Appendix P
Dispersion Modeling Analysis for Carmeuse Lime Maple Grove Facility
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 Carmeuse Lime Maple Grove source area. This document supports Ohio's recommended designation of the Carmeuse Lime Maple Grove 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 Carmeuse Lime Maple Grove 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 Carmeuse Lime and Stone for all SO_2 sources at the Carmeuse Lime Maple Grove 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), hourly SO_2 emissions for Carmeuse Lime Maple Grove were based on fuel usage and fuel sulfur content calculations. Only a single SO_2 source is present at the Carmeuse Lime Maple Grove 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. AERMOD and all associated preprocessors were run in the default regulatory mode.

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 #94830 located at the Toledo Express Airport (KTOL) 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 Seneca County, OH and the Carmeuse Lime Maple Grove 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.

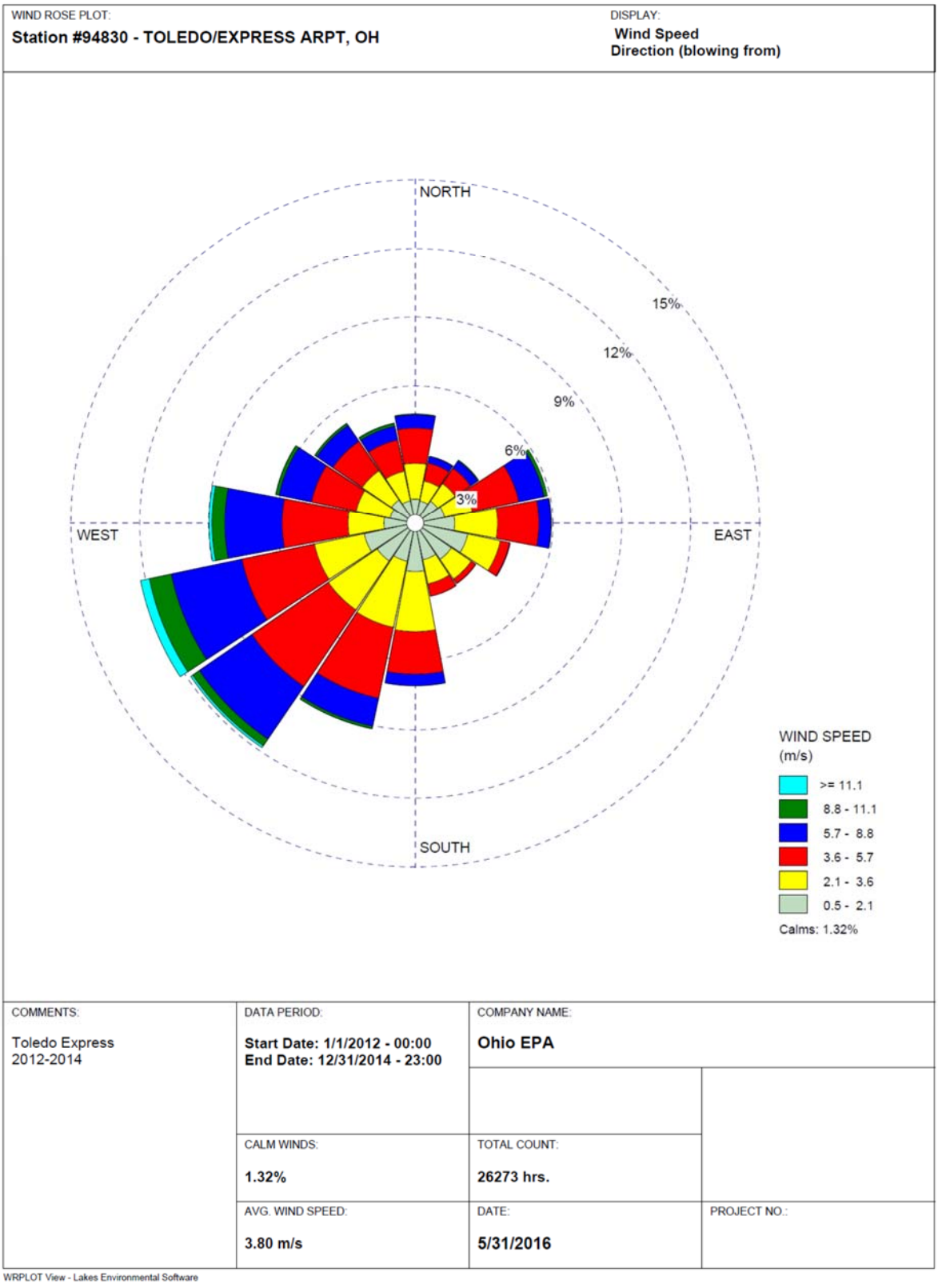

Figure 1: Wind roses, years 2012-2014, Toledo met station.

The predominant wind directions were used, in part, to inform which facilities within 50 kilometers may potentially impact ambient SO_2 concentrations in the Carmeuse Lime 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, with some degree of contribution from northeasterly winds. Figure 2 shows the location of all facilities within 50 kilometers of the Carmeuse Lime Maple Grove facility, as well as a composite wind rose, years 2012-2014, from the Toledo meteorological station.

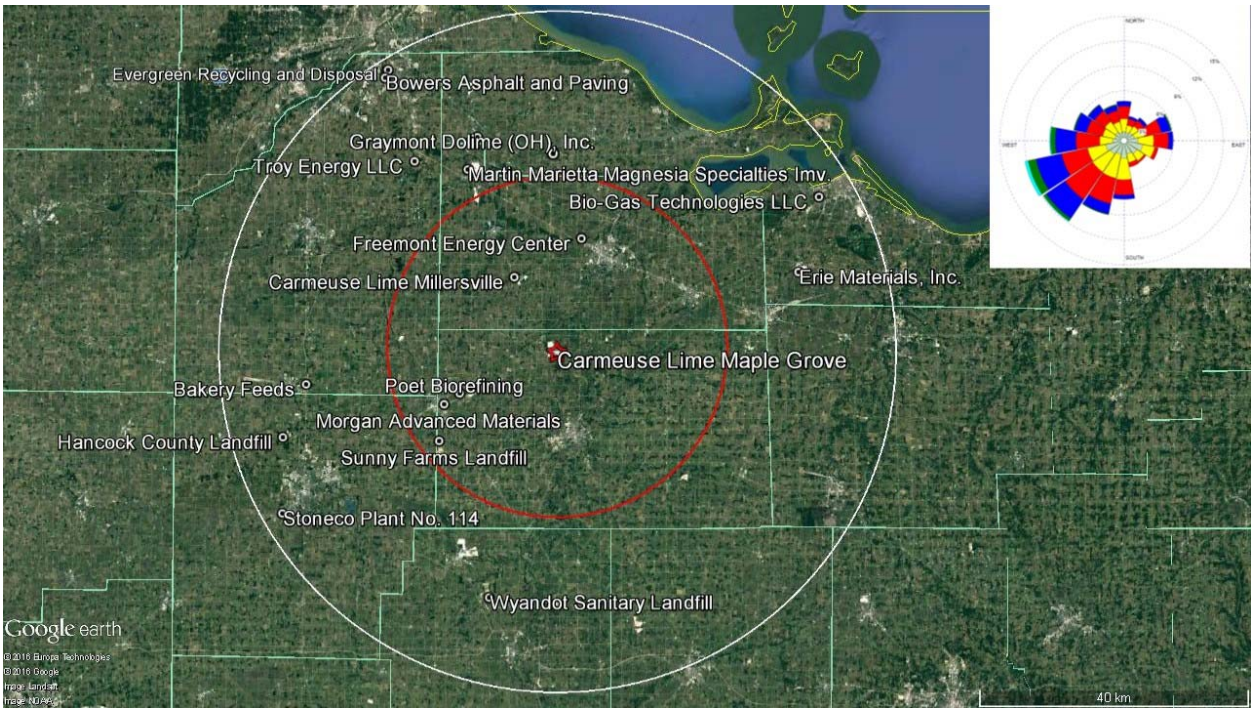

Figure 2: SO_2 sources in the Carmeuse Lime Maple Grove source area, with 2012-2014 composite wind rose.

Considering the predominant wind directions, Ohio does not conclude that the emissions from those sources located to the north and northwest of the Carmeuse Lime Maple Grove facility impact ambient SO_2 concentrations in the Carmeuse Lime Maple Grove source area. Ohio does not conclude that emissions from these sources impact ambient SO_2 concentrations beyond the background level accounted for in the refined dispersion modeling analysis, nor, given the emissions levels of the facilities and the considerable distance between these facilities and the Carmeuse Lime Maple Grove facility, are the combined emissions from these facilities likely to model an exceedance of the standard. Wind direction suggests that emissions from Sunny Farms Landfill could potentially impact ambient SO_2 concentrations. However, due to the significant distance, 22 kilometers, and low level of emissions, 318 TPY, it is highly unlikely this source has any significant impact. Regardless, Ohio EPA conservatively modeled this source to inform the modeled background in the source area.

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 fixed background concentration, informed in part by screen level modeling. This was done because there are no ambient air quality monitors located sufficiently close to the source area to allow a representative background to be determined from monitored data. The background utilized in this source area was 12 ppb, or 31.392 $\mu g/m^3$. Given the rural nature and approximately 80% agricultural land use in Seneca and surrounding counties, Ohio EPA contends that this background is extremely conservative.

Emission Sources

The singular SO_2 emission source at the Carmeuse Lime Maple Grove facility was included in the designation modeling analysis as a single egress point. This egress point represents the combined stack for the two rotary lime kilns at the Carmeuse Lime Maple Grove facility. Variable emissions for the egress point 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 background applied in the modeling domain. The relevant release point parameter for the singular egress point included in the analysis is presented in Table 1, below. This singular emissions source was included in the modeling as a point source.

	Source ID	Source Description	Easting (X)	Northing (Y)	Base Elevation	Stack Height	Temperature	Exit Velocity	Stack Diameter	SO2
			(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(lbs/hr)
Carmeuse Lime Maple Grove	KILN	Kiln 1 and 2 Stack	314903.67	4566022.93	217.09	60.3504	Variable	Variable	3.048	Variable

Table 1: Modeled source parameters, Carmeuse Lime source area, 2012-2014.

Table 2 presents 2014 SO_2 emissions for all sources greater than 1 TPY of SO_2 within 50 kilometers of the Carmeuse Lime Maple Grove facility. Seneca County and the surrounding region are primarily un-industrialized, agricultural counties. Ohio EPA considered all sources with 2014 SO_2 emissions greater than 1 TPY 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.

Based on the data shown in Table 2, explicitly modeled emissions from the Carmeuse Lime Maple Grove facility account for 59% of all SO_2 emissions within the 50-kilometer source area. Further, Ohio EPA, modeled emissions in a separate analysis of the Graymont Dolime and Martin Marietta Magnesia “cluster” source area, as described in the State of Ohio 2010 Revised Sulfur Dioxide National Ambient Air Quality Standard, Recommended Area Designations, Round 3 submittal. Therefore, Ohio EPA has explicitly modeled approximately 94%of all SO_2 emissions within the 50-kilometer source

area. This does not include the screen modeling of the Sunny Farms Landfill used to inform the background concentration included in the modeling analysis of the Carmeuse Lime Maple Grove facility.

Ohio EPA's experience in modeling for both the 1-hour SO_2 and NO_2 standards that sources located beyond 25 kilometers are unlikely to interact or contribute significantly to a concentration gradient. Those sources within 25 kilometers warrant further discussion. Figure 3 shows those sources with 2014 emissions greater than 1 TPY located within 25 kilometers of the Carmeuse Lime Maple Grove facility.

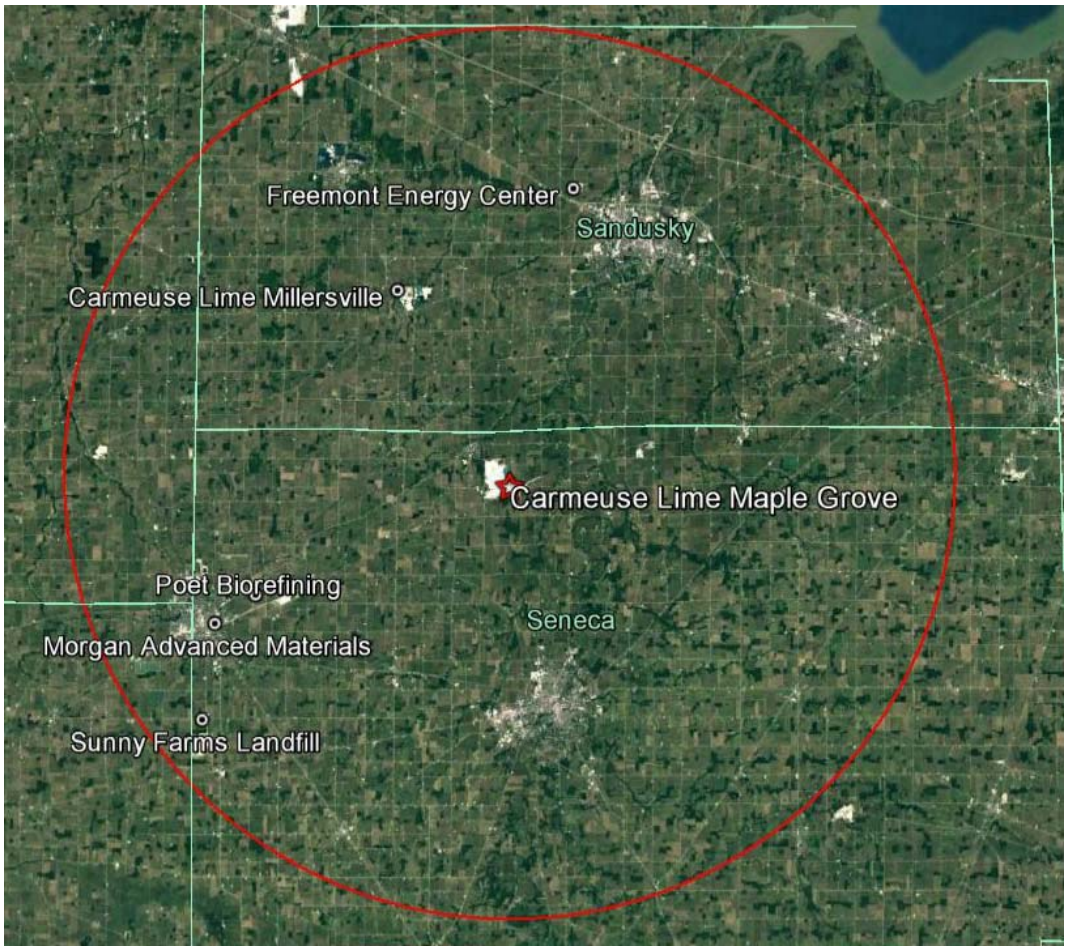

Figure 3: Sources within 25 km of the Carmeuse Lime Maple Grove facility.

Of the five sources located within 25 kilometers of the Carmeuse Lime Maple Grove facility, the largest, Sunny Farms Landfill (318 TPY), was modeled to determine a conservative background applied in the modeling analysis. Of the remaining sources, the Fremont Energy Center (63 TPY, 17 kilometers) and Carmeuse Lime Millersville (19 TPY, 12.5 kilometers), are located to the north and northwest of the Carmeuse Lime Maple Grove facility. Taking into account the predominant wind direction, low emissions, and distance between these sources and the Carmeuse Lime Maple Grove facility, it is highly

unlikely that these sources would together or individually contribute to a concentration gradient beyond what is accounted for in the conservative background applied in the modeling analysis. Poet Biorefining (1.16 TPY, 15 kilometers) and Morgan Advanced Materials (7.26 TPY, 18 kilometers) have very low emissions and located at sufficient distance that it is again unlikely that these sources will contribute to a concentration gradient beyond what is accounted for in background.

Based on an extensive analysis of emissions sources within 50 kilometers of the Carmeuse Lime Maple Grove source area, it was determined that the only source necessitating inclusion in the modeling analysis was the Carmeuse Lime Maple Grove facility and the remaining sources are represented via the background concentrations.

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from Carmeuse Lime Maple Grove (km)
OH	Seneca	0374000010	Carmeuse Lime, Inc. - Maple Grove Operations	4,438	--
OH	Seneca	0374010199	Sunny Farms Landfill	318.46	22
OH	Seneca	0374010109	Morgan Advanced Materials	7.26	18
OH	Seneca	0374010235	Poet Biorefining Fostoria	1.16	15
			Seneca Total	***4,764.88***	
OH	Sandusky	0372000081	Carmeuse Lime Inc Millersville Operations	18.96	12.5
OH	Sandusky	0372000127	Martin Marietta Magnesia Specialties Inc.	1809.86	30
OH	Sandusky	0372030241	AMP Fremont Energy Center	62.74	17
			Sandusky Total	***1,891.56***	
OH	Wyandot	0388000039	Wyandot Sanitary Landfill	1.68	37
			Wyandot Total	***1.68***	
OH	Hancock	0332010095	Hancock County Landfill	1.43	42
OH	Hancock	0664980009	Stoneco Plant No. 114	1.42	46
			Hancock Total	***2.85***	
OH	Ottawa	0362000079	Graymont Dolime (OH), Inc.	809.7	33.6
OH	Ottawa	0362000009	Materion Brush Inc.	15.2	29
OH	Ottawa	0362010118	Port Clinton Landfill	2.63	36
			Ottawa Total	***827.55***	
OH	Wood	0387040084	Bower's Asphalt and Paving, Inc.	3.65	48
OH	Wood	0387000386	Bakery Feeds	3.62	37

State	County	Facility ID	Facility Name	2014 SO2 Emissions (TPY)	Distance from Carmeuse Lime Maple Grove (km)
OH	Wood	0387000377	Troy Energy, LLC	2.82	35
OH	Wood	0387000259	Evergreen Recycling	2.12	48
			Wood Total	***12.21***	
OH	Erie	0322000295	Bio-Gas Technologies, LTD	8.09	44
OH	Erie	0322020211	Erie Materials, Inc.	7.78	37
			Erie Total	***15.87***	
			Grand Total within 50 km of Carmeuse Lime	***7,516.61***	

Table 2: SO2 sources and 2014 emissions within 50 km of Carmeuse Lime Maple Grove.

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 Carmeuse Lime Maple Grove facility.

Receptors

A total of 19,337 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 Carmeuse Lime Maple Grove facility, and a 50 meters spacing to 1.5 kilometers from these fenceline was used. 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 2.5 kilometers of the fenceline, 250 meters spacing was used to 5 kilometers from the fenceline, and a 500 meters spacing was used to 10 kilometers from the fenceline. Beyond 10 kilometers, a 1,000 meters spacing was used to 25 kilometers distant. 2,500 meter 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.

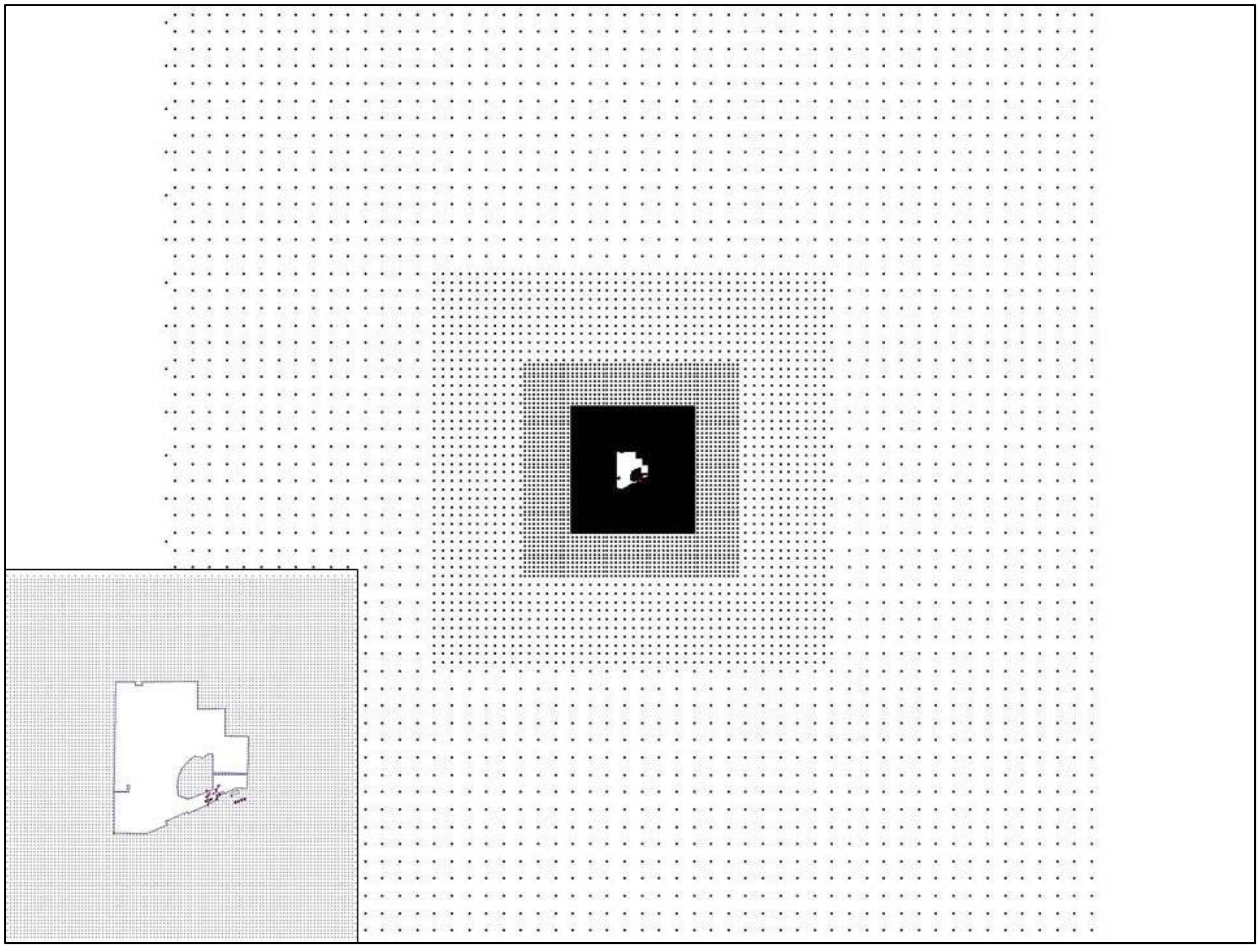

Figure 4: Carmeuse Lime Maple Grove facility and receptor grid. Dense (50 meter) grid and fencelines, inset.

Results

The dispersion modeling analysis evaluated the impact of the Carmeuse Lime Maple Grove 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 146.01914 $\mu g/m^3$. 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 125 $\mu g/m^3$ or greater are displayed.

Figure 5: Maximum SO_2 impacts, Carmeuse Lime Maple Grove facility, 2012-2014. Concentrations in μg/m³, including background.

The maximum modeled concentration, 146.01914 μg/m³, or 55.8 ppb including background, was modeled approximate 360 meters to the east of the Carmeuse Lime fenceline, approximately 850 meters from the Carmeuse Lime egress point, the singular source modeled in this analysis. Modeled 3-year design values greater than or equal to 125 μg/m³ did not extend beyond 1.3 kilometers from the modeled source.

The dispersion modeling analysis for the designation of the area surrounding the Carmeuse Lime Maple Grove 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.