Technical Support Document:

Chapter 13
Final Round 3 Area Designations for the 2010 1-Hour SO_2 Primary National Ambient Air Quality Standard for Indiana

1. Summary

Pursuant to section 107(d) of the Clean Air Act (CAA), the U.S. Environmental Protection Agency (the EPA, we, or us) must designate areas as either "nonattainment," "attainment," or "unclassifiable" for the 2010 1-hour sulfur dioxide (SO_2) primary national ambient air quality standard (NAAQS) (2010 SO_2 NAAQS). Our Notice of Availability (NOA)[1] and our Technical Support Document[2] for our intended designations for the round of designations we are required to complete by December 31, 2017, provided background on the relevant CAA definitions and the history of the designations for this NAAQS. Chapter 1 of this TSD for the final designations explains the definitions we are applying in the final designations. The TSD for the intended Round 3 area designations also described Indiana's recommended designations, assessed the available relevant monitoring, modeling, and any other information, and provided our intended designations.

This TSD for the final Round 3 area designations for Indiana addresses any change in Indiana's recommended designations by Indiana since we communicated our intended designations for areas in Indiana. It also provides our assessment of additional relevant information that were submitted too close to the signature of the NOA to have been considered in our intended designations, or that have been submitted by Indiana or other parties since the publication of the NOA. This TSD does not repeat information contained in the TSD for our intended designations except as needed to explain our assessment of the newer information and to make clear the final action we are taking and its basis, but that information is incorporated as part of our final designations. If our assessment of the information already considered in our TSD for our intended designations has changed based on new information and we are finalizing a designation based on such change in our assessment, this TSD also explains that change. For areas of Indiana not explicitly addressed in this chapter, we are finalizing the designations described in our 120-day letters and the TSD for the intended Round 3 area designations. All the final designations are listed in Table 1 below.

In response to our 120-day letter to Indiana, Indiana provided additional modeling for the area in Warrick County near the Alcoa facilities, and Indiana provided comments regarding the Huntington County area. In addition, Sierra Club provided additional modeling for Warrick

[1] EPA Responses to Certain State Designation Recommendations for the 2010 Sulfur Dioxide Primary National Ambient Air Quality Standard: Notification of Availability and Public Comment Period, September 5, 2017 (82 FR 41903)

[2] Intended Round 3 Area Designations for the 2010 1-Hour SO_2 Primary National Ambient Air Quality Standard Technical Support Document, August 2017. https://www.epa.gov/sulfur-dioxide-designations/initial-technical-support-documents-area-designations-round-3

County. Section 2 below reviews these two new modeling analyses for Warrick County.

Indiana also commented regarding the EPA's intended designation for the Huntington County area and clarified information regarding the Floyd County area. The comments specific to Huntington and Floyd Counties are addressed in the response to comments document associated with this final action.

For the areas in Indiana that are part of the Round 3 designations process, Table 1 identifies EPA's final designations and the counties or portions of counties to which they apply. It also lists Indiana's current recommendations. The EPA's final designations for these areas are based on an assessment and characterization of air quality through ambient air quality data, air dispersion modeling, other evidence and supporting information, or a combination of the above.

Table 1. Summary of the EPA's Final Designations and the Designation Recommendations by Indiana

Area/County	Indiana's Recommended Area Definition	Indiana's Recommended Designation	EPA's Intended Designation	EPA's Final Area Definition	EPA's Final Designation[3]
Gallagher/Floyd County	Floyd County	Attainment	Unclassifiable/ Attainment	Same as State's recommendation	Attainment/ Unclassifiable
U.S. Mineral Products/ Huntington County	Huntington County	Unclassifiable	Nonattainment	Huntington Township	Nonattainment*
NIPCSO-R.M. Schahfer/ Jasper County	Kankakee Township	Attainment	Unclassifiable/ Attainment	Jasper County	Attainment/ Unclassifiable
ArcelorMittal, Cokenergy, U.S. Steel/ Lake County	Calumet, North Townships	Attainment	Unclassifiable/ Attainment	Lake County	Attainment/ Unclassifiable
SABIC Innovative Plastics/ Posey County	Black Township	Attainment	Unclassifiable/ Attainment	Black, Point Townships	Attainment/ Unclassifiable
Hoosier Energy Merom/ Sullivan County	Gill Township	Attainment	Unclassifiable/ Attainment	Sullivan County	Attainment/ Unclassifiable

[3] Refer to Chapter 1 of Technical Support Document: Final Round 3 Area Designations for the 2010 1-Hour SO_2 Primary National Ambient Air Quality Standard for definitions of the designation categories and the terminology change from Unclassifiable/Attainment to Attainment/Unclassifiable.

Duke-Cayuga/ Vermillion County	Eugene, Vermillion Townships	Attainment	Unclassifiable/ Attainment	Same as State's recommendation	Attainment/ Unclassifiable
Alcoa Warrick Power Plant, Alcoa Warrick Operations/ Warrick County	Anderson Township	Attainment	Nonattainment	Warrick County	Attainment/ Unclassifiable
Remaining areas in Indiana except for Porter County**	Remaining Full or Partial Counties	Attainment	Unclassifiable/ Attainment	Remaining Full or Partial Counties	Attainment/ Unclassifiable

* The EPA is designating the remainder of the county as attainment/unclassifiable.
**Except for areas that are associated with sources for which Indiana elected to install and began timely operation of a new SO_2 monitoring network meeting EPA specifications referenced in EPA's SO_2 DRR (i.e., Porter County, *see* Table 2), the EPA is designating the remaining undesignated counties (or portions of counties) in Indiana as separate "attainment/unclassifiable." These areas that we are designating as attainment/unclassifiable (those to which this row of this table is applicable) are identified more specifically in section 11 of Chapter 13 (addressing Indiana) of the TSD for our intended designations.

The Porter County, Indiana, area is an area for which the state elected to install and began timely operation of a new, approved SO_2 monitoring network. This area is centered around the ArcelorMittal-Burns Harbor facility, which is a source listed as subject to the DRR, though the area also includes NIPSCO's Bailly Station, which is a smaller source that is not listed as subject to the DRR. Pursuant to the court ordered schedule, the EPA is required to designate such areas by December 31, 2020. This area is listed in Table 2.

Table 2. Undesignated Areas Which the EPA Is Not Addressing in this Round of Designations (and Associated Source or Sources)

Area	Source
Porter County	ArcelorMittal-Burns Harbor

The four areas in Indiana that the EPA designated nonattainment in Round 1 (*see* 78 FR 47191) and the five areas in Indiana that the EPA designated unclassifiable/attainment in Round 2 (*see* 81 FR 45039) are not affected by the designations in Round 3 and are not listed in Table 1.

2. Technical Analysis of New Information for the Warrick County (Alcoa Facilities) Area

2.1. Introduction

The EPA must designate the Warrick County area by December 31, 2017, because the area has not been previously designated and Indiana has not installed and begun timely operation of a new, approved SO_2 monitoring network to characterize air quality in the vicinity of any source in Warrick County.

On August 22, 2017, the EPA sent Indiana a "120-day letter" stating the EPA's intent to designate portions of Warrick County as nonattainment. This intended designation for Warrick County was based on all available information, including modeling information and all relevant monitoring information, most notably on modeling provided by Sierra Club on March 31, 2016, which had been submitted during deliberations on the designation for the area in Posey County near the A.B. Brown power plant. The 120-day letter also acknowledged ongoing air quality modeling work being conducted by Alcoa and the Indiana Department of Environmental Management (IDEM). In response to the 120-day letter and the EPA's intended designation for Warrick County, Sierra Club submitted additional modeling on October 5, 2017, and Indiana provided modeling (reflecting an amended version of modeling provided by a consultant to Alcoa) on October 18, 2017. The following discussion reviews these supplemental modeling analyses.

There are two sources in the Warrick County area subject to DRR requirements: Alcoa-Warrick Operations, engaging in aluminum smelting, and Alcoa Allowance Management, engaging in electricity generation. These facilities were listed as incurring DRR requirements on the basis of 2014 SO_2 emissions of 3,500 tons and 4,993 tons, respectively.

In addition to these two facilities, a significant nearby facility is Vectron's F.B. Culley Station (Culley), located adjacent to Alcoa in Warrick County. In 2014, Culley emitted 1,896 tons of SO_2. More distant sources include A. B. Brown Power Plant, AEP Rockport Power Plant, Owensboro Municipal Utilities, Big Rivers Electric Corporation Coleman Station, Century Aluminum of Kentucky, and Owensboro Grain. The treatment of these facilities in Sierra Club's and IDEM's modeling analyses is described below.

2.2. Summary of Information Reviewed in the TSD for the Intended Round 3 Area Designations

The following Table 3 identifies all the modeling assessments evaluated for the 120-day letters and discussed in the TSD for the Intended Round 3 Area Designations. Additional details can be found in the TSD for the Intended Round 3 Area Designations, Chapter 13.

Table 3 –Modeling Assessment Evaluated in the TSD for the Intended Designation for the Warrick County Area

Organization Submitting Assessment	Date of the Assessment	Identifier used in the TSD for the Intended Round 3 Area Designations, Chapter 13	Distinguishing or Otherwise Key Features
Sierra Club	March 31, 2016	2016 Sierra Club Modeling	1 km receptor grid in Warrick County

The EPA considered all available information for the Warrick County area. The state provided available monitoring data, based on historic monitoring at one site, through 2010, and more recent data at that site and three other sites, for approximately a 7-1/2 month period from July 1, 2015 to mid-February 2016. However, because these data were too limited to provide a valid design value, these data were deemed insufficient to provide an indication of the attainment status of this area.

The state did not provide modeling for the EPA's review prior to the 120-day letter. However, as noted above, Sierra Club had provided modeling during the review of Round 2 designations, commenting on the designation for the area in Posey County near the A.B. Brown facility but identifying violations near Alcoa. A full review of that modeling is available in the TSD for the intended Indiana designations (Chapter 13, Section 10). This modeling was the primary basis for the EPA's intended nonattainment designation for portions of Warrick County.

2.3. Assessment of New Air Quality Monitoring Data for the Warrick County Area

This factor considers the SO_2 air quality monitoring data in the area of Warrick County. Our TSD for the intended area designations considered available data through 2016 for four monitoring sites. We do not have certified data for any additional complete calendar years at any site, and we have no new monitoring information of any other type that warrants revising our prior analysis of available monitoring data.

2.4. Assessment of New Air Quality Modeling Analysis for the Warrick County Area Addressing the Alcoa Sources

2.4.1. Introduction

This section 2.4 presents all the newly available air quality modeling information for a portion of Warrick County that includes Alcoa-Warrick Operations, Alcoa Allowance Management, and Culley. These sources have been described above. Because we have available results of air quality modeling in which these sources are modeled together, the area around this group of sources is being addressed in this section with consideration given to the impacts of all these sources.

As noted above, on October 18, 2017, Indiana submitted new modeling analyzing air quality in Warrick County. This new assessment and characterization was performed using air dispersion modeling software, i.e., AERMOD generally analyzing actual emissions. The area that Indiana has assessed via air quality modeling includes Warrick County and portions of neighboring Spencer County and Henderson and Daviess Counties, Kentucky. Indiana's analysis supports a different designation than the EPA's intended designation for this area. The EPA expressed an

intent to designate the area as nonattainment, whereas Indiana's analysis supports a designation as attainment/unclassifiable.

In addition, on October 5, 2017, Sierra Club submitted new modeling also analyzing air quality in Warrick County and nearby areas. This new assessment and characterization was also performed using air dispersion modeling software, i.e., AERMOD, generally analyzing actual emissions. The Sierra Club's analysis supports the EPA's intended nonattainment designation for this area. After careful review of Indiana's and Sierra Club's new assessment, supporting documentation, and all available data, the EPA finds that both analyses generally conform with the recommendations of the Modeling TAD, but the EPA finds that Indiana's analysis more reliably assesses air quality, leading the EPA to designate the area as attainment/unclassifiable. Our reasoning for this conclusion is explained in a later section of this TSD, after all the available information is presented.

For convenience, Table 4 summarizes the new modeling that the EPA has received for this area, beyond the analysis identified above in Table 3 that was reviewed in its TSD for its intended designations. This table lists these new analyses, indicates when they were received, provides an identifier for the assessment that is used in the discussion of the assessments that follow, and identifies key distinguishing features of the modeling assessments.

Table 4 –New Modeling Assessments for Warrick County

Organization Submitting Assessment	Date of the Assessment	Identifier Used in this TSD	Distinguishing or Otherwise Key Features
Indiana	October 18, 2017	Indiana modeling	Partly urban, merged stacks
Sierra Club	October 5, 2017	2017 Sierra Club modeling	Rural

As seen in Figure 1 below, the Alcoa facilities are located on the Ohio River approximately seven kilometers (km) southeast of Newburgh, Indiana. Figure 1 also shows Culley, adjacent on the southeast border of the Alcoa facilities.

Figure 1. Map of the Alcoa Facilities' Ambient Air Boundary and Surrounding Area

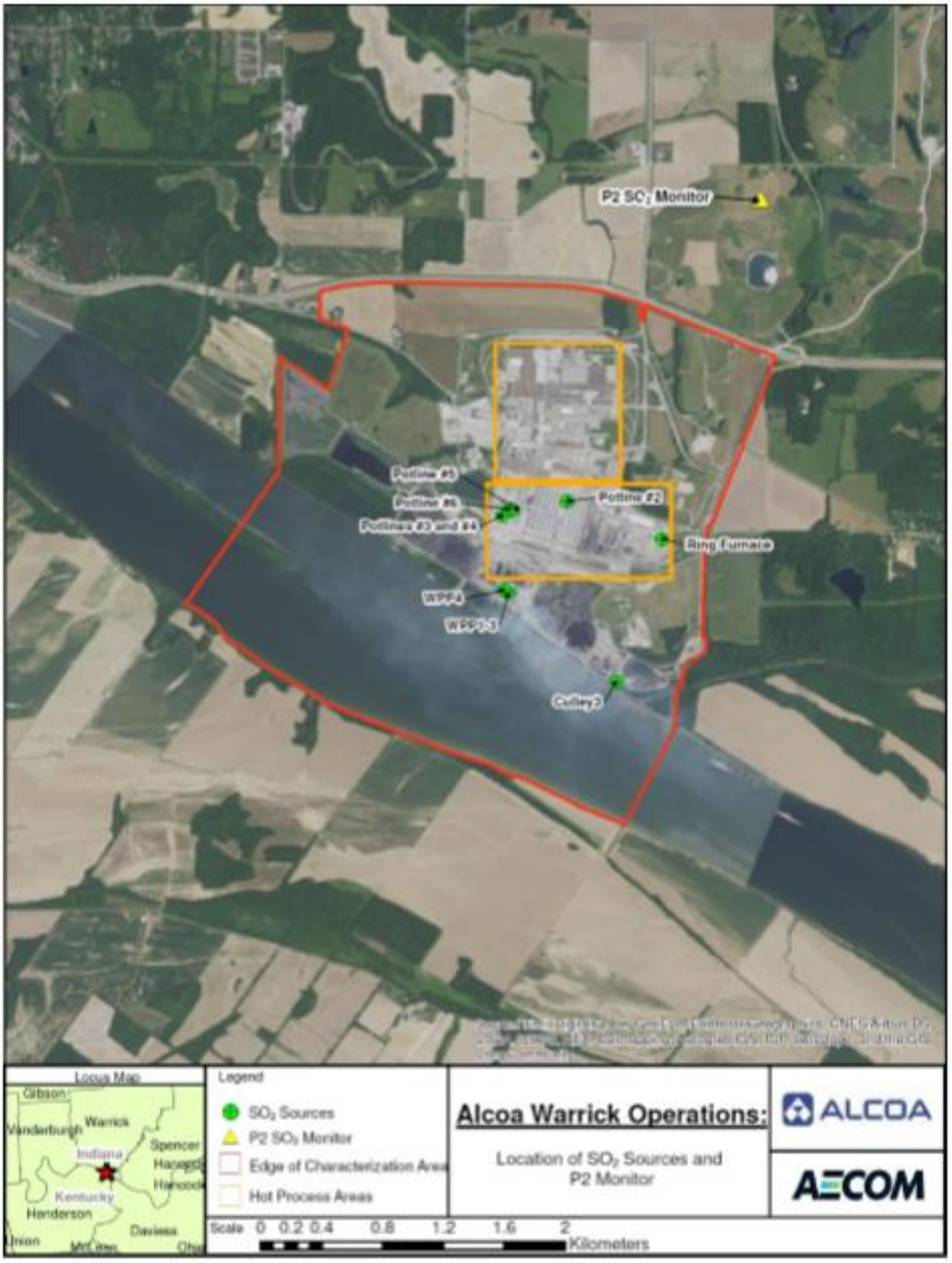
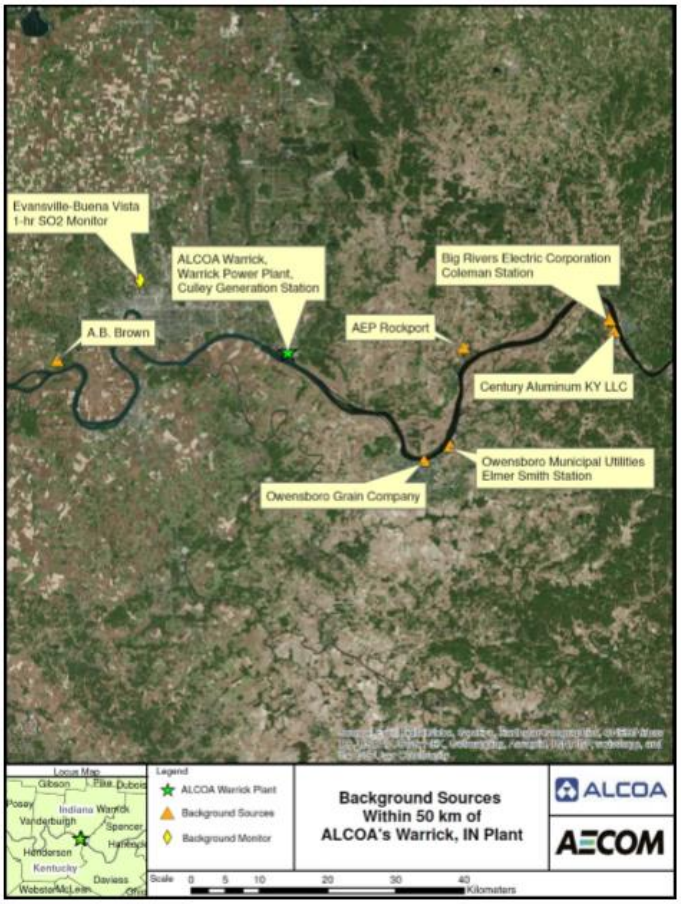


Figure 2 shows the broader area included in both Indiana's and Sierra Club's analyses, showing a number of additional facilities included in both of these analyses. Further discussion of the included facilities is provided in section 2.4.3.6 and 2.4.4.6 below, for the Indiana and Sierra Club analyses, respectively.

Figure 2: Map of Modeled Facilities



The EPA's final designation boundary for Warrick County area is not shown in these figures, but is shown in a figure in the section below that summarizes our final designation. The discussion and analysis that follows below will reference the Modeling TAD and the factors for evaluation contained in the EPA's July 22, 2016, guidance and March 20, 2015, guidance as cited in Chapter 1 of this TSD, as appropriate.

2.4.2. Differences Among the Available Analyses for the Warrick County Area

The EPA's designation for the Warrick County area reflects consideration of the three modeling analyses it has received for this area as well as of the limited monitoring data that is available for this area. A review of the 2016 Sierra Club analysis is provided in the TSD for the intended designations, specifically in section 10.3 of Chapter 13 of the TSD for the intended designations. A review of the Indiana modeling is provided in section 2.4.3 below, and a review of the 2017 Sierra Club modeling is provided in section 2.4.4 below. These sections provide a full characterization of these respective modeling analyses, as well as a review of the merits of each individual analysis. Nevertheless, a brief comparison of the features of the three analyses

follows.

The 2016 Sierra Club modeling was submitted during the development of the Round 2 SO_2 designations. The A.B. Brown power plant was among the facilities addressed in that round of designations, and the pertinent 2016 Sierra Club modeling, while including receptors in Warrick County, was focused on impacts of A.B. Brown. As such, these model runs had a relatively sparse receptor network in Warrick County, and the meteorological data were for 2012 to 2014. Sierra Club performed modeling both with actual emissions and with allowable emissions, although the EPA focused on the modeling of actual emissions as being more in accordance with the Modeling TAD. The 2017 Sierra Club modeling is similar to the 2016 Sierra Club modeling in many respects, except that the 2017 modeling included four runs, reflecting two meteorological data sets (2013 to 2015 and 2014 to 2016) and two emission scenarios (one pair of runs using actual emissions for all sources and one pair of runs mostly using actual emissions but using allowable emissions for A.B. Brown).

While the Indiana analysis and the two Sierra Club analyses were fairly similar in some respects, such as the model used, the area of analysis, and the sources considered, the Indiana analysis used substantially different approaches for selected model inputs. The Indiana analysis used urban dispersion characteristics for simulating dispersion of emissions from Alcoa's potlines, whereas Sierra Club's analyses used rural dispersion characteristics for all sources. Indiana excluded numerous receptors as not being in what Indiana considered ambient air or as being over the Ohio River, whereas Sierra Club made no such exclusions. Indiana's analysis considered building downwash from the Alcoa facilities, whereas the Sierra Club analyses did not. Indiana modeled the emissions from the potlines as if the emissions were released from a reduced number of merged stacks, whereas the Sierra Club analyses modeled all of the emissions of each potline as if it were emitted from a single representative stack.

As noted above, separate reviews of these three analyses are provided in section 10.3 of the TSD for the intended Indiana designations and in the following sections 2.4.3 and 2.4.4, respectively. Section 2.8 provides a more complete comparison of these three analyses and provides a comparative assessment of the relative merits of the three modeling analyses and the available monitoring data.

2.4.3. Modeling Analysis Provided by the State

The modeling submitted by Indiana predominantly reflects work by a consultant to Alcoa. On June 23, 2017, prior to the EPA's issuance of its 120-day letter to Indiana, IDEM staff had provided a protocol, developed by the consultant, for modeling Warrick County. The EPA did not have the opportunity to review the protocol by the time we issued the 120-day letters, but subsequently, on August 31, 2017, the EPA provided comments on the protocol to Indiana. On October 2, 2017, Indiana provided a revised protocol (formally transmitted on October 5, 2017), addressing the EPA's comments, and on October 17, 2017, the EPA informed Indiana that it concurred with the modeling procedures that the protocol recommended.[4] Key elements of this protocol included:

[4] The EPA's comments on Indiana's protocol and Indiana's revised protocol were provided to Sierra Club on October 2, 2017, and were added to the docket at about the same time.

- Use of urban dispersion coefficients for assessing dispersion from the potline stacks at Alcoa's smelting operations, and rural dispersion coefficients for other stacks
- Merging of some arrays of stacks into arrays with fewer stacks

In addition, Indiana's final submittal provided further information regarding the preclusion of public access to the substantial area that is Alcoa plant property as well as regarding the treatment of receptors on the Culley plant property with respect to the emissions from Alcoa facilities. These features of Indiana's modeling analysis are discussed at greater length below.

2.4.3.1. Model Selection and Modeling Components

The EPA's Modeling TAD notes that for area designations under the 2010 SO_2 NAAQS, the AERMOD modeling system should be used, unless use of an alternative model can be justified. The AERMOD modeling system contains the following components:

- AERMOD: the dispersion model
- AERMAP: the terrain processor for AERMOD
- AERMET: the meteorological data processor for AERMOD
- BPIPPRM: the building input processor
- AERMINUTE: a pre-processor to AERMET incorporating 1-minute automated surface observation system (ASOS) wind data
- AERSURFACE: the surface characteristics processor for AERMET
- AERSCREEN: a screening version of AERMOD

IDEM used the most recent AERMOD version, 16216r. The AERMET version was 16216. A discussion of IDEM's approach to the individual components is provided in the corresponding discussion that follows, as appropriate.

2.4.3.2. Modeling Parameter: Rural or Urban Dispersion

For any dispersion modeling exercise, the determination of whether a source is in an "urban" or "rural" area is important in determining the boundary layer characteristics that affect the model's prediction of downwind concentrations. For SO_2 modeling, the urban/rural determination is also important because AERMOD invokes a 4-hour half-life for urban SO_2 sources. Section 6.3 of the Modeling TAD details the procedures used to determine if a source is urban or rural based on land use or population density.

For the Alcoa modeling, a land use analysis of the TAD recommended 3-mile area surrounding the facility shows the area to be rural because less than 50% of the land use is classified as urban. However, the Alcoa smelting operations were modeled using urban dispersion because of a localized urban heat island effect created by hot, industrial operations. The Guideline on Air Quality Modeling (40 CFR Part 51 Appendix W) discusses non-population based urban areas in section 7.2.1.1. That discussion recognizes that some industrial areas generate enough ambient heat that emitted plumes are better characterized using an urban dispersion treatment to simulate nighttime heat island effects. The Alcoa smelter facility utilizes approximately 450 MW daily

electrical usage. Approximately 100 MW of this usage is released as residual heat. This creates a significant difference in temperature between air just over the smelter facility and the temperature of air just beyond the smelter operations. Similar facilities in northwest Indiana have been extensively studied with respect to this temperature difference using satellite infrared imagery. Using the residual heat loss value related to 100 MW, and the subsequent urban/rural temperature difference, a representative population of 2,000,000 was used in AERMOD to simulate the strength of the local heat island effect. The urban treatment was limited to the smelter operations. A full discussion of the technical aspects of this approach is provided in Appendix B of Alcoa's DRR modeling protocol, included as Attachment B to the state submittal.[5] The Warrick Power Plant and nearby Culley Power Plant were modeled using rural dispersion. As discussed later in this document, the availability of an extensive air quality monitoring network focused on the Alcoa facility was useful in verifying the appropriateness of the use of urban and rural dispersion coefficients in this analysis.

The EPA agrees with the use of urban dispersion coefficients for the modeling of smelter operation emissions and the use of rural dispersion for all other sources.

2.4.3.3. Modeling Parameter: Area of Analysis (Receptor Grid)

The TAD recommends that the first step towards characterization of air quality in the area around a source or group of sources is to determine the extent of the area of analysis and the spacing of the receptor grid. Considerations presented in the Modeling TAD include but are not limited to: the location of the SO_2 emission sources or facilities considered for modeling; the extent of significant concentration gradients due to the influence of nearby sources; and sufficient receptor coverage and density to adequately capture and resolve the model predicted maximum SO_2 concentrations.

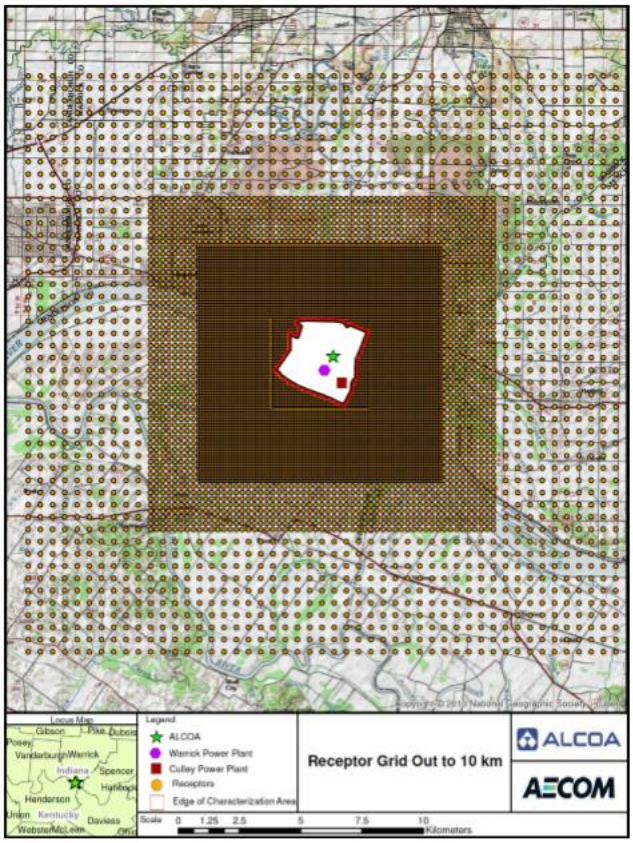
The sources of SO_2 emissions subject to the DRR in this area are described in the introduction to this section. The grid receptor spacing for the IDEM analysis focused on the Alcoa facility and is described as follows:

- 50m spacing at the ambient air boundary
- 100m spacing out to 3km
- 250m spacing out to 5 km
- 500m spacing out to 10 km

Figure 3 shows the IDEM area of analysis and receptor grid surrounding the Alcoa/Warrick facility.

[5] *See* Docket ID: EPA-HQ-OAR-2017-0003-0551

Figure 3. Receptor Network for Indiana's Modeling for the Warrick County Area



IDEM placed receptors for the purposes of this designation effort in locations that they consider ambient air relative to the modeled facility. Receptors were removed from facility locations, including the nearby Culley property. Receptors were also not placed over the Ohio River just to the south of the Alcoa facility, as recommended in the Modeling TAD.

In response to the EPA's comments[6] requesting justification and verification of the receptor grid proposed by the facility, IDEM submitted an attachment to their main document which describes in more detail how public access to the Alcoa/Culley facility property is precluded. The document notes fencing along the northern, western, and eastern boundaries of the property. Photographs are provided of the fencing near the Culley facility and on the western and northern boundary of the Alcoa property. Photographs of signage identifying Alcoa property are also included. The Ohio River is located immediately to the south of the facility. Security patrols are also discussed. The business relationship between Alcoa and Culley is discussed in detail. Alcoa and Culley co-own property to the east and southeast of the Alcoa operations. Based on the IDEM attachment[7], Culley has denied access to its property for purposes of air quality monitoring. Additionally, the attachment identifies areas near Culley and near the river that are not suitable for monitor placement. Given the combination of fencing, posting, control and ownership of land, and areas where monitor siting is not feasible, we agree with IDEM that

[6] *See* Docket ID: EPA-HQ-OAR-2017-0003-0516
[7] *See* Docket ID: EPA-HQ-OAR-2017-0003-0552

public access to the pertinent areas on Alcoa and Culley property is sufficiently precluded to public access and that Indiana has justified treating these areas as not being ambient air. Because these areas are not accessible to the public, it would not be reasonable to expect that a monitor would be placed at the site to assess air quality that could impact public health there. In addition, Culley has stated that it will not agree to site a monitor on its property, and the EPA does not consider the property of these plants or the locations on the Ohio River to be suitable or feasible locations to place a monitor. For these reasons, the EPA finds that Indiana has suitably excluded receptors consistent with the EPA's 2015 Guidance[8] that details how modeling can best be used to simulate a monitoring approach.

2.4.3.4. Modeling Parameter: Source Characterization

Section 6 of the Modeling TAD offers recommendations on source characterization including source types, use of accurate stack parameters, inclusion of building dimensions for building downwash (if warranted), and the use of actual stack heights with actual emissions or following GEP policy with allowable emissions.

Building Downwash

IDEM included buildings in the modeling for the Alcoa/Warrick facilities. The potline buildings were included for the potline stacks. Buildings were also included for the Warrick Power Plant and Culley Power Plant stacks. For the other more distant sources included in the modeling, building downwash was not included generally due to their large distance from the Alcoa sources.

The EPA agrees that including building downwash for the Alcoa, Warrick, and Culley sources is important and that not including downwash for distant sources will not significantly affect pertinent results and is reasonable. The EPA finds that IDEM properly accounted for downwash using BPIPPRM in this assessment.

Emission Releases

Emissions from the Alcoa power plant facility were represented through a variety of approaches. Emissions from the vent opening running along the top of the six potline buildings were modeled using AERMOD's Buoyant Line and Point Source (BLP) algorithm. Emissions from the building vent openings represent less than 5% of the smelter related emissions.

Emissions from the two Warrick Power Plant stacks were modeled as traditional point sources using hourly varying stack temperatures and velocities. Three units are exhausted through one 115-meter stack. Unit 4 is also exhausted through a 115-meter stack. The actual heights for the two stacks serving units 1-4 is 152 meters. The height of 115 meters represents the GEP (good engineering practice) stack height for those stacks. Use of the lower GEP heights could be considered a conservative approach, meaning use of the lower stack heights in the modeling may

[8] https://www.epa.gov/sites/production/files/2016-04/documents/20150320so2designations.pdf

produce higher concentrations (less dispersion) than what would be produced if using a taller stack. The Culley Power Plant was modeled using hourly varying stack temperatures and velocities. The modeled stack height for Culley was 137 meters. As with the Warrick stacks, this is shorter than the actual stack height of 152 meters. Again, the state followed a presumptively conservative approach by using the lower GEP stack height.

The smelter potline stacks were modeled two ways; the single stacks representing Potlines 3 and 4 were modeled as point sources using actual stack parameters. The stack arrays representing Potlines 2, 5, and 6 were modeled with individual stacks being merged. For Potline 2 stacks, 4 stacks were used to represent the 6 x 6 array of stacks. For Potlines 5 and 6, 6 stacks for each potline were used to represent the 3 x 12 adjacent arrays. Additionally, the 6 stacks associated with the western reactor of the bake furnace were merged into a single stack. Stack diameters and exit velocities for the stacks representing the merged stacks were modified to maintain equivalent flow rates. The merging of the stacks was justified based on the close proximity of the groups of stacks, the expectation that the collective heat release would yield enhanced plume rise, and most importantly, the use of the site-specific monitoring data showing that model performance was significantly improved when the potline array stack emissions were characterized through merging rather than each stack modeled separately.

The EPA agrees with the merging methodology used for the smelter and bake furnace stacks in this application.

Further explanation is warranted as to why Indiana collected site-specific monitoring data near Alcoa and how Indiana used these data. In 2015, in an effort to justify an alternative model proposal for use in a planned State Implementation Plan revision effort, the EPA, Alcoa, and IDEM agreed upon a monitoring network around the Alcoa facility that consisted of three fence line monitors in addition to a more distant, historic monitor location. The network was designed to measure peak concentrations coming from the Alcoa facility. Based on air quality modeling results, and information from previous short-term monitoring studies, peak concentrations were determined to be near the property boundary and the monitors were sited accordingly. The more distant monitor location (about 1 km northeast of the Alcoa property) had been used to measure peak impacts from the power plant operations. A meteorological tower was sited at the more distant monitor location. The network began operation in July 2015 and ended in February 2016. This provided the source with roughly 7 months of SO_2 monitoring and meteorological data.

During the DRR protocol development stage, Alcoa evaluated several modeling approaches that were under discussion, including: a regulatory default AERMOD run (rural dispersion, no stack merging, standard meteorological data); a run modeling all Alcoa facilities with urban dispersion, no stack merging, and meteorology using the Adj_U* option; a run modeling urban dispersion for all Alcoa facilities and a limited stack merging scenario along with the Adj_U* option; and runs looking at the power plant as urban and rural, along with additional merging of the smelter source stacks with the use of the Adj_U* option. The results of the analysis demonstrate the best model-to-monitor comparison occurs with the scenario using the added merging of stacks, urban dispersion for the smelter sources, rural dispersion for the power plants, and the Adj_U* option for meteorology. That scenario was subsequently selected and submitted by the state. The EPA generally found the network well designed for evaluating the ability of

AERMOD to obtain reliable estimates of maximum concentrations in the area using various stack characterizations and other model inputs, and so these model-monitor comparisons were an important factor in determining the comparative reliability of the Indiana analysis and the two Sierra Club analyses.

2.4.3.5. Modeling Parameter: Emissions

The EPA's Modeling TAD notes that for the purpose of modeling to characterize air quality for use in designations, the recommended approach is to use the most recent 3 years of actual emissions data and concurrent meteorological data. However, the TAD also indicates that it would be acceptable to use allowable emissions in the form of the most recently permitted (referred to as PTE or allowable) emissions rate that is federally enforceable and effective.

The EPA believes that continuous emissions monitoring systems (CEMS) data provide acceptable historical emissions information, when they are available. These data are available for many electric generating units. In the absence of CEMS data, the EPA's Modeling TAD highly encourages the use of AERMOD's hourly varying emissions keyword HOUREMIS, or through the use of AERMOD's variable emissions factors keyword EMISFACT. When choosing one of these methods, the EPA recommends using detailed throughput, operating schedules, and emissions information from the impacted source(s).

In certain instances, states and other interested parties may find that it is more advantageous or simpler to use PTE rates as part of their modeling runs. For example, where a facility has recently adopted a new federally enforceable emissions limit or implemented other federally enforceable mechanisms and control technologies to limit SO_2 emissions to a level that indicates compliance with the NAAQS, a state may choose to model PTE rates. These new limits or conditions may be used in the application of AERMOD for the purposes of modeling for designations, even if the source has not been subject to these limits for the entirety of the most recent 3 calendar years. In these cases, the Modeling TAD notes that a state should be able to find the necessary emissions information for designations-related modeling in the existing SO_2 emissions inventories used for permitting or SIP planning demonstrations. In the event that these short-term emissions are not readily available, they may be calculated using the methodology in Table 8-1 of Appendix W to 40 CFR Part 51 titled, "Guideline on Air Quality Models."

IDEM modeled the Alcoa facility using actual emissions from the years 2013-2015. The three-year average of the smelter related emissions modeled is approximately 3,416 tpy. The three-year average of the Warrick power plant emissions is roughly 4,535 tpy. Emissions for the individual years are listed in the table below.

IDEM modeled the Culley facility using actual hourly emissions from 2013-2015 as obtained from the EPA's Clean Air Markets Division (CAMD) database. The EPA confirmed the modeled emissions for the Culley plant match the facility total reported in CAMD.

Table 5. Actual SO_2 Emissions Between 2013 – 2015 from Facilities in the Warrick County Area

Facility Name	SO_2 Emissions (tpy)		
	2013	2014	2015
Alcoa Power Plant Totals[a]	5,707	4,992	2,906
Alcoa Smelter Operations Totals[a]	3,708	3,363	3,176
AEP Rockport[a]	51,640	54,985	29,892
Culley Power Plant[a]	1,948	1,896	1,513
Owensboro Municipal Utilities[a] (KY)	7,253	4,616	3,254
A.B. Brown[b]	9,453	9,453	9,453
Big Rivers Electric[c] (KY)	8,146	8,146	8,146
Century Aluminum[d] (KY)	2,053	2,053	2,053
Owensboro Grain[d] (KY)	438	438	438
Total Emissions from All Modeled Facilities in the Area of Analysis	90,346	89,942	61,031

[a] Based on HOUREMIS (hourly emissions) file submitted with the modeling.
[b] Emission equivalent of A.B. Brown SO_2 limits from Round 2 designation requirements.
[c] Constant modeled emission rate based on 2013 NEI emissions. NEI emissions were zero in 2015.
[d] Constant modeled emission rate based on average of 2013-2015 NEI emissions.

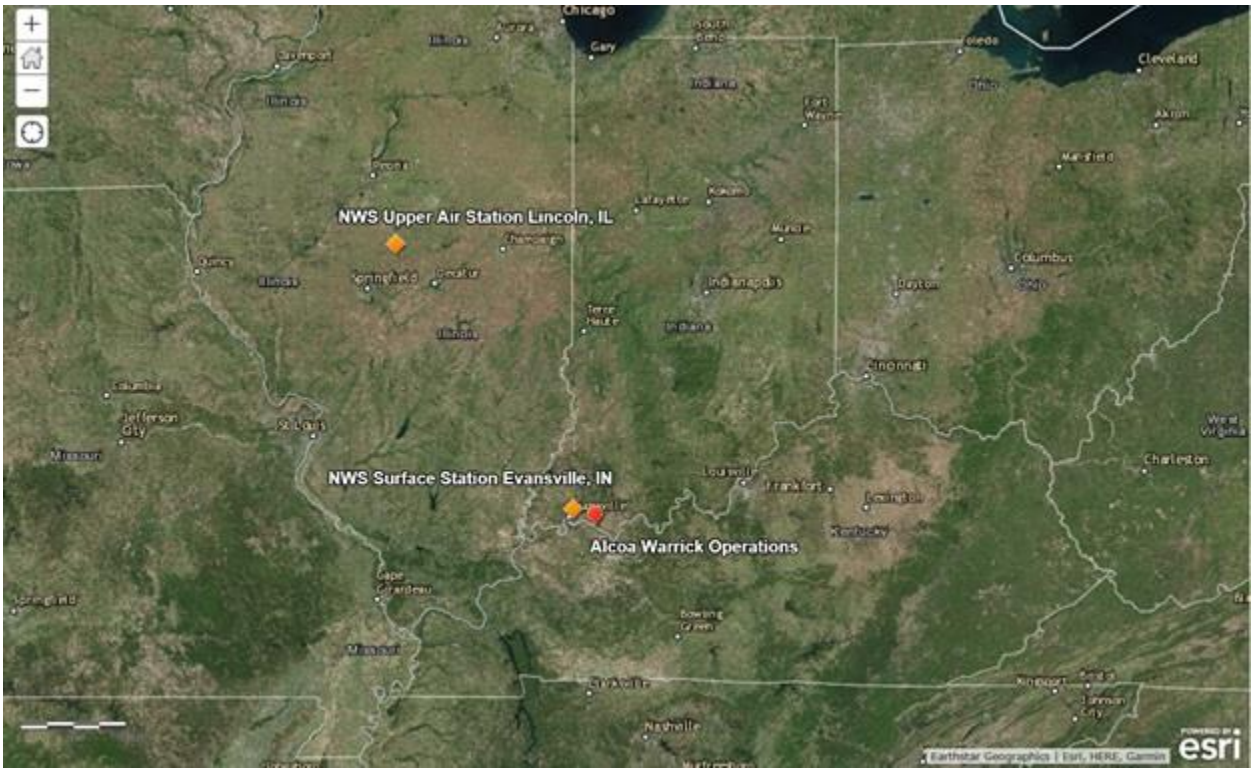
The EPA agrees with the emissions used in the Alcoa area analysis.

2.4.3.6. Modeling Parameter: Meteorology and Surface Characteristics

As noted in the Modeling TAD, the most recent 3 years of meteorological data (concurrent with the most recent 3 years of emissions data) should be used in designations efforts. The selection of data should be based on spatial and climatological (temporal) representativeness. The representativeness of the data is determined based on: 1) the proximity of the meteorological monitoring site to the area under consideration, 2) the complexity of terrain, 3) the exposure of the meteorological site, and 4) the period of time during which data are collected. Sources of meteorological data include National Weather Service (NWS) stations, site-specific or onsite data, and other sources such as universities, Federal Aviation Administration (FAA), and military stations.

For the Alcoa assessment, IDEM used the surface meteorology from the Evansville, Indiana, Regional Airport NWS site, located roughly 20 km northwest of the Alcoa facility. Upper air observations were taken from the Lincoln, Illinois, NWS site, located approximately 300 km northwest of the facility. The locations of the meteorological data sites are shown in Figure 4. The meteorological data was processed through AERMET by Alcoa's consultant.

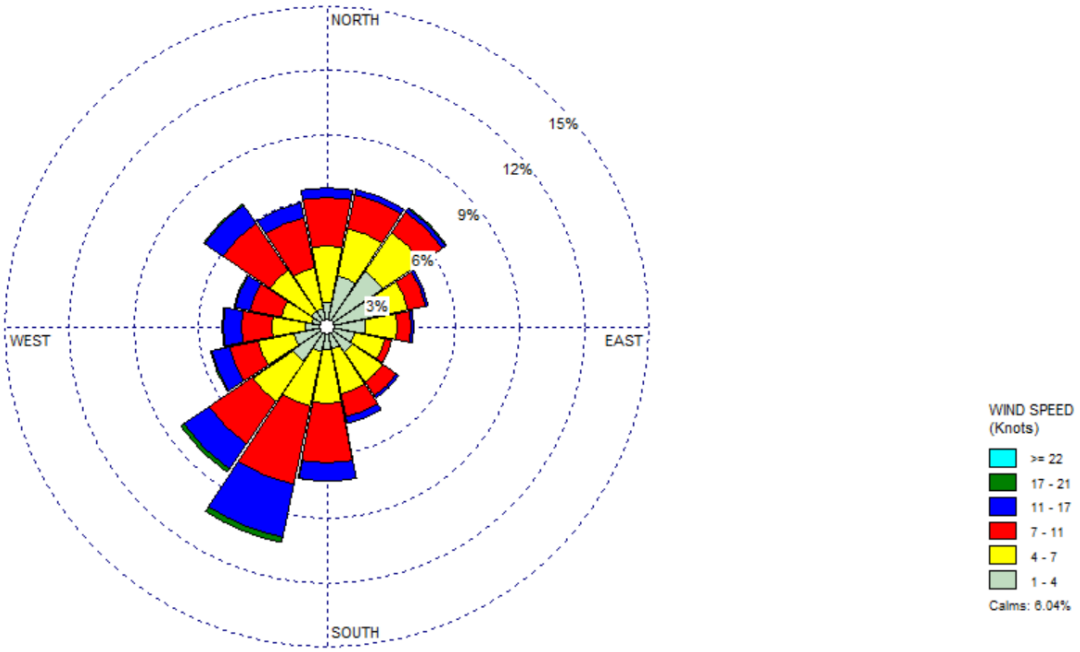
Figure 4. Area of Analysis and the NWS stations in the Warrick County Area



The meteorological data processed used AERSURFACE version 13016 using data from the Evansville, Indiana, Regional Airport NWS site, to estimate the surface characteristics (albedo, Bowen ratio, and surface roughness (z_o)) of the area of analysis. Albedo is the fraction of solar energy reflected from the earth back into space, the Bowen ratio is the method generally used to calculate heat lost or heat gained in a substance, and the surface roughness is sometimes referred to as "z_o." For the surface roughness, the year 2014 was run twice because the meteorological tower was moved on March 17, 2014, approximately 800 m to the northeast of the previous location. To account for this, the full year was run for both locations using AERSURFACE and AERMET. Then, the meteorological data files were combined representing conditions before and after the tower site move. Surface roughness values were estimated for 12 spatial sectors out to 1 km at a monthly temporal resolution.

Figure 5 shows the frequency and magnitude of wind speed and direction, defined in terms of from where the wind is blowing. Winds are predominantly from the southwest and northeast. The majority of hours over the 3-year period have wind speeds in the 4 – 12 mph range with a higher percentage of stronger winds coming from the southwesterly directions. The plot below shows calm winds (below 1 knot (1.15 mph)) represent about 6% of the hours.

Figure 5. Evansville, Indiana, NWS Cumulative Annual Wind Rose for Years 2013 – 2015



Meteorological data from the above surface and upper air NWS stations were used in generating AERMOD-ready files with the AERMET (version 16216) processor. The output meteorological data created by the AERMET processor is suitable for being applied with AERMOD input files for AERMOD modeling runs. AERMET was processed using the ADJ_U* keyword to account for increased surface friction velocity during light wind hours. This is an AERMOD regulatory option in the recently promulgated Appendix W Guideline on Air Quality Models. As noted above, the meteorological data was processed through AERMET by Alcoa and provided to IDEM for review. The surface and upper air meteorological files were submitted by IDEM with the modeling files.

Hourly surface meteorological data records are read by AERMET, and include all the necessary elements for data processing. However, wind data taken at hourly intervals may not always portray wind conditions for the entire hour, which can be variable in nature. Hourly wind data may also be overly prone to indicate calm conditions, which are not modeled by AERMOD. In order to better represent actual wind conditions at the meteorological tower, wind data of 1-minute duration was provided from the Evansville, Indiana, NWS station but in a different formatted file to be processed by a separate preprocessor, AERMINUTE version 15272. These data were subsequently integrated into the AERMET processing to produce final hourly wind records of AERMOD-ready meteorological data that better estimate actual hourly average conditions and that are less prone to over-report calm wind conditions. This allows AERMOD to

apply more hours of meteorology to modeled inputs, and therefore produce a more complete set of concentration estimates. As a guard against excessively high concentrations that could be produced by AERMOD in very light wind conditions, the state set a minimum threshold of 0.5 meters per second in processing meteorological data for use in AERMOD. In setting this threshold, no wind speeds lower than this value would be used for determining concentrations. This threshold was specifically applied to the 1-minute wind data.

Given the relatively flat terrain in this portion of Indiana and Kentucky and the proximity of the surface station to the Alcoa facility, the meteorological data used in the modeling is expected to be adequately representative of the conditions at the facility.

2.4.3.7. Modeling Parameter: Geography, Topography (Mountain Ranges or Other Air Basin Boundaries) and Terrain

The terrain in the area of analysis is best described as gently rolling. Elevations rise roughly 40-50 meters in a limited area to the northeast, within 5-10 km. The terrain is relatively flat in all other directions. To account for these terrain changes, the AERMAP (version 11103) terrain program was used to specify terrain elevations for all the receptors. The source of the elevation data incorporated into the model is from the National Elevation Database (NED) using the North American Datum 1983. The EPA has assessed this component of the state's modeling and concludes that it is appropriate.

2.4.3.8. Modeling Parameter: Background Concentrations of SO_2

The Modeling TAD offers two mechanisms for characterizing background concentrations of SO_2 that are ultimately added to the modeled design values: 1) a "tier 1" approach, based on a monitored design value, or 2) a temporally varying "tier 2" approach, based on the 99th percentile monitored concentrations by hour of day and season or month. For this area of analysis, the tier 2 approach was used based on concentrations from the Evansville Buena Vista Road monitor (18-163-0005). The monitor is located roughly 25 km west-northwest of the Alcoa Facility. Hour by day and seasonal values used in the assessment are listed in Table 6 below. This table shows values in ppb; in $\mu g/m^3$, these values correspond to a range from 4.5 $\mu g/m^3$ to 33.3 $\mu g/m^3$. The background values used in the Alcoa modeling assessment are appropriate.

Table 6. Temporally Varying Seasonal Background Values (ppb)

	Hr 1	Hr 2	Hr 3	Hr 4	Hr 5	Hr 6	Hr 7	Hr 8
Winter	5.0	4.2	3.6	5.6	4.5	4.5	4.4	5.2
Spring	3.6	5.0	3.4	3.5	3.3	6.7	5.8	5.4
Summer	2.5	1.8	1.7	1.7	1.7	2.3	2.4	4.4
Fall	3.5	3.4	3.0	3.5	4.2	4.2	4.7	4.6

	Hr 9	Hr 10	Hr 11	Hr 12	Hr 13	Hr 14	Hr 15	Hr 16
Winter	8.9	10.0	9.0	9.8	11.2	11.9	12.1	12.7
Spring	8.2	10.2	11.9	9.0	8.9	9.8	9.3	8.8
Summer	8.7	8.4	6.4	6.1	6.1	6.7	5.1	4.5
Fall	5.5	7.7	9.8	8.2	9.3	8.6	8.7	6.1

	Hr 17	Hr 18	Hr 19	Hr 20	Hr 21	Hr 22	Hr 23	Hr 24
Winter	11.2	10.4	8.3	9.6	6.9	8.0	6.0	11.2
Spring	10.5	9.2	6.8	6.6	4.8	2.4	4.9	10.5
Summer	5.4	5.8	6.0	4.6	3.3	1.9	2.7	5.4
Fall	6.2	5.7	4.3	5.7	4.2	3.3	3.7	6.2

2.4.3.9. Summary of Modeling Inputs and Results

The AERMOD modeling input parameters for the Alcoa facility area of analysis are summarized below in Table 7.

Table 7: Summary of AERMOD Modeling Input Parameters for the Alcoa Analysis

Input Parameter	Value
AERMOD Version	16216r
Dispersion Characteristics	Urban (smelter) and Rural
Modeled Sources	9
Modeled Stacks	32
Modeled Structures	21
Modeled Fencelines	1
Total receptors	12,221
Emissions Type	Actual (A.B. Brown allowable)
Emissions Years	2013-2015
Meteorology Years	2013-2015
NWS Station for Surface Meteorology	Evansville, IN NWS (KEVV)
NWS Station Upper Air Meteorology	Lincoln, IL NWS (KILX)
NWS Station for Calculating Surface Characteristics	Evansville, IN Tower
Methodology for Calculating Background SO_2 Concentration	Tier 2 - Values varying by season/hour-of-day Evansville Buena Vista Road (18-163-0005)
Calculated Background SO_2 Concentration	Range from 1.7 to 12.7 ppb

The results presented below in Table 8 show the magnitude and geographic location of the highest predicted modeled concentration based on the input parameters.

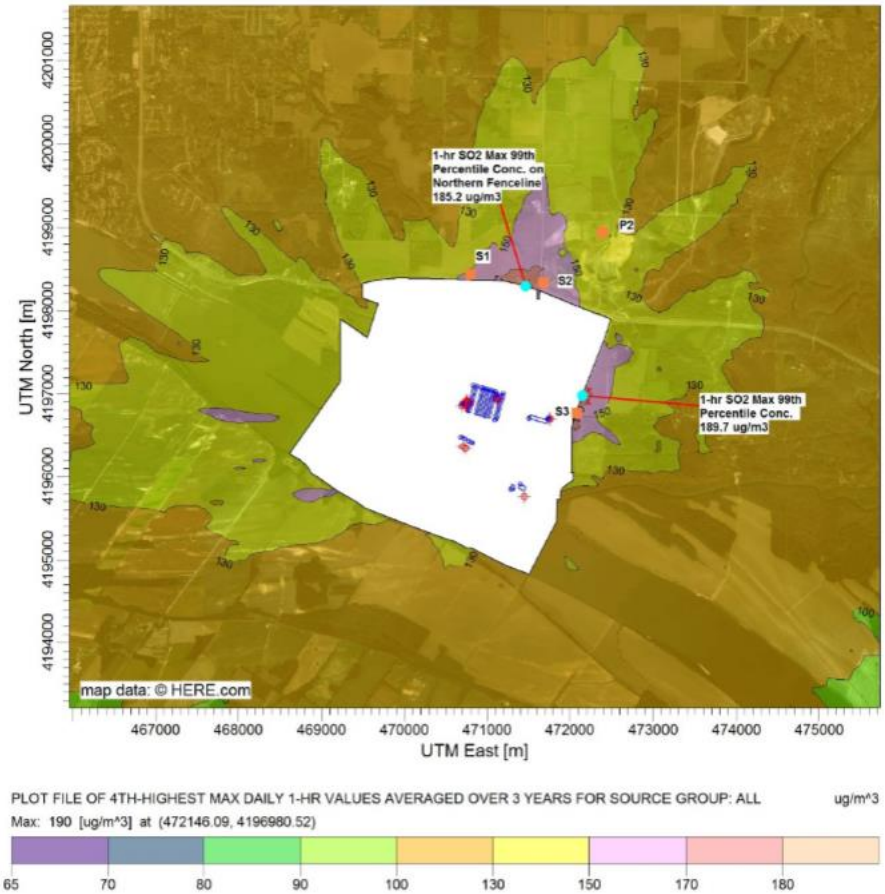
Table 8. Maximum Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentration Averaged Over Three Years for the Area of Analysis for the Warrick County Area

		Receptor Location UTM zone 16		99th percentile daily maximum 1-hour SO_2 Concentration ($\mu g/m^3$)	
Averaging Period	**Data Period**	**UTM Easting (m)**	**UTM Northing (m)**	**Modeled concentration (including background)**	**NAAQS Level**
99th Percentile 1-Hour Average	2013-2015	472146	4196980	189.7	196.4*

*Equivalent to the 2010 SO_2 NAAQS of 75 ppb, reflecting a 2.619 $\mu g/m^3$ per ppb conversion factor.

The IDEM modeling indicates that the highest predicted 99th percentile daily maximum 1-hour concentration within the chosen modeling domain is 189.7 $\mu g/m^3$, equivalent to 72.4 ppb. This modeled concentration includes impacts from nearby sources and the background concentration. Figure 6 below was included as part of IDEM's analysis, and shows that the predicted design value occurred just to the east of the Alcoa facility.

Figure 6. Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentrations Averaged Over Three Years for the Alcoa Area



From Page 6-2; AECOM "Modeling Report for the 1-hour SO_2 Data Requirements Rule." October 2017.

The modeling submitted by the state indicates that the 1-hour SO_2 NAAQS is attained at all receptors in the area.

2.4.3.10. The EPA's Assessment of the Modeling Information Provided by the State

The modeling submitted by IDEM for the Alcoa area followed the guidance as presented in the TAD. Where it varied from the TAD, theoretical and empirical evidence was provided by the company and the state to the EPA adequately justifying the methods. Specifically, the use of urban dispersion in modeling the smelter operation sources and the merging of stacks in the potline arrays was evaluated using assumptions about the impact of an industrial heat island but the results were also judged based on approximately 7 months of ambient monitoring data. In addition to Alcoa emissions, the modeling included larger sources of SO_2 within a substantial distance of the Alcoa facility. Appropriate meteorological data and background concentrations of SO_2 were incorporated into the modeling. For these reasons, the EPA agrees with the state's modeling of the Alcoa area and that it demonstrates that the 1-hour SO_2 NAAQS is attained in

this area.

2.4.4. Modeling Analysis Provided by Sierra Club

As noted above, in addition to the modeling analysis that Sierra Club submitted during the Round 2 designations process, focused on the A.B. Brown power plant, Sierra Club submitted an updated analysis focusing on concentrations in the area of the Alcoa facilities. This section 2.4.3 describes the relevant features of this analysis and provides a review. On October 19, 2017, Indiana also provided a review of this Sierra Club analysis; a discussion of the state's review is provided in section 2.4.4.10 below.

2.4.4.1. Model Selection and Modeling Components

The EPA's Modeling TAD notes that for area designations under the 2010 SO_2 NAAQS, the AERMOD modeling system should be used, unless use of an alternative model can be justified. The AERMOD modeling system contains the following components:

- AERMOD: the dispersion model
- AERMAP: the terrain processor for AERMOD
- AERMET: the meteorological data processor for AERMOD
- BPIPPRM: the building input processor
- AERMINUTE: a pre-processor to AERMET incorporating 1-minute automated surface observation system (ASOS) wind data
- AERSURFACE: the surface characteristics processor for AERMET
- AERSCREEN: a screening version of AERMOD

The Sierra club used AERMOD version 16216r. The AERMET version was 16216. A discussion of Sierra Club's approach to the individual components is provided in the corresponding discussion that follows, as appropriate.

2.4.4.2. Modeling Parameter: Rural or Urban Dispersion

For any dispersion modeling exercise, the determination of whether a source is in an "urban" or "rural" area is important in determining the boundary layer characteristics that affect the model's prediction of downwind concentrations. For SO_2 modeling, the urban/rural determination is also important because AERMOD invokes a 4-hour half-life for urban SO_2 sources. Section 6.3 of the Modeling TAD details the procedures used to determine if a source is urban or rural based on land use or population density.

For Sierra Club's Alcoa area modeling, a land use analysis for the 3-kilometer area surrounding the facility shows the area to be rural because less than 50% of the land use is classified as urban. Consequently, the modeling conducted by the Sierra Club used rural dispersion coefficients for all sources.

This approach differs from Indiana's, insofar as Indiana modeled Alcoa's potlines using urban dispersion parameters. The TAD and Appendix W modeling guidance both discuss methods available to determine whether urban or rural dispersion is most appropriate. The default

recommendation is to examine the land-use within a 3-kilometer radius of the facility as described above. A refined analysis, discussed in Appendix W Sections 7.2.1.1.c and d, takes into consideration the influence of isolated industrialized areas on the determination. The refinement resulted in an urban classification in the State modeling. In this case, the default approach used by the Sierra Club is acceptable and consistent with the general TAD recommendations. The state modeling approach is also acceptable as a refinement based on supplementary recommendations in Appendix W. Section 2.8 below discusses which approach provides a more reliable indication of air quality in and near Warrick County.

2.4.4.3. Modeling Parameter: Area of Analysis (Receptor Grid)

The TAD recommends that the first step towards characterization of air quality in the area around a source or group of sources is to determine the extent of the area of analysis and the spacing of the receptor grid. Considerations presented in the Modeling TAD include but are not limited to: the location of the SO_2 emission sources or facilities considered for modeling; the extent of significant concentration gradients due to the influence of nearby sources; and sufficient receptor coverage and density to adequately capture and resolve the model predicted maximum SO_2 concentrations.

The sources of SO_2 emissions subject to the DRR in this area are described in the introduction to this section. The grid receptor spacing for the Sierra Club analysis focused on the Alcoa facility and is described as follows:

- 100 m spacing, centered at the Alcoa operations and extending out 5 km
- 500 m spacing out to 10 km
- 1 km spacing out to 50 km

Sierra Club did not provide a map of its receptor network, but the area modeled, extending 50 km in each cardinal direction from Alcoa, includes all or part of Gibson, Pike, Dubois, Posey, Vanderburgh, Warrick, and Spencer Counties in Indiana, Union, Henderson, Daviess, Hancock, Webster, and McLean Counties in Kentucky, and smaller portions of several additional Indiana and Kentucky counties.

The Sierra Club receptor grid did not consider any facility fencelines. Consequently, receptors are placed throughout the Alcoa property, including areas that Indiana has justified as not being ambient air and where one would not place a monitor. Similarly, receptors were placed on locations over the Ohio River. The Sierra Club utilized “flagpole” receptors at a height of 1.5m.

The density and spatial extent of the Sierra Club receptor grid is appropriate. However, the inclusion of modeled receptors on fenced plant property would produce conservative results, leading to higher concentrations being identified as compared to modeling that removed receptors in locations that are not ambient air and/or where it would be infeasible to place a monitor consistent with the March 2015 Guidance. Additionally, the use of flagpole receptor heights is acceptable for use in designations modeling. However, the TAD notes that their use is not necessary and a receptor height other than ground level is not specified in Appendix W.

2.4.4.4. Modeling Parameter: Source Characterization

Section 6 of the Modeling TAD offers recommendations on source characterization including source types, use of accurate stack parameters, inclusion of building dimensions for building downwash (if warranted), and the use of actual stack heights with actual emissions or following GEP policy with allowable emissions.

Building Downwash

The Sierra Club modeling did not include building downwash except for the A. B. Brown facility. While exempting building downwash at modeled facilities that are a large distance from the source of interest is reasonable given the likely minimal impact, building downwash at the Alcoa facility, particularly around the smelting operations, is an important aspect of local dispersion and should be included in the modeling. In general, adding building downwash to the modeled analysis will increase concentrations as plume rise and dispersion are reduced. Sierra Club may not have had access to the necessary building information to include downwash around the Alcoa sources, but the EPA must nevertheless take into account the resulting effect on the reliability of the analysis.

Sierra Club's modeling simplified the smelter related releases by co-locating the smelter stacks at a single location. This would generally be a conservative approach, i.e. cause an overestimation in concentrations. The impacts of these modeling options are discussed more completely below.

Emission Releases

The Sierra Club modeling report discusses four emissions scenarios.

1) Emissions for 2013-2015 for
   - Alcoa Power Plant (CEMs)
   - A.B. Brown Power Plant (CEMs)
   - F.B. Culley Power Plant (CEMs)
   - Alcoa potline sources (actual annual average emissions)

2) Emissions for 2013-2015 for
   - Alcoa Power Plant (CEMs)
   - A.B. Brown Power Plant (allowable emissions)
   - F.B. Culley Power Plant (CEMs)
   - Alcoa potline sources (actual annual average emissions)

3) Emissions for 2014-2016 for
   - Alcoa Power Plant (CEMs)
   - A.B. Brown Power Plant (CEMs)
   - F.B. Culley Power Plant (CEMs)
   - Alcoa potline sources (actual annual average emissions)

4) Emissions for 2014-2016 for
   - the Alcoa Power Plant (CEMs)
   - A.B. Brown Power Plant (allowable emissions)
   - F.B. Culley Power Plant (CEMs)
   - Alcoa potline sources (actual annual average emissions)

Emissions from the two Warrick Power Plant stacks were modeled as traditional point sources with fixed stack temperatures and velocities. Each of the four units were modeled through an individual stack. Three units were exhausted through three 116-meter stacks. Unit 4 was modeled through a 152-meter stack. The 116-meter stack height actually represents what the GEP height would be for that stack. As with the state modeling, use of the lower stack height for those three units would produce conservative results (i.e. overestimation of concentrations). The Culley Power Plant was modeled with fixed temperatures and velocities through a 152 meter stack. A. B. Brown was modeled using fixed temperatures and velocities.

The array of stacks for potlines 2, 5 and 6, and the bake furnace, along with the single stacks for potlines 3 and 4 were all collocated at stacks located on the western edge of the smelter operation. Stack heights and diameters for each of the collocated stacks reflected the height and diameter of an individual stack from the potline array. Stack temperatures and velocities did vary for each of the collocated smelter stacks. The exit velocities used for each stack seem excessively high when compared to the exit velocities provided by the state and company. The exit velocities used in the state modeling were around 16 m/s for each of the 3 potline arrays of stacks. The Sierra Club modeling exit velocities for the 3 potline arrays were 49 m/s, 69 m/s, and 81 m/s. The exit velocity used by Sierra Club for potlines 3 and 4 which feature a taller stack was roughly twice the value used by the state. In general, a higher exit velocity would lead to higher plume rise and consequently would cause lower predicted concentrations as compared to a lower exit velocity. Emissions from the vent openings at the top of the long potline buildings were not modeled explicitly in AERMOD. The state used BLP to simulate these emissions. These emissions account for less than 5% of the total smelter related emissions.

The merging of the multiple stacks at the smelter and bake furnace operations into single, collocated stacks is a simplification that would generally result in higher maximum concentrations. However, given that downwash was not included and that exit velocities may be too high, it's difficult to tell whether the overall approach is overly conservative or not. With the resulting uncertainties, the modeling is a useful indication of air quality that the EPA would consider to be suitably in accordance with the Modeling TAD, though these uncertainties influence the EPA's judgment, discussed in section 2.8 below, as to whether the state's or Sierra Club's analyses provide a more reliable assessment of air quality in the area.

2.4.4.5. Modeling Parameter: Emissions

The EPA's Modeling TAD notes that for the purpose of modeling to characterize air quality for use in designations, the recommended approach is to use the most recent 3 years of actual emissions data and concurrent meteorological data. However, the TAD also indicates that it would be acceptable to use allowable emissions in the form of the most recently permitted

(referred to as PTE or allowable) emissions rate that is federally enforceable and effective.

The EPA believes that continuous emissions monitoring systems (CEMS) data provide acceptable historical emissions information, when they are available. These data are available for many electric generating units. In the absence of CEMS data, the EPA's Modeling TAD highly encourages the use of AERMOD's hourly varying emissions keyword HOUREMIS, or through the use of AERMOD's variable emissions factors keyword EMISFACT. When choosing one of these methods, the EPA recommends using detailed throughput, operating schedules, and emissions information from the impacted source(s).

In certain instances, states and other interested parties may find that it is more advantageous or simpler to use PTE rates as part of their modeling runs. For example, where a facility has recently adopted a new federally enforceable emissions limit or implemented other federally enforceable mechanisms and control technologies to limit SO_2 emissions to a level that indicates compliance with the NAAQS, a state may choose to model PTE rates. These new limits or conditions may be used in the application of AERMOD for the purposes of modeling for designations, even if the source has not been subject to these limits for the entirety of the most recent 3 calendar years. In these cases, the Modeling TAD notes that a state should be able to find the necessary emissions information for designations-related modeling in the existing SO_2 emissions inventories used for permitting or SIP planning demonstrations. In the event that these short-term emissions are not readily available, they may be calculated using the methodology in Table 8-1 of Appendix W to 40 CFR Part 51 titled, "Guideline on Air Quality Models."

As discussed above, the Sierra Club submitted four emissions scenarios, two scenarios each for the years 2013-2015 and 2014-2016. One scenario used actual emissions for all modeled sources and one scenario used actuals for all sources except A.B. Brown, where allowable emissions were used. The allowable emissions were based on the peak emission rate allowed for each unit in the current air quality permit. It should be noted that the potline emission totals used in the Sierra Club modeling and listed below are roughly 40% of what is reported in the 2014 NEI for these sources and also is about 40% of what the state used for potline emissions in their initial modeling.

The Sierra Club modeling included fewer nearby sources than the modeling submitted by the state. However, the sources that Sierra Club did not include, that were included in the state's modeling, are a sizable distance away from Alcoa. Any impacts from these sources should be captured in the added background SO_2 concentration used by Sierra Club, which was higher than that used by the state.

Table 9. Modeled Actual SO_2 Emissions Between 2013 – 2016 from Facilities in the Warrick County Area

Facility Name	SO_2 Emissions (tpy)*			
	2013	2014	2015	2016
Alcoa Power Plant Totals*	5707	4992	2906	3541
Alcoa Smelter Totals**	1371	1371	1371	1371
Culley Power Plant*	1947	1895	1513	1310
A.B. Brown Power Plant	6815	8079	6942	3854
Total Emissions from All Modeled Facilities	15840	16337	12732	10076

* Based on HOUREMIS (hourly emissions) file submitted with the modeling
** Based on AERMOD modeled emission rates.

Two of the modeled scenarios utilized allowable emissions for A.B. Brown. Those emissions equaled 9,421 tons per year for unit 1 and zero emissions for unit 2.

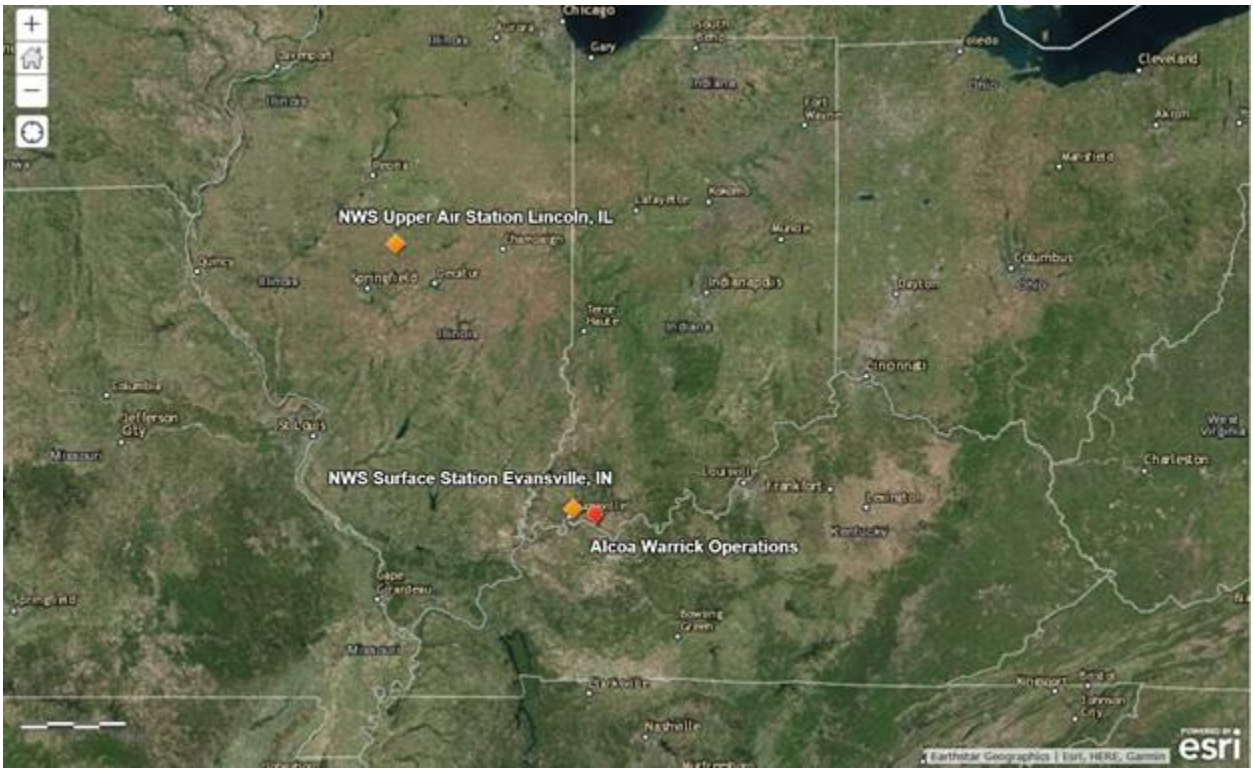
2.4.4.6. Modeling Parameter: Meteorology and Surface Characteristics

As noted in the Modeling TAD, the most recent 3 years of meteorological data (concurrent with the most recent 3 years of emissions data) should be used in designations efforts. The selection of data should be based on spatial and climatological (temporal) representativeness. The representativeness of the data is determined based on: 1) the proximity of the meteorological monitoring site to the area under consideration, 2) the complexity of terrain, 3) the exposure of the meteorological site, and 4) the period of time during which data are collected. Sources of meteorological data include National Weather Service (NWS) stations, site-specific or onsite data, and other sources such as universities, Federal Aviation Administration (FAA), and military stations.

For the Alcoa assessment, Sierra Club used the surface meteorology processed by IDEM from the Evansville, Indiana, Regional Airport NWS site, located at 38.050102 N and 87.514692 W, roughly 20 km northwest of the Alcoa facility. Upper air observations were taken from the Lincoln, Illinois, NWS site, located at 40.1494 N and 89.3373 W, approximately 300 km northwest of the facility.

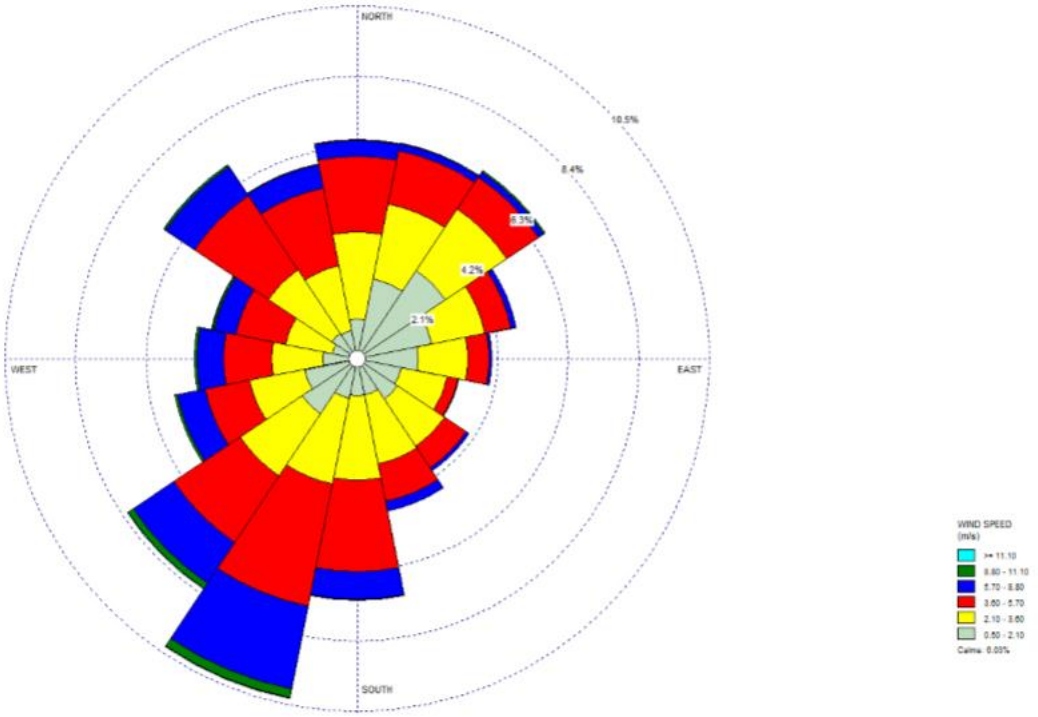
The Sierra Club used meteorological data processed by IDEM, which IDEM processed using the regulatory default ADJ_U* option. Details regarding the processing of the data by the state were not provided in the Sierra Club report. However, the report does mention the use of AERSURFACE to generate the surface characteristics that AERMET needs, namely surface roughness, albedo, and Bowen ratio. The land cover data was extracted from the U.S. Geological Survey's 1992 National Land Cover Dataset.

Figure 7. Area of Analysis and the NWS stations in the Warrick County Area



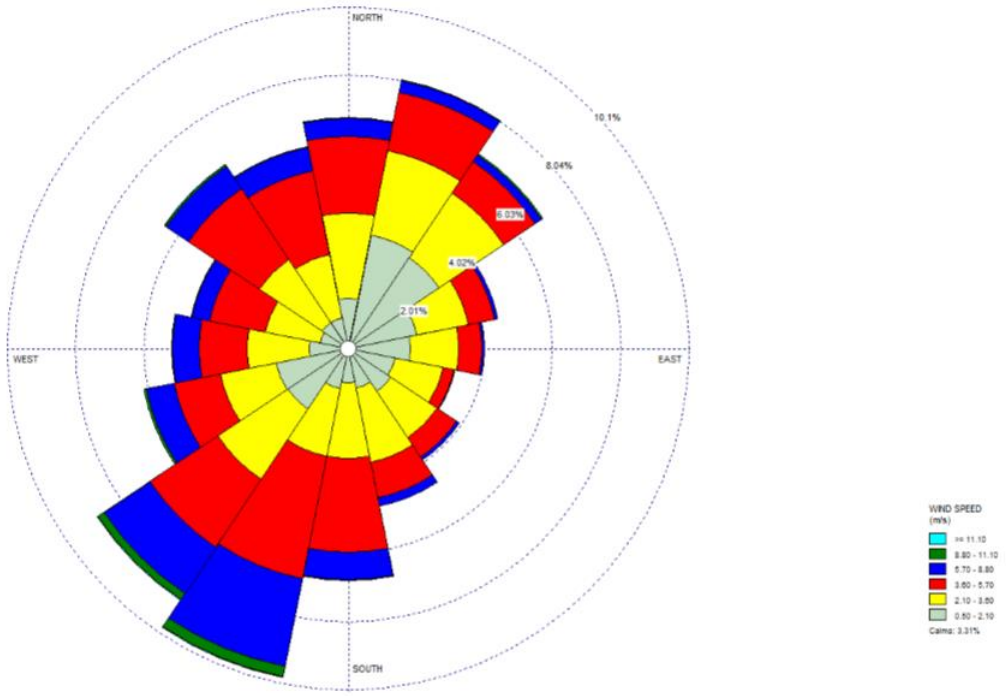
In Figures 8 and 9, showing wind roses for 2013 to 2015 and for 2014 to 2016, respectively, the frequency and magnitude of wind speed and direction are defined in terms of from where the wind is blowing. Winds are predominantly from the southwest and northeast. The majority of hours over the 3-year period have wind speeds in the 4 – 12 mph range with a higher percentage of stronger winds coming from the southwesterly directions. The plot below shows calm winds (below 1 knot (1.15 mph)) represent about 6% of the hours.

Figure 8: Evansville, Indiana, NWS Cumulative Annual Wind Rose for Years 2013 – 2015



Lakes Environmental WRPLOT

Figure 9: Evansville, Indiana, NWS Cumulative Annual Wind Rose for Years 2014 – 2016



Lakes Environmental WRPLOT

Based on the Sierra Club modeling report and our knowledge of IDEM's standard meteorological processing approach, meteorological data from the above surface and upper air NWS stations were used in generating AERMOD-ready files with the AERMET version 16216 processor. The output meteorological data created by the AERMET processor is suitable for being applied with AERMOD input files for AERMOD modeling runs. AERMET was processed using the ADJ_U* keyword to account for increased surface friction velocity during light wind hours. This is an AERMOD regulatory option in the recently promulgated Appendix W Guideline on Air Quality Models. As noted above, the meteorological data was generated by IDEM.

Hourly surface meteorological data records are read by AERMET, and include all the necessary elements for data processing. However, wind data taken at hourly intervals may not always portray wind conditions for the entire hour, which can be variable in nature. Hourly wind data may also be overly prone to indicate calm conditions, which are not modeled by AERMOD. In order to better represent actual wind conditions at the meteorological tower, wind data of 1-minute duration was provided from the Evansville, Indiana, NWS station but in a different formatted file to be processed by a separate preprocessor, AERMINUTE. These data were subsequently integrated into the AERMET processing to produce final hourly wind records of AERMOD-ready meteorological data that better estimate actual hourly average conditions and that are less prone to over-report calm wind conditions. This allows AERMOD to apply more

hours of meteorology to modeled inputs, and therefore produce a more complete set of concentration estimates. As a guard against excessively high concentrations that could be produced by AERMOD in very light wind conditions, the state set a minimum threshold of 0.5 meters per second in processing meteorological data for use in AERMOD. In setting this threshold, no wind speeds lower than this value would be used for determining concentrations. This threshold was specifically applied to the 1-minute wind data.

Given the relatively flat terrain in this portion of Indiana and Kentucky, the proximity of the surface station to the Alcoa facility, and the process used to generate the meteorological data, the surface and upper air data files used in the modeling are expected to be adequately representative of the area modeled by Sierra Club.

2.4.4.7. Modeling Parameter: Geography, Topography (Mountain Ranges or Other Air Basin Boundaries) and Terrain

The terrain in the area of analysis is best described as gently rolling. Elevations rise roughly 40-50 meters in a limited area to the northeast, within 5-10 km. The terrain is relatively flat in all other directions. To account for these terrain changes, the AERMAP version 11103 terrain program was used to specify terrain elevations for all the receptors. The source of the elevation data incorporated into the model is from the 30-meter resolution National Elevation Database (NED).

2.4.4.8. Modeling Parameter: Background Concentrations of SO_2

The Modeling TAD offers two mechanisms for characterizing background concentrations of SO_2 that are ultimately added to the modeled design values: 1) a “tier 1” approach, based on a monitored design value, or 2) a temporally varying “tier 2” approach, based on the 99th percentile monitored concentrations by hour of day and season or month. For this area of analysis, the Sierra Club, like the state, used a “tier 2” approach using a value that varies by season/hour-of-day. It is unclear whether the analysis removed any values that were impacted by explicitly modeled facilities, such as A.B. Brown. The monitor used is the Buena Vista Road monitor in Evansville (18-163-0005). Data was obtained for the years 2014-2016. Background values used in the modeling varied on a season/hour-of-day basis and ranged from 4.37 ppb to 33.27 ppb. The monitor is located roughly 25 km west-northwest of the Alcoa Facility.

The background values used by Sierra Club may be considered conservative (i.e. may double count some source impacts) and the EPA finds the values adequate for use in this analysis. Further discussion of the relative merits of Sierra Club’s values and Indiana’s values is provided in section 2.8 below.

2.4.4.9. Summary of Modeling Inputs and Results

The AERMOD modeling input parameters for the Alcoa facility area of analysis are summarized below in Table 10.

Table 10: Summary of AERMOD Modeling Input Parameters for the Alcoa Area Analysis

Input Parameter	Value
AERMOD Version	16216r
Dispersion Characteristics	Rural
Modeled Sources	4
Modeled Stacks	15
Modeled Structures	5 (only for A.B. Brown)
Modeled Fencelines	0
Total receptors	21,201
Emissions Type	Actual and Allowable
Emissions Years	2013-2015 / 2014-2016
Meteorology Years	2013-2015 / 2014-2016
NWS Station for Surface Meteorology	Evansville, IN NWS
NWS Station Upper Air Meteorology	Lincoln, IL NWS
NWS Station for Calculating Surface Characteristics	Evansville, IN Tower
Methodology for Calculating Background SO_2 Concentration	Tier 2 - Values varying by season/hour-of-day Evansville Buena Vista Road (18-163-0005)
Calculated Background SO_2 Concentration	Range from 4.37 to 33.27 ppb

The results presented below in Table 11 show the magnitude and geographic location of the highest predicted modeled concentration based on the input parameters for each of the four scenarios described above in section 2.4.4.4.

Table 11. Maximum Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentration Averaged Over Three Years for the Area of Analysis for the Warrick County Area Presenting Results for All Four Scenarios

		Receptor Location UTM zone 16		99th percentile daily maximum 1-hour SO_2 Concentration (µg/m^3)	
Averaging Period	**Data Period/Emissions**	**UTM Easting (m)**	**UTM Northing (m)**	**Modeled concentration (including background)**	**NAAQS Level**
99th Percentile 1-Hour Average	1. 2013-2015 Actual	470947	4196946	592.9	196.4*
	2. 2013-2015 Allow.**	470947	4196946	592.9	
	3. 2014-2016 Actual	470847	4197046	619.4[9]	
	4. 2014-2016 Allow.**	470847	4197046	619.4	

*Equivalent to the 2010 SO_2 NAAQS of 75 ppb, reflecting a 2.619 µg/m^3 per ppb conversion factor

**A.B. Brown is modeled with allowable emissions; all other sources are modeled with actual emissions.

The Sierra Club modeling indicates that the highest predicted 99th percentile daily maximum 1-hour concentration within the chosen modeling domain is 619.4 µg/m^3, equivalent to 236.5 ppb. This modeled concentration represented both scenarios for the years 2014-2016, i.e., actual emissions and actual emissions except allowable emissions for A.B. Brown. Results using the meteorology and emissions from 2013 to 2015 were slightly lower. All results included the background concentration of SO_2. Figures 10 through 13 below were included as part of the Sierra Club's analysis, showing a map of estimated concentrations for each of the four modeled scenarios, all indicating that the highest predicted values occurred on Alcoa property with relatively high concentrations also occurring about 3 km to the northeast of the Alcoa facility.

[9] These are results shown in modeling files provided by Sierra Club. Sierra Club's model report as contained in their comment letter lists slightly lower design values, namely 604.7 µg/m^3 and 604.8 µg/m^3, respectively.

Figure 10: Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentrations Averaged Over Three Years based on Scenario 1 Emissions

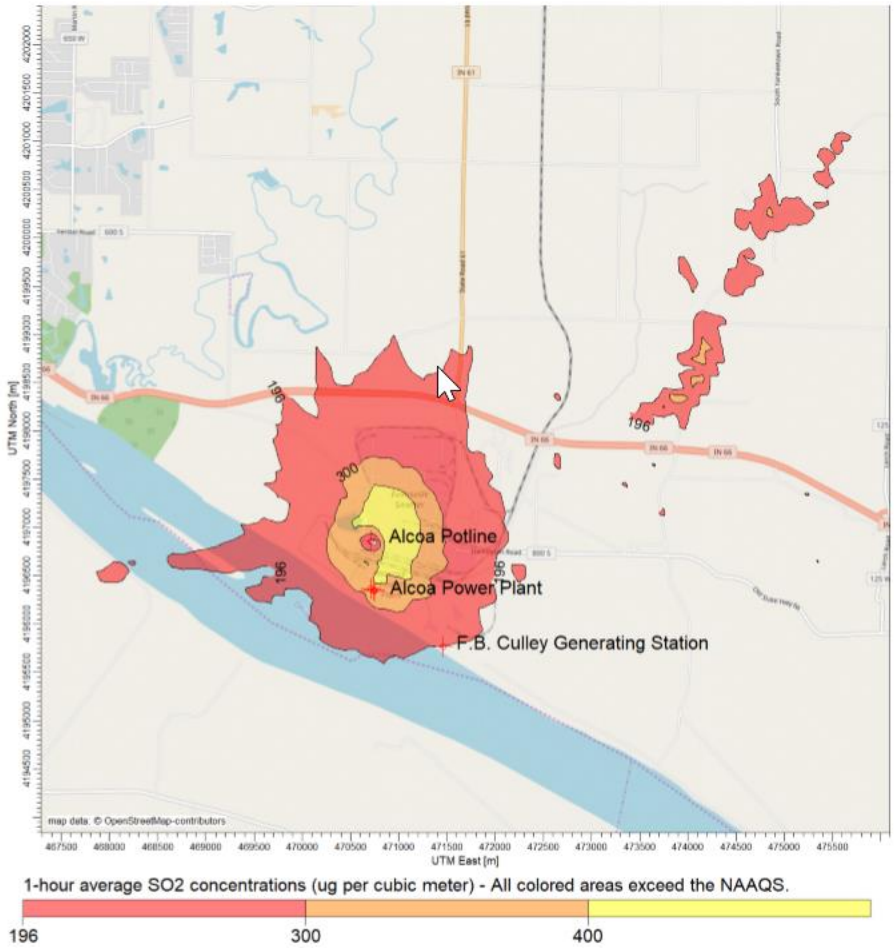


Figure 11: Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentrations Averaged Over Three Years based on Scenario 2 Emissions

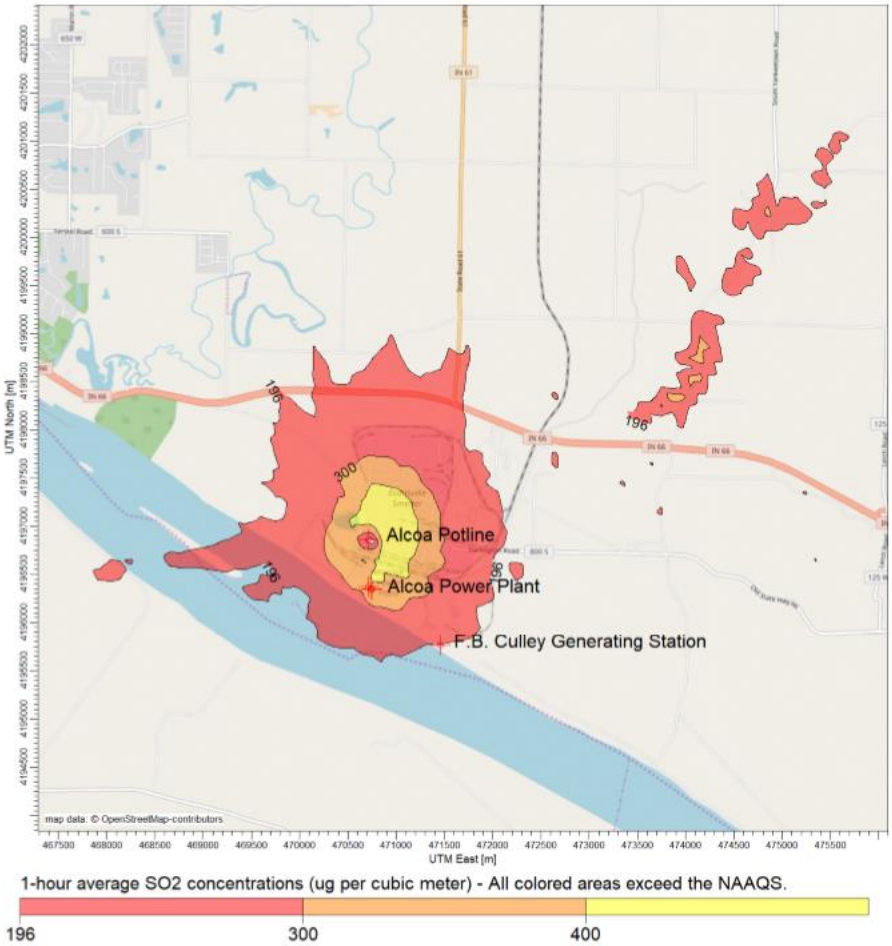


Figure 12: Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentrations Averaged Over Three Years based on Scenario 3 Emissions

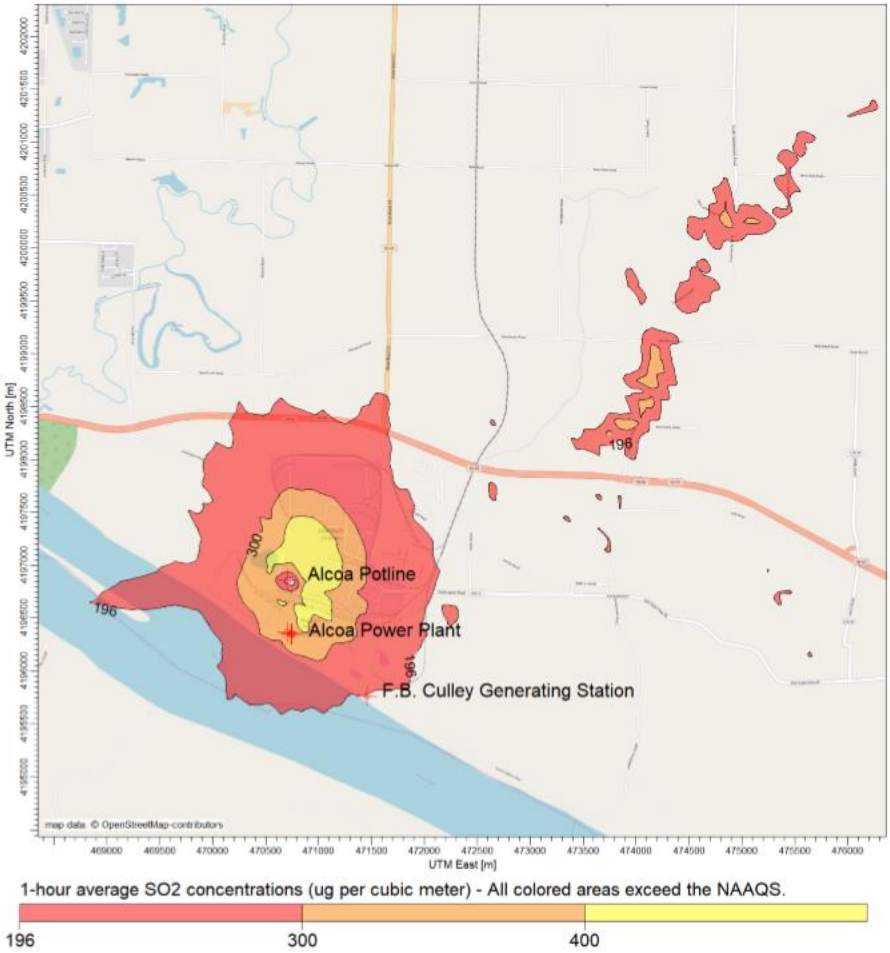
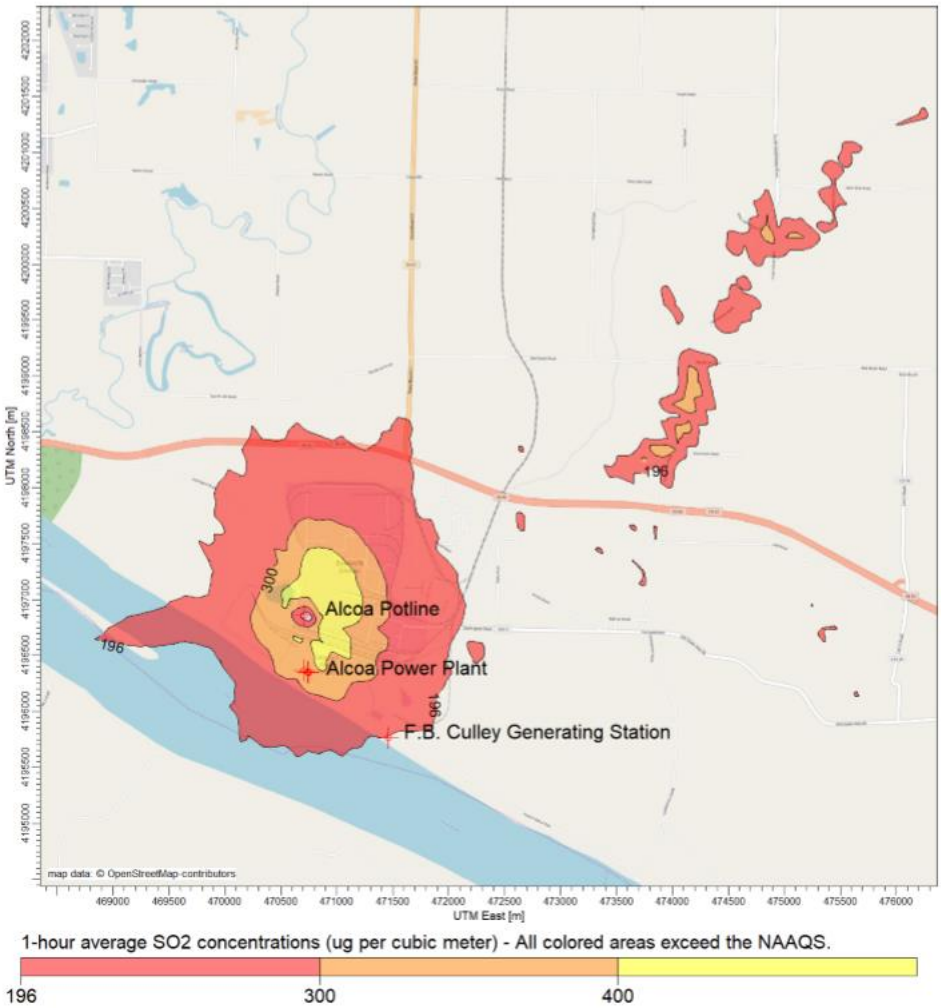


Figure 13: Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentrations Averaged Over Three Years based on Scenario 4 Emissions



2.4.4.10. Indiana's Review of the 2017 Sierra Club Modeling

The state submitted comments to the EPA on October 19, 2017, reviewing comments and updated modeling submitted by Sierra Club to the EPA on October 5, 2017. The Sierra Club initially conducted modeling in the Spring of 2016 for the A. B. Brown power plant. That modeling had a receptor grid extensive enough that it included modeled estimates in the area around the Alcoa facility. As discussed elsewhere in this chapter, the EPA based its intended nonattainment designation for portions of Warrick County on that modeling. The Sierra Club submitted updated modeling for the Alcoa area in October 2017. The following sections discuss the state's comments relative to the updated modeling performed by Sierra Club, first presenting the state's various comments and then providing the EPA's response.

The state referenced the air quality monitors that were sited around the Alcoa facility and operated for a 7-month plus period covering 2015-2016. The state compared Sierra Club

modeling results, at the locations of the monitors, and found the model predicted higher than measured concentrations ranging by a ratio from 1.2 to 3 times. The state claimed the Sierra Club modeling thus over-predicted actual concentrations.

The state agreed with the Sierra Club that dispersion modeling is an appropriate approach to determining attainment status. However, the state expressed concerns as to accuracy of the source characterization in Sierra Club's modeling.

The Sierra Club noted in their comments to the EPA that modeling for designation purposes must include large sources within the modeling domain, in addition to the DRR source(s). The state agreed with this and discussed how the state's modeling expanded the modeling inventory to include large sources, in accordance with the Modeling TAD.

The state noted that the Sierra Club did not submit a modeling protocol to the EPA for review prior to submission of any modeling assessments as was required of the state. Additionally, the state maintains that only through collaborative dialogue between the source, the state, and the EPA can modeling be conducted that best characterizes the emissions. They also asserted that the use of the existing monitoring data around Alcoa is a way to evaluate whether source characterization approaches were reasonable and similar to a model performance evaluation

The state agreed with the Sierra Club that the existing monitoring data around the Alcoa facility is not adequate to establish a 1-hour SO_2 design value to compare to the 1-hour SO_2 NAAQS.

The state disagreed with Sierra Club's statement that the EPA agreed to address modeled violations, indicated in Sierra Club's modeling submitted during the 2nd round, in the 3rd round of designations. The state clarifies that Alcoa was included under Round 3 of the DRR because its emissions exceeded the 2,000 ton per year threshold during the most recent year of data (2014). The state also commented that they do not agree with the EPA's assessment of the third-party modeling, or any third-party modeling, as being reliable due to the concerns regarding the accurate characterization of emissions in general, and the Alcoa emissions, in particular. The state claimed that an assessment should undergo regulatory protocol review in order to be used to judge attainment of any NAAQS.

The state further details comments pertaining to how the Sierra Club modeling characterized emission releases at Alcoa, particularly the potline stacks. The Sierra Club modeling used five stacks to represent the stack arrays at the 5 potlines. A single stack was also used to represent emissions from the bake furnace stacks. These 6 stacks were all placed in the same location. The state commented that the approach used by Sierra Club was inaccurate and leads to gross over-prediction, based on concentrating all the smelter emissions as arising from the same location. The state noted the substantial differences between the Sierra Club approach and the merged stack approach submitted by the state.

The state commented that the Sierra Club modeling did not include downwash, except for the

A.B. Brown facility. They further note that modeling without downwash is inconsistent with the Modeling TAD and constitutes an alternative model for which the Sierra Club did not get prior approval or concurrence.

The state claimed that use of flagpole height receptors, as was used in the Sierra Club modeling, is not consistent with EPA recommendations.

The state commented that while the Sierra Club used rural dispersion characterization for all sources in their modeling, the Alcoa smelter operations have been demonstrated to be better characterized as urban based on the heat generated and released at the smelting operations.

Lastly, the state commented that the Sierra Club modeling did not take into account areas at Alcoa where public access is precluded. That is, the Sierra Club modeling placed modeled receptors in locations that are not ambient air or where monitor siting is infeasible. This, according to the State, results in the maximum modeled impacts being "grossly overstated."

The EPA has reviewed the state's comments as part of its review of the 2017 Sierra Club analysis. Regarding source characterization, the state commented particularly on three main areas: dispersion coefficients, stack merging, and building downwash. As a default approach, the EPA agrees that a land-use analysis as suggested in Appendix W. Section 7.2.1.1.i, and used by the Sierra Club, is an acceptable method to determining whether an area should be modeled using rural or urban dispersion coefficients. However, Appendix W also allows for that determination to be refined based on industrial heat island effects. The state appropriately refined the analysis to consider the heat generated and lost by the Alcoa smelter operations. Thus, while either approach may be considered consistent with Appendix W, the state's approach is more refined and therefore more likely to provide a more reliable assessment of concentrations in the area.

On the issues involving stack merging and building downwash, it is acceptable for the Sierra Club to incorporate conservative aspects into their modeling methodology. However, based on the State's refined modeling, the EPA agrees with the state that the use of one collocated stack to represent the emissions coming from each of the six potline or bake furnace buildings leads to higher predicted concentrations than if modeled using the more credible state approach, all things being equal. The state also commented that the collocated approach led to gross over-predictions. While we agree the Sierra Club approach is an unrealistic simplification, it's unclear if the collocated stack method led to over-predictions given that building downwash was not modeled. Typically, collocating stacks and emissions would be a conservative approach for modeling a source. However, as the state also points out, the Sierra Club did not include building downwash for the smelter operations, which would have led to increased localized concentrations. Consequently, it is not clear whether Sierra Club's approach to source characterization was conservative, or instead may have under-estimated near-source concentrations. As noted in Section 2.4.3.4, the state also merged stacks but did so in a more spatially representative way that took into account the merging of plumes that can occur in

industrial heat island situations. Additionally, the approach was evaluated using monitoring data available from the site-specific monitoring network as discussed earlier in this document, which suggested that the state's approach was more reliable.

The state also conducted a comparison of Sierra Club modeled predictions using data from 2013-2015 at the locations of the four Alcoa monitors. The monitored concentrations represent a little more than seven months of data. The results showed the Sierra Club modeling predicted higher peak concentrations than the monitored values at the monitor locations. However, at the monitor location recording the highest concentration, the model-to-monitor ratio was 1.3. At two other fence line monitors, the ratios were 1.8 and 1.2. At the more distant monitor, which recorded the lowest concentration, the model-to-monitor ratio was 3. While each comparison showed modeled predictions higher than monitored, the concentrations compare quite reasonably with the exception of the more distant monitor comparison. However, peak off-property concentrations in the Sierra Club modeling occur several kilometers to the northeast which makes a direct fenceline model to monitor comparison appear less reliable.

While the EPA agrees that use of flagpole receptors is not specifically recommended, the Modeling TAD does not preclude their use. The Sierra Club used 1.5 meters to represent an average breathing height. The EPA's general guidance does not specify a height other than ground level (0 m), except in cases when bridges, balconies, rooftops, etc., must be evaluated. It is unlikely that this parameter significantly affected estimated concentrations.

The EPA disagrees with the state's general comment that any third-party modeling should not be considered reliable or that a protocol must be submitted in order to consider third-party modeling. For regulatory modeling purposes, a protocol is an important document to ensure that a modeling methodology is being developed that will be acceptable to reviewing authorities. Submittal of a modeling protocol facilitates discussions aimed at assuring the quality of submitted modeling, and for that reason the Data Requirements Rule included a requirement for states to submit modeling protocols for sources that the states elected to address through modeling. However, in evaluating the appropriate designations for Warrick County and elsewhere, the EPA must consider all available information, irrespective of whether a modeling protocol was submitted, and irrespective of who conducted the modeling.

Lastly, in their modeling, Sierra Club did not remove any receptors and modeled concentrations at all locations inside and outside the facility, including over water. While the state modeling appropriately excluded receptors from the areas to which public access is precluded and where it is infeasible to place a monitor consistent with the March 2015 Guidance, this difference does not make the Sierra Club modeling inconsistent with relevant EPA Guidance. Rather for the other reasons explained in this document, the EPA finds the state's modeling to be a more reliable indicator of current air quality in the area. Consistent with the EPA's March 2015 guidance and guidance on ambient air, the EPA believes that the designation of this and other areas should be based on air quality in areas that are ambient air and where monitoring is feasible.

2.4.4.11. The EPA's Assessment of the Modeling Information Provided by Sierra Club

The modeling submitted by Sierra Club indicates that the 1-hour SO_2 NAAQS is violated at numerous receptors in and around the Alcoa facilities, including locations precluded to public access or where it is infeasible to place a monitor. In particular, this modeling indicates that violations are primarily estimated to be occurring in Anderson Township, but this modeling also suggests that small portions of Ohio and Boon Townships are experiencing violations as well.

The Sierra Club modeling was generally conducted in accordance with the recommendations of the Modeling TAD but deviates in several significant ways. Firstly, the modeling does not include building downwash for any of the sources except A.B. Brown. Downwash is clearly an influence on impacts of the smelter emissions. Excluding building downwash in the modeling, keeping everything else equal, would lead to underestimating concentrations, especially close to the source. Sierra Club may not have had access to the necessary building information to include downwash around Alcoa, but the EPA must nevertheless take into account the resulting effect on the reliability of the analysis. Another aspect where the modeling deviates from standard modeling approaches is the collocation of 6 stacks representing the smelter operations, which is prone to overestimate impacts. Additionally, there is uncertainty regarding the appropriateness of the exit velocities used for the potline stacks. The collocated stack approach should provide a conservative estimate of modeled concentrations. However, it's unclear whether the overall approach to modeling the smelter operations is conservative or not given the lack of building downwash and the uncertainty of the stack exit velocities. Lastly, Sierra Club placed receptors in areas that the state has sufficiently justified as non-ambient (i.e. precluded to public access) or in areas where it would not be feasible to place a monitor consistent with the EPA's 2015 Guidance which states that receptors should only be placed in locations a monitor could be placed. Additionally, it would not be reasonable to expect that a monitor would be placed in locations to assess air quality that could impact public health where public access is precluded. As noted previously, while this aspect of the Sierra Club's modeling does not alone make it inconsistent with applicable EPA guidance, it does factor into the EPA's assessment of whether the state's or Sierra Club's modeling is most reliable for determining the area's air quality. The Sierra Club's inclusion of receptors in such locations resulted in predicted concentrations much larger than those predicted to occur outside such areas.

While the Sierra Club modeling provides reasonable evidence as to whether the area around the Alcoa facilities is violating the SO_2 standard, there are aspects of the methodology that fall outside our recommendations which must be considered in evaluating the relative merits of this modeling versus the state's modeling, as discussed in section 2.8 below.

2.5. Emissions and Emissions-Related Data, Meteorology, Geography, and Topography for the Warrick County Area

These factors have been incorporated into the air quality modeling efforts and results discussed above. The EPA is giving consideration to these factors by considering whether they were properly incorporated and by considering the air quality concentrations predicted by the modeling. The three modeling analyses that the EPA has received all use similar information on emissions, meteorology, geography, and topography in and near Warrick County.

2.6. Jurisdictional Boundaries in the Warrick County Area

Existing jurisdictional boundaries are considered for the purpose of informing the EPA's designation action for Warrick County. Our goal is to base designations on clearly defined legal boundaries, and to have these boundaries align with existing administrative boundaries when reasonable.

The EPA's intended boundaries for the Warrick County area were based on townships in the county, reflecting its view that some townships warranted a designation of nonattainment and other townships warranted a designation of unclassifiable/attainment. The EPA is now concluding, based on all available information, that air quality meets the standard in all of the county, including portions near the Alcoa facilities as well as in the remainder of the county. The state provided separate recommendations for designating separate portions of the county as attaining the standard. However, to reduce administrative burden or confusion, the EPA is instead designating the area as an area that includes the full county. Therefore, the EPA is designating a single attainment/unclassifiable area that includes the entirety of Warrick County.

2.7. Other Additional Information Relevant to the Designations for the Warrick County Area

The Indiana Chapter of the TSD for our intended designations, specifically Section 10 regarding Warrick County, reviewed Sierra Club modeling provided in 2016 and the limited monitoring data available for the area as provided by the state. This Chapter of the TSD for our final designations reviews Sierra Club modeling provided in 2017 as well as modeling submitted by Indiana. In addition, the EPA has monitoring data for a short period. The EPA has no other evidence that is similarly indicative of air quality in or near Warrick County.

Also relevant to the designation for Warrick County is whether sources in Warrick County contribute to violations elsewhere, i.e., whether some or all of Warrick County should be designated nonattainment due to contribution to violations elsewhere. Similarly, the EPA must consider the potential contribution of Warrick County sources to potential violations in areas that will remain undesignated even after these Round 3 designations. Although the EPA in Round 3 is designating most of the country that is not already designated, the EPA is not yet designating a modest number of areas where a new approved monitoring network has begun operation that will provide monitoring data to inform designations which must be promulgated by the end of 2020. The EPA cannot prejudge whether these areas will measure violations and warrant being designated as nonattainment, and the EPA also cannot prejudge precise boundaries of areas that

might be found either to be violating the standard or contributing to such potential violations. Nevertheless, in conjunction with waiting to designate areas that are newly monitoring air quality, the EPA is also determining whether available information indicates that areas being designated now contribute to nearby areas that violate the NAAQS. Thus, the EPA must evaluate whether available information indicates that Warrick County is presently contributing to concentrations that are over the standard in nearby areas.

The nearest area that is either already designated nonattainment or is being designated nonattainment in this Round 3 action is Pike and Daviess Counties, approximately 57 km north of the Alcoa facilities. At that distance, the EPA considers the Alcoa facilities (and neighboring Culley) neither to be contributing to nonattainment in that area or to be nearby to that area. Since the remainder of Warrick County has no sources emitting over 10 tons of SO_2 per year, the remainder of Warrick County also does not contribute to any current or Round 3 nonattainment areas. In addition, Kentucky has recently begun monitoring near a set of three DRR sources in Henderson and Webster Counties that are located approximately 32 km southwest of the Alcoa facilities. The EPA cannot prejudge whether this area will be found to violate the standard or what set of sources would be found to contribute to violations should they occur. Therefore, the EPA concludes that available information does not indicate that Warrick County is contributing to violations in Kentucky.

2.8. The EPA's Assessment of the Available Information for the Warrick County Area

As noted above, the EPA has received three separate modeling analyses of air quality in the Warrick County area. The first of these was submitted by Sierra Club during the development of Round 2 designations; this analysis was reviewed in the Indiana Chapter of the TSD for our intended designations. The second analysis was submitted by Sierra Club in response to the EPA's intended designation for Warrick County, and the third analysis was submitted by Indiana in response to the 120-day letter stating our intended designation for Warrick County; these analyses are reviewed in sections 2.4.2 and 2.4.3 above, respectively.

Also available were monitoring data from a network of four sites. Unfortunately, this network only operated for approximately 7 months, and no valid design value can be computed from any of these sites. Nevertheless, this network was established in part for purposes of evaluating model performance, and as previously mentioned these data provide a useful basis for evaluating the relative merits of the three modeling analyses addressing this area that the EPA has received.

Table 12 below summarizes the features of the three modeling analyses. This table is a compilation of the tables provided in the separate reviews of the respective analyses, compiling the summaries of features shown in Tables 7 and 10 above and Table 39 of the TSD for our intended designations (in Chapter 13, for Indiana). Besides facilitating comparison of these three analyses with respect to the parameters addressed in these other tables, Table 12 also shows values for additional parameters for which the three analyses differ significantly.

Table 12: Summary of Input Parameters for the Three Alcoa Modeling Analyses

Input Parameter	Indiana Values	SC 2016 Values	SC 2017 Values
AERMOD Version	16216r	15181	16216r
Dispersion Characteristics	Urban (smelter) and Rural	Rural	Rural
Modeled Sources	9	6	3
Modeled Stacks	32	22	15
Modeled Structures	21	5 (only for A.B. Brown)	5 (only for A.B. Brown)
Modeled Fencelines	1	0	0
Receptor Exclusions	Plant property, Ohio River	None	None
Receptor spacing near Alcoa facilities	50 m/100 m	1,000 m	100 m
Total receptors	12,221	21,201	21,201
Stack characterization for Potline 2	Merged 36 stacks into 4 for Potline 2	1 representative stack for each of the 5 potlines and bake furnace, all collocated	1 representative stack for each of 5 potlines and bake furnace, all collocated.
Stack characterization for Potlines 5 and 6	Merged 36 stacks into 6 for each of Potlines 5 and 6.		
Stack characterization for Potlines 3 and 4	Emitted through single stack. Used actual stack parameters		
Bake Furnace	Merged 6 stacks into 1		
Emissions Type	Actual (A.B. Brown allowable)	Actual and Allowable	Similar to Indiana*
Emissions Years	2013-2015	2012-2014	2013-2015 / 2014-2016
Potline Emissions (Average per year)	3,416 tpy	3,404 tpy	1,371 tpy
Meteorology Years	2013-2015	2012-2014	2013-2015 / 2014-2016
NWS Station for Surface Meteorology	Evansville, IN NWS (KEVV)	Evansville, IN NWS (KEVV)	Evansville, IN NWS (KEVV)
NWS Station Upper Air Meteorology	Lincoln, IL NWS (KILX)	Lincoln, IL NWS (KILX)	Lincoln, IL NWS (KILX)
NWS Station for Calculating Surface	Evansville, IN Tower (KEVV)	Evansville, IN Tower (KEVV)	Evansville, IN Tower (KEVV)

Characteristics			
Monitoring Site Used for Background Value	Buena Vista Road, site 18-163-0005	Buena Vista Road, site 18-163-0005	Buena Vista Road, site 18-163-0005
Methodology for Calculating Background SO_2 Concentration	Tier 2 - Values varying by season/hour-of-day, some wind directions removed to avoid double-counting.	Tier 2 - Values varying by season/hour-of-day	Tier 2 - Values varying by season/hour-of-day
Calculated Background SO_2 Concentration	Range from 1.7 to 12.7 ppb	Range from 1.0 to 19.76 ppb	Range from 4.37 to 33.27 ppb

* Smelter emissions were modeled as constant. IDEM's modeling varied smelter emissions monthly.

*Whereas Sierra Club's 2016 runs either modeled all sources with allowable emissions or modeled all sources with actual emissions, Sierra Club's 2017 runs modeled most sources with actual emissions (using either 2013 to 2015 emissions or 2014 to 2016 emissions), except that one pair of runs used actual emissions for A.B. Brown and another pair of runs used allowable emissions for A.B. Brown. The run using allowable emissions for A.B. Brown and 2013 to 2015 actual emissions for other sources most closely resembles the emission inputs of Indiana's analysis.

Several elements of this comparison warrant highlighting. All of these analyses used AERMOD, and in fact the state's analysis and Sierra Club's 2017 analysis both used the same version of AERMOD. Both the state's analysis and Sierra Club's 2017 analysis used the same 2013 to 2015 meteorological data. Sierra Club's 2017 analysis also used 2014 to 2016 meteorological data, runs which yielded results quite similar to the results of using 2013 to 2015 meteorological data. This suggests that the use of 2012 to 2014 meteorological data in Sierra Club's 2016 analysis is less significant that other differences between this analysis and the other two analyses.

However, other elements of the analyses are significantly different, in ways that are prone to yield substantial differences in concentration estimates. These are outlined as follows:
1) The state's modeling modeled most sources using rural dispersion coefficients but modeled the Alcoa smelter operations using urban dispersion coefficients with an effective population of 2 million.
2) The state's analysis excluded numerous receptors as not being ambient air locations (on plant property from which public access is precluded) and/or being locations where placement of a monitor would be infeasible (e.g., being over the Ohio River), whereas neither of Sierra Club analyses excluded any receptors. Sierra Club's 2016 analysis, being focused on the A.B. Brown facility, used 1000 meter receptor spacing near the Alcoa facilities, whereas Sierra Club's 2017 analysis used 100 meter receptor spacing near the Alcoa facilities, more similar to the mix of 50 meter and 100 meter spacing used by the state.
3) The state's analysis considered downwash for the Alcoa facility and other nearby facilities, whereas Sierra Club's analyses did not. (Sierra Club's analyses considered downwash for the A.B. Brown facility, but this factor may be presumed to have insignificant impacts on concentrations estimated in Warrick County.)
4) The state modeled the stacks from the various Alcoa potlines using substantial merging. In

particular, the state modeled Potline 2 using 4 stacks, each of which was modeled with the combined flow and heat flux of 9 actual stacks at this potline. Similarly, the state modeled Potline 5 using 6 stacks, each with the combined flow and heat flux of 6 stacks, and the state modeled Potline 6 the same way. The state modeled the bake furnace with 1 stack merging the flow and heat flux of the 6 stacks. Including Potlines 3 and 4, both represented by a single stack that the state modeled with actual conditions, the state used 18 stacks to represent the release of emissions from a total of 116 actual stacks. In contrast, Sierra Club used 6 collocated stacks, with temperatures and velocities representative of each potline and bake furnace, to represent the release of emissions from the 116 stacks.

As a general matter, all three of these analyses provide credible analyses of air quality in Warrick County that may be considered to be consistent with the Modeling TAD. Therefore, the determination of the EPA's best judgment as to air quality in Warrick County hinges on the evaluation of the relative merits of these three analyses, which in turn especially involves evaluating the relative merits of these different model inputs.

1) The land use near the Alcoa facilities is quite rural. However, as noted in section 7.2.1.1(d) of the Guideline on Air Quality Models, industrial areas with minimal population may nevertheless have urban dispersion conditions. This finding reflects studies showing that sources with substantial heat release may cause conditions that are best represented with urban dispersion coefficients. The smelting of aluminum ore that is conducted at Alcoa's Warrick Operations facility is a high temperature activity that is prone to cause substantial heat flux. Appendix B of Indiana's submittal, titled "Urban Characterization of Industrial Source Complexes for AERMOD Modeling", includes a determination that the dispersion environment at Alcoa's smelting operations is equivalent to conditions in an urban area with a population of two million people. Under these circumstances, the EPA believes that modeling of emissions from the potlines using urban dispersion parameters provides a more reliable assessment of concentrations than using rural dispersion parameters.

Although the potlines are in relatively close proximity to the Warrick power plant, Indiana has modeled the power plant using rural dispersion parameters. The EPA questioned this approach in its comments on a modeling protocol provided by Alcoa's consultant, a revised version of which was the basis for the state's modeling. The consultant's responses are provided in the state's submittal, stating that a modeling regime in which modeling sources other than the potlines using rural dispersion parameters provided for modeled concentration estimates that more closely replicated available monitoring data. Further review of this recommendation is given below.

2) A second significant difference among these analyses is the receptor network. The Modeling TAD provides the option of excluding receptors that are 1) not in ambient air, by virtue of being on plant property from which public access is precluded, or 2) over water bodies or other locations where monitoring is infeasible. Excluding receptors where one would not place a monitor in order for the modeling to better simulate a monitoring approach is consistent with the March 2015 Guidance. The merits of Indiana's exclusions are discussed in section 2.4.2.3 above, with a conclusion that Indiana has appropriately justified these exclusions.

It is the EPA's intent to designate areas according to air quality in locations that are ambient air

where monitoring is feasible. Therefore, irrespective of whether the available modeling runs exclude receptors elsewhere, i.e., irrespective of whether the available modeling runs exclude receptors in areas that are not ambient air and/or areas where placing a monitor is infeasible, the EPA intends not to consider air quality in these areas which under the March 2015 Designations Guidance (and Modeling TAD) may be excluded. As is discussed below, the concentrations that Sierra Club estimated within the area that Indiana excluded from its receptor network are substantially higher than the concentrations that Sierra Club estimated outside that area, so that this difference in analyses explains a substantial portion of the difference in modeling results between Indiana's modeling and the Sierra Club modeling.

Sierra Club's 2016 analysis used much more widely spaced receptors in Warrick County than its 2017 analysis or the state's analysis. This would be expected to lead to an underestimation of maximum concentrations, and yet this analysis yielded the highest design concentration. Sierra Club's 2017 analysis used receptor spacing similar to that in the state's analysis. Thus, the difference in receptor spacing may have made minimal difference to estimated maximum concentrations.

3) A third difference among these analyses is the treatment of building downwash. The modeling protocol provided by Alcoa's consultant proposed not to consider downwash, and an important improvement in the final modeling analysis developed by the consultant and (with minor revisions) submitted by the state in response to the EPA comments, was to incorporate consideration of downwash. In this respect, the state submittal is much more reliable than the Sierra Club analyses, which did not consider downwash in the area of the Alcoa facilities. Sierra Club may not have had access to the necessary building information to include downwash around the Alcoa sources, but the EPA must nevertheless take into account the resulting effect on the reliability of the analysis. Consideration of downwash generally yields higher concentration estimates relatively near to a source, and yet the Sierra Club analyses yielded higher concentration estimates than the state's analysis. Thus, the significance of this difference in the analyses is not clear.

4) A fourth difference involves the source characterization of the potline stacks. Under ordinary circumstances, the ideal means of estimating impacts of emissions from these 116 stacks would be to model 116 separate emission points, and for pragmatic purposes the modeler would typically seek to identify a configuration of a smaller number of stacks with similar release parameters and the same total emissions that would be expected to yield approximately the same estimated impact as the real stack configuration. The Sierra Club's analyses apply this approach, although the use of a single stack for each potline to represent the multiple stacks at three of the five potlines, and the collocation of these modeled stacks, is prone to be an oversimplification that reduces the reliability of the analysis.

Indiana has provided evidence that typical approaches to representing the impact of emissions of multiple similar stacks are prone to provide less reliable representation of the impacts of these emissions in this case. As discussed above, Indiana has provided justification that representing multiple stacks at three of these potlines and at the bake furnace with a smaller number of stacks is prone to yield more reliable concentration estimates.

Table 13 summarizes the results of the three analyses that the EPA has received. Although the two Sierra Club analyses both included more than one model run, Table 13 shows a single result selected as the most pertinent. The 2016 Sierra Club analysis included a model run using actual emissions and a model run using allowable emissions. Table 13 shows results for the run with actual emissions because this run is more consistent with the recommendations of the Modeling TAD for assessing current actual air quality. The 2017 Sierra Club analysis included a pair of runs for 2013 to 2015 and a pair of runs for 2014 to 2016, each pair consisting of one run with all sources modeled with actual emissions and one run modified to simulate the A.B. Brown facility's allowable emissions. Table 13 shows results for the run with 2013 to 2015 meteorological data and allowable emissions for A.B. Brown, because this run is most comparable to the Indiana run, although the results of the other runs (presented in section 2.4.4.9, Table 11 above) are similar, showing no significant effect of A.B. Brown emissions and showing slightly higher concentrations for 2014 to 2016 than for 2013 to 2015. For comparison purposes, Table 13 also shows the design concentration from the 2017 Sierra Club modeling looking only at the area that Indiana included in its analysis, i.e., excluding areas determined not to be ambient air and/or determined not to be a feasible monitoring location, again from the run using 2013 to 2015 meteorological data and allowable emissions from A.B. Brown.

Table 13. Maximum Predicted 99th Percentile Daily Maximum 1-Hour SO_2 Concentration Averaged Over Three Years for the Area of Analysis for the Warrick County Area

		Receptor Location UTM zone 16		99th percentile daily maximum 1-hour SO_2 Concentration ($\mu g/m^3$)	
Modeling Run	**Data Period**	**UTM Easting (m)**	**UTM Northing (m)**	**Modeled concentration (including background)**	**NAAQS Level**
Indiana	2013-2015	472146	4196980	189.7	196.4*
2016 Sierra Club	2012-2014	474153	4198593	1,197	196.4*
2017 Sierra Club (AB Brown allowable)	2013-2015	470947	4196946	592.9	196.4*
2017 Sierra Club (AB Brown allowable; in area modeled by Indiana)	2013-2015	474847	4200246	320.0	196.4*

*Equivalent to the 2010 SO_2 NAAQS of 75 ppb, reflecting a 2.619 $\mu g/m^3$ per ppb conversion factor

Based on the review provided in section 10.3 of Chapter 13 of the TSD for our intended designations (reviewing the 2016 Sierra Club analysis), section 2.4.3 above (reviewing Indiana's analysis), and section 2.4.4 above (reviewing the 2017 Sierra Club analysis), the EPA finds that all three analyses may be considered to have been conducted reasonably in accordance with the Modeling TAD. Nevertheless, as just noted, these analyses have significant differences and yield

significantly different results. Thus, in order to determine the appropriate designation for this area, the EPA must determine which of these analyses most reliably assesses air quality in the area.

In assessing the relative merits of these disparate analyses, the EPA considered the challenges of modeling Alcoa's smelting operations. The EPA recognizes the fact that high temperature operations like this smelting facility can create heat flux that results in dispersion conditions more similar to those in an urban heat island than to those in rural areas. However, the characterization of dispersion in such circumstances is subject to substantial uncertainty. Likewise, the heat flux in and around the multiple stacks exiting three of the potlines can lead the plumes from the multiple stacks to merge, behaving to some degree as if the emissions and heat flux from multiple stacks had been emitting from a single merged stack, and yet the most appropriate means of addressing this situation can be difficult to determine.

Under these circumstances, the monitoring data provided valuable information regarding the performance of alternate means of characterizing dispersion of the Alcoa emissions. Although the monitoring data are only available for approximately 7 months, and thus are insufficient for calculating a design value or otherwise using independently, the network is well designed to measure maximum concentrations in the area, and so these data are sufficient for informing an assessment of alternate approaches for simulating dispersion of the Alcoa emissions. As part of the model protocol, Alcoa's consultant provided a comparison[10] of model results against the available monitoring data for several modeling approaches. This comparison indicates that the conventional modeling approach used by Sierra Club is prone to overestimate concentrations, and that Indiana's modeling approach provides a more reliable assessment of concentrations in the area. In addition, the EPA finds Indiana's approaches to determining model inputs to provide plausible means of simulating dispersion of these sources' emissions. Therefore, the EPA considers Indiana's assessment to provide the most reliable assessment of SO_2 air quality in the Warrick County area. This assessment demonstrates the area is attaining the standard. On this basis, the EPA is designating the Warrick County area as attainment/unclassifiable for the 2010 SO_2 standard.

In its 120-day letters, the EPA expressed intent not only to designate portions of Warrick County as nonattainment but also to designate portions of Henderson County, Kentucky, as unclassifiable, in both cases based on evidence from the 2016 Sierra Club modeling that these areas are or may be violating the standard, respectively. However, the EPA considers Indiana's modeling to provide better characterization of air quality in nearby portions of Henderson County, Kentucky, as well as in modeled portions of Warrick County than the 2016 Sierra Club modeling. Indiana's modeling shows that this area, as well as the modeled area in Warrick County, is attaining the standard. Therefore, the EPA now believes that available information does not indicate that Warrick County is contributing to NAAQS violations in the nearby portions of Henderson County, Kentucky.

As discussed in the Kentucky Chapter of the TSD for our final designations (Chapter 15), the EPA is not designating portions of Henderson and Webster Counties, Kentucky, at this time pending data collection at a newly established monitoring site. The Kentucky Chapter also notes

[10] See Docket ID: EPA-HQ-OAR-2017-0003-0517

that the EPA is designating the portions of Henderson County that are near the Alcoa facilities as attainment/unclassifiable, based on the review provided in this Chapter 13 of the TSD (addressing Indiana).

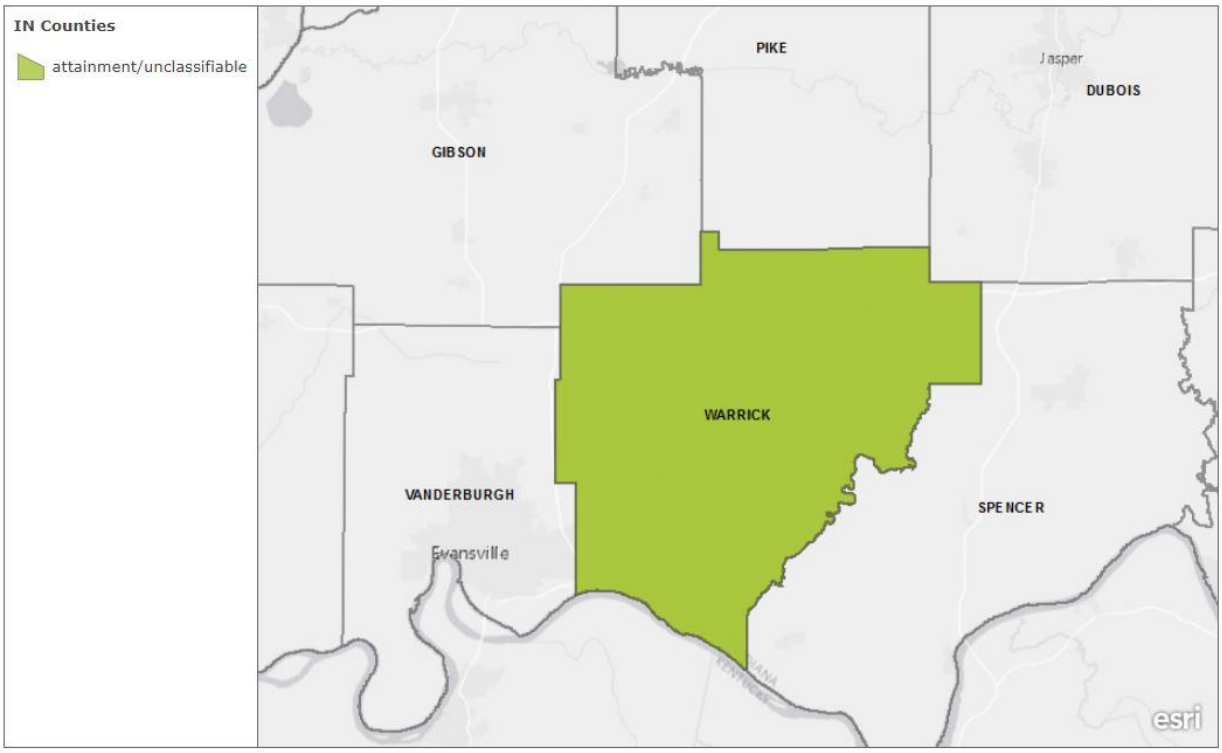
Based on this information, the EPA believes that the area modeled by Indiana is attaining the SO_2 standard. This area included approximately the southern third of Warrick County, as well as portions of neighboring counties noted above. Since no significant sources exist elsewhere in Warrick County or in its immediate vicinity, Indiana's modeling also supports the view that the entirety of Warrick County is attaining the standard. Therefore, the EPA is designating the entirety of Warrick County as a single final attainment/unclassifiable area. The EPA believes that this area has clearly defined legal boundaries, and we find these boundaries to be a suitable basis for defining our final attainment/unclassifiable area.

2.9. Summary of Our Final Designation for the Warrick County Area

After careful evaluation of the state's recommendation and supporting information, as well as all available relevant information, the EPA is designating Warrick County as attainment/unclassifiable for the 2010 SO_2 NAAQS because the most reliable available evidence indicates that this area is attaining the standard and does not indicate that the area contributes to any nearby areas that do not meet the NAAQS. The EPA finds that modeling provided by the state, indicating attainment around the Alcoa facilities, is a more reliable assessment of air quality than the two modeling analyses provided by Sierra Club. The EPA also finds that the remainder of the county has less potential to violate the standard, so that the finding of attainment in the southern portion of Warrick County (and in nearby portions of Henderson County, Kentucky) signifies that the remainder of Warrick County is attaining the standard as well. Designating the entirety of Warrick County as a single attainment/unclassifiable area will reduce administrative burden or confusion than would designating southern portions of the county separately from the remainder of the county. Therefore, the EPA is designating a single attainment/unclassifiable area consisting of the entirety of Warrick County.

Figure 14 shows the boundary of this final designated area.

Figure 14. Boundary of the Final Warrick County Attainment/Unclassifiable Area



Esri, HERE, Garmin, NGA, USGS, NPS | Esri, HERE, NPS

At this time, our final designations for the state apply to this area and the other areas presented in the TSD for our intended designations (Chapter 13, specific to Indiana). This action addresses all portions of Indiana that were not previously designated except for Porter County, which timely began operation of a new, approved monitoring network meeting EPA specifications in the SO_2 DRR. The EPA intends in a separate action to evaluate and designate this one remaining undesignated area in Indiana by December 31, 2020.