INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
We Protect Hoosiers and Our Environment.
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Eric J. Holcomb
Governor

Bruno L. Pigott
Commissioner

November 2, 2018

Ms. Cathy Stepp
Regional Administrator
U.S. Environmental Protection Agency
Region V
77 West Jackson Boulevard
Chicago, IL 60604-3950

Dear Ms. Stepp:

Re: Indiana's Infrastructure State Implementation Plan (SIP) Submittal under Clean Air Act Sections 110(a)(1) and 110(a)(2) for the 2015 8-Hour Ozone National Ambient Air Quality Standards (NAAQS)

The Indiana Department of Environmental Management (IDEM) submits Indiana's Infrastructure State Implementation Plan for the 2015 8-hour Ozone National Ambient Air Quality Standards (NAAQS). The document lists the infrastructure SIP elements under Clean Air Act Sections 110(a)(1) and 110(a)(2) and provides details about IDEM's ability to fulfill each requirement for the implementation of the 2015 8-hour ozone standards.

IDEM provided a 30-day public comment period and opportunity for a public hearing concerning this submittal. A public hearing was not requested. IDEM received written comments during the public comment period. Please refer to Enclosure 2, *Public Participation Process Documentation*, which includes IDEM's responses as well as further information and dates regarding the public participation process.

This submittal consists of one (1) hard copy of the required documentation. An electronic version of the submittal in PDF format that is identical to the hard copy has been sent to Mr. Doug Aburano, Chief of United States Environmental Protection Agency (U.S. EPA) Region 5's Attainment Planning and Maintenance Section, as well as Mr. Chris Panos and Ms. Sarah Arra of U.S. EPA Region 5.

IDEM requests that United States Environmental Protection Agency (U.S. EPA) proceed with review and approval of this infrastructure SIP submittal. If you have any questions concerning this infrastructure SIP submittal, please do not hesitate to contact Mr. Brian Callahan, Chief of the Air Quality Standards and Implementation Section in the Air Programs Branch of IDEM's Office of Air Quality, at (317) 233-8244 or bcallaha@idem.IN.gov.

Sincerely,

Keith Baugues

Keith Baugues
Assistant Commissioner

KB/sd/bc/gf/as
Enclosures:
1. *Indiana's Infrastructure State Implementation Plan (SIP) Submittal under Clean Air Act Sections 110(a)(1) and 110(a)(2) for the 2015 8-Hour Ozone National Ambient Air Quality Standards (NAAQS)*
2. *Public Participation Process Documentation*

cc: Doug Aburano, U.S. EPA Region 5 (no enclosures)
Chris Panos, U.S. EPA Region 5 (no enclosures)
Sarah Arra, U.S. EPA (no enclosures)
Scott Deloney, IDEM-OAQ (no enclosures)
Brian Callahan, IDEM-OAQ (w/enclosures)
Gale Ferris, IDEM-OAQ (w/enclosures)
Amy Smith, IDEM-OAQ (w/enclosures)
File Copy

<u>**Enclosure 1**</u>

Indiana's Infrastructure State Implementation Plan (SIP) Submittal under Clean Air Act Sections 110(a)(1) and 110(a)(2) for the 2015 8-Hour Ozone National Ambient Air Quality Standards (NAAQS)

November 2018

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Introduction

Sections 110(a)(1) and 110(a)(2) of the federal Clean Air Act (CAA) require states, after reasonable public notice and hearing, to adopt and submit plans to United States Environmental Protection Agency (U.S. EPA) that ensure that state resources and authority (infrastructure) are sufficient for the implementation, maintenance and enforcement of each primary and secondary national ambient air quality standard (NAAQS). When a new NAAQS is adopted or revised, states must submit their infrastructure state implementation plan (SIP) to U.S. EPA within three years of the promulgation date for the new NAAQS.

Indiana has developed this infrastructure SIP for the 8-hour ozone NAAQS promulgated on October 1, 2015, in consultation with U.S. EPA Region 5 and in accordance with 40 Code of Federal Regulations (CFR) 51, Appendix V, "Criteria for Determining the Completeness of Plan Submissions."[1] The SIP elements listed below are required under Section 110(a)(2) of the CAA. Section 110(a)(1) provides the procedural and timing requirements for SIPs. Section 110(a)(2) lists the basic or "infrastructure" elements that all SIPs must contain. Following each Section 110(a)(2) element is the Indiana Department of Environmental Management's (IDEM's) discussion of the department's ability to fulfill the requirement.

Indiana Infrastructure SIP Submittal: Section 110(a)(2) Elements

Section 110(a)(2)(A): Emission Limits and Other Control Measures

Section 110(a)(2)(A) requires SIPs to include enforceable emission limits and other control measures, means, or techniques, as well as schedules and timetables for compliance.

> Indiana environmental laws are found at Title 13 of the Indiana Code (IC 13) and Air Pollution Control Division rules are found at Title 326 of the Indiana Administrative Code (326 IAC).[2] IDEM continues to update and implement needed revisions to Indiana's SIP as necessary to meet the NAAQS. The department's designation as Indiana's air pollution control agency is found at *IC 13-13-5 Designation of Department for Purposes of Federal Law*. The establishment of the Indiana Environmental Rules Board, the entity responsible for adopting air, land, and water quality rules, is found at *IC 13-13-8 Environmental Rules Board.* The board's authority to adopt rules, emission standards, and compliance schedules can be found at *IC 13-14-8 Rules and Standards*, *IC 13-17-3-4 Adoption or amendment of rules*, *IC 13-17-3-11 Power*

[1] Appendix V to 40 CFR 51 is available in the e-CFR at https://www.ecfr.gov/cgi-bin/text-idx?SID=052946f14cc3872f219bfdd67484aad7&mc=true&node=ap40.2.51_11303.v&rgn=div9.
[2] The Indiana Code can be viewed online at http://iga.in.gov/legislative/laws/2017/ic/titles/001. The Indiana Administrative Code can be viewed online at http://www.in.gov/legislative/iac/.

to adopt rules under state discretionary authority, and *IC 13-17-3-14 Duty to adopt rules classifying areas and setting air quality standards*.

Established rules pertaining to ozone precursor emissions including volatile organic compounds (VOCs) and nitrogen oxides (NO_x) that will ensure attainment and maintenance of the NAAQS (i.e., the 2015 8-hour ozone NAAQS) are *326 IAC 8 Volatile Organic Compound Rules* and *326 IAC 10 Nitrogen Oxides Rules*. These rules include category specific and source specific VOC and NO_x emission limitations and requirements in addition to emission limitations and requirements set specifically for Clark, Floyd, and Warrick for NO_x and Boone, Clark, Dearborn, Elkhart, Floyd, Hamilton, Hancock, Harrison, Hendricks, Johnson, Lake, Marion, Morgan, Porter, St. Joseph, and Shelby counties for VOCs.

Designations for the 2015 8-hour ozone NAAQS were issued in two rounds. On November 6, U.S. EPA designated 74 of Indiana's 92 counties as "attainment/unclassifiable" in the first round of air quality designations under the NAAQS (82 FR 54232). On April 30, 2018, U.S. EPA designated all remaining counties in Indiana as "attainment/unclassifiable" under the standard (83 FR 25776) except for the following areas:

- Clark and Floyd counties, which have been designated as part of the Louisville, KY-IN Nonattainment Area, and
- Calumet, Hobart, North, Ross, and Saint John townships in Lake County, which have been designated as part of the Chicago, IL-IN-WI Nonattainment Area.

IDEM notes that, consistent with U.S. EPA's historical guidance on NAAQS implementation[3], the emissions limitations and other control measures needed to attain the NAAQS in areas designated as nonattainment for the 2015 8-hour ozone standards will be due on a different schedule from the requirements of this infrastructure SIP. Any necessary emissions limitations and/or control measures will be reviewed and acted upon with regard to approvability for the specific purposes of such an attainment plan under Part D of the CAA through a separate process at a later time.

Under the previous 2008 8-hour ozone standards, Lake and Porter counties were designated as part of the Chicago-Naperville, IL-IN-WI Nonattainment Area and classified as Marginal on May 31, 2012 (77 FR 34221). Due to the area's failure to attain the standard by July 20, 2015, it was reclassified as Moderate on April 11, 2016, with an attainment date of July 20, 2018 (81 FR 26697). Indiana submitted a State Implementation Attainment Plan to U.S. EPA for review and approval on February 28, 2017.[4] Lawrenceburg Township in Dearborn County

[3] https://www.epa.gov/criteria-air-pollutants/naaqs-implementation-process.
[4] The documents can be viewed on the IDEM website at https://www.in.gov/idem/airquality/2433.htm.

was designated as part of the Cincinnati, OH-KY-IN Nonattainment Area and classified as Marginal on April 30, 2012 (77 FR 30088). On March 17, 2017, U.S. EPA-redesignated Lawrenceburg Township to Attainment, as well as approved Indiana's maintenance plan for the area (82 FR 16940).

Section 110(a)(2)(B): Ambient Air Quality Monitoring/Data System

Section 110(a)(2)(B) requires SIPs to include provisions that provide for the establishment and operation of appropriate devices, methods, systems, and procedures necessary to monitor, compile, and analyze ambient air quality data, and upon request, make such data available to U.S. EPA.

IDEM maintains the resources needed to conduct ambient air monitoring in Indiana and operates Indiana's ambient air monitoring network in accordance with requirements in federal rules at 40 CFR 50, 40 CFR 53, and 40 CFR 58 and Indiana's SIP. Procedures to sample the ambient air quality in Indiana are conducted in accordance with 40 CFR 50, and appendices or other equivalent methods approved by the IDEM Commissioner, in accordance with general provisions in rules at 326 IAC 1-3 *Ambient Air Quality Standards.*

IDEM ensures the submittal of quality assured ambient air monitoring data to U.S. EPA's Air Quality System (AQS) in a timely manner, in accordance with 40 CFR 58. Indiana's ambient air monitoring program data is used to determine compliance with U.S. EPA's NAAQS. IDEM submits an Ambient Air Monitoring Network Plan to U.S. EPA annually, describing the framework for the establishment and maintenance of Indiana's air quality surveillance system and any network changes proposed to take place in the upcoming monitoring season. IDEM's *Quality Assurance Manual*[5] for the Indiana ambient air monitoring program contains details relating to state and federal requirements, site selection, monitoring equipment selection, audit/calibration equipment and procedures, sampling procedures, data validation, chain of custody, data reporting, precision/accuracy reporting, meteorological issues, and roles and responsibilities.

IDEM remains committed to working with U.S. EPA in order to address any necessary changes in Indiana's monitoring network plan or monitoring sites, consistent with 40 CFR 58.

Section 110(a)(2)(C): Programs for Enforcement of Control Measures

Section 110(a)(2)(C) requires SIPs to include a program to provide for the enforcement of emission limits through control measures, regulation of the modification

[5] Available online at https://www.in.gov/idem/airquality/2377.htm.

and/or construction of any stationary source within areas covered by the plan, and a permitting program to assure that the NAAQS are achieved.

IDEM maintains an enforcement program in order to ensure compliance with SIP requirements. *IC 13-14-1-12 Enforcement of rules*, provides the IDEM Commissioner with the authority to enforce rules "consistent with the purposes of the air pollution control laws". The IDEM Commissioner also has authority under *IC 13-14-2-6 Court actions by commissioner*, *13-14-2-7 Orders to secure compliance; civil penalties*, *IC 13-17-3-3 Enforcement*, and *IC 13-30-3 Investigation of Violations; Administrative Proceedings and Orders*, to assess civil penalties and obtain compliance with any applicable rule a board has adopted in order to enforce air pollution control laws. Additionally, *IC 13-14-10-2 Suit on behalf of state to restrain person contributing to pollution* allows for the IDEM Commissioner, upon receipt of evidence that a pollution source or combination of sources is endangering the health or welfare of persons, to bring suit on behalf of the state in the appropriate court to "immediately restrain any person causing or contributing to the alleged pollution to stop the discharge or introduction of contaminants causing or contributing to the pollution; or take other necessary action."

Indiana's SIP-approved PSD rules are found in *326 IAC 2-2 Prevention of Significant Deterioration (PSD) Requirements*, and it is IDEM's intention that these rules satisfy the requirements of Section 110(a)(2)(C) and the applicable requirements of Section 110(a)(2)(D). The Indiana Environmental Rules Board adopted amendments to *326 IAC 1-3-4 Ambient air quality standards* concerning the revision of the 8-hour primary and secondary ozone NAAQS to a level of 0.070 parts per million to provide consistency between federal and state rules. The amended rule was effective August 11, 2017, and ensures that IDEM's SIP-approved PSD program addresses the most current NAAQS, including the 2015 8-hour ozone NAAQS.

In accordance with rules found at *326 IAC 2-2,* IDEM implements its PSD permit program while ensuring that the construction of minor stationary sources, minor modifications, and construction and/or modification of major stationary sources do not cause or contribute to a violation of any NAAQS.

Furthermore, IDEM's U.S. EPA-approved PSD SIP includes provisions that satisfy U.S. EPA's requirements set forth in 40 CFR 52.21 and analogous sections of 40 CFR 51.166. As a result, the applicable infrastructure SIP requirements related to PSD are met and include the provisions required by the Phase 2 Ozone Implementation Rule, the 2008 $PM_{2.5}$ NSR Rule, and the 2010 $PM_{2.5}$ NSR rule. Final approval of the requirements related to the 2008 NSR Rule and Phase 2 Ozone Implementation Rule were published in the Federal Register on October 29, 2012 (77 FR 65478). Final approval of the mandated portions of the 2010 NSR Rule were published July 2, 2014 (79 FR 37646) and August 11, 2014 (79 FR 46709).

Indiana has satisfied requirements contained in 40 CFR 52.21 and 40 CFR 51.166 for the review of new sources and modifications, as well as applicable infrastructure SIP requirements related to PSD contained in Section 110(a)(2)(C), Section 110(a)(2)(D), and Section 110(a)(2)(J).

With respect to the permitting of greenhouse gas (GHG) emitting sources, U.S. EPA finalized approval of revisions to Indiana's PSD SIP on September 15, 2011 (76 FR 59899). These revisions include the adoption of the federal thresholds for PSD permitting of GHG-emitting sources. Indiana has therefore satisfied the GHG permitting requirements for Section 110(a)(2)(C), Section 110(a)(2)(D), and Section 110(a)(2)(J). IDEM also observes that with the adoption of the federal thresholds for PSD permitting of GHG-emitting sources, the requirements of Section 110(a)(2)(E) have been met, specifically as they relate to the necessary resources and personnel for such permitting purposes.

Section 110(a)(2)(D)(i)(I): Prong 1 and Prong 2: Interstate Transport – Significant Contribution and Interference with Maintenance

Section 110(a)(2)(D)(i)(I) requires SIPs to include provisions prohibiting any source or other type of emissions activity within the state from emitting any air pollutant in amounts which will contribute significantly to nonattainment in, or interfere with maintenance by, any other state with respect to any national primary or secondary ambient air quality standard.

Indiana has made amendments to existing rules in response to the replacement of the Clean Air Interstate Rule (CAIR) with the Cross State Air Pollution Rule (CSAPR)[6] to address interstate air pollution transport, according to U.S. EPA rules for CSAPR's implementation.

Rule changes titled "Cross-State Air Pollution Rule, LSA #16-209(F)" were adopted by the Indiana Environmental Rules Board on July 12, 2017. These changes consist of the repeal of CAIR as it applies to electric generating units (EGUs), revisions to *326 IAC 26 Regional Haze,* and the addition of CSAPR trading programs at *326 IAC 24* in order to fully implement the NO_x annual trading programs established in the July 2011 CSAPR rule and the NO_x ozone season requirements in the 2016 CSAPR Update Rule.[7] Allocations for the programs start in 2021. Indiana's rule revisions became effective on November 24, 2017, and were submitted to U.S. EPA for approval as an amendment to Indiana's SIP.

[6] U.S. EPA affirmed the changes through a rulemaking action in February 2016 (81 FR 13275) (https://www.epa.gov/csapr/date-change-affirmation-rules-cross-state-air-pollution-rule-csapr).
[7] 81 FR 74504 (https://www.federalregister.gov/documents/2016/10/26/2016-22240/cross-state-air-pollution-rule-update-for-the-2008-ozone-naaqs)

Rule changes titled "NO_x Emissions from Large Affected Units, LSA #15-414(F)" were adopted by the Indiana Environmental Rules Board on April 11, 2018. These revisions concern the treatment of NO_x emissions for the ozone season from certain large affected units that were formerly regulated under CAIR but are not addressed under the "Cross State Air Pollution Control Rule, LSA #16-209(F)". The changes ensure the units' compliance with NO_x SIP Call rules at 40 CFR 51.121 and include an addition to and an amendment of *326 IAC 10 Nitrogen Oxides Rules*, and the repeal of certain rules at *326 IAC 24 Clean Air Interstate Rule* as it applies to non-EGUs.[8] Indiana will submit the rule amendments to U.S. EPA for approval as an amendment to Indiana's SIP.

Indiana has a long history of compliance with federal ozone transport regulations, including the NO_x SIP Call and CAIR. As a result, both large EGUs and non-EGUs operating in the state have achieved significant and permanent reductions in ozone precursors emissions (i.e., NO_x and VOCs), as well as emissions of SO_2 and fine particulate matter ($PM_{2.5}$)). The state's rule amendments under CSAPR for boilers, turbines and combined cycle units at large EGUs, as well as boilers and turbines at heavy non-EGUs such as aluminum smelters, petroleum refiners, iron and steel production facilities and institutional facility steam plants, ensure that Prong 1 and Prong 2 provisions will continue to be met. As such, Indiana's emissions do not contribute significantly to issues with attainment or maintenance of the 2015 8-hour ozone NAAQS in downwind states. Therefore, Indiana believes that additional control measures are not necessary to address the state's contribution to interstate transport.

To further demonstrate Indiana's fulfillment of Section 110(a)(2)(D)(i)(I), IDEM is providing a Weight of Evidence Analysis performed on interstate transport of Indiana's emissions relative to the 2015 8-hour ozone NAAQS and U.S. EPA's March 27, 2018, memorandum concerning "good neighbor" provisions and modeling projections of 2023 ozone design values and 2023 contributions. Indiana's technical analysis has been conducted in coordination with the Lake Michigan Air Directors Consortium (LADCO) and LADCO member states. The weight of evidence (WOE) analysis is provided as formal technical supporting documentation for 110(a)(2)(D)(i)(I) in Attachment 1.

Section 110(a)(2)(D)(i)(II): Prong 3 and Prong 4: Interstate Transport: Prevention of Significant Deterioration and Protect Visibility

Section 110(a)(2)(D)(i)(II) requires SIPs to include provisions prohibiting any source or other type of emissions activity within the state from emitting any air pollutant

[8] Provisions are added at *326 IAC 10-2; 326 IAC 10-3-1* and *326 IAC 10-3-3* concerning nitrogen oxides (NO_x) emissions from large affected units are amended; and *326 IAC 10-4*, *326 IAC 24-3-1*, *326 IAC 24-3-2*, *326 IAC 24-3-4*, and *326 IAC 24-3-11* are repealed. Links to rule notices and documents are found on the Air Pollution Control Division rules website at https://www.in.gov/idem/legal/2351.htm.

in amounts which will interfere with applicable implementation measures used by another state to protect visibility or to prevent significant deterioration of air quality.

IDEM's SIP-approved PSD rules are found in *326 IAC 2-2 Permit review rules*, and it is IDEM's intention that these rules satisfy the requirements of Section 110(a)(2)(C), as well as the applicable Prong 3 requirements of Section 110(a)(2)(D)(i)(II).

Indiana is subject to the regional haze program that addresses visibility-impairing pollutants and has implemented regional haze rules at *326 IAC 26 Regional Haze*. On June 11, 2012, U.S. EPA published limited approval of Indiana's regional haze SIP (see 77 FR 34218) for the first implementation period that ends in 2018. On March 30, 2016, Indiana submitted a five-year regional haze progress report SIP revision, which included a determination that Indiana's existing regional haze SIP required no substantive revision to achieve the established regional haze visibility improvement and emissions reduction goals for 2018. On January 23, 2018, U.S. EPA issued a final rule approving the five-year regional haze progress report SIP revision (83 FR 4847). To fulfill all of the requirements of Prong 4, Indiana will work with Region 5 to demonstrate compliance after the transport analysis referenced in Section 110(a)(2)(D)(i)(I) has provided updated CSAPR budgets.

In conjunction with Indiana's U.S. EPA-approved regional haze program, PSD program, and nonattainment NSR program (approved October 7, 1994), IDEM believes that it has met Prong 4 visibility protection requirements of Section 110(a)(2)(D)(i)(II) and that these approved rules satisfy Prong 3 (regarding interference with PSD) and Prong 4 (regarding interference with visibility protection of the interstate transport provisions).

Section 110(a)(2)(D)(ii): Interstate and International Pollution Abatement

Section 110(a)(2)(D)(ii) requires states to ensure compliance with applicable requirements of Sections 126 and 115 (relating to interstate and international pollution abatement).

Indiana's SIP meets the requirements of Section 110(a)(2)(D)(ii), which relates to Section 115 and Section 126 of the CAA. With respect to Section 115, Indiana has no pending obligations related to international pollution abatement. IDEM's SIP-approved PSD rules require that neighboring states be notified of new or modified sources, consistent with the requirements of Section 126(a). Indiana has no pending obligations under Section 126(b), which pertains to petitions for finding that major sources emit or would emit prohibited air pollutants. Finally, no source or sources within the state are the subject of an active finding under section 126(c) with respect to the particular NAAQS at issue.

Section 110(a)(2)(E): Adequate Authority and Resources

Section 110(a)(2)(E) requires SIPs to provide necessary assurances that the state will have adequate personnel, funding, and legal authority under state law to carry out each implementation plan, and to provide necessary assurances that the state retains responsibility for ensuring adequate implementation of the SIP where the state relies on a local or regional government for implementation of any SIP provision.

IDEM continues to update and implement needed revisions to Indiana's SIP as necessary to meet the NAAQS. The department's designation as Indiana's air pollution control agency is found at *IC 13-13-5 Designation of Department for Purposes of Federal Law*. The establishment of the Indiana Environmental Rules Board, the entity responsible for adopting air, land, and water quality rules, can be found at *IC 13-13-8 Environmental Rules Board.* The board's authority to adopt rules, emissions standards, and compliance schedules can be found at *IC 13-14-8 Rules and standards*, *IC 13-17-3-4 Adoption or amendment of rules*, *IC 13-17-3-11 Power to adopt rules under state discretionary authority*, and *IC 13-17-3-14 Duty to adopt rules classifying areas and setting air quality standards*.

Rules established pertaining to ozone precursor emissions including volatile organic compounds (VOCs) and nitrogen oxides (NO_x) are found *at 326 IAC -8 Volatile Organic Compound Rules* and *326 IAC 10 Nitrogen Oxides Rules*. These rules contain category specific and source specific VOC and NO_x emission limitations and requirements, in addition to emission limitations and requirements set specifically for Clark, Floyd, and Warrick for NO_x and Boone, Clark, Dearborn, Elkhart, Floyd, Hamilton, Hancock, Harrison, Hendricks, Johnson, Lake, Marion, Morgan, Porter, St. Joseph, and Shelby counties for VOCs.

The budget and personnel plans for IDEM are documented in IDEM's biennial budget and the Performance Partnership Grant (PPG) agreement. IDEM does not rely on local or regional governments for implementation of SIP provisions.

In order to satisfy the requirements of Section 110(a)(2)(E)(ii), the Indiana legislature passed *IC 13-13-8 Environmental Rules Board* to reflect the formation of a single environmental rules board. On November 29, 2012, IDEM submitted an amendment to Indiana's SIP requesting that U.S. EPA approve the statutory changes as part of the SIP. Notably, the Indiana Environmental Rules Board does not act on permit or enforcement orders; therefore, only the requirements of Section 128(a)(2) apply. The Indiana Environmental Rules Board is required to fully disclose any potential conflicts of interest relating to permits or enforcement orders under the CAA, as found in *IC 13-13-8-11 Disclosure of conflicts of interest*.

U.S. EPA finalized approval of these provisions on December 24, 2013, as meeting the applicable requirements of Section 128. These requirements are not

NAAQS specific, and the approval satisfies the applicable requirements of Section 110(a)(2)(E)(ii) of the CAA for all NAAQS, including the 2015 8-hour ozone NAAQS.

Section 110(a)(2)(F): Stationary Source Monitoring System

Section 110(a)(2)(F) provides that SIPs are to require the installation, maintenance, and replacement of equipment and the implementation of other necessary steps by owners or operators of stationary sources to monitor emissions from stationary sources. Section 110(a)(2)(F) also provides that SIPs are to require periodic reports on the nature and amounts of emissions and emission-related data from the stationary source, and correlation of the reports by the state agency with any emission limitations or standards established; the reports shall be available at reasonable times for public inspection.

IDEM's rules for monitoring requirements are contained in *326 IAC* 3 *Monitoring Requirements* and include rules specific to the continuous monitoring of emissions, minimum performance and operating specifications, quality assurance requirements, record keeping requirements, source sampling procedures, and fuel sampling and analysis procedures. Additional emission reporting requirements can be found in *326 IAC 2-6 Emission Reporting*. Emission reports are available upon request by U.S. EPA or other interested parties.

Section 110(a)(2)(G): Emergency Power

Section 110(a)(2)(G) requires SIPs to provide authority to address activities causing imminent and substantial endangerment to public health, welfare, or the environment, and to provide for adequate contingency plans to implement the emergency episode provisions.

IDEM's rule at *326 IAC 1-5 Episode Alert Levels* establishes air pollution episode levels based on concentrations of criteria pollutants. The rule requires that emergency reduction plans (ERPs) be submitted to the Commissioner by major air pollution sources. The ERPs shall state those actions that will be taken to reduce or eliminate emissions of the appropriate air pollutants when each episode level is declared.

Under *IC 13-17-4 Air Pollution Emergencies*, IDEM also has the ability to declare an air pollution emergency and order all persons causing or contributing to the conditions warranting the air pollution emergency to immediately reduce or discontinue the emission of air pollutants. IDEM believes that *IC 13-17-4* is sufficient; therefore, specific contingency plans beyond the ability and authority to restrain any source from causing or contributing to an imminent and substantial endangerment as it relates to any NAAQS are not required.

Section 110(a)(2)(H): Future SIP Revisions

Section 110(a)(2)(H) requires SIPs to provide for the revision of the plan from time to time as may be necessary to take account of revisions of a national primary or secondary ambient air quality standard or the availability of improved or more expeditious methods of attaining the standard, and whenever U.S. EPA finds that the plan is substantially inadequate to attain the NAAQS which it implements.

IDEM continues to update and implement needed revisions to Indiana's SIP as necessary to meet the NAAQS. The establishment of the Indiana Environmental Rules Board, the entity responsible for adopting air, land, and water quality rules, can be found at *IC 13-13-8 Environmental Rules Board.* The board's authority to adopt rules, emissions standards, and compliance schedules can be found at *IC 13-14-8 Rules and standards*, *IC 13-17-3-4 Adoption or amendment of rules*, *IC 13-17-3-11 Power to adopt rules under state discretionary authority*, and *IC 13-17-3-14 Duty to adopt rules classifying areas and setting air quality standards*.

Section 110(a)(2)(I): Plan Revisions for Nonattainment Areas

Section 110(a)(2)(I) requires a plan or a plan revision for an area designated as a nonattainment area to meet the applicable requirements of part D (relating to nonattainment areas). These provisions are addressed under a different submission and schedule and are not expected by U.S. EPA to be included in the infrastructure SIP submittal.

Section 110(a)(2)(J): Consultation with Government Officials, Public Notification, PSD, and Visibility Protection

Section 110(a)(2)(J) requires SIPs to provide a process for consultation with local governments and Federal Land Managers carrying out NAAQS implementation requirements, a process for States to notify the public if NAAQS are exceeded in an area, and a process to enhance public awareness of measures that can be taken to prevent exceedances. In addition, SIPs are to meet applicable requirements of Part C of the CAA related to PSD and visibility.

IDEM actively participates in the regional planning efforts that include state rule developers, representatives from the Federal Land Managers, and other affected stakeholders. Additionally, IDEM is an active member of the Lake Michigan Air Directors Consortium (LADCO).

IDEM monitors air quality daily and reports the daily air quality index to the interested public and media when necessary. IDEM participates and submits information to U.S. EPA's AIRNOW program. Additionally, IDEM maintains SmogWatch, an informational tool created by IDEM to share air quality forecasts each day. SmogWatch provides daily information about ground-level ozone and particulate matter concentration levels, as well as health information and monitoring data for seven regions in Indiana.

As discussed in the section above addressing Section 110(a)(2)(C), Indiana has a U.S. EPA-approved PSD program that is consistent with U.S. EPA's own regulations contained in 40 CFR 52.21 and 40 CFR 51.166.

While there is a visibility protection requirement contained in Section 110(a)(2)(J), consultation with U.S. EPA indicates that these requirements are different from the ones set forth in Section 110(a)(2)(D)(i)(II) in that the visibility protection requirements of Section 110(a)(2)(J) are not "triggered" by the promulgation of a new or revised NAAQS. Therefore, the visibility protection requirements of Section 110(a)(2)(J) are not germane to infrastructure SIPs for the 2015 ozone NAAQS.

Section 110(a)(2)(K): Air Quality Modeling/Data

Section 110(a)(2)(K) requires SIPs to provide for the performance of air quality modeling that U.S. EPA may prescribe for the purpose of predicting the effect on ambient air quality of any emissions of any air pollutant for which U.S. EPA has established a NAAQS, and, upon request, the submission of data related to the air quality modeling to U.S. EPA.

IDEM reviews the potential impact of major and some minor new sources. IDEM's rules regarding air quality modeling are contained in *326 IAC 2-2-4 Air quality analysis; requirements*, *326 IAC 2-2-5 Air quality impact; requirements*, *326 IAC 2-2-6 Increment consumption; requirements*, and *326 IAC 2-2-7 Additional analysis; requirements*. Modeling data are available upon request by U.S. EPA or other interested parties.

Section 110(a)(2)(L): Permitting Fees

Section 110(a)(2)(L) requires the owner or operator of each major stationary source to pay to the permitting authority a fee sufficient to cover the reasonable costs of reviewing and acting upon any application for a permit and, if the owner or operator received a permit for a source, the reasonable costs of implementing and enforcing the terms and conditions of any permit, until the fee requirement is superseded with respect to the source by U.S. EPA's approval of a fee program under Title V of the CAA.

IDEM continues to implement the approved Title V program, including the requirement that major sources pay permit fees. The authority to establish Title V permit fees can be found in *IC 13-17-8 Title V Operating Permit Program, Trust Fund, and Fees*. The requirement to pay fees for Title V is found in *326 IAC 2-7-19 Fees*. All permitting fees are found in *326 IAC 2-1.1-7 Fees*, including those that may apply to Title V sources. Lastly, as ascertained in the discussion surrounding Section 110(a)(2)(E), IDEM retains all the necessary resources and funding to administer an air quality management program, including the ability to collect permitting fees.

Section 110(a)(2)(M): Consultation/Participation by Affected Local Entities

Section 110(a)(2)(M) requires SIPs to provide for consultation and participation by local political subdivisions affected by the SIP.

IDEM rulemaking procedures in *IC 13-14-9 Rulemaking Procedures* allow for public participation in the SIP development process. IDEM also ensures that the requirements of 40 CFR 51.102 are satisfied during the SIP development process.

Conclusion

As documented above, Indiana's legal authority and SIP-approved regulations meet or exceed the requirements in CAA Sections 110(a)(1) and 110(a)(2) for the implementation of the NAAQS, and IDEM is fully able to fulfill each requirement for the 2015 8-hour ozone standards.

Attachment 1

Interstate Transport "Good Neighbor" Provision Weight of Evidence Analysis for Indiana's Infrastructure State Implementation Plan (SIP) Submittal Under Clean Air Act Sections 110(a)(1) and 110(a)(2) for the 2015 8-Hour Ozone National Ambient Air Quality Standards (NAAQS)

November 2018

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Executive Summary

On October 1, 2015, the United States Environmental Protection Agency (U.S. EPA) promulgated a revision to the 8-hour Ozone National Ambient Air Quality Standard (NAAQS), lowering the level of both the primary and secondary standards to 70 parts per billion (ppb). Pursuant to Clean Air Act Section (CAA) 110(a), states are required to submit plans to U.S. EPA that ensure state resources and authority (infrastructure) are sufficient for the implementation, maintenance and enforcement of the 2015 8-hour ozone NAAQS. Submitted plans, referred to as Infrastructure State Implementation Plans (SIPs), must include the states' provisions for prohibiting significant contributions to nonattainment in, or interfering with maintenance by, any other state with respect to such national primary or secondary ambient air quality standards, as required under Section 110(a)(2)(D)(i)(I) of the CAA. This provision of the CAA, Section 110(a)(2)(D)(i)(I), is generally referred to as the "good neighbor" provision.

On March 27, 2018, U.S. EPA released a memorandum entitled "*Information on the Interstate Transport State Implementation Plan Submissions for the 2015 Ozone National Ambient Air Quality Standards under Clean Air Act Section 110(a)(2)(D)(i)(I)*." This memo (transport memo) provided states with U.S. EPA modeling predictions for 8-hour ozone design values in 2023, along with state contributions to those ozone monitors which were predicted to violate (nonattainment) or were in danger of violating (maintenance) the 2015 8-hour ozone NAAQS. In the transport memo, states that were projected to contribute 0.7 ppb or greater to a nonattainment or maintenance monitor are considered to be contributing significantly to these monitors. Updated modeling results from U.S. EPA were released in May 2018 and additional guidance on contribution thresholds was released in August 2018.

Based on this modeling, states are required to submit good neighbor SIPs that address the state's responsibility in reducing its contribution to these nonattainment and maintenance monitors. In the transport memo, U.S. EPA provided states flexibilities related to analytical approaches for developing a good neighbor SIP. These flexibilities do not tie states to the modeling results presented by U.S. EPA in the transport memo.

The Indiana Department of Environmental Management (IDEM) is providing this weight of evidence (WOE) analysis as a supplement to its Infrastructure SIP. This document provides IDEM's analysis of different flexibilities provided by the U.S. EPA in its transport memo, as well as analyses of state and regional ozone trends and meteorological data. IDEM believes that the analyses provided here demonstrate a clear weight of evidence that Indiana has met its obligations under the good neighbor provision of the CAA.

Weight of Evidence Analysis of Indiana's 8-Hour Ozone Impact at Projected Nonattainment and/or Maintenance Monitors in the Midwest and Northeast U.S.

1.0 Background

On March 27, 2018, U.S. EPA released a memorandum from Peter Tsirigotis titled "*Information on the Interstate Transport State Implementation Plan Submissions for the 2015 Ozone National Ambient Air Quality Standards under Clean Air Act Section 110(a)(2)(D)(i)(I)*" (Appendix A). In this memo, U.S. EPA provided states with its modeling predictions for 8-hour ozone design values in 2023, along with state contributions to those ozone monitors which were predicted to violate (nonattainment) or were in danger of violating (maintenance) the 2015 8-hour ozone NAAQS. U.S. EPA also provided states with the option to consider certain approaches or flexibilities that allow alternative transport frameworks to address good neighbor obligations or considerations outside the familiar four-step transport framework. Those four steps, and some potential flexibilities for each step, include:

1) Identify downwind air quality problems:
    a. Identification of maintenance monitors,
    b. Consideration of downwind air quality context,
    c. Consideration of model performance.
2) Identify upwind states that contribute enough to downwind receptors with air quality problems to prompt further review and analysis:
    a. Consideration related to determining contributions, including several different source apportionment analyses,
    b. Considerations related to evaluating contributions.
3) Identify emission reductions necessary, considering cost and air quality factors, to prevent an identified upwind state from contributing significantly to these downwind air quality problems:
    a. Consideration of international emissions,
    b. Apportioning responsibility among states that are found to contribute significantly to nonattainment or interfere with maintenance of the NAAQS downwind,
    c. Considerations for states linked to maintenance receptors.
4) Adopt permanent and enforceable measures necessary for emission reductions.

The March 27, 2018, memorandum also identified projected ozone design values at potential nonattainment and maintenance receptors based on U.S. EPA's 2023 transport modeling. Included in these modeling results are a flexibility incorporated by U.S. EPA to include or not include photochemical modeling grid cells that contain 50% or more water and do not have an ozone monitor residing inside the grid cell. U.S. EPA also included modeling results showing each state's modeled contributions to projected nonattainment or maintenance monitors in 2023.

IDEM examined ozone measurements, emissions sources, several different modeling results, meteorological conditions, and backward trajectories, and evaluated several flexibilities as recommended by U.S. EPA to address the transport of Indiana's emissions on areas downwind of the state. This document discusses the evaluation and analyses conducted for Indiana's obligation to address interstate transport for 8-hour ozone.

2.0 Indiana's Analytic Flexibilities

Indiana has chosen or considered several flexibilities listed in U.S. EPA's transport memo for its WOE analysis. With regards to analytics, Indiana chose to use alternative power sector emissions modeling and state-specific information on emission sources and optimization of nitrogen oxide (NO_x) emission controls. Indiana is a member of the Lake Michigan Air Director's Consortium (LADCO), which consists of LADCO staff and staff from the air agencies of the U.S. EPA Region V states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. Indiana, together with LADCO, has been heavily involved in the development of the Eastern Regional Technical Advisory Committee (ERTAC) Electric Generating Unit (EGU) tool. This tool integrates state-reported information on EGU operations and emissions forecasts. The ERTAC EGU tool provides better estimates on the growth and control forecast of EGUs in the Midwest and Northeast than the emission inventory used in the U.S. EPA transport modeling. LADCO replaced the EGU emissions in the U.S. EPA EN emissions platform with 2023 EGU forecasts estimated with the ERTAC EGU Tool version 2.7.

Several other flexibilities were considered by Indiana for this analysis. Those flexibilities and a discussion as to whether or not they were chosen by Indiana are included below:

1) Use of a 1 ppb significance threshold. **Chosen:** More representative of Indiana's downwind impacts based on U.S. EPA's collective contribution analysis.
2) Alternative means of calculating base-year design values for which to calculate future year design values for maintenance monitors. **Considered but not chosen.**
3) Elimination, within the attainment test calculation, of model grid cells that contain over 50% water in the cell and did not contain an ozone monitor within the cell. **Considered but not chosen.**
4) Analysis of modeling results utilizing 4 kilometer grid cell resolution. **Considered but not chosen.**
5) Reliance on model performance statistical analysis (top 10 highest days with normalized biases less than or equal to 15%) to determine the appropriate modeled days to compare to observed ozone on those days. **Considered but not chosen.**
6) Use of more current design values to account for actual emission reductions that have occurred after the 2011 emissions platform was established for modeling. This approach gives a more realistic base year

design value in which to apply Relative Response Factors to determine future year design values. **Considered but not chosen.**

3.0 Significance Threshold

Indiana has opted to use 1 ppb as the significance threshold in determining whether an upwind state has a significant impact on downwind nonattainment or interferes with maintenance at a monitor to attain the 2015 8-hour ozone standard. Several factors helped Indiana come to this conclusion. U.S. EPA guidance on addressing significance in air quality demonstrations to determine upwind contributions to downwind receptors can be found in the August 31, 2018, memorandum from Peter Tsirigotis titled "*Analysis of Contribution Thresholds for Use in Clean Air Act Sections 110(a)(2)(D)(i)(I) Interstate Transport State Implementations Plan Submissions for the 2015 Ozone National Ambient Air Quality Standards.*"[1] U.S. EPA conducted post-processing of its transport modeling results and compared several different threshold levels to determine if the level of the significance threshold had any bearing on the number of identified upwind states. The analysis, found in Appendix B, shows that the difference between 1 ppb and 1% of the 8-hour ozone NAAQS (0.7 ppb) and the number of states identified as significant is very small. As such, U.S. EPA believes use of the 1 ppb is approvable for SIP purposes and Indiana is following this guidance to use 1 ppb as its significance impact threshold.

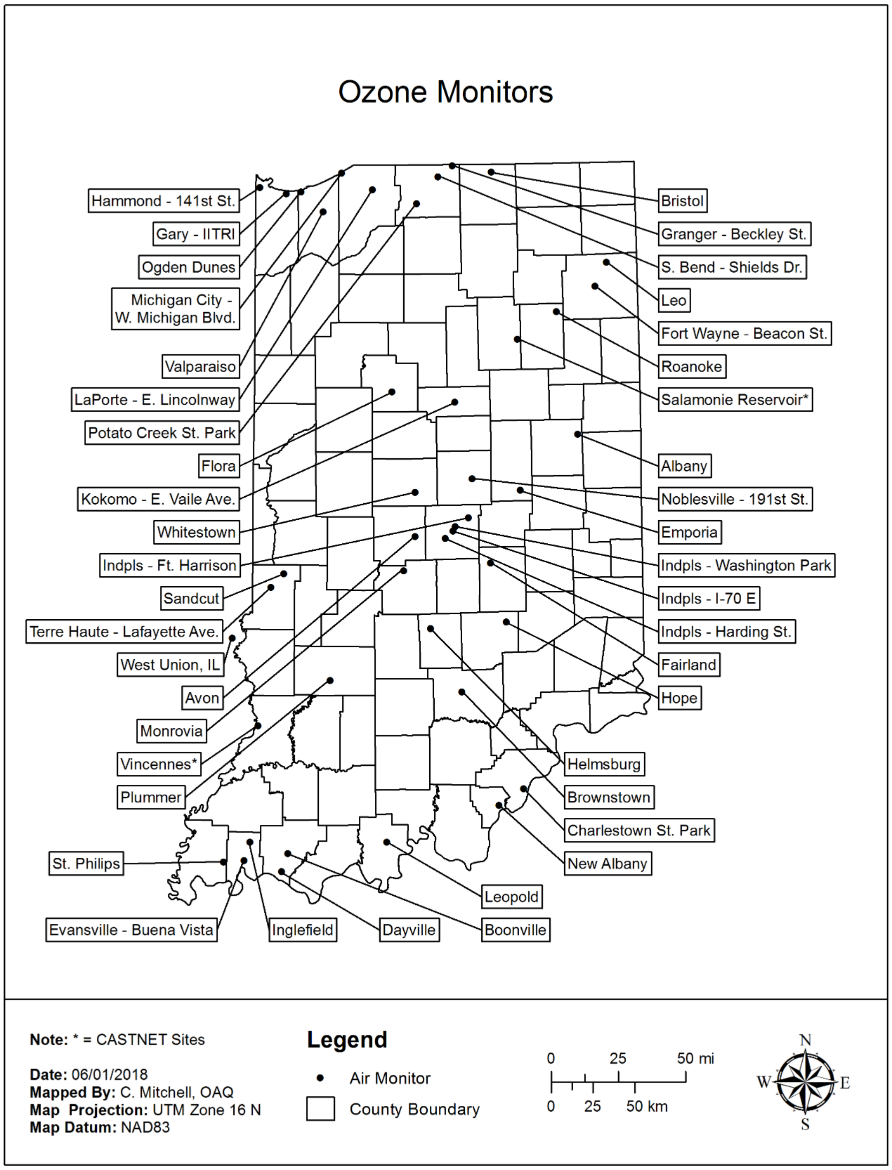
It is worth noting that the tolerance level of ozone monitors is 1 ppb; measuring ozone below that level is beyond the capability of the monitor. In addition, conducting photochemical modeling using a significance threshold of 0.7 ppb is not appropriate, as model run results may contain biases much larger than the threshold value. As such, Indiana selected the 1 ppb significant threshold level for this WOE analysis for its projected ozone impacts on downwind states.

4.0 Ozone Monitoring Data Analysis

Currently, Indiana has 43 ozone monitors throughout the state, 41 are operated by IDEM and two are U.S. EPA Clean Air Status and Trends Network (CASTNET) sites (i.e., Salamonie Reservoir and Vincennes). Indiana also operates a monitor located in West Union, Illinois, just across the state line and upwind of Vigo County. A map of all the ozone monitors in the state is found in Figure 1.

[1] https://www.epa.gov/sites/production/files/2018-09/documents/contrib_thresholds_transport_sip_subm_2015_ozone_memo_08_31_18.pdf

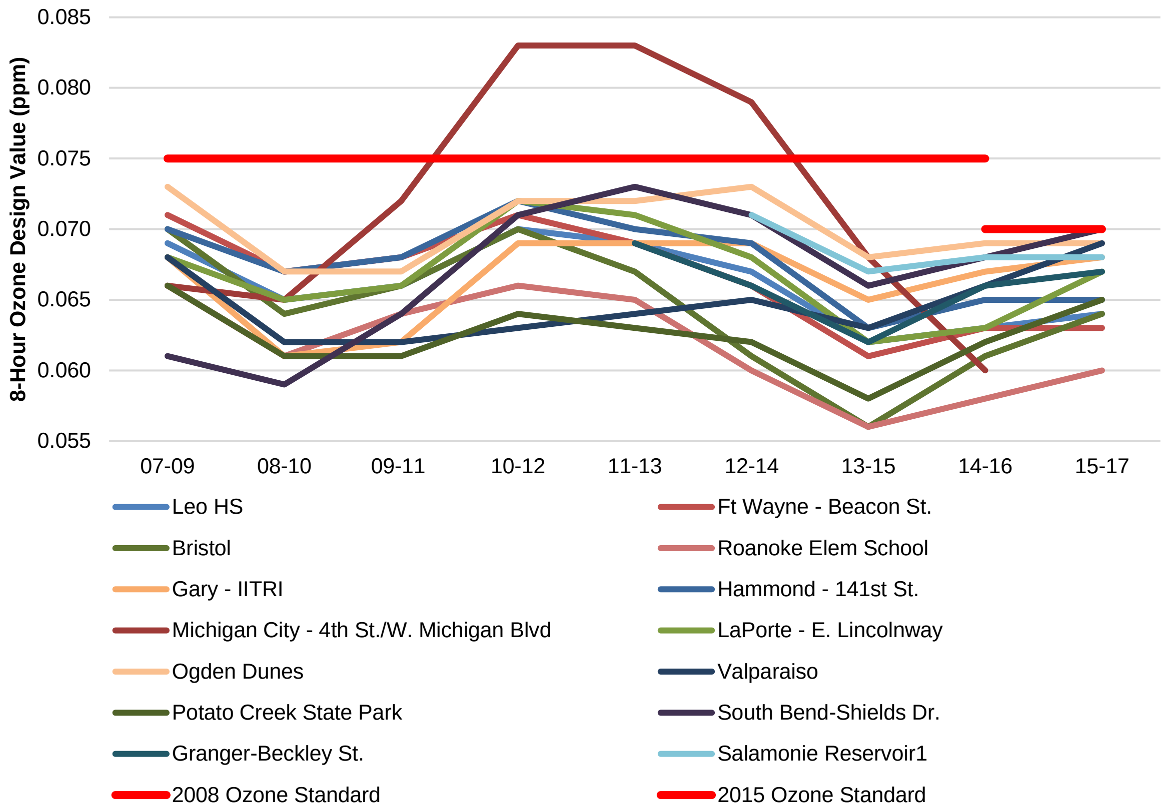
Figure 1. Map of Ozone Monitors in Indiana



The 2015 8-hour ozone NAAQS are met at an ambient air quality monitoring site when the three-year average of the annual fourth-highest daily maximum 8-hour average concentration is less than or equal to 70 ppb. When this occurs, the site is deemed to be in attainment. An exceedance 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 (i.e., design value) is greater than the standard.

Charts 1-3 display 2007-2017 8-hour ozone design values for Indiana, broken out into three geographic regions (i.e., northern, central and southern). While the impact from the abnormally hot summer of 2012 is evident, ozone concentrations have been trending downward throughout the state. In fact, all but two of Indiana's ozone monitors had 2015-2017 design values below the standard.

Chart 1. 8-Hour Ozone Design Values for Northern Indiana Monitors (2007-2017)



***Michigan City 2015-2017 design value is invalid due to incomplete data.**

Chart 2. 8-Hour Ozone Design Values for Central Indiana Monitors (2007-2017)

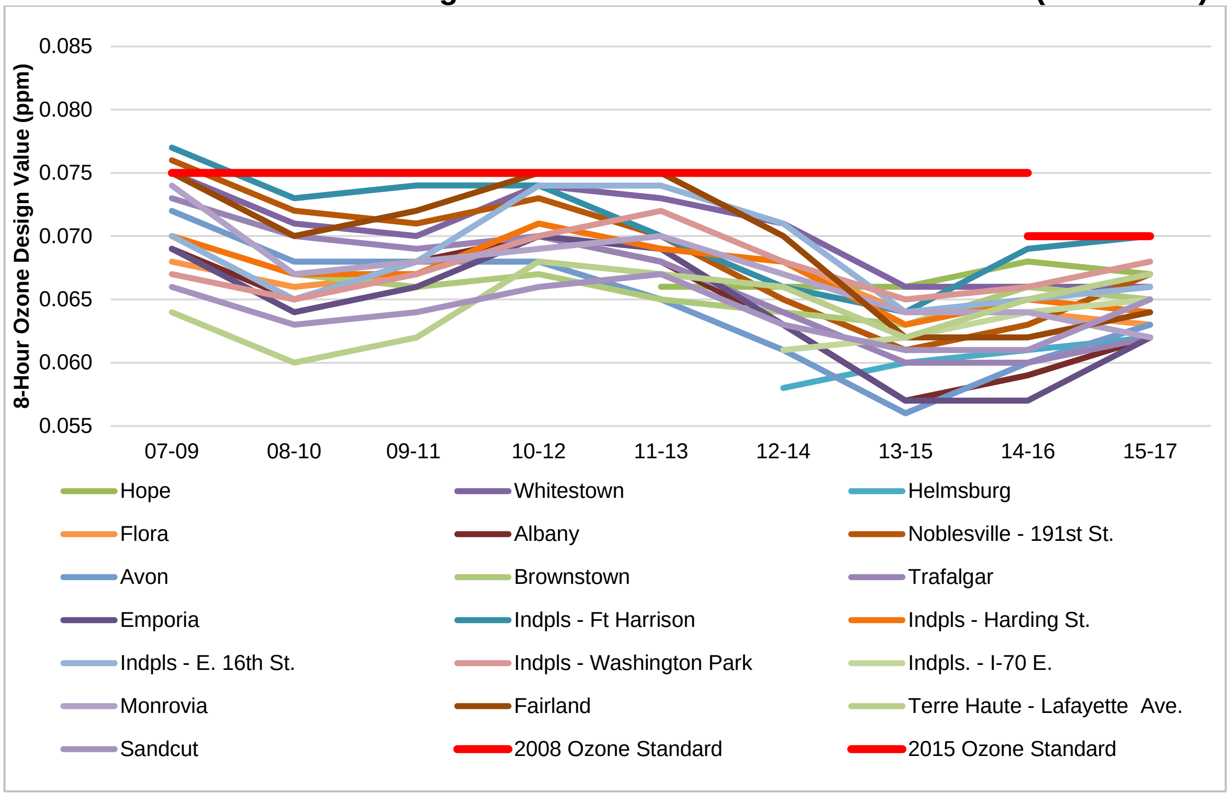


Chart 3. 8-Hour Ozone Design Values for Southern Indiana Monitors (2007-2017)

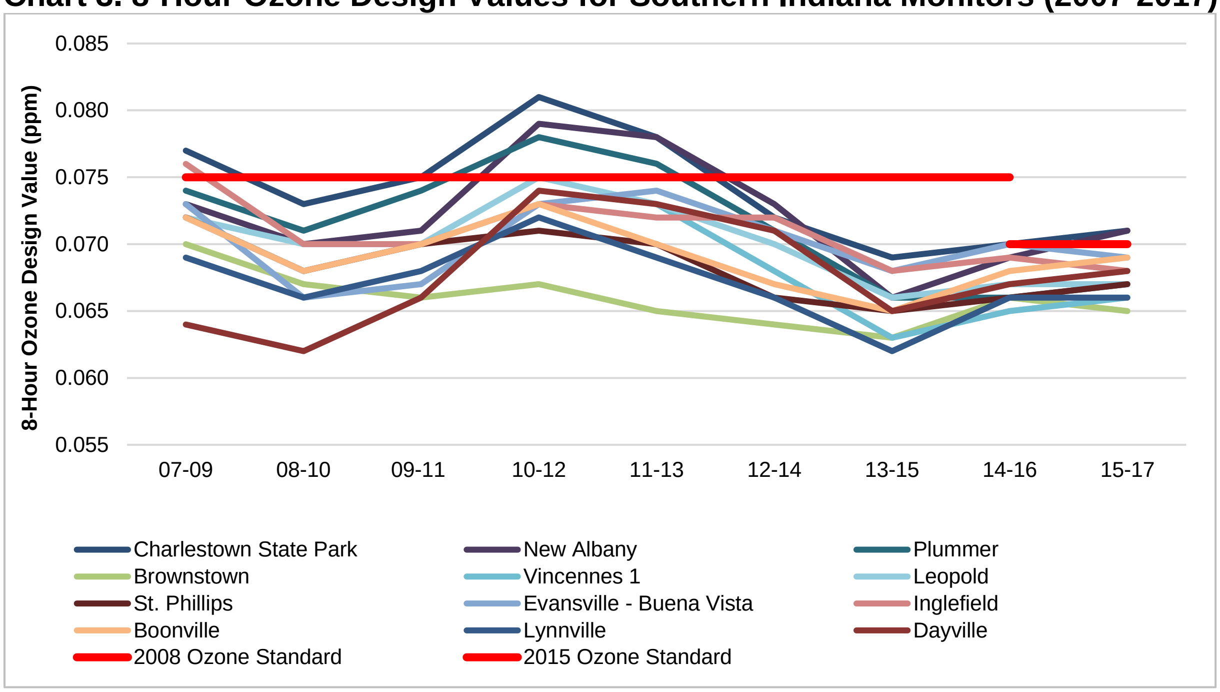
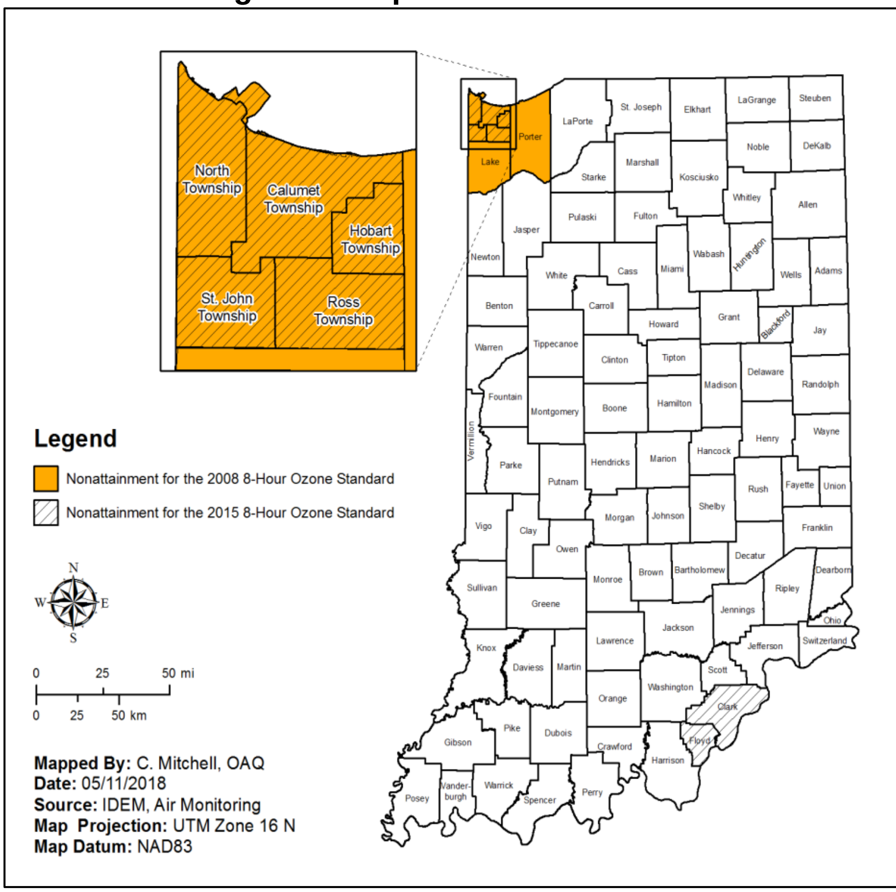


Figure 2 displays the current nonattainment areas in Indiana for the 2008 and 2015 8-hour ozone NAAQS. While all ozone monitors within Lake and Porter counties attain both the 2008 and 2015 standards, these counties are included in the Chicago-Naperville, IL-IN-WI 8-hour ozone nonattainment area and have been designated within the Core Based Statistical Area (CBSA) or Combined Statistical Area (CSA). While Lake and Porter counties are included in their entirety for the 2008 8-hour ozone NAAQS, only five townships in Lake County (Calumet, Hobart, North, Ross and St. John townships) have been designated by U.S. EPA as nonattainment for the 2015 8-hour ozone NAAQS. Clark and Floyd counties are situated downwind of the Louisville metropolitan area and are impacted by emissions from Louisville and the Ohio River Valley.

Figure 2. Map of Ozone Nonattainment Areas in Indiana



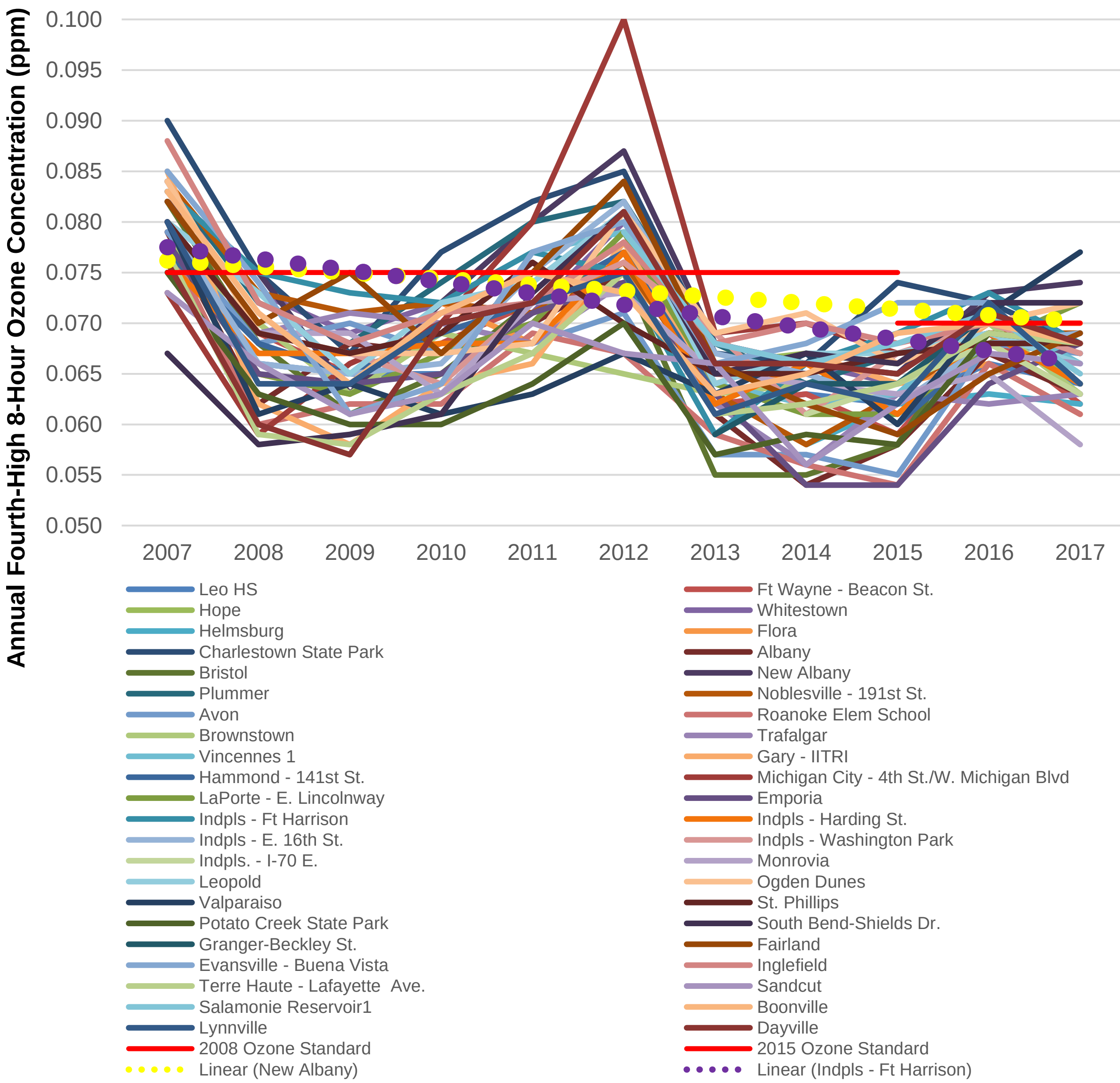
County	Nonattainment for 2008 Standard
Lake	Entire County
Porter	Entire County

County	Nonattainment for 2015 Standard
Clark	Entire County
Floyd	Entire County
Lake	Calumet Township
	Hobart Township
	North Township
	Ross Township
	St. John Township

4.1 Ozone Trends in Indiana

Chart 4 displays annual fourth-high 8-hour averages for each ozone monitor in Indiana from 2007-2017, indicating a general downward trend in ozone concentrations. While ozone concentrations are driven by conducive conditions during the late spring and summer, as evident by the sunny, dry and hot conditions experienced in Indiana in 2012, overall ozone design values have been declining. Emission reductions have played a key role in lessening the ozone impacts from Indiana and other states throughout the country.

Chart 4. Annual Fourth-High Ozone Concentrations for Indiana (2007-2017)



***Michigan City 2015-2017 design value is invalid due to incomplete data.**

Analyses were conducted for two Indiana monitors with the highest 8-hour ozone concentrations over the recent period. Over the 11-year period (2007-2017), general trends for the New Albany and Indpls – Ft. Harrison monitors design values in 2007 began at or above the 2008 ozone standard of 75 ppb. By 2017, the fourth-high ozone values approached the 2015 ozone standard of 70 ppb, as indicated by the dotted trend lines in Chart 4. The resulting decreases of the fourth-highest 8-hour ozone averages, ranging from 8 ppb to 15 ppb over the 11-year timeframe, show the decline in ozone concentrations. A comparison of all ozone monitors in the state show similar trends for decreasing ozone over time.

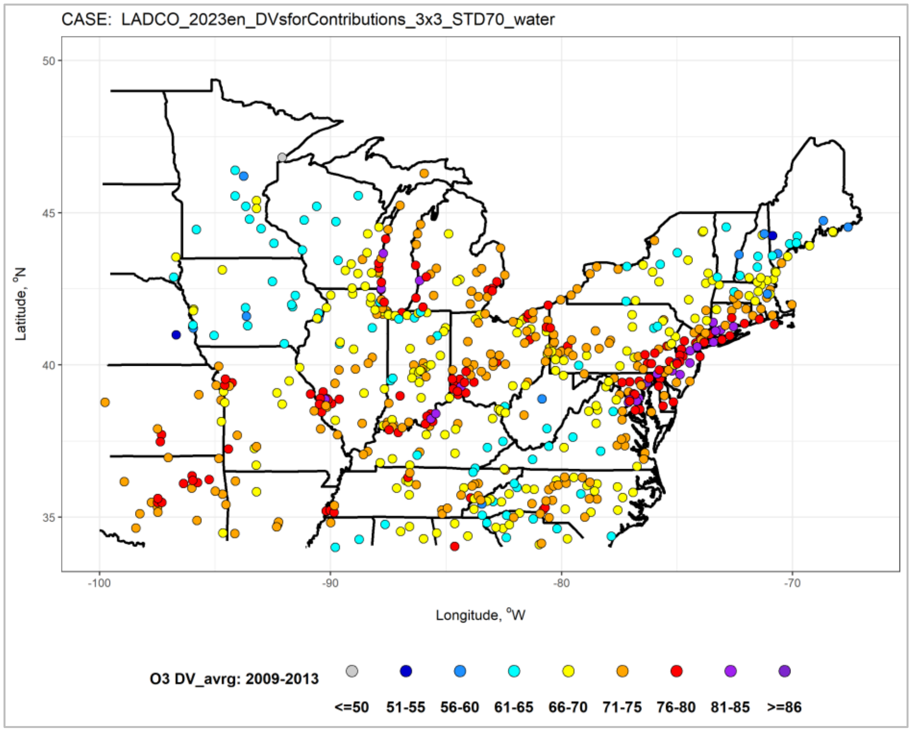
4.2 Summary of Ozone Trends for Indiana

Ozone data through 2017 show two monitors in Indiana have 2015-2017 8-hour ozone design values above 70 ppb: New Albany and Charlestown St. Park, located in Floyd County and Clark County, respectively. These monitors are impacted by the Louisville metropolitan area and associated emissions from the Ohio River Valley. Over the past 11 years, a majority of the ozone monitors in the state have observed decreases in 8-hour ozone design values and analysis shows ozone concentrations continue to trend downward throughout the state, despite warmer than normal summer temperatures. This can be attributed in part to emission reductions realized throughout the state and country. While ozone transport occurs downwind, especially when emissions are released high into the atmosphere, the fact that ozone concentrations overall are decreasing throughout the state indicates improving air quality. This improvement will lessen ozone impacts at downwind monitors as well.

4.3 Ozone Trend Analysis for Monitors Downwind of Indiana

Figure 3 shows the 2009 – 2013 5-year weighted design values for the Midwest and Northeast U.S regions. Design values (DVs) are generally higher near metropolitan areas and along coastal regions. This is most evident along the lower Great Lakes and Northeast coast.

Figure 3. 2009-2013 Design Values (DVs) for Midwest and Northeast Ozone Monitors



LADCO photochemical modeling, using Comprehensive Air Quality Model with extensions (CAMx) version 6.4, identified one nonattainment and one maintenance monitor in the Northeast U.S. and two maintenance monitors along the Lake Michigan coast where Indiana was projected to have a significant contribution, based on a 1 ppb significance threshold. LADCO's modeling results were very similar to U.S. EPA's transport modeling results released in March 2018 and updated in May 2018. LADCO modeling incorporated alternative power sector emissions taken from the ERTAC EGU tool version 2.7 as a flexibility. IDEM has been actively participating in the development of the ERTAC EGU tool, and feels this tool better projects future EGU loads and ultimately, more accurate emission estimates for the future. LADCO's *Interstate Transport Modeling for the 2015 Ozone National Ambient Air Quality Standard, Technical Support Document (TSD)* is attached in Appendix C. The results presented here follow the regular 3 x 3 grid cell approach where water dominated cells are included in the Relative Response Factor (RRF) calculation. The one nonattainment and three maintenance monitors to which Indiana is projected to be a significant contributor are listed in Table 1. 2015 – 2017 design values (DVs) are included to show the conservative nature of the modeling, using average (avrg) and maximum (max) weighted design values from 2009 – 2013. Current design values run 4 ppb to 14 ppb lower than the average 2009 – 2013 weighted design values.

Table 1. Monitors with Significant Indiana Contributions (ppb)

Site ID	State	County	2009-2013 Avrg	2009-2013 Max	2023 "3x3" Avrg	2023 "3x3" Max	RRF	IN Cont.	2015-2017 DV
240251001	MD	Harford	90.0	93	71.0	73.3	0.7888	1.36	76
260050003	MI	Allegan	82.7	86	68.8	71.5	0.8319	6.91	73
360850067	NY	Richmond	81.3	83	70.9	72.4	0.8720	1.00	76
551170006	WI	Sheboygan	84.3	87	70.5	72.8	0.8362	6.19	80

Analysis of the three-year design values for the 8-hour ozone monitors projected to be nonattainment and maintenance in Maryland and New York show a declining trend of design values over the past 14 years for all monitors. With national emission reduction regulations in place for electric generating units, tighter mobile source emission controls and other transport related emission reduction measures, the design values are expected to continue to trend lower over time and attain the 2015 8-hour ozone NAAQS.

Trends analyses show, despite some variation in the design values due to ozone conducive meteorological conditions in the Northeast U.S. over the past several years, ozone levels continue to fall. This point is brought out in the trend analysis of the 8-hour ozone design values for the Harford, Maryland and Richmond, New York ozone monitors. These monitors have been identified through U.S. EPA modeling projections as nonattainment for future year 2023. Charts 5 and 6 show the 8-hour ozone design values from 2004 through 2017 and the trend line (dotted) over the same period of time. The downward trend in ozone design values for both monitors is evident and, if the trend continues as expected, should reach attainment before 2023. Appendix D contains several additional monitors that are projected as maintenance by 2023 and modeling indicates Indiana may have an impact greater than 1 ppb.

Chart 5. Ozone Design Values for Harford, MD Monitor #240251001 (2004-2017)

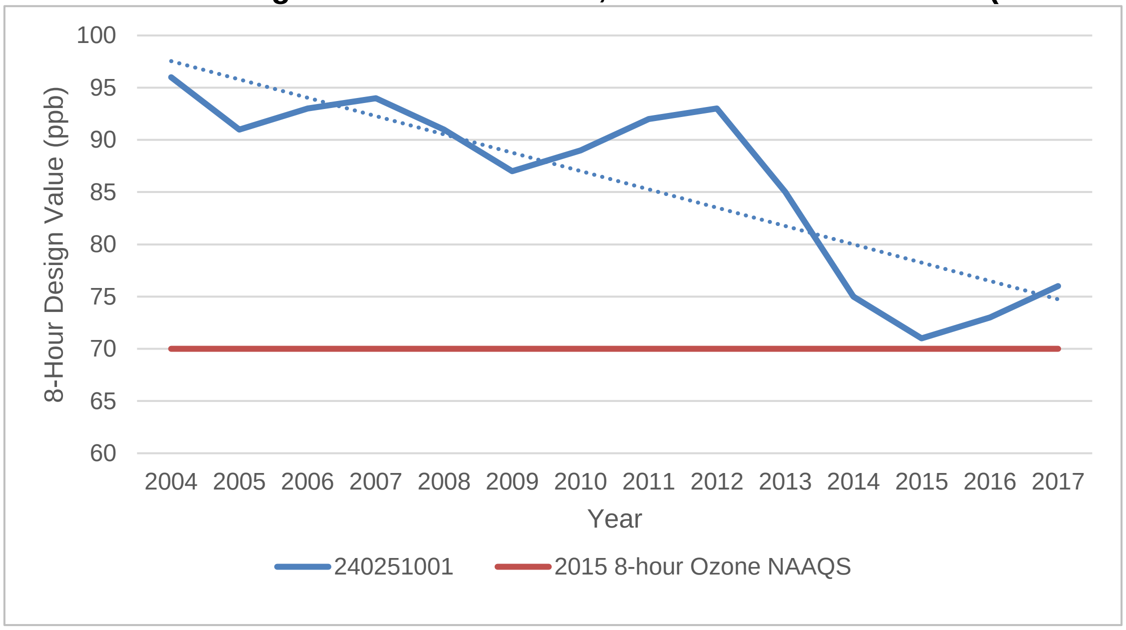
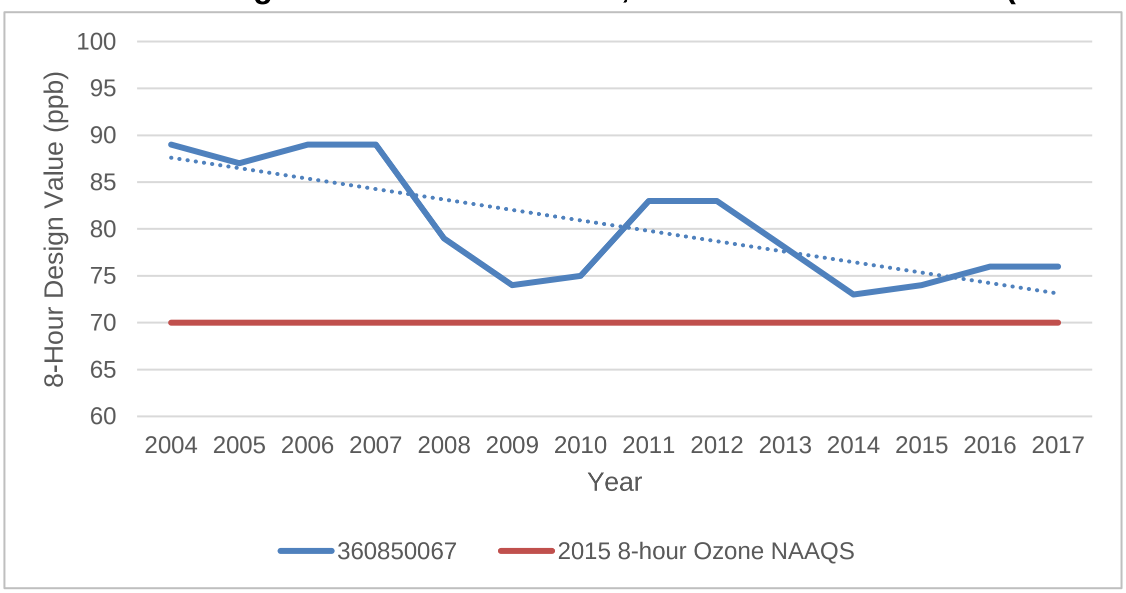


Chart 6. Ozone Design Values for Richmond, NY Monitor #360850067 (2004-2017)



Charts 7 and 8 show the fourth-highest 8-hour ozone concentrations and the average of the top 10 highest daily maximum 8-hour ozone concentrations for Harford, MD, and Richmond, NY monitors for 2009-2017. Analysis of single year ozone values continue to show the downward trend of ozone concentrations as well.

Chart 7. Single Year Ozone Values for Harford, MD Monitor #240251001 (2009-2017)

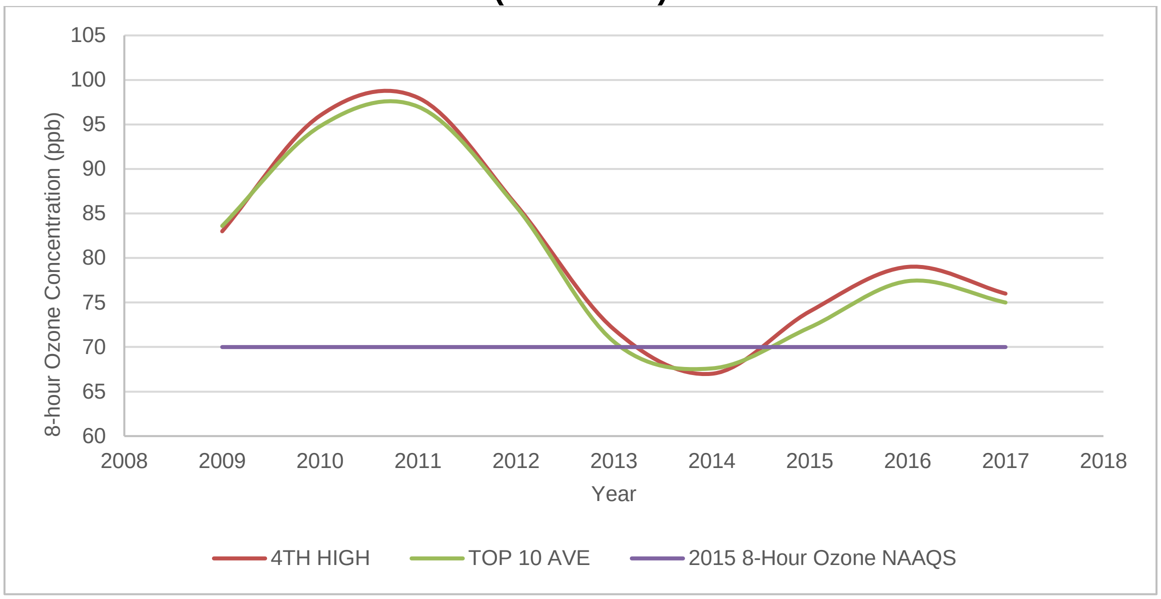
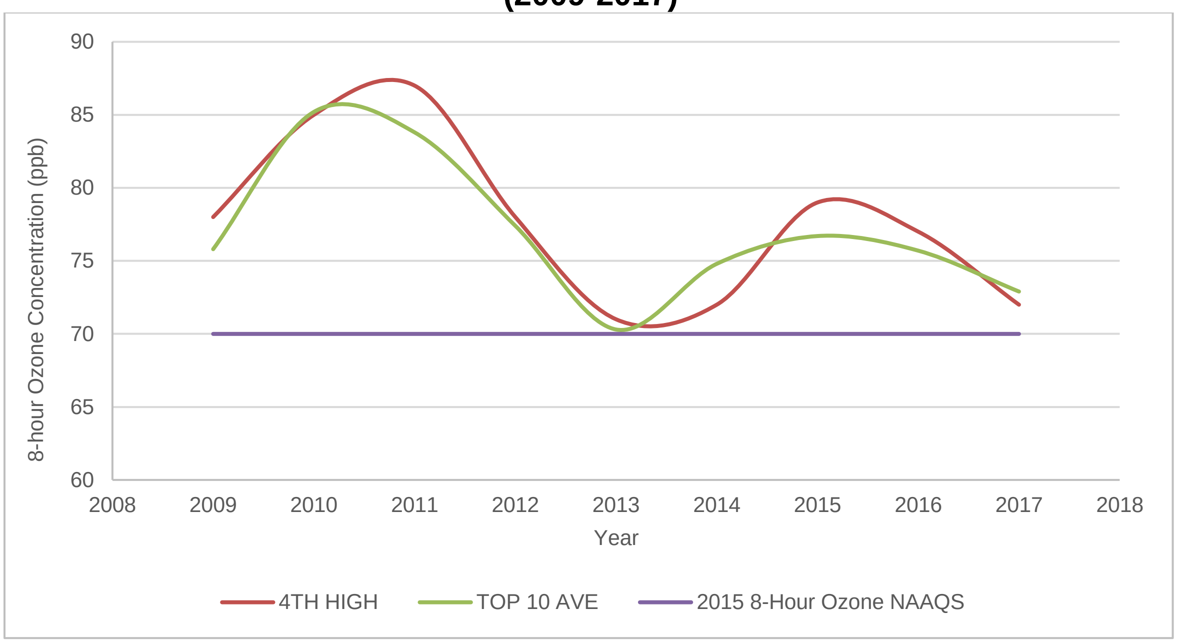


Chart 8. Single Year Ozone Values for Richmond, NY Monitor #360850067 (2009-2017)



4.4 Conclusion for Ozone Data Trend Analysis

The ozone data trend analysis shows that three-year 8-hour ozone design values, as well as single year trends are declining for most of Indiana's ozone monitors. With the exception of several Northeast coastal ozone monitors, the downwind monitors have either met or have nearly met modeled design value projections for 2023. For those monitors in the Northeast that have higher design values based on current monitoring data, U.S. EPA has concluded in Norm Possiel's presentation *"Analysis of Ozone Trends in the East in Relation to Interstate Transport",* dated May 14, 2018 (Appendix E), that since these monitors are located along the East Coast, especially centered along coastal Connecticut, they are impacted from more local emissions: emissions within the Northeast Corridor and the on-shore wind flow from the Atlantic Ocean.

While further analysis is needed, Indiana concludes that the coastal Northeast monitors are impacted more from local emissions than other surrounding inland monitors in the region. This assertion is confirmed by the back trajectory analysis discussed later in this document. Back trajectories taken from the high ozone days at the Northeast monitors show an overwhelming number of trajectories that recirculate over the East Coast or pass over the coastal states. It would be expected with the overall emissions reductions observed in Indiana and other upwind states, the design values at the Northeast U.S. ozone monitors projected to be nonattainment or maintenance would respond to those upwind state emission reductions, resulting in lower ozone concentrations. However, ozone values and the number of exceedance days have remained steady or increased over the past few years in the Northeast. While a meteorological analysis shows temperatures have been warmer than normal over the East Coast, the local and regional impact of emissions from coastal areas cannot be ignored.

5.0 Emissions Analysis

5.1 Indiana's Anthropogenic Emissions Analysis

Indiana maintains a statewide emissions inventory through its Emission Inventory Tracking System (EMITS) program as mandated by the Emission Statement Rule in 326 Indiana Administrative Code 2-6 and has compiled nitrogen oxides (NO_x) and volatile organic compounds (VOC) emissions from the most current reporting years (2005, 2008, 2011 and 2014). The emission totals are reported to U.S. EPA's National Emission Inventory (NEI), Tier 1 Summaries[2]. Emission comparisons for NO_x and VOCs show a decrease in emissions over the 10-year period (2005-2014).

Table 2 shows all reported anthropogenic NO_x emissions for Indiana for NEI reporting years 2005, 2008, 2011 and 2014. Overall, Indiana's statewide NO_x emissions have decreased by 33% from 2005 to 2014. Highway vehicle emissions have

[2] https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

decreased by 8% but represent the largest category of NO_x emissions among all NO_x source sectors in 2014. Significant emission reductions of 48% from fuel combustion from the electric utility sector have occurred from 2005 to 2014, as well as emission reductions from off-highway vehicles of 41%. Several other emission sectors show slight decreases or increases in their 2014 emissions.

Table 2. Anthropogenic NO_x Source Emissions for Indiana

NO_x Source Description	2005	2008	2011	2014
Fuel Combustion Elec Util.	210,819	199,014	119,632	110,253
Fuel Combustion Industrial	56,995	46,661	40,422	31,579
Fuel Combustion Other	22,600	17,972	16,674	14,534
Chemical & Allied Product Mfg.	144	133	750	392
Metals Processing	8,007	6,686	5,740	5,565
Petroleum & Related Industries	338	274	6,387	5,055
Other Industrial Processes	12,607	10,364	9,220	8,474
Solvent Utilization	248	13	7	10
Storage & Transport	153	25	8	18
Waste Disposal & Recycling	4,832	2,930	2,253	2,561
Highway Vehicles	165,903	179,870	171,439	151,846
Off-Highway	110,676	81,776	70,546	65,386
Miscellaneous	268	573	468	971
Total	**593,589**	**546,292**	**443,546**	**396,644**

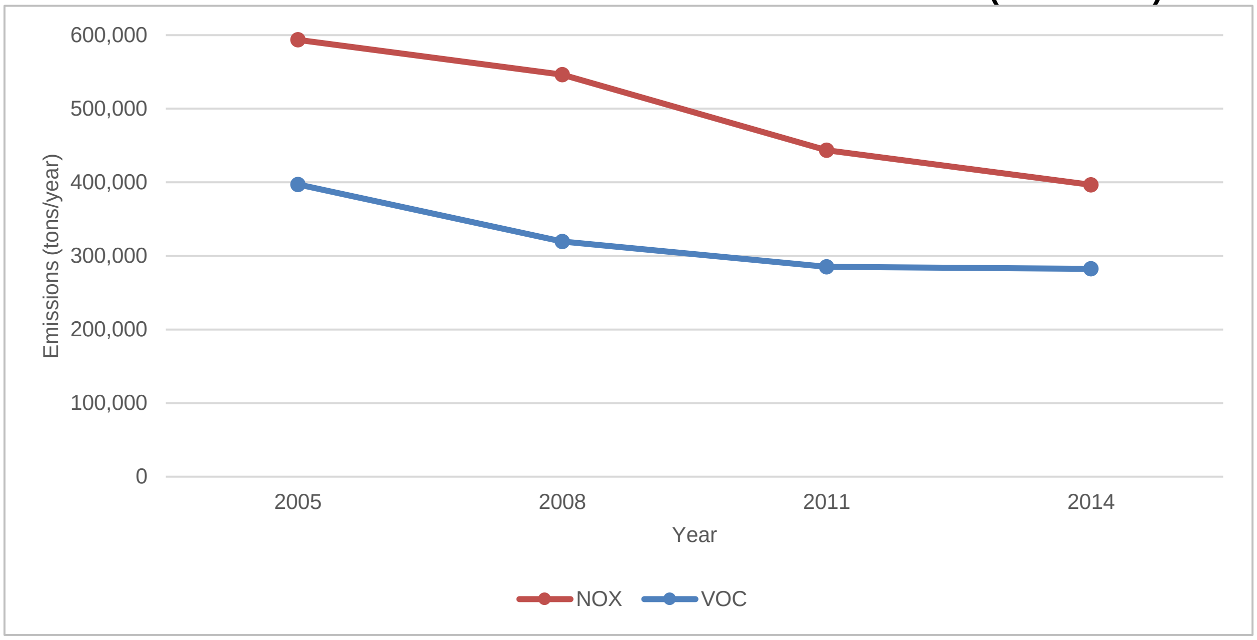
Table 3 shows all VOC emissions reported for Indiana major sources for NEI years 2005, 2008, 2011 and 2014. Solvent utilization has shown significant VOC emission reductions of 40% from 2005 to 2014, as well as VOC emission reductions from highway vehicles of 34%. While overall VOC emissions throughout the state have decreased by 29%, several other emission sectors show increases from 2005 to 2014 emissions, especially for petroleum and related industries, fuel combustion for sources other than electric utilities and industrial sources and miscellaneous. A change in the reporting requirements in 2011 for the petroleum and related industries is the cause of the dramatic increase in VOC emissions for that source category.

Table 3. Anthropogenic VOC Source Emissions for Indiana

VOC Source Description	2005	2008	2011	2014
Fuel Combustion Elec Util.	2,167	2,046	1,839	1,686
Fuel Combustion Industrial	2,132	1,926	2,148	1,555
Fuel Combustion Other	8,181	10,146	13,122	14,400
Chemical & Allied Product Mfg.	1,126	754	2,623	1,077
Metals Processing	6,587	5,980	5,030	4,485
Petroleum & Related Industries	1,151	788	12,249	17,814
Other Industrial Processes	11,929	8,667	8,261	8,434
Solvent Utilization	153,409	132,697	78,080	91,969
Storage & Transport	37,715	25,243	26,704	13,055
Waste Disposal & Recycling	5,236	3,091	2,115	3,455
Highway Vehicles	108,738	74,576	84,174	72,127
Off-Highway	55,831	48,588	42,738	34,248
Miscellaneous	2,967	4,966	6,107	18,100
Total	**397,168**	**319,468**	**285,190**	**282,404**

A summary of Indiana's statewide anthropogenic NO_x and VOC emissions from 2005 to 2014 is shown in Chart 9. As can be seen, both NO_x and VOC emissions have steadily declined over the 10-year period as a result of permanent and enforceable control measures, with additional reductions anticipated for reporting year 2017 and further decreases projected by 2023. These reductions will lessen Indiana's impacts on downwind ozone concentrations into the future.

Chart 9. Trends in Indiana's NO_x and VOC Total Emissions (2005-2014)



It is important to note that a review of Indiana's EGU emissions from base-year 2011 and 2016 shows substantial NO_x emission reductions on the order of 30% during the six-year period with projected reductions in NO_x emissions by 2023 by an additional 15%-20% based on U.S. EPA and ERTAC emission models.

5.2 LADCO and U.S. EPA 2023 EGU Emission Projection Summary

The emissions differences for Indiana EGUs between ERTAC and U.S. EPA's NO_x emission projections are 1.7%, with ERTAC projecting less NO_x emissions of 2,083 tons/year. This difference reinforces the fact that both emission platforms are projecting similar 2023 NO_x and VOC emissions and both continue to show significant emission reductions from the NEI 2011 base-year emissions. ERTAC's projected NO_x reductions will be between 49% and 64% among the LADCO states. The ERTAC tool projects lower NO_x emissions in Indiana relative to U.S. EPA "EN" platform, but slightly higher NO_x emissions (approximately 0.6% higher) across the LADCO region due to higher projections in Ohio and Wisconsin. ERTAC's projected VOC emissions were reduced from LADCO states from 2011 to 2023, ranging from 6% to 24%, while U.S. EPA's projected VOC emission reductions for the LADCO states from 2011 to 2023 ranged between 10% and 41%. Table 4 shows NO_x and VOC total emissions for the LADCO states and regional trends for the five multi-jurisdictional organizations (MJOs).

Table 4. Comparison of NEI 2011 EGU NO_x Emissions with ERTAC and U.S. EPA's 2023 EGU NO_x Emission Projections

State/ Region	NEIv6.3 2011		ERTAC2.7 2023		EPA EN 2023	
LADCO States (tons/year)	**NO_x**	**VOC**	**NO_x**	**VOC**	**NO_x**	**VOC**
IL	73,644	1,602	34,078	1,459	30,764	1,155
IN	120,264	1,797	61,314	1,669	63,397	1,327
MI	77,739	1,142	27,977	868	33,708	910
MN	35,181	694	14,600	596	21,919	594
OH	103,189	1,503	50,140	1,060	37,573	894
WI	31,702	714	15,829	668	15,419	640
Regional Totals (tons/year)	**NO_x**	**VOC**	**NO_x**	**VOC**	**NO_x**	**VOC**
LADCO	441,719	7,453	203,938	6,516	202,780	5,521
MARAMA/ OTC	276,045	4,016	84,533	4,406	97,903	4,334
SESARM	468,394	11,193	291,058	9,236	328,132	9,958
CENSARA	513,158	10,038	274,253	9,062	221,846	7,756
WESTAR	331,503	5,267	298,107	3,485	201,044	5,028

Chart 10 shows the reductions in projected NO_x emissions from EGUs in each of the LADCO states from 2011 to 2023. Within the LADCO states, NO_x emissions are projected to be reduced from 49% to 64%. Chart 11 shows the 2011 and 2023 LADCO and U.S. EPA projected VOC emissions for each of the six LADCO states. Within the LADCO states, VOC emissions are projected to be reduced from 6% to 29%.

Chart 10. EGU Annual NO_x Emission Comparison for LADCO States (tons/year)

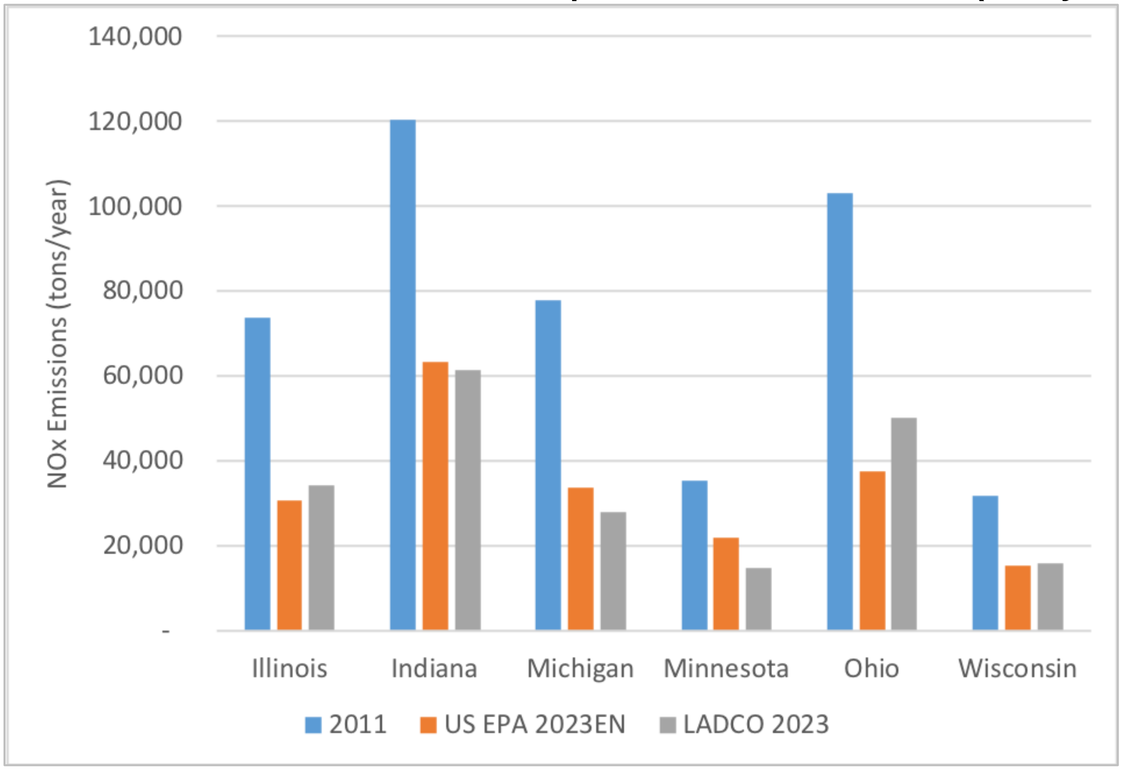
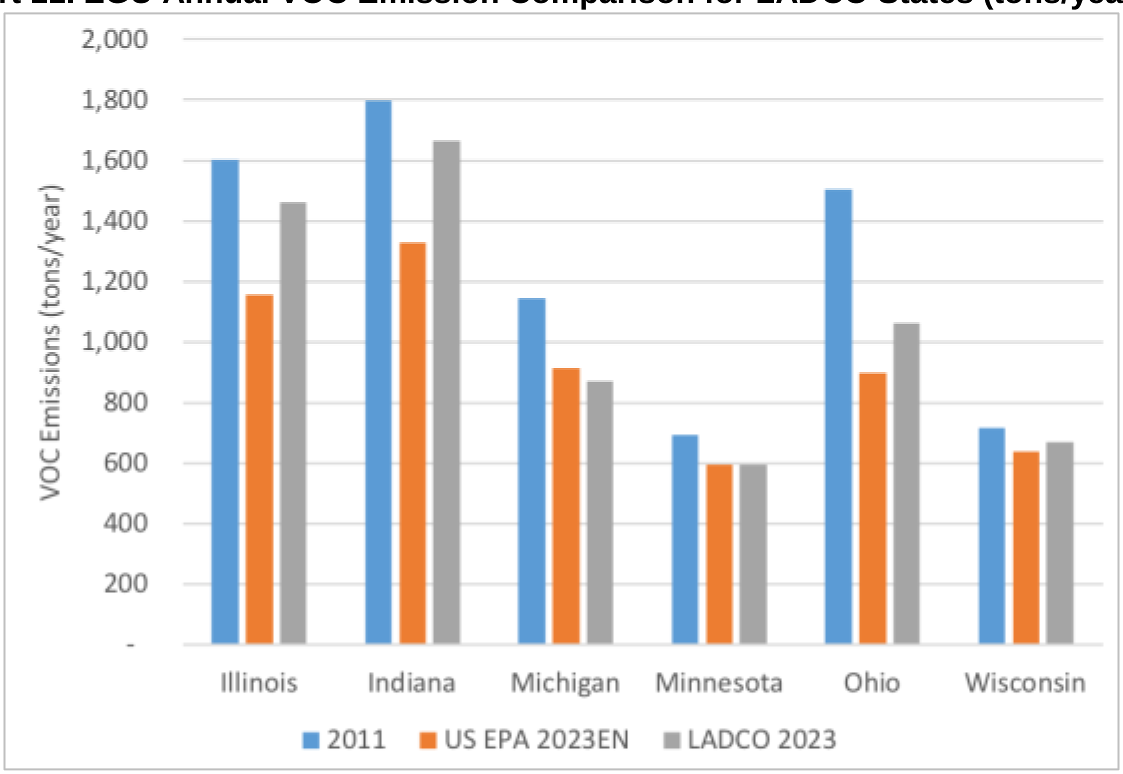


Chart 11. EGU Annual VOC Emission Comparison for LADCO States (tons/year)



While these annual summaries mask the fine scale temporal differences between the EGU projection methodologies, the differences in ozone projections between the LADCO and U.S. EPA simulations are consistent with the differences in annual total NO_x emissions between the EGU projections used in each simulation.

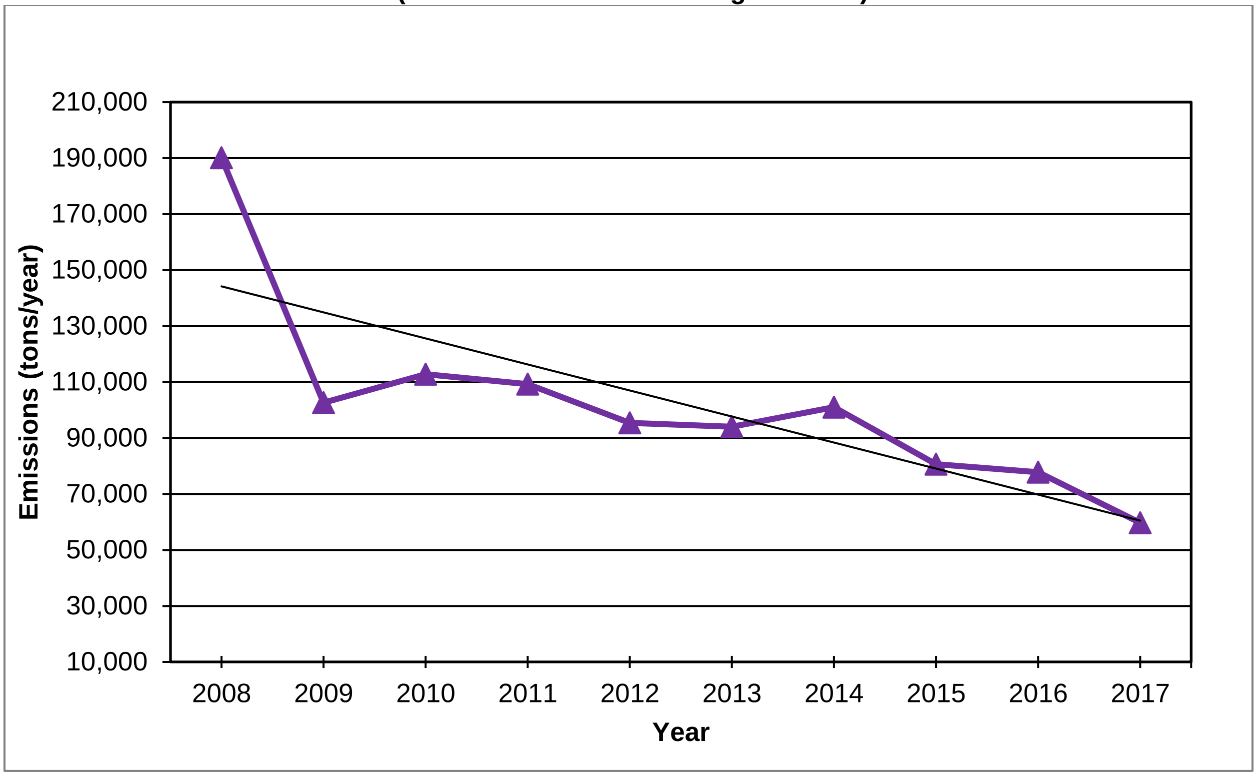
5.3 Comprehensive Analysis of NOx Controls for Indiana's EGUs and non-EGUs

Indiana's future NO_x emission reduction potential for EGU and non-EGU emission units were evaluated over a 10-year timeframe beginning in 2008 and ending in 2017. More specifically, NO_x control measures, consent decree requirements, future fuel switches and retirements for large EGUs and non-EGUs were considered and the NO_x emissions from 2008 to 2017 for both source categories analyzed. Large EGUs include boilers, turbines, and combined cycle units with a capacity of 250,000 mmBtu/hr or more used to generate electricity for sale, whereas large non-EGUs include boilers and turbines at heavy manufacturing facilities, such as aluminum smelters, petroleum refineries, iron and steel production facilities and steam plants at institutional settings, such as large universities with a capacity of 250,000 mmBtu/hr or more.

Charts 12 and 13 shows a downward trend in annual NO_x emissions for Indiana's EGUs and non-EGUs from 2008 to 2017. This is due primarily to a series of state and federal rules promulgated and implemented over the last 10 years designed to target fossil fuel-fired EGUs and other large emitters of nitrogen oxides. The Ozone Transport NO_x SIP Call Rule (commonly referred to as the NO_x SIP Call Rule), Regional Haze Rule, Clean Air Interstate Rule (CAIR), Cross-State Air Pollution Rule (CSAPR) and Consent Decree Agreements have driven many sources in Indiana to install Best Available Retro-fit Technologies (BART)/add-on controls, convert to natural gas or shut down affected units to comply with the requirements associated with these rules and agreements. As a result, total annual NO_x emissions have decreased by 69% for EGUs and 58% for non-EGUs since 2008.

The NO_x Budget Trading Program (NBP) was an allowance trading program the U.S. EPA provided in the NO_x SIP Call Rule as an option for states to use to meet NO_x SIP Call Rule obligations. Indiana's NBP was adopted in 2001. The rulemaking generally applied to EGUs, however Indiana is one of the states that allowed large non-EGUs to opt into the NBP. As a result, EGUs and non-EGUs installed NO_x emission controls early for the NO_x SIP Call Rule, implemented in 2004, and later in response to CAIR, implemented in 2009. The 10-year timeframe used for this analysis captures a 46% drop in NO_x emissions from EGUs one year prior to the implementation of CAIR as shown in Chart 12, which is consistent with the installation of NO_x emission controls on EGUs to comply with CAIR requirements. Annual NO_x emissions from EGUs increased slightly between 2009 and 2010 after CAIR was remanded in 2008 then had a slight increase between 2013 and 2014 after CSAPR was challenged at the end of 2011. However, the overall trend of NO_x emissions from EGUs are lower over this time period. Appendix F contains a list of NO_x emission controls and annual NO_x emissions for the state of Indiana's EGU and non-EGU fleets.

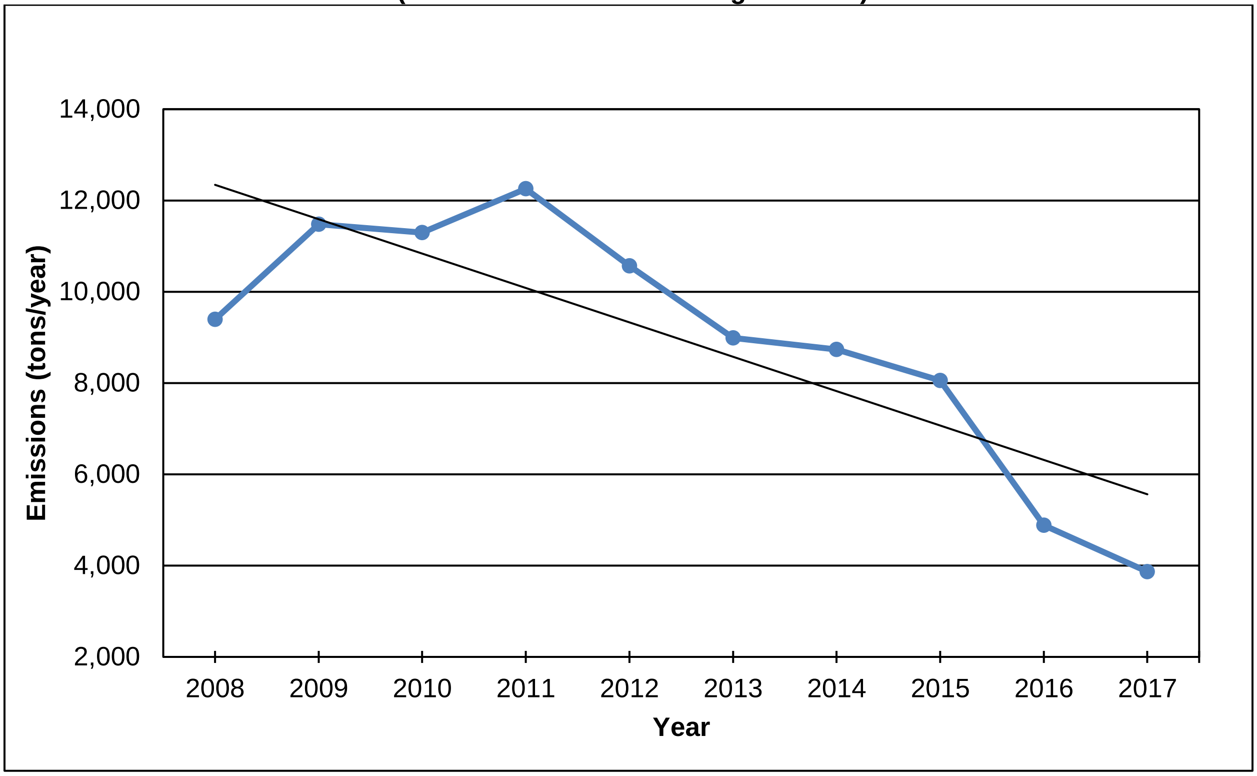
Chart 12. Indiana's 10-Year Annual EGU NO_x Emissions Trend
(Based on Air Markets Program Data)



Coal-fired EGUs and non-EGUs are the primary contributors of NO_x emissions from fossil fuel-fired electric generating units in Indiana. Chart 13 illustrates that the trend line for non-EGUs followed a similar trend as the large coal-fired non-EGUs in Indiana's non-EGU fleet. More specifically, NO_x emissions from the three coal-fired non-EGUs at Alcoa mirror the trend line for Indiana's entire non-EGU fleet over the 10-year evaluation period because NO_x emissions from these units far exceeded emissions from all other non-EGUs in the non-EGU fleet. The only year total annual NO_x emissions from non-EGUs are in contrast to the combined NO_x emissions from the three coal-fired units at Alcoa is from 2013 to 2014. The total NO_x emissions from Alcoa's three units increased in 2014, whereas total annual NO_x emissions from the remaining non-EGU fleet decreased. This is due to the fact that NO_x emissions from several of the other non-EGUs in the state decreased in 2014 to a level that offset the increase in NO_x emissions from the three Alcoa coal-fired units.

On June 11, 2012, the U.S. EPA finalized a limited approval of the revisions to the Indiana SIP addressing regional haze for the first implementation period. As part of this action, the U.S. EPA proposed the emission reductions from 326 IAC 26-2 would suffice to address the BART requirements for Alcoa and approved regulation 326 IAC 26-2 for incorporation into Indiana's SIP. Alcoa's BART strategy requires each of the three boilers to be equipped with low NO_x burners with staged over-fire air and restricts NO_x emissions to a 24-hour daily average limit of 0.38 lbs/MMBtu. BART NO_x controls and emission limits for these units have been implemented and incorporated into the source's Part 70 Operating permit. The date for compliance with Indiana's Regional Haze SIP and BART Emission Limitations Rule, 326 IAC 26-2 was February 22, 2013.

Chart 13. Indiana's 10-Year Annual non-EGU NO_x Emissions Trend
(Based on Air Markets Program Data)



The NBP established under the NO_x SIP Call instituted a statewide NO_x budget for the ozone season for EGUs and non-EGUs that opted into the program. The large non-EGUs included in Indiana's NBP were moved collectively to Indiana's CAIR NO_x Ozone Season Trading Program rules when CAIR became effective. CAIR referred to non-EGUs as large affected units with the overall non-EGU budget being covered by the following set-asides: 8,727 tons of NO_x allowances for existing large affected units, 400 tons of NO_x allowances for new large affected units, 500 tons of NO_x allowances for energy efficiency, and 150 tons of NO_x allowances for hardship. So, Indiana CAIR NO_x Ozone Season Trading Program had a large affected units total budget of 9,777 tons of NO_x emissions per ozone season.

Indiana's CSAPR Programs and NO_x Emissions from Large Affected Units (non-EGU) rulemakings have been submitted to the U.S. EPA for review and approval. Indiana's CSAPR Programs rulemaking incorporates CSAPR requirements and repeals portions of CAIR. The final rule, 326 IAC 24 (LSA# 16-209), became effective on November 24, 2017 and was submitted to the U.S. EPA for SIP approval on November 27, 2017. Indiana's NO_x Emissions from Large Affected Units rulemaking incorporates NO_x SIP Call monitoring requirements and repeals the NBP. The final rule, 326 IAC 10 (LSA# 15-414), became effective August 26, 2018 and was submitted to the U.S. EPA for SIP approval on August 28, 2018. IDEM included a budget demonstration with the

State's NO_x Emissions from Large Affected Units rulemaking submittal to the U.S. EPA that shows continued compliance with the NO_x SIP Call requirements with regard to large non-EGUs.

According to the large non-EGU budget demonstration submitted, the total ozone-season NO_x emissions from large non-EGUs (i.e., all large non-EGUs included in the trading program at 326 IAC 24-3, except steel mills) could not exceed the large non-EGU budget imposed by the NO_x SIP Call, even if these units were to operate every hour of the ozone season. The demonstration shows the total ozone season NO_x emissions without the steel mills' blast furnace gas units because these units were not included in the final budget analysis. Reductions from these units were not needed to meet Indiana's NO_x SIP Call obligations, even though some of these units were included in Indiana's NO_x Budget Trading Program.

NO_x emissions from Indiana's non-EGUs for the last year of the evaluation period, 2017, were over 93% less than NO_x emissions from EGUs in 2017. Therefore, IDEM is not requiring sources of non-EGUs to install additional NO_x controls because it is not a cost effective solution for future NO_x emission reductions from Indiana's nonEGUs. The costs to retro-fit non-EGUs with additional NO_x controls far outweigh the benefit of any additional reductions realized due to the fact that 2017 NO_x emissions from EGUs exceed NO_x emissions from non-EGUs in 2017 by a factor of 15. Future NO_x emission reductions from EGUs will continue to be the primary driver for NO_x emission reductions from fossil fuel-fired electric generating units. Therefore, U.S. EPA approval and state implementation of the CSAPR Programs and NO_x Emissions from Large Affected Units rulemakings, along with existing consent decree agreements, planned fuel conversions and planned unit shutdowns over the next decade are expected to continue to reduce NO_x annual emissions. Expected changes to Indiana's EGU fleet over the next five years includes planned shut downs of nine EGUs, planned fuel switches to natural gas for three EGUs and eleven EGUs with enforceable consent decree caps on NO_x emissions. Appendix G identifies EGUs with existing consent decree caps and planned future retirements.

5.4 Anticipated Future EGU Emission Reductions in Indiana

In addition to the emission reductions listed in Indiana's NO_x SIP Call obligations and NO_x Budget Trading Program and accounted for in the current ERTAC EGU projections, it is expected that several retirements of coal-fired boilers or retrofits will occur within Indiana over the next few years. Those retirements/retrofits are as follows and the anticipated emission reductions are listed below in Table 5. Further EGU retirements or retrofits within the state may occur in the next few years.

- Vectren AB Brown - Units 1 and 2, located in Posey County, to retire by 2024
- Vectren FB Culley - Unit 2, located in Warrick County, to retire by 2024
- Vectren FB Culley - Unit 3, located in Warrick County, to retrofit controls but continue to operate on coal
- Alcoa Power Plant - Unit 4, located in Warrick County, to cease selling power to Vectren by the end of 2023, exiting their existing agreement

Table 5. Anticipated Retirements for Future Year Emission Reductions for EGUs in Indiana

EGU Retirements by 2024 NOT in Current FY Projections	NO_x (tpy)
AB Brown - Units 1 & 2	1,537.65
FB Culley - Unit 2	102.49
Alcoa Warrick - Unit 4	1,508.01
Total Anticipated Emission Reductions	**3,148.15**

5.5 Projected Ozone Season Emissions

The total ozone season emissions used in the LADCO photochemical modeling are summarized by state and pollutant. Table 6 presents the total 2023 ozone season (May 1 – September 30) emissions for the major criteria pollutants for each of the LADCO states.

Table 6. Total Ozone Season Emissions for 2023 LADCO Modeling

State/ Region	CO	NO_x	VOC	SO_2	NH_3	$PM_{2.5}$
LADCO States						
IL	607,125	143,052	497,088	44,492	47,348	41,223
IN	513,679	110,536	327,044	65,725	61,564	28,785
MI	632,948	102,683	609,349	43,644	39,374	25,621
MN	984,896	95,232	661,274	16,987	103,977	82,507
OH	687,300	115,544	424,614	58,947	62,778	32,843
WI	417,474	69,094	504,084	13,832	74,005	20,940

5.6 Conclusion for Emissions Analysis

Emissions in Indiana are trending downward as a result of current control programs. Overall, Indiana's anthropogenic NO_x and VOC emissions have been trending downward with NO_x decreasing by 33% from 2005 to 2014 with additional reductions anticipated for reporting year 2017, and further decreases are projected by 2023. VOC emissions have trended downward by 29% from 2005 to 2014 with projected emissions even lower by 2023.

In particular, EGU emissions from coal-fired power plants are significantly lower since 2011. It is important to note that a review of Indiana's EGU emissions shows substantial reductions from 2011 NO_x emissions of 120,264 tons to 82,475 tons of NO_x for 2016, on the order of 30% reduction during the six-year period. An additional 15%-20% in NO_x emissions reductions, based on U.S. EPA and ERTAC emission models, is projected by 2023. This fact, coupled with newly announced retirements or retrofits to coal fired EGUs in southern Indiana, will reduce NO_x emissions by an additional several thousand tons beyond what is currently modeled in either the U.S. EPA or ERTAC EGU

2023 simulations. These additional reductions will further assure future year attainment of the ozone standard at downwind receptors.

6.0 Photochemical Modeling Analyses

6.1 Modeling Platform

U.S. EPA conducted modeling to provide states support to demonstrate future year attainment of the 2015 8-hour ozone standard, as mandated by the CAA Section 110(a)(2)(D)(i)(I), which requires states to submit “good neighbor” SIPs to address any downwind impacts they may have on states that have nonattainment or maintenance areas. U.S. EPA used the framework of photochemical modeling conducted to support the Cross State Air Pollution Rulemaking (CSAPR) in 2011 and the CSAPR update rule in 2016.

LADCO conducted regional modeling to support the good neighbor provision obligations for its states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. This modeling was set up to mirror U.S. EPA's modeling with a few exceptions. Details of LADCO's modeling platform are listed in Section 2 of LADCO's *Interstate Transport Modeling for the 2015 Ozone National Ambient Air Quality Standard, Technical Support Document* and can be found in Appendix C of this document.

6.2 Alternative EGU Emissions Platform

The 2023 emissions data for the LADCO modeling study were based on the U.S. EPA 2011 version 6.3 EN emissions modeling platform. U.S. EPA generated this platform for their final assessment of interstate transport for the 2008 8-hour ozone NAAQS. Updates from earlier 2011-based emissions modeling platforms included a new engineering approach for forecasting emissions from EGUs. While U.S. EPA made several changes to the forecasted 2023 emissions in the EN platform relative to the earlier EL emissions platform, the changes to the base-year (2011) model between the two platforms were minor. LADCO replaced the EGU emissions in the U.S. EPA EN platform with 2023 EGU forecasts estimated with the ERTAC EGU Tool version 2.7[3]. ERTAC EGU 2.7 integrates state-reported information on EGU operations and forecasts as of May 2017. Full documentation for the ERTAC EGU Tool emissions model version 2.7 simulations can be found in Appendix H and are also available through the MARAMA website.

The ERTAC EGU Tool provided more accurate estimates of the growth and control forecasts for EGUs in the Midwest and Northeast states than the U.S. EPA approach used for the EN platform. The ERTAC EGU Tool respects the projected growth rates and emission rates limited by federal regulations. When power generation exceeds growth, the tool has the ability to shift generation to other fuels to fill the gap. The ERTAC tool is updated manually every six months after an intensive state review

[3] http://www.marama.org/2013-ertac-egu-forecasting-tool-documentation

process that can include review by the affected utilities as well. The ERTAC EGU Tool input files are built by the ERTAC leadership committee from a wide variety of existing data. These input files are subject to periodic quality assurance and are updated by the state agencies. Agencies provide information on new units and controls, fuel switches, shutdowns and other unit-specific changes. The ERTAC EGU growth committee prepares updates to the growth factors when newer versions of the Energy Information Agency (EIA) Annual Energy Outlook (AEO) and the National Energy Reliability Corporation (NERC) projection of peak generation rates become available. Periodic updates of these input files drive the need for new ERTAC runs. The ERTAC EGU tool projects fossil fuel fired units that report emissions to U.S. EPA's Clean Air Markets Division (CAMD) and serve as a generator of at least 25 megawatts (MW) (there are exemptions in the Northeast U.S. where units are sized less than 25 MW). LADCO used the U.S. EPA EN Platform emissions estimates for all other inventory sectors.

6.3 Electricity Generating Unit Emissions Development

The ERTAC EGU model for growth was developed around 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 of 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 model is straightforward given the complexity of the projection calculations and inputs. The model imports base-year Continuous Emissions Monitoring (CEM) data from U.S. EPA and sorts the data from the peak generation hour to the lowest generation hour. It applies hour specific growth rates that include peak and off peak rates. Future emission rates are developed from base-year rates adjusted to account for state knowledge of expected emission controls, fuel switches, regulatory obligations, retirements and new units.

6.3.1 Determination of Peak and Off Peak Growth Rates

Peak growth rates are derived by determining relative peak growth from NERC Electricity Supply & Demand (ES&D) data and applying it to the annual growth rates. The derived relative peak growth rates are not delineated by fuel so the ratio of peak to off peak growth rates for each fuel within a single region is constant. Annual average regional growth rates are adjusted to account for the peak hours. Peak and off peak growth is assigned to every hour by ordering all hours of the year by base-year utilization. The peak growth factor is assigned by fuel type to a limited number of hours with the highest utilization in the base-year. Growth is then transitioned gradually to the off peak growth rate. The number of peak and transition hours are differentiated by fuel type and region. Fuel specific hourly regional growth factors are adjusted to account for activity from new units and shutdowns. The tool then applies the adjusted hourly growth factors to the base-year hourly generation data to estimate hourly future generation. This generation is assigned to the units burning the specified fuel within the region. After generation is assigned, the tool confirms that unit capacity and all federal and state emission limits are not exceeded.

The model then balances the system for all units and hours that exceed physical or regulatory limits. The ERTAC EGU model applies future year controls to the emissions estimates and tests for reserve power generation capacity. Future generation by unit is estimated by merging national, regional and state growth files with state knowledge of the applicability of federal regulations to each unit. Hourly future emissions of NO_x are calculated by multiplying hourly projected future heat input by future emission rates. The model then generates quality assurance reports, and converts the outputs to Sparse Matrix Operator Kernel Emissions (SMOKE) emission files ready for input into the photochemical modeling.

6.3.2 ERTAC Forecast Methods

The ERTAC EGU model has distinct advantages over other growth methodologies because it is capable of generating hourly future year estimates, which are key to understanding ozone episodes. The model does not shutdown or mothball existing units because economic algorithms suggest they are not economically viable. Additionally, alternate control scenarios are easy to simulate with the model.

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 EGU forecast used in the 2023 EN modeling used CEM data available through the end of 2016 and comments from states and stakeholders received through April 17, 2017 (US EPA, 2017). ERTAC EGU v2.7 used CEM data from 2011 and state-reported changes to EGUs through May 2017. The ERTAC EGU Committee periodically updates the model forecasts to integrate the most recent information on current and future year energy system changes.

Demand transfer is a new concept made possible by use of the new v2.7 ERTAC EGU code. The concept is to transfer some demand for particular hours from one fuel bin to alleviate the generation deficit unit (GDU). Another use for a demand transfer where a significant system change occurs which was not anticipated by the EIA in the AEO. The example in ERTAC EGU v2.7 is the retirement of a large nuclear power plant near New York City. This results in other fuel bins having to provide a large amount of generation that was not anticipated by the EIA in the AEO.

The ERTAC EGU v2.7 emissions used for the LADCO modeling represent the best available information on EGU forecasts for the Midwest and Eastern U.S. available during Spring-early Summer 2018. As new ERTAC EGU inventories become available, LADCO will consider simulating these data with CAMx to evaluate the changes to future year air quality from differences in ERTAC EGU emissions forecasts. ERTAC Electricity Generating Unit (EGU) Committee develops reference runs for the continental United States (CONUS). CONUS 2.7 is based on 2011 base-year continuous emission monitoring (CEM) data and growth factors from the AEO2017 projection that does not include the Clean Power Plan (U.S. Energy Information Administration, January 2017) due to its proposed repeal. On August 21, 2018, U.S. EPA issued the proposed Affordable Clean Energy (ACE) Rule to replace the Clean Power Plan. Once ACE has been approved and becomes effective, the emission reductions from ACE will be evaluated.

6.4 Modeling Results

For purposes of this WOE analysis, Indiana is using LADCO's modeling results, as they closely follow U.S. EPA's results with the exception of LADCO's use of ERTAC's EGU emissions in place of the EGU emissions used by U.S. EPA in its EN emission platform. U.S. EPA modified its approach to post-processing the modeling results in order to exclude modeling grid cells without ozone monitors that are predominantly water (greater than 50% of the grid cell contains water). This approach only affects the modeled projection of design values for monitoring on or near a coastal region. LADCO has chosen and Indiana agrees with the usage of the "water" approach, which includes water cells in the post-processing of the modeling results.

Table 7 shows LADCO's modeling results released in July 2018, based on the ERTAC 2023 EN emissions platform. Included in the results are Indiana's projected contributions at each monitor. Indiana's modeled contributions are listed for each of the monitors projected to be either nonattainment, maintenance or other ozone monitors of concern. 2023 average design values in purple text indicate nonattainment projections above the 2015 ozone standard, 2023 maximum design values in red text indicate maintenance projections above the standard. The orange shading indicated Indiana's contributions predicted to be 1 ppb or greater at a projected nonattainment or maintenance monitor.

Table 7. LADCO's Ozone Modeling Results--2023

monitor_id	county_name	2023en_avrg	2023en_max	IN impact
90010017	Fairfield	68.9	71.2	0.45
90013007	Fairfield	69.8	73.7	0.97
90019003	Fairfield	71.4	74.2	0.83
90099002	New Haven	69.9	72.6	0.47
360810124	Queens	69.2	71	0.68
240251001	Harford	71	73.3	1.36
260050003	Allegan	68.8	71.5	6.91
261630019	Wayne	68.3	70.3	2.46
550790085	Milwaukee	63.6	66.6	4.63
551170006	Sheboygan	70.5	72.8	6.19
361030002	Suffolk	71.6	73.1	0.76
360850067	Richmond	70.9	72.4	1.00

Use of LADCO's modeling is justified due to the similar results when compared to U.S. EPA's latest modeling, updated in May 2018. Table 8 shows the average, maximum modeled results, and Indiana contributions for both model runs and the difference between each.

Table 8. Comparison of LADCO and U.S. EPA's 2023 Ozone Modeling

	2023en Avrg (ppb)			2023en Max (ppb)			IN Cont. (ppb)		
County/State	**LADCO**	**EPA**	**Diff.**	**LADCO**	**EPA**	**Diff.**	**LADCO**	**EPA**	**Diff.**
Harford, MD	71	71.4	-0.4	73.3	73.8	-0.5	1.36	1.36	0
Allegan, MI	68.8	69	-0.2	71.5	71.8	-0.3	6.91	7.11	-0.2
Wayne, MI	68.3	69	-0.7	70.3	71	-0.7	2.46	2.51	-0.05
Richmond, NY	70.9	71.9	-1	72.4	73.4	-1	1.0	0.99	0.01
Suffolk, NY	71.6	72.5	-0.9	73.1	74	-0.9	0.76	0.67	0.09
Sheboygan, WI	70.5	70.8	-0.3	72.8	73.1	-0.3	6.19	6.92	-0.73
Fairfield, CT	69.8	71.2	-1.4	73.7	75.2	-1.5	0.97	0.97	0
Fairfield, CT	71.4	72.7	-1.3	74.2	75.6	-1.4	0.83	0.83	0

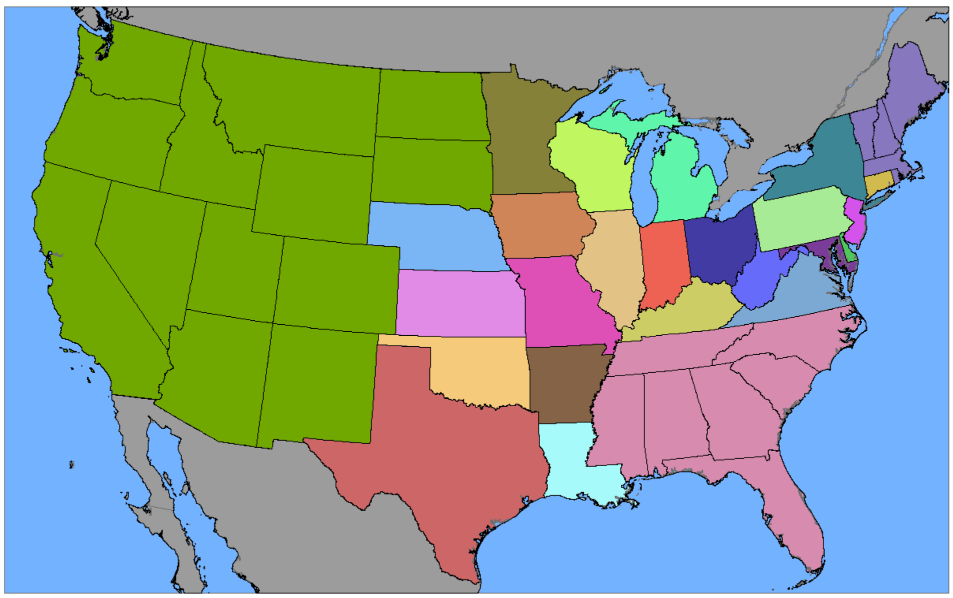
6.5 Ozone Source Apportionment Modeling

LADCO incorporated the Anthropogenic Precursor Culpability Assessment (APCA) source apportionment tool within CAMx to identify upwind sources of ozone at downwind ozone monitoring sites. LADCO feels APCA is more appropriate to associate ozone formation to anthropogenic emissions, even if the reaction to form ozone occurs with biogenic VOC or NO_x emissions.

6.5.1 State Sector Source Apportionment

LADCO performed two APCA modeling runs. One model run tagged emissions based on regional location by state as well as tagging fire emissions, biogenic emissions, offshore emissions, tribal emissions, Canada/Mexico emission and initial/boundary conditions. The modeled regions are shown below in Figure 4.

Figure 4. CAMx APCA Source Regions Used by LADCO



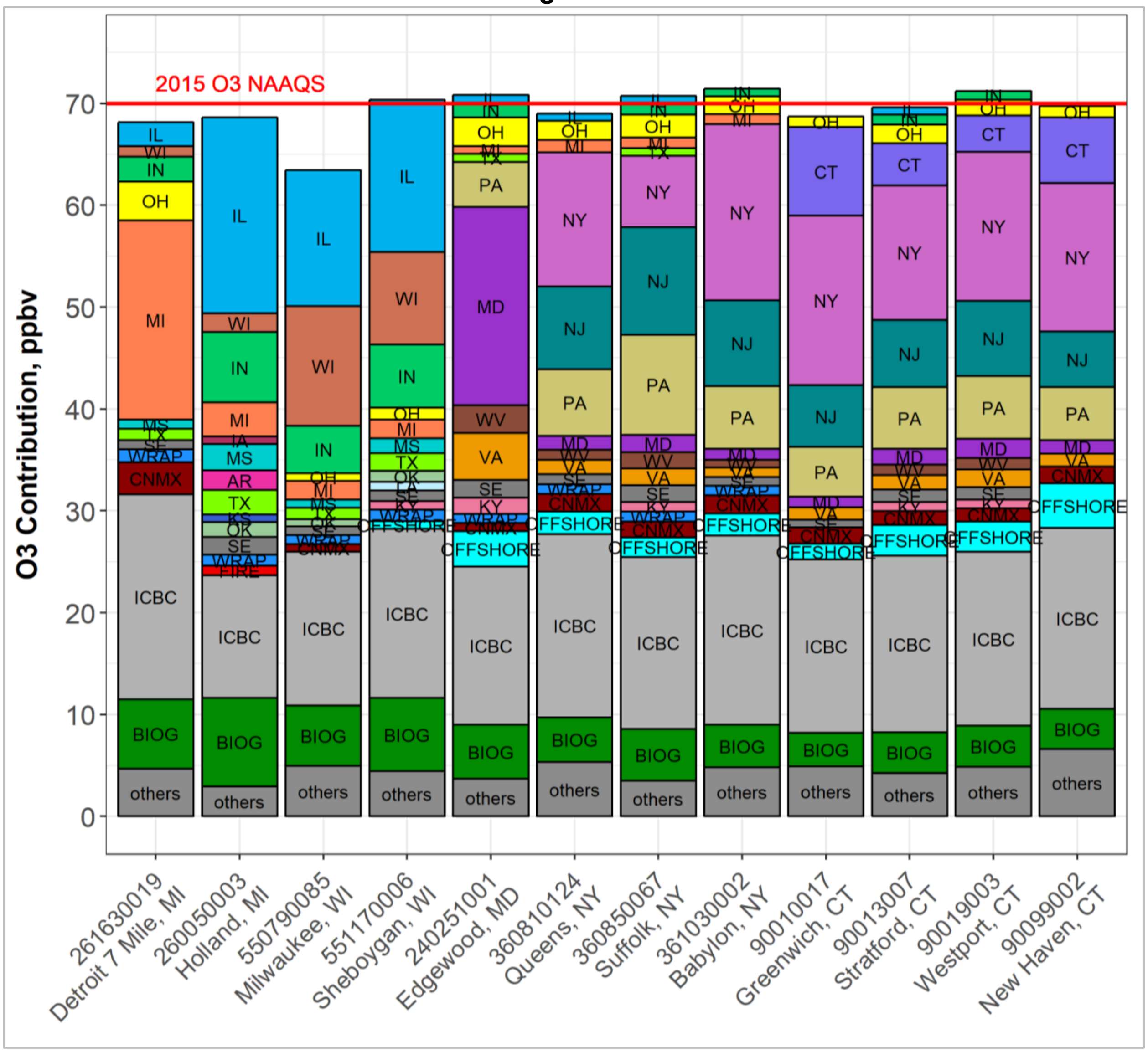
Results of LADCO's APCA contribution modeling run are summarized in Table 9. 2023 average design values in purple text indicate nonattainment projections above the 2015 ozone standard. 2023 maximum design values in red text indicate maintenance projections above the standard. The darker orange shading indicated state's contributions predicted to be 1 ppb or greater at a projected nonattainment or maintenance monitor.

Indiana had ozone impacts over the significance level at the two projected maintenance monitors in the Lake Michigan area (Sheboygan, WI and Allegan County, MI). Indiana's impacts are projected to be 6 ppb to 7 ppb at the Sheboygan and Allegan monitors in the Lake Michigan area, representing 8% to 10% of the total ozone impact on the monitors. Of the Northeast U.S. monitors, only Harford, MD and Richmond, NY were shown by LADCO's photochemical modeling results to have ozone impacts of 1 ppb or greater from Indiana. Chart 14 gives a different perspective on the cumulative impacts from all the states, showing the majority of impacts from surrounding Northeast states with minimum impacts from upwind states. One telling sector is the offshore emissions with impacts ranging from 2 ppb to 4 ppb at the Northeast monitors. The offshore impacts are greater than Indiana's total projected impacts and are more localized.

Table 9. LADCO's APCA Modeling Results for State Impacts

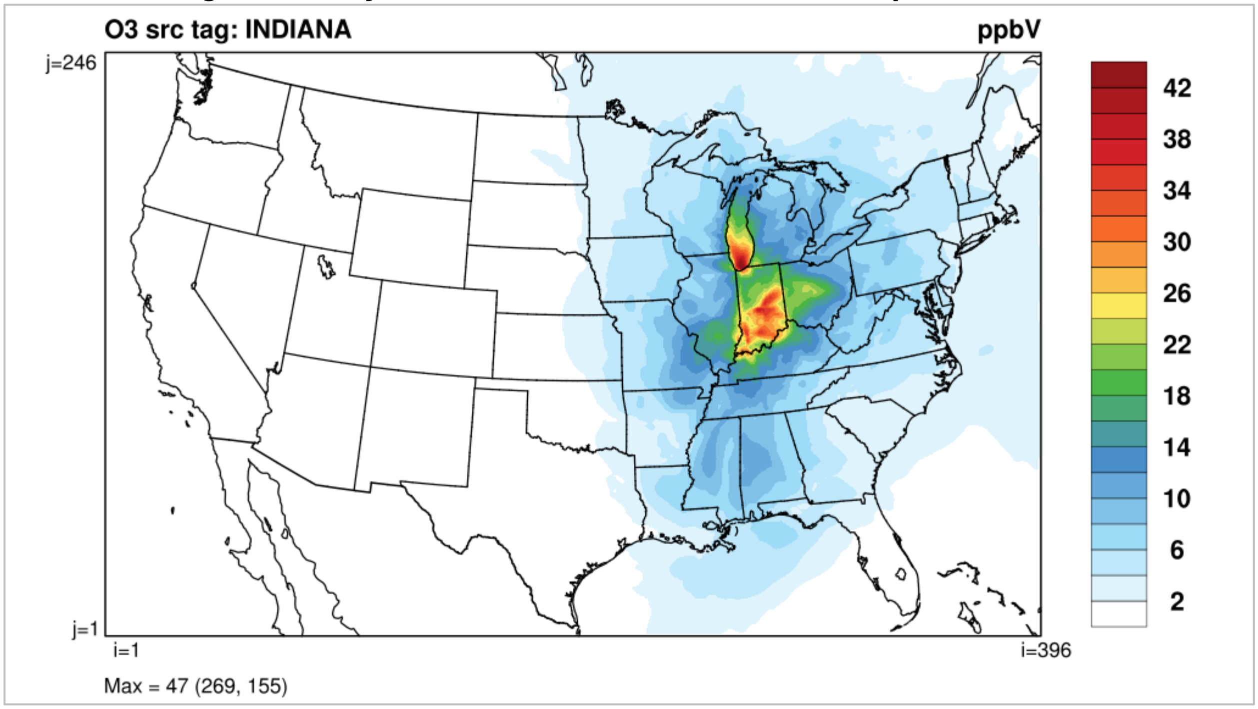
County & AIRS ID	Suffolk, 361030002	Fairfield, 90019003	Harford, 240251001	Sheboygan, 551170006	Richmond, 360850067	New Haven, 90099002	Fairfield, 90013007	Wayne, 261630019	Queens, 360810124	Fairfield, 90010017	Allegan, 260050003	Milwaukee, 550790085
STATE	**NY**	**CT**	**MD**	**WI**	**NY**	**CT**	**CT**	**MI**	**NY**	**CT**	**MI**	**WI**
2015-2017 DV	76.0	83.0	75.0	80.0	76.0	82.0	83.0	73.0	74.0	79.0	73.0	71.0
2009-2013 AVRG	83.3	83.7	90.0	84.3	81.3	85.7	84.3	78.7	78.0	80.3	82.7	78.3
2009-2013 MAX	85.0	87.0	93.0	87.0	83.0	89.0	89.0	81.0	80.0	83.0	86.0	82.0
2023 AVRG	**71.6**	**71.4**	**71.0**	70.5	70.9	69.9	69.8	68.3	69.2	68.9	68.8	63.6
2023 MAX	**73.1**	**74.2**	**73.3**	**72.8**	**72.4**	**72.6**	**73.7**	70.3	**71.0**	**71.2**	**71.5**	66.6
IL	0.65	0.67	0.85	14.93	0.86	0.43	0.72	2.32	0.72	0.39	19.25	13.36
WI	0.24	0.20	0.24	9.10	0.31	0.24	0.24	1.03	0.37	0.25	1.84	11.75
IN	0.76	0.83	1.36	6.19	1.00	0.47	0.97	2.46	0.68	0.45	6.91	4.63
OH	1.75	1.58	2.83	1.17	2.24	1.12	1.84	3.81	1.88	1.05	0.19	0.77
MI	0.96	0.60	0.77	1.85	1.03	0.67	0.68	19.56	1.22	0.48	3.35	1.81
MN	0.16	0.14	0.13	0.24	0.13	0.17	0.15	0.30	0.16	0.17	0.11	0.35
IA	0.19	0.16	0.23	0.45	0.25	0.15	0.16	0.44	0.25	0.11	0.74	0.70
MS	0.39	0.37	0.60	1.44	0.51	0.28	0.39	0.92	0.38	0.22	2.59	0.83
AR	0.14	0.15	0.21	0.62	0.16	0.10	0.15	0.32	0.11	0.08	1.92	0.43
LA	0.11	0.10	0.18	0.83	0.16	0.07	0.10	0.21	0.13	0.04	0.66	0.60
TX	0.57	0.45	0.77	1.76	0.77	0.39	0.44	1.13	0.59	0.31	2.40	1.10
OK	0.34	0.22	0.38	1.09	0.41	0.24	0.22	0.67	0.34	0.17	1.42	0.74
KS	0.19	0.14	0.24	0.49	0.24	0.13	0.14	0.46	0.19	0.09	0.77	0.31
NE	0.12	0.08	0.14	0.07	0.15	0.09	0.08	0.19	0.13	0.06	0.17	0.06
OTC[1]	0.08	0.16	0.01	0.00	0.05	0.28	0.19	0.00	0.40	0.11	0.00	0.00
CT	0.59	3.54	0.00	0.00	0.25	6.43	4.13	0.00	0.51	8.70	0.00	0.00
NY	17.30	14.66	0.16	0.03	6.99	14.61	13.24	0.06	13.18	16.64	0.00	0.02
NJ	8.42	7.35	0.06	0.00	10.57	5.45	6.60	0.00	8.13	6.07	0.00	0.00
PA	6.18	6.20	4.43	0.43	9.83	5.19	6.04	0.17	6.53	4.90	0.05	0.29
DE	0.19	0.37	0.04	0.00	0.44	0.33	0.32	0.00	0.35	0.16	0.00	0.00
MD	1.07	1.88	19.49	0.03	1.69	1.35	1.55	0.02	1.38	1.04	0.01	0.02
DC	0.04	0.08	0.64	0.00	0.06	0.05	0.06	0.00	0.05	0.04	0.00	0.00
WV	0.78	1.10	2.72	0.64	1.61	0.59	1.06	0.21	0.98	0.67	0.11	0.49
VA	0.93	1.74	4.58	0.12	1.66	1.25	1.38	0.15	1.43	1.20	0.04	0.11
SE[2]	0.84	1.25	1.77	1.04	1.62	0.69	1.23	0.87	0.96	0.74	1.76	0.82
KY	0.52	0.81	1.59	0.87	0.95	0.33	0.92	0.66	0.44	0.36	0.60	0.70
WRAP[3]	0.96	0.62	0.91	1.11	1.01	0.67	0.62	1.29	0.96	0.53	1.09	0.92
CNMX	1.76	1.35	0.79	0.64	1.54	1.66	1.34	3.14	1.72	1.64	0.53	0.73
OFFSHORE	2.17	2.97	3.48	0.76	1.92	4.36	3.02	0.36	2.23	1.52	0.45	0.54
TRIBAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIRE	0.28	0.33	0.42	0.66	0.37	0.21	0.33	0.43	0.24	0.20	0.91	0.33
ICBC	18.59	17.07	15.52	16.61	16.87	17.80	17.34	20.10	17.98	17.05	12.04	15.09
BIOG	4.18	4.04	5.31	7.19	5.10	3.95	3.98	6.86	4.40	3.29	8.73	5.94

Chart 14. APCA State Sector Modeling Results for Northeast/Midwest Monitors



In addition to the APCA results, LADCO created plots of the ozone impacts from each Midwest state and emission sector modeled. The ozone tracer for maximum impacts from Indiana emissions are shown in Figure 5. Within the LADCO region, Indiana sources have the greatest influence on ozone concentrations over southern Lake Michigan, southern Illinois, southern Michigan, northern Kentucky and central Ohio. The larger ozone impacts are in and near Indiana with significant concentration gradients observed beyond the state lines. CAMx estimated maximum modeled ozone impacts of 2 ppb from Indiana on the coastal areas in the Northeast.

Figure 5. Projected Maximum Ozone Season Impacts from Indiana



6.5.2 Emission Sector Source Apportionment

The second APCA model run was based on emission source sectors. LADCO chose 15 inventory source sector tracers for the APCA run, including emissions from commercial marine vessels, onroad and offroad mobile, EGU point sources, non-EGU point sources, and nonpoint/area sources. A complete list of the emission sectors modeled can be found below in Table 10.

Table 10. CAMx APCA Emission Source Sectors Used by LADCO

Sector (Abbr)	Sector (Abbr)
Biogenic (Biog)	Residential Wood Combustion (RWC)
Fugitive Dust (AFDust)	Onroad Mobile (Onroad)
Commercial Marine Vessels (CMV)	Offroad Mobile (Nonroad)
Point Fires (PtFire)	Nonpoint/Area (Nonpt)
Oil and Gas (OilGas)	Electricity Generating Point (EGU)
Agricultural (Ag)	Non-EGU Point (NEGUPt)
Agricultural Fire (AgFire)	Canada & Mexico (CanMex)
Rail (Rail)	

LADCO conducted emission sector source apportionment for the nonattainment, maintenance and other ozone monitors that were identified in U.S. EPA, LADCO and other photochemical modeling analyses. Results of the emission sector APCA modeling is shown below in Table 11. A breakdown of the anthropogenic emissions contributing to the overall modeled concentrations for several of the Lake Michigan area and Northeast U.S. ozone monitors indicates large onroad/nonroad impacts. The onroad contributions are between 14% and 15% of the projected modeled ozone for the

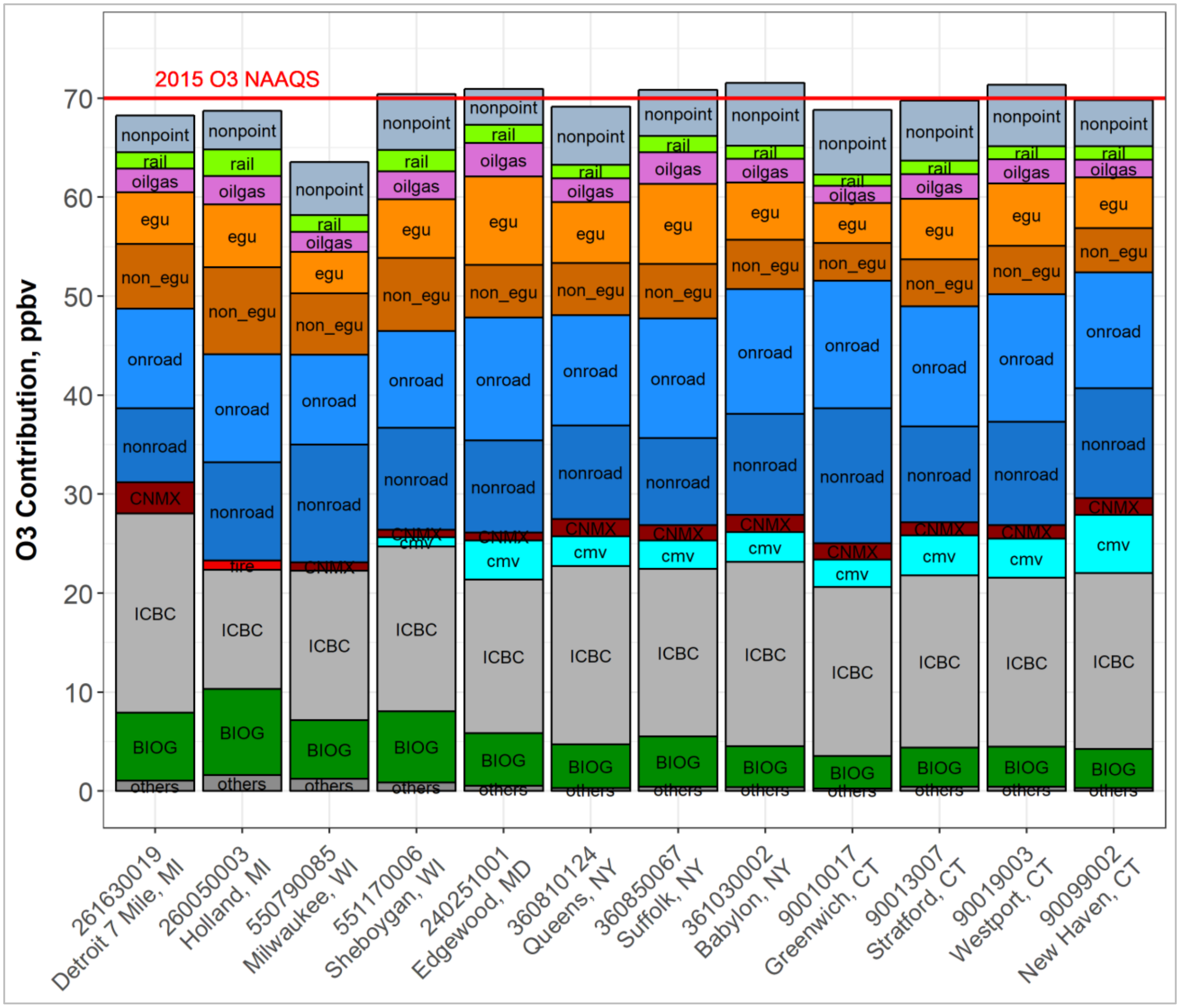
Lake Michigan monitors and are 17% and 18% of the projected modeled ozone for the Northeast monitors. Nonroad sector contributions are approximately 14% on the Lake Michigan monitors while approximately 13% of the contributions on the Northeast monitors. These impacts overshadow the overall EGU and non-EGU contribution which equate to approximately 12%, of which Indiana's EGU portion of the overall contribution would be much smaller in the Northeast while the combined impacts on the Lake Michigan monitors from onroad/nonroad are 29% as compared to the EGU/Non-EGU impacts of 21% at the Allegan County, MI monitor. This difference is even more pronounced at Sheboygan, WI as the onroad/nonroad impacts total 27% of the anthropogenic contributions compared to 18% of EGU/Non-EGU impacts at the monitor. While Canadian and Mexican emission impacts on the Lake Michigan and Northeast monitors is relatively small, these emissions need to be addressed by U.S. EPA. Chart 15 highlights the contributions from the modeled emission sectors.

Indiana's regulated sources, especially the EGU and non-EGU sources, have reduced and continue to reduce emissions to comply with national control measures. Therefore, the less regulated or non-regulated emission source sectors, (i.e., those associated with non-point, onroad and nonroad emission sectors) should need to make emission reductions in order to effectively lower ozone values regionally and nationally. These emission sectors are projected to have higher overall ozone contributions than the larger EGU and industrial sources.

Table 11. APCA Modeling Results for Emission Source Sector Impacts

County & AIRS ID	Suffolk, 361030002	Fairfield, 90019003	Harford, 240251001	Sheboygan, 551170006	Richmond, 360850067	New Haven, 90099002	Fairfield, 90013007	Wayne, 261630019	Queens, 360810124	Fairfield, 90010017	Allegan, 260050003	Milwaukee, 550790085
STATE	**NY**	**CT**	**MD**	**WI**	**NY**	**CT**	**CT**	**MI**	**NY**	**CT**	**MI**	**WI**
2015-2017 DV	76.0	83.0	75.0	80.0	76.0	82.0	83.0	73.0	74.0	79.0	73.0	71.0
2009-2013 AVRG	83.3	83.7	90.0	84.3	81.3	85.7	84.3	78.7	78.0	80.3	82.7	78.3
2009-2013 MAX	85.0	87.0	93.0	87.0	83.0	89.0	89.0	81.0	80.0	83.0	86.0	82.0
2023 AVRG	71.6	71.4	71.0	70.5	70.9	69.9	69.8	68.3	69.2	68.9	68.8	63.6
2023 MAX	**73.1**	**74.2**	**73.3**	**72.8**	**72.4**	**72.6**	**73.7**	70.3	**71.0**	**71.2**	**71.5**	66.6
Comm Marine	3.0	4.0	4.0	1.0	2.9	5.9	4.0	0.5	3.0	2.8	0.7	0.7
Fire	0.3	0.3	0.4	0.7	0.4	0.2	0.3	0.4	0.2	0.2	0.9	0.3
Oil & Gas	2.4	2.4	3.4	2.8	3.2	1.8	2.5	2.4	2.4	1.7	2.9	2.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ag Fire	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1
Rail	1.3	1.4	1.9	2.2	1.6	1.4	1.4	1.7	1.4	1.1	2.7	1.7
RWC	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Onroad	12.6	12.9	12.4	9.8	12.1	11.7	12.2	10.1	11.1	12.9	10.9	9.1
Nonroad	10.2	10.4	9.3	10.3	8.8	11.1	9.7	7.5	9.5	13.6	10.0	11.9
Nonpoint	6.4	6.2	3.6	5.6	4.7	4.7	6.1	3.7	5.9	6.6	3.9	5.4
EGU Point	5.8	6.3	8.9	6.0	8.1	5.1	6.1	5.2	6.1	4.1	6.3	4.2
Non-EGU Point	5.0	4.9	5.3	7.3	5.5	4.5	4.7	6.6	5.3	3.8	8.8	6.2
Canada/Mex	1.8	1.4	0.8	0.8	1.6	1.7	1.4	3.1	1.7	1.6	0.6	0.8
ICBC	18.6	17.1	15.5	16.6	16.9	17.8	17.4	20.1	18.0	17.1	12.1	15.1
Biogenic	4.2	4.0	5.3	7.2	5.1	4.0	4.0	6.8	4.4	3.3	8.7	5.9

Chart 15. APCA Emission Sector Modeling Results for Northeast/Midwest Monitors



Indiana would point to the emissions reductions by its EGU emission sector (demonstrated in Section 5.1 of this document) that have been realized over the last several years. This has translated to lower overall ozone design values over the past decade. However, further emissions reductions from the EGU and non-EGU sector are getting more difficult to mandate due to reduced effectiveness of controls to make significant decreases in ozone values, operational concerns for a source and increased costs for emission controls that affect customers; emission reductions from other source sectors that will have more localized impacts on ozone are more necessary to impact the ozone values at nearby monitors.

Impacts from Indiana's mobile and nonroad emission sectors are not likely to contribute to ozone values at the Northeast U.S. monitors. In addition, the nonpoint and commercial marine vehicles (cmv) sectors appear to each have 3 ppb to 5 ppb ozone impacts on the Northeast U.S. monitors, indicating a more localized contribution to measured ozone values. Chart 15 bears out the significance of emission sector impacts on each of the monitors.

LADCO created graphical results of each emission sector's modeled impacts. In Figures 6-10 below, the ozone tracer from several emission sectors and their modeled impacts throughout the country are shown. The larger ozone impacts are clearly commercial marine vessel and nonroad mobile emissions along the eastern U.S. coast. The impact of nonroad mobile emissions on the east coast region is evident, as well as along the Lake Michigan, Lake Ontario and Lake Erie regions.

The commercial marine vessel emissions have large impacts along the East Coast and Gulf Coast region near the Louisiana and the eastern Texas coastlines. These impacts cannot be ignored or discounted as they represent contributions from local emissions and are more likely to react on ozone conducive days. Overall EGU impacts, while evident, are not at a magnitude of the more localized emissions mentioned above. Significant EGU emission reductions have been federally mandated, have been realized, and further emission reductions are anticipated, thereby lessening Indiana's downwind ozone impacts even more. Indiana believes the regulated sources have made significant emission reductions while the less-regulated sources, such as those associated with mobile, nonroad and nonpoint sectors, which represent low-level emissions released near ground level, have greater impacts on the local ozone values. In some cases, these emission sectors have greater total emissions that the traditional larger emission sectors, included fuel combustion sources for electricity generation and industry.

Use of ERTAC's projected 2023 EGU emissions and the analytic flexibilities have shown that the projected 2023 8-hour ozone design values for Sheboygan and Allegan County ozone monitors will attain the standard. In addition, source apportionment modeling shows several emission source sectors are significant contributors to the projected design values. Among those emission source sectors are the mobile and nonroad sectors, which contribute more to ozone values at Sheboygan and Allegan County monitors than the EGU and non-EGU source sectors. Significant emission reductions have occurred in electricity generation and other large industrial source sectors, resulting in ozone values trending much lower over the past decade or more. Therefore, implementing additional national emission control measures on sources associated with the onroad and nonroad emission sectors would be more beneficial in effectively reducing ozone at the Lake Michigan area monitors.

Figure 6. Ozone Season Maximum O_3 Tracers—Nonroad Mobile

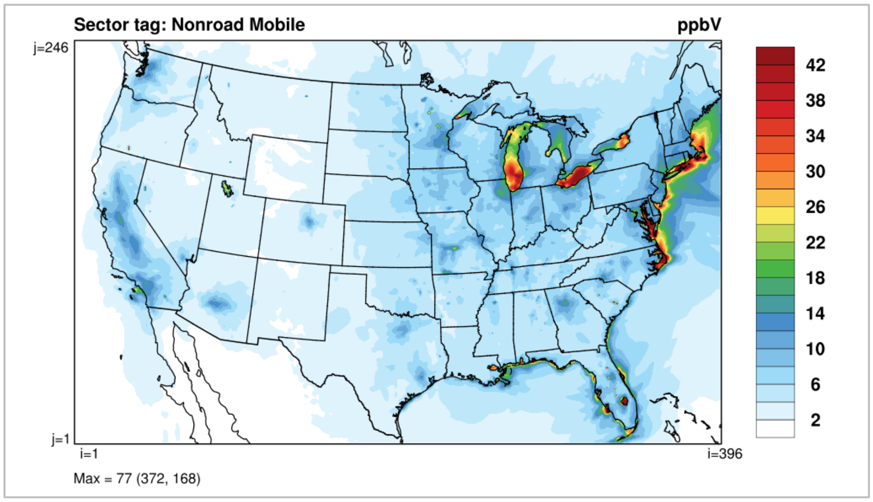


Figure 7. Ozone Season Maximum O_3 Tracers--Commercial Marine Vessels

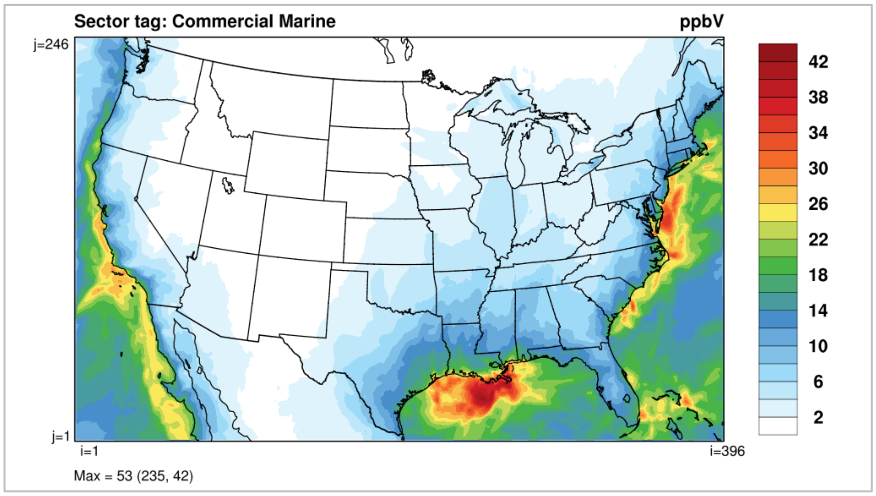


Figure 8. Ozone Season Maximum O_3 Tracers – Onroad Mobile

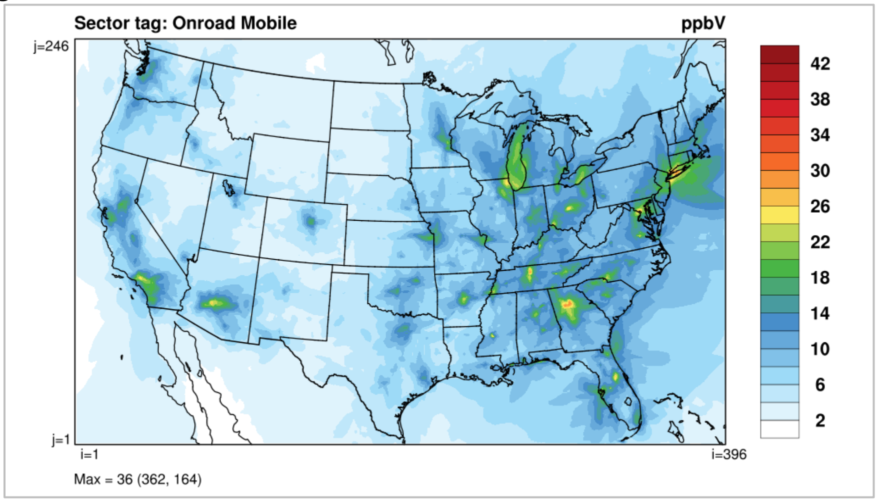


Figure 9. Ozone Season Maximum O_3 Tracers – EGU Point

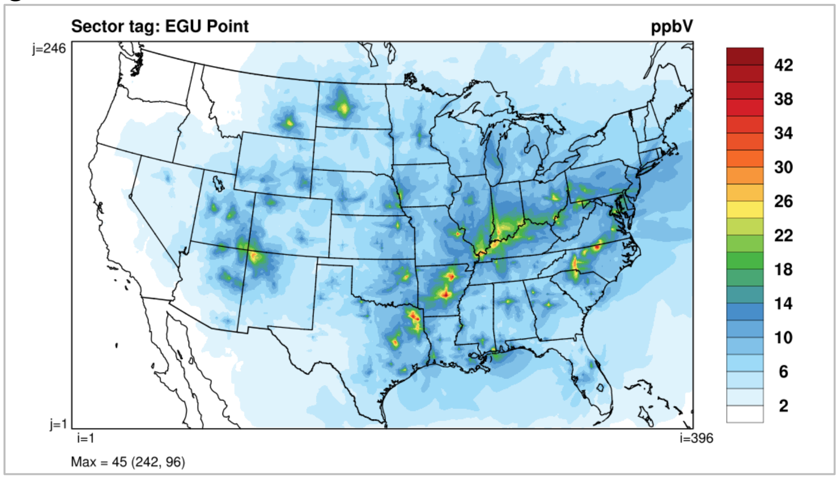
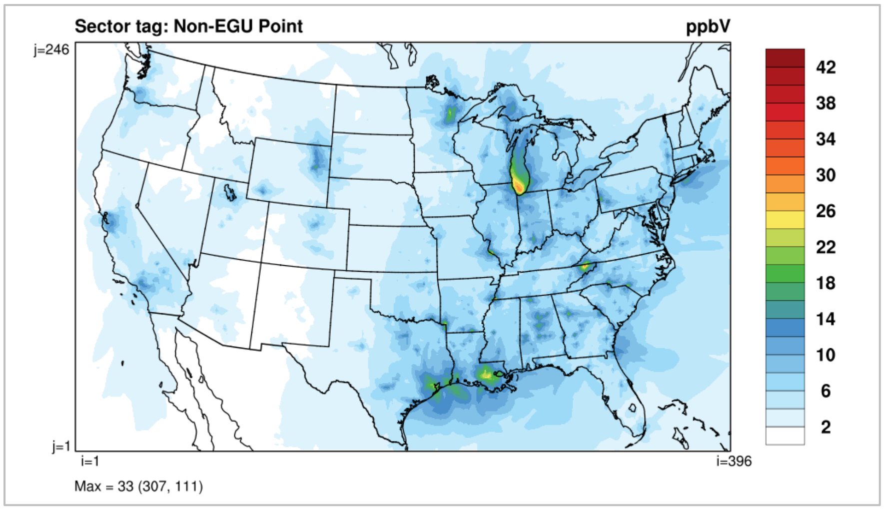


Figure 10. Ozone Season Maximum O_3 Tracers – Non-EGU Point



6.6 Comparison of Monitoring Data to Model Predictions for Northeast U.S. Monitors

U.S. EPA and LADCO 2023 modeling results are compared with 2012-2017 monitoring data for the Northeast U.S. ozone monitors identified as nonattainment or maintenance and being impacted by Indiana. This comparison is made using a ratio of the average 8-hour ozone concentrations of the top 10 monitored days for each year to the same metric for 2011. This shows either an increase or reduction relative to 2011 for each year. This ratio is calculated in the same manner as the RRF is calculated from photochemical modeling results. Comparing these monitoring reductions with the modeling reductions can give insight into whether a monitor is on track to meet its future year projected design value. Charts 16-17 below show this analysis for the one projected nonattainment and one maintenance monitor in Northeast U.S. The blue line shows the annual reduction trend, while the orange line shows the 2023 LADCO modeled RRF and the red line shows the 2023 U.S. EPA modeled RRF. These reduction trend charts addressing additional maintenance monitors with significant contributions from Indiana are shown in Appendix D. The charts show that the monitors are already below their projected 2023 reductions.

Chart 16. Reduction Trend for Harford, MD Monitor (2012-2017)

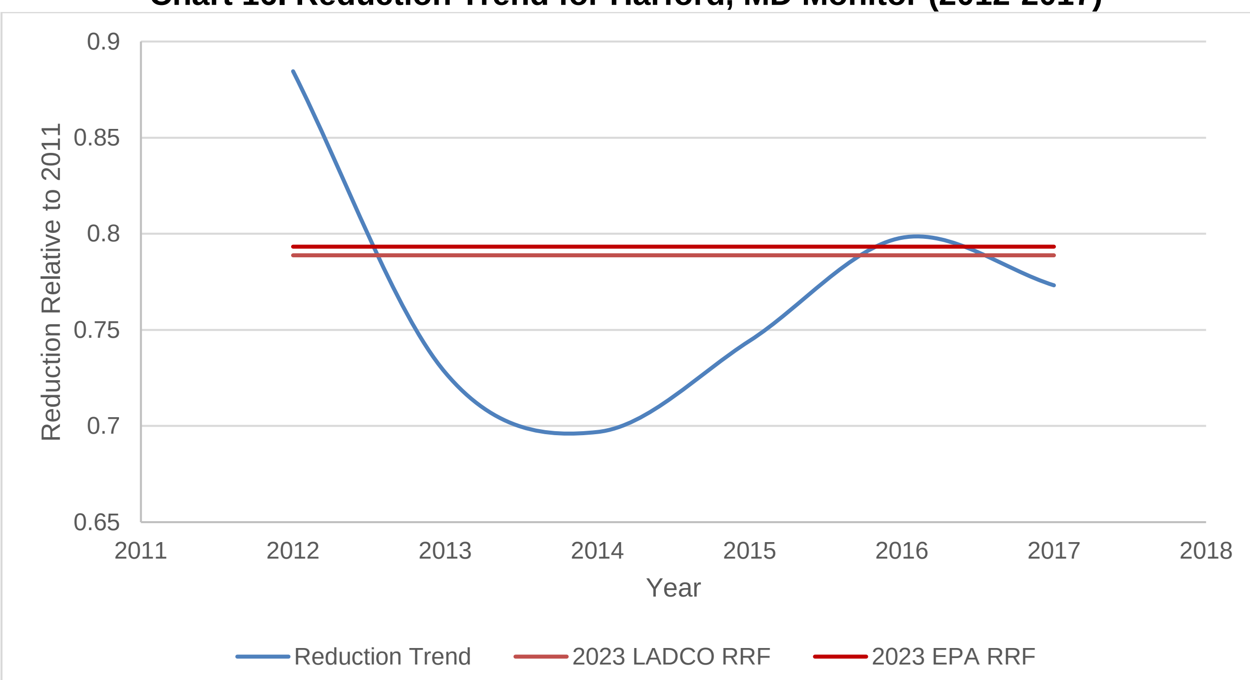
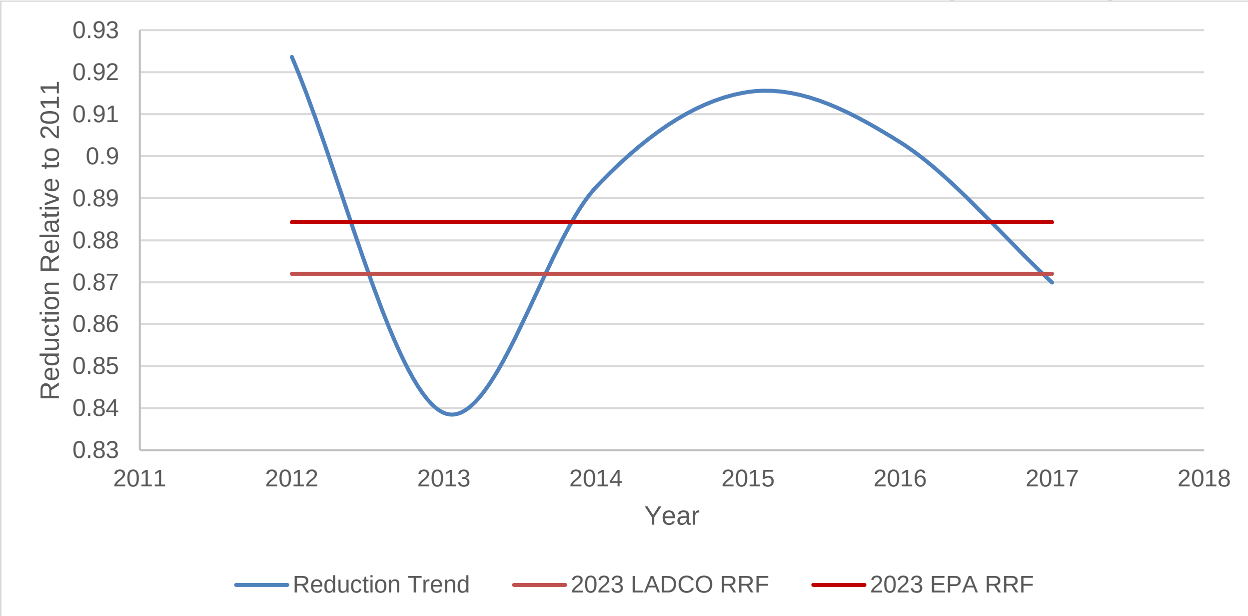


Chart 17. Reduction Trend for Richmond, NY Monitor (2012-2017)



6.7 Red-line Contributions for the Harford, MD Nonattainment Monitor

An analysis was conducted to determine the amount of reduction necessary from a state's contribution to bring the design values for monitors that model nonattainment into attainment. For the Harford, MD nonattainment monitor identified in the LADCO modeling, Indiana would be required to reduce its ozone contribution by 0.0077 ppb (with a significance level of 1 ppb). This small amount is well within the error of the model and would be difficult to translate to an emission reduction requirement. Calculation of the red-line contribution is detailed in Table 12.

Table 12. Red-line Contribution Calculation for the Harford, MD monitor

Site ID	County	State	2023 Design Value (ppb)
240251001	Harford	Maryland	71.0
Required Reduction to Attain Standard	0.1		
Significant States at 1 ppb			
State	**Contribution (ppb)**	**Fraction of Significant Contribution**	**Required Reduction (ppb)**
IN	1.36	0.077	0.0077
OH	2.83	0.161	0.0161
PA	4.43	0.252	0.0252
WV	2.72	0.155	0.0155
VA	4.58	0.261	0.0261
KY	1.59	0.09	0.009
Total	17.51		

6.8 Model Performance – LADCO and U.S. EPA CAMx Modeling

In using U.S. EPA's modeling platform to conduct the transport modeling, LADCO felt a comparison of results was in order to determine model performance. Figures 11 and 12 compare summer season maximum daily average 8-hour ozone (MDA8) between the LADCO 2011 (LADCO_2011en) and the U.S. EPA 2011 EN (EPA_2011en) simulations at the locations of all of the U.S. EPA Air Quality System (AQS) and Clean Air Status Trends Network (CASTNET) monitors. The LADCO simulation had a small negative mean bias (MB) relative to U.S. EPA's simulation across both the AQS (MB: -0.29 ppb) and CASTNET (MB: -0.2 ppb) monitoring networks, indicating the LADCO 2011 simulation estimated slightly lower ozone values than the U.S. EPA 2011 simulation on average but well within acceptable statistical parameters.

Figure 11. LADCO 2011 VS U.S. EPA 2011 Summer Season AQS Monitors

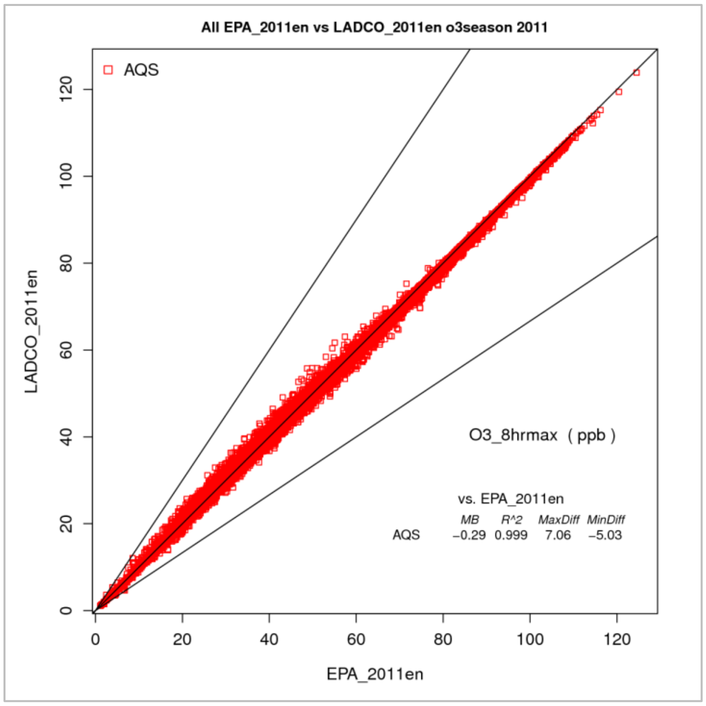
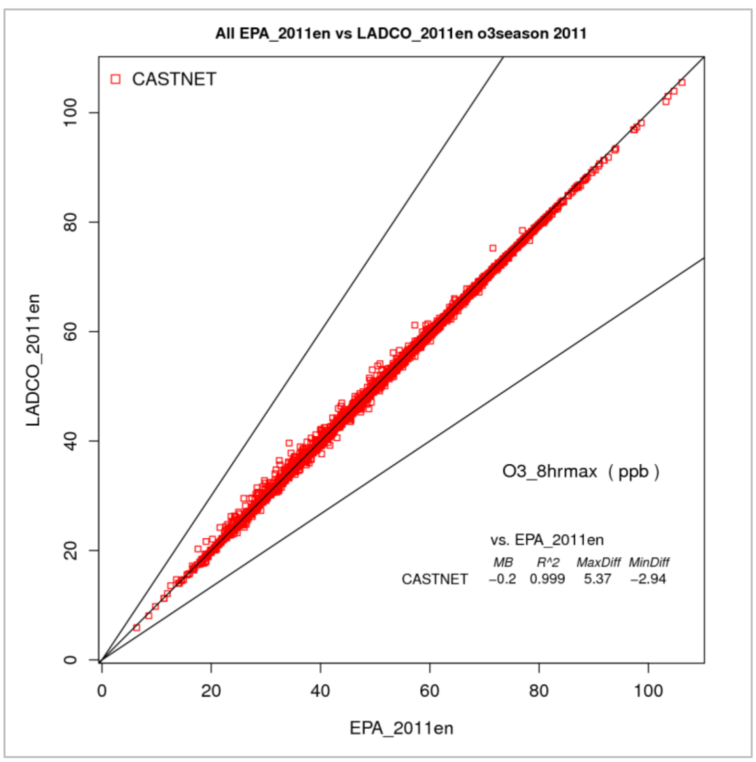
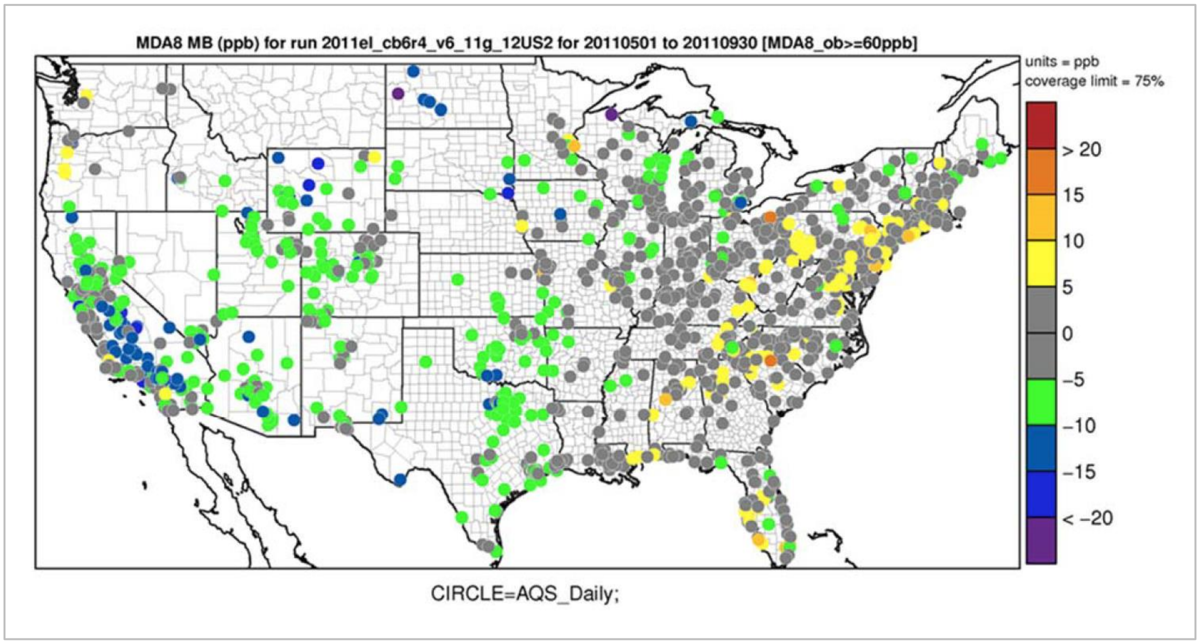


Figure 12. LADCO 2011 VS U.S. EPA 2011 Summer Season CASTNET Monitors



The U.S. EPA conducted a model performance evaluation (MPE) on their 2011 base case model run. This MPE was conducted in 2016 and U.S. EPA stated the performance of the 2011 EL emission platform was within the range of other recent peer-reviewed and regulatory applications. Figure 13 illustrates the spatial variability in model performance on high ozone days. Mean bias statistics are within +/- 5 ppb at many ozone monitoring sites in the Midwest and Northeast, with some over-prediction of 5-10 ppb at sites in the Northeast. This emphasizes the limitations of the CAMx and any other photochemical model to perform within any degree of accuracy in order to determine downwind ozone impacts.

Figure 13. Maximum Daily Average 8-Hour Ozone Mean Bias Results for Ozone Monitors in the U.S.



The mean bias, mean error, normalized mean bias and normalized mean error statistics were calculated for several of the Northeast U.S. and Midwest ozone monitors projected to be nonattainment or maintenance by LADCO's modeling. The statistical analysis on the LADCO modeling is found in Table 13. With the exception of the Wayne, MI monitor, results indicate good agreement with observed data with a slight underprediction of concentrations.

Table 13. Model Statistics for LADCO Maximum Daily Average 8-Hour Ozone Results with Observations Greater than 60 ppb

Site_ID	County, State	Mean Obs	Mean Mod	MB (ppb)	ME (ppb)	NMB (%)	NME (%)
90010017	Fairfield, CT	69.6	68.6	-1.0	12.5	-1.5	18.0
90013007	Fairfield, CT	73.0	73.4	0.5	9.6	0.7	13.2
90019003	Fairfield, CT	72.0	73.5	1.5	9.0	2.1	12.5
240251001	Harford, MD	73.7	73.6	0.0	8.7	-0.1	11.8
260050003	Allegan, MI	69.3	68.9	-0.4	8.2	-0.6	11.8
261630019	Wayne, MI	69.3	58.6	-10.8	11.4	-15.5	16.4
360810124	Queens, NY	72.1	65.1	-7.1	9.9	-9.8	13.7
360850067	Richmond, NY	71.3	67.6	-3.7	8.7	-5.1	12.1
361030002	Suffolk, NY	73.0	70.0	-3.0	7.4	-4.2	10.2
550790085	Milwaukee, WI	71.1	63.8	-7.4	11.0	-10.4	15.5
551170006	Sheboygan, WI	72.9	64.5	-8.4	11.2	-11.5	15.3

6.9 Meteorological Data Analysis

Temperature analyses were conducted in order to review the ozone conducive conditions present over the previous seven years. 2011 is the base-year of emissions and meteorological data used in the modeling and was the first year of the temperature analysis. Indiana had much warmer than normal May-October periods in 2012 and 2016 and the increased number of ozone exceedance days corresponded to the more ozone conducive conditions. In Maryland, 2011, 2012, 2015, 2016 and 2017 were extremely warm and statewide ozone exceedances were more numerous, while 2013 and 2014 were cooler periods and had less ozone exceedances.

Figure 14 lists the state rankings for the May through October maximum temperature for 2011 through 2017. Tables 14-18 list the number of exceedance days for all ozone monitors for Indiana, Maryland, New York, Michigan and Wisconsin. For comparison purposes, the number of exceedance days at the projected nonattainment and maintenance monitors that Indiana is modeled to have a significant impact are listed as well. The correlation of the warmer temperatures and higher number of exceedance days throughout the Northeast is evident as 2011, 2012 and 2016 had greater numbers of exceedance days on those warmer than normal summers. Coastal or near coastal monitors appear to have the majority of the ozone exceedances during these summers. It is evident that the number of ozone exceedances at the nonattainment and maintenance monitors is trending downward, despite several warmer than normal summers in the past several years. While meteorological conditions may drive the 8-hour maximum daily ozone values very high on conducive days, the number of these occurences is decreasing.

Figure 14. National Temperature Rankings from 2011 through 2017

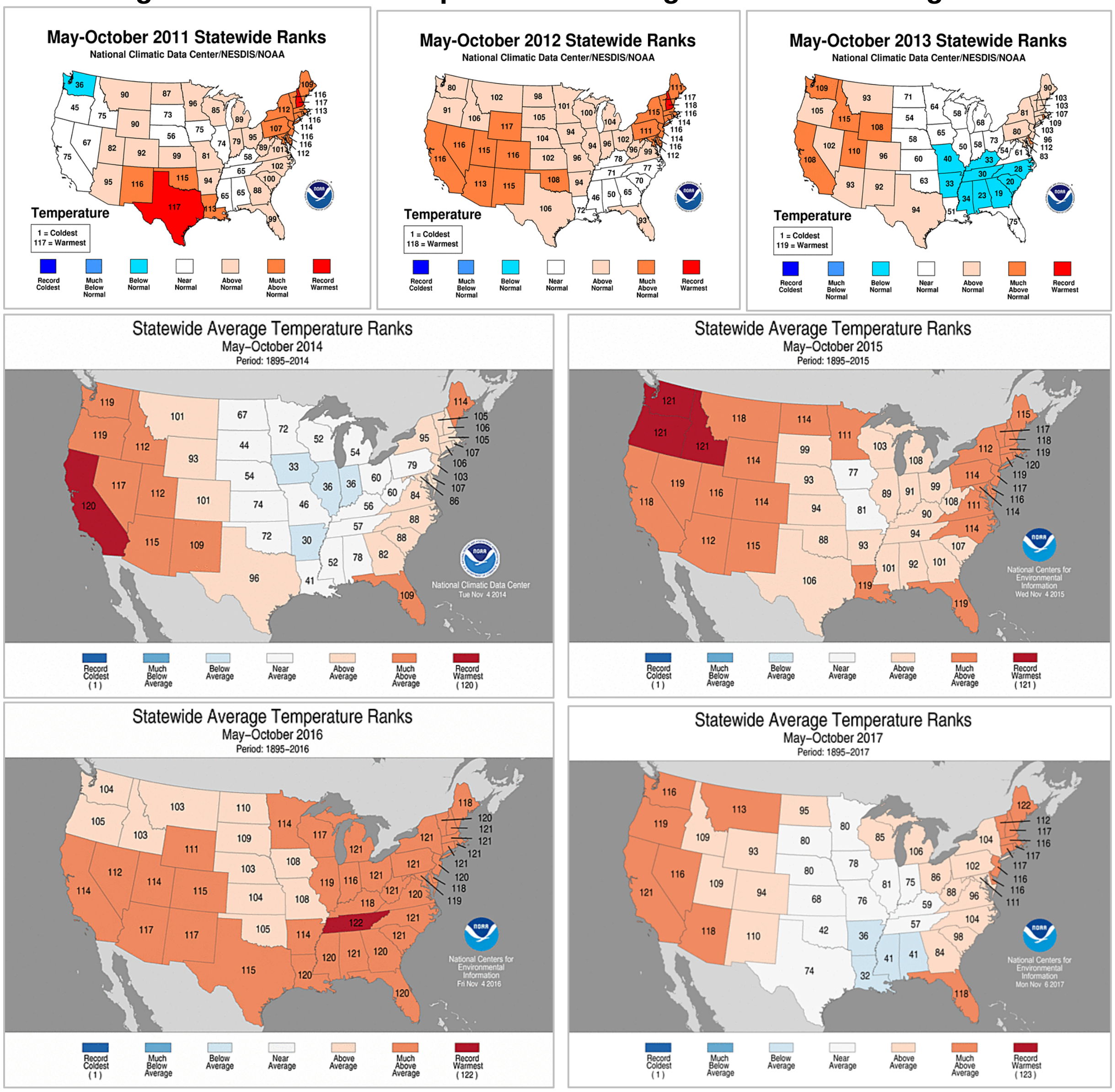


Table 14. Number of 8-Hour Ozone Exceedances per Year in Indiana

Year	# of Exceedances Statewide	Temperature Ranking (May – October)
2011	71	79 - (39th warmest/117 years)
2012	212	96 – (23rd warmest/118 years)
2013	5	58 – (62nd warmest/119 years)
2014	9	36 – (85th warmest/120 years)
2015	9	91 – (31st warmest/121 years)
2016	132	116 – (7th warmest/122 years)
2017	76	75 – (49th warmest/123 years)

Table 15. Number of 8-Hour Ozone Exceedances per Year in Maryland

Year	# of Exceedances Statewide	# of Exceedances Harford	Temperature Ranking (May – October)
2011	271	22	112 - (6th warmest/117 years)
2012	305	17	112 – (7th warmest/118 years)
2013	42	5	83 – (37th warmest/119 years)
2014	27	3	86 – (35th warmest/120 years)
2015	69	5	114 – (8th warmest/121 years)
2016	121	9	119 – (4th warmest/122 years)
2017	60	6	111 – (13th warmest/123 years)

Table 16. Number of 8-Hour Ozone Exceedances per Year in New York

Year	# of Exceedances Statewide	# of Exceedances Richmond	Temperature Ranking (May – October)
2011	139	17	112 - (6th warmest/117 years)
2012	232	14	115 – (4th warmest/118 years)
2013	50	4	81 – (39th warmest/119 years)
2014	30	6	95 – (26th warmest/120 years)
2015	88	10	112 – (10th warmest/121 years)
2016	101	10	121 – (2nd warmest/122 years)
2017	57	7	104 – (20th warmest/123 years)

Table 17. Number of 8-Hour Ozone Exceedances per Year in Michigan

Year	# of Exceedances Statewide	# of Exceedances Allegan County	Temperature Ranking (May – October)
2011	199	9	89 - (29th warmest/117 years)
2012	569	36	104 – (15th warmest/118 years)
2013	63	8	68 – (52nd warmest/119 years)
2014	65	7	54 – (67th warmest/120 years)
2015	57	4	108 – (14th warmest/121 years)
2016	177	9	121 – (2nd warmest/122 years)
2017	45	4	106 – (18th warmest/123 years)

Table 18. Number of 8-Hour Ozone Exceedances per Year in Wisconsin

Year	# of Exceedances Statewide	# of Exceedances Sheboygan	Temperature Ranking (May – October)
2011	100	13	85 - (33th warmest/117 years)
2012	392	35	100 – (19th warmest/118 years)
2013	46	10	58 – (62th warmest/119 years)
2014	68	4	52 – (69th warmest/120 years)
2015	47	11	103 – (19th warmest/121 years)
2016	123	11	117 – (6th warmest/122 years)
2017	70	13	85 – (39th warmest/123 years)

6.10 Back Trajectory Analysis

A back trajectory analysis using the National Oceanic and Atmospheric Administration's (NOAA) HYSPLIT model was performed to evaluate Indiana's ozone contribution to the Northeast U.S. The trajectories were run at 10 and 750 meters above ground level (AGL). Back trajectories were initialized at 18Z Greenwich Mean Time (2:00 PM EDT) over a three-year period from 2015 through 2017. The trajectories started near the coastal New York and Maryland monitoring sites that are projected to be nonattainment or maintenance. The trajectories were run backwards over a 72-hour period. Meteorological data used in this analysis consisted of the North American Regional Reanalysis (NARR) dataset.

There were 20 total exceedances days measured at the Harford monitor from 2015-2017, as shown in Table 19. One trajectory passed through Indiana at a 10 meter height and six trajectories at a 750 meter height which were associated with the exceedances days over the three-year period, meaning a majority of the exceedance days did not have direct Indiana impacts associated with their high ozone values. The higher altitude trajectories point out the large extent of the country that the air impacting the Harford monitor passes over. Based on Figure 15 and Figure 16 below, the majority of the back trajectories indicate shorter trajectory paths over the 72 hour period leading up to the exceedance day, meaning more stagnant conditions were associated with the exceedance days. The majority of the 10 meter trajectories passed over central Maryland, Pennsylvania, Virginia, West Virginia, New Jersey, Delaware and Washington D.C area while the 750 meter trajectories as expected, cover much of the eastern half of the continental U.S. Typical weather conditions associated with higher ozone days along the East Coast are evident; persistent high pressure systems located along the western Atlantic Ocean and southeast portion of the U.S. caused hot, stagnant conditions which persisted during the ozone exceedance events.

Table 19. 8-Hour Ozone Exceedance Days Measured at Harford,MD (2015-2017)

Date	Max 8-hr (ppm)	Date	Max 8-hr (ppm)	Date	Max 8-hr (ppm)
9/2/2015	0.088	7/22/2016	0.082	6/13/2017	0.088
6/11/2015	0.074	5/26/2016	0.080	7/20/2017	0.086
9/3/2015	0.074	9/23/2016	0.080	6/12/2017	0.077
9/4/2015	0.074	5/25/2016	0.079	5/17/2017	0.076
8/31/2015	0.072	6/20/2016	0.079	5/18/2017	0.073
		7/27/2016	0.079	7/19/2017	0.072
		9/14/2016	0.077		
		7/25/2016	0.076		
		7/21/2016	0.072		

Figure 15. Frequency Plot of Trajectory Points for Air Arriving at Harford, MD (May through September, 2015-2017 at 10 meter altitude)

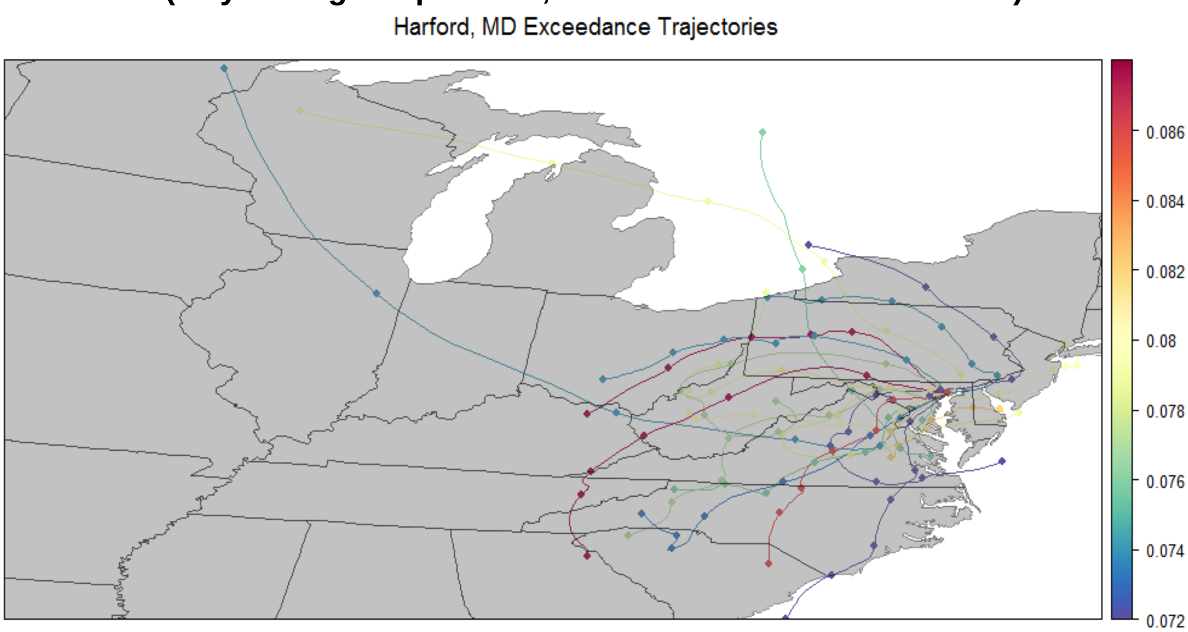
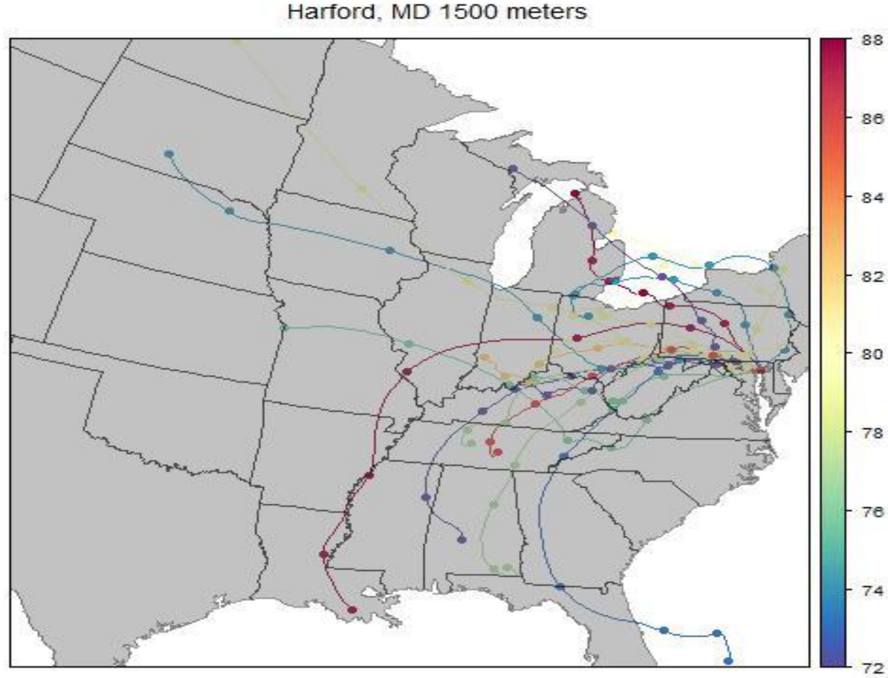


Figure 16. Frequency Plot of Trajectory Points for Air Arriving at Harford, MD (May through September, 2015-2017 at 750 meter altitude)



There were 27 total exceedances days measured at the Richmond, NY monitor from 2015-2017, as shown in Table 20. Three trajectories passed through Indiana at a 10 meter height and eight trajectories passed over Indiana at a 750 meter height and were associated with the exceedances days over the three-year period at the Richmond monitor. The majority of exceedance days did not have direct Indiana impacts associated with the high ozone values. The higher altitude trajectories clearly shows the large extent of the country that air passed over and impacted the Richmond monitor; some trajectories originated in the northern Plains and Texas. Based on the back trajectory maps as seen in Figures 17 and 18 below, the majority of the 10 meter trajectories appear to pass over eastern Pennsylvania, Maryland, New Jersey, Delaware and Washington D.C area as well as the eastern coastal region from Virginia to New York while the 750 meter trajectories cover much of the eastern half of the continental U.S.

Table 20. 8-Hour Ozone Exceedance Days Measured at Richmond, NY (2015-2017)

Date	Max 8hr (ppm)	Date	Max 8hr (ppm)	Date	Max 8hr (ppm)
9/17/2015	0.085	5/25/2016	0.086	5/17/2017	0.081
9/3/2015	0.081	7/22/2016	0.081	6/12/2017	0.079
6/11/2015	0.08	5/26/2016	0.078	5/18/2017	0.074
7/28/2015	0.079	7/21/2016	0.077	6/13/2017	0.072
5/5/2015	0.075	7/6/2016	0.075	7/22/2017	0.072
8/15/2015	0.075	5/28/2016	0.074	8/1/2017	0.072
8/17/2015	0.074	7/29/2016	0.073	6/10/2017	0.071
5/17/2015	0.073	6/11/2016	0.071		
7/19/2015	0.073	7/15/2016	0.071		
8/16/2015	0.072	7/28/2016	0.071		

Figure 17. Frequency Plot of Trajectory Points for Air Arriving at Richmond, NY (Exceedance Days, 2015-2017 at 10 meter altitude)

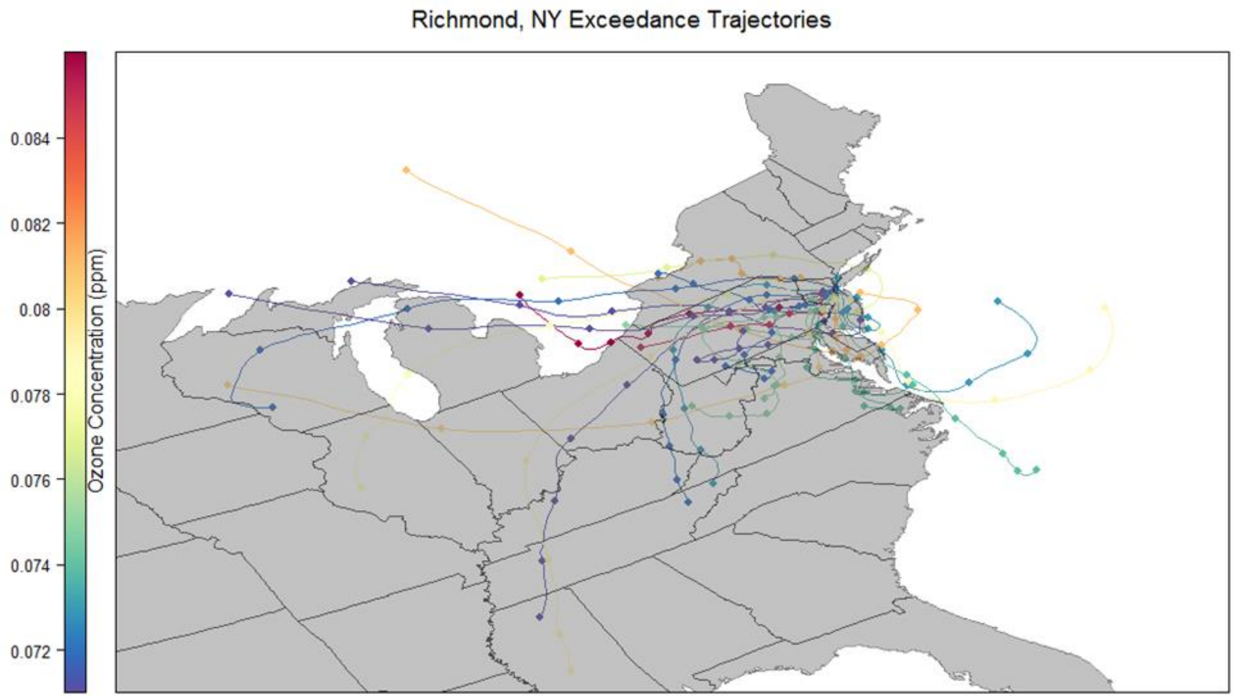
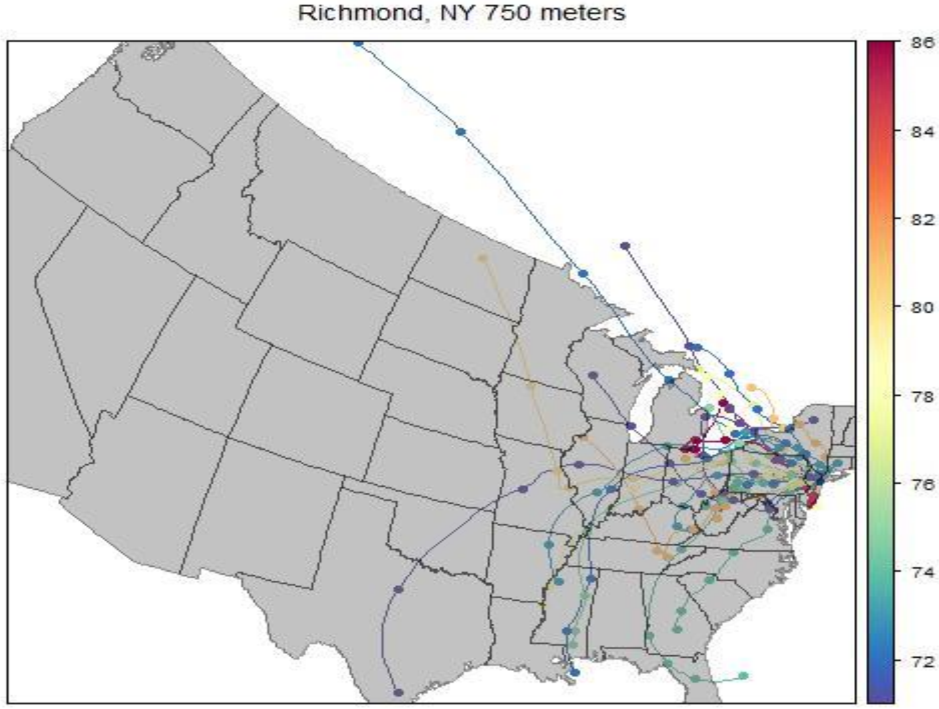


Figure 18. Frequency Plot of Trajectory Points for Air Arriving at Richmond, NY (Exceedance Days, 2015-2017 at 750 meter altitude)



6.11 Conclusion

LADCO modeling for 2023 has projected one Northeast U.S. ozone monitor as nonattainment and three monitors in the New York and Lake Michigan areas as maintenance monitors for the 2015 8-hour ozone standard. Contribution modeling demonstrates that Indiana has projected modeled impacts above 1 ppb at those monitors.

Use of ERTAC's projected 2023 EGU emissions and various other analytic flexibilities have clearly shown that the projected 2023 8-hour ozone design values for Sheboygan and Allegan County ozone monitors will be in attainment of the 2015 Ozone NAAQS. Continued NO_x and VOC emission reductions from Indiana will aid in both monitors attaining the 2015 ozone standard by the attainment date. Based on source apportionment modeling, several emission source sectors are significant contributors to the projected design values. Among those emission source sectors shown to be contributors are the mobile and nonroad sectors, which contribute more to ozone values at Sheboygan and Allegan County monitors than the EGU and non-EGU source sectors. Significant emission reductions have occurred in electricity generation and other large industrial source sectors, resulting in ozone values trending much lower over the past decade or more; Indiana’s emission sources may not be able to achieve additional significant emission reductions that would lower ozone values further. Other emission sectors, especially those associated with onroad and nonroad, represent the largest contributors for Sheboygan, WI and Allegan County, MI. Therefore, implementing additional national emission control measures on sources associated with the onroad and nonroad emission sectors would be more beneficial in effectively reducing ozone at the Lake Michigan area monitors.

Indiana has demonstrated that based on the actual reduction in concentrations necessary for the Northeast U.S. monitors to attain the 8-hour ozone standard of 70 ppb, Indiana's portion of the reduction in ozone values is considered extremely small and is well below the accuracy of the photochemical models. Indiana has made great strides in NO_x and VOC emission reductions over the past decade or more while its projected impacts on the Northeast U.S. ozone monitors are overstated. While Indiana believes its NO_x and VOC emissions will continue to decrease in the future, the local low-level emissions (onroad and nonroad mobile, commercial marine and local point sources) within the eastern U.S. coastal region should be the focal point of emission reductions in order to demonstrate attainment and maintenance of the 8-hour ozone standard at the Northeast U.S. monitors.