EAST KENTUCKY POWER COOPERATIVE

September 2, 2015

*Via Hand Delivery*

Sean Alteri, Director
Division for Air Quality
200 Fair Oaks Lane, First Floor
Frankfort, Kentucky 40601

RE: John Sherman Cooper Power Station (AI 3808)
Burnside, Pulaski County, Kentucky
2010 1-Hour $SO_2$ NAAQS Designation Analysis

Dear Mr. Alteri:

East Kentucky Power Cooperative, Inc. (EKPC) submits the enclosed Air Dispersion Modeling Report – Cooper Station -- $SO_2$ NAAQS Designation Analysis (the Report), prepared by Trinity Consultants, for the Division's review and use. This analysis was prepared in support of the Division's response to the U.S. Environmental Protection Agency's (EPA) March 20, 2015 letter to Commissioner Bruce Scott of the Kentucky Department of Environmental Protection (KDEP). The Report is the result of the dispersion modeling conducted pursuant to the Air Dispersion Modeling Protocol for Cooper Station $SO_2$ Designation Analysis submitted by EKPC to the Division on August 3, 2015, as revised in response to subsequent discussion of comments from the Division and EPA, including the discussion on the August 27, 2015 conference call among EPA, the Division and EKPC.

A. Summary of Report Conclusions

The analysis demonstrates that the maximum modeled impacts (expressed in the form of the 1-hour $SO_2$ National Ambient Air Quality Standard (NAAQS)) including emissions from Cooper Station, emissions from the selected regional sources, and the background concentration are below the 1-hour $SO_2$ NAAQS. Specifically, the maximum combined impact is 173.1 $\mu g/m^3$ as compared to the 1-hour $SO_2$ NAAQS of 196 $\mu g/m^3$ (75 ppb). Therefore, this modeling demonstrates that the area surrounding the Cooper Station should be designated attainment for the 1-hour $SO_2$ NAAQS.

B. Federally Enforceable Limits

As explained in the Report, EKPC modeled actual emissions from Cooper Unit 2 and allowable emissions from Cooper Unit 1. Cooper Unit 2 is subject to a federally enforceable $SO_2$ emission limit of 95 percent removal efficiency 30-day rolling average or 0.100 lb/MMBtu $SO_2$ 30-day rolling average, which has been in place since July 1, 2012. See Condition B.2.c. of Title V Permit No. V-12-019R1, which was added to the permit pursuant to the Consent Decree

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between EPA and EKPC entered September 24, 2007 in Civil Action No. 04-34-KSF. The Unit 2 modeled actual emissions reflect operation of the unit in compliance with this limit.

For Cooper Unit 1, EKPC modeled an allowable emission rate of 178 pounds/hour (0.165 lb/MMBtu) derived from the existing Title V permit limit of 3.3 lb/MMBtu $SO_2$ 24-hour average assuming 95 percent reduction and operating at 1080 MMBtu/hr for 8,760 hours per year. The 95 percent reduction was applied to the existing permit limit because EKPC expects to meet a federally enforceable $SO_2$ emission limit of 95 percent removal efficiency 30-day rolling average or 0.100 lb/MMBtu $SO_2$ 30-day rolling average on both Cooper units once the tie-in of Unit 1 into the Unit 2 Dry Flue Gas Desulfurization (DFGD) System is complete later this year. EKPC chose to model Unit 1 at 0.165 lb/MMBtu instead of 0.100 lb/MMBtu to account for the dual nature of the limit (either 95 percent removal or 0.100 lb/MMBtu) and the associated averaging period.

Although EKPC's implementation of the Cooper 1 Reroute Project (with resulting emission reductions) was initiated to comply with the Consent Decree requirement for a Pollution Control Upgrade Analysis, upon further review, EKPC has determined that the better course is to submit an application for revision of the Title V permit to impose the same limitation on Cooper Unit 1 as already spelled out in the permit for Unit 2. EKPC will work with the Division to assure that the permit revision is finalized before the July 2, 2016 deadline for EPA to make its designations of attainment status for the NAAQS. Once these limits are in place, EKPC's position is that the Report reflects modeling of federally enforceable limits and that no other limits are necessary.

EKPC appreciates DAQ's review of this submittal and use of this supplemental information in support of the classification of Pulaski County as attainment for the 1-hour $SO_2$ NAAQS. As the Division and EPA are aware, EKPC has significantly reduced $SO_2$ emissions from Cooper Station since 2012. Pursuant to the 2007 EPA Consent Decree, EKPC implemented additional $SO_2$ controls on Cooper Unit 2. EKPC is now in the process of adding $SO_2$ controls to Cooper Unit 1 through the reroute project mentioned above which will be completed by the beginning of 2016. Cooper 1 and 2 will also meet the requirements of the Mercury and Air Toxics Standards (MATS) by April 16, 2016 in accordance with the one-year extension of the initial deadline. EKPC's significant investment in Cooper Station demonstrates its importance to the EKPC generation and transmission system and the cooperatives it serves.

If you have any questions regarding this letter or the enclosed report, please let me know. In addition to the two hard copies of the Report enclosed herewith, an electronic copy of the Report, including modeling files, is being transmitted today via email by Trinity Consultants to Messrs. Ben Cordes and Kevin Davis.

Sincerely,

Jerry Purvis

Jerry Purvis
Director Environmental Affairs

Enclosure

cc w/o enc.: Jackie Quarles – DAQ
Rick Shewekah – DAQ
Ben Cordes – DAQ
Kevin Davis – DAQ
John West – OGC
Lance Huffman – OGC
George Schewe – Trinity
John Colebrook – Trinity
Louis Petrey - EKPC

# AIR DISPERSION MODELING REPORT
# COOPER STATION
# $SO_2$ NAAQS DESIGNATION ANALYSIS

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September 1, 2015

Trinity Consultants

*Environmental solutions delivered uncommonly well*

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# 1. EXECUTIVE SUMMARY

Eastern Kentucky Power Cooperative, Inc. (EKPC) in association with our air quality contractor, Trinity Consultants (Trinity), submits this dispersion modeling report for the air quality modeling analysis that was performed with respect to EKPC's John Sherman Cooper Power Station (Cooper) and the surrounding area. Cooper consists of two coal-fired electricity generating units referred to as Unit 1 and Unit 2. This work was undertaken in support of the Kentucky Division for Air Quality (KDAQ or Division) response to the March 20, 2015 letter from the U.S. Environmental Protection Agency (U.S. EPA) to Commissioner Scott of the Kentucky Department for Environmental Protection (KDEP) regarding designations of areas currently unclassified with respect to the 2010 1-hour $SO_2$ National Ambient Air Quality Standard (NAAQS).

In that letter, U.S. EPA identified the Cooper Station as one of the Kentucky sources meeting the criteria for evaluation of unclassified areas in the first round of designations as part of a required response by U.S. EPA to the recent Sierra Club vs. Regina McCarthy Consent Decree[1]. Cooper was also identified on the U.S. EPA website listing all areas where designations would be required under the Consent Decree by July 2, 2016[2], which is accelerated as compared to the final Data Requirements Rule (DRR) schedule.[3] The criteria to determine if a source was subject to the Consent Decree are: 1) a nearby monitor showing a violation, or 2) that an area contains a stationary source that according to the EPA's Air Markets Database either emitted more than 16,000 tons of $SO_2$ in 2012 or emitted more than 2,600 tons of $SO_2$ and had an emission rate of at least 0.45 lb $SO_2$/MMBtu in 2012. According to EPA's Air Markets Database, the Cooper Station emitted 7,428 tons $SO_2$ in 2012 and had an average SO2 emission rate of 1.07 lb $SO_2$/MMBtu in 2012. U.S. EPA stated that it would base the designation of the Pulaski County and surrounding area on these emission criteria alone as no $SO_2$ monitors are in the area unless KDAQ submits updated recommendations and supporting information that could be considered in the final designations. To that end, EKPC is facilitating a modeling analysis to aid in the designation determination for the Pulaski County area.

Dispersion modeling conducted in support of the $SO_2$ NAAQS attainment demonstration was conducted following the modeling Technical Assistance Document (TAD) guidance.[4] As favored by the guidance and described in the modeling protocol submitted on August 3, 2015, three years of Continuous Emissions Monitoring System (CEMS) data were utilized for emissions from Unit 2. As recommended by U.S. EPA in their comments provided on the modeling protocol[5], $SO_2$ emissions from Unit 1 were modeled at an allowable hourly emission rate assuming 8,760 hours of operation, determined from the suite of permit limits that will be applicable to this unit after the proposed dry flue gas desulfurization (DFGD) $SO_2$ control system tie-in project is completed in 2015. Because this air pollution control project will be completed well before the July 2016 attainment designation deadline, the Unit 1 modeled emission rate reflects the allowable emission rate that will be in place at the time of the $SO_2$ NAAQS designations under the Consent Decree. Modeling the post-control allowable emission rate on a continuous basis for an affected unit scheduled to be controlled prior to the attainment designation deadline is an acceptable approach under both the modeling TAD[6] and the final DRR.[7] These emissions were paired with static (not varying by hour) engineering estimates of exit velocity and

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1 *Order Granting Joint Motion to Approve and Enter Consent Decree and Denying Other Motions as Moot*, Sierra Club et. al. v. Regina McCarthy, Administrator of the United States Environmental Protection Agency, United States District Court, Northern District of California, Docket Nos. 120, 149, March 2, 2015.
2 http://www.epa.gov/airquality/sulfurdioxide/designations/pdfs/sourceareas.pdf
3 *Data Requirements Rule for the 1-Hour Sulfur Dioxide ($SO_2$) Primary National Ambient Air Quality Standards (NAAQS): Final Rule,* Federal Register Vol. 90 No. 162, pages 51052-51088, August 21, 2015.
4 *$SO_2$ NAAQS Designations Modeling Technical Assistance Document*, Draft, U.S. EPA, Research Triangle Park, NC, December 2013.
5 Email from Rick Gillam (U.S. EPA, Region 4) to Ben Cordes (KDAQ), August 25, 2015
6 Ibid.
7 Ibid.

temperature for the two relevant stack configurations following the Unit 1 DFGD tie-in:  1) Case 1 when only Unit 1 is operational, and 2) Case 2 when both Units 1 and 2 are operational.  The actual stack height was used because the combined Unit 1 and 2 stack does not exceed Good Engineering Practice (GEP) stack height.

Nearby sources were considered within the TAD-suggested 20 km range of Cooper, but also out to 50 km to allow comprehensive consideration of large nearby sources.  Of these, the Kingsford Manufacturing Company facility (located ~ 3 km south of Cooper) was determined to be the only regional source which has the potential to significantly contribute to the location of Cooper Station's maximum modeled impacts.  All other sources were distant enough to fall outside of the TAD general consideration guidance and were likely captured as part of the regional, rural background concentration selected for the modeling (26.9 $\mu g/m^3$) from the $SO_2$ monitor located at Mammoth Cave National Park.  This monitor was determined to be representative of background conditions in Pulaski County and not influenced by either Cooper or Kingsford.

Given this strategy and characterization of sources affecting air quality in the Pulaski County area, the analysis demonstrated that the maximum modeled impacts (expressed in the form of the 1-hr $SO_2$ NAAQS) including emissions from Cooper Station, emissions from the selected regional sources, and the background concentration are below the 1-hour $SO_2$ NAAQS.  Specifically, the maximum combined impact is 173.1 $\mu g/m^3$ as compared to the 1-hour $SO_2$ NAAQS of 196 $\mu g/m^3$ (75 ppb).  Therefore, this modeling demonstrates that the area surrounding the Cooper Station should be considered for designation as attainment.

# 2. INTRODUCTION

This section of the modeling report provides an overview of the Cooper Station along with background information for the basis for the $SO_2$ designation modeling.

## 2.1. FACILITY INFORMATION

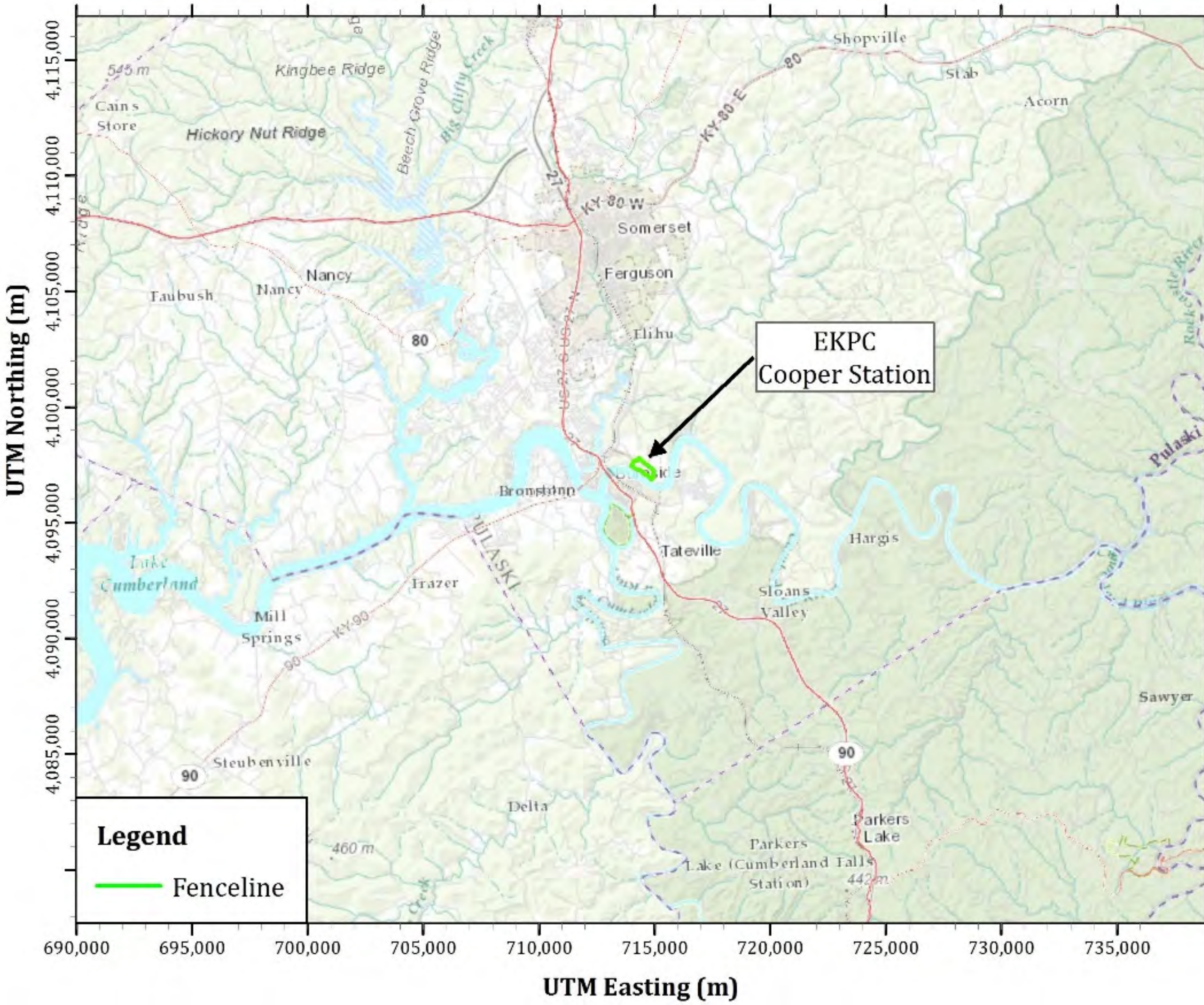
EKPC owns and operates a 364 MW coal fired power plant, the John S. Cooper Station (Cooper), located in Pulaski County, approximately three quarters of a mile northeast of the town of Burnside, Kentucky. Cooper consists of two generating units (Title V ID EU01 and EU02). The first power generating unit (EU01, herein referred to as Unit 1) is a pulverized coal fired boiler with a maximum continuous rating of 1,080 MMBtu/hr. The second unit (EU02, herein referred to as Unit 2) is a pulverized coal fired boiler with a maximum continuous rating of 2,089 MMBtu/hr.

Unit 1 is currently equipped with multiple control devices to reduce emissions of pollutants regulated under various Federal and Commonwealth programs. The current controls include an electrostatic precipitator (ESP) for PM control and low $NO_X$ burners for $NO_X$ control. Unit 1 is undergoing a duct reroute project to tie its exhaust into the existing Unit 2 ductwork, to allow for further control utilizing both an DFGD for $SO_2$ control and a pulse jet fabric filter for additional PM control. Unit 2 is equipped with low $NO_X$ burners, selective catalytic reduction (SCR), FuelSolv treatment, DFGD, and pulse jet fabric filter. These units and other emissions generating activities (emergency generators, etc., not considered under the Consent Decree) at Cooper Station are subject to Title V operating permit V-12-019 R1, issued by KDAQ on August 14, 2013. Unit 1 and Unit 2 are the only significant sources of $SO_2$ emissions at Cooper station, and as such, these are the only sources represented in the modeling analysis.

An aerial photograph and area map of the facility and surrounding area are provided in Figures 2-1 and 2-2, respectively. Figure 2-1 shows the fence line and buildings at Cooper. Figure 2-2 shows the facility relative to predominant geographical features such as roads, rivers, and towns. These figures and the locations of all emission sources, structures, and receptors in the modeling analysis are represented in the Universal Transverse Mercator (UTM) coordinate system. The datum is based on North American Datum 1983 (NAD 83). UTM coordinates for this analysis are located in UTM Zone 16. The central location of Cooper Station is approximately 714,250 meters East and 4,097,343 meters North in Zone 16 of the UTM system.

**Figure 2-1. Aerial Photograph of Cooper Station**

**Figure 2-2. Area Map of Cooper Station**




## 2.2. BASIS FOR ANALYSIS

Following the May 2014 publication of the proposed Data Requirements Rule, the U.S. EPA was sued for "failing to undertake a certain nondiscretionary duty under the Clean Air Act ("CAA"), 42 U.S.C. §§ 7401-7671q, and that such alleged failure is actionable under section 304(a)(2) of the CAA, 42 U.S.C. § 7604(a)(2)." The lawsuit resulted in the Consent Decree that was entered on March 2, 2015 in the U.S. District Court for the Northern District of California (same as that mentioned above and referenced in Footnote 1). As a result of the Consent Decree, an additional designation phase was added to the two designation phases that were already included in the U.S. EPA's August 2015 final Data Requirements Rule. The additional phase affects areas with stationary sources that meet specific emissions criteria laid out in the Consent Decree. The U.S. EPA released a memorandum on March 20, 2015 (referred to herein as the 2015 $SO_2$ Area Designation Guidance) to the Regional Directors clarifying the path forward for states with sources affected by the decree.[8] EKPC is very

[8] *Updated Guidance for Area Designations for the 2010 Primary Sulfur Dioxide National Ambient Air Quality Standard*, memorandum from Stephen Page to Regional Air division Directors, Regions 1-10, March 20, 2015.

aware of these requirements and has conferred with KDAQ to determine a path forward to meet the deadlines for modeling, strategic assessment, and eventual designation of the area around Cooper Station.

Under the DRR, KDAQ has the option of installing a new monitor in the area around Cooper Station or performing dispersion modeling. A schedule for completion of the designations under DRR is established as December 31, 2017 for modeling and December 31, 2020 for monitoring. The deadline required by the Consent Decree, however, is that the U.S. EPA will complete a round of $SO_2$ designations by July 2, 2016. To meet this deadline, KDAQ is required to perform dispersion modeling unless an existing ambient air monitor can be shown to be representative of the area (insufficient time is available to begin a new ambient source-oriented monitoring system). Because the exclusive use of monitoring data for the designation process is unlikely due to the lack of a monitoring station in sufficient proximity to the Cooper Station, modeling must be performed. Results of the modeling analysis will be used to allow appropriate designation of the unclassified area around Cooper as in attainment of the 1-hour $SO_2$ NAAQS.

EKPC has performed this modeling analysis and is providing the results to KDAQ to assist in the designation process. This modeling follows the methodology and modeling guidance from the U.S. EPA in the form of the $SO_2$ NAAQS designation modeling guidance TAD and assists in KDAQ's determination of the ambient levels of $SO_2$ at the 1-hour averaging period in the area around Cooper Station. This report only covers the dispersion modeling requirement and does not cover any other items KDAQ may wish to include within the Pulaski County 1-hr $SO_2$ NAAQS attainment recommendation due to be submitted to U.S. EPA by September 18, 2105.

# 3. 1-HOUR $SO_2$ DESIGNATION MODELING METHODOLOGY

As prescribed by the U.S. EPA in the modeling TAD, dispersion modeling can be used in place of ambient monitoring to evaluate the attainment status of an area in the vicinity of a specific source, in this case the EKPC Cooper Station. U.S. EPA's rationale for this is the distinction that $SO_2$ sources are limited in terms of the distance to where ambient concentration impacts occur. In preparation for providing modeling guidance for designation analysis, U.S. EPA reviewed $SO_2$ ambient monitoring and modeling of concentrations around and near $SO_2$ sources and found that most of the highest impacts fall within a few 10's of kilometers from large sources and a few kilometers for smaller sources. Also of note was that the gradient of these concentrations falls off significantly after the maximum is reached. Thus, the modeling focuses on the use of near-field computational methods such that U.S. EPA's primary preferred industrial source model, the AERMOD Model[9], is the primary model recommended for use. In addition to AERMOD and to allow the best representation of simulated ambient air concentrations, the modeling TAD recommends:

- Using actual emissions as an input for assessing violations to provide results that reflect current actual air quality (i.e., modeling that simulates a monitor)(allowable emissions may also be used which will result in a more conservative estimate of actual ambient air impacts of the source);
- Using three years of modeling results to calculate a simulated design value consistent with the 3-year monitoring period required to develop a monitor design value for comparison to the NAAQS;
- Placing receptors for the modeling only in locations where a monitor could be placed; and
- Using actual stack heights rather than following the Good Engineering Practice stack height policy when using actual emissions.

Following this modeling philosophy and guidance, the remainder of this section provides an overview of the modeling applied to the Cooper Station consistent with the modeling protocol submitted to KDAQ on August 3, 2015, unless stated otherwise.

## 3.1. MODEL SELECTION

Modeling was performed for the 1-hour $SO_2$ analysis following the modeling TAD guidance. The AERMOD Model Version 15181[10], the most current version released by U.S. EPA on July 24, 2015 on the Support Center for Regulatory Air Modeling (SCRAM) website[11], was used to perform the dispersion modeling. The proposed update to U.S. EPA's modeling guidance in the form of the *Guideline on Air Quality Models*[12], was released on July 15, 2015 via the U.S. EPA technical website[13]. This proposed guidance and revised AERMOD model have options that could affect the outcome of dispersion modeling studies and specifically the designation modeling herein. Some of these options address the U.S. EPA and modeling community concerns that AERMOD does not perform well during low wind conditions because turbulence under stable conditions is underestimated.

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[9] *Addendum User's Guide for the AMS/EPA Regulatory Model – AERMOD*, EPA-454/B-03-001, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 2004, Revised May 2014.

[10] Stated by U.S. EPA to be part of the docket at Docket ID No. EPA-HQ-OAR-2015-0310 and available as of date of submittal of this report.

[11] http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod

[12] *Guideline on Air Quality Models.* Appendix W to 40 CFR Parts 51 and 52. Federal Register, November 9, 2005. pp. 68217-68261.

[13] http://www.epa.gov/ttn/scram/

When AERMOD is run with a meteorological dataset derived from one-minute meteorological data as is currently recommended by U.S. EPA, low wind speeds are much more prevalent than in prior versions of the modeling system that did not rely on one-minute meteorological data. These low wind speeds have been linked to potential overestimates in ambient concentrations by AERMOD.[14] These overestimates occur, in part, due to an underestimate of friction velocity (u*) by the AERMET meteorological processor. EPA recognized this underestimation as a potential issue with AERMET (and subsequently, AERMOD) and released AERMET Version 12345 which included a beta option, ADJ_U*, which allowed the friction velocity (u*) to be adjusted using the methods of Qian and Venkatram[15] to better account for turbulence in the atmosphere during low wind speed stable conditions. This beta option was first released in AERMET version 12345, was updated to incorporate a modified Bulk Richardson Number in version 13350, was further modified to adjust u* for low solar elevation angles with version 14134, and was most recently in Version 15181, used to modify the calculation of the turbulence measure, Monin-Obukhov length.[16] Given the refined nature of this beta option and the peer reviewed studies which have acknowledged its accuracy, EKPC has incorporated this option into the modeling analysis to allow more representative and more accurate modeling results. Further justification for inclusion of the beta option ADJ_U* for AERMET is presented in Appendix A.

The pollutant identification was set to "$SO_2$" in AERMOD, which allowed for additional internal model options to be available, thus enabling the output options to be configured properly. Because of the probabilistic form of the 1-hour NAAQS, selecting these correct input options allowed AERMOD to properly calculate an $SO_2$ design value based on the 3-year average of the 99$^{th}$ percentile of the annual distribution of the daily maximum 1-hour concentrations for comparison with the 1-hour $SO_2$ NAAQS of 196 $\mu g/m^3$ (75 ppb).

## 3.2. RURAL/URBAN OPTION SELECTION IN AERMOD

As stated in Section 6.3, Urban/Rural Determination, of the modeling TAD, for any dispersion modeling exercise for $SO_2$, the "urban" or "rural" determination of the location surrounding the subject source is important in determining the applicable boundary layer characteristics that affect a model's calculation of ambient concentrations as well as the possible invocation of AERMOD's 4-hour half-life applicable to $SO_2$ in urban areas. Thus, a determination was made of whether the area around the Cooper Station was urban or rural.

The first method discussed in the modeling TAD (also referring therein to Section 7.2.3c of the Guideline on Air Quality Models, Appendix W) was used to determine the urban or rural status of the area around Cooper. This is the "land use" technique because it examines the various land use within 3 km of Cooper and quantifies the percentage of area in various land use categories. Following this guidance, 2011 land use data (most recent available) were obtained from the U.S. Geological Survey[17] through ArcGIS and a 3 km radius circle inscribed electronically around the Cooper stack coordinates. All data were georeferenced and tabulated using the categories shown in Table 3-1 for urban and rural designation.

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[14] *Wenjun Qian and Akula Venkatram, "Performance of Steady State Dispersion Models Under Low Wind-Speed Conditions," Boundary-Layer Meteorology, no. 138 (2011): 475-491.*

[15] *Ibid.*

[16] http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_mcb3.txt; http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_mcb4.txt; http://www.epa.gov/ttn/scram/7thconf/aermod/AERMET_mcb5.pdf; http://www.epa.gov/ttn/scram/7thconf/aermod/AERMET_mcb6.pdf

[17] http://www.mrlc.gov/viewerjs/

Figure 3-1 shows the layout of the land use where greens, yellows and browns are farmland, forests, and grasses, pinks are non-urban developed lands, and red and dark red are urban areas. Table 3-2 shows the results of this land categorization process. As can be seen the area is predominantly rural by an overwhelming margin at 93 percent, and therefore, was treated as rural in the AERMOD Model.

### Table 3-1. Modeling TAD Urban / Rural Categories

| 2011 NLCD Land Cover Classification | | Auer Land-Use Classification | | Modeling TAD Rural or Urban |
|---|---|---|---|---|
| 11 | Open Water | A5 | Water Surfaces | rural |
| 12 | Perennial Ice/Snow | A5 | Water Surfaces | rural |
| 21 | Developed, Open Space | A1 | Metropolitan Natural | rural |
| 22 | Developed, Low Intensity | R1 | Common Residential | rural |
| 23 | Developed, Medium Intensity | I1, I2, C1, R2, R3 | Industrial/Commercial/Compact Residential | urban |
| 24 | Developed, High Intensity | I1, I2, C1, R2, R3 | Industrial/Commercial/Compact Residential | urban |
| 31 | Barren Land | A3 | Undeveloped (Grasses/Shrub) | rural |
| 41 | Deciduous Forest | A4 | Undeveloped (Wooded) | rural |
| 42 | Evergreen Forest | A4 | Undeveloped (Wooded) | rural |
| 43 | Mixed Forest | A4 | Undeveloped (Wooded) | rural |
| 52 | Shrub/Scrub | A3 | Undeveloped (Grasses/Shrub) | rural |
| 71 | Grassland/Herbaceous | A3 | Undeveloped (Grasses/Shrub) | rural |
| 81 | Pasture/Hay | A2 | Agricultural | rural |
| 82 | Cultivated Crops | A2 | Agricultural | rural |
| 90 | Woody Wetlands | A4 | Undeveloped (Wooded) | rural |
| 95 | Emergent Herbaceous Wetlands | A3 | Undeveloped (Grasses/Shrub) | rural |

### Figure 3-1. Distribution of Land Use within 3km of Cooper Station

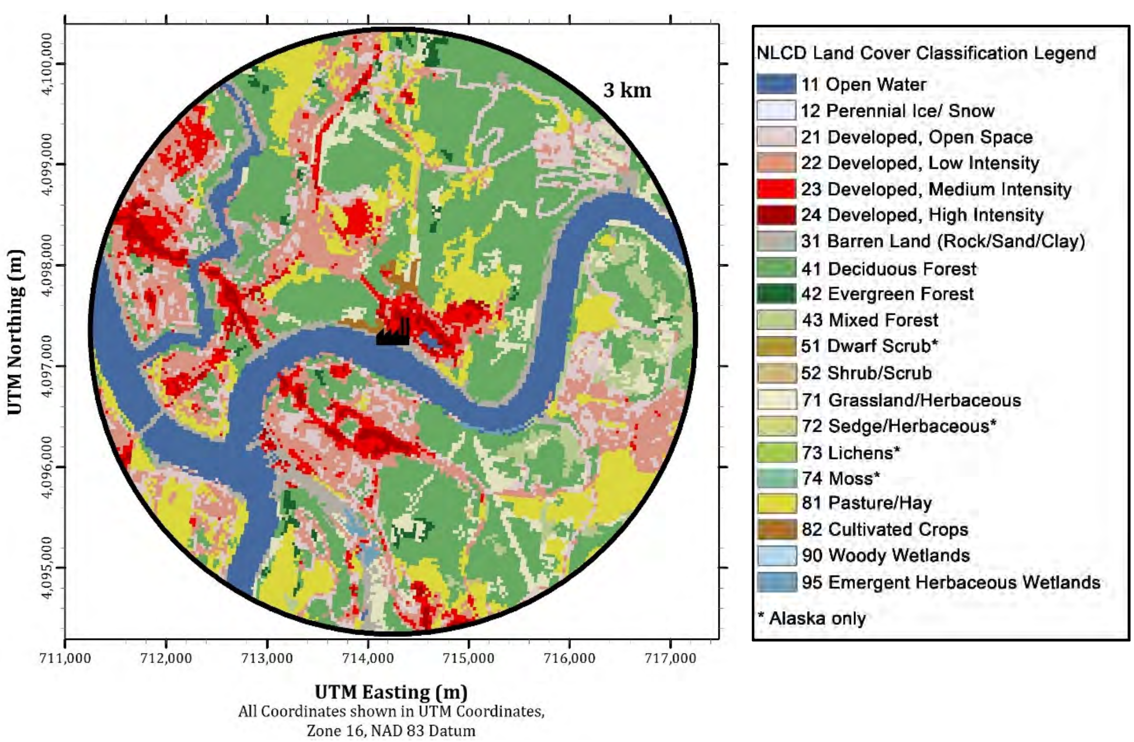

**Table 3-2. Cooper Station Urban/Rural Determination**

| *Pecent Land Categorization ArcGIS Analysis Results for Cooper Station* | | |
|---|---|---|
| **Category ID** | **Category Description** | **Percent** |
| 11 | Open Water | 12.9% |
| 21 | Developed, Open Space | 9.2% |
| 22 | Developed, Low Intensity | 14.4% |
| 23 | Developed, Medium Intensity | 5.3% |
| 24 | Developed, High Intensity | 1.7% |
| 31 | Barren Land | 3.9% |
| 41 | Deciduous Forest | 31.1% |
| 42 | Evergreen Forest | 0.9% |
| 43 | Mixed Forest | 2.7% |
| 52 | Shrub/Scrub | 0.2% |
| 71 | Grassland/Herbaceous | 5.4% |
| 81 | Pasture/Hay | 11.9% |
| 82 | Cultivated Crops | 0.4% |
| 95 | Emergent Herbaceous Wetlands | 0.3% |
| | Total | 100.0% |
| | Urban | 7.0% |
| | Rural | 93.0% |

## 3.3. METEOROLOGICAL DATA

Meteorological data was required as input to the AERMOD model to allow the characterization of the transport and dispersion of the Cooper Station emissions in the atmosphere. As per the modeling TAD, three years of recent data coincidental with the latest three years of Cooper CEMS data reflecting $SO_2$ controls on Unit 2 (beginning July 1, 2012) was obtained from the most representative and nearby National Weather Service (NWS) sites. Data obtained from the NWS included surface (generally, 10 m tower-based) and upper air (radiosonde) meteorological data for the most recent three full year data set (July 1, 2012 through June 30, 2015) and was processed from archived data from the most representative NWS meteorological station in the vicinity of the Cooper Station. Representativeness was determined on the basis of proximity, similarity in terms of land use (and its effect on surface roughness, albedo, and Bowen ratio), and meteorological judgement. AERMOD-ready meteorological data was prepared using the latest version of the AERMET meteorological processing utility (Version 15181). Standard U.S. EPA meteorological data processing guidance was used as outlined in a recent U.S. EPA memorandum[18] as well as other AERMET and associated processor documentation. Additionally, the beta option ADJ_U* was selected during processing, as mentioned in Section 3.1.

A preliminary evaluation of the NWS meteorological data sites within approximately 150 km indicated that several airports were located in the region including Somerset-Pulaski Airport (KSME, 6.6 km to Cooper Station), Wayne County Airport (KEKQ, 28.3 km to Cooper Station), and London-Corbin McGee Field (KLOZ, 46.9 km to Cooper Station). Figure 3-2 shows the locations of the airports having meteorological data sets that were considered for this modeling. Of these candidate sites, the most representative site, the London-Corbin Airport, was the only site having the sufficient hour-by-hour and one-minute meteorological data sets that can be used in the dispersion modeling. Table 3-3 presents the results of a NWS identification exercise based on proximity to

[18] Fox, Tyler, U.S. Environmental Protection Agency. 2013. "Use of ASOS Meteorological Data in AERMOD Dispersion Modeling." Available Online: http://www.epa.gov/ttn/scram/guidance/clarification/20130308_Met_Data_Clarification.pdf

Cooper Station where meteorological stations without adequate data are designated with red highlighting and candidate stations for the modeling analysis are designated without highlighting. As can be seen, other candidate sites have the appropriate one minute data sets, but are located farther away and in a different geographical setting than the Cooper Station. Oak Ridge Airport (KOQT) is in a much more rugged terrain and Blue Grass Airport in Lexington is located in much more open and rolling terrain.

Thus, based on the site proximity, similarity of land use and geographical setting, and general climatic features, the most representative July 1, 2012 through June 30, 2015 surface meteorology data for the modeling of the Cooper Station was determined to be that of the London-Corbin Airport (KLOZ, WBAN No. 03849). With regard to the required upper air data, which is more regional in nature and reflects the overall higher altitude meteorological conditions, the closest and most representative site is from the Nashville International Airport (KBNA, WBAN No. 13897).

**Figure 3-2. Meteorological Stations and $SO_2$ Monitors in the Area near Cooper Station**

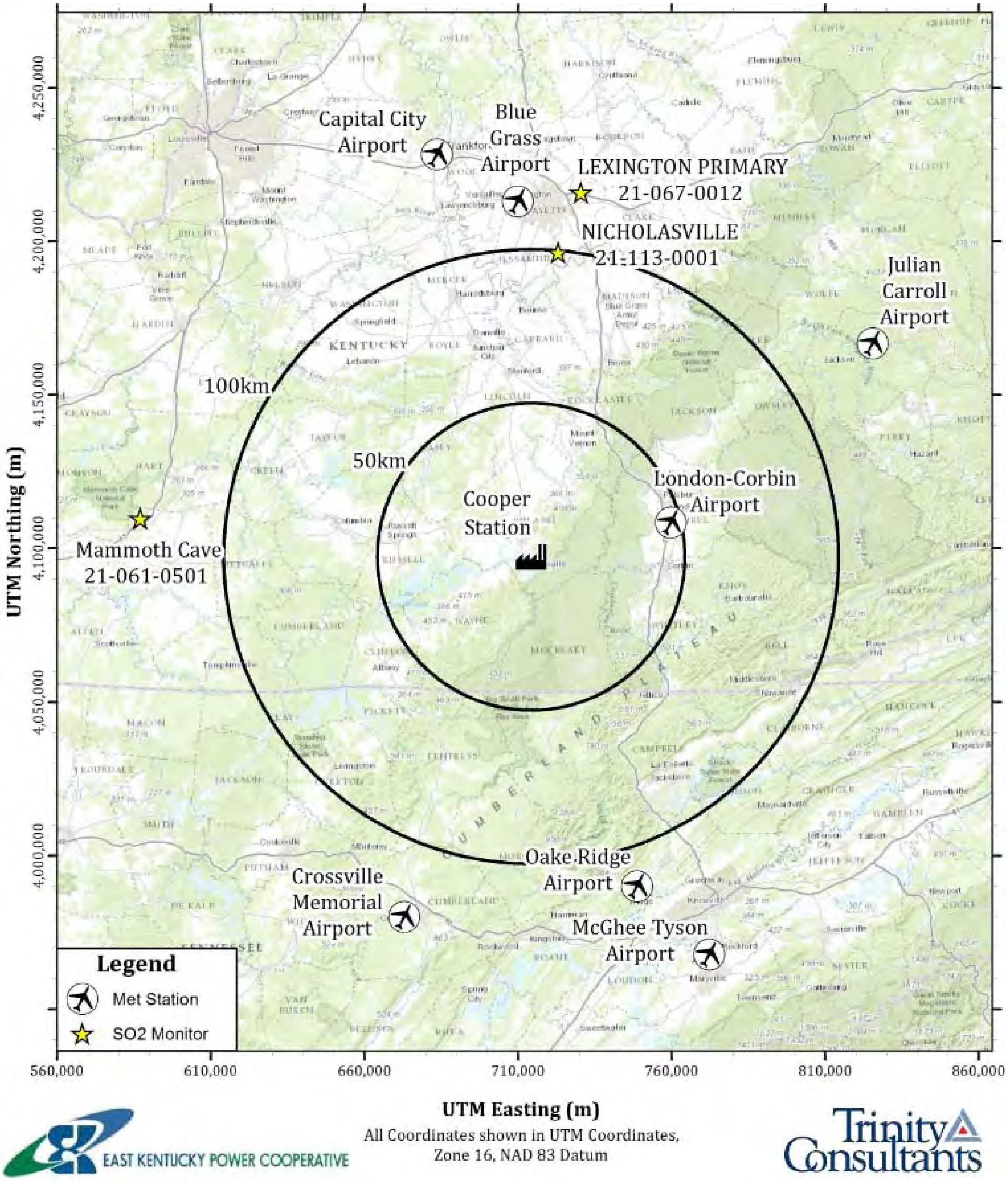

**Table 3-3. Proximity Analysis of Meteorological Stations to Cooper Station**

| Station Name | WBAN Station ID | Station Call Sign | Lat. | Long. | UTM East (m) | UTM North (m) | ASOS One Minute Data Available? | Distance to Cooper (km) |
|---|---|---|---|---|---|---|---|---|
| Somerset-Pulaski Co-J.T. Wils | 63815 | KSME | 37.054 | -84.615 | 712,075 | 4,103,523 | No | 6.6 |
| Wayne County Airport | 63882 | KEKQ | 36.855 | -84.856 | 691,139 | 4,080,933 | No | 28.3 |
| Ldon-Crbn Apt-Mgee Fld Apt | 03849 | KLOZ | 37.087 | -84.077 | 759,811 | 4,108,522 | Yes | 46.9 |
| Stuart Powell Fld | 99999 | KDVK | 37.578 | -84.77 | 696,918 | 4,161,333 | No | 66.3 |
| Middlesboro-Bell County Airpo | 63875 | K1A6 | 36.611 | -83.738 | 791,758 | 4,056,677 | No | 87.5 |
| Oak Ridge | 53868 | KOQT | 36.024 | -84.238 | 748,887 | 3,990,140 | Yes | 112.7 |
| Blue Grass Airport | 93820 | KLEX | 38.041 | -84.606 | 710,085 | 4,213,070 | Yes | 115.8 |
| Crossville 7 Nw | 63855 | -- | 36.014 | -85.135 | 668,068 | 3,987,110 | No | 119.5 |
| Glasgow Municipal Airport | 00361 | KGLW | 37.033 | -85.95 | 593,386 | 4,099,049 | No | 120.9 |
| Versailles 3 Nnw | 63838 | -- | 38.095 | -84.747 | 697,564 | 4,218,753 | No | 122.6 |
| Crossville Memorial -Whitson | 03847 | KCSV | 35.951 | -85.081 | 673,072 | 3,980,216 | Yes | 124.2 |
| Lee County Airport | 00274 | K0VG | 36.654 | -83.218 | 838,097 | 4,063,158 | No | 128.5 |
| Mount Sterling Montgomery Cou | 00146 | KIOB | 38.067 | -83.983 | 764,673 | 4,217,548 | No | 130.4 |
| Julian Carroll Airport | 03889 | KJKL | 37.591 | -83.314 | 825,468 | 4,166,829 | Yes | 131.1 |
| Upper Cumberland Rgnl | 99999 | KSRB | 36.056 | -85.531 | 632,308 | 3,991,158 | No | 134.1 |
| Capital City Airport | 53841 | KFFT | 38.185 | -84.903 | 683,657 | 4,228,420 | Yes | 134.6 |
| Mc Ghee Tyson Airport | 13891 | KTYS | 35.818 | -83.986 | 772,307 | 3,967,956 | Yes | 141.8 |
| Bowling Green 21 Nne | 63849 | NBWG | 37.25 | -86.233 | 568,021 | 4,122,882 | No | 148.4 |
| Godman Aaf Airport | 13807 | KFTK | 37.9 | -85.967 | 590,819 | 4,195,223 | No | 157.5 |
| Louisville Intl-Standiford F | 93821 | KSDF | 38.181 | -85.739 | 610,442 | 4,226,649 | Yes | 165.8 |
| Bowman Field Airport | 13810 | KLOU | 38.228 | -85.664 | 616,936 | 4,231,956 | Yes | 166.1 |
| **Central Coordinates of Cooper:** | **714,250** | **4,097,343** | | | | | | |

### 3.3.1. Surface Data

Unprocessed hourly surface meteorological field data was obtained from the U.S. National Climatic Data Center (NCDC) for the London-Corbin Airport Regional Airport (KLOZ) for July 1, 2012 through June 30, 2015 in the standard ISHD (integrated surface hourly data) format[19]. This data was supplemented with TD-6405 ("1-minute") wind data for each station[20] and processed using the latest version of the AERMINUTE pre-processing tool (version 14337). A threshold wind speed of 0.5 m/s was used in AERMET as per U.S. EPA guidance. The "Ice-Free Winds Group" AERMINUTE option was selected due to the fact that a sonic anemometer was installed at KLOZ on November 11, 2005[21].

### 3.3.2. Upper Air Data

In addition to surface meteorological data, AERMET requires the use of data from an upper air sounding to estimate mixing heights. Upper air data from the nearest U.S. National Weather Service (NWS) radiosonde equipped station was utilized in the modeling analysis. In this case, upper air data from the Nashville International Airport (KBNA, WBAN No. 13897) was obtained from the National Oceanic and Atmospheric Administration (NOAA) in FSL (Forecast Systems Laboratory) format[22] for July 1, 2012 through June 30, 2015.

[19] ftp://ftp.ncdc.noaa.gov/pub/data/noaa/
[20] ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin
[21] http://www.nws.noaa.gov/ops2/Surface/documents/IFW_stat.pdf
[22] http://www.esrl.noaa.gov/raobs/

### 3.3.3. Land Use Analysis

Parameters derived from analysis of land use data (surface roughness, Bowen ratio, and albedo) are also required by AERMET. In accordance with U.S. EPA guidance, these values were determined using the latest version of the AERSURFACE tool (version 13016).[23] AERSURFACE reads gridded land use, land cover data as provided by the United States Geological Survey (USGS)[24] and associates such data with representative values of the three parameters listed above. Typically, the land use analysis would be based on moisture conditions at the location of the meteorological data, that is, the London-Corbin Airport which would be the best representation of the data in terms of wet, dry, or average conditions in comparison to the 30-yr averages for the most recent complete calendar years (in this case, 1985 through 2014). The London-Corbin Airport, however, is missing several years in this time period and thus, another more complete, nearby set of precipitation data was used, namely that of the Jackson Julian Carroll Airport located in Breathitt County, Kentucky about 80 km to the northeast in similar terrain to that of London-Corbin Airport. To make the moisture conditions determination, climatological records of the annual precipitation in each modeled year (July 1, 2012 through June 30, 2015) were compared to the 1985-2014 climatological record[25].

Table 3-4 shows the 30 year precipitation by month for Jackson along with the seasonal totals, averages, and 30th percentile high and low values. These were compared to the actual rainfall in each season for each year of July 1, 2012 through June 30, 2015 which determined the average, wet, or dry option in AERSURFACE. Other specific AERSURFACE settings were used that represent the location of the London-Corbin Airport meteorological station. These settings include location coordinates, monthly versus seasonal differentiation, aridity, and, of course, the surface moisture determination which was just discussed. This determination is used in AERSURFACE to adjust the Bowen ratio estimated by AERSURFACE, which in turn affects the calculation of the daytime mixing heights used in AERMOD.

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[23] U.S. Environmental Protection Agency. 2013. "AERSURFACE User's Guide." EPA-454/B-08-001, Revised 01/16/2013. Available Online: http://www.epa.gov/scram001/7thconf/aermod/aersurface_userguide.pdf

[24] http://www.mrlc.gov/viewerjs/

[25] National Climactic Data Center. 2014 Local Climatological Data (LCD).

### Table 3-4. Moisture Calculation for Jackson Airport (inches of precipitation)

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL | Winter | Spring | Summer | Fall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 3.50 | 2.02 | 3.27 | 0.78 | 5.50 | 4.19 | 9.74 | 5.24 | 1.40 | 4.97 | 6.89 | 1.74 | 49.24 | 7.26 | 9.55 | 19.17 | 13.26 |
| 1986 | 1.84 | 5.44 | 1.56 | 0.95 | 2.42 | 2.15 | 2.73 | 2.49 | 3.27 | 2.38 | 9.32 | 3.06 | 37.61 | 10.34 | 4.93 | 7.37 | 14.97 |
| 1987 | 2.70 | 3.46 | 1.90 | 3.70 | 2.25 | 3.22 | 6.37 | 2.64 | 2.92 | 0.51 | 3.15 | 5.98 | 38.80 | 12.14 | 7.85 | 12.23 | 6.58 |
| 1988 | 2.59 | 2.00 | 3.09 | 2.97 | 4.50 | 1.37 | 4.56 | 4.15 | 7.82 | 1.85 | 6.12 | 4.03 | 45.05 | 8.62 | 10.56 | 10.08 | 15.79 |
| 1989 | 3.48 | 7.61 | 6.74 | 3.23 | 6.43 | 6.96 | 2.21 | 5.22 | 7.37 | 7.36 | 4.28 | 2.40 | 63.29 | 13.49 | 16.4 | 14.39 | 19.01 |
| 1990 | 2.56 | 6.27 | 3.16 | 2.95 | 5.08 | 4.02 | 4.18 | 4.21 | 1.86 | 4.73 | 2.91 | 12.97 | 54.90 | 21.8 | 11.19 | 12.41 | 9.5 |
| 1991 | 3.16 | 4.46 | 6.08 | 2.67 | 4.99 | 7.01 | 4.46 | 2.96 | 2.62 | 2.13 | 5.22 | 9.35 | 55.11 | 16.97 | 13.74 | 14.43 | 9.97 |
| 1992 | 1.87 | 3.12 | 5.80 | 1.66 | 4.61 | 4.08 | 6.67 | 3.20 | 3.66 | 1.60 | 3.23 | 4.92 | 44.42 | 9.91 | 12.07 | 13.95 | 8.49 |
| 1993 | 2.05 | 3.54 | 5.28 | 3.26 | 3.74 | 4.82 | 4.70 | 7.70 | 6.58 | 4.63 | 5.08 | 4.28 | 55.66 | 9.87 | 12.28 | 17.22 | 16.29 |
| 1994 | 7.28 | 7.42 | 11.78 | 5.52 | 3.37 | 4.85 | 3.74 | 6.11 | 2.45 | 2.53 | 2.73 | 2.98 | 60.76 | 17.68 | 20.67 | 14.7 | 7.71 |
| 1995 | 7.16 | 3.71 | 3.51 | 4.90 | 9.91 | 4.22 | 1.77 | 2.07 | 4.01 | 5.03 | 4.18 | 2.36 | 52.83 | 13.23 | 18.32 | 8.06 | 13.22 |
| 1996 | 5.63 | 3.11 | 5.46 | 5.95 | 5.86 | 4.35 | 4.96 | 3.01 | 6.47 | 4.00 | 7.28 | 2.72 | 58.80 | 11.46 | 17.27 | 12.32 | 17.75 |
| 1997 | 3.53 | 2.97 | 9.76 | 1.51 | 5.01 | 9.15 | 2.40 | 4.38 | 2.03 | 2.29 | 4.04 | 2.21 | 49.28 | 8.71 | 16.28 | 15.93 | 8.36 |
| 1998 | 3.76 | 4.45 | 2.86 | 10.00 | 6.28 | 8.29 | 2.46 | 2.47 | 2.09 | 2.59 | 2.98 | 5.16 | 53.39 | 13.37 | 19.14 | 13.22 | 7.66 |
| 1999 | 6.55 | 3.04 | 3.17 | 3.44 | 2.47 | 2.66 | 2.75 | 6.58 | 1.13 | 3.08 | 2.65 | 2.56 | 40.08 | 12.15 | 9.08 | 11.99 | 6.86 |
| 2000 | 2.63 | 3.53 | 1.94 | 4.97 | 4.33 | 6.80 | 5.69 | 4.38 | 4.92 | 1.07 | 1.47 | 4.35 | 46.08 | 10.51 | 11.24 | 16.87 | 7.46 |
| 2001 | 2.50 | 3.72 | 2.17 | 1.69 | 4.39 | 4.19 | 6.43 | 2.41 | 1.09 | 1.41 | 1.82 | 2.55 | 34.37 | 8.77 | 8.25 | 13.03 | 4.32 |
| 2002 | 4.09 | 1.24 | 7.96 | 4.11 | 5.23 | 4.98 | 5.50 | 1.72 | 3.48 | 6.39 | 3.61 | 4.28 | 52.59 | 9.61 | 17.3 | 12.2 | 13.48 |
| 2003 | 2.10 | 7.89 | 1.47 | 5.14 | 5.98 | 7.54 | 3.95 | 5.12 | 4.33 | 2.20 | 5.49 | 3.78 | 54.99 | 13.77 | 12.59 | 16.61 | 12.02 |
| 2004 | 4.23 | 3.77 | 3.87 | 4.01 | 10.78 | 6.18 | 7.02 | 2.39 | 7.55 | 4.96 | 4.37 | 3.27 | 62.40 | 11.27 | 18.66 | 15.59 | 16.88 |
| 2005 | 5.12 | 3.03 | 3.52 | 7.47 | 2.50 | 2.78 | 4.08 | 3.92 | 0.51 | 1.57 | 2.66 | 3.18 | 40.34 | 11.33 | 13.49 | 10.78 | 4.74 |
| 2006 | 5.57 | 1.85 | 2.89 | 4.57 | 3.61 | 3.24 | 3.87 | 3.69 | 6.39 | 5.49 | 2.43 | 2.03 | 45.63 | 9.45 | 11.07 | 10.8 | 14.31 |
| 2007 | 2.83 | 1.20 | 2.71 | 3.22 | 1.82 | 2.15 | 4.05 | 2.64 | 2.49 | 3.80 | 3.37 | 5.18 | 35.46 | 9.21 | 7.75 | 8.84 | 9.66 |
| 2008 | 2.46 | 3.41 | 4.14 | 4.00 | 3.24 | 3.94 | 6.13 | 1.16 | 0.67 | 1.46 | 3.03 | 6.86 | 40.50 | 12.73 | 11.38 | 11.23 | 5.16 |
| 2009 | 5.80 | 1.73 | 3.52 | 3.64 | 9.22 | 7.03 | 6.40 | 3.55 | 4.88 | 3.54 | 0.80 | 5.96 | 56.07 | 13.49 | 16.38 | 16.98 | 9.22 |
| 2010 | 4.27 | 3.11 | 2.43 | 2.61 | 7.92 | 5.60 | 3.34 | 3.51 | 2.05 | 1.68 | 5.77 | 2.97 | 45.26 | 10.35 | 12.96 | 12.45 | 9.5 |
| 2011 | 2.72 | 3.97 | 4.74 | 10.20 | 6.69 | 5.49 | 6.02 | 3.07 | 3.20 | 4.25 | 5.48 | 4.18 | 60.01 | 10.87 | 21.63 | 14.58 | 12.93 |
| 2012 | 4.86 | 3.90 | 4.07 | 2.67 | 4.20 | 1.91 | 7.39 | 4.75 | 6.77 | 4.24 | 0.84 | 6.39 | 51.99 | 15.15 | 10.94 | 14.05 | 11.85 |
| 2013 | 5.73 | 1.91 | 4.63 | 3.70 | 4.23 | 6.36 | 6.62 | 10.04 | 1.27 | 2.13 | 3.01 | 7.09 | 56.72 | 14.73 | 12.56 | 23.02 | 6.41 |
| 2014 | 3.15 | 4.47 | 5.51 | 5.43 | 2.30 | 3.12 | 5.77 | 8.55 | 2.35 | 7.77 | 2.97 | 2.49 | 53.88 | 10.11 | 13.24 | 17.44 | 13.09 |
| 2015 | 2.12 | 4.06 | 6.26 | 10.29 | 1.74 | 7.42 | | | | | | | | 6.18 | 18.29 | 7.42 | 0 |

Precipitation location from http://www.ncdc.noaa.gov/cdo-web/datatools/findstation
KJLK precipitation data - obtained 2014 cumulative report from http://www1.ncdc.noaa.gov/pub/orders
Note: 30year Local climatological Data for Jackson, KY was used due to missing data for London-Corbin airport

| | Winter | Spring | Summer | Fall |
|---|---|---|---|---|
| Upper 30th | 13.27 | 16.31 | 14.97 | 13.23 |
| Lower 30th | 10.05 | 11.15 | 12.22 | 8.17 |

| | Winter | Spring | Summer | Fall |
|---|---|---|---|---|
| 2010 | A | A | A | A |
| 2011 | A | W | A | A |
| 2012 | W | D | A | A |
| 2013 | W | A | W | D |
| 2014 | A | A | W | A |
| 2015 | D | W | W | |

A = average precip
W = wet precip
D = dry precip

## 3.4. COORDINATE SYSTEM

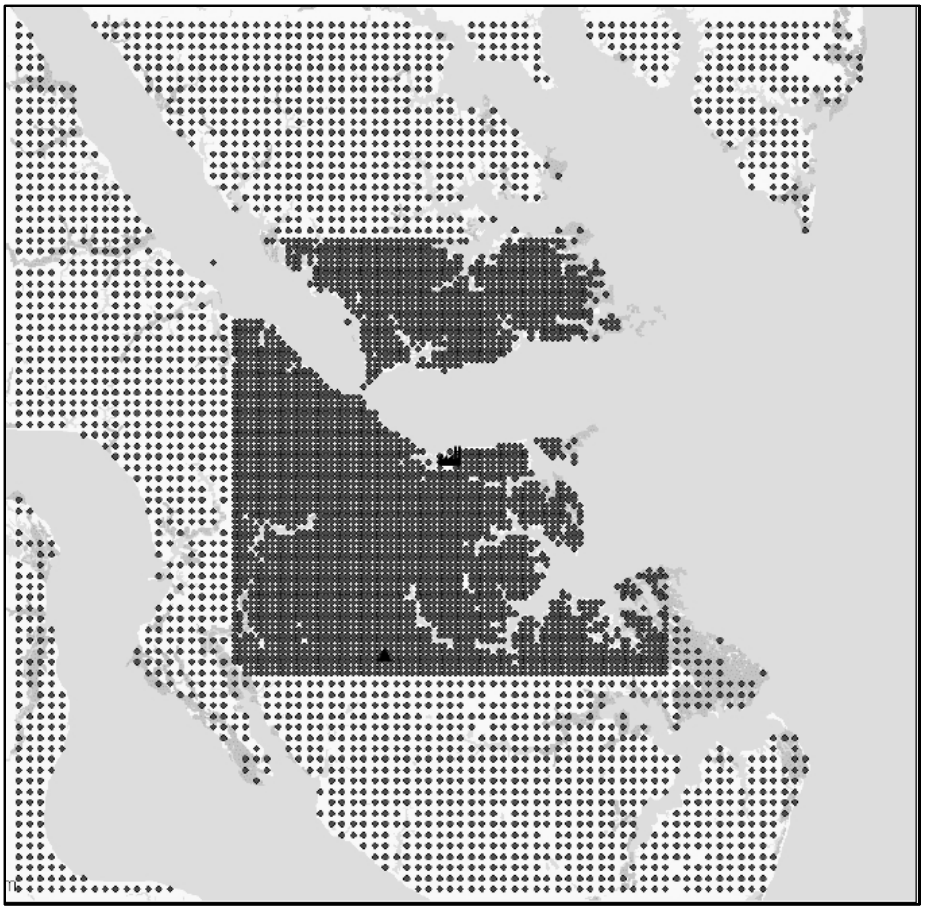
In all modeling input and output files, the locations of emission sources, structures, and receptors are represented in the appropriate Zone of the Universal Transverse Mercator (UTM) coordinate system using the North American Datum 1983 (NAD83). The Cooper Station and the surrounding area lies within Zone 16.

## 3.5. RECEPTOR LOCATIONS

The dispersion modeling followed the guidance of the modeling TAD in terms of only putting receptors in areas where it is feasible to place an actual monitor. Consistent with the example in Figure 3-3 from the modeling TAD, no receptors were placed in lakes, rivers or similar areas. As the modeling TAD states:

> *"In areas where it is not feasible to place a monitor (water bodies, etc.), receptors can be ignored or not placed in those locations. In any case, receptor placement should be of sufficient density to provide resolution needed to detect significant gradients in the concentrations, with receptors placed closer together near the source to detect local gradients and placed farther apart away from the source. In addition, the user should place receptors at key locations such as around facility fence lines (which define the ambient air boundary for a particular source) or monitor locations (for comparison to monitored concentrations for model evaluation purposes)."*

**Figure 3-3. Modeling TAD Receptor Grid Showing Example Excluded Locations over Water**



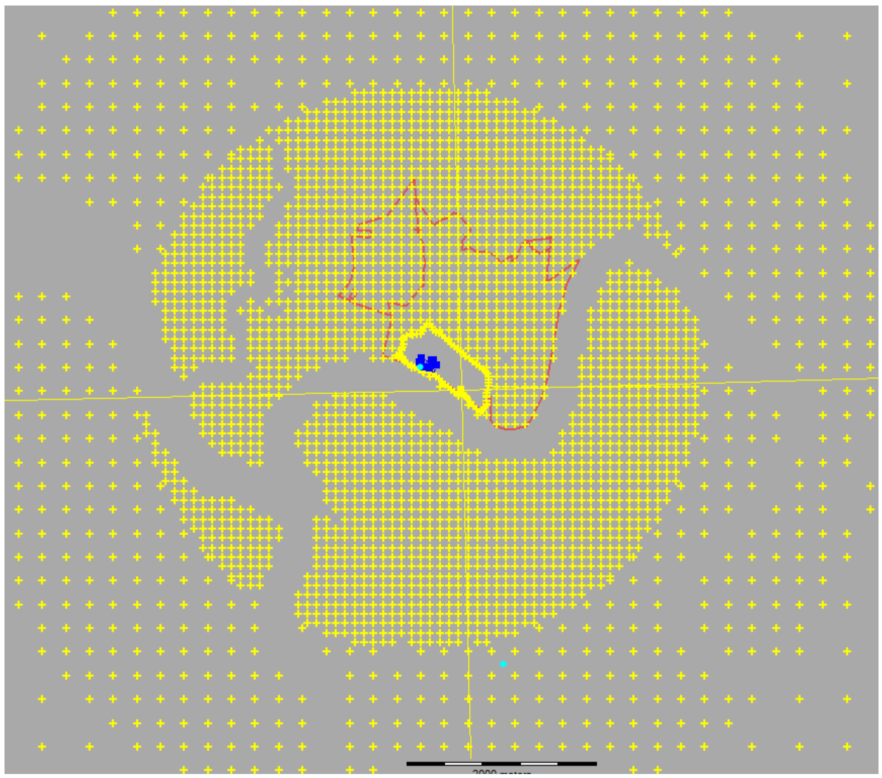
The proposed receptor grid for the modeling of the Cooper Station combined a multi-nested, circular Cartesian grid at various spacing intervals centered on the main Cooper Station stack along with receptor points on the facility's fence line. For the air dispersion modeling analyses, ground-level concentrations were calculated from the fence line out to the location and magnitude of the significant concentration gradient as specified by the modeling TAD. To accommodate the possible farthest extent of this modeling domain and receptor grid, the receptors are a series of nested grids as follows:

- **Fence Line Grid:** "Fence line" grid consisting of evenly-spaced receptors 50 meters apart placed along the main fence line of the Cooper Station,
- **Fine Cartesian Grid:** A "fine" grid containing 100-meter spaced receptors extending to 3 km from the center of the property and beyond the fence line,
- **Medium-Fine Cartesian Grid:** A "medium-fine" grid containing 250-meter spaced receptors extending from 3 km to 5 km from the center of the facility, exclusive of receptors on the fine grid,
- **Medium-Coarse Cartesian Grid:** A "medium-coarse" grid containing 500-meter spaced receptors extending from 5 km to 10 km from the center of the facility, exclusive of receptors on the fine and medium-fine grids,

- **Coarse Cartesian Grid:** A "coarse grid" containing 1,000-meter spaced receptors extending from 10 km to 20 km from the center of the facility, exclusive of receptors on the fine, medium-fine, and medium-coarse grids.

Figure 3-4 shows the innermost grids of the proposed receptors used in the modeling. As can be seen, receptors in the Cumberland River have been eliminated. Also shown is the current fence line of the facility (innermost line of yellow receptors) and the property line as a red annotation to show the extent of EKPC property holdings in the area.

**Figure 3-4. Innermost Portion of the Proposed Modeling Receptor Grid for Cooper**



## 3.6. TERRAIN ELEVATIONS

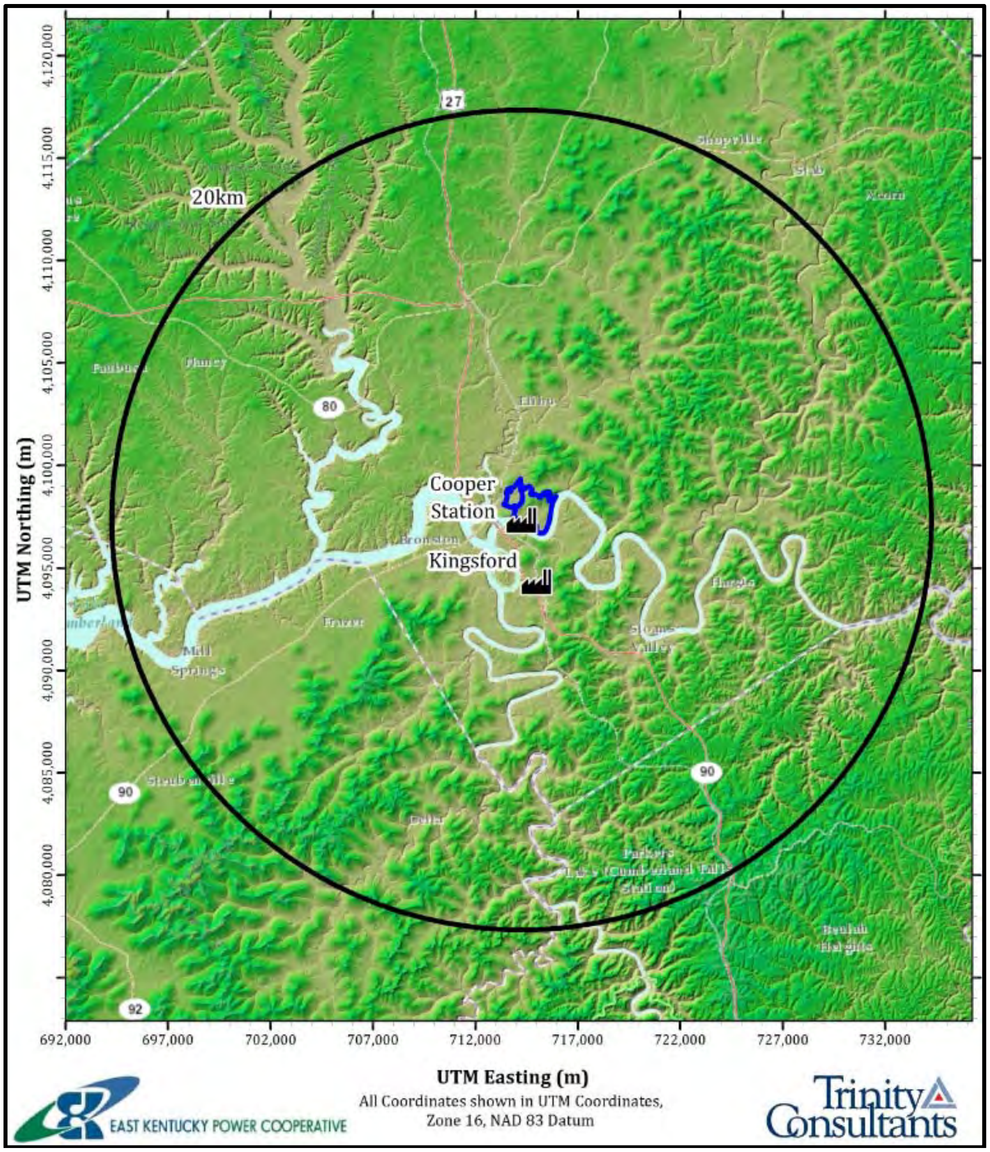
The terrain elevation for each receptor, building, and emission source was determined using USGS 1 arc-second National Elevation Data (NED). The NED, obtained from the USGS[26], has terrain elevations at 30-meter intervals. Using the AERMOD terrain processor, AERMAP (version 11103), the terrain height for each receptor, and outlying buildings included in the model was determined by assigning the interpolated height from the digital terrain elevations surrounding each source. These were used directly in the AERMOD model.

In addition, AERMAP was used to compute the hill height scales associated with each elevated receptor located above the Cooper Station source base elevation. This computation enables the model to determine the effect that terrain will have on plumes from the sources. AERMAP searches all nearby elevation points for the terrain height and location that has the greatest influence on each receptor to determine the hill height scale for that receptor. AERMOD then uses the hill height scale in order to select the point where a plume may divide between

26 http://www.mrlc.gov/viewerjs/

going around a terrain feature and lofting over the feature.   Review of the area indicates that a few hills exist near the Cooper Station and thus, the inclusion of terrain elevations in the modeling is paramount.  Figure 3-5 shows a relief map of the area.

**Figure 3-5.  Relief Map of Area within 20 km of Cooper Station**




## 3.7. COOPER STATION EMISSION SOURCES

The Cooper Station has only one major source of continuous $SO_2$ emissions, which is the main stack associated with coal-fired Units 1 and 2.  Other intermittent sources of $SO_2$ emissions include an Emergency Diesel Generator (Unit 08), a Communication Tower Emergency Generator (Unit 12), Fire Pump Engine (Unit 13), and the Burnside Service Center Emergency Generator (Unit 14).  All are permitted to operate no more than 100 hours per year in non-emergency situations and thus, do not contribute to the annual distribution of daily maximum 1-hour $SO_2$ concentrations.[27]

In addition, actual hourly and annual $SO_2$ emissions from these diesel fuel and propane-fired emergency engines are negligible given the relatively small horsepower rating of the engines and the very low sulfur content of the fuels used. Consistent with U.S. EPA's guidance[28] for treatment of intermittently operated source like emergency engines in 1-hr $SO_2$ and $NO_2$ NAAQS demonstrations, EKPC excluded these engines from the modeled source inventory and only considered $SO_2$ emissions from Units 1 and 2 in the modeling analysis.

The preferred modeling approach for establishing modeled emission rates recommended in the modeling TAD is the use of CEMS data, where available, as a CEMS-derived, hour-by-hour modeled emission rate dataset provides the most accurate representation of the actual emissions history of the source for the relevant time period considered in the modeling. Currently and in the future, the combined flows of each unit at Cooper Station exit through a common stack. The following discussion recognizes this fact and is geared towards defining the individual and combined stack emissions and flows.

Further details regarding the derivation of the modeled hour-by-hour $SO_2$ emission rates representing the sum of the actual emissions from Unit 2 and the allowable emissions from Unit 1 and the combined Unit 1 and 2 stack parameters for each relevant Cooper Station operating mode (i.e., both units running and only Unit 1 running) are presented in the following subsections with explicit references to the associated model input parameter derivation spreadsheet included in Appendix C to this modeling report.

### 3.7.1. Cooper Unit 1 Modeled Emission Rate

Because Unit 1 is undergoing modification to tie-in the exhaust gases into the existing dry flue gas desulfurization (DFGD) currently serving Unit 2, use of Unit 1 CEMS data from the relevant time period is not representative of future emissions or impacts. This $SO_2$ emissions control project for Unit 1 is expected to be completed by January 1, 2016 which is well before the consent decree-driven July 2016 $SO_2$ NAAQS attainment designation deadline.

Under these circumstances, an allowable $SO_2$ emission rate for Unit 1 is applied for every hour of the modeled meteorological period. The Unit 1 allowable $SO_2$ emission rate in its current configuration is 3.3 lb/MMBtu on a 24-hour average basis (refer to Condition B.2.c for Unit 1 on page 3 of 80). In addition, after Unit 1 is tied into the DFGD, it will become subject to an additional limit of 95% control or 0.100 lb/MMBtu on a 30-day rolling average. Based on this suite of $SO_2$ emission limits which will be federally enforceable, EKPC performed dispersion modeling of an emission rate equivalent to 0.165 lb $SO_2$/MMBtu (i.e., 178 lb/hr based on the maximum heat input capacity of Unit 1 of 1,080 MMBtu/hr). This emission rate is derived by taking 95% of the current Title V permit limit of 3.3 lb $SO_2$/MMBtu. As a further measure of added conservatism, this rate was modeled assuming 8,760 hours of operation, rather than only modeling this rate at times when Unit 1 was actually running during the modeled three-year period. EKPC believes that the emission limits discussed above (i.e., 3.3 lb $SO_2$/MMBtu and 95% reduction or 0.100 lb $SO_2$/MMBtu) are sufficient to support the modeled emission rate, and no additional limits are necessary. This modeling approach is different than proposed in the

[27] *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-Hour $NO_2$ National Ambient Air Quality Standard*, Memorandum from Tyler fox, Leader Air Quality Modeling Group to U.S. EPA Regional Air Division Directors, March 1, 2011.
[28] Ibid.

modeling protocol, but reflects consideration of EPA Region 4's comments on the modeling protocol[29] and discussions with KDAQ.

### 3.7.2. Cooper Unit 2 Modeled Emission Rate

As referenced in Section 2.6 of the modeling protocol submitted on August 3, 2015, EKPC has relied on CEMS data from Unit 2 directly with no alterations or refinements because this boiler has been tied into the DFGD system during the entire modeling period. This data is also expected to represent future operation of this unit after the Unit 1 duct rerouting project is completed and in any year after the July 2016 $SO_2$ NAAQS designation deadline. Using coal heat input capacity as a measure of the size of each electric generating unit at the Cooper Station, Unit 2 is nearly two times larger than Unit 1 (i.e., 2,089 MMBtu/hr for Unit 2 versus 1,080 MMBtu/hr for Unit 1). Design evaluations and engineering judgement suggest the Unit 2 $SO_2$ emissions profile will not change as a result of adding a relatively small amount of additional exhaust flow and $SO_2$ emissions loading contributed by the smaller Unit 1 after the tie-in. In light of these facts, EKPC possesses a complete three-year record of valid $SO_2$ emissions data reflective of current and future operation of Unit 2 while operating under a federally enforceable $SO_2$ emission limit that mandates efficient operation of the DFGD (refer to the 95% $SO_2$ removal efficiency or 0.100 lb $SO_2$/MMBtu emission limit applicable on a 30-day rolling average basis in Condition B.2.c of Title V Permit V-12-019 R1 on page 11 of 80). With basically two-thirds of the future $SO_2$ emissions from Cooper Station characterized by CEMS data collected in the representative three-year timeframe selected for the modeling, EKPC does not believe it would be appropriate or justified to consider other modeled emission rate derivation techniques for Unit 2 (e.g., modeling an allowable emission rate).

The CEMS data handling and acquisition system (DHAS) for Unit 2 produces hourly average $SO_2$ emission rates (refer to column C of the 1*. Unit 1 & 2 Emissions* tab in model input parameter spreadsheet in Appendix C) based on the measured $SO_2$ concentration and flow rate in the Unit 2 exhaust after it exits the DGFD but before it merges with the currently uncontrolled (for $SO_2$ ) Unit 1 exhaust stream at the base of the combined Unit 1 and 2 stack. A comprehensive review of the hourly $SO_2$ emissions dataset for Unit 2 generated by the DAHS indicates two issues requiring data substitution techniques.

First, missing and out-of-control data flagged by the DAHS was indicated (refer to TRUE values in column D of the *1. Unit 1 & 2 Emissions* tab in the model input parameter spreadsheet in Appendix C). Missing values and out-of-control (OOC) data periods are required to be filled with estimated $SO_2$ emission rates because actual emissions were occurring during these events. The emissions were just not being measured and recorded properly for these hours. Of the 26,280 data points in the 3-year hourly $SO_2$ emission rate data set for Unit 2, only 48 hours spread over 19 events were flagged by the DAHS as missing or OOC when Unit 2 was in operation (99.92% data completeness in 3-year period). No single missing or OOC data period exceeds more than 6 hours in duration.

Given the very limited number and duration of missing/OOC data periods, EKPC chose a linear interpolation filling technique using the two good data points surrounding the missing/OOC data period rather than a more complex technique involving emission factors or use of peak values from a representative range of boiler operating conditions. This interpolation technique was performed using the FORECAST function in Microsoft® Excel. The first required field to execute this function is a missing/OOC data period count (refer to column F of the *1. Unit 1 & 2 Emissions* in the model input parameter spreadsheet in Appendix C) that starts at 1 for the first missing/OOC hour from an event and continues counting until a valid data point is encountered. The sequential integer list of missing/OOC hours for each event defines the number of data points for which an interpolation

[29] Email from Mr. Rick Gillam, EPA Region 4 Environmental Engineer/Air Modeler to Mr. Ben Cordes, KDAQ Air Dispersion Modeling Section Supervisor, *RE: EKPC Cooper Station - 1-Hour SO2 Air Dispersion Modeling Protocol*, August 17, 2015 and email from Mr. Gillam to Mr. Cordes on August 25, 2015; conference call between EKPC, KDAQ and EPA Region 4 on August 27, 2015.

calculation is required. For example, if three sequential data points were missing, the counter sets the first missing hour to 1, the second missing hour to 2, and the third missing hour to 3. The next field required for this function is the last good hour before the missing/OOC data period starts and the first good hour after the missing/OOC data period ceases. These $SO_2$ emission rates define the starting point and end point for the linear interpolation (refer to columns G and H of the *1. Unit 1 & 2 Emissions* in the model input parameter spreadsheet in Appendix C). The final field required for the function is the range of missing/OOC hours where a 0 is assigned to the position of the last good hour, and a value one greater than the duration of the missing/OOC event is assigned for the first good value after the missing/OOC period. Table 3-5 provides an example of how the FORECAST function is applied to perform linear interpolation where blue text indicates data directly from the CEMS DAHS, black text indicates a calculated value, green highlights indicate a good data hour, and orange highlights indicate a missing/OOC hour requiring filling.

**Table 3-5. Example of Missing/OOC $SO_2$ Emissions Data Filling Technique**

| Date/Hour | Cooper Unit 2 Controlled $SO_2$ Emissions Directly from CEMS (lbs/hr) | Cooper Unit 2 Controlled $SO_2$ Emissions Missing/OOC Flag | Cooper Unit 2 in Operation (min) | Cooper Unit 2 Missing/ OOC $SO_2$ Emissions Data Count | Cooper Unit 2 Missing/OOC $SO_2$ Emissions Start Value for Interpolation | Cooper Unit 2 Missing/OOC $SO_2$ Emissions End Value for Interpolation | Cooper Unit 2 Interpolation Start Hour | Cooper Unit 2 Interpolation End Hour | Filled Unit 2 SO2 Emissions (lb/hr) |
|---|---|---|---|---|---|---|---|---|---|
| 11/14/2012 10 | 1.1 | FALSE | 60 | 0 | 0 | 1.1 | 0 | 1 | 1.10 |
| 11/14/2012 11 | 7.6 | TRUE | 60 | 1 | 1.1 | 13.6 | 0 | 7 | 2.89 |
| 11/14/2012 12 | 7.8 | TRUE | 60 | 2 | 1.1 | 13.6 | 0 | 7 | 4.67 |
| 11/14/2012 13 | 7.4 | TRUE | 60 | 3 | 1.1 | 13.6 | 0 | 7 | 6.46 |
| 11/14/2012 14 | 6.7 | TRUE | 60 | 4 | 1.1 | 13.6 | 0 | 7 | 8.24 |
| 11/14/2012 15 | 7.6 | TRUE | 60 | 5 | 1.1 | 13.6 | 0 | 7 | 10.03 |
| 11/14/2012 16 | 7.6 | TRUE | 60 | 6 | 1.1 | 13.6 | 0 | 7 | 11.81 |
| 11/14/2012 17 | 13.6 | FALSE | 60 | 0 | 1.1 | 13.6 | 0 | 1 | 13.60 |

The missing/OOC data flag built into the DAHS indicates a 6-hour block of missing data occurred from 11/14/12 11 AM until 11/14/12 at 5 PM. The last good reading before the missing/OOC data period starts (1.10 lb/hr) and the first good reading after the missing/OOC ends (13.60 lb/hr) defines the bounds for the $SO_2$ emission rate interpolation (i.e., range of "Y" values). The starting "X" value for the interpolation is always set to hour 0 and the ending "X" value is set to one hour higher than the duration of the event (7 in this case). With these inputs, the results of the FORECAST function creates a smooth line of 6 data points connecting the last good hour before the event to the first good hour after the event. An identical approach was applied to all 19 events in the Unit 2 $SO_2$ emissions data set.

The second issue requiring additional data processing occurred when the operating parameter data tag for Unit 2 operating time (refer to column E in the *1. Unit 1 & 2 Emissions* tab of the model input parameter spreadsheet in Appendix C) is set to zero for several hours while the Unit 2 CEMS is indicating emissions greater than zero (refer to column C in the 1. Unit 1 & 2 Emissions tab of the model input parameter spreadsheet in Appendix C). During the vast majority of these hours, Unit 1 is running. The Unit 2 operating hour tag is a definitive indication of operating status, so EKPC zeroed out the anomalous Unit 2 $SO_2$ emissions data during Unit 2 downtime. This data substitution for Unit 2 downtime was accomplished by simply adding logic to the filled Unit 2 $SO_2$ emission rate calculation (refer to column K of the *1. Unit 1 & 2 Emissions* in the model input parameter spreadsheet in Appendix C) that uses the CEMS-monitored $SO_2$ emission rate only if the operating time flag is greater than 0 minutes. The first instance in the 3-year data period where this type of data substitution was completed for an invalid hour is shown in Table 3-6.

**Table 3-6. Example of Unit 2 $SO_2$ Emissions during Downtime**

| Date/Hour | Cooper Unit 2 Controlled $SO_2$ Emissions Directly from CEMS (lbs/hr) | Cooper Unit 2 Controlled $SO_2$ Emissions Missing/OOC Flag | Cooper Unit 2 in Operation (min) | Filled Unit 2 SO2 Emissions (lb/hr) |
|---|---|---|---|---|
| 07/08/2013 07 | 2.7 | FALSE | 0 | 0 |

The modeled emission rate discussion in Section 2.6 of the modeling protocol indicated startup and shutdown emissions would be handled in a manner consistent with U.S. EPA's intermittent source guidance regarding whether or not such events could be excluded from the modeling analysis. In accordance with relevant guidance, the CEMS data was not further processed to remove $SO_2$ emissions during startup or shutdown of Unit 2.

### 3.7.3. Combined Cooper Units 1 and 2 Modeled Emission Rate

The combined stack for Cooper Units 1 and 2 is represented as a single point source in the $SO_2$ modeling analysis. As such, the modeled emission rate must represent the combined $SO_2$ emissions from both Units 1 and 2. The filled Unit 2 actual emissions dataset obtained from the CEMS defines the $SO_2$ emissions contribution from Unit 2 on an hour-by-hour basis (refer to Column D of the *3. Model Input Parameters* tab of the model input parameter spreadsheet in Appendix C). The fixed allowable emission rate for Unit 1 applied on a continuous basis (refer to Column C of the *3. Model Input Parameters* tab of the model input parameter spreadsheet in Appendix C) is added to the Unit 2 actual emission rate that varies on an hour-by-hour basis to define the modeled emission rate for the combined Unit 1 and 2 stack (refer to Columns E and F of the *3. Model Input Parameters* tab of the model input parameter spreadsheet in Appendix C).

### 3.7.4. Stack Parameter Selection

In Table 2-3 of the modeling protocol, EKPC indicated a single set of stack parameters would be used for all hours of the modeling analysis based on the design stack gas conditions when both Units 1 and 2 are running determined from the design study supporting the Unit 1 DFGD tie-in project. Upon further consideration, EKPC determined that such an approach could overestimate the stack exit velocity at times when only Unit 1 was operating. To address this issue, the final selection process involved picking from two sets of design flow rates: 1) both Units 1 and 2 running with both units exhaust routed through the DFGD (i.e., the original design case presented in Table 2-3 of the modeling protocol), and 2) only Unit 1 running with its exhaust routed through the DFGD. The flow rates and corresponding exit velocities assigned in these two cases are documented in the modeling input parameter spreadsheet in Appendix C (refer to Columns H and I of the *2. Stack Parameters* tab in the model input parameter spreadsheet in Appendix C) and are presented in Table 3-7.

Finally, the stack temperature for all Cooper Station operating cases is set to 160 deg. F which represents the design basis for the DFGD and provides the best estimate of the exhaust conditions from the combined Unit 1 and 2 stack after the Unit 1 DFGD tie-in project is completed. Review of actual in-duct exhaust temperatures for Unit 2 downstream of the DFGD indicates this design value may underestimate actual stack temperatures that will occur after the Unit 1 tie-in, and thus, this input parameter is expected to result in conservatively high modeled impacts (i.e., lower stack temperatures produce lower thermal buoyancy, less plume rise, and higher modeled impacts when all other parameters are held constant).

**Table 3-7. Cooper Station Source Parameters**

| Model ID | Description | UTM Easting[3] (m) | UTM Northing[3] (m) | Elevation (m) | Emission Rate (lb/hr) | Stack Height (ft) | Temp. (F) | Flow Rate[1] (acfm) | Exit Velocity[1] (ft/s) | Diameter (ft) | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| COOPER | Units 1 & 2 Operating | 714,250 | 4,097,343 | 243.84 | CEMS | 260 | 160.0 | 1,100,000 | 72.05 | 18.0 | 2 |
| COOPER | Only Unit 1 Operating | 714,250 | 4,097,343 | 243.84 | 178.20 | 260 | 160.0 | 260,000 | 17.03 | 18.0 | 2 |

[1] Stack flow rates and exit velocities for Units 1 & 2 in operation and Unit 1 operating alone are based on design study performed by engineering firm contracted to perform Unit 1 tie-in to DFGD.

[2] As indicated, only one Modeling ID exists in the AERMOD input file, however stack exit velocity is varied within an hourly emission input file with respect to the specific Units operating for a given hour.

[3] UTM coordinates are represented in NAD83 datum Zone 16.

### 3.7.5. Hourly Emissions File Creation

The final step in the process of assigning model input parameters for the Cooper Station 1-hr $SO_2$ NAAQS attainment demonstration modeling analysis is developing the hourly emission rate and stack parameter file fed to AERMOD. The previously discussed hour-by-hour varying modeled emission rate for Units 1 and 2 on a combined basis is assigned to the hourly emissions file. The Cooper Station operating status-based exit velocity is then assigned depending on whether both units are operating or only Unit 1 is operating (refer to column G of the *3. Model Input Parameters* tab in the model input parameter spreadsheet carried forward from column I of the *2. Stack Parameters* tab in the model input parameter spreadsheet in Appendix C). The constant exit temperature discussed previously is assigned to every hour in the modeling period. Finally, the modeled emission rate, stack temperature, and exit velocity are merged into an hour-by-hour text string which matches the syntax of the AERMOD hourly emissions file invoked with the SO HOUREMIS keyword (refer column J of the *3. Model Input Parameters* tab in the model input parameter spreadsheet in Appendix C).

## 3.8. OTHER SOURCE INVENTORY

Other sources of $SO_2$ emissions in the area surrounding the Cooper Station were evaluated for inclusion in the modeling. This evaluation is documented in the regional inventory processing spreadsheet provided on the CD in Appendix C.

Consistent with the modeling TAD, the determination of which sources to model followed a multi-step process. With the goal of the modeling being to determine those sources that could cause or contribute to a NAAQS violation, the factors considered in developing the modeling inventory included the magnitude of the $SO_2$ emissions, the source parameters, the proximity to Cooper, and the level and extent of the impact of the nearby source. As recommended (and referred to by the modeling TAD) by the additional clarifications memorandum of 2011[30] which is applicable to both $SO_2$ and $NO_2$, several options for screening out regional inventory sources were considered (the AERSCREEN model approach in the 2011 memorandum was not used) and include:

1. Analyzed contour plots of each fully modeled source (AERMOD) which clearly depict the impact area of the source, preferably overlaid on a map that identifies key geographic features that may influence the dispersion patterns. The concentration contour plot also served to visually depict the concentration gradients associated with the source's impact and the overlay of adjacent concentration gradients from nearby sources.

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[30] *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour $NO_2$ National Ambient Air Quality Standard*, memorandum form Tyler Fox to Regional Air Division Directors, March 1, 2011.

2. Identified meteorological conditions that control the source's impacts. Use the MAXDAILY or MXDYBYYR AERMOD output options to help identify the appropriate time periods to be used to calculate controlling design values. Meteorological data sets were cross-checked with model-generated dates of highest concentrations to assist in identifying these controlling meteorological conditions.

3. Using a wind rose of the meteorological data in the modeling can help to analyze flow patterns and determine the potential for the cross-coincidence of impacts from various sources.

EKPC implemented elements of all three regional screening methods. Because this implementation was more robust than applying the AERSCREEN Model, that method was not deemed necessary and was, thus, not used.

An additional technique for differentiating contributing sources is the use the "20D method"[31]. The 20D method says that if the ratio of the emissions to the distance between sources is less than 20 ($Q/d < 20$), a source does not need to be included in the modeling. The specification of the variables in the 20D analysis include:

- Q = Annual actual/potential emissions in tons/year
- d = Distance from the target source in kilometers to the Cooper Station

Because both allowable (or potential) and actual emissions are referenced in the modeling TAD for use in modeling regional sources, a Q/d ratio based on both site-wide actual and site-wide potential emissions has been developed (refer to the Q-D Analysis tab in the regional inventory processing spreadsheet provided on the CD in Appendix C).

Figure 3-6 shows all $SO_2$ source locations within 50 km of the Cooper Station that reported actual $SO_2$ emissions in 2013. An actual annual $SO_2$ emissions magnitude indicator categorized by size and color of the source marker on the map is used to differentiate larger sources from smaller sources (see legend on figure). Of the 16 facilities emitting $SO_2$ within 20 km of the Cooper Station, only one source [Kingsford Manufacturing Company (KMC)] has actual annual emissions greater than 2.5 tpy. With the exception of KMC, the cumulative annual $SO_2$ emissions from all sources within 20 km of Cooper are only 8.5 tpy on actual emissions basis and 40 tpy on a potential emissions basis (refer to columns G and I in the *NAAQS 20D List* tab of the regional inventory processing spreadsheet in Appendix C). In comparison to the modeled $SO_2$ emission rates from Cooper Unit 1 and 2, these small sources generate negligible quantities of $SO_2$ emissions. Furthermore, the vast majority of these sources are located to the north of Cooper Station which is in a low frequency wind sector for wind directions causing transport from the regional source locations to the area of highest impacts for Cooper (refer to frequencies for "blowing from" wind sectors in Figure 3-8 for north, northeast, and northwest quadrants of the London-Corbin airport meteorological station's wind rose). Finally, the cumulative Q/d ratio for all sources within 20 km of the Cooper Station other than KMC is 1.5 tpy/km on an actual emissions basis and 6.2 tpy/km on a potential emissions basis, which are both well below the 20 tpy/km threshold that applies on an individual source basis. Based on this Q/d profile for sources within 20 km of Cooper Station, even if all sources were considered to form a "cluster", their cumulative Q/d ratio would still support screening the sources out of the regional inventory.

When the additional 38 facilities located between 20 and 50 km from the Cooper Station are added to the regional inventory evaluation, all but one source [EKPC Laurel Ridge Landfill Gas to Energy (LGTE) Facility] has actual annual $SO_2$ emissions below 3.5 tpy. The EKPC Laurel Ridge LGTE Facility (with actual $SO_2$ emissions of 36.1 tpy and potential $SO_2$ emissions of 41.3 tpy) is located approximately 45 km east of the Cooper Station. The London-Corbin airport meteorological station wind rose in Figure 3-8 indicates a very low frequency of winds

[31] *A Screening Method for PSD*, letter from Eldewins Haynes, North Carolina Air Permit Unit to Lewis Nagler, EPA, Region 4, Meteorologist, July 22, 1985.

blowing from the East to the West that would favor transport of $SO_2$ emissions from the Laurel Ridge LGTE Facility to the area surrounding the Cooper Station. In addition, the single stack located at the Laurel Ridge LGTE Facility is only 33 feet tall which does not favor the type of long range transport needed to significantly overlap with the Cooper Station impacts, especially considering the moderately complex terrain associated with the area between the landfill and Cooper Station. As a final screening technique, EKPC evaluated the combined Q/d for all sources between 20 km and 50 km from the Cooper Station and again determined these ratios (1.1 tpy/km on an actual emissions basis and 5.7 on a potential emissions basis) do not support the addition of any regional inventory sources beyond 20 km of the Cooper Station.

To ensure any $SO_2$ impacts from the small sources screened out of the inventory are accounted for within the NAAQS analysis, EKPC is proposing to use a conservative background concentration based on the design value in the form of the 1-hr $SO_2$ NAAQS from the selected Mammoth Cave $SO_2$ monitoring station (refer to Section 3.10). Selecting the design value from a background monitor versus temporal pairing of monitored background concentrations with modeled concentrations generally offers the ability to implement more extensive screening of small regional sources due to the higher magnitude of the background concentration included in the NAAQS demonstration. Therefore, EKPC believes the regional inventory screening process and background concentration selection applied for the Cooper $SO_2$ NAAQS analysis achieve an appropriate balance between more extensive regional source screening and selection of a conservatively high background concentration.

As shown in Figure 3-7 and Tables B-1.1 and B-1.2 of Appendix B, the KMC facility in Burnside, Kentucky is the only nearby $SO_2$ emissions source that is of sufficient magnitude and proximity to warrant consideration in the refined modeling. The modeled source parameters for KMC are provided in Table B-1.1 of Appendix B.

**Figure 3-6. Map Showing Regional Source Locations and $SO_2$ Emissions Magnitude near Cooper Station**

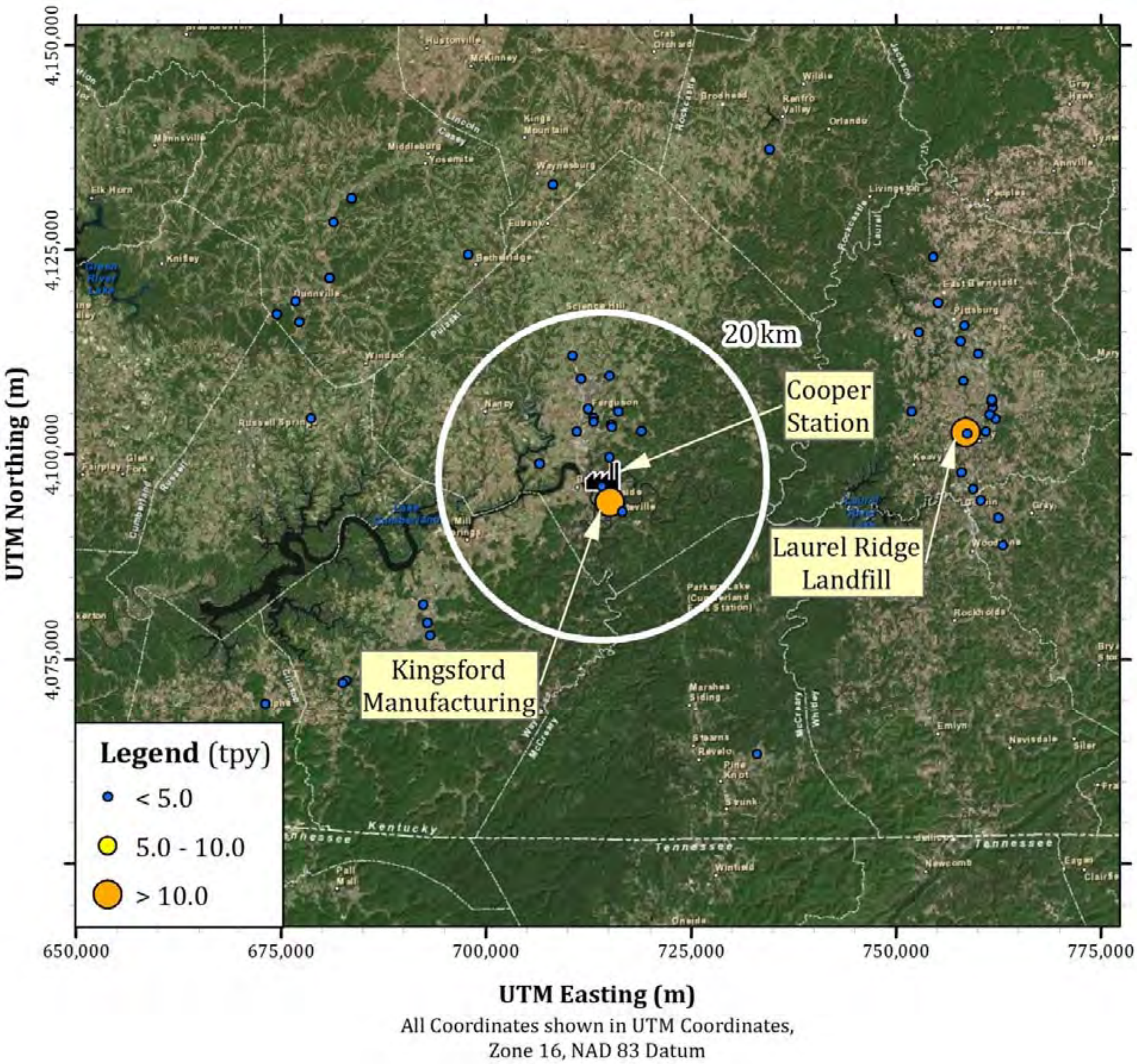
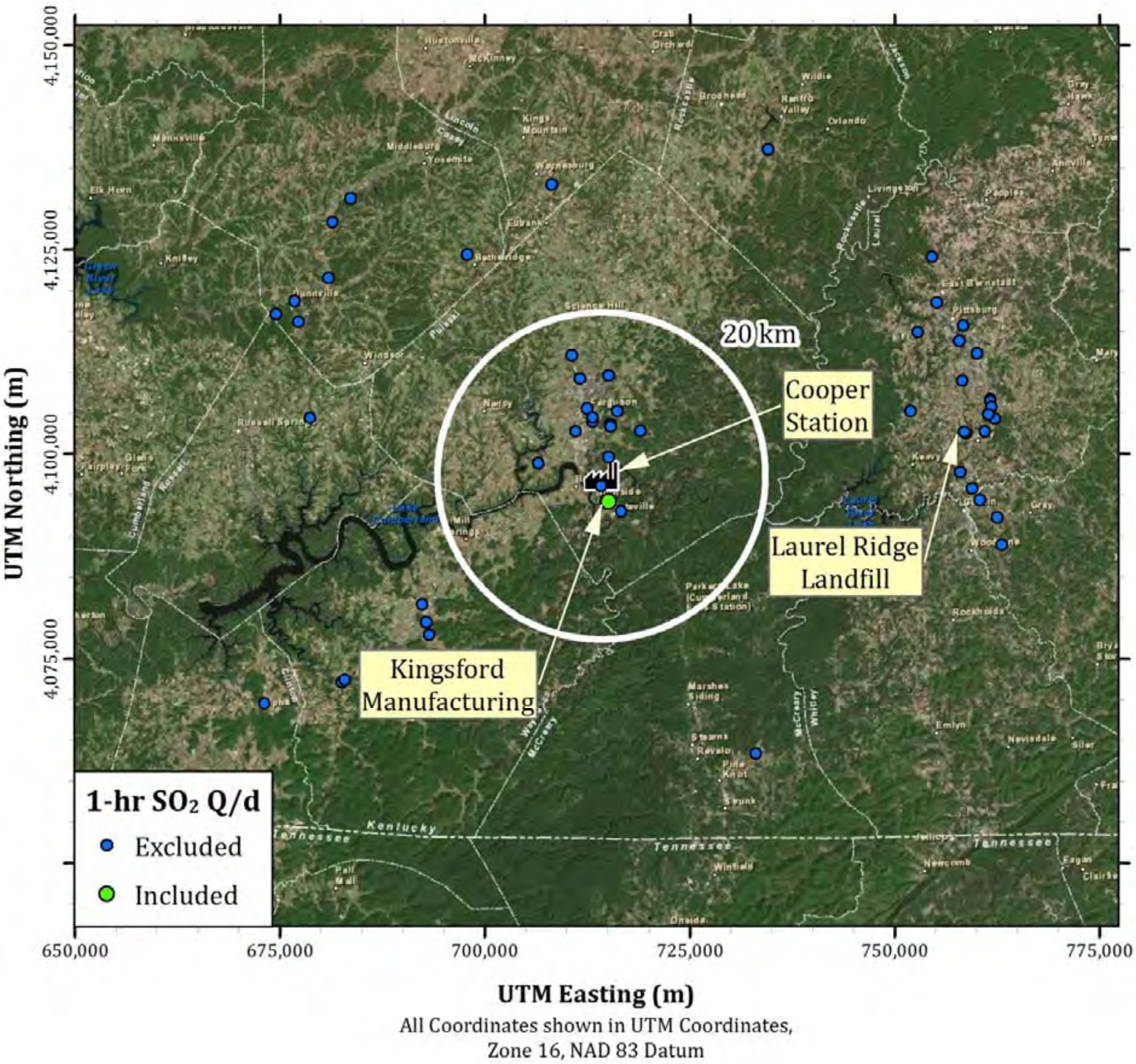


**Figure 3-7. Results of Regional Source Screening Evaluation based on Q/d Analysis**




## 3.9. BUILDING INFLUENCES

The U.S. EPA's Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME) (version 04274), was used to account for building downwash influences on the Unit 1 & 2 main stack. The purpose of a building downwash analysis is to determine if the plume discharged from a stack will be influenced by the turbulent wake of any onsite buildings or other structures, resulting in downwash of the plume. The downwash of the plume can result in elevated ground-level concentrations in the near wake of a building and is required for consideration in the modeling. For "other" sources that are modeled in the area, downwash was not considered, as considering this phenomenon would reduce the impacts from these sources at the location of the Cooper Station's maximum impacts.

## 3.10. BACKGROUND CONCENTRATIONS

As described in Section 8 of the modeling TAD, the inclusion of background ambient monitored concentrations as part of the NAAQS demonstration is important in determining and deciphering the cumulative ambient air impacts. As recommended by the modeling TAD, a first tier approach (i.e., the most conservative option from among the available background concentration selection techniques) based on monitored design values for the latest three year period was implemented for the Cooper Station NAAQS analysis.

As with many locations in Kentucky, a nearby $SO_2$ monitor within the immediate vicinity of the Cooper Station does not exist and, therefore, regional sites were evaluated for use to characterize the background concentration. This selected monitoring site should not be influenced by the subject facility, which is not expected to be the case for $SO_2$ emissions from Cooper Station and any of the candidate monitoring locations. Nearby sources with a significant concentration gradient were explicitly modeled, and the closest monitors were assessed to determine similarity of natural and insignificant local source contributions to those around the Cooper Station.

Due to the lack of a proximal $SO_2$ monitoring site, a regional site was determined to be the best choice for characterizing background concentrations. As shown in Figure 3-2, three $SO_2$ monitors are located within 150 km of the Cooper Station, namely:

1. Nicholasville (21-113-0001)
2. Lexington (21-067-0012)
3. Mammoth Cave National Park (21-061-0501)

Consideration of each monitor as an appropriate background monitor includes the following site-specific selection criteria (adapted from the guidance provided in Section 8.2 of Appendix W):

1. The distance from Cooper Station to the monitor,
2. The land use in the surrounding area as compared between Cooper Station and the monitor,
3. The likelihood of influence from nearby local population-related sources (vehicles, residential heating, etc.) and industrial sources, and
4. Ability of the monitor to capture the impacts of sources that are small and/or distant from the Cooper Station not explicitly modeled due to being screened out of the regional inventory.

The Nicholasville monitor (21-113-0001) site is located approximately 99 km north of Cooper Station and 18 km southwest of the city center of Lexington. The Nicholasville site has a monitoring objective of population exposure and an urban measurement scale with a scale definition of 4 km to 50 km. The surrounding land use and location are light density residential/commercial surrounded by rural agricultural areas. To assess the influence of nearby industrial sources on monitored concentrations, EKPC evaluated the sum of annual actual and potential emissions from all facilities located within the same two screening distances applied in the regional inventory selection process (i.e., 20 km and 50 km). As shown in Table 3-8, the combined $SO_2$ emissions from industrial sources within both 20 km and 50 km from the Nicholasville monitor is not at all comparable to the combined $SO_2$ emissions in the Cooper Station airshed. The higher $SO_2$ emissions totals in the area surrounding the Nicholasville monitor would likely explain the significantly higher 1-hr $SO_2$ NAAQS design value from this monitor (40.0 $\mu g/m^3$) in the most recent three-year period (2012 through 2014) as compared to the same three-year average design values from the other candidate monitoring stations (34.8 $\mu g/m^3$ for the Lexington monitor and 26.9 $\mu g/m^3$ for the Mammoth Cave monitor). Considering these relevant features of the

Nicholasville monitor, EKPC does not consider the $SO_2$ ambient concentrations measured at this monitoring site to be representative of the expected background concentrations in the area surrounding the Cooper Station.

**Table 3-8. Summary of $SO_2$ Emissions from KyEIS Facilities near Cooper Station and Candidate $SO_2$ Monitoring Stations**

| Location | Sum of Annual Actual $SO_2$ Emissions for Facilities within 20 km[1] (tpy) | Sum of Annual Potential $SO_2$ Emissions for Facilities within 20 km[1] (tpy) | Sum of Annual Actual $SO_2$ Emissions for Facilities within 50 km[1] (tpy) | Sum of Annual Potential $SO_2$ Emissions for Facilities within 50 km[1] (tpy) |
|---|---|---|---|---|
| Cooper Station[2] | 53.58 | 238.50 | 205.45 | 1,123.85 |
| Nicholasville Monitor | 2,098.07 | 8,211.61 | 3,387.71 | 40,809.09 |
| Lexington Monitor | 138.50 | 7,644.32 | 3,378.49 | 40,887.00 |
| Mammoth Cave Monitor | 0.56 | 44.29 | 9.15 | 572.03 |

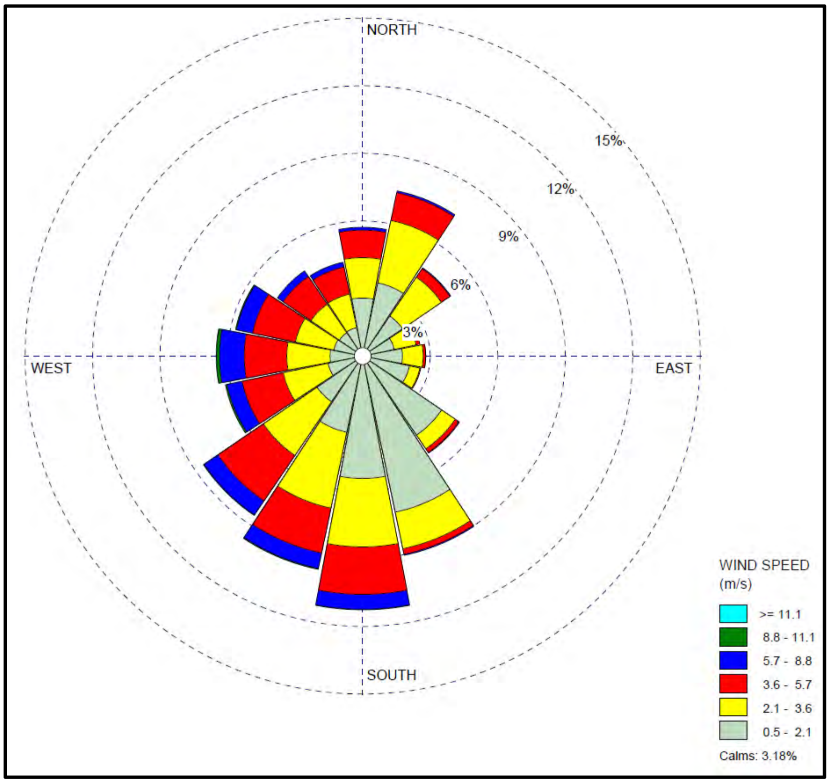
[1] Sum of annual actual or potential emissions from 2013 KyEIS export within specified distances from Cooper Station or candidate monitoring locations.

[2] Combined $SO_2$ emissions from facilities in area surrounding Cooper Station excludes emissions from Cooper Station, as these emissions are the subject of the 1-hr $SO_2$ NAAQS demonstration modeling.

The Lexington monitor (21-067-0012) site is the next closest $SO_2$ monitoring station located at approximately 119 km north of Cooper Station within the city of Lexington, KY. The surrounding land use and location are medium density residential/commercial because the site is located just north of the urban center of Lexington. Due to the urban setting of this monitor, the site captures numerous urban $SO_2$ sources including a high density of stationary industrial sources, mobile sources, and residential and commercial sources. The influence from these urban sources is not representative of the area surrounding Cooper Station. The industrial $SO_2$ emissions profile affecting the Lexington monitor characterized by the KyEIS summary data presented in Table 3-8 is also not comparable to the industrial $SO_2$ emissions profile of the Cooper Station's airshed.

The Mammoth Cave National Park monitor (21-061-0501) monitor is located approximately 139 km to the west of Cooper Station. It has a monitoring objective of general/background without a specified measurement scale. Due to its background status, this monitor is thought to be representative of rural areas with similar influences to the air quality around Cooper Station. The Mammoth Cave monitoring site has the lowest $SO_2$ design value of the candidate monitoring stations most likely due to the significantly lower $SO_2$ emissions totals from industrial sources surrounding the monitoring station. As shown in Table 3-8, the $SO_2$ emissions totals in the area surrounding the Mammoth Cave monitor are most comparable to the Cooper Station's airshed from among the candidate monitoring stations. Also, given the wind patterns in the area (as shown by the London-Corbin Airport wind rose in Figure 3-8), this monitor is expected to reflect the minor contributions from sources in the area surrounding the Bowling Green-Glasgow combined statistical area (CSA) which has a similar population (218,870) to the combined populations of the two nearby micropolitan statistical areas surrounding the Cooper Station, namely Somerset, Kentucky and London, Kentucky (191,141). In addition, the Lexington-Fayette metropolitan statistical area (MSA) in which the Nicholasville and Lexington monitors are located has a much higher population (494,189) than any of the urban centers located near the Mammoth Cave monitoring site or Cooper Station. As population is the most direct indication of regulated air pollutant emissions from non-industrial sources (i.e., mobile sources, residential/commercial sources, etc.), these observed population trends can be used with the industrial source $SO_2$ emissions data summary in Table 3-8 to obtain an overall characterization of the $SO_2$ emissions profile affecting the Cooper Station and each of the candidate monitoring sites.

**Figure 3-8. Wind Rose for London-Corbin Airport from July 2012 – June 2015**




Based on an application of the aforementioned background monitor selection criteria to the candidate sites within 150 km of the Cooper Station, the Mammoth Cave National Park site was chosen to represent the background concentration for the Cooper Station modeling analysis. Since the Mammoth Cave monitor is already located such that it will capture a true background concentration for the Cooper Station, no further processing of the monitor data was necessary to generate temporally varying background concentrations or to exclude influences from modeled sources. As shown in Table 3-9, the fourth highest daily maximum 1-hr $SO_2$ concentrations per year average over the most recent three-year period (2012-2014) from the Mammoth Cave monitor was used to calculate the background concentration applied using the BACKGROUND keyword in AERMOD input file.

**Table 3-9. Selected $SO_2$ Background Concentration**

| Site ID | City | County | State | Downwind Direction to Monitor | Distance to Cooper (km) | $SO_2$ Background Concentration[1] ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| 21-061-0501 | -- | Edmonson | KY | W | 139.1 | 26.9 |

[1] Three-year average for 2012-2014 of the 99$^{th}$ percentile (4$^{th}$ highest) 1-hour daily maximum concentrations.

## 3.11. MODELING FILES

All modeling files are provided to KDAQ in electronic format on a compact disk included in Appendix C. Model and processor input, output, and data files are included. Spreadsheets tabulating Cooper Station and regional source model input parameters referenced in previous sections of this modeling report are also provided on the modeling file CD in Appendix C.

# 4. 1-HOUR $SO_2$ DESIGNATION MODELING RESULTS

Dispersion modeling of the Cooper Station was conducted using the AERMOD Model (Version 15181). Included in this modeling were the Cooper Station CEMS emissions data for Unit 2, Cooper Station allowable emissions data for Unit 1, Kingsford Manufacturing Company potential emission rates, and an appropriate background concentration. Table 4-1 presents the overall results of the Cooper Station 1-hr $SO_2$ NAAQS designation modeling including contributions from all modeled sources and the background concentration expressed in the form of the 1-hour $SO_2$ NAAQS (a 3-year average of the 99$^{th}$ percentile of the annual distribution of daily maximum 1-hr concentrations). As can be seen from Table 4-1, the combined maximum concentration is less than the NAAQS and thus, the area surrounding the Cooper Station is expected to be achieving the 1-hr $SO_2$ NAAQS and should be designated as attainment in the upcoming round of Consent Decree-driven attainment designations.

**Table 4-1. Highest 4$^{th}$ High Modeled 1-hour $SO_2$ Results for Comparison to the NAAQS**

| Averaging Period | Year for Met. Data | NAAQS (μg/m$^3$) | Maximum Impact (μg/m$^3$) | Background Concentration[2] (μg/m$^3$) | Combined Maximum Impact (μg/m$^3$) | UTM East[3] (m) | UTM North[3] (m) | Date | Exceeds NAAQS? |
|---|---|---|---|---|---|---|---|---|---|
| 1-hr[1] | Max. 3-yr Avg. | 196 | 146.2 | 26.9 | 173.1 | 714,550 | 4,098,043 | -- | No |

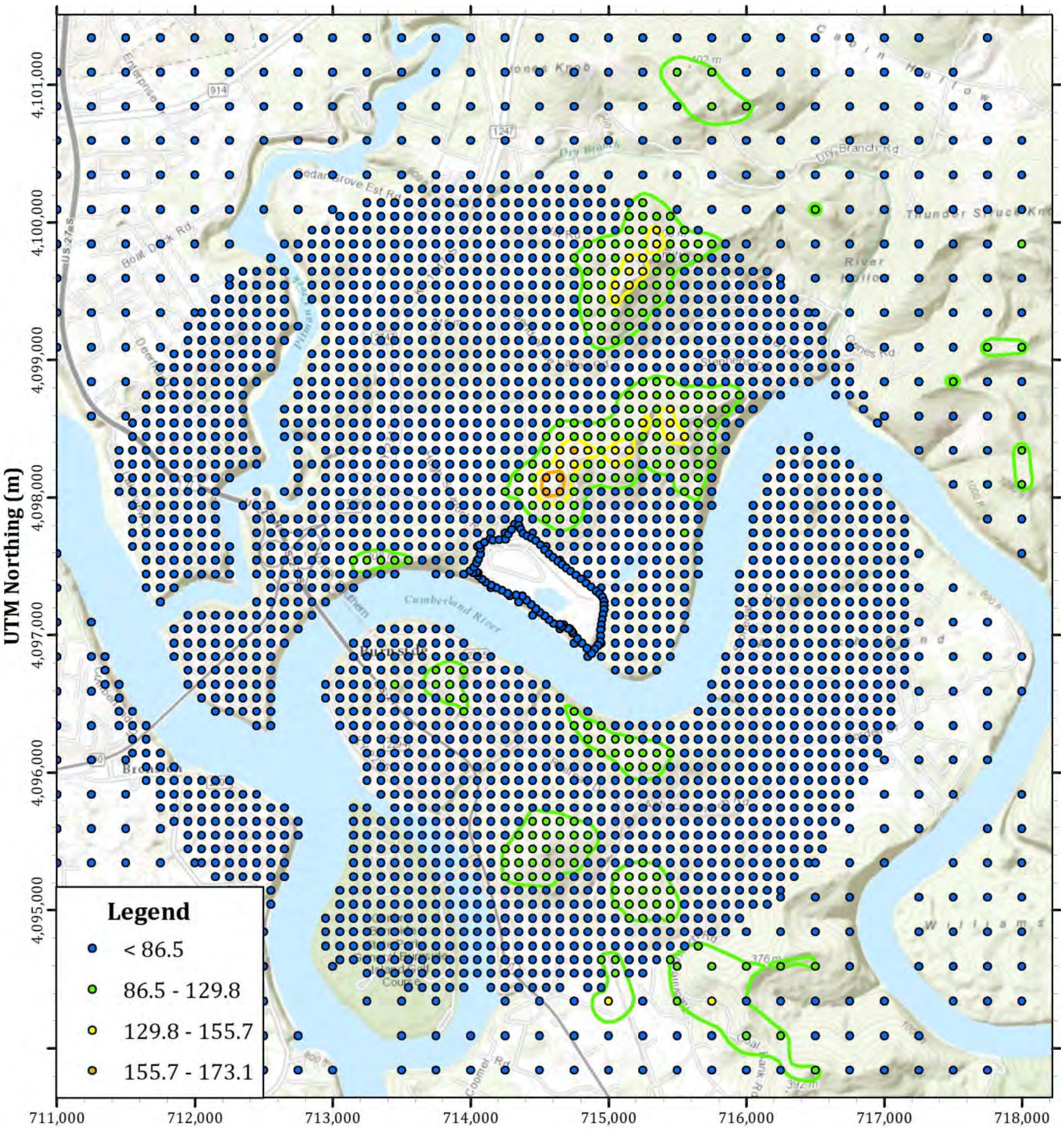
[1] Evaluated the three-year average 4th highest daily maximum 1-hour output for comparison against the NAAQS.

[2] Based on $SO_2$ ambient monitoring data from the Edmonson County monitor in Bowling Green, Kentucky (Site ID 21-061-0501) located within Mammoth Cave National Park. Background concentration for 1-hr modeling is the three-year average from 2012 to 2014 of the 99th percentile daily maximum 1-hr concentrations.

[3] UTM coordinates are represented in NAD83 datum Zone 16.

Figure 4-1 shows the distribution of 1-hour $SO_2$ concentrations across a portion of the modeling domain closest to Cooper Station and the area of maximum impacts as a further graphical presentation of the concentration estimates and their distribution. The maximum impacts as described with coordinates in Table 4-1 and as shown with the orange isopleth in Figure 4-1 occur to the northeast of the Cooper Station on and near a hill in the prevailing wind direction. Concentrations of $SO_2$ in other areas are much less as can be seen by the distribution around the Cooper Station.

**Figure 4-1. Spatial Display of 3-year Average 99th Percentile Annual Distribution of Daily Maximum 1-hr $SO_2$ Concentrations Including Background**




All Coordinates shown in UTM Coordinates, Zone 16, NAD 83 Datum

# APPENDIX A: USE OF U* IN COOPER DISPERSION MODELING

When AERMOD is run with a meteorological dataset derived from one-minute meteorological data as is currently recommended by U.S. EPA, low wind speeds are much more prevalent than in prior versions of the modeling system that did not rely on one-minute meteorological data. These low wind speeds have been linked to potential overestimates in ambient concentrations by AERMOD.[32] These overestimates occur, in part, due to an underestimate of friction velocity (u*) by the AERMET meteorological processor. EPA recognized this underestimation as a potential issue with AERMET and released AERMET Version 12345 which included a beta option, ADJ_U*. The ADJ_U* beta option allows the friction velocity (u*) to be adjusted using the methods of Qian and Venkatram[33] to better account for turbulence in the atmosphere during low wind speed stable conditions. This beta option was updated to incorporate a modified Bulk Richardson Number in version 13350, was further modified to adjust u* for low solar elevation angles with version 14134, and was most recently used to modify the calculation of the turbulence measure, Monin-Obukhov length in Version 15181.[34] Given the refined nature of this beta option and the peer reviewed studies which have acknowledged its accuracy, EKPC has incorporated this option into the modeling analysis to allow more representative and more accurate modeling results.

Because the u* option is not a default option in AERMOD, the combined use of AERMOD plus the u* adjustment in the meteorology file (generated by AERMET) would no longer have "preferred" status in the sense that it is a model to be used for regulatory purposes without additional regulatory authority approval. To substantiate that the adjusted friction velocity option in AERMOD is a valid model to use in this situation, Section 3.2 of Appendix W describes steps to be considered to allow the use of the u* adjusted AERMOD as an acceptable alternative model. The section also describes criteria for determining the acceptability of an alternative model. Section 3.2.2.b states that satisfying any one of the three alternative conditions may make use of an alternative model acceptable. Condition 1 states that the alternative model will demonstrate equivalency. But in this case the AERMOD Model is the preferred model of choice with just an option change (making it alternative). Because the model cannot have a demonstration of equivalency to itself and the option change will result in different results, this condition is not applicable. This leaves the satisfaction of Conditions 2 and 3 as criteria to accept the u* option in AERMOD. Condition 2 requires the formal submittal of a protocol to allow demonstration of superior performance which is acceptable to the control agency and to EKPC. This type of study would require appropriate ambient air quality monitoring and side-by-side modeling and comparisons which were beyond the scope of this project.

Thus, Condition 3 was reviewed and followed along with the individual criteria to meet its requirements. Section 3.2.2.e states that a preferred model may be used provided that five criteria are met. These are:

i. The model has received a scientific peer review;
ii. The model can be demonstrated to be applicable to the problem on a theoretical basis;
iii. The data bases which are necessary to perform the analysis are available and adequate;
iv. Appropriate performance evaluations of the model have shown that the model is not biased towards underestimates; and
v. A protocol on methods and procedures to be followed has been established.

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32 *Wenjun Qian and Akula Venkatram, "Performance of Steady State Dispersion Models Under Low Wind-Speed Conditions," Boundary-Layer Meteorology, no. 138 (2011): 475-491.*
33 Ibid.
34 http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_mcb3.txt; http://www.epa.gov/ttn/scram/7thconf/aermod/aermet_mcb4.txt; http://www.epa.gov/ttn/scram/7thconf/aermod/AERMET_mcb5.pdf; http://www.epa.gov/ttn/scram/7thconf/aermod/AERMET_mcb6.pdf

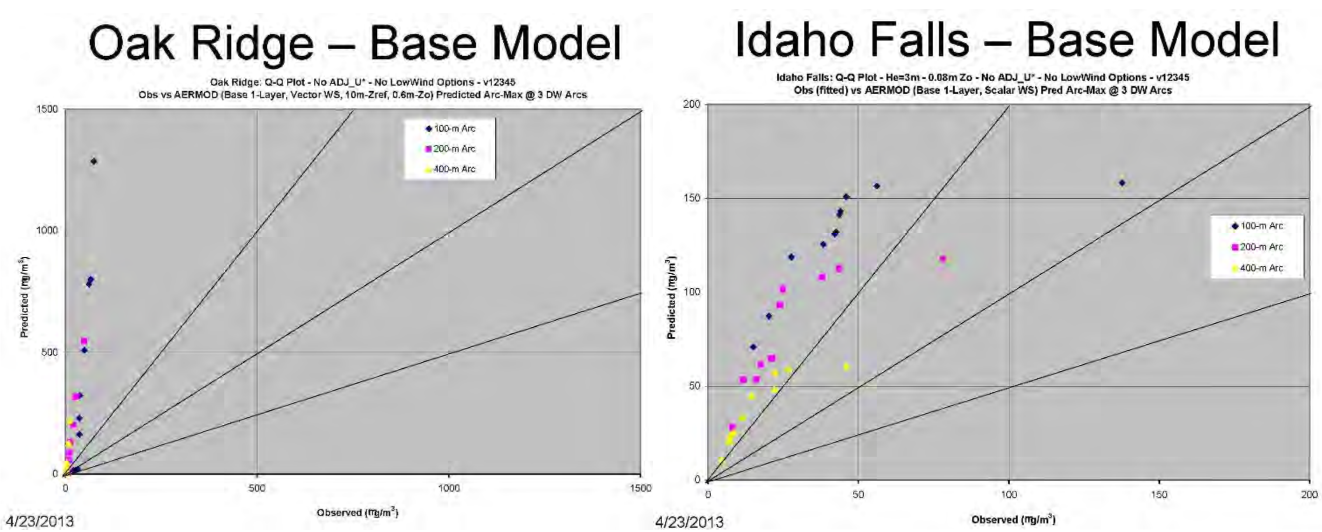
Review of these criteria as well as the responses to each within the context of modeling the Cooper Station have shown the use of the u* option, as generated by AERMET in the meteorological file and used in AERMOD, to be valid and representative for the modeling domain in the vicinity of the Cooper Station. The response to each criteria is given in the following Appendix A subsections.

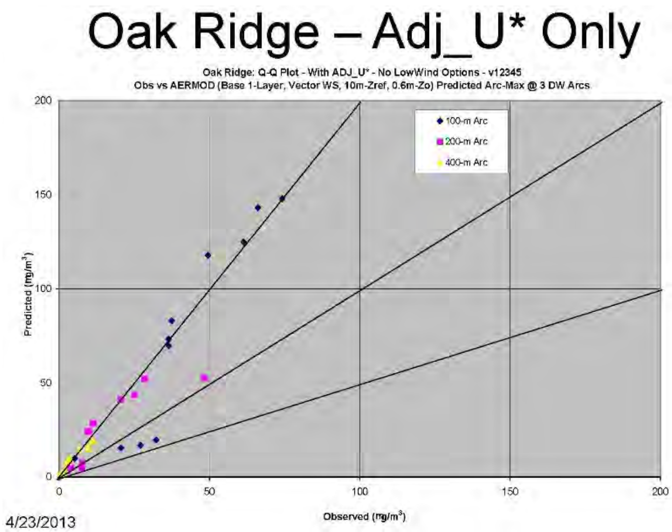
## CRITERIA 3.2.2.e.i - SCIENTIFIC PEER REVIEW

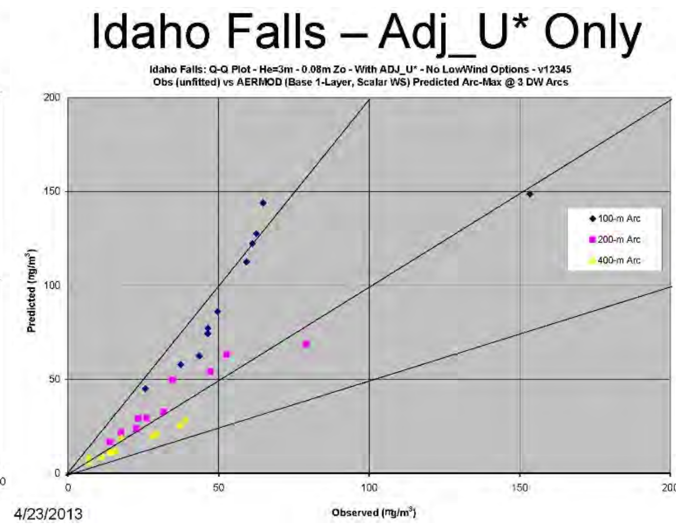
The use of an adjusted friction velocity in AERMOD has received scientific peer review and been evaluated both by U.S. EPA modelers as well as others in the scientific and modeling community. Two examples are:

- The paper entitled "Performance of Steady-State Dispersion Models Under Low Wind-Speed Conditions" by Wenjun Qian and Akula Venkatram, Boundary Layer Meteorology, Volume 138, pp 475-491, 2011. This paper examined the AERMOD Model to estimate dispersion under low wind speed events. Two tracer studies, the Prairie Grass Experiment and the Idaho Falls experiment, were compared to the use of AERMOD with and without u* adjustments. The analysis reports that the tendency of AERMOD to overestimate ambient air impacts during low wind speed events was reduced by incorporating an empirical modification. This modification is incorporated into the AERMET program through the U*_ADJ keyword. This option generates the enhanced friction velocity sets on a low wind speed, stable atmosphere, hour-by-hour basis. Also in his email memorandum dated June 26, 2013, George Bridgers of the U.S. EPA's Office of Air Quality Planning and Standards, notes that "The AERMET BETA option is based on a peer reviewed study (Qian and Venkatram, 2011) which also includes independent evaluations of the new u-star estimates…".
- In his April 23, 2013 presentation at the Regional/State/Local Modeling Meeting in Dallas, Texas, Roger Brode showed "improved AERMOD performance" when including the u* adjustment. The figures below from Mr. Brode's presentation demonstrate the enhanced performance of AERMOD for two field data bases, namely the Oak Ridge Study and the Idaho Falls Study. The closer the points are to the center line of each graph, the better the model performance.

**Figure A-2. Comparison of the AERMOD Model with and without the u* Adjustment**






## CRITERIA 3.2.2.e.ii- APPLICABLE ON A THEORETICAL BASIS

Over the past several years many scientific studies have noted that Gaussian dispersion models tend to over predict concentrations at low wind speeds. In the early days of dispersion modeling when the threshold velocities of the National Weather Service anemometers were a few miles per hour, the common use of 1.0 m/s as the lowest wind speed that would be considered in the model was prevalent. The modeling community recognized that winds lower than that would result in ambient concentration estimates that were not coincidental with ambient monitored values at these same low wind speed conditions. Because concentration is inversely proportional to wind speed as wind speeds dip below 1 m/s, concentrations are greater. In addition, other studies and field research showed that winds tend to meander during low wind speeds, meaning that the wind was not in only one direction during the time step of the Gaussian models, namely one hour, but tended to change over the time step. The relationship between this phenomenon and the friction velocity calculations in AERMET determined that adjusting the u* could have the same effect as adjusting plume meander and was better estimated empirically (as demonstrated in the peer review paper by Qian and Venkatram).

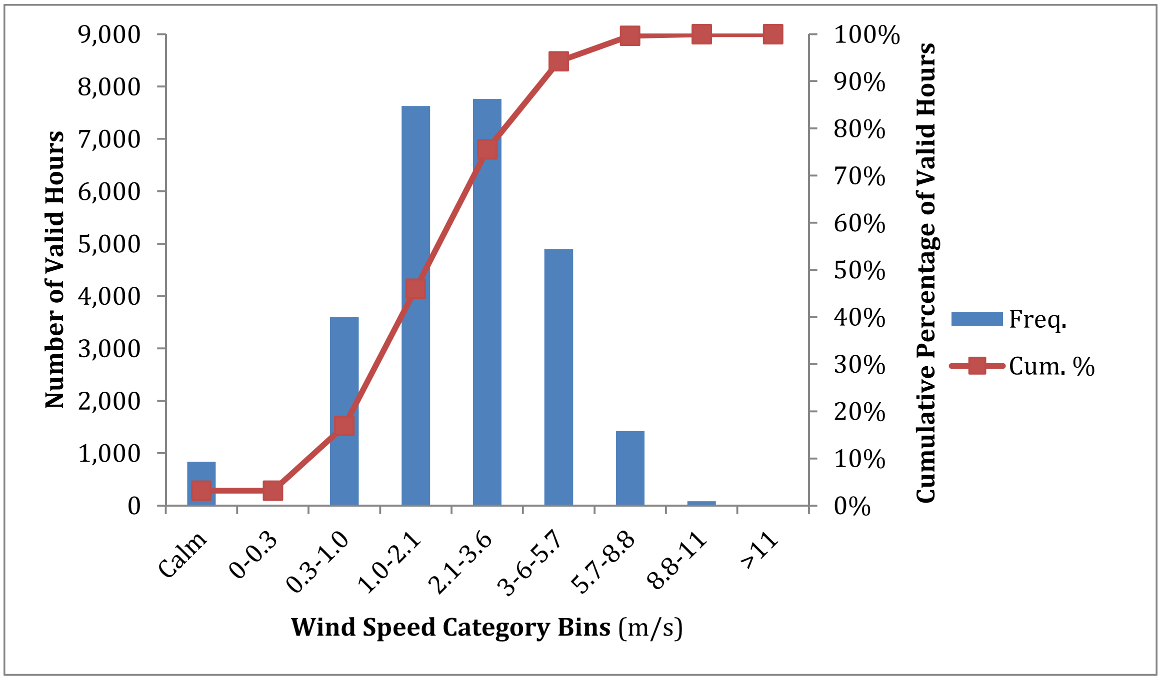
In reviewing the frequency distribution of winds from the London-Corbin (MaGee Field) Airport for the period of record of this modeling analysis, the number of hours in the range of 0.28 m/s (the lower limit where AERMOD will make a calculation) and less than 2.1 m/s wind speed is 11,224 hours over the three year period of record or 42.7%. This distribution is shown in Table A-1 and Figure A-2. Thus, the consideration of better science in terms of the u* adjustment is applicable and reasonable given this relatively high frequency of low wind occurrences.

## Table A-1. Distribution of Hourly Observations by Wind Speed and Wind Direction

Dates: 7/1/2012 - 00:00 ... 6/30/2015 - 23:00

| | Directions / Wind Classes (m/s) | 0.3 - 1.0 | 1.0 - 2.1 | 2.1 - 3.6 | 3.6 - 5.7 | 5.7 - 8.8 | 8.8 - 11.0 | >= 11.0 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 348.75 - 11.25 | 228 | 446 | 469 | 320 | 32 | 0 | 0 | 1495 |
| 2 | 11.25 - 33.75 | 234 | 634 | 740 | 330 | 20 | 0 | 0 | 1958 |
| 3 | 33.75 - 56.25 | 212 | 350 | 546 | 121 | 10 | 0 | 0 | 1239 |
| 4 | 56.25 - 78.75 | 154 | 222 | 259 | 44 | 0 | 0 | 0 | 679 |
| 5 | 78.75 - 101.25 | 178 | 285 | 241 | 28 | 1 | 0 | 0 | 733 |
| 6 | 101.25 - 123.75 | 223 | 333 | 123 | 12 | 0 | 0 | 0 | 691 |
| 7 | 123.75 - 146.25 | 429 | 682 | 192 | 52 | 8 | 0 | 0 | 1363 |
| 8 | 146.25 - 168.75 | 604 | 1247 | 434 | 66 | 11 | 0 | 0 | 2362 |
| 9 | 168.75 - 191.25 | 479 | 942 | 794 | 551 | 172 | 6 | 0 | 2944 |
| 10 | 191.25 - 213.75 | 236 | 668 | 899 | 533 | 182 | 10 | 1 | 2529 |
| 11 | 213.75 - 236.25 | 166 | 476 | 755 | 639 | 196 | 5 | 1 | 2238 |
| 12 | 236.25 - 258.75 | 85 | 325 | 532 | 489 | 179 | 19 | 0 | 1629 |
| 13 | 258.75 - 281.25 | 93 | 286 | 502 | 495 | 287 | 36 | 3 | 1702 |
| 14 | 281.25 - 303.75 | 80 | 262 | 456 | 510 | 188 | 9 | 2 | 1507 |
| 15 | 303.75 - 326.25 | 92 | 236 | 400 | 391 | 78 | 0 | 0 | 1197 |
| 16 | 326.25 - 348.75 | 112 | 225 | 398 | 321 | 57 | 0 | 0 | 1113 |
| | Sub-Total | 3605 | 7619 | 7740 | 4902 | 1421 | 85 | 7 | 25379 |
| | Calms | | | | | | | | 837 |
| | Missing/Incomplete | | | | | | | | 64 |
| | Total | | | | | | | | 26280 |

**Figure A-3. Distribution of Hourly Observations by Wind Speed Category Bin**




As a further measure of assessing the importance of low wind speeds in the meteorological dataset for the Cooper Station $SO_2$ NAAQS demonstration, EKPC evaluated the wind speeds associated with maximum concentrations when the default AERMET processing was employed and when the U*_ADJ option was implemented. For any hourly impact from the Cooper Station above 100 μg/m$^3$ (approximately 50% of the 1-hr $SO_2$ NAAQS) identified in the results from the default and U*_ADJ modeling runs, EKPC determined a wind speed associated with the event. The resulting wind speed dataset was then plotted in a histogram format to determine the cumulative frequency of impacts within selected bins of wind speed. These plots, shown in Figures A-3 and A-4 for the default and U*_ADJ cases, respectively, show a significant bias towards low wind conditions in the default mode relative to the overall distribution of wind speeds within the meteorological dataset. The percentage of wind speeds below 2.1 m/s contributing to Cooper Station impacts above 100 μg/m$^3$ in the default case is 78.3% versus only 42.7% in the overall wind speed distribution. When such a large percentage of high impacts are controlled by a single type of meteorological condition (i.e., low wind speeds in stable conditions), a potential overestimate inherent to the model is most likely the cause rather than an underlying meteorological phenomenon influencing plume dispersion. When the U*_ADJ option is used, the percentage of winds below 2.1 m/s contributing to Cooper Station impacts above 100 μg/m$^3$ drops significantly to only 49.3%. This value is in line with the overall percentage of wind speeds below 2.1 m/s in the selected meteorological dataset (42.7%), and thus, indicates the U*_ADJ option yields a profile of controlling meteorological conditions for maximum impacts that is not unrealistically biased towards low winds.

**Figure A-4. Distribution of Wind Speeds for Cooper Station Impacts above 100 µg/m³ with the Default AERMET Dataset**

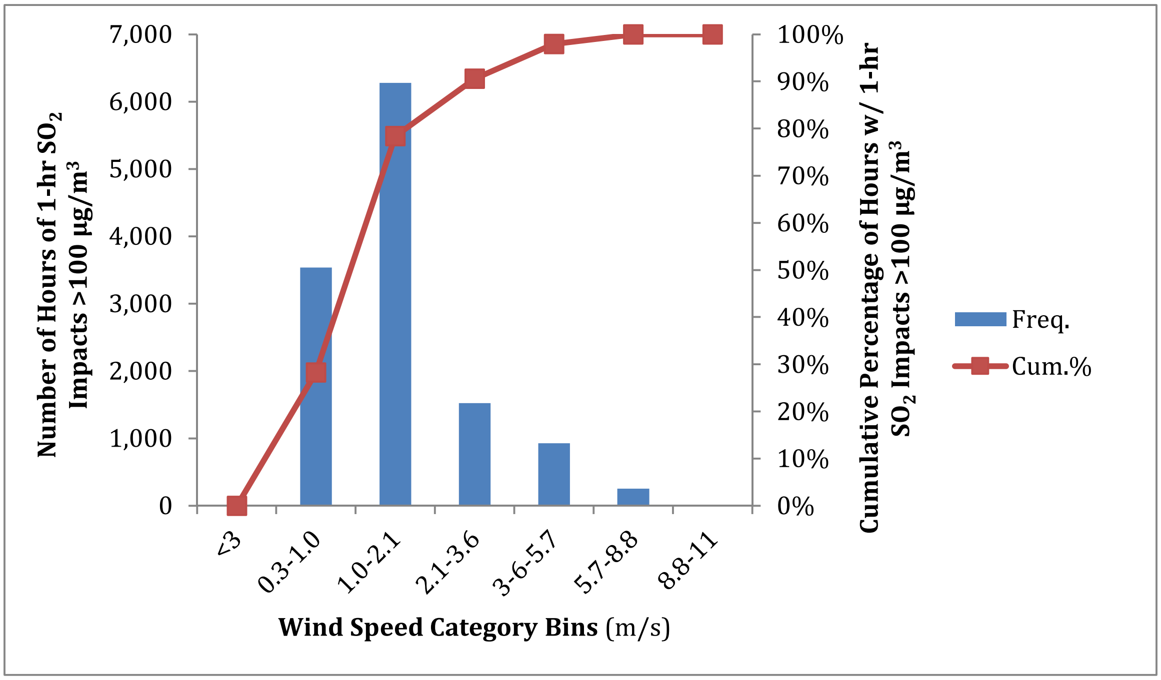
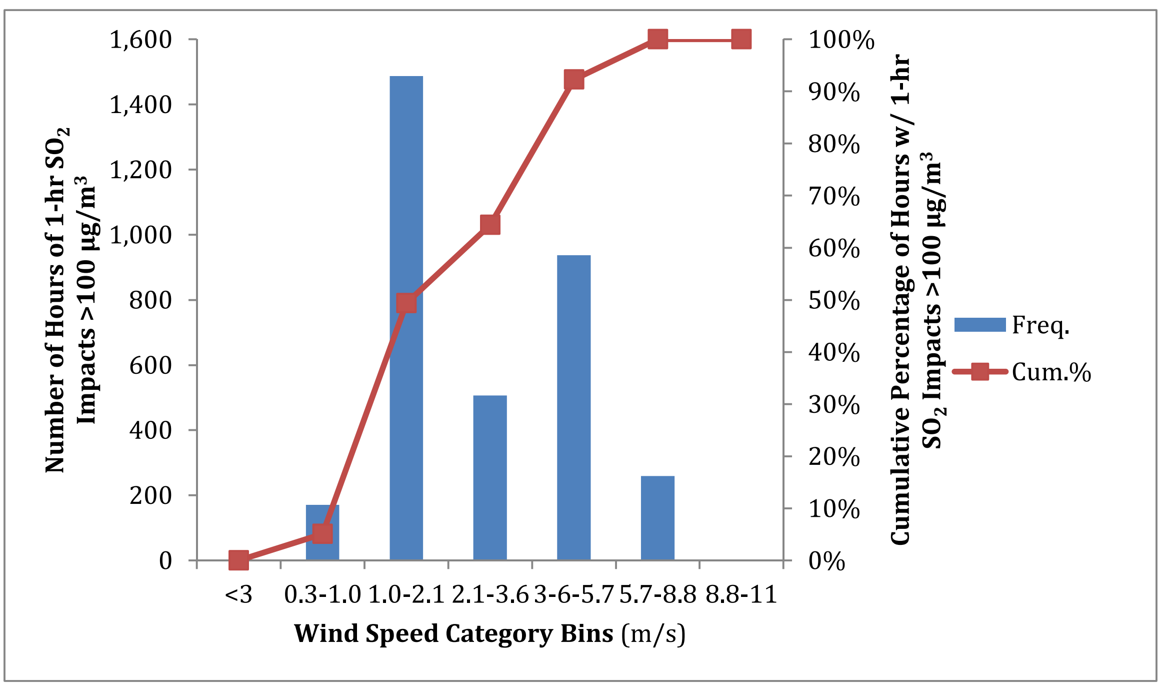



**Figure A-5. Distribution of Wind Speeds for Cooper Station Impacts above 100 µg/m³ with the U*_ADJ AERMET Dataset**



## CRITERIA 3.2.2.e.iii - AVAILABILITY OF DATABASES

The test data bases and reporting for low wind speed observations and evaluation are available to assess model performance. The data bases applicable to this discussion and use of the u* option in AERMET and AERMOD are:

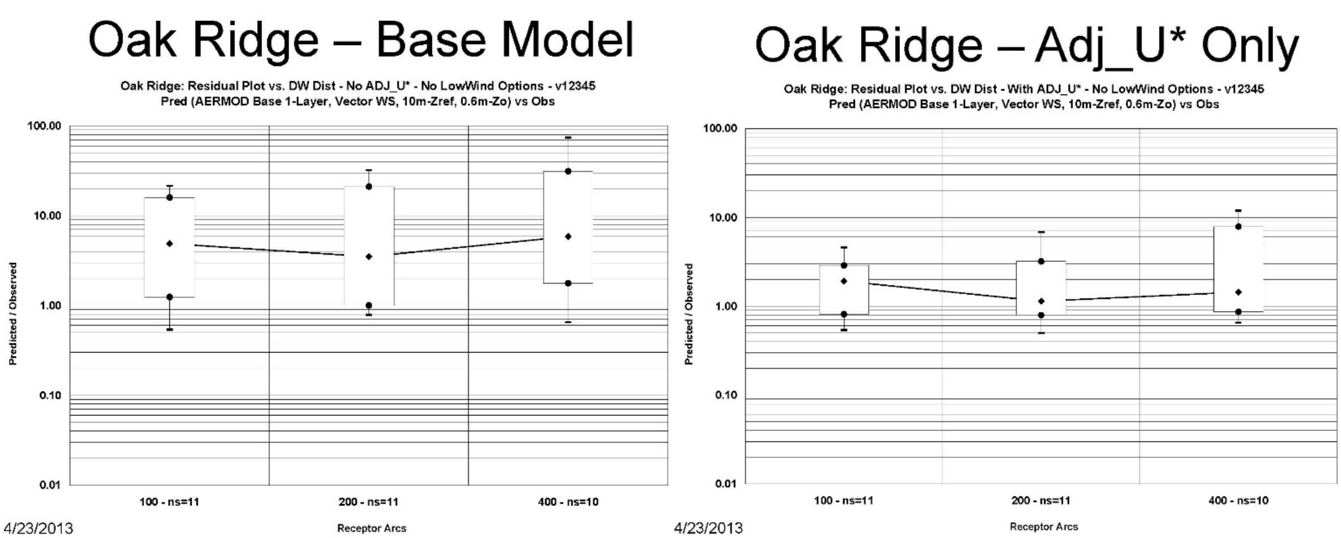
- Idaho Falls Study- Sagendorf JF, Dickson CR (1974) Diffusion under low wind speed, inversion conditions. NOAA Technical Memorandum ERL ARL-52, 89 pp.
- Prairie Grass Study - Barad ML (ed) (1958) Project Prairie Grass. A field program in diffusion. Geophysical research paper no. 59, vols I (300 pp) and II (221 pp). AFCRF-TR-58-235. Air Force Cambridge Research Center, Bedford, Massachusetts; under Model Evaluation Databases on U.S EPA's website - [http://www.epa.gov/ttn/scram/dispersion_prefrec.htm](http://www.epa.gov/ttn/scram/dispersion_prefrec.htm)
- Oak Ridge Study - NOAA Technical Memorandum ERL ARL-61, 1976. Diffusion under Low Wind Speed Conditions near Oak Ridge, Tennessee. Wilson, R. B., G. Start, C. Dickson, N. Ricks. Air Resources Laboratory, Idaho Falls, Idaho.

In addition, the AERMET source code and all input data required for implementing the U*_ADJ are publicly available on U.S. EPA's SCRAM website.

## CRITERIA 3.2.2.e.iv - DEMONSTRATION OF NO BIASES TOWARDS UNDERESTIMATES

As demonstrated in a number of studies over the past 3-5 years, including the 2010 study by AECOM[35], the use of the u* adjustment in dispersion modeling has not shown any bias towards underestimating the ambient concentrations due to sources and emissions. A repeat use of the same Oak Ridge data set in 2013 by the U.S. EPA in their model performance evaluation demonstrates both the improved performance of AERMOD with u* option and no bias towards underestimation as shown in Figure A-5.

**Figure A-6. Residual Plots Showing Improved Performance with u* and No Bias toward Underestimation**

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[35] AERMOD Low Wind Speed Evaluation Study Results, AECOM prepared for the American Petroleum Institute, Washington, DC, March 22, 2010.

## CRITERIA 3.2.2.e.v – A PROTOCOL HAS BEEN ESTABLISHED

A modeling protocol was provided to KDAQ by EKPC on August 3, 2015[36] which provided a detailed overview of the model selection process, potential options to be considered, source and building considerations, receptor grids, meteorological data, other source inventories, and anticipated tabular and graphical outputs. Section 2.1 of the protocol describes the potential frequent occurrence of low winds due to the EPA-recommended use of the one-minute meteorological data available from the National Oceanic and Atmospheric Administration website. The consideration of the use of the LOWWIND options was briefly mentioned in the modeling protocol. The additional and separate consideration of the u* option was certainly of interest although not called out specifically in the protocol. Comments received via email from Rick Gillam (U.S. EPA, Region 4) on August 17, 2015 included one reference to the selection of the use of the low wind options, that being:

> *Section 2.1, Page 11: The protocol discusses the possibility of using the LOWWIND "beta-options" contained in the latest version of AERMOD (Version 15181). Use of these options could be allowed, but it is important to understand that these are non-regulatory "beta-options," and thus are "alternative model options" requiring approval from EPA Region 4 pursuant to Section 3.2.2 of 40 CFR Part 51, Appendix W.*

EKPC selected the U*_ADJ option instead of the LOWWIND option mentioned in the protocol because it is a better representation of impacts due to the Cooper Station in low wind, stable atmospheric conditions that are common in the area. The u* option has also been subject to extensive peer review and thus the likelihood of the approval of its use for this modeling exercise is greater.

No specific protocol for implementing the U*_ADJ option in AERMET is needed since invoking this option only includes the selection of a single keyword.

[36] August 3, 2015 Letter from Jerry Purvis (Director, Environmental Affairs, EKPC) to Sean Alteri (Director, Division for Air Quality, Commonwealth of Kentucky), *Air Dispersion Modeling Protocol Cooper Station $SO_2$ Designation Analysis* (dated July 31, 2015).

# APPENDIX B: NAAQS REGIONAL SOURCE INVENTORY

## B-1. AERMOD Model Inputs: SO2 NAAQS Inventory Sources

Table B-1.1. Kentucky Regional Inventory Sources Modeled as Point Sources for SO2 NAAQS Analysis[1]

| Model ID | Description | UTM Easting[1] (m) | UTM Northing[1] (m) | Elevation[2] (m) | PTE Emission Rate (tpy) | Emission Rate (g/s) | Stack Height (ft) | Stack Height (m) | Temp. (F) | Temp. (K) | Exit Velocity (ft/s) | Exit Velocity (m/s) | Diameter (ft) | Diameter (m) | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KINGFRD1 | ACC Stack | 714,965 | 4,094,231 | 263.73 | 5.78 | 0.166389 | 74.00 | 22.56 | 1,800.00 | 1,255.4 | 46.3 | 14.12 | 10.70 | 3.26 | 4 |
| KINGFRD2 | Briquet Dryer A Stack | 714,948 | 4,094,126 | 268.32 | 41.00 | 1.179360 | 75.00 | 22.86 | 232.00 | 384.3 | 67.1 | 20.46 | 3.42 | 1.04 | 4 |
| KINGFRD3 | Briquet Dryer B Stack | 714,964 | 4,094,141 | 267.36 | 29.74 | 0.855540 | 75.00 | 22.86 | 235.00 | 385.9 | 53.7 | 16.37 | 3.42 | 1.04 | 4 |
| KINGFRD4 | Briquet Dryer C Stack | 714,973 | 4,094,148 | 266.52 | 31.19 | 0.897120 | 75.00 | 22.86 | 259.00 | 399.3 | 51.2 | 15.59 | 3.42 | 1.04 | 4 |
| KINGFRD5 | Waste Heat Boiler Stack | 714,992 | 4,094,424 | 264.03 | 27.90 | 0.802694 | 20.00 | 6.10 | 400.00 | 477.6 | 42.44 | 12.94 | 2.00 | 0.61 | 5 |

[1] Unless otherwise noted, source parameters are obtained from the 2014 KyEIS report for the Kingsford Manufacturing Company facility in Burnside, KY.

[2] Source coordinates obtained from to-scale site plan in Figure 2-2 of the May 2013 Title V renewal application.

[3] Imported sources into AERMOD and ran AERMAP with 1-arc second (approximately 30 meter resolution) NED data to get source elevations.

[4] Stack parameters for ACC Stack and Briquet Dryer A, B, & C Stacks obtained from the 2014 KyEIS Faciltiy General Report differed from those parameters obtained through Section II of the DEP7007 N form submitted with the May 2013 Title V renewal application. Due to the discrepancy, the Title V renewal application stack parameters were taken as the most up to date parameters for the modeling analysis.

[5] No stack parameters are included for the Waste Heater Boiler (KyEIS Eqpt. ID COMB001) in the 2014 KyEIS. Stack parameters were obtained from Section II of the DEP7007 N form submitted with the May 2013 Title V renewal application.

Table B-1.2. List of Regional Inventory Sources Eliminated from the 1-hr SO2 NAAQS Inventory Due to "20D"' Rule[1]

| AI ID | Facility Name | UTM East (m) | UTM North (m) | Distance to Cooper, (d) (km) | Plant-wide Actual Emissions (Q) (tpy) | Actual Q/d (tpy/km) | Plant-wide Potential Emissions (Q) (tpy) | PTE Q/d (tpy/km) | Screened Out Based on "20D" Rule? |
|---|---|---|---|---|---|---|---|---|---|
| 3837 | Somerset Wood Products Inc | 714,167 | 4,096,069 | 1.3 | 0.9 | 0.7 | 3.3 | 2.6 | Y |
| 108315 | Bluegrass Wireless LLC - Bend of the Lake (COW2) | 715,141 | 4,099,610 | 2.4 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 39770 | Hinkle Contracting Co LLC - Tatesville Asphalt Plant | 716,645 | 4,093,017 | 4.9 | 0.0 | 0.0 | 1.4 | 0.3 | Y |
| 6340 | Glen Oak Lumber & Milling Inc | 715,368 | 4,103,286 | 6.0 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 99096 | Forever Pets Cremation Services LLC | 711,127 | 4,102,727 | 6.2 | 0.4 | 0.1 | 0.4 | 0.1 | Y |
| 3813 | Armstrong Hardwood Flooring Co | 715,287 | 4,103,592 | 6.3 | 0.2 | 0.0 | 3.8 | 0.6 | Y |
| 3804 | American Standard Brands | 713,166 | 4,103,958 | 6.7 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 76491 | River Metals Recycling LLC Somerset | 713,205 | 4,104,431 | 7.2 | 2.3 | 0.3 | 2.3 | 0.3 | Y |
| 116249 | KY Utilities Co - Alcalde Substation | 718,966 | 4,102,792 | 7.2 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 108314 | Bluegrass Wireless LLC - Slate Branch (COW14) | 706,577 | 4,098,872 | 7.8 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 108316 | Bluegrass Wireless LLC - Somerset Bypass East | 716,184 | 4,105,219 | 8.1 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 3842 | Continental Refining Company LLC | 712,519 | 4,105,527 | 8.4 | 0.1 | 0.0 | 0.3 | 0.0 | Y |
| 3809 | General Electric Lighting LLC - Somerset Glass Plant | 711,611 | 4,109,205 | 12.2 | 2.0 | 0.2 | 6.0 | 0.5 | Y |
| 71569 | Hinkle Contracting Co LLC - Somerset Asphalt Plant | 715,110 | 4,109,540 | 12.2 | 0.3 | 0.0 | 18.1 | 1.5 | Y |
| 3806 | Eagle Hardwoods Inc | 710,601 | 4,112,048 | 15.2 | 2.2 | 0.1 | 4.4 | 0.3 | Y |
| 4171 | Monticello Flooring & Lumber | 692,401 | 4,081,670 | 26.9 | 0.6 | 0.0 | 3.1 | 0.1 | Y |
| 81844 | Cowboy Charcoal USA | 692,897 | 4,079,461 | 27.9 | 0.7 | 0.0 | 0.6 | 0.0 | Y |
| 4170 | Mago Construction Co LLC - Monticello Plant | 693,230 | 4,077,896 | 28.6 | 1.8 | 0.1 | 33.8 | 1.2 | Y |
| 37652 | Hinkle Contracting Co LLC - Casey Asphalt Plant | 697,890 | 4,124,384 | 31.6 | 0.3 | 0.0 | 18.1 | 0.6 | Y |
| 38966 | East Anderson Hardwoods LLC | 708,180 | 4,132,991 | 36.2 | 0.3 | 0.0 | 0.3 | 0.0 | Y |
| 3893 | Superior Battery Manufacturing Co | 678,696 | 4,104,394 | 36.2 | 0.0 | 0.0 | 0.1 | 0.0 | Y |
| 108206 | Bluegrass Wireless LLC - Cold Hill | 751,979 | 4,105,255 | 38.5 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 40420 | Federal Bureau Of Prisons | 733,125 | 4,063,318 | 38.9 | 0.0 | 0.0 | 44.6 | 1.1 | Y |
| 8882 | Wayne Dry Kilns Inc | 682,971 | 4,072,423 | 40.0 | 0.2 | 0.0 | 0.2 | 0.0 | Y |
| 4162 | American Woodmark Corp | 682,571 | 4,072,073 | 40.5 | 0.0 | 0.0 | 0.9 | 0.0 | Y |
| 108068 | Cumberland Cellular GP - Casey South | 680,966 | 4,121,535 | 41.1 | 0.0 | 0.0 | 0.0 | 0.0 | Y |

| AI ID | Facility Name | UTM East (m) | UTM North (m) | Distance to Cooper, (d) (km) | Plant-wide Actual Emissions (Q) (tpy) | Actual Q/d (tpy/km) | Plant-wide Potential Emissions (Q) (tpy) | PTE Q/d (tpy/km) | Screened Out Based on "20D" Rule? |
|---|---|---|---|---|---|---|---|---|---|
| 108705 | Cumberland Cellular GP - Dunnville | 677,268 | 4,116,184 | 41.5 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 38846 | BPM Lumber LLC | 752,839 | 4,114,950 | 42.4 | 0.8 | 0.0 | 2.1 | 0.0 | Y |
| 750 | Tarter Gate Co Inc | 676,855 | 4,118,729 | 43.1 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 38878 | Doric Products Co | 757,990 | 4,097,719 | 43.7 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 37648 | Columbia Gulf - Clementsville Transmission Station | 674,505 | 4,117,083 | 44.4 | 0.2 | 0.0 | 0.9 | 0.0 | Y |
| 40452 | East KY Power Coop - Laurel Ridge Landfill | 758,536 | 4,102,707 | 44.6 | 36.1 | 0.8 | 41.3 | 0.9 | Y |
| 2581 | Laurel Ridge Landfill | 758,665 | 4,102,526 | 44.7 | 0.0 | 0.0 | 4.6 | 0.1 | Y |
| 40268 | Elmo Greer & Sons Inc - Portable Hanson Quarry Plant | 734,592 | 4,137,300 | 44.8 | 1.1 | 0.0 | 18.1 | 0.4 | Y |
| 108069 | Cumberland Cellular GP - Pricetown | 681,435 | 4,128,360 | 45.2 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 51036 | Metal Products Inc | 759,420 | 4,095,721 | 45.2 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 84396 | Hinkle Contracting Co LLC - London Portable Asphalt Plant | 758,248 | 4,108,900 | 45.5 | 0.5 | 0.0 | 22.2 | 0.5 | Y |
| 108060 | Cumberland Cellular GP - Liberty | 683,637 | 4,131,307 | 45.7 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 50732 | Accent Marble Inc | 755,137 | 4,118,555 | 46.1 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 108181 | Bluegrass Wireless LLC - Corbin Station | 760,399 | 4,094,402 | 46.2 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 2571 | Bimbo Bakeries USA Inc | 757,897 | 4,113,888 | 46.7 | 0.0 | 0.0 | 0.1 | 0.0 | Y |
| 2556 | Aisin Automotive Casting Inc | 761,029 | 4,102,747 | 47.1 | 0.0 | 0.0 | 0.1 | 0.0 | Y |
| 108125 | Bluegrass Wireless LLC - Lily (COW13) Portable | 761,464 | 4,104,803 | 47.8 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 40709 | Elmo Greer & Sons LLC - Morentown Rd - Portable | 758,384 | 4,115,723 | 47.8 | 0.3 | 0.0 | 24.0 | 0.5 | Y |
| 38869 | London Rotary Forms Inc | 760,096 | 4,112,289 | 48.2 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 2573 | Elmo Greer & Sons LLC - Farriston Asphalt Plant 908 | 761,662 | 4,106,413 | 48.3 | 0.1 | 0.0 | 1.8 | 0.0 | Y |
| 38861 | Jasper Iron & Metal Co | 761,805 | 4,105,770 | 48.3 | 3.4 | 0.1 | 3.4 | 0.1 | Y |
| 2568 | Cumberland Forest Product - Fariston Facility | 761,693 | 4,106,693 | 48.4 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 2591 | Robinson Stave Co | 754,550 | 4,124,091 | 48.4 | 0.2 | 0.0 | 0.3 | 0.0 | Y |
| 2559 | Chaney Lumber Co | 762,199 | 4,104,313 | 48.5 | 0.5 | 0.0 | 0.5 | 0.0 | Y |
| 108182 | Bluegrass Wireless LLC - Siler | 762,520 | 4,092,277 | 48.5 | 0.0 | 0.0 | 0.0 | 0.0 | Y |
| 45671 | CTA Acoustics Inc - Corbin Facility | 763,071 | 4,088,900 | 49.5 | 0.1 | 0.0 | 0.2 | 0.0 | Y |
| 108072 | Cumberland Cellular GP - Cartwright | 673,173 | 4,069,541 | 49.6 | 0.0 | 0.0 | 0.0 | 0.0 | Y |

[1] Source list excludes facilities with plant-wide actual emissions of 0 tpy $SO_2$.

# APPENDIX C: MODELING FILES ON CD