2022 Sulfur Dioxide (SO_2) Data Summary Report

Indiana Department of Environmental Management (IDEM)
Office of Air Quality

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About This Report

The Indiana Department of Environmental Management (IDEM) collects and analyzes outdoor air samples for regulated pollutants, including sulfur dioxide (SO_2). Monitoring is conducted for SO_2 year-round, as mandated by United States Environmental Protection Agency (U.S. EPA), and the data is reported to U.S. EPA's Air Quality System (AQS). This ***2022 Sulfur Dioxide (SO_2) Data Summary Report*** provides an overview of SO_2 and its impacts, national air health standards, Indiana's SO_2 monitoring network, a summary of 2022 SO_2 monitoring data, air quality trends over the last ten years, and the status of SO_2 designations in Indiana.

What is Sulfur Dioxide (SO_2)?

SO_2 is one of several highly reactive gases in a larger group of gases known as sulfur oxides (SO_x). Highly reactive gases are those that have a high potential to change in composition under certain conditions of pressure, temperature, light, or upon contact with another chemical. For example, SO_2 that is released into the atmosphere can dissolve in water vapor to form acid rain. Emissions of SO_2 generally lead to formation of other SO_x. SO_x can react with other compounds to form small particles and contribute to particulate matter (PM) pollution. At high concentrations, SO_x can damage foliage and decrease the growth of trees and plants. Of all the gases in the SO_x group, SO_2 is most prevalent in the atmosphere and considered to pose the greatest public health concerns.

Where does SO_2 come from? SO_2 can come from natural sources, like volcanic activity, but also from several manmade sources:

- Fossil fuel combustion at power plants and other industrial facilities.
- Industrial processes such as extracting metal from ore.
- Locomotives, large ships, and non-road equipment that use high-sulfur fuels.

What are the health effects of exposure to SO_2? Breathing SO_2 has been linked to an array of adverse respiratory effects including:

- Narrowing of the airways leading to breathing difficulty (bronchoconstriction).
- Increased asthma symptoms, especially during exercise.
- Increased visits to emergency departments and hospital admissions for respiratory illnesses.

National Ambient Air Quality Standards (NAAQS) for SO_2

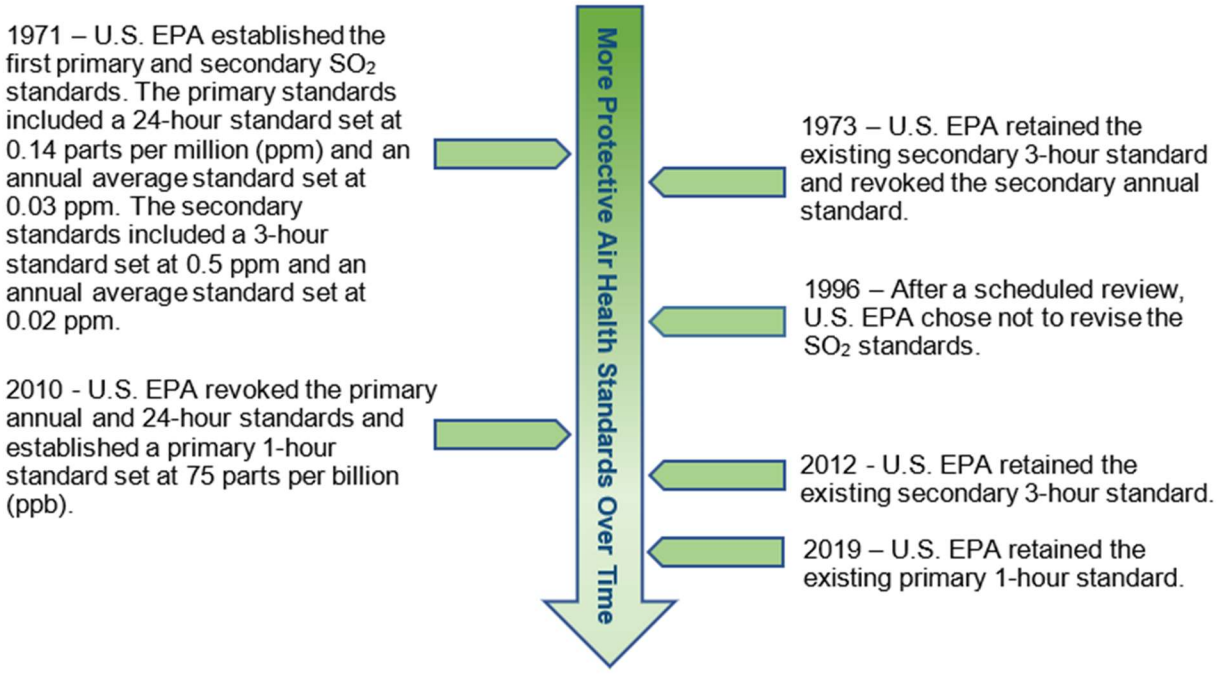
The federal Clean Air Act (CAA) requires U.S. EPA to establish National Ambient Air Quality Standards (NAAQS) for common outdoor air pollutants, including SO_2. The standards for SO_2 are designed to prevent adverse impacts from all of the SO_x gases. NAAQS, which are also known as air health standards, include:

- Primary standards for public health, which set pollutant limits to protect the most vulnerable groups such as young children, the elderly, and individuals with respiratory illnesses.

- Secondary standards for public welfare, which set limits to protect visibility and prevent damage to animals, crops, vegetation, and buildings.

Since the primary and secondary standards were first established for SO_2 in 1971, revisions have been made to both. The 1971 primary standards included both a 24-hour standard of 0.14 parts per million (ppm) not to be exceeded more than once per year and an annual average standard of 0.03 ppm. Both 1971 primary standards were revoked in 2010 and replaced by a more stringent 1-hour primary standard of 75 parts per billion (ppb). The 1971 secondary standards included both a 3-hour standard of 0.5 ppm not to be exceeded more than once per year and an annual average standard of 0.02 ppm. The 1971 secondary annual standard was revoked in 1973. The 1971 secondary 3-hour standard remains in effect. The timeline in Figure 1 notes these milestones in the NAAQS development over the years.

Figure 1: History of the SO_2 NAAQS



Attaining the SO_2 Standards

Air quality monitoring data for SO_2 must measure at or below concentrations set by U.S. EPA for three complete, consecutive years to be in attainment of the NAAQS. For example, an evaluation in 2024 will be based on data from 2021 through 2023.

How does an area attain the primary 1-hour SO_2 standard? An area is determined to be attaining the primary 1-hour SO_2 NAAQS when the 99th percentile of the daily maximum 1-hour concentrations, averaged over three years, does not exceed 75 parts per billion (ppb).

What is a design value? The three-year average of the 99th percentile of the daily maximum 1-hour concentrations is referred to as the **design value**. A monitor's design value is calculated at the end of the year, once all of the data has been quality assured.

What is the difference between an exceedance and a violation? When a monitor records a concentration above the limit established by the NAAQS, it is referred to as an **exceedance**. A monitor can have an exceedance without being in **violation** of the standard. If a monitor's three-year design value exceeds the NAAQS, the monitor is in violation.

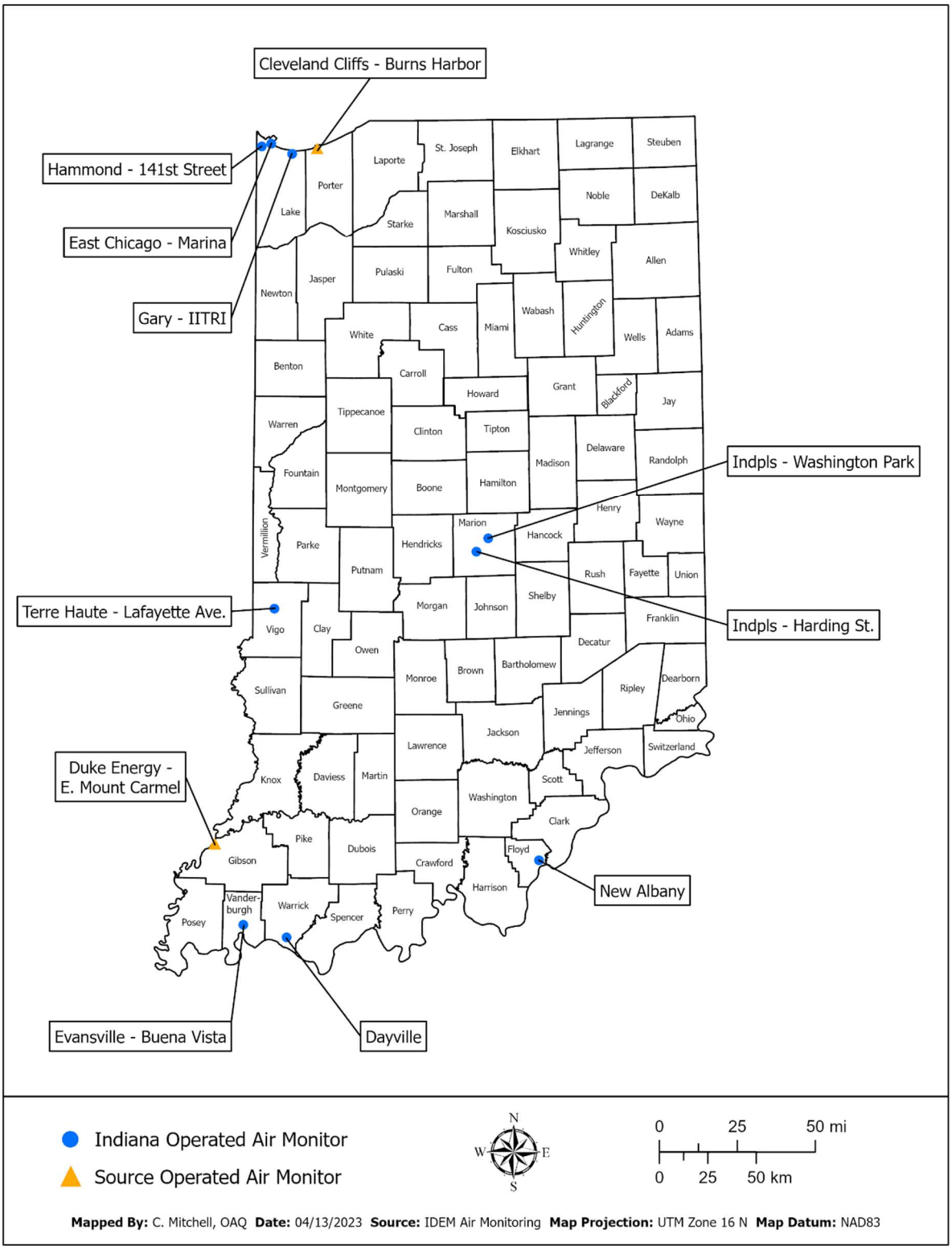
2022 SO_2 Monitoring Network

Indiana's 2022 monitoring network included nine SO_2 monitors in six Indiana counties. The placement of SO_2 monitors in Indiana's network is determined according to U.S. EPA guidance on factors including population and manufacturing levels. IDEM conducts annual reviews of the monitoring network, which are published each year in the *Indiana Ambient Air Monitoring Network Plan* and can be viewed on Indiana's Ambient Air Monitoring Network Web page at: https://www.in.gov/idem/airmonitoring/indianas-ambient-air-monitoring-network/.

In addition to the monitors operated by IDEM, two SO_2 monitors were operated by SO_2 emissions sources in two Indiana counties.

Figure 2 shows SO_2 monitor locations in Indiana for 2022.

Figure 2: 2022 SO_2 Monitoring Network



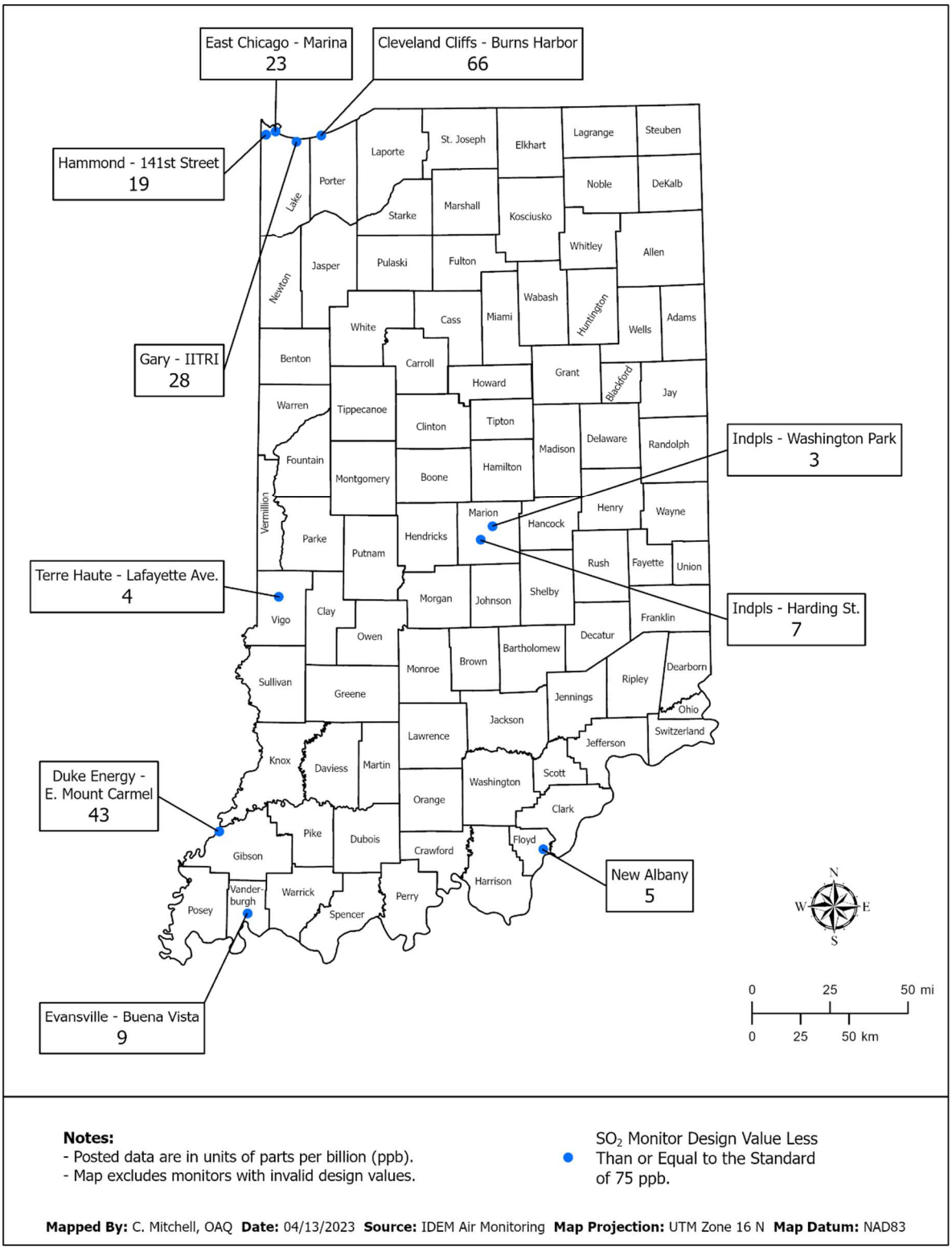
2022 SO_2 Monitoring Data Summary

SO_2 monitoring data has been quality assured for 2022.

2022 Monitoring Data: In 2022, all SO_2 monitors had a 99th percentile maximum value less than the primary 1-hour SO_2 standard of 75 ppb.

Design Values: For 2020-2022, all SO_2 monitors had a design value less than the primary 1-hour standard of 75 ppb. Monitor design values are displayed in Figure 3.

Figure 3: Primary 1-Hour SO_2 Design Values for 2020-2022



Notes:
- Posted data are in units of parts per billion (ppb).
- Map excludes monitors with invalid design values.

● SO_2 Monitor Design Value Less Than or Equal to the Standard of 75 ppb.

Mapped By: C. Mitchell, OAQ **Date:** 04/13/2023 **Source:** IDEM Air Monitoring **Map Projection:** UTM Zone 16 N **Map Datum:** NAD83

SO_2 Air Quality Trends

SO_2 monitoring data in Chart 1 and Chart 2 below is divided into regions as shown in Figure 4.

Figure 4: Indiana Regions

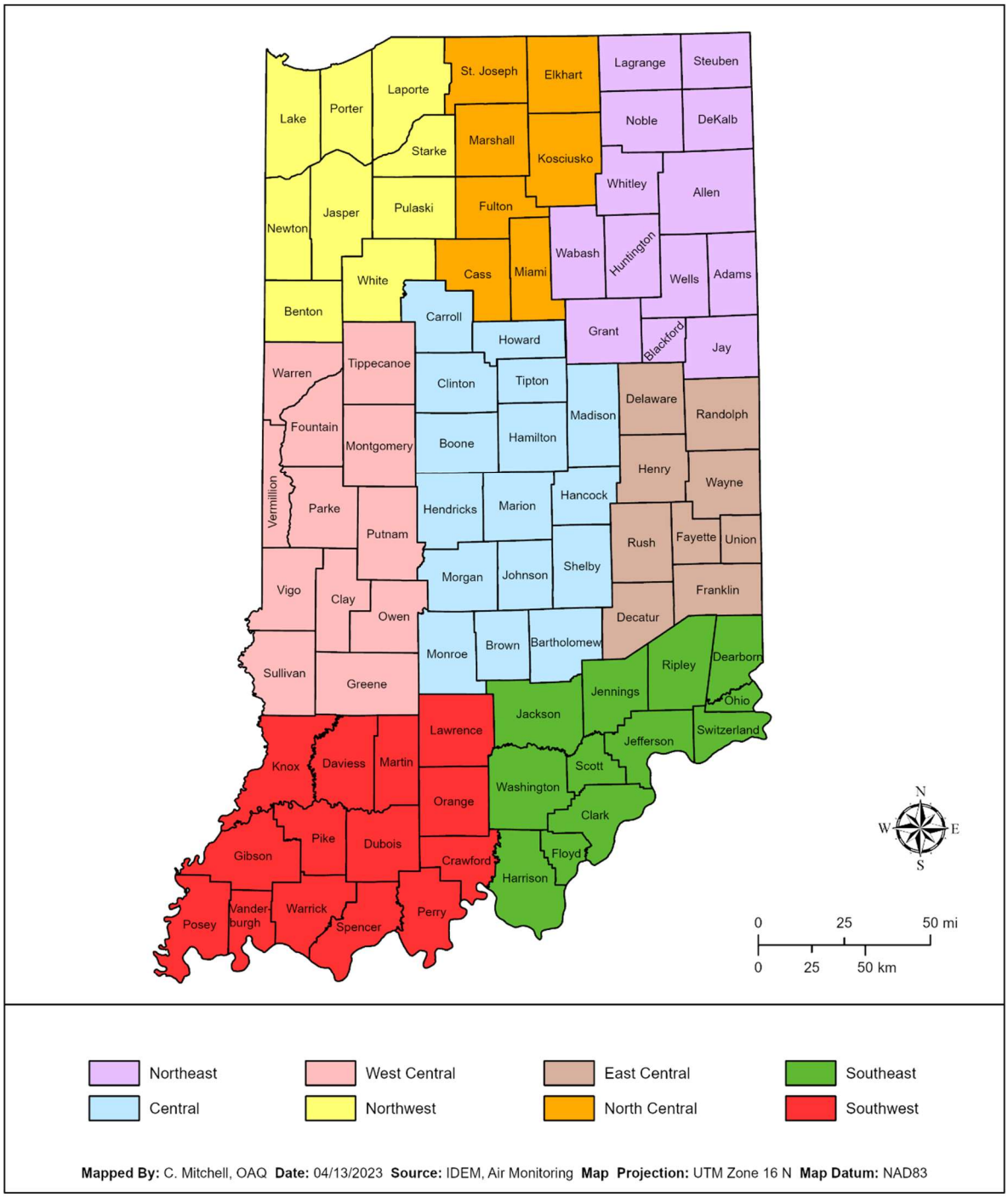


Chart 1 plots the highest annual 99th percentile daily maximum SO_2 concentrations for 2013-2022. Chart 2 plots the highest 3-year design values for 2013-2015 through 2020-2022. They both include the primary 1-hour SO_2 standard for comparison.

Chart 1: SO_2 99th Percentile Value Trends for 2013-2022

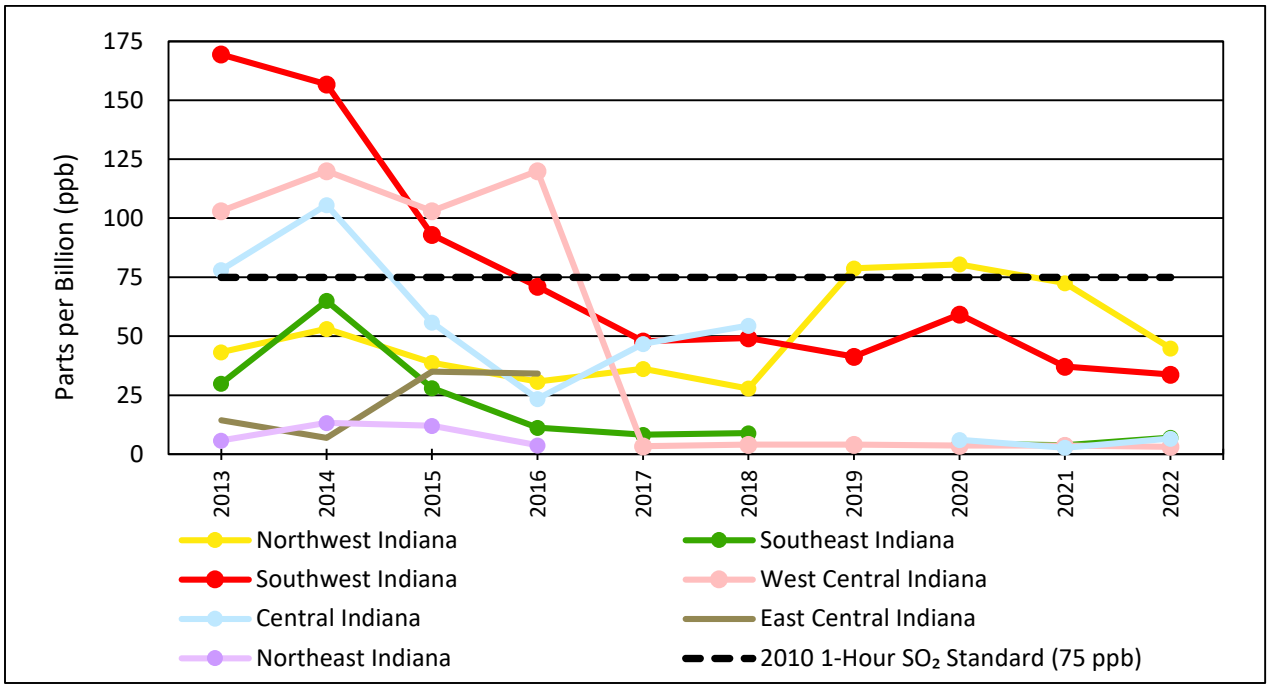
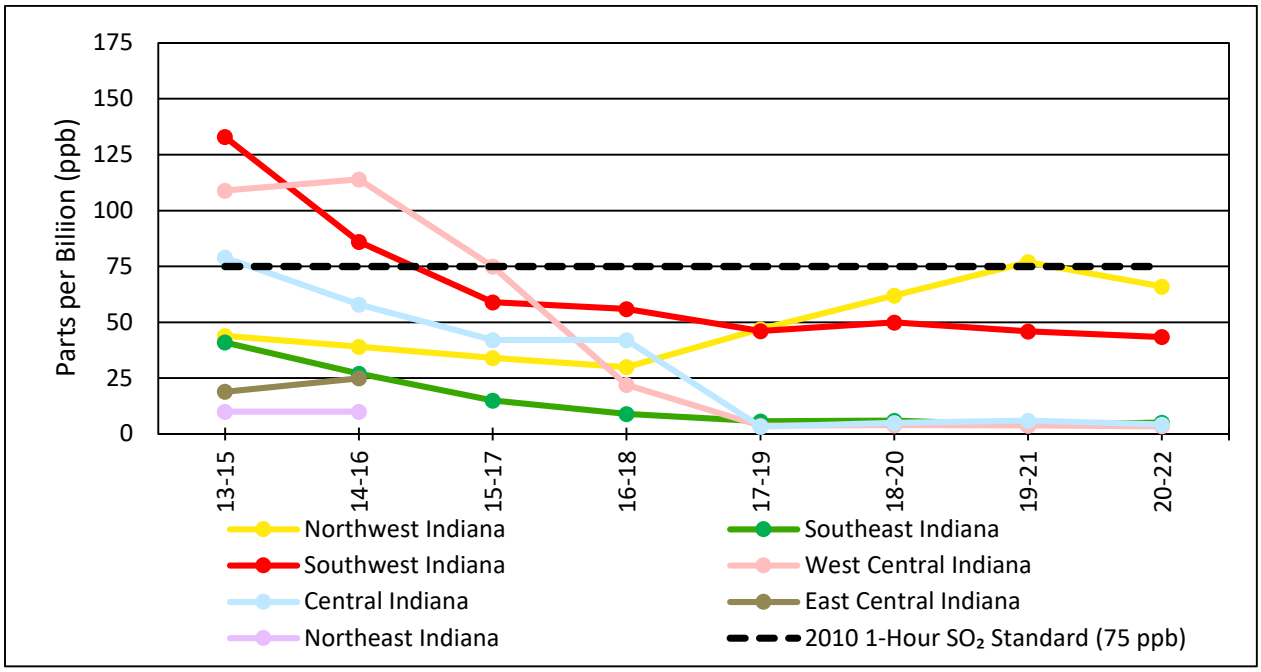


Chart 2: SO_2 Design Value Trends for 2013-2015 through 2020-2022



Status of SO_2 Designations

When a NAAQS is issued, the implementation process begins. The first step is for U.S. EPA to designate air quality for all areas of the country. Areas that are not attaining the new standard, and areas that are contributing to areas that are not attaining the standard, are designated as nonattainment. When a nonattainment area attains the standard, IDEM submits a request to U.S. EPA for the area's redesignation to attainment status. This formal action ensures the area is recognized for its compliance.

2010 Primary 1-Hour NAAQS: U.S. EPA issued designations for the 2010 primary 1-hour SO_2 NAAQS in four rounds. On August 5, 2013, U.S. EPA issued the first round of nonattainment designations for areas with existing SO_2 monitors that violated the primary 1-hour standard, effective October 4, 2013 (78 FR 47191).[1] As a result of a consent decree and subsequent court order, U.S. EPA completed designations for the remainder of the country in three additional rounds. Following is the status of designations in Indiana for each round.

In Round 1, U.S. EPA designated portions of Daviess, Marion, Morgan, Pike, and Vigo counties as nonattainment based on 2009-2011 monitoring data. All areas have since been redesignated to attainment based on modeling data showing compliance with the standard, as shown in Table 1.

[1] Federal Register (FR) notices (cited by volume and page number) can be viewed at https://www.federalregister.gov/.

Table 1: Round 1 Designations Under the 2010 Primary 1-Hour SO_2 NAAQS

County/Township	Area	Status
Daviess County: Veale Township	Southwest Indiana, IN	Attainment, Effective April 30, 2021 (86 FR 12107)
Marion County: Center, Perry, and Wayne Townships	Indianapolis, IN	Attainment, Effective May 21, 2020 (85 FR 30844)
Morgan County: Clay and Washington Townships	Morgan County, IN	Attainment, Effective September 16, 2020 (85 FR 57736)
Pike County: Washington Township	Southwest Indiana, IN	Attainment, Effective April 30, 2021 (86 FR 12107)
Vigo County: Fayette and Harrison Townships	Terre Haute, IN	Attainment, Effective July 8, 2019 (84 FR 32317)

On July 12, 2016, U.S. EPA issued Round 2 designations for unmonitored areas around certain large sources of SO_2 emissions that were identified according to U.S. EPA Air Markets Database, effective September 16, 2016 (81 FR 45039).[2] Designations were based on data from air models, which are computer-generated air quality predictions based on weather and emissions data. As shown in Table 2, Gibson County, Jefferson County (partial), LaPorte County, Posey County (partial) and Spencer County (partial) were designated as attainment/unclassifiable.

[2] Areas that recorded new monitor violations since Round 1 were also addressed in Round 2; however, no new monitor violations were recorded in Indiana.

Table 2: Round 2 Designations Under the 2010 Primary 1-Hour SO_2 NAAQS

County/Area	Source	Status
Gibson County	Duke Energy Gibson Station	Attainment/Unclassifiable
Jefferson County: Graham, Lancaster, Madison, Monroe, Republican, Shelby, and Smyrna Townships	IKEC Clifty Creek Station	Attainment/Unclassifiable
LaPorte County	NIPSCO Michigan City Station	Attainment/Unclassifiable
Posey County: Bethel, Center, Harmony, Lynn, Marrs, Robb, Robinson, and Smith Townships	Vectren A.B. Brown Station	Attainment/Unclassifiable
Spencer County: Ohio Township north of UTM 4187.580 km northing, and Carter, Clay, Grass, Hammond, Harrison, and Jackson Townships	AEP Rockport Station	Attainment/Unclassifiable

Designations issued in Rounds 3 and 4 included areas around large sources that are subject to U.S. EPA's Data Requirements Rule (DRR)[3] as well as certain smaller sources identified by IDEM or U.S. EPA for further air quality characterization. In Round 3, on January 9, 2018, U.S. EPA issued designations for areas around unmonitored sources that elected to use modeling data for the air quality characterization, effective April 9, 2018 (83 FR 1098). As shown in Table 3, a designation of attainment/unclassifiable was issued for all Round 3 areas of Indiana, except for Huntington Township in Huntington County.

[3] 80 FR 51052

Table 3: Round 3 Designations Under the 2010 Primary 1-Hour SO_2 NAAQS

County/Area	Source	Current Status
Floyd	Duke Energy Gallagher Station	Attainment/Unclassifiable
Huntington County: Huntington Township	U.S. Mineral Products Isolatek	IDEM is working with U.S. Mineral Products – Isolatek to establish permanent and enforceable emission limits that will assure compliance with the 1-hour standard for SO_2.
Jasper	NIPSCO R.M. Schahfer Station	Attainment/Unclassifiable
Lake	ISPAT Cokenergy	Attainment/Unclassifiable
	U.S. Steel Gary Works	
	Cleveland-Cliffs Steel (316)*	
Posey	SABIC Innovative Plastics	Attainment/Unclassifiable
Sullivan	Hoosier Energy Merom Station	Attainment/Unclassifiable
Vermillion	Duke Energy Cayuga Station	Attainment/Unclassifiable
Warrick	ALCOA Warrick Power Plant	Attainment/Unclassifiable
	ALCOA Warrick Operations	
All remaining areas of Indiana, except Porter County.		Attainment/Unclassifiable

*Formerly known as ArcelorMittal USA

Areas around DRR sources that elected to install new monitors for air quality characterization were designated in the fourth and final round. A DRR source located in Porter County elected to install new monitors for the area's designation in Round 4. As shown in Table 4, on March 26, 2021, U.S. EPA designated Porter County as attainment/unclassifiable based on 2017-2019 monitoring data, effective April 30, 2021 (86 FR 16055).

Table 4: Round 4 Designations Under the 2010 Primary 1-Hour SO_2 NAAQS

County/Area	Source	Current Status
Porter County	Cleveland-Cliffs Burns Harbor*	Attainment/Unclassifiable

*Formerly known as ArcelorMittal Burns Harbor.

Secondary 3-Hour SO_2 NAAQS: Indiana has never had any nonattainment areas for the secondary 3-hour SO_2 standard.

Indiana's SO_2 nonattainment areas are shown in Figure 5.

Figure 5: Nonattainment Areas Under the 2010 Primary 1-Hour SO_2 Standard

Additional Information

- For near real-time continuous monitoring data, data summaries, and air quality reports, visit IDEM's Air Quality Data Web page at: https://www.in.gov/idem/airmonitoring/air-quality-data/.
- For air quality designations, attainment demonstrations, redesignation petitions and maintenance plans visit IDEM's State Implementation Plans website at: https://www.in.gov/idem/sips/.
- For air quality modeling: https://www.in.gov/idem/airquality/modeling/.
- For information about SO_2 and NAAQS implementation, visit U.S. EPA's NAAQS website at: https://www.epa.gov/naaqs.
- Learn about U.S. EPA's Air Quality System (AQS) at: https://www.epa.gov/aqs.

Contact IDEM's Office of Air Quality

Please feel free to direct questions or comments to Michele Boner, environmental manager with IDEM's Office of Air Quality, at (800) 451-6027 Option 4 (*toll free*), (317) 233-6844 (*direct*), or mboner@idem.in.gov *(email*).