SULFUR DIOXIDE DISPERSION MODELING ANALYSIS

Wisconsin Public Service Corporation Weston Generating Station
Rothschild, Wisconsin
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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 January 15, 2016, the Wisconsin Department of Natural Resources (WDNR) identified Wisconsin Public Service Corporation's Weston Generating Station (WPSC-Weston) in Rothschild, Wisconsin 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 SO_2 concentrations around WPSC-Weston 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

WPSC, a subsidiary of WEC Energy Group, operates the Weston Generating Station in the Village of Rothschild, Wisconsin. The Village of Rothschild straddles the Wisconsin River in Marathon County in central Wisconsin. Rothschild is approximately 80 kilometers west-northwest of Green Bay and 200 kilometers north of Madison. The climate of Rothschild is characterized by variable weather patterns with a large seasonal temperature range and moderate amounts of precipitation. The terrain around Rothschild is hilly, with prominent relief northwest of WPSC-Weston, extending about 765' above the Wisconsin River elevation.

MODEL & METEOROLOGY

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

Meteorological data was processed from 2013-2015 Alexander Field South Wood County Airport (KISW) with Green Bay upper air data. The meteorological was processed with AERMET (16216). The surface wind data at KISW 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 KISW is 57 kilometers south-southwest of WPSC-Weston and the data collected is considered representative of meteorological conditions around the facility. Alexander Field is located near the Wisconsin River at the edge of the City of Wisconsin Rapids, similar to the land cover around WPSC-Weston. There are no geographic features in between KISW and WPSC-Weston that would affect the general air flow, so the wind patterns will be similar between the sites. The Wausau Downtown Airport (KAUW) is located 8 kilometers north-northeast of WPSC-Weston, but the airport is surrounded on three sides by the Wisconsin River and the airflow is dominated by Rib Mountain, located 4 kilometers west. Traditionally, the Wausau data has been used only for facilities located within the downtown area of the City of Wausau. The next closest airport stations, Merrill Municipal Airport (KRRL), Langlade County Airport (KAIG), Stevens Point Municipal Airport (KSTE), Marshfield Municipal Airport (MFI), and Central Wisconsin Airport (CWA) are not considered to be representative as none use the high quality equipment as KISW or KAUW, nor do they report wind information by the minute, and all have high numbers of missing and calm hours.

Surface characteristics around KISW 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 WPSC-Weston and Expera-Mosinee
- 100 meter spacing to 10 kilometers from both facilities

Individual receptors were removed where monitor placement is not feasible, following the recommendations in the *SO_2 NAAQS Designations Modeling Technical Assistance Documents (USEPA, February 2016).* Receptors located inside the fence line of WPSC-Weston, Expera-Mosinee, or Domtar-Rothschild, 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 the Wisconsin River, were also removed from the modeling analysis.

EMISSIONS INVENTORY

WPSC-Weston is a base load electrical generating facility with nominal capacity of 1,027 megawatts that began operating in the 1950's. The facility consists of one natural gas fueled steam generating unit (Unit 2 – B02), and two coal-fueled steam generating units (Unit 3 – B03, Unit 4 – B04). Unit 1 was retired during 2015 and Unit 2 ceased burning coal and oil in 2015. Each remaining main boiler also has a small, natural gas auxiliary heating boiler. There also three combustion turbines at the facility. The heat input, in millions of British Thermal Units per hour (MMBtu/hr), and primary fuel type for each boiler is listed.

• B02	Natural Gas	1000 mmBTU/hr
• B03	Coal, Natural Gas	3424 mmBTU/hr
• B04	Natural Gas, Coal	5173 mmBTU/hr

Rock Oil Refining is located 34 kilometers west of WPSC-Weston. The facility recycles solid waste, including waste contaminated with used oil. The facility reported SO_2 emissions of less than 1 ton in 2015 from combustion of solid waste. Due to the distance between facilities and the small emissions, the impact of Rock Oil Refining is assumed to be part of the background concentration.

Melron Corporation is located 11 kilometers east-northeast of WPSC-Weston with reported SO_2 emissions of less than 1 ton in 2015. The facility manufactures hardware with SO_2 emissions coming from melting, pouring, and cooling of steel. Due to the distance between facilities and the small emissions, the impact of Melron Corporation is assumed to be part of the background concentration.

We Energies, a subsidiary of WEC Energy Group, operates the Biomass Cogeneration Facility located 4 kilometers northeast of WPSC-Weston. The facility reported just over 1 ton of SO_2 in 2015 from the combustion of biomass. The emissions vent through a stack with good dispersion, so the impact of We Energies Biomass Facility is assumed to be part of the background concentration.

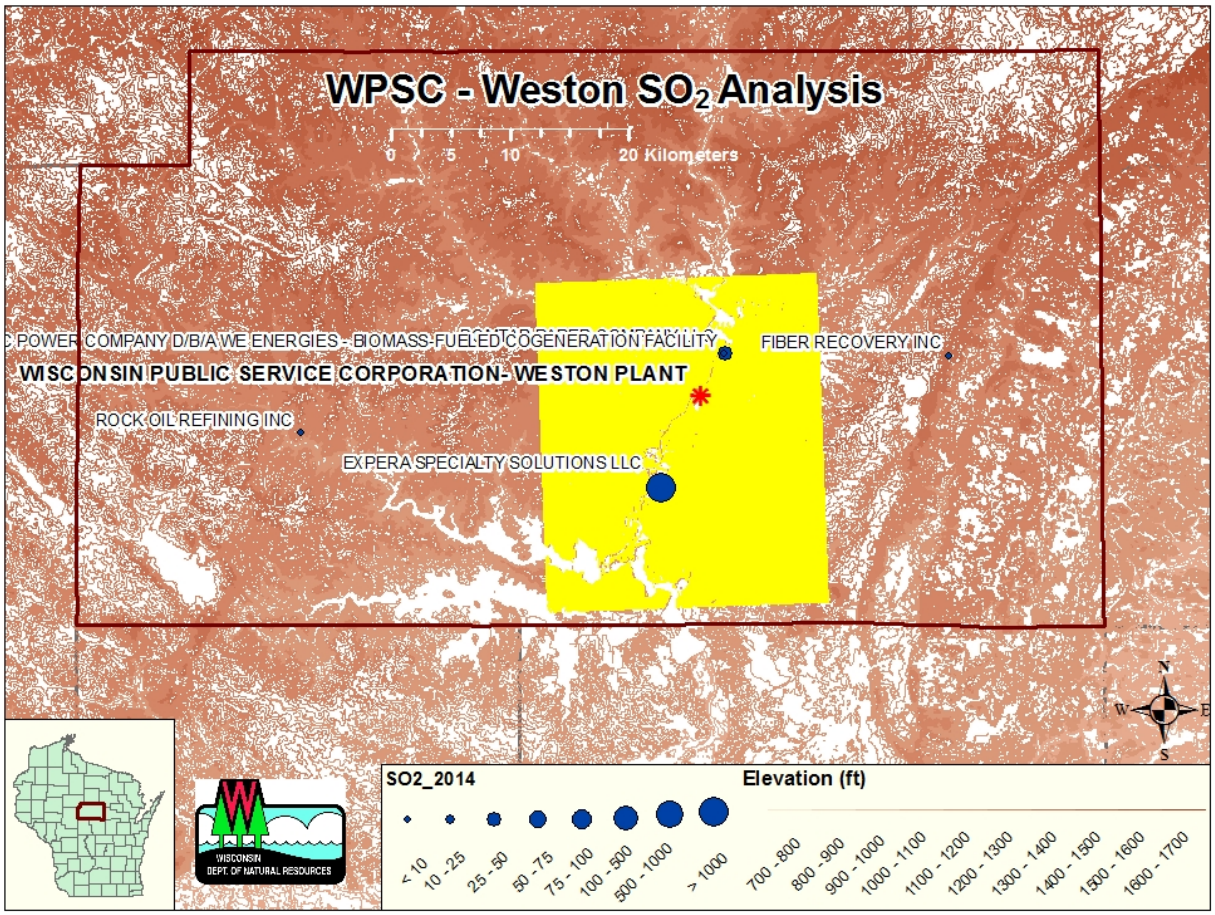
Fiber Recovery is located 21 kilometers east-northeast of WPSC-Weston, with reported SO2 emissions of 4 tons in 2015. The facility is adjacent to a solid waste landfill and combusts landfill gas in internal combustion engines. Regulatory dispersion modeling shows that the stacks are affected by downwash and the maximum impact of the stacks is close to the facility. Since the impact of Fiber Recovery is not in the vicinity of WPSC-Weston, and the emissions are small, the impact of the facility is assumed to be part of the background.

Domtar Paper-Rothschild is located just over 4 kilometers northeast of WPSC-Weston. The facility has an acid plant and other pulping operations that emit SO_2. The facility reported SO_2 emissions of 29 tons in 2015 from several short stacks. Due to the nature of the emissions, the uncertainty of modeled impact from the stacks, and the distance between Domtar-Rothschild and WPSC-Weston, the facility will be included in this analysis.

Expera Specialty Solutions operates a paper mill in Mosinee, Wisconsin, about 8 kilometers south-southwest of WPSC-Weston. The facility is an integrated kraft pulp and paper mill, and has four boilers (B20, B21, B24, B25) to provide steam and electricity for the plant. The facility reported 1,498 tons of SO_2 in 2015, almost all from the two coal boilers B20 (212 mmBTU/hr) and B24 (143 mmBTU/hr. The facility also operates lime kiln that produces SO_2 emissions. Due to the amount and nature of the emissions, and the distance between Expera-Mosinee and WPSC-Weston, the facility will be included in this analysis.

Figure 1 shows the SO_2 emission sources in Marathon County along with the modeled receptor grid (in yellow).

Figure 1 – Marathon County SO_2 Emission Sources



INPUT PARAMETERS

Modeled stack parameters and building downwash data for WPSC-Weston, Domtar-Rothschild, and Expera-Mosinee were derived from recent WDNR analyses, supplemented with additional information provided by the facilities. BPIP-PRIME was used to produce the building downwash information for AERMOD from facility provided plot plans.

Modeled emission rates for Domtar-Rothschild reflect actual operation for the period 2013-2015. Reported yearly SO_2 emissions are consistent 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. The same emission rate was applied to all modeled hours.

Modeled emission rates for Expera-Mosinee reflect actual hourly operation for the period 2013-2015. Reported yearly SO_2 emissions are consistent across the 2013-2015 period. Modeled hourly data for each regularly operated sources 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. The same emission rate was applied to all modeled hours.

Modeled emission rates for Unit 4 at WPSC-Weston reflect actual hourly operation for the period 2013-2015 as obtained from continuous emission monitor (CEM) data, with certain exceptions. WPSC recently installed SO_2 control on S03 (B03), so the modeled hourly emission rate for this source reflects the highest potential short-term hourly rate corresponding to the maximum heat input. WPSC-Weston is a base load plant, so there are minimal variations in the heat input throughout the year. For the modeled scenario, the representative exhaust gas flow rate and temperature will be used.

The federally enforceable emission limit for WPSC-Weston Unit 3 (B03) as of January 1, 2017 is based on the 30-day average of 0.08 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. Weston Unit 3 is a pulverized Powder River Basin coal, tangentially fired, dry bottom subcritical boiler installed in 1981, and is controlled with a dry flue gas desulfurization system. Both Units 1 and 2 at Wisconsin Power & Light's Columbia facility are larger than Weston Unit 3, but are both pulverized Powder River Basin coal, tangentially fired, dry bottom subcritical boilers, with dry flue gas desulfurization systems installed in the mid-1970s. The units at Columbia are comparable units to Weston Unit 3 and the Columbia CEM data will be used to determine the adjustment to the Weston Unit 3 emission limit.

From the emission data captured on the CEM at Wisconsin Power & Light Columbia facility, the 99^{th} percentile of the hourly mass (pounds) value was divided by the 99^{th} percentile of the 30-day average hour mass (pounds) value. The ratios for each unit at Columbia were calculated separately and the higher ratio was determined to be 5. The WPSC-Weston S03 30-day emissions limit of 0.08 lbs/MMBtu was multiplied by 5 resulting in a maximum hourly emission rate estimate of 0.40 lbs/MMBtu (0.08 * 5 = 0.4). This value was then used in the maximum model scenario to calculate a representative, conservative estimate of potential hourly emissions from WPSC-Weston S03 based on boiler heat input.

SO_2 emission rates for S02 (B02) were calculated from USEPA emission factors and maximum heat input to the unit. There were only small, intermittent emissions from testing of the combustion turbines at WPSC-Weston, so these were not be included in this analysis.

WISCONSIN PUBLIC SERVICE - WESTON Point Source Stack Parameters & Emission Rates							
ID	LOCATION (UTM83)	HEIGHT (M)	HEIGHT (ft)	DIAM (M)	VELOCITY (M/S)	TEMP (K)	SO_2 Rate (#/HR)
S02	290278, 4970937	73.95	242.6	3.63	15.66	441.5	0.60
S03	290605, 4970566	151.2	496.0	4.88	35.12	448.7	1370
S04	290777, 4970473	152.4	500.0	6.10	Hourly CEM Data Used		
Expera Specialty Solutions - Mosinee							
S10	286965, 4962944	65.84	216.0	2.60	14.60	449.0	304.8
S11	286920, 4962872	36.88	121.0	1.64	25.70	457.0	9.37
S53	486848, 4962855	23.47	77.0	0.98	8.80	347.0	9.54
Domtar Paper - Rothschild							
S50	292721, 4974191	37.49	123.0	0.52	11.11	285.9	2.42
S51*	292710, 4974192	2.13	7.0	1.25	5.002	294.5	0.15
S54_2903*	292637, 4974200	17.07	56.0	0.716	5.153	298.0	0.15
S54_2907	292660, 4974164	17.98	59.0	0.710	8.936	299.8	0.20
S54_2908	292662, 4974167	17.98	59.0	0.567	3.739	299.8	0.18
S54_3001*	292653, 4974196	17.98	59.0	1.58	5.262	299.8	0.75
S54_3003*	292643, 4974199	2.43	8.0	1.22	3.436	299.8	0.30
S54_3007*	292660, 4974213	3.05	10.0	0.152	25.87	299.8	0.34
S82*	292593, 4974176	1.83	6.0	0.46	5.174	294.3	0.24

*Horizontal stacks modeled as POINTHOR source type

BACKGROUND CONCENTRATION

The closest representative SO_2 monitoring location to WPSC-Weston is the Horicon (Dodge County) monitor located 174 kilometers southeast. The Horicon monitor site uses high sensitivity equipment to detect low SO_2 concentrations. Further, there are no major (100 tons per year) SO_2 sources within 50 kilometers of the Horicon monitor site. The modeling analysis includes all known major point sources of SO_2 within 50 kilometers of WPSC-Weston, 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 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 WPSC-Weston in relation to the 2010 1-hour SO_2 NAAQS is calculated with all other sources operating. The AERMOD results were 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 all operating scenarios. The maximum impact location near Domtar-Rothschild, approximately 4.2 kilometers northeast of WPSC-Weston. 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 $\mu g/m^3$.

WPSC-WESTON (Marathon County) **Modeling Results**		
	Maximum Scenario 1-Hour SO_2 ($\mu g/m^3$)	Maximum Scenario 1-Hour SO_2 (ppb)
Total Impact	142.4	54.4
NAAQS	196.2	75

CONCLUSION

The impact of the SO_2 sources in Marathon County is not predicted to result in a violation of the 1-hour SO_2 NAAQS in any part of the county. WPSC-Weston, 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 modeling analysis or in the background concentration. This analysis therefore supports the designation of Marathon County, Wisconsin as attainment for the 1-hour SO_2 NAAQS.