subpart S.

Wisconsin's I/M program transitioned to an enhanced program in December 1995. The major enhancement involved adding new test procedures to more effectively identify high-emitting vehicles. These new test procedures included a transient emissions test in which tailpipe emissions were measured while the vehicle was driven on a dynamometer (a treadmill-type device). Improving repairs and public convenience were also major focuses of the enhancement effort.

Since July 2001, all model year (MY) 1996 and later cars and light trucks have been inspected by scanning the vehicle's computerized second-generation on-board diagnostic (OBDII) system instead of measuring tailpipe emissions. As of July 2008, the program dropped tailpipe testing entirely and has inspected all vehicles by scanning the OBDII system. This change was the result of statutory changes in the State's 2007-2009 biennial budget which exempted model years of vehicles not federally required to be equipped with the OBDII technology (MY 1995 and earlier cars and light trucks and MY 2006 and earlier heavy trucks). To help offset the emissions reductions lost from exempting the pre-OBDII vehicles, the program increased the testable fleet for MYs 2007 and later by adding gasoline-powered vehicles between 10,001 to 14,000 pounds gross vehicle weight rating (GVWR) and diesel-powered vehicles of all weights up to 14,000 pounds GVWR.

The EPA fully approved Wisconsin's enhanced I/M program on August 16, 2001 (66 FR 42949), including the program's legal authority and administrative requirements in the Wisconsin Statutes and Wisconsin Administrative Code. On June 7, 2012, the WDNR submitted a SIP revision to the EPA covering all the changes to the program since the EPA approved the program in 2001. This submittal included a demonstration under section 110(l) of the CAA addressing emission reductions associated with the program changes. The EPA approved this SIP revision on September 19, 2013 (78 FR 57501).

A modeled demonstration that Wisconsin's current I/M program meets the EPA's enhanced I/M program performance standard was completed as part of this attainment plan (see Appendix 11). This assessment confirms that the program continues to meet enhanced I/M program performance requirements.

Wisconsin's I/M program is jointly administered by the WDNR and the Wisconsin Department of Transportation. Legal authority and administrative requirements for the Wisconsin I/M program are found in sections 110.20 and 285.30 of the Wisconsin Statutes and Chapters NR 485 and Trans 131 of the Wisconsin Administrative Code.

### 6.6. Section 110(l) Noninterference Requirements

When revising rules and regulations in the SIP, the state is responsible for demonstrating that such a change will not interfere with any applicable requirement concerning attainment and reasonable further progress, or any other applicable CAA requirements for any of the criteria pollutants. This attainment plan does not remove or relax any control programs or requirements currently approved in the SIP. Therefore, all requirements related to section 110(l) noninterference are fulfilled. The WDNR has the legal authority and necessary resources to actively enforce any violations of its rules or permit provisions. Removal of any control program from the SIP will be subject to a public hearing process, a demonstration of noninterference, and approval by the EPA.

### 6.7. Section 172(c)(9) Contingency Measures

Contingency measures required by CAA section 172(c)(9) are fully adopted rules or measures that can take effect without further action by the state or the EPA upon failure to meet milestones (like RFP) or attain by the attainment deadline. The purpose of contingency measures is to provide continued emissions reductions while the SIP is being revised to meet the missed milestone or attainment date. Reductions are to be achieved as soon as possible but should generally occur within one year of the triggering event. Contingency measures must be in excess of what is needed to meet any other nonattainment plan requirement in the CAA, such as RACT/RACM, RFP, and attainment modeling.[35]

Since the attainment year for this area is 2023, the WDNR has evaluated contingency measure reductions that would occur by 2024. The 2015 ozone NAAQS SIP requirements rule states that contingency measures should provide one year's worth of emissions reductions, which generally equates to 3% of the baseline emissions inventory, but could vary based on specific circumstances.

As described in Section 3.3, the WDNR has identified and quantified permanent and enforceable NOx and VOC emissions reductions in the nonattainment area that decease emissions further from 2023 to 2024. These reductions are based on a wide range of point, area, and mobile source rules that are permanent, enforceable, and in excess of those otherwise needed to meet attainment planning requirements in 2023 (Section 3.6). These rules are fully adopted and need no further action by the state or the EPA in order to take effect. The CAA contingency measure requirements for this area are therefore satisfied.

[35] The EPA described how states are to address contingency measure requirements for the 2015 ozone NAAQS in its final SIP requirements rule for the NAAQS (83 FR 62998). In response to several court decisions, on December 3, 2024 the EPA released new, nonbinding guidance on this requirement. However, this guidance was released too late to be considered in the development of this submittal.

## 7. PUBLIC PARTICIPATION

To comply with section 110(a)(2) of the CAA, on December 16, 2024, the WDNR published a notice of availability for this proposed SIP revision on its website, making this document available for public comment through January 17, 2025. The WDNR also held a public hearing on this proposed SIP revision on January 16, 2025. A summary of the public comments received, and the WDNR's responses to those comments, are included in Appendix 10.

Staff from EPA Region 5 were also given the opportunity to review the proposed submittal. Based on the feedback received, the WDNR also made the following changes in the final document:

- Modified the presentation of reasonable further progress figures (Section 3.4)
- Expanded the VOC RACT discussion (Section 6.2)
- Removed the transportation conformity budgets for year 2024 (Section 6.4)
- Included an updated modeled performance standard demonstration for the vehicle I/M program (Appendix 11)

## 8. CONCLUSION

This plan is submitted to fulfill the CAA moderate-area attainment requirements for the Sheboygan County 2015 ozone NAAQS nonattainment area. This SIP describes how ozone precursor emissions have decreased in both the nonattainment area and the state and are projected to continue to decrease in the future. Air quality monitoring data indicates that ozone concentrations have declined in the nonattainment area over the long-term, with smaller reductions observed in more recent years. The area has met the required RFP emission reductions due to an array of permanent and enforceable emissions control measures, and has satisfied all other moderate area nonattainment area requirements required under Sections 172 and 182 of the CAA.

# APPENDIX 1

# 2017 Emission Inventories Methodology

## 1. Introduction

This appendix provides additional information for the sector-specific nitrogen oxides (NOx) and volatile organic compounds (VOC) tons per ozone season day (tposd) emission estimates in the Wisconsin Department of Natural Resources (WDNR) Attainment Plan for the Sheboygan County, WI 2015 Ozone NAAQS Moderate Nonattainment Area.

## 2. Emissions Calculation Methodologies

### 2.1. Point Sources

Point sources are industrial, commercial or institutional stationary facilities which are normally located in permanent sites, and which emit specific air pollutants in great enough quantities to warrant individual quantification. To better enable detailed control evaluations, the point source emission inventories include all reporting sources at that facility regardless of the magnitude of reported emissions. For this attainment demonstration, portable point sources, such as asphalt plants and rock crushers, were reported under nonpoint sources to be consistent with other states. The 2017 point source emission inventory was created using annually reported point source emissions, the EPA's Clean Air Markets Division (CAMD) database and approved EPA techniques for emissions calculation (e.g., emission factors).

Whenever feasible, federal, state and local controls were factored into the emission calculations. Emissions were estimated by collecting process-level information from each facility that qualifies for inclusion into the state's point source database. In Wisconsin, this information is normally collected from facilities using web-based software and subsequently loaded into the point source database. Process, boiler, fugitive, and tank emissions are typically calculated using throughput information multiplied by an emission factor for that process. Emission factor sources included mass balance, stack testing, continuous emissions monitors, engineering judgment and EPA's WebFIRE database.[1] Missing data elements such as Source Classification Codes (SCC), North American Industrial Classification System (NAICS) codes and seasonal throughput percentages were added into the state's point source database. Process level confidential data were removed while retaining any associated emissions.

There is one electric generating unit (EGU) point source facility located in the Sheboygan County 2015 ozone NAAQS nonattainment area, the Alliant Energy Edgewater power plant. Appendix 3 provides the detailed methodology used to calculate EGU ozone season day emissions.

The 2017 emissions inventory for non-EGU point sources were tabulated using the emissions data reported annually by each facility operator to the WDNR's air emissions inventory (AEI) system. The AEI calculates emissions for each individual emissions unit or process line by multiplying fuel or process throughput by the appropriate emission factor that is derived from mass balance analysis, stack testing, continuous emissions monitoring, engineering analysis, or

[1] WebFIRE is EPA's online emissions factor repository, retrieval, and development tool, found online at: https://www.epa.gov/electronic-reporting-air-emissions/webfire.

EPA's WebFIRE database. Appendix 4 provides a list of non-EGU point source emissions by facility identification number (FID) and facility name for 2017.

The following procedure was used to determine an average day's emissions for a typical ozone season work weekday for non-EGU point sources. The WDNR obtained the quarterly operation schedule and the normal operating days per week information for each facility as collected by the WDNR AEI. The WDNR used emissions from the third quarter of the calendar year (i.e., July 1 to September 30) to represent the typical ozone season day emissions for these sources. The equation below was then used to calculate the emissions from typical ozone season days for each emission unit and process line. The emissions from each unit/process line at a facility were then summed to arrive at the total tons per ozone season day emissions for that facility.

$$EM = (Annual \times Third\ Quarter\ Percentage)/(DPW \times N_{weeks})$$

Where:

EM = Typical ozone season day emissions in tons per day
Annual = Annual emissions of VOC or NOx in tons
Third Quarter Percentage = the percentage of time that the unit is in operation for the third quarter of the calendar year, compared to the total time the unit is in operation for the entire calendar year, as reported to the WDNR
DPW = Days per week the facility operates, as reported to the WDNR
$N_{weeks}$ = Number of weeks (13) from July 1 to September 30

This equation inherently accounts for ozone season work weekday emissions being higher if a facility only operates during the work week (i.e., five days) instead of the entire week (i.e., seven days), consistent with EPA guidance. This method is also consistent with that used by WDNR in its 2017 baseline emissions inventory for 2015 ozone NAAQS nonattainment areas.

## 2.2. Nonpoint (Area) Sources

Nonpoint sources are stationary sources that are too small and/or too numerous to be tracked individually in the point source inventory. These sources include commercial/institutional, industrial and residential sources such as gasoline stations, dry cleaners, consumer and commercial products, industrial solvent use, auto refinishing and wood combustion. The nonpoint inventory quantifies these emissions collectively.

For the 2017 nonattainment year, nonpoint source emissions inventory estimates were based on the 2017 National Emissions Inventory (NEI), except for agriculture silage, selected categories of solvent utilization and the Stage II refueling category, as described below. The selected solvent utilization categories were graphic arts and miscellaneous non-industrial consumer and commercial categories with source classification code (SCC) 246xxxxxxx except agricultural pesticide application. The selected categories of consumer and commercial solvent utilization were graphic arts, personal care, household, automotive aftermarket, coatings and related, FIFRA related and miscellaneous products, adhesive and sealants, cutback and emulsified asphalt, hot and warm mix asphalt paving, volatile chemical products such as lighter fluids, fire starter and other fuels. For agricultural silage and these selected categories of solvent utilization, the 2017 nonpoint source emissions estimates were adjusted by back calculations based on the data from 2020 NEI and 2022 version 1 emissions modeling platform. Emission calculation methodologies used in developing 2017 nonpoint emissions inventory are available in the EPA's 2017 NEI Technical Support Document (TSD).[2]

The WDNR updated EPA nonpoint emissions estimates for stationary nonpoint sources for the following sectors: fuel combustion for the industrial, commercial and institutional (ICI) sectors; degreasing; dry-cleaning; graphic arts; and most of the solvent utilization for industrial surface coating categories except industrial maintenance, traffic markings and other special purpose categories. The WDNR adopted EPA nonpoint estimates for commercial cooking, solvent utilization for non-industrial surface coating, miscellaneous non-industrial consumer and commercial solvent utilization, residential and commercial portable fuel containers, bulk gasoline terminals and gas stations, waste disposal categories, and miscellaneous non-industrial not elsewhere classified (NEC) categories.

For the WDNR-updated nonpoint fuel combustion sectors, the EPA provided a SCC cross-walk between nonpoint and corresponding point source SCCs. These adjustments were made by subtracting the activity assigned for point sources from the total activity to estimate the adjusted nonpoint source activity. Energy consumption of these sectors for Wisconsin was obtained from the U.S. Department of Energy (DOE)'s Energy Information Administration (EIA). This survey data is the source of activity data for ICI fuel combustion. EIA's State Energy Data System (SEDS) data, as reported in EIA's most recent State Energy Consumption Estimates report, was used to determine total consumption for most fuel oil and kerosene.[3]

To update emission estimates for most of the solvent utilization for industrial surface coating categories, business pattern data from the U.S. Census Bureau's employment and county were used.[4]

To obtain area source emissions for the portion of Sheboygan County located in the 2015 ozone NAAQS nonattainment area, emission estimates from the entire county were allocated to the partial county based on population data. The county's population for 2017 was estimated by interpolating between 2015 and 2020 population data from the Wisconsin Department of Administration. The partial county population was identified based on the relative population of the Minor Civil Divisions (MCDs) in the nonattainment area as compared to the entire county. Using this methodology, for 2017, 59% of the county's population was estimated to live in the nonattainment area. Appendix 5 includes a table of area source emissions by source category.

Gasoline Service Stations, Stage II: Total Refueling

The WDNR estimated emissions from vehicle refueling at gasoline stations (Stage II refueling) using the EPA's MOVES4.0.1 model using the same inputs used for onroad modeling.

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[2] https://www.epa.gov/sites/production/files/2020-04/documents/nei2017_tsd_full_30apr2020.pdf.
[3] https://www.eia.gov/state/seds/sep_use/notes/use_print.pdf.
[4] https://www.census.gov/programs-surveys/cbp/data.html.

Beginning in the 1990s, a Stage II vapor recovery program (vapor recovery nozzles at gas pumps) was in effect in nine Wisconsin counties, including the entire Sheboygan County 2015 ozone NAAQS nonattainment area. This program was effective in reducing refueling emissions in older vehicles, but was redundant or even counter-productive in reducing emissions for newer vehicles, because the newer vehicles controlled refueling emissions through on-board refueling vapor recovery (ORVR) systems.[5] Wisconsin submitted a state implementation plan (SIP) revision removing Stage II requirements, which the EPA approved in November 2013. By 2017, most gasoline stations in the nine Wisconsin counties had removed or decommissioned their Stage II vapor recovery systems. To reflect this, the WDNR input zero emissions reductions from a Stage II program in its MOVES runs for year 2017.

Since the MOVES modeling for onroad emissions used ozone season weekday (oswd) travel activity, whereas the nonpoint emissions are based on the average of all seven days of the week (osd), the WDNR used travel data developed by the Wisconsin Department of Transportation (WDOT) to adjust the MOVES oswd output emissions for Stage II refueling to osd emissions, based on the ratio of average day (weekdays and weekends) to weekday travel during the ozone season. The WDNR-calculated adjustment factor for the Sheboygan County nonattainment area was 0.9501 for 2017.

## 2.3. Onroad Mobile Sources

Onroad mobile sources are motorized mobile equipment that are primarily used on public roadways. Examples of onroad mobile sources are cars, trucks, buses and road motorcycles. The emissions reported in this document were estimated using the MOtor Vehicle Emission Simulator (MOVES), the EPA's recommended mobile source model. The model was run in inventory mode. The version used was MOVES4.0.1, the most recent version of the model, released in January 2024. All estimates were made in accordance with the following EPA technical guidance:

- MOVES4 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity (94 pp, August 2023, EPA-420-B-23-011).

The onroad mobile NOx and VOC emissions for the Sheboygan County 2015 ozone NAAQS nonattainment area for 2017 (as well as the 2023 and 2024 projections) are presented in Appendix 7, separated by source type (vehicle class), fuel type and road type. Tables summarizing vehicle activity data are presented in Appendix 7 after the emissions tables.[6]

### 2.3.1. Transportation Data

The modeling inputs to MOVES include detailed transportation data (e.g., vehicle-miles of travel by vehicle class, road class and hour of day, and average speed distributions), requiring support

[5] The federally required phase in for ORVR systems started with model year 1998 and was required for all light-duty vehicles by model year 2006.
[6] The complete set of inputs to MOVES4.0.1 is too lengthy to include in this document. However, electronic copies of the input files can be obtained from WDNR upon request.

from the state agency responsible for transportation data in Sheboygan County, the Wisconsin Department of Transportation. The WDOT maintains transportation network inventory data for the state. The WDOT has developed and validated travel simulation models to estimate and forecast vehicle miles of travel (VMT) and average speed distributions for the state, including detailed data for both all of Sheboygan County and the Sheboygan County 2015 ozone NAAQS nonattainment area.

The WDOT provided to the WDNR its most recent transportation modeling data for both the entire county and the nonattainment area on July 3, 2024. Data were provided for 2010 (base year) and 2045 (projection year). (Data for intermediate years can be obtained by linear interpolation.) For each of these years, the data include average weekday VMT, vehicle-hours of travel (VHT) and average speed. These data were further broken down into 14 five-mph speed bins within 13 roadway classes within two general vehicle classes. For these data "weekday" includes only the three middle weekdays (Tuesday, Wednesday and Thursday).

The 14 speed bins are: 0-5 mph, 5-10 mph, etc., continuing through 60-65 mph and 65+ mph.

The 13 roadway classes are:

- Interstate
- Freeway
- Ramp
- Expressway
- Urban Principal Arterial
- Urban Minor Arterial
- Urban Collector
- Urban Local
- Rural Principal Arterial
- Rural Minor Arterial
- Rural Major Collector
- Rural Minor Collector
- Rural Local

The two general vehicle classes are: Auto and Truck

Besides WDOT transportation modeling data, the WDNR utilized the following additional WDOT transportation data in developing inputs to MOVES:

- WDOT official VMT estimates posted at the WDOT webpage.[7] In addition, the WDOT provided spreadsheets to the WDNR which expand these posted estimates by breaking down each of the official county VMT estimates into roadway classes.

- Statewide day-of-week and month-of-year VMT adjustment factors developed by the WDOT and provided to the WDNR by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) for the ten-year period of 2008 through 2017.

[7] http://wisconsindot.gov/Pages/projects/data-plan/veh-miles/default.aspx

#### 2.3.2. Descriptions of MOVES Modeling Inputs

The MOVES modeling inputs are described in the following 10 subsections.

##### 2.3.2.1. Vehicle-Miles of Travel (VMT)

A summary of the procedures the WDNR used to obtain ozone season weekday VMT estimates for input to MOVES follows.

- **Factors to Convert Annual Average Daily VMT (AADT) to Ozone Season Weekday VMT:** As specified in the EPA technical guidance, the onroad inventories for ozone SIPs should be based on ozone season *weekday* VMT, where "weekday" includes all five of the weekdays. Following historical practice, the WDNR defined "ozone season" for the mobile sector as the months of June, July and August. Using the WDOT day-of-week and month-of-year statewide VMT adjustment factors, the SEWRPC and the WDNR developed adjustment factors to convert from the AADT (annual VMT divided by 365) to ozone season weekday VMT (see Table A1.1). For the year 2017 (as well as for the 2023 and 2024 projections), adjustment factors were developed from the WDOT data averaged over the 10-year-period of 2008 to 2017.

  **Table A1.1. Factors to Convert AADT to Ozone Season Weekday VMT.**

| MOVES Roadway Type | Years 2017, 2023 and 2024 |
|---|---|
| Rural Restricted | 1.1528 |
| Rural Unrestricted | 1.1494 |
| Urban Restricted | 1.1551 |
| Urban Unrestricted | 1.1536 |

- **Estimation of Ozone Season Weekday VMT in the Sheboygan County 2015 Ozone NAAQS Nonattainment Area:** The WDOT's travel demand model does not provide full VMT coverage. For example, local travel is under-represented. Thus, the WDNR adjusted the WDOT-modeled VMT to match the WDOT's official posted AADT [8]. A summary of the WDOT-provided VMTs and the resulting WDNR-estimated ozone season weekday VMTs is shown in Table A1.2. The WDOT has previously agreed with these WDNR adjustment methods.

[8] http://wisconsindot.gov/Pages/projects/data-plan/veh-miles/default.aspx

**Table A1.2. VMTs for Sheboygan County and the Sheboygan County 2015 Ozone NAAQS Nonattainment Area.**

| WDOT Model Functional Class | Year 2017 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Full Sheboygan County | | | | | Sheboygan County Nonattainment Area | |
| | (a) WDOT-Modeled Weekday (Tu-Th) | (b) WDOT Official Posted AADT | (c) Factor to Ozone Season Weekday | (d) WDOT Official Posted AADT (Adjusted to Ozone Season Weekday) (b)*(c) | (e) Factor for WDOT-Modeled to Ozone Season Weekday (d)/(a) | (f) WDOT-Modeled Weekday (Tu-Th) | (g) WDNR-Estimated Ozone Season Weekday (Mo-Fr) (e)*(f) |
| Interstate | 596,533 | 682,022 | 1.1537 | 786,877 | 1.3191 | 596,390 | **786,688** |
| Other Freeway | 0 | 0 | | 0 | | 0 | **0** |
| Ramp | 43,144 | 39,362 | 1.1538 | 45,416 | 1.0526 | 33,494 | **35,257** |
| Expressway | 383,634 | 200,225 | 1.1546 | 231,174 | 0.6026 | 20,384 | **12,283** |
| Urban - Principal Arterial | 165,707 | 225,370 | 1.1536 | 259,987 | 1.5690 | 138,180 | **216,798** |
| Urban - Minor Arterial | 185,973 | 363,378 | 1.1536 | 419,193 | 2.2541 | 155,485 | **350,471** |
| Urban - Collector | 113,858 | 195,555 | 1.1536 | 225,592 | 1.9813 | 96,464 | **191,128** |
| Urban - Local | 15,190 | 120,908 | 1.1536 | 139,479 | 9.1826 | 14,330 | **131,584** |
| Rural - Principal Arterial | 217,896 | 352,906 | 1.1494 | 405,628 | 1.8616 | 48,773 | **90,795** |
| Rural - Minor Arterial | 349,629 | 199,537 | 1.1494 | 229,346 | 0.6560 | 58,140 | **38,138** |
| Rural - Major Collector | 269,567 | 328,247 | 1.1494 | 377,285 | 1.3996 | 54,536 | **76,329** |
| Rural - Minor Collector | 129,059 | 106,578 | 1.1494 | 122,500 | 0.9492 | 12,099 | **11,484** |
| Rural - Local | 40,098 | 131,182 | 1.1494 | 150,780 | 3.7603 | 14,705 | **55,295** |
| | | | | | | | |
| Total | 2,510,289 | 2,945,270 | 1.1521 | 3,393,257 | | 1,242,981 | **1,996,250** |

- **2017 Ozone Season Weekday VMT:** The WDOT-modeled VMT for an average weekday (Tuesday – Thursday) for the year 2017 is 1,242,981 for the Sheboygan County 2015 ozone NAAQS nonattainment area (interpolated between 2010 and 2045). After adjusting to ozone season weekday and to official WDOT VMT estimates, this value becomes 1,996,250.

- **Allocation of VMT to the 13 Vehicle Classes in MOVES:** The WDOT provided VMT data for two general vehicle classes (Auto and Truck[9]). The MOVES model calculates emissions for 13 vehicle classes as shown in Table A1.3. The WDNR used the MOVES4.0.1 default vehicle class distributions to further break down the VMT into the 13 MOVES classes. Table A1.3 shows the final VMT by vehicle class values the WDNR used in MOVES4.0.1.

[9] This truck class includes buses, but not passenger trucks or light commercial trucks.

**Table A1.3. Ozone Season Weekday VMT Input into MOVES4.0.1.**

| MOVES Vehicle Class | Year 2017 |
|---|---:|
| Motorcycles | 17,998 |
| Passenger Cars | 773,602 |
| Passenger Trucks | 932,377 |
| Light Commercial Trucks | 90,638 |
| Other Buses | 5,172 |
| Transit Buses | 1,930 |
| School Buses | 2,449 |
| Refuse Trucks | 737 |
| Single Unit Short-haul Trucks | 55,251 |
| Single Unit Long-haul Trucks | 3,635 |
| Motor Homes | 3,408 |
| Combination Short-haul Trucks | 38,509 |
| Combination Long-haul Trucks | 70,544 |
| **TOTAL** | **1,996,250** |

### 2.3.2.2. VMT by Hour of Day

The WDNR used the MOVES4.0.1 default hourly VMT distributions for Sheboygan County for the years 2017 (as well as for the 2023 and 2024 projections).

### 2.3.2.3. Vehicle Population

The WDNR estimated vehicle populations for each vehicle class by dividing ozone season weekday VMT by the MOVES4.0.1 default for average daily travel per vehicle on a July weekday. Table A1.4 shows the final vehicle population values the WDNR inputted into MOVES4.0.1.

**Table A1.4. Vehicle Populations Input into MOVES4.0.1.**

| MOVES Vehicle Class | Year 2017 |
|---|---:|
| Motorcycles | 1,748 |
| Passenger Cars | 22,355 |
| Passenger Trucks | 25,871 |
| Light Commercial Trucks | 2,413 |
| Other Buses | 59 |
| Transit Buses | 20 |
| School Buses | 83 |
| Refuse Trucks | 12 |
| Single Unit Short-haul Trucks | 1,379 |
| Single Unit Long-haul Trucks | 60 |
| Motor Homes | 200 |
| Combination Short-haul Trucks | 307 |
| Combination Long-haul Trucks | 244 |
| **TOTAL** | **54,752** |

#### 2.3.2.4. Vehicle Age Distribution

Using two datasets provided by the WDOT listing all vehicles registered in Wisconsin, the first providing registrations as of January 2018 and the second providing registrations as of November 2021, the WDNR calculated vehicle age distributions for those two periods and used those distributions to backcast a distribution to July 2017. The WDNR did these calculations in the year 2022. The WDNR calculated age distributions for all 13 MOVES vehicle classes except the two long-haul truck classes (MOVES classes 53 and 62), for which the WDNR used the MOVES3 default distributions. The WDNR calculated two July 2017 distributions: one for the seven-county vehicle inspection and maintenance (I/M) program region (Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Washington and Waukesha counties) and the other for the remaining 65 Wisconsin counties. Since the Sheboygan County 2015 ozone NAAQS nonattainment area is entirely within the I/M program region, the WDNR used the seven-county distribution for modeling the nonattainment area.

Table A1.4 presents the resulting average vehicle ages for July 2017.

**Table A1.4. Average Vehicle Ages (years old).**

| MOVES Vehicle Class | July 2017 |
|---|---|
| 11 - Motorcycle | 13.9 |
| 21 - Passenger Car | 9.6 |
| 31 - Passenger Truck | 7.8 |
| 32 - Light Commercial Truck | 10.6 |
| 41 - Other Bus | 11.5 |
| 42 - Transit Bus | 13.8 |
| 43 - School Bus | 7.8 |
| 51 - Refuse Truck | 11.0 |
| 52 - Single Unit Short-haul Truck | 11.3 |
| 53 - Single Unit Long-haul Truck | 12.0 |
| 54 - Motor Home | 15.5 |
| 61 - Combination Short-haul Truck | 13.8 |
| 62 - Combination Long-haul Truck | 10.5 |

#### 2.3.2.5. Road Type Distribution

MOVES requires that VMT for each of the 13 source types be allocated to the following four roadway classes:

- Rural – Restricted Access
- Rural – Unrestricted Access
- Urban – Restricted Access
- Urban – Unrestricted Access

The WDNR calculated road type distributions for the Sheboygan County nonattainment area from the transportation modeling data provided by the WDOT (described in section 2.3.1).

A detailed breakdown of VMT by roadway class by MOVES source type is provided in Appendix 7. The proportion of heavy-duty truck travel is significantly higher on restricted access roadways than on unrestricted access roadways.

#### 2.3.2.6. Average Speed Distribution

For each of the four MOVES roadway classes, the WDNR adjusted the 14-bin speed distribution obtained from the WDOT to the 16-bin speed distribution required by the MOVES model.[10] This adjustment was based on the average speeds within the WDOT bins.[11] The resulting distributions of VHT by average trip speed are provided in Appendix 7.

#### 2.3.2.7. Fuel Supply, Formulation and Usage Fraction

The MOVES4.0.1 defaults currently provide the best available fuel data and therefore were used.

#### 2.3.2.8. Alternate Vehicle Fuel and Technology (AVFT) Fractions

A required input for the MOVES model is the fraction of vehicles that are designed to run on each of the following fuel types:

- Gasoline
- Diesel
- 85% Ethanol blends (E-85)
- Compressed Natural Gas (CNG)
- Battery electric
- Fuel cell electric,

where these fractions are individually specified for each model year within each of the 13 MOVES vehicle classes. These fractions sum to 1 for each model year of each vehicle class.

The WDNR developed a table of AVFT fractions by retrieving data from a listing, provided by the WDOT, of all vehicles registered in Wisconsin as of July 2024. The WDOT registration database included a field for fuel type. The AVFT table the WDNR developed covers the seven-county vehicle inspection and maintenance (I/M) program region (Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Washington and Waukesha counties).

A detailed breakdown of vehicle population and VMT by fuel type is included in Appendix 7.

#### 2.3.2.9. Vehicle Inspection and Maintenance Program

[10] These 16 bins are: 0-2.5 mph, 2.5-7.5 mph, 7.5-12.5 mph, etc., continuing through 67.5-72.5 mph and 72.5+ mph. In comparison to the WDOT 14 bins, the MOVES bins include both slower and faster average speeds and are offset from the WDOT bins by 2.5 mph.

[11] For example, if the WDOT 30-35 mph bin has 1000 VHT at an average speed of 34 mph and the WDOT 35-40 mph bin has 1500 VHT at an average speed of 38 mph, then the VHT for the MOVES bin of 32.5-37.5 mph would equal: 1000 VHT * (34 mph – 30 mph)/(35 mph – 30 mph) + 1500 VHT * (40 mph – 38 mph)/(40 mph – 35 mph) = 800 VHT + 600 VHT = 1400 VHT.

The entire Sheboygan County 2015 ozone NAAQS nonattainment area is within the seven-county southeastern Wisconsin vehicle inspection program (I/M program) region. On-Board Diagnostic (OBD) checks were assumed for most model year 1996 and newer passenger cars, passenger trucks and light commercial trucks.

### 2.3.2.10. Meteorology Data

Temperatures conducive to peak ozone formation were assumed for the ozone season weekday modeling. To ensure consistent emission estimates over time, the WDNR has consistently used the same minimum and maximum temperatures for onroad modeling for ozone SIPs since the early 1990s. The temperatures were developed from an analysis of peak ozone days and have minimum/maximum values of 65/93 degrees Fahrenheit for the Sheboygan County 2015 ozone NAAQS nonattainment area.

## 2.4. Nonroad Mobile Sources

Nonroad mobile sources are motorized mobile equipment and other small and large engines that are primarily used off public roadways. Examples of nonroad mobile sources include commercial marine vessels, construction equipment, lawn and garden equipment, locomotives and agricultural equipment.

For purposes of inventory calculation, nonroad mobile sources are divided into two major groups:

- Commercial Marine, Aircraft and Rail Locomotive (MAR)
- All other nonroad categories

Nonroad categories other than MAR include:

- Recreational vehicles
- Construction equipment
- Industrial equipment
- Lawn and garden equipment
- Agricultural equipment
- Commercial equipment
- Logging equipment
- Underground mining equipment
- Oil field equipment
- Pleasure craft
- Railway maintenance equipment

A detailed listing of the nonroad emissions for each of the over 200 nonroad source subcategories, which include both the MAR and non-MAR groups, is presented in Appendix 6.

### 2.4.1. Non-MAR Sources

The 2017 nonroad emissions for the non-MAR categories were developed using the nonroad component of the EPA's MOVES4.0.1 model.

The only change the WDNR made to the MOVES4.0.1 nonroad defaults was an updated monthly distribution of agricultural activity, developed by the Lake Michigan Air Directors Consortium (LADCO) for Wisconsin and other Midwest states. The EPA also used these updated distributions for each Midwest state for the 2016 emission modeling platform and the 2017 and 2020 NEIs.

The model was run for Sheboygan County for the months of June, July and August, using the same hot ozone season day temperatures used for the onroad modeling.[12] The countywide hot ozone season day emissions were then calculated by dividing the total emissions over these three months by 92 (the number of days in the three months).

The WDNR then allocated the countywide hot ozone season day emissions to the portion of the county within the nonattainment area based on surrogates such as population, land area and water area, depending on the category, as described below in section 2.4.3

### 2.4.2. MAR Sources

To estimate emissions for commercial marine vessels, aircraft, and rail locomotive the WDNR first obtained *annual* 2017 emissions from EPA's 2017 NEI[13]. Then the WDNR divided these emissions by 365 to estimate ozone season day emissions. Finally, the WDNR allocated the countywide emissions to the portion of the county within the nonattainment area, as described in section 2.4.3.

[12] The nonroad component of MOVES does not model areas smaller than full counties.
[13] https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data

### 2.4.3. Allocation of Sheboygan County Emissions to the Sheboygan County 2015 Ozone NAAQS Nonattainment Area

The Sheboygan County 2015 ozone NAAQS nonattainment area comprises only part of the full county, thereby requiring surrogates to estimate the proportion of countywide emissions in the nonattainment area. Given the wide range of nonroad mobile sources, several surrogates were employed. They are described below.

#### 2.4.3.1. Land Area

Using the WDOT official county map[14] for Sheboygan County, the WDNR calculated that the land area within the Sheboygan County 2015 ozone NAAQS nonattainment area comprises 17% of the total county land area.

The nonroad categories allocated to the Sheboygan County 2015 ozone NAAQS nonattainment area based on land area are **agriculture**, **logging**, **oilfields**, **recreational**, and **underground mining**. It should be noted that the nonattainment area has no emissions from oilfields or underground mining.

#### 2.4.3.2. Population

As described in section 2.2 (Nonpoint (Area) Sources), the percentage of the Sheboygan County population estimated to live in the Sheboygan County 2015 ozone NAAQS nonattainment area is 59% for 2017.

The nonroad categories allocated to the nonattainment area based on this population percentage are **commercial**, **construction**, **industrial**, and **lawn & garden**.

#### 2.4.3.3. Water Area

Inland Water Area (excluding Lake Michigan)

The WDNR estimated, using the WDOT official county map[15] for Sheboygan County, that the inland water area within the Sheboygan County 2015 ozone NAAQS nonattainment area comprises 0% of the total county inland water area.

Inland Water Area Combined with Lake Michigan Water Area

Sheboygan County also has water area along the Lake Michigan shoreline, of which all (100%) is in the nonattainment area. To estimate the combined percentage of water area within the nonattainment area for Sheboygan County, the WDNR used the above inland water area percentage for the nonattainment area (0%) as well as water area data from two tables in the MOVES4.0.1 nonroad data files: WI WIB.ALO, which provides the water area in each

[14] https://wisconsindot.gov/Pages/travel/road/hwy-maps/county-maps/default.aspx
[15] https://wisconsindot.gov/Pages/travel/road/hwy-maps/county-maps/default.aspx

Wisconsin county applicable to pleasure craft having inboard engines, and WI WOB.ALO, which provides water area in each Wisconsin county applicable to pleasure craft having outboard engines. The difference between these two tables is that WI WIB.ALO includes water area along the Lake Michigan shore as well as inland water area, while WI WOB.ALO only includes the inland water area.

For Sheboygan County, WI WIB.ALO has 145 square kilometers of water area and WI WOB.ALO has 28 square kilometers of water area. The 145 square kilometer value for inboard engines contains Lake Michigan waters (117 square kilometers) and 28 square kilometers of water from several inland lakes. The 28 square kilometer value for outboard engines contains only the water from the inland lakes. Thus, for pleasure craft with inboard engines (117*100.0% + 28*0%)/145= 81% of the associated water area is in the Sheboygan County 2015 ozone NAAQS nonattainment area and for pleasure craft with outboard engines (28*0%)/28 = 0% of the associated water area is in the nonattainment area.

Final Allocation Percentages

The nonroad category allocated to the nonattainment area based on water area is **pleasure craft**. For pleasure craft with inboard engines, the percentage of full county emissions allocated to the Sheboygan County 2015 ozone NAAQS nonattainment area is 81%. And for pleasure craft with outboard engines, the percentage of full county emissions allocated to the nonattainment area is 0%.

#### 2.4.3.4. Lake Michigan Shoreline

Sheboygan County has water area along the Lake Michigan shoreline, of which all (100%) is in the nonattainment area. The nonroad category allocated to the nonattainment area based on Lake Michigan shoreline is **commercial marine**, since all commercial marine emissions attributable to Sheboygan County come from vessels traveling on Lake Michigan past the county. Sheboygan County does not have any ports, inland lakes or inland rivers with commercial marine activity.

#### 2.4.3.5. Airport Location

The WDNR obtained countywide annual aircraft emissions for Sheboygan County from the EPA's 2022 Emissions Modeling Platform, version 1[16]. These summaries include the longitude and latitude of the airport associated with the emissions, allowing one to determine which of the airports are in the nonattainment area. Only one airport was listed for Sheboygan County, Sheboygan County Memorial International Airport, which is located outside of the nonattainment area.

Thus, **aircraft** emissions in the nonattainment area are 0% of the total countywide aircraft emissions.

[16] https://www.epa.gov/air-emissions-modeling/2022v1-emissions-modeling-platform

### 2.4.3.6. Railroad Track Miles

The WDNR estimated, using the WDOT official county map[17] for Sheboygan County, the number of railroad track miles in the full Sheboygan County and in the nonattainment portion of the county as follows:

- 65 total miles, with 29 miles (45%) in the nonattainment area

The WDNR used this percentage to allocate both **rail locomotive** and **railroad maintenance** emissions to the nonattainment area.

[17] https://wisconsindot.gov/Pages/travel/road/hwy-maps/county-maps/default.aspx

# APPENDIX 2

# 2023 and 2024 Emissions Projections Methodology

This appendix provides information for the sector-specific NOx and VOC tons per ozone season day (tposd) emission estimates for the Wisconsin Department of Natural Resources (WDNR) Attainment Plan for the Sheboygan County, WI 2015 Ozone NAAQS Moderate Nonattainment Area. As part of this demonstration, WDNR is providing a projection of emissions for 2023 and 2024.

## 1. EGU Inventory Methodology for 2023 and 2024

See Appendix 3 for the projection methodology related to electric generating units (EGUs).

## 2. Non-EGU Point Source Inventory Methodology for 2023 and 2024

Non-EGU point source emissions are projected for 2023 by using 2023 reported emissions. Emissions are projected for 2024 by applying a growth factor of 1.0 to the 2023 inventory. A list of sources with the 2023 and 2024 emissions is provided in Appendix 4.

## 3. Area Source Inventory Methodology for 2023 and 2024

EPA's 2022 Emissions Modeling Platform, Version 1 includes base year 2022.[1] Emissions for 2023 and 2024 were estimated by extrapolating EPA's 2017 and 2020 NEIs and 2022 base year emissions from EPA's 2022 Emissions Modeling Platform. Year 2023 area source emissions were sourced primarily from the 2022 Emissions Modeling Platform, Version 1, which incorporates area source emissions based on the 2020 NEI nonpoint inventory for both anthropogenic and biogenic emissions.

Methodologies used to develop 2022 emissions modeling platform projection data are available in the EPA's 2022 Version 1 document.[2] According to this document, the 2022 Version 1 nonpoint solvent emissions, except asphalt paving, are projected from the 2020NEI, including state submitted emissions. Using 2021 data, a SCC-specific ratio was derived and applied to 2020NEI emissions. This ensures state-submitted emissions magnitudes are preserved. For asphalt paving, 2020NEI emissions are carried forward. Due to methodology changes for some solvent utilization categories and introducing a new category of agriculture silage for 2020NEI, 2023 and 2024 projections for a number of individual SCCs that fall under "246xxxxxxx" (solvent utilization) showed a significant increase between 2017 and the projection years. To be conservative, WDNR used the projection years estimates based on 2020NEI to back calculate 2017 emissions for these SCCs. The WDNR also projected emissions from vehicle refueling at gasoline stations (Stage II refueling) using EPA's MOVES4.0.1 model with the same inputs used for the onroad modeling, as explained below.

For the Stage II refueling emissions, as was done for 2017, the WDNR adjusted weekday emissions to average day (weekdays and weekends) emissions, based on the ratio of average day to weekday travel, resulting in an adjustment factor of 0.9506 for both 2023 and 2024. Also, as

[1] https://www.epa.gov/air-emissions-modeling/2022v1-emissions-modeling-platform
[2] https://gaftp.epa.gov/Air/emismod/2022/v1/2022v1_emissions_docn.pdf

was done for 2017, no Stage II vapor recovery program was modeled for 2023 and 2024. Owing to most vehicles now having their own vapor recovery system, Stage II controls at the pump are largely redundant or even counter-productive. Wisconsin submitted a SIP revision removing Stage II requirements, and the EPA approved the revision in November 2013. Even without a Stage II program, emissions from Stage II refueling decreased by about 25% from 2017 to 2024, owing to the larger percentage of vehicles with onboard vapor recovery.

To obtain area source emissions for the portion of Sheboygan County located in the 2015 ozone NAAQS nonattainment area, emission estimates from the entire county were allocated to the partial county based on population data. The partial county population was identified based on the relative population of the Minor Civil Divisions (MCDs) in the nonattainment area as compared to the entire county. Using this methodology, for both 2023 and 2024, 59% of the county's population was estimated to live in the nonattainment area. Appendix 5 includes a table of area source emissions by source category.

## 4. Onroad Inventory Methodology for 2023 and 2024

As was done for the 2017 emissions, projected onroad emissions for 2023 and 2024 were developed using the MOVES4.0.1 model. Unless otherwise stated in this section, the methodology the WDNR used for 2023 and 2024 is identical to the methodology the WDNR used for year 2017, as described in Appendix 1, section 2.3.

The WDNR grew vehicle-miles of travel (VMT) from 2017 using the same growth rates provided in the transportation modeling data provided to WDNR by the Wisconsin Department of Transportation (WDOT). The WDOT data provide separate growth rates for the combined light-duty classes ("Autos") and the combined heavy-duty classes ("Trucks"). After growing the VMT for these two general classes, WDNR allocated the VMT to the MOVES sub-classes based on the MOVES4.0.1 default VMT splits by vehicle class for Sheboygan County for 2023 and 2024. Table A2.1 shows the resulting ozone season weekday VMT.

**Table A2.1. Ozone Season Weekday VMT Input into MOVES4.0.1.**

| MOVES Vehicle Class | Year | | |
|---|---|---|---|
| | 2017 | 2023 | 2024 |
| Motorcycles | 17,998 | 19,323 | 19,497 |
| Passenger Cars | 773,602 | 677,654 | 664,472 |
| Passenger Trucks | 932,377 | 1,111,104 | 1,138,992 |
| Light Commercial Trucks | 90,638 | 108,471 | 110,579 |
| Other Buses | 5,172 | 5,037 | 5,097 |
| Transit Buses | 1,930 | 1,685 | 1,691 |
| School Buses | 2,449 | 2,360 | 2,390 |
| Refuse Trucks | 737 | 643 | 646 |
| Single Unit Short-haul Trucks | 55,251 | 61,777 | 62,460 |
| Single Unit Long-haul Trucks | 3,635 | 4,124 | 4,179 |
| Motor Homes | 3,408 | 3,452 | 3,489 |
| Combination Short-haul Trucks | 38,509 | 39,915 | 40,658 |
| Combination Long-haul Trucks | 70,544 | 75,360 | 75,864 |
| **TOTAL** | **1,996,250** | **2,110,904** | **2,130,013** |

The total ozone season weekday VMT increases by 5.74% from 2017 to 2023 and increases a further 0.91% from 2023 to 2024. In terms of annual VMT growth rates, these rates are 0.94% from 2017 to 2023 and 0.91% from 2023 to 2024.

The vehicle populations for each of the years are shown in Table A2.2.

**Table A2.2. Vehicle Populations Input into MOVES4.0.1.**

| MOVES Vehicle Class | Year | | |
|---|---|---|---|
| | **2017** | **2023** | **2024** |
| Motorcycles | 1,748 | 2,058 | 2,070 |
| Passenger Cars | 22,355 | 20,361 | 19,999 |
| Passenger Trucks | 25,871 | 30,993 | 31,744 |
| Light Commercial Trucks | 2,413 | 2,885 | 2,954 |
| Other Buses | 59 | 63 | 65 |
| Transit Buses | 20 | 19 | 20 |
| School Buses | 83 | 86 | 89 |
| Refuse Trucks | 12 | 11 | 11 |
| Single Unit Short-haul Trucks | 1,379 | 1,621 | 1,683 |
| Single Unit Long-haul Trucks | 60 | 71 | 74 |
| Motor Homes | 200 | 221 | 229 |
| Combination Short-haul Trucks | 307 | 333 | 341 |
| Combination Long-haul Trucks | 244 | 259 | 266 |
| **TOTAL** | **54,752** | **58,982** | **59,545** |

The total vehicle population increases by 7.73% from 2017 to 2023 and increases by a further 0.95% from 2023 to 2024. In terms of annual population growth rates, these rates are 1.25% from 2017 to 2023 and 0.95% from 2023 to 2024.

Using a dataset provided by the Wisconsin Department of Transportation (WDOT) listing all vehicles registered in Wisconsin as of July 2024, the WDNR calculated vehicle age distributions for all 13 MOVES vehicle classes except the two long-haul truck classes (MOVES classes 53 and 62), for which the WDNR used the MOVES4 default distributions. The distribution calculated by the WDNR covered the seven southeastern Wisconsin counties in the vehicle inspection and maintenance program region (Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Washington and Waukesha counties). The WDNR used this distribution for calendar year 2024. To approximate a distribution for calendar year 2023, the WDNR adjusted the 2024 distribution by removing the age fraction for model year 2024 for each vehicle class and then normalized the remaining age fractions for each vehicle class so that they would sum to 1. Table A2.3 presents the resulting average vehicle ages for all three inventory years.

**Table A2.3. Average Vehicle Ages (years old).**

| MOVES Vehicle Class | Year | | |
|---|---|---|---|
| | 2017 | 2023 | 2024 |
| 11 - Motorcycle | 13.9 | 15.1 | 15.6 |
| 21 - Passenger Car | 9.6 | 10.9 | 11.7 |
| 31 - Passenger Truck | 7.8 | 7.4 | 8.0 |
| 32 - Light Commercial Truck | 10.6 | 9.6 | 10.2 |
| 41 - Other Bus | 11.5 | 13.4 | 13.3 |
| 42 - Transit Bus | 13.8 | 13.7 | 14.2 |
| 43 - School Bus | 7.8 | 7.1 | 7.7 |
| 51 - Refuse Truck | 11.0 | 18.8 | 19.2 |
| 52 - Single Unit Short-haul Truck | 11.3 | 10.6 | 11.0 |
| 53 - Single Unit Long-haul Truck | 12.0 | 12.9 | 12.9 |
| 54 - Motor Home | 15.5 | 14.5 | 14.8 |
| 61 - Combination Short-haul Truck | 13.8 | 13.2 | 13.4 |
| 62 - Combination Long-haul Truck | 10.5 | 10.6 | 10.7 |

Emissions for 2023 and 2024 were increased by a 15% safety margin, as agreed through the interagency transportation conformity consultative process.

The motor vehicle inspection and maintenance (I/M) program remained in effect for 2023 and 2024.

Detailed listing of the projected onroad emissions and activity data are provided in Appendix 7.

## 5. Nonroad Inventory Methodology for 2023 and 2024

Unless otherwise stated in this section, the methodology for determining 2023 and 2024 projected nonroad emissions is identical to the methodology used to determine the 2017 estimates, as described in Appendix 1, section 2.4.

For all source categories except commercial marine, aircraft and rail locomotive (MAR), the nonroad component of the MOVES4.0.1 model was run for Sheboygan County at hot ozone season day temperatures. As was done for 2017, the only change made to the MOVES4.0.1 nonroad defaults was an updated monthly distribution of agricultural activity, developed by the Lake Michigan Air Directors Consortium (LADCO). The MOVES4.0.1 model's default growth projections were assumed.

For the MAR categories, the WDNR obtained emissions for year 2022 from the EPA's 2022 Emissions Modeling Platform, Version 1[3]. Then, to project emissions to years 2023 and 2024, WDNR linearly extrapolated from the year 2017 emissions (documented in Appendix 1, section 2.4) and the year 2022 modeling platform emissions, with the constraint that if the 2022 emissions were less than the 2017 emissions, the 2023 and 2024 emissions were set equal to the

[3] https://www.epa.gov/air-emissions-modeling/2022v1-emissions-modeling-platform

2022 emissions. The intent of this constraint is to avoid an underestimation of 2023 and 2024 emissions.

In allocating emissions to the Sheboygan County 2015 ozone NAAQS nonattainment area, the same adjustment factors used for 2017 were also used for 2023 and 2024.

Detailed listings of the projected nonroad emissions for over 200 subcategories are provided in Appendix 6.

# APPENDIX 3

# EGU Point Source Emissions for 2017, 2023 and 2024

This appendix provides the methodology for electric generating unit (EGU) sector NOx and VOC tons per ozone season day (tposd) emission estimates found in sections 3.2 and 3.3 of the Wisconsin Department of Natural Resources (WDNR) Attainment Plan for the Sheboygan County, WI 2015 Ozone NAAQS Moderate Nonattainment Area.

Alliant Energy has one point-source facility with EGUs located in the Sheboygan County 2015 ozone NAAQS nonattainment area, the Edgewater coal-fired power plant.

## 1. 2017 Emissions

The 2017 NOx emissions, emission rates and fuel consumption for the generating units at these facilities were derived from data reported by the utility to EPA's Clean Air Markets Program Data (CAMPD) database. The WDNR used the ozone season (i.e., May 1 through September 30) day with the $99^{th}$ percentile highest heat input for each unit during the ozone season to represent ozone season day operations during the 2017 ozone season. Using this $99^{th}$ percentile value provides a conservative, but reasonable, representation of maximum ozone season day operation. The ozone season day emissions were then calculated by multiplying the maximum ozone season day heat inputs in 2017 by the average emission rates for the 2017 ozone season. The NOx emission rates were derived from the CAMPD emissions data for the 2017 ozone season. This base data and the resulting tposd emissions are provided in Table A3.1. The total NOx emissions were 5.97 tposd in 2017.

The 2017 VOC ozone season day emissions are also derived by multiplying the maximum day heat inputs by average VOC emission rates. The base data used in the calculation and the resulting emissions are provided in Table A3.1. In this case, however, VOC emissions are not monitored by continuous emissions monitors and reported to the CAMPD database, as is done for NOx. Therefore, the VOC emission rates were derived by dividing the annual VOC emissions reported to the WDNR Air Emissions Inventory system by the annual heat input reported to the CAMPD database for 2017. The data applied to derive the VOC emission rates are shown in Table A3.2. Multiplying these VOC emission rates by the maximum day heat inputs resulted in 0.35 tposd of VOC in 2017.

Note: emissions from non-electric generating emission units at the plants (i.e., units other than the coal boilers) are not included because they are insignificant (less than 5 tons per year) compared to the EGU emissions.

**Table A3.1. Ozone Season Day Operation and Emissions in 2017 for EGUs.**

| Variable | Unit Number | |
|---|---|---|
| | **B24** | **B25** |
| *Ozone Season Day Heat Input (mmBtu)*[1] | 63,979 | 95,271 |
| *NOx Rate (lbs/mmBtu)*[2] | 0.137 | 0.033 |
| *NOx (tposd)* | 4.38 | 1.59 |
| *NOx Control* | SNCR | SCR |
| *VOC Rate (lbs/mmBtu)*[3] | 0.0062 | 0.0032 |
| *VOC (tposd)* | 0.199 | 0.153 |

SCR = Selective catalytic reduction; SNCR = Selective non-catalytic reduction
[1] Heat input is for the day with the 99th percentile highest heat input during the 2017 ozone season. "Ozone Season" is defined here as May 1 through September 30.
[2] Emission rate derived from the EPA CAMPD ozone season NOx emissions and heat input.
[3] Calculated in Table A3.2.

**Table A3.2. EGU VOC Annual Emissions and Emission Rates in 2017.**

| Variable | Unit Number | |
|---|---|---|
| | **B24** | **B25** |
| *Annual VOC (tons)*[1] | 0.199 | 0.153 |
| *Annual Heat Input (mmBtu)*[2] | 16,770,170 | 25,224,079 |
| *VOC Rate (lbs/mmBtu)* | 0.0062 | 0.0032 |

[1] Emissions reported to the WDNR Air Emissions Inventory.
[2] Heat input reported to the EPA CAMPD database.

### 2. 2023 and 2024 Emissions

Following the same methodology used to calculate 2017 emissions, the WDNR estimated ozone season day emissions in 2023 for the Sheboygan nonattainment area EGUs by multiplying the maximum daily heat input by the average ozone season emission rate. The data used in this calculation and resulting emissions are summarized in Table A3.3.

The Edgewater power plant retired boiler B24 before the start of the 2023 ozone season, therefore that unit has an ozone season day heat input value of "0" for that period. The NOx and VOC tposd emissions from the Edgewater power plant for 2024 are based on the 2023 tposd emissions and using no growth factor from 2023 to 2024.

Based on the information in Tables A3.3 and A3.4, the total emissions from the Edgewater power plant are calculated to be 4.24 tposd for NOx and 0.18 tposd for VOC for 2023 and 2024.

**Table A3.3. Ozone Season Day Operation and Emissions in 2023 and 2024 for EGUs.**

| Variable | Unit Number | |
|---|---|---|
| | **B24** | **B25** |
| *Ozone Season Day Heat Input (mmBtu)*[1] | 0 | 108,505 |
| *NOx Rate (lbs/mmBtu)*[2] | - | 0.064 |
| *NOx (tposd)* | 0 | 4.24 |
| *NOx Control* | 0 | SCR |
| *VOC Rate (lbs/mmBtu)*[3] | - | 0.0033 |
| *VOC (tposd)* | 0 | 0.181 |

SCR = Selective catalytic reduction
[1] Heat input is for the day with the highest 99th percentile daily value for the 2023 ozone season. "Ozone Season" is defined here as May 1 through September 30.
[2] Emission rate derived from the EPA CAMPD ozone season NOx emissions and heat input for 2023.
[3] Calculated in Table A3.4.

**Table A3.4. EGU VOC Annual Emissions and Emission Rates in 2023 and 2024.**

| Variable | Unit Number | |
|---|---|---|
| | **B24** | **B25** |
| *Annual VOC (tons)*[1] | 0 | 0.181 |
| *Annual Heat Input (mmBtu)*[2] | 0 | 21,817,056 |
| *VOC Rate (lbs/mmBtu)* | - | 0.0033 |

[1] Emissions reported to the WDNR Air Emissions Inventory.
[2] Heat input reported to the EPA CAMPD database.

### 3. Summary of EGU Point Source Emissions

Based on the information above, the total ozone season day emissions from the sources with EGUs located in the Sheboygan 2015 ozone NAAQS nonattainment area are summarized in Table A3.5.

**Table A3.5. Total 2017, 2023, and 2024 Emissions from EGUs.**

| Facility Name (FID #) | Pollutant | 2017 (tposd) | 2023 (tposd) | 2024 (tposd) |
|---|---|---|---|---|
| Edgewater (460033090) | NOx | 5.97 | 4.24 | 4.24 |
| | VOC | 0.352 | 0.181 | 0.181 |

# APPENDIX 4

# Non-EGU Point Source Emissions for 2017, 2023 and 2024

This appendix provides a list of the Sheboygan County, WI 2015 ozone NAAQS nonattainment area non-electric generating unit (non-EGU) point source tons per ozone season day (tposd) emissions by facility identification number (FID) and facility name for 2017, 2023 and 2024. The sums of NOx and VOC emissions from these facilities were used for the non-EGU sector NOx and VOC tposd emission estimates found in sections 3.2 (Baseline Year Inventory) and 3.3 (Attainment Year Inventories) of the Wisconsin Department of Natural Resources (WDNR) Attainment Plan for the Sheboygan County, WI 2015 Ozone NAAQS Moderate Nonattainment Area.

**Table A4.1. 2017 Point Non-EGU Emissions for the Sheboygan County, WI 2015 Ozone NAAQS Nonattainment Area[1,2]**

| FID | Facility Name | NAICS | Pollutant | 2017 (tposd) | 2017 (tons) |
|---|---|---|---|---|---|
| 460006360 | SHEBOYGAN WASTEWATER TREATMENT PLANT | 221320 | NOx | 0.00 | 1.71 |
| 460012740 | OLD WISCONSIN SAUSAGE CO PLANT 2 | 311612 | NOx | 0.00 | 2.46 |
| 460023520 | MANNING LIGHTING INC | 332321 | NOx | 0.00 | 0.39 |
| 460023740 | LAKESHORE DISPLAY CO INC | 321999 | NOx | 0.00 | 0.01 |
| 460027810 | ALDRICH CHEMICAL COMPANY, LLC (dba MilliporeSigma) | 325199 | NOx | 0.00 | 8.51 |
| 460029570 | NEMSCHOFF CHAIRS INC. | 337127 | NOx | 0.00 | 0.85 |
| 460032870 | KOHLER CO - METALS PROCESSING COMPLEX | 332999 | NOx | 0.02 | 37.34 |
| 460034740 | PLASTICS ENGINEERING CO N 15TH ST PLANT | 325211 | NOx | 0.01 | 12.29 |
| 460034960 | AUSTIN GRAY IRON FOUNDRY | 331511 | NOx | 0.00 | 0.19 |
| 460035180 | THE VOLLRATH COMPANY LLC | 332999 | NOx | 0.00 | 4.72 |
| 460035730 | WILLMAN INDUSTRIES | 331511 | NOx | 0.00 | 2.56 |
| 460038700 | Discovery Energy LLC | 335311 | NOx | 0.01 | 19.88 |
| 460041230 | NEMAK USA INC - TAYLOR DRIVE | 331314 | NOx | 0.00 | 0.07 |
| 460041670 | Hexion Inc | 325211 | NOx | 0.01 | 19.36 |
| 460106570 | AMERICAN EXCELSIOR | 326150 | NOx | 0.00 | 0.24 |
| 460141330 | NEMAK GATEWAY PLANT | 331314 | NOx | 0.02 | 39.61 |
| 460145840 | SAFCO PRODUCTS CO | 337211 | NOx | 0.00 | 0.86 |
| 460147820 | KOHLER COMPANY - VITREOUS PLANT | 327110 | NOx | 0.00 | 7.00 |
| 460147930 | KOHLER CO-ENGINE PLANT | 333618 | NOx | 0.00 | 2.05 |
| 460006360 | SHEBOYGAN WASTEWATER TREATMENT PLANT | 221320 | VOC | 0.00 | 0.79 |
| 460012740 | OLD WISCONSIN SAUSAGE CO PLANT 2 | 311612 | VOC | 0.00 | 1.95 |
| 460022530 | SHEBOYGAN PAPERBOX CO | 322211 | VOC | 0.02 | 30.92 |
| 460023520 | MANNING LIGHTING INC | 332321 | VOC | 0.00 | 0.05 |
| 460023740 | LAKESHORE DISPLAY CO INC | 321999 | VOC | 0.01 | 10.31 |
| 460027480 | PSCO Kieffer | 339950 | VOC | 0.00 | 4.86 |
| 460027810 | ALDRICH CHEMICAL COMPANY, LLC (dba MilliporeSigma) | 325199 | VOC | 0.00 | 6.40 |
| 460029570 | NEMSCHOFF CHAIRS INC. | 337127 | VOC | 0.01 | 15.73 |
| 460032870 | KOHLER CO - METALS PROCESSING COMPLEX | 332999 | VOC | 0.03 | 57.93 |
| 460034740 | PLASTICS ENGINEERING CO N 15TH ST PLANT | 325211 | VOC | 0.00 | 4.05 |
| 460034960 | AUSTIN GRAY IRON FOUNDRY | 331511 | VOC | 0.00 | 2.49 |
| 460035180 | THE VOLLRATH COMPANY LLC | 332999 | VOC | 0.00 | 0.26 |
| 460035730 | WILLMAN INDUSTRIES | 331511 | VOC | 0.01 | 14.67 |
| 460038700 | Discovery Energy LLC | 335311 | VOC | 0.00 | 9.43 |
| 460038810 | SHEBOYGAN PAINT CO | 325510 | VOC | 0.02 | 41.30 |

| FID | Facility Name | NAICS | Pollutant | 2017 (tposd) | 2017 (tons) |
|---|---|---|---|---|---|
| 460041230 | NEMAK USA INC - TAYLOR DRIVE | 331314 | VOC | 0.00 | 8.88 |
| 460041670 | Hexion Inc | 325211 | VOC | 0.02 | 33.37 |
| 460106570 | AMERICAN EXCELSIOR | 326150 | VOC | 0.00 | 5.58 |
| 460130440 | SACO AEI POLYMERS | 325991 | VOC | 0.00 | 6.61 |
| 460141330 | NEMAK GATEWAY PLANT | 331314 | VOC | 0.01 | 10.07 |
| 460145840 | SAFCO PRODUCTS CO | 337211 | VOC | 0.01 | 22.62 |
| 460147820 | KOHLER COMPANY - VITREOUS PLANT | 327110 | VOC | 0.00 | 0.41 |
| 460147930 | KOHLER CO-ENGINE PLANT | 333618 | VOC | 0.01 | 14.62 |
| 460169600 | FRANZEN GRAPHICS AND SUN GRAPHICS MEDIA | 323111 | VOC | 0.00 | 7.13 |
| **Total** | | | **NOx** | **0.08** | **160.08** |
| | | | **VOC** | **0.16** | **310.44** |

[1] Tons per ozone season day (tposd) emissions were calculated by the WDNR AEI using the 3rd quarter operation information.

[2] According to Wisconsin Administrative Code Chapter NR 438.03(a), facilities that emit less than 3 tons of VOC or less than 5 tons of NOx per year are not required to submit annual emission inventory reports. Sources that chose not to report NOx and/or VOC for a certain year are thus listed as “Not Reporting” for that year.

**Table A4.2. 2023 and 2024 Point Non-EGU Emissions for the Sheboygan County, WI 2015 Ozone NAAQS Nonattainment Area[1,2]**

| FID | Facility Name | NAICS | Pollutant | 2023 (tposd) | 2024 (tposd) | 2023 (tons) | 2024 (tons) |
|---|---|---|---|---|---|---|---|
| 460008230 | GEORGIA PACIFIC CORRUGATED LLC | 322211 | NOx | 0.00 | 0.00 | 4.28 | 4.28 |
| 460012740 | OLD WISCONSIN SAUSAGE CO PLANT 2 | 311612 | NOx | 0.00 | 0.00 | 2.62 | 2.62 |
| 460023740 | LAKESHORE DISPLAY CO INC | 321999 | NOx | 0.00 | 0.00 | 0.17 | 0.17 |
| 460027810 | ALDRICH CHEMICAL COMPANY, LLC (dba MilliporeSigma) | 325199 | NOx | 0.00 | 0.00 | 9.82 | 9.82 |
| 460029570 | NEMSCHOFF CHAIRS INC. | 337127 | NOx | 0.00 | 0.00 | 0.37 | 0.37 |
| 460032870 | KOHLER CO - METALS PROCESSING COMPLEX | 332999 | NOx | 0.02 | 0.02 | 32.77 | 32.77 |
| 460034740 | PLASTICS ENGINEERING CO N 15TH ST PLANT | 325211 | NOx | 0.00 | 0.00 | 8.43 | 8.43 |
| 460034960 | AUSTIN GRAY IRON FOUNDRY | 331511 | NOx | 0.00 | 0.00 | 0.26 | 0.26 |
| 460035180 | THE VOLLRATH COMPANY LLC | 332999 | NOx | 0.00 | 0.00 | 4.60 | 4.60 |
| 460035730 | WILLMAN INDUSTRIES | 331511 | NOx | 0.00 | 0.00 | 2.58 | 2.58 |
| 460036060 | HTT Inc | 332119 | NOx | 0.00 | 0.00 | 0.61 | 0.61 |
| 460038700 | Discovery Energy LLC | 335311 | NOx | 0.02 | 0.02 | 33.19 | 33.19 |
| 460039580 | WATRY INDUSTRIES | 331524 | NOx | 0.00 | 0.00 | 6.42 | 6.42 |
| 460041230 | NEMAK USA INC - TAYLOR DRIVE | 331314 | NOx | 0.00 | 0.00 | 8.42 | 8.42 |
| 460041670 | Hexion Inc | 325211 | NOx | 0.01 | 0.01 | 17.98 | 17.98 |
| 460106570 | AMERICAN EXCELSIOR | 326150 | NOx | 0.00 | 0.00 | 0.27 | 0.27 |
| 460141330 | NEMAK GATEWAY PLANT | 331314 | NOx | 0.01 | 0.01 | 18.83 | 18.83 |
| 460147820 | KOHLER COMPANY - VITREOUS PLANT | 327110 | NOx | 0.00 | 0.00 | 1.58 | 1.58 |
| 460147930 | KOHLER CO-ENGINE PLANT | 333618 | NOx | 0.00 | 0.00 | 4.44 | 4.44 |
| 460008230 | GEORGIA PACIFIC CORRUGATED LLC | 322211 | VOC | 0.00 | 0.00 | 2.99 | 2.99 |
| 460012740 | OLD WISCONSIN SAUSAGE CO PLANT 2 | 311612 | VOC | 0.00 | 0.00 | 2.32 | 2.32 |
| 460023740 | LAKESHORE DISPLAY CO INC | 321999 | VOC | 0.00 | 0.00 | 7.51 | 7.51 |
| 460027810 | ALDRICH CHEMICAL COMPANY, LLC (dba MilliporeSigma) | 325199 | VOC | 0.00 | 0.00 | 4.10 | 4.10 |
| 460029570 | NEMSCHOFF CHAIRS INC. | 337127 | VOC | 0.00 | 0.00 | 7.72 | 7.72 |
| 460032870 | KOHLER CO - METALS PROCESSING COMPLEX | 332999 | VOC | 0.03 | 0.03 | 63.47 | 63.47 |
| 460034740 | PLASTICS ENGINEERING CO N 15TH ST PLANT | 325211 | VOC | 0.00 | 0.00 | 2.89 | 2.89 |
| 460034960 | AUSTIN GRAY IRON FOUNDRY | 331511 | VOC | 0.00 | 0.00 | 2.01 | 2.01 |
| 460035180 | THE VOLLRATH COMPANY LLC | 332999 | VOC | 0.00 | 0.00 | 0.25 | 0.25 |
| 460035730 | WILLMAN INDUSTRIES | 331511 | VOC | 0.01 | 0.01 | 13.94 | 13.94 |
| 460036060 | HTT Inc | 332119 | VOC | 0.00 | 0.00 | 3.89 | 3.89 |
| 460038700 | Discovery Energy LLC | 335311 | VOC | 0.00 | 0.00 | 8.54 | 8.54 |
| 460038810 | SHEBOYGAN PAINT CO | 325510 | VOC | 0.01 | 0.01 | 27.41 | 27.41 |
| 460039580 | WATRY INDUSTRIES | 331524 | VOC | 0.00 | 0.00 | 0.18 | 0.18 |

| FID | Facility Name | NAICS | Pollutant | 2023 (tposd) | 2024 (tposd) | 2023 (tons) | 2024 (tons) |
|---|---|---|---|---|---|---|---|
| 460041230 | NEMAK USA INC - TAYLOR DRIVE | 331314 | VOC | 0.00 | 0.00 | 9.03 | 9.03 |
| 460041670 | Hexion Inc | 325211 | VOC | 0.01 | 0.01 | 18.88 | 18.88 |
| 460106570 | AMERICAN EXCELSIOR | 326150 | VOC | 0.00 | 0.00 | 5.63 | 5.63 |
| 460130440 | SACO AEI POLYMERS | 325991 | VOC | 0.00 | 0.00 | 9.18 | 9.18 |
| 460141330 | NEMAK GATEWAY PLANT | 331314 | VOC | 0.01 | 0.01 | 11.53 | 11.53 |
| 460147820 | KOHLER COMPANY - VITREOUS PLANT | 327110 | VOC | 0.00 | 0.00 | 0.48 | 0.48 |
| 460147930 | KOHLER CO-ENGINE PLANT | 333618 | VOC | 0.00 | 0.00 | 3.49 | 3.49 |
| **Total** | | | **NOx** | **0.08** | **0.08** | **157.61** | **157.61** |
| | | | **VOC** | **0.10** | **0.10** | **205.43** | **205.43** |

[1] Tons per ozone season day (tposd) emissions for 2023 were calculated by the WDNR AEI using the 3rd quarter operation information. 2024 emission estimates are based on assuming no growth from 2023 emissions.

[2] According to Wisconsin Administrative Code Chapter NR 438.03(a), facilities that emit less than 3 tons of VOC or less than 5 tons of NOx per year are not required to submit annual emission inventory reports. Sources that chose not to report NOx and/or VOC for a certain year are thus listed as “Not Reporting” for that year.

# APPENDIX 5

# Area Source Emissions for 2017, 2023 and 2024

This appendix provides a list of the Sheboygan County, WI 2015 ozone NAAQS nonattainment area nonpoint source tons per ozone season day (tposd) emissions by county and source classification code (SCC) for 2017, 2023 and 2024. The sums of NOx and VOC emissions from these nonpoint sources were used for the nonpoint sector NOx and VOC tposd emission estimates found in sections 3.2 (Baseline Year Inventory) and 3.3 (Attainment Year Inventories) of the Wisconsin Department of Natural Resources (WDNR) Attainment Plan for the Sheboygan County, WI 2015 Ozone NAAQS Moderate Nonattainment Area.

| fips code | County | Pollutant | SCC | 2017 (tposd) | 2023 (tposd) | 2024 (tposd) |
|---|---|---|---|---|---|---|
| 55117 | Sheboygan | NOx | 2102001000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2102002000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2102004001 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2102004002 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2102005000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2102006000 | 3.70E-01 | 4.82E-02 | 4.80E-02 |
| 55117 | Sheboygan | NOx | 2102007000 | 4.13E-03 | 2.44E-03 | 2.18E-03 |
| 55117 | Sheboygan | NOx | 2102008000 | 2.29E-01 | 2.08E-01 | 2.02E-01 |
| 55117 | Sheboygan | NOx | 2102011000 | 1.33E-04 | 4.59E-05 | 3.29E-05 |
| 55117 | Sheboygan | NOx | 2103001000 | 1.38E-05 | 1.69E-06 | 1.69E-06 |
| 55117 | Sheboygan | NOx | 2103002000 | 1.85E-03 | 2.27E-04 | 2.27E-04 |
| 55117 | Sheboygan | NOx | 2103004001 | 8.14E-04 | 9.85E-04 | 1.02E-03 |
| 55117 | Sheboygan | NOx | 2103004002 | 1.29E-03 | 1.57E-03 | 1.62E-03 |
| 55117 | Sheboygan | NOx | 2103005000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2103006000 | 1.25E-01 | 1.20E-01 | 1.21E-01 |
| 55117 | Sheboygan | NOx | 2103007000 | 6.64E-03 | 1.48E-02 | 1.62E-02 |
| 55117 | Sheboygan | NOx | 2103008000 | 7.80E-03 | 1.32E-02 | 1.40E-02 |
| 55117 | Sheboygan | NOx | 2103011000 | 6.07E-05 | 1.76E-05 | 1.16E-05 |
| 55117 | Sheboygan | NOx | 2104001000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2104002000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2104004000 | 7.39E-03 | 7.76E-03 | 7.90E-03 |
| 55117 | Sheboygan | NOx | 2104006000 | 2.27E-01 | 2.59E-01 | 2.64E-01 |
| 55117 | Sheboygan | NOx | 2104007000 | 2.18E-02 | 6.70E-02 | 7.37E-02 |
| 55117 | Sheboygan | NOx | 2104008100 | 4.79E-03 | 8.92E-03 | 9.48E-03 |
| 55117 | Sheboygan | NOx | 2104008210 | 2.92E-04 | 5.43E-04 | 5.78E-04 |
| 55117 | Sheboygan | NOx | 2104008220 | 7.76E-04 | 1.45E-03 | 1.54E-03 |
| 55117 | Sheboygan | NOx | 2104008230 | 4.53E-04 | 1.18E-03 | 1.28E-03 |
| 55117 | Sheboygan | NOx | 2104008310 | 2.13E-03 | 3.96E-03 | 4.21E-03 |
| 55117 | Sheboygan | NOx | 2104008320 | 5.66E-03 | 1.05E-02 | 1.12E-02 |
| 55117 | Sheboygan | NOx | 2104008330 | 3.30E-03 | 8.61E-03 | 9.35E-03 |
| 55117 | Sheboygan | NOx | 2104008400 | 2.93E-03 | 4.67E-03 | 4.91E-03 |
| 55117 | Sheboygan | NOx | 2104008510 | 2.04E-03 | 4.14E-03 | 4.43E-03 |
| 55117 | Sheboygan | NOx | 2104008530 | 4.31E-03 | 6.20E-04 | 6.19E-04 |

| fips code | County | Pollutant | SCC | 2017 (tposd) | 2023 (tposd) | 2024 (tposd) |
|---|---|---|---|---|---|---|
| 55117 | Sheboygan | NOx | 2104008610 | 2.21E-03 | 4.48E-03 | 4.79E-03 |
| 55117 | Sheboygan | NOx | 2104008620 | 1.41E-03 | 2.86E-03 | 3.06E-03 |
| 55117 | Sheboygan | NOx | 2104008630 | 1.16E-04 | 2.36E-04 | 2.53E-04 |
| 55117 | Sheboygan | NOx | 2104008700 | 4.86E-03 | 5.82E-03 | 5.94E-03 |
| 55117 | Sheboygan | NOx | 2104009000 | 1.57E-04 | 1.53E-04 | 1.51E-04 |
| 55117 | Sheboygan | NOx | 2104011000 | 1.40E-04 | 8.30E-05 | 7.33E-05 |
| 55117 | Sheboygan | NOx | 2280002201 | 4.41E-02 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2280002202 | 1.29E-02 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2280002203 | 7.53E-02 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2280002204 | 7.56E-03 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2285002006 | 1.11E-02 | 5.15E-03 | 4.30E-03 |
| 55117 | Sheboygan | NOx | 2285002007 | 2.72E-02 | 2.62E-02 | 2.61E-02 |
| 55117 | Sheboygan | NOx | 2610000100 | 3.12E-04 | 3.09E-04 | 3.07E-04 |
| 55117 | Sheboygan | NOx | 2610000400 | 3.12E-04 | 2.30E-04 | 2.18E-04 |
| 55117 | Sheboygan | NOx | 2610000500 | 1.14E-02 | 1.24E-02 | 1.26E-02 |
| 55117 | Sheboygan | NOx | 2610030000 | 1.58E-02 | 1.57E-02 | 1.56E-02 |
| 55117 | Sheboygan | NOx | 2801500000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2810001002 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2810025000 | 1.25E-03 | 1.20E-03 | 1.19E-03 |
| 55117 | Sheboygan | NOx | 2810060100 | 1.57E-04 | 2.28E-04 | 2.38E-04 |
| 55117 | Sheboygan | NOx | 2810060200 | 3.30E-08 | 3.26E-08 | 3.25E-08 |
| 55117 | Sheboygan | NOx | 2811015002 | 4.44E-03 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | NOx | 2811020002 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2102001000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2102002000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2102004001 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2102004002 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2102005000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2102006000 | 2.03E-02 | 2.65E-03 | 2.64E-03 |
| 55117 | Sheboygan | VOC | 2102007000 | 1.51E-04 | 8.92E-05 | 7.97E-05 |
| 55117 | Sheboygan | VOC | 2102008000 | 1.77E-02 | 1.60E-02 | 1.56E-02 |
| 55117 | Sheboygan | VOC | 2102011000 | 1.31E-06 | 4.52E-07 | 3.24E-07 |
| 55117 | Sheboygan | VOC | 2103001000 | 4.59E-07 | 5.63E-08 | 5.62E-08 |
| 55117 | Sheboygan | VOC | 2103002000 | 8.43E-06 | 1.03E-06 | 1.03E-06 |
| 55117 | Sheboygan | VOC | 2103004001 | 1.38E-05 | 1.67E-05 | 1.73E-05 |
| 55117 | Sheboygan | VOC | 2103004002 | 9.00E-05 | 1.09E-04 | 1.13E-04 |
| 55117 | Sheboygan | VOC | 2103005000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2103006000 | 6.90E-03 | 6.61E-03 | 6.63E-03 |
| 55117 | Sheboygan | VOC | 2103007000 | 2.43E-04 | 5.43E-04 | 5.91E-04 |
| 55117 | Sheboygan | VOC | 2103008000 | 6.03E-04 | 1.02E-03 | 1.08E-03 |

| fips code | County | Pollutant | SCC | 2017 (tposd) | 2023 (tposd) | 2024 (tposd) |
|---|---|---|---|---|---|---|
| 55117 | Sheboygan | VOC | 2103011000 | 1.03E-06 | 3.00E-07 | 1.97E-07 |
| 55117 | Sheboygan | VOC | 2104001000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2104002000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2104004000 | 2.93E-04 | 3.08E-04 | 3.13E-04 |
| 55117 | Sheboygan | VOC | 2104006000 | 1.33E-02 | 1.51E-02 | 1.54E-02 |
| 55117 | Sheboygan | VOC | 2104007000 | 8.48E-04 | 2.61E-03 | 2.87E-03 |
| 55117 | Sheboygan | VOC | 2104008100 | 3.48E-02 | 6.48E-02 | 6.89E-02 |
| 55117 | Sheboygan | VOC | 2104008210 | 5.52E-03 | 1.03E-02 | 1.09E-02 |
| 55117 | Sheboygan | VOC | 2104008220 | 4.08E-03 | 1.07E-02 | 1.17E-02 |
| 55117 | Sheboygan | VOC | 2104008230 | 3.39E-03 | 8.85E-03 | 9.61E-03 |
| 55117 | Sheboygan | VOC | 2104008310 | 4.03E-02 | 7.50E-02 | 7.98E-02 |
| 55117 | Sheboygan | VOC | 2104008320 | 2.98E-02 | 7.83E-02 | 8.50E-02 |
| 55117 | Sheboygan | VOC | 2104008330 | 2.48E-02 | 6.46E-02 | 7.01E-02 |
| 55117 | Sheboygan | VOC | 2104008400 | 1.69E-03 | 2.70E-03 | 2.84E-03 |
| 55117 | Sheboygan | VOC | 2104008510 | 1.33E-02 | 2.69E-02 | 2.88E-02 |
| 55117 | Sheboygan | VOC | 2104008530 | 2.49E-03 | 3.59E-04 | 3.58E-04 |
| 55117 | Sheboygan | VOC | 2104008610 | 7.44E-02 | 1.51E-01 | 1.62E-01 |
| 55117 | Sheboygan | VOC | 2104008620 | 4.75E-02 | 9.65E-02 | 1.03E-01 |
| 55117 | Sheboygan | VOC | 2104008630 | 6.74E-05 | 1.37E-04 | 1.46E-04 |
| 55117 | Sheboygan | VOC | 2104008700 | 3.53E-02 | 4.23E-02 | 4.32E-02 |
| 55117 | Sheboygan | VOC | 2104009000 | 8.10E-04 | 7.87E-04 | 7.79E-04 |
| 55117 | Sheboygan | VOC | 2104011000 | 5.44E-06 | 3.23E-06 | 2.85E-06 |
| 55118 | Sheboygan | VOC | 2201000062 | 1.26E-01 | 9.35E-02 | 9.51E-02 |
| 55117 | Sheboygan | VOC | 2280002201 | 1.31E-03 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2280002202 | 3.76E-04 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2280002203 | 3.26E-03 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2280002204 | 3.25E-04 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2285002006 | 5.10E-04 | 1.87E-04 | 1.40E-04 |
| 55117 | Sheboygan | VOC | 2285002007 | 1.26E-03 | 1.26E-03 | 1.26E-03 |
| 55117 | Sheboygan | VOC | 2302002100 | 2.18E-03 | 2.57E-03 | 2.62E-03 |
| 55117 | Sheboygan | VOC | 2302002200 | 5.73E-03 | 7.91E-03 | 8.20E-03 |
| 55117 | Sheboygan | VOC | 2302003000 | 1.41E-03 | 1.55E-03 | 1.57E-03 |
| 55117 | Sheboygan | VOC | 2302003100 | 7.72E-04 | 1.03E-03 | 1.07E-03 |
| 55117 | Sheboygan | VOC | 2302003200 | 4.70E-05 | 5.88E-05 | 6.04E-05 |
| 55117 | Sheboygan | VOC | 2401001000 | 2.19E-01 | 1.30E-01 | 1.17E-01 |
| 55117 | Sheboygan | VOC | 2401005000 | 5.08E-02 | 1.19E-02 | 6.15E-03 |
| 55117 | Sheboygan | VOC | 2401008000 | 3.74E-02 | 2.19E-02 | 1.96E-02 |
| 55117 | Sheboygan | VOC | 2401015000 | 1.03E-02 | 2.03E-03 | 2.03E-03 |
| 55117 | Sheboygan | VOC | 2401020000 | 1.83E-01 | 1.60E-02 | 1.59E-02 |
| 55117 | Sheboygan | VOC | 2401025000 | 7.98E-02 | 7.49E-02 | 7.28E-02 |

| fips code | County | Pollutant | SCC | 2017 (tposd) | 2023 (tposd) | 2024 (tposd) |
|---|---|---|---|---|---|---|
| 55117 | Sheboygan | VOC | 2401055000 | 9.71E-03 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2401070000 | 7.15E-03 | 1.25E-03 | 1.25E-03 |
| 55117 | Sheboygan | VOC | 2401090000 | 3.92E-02 | 1.98E-02 | 1.65E-02 |
| 55117 | Sheboygan | VOC | 2401100000 | 3.38E-02 | 4.51E-02 | 4.68E-02 |
| 55117 | Sheboygan | VOC | 2401200000 | 5.45E-04 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2415000000 | 2.41E-01 | 4.01E-02 | 4.00E-02 |
| 55117 | Sheboygan | VOC | 2420000000 | 3.28E-04 | 1.97E-04 | 1.77E-04 |
| 55117 | Sheboygan | VOC | 2425000000 | 2.11E-01 | 1.87E-01 | 1.82E-01 |
| 55117 | Sheboygan | VOC | 2460030999 | 3.70E-03 | 3.72E-03 | 3.71E-03 |
| 55117 | Sheboygan | VOC | 2460100000 | 2.72E-01 | 2.56E-01 | 2.53E-01 |
| 55117 | Sheboygan | VOC | 2460200000 | 2.39E-01 | 1.60E-01 | 1.47E-01 |
| 55117 | Sheboygan | VOC | 2460400000 | 3.12E-02 | 2.26E-02 | 2.11E-02 |
| 55117 | Sheboygan | VOC | 2460500000 | 2.85E-01 | 2.44E-01 | 2.36E-01 |
| 55117 | Sheboygan | VOC | 2460600000 | 1.22E-01 | 2.14E-01 | 2.29E-01 |
| 55117 | Sheboygan | VOC | 2460800000 | 4.99E-03 | 9.87E-03 | 1.07E-02 |
| 55117 | Sheboygan | VOC | 2460900000 | 3.70E-03 | 3.72E-03 | 3.71E-03 |
| 55117 | Sheboygan | VOC | 2461021000 | 2.11E-01 | 2.12E-01 | 2.12E-01 |
| 55117 | Sheboygan | VOC | 2461022000 | 2.57E-01 | 2.58E-01 | 2.58E-01 |
| 55117 | Sheboygan | VOC | 2461025100 | 7.57E-02 | 7.61E-02 | 7.59E-02 |
| 55117 | Sheboygan | VOC | 2461025200 | 6.81E-03 | 6.84E-03 | 6.83E-03 |
| 55117 | Sheboygan | VOC | 2461850000 | 6.33E-02 | 5.57E-02 | 5.48E-02 |
| 55117 | Sheboygan | VOC | 2501011011 | 4.80E-03 | 2.45E-03 | 2.10E-03 |
| 55117 | Sheboygan | VOC | 2501011012 | 5.39E-03 | 2.75E-03 | 2.36E-03 |
| 55117 | Sheboygan | VOC | 2501011013 | 6.87E-03 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2501011014 | 1.00E-03 | 5.12E-04 | 4.38E-04 |
| 55117 | Sheboygan | VOC | 2501011015 | 1.90E-04 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2501012011 | 2.10E-04 | 1.90E-04 | 1.87E-04 |
| 55117 | Sheboygan | VOC | 2501012012 | 1.72E-04 | 1.56E-04 | 1.53E-04 |
| 55117 | Sheboygan | VOC | 2501012013 | 9.37E-03 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2501012014 | 2.89E-03 | 2.62E-03 | 2.57E-03 |
| 55117 | Sheboygan | VOC | 2501012015 | 3.65E-04 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2501050120 | 9.00E-02 | 2.64E-02 | 1.71E-02 |
| 55117 | Sheboygan | VOC | 2501055120 | 5.18E-05 | 4.97E-05 | 4.95E-05 |
| 55117 | Sheboygan | VOC | 2501060051 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2501060052 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2501060053 | 3.57E-02 | 2.75E-02 | 2.64E-02 |
| 55117 | Sheboygan | VOC | 2501060201 | 4.08E-02 | 2.78E-02 | 2.59E-02 |
| 55117 | Sheboygan | VOC | 2501080050 | 3.44E-02 | 4.40E-02 | 4.56E-02 |
| 55117 | Sheboygan | VOC | 2501080100 | 4.94E-05 | 6.03E-05 | 6.22E-05 |
| 55117 | Sheboygan | VOC | 2505030120 | 2.67E-03 | 1.82E-03 | 1.69E-03 |

| fips code | County | Pollutant | SCC | 2017 (tposd) | 2023 (tposd) | 2024 (tposd) |
|---|---|---|---|---|---|---|
| 55117 | Sheboygan | VOC | 2505040120 | 5.34E-02 | 4.92E-02 | 4.87E-02 |
| 55117 | Sheboygan | VOC | 2610000100 | 1.41E-03 | 1.39E-03 | 1.39E-03 |
| 55117 | Sheboygan | VOC | 2610000400 | 1.41E-03 | 8.07E-04 | 7.15E-04 |
| 55117 | Sheboygan | VOC | 2610000500 | 3.22E-02 | 3.51E-02 | 3.55E-02 |
| 55117 | Sheboygan | VOC | 2610030000 | 1.65E-02 | 1.63E-02 | 1.63E-02 |
| 55117 | Sheboygan | VOC | 2630020000 | 0.00E+00 | 4.10E-03 | 4.69E-03 |
| 55117 | Sheboygan | VOC | 2680003000 | 3.69E-02 | 3.38E-02 | 3.32E-02 |
| 55117 | Sheboygan | VOC | 2801500000 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2802004001 | 5.47E-01 | 5.50E-01 | 5.48E-01 |
| 55117 | Sheboygan | VOC | 2802004002 | 4.10E-02 | 4.12E-02 | 4.11E-02 |
| 55117 | Sheboygan | VOC | 2802004003 | 3.99E-01 | 4.01E-01 | 4.00E-01 |
| 55117 | Sheboygan | VOC | 2805002000 | 5.20E-03 | 7.50E-02 | 8.84E-02 |
| 55117 | Sheboygan | VOC | 2805007100 | 8.62E-05 | 2.53E-03 | 2.89E-03 |
| 55117 | Sheboygan | VOC | 2805009100 | 5.68E-05 | 1.07E-05 | 1.07E-05 |
| 55117 | Sheboygan | VOC | 2805010100 | 6.43E-05 | 2.08E-06 | 2.07E-06 |
| 55117 | Sheboygan | VOC | 2805018000 | 9.55E-02 | 5.93E-02 | 5.14E-02 |
| 55117 | Sheboygan | VOC | 2805025000 | 9.59E-04 | 4.21E-04 | 2.72E-04 |
| 55117 | Sheboygan | VOC | 2805035000 | 2.67E-03 | 1.29E-03 | 1.10E-03 |
| 55117 | Sheboygan | VOC | 2805040000 | 6.71E-04 | 2.48E-04 | 1.80E-04 |
| 55117 | Sheboygan | VOC | 2805045000 | 5.36E-04 | 9.84E-05 | 3.55E-05 |
| 55117 | Sheboygan | VOC | 2810001002 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2810025000 | 3.32E-03 | 3.26E-03 | 3.25E-03 |
| 55117 | Sheboygan | VOC | 2810060100 | 1.32E-05 | 1.91E-05 | 2.00E-05 |
| 55117 | Sheboygan | VOC | 2810060200 | 2.77E-09 | 2.74E-09 | 2.73E-09 |
| 55117 | Sheboygan | VOC | 2811015002 | 3.59E-02 | 0.00E+00 | 0.00E+00 |
| 55117 | Sheboygan | VOC | 2811020002 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **TOTAL** | | | **NOx** | **1.25** | **0.86** | **0.87** |
| | | | **VOC** | **4.73** | **4.27** | **4.27** |

# APPENDIX 6

# Nonroad Emissions for 2017, 2023 and 2024

This appendix provides detailed listings of the estimated nonroad emissions for over 200 subcategories for Sheboygan County as well as the portion of the county comprising the Sheboygan County, WI 2015 ozone NAAQS nonattainment area. These estimated emissions are provided for nitrogen oxides (NOx) and volatile organic compounds (VOC) for the years 2017, 2023 and 2024. The sums of NOx and VOC emissions within the nonattainment area were used for the nonroad sector NOx and VOC tons per ozone season day (tposd) emission estimates in Section 3 of the Wisconsin Department of Natural Resources (WDNR) Attainment Plan for the Sheboygan County, WI 2015 Ozone NAAQS Moderate Nonattainment Area.

These inventories are based on three primary sources of data:

MOVES model estimates[1]
EPA's MOVES4.0.1 model was used for most source categories, with exceptions listed below.

EPA's 2017 National Emissions Inventory (NEI)[2]
Emissions for year 2017 for commercial marine, aircraft and rail locomotive were derived from EPA's 2017 NEI.

EPA's 2022 Emissions Modeling Platform: version 1[3]
Emissions for years 2023 and 2024 for commercial marine, aircraft and rail locomotive were developed from the base year 2022 emissions in the 2022 platform, version 1.

[1] https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves.
[2] https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data
[3] 2022v1 webpage

**Table A6.1. 2017 Nonroad NOx and VOC Emissions: tons per ozone season day (tposd)**
**Sheboygan County and the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA)**

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2017 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2017 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2260001010 | Recreational | 2-Stroke Motorcycles: Off-Road | MOVES | 0.0016 | 0.1558 | 17.0% | 17.0% | land area | 0.0003 | 0.0265 |
| 2260001020 | Recreational | Snowmobiles | MOVES | 0.0000 | 0.0252 | 17.0% | 17.0% | land area | 0.0000 | 0.0043 |
| 2260001030 | Recreational | 2-Stroke All Terrain Vehicles | MOVES | 0.0008 | 0.0422 | 17.0% | 17.0% | land area | 0.0001 | 0.0072 |
| 2260001060 | Recreational | 2-Stroke Specialty Vehicle Carts | MOVES | 0.0006 | 0.0032 | 17.0% | 17.0% | land area | 0.0001 | 0.0005 |
| 2260002006 | Construction | 2-Stroke Tampers/Rammers | MOVES | 0.0002 | 0.0063 | 59.0% | 59.0% | population | 0.0001 | 0.0037 |
| 2260002009 | Construction | 2-Stroke Plate Compactors | MOVES | 0.0000 | 0.0002 | 59.0% | 59.0% | population | 0.0000 | 0.0001 |
| 2260002021 | Construction | 2-Stroke Paving Equipment | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2260002027 | Construction | 2-Stroke Signal Boards | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260002039 | Construction | 2-Stroke Concrete/Industrial Saws | MOVES | 0.0004 | 0.0159 | 59.0% | 59.0% | population | 0.0002 | 0.0094 |
| 2260002054 | Construction | 2-Stroke Crushing/Proc. Equipment | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260003030 | Industrial | 2-Stroke Sweepers/Scrubbers | MOVES | 0.0000 | 0.0006 | 59.0% | 59.0% | population | 0.0000 | 0.0003 |
| 2260003040 | Industrial | 2-Stroke Other General Industrial Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260004015 | Lawn/Garden | 2-Stroke Rotary Tillers < 6 HP (Residential) | MOVES | 0.0000 | 0.0012 | 59.0% | 59.0% | population | 0.0000 | 0.0007 |
| 2260004016 | Lawn/Garden | 2-Stroke Rotary Tillers < 6 HP (Commercial) | MOVES | 0.0001 | 0.0031 | 59.0% | 59.0% | population | 0.0001 | 0.0018 |
| 2260004020 | Lawn/Garden | 2-Stroke Chain Saws < 6 HP (Residential) | MOVES | 0.0003 | 0.0108 | 59.0% | 59.0% | population | 0.0002 | 0.0064 |
| 2260004021 | Lawn/Garden | 2-Stroke Chain Saws < 6 HP (Commercial) | MOVES | 0.0008 | 0.0349 | 59.0% | 59.0% | population | 0.0005 | 0.0206 |
| 2260004025 | Lawn/Garden | 2-Stroke Trimmers/Edgers/Brush Cutters (Res.) | MOVES | 0.0009 | 0.0230 | 59.0% | 59.0% | population | 0.0005 | 0.0135 |
| 2260004026 | Lawn/Garden | 2-Stroke Trimmers/Edgers/Brush Cutters (Com.) | MOVES | 0.0014 | 0.0351 | 59.0% | 59.0% | population | 0.0008 | 0.0207 |
| 2260004030 | Lawn/Garden | 2-Stroke Leafblowers/Vacuums (Residential) | MOVES | 0.0005 | 0.0161 | 59.0% | 59.0% | population | 0.0003 | 0.0095 |
| 2260004031 | Lawn/Garden | 2-Stroke Leafblowers/Vacuums (Commercial) | MOVES | 0.0013 | 0.0352 | 59.0% | 59.0% | population | 0.0007 | 0.0208 |
| 2260004035 | Lawn/Garden | 2-Stroke Snowblowers (Residential) | MOVES | 0.0000 | 0.0017 | 59.0% | 59.0% | population | 0.0000 | 0.0010 |
| 2260004036 | Lawn/Garden | 2-Stroke Snowblowers (Commercial) | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0001 |
| 2260004071 | Lawn/Garden | 2-Stroke Commercial Turf Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260005035 | Agriculture | 2-Stroke Sprayers | MOVES | 0.0000 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0001 |
| 2260006005 | Commercial | 2-Stroke Light Commercial Generator Set | MOVES | 0.0000 | 0.0009 | 59.0% | 59.0% | population | 0.0000 | 0.0005 |
| 2260006010 | Commercial | 2-Stroke Light Commercial Pumps | MOVES | 0.0002 | 0.0062 | 59.0% | 59.0% | population | 0.0001 | 0.0037 |
| 2260006015 | Commercial | 2-Stroke Light Commercial Air Compressors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260006035 | Commercial | 2-Stroke Hydro Power Units | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260007005 | Logging | 2-Stroke Logging Equipment Chain Saws > 6 HP | MOVES | 0.0000 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265001010 | Recreational | 4-Stroke Motorcycles: Off-Road | MOVES | 0.0009 | 0.0080 | 17.0% | 17.0% | land area | 0.0002 | 0.0014 |
| 2265001030 | Recreational | 4-Stroke All Terrain Vehicles | MOVES | 0.0069 | 0.0834 | 17.0% | 17.0% | land area | 0.0012 | 0.0142 |
| 2265001050 | Recreational | 4-Stroke Golf Carts | MOVES | 0.0079 | 0.0281 | 17.0% | 17.0% | land area | 0.0013 | 0.0048 |
| 2265001060 | Recreational | 4-Stroke Specialty Vehicle Carts | MOVES | 0.0009 | 0.0034 | 17.0% | 17.0% | land area | 0.0001 | 0.0006 |
| 2265002003 | Construction | 4-Stroke Asphalt Pavers | MOVES | 0.0001 | 0.0003 | 59.0% | 59.0% | population | 0.0001 | 0.0002 |
| 2265002006 | Construction | 4-Stroke Tampers/Rammers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002009 | Construction | 4-Stroke Plate Compactors | MOVES | 0.0002 | 0.0008 | 59.0% | 59.0% | population | 0.0001 | 0.0005 |
| 2265002015 | Construction | 4-Stroke Rollers | MOVES | 0.0002 | 0.0006 | 59.0% | 59.0% | population | 0.0001 | 0.0003 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2017 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2017 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2265002021 | Construction | 4-Stroke Paving Equipment | MOVES | 0.0004 | 0.0018 | 59.0% | 59.0% | population | 0.0002 | 0.0010 |
| 2265002024 | Construction | 4-Stroke Surfacing Equipment | MOVES | 0.0002 | 0.0006 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |
| 2265002027 | Construction | 4-Stroke Signal Boards | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002030 | Construction | 4-Stroke Trenchers | MOVES | 0.0004 | 0.0011 | 59.0% | 59.0% | population | 0.0002 | 0.0006 |
| 2265002033 | Construction | 4-Stroke Bore/Drill Rigs | MOVES | 0.0002 | 0.0006 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |
| 2265002039 | Construction | 4-Stroke Concrete/Industrial Saws | MOVES | 0.0007 | 0.0023 | 59.0% | 59.0% | population | 0.0004 | 0.0013 |
| 2265002042 | Construction | 4-Stroke Cement & Mortar Mixers | MOVES | 0.0004 | 0.0025 | 59.0% | 59.0% | population | 0.0002 | 0.0015 |
| 2265002045 | Construction | 4-Stroke Cranes | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002054 | Construction | 4-Stroke Crushing/Proc. Equipment | MOVES | 0.0001 | 0.0002 | 59.0% | 59.0% | population | 0.0000 | 0.0001 |
| 2265002057 | Construction | 4-Stroke Rough Terrain Forklifts | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002060 | Construction | 4-Stroke Rubber Tire Loaders | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2265002066 | Construction | 4-Stroke Tractors/Loaders/Backhoes | MOVES | 0.0002 | 0.0007 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |
| 2265002072 | Construction | 4-Stroke Skid Steer Loaders | MOVES | 0.0003 | 0.0005 | 59.0% | 59.0% | population | 0.0002 | 0.0003 |
| 2265002078 | Construction | 4-Stroke Dumpers/Tenders | MOVES | 0.0001 | 0.0004 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265002081 | Construction | 4-Stroke Other Construction Equipment | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0001 | 0.0001 |
| 2265003010 | Industrial | 4-Stroke Aerial Lifts | MOVES | 0.0039 | 0.0056 | 59.0% | 59.0% | population | 0.0023 | 0.0033 |
| 2265003020 | Industrial | 4-Stroke Forklifts | MOVES | 0.0070 | 0.0051 | 59.0% | 59.0% | population | 0.0041 | 0.0030 |
| 2265003030 | Industrial | 4-Stroke Sweepers/Scrubbers | MOVES | 0.0015 | 0.0032 | 59.0% | 59.0% | population | 0.0009 | 0.0019 |
| 2265003040 | Industrial | 4-Stroke Other General Industrial Equipment | MOVES | 0.0030 | 0.0118 | 59.0% | 59.0% | population | 0.0018 | 0.0070 |
| 2265003050 | Industrial | 4-Stroke Other Material Handling Equipment | MOVES | 0.0002 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0002 |
| 2265003060 | Industrial | 4-Stroke Industrial AC/Refrigeration | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265003070 | Industrial | 4-Stroke Terminal Tractors | MOVES | 0.0005 | 0.0004 | 59.0% | 59.0% | population | 0.0003 | 0.0002 |
| 2265004010 | Lawn/Garden | 4-Stroke Lawn mowers (Residential) | MOVES | 0.0060 | 0.0604 | 59.0% | 59.0% | population | 0.0036 | 0.0357 |
| 2265004011 | Lawn/Garden | 4-Stroke Lawn mowers (Commercial) | MOVES | 0.0029 | 0.0186 | 59.0% | 59.0% | population | 0.0017 | 0.0110 |
| 2265004015 | Lawn/Garden | 4-Stroke Rotary Tillers < 6 HP (Residential) | MOVES | 0.0005 | 0.0052 | 59.0% | 59.0% | population | 0.0003 | 0.0031 |
| 2265004016 | Lawn/Garden | 4-Stroke Rotary Tillers < 6 HP (Commercial) | MOVES | 0.0016 | 0.0114 | 59.0% | 59.0% | population | 0.0009 | 0.0068 |
| 2265004025 | Lawn/Garden | 4-Stroke Trimmers/Edgers/Brush Cutters (Res.) | MOVES | 0.0000 | 0.0004 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265004026 | Lawn/Garden | 4-Stroke Trimmers/Edgers/Brush Cutters (Com.) | MOVES | 0.0001 | 0.0005 | 59.0% | 59.0% | population | 0.0000 | 0.0003 |
| 2265004030 | Lawn/Garden | 4-Stroke Leafblowers/Vacuums (Residential) | MOVES | 0.0001 | 0.0006 | 59.0% | 59.0% | population | 0.0000 | 0.0003 |
| 2265004031 | Lawn/Garden | 4-Stroke Leafblowers/Vacuums (Commercial) | MOVES | 0.0031 | 0.0118 | 59.0% | 59.0% | population | 0.0018 | 0.0070 |
| 2265004035 | Lawn/Garden | 4-Stroke Snowblowers (Residential) | MOVES | 0.0000 | 0.0040 | 59.0% | 59.0% | population | 0.0000 | 0.0024 |
| 2265004036 | Lawn/Garden | 4-Stroke Snowblowers (Commercial) | MOVES | 0.0000 | 0.0004 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265004040 | Lawn/Garden | 4-Stroke Rear Engine Riding Mowers (Res.) | MOVES | 0.0013 | 0.0097 | 59.0% | 59.0% | population | 0.0007 | 0.0057 |
| 2265004041 | Lawn/Garden | 4-Stroke Rear Engine Riding Mowers (Comm.) | MOVES | 0.0003 | 0.0012 | 59.0% | 59.0% | population | 0.0002 | 0.0007 |
| 2265004046 | Lawn/Garden | 4-Stroke Front Mowers (Commercial) | MOVES | 0.0005 | 0.0019 | 59.0% | 59.0% | population | 0.0003 | 0.0011 |
| 2265004051 | Lawn/Garden | 4-Stroke Shredders < 6 HP (Commercial) | MOVES | 0.0002 | 0.0014 | 59.0% | 59.0% | population | 0.0001 | 0.0008 |
| 2265004055 | Lawn/Garden | 4-Stroke Lawn & Garden Tractors (Residential) | MOVES | 0.0170 | 0.0945 | 59.0% | 59.0% | population | 0.0100 | 0.0558 |
| 2265004056 | Lawn/Garden | 4-Stroke Lawn & Garden Tractors (Commercial) | MOVES | 0.0044 | 0.0154 | 59.0% | 59.0% | population | 0.0026 | 0.0091 |
| 2265004066 | Lawn/Garden | 4-Stroke Chippers/Stump Grinders (Comm.) | MOVES | 0.0007 | 0.0017 | 59.0% | 59.0% | population | 0.0004 | 0.0010 |
| 2265004071 | Lawn/Garden | 4-Stroke Commercial Turf Equipment (Comm.) | MOVES | 0.0142 | 0.0462 | 59.0% | 59.0% | population | 0.0084 | 0.0273 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2017 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2017 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2265004075 | Lawn/Garden | 4-Stroke Other Lawn & Garden Equip. (Res.) | MOVES | 0.0007 | 0.0050 | 59.0% | 59.0% | population | 0.0004 | 0.0029 |
| 2265004076 | Lawn/Garden | 4-Stroke Other Lawn & Garden Equip. (Com.) | MOVES | 0.0006 | 0.0039 | 59.0% | 59.0% | population | 0.0003 | 0.0023 |
| 2265005010 | Agriculture | 4-Stroke 2-Wheel Tractors | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005015 | Agriculture | 4-Stroke Agricultural Tractors | MOVES | 0.0001 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005020 | Agriculture | 4-Stroke Combines | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005025 | Agriculture | 4-Stroke Balers | MOVES | 0.0007 | 0.0014 | 17.0% | 17.0% | land area | 0.0001 | 0.0002 |
| 2265005030 | Agriculture | 4-Stroke Agricultural Mowers | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005035 | Agriculture | 4-Stroke Sprayers | MOVES | 0.0009 | 0.0023 | 17.0% | 17.0% | land area | 0.0001 | 0.0004 |
| 2265005040 | Agriculture | 4-Stroke Tillers > 5 HP | MOVES | 0.0014 | 0.0077 | 17.0% | 17.0% | land area | 0.0002 | 0.0013 |
| 2265005045 | Agriculture | 4-Stroke Swathers | MOVES | 0.0011 | 0.0017 | 17.0% | 17.0% | land area | 0.0002 | 0.0003 |
| 2265005055 | Agriculture | 4-Stroke Other Agricultural Equipment | MOVES | 0.0013 | 0.0014 | 17.0% | 17.0% | land area | 0.0002 | 0.0002 |
| 2265005060 | Agriculture | 4-Stroke Irrigation Sets | MOVES | 0.0001 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265006005 | Commercial | 4-Stroke Light Commercial Generator Set | MOVES | 0.0055 | 0.0331 | 59.0% | 59.0% | population | 0.0032 | 0.0195 |
| 2265006010 | Commercial | 4-Stroke Light Commercial Pumps | MOVES | 0.0014 | 0.0059 | 59.0% | 59.0% | population | 0.0008 | 0.0035 |
| 2265006015 | Commercial | 4-Stroke Light Commercial Air Compressors | MOVES | 0.0007 | 0.0023 | 59.0% | 59.0% | population | 0.0004 | 0.0014 |
| 2265006025 | Commercial | 4-Stroke Light Commercial Welders | MOVES | 0.0015 | 0.0051 | 59.0% | 59.0% | population | 0.0009 | 0.0030 |
| 2265006030 | Commercial | 4-Stroke Light Commercial Pressure Wash | MOVES | 0.0022 | 0.0120 | 59.0% | 59.0% | population | 0.0013 | 0.0071 |
| 2265006035 | Commercial | 4-Stroke Hydro Power Units | MOVES | 0.0001 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0002 |
| 2265007010 | Logging | 4-Stroke Logging Equipment Shredders > 6 HP | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265007015 | Logging | 4-Stroke Logging Equipment Skidders | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267001060 | Recreational | LPG Specialty Vehicle Carts | MOVES | 0.0002 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267002003 | Construction | LPG Asphalt Pavers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002015 | Construction | LPG Rollers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002021 | Construction | LPG Paving Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002024 | Construction | LPG Surfacing Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002030 | Construction | LPG Trenchers | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267002033 | Construction | LPG Bore/Drill Rigs | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267002039 | Construction | LPG Concrete/Industrial Saws | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002045 | Construction | LPG Cranes | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002054 | Construction | LPG Crushing/Proc. Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002057 | Construction | LPG Rough Terrain Forklifts | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002060 | Construction | LPG Rubber Tire Loaders | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267002066 | Construction | LPG Tractors/Loaders/Backhoes | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002072 | Construction | LPG Skid Steer Loaders | MOVES | 0.0003 | 0.0001 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2267002081 | Construction | LPG Other Construction Equipment | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267003010 | Industrial | LPG Aerial Lifts | MOVES | 0.0035 | 0.0007 | 59.0% | 59.0% | population | 0.0021 | 0.0004 |
| 2267003020 | Industrial | LPG Forklifts | MOVES | 0.1129 | 0.0167 | 59.0% | 59.0% | population | 0.0666 | 0.0099 |
| 2267003030 | Industrial | LPG Sweepers/Scrubbers | MOVES | 0.0008 | 0.0001 | 59.0% | 59.0% | population | 0.0005 | 0.0001 |
| 2267003040 | Industrial | LPG Other General Industrial Equipment | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267003050 | Industrial | LPG Other Material Handling Equipment | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2017 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2017 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2267003070 | Industrial | LPG Terminal Tractors | MOVES | 0.0004 | 0.0001 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2267004066 | Lawn/Garden | LPG Chippers/Stump Grinders (Commercial) | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2267005055 | Agriculture | LPG Other Agricultural Equipment | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267005060 | Agriculture | LPG Irrigation Sets | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267006005 | Commercial | LPG Light Commercial Generator Sets | MOVES | 0.0027 | 0.0005 | 59.0% | 59.0% | population | 0.0016 | 0.0003 |
| 2267006010 | Commercial | LPG Light Commercial Pumps | MOVES | 0.0003 | 0.0001 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2267006015 | Commercial | LPG Light Commercial Air Compressors | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267006025 | Commercial | LPG Light Commercial Welders | MOVES | 0.0003 | 0.0001 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2267006030 | Commercial | LPG Light Commercial Pressure Washers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267006035 | Commercial | LPG Hydro Power Units | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268002081 | Construction | CNG Other Construction Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003020 | Industrial | CNG Forklifts | MOVES | 0.0091 | 0.0048 | 59.0% | 59.0% | population | 0.0054 | 0.0028 |
| 2268003030 | Industrial | CNG Sweepers/Scrubbers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003040 | Industrial | CNG Other General Industrial Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003060 | Industrial | CNG AC/Refrigeration | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003070 | Industrial | CNG Terminal Tractors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268005055 | Agriculture | CNG Other Agricultural Equipment | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2268005060 | Agriculture | CNG Irrigation Sets | MOVES | 0.0003 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2268006005 | Commercial | CNG Light Commercial Generator Sets | MOVES | 0.0011 | 0.0006 | 59.0% | 59.0% | population | 0.0006 | 0.0004 |
| 2268006010 | Commercial | CNG Light Commercial Pumps | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268006015 | Commercial | CNG Light Commercial Air Compressors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268006020 | Commercial | CNG Light Commercial Gas Compressors | MOVES | 0.0005 | 0.0002 | 59.0% | 59.0% | population | 0.0003 | 0.0001 |
| 2270001060 | Recreational | Diesel Specialty Vehicle Carts | MOVES | 0.0022 | 0.0005 | 17.0% | 17.0% | land area | 0.0004 | 0.0001 |
| 2270002003 | Construction | Diesel Pavers | MOVES | 0.0047 | 0.0003 | 59.0% | 59.0% | population | 0.0028 | 0.0002 |
| 2270002006 | Construction | Diesel Tampers/Rammers (unused) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270002009 | Construction | Diesel Plate Compactors | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2270002015 | Construction | Diesel Rollers | MOVES | 0.0133 | 0.0008 | 59.0% | 59.0% | population | 0.0078 | 0.0005 |
| 2270002018 | Construction | Diesel Scrapers | MOVES | 0.0119 | 0.0006 | 59.0% | 59.0% | population | 0.0070 | 0.0004 |
| 2270002021 | Construction | Diesel Paving Equipment | MOVES | 0.0009 | 0.0001 | 59.0% | 59.0% | population | 0.0005 | 0.0000 |
| 2270002024 | Construction | Diesel Surfacing Equipment | MOVES | 0.0008 | 0.0001 | 59.0% | 59.0% | population | 0.0005 | 0.0000 |
| 2270002027 | Construction | Diesel Signal Boards | MOVES | 0.0025 | 0.0002 | 59.0% | 59.0% | population | 0.0015 | 0.0001 |
| 2270002030 | Construction | Diesel Trenchers | MOVES | 0.0088 | 0.0007 | 59.0% | 59.0% | population | 0.0052 | 0.0004 |
| 2270002033 | Construction | Diesel Bore/Drill Rigs | MOVES | 0.0120 | 0.0009 | 59.0% | 59.0% | population | 0.0071 | 0.0005 |
| 2270002036 | Construction | Diesel Excavators | MOVES | 0.0393 | 0.0020 | 59.0% | 59.0% | population | 0.0232 | 0.0012 |
| 2270002039 | Construction | Diesel Concrete/Industrial Saws | MOVES | 0.0006 | 0.0001 | 59.0% | 59.0% | population | 0.0004 | 0.0000 |
| 2270002042 | Construction | Diesel Cement & Mortar Mixers | MOVES | 0.0005 | 0.0001 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270002045 | Construction | Diesel Cranes | MOVES | 0.0133 | 0.0007 | 59.0% | 59.0% | population | 0.0078 | 0.0004 |
| 2270002048 | Construction | Diesel Graders | MOVES | 0.0091 | 0.0005 | 59.0% | 59.0% | population | 0.0054 | 0.0003 |
| 2270002051 | Construction | Diesel Off-highway Trucks | MOVES | 0.0481 | 0.0020 | 59.0% | 59.0% | population | 0.0284 | 0.0012 |
| 2270002054 | Construction | Diesel Crushing/Proc. Equipment | MOVES | 0.0029 | 0.0002 | 59.0% | 59.0% | population | 0.0017 | 0.0001 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2017 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2017 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2270002057 | Construction | Diesel Rough Terrain Forklifts | MOVES | 0.0190 | 0.0013 | 59.0% | 59.0% | population | 0.0112 | 0.0008 |
| 2270002060 | Construction | Diesel Rubber Tire Loaders | MOVES | 0.0658 | 0.0036 | 59.0% | 59.0% | population | 0.0388 | 0.0022 |
| 2270002066 | Construction | Diesel Tractors/Loaders/Backhoes | MOVES | 0.0629 | 0.0117 | 59.0% | 59.0% | population | 0.0371 | 0.0069 |
| 2270002069 | Construction | Diesel Crawler Tractors | MOVES | 0.0484 | 0.0024 | 59.0% | 59.0% | population | 0.0285 | 0.0014 |
| 2270002072 | Construction | Diesel Skid Steer Loaders | MOVES | 0.0481 | 0.0109 | 59.0% | 59.0% | population | 0.0284 | 0.0064 |
| 2270002075 | Construction | Diesel Off-Highway Tractors | MOVES | 0.0081 | 0.0004 | 59.0% | 59.0% | population | 0.0048 | 0.0002 |
| 2270002078 | Construction | Diesel Dumpers/Tenders | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2270002081 | Construction | Diesel Other Construction Equipment | MOVES | 0.0085 | 0.0005 | 59.0% | 59.0% | population | 0.0050 | 0.0003 |
| 2270003010 | Industrial | Diesel Aerial Lifts | MOVES | 0.0082 | 0.0019 | 59.0% | 59.0% | population | 0.0049 | 0.0011 |
| 2270003020 | Industrial | Diesel Forklifts | MOVES | 0.0494 | 0.0021 | 59.0% | 59.0% | population | 0.0292 | 0.0012 |
| 2270003030 | Industrial | Diesel Sweepers/Scrubbers | MOVES | 0.0252 | 0.0015 | 59.0% | 59.0% | population | 0.0148 | 0.0009 |
| 2270003040 | Industrial | Diesel Other General Industrial Equipment | MOVES | 0.0316 | 0.0022 | 59.0% | 59.0% | population | 0.0186 | 0.0013 |
| 2270003050 | Industrial | Diesel Other Material Handling Equipment | MOVES | 0.0020 | 0.0003 | 59.0% | 59.0% | population | 0.0012 | 0.0002 |
| 2270003060 | Industrial | Diesel AC/Refrigeration | MOVES | 0.0302 | 0.0018 | 59.0% | 59.0% | population | 0.0178 | 0.0011 |
| 2270003070 | Industrial | Diesel Terminal Tractors | MOVES | 0.0231 | 0.0012 | 59.0% | 59.0% | population | 0.0136 | 0.0007 |
| 2270004031 | Lawn/Garden | Diesel Leafblowers/Vacuums (Commercial) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270004036 | Lawn/Garden | Diesel Snowblowers (Commercial) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270004046 | Lawn/Garden | Diesel Front Mowers (Commercial) | MOVES | 0.0086 | 0.0009 | 59.0% | 59.0% | population | 0.0051 | 0.0005 |
| 2270004056 | Lawn/Garden | Diesel Lawn & Garden Tractors (Commercial) | MOVES | 0.0017 | 0.0002 | 59.0% | 59.0% | population | 0.0010 | 0.0001 |
| 2270004066 | Lawn/Garden | Diesel Chippers/Stump Grinders (Commercial) | MOVES | 0.0132 | 0.0011 | 59.0% | 59.0% | population | 0.0078 | 0.0007 |
| 2270004071 | Lawn/Garden | Diesel Commercial Turf Equipment (Comm.) | MOVES | 0.0010 | 0.0001 | 59.0% | 59.0% | population | 0.0006 | 0.0000 |
| 2270004076 | Lawn/Garden | Diesel Other Lawn & Garden Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270005010 | Agriculture | Diesel 2-Wheel Tractors | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005015 | Agriculture | Diesel Agricultural Tractors | MOVES | 0.2123 | 0.0170 | 17.0% | 17.0% | land area | 0.0361 | 0.0029 |
| 2270005020 | Agriculture | Diesel Combines | MOVES | 0.0323 | 0.0026 | 17.0% | 17.0% | land area | 0.0055 | 0.0004 |
| 2270005025 | Agriculture | Diesel Balers | MOVES | 0.0002 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005030 | Agriculture | Diesel Agricultural Mowers | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005035 | Agriculture | Diesel Sprayers | MOVES | 0.0026 | 0.0003 | 17.0% | 17.0% | land area | 0.0004 | 0.0000 |
| 2270005040 | Agriculture | Diesel Tillers > 6 HP | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005045 | Agriculture | Diesel Swathers | MOVES | 0.0023 | 0.0003 | 17.0% | 17.0% | land area | 0.0004 | 0.0000 |
| 2270005055 | Agriculture | Diesel Other Agricultural Equipment | MOVES | 0.0056 | 0.0005 | 17.0% | 17.0% | land area | 0.0010 | 0.0001 |
| 2270005060 | Agriculture | Diesel Irrigation Sets | MOVES | 0.0019 | 0.0001 | 17.0% | 17.0% | land area | 0.0003 | 0.0000 |
| 2270006005 | Commercial | Diesel Light Commercial Generator Sets | MOVES | 0.0167 | 0.0018 | 59.0% | 59.0% | population | 0.0099 | 0.0010 |
| 2270006010 | Commercial | Diesel Light Commercial Pumps | MOVES | 0.0040 | 0.0004 | 59.0% | 59.0% | population | 0.0023 | 0.0002 |
| 2270006015 | Commercial | Diesel Light Commercial Air Compressors | MOVES | 0.0079 | 0.0006 | 59.0% | 59.0% | population | 0.0047 | 0.0004 |
| 2270006025 | Commercial | Diesel Light Commercial Welders | MOVES | 0.0052 | 0.0012 | 59.0% | 59.0% | population | 0.0031 | 0.0007 |
| 2270006030 | Commercial | Diesel Light Commercial Pressure Washer | MOVES | 0.0006 | 0.0001 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270006035 | Commercial | Diesel Hydro Power Units | MOVES | 0.0004 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2270007015 | Logging | Diesel Logging Equip Fell/Bunch/Skidders | MOVES | 0.0007 | 0.0000 | 17.0% | 17.0% | land area | 0.0001 | 0.0000 |
| 2275000000 | Airport | All Airport | 2017NEI | 0.0164 | 0.0192 | 0.0% | 0.0% | airport location | 0.0000 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2017 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2017 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2280002x01/2 | Comm. Mar. | CM Vessels, Diesel, C1&C2 | 2017NEI | 0.1360 | 0.0040 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.1360 | 0.0040 |
| 2280002x03/4 | Comm. Mar. | CM Vessels, Diesel, C3 | 2017NEI | 0.1024 | 0.0042 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.1024 | 0.0042 |
| 2282005010 | Pleasure Craft | 2-Stroke Outboards | MOVES | 0.0466 | 0.3138 | 0.0% | 0.0% | water area | 0.0000 | 0.0000 |
| 2282005015 | Pleasure Craft | 2-Stroke Personal Watercraft | MOVES | 0.0207 | 0.0546 | 81.0% | 81.0% | water area | 0.0168 | 0.0442 |
| 2282010005 | Pleasure Craft | 4-Stroke Inboards | MOVES | 0.1530 | 0.1745 | 81.0% | 81.0% | water area | 0.1239 | 0.1413 |
| 2282020005 | Pleasure Craft | Diesel Inboards | MOVES | 0.1431 | 0.0073 | 81.0% | 81.0% | water area | 0.1159 | 0.0059 |
| 2282020010 | Pleasure Craft | Diesel Outboards | MOVES | 0.0001 | 0.0000 | 0.0% | 0.0% | water area | 0.0000 | 0.0000 |
| 228500200x | Railroad | All Diesel Line Haul Locomotives | 2017NEI | 0.1014 | 0.0055 | 45.0% | 45.0% | track miles | 0.0456 | 0.0025 |
| 2285002015 | Railway Maint. | Diesel Railway Maintenance | MOVES | 0.0003 | 0.0001 | 45.0% | 45.0% | track miles | 0.0001 | 0.0000 |
| 2285004015 | Railway Maint. | 4-Stroke Gasoline Railway Maintenance | MOVES | 0.0000 | 0.0000 | 45.0% | 45.0% | track miles | 0.0000 | 0.0000 |
| 2285006015 | Railway Maint. | LPG Railway Maintenance | MOVES | 0.0000 | 0.0000 | 45.0% | 45.0% | track miles | 0.0000 | 0.0000 |
| | | | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | | **1.8902** | **1.6356** | **58.8%** | **40.4%** | | **1.1111** | **0.6607** |
| | | | | | | | | | | |
| 22xx005xxx | Agriculture | All | MOVES | 0.2633 | 0.0364 | 17.0% | 17.0% | land area | 0.0448 | 0.0062 |
| 22750xxxxx | Airport | All | 2017NEI | 0.0164 | 0.0192 | 0.0% | 0.0% | airport location | 0.0000 | 0.0000 |
| 22xx006xxx | Commercial | All | MOVES | 0.0517 | 0.0714 | 59.0% | 59.0% | population | 0.0305 | 0.0422 |
| 2280002xxx | Comm. Mar | All | 2017NEI | 0.2384 | 0.0082 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.2384 | 0.0082 |
| 22xx002xxx | Construction | All | MOVES | 0.4353 | 0.0758 | 59.0% | 59.0% | population | 0.2568 | 0.0447 |
| 22xx003xxx | Industrial | All | MOVES | 0.3129 | 0.0606 | 59.0% | 59.0% | population | 0.1846 | 0.0358 |
| 22xx004xxx | Lawn/Garden | All | MOVES | 0.0844 | 0.4578 | 59.0% | 59.0% | population | 0.0498 | 0.2701 |
| 22xx007xxx | Logging | All | MOVES | 0.0007 | 0.0004 | 17.0% | 17.0% | land area | 0.0001 | 0.0001 |
| 22820xxxxx | Pleasure Craft | All | MOVES | 0.3635 | 0.5502 | 70.6% | 34.8% | water area | 0.2566 | 0.1915 |
| 228500200x | Railroad | All | 2017NEI | 0.1014 | 0.0055 | 45.0% | 45.0% | track miles | 0.0456 | 0.0025 |
| 228500x015 | Railway Maint. | All | MOVES | 0.0003 | 0.0001 | 45.0% | 45.0% | track miles | 0.0001 | 0.0000 |
| 22xx001xxx | Recreational | All | MOVES | 0.0220 | 0.3499 | 17.0% | 17.0% | land area | 0.0037 | 0.0595 |
| | | | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | | **1.8902** | **1.6356** | **58.8%** | **40.4%** | | **1.1111** | **0.6607** |

**Table A6.2. 2023 Nonroad NOx and VOC Emissions: tons per ozone season day (tposd)**
**Sheboygan County and the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA)**

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2023 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2023 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2260001010 | Recreational | 2-Stroke Motorcycles: Off-Road | MOVES | 0.0017 | 0.1326 | 17.0% | 17.0% | land area | 0.0003 | 0.0225 |
| 2260001020 | Recreational | Snowmobiles | MOVES | 0.0000 | 0.0205 | 17.0% | 17.0% | land area | 0.0000 | 0.0035 |
| 2260001030 | Recreational | 2-Stroke All Terrain Vehicles | MOVES | 0.0009 | 0.0162 | 17.0% | 17.0% | land area | 0.0002 | 0.0027 |
| 2260001060 | Recreational | 2-Stroke Specialty Vehicle Carts | MOVES | 0.0005 | 0.0030 | 17.0% | 17.0% | land area | 0.0001 | 0.0005 |
| 2260002006 | Construction | 2-Stroke Tampers/Rammers | MOVES | 0.0002 | 0.0072 | 59.0% | 59.0% | population | 0.0001 | 0.0043 |
| 2260002009 | Construction | 2-Stroke Plate Compactors | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2260002021 | Construction | 2-Stroke Paving Equipment | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2260002027 | Construction | 2-Stroke Signal Boards | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260002039 | Construction | 2-Stroke Concrete/Industrial Saws | MOVES | 0.0005 | 0.0182 | 59.0% | 59.0% | population | 0.0003 | 0.0107 |
| 2260002054 | Construction | 2-Stroke Crushing/Proc. Equipment | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260003030 | Industrial | 2-Stroke Sweepers/Scrubbers | MOVES | 0.0000 | 0.0007 | 59.0% | 59.0% | population | 0.0000 | 0.0004 |
| 2260003040 | Industrial | 2-Stroke Other General Industrial Equipment | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260004015 | Lawn/Garden | 2-Stroke Rotary Tillers < 6 HP (Residential) | MOVES | 0.0000 | 0.0011 | 59.0% | 59.0% | population | 0.0000 | 0.0007 |
| 2260004016 | Lawn/Garden | 2-Stroke Rotary Tillers < 6 HP (Commercial) | MOVES | 0.0001 | 0.0031 | 59.0% | 59.0% | population | 0.0001 | 0.0018 |
| 2260004020 | Lawn/Garden | 2-Stroke Chain Saws < 6 HP (Residential) | MOVES | 0.0003 | 0.0107 | 59.0% | 59.0% | population | 0.0002 | 0.0063 |
| 2260004021 | Lawn/Garden | 2-Stroke Chain Saws < 6 HP (Commercial) | MOVES | 0.0008 | 0.0347 | 59.0% | 59.0% | population | 0.0005 | 0.0205 |
| 2260004025 | Lawn/Garden | 2-Stroke Trimmers/Edgers/Brush Cutters (Res.) | MOVES | 0.0009 | 0.0227 | 59.0% | 59.0% | population | 0.0005 | 0.0134 |
| 2260004026 | Lawn/Garden | 2-Stroke Trimmers/Edgers/Brush Cutters (Com.) | MOVES | 0.0014 | 0.0350 | 59.0% | 59.0% | population | 0.0008 | 0.0206 |
| 2260004030 | Lawn/Garden | 2-Stroke Leafblowers/Vacuums (Residential) | MOVES | 0.0005 | 0.0159 | 59.0% | 59.0% | population | 0.0003 | 0.0094 |
| 2260004031 | Lawn/Garden | 2-Stroke Leafblowers/Vacuums (Commercial) | MOVES | 0.0013 | 0.0351 | 59.0% | 59.0% | population | 0.0007 | 0.0207 |
| 2260004035 | Lawn/Garden | 2-Stroke Snowblowers (Residential) | MOVES | 0.0000 | 0.0016 | 59.0% | 59.0% | population | 0.0000 | 0.0009 |
| 2260004036 | Lawn/Garden | 2-Stroke Snowblowers (Commercial) | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0001 |
| 2260004071 | Lawn/Garden | 2-Stroke Commercial Turf Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260005035 | Agriculture | 2-Stroke Sprayers | MOVES | 0.0000 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0001 |
| 2260006005 | Commercial | 2-Stroke Light Commercial Generator Set | MOVES | 0.0000 | 0.0010 | 59.0% | 59.0% | population | 0.0000 | 0.0006 |
| 2260006010 | Commercial | 2-Stroke Light Commercial Pumps | MOVES | 0.0002 | 0.0069 | 59.0% | 59.0% | population | 0.0001 | 0.0041 |
| 2260006015 | Commercial | 2-Stroke Light Commercial Air Compressors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260006035 | Commercial | 2-Stroke Hydro Power Units | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260007005 | Logging | 2-Stroke Logging Equipment Chain Saws > 6 HP | MOVES | 0.0000 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265001010 | Recreational | 4-Stroke Motorcycles: Off-Road | MOVES | 0.0009 | 0.0073 | 17.0% | 17.0% | land area | 0.0002 | 0.0012 |
| 2265001030 | Recreational | 4-Stroke All Terrain Vehicles | MOVES | 0.0063 | 0.0763 | 17.0% | 17.0% | land area | 0.0011 | 0.0130 |
| 2265001050 | Recreational | 4-Stroke Golf Carts | MOVES | 0.0078 | 0.0280 | 17.0% | 17.0% | land area | 0.0013 | 0.0048 |
| 2265001060 | Recreational | 4-Stroke Specialty Vehicle Carts | MOVES | 0.0006 | 0.0025 | 17.0% | 17.0% | land area | 0.0001 | 0.0004 |
| 2265002003 | Construction | 4-Stroke Asphalt Pavers | MOVES | 0.0001 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0002 |
| 2265002006 | Construction | 4-Stroke Tampers/Rammers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002009 | Construction | 4-Stroke Plate Compactors | MOVES | 0.0002 | 0.0009 | 59.0% | 59.0% | population | 0.0001 | 0.0006 |
| 2265002015 | Construction | 4-Stroke Rollers | MOVES | 0.0002 | 0.0007 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2023 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2023 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2265002021 | Construction | 4-Stroke Paving Equipment | MOVES | 0.0004 | 0.0020 | 59.0% | 59.0% | population | 0.0002 | 0.0012 |
| 2265002024 | Construction | 4-Stroke Surfacing Equipment | MOVES | 0.0002 | 0.0007 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |
| 2265002027 | Construction | 4-Stroke Signal Boards | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002030 | Construction | 4-Stroke Trenchers | MOVES | 0.0004 | 0.0012 | 59.0% | 59.0% | population | 0.0002 | 0.0007 |
| 2265002033 | Construction | 4-Stroke Bore/Drill Rigs | MOVES | 0.0002 | 0.0007 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |
| 2265002039 | Construction | 4-Stroke Concrete/Industrial Saws | MOVES | 0.0008 | 0.0026 | 59.0% | 59.0% | population | 0.0005 | 0.0015 |
| 2265002042 | Construction | 4-Stroke Cement & Mortar Mixers | MOVES | 0.0004 | 0.0026 | 59.0% | 59.0% | population | 0.0002 | 0.0015 |
| 2265002045 | Construction | 4-Stroke Cranes | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002054 | Construction | 4-Stroke Crushing/Proc.  Equipment | MOVES | 0.0001 | 0.0002 | 59.0% | 59.0% | population | 0.0000 | 0.0001 |
| 2265002057 | Construction | 4-Stroke Rough Terrain Forklifts | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002060 | Construction | 4-Stroke Rubber Tire Loaders | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2265002066 | Construction | 4-Stroke Tractors/Loaders/Backhoes | MOVES | 0.0002 | 0.0008 | 59.0% | 59.0% | population | 0.0001 | 0.0005 |
| 2265002072 | Construction | 4-Stroke Skid Steer Loaders | MOVES | 0.0002 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0003 |
| 2265002078 | Construction | 4-Stroke Dumpers/Tenders | MOVES | 0.0001 | 0.0004 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265002081 | Construction | 4-Stroke Other Construction Equipment | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265003010 | Industrial | 4-Stroke Aerial Lifts | MOVES | 0.0028 | 0.0050 | 59.0% | 59.0% | population | 0.0017 | 0.0029 |
| 2265003020 | Industrial | 4-Stroke Forklifts | MOVES | 0.0073 | 0.0053 | 59.0% | 59.0% | population | 0.0043 | 0.0032 |
| 2265003030 | Industrial | 4-Stroke Sweepers/Scrubbers | MOVES | 0.0018 | 0.0039 | 59.0% | 59.0% | population | 0.0010 | 0.0023 |
| 2265003040 | Industrial | 4-Stroke Other General Industrial Equipment | MOVES | 0.0037 | 0.0147 | 59.0% | 59.0% | population | 0.0022 | 0.0087 |
| 2265003050 | Industrial | 4-Stroke Other Material Handling Equipment | MOVES | 0.0002 | 0.0003 | 59.0% | 59.0% | population | 0.0001 | 0.0002 |
| 2265003060 | Industrial | 4-Stroke Industrial AC/Refrigeration | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265003070 | Industrial | 4-Stroke Terminal Tractors | MOVES | 0.0007 | 0.0005 | 59.0% | 59.0% | population | 0.0004 | 0.0003 |
| 2265004010 | Lawn/Garden | 4-Stroke Lawn mowers (Residential) | MOVES | 0.0055 | 0.0517 | 59.0% | 59.0% | population | 0.0032 | 0.0305 |
| 2265004011 | Lawn/Garden | 4-Stroke Lawn mowers (Commercial) | MOVES | 0.0029 | 0.0185 | 59.0% | 59.0% | population | 0.0017 | 0.0109 |
| 2265004015 | Lawn/Garden | 4-Stroke Rotary Tillers < 6 HP (Residential) | MOVES | 0.0005 | 0.0045 | 59.0% | 59.0% | population | 0.0003 | 0.0027 |
| 2265004016 | Lawn/Garden | 4-Stroke Rotary Tillers < 6 HP (Commercial) | MOVES | 0.0015 | 0.0108 | 59.0% | 59.0% | population | 0.0009 | 0.0064 |
| 2265004025 | Lawn/Garden | 4-Stroke Trimmers/Edgers/Brush Cutters (Res.) | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265004026 | Lawn/Garden | 4-Stroke Trimmers/Edgers/Brush Cutters (Com.) | MOVES | 0.0001 | 0.0005 | 59.0% | 59.0% | population | 0.0000 | 0.0003 |
| 2265004030 | Lawn/Garden | 4-Stroke Leafblowers/Vacuums (Residential) | MOVES | 0.0001 | 0.0006 | 59.0% | 59.0% | population | 0.0000 | 0.0003 |
| 2265004031 | Lawn/Garden | 4-Stroke Leafblowers/Vacuums (Commercial) | MOVES | 0.0027 | 0.0115 | 59.0% | 59.0% | population | 0.0016 | 0.0068 |
| 2265004035 | Lawn/Garden | 4-Stroke Snowblowers (Residential) | MOVES | 0.0000 | 0.0037 | 59.0% | 59.0% | population | 0.0000 | 0.0022 |
| 2265004036 | Lawn/Garden | 4-Stroke Snowblowers (Commercial) | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265004040 | Lawn/Garden | 4-Stroke Rear Engine Riding Mowers (Res.) | MOVES | 0.0011 | 0.0088 | 59.0% | 59.0% | population | 0.0007 | 0.0052 |
| 2265004041 | Lawn/Garden | 4-Stroke Rear Engine Riding Mowers (Comm.) | MOVES | 0.0003 | 0.0012 | 59.0% | 59.0% | population | 0.0002 | 0.0007 |
| 2265004046 | Lawn/Garden | 4-Stroke Front Mowers (Commercial) | MOVES | 0.0004 | 0.0016 | 59.0% | 59.0% | population | 0.0002 | 0.0009 |
| 2265004051 | Lawn/Garden | 4-Stroke Shredders < 6 HP (Commercial) | MOVES | 0.0002 | 0.0013 | 59.0% | 59.0% | population | 0.0001 | 0.0007 |
| 2265004055 | Lawn/Garden | 4-Stroke Lawn & Garden Tractors (Residential) | MOVES | 0.0147 | 0.0868 | 59.0% | 59.0% | population | 0.0087 | 0.0512 |
| 2265004056 | Lawn/Garden | 4-Stroke Lawn & Garden Tractors (Commercial) | MOVES | 0.0043 | 0.0153 | 59.0% | 59.0% | population | 0.0026 | 0.0090 |
| 2265004066 | Lawn/Garden | 4-Stroke Chippers/Stump Grinders (Comm.) | MOVES | 0.0007 | 0.0017 | 59.0% | 59.0% | population | 0.0004 | 0.0010 |
| 2265004071 | Lawn/Garden | 4-Stroke Commercial Turf Equipment (Comm.) | MOVES | 0.0141 | 0.0459 | 59.0% | 59.0% | population | 0.0083 | 0.0271 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2023 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2023 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2265004075 | Lawn/Garden | 4-Stroke Other Lawn & Garden Equip. (Res.) | MOVES | 0.0006 | 0.0041 | 59.0% | 59.0% | population | 0.0003 | 0.0024 |
| 2265004076 | Lawn/Garden | 4-Stroke Other Lawn & Garden Equip. (Com.) | MOVES | 0.0005 | 0.0032 | 59.0% | 59.0% | population | 0.0003 | 0.0019 |
| 2265005010 | Agriculture | 4-Stroke 2-Wheel Tractors | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005015 | Agriculture | 4-Stroke Agricultural Tractors | MOVES | 0.0001 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005020 | Agriculture | 4-Stroke Combines | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005025 | Agriculture | 4-Stroke Balers | MOVES | 0.0005 | 0.0009 | 17.0% | 17.0% | land area | 0.0001 | 0.0002 |
| 2265005030 | Agriculture | 4-Stroke Agricultural Mowers | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005035 | Agriculture | 4-Stroke Sprayers | MOVES | 0.0006 | 0.0018 | 17.0% | 17.0% | land area | 0.0001 | 0.0003 |
| 2265005040 | Agriculture | 4-Stroke Tillers > 5 HP | MOVES | 0.0011 | 0.0052 | 17.0% | 17.0% | land area | 0.0002 | 0.0009 |
| 2265005045 | Agriculture | 4-Stroke Swathers | MOVES | 0.0007 | 0.0011 | 17.0% | 17.0% | land area | 0.0001 | 0.0002 |
| 2265005055 | Agriculture | 4-Stroke Other Agricultural Equipment | MOVES | 0.0008 | 0.0010 | 17.0% | 17.0% | land area | 0.0001 | 0.0002 |
| 2265005060 | Agriculture | 4-Stroke Irrigation Sets | MOVES | 0.0001 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265006005 | Commercial | 4-Stroke Light Commercial Generator Set | MOVES | 0.0053 | 0.0332 | 59.0% | 59.0% | population | 0.0031 | 0.0196 |
| 2265006010 | Commercial | 4-Stroke Light Commercial Pumps | MOVES | 0.0014 | 0.0064 | 59.0% | 59.0% | population | 0.0008 | 0.0037 |
| 2265006015 | Commercial | 4-Stroke Light Commercial Air Compressors | MOVES | 0.0007 | 0.0025 | 59.0% | 59.0% | population | 0.0004 | 0.0015 |
| 2265006025 | Commercial | 4-Stroke Light Commercial Welders | MOVES | 0.0015 | 0.0055 | 59.0% | 59.0% | population | 0.0009 | 0.0033 |
| 2265006030 | Commercial | 4-Stroke Light Commercial Pressure Wash | MOVES | 0.0024 | 0.0130 | 59.0% | 59.0% | population | 0.0014 | 0.0077 |
| 2265006035 | Commercial | 4-Stroke Hydro Power Units | MOVES | 0.0001 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0003 |
| 2265007010 | Logging | 4-Stroke Logging Equipment Shredders > 6 HP | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265007015 | Logging | 4-Stroke Logging Equipment Skidders | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267001060 | Recreational | LPG Specialty Vehicle Carts | MOVES | 0.0001 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267002003 | Construction | LPG Asphalt Pavers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002015 | Construction | LPG Rollers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002021 | Construction | LPG Paving Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002024 | Construction | LPG Surfacing Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002030 | Construction | LPG Trenchers | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002033 | Construction | LPG Bore/Drill Rigs | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267002039 | Construction | LPG Concrete/Industrial Saws | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002045 | Construction | LPG Cranes | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002054 | Construction | LPG Crushing/Proc.  Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002057 | Construction | LPG Rough Terrain Forklifts | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002060 | Construction | LPG Rubber Tire Loaders | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002066 | Construction | LPG Tractors/Loaders/Backhoes | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002072 | Construction | LPG Skid Steer Loaders | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267002081 | Construction | LPG Other Construction Equipment | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267003010 | Industrial | LPG Aerial Lifts | MOVES | 0.0021 | 0.0004 | 59.0% | 59.0% | population | 0.0013 | 0.0002 |
| 2267003020 | Industrial | LPG Forklifts | MOVES | 0.1131 | 0.0132 | 59.0% | 59.0% | population | 0.0667 | 0.0078 |
| 2267003030 | Industrial | LPG Sweepers/Scrubbers | MOVES | 0.0009 | 0.0001 | 59.0% | 59.0% | population | 0.0005 | 0.0001 |
| 2267003040 | Industrial | LPG Other General Industrial Equipment | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2267003050 | Industrial | LPG Other Material Handling Equipment | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2023 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2023 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2267003070 | Industrial | LPG Terminal Tractors | MOVES | 0.0005 | 0.0001 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2267004066 | Lawn/Garden | LPG Chippers/Stump Grinders (Commercial) | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267005055 | Agriculture | LPG Other Agricultural Equipment | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267005060 | Agriculture | LPG Irrigation Sets | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267006005 | Commercial | LPG Light Commercial Generator Sets | MOVES | 0.0017 | 0.0003 | 59.0% | 59.0% | population | 0.0010 | 0.0002 |
| 2267006010 | Commercial | LPG Light Commercial Pumps | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267006015 | Commercial | LPG Light Commercial Air Compressors | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267006025 | Commercial | LPG Light Commercial Welders | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267006030 | Commercial | LPG Light Commercial Pressure Washers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267006035 | Commercial | LPG Hydro Power Units | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268002081 | Construction | CNG Other Construction Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003020 | Industrial | CNG Forklifts | MOVES | 0.0092 | 0.0039 | 59.0% | 59.0% | population | 0.0054 | 0.0023 |
| 2268003030 | Industrial | CNG Sweepers/Scrubbers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003040 | Industrial | CNG Other General Industrial Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003060 | Industrial | CNG AC/Refrigeration | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003070 | Industrial | CNG Terminal Tractors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268005055 | Agriculture | CNG Other Agricultural Equipment | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2268005060 | Agriculture | CNG Irrigation Sets | MOVES | 0.0002 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2268006005 | Commercial | CNG Light Commercial Generator Sets | MOVES | 0.0007 | 0.0004 | 59.0% | 59.0% | population | 0.0004 | 0.0002 |
| 2268006010 | Commercial | CNG Light Commercial Pumps | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268006015 | Commercial | CNG Light Commercial Air Compressors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268006020 | Commercial | CNG Light Commercial Gas Compressors | MOVES | 0.0005 | 0.0002 | 59.0% | 59.0% | population | 0.0003 | 0.0001 |
| 2270001060 | Recreational | Diesel Specialty Vehicle Carts | MOVES | 0.0016 | 0.0003 | 17.0% | 17.0% | land area | 0.0003 | 0.0001 |
| 2270002003 | Construction | Diesel Pavers | MOVES | 0.0026 | 0.0001 | 59.0% | 59.0% | population | 0.0016 | 0.0001 |
| 2270002006 | Construction | Diesel Tampers/Rammers (unused) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270002009 | Construction | Diesel Plate Compactors | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2270002015 | Construction | Diesel Rollers | MOVES | 0.0085 | 0.0004 | 59.0% | 59.0% | population | 0.0050 | 0.0002 |
| 2270002018 | Construction | Diesel Scrapers | MOVES | 0.0048 | 0.0003 | 59.0% | 59.0% | population | 0.0028 | 0.0002 |
| 2270002021 | Construction | Diesel Paving Equipment | MOVES | 0.0006 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270002024 | Construction | Diesel Surfacing Equipment | MOVES | 0.0006 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270002027 | Construction | Diesel Signal Boards | MOVES | 0.0025 | 0.0002 | 59.0% | 59.0% | population | 0.0015 | 0.0001 |
| 2270002030 | Construction | Diesel Trenchers | MOVES | 0.0066 | 0.0003 | 59.0% | 59.0% | population | 0.0039 | 0.0002 |
| 2270002033 | Construction | Diesel Bore/Drill Rigs | MOVES | 0.0088 | 0.0006 | 59.0% | 59.0% | population | 0.0052 | 0.0003 |
| 2270002036 | Construction | Diesel Excavators | MOVES | 0.0151 | 0.0007 | 59.0% | 59.0% | population | 0.0089 | 0.0004 |
| 2270002039 | Construction | Diesel Concrete/Industrial Saws | MOVES | 0.0005 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270002042 | Construction | Diesel Cement & Mortar Mixers | MOVES | 0.0004 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2270002045 | Construction | Diesel Cranes | MOVES | 0.0058 | 0.0003 | 59.0% | 59.0% | population | 0.0034 | 0.0002 |
| 2270002048 | Construction | Diesel Graders | MOVES | 0.0028 | 0.0002 | 59.0% | 59.0% | population | 0.0017 | 0.0001 |
| 2270002051 | Construction | Diesel Off-highway Trucks | MOVES | 0.0376 | 0.0009 | 59.0% | 59.0% | population | 0.0222 | 0.0005 |
| 2270002054 | Construction | Diesel Crushing/Proc. Equipment | MOVES | 0.0016 | 0.0001 | 59.0% | 59.0% | population | 0.0009 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2023 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2023 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2270002057 | Construction | Diesel Rough Terrain Forklifts | MOVES | 0.0126 | 0.0005 | 59.0% | 59.0% | population | 0.0074 | 0.0003 |
| 2270002060 | Construction | Diesel Rubber Tire Loaders | MOVES | 0.0326 | 0.0015 | 59.0% | 59.0% | population | 0.0192 | 0.0009 |
| 2270002066 | Construction | Diesel Tractors/Loaders/Backhoes | MOVES | 0.0379 | 0.0058 | 59.0% | 59.0% | population | 0.0224 | 0.0034 |
| 2270002069 | Construction | Diesel Crawler Tractors | MOVES | 0.0240 | 0.0010 | 59.0% | 59.0% | population | 0.0141 | 0.0006 |
| 2270002072 | Construction | Diesel Skid Steer Loaders | MOVES | 0.0406 | 0.0070 | 59.0% | 59.0% | population | 0.0239 | 0.0041 |
| 2270002075 | Construction | Diesel Off-Highway Tractors | MOVES | 0.0051 | 0.0002 | 59.0% | 59.0% | population | 0.0030 | 0.0001 |
| 2270002078 | Construction | Diesel Dumpers/Tenders | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2270002081 | Construction | Diesel Other Construction Equipment | MOVES | 0.0044 | 0.0002 | 59.0% | 59.0% | population | 0.0026 | 0.0001 |
| 2270003010 | Industrial | Diesel Aerial Lifts | MOVES | 0.0074 | 0.0012 | 59.0% | 59.0% | population | 0.0044 | 0.0007 |
| 2270003020 | Industrial | Diesel Forklifts | MOVES | 0.0359 | 0.0007 | 59.0% | 59.0% | population | 0.0212 | 0.0004 |
| 2270003030 | Industrial | Diesel Sweepers/Scrubbers | MOVES | 0.0138 | 0.0006 | 59.0% | 59.0% | population | 0.0082 | 0.0003 |
| 2270003040 | Industrial | Diesel Other General Industrial Equipment | MOVES | 0.0170 | 0.0009 | 59.0% | 59.0% | population | 0.0100 | 0.0005 |
| 2270003050 | Industrial | Diesel Other Material Handling Equipment | MOVES | 0.0015 | 0.0002 | 59.0% | 59.0% | population | 0.0009 | 0.0001 |
| 2270003060 | Industrial | Diesel AC/Refrigeration | MOVES | 0.0322 | 0.0011 | 59.0% | 59.0% | population | 0.0190 | 0.0007 |
| 2270003070 | Industrial | Diesel Terminal Tractors | MOVES | 0.0080 | 0.0003 | 59.0% | 59.0% | population | 0.0047 | 0.0002 |
| 2270004031 | Lawn/Garden | Diesel Leafblowers/Vacuums (Commercial) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270004036 | Lawn/Garden | Diesel Snowblowers (Commercial) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270004046 | Lawn/Garden | Diesel Front Mowers (Commercial) | MOVES | 0.0073 | 0.0006 | 59.0% | 59.0% | population | 0.0043 | 0.0004 |
| 2270004056 | Lawn/Garden | Diesel Lawn & Garden Tractors (Commercial) | MOVES | 0.0016 | 0.0001 | 59.0% | 59.0% | population | 0.0009 | 0.0001 |
| 2270004066 | Lawn/Garden | Diesel Chippers/Stump Grinders (Commercial) | MOVES | 0.0096 | 0.0007 | 59.0% | 59.0% | population | 0.0056 | 0.0004 |
| 2270004071 | Lawn/Garden | Diesel Commercial Turf Equipment (Comm.) | MOVES | 0.0006 | 0.0000 | 59.0% | 59.0% | population | 0.0004 | 0.0000 |
| 2270004076 | Lawn/Garden | Diesel Other Lawn & Garden Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270005010 | Agriculture | Diesel 2-Wheel Tractors | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005015 | Agriculture | Diesel Agricultural Tractors | MOVES | 0.1165 | 0.0077 | 17.0% | 17.0% | land area | 0.0198 | 0.0013 |
| 2270005020 | Agriculture | Diesel Combines | MOVES | 0.0195 | 0.0015 | 17.0% | 17.0% | land area | 0.0033 | 0.0003 |
| 2270005025 | Agriculture | Diesel Balers | MOVES | 0.0001 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005030 | Agriculture | Diesel Agricultural Mowers | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005035 | Agriculture | Diesel Sprayers | MOVES | 0.0016 | 0.0002 | 17.0% | 17.0% | land area | 0.0003 | 0.0000 |
| 2270005040 | Agriculture | Diesel Tillers > 6 HP | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005045 | Agriculture | Diesel Swathers | MOVES | 0.0014 | 0.0002 | 17.0% | 17.0% | land area | 0.0002 | 0.0000 |
| 2270005055 | Agriculture | Diesel Other Agricultural Equipment | MOVES | 0.0027 | 0.0002 | 17.0% | 17.0% | land area | 0.0005 | 0.0000 |
| 2270005060 | Agriculture | Diesel Irrigation Sets | MOVES | 0.0011 | 0.0001 | 17.0% | 17.0% | land area | 0.0002 | 0.0000 |
| 2270006005 | Commercial | Diesel Light Commercial Generator Sets | MOVES | 0.0135 | 0.0012 | 59.0% | 59.0% | population | 0.0080 | 0.0007 |
| 2270006010 | Commercial | Diesel Light Commercial Pumps | MOVES | 0.0032 | 0.0003 | 59.0% | 59.0% | population | 0.0019 | 0.0002 |
| 2270006015 | Commercial | Diesel Light Commercial Air Compressors | MOVES | 0.0054 | 0.0003 | 59.0% | 59.0% | population | 0.0032 | 0.0002 |
| 2270006025 | Commercial | Diesel Light Commercial Welders | MOVES | 0.0045 | 0.0007 | 59.0% | 59.0% | population | 0.0027 | 0.0004 |
| 2270006030 | Commercial | Diesel Light Commercial Pressure Washer | MOVES | 0.0004 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270006035 | Commercial | Diesel Hydro Power Units | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2270007015 | Logging | Diesel Logging Equip Fell/Bunch/Skidders | MOVES | 0.0001 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2275000000 | Airport | All Airport | 2022EMP | 0.0171 | 0.0226 | 0.0% | 0.0% | airport location | 0.0000 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2023 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2023 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2280002x01/2 | Comm. Mar. | CM Vessels, Diesel, C1&C2 | 2022EMP | 0.0949 | 0.0029 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.0949 | 0.0029 |
| 2280002x03/4 | Comm. Mar. | CM Vessels, Diesel, C3 | 2022EMP | 0.0715 | 0.0030 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.0715 | 0.0030 |
| 2282005010 | Pleasure Craft | 2-Stroke Outboards | MOVES | 0.0488 | 0.1748 | 0.0% | 0.0% | water area | 0.0000 | 0.0000 |
| 2282005015 | Pleasure Craft | 2-Stroke Personal Watercraft | MOVES | 0.0232 | 0.0302 | 81.0% | 81.0% | water area | 0.0188 | 0.0245 |
| 2282010005 | Pleasure Craft | 4-Stroke Inboards | MOVES | 0.1087 | 0.1380 | 81.0% | 81.0% | water area | 0.0880 | 0.1118 |
| 2282020005 | Pleasure Craft | Diesel Inboards | MOVES | 0.1351 | 0.0083 | 81.0% | 81.0% | water area | 0.1095 | 0.0067 |
| 2282020010 | Pleasure Craft | Diesel Outboards | MOVES | 0.0001 | 0.0000 | 0.0% | 0.0% | water area | 0.0000 | 0.0000 |
| 228500200x | Railroad | All Diesel Line Haul Locomotives | 2022EMP | 0.0572 | 0.0026 | 45.0% | 45.0% | track miles | 0.0257 | 0.0012 |
| 2285002015 | Railway Maint. | Diesel Railway Maintenance | MOVES | 0.0002 | 0.0000 | 45.0% | 45.0% | track miles | 0.0001 | 0.0000 |
| 2285004015 | Railway Maint. | 4-Stroke Gasoline Railway Maintenance | MOVES | 0.0000 | 0.0000 | 45.0% | 45.0% | track miles | 0.0000 | 0.0000 |
| 2285006015 | Railway Maint. | LPG Railway Maintenance | MOVES | 0.0000 | 0.0000 | 45.0% | 45.0% | track miles | 0.0000 | 0.0000 |
| | | | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | | **1.3616** | **1.3103** | **59.7%** | **43.4%** | | **0.8127** | **0.5682** |
| | | | | | | | | | | |
| 22xx005xxx | Agriculture | All | MOVES | 0.1473 | 0.0208 | 17.0% | 17.0% | land area | 0.0250 | 0.0035 |
| 22750xxxxx | Airport | All | 2022EMP | 0.0171 | 0.0226 | 0.0% | 0.0% | airport location | 0.0000 | 0.0000 |
| 22xx006xxx | Commercial | All | MOVES | 0.0425 | 0.0726 | 59.0% | 59.0% | population | 0.0251 | 0.0428 |
| 2280002xxx | Comm. Mar | All | 2022EMP | 0.1664 | 0.0059 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.1664 | 0.0059 |
| 22xx002xxx | Construction | All | MOVES | 0.2612 | 0.0604 | 59.0% | 59.0% | population | 0.1541 | 0.0356 |
| 22xx003xxx | Industrial | All | MOVES | 0.2585 | 0.0534 | 59.0% | 59.0% | population | 0.1525 | 0.0315 |
| 22xx004xxx | Lawn/Garden | All | MOVES | 0.0746 | 0.4337 | 59.0% | 59.0% | population | 0.0440 | 0.2559 |
| 22xx007xxx | Logging | All | MOVES | 0.0002 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0001 |
| 22820xxxxx | Pleasure Craft | All | MOVES | 0.3159 | 0.3513 | 68.5% | 40.7% | water area | 0.2162 | 0.1429 |
| 228500200x | Railroad | All | 2022EMP | 0.0572 | 0.0026 | 45.0% | 45.0% | track miles | 0.0257 | 0.0012 |
| 228500x015 | Railway Maint. | All | MOVES | 0.0002 | 0.0001 | 45.0% | 45.0% | track miles | 0.0001 | 0.0000 |
| 22xx001xxx | Recreational | All | MOVES | 0.0205 | 0.2866 | 17.0% | 17.0% | land area | 0.0035 | 0.0487 |
| | | | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | | **1.3616** | **1.3103** | **59.7%** | **43.4%** | | **0.8127** | **0.5682** |

**Table A6.3. 2024 Nonroad NOx and VOC Emissions: tons per ozone season day (tposd)
Sheboygan County and the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA)**

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2024 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2024 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2260001010 | Recreational | 2-Stroke Motorcycles: Off-Road | MOVES | 0.0017 | 0.1309 | 17.0% | 17.0% | land area | 0.0003 | 0.0223 |
| 2260001020 | Recreational | Snowmobiles | MOVES | 0.0000 | 0.0202 | 17.0% | 17.0% | land area | 0.0000 | 0.0034 |
| 2260001030 | Recreational | 2-Stroke All Terrain Vehicles | MOVES | 0.0009 | 0.0145 | 17.0% | 17.0% | land area | 0.0002 | 0.0025 |
| 2260001060 | Recreational | 2-Stroke Specialty Vehicle Carts | MOVES | 0.0005 | 0.0029 | 17.0% | 17.0% | land area | 0.0001 | 0.0005 |
| 2260002006 | Construction | 2-Stroke Tampers/Rammers | MOVES | 0.0002 | 0.0073 | 59.0% | 59.0% | population | 0.0001 | 0.0043 |
| 2260002009 | Construction | 2-Stroke Plate Compactors | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2260002021 | Construction | 2-Stroke Paving Equipment | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2260002027 | Construction | 2-Stroke Signal Boards | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260002039 | Construction | 2-Stroke Concrete/Industrial Saws | MOVES | 0.0005 | 0.0183 | 59.0% | 59.0% | population | 0.0003 | 0.0108 |
| 2260002054 | Construction | 2-Stroke Crushing/Proc. Equipment | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260003030 | Industrial | 2-Stroke Sweepers/Scrubbers | MOVES | 0.0000 | 0.0007 | 59.0% | 59.0% | population | 0.0000 | 0.0004 |
| 2260003040 | Industrial | 2-Stroke Other General Industrial Equipment | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260004015 | Lawn/Garden | 2-Stroke Rotary Tillers < 6 HP (Residential) | MOVES | 0.0000 | 0.0011 | 59.0% | 59.0% | population | 0.0000 | 0.0007 |
| 2260004016 | Lawn/Garden | 2-Stroke Rotary Tillers < 6 HP (Commercial) | MOVES | 0.0001 | 0.0031 | 59.0% | 59.0% | population | 0.0001 | 0.0018 |
| 2260004020 | Lawn/Garden | 2-Stroke Chain Saws < 6 HP (Residential) | MOVES | 0.0003 | 0.0107 | 59.0% | 59.0% | population | 0.0002 | 0.0063 |
| 2260004021 | Lawn/Garden | 2-Stroke Chain Saws < 6 HP (Commercial) | MOVES | 0.0008 | 0.0347 | 59.0% | 59.0% | population | 0.0005 | 0.0205 |
| 2260004025 | Lawn/Garden | 2-Stroke Trimmers/Edgers/Brush Cutters (Res.) | MOVES | 0.0009 | 0.0226 | 59.0% | 59.0% | population | 0.0005 | 0.0134 |
| 2260004026 | Lawn/Garden | 2-Stroke Trimmers/Edgers/Brush Cutters (Com.) | MOVES | 0.0014 | 0.0349 | 59.0% | 59.0% | population | 0.0008 | 0.0206 |
| 2260004030 | Lawn/Garden | 2-Stroke Leafblowers/Vacuums (Residential) | MOVES | 0.0005 | 0.0159 | 59.0% | 59.0% | population | 0.0003 | 0.0094 |
| 2260004031 | Lawn/Garden | 2-Stroke Leafblowers/Vacuums (Commercial) | MOVES | 0.0013 | 0.0350 | 59.0% | 59.0% | population | 0.0007 | 0.0207 |
| 2260004035 | Lawn/Garden | 2-Stroke Snowblowers (Residential) | MOVES | 0.0000 | 0.0016 | 59.0% | 59.0% | population | 0.0000 | 0.0009 |
| 2260004036 | Lawn/Garden | 2-Stroke Snowblowers (Commercial) | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0001 |
| 2260004071 | Lawn/Garden | 2-Stroke Commercial Turf Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260005035 | Agriculture | 2-Stroke Sprayers | MOVES | 0.0000 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0001 |
| 2260006005 | Commercial | 2-Stroke Light Commercial Generator Set | MOVES | 0.0000 | 0.0010 | 59.0% | 59.0% | population | 0.0000 | 0.0006 |
| 2260006010 | Commercial | 2-Stroke Light Commercial Pumps | MOVES | 0.0003 | 0.0070 | 59.0% | 59.0% | population | 0.0001 | 0.0041 |
| 2260006015 | Commercial | 2-Stroke Light Commercial Air Compressors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260006035 | Commercial | 2-Stroke Hydro Power Units | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2260007005 | Logging | 2-Stroke Logging Equipment Chain Saws > 6 HP | MOVES | 0.0000 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265001010 | Recreational | 4-Stroke Motorcycles: Off-Road | MOVES | 0.0009 | 0.0072 | 17.0% | 17.0% | land area | 0.0002 | 0.0012 |
| 2265001030 | Recreational | 4-Stroke All Terrain Vehicles | MOVES | 0.0062 | 0.0757 | 17.0% | 17.0% | land area | 0.0011 | 0.0129 |
| 2265001050 | Recreational | 4-Stroke Golf Carts | MOVES | 0.0078 | 0.0279 | 17.0% | 17.0% | land area | 0.0013 | 0.0047 |
| 2265001060 | Recreational | 4-Stroke Specialty Vehicle Carts | MOVES | 0.0006 | 0.0024 | 17.0% | 17.0% | land area | 0.0001 | 0.0004 |
| 2265002003 | Construction | 4-Stroke Asphalt Pavers | MOVES | 0.0001 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0002 |
| 2265002006 | Construction | 4-Stroke Tampers/Rammers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002009 | Construction | 4-Stroke Plate Compactors | MOVES | 0.0002 | 0.0009 | 59.0% | 59.0% | population | 0.0001 | 0.0006 |
| 2265002015 | Construction | 4-Stroke Rollers | MOVES | 0.0002 | 0.0007 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2024 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2024 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2265002021 | Construction | 4-Stroke Paving Equipment | MOVES | 0.0004 | 0.0020 | 59.0% | 59.0% | population | 0.0002 | 0.0012 |
| 2265002024 | Construction | 4-Stroke Surfacing Equipment | MOVES | 0.0002 | 0.0007 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |
| 2265002027 | Construction | 4-Stroke Signal Boards | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002030 | Construction | 4-Stroke Trenchers | MOVES | 0.0004 | 0.0012 | 59.0% | 59.0% | population | 0.0002 | 0.0007 |
| 2265002033 | Construction | 4-Stroke Bore/Drill Rigs | MOVES | 0.0002 | 0.0007 | 59.0% | 59.0% | population | 0.0001 | 0.0004 |
| 2265002039 | Construction | 4-Stroke Concrete/Industrial Saws | MOVES | 0.0008 | 0.0026 | 59.0% | 59.0% | population | 0.0005 | 0.0015 |
| 2265002042 | Construction | 4-Stroke Cement & Mortar Mixers | MOVES | 0.0004 | 0.0026 | 59.0% | 59.0% | population | 0.0002 | 0.0015 |
| 2265002045 | Construction | 4-Stroke Cranes | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002054 | Construction | 4-Stroke Crushing/Proc.  Equipment | MOVES | 0.0001 | 0.0002 | 59.0% | 59.0% | population | 0.0000 | 0.0001 |
| 2265002057 | Construction | 4-Stroke Rough Terrain Forklifts | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265002060 | Construction | 4-Stroke Rubber Tire Loaders | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2265002066 | Construction | 4-Stroke Tractors/Loaders/Backhoes | MOVES | 0.0002 | 0.0008 | 59.0% | 59.0% | population | 0.0001 | 0.0005 |
| 2265002072 | Construction | 4-Stroke Skid Steer Loaders | MOVES | 0.0002 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0003 |
| 2265002078 | Construction | 4-Stroke Dumpers/Tenders | MOVES | 0.0001 | 0.0004 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265002081 | Construction | 4-Stroke Other Construction Equipment | MOVES | 0.0001 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265003010 | Industrial | 4-Stroke Aerial Lifts | MOVES | 0.0027 | 0.0049 | 59.0% | 59.0% | population | 0.0016 | 0.0029 |
| 2265003020 | Industrial | 4-Stroke Forklifts | MOVES | 0.0076 | 0.0055 | 59.0% | 59.0% | population | 0.0045 | 0.0033 |
| 2265003030 | Industrial | 4-Stroke Sweepers/Scrubbers | MOVES | 0.0018 | 0.0040 | 59.0% | 59.0% | population | 0.0011 | 0.0024 |
| 2265003040 | Industrial | 4-Stroke Other General Industrial Equipment | MOVES | 0.0038 | 0.0153 | 59.0% | 59.0% | population | 0.0022 | 0.0090 |
| 2265003050 | Industrial | 4-Stroke Other Material Handling Equipment | MOVES | 0.0002 | 0.0004 | 59.0% | 59.0% | population | 0.0001 | 0.0002 |
| 2265003060 | Industrial | 4-Stroke Industrial AC/Refrigeration | MOVES | 0.0000 | 0.0001 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2265003070 | Industrial | 4-Stroke Terminal Tractors | MOVES | 0.0007 | 0.0005 | 59.0% | 59.0% | population | 0.0004 | 0.0003 |
| 2265004010 | Lawn/Garden | 4-Stroke Lawn mowers (Residential) | MOVES | 0.0055 | 0.0516 | 59.0% | 59.0% | population | 0.0032 | 0.0304 |
| 2265004011 | Lawn/Garden | 4-Stroke Lawn mowers (Commercial) | MOVES | 0.0029 | 0.0185 | 59.0% | 59.0% | population | 0.0017 | 0.0109 |
| 2265004015 | Lawn/Garden | 4-Stroke Rotary Tillers < 6 HP (Residential) | MOVES | 0.0005 | 0.0045 | 59.0% | 59.0% | population | 0.0003 | 0.0027 |
| 2265004016 | Lawn/Garden | 4-Stroke Rotary Tillers < 6 HP (Commercial) | MOVES | 0.0015 | 0.0108 | 59.0% | 59.0% | population | 0.0009 | 0.0063 |
| 2265004025 | Lawn/Garden | 4-Stroke Trimmers/Edgers/Brush Cutters (Res.) | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265004026 | Lawn/Garden | 4-Stroke Trimmers/Edgers/Brush Cutters (Com.) | MOVES | 0.0001 | 0.0005 | 59.0% | 59.0% | population | 0.0000 | 0.0003 |
| 2265004030 | Lawn/Garden | 4-Stroke Leafblowers/Vacuums (Residential) | MOVES | 0.0001 | 0.0006 | 59.0% | 59.0% | population | 0.0000 | 0.0003 |
| 2265004031 | Lawn/Garden | 4-Stroke Leafblowers/Vacuums (Commercial) | MOVES | 0.0027 | 0.0115 | 59.0% | 59.0% | population | 0.0016 | 0.0068 |
| 2265004035 | Lawn/Garden | 4-Stroke Snowblowers (Residential) | MOVES | 0.0000 | 0.0037 | 59.0% | 59.0% | population | 0.0000 | 0.0022 |
| 2265004036 | Lawn/Garden | 4-Stroke Snowblowers (Commercial) | MOVES | 0.0000 | 0.0003 | 59.0% | 59.0% | population | 0.0000 | 0.0002 |
| 2265004040 | Lawn/Garden | 4-Stroke Rear Engine Riding Mowers (Res.) | MOVES | 0.0011 | 0.0088 | 59.0% | 59.0% | population | 0.0006 | 0.0052 |
| 2265004041 | Lawn/Garden | 4-Stroke Rear Engine Riding Mowers (Comm.) | MOVES | 0.0003 | 0.0012 | 59.0% | 59.0% | population | 0.0002 | 0.0007 |
| 2265004046 | Lawn/Garden | 4-Stroke Front Mowers (Commercial) | MOVES | 0.0004 | 0.0015 | 59.0% | 59.0% | population | 0.0002 | 0.0009 |
| 2265004051 | Lawn/Garden | 4-Stroke Shredders < 6 HP (Commercial) | MOVES | 0.0002 | 0.0013 | 59.0% | 59.0% | population | 0.0001 | 0.0007 |
| 2265004055 | Lawn/Garden | 4-Stroke Lawn & Garden Tractors (Residential) | MOVES | 0.0147 | 0.0865 | 59.0% | 59.0% | population | 0.0087 | 0.0511 |
| 2265004056 | Lawn/Garden | 4-Stroke Lawn & Garden Tractors (Commercial) | MOVES | 0.0043 | 0.0153 | 59.0% | 59.0% | population | 0.0026 | 0.0090 |
| 2265004066 | Lawn/Garden | 4-Stroke Chippers/Stump Grinders (Comm.) | MOVES | 0.0007 | 0.0017 | 59.0% | 59.0% | population | 0.0004 | 0.0010 |
| 2265004071 | Lawn/Garden | 4-Stroke Commercial Turf Equipment (Comm.) | MOVES | 0.0140 | 0.0458 | 59.0% | 59.0% | population | 0.0083 | 0.0270 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2024 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2024 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2265004075 | Lawn/Garden | 4-Stroke Other Lawn & Garden Equip. (Res.) | MOVES | 0.0005 | 0.0040 | 59.0% | 59.0% | population | 0.0003 | 0.0024 |
| 2265004076 | Lawn/Garden | 4-Stroke Other Lawn & Garden Equip. (Com.) | MOVES | 0.0004 | 0.0032 | 59.0% | 59.0% | population | 0.0003 | 0.0019 |
| 2265005010 | Agriculture | 4-Stroke 2-Wheel Tractors | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005015 | Agriculture | 4-Stroke Agricultural Tractors | MOVES | 0.0001 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005020 | Agriculture | 4-Stroke Combines | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005025 | Agriculture | 4-Stroke Balers | MOVES | 0.0004 | 0.0008 | 17.0% | 17.0% | land area | 0.0001 | 0.0001 |
| 2265005030 | Agriculture | 4-Stroke Agricultural Mowers | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265005035 | Agriculture | 4-Stroke Sprayers | MOVES | 0.0006 | 0.0017 | 17.0% | 17.0% | land area | 0.0001 | 0.0003 |
| 2265005040 | Agriculture | 4-Stroke Tillers > 5 HP | MOVES | 0.0010 | 0.0049 | 17.0% | 17.0% | land area | 0.0002 | 0.0008 |
| 2265005045 | Agriculture | 4-Stroke Swathers | MOVES | 0.0007 | 0.0010 | 17.0% | 17.0% | land area | 0.0001 | 0.0002 |
| 2265005055 | Agriculture | 4-Stroke Other Agricultural Equipment | MOVES | 0.0007 | 0.0009 | 17.0% | 17.0% | land area | 0.0001 | 0.0002 |
| 2265005060 | Agriculture | 4-Stroke Irrigation Sets | MOVES | 0.0001 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265006005 | Commercial | 4-Stroke Light Commercial Generator Set | MOVES | 0.0053 | 0.0336 | 59.0% | 59.0% | population | 0.0031 | 0.0198 |
| 2265006010 | Commercial | 4-Stroke Light Commercial Pumps | MOVES | 0.0014 | 0.0064 | 59.0% | 59.0% | population | 0.0008 | 0.0038 |
| 2265006015 | Commercial | 4-Stroke Light Commercial Air Compressors | MOVES | 0.0007 | 0.0026 | 59.0% | 59.0% | population | 0.0004 | 0.0015 |
| 2265006025 | Commercial | 4-Stroke Light Commercial Welders | MOVES | 0.0015 | 0.0056 | 59.0% | 59.0% | population | 0.0009 | 0.0033 |
| 2265006030 | Commercial | 4-Stroke Light Commercial Pressure Wash | MOVES | 0.0024 | 0.0133 | 59.0% | 59.0% | population | 0.0014 | 0.0078 |
| 2265006035 | Commercial | 4-Stroke Hydro Power Units | MOVES | 0.0001 | 0.0005 | 59.0% | 59.0% | population | 0.0001 | 0.0003 |
| 2265007010 | Logging | 4-Stroke Logging Equipment Shredders > 6 HP | MOVES | 0.0000 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2265007015 | Logging | 4-Stroke Logging Equipment Skidders | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267001060 | Recreational | LPG Specialty Vehicle Carts | MOVES | 0.0001 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267002003 | Construction | LPG Asphalt Pavers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002015 | Construction | LPG Rollers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002021 | Construction | LPG Paving Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002024 | Construction | LPG Surfacing Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002030 | Construction | LPG Trenchers | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002033 | Construction | LPG Bore/Drill Rigs | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267002039 | Construction | LPG Concrete/Industrial Saws | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002045 | Construction | LPG Cranes | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002054 | Construction | LPG Crushing/Proc. Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002057 | Construction | LPG Rough Terrain Forklifts | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002060 | Construction | LPG Rubber Tire Loaders | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002066 | Construction | LPG Tractors/Loaders/Backhoes | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267002072 | Construction | LPG Skid Steer Loaders | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267002081 | Construction | LPG Other Construction Equipment | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267003010 | Industrial | LPG Aerial Lifts | MOVES | 0.0020 | 0.0003 | 59.0% | 59.0% | population | 0.0012 | 0.0002 |
| 2267003020 | Industrial | LPG Forklifts | MOVES | 0.1171 | 0.0137 | 59.0% | 59.0% | population | 0.0691 | 0.0081 |
| 2267003030 | Industrial | LPG Sweepers/Scrubbers | MOVES | 0.0009 | 0.0001 | 59.0% | 59.0% | population | 0.0005 | 0.0001 |
| 2267003040 | Industrial | LPG Other General Industrial Equipment | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2267003050 | Industrial | LPG Other Material Handling Equipment | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2024 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2024 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2267003070 | Industrial | LPG Terminal Tractors | MOVES | 0.0006 | 0.0001 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2267004066 | Lawn/Garden | LPG Chippers/Stump Grinders (Commercial) | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267005055 | Agriculture | LPG Other Agricultural Equipment | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267005060 | Agriculture | LPG Irrigation Sets | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2267006005 | Commercial | LPG Light Commercial Generator Sets | MOVES | 0.0016 | 0.0002 | 59.0% | 59.0% | population | 0.0009 | 0.0001 |
| 2267006010 | Commercial | LPG Light Commercial Pumps | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267006015 | Commercial | LPG Light Commercial Air Compressors | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267006025 | Commercial | LPG Light Commercial Welders | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2267006030 | Commercial | LPG Light Commercial Pressure Washers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2267006035 | Commercial | LPG Hydro Power Units | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268002081 | Construction | CNG Other Construction Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003020 | Industrial | CNG Forklifts | MOVES | 0.0095 | 0.0041 | 59.0% | 59.0% | population | 0.0056 | 0.0024 |
| 2268003030 | Industrial | CNG Sweepers/Scrubbers | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003040 | Industrial | CNG Other General Industrial Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003060 | Industrial | CNG AC/Refrigeration | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268003070 | Industrial | CNG Terminal Tractors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268005055 | Agriculture | CNG Other Agricultural Equipment | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2268005060 | Agriculture | CNG Irrigation Sets | MOVES | 0.0002 | 0.0001 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2268006005 | Commercial | CNG Light Commercial Generator Sets | MOVES | 0.0006 | 0.0004 | 59.0% | 59.0% | population | 0.0004 | 0.0002 |
| 2268006010 | Commercial | CNG Light Commercial Pumps | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268006015 | Commercial | CNG Light Commercial Air Compressors | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2268006020 | Commercial | CNG Light Commercial Gas Compressors | MOVES | 0.0005 | 0.0003 | 59.0% | 59.0% | population | 0.0003 | 0.0001 |
| 2270001060 | Recreational | Diesel Specialty Vehicle Carts | MOVES | 0.0015 | 0.0003 | 17.0% | 17.0% | land area | 0.0003 | 0.0001 |
| 2270002003 | Construction | Diesel Pavers | MOVES | 0.0023 | 0.0001 | 59.0% | 59.0% | population | 0.0014 | 0.0001 |
| 2270002006 | Construction | Diesel Tampers/Rammers (unused) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270002009 | Construction | Diesel Plate Compactors | MOVES | 0.0003 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2270002015 | Construction | Diesel Rollers | MOVES | 0.0077 | 0.0003 | 59.0% | 59.0% | population | 0.0045 | 0.0002 |
| 2270002018 | Construction | Diesel Scrapers | MOVES | 0.0042 | 0.0002 | 59.0% | 59.0% | population | 0.0025 | 0.0001 |
| 2270002021 | Construction | Diesel Paving Equipment | MOVES | 0.0006 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270002024 | Construction | Diesel Surfacing Equipment | MOVES | 0.0005 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270002027 | Construction | Diesel Signal Boards | MOVES | 0.0025 | 0.0002 | 59.0% | 59.0% | population | 0.0015 | 0.0001 |
| 2270002030 | Construction | Diesel Trenchers | MOVES | 0.0064 | 0.0003 | 59.0% | 59.0% | population | 0.0038 | 0.0002 |
| 2270002033 | Construction | Diesel Bore/Drill Rigs | MOVES | 0.0082 | 0.0005 | 59.0% | 59.0% | population | 0.0048 | 0.0003 |
| 2270002036 | Construction | Diesel Excavators | MOVES | 0.0131 | 0.0006 | 59.0% | 59.0% | population | 0.0077 | 0.0004 |
| 2270002039 | Construction | Diesel Concrete/Industrial Saws | MOVES | 0.0005 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270002042 | Construction | Diesel Cement & Mortar Mixers | MOVES | 0.0004 | 0.0000 | 59.0% | 59.0% | population | 0.0002 | 0.0000 |
| 2270002045 | Construction | Diesel Cranes | MOVES | 0.0049 | 0.0003 | 59.0% | 59.0% | population | 0.0029 | 0.0001 |
| 2270002048 | Construction | Diesel Graders | MOVES | 0.0024 | 0.0001 | 59.0% | 59.0% | population | 0.0014 | 0.0001 |
| 2270002051 | Construction | Diesel Off-highway Trucks | MOVES | 0.0367 | 0.0008 | 59.0% | 59.0% | population | 0.0217 | 0.0005 |
| 2270002054 | Construction | Diesel Crushing/Proc. Equipment | MOVES | 0.0015 | 0.0001 | 59.0% | 59.0% | population | 0.0009 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2024 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2024 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2270002057 | Construction | Diesel Rough Terrain Forklifts | MOVES | 0.0115 | 0.0005 | 59.0% | 59.0% | population | 0.0068 | 0.0003 |
| 2270002060 | Construction | Diesel Rubber Tire Loaders | MOVES | 0.0291 | 0.0013 | 59.0% | 59.0% | population | 0.0171 | 0.0008 |
| 2270002066 | Construction | Diesel Tractors/Loaders/Backhoes | MOVES | 0.0331 | 0.0047 | 59.0% | 59.0% | population | 0.0195 | 0.0028 |
| 2270002069 | Construction | Diesel Crawler Tractors | MOVES | 0.0220 | 0.0009 | 59.0% | 59.0% | population | 0.0130 | 0.0005 |
| 2270002072 | Construction | Diesel Skid Steer Loaders | MOVES | 0.0393 | 0.0065 | 59.0% | 59.0% | population | 0.0232 | 0.0039 |
| 2270002075 | Construction | Diesel Off-Highway Tractors | MOVES | 0.0049 | 0.0002 | 59.0% | 59.0% | population | 0.0029 | 0.0001 |
| 2270002078 | Construction | Diesel Dumpers/Tenders | MOVES | 0.0001 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2270002081 | Construction | Diesel Other Construction Equipment | MOVES | 0.0037 | 0.0002 | 59.0% | 59.0% | population | 0.0022 | 0.0001 |
| 2270003010 | Industrial | Diesel Aerial Lifts | MOVES | 0.0073 | 0.0011 | 59.0% | 59.0% | population | 0.0043 | 0.0007 |
| 2270003020 | Industrial | Diesel Forklifts | MOVES | 0.0367 | 0.0007 | 59.0% | 59.0% | population | 0.0216 | 0.0004 |
| 2270003030 | Industrial | Diesel Sweepers/Scrubbers | MOVES | 0.0130 | 0.0005 | 59.0% | 59.0% | population | 0.0077 | 0.0003 |
| 2270003040 | Industrial | Diesel Other General Industrial Equipment | MOVES | 0.0155 | 0.0008 | 59.0% | 59.0% | population | 0.0091 | 0.0005 |
| 2270003050 | Industrial | Diesel Other Material Handling Equipment | MOVES | 0.0014 | 0.0002 | 59.0% | 59.0% | population | 0.0008 | 0.0001 |
| 2270003060 | Industrial | Diesel AC/Refrigeration | MOVES | 0.0332 | 0.0011 | 59.0% | 59.0% | population | 0.0196 | 0.0007 |
| 2270003070 | Industrial | Diesel Terminal Tractors | MOVES | 0.0075 | 0.0003 | 59.0% | 59.0% | population | 0.0044 | 0.0002 |
| 2270004031 | Lawn/Garden | Diesel Leafblowers/Vacuums (Commercial) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270004036 | Lawn/Garden | Diesel Snowblowers (Commercial) | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270004046 | Lawn/Garden | Diesel Front Mowers (Commercial) | MOVES | 0.0071 | 0.0006 | 59.0% | 59.0% | population | 0.0042 | 0.0003 |
| 2270004056 | Lawn/Garden | Diesel Lawn & Garden Tractors (Commercial) | MOVES | 0.0016 | 0.0001 | 59.0% | 59.0% | population | 0.0009 | 0.0001 |
| 2270004066 | Lawn/Garden | Diesel Chippers/Stump Grinders (Commercial) | MOVES | 0.0090 | 0.0007 | 59.0% | 59.0% | population | 0.0053 | 0.0004 |
| 2270004071 | Lawn/Garden | Diesel Commercial Turf Equipment (Comm.) | MOVES | 0.0006 | 0.0000 | 59.0% | 59.0% | population | 0.0004 | 0.0000 |
| 2270004076 | Lawn/Garden | Diesel Other Lawn & Garden Equipment | MOVES | 0.0000 | 0.0000 | 59.0% | 59.0% | population | 0.0000 | 0.0000 |
| 2270005010 | Agriculture | Diesel 2-Wheel Tractors | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005015 | Agriculture | Diesel Agricultural Tractors | MOVES | 0.1053 | 0.0068 | 17.0% | 17.0% | land area | 0.0179 | 0.0012 |
| 2270005020 | Agriculture | Diesel Combines | MOVES | 0.0175 | 0.0014 | 17.0% | 17.0% | land area | 0.0030 | 0.0002 |
| 2270005025 | Agriculture | Diesel Balers | MOVES | 0.0001 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005030 | Agriculture | Diesel Agricultural Mowers | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005035 | Agriculture | Diesel Sprayers | MOVES | 0.0014 | 0.0001 | 17.0% | 17.0% | land area | 0.0002 | 0.0000 |
| 2270005040 | Agriculture | Diesel Tillers > 6 HP | MOVES | 0.0000 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2270005045 | Agriculture | Diesel Swathers | MOVES | 0.0013 | 0.0001 | 17.0% | 17.0% | land area | 0.0002 | 0.0000 |
| 2270005055 | Agriculture | Diesel Other Agricultural Equipment | MOVES | 0.0024 | 0.0002 | 17.0% | 17.0% | land area | 0.0004 | 0.0000 |
| 2270005060 | Agriculture | Diesel Irrigation Sets | MOVES | 0.0011 | 0.0001 | 17.0% | 17.0% | land area | 0.0002 | 0.0000 |
| 2270006005 | Commercial | Diesel Light Commercial Generator Sets | MOVES | 0.0131 | 0.0011 | 59.0% | 59.0% | population | 0.0077 | 0.0007 |
| 2270006010 | Commercial | Diesel Light Commercial Pumps | MOVES | 0.0031 | 0.0003 | 59.0% | 59.0% | population | 0.0018 | 0.0002 |
| 2270006015 | Commercial | Diesel Light Commercial Air Compressors | MOVES | 0.0051 | 0.0002 | 59.0% | 59.0% | population | 0.0030 | 0.0001 |
| 2270006025 | Commercial | Diesel Light Commercial Welders | MOVES | 0.0044 | 0.0006 | 59.0% | 59.0% | population | 0.0026 | 0.0004 |
| 2270006030 | Commercial | Diesel Light Commercial Pressure Washer | MOVES | 0.0004 | 0.0000 | 59.0% | 59.0% | population | 0.0003 | 0.0000 |
| 2270006035 | Commercial | Diesel Hydro Power Units | MOVES | 0.0002 | 0.0000 | 59.0% | 59.0% | population | 0.0001 | 0.0000 |
| 2270007015 | Logging | Diesel Logging Equip Fell/Bunch/Skidders | MOVES | 0.0001 | 0.0000 | 17.0% | 17.0% | land area | 0.0000 | 0.0000 |
| 2275000000 | Airport | All Airport | 2022EMP | 0.0172 | 0.0232 | 0.0% | 0.0% | airport location | 0.0000 | 0.0000 |

| SCC | Segment Description | SCC Description | Emis-sions from | Sheboygan Co. 2024 Emissions | | % in NAA | | Allocate by | Sheb. Co. NAA 2024 Emissions | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | NOx | VOC | NOx | VOC | | NOx | VOC |
| 2280002x01/2 | Comm. Mar. | CM Vessels, Diesel, C1&C2 | 2022EMP | 0.0949 | 0.0029 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.0949 | 0.0029 |
| 2280002x03/4 | Comm. Mar. | CM Vessels, Diesel, C3 | 2022EMP | 0.0715 | 0.0030 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.0715 | 0.0030 |
| 2282005010 | Pleasure Craft | 2-Stroke Outboards | MOVES | 0.0491 | 0.1608 | 0.0% | 0.0% | water area | 0.0000 | 0.0000 |
| 2282005015 | Pleasure Craft | 2-Stroke Personal Watercraft | MOVES | 0.0233 | 0.0293 | 81.0% | 81.0% | water area | 0.0189 | 0.0237 |
| 2282010005 | Pleasure Craft | 4-Stroke Inboards | MOVES | 0.1009 | 0.1324 | 81.0% | 81.0% | water area | 0.0818 | 0.1072 |
| 2282020005 | Pleasure Craft | Diesel Inboards | MOVES | 0.1341 | 0.0085 | 81.0% | 81.0% | water area | 0.1086 | 0.0069 |
| 2282020010 | Pleasure Craft | Diesel Outboards | MOVES | 0.0001 | 0.0000 | 0.0% | 0.0% | water area | 0.0000 | 0.0000 |
| 228500200x | Railroad | All Diesel Line Haul Locomotives | 2022EMP | 0.0572 | 0.0026 | 45.0% | 45.0% | track miles | 0.0257 | 0.0012 |
| 2285002015 | Railway Maint. | Diesel Railway Maintenance | MOVES | 0.0002 | 0.0000 | 45.0% | 45.0% | track miles | 0.0001 | 0.0000 |
| 2285004015 | Railway Maint. | 4-Stroke Gasoline Railway Maintenance | MOVES | 0.0000 | 0.0000 | 45.0% | 45.0% | track miles | 0.0000 | 0.0000 |
| 2285006015 | Railway Maint. | LPG Railway Maintenance | MOVES | 0.0000 | 0.0000 | 45.0% | 45.0% | track miles | 0.0000 | 0.0000 |
| | | | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | | **1.3200** | **1.2829** | **60.0%** | **43.7%** | | **0.7922** | **0.5612** |
| | | | | | | | | | | |
| 22xx005xxx | Agriculture | All | MOVES | 0.1330 | 0.0190 | 17.0% | 17.0% | land area | 0.0226 | 0.0032 |
| 22750xxxxx | Airport | All | 2022EMP | 0.0172 | 0.0232 | 0.0% | 0.0% | airport location | 0.0000 | 0.0000 |
| 22xx006xxx | Commercial | All | MOVES | 0.0415 | 0.0733 | 59.0% | 59.0% | population | 0.0245 | 0.0433 |
| 2280002xxx | Comm. Mar | All | 2022EMP | 0.1664 | 0.0059 | 100.0% | 100.0% | Lk. Mich. Shoreline | 0.1664 | 0.0059 |
| 22xx002xxx | Construction | All | MOVES | 0.2408 | 0.0581 | 59.0% | 59.0% | population | 0.1421 | 0.0343 |
| 22xx003xxx | Industrial | All | MOVES | 0.2620 | 0.0546 | 59.0% | 59.0% | population | 0.1546 | 0.0322 |
| 22xx004xxx | Lawn/Garden | All | MOVES | 0.0737 | 0.4328 | 59.0% | 59.0% | population | 0.0435 | 0.2553 |
| 22xx007xxx | Logging | All | MOVES | 0.0001 | 0.0003 | 17.0% | 17.0% | land area | 0.0000 | 0.0001 |
| 22820xxxxx | Pleasure Craft | All | MOVES | 0.3076 | 0.3309 | 68.0% | 41.6% | water area | 0.2093 | 0.1378 |
| 228500200x | Railroad | All | 2022EMP | 0.0572 | 0.0026 | 45.0% | 45.0% | track miles | 0.0257 | 0.0012 |
| 228500x015 | Railway Maint. | All | MOVES | 0.0002 | 0.0001 | 45.0% | 45.0% | track miles | 0.0001 | 0.0000 |
| 22xx001xxx | Recreational | All | MOVES | 0.0203 | 0.2822 | 17.0% | 17.0% | land area | 0.0035 | 0.0480 |
| | | | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | | **1.3200** | **1.2829** | **60.0%** | **43.7%** | | **0.7922** | **0.5612** |

# APPENDIX 7

# Onroad Emissions for 2017, 2023 and 2024

This appendix provides detailed listings of onroad tons per ozone season weekday (tposwd) emissions and activity data by source type, fuel type and road type for the Sheboygan County, WI 2015 ozone NAAQS nonattainment area for the years 2017, 2023 and 2024. The sums of nitrogen oxides (NOx) and volatile organic compounds (VOC) emissions from these onroad categories were used for the onroad sector NOx and VOC tposwd emissions estimates in Section 3 of the Wisconsin Department of Natural Resources (WDNR) Attainment Plan for the Sheboygan County, WI 2015 Ozone NAAQS Moderate Nonattainment Area.

EPA's MOVES4.0.1[1] model was used to estimate these emissions.

[1] https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves.

**Table A7.1. 2017 Onroad NOx and VOC Emissions, tons per ozone season weekday (tposwd), for the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA).**

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2017 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Motorcycle | Gasoline | Off-Network | 0.0000 | 0.0001 | 0.0262 | 0.0264 |
| Motorcycle | Gasoline | Rural Restricted | 0.0026 | 0.0028 | 0.0011 | 0.0039 |
| Motorcycle | Gasoline | Rural Unrestricted | 0.0016 | 0.0025 | 0.0016 | 0.0041 |
| Motorcycle | Gasoline | Urban Restricted | 0.0017 | 0.0018 | 0.0007 | 0.0025 |
| Motorcycle | Gasoline | Urban Unrestricted | 0.0048 | 0.0078 | 0.0050 | 0.0128 |
| Passenger Car | Gasoline | Off-Network | 0.0400 | 0.0437 | 0.1457 | 0.1894 |
| Passenger Car | Gasoline | Rural Restricted | 0.0377 | 0.0079 | 0.0032 | 0.0110 |
| Passenger Car | Gasoline | Rural Unrestricted | 0.0180 | 0.0054 | 0.0034 | 0.0088 |
| Passenger Car | Gasoline | Urban Restricted | 0.0323 | 0.0067 | 0.0027 | 0.0094 |
| Passenger Car | Gasoline | Urban Unrestricted | 0.0706 | 0.0222 | 0.0142 | 0.0364 |
| Passenger Car | Diesel | Off-Network | 0.0003 | 0.0004 | 0.0000 | 0.0004 |
| Passenger Car | Diesel | Rural Restricted | 0.0004 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Car | Diesel | Rural Unrestricted | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Car | Diesel | Urban Restricted | 0.0003 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Car | Diesel | Urban Unrestricted | 0.0007 | 0.0003 | 0.0000 | 0.0003 |
| Passenger Car | Ethanol (E-85) | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0001 |
| Passenger Car | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Gasoline | Off-Network | 0.0670 | 0.0543 | 0.1021 | 0.1564 |
| Passenger Truck | Gasoline | Rural Restricted | 0.0580 | 0.0086 | 0.0027 | 0.0113 |
| Passenger Truck | Gasoline | Rural Unrestricted | 0.0294 | 0.0069 | 0.0032 | 0.0101 |
| Passenger Truck | Gasoline | Urban Restricted | 0.0364 | 0.0054 | 0.0017 | 0.0071 |
| Passenger Truck | Gasoline | Urban Unrestricted | 0.0815 | 0.0202 | 0.0094 | 0.0296 |
| Passenger Truck | Diesel | Off-Network | 0.0056 | 0.0005 | 0.0000 | 0.0005 |
| Passenger Truck | Diesel | Rural Restricted | 0.0033 | 0.0005 | 0.0000 | 0.0005 |
| Passenger Truck | Diesel | Rural Unrestricted | 0.0027 | 0.0005 | 0.0000 | 0.0005 |
| Passenger Truck | Diesel | Urban Restricted | 0.0021 | 0.0003 | 0.0000 | 0.0003 |
| Passenger Truck | Diesel | Urban Unrestricted | 0.0075 | 0.0015 | 0.0000 | 0.0015 |
| Passenger Truck | Ethanol (E-85) | Off-Network | 0.0001 | 0.0001 | 0.0002 | 0.0003 |
| Passenger Truck | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Urban Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Gasoline | Off-Network | 0.0146 | 0.0103 | 0.0148 | 0.0251 |
| Light Commercial Truck | Gasoline | Rural Restricted | 0.0121 | 0.0019 | 0.0005 | 0.0023 |
| Light Commercial Truck | Gasoline | Rural Unrestricted | 0.0065 | 0.0019 | 0.0005 | 0.0024 |
| Light Commercial Truck | Gasoline | Urban Restricted | 0.0102 | 0.0016 | 0.0004 | 0.0020 |
| Light Commercial Truck | Gasoline | Urban Unrestricted | 0.0233 | 0.0072 | 0.0019 | 0.0091 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2017 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Light Commercial Truck | Diesel | Off-Network | 0.0105 | 0.0009 | 0.0000 | 0.0009 |
| Light Commercial Truck | Diesel | Rural Restricted | 0.0059 | 0.0009 | 0.0000 | 0.0009 |
| Light Commercial Truck | Diesel | Rural Unrestricted | 0.0044 | 0.0008 | 0.0000 | 0.0008 |
| Light Commercial Truck | Diesel | Urban Restricted | 0.0050 | 0.0008 | 0.0000 | 0.0008 |
| Light Commercial Truck | Diesel | Urban Unrestricted | 0.0158 | 0.0031 | 0.0000 | 0.0031 |
| Light Commercial Truck | Ethanol (E-85) | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Gasoline | Off-Network | 0.0009 | 0.0009 | 0.0006 | 0.0015 |
| Other Buses | Gasoline | Rural Restricted | 0.0012 | 0.0003 | 0.0000 | 0.0003 |
| Other Buses | Gasoline | Rural Unrestricted | 0.0005 | 0.0002 | 0.0000 | 0.0002 |
| Other Buses | Gasoline | Urban Restricted | 0.0013 | 0.0003 | 0.0000 | 0.0004 |
| Other Buses | Gasoline | Urban Unrestricted | 0.0022 | 0.0009 | 0.0001 | 0.0010 |
| Other Buses | Diesel | Off-Network | 0.0016 | 0.0002 | 0.0000 | 0.0002 |
| Other Buses | Diesel | Rural Restricted | 0.0040 | 0.0002 | 0.0000 | 0.0002 |
| Other Buses | Diesel | Rural Unrestricted | 0.0016 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Urban Restricted | 0.0044 | 0.0002 | 0.0000 | 0.0002 |
| Other Buses | Diesel | Urban Unrestricted | 0.0068 | 0.0004 | 0.0000 | 0.0004 |
| Other Buses | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Gasoline | Off-Network | 0.0002 | 0.0002 | 0.0001 | 0.0003 |
| Transit Bus | Gasoline | Rural Restricted | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Gasoline | Rural Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Gasoline | Urban Restricted | 0.0003 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Gasoline | Urban Unrestricted | 0.0004 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Off-Network | 0.0017 | 0.0002 | 0.0000 | 0.0002 |
| Transit Bus | Diesel | Rural Restricted | 0.0029 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Rural Unrestricted | 0.0013 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Urban Restricted | 0.0040 | 0.0002 | 0.0000 | 0.0002 |
| Transit Bus | Diesel | Urban Unrestricted | 0.0057 | 0.0004 | 0.0000 | 0.0004 |
| Transit Bus | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2017 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Transit Bus | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Off-Network | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| School Bus | Gasoline | Rural Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Urban Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Urban Unrestricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| School Bus | Diesel | Off-Network | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| School Bus | Diesel | Rural Restricted | 0.0014 | 0.0001 | 0.0000 | 0.0001 |
| School Bus | Diesel | Rural Unrestricted | 0.0008 | 0.0001 | 0.0000 | 0.0001 |
| School Bus | Diesel | Urban Restricted | 0.0013 | 0.0001 | 0.0000 | 0.0001 |
| School Bus | Diesel | Urban Unrestricted | 0.0027 | 0.0003 | 0.0000 | 0.0003 |
| School Bus | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Off-Network | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Refuse Truck | Diesel | Rural Restricted | 0.0012 | 0.0001 | 0.0000 | 0.0001 |
| Refuse Truck | Diesel | Rural Unrestricted | 0.0006 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Urban Restricted | 0.0014 | 0.0001 | 0.0000 | 0.0001 |
| Refuse Truck | Diesel | Urban Unrestricted | 0.0019 | 0.0002 | 0.0000 | 0.0002 |
| Refuse Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Gasoline | Off-Network | 0.0075 | 0.0046 | 0.0056 | 0.0102 |
| Single Unit Short-haul Truck | Gasoline | Rural Restricted | 0.0028 | 0.0006 | 0.0001 | 0.0007 |
| Single Unit Short-haul Truck | Gasoline | Rural Unrestricted | 0.0014 | 0.0005 | 0.0001 | 0.0006 |
| Single Unit Short-haul Truck | Gasoline | Urban Restricted | 0.0031 | 0.0006 | 0.0001 | 0.0007 |
| Single Unit Short-haul Truck | Gasoline | Urban Unrestricted | 0.0043 | 0.0017 | 0.0002 | 0.0020 |
| Single Unit Short-haul Truck | Diesel | Off-Network | 0.0188 | 0.0026 | 0.0000 | 0.0026 |
| Single Unit Short-haul Truck | Diesel | Rural Restricted | 0.0246 | 0.0019 | 0.0000 | 0.0019 |
| Single Unit Short-haul Truck | Diesel | Rural Unrestricted | 0.0146 | 0.0016 | 0.0000 | 0.0016 |
| Single Unit Short-haul Truck | Diesel | Urban Restricted | 0.0276 | 0.0021 | 0.0000 | 0.0021 |
| Single Unit Short-haul Truck | Diesel | Urban Unrestricted | 0.0459 | 0.0050 | 0.0000 | 0.0050 |
| Single Unit Short-haul Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2017 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Single Unit Short-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0002 | 0.0003 |
| Single Unit Long-haul Truck | Gasoline | Rural Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Rural Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Urban Restricted | 0.0002 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Urban Unrestricted | 0.0003 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Off-Network | 0.0008 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Rural Restricted | 0.0014 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Rural Unrestricted | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Urban Restricted | 0.0016 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Urban Unrestricted | 0.0031 | 0.0003 | 0.0000 | 0.0003 |
| Single Unit Long-haul Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Gasoline | Off-Network | 0.0004 | 0.0005 | 0.0039 | 0.0044 |
| Motor Home | Gasoline | Rural Restricted | 0.0016 | 0.0003 | 0.0001 | 0.0004 |
| Motor Home | Gasoline | Rural Unrestricted | 0.0008 | 0.0003 | 0.0001 | 0.0004 |
| Motor Home | Gasoline | Urban Restricted | 0.0015 | 0.0003 | 0.0001 | 0.0004 |
| Motor Home | Gasoline | Urban Unrestricted | 0.0024 | 0.0010 | 0.0002 | 0.0012 |
| Motor Home | Diesel | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Diesel | Rural Restricted | 0.0017 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Rural Unrestricted | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Urban Restricted | 0.0016 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Urban Unrestricted | 0.0027 | 0.0004 | 0.0000 | 0.0004 |
| Motor Home | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0001 | 0.0001 |
| Combination Short-haul Truck | Gasoline | Rural Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Rural Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Urban Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Urban Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Diesel | Off-Network | 0.0197 | 0.0021 | 0.0000 | 0.0021 |
| Combination Short-haul Truck | Diesel | Rural Restricted | 0.0772 | 0.0030 | 0.0000 | 0.0030 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2017 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | **Total** | Exhaust | Evaporative | **Total** |
| Combination Short-haul Truck | Diesel | Rural Unrestricted | 0.0355 | 0.0020 | 0.0000 | 0.0020 |
| Combination Short-haul Truck | Diesel | Urban Restricted | 0.0705 | 0.0027 | 0.0000 | 0.0027 |
| Combination Short-haul Truck | Diesel | Urban Unrestricted | 0.0735 | 0.0041 | 0.0000 | 0.0041 |
| Combination Short-haul Truck | CNG | Off-Network | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Combination Short-haul Truck | CNG | Rural Restricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Combination Short-haul Truck | CNG | Rural Unrestricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Combination Short-haul Truck | CNG | Urban Restricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Combination Short-haul Truck | CNG | Urban Unrestricted | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Combination Short-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Diesel | Off-Network | 0.0353 | 0.0044 | 0.0000 | 0.0044 |
| Combination Long-haul Truck | Diesel | Rural Restricted | 0.2432 | 0.0084 | 0.0000 | 0.0084 |
| Combination Long-haul Truck | Diesel | Rural Unrestricted | 0.0427 | 0.0019 | 0.0000 | 0.0019 |
| Combination Long-haul Truck | Diesel | Urban Restricted | 0.1187 | 0.0041 | 0.0000 | 0.0041 |
| Combination Long-haul Truck | Diesel | Urban Unrestricted | 0.0775 | 0.0035 | 0.0000 | 0.0035 |
| Combination Long-haul Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **1.6358** | **0.2994** | **0.3527** | **0.6521** |
| | | | | | | |
| Motorcycle | ALL | ALL | 0.0108 | 0.0150 | 0.0347 | 0.0497 |
| Passenger Car | ALL | ALL | 0.2005 | 0.0869 | 0.1692 | 0.2561 |
| Passenger Truck | ALL | ALL | 0.2938 | 0.0989 | 0.1194 | 0.2182 |
| Light Commercial Truck | ALL | ALL | 0.1084 | 0.0295 | 0.0181 | 0.0475 |
| Other Buses | ALL | ALL | 0.0246 | 0.0038 | 0.0007 | 0.0045 |
| Transit Bus | ALL | ALL | 0.0168 | 0.0014 | 0.0001 | 0.0015 |
| School Bus | ALL | ALL | 0.0073 | 0.0010 | 0.0001 | 0.0010 |
| Refuse Truck | ALL | ALL | 0.0058 | 0.0005 | 0.0000 | 0.0005 |
| Single Unit Short-haul Truck | ALL | ALL | 0.1506 | 0.0214 | 0.0060 | 0.0274 |
| Single Unit Long-haul Truck | ALL | ALL | 0.0086 | 0.0010 | 0.0003 | 0.0013 |
| Motor Home | ALL | ALL | 0.0137 | 0.0033 | 0.0042 | 0.0075 |
| Combination Short-haul Truck | ALL | ALL | 0.2775 | 0.0144 | 0.0001 | 0.0146 |
| Combination Long-haul Truck | ALL | ALL | 0.5176 | 0.0224 | 0.0000 | 0.0224 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **1.6358** | **0.2994** | **0.3527** | **0.6521** |
| | | | | | | |
| ALL | Gasoline | ALL | 0.5835 | 0.2336 | 0.3524 | 0.5860 |
| ALL | Diesel | ALL | 1.0513 | 0.0651 | 0.0000 | 0.0651 |
| ALL | CNG | ALL | 0.0008 | 0.0006 | 0.0000 | 0.0006 |
| ALL | Ethanol (E-85) | ALL | 0.0003 | 0.0002 | 0.0003 | 0.0005 |
| ALL | Electricity | ALL | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **1.6358** | **0.2994** | **0.3527** | **0.6521** |

| **Source Type** | **Fuel Type** | **Road Type** | **Sheboygan 2015 Ozone NAAQS NAA Year 2017** | | | |
|---|---|---|---|---|---|---|
| | | | **$NO_x$ Emissions (tposwd)** | **VOC Emissions (tposwd)** | | |
| | | | **Total** | Exhaust | Evaporative | **Total** |
| | | | | | | |
| ALL | ALL | Off-Network | 0.2269 | 0.1269 | 0.2995 | 0.4264 |
| ALL | ALL | Rural Restricted | 0.4842 | 0.0382 | 0.0077 | 0.0458 |
| ALL | ALL | Rural Unrestricted | 0.1647 | 0.0253 | 0.0088 | 0.0341 |
| ALL | ALL | Urban Restricted | 0.3259 | 0.0280 | 0.0057 | 0.0337 |
| ALL | ALL | Urban Unrestricted | 0.4341 | 0.0810 | 0.0310 | 0.1120 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **1.6358** | **0.2994** | **0.3527** | **0.6521** |

**Table A7.2. 2023 Onroad NOx and VOC Emissions, tons per ozone season weekday (tposwd), for the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA).**

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2023 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Motorcycle | Gasoline | Off-Network | 0.0000 | 0.0002 | 0.0304 | 0.0306 |
| Motorcycle | Gasoline | Rural Restricted | 0.0026 | 0.0024 | 0.0012 | 0.0036 |
| Motorcycle | Gasoline | Rural Unrestricted | 0.0019 | 0.0024 | 0.0018 | 0.0042 |
| Motorcycle | Gasoline | Urban Restricted | 0.0018 | 0.0016 | 0.0008 | 0.0024 |
| Motorcycle | Gasoline | Urban Unrestricted | 0.0049 | 0.0068 | 0.0053 | 0.0121 |
| Passenger Car | Gasoline | Off-Network | 0.0240 | 0.0278 | 0.1221 | 0.1499 |
| Passenger Car | Gasoline | Rural Restricted | 0.0173 | 0.0039 | 0.0026 | 0.0065 |
| Passenger Car | Gasoline | Rural Unrestricted | 0.0094 | 0.0032 | 0.0031 | 0.0063 |
| Passenger Car | Gasoline | Urban Restricted | 0.0151 | 0.0034 | 0.0023 | 0.0057 |
| Passenger Car | Gasoline | Urban Unrestricted | 0.0334 | 0.0120 | 0.0118 | 0.0238 |
| Passenger Car | Diesel | Off-Network | 0.0001 | 0.0002 | 0.0000 | 0.0002 |
| Passenger Car | Diesel | Rural Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Diesel | Rural Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Diesel | Urban Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Diesel | Urban Unrestricted | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Car | Ethanol (E-85) | Off-Network | 0.0000 | 0.0000 | 0.0001 | 0.0001 |
| Passenger Car | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Gasoline | Off-Network | 0.0391 | 0.0379 | 0.0903 | 0.1282 |
| Passenger Truck | Gasoline | Rural Restricted | 0.0168 | 0.0040 | 0.0024 | 0.0064 |
| Passenger Truck | Gasoline | Rural Unrestricted | 0.0097 | 0.0033 | 0.0031 | 0.0064 |
| Passenger Truck | Gasoline | Urban Restricted | 0.0108 | 0.0026 | 0.0015 | 0.0041 |
| Passenger Truck | Gasoline | Urban Unrestricted | 0.0243 | 0.0089 | 0.0084 | 0.0172 |
| Passenger Truck | Diesel | Off-Network | 0.0021 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Rural Restricted | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Rural Unrestricted | 0.0008 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Urban Restricted | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Urban Unrestricted | 0.0022 | 0.0004 | 0.0000 | 0.0004 |
| Passenger Truck | Ethanol (E-85) | Off-Network | 0.0001 | 0.0001 | 0.0002 | 0.0003 |
| Passenger Truck | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Gasoline | Off-Network | 0.0077 | 0.0062 | 0.0127 | 0.0190 |
| Light Commercial Truck | Gasoline | Rural Restricted | 0.0046 | 0.0009 | 0.0004 | 0.0012 |
| Light Commercial Truck | Gasoline | Rural Unrestricted | 0.0028 | 0.0010 | 0.0005 | 0.0014 |
| Light Commercial Truck | Gasoline | Urban Restricted | 0.0039 | 0.0007 | 0.0003 | 0.0011 |
| Light Commercial Truck | Gasoline | Urban Unrestricted | 0.0091 | 0.0033 | 0.0015 | 0.0049 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2023 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Light Commercial Truck | Diesel | Off-Network | 0.0060 | 0.0004 | 0.0000 | 0.0004 |
| Light Commercial Truck | Diesel | Rural Restricted | 0.0025 | 0.0004 | 0.0000 | 0.0004 |
| Light Commercial Truck | Diesel | Rural Unrestricted | 0.0022 | 0.0004 | 0.0000 | 0.0004 |
| Light Commercial Truck | Diesel | Urban Restricted | 0.0022 | 0.0003 | 0.0000 | 0.0003 |
| Light Commercial Truck | Diesel | Urban Unrestricted | 0.0071 | 0.0012 | 0.0000 | 0.0012 |
| Light Commercial Truck | Ethanol (E-85) | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Gasoline | Off-Network | 0.0008 | 0.0008 | 0.0006 | 0.0014 |
| Other Buses | Gasoline | Rural Restricted | 0.0006 | 0.0003 | 0.0000 | 0.0004 |
| Other Buses | Gasoline | Rural Unrestricted | 0.0003 | 0.0001 | 0.0000 | 0.0002 |
| Other Buses | Gasoline | Urban Restricted | 0.0006 | 0.0004 | 0.0000 | 0.0004 |
| Other Buses | Gasoline | Urban Unrestricted | 0.0010 | 0.0006 | 0.0001 | 0.0007 |
| Other Buses | Diesel | Off-Network | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Rural Restricted | 0.0020 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Rural Unrestricted | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Urban Restricted | 0.0021 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Urban Unrestricted | 0.0035 | 0.0002 | 0.0000 | 0.0002 |
| Other Buses | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Gasoline | Off-Network | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Gasoline | Urban Restricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Gasoline | Urban Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Off-Network | 0.0012 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Rural Restricted | 0.0018 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Rural Unrestricted | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Urban Restricted | 0.0024 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Urban Unrestricted | 0.0035 | 0.0002 | 0.0000 | 0.0002 |
| Transit Bus | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2023 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Transit Bus | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Off-Network | 0.0001 | 0.0002 | 0.0001 | 0.0002 |
| School Bus | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Off-Network | 0.0005 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Rural Restricted | 0.0004 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Rural Unrestricted | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Urban Restricted | 0.0004 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Urban Unrestricted | 0.0010 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Off-Network | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Refuse Truck | Diesel | Rural Restricted | 0.0009 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Rural Unrestricted | 0.0005 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Urban Restricted | 0.0011 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Urban Unrestricted | 0.0014 | 0.0001 | 0.0000 | 0.0001 |
| Refuse Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Gasoline | Off-Network | 0.0065 | 0.0047 | 0.0049 | 0.0096 |
| Single Unit Short-haul Truck | Gasoline | Rural Restricted | 0.0008 | 0.0004 | 0.0001 | 0.0004 |
| Single Unit Short-haul Truck | Gasoline | Rural Unrestricted | 0.0004 | 0.0003 | 0.0001 | 0.0004 |
| Single Unit Short-haul Truck | Gasoline | Urban Restricted | 0.0009 | 0.0004 | 0.0001 | 0.0005 |
| Single Unit Short-haul Truck | Gasoline | Urban Unrestricted | 0.0011 | 0.0009 | 0.0002 | 0.0011 |
| Single Unit Short-haul Truck | Diesel | Off-Network | 0.0139 | 0.0009 | 0.0000 | 0.0009 |
| Single Unit Short-haul Truck | Diesel | Rural Restricted | 0.0091 | 0.0005 | 0.0000 | 0.0005 |
| Single Unit Short-haul Truck | Diesel | Rural Unrestricted | 0.0069 | 0.0005 | 0.0000 | 0.0005 |
| Single Unit Short-haul Truck | Diesel | Urban Restricted | 0.0102 | 0.0006 | 0.0000 | 0.0006 |
| Single Unit Short-haul Truck | Diesel | Urban Unrestricted | 0.0196 | 0.0014 | 0.0000 | 0.0014 |
| Single Unit Short-haul Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2023 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | **Total** | Exhaust | Evaporative | **Total** |
| Single Unit Short-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0003 | 0.0003 |
| Single Unit Long-haul Truck | Gasoline | Rural Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Urban Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Urban Unrestricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Off-Network | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Rural Restricted | 0.0007 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Diesel | Rural Unrestricted | 0.0005 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Diesel | Urban Restricted | 0.0008 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Urban Unrestricted | 0.0016 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Gasoline | Off-Network | 0.0003 | 0.0004 | 0.0030 | 0.0034 |
| Motor Home | Gasoline | Rural Restricted | 0.0008 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | Gasoline | Rural Unrestricted | 0.0004 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | Gasoline | Urban Restricted | 0.0007 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | Gasoline | Urban Unrestricted | 0.0011 | 0.0005 | 0.0001 | 0.0006 |
| Motor Home | Diesel | Off-Network | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Diesel | Rural Restricted | 0.0010 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Rural Unrestricted | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Urban Restricted | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Urban Unrestricted | 0.0017 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0001 | 0.0001 |
| Combination Short-haul Truck | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Diesel | Off-Network | 0.0170 | 0.0009 | 0.0000 | 0.0009 |
| Combination Short-haul Truck | Diesel | Rural Restricted | 0.0352 | 0.0012 | 0.0000 | 0.0012 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2023 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Combination Short-haul Truck | Diesel | Rural Unrestricted | 0.0214 | 0.0008 | 0.0000 | 0.0008 |
| Combination Short-haul Truck | Diesel | Urban Restricted | 0.0322 | 0.0011 | 0.0000 | 0.0011 |
| Combination Short-haul Truck | Diesel | Urban Unrestricted | 0.0398 | 0.0015 | 0.0000 | 0.0015 |
| Combination Short-haul Truck | CNG | Off-Network | 0.0004 | 0.0002 | 0.0000 | 0.0002 |
| Combination Short-haul Truck | CNG | Rural Restricted | 0.0001 | 0.0002 | 0.0000 | 0.0002 |
| Combination Short-haul Truck | CNG | Rural Unrestricted | 0.0001 | 0.0002 | 0.0000 | 0.0002 |
| Combination Short-haul Truck | CNG | Urban Restricted | 0.0001 | 0.0002 | 0.0000 | 0.0002 |
| Combination Short-haul Truck | CNG | Urban Unrestricted | 0.0003 | 0.0004 | 0.0000 | 0.0004 |
| Combination Short-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Diesel | Off-Network | 0.0277 | 0.0020 | 0.0000 | 0.0020 |
| Combination Long-haul Truck | Diesel | Rural Restricted | 0.1306 | 0.0042 | 0.0000 | 0.0042 |
| Combination Long-haul Truck | Diesel | Rural Unrestricted | 0.0296 | 0.0010 | 0.0000 | 0.0010 |
| Combination Long-haul Truck | Diesel | Urban Restricted | 0.0638 | 0.0020 | 0.0000 | 0.0020 |
| Combination Long-haul Truck | Diesel | Urban Unrestricted | 0.0484 | 0.0016 | 0.0000 | 0.0016 |
| Combination Long-haul Truck | CNG | Off-Network | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Rural Restricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Combination Long-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.8253** | **0.1716** | **0.3128** | **0.4844** |
| | | | | | | |
| Motorcycle | ALL | ALL | 0.0111 | 0.0135 | 0.0396 | 0.0530 |
| Passenger Car | ALL | ALL | 0.0998 | 0.0506 | 0.1420 | 0.1926 |
| Passenger Truck | ALL | ALL | 0.1076 | 0.0576 | 0.1060 | 0.1636 |
| Light Commercial Truck | ALL | ALL | 0.0480 | 0.0148 | 0.0154 | 0.0302 |
| Other Buses | ALL | ALL | 0.0128 | 0.0028 | 0.0008 | 0.0036 |
| Transit Bus | ALL | ALL | 0.0101 | 0.0009 | 0.0001 | 0.0009 |
| School Bus | ALL | ALL | 0.0029 | 0.0004 | 0.0001 | 0.0005 |
| Refuse Truck | ALL | ALL | 0.0046 | 0.0003 | 0.0000 | 0.0003 |
| Single Unit Short-haul Truck | ALL | ALL | 0.0694 | 0.0107 | 0.0052 | 0.0160 |
| Single Unit Long-haul Truck | ALL | ALL | 0.0046 | 0.0005 | 0.0003 | 0.0009 |
| Motor Home | ALL | ALL | 0.0075 | 0.0019 | 0.0032 | 0.0051 |
| Combination Short-haul Truck | ALL | ALL | 0.1468 | 0.0066 | 0.0001 | 0.0066 |
| Combination Long-haul Truck | ALL | ALL | 0.3002 | 0.0110 | 0.0000 | 0.0110 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.8253** | **0.1716** | **0.3128** | **0.4844** |
| | | | | | | |
| ALL | Gasoline | ALL | 0.2563 | 0.1438 | 0.3124 | 0.4562 |
| ALL | Diesel | ALL | 0.5674 | 0.0263 | 0.0000 | 0.0263 |
| ALL | CNG | ALL | 0.0014 | 0.0014 | 0.0000 | 0.0014 |
| ALL | Ethanol (E-85) | ALL | 0.0002 | 0.0002 | 0.0004 | 0.0005 |
| ALL | Electricity | ALL | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.8253** | **0.1716** | **0.3128** | **0.4844** |

| **Source Type** | **Fuel Type** | **Road Type** | **Sheboygan 2015 Ozone NAAQS NAA Year 2023** | | | |
|---|---|---|---|---|---|---|
| | | | **$NO_x$ Emissions (tposwd)** | **VOC Emissions (tposwd)** | | |
| | | | **Total** | Exhaust | Evaporative | **Total** |
| | | | | | | |
| ALL | ALL | Off-Network | 0.1502 | 0.0837 | 0.2648 | 0.3485 |
| ALL | ALL | Rural Restricted | 0.2289 | 0.0192 | 0.0067 | 0.0260 |
| ALL | ALL | Rural Unrestricted | 0.0898 | 0.0139 | 0.0087 | 0.0225 |
| ALL | ALL | Urban Restricted | 0.1511 | 0.0142 | 0.0051 | 0.0193 |
| ALL | ALL | Urban Unrestricted | 0.2054 | 0.0406 | 0.0275 | 0.0681 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.8253** | **0.1716** | **0.3128** | **0.4844** |
| | | | | | | |
| Safety Margin | | | 15% | | | 15% |
| **Emissions Budget** | | | **0.9491** | | | **0.5571** |

**Table A7.3. 2024 Onroad NOx and VOC Emissions, tons per ozone season weekday (tposwd), for the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA).**

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2024 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Motorcycle | Gasoline | Off-Network | 0.0000 | 0.0002 | 0.0307 | 0.0309 |
| Motorcycle | Gasoline | Rural Restricted | 0.0027 | 0.0025 | 0.0012 | 0.0037 |
| Motorcycle | Gasoline | Rural Unrestricted | 0.0019 | 0.0025 | 0.0019 | 0.0044 |
| Motorcycle | Gasoline | Urban Restricted | 0.0018 | 0.0017 | 0.0008 | 0.0025 |
| Motorcycle | Gasoline | Urban Unrestricted | 0.0049 | 0.0070 | 0.0054 | 0.0124 |
| Passenger Car | Gasoline | Off-Network | 0.0227 | 0.0275 | 0.1239 | 0.1514 |
| Passenger Car | Gasoline | Rural Restricted | 0.0140 | 0.0033 | 0.0028 | 0.0061 |
| Passenger Car | Gasoline | Rural Unrestricted | 0.0077 | 0.0026 | 0.0033 | 0.0059 |
| Passenger Car | Gasoline | Urban Restricted | 0.0123 | 0.0029 | 0.0024 | 0.0053 |
| Passenger Car | Gasoline | Urban Unrestricted | 0.0272 | 0.0094 | 0.0124 | 0.0219 |
| Passenger Car | Diesel | Off-Network | 0.0001 | 0.0002 | 0.0000 | 0.0002 |
| Passenger Car | Diesel | Rural Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Diesel | Rural Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Diesel | Urban Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Diesel | Urban Unrestricted | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Car | Ethanol (E-85) | Off-Network | 0.0000 | 0.0000 | 0.0001 | 0.0001 |
| Passenger Car | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Car | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Gasoline | Off-Network | 0.0393 | 0.0380 | 0.0955 | 0.1335 |
| Passenger Truck | Gasoline | Rural Restricted | 0.0163 | 0.0039 | 0.0026 | 0.0065 |
| Passenger Truck | Gasoline | Rural Unrestricted | 0.0093 | 0.0033 | 0.0034 | 0.0067 |
| Passenger Truck | Gasoline | Urban Restricted | 0.0105 | 0.0025 | 0.0017 | 0.0042 |
| Passenger Truck | Gasoline | Urban Unrestricted | 0.0231 | 0.0085 | 0.0091 | 0.0177 |
| Passenger Truck | Diesel | Off-Network | 0.0020 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Rural Restricted | 0.0008 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Rural Unrestricted | 0.0008 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Urban Restricted | 0.0005 | 0.0001 | 0.0000 | 0.0001 |
| Passenger Truck | Diesel | Urban Unrestricted | 0.0020 | 0.0003 | 0.0000 | 0.0003 |
| Passenger Truck | Ethanol (E-85) | Off-Network | 0.0001 | 0.0001 | 0.0002 | 0.0003 |
| Passenger Truck | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Passenger Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Gasoline | Off-Network | 0.0076 | 0.0063 | 0.0130 | 0.0192 |
| Light Commercial Truck | Gasoline | Rural Restricted | 0.0042 | 0.0008 | 0.0004 | 0.0012 |
| Light Commercial Truck | Gasoline | Rural Unrestricted | 0.0026 | 0.0009 | 0.0005 | 0.0013 |
| Light Commercial Truck | Gasoline | Urban Restricted | 0.0037 | 0.0007 | 0.0003 | 0.0010 |
| Light Commercial Truck | Gasoline | Urban Unrestricted | 0.0082 | 0.0030 | 0.0016 | 0.0046 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2024 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Light Commercial Truck | Diesel | Off-Network | 0.0060 | 0.0004 | 0.0000 | 0.0004 |
| Light Commercial Truck | Diesel | Rural Restricted | 0.0024 | 0.0003 | 0.0000 | 0.0003 |
| Light Commercial Truck | Diesel | Rural Unrestricted | 0.0021 | 0.0003 | 0.0000 | 0.0003 |
| Light Commercial Truck | Diesel | Urban Restricted | 0.0021 | 0.0003 | 0.0000 | 0.0003 |
| Light Commercial Truck | Diesel | Urban Unrestricted | 0.0069 | 0.0012 | 0.0000 | 0.0012 |
| Light Commercial Truck | Ethanol (E-85) | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Ethanol (E-85) | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Light Commercial Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Gasoline | Off-Network | 0.0008 | 0.0008 | 0.0006 | 0.0014 |
| Other Buses | Gasoline | Rural Restricted | 0.0005 | 0.0003 | 0.0000 | 0.0003 |
| Other Buses | Gasoline | Rural Unrestricted | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Gasoline | Urban Restricted | 0.0005 | 0.0003 | 0.0000 | 0.0004 |
| Other Buses | Gasoline | Urban Unrestricted | 0.0007 | 0.0005 | 0.0001 | 0.0005 |
| Other Buses | Diesel | Off-Network | 0.0010 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Rural Restricted | 0.0021 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Rural Unrestricted | 0.0010 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Urban Restricted | 0.0023 | 0.0001 | 0.0000 | 0.0001 |
| Other Buses | Diesel | Urban Unrestricted | 0.0037 | 0.0002 | 0.0000 | 0.0002 |
| Other Buses | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Other Buses | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Gasoline | Off-Network | 0.0001 | 0.0002 | 0.0002 | 0.0004 |
| Transit Bus | Gasoline | Rural Restricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Gasoline | Rural Unrestricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Gasoline | Urban Restricted | 0.0002 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Gasoline | Urban Unrestricted | 0.0003 | 0.0001 | 0.0000 | 0.0002 |
| Transit Bus | Diesel | Off-Network | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Rural Restricted | 0.0012 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Rural Unrestricted | 0.0006 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Diesel | Urban Restricted | 0.0016 | 0.0001 | 0.0000 | 0.0001 |
| Transit Bus | Diesel | Urban Unrestricted | 0.0025 | 0.0002 | 0.0000 | 0.0002 |
| Transit Bus | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Transit Bus | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2024 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | Total | Exhaust | Evaporative | Total |
| Transit Bus | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Off-Network | 0.0001 | 0.0002 | 0.0001 | 0.0002 |
| School Bus | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Gasoline | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Off-Network | 0.0005 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Rural Restricted | 0.0004 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Rural Unrestricted | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Urban Restricted | 0.0004 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Diesel | Urban Unrestricted | 0.0010 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| School Bus | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Gasoline | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Off-Network | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Refuse Truck | Diesel | Rural Restricted | 0.0008 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Rural Unrestricted | 0.0005 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Urban Restricted | 0.0010 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Diesel | Urban Unrestricted | 0.0013 | 0.0001 | 0.0000 | 0.0001 |
| Refuse Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Refuse Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Gasoline | Off-Network | 0.0068 | 0.0050 | 0.0051 | 0.0101 |
| Single Unit Short-haul Truck | Gasoline | Rural Restricted | 0.0007 | 0.0004 | 0.0001 | 0.0004 |
| Single Unit Short-haul Truck | Gasoline | Rural Unrestricted | 0.0004 | 0.0003 | 0.0001 | 0.0004 |
| Single Unit Short-haul Truck | Gasoline | Urban Restricted | 0.0008 | 0.0004 | 0.0001 | 0.0005 |
| Single Unit Short-haul Truck | Gasoline | Urban Unrestricted | 0.0010 | 0.0009 | 0.0002 | 0.0011 |
| Single Unit Short-haul Truck | Diesel | Off-Network | 0.0138 | 0.0008 | 0.0000 | 0.0008 |
| Single Unit Short-haul Truck | Diesel | Rural Restricted | 0.0084 | 0.0005 | 0.0000 | 0.0005 |
| Single Unit Short-haul Truck | Diesel | Rural Unrestricted | 0.0066 | 0.0005 | 0.0000 | 0.0005 |
| Single Unit Short-haul Truck | Diesel | Urban Restricted | 0.0095 | 0.0005 | 0.0000 | 0.0005 |
| Single Unit Short-haul Truck | Diesel | Urban Unrestricted | 0.0184 | 0.0013 | 0.0000 | 0.0013 |
| Single Unit Short-haul Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2024 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | **Total** | Exhaust | Evaporative | **Total** |
| Single Unit Short-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Short-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0002 | 0.0003 |
| Single Unit Long-haul Truck | Gasoline | Rural Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Urban Restricted | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Gasoline | Urban Unrestricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Off-Network | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | Diesel | Rural Restricted | 0.0007 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Diesel | Rural Unrestricted | 0.0005 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Diesel | Urban Restricted | 0.0008 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Diesel | Urban Unrestricted | 0.0016 | 0.0001 | 0.0000 | 0.0001 |
| Single Unit Long-haul Truck | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Single Unit Long-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Gasoline | Off-Network | 0.0003 | 0.0004 | 0.0029 | 0.0033 |
| Motor Home | Gasoline | Rural Restricted | 0.0007 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | Gasoline | Rural Unrestricted | 0.0004 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | Gasoline | Urban Restricted | 0.0007 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | Gasoline | Urban Unrestricted | 0.0010 | 0.0005 | 0.0001 | 0.0006 |
| Motor Home | Diesel | Off-Network | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Diesel | Rural Restricted | 0.0010 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Rural Unrestricted | 0.0006 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Urban Restricted | 0.0009 | 0.0001 | 0.0000 | 0.0001 |
| Motor Home | Diesel | Urban Unrestricted | 0.0017 | 0.0002 | 0.0000 | 0.0002 |
| Motor Home | CNG | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Motor Home | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Gasoline | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Diesel | Off-Network | 0.0172 | 0.0008 | 0.0000 | 0.0008 |
| Combination Short-haul Truck | Diesel | Rural Restricted | 0.0333 | 0.0011 | 0.0000 | 0.0011 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2024 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | **Total** | Exhaust | Evaporative | **Total** |
| Combination Short-haul Truck | Diesel | Rural Unrestricted | 0.0210 | 0.0007 | 0.0000 | 0.0007 |
| Combination Short-haul Truck | Diesel | Urban Restricted | 0.0305 | 0.0010 | 0.0000 | 0.0010 |
| Combination Short-haul Truck | Diesel | Urban Unrestricted | 0.0384 | 0.0013 | 0.0000 | 0.0013 |
| Combination Short-haul Truck | CNG | Off-Network | 0.0004 | 0.0003 | 0.0000 | 0.0003 |
| Combination Short-haul Truck | CNG | Rural Restricted | 0.0002 | 0.0002 | 0.0000 | 0.0002 |
| Combination Short-haul Truck | CNG | Rural Unrestricted | 0.0002 | 0.0002 | 0.0000 | 0.0002 |
| Combination Short-haul Truck | CNG | Urban Restricted | 0.0002 | 0.0002 | 0.0000 | 0.0002 |
| Combination Short-haul Truck | CNG | Urban Unrestricted | 0.0003 | 0.0004 | 0.0000 | 0.0004 |
| Combination Short-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Short-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Diesel | Off-Network | 0.0269 | 0.0018 | 0.0000 | 0.0018 |
| Combination Long-haul Truck | Diesel | Rural Restricted | 0.1212 | 0.0037 | 0.0000 | 0.0037 |
| Combination Long-haul Truck | Diesel | Rural Unrestricted | 0.0287 | 0.0009 | 0.0000 | 0.0009 |
| Combination Long-haul Truck | Diesel | Urban Restricted | 0.0592 | 0.0018 | 0.0000 | 0.0018 |
| Combination Long-haul Truck | Diesel | Urban Unrestricted | 0.0462 | 0.0014 | 0.0000 | 0.0014 |
| Combination Long-haul Truck | CNG | Off-Network | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Rural Restricted | 0.0001 | 0.0001 | 0.0000 | 0.0001 |
| Combination Long-haul Truck | CNG | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | CNG | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Off-Network | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Rural Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Rural Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Urban Restricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Combination Long-haul Truck | Electricity | Urban Unrestricted | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.7770** | **0.1645** | **0.3233** | **0.4878** |
| | | | | | | |
| Motorcycle | ALL | ALL | 0.0113 | 0.0138 | 0.0400 | 0.0538 |
| Passenger Car | ALL | ALL | 0.0846 | 0.0460 | 0.1450 | 0.1910 |
| Passenger Truck | ALL | ALL | 0.1048 | 0.0571 | 0.1126 | 0.1697 |
| Light Commercial Truck | ALL | ALL | 0.0460 | 0.0141 | 0.0158 | 0.0300 |
| Other Buses | ALL | ALL | 0.0129 | 0.0027 | 0.0007 | 0.0033 |
| Transit Bus | ALL | ALL | 0.0077 | 0.0009 | 0.0003 | 0.0011 |
| School Bus | ALL | ALL | 0.0029 | 0.0004 | 0.0001 | 0.0005 |
| Refuse Truck | ALL | ALL | 0.0043 | 0.0003 | 0.0000 | 0.0003 |
| Single Unit Short-haul Truck | ALL | ALL | 0.0665 | 0.0106 | 0.0055 | 0.0161 |
| Single Unit Long-haul Truck | ALL | ALL | 0.0044 | 0.0005 | 0.0003 | 0.0008 |
| Motor Home | ALL | ALL | 0.0074 | 0.0019 | 0.0031 | 0.0050 |
| Combination Short-haul Truck | ALL | ALL | 0.1418 | 0.0063 | 0.0000 | 0.0064 |
| Combination Long-haul Truck | ALL | ALL | 0.2824 | 0.0099 | 0.0000 | 0.0099 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.7770** | **0.1645** | **0.3233** | **0.4878** |
| | | | | | | |
| ALL | Gasoline | ALL | 0.2370 | 0.1388 | 0.3230 | 0.4617 |
| ALL | Diesel | ALL | 0.5381 | 0.0240 | 0.0000 | 0.0240 |
| ALL | CNG | ALL | 0.0016 | 0.0016 | 0.0000 | 0.0016 |
| ALL | Ethanol (E-85) | ALL | 0.0002 | 0.0002 | 0.0004 | 0.0006 |
| ALL | Electricity | ALL | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.7770** | **0.1645** | **0.3233** | **0.4878** |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA Year 2024 | | | |
|---|---|---|---|---|---|---|
| | | | $NO_x$ Emissions (tposwd) | VOC Emissions (tposwd) | | |
| | | | **Total** | Exhaust | Evaporative | **Total** |
| | | | | | | |
| ALL | ALL | Off-Network | 0.1484 | 0.0834 | 0.2725 | 0.3559 |
| ALL | ALL | Rural Restricted | 0.2121 | 0.0179 | 0.0071 | 0.0250 |
| ALL | ALL | Rural Unrestricted | 0.0857 | 0.0130 | 0.0093 | 0.0223 |
| ALL | ALL | Urban Restricted | 0.1397 | 0.0132 | 0.0054 | 0.0186 |
| ALL | ALL | Urban Unrestricted | 0.1910 | 0.0370 | 0.0290 | 0.0660 |
| | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **0.7770** | **0.1645** | **0.3233** | **0.4878** |
| | | | | | | |
| Safety Margin | | | 15% | | | 15% |
| **Emissions Budget** | | | **0.8935** | | | **0.5610** |

**Table A7.4. Vehicle Activity Data Output from the MOVES4.0.1 Model for Years 2017, 2023 and 2024 for the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA).**

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Motorcycle | Gasoline | Off-Network | 1,748 | 2,058 | 2,070 | | | |
| Motorcycle | Gasoline | Rural Restricted | | | | 3,874 | 4,047 | 4,067 |
| Motorcycle | Gasoline | Rural Unrestricted | | | | 2,846 | 3,329 | 3,402 |
| Motorcycle | Gasoline | Urban Restricted | | | | 2,514 | 2,688 | 2,711 |
| Motorcycle | Gasoline | Urban Unrestricted | | | | 8,764 | 9,258 | 9,317 |
| Passenger Car | Gasoline | Off-Network | 22,167 | 20,064 | 19,704 | | | |
| Passenger Car | Gasoline | Rural Restricted | | | | 162,430 | 137,812 | 134,642 |
| Passenger Car | Gasoline | Rural Unrestricted | | | | 92,233 | 87,599 | 87,039 |
| Passenger Car | Gasoline | Urban Restricted | | | | 139,228 | 120,914 | 118,527 |
| Passenger Car | Gasoline | Urban Unrestricted | | | | 373,003 | 319,975 | 313,062 |
| Passenger Car | Diesel | Off-Network | 149 | 100 | 97 | | | |
| Passenger Car | Diesel | Rural Restricted | | | | 1,090 | 661 | 634 |
| Passenger Car | Diesel | Rural Unrestricted | | | | 619 | 420 | 410 |
| Passenger Car | Diesel | Urban Restricted | | | | 934 | 580 | 558 |
| Passenger Car | Diesel | Urban Unrestricted | | | | 2,502 | 1,536 | 1,474 |
| Passenger Car | Ethanol (E-85) | Off-Network | 14 | 13 | 13 | | | |
| Passenger Car | Ethanol (E-85) | Rural Restricted | | | | 111 | 91 | 87 |
| Passenger Car | Ethanol (E-85) | Rural Unrestricted | | | | 63 | 58 | 56 |
| Passenger Car | Ethanol (E-85) | Urban Restricted | | | | 96 | 80 | 76 |
| Passenger Car | Ethanol (E-85) | Urban Unrestricted | | | | 256 | 210 | 201 |
| Passenger Car | Electricity | Off-Network | 24 | 184 | 185 | | | |
| Passenger Car | Electricity | Rural Restricted | | | | 220 | 1,596 | 1,588 |
| Passenger Car | Electricity | Rural Unrestricted | | | | 125 | 1,015 | 1,027 |
| Passenger Car | Electricity | Urban Restricted | | | | 188 | 1,401 | 1,398 |
| Passenger Car | Electricity | Urban Unrestricted | | | | 505 | 3,706 | 3,693 |
| Passenger Truck | Gasoline | Off-Network | 25,643 | 30,632 | 31,359 | | | |
| Passenger Truck | Gasoline | Rural Restricted | | | | 228,181 | 263,650 | 269,032 |
| Passenger Truck | Gasoline | Rural Unrestricted | | | | 143,327 | 185,382 | 192,383 |
| Passenger Truck | Gasoline | Urban Restricted | | | | 143,317 | 169,502 | 173,541 |
| Passenger Truck | Gasoline | Urban Unrestricted | | | | 409,738 | 478,671 | 489,140 |
| Passenger Truck | Diesel | Off-Network | 161 | 108 | 106 | | | |
| Passenger Truck | Diesel | Rural Restricted | | | | 1,282 | 845 | 824 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Passenger Truck | Diesel | Rural Unrestricted | | | | 806 | 594 | 589 |
| Passenger Truck | Diesel | Urban Restricted | | | | 806 | 543 | 532 |
| Passenger Truck | Diesel | Urban Unrestricted | | | | 2,303 | 1,533 | 1,499 |
| Passenger Truck | Ethanol (E-85) | Off-Network | 64 | 67 | 65 | | | |
| Passenger Truck | Ethanol (E-85) | Rural Restricted | | | | 607 | 554 | 533 |
| Passenger Truck | Ethanol (E-85) | Rural Unrestricted | | | | 381 | 390 | 381 |
| Passenger Truck | Ethanol (E-85) | Urban Restricted | | | | 381 | 356 | 344 |
| Passenger Truck | Ethanol (E-85) | Urban Unrestricted | | | | 1,090 | 1,006 | 969 |
| Passenger Truck | Electricity | Off-Network | 4 | 187 | 214 | | | |
| Passenger Truck | Electricity | Rural Restricted | | | | 38 | 1,940 | 2,207 |
| Passenger Truck | Electricity | Rural Unrestricted | | | | 24 | 1,364 | 1,578 |
| Passenger Truck | Electricity | Urban Restricted | | | | 24 | 1,247 | 1,424 |
| Passenger Truck | Electricity | Urban Unrestricted | | | | 69 | 3,522 | 4,013 |
| Light Commercial Truck | Gasoline | Off-Network | 2,156 | 2,628 | 2,687 | | | |
| Light Commercial Truck | Gasoline | Rural Restricted | | | | 17,815 | 21,142 | 21,428 |
| Light Commercial Truck | Gasoline | Rural Unrestricted | | | | 10,470 | 13,908 | 14,336 |
| Light Commercial Truck | Gasoline | Urban Restricted | | | | 15,028 | 18,255 | 18,564 |
| Light Commercial Truck | Gasoline | Urban Unrestricted | | | | 38,249 | 45,894 | 46,580 |
| Light Commercial Truck | Diesel | Off-Network | 250 | 244 | 253 | | | |
| Light Commercial Truck | Diesel | Rural Restricted | | | | 1,914 | 1,863 | 1,933 |
| Light Commercial Truck | Diesel | Rural Unrestricted | | | | 1,125 | 1,226 | 1,294 |
| Light Commercial Truck | Diesel | Urban Restricted | | | | 1,615 | 1,609 | 1,675 |
| Light Commercial Truck | Diesel | Urban Unrestricted | | | | 4,110 | 4,045 | 4,203 |
| Light Commercial Truck | Ethanol (E-85) | Off-Network | 7 | 8 | 8 | | | |
| Light Commercial Truck | Ethanol (E-85) | Rural Restricted | | | | 68 | 62 | 61 |
| Light Commercial Truck | Ethanol (E-85) | Rural Unrestricted | | | | 40 | 41 | 41 |
| Light Commercial Truck | Ethanol (E-85) | Urban Restricted | | | | 57 | 53 | 53 |
| Light Commercial Truck | Ethanol (E-85) | Urban Unrestricted | | | | 146 | 134 | 132 |
| Light Commercial Truck | Electricity | Off-Network | 0 | 5 | 6 | | | |
| Light Commercial Truck | Electricity | Rural Restricted | | | | 0 | 51 | 60 |
| Light Commercial Truck | Electricity | Rural Unrestricted | | | | 0 | 34 | 40 |
| Light Commercial Truck | Electricity | Urban Restricted | | | | 0 | 44 | 52 |
| Light Commercial Truck | Electricity | Urban Unrestricted | | | | 1 | 111 | 130 |
| Other Buses | Gasoline | Off-Network | 41 | 47 | 48 | | | |
| Other Buses | Gasoline | Rural Restricted | | | | 843 | 882 | 905 |
| Other Buses | Gasoline | Rural Unrestricted | | | | 371 | 429 | 447 |
| Other Buses | Gasoline | Urban Restricted | | | | 914 | 957 | 982 |
| Other Buses | Gasoline | Urban Unrestricted | | | | 1,575 | 1,618 | 1,654 |
| Other Buses | Diesel | Off-Network | 18 | 15 | 16 | | | |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Other Buses | Diesel | Rural Restricted | | | | 334 | 247 | 239 |
| Other Buses | Diesel | Rural Unrestricted | | | | 147 | 120 | 118 |
| Other Buses | Diesel | Urban Restricted | | | | 362 | 269 | 259 |
| Other Buses | Diesel | Urban Unrestricted | | | | 625 | 454 | 437 |
| Other Buses | CNG | Off-Network | 0 | 1 | 1 | | | |
| Other Buses | CNG | Rural Restricted | | | | 0 | 14 | 13 |
| Other Buses | CNG | Rural Unrestricted | | | | 0 | 7 | 6 |
| Other Buses | CNG | Urban Restricted | | | | 0 | 15 | 14 |
| Other Buses | CNG | Urban Unrestricted | | | | 0 | 26 | 23 |
| Other Buses | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Other Buses | Electricity | Rural Restricted | | | | 0 | 0 | 0 |
| Other Buses | Electricity | Rural Unrestricted | | | | 0 | 0 | 0 |
| Other Buses | Electricity | Urban Restricted | | | | 0 | 0 | 0 |
| Other Buses | Electricity | Urban Unrestricted | | | | 0 | 0 | 0 |
| Transit Bus | Gasoline | Off-Network | 7 | 5 | 8 | | | |
| Transit Bus | Gasoline | Rural Restricted | | | | 162 | 103 | 124 |
| Transit Bus | Gasoline | Rural Unrestricted | | | | 73 | 51 | 62 |
| Transit Bus | Gasoline | Urban Restricted | | | | 221 | 140 | 169 |
| Transit Bus | Gasoline | Urban Unrestricted | | | | 315 | 197 | 236 |
| Transit Bus | Diesel | Off-Network | 12 | 13 | 12 | | | |
| Transit Bus | Diesel | Rural Restricted | | | | 244 | 231 | 212 |
| Transit Bus | Diesel | Rural Unrestricted | | | | 109 | 115 | 107 |
| Transit Bus | Diesel | Urban Restricted | | | | 332 | 316 | 290 |
| Transit Bus | Diesel | Urban Unrestricted | | | | 474 | 442 | 405 |
| Transit Bus | CNG | Off-Network | 0 | 0 | 0 | | | |
| Transit Bus | CNG | Rural Restricted | | | | 0 | 12 | 11 |
| Transit Bus | CNG | Rural Unrestricted | | | | 0 | 6 | 6 |
| Transit Bus | CNG | Urban Restricted | | | | 0 | 16 | 15 |
| Transit Bus | CNG | Urban Unrestricted | | | | 0 | 23 | 21 |
| Transit Bus | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Transit Bus | Electricity | Rural Restricted | | | | 0 | 7 | 7 |
| Transit Bus | Electricity | Rural Unrestricted | | | | 0 | 3 | 3 |
| Transit Bus | Electricity | Urban Restricted | | | | 0 | 10 | 9 |
| Transit Bus | Electricity | Urban Unrestricted | | | | 0 | 13 | 13 |
| School Bus | Gasoline | Off-Network | 18 | 28 | 28 | | | |
| School Bus | Gasoline | Rural Restricted | | | | 129 | 186 | 183 |
| School Bus | Gasoline | Rural Unrestricted | | | | 66 | 105 | 105 |
| School Bus | Gasoline | Urban Restricted | | | | 126 | 182 | 178 |
| School Bus | Gasoline | Urban Unrestricted | | | | 222 | 314 | 308 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| School Bus | Diesel | Off-Network | 65 | 57 | 60 | | | |
| School Bus | Diesel | Rural Restricted | | | | 446 | 364 | 373 |
| School Bus | Diesel | Rural Unrestricted | | | | 228 | 206 | 214 |
| School Bus | Diesel | Urban Restricted | | | | 435 | 355 | 364 |
| School Bus | Diesel | Urban Unrestricted | | | | 767 | 615 | 628 |
| School Bus | CNG | Off-Network | 1 | 1 | 1 | | | |
| School Bus | CNG | Rural Restricted | | | | 7 | 7 | 7 |
| School Bus | CNG | Rural Unrestricted | | | | 4 | 4 | 4 |
| School Bus | CNG | Urban Restricted | | | | 7 | 7 | 7 |
| School Bus | CNG | Urban Unrestricted | | | | 12 | 13 | 12 |
| School Bus | Electricity | Off-Network | 0 | 0 | 0 | | | |
| School Bus | Electricity | Rural Restricted | | | | 0 | 0 | 2 |
| School Bus | Electricity | Rural Unrestricted | | | | 0 | 0 | 1 |
| School Bus | Electricity | Urban Restricted | | | | 0 | 0 | 2 |
| School Bus | Electricity | Urban Unrestricted | | | | 0 | 0 | 3 |
| Refuse Truck | Gasoline | Off-Network | 1 | 1 | 1 | | | |
| Refuse Truck | Gasoline | Rural Restricted | | | | 10 | 13 | 13 |
| Refuse Truck | Gasoline | Rural Unrestricted | | | | 5 | 7 | 7 |
| Refuse Truck | Gasoline | Urban Restricted | | | | 12 | 15 | 15 |
| Refuse Truck | Gasoline | Urban Unrestricted | | | | 16 | 20 | 19 |
| Refuse Truck | Diesel | Off-Network | 11 | 10 | 11 | | | |
| Refuse Truck | Diesel | Rural Restricted | | | | 163 | 138 | 138 |
| Refuse Truck | Diesel | Rural Unrestricted | | | | 81 | 76 | 77 |
| Refuse Truck | Diesel | Urban Restricted | | | | 192 | 162 | 162 |
| Refuse Truck | Diesel | Urban Unrestricted | | | | 256 | 212 | 212 |
| Refuse Truck | CNG | Off-Network | 0 | 0 | 0 | | | |
| Refuse Truck | CNG | Rural Restricted | | | | 0 | 0 | 1 |
| Refuse Truck | CNG | Rural Unrestricted | | | | 0 | 0 | 0 |
| Refuse Truck | CNG | Urban Restricted | | | | 0 | 0 | 1 |
| Refuse Truck | CNG | Urban Unrestricted | | | | 0 | 0 | 1 |
| Refuse Truck | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Refuse Truck | Electricity | Rural Restricted | | | | 0 | 0 | 0 |
| Refuse Truck | Electricity | Rural Unrestricted | | | | 0 | 0 | 0 |
| Refuse Truck | Electricity | Urban Restricted | | | | 0 | 0 | 0 |
| Refuse Truck | Electricity | Urban Unrestricted | | | | 0 | 0 | 0 |
| Single Unit Short-haul Truck | Gasoline | Off-Network | 423 | 567 | 597 | | | |
| Single Unit Short-haul Truck | Gasoline | Rural Restricted | | | | 4,394 | 5,636 | 5,749 |
| Single Unit Short-haul Truck | Gasoline | Rural Unrestricted | | | | 2,247 | 3,187 | 3,295 |
| Single Unit Short-haul Truck | Gasoline | Urban Restricted | | | | 4,920 | 6,324 | 6,447 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Single Unit Short-haul Truck | Gasoline | Urban Unrestricted | | | | 6,927 | 8,732 | 8,871 |
| Single Unit Short-haul Truck | Diesel | Off-Network | 956 | 1,054 | 1,085 | | | |
| Single Unit Short-haul Truck | Diesel | Rural Restricted | | | | 8,737 | 8,939 | 8,985 |
| Single Unit Short-haul Truck | Diesel | Rural Unrestricted | | | | 4,467 | 5,055 | 5,149 |
| Single Unit Short-haul Truck | Diesel | Urban Restricted | | | | 9,783 | 10,030 | 10,076 |
| Single Unit Short-haul Truck | Diesel | Urban Unrestricted | | | | 13,773 | 13,848 | 13,865 |
| Single Unit Short-haul Truck | CNG | Off-Network | 0 | 0 | 0 | | | |
| Single Unit Short-haul Truck | CNG | Rural Restricted | | | | 1 | 5 | 5 |
| Single Unit Short-haul Truck | CNG | Rural Unrestricted | | | | 0 | 3 | 3 |
| Single Unit Short-haul Truck | CNG | Urban Restricted | | | | 1 | 5 | 5 |
| Single Unit Short-haul Truck | CNG | Urban Unrestricted | | | | 1 | 7 | 7 |
| Single Unit Short-haul Truck | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Single Unit Short-haul Truck | Electricity | Rural Restricted | | | | 0 | 1 | 1 |
| Single Unit Short-haul Truck | Electricity | Rural Unrestricted | | | | 0 | 1 | 1 |
| Single Unit Short-haul Truck | Electricity | Urban Restricted | | | | 0 | 1 | 1 |
| Single Unit Short-haul Truck | Electricity | Urban Unrestricted | | | | 0 | 1 | 1 |
| Single Unit Long-haul Truck | Gasoline | Off-Network | 16 | 20 | 20 | | | |
| Single Unit Long-haul Truck | Gasoline | Rural Restricted | | | | 217 | 269 | 272 |
| Single Unit Long-haul Truck | Gasoline | Rural Unrestricted | | | | 118 | 162 | 166 |
| Single Unit Long-haul Truck | Gasoline | Urban Restricted | | | | 251 | 312 | 316 |
| Single Unit Long-haul Truck | Gasoline | Urban Unrestricted | | | | 388 | 472 | 476 |
| Single Unit Long-haul Truck | Diesel | Off-Network | 44 | 50 | 53 | | | |
| Single Unit Long-haul Truck | Diesel | Rural Restricted | | | | 588 | 638 | 646 |
| Single Unit Long-haul Truck | Diesel | Rural Unrestricted | | | | 320 | 385 | 395 |
| Single Unit Long-haul Truck | Diesel | Urban Restricted | | | | 682 | 741 | 751 |
| Single Unit Long-haul Truck | Diesel | Urban Unrestricted | | | | 1,052 | 1,122 | 1,132 |
| Single Unit Long-haul Truck | CNG | Off-Network | 0 | 0 | 0 | | | |
| Single Unit Long-haul Truck | CNG | Rural Restricted | | | | 4 | 5 | 5 |
| Single Unit Long-haul Truck | CNG | Rural Unrestricted | | | | 2 | 3 | 3 |
| Single Unit Long-haul Truck | CNG | Urban Restricted | | | | 5 | 6 | 5 |
| Single Unit Long-haul Truck | CNG | Urban Unrestricted | | | | 7 | 8 | 8 |
| Single Unit Long-haul Truck | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Single Unit Long-haul Truck | Electricity | Rural Restricted | | | | 0 | 0 | 1 |
| Single Unit Long-haul Truck | Electricity | Rural Unrestricted | | | | 0 | 0 | 0 |
| Single Unit Long-haul Truck | Electricity | Urban Restricted | | | | 0 | 0 | 1 |
| Single Unit Long-haul Truck | Electricity | Urban Unrestricted | | | | 0 | 0 | 1 |
| Motor Home | Gasoline | Off-Network | 145 | 156 | 161 | | | |
| Motor Home | Gasoline | Rural Restricted | | | | 628 | 621 | 623 |
| Motor Home | Gasoline | Rural Unrestricted | | | | 301 | 329 | 335 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Motor Home | Gasoline | Urban Restricted | | | | 584 | 580 | 581 |
| Motor Home | Gasoline | Urban Unrestricted | | | | 912 | 887 | 887 |
| Motor Home | Diesel | Off-Network | 55 | 64 | 68 | | | |
| Motor Home | Diesel | Rural Restricted | | | | 254 | 266 | 273 |
| Motor Home | Diesel | Rural Unrestricted | | | | 122 | 141 | 147 |
| Motor Home | Diesel | Urban Restricted | | | | 237 | 248 | 255 |
| Motor Home | Diesel | Urban Unrestricted | | | | 370 | 380 | 388 |
| Motor Home | CNG | Off-Network | 0 | 0 | 0 | | | |
| Motor Home | CNG | Rural Restricted | | | | 0 | 0 | 0 |
| Motor Home | CNG | Rural Unrestricted | | | | 0 | 0 | 0 |
| Motor Home | CNG | Urban Restricted | | | | 0 | 0 | 0 |
| Motor Home | CNG | Urban Unrestricted | | | | 0 | 0 | 0 |
| Motor Home | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Motor Home | Electricity | Rural Restricted | | | | 0 | 0 | 0 |
| Motor Home | Electricity | Rural Unrestricted | | | | 0 | 0 | 0 |
| Motor Home | Electricity | Urban Restricted | | | | 0 | 0 | 0 |
| Motor Home | Electricity | Urban Unrestricted | | | | 0 | 0 | 0 |
| Combination Short-haul Truck | Gasoline | Off-Network | 2 | 1 | 1 | | | |
| Combination Short-haul Truck | Gasoline | Rural Restricted | | | | 23 | 10 | 8 |
| Combination Short-haul Truck | Gasoline | Rural Unrestricted | | | | 10 | 5 | 4 |
| Combination Short-haul Truck | Gasoline | Urban Restricted | | | | 21 | 9 | 8 |
| Combination Short-haul Truck | Gasoline | Urban Unrestricted | | | | 21 | 9 | 8 |
| Combination Short-haul Truck | Diesel | Off-Network | 301 | 323 | 329 | | | |
| Combination Short-haul Truck | Diesel | Rural Restricted | | | | 11,404 | 11,489 | 11,568 |
| Combination Short-haul Truck | Diesel | Rural Unrestricted | | | | 5,111 | 5,696 | 5,813 |
| Combination Short-haul Truck | Diesel | Urban Restricted | | | | 10,411 | 10,511 | 10,578 |
| Combination Short-haul Truck | Diesel | Urban Unrestricted | | | | 10,411 | 10,308 | 10,338 |
| Combination Short-haul Truck | CNG | Off-Network | 4 | 9 | 11 | | | |
| Combination Short-haul Truck | CNG | Rural Restricted | | | | 334 | 568 | 705 |
| Combination Short-haul Truck | CNG | Rural Unrestricted | | | | 150 | 282 | 354 |
| Combination Short-haul Truck | CNG | Urban Restricted | | | | 305 | 520 | 644 |
| Combination Short-haul Truck | CNG | Urban Unrestricted | | | | 305 | 510 | 630 |
| Combination Short-haul Truck | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Combination Short-haul Truck | Electricity | Rural Restricted | | | | 0 | 0 | 0 |
| Combination Short-haul Truck | Electricity | Rural Unrestricted | | | | 0 | 0 | 0 |
| Combination Short-haul Truck | Electricity | Urban Restricted | | | | 0 | 0 | 0 |
| Combination Short-haul Truck | Electricity | Urban Unrestricted | | | | 0 | 0 | 0 |
| Combination Long-haul Truck | Diesel | Off-Network | 243 | 258 | 265 | | | |
| Combination Long-haul Truck | Diesel | Rural Restricted | | | | 35,932 | 38,078 | 38,307 |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Combination Long-haul Truck | Diesel | Rural Unrestricted | | | | 6,022 | 7,059 | 7,197 |
| Combination Long-haul Truck | Diesel | Urban Restricted | | | | 17,520 | 18,606 | 18,707 |
| Combination Long-haul Truck | Diesel | Urban Unrestricted | | | | 10,767 | 11,213 | 11,236 |
| Combination Long-haul Truck | CNG | Off-Network | 1 | 1 | 1 | | | |
| Combination Long-haul Truck | CNG | Rural Restricted | | | | 156 | 205 | 205 |
| Combination Long-haul Truck | CNG | Rural Unrestricted | | | | 26 | 38 | 38 |
| Combination Long-haul Truck | CNG | Urban Restricted | | | | 76 | 100 | 100 |
| Combination Long-haul Truck | CNG | Urban Unrestricted | | | | 47 | 60 | 60 |
| Combination Long-haul Truck | Electricity | Off-Network | 0 | 0 | 0 | | | |
| Combination Long-haul Truck | Electricity | Rural Restricted | | | | 0 | 0 | 7 |
| Combination Long-haul Truck | Electricity | Rural Unrestricted | | | | 0 | 0 | 1 |
| Combination Long-haul Truck | Electricity | Urban Restricted | | | | 0 | 0 | 4 |
| Combination Long-haul Truck | Electricity | Urban Unrestricted | | | | 0 | 0 | 2 |
| | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **54,752** | **58,982** | **59,545** | **1,996,247** | **2,110,899** | **2,130,011** |
| | | | | | | | | |
| Motorcycle | ALL | ALL | 1,748 | 2,058 | 2,070 | 17,998 | 19,323 | 19,497 |
| Passenger Car | ALL | ALL | 22,355 | 20,361 | 19,999 | 773,602 | 677,655 | 664,472 |
| Passenger Truck | ALL | ALL | 25,871 | 30,993 | 31,744 | 932,374 | 1,111,099 | 1,138,989 |
| Light Commercial Truck | ALL | ALL | 2,413 | 2,885 | 2,954 | 90,638 | 108,471 | 110,579 |
| Other Buses | ALL | ALL | 59 | 63 | 65 | 5,172 | 5,037 | 5,097 |
| Transit Bus | ALL | ALL | 20 | 19 | 20 | 1,930 | 1,685 | 1,691 |
| School Bus | ALL | ALL | 83 | 86 | 89 | 2,449 | 2,360 | 2,390 |
| Refuse Truck | ALL | ALL | 12 | 11 | 11 | 737 | 643 | 646 |
| Single Unit Short-haul Truck | ALL | ALL | 1,379 | 1,621 | 1,683 | 55,251 | 61,777 | 62,460 |
| Single Unit Long-haul Truck | ALL | ALL | 60 | 71 | 74 | 3,635 | 4,124 | 4,179 |
| Motor Home | ALL | ALL | 200 | 221 | 229 | 3,408 | 3,452 | 3,489 |
| Combination Short-haul Truck | ALL | ALL | 307 | 333 | 341 | 38,509 | 39,915 | 40,658 |
| Combination Long-haul Truck | ALL | ALL | 244 | 259 | 266 | 70,544 | 75,360 | 75,864 |
| | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **54,752** | **58,982** | **59,545** | **1,996,247** | **2,110,899** | **2,130,011** |
| | | | | | | | | |
| ALL | Gasoline | ALL | 52,367 | 56,208 | 56,683 | 1,818,043 | 1,914,790 | 1,931,222 |
| ALL | Diesel | ALL | 2,266 | 2,298 | 2,355 | 172,265 | 174,532 | 175,667 |
| ALL | CNG | ALL | 6 | 13 | 15 | 1,449 | 2,475 | 2,920 |
| ALL | Ethanol (E-85) | ALL | 85 | 88 | 86 | 3,295 | 3,034 | 2,933 |
| ALL | Electricity | ALL | 28 | 376 | 406 | 1,195 | 16,069 | 17,269 |
| | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **54,752** | **58,982** | **59,545** | **1,996,247** | **2,110,899** | **2,130,011** |

| Source Type | Fuel Type | Road Type | Sheboygan 2015 Ozone NAAQS NAA | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Vehicle Population | | | Vehicle-Miles of Travel Ozone Season Weekday | | |
| | | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| | | | | | | | | |
| ALL | ALL | Off-Network | 54,752 | 58,982 | 59,545 | | | |
| ALL | ALL | Rural Restricted | | | | 482,642 | 503,247 | 506,682 |
| ALL | ALL | Rural Unrestricted | | | | 272,040 | 318,833 | 326,633 |
| ALL | ALL | Urban Restricted | | | | 351,585 | 367,711 | 370,399 |
| ALL | ALL | Urban Unrestricted | | | | 889,980 | 921,108 | 926,297 |
| | | | | | | | | |
| **ALL (Total)** | **ALL (Total)** | **ALL (Total)** | **54,752** | **58,982** | **59,545** | **1,996,247** | **2,110,899** | **2,130,011** |

**Table A7.5. Average Speed Distributions Input into the MOVES4.0.1 Model for the Sheboygan County 2015 Ozone NAAQS Nonattainment Area (NAA).**

| Road Type | Average Trip Speed | Percent of Vehicle-Hours of Travel (VHT) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Light-Duty Classes (1) | | | Heavy-Duty Classes (2) | | |
| | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Rural Restricted Access | 0.0 to 2.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 2.5 to 7.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 7.5 to 12.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 12.5 to 17.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 17.5 to 22.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 22.5 to 27.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 27.5 to 32.5 mph | 5.07% | 5.19% | 5.21% | 4.93% | 5.02% | 5.03% |
| Rural Restricted Access | 32.5 to 37.5 mph | 5.07% | 5.19% | 5.21% | 4.93% | 5.02% | 5.03% |
| Rural Restricted Access | 37.5 to 42.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 42.5 to 47.5 mph | 2.13% | 2.40% | 2.44% | 2.24% | 2.57% | 2.62% |
| Rural Restricted Access | 47.5 to 52.5 mph | 2.13% | 2.40% | 2.44% | 2.24% | 2.57% | 2.62% |
| Rural Restricted Access | 52.5 to 57.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 27.5 to 62.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 62.5 to 67.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 67.5 to 72.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Restricted Access | 72.5+ mph | 85.59% | 84.82% | 84.70% | 85.65% | 84.83% | 84.70% |
| | | | | | | | |
| Rural Restricted Access | Total | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |

| Road Type | Average Trip Speed | Percent of Vehicle-Hours of Travel (VHT) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Light-Duty Classes (1) | | | Heavy-Duty Classes (2) | | |
| | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Rural Unrestricted Access | 0.0 to 2.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Unrestricted Access | 2.5 to 7.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Unrestricted Access | 7.5 to 12.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Unrestricted Access | 12.5 to 17.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Unrestricted Access | 17.5 to 22.5 mph | 5.97% | 5.25% | 5.15% | 4.82% | 4.29% | 4.22% |
| Rural Unrestricted Access | 22.5 to 27.5 mph | 8.64% | 8.08% | 8.00% | 7.76% | 7.40% | 7.35% |
| Rural Unrestricted Access | 27.5 to 32.5 mph | 8.09% | 8.98% | 9.10% | 7.88% | 8.83% | 8.96% |
| Rural Unrestricted Access | 32.5 to 37.5 mph | 21.18% | 20.90% | 20.86% | 19.98% | 20.23% | 20.27% |
| Rural Unrestricted Access | 37.5 to 42.5 mph | 31.87% | 30.42% | 30.22% | 33.99% | 32.47% | 32.26% |
| Rural Unrestricted Access | 42.5 to 47.5 mph | 20.17% | 21.01% | 21.13% | 22.25% | 22.36% | 22.38% |
| Rural Unrestricted Access | 47.5 to 52.5 mph | 4.07% | 5.35% | 5.52% | 3.31% | 4.41% | 4.56% |
| Rural Unrestricted Access | 52.5 to 57.5 mph | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% | 0.01% |
| Rural Unrestricted Access | 27.5 to 62.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Unrestricted Access | 62.5 to 67.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Unrestricted Access | 67.5 to 72.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rural Unrestricted Access | 72.5+ mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| | | | | | | | |
| Rural Unrestricted Access | Total | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |

| Road Type | Average Trip Speed | Percent of Vehicle-Hours of Travel (VHT) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Light-Duty Classes (1) | | | Heavy-Duty Classes (2) | | |
| | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Urban Restricted Access | 0.0 to 2.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 2.5 to 7.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 7.5 to 12.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 12.5 to 17.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 17.5 to 22.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 22.5 to 27.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 27.5 to 32.5 mph | 5.07% | 5.19% | 5.21% | 4.93% | 5.02% | 5.03% |
| Urban Restricted Access | 32.5 to 37.5 mph | 5.07% | 5.19% | 5.21% | 4.93% | 5.02% | 5.03% |
| Urban Restricted Access | 37.5 to 42.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 42.5 to 47.5 mph | 2.13% | 2.40% | 2.44% | 2.24% | 2.57% | 2.62% |
| Urban Restricted Access | 47.5 to 52.5 mph | 2.13% | 2.40% | 2.44% | 2.24% | 2.57% | 2.62% |
| Urban Restricted Access | 52.5 to 57.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 27.5 to 62.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 62.5 to 67.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 67.5 to 72.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Restricted Access | 72.5+ mph | 85.59% | 84.82% | 84.70% | 85.65% | 84.83% | 84.70% |
| | | | | | | | |
| Urban Restricted Access | Total | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |

| Road Type | Average Trip Speed | Percent of Vehicle-Hours of Travel (VHT) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Light-Duty Classes (1) | | | Heavy-Duty Classes (2) | | |
| | | 2017 | 2023 | 2024 | 2017 | 2023 | 2024 |
| Urban Unrestricted Access | 0.0 to 2.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Unrestricted Access | 2.5 to 7.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Unrestricted Access | 7.5 to 12.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Unrestricted Access | 12.5 to 17.5 mph | 0.40% | 0.38% | 0.38% | 0.45% | 0.43% | 0.43% |
| Urban Unrestricted Access | 17.5 to 22.5 mph | 3.05% | 2.93% | 2.91% | 2.19% | 2.07% | 2.05% |
| Urban Unrestricted Access | 22.5 to 27.5 mph | 6.31% | 6.29% | 6.29% | 5.01% | 4.99% | 4.99% |
| Urban Unrestricted Access | 27.5 to 32.5 mph | 13.40% | 13.42% | 13.42% | 11.84% | 11.95% | 11.97% |
| Urban Unrestricted Access | 32.5 to 37.5 mph | 37.37% | 37.23% | 37.21% | 36.32% | 36.19% | 36.17% |
| Urban Unrestricted Access | 37.5 to 42.5 mph | 30.38% | 30.29% | 30.27% | 32.14% | 31.83% | 31.78% |
| Urban Unrestricted Access | 42.5 to 47.5 mph | 5.93% | 6.10% | 6.12% | 8.21% | 8.39% | 8.42% |
| Urban Unrestricted Access | 47.5 to 52.5 mph | 3.17% | 3.36% | 3.39% | 3.83% | 4.15% | 4.20% |
| Urban Unrestricted Access | 52.5 to 57.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Unrestricted Access | 27.5 to 62.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Unrestricted Access | 62.5 to 67.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Unrestricted Access | 67.5 to 72.5 mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Urban Unrestricted Access | 72.5+ mph | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| | | | | | | | |
| Urban Unrestricted Access | Total | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |

(1) The Light-Duty Classes are the following four MOVES Source Types:
   a. Motorcycle
   b. Passenger
   c. Passenger Truck
   d. Light Commercial Truck

(2) The Heavy-Duty Classes are the following nine MOVES Source Types:
   a. Other Buses
   b. Transit Bus
   c. School Bus
   d. Refuse Truck
   e. Single Unit Short-haul Truck
   f. Single Unit Long-haul Truck
   g. Motor Home
   h. Combination Short-haul Truck
   i. Combination Long-haul Truck

# APPENDIX 8

# Wisconsin VOC RACT Regulations and Negative Declarations

## Background

Reasonably Available Control Technology (RACT) represents the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility (44 FR 53761). Section 182(b)(2) of the Clean Air Act (CAA) requires nonattainment areas classified as moderate or higher to implement RACT for sources of volatile organic compounds (VOCs).

Section 183 of the CAA requires the EPA to issue guidance for RACT controls for reducing emissions from stationary sources. The EPA has issued such guidance in the form of Control Techniques Guidelines (CTGs), which represent "presumptive norms" for RACT for specific categories of VOC sources. States with nonattainment areas subject to section 182(b)(2) are required to implement RACT for CTGs issued between the date of the CAA Amendments of 1990 and the date of attainment (section 182(b)(2)(A)), and for CTGs issued before the date of enactment of the CAA Amendments of 1990 (section 182(b)(2)(B)).

## Wisconsin's VOC RACT Rules

Generally, states meet RACT requirements by codifying the control requirements established in CTG documents. Wisconsin's VOC RACT rules are contained in chapters 420 through 423, Wisc. Admin. Code. Table A8-1 lists these RACT rules, the associated CTGs they incorporate, and applicable source categories. In addition to the listed rules, chapter NR 424, Wisc. Admin. Code, addresses the control of VOC emissions from process lines, and chapter NR 425 covers compliance schedules, delays, exemptions and internal offsets.

## Negative Declarations

To satisfy Section 182(b)(2)(A) and (B), the WDNR must certify that there are no facilities in the nonattainment area for which RACT requirements have not been codified or for which the state rules do not reflect the most recently published CTG (i.e., make a negative declaration). Wisconsin has not adopted VOC RACT requirements covered by the following CTGs:

- Shipbuilding and Ship Repair (61 FR-44050 8/27/96; 1996),
- Aerospace Manufacturing (EPA-453/R-97-004; 1997),
- Fiberglass Boat Manufacturing (EPA 453/R-08-004; 2008), and
- Oil and Natural Gas Industry (EPA-453/B-16-001; 2016).

In addition, Wisconsin previously promulgated RACT requirements for automobile and light-duty truck manufacturing (NR 422.09). However, the Wisconsin Administrative Code does not currently reflect the EPA's most recent CTG for Automobile and Light-Duty Truck Assembly Coatings (EPA 453/R-08-006; 2008).

The WDNR reviewed available source information in the nonattainment area and did not find any facilities engaging in activities subject any CTG category for which Wisconsin has not adopted or updated RACT requirements. Therefore, to satisfy Section 182(b)(2) requirements, the WDNR is submitting a negative declaration for these five CTG categories for this nonattainment area.

**Table A8-1. Volatile Organic Compounds (VOC) Control Technique Guidelines Incorporated into Wisconsin Administrative Code.**

| Source | Title (Description) | EPA CTG Report No. | Wis. Adm. Code Ref. | Emissions Inventory Classification[1] |
|---|---|---|---|---|
| **Petroleum and Gasoline Sources** | | | | |
| Bulk Gasoline Plants | Control of Volatile Organic Emissions from Bulk Gasoline Plants [bulk gasoline plant unloading, loading and storage] | EPA-450/2-77-035 | NR 420.04(2) | Stationary Point Source |
| Refinery Equipment - Vacuum Producing Systems, Wastewater Separators, and Process Unit Turnarounds | Control of Refinery Vacuum Producing Systems, Wastewater Separators, and Process Unit Turnarounds | EPA-450/2-77-025 | NR 420.05(1), (2) and (3) | Stationary Point Source |
| Refinery Equipment - Control of VOC Leaks | Control of Volatile Organic Compound Leaks from Petroleum Refinery Equipment | EPA-450/2-78-036 | NR 420.05(4) | Stationary Point Source |
| Refinery Equipment - Control of VOC Leaks | Control of Volatile Organic Compound Equipment Leaks from Natural Gas/Gasoline Processing Plants | EPA-450/3-83-007 | NR 420.05(4) | Stationary Point Source |
| Tanks - Fixed Roof | Control of Volatile Organic Emissions from Storage of Petroleum Liquids in Fixed-Roof Tanks | EPA-450/2-77-036 | NR 420.03(5) | Stationary Point Source |
| Tanks - External Floating Roofs | Control of Volatile Organic Emissions from Petroleum Liquid Storage in External Floating Roof Tanks | EPA-450/2-78-047 | NR 420.03(6) and (7) | Stationary Point Source |
| Gasoline Loading Terminals | Control of Hydrocarbons from Tank Truck Gasoline Loading Terminals | EPA-450/2-77-026 | NR 420.04(1) | Stationary Point Source |
| Tank Trucks | Control of Volatile Organic Compound Leaks from Gasoline Tank Trucks and Vapor Collection Systems | EPA-450/2-78-051 | NR 420.04(4) | Stationary Area Source |
| Gasoline Delivery - Stage I Vapor Control Systems | Design Criteria for Stage I Vapor Control Systems – Gasoline Service Stations | EPA-450/R-75-102 | NR 420.04(3) | Stationary Area Source |
| **Surface Coating** | | | | |
| Adhesives | Control Techniques Guidelines for Miscellaneous Industrial Adhesives | EPA 453/R-08-005 | NR 422.128 | Stationary Point Source |

| Source | Title (Description) | EPA CTG Report No. | Wis. Adm. Code Ref. | Emissions Inventory Classification[1] |
|---|---|---|---|---|
| Automobile & Light-duty Truck | Control Techniques Guidelines for Automobile and Light-Duty Truck Assembly Coatings | EPA 453/R-08-006 | NR 422.09 | Stationary Point Source |
| Cans | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks | EPA-450/2-77-008 | NR 422.05 | Stationary Point Source |
| Coils | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks | EPA-450/2-77-008 | NR 422.06 | Stationary Point Source |
| Fabric & Vinyl | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks | EPA-450/2-77-008 | NR 422.08 | Stationary Point Source |
| Flat Wood Paneling | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume VII: Factory Surface Coating of Flat Wood Paneling | EPA-450/2-78-032 | NR 422.13 | Stationary Point Source |
| | Control Techniques Guidelines for Flat Wood Paneling Coatings | EPA-453/R-06-004 | NR 422.131 | Stationary Point Source |
| Large Appliances | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume V: Surface Coating of Large Appliances | EPA-450/2-77-034 | NR 422.11 | Stationary Point Source |
| | Control Techniques Guidelines for Large Appliance Coatings | EPA 453/R-07-004 | NR 422.115 | Stationary Point Source |
| Magnet Wire | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume IV: Surface Coating of Insulation of Magnet Wire | EPA-450/2-77-033 | NR 422.12 | Stationary Point Source |
| Metal Furniture | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume III: Surface Coating of Metal Furniture | EPA-450/2-77-032 | NR 422.1 | Stationary Point Source |
| | Control Techniques Guidelines for Metal Furniture Coatings | EPA 453/R-07-005 | NR 422.105 | Stationary Point Source |

| Source | Title (Description) | EPA CTG Report No. | Wis. Adm. Code Ref. | Emissions Inventory Classification[1] |
|---|---|---|---|---|
| Metal Parts, miscellaneous | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume VI: Surface Coating of Miscellaneous Metal Parts and Products | EPA-450/2-78-015 | NR 422.15 | Stationary Point Source |
| | Control Techniques Guidelines for Miscellaneous Metal and Plastic Parts Coatings | EPA 453/R-08-003 | NR 422.151 | Stationary Point Source |
| | Fire Truck and Emergency Response Vehicle Manufacturing - surface coating | (covered under Misc. Metal Parts CTG) | NR 422.151 | Stationary Point Source |
| Paper, Film and Foil | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks | EPA-450/2-77-008 | NR 422.07 | Stationary Point Source |
| | Control Techniques Guidelines for Paper, Film, and Foil Coatings | EPA 453/R-07-003 | NR 422.075 | Stationary Point Source |
| Plastic Parts - Coatings | Control Techniques Guidelines for Miscellaneous Metal and Plastic Parts Coatings | EPA 453/R-08-003 | NR 422.084 | Stationary Point Source |
| Traffic Markings | Reduction of Volatile Organic Compound Emissions from the Application of Traffic Markings | EPA-450/3-88-007 | NR 422.17 | Stationary Area Source |
| Wood Furniture | Control of Volatile Organic Compound Emissions from Wood Furniture Manufacturing Operations | EPA-453/R-96-007 | NR 422.125 | Stationary Point Source |
| **Graphic Arts** | | | | |
| Rotogravure & Flexography | Control of Volatile Organic Emissions from Existing Stationary Sources – Volume VIII: Graphic Arts-Rotogravure and Flexography | EPA-450/2-78-033 | NR 422.14 | Stationary Point Source |
| Flexible Packaging | Control Techniques Guidelines for Flexible Package Printing | EPA-453/R-06-003 | NR 422.141 | Stationary Point Source |
| Letterpress | Control Techniques Guidelines for Offset Lithographic Printing and Letterpress Printing | EPA-453/R-06-002 | NR 422.144 | Stationary Point Source |
| Lithographic | Control Techniques Guidelines for Offset Lithographic Printing and Letterpress Printing | EPA-453/R-06-002 | NR 422.142 and 422.143 | Stationary Point Source |

| Source | Title (Description) | EPA CTG Report No. | Wis. Adm. Code Ref. | Emissions Inventory Classification[1] |
|---|---|---|---|---|
| **Solvents** | | | | |
| Dry Cleaning | Control of Volatile Organic Emissions from Perchloroethylene Dry Cleaning Systems | EPA-450/2-78-050 | NR 423.05 | Stationary Area Source |
| Dry Cleaning | Control of Volatile Organic Compound Emissions from Large Petroleum Dry Cleaners | EPA-450/3-82-009 | NR 423.05 | Stationary Area Source |
| Industrial Cleaning | Control Techniques Guidelines for Industrial Cleaning Solvents | EPA-453/R-06-001 | NR 423.035 and 423.037 | Stationary Area Source |
| Metal Cleaning | Control of Volatile Organic Emissions from Solvent Metal Cleaning | EPA-450/2-77-022 | NR 423.03 | Stationary Area Source |
| **Chemical** | | | | |
| Pharmaceutical | Control of Volatile Organic Emissions from Manufacture of Synthesized Pharmaceutical Products | EPA-450/2-78-029 | NR 421.03 | Stationary Point Source |
| Polystyrene | Control of Volatile Organic Compound Emissions from Manufacture of High-Density Polyethylene, Polypropylene, and Polystyrene Resins | EPA-450/3-83-008 | NR 421.05 | Stationary Point Source |
| Rubber | Control of Volatile Organic Emissions from Manufacture of Pneumatic Rubber Tires | EPA-450/2-78-030 | NR 421.04 | Stationary Point Source |
| Synthetic Organic | Control of Volatile Organic Compound Emissions from Air Oxidation Processes in Synthetic Organic Chemical Manufacturing Industry | EPA-450/3-84-015 | NR 421.07 | Stationary Point Source |
| Synthetic Organic | Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations in Synthetic Organic Chemical Manufacturing Industry | EPA-450/4-91-031 | NR 421.07 | Stationary Point Source |
| Synthetic Resin | Control of Volatile Organic Compound Leaks from Synthetic Organic Chemical Polymer and Resin Manufacturing Equipment | EPA-450/3-83-006 | NR 421.05 | Stationary Point Source |
| **Manufacturing** | | | | |

| Source | Title (Description) | EPA CTG Report No. | Wis. Adm. Code Ref. | Emissions Inventory Classification[1] |
|---|---|---|---|---|
| Asphalt | Control of Volatile Organic Emissions from Use of Cutback Asphalt | EPA-450/2-77-037 | NR 422.16 | Stationary Area Source |

[1]For purposes of this table, an “Area” source is defined as a nonpoint or fugitive emission source

# APPENDIX 9

# LADCO 2015 Ozone NAAQS Attainment Modeling Technical Support Document

# Attainment Demonstration Modeling for the 2015 Ozone National Ambient Air Quality Standard

## Technical Support Document

**Lake Michigan Air Directors Consortium**
**4415 W Harrison Ave, Suite 548**
**Hillside, IL 60162**

Please direct question/comments to adelman@ladco.org

September 21, 2022

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## Contents

## Document Change Log

| Version | Date | Comments/Changes |
|---|---|---|
| 1 | May 24, 2022 | First draft to LADCO members |
| 2 | July 27, 2022 | Assimilated comments from LADCO members and US EPA |
| 3 | September 21, 2022 | Final TSD: assimilated comments from IL EPA and US EPA |

## Errata/Known Issues

| # | Description |
|---|---|
| | |
| | |

# Figures

# Tables

# Executive Summary

LADCO prepared this Technical Support Document (TSD) to support the development of 2015 ozone ($O_3$) national ambient air quality standard (NAAQS) nonattainment area (NAA) state implementation plans (SIPs). LADCO used the Comprehensive Air Quality Model with Extensions (CAMx) v7.10 photochemical model to support these analyses. The LADCO CAMx modeling results are used here to identify $O_3$ monitoring sites that may have nonattainment or maintenance problems for the 2015 $O_3$ NAAQS by the August 3, 2024 attainment date for moderate NAAs. Because the attainment date occurs during the 2024 $O_3$ season, the effective attainment deadline is the end of the 2023 $O_3$ season and thus resulted in the selection of 2023 as the projection year for this modeling application. LADCO used 2016 as the base modeling year from which we projected air quality in 2023.

LADCO based our 2023 $O_3$ air quality and NAA attainment forecasts on meteorology modeling that was optimized for conditions in the Great Lakes Basin. We used U.S. EPA 2016fh emissions modeling platform data, and other CAMx modeling platform inputs released by the U.S. EPA in September 2019 for this application. LADCO replaced the Electricity Generating Unit (EGU) emissions in the 2016fh platform with 2023 EGU forecasts estimated with the ERTAC EGU Tool version 16.2 beta. ERTAC EGU 16.2 beta integrated state-reported information on EGU operations and forecasts as of September 2021. Overall the CO, NOx, and VOC ozone season emissions are projected to decrease in 2023 relative to 2016 in all LADCO states.

The LADCO 2023 CAMx simulation predicts that the Chiwaukee Prairie, WI and Sheboygan Kohler Andrae, WI monitors are the only two receptors in the region that will have an average future year design value ($DV_{2023}$) that exceeds the 2015 $O_3$ NAAQS.

We justify the use of the LADCO 2016 modeling platform by comparing $O_3$ modeling performance benchmarks against recent U.S. EPA 2016 modeling and demonstrating that the LADCO model is a superior model of ground level $O_3$ in the Great Lakes Basin.

# 1. Introduction

The Lake Michigan Air Directors Consortium (LADCO) was established by the states of Illinois, Indiana, Michigan, and Wisconsin in 1989. The four states and EPA signed a Memorandum of Agreement (MOA) that initiated the Lake Michigan Ozone Study and identified LADCO as the organization to oversee the study. Additional MOAs were signed by the states in 1991 (to establish the Lake Michigan Ozone Control Program), January 2000 (to broaden LADCO's responsibilities), and June 2004 (to update LADCO's mission and reaffirm the commitment to regional planning). In March 2004, Ohio joined LADCO. Minnesota joined the Consortium in 2012. LADCO consists of a Board of Directors (i.e., the State Air Directors), a technical staff, and various workgroups. The main purposes of LADCO are to provide technical assessments for and assistance to its member states, to provide a forum for its member states to discuss regional air quality issues, and to facilitate training for staff in the member states.

On October 26, 2015 the U.S. EPA revised the primary and secondary National Ambient Air Quality Standard (NAAQS) for ozone ($O_3$), strengthening the standard to a level of 0.070 parts per million (ppm) for a maximum daily 8-hour average (80 FR 65291)[1]. The form of the 8-hour $O_3$ NAAQS remained the same as the previous standard, the annual fourth-highest daily maximum averaged over three consecutive years. When U.S. EPA adopts a new or revises an existing NAAQS, it is required by Section 107(d)(1) of the Clean Air Act (CAA) to designate areas as nonattainment, attainment, or unclassifiable. Accordingly, on November 6, 2017 U.S. EPA considered recommendations from states and tribes and designated as attainment/ unclassifiable 2,646 counties and tribal lands across the U.S. (82 FR 54232). The U.S. EPA followed up this action on June 4, 2018 and initially designated several areas in the Great Lakes region, among other areas in the country, as "marginal" $O_3$ nonattainment areas (NAA) based on 2014-2016 ambient air quality data (85 FR 25776). Table 1-1 shows the areas in the LADCO region initially designated by U.S. EPA as nonattainment of the 2015 $O_3$ NAAQS.

[1] The final rule was effective December 8, 2015.

**Table 1-1. June 4, 2018 designations of 2015 Ozone NAAQS NAAs in the LADCO region**

| Area | State | Designation |
|---|---|---|
| Allegan County | MI | Marginal |
| Berrien County | MI | Marginal |
| Chicago | IL, IN, WI | Marginal |
| Cincinnati | OH, KY | Marginal |
| Cleveland | OH | Marginal |
| Columbus | OH | Marginal |
| Detroit | MI | Marginal |
| Door County | WI | Marginal |
| Louisville | KY, IN | Marginal |
| Manitowoc County | WI | Marginal |
| Milwaukee | WI | Marginal |
| Muskegon County | MI | Marginal |
| St. Louis | MO, IL | Marginal |
| Sheboygan County | WI | Marginal |

Several follow-up U.S. EPA actions redesignated some of the areas in the LADCO region from nonattainment to maintenance areas or changed the boundaries of the nonattainment areas. Table 1-2 summarizes the subsequent 2015 $O_3$ NAAQS final actions taken by U.S. EPA on NAAs in the LADCO region.

**Table 1-2. U.S. EPA final actions on 2015 Ozone NAAQS NAAs in the LADCO region as of July 27, 2022**

| Area | State | Action | Date |
|---|---|---|---|
| Columbus | OH | Redesignation to maintenance | 8/21/2019 |
| Door County-Revised | WI | Redesignation to maintenance | 6/10/2020 |
| Sheboygan County | WI | Boundary change | 6/14/2021 |
| Manitowoc County | WI | Boundary change | 6/14/2021 |
| Milwaukee | WI | Boundary change | 6/14/2021 |
| Door County-Revised | WI | Designation to marginal NAA | 6/14/2021 |
| Chicago | IL, IN, WI | Boundary change | 6/14/2021 |
| St. Louis | MO, IL | Boundary change | 6/14/2021 |
| Manitowoc County | WI | Redesignation to maintenance | 3/1/2022 |
| Door County-Revised | WI | Redesignation to maintenance | 4/29/2022 |
| Cincinnati | OH | Redesignation to maintenance | 6/9/2022 |
| Louisville | IN | Redesignation to maintenence | 7/5/2022 |

On April 13, 2022, U.S. EPA determined that several NAAs in the LADCO region failed to attain the 2015 $O_3$ NAAQS by the August 3, 2021 attainment date and proposed to reclassify the areas as "moderate" $O_3$ NAAs. The attainment deadline for moderate NAAs to meet the 2015 $O_3$ NAAQS is August 3, 2024.

The 2015 $O_3$ NAAQS nonattainment areas in the LADCO region as of July 27, 2022 are shown in Figure 1-1. The states with NAAs shown in this figure must submit State Implementation Plans (SIPs) to U.S. EPA that meet the requirements applicable to "moderate" $O_3$ NAAs. The NAA SIPs, or attainment demonstrations, must include a demonstration which identifies emissions reduction strategies that are enough to achieve the NAAQS by August 3, 2024, the attainment date for moderate NAAs. Because the attainment deadline occurs during the 2024 $O_3$ season, the effective attainment deadline is the end of the 2023 $O_3$ season.

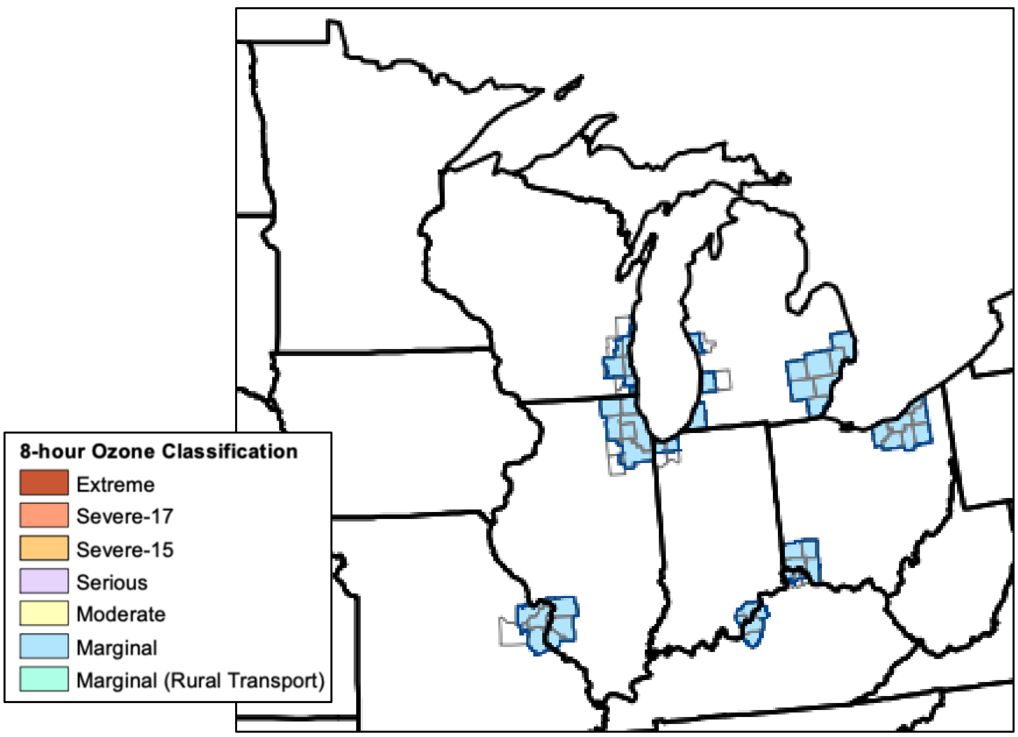


**Figure 1-1. Nonattainment areas in the Lake Michigan region for the 2015 $O_3$ NAAQS (Source: U.S. EPA, June 30, 2022).[2]**

[2] For the Cincinnati, OH-KY nonattainment area the Ohio portion was redesignated on June 9, 2022. For the Louisville, KY-IN nonattainment area the Indiana portion was redesignated on July 5, 2022. Neither of the Kentucky portions of these areas have been redesignated. The entire area is not considered in maintenance until all states in a multi-state area are redesignated.

One of LADCO's responsibilities is to provide technical air quality modeling guidance and support to the LADCO member states. LADCO prepared this Technical Support Document (TSD) to support the development of the $O_3$ NAA SIPs (e.g., attainment plans) for our members pursuant to the 2015 $O_3$ NAAQS. The analyses prepared by LADCO include preparation of modeling emissions inventories for the base year (2016) and the last completed ozone season (2023) before the attainment year (2024), evaluation and application of meteorological and photochemical grid models, analysis of ambient monitoring data, and a modeled attainment test for surface $O_3$ monitors in the existing NAAs. In this report LADCO provides technical information on the validity of the model used to forecast future air quality, and our predictions of future $O_3$ design values for the following 2015 $O_3$ NAAQS nonattainment areas:

- Chicago, IL/IN/WI
- St. Louis, MO/IL
- Allegan County, MI
- Berrien County, MI
- Muskegon County, MI
- Detroit, MI
- Cleveland, OH
- Milwaukee, WI
- Sheboygan County, WI

## 1.1. Conceptual Models of Ozone Formation in the LADCO Region

An $O_3$ conceptual model is a qualitative description of the physical and chemical parameters that drive ground level $O_3$ formation in a specific area. The purpose of the model is to build understanding of the meteorological and chemical factors contributing to high $O_3$ concentrations. Ozone conceptual models are a component of attainment plans because a fundamental understanding of the cause of $O_3$ pollution is needed to enable the development of effective mitigation strategies.

LADCO compiled a library of $O_3$ conceptual models for the different NAAs in the region on the LADCO website:

**Conceptual Models of Ozone Formation in the LADCO Region**

The site includes conceptual models for the following areas in the LADCO region,

- Chicago, IL/IN/WI
- Cincinnati, OH/KH
- Cleveland, OH
- Southeast Michigan
- Louisville, KY/IN
- Wisconsin Lakeshore
- St. Louis, MO/IL
- Western Michigan

## 1.2. LADCO Ozone Synthesis Project

Starting in 2017 with the Lake Michigan Ozone Study, LADCO has been building a library of contemporary, state-of-the-science information on ground level $O_3$ pollution in the Great Lakes Basin. The purpose of this effort is to synthesize all known, recent information about $O_3$ in the region into a coherent picture of the drivers of and potential solutions to $O_3$ air pollution. The goal of the effort is to provide the LADCO member states with comprehensive decision support resources that are based on the best available information on emissions, ambient observations, satellite-based remote sensing, and modeling.

The LADCO $O_3$ Synthesis Project supplements this TSD with reports on the following areas:

- Ozone chemistry
- Satellite-based remote sensing
- Ozone trends
- Ozone precursor emissions reduction options
- Machine learning applications for understanding ozone

- Insights from recent monitoring and modeling intensives (LMOS and MOOSE)

The LADCO $O_3$ Synthesis Project reports are available on the $O_3$ Science page of the LADCO website:

**LADCO Ozone Science for the Great Lakes Basin**[3]

## 1.3. Project Overview

LADCO conducted regional air quality modeling to support the statutory obligations of the LADCO member states under Clean Air Section 172**.** These obligations include SIP revisions that are plans describing how states with designated NAAs will bring the areas back into attainment of the NAAQS. LADCO used the Comprehensive Air Quality Model with Extensions (CAMx[4]) to support these analyses. LADCO used CAMx version 7.10 to predict $O_3$ concentrations in 2023 to determine if current emissions control programs in the region will lead to attainment of the 2015 $O_3$ NAAQS.

## 1.4. Organization of the Technical Support Document

This TSD is presented to the LADCO member states for estimating year 2023 $O_3$ design values ($DVF_{2023}$). The TSD is organized into the following sections.

- Section 2 describes current surface $O_3$ conditions in the LADCO region and trends in $O_3$ concentrations over the past decade
- Section 3 describes the methods and data that LADCO used for air quality modeling, model performance evaluation, and source apportionment modeling.
- Section 4 describes the 2016 and 2023 emissions used for the modeling and attainment testing described in this TSD
- Section 5 summarizes the results of LADCO 2016 air quality model performance evaluation, including a summary and references to details of the WRF meteorology modeling used to support the CAMx simulations

[3] https://www.ladco.org/public-issues/ozone/ozone-science/

[4] www.camx.com

- Section 6 describes LADCO's model attainment testing methods and results
- Section 7 presents source apportionment modeling results that associate $O_3$ precursors sources to $O_3$ concentrations at NAA receptors in the region.
- Section 8 provides a justification for using the LADCO 2016 modeling for the 2015 $O_3$ NAAQS moderate area attainment demonstrations
- The TSD concludes with a summary of significant findings and observations from the LADCO modeling.
- The TSD Supplement is a separate document that includes additional supplementary technical information to support this TSD.

Throughout the TSD, the modeling and analysis results are organized by the 2015 $O_3$ NAAQS NAAs where appropriate. The TSD presents average ozone season day emissions summaries, CAMx model performance, $O_3$ attainment test results, and source apportionment results for each 2015 $O_3$ NAAQS NAA in the LADCO region.

# 2. 2016 Ambient Air Quality Data Analysis

LADCO retrieves and conducts analyses on surface $O_3$ data collected at routine and special-purpose ambient monitors throughout the region. The current monitored $O_3$ design values (DVs), or the three-year average of the $4^{th}$ highest daily maximum 8-hour average (MDA8) $O_3$ concentrations, are presented in this section along with a discussion of trends in $O_3$ DVs and other metrics for tracking the changes in surface $O_3$ concentrations in the region. Design values are labeled by the last year of the three-year average. For example, the 2021 $O_3$ DV is the average of the annual $4^{th}$ highest MDA8 $O_3$ concentrations for the years 2019-2021.

## 2.1. Current Conditions

Figure 2-1 shows maps of the 2021 annual fourth high MDA8 values and the 2021 DVs for the LADCO region. Figure 2-2 shows the same DV data for each $O_3$ NAA and maintenance area. DVs exceeding the level of the 2015 $O_3$ NAAQS (70 ppb) are shown in orange. These figures also show the locations of the 2015 $O_3$ NAAQS NAAs and maintenance areas.

Table 2-1 and Table 2-2 show the historical trends in $O_3$ DVs in $O_3$ nonattainment and maintenance areas in the region. Table 2-1 shows the annual DVs for each area from 2015 to 2021; these values show the DV from the “controlling” monitor, or the monitor with the highest 3-year DV in the entire area. Table 2-2 shows the annual DVs for all monitors in the NAAs and maintenance areas from 2015 to 2021.

The DV tables and figures show that about half of the areas in the LADCO region were attaining the 2015 $O_3$ NAAQS in 2021. These attaining areas include the Door County-Revised, WI, Manitowoc County, WI, Detroit, MI, St. Louis, MO-IL, Louisville, KY-IN, and Cincinnati, OH-KY areas. Six areas around Lake Michigan (Sheboygan, WI, Milwaukee, WI, Chicago, IL-IN-WI, and the Berrien, Allegan, and Muskegon county areas in MI) and Cleveland, OH violated the 2015 $O_3$ NAAQS in 2021; no areas violated the 2008 ozone NAAQS in 2021.

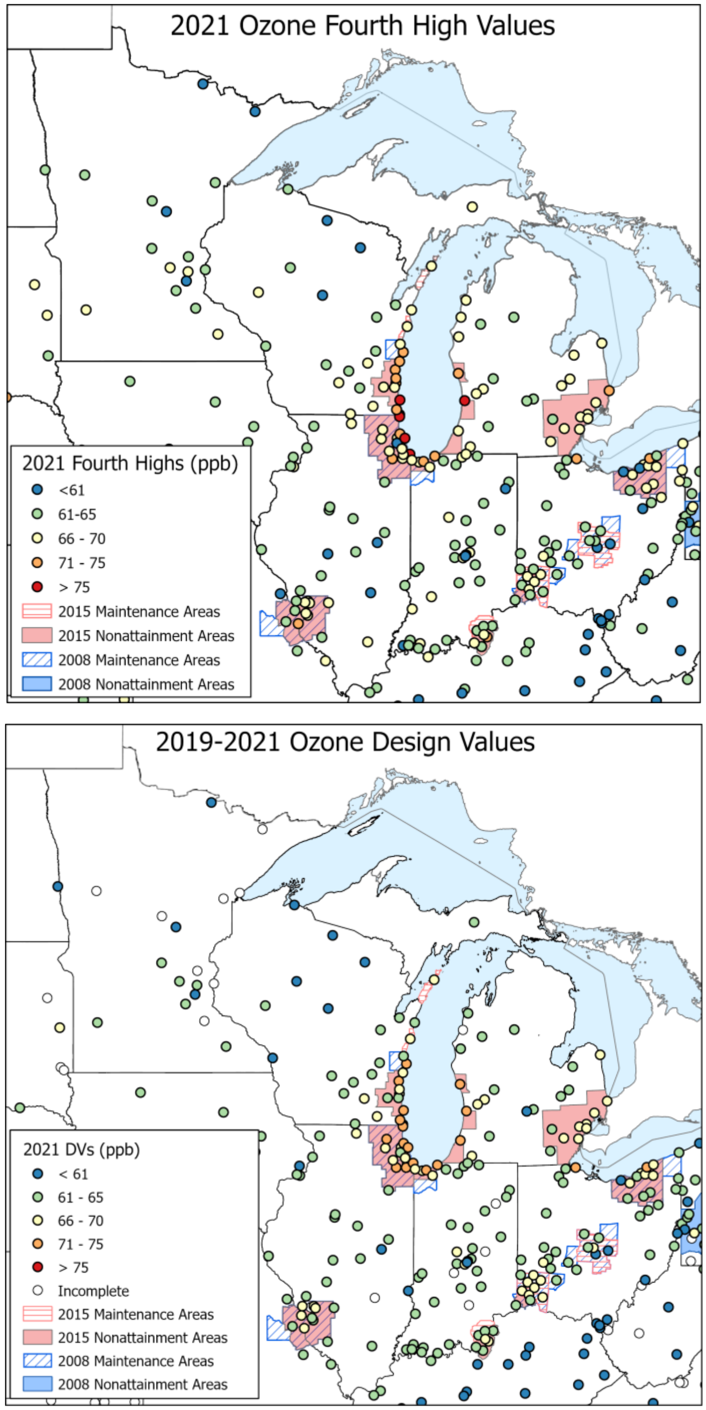


**Figure 2-1. 2021 fourth high ozone MDA8 values (top) and draft 2019-2021 ozone design values (bottom) for the LADCO region. Nonattainment and maintenance areas for the 2008 and 2015 ozone NAAQS are shown for comparison. Where the current nonattainment areas overlap, the area appears purple.**

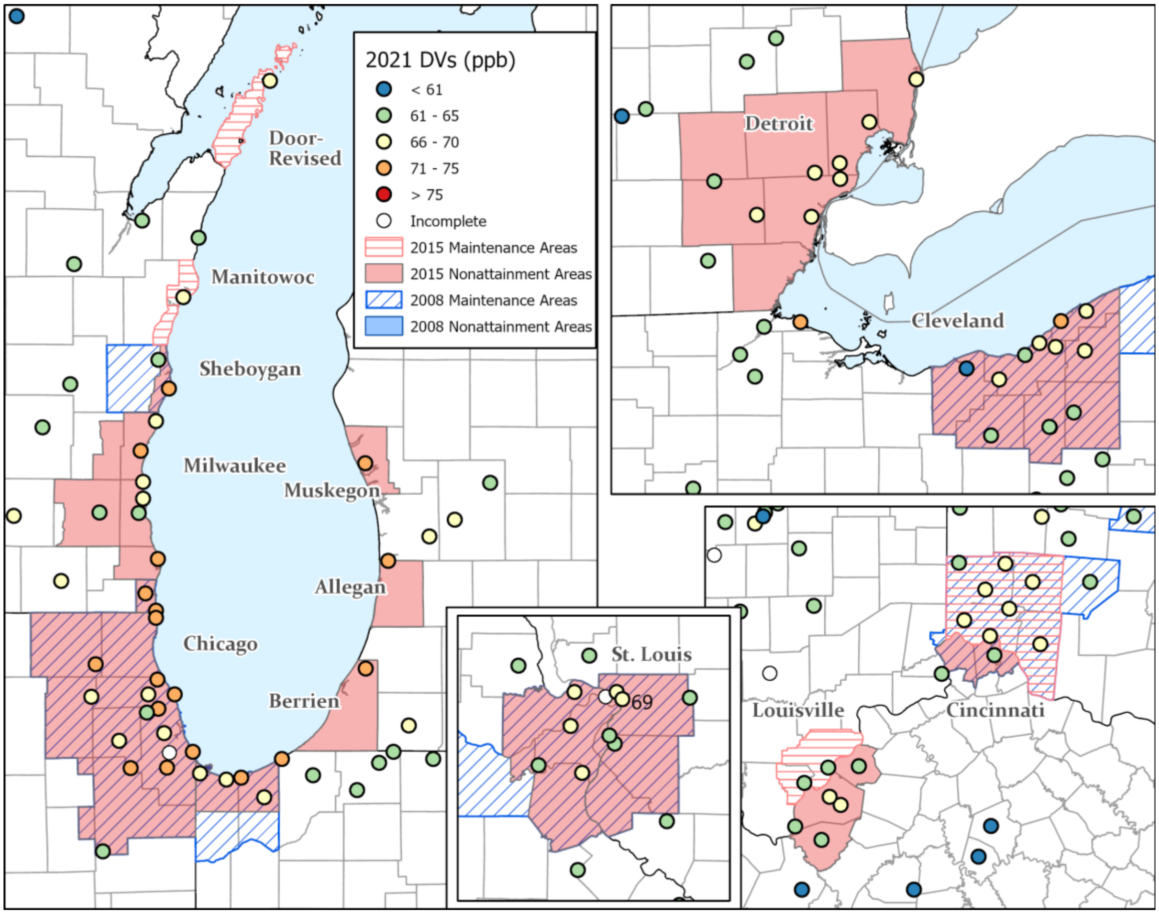


**Figure 2-2. 2019-2021 ozone design values for the nonattainment and maintenance areas in the LADCO region. Nonattainment and maintenance areas for the 2008 and 2015 ozone NAAQS are shown for comparison. Where the current nonattainment areas overlap, the area appears purple.**

**Table 2-1. LADCO nonattainment and maintenance area design values (ppb). Values exceeding the 2015 NAAQS are highlighted in light orange. Values exceeding the 2008 NAAQS are highlighted in medium orange. Design values were downloaded from AQS.**

| Designated Area | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|
| Allegan County, MI | 75 | 75 | 73 | 73 | 72 | 73 | 75 |
| Berrien County, MI | 73 | 74 | 73 | 73 | 69 | 72 | 71 |
| Muskegon County, MI | 74 | 75 | 74 | 76 | 74 | 76 | 74 |
| Door County, WI | 69 | 72 | 73 | 73 | 70 | 72 | 70 |
| Manitowoc County, WI | 72 | 72 | 74 | 73 | 71 | 70 | 68 |
| Milwaukee, WI | 70 | 73 | 74 | 78 | 74 | 73 | 73 |
| Sheboygan County, WI | 77 | 79 | 80 | 81 | 75 | 75 | 72 |
| Chicago, IL-IN-WI | 75 | 77 | 78 | 79 | 75 | 77 | 75 |
| Cincinnati, OH-KY | 71 | 72 | 73 | 75 | 74 | 74 | 70 |
| Cleveland, OH | 73 | 74 | 73 | 74 | 73 | 74 | 72 |
| Detroit, MI | 71 | 71 | 71 | 69 | 68 | 67 | 66 |
| Louisville, KY-IN | 72 | 73 | 73 | 74 | 72 | 72 | 70 |
| St. Louis, MO-IL | 69 | 74 | 74 | 75 | 72 | 72 | 69 |

**Table 2-2. LADCO nonattainment and maintenance area monitor design values (ppb). Values exceeding the 2015 NAAQS are highlighted in light orange. Values exceeding the 2008 NAAQS are highlighted in medium orange. Design values were downloaded from AQS**

| Site | Site Name | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| *Allegan County, MI* | | | | | | | | |
| 260050003 | Holland | 75 | 75 | 73 | 73 | 72 | 73 | 75 |
| *Berrien County, MI* | | | | | | | | |
| 260210014 | Coloma | 73 | 74 | 73 | 73 | 69 | 72 | 71 |
| *Muskegon County, MI* | | | | | | | | |
| 261210039 | Muskegon | 74 | 75 | 74 | 76 | 74 | 76 | 74 |
| *Door County, WI* | | | | | | | | |
| 550290004 | Newport | 69 | 72 | 73 | 73 | 70 | 72 | 70 |
| *Manitowoc County, WI* | | | | | | | | |
| 550710007 | Manitowoc | 72 | 72 | 74 | 73 | 71 | 70 | 68 |
| *Milwaukee, WI* | | | | | | | | |
| 550790010 | Milw-16th St | 62 | 64 | 65 | 67 | 64 | | |
| 550790026/68 | SER DNR/UWM Upark | 66 | 68 | 67 | 69 | 65 | 68 | 68 |
| 550790085 | Bayside | 68 | 71 | 71 | 73 | 69 | 70 | 70 |
| 550890008 | Grafton | 70 | 71 | 71 | 72 | 71 | 71 | 71 |
| 550890009 | Harrington Beach | 69 | 73 | 73 | 74 | 70 | 70 | 70 |
| 551010020 | Racine-P&D | | | 74 | 78 | 74 | 73 | 73 |
| 551330027 | Waukesha | 63 | 66 | 65 | 66 | 63 | 64 | 65 |

| Site | Site Name | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| *Sheboygan County, WI* | | | | | | | | |
| 551170006 | Sheboygan KA | 77 | 79 | 80 | 81 | 75 | 75 | 72 |
| *Chicago, IL-IN-WI* | | | | | | | | |
| 170310001 | Alsip | 65 | 69 | 73 | 77 | 75 | 75 | 71 |
| 170310032 | Chicago SWFP | 68 | 70 | 72 | 75 | 73 | 74 | 75 |
| 170310076 | Chicago Com Ed | 64 | 69 | 72 | 75 | 72 | 69 | 67 |
| 170311003 | Chicago Taft HS | 66 | 69 | 67 | 69 | 67 | 73 | 71 |
| 170311601 | Lemont | 66 | 69 | 69 | 70 | 68 | 71 | 72 |
| 170313103 | Schiller Park | 61 | 62 | 62 | 64 | 63 | 65 | 64 |
| 170314002 | Cicero | 62 | 66 | 68 | 72 | 68 | 71 | 70 |
| 170314007 | Des Plaines | 68 | 71 | 71 | 74 | 70 | 71 | 69 |
| 170314201 | Northbrook | 68 | 71 | 72 | 77 | 74 | 77 | 74 |
| 170317002 | Evanston | 70 | 72 | 73 | 77 | 75 | 75 | 73 |
| 170436001 | Lisle | 64 | 68 | 70 | 71 | 70 | 71 | 70 |
| 170890005 | Elgin | 65 | 68 | 69 | 71 | 70 | 72 | 70 |
| 170971007 | Zion | 71 | 73 | 73 | 75 | 71 | 72 | 73 |
| 171110001 | Cary | 65 | 68 | 69 | 72 | 71 | 73 | 71 |
| 171971011 | Braidwood | 63 | 64 | 65 | 67 | 66 | 66 | 64 |
| 180890022 | Gary-IITRI | 65 | 67 | 68 | 70 | 68 | 70 | 69 |
| 180892008 | Hammond | 63 | 65 | | 66 | 65 | 66 | 68 |
| 181270024 | Ogden Dunes | 68 | 69 | 69 | 71 | 70 | 71 | 72 |
| 181270026 | Valparaiso | 63 | 66 | 69 | 73 | 73 | 69 | 68 |
| 550590019 | Chiwaukee | 75 | 77 | 78 | 79 | 75 | 74 | 74 |
| 550590025 | Kenosha WT | 69 | 71 | 73 | 77 | 74 | 74 | 72 |
| *Cincinnati, OH-KY* | | | | | | | | |
| 210150003 | East Bend | 61 | 63 | 62 | 64 | 63 | 64 | 61 |
| 210373002 | N Kentucky Univ | 71 | 70 | 69 | 67 | 65 | 63 | 63 |
| 390170018 | Middletown | 69 | 70 | 71 | 73 | 71 | 71 | 67 |
| 390170023 | Crawford Woods | 69 | 72 | 72 | 73 | 70 | 69 | 66 |
| 390179991 | Oxford | 68 | 69 | 69 | 70 | 68 | 66 | 64 |
| 390250022 | Batavia | 68 | 70 | 70 | 70 | 69 | 68 | 66 |
| 390610006 | Sycamore | 70 | 72 | 73 | 75 | 74 | 74 | 70 |
| 390610010 | Colerain | 69 | 72 | 70 | 72 | 70 | 70 | 67 |
| 390610040 | Taft | 69 | 71 | 71 | 72 | 71 | 70 | 69 |
| 391650007 | Lebanon | 69 | 72 | 71 | 72 | 71 | 72 | 70 |
| *Cleveland, OH* | | | | | | | | |
| 390350034 | District 6 | 69 | 69 | 68 | 70 | 69 | 71 | 70 |
| 390350060 | GT Craig | 62 | 64 | 62 | 62 | 63 | 65 | 63 |
| 390350064 | Berea BOE | 63 | 64 | 66 | 66 | 64 | 65 | 66 |
| 390355002 | Mayfield | 66 | 67 | 70 | 71 | 71 | 71 | 68 |
| 390550004 | Notre Dame | 67 | 70 | 72 | 72 | 70 | 68 | 66 |

| Site | Site Name | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| 390850003 | Eastlake | 73 | 74 | 73 | 74 | 73 | 74 | 72 |
| 390850007 | Painesville | 66 | 67 | 70 | 70 | 70 | 68 | 66 |
| 390930018 | Elyria-Sheffield | 63 | 65 | 65 | 67 | 64 | 62 | 58 |
| 391030004 | Chippewa Lake | 64 | 64 | 64 | 65 | 61 | | 61 |
| 391331001 | Lake Rockwell | 61 | 61 | 62 | 63 | 63 | 62 | 62 |
| 391530020 | Patterson Park | 61 | 61 | 64 | 65 | 67 | 65 | 64 |
| *Columbus, OH* | | | | | | | | |
| 390410002 | Delaware | 68 | 67 | 65 | 64 | 63 | 64 | 62 |
| 390490029 | New Albany | 71 | 71 | 71 | 69 | 68 | 67 | 66 |
| 390490037 | Franklin Park | 67 | 66 | 65 | | | | |
| 390490081 | Columbus-Maple | 65 | 67 | 66 | 66 | 62 | 62 | 62 |
| 390890005 | Heath | 66 | 67 | 66 | 64 | 61 | 60 | 59 |
| 390890008 | Reynoldsburg | | | | | | 61 | 58 |
| *Detroit, MI* | | | | | | | | |
| 260990009 | New Haven | 71 | 72 | 71 | 72 | 68 | 71 | 68 |
| 260991003 | Warren | 66 | 67 | 66 | 69 | 66 | 68 | 66 |
| 261250001 | Oak Park | 66 | 69 | 70 | 73 | 70 | 72 | 69 |
| 261470005 | Port Huron | 72 | 73 | 71 | 72 | 71 | 71 | 70 |
| 261610008 | Ypsilanti | 66 | 67 | 67 | 69 | 66 | 67 | 66 |
| 261619991 | Dexter | | 68 | 69 | 71 | 66 | 65 | 62 |
| 261630001 | Allen Park | 63 | 65 | 66 | 68 | 66 | 67 | 67 |
| 261630019 | Detroit-E 7 Mile | 70 | 72 | 73 | 74 | 72 | 71 | 70 |
| *Louisville, KY-IN* | | | | | | | | |
| 180190008 | Charlestown SP | 69 | 70 | 71 | 70 | 67 | 65 | 63 |
| 180431004 | New Albany | 67 | 69 | 71 | 73 | 70 | 67 | 64 |
| 210290006 | Shepherdsville | 65 | 66 | 65 | 66 | 64 | 65 | 64 |
| 211110051 | Watson Ln | | 69 | 68 | 68 | 66 | 65 | 65 |
| 211110067 | Cannons Lane | | 74 | 74 | 75 | 72 | 72 | 69 |
| 211110080 | Carrithers MS | | | | | | 67 | 68 |
| 211850004 | Buckner | 68 | 70 | 68 | 67 | 66 | 65 | 63 |
| *St. Louis, MO-IL* | | | | | | | | |
| 171190120 | Alton-HM Sch | 71 | 71 | 69 | 70 | 68 | 69 | 68 |
| 171191009 | Maryville | 69 | 67 | 68 | 72 | 71 | 68 | 67 |
| 171193007 | Wood River | 69 | 71 | 70 | 71 | 69 | 70 | 69 |
| 171199991 | Alhambra | 68 | 67 | 67 | 68 | 66 | 66 | 64 |
| 171630010 | East St. Louis | 66 | 68 | 68 | 71 | 68 | 67 | 65 |
| 291831002 | West Alton | 71 | 72 | 72 | 74 | 71 | 71 | |
| 291831004 | Orchard Farm | 69 | 71 | 70 | 72 | 69 | 68 | 66 |
| 291890005 | Pacific | 65 | 65 | 64 | 66 | 65 | 66 | 64 |
| 291890014 | Maryland Heights | 70 | 71 | 69 | 70 | 68 | 71 | 69 |
| 295100085 | Blair Street | 65 | 65 | 66 | 71 | 69 | 68 | 65 |

## 2.2. Ozone Trends

Figure 2-3 and Figure 2-4 illustrate the 17-year trends in $O_3$ DVs at surface monitors in the different $O_3$ NAAs. Ozone DVs in all nonattainment and maintenance areas decreased over this period from high values in the mid-2000s to values in 2021 that were either record lows or near-record lows in many areas. The $O_3$ DV reductions are particularly notable for the Manitowoc, Sheboygan, and Door County areas along Wisconsin's lakeshore, as well as for Detroit, MI, and the southern areas of Cincinnati, OH, Louisville, KY-IN, and St. Louis, MO-IL. In contrast, while $O_3$ DVs in the Chicago, IL-IN-WI appear to have been relatively stable since 2010, the area has attained the 2008 ozone NAAQS in two out of the last three design value years.

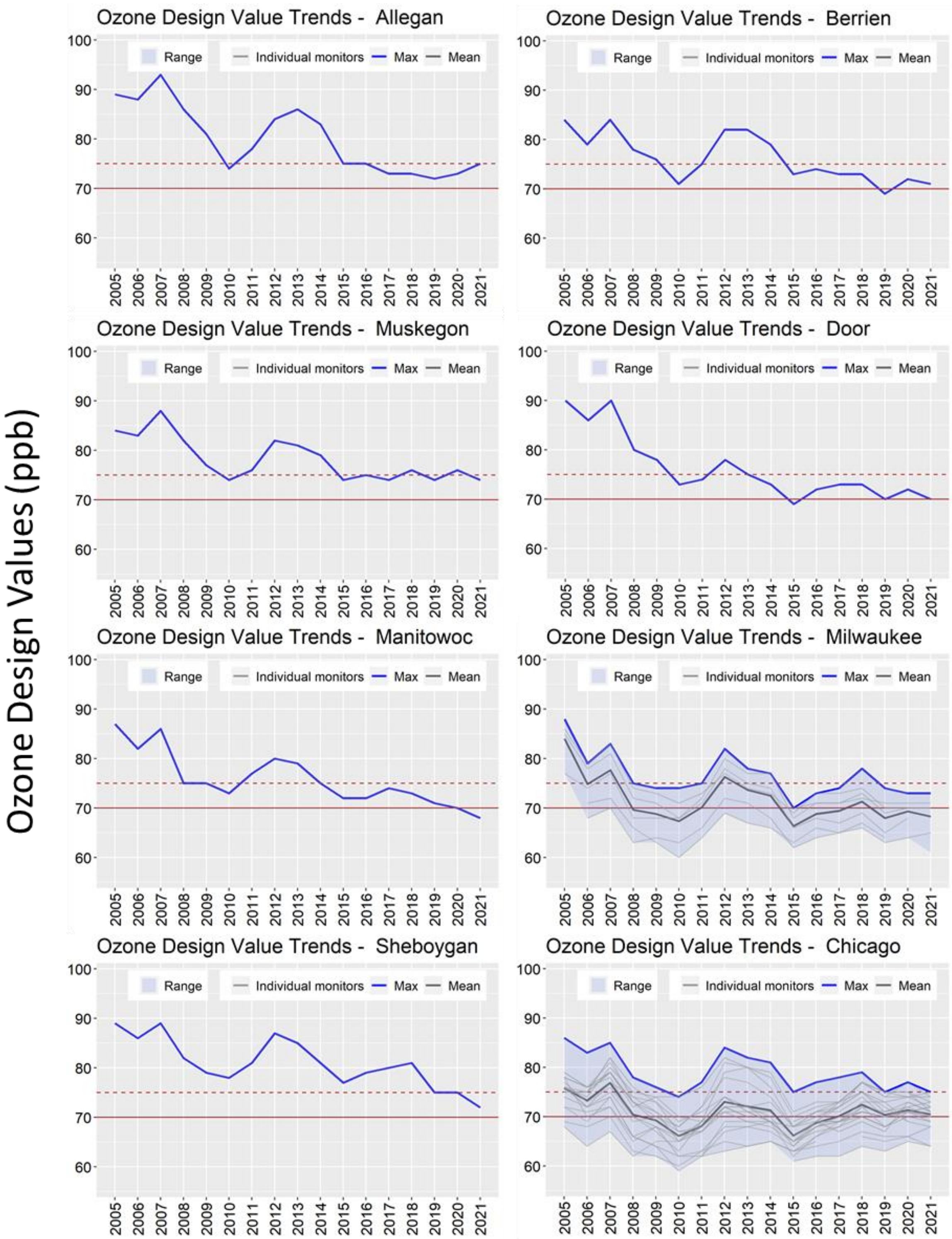


**Figure 2-3. 3-year $O_3$ design value trends from 2005 to 2019 in the LADCO ozone nonattainment and maintenance areas. Area mean and maximum values are shown, along with values for individual monitors. The solid red line shows the level of the 2015 ozone NAAQS, and the dashed line shows the level of the 2015 ozone NAAQS.**

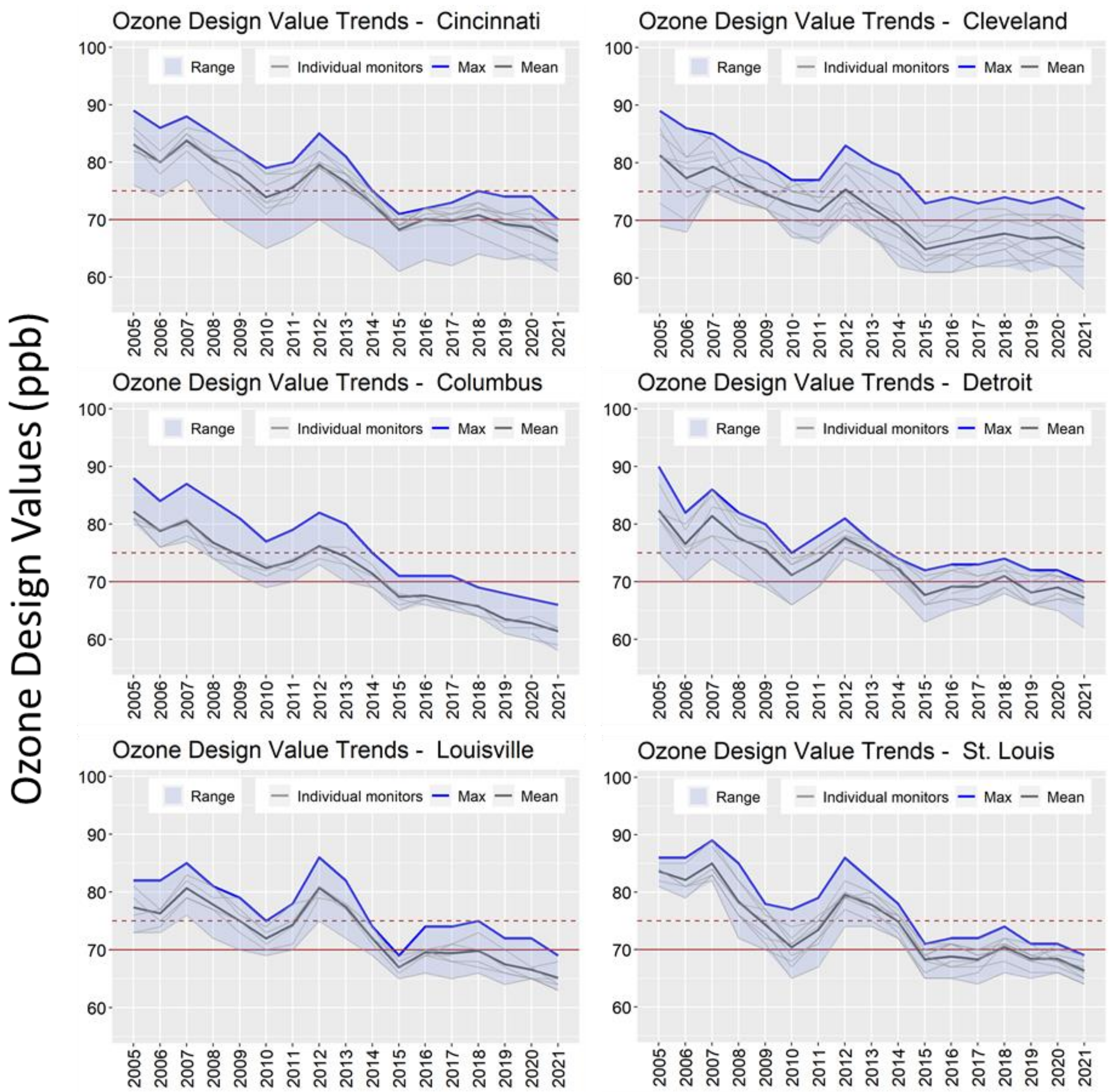


**Figure 2-4. 3-year $O_3$ design value trends from 2005 to 2019 in the LADCO ozone nonattainment and maintenance areas. Area mean and maximum values are shown, along with values for individual monitors. The solid red line shows the level of the 2015 ozone NAAQS, and the dashed line shows the level of the 2008 ozone NAAQS.**

## 2.3. Meteorology and Transport

Ozone concentrations are greatly influenced by meteorological factors. Qualitatively, $O_3$ episodes in the region are associated with hot weather, clear skies (sometimes hazy), low wind speeds, high solar radiation, and winds with a southerly component. These conditions are often a result of a slow-moving high-pressure system to the east of the region. The relative importance of various meteorological factors in select NAAs is discussed later in this section.

Transport of $O_3$ and its precursors is a significant factor in the LADCO region and occurs on several spatial scales. Regionally, over a multi-day period, somewhat stagnant summertime conditions can lead to the build-up of $O_3$ and $O_3$ precursor concentrations over a large spatial area. This polluted air mass can be transported long distances, resulting in elevated $O_3$ levels in locations far downwind. Locally, emissions from urban areas add to the regional background leading to $O_3$ concentration hot spots downwind. Depending on the synoptic wind patterns and presence of local land-lake breezes in some areas, different downwind areas are affected. The following key findings related to transport can be made:

- Ozone transport is an issue affecting many portions of the eastern U.S. NAAs in the LADCO region receive high concentrations of incoming (transported) $O_3$ and $O_3$ precursors from upwind source areas on many hot summer days. Sources in the LADCO region also contribute to the high concentrations of $O_3$ and $O_3$ precursors affecting downwind receptor areas.
- Lake Michigan and Lake Erie influence the formation and transport of $O_3$ in the region, particularly at sites within a few kilometers of the shoreline. Depending on large-scale synoptic winds and local-scale lake breezes, different parts of the area experience high $O_3$ concentrations. For example, during southerly flow, high $O_3$ can be transported from Chicago to the Wisconsin lakeshore, whereas during southwesterly flow, high $O_3$ from Chicago can be transported to western Michigan.

## 2.4. Adjustment of Ozone Trends for Meteorology

Given the importance of the impacts of meteorology on ambient $O_3$ concentrations, year-to-year variations in meteorology can make it difficult to assess short term (e.g. less than 10 years) trends in $O_3$ concentrations. One approach to adjust the trends in $O_3$ concentrations for meteorological influences uses Classification and Regression Trees (CART). CART is a statistical tool to classify data (Breiman et al., 1984). We applied CART to MDA $O_3$ and meteorological data to determine the meteorological conditions most commonly associated with high $O_3$ days in nonattainment and maintenance areas in the LADCO region. Once days are classified by their unique, shared meteorological characteristics, $O_3$ concentration trends among days with similar meteorological conditions can be examined. The LADCO CART analysis removes the influence of year-to-year meteorological variability on $O_3$ concentrations, and any remaining trend is assumed to be the result of non-meteorological factors, such as reductions in emissions of $O_3$ precursors.

LADCO conducted the CART analyses using MDA8 $O_3$ monitoring data from regulatory monitors in the NAAs and daily meteorological data from airport weather stations. The analysis included data from the years 2005 through 2020 to identify the trends in ambient, surface $O_3$ concentrations after adjustment for meteorology. LADCO developed regression trees to classify each summer day (May – September) by a common set of meteorology variables. Each branch in a regression tree describes the meteorological conditions associated with different $O_3$ concentrations. We assigned meteorologically similar days to day-type groups (known in CART as "nodes"), which are equivalent to branches of the regression tree. Grouping days with similar meteorology normalizes the influence of meteorological variability on the underlying trend in $O_3$ concentrations. The remaining trend in $O_3$ concentrations can be presumed to be due to trends in non-meteorological predictors, such as precursor emissions. We then plotted the $O_3$ trends for each of the different CART nodes.

This TSD gives a high-level summary of the CART results for the currently designated ozone NAAs. A brief description of CART analysis is provided in Section S3 of the Supplement to this TSD. A more complete description of the results for all nonattainment and maintenance areas, along with the CART methodology, is available in a LADCO report on CART.[5]

Although the exact selection of predictive variables changes from site to site, the most common predictors of high surface $O_3$ concentrations during the period we analyzed are temperature, wind direction, and relative humidity. Trends in $O_3$ concentrations in high-$O_3$ nodes were found to be declining over the 16-year period for almost all areas studied (Figure 2-5 and Figure 2-6). These plots reflect long term trends and are not meant to depict trends over shorter time periods.

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[5] https://www.ladco.org/wp-content/uploads/Projects/Ozone/LADCO_O3_CART-Analysis_27Oct2021-FINAL-with-Appendices.pdf

### 2.4.1. Western Michigan NAA CART Analyses

LADCO conducted CART analyses for each of the three NAAs along Michigan's Lake Michigan shoreline. This TSD examines the analyses for these three NAAs, all of which are currently designated nonattainment for the 2015 $O_3$ NAAQS. The high-ozone nodes from the CART analysis for the Muskegon County monitor generally have southerly transport, hot temperatures, and low relative humidity (Supplement Table S11). Similarly, the high-ozone nodes for the Allegan County monitor all had southerly transport and hot temperatures (Supplement Table S11), but relative humidity was not a factor. The most important factors for the high-ozone nodes for the Berrien County monitor were hot temperatures and low relative humidity (Supplement Table S11). Several Berrien County nodes also have southerly winds or transport. Mean $O_3$ concentrations in all high-ozone nodes in Muskegon and Allegan counties have decreased from 2005 to 2020 (Figure 2-5). In Berrien County, mean $O_3$ concentrations in all but one of the high-ozone nodes have decreased from 2005 to 2020 (Figure 2-5); the one node with steady $O_3$ concentrations has a mean concentration of 53 ppb, so these days are unlikely to contribute to $O_3$ nonattainment.

### 2.4.2. Wisconsin NAA CART Analyses

LADCO conducted CART analyses for each of the four NAAs along Wisconsin's Lake Michigan shoreline. This TSD examines the analyses for the Sheboygan and Milwaukee NAAs, both of which are currently designated nonattainment for the 2015 $O_3$ NAAQS. The high-ozone nodes from the CART analysis for the Sheboygan County monitor generally have southerly winds/transport and hot temperatures (Supplement Table S11). Mean $O_3$ concentrations in all the high-ozone nodes have decreased from 2005 to 2020 (Figure 2-5). Similarly, the high-ozone nodes from the CART analysis for the Milwaukee monitors generally have hot temperatures and southerly winds (Supplement Table S11). The highest $O_3$ node also has winds that are either weak from the west (<2.0 m/s) or from the east. Mean $O_3$ concentrations in all the high-ozone nodes have decreased from 2005 to 2020 (Figure 2-5).

### 2.4.3. Chicago, IL-IN-WI, CART Analyses

LADCO conducted CART analyses for three different parts of the large Chicago NAA: the far north (Kenosha and Lake counties, WI-IL), central (Cook County, IL), and the far east (Lake and Porter counties, IN). The high-ozone nodes from all three CART analyses generally have hot temperatures and low relative humidity (Supplement Table S11). Some of the nodes in all three of the analyses are also influenced by southerly transport, although southerly transport is most important for the northern Kenosha and Lake County monitors. Several nodes in the Indiana monitor analysis are also influenced by wind speeds. For the far north and far eastern parts of Chicago, mean $O_3$ concentrations in all the high-ozone nodes have decreased from 2005 to 2020 (Figure 2-5). In contrast, mean $O_3$ concentrations in most of the high-concentration nodes in central Chicago have increased from 2005 to 2020 (Figure 2-5).

### 2.4.1. Detroit, MI, CART Analyses

LADCO conducted CART analyses for the Detroit nonattainment area. The high-ozone nodes from the CART analysis for the Detroit monitors generally have hot temperatures and low relative humidity (Supplement Table S11). The highest ozone nodes also have winds from the east to south-southwest, and other high-ozone nodes have low wind speeds. Southerly winds and transport appear as important variables. Figure 2-6 shows that the mean $O_3$ concentrations in all the high-concentration nodes for Detroit have decreased from 2005 to 2020.

### 2.4.2. St. Louis, MO-IL, CART Analyses

LADCO conducted CART analyses for the St. Louis nonattainment area. The high-ozone nodes from the CART analysis for the St. Louis monitors generally have low relative humidity and hot temperatures (Supplement Table S11). The highest ozone nodes also have gentle winds or shorter transport distances, with easterly winds. These factors also appear as important variables, with relative humidity-related parameters being the most important. Figure 2-6 shows that the mean $O_3$ concentrations in all the high-concentration nodes for St. Louis have decreased from 2005 to 2020.

### 2.4.3. Cleveland, OH, CART Analyses

LADCO conducted CART analyses for the Cleveland nonattainment area. The high-ozone nodes from the CART analysis generally have hot temperatures and low relative humidity (Supplement Table S11). The highest ozone nodes for Cleveland have low wind speed, which also appears as an important variable, along with southerly transport. Figure 2-6 shows that the mean $O_3$ concentrations in all the high-concentration nodes for Cleveland have decreased from 2005 to 2020 (Figure 2-6).

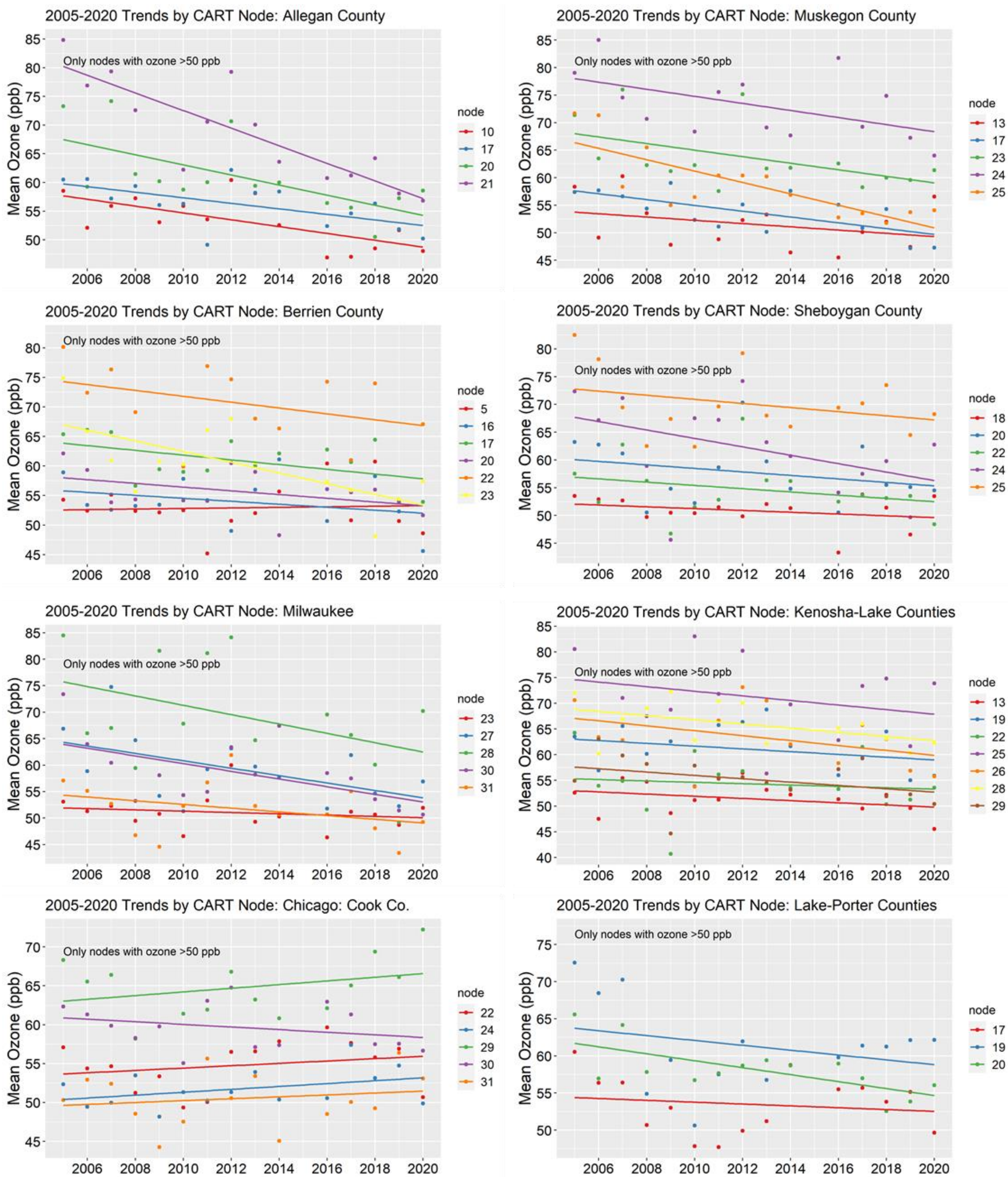


**Figure 2-5. Ozone trends in high-ozone nodes in select ozone nonattainment areas in the LADCO region.**

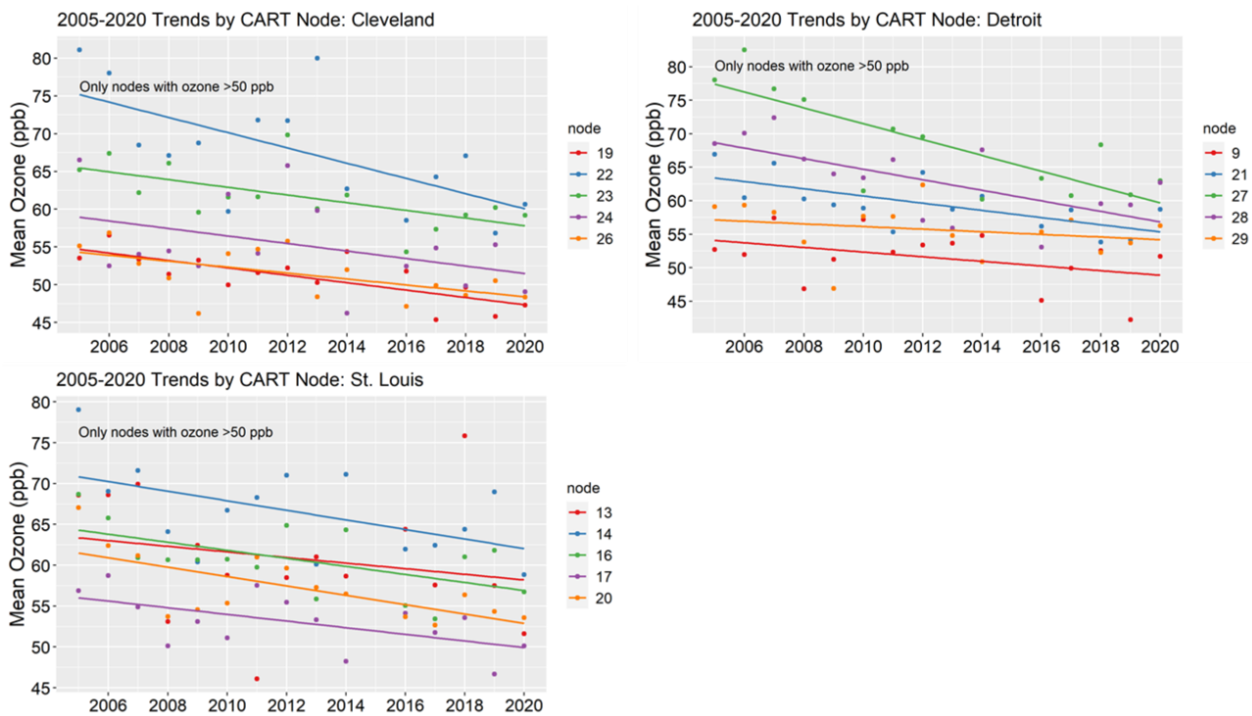


**Figure 2-6. Ozone trends in high-ozone nodes in select ozone nonattainment areas in the LADCO region.**

## 2.5. Summary

Overall, the LADCO CART analysis shows that $O_3$ DVs have decreased considerably since 2005, reaching levels where all nonattainment and maintenance areas attained the 2008 ozone NAAQS and many areas attained the 2015 $O_3$ NAAQS in 2021. Ozone concentrations in the different areas are impacted by different meteorological factors, with all areas impacted by high temperatures and many areas impacted by southerly transport and low relative humidity. When adjusted for meteorology using CART, $O_3$ concentrations on high-ozone days in select NAAs (those that did not attain the 2015 ozone NAAQS in 2021) decreased for almost all types of days in almost all NAAs. The notable exception is for central Chicago, where meteorologically-adjusted $O_3$ concentrations appear to have increased since 2005. The CART trends indicate that ongoing reductions of $O_3$ precursor emissions are continuing to reduce $O_3$ concentrations in most areas of the LADCO region.

# 3. Air Quality Modeling Platform

## 3.1. 2016 Modeling Platform

LADCO based our 2016 $O_3$ air quality predictions on the 2016v1 National Emission Inventory Collaborative emissions inventory[7] and the U.S. EPA 2016fh_16j (herein referred to as 2016fh) emissions modeling platform (US EPA, 2021). LADCO generated the Weather Research Forecast (WRF) model meteorology (LADCO, 2022) and used initial and boundary conditions from the U.S. EPA 2016fg CAMx modeling platform (US EPA, 2019). LADCO processed the 2016 emissions using the U.S. EPA Sparse Matrix Operator Kernel Emissions (SMOKE) scripts distributed with the 2016fh emissions modeling platform. The CAMx inputs, including the meteorology data simulated with the Weather Research Forecast (WRF) model, emissions data, and boundary conditions represent year 2016 conditions.

## 3.2. Modeling Year Justification

LADCO selected 2016 as a modeling year for this study because at the initiation of this project in late 2019 CAMx input data for 2016 were widely available and they represented the state-of-the-science for emissions and meteorology data. In 2017, a group of multi-jurisdictional organizations (MJOs), states, and EPA established 2016 as the new base year for a national air quality modeling platform[8]. The group concluded that if only one recent year could be selected, that 2016 would serve as a good base year because of typical $O_3$ conditions and average wildfire conditions. Following from the base year recommendations from that group, several modeling centers, including U.S. EPA and LADCO, developed data and capabilities for simulating and evaluating air quality in 2016.

Following from the selection of 2016 as the base year for a national modeling platform, starting in late 2017, the MJOs, states, and EPA formed the National Emissions Inventory Collaborative to develop a 2016 emissions inventory and modeling platform. Over 200

[7] http://views.cira.colostate.edu/wiki/wiki/10202

[8] Base Year Selection Workgroup Final Report

participants collaborated across 12 workgroups to develop base and future year emissions to support upcoming regulatory modeling applications. This effort was designed to involve a broad group of emissions experts in the development of a new national emissions modeling platform. LADCO used the 2016 and 2023 inventories developed by the Collaborative for the modeling presented here. Section 8 presents LADCO's justification for using the 2016v1 emissions data over the 2016v2 data for the modeling reported in this TSD.

The attainment date for 2015 $O_3$ NAAQS moderate NAAs is August 3, 2024. LADCO selected 2023 as the future projection year because it aligns with the last complete $O_3$ season that will be used to determine attainment of these areas.

## 3.3. Air Quality Model Configuration and Data

LADCO based our CAMx air quality modeling platform for this application on the configuration that we recently used for 2008 $O_3$ NAAQS attainment demonstration modeling (LADCO, 2020) and regional haze modeling for the Regional Haze Rule 2$^{nd}$ implementation period (LADCO, 2021). LADCO used CAMx 7.10 (Ramboll, 2020) as the photochemical grid model for this application. CAMx is a three-dimensional, Eulerian air quality model that simulates the chemical transformation and physical transport processes of air pollutants in the troposphere. It includes capabilities to estimate the concentrations of primary and secondary gas and particle phase air pollutants, and dry and wet deposition, from urban to continental spatial scales. As CAMx associates source-level air pollution emissions estimates with air pollution concentrations, it can be used to design and assess emissions reduction strategies pursuant to NAAQS attainment goals.

LADCO selected CAMx for this study because it is a component of recent LADCO and U.S. EPA modeling platforms for investigating the drivers of ground level $O_3$ in the Great Lakes region and across the U.S. As CAMx is a component of U.S. EPA studies with a similar scope to this project, LADCO was able to leverage the data and software elements that are distributed with recent U.S. EPA regulatory air quality modeling platforms. Using these elements saved LADCO significant resources relative to building a modeling platform from scratch.

Figure 3-1 shows the LADCO WRF modeling domains used for this application. A 12-km uniform grid (12US2) covers all the continental U.S. and includes parts of Southern Canada and

Northern Mexico. A 4-km domain covers all the LADCO member states in their entirety. A 1.33-km domain covers Lake Michigan. The vertical modeling domain has 36 layers with a model top at about 17,550 meters (50 mb). LADCO used the same U.S. EPA 12-km domain for this project because it supported the use of initial and boundary conditions data that were readily available from U.S. EPA.

Table 3-1 summarizes the CAMx science configurations and options LADCO used for the 2016 and 2023 CAMx modeling for this application. We used the Piecewise Parabolic Method (PPM) advection solver for horizontal transport along with the spatially varying (Smagorinsky) horizontal diffusion approach. We used K-theory for vertical diffusion using the CMAQ-like vertical diffusivities from WRFCAMx. The CB6r5 gas-phase chemical mechanism was selected because it includes the latest chemical kinetic rates and represents improvements over the other alternative CB05 and SAPRC chemical mechanisms as well as active methane chemistry. Additional CAMx inputs were as follows:

Meteorological Inputs: The LADCO WRF-derived meteorological fields (LADCO, 2022) were processed to generate CAMx meteorological inputs using the WRFCAMx processor, as described in Section 3.3.1.

Initial/Boundary Conditions: LADCO used 2016 initial and boundary conditions for CAMx generated by the U.S. EPA from a northern hemisphere simulation of the Community Multiscale Air Quality (CMAQ) model (US EPA, 2019d). EPA generated hourly, one-way nested boundary conditions (i.e., hemispheric-scale to regional-scale) from a 2016 108-km x 108-km polar stereographic CMAQ simulation of the northern hemisphere. Following the convention of the U.S. EPA 2016 regional haze modeling (U.S. EPA, 2019b), LADCO used year 2016 CMAQ boundary conditions for modeling 2016 and 2023 air quality with CAMx.

Photolysis Rates: LADCO prepared the photolysis rate inputs as well as albedo/haze/ozone/snow inputs for CAMx. Day-specific $O_3$ column data were based on the Total Ozone Mapping Spectrometer (TOMS) data measured using the satellite-based Ozone Monitoring Instrument (OMI). Albedo were based on land use data. LADCO used the TUV photolysis rate processor to prepare clear-sky photolysis rates for CAMx. If there were periods where daily TOMS data were unavailable in 2016, the TOMS measurements were interpolated between the days with valid data. CAMx was also configured to use the in-line TUV to adjust for cloud cover and account for the effects that modeled aerosol loadings have on photolysis rates; this latter effect on photolysis may be especially important in adjusting the photolysis rates due to the occurrence of PM concentrations associated with emissions from fires.

Landuse: LADCO used landuse/landcover data from the U.S. EPA WRF simulation.

Spin-Up Initialization: A minimum of ten days of model spin up (e.g., December 21-31, 2015) was used for all modeling domains. LADCO ran monthly CAMx simulations, initializing each month with a 10-day spin-up period.

As the focus of this study is on $O_3$, LADCO used CAMx to simulate the 2016 $O_3$ season. LADCO simulated April 1 through October 31, 2016 as individual months using 10-day model spin-up periods for each month. LADCO selected a CAMx configuration that was consistent with previous $O_3$ modeling applications performed by LADCO (2020) and U.S. EPA. U.S. EPA (2019).

**Table 3-1. LADCO 2016 CAMx modeling platform configuration**

| Science Options | Configuration |
|---|---|
| Model Codes | CAMx v7.10 |
| Simulation Period | March 20-October 31, 2016 |
| Horizontal Grid Mesh | 12 km, 396 cols x 246 rows<br>4 km, 420 cols x 390 rows<br>1.33 km, 279 cols x 450 rows |
| Vertical Grid Mesh | 36 layers up to 50 mb |
| Grid Interaction | Two-way nested |
| Initial Conditions | 10-day spin up on all grids |
| Boundary Conditions | 12km from hemispheric CMAQ (U.S. EPA 2016ff) |
| Emissions | |
| Baseline Emissions Processing | Sparse Matrix Operator Kernel Emissions (SMOKE), EPA's MOtor Vehicle Emission Simulator (MOVES2014) and Biogenic Emission Inventory System (BEIS) |
| Emissions Modeling Platform | U.S. EPA 2016fh_16j Platform with<br>ERTAC 16.2 beta EGU Point and hourly CEMs |
| Chemistry | |
| Gas Phase Chemistry | CB6r5 |
| Aerosol Chemistry | CF + SOAP |
| Meteorological Processor | WRFCAMx_v4.9.1 |
| Horizontal Diffusion | Spatially varying |
| Vertical Diffusion | CMAQ-like in WRF2CAMx |
| Diffusivity Lower Limit | Kz_min = 0.1 to 1.0 $m^2/s$ or 2.0 $m^2/s$ |
| Dry Deposition | Zhang dry deposition scheme (CAMx) |
| Wet Deposition | CAMx-specific formulation |
| Gas Phase Chemistry Solver | Euler Backward Iterative (EBI) -- Fast Solver |

| Science Options | Configuration |
|---|---|
| Vertical Advection Scheme | Implicit scheme w/ vertical velocity update (CAMx) |
| Horizontal Advection Scheme | Piecewise Parabolic Method (PPM) scheme |
| Integration Time Step | Wind speed dependent |
| Source Apportionment | CAMx APCA with region and inventory sector tags |

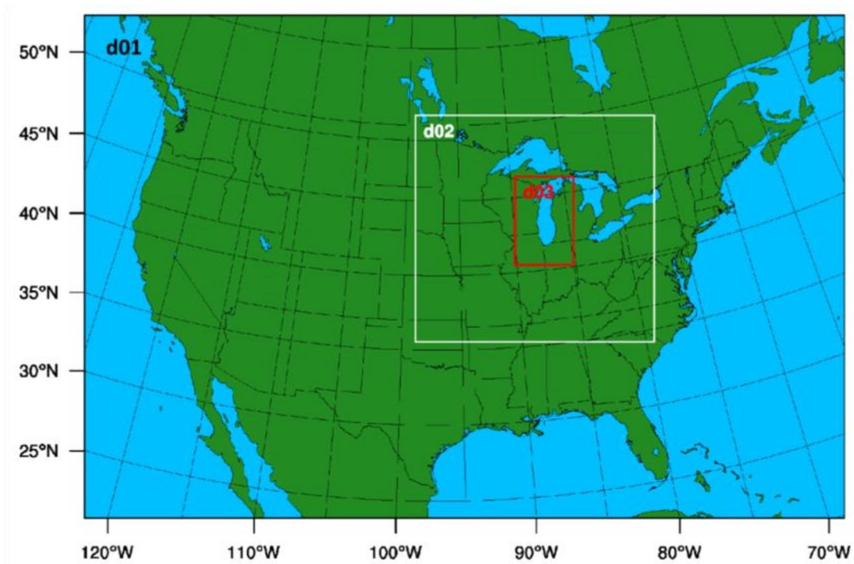


**Figure 3-1. LADCO WRF modeling domains**

### 3.3.1. Meteorology Data

LADCO developed 2016 WRF data for this application (LADCO, 2022). We used version 3.9.1 of the WRF model, initialized with the 12-km North American Model (NAM) from the National Climatic Data Center (NCDC) to simulate 2016 meteorology. Complete details of the WRF simulation, including the input data, physics options, and four-dimensional data assimilation (FDDA) configuration are detailed in the LADCO Meteorology Model Performance for Annual 2016 Simulation report (LADCO, 2022). LADCO prepared the WRF data for input to CAMx with version 4.8 of the WRFCAMx software.

## 3.4. 2016 and 2023 Emissions Data

LADCO collected 2016 and 2023 emissions data for this study primarily from the U.S. EPA 2016fh emissions modeling platform (U.S. EPA, 2021). U.S. EPA and the 2016 Emissions

Inventory Collaborative[9] generated version 1 of the 2016 (2016v1) inventory for use in $O_3$ NAAQS and Regional Haze SIPs. The first version of the 2016 inventories used 2014 inventory data; the 2016v1 inventory fully integrated 2016 estimates of emissions activities, growth and controls, and the latest emissions factors. Table 3-2 lists the 2016 base year inventory components that LADCO used to simulate 2016 air quality for this application.

LADCO replaced the 2023 EGU emissions in the U.S. EPA 2016fh emissions modeling platform with 2023 EGU forecasts estimated with the August 2021 version of the ERTAC EGU Tool version 16.2 beta (MARAMA, 2012). LADCO also used a version of the 2016fh non-EGU point inventory that is synchronized with the ERTAC EGU inventory in our 2016 modeling platform to ensure consistency with the EGU sector. The ERTAC model defines EGUs as power generating units with Continuous Emissions Monitoring (CEM). The U.S. EPA EGU inventory encompasses all power generating units, including industrial facilities such as paper mills and aluminum foundries. The non-EGU point inventory needed to be modified to work with the ERTAC EGU inventory by including the industrial sources from the U.S EPA EGU point inventory that are not included in the ERTAC model.

Figure 3-2 through Figure 3-7 show 2016 daily total EGU NOx emissions by fuel type for each of the LADCO states. These figures show that in 2016 the NOx emissions from power generation in the LADCO region were primarily emitted by sources that burn coal, that there is significant day to day variation in power plant emissions, and that the summer and winter seasons are the peak periods of EGU NOx emissions. Note that vertical axis of these figures varies from state to state.

[9] http://views.cira.colostate.edu/wiki/wiki/10202

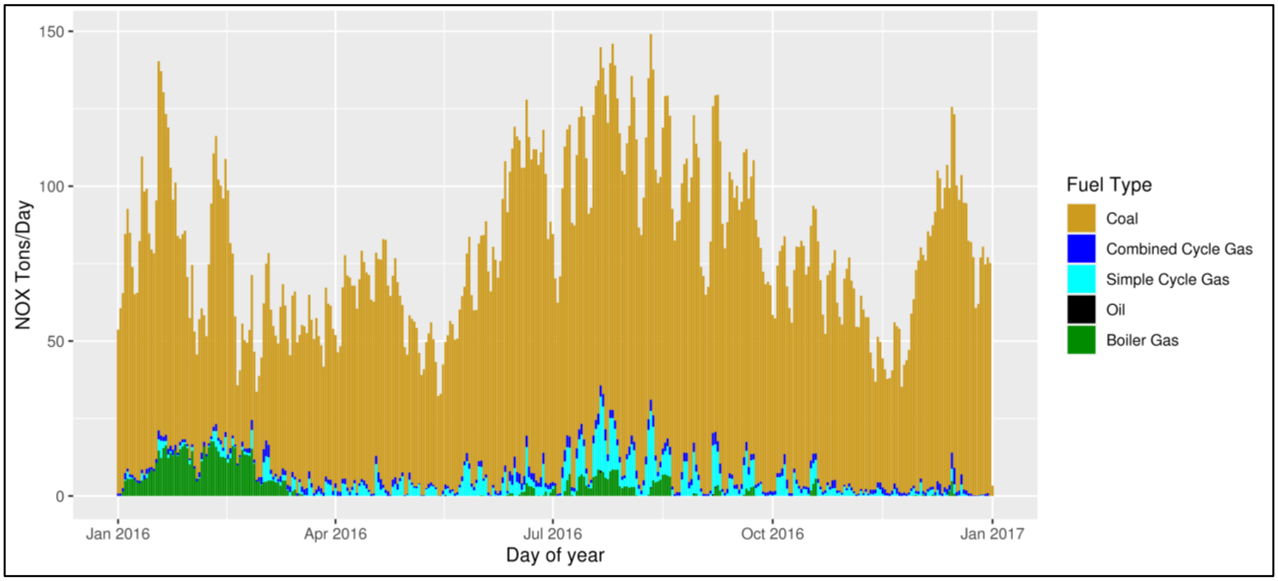


**Figure 3-2. Illinois power generation 2016 daily NOx emissions by fuel type**

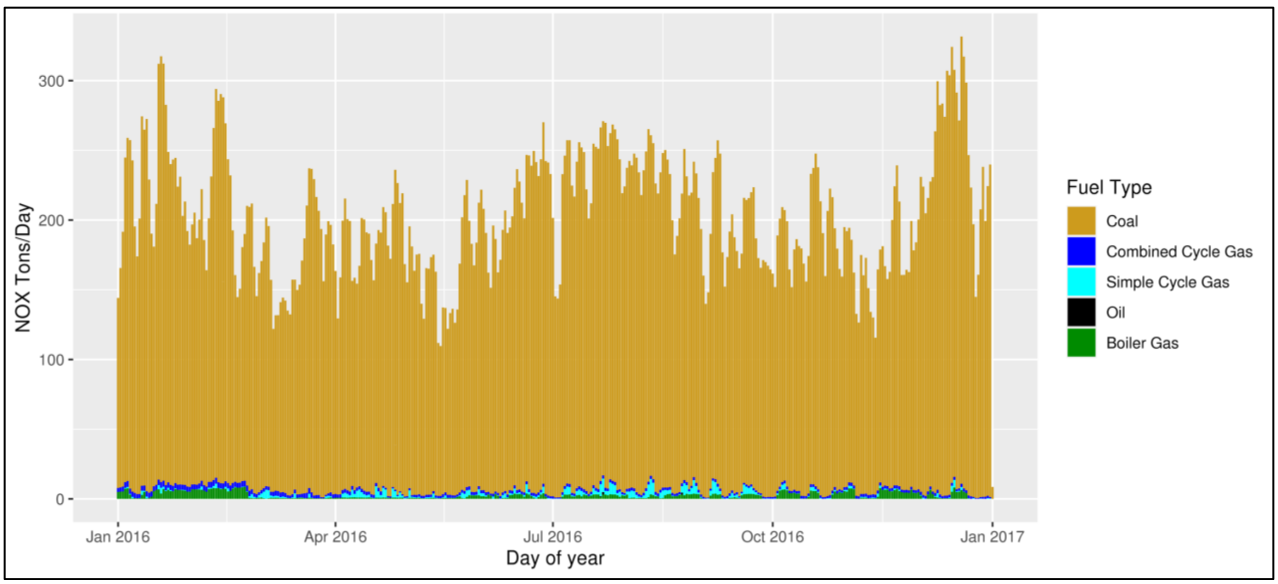


**Figure 3-3. Indiana power generation 2016 daily NOx emissions by fuel type**

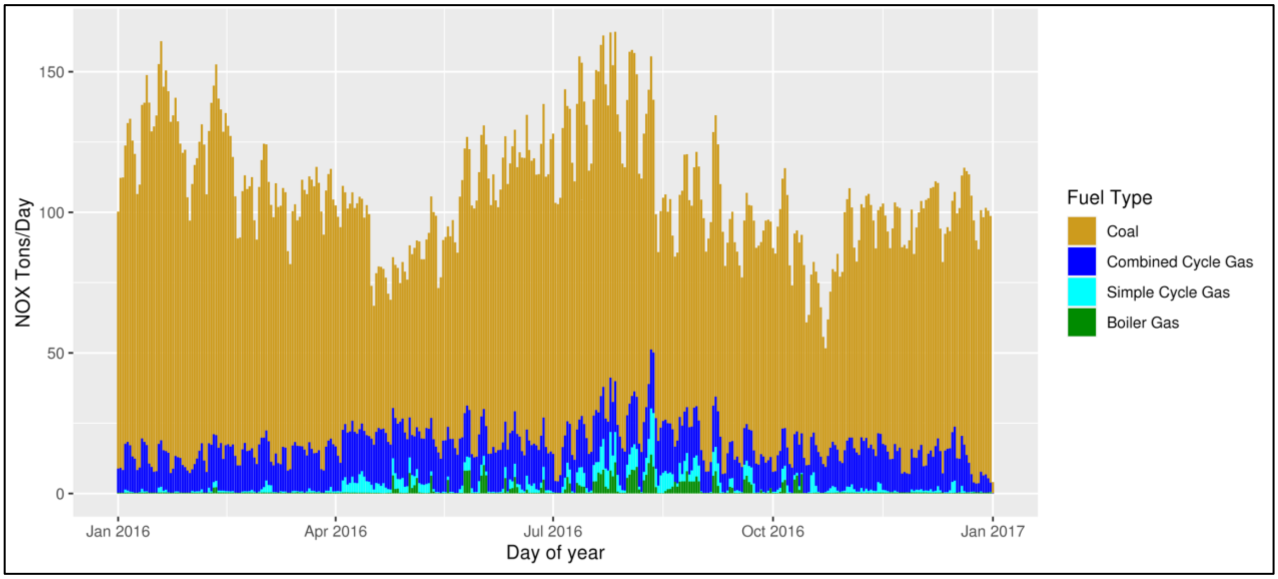


**Figure 3-4. Michigan power generation 2016 daily NOx emissions by fuel type**

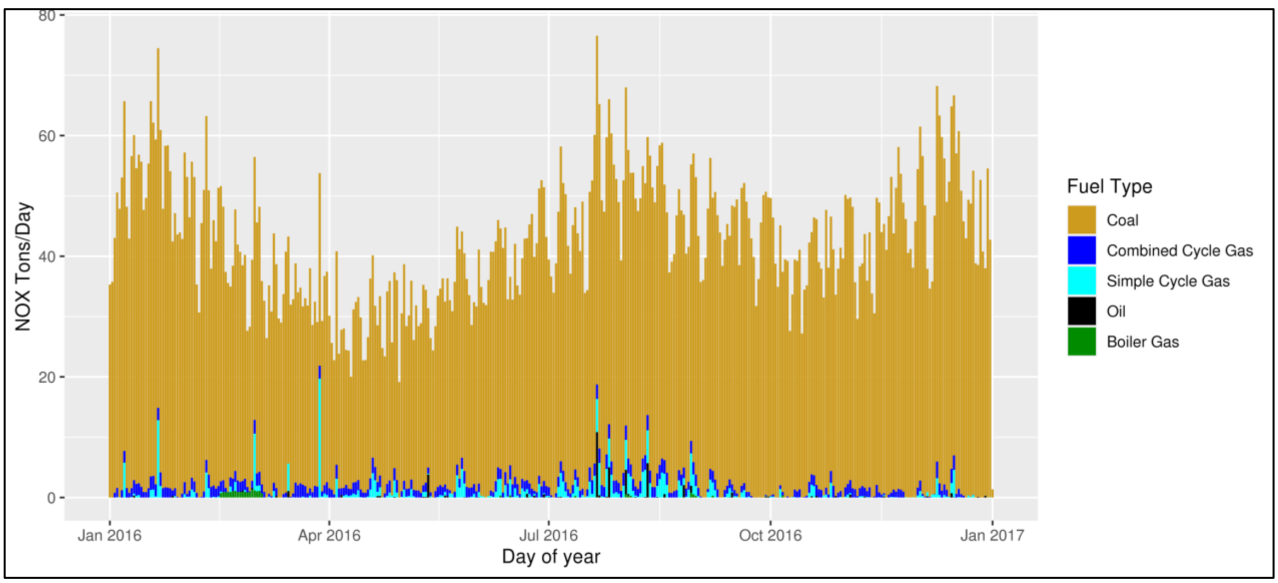


**Figure 3-5. Minnesota power generation 2016 daily NOx emissions by fuel type**

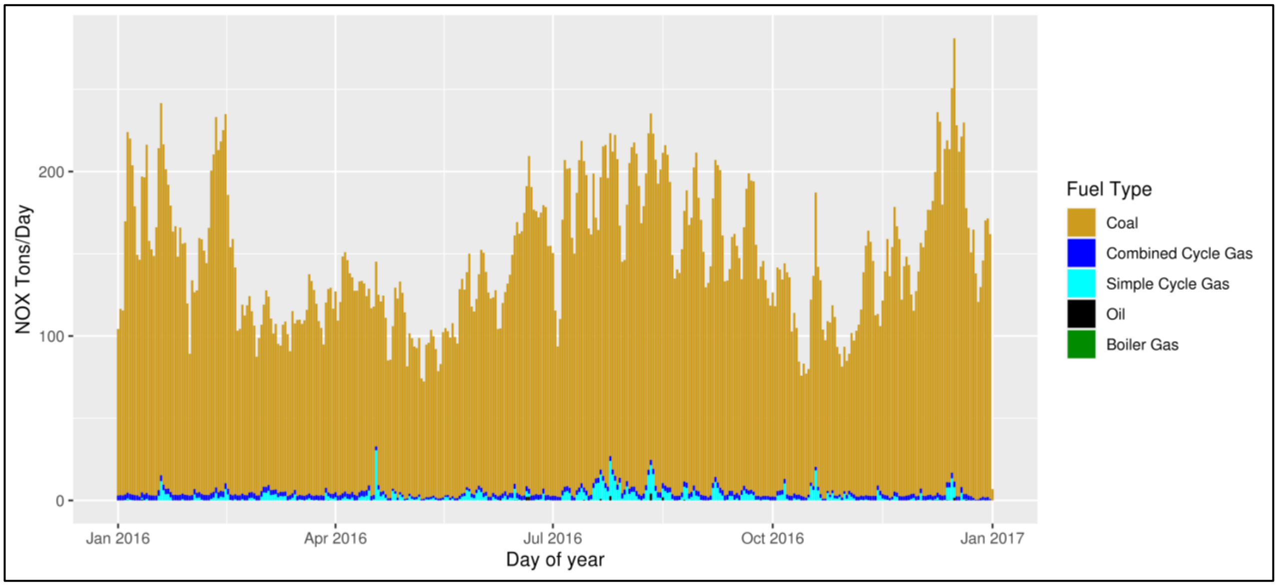


**Figure 3-6. Ohio power generation 2016 daily NOx emissions by fuel type**

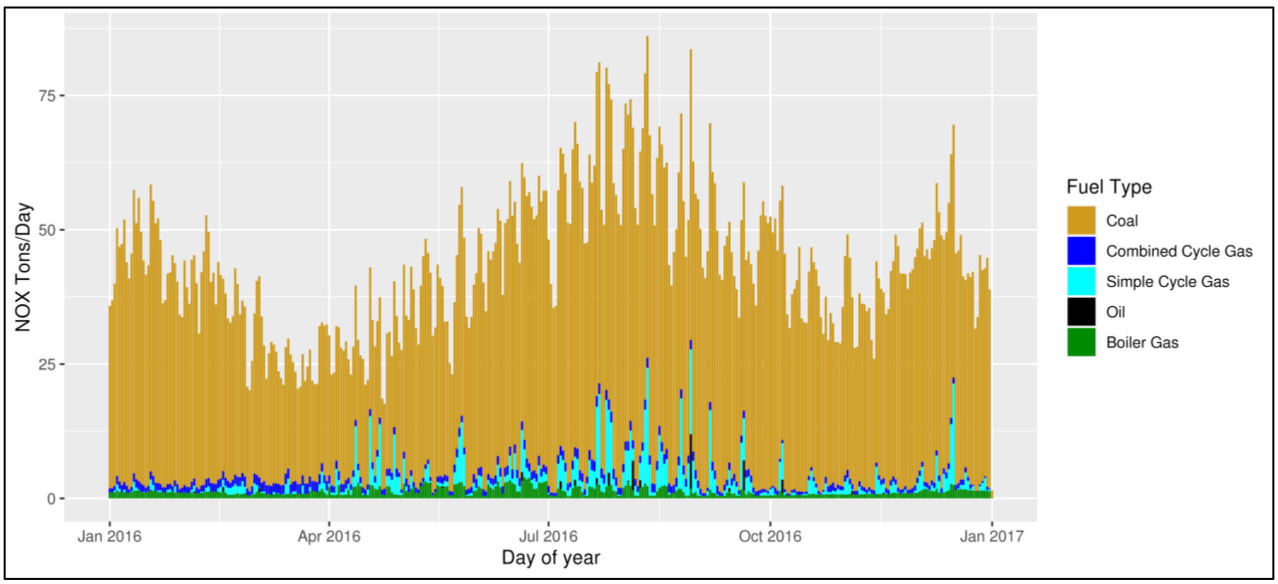


**Figure 3-7. Wisconsin power generation 2016 daily NOx emissions by fuel type**

LADCO modified the ERTAC EGU 16.2 beta inventory forecasts for 2023 to exclude the emissions from two EGU units that announced shutdowns that will occur before 2023. These announcements came after the ERTAC EGU 16.2 beta emissions were developed. LADCO zeroed out the 2023 emissions from these units in our 2016-based modeling forecasts for 2023. The two units removed from the ERTAC EGU 16.2 beta inventory included:

- ComED Will County, Illinois (ORIS ID: 884)

- WEPCO Rock River, Wisconsin (ORIS ID: 4057).

Supplement Section S4 to this TSD is a table of all of the EGU sources that operated in 2016 but were removed from the 2023 inventory and LADCO CAMx simulation due to retirement dates that occurred before the end of 2023.

Table 3-2 lists the 2016 base year and 2023 future year inventory components that LADCO used to simulate 2016 and 2023 air quality for this application. LADCO processed the inventories into CAMx binary format with SMOKE to estimate hourly emissions on three nested modeling domains (12/4/1.33 km) for March 20, 2016 through October 31, 2016.

**Table 3-2. LADCO 2016 emissions modeling platform inventory components**

| Sector | Abbreviation | Base Year Data Source | Future Year Data Source |
|---|---|---|---|
| Agriculture | ag | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Fugitive Dust | afdust | U.S. EPA 2016 fh | U.S. EPA 2023fh |
| Airports | airports | U.S. EPA 2016 fh | U.S. EPA 2023fh |
| Biogenic | BEIS3 | U.S. EPA 2016fh | U.S. EPA 2013fh |
| C1/C2 Commercial Marine | cmv_c1c2 | U.S. EPA 2016fh | U.S. EPA 2023fh |
| C3 Commercial Marine | cmv_c2 | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Nonpoint | nonpt | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Offroad Mobile | nonroad | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Nonpoint Oil & Gas | np_oilgas | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Onroad Mobile | onroad | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Point Oil & Gas | pt_oilgas | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Electricity Generation | ptertac | ERTAC 16.1 | ERTAC 16.2 modified |
| Industrial Point | ptnonertac | U.S. EPA 2016fh | U.S. EPA 2023fh modified |
| Minnesota Taconite | ptmntaconite | Provided by MPCA | Provided by MPCA |
| Rail | rail | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Residential Wood Combustion | rwc | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Agricultural Fires | ptagfire | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Wild and Prescribed Fires | ptfire | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Mexico Anthropogenic | othar/othpt/ | U.S. EPA 2016fh | U.S. EPA 2023fh |
| Canada Anthropogenic | othar/othpt | U.S. EPA 2016fh | U.S. EPA 2023fh |

### 3.4.1. Spatial Surrogates and Emissions Grids

LADCO's 2016 air quality modeling platform uses three nested modeling grids that focus on the Great Lakes region. We processed the 2016fh emissions on the LADCO modeling grids using U.S. EPA 12-km and 4-km spatial surrogates. LADCO used the Spatial Allocator Surrogate Tool with the GIS shapefiles that U.S. EPA used for the 12-km and 4-km spatial surrogates to generate surrogates for the LADCO 1.33 km grid. We processed the point source emissions inventory modeling files for CAMx.

## 3.5. Source Apportionment Modeling

LADCO used the CAMx Anthropogenic Precursor Culpability Assessment (APCA) tool to calculate emissions tracers for identifying upwind sources of ozone precursors at downwind monitoring sites. We used APCA to quantify the impacts of inventory sectors or geographic source regions on ozone concentrations at receptors. LADCO simulated 2016 meteorology and emissions on the 12-km modeling domain for the APCA simulations used for this application.

### 3.5.1. 2016 Inventory Sector Source Apportionment Configuration

LADCO used CAMx APCA to track the contributions of emissions sources on modeled $O_3$ concentrations. We configured the 2016fh emissions modeling platform to track the influence of emissions from key inventory sectors on $O_3$ concentrations in the region. We split the nonpoint, onroad mobile, and offroad mobile (nonroad) into subsectors to better distinguish the sources of $O_3$ pollution from these sectors. For example, LADCO split the two mobile sectors into diesel and non-diesel (gasoline, natural gas, and other) to resolve the impacts of diesel and non-diesel engines on $O_3$ in the region. Table 3-3 lists the APCA tags used for the LADCO 2016 CAMx APCA "sectors" simulation.

**Table 3-3. LADCO 2016 CAMx APCA "sector" tags**

| Tag | Description | Tag | Description |
|---|---|---|---|
| 1 | Biogenic | 12 | Offroad Mobile - diesel |
| 2 | Agriculture | 13 | Offroad Mobile – non-diesel |
| 3 | Nonpoint – industrial combustion | 14 | Rail |
| 4 | Nonpoint – other combustion, including residential wood combustion | 15 | Onroad Mobile – California only* |
| 5 | Nonpoint – non-combustion | 16 | Commercial Marine (C2/C3) |
| 6 | Nonpoint – solvents | 17 | Point - agricultural fires |
| 7 | Nonpoint – waste | 18 | Point – electricity generation |
| 8 | Oil and gas | 19 | Point – wildfires |
| 9 | Onroad Mobile - diesel | 20 | Point – non-electricity generation |
| 10 | Onroad Mobile – non-diesel | 21 | Point – airports |
| 11 | Canada and Mexico | | |

* Emissions for this sector are for sources in California only and were generated with the EMFAC model

### 3.5.2. 2016 Geographic Source Apportionment Configuration

LADCO used CAMx APCA to track the contributions of geographic source regions on modeled $O_3$ concentrations. For the 2016 APCA simulation LADCO used the CAMx point source override option to tag emissions from geographic source groups. Emissions from all sectors, point and non-point, used the point source override option to better identify the locations of the source emissions. LADCO prepared the emissions through SMOKE by including state/county code-based geographic tags in each inventory sector processing stream to support the point source override option. This option is an improvement over the spatial masks traditionally used to tag emissions by source region because it does not suffer from the border errors in which a model grid cell can only be associated with one geographic region. Table 3-4 lists the APCA geographic tags used for the LADCO 2016 CAMx simulation.

For the states that have both state and county tags (IL, IN, MI, OH, WI) the state tag includes emissions from the areas of the state outside of the explicitly-tagged counties. For example, the tracer for WI sources (Tag = 6) includes the emissions from all areas of the state except for the counties included in Tags 20 and 21.

**Table 3-4. LADCO 2016 CAMx APCA "geographic" tags**

| Tag | Description | Tag | Description |
|---|---|---|---|
| 1 | Biogenic | 14 | West: NM, AZ, CO, UT, WY, MT, ID, WA, OR, CA, NV, ND, SD |
| 2 | Miscellaneous | 15 | Northeast: ME, NH, VT, MA, RI, CT, NY, NJ, PA, DE, MD, DC |
| 3 | IL | 16 | Chicago IL Metro Counties: Cook, Du Page, Kane, Lake, Mc Henry, Will, |
| 4 | IN | 17 | Chicago IL Exurb Counties: Boone, De Kalb, Ford, Grundy, Iroquois, Kankakee, Kendall, La Salle, Lee, Livingston, Ogle, Stephenson, Winnebago |
| 5 | MI | 18 | East St. Louis IL Counties: Madison, Monroe, St. Clair |
| 6 | WI | 19 | Northern IN Counties: De Kalb, Elkhart, Fulton, Jasper, Kosciusko, Lagrange, La Porte, Marshall, Newton, Noble, Polaski, St. Joesph, Starke, Steuben, Porter, Lake |
| 7 | MN | 20 | Southeast WI Counties: Kenosha, Racine, Milwaukee, Ozaukee, Washington, Waukesha |
| 8 | OH | 21 | Central Coast WI: Kewaunee, Manitowoc, Sheboygan |
| 9 | MO | 22 | Detroit MI Counties: Livingston, Macomb, Monroe, Oakland, St. Claire, Washtenaw, Wayne |
| 10 | KY | 23 | Berrien County, MI |
| 11 | TX | 24 | Allegan County, MI |
| 12 | Southeast: WV, VA, NC, SC, TN, GA, AL, FL, MS | 25 | Muskegon County, MI |
| 13 | Great Plains: AR, KS, IA, NE, OK | 26 | Cincinnati OH Counties: Butler, Clermont, Hamilton, Warren |
| | | 27 | Cleveland OH Counties: Cuyahoga, Geauga, Lake, Lorain, Medina, Portage, Summit |

## 3.6. LADCO Modeling Platform Summary

Table 3-5 summarizes the LADCO 2016 air quality modeling platform elements.

**Table 3-5. Listing of the LADCO 2016 air quality modeling platform components**

| Platform Element | Configuration | Reference | Data source |
|---|---|---|---|
| Meteorology Data | WRFv3.9.1 | LADCO, 2022 | LADCO |
| Initial and Boundary Conditions | 2016 Hemispheric CMAQ | U.S. EPA, 2019c | U.S. EPA |
| 2016 Emissions Data | Inventory Collaborative 2016v1 ERTAC16.1 EGU Point and hourly CEMs | | Inventory Collaborative and ERTAC |
| 2023 Emissions Data | Inventory Collaborative 2016v1<br>ERTAC16.1 EGU Point | | LADCO and ERTAC |
| Emissions Modeling Platform | U.S. EPA 2016fh_16j | | U.S. EPA |
| Photochemical Grid Model | CAMxv7.10 | Ramboll, 2020 | LADCO |

## 3.7. 2016 CAMx Model Performance Evaluation Methods

LADCO simulated 2016 air quality with CAMx using data derived from the U.S. EPA 2016fh emissions modeling platform. The CAMx model performance evaluation (MPE) presented here focuses on $O_3$ at surface monitors in the LADCO states with 2015 $O_3$ NAAQS NAAs, including Illinois (IL), Indiana (IN), Michigan (MI), Ohio (OH), and Wisconsin (WI). These states will use the information in this TSD as weight of evidence in support of the moderate area NAA SIPs. LADCO used the Atmospheric Model Evaluation Tool (AMET) version 1.4 to pair the model results and surface observations in space and time, generate bi-variate statistics of model performance, and to produce MPE plots.

LADCO evaluated the CAMx 2016 modeled $O_3$ concentrations against concurrent measured surface ambient $O_3$ concentrations using graphical displays of model performance and statistical model performance measures. We compared the statistical measures against established model performance goals and criteria (Emery et al., 2017) and following the procedures recommended in EPA's photochemical modeling guidance document (US EPA, 2018).

### 3.7.1. Available Aerometric Data for the Model Evaluation

LADCO used the following routine air quality measurement data networks operating in in 2016 to assess CAMx $O_3$ model performance:

**EPA AQS Surface Air Quality Data**: Data files containing hourly-averaged concentration measurements at a wide variety of state and EPA monitoring networks are available in the Air Quality System (AQS) database throughout the U.S. The AQS consists of many sites that tend to be mainly located in and near major cities. There are several types of networks within AQS that measure different species. The standard hourly AQS AIRS monitoring stations typically measure hourly $O_3$, $NO_2$, $NO_X$ and CO concentration and there are thousands of sites across the U.S. Figure 3-8 shows the locations of AQS surface monitors in the LADCO region.

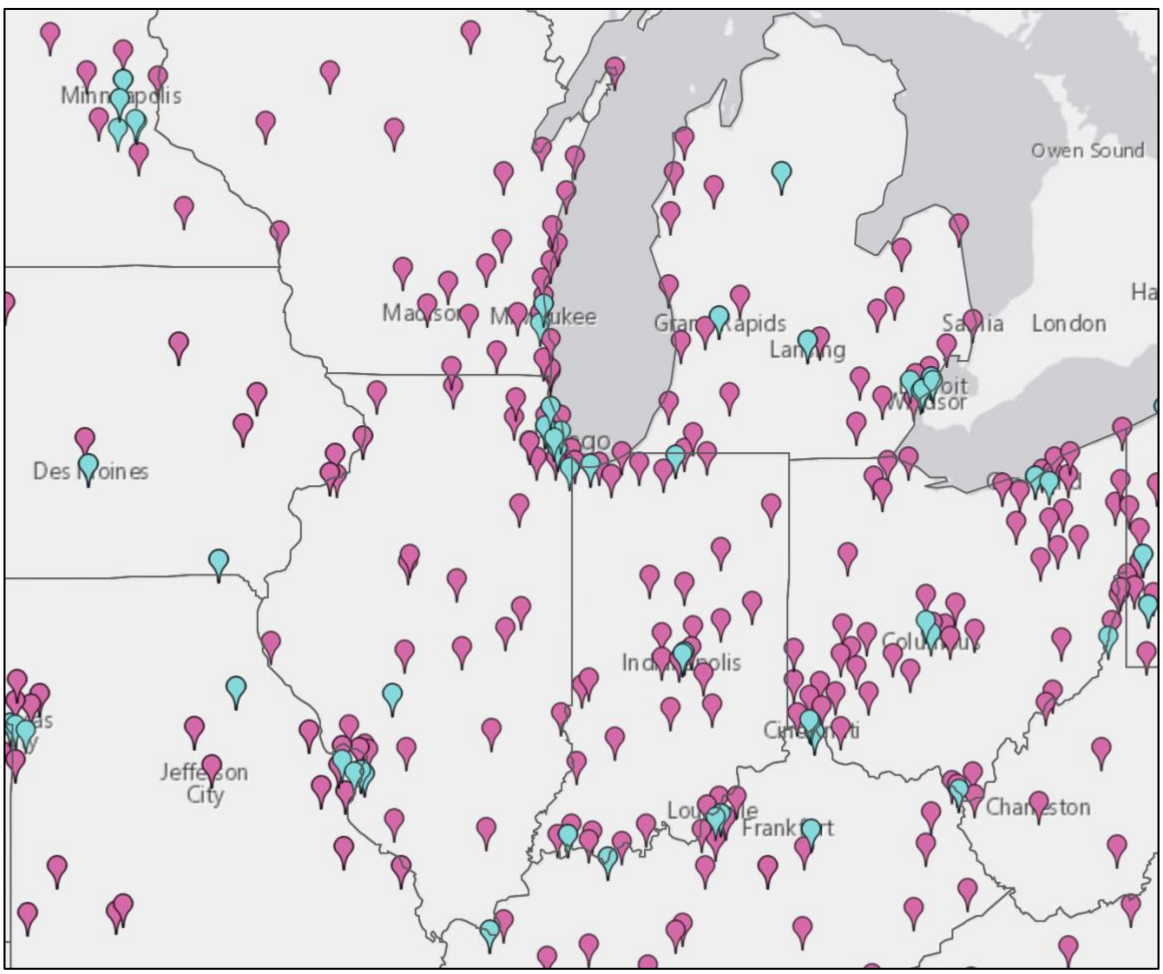


**Figure 3-8. Locations of AQS monitors in the LADCO region, $O_3$ monitors are pink and $NO_2$ monitors are blue; source: U.S. EPA AirData**

**CASTNet Monitoring Network**: The Clean Air Status and Trends Network (CASTNet) operates approximately 80 monitoring sites in mainly rural areas across the U.S. CASTNet sites typically collect hourly $O_3$, temperature, wind speed and direction, the standard deviation of the wind direction, solar radiation, relative humidity, precipitation and surface wetness. CASTNet also collects weekly (Tuesday to Tuesday) samples of speciated $PM_{2.5}$ sulfate, nitrate, ammonium and other relevant ions and weekly gaseous $SO_2$ and nitric acid ($HNO_3$). Figure 3-9 displays the locations of the approximately 80 CASTNet sites across the U.S.


**Figure 3-9. Locations of CASTNet monitoring sites; source: https://www.epa.gov/castnet**

### 3.7.2. Model Performance Statistics, Goals and Criteria

U.S. EPA (2018) recommended a 60 ppb observed $O_3$ cut-off threshold when calculating $O_3$ model performance statistics. Emery et al., (2017) conducted a meta-analysis of 38 peer-reviewed articles from 2005 through 2015 on photochemical grid modeling applications to update the MPE benchmarks for $O_3$ and particulate matter modeling. Table 3-6 lists their recommended MPE goals and criteria, and cutoff concentrations. In addition, Emery et al., recommended that MPE statistics for $O_3$ should be calculated for time periods of roughly 1 week (episodic) and not to exceed 1 month.

**Table 3-6. Ozone model performance benchmarks by Emery, et al. (2017)**

| Metric | Goal | Criteria | Cutoff |
|---|---|---|---|
| Normalized Mean Bias (NMB) | ≤± 5% | ≤± 15% | 40 ppb for 1-hour $O_3$, no cutoff for MDA8 $O_3$ |
| Normalized Mean Error (NME) | < 15% | < 25% | 40 ppb for 1-hour $O_3$, no cutoff for MDA8 $O_3$ |
| Correlation Coefficient (r) | > 0.75 | > 0.5 | No cutoff |

The model performance goals by U.S. EPA and Emery et al. are not used to assign passing or failing grades to model performance, but rather to help interpret the model performance and intercompare across locations, species, time periods and model applications. The model inputs to CAMx vary hourly, but tend to represent average conditions that do not account for unusual or extreme conditions. For example, an accident or large event could cause significant increases in congestion and motor vehicle emissions that are not accounted for in the average emissions inputs used in the model.

U.S. EPA compiled and interpreted the model performance from 69 air quality modeling studies in the peer-reviewed literature between 2006 and March 2012 and developed recommendations on what should be reported in a model performance evaluation (Simon, et al., 2012). Included in the most recent EPA guidance (U.S. EPA, 2018), they are useful and were used by LADCO in our model performance evaluation:

- Photochemical modeling MPE studies should at a minimum report the Mean Bias (MB) and Error (ME or RMSE), and Normalized Mean Bias (NMB) and Error (NME) and/or Fractional Bias (FB) and Error (FE). The NMB and NME are unbounded on the positive end ( + ∞) but bounded at -100% for bias and 0% for error, while FE is bounded in 0-200% and FB is bounded in -200% to +200%.
- The model evaluation statistics should be calculated for the highest temporal resolution available and for important regulatory averaging times (e.g., daily maximum 8-hour $O_3$).
- It is important to report processing steps in the model evaluation and how the predicted and observed data were paired and whether data are spatially/temporally averaged before the statistics are calculated.

- Predicted values should be taken from the grid cell that contains the monitoring site, although bilinear interpolation to the monitoring site point can be used for higher resolution modeling (< 12 km).
- Evaluation should be performed for subsets of the data including, high observed concentrations (e.g., $O_3$ > 60 ppb), by subregions and by season or month.
- Evaluation should include more than just $O_3$ and $PM_{2.5}$, such as $SO_2$, $NO_2$ and CO.
- Spatial displays should be used in the model evaluation to evaluate model predictions away from the monitoring sites. Time series of predicted and observed concentrations at a monitoring site should also be used.
- It is necessary to understand measurement artifacts to make meaningful interpretation of the model performance evaluation.

We incorporated the recommendations of U.S. EPA (2018) and Emery et al., (2017) into the LADCO CAMx model performance evaluation. The LADCO evaluation products include qualitative and quantitative evaluation for MDA8 $O_3$ with and without a 60 ppb threshold.

**Table 3-7. Definition of model performance evaluation statistical measures used to evaluate CAMx.**

| Statistical Measure | Mathematical Expression | Notes |
|---|---|---|
| Normalized Mean Error (NME) | $\frac{\sum_{i=1}^{N} \lvert P_i - O_i \rvert}{\sum_{i=1}^{N} O_i}$ | Reported as % |
| Normalized Mean Bias (NMB) | $\frac{\sum_{i=1}^{N} (P_i - O_i)}{\sum_{i=1}^{N} O_i}$ | Reported as % |
| Correlation Coefficient (r) | $\frac{\sum \left[ (P_j - \bar{P}) \times (O_j - \bar{O}) \right]}{\sqrt{\sum (P_j - \bar{P})^2 \times \sum (O_j - \bar{O})^2}}$ | Unitless, -1 ≤ r ≤ +1<br>r =1 is perfectly correlated<br>r = 0 is totally uncorrelated |

### 3.7.3. Subregional Evaluation of Model Performance

The evaluation of the LADCO 2016 CAMx simulations focuses on monthly and $O_3$ season model performance at monitors in IL, IN, MI, OH and WI. We also examined summer season high $O_3$ episodes in the 2015 $O_3$ NAAQS NAAs in the LADCO region to determine how well the model performs on $O_3$ exceedance days in policy relevant locations.

# 4. 2016 and 2023 Emissions Summary

In this section we summarize the base and future year emissions modeling results used to forecast ground-level $O_3$ concentrations in 2023. The emissions projections from the 2016 base year to 2023 are the foundation of the air quality model forecasts of future year air quality. The emissions plots and tables in this section illustrate and quantify how the U.S. emissions modeling community, including LADCO, U.S. EPA, and state air quality planning agencies forecasted air pollution emissions for the current round of 2015 $O_3$ NAAQS attainment demonstrations.
As described in Section 3.4, LADCO based the 2016 and 2023 emissions data for this application on the U.S. EPA 2016fh emissions modeling platform (US EPA, 2021). LADCO replaced the EGU emissions in the U.S. EPA 2016fh platform with 2023 EGU forecasts estimated with a modified version of the ERTAC EGU Tool version 16.2 beta (MARAMA, 2012). Table 3-2 lists the 2016 base year and 2023 future year inventory components that LADCO used to simulate 2016 and 2023 air quality for this application.

The following sections summarize the 2016 and 2023 emissions used by LADCO for simulating $O_3$ and $O_3$ precursors during these years. Tabulated ozone season total emissions by state, county, and sector for the data used by LADCO for this TSD are include in the supporting materials to this TSD:

2016 and 2023 State, County, and Sector Emissions Summary (XLSX; 41 Mb)

## 4.1. 2016 Emissions Summary

The tables and figures in this section summarize the emissions used in the LADCO 2016 CAMx simulation. Table 4-1 shows the LADCO state 2016 average $O_3$ season (March – October) day emissions (OSDE) for CO, NOx, and VOC for all sectors, including natural sources like biogenics and fires. The calculation for average OSDE is shown in Equation 4-1.

$$OSDE_{s,p} = \frac{\sum_{m=mar}^{oct} \sum_{y=1}^{n} E_{m,y,s,p}}{244} \quad \text{(Equation 4-1)}$$

Where *E* = monthly total emissions, *s* = state, *p* = pollutant, *m* = month, *y* = inventory sector, *n* = number of inventory sectors; note that 244 is the number of days in March - October 2016

Figure 4-1 through Figure 4-9 are tile plots of the 12-km, 4-km, and 1.33-km gridded, July 2016 total CO, NOx, and VOC surface layer emissions, respectively. The CO and NOx plots illustrates that the highest emissions occur in proximity to urban areas and roadways. The VOC plot shows high emissions around urban areas and a diffuse emissions signal from biogenic sources. Table 4-2 through Table 4-4 show the 2016 average OSDE for CO, NOx, and VOC, respectively, by LADCO member state and inventory sector.

**Table 4-1. 2016 average ozone season day emissions (OSDE) by state (tons/day)**

| State | CO | NOX | VOC |
|---|---|---|---|
| Illinois | 4,421 | 1,082 | 2,703 |
| Indiana | 3,578 | 876 | 1,789 |
| Michigan | 4,123 | 805 | 3,152 |
| Minnesota | 4,355 | 652 | 2,838 |
| Ohio | 4,776 | 946 | 2,371 |
| Wisconsin | 2,636 | 533 | 2,399 |

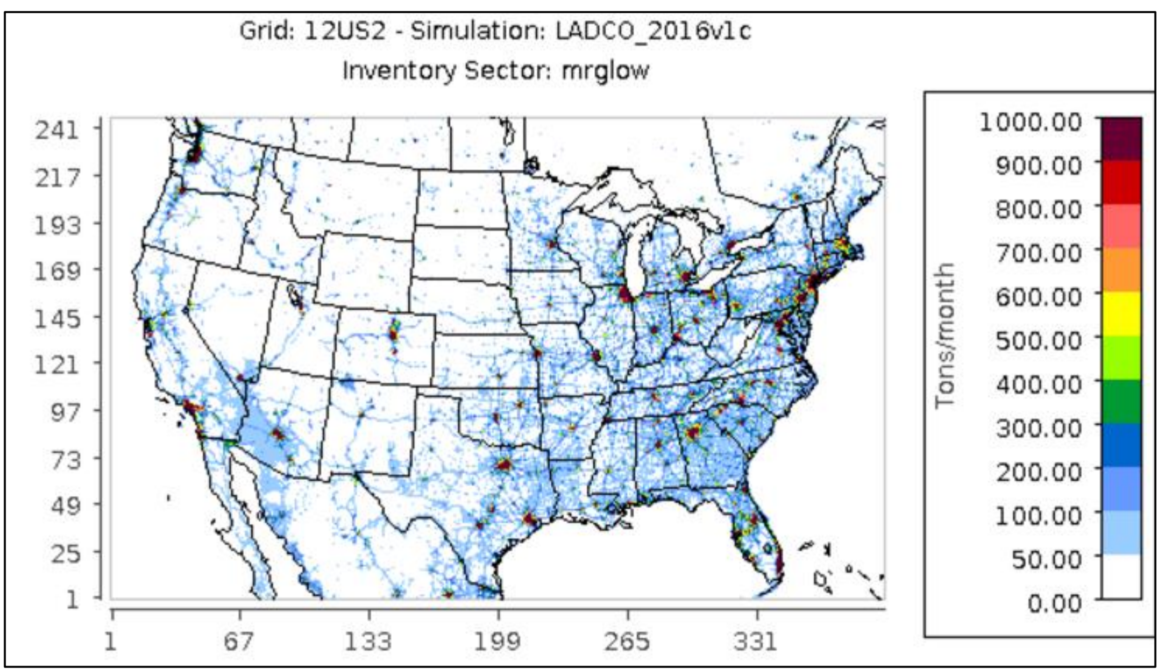


**Figure 4-1. July 2016 total 12-km gridded CO surface layer emissions (tons/month)**

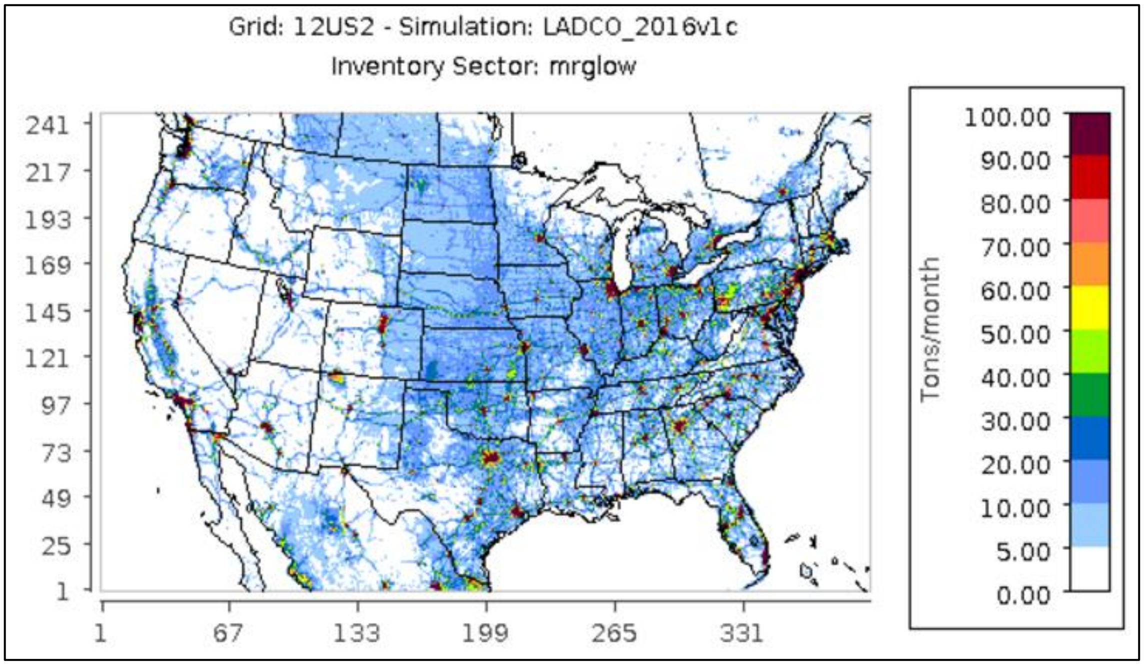


**Figure 4-2. July 2016 total 12-km gridded NOx surface layer emissions (tons/month)**

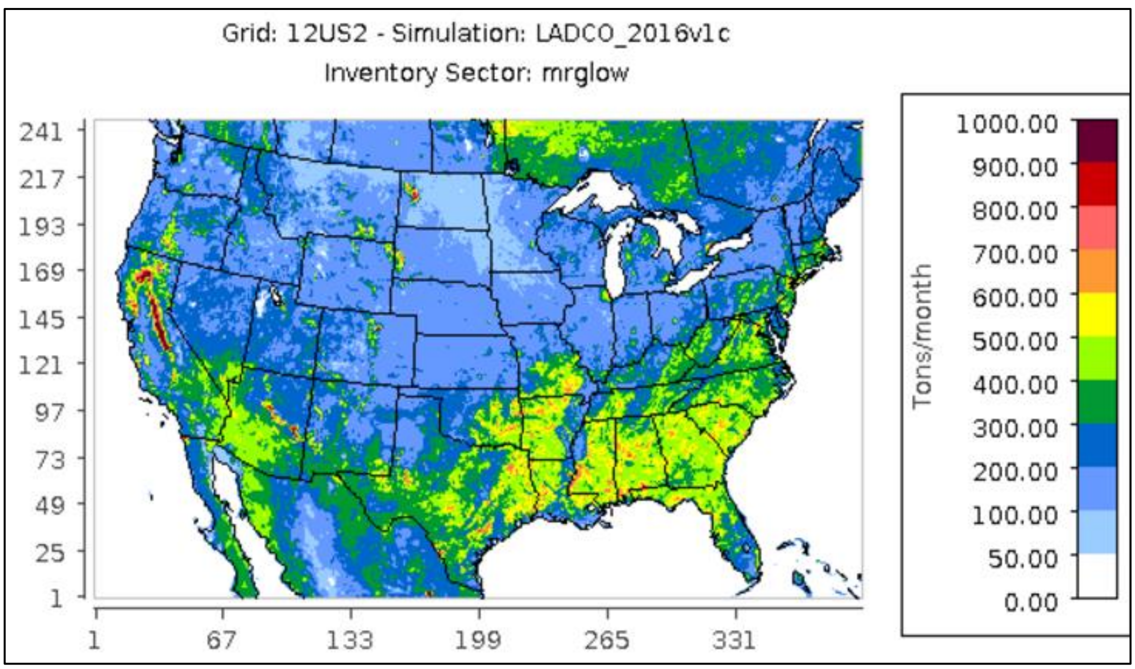


**Figure 4-3. July 2016 total 12-km gridded VOC surface layer emissions (tons/month)**

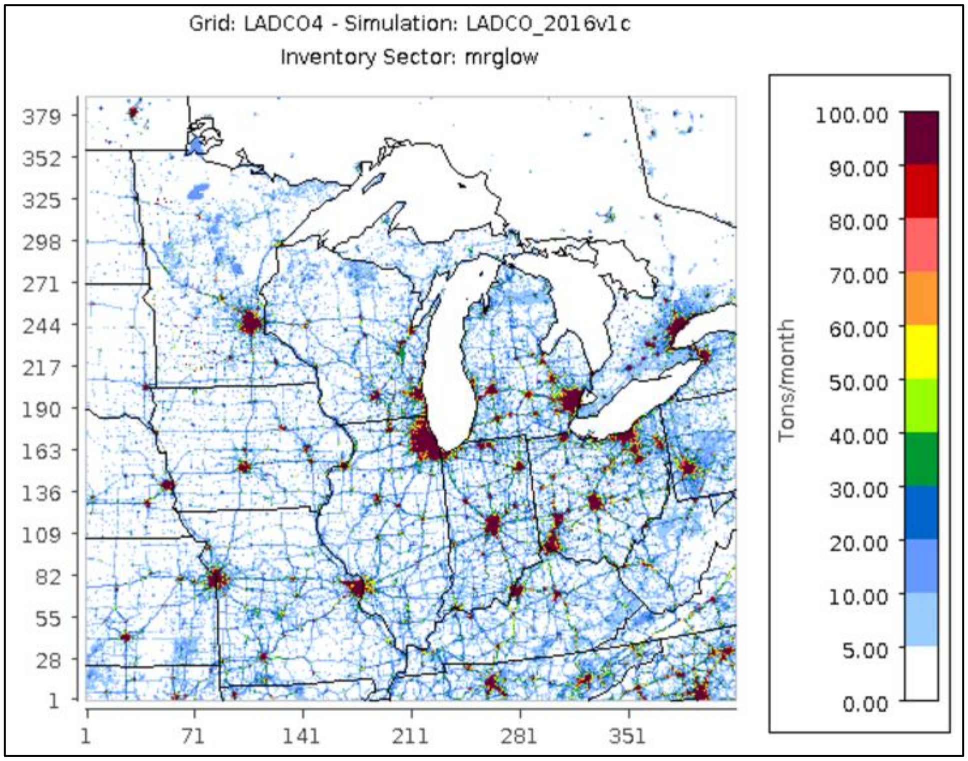


**Figure 4-4. July 2016 4-km gridded CO surface layer emissions (tons/month)**

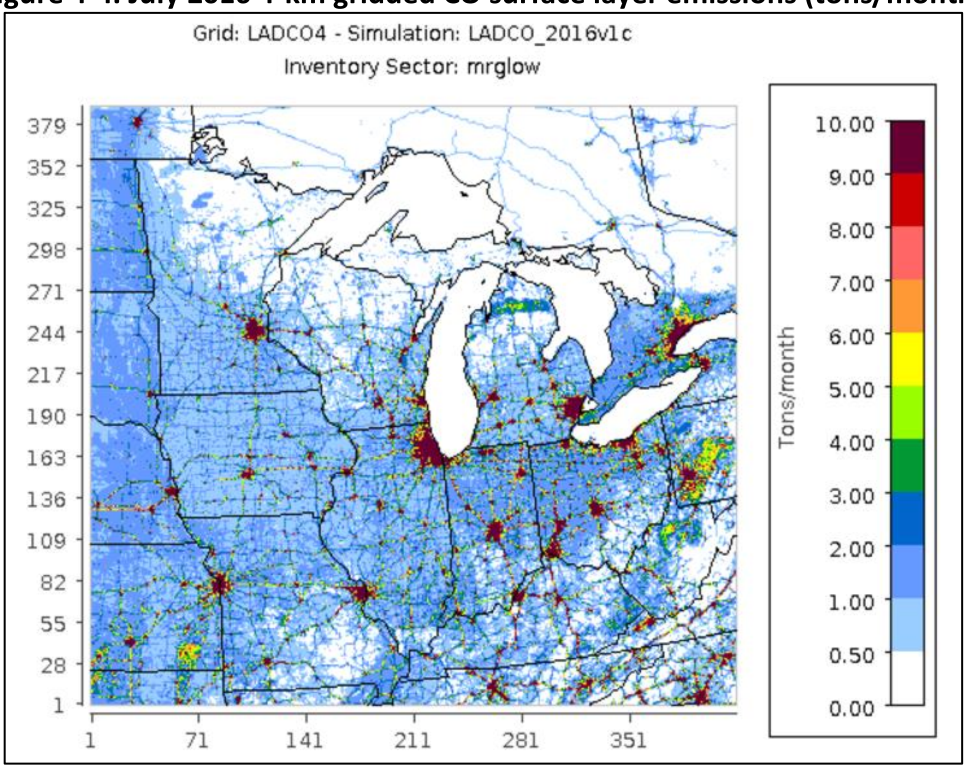


**Figure 4-5. July 2016 4-km gridded NOx surface layer emissions (tons/month)**

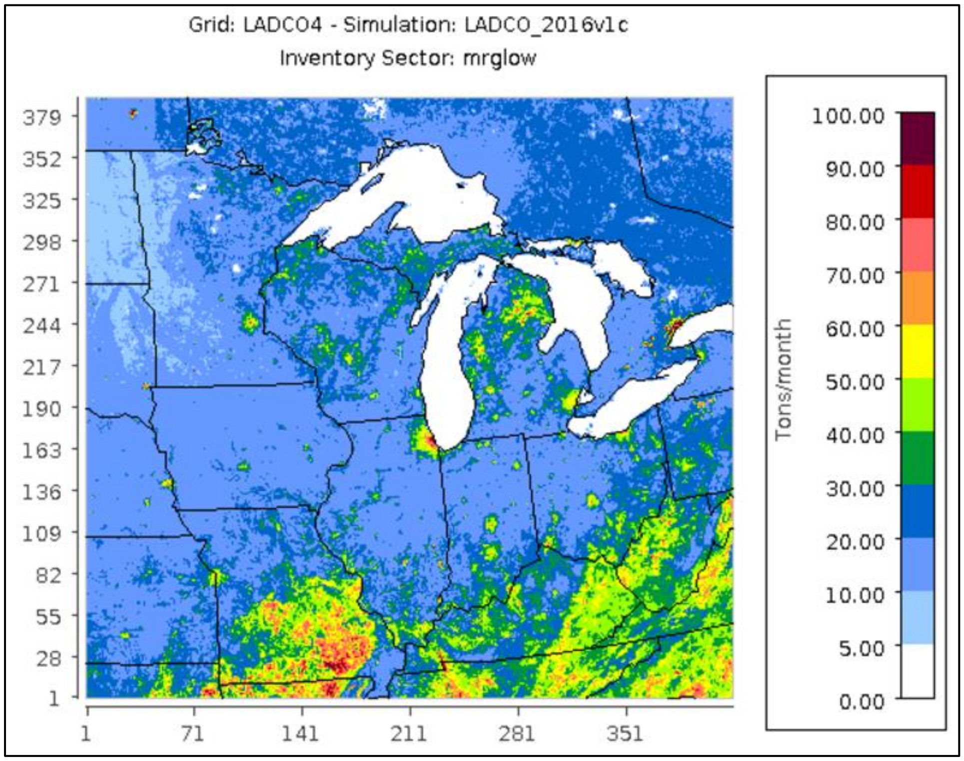


**Figure 4-6. July 2016 4-km gridded VOC surface layer emissions (tons/month)**

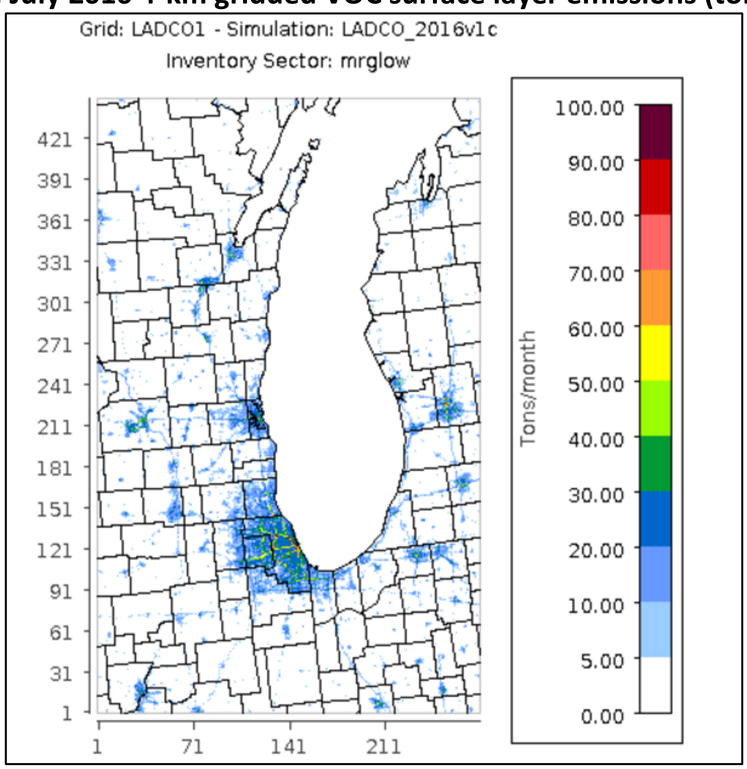


**Figure 4-7. July 2016 1.33-km gridded CO surface layer emissions (tons/month)**

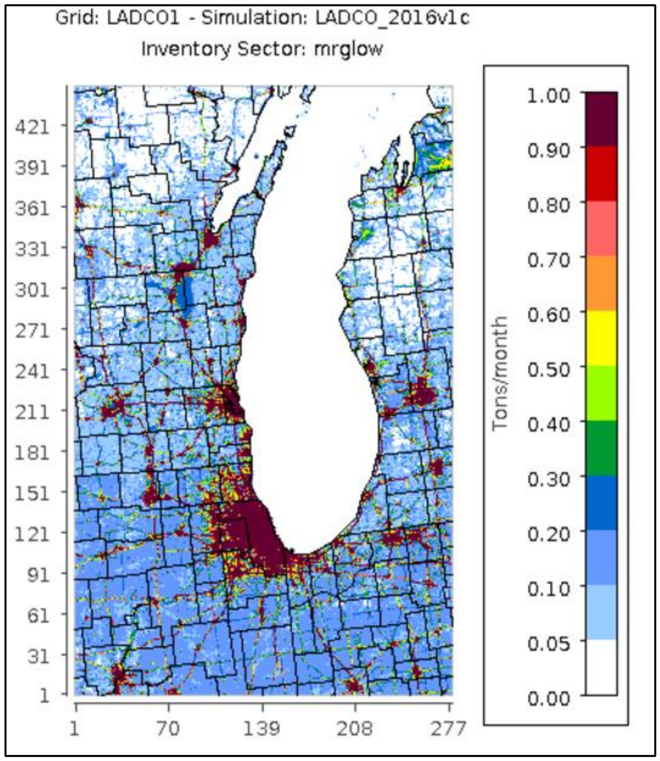


**Figure 4-8. July 2016 1.33-km gridded NOx surface layer emissions (tons/month)**

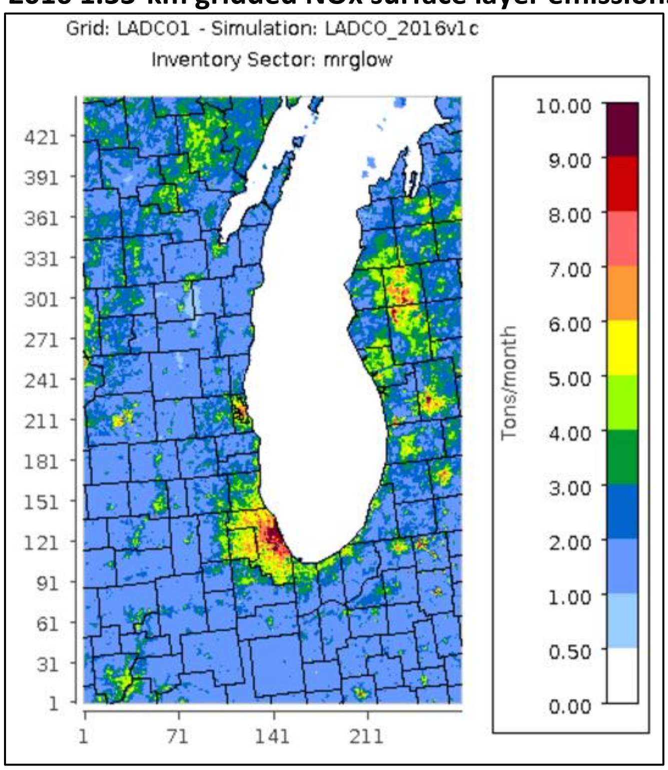


**Figure 4-9. July 2016 1.33-km gridded VOC surface layer emissions (tons/month)**

**Table 4-2. 2016 average ozone season day CO emissions by inventory sector (tons/day)**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Airports | 91 | 27 | 44 | 37 | 45 | 25 |
| Biogenic | 344 | 220 | 391 | 424 | 247 | 313 |
| C1/C2 Commercial Marine | 2 | 1 | 2 | 0 | 1 | 1 |
| C3 Commercial Marine | 0 | 0 | 2 | 0 | 0 | 0 |
| Nonpoint | 164 | 112 | 202 | 118 | 265 | 157 |
| Offroad Mobile | 1,379 | 749 | 1,010 | 828 | 1,315 | 730 |
| Nonpoint Oil & Gas | 58 | 14 | 48 | | 4 | |
| Onroad Mobile | 1,926 | 1,624 | 1,870 | 1,191 | 2,253 | 1,020 |
| Point Oil & Gas | 7 | 4 | 11 | 1 | 7 | 0 |
| Agricultural Fires | 1 | 0 | 1 | 6 | 0 | 1 |
| Electricity Generation | 29 | 25 | 30 | 21 | 40 | 27 |
| Wild and Prescribed Fires | 236 | 141 | 132 | 1,091 | 79 | 152 |
| Industrial Point | 80 | 543 | 149 | 38 | 360 | 56 |
| Rail | 17 | 8 | 2 | 7 | 12 | 5 |
| RWC* | 87 | 109 | 229 | 591 | 147 | 148 |
| **Total** | **4,421** | **3,578** | **4,123** | **4,355** | **4,776** | **2,636** |

* RWC = Residential Wood Combustion

**Table 4-3. 2016 average ozone season day NOx emissions by inventory sector (tons/day)**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Airports | 27 | 5 | 10 | 9 | 6 | 3 |
| Biogenic | 141 | 77 | 51 | 104 | 64 | 59 |
| C1/C2 Commercial Marine | 16 | 4 | 13 | 2 | 7 | 5 |
| C3 Commercial Marine | 0 | 1 | 17 | 2 | 2 | 2 |
| Nonpoint | 98 | 24 | 78 | 47 | 72 | 42 |
| Offroad Mobile | 157 | 116 | 78 | 134 | 130 | 71 |
| Nonpoint Oil & Gas | 39 | 10 | 34 | | 4 | |
| Onroad Mobile | 323 | 288 | 270 | 182 | 340 | 221 |
| Point Oil & Gas | 24 | 14 | 29 | 8 | 31 | 1 |
| Agricultural Fires | 0 | 0 | 0 | 0 | 0 | 0 |
| Electricity Generation | 76 | 182 | 100 | 46 | 132 | 41 |
| Wild and Prescribed Fires | 4 | 2 | 2 | 9 | 1 | 2 |
| Industrial Point | 83 | 110 | 107 | 62 | 90 | 55 |
| Rail | 91 | 43 | 13 | 38 | 65 | 28 |
| RWC | 1 | 1 | 3 | 7 | 2 | 2 |
| **Total** | **1,082** | **876** | **805** | **652** | **946** | **533** |

**Table 4-4. 2016 average ozone season day VOC emissions by inventory sector (tons/day)**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Agriculture | 21 | 21 | 9 | 39 | 19 | 15 |
| Airports | 9 | 2 | 4 | 3 | 3 | 2 |
| Biogenic | 1,689 | 1,118 | 2,328 | 2,016 | 1,440 | 1,922 |
| C1/C2 Commercial Marine | 1 | 0 | 0 | 0 | 0 | 0 |
| C3 Commercial Marine | 0 | 0 | 1 | 0 | 0 | 0 |
| Nonpoint | 372 | 262 | 352 | 184 | 419 | 178 |
| Offroad Mobile | 106 | 59 | 100 | 94 | 120 | 80 |
| Nonpoint Oil & Gas | 161 | 44 | 62 | | 43 | |
| Onroad Mobile | 173 | 150 | 169 | 105 | 205 | 90 |
| Point Oil & Gas | 4 | 1 | 4 | 0 | 5 | 1 |
| Agricultural Fires | 0 | 0 | 0 | 0 | 0 | 0 |
| Electricity Generation | 3 | 3 | 2 | 1 | 3 | 2 |
| Wild and Prescribed Fires | 56 | 33 | 31 | 256 | 19 | 36 |
| Industrial Point | 88 | 75 | 55 | 44 | 69 | 51 |
| Rail | 4 | 2 | 1 | 2 | 3 | 1 |
| RWC | 15 | 18 | 35 | 93 | 24 | 22 |
| **Total** | **2,703** | **1,789** | **3,152** | **2,838** | **2,371** | **2,399** |

## 4.2. $2023_{2016}$ Emissions Summary

The tables and figures in this section summarize the emissions used in the LADCO 2016-based 2023 CAMx simulation. Table 4-5 shows the LADCO state 2023 average OSDE for CO, NOx, and VOC for all sectors, including natural sources like biogenics and fires. Table 4-6 shows the percent difference in average OSDE between 2023 and 2016.Table 4-7 through Table 4-12 Figure 4-10 through Figure 4-24 are tile plots of the 12-km, 4-km, and 1.33-km gridded, July 2023 total CO, NOx, and VOC surface layer emissions, and emissions differences between 2023 and 2016. The difference plots show the locations where emissions are projected to change in 2023 relative to 2016. The emissions differences indicate widespread reductions across the region. The largest CO and NOx emissions reductions will occur along roadways and in urban areas; emissions increases are projected in oil and gas development regions, in Mexico, and in Canadian offshore sources in the Great Lakes. VOC emissions reductions are projected to occur in urban areas; increasing VOC emissions are expected in oil and gas development areas.

**Table 4-5. $2023_{2016}$ average ozone season day emissions (OSDE) by state (tons/day)**

| State | CO | NOx | VOC |
|---|---|---|---|
| Illinois | 3,799 | 798 | 2,609 |
| Indiana | 3,093 | 590 | 1,719 |
| Michigan | 3,528 | 578 | 3,049 |
| Minnesota | 3,996 | 493 | 2,772 |
| Ohio | 4,054 | 663 | 2,266 |
| Wisconsin | 2,308 | 367 | 2,339 |

**Table 4-6. 2023-2016 percent difference in average OSDE by state**

| State | CO | NOx | VOC |
|---|---|---|---|
| Illinois | -14% | -26% | -3% |
| Indiana | -14% | -33% | -4% |
| Michigan | -14% | -28% | -3% |
| Minnesota | -8% | -24% | -2% |
| Ohio | -15% | -30% | -4% |
| Wisconsin | -12% | -31% | -3% |

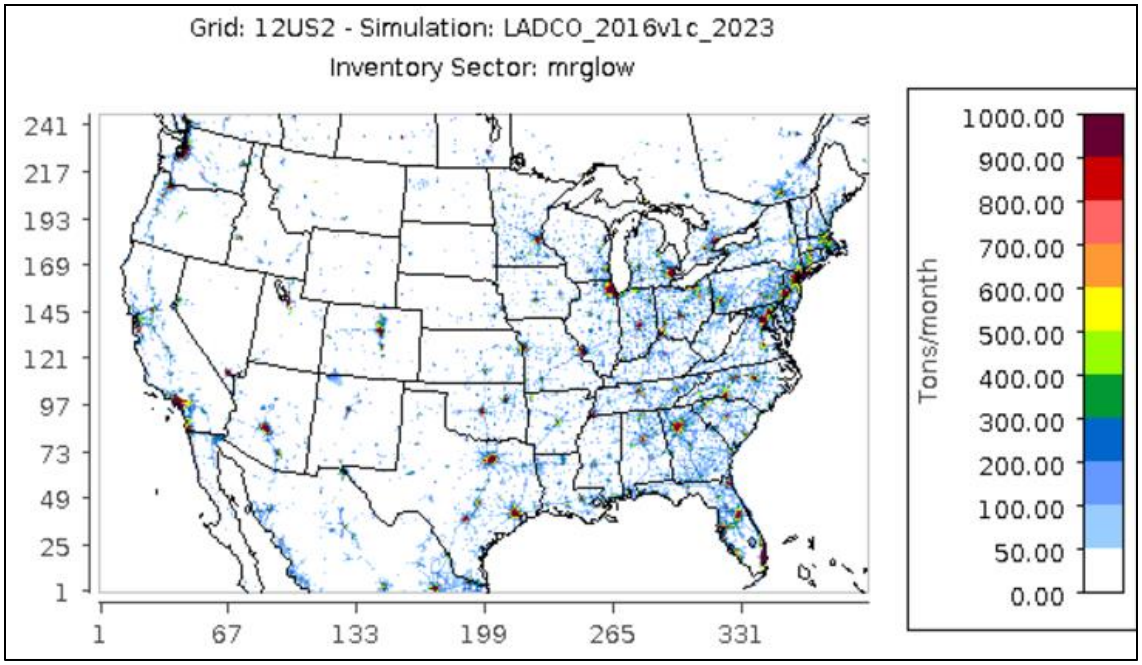


**Figure 4-10. July 2023 total 12-km gridded CO surface layer emissions (tons/month).**

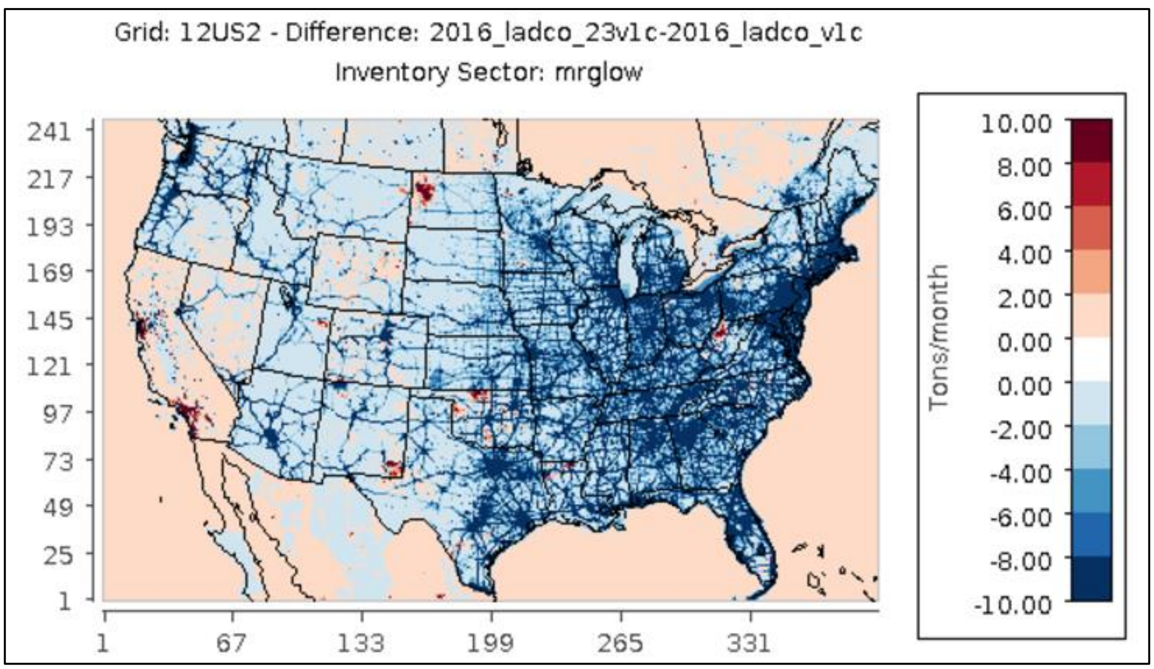


**Figure 4-11. Difference (2023-2016) in July 12-km gridded CO surface layer emissions**

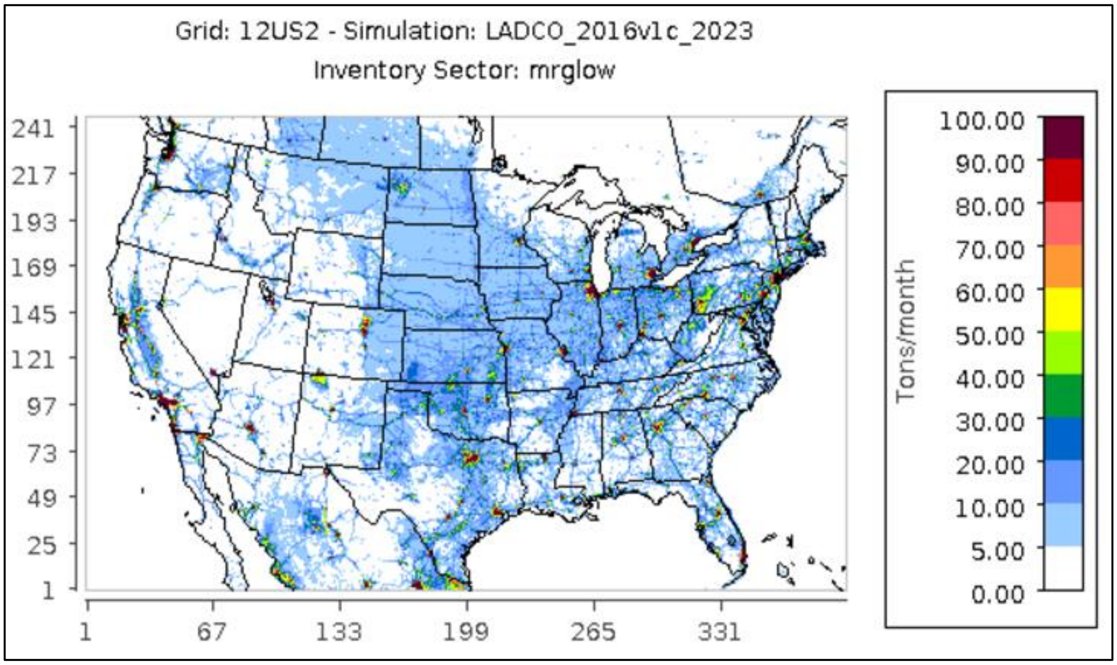


**Figure 4-12. July 2023 total 12-km gridded NOx surface layer emissions (tons/month).**

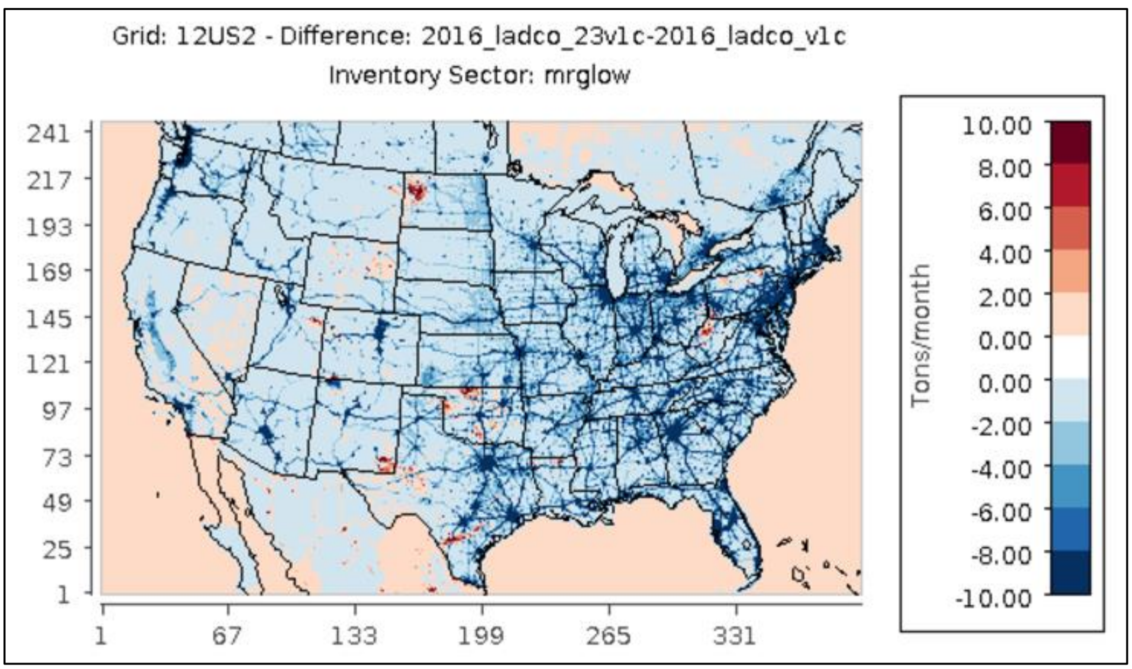


**Figure 4-13. Difference (2023-2016) in July 12-km gridded NOx surface layer emissions (tons/month)**

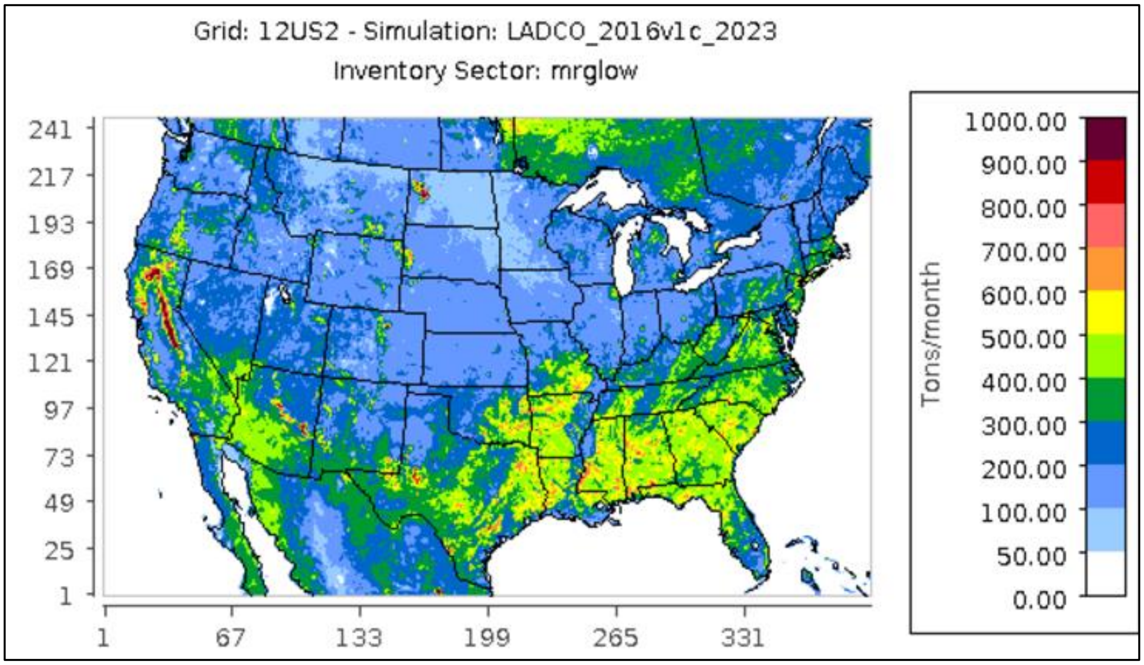


**Figure 4-14. July 2023 total 12-km gridded VOC surface layer emissions (tons/month).**

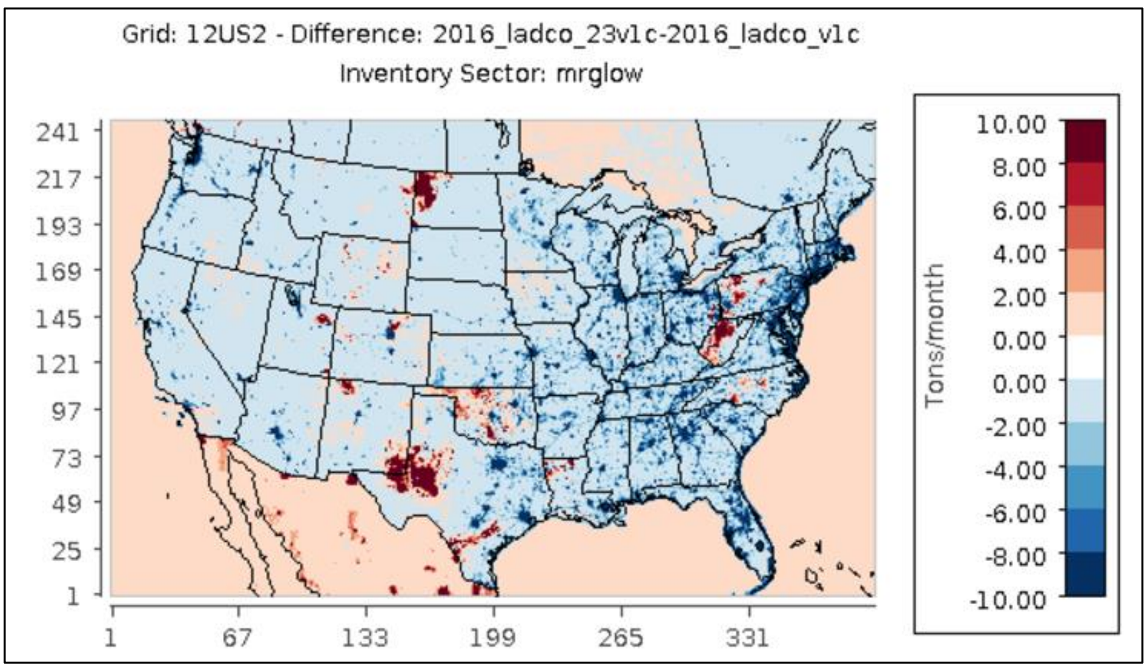


**Figure 4-15. Difference (2023-2016) in July 12-km gridded VOC surface layer emissions (tons/month)**

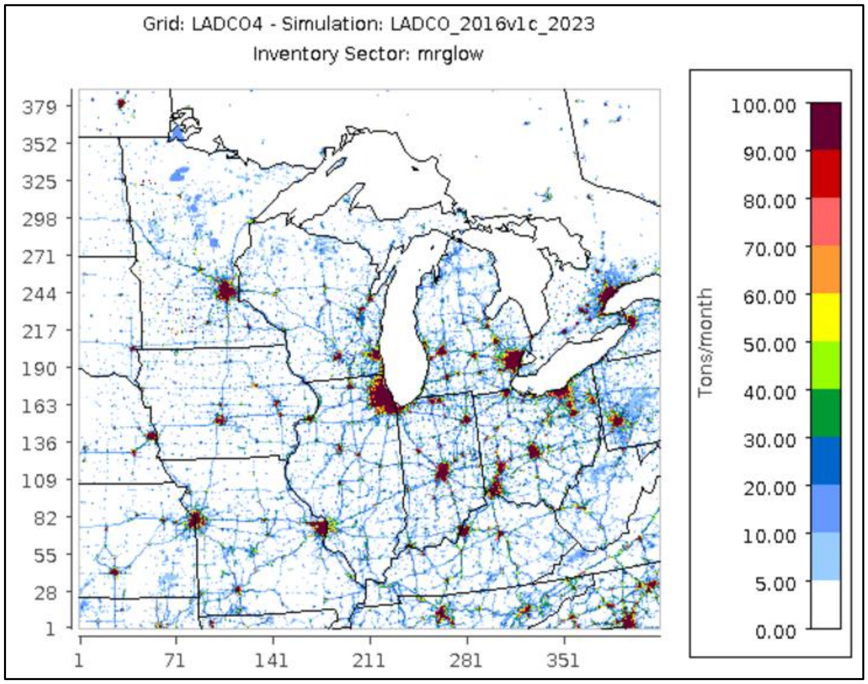


**Figure 4-16. July 2023 total 4-km gridded CO surface layer emissions (tons/month).**

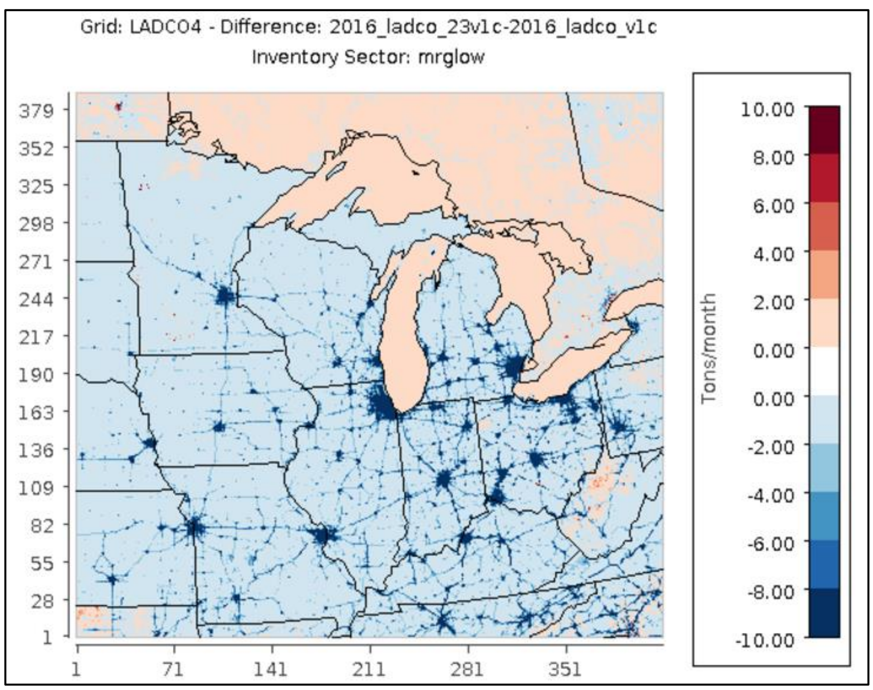


**Figure 4-17. Difference (2023-2016) in July 4-km gridded CO surface layer emissions (tons/month)**

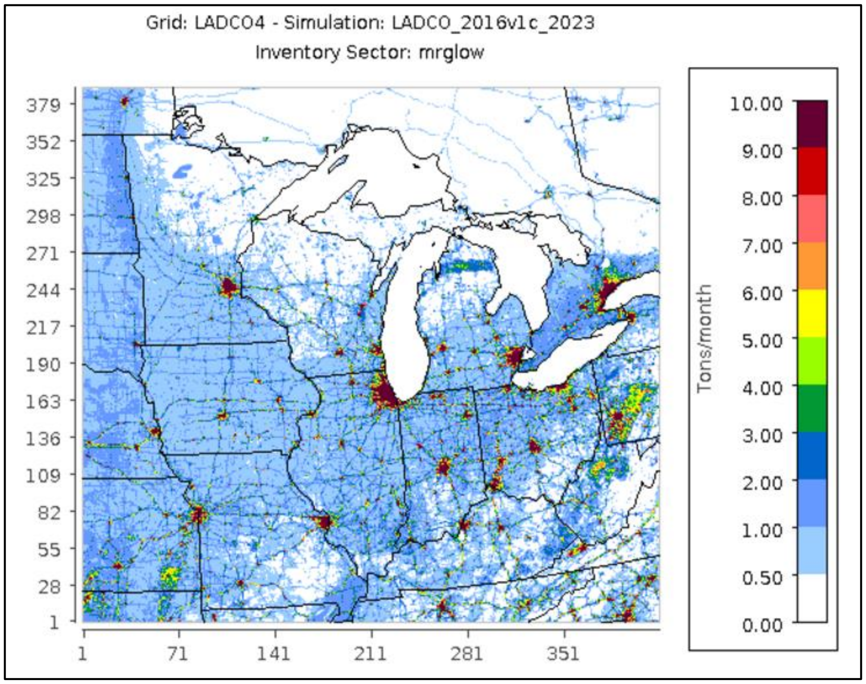


**Figure 4-18. July 2023 total 4-km gridded NOx surface layer emissions (tons/month).**

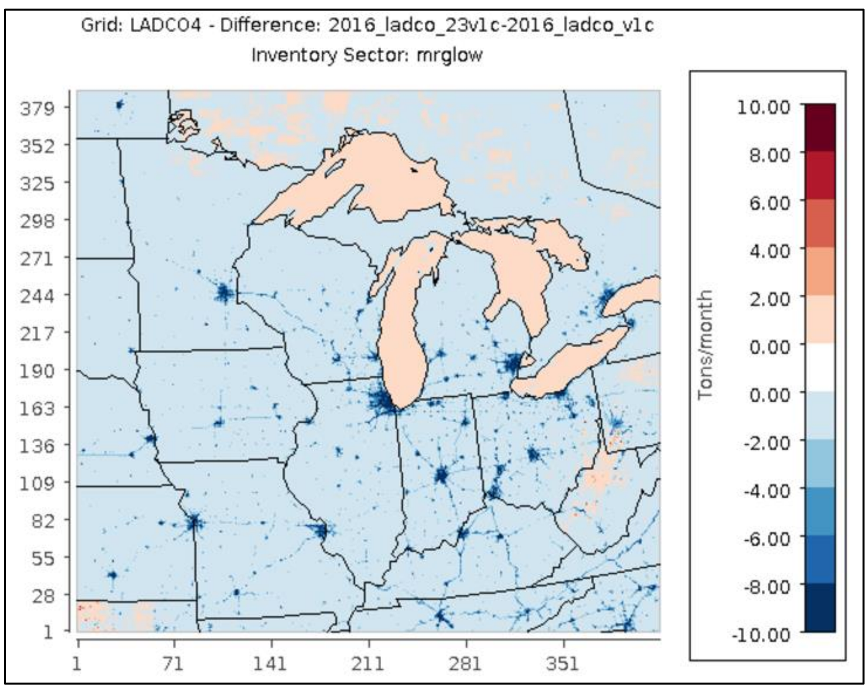


**Figure 4-19. Difference (2023-2016) in July 12-km gridded NOx surface layer emissions (tons/month).**

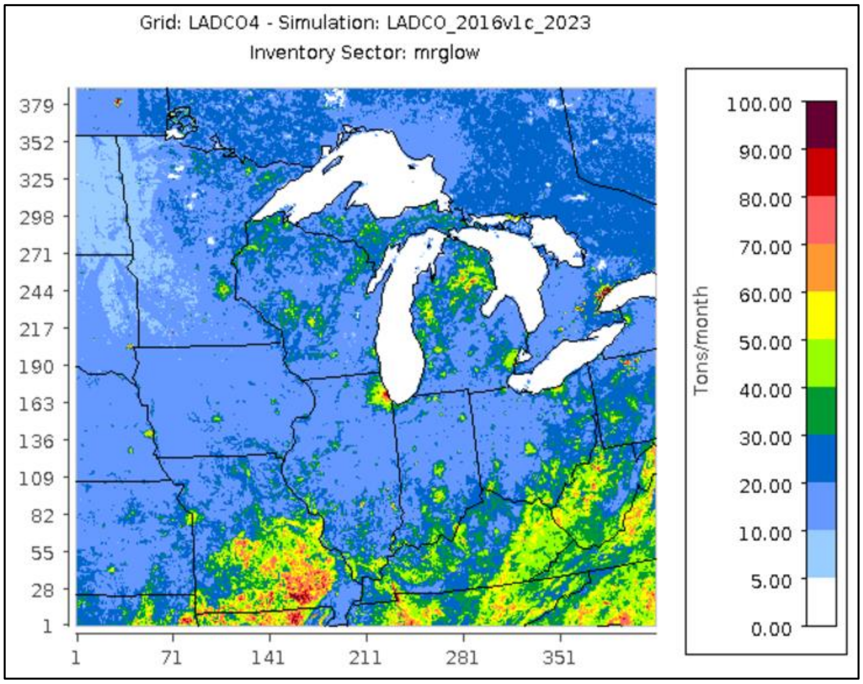


**Figure 4-20. July 2023 total 4-km gridded VOC surface layer emissions (tons/month).**

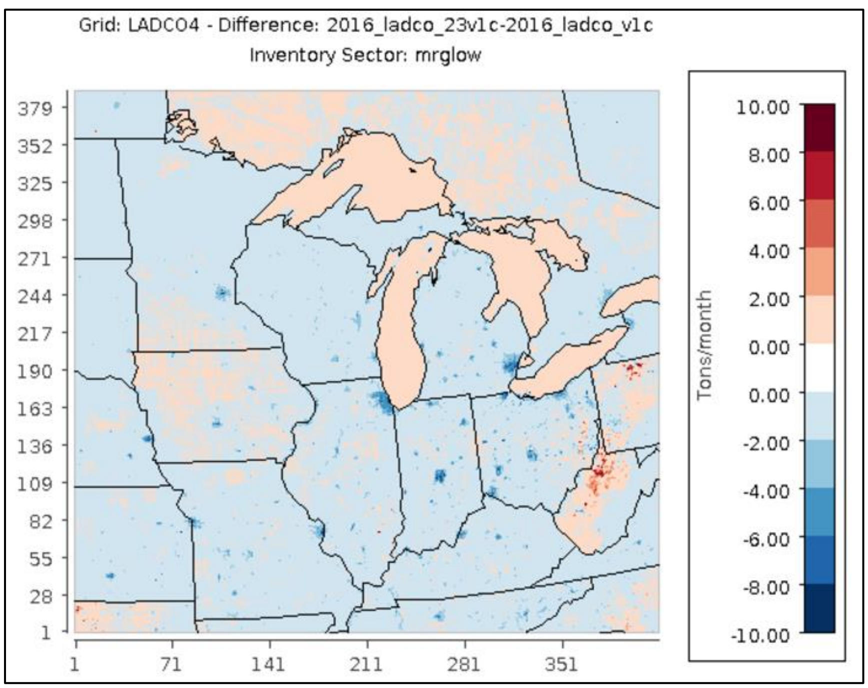


**Figure 4-21. Difference (2023-2016) in July 4-km gridded VOC surface layer emissions (tons/month)**

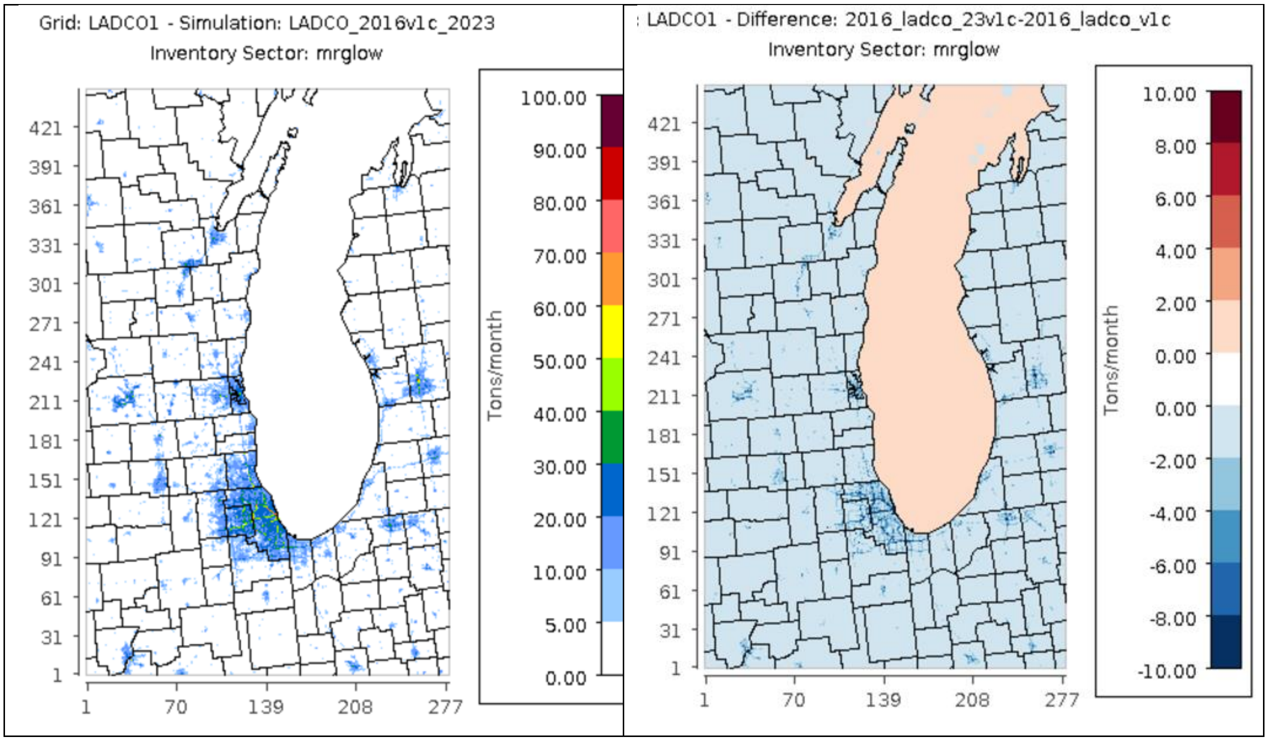


**Figure 4-22. July 2023 total (left) and difference (2023-2016) [right] in 1-km gridded CO surface layer emissions (tons/month).**

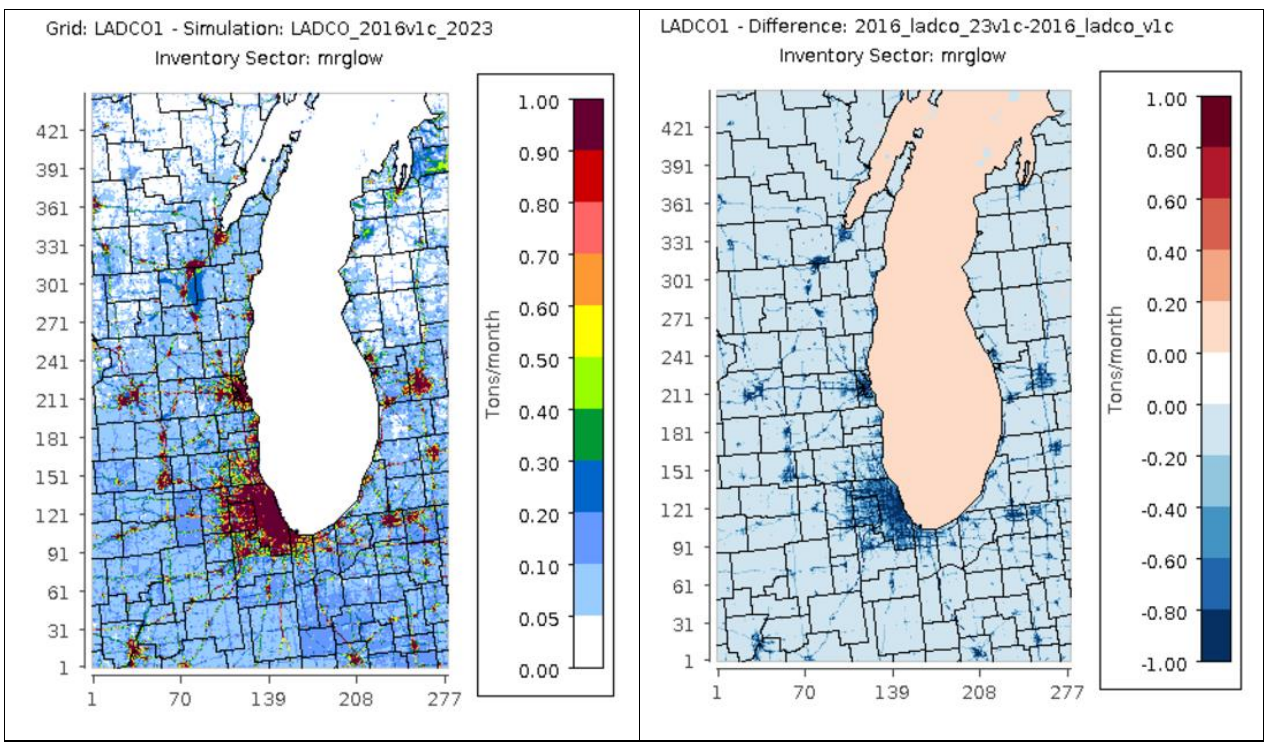


**Figure 4-23. July 2023 total (left) and difference (2023-2016) [right] in 1-km gridded NOx surface layer emissions (tons/month).**

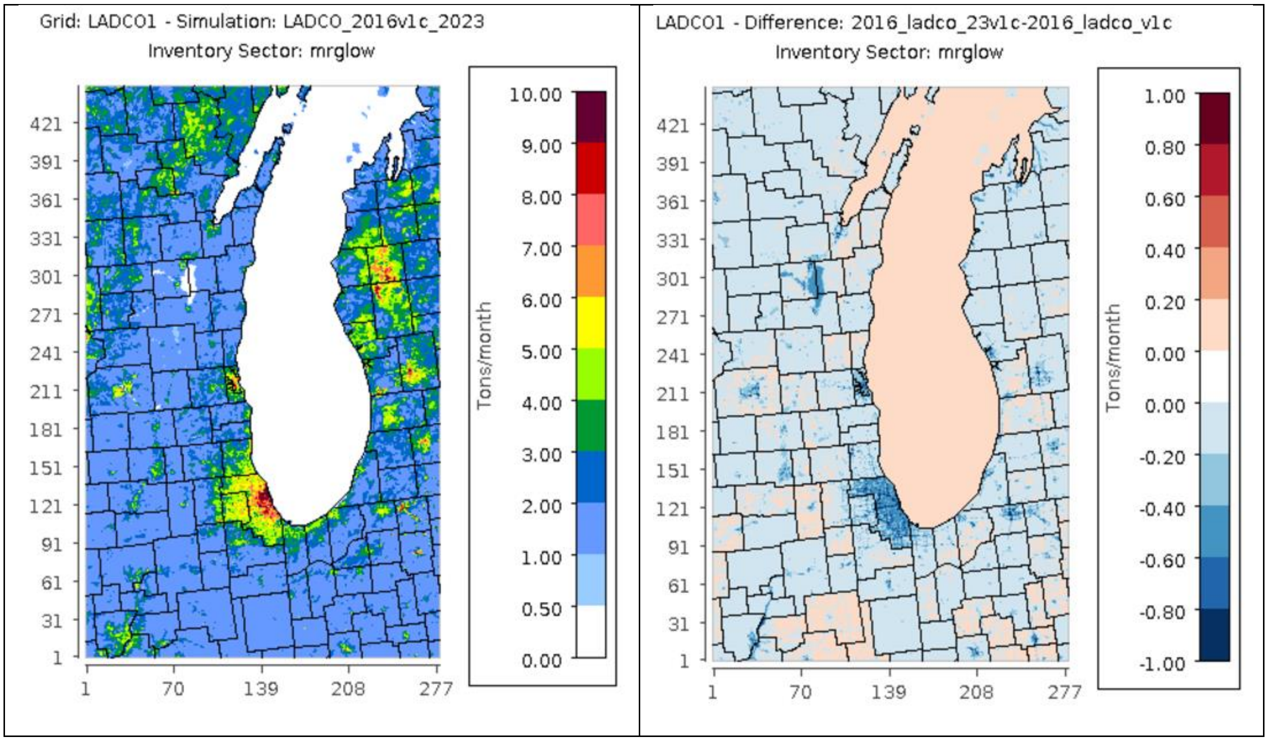


**Figure 4-24. July 2023 total (left) and difference (2023-2016) [right] in 1-km gridded VOC surface layer emissions (tons/month).**

Table 4-7 through Table 4-12 show the LADCO state $2023_{2016}$ average OSDE CO, NOx, and VOC emissions, and compare the future and base year OSDE values by state and inventory sector. Negative numbers in these tables indicate percent emissions reductions in 2023 relative to 2016. Comparisons of the EGU and industrial point source emissions changes between 2016 and 2023 is confounded by the different methods used by the U.S EPA and ERTAC EGU projection models for distinguishing EGU from non-EGU industrial point sources. ERTAC only forecasts emissions for sources with CEM data while EPA does economic projections of all units that sell power to the grid including facilities with co-generation units like paper mills and aluminum foundries. For the LADCO modeling that used ERTAC to project power plant emissions, we used the EPA 2023 inventory projections for those sources that generate power but do not have CEMs.

LADCO projects that overall CO, NOx, and VOC emissions will decrease in 2023 relative to 2016 in each of the LADCO states. The total NOx reductions range from -24% to -33% across the LADCO states, driven primarily by reductions in EGU point, onroad mobile, and offroad mobile source emissions. We project that the total VOC emissions reductions will range from -2% to -4% across the LADCO states. These reductions are driven by changes to onroad and offroad mobile sources.

**Table 4-7. 2023 average ozone season day CO emissions by inventory sector (tons/day)**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Airports | 101 | 26 | 47 | 40 | 45 | 27 |
| Biogenic | 344 | 220 | 391 | 424 | 247 | 313 |
| C1/C2 Commercial Marine | 2 | 1 | 2 | 0 | 1 | 1 |
| C3 Commercial Marine | 0 | 0 | 2 | 0 | 0 | 0 |
| Nonpoint | 163 | 112 | 201 | 119 | 265 | 157 |
| Offroad Mobile | 1,355 | 747 | 975 | 810 | 1,283 | 699 |
| Nonpoint Oil & Gas | 55 | 13 | 43 | | 6 | |
| Onroad Mobile | 1,339 | 1,141 | 1,322 | 858 | 1,572 | 723 |
| Point Oil & Gas | 9 | 5 | 12 | 1 | 10 | 0 |
| Agricultural Fires | 1 | 0 | 1 | 6 | 0 | 1 |
| Electricity Generation | 17 | 27 | 22 | 14 | 28 | 27 |
| Wild and Prescribed Fires | 236 | 141 | 132 | 1,091 | 79 | 152 |
| Industrial Point | 81 | 545 | 150 | 40 | 362 | 56 |
| Rail | 17 | 8 | 2 | 7 | 12 | 5 |
| RWC | 81 | 106 | 227 | 586 | 143 | 147 |
| **Total** | **3,799** | **3,093** | **3,528** | **3,996** | **4,054** | **2,308** |

**Table 4-8. Percent difference between base and future year (2023-2016) average ozone season day CO emissions**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Airports | 11% | -3% | 7% | 6% | 0% | 6% |
| Biogenic | 0% | 0% | 0% | 0% | 0% | 0% |
| C1/C2 Commercial Marine | -1% | -1% | -1% | -1% | -1% | -1% |
| C3 Commercial Marine | 15% | 15% | 15% | 15% | 15% | 15% |
| Nonpoint | -1% | 0% | 0% | 0% | 0% | 0% |
| Offroad Mobile | -2% | 0% | -4% | -2% | -2% | -4% |
| Nonpoint Oil & Gas | -4% | -4% | -11% | | 74% | |
| Onroad Mobile | -31% | -30% | -29% | -28% | -30% | -29% |
| Point Oil & Gas | 25% | 36% | 1% | 0% | 32% | 41% |
| Agricultural Fires | 0% | 0% | 0% | 0% | 0% | 0% |
| Electricity Generation | -43% | 6% | -26% | -34% | -31% | 0% |
| Wild and Prescribed Fires | 0% | 0% | 0% | 0% | 0% | 0% |
| Industrial Point | 1% | 0% | 0% | 4% | 1% | 0% |
| Rail | 1% | 2% | 0% | 1% | 1% | 1% |
| RWC | -7% | -3% | -1% | -1% | -3% | -1% |
| **Total** | -14% | -14% | -14% | -8% | -15% | -12% |

**Table 4-9. 2023 average ozone season day NOx emissions by inventory sectors (tons/day)**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Airports | 34 | 6 | 13 | 11 | 7 | 4 |
| Biogenic | 141 | 77 | 51 | 104 | 64 | 59 |
| C1/C2 Commercial Marine | 11 | 3 | 9 | 2 | 5 | 4 |
| C3 Commercial Marine | 0 | 1 | 19 | 2 | 2 | 2 |
| Nonpoint | 94 | 23 | 75 | 47 | 70 | 41 |
| Offroad Mobile | 99 | 72 | 55 | 90 | 86 | 48 |
| Nonpoint Oil & Gas | 37 | 9 | 30 | | 7 | |
| Onroad Mobile | 157 | 140 | 125 | 86 | 157 | 98 |
| Point Oil & Gas | 27 | 20 | 31 | 8 | 36 | 2 |
| Agricultural Fires | 0 | 0 | 0 | 0 | 0 | 0 |
| Electricity Generation | 34 | 88 | 53 | 29 | 83 | 27 |
| Wild and Prescribed Fires | 4 | 2 | 2 | 9 | 1 | 2 |
| Industrial Point | 82 | 112 | 101 | 67 | 87 | 54 |
| Rail | 77 | 36 | 11 | 32 | 55 | 24 |
| RWC | 1 | 1 | 3 | 7 | 2 | 2 |
| **Total** | **798** | **590** | **578** | **493** | **663** | **367** |

**Table 4-10. Percent difference between base and future year (2023-2016) average ozone season day NOx emissions**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Airports | 24% | 19% | 25% | 17% | 13% | 27% |
| Biogenic | 0% | 0% | 0% | 0% | 0% | 0% |
| C1/C2 Commercial Marine | -29% | -29% | -29% | -29% | -29% | -29% |
| C3 Commercial Marine | 9% | 9% | 9% | 9% | 9% | 9% |
| Nonpoint | -4% | -2% | -4% | -1% | -4% | -3% |
| Offroad Mobile | -37% | -38% | -29% | -33% | -33% | -32% |
| Nonpoint Oil & Gas | -4% | -5% | -12% | | 68% | |
| Onroad Mobile | -51% | -51% | -54% | -53% | -54% | -56% |
| Point Oil & Gas | 12% | 42% | 5% | -3% | 16% | 20% |
| Agricultural Fires | 0% | 0% | 0% | 0% | 0% | 0% |
| Electricity Generation | -56% | -52% | -47% | -37% | -38% | -34% |
| Wild and Prescribed Fires | 0% | 0% | 0% | 0% | 0% | 0% |
| Industrial Point | -2% | 1% | -6% | 7% | -3% | -2% |
| Rail | -15% | -15% | -11% | -16% | -16% | -16% |
| RWC | -3% | 1% | 3% | 2% | 2% | 3% |
| **Total** | -26% | -33% | -28% | -24% | -30% | -31% |

**Table 4-11. 2023 average ozone season day VOC emissions by inventory sectors (tons/day)**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Agriculture | 23 | 23 | 10 | 42 | 21 | 15 |
| Airports | 10 | 2 | 4 | 4 | 3 | 2 |
| Biogenic | 1,689 | 1,118 | 2,328 | 2,016 | 1,440 | 1,922 |
| C1/C2 Commercial Marine | 1 | 0 | 0 | 0 | 0 | 0 |
| C3 Commercial Marine | 0 | 0 | 1 | 0 | 0 | 0 |
| Nonpoint | 377 | 265 | 352 | 188 | 424 | 180 |
| Offroad Mobile | 82 | 48 | 70 | 64 | 89 | 54 |
| Nonpoint Oil & Gas | 157 | 44 | 59 | | 48 | |
| Onroad Mobile | 102 | 86 | 98 | 61 | 119 | 53 |
| Point Oil & Gas | 5 | 1 | 4 | 1 | 7 | 1 |
| Agricultural Fires | 0 | 0 | 0 | 0 | 0 | 0 |
| Electricity Generation | 2 | 3 | 2 | 1 | 2 | 1 |
| Wild and Prescribed Fires | 56 | 33 | 31 | 256 | 19 | 36 |
| Industrial Point | 89 | 76 | 54 | 45 | 68 | 52 |
| Rail | 3 | 2 | 1 | 1 | 2 | 1 |
| RWC | 14 | 18 | 34 | 93 | 24 | 22 |
| **Total** | **2,609** | **1,719** | **3,049** | **2,772** | **2,266** | **2,339** |

**Table 4-12. Percent difference between base and future year (2023-2016) average ozone season day VOC emissions**

| Sector | IL | IN | MI | MN | OH | WI |
|---|---|---|---|---|---|---|
| Agriculture | 10% | 8% | 6% | 8% | 8% | 2% |
| Airports | 10% | 3% | 6% | 5% | -2% | 5% |
| Biogenic | 0% | 0% | 0% | 0% | 0% | 0% |
| C1/C2 Commercial Marine | -32% | -31% | -32% | -32% | -32% | -32% |
| C3 Commercial Marine | 15% | 15% | 15% | 15% | 15% | 15% |
| Nonpoint | 1% | 1% | 0% | 2% | 1% | 1% |
| Offroad Mobile | -23% | -19% | -29% | -32% | -26% | -32% |
| Nonpoint Oil & Gas | -2% | 0% | -5% | | 12% | |
| Onroad Mobile | -41% | -43% | -42% | -41% | -42% | -41% |
| Point Oil & Gas | 40% | 50% | 6% | 10% | 56% | 45% |
| Agricultural Fires | 0% | 0% | 0% | 0% | 0% | 0% |
| Electricity Generation | -49% | -8% | -1% | -27% | -24% | -18% |
| Wild and Prescribed Fires | 0% | 0% | 0% | 0% | 0% | 0% |
| Industrial Point | 1% | 2% | 0% | 3% | -1% | 0% |
| Rail | -21% | -20% | -13% | -22% | -22% | -22% |
| RWC | -4% | -2% | -1% | -1% | -2% | -1% |
| **Total** | -3% | -4% | -3% | -2% | -4% | -3% |

#### 4.2.1. LADCO 2023 Electricity Generating Unit Emissions

The ERTAC EGU model was developed using EGU activity pattern matching algorithms designed to provide hourly EGU emissions data for air quality planning. The original goal of the model was to create low-cost software that air quality planning agencies could use for developing EGU emissions projections. States needed a transparent model that was numerically stable and did not produce dramatic changes to the emissions forecasts with small changes in inputs. A key feature of the model includes data transparency; all the inputs to the model are publicly available. The code is also operationally transparent and includes extensive documentation, open source code, and a diverse user community to support new users of the software.

Operation of the ERTAC EGU model is straightforward given the complexity of the projection calculations and inputs. The model imports base year CEM data from U.S. EPA and sorts the data from the peak to the lowest generation hour. It applies hour-specific growth rates that include peak and off-peak rates. The model then balances the system for all units and hours that exceed physical or regulatory limits. ERTAC EGU applies future year controls to the emissions estimates and tests for reserve capacity, generates quality assurance reports, and converts the outputs to SMOKE-ready modeling files.

ERTAC EGU has distinct advantages over other EGU growth methodologies because it can generate hourly future year estimates that are key to understanding $O_3$ episodes. The model does not shutdown or mothball existing units because economics algorithms suggest they are not economically viable. Additionally, alternate control scenarios are easy to simulate with the model. In recent years significant effort has been put into the model to help users to prevent the generation of new coal plants to fit demand. The model allows portability of generation to different fuels like renewables and natural gas to prevent this.

Differences between the U.S. EPA and ERTAC EGU emissions forecasts arise from alternative forecast algorithms and from the data used to inform the model predictions. The U.S. EPA based the EGU emissions forecast in their 2016fh modeling platform on comments from states and stakeholders received through Spring 2020. ERTAC EGU 16.2 beta used CEM data from 2016 and state-reported changes to EGUs received through July 2021. The ERTAC EGU 16.2 beta emissions used for this modeling application represented the best available information on EGU forecasts for the Midwest and Eastern U.S. that was available in September 2021.

## 4.3. Emissions Summaries by Nonattainment Area

Table 4-13 presents average OSDE for CO, NOx, and VOC in 2016 and 2023 for each of the 2015 $O_3$ NAAQS NAAs in the LADCO region. These emissions include all sources, anthropogenic and natural, in the entirety of the counties contained in each NAA. The emissions in this table include the total county emissions and do not reflect partial county totals for those NAAs that have partial-county designations.

**Table 4-13. Average ozone season day emissions by nonattainment area (tons/day)**

| State and NAA | CO | | NOX | | VOC | |
|---|---|---|---|---|---|---|
| | 2016 | 2023 | 2016 | 2023 | 2016 | 2023 |
| **Illinois** | | | | | | |
| Chicago, IL | 2,130 | 1,845 | 393 | 283 | 503 | 467 |
| **Indiana** | | | | | | |
| Chicago, IN | 668 | 635 | 93 | 77 | 72 | 68 |
| **Kentucky** | | | | | | |
| Cincinnati, OH-KY | 123 | 108 | 31 | 24 | 55 | 53 |
| **Michigan** | | | | | | |
| Allegan, MI | 59 | 49 | 11 | 8 | 46 | 44 |
| Berrien, MI | 69 | 56 | 12 | 8 | 30 | 28 |
| Muskegon, MI | 66 | 54 | 9 | 6 | 40 | 37 |
| **Missouri** | | | | | | |
| St. Louis, MO-IL | 759 | 650 | 156 | 113 | 340 | 326 |
| **Ohio** | | | | | | |
| Cleveland, OH | 892 | 750 | 131 | 91 | 267 | 249 |
| **Wisconsin** | | | | | | |
| Chicago, WI | 43 | 36 | 13 | 6 | 16 | 15 |
| Milwaukee/Ozaukee, WI | 458 | 406 | 82 | 60 | 130 | 123 |
| Sheboygan, WI | 41 | 35 | 10 | 5 | 19 | 18 |

# 5. Model Performance Evaluation

## 5.1. WRF 2016 Meteorology Modeling Performance Evaluation

LADCO used the WRF version 3.9.1.1 model (Advanced Research WRF dynamic core WRF-ARW) to simulate meteorology on 12-km, 4-km, and 1.33-km domains focused on the Great Lakes Basin for the year 2016. The physics options for the LADCO WRF simulation were based on the best performing configuration identified through a collaboration with University of Wisconsin researchers through a NASA Health and Air Quality (HAQ) program grant-funded project.

LADCO conducted qualitative and quantitative analysis to assess operational performance of the 2016 WRF modeling. Focus of this analysis is on the LADCO region. For the 4-km domains, LADCO evaluated the WRF performance by state; and for the 1.33 domains LADCO evaluated the performance across all monitors in the entire domain. LADCO compared modeled surface pressure, precipitation, and wind vectors against observations by season and for high-concentration ozone episodic events. We also performed a detailed analysis of the model during lake breeze events at the shoreline monitors of Lake Michigan and Lake Erie.

LADCO found that the 12-km and 4-km WRF simulations adequately captured the observed meso- and synoptic-scale processes during high-concentration ozone periods. The LADCO WRF 2016 output fields represent a reasonable approximation of the actual meteorology that occurred in 2016. While the WRF performance statistics for the 12-km grid resolution simulation are within the acceptable performance benchmarks, the simulation has a cold and dry bias in the summer across much of the Eastern U.S. For the 4-km WRF simulation all the summer season metrics, except for wind direction error, fall within the simple terrain model performance benchmarks; the wind direction error falls within the complex terrain benchmark (Table 5-1).

**Table 5-1. 2016 summer season (JJA) 4-km WRF model performance for the LADCO states**

| State* | Temp2m (K) | | MixingRatio2m (g/kg) | | WS10m (m/s) | | WD10m (degrees) | |
|---|---|---|---|---|---|---|---|---|
| | MAE | MB | MAE | MB | MAE | MB | MAE | MB |
| IL | 1.0 | 0.1 | 1.2 | -0.5 | 1.0 | 0.1 | 35.3 | 3.6 |
| IN | 1.1 | 0.1 | 1.4 | -0.1 | 0.9 | 0.1 | 35.4 | 3.8 |
| MI | 1.2 | 0.0 | 1.0 | 0.0 | 1.0 | 0.1 | 34.4 | 5.5 |
| MN | 1.2 | 0.0 | 1.1 | -0.1 | 1.1 | 0.2 | 33.4 | 4.0 |
| OH | 1.2 | 0.0 | 1.3 | -0.3 | 0.9 | -0.1 | 37.5 | 8.5 |
| WI | 1.2 | -0.1 | 1.1 | 0.0 | 1.0 | 0.3 | 32.0 | 4.6 |

*Green shading indicates a metric that meets the performance benchmarks for simple conditions, orange for complex conditions, and red for outside of the performance benchmarks

The LADCO 1.33 km WRF simulations had very good model performance with low errors for all variables and biases near zero (Table 5-2). Both errors and biases for temperature and specific humidity at the 12-km grid resolution are reduced by about 20% at the 4-km resolution. Model performance remains about the same for the wind speed and direction when going from 12-km to 4-km resolution. There was not an appreciative improvement in model performance for the analyzed variables between the 4-km and 1.33-km resolution simulations.

**Table 5-2. 2016 seasonal average 1.33-km WRF model performance statistics**

| Season* | Temp2m (K) | | MixingRatio2m (g/kg) | | WS10m (m/s) | | WD10m (degrees) | |
|---|---|---|---|---|---|---|---|---|
| | MAE | MB | MAE | MB | MAE | MB | MAE | MB |
| | **1.33 km d03: Lake Michigan** | | | | | | | |
| Spring (AM) | 1.3 | 0.0 | 0.9 | 0.5 | 1.3 | 0.1 | 34.1 | 1.1 |
| Summer (JJA) | 1.3 | 0.1 | 1.2 | 0.2 | 1.1 | 0.1 | 32.8 | 3.4 |
| Fall (SO) | 1.2 | 0.0 | 0.8 | 0.0 | 1.2 | 0.3 | 31.1 | -0.1 |
| | **1.33 km d04: Detroit and Ohio River Valley** | | | | | | | |
| Spring (AM) | 1.3 | -0.2 | 1.1 | 0.6 | 1.2 | 0.1 | 37.0 | 1.7 |
| Summer (JJA) | 1.3 | 0.7 | 1.3 | 0.3 | 1.1 | 0.0 | 37.1 | 5.1 |
| Fall (SO) | 1.3 | 0.0 | 0.8 | -0.1 | 1.1 | 0.1 | 36.9 | 1.6 |

*Green shading indicates a metric that meets the performance benchmarks for simple conditions, orange

Analysis of WRF performance at shoreline monitors during lake breeze events showed that the model successfully reproduced the surface conditions. LADCO developed a CART statistical model using data from selected surface stations on the shorelines of Lake Michigan and Lake Erie for predicting lake-breeze days. The CART lake breeze model prediction accuracies were

92% for Lake Michigan and 82% for Lake Erie, on average. LADCO used the CART model to determine the typical meteorological conditions and indicators for lake-breeze days along the shores of Lake Michigan and Lake Erie. The model identified wind direction and 2-m temperature as the top two variables for explaining lake breeze vs. non-lake breeze events in the Lake Michigan shore, while 2-m temperature, wind speed, and specific humidity were the variables most associated with the lake breeze along the south shore of Lake Erie. WRF performed well predicting temperature, moisture, and winds at the shoreline monitors of both lakes during lake breeze events (Table 5-3). The WRF model errors and biases are within the WRF performance benchmarks for temperature, specific humidity and wind speed, and less than 30-degree errors for wind direction. The model performance is slightly degraded on the lake-breeze days compared to the non-lake breeze days on shoreline of Lake Michigan, while opposite is true on the south shore of Lake Erie. The errors and biases for lake breeze days were slightly improved at finer grids in Lake Michigan and Lake Erie shore.

**Table 5-3. Average WRF model performance summary for lake breeze and non-lake breeze days along the shoreline of Lake Michigan**

| Variable* | Lake Breeze | | Non-Lake Breeze | |
|---|---|---|---|---|
| | MAE | MB | MAE | MB |
| Temp2m | 1.24 | 0.50 | 1.06 | 0.21 |
| MixingRatio2m | 1.30 | -0.65 | 1.06 | -0.41 |
| Wind speed10m | 1.14 | -0.68 | 1.14 | -0.73 |
| Wind direction10m | 25.93 | 1.73 | 22.29 | -2.05 |

*Green shading indicates a metric that meets the performance benchmarks for simple conditions, orange

Additional details and results for the LADCO 2016 WRF model performance analysis are available in the LADCO Weather Research and Forecast 2016 Meteorological Model Simulation and Evaluation TSD (https://www.ladco.org/technical/modeling/ladco-2016-wrf-modeling).

## 5.2. CAMx 2016 Ozone Modeling Performance Evaluation

The CAMx model performance evaluation (MPE) results presented in this section establish the validity of the photochemical modeling platform that LADCO developed to support $O_3$ planning in the Great Lakes region. The MPE results are presented by increasing spatial resolution, first from a regional perspective, averaged across each state, and then by 2015 $O_3$ NAAQS nonattainment area.

LADCO simulated the April 1 – October 31, 2016 with CAMx using the 2016 CAMx modeling platform described previously. Figure 5-1 summarizes ground level $O_3$ concentrations during the 2016 $O_3$ season across the 2015 $O_3$ NAAQS NAAs in the LADCO region. The first high concentration $O_3$ episode in the season was a regional event in the middle of April. The last $O_3$ episode happened September 21-23 in the southern part of the LADCO domain. The model performance evaluation presented here will focus on April through September as these were the months in 2016 that experienced high $O_3$ concentration periods in this region.

### 5.2.1. Regional Model Performance Evaluation

Figure 5-2 is a set of spatial plots of monthly MDA8 $O_3$ normalized mean bias (NMB) for the LADCO 4-km CAMx simulation. Each colored symbol in the figure is an AQS or CASTNet monitoring location. Cool colors represent monitors at which the observed MDA $O_3$ concentrations were underestimated by the CAMx simulation; warm colors represent where CAMx overestimated the observations. Grey and lighter shades represent low bias, or acceptable model performance, relative to the model performance goals discussed in Section 3.7.2. The CAMx average monthly MDA8 $O_3$ NMB plots shown in Figure 5-2 reveal a seasonal trend in the bias. Early in the $O_3$ season (April – June) CAMx underpredicted $O_3$ throughout the LADCO region. For many of the northern and near-shore monitors in the LADCO region the monthly averaged NMB values miss the model performance criteria for $O_3$ (+/- 15%) in April. In the latter part of the season (July – September), CAMx overpredicted $O_3$ at most of the monitors in the region. The overpredictions in the later months of the season are worse in the southern and eastern areas of the LADCO region. The model misses the NMB $O_3$ performance criteria for sites in St. Louis, Ohio River valley, Indianapolis, and most of Ohio in August and September.

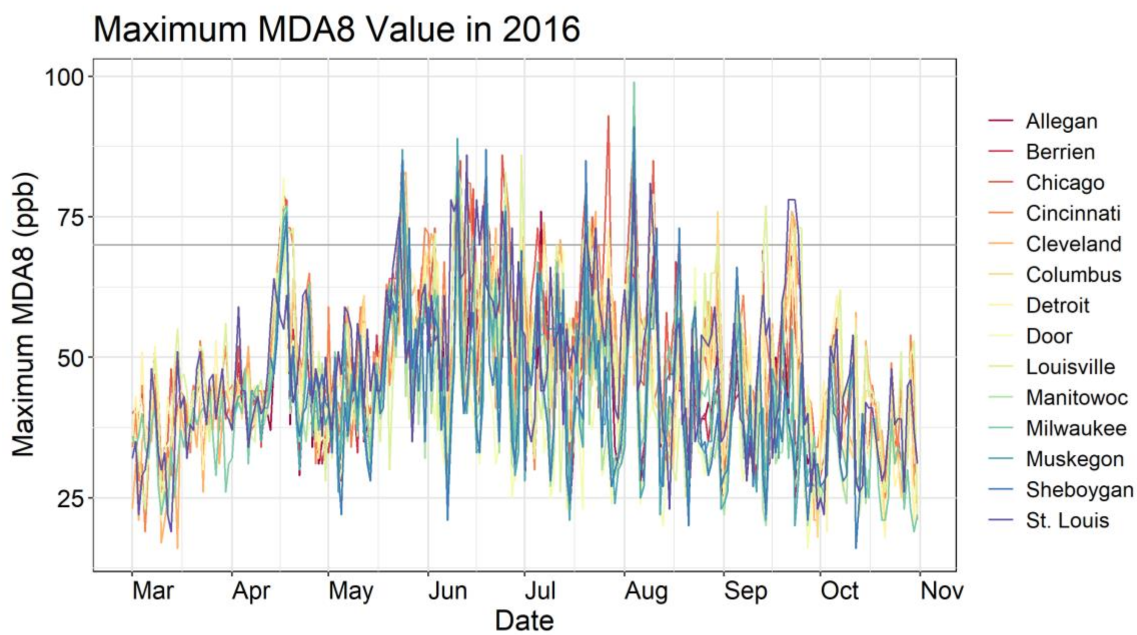


**Figure 5-1. March 1 – October 31, 2016 observed MDA8 $O_3$ concentrations in the LADCO region 2015 $O_3$ NAAQS nonattainment and maintenance areas**

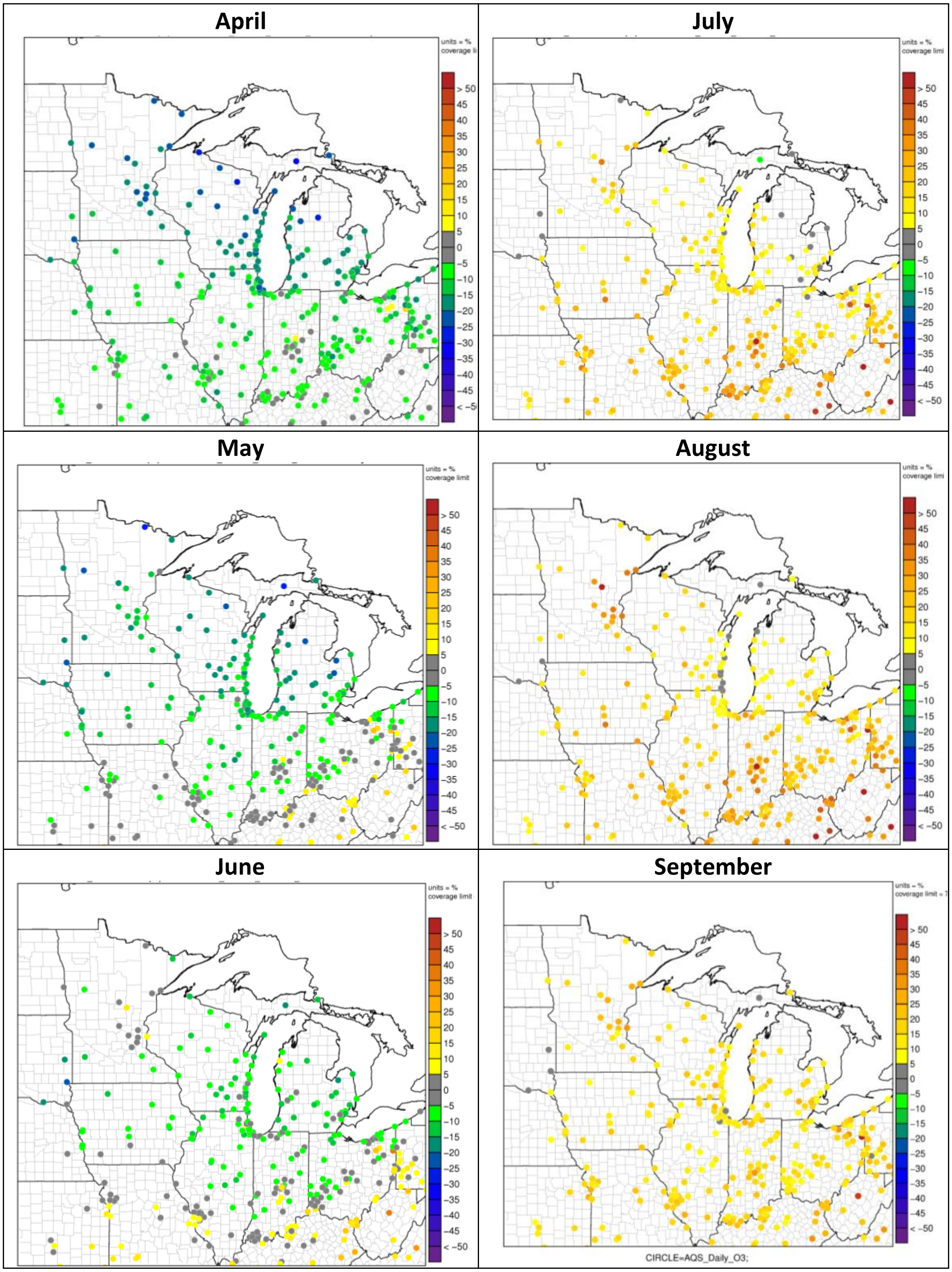


**Figure 5-2. Monthly 2016 MDA8 $O_3$ normalized mean bias spatial stats plots; no concentration cutoff**

### 5.2.2. Performance Evaluation by LADCO State

Table 5-4 through Table 5-8 show MDA8 $O_3$ performance statistics by month and state for the LADCO 2016 4-km CAMx simulation. The NMB, NME, and correlation coefficients in these tables are monthly averages across all Air Quality System (AQS) sites in each state. Each statistic is calculated for all days and for days only with observed MDA8 $O_3$ > 60 ppb. The latter is used to determine the performance of the model on days with high observed $O_3$ concentrations. These statistics quantify the LADCO CAMx 4-km simulation seasonal $O_3$ biases and show that the model performance generally improves (reductions in NMB and NME) at higher observed concentrations. The orange shading in these tables indicate the statistics which fall outside of the benchmark model performance criteria for $O_3$; the green shading indicates model performance that meets or exceeds the Emery, et al. (2017) benchmark goal for $O_3$.

Consistent with the spatial statistics plots in Figure 5-2 these tables highlight that the model underestimates (negative NMBs) $O_3$ in April through June and overestimates $O_3$ in July through September. On high $O_3$ concentration days (> 60 ppb) the early-season underestimates get worse while the late-season overestimates are improved. The model errors (NME) by state and month are predominantly within the performance benchmarks, and in many cases, they meet or exceed the performance goal of NME <15%. While the correlation (r) of the model with the observations on all days is within the performance benchmark criteria (> 0.5), on high $O_3$ days the correlations are outside of the benchmarks.

Despite the model performance deficits shown in these statistics, the $O_3$ model performance criteria for bias (NMB ≤±15%) is missed only for high concentrations in April and May at the AQS monitors. The performance goal for error (NME < 25%) is met across all but one of the location-months (IN in August) presented here.

**Table 5-4. CAMx 4-km monthly MDA8 $O_3$ performance at AQS sites in IL**

| Region | NMB (%) | | NME (%) | | r | |
|---|---|---|---|---|---|---|
| | All | > 60ppb | All | > 60ppb | All | > 60ppb |
| April | -11.50 | -13.50 | 15.40 | 13.70 | 0.83 | 0.74 |
| May | -9.66 | -18.60 | 15.10 | 18.60 | 0.74 | 0.66 |
| June | -5.53 | -10.50 | 11.70 | 11.80 | 0.75 | 0.46 |
| July | 16.50 | 9.31 | 18.90 | 12.10 | 0.74 | 0.15 |
| August | 16.40 | -8.97 | 19.30 | 11.40 | 0.79 | 0.18 |
| September | 13.50 | 5.44 | 16.00 | 10.30 | 0.82 | 0.03 |

**Table 5-5. CAMx 4-km monthly MDA8 $O_3$ performance at AQS sites in IN**

| Region | NMB (%) | | NME (%) | | r | |
|---|---|---|---|---|---|---|
| | All | > 60ppb | All | > 60ppb | All | > 60ppb |
| April | -6.94 | -8.98 | 13.0 | 9.52 | 0.84 | 0.60 |
| May | -5.30 | -17.70 | 13.50 | 17.70 | 0.75 | 0.54 |
| June | -1.34 | -11.20 | 11.80 | 11.80 | 0.69 | 0.59 |
| July | 23.50 | 12.10 | 24.50 | 19.40 | 0.66 | -0.66 |
| August | 25.30 | -10.50 | 26.30 | 10.70 | 0.81 | -0.03 |
| September | 18.00 | 4.66 | 18.80 | 5.73 | 0.88 | 1.00 |

**Table 5-6. CAMx 4-km monthly MDA8 $O_3$ performance at AQS sites in MI**

| Region | NMB (%) | | NME (%) | | r | |
|---|---|---|---|---|---|---|
| | All | > 60ppb | All | > 60ppb | All | > 60ppb |
| April | -17.70 | -16.60 | 18.80 | 16.60 | 0.87 | 0.68 |
| May | -5.30 | -17.70 | 17.40 | 19.30 | 0.80 | 0.74 |
| June | -1.34 | -11.20 | 14.30 | 15.80 | 0.83 | 0.46 |
| July | 23.50 | 12.10 | 14.30 | 12.50 | 0.78 | -0.11 |
| August | 25.30 | -10.50 | 16.20 | 10.20 | 0.83 | 0.73 |
| September | 18.00 | 4.66 | 17.60 | | 0.81 | |

**Table 5-7. CAMx 4-km monthly MDA8 $O_3$ performance at AQS sites in OH**

| Region | NMB (%) | | NME (%) | | r | |
|---|---|---|---|---|---|---|
| | All | > 60ppb | All | > 60ppb | All | > 60ppb |
| April | -8.56 | -9.98 | 14.30 | 10.60 | 0.81 | 0.66 |
| May | -2.21 | -16.40 | 13.60 | 16.40 | 0.68 | 0.38 |
| June | -1.61 | -11.90 | 12.10 | 13.10 | 0.67 | 0.43 |
| July | 16.10 | 3.12 | 18.00 | 8.19 | 0.65 | 0.02 |
| August | 21.80 | 5.59 | 22.70 | 8.28 | 0.79 | -0.28 |
| September | 16.40 | -3.39 | 17.70 | 6.05 | 0.85 | 0.38 |

**Table 5-8. CAMx 4-km monthly MDA8 $O_3$ performance at AQS sites in WI**

| Region | NMB (%) | | NME (%) | | r | |
|---|---|---|---|---|---|---|
| | All | > 60ppb | All | > 60ppb | All | > 60ppb |
| April | -19.40 | -16.70 | 20.0 | 16.70 | 0.89 | 0.73 |
| May | -15.10 | -15.90 | 18.30 | 15.90 | 0.80 | 0.49 |
| June | -8.85 | -9.56 | 12.30 | 11.40 | 0.87 | 0.58 |
| July | 10.20 | 1.79 | 14.90 | 8.70 | 0.81 | 0.00 |
| August | 10.80 | -12.20 | 15.00 | 12.70 | 0.86 | 0.73 |
| September | 14.60 | | 16.40 | | 0.78 | |

Figure 5-3 compares monthly, state averaged model performance (NMB) for MDA8 $O_3$ days > 60 ppb across four CAMx simulations. Three of the CAMx simulations are the runs used for this TSD at 12-km (Sim 1), 4-km (Sim 2), and 1.33-km (Sim 3) grid resolutions, and the fourth CAMx simulation is a 12-km resolution simulation run by LADCO that used U.S. EPA meteorology (Sim 4; US EPA, 2020). These plots show the same early season (April-June) underestimates and late season (July-September) overestimates as the bubble plots in Figure 5-2, although they include the 60 ppb concentration cutoff. The plots also show that from a state-wide average, there is not a significant performance difference between the model grid resolutions (Sim 1, Sim 2, and Sim 3). The CAMx two-way nested configuration used for these simulations explains the similarity in performance across the three resolutions[10]. The U.S. EPA meteorology used for Sim 4 produced lower MDA8 $O_3$ concentrations, which lead to worse model underpredictions in April through June, but improvements to the model overpredictions in July through September. The key takeaway from Figure 5-3 is that for most months and states, on average, the LADCO 2016 CAMx modeling predicts MDA8 $O_3$ concentrations > 60 ppb within the performance NMB benchmark (≤± 15%).

[10] With CAMx two-way nesting the fine grid, nested domains provide much of the solution to the parent grid

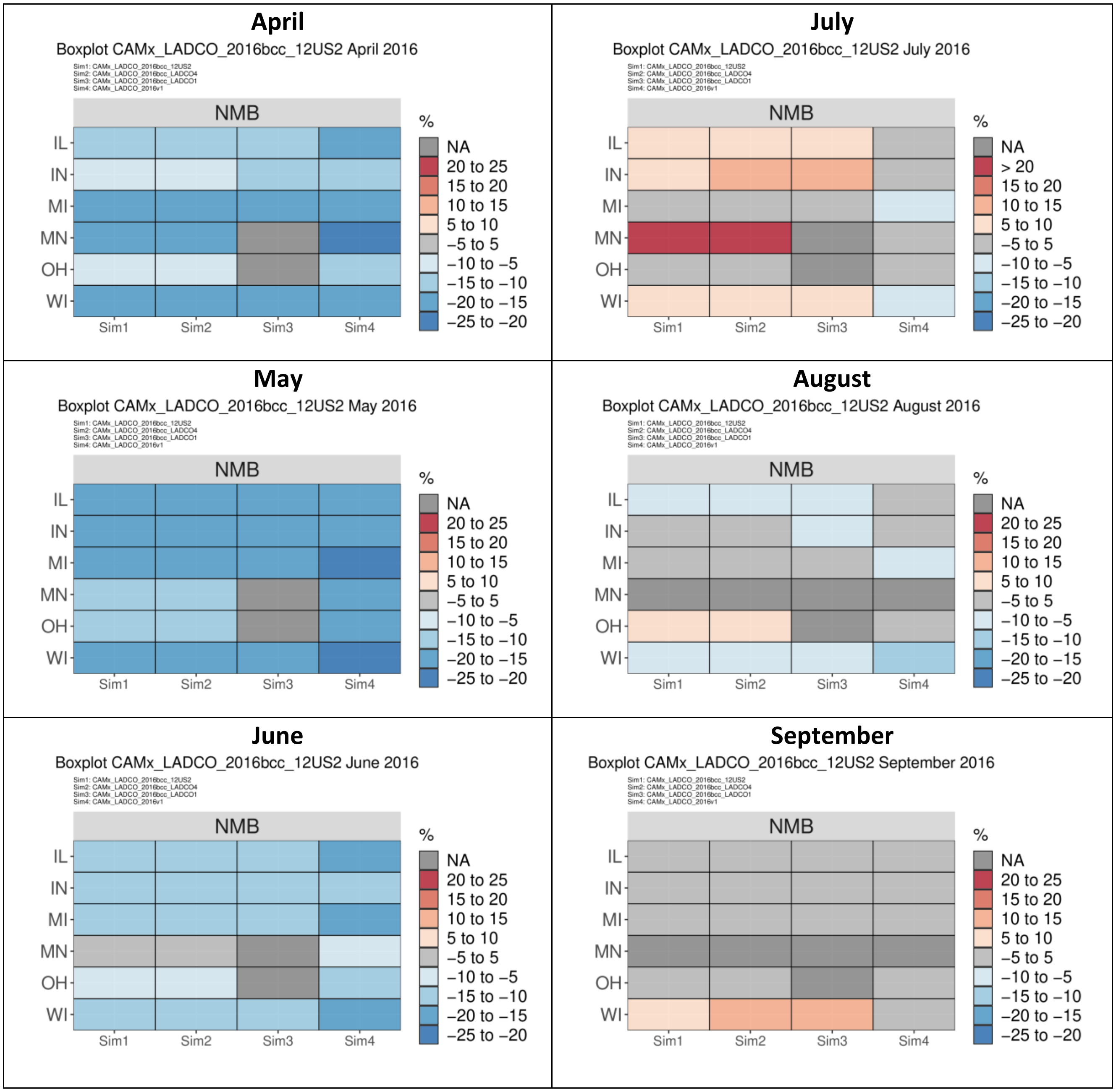


**Figure 5-3. Monthly 2016 MDA8 $O_3$ normalized mean bias state summary plots on days with observed values > 60 ppb**

Figure 5-4 through Figure 5-8 are monthly box and whisker plots of CAMx and observed MDA8 $O_3$ concentrations for AQS sites in IL, IN, MI, OH, WI, respectively. The box and whisker plots show the observed and model median concentrations as symbols connected by lines (blue for CAMx and black for observations), the 25$^{th}$ and 75$^{th}$ percentile concentrations as the bottom and top of each box, and the 5th and 95th percentile concentrations as the bottom and top of each whisker. Each figure compares CAMx and observations on all days, and only on days with MDA8 $O_3$ > 60 ppb. These plots further highlight the seasonal shift in biases as seen by the median values for CAMx relative to the observations across all the states. Where the observations for all days have a seasonal profile with median values that peak in all states in June, the seasonality of the median observed MDA8 $O_3$ on high-concentration days is generally flatter across the months. The CAMx predictions have a seasonal profile with peak median values in July in most states for both all days and high $O_3$ days.

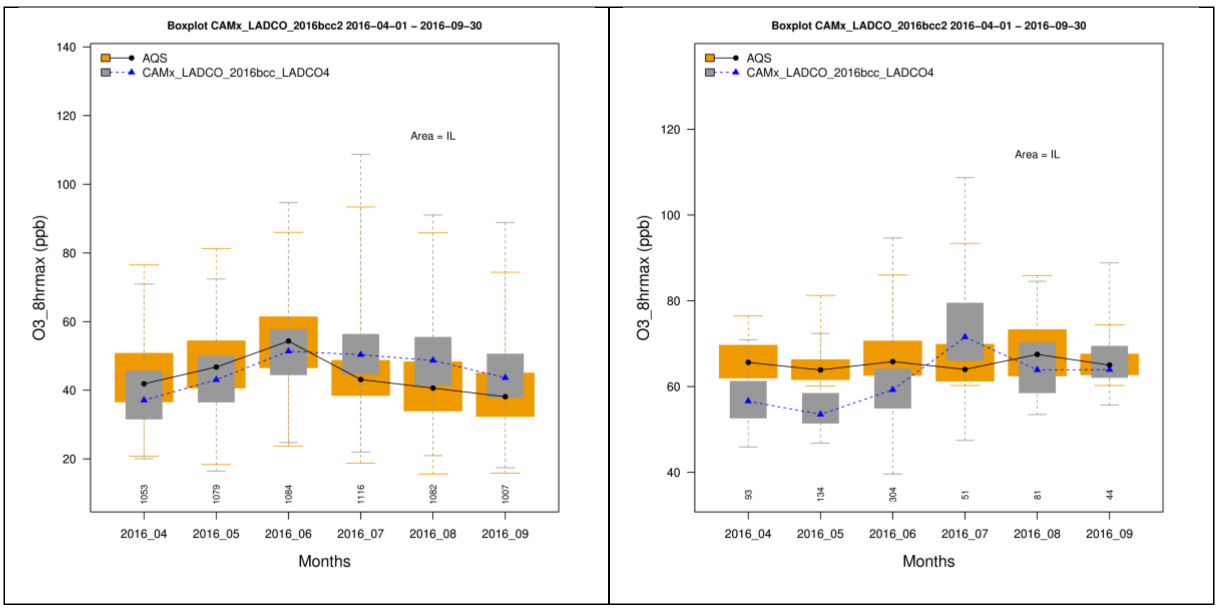


**Figure 5-4. 2016 monthly MDA8 $O_3$ box and whisker plots comparing CAMx with AQS monitors for sites in IL; all days (left) and days with obs > 60 ppb (right)**

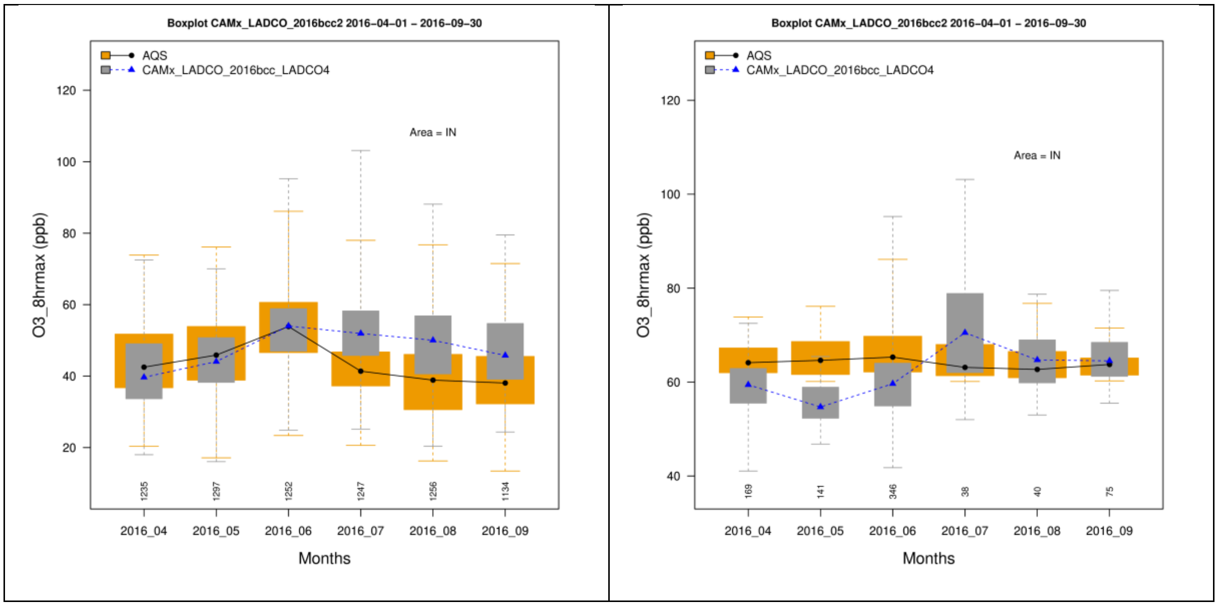


**Figure 5-5. 2016 monthly MDA8 $O_3$ box and whisker plots comparing CAMx with AQS monitors for sites in IN; all days (left) and days with obs > 60 ppb (right)**

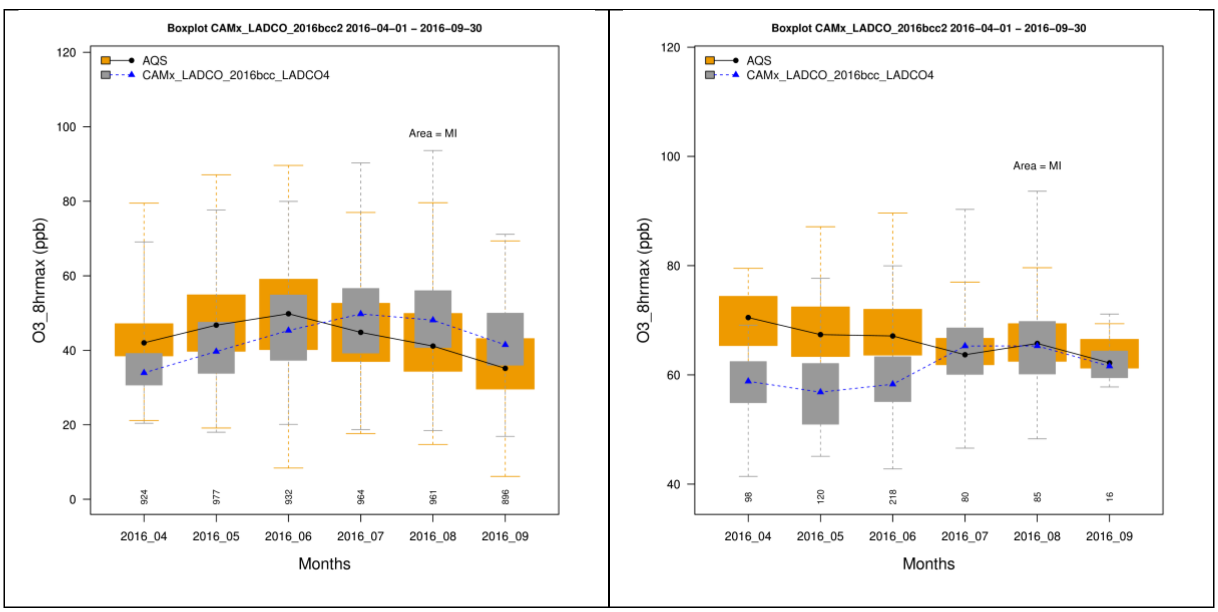


**Figure 5-6. 2016 monthly MDA8 $O_3$ box and whisker plots comparing CAMx with AQS monitors for sites in MI; all days (left) and days with obs > 60 ppb (right)**

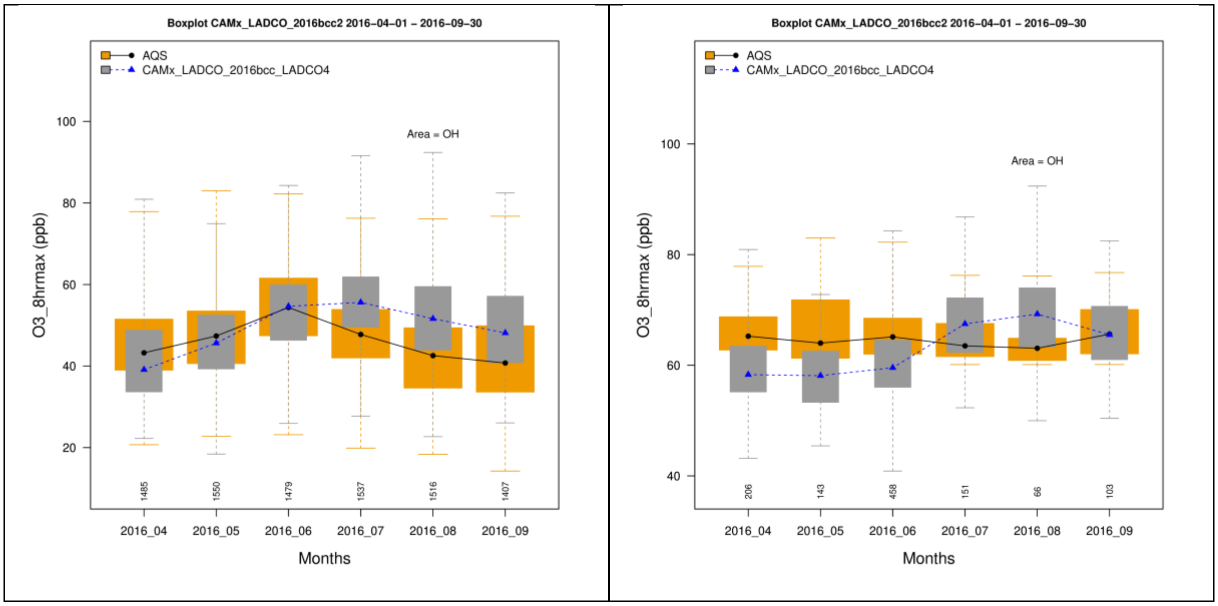


**Figure 5-7. 2016 monthly MDA8 $O_3$ box and whisker plots comparing CAMx with AQS monitors for sites in OH; all days (left) and days with obs > 60 ppb (right)**

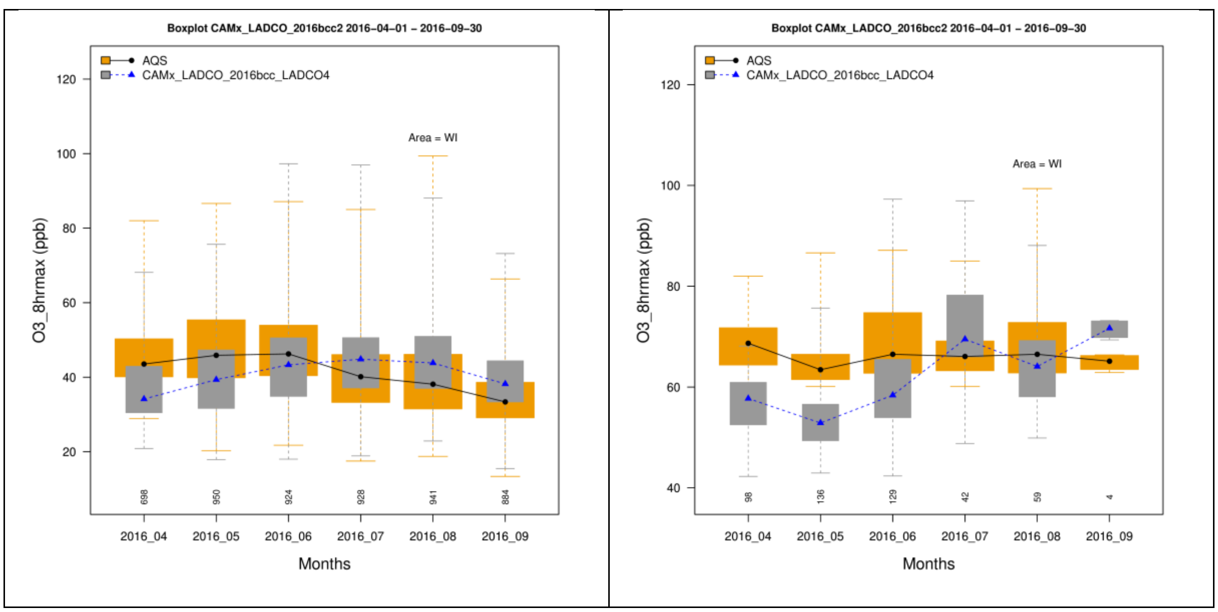


**Figure 5-8. 2016 monthly MDA8 $O_3$ box and whisker plots comparing CAMx with AQS monitors for sites in WI; all days (left) and days with obs > 60 ppb (right)**

### 5.2.3. Performance Evaluation by Ozone Nonattainment Area

This section presents the 2016 LADCO 4-km CAMx model performance evaluation results by month averaged across all the monitors in each of the different 2015 $O_3$ NAAQS NAAs. The statistics in the plots and tables described in this section indicate the skill of the model at simulating MDA8 $O_3$ on all days and on high concentrations days (observed MDA8 concentrations > 60 ppb) at the small set of monitors contained within each NAA boundary. In some cases, these performance results are based on a single monitor, particularly at the more rural, downwind NAAs.

Figure 5-9 and Figure 5-10 show the average percent NMB and NME, respectively, for high concentration MDA8 $O_3$ days at each NAA by month. The green dashed lines in these figures show the levels of the Emery et al (2017) MPE goal, and the orange dashed lines show the MPE benchmark. While the NMB results in Figure 5-9 reflect the more general trend already discussed of CAMx underestimating $O_3$ (NMB < 0) in April – June and overestimating $O_3$ (NMB > 0) in July – September, it shows that the model meets the less stringent performance criteria for most NAAs in all months. The exception is for the downwind Lake Michigan coastline NAAs in April and May. The LADCO 2016 CAMx model underestimated MDA8 $O_3$ on high concentration days for the Western MI NAAs and the Sheboygan County, WI NAA by more than 15% in April and May. The reasons for the model underpredictions >-15% at these locations early in the ozone season are not clear. The model shows particularly good performance for the Cleveland NAA, with biases within +/- 10% for all months other than May.

The NME plot in Figure 5-10 shows that the model performance improves as the $O_3$ season progresses with the lowest errors at all monitors in August and September. The model meets the MDA8 $O_3$ NME performance criteria (25%) for all NAAs and all months, and meets the more stringent performance goal (15%) for most monitors and months.

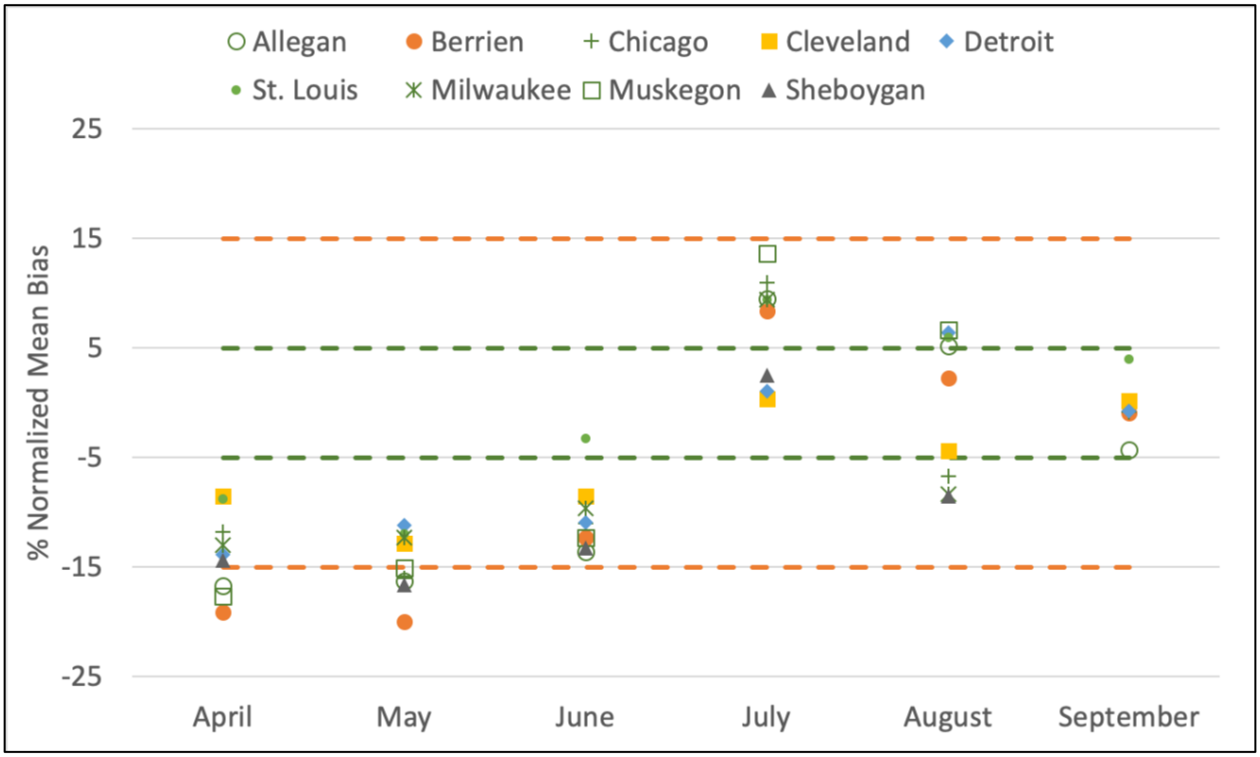


**Figure 5-9. MDA8 $O_3$ average normalized mean bias by month and nonattainment area for days with MDA8 observations > 60 ppb; dashed lines indicate model performance benchmarks**

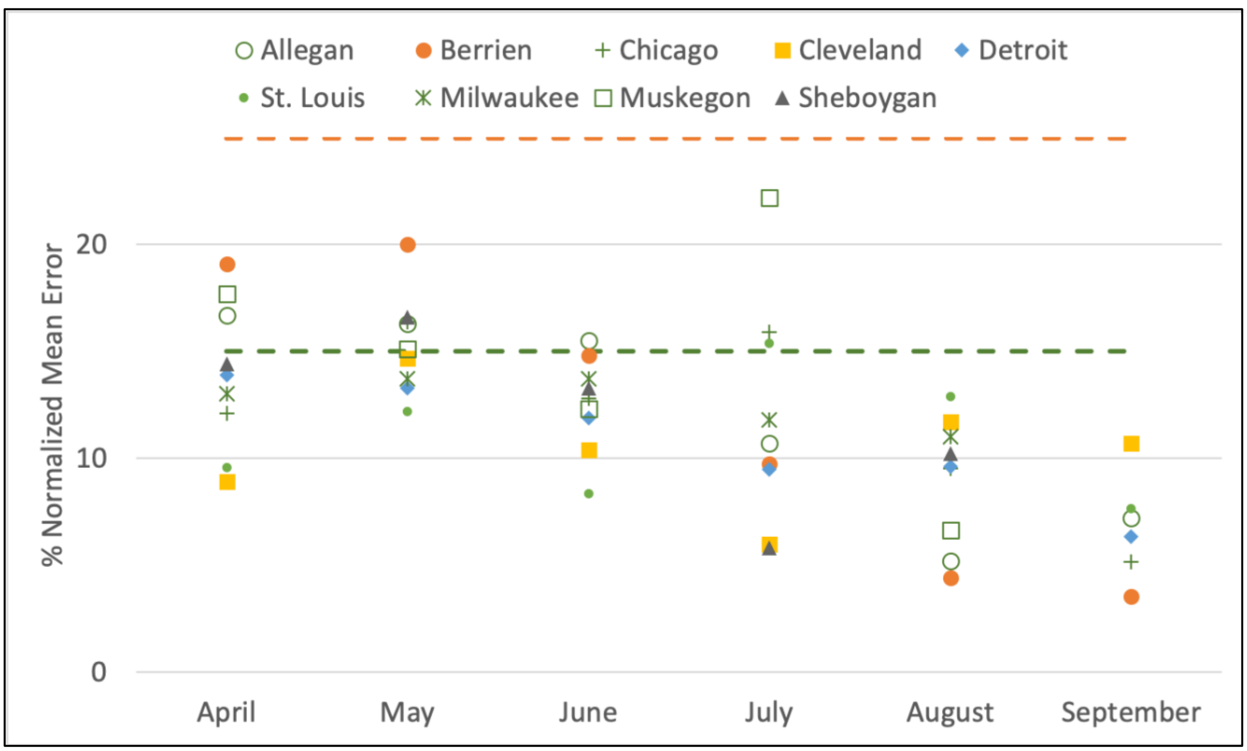


**Figure 5-10. MDA8 $O_3$ average normalized mean error by month and nonattainment area for days with MDA8 observations > 60 ppb; dashed lines indicate model performance benchmarks**

The Supplement to this TSD includes additional MDA8 $O_3$ model performance results for the 2015 $O_3$ NAAQS NAAs in the LADCO region. Box and whisker plots by NAA generally show similar patterns as the statewide figures, with CAMx underestimating $O_3$ in April – June and overestimating in July – September. Tables of monthly NMB, NME, and correlation coefficients are shaded (green = better than the performance goal; orange = worse than the performance criteria) to indicate how well CAMx simulates MDA8 $O_3$ on all days and on high concentration days. Along with a tabulated form of the data shown in Figure 5-9 and Figure 5-10 for the high concentration days, these tables include the performance statistics for all days.

Table S 1 in the Supplementary Materials lists LADCO 2016 CAMx 4-km simulation performance statistics for all monitors in each of the 2015 $O_3$ NAAQS NAAs. These statistics show the model performance on high observed concentration days (> 60 ppb) for the CAMx 4-km grid cell that contains each monitor. Although CAMx misses the Emery et al. (2017) performance criteria for correlation (>0.5) at some monitors, particularly in the Cleveland and Detroit NAAs, it meets or exceeds the performance criteria for NMB and NME at most of the monitor locations.

The value of including the NAA-specific performance data in this TSD is to demonstrate the validity of the LADCO 2016-based CAMx model to $O_3$ planning applications and attainment testing for the NAAs in the region.

## 5.3. CAMx 2016 Ozone Precursor Modeling Performance Evaluation

LADCO calculated performance statistics for $O_3$ precursor pollutants with 2016 observations from the AQS network. The LADCO CAMx 2016 4-km simulation is evaluated against hourly $NO_2$ and CO AQS observations, and 1-in-6 day 24-hour average formaldehyde, acetaldehyde, ethane, isoprene, and toluene observations from Photochemical Assessment Monitoring Station (PAMS) locations in the region. Figure 3-8 shows the locations of the AQS $NO_2$ (and CO) monitors and Figure 5-11 shows the locations of the PAMS monitors that collected the 2016 data used in the statistics presented here. The CAMx 4-km model results are paired in space and time with the AQS observations for the model grid cell in which each monitor is located.

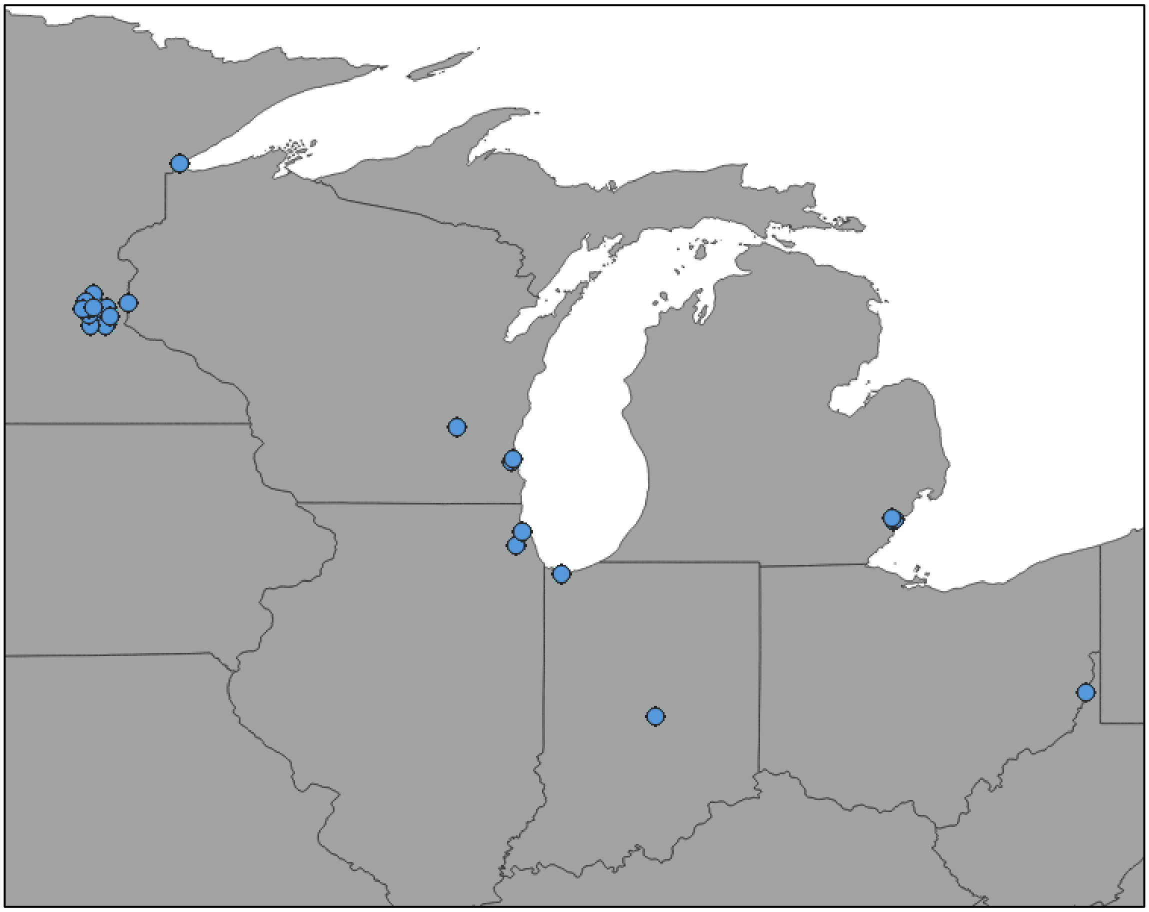

**Figure 5-11. Locations of PAMs monitors with VOC observations for 2016 in the LADCO region**

Table 5-9 summarizes the summer season (June – August) 4-km domain average CAMx performance statistics for the LADCO 2016 CAMx 4-km simulation. The model underestimates (NMB < 0) for all reported $O_3$ precursor species except for Acetaldehyde. Table 5-10 shows the state-averaged summer season NMB and NME from the LADCO 2016 CAMx 4-km simulation for $NO_2$, CO, formaldehyde, and isoprene. The state-averaged results mirror the regional-average results in which the CAMx simulation underestimated all reported species.

Figure 5-12 expands on these tables and shows state-averaged monthly NMB for April – September for select $O_3$ precursor species for the LADCO CAMx 2016 4-km simulation. The LADCO CAMx simulation underestimated (NMB < 0) most of the precursor species in most months during that period. The CAMx simulation significantly overestimated (NMB > 0) isoprene in April and May, likely related to mischaracterization of the biogenic emissions during that period.

There are an insufficient number of $O_3$ precursor species monitoring stations to estimate performance statistics by nonattainment area.

**Table 5-9. LADCO CAMx 2016 4-km summer (JJA) average ozone precursor model performance statistics**

| Pollutant | CAMx Avg (ppb) | Obs Avg (ppb) | NMB (%) | NME (%) | r | # obs |
|---|---|---|---|---|---|---|
| $NO_2$ | 7.03 | 8.79 | -19.76 | 53.84 | 0.53 | 69470 |
| CO | 174.37 | 276.00 | -35.26 | 48.13 | 0.25 | 75234 |
| Formaldehyde | 2.19 | 3.67 | -36.72 | 43.63 | 0.32 | 127 |
| Acetaldehyde | 0.89 | 0.91 | 3.30 | 36.20 | 0.23 | 127 |
| Ethane | 1.41 | 5.38 | -60.77 | 61.94 | 0.16 | 201 |
| Isoprene | 0.24 | 0.30 | -25.66 | 51.79 | 0.66 | 199 |
| Toluene | 0.46 | 0.58 | -9.95 | 52.37 | 0.33 | 531 |

**Table 5-10. LADCO CAMx 2016 4-km summer (JJA) average ozone precursor model performance statistics by state**

| State | $NO_2$ | | CO | | Formaldehyde | | Isoprene | |
|---|---|---|---|---|---|---|---|---|
| | NMB | NME | NMB | NME | NMB | NME | NMB | NME |
| IL | -3.18 | 45.00 | -25.83 | 38.23 | -18.57 | 26.57 | -3.40 | 31.03 |
| IN | -13.05 | 53.43 | -45.50 | 61.83 | -47.17 | 56.83 | -17.70 | 61.80 |
| MI | -33.50 | 48.63 | -42.27 | 47.87 | -51.03 | 51.60 | | |
| MN | 2.05 | 60.40 | -24.90 | 47.57 | | | | |
| OH | -35.00 | 53.80 | -35.13 | 49.17 | | | | |
| WI | -35.90 | 61.77 | -37.93 | 44.13 | -30.10 | 39.53 | -55.87 | 62.53 |

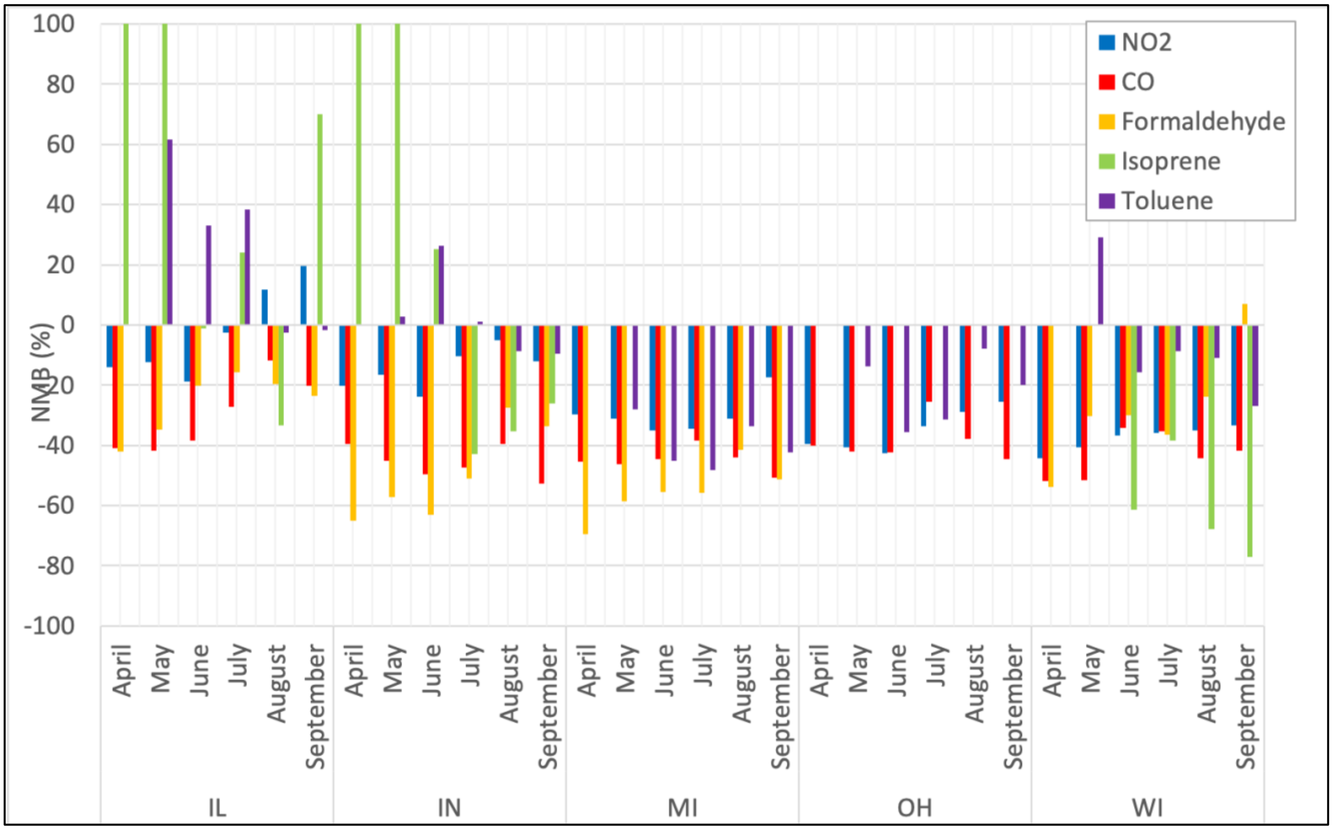


**Figure 5-12. Monthly state average LADCO CAMx 2016 4km ozone precursor NMB**

## 5.4. CAMx Model Performance Discussion

U.S. EPA (2019) reported model performance for the 2016 CAMx modeling platform upon which the LADCO 2016 modeling platform is based. The U.S. EPA evaluated the model by comparing CAMx-predicted MDA8 $O_3$ to observations at the U.S. EPA AQS and CASTNet networks. They performed statistical evaluations using modeled and observed data that were paired in space and time. U.S. EPA developed statistics across spatial and temporal scales and in aggregate across multiple sites by climate region.

The results provided by U.S. EPA (2019; 2022) from their operational model performance evaluations of their 2016 simulations are like the results of the LADCO 2016 CAMx modeling MPE. U.S. EPA and LADCO both found that the 2016 CAMx modeling platform on average underestimates MDA8 $O_3$ in April – June, and overpredicts in July – October. The biases in the April – June period are more severe than in the later months. In July – September the mean bias is within +/- 5 ppb at many sites in the LADCO region.

Investigation of the diurnal variability at key monitors demonstrated that CAMx generally captured day to day fluctuations in observed MDA8 $O_3$ but missed the peaks on many of the highest observed days, particularly during April – June.

The $O_3$ performance evaluation by nonattainment area reveals that the LADCO CAMx 4-km simulation met the model performance benchmarks averaged across the high concentration days (> 60 ppb).

The LADCO CAMx 4-km simulation underestimated most of the available $O_3$ precursor species, including $NO_2$, CO, isoprene, and formaldehyde in most months and locations. The exception was for isoprene, where the simulation significantly overestimated the observations in April and May.

The statistics and model performance metrics presented in this section demonstrate that the LADCO CAMx 2016 $O_3$ model performance is within conventional and accepted model performance benchmarks, and is a valid model for use in regulatory applications.

# 6. LADCO 2023 Air Quality Projections

## 6.1. Attainment Test Methods

LADCO followed the U.S. EPA Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze (US EPA, 2018) to calculate future-year design values in 2023 ($DVF_{2023}$) for monitors in IL, IN, MI, OH, and WI[11]. As we used a base year of 2016, we estimated the base year design values using surface observations for the years 2014-2018 ($DVB_{2014-2018}$). LADCO estimated the $DVF_{2023}$ with version 1.6 of the Software for Modeled Attainment Test Community Edition (SMAT-CE)[12]. SMAT-CE was configured to use the daily max average 8-hr (MDA8) $O_3$ concentration above 60 ppb in a 3x3 matrix around each monitor across for the 10 highest modeled days, per the U.S. EPA Guidance. If there are less than 10 days with MDA8 O3 greater than 60 ppb, SMAT-CE uses all days, if there are at least 5 days that meet the minimum threshold criteria[13].

Consistent with US EPA modeling guidance (US EPA, 2018), SMAT-CE uses a four-step process to estimate $DVF_{2023}$:

1. Calculate $DVB_{2014-2018}$ for each monitor
    - The $O_3$ design value is a three-year average of the 4th highest daily maximum 8 hour average $O_3$ ($MDA8_4$):

$$DV_{2016} = (MDA8_{4,2014} + MDA8_{4,2015} + MDA8_{4,2016})/3$$

    - Weighted 5-year average of design values centered on the base model year (2016):

$$DVB_{2014-2018} = (DV_{2016} + DV_{2017} + DV_{2018})/3$$

2. Find highest base year modeled days surrounding each monitor
    - Find ten days with the highest base year modeled MDA8 from within a 3x3 matrix of grid cells surrounding each monitor
    - At least 5 days with modeled MDA8 >= 60 ppb are needed to retain the monitor for the future year DV calculation

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[11] MN is not included because there are no 2015 O3 NAAQS nonattainment or maintenance areas in the state

[12] https://www.epa.gov/scram/photochemical-modeling-tools

[13] 26 sites dropped out of the SMAT-CE design value calculation because their data did not meet the threshold criteria; none of these sites are located in 2015 O3 NAQQS nonattainment or maintenance areas

3. Calculate relative response factor (RRF) for each monitor
    - Calculate multi-day average MDA8 for the base and future years from the maximum paired in space values in the 3x3 matrix
    - Calculate the RRF as the ratio of the multi-day average future to multi-day average base year MDA8:

$$RRF = MDA8_{2023,avg}/MDA8_{2016,avg}$$

4. Calculate $DVF_{2023}$ for each monitor

$$DVF_{2023} = RRF * DVB_{2014\text{-}2018}$$

LADCO used the $DVF_{2023}$ to identify nonattainment sites in 2023 using the 5-year weighted average baseline design values (2014-2018) per U.S. EPA (2018). Under this methodology, sites with an average $DVF_{2023}$ that exceeds the 2015 $O_3$ NAAQS (71.0 ppb or greater) would be considered nonattainment in 2023.

## 6.2. 2023 CAMx Modeling Results

LADCO modified the emissions in the U.S. EPA 2016fh CAMx modeling platform to create a LADCO 2016 modeling platform with a projection year to 2023 (see Section 3.4). The LADCO 2023 CAMx simulation forecasted air quality on three nested modeling domains, including EGU emissions forecasts from the ERTAC v16.1 model. Figure 6-1 and Figure 6-2 show April through September 2016 maximum MDA8 $O_3$ for the LADCO 2016 and 2023 CAMx simulations, respectively, on the CONUS12 modeling domain. Figure 6-3 shows the difference (2023-2016) in $O_3$ season maximum MDA8 $O_3$ between the two simulations. Cool colors indicate that the 2023 simulation forecasted lower $O_3$ than the 2016 simulation; warm colors indicate higher $O_3$ in the 2023 forecast. As Figure 6-3 is a difference of the $O_3$ season maximum MDA $O_3$ concentrations, it represents the extent to which the highest concentrations are forecast to change in 2023.

The LADCO 2023 CAMx 12-km simulation predicted lower seasonal maximum $O_3$ concentrations across much of the modeling domain, with the largest reductions occurring in the eastern U.S., and in some urban areas in the west, namely Phoenix and Denver. Note that the concentration changes shown in these figures mask finer temporal resolution features (i.e., hourly and daily) that also exist between the base and future year simulations.

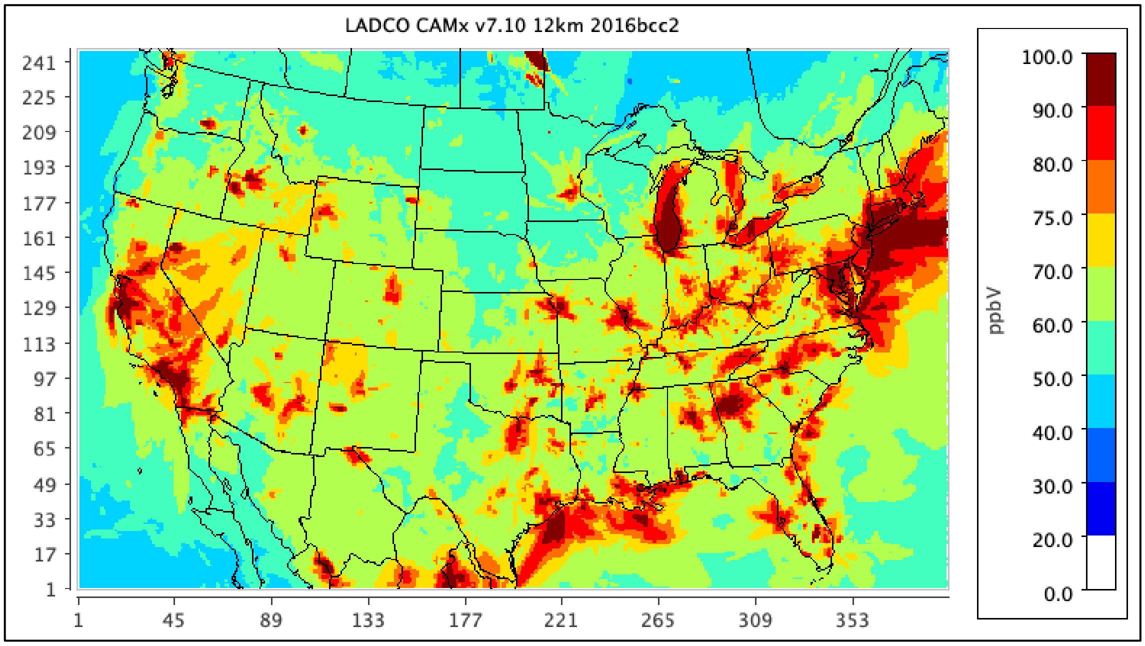


**Figure 6-1. LADCO CAMx 12-km 2016 $O_3$ season maximum MDA8 $O_3$ concentrations**

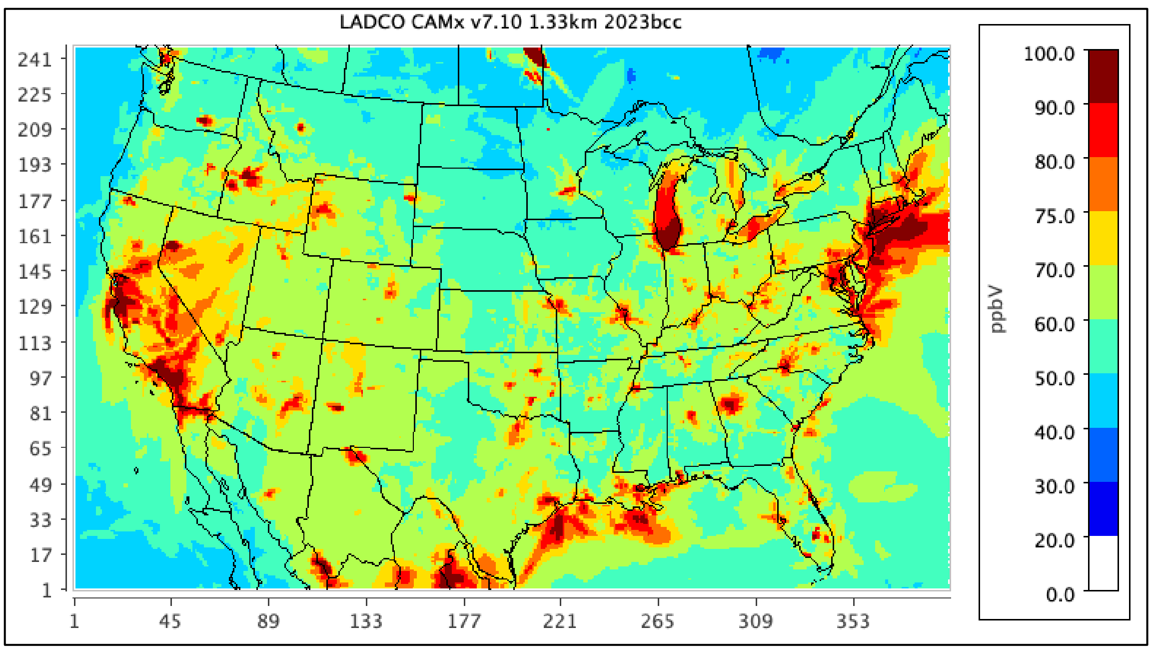


**Figure 6-2. LADCO CAMx 12-km 2023 $O_3$ season maximum MDA8 $O_3$ concentrations**

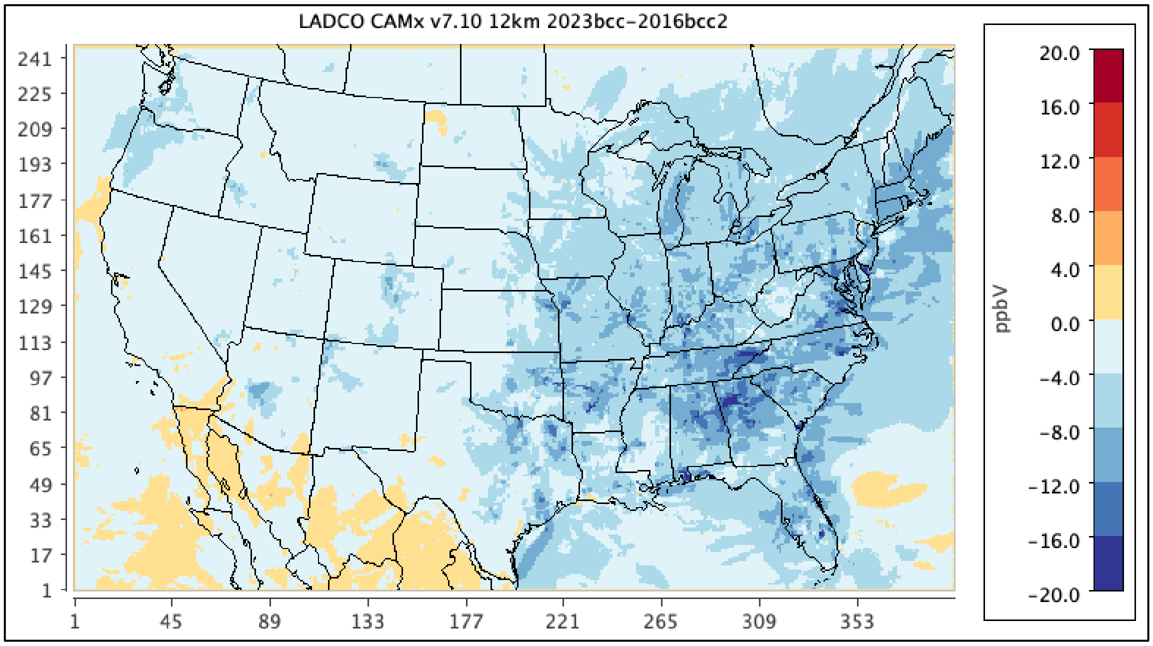


**Figure 6-3. LADCO CAMx 12-km difference (2023-2016) in $O_3$ season maximum MDA8 $O_3$ concentrations**

Figure 6-4 and Figure 6-5 show April through September 2016 maximum MDA8 $O_3$ for the LADCO 2016 and 2023 CAMx simulations, respectively, on the LADCO 4-km modeling domain. Figure 6-6 shows the difference (2023-2016) in $O_3$ season maximum MDA8 $O_3$ between the two simulations. The LADCO simulation forecasts a 4-8 ppb decrease in seasonal maximum MDA8 $O_3$ across much of the domain in 2023. The largest concentration decreases (12-16 ppb) in 2023 are forecast downwind of the urban areas, particularly in the southern half of the domain. Concentration decreases in the range of 8-12 ppb are forecast over Lakes Michigan and Erie.

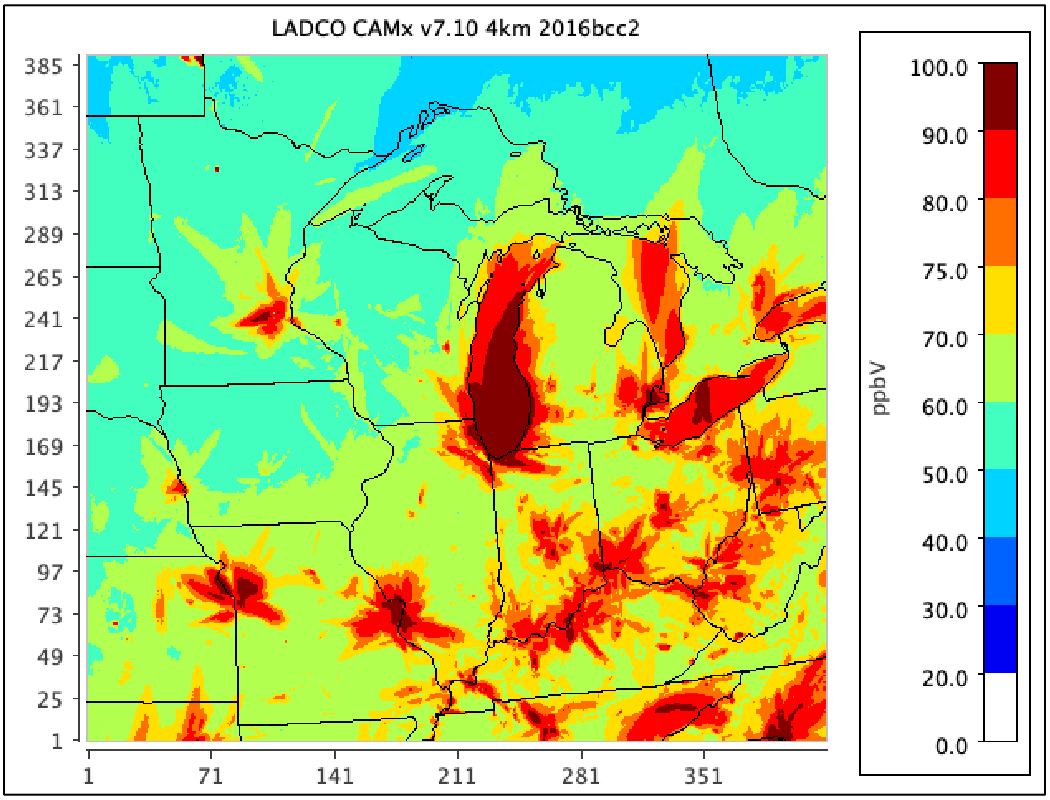


**Figure 6-4. LADCO CAMx 4-km 2016 $O_3$ season maximum MDA8 $O_3$ concentrations**

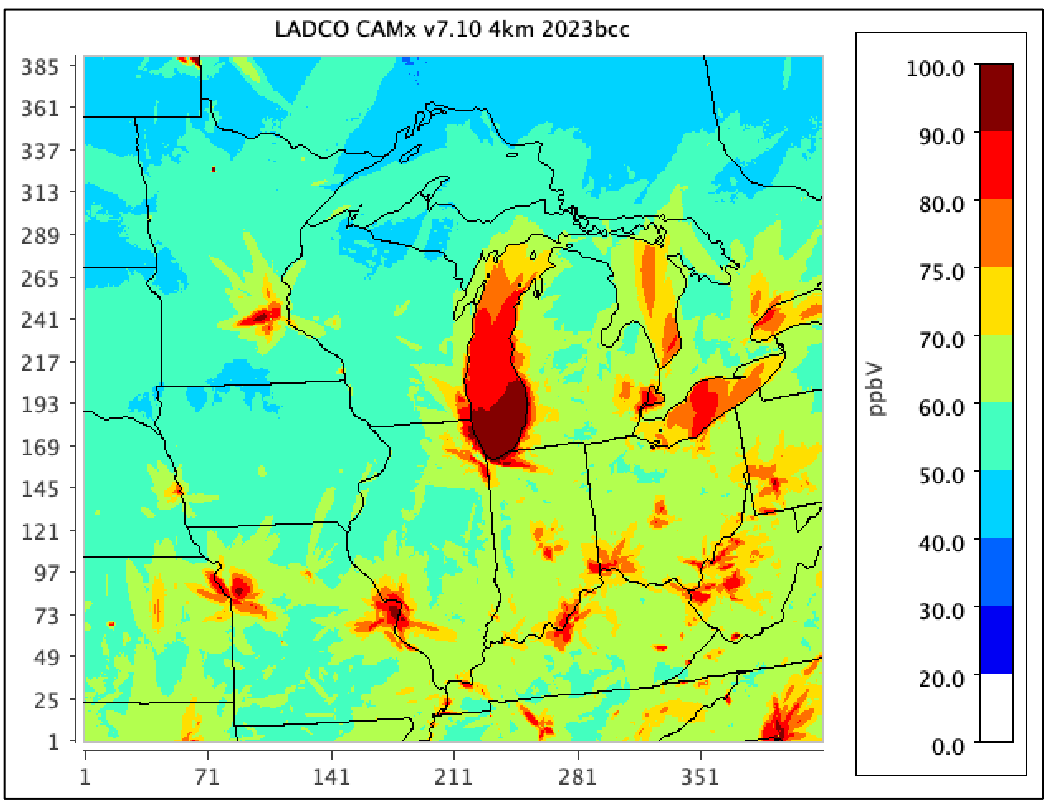


**Figure 6-5. LADCO CAMx 4-km 2023 $O_3$ season maximum MDA8 $O_3$ concentrations**

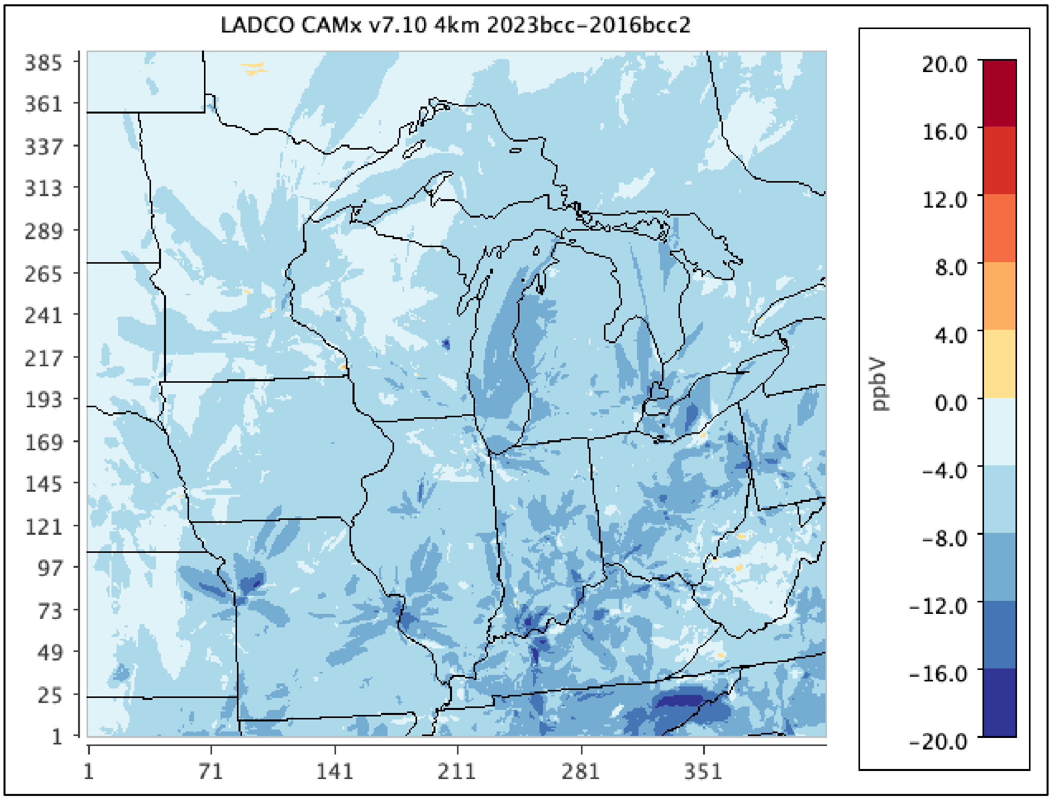


**Figure 6-6. LADCO CAMx 4-km difference (2023-2016) in $O_3$ season maximum MDA8 $O_3$ concentrations**

Figure 6-7 and Figure 6-8 show April through September 2016 maximum MDA8 $O_3$ for the LADCO 2016 and 2023 CAMx simulations, respectively, on the LADCO 1.33-km modeling domain. Figure 6-9 shows the difference (2023-2016) in $O_3$ season maximum MDA8 $O_3$ between the two simulations. The LADCO simulation forecasts a 4-8 ppb decrease in seasonal maximum MDA8 $O_3$ across much of the domain in 2023. The largest concentration decrease (12-16 ppb) in 2023 is forecast over Lake Winnebago in Wisconsin. Concentration decreases in the range of 8-12 ppb are forecast over Lake Michigan and extend inland into northern Indiana and western Michigan.

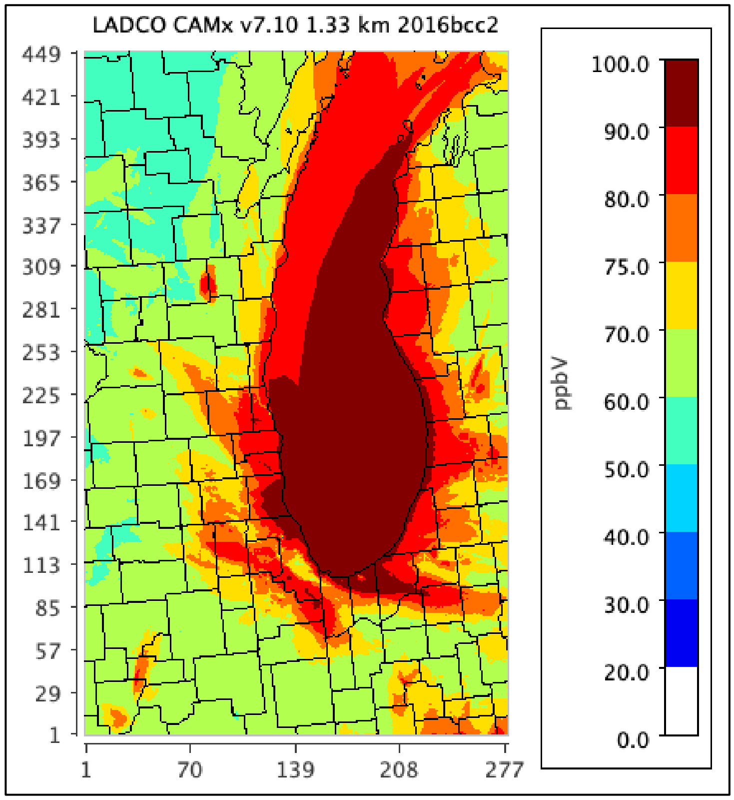


**Figure 6-7. LADCO CAMx 1.33-km 2016 $O_3$ season maximum MDA8 $O_3$ concentrations**

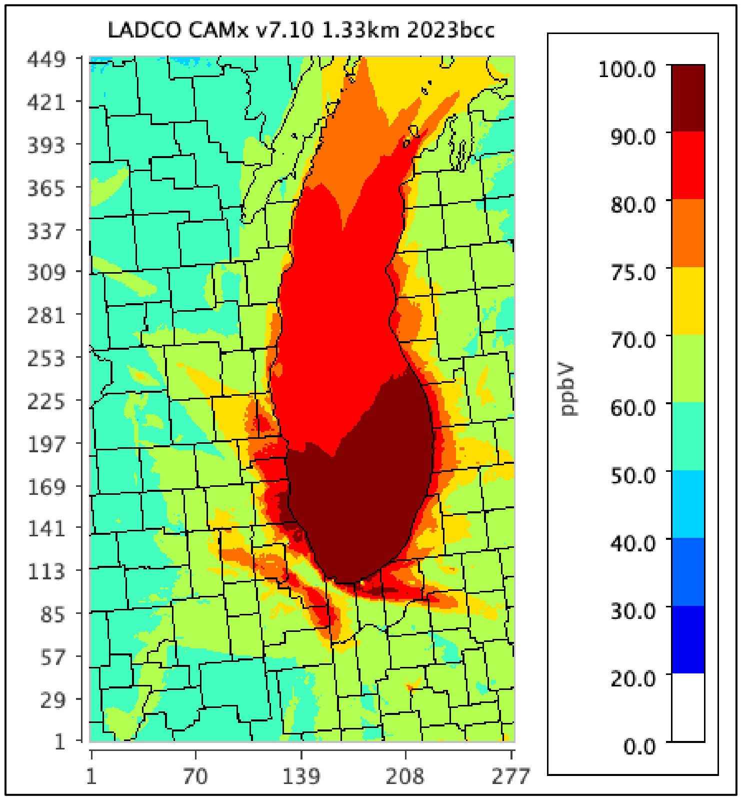


**Figure 6-8. LADCO CAMx 1.33-km 2023 $O_3$ season maximum MDA8 $O_3$ concentrations**

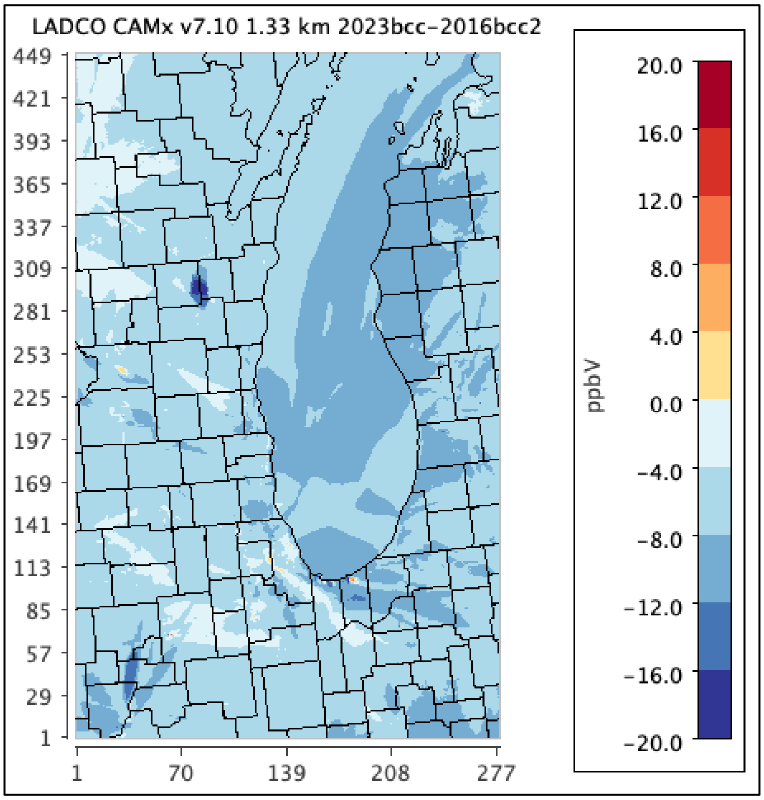


**Figure 6-9. LADCO CAMx 1.33-km difference (2023-2016) in $O_3$ season maximum MDA8 $O_3$ concentrations**

## 6.3. 2023 $O_3$ Design Values

Figure 6-10 shows the $O_3$ $DVF_{2023}$ values from the LADCO 2023 4-km CAMx simulation. Figure 6-11 is a map of the SMAT-CE 2023 relative response factors (RRFs) from the LADCO CAMx 4-km modeling. LADCO generated these results with SMAT-CE using the standard U.S. EPA attainment test configuration (top 10 modeled days, 3x3 cell matrix around the monitor, including water cells). We are showing the $DVF_{2023}$ calculated from the 4-km CAMx simulation because the domain encompasses the entire LADCO region, and presents an optimized model configuration relative to the 12-km domain. As described previously in this TSD, the CAMx two-way nesting configuration used by LADCO propagates the fine grid model solution upward to the parent grids. The solution for the model grid cells in the 4-km modeling domain that include the 1.33-km nested domain is primarily from the 1.33-km simulation. Similarly, the model solution in the grid cells in the 12-km modeling domain that include the 4-km domain is primarily from the 4-km simulation.

The LADCO $O_3$ $DVF_{2023}$ values presented here used observational data completeness criteria based on the 2015 $O_3$ NAAQS. The completeness criteria are tied to the level of the standard in cases in which the number of valid observations falls below a statutory threshold but when at least one of the valid observations is greater than the NAAQS (see 40 CFR Part 50 Appendix U, Section 3(d)). By using the 2015 $O_3$ NAAQS for determining completeness, LADCO includes more available data points in the DV calculations than if we had used the 2008 $O_3$ NAAQS completeness criteria because the lower standard is more inclusive of the available monitoring data (i.e., there are more MDA8 $O_3$ observations >= 70 ppb than there are observations >= 75 ppb). Per U.S. EPA modeling guidance (U.S. EPA, 2018), LADCO truncated the SMAT-CE average $DVF_{2023}$ values to integer numbers.

The LADCO 2023 CAMx simulation predicts that two monitors in the region will have an average $DVF_{2023}$ that exceeds the 2015 $O_3$ NAAQS: Sheboygan Kohler Andrae in Sheboygan County, Wisconsin ($DVF_{2023}$ = 75) and Chiwaukee Prairie in Kenosha County, Wisconsin ($DVF_{2023}$ =71). The RRF plot shows that the LADCO CAMx modeling projected all the monitors along the western shore of Lake Michigan and southern shore of Lake Erie, along with a few other areas of the region, to have 5-9% reductions in their $DVF_{2023}$ values (RRFs = 0.91-0.95). Most of the monitors in the region are forecast to have 10-14% $DVF_{2023}$ reductions (RRFs = 0.86-0.9). Table 6-1 presents the average $DVF_{2023}$ values for monitors in each of the 2015 $O_3$ NAAQS NAAs in the region. As with the $DVF_{2023}$ and RRF figures in this section, this table presents the $DVF_{2023}$ values calculated from the LADCO 4-km CAMx modeling using a matrix of 3x3 grid cells surrounding each monitor and including water cells in the calculation.

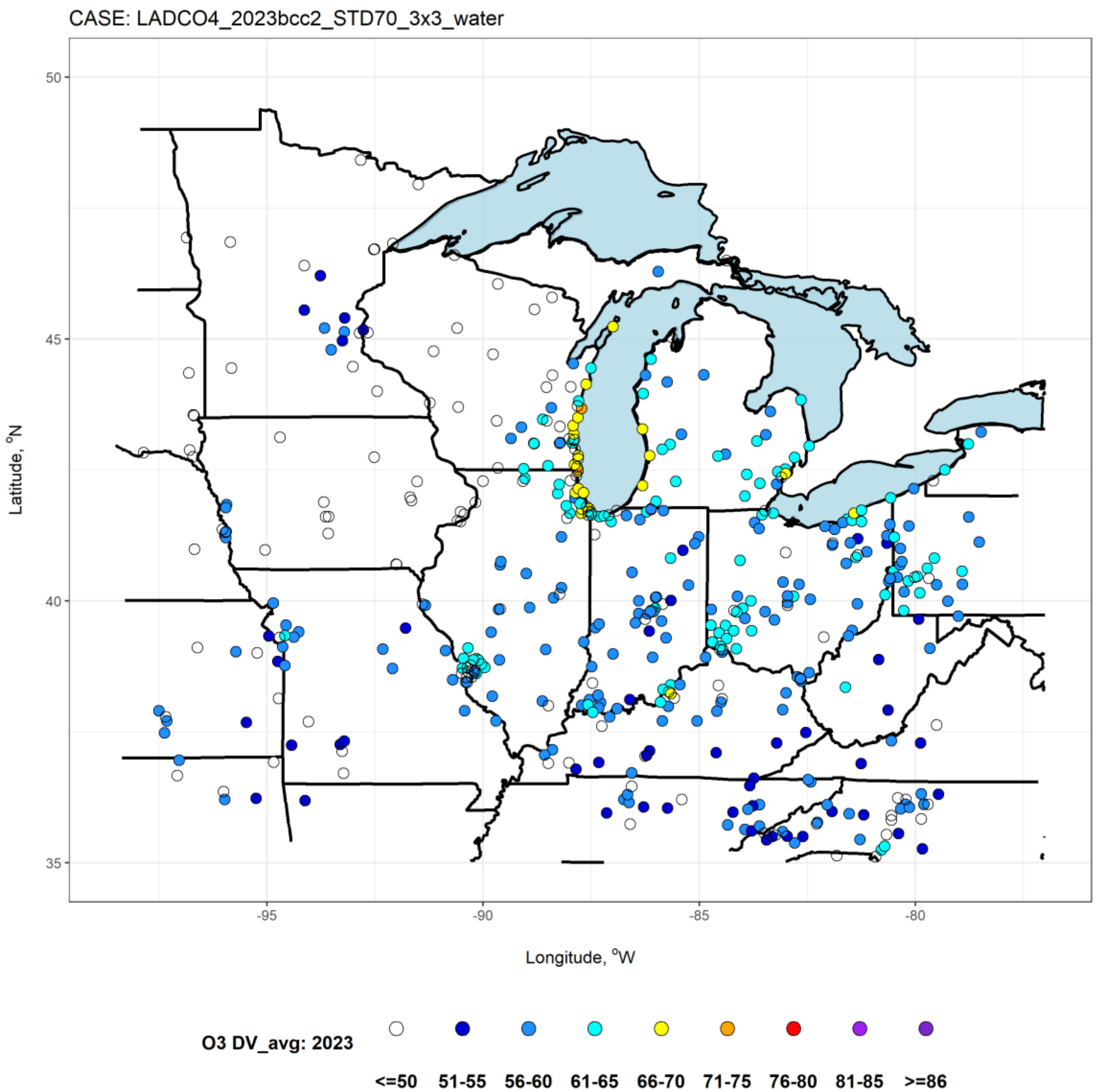


**Figure 6-10. $DVF_{203}$ $O_3$ design values calculated with water cells included from the LADCO 2023 4-km CAMx simulation.**

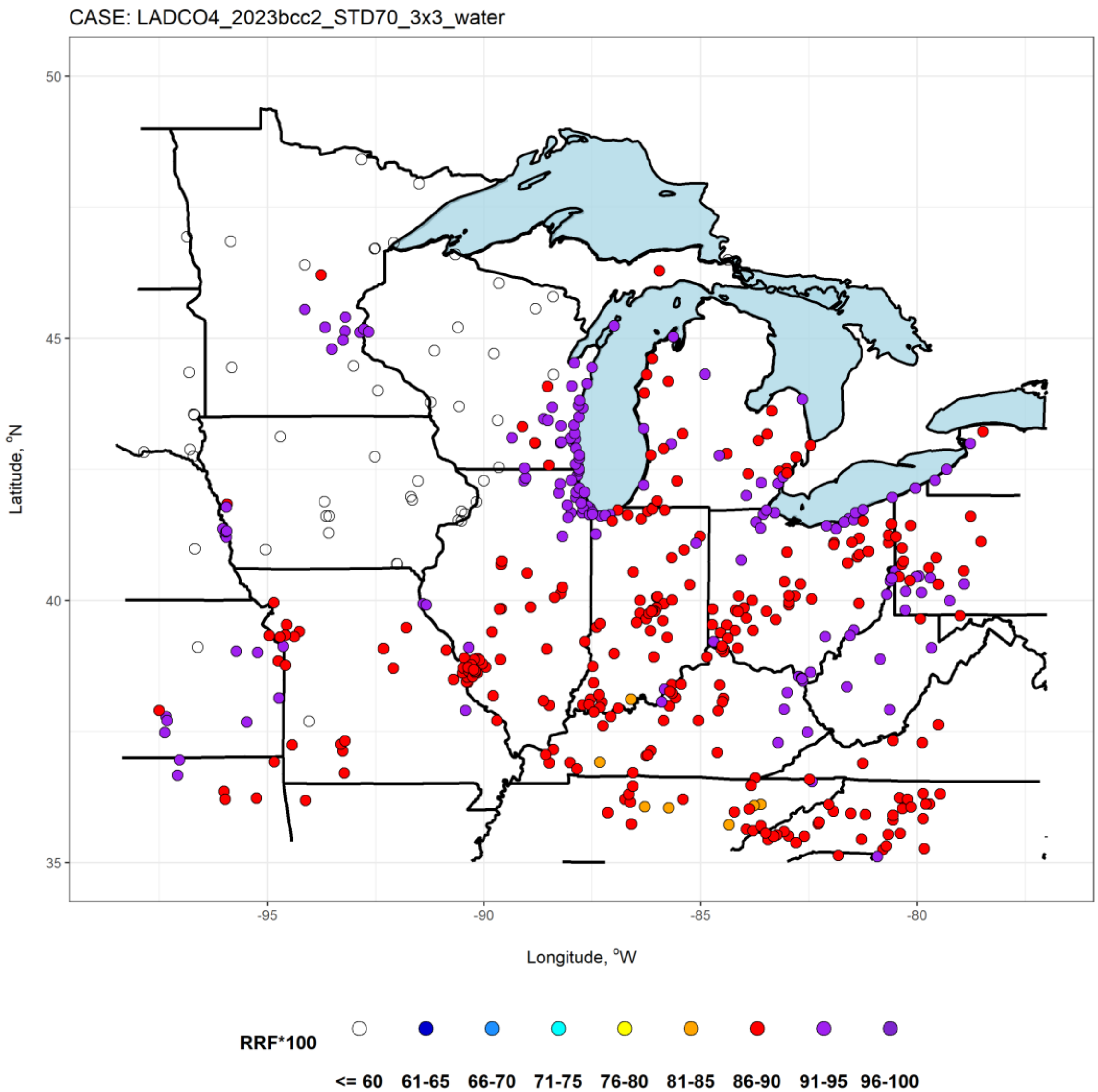


**Figure 6-11. 2023 RRFs calculated with water cells included from the LADCO 2023 4-km CAMx simulation.**

**Table 6-1. 2023 $O_3$ design values at each monitor in the 2015 $O_3$ NAAQS NAAs in the LADCO region; calculated from the LADCO 4-km CAMx modeling with water cells included in the 3x3 matrix surrounding the monitor**

| State | NAA | AQS Site ID | Site Name | 2021 DV | 2023 DV | RRF |
|---|---|---|---|---|---|---|
| Michigan | Allegan County, MI | 260050003 | HOLLAND | 75 | 66.9 | 0.9084 |
| Michigan | Berrien County, MI | 260210014 | COLOMA | 71 | 67.3 | 0.9185 |
| Michigan | Muskegon County, MI | 261210039 | MUSKEGON | 74 | 68.6 | 0.9149 |
| Illinois | Chicago, IL-IN-WI | 170310001 | ALSIP | 71 | 67.5 | 0.9251 |
| Illinois | Chicago, IL-IN-WI | 170314201 | NORTHBRK | 74 | 68.0 | 0.9285 |
| Illinois | Chicago, IL-IN-WI | 170317002 | EVANSTON | 73 | 68.9 | 0.9324 |
| Illinois | Chicago, IL-IN-WI | 170310032 | CHI_SWFP | 75 | 66.6 | 0.9214 |
| Illinois | Chicago, IL-IN-WI | 170310076 | CHI_COM | 0 | 67.9 | 0.9436 |
| Illinois | Chicago, IL-IN-WI | 170971007 | ZION | 73 | 67.9 | 0.9218 |
| Illinois | Chicago, IL-IN-WI | 170314007 | DESPLNS | 69 | 66.1 | 0.9187 |
| Illinois | Chicago, IL-IN-WI | 170314002 | CICERO | 70 | 64.9 | 0.9448 |
| Illinois | Chicago, IL-IN-WI | 171110001 | CARY | 71 | 63.7 | 0.9151 |
| Illinois | Chicago, IL-IN-WI | 170436001 | LISLE | 70 | 65.3 | 0.9383 |
| Illinois | Chicago, IL-IN-WI | 170890005 | ELGIN | 70 | 64.3 | 0.9285 |
| Illinois | Chicago, IL-IN-WI | 170311601 | LEMONT | 72 | 64.8 | 0.9363 |
| Illinois | Chicago, IL-IN-WI | 170311003 | CHI_TAFT | 71 | 63.3 | 0.9281 |
| Illinois | Chicago, IL-IN-WI | 171971011 | BRAIDWD | 64 | 60.2 | 0.9227 |
| Illinois | Chicago, IL-IN-WI | 170313103 | SCHILPRK | 64 | 59.4 | 0.9486 |
| Indiana | Chicago, IL-IN-WI | 181270026 | Valparaiso | 68 | 62.5 | 0.9022 |
| Indiana | Chicago, IL-IN-WI | 181270024 | Ogden Dunes | 72 | 63.4 | 0.9097 |
| Indiana | Chicago, IL-IN-WI | 180890022 | Gary-IITRI | 69 | 62.2 | 0.912 |
| Indiana | Chicago, IL-IN-WI | 180892008 | Hammond-141st St | 68 | 61.1 | 0.9259 |
| Wisconsin | Chicago, IL-IN-WI | 550590019 | CHIWAUKEE | 74 | 71.6 | 0.9183 |
| Wisconsin | Chicago, IL-IN-WI | 550590025 | Kenosha-Water Tower | 72 | 67.6 | 0.9184 |
| Ohio | Cincinnati, OH-KY | 390610006 | Sycamore | 70 | 65.8 | 0.8985 |
| Ohio | Cincinnati, OH-KY | 390170018 | Middletown Airport | 67 | 63.8 | 0.8955 |
| Ohio | Cincinnati, OH-KY | 390170023 | Crawford Woods | 66 | 64.4 | 0.8915 |
| Ohio | Cincinnati, OH-KY | 390610010 | Colerain | 67 | 64.8 | 0.9099 |
| Ohio | Cincinnati, OH-KY | 390610040 | Taft NCore | 69 | 63.8 | 0.895 |
| Ohio | Cincinnati, OH-KY | 391650007 | Lebanon | 70 | 63.4 | 0.8844 |
| Ohio | Cincinnati, OH-KY | 390179991 | Oxford | 64 | 62.8 | 0.9042 |
| Ohio | Cincinnati, OH-KY | 390250022 | Batavia | 66 | 62.3 | 0.8914 |
| Ohio | Cleveland, OH | 390850003 | Eastlake | 72 | 67.1 | 0.9113 |
| Ohio | Cleveland, OH | 390550004 | Notre Dame | 66 | 63.8 | 0.8958 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ohio | Cleveland, OH | 390355002 | Mayfield | 68 | 63.3 | 0.9142 |
| Ohio | Cleveland, OH | 390350034 | District 6 | 70 | 63.3 | 0.9185 |
| Ohio | Cleveland, OH | 390850007 | Painesville | 66 | 62.7 | 0.9095 |
| Ohio | Cleveland, OH | 390930018 | Sheffield | 58 | 59.7 | 0.9095 |
| Ohio | Cleveland, OH | 390350064 | Berea BOE | 66 | 59.5 | 0.9123 |
| Ohio | Cleveland, OH | 391030004 | Chippewa | 61 | 57.5 | 0.8953 |
| Ohio | Cleveland, OH | 391530020 | Patterson Park | 64 | 56.9 | 0.899 |
| Ohio | Cleveland, OH | 390350060 | GT Craig NCore | 63 | 58.1 | 0.9272 |
| Ohio | Cleveland, OH | 391331001 | Lake Rockwell | 62 | 55.6 | 0.8983 |
| Michigan | Detroit, MI | 261630019 | East 7 MILE | 70 | 66.3 | 0.9085 |
| Michigan | Detroit, MI | 261250001 | OAK PARK | 69 | 64.1 | 0.9077 |
| Michigan | Detroit, MI | 261470005 | PORT HURON | 70 | 64.8 | 0.9008 |
| Michigan | Detroit, MI | 260990009 | NEW HAVEN | 68 | 64.4 | 0.8994 |
| Michigan | Detroit, MI | 261619991 | Ann Arbor | 62 | 62.8 | 0.9067 |
| Michigan | Detroit, MI | 260991003 | WARREN | 66 | 61.0 | 0.9077 |
| Michigan | Detroit, MI | 261610008 | YPSILANTI | 66 | 62.0 | 0.917 |
| Michigan | Detroit, MI | 261630001 | ALLEN PARK | 67 | 60.9 | 0.9193 |
| Indiana | Louisville, KY-IN | 180431004 | New Albany | 64 | 64.9 | 0.9148 |
| Indiana | Louisville, KY-IN | 180190008 | Charlestown State Park | 63 | 62.9 | 0.8952 |
| Wisconsin | Milwaukee, WI | 551010020 | Racine | 73 | 69.5 | 0.9148 |
| Wisconsin | Milwaukee, WI | 550890009 | HARRINGTON BCH | 70 | 68.7 | 0.9381 |
| Wisconsin | Milwaukee, WI | 550790085 | BAYSIDE | 70 | 66.5 | 0.9282 |
| Wisconsin | Milwaukee, WI | 550890008 | GRAFTON | 71 | 66.0 | 0.926 |
| Wisconsin | Milwaukee, WI | 550790026 | MILWAUKEE SER | 68 | 63.1 | 0.928 |
| Wisconsin | Milwaukee, WI | 550790010 | MILWAUKEE 16TH ST | 61 | 61.0 | 0.9354 |
| Wisconsin | Milwaukee, WI | 551330027 | CLEVELAND AVE | 65 | 60.5 | 0.9209 |
| Wisconsin | Sheboygan County, WI | 551170006 | SHEBOYGAN | 72 | 75.1 | 0.9391 |
| Wisconsin | Sheboygan County, WI | 551170009 | Sheboygan-Haven | 65 | 65.2 | 0.9328 |
| Illinois | St. Louis, MO-IL | 171191009 | MARYVILL | 67 | 61.5 | 0.8923 |
| Illinois | St. Louis, MO-IL | 171193007 | WOOD_WTP | 69 | 63.0 | 0.8916 |
| Illinois | St. Louis, MO-IL | 171630010 | East St. Louis | 65 | 62.1 | 0.9 |
| Illinois | St. Louis, MO-IL | 171199991 | Alhambra | 64 | 59.5 | 0.8846 |

### 6.3.1. Alternative $DVF_{2023}$ Results

Confidence in the ability of photochemical models to accurately estimate $O_3$ over water is a persistent concern with the use of the models for air quality planning. This concern prompted measurement campaigns in the Eastern U.S. to address the issue (see the 2017 Lake Michigan

Ozone Study, Long Island Sound Tropospheric Ozone Study, and OWLETS). The meteorology and chemistry processes in model grid cells that are dominated by water (> 50% landuse area) are a challenge to simulate because the conventional technical formulations of the models were not optimized for water cells. Even with the introduction of new algorithms to simulate the dynamical and chemical features of water cells, a lack of over-water observations hinders our ability to verify the accuracy of the models in simulating these conditions.

In consideration that the models may not perform well in simulating water cells, U.S. EPA and others have presented alterative DVF calculation approaches that exclude water cells (US EPA, 2017; US EPA, 2018b). Per U.S. EPA (2018, pg. 109), when appropriate there may be cases where certain cells along the periphery of the 3 x 3 model grid cell matrix have different modeled responses than what would be expected at the monitor location at the center of a matrix due to a specific local topographic or geographical feature (e.g., a large water body or a significant elevation change). A potential example of this situation would be a matrix of grid cells where several grid cells are over water and where the meteorological conditions and relevant emissions sources differ substantially from the land-based monitor location. Again, in these types of cases and with appropriate justification, air agencies could consider removing the unrepresentative cells from the calculation.

Section 4.2.2 of the U.S EPA (2018) modeling guidance states, “In cases in which the spatial representativeness of a monitoring location is much smaller or larger than the area covered by the 3x3 array of cells, air agencies may consider assessing site-specific model response over an alternative grid cell array as part of corroborative analyses that inform the aggregate weight of evidence determination. Additionally, there may be cases where certain cells along the periphery of the 3 x 3 array have different modeled responses than what would be expected at the monitor location at the center of array due to a specific local topographic or geographical feature (e.g., a large water body or a significant elevation change). “

Factoring in the impact of water cells on the DVF calculation does not require additional CAMx simulations. It is implemented through a postprocessing sequence per U.S. EPA (2018b) in which model grid cells that are dominated by water (> 50% landuse area) are removed from the 3x3 matrix in the RRF and DVF calculation. One important modification to this process is to override the exclusion condition for cells that contain monitors; in other words, grid cells that contain monitors will be included in the 3x3 matrix regardless of the amount of water coverage in the cell.

Adjustments to the size of the grid cell matrix used in the DVF calculation is a configuration that can be adjusted in SMAT-CE. The program gives users the option to calculate DVs using only the model grid cell that contains a monitor, or matrices of 3x3, 5x5, or 7x7 cells around a monitor location. LADCO's 2016 CAMx modeling platform used a 3:1 nesting ratio to simulation air quality at 12-km, 4-km, and 1.33-km resolution. To normalize the area around a monitor used for calculating DVFs, the size of the matrix surrounding a monitor can be increased at finer grid resolutions.

LADCO conducted a series of attainment test experiments to understand the impacts on DVFs of excluding water cells or changing the size of the grid cell matrix. Table 6-2 shows the results of attainment test experiments for controlling[14] monitors at the lakeshore nonattainment areas in the region. The results in this table compare $DVF_{2023}$ values for SMAT-CE configurations that include/exclude water cells and use different matrix sizes around the monitor. The range of $DVF_{2023}$ values at a monitor resulting from the different configurations presented in the table averages about 0.5 ppb.

**Table 6-2. Comparison of LADCO 2023 4-km $O_3$ design values at shoreline nonattainment area monitors in the region**

| NAA | AQS Site ID | 3x3 | | 5x5 | | 7x7 | |
|---|---|---|---|---|---|---|---|
| | | Water | No Water | Water | No Water | Water | No Water |
| Allegan County, MI | 260050003 | 66.9 | 66.9 | 67.6 | 67.2 | 67.5 | 67.2 |
| Berrien County, MI | 260210014 | 67.3 | 67.3 | 67.8 | 67.4 | 67.9 | 67.7 |
| Muskegon County, MI | 261210039 | 68.6 | 68.6 | 68.9 | 68.6 | 68.9 | 68.5 |
| Chicago, IL-IN-WI | 550590019 | 71.6 | 72.0 | 71.3 | 71.8 | 71.5 | 71.8 |
| Cleveland, OH | 390850003 | 67.1 | 66.5 | 67.3 | 66.7 | 67.4 | 66.5 |
| Detroit, MI | 261630019 | 66.3 | 66.3 | 66.0 | 66.0 | 66.0 | 66.1 |
| Milwaukee, WI | 551010020 | 69.5 | 69.4 | 69.6 | 69.4 | 69.4 | 69.5 |
| Sheboygan County, WI | 551170006 | 75.1 | 74.6 | 75.1 | 74.7 | 74.5 | 74.6 |

[14] The controlling monitor is the monitor location in the nonattainment area with the highest base year design value

Figure 6-12 compares different $DVF_{2023}$ estimates for the Sheboygan Kohler Andrae monitor in Wisconsin. This figure adds the impacts of model grid resolution on the $DVF_{2023}$ estimates by comparing configurations that include/exclude water cells, different grid cell matrix sizes, and model resolution. As seen in the table above, the attainment test configuration has a modest impact (~0.5 ppb) on the $DVF_{2023}$ results, and will only be important for monitors that have estimated DVFs that are close to the NAAQS value.

LADCO's CAMx DVF estimates are available in supporting materials to this TSD in the following spreadsheet. The spreadsheet includes tables and figures of $DVF_{2023}$ values calculated from the LADCO 12-km, 4-km, and 1.33-km CAMx modeling that use the different SMAT-CE configurations presented here.

LADCO 2016-based 2023 Design Value Forecasts (19 MB; XLSX)

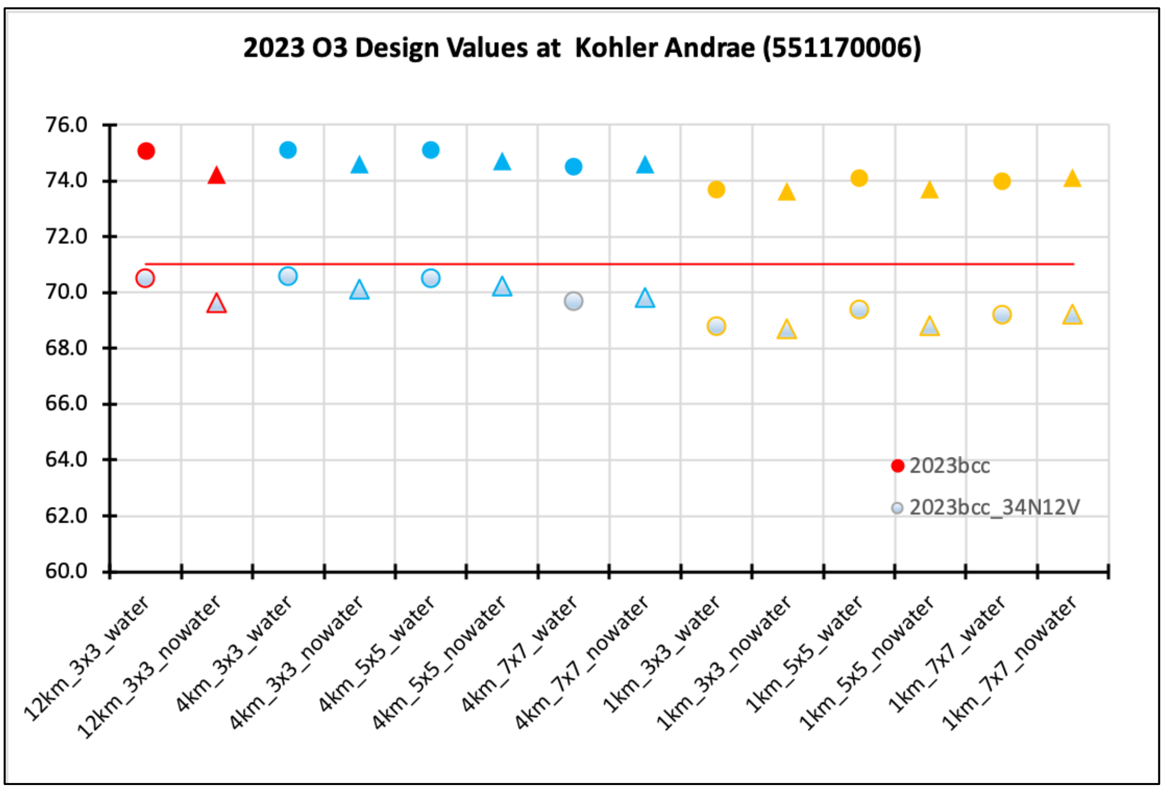


**Figure 6-12. Alternative $DVF_{2023}$ results for Sheboygan Kohler Andrae, WI**

# 7. Source Apportionment Modeling Results

LADCO conducted source apportionment modeling with CAMx to quantify source-receptor relationships for $O_3$ in 2016. The CAMx APCA results show the extent to which emission from different source regions or inventory sectors impact ground-level $O_3$ concentrations in the region. The information provided by APCA can be used to inform air quality planners about the main drivers of $O_3$ formation at specific locations. The techniques used by LADCO to process the APCA results provide information on the sources that contribute to the annual 4$^{th}$ highest MDA8 $O_3$ concentrations at each monitor location.

In Section 3.4.1 we discussed the APCA configurations for the LADCO 2016-based CAMx simulations. The configuration description includes the APCA emission sector tags and geographic source region tags used for quantifying the contributions of upwind states, regions, and inventory sectors at downwind $O_3$ monitors.

## 7.1. APCA Post-processing for Source Contribution Estimates

LADCO post-processed the CAMx APCA tagged species model outputs to create SMAT-CE input files. This process involved operations on both the 2016 core model concentration outputs and the source apportionment outputs. The core model outputs are the total $O_3$ concentrations, while the source apportionment outputs track the amount of $O_3$ formed by either NOx or VOC emissions from the tagged sources.

The model attainment test software SMAT-CE processes daily average $O_3$ concentrations from a 3 x 3 grid cell matrix surrounding each $O_3$ monitor location in the CAMx modeling domain. LADCO used the following steps to prepare the SMAT-CE input files and to run the software to calculate the contribution of the tracers to $O_3$ at downwind receptors.

1. Combine hourly CAMx core model output into hourly total concentrations (File A).
2. Generate hourly pseudo total concentration outputs (File X') for each source tag by subtracting the tagged source apportionment output (File X) from File A.
3. Generate daily average total (File $\bar{A}$) concentration files from File A and File X', respectively

4. Extract the results in File $\bar{A}$ and File $\bar{X}'$ from 3x3 grid cells surrounding each monitor location in the modeling domain. LADCO then converted the extracted netCDF data to comma-delimited (CSV) files in the SMAT-CE input file format; the CSV outputs for File $\overline{A2}$ and File $\overline{X2'}$ were then ready for SMAT-CE.
5. Run SMAT-CE version 1.6 using the File $\overline{A2}$ and File $\overline{X2'}$ with observed surface $O_3$ data as inputs
6. We then used R to prepare the raw SMAT-CE for easy import to a spreadsheet for plotting and tabulation of the results.

LADCO's CAMx APCA $O_3$ tracer estimates are available in the supporting materials to this TSD in the following spreadsheet:

**LADCO 2016-based O3 tracer contributions** (8 MB; XLSX)

## 7.2. CAMx 2016 APCA Results

This section illustrates some of the results from the LADCO CAMx 2016-based APCA configurations that are included in the spreadsheet described in the previous section. The LADCO CAMx 2016 geographic tracer APCA modeling estimated the amount of $O_3$ contributed by $O_3$ precursor (NOx and VOC) emissions originating from states, groups of counties, biogenic, initial and boundary condition (ICBC), and international (Canada and Mexico) anthropogenic sources. The LADCO CAMx 2016 inventory sectors tracer APCA modeling estimated the amount of $O_3$ contributed by $O_3$ precursor emissions from various inventory sectors.

Figure 7-1 through Figure 7-10 show the contributions of emissions from the geographic and sectors tags to the 2016 O3 design value ($DV_{2016}$), or the annual 4$^{th}$ highest MDA8 $O_3$ at each monitor in Illinois, Indiana, Michigan, Ohio, and Wisconsin, respectively. These results are summarized by the NAAs in each state below.

### 7.2.1. APCA Tracer Contributions to Illinois $O_3$

**Chicago**

Figure 7-1 shows that the IL monitors with the highest $DV_{2016}$ values in the state are in the Chicago NAA. NOx and VOC emissions from the Chicago metro and suburban counties are the largest contributors to $O_3$ at the Chicago NAA monitors. The Chicago metro/suburban area tracers contribute about 35-40% of the $DV_{2016}$ at the monitors north and northwest of downtown Chicago. For example, the Chicago metro/suburban county emissions are associated with 37% of the $DV_{2016}$ at the Zion, IL monitor (170971007) near the border with Wisconsin. Emissions from these same counties contribute ~24-30% of the $DV_{2016}$ at monitors to the south of downtown. For example, emissions from these counties contribute 24% of the $DV_{2016}$ at the South Water Treatment Plant (170310032). Emissions from the northern Indiana counties are the next largest single source region contributor to the Chicago NAA monitors, associated with about 5% of the $DV_{2016}$ values.

Figure 7-2 shows that onroad mobile non-diesel (~12-15%) and onroad mobile diesel (~8-11%) sources are the largest emissions contributors to the Chicago $DV_{2016}$ values. Other anthropogenic emissions sectors with notable contributions to Chicago $O_3$ concentrations include non-EGU point (~6-10%), offroad diesel engines (~5-7%), and offroad non-diesel engines (~5-6%).

**East St. Louis**

Emissions from anthropogenic sources in Missouri are the largest contributor to $DV_{2016}$ values at monitors in the East St. Louis, IL counties (~30-40%). Other significant contributors to the East St. Louis, IL $DV_{2016}$ values include emissions from the East St. Louis, IL counties (~10-15%), statewide emissions in TX and LA (~5%), and statewide emissions from the rest of the CenSARA states (~7%). Onroad mobile diesel (~12-13%) and onroad mobile non-diesel (~12-13%) emissions are the largest anthropogenic inventory sector contributors to $O_3$ at the East St. Louis, IL monitors. EGU point (~10-13%) and offroad diesel engines (~6-8%) are also important sources of emissions that contribute to $O_3$ at the East St. Louis monitors.

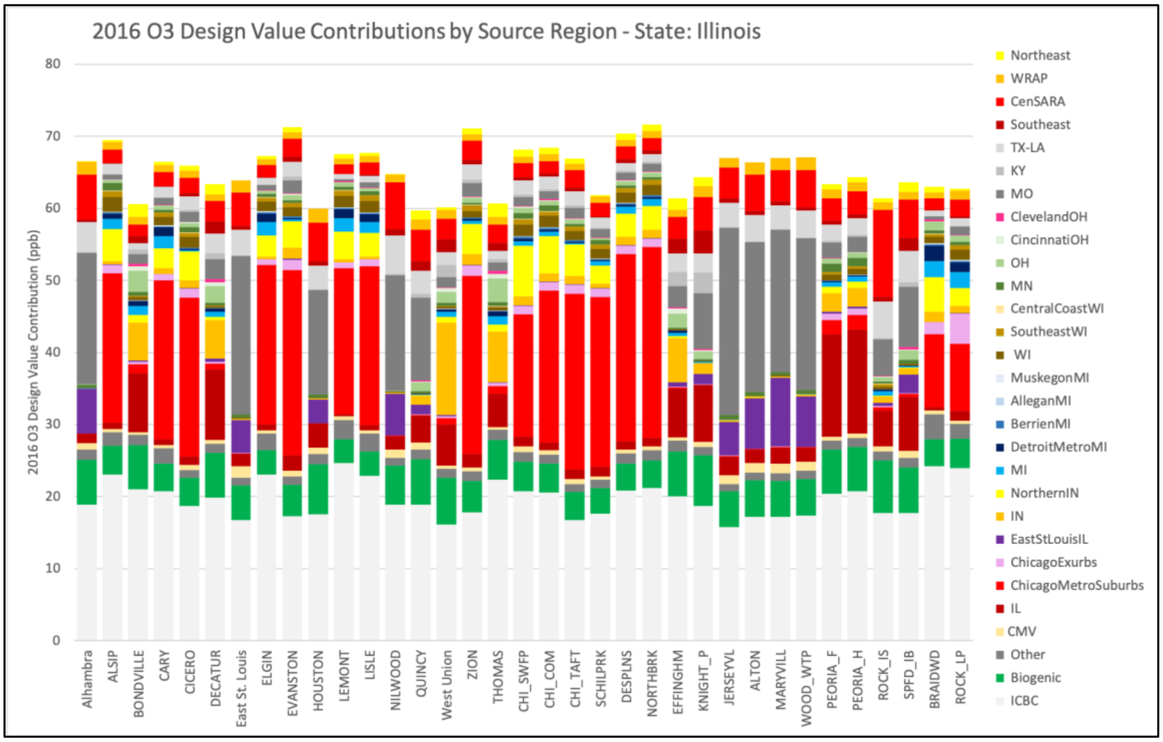


**Figure 7-1. Geographic tracer contributions to 2016 MDA8 $O_3$ at IL monitors**

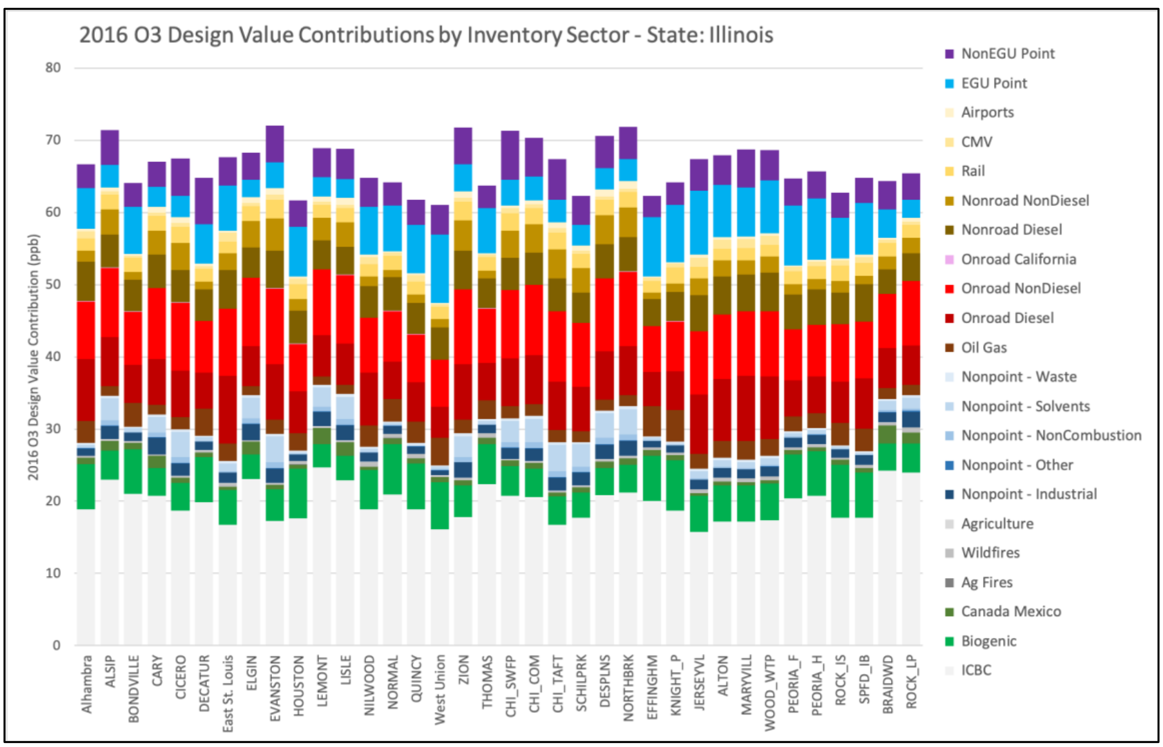


**Figure 7-2. Inventory sector tracer contributions to 2016 MDA8 $O_3$ at IL monitors**

### 7.2.2. APCA Tracer Contributions to Indiana $O_3$

**Indianapolis**

Figure 7-3 shows that the IN monitors with the highest $DV_{2016}$ values in the state are in Indianapolis, northern Indiana near Lake Michigan, and in the Louisville area. Statewide emissions from Indiana, excluding the northern counties, are the largest contributor (~33-34%) to $O_3$ at the Indianapolis monitors. No other single source region contributes more than about 4% of the $O_3$ at the Indianapolis monitors. Figure 7-7 shows the inventory sectors contributing to $O_3$ concentrations in Indiana. Ozone at the Indianapolis monitors is most impacted by emissions from onroad mobile non-diesel (~17%) and onroad mobile diesel (~10%) sources. Other notable contributors to $DV_{2016}$ values in Indianapolis include emissions from offroad diesel engines (~8%) and EGU point (~7%) sources.

**Northwest Indiana**

Ozone at the northern Indiana monitors is primarily impacted by emissions from the northern Indiana counties (~15-23%) and from the Chicago metro/suburban counties (~10-18%). The largest sources contributing to $O_3$ at the northern Indiana $O_3$ monitors include onroad mobile non-diesel (~13%), non-EGU point (~10-12%), onroad mobile diesel (~10%), offroad diesel engines (~7%), offroad non-diesel engines (~6-7%), and EGU point (~5%).

**Louisville Area**

Statewide emissions from Kentucky are the largest contributor to $O_3$ (~27%) at the Louisville area monitors in Indiana. Indiana statewide NOx and VOC emissions contribute about 10-13% of the $DV_{2016}$ at these monitors. Ozone concentrations in the Indiana counties in the Louisville area are impacted most by emissions from onroad mobile non-diesel (~15-16%), EGU point (~12-13%), onroad mobile diesel (~10%), non-EGU point (~7%), and offroad diesel engines (~6%).

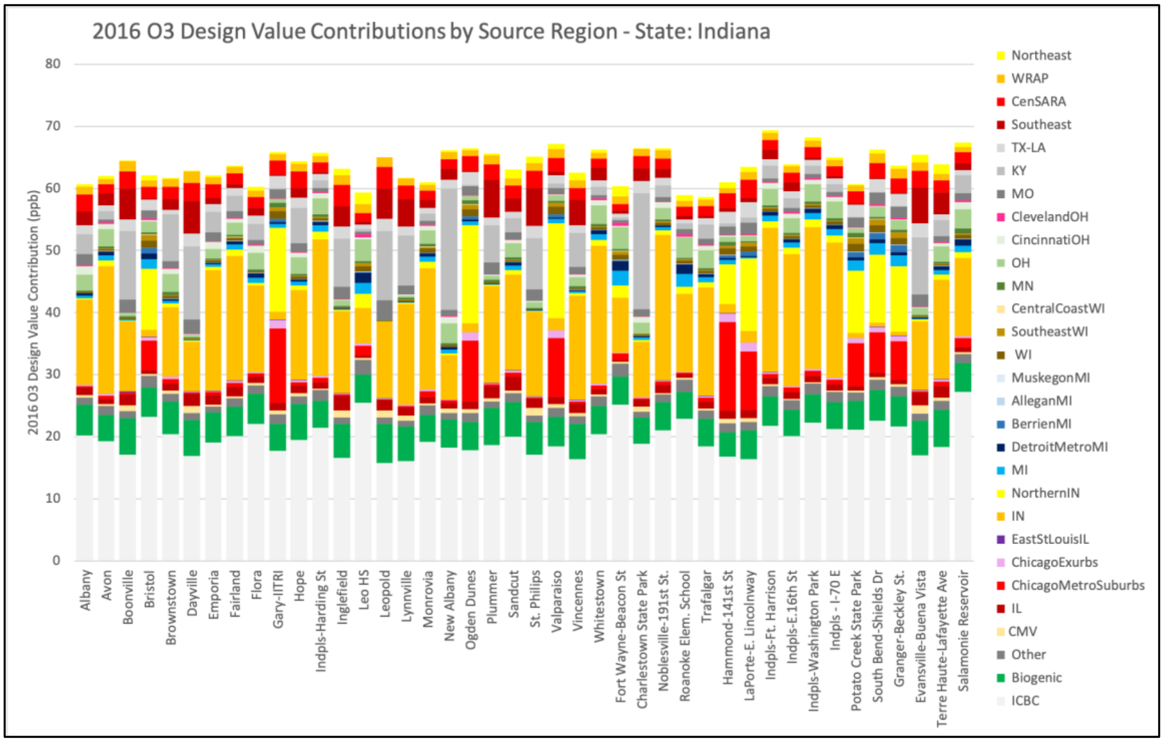


**Figure 7-3. Geographic tracer contributions to 2016 MDA8 $O_3$ at IN monitors**

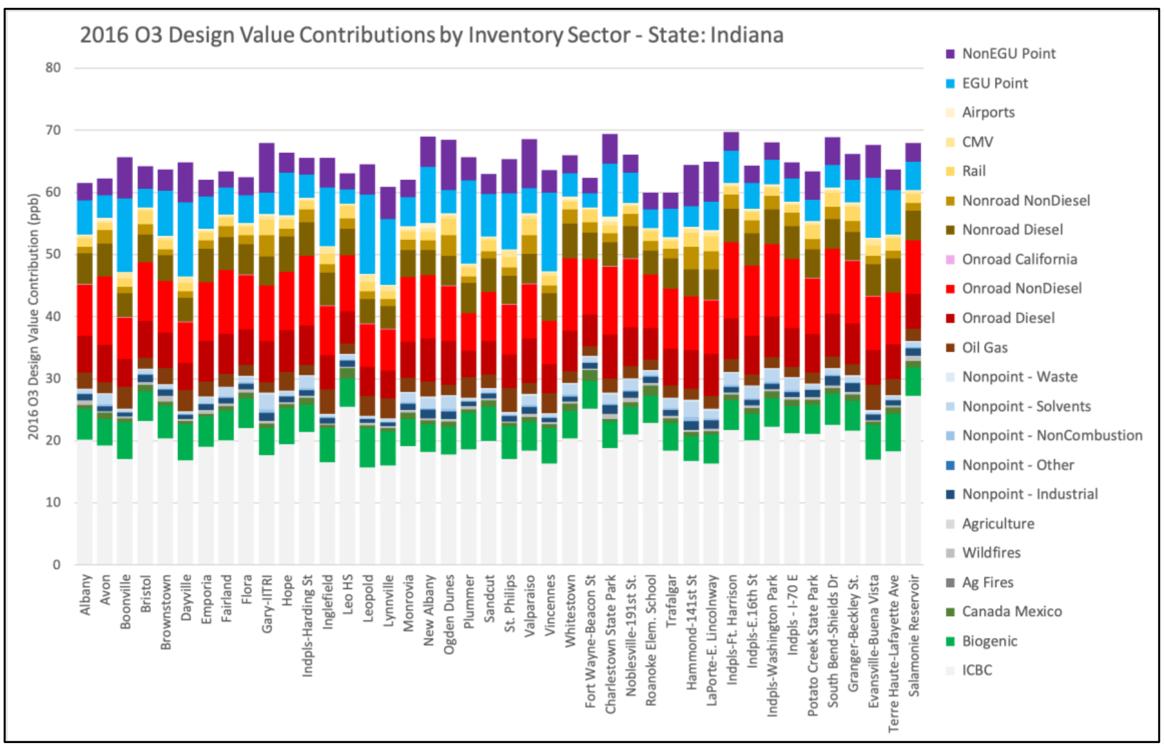


**Figure 7-4. Inventory sector tracer contributions to 2016 MDA8 $O_3$ at IN monitors**

### 7.2.1. APCA Tracer Contributions to Michigan $O_3$

**Detroit**

Figure 7-5 shows that the monitors in Michigan with the highest $DV_{2016}$ values are along the shore of Lake Michigan and in the Detroit area. The geographic source regions with the largest NOx and VOC emissions contributions to $O_3$ at Detroit monitors include the Detroit metro counties (~18-25%) and the rest of state Michigan (~3-5%). Canadian emissions sources contribute ~5-9% of the $DV_{2016}$ value, with the largest impact (9%) at the Port Huron monitor (261470005). Figure 7-6 shows that onroad mobile non-diesel emissions sources are the largest contributor to $O_3$ at the Detroit monitors (~10-15%). Other notable anthropogenic emissions sectors contributing to $O_3$ in Detroit include EGU point (~5-8%), onroad mobile diesel (~5-8%), non-EGU point (~5-6%), and offroad diesel engines (~4-5%).

**Western Michigan**

Emissions from the Chicago metro/surburban counties are the largest contributor (~16-22%) to the $DV_{2016}$ values at the western Michigan monitors. Other notable emissions source regions include the northern Indiana counties (~8-14%), and the CenSARA states (~12-14%). The inventory sectors that have the largest contributions to $O_3$ at the western Michigan monitors include onroad mobile non-diesel (~13%), onroad mobile diesel (~11%), non-EGU point (~10%), and EGU point (~6-7%).

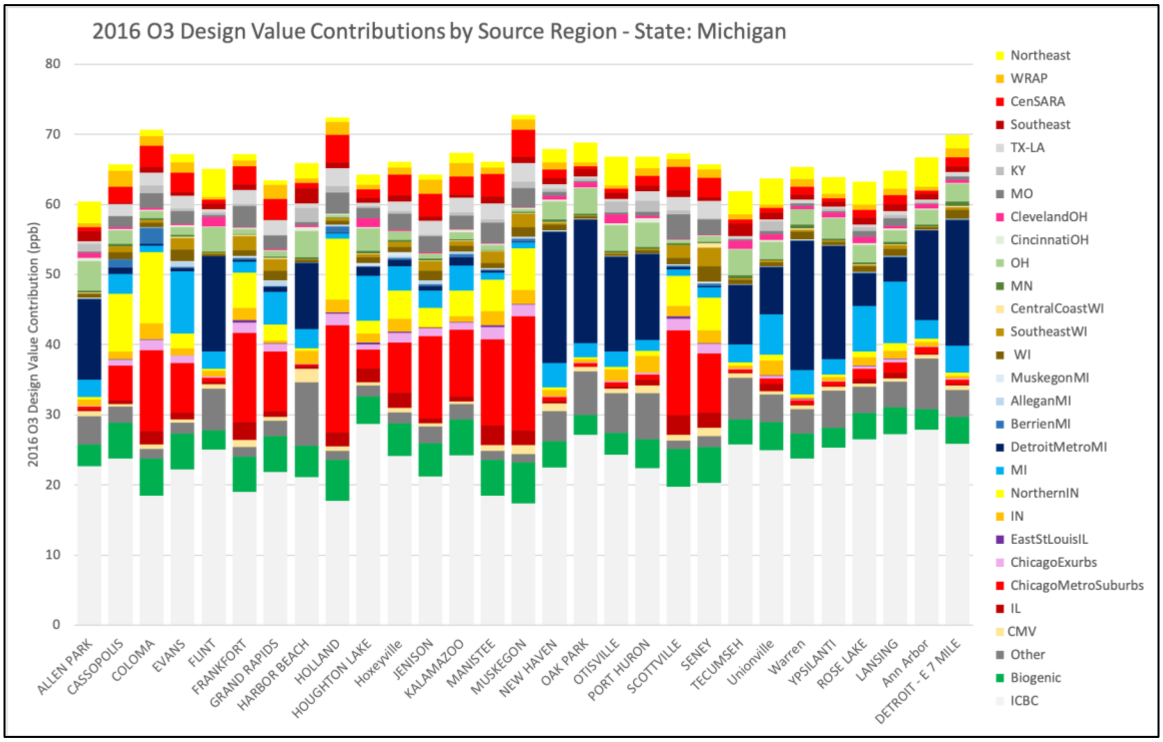


**Figure 7-5. Geographic tracer contributions to 2016 MDA8 $O_3$ at MI monitors**

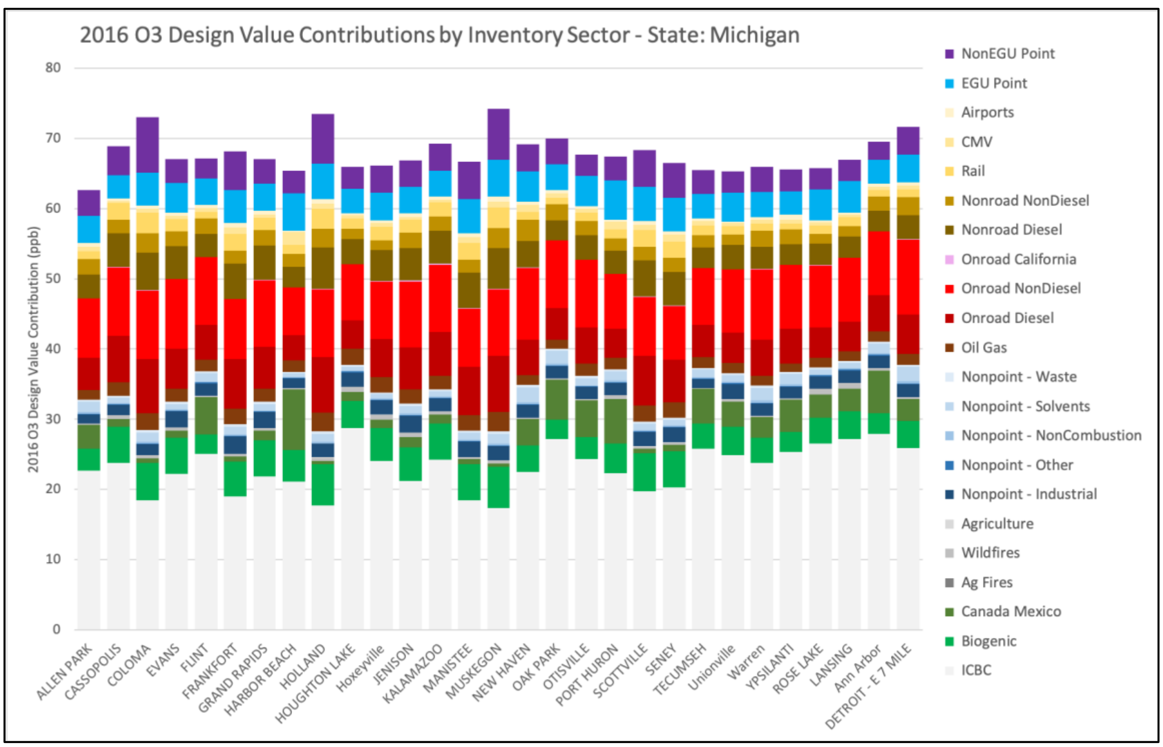


**Figure 7-6. Inventory sector tracer contributions to 2016 MDA8 $O_3$ at MI monitors**

### 7.2.1. APCA Tracer Contributions to Ohio $O_3$

**Cincinnati**

Figure 7-7 shows that NOx and VOC emissions from the Cincinnati counties are the largest contributor (~15-20%) to the $DV_{2016}$ values at the Cincinnati $O_3$ monitors. Other notable geographic source regions that contribute to $O_3$ concentrations in Cincinnati include statewide Kentucky (~10-13%), the CenSARA states (~7-10%), the rest of Ohio (~5-10%), and statewide Indiana (~4-7%). Figure 7-8 shows that the largest inventory sector contributors to Cincinnati $O_3$ include emissions from onroad mobile non-diesel (~15-16%), EGU point (~12-14%), onroad mobile diesel (~9-10%), and non-EGU point (~5%) sources.

**Cleveland**

Ozone at the Cleveland monitors is most impacted by NOx and VOC emissions from the Cleveland area counties (~15-23%), the rest of Ohio statewide (~12-15%), and the states in the SESARM region (~10-13%). Onroad mobile non-diesel emissions sources are the largest contributor (~13-15%) to $O_3$ in the Cleveland area. Other notable anthropogenic inventory sectors that contribute to Cleveland $O_3$ include onroad mobile diesel (~7-9%), EGU point (~7-8%), non-EGU point (~6%), offroad diesel engines (~7-8%), and offroad non-diesel engines (~5-6%).

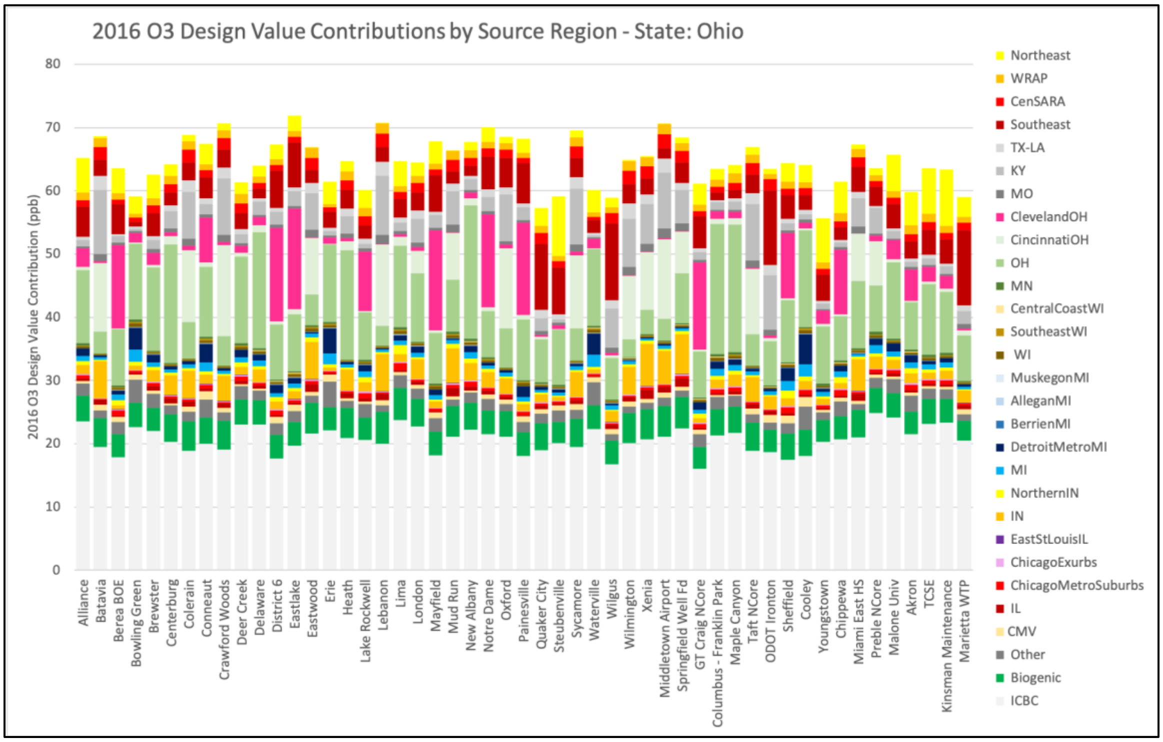


**Figure 7-7. Geographic tracer contributions to 2016 MDA8 $O_3$ at OH monitors**

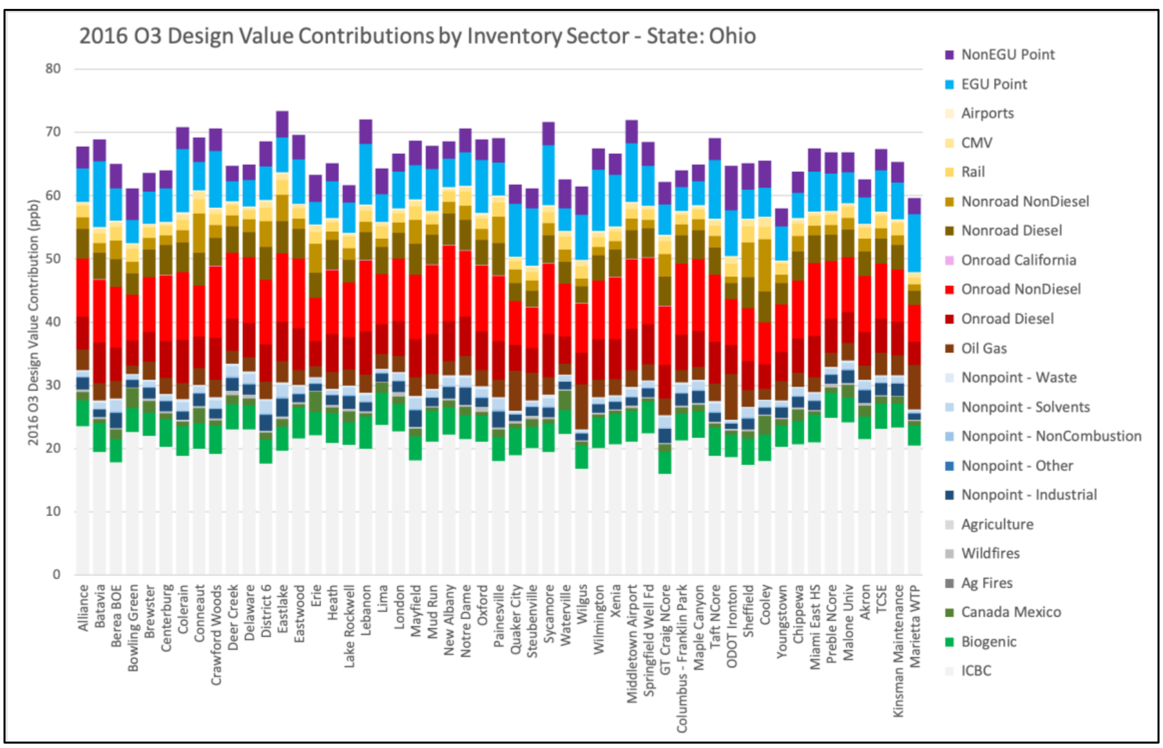


**Figure 7-8. Inventory sector tracer contributions to 2016 MDA8 $O_3$ at OH monitors**

### 7.2.1. APCA Tracer Contributions to Wisconsin $O_3$

**Southeast Wisconsin**

Figure 7-9 shows that highest $DV_{2016}$ values in Wisconsin are measured at the Lake Michigan coastline monitors. Ozone concentrations in the southeastern counties (Kenosha and Racine) near the border with Illinois are most impacted by NOx and VOC emissions from the Chicago metro/suburban counties (~27-32%). Other notable geographic source regions contributing to $O_3$ in southeast Wisconsin include the northern Indiana counties (~6-7%) and the CenSARA states (~8-10%). Emissions sources in the southeast Wisconsin counties contribute ~1-2% of the $DV_{2016}$. Figure 7-10 shows that onroad mobile non-diesel sources are the largest contributor to $O_3$ in this area (~14%). Other anthropogenic inventory sectors with notable contributions to $O_3$ in southeast Wisconsin include onroad mobile diesel (~11%), non-EGU point (~7-8%), offroad diesel engines (~7-8%), offroad non-diesel engines (~5-6%), and EGU point (~5-6%).

**Milwaukee**

Emissions from the Chicago metro/surburban counties are the largest contributor to $O_3$ at monitors in Milwaukee (~18-19%). Emissions from southeast Wisconsin counties, which include Milwaukee, contribute about 7-9% of the $DV_{2016}$ values. Other notable geographic source regions contributing to Milwaukee $O_3$ include NOx and VOC emissions from the northern Indiana counties (~5-6%) and the CenSARA states (~7%). Onroad mobile non-diesel sources are the largest contributor to $O_3$ in this area (~13%). Other anthropogenic inventory sectors with notable contributions to $O_3$ in Milwaukee include onroad mobile diesel (~10%), non-EGU point (~7%), offroad diesel engines (7%), and EGU point (~6%).

**Sheboygan County**

Emissions from the Chicago metro/surburban counties are the largest contributor to $O_3$ at monitors in Sheboygan county (~19-21%). Other notable anthropogenic emission source regions to Sheboygan county $O_3$ include the CenSARA states (~8%) and the northern Indiana counties (~7%). Anthropogenic emissions from the Wisconsin central coast counties, which include Sheboygan county, contribute ~1% to the $DV_{2016}$ value for this area. Onroad mobile non-diesel sources are the largest contributor to $O_3$ in this area (~13%). Other anthropogenic inventory sectors with notable contributions to $O_3$ in Sheboygan county include onroad mobile diesel (~9%), non-EGU point (~8%), offroad diesel engines (7%), and EGU point (~6%).

**Door County**

Emissions from the Chicago metro/surburban counties are the largest contributor to $O_3$ at monitors in Door county (~17%). Other notable anthropogenic emission source regions to Door county $O_3$ include the CenSARA states (~11%) and the northern Indiana counties (~7%). Onroad mobile non-diesel sources are the largest contributor to $O_3$ in this area (~12%). Other anthropogenic inventory sectors with notable contributions to $O_3$ in Door county include onroad mobile diesel (~10%), non-EGU point (~8%), offroad diesel engines (7%), and EGU point (~7%).

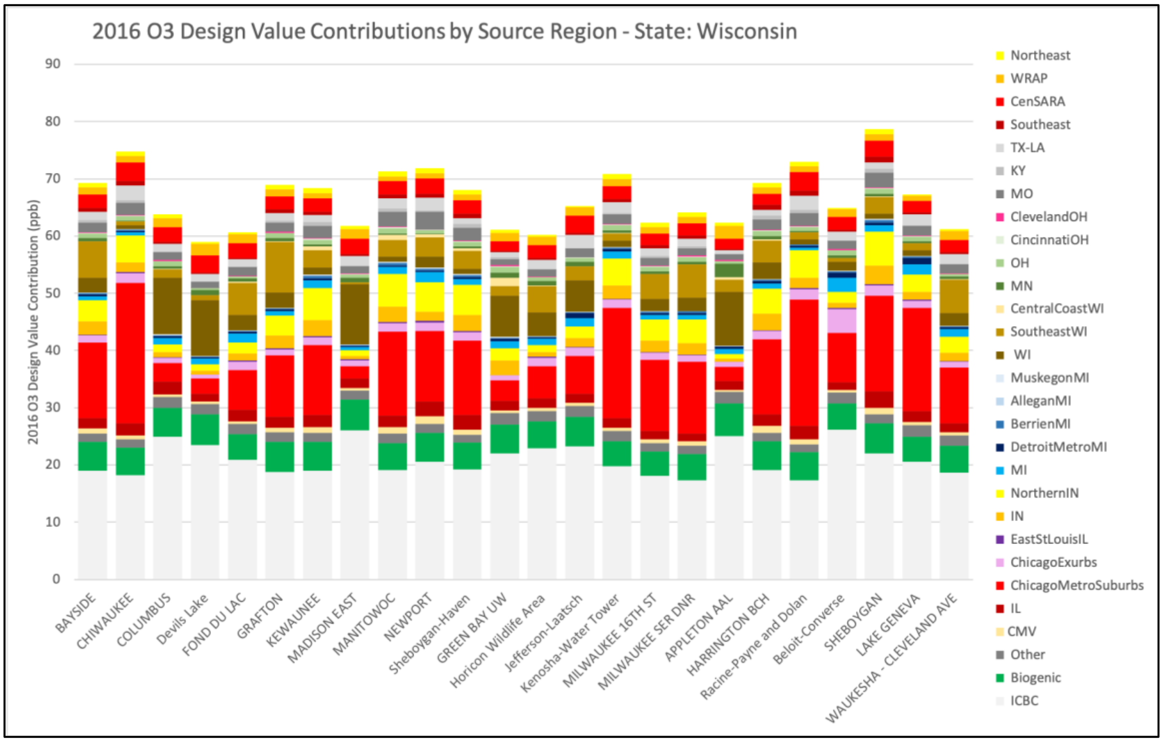


**Figure 7-9. Geographic tracer contributions to 2016 MDA8 $O_3$ at WI monitors**

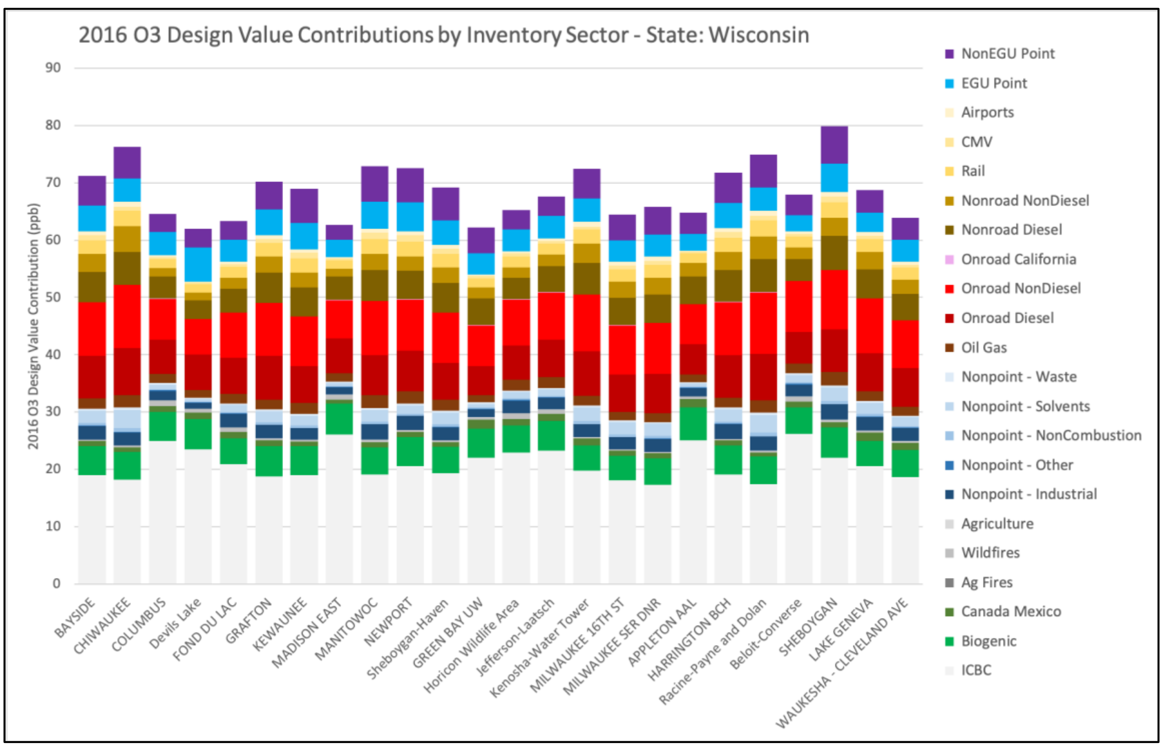


**Figure 7-10. Inventory sector tracer contributions to 2016 MDA8 $O_3$ at WI monitors**

# 8. 2016 Version 1 Modeling Platform Justification

As described in Section 3, LADCO used a modified version of the 2016v1 Inventory Collaborative emissions inventory and the U.S. EPA 2016fh emissions modeling platform to build the LADCO 2016 modeling platform. The LADCO 2016 platform used WRF 3.9.1 meteorology data optimized for the Great Lakes Basin (LADCO, 2022) and CAMx v7.10 to simulate 2016 and 2023 ozone concentrations. A key feature of the LADCO 2016 platform is the use of 12-km/4-km/1.33-km two-way nested domains centered on the LADCO region and Lake Michigan. Section 5 validated the performance of the LADCO 2016 platform for simulating $O_3$ concentrations in the Great Lakes region.

LADCO originally developed the 2016 modeling platform in early 2021 for demonstrating progress for the second regional haze planning period (LADCO, 2021). We extended the regional haze CAMx modeling to include the LADCO 2016 WRF meteorology and nested domains during spring and summer 2021, completing the LADCO CAMx simulations documented in this TSD (LADCO CAMx 2016bcc2 and 2023bcc) in late 2021.

U.S. EPA officially released the full 2016v2 emissions modeling platform in February 2022 (US EPA, 2022b). Starting in July 2021, U.S. EPA began to release components of the 2016v2 platform with MOVES3 onroad mobile source emission factors tables and inventory data for 2016 and 2023. U.S. EPA then released the rest of the inventory and modeling platform components by October 2021.

When U.S. EPA began to release the 2016v2 emissions data in summer 2021, LADCO was already committed to using the 2016v1-based emissions modeling platform to support 2015 $O_3$ NAAQS moderate area attainment demonstrations. As described in this section, LADCO's use of the 2016v1 emissions was justified for the following reasons:

1. LADCO had already invested significant resources into developing and evaluating the 2016v1-based platform when U.S. EPA released the 2016v2 data, and we did not have time to restart the modeling and evaluation to meet our commitments to our member states
2. While there are differences in the NOx and VOC emissions estimates between the 2016v1 and 2016v2 platforms, the differences are driven primarily by changes to the biogenic and

onroad mobile sectors. LADCO feels that the 2016v2 platform methodological updates to the models used to estimate the emissions for these sectors, BEIS and MOVES, respectively, require further evaluation for sources in the Great Lakes region. As described below, LADCO's modeling using 2016v1 emissions is well within the model performance benchmarks and is a better model than U.S. EPA's model using 2016v2 emissions in the LADCO region. Therefore, we did not feel that it was a good use of our time or resources to evaluate the extent to which the changes to these sectors impacted model performance and attainment testing for receptors in the Great Lakes region.

3. The LADCO 2016v1-based modeling platform has equal or better skill at simulating $O_3$ in the Great Lakes region than the U.S. EPA 2016v2-based platform

#### 8.1.1. 2016v1 and 2016v2 Emissions Comparison

A comparison of the 2016fh and 2016v2 EMP estimates of NOx and VOC emissions shows differences for the states in the LADCO region. Table 8-1 shows that the 2016 annual, state total anthropogenic VOC emissions decrease across a range of 1% (WI) to 21% (MI) in the v2 platform relative to 2016fh. The 2023 annual, state total anthropogenic VOC emissions differences range from a 4% (WI) increase to a 19% (MI) decrease in the v2 platform relative to 2016fh. Table 8-2 shows that the 2016 annual, state total anthropogenic NOx emissions differences range from a 4% increase in OH to 6% decrease in WI. The 2023 annual, state total anthropogenic NOx emissions changes range from a negligible decrease in MN to a 10% decrease in OH.

**Table 8-1. LADCO state annual total anthropogenic VOC emissions in the 2016fh and 2016v2 platforms (tons/year)**

| | 2016 | | | 2023 | | |
|---|---|---|---|---|---|---|
| **State** | **2016fh** | **V2** | **V2-fh (%)** | **2016fh** | **V2** | **V2-fh (%)** |
| Illinois | 358,774 | 323,933 | -10% | 323,736 | 300,714 | -7% |
| Indiana | 238,181 | 191,731 | -20% | 212,422 | 173,352 | -18% |
| Michigan | 318,496 | 253,054 | -21% | 274,125 | 221,088 | -19% |
| Minnesota | 244,278 | 220,320 | -10% | 212,262 | 198,488 | -6% |
| Ohio | 340,110 | 286,892 | -16% | 303,176 | 261,050 | -14% |
| Wisconsin | 181,182 | 179,946 | -1% | 154,312 | 160,096 | 4% |

**Table 8-2. LADCO state annual total anthropogenic NOx emissions in the 2016fh and 2016v2 platforms (tons)**

| State | 2016 | | | 2023 | | |
|---|---|---|---|---|---|---|
| | 2016fh | V2 | V2-fh (%) | 2016fh | V2 | V2-fh (%) |
| Illinois | 350,279 | 338,053 | -3% | 256,826 | 243,255 | -5% |
| Indiana | 305,578 | 303,099 | -1% | 200,095 | 186,696 | -7% |
| Michigan | 284,877 | 275,104 | -3% | 212,245 | 197,776 | -7% |
| Minnesota | 211,544 | 208,421 | -1% | 151,136 | 150,577 | 0% |
| Ohio | 334,833 | 348,213 | 4% | 242,282 | 218,930 | -10% |
| Wisconsin | 178,423 | 168,119 | -6% | 118,851 | 112,283 | -6% |

Figure 8-1 and Figure 8-2 are thematic maps of 2016fh and v2 platform differences in annual county total (anthropogenic + natural) NOx and VOC emissions in 2016 and 2023. The maps show that the emissions differences between the two platforms are not spatially uniform. The 2016 NOx emissions map (Figure 8-1, top) for example shows that many of the counties in the Great Lakes region have higher annual total NOx emissions in the 2016v2 platform relative to 206fh, despite lower state total emissions.

Table 8-3 compares the annual state total biogenic emissions between the 2016fh and v2 platforms. The statewide biogenic NO emissions increase across the region in the v2 platform relative to 2016fh ranging from +13% (IL) to +30% (WI). The statewide biogenic VOC emissions decrease in the v2 platform across the region with a range from -22% (OH) to -44% (IL). The biogenic sector is the single largest VOC emissions source on an annual, statewide basis.

As 2016fh emissions are generally higher than those included in 2016v2, LADCO's modeling using 2016fh emissions is likely conservative and predicting higher $O_3$ than if 2016v2 emissions were used.

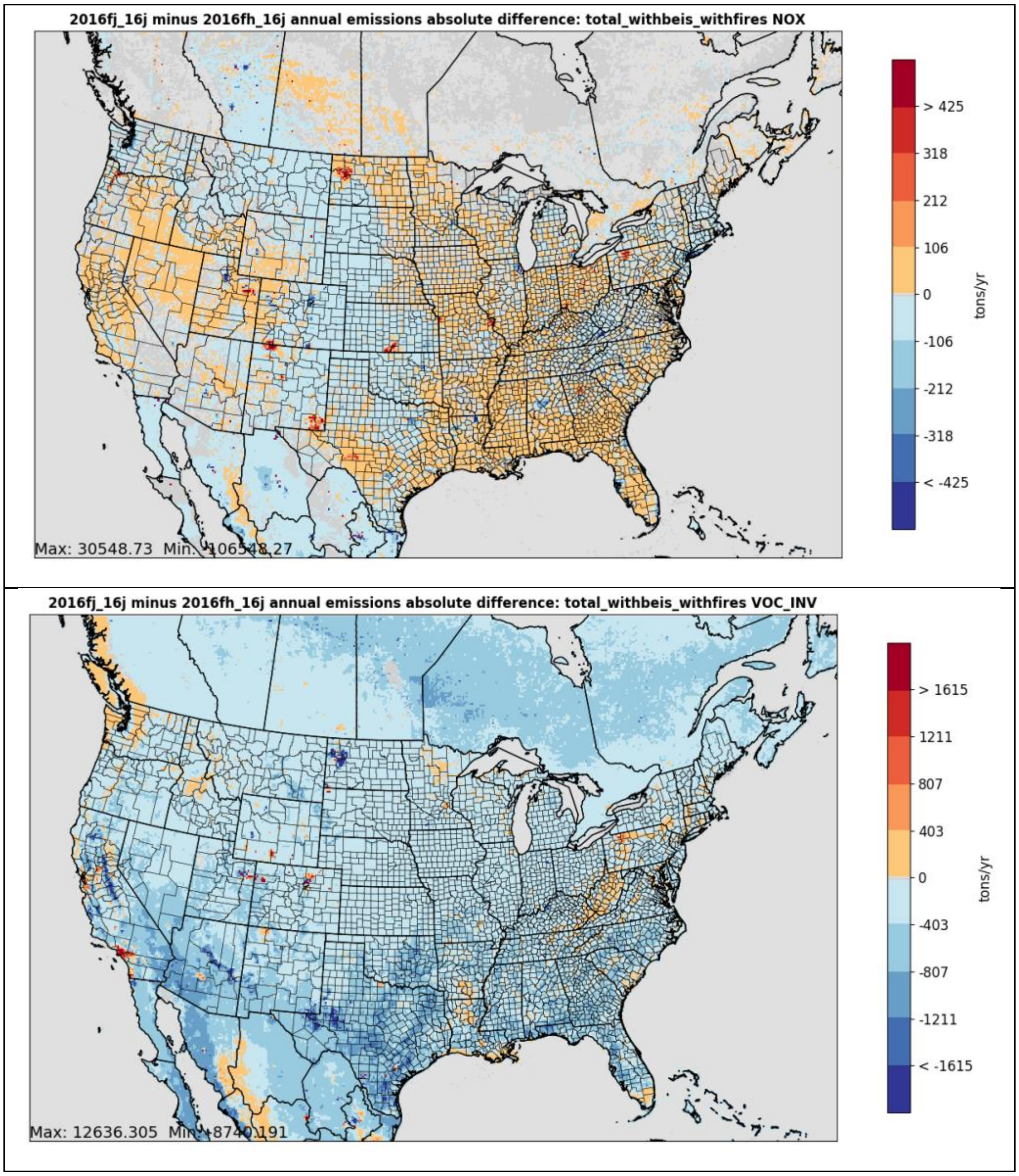


**Figure 8-1. Comparison of annual 2016 NOx (top) and VOC (bottom) emissions between the 2016fh and 2016v2 modeling platforms**

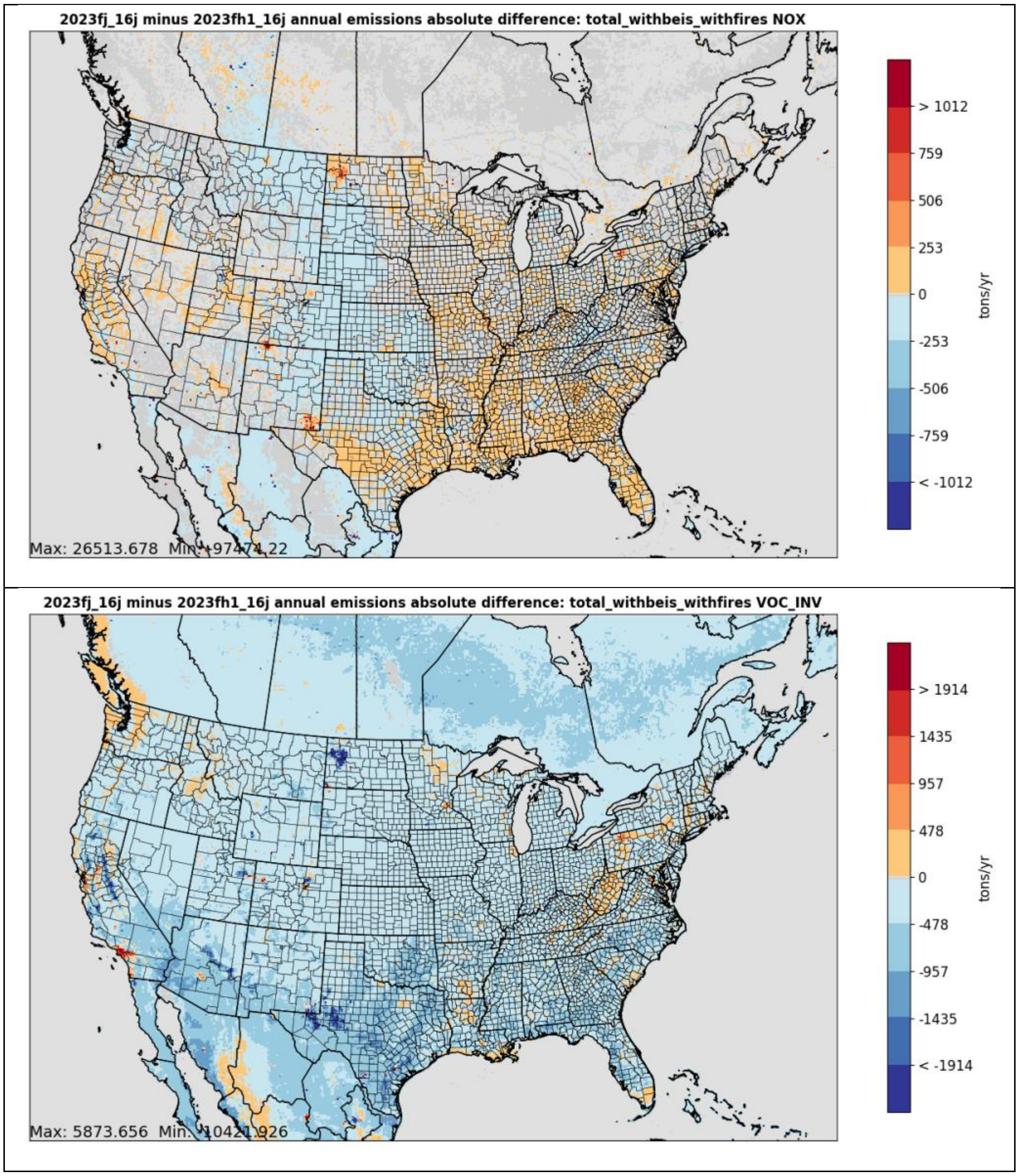


**Figure 8-2. Comparison of annual 2023 NOx (top) and VOC (bottom) emissions between the 2016fh and 2016v2 modeling platforms**

**Table 8-3. Annual state total biogenic emissions in the 2016fh and v2 platforms (tons)**

| State | NO | | | VOC | | |
|---|---|---|---|---|---|---|
| | 2016fh | V2 | V2-fh (%) | 2016fh | V2 | V2-fh (%) |
| Illinois | 38,921 | 44,043 | 13% | 422,736 | 236,316 | -44% |
| Indiana | 21,381 | 24,667 | 15% | 279,976 | 188,777 | -33% |
| Michigan | 14,572 | 17,990 | 23% | 593,916 | 401,359 | -32% |
| Minnesota | 28,031 | 35,863 | 28% | 510,385 | 366,050 | -28% |
| Ohio | 18,120 | 21,720 | 20% | 360,156 | 279,428 | -22% |
| Wisconsin | 16,095 | 20,871 | 30% | 484,780 | 324,112 | -33% |

#### 8.1.2. 2016v1 and 2016v2 Ozone Model Performance Comparison

Figure 8-3 through Figure 8-10 compare LADCO 2016v1 and U.S. EPA 2016v2 12-km CAMx model performance in simulating $O_3$ season (May – September) MDA8 $O_3$ on days with observed concentrations > 60 ppb. The U.S. EPA figures are extracted from the U.S. EPA 2016v2 modeling platform technical support document (U.S. EPA, 2022). The figures show average $O_3$ season bias and error statistics at sites in the LADCO region. Each pair of figures compares the CAMx performance between the LADCO and U.S. EPA simulations. Note that the color scales are normalized in these figures, with the color scale legend included in the LADCO plot for each statistic. Figure 8-3 and Figure 8-4 show LADCO and U.S. EPA CAMx mean error (ME), respectively. The LADCO simulation has a lower ME compared to the U.S. EPA simulation at almost every site in and near the LADCO states. Most notably, the LADCO simulation has a significantly lower ME (5-10 ppb) at the lakeshore monitors throughout the region.

Figure 8-5 and Figure 8-6 compare the seasonal normalized mean error (NME) on high MDA8 $O_3$ days between the LADCO and U.S. EPA simulations, respectively. The NME comparison highlights the superior performance of the LADCO CAMx simulation throughout the domain and most notably at the lakeshore monitors. While the two simulations have similar NME values at sites around the Ohio River Valley and south, the LADCO simulation has NMEs that are consistently 5-10% lower at inland sites in Illinois, Indiana, and Ohio. Compared to the EPA CAMx simulation, the LADCO simulation has NMEs that are 10-15% lower at lakeshore sites, and at inland sites in Wisconsin and Michigan.

Figure 8-7 and Figure 8-8 show $O_3$ season average MDA8 $O_3$ mean bias (MB) for days with observations higher than 60 ppb. Both simulations had very good performance around the Ohio River Valley with MB values less than ±5 ppb. The LADCO simulation outperforms the U.S. EPA simulation at nearly all monitors in the LADCO states. The U.S. EPA CAMx simulation on average underestimates high MDA8 $O_3$ concentrations by 5-15 ppb, with the worst performance around Lake Michigan and at inland sites in Wisconsin and Michigan. The LADCO CAMx simulation also underestimates MDA8 $O_3$ on average at these sites but has MBs in the range of 0-10 ppb.

Figure 8-9 and Figure 8-10 compare the $O_3$ season normalized mean bias (NMB) for the LADCO and U.S. EPA CAMx simulations. These figures show similar performance differences as the previous error and MB plots, with the LADCO CAMx simulation systematically outperforming the U.S. EPA CAMx simulation at nearly all sites in the domain. Most notably, LADCO CAMx simulated very low seasonal averaged NMB (<10%) at all the controlling monitors in the 2015 $O_3$ NAAQS NAAs in the region. The U.S. EPA simulation for many of these monitors underestimated MDA8 $O_3$ on high concentration days by 10-30%.

These comparisons of the LADCO and U.S. EPA CAMx simulations indicate that on average, for high $O_3$ concentration days the LADCO 2016v1-based CAMx is a better model of ground-level $O_3$ for the Great Lakes region than the U.S. EPA 2016v2-based CAMx model. These comparisons reflect differences in both meteorology and emissions inputs to the model, but taken together the LADCO CAMx model presented here is well within the model performance benchmarks cited by U.S. EPA (2022), and superior to the current U.S. EPA model for this region.

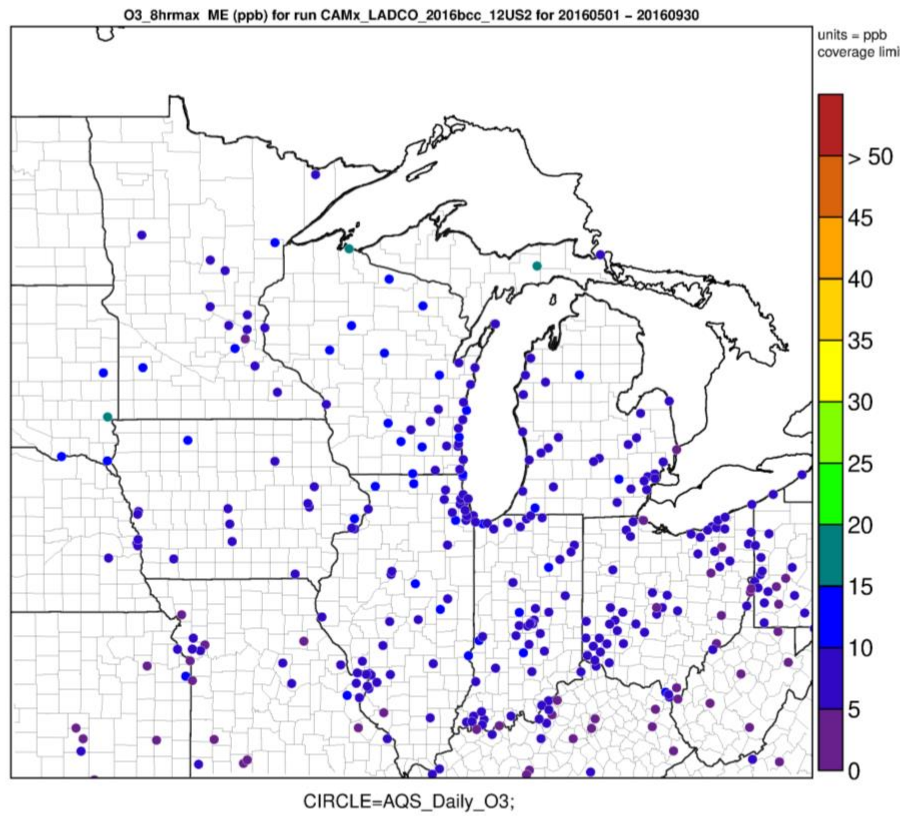


**Figure 8-3. LADCO CAMx 12km MDA8 O3 May – September average mean error for days > 60 ppb.**

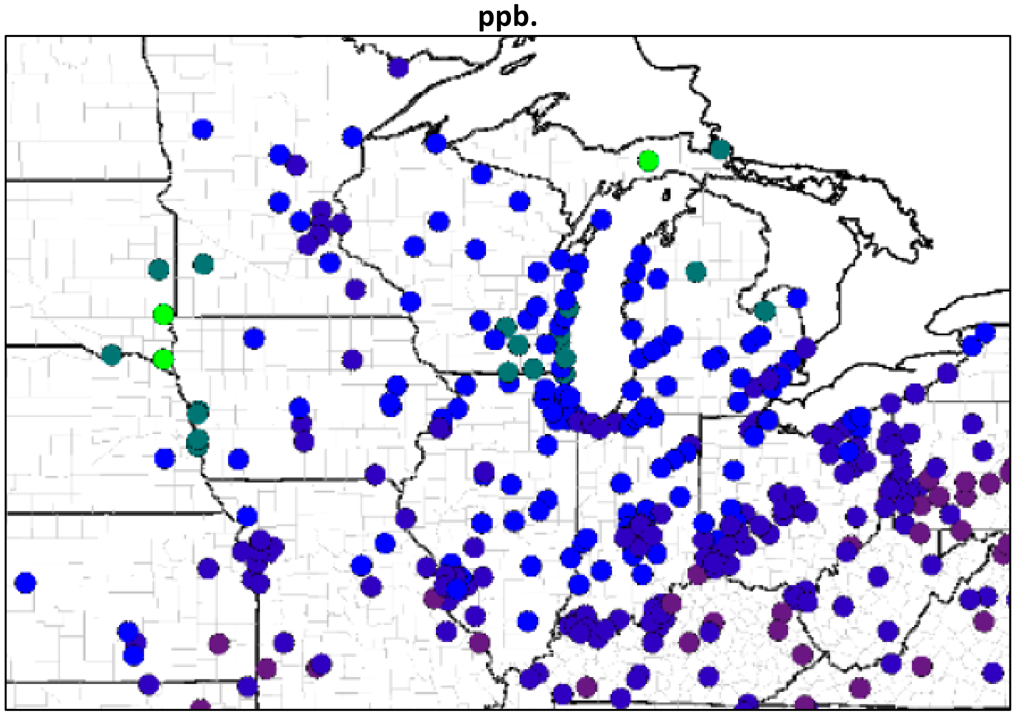

**Figure 8-4. US EPA 2016v2 (2016fj_v710_CB6r5) CAMx 12km MDA8 O3 May – September average mean error for days > 60 ppb (US EPA, 2022).**

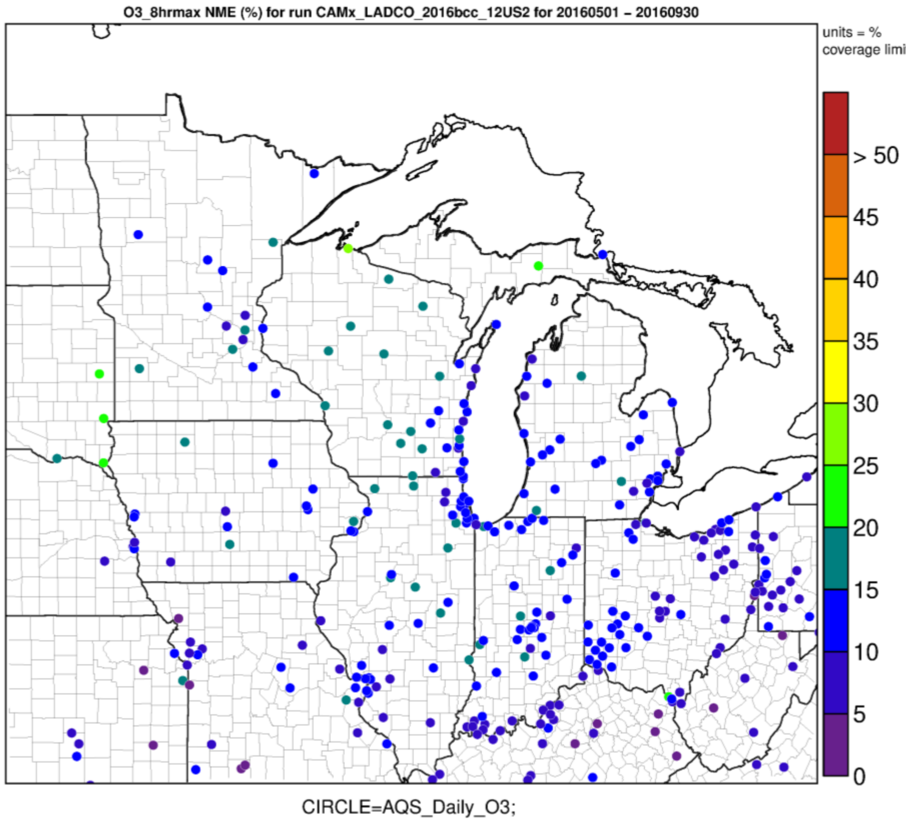


**Figure 8-5. LADCO CAMx 12km MDA8 O3 May – September average normalized mean error for days > 60 ppb.**

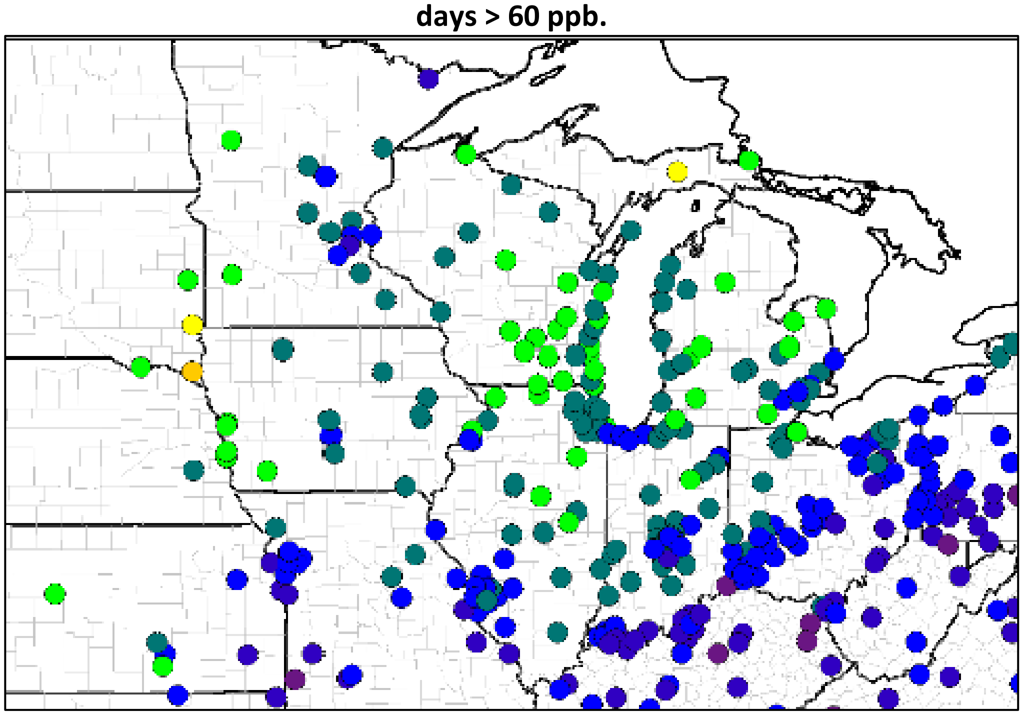

**Figure 8-6. US EPA 2016v2 (2016fj_v710_CB6r5) CAMx 12km MDA8 O3 May – September average normalized mean error for days > 60 ppb (US EPA, 2022).**

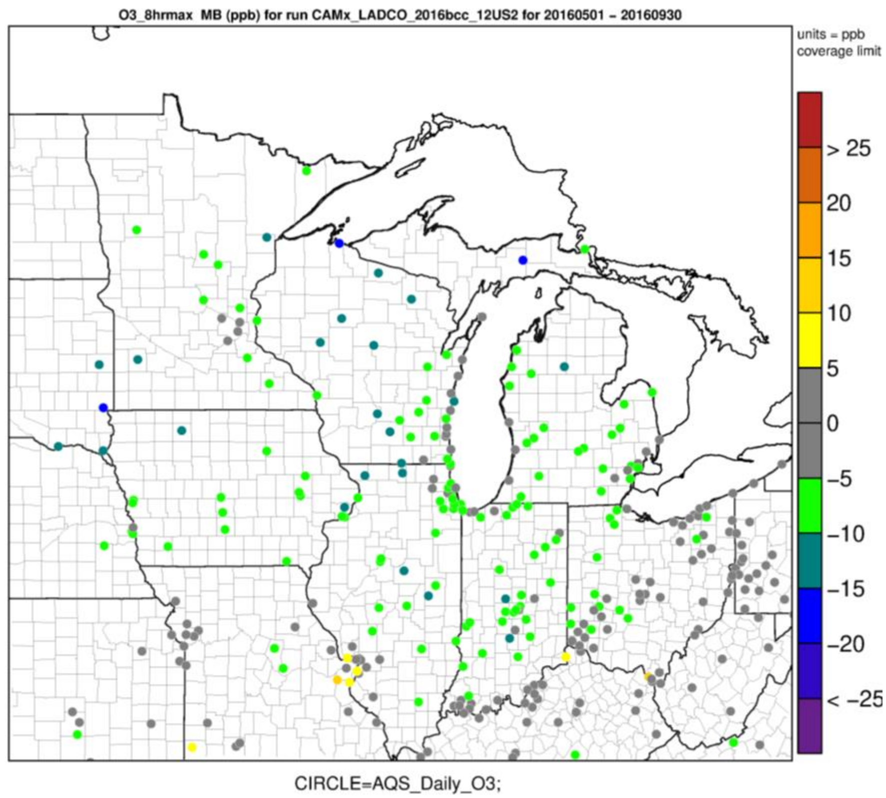


**Figure 8-7. LADCO CAMx 12km MDA8 O3 May – September average mean bias for days > 60 ppb.**

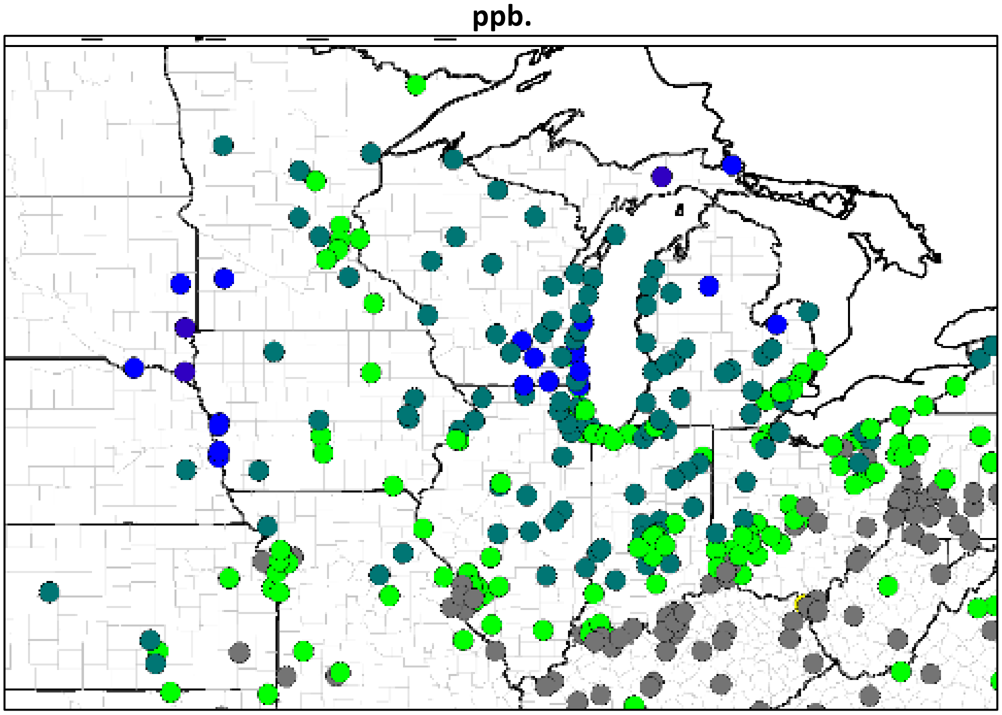

**Figure 8-8. US EPA 2016v2 (2016fj_v710_CB6r5) CAMx 12km MDA8 O3 May – September average mean bias for days > 60 ppb (US EPA, 2022).**

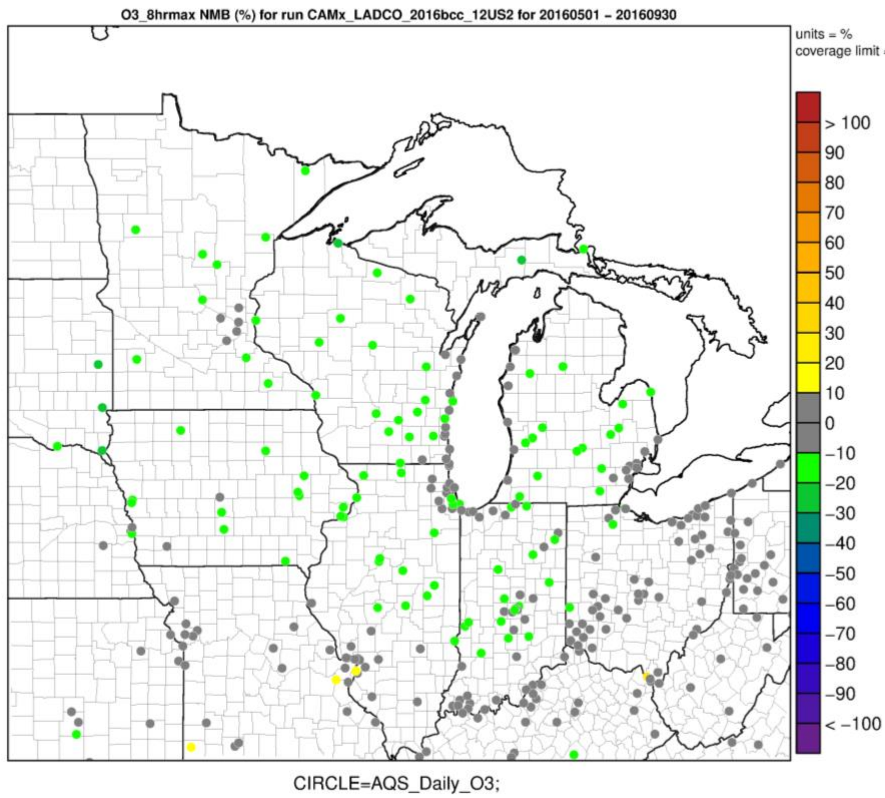


**Figure 8-9. LADCO CAMx 12km MDA8 O3 May – September average normalized mean bias for days > 60 ppb.**

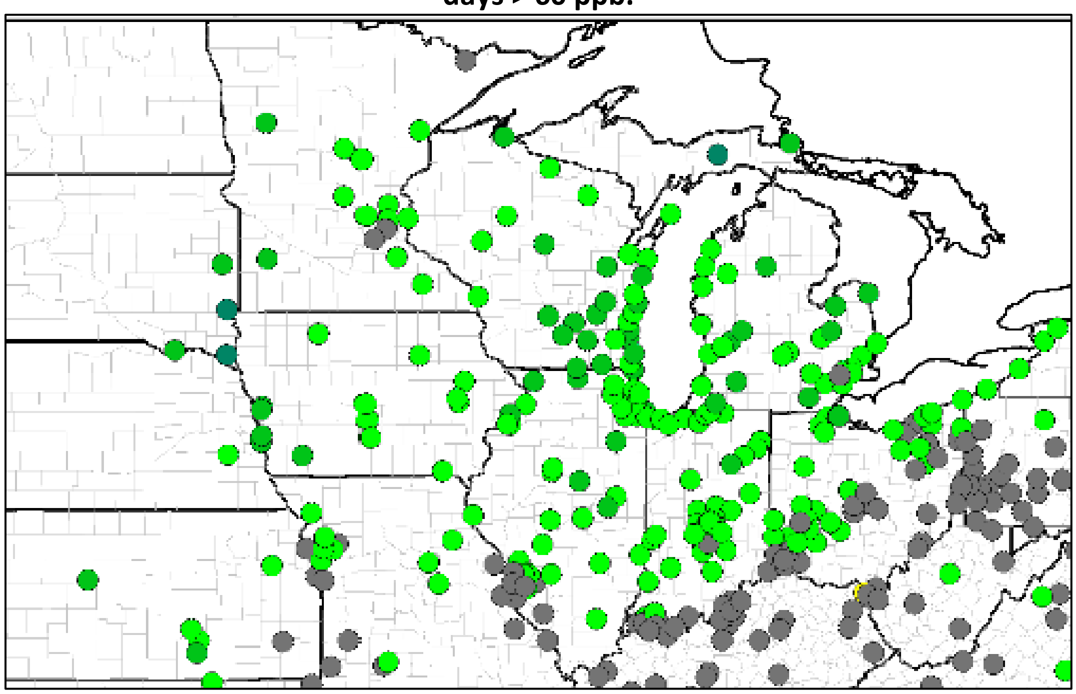

**Figure 8-10. US EPA 2016v2 (2016fj_v710_CB6r5) CAMx 12km MDA8 O3 May – September average normalized mean bias for days > 60 ppb (US EPA, 2022).**

#### 8.1.3. 2016v1 and 2016v2 Attainment Test Comparison

Table 8-4 compares the 2023 $O_3$ attainment test results for the LADCO 2016v1-based and U.S. EPA 2016v2-based CAMx modeling. The $O_3$ future year design values ($DVF_{2023}$) in this table are calculated from CAMx 12-km simulations that used similar SMAT-CE configurations (3x3 cells surrounding the monitors, including water cells in the calculations). The table compares average and $DVF_{2023}$ values. The table shows 2023 DVs for every site in all 2015 $O_3$ NAAQS nonattainment areas in the LADCO region.

There is no systematic difference between the LADCO and U.S. EPA CAMx-estimated $DVF_{2023}$ values. The LADCO CAMx simulation forecasted that two sites in the Great Lakes region will exceed the 2015 $O_3$ NAAQS in 2023, the coastal Wisconsin sites Sheboygan Kohler Andrae and Chiwaukee Prairie. The U.S. EPA CAMx simulation forecasted that four sites in the LADCO region will exceed the NAAQS, the same two sites as the LADCO simulation plus Racine County, Wisconsin and Evanston, Illinois.

**Table 8-4. LADCO and US EPA v2 2023 average $O_3$ design values at all monitors in the LADCO region 2015 O3 NAAQS nonattainment areas**

| State | NAA | Site ID | Site Name | LADCO 2023 DV | EPA 2023 DV |
|---|---|---|---|---|---|
| Michigan | Allegan County, MI | 260050003 | HOLLAND | 67.5 | 67.8 |
| Michigan | Berrien County, MI | 260210014 | COLOMA | 67.7 | 68.7 |
| Michigan | Muskegon County, MI | 261210039 | MUSKEGON | 68.9 | 69.1 |
| Illinois | Chicago, IL-IN-WI | 170310001 | ALSIP | 67.7 | 69.6 |
| Illinois | Chicago, IL-IN-WI | 170314201 | NORTHBRK | 67.6 | 70.0 |
| Illinois | Chicago, IL-IN-WI | 170317002 | EVANSTON | 68.2 | **71.1** |
| Illinois | Chicago, IL-IN-WI | 170310032 | CHI_SWFP | 67.0 | 70.1 |
| Illinois | Chicago, IL-IN-WI | 170310076 | CHI_COM | 66.9 | 69.3 |
| Illinois | Chicago, IL-IN-WI | 170971007 | ZION | 67.8 | 70.0 |
| Illinois | Chicago, IL-IN-WI | 170314007 | DESPLNS | 66.4 | 68.8 |
| Illinois | Chicago, IL-IN-WI | 170314002 | CICERO | 64.3 | 66.9 |
| Illinois | Chicago, IL-IN-WI | 171110001 | CARY | 64.1 | 64.5 |
| Illinois | Chicago, IL-IN-WI | 170436001 | LISLE | 65.5 | 65.8 |
| Illinois | Chicago, IL-IN-WI | 170890005 | ELGIN | 64.0 | 64.8 |
| Illinois | Chicago, IL-IN-WI | 170311601 | LEMONT | 64.5 | 65.2 |
| Illinois | Chicago, IL-IN-WI | 170311003 | CHI_TAFT | 63.3 | 65.8 |
| Illinois | Chicago, IL-IN-WI | 170313103 | SCHILPRK | 57.8 | 59.5 |
| Indiana | Chicago, IL-IN-WI | 181270026 | Valparaiso | 63.0 | 64.5 |

| | | | | | |
|---|---|---|---|---|---|
| Indiana | Chicago, IL-IN-WI | 181270024 | Ogden Dunes | 63.8 | 65.5 |
| Indiana | Chicago, IL-IN-WI | 180890022 | Gary-IITRI | 62.4 | 65.2 |
| Indiana | Chicago, IL-IN-WI | 180892008 | Hammond-141st St | 60.5 | 63.3 |
| Wisconsin | Chicago, IL-IN-WI | 550590019 | CHIWAUKEE | **71.5** | **73.6** |
| Wisconsin | Chicago, IL-IN-WI | 550590025 | Kenosha-Water Tower | 67.5 | 69.2 |
| Ohio | Cincinnati, OH-KY | 390610006 | Sycamore | 64.9 | 64.6 |
| Ohio | Cincinnati, OH-KY | 390170018 | Middletown Airport | 63.2 | 62.4 |
| Ohio | Cincinnati, OH-KY | 390170023 | Crawford Woods | 64.5 | 63.4 |
| Ohio | Cincinnati, OH-KY | 390610010 | Colerain | 64.7 | 62.7 |
| Ohio | Cincinnati, OH-KY | 390610040 | Taft NCore | 63.9 | 62.8 |
| Ohio | Cincinnati, OH-KY | 391650007 | Lebanon | 63.3 | 62.9 |
| Ohio | Cincinnati, OH-KY | 390179991 | Oxford | 62.1 | 61.1 |
| Ohio | Cincinnati, OH-KY | 390250022 | Batavia | 62.3 | 60.4 |
| Ohio | Cleveland, OH | 390850003 | Eastlake | 67.5 | 65.6 |
| Ohio | Cleveland, OH | 390550004 | Notre Dame | 63.6 | 62.0 |
| Ohio | Cleveland, OH | 390355002 | Mayfield | 63.6 | 61.9 |
| Ohio | Cleveland, OH | 390350034 | District 6 | 63.0 | 62.1 |
| Ohio | Cleveland, OH | 390850007 | Painesville | 63.1 | 62.1 |
| Ohio | Cleveland, OH | 390930018 | Sheffield | 59.6 | 58.4 |
| Ohio | Cleveland, OH | 390350064 | Berea BOE | 59.6 | 58.5 |
| Ohio | Cleveland, OH | 391030004 | Chippewa | 58.1 | 56.2 |
| Ohio | Cleveland, OH | 391530020 | Patterson Park | 56.9 | 54.9 |
| Ohio | Cleveland, OH | 390350060 | GT Craig NCore | 57.3 | 56.1 |
| Ohio | Cleveland, OH | 391331001 | Lake Rockwell | 55.6 | 53.8 |
| Michigan | Detroit, MI | 261630019 | East 7 MILE | 66.2 | 65.7 |
| Michigan | Detroit, MI | 261250001 | OAK PARK | 64.4 | 64.4 |
| Michigan | Detroit, MI | 261470005 | PORT HURON | 65.6 | 66.4 |
| Michigan | Detroit, MI | 260990009 | NEW HAVEN | 64.3 | 64.5 |
| Michigan | Detroit, MI | 261619991 | Ann Arbor | 62.6 | 63.2 |
| Michigan | Detroit, MI | 260991003 | WARREN | 60.7 | 60.2 |
| Michigan | Detroit, MI | 261610008 | YPSILANTI | 62.2 | 62.5 |
| Michigan | Detroit, MI | 261630001 | ALLEN PARK | 60.9 | 60.2 |
| Indiana | Louisville, KY-IN | 180431004 | New Albany | 64.0 | 63.6 |
| Indiana | Louisville, KY-IN | 180190008 | Charlestown State Park | 62.9 | 62.2 |
| Wisconsin | Milwaukee, WI | 551010020 | Racine | 69.6 | **71.1** |

| | | | | | |
|---|---|---|---|---|---|
| Wisconsin | Milwaukee, WI | 550890009 | HARRINGTON BCH | 68.3 | 68.7 |
| Wisconsin | Milwaukee, WI | 550790085 | BAYSIDE | 66.7 | 66.5 |
| Wisconsin | Milwaukee, WI | 550890008 | GRAFTON | 66.0 | 66.6 |
| Wisconsin | Milwaukee, WI | 550790026 | MILWAUKEE SER | 62.6 | 63.5 |
| Wisconsin | Milwaukee, WI | 550790010 | MILWAUKEE 16TH ST | 59.7 | 60.7 |
| Wisconsin | Milwaukee, WI | 551330027 | CLEVELAND AVE | 59.9 | 60.3 |
| Wisconsin | Sheboygan County, WI | 551170006 | SHEBOYGAN | **75.1** | **74.7** |
| Wisconsin | Sheboygan County, WI | 551170009 | Sheboygan-Haven | 65.6 | 65.1 |
| Illinois | St. Louis, MO-IL | 171191009 | MARYVILL | 61.9 | 62.3 |
| Illinois | St. Louis, MO-IL | 171193007 | WOOD_WTP | 63.1 | 63.8 |
| Illinois | St. Louis, MO-IL | 171630010 | East St. Louis | 61.3 | 62.4 |
| Illinois | St. Louis, MO-IL | 171199991 | Alhambra | 60.2 | 60.4 |

# 9. Conclusions and Significant Findings

LADCO presents in this TSD a regional air quality modeling platform for quantifying and evaluating future year $O_3$ concentrations pursuant to testing attainment of the 2015 $O_3$ NAAQS moderate area designations for receptors at nonattainment areas throughout the Great Lakes Basin. After establishing that the LADCO 2016-based modeling platform is an acceptable tool for simulating regional $O_3$ concentrations, we presented the results from projections of future $O_3$ concentrations and for calculating $O_3$ design values in 2023. A summary of the significant findings from the LADCO modeling follows.

- <u>Finding 1</u>: While the LADCO 2016v1-based CAMx modeling platform has an underprediction bias for high $O_3$ concentrations, the LADCO platform skill is the same or better than U.S. EPA 2016 modeling platforms used to support recent $O_3$ regulatory actions.
- <u>Finding 2</u>: The LADCO 2023 CAMx simulation predicts that two monitors in the LADCO region will have an average $DV_{2023}$ that exceeds the 2015 $O_3$ NAAQS.
- <u>Finding 3</u>: Excluding water cells in the attainment test calculation results in both higher and lower $DVs_{2023}$ for the lakeshore monitors in the LADCO region.
- <u>Finding 4</u>: Compared to the U.S. EPA 2016v2 CAMx modeling platform, the LADCO CAMx modeling platform is a superior model of $O_3$ in the Great Lakes Basin

As with all regional air quality modeling applications, there are uncertainties in the model inputs and in the model formulation that produce biases in the results presented here. LADCO determined that when the modeling for this application was started in Fall 2021 the LADCO 2016 WRF meteorology, U.S. EPA 2016fh emissions modeling platform, and the ERTAC EGU 16.2 beta emissions were the best available data for forecasting 2023 air quality for the LADCO member states.

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# APPENDIX 10

# Responses to Public Comment

## Responses to Public Comments Received on the Draft Attainment Plan

This attainment plan SIP submittal was made available for public review and comment from December 16, 2024, to January 17, 2025. In addition, a virtual public hearing was held online on January 16, 2025, and was attended by eight members of the public. The WDNR received two comments, one during the virtual public hearing and one written comment. This appendix contains a summary of the comments and the WDNR's responses.

Note that a single comment period and public hearing were held for all three of the WDNR's 2015 ozone NAAQS moderate area attainment plans (for the Sheboygan, Milwaukee, and Kenosha nonattainment areas). As such, unless specifically noted by the commenter, the WDNR assumed comments were intended to apply generally to all the plans, rather than a specific SIP.

### Commenter 1: Laura Lane

<u>Comment:</u> The commenter expresses concern about the poor air quality in Milwaukee, Sheboygan, and Kenosha, noting that data from the American Lung Association's 2024 State of the Air Report shows that there are serious air quality concerns in these areas. The commenter requests expanded air monitoring programs in these communities.

The commenter also requests that the WDNR stop "rubber stamping" air permits for new fossil fuel projects, especially in environmental justice communities. The commenter specifically notes We Energies' proposals to develop methane gas infrastructure, including reciprocal internal combustion engines in Paris and a methane gas plant in Oak Creek. The commenter questions how WDNR can continue to approve air permits for fossil fuel projects and data centers without doing a more comprehensive review of the public health and environmental impacts to vulnerable communities that experience environmental injustices like poor air quality.

The commenter concludes that the WDNR's proposed submittal and its practice of approving air permits without doing meaningful and comprehensive assessments means the department is failing to protect public health, especially for its most vulnerable citizens.

<u>Response:</u> Thank you for these comments. In terms of air quality monitoring, as described in Section 5.2 of the plans, the WDNR operates two ozone monitors in Sheboygan County (one in the nonattainment area), seven monitors in the Milwaukee nonattainment area, and two monitors in Kenosha area.[1] This monitoring network exceeds federal requirements and is reviewed by the WDNR and approved by the EPA annually. This network is considered more than adequate to assess ambient ozone concentrations in these areas and no additional monitors are currently being contemplated.

In response to the comments about permitting, as noted in Section 1 of the plans, these SIPs are being submitted to fulfill specific Clean Air Act requirements associated with demonstrating attainment in these areas. No air pollution control permitting programs are impacted by these SIP submittals, and nothing in these submittals can or would change any permitting requirements for any emissions source. Comments relating to the WDNR's air permitting processes or decisions

[1] In addition, Illinois and Indiana operate almost 20 monitors in their portions of the Chicago nonattainment area.

are therefore outside of the scope of these SIPs, and no changes were made to the plans in response to this comment.

However, the WDNR reiterates that all air pollution control permit applications received by the department are subject to a rigorous review process. Before the WDNR can issue an air pollution control permit, state and federal laws require the WDNR to assure that the worst-case air pollution emissions from a facility will not cause pollution concentrations in the vicinity that would exceed any National Ambient Air Quality Standard set by the EPA. This is done through air quality analysis and dispersion modeling, which includes consideration of emissions from nearby industries and other sources. Air pollution control permits are also subject to public review and comment prior to issuance.

**Commenter 2: Brittany Keyes (Healthy Climate Wisconsin/NAACP WI State Conference)**

Comment: The commenter observes that some citations and research in the submittal are from the 1970s, 1980s and 1990s. As an example, the commenter points to the mesoscale meteorological data presented in Section 2.3. The commenter also notes that the hourly surface temperature for Racine (Figure 2.2) uses data from 2002, even as NOAA data shows that global average temperatures have changed since 2002. From the perspective of a researcher, the commenter requests that the WDNR use more recent data when available, especially given global shifts in climate and temperatures.

Response: Thank you for this comment. Section 2 of the plans, to which the commenter refers, contains a general discussion of ozone dynamics along the Wisconsin lakeshore. While not necessary to fulfill a specific CAA requirement, the WDNR has long included this information in ozone SIPs to provide important context to understanding how local and regional emissions impact ozone values along Wisconsin's lakeshore. This discussion pulls from decades of research that continues to be corroborated by ongoing field studies and data analysis, and is specific to the unique conditions and processes present in the Lake Michigan region (as opposed to global trends). As the WDNR notes in a footnote in Section 2, the scientific principles and findings in this section remain current, even if the examples utilize older data. While the WDNR will consider updating the examples in future SIPs to reflect data of more recent vintage, no changes were made to these plans in response to this comment.

Comment: The commenter requests that the WDNR more critically analyze Wisconsin industrial sources of air pollution in these nonattainment areas, even if there are unique conditions in this region that cause out-of-state emissions to impact the air quality in these areas. For example, based on industry-reported $CO_2$ emissions data in the EPA's FLIGHT[2] tool, in 2023 four industrial polluters in Sheboygan County reported over 2.5 million metric tons of greenhouse gases (GHGs). The Alliant Edgewater coal plant was responsible for over 2 million metric tons (over 80% of the county total). In Milwaukee County, 13 sources reported emissions of almost 11 million metric tons of GHGs in 2023, with just under 10 million tons coming from We Energies' coals plants at South Oak Creek and Elm Road (accounting for 90% of the county's reported industrial emissions).

[2] Facility Level Information on GreenHouse gases Tool

The SIPs highlight the cross-state nature of air pollution. The commenter notes that, in 2023, there were 23 industrial polluters in Cook County (Chicago) that together reported less than 2 million metric tons of $CO_2$. Emissions from the Sheboygan Edgewater power plant would therefore appear to be greater than Cook County's total industrial emissions. Similarly, We Energies' coal plants in Milwaukee County would appear to emit five times more emissions than all industrial polluters in Cook County.

The commenter appreciates that emissions have declined overall leading up to 2020. However, the conclusions in the SIPs fail to recognize that emissions reductions have plateaued and even reversed since then. The commenter notes this was identified in a presentation made by Air Management Program staff at the For Kids Health Summit hosted by the Children's Health Alliance of Wisconsin. The commenter requests that the WDNR amend the conclusion of these plans to reflect that emissions have plateaued since 2020.

Response: Thank you for these comments. The emissions data referenced by the commenter refers are for $CO_2$ (or GHGs in general). As described in Section 1, these SIPs are being submitted to fulfill specific CAA attainment planning requirements associated with ground-level ozone, which is caused by emissions of two precursor pollutants: nitrogen oxides (NOx), and volatile organic compounds (VOCs). For this reason, any discussion of $CO_2$ or GHG emissions are outside the scope of these submittals.

In terms of emission trends, as discussed in Section 3 of the plans, emissions of the precursor pollutants of NOx and VOCs have decreased between the nonattainment base year (2017) and attainment year (2023) in all three nonattainment areas. As pointed out by the commenter, ozone measurements in these nonattainment areas have not kept pace with these emissions reductions. While the WDNR acknowledged this in Section 5.2.1 of the plans,[3] in response to this comment, the WDNR has also noted this trend in the conclusion of each plan (Section 8).

Comment: The commenter did not see environmental justice considerations reflected in the plans. This is important, as high-polluting industry often situates itself near low income and minority communities. The commenter requests that the WDNR consider historic and ongoing environmental injustices when evaluating any new minor or major air permits being considered in these nonattainment areas.

The commenter notes that, according to the NAACP, race, more than class, is the number one indicator for the placement of toxic facilities in the U.S. Racially diverse communities continue to be those located closest to gas plants and high-polluting facilities. When it comes to public health, these communities will continue to have higher rates of cancer risk and chronic disease until regulators are able to fully evaluate cumulative impacts and prioritize environmental justice assessments as part of permitting processes. The commenter asks that the WDNR incorporate assessment and modeling for regional pollution identifying cumulative impacts.

The commenter further notes that evaluating cumulative impacts is very important when considering impacts on public health. It is especially important to evaluate environmental justice

[3] See, for example, Section 5.2.1 of the Milwaukee plan: "Despite continuing reductions of regional emissions, a leveling-out of ozone values has been observed in more recent years."

considerations from a regional perspective. This SIP considered emissions and impacts from as far away as the Ohio River valley. In contrast, a recent nonattainment permit (this may not have been a Wisconsin permit) only considered environmental justice impacts within a one-mile radius around the facility. The commenter asks that the WDNR apply a regional approach when assessing health impacts and environmental justice concerns.

Finally, the commenter thanks the WDNR for its work and effort on the SIP, and asks that the WDNR continue to strengthen its processes and protections for the health of residents across the state of Wisconsin.

Response: Thank you for this comment. As discussed in the response to Commenter 1, these SIPs are being submitted to fulfill specific Clean Air Act requirements associated with demonstrating attainment in these areas. Comments relating to the WDNR's air permitting processes or decisions are therefore outside of the scope of these submittals.

As described in Section 1 of the plans, the CAA prescribes specific requirements that need to be satisfied by attainment SIPs being submitted for moderate nonattainment areas. These requirements include implementation of specific control programs (e.g., reasonably available control measures (RACT) rules, vehicle inspection and maintenance programs) as well as other, specific attainment planning obligations (such as development of a modeled attainment demonstration). Technical work beyond those requirements, such assessing cumulative impacts or evaluating source-specific air pollution impacts on environmental justice communities, have not been included in these plans, as those are beyond the CAA attainment planning obligations these SIPs have been developed to fulfill.

However, the WDNR agrees with the commenter that improving the air quality in nonattainment areas is critical. Long-term ozone nonattainment results in adverse health impacts on the residents of these areas. The WDNR continues to work closely with the EPA and neighboring states to address the challenges that nonattainment poses, especially the impact of out-of-state emissions on these areas, in order to ensure that these communities meet federal ozone standards as soon as possible.

# APPENDIX 11

# Enhanced I/M Program Performance Standard Modeling Demonstration

This appendix provides a modeled demonstration that Wisconsin's current motor vehicle inspection and maintenance (I/M) program meets the requirements of EPA's enhanced performance standard for areas designated and classified under the 8-hour ozone standard as specified in [40 CFR 51.351(i)](). This section of the CFR specifies a model program which is to be compared to the state I/M program being assessed using emissions modeling.

A previous modeling demonstration that confirmed that Wisconsin's I/M program met the enhanced I/M program performance standard was completed in 2021 as part of the state's redesignation request for the Kenosha County (partial) 2008 ozone nonattainment area. The EPA approved this demonstration on April 11, 2022 (87 FR 21027). This appendix updates that modeling demonstration for the 2015 ozone nonattainment areas within the I/M program area.

## 1. Description of the Wisconsin I/M Program

Wisconsin's I/M program has been in operation since 1984. It was originally implemented in accordance with the 1977 CAA Amendments and operated in the six counties of Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha. Sheboygan County was added to the program in July 1993, resulting in a seven-county program area that has remained to the present. Vehicles were originally tested by measuring tailpipe emissions using a steady-state idle test. Tampering inspections were added in 1989.

The 1990 CAA Amendments set additional requirements for I/M programs. For moderate areas, a "basic" program was required under section 182(b)(4). For serious or worse areas, an "enhanced" program was required under section 182(c)(3). The EPA's requirements for basic and enhanced I/M programs are found in 40 CFR part 51, subpart S.

Wisconsin's I/M program transitioned to an enhanced program in December 1995. The major enhancement involved adding new test procedures to more effectively identify high-emitting vehicles. These new test procedures included a transient emissions test in which tailpipe emissions were measured while the vehicle was driven on a dynamometer (a treadmill-type device). Improving repairs and public convenience were also major focuses of the enhancement effort.

Since July 2001, all model year (MY) 1996 and later cars and light trucks have been inspected by scanning the vehicle's computerized second-generation on-board diagnostic (OBDII) system instead of measuring tailpipe emissions. As of July 2008, the program dropped tailpipe testing entirely and has inspected all vehicles by scanning the OBDII system. This change was the result of statutory changes in Wisconsin's 2007-2009 biennial budget which exempted model years of vehicles not federally required to be equipped with the OBDII technology (MY 1995 and earlier cars and light trucks and MY 2006 and earlier heavy trucks). To help offset the emissions reductions lost from exempting the pre-OBDII vehicles, the program increased the testable fleet for MYs 2007 and later by adding gasoline-powered vehicles between 10,001 to 14,000 pounds gross vehicle weight rating (GVWR) and diesel-powered vehicles of all weights up to 14,000 pounds GVWR.

The EPA approved Wisconsin's enhanced I/M program on August 16, 2001 (66 FR 42949), including the program's legal authority and regulatory requirements. On June 7, 2012, the WDNR submitted a SIP revision to the EPA covering all the changes to the program since the EPA approved the program in 2001. This submittal included a demonstration under section 110(l) of the CAA addressing emission reductions associated with the program changes. The EPA approved this SIP revision on September 19, 2013 (78 FR 57501).

Wisconsin's I/M program is jointly administered by the WDNR and the Wisconsin Department of Transportation. Legal authority and administrative requirements for the Wisconsin I/M program are found in ss. 110.20 and 285.30, Wisc. Stats. and Ch. NR 485 and Trans 131, Wisc. Admin. Code.

**2. Description of the Modeling Demonstration**

The WDNR conducted this modeling demonstration using the most recent version of the EPA's mobile source emissions model, MOVES5.0.0, released in November 2024. This modeling was conducted in accordance with the following EPA technical guidance:

- Performance Standard Modeling for New and Existing Vehicle Inspection and Maintenance (I/M) Programs Using the MOVES Mobile Source Emissions Model, EPA-420-B-22-034, October 2022.
- MOVES5 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity, EPA-420-B-24-043, November 2024.

The demonstration involves a comparison of emission levels from the EPA's model program specified in 40 CFR 51.351(i) and Wisconsin's program as currently implemented. The WDNR did separate modeling for each of the individual counties in Wisconsin's seven county I/M program area and then compared overall program results to the performance standard.

Since the attainment date for the 2015 ozone NAAQS for moderate areas, August 3, 2024, has passed, in accordance with the EPA's above-cited Performance Standard Modeling guidance[1], the WDNR modeled an evaluation date of July 2025, which is within the calendar year this demonstration will be submitted.

Table A11.1 summarizes the MOVES5.0.0 modeling assumptions used, other than those inputs pertaining to the I/M program.

[1] Performance Standard Modeling for New and Existing Vehicle Inspection and Maintenance (I/M) Programs Using the MOVES Mobile Source Emissions Model, EPA-420-B-22-034, October 2022, page 10.

**Table A11.1. Assumptions, Other than I/M Program Parameters, Associated with MOVES5.0.0 I/M Performance Standard Modeling.**

| Category | Area | |
|---|---|---|
| | Six SEWRPC Counties | Sheboygan County |
| Calendar Year | 2025 | 2025 |
| Month | July | July |
| Day Type | Weekday | Weekday |
| Age Distribution | WDNR 2025 projections by county | WDNR 2025 projections |
| Vehicle Miles of Travel | 2023 NEI VMT grown to 2025 | 2025 VMT projections by WDOT and WDNR using conversion factors |
| Vehicle Population | 2023 NEI population grown to 2025 | 2023 NEI population grown to 2025 |
| Fuel Inputs | MOVES5 Defaults with 2023 NEI AVFT projected to 2025 | MOVES5 Defaults with 2023 NEI AVFT projected to 2025 |
| Road Type Distribution | 2023 NEI distribution | 2023 NEI distribution |
| Average Speed Distribution | 2023 I/M Program Data | 2023 I/M Program Data |
| Daily Temperature Range | 70 to 94 degrees Fahrenheit | 65 to 93 degrees Fahrenheit |
| Daily Humidity Range | 57.0% to 85.8% | 55.5% to 87.0% |

Note: The following abbreviations are used in this table: I/M = Inspection/Maintenance; MOVES5= United States Environmental Protection Agency's Motor Vehicle Emissions Simulator Model (Version 5); NEI = National Emissions Inventory; SEWRPC = Southeastern Wisconsin Regional Planning Commission; VMT = Vehicle-Miles of Travel; WDNR = Wisconsin Department of Natural Resources; WDOT = Wisconsin Department of Transportation

The I/M parameters used in the modeling for both the EPA model program for the enhanced performance standard and Wisconsin's current program are presented in Table A11.2.

**Table A11.2. I/M Program Parameters Associated with MOVES5.0.0 I/M Performance Standard Modeling.**

| Category | I/M Program | |
|---|---|---|
| | Enhanced I/M Performance Standard | Wisconsin I/M Program |
| Evaluation Date | July 2025 | July 2025 |
| Test Type | | |
| Unloaded Idle Test | MYs 1968 to 2000 | Not done |
| Evaporative System OBD Check | MYs 2001 to 2025 | MYs 1996 to 2022 |
| Exhaust OBD Check | MYs 2001 to 2025 | MYs 1996 to 2022 |
| Test Frequency | Annual | Biennial |
| Fuel Types Tested for:<br>Passenger Cars<br>Passenger Trucks<br>Light Commercial Trucks | Gasoline and E-85 | Gasoline and E-85 |
| Fuel Types Tested for:<br>School Buses<br>Refuse Truck<br>Single Unit Short-haul Trucks<br>Single Unit Long-haul Trucks | Not Included | Gasoline Only |
| Waiver Rate | 3.00% | 0.21% |
| Compliance Rate | 96.0% | 84.74% |
| Failure Rate | 3.68% | 3.68% |
| Maximum GVWR Tested for MYs 2006 and Older | 8,500 pounds | 8,500 pounds |
| Maximum GVWR Tested for MYs 2007 and Newer | 8,500 pounds | 14,000 pounds |
| Regulatory Class Coverage Adjustment | | |
| Passenger Cars | | |
| All MYs | 1.0000 | 1.0000 |
| Passenger Trucks | | |
| MYs 2006 and Older | 0.9727 | 0.9727 |
| MYs 2007 and Newer | 0.9727 | 1.0000 |
| Light Commercial Trucks | | |
| MYs 2006 and Older | 0.7630 | 0.7630 |
| MYs 2007 and Newer | 0.7630 | 1.0000 |
| School Buses | | |
| MYs 2006 and Older | 0.0000 | 0.0000 |

| Category | I/M Program | |
|---|---|---|
| | Enhanced I/M Performance Standard | Wisconsin I/M Program |
| MYs 2007 and Newer | 0.0000 | 0.0014 |
| Refuse Trucks | | |
| MYs 2006 and Older | 0.0000 | 0.0000 |
| MYs 2007 and Newer | 0.0000 | 0.0292 |
| Single Unit Short-haul Trucks | | |
| MYs 2006 and Older | 0.0000 | 0.0000 |
| MYs 2007 and Newer | 0.0000 | 0.5709 |
| Single Unit Long-haul Trucks | | |
| MYs 2006 and Older | 0.0000 | 0.0000 |
| MYs 2007 and Newer | 0.0000 | 0.5798 |
| Final Compliance Factor | | |
| Passenger Cars | | |
| All MYs | 95.7696 | 84.73 |
| Passenger Trucks | | |
| MYs 2006 and Older | 93.1551 | 82.42 |
| MYs 2007 and Newer | 93.1551 | 84.73 |
| Light Commercial Trucks | | |
| MYs 2006 and Older | 73.0722 | 64.65 |
| MYs 2007 and Newer | 73.0722 | 84.73 |
| School Buses | | |
| MYs 2006 and Older | 0.00 | 0.00 |
| MYs 2007 and Newer | 0.00 | 0.12 |
| Refuse Trucks | | |
| MYs 2006 and Older | 0.00 | 0.00 |
| MYs 2007 and Newer | 0.00 | 2.47 |
| Single Unit Short-haul Trucks | | |
| MYs 2006 and Older | 0.00 | 0.00 |
| MYs 2007 and Newer | 0.00 | 48.37 |
| Single Unit Long-haul Trucks | | |
| MYs 2006 and Older | 0.00 | 0.00 |
| MYs 2007 and Newer | 0.00 | 49.13 |

Note 1: Abbreviations: E-85 = gasoline-ethanol blend with up to 85% ethanol; GVWR = Gross Vehicle Weight Rating; I/M = Inspection/Maintenance; MYs = Model Years; OBD = On-Board Diagnostics
Note 2: For the Enhanced I/M Performance Standard Program, the test types, test frequency, vehicle classes, waiver rate and compliance rate are specified in 40 CFR 51.351(i). Since no overall failure rate is specified in 40 CFR 51.351(i), the failure rate for the actual Wisconsin I/M program (3.68%) is used.
Note 3: For Wisconsin's program, the waiver rate and compliance rate were provided by DOT for 2023, while the failure rate can be obtained on page 55 of the Wisconsin Vehicle Inspection Program Annual Report 2022.
Note 4: Regulatory Class Coverage Adjustments obtained from EPA's MOVES5 Technical Guidance (Appendix A starting on p. 90.)
Note 5: Final Compliance Factors are calculated as specified in EPA's MOVES5 Technical Guidance (pp. 69-71).
Note 6: Although Wisconsin's I/M program tests some school buses, refuse trucks, single unit short-haul and long haul trucks, MOVES currently does not provide I/M emission reductions for the OBD testing of these vehicles.

### 3. Modeling Results

Tables A11.3 and A11.4 provide the modeling results. In all cases, the emission reductions from Wisconsin's actual I/M program, while short of meeting the emission factors established by the performance standard, are within the 0.02 gram-per-mile buffer allowed by 40 CFR 51.351(i). Therefore, Wisconsin's current I/M program meets the applicable enhanced I/M performance requirements in 40 CFR 51.351 in all areas in which the program is implemented.

The MOVES data files used in this assessment are available from the WDNR upon request.

**Table A11.3. I/M Program Performance Standard Modeling Results - VOCs.**

| County | VMT | Emissions (grams) | | Emission Factor (g/mile) | | Wisc. I/M Program Shortfall (g/mile) | Allowable Shortfall (g/mile) | Meets Perf. Std? |
|---|---|---|---|---|---|---|---|---|
| | | Perf Std | Wisc. I/M Program | Perf Std | Wisc. I/M Program | | | |
| Kenosha | 5,426,228 | 1,216,175 | 1,245,892 | 0.224129 | 0.229606 | 0.005477 | | |
| Milwaukee | 22,040,346 | 5,205,915 | 5,337,176 | 0.236199 | 0.242155 | 0.005955 | | |
| Ozaukee | 3,428,799 | 773,349 | 791,161 | 0.225545 | 0.23074 | 0.005195 | | |
| Racine | 5,658,640 | 1,306,499 | 1,336,236 | 0.230886 | 0.236141 | 0.005255 | | |
| Sheboygan | 3,529,630 | 797,948 | 816,541 | 0.226071 | 0.231339 | 0.005268 | | |
| Washington | 5,239,504 | 1,166,716 | 1,193,497 | 0.222677 | 0.227788 | 0.005111 | | |
| Waukesha | 13,902,350 | 3,173,965 | 3,249,972 | 0.228304 | 0.233771 | 0.005467 | | |
| **ALL** | **59,225,497** | **13,640,567** | **13,970,475** | **0.230316** | **0.235886** | **0.005570** | **0.02** | **Yes** |

**Table A11.4. I/M Program Performance Standard Modeling Results - NOx.**

| County | VMT | Emissions (grams) | | Emission Factor (g/mile) | | Wisc. I/M Program Shortfall (g/mile) | Allowable Shortfall (g/mile) | Meets Perf. Std? |
|---|---|---|---|---|---|---|---|---|
| | | Perf Std | Wisc. I/M Program | Perf Std | Wisc. I/M Program | | | |
| Kenosha | 5,426,228 | 1,383,130 | 1,387,393 | 0.254897 | 0.255683 | 0.000786 | | |
| Milwaukee | 22,040,346 | 4,874,839 | 4,885,537 | 0.221178 | 0.221663 | 0.000485 | | |
| Ozaukee | 3,428,799 | 1,037,005 | 1,039,472 | 0.30244 | 0.303159 | 0.000719 | | |
| Racine | 5,658,640 | 1,761,280 | 1,765,419 | 0.311255 | 0.311986 | 0.000731 | | |
| Sheboygan | 3,529,630 | 1,109,090 | 1,111,780 | 0.314223 | 0.314985 | 0.000762 | | |
| Washington | 5,239,504 | 1,545,326 | 1,549,083 | 0.294937 | 0.295655 | 0.000717 | | |
| Waukesha | 13,902,350 | 3,221,091 | 3,231,408 | 0.231694 | 0.232436 | 0.000742 | | |
| **ALL** | **59,225,497** | **14,931,761** | **14,970,092** | **0.252117** | **0.252764** | **0.000647** | **0.02** | **Yes** |