



**Navajo Nation Environmental Protection Agency  
Air & Toxics Department  
Air Quality Control Program**

**Summary of the Four Corners Power Plant SO<sub>2</sub> DRR  
Dispersion Modeling Protocol and Analysis Results**

**January 2017**

# Table of Contents

<b>1.1 Modeling Approach</b> .....	2
<b>2.1 Meteorological Data</b> .....	2
<b>3.1 Ambient Background Concentration</b> .....	4
3.1.1 Nearby Sources .....	4
<b>4.1 Emissions Data</b> .....	4
<b>5.1 Receptors</b> .....	5
<b>6.1 Building Downwash Analysis</b> .....	5
<b>7.1 Modeling Analysis Results</b> .....	6
<b>Appendix A</b> .....	7
<b>Appendix B</b> .....	10

## List of Tables

<b>Table 1. Differences Between 2014 EIS NAAQS and 2016 SO<sub>2</sub> DRR Modeling</b> .....	2
<b>Table 2. Units 4 and 5 Exhaust Parameters</b> .....	5

## List of Figures

<b>Figure 1. Cumulative Wind Rose for Navajo Met 1 Station (2012-2014)</b> .....	3
<b>Figure 2. Four Corners Power Plant 1-Hour SO<sub>2</sub> Air Dispersion Modeling Results</b> .....	6
<b>Figure 3 Four Corners Power Plant and San Juan Generating Station 1-Hour SO<sub>2</sub> Air Dispersion Modeling Results</b> .....	10

## 1.1 Modeling Approach

The NNEPA modeling protocol references existing near-field dispersion modeling of the FCPP using earlier versions of AERMOD, conducted as part of the 2014 Environmental Impact Statement NAAQS (herein referred to as “2014 EIS NAAQS”)<sup>1</sup> study as required for federal lease extension. The modeling protocol has been reviewed and discussed with U.S. EPA Region 9 for applicability to the DRR. The current SO<sub>2</sub> DRR modeling presented here followed the procedures described in the 2014 EIS NAAQS study with recommended updates summarized in Table 1 below.

**Table 1. Differences Between 2014 EIS NAAQS and 2016 SO<sub>2</sub> DRR Modeling**

<i>2014 EIS NAAQS Dispersion Modeling</i>	<i>2016 DRR Dispersion Modeling</i>
2009-2011 actual SO <sub>2</sub> emissions, actual temperature and velocity	2012-2014 actual SO <sub>2</sub> emissions, actual temperature and velocity
2009-2011 Meteorological Tower 1 surface observations	2012-2014 Meteorological Tower 1 surface observations
AERMOD/AERMET version 13350 with Beta ADJ_U* option	AERMOD/AERMET version 15181 with default option
Receptors placed over Morgan Lake and excluded from the Navajo Mine area	Receptors excluded from Morgan Lake and placed over the Navajo Mine area

There are two input data processors that are regulatory components of the AERMOD modeling system: 1) AERMET, meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and 2) AERMAP, a terrain preprocessor that incorporates complex terrain using United States Geological Survey (USGS) Digital Elevation Data. NNEPA used the latest version of AERMOD and the associated preprocessors available at the time of the attainment modeling analysis. These are as follows: AERMOD version 15181, AERMET version 15181, AERSURFACE version 13016 and AERMAP version 11103. All dispersion modeling for this submittal was conducted following NNEPA’s modeling protocol and recommended updates. AERMOD and all associated preprocessors were run in the default regulatory mode.

## 2.1 Meteorological Data

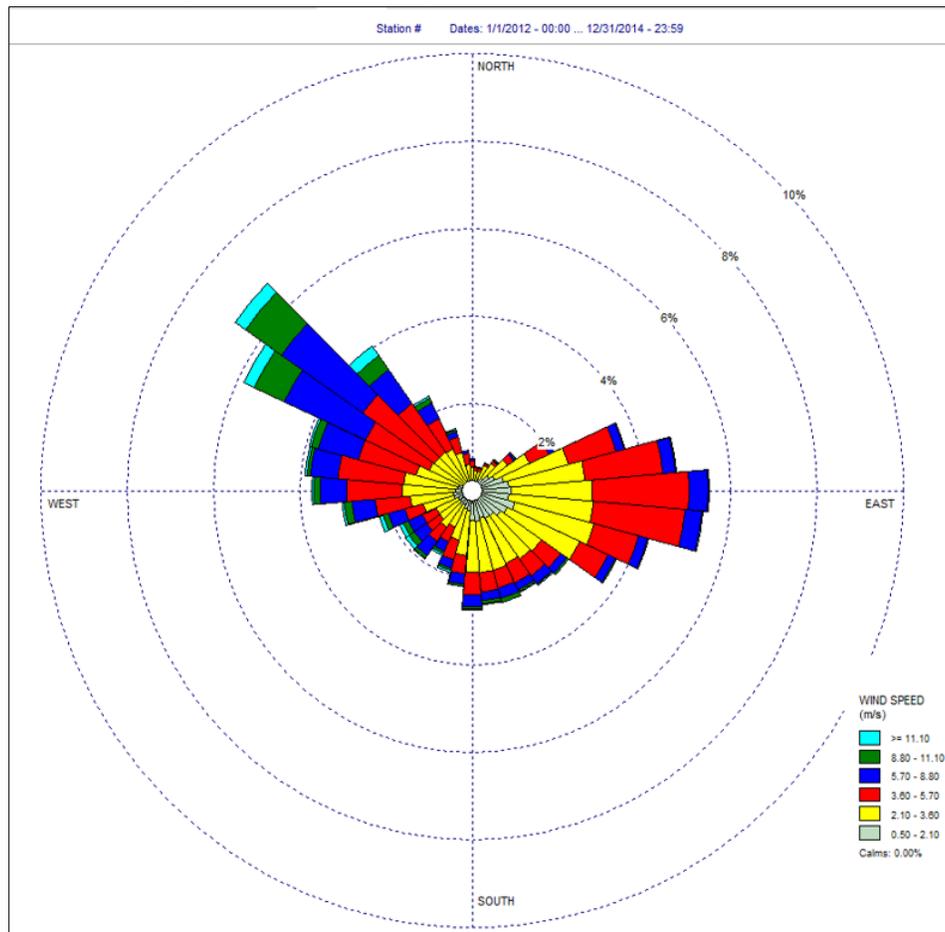
In order to generate meteorological input data for use with AERMOD, AERMET and AERSURFACE preprocessing for the modeling domain was performed to generate input files for the surface (.sfc) boundary layer parameters and meteorological profile (.pfl). Three years of hourly surface meteorological data from 2012-2014 from the on-site surface station, Navajo Met Tower 1, was processed with AERMET. This surface station did meet U.S. EPA’s ambient monitoring guidance relative to quarterly data capture completeness. Furthermore, the data and instrumentation are routinely maintained to the quality that would be required for modeling

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<sup>1</sup> “Four Corners Power Plant and Navajo Mine Energy Project Environmental Impact Statement NAAQS Modeling Study,” AECOM, February 2014, Chelmsford, MA.

according to U.S. EPA's ambient air monitoring guidance.

AERSURFACE was used to determine surface characteristics around this meteorological site using land cover data from the USGS National Land Cover Data 1992 archives (NLCD92). AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category. Monthly precipitation values, years 2012-2014 from the meteorological station were compared to the 30 year climatological average record to characterize monthly surface moisture conditions. Upper air data for the concurrent period was obtained from Albuquerque International Airport, New Mexico. Parameters not available at the Navajo Met Tower 1, such as cloud cover, were taken from the Farmington Regional Airport, New Mexico and processed with AERMET. A cumulative wind rose depicting annual trends of wind speed classes and wind direction frequency, years 2012-2014, for the surface station are shown in Figure 1. The wind rose demonstrates that average wind speeds are ~ 4 m/s with predominate wind directions from the east, and significant contributions from winds originating in the northwest and blowing to the southwest.



**Figure 1. Cumulative Wind Rose for Navajo Met 1 Station (2012-2014)**

### 3.1 Ambient Background Concentration

The NNEPA reviewed 2012-2014 1-hour SO<sub>2</sub> monitoring data observed at the Shiprock Substation (SLAMS network) located in Waterflow, NM. The monitor (ID: 35-045-1005) is maintained by the New Mexico Environment Department (NMED) Air Quality Bureau (AQB), who maintains a quality assurance program to validate data and ensure integrity and traceability to known standards. The monitor was therefore found to be the most closest and representative SO<sub>2</sub> monitor of ambient background concentrations. The 1-hour SO<sub>2</sub> design value at this monitor is relatively low (21 ppbv) and the data was processed for hourly seasonal 99<sup>th</sup> percentile values and added to the modeled concentrations. Use of this monitor is conservative as it most likely double-counts emissions from the FCPP.

#### 3.1.1 Nearby Sources

A 2014 EIS NAAQS review of major emission sources (e.g., with emissions exceeding 250 tpy) out to distances as large as 40 km from FCPP indicated two sources: 1) San Juan Generating Station (SJGS) and 2) the San Juan River Gas Plant. The San Juan River Gas Plant has since retired their major emissions source, a Sulfur Recovery Unit<sup>2</sup>. Therefore, it was concluded that the only background source to be evaluated (determining whether it would have a significant concentration gradient) for modeling is the SJGS, located about 13 km from FCPP. It is noteworthy that the monitored background data comes from the Shiprock Substation SO<sub>2</sub> monitor which is in close proximity to SJGS, indicating the impacts from SJGS are already included in the monitored background. Furthermore, a concentration gradient analysis was conducted to model impacts from SJGS and NNEPA also modeled impacts from SJGS using most current stack and auxiliary boiler emissions. These analyses are described in Appendix B, and indicates that the relative change in modeled concentrations between the location of FCPP and the peak SO<sub>2</sub> impact location is minimal (<30%). Consequently, the concentration gradient from SJGS is insignificant, and impacts from that source are rather included within the monitored background.

### 4.1 Emissions Data

The closure of FCPP Units 1, 2, and 3 was completed in 2013. Therefore, dispersion modeling of only the operating Units 4 and 5 were conducted for this analysis using 2012-2014 hourly SO<sub>2</sub> emissions, hourly exit temperatures, and hourly exit velocities. Table 2 summarizes exhaust parameters for the FCPP Units 4 and 5 stack. The exit velocity, temperature and emissions vary by hour and are not listed in Table 2. These parameters can be found in the modeling archive files listed in Appendix A with a digital copy provided. Both FCPP Unit 4 and 5 have separate flue gases that exhaust into a common stack, as a result, the emissions for these two units were combined and modeled as a single stack with an effective diameter equivalent to the combined

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<sup>2</sup> See <http://www.docstoc.com/docs/106180605/Public-Notice-Western-Gas-R-San-Juan-River-Gas-Plant-2013-M328July10>; the resulting SO<sub>2</sub> annual emissions would be less than 150 tpy, and the facility would be screened out with a “20D” rule due to its distance of over 12 km from FCPP.

area circle. Similarly, for each modeled hour, the exhaust flows were combined to calculate a flow-weighted exit velocity and temperature.

**Table 2. Units 4 and 5 Exhaust Parameters**

UTM X, Zone 12, NAD83	725350
UTM Y, Zone 12, NAD83	4063099
Actual Stack Height (m)	115.8
Stack Base Elevation (m)	1632.1
Effective Diameter (m)	12.28
Stack Temperature (K)	Vary by hour
Exit Velocity (m/s)	Vary by hour

## 5.1 Receptors

The modeling domain was centered on the FCPP and extend out to 30 km. Modeled receptors were set up along the plant fence line 50 meters apart. Additional receptors were set out as follows:

- Every 100 meters out to a distance of 2 km beyond the fence line.
- Every 250 meters out to a distance of 5 kilometers from the center of the plant.
- Every 500 meters out to a distance of 10 kilometers from the center of the plant.
- Every 1000 meters out to a distance of 20 kilometers from the center of the plant.
- Every 2500 meters out to a distance of 30 kilometers from the center of the plant.

Additional 100-meter spaced receptors were placed on the Hogback Ridge to the west of the stacks and no receptors were placed on Morgan Lake, north of the stacks. The total number of receptors included in the modeling network was 4,034. Terrain elevations from USGS National Elevation Data (NED) were processed with AERMAP (version 11103) to develop the receptor terrain elevations required by AERMOD.

## 6.1 Building Downwash Analysis

According to the Modeling TAD, “EPA recommends the use of actual stack heights so that the modeling analysis can most closely represent the actual ambient air quality conditions as influenced by the source.” Also, “for both actual and Good Engineering Practice (GEP) stack heights, if building downwash is being considered, the BPIPROME program should be used to input building parameters for AERMOD.” The actual stack heights listed in Table 2, were used in the modeling analysis. Wind direction-specific building dimensions for input to AERMOD were developed with the EPA’s Building Profile Input Processor (“BPIPROME”). These BPIPROME input files can be found in the modeling archive files listed in Appendix A with a digital copy provided.

It should also be noted that according to the 2014 EIS NAAQS study, “For SO<sub>2</sub>, the principle issue is that the highest predicted concentrations are caused by building downwash in high winds

due to the influence of the Unit 4 and 5 boiler buildings...note that aside from a narrow area of downwash impacts due to northwest winds, the remaining design 1-hour SO<sub>2</sub> concentrations are under 150 µg/m<sup>3</sup>, well below the NAAQS.”

### 7.1 Modeling Analysis Results

The NNEPA, modeling analysis results of the 99<sup>th</sup> percentile maximum daily values, averaged over the three years modeled, are equal to 163.1 µg/m<sup>3</sup> (62 ppbv), which is below the 1-Hour SO<sub>2</sub> NAAQS of 196 µg/m<sup>3</sup> (75ppbv). The peak impact occurs in the area covered by 100-meter spaced receptors located less than a kilometer to the southeast of the Units 4 and 5 stack (see Figure 2). All modeling archive files are listed in Appendix A, with a digital copy provided. The NNEPA provides this information to U.S. EPA Region 9 in support of a NAAQS attainment designation.

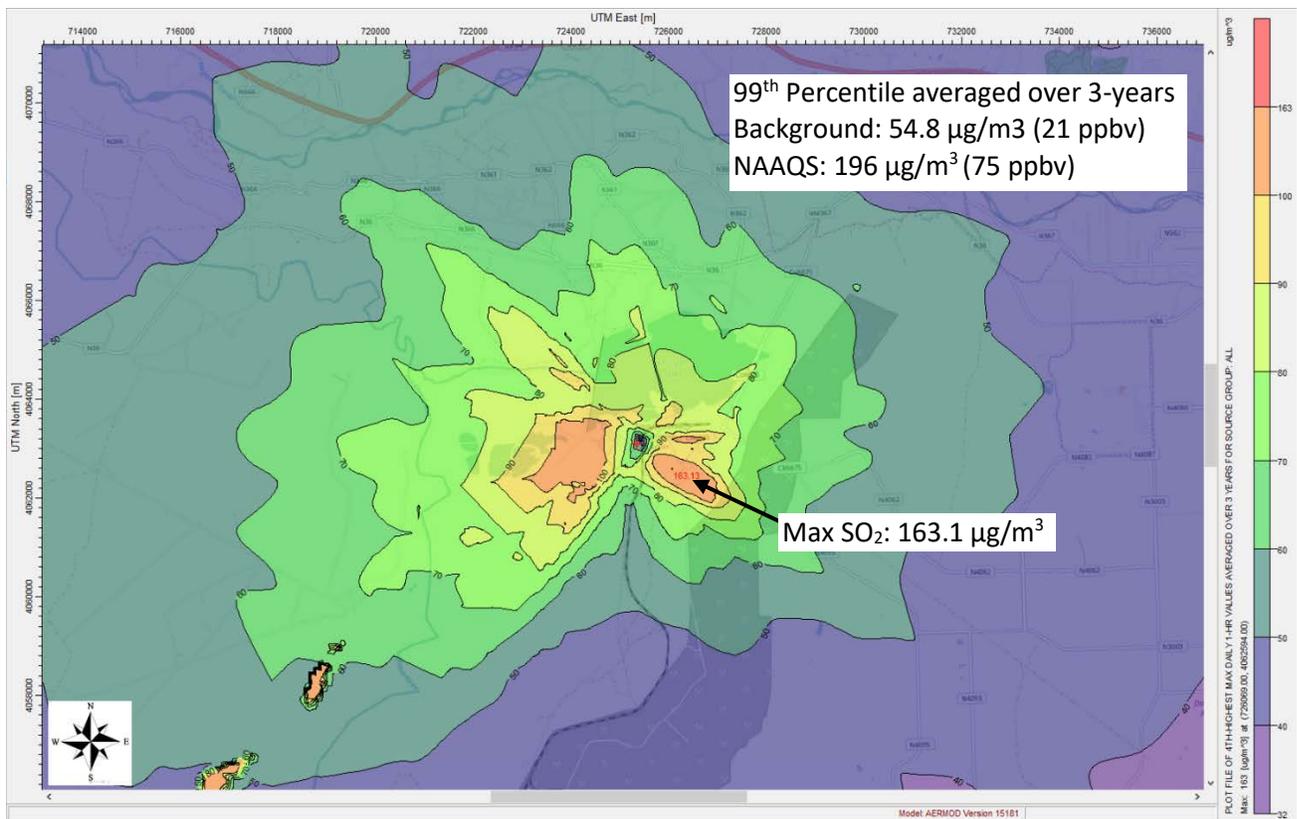


Figure 2. Four Corners Power Plant 1-Hour SO<sub>2</sub> Air Dispersion Modeling Results

## Appendix A

### Modeling Archive Files for Four Corners Power Plant (Units 4&5) 1-hour SO<sub>2</sub> AERMOD Modeling

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#### AERMET

The 10-meter surface meteorological data from Navajo Met Tower 1, Farmington airport (used for cloud cover) and upper air data from Albuquerque were processed with AERMET.

#### AERSURFACE

Contains files used to process the land use data around the site Met Tower 1 for input into Stage3. AERSURFACE was run for all three surface moisture conditions – average, wet, and dry.

- AERSURFACE.bat : Batch file when executed run AERSURFACE
- aersurface.exe : AERSURFACE executable (Version 13016)
- \*.DAT : AERSURFACE input file
- \*.out : AERSURFACE output file
- \*.log : AERSURFACE output – log file
- \*.xlsx : AERSURFACE climatology worksheet for Stage 3 inputs

#### ISH\_Farmington

- \*.ISH : Integrated Surface Hourly (ISH) format of the surface data

#### FSL\_Albuquerque

- \*.FSL : Twice-daily upper air soundings
-

## Run default

AERMET processing input and output files with the default option.

“Navajo Met 1 2012-2014 data filled with Met 2.xlsx” spreadsheet with the onsite data. The Met Tower 1 data was filled here with the Met Tower 2 data.

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- \*.exe : AERMET executable
  - \*.dat : Onsite data
  - \*.INP : AERMET input files for Stage 1, 2 and 3
  - \*.QA : AERMET upper air and surface quality assessment files
  - \*.RPT1 : AERMET report file for Stage 1
  - \*.RPT2 : AERMET report file for Stage 2
  - \*.RPT3 : AERMET report file for Stage 3
  - \*.MSG1 : AERMET message file for Stage 1
  - \*.MSG2 : AERMET message file for Stage 2
  - \*.MSG3 : AERMET message file for Stage 3
  - \*.MRG : AERMET Stage 2 merged file
  - \*.bat : Batch file to run AERMET
  - .PFL : Upper Air data file for AERMOD
  - .SFC : Surface data file for AERMOD
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## AERMAP

This folder contains AERMAP (version 11103) files used to process terrain data to produce the receptor elevations and critical hill heights for use in AERMOD.

- \*.ast : AERMAP output file for the Cartesian grid receptors
- \*.api : AERMAP input file for the Cartesian grid receptors
- \*.ROU : AERMAP file containing Cartesian grid receptor elevations and Critical hill heights (input to AERMOD)

*Note that the raw terrain data files are not provided because of their large size. It is downloaded*

*automatically by Lakes AERMAP program in USGS NED GeoTIFF format.*

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## **GEP**

This folder contains BPIP input and output files. BPIP Version 04274 was used.

- \*.bpi : BPIP input file
  - \*.pro : BPIP output file
  - \*.sup : BPIP summary file
- 

## **Emissions and Stack Data**

- “Unit 45\_2012\_2013\_2014.xlsx” AERMOD hourly emissions, temperature and velocity file for Unit 4 and 5. Weighted temperature and velocity were calculated here for the combined units. The data from this spreadsheet was used to produce the \*.prn file for AERMOD.
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## **Ambient Data**

- “Shiprock Substation Season Hour-of-Day.xlsx” Excel spreadsheet provides calculation of the season and hour-of-day SO<sub>2</sub> monitoring data for input to AERMOD.
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## **AERMOD**

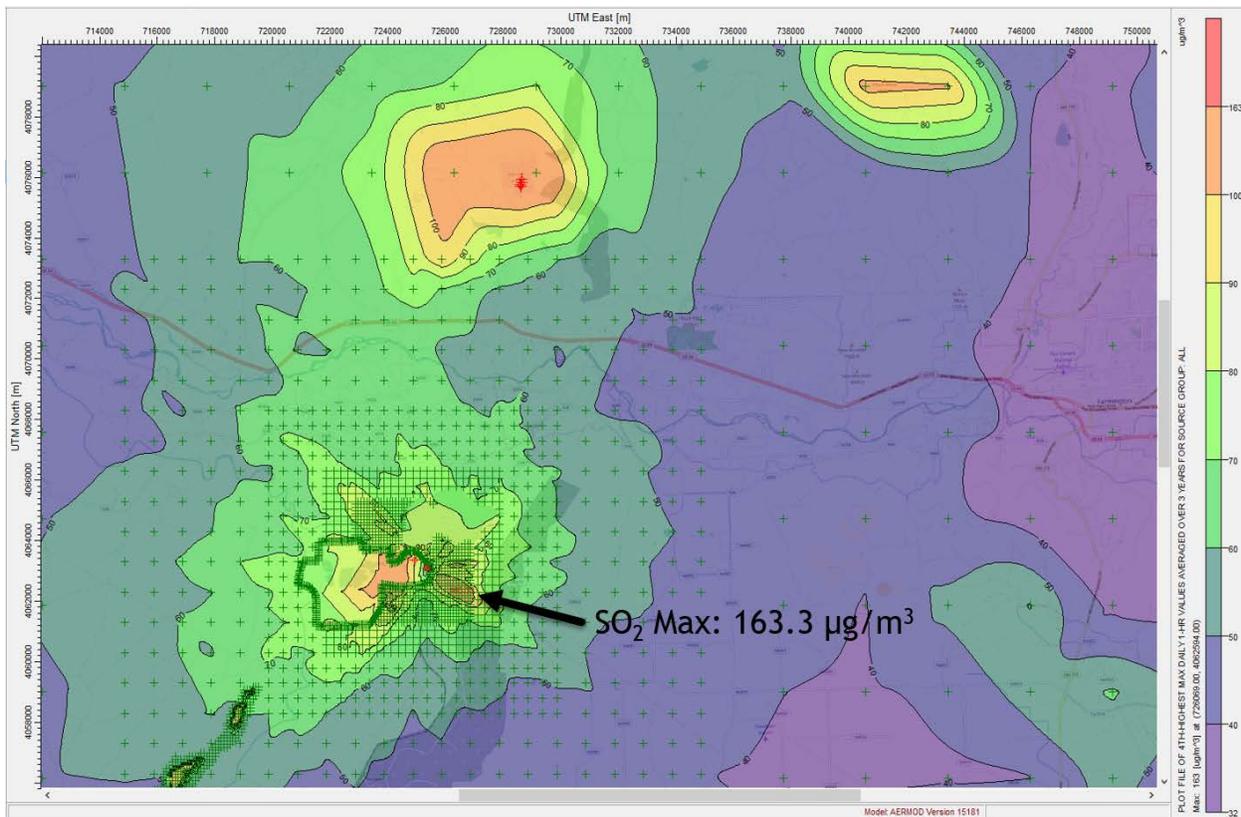
This folder contains AERMOD files with the default option.

- \*.inp : AERMOD input file
- \*.out : AERMOD output file
- \*.prn : AERMOD hourly emissions/temp/velocity file
- \*.ROU : AERMAP receptor file
- \*.PLT : AERMOD plot file for making isopleths
- RUN.BAT : Batch file to execute AERMOD

## Appendix B

### Significant Concentration Gradient Analysis

To determine if there is a significant concentration gradient beyond the FCPP location from San Juan Generating Station (SJGS) emissions, the 2014 EIS NAAQS study modeled impacts from that facility along a line of receptors passing through and beyond the Four Corners Power Plant. The modeling results indicated that the relative change in the predicted SO<sub>2</sub> concentrations from SJGS is a small fraction (<30%)<sup>3</sup> between FCPP and the distance to the maximum concentration for 1-hour SO<sub>2</sub>. In addition, NNEPA modeled impacts from SJGS, to include most recent stack and auxiliary boiler emissions and also observed a relatively small change in the maximum 1-hour SO<sub>2</sub> (see Figure 3). Therefore, SJGS does not have a detectable (significant) concentration gradient in the vicinity of FCPP, and was not included in the modeling. Rather, its impact is accounted for in the monitored background.



**Figure 3 Four Corners Power Plant and San Juan Generating Station 1-Hour SO<sub>2</sub> Air Dispersion Modeling Results**

<sup>3</sup> USEPA 2008b. (<http://www.epa.gov/ttnamti1/files/ambient/pm25/qa/QA-Handbook-Vol-II.pdf>; see Table 10-3 for audit tolerances).