UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

MEMORANDUM **MAY 13 2016**

SUBJECT: Concurrence Request for the use of BETA Adjust U* in Modeling Demonstration for the Herbert A. Wagner Generating Station near Baltimore, MD

FROM: Timothy A. Leon Guerrero, Meteorologist TALG
Office of Air Monitoring & Analysis, EPA Region III

TO: George Bridgers, Director of Model Clearinghouse
Air Quality Modeling Group, Office of Air Quality Planning and Standards

THRU: Alice Chow, Associate Director
Office of Air Monitoring & Analysis, EPA Region III

EPA Region III is seeking concurrence with the Model Clearinghouse on the use of the BETA Adjust U* option that was a part of a modeling analysis recently received from the Maryland Department of the Environment (MDE) for the Herbert A. Wagner Generating Station located near the City of Baltimore. MDE sought permission to use the BETA Adjust U* option in a formal request sent to the Regional Administrator under 40 CFR Part 51, specifically Section 3.2.2 of Appendix W – Guideline on Air Quality Models. The formal request letter from MDE dated April 14, 2016 and its attachment are included as part of this concurrence request package.

We have performed a technical review of MDE's submittal and determined that the use of the alternative model BETA Adjust U* option should be granted. A short technical analysis is included for your consideration. This analysis was coordinated with MDE and Clearinghouse staff prior to formal submittal. We therefore seek concurrence with the Model Clearinghouse in accordance with EPA's December 10, 2015 memorandum. Please feel free to contact me if you have specific questions regarding our concurrence request. I can be reached via email or by phone at 215-814-2192.

Attachment

Regulatory Background

On August 5, 2013, EPA published a final rule establishing air quality designations for 29 areas in the United States for the 2010 SO_2 NAAQS, based on recorded air-quality monitoring data from 2009-11 showing violations of the NAAQS (78 FR 47191). Following the initial August 5, 2013 designations, three lawsuits were filed against EPA in different U.S. District Courts, alleging the Agency had failed to perform a nondiscretionary duty under the CAA by not designating all portions of the country by the June 2013 deadline. In an effort intended to resolve the litigation in one of those cases, plaintiffs Sierra Club and the Natural Resources Defense Council and EPA filed a proposed consent decree with the U.S. District Court for the Northern District of California. On March 2, 2015, the court entered the consent decree and issued an enforceable order for EPA to complete the area designations according to the consent decree schedule. As part of this consent decree, on March 20, 2015 EPA informed Maryland that the Wagner Power Plant (Wagner) would be part of the expedited round of designations.

On January 15, 2016, Maryland submitted a supplement to its 2015 recommendation which included a modeling analysis for the area around Wagner. Additionally, this supplement included comments on air dispersion modeling dated January 4, 2016, performed by Sierra Club and submitted to EPA, asserting that violations of the NAAQS are present in the area around Wagner. Maryland did not update its recommendation for Baltimore City in its 2015 updated recommendation. After careful review of the State's 2015 recommendation and all submitted available data including air quality characterization, emissions data, meteorology, geography, topography, and modeling analyses for the Wagner area, EPA disagreed with the State's recommendations, and intends to designate the area surrounding Wagner (portions of Anne Arundel County and Baltimore County) as nonattainment, and Baltimore City as unclassifiable/attainment.

The Maryland Department of the Environment (MDE) filed comments on EPA's proposed designations for the City of Baltimore, Anne Arundel County and Baltimore County on April 19, 2016. A request for use of an alternative model was be part of MDE's official comment package. EPA intends to promulgate final designations for the 1-hour SO_2 NAAQS by July 2, 2016 based on information submitted by MDE and others submitted during the 30-day public comment period.

Facility Location and Modeling Domain Description

The Wagner Power Plant consists of four (4) steam electric generating units, which burn a mix of fuels including natural gas, oil, and coal. Wagner is located in northern Ann Arundel County just outside Baltimore, MD and is co-located with the Brandon Shores Power Plant, which includes two (2) primarily coal-fired units with FGD controls. Both plants are part of the Fort Smallwood complex and are under common ownership; Wagner is owned by H.A. Wagner LLC, operated by Raven Power Fort Smallwood LLC (Raven Power), and is a subsidiary of Talen Energy LLC. The modeling analysis MDE has submitted to EPA Region 3 includes additional SO_2 sources. These include the C.P Crane Generating Station (CRANE), a two (2) unit coal-fired power plant located approximately 21 kilometers northeast of Wagner and Wheelabrator Baltimore, a municipal-waste-to-energy facility located approximately 13 kilometers northwest of Wagner in the City of Baltimore.

The Fort Smallwood complex sits along the western shore of the Chesapeake Bay. Elevations for all sources included in MDE's modeling analysis lie on the Atlantic Coastal Plane physiographic region and are less than 10 meters AMSL. The Atlantic Plain gives way to higher elevations of the Piedmont approximately 17 kilometers northwest of Wagner. Stack heights for all sources are relatively tall ranging from 87 to 122 meters; the lowest effective stack elevation (stack + base height) is ~ 93 meters.

MDE's modeling domain consists of a primary receptor grid that is 50 by 50 kilometers centered on the Fort Smallwood and Crane facilities. A smaller roughly 20 by 20 kilometer domain was added along the northwest corner of the larger domain to examine model concentrations in the elevated terrain northwest of the City of Baltimore. A total of 17,000 receptors were included in the modeling analysis with the bulk within 50 km of Wagner. In accordance with EPA Modeling Technical Assistance Document[1], model receptors over open water were removed from the analysis.

Meteorological files were produced using three (3) years (2013-15) surface meteorological data from Baltimore-Washington International (BWI) Airport along with upper-air soundings from Dulles Airport (IAD). BWI is approximately 13 km west of Wagner, while IAD is located approximately 91 km to the west south-west. Surface data was supplemented with 2-min data using AERMINUTE. Figure 1 depicts the locations of the MDE sources, the Fort Smallwood Complex, the contour of the lowest effective stack height, the modeling domain and the sites of

[1] https://www3.epa.gov/airquality/sulfurdioxide/implement.html

the surface (Baltimore-Washington International) and upper air (Dulles International) meteorological data collection.

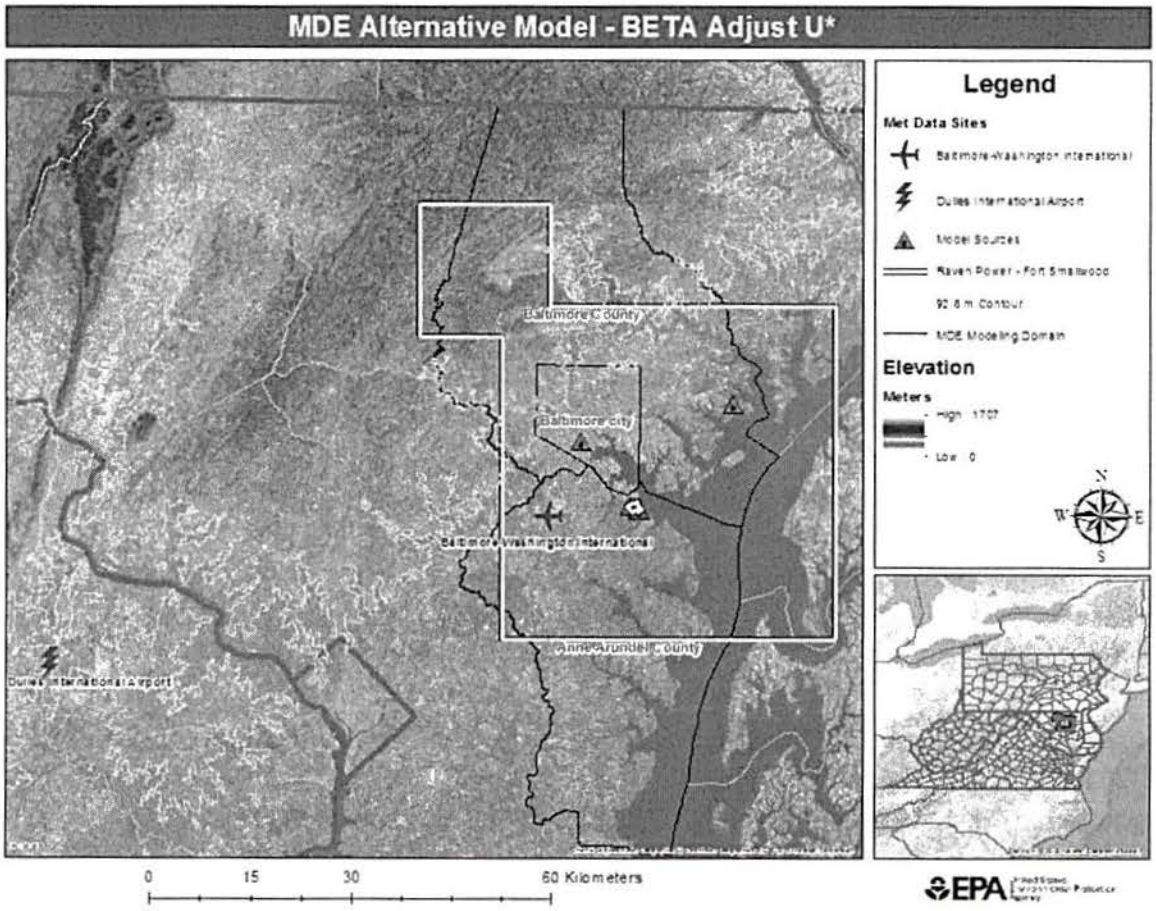


Figure 1. Wagner MDE Modeling Analysis – Source Locations, Fort Smallwood Complex, MDE Modeling Domain, Lowest Effective Stack-Height Contour, Elevation, Surface and Upper Air Meteorological Site Locations

Use of BETA Adjust U* to Address AERMOD Over Predictions

EPA has acknowledged that AERMOD's regulatory default mode over-predicts concentrations for stable atmospheric conditions with light wind speeds (Robison and Brode 2007, EPA 2016). Several studies (Qian and Venkatram, 2011; Connors and Paine, 2014; Paine et al., 2015) have demonstrated that AERMET with default options tends to significantly underestimate surface friction velocity (u*) under stable low wind-speed conditions. This results in underestimations of turbulence and mixing height in AERMOD, thus reducing dispersion and leading to over-predicted concentrations.

Starting with AERMOD Version 12345, EPA added the BETA Adjust U* option to address over predicted concentration estimates associated with low wind speed under stable conditions (i.e., Monin-Obukhov [M-O] length > 0) following the method outlined in Qian and Venkatram. This option was subsequently updated in AERMOD versions 13350, 14134 and 15181 with the latter proposed as regulatory default under the Revision to the Guideline on Air Quality Models Notice of Proposed Rulemaking dated July 29, 2015[2]. BETA Adjust U* is currently an AERMOD processing option for calculating u* for low wind speeds during stable (nighttime) conditions (EPA 2015a).

Qian and Venkatram (2011) suggested a new method for calculating u* and showed results that support improved u* and model concentration predictions in the low wind-speed regime. EPA has incorporated this calculation methodology in AERMET as ADJ_U* (EPA 2013), most recently in AERMET version 15181. The BETA Adjust U* method is a processing option for calculating u* for low wind speeds during stable (nighttime) conditions (EPA 2015a).

Justification for use of BETA Adjust U* in MDE Wagner Modeling Analysis

The use of the BETA Adjust U* options requires approval under Section 3.2.2 of Appendix W to 40 CFR Part 51, ("Revision to the Guideline on Air Quality Models", November 9, 2005). MDE chose to follow approval under Section 3.2.2 (b)(3); "*... preferred model is less appropriate for the specific application...* " This procedure is slightly different than EPA's recent approval for the Donlin Gold Limited Liability Company[3], which received approval under Section 3.2.2 (b)(2).

MDE presented supporting documentation under Section 3.2.2 (e). Please see MDE's April 14, 2016 letter to EPA Region 3 Administrator Shawn Gavin for a complete discussion of these points. A brief summary of each point under Section 3.2.2 (e) is presented here.

Condition 1: The model has received a scientific peer review

MDE included documentation demonstrating BETA Adjust U* has undergone sufficient peer review (as noted in the previous section) and technical analysis (see AERMET Addendum document) to satisfy this condition.

[2] See 11th Conference on Air Quality Modeling. Link: https://www3.epa.gov/scram001/11thmodconf.htm
[3] https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=16-X-01

Condition 2: The model can be demonstrated to be applicable to the problem on a theoretical basis

MDE established that there is no theoretical limitation to the application of the AERMET BETA Adjust U* and it use is generally applicable to the Wagner modeling analysis. The current default algorithm in AERMET has been demonstrated to over predict concentrations under low wind stable conditions and the BETA Adjust U* approach generally provides better predictions.

Condition 3: The databases which are necessary to perform the analysis are available and adequate

MDE provided surface meteorological data from the BWI airport and upper air soundings from IAD in accordance with EPA's Modeling TAD. This data is sufficient to run with the BETA Adjust U* option.

Condition 4: Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates

MDE outlined more specific analyses of the BETA Adjust U* option for sources similar to Wagner; tall stacks with complex terrain (terrain above stack height) in the modeling domain. Of these, the Lovett Generating Station (Lovett) analysis was the primary focus since it was the most similar to Wagner. Q-Q plots for Lovett, shown in Appendix F of EPA's *Addendum AERMOD* (v15181) *User's Guide*, show that Lovett's modeled concentrations show substantial over prediction when the Lovett met tower's turbulence data was excluded. This case is the closest match to the surface/upper air pairing for the Wagner analysis since no turbulence data or delta temperature profiles are available. Model performance from the Q-Q plots depicted on page F-37 of Appendix F (Addendum AERMOD User's Guide) shows the default option over predictions are alleviated using the BETA Adjust U* option without adding an under prediction bias. An under prediction bias, however is noted when BETA Adjust U* and any of the Low Wind options are used simultaneously. Improved model predictions using the BETA Adjust U* option in AERMOD is supported by other analyses presented by EPA in its recently proposed revisions to Appendix W (EPA, 2015b). A model sensitivity analysis was also competed by MDE and will be discussed further.

Condition 5: A protocol on methods and procedures to be followed has been established

A modeling protocol addressing the 1-hour SO_2 characterization of the Wagner area was prepared by AECOM and submitted to EPA Region 3 in February 2016. Comments on the modeling protocol were received from EPA Region 3 in March 2016. MDE reviewed the modeling protocol prepared for utilizing BETA Adjust U* and EPA Region 3 comments and believed that the comments were been adequately addressed.

MDE provided an AERMOD model sensitivity analysis examining u* and wind speed values with the default and the BETA Adjust U* options. Modeled 1-hour SO_2 concentrations exceeded the NAAQS. Violating receptor locations are shown in Figure 2 and occur in the immediate vicinity of Wagner (Fort Smallwood) and in several portions of Baltimore County west and northwest of the City of Baltimore. The far-off violating receptors are generally located in terrain above the lowest effective stack height and at distances ranging from approximately 20 km to 34-37 km from Wagner. The other group of violating receptors is located in areas within 5 km of Wagner at elevations between 0 and 10 m AMSL.

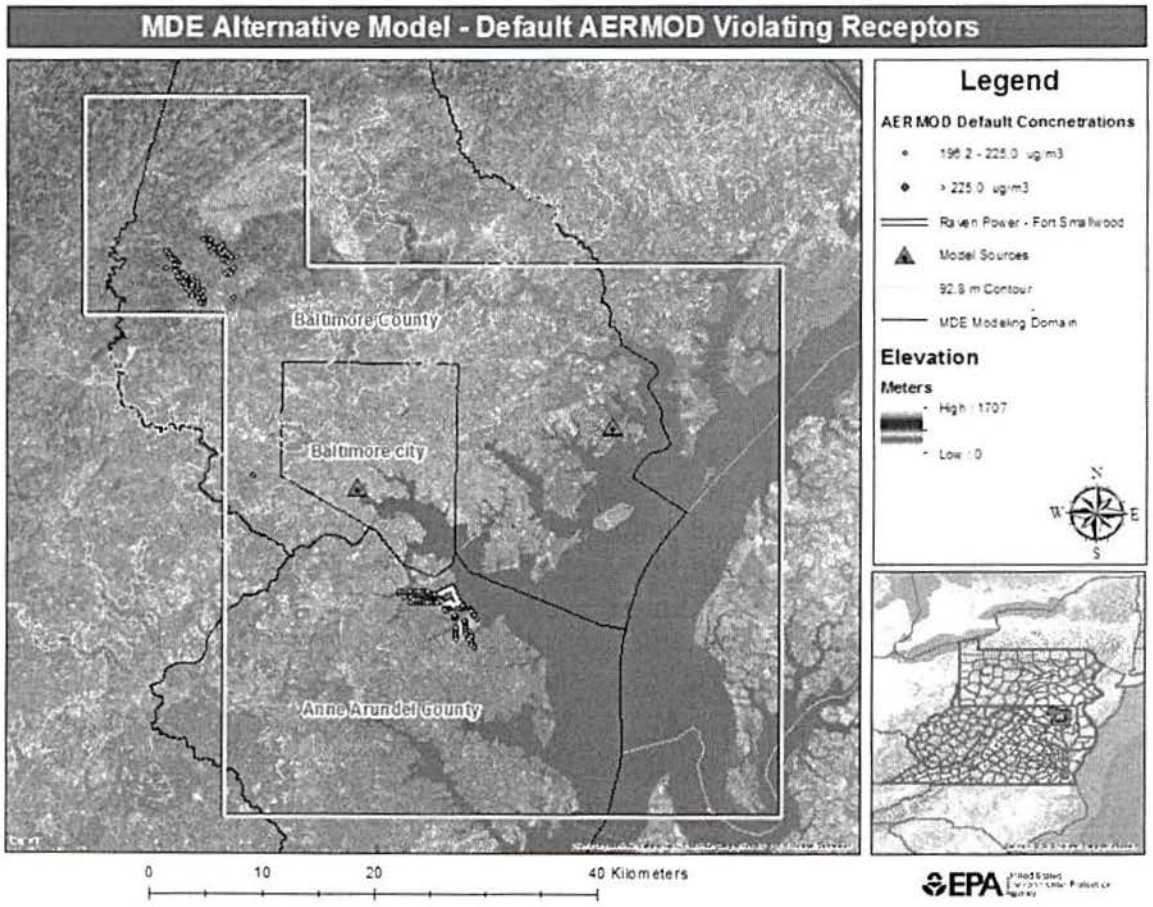


Figure 2. Default AERMOD violating receptor locations and concentrations

Employing the BETA Adjust U* option within AERMOD did not eliminate all modeled violations in MDE's modeling analysis. Figure 3 shows the violating receptors for the BETA Adjust U* run. They are generally confined to an area within 5 km of Wagner. Peak model concentrations, which occurred close to Wagner, were identical between the default and BETA Adjust U* runs.

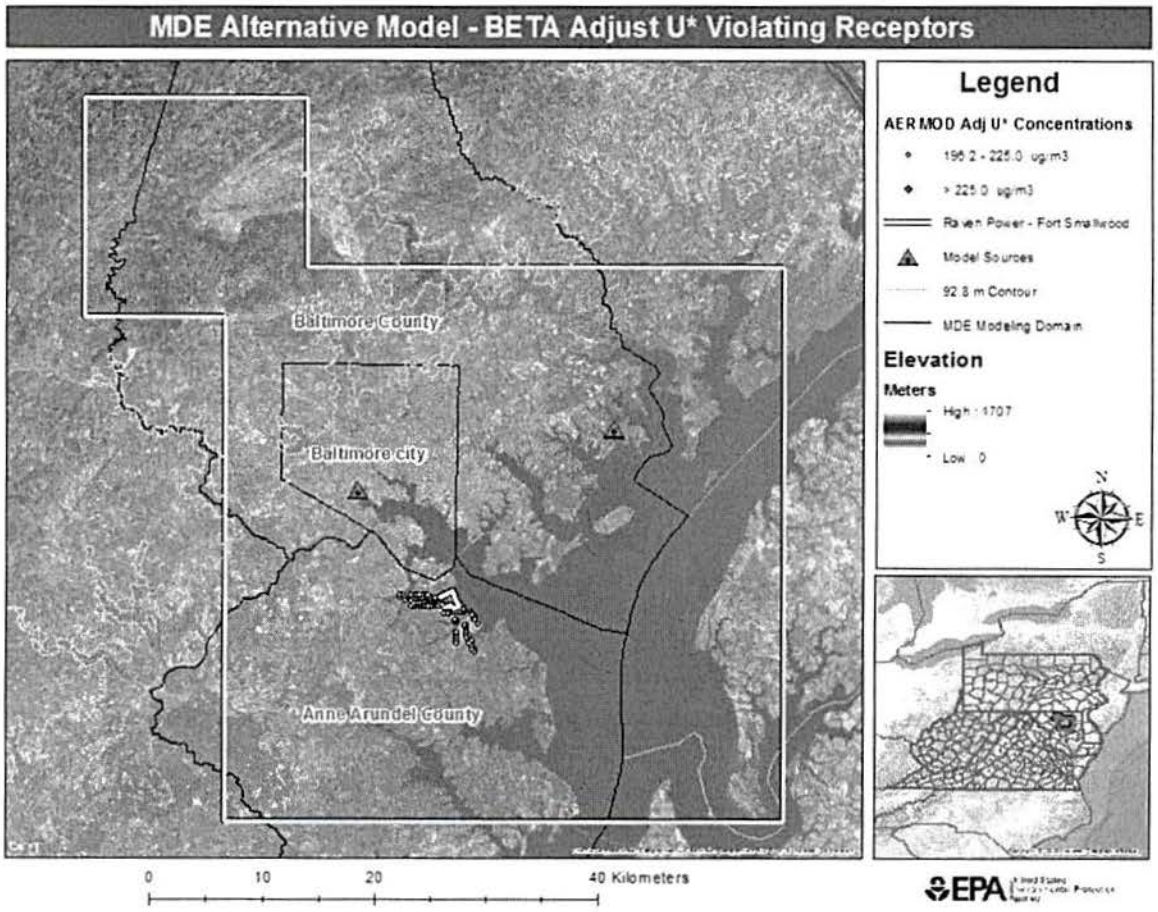


Figure 3. BETA Adjust U* AERMOD violating receptor locations and concentrations

To examine the impact of using the BETA Adjust U* option in AERMOD, MDE conducted a more detailed analysis of this option's impact on u* and wind speed values. This is similar to the analysis done for the Dolin gold mine included in the Model Clearinghouse (see February 10, 2016 memo). There were 274 violating receptors in the default AERMOD run. To minimize the number of receptors examined, MDE picked twelve (12) individual receptors that represented groups of violating receptors to analyze (See Figure 4). The u* and wind speed values for each receptor's highest 1-hr SO_2 concentration from the BETA Adjust U* run was pulled to compare values from the default AERMOD run; note that the final model receptor concentration is an

average of the 4th highest model concentrations for each year of the three (3) year simulation. These results are presented in Table 1.

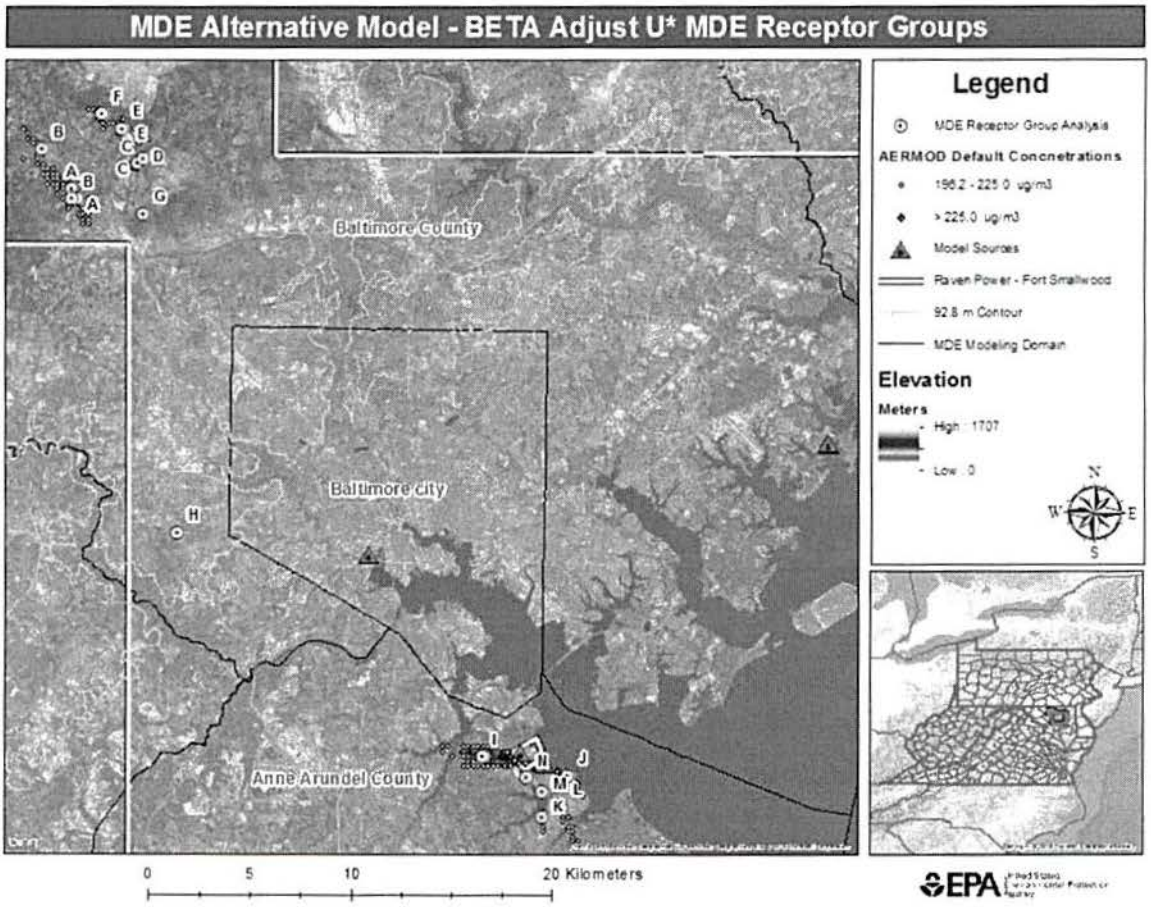


Figure 4. Default AERMOD violating receptors and MDE receptor group locations

MDE's sensitivity analysis showed that u* values increased when the BETA Adjust U* option was employed for most of the receptor groups. Table 1 also shows that highest model concentrations for all of the violating receptors that exceeded the lowest model source effective stack height (~93 m, or receptors A-H) occurred during the overnight hours (stable conditions/low wind speeds). The highest concentrations at the violating receptors below the lowest effective stack height (receptors I-N) all occurred during daylight hours indicating stack plumes were being mixed to the surface receptors. U* values for receptors I-N were generally unchanged and consequently deploying BETA Adjust U* had little to no impact on these receptor's modeled concentrations. This result was not unexpected since the primary purpose of deploying BETA Adjust U* was to alleviated AERMOD's tendency to over predict during times of light winds and stable atmospheric conditions.

							Default AERMOD		BETA Adjust U*	
Group	X	Y	Elevation (m)	Year	Julian Day	Hour	Surface Friction Velocity (u*) (m/s)	Wind Speed (m/s)	Surface Friction Velocity (u*) (m/s)	Wind Speed (m/s)
A	344732.83	4366325.66	212.8	2014	247	20	0.081	2.25	0.15	2.25
A	344982.83	4365825.66	209.6	2014	247	20	0.081	2.25	0.15	2.25
B	343232.83	4368325.66	213.7	2014	247	20	0.081	2.25	0.15	2.25
B	343232.83	4368075.66	210.3	2014	55	22	0.026	0.79	0.095	0.79
C	347982.83	4367575.66	209.1	2014	19	5	0.036	1.08	0.095	1.08
C	347953.75	4367592.5	208.34	2014	19	5	0.036	1.08	0.095	1.08
D	348232.83	4367825.66	205.3	2014	60	22	0.031	0.86	0.097	0.86
E	347482.83	4368825.66	217.5	2014	19	5	0.036	1.08	0.095	1.08
E	347232.83	4369325.66	219.5	2014	273	19	0.05	1.37	0.095	1.37
F	346232.83	4370075.66	219.4	2014	19	5	0.036	1.08	0.095	1.08
G	348232.83	4365075.66	201.2	2015	128	20	0.069	1.94	0.126	1.94
H	349953.75	4349092.5	159.13	2014	273	20	0.047	1.3	0.094	1.3
I	365075	4337890	9.39	2014	358	13	0.118	1.55	0.118	1.55
J	369375	4336940	7.69	2014	363	13	0.179	1.99	0.179	1.99
K	368075	4334890	9.16	2014	61	16	0.165	2.04	0.165	2.04
I	369075	4335390	7.84	2014	64	10	0.094	0.69	0.094	0.69
M	368075	4336140	6.51	2015	33	13	0.118	1.3	0.118	1.3
N	367275	4336840	14.04	2014	274	6	0.148	3	0.187	3

Table 1. Analysis of u* and wind speed values from the default and BETA Adjust U* runs completed by MDE.

Conclusions

On April 14, 2016 MDE submitted an alternative model request (for BETA Adjust U*) to the U.S. EPA Region 3 Regional Administrator under Section 3.2.2 (b)(3) of Appendix W to 40 CFR Part 51 – Guideline on Air Quality Models (2005). EPA Region 3 reviewed the request and has determined that MDE's submittal has met the conditions laid out in Section 3.2.2 (e)(1-5) including establishing proper peer review, model applicability to the problem, adequate data base availability, appropriate model performance analyses and prior establishment of a modeling protocol. The deployment of BETA Adjust U* has been shown via sensitivity analysis to only impact model concentrations during periods when the default version of AERMOD has been shown to over predict surface concentrations; during times of low wind periods and stable atmospheric conditions.

At this time, EPA Region 3 is approving MDE's alternative model request under Section 3.2.2 Appendix W to 40 CFR Part 51 – Guideline on Air Quality Models. We will seek concurrence with the Model Clearinghouse in accordance with the process outlined in the December 10, 2015 Clearinghouse Memorandum.

References

EPA (2016) see February 10, 2016 Clearinghouse Memo: "*Model Clearinghouse Review of the Use of the ADJ_U* Beta Option in the AERMET Meteorological Processor (Version 15181) for the Donlin Mine Compliance Demonstration.*"
https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=16-X-01

EPA, 2015a. Addendum, User's Guide for the AERMOD Meteorological Preprocessor (AERMET). (EPA-454/B-03-002, November 2004). Office of Air Quality Planning and Standards, Research Triangle Park, NC. June 2015.

EPA. 2015b. Overview of Proposed Revisions to Appendix W . Tyler Fox, Office of Air Quality, Planning and Standards. 11th Modeling Conference, Research Triangle Park, NC. August 12, 2015.

Robert Paine, Olga Samani, Mary Kaplan, Eladio Knipping & Naresh Kumar (2015) Evaluation of low wind modeling approaches for two tall-stack databases, Journal of the Air & Waste Management Association, 65:11, 1341-1353,

Paine, B. and J. Connors (2013) AERMOD Low Wind Speed Issues: Review of New Model Release. AECOM, EPA 2013 Modeling Workshop Presentation. April 23, 2013
http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2013/agenda.htm

Qian, W. and A. Venkatram. (2011) Performance of Steady-State Dispersion Models Under Low Wind-Speed Conditions. Boundary-Layer Meteorology 138, 475-491

Robinson, R. and R. Brode (2007) AERMOD Implementation Workgroup Presentation at EPA Regional/State/Local Modelers Workshop, Virginia Beach, VA. See AERMOD Implementation Workgroup Presentation on May 15th.
http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2007/agenda.htm

Maryland
Department of
the Environment

Larry Hogan
Governor

Boyd Rutherford
Lieutenant Governor

Ben Grumbles
Secretary

April 14, 2016

Mr. Shawn M. Garvin
Regional Administrator
USEPA Region 3
1650 Arch Street
Mail Code: 3RA00
Philadelphia, PA 19103-2029

Dear Mr. Garvin: Shawn

I am writing to you regarding the 1-hour SO_2 Characterization Modeling for the area around the H.A. Wagner and Brandon Shores power plants air quality modeling protocol that was recently submitted to the Maryland Department of the Environment (MDE), Air and Radiation Management Administration (ARMA). This modeling protocol was prepared to describe the approach being taken to demonstrate that the H.A. Wagner (Wagner) power plant located in Anne Arundel County, Maryland would be in attainment of the 1-hour SO_2 National Ambient Air Quality Standard (NAAQS).

On March 20, 2015, EPA informed Maryland that the Wagner Power Plant would be part of the expedited round of designations under the 1-hour SO_2 NAAQS due to terms of the SO_2 Consent Decree negotiated between the Sierra Club and EPA (Sierra Club *v.* McCarthy). The EPA intends to designate the Wagner Power Plant area as either unclassifiable/attainment, nonattainment or unclassifiable by July 2, 2016 after a review of available modeling or monitoring data to support the SO_2 concentration characterization.

The model selected for this modeling application is the EPA American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) modeling system version 15181, including the American Meteorological Society/Environmental Protection Agency Regulatory Improvement Committee (AERMIC) meteorological (AERMET) non-regulatory default/beta ADJ_U* option (EPA,2015a). EPA has indicated support for this change as part of their July 29, 2015 Appendix W proposal. In addition, Roger Brode's (USEPA) Proposed Updates to AERMOD Modeling System presentation (EPA, 2015b) delivered at the 11th Modeling Conference on August 12, 2015 indicated that the ADJ_U* option be incorporated into the regulatory versions of AERMOD and AERMET in the notice of proposed rulemaking (NPRM).

Section 3.2.2.b of Appendix W to 40 CFR Part 51, ("Revision to the Guideline on Air Quality Models", November 9, 2005), details the approach for approval of an alternative model. Specially, the request must meet one of the following three conditions:

1. If a demonstration can be made the model produces concentrations estimates equivalent to the estimates obtained using a preferred model;
2. If a statistical performance evaluation has been conducted using measured air quality data and the results of that evaluation indicate the alternative model performs better for the given application than a comparable model; or
3. If the preferred model is less appropriate for the specific application, or there is no preferred model.

The Wagner power plant request falls under condition 3.

Appendix W (Section 3.2.2.e) states that for condition 3 in paragraph b of section 3.2.2 of Appendix W to 40CFRPart 51, "an alternative refined model may be used provided that:

1. The model has received a scientific peer review;
2. The model can be demonstrated to be applicable to the problem on a theoretical basis;
3. The databases which are necessary to perform the analysis are available and adequate;
4. Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates; and,
5. A protocol on methods and procedures to be followed has been established."

These five (5) points are discussed below separately.

Condition 1: The model has received a scientific peer review

EPA has acknowledged poor AERMOD performance during low wind-speed conditions (Robinson and Brode 2007). The proposed AERMET formulation changes to the friction velocity computation for low wind speeds are referenced in a Boundary-Layer Meteorology Qian and Venkatram (2011) peer-reviewed paper which demonstrated that the AERMOD meteorological preprocessor (AERMET) tends to grossly under-predict surface friction velocity (u*) under low wind-speed conditions (less than two meters per second). When simulating emission sources with AERMOD, the under-prediction of u* leads to inappropriately low mechanical mixing heights, consequently resulting in overly conservative (excessively high) ambient concentration estimations (EPA 2015c; Paine and Connors 2013; Qian and Venkatram 2011, Robert Paine 2015).

Qian and Venkatram (2011) suggested a new method for calculating u* and showed results that support improved u* and model concentration predictions in the low wind-speed regime. EPA has incorporated this calculation methodology in AERMET as ADJ_U* (EPA 2013), most recently in AERMET version 15181. The ADJ_U* method is a processing option for calculating u* for low wind speeds during stable (nighttime) conditions (EPA 2015a). Several study results support the conclusion that the application of the ADJ_U* option significantly improves
AERMOD performance for low wind-speed conditions while maintaining a conservatively

high bias in predicted concentrations (EPA 2013; EPA 2015c; EPA 2014; Paine and Connors 2013).
These studies indicate that the ADJ_U* option has been sufficiently peer-reviewed.

Condition 2: The model can be demonstrated to be applicable to the problem on a theoretical basis

There is no theoretical limitation to the application of the AERMET ADJ_U* - it is generally applicable. The current default algorithm in AERMET has been demonstrated to be faulty and needs to be replaced by the ADJ_U* approach.

Condition 3: The databases which are necessary to perform the analysis are available and adequate

The necessary data needed for implementing ADJ_U* within the AERMOD modeling system is routine meteorological data are already available and are sufficient for exercising this low wind option. The use of the Baltimore Washington International Thurgood Marshall Airport (BWI) National Weather Service (NWS) data is sufficient. There are no special database requirements for the use of the ADJ_U* option.

Condition 4: Appropriate performance evaluations of the model have shown that the model is not biased toward underestimates

There have been many model evaluation studies that illustrate improved performance of the AERMOD modeling system with the use of the ADJ_U* option. Most notably is the performance evaluation referenced in Appendix F of the AERMOD User's Guide (EPA 2015c) that was conducted by EPA. This performance evaluation performed by EPA utilizes three evaluation databases: (1) Idaho Falls (NOAA Technical Memorandum ERL ARL-52, August 1974), (2) Oak Ridge (NOAA Technical Memorandum ERL ARL-61, August 1976), and (3) Lovett. The first two databases were part of the API-sponsored evaluation of AERMOD conducted by AECOM, that were submitted as part of API's public comments on EPA's 10th Conference on Air Quality Models held in March 2012. The two NOAA field studies were low-level, non-buoyant tracer releases with three arcs of samplers located at 100 m, 200 m, and 400 m from the release point. The Idaho Falls study was located in a flat terrain, while Oak Ridge was located in complex terrain.

The third database utilized by EPA to evaluate the ADJ_U* option presented in Appendix F of the AERMOD User's Guide (EPA 2015c) was the Lovett database. Lovett is a historical AERMOD evaluation database and features a single 145 meter stack located within a few kilometers of complex terrain. The Lovett field study was a year-long SO_2 field program with monitors located on the primary terrain features to the north of the stack.

The most representative field program that could be used to predict the performance of ADJ_U* for a modeling study at the Wagner power plant is the Lovett field program.

Overall for Lovett, the Q-Q plots on pages F-35 through F-37 (EPA 2015c) demonstrate that the inclusion of the ADJ_U* option improves model performance. Whether the ADJ_U* option is correcting an under-prediction bias as shown on page F-35 (Figure 1) or an over-prediction bias as shown on pages F-36 (Figure 2) and F-37 (Figure 3), the model performance is better.

In Attachment A (Modeling Analysis to Support Use of ADJ_U* Option) of this letter is an additional analysis completed to demonstrate that the model using ADJ_U* is not biased toward underestimate. In addition, the modeling files used in this analysis to support the use of ADJ_U* are also enclosed.

In the proposed revisions to the Guideline (EPA 2015d), EPA intends for the ADJ_U* option to be part of the regulatory default AERMOD modeling system. EPA made this proposal in the preamble to the proposed changes to the Guideline, referred to below as NPRM.

Due to several initial comments from stakeholders, members of the EPA modeling group provided clarifications (EPA 2015e and 2015f) that reinforced EPA's intent to include ADJ_U* as a regulatory default option. These clarifications were provided during EPA's 11th Conference on Air Quality Modeling and Public Hearing for the Proposed Revisions to the Guideline held on August 12–13, 2015 (2015 Conference). EPA's statements regarding the ADJ_U* option as presented in the NPRM and the 2015 Conference are provided below.

From NPRM section IV.A.2., "Updates to EPA's AERMOD Modeling System" (EPA 2015g):

> *"Based on studies presented and discussed at the Tenth Modeling Conference, and additional relevant research since 2010, the EPA and other researchers have conducted additional model evaluations and developed changes to the model formulation of the AERMOD modeling system to improve model performance in its regulatory applications. We propose the following updates to the AERMOD modeling system to address a number of technical concerns expressed by stakeholders:*
>
> 1. *A proposed option incorporated in AERMET to adjust the surface friction velocity (u*) to address issues with AERMOD model over prediction under stable, low wind speed conditions. This proposed option is selected by the user with the METHOD STABLEBL ADJ_U* record in the AERMET Stage 3 input file."*

As presented on the public record at the 2015 Conference by Tyler Fox in his presentation "Overview of Proposed Revisions to Appendix W" (EPA 2015e):

> *"In the NPRM, EPA has proposed to incorporate specific updates to the regulatory version that are the subject of public review and comment and then would be codified as part of the final rule action, as appropriate.*

– These options have thus remained "beta" in v15181 to allow for public testing & evaluation"

As presented on the public record at the 2015 Conference by Roger Brode in his presentation
"Proposed Updates to AERMOD Modeling System" (EPA 2015f):

"EPA has proposed in the NPRM that the ADJ_U option (with or without BULKRN) be incorporated into the regulatory version of AERMET."*

It is clear that EPA, pending review and comments during the public comment period, intends to incorporate ADJ_U* as a regulatory default option. At this time, ADJ_U* remains a nondefault option and requires approval from EPA for use in modeling compliance demonstrations. According to statements at the 2015 Conference, the proposed revisions to the Guideline are expected to be finalized by the spring of 2016 (EPA 2015e).

MDE/ARMA believes that these evaluations satisfy this condition.

Condition 5: A protocol on methods and procedures to be followed has been established

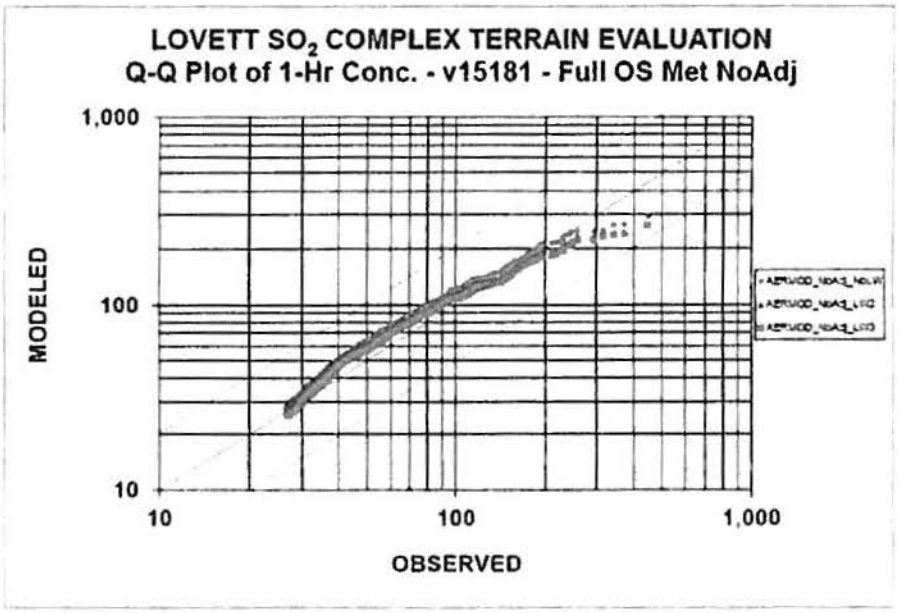
A modeling protocol addressing the 1-hour SO_2 characterization of the Wagner area was prepared by AECOM and submitted to EPA Region 3 in February 2016. Comments on the modeling protocol were received from EPA Region 3 in March 2016. MDE/ARMA has reviewed the modeling protocol prepared for utilizing ADJ_U* and EPA Region 3 comments and the implementation of the ADJ_U* in the application, and we believe that the comments have been adequately addressed.

MDE/ARMA believes for the reasons described previously that the ADJ_U* option is justified for use in the 1-hour SO_2 characterization air quality modeling for the Wagner power plant. If there are any specific questions related to the technical aspects of this air modeling issue, please contact Mr. Michael Woodman of MDE/ARMA at (410) 537-3229.

Sincerely,

Ben Grumbles
Secretary

cc: Tim Leon Guerrero, U.S. EPA Region III (e-mail)
George (Tad) S. Aburn, Jr., MDE
Enclosures



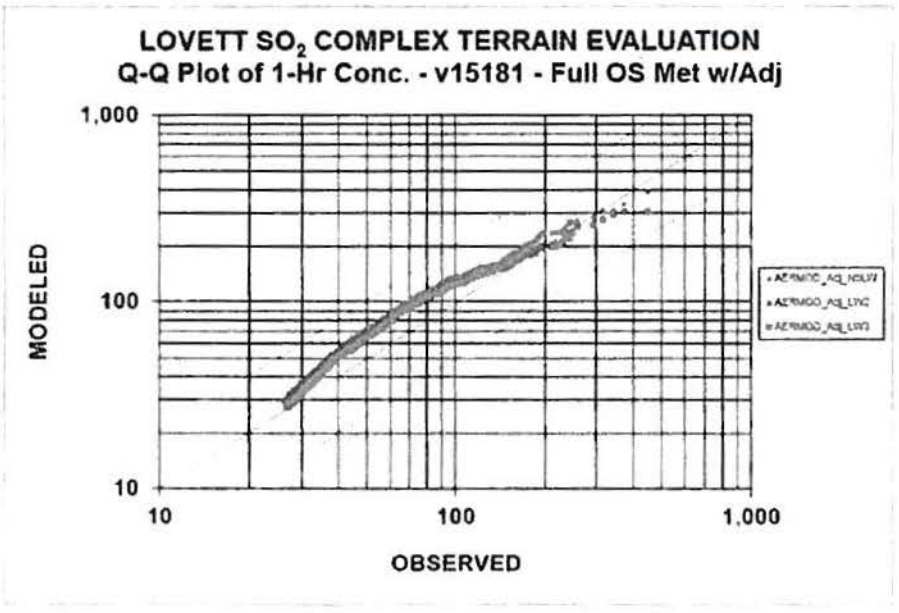
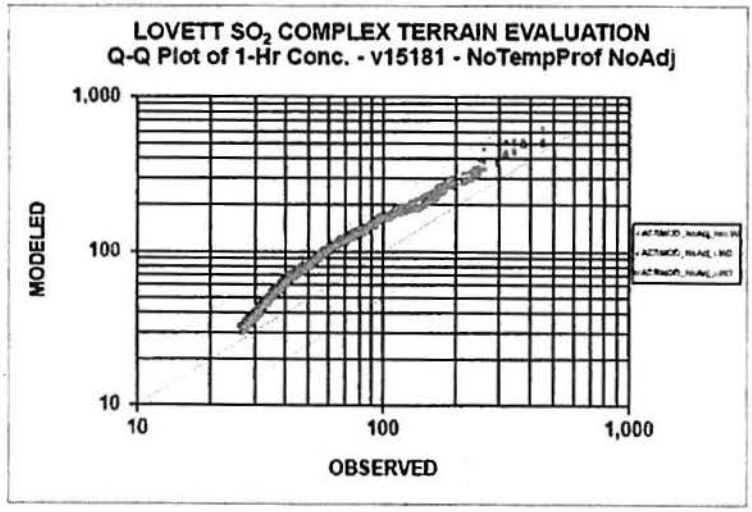


Figure 1. EPA AERMOD Evaluation Results for Lovett
(From page F-35 (EPA2015c))



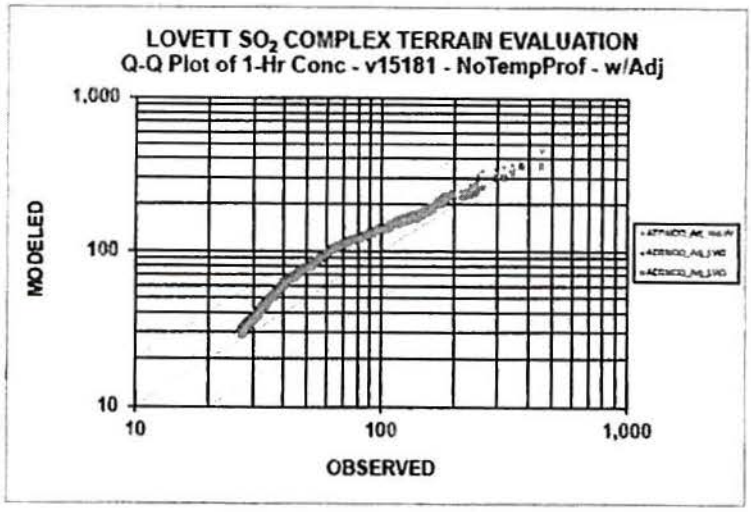


Figure 2. EPA AERMOD Evaluation Results for Lovett
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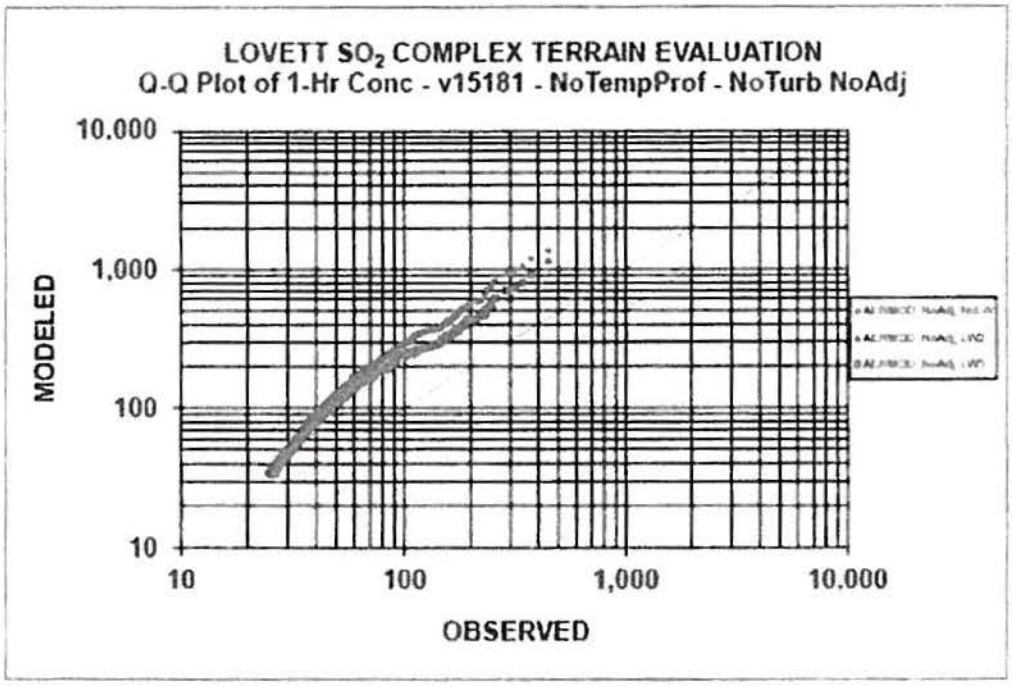

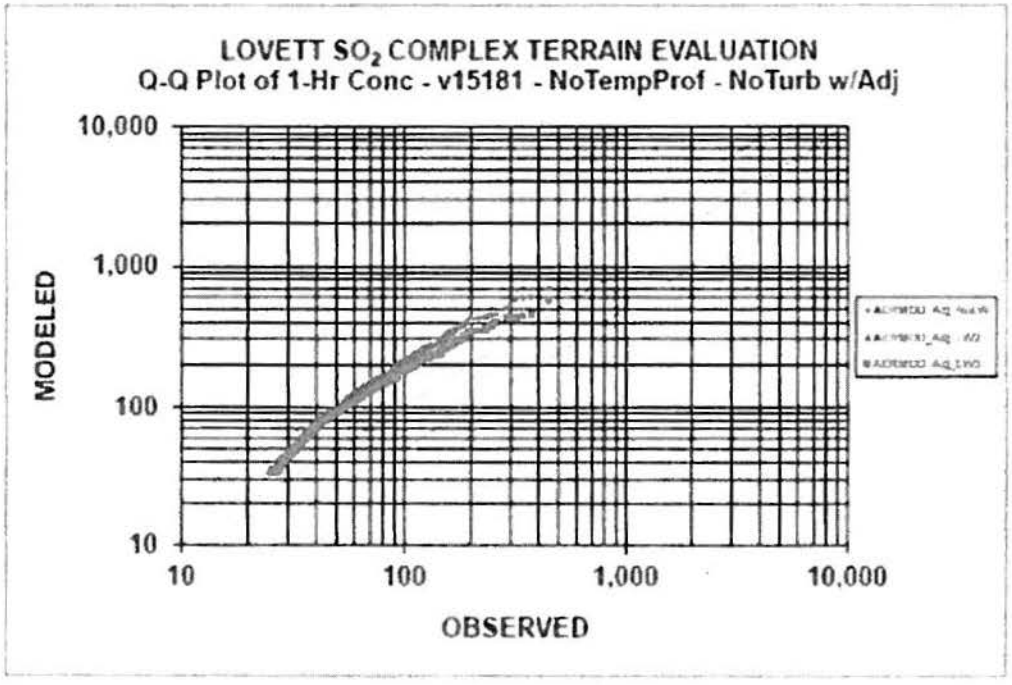

Figure 3. EPA AERMOD Evaluation Results for Lovett
(From page F-36 (EPA2015c))

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Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

This AERMOD modeling analysis was completed to demonstrate that use non-regulatory ADJ_U*is applicable in this instance.

1-hour SO_2 modeling completed using AERMOD with regulatory default options and variable hourly emissions resulted in modeled 4th high 1-hour SO_2 concentrations nearby the Wagner power plant (Wagner) area and approximately 35 km to the northwest of the Wagner area in Baltimore County (Figure 1A).

Figure 1A. Modeled 4th High 1-hour SO_2 Concentrations

Within each of these areas of modeled 4th high 1-hour SO_2 concentrations, one or two of the highest reading receptors were chosen and closely looked at. The areas to the northwest of the Wagner area were assigned the letters A – H to represent the various modeled 4th high 1-hour SO_2 concentration areas. The group A-G receptors are shown in Figure 2A and Figure 3A shows the receptor group H. The receptors that will be further analyzed are represented by red dots. Areas of modeled 4th high 1-hour SO_2 concentrations located in the Wagner area are represented by receptor group's I-N as seen in Figure 4A.

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

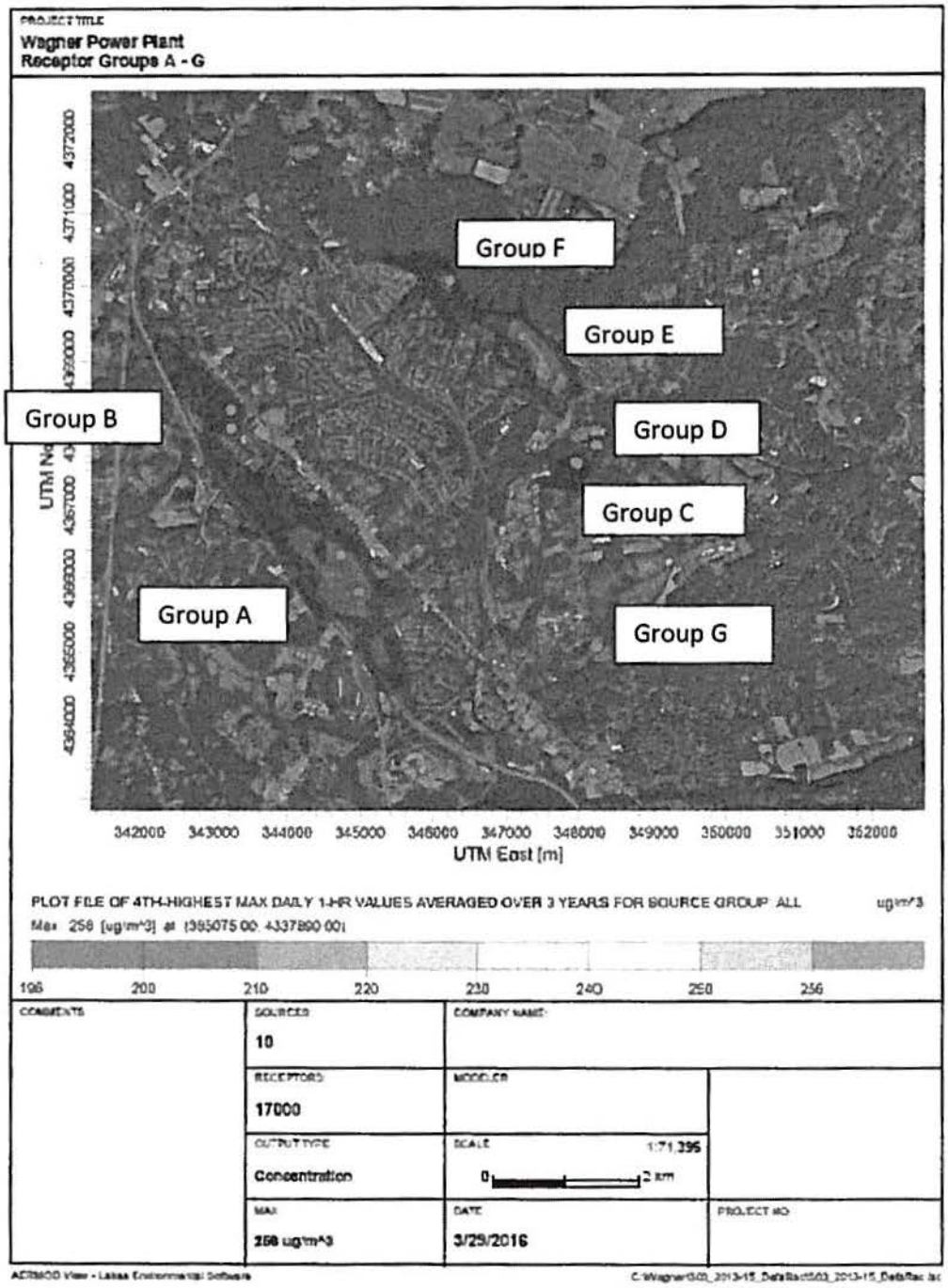

Figure 2A. Receptor Groups A – G

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

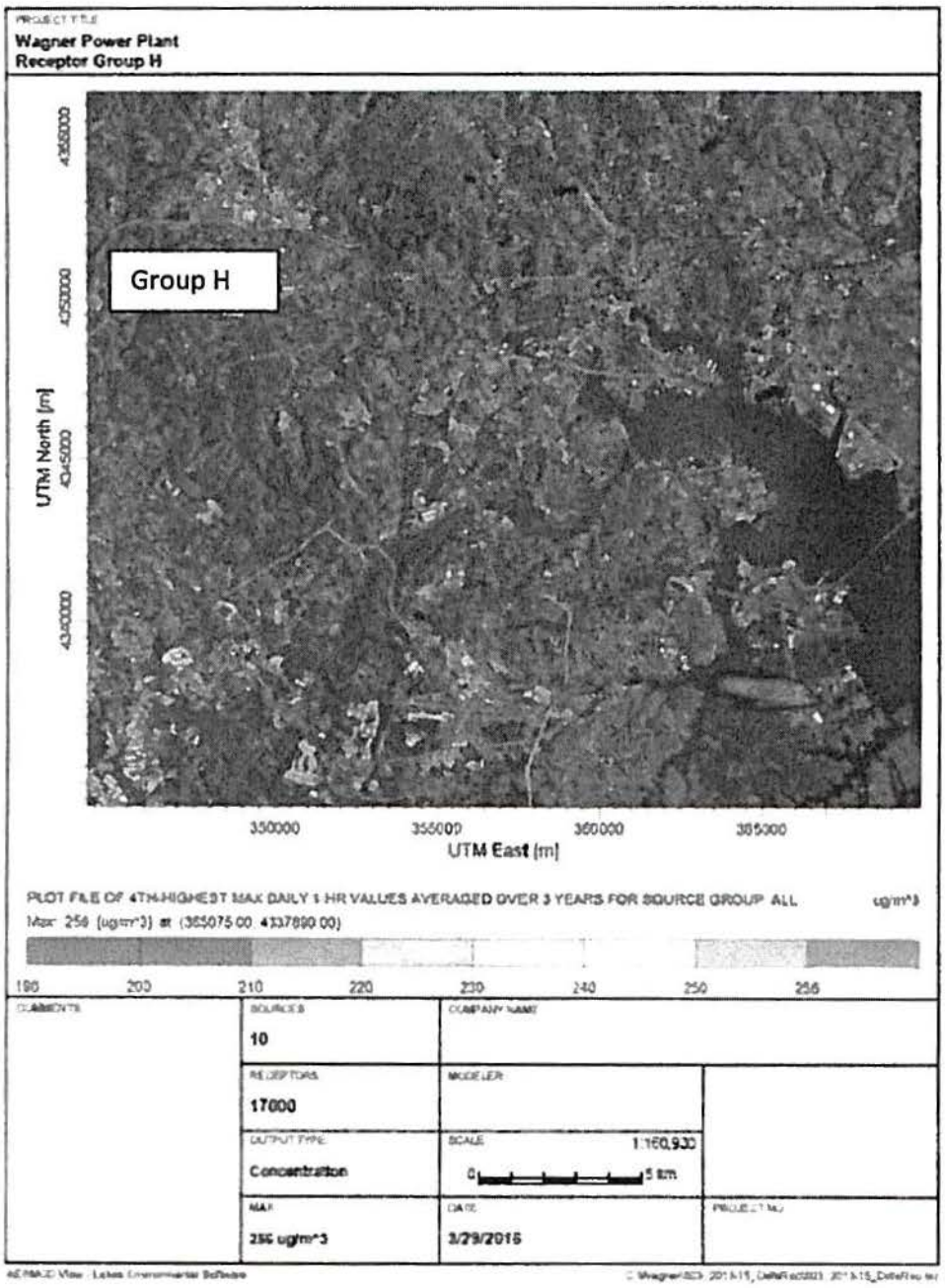

Figure 3A. Receptor Group H

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

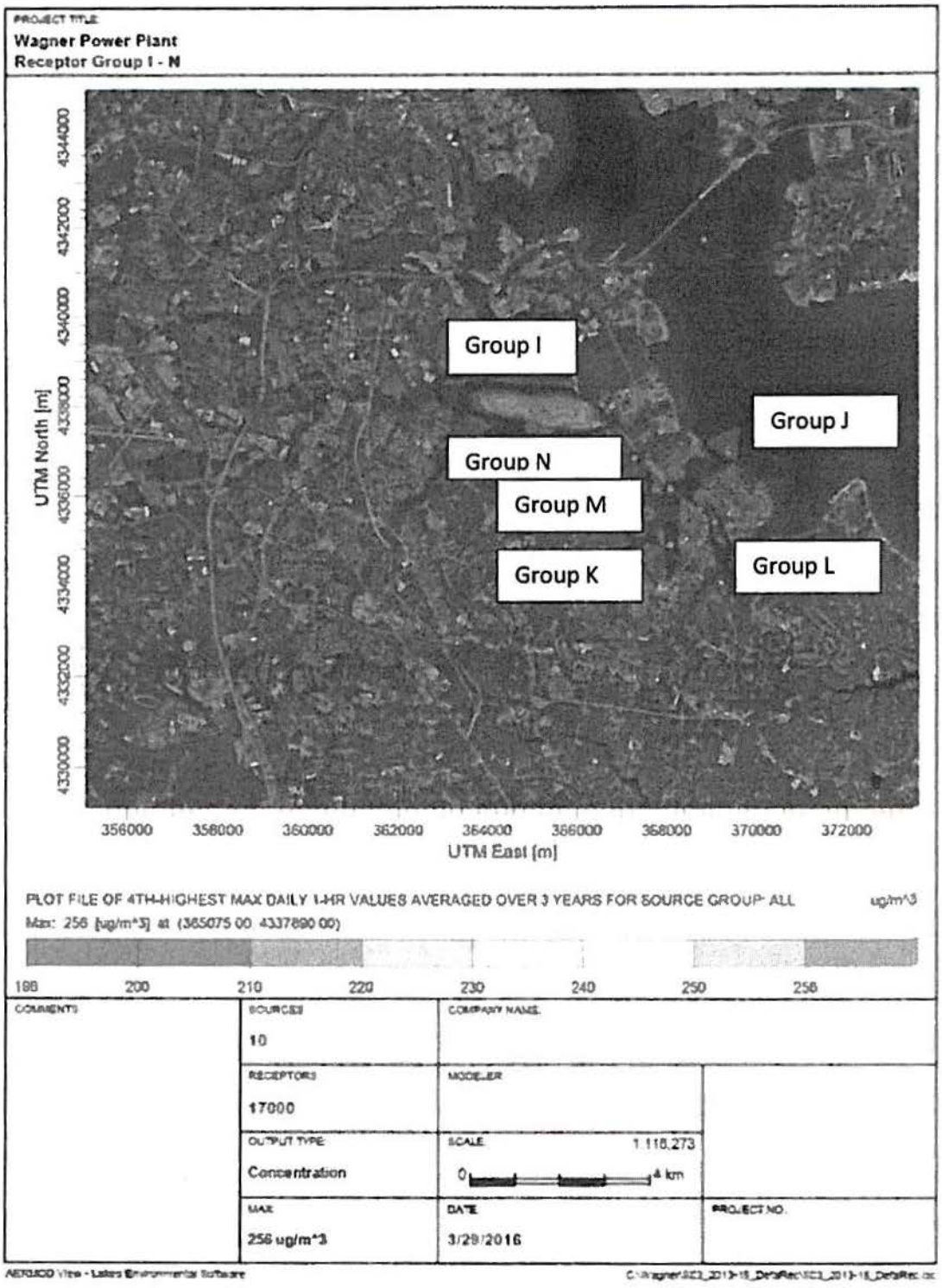

Figure 4A. Receptor Groups I – N

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

Within the areas A-N a total of 18 receptors were further analyzed. For each of these receptors the elevation, Julian day, hour, surface friction velocity (U*) and wind speed without and with the adjustment to U* are in Table 1A.

Based on Table 1A, the receptors in groups A-H are all located in areas of complex terrain and the greatest distance from the Wagner area. In addition, hours of the maximum concentrations at these receptors are all between the hours when stable conditions are expected and winds are light. The application of the ADJ_U* option reduces the frequency of low surface friction velocity (U*) values that are known to result in over-predictions of modeled concentrations with AERMOD. Receptors in groups I – N are in the immediate Wagner area and not located in complex terrain. The surface friction velocities are similar during the hours when unstable conditions are expected.

In addition, the data in Table 1A and the fact that the modeled 4th high 1-hour SO_2 concentrations in Baltimore County are located at such a far distance from the Wagner area calls the model's applicability into question.

The Baltimore Washington International Thurgood Marshall (BWI) Airport wind rose (Figure 5A) shows that the prevailing wind direction is from the west and west northwest. Based on the wind rose the frequency of strong winds needed to cause the high concentrations of 1-hour SO_2 to affect an area 35 kilometers away is not supported.

Figure 6A shows the modeling run that was completed using the exact same input parameters, except the non-regulatory ADJ_U* option was used. This particular scenario still resulted in 4th high 1-hour SO_2 modeled concentrations in the immediate Wagner area but the high concentrations approximately 35 kilometers to the northwest of the Wagner area in Baltimore County were no longer present.

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

Table 1A. Surface Friction Velocity (U*) With and Without the Adjustment

						Without ADJ_U*		With ADJ_U*	
						Surface Friction Velocity (U*)	Wind Speed (Ws)	Surface Friction Velocity (U*)	Wind Speed (Ws)
Group	X	Y	Elevation	Julian Day	Hour	(m/s)	(m/s)	(m/s)	(m/s)
A	344732.83	4366325.66	212.8	247	20	0.081	2.25	0.15	2.25
A	344982.83	4365825.66	209.6	247	20	0.081	2.25	0.15	2.25
B	343232.83	4368325.66	213.7	247	20	0.081	2.25	0.15	2.25
B	343232.83	4368075.66	210.3	55	22	0.026	0.79	0.095	0.79
C	347982.83	4367575.66	209.1	19	5	0.036	1.08	0.095	1.08
C	347953.75	4367592.5	208.34	19	5	0.036	1.08	0.095	1.08
D	348232.83	4367825.66	205.3	60	22	0.031	0.86	0.097	0.86
E	347482.83	4368825.66	217.5	19	5	0.036	1.08	0.095	1.08
E	347232.83	4369325.66	219.5	273	19	0.050	1.37	0.095	1.37
F	346232.83	4370075.66	219.4	19	5	0.036	1.08	0.095	1.08
G	348232.83	4365075.66	201.2	128	20	0.069	1.94	0.126	1.94
H	349953.75	4349092.5	159.13	273	20	0.047	1.30	0.094	1.30
I	365075	4337890	9.39	358	13	0.118	1.55	0.118	1.55
J	369375	4336940	7.69	363	13	0.179	1.99	0.179	1.99
K	368075	4334890	9.16	61	16	0.165	2.04	0.165	2.04
L	369075	4335390	7.84	64	10	0.094	0.69	0.094	0.69
M	368075	4336140	6.51	33	13	0.118	1.30	0.118	1.30
N	367275	4336840	14.04	274	6	0.148	3.00	0.187	3.00

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

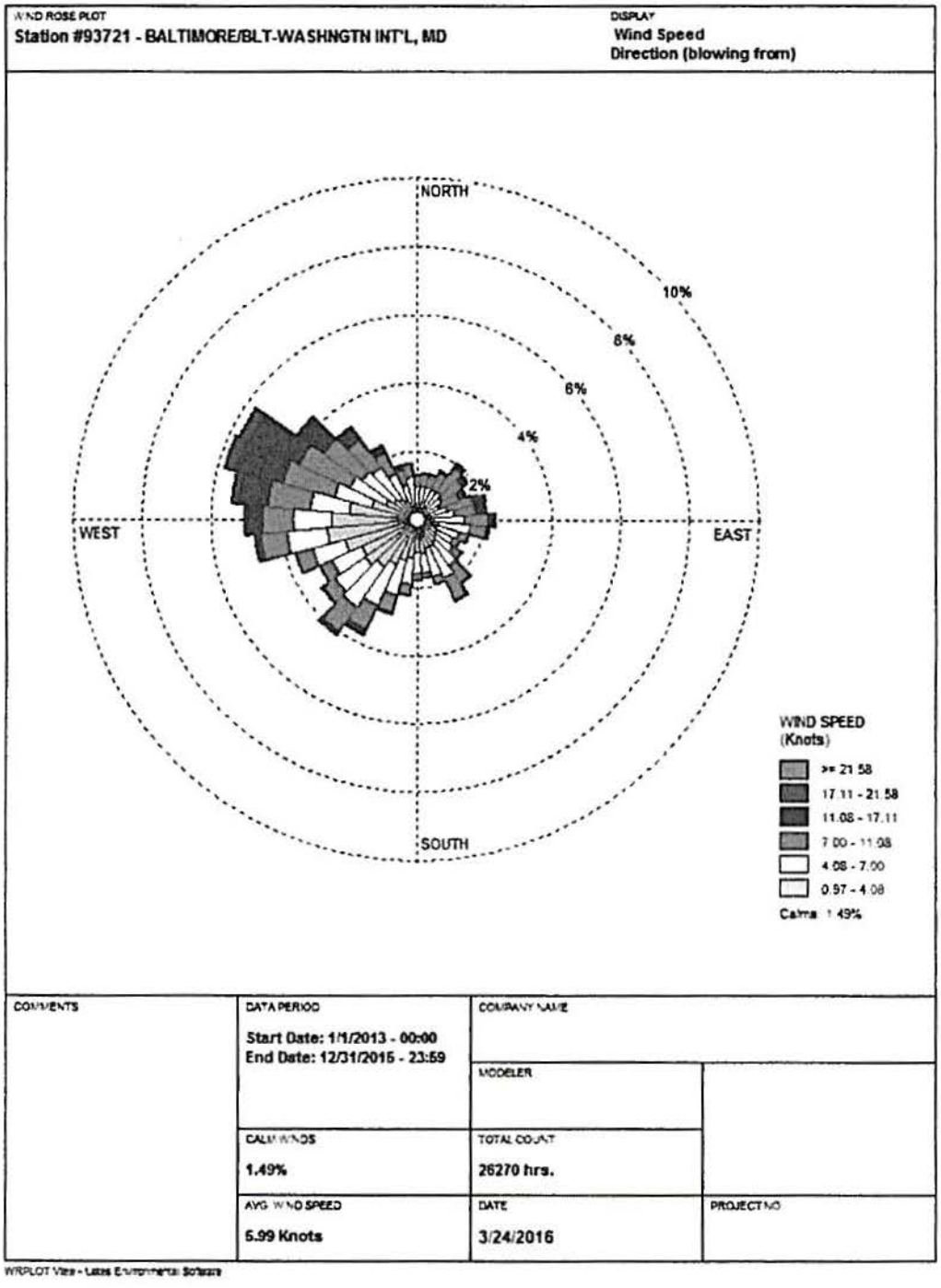

Figure 5A. BWI Airport Wind Rose

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

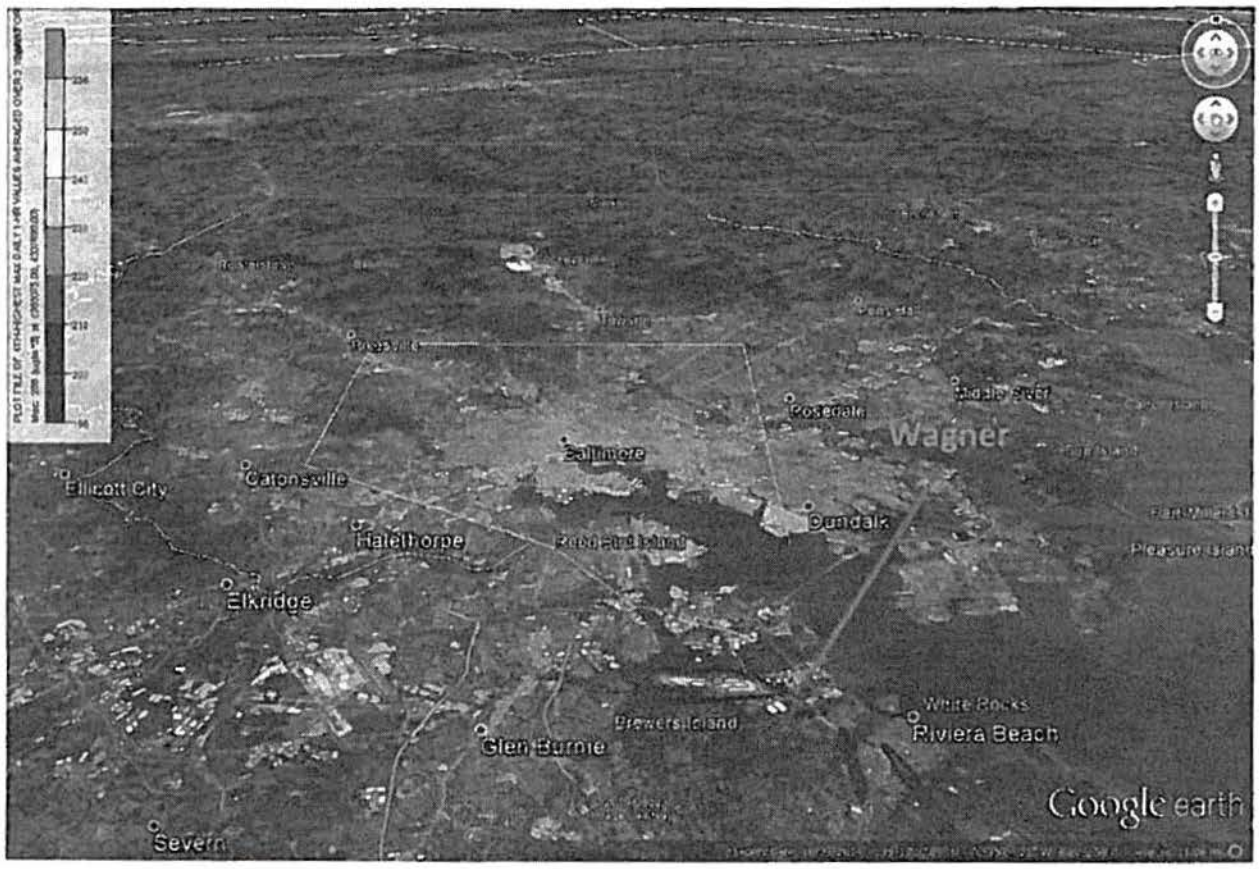

Figure 6. Non-Regulatory Default ADJ_U* 4th High 1-Hour Modeling Results

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

The completed modeling analysis demonstrates that the use of the regulatory default options and non-regulatory default ADJ_U* option results in very similar modeled 4th high 1-hour SO_2 concentrations. The only difference between the two is that the modeled 4th high 1-hour SO_2 concentrations 35 kilometers away in Baltimore County are no longer present using the non-regulatory default ADJ_U* option. As previously mentioned, the 4th high 1-hour SO_2 modeled concentrations are not highly probable based on the low wind speeds observed during the hours in question based on the available meteorological data. In addition, this same conclusion was reached by Raven Power based on the comments they submitted. In those comments, Raven Power says "it is impossible for the plume to travel that distance within the model's 1-hour averaging time" (Raven Power Comments on EPA's Proposed SO_2 Non-Attainment Designation for H.A. Wagner Power Plant, March 31, 2016). In conclusion, Maryland should be granted approval to use the non-regulatory default ADJ_U* option in this particular instance.

Attachment A
Modeling Analysis to Support Use of ADJ_U* Option

References

Raven Power Comments on EPA's Proposed SO2 Non-Attainment Designation for H.A. Wagner Power Plant, Baltimore, MD, Submitted by Raven Power, A Subsidiary of Talen Energy, March 31, 2016. Docket # EPA-HQ-OAR-2014-0464.