SULFUR DIOXIDE DISPERSION MODELING ANALYSIS

USG Interiors - Walworth, Wisconsin
January 2017

INTRODUCTION

On August 21, 2015 the United States Environmental Protection Agency (USEPA) issued the final Data Requirements Rule for the 2010 1-hour Sulfur Dioxide (SO_2) National Ambient Air Quality Standard (NAAQS). On April 12, 2016, USEPA notified the Wisconsin Department of Natural Resources (WDNR) that USG Interiors, LLC - Walworth (USG-Walworth) facility required further air quality characterization under the rule. Based upon the dispersion modeling protocol submitted to USEPA on July 1, 2016, WDNR characterized the ambient SO_2 concentrations around USG-Walworth using air quality dispersion modeling. The analysis used the regulatory dispersion model AERMOD (AMS/EPA Regulatory Model) following the methods outlined and the input parameters listed.

AREA CHARACTERIZATION

USG-Walworth is located in the Village of Walworth, in southern Walworth County, Wisconsin, bordering the State of Illinois. Walworth is located in south central Wisconsin approximately 90 kilometers southeast of Madison. The climate of Walworth is characterized by variable weather patterns with a large seasonal temperature range and moderate amounts of precipitation. The terrain in Walworth County is generally flat with rolling hills extending to the east and southeast with local relief 150'-200' above the elevation of USG.

MODEL & METEOROLOGY

WDNR used the current regulatory version (16216) of AERMOD in the dispersion modeling analysis, with the regulatory default options. The area around USG-Walworth consists primarily of residences, with some commercial property. Following the *Guideline on Air Quality Models (40 CFR Part 51, Appendix W, USEPA, December 2016)*, an assessment of the land use around USG-Walworth shows that less than 50% of the land area within 3 kilometers is industrial, commercial, or dense residential. Therefore, rural dispersion coefficients were used in AERMOD.

Meteorological data was processed from 2011-2015 Dane County Regional Airport (KMSN) surface data with Green Bay upper air data. The meteorological data was processed with AERMET (16216). The KMSN surface wind data is 2-minute average speed and direction, reported each minute. This minute-based wind information was processed with AERMINUTE. Processing used an anemometer height of 10.0 meters above ground.

To address concerns regarding potential under prediction of the surface friction velocity (u*) during low-wind, stable conditions that could contribute to over prediction of ambient air impacts by AERMOD, USEPA developed the ADJ_U* option in the AERMET processor. The regulatory default ADJ_U* option in AERMET produces more representative modeled concentrations in AERMOD when high modeled concentrations are likely to occur under low wind, stable conditions, such as for a tall stack located near complex terrain, and was used in this analysis.

The instrumentation tower at KMSN is 90 kilometers northwest of USG-Walworth and the data collected is considered representative of meteorological conditions around the facility. The Dane County Regional Airport is northeast of the City of Madison and is surrounded by small farm fields and wetlands, similar to the land cover around USG-Walworth. The Chicago-Rockford International Airport is 56 kilometers southwest of USG-Walworth, but the airport is within the much larger city of Rockford and both surface characteristics and dispersion parameters are not representative. The Southern Wisconsin Regional Airport (KJVL), the Burlington Municipal Airport (KBUU), and the Waukesha County Airport (KUES) are not considered to be representative as none use the same quality of equipment as KMSN or KRFD, they do not report wind information by the minute, and they have high numbers of missing or calm hours.

Surface characteristics around KMSN were generated using AERSURFACE following the methods described in the *AERMOD Implementation Guide.* Specifically, snow cover for each month during the period 2011-2015 was derived from National Snow Analyses maps from the National Operational Hydrologic Remote Sensing Center. AERSURFACE was run both for snow and no-snow conditions. The albedo, Bowen ratio, and surface roughness were adjusted based on the number of days with snow cover during each month. Also as detailed in the *AERMOD Implementation Guide*, soil moisture conditions for each meteorological data year were based on the monthly Palmer Drought Severity Index for the area as obtained from the National Centers for Environmental Information.

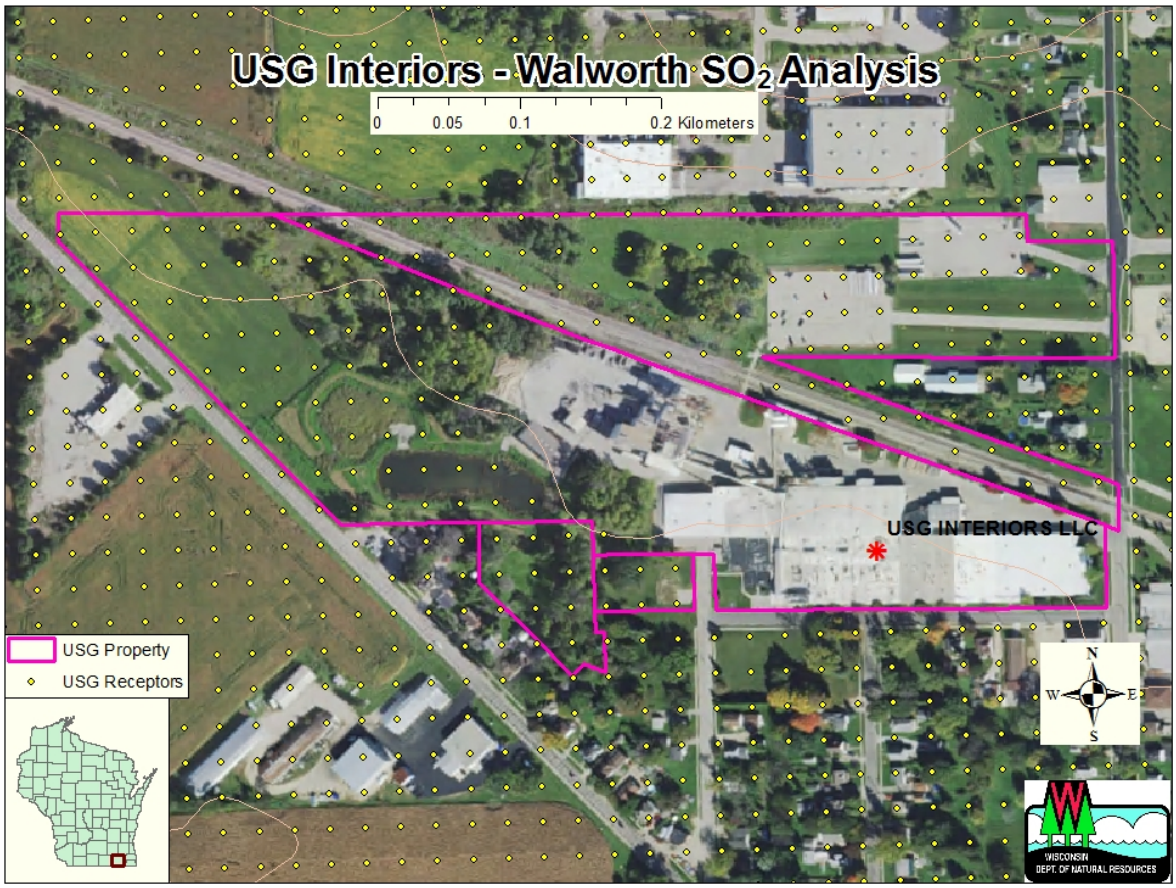
RECEPTOR GRID

The receptor grid used in the analysis consists of a series of nested rectangular grids with terrain derived from AERMAP using National Elevation Dataset information:

- 25 meter spacing to 700 meters from the center of the facility
- 50 meter spacing to 1200 meters from the center of the facility
- 100 meter spacing to 10 kilometers

Individual receptors located inside the fence line of USG-Walworth, or those not considered ambient air, were removed from the modeling analysis. Figure 1 shows the property line of USG-Walworth along with the as-modeled, ambient air receptor grid.

Figure 1 – USG Walworth Property and Receptor Grid

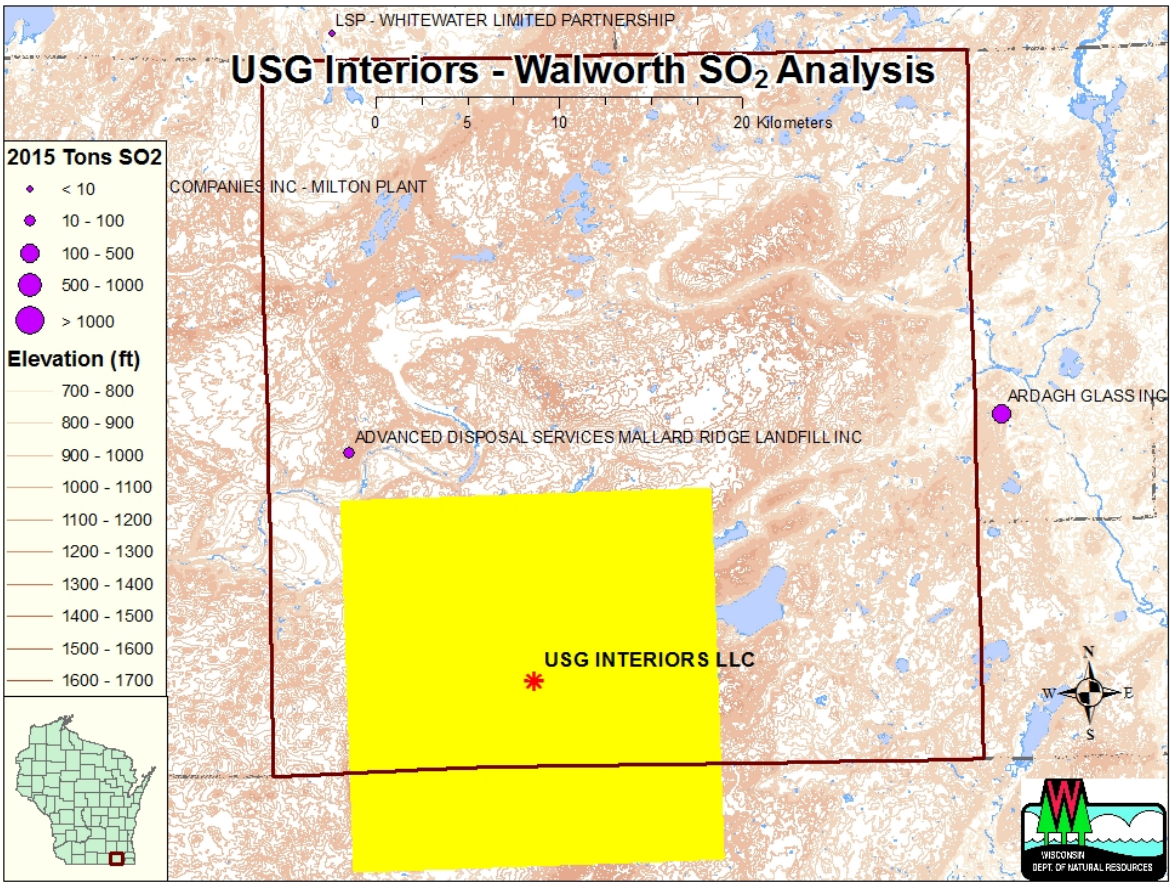


EMISSIONS INVENTORY

USG-Walworth produces mineral fiber and acoustical ceiling tiles. In addition to manufacturing tiles onsite, some of the mineral wool fiber is transported to a sister facility for tile production. The facility was initially constructed in the late 1950s and was expanded in 1987 with the addition of a second tile production line. The mineral fiber operation consists of fiber formation and collection equipment. Metallurgical coke is the primary fuel and is a source of SO_2 emissions along with sulfur in the raw materials. These exhaust from the cupola stack after being combusted in a thermal oxidizer that is used to destroy carbon monoxide and reduced sulfur compounds. Fiber collection occurs in a blow chamber that exhausts a small fraction of SO_2 emissions through three filters. USG-Walworth is the largest SO_2 emission source within Walworth County. All sources of SO_2 emissions at USG-Walworth were considered in this analysis.

Advanced Disposal Services Mallard Ridge Landfill is located approximately 16 kilometers northwest of USG-Walworth. The facility reported SO_2 emissions of 19 tons in 2015 from engine and flare stacks. Regulatory dispersion modeling shows that Mallard Ridge is affected by downwash and the maximum impact from the stacks is close to the facility. Since the impact of Mallard Ridge is not in the vicinity of USG-Walworth and the emissions are small, the impact of Mallard Ridge is assumed to be part of the background concentration. Figure 2 shows the SO_2 emission sources in Walworth County along with the modeled receptor grid (in yellow).

Figure 2 – Walworth County SO_2 Emission Sources



INPUT PARAMETERS

Modeled stack parameters and building downwash data for USG-Walworth were taken from the most recent WDNR analysis for the facility, with additional information provided by the facility, including information for a new, taller cupola stack (S12). BPIP-PRIME was used to produce the building downwash information from facility provided plot plans.

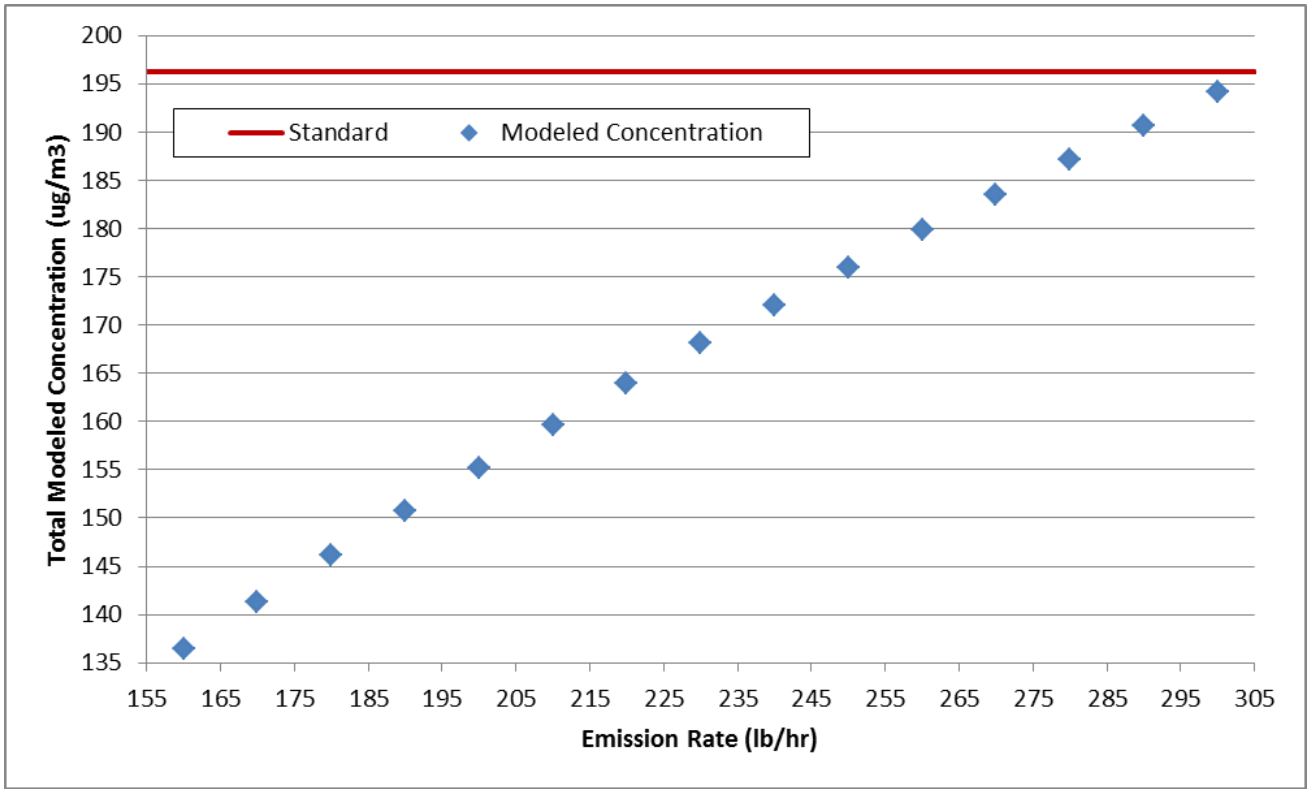
Operating Condition (Load) Analysis

To determine the worst-case operating conditions, emission rate and air flow rate were calculated for a variety of operating conditions. The total SO_2 emissions from the process are primarily vented through the cupola stack S12, with a small percentage passing through the blow chamber stacks S21, S22, and S24. As the facility generates more fiber, fuel and material inputs increase such that more air is needed for combustion and thermal oxidizer operation. The blow chamber stacks have set air flow rates but as the air flow increases from S12, so does atmospheric dispersion, and this can mitigate the increase of emission due to the higher process inputs.

WDNR staff calculated emission rates and airflow rates in matched sets and each scenario was modeled assuming 4.6% of the material passing to the blow chamber stacks. The main cupola stack (S12) and the blow chamber stacks (S21, S22, S24) were analyzed for each set of conditions on a subset of the full receptor grid, using the full five-year meteorological data and background concentrations. The results of this load analysis are listed in the table and plotted in Figure 3.

USG INTERIORS – WALWORTH Operating Scenario (Load) Analysis Inputs		
Total SO_2 Rate (lb/hr)	Flow Rate (acfm)	Concentration Including Background ($\mu g/m^3$)
160	12006	136.4
170	12798	141.3
180	13590	146.1
190	14382	150.7
200	15174	155.2
210	15966	159.6
220	16758	163.9
230	17550	168.1
240	18341	172.1
250	19100	175.9
260	19925	179.8
270	20717	183.5
280	21509	187.1
290	22301	190.7
300	23093	194.2

Figure 3 – Modeled Concentration at Various Operating Conditions



Based on the results of the operating scenario (load) analysis, the maximum emission rate scenario has the highest impact and is used in this analysis. The modeled emission rate of 301.3 lb/hr for the mineral wool process was distributed between the cupola stack S12 (95.4%) and the three blow chamber stacks (4.6%), with the specific emission to S21, S22, and S24 weighted by air flow. The remaining sources analyzed represent various natural gas ovens and heating units with the SO_2 rates based on maximum theoretical emissions.

USG INTERIORS – WALWORTH
Point Source Stack Parameters & Emission Rates

ID	LOCATION (UTM83)	HEIGHT (M)	HEIGHT (ft)	DIAM (M)	VELOCITY (M/S)	TEMP (K)	SO_2 Rate (#/HR)
S12	368317, 4710690	53.34	175.0	0.9144	16.67 (23196 acfm)	412.4	287.44
S21	368300, 4710653	15.54	51.0	1.34	15.71	341.9	3.63
S22	368322, 4710643	16.76	55.0	1.34	17.54	341.9	4.06
S24	368285, 4711645	15.24	50.0	1.68	17.09	341.9	6.17
Total Mineral Wool Process Emissions							**301.3**
S11V	368454, 4710527	9.45	31.0	0.508	6.99	477.6	0.00841
S25	368448, 4710565	7.62	25.0	0.610	3.23	477.6	0.000706
S26	368446, 4710573	7.62	25.0	0.610	3.23	477.6	0.000706
S138B1A	368429, 4710541	10.36	34.0	0.369	14.27	455.4	0.00647
S138A1B	368448, 4710542	10.36	34.0	0.369	14.27	455.4	0.00647
S137B2A	368460, 4710541	10.36	34.0	0.369	14.27	455.4	0.00647
S137A2B	368473, 4710540	10.36	34.0	0.369	14.27	455.4	0.00647
S136B3A	368480, 4710537	10.36	34.0	0.482	8.37	455.4	0.00647
S136A3B	368501, 4710541	9.75	32.0	0.508	7.49	455.4	0.00647
S135B4A	368510, 4710536	15.85	52.0	0.469	8.71	455.4	0.00647
S131514A	368519, 4710543	15.85	52.0	0.469	8.71	455.4	0.00647
S135A4B	368534, 4710535	15.85	52.0	0.469	8.71	455.4	0.00647
S1315A4B	368545, 4710542	15.91	52.0	0.469	8.71	455.4	0.00647

BACKGROUND CONCENTRATION

The closest representative monitoring location to USG-Walworth is the Horicon (Dodge County) monitor located 100 kilometers north of the facility. There are no major (100 tons per year) SO_2 sources within 50 kilometers of the Horicon site, which uses high sensitivity equipment to detect low SO_2 concentrations. The modeling analysis includes all known major point sources of SO_2 within 30 kilometers of USG-Walworth, and the monitor location is similarly affected by distant SO_2 sources (in central, southern, and eastern Wisconsin). Nationally, the SO_2 impact from mobile sources has been minimized with the advent of lower sulfur fuel and improved emission control technology, so the local impact from this sector is small and included in the background concentration.

Following the methodology in the 2016 *SO_2 NAAQS Designations Modeling Technical Assistance Document*, temporally varying background monitored concentrations were developed from the 2013-2015 Horicon SO_2 data. The 2016 *Modeling Technical Assistance Document* references calculating background concentrations by hour of day and season as noted in the earlier March 1, 2011 memorandum, *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 Ambient Air Quality Standard*. When calculating the hour of day and season background values, the selected value should represent the ranked percentile of the standard. However, the March 2011 *Clarification* memo also discusses calculating background concentrations by hour of day and month but using a higher ranked value such as the maximum in each period. Using the maximum average 2013-2015 hour of day and month concentration is more conservative than using the 99^{th} percentile values. In addition, using hour of day and month values addresses questions about the seasonal AERMOD definition of winter months.

MODELING RESULTS

The impact of USG-Walworth in relation to the 2010 1-hour SO_2 NAAQS is calculated for the worst-case, maximum emission scenario with all stacks operating. The default option in AERMOD was selected and results compiled consistent with the form of the 1-hr SO_2 NAAQS, i.e. the five year average of the fourth highest daily max-hour, plus background, was computed for each receptor and compared with the standard.

The result from the analysis shows concentrations below the NAAQS for the worst-case, and thus for all, operating scenarios. The maximum impact location is off property, approximately 300 meters northeast of the stacks and about 100 meters north of the USG Interiors property in a commercial/warehouse area. Results are presented both in micrograms per cubic meter ($\mu g/m^3$) and in parts per billion (ppb), assuming a conversion factor (1 atm, 20^o C) of 1 ppb = 2.616 $\mu g/m^3$.

USG INTERIORS – WALWORTH **Modeling Results**		
	Maximum 1-Hour SO_2 ($\mu g/m^3$)	Maximum 1-Hour SO_2 (ppb)
Total Impact	194.5	74.35
NAAQS	196.2	75

CONCLUSION

The impact of the SO_2 sources in Walworth County is not predicted to result in a violation of the 1-hour SO_2 NAAQS in any part of the county. USG Interiors, the main source of SO_2 in the county, was explicitly modeled following the procedures in the *Guideline on Air Quality Models (40 CFR Part 51, Appendix W, USEPA, December 2016)* and the *SO_2 NAAQS Designations Technical Assistance Documents (USEPA, August 2016).* The other smaller sources of SO_2 emissions in the county were appropriately considered in the selected background concentration or otherwise demonstrated to have a small impact relative to USG Interiors. This analysis therefore supports the designation of Walworth County, Wisconsin as attainment for the 1-hour SO_2 NAAQS.