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ALCOA Modeling Report for the 1-hour SO_2 Data Requirements Rule

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Modeling Report for the 1-hour SO_2 Data Requirements Rule

Alcoa Warrick Operations, Warrick Power Plant, and Culley Generating Station

Alcoa Warrick LLC
Newburgh, Indiana

Project Number: 60537431.2

October 2017

Quality information

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1. Introduction and Summary

1.1 Background

The United States Environmental Protection Agency (EPA) promulgated a 1-hour National Ambient Air Quality Standard (NAAQS) for SO_2 in 2010. The 1-hour SO_2 NAAQS is set to 75 ppb and the form of the standard is the average of the 99th percentile of the daily maximum 1-hour average concentrations realized in each of three consecutive calendar years (the “design value,” or DV).

The EPA is implementing the 2010 1-hour SO_2 NAAQS in an approach that involves either a dispersion modeling or monitoring approach to characterize local SO_2 concentrations near isolated emission sources. EPA’s Data Requirements Rule (DRR) was finalized on August 21, 2015 and two sources in Indiana that are subject to the DRR provisions are the Alcoa Warrick aluminum smelter and the adjacent Alcoa Warrick Power Plant, since both of these facilities have had annual SO_2 emissions in excess of 2,000 tons in recent operating years. Indiana elected, and Alcoa agreed, that the appropriate approach to characterize SO_2 concentrations in the vicinity of its facilities in Warrick County is modeling. The modeling approach has been guided, in part, by the results of an SO_2 monitoring field study conducted during portions of 2015 and 2016 in the vicinity of these sources which has indicated SO_2 concentrations well below the NAAQS. This study has supported a site-specific characterization of the smelter sources (while not altering the guideline model, AERMOD) for this modeling application, and it employs new modeling approaches recently promulgated in 2017 with Appendix W (EPA’s modeling guideline). The modeling procedures are described in a modeling protocol[1] submitted in September 2017 to the Indiana Department of Environmental Management (IDEM) and EPA.

This document describes the results of the DRR modeling that characterize the SO_2 concentrations in the vicinity of the Alcoa facilities. In an appendix to the separately-submitted protocol[1], we provided the results of an evaluation of the modeling approach using the recently-collected field data at 4 monitors in the vicinity of the Alcoa sources to support the modeling approach used in this analysis.

1.2 Summary of Modeling Results

AECOM modeled Alcoa’s Warrick aluminum smelter and the adjacent Alcoa Warrick Power Plant as well as cumulative background sources within 50 kilometers of the Alcoa Warrick operations for the 1-hour SO_2 Data Requirements Rule (DRR). The background sources included the nearby Culley Power Plant and other regional emission sources provided by IDEM. The modeled maximum design concentration is 189.7$\mu g/m^3$, which is below the NAAQS of 196.5 $\mu g/m^3$. This modeled impact occurs along the eastern fence line. A secondary modeled maximum concentration region of 185.2 $\mu g/m^3$ occurs along the northern fence line. These peak modeled concentrations are very close to the monitors that were deployed in 2015 and 2016.

1.3 Document Organization

Section 2 provides a discussion of the Warrick County sources, which are the Alcoa smelter, the Warrick Power Plant, as well as an adjacent source (the Culley Generating Station); these sources were modeled with actual emissions for the period 2013-2015. Section 3 describes the selection of the dispersion modeling approach for the Alcoa smelter, which is slightly different from the other sources included in the modeling. The background sources and regional background used in the study are discussed in Section 4. The details of the modeling procedures are discussed in Section 5. Section 6 summarizes the modeling results.

[1] AECOM, 2017. Modeling Protocol for the 1-hour SO_2 Data Requirements Rule: Alcoa Warrick Operations, Warrick Power Plant, and Culley Generating Station. Document Number 60537431.1.

2. Description of Warrick County SO_2 Emission Sources

2.1 Alcoa Smelter – Warrick Operations

Alcoa Warrick Operations is located in Warrick County Indiana, approximately 20 kilometers east-southeast of Evansville (and the Evansville airport) on the banks of the Ohio River. The area surrounding Alcoa Warrick Operations can be considered rural with mostly flat or gently sloping terrain. The major SO_2 sources at the smelter facility (during the modeling period of 2013-2015), besides a small fraction of SO_2 emissions which vents through the 10 potroom building roof vents, include:

Potline #2	Exhausted through a bank of 36 individual 14.94-m (height) stacks ("P02")
Potlines #3 & #4	Exhausted through the 60.66-m high GTC stack ("P01")
Potline #5	Exhausted through a bank of 36 individual 14.94-m high stacks ("P03")
Potline #6	Exhausted through a bank of 36 individual 14.94-m high stacks ("P04")
Ring Furnace	Exhausted through a bank of 7 individual 22.25-m high stacks ("P05")

Figure 2-1 shows the locations of the major SO_2 sources associated with the Alcoa Warrick Operations, including the P2 monitoring site. This figure also outlines areas of processes that emit fugitive heat in the smelter complex.

Typical stack exhaust parameters for use in the model performance evaluation are provided in Tables 2-1 through 2-3 for the smelter sources. The smelter operation sources listed in Tables 2-1 through 2-3 have very steady operation, inherent in the nature of the aluminum production. Table 2-1 lists the stacks and associated stack parameters for the individual point sources. Table 2-2 lists the merged stacks and associated parameters that were modeled with the site-specific modeling approach, discussed in Section 5. The actual exit velocities and exit temperatures that were modeled for the potline stacks varied by month and season. The values listed in Tables 2-1 and 2-2 are values which are based on typical monthly data. The effective stack diameters listed in Table 2-2 for the potline stacks P02, P03, and P04 are based on the merging of several individual stacks, and the effective stack diameter for the western ring furnace stacks P05 is also based on the merging of several individual stacks. Table 2-3 lists the exhaust parameters for the smelter buoyant line sources; i.e., the potroom buildings.

Actual monthly-averaged emissions and monthly-measured exhaust parameters were used in the modeling and were provided by Alcoa. These detailed emissions and exhaust parameters are included in the modeling archive.

Table 2-1: Typical Exhaust Parameters for Alcoa Warrick Smelter SO_2 Point Sources, Not Merged

Index	Stack Name	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
P01	Potlines #3 & #4 GTC Pollution Controls (1 stack)	60.66	6.10	15.49	359.7
P02	Potline #2 A-398 (36 individual stacks)	14.94	0.63	14.79	355.2
P03	Potline #5 A-398 (36 individual stacks)	14.94	0.63	17.92	350.2
P04	Potline #6 A-398 (36 individual stacks)	14.94	0.63	15.65	350.8
P5W1	Ring Furnace A-446 Western Reactors' Stack 1	22.25	0.67	16.10	351.0
P5W2	Ring Furnace A-446 Western Reactors' Stack 2	22.25	0.67	16.10	351.0
P5W3	Ring Furnace A-446 Western Reactors' Stack 3	22.25	0.67	16.10	351.0
P5W4	Ring Furnace A-446 Western Reactors' Stack 4	22.25	0.67	16.10	351.0
P5W5	Ring Furnace A-446 Western Reactors' Stack 5	22.25	0.67	16.10	351.0
P5W6	Ring Furnace A-446 Western Reactors' Stack 6	22.25	0.67	16.10	351.0
P5E1	Ring Furnace A-446 Eastern Reactor Stack	22.25	1.17	16.10	351.0

Table 2-2: Typical Exhaust Parameters for Alcoa Warrick Smelter SO_2 Point Sources, Merged Stacks

Index	Stack Name	Stack Height (m)	Effective Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (K)
P01	Potlines #3 & #4 GTC Pollution Controls	60.66	6.10	15.49	359.7
P02	Potline #2 A-398 (4 stacks)	14.94	1.89	14.79	355.2
P03	Potline #5 and #6 A-398 (6 stacks)	14.94	1.54	17.92	350.2
P04	Potline #5 and #6 A-398 (6 stacks)	14.94	1.54	15.65	350.8
P05W	Ring Furnace A-446 Western Reactors (6 stacks)	22.25	1.64	16.10	351.0
P5E1	Ring Furnace A-446 Eastern Reactor	22.25	1.17	16.10	351.0

Table 2-3: Typical Exhaust Parameters for Alcoa Warrick Smelter Buoyant Line Sources

Index	Source Name	Release Height (m)	Avg Building Length (m)	Avg Building Width (m)	Avg Line Source Width (m)	Avg Building Separation (m)
L01	Potline #2, Room 103	14.02	305.00	18.30	1.52	21.60
L02	Potline #2, Room 104	14.02	305.00	18.30	1.52	21.60
L03	Potline #3, Room 105	14.02	305.00	18.30	1.52	21.60
L04	Potline #3, Room 106	14.02	305.00	18.30	1.52	21.60
L05	Potline #4, Room 107	14.02	305.00	18.30	1.52	21.60
L06	Potline #4, Room 108	14.02	305.00	18.30	1.52	21.60
L07	Potline #5, Room 109	14.02	305.00	18.30	1.52	21.60
L08	Potline #5, Room 110	14.02	305.00	18.30	1.52	21.60
L09	Potline #6, Room 111	14.02	305.00	18.30	1.52	21.60
L10	Potline #6, Room 112	14.02	305.00	18.30	1.52	21.60

2.2 Warrick Power Plant

Alcoa's Warrick Power Plant (WPP) is a 742-megawatt (MW) coal-fired power plant that provides the power necessary to operate the aluminum smelter. WPP's four active coal-fired boilers were included in the modeling, as nearby background sources. Units 1-3 exhaust through individual flues housed in a common stack, while Unit 4 exhausts through a separate stack. All units have wet scrubber controls for SO_2.

Typical stack exhaust parameters used in the model performance evaluation are provided in Table 2-4. Actual hourly emissions and exhaust parameters were used in the modeling and were provided by Alcoa. These detailed emissions and exhaust parameters are included in the modeling archive.

Figure 2-1 shows the locations of the WPP sources in relation to the Alcoa smelter sources.

Table 2-4: Typical Exhaust Parameters for Warrick Power Plant SO_2 Point Sources

Index	Stack Name	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/sec)	Exit Temperature (K)
WPP_1-3	WPP Units 1-3	115.82	7.12 (Merged)	16.48	329.00
WPP_4	WPP Unit 4	115.82	6.10	15.80	329.00

2.3 Culley Power Plant

The F. B. Culley Generating Station (Culley), a 369-megawatt (MW) power plant, which is located about 1 km east-southeast of the Warrick Power Plant, was also modeled as a nearby background source due to its proximity and physical interconnections to Alcoa. This plant is owned and operated by Vectren Corporation (formerly Southern Indiana Gas and Electric Company). There are two units: Unit 2 (103.7

MW) and Unit 3 (265.2 MW); however, Unit 2 has been permanently retired. Therefore, only Unit 3's emissions were modeled in this analysis.

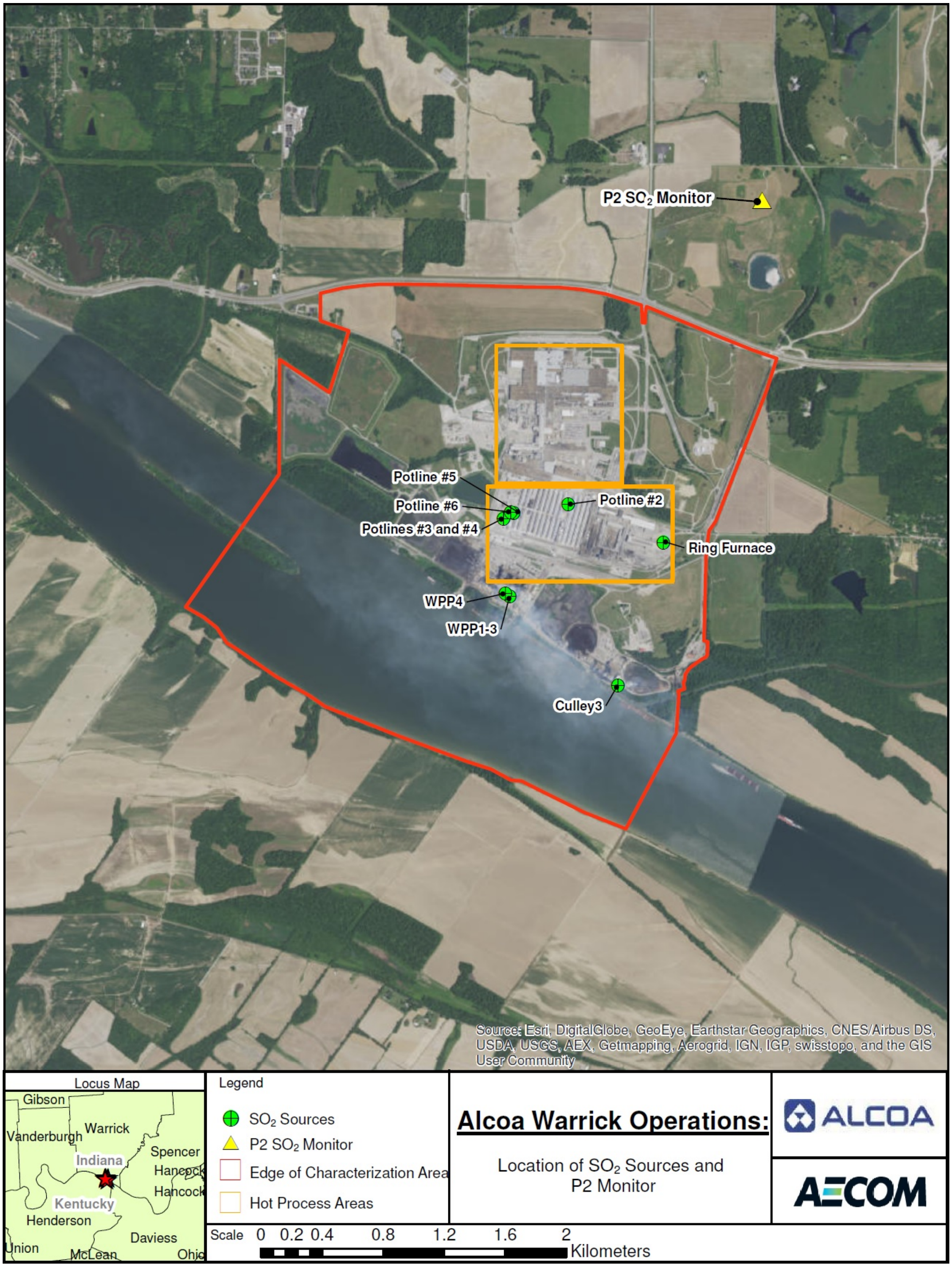
Typical stack exhaust parameters for use in the model performance evaluation are provided in Table 2-5 for Culley Unit 3. Actual hourly emissions and exhaust parameters were used in the modeling and were provided by Vectren. The detailed emissions and exhaust parameters are included in the modeling archive.

Figure 2-1 shows the location of the Culley Unit 3 stack in relation to Alcoa.

Table 2-5: Typical Exhaust Parameters for Culley Power Plant SO_2 Point Sources

Index	Stack Name	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/sec)	Exit Temperature (K)
Culley 3	Culley Unit 3	137.12	6.10	13.04	326.00

Figure 2-1: Alcoa SO_2 Sources, Hot Smelter Process Areas, and Surrounding Areas



3. Dispersion Modeling Approach

3.1 Use of AERMOD in Rural Mode for Most Sources

The choice of rural or urban for dispersion conditions at the Alcoa smelter operations, WPP, and Culley usually depends upon the land use characteristics within 3 kilometers of the facilities (Appendix W to 40 CFR Part 51)[2]. Factors that affect the rural/urban choice, and thus the dispersion, include the extent of vegetated surface area, the water surface area, types of industry and commerce, and building types and heights within this area.

An Auer analysis of the area surrounding the Alcoa smelter operations, WPP, and Culley was conducted using satellite data as shown in Figure 3-1. The Auer land-use approach classifies an area according to 12 land-use types. In this scheme, areas of industrial, commercial, and compact residential land-use are designated urban. According to EPA modeling guidelines, if more than 50 percent of an area within a three-kilometer radius of a facility is classified as rural, then rural dispersion coefficients are to be used in the modeling.

The Auer analysis indicates that the land use around the facilities is rural. As a result, the WPP and Culley sources were modeled using rural dispersion characteristics. However, due to the large industrial complex heat releases, the Alcoa smelter sources were modeled as urban, as explained further in the next subsection. Due to the influence of the Ohio River, the WPP and Culley sources are modeled as rural.

3.2 Use of AERMOD in Urban Mode for Alcoa Smelter

Emission sources such as the Alcoa Warrick aluminum smelter are associated with large fugitive heat releases that result in a local urban-like dispersion environment. AERMOD typically estimates urban heat island effects using an urban/rural classification based on population or land use, but until updates to Appendix W proposed in July 2015 (80 FR 45340, July 29, 2015) that were promulgated in 2017, AERMOD has not considered the urban effects that are created by large industrial complexes located in rural areas. The “highly industrialized area” effect can be addressed by a technique that accounts for the excess heat from an industrial complex and derives an effective population related to the excess heat generated by the highly industrialized area as input to AERMOD. A discussion of this approach is provided in Appendix B of the modeling protocol, which has previously been provided to EPA by the American Iron & Steel Institute (AISI). A peer-reviewed published journal article describing source characterization of the highly industrialized area heat island effect (and three other source characterization techniques) is provided in Appendix C of the modeling protocol.

In the case of the Alcoa smelter, there is approximately a 450-MW electrical usage needed to power the 5 aluminum reduction lines. In addition, hot rolling mills in the area to the north of the smelting operations also emit fugitive heat. The area involved in the Alcoa Warrick Operations process, shown in the orange rectangles in Figure 2-1, is on the order of 2 square kilometers (2×10^6 m^2).

The heat losses associated with the use of electricity in the aluminum smelting process can be on the order of 40-50%[3]. Taking the midpoint of that range and conservatively assuming that half of this is lost to the atmosphere (the rest to the buildings), we get an atmospheric heat loss rate of about 100 MW. The heat loss to the atmosphere, when applied to the 2 square km area, results in an effective urban-rural temperature difference is 50 W/m^2, which converts to an effective urban population of 2 million, based upon the formulation described in Appendix B of the modeling protocol.

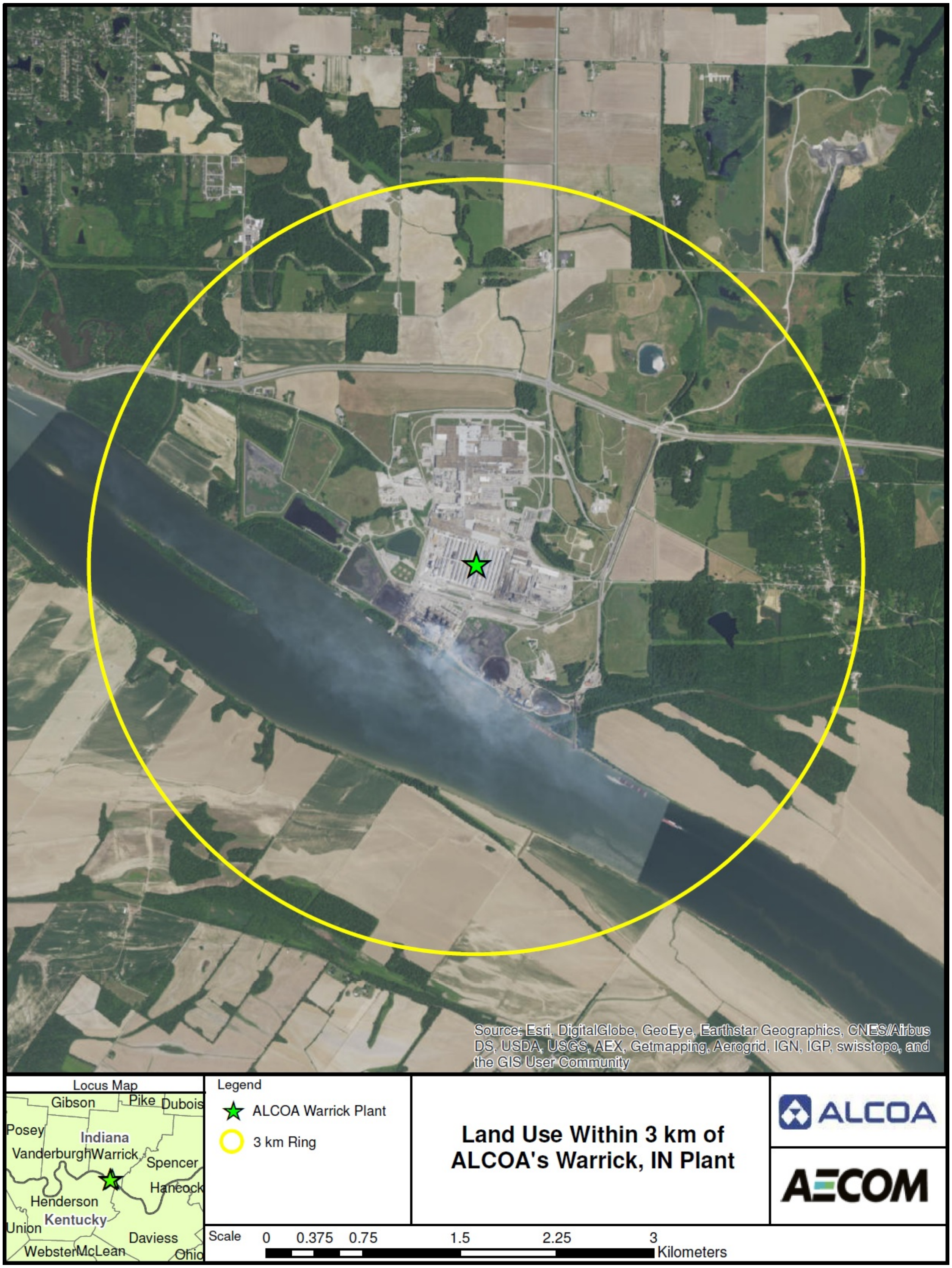
[2] EPA's Guideline on Air Quality Models, available at http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf.
[3] See, for example discussions at http://peter-entner.com/E/Theory/EBal/EBal.aspx and http://www.tms.org/pubs/journals/JOM/9905/Welch-9905.html.

Consistent with the calculations provided above, the modeling approach for the source characterization effects for Warrick Operations assumed that the aluminum smelter sources are emitting into an urban boundary layer for AERMOD modeling with an effective population of 2 million.

3.3 Building Downwash Treatment for Smelter Sources

The effects of the large heat releases from the smelter play a role in the merging of plumes from adjacent dry scrubber stacks and in a liftoff effect that resists building downwash effects. In the case of the aluminum smelter, the potline buildings are not enclosed, but instead have openings that promote inflow from the bottom so that the natural convection will improve the dispersion (and increase the lift) of the hot effluent from the potline roof vents. The associated fugitive heat losses will offset building downwash effects. However, downwash effects are conservatively retained in this modeling application, while the convective heating effects are accommodated with partial stack merging as described in Section 5.

Figure 3-1: Satellite Photo of the Area within 3 km of the Alcoa Operations, WPP, and Culley



4. Background Sources and Regional Background

4.1 Emission Sources Outside Warrick County

Besides the Warrick and Culley power plants, other SO_2 background sources provided by IDEM that are located within 50 kilometers from the Warrick operations were also included in the modeling for this analysis. The sources that were modeled are listed in Table 4-1. Figure 4-1 shows the locations of these background sources with respect to the Warrick operations.

Table 4-1: Background Sources Included in the Modeling

Source	Source ID	Location
A.B. Brown	18-129-00010	Posey County, IN
AEP Rockport	18-147-00020	Spencer County, IN
Owensboro Municipal Utilities Elmer Smith Station	21-059-00027	Daviess County, KY
Big Rivers Electric Corporation Coleman Station	21-091-00003	Hancock County, KY
Century Aluminum of KY LLC	21-091-00004	Hancock County, KY
Owensboro Grain Company	21-059-00039	Daviess County, KY

4.2 Regional Background from Area Monitor

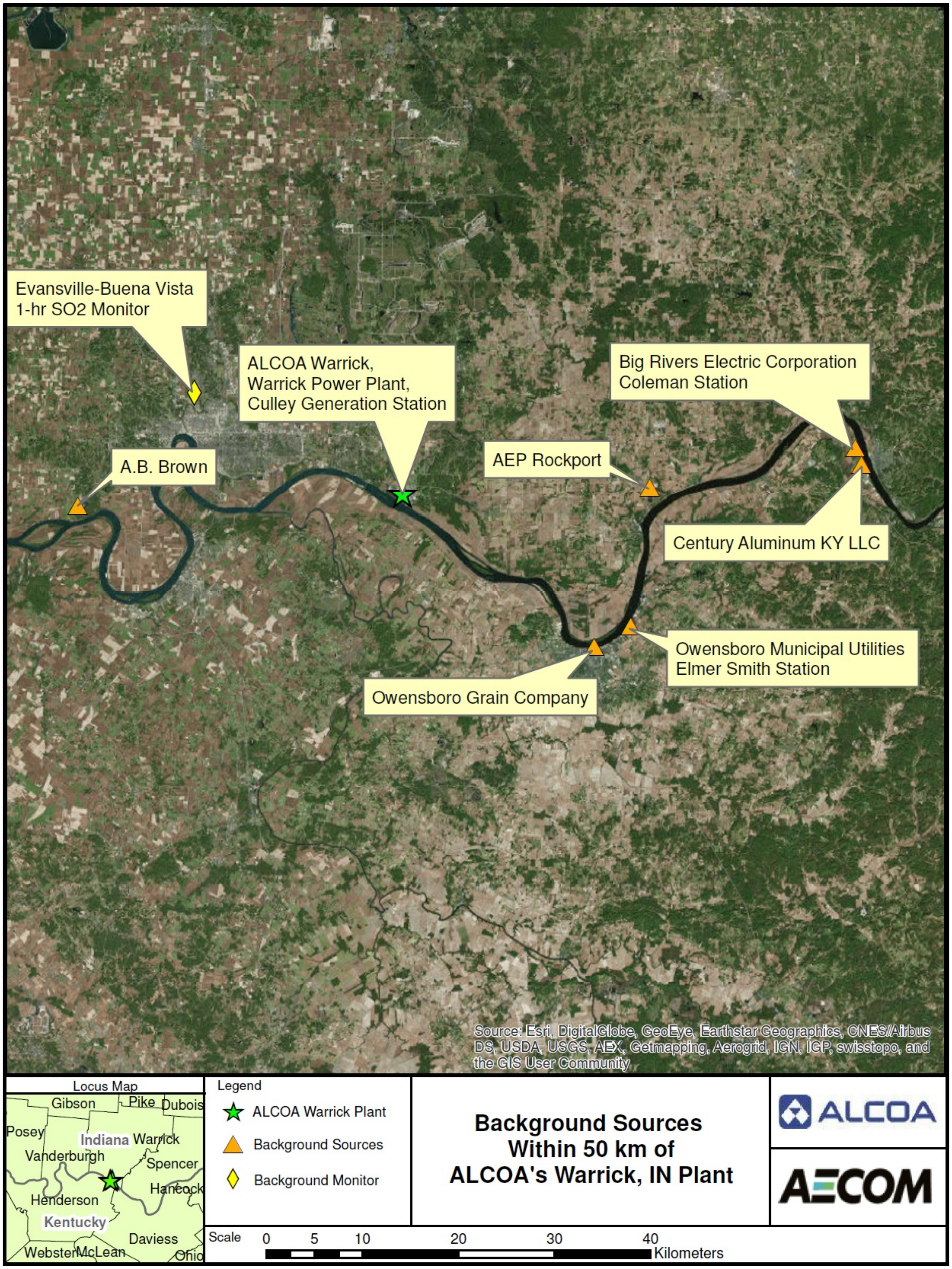
Hourly SO_2 ambient background data for the Evansville-Buena Vista monitor was processed into season/hour-of-day format following procedures described in the EPA March 1, 2011 guidance[4] for use in this modeling analysis. The most recent three years of data were used (2014-2016). Although the monitoring could double count the impacts of the modeled Alcoa or the A.B. Brown sources (see the monitor location in Figure 4-1), the values as listed in Table 4-2 have not been adjusted for that effect. These values were used in conjunction with the BACKGRND SEASHR keyword in the source card and added to the AERMOD-predicted concentrations for comparison with the 1-hour SO_2 NAAQS of 75 ppb, or 196.5 $\mu g/m^3$.

[4] https://www3.epa.gov/ttn/scram/guidance/clarification/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf

Table 4-2: Evansville-Buena Vista Monitored SO_2 Background Concentrations (µg/m^3)

Hour	WINTER	SPRING	SUMMER	FALL
0	13.10	9.34	6.46	9.26
1	11.00	13.10	4.72	9.00
2	9.52	9.00	4.37	7.77
3	14.58	9.08	4.54	9.08
4	11.88	8.65	4.37	10.92
5	11.70	17.55	6.11	10.92
6	11.44	15.20	6.38	12.31
7	13.54	14.06	11.53	12.05
8	23.41	21.48	22.71	14.32
9	26.11	26.72	21.92	20.09
10	23.58	31.18	16.86	25.59
11	25.76	23.49	15.98	21.40
12	29.43	23.32	16.07	24.45
13	31.27	25.76	17.55	22.44
14	31.70	24.28	13.45	22.71
15	33.27	23.14	11.88	15.89
16	29.43	27.51	14.15	16.24
17	27.16	24.10	15.20	14.93
18	21.75	17.82	15.72	11.18
19	25.06	17.20	12.05	14.93
20	18.17	12.66	8.56	10.92
21	20.87	6.20	4.89	8.73
22	15.63	12.75	6.99	9.69
23	18.25	11.53	5.59	9.69

Figure 4-1: Sources to be Included in the Modeling



5. Modeling Procedures

5.1 Alcoa's Site-Specific Model

The proposed modeling approach used AERMOD version 16216r with source characterization refinements as noted below, including the BLP model component for the potline roof emissions, and AERMOD's normal point-source treatment for the other (stack) sources. The modeling approach involved no changes to AERMOD; rather, the only unique issues involved how the Alcoa smelter sources were characterized for input to the modeling.

Although the power plant stack sources were modeled in the same manner (using the EPA-approved ADJ_U* low wind option), the Warrick Operations smelter sources were modeled as urban to account for source characterization effects such as those noted by the AISI presentation[5] made by Robert Paine at the 11th EPA Modeling Conference, a technique further described in the published journal article provided in Appendix C of the modeling protocol. Specifically, the modeling approach differed from a default modeling approach that does not consider the site-specific issues in the following areas:

- Clusters of the adjacent dry scrubber stacks and ring furnace stacks at the smelter were merged due to the tremendous heat release (see Figure 5-1) that basically results in a combined plume rise. Specifically, six stacks each represented the emissions from the long and narrow rectangular Potline Areas 5 and 6 (see Figure 5-2), four stacks represented the combined emissions from nearly square Potline Area 2 (see Figure 5-2), and six stacks were merged for the ring furnace's western reactor area (see Figure 5-3), as noted in Table 2-2. The merging process retained the common stack height for stacks in each cluster, but summed the stack top areas for an equivalent diameter stack where the default option of stack-tip downwash was used. The emissions from Potline Areas 3 and 4 were modeled with the current 199-ft stack. Likewise, the emissions from the ring furnace's eastern reactor were modeled with the current stack (not merged).
- Urban dispersion characterization was used for the smelter sources, as discussed in Section 3.2. The power plant sources were assigned a rural characterization.
- For the smelter sources, building downwash was included in the modeling in spite of the tremendous fugitive heat releases within the smelter area that would tend to make the emissions buoyant.
- The aluminum smelter rooftop vent sources were modeled with the BLP approach installed in AERMOD version 16216r. The five sets of twin potline roof vents are listed in Table 2-3 and represent the buoyant line sources.
- For the stack merging, the nearly square shape of the Potline 2 stacks (see Figure 5-2) was amenable to a set of 4 stacks distributed evenly through the set of 6 x 6 stacks, with each merged stack representing a 3x3 array of individual stacks. The use of the same approach for the more elongated areas for Potlines 5 and 6 (also shown in Figure 5-2) led to model under-predictions[6] in the evaluation described in Appendix A of the modeling protocol, so a more conservative approach that better fit the shape of the stack area was to merge only 6 stacks in a group. The discussion in Appendix A of the protocol shows that merging of fewer stacks (such as 3 in each line) led to AERMOD over-predictions.

[5] http://www.epa.gov/ttn/scram/11thmodconf/presentations/2-2_AISI_NAAQS_Issues.pdf.

[6] The tests that resulted in under-predictions are not included in Appendix A of the modeling protocol; modeling approaches that resulted in under-predictions were not considered for the final model evaluation tests.

5.2 Meteorological Processing

5.2.1 Meteorological Processing: AERMET

Three years (2013-2015) of the most recent hourly surface meteorological data from Evansville, IN airport were processed with AERMET, the meteorological preprocessor for AERMOD, which is consistent with guidance stated in 9.3.1.2 of 40 CFR Part 51, Appendix W (EPA modeling guidelines). Concurrent hourly upper air data from Lincoln, IL was also processed. AERMET also used 1-minute wind speeds and directions taken from the Evansvillle, IN airport surface station as processed by the most recent version of AERMINUTE (15272). The "ADJ_U*" option was also used, which is considered a default option under the 2017 Appendix W final rule that became effective on May 22, 2017. Processing of the meteorological data was performed by AECOM and provided to IDEM for their approval. IDEM approved of AECOM's methodology which is described in more detail below.

The meteorological data required for input to AERMOD was created with the latest version of AERMET (16216). AERMET creates two output files for input to AERMOD:

- SURFACE: a file with boundary layer parameters such as sensible heat flux, surface friction velocity, convective velocity scale, vertical potential temperature gradient in the 500-meter layer above the planetary boundary layer, and convective and mechanical mixing heights. Also provided are values of Monin-Obukhov length, surface roughness, albedo, Bowen ratio, wind speed, wind direction, temperature, and heights at which measurements were taken.
- PROFILE: a file containing multi-level meteorological data with wind speed, wind direction, temperature, sigma-theta (σ_θ) and sigma-w (σ_W) when such data are available. AERMET requires specification of site characteristics including surface roughness (z_o), albedo (r), and Bowen ratio (B_o).

The year 2014 was run twice in AERMET because the meteorological tower was moved on March 17, 2014 approximately 813.5 meters to the northeast of its previous position (Figure 5-4). To account for this in the AERMET processing, the full year of 2014 was run at both locations for both AERMET and AERSURFACE. Then, SURFACE and PROFILE files were created which include the AERMET/AERSURFACE output for January 1, 2014 – March 17, 2014 modeled with the previous tower location and combined it with the AERMET/AERSURFACE output for March 18, 2014 – December 31, 2014 modeled with the new tower location. The year 2013 was modeled with the previous tower location and 2015 was modeled with the new tower location.

5.2.2 Meteorological Processing: Surface Characteristics

AERMET requires specification of site characteristics including surface roughness (z_o), albedo (r), and Bowen ratio (B_o). These parameters were developed according to the guidance provided by EPA in the recently revised AERMOD Implementation Guide[7] (AIG).

The AIG provides the following recommendations for determining the site characteristics:

1. The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.
2. The determination of the Bowen ratio should be based on a simple un-weighted geometric mean (i.e., no direction or distance dependency) for a representative domain,

[7] EPA 2015. AERMOD Implementation Guide (AIG). Office of Air Quality Planning and Standards, Research Triangle Park, NC. August.https://www3.epa.gov/ttn/scram/models/aermod/aermod_implementation_guide.pdf

with a default domain defined by a 10-km by 10-km region centered on the measurement site.

3. The determination of the albedo should be based on a simple un-weighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10-km by 10-km region centered on the measurement site.

The AIG recommends that the surface characteristics should be determined based on digitized land cover data. EPA has developed a tool called AERSURFACE that can be used to determine the site characteristics based on digitized land cover data in accordance with the recommendations from the AIG discussed above. AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category. AERSURFACE was applied by AECOM based on the instructions provided in the AERSURFACE User's Guide. IDEM approved of AECOM's processing and resulting surface characteristics.

The latest version of AERSURFACE (Version 13016) supports the use of land cover data from the USGS National Land Cover Data 1992 archives[8] (NLCD92). The NLCD92 archive provides data at a spatial resolution of 30 meters based upon a 21-category classification scheme applied over the continental U.S. The AIG recommends that the surface characteristics be determined based on the land use surrounding the site where the surface meteorological data were collected.

As recommended in the AIG for surface roughness, the 1-km radius circular area centered at the surface station was divided into 12 sectors for this analysis.

An analysis of satellite imagery from 2010 (Figure 5-5) shows a building located less than 1 kilometer south of the meteorological tower's 2013-March 17, 2014 location. Satellite imagery from 1992 does not show this building (Figure 5-6). Since this building was constructed after 1992, it is not represented in the 1992 NLCD data. Figure 5-7 shows the 1992 land cover data. The red areas indicate areas of urban development. Note that there is no red area in the 150° to 180° sector to indicate a building in the land use data. The land use data indicates that this region is designated for use as pasture/hay (yellow) or urban/recreational grasses (orange), which have lower surface roughness values. In a discussion with EPA[9], EPA indicated that it was appropriate to adjust the surface roughness values in this sector to account for this building. AECOM adjusted the surface roughness values by replacing the AERSURFACE-assigned surface roughness values in the 150° to 180° sector with the AERSURFACE-assigned surface roughness values for the sector to the west-southwest, or the 210° to 240° sector, which has a similar urban coverage. AECOM changed only the spring and late autumn/winter-with-no-snow surface roughness values because the summer and early autumn surface roughness values were similar for both sectors.

This modification only applies to the surface characteristics for 2013 and January 1, 2014 to March 17, 2014 before the meteorological tower was moved. When the meteorological tower was moved to its current position on March 17, 2014, the building was no longer a major contributor to the surface characteristics because it is located at the edge of the 1-kilometer radius. Figure 5-4 shows the current location of the meteorological tower as well as the 1-kilometer radius and land use sectors.

In AERSURFACE, the various land cover categories are linked to a set of seasonal surface characteristics. As such, AERSURFACE requires specification of the seasonal category for each month of the year. The following five seasonal categories are supported by AERSURFACE, with the applicable months of the year specified for this site.

1. Midsummer with lush vegetation (June, July, August).

[8] http://edcftp.cr.usgs.gov/pub/data/landcover/states/
[9] U.S. EPA, Blakley, Pamela. 2013. EPA Comments on ALCOA Modeling Protocol. EPA Region 5, Control Strategies Section of the Air and Radiation Division. Chicago, IL. Included in the computer modeling archive.

2. Autumn with un-harvested cropland (September, October).
3. Late autumn after frost and harvest, or winter with no snow (January, February, November, December).
4. Winter with continuous snow on ground (not used).
5. Transitional spring with partial green coverage or short annuals (March, April, May).

For Bowen ratio, the land use values are linked to three categories of surface moisture corresponding to average, wet, and dry conditions. The surface moisture condition for the site may vary depending on the meteorological data period for which the surface characteristics were applied. AERSURFACE applies the surface moisture condition for the entire data period. Therefore, if the surface moisture condition varies significantly across the data period, then AERSURFACE can be applied multiple times to account for those variations. As recommended in the AERSURFACE User's Guide, the surface moisture condition for each month was determined by comparing the Evansville airport precipitation for the period of data processed to the 30-year climatological record, selecting "wet" conditions if precipitation is in the upper 30th percentile, "dry" conditions if precipitation is in the lower 30th percentile, and "average" conditions if precipitation is in the middle 40th percentile. The 30-year precipitation data set used in this modeling was taken from the National Weather Service Forecast Office for Paducah, KY[10]. The data is specifically for the Evansville, IN area.

The monthly designations of surface moisture input to AERSURFACE are summarized in Table 5-1.

Table 5-1: AERSURFACE Bowen Ratio Condition Designations

Month	Bowen Ratio Category		
	2013	2014	2015
January	Wet	Dry	Average
February	Average	Dry	Average
March	Average	Average	Wet
April	Average	Wet	Wet
May	Average	Average	Average
June	Wet	Average	Wet
July	Average	Average	Average
August	Average	Wet	Average
September	Average	Average	Dry
October	Wet	Wet	Average
November	Dry	Average	Average
December	Wet	Average	Wet

5.3 Good Engineering Practice Stack Height Analysis

A Good Engineering Practice (GEP) stack height analysis was performed to determine the potential for building-induced aerodynamic downwash for all stacks subject to downwash effects. The analysis procedures described in EPA's Guidelines for Determination of Good Engineering Practice Stack Height (EPA 1985)[11], Stack Height Regulations (40 CRF 51), and current Model Clearinghouse guidance[12] were

[10] http://w2.weather.gov/climate/xmacis.php?wfo=pah
[11] Available at http://www.epa.gov/scram001/guidance/guide/gep.pdf.
[12] http://www.epa.gov/scram001/guidance_clearinghouse.htm

used. For the BLP-type analysis, we used the building dimensions used historically for the Alcoa BLP-only modeling (see Table 2-3).

The EPA's Building Profile Input Program (BPIP-Version 04274) version that is appropriate for use with PRIME algorithms in AERMOD was used to incorporate downwash effects in the model. The building dimensions of each structure were input in the BPIP-PRIME program to determine direction specific building data. BPIP-PRIME addresses the entire structure of the wake, from the cavity immediately downwind of the building, to the far wake.

5.4 Receptors

For SO_2 DRR modeling, receptors were excluded from the nearby Ohio River (only in the area near the Alcoa and Vectren's Culley facilities for simplicity) as well as within the secured areas of the Alcoa and Culley plants themselves. The secured areas on Alcoa property excluded from receptor placement were recently reviewed by Alcoa, and they include certain areas along the Ohio River bank that were included in previous modeling, but should have been excluded. These areas are posted and/or patrolled by plant personnel, and any unauthorized person who accesses the site will be noticed and removed. An area on Culley property east of a service road was included in the modeling although it could have been excluded based upon posting and patrolling; this area is not close to peak predicted areas.

The secured areas of both Alcoa and Culley were excluded from receptor placement; they are not "ambient air". The Alcoa smelter and the adjacent Warrick Power Plant are considered as one facility in their operating permit. In addition, the Alcoa and Vectren facilities have substantial interconnected and joint operations and joint ownership as follows:

- Vectren owns a portion of the Warrick Power Plant ("Alcoa Power") Unit 4.
- FERC documentation[13] describes the interrelationship between Alcoa and Vectren, as further noted below.
- Alcoa and Vectren jointly own and operate the "Tie Line 3 facility", a 2.2 mile,138-kV line on these properties.
- Alcoa Power and Vectren jointly own other facilities in that area, including a 138 kV bus located at the Warrick plant to service the Warrick plant's operation.
- Tie Line 3 runs from a jointly-owned generating unit (Warrick Unit 4) to the 138 kV ring bus, and then to the Culley substation.
- Additional distribution lines connect the Culley Substation to the Warrick plant and are used to meet the energy needs of Alcoa's smelting and rolling mill operations.
- A legal agreement dating back to the initiation of operations at the smelter provide for an emissions easement, which in effect provides Alcoa a property right, due to emissions from Alcoa onto Culley property (now Vectren, but formerly Southern Indiana Electric & Gas Company, or SIGECO). They are provided in Appendix E of the modeling protocol, along with a map showing the area involved in the easement.

The receptor grid has 50-m spacing along the boundary of the secured areas of the joint Alcoa and Vectren property with receptor spacing as follows:

- Every 100 meters out to a distance of 3 kilometers,
- Every 250 meters between 3 and 5 kilometers,
- Every 500 meters between 5 and 10 kilometers.

[13] https://www.ferc.gov/CalendarFiles/20131206161329-OA13-6-000.pdf.

The receptor grid is illustrated in Figures 5-8 and 5-9.

The peak model predictions did not extend beyond 10 kilometers from the Alcoa sources, since historical monitoring had indicated that peak impacts are in close proximity to these sources. Beyond the ambient air boundary, this receptor grid spacing is consistent with the IDEM SO_2 DRR modeling protocol. The model-ready receptor file used the most recent version of AERMAP version 11103.[14]

[14] Indiana's Air Quality Modeling Protocol – Data Requirements Rule for the 2010 Primary 1-Hour Sulfur Dioxide Addressing the National Ambient air Quality Standard (NAAQS), June 2016.

Figure 5-1: Visible and Infrared Imagery of Potline Area at an Aluminum Smelter

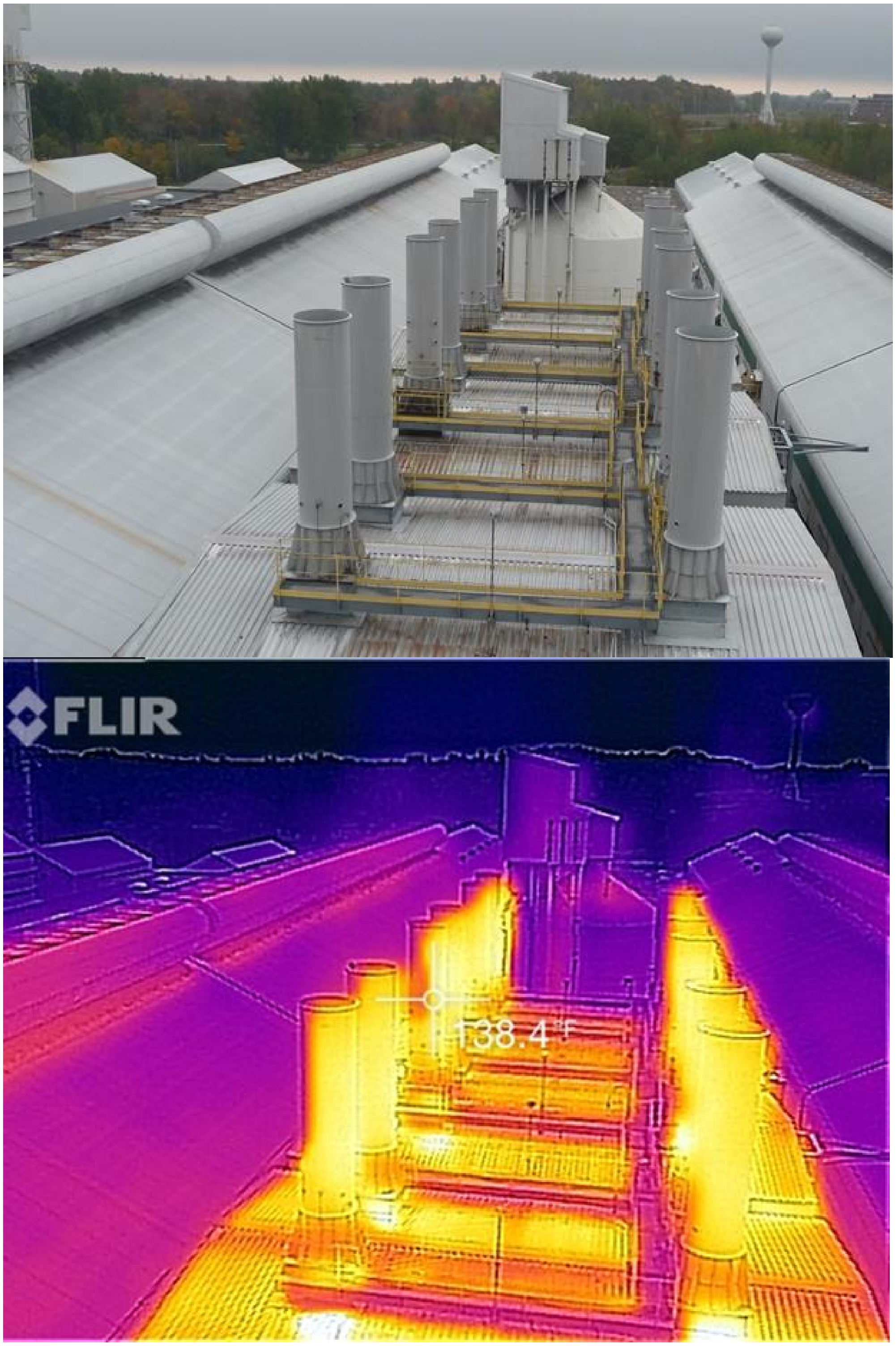


Figure 5-2: Depiction of Stack Merging for Potlines 2, 5, and 6

Figure 5-3: Depiction of Stack Merging for the Aluminum Smelter Stacks

Figure 5-4: 1-km Radius Around the Current Location of Evansville, IN Airport Meteorological Tower with Surface Roughness Sectors Shown Over a 2016 Aerial Photo

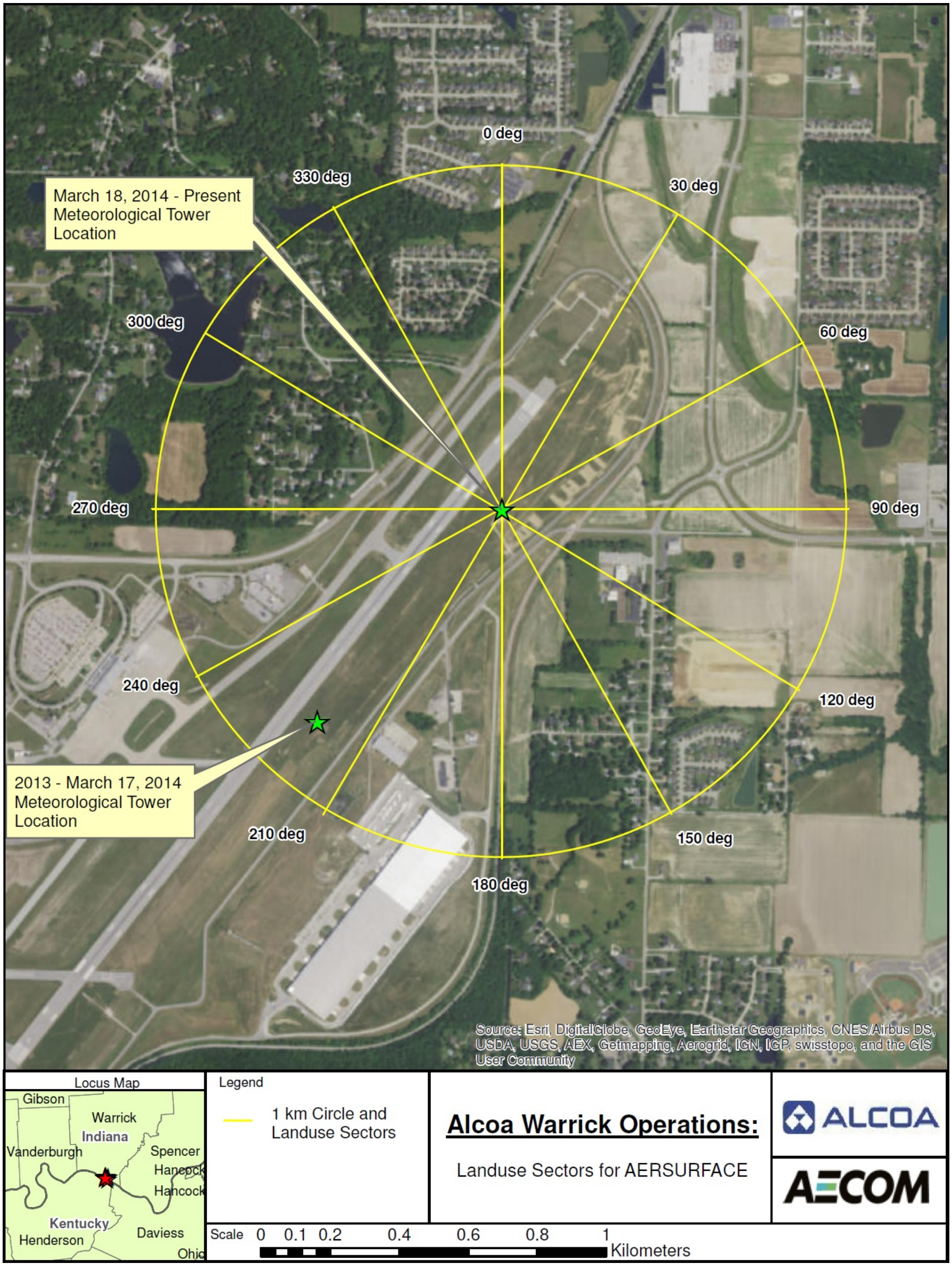


Figure 5-5: 1-km Radius Around the Evansville, IN Airport Meteorological Tower with Surface Roughness Sectors Shown Over a 2010 Aerial Photo

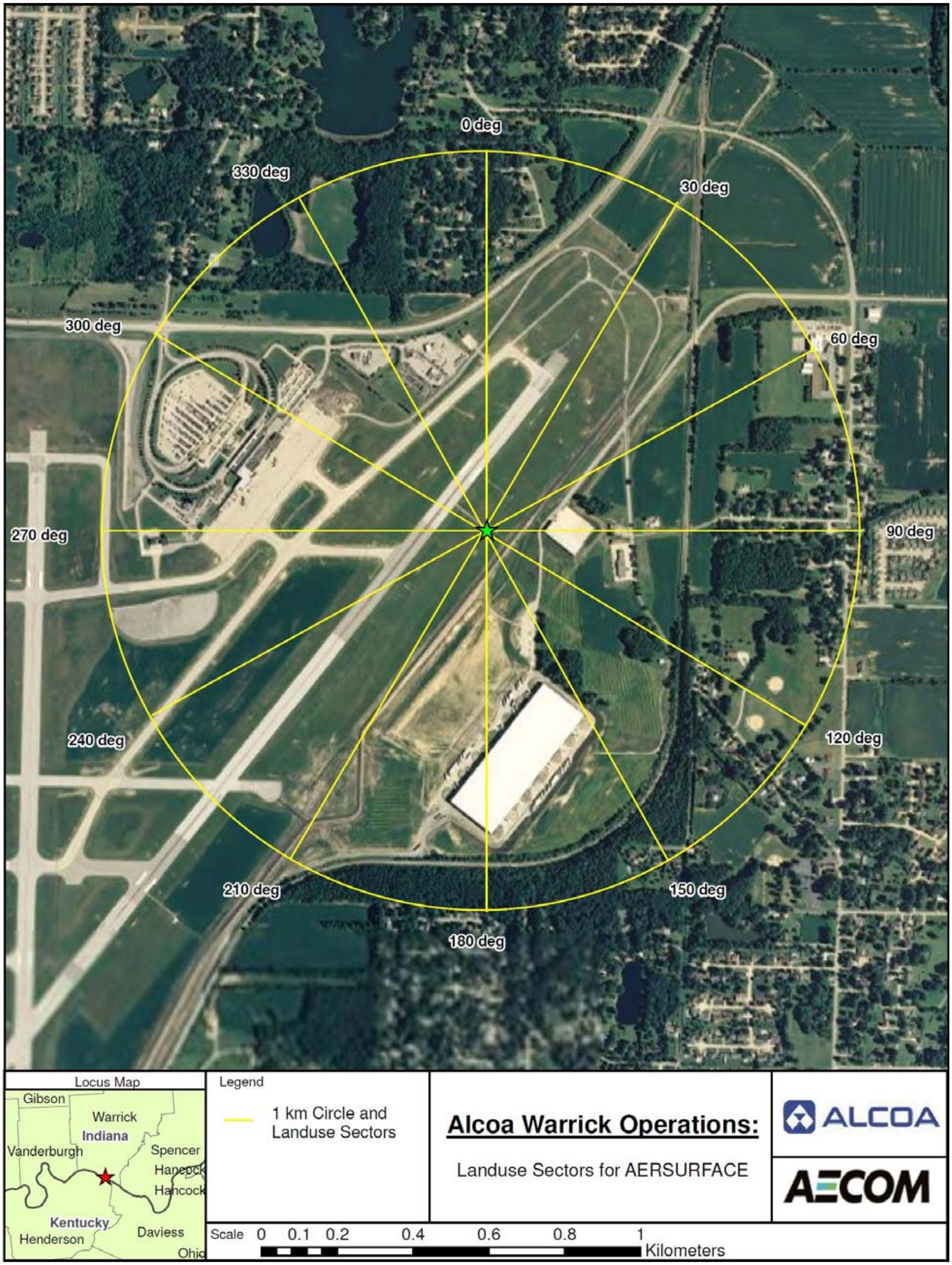


Figure 5-6: 1-km Radius Around the Evansville, IN Airport Meteorological Tower with Surface Roughness Sectors Shown Over a 1992 Aerial Photo (Courtesy of Google Earth)

Figure 5-7: 1-km Radius Around the Evansville, IN Airport Meteorological Tower with Surface Roughness Sectors Shown Over the 1992 Land Cover Map

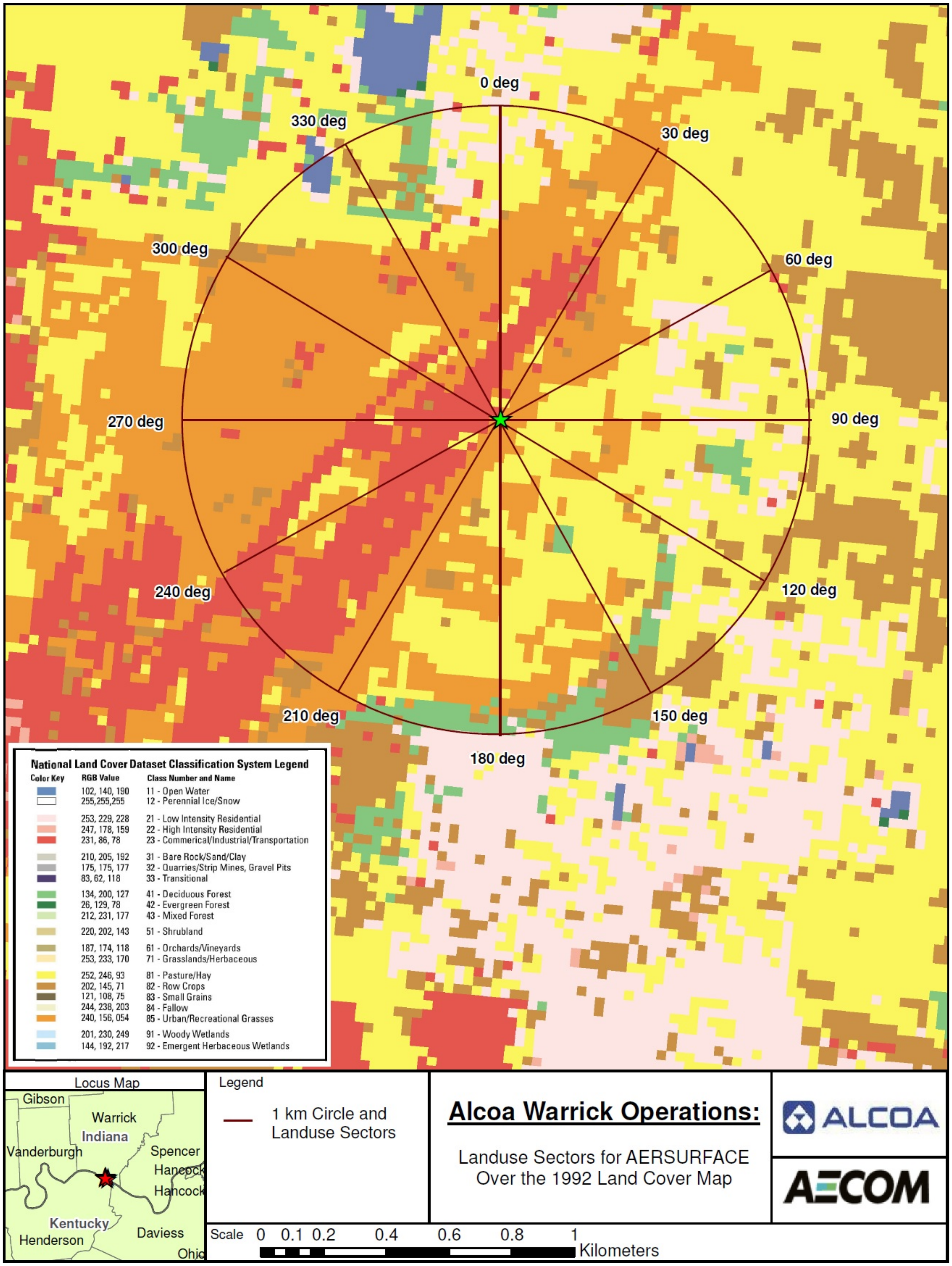


Figure 5-8: Receptor Grid Used for Modeling (Zoom-Out View)

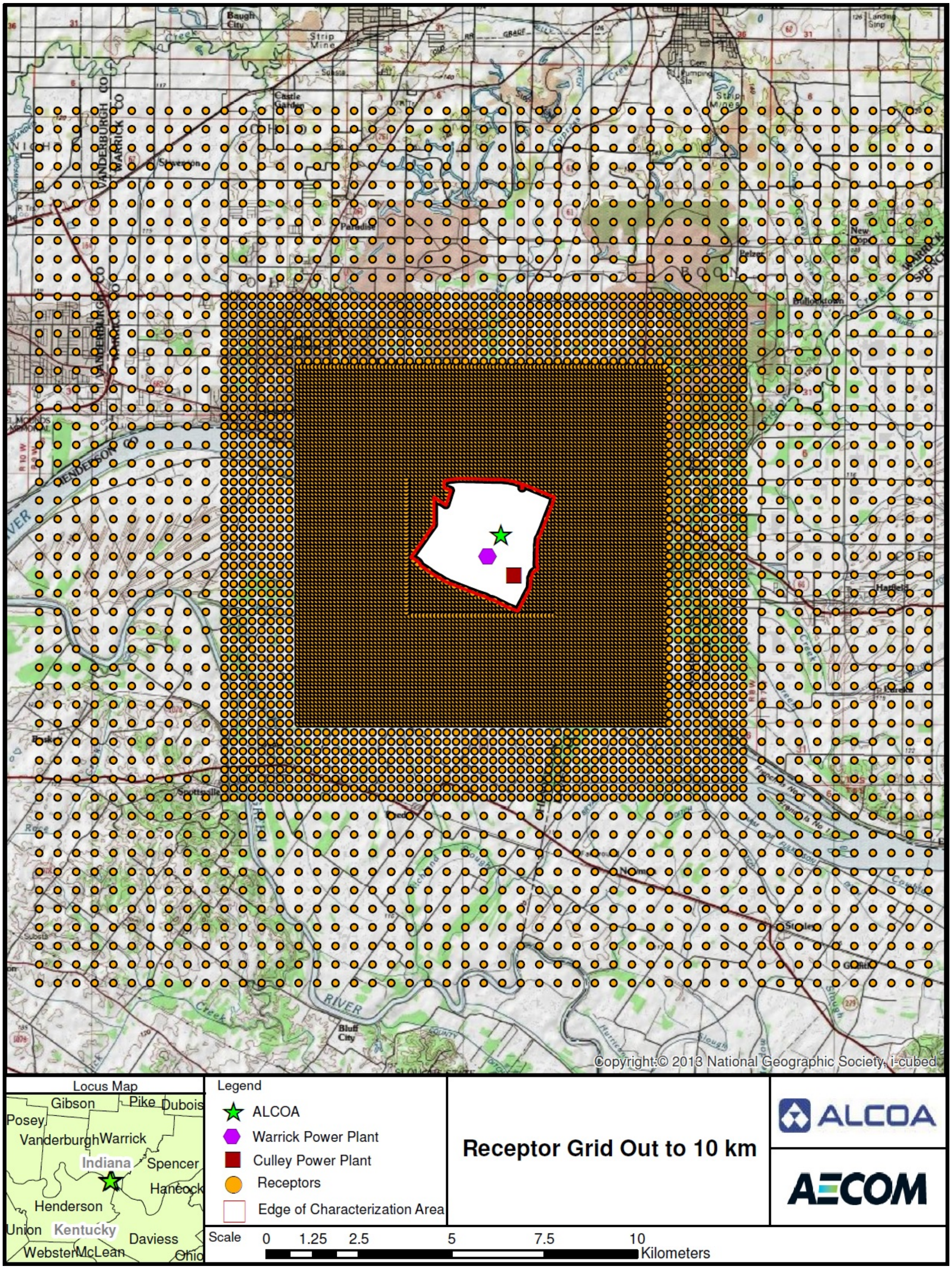
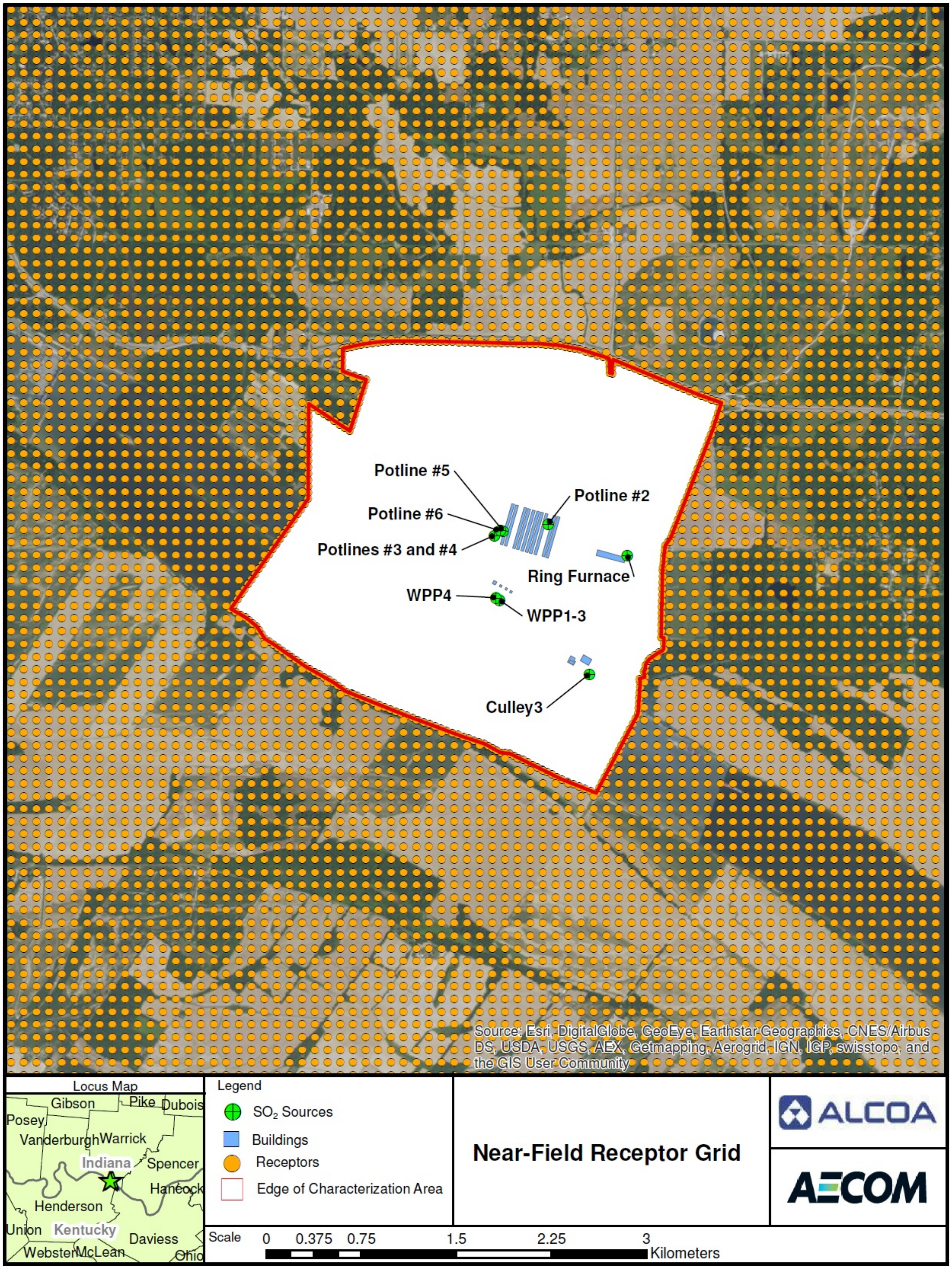


Figure 5-9: Receptor Grid Used for Modeling (Zoom-In View)



6. Results of SO_2 Characterization Modeling Analysis

AECOM conducted NAAQS compliance modeling in accordance with the 1-hour SO_2 Data Requirements Rule (DRR) for Alcoa's Warrick aluminum smelter and the adjacent Alcoa Warrick Power Plant which are subject to DRR requirements. Cumulative background sources within 50 kilometers of the Alcoa Warrick operations were also modeled. This includes the nearby Culley Power Plant and other regional emission sources provided by IDEM.

As can be seen from Table 6-1, the characterization of SO_2 concentrations due to emissions from the Alcoa Warrick Operations along with nearby background sources indicates attainment of the 1-hour SO_2 NAAQS standard. The maximum design concentration is 189.7μg/m^3, which is below the standard of 196.5 μg/m^3. The Alcoa and background sources contributed 90.8% to the total design SO_2 concentration while ambient background contributed to 9.2% of the total concentration.

As seen in Figure 6-1, the predicted 99th percentile peak daily 1-hour maximum concentrations occur along the eastern fence line; this is consistent with historical SO_2 monitoring in the area. A secondary region of high concentrations occurs along the Alcoa northern fence line, which is also consistent with the monitoring record. Figure 6-1 shows a zoomed-in display of concentration isopleths, while Figure 6-2 shows the concentrations throughout the entire modeling domain.

Table 6-1: 1-hour SO_2 Modeling Results

Pollutant	Averaging Period	Rank	3-Year Averaged Maximum AERMOD Predicted Concentration (Without Background) (μg/m^3)	Ambient Background (μg/m^3)	Total Concentration (μg/m^3)	NAAQS (μg/m^3)	% of NAAQS
SO_2	1-hour	99th	172.16	17.52	189.68	196.5	96.5%

Figure 6-1: SO_2 99th Percentile Peak Daily 1-hour Maximum Concentrations Isopleth Map

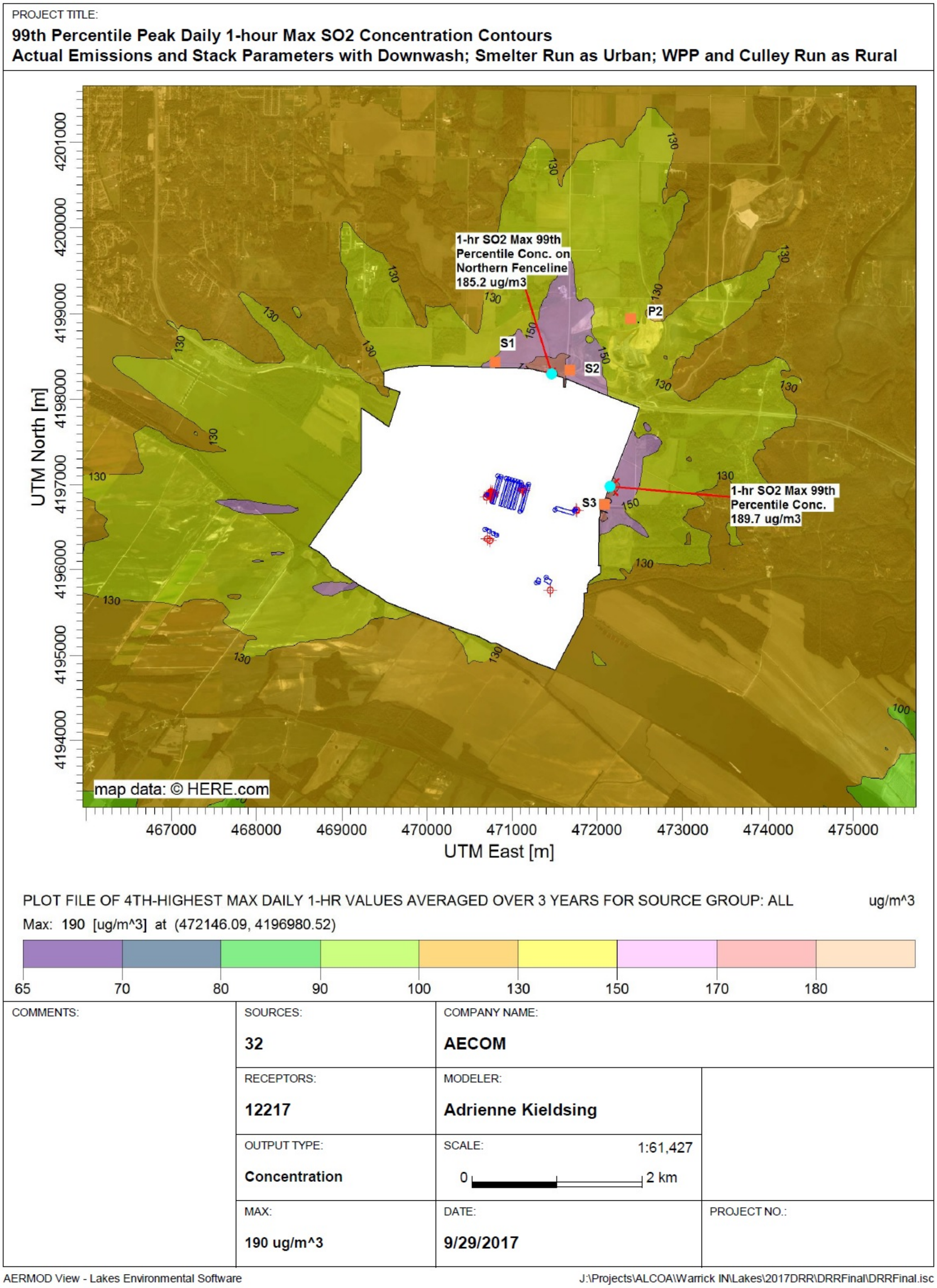
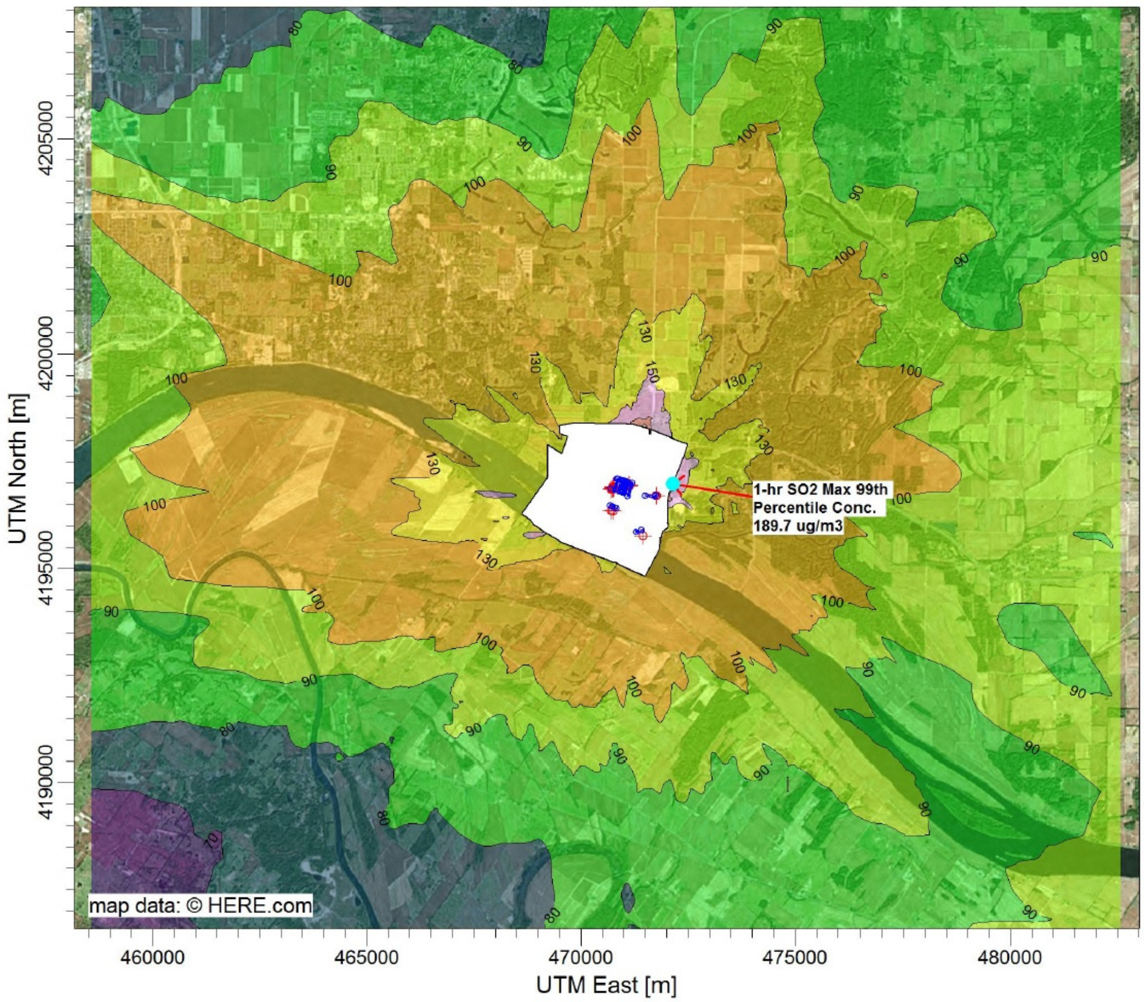


Figure 6-2: SO_2 99th Percentile Peak Daily 1-hour Maximum Concentrations Zoomed Out Isopleth Map

PROJECT TITLE:

99th Percentile Peak Daily 1-hour Max SO2 Concentration Contours
Actual Emissions and Stack Parameters with Downwash; Smelter Run as Urban; WPP and Culley Run as Rural



PLOT FILE OF 4TH-HIGHEST MAX DAILY 1-HR VALUES AVERAGED OVER 3 YEARS FOR SOURCE GROUP: ALL ug/m^3

Max: 190 [ug/m^3] at (472146.09, 4196980.52)

65 70 80 90 100 130 150 170 180

COMMENTS:	SOURCES: 32	COMPANY NAME: AECOM	
	RECEPTORS: 12217	MODELER: Adrienne Kieldsing	
	OUTPUT TYPE: Concentration	SCALE: 1:156,188 (0 – 5 km)	
	MAX: 190 ug/m^3	DATE: 9/29/2017	PROJECT NO.:

AERMOD View - Lakes Environmental Software J:\Projects\ALCOA\Warrick IN\Lakes\2017DRR\DRRFinal\DRRFinal.isc

Attachment E

U.S. EPA Region 5 Correspondence
Pertaining to ALCOA's DRR Modeling Analysis

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF

AR-18J

AUG 3 1 2017

Received
State of Indiana

SEP - 5 2017

Dept of Environmetal Management
Office of Air Quality

Mark Derf
Section Chief
Technical Support and Modeling
Office of Air Quality
Indiana Department of Environmental Management
100 North Senate Avenue
Indianapolis, Indiana 46204

Dear Mr. Derf:

Thank you for forwarding the June 23, 2017 email containing links to the Alcoa Warrick LLC (ALCOA) facility sulfur dioxide (SO_2) Data Requirements Rule (DRR) modeling protocol and supplemental modeling information (Protocol). While the email does not represent a formal protocol submittal from the Indiana Department of Environmental Management, we appreciate the opportunity to provide feedback in consideration of the short time-frame before comments on proposed designations are due from the states.

We've reviewed the Protocol, consulted with the Office of Air Quality Planning and Standards (OAQPS) and have the following comments. We have limited our comments to specific areas of concern.

Areas of Concern:

- **Dispersion coefficients (urban vs rural)**
  The Protocol notes that the Auer/Irwin analysis results in a rural dispersion coefficient determination. However, the Protocol further states that because of the significant heat island effect created by the smelter operations, the baking furnace, and the rolling mills, release points associated with those areas should be modeled as urban.

  The recent update to Appendix W (Guideline on Air Quality Models) recognizes that areas with low population, but with significant industrial activity, can sometimes be best characterized as urban.[1] EPA agrees that there is likely an urban heat island effect emanating from the potline and bake furnace areas of the ALCOA facility. The Protocol discusses a population value of 2,000,000 to represent the strength of the heat island. In

[1] 40 CFR Part 51 Appendix W, Section 7.2.1.1.c and d

this context, the population is a function of the electrical usage at the smelting operations. Information should be provided to verify the 500 Megawatt number. If that value is verified, the population would be an appropriate value.

The Protocol proposes to model the nearby power plant stacks as rural, based on the results of an Auer/Irwin analysis. However, the Warrick stacks are in very close proximity to the region defined in the Protocol as urban based on the "hot process area". Considering the location of the stack relative to the smelter along with the considerable amount of heat coming from the smelter operations, and without any additional justification for the use of rural, the Warrick stacks should be considered an urban source as well. The Culley stacks are taller, further away from the smelter operations, and are more likely best characterized by rural dispersion.

- **Downwash**
  The Protocol proposes no building downwash for the smelter sources (potline and ring furnace stacks.) Power plant stacks would be modeled with building dimensions. The justification for not modeling downwash on the smelter sources is based on the heat island assumptions discussed above and on information from the LIFTOFF postprocessor (a tool that applies a weighted factor to source specific AERMOD results, with and without downwash.)

The LIFTOFF postprocessor, while not modifying the AERMOD code, impacts how the emissions from the smelter operations are dispersed. The Protocol approach would effectively disregard the dimensions of the buildings housing the smelter operations, and consequently cannot be judged to be improving source characterization. Rather, the Protocol approach represents a reformulation of AERMOD dispersion and must be judged in accordance with the alternative model requirements in Appendix W, Section 3.2.2.b.d.

Given the extremely short time-period before decisions on SO_2 designations must be made, and the uncertainty regarding timeframes and ultimate approval of a LIFTOFF alternative model demonstration, EPA strongly recommends completing the DRR modeling with the use of downwash. This does not preclude discussion of the appropriateness of LIFTOFF for use in post-designation applications.

Merged sources

The Protocol proposes to merge stacks from Potline arrays 2, 5, 6 and the west ring furnace. Potlines 5 and 6 are adjacent three by twelve arrays of stacks that would be merged into six stacks at each potline. Potline 2 is two adjacent three by six arrays of stacks that would be merged into four stacks. The west ring furnace consists of six stacks that are merged into one stack.

EPA agrees that there is justification to assume plumes from the above mentioned stacks would merge to some degree. It is partially supported by an Atmospheric Environment article by Macdonald et. al[2] which examined plume rise due to combined plumes for a variety of separation distances. The situation at ALCOA is much more complicated than the scenarios examined in Macdonald et al. The study found that maximum plume merging occurred when flow was parallel to the stacks, and that little to no merging occurred when flow was perpendicular to the stack alignment. Results were mixed when the flow approached two stacks at an angle.

With the geometry of the stacks at Potline 2, at Potlines 5 and 6, and at the ring furnace, the number of stacks that may be considered to line up with the wind depends on the wind direction. For example, for Potline 2, with a west-northwest wind, six sets of six stacks each would line up close to directly upwind/downwind of each other. Thus, for this wind direction, using six stacks, each reflecting the merging of six stacks, appears warranted. A similar situation applies with south-southwest winds. However, with west-southwest winds, fewer stacks line up as upwind/downwind and much less merging would be expected. With this wind direction, arguably some stacks' emissions would not be expected to merge with any other stack's emissions, some stacks' emissions would be expected to merge with one other stacks' emissions, and most stacks' emissions would be expected to merge as part of a group of three stacks. That is, for this wind direction for the stacks at Potline 2, a more appropriate characterization of the likely degree of plume merging might be to use twelve stacks merging an average of three stacks each.

We will need more discussion of a more appropriate means of characterizing the degree of plume merging that can be expected for each of the pertinent sets of stacks. Useful information for those discussions might be whether any wind directions are of particular interest. In any case, considering all the information in the journal article mentioned above, and the full spectrum of wind directions, EPA believes the Protocol is overstating the merging that may actually be occurring at the smelter sources.

- **Receptor Grid**

  The proposed resolution of the receptor grid network is acceptable, with 50 meter spacing along the fenceline and varying resolution out to 50 kilometers. Receptors must be placed in areas that are considered ambient air. The property boundary must be consistent with EPA's ambient air policy which allows modeled receptors to be excluded from areas that are controlled by the source and which adequately preclude public access, through use of fencing or other effective physical barriers. It's unclear from the submittal if effective barriers surround the facility and this should be confirmed. For DRR purposes, receptors do not need to be placed over bodies of water. Additionally, receptors should be placed on Culley property unless it can be shown that the business relationship between Culley and ALCOA allows ALCOA control over access to that property or that placement of a monitor on Culley property is infeasible.

[2] Macdonald, R.W., Strom, R.K; Slawson, P.R.; 2002. Water flume study of the enhancement of buoyant rise in pairs of merging plumes, Atmospheric Environment, 36, pages 4603-4615.

Thank you again for sending the DRR modeling information for ALCOA. EPA remains committed to work with you toward resolution of these issues and is available for future discussions. If you have additional questions about this matter, please contact me or Randy Robinson, of my staff, at (312) 353-6713.

Sincerely,

Pamela Blakley

Pamela Blakley
Chief
Control Strategies Section
Air and Radiation Division

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

OCT 17 2017

REPLY TO THE ATTENTION OF

Keith Baugues
Assistant Commissioner
Office of Air Quality
Indiana Department of Environmental Management
100 North Senate Avenue
Indianapolis, Indiana 46204

Dear Mr. Baugues:

Thank you for the October 5, 2017 letter requesting U.S. Environmental Protection Agency Region 5's approval of the Data Requirement Rule (DRR) modeling protocol for the Alcoa Warrick LLC (ALCOA) facility. In a letter dated August 31, 2017, EPA Region 5 highlighted the areas of the protocol which were considered to be problematic. The most recent protocol, dated September 2017, was developed in response to Region 5 comments.

We have reviewed the protocol and find that the configuration of AERMOD as proposed in Section 5.1 is acceptable for use in these circumstances. Specifically, we agree with the use of urban dispersion coefficients, building downwash, and the merging of stacks in accordance with the protocol for the smelting operations. Similarly, the modeling of the Warrick and Culley power plant stacks with downwash and rural dispersion coefficients is acceptable. The site-specific air quality monitoring data that you have provided was a significant factor in evaluating the reasonableness of the above options.

We are still reviewing the appropriateness of the proposed ambient air boundary around the facility and understand that additional justification is being prepared and will be submitted with the DRR modeling later this month.

Thank you again for your assistance in moving this process toward a successful resolution. We look forward to evaluating the actual DRR air quality modeling once it is completed and submitted for review. If you have any questions, please contact me or Randy Robinson, of my staff, at (312) 353-6713.

Sincerely,

Edward Nam
Director
Air and Radiation Division

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Attachment F

ALCOA SO_2 Field Monitoring Information

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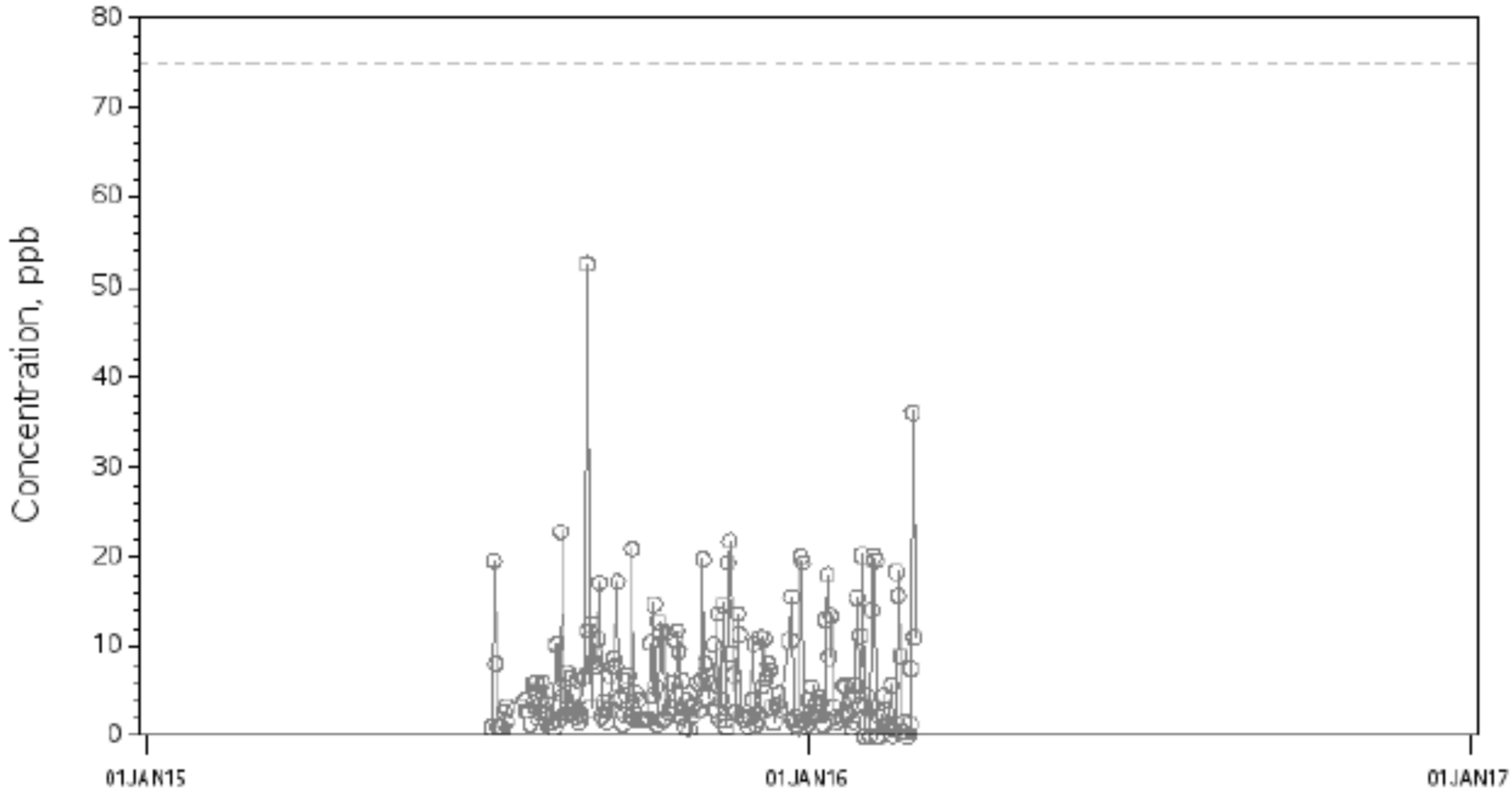
Daily Max 1-hour SO2 Concentrations from 01/01/15 to 12/31/16

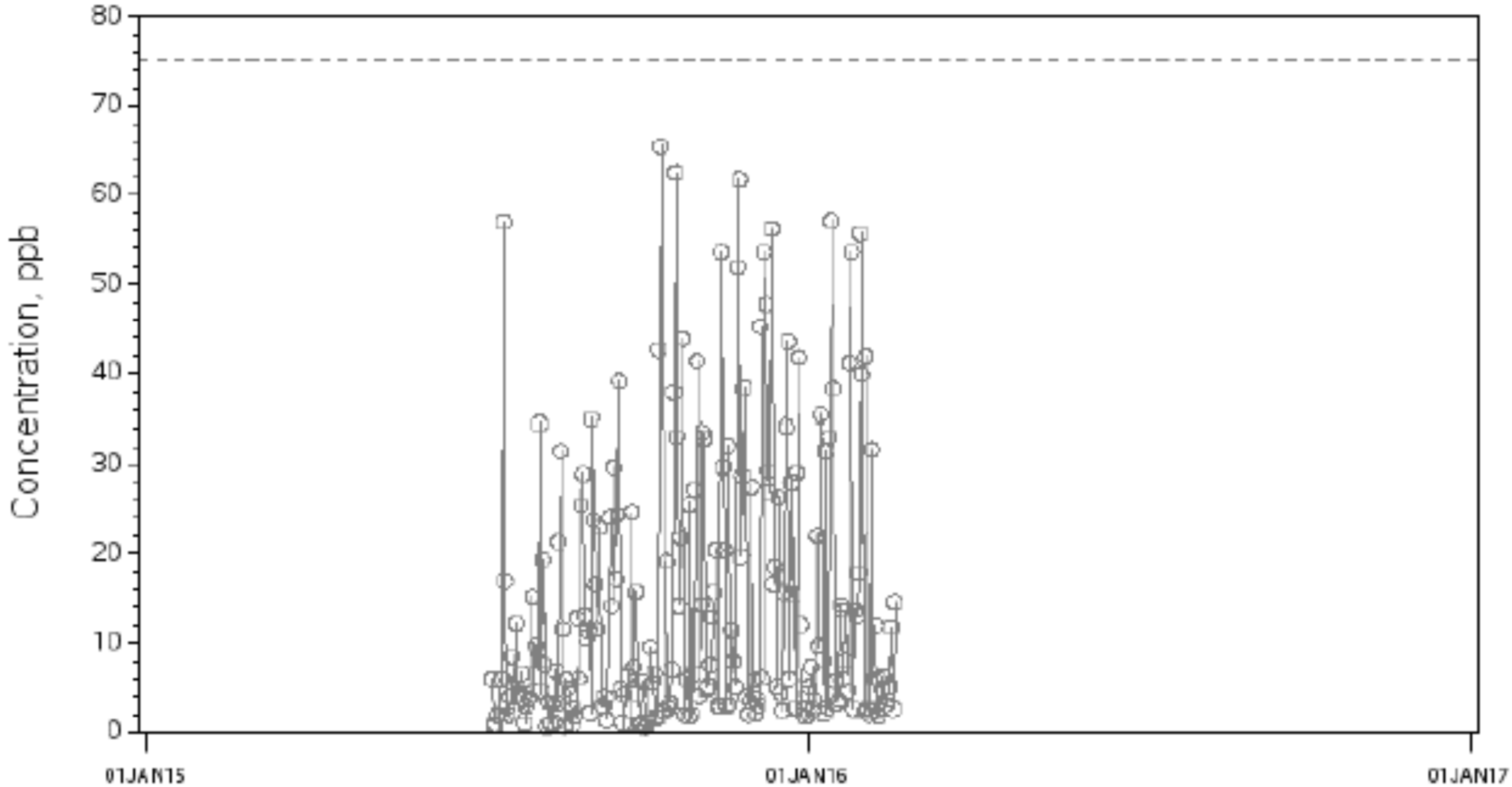
Parameter: Sulfur dioxide (Applicable standard is 75 ppb)
CBSA: Evansville, IN-KY
County: Warrick
State: Indiana
AQS Site ID: 18-173-0002, poc 1



Source: U.S. EPA AirData <https://www.epa.gov/air-data>
Generated: October 12, 2017

Daily Max 1-hour SO2 Concentrations from 01/01/15 to 12/31/16

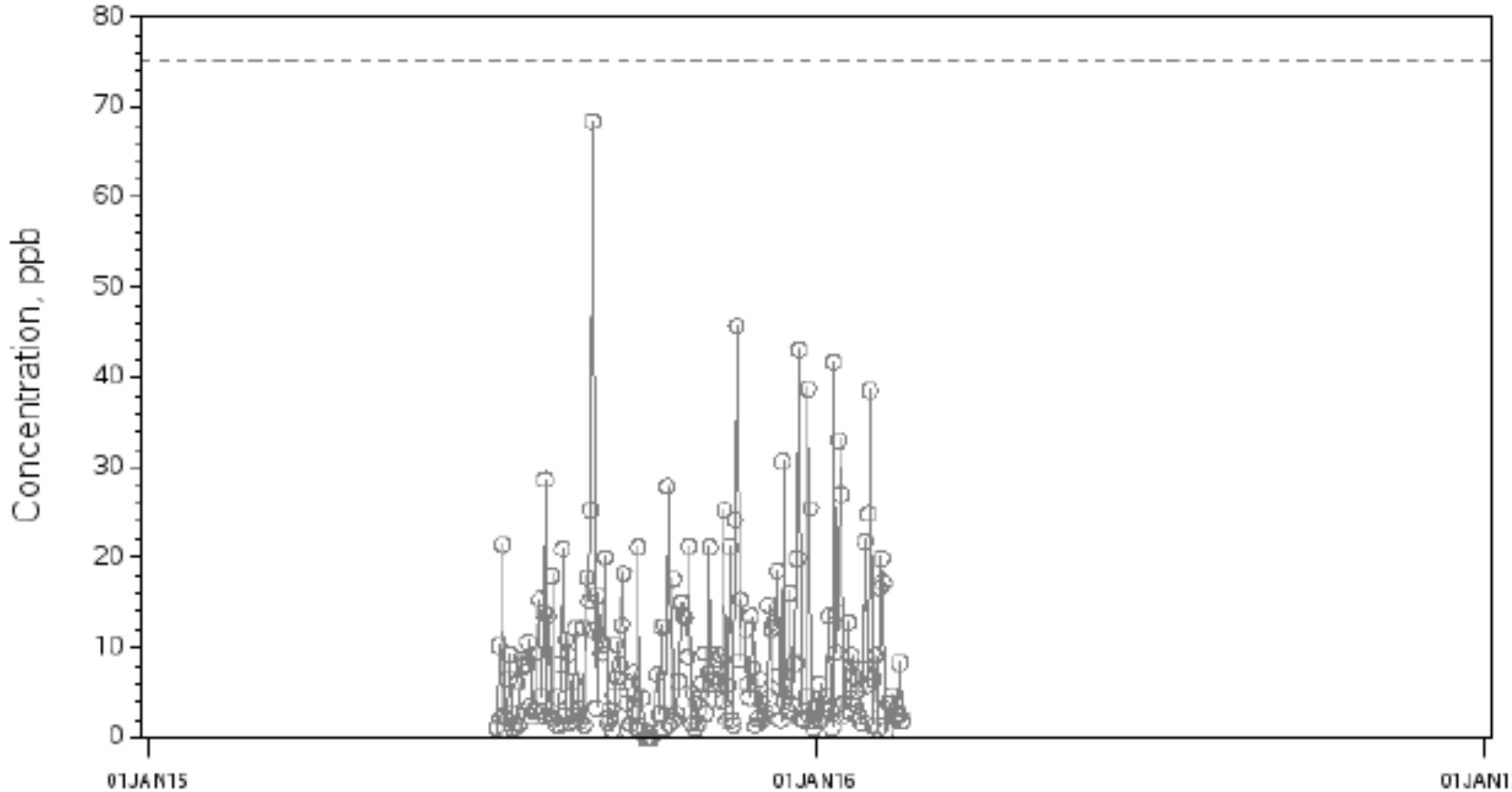
Parameter: Sulfur dioxide (Applicable standard is 75 ppb)
CBSA: Evansville, IN-KY
County: Warrick
State: Indiana
AQS Site ID: 18-173-0004, poc 1



Source: U.S. EPA AirData <https://www.epa.gov/air-data>
Generated: October 12, 2017

Daily Max 1-hour SO2 Concentrations from 01/01/15 to 12/31/16

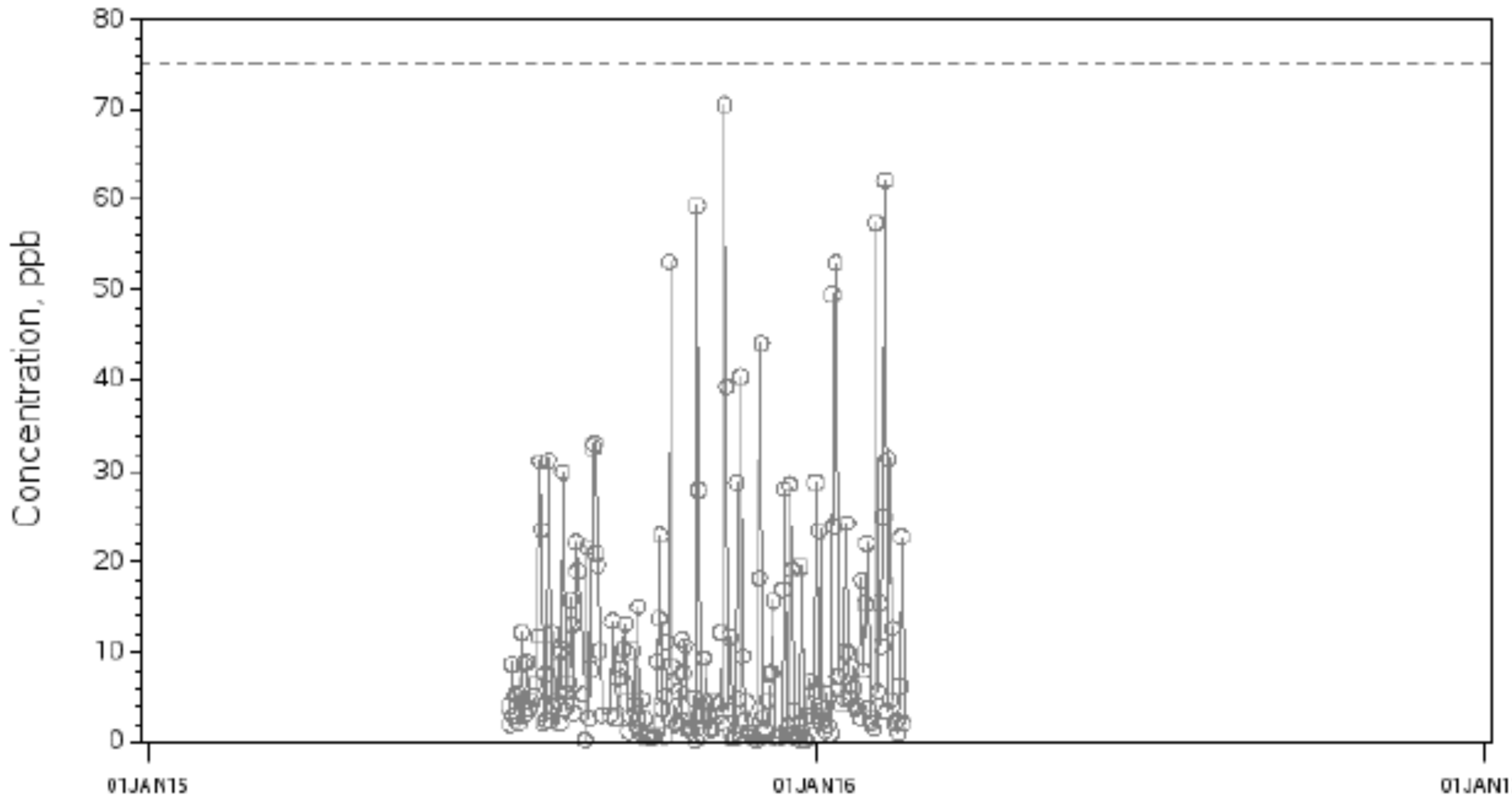
Parameter: Sulfur dioxide (Applicable standard is 75 ppb)
CBSA: Evansville, IN-KY
County: Warrick
State: Indiana
AQS Site ID: 18-173-0005, poc 1



Source: U.S. EPA AirData <https://www.epa.gov/air-data>
Generated: October 12, 2017

Daily Max 1-hour SO2 Concentrations from 01/01/15 to 12/31/16

Parameter: Sulfur dioxide (Applicable standard is 75 ppb)
CBSA: Evansville, IN-KY
County: Warrick
State: Indiana
AQS Site ID: 18-173-0012, poc 1



Source: U.S. EPA AirData <https://www.epa.gov/air-data>
Generated: October 12, 2017

IDEM

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

We Protect Hoosiers and Our Environment.

100 N. Senate Avenue • Indianapolis, IN 46204

(800) 451-6027 • (317) 232-8603 • www.idem.IN.gov

Michael R. Pence
Governor

Carol S. Comer
Commissioner

September 29, 2015

Mr. Samuel H. Bruntz
Alcoa Inc. – Warrick Operations
4700 Darlington Road
P.O. Box 10
Newburgh, IN 47630-0010

Dear Mr. Bruntz:

Re: **Evaluation of the Alcoa – Warrick Operations Ambient Air Monitoring Network**

In July 2015, Alcoa – Warrick Operations expanded its sulfur dioxide monitoring network to collect a full-year ambient sulfur dioxide database to calibrate a site-specific air quality model. On September 2 - 3, 2015, Nikki Jeffers and James Roane from the Quality Assurance Section of the Office of Air Quality (OAQ) met with you and Air Quality Services staff to conduct a performance evaluation of the sulfur dioxide analyzers and meteorological equipment (wind speed, wind direction, and outdoor temperature) located at the Alcoa – Warrick Operations ambient air monitoring network. The performance evaluation is a quantitative assessment of each measurement parameter device relative to a known or expected value and was performed in accordance with criteria outlined in the IDEM OAQ Quality Assurance Manual.

Site Evaluation Results

The four monitoring sites are located in the northeast quadrant surrounding the Alcoa – Warrick Operations complex. Sites designated as S-1, S-2, and S-3 contain a monitoring shelter housing a continuous sulfur dioxide (SO_2) analyzer (Thermo Scientific model 43i), an ESC data logger, a gas calibrator (Thermo Scientific model 146i) and other ancillary equipment. The P-2 site has a similar setup along with an open grid 10 meter meteorological tower and a 2 meter outdoor temperature probe.

- Each shelter was clean and well organized.

- Each monitoring site is located away from buildings or other obstacles that may scavenge SO_2 and that can restrict airflow to the inlet (ref: 40 CFR 58 Appendix E §4(a)).

- Each monitoring site is located such that the distance from the inlet probe to any nearby trees is greater than 10 meters to the tree drip-line (ref: 40 CFR 58 Appendix E §5(a)).

- The height of each inlet above the ground was within the requirement of 2 to 15 meters for SO_2 monitors.

    - S-1: 3.81-m
    - S-2: 4.11-m
    - S-3: 3.96-m
    - P-2: 3.98-m

  The inlet probes are for the most part away from dusty or dirty areas. Because sites S-1 and S-3 are located on agricultural fields, the issue of a dusty particulate atmosphere may occur during the corn harvest (ref: 40 CFR Part 58 Appendix E §2).

During the evaluation, no major problems were noted with the ancillary equipment within the shelter:

- Shelter temperature at each monitoring site was within ± 2.0 °C of the QA temperature value.

- Values from the analyzer, chart recorder, and data logger were in agreement.

- The on-site gas dilution calibrators and SO_2 gas cylinders were all within their certification periods.

Site	Gas Dilution Calibrator	SO_2 gas cylinder	Certification Date
S-1	Thermo Model 146i s/n 1150560116	FF40704	July 17, 2015
S-2	Thermo Model 146i s/n 11505600117	FF22943	April 9, 2015
S-3	Thermo Model 146i s/n 115056115	FF40732	August 31, 2015
P-2	Thermo Model 146i s/n 708620524	CC131989	July 21, 2015

One item that warrants further investigation is the sample residence time at each monitoring site. Because sulfur dioxide is a reactive gas, the sample residence time (the time for the gas to transfer from the probe inlet to the sampler) needs to be less than 20 seconds (ref: Quality Assurance Handbook for Air Pollution Measurement Systems, vol. 2, EPA-454/B-13-003, May 2013). The residence time for the sample tubing can be calculated using the following equation:

$$residence\ time, seconds = \frac{\left[\pi \times \frac{(inner\ diameter, cm)^2}{4} \times Length, cm\right]}{Flow, lpm} \times \frac{1\ liter}{1000\ cm^3} \times \frac{60\ seconds}{1\ minute}$$

For example, if one considers a 20-ft (609.6-cm) length of ¼-inch sample line with an inner diameter of 1/8" (0.3175 cm) and a flow rate of 0.5 lpm, the residence time calculates to be 5.8 seconds. If a larger diameter sample line (inner diameter of 3/16" (0.47625-cm) is substituted in the previous example, the residence time calculates to be 13.0 seconds. If a sampling path includes a moisture trap (e.g., a volumetric flask) that adds to the sampling path volume, the additional residence time due to that item can be determined using the volume of the flask and the sample flow rate.

Performance Evaluation Results

Sulfur Dioxide Analyzers

A Sabio gas calibrator (Model 2010, s/n 03050906A, certified 6/23/15) and a Praxair SO_2 gas cylinder (cylinder FF17530, 30.08 ppm, certified 07/14/15) were used to audit the SO_2 analyzer at the S-1 monitoring site. An ESC gas calibrator (Model 7700P, s/n 0111, certified 5/19/15) and a Mittler SO_2 gas cylinder (cylinder EA0001644, 40.36 ppm, certified 06/03/15) were used to audit the SO_2 analyzer at the S-2, S-3, and P-2 monitoring sites. Each site analyzer was challenged with the following sequence of concentrations:

- a zero contaminant air concentration,
- a Level 9 accuracy audit SO_2 concentration (range 0.2600 - 0.7999 ppm),
- a Level 8 accuracy audit SO_2 concentration (range 0.1500 – 0.2599 ppm),
- a Level 6 accuracy audit SO_2 concentration (range 0.0500 - 0.0999 ppm), and
- a zero contaminant air concentration.

The SO_2 performance audit at each monitoring site was satisfactory with the results presented in Table 1. The limit of 15% in Table 1 is based on the accuracy limit prescribed in Appendix D of the EPA Quality Assurance Handbook for Air Pollution Measurements, Vol. 2: Ambient Air Quality Monitoring Program, EPA-454/B-13-003, May 2013.

Table 1. Sulfur Dioxide Performance Evaluation Results.

Site	Observed Concentration, ppb	Audit Concentration, ppb	Difference	Limit
ALCOA-Warrick Operations – S1 (AQS No. 18-173-0004) Thermo 43i, s/n 1150560114 Calibration date Jul 17, 2015	0.2	0.0	0.2 ppb	±15%
	263.0	296.4	-11.3%	
	154.0	165.5	-7.0%	
	70.6	74.9	-5.7%	
	0.2	0.000	0.2 ppb	
ALCOA-Warrick Operations – S2 (AQS No. 18-173-0005) Thermo 43i, s/n 1150560113 Calibration date Aug 18, 2015	0.5	0.0	0.5 ppb	±15%
	275.0	286.0	-3.8%	
	158.0	163.9	-3.6%	
	72.8	75.8	-4.0%	
	0.8	0.0	0.8 ppb	
ALCOA-Warrick Operations – S3 (AQS No. 18-173-0012) Thermo 43i, s/n 115056112 Calibration date Aug 31, 2015	0.4	0.0	0.4 ppb	±15%
	275.0	286.9	-4.2%	
	158.0	163.9	-3.6%	
	73.2	75.8	-3.4%	
	0.8	0.0	0.8 ppb	
ALCOA-Warrick Operations – P2 (AQS No. 18-173-0002) Thermo 43i, s/n JC130700750 Calibration date Aug 21, 2015	0.6	0.0	0.6 ppb	±15%
	267.0	286.0	-6.6%	
	152.0	162.9	-6.7%	
	70.7	76.0	-6.9%	
	0.9	0.0	0.9 ppb	

Meteorological Monitors

The evaluation results of the meteorological parameters were satisfactory and are presented in Table 2. At the P-2 monitoring site, the wind monitor (R. M. Young Model 05305VP) is mounted on an open grid 10-m tower and the temperature probe (R. M. Young Model 41342VC) is mounted on the fence 2-m above the ground. The shaft speed of the wind speed sensor (R.M. Young Model 05365) was verified using a NIST traceable synchronous motor (Young Selectable Speed Calibrating Unit Model 18801, s/n CA01616, certified November 17, 2014). The wind direction sensor was verified using the site established reference point, which was checked with a Brunton pocket transit compass. The ambient temperature sensor was verified using a water bath of different temperatures and a NIST traceable temperature probe (VWR Model 100A, s/n C469996, certified August 20, 2015). Because the sulfur dioxide data will be used for modeling purposes, the limits prescribed in Table 2 are based on the modeling application accuracy limits defined in Table 0-10 of the EPA Quality Assurance Handbook for Air Pollution Measurements, Vol. IV: Meteorological Measurements, version 2.0, EPA-454/B-08-002, March 2008.

Table 2. Meteorological Parameters Performance Evaluation Results.

Parameter	Observed Value	Audit Value	Difference	Limit
Outdoor Temperature, (° C)	0.32	0.1	0.2	± 0.5°C
	26.24	26.1	0.1	
	48.66	48.6	0.1	
Wind speed (mph)	0.01	0.00	0.01	±0.45 mph (±0.2 m/s)
	4.56	4.58	-0.02	
	11.44	11.45	-0.01	
	22.92	22.90	+0.02	
	57.32	57.27	+0.05	
Wind direction (degrees)	360.4	360	+0.4	± (3-5)°
	176.2	180	-3.8	

Requirement

The sample residence time must be calculated for each monitoring site. If the sample residence time is less than twenty seconds, the calculation result for each monitoring site (e.g., a simple spread-sheet) must be included as an addendum to the Quality Assurance Project Plan (QAPP). If the sample residence time is determined to be greater than twenty seconds, changes to the sampling path must be initiated to decrease the residence time. The changes to the sampling path needed to meet the required residence time must be documented in the QAPP. These changes could include, but are not limited to,

- shortening the overall length of sample line,
- increasing the flow rate,
- decreasing the volume of the moisture trap,
- removing the moisture trap and using heat tape to prevent condensation formation,
- addition of a manifold and blower system, or
- a combination of changes.

In either case, please respond with a letter identifying the residence time at each monitoring site and what corrective actions, if any, were instituted to meet the twenty second residence time requirement.

Overall, the Alcoa-Warrick Operations ambient air-monitoring network was found to be operating effectively. Other than the potential issue with the sample residence time, no major problems were observed with the monitoring sites, monitoring equipment, calibration and audit equipment, operating procedures, and the data collection procedures.

We appreciate the time and effort provided by Mr. Jim Jamerson (Alcoa – Warrick Operations), Air Quality Services staff (Pam Block and Leslie Ashley), and yourself in assisting with this evaluation. If you have any questions or comments, please feel free to contact me by telephone at (317) 308-3257 or by e-mail at jwicker@idem.in.gov. You may direct correspondence to 100 N. Senate Avenue, MC 61-50-2 Shadeland, Indianapolis, IN 46206-2251.

Sincerely,

John W. Wicker, Chief
Quality Assurance Section
Air Monitoring Branch
Office of Air Quality

JWW/jer

ALCOA

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Certified Mail No. 7015 0640 0004 5075 0138

2015 November 9

Mr. John W. Wicker, Section Chief
Indiana Department of Environmental Management
Quality Assurance Section
Office of Air Quality / Air Monitoring Branch
100 N. Senate Avenue
Indianapolis, IN 46204

RE: Response to Evaluation of the Alcoa – Warrick Operations Ambient Air Monitoring Network Performance Evaluation Findings

In response to your letter to me dated September 29, 2015, Alcoa Inc. – Warrick Operations has asked its contractor Air Quality Services to evaluate the issues raised by your office with respect to the issue raised in your letter regarding sample residence time.

Air Quality Services, LLC (AQS) subsequently performed an evaluation of the existing sample lines for each of the four monitoring sites. The sample residence time of each site was found to be greater than 20 seconds when the volume of the moisture trap (182 ml) was included with the sample line volume. The details and variables of this evaluation are included in Attachment 1, Table 1. It should be noted that the minimum recorded analyzer flow rate for each site analyzer was conservatively used in the evaluation. Table 2 of Attachment 1 is an evaluation of the sample residence time with the moisture trap removed for each monitoring site. As demonstrated, the residence time is reduced to less than 20 seconds when the moisture trap is removed.

CORRECTIVE ACTION

Sample line moisture is an issue with any ambient monitoring program, particularly in the summer months when hot, humid air is pulled from the outside into an air conditioned shelter. The humid air will condense with the sudden change in temperature. Simply removing the moisture trap to reduce the sample path volume would leave the monitoring sites vulnerable to moisture in the lines, which could potentially interfere with the sample concentration or damage the analyzer. Therefore, in addition to removing the moisture trap, AQS has taken the following actions:

1. The particulate filter holder was moved from the back of the instrument to the location of the moisture trap. A small amount of volume (54 ml) is available within the filter holder for moisture, if needed. By moving the filter holder away from the analyzer, the risk of moisture reaching the analyzer is reduced.

2. The sample line has been insulated with Armaflex ½" insulation to maintain the outdoor air temperature of the sample to the analyzer inlet. Without the sudden change in
temperature, the chance of condensation is reduced.
3. The shelter temperature has been increased during the warm months to reduce the
temperature differential and, thus, the condensation. When the ambient temperature rises during the spring and summer months of 2016, AQS will monitor the sample lines very closely for any signs of moisture. Should moisture be seen, then the sample lines will be heated with heat trace so the temperature differential is eliminated. If this step is found necessary, your office will be notified immediately to document this change.

QAPP / MONITORING PLAN DOCUMENTATION

The Ambient Air Monitoring Plan for this project was revised and submitted to IDEM in August of 2015. Although the corrective action outlined above did not affect the Monitoring Plan directly, the following Standard Operating Procedures are affected as detailed:
□□Weekly Site Check Procedure, Section D (SOP ID: AQS-AM-05)
o Attachment 1 – Weekly Site Check Sheet
□□Equipment Installation and Programming Procedure, Section B (SOP ID: AQS-AM-07)
o Attachment 1 – SO2 Analyzer and Calibrator "Plumbing" Diagram

Revised copies of these Standard Operating Procedures and affected attachments are included within Appendix A, herein. The "track changes" feature was used to clarify the revisions made.

CONCLUSION
The existing moisture traps on the sample lines of each monitoring site increased the sample path volume so that the residence time was greater than the 20 seconds listed within Section 7 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 2. The above described changes have been implemented. Heat trace will be added to the sample lines if moisture is found evident during the warm summer months.

Sincerely,

Samuel H. Bruntz
Sr. Staff Environmental Engineer

ATTACHMENT 1: RESIDENCE TIME EVALUATION

TABLE 1: Calculated Residence Time - With Moisture Trap

Site	Moisture Trap Volume (cm^3)	Filter Cartridge Volume (cm^3)	Sample Line Length (cm)	Sample Line Volume (cm^3) [1]	Total Volume (cm^3)	Total Volume (liters)	Lowest Recorded Analyzer Flow Rate (lpm)	Residence Time (m)	Residence Time (s) [2]
S1	182	54	891.5	70.58	306.58	0.306583	0.447	0.685868	41.15
S2	182	54	802.6	63.54	299.54	0.299544	0.452	0.662709	39.76
S3	182	54	886.5	70.19	306.19	0.306187	0.443	0.691167	41.47
P2	182	54	550.4	43.58	279.58	0.279577	0.467	0.598666	35.92

TABLE 2: Calculated Residence Time - Without Moisture Trap

Site	Moisture Trap Volume (cm^3)	Filter Cartridge Volume (cm^3)	Sample Line Length (cm)	Sample Line Volume (cm^3) [1]	Total Volume (cm^3)	Total Volume (liters)	Lowest Recorded Analyzer Flow Rate (lpm)	Residence Time (m)	Residence Time (s) [2]
S1	182	54	891.5	70.58	124.58	0.124583	0.447	0.278709	16.72
S2	182	54	802.6	63.54	117.54	0.117544	0.452	0.260054	15.60
S3	182	54	886.5	70.19	124.19	0.124187	0.443	0.280332	16.82
P2	182	54	550.4	43.58	97.58	0.097577	0.467	0.208944	12.54

[1] **Sample lines are 1/4 Teflon, inside diameter = 0.3175 cm, volume = $\Pi(0.3175)^2/4)$ * length**
[2] **Residence Time, seconds = Total Volume, cm^3 * 1/Flow Rate, lpm * 1 liter/1000 cm^3 * 60 sec/min**

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APPENDIX A

Modifications to the Standard Operating Procedures
(Changes are Tracked or Highlighted)

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ALCOA AMBIENT AIR MONITORING NETWORK
STANDARD OPERATING PROCEDURE

WEEKLY SITE VISITS

1.0 PURPOSE / SCOPE

The purpose of this document is to provide a uniform standard operating procedure (SOP) for performing weekly site visits at ambient air monitoring sites.

2.0 RESPONSIBILITIES

The Alcoa laboratory staff shall follow this SOP at Site P2. AQS Field Technicians shall follow this SOP at Sites S1, S2, and S3.

3.0 EQUIPMENT AND MATERIALS

Site Service Check Sheets and a site logbook are to be maintained on-site. Example Weekly Site Check Sheets are included as Attachment 1. For the Bi-weekly chart recorder download (Item 4.E), a laptop and USB card reader are required.

4.0 WEEKLY SITE VISIT PROCEDURE

The ambient air monitoring sites are visited weekly to ensure that the physical location and the monitoring equipment are operational and undamaged by the elements or tampering.

A. Analyzer Check

1. Push the "MENU" button on the analyzer and, using the ↓ arrow key, scroll down to *Range*. Hit "ENTER". Record the range setting in the appropriate blank on the Weekly Check Sheet. The range setting, 0 – 0.500 ppm, was entered during the initial set-up of the system and should not be changed.

2. Push the "MENU" button on the analyzer and, using the ↓ arrow key, scroll down to *Calibration Factors* and record both the background and coefficient on the Weekly Check Sheet. Push the "MENU" button on the analyzer. NOTE: Although the background factor will fluctuate a bit from one visit to another, the coefficient will not change unless the analyzer is recalibrated. A change in coefficient value is an indication of tampering. Call the Project Manager.

3. From the *Main Menu*, scroll down to *Diagnostics*. Hit "Enter". Scroll through to locate *Interface Voltages*, *Internal and Chamber Temperatures*, *Pressure*, *Flow Rates*, and *Lamp Intensity*, as listed on the Site Service Check Sheet. Hit "Enter" at each diagnostic and record the values indicated on the screen in the appropriate blanks on the Check Sheet. Compare each entry on the Check Sheet with the entries from preceding visits to determine if there has been a precipitous change in any parameter or if there is an ongoing trend toward an unacceptable status in any

parameter. If such change or trend in noted, consult the trouble-shooting section of the instrument manual. When all diagnostics have been checked and recorded, push the "Menu" button and scroll down to *Alarm*, the last option under *Menu*. Hit "Enter". If there are no alarms indicated, enter "0" or "None" on the Site Service Check Sheet. Exit Alarm by pushing the "Menu" button.

NOTE: An alarm is indicated only until the parameter is back within acceptable limits. They are not indicated until acknowledged by the system operator. If an alarm is indicated, scroll through the listed parameters to the one in alarm. Hit "Enter". The screen will indicate the current reading and the acceptable range for that specific parameter. Correct the problem, if possible, using the instrument operator's manual for guidance.

4. If you are unable to diagnose and correct a problem indicated either by a significant change from previous check sheet entries or by an Alarm, call the Project Manager.

5. Hit "Enter" to return to *Menu*. Hit "Run" to put the analyzer back on-line. The word "Remote" should appear on the screen when the analyzer is on-line.

6. Verify that the analyzer is in Sample Mode. The word SAMPLE will be evident in the status bar of the analyzer display.

B. Calibrator Check

1. From the *Main Menu*, choose "Diagnostics" and record the voltages and internal temperature values on the Site Service Check Sheet.

2. The nightly zero and span will not run if the calibrator is in Standby. Hit the "Run" button. If the word "Standby" is evident, choose "flow modes" and "gas dilution" from the menu to turn off Standby.

C. MET and Miscellaneous Checks (MET is at Site P2 Only)

Miscellaneous items to be checked and recorded on the Site Service Check Sheet during each weekly visit include:

- Visually look at the tower to see if any obvious damage to the tower or instruments is evident. (P2 only)
- Visually observe the wind speed and wind direction and compare those observations to the values displayed on the data logger screen. (P2 only)
- Listen to the temperature sensor aspirator motor. Can it be heard running? Enter Y or N on the Check Sheet. At the first visit of the month, open up the aspirator shield and wipe out any dust or debris. (P2 only)
- Maximum and minimum ambient shelter temperatures – Remember to re-set the max-min thermometer after recording the high and low for the week. Shelter

temperature must be maintained between 15° and 33°C. If the temperature is found outside these limits, check that the heating and/or AC is on for the appropriate season and contact the Project Manager.

- Record the cylinder pressure – adjust to 30 psi if needed.
- Record the cylinder delivery pressure, if less than 500 psi, a new cylinder should be ordered.

D. Other Considerations

In addition to the weekly site check regimen, the following routine maintenance tasks should be performed (as required) during the weekly site visits:

- As air is pulled into the sample line, there is a threat of condensation building inside the line, particularly during the hot, humid months. This is a serious problem. The sample line has been wrapped in insulation to alleviate this problem. In addition, should any residual moisture be present, the inline particulate filter and associated filter holder have an added benefit of collecting the moisture before it reaches the analyzer. As such, this filter holder should be checked each week for moisture. ~~moisture trap is in place to remove any moisture in the sample before it gets to the analyzer.~~ If moisture is ~~only~~ present, remove the filter holder, dry it out with a clean towel and replace the filter. ~~in the trap, dump it out.~~ If moisture ~~it~~ is evident in the line ~~after moisture trap~~, assure that it has not reached the analyzer. The line may need to be blown out and dried with zero air. ~~Also, if the moisture reached the in-line filter, it must be changed.~~ Record these findings in the logbook. If moisture has reached the analyzer, call the Project Manager.
- There is also a moisture trap and filter in the zero air unit. Empty any moisture present by turning the knob on the base left and allowing it to trickle into a cup.
- Replace the in-line sample filter on the back of the analyzer monthly or as needed. Leak check the system after a filter change.
- Clean the porous filters on the cooling fan inlets on the backs of the instruments monthly or as needed.
- Change the desiccant in the calibration gas generator as needed by observing the color change of the desiccant. If the color change is between 1 and 2 inches of the cylinder, it is time to change the desiccant.
- Change the charcoal in the calibration gas generator at least once every six months. Make note of this on the Check Sheet and in the site logbook.
- Verify that the data logger and the chart recorder time are within two (2) minutes of the time observed on an atomic clock (cell phone clock will serve for this). Adjust as necessary. All station time devices must remain on local standard time throughout the year.

- Verify that the analyzer, data logger, and chart recording ambient concentration readings are within 0.002 ppm of each other. If one of these is not, then the linearity of the devices may need to be calibrated. Check with the Project Manager.

E. Yokogawa Chart Recorder Data Download

The Yokogawa chart recorder data is downloaded, at a minimum, once every two (2) weeks. The memory card (CF Card) is removed from the recorder and downloaded onto a laptop using a card reader. Step-by-step instructions to remove the card, copy the data, and reinsert the card are included as Attachment 2. These instructions are also in place next to the recorder at each site.

NOTE: Upon completion of any site visit, record the purpose of the visit and all tasks performed during that visit in the Site Logbook, which is to be maintained on-site. It is not necessary to record each reading from the Site Service Check Sheet in the log, just the fact that the site check was performed and a short, descriptive statement describing the findings that were recorded on the Site Service Check Sheet.

ATTACHMENT 1

Alcoa Warrick Operations

WEEKLY CHECK SHEET for P2 AMBIENT SO_2 MONITORING NETWORK

ANALYZER: TEI 43i / SN:			
Service Log Item	**Reading**		
Date			
Range Setting			
Coefficients (Background/Coefficient)	/	/	/
Interface Voltages			
PMT			
Flash			
Internal Temperature			
Chamber Temperature			
Pressure			
Flow Rate			
Lamp intensity			
Alarms (If Yes, note in comments)			
*Sample Line Filter Change (Y/N)			
*Cooling Filter Cleaned (Y/N)			
Desiccant Changed (Y or OK)			
Carbon Changed 6-mos (Y/N)			

CALIBRATOR: TECO Model 146i / SN:			
Service Log Item	**Reading**		
Internal Temperature			
Confirm Standby OFF (Ok?)			

MISCELLANEOUS			
Service Log Item	**Reading**		
MET Tower OK			
Wind speed indicator OK			
Wind direction indicator OK			
Temp Sensor Aspirator Motor OK			
*Aspirator Motor Wipe Down			
Max / Min Temperature			
Cylinder Pressure (psi)			
Delivery Pressure (psi)			
Sample Pump OK			
Moisture in lines, filter holder or zero air (Y/N)			
Reset Modem (if necessary) (Y/N)			
Analyzer/Data Logger/Ch Recorder Time	/ /	/ /	/ /
Analyzer/Data Logger/Ch Recorder Conc	/ /	/ /	/ /
Operator Initials			

**** Replace/clean first week of the month at minimum***

COMMENTS / ALARMS AND CORRECTIVE ACTIONS

ATTACHMENT 1

Alcoa Warrick Operations
WEEKLY CHECK SHEET for AMBIENT SO_2 MONITORING NETWORK

"S" Site ID #: _______________

ANALYZER: TEI 43i / SN:			
Service Log Item	**Reading**		
Date			
Range Setting			
Coefficients (Background/Coefficient)	/	/	/
Interface Voltages			
PMT			
Flash			
Internal Temperature			
Chamber Temperature			
Pressure			
Flow Rate			
Lamp intensity			
Alarms (If Yes, note in comments)			
*Sample Line Filter Change (Y/N)			
*Cooling Filter Cleaned (Y/N)			
Desiccant Changed (Y or OK)			
Carbon Changed 6-mos (Y/N)			

CALIBRATOR: TECO Model 146i / SN:			
Service Log Item	**Reading**		
Internal Temperature			
Confirm Standby OFF (Ok?)			

MISCELLANEOUS			
Service Log Item	**Reading**		
Max / Min Temperature			
Cylinder Pressure (psi)			
Delivery Pressure (psi)			
Sample Pump OK			
Moisture in lines, filter holder or zero air (Y/N)			
Reset Modem (if necessary) (Y/N)			
Analyzer/Data Logger/Chart Recorder Time	/ /	/ /	/ /
Analyzer/Data Logger/Ch Recorder Conc	/ /	/ /	/ /
Operator Initials			

**** Replace/clean first week of the month as minimum***

COMMENTS / ALARMS AND CORRECTIVE ACTIONS

ALCOA AMBIENT AIR MONITORING NETWORK STANDARD OPERATING PROCEDURE

EQUIPMENT INSTALLATION AND PROGRAMMING

1.0 PURPOSE / SCOPE

The purpose of this document is to provide a uniform standard operating procedure (SOP) for installing and programming the monitoring and data handling system of an ambient air SO_2 monitoring site. This SOP describes the general setup and layout of the site. This SOP is not intended to be a stand alone document but rather is intended to accompany the equipment user manuals for the programming of instrumentation. Documentation is included herein to provide specific programming parameters and settings.

At no time should a field technician attempt to program the instrumentation of the ambient monitoring equipment unless under the direct supervision of the Project Manager either in person or via telephone.

2.0 RESPONSIBILITIES

- Project Manager
- Field Technician at the direction of the Project Manager

3.0 EQUIPMENT

A listing of the site specific equipment for each of the Alcoa monitoring sites is included as Attachment 6. This listing also includes the site operational dates and the site specific AQS codes. Attachment 7 is a listing of materials and documents that will be kept at each monitoring site.

A. Shelters

Each of the four (4) ambient monitoring sites is equipped with an EKTO Monitoring Shelter. There are no windows in any of these shelters, so all instrumentation is protected from exposure to sunlight. The shelters allow for adequate space to maneuver around the instruments and they are equipped with 120V electric service. Heating and air conditioning are in place to assure that the shelter temperature is maintained between 15 and 33°C. Each shelter is equipped with a fire extinguisher.

The shelter at P2 is 8x8x8 feet, and is equipped with a 10-meter tower for the wind speed and wind direction instrumentation. The tower is accessed by a permanent access structure which meets the safety criteria of Alcoa.

The EKTO shelters at S1 and S3 are 8x8x14 feet, and the shelter at S2 is 8x8x16 feet. These shelters were recently moved from the Alcoa plant and have historically been used to house continuous emissions monitors.

B. SO_2 Monitoring Equipment

- TEI Model 43i SO_2 Analyzer
- TEI Model 146i Calibrator
- ESC Model 8816 or 8832 Data Logger
- Wilkerson Wall Mounted Zero Air Supply, including 1/3 hp pump, air line filter, 3/8" regulator, pressure gauge, two (2) desiccant dryers, activate carbon, and desiccant material
- Yokogawa Electronic Chart Recorder Model DX1006-3-4-2
- In-line solenoid (¼")
- ¼" Teflon® tubing
- ¼" Teflon® union tees
- ¼" Teflon® unions
- ¼" Teflon filter holder~~Moisture trap system: Erlenmeyer flask – 125 ml, air flow stopper, bushing, and pinch clamp~~

C. Meteorological Monitoring Equipment

- R.M. Young Model 05305VP Wind Monitor (wind speed and wind direction).
- R.M. Young 41342VC Platinum Temperature Probe (indoor temperature)
- Wiring (CHR) two (2) pair wind monitor; single pair temperature probe
- 10-meter aluminum tilt-down tower equipped with lightning rod
- Surge-protector box

D. Data Storage and Acquisition

- ESC Model 8816 or 8832 Data Logger
- US Robotics 56K Modem
- Yokogawa Electronic Chart Recorder Model DX1006-3-4-2 (Sites S1, S2, and S3)
- Yokogawa Electronic Chart Recorder Model DX1012-3-4-2 (Site P2)
- AirVision software, produced by Agilaire

4.0 EQUIPMENT SET-UP / DESCRIPTION

A. SO_2 Monitoring

Ambient air is pulled through the ¼-inch Teflon® tubing sample line. The sample line inlet is approximately 13 feet above the ground and mounted through either the roof or the side wall of the building. The sample line passes through a Teflon filter holder equipped with an inline particulate filter~~moisture trap~~ and then on to the SO_2 analyzer. The residence time through the sample line is maintained at < 20 seconds. Residence time is calculated based upon the equation presented in Section 4.2.1.3 of the IDEM Quality Assurance Manual.

SO_2 is monitored using a TEI 43i SO_2 monitor. The SO_2 analyzer's internal pump pulls ambient air through the sample line. Concentration levels are displayed on the front of the analyzer.

The analyzer provides a 0 – 1 volt signal, proportional to the SO_2 concentration such that the analyzer slope is set to 0 – 1 V = 0 – 0.500 ppm. This signal is split, delivered to the ESC data logger and the Yokogawa ECR. The data logger stores the digital data first as minute averaged data, and then as hourly averaged data. The chart recorder also collects and stores the digital minute data and is used as a back-up data system.

The SO_2 Monitor is calibrated using the TEI 146i gas dilution calibrator. NIST traceable SO_2 cylinder gas is diluted with scrubbed zero air to deliver the desired SO_2 gas concentration. An external pump is utilized for dilution air. The calibrator is certified as a transfer standard at the IDEM QA Lab. During a calibration, the analyzer will be adjusted as necessary to respond within appropriate variation levels of gas delivered by the calibrator. During an audit, the analyzer will be compared to the known calibration gas to assure the analyzer is operating within limits.

Exhaust air from the analyzer is routed through ¼-inch Teflon® tubing through the floor of the building.

Every 24 hours (usually at or approaching midnight) the calibrator will automatically run a "zero and span". The data logger sends the command to the calibrator to start the nightly zero and span through a simple relay system.

Sample and Exhaust Line Plumbing – All tubing is ¼-inch Teflon®. Fittings are also Teflon® where there is contact with the ambient air sample. All other fittings are either Teflon® or stainless steel. The sample line is replaced every year. The in-line particulate filter holder ~~moisture trap assembly~~ is cleaned with acetone and distilled water when the sample line is changed. A plumbing diagram is included as Attachment 1.

1. Wiring
   a. "Voltage In" to the data logger: Refer to Attachment 2 for a wiring diagram for "Voltage In" to the data logger. The SO_2 analyzer signal is wired to channel 1 of the data logger. The connector for this is inserted into the "1-8" inlet on the back of the analyzer. Pin 2 carries the signal; Pin 1 is the ground. These wires run to the first and second slots of channel 1, respectively, in the "Voltage In" connector on the back of the data logger.
   b. "Voltage Out" of the data logger: The "Voltage Out" option of the data logger is used to trigger the nightly zero and span within the calibrator. A wiring diagram is included as Attachment 3. The second and third outputs from the data logger are wired to the 25-Pin connector on the back of the calibrator. Output #4 is wired directly to the zero air pump.

B. Meteorological Instrumentation

An R.M. Young 05305VP Wind Monitor is used to monitor wind speed and wind direction. The instruments are mounted to a boom extending from a 10-meter tower. The wind monitor is wired from the connector inside the housing of the monitor. From the top of the tower, the wiring is run down the tower, through the wiring conduit of the building, and into a surge protector. From the surge protector, the wiring then goes to the "Voltage In" to the data logger. The shelter temperature probe is wired directly into the data logger. Attachment 2 illustrates this wiring configuration.

5.0 SYSTEM PROGRAMMING

It is not the intention of this SOP to provide step-by-step key strokes for programming the data logger and ECR, but rather to document the programming parameters for reference. The relevant equipment manuals should be consulted for more specific programming steps. These programming parameters can be found in Attachments 4 and 5.

6.0 REMOVE AND REINSTALL CALIBRATOR FOR CERTIFICATION

The TEI 146i rack calibrators are recertified by IDEM each 6 months. It is important that they are removed and reinstalled properly to avoid loss of data.

A. Removing a TEI 146i Calibrator

1. Turn the calibrator off.
2. Carefully remove the signal lines and power cords from the back of the calibrator.
3. Remove Teflon® tubing from the back of the calibrator. NOTE: THE OUTPUT LINE "Ts" INTO THE SAMPLE LINE. REPLACE THE CALIBRATOR LINE AT THE "T" WITH A TEFLON® CAP. This is to prevent the analyzer from sampling shelter air while the calibrator is pulled.
4. Remove the calibrator from the rack.
5. Remove the regulator from the SO_2 gas cylinder and replace the cylinder cap.
6. The calibrator and gas cylinder are now ready for transport to IDEM.

B. Installing a TEI 146i Calibrator After Certification

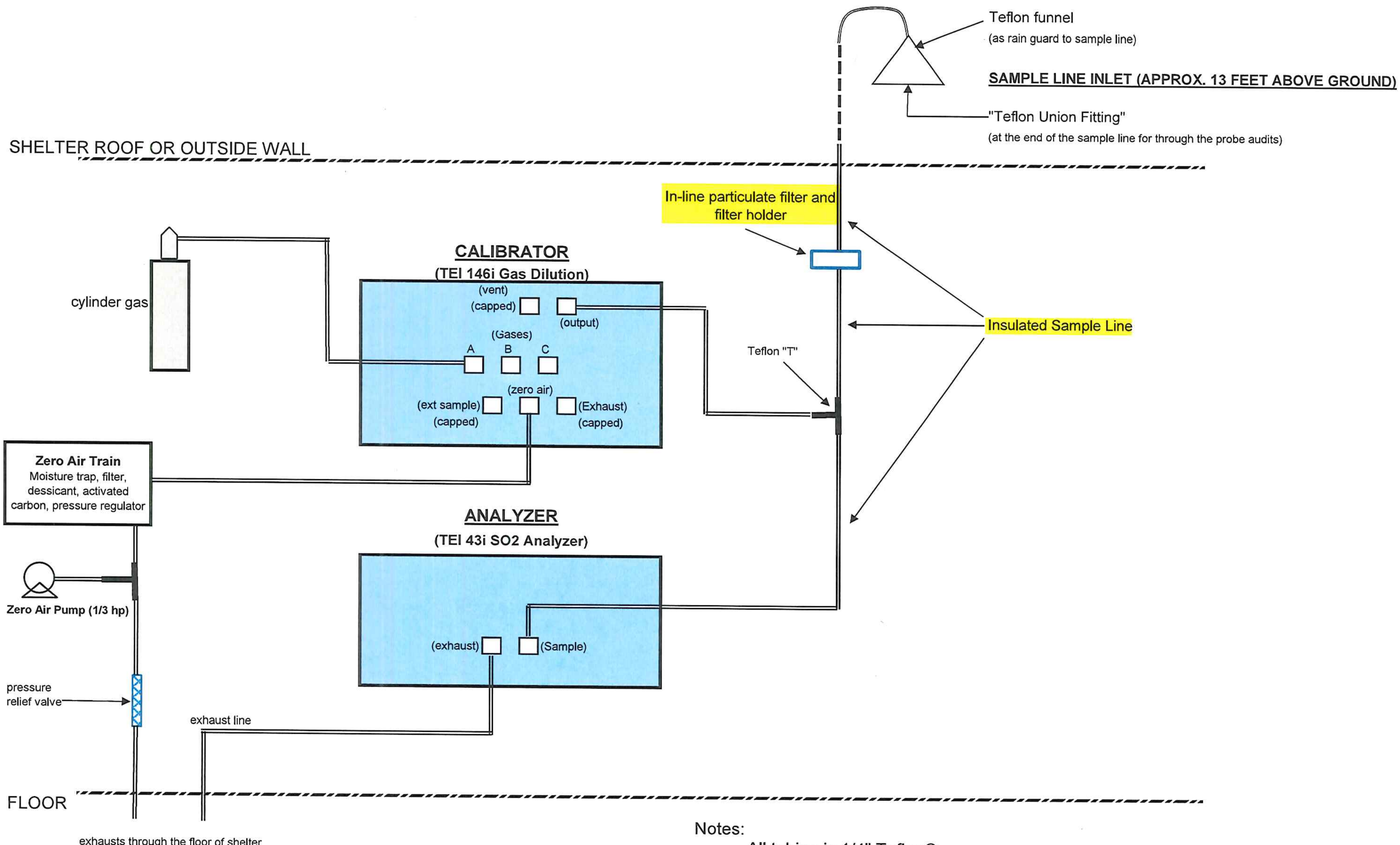
It is important to properly install the 146i calibrator in the rack after the bi-annual IDEM certification to assure that it is ready to receive the commands from the data logger for the automatic nightly zero and span. These steps are as follows:

1. Place the calibrator in the instrument rack.
2. Secure the cylinder gas in the clamp. Install the regulator and gas line to the regulator.

3. Attach the zero air line to the zero air port on the back of the calibrator.
4. Attach the cylinder gas line to the "Gas A" port on the back of the calibrator.
5. Attach the calibrator connector to "digital inputs" on the back of the calibrator.
6. Plug in the calibrator.
7. Program the gas setup with the new IDEM certification.
   a. Main Menu
   b. Gas Setup
   c. Gas A
   d. Gas Name – Use the arrow keys and name the gas SO_2.
   e. Tank Concentration – Use the arrow keys to enter the tank concentration (in ppm) as determined by IDEM during the certification. (IDEM has this labeled on both the cylinder gas tank and on the top of the calibrator.)
   f. Zero Air – Set the zero air to between 2000 and 4000 sccm.
   g. Span 1 – This should be set as the "Level 1" span which is 70 – 90% of the analyzer range, or 0.350 – 0.450 ppm. Enter the Level 1 concentration and total flow from the IDEM certification.
   h. Span 2 – This is a calibration point and should be approximately half of what was entered for Span 1. Enter the span value and total flow.
   i. Span 3 and Span 4 – These are both set as precision point values, from 0.080 – 0.100 ppm, usually about 0.090. Enter the value and total flow for the precision point from the IDEM certification.
8. Press the "MENU" button.
9. The Service Mode should be off. To check, go to *Main Menu*, choose "Instrument Controls", then "Service Mode". If currently "on", choose "off" and hit "ENTER".
10. Double check that the calibrator is NOT in Standby Mode. From the *Main Menu*, choose "Flow Modes", then "Gas Dilution".
11. The calibrator is now set to run nightly zero and spans through the data logger programming.

ATTACHMENT 1

SO_2 Analyzer and Calibrator "Plumbing" Diagram



Notes:

All tubing is 1/4" Teflon®

Fittings that are in contact with the sample are Teflon®

Fittings that do not contact the sample are Teflon® or stainless steel

User ID: WLV

QA Data Quality Indicator Report

Report Request ID: 1594064 | Report Code: AMP256 | Oct. 12, 2017

GEOGRAPHIC SELECTIONS

Tribal Code	State	County	Site	Parameter	POC	City	AQCR	UAR	CBSA	CSA	EPA Region
	18	173	0002								
	18	173	0004								
	18	173	0005								
	18	173	0012								

PROTOCOL SELECTIONS

Parameter Classification	Parameter	Method	Duration
APP_A_PARAMETERS			

SELECTED OPTIONS

Option Type	Option Value
WORKFILE DELIMITER	,
MERGE PDF FILES	YES
AGENCY ROLE	PQAO
RESTRICT TO MONITORING SEASONS	YES

DATE CRITERIA

Start Date	End Date
2015 07 01 Q3	2016 03 31 Q1

Notes About this Report

For specific information about the fields appearing within this report, please refer to the README.txt file that is included with the WORKFILE output for this report.

If you see this value for a column in a summarized row, this means that more than one occurence exist in the summary. For example, if you have a PQAO summary that spans multiple States, you would see this value in the States column.

Code Listing

The following codes may be seen in the "MT" column throughout this report. Please be advised that not all of the codes may appear in the report. They are provided for completeness.

Code	Description	Code	Description
E	EPA	F	NON-EPA FEDERAL
ID	INDUSTRIAL	O	OTHER
S	SLAMS	SP	SPM
T	TRIBAL		

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AIR QUALITY SYSTEM

DATA QUALITY INDICATOR REPORT

One Point Quality Control

Oct. 12, 2017

Pollutant: 42401 (Sulfur dioxide) **PQAO:** Aluminum Company Of America (0024) **App A?** Y

Year	Region	State	Site IDs	POC	MT	Begin Date	End Date	Intervals Required	Valued Intervals	% Complete	CV UB	Bias UB
2015	05	IN	18-173-0002	1	ID	11-JUL-15	31-DEC-15	12	11	92	2.76	+/- 1.99
2015	05	IN	18-173-0004	1	ID	01-JUL-15	31-DEC-15	13	13	100	2.82	+/- 2.53
2015	05	IN	18-173-0005	1	ID	01-JUL-15	31-DEC-15	13	13	100	2.84	+/- 2.47
2015	05	IN	18-173-0012	1	ID	01-JUL-15	31-DEC-15	13	12	92	3.69	+/- 3.33
2015			**SUMMARY**			01-JUL-15	31-DEC-15	51	49	96	2.85	+/- 2.24
2016	05	IN	18-173-0002	1	ID	01-JAN-16	01-MAR-16	4	4	100	6.14	+/- 5.68
2016	05	IN	18-173-0004	1	ID	01-JAN-16	19-FEB-16	3	3	100	2.78	- 3.34
2016	05	IN	18-173-0005	1	ID	01-JAN-16	19-FEB-16	3	3	100	3.54	+/- 2.99
2016	05	IN	18-173-0012	1	ID	01-JAN-16	19-FEB-16	3	3	100	1.58	+ 2.57
2016			**SUMMARY**			01-JAN-16	01-MAR-16	13	13	100	3.27	+/- 2.71
SUMMARY			**SUMMARY**			01-JUL-15	01-MAR-16	64	62	97	2.81	+/- 2.24

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

AIR QUALITY SYSTEM

DATA QUALITY INDICATOR REPORT

Annual Performance Evaluation (APE)

Oct. 12, 2017

Pollutant: 42401 (Sulfur dioxide) **PQAO:** Aluminum Company Of America (0024) **App A?:** Y

Year	Region	State	Site ID	POC	MT	Begin Date	End Date	Avg %D / Level L1/6	L 2/7	L 3/8	L4/9	L5/10	Obs / Q Q1	Q2	Q3	Q4	Criteria Met?	Conf. Limits Lower	Upper	% Bet. Cf Lim
2015	05	IN	18-173-0002	1	ID	11-JUL-15	01-MAR-16						0	0	3	3	Y	-4.26	3.59	
						(Levels 6 thru 10)		-5.56		-5.19	-5.50									
2015	05	IN	18-173-0004	1	ID	01-JUL-15	19-FEB-16						0	0	3	3	Y	-5.43	3.24	100
						(Levels 6 thru 10)		-0.56		-0.47	0.00									
2015	05	IN	18-173-0005	1	ID	01-JUL-15	19-FEB-16						0	0	3	3	Y	-5.30	3.20	100
						(Levels 6 thru 10)		-3.89		-3.30	-3.35									
2015	05	IN	18-173-0012	1	ID	01-JUL-15	19-FEB-16						0	0	3	3	Y	-3.86	7.06	
						(Levels 6 thru 10)		-7.78		-7.55	-7.66									
2015			SUMMARY			01-JUL-15	01-MAR-16						0	0	12	12	Y	-5.22	4.66	58
						(Levels 6 thru 10)		-4.44		-4.13	-4.13									
2016	05	IN	18-173-0002	1	ID	11-JUL-15	01-MAR-16						3	0	0	0	Y	-8.87	3.55	100
						(Levels 6 thru 10)		-7.69		-5.63	-5.40									
2016	05	IN	18-173-0004	1	ID	01-JUL-15	19-FEB-16						3	0	0	0	Y	-4.79	0.83	
						(Levels 6 thru 10)		4.40		2.88	3.61									
2016	05	IN	18-173-0005	1	ID	01-JUL-15	19-FEB-16						3	0	0	0	Y	-4.91	2.25	67
						(Levels 6 thru 10)		-5.49		-4.23	-3.99									
2016	05	IN	18-173-0012	1	ID	01-JUL-15	19-FEB-16						3	0	0	0	Y	0.07	3.59	
						(Levels 6 thru 10)		-5.49		-5.16	-5.87									
2016			SUMMARY			01-JUL-15	01-MAR-16						12	0	0	0	Y	-5.95	4.15	83
						(Levels 6 thru 10)		-3.57		-3.03	-2.91									
SUMMARY			SUMMARY			01-JUL-15	01-MAR-16						12	0	12	12	Y	-5.39	4.54	58
						(Levels 6 thru 10)		-4.15		-3.76	-3.72									