Technical Support Document for Regional Haze State Implementation Plan Revision for the Coronado Generating Station

July 19, 2016

Arizona Department of Environmental Quality

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1. Introduction

This document provides technical support (Technical Support Document or TSD) for a source-specific revision to the Arizona Regional Haze State Implementation Plan (Arizona RH SIP) that establishes best available retrofit technology (BART) for Unit 1 at Salt River Project Agricultural Improvement and Power District's (SRP) Coronado Generating Station (CGS).

CGS consists of two pulverized coal-fired, electric utility boilers (Units 1 and 2), which generate approximately 762 megawatts (MW) (net) of electricity. Units 1 and 2 were completed and started operation in 1979-1980. CGS generates electricity for sale and the SIC code for this operation is 4911. Units 1 and 2 are dry-bottom turbo-fired boilers with a net rated output of 380 MW and 382 MW, respectively, primarily firing low-sulfur western coals. Both units are Regional Haze Program - BART eligible units per 40 CFR § 51.301. ADEQ determined that CGS units may reasonably be anticipated to cause or contribute to visibility impairment at a Class I area and, as such, are subject to BART.

On February 28, 2011, ADEQ submitted to EPA the state's initial Regional Haze SIP for the first planning period of the regional haze program. This submission included BART determinations for CGS Units 1 and 2. On December 5, 2012, EPA issued a final rule approving in part and disapproving in part ADEQ's Regional Haze SIP.[1] EPA also promulgated a federal implementation plan (FIP) for the CGS units with an oxides of nitrogen (NOx) emission limit of 0.065 pounds per million British thermal unit (lb/MMBtu), applicable across both CGS units on a 30-boiler-operating-day average basis. The final compliance date for the BART FIP NOx limit is December 5, 2017 (five years from the date of publication of the FIP) and involves installation and operation of selective catalytic reduction (SCR) systems for control of NOx emissions on both CGS units. Unit 2 was equipped with SCR in 2014, as required by a consent decree between SRP and the United States.[2]

SRP filed a petition for administrative reconsideration of the NOx BART determination for CGS with EPA in February 2013. EPA granted reconsideration of the NOx emission limit and compliance methodology (i.e., the methodology used to calculate compliance with the plant-wide average) in April 2013. On March 31, 2015, EPA proposed revisions to the NOx BART determination for CGS units.[3] The proposal established a Unit 1 BART NOx limit of 0.065 lb/MMBtu and a Unit 2 BART NOx limit of 0.080 lb/MMBtu (2016 EPA BART Reconsideration). Both limits are to be met on a 30-boiler-operating-day average. EPA did not propose to change the initial compliance date for the NOx BART limits, which remains December 5, 2017. EPA has taken final action on the reconsideration proposal, which was published in the Federal Register on April 13, 2016, approving the unit-specific BART NOx limit of 0.065 lb/MMBtu for Unit 1 and unit-specific NOx BART limit of 0.080 lb/MMBtu for Unit 2 (2016 EPA BART Reconsideration).

In June 2014, EPA released its proposed Carbon Pollution Emission Guidelines for Existing Electric Utility Generating Units, commonly referred to as the Clean Power Plan (CPP). This rule package was finalized in August 2015.[4] In the rule, EPA had given states until September 2018 to submit final plans outlining how they will meet the requirements set forth by EPA in the final CPP. On February 9, 2016, the U.S. Supreme Court granted a stay, halting implementation of the CPP pending the resolution of legal challenges to the program in court. This action has created additional uncertainty for SRP with respect to the nature and timing of its compliance obligations for the CGS units.

[1] 77 Fed. Reg. 72512 (Dec. 5, 2012).
[2] United States v. Salt River Project Agricultural Improvement and Power District, Civil Action No. 2:08-cv-1479- JAT (D. Ariz.), August 12, 2008.
[3] 80 Fed. Reg. 17010 (Mar. 31, 2015).
[4] The final rule was published at 80 Fed. Reg. 64,662 (Oct. 23, 2015).

On January 22, 2016, SRP submitted an Application for a Significant Permit Revision and a Regional Haze State Implementation Plan Revision for CGS to ADEQ. On July 19, 2016, SRP submitted addendums to the application. In this submittal, SRP requested that ADEQ adopt the BART Alternative as a revision to the Arizona Regional Haze SIP and submit the revision to EPA for approval.

2. BART Alternative Operating Strategies for CGS

To meet the requirements of the RHR, ADEQ evaluated a BART Alternative comprising two alternative operating strategies as better-than-BART (BTB) compliance options as follows.

2.1 Operating Strategy (OS-1): Seasonal Curtailments Followed by SCR on Unit 1

This operating strategy requires SRP to comply with the Unit 1 interim BART Alternative operating strategy referred to as interim operating strategy (IS) followed by installation of an SCR system on Unit 1 no later than December 31, 2029 to achieve a NOx limit of 0.065 lb/MMBtu at Unit 1 on a 30-boiler-operating-day average. The interim operating strategy includes four separate seasonal curtailment periods for CGS Unit 1 coupled with options for operation at lower sulfur dioxide (SO_2) emissions rates below the BART limits at both units and a NOx emissions rate below the permit limit at Unit 1. In each year, the length of the required curtailment period for CGS Unit 1 is dependent on the NOx emissions performance of Unit 1 and the SO_2 emissions performance of Units 1 and 2.

2.2 Operating Strategy (OS-2): Seasonal Curtailments Followed by Unit 1 Shutdown

Under this operating strategy, SRP would comply with the interim operating strategy followed by permanent cessation of operation of Unit 1 no later than December 31, 2029.

2.3 BART Alternative Implementation Schedule

Under the BART Alternative, the interim operating strategy will take effect on December 5, 2017, the compliance date established by EPA's BART FIP. In the first year of implementation, Unit 1 will begin the interim operating strategy on December 5 and end according to the emissions performance of that year. In subsequent years, the interim operating strategy will begin and end according to the emission performance of the corresponding year. Once SRP achieves certainty regarding future operation of CGS Unit 1 under a final approved CPP state plan (if the CPP remains in effect), SRP will finalize its choice of BART Alternative operating strategy and will submit a notification to EPA and ADEQ regarding the same. This notification will be made no later than December 31, 2026.

The CPP is currently stayed by the Supreme Court, increasing uncertainty about the schedule for implementation of the rule and thus impacting SRP's ability to finalize plans regarding CGS. Based on the anticipated litigation schedule, there will likely not be a final decision in the CPP litigation until at least 2018. Assuming the CPP implementation schedule revision provides a day-for-day compliance deadline extension to account for the stay, initial compliance could be expected to begin in 2025, 1 year prior to the 2026 BART Alternative Option selection deadline. With additional pre-notification planning and recognizing the need to potentially take other preliminary steps prior to the notification deadline, SRP expects that it will have sufficient time to design and construct an SCR if it selects OS-1 and to make the necessary resource arrangements if it selects OS-2.

If SRP selects OS-1, SRP will apply the interim operating strategy until an SCR system is installed and operating, which will occur no later than December 31, 2029. If SRP selects OS-2, SRP will apply the interim operating strategy until the Unit 1 closure, which will occur no later than December 31, 2029.

Figure 1 shows an overview of the BART Alternative operating strategies for CGS.

Figure 1: Overview of BART Alternative Operating Strategies for CGS Unit 1

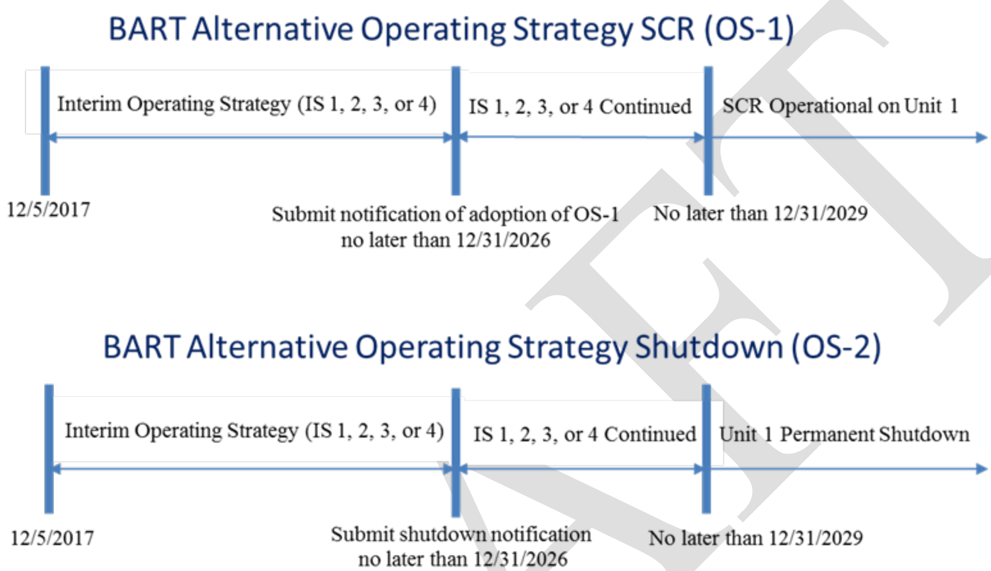


Table 1 lists the emission limits for Unit 1 and Unit 2 and the curtailment periods for Unit 1 for the four seasonal curtailment options under the interim operating strategy. For comparison purposes, the emission limits required by the 2016 EPA BART Reconsideration for NOx and the 2012 ADEQ BART for SO_2 as approved by EPA (hereinafter referred to as "BART control strategy") are also included in Table 1. The interim operating strategy and compliance methods are incorporated as a new Attachment "E" to the facility's Operating Permit #52639 revised by significant permit revision #63088.

Table 1: Emission Limits for CGS under BART Alternative Operating Strategies

Control Strategy		Unit 1 (lb/MMBtu) (30-boiler-operating-day average) NOx	Unit 1 (lb/MMBtu) (30-boiler-operating-day average) SO_2	Unit 2 SO_2 (lb/MMBtu) (30-boiler-operating-day average)	Unit 1 Curtailment Period
BART control strategy (2016 EPA BART Reconsideration for NOx and 2012 ADEQ BART for SO_2)		0.065	0.080	0.080	N/A
BART Alternative Operating Strategy SCR Option (OS-1)					
Interim Operating Strategy	IS1	0.320	0.080	0.080	Oct. 1-Apr. 15
	IS2	0.320	0.070	0.070	Oct. 21-Jan. 31
	IS3	0.320	0.050	0.050	Nov. 21-Jan. 20
	IS4	0.310	0.060	0.060	Nov. 21-Jan. 20
Final BART Alternative Strategy	SCR Installation and Operation no later than December 31, 2029.	0.065	0.080	0.080	N/A
BART Alternative Operating Strategy Shutdown Unit 1 Option (OS-2)					
Interim Operating Strategy	IS1	0.320	0.080	0.080	Oct. 1-Apr. 15
	IS2	0.320	0.070	0.070	Oct. 21-Jan. 31
	IS3	0.320	0.050	0.050	Nov. 21-Jan. 20
	IS4	0.310	0.060	0.060	Nov. 21-Jan. 20
Final BART Alternative Strategy	Unit Closure no later than December 31, 2029.	0.000	0.000	0.080	N/A

3. Applicable Regulatory Requirements and Elements of TSD

3.1 RHR Provisions for BART Alternatives

The RHR contains provisions whereby a state may choose to implement measures as an alternative to BART if the state can demonstrate that the alternative measure achieves greater reasonable progress toward achieving natural visibility conditions than would be achieved through the installation, operation, and maintenance of BART. The requirements for alternative measures are established at 40 CFR 51.308(e)(2) and (3). As explained in the RHR, the state must demonstrate that all necessary emission reductions will take place during the first long term strategy period (i.e., by 2018) and that the emissions reductions resulting from the alternative measure will be surplus to those reductions resulting from measures adopted to meet requirements of the CAA as of the baseline date of the SIP.

40 CFR § 51.308(e)(2)(i) establishes five criteria for demonstrating that BART alternative measures will achieve greater reasonable progress than would have resulted from installation and operation of BART, as follows:

- A list of all BART-eligible sources. ADEQ included a list of all BART-eligible sources in the Arizona Regional Haze SIP;
- A list of all BART-eligible sources that would be covered by the BART alternative. The BART alternative covers emissions from CGS Units 1 and 2;
- An analysis of BART and associated emissions reductions from the units covered by the BART alternative;
- An analysis of projected emissions reductions through application of the BART alternatives; and
- A determination that the alternative "achieves greater reasonable progress than would be achieved through the installation and operation of BART at the covered sources." The determination is to be made based either on the relevant criteria in 40 CFR § 51.308(e)(3) or on the "clear weight of evidence" as provided in 40 CFR § 51.308(e)(2)(i)(E)

40 CFR § 51.308(e)(3) specifies two tests for determining whether the BART Alternative achieves greater reasonable progress than BART. If the distribution of emissions under the alternative measure is not substantially different than under BART, and the alternative measure results in greater emissions reductions, then the alternative measure may be deemed to achieve greater reasonable progress. However, if the distribution of emissions is significantly different, or if the alternative measure does not result in greater emissions reductions, then a dispersion modeling analysis to determine the differences in visibility between BART and the BART Alternative may be conducted for each impacted Class I area, for the worst and best 20% of days (W20% and B20% days). The modeling demonstrates "greater reasonable progress" if both of the following criteria are met:

- Visibility does not decline in any Class I area; and
- There is an overall improvement in visibility, determined by comparing the average differences between BART and the BART Alternative over all affected Class I areas.

ADEQ has determined that the BART Alternative operating strategies do not necessarily achieve greater emissions reductions than the 2016 EPA BART Reconsideration, because, although there will be greater SO_2 and PM emissions reductions under the alternative, there will be higher NOx emissions as compared to BART for CGS. SRP opted to performed a dispersion modeling analysis to demonstrate that the BART alternative would result in "greater reasonable progress" consistent with the two-prong test above.

3.2 Section 110 (l) of the Clean Air Act

Section 110(l) of the Clean Air Act (CAA) indicates that EPA cannot approve a State Implementation Plan (SIP) revision if the revision would interfere with any applicable requirement concerning attainment and reasonable further progress (RFP), or any other applicable requirement of the CAA. Therefore, EPA will approve a SIP revision that removes or modifies control measure(s) in the SIP only after the State has demonstrated that such removal or modification will not interfere with attainment of the National Ambient air Quality Standards (NAAQS), Rate of Progress (ROP), RFP or any other applicable requirement of the CAA.

Specifically, section 110(l) states:

> "*Each revision to an implementation plan submitted by a State under this Act shall be adopted by such State after reasonable notice and public hearing. The Administrator shall not approve a revision of a plan if the revision would interfere with any applicable requirement concerning attainment and reasonable further progress (as defined in section 171), or any other applicable requirement of this Act*."

Section 110(l) applies to all requirements of the CAA and to all areas of the country, whether attainment, nonattainment, unclassifiable or maintenance for one or more of the six criteria pollutants: ozone, particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and lead (Pb). Section 110(l) is not limited in scope to those SIP revisions that only impact ambient air quality. Therefore, the demonstration of noninterference under section 110(l) should address not only NAAQS but all other applicable requirements. The EPA's Draft Guidance on Demonstration of Noninterference under section 110(l) lists many other applicable requirements such as Regional Haze under sections 169A and 169B of the CAA, Prevention of Significant Deterioration (PSD), Maximum Achievable Control Technology (MACT) for Air Toxics, New Source Performance Standards (NSPS), etc.[5]

Under the first BART Alternative operating strategy (OS-1), in which an SCR system is installed on Unit 1, PSD review will be triggered for collateral emissions increases for three pollutants: particulate matter less than 10 micrometers (µm) mean aerodynamic diameter (PM_{10}), particulate matter less than 2.5 µm mean aerodynamic diameter ($PM_{2.5}$), and sulfuric acid mist (H_2SO_4). Regarding compliance with the PSD requirement, this TSD refers to the technical supporting document for significant permit revision #63088 (Appendix C of SIP document) that details the best available control technology (BACT) determination for H_2SO_4, PM_{10}, and $PM_{2.5}$ as well as the NAAQS and PSD increment modeling for PM_{10} and $PM_{2.5}$. This TSD will focus on the demonstration of noninterference with NAAQS and noninterference with Regional Haze regulations under sections 169A and 169B of the CAA.

3.3 Elements of TSD

To address the regulatory requirements as presented above, this TSD includes the following two elements:

- **Annual Emissions Analysis (Section 4)**. This section compares estimated emissions under baseline, BART control strategy, and BART Alternative operating strategies. The results are used to address the emission reduction provisions of 40 CFR § 51.308 as well as the demonstration of noninterference with NAAQS under Section 110(l) of CAA.

[5] http://www.4cleanair.org/Oldmembers/members/committee/criteria/110STAPPA.pdf

- **Visibility Impact Analysis (Section 5)**. This section compares the visibility impacts from CGS units on nearby Class I areas under baseline, BART control strategy, and the interim operating strategy under the two BART Alternative operating strategies. In particular, this section evaluates each of the interim operating strategies to demonstrate that each of these strategies achieves greater overall visibility benefits on average as compared to BART for CGS, consistent with 40 CFR § § 51.308(e)(2)(i) and 40 CFR § 51.308(e)(3). This section also demonstrates that the control strategies for CGS are consistent with the long-term goals and plans of the RHR and will not interfere with regional haze requirements under sections 169A and 169B of the CAA.

4. Annual Emissions

This section presents and compares estimated emissions under the baseline (without additional controls), the BART control strategy, and the interim operating strategy under the BART Alternative operating strategies. The results are used to address the emission reduction requirements under 40 CFR § 51.308 as well as the demonstration of noninterference with NAAQS under Section 110(l) of the CAA.

4.1 Scenarios for Emissions Evaluation

Six scenarios were evaluated. Two of the scenarios are the baseline and the BART control strategy as follows:

- **2014 Baseline**. This scenario reflects 2008 consent decree (CD) controls, which include new wet flue gas desulfurization (FGD) and low NOx burners (LNB) with over-fired air (OFA) on both units, and SCR on Unit 2.

- **BART Control Strategy (2016 EPA BART Reconsideration for NOx and 2012 ADEQ BART for SO_2 and PM)**. This scenario adjusts the NOx limitation to reflect 2016 EPA BART reconsideration. This scenario is consistent with 2012 ADEQ BART for SO_2 and PM, reflecting wet FGD controls for SO_2 and hot-side ESP controls for PM for both CGS units. Compared to the 2014 Baseline scenario, this scenario adjusts the NOx emission limit for Unit 1.

In addition, there are the following four seasonal curtailment options under the interim operating strategy for the BART Alternative:

- **IS1.** This scenario is identical to the 2014 Baseline scenario except that it includes a seasonal curtailment period from October 1 to April 15 for Unit 1.

- **IS2.** Compared to the 2014 Baseline scenario, this scenario incorporates operation at a lower SO_2 emissions rate for both units and a seasonal curtailment period from October 21 to January 31 for Unit 1.

- **IS3.** Compared to the 2014 Baseline scenario, this scenario incorporates operation at a lower SO_2 emissions rate for both units and a seasonal curtailment period from November 21 to January 20 for Unit 1. IS3 has a lower SO_2 emissions rate for both units and a shorter seasonal curtailment period than does IS2.

- **IS4.** Compared to the 2014 Baseline scenario, this scenario incorporates operation at a lower SO_2 emissions rate for both units, a lower NOx emissions rate for Unit 1, and a seasonal curtailment period from November 21 to January 20 for Unit 1. IS4 has a slightly higher SO_2 emissions rate for both units and a lower NOx emissions rate for Unit 1 than does IS3, and the same seasonal curtailment period as IS3.

Annual NOx, SO_2, and PM emissions were calculated using the operating parameters in Table 2. For comparison purposes, all scenarios were assumed to have the same average heat input rate and the same percentage for the annual (non-curtailed) utilization factor. For the interim operating strategy, utilization factors are based on the seasonal curtailment options of Unit 1 operations.

Average daily heat inputs for CGS Units 1 and 2 were derived from the Clean Air Markets Division (CAMD) heat input data for the period of 2008 to 2010, for operational hours on a daily basis.[6] This data set was also used to calculate the annual utilization rate using the hours of operation for each unit and the total number of

[6] Data available at the Clean Air Market Divisions website: http://ampd.epa.gov/ampd.

hours in the period.

The 2014 baseline emission factors are from the 2008 CD.[7] The BART control strategy reflects the 2016 EPA BART Reconsideration for NOx[8] and the 2012 ADEQ BART for SO_2 and PM for the two units.[9] The emission factors for IS 1-4 are previously presented in Table 1.

Table 2: Parameters Used for Emissions Estimation for Baseline, BART and Interim Operating Strategy

Scenario	Unit	Pollutant	Average EF (lb/MMBtu)	Average Heat Input (MMBtu/hr)	Annual Utilization Rate
2014 Baseline	Unit 1	NOx	0.320	3,986	92%
		SO_2	0.080	3,986	92%
		PM	0.030	3,986	92%
	Unit 2	NOx	0.080	4,018	97%
		SO_2	0.080	4,018	97%
		PM	0.030	4,018	97%
BART Control Strategy	Unit 1	NOx	0.065	3,986	92%
		SO_2	0.080	3,986	92%
		PM	0.030	3,986	92%
	Unit 2	NOx	0.080	4,018	97%
		SO_2	0.080	4,018	97%
		PM	0.030	4,018	97%
IS1 (Unit 1 curtailment period Oct 1 to April 15)	Unit 1	NOx	0.320	3,986	43%
		SO_2	0.080	3,986	43%
		PM	0.030	3,986	43%
	Unit 2	NOx	0.080	4,018	97%
		SO_2	0.080	4,018	97%
		PM	0.030	4,018	97%
IS2 (Unit 1 curtailment period Oct 21 to Jan 31)	Unit 1	NOx	0.320	3,986	66%
		SO_2	0.070	3,986	66%
		PM	0.030	3,986	66%
	Unit 2	NOx	0.080	4,018	97%
		SO_2	0.070	4,018	97%
		PM	0.030	4,018	97%
IS3 (Unit 1 curtailment period Nov 21 to Jan 20)	Unit 1	NOx	0.320	3,986	77%
		SO_2	0.050	3,986	77%
		PM	0.030	3,986	77%
	Unit 2	NOx	0.080	4,018	97%
		SO_2	0.050	4,018	97%
		PM	0.030	4,018	97%
IS4 (Unit 1 curtailment period Nov 21 to Jan 20)	Unit 1	NOx	0.310	3,986	77%
		SO_2	0.060	3,986	77%
		PM	0.030	3,986	77%
	Unit 2	NOx	0.080	4,018	97%
		SO_2	0.060	4,018	97%
		PM	0.030	4,018	97%

[7] United States v. Salt River Project Agricultural Improvement and Power District, Civil Action No. 2:08-cv-1479- JAT (D. Ariz.), August 12, 2008.
[8] 81 Fed. Reg. 21735 (Apr. 13, 2016).
[9] 77 Fed. Reg. 72512 (Dec. 5, 2012).

4.2 Annual Emissions Estimation and Comparison

Table 3 presents the estimates of annual emissions of PM, NOx, and SO_2 under varied operating scenarios.

Table 3: Annual Emissions for 2014 Baseline, BART, and BART Alternatives

Scenario	Unit	Pollutant	Annual Emission (tons/year)
2014 Baseline	Unit 1	NOx	5,140
		SO_2	1,285
		PM	482
	Unit 2	NOx	1,366
		SO_2	1,366
		PM	512
BART Control Strategy	Unit 1	NOx	1,044
		SO_2	1,285
		PM	482
	Unit 2	NOx	1,366
		SO_2	1,366
		PM	512
IS1 (Unit 1 curtailment period Oct 1 to April 15)	Unit 1	NOx	2,402
		SO_2	601
		PM	225
	Unit 2	NOx	1,366
		SO_2	1,366
		PM	512
IS2 (Unit 1 curtailment period Oct 21 to Jan 31)	Unit 1	NOx	3,687
		SO_2	807
		PM	346
	Unit 2	NOx	1,366
		SO_2	1,195
		PM	512
IS3 (Unit 1 curtailment period Nov 21 to Jan 20)	Unit 1	NOx	4,302
		SO_2	672
		PM	403
	Unit 2	NOx	1,366
		SO_2	854
		PM	512
IS4 (Unit 1 curtailment period Nov 21 to Jan 20)	Unit 1	NOx	4,167
		SO_2	807
		PM	403
	Unit 2	NO_x	1,366
		SO_2	1,024
		PM	512

Table 4 summarizes the combined Unit 1 and Unit 2 annual emissions for PM, NOx, and SO_2.

Table 4: Combined Unit 1 and Unit 2 Annual Emissions (tons/year)

Operating Strategies	NO_X	SO_2	PM	Total
2014 Baseline	6,506	2,651	994	10,151
BART Control Strategy	2,410	2,651	994	6,055
IS1	3,768	1,966	737	6,472
IS2	5,053	2,002	858	7,912
IS3	5,667	1,526	915	8,109
IS4	5,533	1,831	915	8,279

Table 5 compares the annual emission reductions for the interim operating strategy and the BART control strategy relative to the 2014 baseline emissions. As indicated in Table 5, 2016 EPA BART Reconsideration would result in a total NOx emission reduction below the 2014 baseline emissions of 63% or the 4,096 tons/year due to the implementation of SCR on Unit 1. Although the NOx reductions from the interim operating strategy would be less than the 63% reduction under the 2016 EPA BART Reconsideration, the BART Alternative would produce significant SO_2 and PM emissions reductions. SO_2 emissions reductions from the CGS units would range from 24% to 42%, and PM emissions reductions would range from 8% to 26%. This is because, under the BART Alternative, during the interim operating strategy implementation period, SRP would reduce SO_2 emissions from both of the CGS units through (i) annual operation at a lower SO_2 emissions rate and/or (ii) seasonal curtailment of CGS Unit 1. In addition, under the interim operating strategy, SRP would reduce PM emissions from both units through seasonal curtailment of CGS Unit 1.

Table 5: Annual Emission Reductions Associated with the BART and Interim Operating Strategy (Part of BART Alternative) as Compared to the 2014 Baseline Emissions

Strategy Comparison	NOx Reduction		SO_2 Reduction		PM Reduction	
	(tons/year)	Percentage	(tons/year)	Percentage	(tons/year)	Percentage
BART Control Strategy	-4,096	63%	0	0%	0	0%
IS1	-2,738	42%	-684	26%	-257	26%
IS2	-1,453	22%	-649	24%	-136	14%
IS3	-832	13%	-1,125	42%	-79	8%
IS4	-972	15%	-820	31%	-79	8%

Based on the above data, the following conclusions can be made:

- The BART Alternative provides significant reductions in emissions of NOx, SO_2, and PM as compared to the 2014 baseline. The emissions reductions resulting from the BART Alternative would be surplus to those reductions resulting from measures adopted to meet requirements of the Clean Air Act as of the baseline date of the SIP.

- The total tonnage of emissions reductions under all four seasonal curtailment options under the interim operating strategy is less than that under the 2016 EPA BART Reconsideration, but the 2016 EPA BART Reconsideration realizes emissions reductions solely from NOx control while the BART Alternative realizes reductions in NOx, SO_2, and PM. SRP performed a dispersion modeling analysis to demonstrate that the BART Alternative would provide overall improvement in visibility compared to the BART control strategy.

As the BART Alternative would result in greater SO_2 emission reductions (as well as PM emission reductions) but lower NOx emission reductions when compared with the BART control strategy, the modeling analysis evaluates the trade-offs of visibility benefits between SO_2 emission reductions and NOx emission reductions. Section 5 presents detailed modeling analyses for visibility impacts.

4.3 Long-Term Annual Emissions under the BART Alternative

As previously discussed, the BART Alternative operating strategies include an interim operating strategy followed by either SCR installation on Unit 1 or Unit 1 shutdown. To better understand the changes of annual emissions under BART Alternative, ADEQ examined the emissions expectations during 2015-2035 for the relevant pollutants (PM, SO_2, and NOx). ADEQ further evaluated the potential impact of the control strategies on the attainment and maintenance of NAAQS. It should be noted that the long-term annual emissions estimates were based on the emission limits imposed rather than the actual emissions.

To simplify the calculations, the following assumptions were made:

- The BART Alternative will take effect on December 5, 2017;
- SRP will commit to the final BART Alternative operating strategy no later than December 31, 2026;
- Under OS-1, the "SCR installation" scenario, an SCR system will be installed and operated at Unit 1 by December 31, 2029; and
- Under OS-2, the "shutdown" scenario, SRP will permanently cease operation of Unit 1 no later than December 31, 2029.

4.3.1 Long-Term Annual Emissions of PM

Figure 2 shows long-term annual emissions of PM at CGS over the period from 2015 through 2035. It should be noted that the PM metric includes only filterable PM emissions and does not include condensable PM emissions such as the H_2SO_4 and other PM emissions that would result from installation and operation of SCR at Unit 1 under the BART Control Strategy.

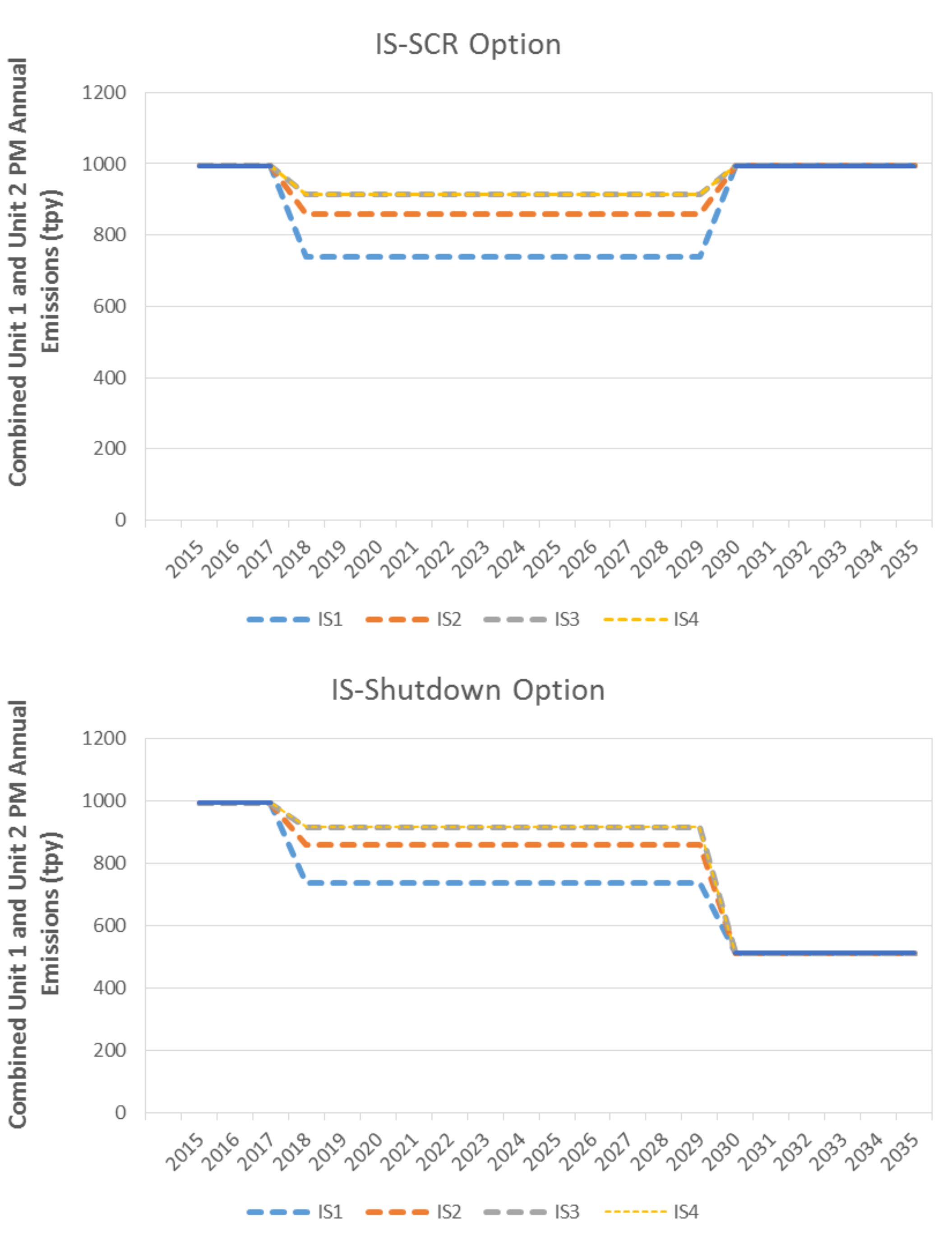
For OS-1 under the BART Alternative, the PM emissions control strategies are generally consistent with those of the 2011 AZ SIP except that they include a seasonal curtailment period, resulting in lower annual emissions during 2017-2029. OS-2 under the BART Alternative also includes a seasonal curtailment period from 2017 to the date of the unit closure, which would be no later than December 31, 2029. The permanent shutdown of Unit 1 would significantly reduce facility-wide PM emissions, resulting in additional long-term environmental benefits. For either of the operating strategies under the BART Alternative, the PM annual emissions would be equal to or lower than the existing emissions for any periods.

CGS is located in Apache County, Arizona. The area is designated as attainment or unclassifiable for PM_{10} and $PM_{2.5}$ (1997, 2006, and 2012 NAAQS),[10] and there are no nonattainment or maintenance SIPs that would rely on emission reductions at CGS to ensure continued attainment of the NAAQS. OS-2 would result in significant reductions of PM_{10} and primary $PM_{2.5}$ emissions (and, by December 31, 2029, elimination of all PM emissions from Unit 1). For OS-1, the installation of an SCR system would result in significant increases in emissions of H_2SO_4 and thus emissions of PM_{10} and primary $PM_{2.5}$. However, the dispersion modeling analysis indicates that these emissions increases will not cause or contribute to a violation of the NAAQS or PSD increment for PM_{10} and $PM_{2.5}$ (see Appendix C: TSD for SPR #63088). Moreover, both strategies would achieve significant emission reductions of SO_2 and NOx (as discussed later in Sections 4.3.2 and 4.3.3), which is an effective

[10] EPA, The Green Book Nonattainment Areas for Criteria Pollutants, at http://www.epa.gov/airquality/greenbook/(last visited Mar. 24, 2015).

strategy for reducing secondary $PM_{2.5}$ formation. Therefore, the BART Alternative will not result in any interference with attainment or maintenance of the PM_{10} or $PM_{2.5}$ NAAQS.

Figure 2: Annual Emissions of PM over 2015-2035 under BART Alternative



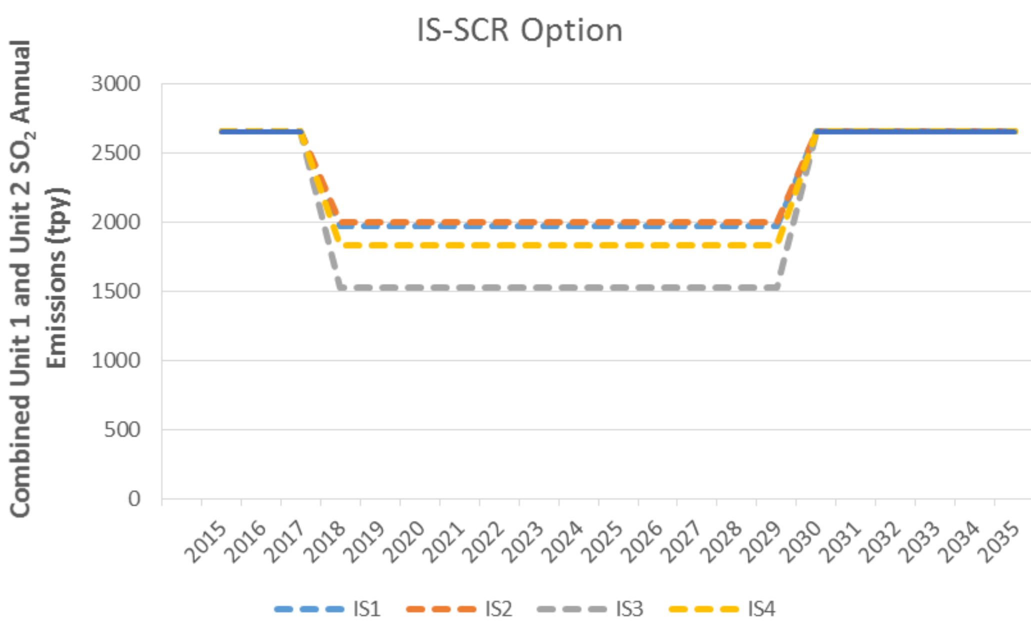
4.3.2 Long-Term Annual Emissions of SO_2

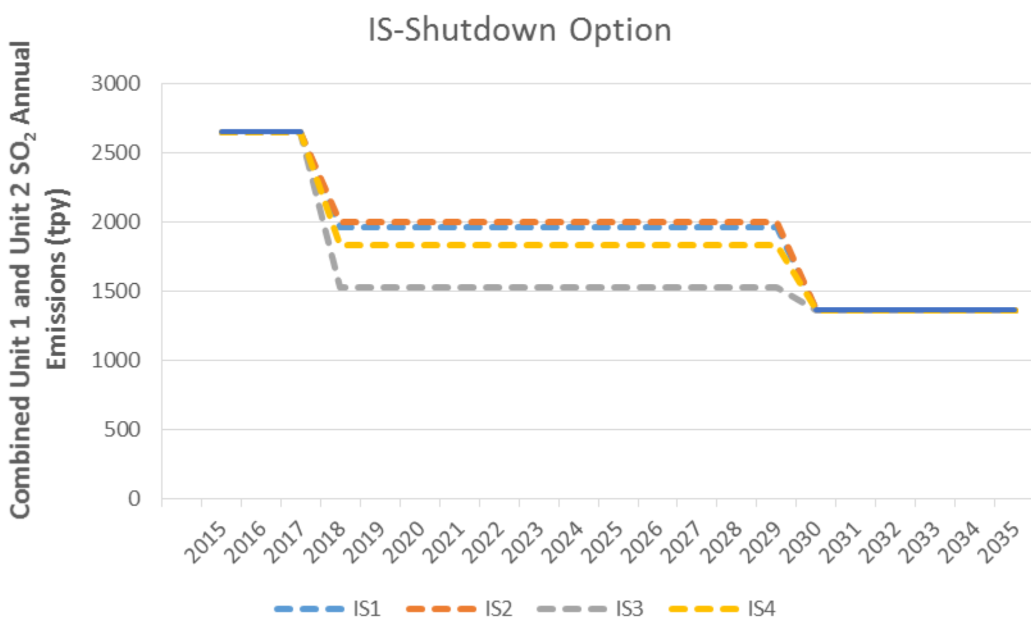
Figure 3 shows long-term annual emissions of SO_2 at CGS over 2015-2035. For OS-1 under the BART Alternative, the SO_2 emissions control strategies are generally consistent with those of the 2011 AZ SIP except that they include a seasonal curtailment period, resulting in lower annual SO_2 emissions during 2017-2029. OS-2 under the BART Alternative also includes a seasonal curtailment period from 2017 to the date of the unit closure, which would occur no later than December 31, 2029. In addition, three of the four interim operating strategies involve a reduction in the SO_2 emission rate at both Unit 1 and Unit 2. The permanent shutdown of Unit 1 would significantly reduce facility-wide SO_2 emissions, resulting in additional long-term environmental benefits. For either of the operating strategies under the BART Alternative, the SO_2 annual emissions would be equal to or lower than the existing emissions for any periods.

Apache County is designated as attainment or unclassifiable for the 1971 SO_2 NAAQS (see Footnote 10). Although designations have not yet been made for the 2010 SO_2 NAAQS, the area was recommended by the state as attainment or unclassifiable under CAA Section 107(d)(1)(A).[11] There are no nonattainment or maintenance SIPs that would rely on emission reductions at CGS to ensure continued attainment of the NAAQS. Therefore, the BART Alternative for CGS will not interfere with attainment or maintenance of the SO_2 NAAQS.

[11] *See generally* ADEQ, *Air Quality Division: Plans*, at http://www.azdeq.gov/environ/air/plan/so2.html.

Figure 3: Annual Emissions of SO_2 over 2015-2035 under BART Alternative





4.3.3 Long-Term Annual Emissions of NO_x

Figure 4 shows long-term annual emissions of NO_x at CGS over 2015-2035. For OS-1 under the BART Alternative, the implementation of seasonal curtailment would moderately or slightly reduce NO_x emissions during 2017-2029 due to a seasonal curtailment period for Unit 1. Beginning in 2030 onwards, the installation of a SCR system at Unit 1 would achieve significant additional NOx emission reductions. OS-2 under the BART Alternative also includes a seasonal curtailment period from 2017 to the date of the unit closure, which would occur no later than December 31, 2029. The permanent shutdown of Unit 1 would significantly reduce facility-wide NOx emissions, resulting in additional long-term environmental benefits. For either of the operating strategies under the BART Alternative, the NOx annual emissions would be lower than the existing emissions for any periods.

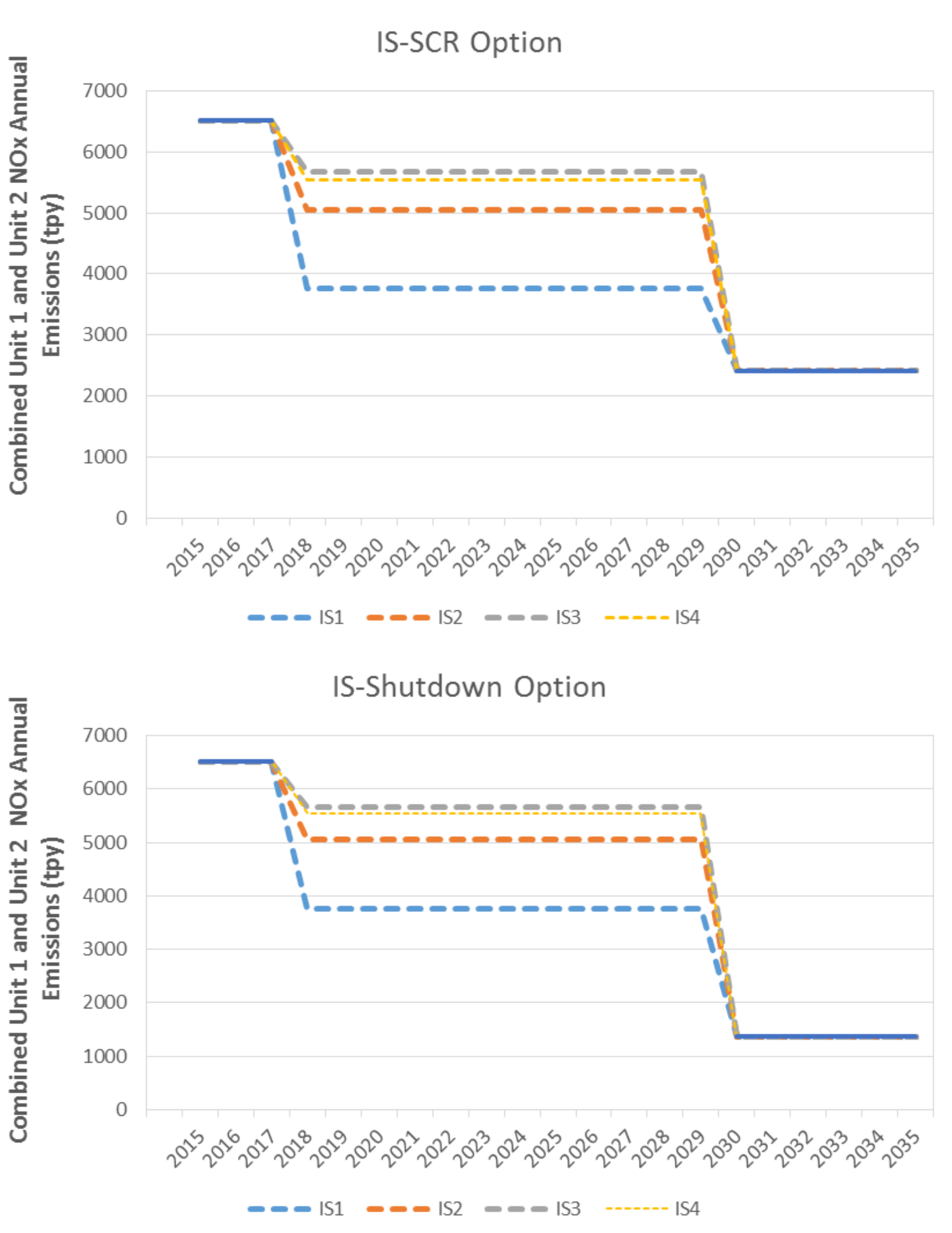
Apache County is designated as attainment or unclassifiable for the NO_2 NAAQS (see Footnote 10), and there are no nonattainment or maintenance SIPs that would rely on emission reductions at CGS to ensure continued attainment of the NAAQS. Since the BART Alternative will result in NOx emission reductions relative to the existing operating conditions of the facility, the BART Alternative will not interfere with attainment or maintenance of the NO_2 NAAQS.

NOx emissions under the BART Alternative are higher than those under the 2016 EPA BART Reconsideration during the 2017-2029 period. While the BART Alternative is less stringent than the 2016 EPA BART Reconsideration with respect to NOx controls during the 2017-2029 period, section 110(l) of the CAA does not require a BART Alternative to be more stringent for emission controls for each criteria pollutant in every instance, and at every point in time, to be approvable and to supersede a prior BART determination. Rather, Section 110(l) of the CAA addresses whether the SIP revisions will interfere with attainment of the NAAQS or RFP. Apache County does not rely on the EPA FIP for CGS to ensure continued attainment of the NO_2 NAAQS or to meet any RFP requirements. The 2016 EPA BART Reconsideration does not represent existing control measures that have been implemented for attainment or maintenance of the NAAQS. As shown in Figure 4, facility-wide emissions of NOx at CGS will be reduced under the BART Alternative compared to current levels.

NOx is one of the most important precursors of ozone. Apache County is designated attainment/unclassifiable for the 2008 ozone NAAQS. There is no evidence that Apache County will violate the 2015 NAAQS and the proposed nonattainment-area boundaries for the 2015 ozone NAAQS issued by ADEQ on May 31, 2016 do not include Apache County.[12] Although the BART Alternative is less stringent for NOx than the EPA FIP during 2017-2029, Apache County does not rely on the EPA FIP for CGS to ensure continued attainment of the ozone NAAQS or to meet any RFP requirements. Therefore, the BART Alternative will not interfere with attainment or maintenance of the NAAQS for ozone.

[12] http://legacy.azdeq.gov/calendar/draft_rpt_naaqs.pdf (last visited on July 12, 2016).

Figure 4: Annual Emissions of NOx over 2015-2035 under BART Alternative



5. Modeled Visibility Impacts

SRP performed a dispersion modeling analysis to demonstrate "greater reasonable progress." This section quantifies the visibility benefits of the BART Alternative compared to the BART control strategy (2016 EPA BART Reconsideration for NOx and 2012 ADEQ BART for SO_2 and PM).

5.1 Model Selection

5.1.1 CALPUFF versus Photochemical Grid Models (PGMs)

In 2005, EPA recommended that the states use the CALPUFF model for implementation of the BART requirements under the Regional Haze Rule.[13] Since 2005, states have used CALPUFF in hundreds of BART determinations. However, there are fundamental differences between BART analyses and the "Better than BART" demonstration for BART alternatives. BART analyses with CALPUFF are targeted towards assessing the maximum (or 98th percentile) impacts of a single facility's sources on Class I areas without considering any other emission sources. For a "Better than BART" demonstration, however, the language of 40 CFR 51.308(e) addresses "greater reasonable progress" that would resulted from BART alternatives compared to BART. To demonstrate "greater reasonable progress," a full photochemical grid model (PGM) that includes modeling of all emissions in the modeling domain may be more appropriate in many circumstances than CALPUFF.

From a scientific perspective, CALPUFF uses a rather simple chemistry mechanism while PGMs use a significantly more complex chemistry mechanism. In July 2015, EPA proposed revisions to its modeling guidelines that would delist CALPUFF as the EPA-preferred long range transport model, mainly due to the fact that CALPUFF has highly simplified chemical transformation algorithms that have been shown to have bias in sulfate and nitrate formation.[14] Instead, EPA proposed to recommend PGMs for applications involving secondary $PM_{2.5}$ formation, including visibility impairment due to sulfate and nitrate.

Due to the reasons above, a PGM rather than CALPUFF was used for CGS Better-than-BART modeling.

5.1.2 Comprehensive Air-Quality Model with Extensions (CAMx)

The Comprehensive Air-Quality Model with extensions (CAMx) was selected for the CGS Better-than-BART demonstration.[15] The reasons are:

- CAMx is one of the two PGMs referred to in EPA's latest modeling guidelines and guidance[16] that satisfies all the requirements for simulating secondary $PM_{2.5}$ formation.

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[13] CFR Part 51 Regional Haze Regulations and Guidelines for Best Available Retrofit Determinations. http://www.gpo.gov/fdsys/pkg/FR- 2005-07-06/pdf/05-12526.pdf

[14] Revision to the Guideline on Air Quality Models: Enhancement to the AERMOD Dispersion Modeling System and Incorporation of Approaches to Address Ozone and Fine Particulate Matter – Appendix W. 40 CFR Part 51. http://www.epa.gov/ttn/scram/11thmodconf/9930-11- OAR_AppendixW_Proposal.pdf

[15] http://www.camx.com/

[16] Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze. http://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM- RH_Modeling_Guidance-2014.pdf

- CAMx includes full science chemistry algorithms for secondary $PM_{2.5}$ formation (e.g., sulfate and nitrate) that is important in this application. Given that the CGS BART Alternative modeling involves assessment of visibility benefits from reductions in SO_2 emissions (in the alternative strategies) versus visibility benefits from reduced NOx emissions (in the BART control strategy), accurate and unbiased treatment of sulfate and nitrate formation chemistry is needed.

- The databases that, in part, are necessary to perform the CAMx modeling analysis are available and adequate. The CAMx modeling for CGS extensively used a 2008 modeling database that was originally developed as part of the Western Regional Air Partnership (WRAP) West-wide Jump-Start Air Quality Modeling Study [17] and then adopted by the Western Air Quality Study.[18] The 2008 modeling database is complete and comprehensive.

- CAMx includes a subgrid-scale Plume-in-Grid (PiG) chemically reactive Gaussian puff model to treat the near-source plume dispersion, dynamics and chemistry within point-source plume, which is critical for CGS modeling. It also includes a mature, fully tested and evaluated Particulate Source Apportionment Technology (PSAT) tool for separately tracking the particulate matter impacts associated with emissions from CGS.

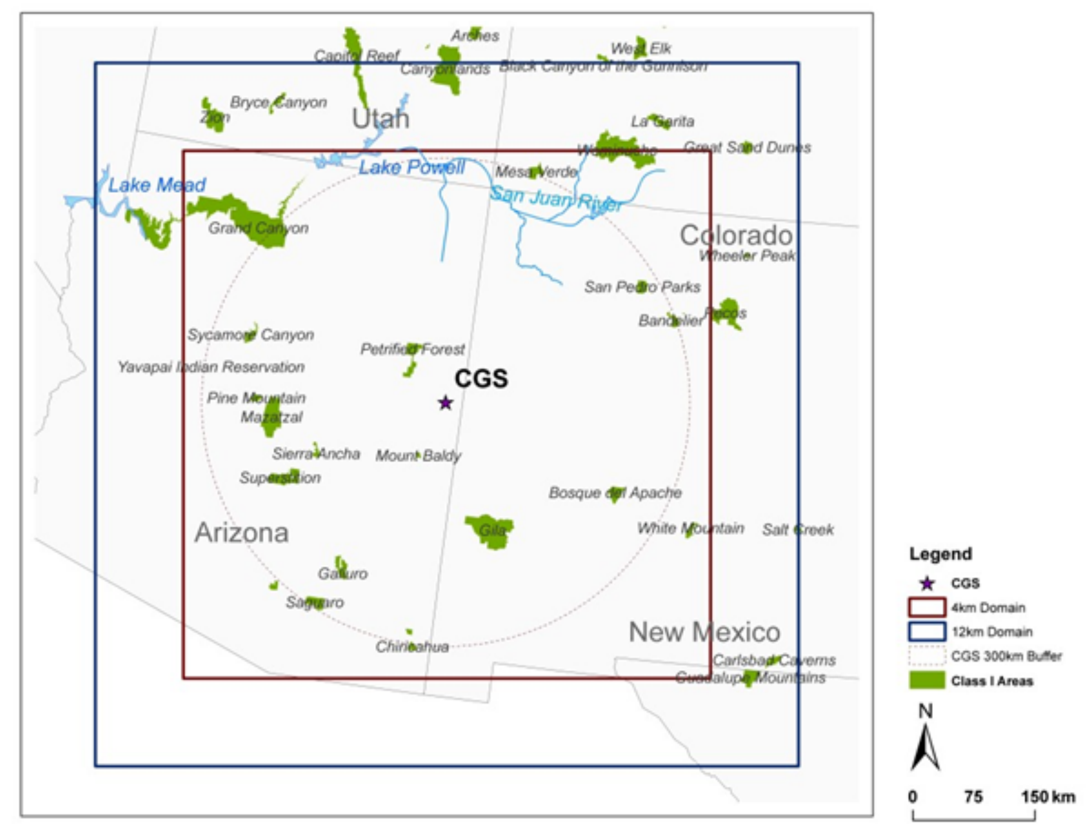
- The model performance evaluation for CAMx has shown that the model is not inappropriately biased for regulatory application (see Section 5.4).

5.2 Modeling Domain

The model domain setup must consider source-receptor couples, influence of boundary conditions, adequate resolution in key areas, and resource/time constraints. The CAMx CGS modeling domain is shown in Figure 5. The modeling domain is a nested 12 km and 4 km horizontal resolution modeling domain centered on CGS. The 4 km domain covers an area out to 300 km from CGS, which provides sufficient resolution to estimate the visibility impacts from CGS on all Class I areas within 300 km of CGS.

[17] http://www.wrapair2.org/WestJumpAQMS.aspx; http://www.wrapair2.org/pdf/WestJumpAQMS_FinRpt_Finalv2.pdf
[18] http://views.cira.colostate.edu/tsdw/

Figure 5: CGS CAMx 12/4 km Resolution Modeling Domains with Circle of Radius 300 km Centered on CGS



5.3 Model Inputs

CAMx inputs were developed using independent third-party models and processing tools that characterize meteorology, emissions, land cover, radiative/photolysis properties, and initial/boundary conditions (IC/BCs). For model performance evaluation purposes, the CAMx modeling for CGS used a 2008 modeling database that was originally developed as part of the Western Regional Air Partnership (WRAP) West-wide Jump-Start Air Quality Modeling Study and then adopted by the Western Air Quality Study. For detailed model inputs and associated technical memorandums, please refer to the WestJumpAQMS website:

http://www.wrapair2.org/WestJumpAQMS.aspx#.

For the "Better-than-BART" demonstration, the CAMx modeling for CGS used a future year (2020) emissions CAMx modeling database instead of the 2008 emissions CAMx modeling database. Moreover, the "Better-than-BART" CAMx simulations used initial/boundary conditions based on the 2020 emissions inventory as well. For other model inputs such as meteorology, the 2008 modeling database was still used.

5.3.1 Model Inputs for Meteorology, Photolysis, and Geographic and Initial/Boundary Conditions

Table 6 provides a summary of the key model inputs for meteorology, photolysis, and geographic and initial/boundary conditions for the CAMx modeling for CGS. More details about meteorology are provided below.

For the WestJumpAQMS study, the Weather Research Forecast (WRF3 Version 3.3.1) Advanced Research WRF (WRF-ARW) was applied for the 2008 calendar year on 36 km continental U.S. (CONUS), 12 km western U.S. (WESTUS) and 4 km Intermountain West Domain (IMWD) modeling domains.[19] WRF is a next-generation mesoscale prognostic meteorological model routinely used for urban- and regional-scale photochemical, fine particulate and regional haze regulatory modeling studies. WRF-ARW has become the new standard model used in place of the older Mesoscale Meteorological Model (MM5) for regulatory air quality applications in the U.S. It is suitable for use in a broad spectrum of applications across scales ranging from hundreds of meters to thousands of kilometers.

The WestJumpAQMS 2008 WRF model performance was evaluated against surface wind, temperature and mixing ratio observations and maps of precipitation analysis fields based on observations prepared by the Climate Prediction Center (CPC). It was concluded that the WestJumpAQMS 2008 WRF application exhibited reasonably good model performance that was as good as or better than other recent prognostic model applications used in air quality planning and it was therefore reasonable to proceed with its use for inputs for CGS photochemical grid modeling.

[19] http://www.wrapair2.org/pdf/WestJumpAQMS_2008_Annual_WRF_Final_Report_February29_2012.pdf

Table 6: Model Inputs for Meteorology, Photolysis, and Geographic and Initial/Boundary Conditions

Components of Model Inputs	Data Fields	Models & Pre-Processers	Configuration
Meteorology	3-dimensional gridded fields of meteorological parameters	Weather Research and Forecast (WRF)[20]	WRF was used in WestJumpAQMS to generate the CAMx meteorological input files for the 2008 calendar year; WRF was configured with a 36/12/4 km nested domain structure using the LCP projection parameters; WRF was run with 37 vertical layers up to 50 mb (approximately 19 km above sea level) that were collapsed to 25 CAMx layers.
Geographic	Gridded surface characteristics	GIS Processing and MERGE_ LULAI	CGS 12 and 4 km resolution land use files were based on USGS Geographic Information Retrieval and Analysis System (GIRAS) data, which contain the fraction of land cover in each of the 26 land use categories in the Zhang deposition scheme [21]used by CAMx; monthly leaf area indices in each grid cell were prepared for the Zhang deposition scheme.
Photolysis	Gridded ozone column codes and photolysis rates lookup table	O3MAP, The Tropospheric Ultraviolet and Visible (TUV) radiative transfer model[22]	Global and daily ozone column data were obtained from the database of space-based measurements from the Ozone Monitoring Instrument (OMI) on the Aura satellite and processed for the 12 and 4 km domains using the O3MAP program. The TUV model developed by NCAR used ozone column outputs and appropriate chemical mechanism to calculate the photolysis rates.
Initial and Boundary Conditions	Gridded initial concentrations, gridded lateral/top boundary concentrations	MOZART global chemistry model[23]	For model performance evaluation, CAMx initial and boundary conditions for CGS 12/4 km domain were prepared by extracting hourly atmospheric concentrations of all modeled pollutants from the WestJumpAQMS 36 km CONUS and 12 km WESTUS 3-dimensional CAMx model outputs. The Better-than-BART CAMx simulations used IC/BCs from 3-dimensional model outputs of a 36 km CAMx simulation based on the 2020 EPA emissions inventory with updates.

[20] http://www.wrf-model.org/index.php
[21] Zhang, et al., 2001. Atmos. Environ., 35, 549-560; Zhang, et al, 2003. Atmos. Chem. Phys., 3, 2067–2082.
[22] https://www2.acom.ucar.edu/modeling/tropospheric-ultraviolet-and-visible-tuv-radiation-model
[23] https://www2.acom.ucar.edu/gcm/mozart

Components of Model Inputs	Data Fields	Models & Pre-Processers	Configuration
Chemistry	Chemical mechanism and associated species properties and reaction types and rates		Revision 2 of the Carbon Bond Version 6 chemical mechanism (CB6r2) defined in the CAMx control file.

5.3.2 Model Inputs for Emissions

Emission inputs for model performance evaluation

For model performance evaluation purposes, the emissions were taken directly from the WestJumpAQMS emissions inventory and are referred to as the Actual 2008 Base Case emissions. The primary source for the 2008 base case emissions was Version 2.0 of the National Emission Inventory (NEIV2.0).[24] Table 7 provides a summary of emission sources used to develop the 2008 actual base case emissions.

For major (≥ 25 MWe) electric generating units (EGUs) including CGS, emissions of SO_2 and NOx were hour-specific Continuous Emissions Monitor (CEM) measurement data from the EPA Clean Air Markets Division (CAMD). The temporal variability of other pollutant emissions besides SO_2 and NOx were estimated using the hourly CEM heat input data to allocate the annual emissions from the NEIv2.0 to each hour of the year.

Table 7: Emission Sources Used to Develop the 2008 Actual Base Case Emissions for Model Performance Evaluation

Emissions Component	Configuration	Details
Oil and Gas Emissions	Update WRAP Phase III 2006 to 2008	Seven WRAP Phase III Basins in CO, NM, UT and WY plus add 2008 Permian Basin O&G Emissions
Area Source Emissions	2008 NEIv2.0	Western state updates, then SMOKE processing of http://www.epa.gov/ttn/chief/net/2008inventory.html
On-Road Mobile Sources	MOVES	MOVES 2008 emissions run in inventory mode
Point Sources	2008 CEM and Non-CEM Sources	Use 2008 day-specific hourly measured CEM for SO_2 and NOx emissions for CEM sources, 2008 NEIv2.0 for other pollutants and non-CEM sources
Off-Road Mobile Sources	2008 NEIv2.0	Based on EPA NONROAD model http://www.epa.gov/oms/nonrdmdl.htm
Wind Blown Dust Emissions	WRAP Wind Blown Dust (WBD)	WRAP WBD Model with 2008 WRF meteorology adjusted to be consistent with 2002 WBD modeling
Ammonia Emissions	2008 NEIv2.0	Based on CMU Ammonia Model. Review and update spatial allocation if appropriate.

[24] http://www.epa.gov/ttn/chief/net/2008inventory.html

Emissions Component	Configuration	Details
Biogenic Sources	MEGAN	Enhanced version of MEGAN Version 2.1 from WRAP Biogenics study http://www.wrapair2.org/pdf/WGA_BiogEmisInv_FinalReport_Ma rch20_2012.pdf
Fires	2008 DEASCO3	2008 DEASCO3 fire inventory used. https://wraptools.org/pdf/ei_methodology_20130930.pdf
Temporal Adjustments	Seasonal, day, hour	Based on latest collected information
Chemical Speciation	CB6r2 Chemical Speciation	Revision 2 of the Carbon Bond Version 6 chemical mechanism
Gridding	Spatial Surrogates based on land use	Develop new spatial surrogates using 2010 census data and other data
Quality Assurance	SMOKE QA Tools; PAVE, VERDI plots; Summary reports	Follow WRAP emissions QA/QC plan.

Emission inputs for "Better-than-BART" demonstration

For "Better-than-BART" demonstration purposes, the CAMx modeling used a future year (2020) emissions modeling database instead of the 2008 base case emissions database.

The regional inventory that was used to develop the future year emissions scenario for the Better-than-BART CAMx modeling is based on the 2020 EPA emissions inventory used for the PM NAAQS Rule (available at http://www.epa.gov/ttn/chief/emch). The 2020 EPA emissions inventory represents projected emissions with promulgated Federal and State control measures, as well as projected economic changes and fuel usage for EGU and mobile sectors. Oil and gas emissions were updated from the 2020 EPA inventory to account for additional reasonably foreseeable development (RFD). The RFD is defined as: i) air emissions from the undeveloped portions of authorized NEPA projects and Resource Management Plans (RMPs), and ii) air emissions from not-yet-authorized NEPA projects (if emissions are quantified when emissions modeling commences). These sources are in addition to regional sources present in the 2020 EPA emissions inventory. For the future year emissions scenarios, the following emission categories were assumed to remain unchanged from the 2008 base case emissions scenario:

- Biogenic emissions;
- Fire emissions;
- Lightning emissions;
- Sea salt emissions; and
- Windblown dust emissions.

Table 8 presents six separate CGS emissions scenarios, including baseline, BART control strategy, and four seasonal curtailment options (IS1, IS2, IS3 and IS4) under the interim operating strategy for the BART Alternative. As shown in Table 8, the emission factors for SO_2 and NOx emissions rates (lb/MMBtu) vary among different scenarios. The emissions of PM were specified following the NPS Particulate Matter Speciation recommendations for dry-bottom pulverized coal-fired boilers equipped with FGD and ESP controls.[25] The CGS unit 1 and 2 daily and hourly heat input data were analyzed from EPA's Acid Rain database for the 5 year

[25] https://www.nature.nps.gov/air/permits/ect/index.cfm

period (2006-2010), centered on the BART analysis 2008 baseline year, to develop monthly and hourly emission scalars that reflect the typical seasonal and diurnal variations in heat input rates and resulting mass emission rates. The full load mass emission rates in Table 8 were then multiplied by the monthly and diurnally varying emission scalars to calculate time varying mass emission rates that were input to the CAMx model. During the Unit 1 shutdown periods for the alternative strategies, the emissions for Unit 1 were set to zero.

Table 8: CGS Emission Rates for Baseline, BART and Four Seasonal Curtailment Options under Interim Operating Strategy

Scenario	Unit	lb/MMBtu		Emissions in pounds per hour**								
		SO_2 Emission Factor	NOx Emission Factor	SO_2	SO4	NOx	HNO_3	NO_3	PMF	PMC	EC	SOA
Baseline	1	0.08	0.32	377.5	1.89	1,510.1	0	0	59.03	80.27	2.3	0
	2	0.08	0.08	377.5	12.4	377.5	0	0	59.03	80.27	2.3	0
BART Control Strategy *	1	0.08	0.065	377.5	12.4	306.7	0	0	59.03	80.27	2.3	0
	2	0.08	0.08	377.5	12.4	377.5	0	0	59.03	80.27	2.3	0
IS1	1	0.08	0.32	377.5	1.89	1,510.1	0	0	59.03	80.27	2.3	0
	2	0.08	0.08	377.5	12.4	377.5	0	0	59.03	80.27	2.3	0
IS2	1	0.07	0.32	330.3	1.89	1,510.1	0	0	59.03	80.27	2.3	0
	2	0.07	0.08	330.3	12.4	377.5	0	0	59.03	80.27	2.3	0
IS3	1	0.05	0.32	236.0	1.89	1,510.1	0	0	59.03	80.27	2.3	0
	2	0.05	0.08	236.0	12.4	377.5	0	0	59.03	80.27	2.3	0
IS4	1	0.06	0.31	283.1	1.89	1,462.9	0	0	59.03	80.27	2.3	0
	2	0.06	0.08	283.1	12.4	377.5	0	0	59.03	80.27	2.3	0

**2016 EPA BART Reconsideration for NOx and 2012 ADEQ BART for PM and SO_2.*
*** These emission rates represent full load mass emission rates based on the maximum heat input rate of 4,719 MMBtu/hr for each unit.*

5.4 Model Performance Evaluation

The model performance evaluation (MPE) for CGS CAMx 2008 12/4 km Actual Base Case simulation focused on the model's ability to simulate $PM_{2.5}$ total mass, $PM_{2.5}$ individual species mass, and species specific visibility extinctions since the focus of this study is to assess visibility impacts only. This MPE relied on WestJumpAQMS and Western Air Quality Study (WAQS) CAMx 2008 base case MPE results, which are documented in the WestJumpAQMS final report [26] and the WAQS report.[27]

This section presents a summary of the evaluation of CGS 2008 12/4 km Actual Base Case simulation for visibility.

[26] http://wrapair2.org/pdf/WestJumpAQMS_FinRpt_Finalv2.pdf
[27] http://views.cira.colostate.edu/tsdw/Documents/

5.4.1 Model Performance Evaluation Approach

CGS CAMx 2008 12/4 km Actual Base Case was evaluated by comparing the model's $PM_{2.5}$ and visibility predictions at Interagency Monitoring of Protected Visual Environments (IMPROVE) sites in the CGS 4 km domain. The sites include: Bandelier (BAND1); Chiricahua (CHIR1); Grand Canyon (GRCA2); Mesa Verde (MEVE); Petrified Forest (PEFO1); Saguaro (SAGU1); San Pedro Parks (SAPE1); Sierra Ancha (SIAN1); and Sycamore Canyon (SYCA1).

The predicted and observed $PM_{2.5}$ species and NO_2 concentrations were converted to visibility extinction using the latest IMPROVE equation and Class I area-specific relative humidity adjustment factors [f(RH)] following the procedures in the 2010 Federal Land Managers' Air Quality Related Values Work Group (FLAG) report.[28] The total and species-specific $PM_{2.5}$ mass and visibility extinction model performance statistics were compared against established PM Performance Goals and Criteria as well as the more stringent ozone Performance Goals. Table 9 presents the PM Performance Goals and Criteria.

Table 9: PM Model Performance Goals and Criteria

Fractional Bias (FB)	Fractional Error (FE)	Comments
$\leq \pm 15\%$	$\leq 35\%$	Ozone model performance goal that would be considered very good model performance for PM species
$\leq \pm 30\%$	$\leq 50\%$	PM model performance goal, considered good PM performance
$\leq \pm 60\%$	$\leq 75\%$	PM model performance Criteria, considered average PM performance. Exceeding this level of performance for PM species with significant mass may be cause for concern.

5.4.2 Model Performance Evaluation Results

Bias and Error Statistics

Table 10 summarizes bias and error statistics averaged across IMPROVE monitoring sites in the 4 km CGS domain.

As indicated in Table 10, the annual average total visibility extinction achieves the most stringent ozone performance goal. The seasonal visibility model performance shows good performance for the warmer months and an overestimation bias for the cooler months. The monthly average total visibility extinction achieves the PM model performance criteria for all 12 months and achieves the PM model performance goal for 9 months. The overestimation bias in the winter months falls between the PM Performance Goals and Criteria.

The ammonium sulfate (AmmSO4) performance is fairly good with 9 of 12 months achieving the PM Performance Criteria. The PM Performance Criteria is not achieved in three winter months due to the overestimated bias.

The ammonium nitrate (AmmNO3) performance is fairly good with 9 of 12 months achieving the PM Performance Criteria. The PM Performance Criteria is not achieved for two winter months due to the overestimation bias and in one summer month due to the underestimation bias.

[28] http://www.nature.nps.gov/air/Pubs/pdf/flag/FLAG_2010.pdf

Table 10: Bias and Error Statistics Averaged across IMPROVE Monitoring Sites in the 4 km CGS Domain

Parameters	Bias and Error	Comments
Annual average total visibility extinction	Bias = 14%; Error = 34%	Achieve ozone model performance goal
Monthly average total visibility extinction	Bias ≤ ±60%) and error ≤ 75% for all 12 months of the year	Achieve PM model performance criteria
	Bias ≤ ±30%) and error ≤ 55% for 9 months of the year (March-November)	Achieve PM model performance goal
	Bias > 30% for winter months (December - February)	Overestimation bias
Ammonium sulfate	Bias ≤ ±60% and error ≤ 75% for 9 months of the year (March-November)	Achieve PM model performance criteria
	Bias > ±60% for winter months (December-February)	Overestimation bias
Ammonium nitrate	Bias ≤ ±60% and error ≤ 75% for 9 months of the year (March-July; September - December)	Achieve PM model performance criteria
	Bias > ±60% and/or Fractional error > 75%	Underestimation bias for Summer (August) and Overestimation bias for Winter (January and February) are fairly typical of PGMs.

Annual Average and Quarterly Average Speciated Extinction Performance by Monitor

Figure 6 displays stacked bar charts of annual and quarterly average total extinction at each IMPROVE site with the stacked bars showing each $PM_{2.5}$ component of extinction. For most sites, the observed and predicted annual average total extinction are similar, although the modeled annual average total extinction tends to be the same or slightly higher than the observed value. The modeled annual average extinction overestimation is primarily due to overstated extinction across several species in Q1 and Q4. The model extinction performance in Q2 and Q3 is quite good at all monitoring sites.

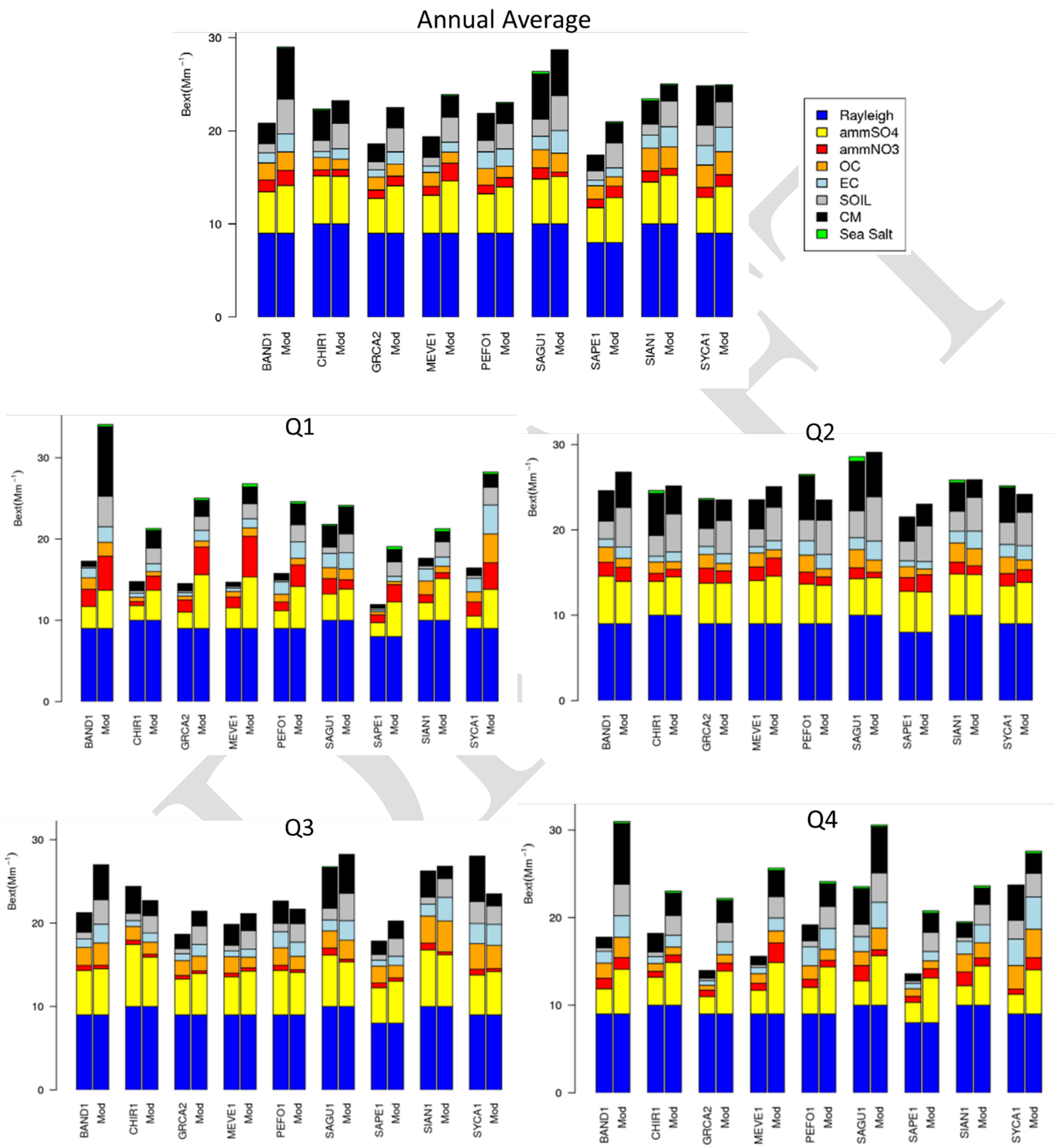
Annual average $AmmSO_4$ extinction agrees well at all IMPROVE sites. The quarterly average $AmmSO_4$ extinction performance in Q2 and Q3 is quite good at all monitoring sites. The model tends to overestimate AmmSO4 extinction in Q1 and Q4.

Annual average $AmmNO_3$ extinction agrees well at all IMPROVE sites. The model tends to underestimate the summer low values while it overestimates the winter high values, which is typical of $AmmNO_3$ performance with a PGM.

Conclusions

The main objective of CGS Better-than-BART visibility modeling is to evaluate the trade-offs of visibility benefits between reducing CGS's NOx versus SO_2 emissions. Given that the visibility performance for $AmmSO_4$ and $AmmNO_3$ is fairly good and mostly unbiased, with what bias that does occur (slight winter overestimation) being common with respect to $AmmSO_4$ and $AmmNO_3$, and given that CAMx incorporates state-of-the-science sulfate and nitrate formation chemistry algorithms, the CAMx 2008 12/4 km CGS modeling platform should provide an accurate and reliable database for evaluating the interim operating strategy.

Figure 6: Predicted and Observed Annual and Seasonal Average Total Extinction (Mm^{-1})



5.5 CAMx CGS Better-than-BART Modeling

CAMx was applied for CGS Baseline emissions, CGS BART Control Strategy emissions, and emissions for the four seasonal curtailment options under the interim operating strategy of the CGS BART Alternative using the 12/4 km modeling domain, 2008 meteorological conditions and 2020 future case emissions for all other sources. The CAMx Particulate Source Apportionment Technology (PSAT) Probing Tool was used to separately track contributions of particulate matter and reactive gaseous nitrogen (RGN) concentrations (which include NO_2) due to SO_2, NOx, and PM emissions from CGS units.

5.5.1 Particulate Source Apportionment Tool (PSAT) and Its Configuration

The PSAT source apportionment tool uses reactive tracers (also called tagged species) that run in parallel to the host model to determine the contributions to PM from user-selected Source Groups. For CGS CAMx source apportionment modeling, the Source Groups consist of the two CGS units and all other natural and anthropogenic emissions.

The CAMx PSAT particulate source apportionment method has five different families of tracers that can be invoked separately or together to track source apportionment for the following particulate species: (i) Sulfate (SO_4); (ii) Nitrate and Ammonium (NO_3 and NH_4); (iii) Primary PM; (iv) Secondary Organic Aerosol (SOA); and (v) Mercury. Because PSAT needs to track the PM source apportionment from the PM precursor emissions to the PM species, the number of tracers needed to track a Source Group's source apportionment depends on the complexity of the chemistry and number of PM and intermediate species involved. For CGS CAMx source apportionment modeling, the PSAT SO_4, NO_3/NH_4, and Primary PM families of source apportionment tracers were used. The PSAT SOA family of source apportionment was not used because CGS EGU units do not emit any VOC species that are SOA precursors.

Emissions of SO_2, NOx, and primary PM from CGS units were tagged for treatment by the PSAT tool for each of the emission scenarios. For CGS baseline and CGS BART Control Strategy simulations, CAMx was run with 3 source groups: CGS unit 1; CGS unit 2; and all other emissions sources. For the interim operating strategy IS1 simulation, CAMx was run with 16 source groups. One source group represented non-CGS emissions, another represented CGS unit 2 emissions and the other 14 source groups represented the CGS unit 1 emissions for different time periods as follows:

- January and February combined (1 group);
- March and April ~ 15 day periods each (4 groups);
- May, June, July, August as individual months (4 groups);
- September and October ~ 15 day periods each (4 groups) and
- November and December combined (1 group).

For the other three interim operating strategy simulations (IS2, IS3, and IS4), CAMx was run with 18 source groups. One source group represented non-CGS emissions, another represented CGS unit 2 emissions and the other 16 source groups represented the CGS unit 1 emissions for different time periods as follows:

- January 1 to March 10 (~ 10 day periods) (7 groups);
- March 11 to June 30 (1 groups);
- July 1 to October 20 (1 groups); and
- October 21 – December 31 (~ 10 day periods (7 groups).

Performing the CAMx simulations for the four interim operating strategies with CGS unit 1 tagged separately for different periods enables evaluation of the CGS alternative visibility impacts using different CGS unit 1 shutdown assumptions without having to rerun CAMx.

5.5.2 Post-Processing CGS CAMx Modeling Results

Visibility impacts attributed to CGS for baseline, BART and the BART Alternative operating strategies were calculated at all Class I areas within the modeling domain.

The method to determine the visibility impacts based on the CAMx outputs was similar to that of CALPUFF. Basically, the CAMx PSAT tool quantified the incremental concentration contributions of PM species due to CGS emissions and then the IMPROVE extinction equation was applied to calculate the visibility impacts, following the procedures as discussed in the FLAG Phase I 2010 report.[29] Please refer to the FLAG 2010 report for detailed descriptions of the IMPROVE extinction equation as well as FLAG-recommended procedures for determining visibility impacts in Class I areas. The change in light extinction due to CGS emissions was calculated for each day for each grid cell that intersects a Class I area within 300 km of CGS. The average visibility impact over a 3x3 grid cell array centered at (i) the IMPROVE monitor associated with the Class I area or (ii) the centroid of the Class I area (if there was no associated IMPROVE site) was used to represent the visibility impact at that Class I area.

The IMPROVE equation species include:

- Sulfate (SO_4);
- Nitrate (NO_3);
- Elemental Carbon (EC);
- Organic Mass (OM);
- Fine Soil (FS);
- Coarse Mass (CM);
- Sea Salt; and
- NO_2.

To utilize the IMPROVE equation, the CAMx PSAT source apportionment runs provide incremental concentration contributions due to CGS emissions for the following species:

- Sulfate (SO_4);
- Nitrate (NO_3);
- Elemental Carbon (EC);
- Primary Organic Aerosol (POA, used for Organic Mass);
- Fine Crustal (FCRS) and Other (FPRM) primary $PM_{2.5}$ emissions (used for Fine Soil);
- Coarse Crustal (CCRS) and Other (CPRM) coarse ($PM_{2.5}$-$_{10}$) PM species (used for Coarse Mass); and
- Reactive Gaseous Nitrogen (RGN, used for NO_2).

CGS incremental sulfate and nitrate concentrations were assumed to be completely neutralized by ammonium.

The PSAT source apportionment algorithm does not separately track NO_2 concentrations but instead tracks total reactive nitrogen (RGN) that consists mainly of NO, NO_2 and other smaller mass reactive nitrogen species (e.g., N_2O_5, NO_3 radical, etc.). CGS incremental concentrations of the PSAT RGN species were used to represent light extinction due to NO_2. This may overstate CGS visibility impairment associated with NO_2. In

[29] http://www.nature.nps.gov/air/Pubs/pdf/flag/FLAG_2010.pdf

terms of the Better-than-BART test, this assumption is conservative in that it overstates the visibility reductions in the EPA BART control strategy relative to the visibility reductions in the BART Alternative since the EPA BART control strategy has more NOx emission reductions. In any event, the vast majority of visibility impairment attributed to emissions from CGS is due to ammonium sulfate. Ammonium nitrate and the treatment of NO_2 in the visibility calculations have only a minimal impact.

In addition, the PSAT tool did not track the sea salt concentrations (sodium and particulate chloride) in the CGS visibility assessment because sea salt concentrations are negligible in the inland area and there are no sodium or chloride emissions associated with the CGS units.

5.5.3 CGS Visibility Impacts

The CAMx results were processed for the observed best (clearest) 20 percent (B20%) days, worst (haziest) 20 percent (W20%) days, and all days of the modeled year (2008) for each Class I area. These 20% clearest and 20% haziest days were determined based on the observational data from the IMPROVE sites in 2008.[30]

Table 11 presents CGS visibility impacts from CGS Baseline emissions averaged over the B20% days, W20% days, and all days in 2008. Table 12 reports CGS visibility impacts from CGS BART Control Strategy emissions averaged over the B20% days, W20% days, and all days. Table 13, Table 14, Table 15, and Table 16 report CGS visibility impacts from the four seasonal curtailment options under the interim operating strategy pursuant to the BART Alternative (IS1, IS2, IS3, and IS4 respectively) averaged over the B20% days, W20% days, and all days in 2008.

For B20% days, CGS Baseline impacts range from 0.0006 dv to 0.0224 dv over all class I areas. The corresponding CGS BART Control Strategy impacts range from 0.0004 dv to 0.0184 dv and the impacts from the various seasonal curtailment options range from 0.0004 dv to 0.0166 dv. For W20% days, CGS Baseline impacts range from 0.0013 dv to 0.0172 dv over all class I areas. The corresponding CGS BART Control Strategy impacts range from 0.0012 dv to 0.0138 dv, and the impacts from the various seasonal curtailment options range from 0.0010 dv to 0.0155 dv. For the annual average, CGS Baseline impacts range from 0.0023 dv to 0.0406 dv over all class I areas. The corresponding CGS BART Control Strategy impacts range from 0.0019 dv to 0.0346 dv, and the impacts from the various seasonal curtailment options range from 0.0017 dv to 0.0338 dv. For any of the emissions scenarios (Baseline, BART Control Strategy, and interim operating strategy), the annual highest predicted visibility impacts occur at Petrified Forest National Park, the nearest class I area to CGS.

As shown in Tables 11 to 16, the modeled visibility impacts using CAMx are much lower in magnitude than typical modeled visibility values in BART analyses with CALPUFF. There are fundamental differences in modeling visibility impacts between CAMx and CALPUFF, which makes CAMx and CALPUFF results not directly comparable. First, under a typical BART analysis with CALPUFF, the ammonia and other pre-cursors are more fully available to react with the facility's emissions and generate haze-causing pollutants. Comparatively, CAMx is a full photochemical model with all the other sources quantified and added to the modeling, such that emissions from other sources react with available pre-cursors such as ammonia. This limits the amount of ammonia (and other pre-cursors) that are available to react with the CGS emissions that are being assessed. Second, a typical BART analysis with CALPUFF is focused on the highest impact (maximum or 98th percentile) from a facility regardless of the monitored values at the Class I area, whereas the CAMx analysis is focused on the 20% best and 20% worst monitored days regardless of whether the facility was having an impact during those days. Finally, CALPUFF uses a rather simple chemistry mechanism while CAMx uses a technically sophisticated chemistry mechanism. It is unclear how this last factor ultimately

[30] http://vista.cira.colostate.edu/improve/Data/data.htm

impacts the differences in model estimates between these two models, as the two chemistry approaches are vastly different.

Table 11: CGS Visibility Conditions with Baseline Emissions

	Delta Dv		
	Average Best 20% Days**	Average Worst 20% Days**	Annual Average
Class I Area	**Absolute (dv)**	**Absolute (dv)**	**Absolute (dv)**
Bandalier NM	0.0063	0.0170	0.0096
Bosque	0.0063	0.0049	0.0104
Chiricahua NM	0.0081	0.0015	0.0040
Chiricahua Wild	0.0092	0.0015	0.0041
Galiuro Wild	0.0051	0.0016	0.0031
Gila Wild	0.0151	0.0030	0.0140
Grand Canyon NP	0.0006	0.0030	0.0044
Mazatzal Wild	0.0167	0.0039	0.0053
Mesa Verde NP	0.0013	0.0063	0.0071
Mount Baldy Wild	0.0209	0.0172	0.0226
Petrified Forest NP	0.0087	0.0147	0.0406
Pine Mountain Wild	0.0133	0.0025	0.0052
Saguro NP	0.0041	0.0013	0.0023
San Pedro Parks Wild	0.0080	0.0134	0.0126
Sierra Ancha Wild			0.0087
Superstition Wild	0.0224	0.0027	0.0060
Sycamore Canyon Wild	0.0058	0.0037	0.0050
Maximum	**0.0224**	**0.0172**	**0.0406**
Cumulative (sum)	**0.1521**	**0.0982**	**0.1649**
Average	**0.0095**	**0.0061**	**0.0097**
Minimum	**0.0006**	**0.0013**	**0.0023**

*** Best and Worst Days of Monitored visibility, from MATS (IMPROVE) database, some sites/years lack data.*

Table 12: CGS Visibility Conditions with BART Control Strategy Emissions (2016 EPA BART Reconsideration for NOx and 2012 AZ BART for SO_2 and PM)

	Delta Dv		
	Average Best 20% Days**	Average Worst 20% Days**	Annual Average
Class I Area	**Absolute (dv)**	**Absolute (dv)**	**Absolute (dv)**
Bandalier NM	0.0050	0.0138	0.0077
Bosque	0.0052	0.0040	0.0085
Chiricahua NM	0.0060	0.0014	0.0033
Chiricahua Wild	0.0069	0.0014	0.0034
Galiuro Wild	0.0041	0.0014	0.0025
Gila Wild	0.0121	0.0026	0.0113
Grand Canyon NP	0.0004	0.0024	0.0039
Mazatzal Wild	0.0127	0.0033	0.0043
Mesa Verde NP	0.0011	0.0055	0.0064
Mount Baldy Wild	0.0171	0.0137	0.0175
Petrified Forest NP	0.0081	0.0117	0.0346
Pine Mountain Wild	0.0103	0.0022	0.0045
Saguro NP	0.0034	0.0012	0.0019
San Pedro Parks Wild	0.0061	0.0107	0.0099
Sierra Ancha Wild			0.0075
Superstition Wild	0.0184	0.0022	0.0051
Sycamore Canyon Wild	0.0043	0.0032	0.0045
Maximum	**0.0184**	**0.0138**	**0.0346**
Cumulative (sum)	**0.1213**	**0.0806**	**0.1368**
Average	**0.0076**	**0.0050**	**0.0080**
Minimum	**0.0004**	**0.0012**	**0.0019**

*** Best and Worst Days of Monitored visibility, from MATS (IMPROVE) database, some sites/years lack data.*

Table 13: CGS Visibility Conditions with IS1 Seasonal Curtailment Option

	Delta Dv		
	Average Best 20% Days**	**Average Worst 20% Days****	**Annual Average**
Class I Area	**Absolute (dv)**	**Absolute (dv)**	**Absolute (dv)**
Bandalier NM	0.0039	0.0118	0.0074
Bosque	0.0040	0.0039	0.0083
Chiricahua NM	0.0051	0.0015	0.0032
Chiricahua Wild	0.0057	0.0015	0.0033
Galiuro Wild	0.0035	0.0016	0.0024
Gila Wild	0.0092	0.0029	0.0109
Grand Canyon NP	0.0004	0.0029	0.0033
Mazatzal Wild	0.0105	0.0038	0.0039
Mesa Verde NP	0.0008	0.0050	0.0054
Mount Baldy Wild	0.0128	0.0145	0.0174
Petrified Forest NP	0.0050	0.0124	0.0316
Pine Mountain Wild	0.0083	0.0024	0.0038
Saguro NP	0.0033	0.0011	0.0017
San Pedro Parks Wild	0.0048	0.0094	0.0096
Sierra Ancha Wild			0.0062
Superstition Wild	0.0137	0.0022	0.0041
Sycamore Canyon Wild	0.0037	0.0032	0.0037
Maximum	**0.0137**	**0.0145**	**0.0316**
Cumulative (sum)	**0.0949**	**0.0801**	**0.1260**
Average	**0.0059**	**0.0050**	**0.0074**
Minimum	**0.0004**	**0.0011**	**0.0017**

***Best and Worst Days of Monitored visibility, from MATS (IMPROVE) database, some sites/years lack data.*

Table 14: CGS Visibility Conditions with IS2 Seasonal Curtailment Option

	Delta Dv		
	Average Best 20% Days**	**Average Worst 20% Days****	**Annual Average**
Class I Area	**Absolute (dv)**	**Absolute (dv)**	**Absolute (dv)**
Bandalier NM	0.0042	0.0127	0.0078
Bosque	0.0051	0.0038	0.0089
Chiricahua NM	0.0071	0.0014	0.0034
Chiricahua Wild	0.0080	0.0014	0.0036
Galiuro Wild	0.0038	0.0015	0.0026
Gila Wild	0.0112	0.0027	0.0118
Grand Canyon NP	0.0006	0.0027	0.0035
Mazatzal Wild	0.0136	0.0036	0.0044
Mesa Verde NP	0.0010	0.0047	0.0053
Mount Baldy Wild	0.0137	0.0139	0.0187
Petrified Forest NP	0.0066	0.0120	0.0328
Pine Mountain Wild	0.0110	0.0023	0.0044
Saguro NP	0.0037	0.0011	0.0019
San Pedro Parks Wild	0.0057	0.0094	0.0101
Sierra Ancha Wild			0.0072
Superstition Wild	0.0166	0.0022	0.0048
Sycamore Canyon Wild	0.0056	0.0030	0.0043
Maximum	**0.0166**	**0.0139**	**0.0328**
Cumulative (sum)	**0.1175**	**0.0787**	**0.1356**
Average	**0.0073**	**0.0049**	**0.0080**
Minimum	**0.0006**	**0.0011**	**0.0019**

*** Best and Worst Days of Monitored visibility, from MATS (IMPROVE) database, some sites/years lack data.*

Table 15: CGS Visibility Conditions with IS3 Seasonal Curtailment Option

	Delta Dv		
	Average Best 20% Days**	**Average Worst 20% Days****	**Annual Average**
Class I Area	**Absolute (dv)**	**Absolute (dv)**	**Absolute (dv)**
Bandalier NM	0.0042	0.0120	0.0071
Bosque	0.0047	0.0034	0.0081
Chiricahua NM	0.0067	0.0011	0.0031
Chiricahua Wild	0.0075	0.0011	0.0032
Galiuro Wild	0.0035	0.0012	0.0023
Gila Wild	0.0108	0.0023	0.0110
Grand Canyon NP	0.0005	0.0023	0.0032
Mazatzal Wild	0.0142	0.0031	0.0042
Mesa Verde NP	0.0009	0.0047	0.0049
Mount Baldy Wild	0.0141	0.0148	0.0183
Petrified Forest NP	0.0066	0.0113	0.0326
Pine Mountain Wild	0.0112	0.0018	0.0041
Saguro NP	0.0031	0.0010	0.0017
San Pedro Parks Wild	0.0058	0.0103	0.0094
Sierra Ancha Wild			0.0069
Superstition Wild	0.0157	0.0023	0.0045
Sycamore Canyon Wild	0.0050	0.0028	0.0038
Maximum	**0.0157**	**0.0148**	**0.0326**
Cumulative (sum)	**0.1146**	**0.0757**	**0.1287**
Average	**0.0072**	**0.0047**	**0.0076**
Minimum	**0.0005**	**0.0010**	**0.0017**

*** Best and Worst Days of Monitored visibility, from MATS (IMPROVE) database, some sites/years lack data.*

Table 16: CGS Visibility Conditions with IS4 Seasonal Curtailment Option

	Delta Dv		
	Average Best 20% Days**	**Average Worst 20% Days****	**Annual Average**
Class I Area	**Absolute (dv)**	**Absolute (dv)**	**Absolute (dv)**
Bandalier NM	0.0042	0.0127	0.0076
Bosque	0.0049	0.0036	0.0086
Chiricahua NM	0.0069	0.0013	0.0033
Chiricahua Wild	0.0078	0.0013	0.0034
Galiuro Wild	0.0037	0.0013	0.0025
Gila Wild	0.0111	0.0025	0.0115
Grand Canyon NP	0.0006	0.0025	0.0035
Mazatzal Wild	0.0140	0.0033	0.0044
Mesa Verde NP	0.0010	0.0052	0.0054
Mount Baldy Wild	0.0139	0.0155	0.0191
Petrified Forest NP	0.0068	0.0116	0.0338
Pine Mountain Wild	0.0110	0.0020	0.0044
Saguro NP	0.0034	0.0011	0.0018
San Pedro Parks Wild	0.0059	0.0109	0.0099
Sierra Ancha Wild			0.0073
Superstition Wild	0.0164	0.0024	0.0048
Sycamore Canyon Wild	0.0055	0.0031	0.0041
Maximum	**0.0164**	**0.0155**	**0.0338**
Cumulative (sum)	**0.1169**	**0.0804**	**0.1356**
Average	**0.0073**	**0.0050**	**0.0080**
Minimum	**0.0006**	**0.0011**	**0.0018**

*** Best and Worst Days of Monitored visibility, from MATS (IMPROVE) database, some sites/years lack data.*

5.6 Better-than-BART Test

5.6.1 Evaluation Criteria

The requirements for demonstrating an alternative control strategy is better than a BART control strategy are outlined in EPA's BART rules.[31] The rules describe a two-pronged test that can be used to demonstrate that the alternative control strategy is better than the BART control strategy (i.e., "Better-than-BART" or "BTB"):

"The modeling would demonstrate 'greater reasonable progress' if both of the following two criteria are met:

- *(i) Visibility does not decline in any Class I area, and*

- *(ii) There is an overall improvement in visibility, determined by comparing the average differences between BART and the alternative over all affected Class I areas."*

To pass Prong 1 of the Better-than-BART test, the alternative control strategy must not reduce visibility in any Class I area. For any Class I area, the visibility impacts based on the Baseline scenario may be used to represent current visibility conditions. Therefore, if the alternative control strategy results in visibility that is better than the visibility attributed to the Baseline scenario at each affected Class I area for both the B20% and W20% days, then the alternative control strategy satisfies Prong 1 of the Better-than-BART test.

For Prong 2 of the Better-than-BART test, the alternative control strategy must achieve an overall improvement in visibility averaged across all affected Class I areas compared to visibility in those area under the BART control strategy. To facilitate the comparison between the BART control strategy and the alternative control strategy, the difference in visibility for the two strategies is calculated. If the alternative control strategy shows better visibility impacts than the BART control strategy when averaged over all Class I areas for both the B20% and W20% days in the modeled year (even if the differences are marginal), the alternative control strategy passes Prong 2 of the Better-than-BART test.

5.6.2 Better-than-BART Test - Prong 1

Table 17 displays the results of Prong 1 of the Better-than-BART test for the four seasonal curtailment options under the interim operating strategy in the BART Alternative. This prong examines the differences in deciviews of visibility conditions (delta dv) between the Baseline and the BART Alternative (Baseline – BART Alternative). As shown in Table 17, all differences are positive, which indicates that the BART Alternative exhibits visibility improvements at each affected Class I area during the interim operating strategy. Therefore, the BART Alternative shows that "visibility does not decline in any Class I area" and hence the BART Alternative passes Prong 1 of the Better-than-BART test.

5.6.3 Better-than-BART Test - Prong 2

Table 18 displays the differences in visibility (delta dv) between the BART Control Strategy and the BART Alternative (BART- BART Alternative) for each affected Class I area for each time averaging method (B20%

[31] CFR Part 51 Regional Haze Regulations and Guidelines for Best Available Retrofit Determinations. http://www.gpo.gov/fdsys/pkg/FR- 2005-07-06/pdf/05-12526.pdf

days, W20% days, and annual) during the interim operating strategy. Table 19 provides the average differences and percentage differences over all affected Class I areas for the B20% days, the W20% days, and all days. As Table 19 indicates, each of the four seasonal curtailment options in the interim operating strategy for each averaging method produces more visibility benefits than the BART Control Strategy. The BART Alternative thus provides an "overall improvement in visibility" compared to the BART control strategy and satisfies Prong 2 of the Better-than-BART test.

Table 17: Prong 1 Test - Delta Dv Differences of Visibility Conditions between Baseline and Interim Operating Strategy under BART Alternative (Baseline-BART Alternative)

Class I Area	Average Best 20% Days				Average Worst 20% Days				Annual Average			
	IS1	IS2	IS3	IS4	IS1	IS2	IS3	IS4	IS1	IS2	IS3	IS4
Bandalier NM	0.0023	0.0021	0.0021	0.0020	0.0052	0.0043	0.0050	0.0043	0.0022	0.0017	0.0024	0.0019
Bosque	0.0023	0.0012	0.0016	0.0015	0.0010	0.0011	0.0015	0.0013	0.0021	0.0015	0.0023	0.0018
Chiricahua NM	0.0030	0.0010	0.0014	0.0012	0.000002	0.0001	0.0004	0.0003	0.0008	0.0005	0.0009	0.0007
Chiricahua Wild	0.0034	0.0011	0.0016	0.0014	0.000002	0.0001	0.0004	0.0003	0.0008	0.0006	0.0009	0.0007
Galiuro Wild	0.0015	0.0012	0.0016	0.0013	0.00003	0.0001	0.0004	0.0003	0.0007	0.0004	0.0007	0.0006
Gila Wild	0.0060	0.0040	0.0044	0.0040	0.00004	0.0002	0.0007	0.0005	0.0032	0.0023	0.0030	0.0025
Grand Canyon NP	0.0002	0.00002	0.0001	0.00004	0.0001	0.0003	0.0006	0.0004	0.0011	0.0009	0.0012	0.0009
Mazatzal Wild	0.0062	0.0032	0.0025	0.0028	0.0001	0.0003	0.0008	0.0006	0.0014	0.0008	0.0010	0.0008
Mesa Verde NP	0.0006	0.0003	0.0004	0.0004	0.0013	0.0015	0.0015	0.0011	0.0017	0.0018	0.0022	0.0017
Mount Baldy Wild	0.0081	0.0072	0.0069	0.0070	0.0027	0.0033	0.0024	0.0017	0.0052	0.0039	0.0042	0.0035
Petrified Forest NP	0.0037	0.0021	0.0021	0.0020	0.0024	0.0027	0.0034	0.0031	0.0090	0.0078	0.0080	0.0068
Pine Mountain Wild	0.0050	0.0023	0.0021	0.0023	0.0001	0.0002	0.0007	0.0004	0.0014	0.0008	0.0011	0.0009
Saguro NP	0.0007	0.0004	0.0010	0.0007	0.0003	0.0002	0.0003	0.0002	0.0005	0.0004	0.0006	0.0004
San Pedro Parks Wild	0.0033	0.0023	0.0022	0.0021	0.0040	0.0040	0.0031	0.0025	0.0030	0.0024	0.0032	0.0026
Sierra Ancha Wild									0.0025	0.0015	0.0017	0.0014
Superstition Wild	0.0087	0.0058	0.0067	0.0060	0.0005	0.0005	0.0004	0.0003	0.0019	0.0012	0.0015	0.0013
Sycamore Canyon Wild	0.0021	0.0003	0.0008	0.0004	0.0005	0.0006	0.0008	0.0006	0.0013	0.0007	0.0013	0.0009

Table 18: Prong 2 Test - Delta Dv Differences of Visibility Conditions between BART Control Strategy and Interim Operating Strategy under BART Alternative (BART-BART Alternative)

Class I Area	Average Best 20% Days				Average Worst 20% Days				Annual Average			
	IS1	IS2	IS3	IS4	IS1	IS2	IS3	IS4	IS1	IS2	IS3	IS4
Bandalier NM	0.0011	0.0009	0.0009	0.0008	0.0020	0.0011	0.0018	0.0011	0.0003	-0.0001	0.0005	0.0001
Bosque	0.0012	0.0001	0.0005	0.0003	0.0001	0.0001	0.0006	0.0004	0.0003	-0.0003	0.0004	-0.0001
Chiricahua NM	0.0009	-0.0011	-0.0007	-0.0009	-0.0002	0.0000	0.0002	0.0001	0.0000	-0.0002	0.0001	-0.0001
Chiricahua Wild	0.0012	-0.0011	-0.0006	-0.0009	-0.0002	0.0000	0.0003	0.0001	0.0001	-0.0002	0.0002	-0.0001
Galiuro Wild	0.0006	0.0003	0.0006	0.0004	-0.0002	-0.0001	0.0002	0.0000	0.0001	-0.0001	0.0002	0.0000
Gila Wild	0.0029	0.0009	0.0013	0.0009	-0.0003	-0.0001	0.0003	0.0001	0.0004	-0.0004	0.0003	-0.0002
Grand Canyon NP	0.0001	-0.0001	-0.0001	-0.0001	-0.0005	-0.0003	0.0000	-0.0001	0.0005	0.0003	0.0007	0.0004
Mazatzal Wild	0.0022	-0.0009	-0.0015	-0.0012	-0.0005	-0.0004	0.0002	-0.0001	0.0005	-0.0001	0.0001	-0.0001
Mesa Verde NP	0.0004	0.0001	0.0002	0.0002	0.0006	0.0008	0.0008	0.0003	0.0011	0.0011	0.0016	0.0010
Mount Baldy Wild	0.0043	0.0034	0.0030	0.0032	-0.0008	-0.0003	-0.0012	-0.0018	0.0002	-0.0012	-0.0008	-0.0016
Petrified Forest NP	0.0031	0.0015	0.0015	0.0013	-0.0007	-0.0004	0.0004	0.0000	0.0030	0.0018	0.0020	0.0008
Pine Mountain Wild	0.0020	-0.0007	-0.0009	-0.0007	-0.0001	0.0000	0.0004	0.0002	0.0007	0.0001	0.0003	0.0001
Saguro NP	0.0000	-0.0003	0.0003	0.0000	0.0001	0.0000	0.0002	0.0001	0.0002	0.0000	0.0003	0.0001
San Pedro Parks Wild	0.0013	0.0003	0.0002	0.0002	0.0013	0.0013	0.0004	-0.0002	0.0003	-0.0003	0.0005	-0.0001
Sierra Ancha Wild									0.0013	0.0003	0.0005	0.0002
Superstition Wild	0.0047	0.0018	0.0027	0.0020	-0.0001	-0.0001	-0.0001	-0.0003	0.0009	0.0003	0.0006	0.0003
Sycamore Canyon Wild	0.0006	-0.0013	-0.0008	-0.0012	0.0000	0.0001	0.0003	0.0001	0.0008	0.0002	0.0007	0.0004
Average	**0.0017**	**0.0002**	**0.0004**	**0.0003**	**0.00003**	**0.0001**	**0.0003**	**0.00001**	**0.0006**	**0.0001**	**0.0005**	**0.0001**

Table 19: Summary of Prong 2 Test Results (BART – BART Alternative)

Strategy	Average Delta Dv of Class I Areas					
	Average Best 20% Days		Average Worst 20% Days		Annual Average	
	Absolute (dv)	Relative	Absolute (dv)	Relative	Absolute (dv)	Relative
IS1	0.0017	21.8%	0.00003	0.6%	0.0006	7.9%
IS2	0.0002	2.5%	0.0001	1.3%	0.0001	1.0%
IS3	0.0004	3.6%	0.0003	9.1%	0.0005	7.9%
IS4	0.0003	0.3%	0.00001	2.0%	0.0001	2.1%

5.7 Supplemental Analysis of IMPROVE Monitoring Data

The relative contributions of NOx, SO_2, and PM emissions reductions to visibility improvement is an important factor for determining whether the BART Alternative is better than BART. The interim operating strategy tends to reduce SO_2 emissions to a somewhat greater extent than it does NOx emissions in comparison to the BART control strategy. Therefore, it is relevant to investigate the relative contributions of NOx and SO_2 emissions to visibility impairment based on IMPROVE monitoring measurements.

ADEQ discussed the relative contributions of NOx and SO_2 emissions to visibility impairment in the BART alternative Technical Support Document for the Apache Generating Station.[32] Specifically, ADEQ noted in the Apache BART report that the SO_2-attributed visibility extinction is generally more than three times the NOx-attributed visibility extinction. For the CGS case, ADEQ further reviewed ammonium sulfate and ammonium nitrate data for all CGS-affected Class I areas over 2004-2014.[33] Figure 7 compares visibility extinction due to SO_2-attibuted ammonium sulfate and visibility extinction due to NOx-attributed ammonium nitrate averaged over 2004-2014 for each CGS-affected Class I area. The ratio of the SO_2-attributed visibility extinction to NOx-attributed visibility extinction ranges from 2.2 to 6.3, from 2.6 to 8.7, and from 3.0 to 7.8 for the 20% best days, the 20% worst days, and all days, respectively. The ratios averaged over all Class I areas are 3.7, 4.2 and 4.2 for the 20% best days, the 20% worst days, and all days, respectively. As one of the most significant contributors to aerosol light extinction, ammonium sulfate typically accounts for 15-30 percent of total light extinction for CGS-affected Class I areas. Ammonium nitrate plays a lesser role in aerosol light extinction, typically accounting for only 4-8 percent of total light extinction for CGS-affected Class I areas.

In addition, ADEQ reviewed the trends of SO_2-attributed visibility extinction and NOx-attributed visibility extinction at Petrified Forest NP during 2004-2014 (Figure 8). As the nearest Class I area to CGS, Petrified Forest NP has the highest visibility impacts from CGS among all CGS affected Class I areas based on the CAMx modeling. As illustrated in Figure 8, the SO_2-attributed visibility extinction at Petrified Forest NP has improved (i.e., has declined) for the 20% best days, 20% worst days, and all days during 2004-2014. Comparatively, the NOx-attributed visibility extinction appears not to have declined, especially for the 20% worst days. To provide insights about the different trends of NOx- or SO_2-attributed visibility extinction,

[32] "AEPCO Apache Generating Station BART Alternative Control Review Technical Support Document," ADEQ, April 15, 2014.

[33] http://vista.cira.colostate.edu/improve/Data/IMPROVE/summary_data.htm

ADEQ examined the annual emissions of SO_2 and NOx from CGS as well as from the Arizona Public Service Company's Cholla facility (Cholla) during 2004-2014.[34] CGS and Cholla are significant NOx and SO_2 stationary sources in the vicinity of the Petrified Forest NP. ADEQ's analysis attempted to address how the NOx- or SO_2-attributed visibility extinction data responded to the emission reductions of NOx and SO_2 at the two sources.

Figure 9 displays SO_2 and NOx annual emissions of CGS and Cholla versus concurrent sulfate and nitrate visibility extinctions during 2004-2014. It is evident from Figure 9 that there is a strong positive correlation between SO_2 emissions and sulfate visibility extinctions. Significant reductions of SO_2 emissions from both facilities have resulted in the decrease of sulfate visibility extinction during 2004-2014. On the contrary, nitrate visibility extinction appears to be independent of NOx emissions from CGS and Cholla. Although significant reductions of NOx emissions also occurred at both facilities during this period, the nitrate visibility extinctions did not appear to respond to an appreciable extent to the NOx emission reductions. ADEQ believes that the Petrified Forest NP area is ammonia-limited, where all of the sulfate is neutralized but the formation of ammonium nitrate is limited by a scarcity of remaining ammonium. Moreover, the formation of aerosol ammonium nitrate is in accordance with thermodynamic equilibrium. In the summer, even if additional ammonia is available in excess of what is needed to neutralize the sulfate, high temperatures may not be favorable for the formation of ammonium nitrate.

Based on the discussion above, ADEQ believes that SO_2 emissions reductions would produce greater visibility improvements than would NOx emissions reductions for CGS-affected Class I areas. The BART Alternative operating strategies would tend to realize a greater degree of visibility improvement than the BART control strategy due in part to significant reductions in SO_2 emissions under the interim operating strategy.

[34] https://ampd.epa.gov/ampd/

Figure 7: Ammonium Sulfate Visibility Extinction and Ammonium Nitrate Visibility Extinction (Mm^{-1}) averaged over 2004-2014 at all CGS-Affected Class I Areas

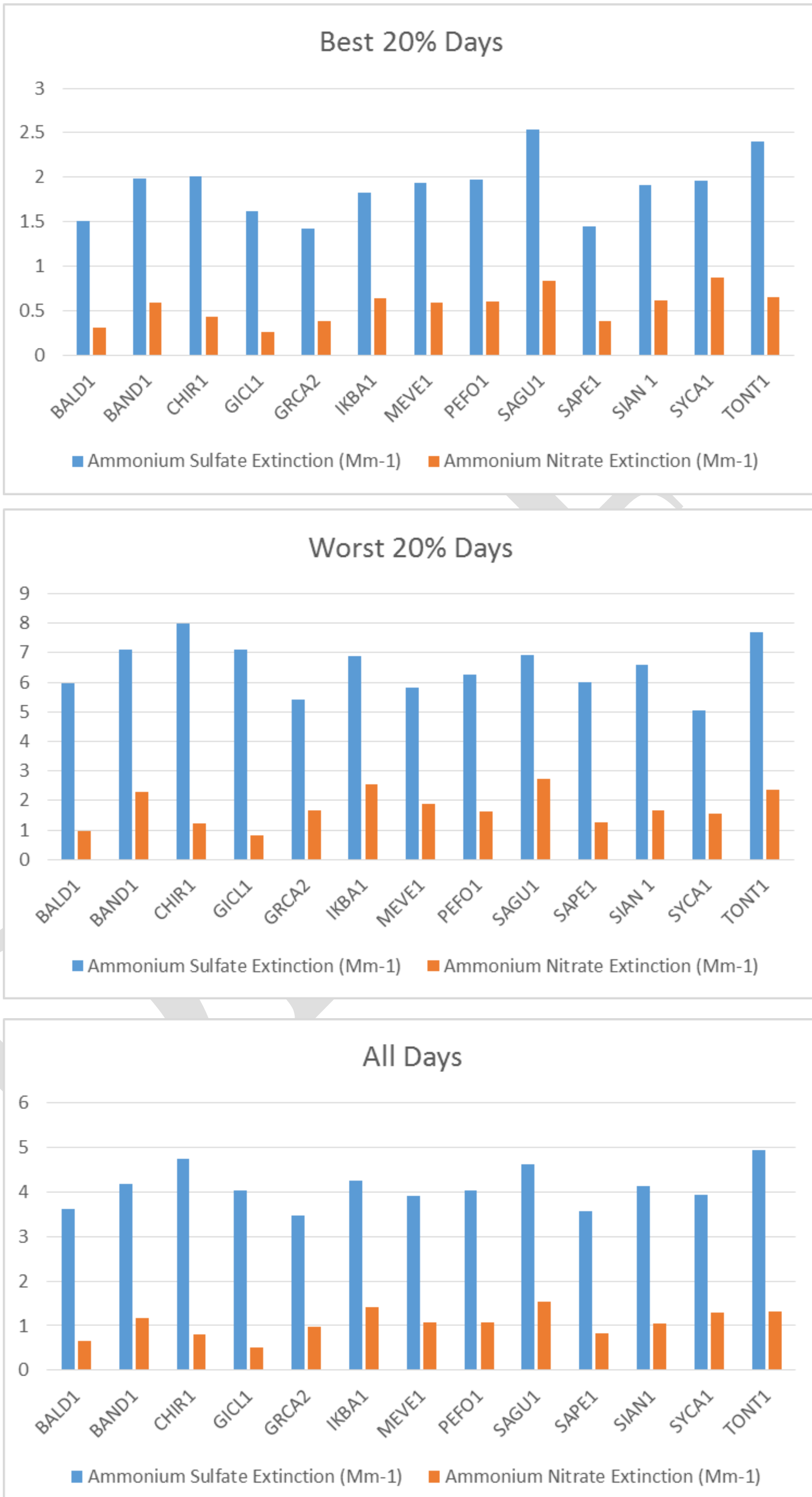


Figure 8: Trends of Ammonium Sulfate Visibility Extinction and Ammonium Nitrate Visibility Extinction (Mm^{-1}) at Petrified Forest NP during 2004-2014

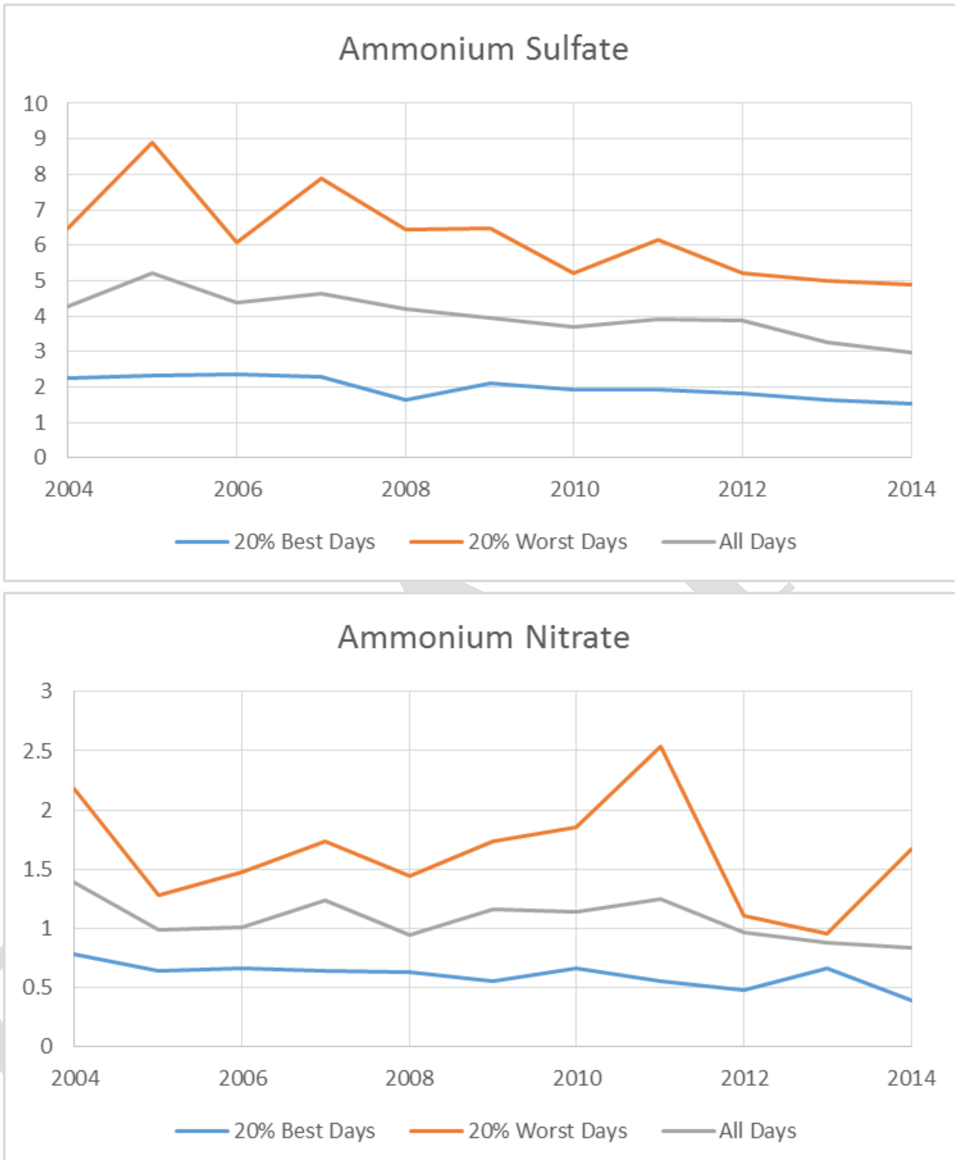
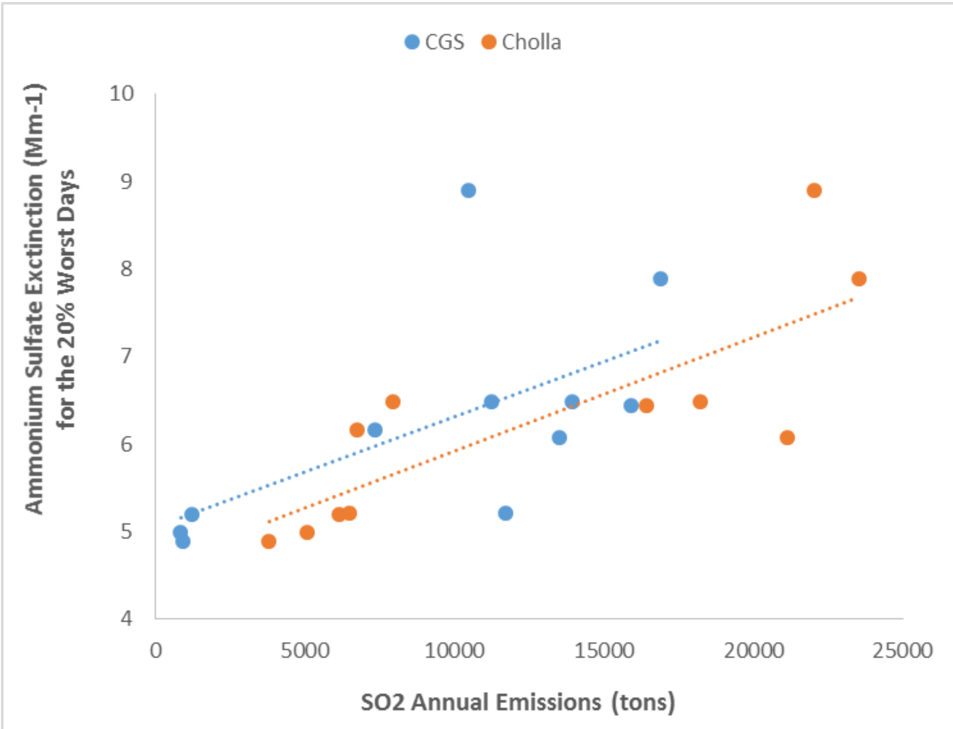
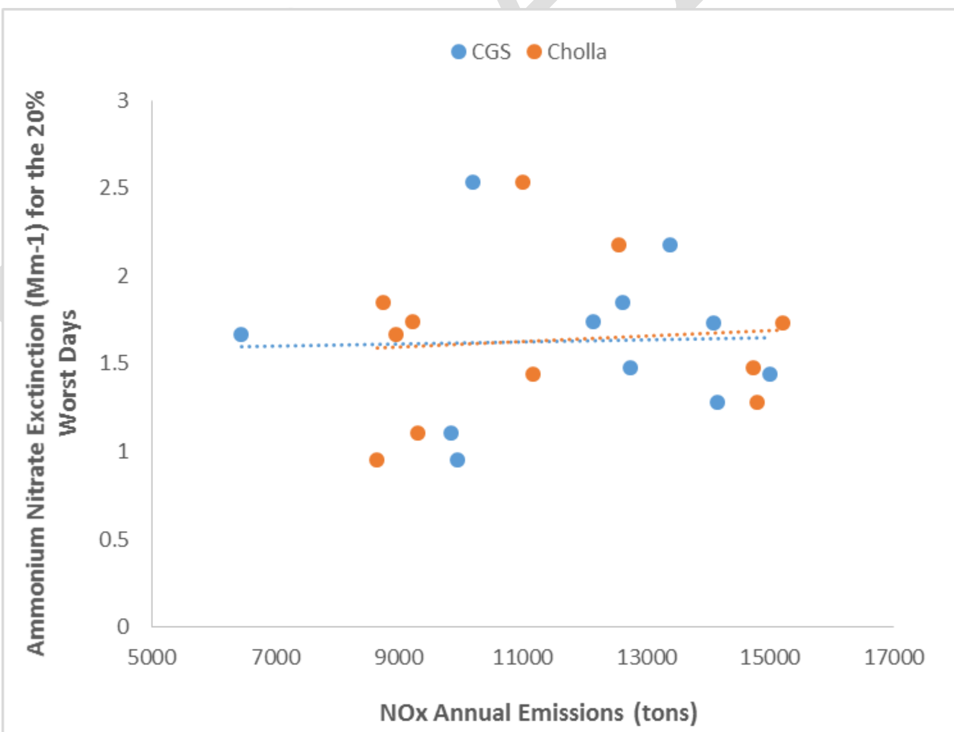


Figure 9: Annual SO_2 and NOx Emissions from Cholla and CGS vs. Ammonium Sulfate and Ammonium Nitrate Visibility Extinction (Mm^{-1}) at Petrified Forest NP during 2004-2014





5.8 Conclusion

The IMPROVE monitoring data collected from CGS-affected Class I areas indicate that ammonium sulfate plays a more significant role in visibility impairment than ammonium nitrate. Moreover, an analysis of Petrified Forest NP monitoring data indicates that SO_2 emissions reductions would produce greater visibility improvements than would emissions reductions of NOx. Because the BART Alternative interim operating strategy would result in a larger amount of SO_2 emissions reductions and smaller amount of lesser NOx emissions reductions than would the BART control strategy, the CAMx modeling analysis evaluates visibility benefits of both SO_2 emissions reductions and NOx emissions reductions. The CAMx modeling demonstrates that all four seasonal curtailment options under the interim operating strategy pass Prong 1 and Prong 2 of the Better-than-BART test. These model results are consistent with monitoring data analyses. Therefore, ADEQ concludes that the BART Alternative achieves greater reasonable progress than the BART control strategy.