

SULFUR DIOXIDE DISPERSION MODELING ANALYSIS

Wisconsin Power and Light Edgewater Generating Station - Sheboygan, 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 (SO₂) National Ambient Air Quality Standard (NAAQS). On January 15, 2016, the Wisconsin Department of Natural Resources (WDNR) identified Wisconsin Power and Light's Edgewater Generating Station (WPL-Edgewater) as requiring further air quality characterization under the rule. Based upon the dispersion modeling protocol submitted to USEPA on July 1, 2016, WDNR characterized the ambient SO₂ concentrations around WPL-Edgewater 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

WPL, a utility subsidiary of Alliant Energy Corporation, operates the Edgewater Generating Station which is located in the southern part of the City of Sheboygan, adjacent to Lake Michigan in Sheboygan County, Wisconsin. Sheboygan is located in east central Wisconsin approximately 50 kilometers north-northeast of Milwaukee. The climate of Sheboygan is characterized by variable weather patterns with a large seasonal temperature range and moderate amounts of precipitation. Temperature extremes are ameliorated by proximity to Lake Michigan, with its attendant lake and land breeze circulations. The terrain in Sheboygan County is generally flat, except in the western portion of the county (approximately 30 kilometers west of the City of Sheboygan) where local relief is 500'-600' above the elevation of Lake Michigan.

MODEL & METEOROLOGY

WDNR used the current regulatory version (16216) of AERMOD in the dispersion modeling analysis, with the regulatory default options. The area around WPL-Edgewater consists primarily of water (Lake Michigan), commercial property, residences, and the Sheboygan Wastewater Treatment Plant. Following the *Guideline on Air Quality Models (40 CFR Part 51, Appendix W, USEPA, December 2016)*, an assessment of the land use around WPL-Edgewater 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 2013-2015 Sheboygan County Memorial Airport (KSBM) surface data with Green Bay upper air data. The meteorological data was processed with the regulatory options in AERMET (16216). The surface wind data at KSBM 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 KSBM is 13 kilometers northwest of WPL-Edgewater and is the closest station that records wind speed and direction each minute. The data collected is considered representative of meteorological conditions around the facility. The Sheboygan County Memorial Airport is west of the City of Sheboygan and is surrounded by small farm fields and wetlands. The climate of the area is dominated by the lake breeze circulation developed by Lake Michigan, and with no geographic features in between WPL-Edgewater and the airport, the wind patterns will be similar between the sites.

Surface characteristics around KSBM were generated using AERSURFACE following the methods described in the *AERMOD Implementation Guide*. Specifically, snow cover for each month during the period 2013-2015 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:

- 50 meter spacing to 1000 meters from the stacks
- 100 meter spacing to 10 kilometers
- Due to the higher terrain in western Sheboygan County, additional 100-meter spaced points were placed extending to 35 km west of the facility

Individual receptors were removed where monitor placement is not feasible, following the recommendations in the *SO₂ NAAQS Designations Modeling Technical Assistance Documents (USEPA, August 2016)*. Receptors located inside the fence line of WPL-Edgewater, or are otherwise not considered ambient air, were removed from the modeling analysis. In addition, using WDNR geographic information service (GIS) data, receptors located over water bodies, including Lake Michigan, were also removed from the modeling analysis.

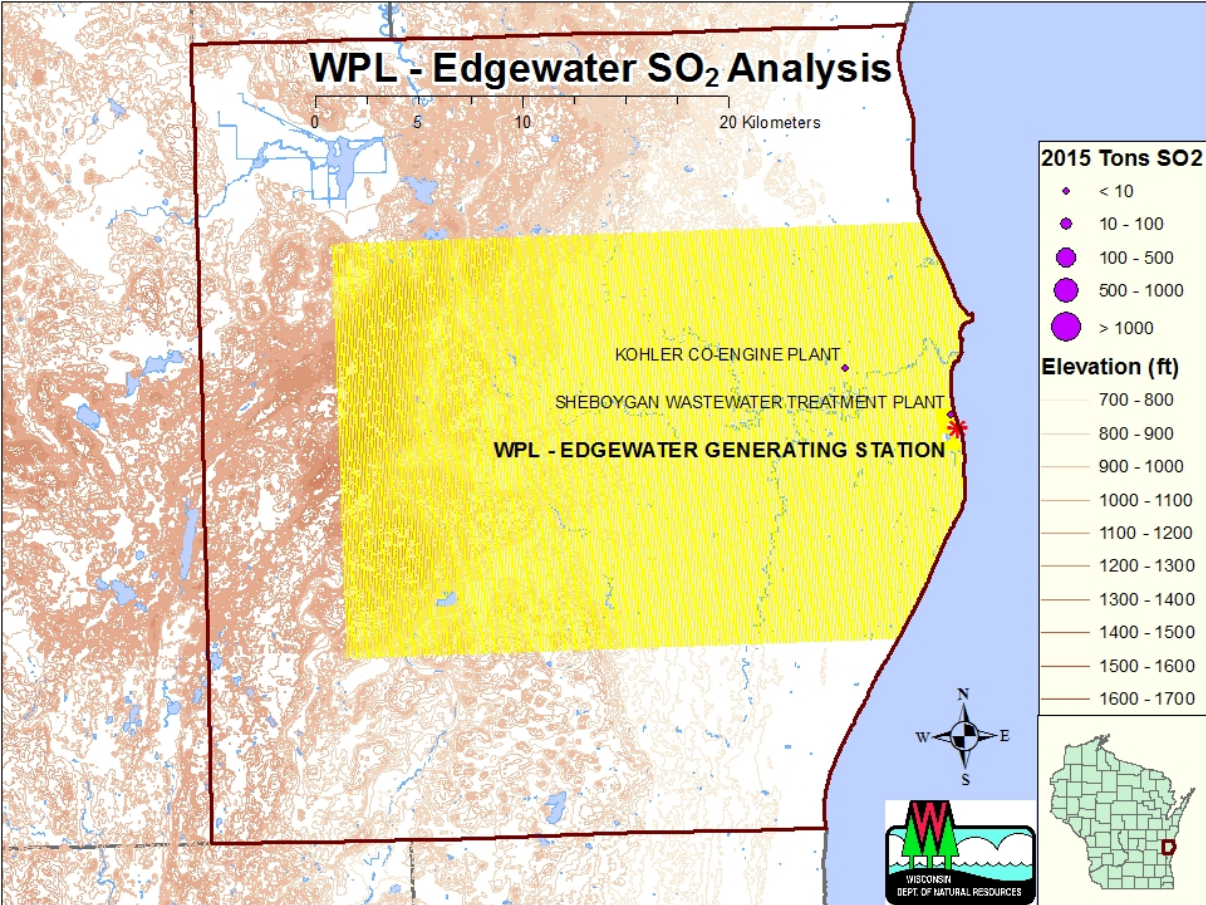
EMISSIONS INVENTORY

WPL-Edgewater is a base load electrical generating facility with nominal capacity of 770 megawatts that began operation during the 1930's. The facility consists of two pulverized subbituminous coal fired boiler/generator sets, with maximum rated heat capacity of 3,529 million British Thermal Units per hour (MMBtu/hr) for Unit 4, and 4,366 MMBtu/hr for Unit 5. A smaller Unit 3 was retired at the end of December 2015. Beginning January 1, 2017, Unit 4 will be limited by federally enforceable conditions to 4.07 pounds of SO₂ per MMBtu (lbs/MMBtu) over a 24-hour average and 0.700 lbs/MMBtu over a 12-month average. Also beginning January 1, 2017, Unit 5 will be limited to 0.075 lbs/MMBtu of SO₂ over a 30-day rolling average. WPL-Edgewater is the largest SO₂ emission source within Sheboygan County. There are no other SO₂ emitting sources at WPL-Edgewater other than the two coal boilers, Unit 4 and Unit 5.

The Sheboygan Wastewater Treatment Plant (WWTP) shares the northern property line of WPL-Edgewater. The facility digests municipal liquid waste and combusts the gas in micro-turbines to produce small amounts of electricity. The Sheboygan WWTP does not currently hold any air pollution control permits as emissions are small, but the emissions are reported to the Wisconsin air emissions inventory. The reported SO₂ emission in 2015 was approximately 4 tons for the entire facility. The micro-turbines were reported to operate regularly throughout the year. The maximum impact of Sheboygan WWTP will not occur in the same location as the maximum impact of WPL-Edgewater, but will be in the vicinity of WPL-Edgewater itself; therefore the emissions will be included in this analysis.

Kohler Company’s Engine Plant, located 6 kilometers northwest of WPL-Edgewater, manufactures engines ranging in size from 23-40 horsepower. These small engines are tested while using natural gas, propane, or unleaded gasoline. The reported SO₂ emission in 2015 was approximately 0.7 tons for the facility. Regulatory dispersion modeling for the Kohler Engine Plant shows that maximum modeled impacts are close to the facility, not in the vicinity of WPL-Edgewater. Due to the amount of emission and the distance between facilities, the impact of the Kohler Engine SO₂ emissions is assumed to be included in the background concentration. Figure 1 shows the SO₂ emission sources in Sheboygan County along with the modeled receptor grid (in yellow).

Figure 1 – Sheboygan County SO₂ Emission Sources



INPUT PARAMETERS

Modeled stack parameters and building downwash data for WPL-Edgewater were taken from the most recent WDNR analysis for the facility, with additional information provided by WPL. Modeled emission rates for Unit 4 (S11) reflect actual hourly operation for the period 2013-2015, with emission rate, exit gas velocity, and exit gas temperature entered for each hour. Data for S11 was obtained from the continuous emissions monitors at WPL-Edgewater and examined for completeness in conjunction with WPL. Modeled emission rates for Unit 5 (S12) reflect both the highest potential short-term hourly rate corresponding to the maximum heat input, and the normal or typical scenario corresponding to the most common heat input. WPL-Edgewater is a base load plant, so there are minimal variations in the heat input throughout the year. For each S12 modeled scenario (maximum and normal), the representative exhaust gas flow rate and temperature were used. BPIP-PRIME was also used to produce the building downwash information from facility provided plot plans.

The federally enforceable emission limit for WPL-Edgewater Unit 5 (S12) as of January 1, 2017 is based on the 30-day average of 0.075 lbs/MMBtu. To conservatively estimate a comparable hourly emission rate, the method outlined in Appendix B of the *Guidance for 1-Hour SO2 Nonattainment Area SIP Submissions (USEPA, Apr 23, 2014)* was followed. WPL partially owns and operates the Columbia Energy Center (WPL-Columbia) in Columbia County, Wisconsin. The two coal units at WPL-Columbia are comparable in size and age to Unit 5 at WPL-Edgewater, and both Columbia units have limitations on their SO₂ emissions identical to Edgewater. Both WPL-Columbia units also have the same type of SO₂ emission control as WPL-Edgewater Unit 5 (S12) and both WPL-Columbia units have been meeting the emission limitation since January 1, 2015 or earlier. From the 2015 emission data captured on the continuous emission monitors at WPL-Columbia, the 99th percentile of the hourly mass (pounds) value was divided by the 99th percentile of the 30-day average hour mass (pounds) value for both units. The ratios for each unit were calculated separately and the higher ratio was determined to be 5.0. The WPL-Edgewater S12 30-day emissions limit of 0.075 lbs/MMBtu was multiplied by 5.0 resulting in a maximum hourly emission rate estimate of 0.375 lbs/MMBtu (0.075 * 5.0 = 0.375). This value was then used in both the maximum and normal model scenarios to calculate a representative, conservative estimate of potential hourly emissions from WPL-Edgewater S12 based on boiler heat input.

WPL EDGEWATER - SHEBOYGAN Point Source Stack Parameters & Emission Rates							
ID	LOCATION (UTM83)	HEIGHT (M)	HEIGHT (ft)	DIAM (M)	VELOCITY (M/S)	TEMP (K)	SO ₂ Rate (#/HR)
S11	443193, 4840499	167.03	548.0	5.18	Hourly CEM Data Will Be Used		
S12Max	443063, 4840702	167.03	548.0	5.49	33.57	348.4	1637
S12Norm	443063, 4840702	167.03	548.0	5.49	30.22	347.0	1410
Sheboygan WWTP							
S03A*	442929, 4840825	9.632	31.6	0.3566	2.362	422.0	0.08
S03B*	442929, 4840823	9.632	31.6	0.3566	2.362	422.0	0.08
S04A	442932, 4840836	4.877	16.0	0.3048	21.11	533.2	0.16
S04B	442934, 4840836	4.877	16.0	0.3048	21.11	533.2	0.16
S05A	442917, 4840836	4.877	16.0	0.3048	24.62	533.2	0.14
S05B	442925, 4840836	4.877	16.0	0.3048	24.62	533.2	0.14

*Obstructed stacks modeled as POINTCAP source type

Modeled stack parameters for Sheboygan WWTP were derived from emission submittals from the facility and verified by the facility. Reported yearly emissions are consisted across the 2013-2015 period. Modeled hourly rates for each regularly operated source were calculated by dividing the yearly mass by the reported hours of operation in each year 2013, 2014, and 2015, then averaging the hourly rates by stack.

BACKGROUND CONCENTRATION

The closest representative monitoring location to WPL-Edgewater is the Horicon (Dodge County) monitor located 50 kilometers southwest of the facility. WPL-Edgewater is the only major (100 tons per year) SO₂ source within 50 kilometers of the Horicon site, which uses high sensitivity equipment to detect low SO₂ concentrations. The modeling analysis includes all known major point sources of SO₂ within 50 kilometers of WPL-Edgewater, and the monitor location is similarly affected by distant SO₂ sources (in central, southern, and eastern Wisconsin). Nationally, the SO₂ 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 *SO₂ NAAQS Designations Modeling Technical Assistance Document*, temporally varying background monitored concentrations were developed from the 2013-2015 Horicon SO₂ data. The 2016 *Modeling Technical Assistance Document* references calculating 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 values, the selected value should represent the ranked percentile of the standard. However, the March 2011 *Clarification* memo also discusses calculating 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 99th percentile values. In addition, using hour of day and month values addresses questions about the seasonal definition of winter months in AERMOD.

MODELING RESULTS

The impact of WPL-Edgewater in relation to the 2010 1-hour SO₂ NAAQS is calculated for each S12 scenario (maximum and normal) with all other sources operating. The regulatory option in AERMOD was selected and results compiled consistent with the form of the 1-hr NAAQS, i.e. the three 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 3.2 kilometers northwest of WPL-Edgewater in a commercial area. Results are presented both in micrograms per cubic meter (µg/m³) and in parts per billion (ppb), assuming a conversion factor (1 atm, 20° C) of 1 ppb = 2.616 µg/m³.

WPL-EDGEWATER (SHEBOYGAN)				
Modeling Results				
	Maximum Scenario 1-Hour SO ₂ (µg/m ³)	Maximum Scenario 1-Hour SO ₂ (ppb)	Normal Scenario 1-Hour SO ₂ (µg/m ³)	Normal Scenario 1-Hour SO ₂ (ppb)
Total Impact	87.5	33.5	84.5	32.3
NAAQS	196.2	75	196.2	75

CONCLUSION

The impact of the SO₂ sources in Sheboygan County is not predicted to result in a violation of the 1-hour SO₂ NAAQS in any part of the county. WPL-Edgewater, the main source of SO₂ 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 *SO₂ NAAQS Designations Technical Assistance Documents (USEPA, August 2016)*. The other smaller sources of SO₂ emissions in the county were appropriately considered in the modeling analysis or in the background concentration. This analysis therefore supports the designation of Sheboygan County, Wisconsin as attainment for the 1-hour SO₂ NAAQS.