Appendix S
Dispersion Modeling Analysis for Miami Fort Station
2010 SO_2 NAAQS Recommended Designation

Introduction

The United States Environmental Protection Agency (U.S. EPA) established a new National Ambient Air Quality Standard (NAAQS) for SO_2 on June 22, 2010, of 75 ppb, as the 99th percentile of maximum daily values, averaged over three years. In addition, U.S. EPA revoked the primary annual and 24-hour standards.

Pursuant to the third round of designations and in accordance with the August 21, *2015 Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO2) Primary National Ambient Air Quality Standard (NAAQS); Final Rule*, Ohio EPA is submitting a designation recommendation for the Miami Fort Station source area. This document supports Ohio's recommended designation of the Miami Fort Station source area based on refined dispersion modeling.

Per U.S. EPA's guidance (February 2016 *Draft SO_2 NAAQS Designations Modeling Technical Assistance Document* (herein referred to as "Modeling TAD"), "The primary objective of the modeling would be to determine whether an area currently meets the SO_2 NAAQS, and thereby indicate the designation process for the area". Ohio EPA is including this refined dispersion modeling analysis as a portion of the five-factor approach recommended by U.S. EPA in defining designation areas.

The dispersion modeling analysis was conducted for the 2012-2014 period, using actual hourly variable emissions from the Miami Fort Station facility. This was done per the Modeling TAD, in which U.S. EPA recommends modeling the most recent 3 years of actual emissions.

Temporally varying emissions were modeled to determine the contribution of emissions from each source in the modeling domain. Ohio EPA used variable emissions at the finest temporal scale available for each unit included in the modeling domain. Hourly variable emissions data for the 2012-2014 period were submitted to Ohio EPA by Dynegy, LLC for all SO_2 sources at the Miami Fort Station facility. As described in Ohio's designation modeling protocol (Appendix B of the State of Ohio 2010 Revised Sulfur Dioxide National Ambient Air Quality Standard, Recommended Area Designations, Round 3 submittal), Part 75 emissions reporting data was used for the majority of hourly emissions, with data substitutions for some hours, as described in the modeling protocol. Two SO_2 sources are present at the Miami Fort Station facility.

Modeling Approach

Per U.S. EPA's Modeling TAD,

> "Since the purpose here pertains to designations, this guidance supports analyses of existing air quality rather than analyses of emissions limits necessary to provide for attainment. Consequently, the guidance in this TAD differs in selected respects from the guidance published in Appendix W. These differences include:
>
> - Placement of receptors only in areas where it is feasible to place a monitor vs. all ambient air locations (NSR, PSD, and SIP)
> - Use of the most recent 3 years of actual emissions (designations) vs. maximum allowable emissions (NSR, PSD, and SIP)
> - Use of 3 years of meteorological data (designations) vs. one to five years (NSR, PSD, and SIP)
> - Use of actual stack height for designations using actual emissions vs. Good Engineering Practice (GEP) stack height for other regulatory applications (NSR, PSD, and SIP)

Ohio EPA incorporated the differences listed above and followed Appendix W guidance where applicable to modeling for designation purposes. The averaging period for the 2010 SO_2 NAAQS is the 99th percentile of maximum monitored daily values, averaged over three years. Per the Modeling TAD, three years of National Weather Service data is sufficient to allow the modeling to simulate a monitor. Thus, the modeled form of the standard is expressed as the 99th percentile of maximum daily values averaged over three years (herein referred to as "design value") for the purposes of designation.

The recommended dispersion model for modeling for SO_2 designations is the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) modeling system. There are two input data processors that are regulatory components of the AERMOD modeling system: AERMET, a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and AERMAP, a terrain data preprocessor that incorporates complex terrain using United States Geological Survey (USGS) Digital Elevation Data. Additionally, Ohio EPA utilized the AERMINUTE module to incorporate 1-minute ASOS meteorological data into the hourly surface input file. Ohio EPA utilized the most up-to-date versions of AERMOD and the associated preprocessors available at the time of the attainment modeling analyses. These are as follows: AERMOD version 15181, AERMET version 15181, AERMINUTE version 14337, and AERMAP version 11103. All dispersion modeling for this submittal was conducted following Ohio EPA's designations modeling protocol.

Meteorological Data

In order to generate meteorological input data for use with AERMOD, AERMET, along with AERMINUTE and AERSURFACE preprocessing for the modeling domain was conducted to generate the surface (.sfc) and profile (.pfl). Ohio EPA used the AERMINUTE pre-processing module. This module accepts as input 1-minute ASOS meteorological surface observations, calculates an hourly average for each hour in the

modeled time period, and substitutes any missing values from the co-located ISHD surface data. Use of AERMINUTE reduces the number of calm hours present in the input files, and these enhanced hourly files are therefore considered more representative of local meteorological conditions.

Meteorological data from 2012-2014 from surface station #93814 located at the Cincinnati Northern Kentucky Airport (KCVG) and upper air station #13841 located at the Wilmington Airborne Park (KILN) were used in these analyses. These sites were determined to be representative of Hamilton County, OH and the Miami Fort Station facility. AERSURFACE was run using twelve sectors and monthly surface characteristics, centered on the location of the surface meteorological station. Monthly precipitation values, years 2012-2014 from the surface station were compared to the 30-year climatological averages to inform monthly surface characteristics. A composite wind-rose of annual trends and distribution of wind directions, years 2012-2014 from the surface station are shown in Figure 1, below.

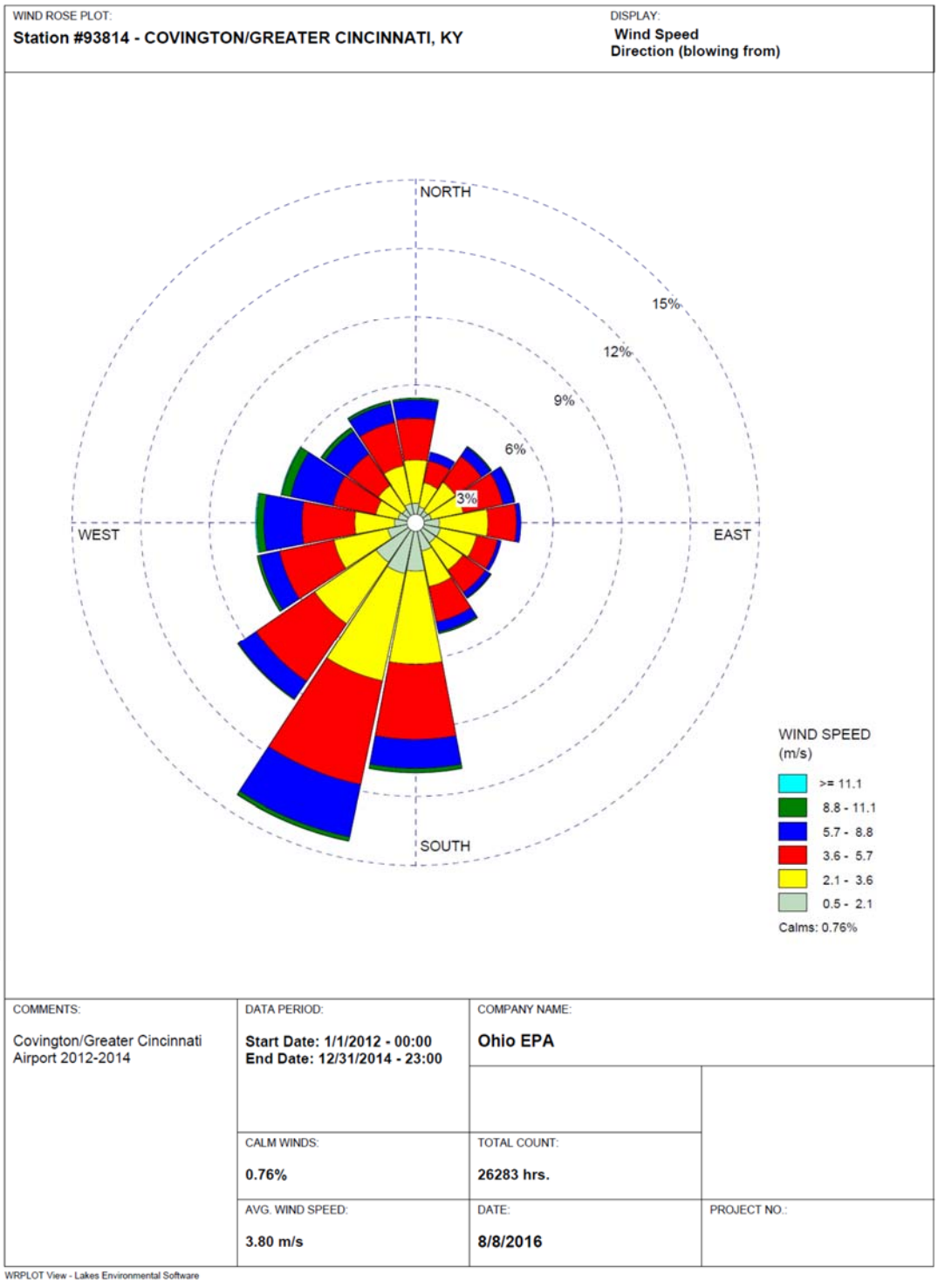

Figure 1: Wind rose, years 2012-2014, Cincinnati met station.

The predominant wind directions were used, in part, to inform which facilities within 50 kilometers may potentially impact ambient SO_2 concentrations in the Miami Fort Station source area not accounted for by background and therefore necessitate inclusion in the dispersion modeling analysis. As shown in Figure 1, the predominant winds in the source area originate from the southwest and south. Figure 2 shows the location of all facilities within 50 kilometers of Miami Fort Station, as well as a composite wind rose, years 2012-2014, from the Cincinnati meteorological station.

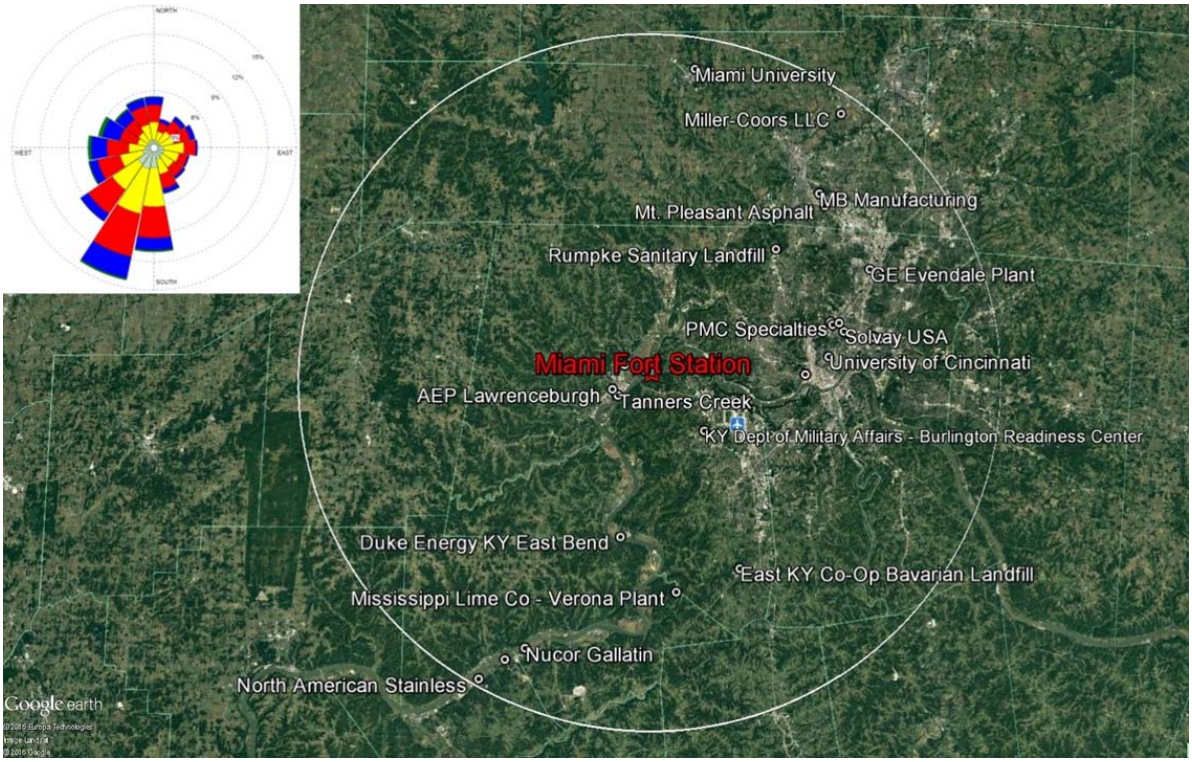

Figure 2: SO_2 sources in the Miami Fort Station source area, with 2012-2014 composite wind rose.

Considering the predominant wind directions, Ohio does not conclude that the emissions from the smaller sources located to the east and west of the Miami Fort Station facility impact ambient SO_2 concentrations in Hamilton County beyond what is accounted for in background. The Duke Energy KY East Bend facility is situated such that prevailing winds would likely carry emissions to the area impacted by Miami Fort Station. Given the relatively low emissions from this facility (2,103 tons) and distance (23.5 kilometers) from Miami Fort Station, Ohio does not conclude that emissions from this source impact ambient SO_2 concentrations beyond the background level accounted for in the refined dispersion modeling analysis. Additional considerations of emissions are detailed in the Emissions Sources section of this document.

Background

Ohio EPA applied background concentrations of SO_2 to all modeled results under all scenarios. As described in Appendix O of the State of Ohio 2010 Revised Sulfur Dioxide National Ambient Air Quality Standard, Recommended Area Designations, Round 3 submittal, Ohio EPA utilized a conservative seasonal and hourly variable background concentration derived from monitor 39-061-0010, located approximately 14.5 kilometers to the northeast of the facility. The seasonal and hourly varying emissions are shown in Figure 3.

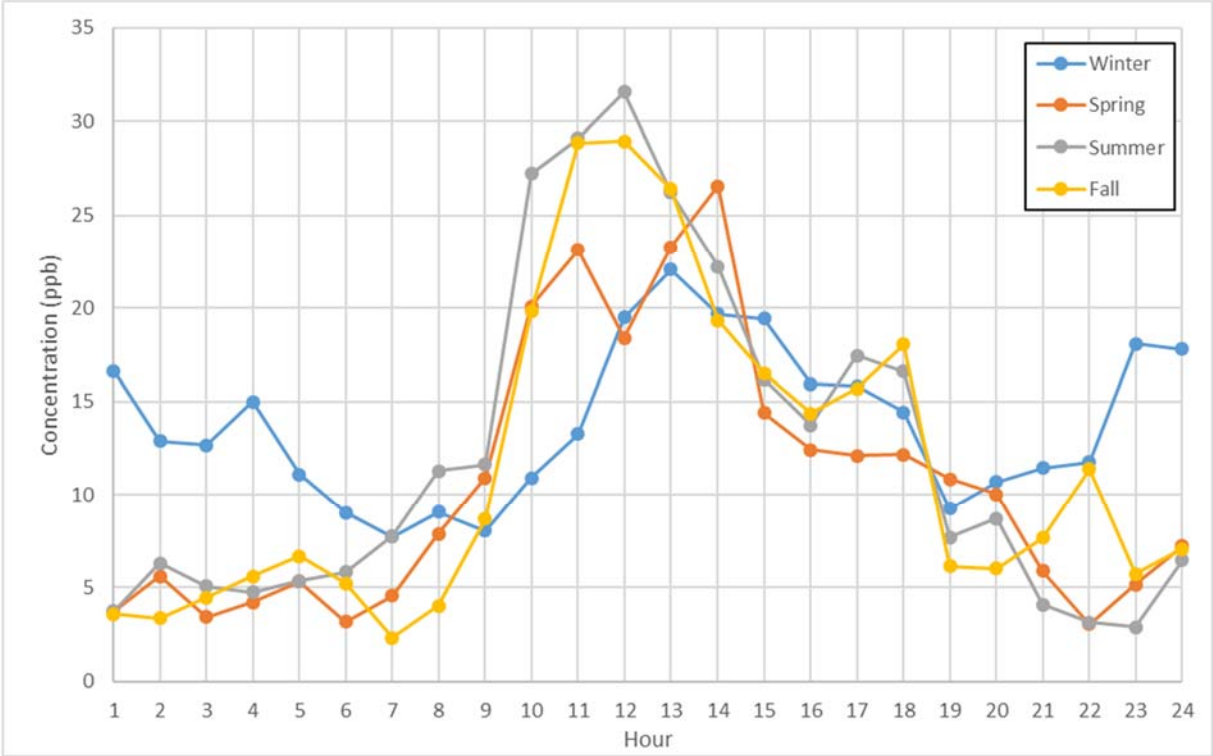

Figure 3: Hourly and seasonally variable SO_2 background, derived from air quality monitor 39-061-0010.

Emission Sources

The SO_2 emission sources at the Miami Fort facility were included in the designation modeling analysis as two egress points. These egress points represent the emissions from the Unit 7 and Unit 8 coal fired boilers. A third unit at the facility, Unit 6, was shutdown on June 1, 2015 and therefore, following U.S. EPA guidance, not included in the modeling analysis (Appendix T of S). Variable emissions for the egress points were included in the model via the HOUREMIS input pathway, years 2012-2014. Ohio EPA utilized the 1-hour SO_2 design value output option internal to the AERMOD code to simplify post processing and eliminate the need to generate large hourly output files. Ohio EPA included background as a separate source in the model, to simplify the inclusion of the variable background applied in the modeling domain. The relevant release point

parameters for the egress points included in the analysis are presented in Table 1, below. Both emissions sources were included in the modeling as point sources.

		Easting (X)	Northing (Y)	Base Elevation	Stack Height	Temperature	Exit Velocity	Stack Diameter	SO2
Source ID	Source Description	(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(g/s)
UNIT7	Miami Fort U7	689801.8	4331830	149.15	243.84	VARIABLE	VARIABLE	7.15	VARIABLE
UNIT8	Miami Fort U8	690125.4	4331565	149.84	243.84	VARIABLE	VARIABLE	7.15	VARIABLE

Table 1: Modeled source parameters, Miami Fort source area, 2012-2014.

This area of Ohio borders Kentucky and Indiana and, based on a 50-kilometer buffer around the Miami Fort Station, Ohio EPA considered sources located in Dearborn County, Indiana, and the Counties of Boone, Carroll, and Gallatin in Kentucky (Figure 2). Ohio EPA considered all sources with 2014 SO_2 emissions for this analysis, with a particular focus on those sources with the potential to cause a significant concentration gradient in the source area beyond what is accounted for in background. This inventory, inclusive of 2014 SO_2 emissions and distance from the Miami Fort Station facility are summarized in Table 2.

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from Miami Fort Station (km)
OH	Hamilton	1431350093	Dynegy, LLC Miami Fort Station	28,479	--
OH	Hamilton	1431394148	DTE St. Bernard, LLC	1,665.91	27
OH	Hamilton	1431070952	Rock-Tenn Converting Company	179.43	33
OH	Hamilton	1431350817	Chemours Fort Hill Plant	152.93	0.8
OH	Hamilton	1431150060	G.E. Aviation, Evendale Plant	52.09	35
OH	Hamilton	1431070944	Mill Creek WWTP	19.92	22
OH	Hamilton	1431380075	PMC Cincinnati, Inc.	16.48	28
OH	Hamilton	1431070849	University of Cincinnati	13.85	26
OH	Hamilton	1431070001	Solvay USA, Inc.	12.65	28
OH	Hamilton	1431073342	Cast-Fab Technologies, Inc.	8.30	32
OH	Hamilton	1431092049	Rumpke Sanitary Landfill, Inc.	3.24	26
OH	Hamilton	1431074278	Emery Oleochemicals LLC	1.07	26
			Hamilton Total	***30,604.87***	

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from Miami Fort Station (km)
OH	Butler	1409000353	MillerCoors LLC	334.00	47
OH	Butler	1409090081	Miami University	271.15	45
OH	Butler	1409030042	Mt Pleasant Asphalt Company Inc.	1.75	35
OH	Butler	1409030403	MB MANUFACTURING CORP.	1.24	36
			Butler Total	***608.14***	
OH	Clermont	362000009	W.C. Beckjord Station	32,603	46
			Clermont Total	***32,603***	
IN	Dearborn	00002	Tanners Creek Power	18,109.13	5.7
IN	Dearborn	00007	Anchor Glass Container Corp.	154.64	3.9
IN	Dearborn	00033	AEP Lawrenceburg Plant	7.19	6.1
			Dearborn Total	***18,270.96***	
KY	Boone	2101500029	Duke Energy East Bend	2,102.76	23.5
KY	Boone	2101500138	East KY Power Coop - Bavarian Landfill	26.46	30.5

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from Miami Fort Station (km)
KY	Boone	2101500188	KY Dept of Military Affairs - Burlington Readiness Center	2.37	11.5
			Boone Total	***2,131.59***	
KY	Carroll	2104100010	KY Utilities Co - Ghent Station	14,851.37	45
KY	Carroll	2104100034	North American Stainless	2.09	49
			Carroll Total	***14,853.46***	
KY	Gallatin	2107700031	Mississippi Lime Co - Verona Plant	43.05	31
KY	Gallatin	2107700018	Nucor Steel Gallatin LLC	31.88	42
			Gallatin Total	***74.93***	
			Grand Total	***99,146.95***	

Table 2: SO2 sources and 2014 emissions, Miami Fort Station source area.

A substantial number of sources are inventoried in Table 2. Of those sources located within 50 kilometers of Miami Fort Station, Ohio EPA believes relatively few of these sources are significant enough to warrant further consideration. Sources identified for further discussion by Ohio EPA are:

DTE St. Bernard Facility (1,666 TPY, 27 kilometers distant)

W.C. Beckjord Station (32,603 TPY, 46 kilometers distant)

Tanners Creek Power (18,109 TPY, 5.7 kilometers distant)

Duke Energy East Bend (2,103 TPY, 23.5 kilometers distant)

Kentucky Utilities Company, Ghent Station (14,851 TPY, 45 kilometers distant)

Those sources not listed have emissions low enough or are located sufficient distant from Miami Fort Station that they are unlikely to impact the area surrounding the Miami Fort Station beyond what is accounted for in background. Of the above sources, the W.C. Beckjord facility is permanently shutdown, shuttered on October 1, 2014, and the Tanners Creek facility is permanently shutdown, shuttered on May 31, 2015 (Appendix U of S and Appendix V of S, respectively.). DTE St. Bernard converted all coal-fired boilers to natural gas in November of 2015, and has a facility-wide SO_2 potential to emit of 55.6 tons per year. At a distance of 27 kilometers, it is highly unlikely that DTE St. Bernard will impact concentrations in the area impacted by Miami Fort Station emissions beyond background concentration, especially considering the conversion to natural gas.

Of the remaining two sources, Duke Energy East Bend and Ghent Station, Ohio does not believe that either source is located sufficiently close to the area impacted by Miami Fort Station to above what is accounted for in background. While Ghent Station emissions are significant, it still remains unlikely that, at a distance of 45 kilometers, emissions from this facility will interact with those of Miami Fort Station or cause a significant concentration gradient in Hamilton County, Ohio. Further, Ohio EPA understands that the Ghent Station will be subject to further ambient air quality characterization under the Data Requirements Rule. Ohio EPA's experience modeling SO_2 sources for the 1-hour standard indicates that impacts from tall-stack sources are most significant within 1 to 10 kilometers of egress point. Beyond these distances, modeled design values are dominated by background.

Therefore, it was determined the only source necessitating inclusion in the modeling analysis was the Miami Fort Station facility and the remaining sources are represented via the background concentrations.

Analysis

The designation modeling analysis consisted of a single modeling run, years 2012-2014. The results of this analysis are to be used to inform the designation process for the area surrounding the Miami Fort Station facility.

Receptors

A total of 36,443 receptors were included in the modeling domain for the purposes of designations modeling. The designations modeling grid consisted of several nested receptor grids, with increased spacing for grids located further from the source. 50 meters spacing was used along the fenceline of the Miami Fort facility and extending to 2 kilometers. The dense grid around the facility was informed by screen modeling to ensure that the point of maximum impact would be located within this densely-spaced grid. 100 meters spacing was used within 5 kilometers of the fenceline, 250 meters spacing was used to 10 kilometers from the fenceline, and a 500 meters spacing was used to 15 kilometers from the fenceline. Beyond 15 kilometers, a 1,000 meters spacing was used to 25 kilometers distant. A 2,500 meters spacing was used to a distance of 50 kilometers. Figure 4 shows the location of the facilities as well as the receptor grid used. For clarity, receptors beyond 25 kilometers are not shown.

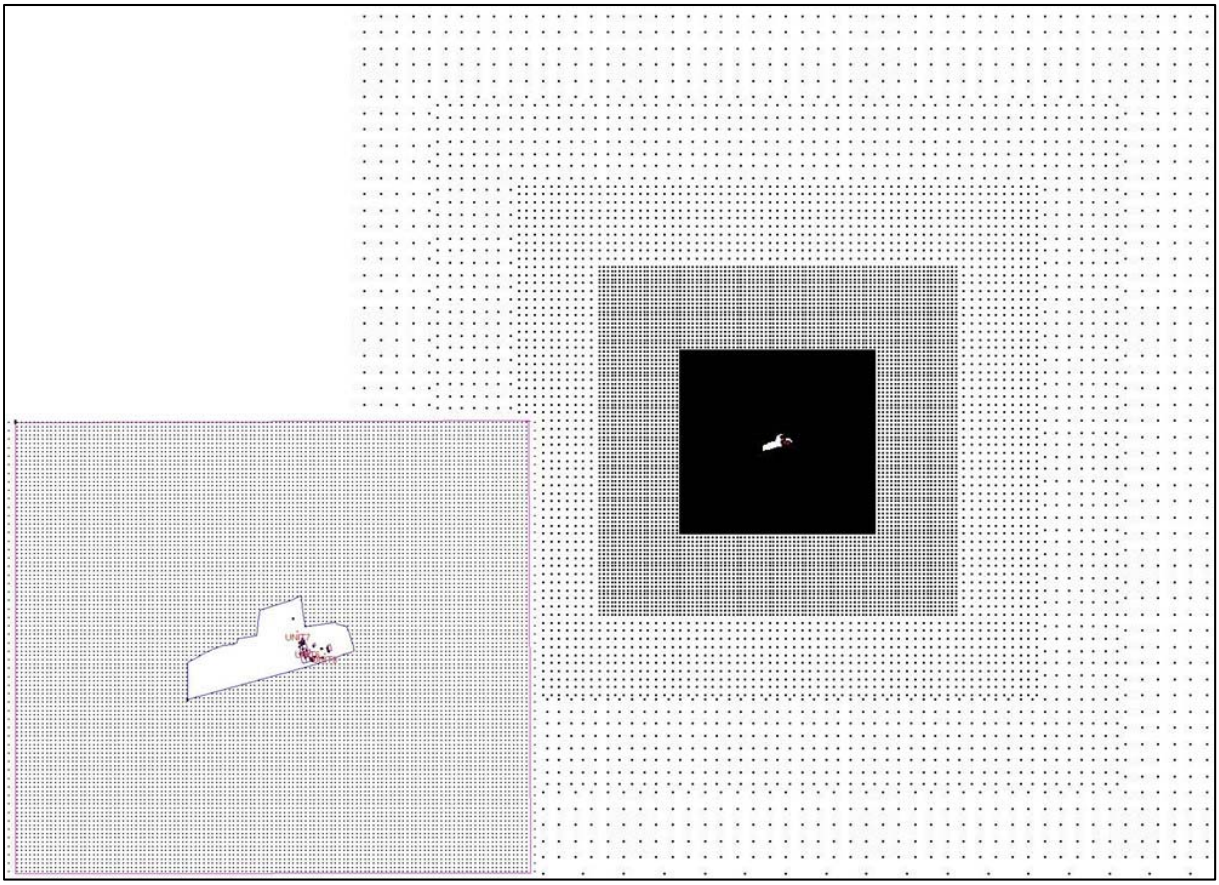

Figure 4: Miami Fort Station and receptor grid. Dense (50 meter) grid and fenceline, inset.

Results

The dispersion modeling analysis evaluated the impact of the Miami Fort Station facility as a design value when modeled using hourly variable SO_2 emissions. Any maximum impact exceeding 196.2 $\mu g/m^3$ would represent a modeled exceedance, inclusive of

background, which was included as a source in the modeling domain. For this analysis, the maximum modeled 3-year design value, years 2012-2014, was 159.08418 μg/m^3. Thus, no exceedance of the standard was modeled. The results of this analysis are shown in Figure 5. Note that for clarity, only design values of 145 μg/m^3 or greater are displayed.

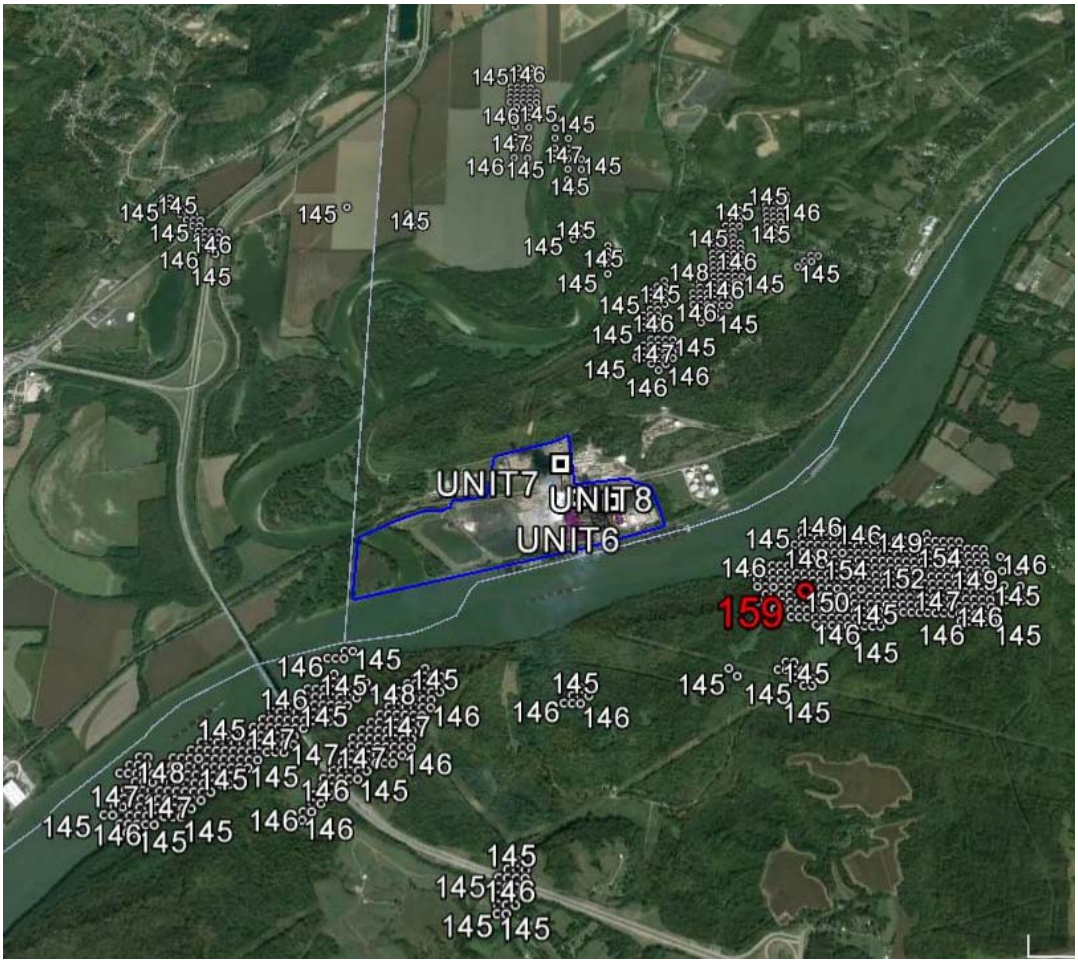

Figure 5: Maximum SO_2 impacts, Miami Fort Station, 2012-2014. Concentrations in μg/m^3, including background.

The maximum modeled concentration, 159.08418 μg/m^3, or 60.8 ppb including background, was modeled approximately 1.4 kilometers to the east-southeast of the Miami Fort fenceline. Modeled 3-year design values greater than or equal to 145 μg/m^3 did not extend beyond 4 kilometers from the modeled source. Beyond approximately 10 kilometers, concentrations become relatively uniform, as the design values are dominated by the peak hourly background (31.57 ppb) rather than the impact of emissions from the Miami Fort Station facility.

The dispersion modeling analysis for the designation of the area surrounding the Miami Fort Station facility inclusive of a conservative background demonstrates no modeled exceedances of the 2010 SO_2 standard based on the 2012-2014 period. Further,

dispersion modeling performed with the AERMOD model accounts for multiple aspects of the five-factor analysis emphasized by U.S. EPA in designating areas. As such, Ohio EPA asserts that the modeling results presented here should carry significant weight in the designation process.